OFFSITE DOSE CALCULATION MANUAL (ODCM)

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SECTION 1.0 AND 2.0

CONTROLS AND SURVEILLANCE REQUIREMENTS

INTRODUCTION

The Browns Ferry Nuclear Plant (BFN) Offsite Dose Calculation Manual (ODCM) is a supporting document of the BFN Technical Specifications. The ODCM is divided into two major parts. The first part of the ODCM contains: 1) Radioactive Effluent Controls specified by the BFN Technical Specifications; 2) Radiological Environmental Monitoring Controls required by the BFN Technical Specifications; 3) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports required by BFN Technical Specifications; and, 4) Administrative Controls for the ODCM requirements. The second part of the ODCM contains the methodologies used to: 1) calculate offsite doses resulting from radioactive gaseous and liquid effluents; 2) calculate gaseous and liquid effluent monitor Alarm/Trip setpoints; and, 3) conduct the Environmental Radiological Monitoring Program.

The BFN ODCM is maintained for use as a reference guide on accepted methodologies and calculations. Changes in the calculation methods or parameters will be incorporated into the ODCM in order to assure that the ODCM represents the present methodology in all applicable areas. Any licensee initiated ODCM changes will be implemented in accordance with BFN Technical Specifications.

Radioactive waste release levels to UNRESTRICTED AREAS should be kept "as low as reasonably achievable" and are not to exceed the concentration limits specified in 10 CFR Part 20, Appendix B, Table II. At the same time, the requirements specified in this manual permit the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided a dependable source of power under unusual operating conditions which may temporarily result in releases higher than design objectives but still within the concentration limits specified in 10 CFR Part 20. It is expected that by using this operational flexibility and exerting every effort to keep levels of radioactive releases "as low as reasonably achievable" in accordance with criteria established in 10 CFR Part 50, Appendix I, the annual releases will result in a small fraction of the annual average concentration limits specified in 10 CFR Part 20, Appendix B, Table II.

The surveillance/testing requirements given in this manual provide assurance that liquid and gaseous wastes are properly controlled and monitored during any release of radioactive materials in the liquid and gaseous effluents. These requirements provide the data for the licensee and the Commission to evaluate the station's performance relative to radioactive materials released to the environment. Reports on the quantities of radioactive materials released in effluents shall be furnished to the Commission on the basis of Section 5.0 of this manual. On the basis of such reports and any additional information the Commission may obtain from the licensee or others, the Commission may from time to time require the licensee to take such actions as the Commission deems appropriate.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.0 APPLICABILITY

CONTROLS

1.0.1 Compliance with the Controls contained in the succeeding sections is required during the conditions specified therein; except that upon failure to meet the Control, the associated ACTION requirements shall be met.

1.0.2 Noncompliance with a Control shall exist when the requirements of the Control and associated ACTION requirements are not met within the specified time intervals. If the Control is restored prior to the expiration of the specified intervals, completion of the ACTION requirements is not required.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.0 APPLICABILITY

SURVEILLANCE REQUIREMENTS

2.0.1 Surveillance Requirements shall be met during the conditions specified for individual Controls unless otherwise stated in the individual Surveillance Requirement.

2.0.2 Each Surveillance Requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance interval.

2.0.3 Performance of a Surveillance Requirement within the specified time interval shall constitute compliance and OPERABILITY requirements for a Control and associated action statements unless otherwise required by these Controls. Surveillance Requirements do not have to be performed on inoperable equipment.

Table 1.1-1 (Page 1 of 2)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument*	Minimum Channels OPERABLE	Applicability	Action
1. Liquid Radwaste Effluent Monitor (RM-90-130)	1	**	A/B
2. RHR Service Water Monitor (RM-90-133, -134)	1	***	C
3. Raw Cooling Water Monitor (RM-90-132)	1	**	D
4. Liquid Radwaste Effluent Flow Rate (77-60 loop)	1	**	E

* Alarm/trip setpoints will be calculated in accordance with the guidance given in Section 6.2.

** During Releases via this pathway.

*** During operation of an RHR loop and associated RHR service water system.

Table 1.1-1 (Page 2 of 2)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
TABLE NOTATION

ACTION A
During release of radioactive wastes from the radwaste processing system, the following shall be met:

(1) liquid waste activity and flowrate shall be continuously monitored and recorded during release and shall be set to alarm and automatically close the waste discharge valve before exceeding the limits specified in Control 1.2.1.1,
(2) if this cannot be met, two independent samples of the tank being discharged shall be analyzed in accordance with the sampling and analysis program specified in Table 2.2.1 and two qualified station personnel shall independently verify the release rate calculations and check valving before the discharge. Otherwise, suspend releases via this pathway.

ACTION B
With a radioactive liquid effluent monitoring channel alarm/trip setpoint less conservative than required by these requirements, suspend release via this pathway without delay, declare the channel inoperable, or adjust the alarm/trip setpoint to establish the conservatism required by these requirements.

ACTION C
During operation of an RHR loop and associated RHR service water system, the effluent from that unit's service water shall be continuously monitored. If an installed monitoring system is not available, a temporary monitor or grab samples taken every 4 hours and an analysis with at least an LLD[1] of 1E-7 μCi/ml (gross) or < applicable MPC ratio (γ isotopic) shall be used to monitor the effluent.

ACTION D
With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that a temporary monitor is installed or, at least once per 8 hours, grab samples are collected and analyzed for radioactivity with an LLD[1] of 1E-7 μCi/ml (gross) or < applicable MPC ratio (γ isotopic).

ACTION E
With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continued provided the flow rate is estimated at least once per 4 hours during actual releases. Pump curves may be used to estimate flow.

[1] See Table 2.2-1, Table Notation for the definition of LLD.

Table 2.1-1 (Page 1 of 2)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS

Instrument	INSTRUMENT CHECK	SOURCE CHECK	CHANNEL CALIBRATION	FUNCTIONAL TEST
a. Liquid Radwaste Effluent Monitor (RM-90-130)	D^4	M	R^5	Q^1
b. RHR Service Water Monitor (RM-90-133,-134)	D^4	M	R^5	Q^2
c. Raw Cooling Water Monitor (RM-90-132)	D^4	M	R^5	Q^2
d. Liquid Radwaste Effluent Flow Rate (77-60 loop)	D^4	N/A	R	Q^3

Table 2.1-1 (Page 2 of 2)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS
TABLE NOTATION

NOTE: Each requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the interval given.

1 The CHANNEL FUNCTIONAL TEST shall demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm/trip setpoint.
b. Instrument indicates an inoperative/downscale failure.
c. Instrument controls not set in operate mode.

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

a. Instrument indicates measured levels above the alarm/trip setpoint.
b. Instrument indicates an inoperative/downscale failure.
c. Instrument controls not set in operate mode.

3 This functional test shall consist of measuring rate of tank decrease over a period of time and comparing this value with flow rate instrument reading.

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

5 The CHANNEL CALIBRATION shall include the use of a known (traceable to the National Institute of Standards and Technology (NIST)) radioactive source(s) positioned in a reproducible geometry with respect to the sensor or using standards that have been obtained from suppliers that participate in measurement assurance activities with the NIST.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.1 INSTRUMENTATION

1/2.1.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

1.1.2 In accordance with BFN Technical Specification 6.8.4.1.a, the radioactive gaseous effluent monitoring instruments listed in Table 1.1-2 shall be OPERABLE with the applicability as shown in Table 1.1-2. Alarm/trip setpoints will be set in accordance with guidance given in ODCM Section 7.2 to ensure that the limits of ODCM Control 1.2.2.1 are not exceeded.

APPLICABILITY: As shown in Table 1.1-2.

ACTION:

a. With a radioactive gaseous effluent monitoring channel alarm/trip setpoint less conservative than required by these requirements, suspend the release without delay, declare the channel inoperable or adjust the alarm/trip setpoint to establish the conservatism required by these requirements.

b. Both off-gas treatment monitors may be taken out of service for less than one hour for purging of monitors during SI performance.

c. The action required when the number of operable channels is less than the minimum channels operable requirement is specified in the notes for Table 1.1-2. Exert best efforts to return the instrument(s) to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

SURVEILLANCE REQUIREMENTS

2.1.2 Each of the radioactive gaseous effluent monitoring instruments shall be demonstrated OPERABLE by performance of tests in accordance with Table 2.1-2.

Table 1.1-2 (Page 1 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Channels/ Devices OPERABLE	Applicability	Action
1. Stack (RM-90-147B & -148B)			
a. Noble Gas Monitor	1	*	A/C
b. Iodine Cartridge	1	*	B/C
c. Particulate Filter	1	*	B/C
d. Sampler Flow Abnormal	1	*	D
e. Stack Flow (FT, FM, FI-90-271)	1	*	D
2. Reactor/Turbine Building Ventilation (RM-90-250)			
a. Noble Gas Monitor	1	*	A/C
b. Iodine Sampler	1	*	B/C
c. Particulate Sampler	1	*	B/C
d. Sampler Flowmeter	1	*	D
3. Turbine Building Exhaust (RM-90-249, 251)			
a. Noble Gas Monitor	1	**	A/C
b. Iodine Sampler	1	**	B/C
c. Particulate Sampler	1	**	B/C
e. Sampler Flowmeter	1	**	D
4. Radwaste Building Vent (RM-90-252)			
a. Noble Gas Monitor	1	*	A/C
b. Iodine Sampler	1	*	B/C
c. Particulate Sampler	1	*	B/C
e. Sampler Flowmeter	1	*	D
5. Offgas Post Treatment			
a. Noble Gas Activity Monitor (RM-90-265, -266)	1	*	F
b. Sample Flow Abnormal (PA-90-262)	1	*	D

Table 1.1-2 (Page 2 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
TABLE NOTATION

* At all times.
** During releases via this pathway

ACTION A

With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue provided a temporary monitoring system is installed or grab samples are taken and analyzed at least once every 8 hours.

ACTION B

With a number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided samples are continuously collected with auxiliary sampling equipment for periods on the order of seven (7) days and analyzed in accordance with the sampling and analysis program specified in Table 2.2-2 within 48 hours after the end of the sampling period.

ACTION C

A monitoring system may be out of service for 4 hours for functional testing, calibration, or repair without providing or initiating grab sampling.

ACTION D

With the number of channels OPERABLE less than required by the Minimum Channels Operable requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

ACTION F

With the number of channels OPERABLE less than required by the Minimum Channels Operable requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 8 hours and these samples are analyzed for gross activity within 24 hours. Purging during SI performance is not considered a loss of monitoring capability.

Table 2.1-2 (Page 1 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS

Instrument	INSTRUMENT CHECK	SOURCE CHECK	CHANNEL CALIBRATION	FUNCTIONAL TEST
1. STACK				
a. Noble Gas Monitor[4]	D	M	R[1]	Q[2]
b. Iodine Cartridge	W	N/A	N/A	N/A
c. Particulate Filter	W	N/A	N/A	N/A
d. Sampler Flow Abnormal	D	N/A	R	Q
e. Stack Flowmeter	D	N/A	R	Q
2. REACTOR/TURBINE BUILDING VENT				
a. Noble Gas Monitor[5]	D	M	R[1]	Q[2]
b. Iodine Sampler	W	N/A	N/A	N/A
c. Particulate Sampler	W	N/A	N/A	N/A
b. Sampler Flowmeter	D	N/A	R	Q
3. TURBINE BUILDING EXHAUST				
a. Noble Gas Monitor[5]	D	M	R[1]	Q[2]
b. Iodine Sampler	W	N/A	N/A	N/A
c. Particulate Sampler	W	N/A	N/A	N/A
b. Sampler Flowmeter	D	N/A	R	Q
4. RADWASTE BUILDING VENT				
a. Noble Gas Monitor[5]	D	M	R[1]	Q[2]
b. Iodine Sampler	W	N/A	N/A	N/A
c. Particulate Sampler	W	N/A	N/A	N/A
b. Sampler Flowmeter	D	N/A	R	Q
5. OFF GAS POST TREATMENT[4]				
a. Noble Gas Activity Monitor	D	M	R[1]	Q[3]
b. Sample Flow Abnormal	D	N/A	R	Q[2]

Table 2.1-2 (Page 2 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS

NOTE: Each requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the interval given.

1 The CHANNEL CALIBRATION shall include the use of a known (traceable to the National Institute of Standards and Technology (NIST)) radioactive source(s) positioned in a reproducible geometry with respect to the sensor or using standards that have been obtained from suppliers that participate in measurement assurance activities with the NIST.

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

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Instrument indicates an inoperative/downscale failure.
3. Instrument controls not set in operate mode (stack only).

3 The CHANNEL FUNCTIONAL TEST shall demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Instrument indicates an inoperative/downscale failure.
3. Instrument controls not set in operate mode (stack only).

The two channels are arranged in a coincidence logic such that 2 upscale, or 1 downscale and 1 upscale or 2 downscale will isolate the offgas line.

4 The noble gas monitor shall have a LLD of 1E-5 (Xe-133 Equivalent)

5 The noble gas monitor shall have a LLD of 1E-6 (Xe-133 Equivalent)

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.1 LIQUID EFFLUENTS

1/2.2.1.1 CONCENTRATION

CONTROLS

1.2.1.1 In accordance with BFN Technical Specifications 6.8.4.1.b and c, the concentration of radioactive material released at any time from the site to UNRESTRICTED AREAS (see Figure 3.1) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-4 µCi/ml total activity.

APPLICABILITY: At all times.

ACTION:

If the above limits are exceeded, appropriate action shall be initiated without delay to bring the release within limits. Provide prompt notification to the NRC pursuant to Technical Specification 6.9.1.4.

SURVEILLANCE REQUIREMENTS

2.2.1.1.1 Facility records shall be maintained of radioactive concentrations and volume before dilution of each batch of liquid effluent released, and of the average dilution flow and the length of time over which each discharge occurred.

2.2.1.1.2 Radioactive liquid waste sampling and activity analysis of each liquid waste batch to be discharged shall be performed prior to release in accordance with the sampling and analysis program specified in Table 2.2-1.

2.2.1.1.3 The operation of the automatic isolation valves and discharge tank selection valves shall be checked annually.

2.2.1.1.4 The results of the analysis of samples collected from release points shall be used with the calculational methodology in ODCM Section 6.1 to assure that the concentrations at the point of discharge are maintained within the above limits.

Table 2.2-1 (Page 1 of 3)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	System Design Capability Lower Limit of Detection (LLD) (μCi/ml)
Batch Waste Releases[1]	Each Batch	Each Batch Prior to Release	Principal Gamma Emitters[4]	$5x10^{-7}$ [3]
	One Batch per Month	Monthly	Dissolved and Entrained Gases[5]	$1x10^{-5}$ [3]
	Monthly Proportional Composite[2]	Monthly	Tritium	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Quarterly Proportional Composite[2]	Quarterly	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

Table 2.2-1 (Page 2 of 3)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

[1] A batch release is the discharge of liquid waste of a discrete volume. The discharge shall be thoroughly mixed prior to sampling.

[2] A proportional composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged from the plant and is representative of the liquid discharged.

[3] The LLD is defined for the purpose of these requirements 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 a 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 s_b}{E \quad V \quad 2.22E{+}06 \quad Y \quad \exp(-\lambda \Delta t)}$$

Where:

LLD = the "a priori" lower limit of detection as defined above (microcurie 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)
2.22E+06 = the number of disintegrations per minute per microcurie,
Y = the fractional radiochemical yield, when applicable,
λ = the radioactive decay constant for the particular radionuclide (s^{-1}), and
Δt = the elapsed time between midpoint of sample collection and time of counting (s).

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 <u>a priori</u> (before the fact) limit representing the capability of a measurement system and not an <u>a posteriori</u> (after the fact) limit for a particular measurement.

[4] The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Zn-65, Co-60, Cs-137, Mn-54, Co-58, Cs-134, Ce-141, Ce-144, Mo-99 and Fe-59 for

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.1 INSTRUMENTATION

1/2.1.1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

1.1.1 In accordance with BFN Technical Specification 6.8.4.1.a, the radioactive liquid effluent monitoring instrumentation listed in Table 1.1-1 shall be OPERABLE with the applicability as shown in Tables 1.1-1 and 2.1-1. Alarm/trip setpoints will be set in accordance with guidance given in ODCM Section 6.2 to ensure that the limits of Control 1.2.1.1 are not exceeded.

APPLICABILITY: This requirement is applicable as shown in Table 1.1-1.

ACTION:

a. With a radioactive liquid effluent monitoring channel alarm/trip setpoint less conservative than required by these requirements, suspend the release without delay, declare the channel inoperable, or adjust the alarm/trip setpoint to establish the conservatism required by these requirements.

b. The action required when the number of OPERABLE channels is less than the minimum channels OPERABLE requirement is specified in the notes for Table 1.1-1. Exert best efforts to return the instrument(s) to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

SURVEILLANCE REQUIREMENTS

2.1.1 Each of the radioactive liquid effluent monitoring instruments shall be demonstrated OPERABLE by performance of tests in accordance with Table 2.1-1.

Table 2.2-1 (Page 3 of 3)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

liquid releases. This list does not mean that only these nuclides are to be detected and reported. Other nuclides detected within a ≈95% confidence level, together with the above nuclides, shall also be identified and reported as being present. Nuclides which are below the LLD for the analysis may not be reported as being present at the LLD level for that nuclide. I-131 shall have a LLD of ≤ 1E-6.

5 Gamma Emitters Only.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.1 LIQUID EFFLUENTS

1/2.2.1.2 DOSE

CONTROLS

1.2.1.2 In accordance with BFN Technical Specifications 6.8.4.1.d and e, the doses or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from each unit to UNRESTRICTED AREAS shall be limited:

a. During any calendar quarter to $<$ 1.5 mrem to the total body and to $<$ 5 mrem to any organ, and

b. During any calendar year to $<$ 3 mrem to the total body and to $<$ 10 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

If the limits specified above are exceeded, prepare and submit a Special Report pursuant to ODCM Administrative Control 5.4.

SURVEILLANCE REQUIREMENTS

2.2.1.2 Cumulative quarterly and yearly dose contributions from liquid effluents shall be determined as specified in ODCM Section 6.3 at least once every 31 days.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.1 LIQUID EFFLUENTS

1/2.2.1.3 LIQUID RADWASTE TREATMENT SYSTEM

CONTROLS

1.2.1.3 In accordance with BFN Technical Specification 6.8.4.1.f, the liquid radwaste system shall be used to reduce the radioactive materials in liquid discharge from the site when the projected monthly dose would exceed 0.06 mrem to the total body or 0.21 mrem to any other organ per unit.

APPLICABILITY: At all times.

ACTION:

With radioactive liquid waste being discharged for more than 31 days without treatment and when the projected dose is in excess of limits specified above, prepare and submit the Special Report pursuant to ODCM Administrative Control 5.4.

SURVEILLANCE REQUIREMENTS

2.2.1.3 Doses due to liquid releases to UNRESTRICTED AREAS shall be projected at least once per 31 days, in accordance with ODCM Section 6.5.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2 GASEOUS EFFLUENTS

1/2.2.2.1 DOSE RATE

CONTROLS

1.2.2.1 In accordance with BFN Technical Specification 6.8.4.1.g, the dose rate at any time to areas at and beyond the SITE BOUNDARY (see Figure 3.1) due to radioactivity released in gaseous effluents from the site shall be limited to the following values:

a. The dose rate limit for noble gases shall be <500 mrem/yr to the total body and <3000 mrem/yr to the skin, and

b. The dose rate limit for I-131, I-133, H-3 and particulates with greater than eight day half-lives shall be <1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTION: If the limits above are exceeded, appropriate corrective action shall be immediately initiated to bring the release within limits. Provide prompt notification to the NRC pursuant to Technical Specification 6.9.1.4.

SURVEILLANCE REQUIREMENTS

2.2.2.1.1 The gross ß/γ and particulate activity of gaseous wastes released to the environment shall be monitored and recorded.

a. For effluent streams having continuous monitoring capability, the activity shall be monitored and flow rate evaluated and recorded to enable release rates of gross radioactivity to be determined at least once per shift using instruments specified in Table 1.1-2.

b. For effluent streams without continuous monitoring capability, the activity shall be monitored and recorded and the release through these streams controlled to within the limits specified above.

2.2.2.1.2 Radioactive gaseous waste sampling and activity analysis shall be performed in accordance with the sampling and analysis program specified in Table 2.2-2. Dose rates shall be determined to be within the above limits using methods contained in ODCM Section 7.3.

2.2.2.1.3 Samples of offgas system effluents shall be analyzed at least weekly to determine the identity and quantity of the principal radionuclides being released.

Table 2.2-2 (Page 1 of 2)

RADIOACTIVE GASEOUS WASTE MONITORING SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	System Design Capability Lower Limit of Detection (LLD) (μCi/ml)
A. Containment Purge	Prior to Each PURGE Grab Sample	Prior to Each PURGE	Principal Gamma Emitters[3]	$1x10^{-4}$ [1]
			H-3	$1x10^{-6}$
B.1. Stack	Grab Sample	Monthly[4]	Principal Gamma Emitters[3]	$1x10^{-4}$ [1]
2. Building Ventilation a. Reactor/Turbine b. Turbine Exhaust c. Radwaste	Grab Sample	Monthly[4]	H-3	$1x10^{-6}$
C. All Release Points Listed in B. Above	Continuous Sampler	Charcoal Sample Weekly[4]	I-131	$1x10^{-12}$ [2]
	Continuous Sampler	Particulate Sample Weekly[4]	Principal Gamma Emitters[3]	$1x10^{-11}$ [2]
			I-131	$1x10^{-12}$ [2]
	Continuous Sampler	Composite Particulate Sample Monthly	Gross Alpha	$1x10^{-11}$
	Continuous Sampler	Composite Particulate Sample Quarterly	Sr-89, Sr-90	$1x10^{-11}$

Table 2.2-2 (Page 2 of 2)
RADIOACTIVE GASEOUS WASTE MONITORING SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

1 The LLD is defined, for the purpose of this requirement, 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 a 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 s_b}{E \quad V \quad 2.22E+06 \quad Y \quad \exp(-\lambda \Delta t)}$$

Where:

LLD = the "a priori" lower limit of detection (microcurie 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)

2.22E+06 = the number of disintegrations per minute per microcurie,

Y = the fractional radiochemical yield, when applicable,

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

Δt = the elapsed time between midpoint of sample collection and time of counting (s).

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 an a posteriori (after the fact) limit for a particular measurement.

2 When samples are taken more often than that shown, the minimum detectable concentrations can be correspondingly higher.

3 The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide.

4 Analysis shall also be performed if the radiation monitor alarm exceeds the setpoint value.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2 GASEOUS EFFLUENTS

1/2.2.2.2 DOSE - NOBLE GASES

CONTROLS

1.2.2.2 In accordance with BFN Technical Specification 6.8.4.1.h, the air dose to areas at and beyond the SITE BOUNDARY (see Figure 3.1) due to noble gases released in gaseous effluents per unit shall be limited to the following:

a. During any calendar quarter, to $\leq$ 5 mrad for gamma radiation and $\leq$10 mrad for beta radiation;

b. During any calendar year, to $\leq$ 10 mrad for gamma radiation and $\leq$ 20 mrad for beta radiation.

APPLICABILITY: At all times.

ACTION:

If the calculated air dose exceeds the limits specified above, prepare and submit a special report pursuant to ODCM Administrative Control 5.4.

SURVEILLANCE REQUIREMENTS

2.2.2.2 Cumulative quarterly and yearly dose contributions from gaseous releases shall be determined using methods contained in ODCM Section 7.3 at least once every 31 days.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2 GASEOUS EFFLUENTS

1/2.2.2.3 DOSE - I-131, I-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM WITH HALF-LIVES GREATER THAN EIGHT DAYS

CONTROLS

1.2.2.3 In accordance with BFN Technical Specification 6.8.4.1.e and i, the dose to a MEMBER OF THE PUBLIC from radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases with half-lives greater than 8 days in gaseous effluent released per unit to areas at and beyond the SITE BOUNDARY (see Figure 3.1) shall be limited to the following:

a. To any organ during any calendar quarter to ≤ 7.5 mrem;

b. To any organ during any calendar year to ≤ 15 mrem.

APPLICABILITY: At all times.

ACTION:

If the calculated doses exceed the limits specified above, prepare and submit a special report pursuant to ODCM Administrative Control 5.4.

SURVEILLANCE REQUIREMENTS

2.2.2.3 Cumulative quarterly and yearly dose contributions from gaseous releases shall be determined using methods contained in ODCM Section 7.4 at least once every 31 days.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2 GASEOUS EFFLUENTS

1/2.2.2.4 GASEOUS RADWASTE TREATMENT

CONTROLS

1.2.2.4 During operation above 25% power, the discharge of the SJAE must be routed through the charcoal adsorbers.

In accordance with BFN Technical Specification 6.8.4.1.f, the GASEOUS RADWASTE TREATMENT SYSTEM shall be operable and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluents from each unit, to areas at and beyond the site boundary, would exceed:

a. 0.2 mrad to air from gamma radiation, or
b. 0.4 mrad to air from beta radiation, or
c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY: At all times.

ACTION:

With the gaseous waste being discharged for more than 7 days without treatment through the charcoal adsorbers and in excess of the above limits, prepare and submit a special report pursuant to ODCM Administrative Control 5.4.

SURVEILLANCE REQUIREMENTS

2.2.2.4.1 During operation above 25% power, the position of the charcoal bed bypass valve will be verified daily.

2.2.2.4.2 Doses due to gaseous releases to areas at and beyond the SITE BOUNDARY shall be projected in accordance with Section 7.5 at least once per 31 days.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.3 TOTAL DOSE

CONTROLS

1.2.3 In accordance with BFN Technical Specification 6.8.4.1.j, the dose or dose commitment to a real individual from all uranium fuel cycle sources is limited to $\leq$ 25 mrem to the total body or any organ (except the thyroid, which is limited to $\leq$ 75 mrem) over a period of one calendar year.

APPLICABILITY: At all times.

ACTION:

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of ODCM Control 1.2.1.2, 1.2.2.2, or 1.2.2.3, prepare and submit a Special Report to the Commission pursuant to ODCM Administrative Control 5.4 and limit the subsequent releases such that the above limits are not exceeded.

SURVEILLANCE REQUIREMENTS

2.2.3 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with ODCM Sections 6.3, 7.3, and 7.4 and the methods in ODCM Section 8.0.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.1 MONITORING PROGRAM

CONTROLS

1.3.1 In accordance with BFN Technical Specification 6.8.4.2.a, the radiological environmental monitoring program shall be conducted as specified in Table 2.3-1.

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 2.3-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability or malfunction of automatic sampling equipment. If the latter, 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 reported in the Annual Radiological Environmental Operating Report.

b. With the level of radioactivity in an environmental sampling medium exceeding the reporting levels of Table 2.3-3 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected quarter a report which 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 ODCM Controls 1.2.1.2, 1.2.2.2, and 1.2.2.3. When one or more of the radionuclides in Table 2.3-2 is detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 2.3-3 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 is equal to or greater than the calendar year limits of ODCM Controls 1.2.1.2, 1.2.2.2, and 1.2.2.3. 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.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.1 MONITORING PROGRAM

CONTROLS

ACTION (CONTINUED):

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 2.3-1, identify locations for obtaining replacement samples, if available, and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program.

Pursuant to Control 1.3.1.b, identify the cause of the unavailability of samples and identify the new location(s), if available, for obtaining replacement samples in the next Annual Radiological Environmental Operating Report and also include a revised figure(s) and table(s) for the ODCM reflecting the new location(s).

The detection capabilities required by Table 2.3-2 are state-of-the art for routine environmental measurements in industrial laboratories. 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 *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, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing circumstances will be identified and described in the Annual Radiological Environmental Operating Report.

SURVEILLANCE REQUIREMENTS

2.3.1.1 The radiological environmental monitoring samples shall be collected pursuant to Table 2.3-1 from the locations given in the tables and figures listed below and shall be analyzed pursuant to the requirements of Table 2.3-1 and the detection capabilities required by Table 2.3-2.

2.3.1.2 If measured levels of radioactivity in a environmental sampling medium are determined to exceed the reporting level values of Table 2.3-3 when averaged over any calendar quarter sampling period, a report shall be submitted to the Commission pursuant to Control 1.3.1.b.

Table 2.3-1 (1 of 3)

MINIMUM REQUIRED RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
Radioiodine/ Particulates	Minimum of 5 locations	Continuous operation of sampler with sample collection as required by dust loading but at least once per 7 days.	Radioiodine canister: Analyze at least once per 7 days for I-131. Particulate sampler: Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is > 10 times the average of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 92 days.
2. DIRECT RADIATION	At least 40 locations with ≥ 2 dosimeters at each location.	At least once per 92 days.	Gamma Dose. At least once per 92 days.

[a] Sample locations are given in ODCM Section 9.0.

Table 2.3-1 (2 of 3)
MINIMUM REQUIRED RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface	2 locations	Composite sample collected over a period of ≤ 31 days.[b]	Gamma isotopic analysis of each composite sample. Tritium analysis of composite sample at least once per 92 days.
b. Drinking	Minimum of 1 downstream location, or all water supplies within 10 miles downstream which are taken from the Tennessee River	Composite sample collected[c] over a period of ≤ 31 days.[b,c]	Gross beta and gamma isotopic analysis of each composite sample. Tritium analysis of composite sample at least once per 92 days.
c. Sediment	Minimum of 1 location.	At least once per 184 days	Gamma isotopic analysis of each sample.
d. Ground[d]			

a Sample locations are given in ODCM Section 9.0.

b Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

c Composite samples shall be collected over a period of ≤ 14 days for I-131 if drinking water is obtained within 3 miles downstream of the plant.

d Ground water movement in the area has been determined to be from the plant site toward the Tennessee River. Since no drinking water wells exist between the plant and the river, ground water will not be monitored.

Table 2.3-1 (3 of 3)

MINIMUM REQUIRED RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
4. INGESTION			
a. Milk	3 locations	At least once per 15 days when animals are on pasture; at least once per 31 days at other times.	I-131 analysis of each sample. Gamma isotopic analysis at least once per 31 days
b. Fish	2 samples	One sample in season, or at least once per 184 days if not seasonal. One sample of commercial and game species.	Gamma isotopic analysis on edible portions.
c. Food Products[e]	2 locations	At least once per year at time of harvest	Gamma isotopic analysis on edible portion.

[a] Sample locations are given in ODCM Section 9.0.

[e] Since water from the Tennessee River in the immediate area downstream is not used for irrigation purposes, the sampling of food products (primarily broad leaf vegetation) is not required unless milk sampling is not performed.

Table 2.3-2 (1 of 2)

MAXIMUM VALUES FOR THE LOWER LIMIT OF DETECTION (LLD)[a,c]
FOR ENVIRONMENTAL SAMPLES

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	N/A	N/A	N/A	N/A
H-3	2000	N/A	N/A	N/A	N/A	N/A
Mn-54	15	N/A	130	N/A	N/A	N/A
Fe-59	30	N/A	260	N/A	N/A	N/A
Co-58, 60	15	N/A	130	N/A	N/A	N/A
Zn-65	30	N/A	260	N/A	N/A	N/A
Zr-95	30	N/A	N/A	N/A	N/A	N/A
Nb-95	15	N/A	N/A	N/A	N/A	N/A
I-131	1[b]	0.07	N/A	1	60	N/A
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60	N/A	N/A	60	N/A	N/A
La-140	15	N/A	N/A	15	N/A	N/A

Table 2.3-2 (2 of 2)
MAXIMUM VALUES FOR THE LOWER LIMIT OF DETECTION (LLD)[a,c]
FOR ENVIRONMENTAL SAMPLES
TABLE NOTATION

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

For a particular measurement system, which may include radiochemical separation:

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

Where:
- LLD = the "a priori" lower limit of detection as defined above, (as 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, (as counts per minute).
- E = the counting efficiency, (as counts per disintegration).
- V = the sample size (in units of mass or volume).
- 2.22 = the number of disintegrations per minute per picocurie.
- Y = the fractional radiochemical yield, (when applicable).
- λ = the radioactive decay constant for the particular radionuclide, $seconds^{-1}$ and
- Δt = for environmental samples is the elapsed time between sample collection, (or end of the sample collection period), and time of counting (for environmental samples, not plant effluent samples), seconds.

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.

[b] LLD for analysis of drinking water and surface water samples shall be performed by gamma spectroscopy at approximately 15 pCi/L. If levels greater than 15 pCi/L are identified in surface water samples downstream from the plant, or in the event of an unanticipated release of I-131, drinking water samples will be analyzed at an LLD of 1.0 pCi/L for I-131.

[c] Other peaks which are measurable and identifiable shall be identified and reported.

Table 2.3-3

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	2×10^4(a)	N.A	N.A	N.A.	N.A.
Mn-54	1×10^3	N.A.	3×10^4	N.A.	N.A.
Fe-59	4×10^2	N.A.	1×10^4	N.A.	N.A.
Co-58	1×10^3	N.A.	3×10^4	N.A.	N.A.
Co-60	3×10^2	N.A.	1×10^4	N.A.	N.A.
Zn-65	3×10^2	N.A.	2×10^4	N.A.	N.A.
Zr-Nb-95	4×10^2	N.A.	N.A.	N.A.	N.A.
I-131	2	0.9	N.A.	3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2	N.A.	N.A.	3×10^2	N.A.

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

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.2 LAND USE CENSUS

CONTROLS

1.3.2 In accordance with BFN Technical Specification 6.8.4.2.b, a land use census shall be conducted and shall identify the location of the nearest milk animal, the nearest residence and the nearest garden[1] of greater than 500 square feet producing vegetables in each of the 16 meteorological sectors within a distance of 5 miles. (For elevated releases as defined in Regulatory Guide 1.111, Revision 1, July 1977, the land use census shall also identify the locations of all milk animals and gardens of greater than 500 square feet producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of three miles.)

[1] Broad leaf vegetation sampling may be performed at the SITE BOUNDARY in the direction sector with the highest D/Q in lieu of the garden census.

APPLICABILITY: At all times.

ACTION:

With a land use census identifying a location(s) which yields a calculated dose or dose commitment greater than the maximum value currently being calculated in Section 7.5, identify the new location(s) in the next Annual Radiological Environmental Operating Report.

With a land use census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with ODCM Control 1.3.1, add the new location(s) to the radiological environmental monitoring program within 30 days if the owner consents. The sampling location(s), excluding the control station 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. Identify the new location(s) in the next Annual Radiological Environmental Operating Report and provide a revised figure(s) and table(s) reflecting the new location(s).

SURVEILLANCE REQUIREMENTS

(see next page)

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.2 LAND USE CENSUS

SURVEILLANCE REQUIREMENTS

2.3.2 The land use census shall be conducted at least once per calendar year between the dates of April 1 and October 1 using the following techniques:

1. Within a 2-mile radius from the plant or within the 15 mrem per year isodose line, whichever is larger, enumeration by a door-to-door or equivalent counting technique.

2. Within a 5-mile radius from the plant, enumeration by using appropriate techniques such as door-to-door survey, mail survey, telephone survey, aerial survey, or information from local agricultural authorities or other reliable sources.

1/2 CONTROLS AND SURVEILLANCE REQUIREMENTS

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

1.3.3 In accordance with BFN Technical Specifications 6.8.4.2.c, analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the Commission.

APPLICABILITY: At all times.

ACTION:

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.

SURVEILLANCE REQUIREMENTS

2.3.3 A summary of the results obtained as part of the above required Interlaboratory Comparison Program (or participants in the Environmental Protection Agency (EPA) cross check program shall provide the EPA program code designation for the unit) shall be included in the Annual Radiological Environmental Operating Report.

BASES FOR

SECTIONS 1.0 AND 2.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

NOTE

The BASES contained in succeeding pages summarize the reasons for the Controls in Sections 1.0 and 2.0, but are not part of these Controls.

BASES

1/2.1 EFFLUENT MONITORING INSTRUMENTATION

1/2.1.1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

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 in accordance with guidance provided in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits or 10 CFR Part 20 Appendix B, Table II, Column 2. 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.

1/2.1.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

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 will be calculated in accordance with Section 7.2.1 to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The operability and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

The action required when the number of OPERABLE channels is less than the Minimum Channels Operable requirement is specified in the notes for Table 1.1-2. Exert best efforts to return the instruments to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.1.1 CONCENTRATION

This requirement is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to UNRESTRICTED AREAS will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will result in exposures within (1) the Section II.A limits of Appendix I to 10 CFR Part 50 to the population. The concentration limit for noble gases is based upon the assumption that Xe-135 is the

BASES

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.1.1 CONCENTRATION (continued)

controlling radioisotope and its Maximum Permissible Concentration in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission of Radiological Protection (ICRP) Publication 2.

1/2.2.1.2 DOSE

This requirement is provided to implement the dose requirements of Section II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. The requirement implements the guides set forth in Section II.A of Appendix I.

This action provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonable achievable". Also, for fresh water sites with drinking water supplies which can potentially be affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR 141. The dose calculations in Section 6.0 implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in Section 6.0 for calculating the doses due to the actual release rates of radioactive materials in liquid effluents will be consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Implementing Appendix I," October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I" April 1977. NUREG-0133 provides methods for dose calculations consistent with Regulatory Guides 1.109 and 1.113.

1/2.2.1.3 LIQUID WASTE TREATMENT

This section requires that the appropriate portions of the liquid radwaste treatment system be used when specified. This provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable." This requirement implements the requirements of 10 CFR Part 50.36a,

BASES

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.1.3 LIQUID WASTE TREATMENT (continued)

General Design Criterion 60 of Appendix A to 10 CFR Part 50 and design objective Section II.D of Appendix I to 10 CFR 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the guide set forth in Section II.A of Appendix I, 10 CFR 50, for liquid effluents.

This section also requires submittal of a special report if the limiting values are exceeded and unexpected failures of non-redundant radwaste processing equipment halt waste treatment.

1/2.2.2.1 DOSE RATE

This requirement is provided to ensure that the dose rate at anytime at the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 for UNRESTRICTED AREAS. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. 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, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR Part 20.106(b)). For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of the MEMBER OF THE PUBLIC will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY.

The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates to an individual at or beyond the SITE BOUNDARY to < 500 mrem/year to the total body or < 3000 mrem/year to the skin. These release rates also restrict, at all times, the corresponding thyroid dose rate above background to an infant via the cow-milk-infant pathway to < 1500 mrem/year for the nearest cow to the plant.

The action for this requirement requires that appropriate corrective action(s) be taken to reduce gaseous effluent releases if the limits are exceeded.

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2.2 DOSE - NOBLE GASES

This requirement is provided to implement the requirements of Section II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. The limits are the guides set forth in Section II.C of Appendix I.

The action to be taken for exceeding these limits provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as reasonably achievable." Section 7.0 calculational methods implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. Section 7.0 calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodologies provided in NUREG/CR-1004, "A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides." October 1979 and Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purposes 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 ODCM equations also provide for determining the air doses at the exclusion area boundary are based upon the historical average atmospheric conditions. NUREG-0133 provides methods for dose calculations consistent with Regulatory Guides 1.109 and 1.111.

If these limits are exceeded, this section requires that a special report be prepared and submitted to explain violations of the limiting doses contained in the section above.

BASES

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2.3 DOSE - I-131, I-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

This requirement is provided to implement the requirements of Section II.C, III.A, and IV of Appendix I, 10 CFR Part 50. The limits are the guides set forth in Section II.C of Appendix I.

The action to be taken for exceeding these limits provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as reasonably achievable." Section 7.0 calculational methods implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. Section 7.0 calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodologies provided in NUREG/CR-1004, "A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides," October 1979 and Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purposes 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 iodines, radioactive material in particulate form and radionuclides other than noble gases are dependent on the existing radionuclide pathways to man in the UNRESTRICTED AREA. The pathways which were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

If these limits are exceeded, this section requires that a special report be prepared and submitted to explain violations of the limiting doses contained in the section above.

1/2.2 RADIOACTIVE EFFLUENTS

1/2.2.2.4 GASEOUS RADWASTE TREATMENT

This requires that the offgas charcoal adsorber beds be used when specified to treat gaseous effluents prior their release to the environment. This provides reasonable assurance that the release of radioactive materials in gaseous effluents will be kept "as low as is reasonable achievable". This requirement implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and design objective Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the guide set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This action requires that a special report be prepared and submitted to explain reasons for any failure to comply with the above requirements.

1/2.2.3 TOTAL DOSE

This requirement is provided to meet the dose limitations of 40 CFR 190. This requirement requires the preparation and submittal of a Special Report whenever the calculated doses from plant radioactive effluents exceed twice the design objective doses of Appendix I. 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 190 if the individual reactors remain within the reporting requirement level. The Special Report will describe a course of action which should result in the limitation of dose to a member of the public for the calendar year to be within 40 CFR 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 fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities within a radius of five miles must be considered.

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.1 MONITORING PROGRAM

The radiological environmental monitoring program required by this section provides measurements of radiation and radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring

1/2.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

1/2.3.1 MONITORING PROGRAM (continued)

program by verifying that the measurable concentration of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways.

1/2.3.2 LAND USE CENSUS

This requirement is provided to ensure that changes in the use of UNRESTRICTED AREAS are identified and that modifications to the monitoring program are made if required by the results of this census. The best survey information from the door-to-door, mail, telephone, aerial or consulting with local authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 500 square feet provides assurance that significant exposure pathways via the leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetation assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were used: 1) that 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/square meter.

1/2.3.3 INTERLABORATORY COMPARISON PROGRAM

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

SECTION 3.0

DEFINITIONS

3.0 DEFINITIONS

The defined terms in this section appear in capitalized type in the text and are applicable throughout these controls.

3.0.A. CHANNEL CALIBRATION

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including alarm and/or trip functions, and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated. Non-calibratable components shall be excluded from this requirement, but will be included in CHANNEL FUNCTIONAL TEST and SOURCE CHECK.

3.0.B. CHANNEL FUNCTIONAL TEST

A CHANNEL FUNCTIONAL TEST shall be:

a. Analog channels - the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY including alarm and/or trip functions.
b. Bistable channel - the injection of a simulated signal into the sensor to verify OPERABILITY including alarm and/or trip function.

3.0.C. GASEOUS WASTE TREATMENT SYSTEM

The GASEOUS WASTE TREATMENT SYSTEM consists of the charcoal adsorber vessels installed in the discharge of the steam jet air ejector to provide delay to a unit's offgas activity prior to release.

3.0.D. DOSE EQUIVALENT I-131

DOSE EQUIVALENT I-131 shall be that concentration of I-131 (μCi/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."

3.0.E. MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all individuals who by virtue of their occupational status have no formal association with the plant.

This category shall include non-employees of the licensee who are permitted to use portions of the site for recreational, occupational, or other purposes not associated with plant functions. This category shall not include non-employees such as vending machine servicemen or postmen who, as part of their formal job function, occasionally enter RESTRICTED AREAS.

3.0.F. OPERABLE - OPERABILITY

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

3.0.G. PURGE - PURGING

PURGE or PURGING is the controlled process of discharging air or gas from the primary containment to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the containment.

3.0.H. RATED POWER

RATED POWER refers to operation at a reactor power of 3,293 MWt; this is also termed 100 percent power and is the maximum power level authorized by the operating license. Rated steam flow, rated coolant flow, rated neutron flux, and rated nuclear system pressure refer to the values of these parameters when the reactor is at rated power. Design power, the power to which the safety analysis applies, corresponds to 3,440 MWt.

3.0.I. SITE BOUNDARY

The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by TVA (see Figure 3.1).

3.0.J. SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source or multiple of sources.

3.0.K. UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area, at or beyond the SITE BOUNDARY to which access is not controlled by the licensee for purposed of protection of individuals from exposure to radiation and radioactive materials or any area within the SITE BOUNDARY used for residential quarters or industrial, commercial, institutional, and/or recreational purposes (see Figure 3.1).

3.0.L. VENTING

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

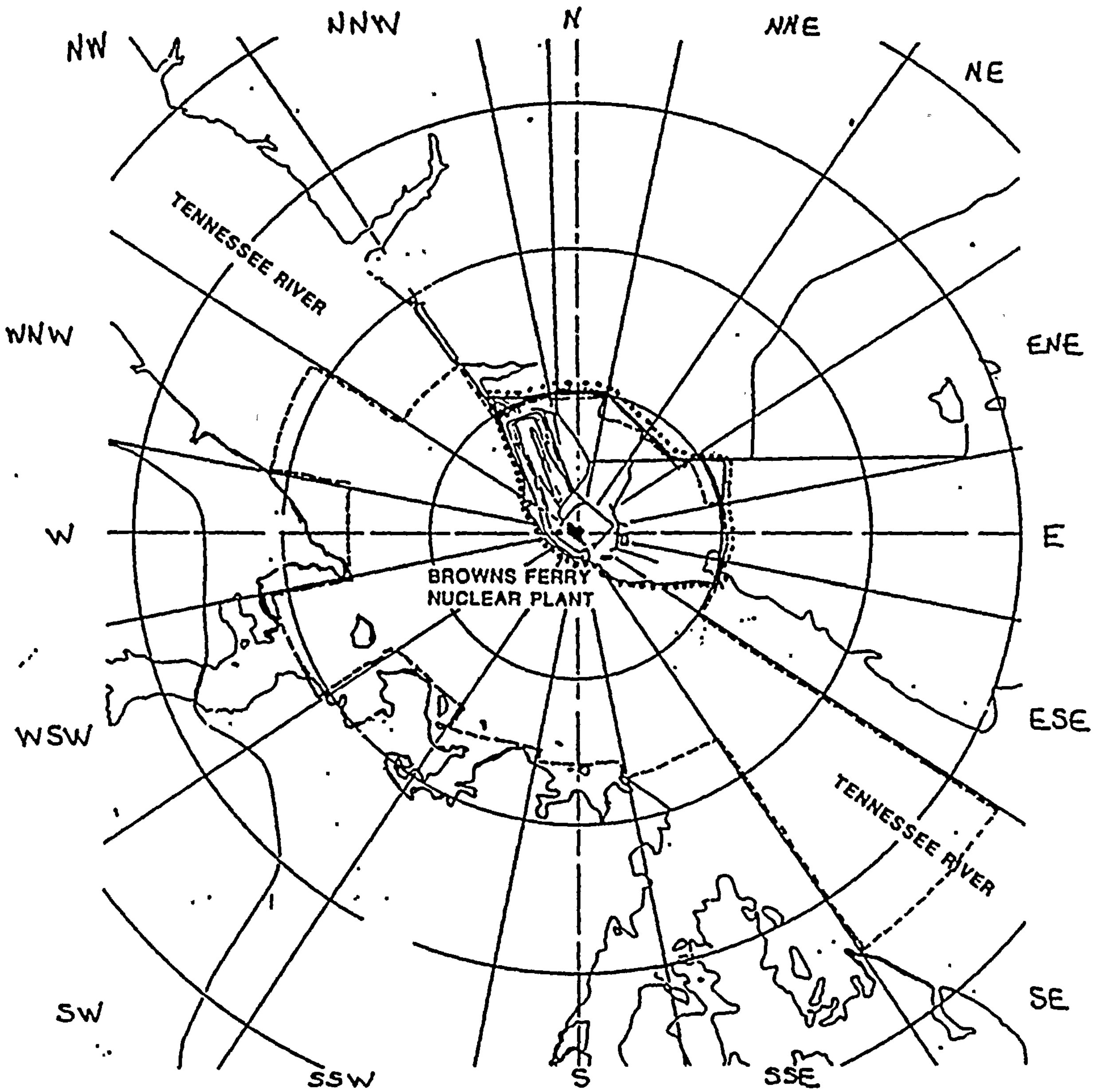
Table 3.1

FREQUENCY NOTATION

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

Figure 3.1

LAND SITE BOUNDARY



-------- Land Site Boundary (for gaseous effluents)

·············· Unrestricted Area Boundary (for liquid effluents)

SECTION 4.0

(NOT USED)

SECTION 5.0

ADMINISTRATIVE CONTROLS

5.0 ADMINISTRATIVE CONTROLS

5.1 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

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, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The report shall also include the results of land use censuses required by Control 1.3.2. If harmful effects or evidence of irreversible damage are detected by the monitoring, the report shall provide an analysis of the problems and a planned course of action to alleviate the problem.

The Annual Radiological Environmental Operating Report shall include summarized and tabulated results in the format of Regulatory Guide 4.8, December 1975 of all radiological environmental samples taken during the report period. In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The report shall also include the following: a summary description of the radiological environmental monitoring program; a map of all sampling locations keyed to a table giving distances and directions from one reactor; and the results of licensee participation in the Interlaboratory Comparison Program required by Control 1.3.3.

5.2 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Annual Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste shipped from the plant as delineated 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.

The report shall include a summary of the meteorological conditions concurrent with the release of gaseous effluents during each quarter as outlined in Regulatory Guide 1.21, Revision 1, with data summarized on a quarterly bases following the format of Appendix B thereof. Calculated offsite dose to members of the public resulting from the release of liquid and gaseous effluents and their subsequent dispersion in the river and atmosphere shall be reported as recommended in Regulatory Guide 1.21, Revision 1.

5.2 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (continued)

The Annual Radioactive Effluent Release Report shall include the information regarding solid waste as specified in the Process Control Program.

5.3 OFFSITE DOSE CALCULATION MANUAL CHANGES

As required by BFN TS 6.12, changes to the ODCM:

1. Shall be documented and records of reviews performed shall be retained as required by BFN TS 6.10.1. This documentation shall contain:

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

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

2. Shall become effective after review and acceptance by the PORC.

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

5.4 SPECIAL REPORTS

Special Reports shall be submitted to the NRC in accordance with 10 CFR 50.4.

5.5 QUALITY ASSURANCE PROCEDURES

Quality Assurance procedures shall be established, implemented, and maintained for effluent and environmental monitoring, using the guidance in Regulatory Guide 1.21, Rev. 1, June 1974 and Regulatory Guide 4.1, April 1975 or Regulatory Guide 4.15, Dec. 1977.

SECTION 6.0

LIQUID EFFLUENTS

6.0 - LIQUID EFFLUENTS

RELEASE POINTS

The minimum flow available for dilution of radwaste are shown below:

```
               --→ open - 2 pumps @ 200,000 gpm/pump------
               ↑                                          ↓
Radwaste ----->                                           ---->   Discharge
               ↓                                          ↑       Conduit
               --→ closed - 50,000 gpm --------------------
```

6.1 LIQUID RELEASES

6.1.1 Pre-release Analysis/MPC - Sum of the Ratios

Prior to release, a grab sample will be analyzed to determine the concentration (C_i) of each gamma emitting radionuclide i in the radwaste tank. The following equation is used to calculate MPC fractions (M_i).

$$M_i = \frac{C_i}{MPC_i} \qquad (6.1)$$

where:

M_i = MPC fraction of radionuclide i.
C_i = concentration of radionuclide i in the radwaste tank, µCi/ml.
MPC_i = MPC of radionuclide i as specified in Control 1.2.1.1, µCi/ml.

The sum of the ratios (R) will be calculated by the following relationship:

$$R = \sum_i M_i \qquad (6.2)$$

where:

R = the sum of the ratios.
M_i = MPC fraction from equation 6.1.

6.1.2 Release Flow Rate Calculations

The sum of the ratios at the diffuser pipes must be $\leq$ 1 due to the releases from the above source. The following relationship will assure this criterion is met:

$$f\ (R-1) \leq F \qquad (6.3)$$

where:

f = the effluent flow rate (gallons/minute) before dilution.
R = the sum of the ratios as determined by Equation 6.2.
F = minimum dilution flow rate for prerelease analysis.

The allowable release rate is calculated before each release and the release rate is continuously monitored during the release so that the MPC limit is not exceeded.

6.1.3 Post-release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in Control 1.2.1.1 were not exceeded.

A composite list of concentrations (C_i) by isotope, will be used with actual liquid radwaste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equations 6.1, 6.2 and 6.3 to demonstrate compliance with the limits in Control 1.2.1.1. This data and setpoints will be recorded in auditable records by plant personnel.

6.2 INSTRUMENT SETPOINTS

Alarm/trip setpoints for each liquid monitor will be established and set such that Equation 6.3 is satisfied. The locations and identification numbers for each liquid effluent radiation detector are shown in Figures 6.1 and 6.2. This section of the ODCM describes the methodology that will be used to determine allowable values. The allowable values are then used to determine the physical settings on the monitors. The physical settings are calculated in the applicable Scaling and Setpoint Document.

6.2.1 Radwaste Discharge Monitor

The allowable value for the radwaste discharge monitor (RM-90-130), shown in Figures 6.1 and 6.2, will be established using the methodology below. The alarm/trip allowable value will be set such that Equation 6.3 is satisfied. The trip allowable value for the monitor, which will automatically isolate the release, is set at less than or equal to the limit in Control 1.2.1.1. The alarm allowable value is set at 50% of the trip allowable value.

The maximum activity concentration[1] of liquid radwaste that can be discharged can be calculated as:

$$A = \frac{F + f}{f * \sum_i \frac{WF_i}{MPC_i}}$$

where

A = maximum batch activity concentration, µCi/ml

MPC_i = Maximum Permissible Concentration, from 10 CFR 20 Appendix B for nuclide i, µCi/ml.

WF_i = weighting factor for nuclide i, defined as the fraction of the total concentration which is attributed to nuclide i.

F = dilution water flow rate, gpm.

f = maximum discharge flow rate, gpm

[1] The maximum activity concentration is based on a selected isotopic mixture so that an allowable value can be calculated. The selected isotopic mixture will be documented in TI 45. If the actual batch MPC is less restrictive than the MPC for the selected isotopic mixture, then the actual activity concentration may be higher than the calculated maximum activity concentration.

The monitor isolation allowable value, in cps, for releases to the CCW discharge conduit is calculated using the following equation:

$$\text{Monitor Isolation Allowable Value} = (A * \sum_i WF_i * E_i) + B$$

where:

A = maximum batch activity concentration as calculated above, µCi/ml
WF_i = weighting factor for nuclide i, defined as the fraction of the total concentration which is attributed to nuclide i
E_i = efficiency of the monitor for nuclide i, cps/µCi/ml
B = monitor background, cps

The calculation of these allowable values are documented further in TI 45, including the numerical values for each of the parameters described above.

6.2.2 Raw Cooling Water and Residual Heat Removal Service Water Monitors

The allowable value for the Raw Cooling Water (RCW) monitors and the Residual Heat Removal Service Water (RHRSW) monitors (RM-90-132 and RM-90-133,134 respectively), shown in Figure 6.1, will be established using the methodology below. The alarm/trip allowable values will be set such that Equation 6.3 is satisfied. The allowable values for these monitors, which will alarm in the control room, are based on the 10 CFR 20 Appendix B concentration limits. These allowable values are also based on a selected isotopic mixture.

The monitor alarm allowable values, in cpm, for the RCW and RHRSW effluent monitors are calculated using the following equation:

$$\text{Monitor Allowable Values} \leq (A * \sum_i WF_i * E_i) + B$$

where

A = total activity concentration, µCi/ml.
WF_i = weighting factor for nuclide i, defined as the fraction of the total concentration which is attributed to nuclide i.
E_i = efficiency of the monitor for nuclide i, cpm/µCi/ml.
B = monitor background, cpm.

The calculation of these allowable values are documented further in TI 45, including the numerical values for each of the parameters described above.

6.3 CUMULATIVE LIQUID EFFLUENT DOSE CALCULATION

6.3.1 Monthly Analysis

Principal radionuclides will be used to conservatively estimate the monthly contribution to the cumulative dose. If the projected dose calculated by this monthly method exceeds the monthly fraction of the annual limits in Control 1.2.1.2, then the methodology in Section 6.6 will be implemented.

The 20 nuclides listed below, based on operational source terms, contribute more than 95 percent of the total estimated dose to the total body and the most critical organ for both the water and fish ingestion pathways. The organs considered for both water ingestion and fish ingestion are the gastrointestinal tract (GIT), bone, thyroid and liver.

H-3	Fe-59	Sr-90	I-131
Na-24	Co-58	Zr/Nb-95	I-133
Cr-51	Co-60	Mo/Tc-99m	Cs-134
Mn-54	Zn-65	Ag-110m	Cs-136
Fe-55	Sr-89	Sb-124	Cs-137

A conservative calculation of the monthly dose will be done according to the following procedure. First, the monthly operating report containing the release data will be obtained and the activities reported (if any) for each of the above 20 radionuclides will be noted. This information will then be used in the following calculations.

6.3.1.1 Water Ingestion

The dose to an individual from ingestion of water is described by the following equation.

$$D_{jk} = \frac{10^{12}}{0.95} \sum_{i=1}^{20} (DFL)_{ijk} \, I_{ik} \qquad (6.4)$$

where:

D_{jk} = dose for the jth organ and the kth age group from the 20 radionuclides, mrem.
j = the organ of interest (bone, GIT, thyroid, liver or total body).
k = the age group being considered, child or adult.
10^{12} = conversion factor, pCi/Ci.
0.95 = conservative correction factor, considering only 20 radionuclides.
DFL_{ijk} = ingestion dose commitment factor for the ith radionuclide for the jth organ for the kth age group, mrem/pCi (Table 6.4)
I_{ik} = monthly activity ingested of the ith radionuclide by the kth age group, Ci.

The activity ingested due to drinking water, I_{ik}, is described by:

$$I_{ik} = \frac{10^3 \; A_i \; U_{wa} \; (1/12)}{F \; d \; (7.34E+10)} \qquad (6.5)$$

where:

10^3 = conversion factor, ml/L.
A_i = activity released of ith radionuclide during the month, Ci.
U_{wa} = maximum individual water consumption rate corresponding to the kth age group (Table 6.3), L/yr.
1/12 = conversion factor, yr/month.
F = average river flow rate for the month (cubic feet per second)
d = fraction of river flow available for dilution (0.30)
7.34E+10 = conversion from cubic feet per second to milliliters per month

Inserting this for I_{ik} in equation 6.4, the dose equation for water ingestion then becomes:

$$D_{jk} = \frac{3.98E+03}{F} \sum_{i=1}^{20} U_{wa} \; DFL_{ijk} \; A_i \qquad (6.6)$$

6.3.1.2 Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation 6.4. In this case, the activity ingested of the ith radionuclide due to eating fish (I_{ik}) is described by

$$I_{ik} = \frac{10^3 \; A_i \; B_i \; U_{fa} \; (1/12)}{F \; d \; (7.34E{+}10)} \qquad (6.7)$$

where:

10^3 = conversion factor, g/kg.
A_i = activity released of the ith radionuclide during the month, Ci
B_i = bioaccumulation factor of ith radionuclide, µCi/g per µCi/ml. (Table 6.5)
U_{fa} = amount of fish eaten yearly by the kth age group (Table 6.3), kg/yr.
1/12 = conversion factor, yr/month.
F = average river flow rate for the month, cubic feet per second.
d = fraction of river flow available for dilution, 0.30.
7.34E+10 = conversion from cubic feet per second to milliliters per month.

Inserting this for I_{ik} in equation 6.4, the dose equation for fish ingestion then becomes:

$$D_{jk} = \frac{3.98E{+}03}{F} \sum_{i=1}^{20} A_i \; B_i \; U_{fa} \; DFL_{ijk} \qquad (6.8)$$

6.3.1.3 Recreation

For the recreation dose calculation, the total dose is estimated based on a calculation of the shoreline dose for Co-58, Co-60, Cs-134, and Cs-137. The shoreline dose due to these four nuclides is expected to contribute over 95 percent of the total recreation dose. The total body and maximum organ dose to an individual via the shoreline recreation pathway are assumed to be equal. The recreation dose is described by the following equation:

$$D_r = \frac{10^{12}}{0.95} \sum_{i=1}^{4} 42\ DF_{Gi}\ \xi_i \qquad (6.9)$$

where:

D_r = recreation dose from plant releases, mrem.
10^{12} = conversion factor, pCi/Ci.
0.95 = conservative correction factor for considering only 4 radionuclides.
42 = assumed monthly exposure time for maximum individual, hours
DF_{Gi} = dose commitment factor for standing on contaminated ground for the ith radionuclide, mrem/hr per pCi/m^2 (Table 6.6).
ξ_i = concentration of ith radionuclide in shoreline sediment, Ci/m^2, as described by the following equation (based on equation A-5 in Regulatory Guide 1.109).

$$= 10^3\ 6.94E{-}04\ 100\ RHL_i\ W[1-\exp(-\lambda_i t_b]\ C_i \qquad (6.10)$$

where:

10^3 = conversion factor, ml/L.
6.94E-04 = conversion factor, d/min.
RHL_i = radiological half-life of the ith radioisotope, minutes (Table 1.11).
100 = conversion factor, L/(M^2d) (defined in Regulatory Guide 1.109).
W = shoreline width factor (Table 6.3).
λ_i = decay constant of the ith radionuclide, sec^{-1} (Table 1.11).
t_b = buildup time in sediment, seconds (Table 6.3)
C_i = concentration of ith radionuclide in the Tennessee River, Ci/ml.
= A_i/(F d 7.34E+10)

where:

A_i = activity released of ith radionuclide during the month, Ci/month.
F = average river flow for the month, cfs.
d = fraction of river flow available for dilution, 0.30.
7.34E+10 = conversion from cfs to ml/month.

The recreation dose equation then becomes:

$$D_r = \frac{1}{F} (29.8\ A_1 + 1690\ A_2 + 539\ A_3 + 812\ A_4) \qquad (6.11)$$

where:

A_1, A_2, A_3, A_4, = the activities of Co-58, Co-60, Cs-134, and Cs-137, respectively, µCi.

6.3.1.4 Monthly Summary

To obtain the total monthly dose to the total body, sum the total body dose from water ingestion, the total body dose from fish ingestion, and the recreation dose. This value will be compared to the limit for total body dose. To obtain the total monthly dose to the maximum organ, sum the maximum organ dose from water ingestion, the maximum organ dose from fish ingestion, and the recreation dose. This value will be compared to the limit for maximum organ dose. Calendar quarter and calendar year doses are first estimated by summing the doses calculated for each month in that year. However, if the annual doses determined in this manner exceed or approach the specification limits, doses calculated for previous quarters with the methodology of ODCM Section 6.6 will be used instead of those quarterly doses estimated by summing monthly results. An annual check will be made to ensure that the monthly dose estimates account for at least 95 percent of the dose calculated by the method described in ODCM Section 6.6. If less than 95 percent of the dose has been estimated, either a new list of principal isotopes will be prepared or a new correction factor will be used. The latter option will not be used if less than 90 percent of the total dose is predicted.

6.4 LIQUID RADWASTE TREATMENT SYSTEM

The liquid radwaste treatment system shall be maintained and operated to keep releases ALARA. A flow diagram for the LRTS is given in Figure 6.2.

6.5 DOSE PROJECTIONS

Dose projections will be done by averaging the calculated dose for the most recent month and the calculated dose for the previous month and assigning that average dose as the projection for the current month.

6.6 DOSE CALCULATIONS FOR REPORTING PURPOSES

A complete dose analysis utilizing the total estimated liquid releases for each calendar quarter will be performed and reported as required in ODCM Administrative Control 5.2. Methodology for this analysis is that which is described in this section using the quarterly release values reported by the plant personnel. The releases are assumed, for this calculation, to be continuous over the 90 day period.

The average dilution factor, D, used for these calculations is:

$$D = \frac{1}{RF * 0.30} \quad \text{(for receptors upstream of Wheeler Dam)} \qquad (6.13a)$$

and

$$D = \frac{1}{RF} \quad \text{(for receptors downstream of Wheeler Dam)} \qquad (6.13b)$$

where:

RF = the average actual riverflow for the location at which the dose is being determined, cfs.
0.30 = the fraction of the riverflow available for dilution in the near field, dimensionless.

6.6.1 Water Ingestion

Water ingestion doses are calculated for each Public Water Supply (PWS) identified within a 50 mile radius downstream of BFN (Table 6.1). Water ingestion doses are calculated for the total body and each internal organ as described below:

$$D_{org} = 10^6 \; 9.8E{-}09 \; A_{Wit} \; Q_i \; D \; \exp(-8.64E{+}04 \; \lambda_i \; t_d) \qquad (6.14)$$

where

10^6 = conversion factor, µCi/Ci.
9.8E-09 = conversion factor, cfs per ml/hour.
A_{Wit} = Dose factor for water ingestion for nuclide i, age group t, mrem/hour per µCi/ml, as calculated in Section 6.7.1.
Q_i = Quantity of nuclide i released during the quarter, Curies.
D = dilution factor, as described above, cfs^{-1}.
λ_i = radiological decay constant of nuclide i, $seconds^{-1}$ (Table 6.3).
t_d = decay time for water ingestion, equal to the travel time from the plant to the water supply plus one-half day (12 hours) to account for the time of processing at the water supply (per Regulatory Guide 1.109), days.
8.64E+04 = conversion factor, seconds per day.

6.6.2 Fish Ingestion

Fish ingestion doses are calculated for each identified reach within a 50 mile radius downstream of BFN (Table 6.1). Individual fish ingestion doses are calculated for the total body and each internal organ as described below:

$$D_{org} = 10^6 \; 9.8E{-}09 \; 0.25 \; A_{Fit} \; Q_i \; D \; \exp(-8.64E{+}04 \; \lambda_i \; t_d) \qquad (6.15)$$

where

10^6 = conversion factor, µCi/Ci.
9.8E-09 = conversion factor, cfs per ml/hour.
0.25 = fraction of the yearly fish consumption eaten in one quarter, dimensionless.
A_{Fit} = Dose factor for fish ingestion for nuclide i, age group t, mrem/hour per µCi/ml, as calculated in ODCM Section 6.7.2.
Q_i = Quantity of nuclide i released during the quarter, Curies.
D = dilution factor, as described above, cfs^{-1}.
λ_i = radiological decay constant of nuclide i, $seconds^{-1}$ (Table 6.3).
t_d = decay time for fish ingestion, equal to the travel time from the plant to the center of the reach plus one day to account for transit through the food chain and food preparation time (per Regulatory Guide 1.109), days.
8.64E+04 = conversion factor, seconds per day.

6.6.3 Shoreline Recreation

Recreation doses are calculated for each identified reach within a 50 mile radius downstream of BFN (Table 6.1). It is assumed that the maximum exposed individual spends 500 hours per year on the shoreline at a location immediately downstream from the diffusers. Individual recreation shoreline doses are calculated for the total body and skin as described below:

$$D_{org} = 10^6 \; 9.8E{-}09 \; rf \; A_{Rit} \; Q_i \; D \; \exp(-8.64E{+}04 \; \lambda_i \; t_d) \qquad (6.16)$$

where

10^6 = conversion factor, µCi/Ci.
9.8E-09 = conversion factor, cfs per ml/hour.
rf = recreation factor, used to account for the fact that the same amount of time will not be spent at a recreation site during each quarter. Recreation factors used are:
1st quarter - 0.1
2nd quarter - 0.3
3rd quarter - 0.4
4th quarter - 0.2.

A_{Rit} = Dose factor for shoreline recreation for nuclide i, age group t, mrem/hour per µCi/ml, as calculated in ODCM Section 6.7.3.
Q_i = Quantity of nuclide i released during the quarter, Curies.
D = dilution factor, as described above, cfs^{-1}.
λ_i = radiological decay constant of nuclide i, $seconds^{-1}$ (Table 6.3).
t_d = decay time for recreation, equal to the travel time from the plant to the center of the reach, days.
8.64E+04 = conversion factor, seconds per day.

6.6.4 Total Maximum Individual Dose

The total maximum individual total body dose is obtained by summing the following for each age group: the highest total body water ingestion dose from among all the public water supplies; the highest total body fish ingestion dose from among all the reaches; and the total body maximum shoreline recreation dose. The total maximum individual organ dose is obtained by summing the following for each organ and each age group: that organ's highest water ingestion dose from among all the public water supplies; that organ's highest fish ingestion dose from among all the reaches; and the total body maximum shoreline recreation dose. The total maximum individual skin dose is that skin dose calculated for the maximum shoreline dose.

6.6.5 Population Doses

For determining population doses to the 50-mile population around the plant, an average dose is calculated for each age group and each pathway and then multiplied by the population.

For water ingestion, the general equation used for calculating the population doses, POPWTR, in man-rem for a given PWS is:

$$POPWTR_t = 10^{-3} \sum_{m=1}^{3} POP_m \sum_{a=1}^{4} POP_a \quad ATMW_a \quad TWDOS_{amt} \qquad (6.17)$$

where:

$POPWTR_t$ = water ingestion population dose to organ t, man-rem.
POP_a = fraction of population in each age group a (from NUREG CR-1004, Table 3.39).
= 0.665 for adult
= 0.168 for child
= 0.015 for infant
= 0.153 for teen
POP_m = population at PWS m. The 3 PWSs and their populations are listed in Table 6.1.
$ATMW_a$ = ratio of average to maximum water ingestion rates for each age group a. Maximum water ingestion rates are given in Table 6.3. Average water ingestion rates are obtained from R.G. 1.109 Table E-4). The ratios are:
= 0.5069 for adult
= 0.5098 for child
= 0.7879 for infant
= 0.5098 for teen
$TWDOS_{amt}$ = total individual water ingestion dose to organ t at PWS m, to the age group a, as described in Section 6.6.1, mrem.
10^{-3} = conversion factor for rem/mrem.

For population doses resulting from fish ingestion the calculation assumes that all fish caught within a 50-mile radius downstream of BFN are consumed by local population. An additional 7-days decay is added due to distribution time of sport fish. The general equation for calculating population doses, POPF, in man-rem from fish ingestion of all fish caught within a 50-mile radius downstream is:

$$POPF_t = 10^{-3} \; 10^{-3} \sum_{r=1}^{3} \sum_{a=1}^{3} \frac{453.6 \; HVST \; APR_r}{FISH_a \; POP_a} \; POP_a \; TFDOS_{art} \qquad (6.18)$$

where:

$POPF_t$ = total fish ingestion population dose to organ t, man-rem.
HVST = fish harvest for the Tennessee River, 8.32 lbs/acre/year.
APR_r = size of reach r, acres (Table 6.1).
$TFDOS_{art}$ = total fish ingestion dose to organ t for reach r, for the age group a, as described in Section 6.6.2, mrem. Calculated with t_d in that equation equal to travel time plus 8 days.
POP_a = fraction of population in each age group a, as given above.
$FISH_a$ = amount of fish ingested by each age group a, kg/year per person. The average fish ingestion rates (R.G. 1.109 Table E-4) are:

Adult = 6.9
Child = 2.2
Teen = 5.2

453.6 = conversion factor, g/lb.
10^{-3} = conversion factor, rem/mrem.
10^{-3} = conversion factor, kg/g.

For shoreline recreation, the general equation used for calculating the population doses, POPR, in man-rem is:

$$POPR_t = \frac{REQFRA}{10^3} \sum_{r=1}^{3} SHVIS_r \; HRSVIS_r \; TSHDOS_{rt} \qquad (6.19)$$

where:

$POPR_t$ = total recreation population dose for all reaches to organ t, man-rem.
REQFRA = fraction of yearly recreation which occurs in that quarter, as given in Section 6.6.3, year per quarter.
$SHVIS_r$ = shoreline visits per year at each reach r, (Table 6.1).
$HRSVIS_r$ = length of shoreline recreation visit at reach r, 5 hours.
10^3 = conversion factor, mrem/rem.
$TSHDOS_{rt}$ = total shoreline dose rate for organ t, in reach r, mrem-quarter/h per quarter.

$$= \frac{Q_i \exp(-\lambda_i t_r) \; K_c \; M \; DF_{Git} \; 10^{12} \; 24 \; 10^3 \; D_r}{2.22E11 \; \lambda_i}$$

where:

Q_i = total activity released during the quarter, Ci.
λ_i = decay constant for nuclide i, day^{-1}.
t_r = travel time from the plant to reach r, days.
K_c = transfer coefficient from water to sediment, L/kg-hr, (Table 6.3).
M = mass density of sediment, kg/m^2, (Table 6.3).
DF_{Git} = dose conversion factor for standing on contaminated ground for nuclide i and organ t (total body and skin), mrem/hr per pCi/m^2.
10^{12} = conversion factor, pCi/Ci.
24 = conversion factor, hr/day.
10^3 = conversion factor, ml/L.
D_r = dilution factor for reach r, cfs^{-1}. Calculated as described in Equation 6.13.
2.22E11 = conversion factor, ml/quarter per cfs.

6.7 LIQUID DOSE FACTOR EQUATIONS

6.7.1 Water Ingestion Dose Factors

$$A_{Wit} = \frac{DF_{Liat}\ U_{wa}\ 10^6\ 10^3}{8760}$$

where:

DF_{Liat} = ingestion dose conversion factor for nuclide i, age group a, organ t, mrem/pCi, (Table 6.4).
U_{wa} = water consumption rate for age group a, L/year, (Table 6.3).
10^6 = conversion factor, pCi/μCi.
10^3 = conversion factor, ml/L.
8760 = conversion factor, hours per year.

6.7.2 Fish Ingestion Dose Factors

$$A_{Fit} = \frac{DF_{Liat}\ U_{fa}\ B_i\ 10^6\ 10^3}{8760}$$

where:

DF_{Liat} = ingestion dose conversion factor for nuclide i, age group a, organ t, mrem/pCi, (Table 6.4).
U_{fa} = fish consumption rate for age group a, kg/year, (Table 6.3).
B_i = bioaccumulation factor for nuclide i, pCi/kg per pCi/L, (Table 6.5).
10^6 = conversion factor, pCi/μCi.
10^3 = conversion factor, ml/L.
8760 = conversion factor, hours per year.

6.7.3 Shoreline Recreation Dose Factors

$$A_{Rit} = \frac{DF_{Git}\ K_c\ M\ W\ 10^3\ 10^6\ U}{8760 * 3600\ \lambda_i} [1-\exp(-\lambda_i\ t_b)]$$

where:

DF_{Git} = dose conversion factor for standing on contaminated ground for nuclide i and organ t (total body and skin), mrem/hr per pCi/m^2, (Table 6.6).
K_c = transfer coefficient from water to shoreline sediment, L/kg-hr, (Table 6.3).
M = mass density of sediment, kg/m^2, (Table 6.3).
W = shoreline width factor, dimensionless, (Table 6.3).
10^3 = conversion factor, ml/L.
10^6 = conversion factor, pCi/μCi.
3600 = conversion factor, seconds/hour.
λ_i = decay constant for nuclide i, seconds^{-1}, (Table 6.2).
t_b = time shoreline is exposed to the concentration in the water, seconds, (Table 6.3).
U = usage factor, 500 hours/year.
8760 = conversion factor, hours/year.

Table 6.1
RECEPTORS FOR LIQUID DOSE CALCULATIONS

Tennessee River Reaches Within
50 Mile Radius Downstream of BFN

Name	Beginning TRM*	Ending TRM	Size (acres)	Recreation visits/year
Wheeler Lake below BFN	294.0	275.0	26076	1,408,600
Wilson Lake	275.0	260.0	15930	3,816,800
Pickwick Lake	260.0	230.0	15048	705,500

Public Water Supplies Within
50 Mile Radius Downstream of BFN

Name	TRM	Population
Muscle Shoals, AL	259.6	10,740
Sheffield, AL	254.3	13,065
Cherokee, AL	239.2	3,400

* TRM = Tennessee River Mile

Table 6.2 (1 of 3)
RADIONUCLIDE DECAY AND STABLE ELEMENT TRANSFER DATA

	Half-Life (minutes)	λ (1/s)	B_{iv}	F_{mi} (cow)	F_{mi} (goat)	F_{fi} (beef)
H-3	6.46E+06	1.79E-09	4.80E+00	1.00E-02	1.70E-01	1.20E-02
C-14	3.01E+09	3.84E-12	5.50E+00	1.20E-02	1.00E-01	3.10E-02
Na-24	9.00E+02	1.28E-05	5.20E-02	4.00E-02	4.00E-02	3.00E-02
P-32	2.06E+04	5.61E-07	1.10E+00	2.50E-02	2.50E-01	4.60E-02
Cr-51	3.99E+04	2.90E-07	2.50E-04	2.20E-03	2.20E-03	2.40E-03
Mn-54	4.50E+05	2.57E-08	2.90E-02	2.50E-04	2.50E-04	8.00E-04
Mn-56	1.55E+02	7.45E-05	2.90E-02	2.50E-04	2.50E-04	8.00E-04
Fe-55	1.42E+06	8.13E-09	6.60E-04	1.20E-03	1.30E-04	1.20E-02
Fe-59	6.43E+04	1.80E-07	6.60E-04	1.20E-03	1.30E-04	1.20E-02
Co-57	3.90E+05	2.96E-08	9.40E-03	1.00E-03	1.00E-03	1.30E-02
Co-58	1.02E+05	1.13E-07	9.40E-03	1.00E-03	1.00E-03	1.30E-02
Co-60	2.77E+06	4.17E-09	9.40E-03	1.00E-03	1.00E-03	1.30E-02
Ni-63	5.27E+07	2.19E-10	1.90E-02	6.70E-03	6.70E-03	5.30E-02
Ni-65	1.51E+02	7.65E-05	1.90E-02	6.70E-03	6.70E-03	5.30E-02
Cu-64	7.62E+02	1.52E-05	1.20E-01	1.40E-02	1.30E-02	9.70E-04
Zn-65	3.52E+05	3.28E-08	4.00E-01	3.90E-02	3.90E-02	3.00E-02
Zn-69m	8.26E+02	1.40E-05	4.00E-01	3.90E-02	3.90E-02	3.00E-02
Zn-69	5.56E+01	2.08E-04	4.00E-01	3.90E-02	3.90E-02	3.00E-02
Br-82	2.12E+03	5.45E-06	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Br-83	1.43E+02	8.08E-05	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Br-84	3.18E+01	3.63E-04	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Br-85	2.87E+00	4.02E-03	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Rb-86	2.69E+04	4.29E-07	1.30E-01	3.00E-02	3.00E-02	3.10E-02
Rb-88	1.78E+01	6.49E-04	1.30E-01	3.00E-02	3.00E-02	3.10E-02
Rb-89	1.54E+01	7.50E-04	1.30E-01	3.00E-02	3.00E-02	3.10E-02
Sr-89	7.28E+04	1.59E-07	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Sr-90	1.50E+07	7.70E-10	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Sr-91	5.70E+02	2.03E-05	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Sr-92	1.63E+02	7.09E-05	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Y-90	3.85E+03	3.00E-06	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-91m	4.97E+01	2.32E-04	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-91	8.43E+04	1.37E-07	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-92	2.12E+02	5.45E-05	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-93	6.06E+02	1.91E-05	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Zr-95	9.22E+04	1.25E-07	1.70E-04	5.00E-06	5.00E-06	3.40E-02
Zr-97	1.01E+03	1.14E-05	1.70E-04	5.00E-06	5.00E-06	3.40E-02
Nb-95	5.05E+04	2.29E-07	9.40E-03	2.50E-03	2.50E-03	2.80E-01
Nb-97	7.21E+01	1.60E-04	9.40E-03	2.50E-03	2.50E-03	2.80E-01
Mo-99	3.96E+03	2.92E-06	1.20E-01	7.50E-03	7.50E-03	1.10E-03
Tc-99m	3.61E+02	3.20E-05	2.50E-01	2.50E-02	2.50E-02	4.00E-01
Tc-101	1.42E+01	8.13E-04	2.50E-01	2.50E-02	2.50E-02	4.00E-01
Ru-103	5.67E+04	2.04E-07	5.00E-02	1.00E-06	1.00E-06	4.00E-01
Ru-105	2.66E+02	4.34E-05	5.00E-02	1.00E-06	1.00E-06	4.00E-01
Ru-106	5.30E+05	2.18E-08	5.00E-02	1.00E-06	1.00E-06	4.00E-01
Ag-110m	3.60E+05	3.21E-08	1.50E-01	5.00E-02	5.00E-02	1.70E-02

Table 6.2 (2 of 3)
RADIONUCLIDE DECAY AND STABLE ELEMENT TRANSFER DATA

	Half-Life (minutes)	λ (1/s)	B_{iv}	F_{mi} (cow)	F_{mi} (goat)	F_{fi} (beef)
Sb-124	8.67E+04	1.33E-07	N/A	1.50E-03	1.50E-03	N/A
Sb-125	1.46E+06	7.91E-09	N/A	1.50E-03	1.50E-03	N/A
Te-125m	8.35E+04	1.38E-07	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-127m	1.57E+05	7.36E-08	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-127	5.61E+02	2.06E-05	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-129m	4.84E+04	2.39E-07	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-129	6.96E+01	1.66E-04	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-131m	1.80E+03	6.42E-06	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-131	2.50E+01	4.62E-04	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-132	4.69E+03	2.46E-06	1.30E+00	1.00E-03	1.00E-03	7.70E-02
I-130	7.42E+02	1.56E-05	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-131	1.16E+04	9.96E-07	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-132	1.38E+02	8.37E-05	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-133	1.25E+03	9.24E-06	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-134	5.26E+01	2.20E-04	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-135	3.97E+02	2.91E-05	2.00E-02	1.20E-02	4.30E-01	2.90E-03
Cs-134	1.08E+06	1.06E-08	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Cs-136	1.90E+04	6.08E-07	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Cs-137	1.59E+07	7.26E-10	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Cs-138	3.22E+01	3.59E-04	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Ba-139	8.31E+01	1.39E-04	5.00E-03	4.00E-04	4.00E-04	3.20E-03
Ba-140	1.84E+04	6.28E-07	5.00E-03	4.00E-04	4.00E-04	3.20E-03
Ba-141	1.83E+01	6.31E-04	5.00E-03	4.00E-04	4.00E-04	3.20E-03
Ba-142	1.07E+01	1.08E-03	5.00E-03	4.00E-04	4.00E-04	3.20E-03
La-140	2.41E+03	4.79E-06	2.50E-03	5.00E-06	5.00E-06	2.00E-04
La-142	9.54E+01	1.21E-04	2.50E-03	5.00E-06	5.00E-06	2.00E-04
Ce-141	4.68E+04	2.47E-07	2.50E-03	1.00E-04	1.00E-04	1.20E-03
Ce-143	1.98E+03	5.83E-06	2.50E-03	1.00E-04	1.00E-04	1.20E-03
Ce-144	4.09E+05	2.82E-08	2.50E-03	1.00E-04	1.00E-04	1.20E-03
Pr-143	1.95E+04	5.92E-07	2.50E-03	5.00E-06	5.00E-06	4.70E-03
Pr-144	1.73E+01	6.68E-04	2.50E-03	5.00E-06	5.00E-06	4.70E-03
Nd-147	1.58E+04	7.31E-07	2.40E-03	5.00E-06	5.00E-06	3.30E-03
W-187	1.43E+03	8.08E-06	1.80E-02	5.00E-04	5.00E-04	1.30E-03
Np-239	3.39E+03	3.41E-06	2.50E-03	5.00E-06	5.00E-06	2.00E-04
Ar-41	1.10E+02	1.05E-04	N/A	N/A	N/A	N/A
Kr-83m	1.10E+02	1.05E-04	N/A	N/A	N/A	N/A
Kr-85m	2.69E+02	4.29E-05	N/A	N/A	N/A	N/A
Kr-85	5.64E+06	2.05E-09	N/A	N/A	N/A	N/A
Kr-87	7.63E+01	1.51E-04	N/A	N/A	N/A	N/A
Kr-88	1.70E+02	6.79E-05	N/A	N/A	N/A	N/A
Kr-89	3.16E+00	3.66E-03	N/A	N/A	N/A	N/A
Kr-90	5.39E-01	2.14E-02	N/A	N/A	N/A	N/A
Xe-131m	1.70E+04	6.79E-07	N/A	N/A	N/A	N/A
Xe-133m	3.15E+03	3.67E-06	N/A	N/A	N/A	N/A

Table 6.2 (3 of 3)
RADIONUCLIDE DECAY AND STABLE ELEMENT TRANSFER DATA

	Half-Life (minutes)	λ (1/s)	B_{iv}	F_{mi} (cow)	F_{mi} (goat)	F_{fi} (beef)
Xe-133	7.55E+03	1.53E-06	N/A	N/A	N/A	N/A
Xe-135m	1.54E+01	7.50E-04	N/A	N/A	N/A	N/A
Xe-135	5.47E+02	2.11E-05	N/A	N/A	N/A	N/A
Xe-137	3.83E+00	3.02E-03	N/A	N/A	N/A	N/A
Xe-138	1.41E+01	8.19E-04	N/A	N/A	N/A	N/A

References:

Half lives for all nuclides: DOE-TIC-11026, "Radioactive Decay Data Tables - A handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessment," D. C. Kocher, 1981.

Transfer factors for Sb- isotopes are from ORNL 4992, "Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment," March 1976, Table 2-7.

Cow-milk transfer factors for Iodine, Strontium, and Cesium nuclides are from NUREG/CR-1004, Table 3.17.

Goat-milk transfer factors for Iodine nuclides are from NUREG/CR-1004, Table 3.17.

Beef transfer factors for Iron, Copper, Molybdenum, and Cesium nuclides are from NUREG/CR-1004, Table 3.18.

All other nuclides' transfer factors are from Regulatory Guide 1.109, Tables E-1 and E-2.

Table 6.3 (1 of 2)

DOSE CALCULATION FACTORS

Factor	Value	Units	Reference
BR_a (infant)	1400	m^3/year	ICRP 23
BR_a (child)	5500	m^3/year	ICRP 23
BR_a (teen)	8000	m^3/year	ICRP 23
BR_a (adult)	8100	m^3/year	ICRP 23
f_g	1		TVA Assumption
f_L	1		R. G. 1.109 (Table E-15)
f_p	1		TVA Assumption
f_s	0		TVA Assumption
H	9	g/m^3	TVA Value
K_c	0.072	L/kg-hr	R. G. 1.109 (Section 2.C.)
M	40	kg/m^2	R. G. 1.109 (Section 2.C.)
P	240	kg/m^2	R. G. 1.109 (Table E-15)
Q_f (cow)	64	kg/day	NUREG/CR-1004 (Sect. 3.4)
Q_f (goat)	08	kg/day	NUREG/CR-1004 (Sect. 3.4)
r	0.47		NUREG/CR-1004 (Sect. 3.2)
t_b	4.73E+08 (15 years)	seconds	R. G. 1.109 (Table E-15)
t_{cb}	7.78E+06 (90 days)	seconds	SQN FSAR Section 11.3.9.1
t_{csf}	1.56E+07 (180 days)	seconds	SQN FSAR Section 11.3.9.1
t_e	5.18E+06 (60 days)	seconds	R. G. 1.109 (Table E-15)
t_{ep}	2.59E+06 (30 days)	seconds	R. G. 1.109 (Table E-15)
t_{esf}	7.78E+06 (90 days)	seconds	R. G. 1.109 (Table E-15)
t_{fm}	8.64E+04 (1 day)	seconds	SQN FSAR Section 11.3.9.1
t_{hc}	8.64E+04 (1 day)	seconds	NUREG/CR-1004, Table 3.40
t_s	1.12E+06 (13 days)	seconds	NUREG/CR-1004, Table 3.40
t_{sv}	2.38E+07 (275 days)	seconds	SQN FSAR Section 11.3.9.1
U_m (infant)	0	kg/year	R. G. 1.109 (Table E-5)
U_m (child)	41	kg/year	R. G. 1.109 (Table E-5)
U_m (teen)	65	kg/year	R. G. 1.109 (Table E-5)
U_m (adult)	110	kg/year	R. G. 1.109 (Table E-5)
U_p (infant)	330	L/year	R. G. 1.109 (Table E-5)
U_p (child)	330	L/year	R. G. 1.109 (Table E-5)
U_p (teen)	400	L/year	R. G. 1.109 (Table E-5)
U_p (adult)	310	L/year	R. G. 1.109 (Table E-5)

Table 6.3 (2 of 2)
DOSE CALCULATION FACTORS

Factor	Value	Units	Reference
U_f(infant)	0	kg/year	R. G. 1.109 (Table E-5)
U_f(child)	6.9	kg/year	R. G. 1.109 (Table E-5)
U_f(teen)	16	kg/year	R. G. 1.109 (Table E-5)
U_f(adult)	21	kg/year	R. G. 1.109 (Table E-5)
U_{FL} (infant)	0	kg/year	R. G. 1.109 (Table E-5)
U_{FL} (child)	26	kg/year	R. G. 1.109 (Table E-5)
U_{FL} (teen)	42	kg/year	R. G. 1.109 (Table E-5)
U_{FL} (adult)	64	kg/year	R. G. 1.109 (Table E-5)
U_S (infant)	0	kg/year	R. G. 1.109 (Table E-5)
U_S (child)	520	kg/year	R. G. 1.109 (Table E-5)
U_S (teen)	630	kg/year	R. G. 1.109 (Table E-5)
U_S (adult)	520	kg/year	R. G. 1.109 (Table E-5)
U_w(infant)	330	L/year	R. G. 1.109 (Table E-5)
U_w(child)	510	L/year	R. G. 1.109 (Table E-5)
U_w(teen)	510	L/year	R. G. 1.109 (Table E-5)
U_w(adult)	730	L/year	R. G. 1.109 (Table E-5)
W	0.3	none	R. G. 1.109 (Table A-2)
Y_f	1.85	kg/m^2	NUREG/CR-1004 (Table 3.4)
Y_p	1.18	kg/m^2	NUREG/CR-1004 (Table 3.3)
Y_{sf}	0.64	kg/m^2	NUREG/CR-1004 (Table 3.3)
Y_{sv}	0.57	kg/m^2	NUREG/CR-1004 (Table 3.4) (value selected is for non-leafy vegetables)
λ_w (iodines)	7.71E-07 (15.4 d half-life)	sec^{-1}	NUREG/CR-1004 (Table 3.10)
λ_w (particulates)	5.21E-07 (10.4 d half-life)	sec^{-1}	NUREG/CR-1004 (Table 3.10)

Table 6.4 (1 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C-14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
Cr-51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
Mn-56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
Co-57	0.00E+00	1.75E-07	2.91E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Co-58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
Co-60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
Cu-64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
Zn-69m	1.70E-07	4.08E-07	3.73E-08	0.00E+00	2.47E-07	0.00E+00	2.49E-05
Br-82	0.00E+00	0.00E+00	2.26E-06	0.00E+00	0.00E+00	0.00E+00	2.59E-06
Br-83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
Br-84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
Br-85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
Rb-88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
Rb-89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
Sr-89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
Sr-90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
Sr-91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
Sr-92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y-90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y-91m	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y-91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-05
Y-92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y-93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
Nb-97	5.22E-11	1.32E-11	4.82E-12	0.00E+00	1.54E-11	0.00E+00	4.87E-08
Mo-99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
Tc-99m	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
Ru-105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
Ru-106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
Ag-110m	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05

Table 6.4 (2 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	2.80E-06	5.29E-08	1.11E-06	6.79E-09	0.00E-00	2.18E-06	7.95E-05
Sb-125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.00E-00	1.38E-06	1.97E-05
Te-125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
Te-127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
Te-129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
Te-131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
La-140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05

References:

Regulatory Guide 1.109, Table E-11.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 4.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 6.4 (3 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C-14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	0.00E+00	0.00E+00	0.00E+00	2.32E-05
Cr-51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
Mn-56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
Co-57	0.00E+00	2.38E-07	3.99E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Co-58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
Co-60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
Cu-64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
Zn-69m	2.40E-07	5.66E-07	5.19E-08	0.00E+00	3.44E-07	0.00E+00	3.11E-05
Br-82	0.00E+00	0.00E+00	3.04E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
Rb-88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
Rb-89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
Sr-89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
Sr-90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
Sr-91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Sr-92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y-90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y-91m	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y-91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y-92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y-93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
Nb-97	7.37E-11	1.83E-11	6.68E-12	0.00E+00	2.14E-11	0.00E+00	4.37E-07
Mo-99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
Tc-99m	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
Ru-103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
Ru-105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
Ru-106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
Ag-110m	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05

Table 6.4 (4 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	3.87E-06	7.13E-08	1.51E-06	8.78E-09	0.00E-00	3.38E-06	7.80E-05
Sb-125	2.48E-06	2.71E-08	5.80E-07	2.37E-09	0.00E+00	2.18E-06	1.93E-05
Te-125m	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
Te-127m	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
Te-129m	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
Te-131m	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
La-142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05

References:

Regulatory Guide 1.109, Table E-12.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 3.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 6.4 (5 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C-14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
Cr-51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
Mn-56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
Co-57	0.00E+00	4.93E-07	9.98E-07	0.00E+00	0.00E+00	0.00E+00	4.04E-06
Co-58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
Co-60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
Cu-64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
Zn-69m	7.10E-07	1.21E-06	1.43E-07	0.00E+00	7.03E-07	0.00E+00	3.94E-05
Br-82	0.00E+00	0.00E+00	7.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
Rb-88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
Rb-89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
Sr-89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
Sr-90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
Sr-91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
Sr-92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y-90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y-91m	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y-91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y-92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y-93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
Nb-97	2.17E-10	3.92E-11	1.83E-11	0.00E+00	4.35E-11	0.00E+00	1.21E-05
Mo-99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
Tc-99m	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
Ru-103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
Ru-105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
Ru-106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
Ag-110m	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05

Table 6.4 (6 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	1.11E-05	1.44E-07	3.89E-06	2.45E-08	0.00E+00	6.16E-06	6.94E-05
Sb-125	7.16E-06	5.52E-08	1.50E-06	6.63E-09	0.00E+00	3.99E-06	1.71E-05
Te-125m	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
Te-127m	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
Te-129m	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
Te-131m	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.00E+00	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05

References:

Regulatory Guide 1.109, Table E-13.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 2.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 6.4 (7 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C-14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
Cr-51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
Mn-56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
Co-57	0.00E+00	1.15E-06	1.87E-06	0.00E+00	0.00E+00	0.00E+00	3.92E-06
Co-58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
Co-60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
Cu-64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
Zn-69m	1.50E-06	3.06E-06	2.79E-07	0.00E+00	1.24E-06	0.00E+00	4.24E-05
Br-82	0.00E+00	0.00E+00	1.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
Rb-88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
Rb-89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
Sr-89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
Sr-90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
Sr-91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
Sr-92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y-90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y-91m	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y-91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y-92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y-93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
Nb-97	4.59E-10	9.79E-11	3.53E-11	0.00E+00	7.65E-11	0.00E+00	3.09E-05
Mo-99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
Tc-99m	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
Ru-103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
Ru-105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
Ru-106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
Ag-110m	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05

Table 6.4 (8 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.00E+00	1.34E-05	6.60E-05
Sb-125	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.00E+00	7.72E-06	1.64E-05
Te-125m	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
Te-127m	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
Te-129m	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
Te-131m	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05

References:

Regulatory Guide 1.109, Table E-14.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 1.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 6.5

BIOACCUMULATION FACTORS FOR FRESHWATER FISH

H-3	9.0E-01	Tc-99m	1.5E+01
C-14	4.6E+03	Tc-101	1.5E+01
Na-24	1.0E+02	Ru-103	1.0E+01
P-32	1.0E+05	Ru-105	1.0E+01
Cr-51	2.0E+02	Ru-106	1.0E+01
Mn-54	4.0E+02	Ag-110m	0.0E+00
Mn-56	4.0E+02	Sb-124	1.0E+00
Fe-55	1.0E+02	Sb-125	1.0E+00
Fe-59	1.0E+02	Te-125m	4.0E+02
Co-57	5.0E+01	Te-127m	4.0E+02
Co-58	5.0E+01	Te-127	4.0E+02
Co-60	5.0E+01	Te-129m	4.0E+02
Ni-63	1.0E+02	Te-129	4.0E+02
Ni-65	1.0E+02	Te-131m	4.0E+02
Cu-64	5.0E+01	Te-131	4.0E+02
Zn-65	2.0E+03	Te-132	4.0E+02
Zn-69	2.0E+03	I-130	4.0E+01
Zn-69m	2.0E+03	I-131	4.0E+01
Br-82	4.2E+02	I-132	4.0E+01
Br-83	4.2E+02	I-133	4.0E+01
Br-84	4.2E+02	I-134	4.0E+01
Br-85	4.2E+02	I-135	4.0E+01
Rb-86	2.0E+03	Cs-134	1.9E+03
Rb-88	2.0E+03	Cs-136	1.9E+03
Rb-89	2.0E+03	Cs-137	1.9E+03
Sr-89	5.6E+01	Cs-138	1.9E+03
Sr-90	5.6E+01	Ba-139	4.0E+00
Sr-91	5.6E+01	Ba-140	4.0E+00
Sr-92	5.6E+01	Ba-141	4.0E+00
Y-90	2.5E+01	Ba-142	4.0E+00
Y-91m	2.5E+01	La-140	2.5E+01
Y-91	2.5E+01	La-142	2.5E+01
Y-92	2.5E+01	Ce-141	1.0E+00
Y-93	2.5E+01	Ce-143	1.0E+00
Zr-95	3.3E+00	Ce-144	1.0E+00
Zr-97	3.3E+00	Pr-143	2.5E+01
Nb-95	3.0E+04	Pr-144	2.5E+01
Nb-97	3.0E+04	Nd-147	2.5E+01
Mo-99	1.0E+01	W-187	1.2E+03
		Np-239	1.0E+01

References:

Bioaccumulation factors for Antimony nuclides are from ORNL-4992, "A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment, March 1976, Table 4.12A.

Bioaccumulation factors for Iodine, Cesium, and Strontium nuclides are from NUREG/CR-1004, Table 3.2.4.

All other nuclides' bioaccumulation factors are from Regulatory Guide 1.109, Table A-1.

Table 6.6 (1 of 2)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/h per pCi/m^2)

Nuclide	Total Body	Skin
H-3	0.0	0.0
C-14	0.0	0.0
Na-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-57	1.77E-09	2.21E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Ni-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Zn-69m	5.50E-09	6.59E-09
Br-82	3.18E-08	3.90E-08
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91m	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Nb-97	8.11E-09	1.00E-08
Mo-99	1.90E-09	2.20E-09
Tc-99m	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110m	1.80E-08	2.10E-08
Sb-124	2.17E-08	2.57E-08

Table 6.6 (2 of 2)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/h per pCi/m^2)

Nuclide	Total Body	Skin
Sb-125	5.48E-09	6.80E-09
Te-125m	3.50E-11	4.80E-11
Te-127m	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129m	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131m	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	0.0	0.0
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

References:

Regulatory Guide 1.109, Table E-6.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities, D. C. Kocher, Health Physics Volume 38, April 1980.

Figure 6.1
LIQUID RELEASE POINTS

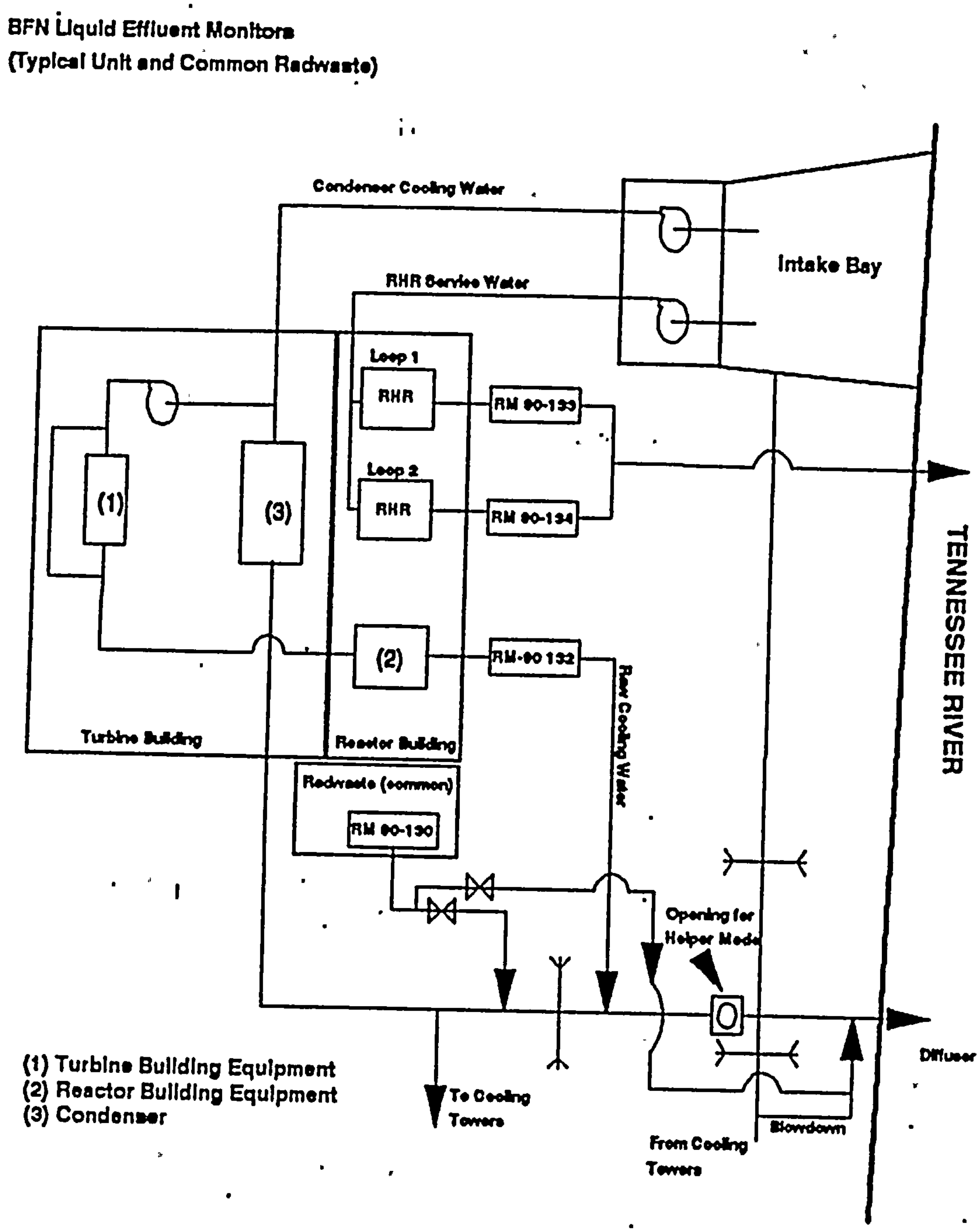
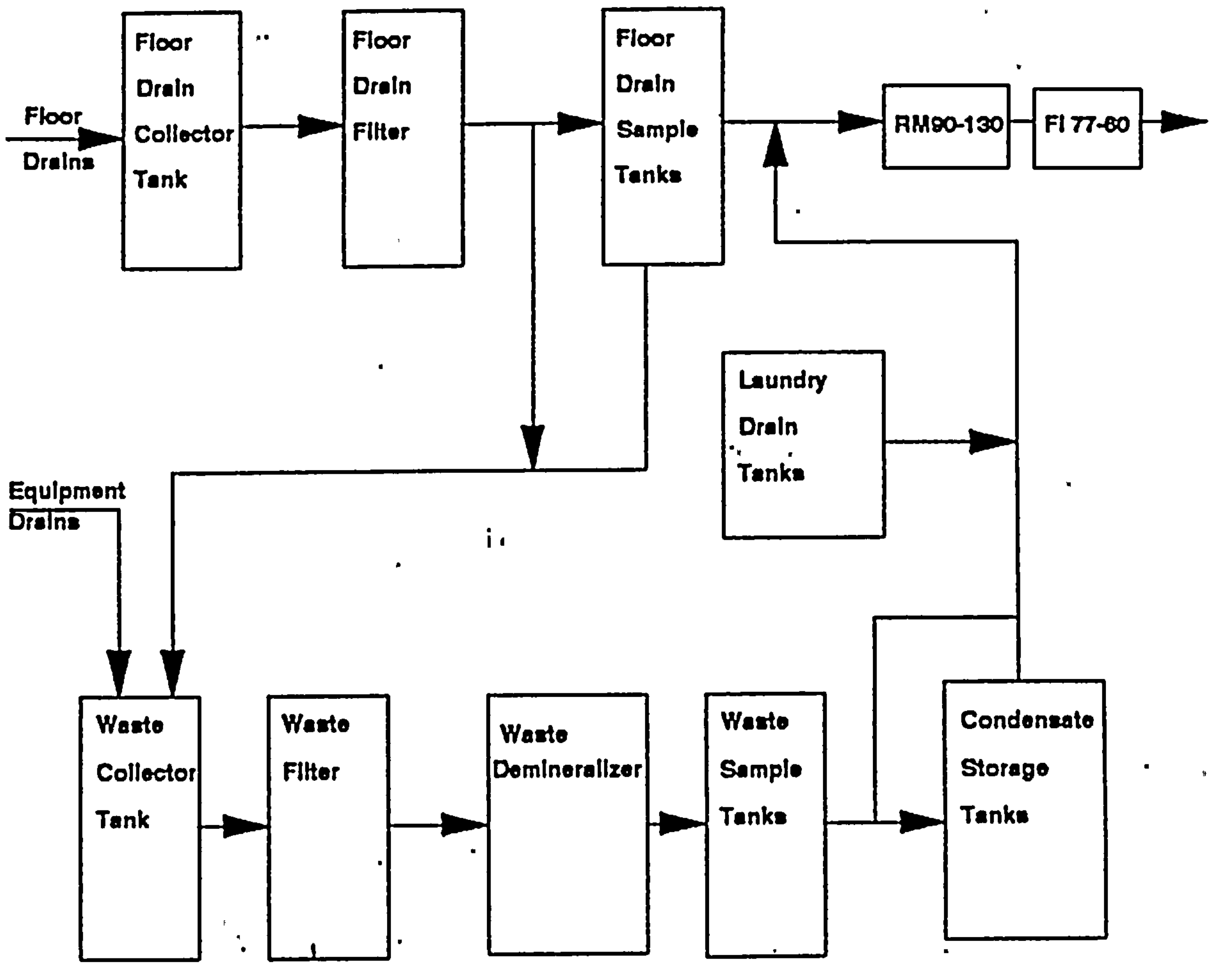


Figure 6.2
LIQUID RADWASTE SYSTEM



SECTION 7.0

GASEOUS EFFLUENTS

7.0 GASEOUS EFFLUENTS

RELEASE POINTS DESCRIPTION

There are eleven monitored discharge points at BFN: a Reactor Building exhaust for each unit, the Radwaste Building Exhaust, two sets of Turbine Deck Roof Fans for each unit, and the Stack. The Reactor and Radwaste Exhausts exit the plant on the roof of the reactor building.

The Reactor Building Exhausts include exhaust from the refuel floor of the reactor buildings, exhaust from the Primary Containment Purge System, and exhaust from the turbine buildings. These discharge points are monitored by radiation monitors 1-,2-,3-RM-90-250.

The Radwaste Building Exhaust includes exhaust from the common radwaste building. This discharge point is monitored by radiation monitor RM-90-252.

There are nine roof fans on the roof of each unit's turbine building to provide building ventilation. These are generally used in the warmer months to control building temperature. For each unit, there are two radiation monitors. One of these monitors the exhaust through four of the fans (1-,2-RM-90-249 and 3-RM-90-251). The other monitors the exhaust through the remaining five fans (1-,2-RM-90-251 and 3-RM-90-249).

The common 600 foot plant stack receives the Condenser Offgas exhaust, the Filter Cubicle exhaust, the Steam Packing and Mechanical Vacuum exhaust, and the Standby Gas Treatment System (SBGTS) exhaust. The stack effluents are monitored by radiation monitors RM-90-147 and 148.

Figures 7.1 and 7.2 show the Offgas System, the Standby Gas Treatment System and normal building ventilation with effluent monitor locations.

7.1 RELEASE RATE LIMIT METHODOLOGY

A dose rate (D_{TB}, D_S, or D_{TH}) is calculated based on the design objective source term mix used in the licensing of the plant. Dose rates are determined for (1) noble gases and (2) iodines and particulates as described below.

Total Body Dose Rate

The dose rate to the total body from nuclide i, D_{TBi} in mrem/year, is calculated using the following equation:

$$D_{TBi} = (^X/Q)\ Q_i\ DF_{Bi}$$

where

- $^X/Q$ = relative concentration, s/m^3. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.9.2 using the historical meteorological data for the period 1977-1979 given in Table 7.3.
- Q_i = release rate of noble gas nuclide i, µCi/sec.
- DF_{Bi} = total body dose factor due to gamma radiation for noble gas nuclide i, mrem/y per µCi/m^3 (Table 7.4).

Skin Dose Rate

The dose rate to the skin for nuclide i, D_{Si} in mrem/year, is calculated using the following equation:

$$D_{Si} = (^X/Q)\ Q_i(DF_{Si} + 1.11\ DF_{\gamma i})$$

where

- $^X/Q$ = relative concentration, s/m^3. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.9.2 using the historical meteorological data for the period 1977-1979 given in Table 7.3.
- Q_i = release rate of noble gas nuclide i, µCi/sec.
- DF_{Si} = skin dose factor due to beta radiation for noble gas nuclide i, mrem/y per µCi/m^3 (Table 7.4).
- 1.11 = the average ratio of tissue to air energy absorption coefficients, mrem/mrad.
- $DF_{\gamma i}$ = dose conversion factor for external gamma for noble gas nuclide i, mrad/year per µCi/m^3 (Table 7.4).

Organ Dose Rate due to I-131, I-133, Tritium, and All Radionuclides in Particulate Form with Half-lives of Greater Than 8 Days

Organ dose rates are calculated for all age groups (adult, teen, child, and infant) and all organs (bone, liver, total body, thyroid, kidney, lung, and GI Tract) using the following equation:

For tritium,

$$D_{org} = Q_T(^X/Q)\ [R_{IT} + R_{CTP}]$$

For all other particulates,

$$D_{org} = Q_i[(^X/Q)R_{Ii} + (^D/Q)\ [R_{CPi}+R_{Gi}]]$$

where

Q_T = release rate of tritium in, µCi/sec.

$^X/Q$ = relative concentration, s/m^3. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.9.2 using the historical meteorological data for the period 1977-1979 given in Table 7.3.

R_{IT} = inhalation dose factor for tritium, mrem/year per $\mu Ci/m^3$. Dose factor is calculated as described in Section 7.8.13.

R_{CTP} = Grass-cow-milk dose factor for tritium, mrem/year per $\mu Ci/m^3$. Dose factor is calculated as described in Section 7.8.7.

Q_i = release rate of nuclide i, µCi/sec.

R_{Ii} = inhalation dose factor for each identified nuclide i, mrem/year per $\mu Ci/m^3$. Dose factors are calculated as described in Section 7.8.13.

D/Q = relative deposition, $1/m^2$. Relative deposition is calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.9.3 using the historical meteorological data for the period 1977-1979 given in Table 7.3.

R_{CPi} = Grass-cow-milk dose factor for each identified nuclide i, m^2-mrem/year per µCi/s. Dose factors are calculated as described in Section 7.8.1.

R_{Gi} = ground plane dose factor for each identified nuclide i, m^2-mrem/year per µCi/s. Dose factors are calculated as described in Section 7.8.14.

The dose rate limits of interest are:

Total Body = 500 mrem/yr
Skin = 3000 mrem/yr
Maximum Organ = 1500 mrem/yr

These limits are divided by the corresponding calculated dose rates described above:

$$R_{TB}(\text{vent or stack}) = \frac{\text{Total Body Dose Rate Limit}}{D_{TB}\ (\text{vent or stack})}$$

$$R_{S}(\text{vent or stack}) = \frac{\text{Skin Dose Rate Limit}}{D_{S}\ (\text{vent or stack})}$$

$$R_{TH}(\text{vent or stack}) = \frac{\text{Maximum Organ Dose Rate Limit}}{D_{TH}\ (\text{vent or stack})}$$

These ratios represent how far above or below the guidelines the dose rate calculations were.

A total release rate, Q, for each nuclide type (noble gas or iodine/particulate) and release point (building vent or stack) is calculated, using the source term data in Table 7.2. Thus, four total release rates are calculated:

Q_{ngv} = Total noble gas release rate from building exhaust vents, Ci/s.
Q_{ngs} = Total noble gas release rate from main stack, Ci/s.
Q_{ipv} = Total iodine and particulate release rate from building exhaust vents, Ci/s.
Q_{ips} = Total iodine and particulate release rate from main stack, Ci/s.

To obtain a release rate limit, r, for each nuclide type and release point, the total release rate, Q, for that nuclide type and release point is multiplied by the corresponding ratio, R:

For noble gases released from building vents:

$$r_{ngv} = R_{TBv}\, Q_{ngv}, \quad \text{or}$$
$$= R_{Sv}\, Q_{ngv}$$

whichever is more restrictive, i.e., smaller.

where

r_{ngv} = Calculated release rate limit for noble gases released from building vents.

R_{TBv} = Ratio of total body dose rate limit to total body dose rate for building vent releases, as calculated above.

Q_{ngv} = Total Table 7.2 noble gas release rate from building vents.

R_{Sv} = Ratio of skin dose rate limit to skin dose rate for building vent releases, as calculated above.

For noble gases released from the stack:

$$r_{ngs} = R_{TBs}\, Q_{ngs}, \quad \text{or}$$
$$= R_{Ss}\, Q_{ngs}$$

whichever is more restrictive, i.e., smaller.

where

r_{ngs} = Calculated release rate limit for noble gases released from the stack.

R_{TBs} = Ratio of total body dose rate limit to total body dose rate for stack releases, as calculated above.

Q_{ngs} = Total Table 7.2 noble gas release rate from stack.

R_{Ss} = Ratio of skin dose rate limit to skin dose rate for stack releases, as calculated above.

For iodines and particulates with half-lives greater than 8 days released from building vents:

$$r_{ipv} = R_{THv}\, Q_{ipv}$$

where

r_{ipv} = Calculated release rate limit for iodines and particulates released from building vents.

R_{THv} = Ratio of maximum organ dose rate limit to maximum organ dose rate for building vent releases, as calculated above.

Q_{ipv} = Total Table 7.2 iodine and particulate release rate from building vents.

For iodines and particulates with half-lives greater than 8 days released from the stack:

$$r_{ips} = R_{THs}\, Q_{ips}$$

where

r_{ips} = Calculated release rate limit for iodines and particulates released from the stack.

R_{THs} = Ratio of maximum organ dose rate limit to maximum organ dose rate for stack releases, as calculated above.

Q_{ips} = Total Table 7.2 iodine and particulate release rate from stack.

The release rate limits, r, calculated for BFN using this methodology are:

	Noble Gas	Iodine and Particulate
Stack	r_{ngs} = 1.44E+01 Ci/s	r_{ips} = 3.57E-05 Ci/s
Building Vents	r_{ngv} = 1.50E-01 Ci/s	r_{ipv} = 2.19E-06 Ci/s

The values listed are used as administrative guidelines for operation.

The instantaneous release rates, r in Ci/sec, for each nuclide type and release point are limited by the following equations:

For noble gases,

$$\frac{r_{ngv}}{0.15} + \frac{r_{ngs}}{14.4} \leq 1$$

For iodines and particulates,

$$\frac{r_{ipv}}{2.19E-06} + \frac{r_{ips}}{3.57E-05} \leq 1$$

7.2 GASEOUS EFFLUENT MONITOR INSTRUMENT SETPOINTS

7.2.1 Alarm/Trip Setpoints

Control 1.1.2 requires gaseous effluent monitors to have alarm/trip setpoints to ensure that the above dose rates are not exceeded. This section of the ODCM describes the methodology that will be used to determine these allowable values which are used to calculate setpoints. Figures 7.1 and 7.2 show the Offgas System, the Standby Gas Treatment System and normal building ventilation with effluent monitor locations.

The methodology for determining alarm/trip allowable values is divided into two major parts. The first consists of backcalculating from a dose rate to a release rate limit, in µCi/s, for each nuclide and release point. The methodology for the calculation of these release rate limits is given in Section 7.1. The second consists of using the release rate limits to determine the allowable values which are used to calculate the physical settings on the monitors. The methodology for the calculation of the allowable values is given below. The monitor setpoints are calculated in the applicable Scaling and Setpoint Document.

7.2.2 Allowable Values

To determine allowable values for gaseous effluent monitors, shown in Figures 7.1 and 7.2, the noble gas release rate limits are used.

The allowable values are calculated using the following equation

$$\text{Allowable Value} \leq \frac{r\ f\ A}{F\ E} + B$$

where

r = release rate limit for stack or ground level, µCi/sec. The release rate limits used for the allowable value calculation are 1.44E+07 µCi/sec for the stack and 1.50E+05 µCi/sec for the building vents.

f = fraction of the limits r which is allowed for the release mode (elevated or ground level).
NOTE: The sum of the f values for elevated and ground levels must be less than or equal to 1. This lowers the limits to ensure that the site dose rate limit will not be exceeded if both the stack and the ground level release rate limits were reached simultaneously.

A = allocation factor. This is the portion of the release rate limit r which is assigned to the release point under consideration. This ensures that the ground level release rate limit will not be exceeded if all building vents were to reach their limit simultaneously. This is equal to 1 for the stack. The building vent release rate limit is divided among the ten vents based on the flow rates.

F = flow rate for the vent, cc/sec. Maximum flow rates are used to ensure conservative setpoints.
E = efficiency of the monitor, (µCi/cc)/cpm (or (µCi/cc)/cps for the stack monitor)
B = background of the monitor, cpm (cps for the stack monitor)

The calculation of these setpoints are documented further in Technical Instruction (TI) 15 and the applicable Scaling and Setpoint Document, including the numerical values for each of the parameters described above.

7.3 GASEOUS EFFLUENTS - DOSE RATES

7.3.1 Noble Gas Dose Rates

Dose rates are calculated for total body and skin, due to submersion within a cloud of noble gases, using a semi-infinite cloud model. The use of a finite cloud model would result in calculated doses of 0 to 10 percent higher than those calculations using the semi-infinite cloud model for Browns Ferry Nuclear Plant (BFN). The dose rates are evaluated at the offsite locations with the highest expected concentrations, i.e., the nearest SITE BOUNDARY points in each sector (from Table 7.1) and at other locations expected to be the maximum exposure points.

The noble gas radionuclide mix used in this calculation is based on the design objective source term given in Table 7.2. Dispersion of the released radioactivity is handled as described in Section 7.9 using historical annual average meteorological data given in Table 7.3. No credit is taken for shielding by residence.

To calculate the noble gas dose rate from radiological effluents discharged from a given release point for any one of the potential maximum-exposure points, the equations given in Section 7.7.1 are used.

The total body and skin dose rate calculations are repeated for each release point. Dose rates for releases from all building vents are summed. The maximum stack and building vent total body and skin dose rates will be used to determine release rate limits.

7.3.2 I-131, I-133, Tritium and all Radionuclides in Particulate Form with Half-lives of Greater than 8 days - Organ Dose Rate

Dose rates are calculated for the critical organ, thyroid, of the critical age group, infant. Pathways considered are inhalation, ground contamination and milk ingestion. The dose rates are evaluated at the offsite locations with the highest expected concentrations, i.e., the nearest SITE BOUNDARY points in each of the 16 sectors (from Table 7.1) and at other locations expected to be the maximum exposure points. This calculation assumes that a (hypothetical) cow is at each of these locations. These cows are assumed, conservatively, to obtain 100 percent of their food from pasture grass.

The inhalation, ground contamination, and milk ingestion dose rates (in mrem/year) for the selected organ (thyroid) and age group (infant) are calculated using Equation 7.9 as described in Section 7.6.2. For determining the total thyroid dose rate from iodines and particulates:

$$D_{TH} = D_{THI} + D_{TBG} + D_{THM} \qquad (7.1)$$

where:

D_{TH} = total thyroid dose rate, mrem/yr.
D_{THI} = thyroid dose rate due to inhalation, mrem/yr.
D_{TBG} = total body dose rate due to ground contamination, mrem/yr. The thyroid dose rate is assumed to be equal to the total body dose rate for this pathway.
D_{THM} = thyroid dose rate due to pasture grass-cow-milk ingestion, mrem/yr.

The iodine and particulate dose rates are calculated for the design objective source term given in Table 7.2. The above dose rate calculation is repeated for each release point. Dose rates for releases from all building vents are summed. The maximum stack and building vent thyroid dose rates will be used to determine release rate limits.

7.4 DOSE - NOBLE GASES

7.4.1 Monthly Noble Gas Dose

Doses to be calculated are gamma and beta air doses due to exposure to a semi-infinite cloud of noble gases. The use of a finite cloud model would result in calculated doses of 0 to 10 percent higher than those calculations using the semi-infinite cloud model for BFN. Releases of Ar-41, Kr-85m, Kr-85, Kr-87, Kr-88, Xe-131m, Xe-133m, Xe-133, Xe-135m, Xe-135, and Xe-138 are considered. Because only these nuclides are considered, the dose is divided by 0.9, to account for a possible 10 percent contribution of dose from other nuclides.

The dispersion factor used will be the highest annual-average χ/Q based on 1977-1979 meteorological data (Table 7.3). Dispersion factors are calculated using the methodology described by Equation 7.11. Stack releases are considered elevated releases. All other vent releases will be treated as ground level.

No credit is taken for radioactive decay.

7.4.1.1 Monthly Conservative Model - Gamma Air Dose

$$D_\gamma = \frac{(\chi/Q)}{0.9} \frac{10^6}{3.15E+07} \sum_i Q_i \, DF_{\gamma i} \qquad (7.2)$$

where:

D_γ = gamma dose to air, mrad.

χ/Q = highest annual-average relative concentration at or beyond the SITE BOUNDARY, s/m^3 (from Table 7.1).
= 1.84E-06 for ground level releases,
= 2.08E-08 for elevated releases (stack).

0.9 = fraction of total gamma dose expected to be contributed by the assumed nuclides.

10^6 = µCi/Ci conversion factor.

3.15E+07 = s/yr conversion factor.

Q_i = monthly release of radionuclide i, Ci.

$DF_{\gamma i}$ = gamma-to-air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 7.4).

7.4.1.2 Monthly Conservative Model - Beta Air Dose

$$D_\beta = \frac{(\chi/Q)}{0.9} \; \frac{10^6}{3.15E+07} \sum_i Q_i \; DF_{\beta i} \qquad (7.3)$$

where:

D_β = beta dose to air, mrad.

χ/Q = highest annual-average relative concentration at or beyond the SITE BOUNDARY, s/m^3 (from Table 7.1).
= 1.84E-06 for ground level releases,
= 2.08E-08 for elevated releases (stack).

0.9 = fraction of total beta dose expected to be contributed by the assumed nuclides.

10^6 = µCi/Ci conversion factor.

3.15E+07 = s/yr conversion factor.

Q_i = monthly release of radionuclide i, Ci.

$DF_{\beta i}$ = beta-to-air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 7.4).

7.4.1.3 Cumulative Dose - Noble Gas

Cumulative calendar quarter doses are estimated by summing the doses calculated for each month in that quarter. Cumulative calendar year doses are estimated by summing the doses calculated for each month in that year.

7.4.1.4 Comparison to Limits

The cumulative calendar quarter and calendar year doses are compared to their respective limits to determine compliance.

7.5 CUMULATIVE DOSE - I-131, I-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM WITH HALF-LIVES GREATER THAN 8 DAYS

Doses are to be calculated for the infant thyroid from milk ingestion and for the child bone and teen gastrointestinal tract (GIT) from vegetable ingestion. Releases of H-3, I-131, and I-133 are considered for the milk pathway. H-3, Sr-89, Sr-90, Cs-134, and Cs-137 releases are considered for the vegetable pathway to the child bone. H-3, Co-58, and Co-60 releases are considered for the vegetable pathway to the teen GIT. The most critical real cow location is considered for the milk pathway and the most critical location with a home-use garden is considered for the vegetable pathways (see Table 7.1). The cow is assumed to graze on pasture grass for the whole year.

The highest annual-average χ/Q and D/Q based on 1977-1979 meteorological data (Table 7.3) will be used for ingestion pathway locations. Dispersion values are calculated as described by Equations 7.12 and 7.13. Stack releases are considered elevated releases. All other vent releases will be treated as ground level.

No credit is taken for radioactive decay.

Doses are divided by 0.9 to account for a possible 10 percent contribution from other nuclides.

The maximum monthly organ dose is the highest of the three doses calculated.

7.5.1 Monthly Conservative Model - Infant Thyroid Dose from Milk Ingestion

The monthly thyroid dose from milk ingestion is calculated using the following equation:

$$D_{TH} = \frac{[\sum_i (Q_i\ R_{CPi})\ D/Q + (Q_T\ R_{CPT})\ \chi/Q\ ]\ 10^6}{0.9\ (3.15E+07)} \qquad (7.4)$$

where

- Q_i = monthly release of iodine nuclide i, Ci.
- Q_T = monthly release of H-3, Ci.
- R_{CPi} = I-131 or I-133 pasture grass-cow-milk ingestion dose factor for infant thyroid, mrem/yr per μCi/m^2-s. Dose factors are calculated as described in Section 7.8.1.
- R_{CPT} = H-3 pasture grass-cow-milk ingestion dose factor for infant thyroid, mrem/yr per μCi/m^3. The dose factor is calculated as described in Section 7.8.7.
- D/Q = highest relative deposition rate for a location with an identified milk cow, m^{-2} (from Table 7.1).
  - = 3.16E-10 for ground level releases,
  - = 2.30E-10 for elevated releases (stack).
- χ/Q = highest relative air concentration for a location with an identified milk cow, s/m^3 (from Table 7.1).
  - = 1.47E-07 for ground level releases,
  - = 1.69E-08 for elevated releases (stack).
- 0.9 = fraction of dose expected to be contributed by I-131, I-133 and H-3.
- 3.15E+07 = s/yr.
- 10^6 = μCi/Ci.

7.5.2 Monthly Conservative Model - Child Bone Dose from Vegetable Ingestion

The monthly bone dose from vegetable ingestion is calculated using the following equation:

$$D_{BC} = \frac{[\sum_i (Q_i\ DF_i)\ D/Q + Q_T\ DF_T\ \chi/Q\ ]\ 10^6}{0.9\ (3.15E+07)} \qquad (7.5)$$

where

Q_i = monthly release of Sr or Cs nuclide i, Ci.
Q_T = monthly release of H-3, Ci.
DF_i = Total vegetable ingestion dose factor to child bone for Sr-89, Sr-90, Cs-134 or Cs-137, mrem/yr per µCi/m^2-s.
= $R_{VFi} + R_{VSi}$, where R_{VFi} is the dose factor for fresh leafy vegetables (as calculated in Section 7.8.5) and R_{VSi} is the dose factor for stored vegetables (as calculated in Section 7.8.6).
DF_T = Total vegetable ingestion dose factor for child bone for H-3, mrem/yr per µCi/m^3.
= $R_{VFT} + R_{VST}$, where R_{VFT} is the tritium dose factor for fresh leafy vegetables (as calculated in Section 7.8.11) and R_{VSi} is the tritium dose factor for stored vegetables (as calculated in Section 7.8.12).
D/Q = highest relative deposition rate for a location with an identified home use garden, m^{-2} (from Table 7.1).
= 4.46E-09 for ground level releases,
= 1.13E-09 for elevated releases (stack).
χ/Q = highest relative air concentration for a location with an identified home use garden, s/m^3 (from Table 7.1).
= 1.57E-06 for ground level releases,
= 9.50E-09 for elevated releases (stack).
3.15E+07 = s/yr.
10^6 = µCi/Ci.
0.9 = fraction of total child bone dose expected to be contributed by H-3, Sr-89, Sr-90, Cs-134, and Cs-137.

7.5.3 Monthly Conservative Model – Teen Gastrointestinal Tract (GIT) Dose from Vegetable Ingestion

The monthly teen GIT dose from vegetable ingestion is calculated using the following equation:

$$D_{GT} = \frac{\left[\sum_i (Q_i \; DF_i) \; D/Q + Q_T \; DF_T \; \chi/Q \right] 10^6}{0.9 \; (3.15E+07)} \qquad (7.6)$$

where

Q_i = monthly release of cobalt nuclide i, Ci.

Q_T = monthly release of H-3, Ci.

DF_i = Total vegetable ingestion dose factor to the teen GIT for Co-58 or Co-60, mrem/yr per $\mu Ci/m^2$-s.
= $R_{VFi} + R_{VSi}$, where R_{VFi} is the dose factor for fresh leafy vegetables (as calculated in Section 7.8.5) and R_{VSi} is the dose factor for stored vegetables (as calculated in Section 7.8.6).

DF_T = Total vegetable ingestion dose factor to the teen GIT for H-3, mrem/yr per $\mu Ci/m^3$.
= $R_{VFT} + R_{VST}$, where R_{VFT} is the tritium dose factor for fresh leafy vegetables (as calculated in Section 7.8.11) and R_{VST} is the tritium dose factor for stored vegetables (as calculated in Section 7.8.12).

D/Q = highest relative deposition rate for a location with an identified home use garden, m^{-2} (from Table 7.1).
= 4.46E-09 for ground level releases,
= 1.13E-09 for elevated releases (stack).

χ/Q = highest relative air concentration for a location with an identified home use garden, s/m^3 (from Table 7.1).
= 1.57E-06 for ground level releases,
= 9.50E-09 for elevated releases (stack).

3.15E+07 = s/yr.

10^6 = µCi/Ci.

0.9 = fraction of total teen GIT dose expected to be contributed by H-3, Co-58, and Co-60.

7.5.4 Cumulative Doses

Cumulative calendar quarter doses are estimated by summing the doses calculated for each month in that quarter. Cumulative calendar year doses are estimated by summing the doses calculated for each month in that year.

7.5.5 Total Monthly Dose - Comparison to Limits

The cumulative calendar quarter and calendar year doses are compared to their respective limits to determine compliance.

7.6 GASEOUS RADWASTE TREATMENT

7.6.1 Dose Projections

Dose projections will be performed by averaging the calculated dose for the most recent month and the calculated dose for the previous month and assigning that average dose as the projection for the current month.

If the results of the dose projection indicate potential doses in excess of the monthly fraction of the annual dose limit, efforts will be made to minimize future releases.

7.6.2 System Description

A flow diagram for the GRTS is given in Figure 7.1. The system includes the subsystems that process and dispose of the gases from the main condenser air ejectors, the startup vacuum pumps, and the gland seal condensers. One gaseous radwaste treatment system is provided for each unit. The processed gases from each unit are routed to the plant stack for dilution and elevated release to the atmosphere. The air-ejector off-gas line of each unit and the stack are continuously monitored by radiation monitors.

7.7 DOSE CALCULATIONS FOR REPORTING PURPOSES

A complete dose analysis utilizing the total estimated gaseous releases for each calendar quarter will be performed and reported as required in ODCM Administrative Control 5.2. Methodology for this analysis is that which is described below, using the quarterly release values reported by the plant personnel. For iodine releases, it will be assumed that half the iodines released are organic iodines, which contribute only to the inhalation dose. All real pathways and receptor locations (as identified in the most recent land use survey) are considered. In addition, actual meteorological data representative of each corresponding calendar quarter will be used to calculate dispersion factors as described in Section 7.9. Stack releases will be considered elevated releases. Radwaste and reactor building releases will be considered split-level releases. Turbine building releases will be treated as ground level.

7.7.1 Noble Gas Dose

All measured radionuclides are used to calculate gamma and beta air doses. The dose is evaluated at the nearest SITE BOUNDARY point in each sector and at other locations expected to be maximum exposure points using a semi-infinite cloud model. The use of a finite cloud model would result in calculated doses of 0 to 10 percent higher than those calculations using the semi-infinite cloud model for BFN.

Radioactive decay is considered in this calculation. The quarterly release is averaged over one year to obtain an average release rate.

7.7.1.1 Gamma Dose to Air

$$D_{\gamma n} = \sum_i X_{ni} \, DF_{\gamma i} \qquad (7.7)$$

where:

$D_{\gamma n}$ = gamma dose to air for sector n, mrad.
X_{ni} = air concentration of radionuclide i in sector n, µCi-year/m^3. Air concentrations are calculated as described by Equation 7.11.
$DF_{\gamma i}$ = gamma-to-air dose factor for radionuclide i, mrad/yr per µCi/m^3 (Table 7.4).

7.7.1.2 Beta Dose to Air

$$D_{\beta n} = \sum_i X_{ni} \, DF_{\beta i} \qquad (7.8)$$

where:

$D_{\beta n}$ = beta dose to air for sector n, mrad.
X_{ni} = air concentration of radionuclide i in sector n, µCi-year/m^3. Air concentrations are calculated as described by Equation 7.11.
$DF_{\beta i}$ = beta to air dose factor for radionuclide i, mrad/yr per µCi/m^3 (Table 7.4).

7.7.2 Radioiodine, Particulate and Tritium - Maximum Organ Dose

Organ doses due to radioiodine, particulate and tritium releases are calculated using the following equation:

$$D_{org} = 3.17E{-}08 \left[\sum_i \left({}^{D}/_{Q} \sum_P R_{Pi} + {}^{D}/_{Q}\, R_{Gi} + {}^{X}/_{Q}\, R_{Ii}\right) Q_i + \sum_P \left({}^{X}/_{Q}\, R_{PT}\right) Q_T\right] \quad (7.9)$$

where:

D_{org} = Organ dose, mrem.
3.17E-08 = conversion factor, year/second.
X/Q = Relative concentration for location under consideration, sec/m^3. Relative concentrations are calculated as described by Equation 7.12.
R_{Pi} = ingestion dose factor for pathway P for each identified nuclide i (except tritium), m^2-mrem/year per µCi/second. Ingestion pathways available for consideration include:
- pasture grass-cow-milk ingestion
- stored feed-cow-milk ingestion
- pasture grass-goat-milk ingestion
- stored feed-goat-milk ingestion
- pasture grass-beef ingestion
- stored feed-beef ingestion
- fresh leafy vegetable ingestion
- stored vegetable ingestion

Equations for calculating these ingestion dose factors are given in Sections 7.8.1 through 7.8.6.
D/Q = Relative deposition for location under consideration, m^{-2}. Relative deposition is calculated as described in Equation 7.13.
R_{Gi} = Dose factor for standing on contaminated ground, m^2-mrem/year per µCi/second. The equation for calculating the ground plane dose factor is given in Section 7.8.14.
R_{Ii} = Inhalation dose factor, mrem/year per µCi/m^3. The equation for calculating the inhalation dose factor is given in Section 7.8.13.

Q_i = adjusted release for nuclide i for location under consideration, µCi. The initial release is adjusted to account for decay between the release point and the location, depending on the frequency of wind speeds applicable to that sector. Hence, the adjusted release is equal to the actual release decayed for an average travel time during the period.

$$= Q_{i0} \sum_{j=1}^{9} f_j \exp(-\lambda_i \, x/u_j)$$

where

Q_{i0} = initial average release for nuclide i over the period, µCi.

f_j = joint relative frequency of occurrence of winds in windspeed class j blowing toward this exposure point, expressed as a fraction.

λ_i = radiological decay constant for nuclide i, sec^{-1}.

x = downwind distance, meters.

u_j = midpoint value of wind speed class interval j, m/s.

R_{PT} = ingestion dose factor for pathway P for tritium, mrem/year per $\mu Ci/m^3$. Ingestion pathways available for consideration are the same as those listed above for R_{Pi}. Equations for calculating ingestion dose factors for tritium are given in Sections 7.8.7 through 7.8.12.

Q_T = adjusted release for tritium for location under consideration, µCi. Calculated in the same manner as Q_i above.

7.7.3 Population Doses

For determining population doses to the 50-mile population around the plant, each compass sector is broken down into elements. These elements are defined in Table 7.5. For each of these sector elements, an average dose is calculated, and then multiplied by the population in that sector element. Dispersion factors are calculated for the midpoint of each sector element (see Table 7.5). For population doses resulting from ingestion, it is conservatively assumed that all food eaten by the average individual is grown locally.

The general equation used for calculating the population dose in a given sector element is:

$$Dose_{pop} = \sum_{P} RATIO_P * POPN * AGE * 0.001 * DOSE_P \qquad (7.10)$$

where

$RATIO_P$ = ratio of average to maximum dose for pathway P. (Average ingestion rates are obtained from Regulatory Guide 1.109, Table E-4.)
= 0.5 for submersion and ground exposure pathways, a shielding/occupancy factor.
= 1.0 for the inhalation pathway.
= 0.515, 0.515, 0.5, and 0.355 for milk, for infant, child, teen and adult, respectively. (It is assumed that the ratio of average to maximum infant milk ingestion rates is the same as that for child.)
= 1.0, 0.90, 0.91, 0.86 for beef ingestion, for infant, child, teen and adult, respectively.
= 1.0, 0.38, 0.38, 0.37 for vegetable ingestion, for infant, child, teen and adult, respectively. (It is assumed that the average individual eats no fresh vegetables, only stored vegetables.)

POPN = the population of the sector element, persons (Table 7.6).

AGE = fraction of the population belonging to each age group.
= 0.015, 0.168, 0.153, 0.665 for infant, child, teen and adult, respectively (fractions taken from NUREG/CR-1004, Table 3.39).

0.001 = conversion from mrem to rem.

$DOSE_P$ = the dose for pathway P to the maximum individual at the location under consideration, mrem. For ingestion pathways, this dose is multiplied by an average decay correction to account for decay as the food is moved through the food distribution cycle. This average decay correction, ADC, is defined as:

$ADC = \exp(-\lambda_i t)$, for milk and vegetables,

where

λ_i = decay constant for nuclide i, seconds.
t = distribution time for food product under consideration (from Regulatory Guide 1.109, Table D-1).
= 1.21E+06 seconds (14 days) for vegetables.
= 3.46E+05 seconds (4 days) for milk.

$$ADC = \frac{\exp(-\lambda_i t)\ \lambda_i t_{cb}}{1 - \exp(-\lambda_i t_{cb})}, \text{ for meat,}$$

where

λ_i = decay constant for nuclide i, seconds.
t = additional distribution time for meat, over and above the time for slaughter to consumption described in Section 7.8.3, 7 days (from Regulatory Guide 1.109, Table D-2).
t_{cb} = time to consume a whole beef, as described in Section 7.8.3.

For beef ingestion, the additional factors in the calculation of ADC negate the integration of the dose term over the period during which a whole beef is consumed, for the calculation of population dose. This assumes that the maximum individual freezes and eats a whole beef, but the average individual buys smaller portions at a time.

Population doses are summed over all sector elements to obtain a total population dose for the 50-mile population.

7.7.4 Reporting of Doses

The calculated quarterly doses and calculated population doses described in this section are reported in the Annual Radioactive Effluent Release Report as described in ODCM Administrative Control 5.2

7.8 GASEOUS DOSE FACTOR EQUATIONS

7.8.1 Pasture Grass-Cow-Goat-Milk Ingestion Dose Factors (m^2-mrem/year per µCi/sec)

$$R_{CPi} = 10^6 DFL_{iao} U_{ap} F_{mi} Q_f \exp(-\lambda_i t_{fm}) f_p \left\{ \frac{r(1-\exp(-\lambda_E t_{ep}))}{Y_p \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P \lambda_i} \right\}$$

where:

10^6 = conversion factor, pCi/µCi.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/pCi (Table 6.4).
U_{ap} = milk ingestion rate for age group a, L/year.
F_{mi} = transfer factor for nuclide i from animal's feed to milk, days/L (Table 6.2).
Q_f = animal's consumption rate, kg/day.
λ_i = decay constant for nuclide i, $seconds^{-1}$ (Table 6.2).
t_{fm} = transport time from milking to receptor, seconds.
f_p = fraction of time animal spends on pasture, dimensionless.
r = fraction of activity retained on pasture grass, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, $seconds^{-1}$, equal to $\lambda_i + \lambda_w$.
λ_w = weathering decay constant for leaf and plant surfaces, $seconds^{-1}$.
t_{ep} = time pasture is exposed to deposition, seconds.
Y_p = agricultural productivity by unit area of pasture grass, kg/m^2.
B_{iv} = transfer factor for nuclide i from soil to vegetation, pCi/kg (wet weight of vegetation) per pCi/kg (dry soil).
t_b = time period over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.2 Stored Feed-Cow/Goat-Milk Ingestion Dose Factors
(m²-mrem/year per µCi/second)

$$R_{CSi} = 10^6\ DFL_{iao}\ U_{ap}\ F_{mi}\ Q_f\ f_s\ \exp(-\lambda_i t_{fm})\ \frac{(1-\exp(-\lambda_i t_{csf}))}{t_{csf}\ \lambda_i}$$

$$\left\{ \frac{r(1-\exp(-\lambda_E t_{esf}))}{Y_{sf}\ \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P\ \lambda_i} \right\}$$

where:

10^6 = conversion factor, pCi/µCi.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/pCi (Table 6.4).
U_{ap} = milk ingestion rate for age group a, L/year.
F_{mi} = transfer factor for nuclide i from animal's feed to milk, days/L (Table 6.2).
Q_f = animal's consumption rate, kg/day.
f_s = fraction of time animal spends on stored feed, dimensionless.
λ_i = decay constant for nuclide i, seconds^{-1} (Table 6.2).
t_{fm} = transport time from milking to receptor, seconds.
t_{csf} = time between harvest of stored feed and consumption by animal, seconds.
r = fraction of activity retained on pasture grass, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, seconds^{-1}, equal to $\lambda_i + \lambda_w$.
λ_w = weathering decay constant for leaf and plant surfaces, seconds^{-1}.
t_{esf} = time stored feed is exposed to deposition, seconds.
Y_{sf} = agricultural productivity by unit area of stored feed, kg/m^2.
B_{iv} = transfer factor for nuclide i from soil to vegetation, pCi/kg (wet weight of vegetation) per pCi/kg (dry soil).
t_b = time period over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.3 Pasture Grass-Beef Ingestion Dose Factors
(m^2-mrem/year per µCi/second)

$$R_{MPi} = 10^6 \, DFL_{iao} \, U_{am} \, F_{fi} \, Q_f \, \frac{(1-\exp(-\lambda_i t_{cb}))}{\lambda_i \, t_{cb}} \exp(-\lambda_i t_s)$$

$$f_p \left\{ \frac{r(1-\exp(-\lambda_E t_{ep}))}{Y_p \, \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P \, \lambda_i} \right\}$$

where:

10^6 = conversion factor, pCi/µCi.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/pCi (Table 6.4).
U_{am} = meat ingestion rate for age group a, kg/year.
F_{fi} = transfer factor for nuclide i from cow's feed to meat, days/kg (Table 6.2).
Q_f = cow's consumption rate, kg/day.
λ_i = decay constant for nuclide i, seconds^{-1} (Table 6.2).
t_{cb} = time for receptor to consume a whole beef, seconds.
t_s = transport time from slaughter to consumer, seconds.
f_p = fraction of time cow spends on pasture, dimensionless.
r = fraction of activity retained on pasture grass, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, seconds^{-1}, equal to $\lambda_i + \lambda_w$.
λ_w = weathering decay constant for leaf and plant surfaces, seconds^{-1}.
t_{ep} = time pasture is exposed to deposition, seconds.
Y_p = agricultural productivity by unit area of pasture grass, kg/m^2.
B_{iv} = transfer factor for nuclide i from soil to vegetation, pCi/kg (wet weight of vegetation) per pCi/kg (dry soil).
t_b = time over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.4 Stored Feed-Beef Ingestion Dose Factors
(m^2-mrem/year per μCi/second)

$$R_{MSi} = 10^6 \, DFL_{iao} \, U_{am} \, F_{fi} \, Q_f \, \frac{(1-\exp(-\lambda_i t_{cb}))}{\lambda_i \, t_{cb}} \exp(-\lambda_i t_s)$$

$$f_s \, \frac{(1-\exp(-\lambda_i t_{csf}))}{\lambda_i \, t_{csf}} \left\{ \frac{r(1-\exp(-\lambda_E t_{esf}))}{Y_{sf} \, \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P \, \lambda_i} \right\}$$

where:

10^6 = conversion factor, pCi/μCi.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/pCi (Table 6.4).
U_{am} = meat ingestion rate for age group a, kg/year.
F_{fi} = transfer factor for nuclide i from cow's feed to meat, days/kg (Table 6.2).
Q_f = cow's consumption rate, kg/day.
λ_i = decay constant for nuclide i, seconds^{-1} (Table 6.2).
t_{cb} = time for receptor to consume a whole beef, seconds.
t_s = transport time from slaughter to consumer, seconds.
f_s = fraction of time cow spends on stored feed, dimensionless.
t_{csf} = time between harvest of stored feed and consumption by cow, seconds.
r = fraction of activity retained on pasture grass, dimensionless.
t_{esf} = time stored feed is exposed to deposition, seconds.
Y_{sf} = agricultural productivity by unit area of stored feed, kg/m^2.
λ_E = the effective decay constant, due to radioactive decay and weathering, seconds^{-1}, equal to $\lambda_i + \lambda_w$.
λ_w = weathering decay constant for leaf and plant surfaces, seconds^{-1}.
B_{iv} = transfer factor for nuclide i from soil to vegetation, pCi/kg (wet weight of vegetation) per pCi/kg (dry soil).
t_b = time over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.5 Fresh Leafy Vegetable Ingestion Dose Factors
(m^2-mrem/year per µCi/second)

$$R_{VFi} = 10^6 \, DFL_{iao} \, e(-\lambda_i t_{hc}) \, U_{FLa} f_L \left\{ \frac{r(1-e(-\lambda_E t_e))}{Y_f \, \lambda_E} + \frac{B_{iv}(1-e(-\lambda_i t_b))}{P \, \lambda_i} \right\}$$

where:

10^6 = conversion factor, pCi/µCi.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/pCi (Table 6.4).
λ_i = decay constant for nuclide i, $seconds^{-1}$ (Table 6.2).
t_{hc} = average time between harvest of vegetables and their consumption and/or storage, seconds.
U_{FLa} = consumption rate of fresh leafy vegetables by the receptor in age group a, kg/year.
f_L = fraction of fresh leafy vegetables grown locally, dimensionless.
r = fraction of deposited activity retained on vegetables, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, $seconds^{-1}$.
$= \lambda_i + \lambda_w$
λ_w = decay constant for removal of activity on leaf and plant surfaces by weathering, $seconds^{-1}$.
t_e = exposure time in garden for fresh leafy and/or stored vegetables, seconds.
Y_f = vegetation areal density for fresh leafy vegetables, kg/m^2.
B_{iv} = transfer factor for nuclide i from soil to vegetables, pCi/kg (wet weight of vegetation) per pCi/kg (dry soil).
t_b = time period over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.6 <u>Stored Vegetable Ingestion Dose Factors</u>
m^2-mrem/year per µCi/second)

$$R_{VSi} = 10^6 \ DFL_{iao} \exp(-\lambda_i t_{hc}) \ U_{Sa} f_g \frac{(1-e(-\lambda_i t_{sv}))}{\lambda_i \ t_{sv}}$$

$$\left\{ \frac{r(1-e(-\lambda_E t_e))}{Y_{sv} \ \lambda_E} + \frac{B_{iv}(1-e(-\lambda_i t_b))}{P \ \lambda_i} \right\}$$

where:

10^6 = conversion factor, pCi/µCi.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/pCi (Table 6.4).
λ_i = decay constant for nuclide i, $seconds^{-1}$ (Table 6.2).
t_{hc} = average time between harvest of vegetables and their consumption and/or storage, seconds.
U_{Sa} = consumption rate of stored vegetables by the receptor in age group a, kg/year.
f_g = fraction of stored vegetables grown locally, dimensionless.
t_{sv} = time between storage of vegetables and their consumption, seconds.
r = fraction of deposited activity retained on vegetables, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, $seconds^{-1}$.
= $\lambda_i + \lambda_w$
λ_w = decay constant for removal of activity on leaf and plant surfaces by weathering, $seconds^{-1}$.
t_e = exposure time in garden for fresh leafy and/or stored vegetables, seconds.
Y_{sv} = vegetation areal density for stored vegetables, kg/m^2.
B_{iv} = transfer factor for nuclide i from soil to vegetables, pCi/kg (wet weight of vegetation) per pCi/kg (dry soil).
t_b = time period over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.7 Tritium-Pasture Grass-Cow/Goat-Milk Dose Factor (mrem/year per µCi/m³)

$$R_{CTP} = 10^3\ 10^6\ DFL_{Tao}\ F_{mT}\ Q_f\ U_{ap}\ [0.75(0.5/H)]\ f_p\ \exp(-\lambda_T t_{fm})$$

where:

10^3 = conversion factor, g/kg.
10^6 = conversion factor, pCi/µCi.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/pCi (Table 6.4).
F_{mT} = transfer factor for tritium from animal's feed to milk, days/L (Table 6.2).
Q_f = animal's consumption rate, kg/day.
U_{ap} = milk ingestion rate for age group a, L/year.
0.75 = the fraction of total feed that is water.
0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m³.
f_p = fraction of time animal spends on pasture, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_{fm} = transport time from milking to receptor, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.8 Tritium-Stored Feed-Cow/Goat-Milk Dose Factor (mrem/year per μCi/m³)

$$R_{CTS} = 10^3\ 10^6\ DFL_{Tao}\ F_{mT}\ Q_f\ U_{ap}\ [0.75(0.5/H)]\ f_s\ \frac{(1-\exp(-\lambda_T t_{csf}))}{\lambda_T\ t_{csf}}\ \exp(-\lambda_T t_{fm})$$

where:

10^3 = conversion factor, g/kg.
10^6 = conversion factor, pCi/μCi.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/pCi (Table 6.4).
F_{mT} = transfer factor for tritium from animal's feed to milk, days/L (Table 6.2).
Q_f = animal's consumption rate, kg/day.
U_{ap} = milk ingestion rate for age group a, L/year.
0.75 = the fraction of total feed that is water.
0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m³.
f_s = fraction of time animal spends on stored feed, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_{csf} = time between harvest of stored feed and consumption by animal, seconds.
t_{fm} = transport time from milking to receptor, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.9 Tritium-Pasture Grass-Beef Dose Factor
(mrem/year per µCi/m^3)

$$R_{MT} = 10^3\ 10^6\ DFL_{Tao}\ F_{fT}\ Q_f\ U_{am}\ [0.75(0.5/H)]\ f_p\ \exp(-\lambda_T t_s)\ \frac{(1-\exp(-\lambda_T t_{ep}))}{\lambda_T\ t_{ep}}\ \frac{(1-\exp(-\lambda_T t_{cb}))}{\lambda_T\ t_{cb}}$$

where:

10^3 = conversion factor, g/kg.
10^6 = conversion factor, pCi/µCi.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/pCi (Table 6.4).
F_{fT} = transfer factor for tritium from cow's feed to meat, days/kg (Table 6.2).
Q_f = cow's consumption rate, kg/day.
U_{am} = meat ingestion rate for age group a, kg/year.
0.75 = the fraction of total feed that is water.
0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m^3.
f_p = fraction of time cow spends on pasture, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_s = transport time from slaughter to consumer, seconds.
t_{ep} = time pasture is exposed to deposition, seconds.
t_{cb} = time for receptor to consume a whole beef, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.10 Tritium-Stored Feed-Beef Dose Factor
(mrem/year per μCi/m^3)

$$R_{MTS} = 10^3 \, 10^6 \, DFL_{Tao} \, F_{fT} \, Q_f \, U_{am} \, [0.75(0.5/H)] \, f_s \, \exp(-\lambda_T t_s) \frac{(1-\exp(-\lambda_T t_{csf}))}{\lambda_T \, t_{csf}} \frac{(1-\exp(-\lambda_T t_{cb}))}{\lambda_T \, t_{cb}}$$

where:

10^3 = conversion factor, g/kg.
10^6 = conversion factor, pCi/μCi.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/pCi (Table 6.4).
F_{fT} = transfer factor for tritium from cow's feed to meat, days/kg (Table 6.2).
Q_f = cow's consumption rate, kg/day.
U_{am} = meat ingestion rate for age group a, kg/year.
0.75 = the fraction of total feed that is water.
0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m^3.
f_s = fraction of time cow spends on stored feed, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_s = transport time from slaughter to consumer, seconds.
t_{csf} = time between harvest of stored feed and consumption by animal, seconds.
t_{cb} = time for receptor to consume a whole beef, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.11 <u>Tritium-Fresh Leafy Vegetable Dose Factor</u>
(mrem/year per μCi/m^3)

$$R_{VTF} = 10^3\ 10^6\ DFL_{Tao}\ [0.75(0.5/H)]\ U_{FLa}\ f_L\ \exp(-\lambda_T t_{hc})$$

where:

10^3 = conversion factor, g/kg.
10^6 = conversion factor, pCi/μCi.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/pCi (Table 6.4).
0.75 = the fraction of total vegetation that is water.
0.5 = the ratio of the specific activity of the vegetables water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m^3.
U_{FLa} = consumption rate of fresh leafy vegetables by the receptor in age group a, kg/year.
f_L = fraction of fresh leafy vegetables grown locally, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_{hc} = time between harvest of vegetables and their consumption and/or storage, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.12 Tritium-Stored Vegetables Dose Factor
(mrem/year per µCi/m³)

$$R_{VTS} = 10^3\ 10^6\ DFL_{Tao}\ [0.75(0.5/H)]\quad U_{Sa} f_g\ \frac{(1-\exp(-\lambda_T t_{sv}))}{\lambda_T\ t_{sv}}\ \exp(-\lambda_T t_{hc})$$

where:

10^3 = conversion factor, g/kg.
10^6 = conversion factor, pCi/µCi.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/pCi (Table 6.4).
0.75 = the fraction of total vegetation that is water.
0.5 = the ratio of the specific activity of the vegetation water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m³.
U_{Sa} = consumption rate of stored vegetables by the receptor in age group a, kg/year.
f_g = fraction of stored vegetables grown locally, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_{sv} = time between harvest of stored vegetables and their consumption and/or storage, seconds.
t_{hc} = time between harvest of vegetables and their storage, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values, are listed in Table 6.3.

7.8.13 Inhalation Dose Factors
(mrem/year per µCi/m³)

$$R_{Ii} = DFA_{iao}\ BR_a\ 10^6$$

where:

DFA_{iao} = inhalation dose conversion factor for nuclide i, age group a and organ o, mrem/pCi (Table 7.7).
BR_a = breathing rate for age group a, m^3/year (Table 6.3).
10^6 = conversion factor, pCi/µCi.

7.8.14 Ground Plane Dose Factors
(m^2-mrem/year per µCi/second)

$$R_{Gi} = DF_{Gio}\ (1/\lambda_i)\ 10^6\ 8760\ [1 - \exp(-\lambda_i t_b)]$$

where:

DF_{Gio} = dose conversion factor for standing on contaminated ground for nuclide i and organ o (total body and skin), mrem/hr per pCi/m^2 (Table 6.6).
λ_i = decay constant of nuclide i, $seconds^{-1}$ (Table 6.2).
10^6 = conversion factor, pCi/µCi.
8760 = conversion factor, hours/year.
t_b = time period over which the ground accumulation is evaluated, seconds (Table 6.3).

7.9 DISPERSION METHODOLOGY

Dispersion factors are calculated for radioactive effluent releases using hourly average meteorological data collected onsite.

Meteorological data for ground level releases consist of windspeed and direction measurements at 10m and temperature measurements of 10m and 45 m.

Hourly average meteorological data for the ground level portion of a split level release consist of wind speeds and directions measured at the 10m level and temperature measurements at 10m and 45m. The elevated portion of the split level release uses wind speeds and directions measured at the 46m level and temperature measurements at 45m and 90m.

Raw meteorological data for the elevated releases consist of windspeed and directions measured at 93m. Stability class D is assumed to persist during the entire period for elevated releases, except for the dose calculations described in Section 7.7 when all stability classes will be used to evaluate the elevated results.

Meteorological data are expressed as a joint-frequency distribution of wind speed, wind direction, and atmospheric stability for each release level (ground, split and elevated). The joint-frequency distributions which represent the historical meteorological data for the period January 1977 to December 1979 are given in Table 7.3.

The wind speed classes that are used are as follows:

Number	Range (m/s)	Midpoint (m/s)
1	<0.3	0.13
2	0.3-0.6	0.45
3	0.7-1.5	1.10
4	1.6-2.4	1.99
5	2.5-3.3	2.88
6	3.4-5.5	4.45
7	5.6-8.2	6.91
8	8.3-10.9	9.59
9	>10.9	10.95

The stability classes that will be used are the standard A through G classifications. The stability classes 1-7 will correspond to A=1, B=2, ..., G=7.

A sector-average dispersion equation consistent with Regulatory Guide 1.111 is used. The dispersion model considers plume depletion (using information from Figure 7.3), and building wake effects. Terrain effects on dispersion are not considered except for reducing the effective height of an elevated release by the terrain height.

7.9.1 Annual Average Air Concentration χ (μCi-year/m^3)

Air concentrations of nuclides at downwind locations are calculated using the following equation:

$$\chi_i = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk}\, Q_i\, p}{\Sigma_{zk} u_j (2\pi x/n)} \exp(-\lambda_i x/u_j) \exp(-h_e^2/2\sigma_{zk}^2)\ 10^6\ 3.17E\text{-}08 \quad (7.11)$$

where:

f_{jk} = joint relative frequency of occurrence of winds in windspeed class j, stability class k, blowing toward this exposure point, expressed as a fraction.
Q_i = amount released of radionuclide i, Ci.
p = fraction of radionuclide remaining in plume (Figure 7.3).
Σ_{zk} = vertical dispersion coefficient for stability class k which includes a building wake adjustment,
= $(\sigma_{zk}^2 + cA/\pi)^{1/2}$,

or = $\sqrt{3}\,\sigma_{zk}$, whichever is smaller (for ground level releases).

where
σ_{zk} is the vertical dispersion coefficient for stability class k (m) (Figure 7.4),
c is a building shape factor (c=0.5),
A is the minimum building cross-sectional area (2400 m^2).

u_j = midpoint value of wind speed class interval j, m/s.
x = downwind distance, m.
n = number of sectors, 16.
λ_i = radioactive decay coefficient of radionuclide i, s^{-1}
$2\pi x/n$ = sector width at point of interest, m.
h_e = effective release height, m. The effective release height is calculated as described in Section 7.9.4.
10^6 = conversion factor, μCi per Ci.
3.17E-08 = conversion factor, years per second.

7.9.2 Relative Concentration
χ/Q (sec/m^3)

Relative concentrations of nuclides at downwind locations are calculated using the following equation:

$$\chi/Q = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk}}{\Sigma_{zk}\, u_j\, (2\pi x/n)} \exp(-h_e^2/2\sigma_{zk}^2) \qquad (7.12)$$

where:

f_{jk} = joint relative frequency of occurrence of winds in windspeed class j, stability class k, blowing toward this exposure point, expressed as a fraction.

Σ_{zk} = vertical dispersion coefficient for stability class k which includes a building wake adjustment,
= $(\sigma_{zk}^2 + cA/\pi)^{1/2}$,
or = $\sqrt{3}\,\sigma_{zk}$, whichever is smaller (for ground level releases).

where
σ_{zk} is the vertical dispersion coefficient for stability class k (m) (Figure 7.4),
c is a building shape factor (c=0.5),
A is the minimum building cross-sectional area (2400 m^2).

u_j = midpoint value of wind speed class interval j, m/s.
x = downwind distance, m.
n = number of sectors, 16.
$2\pi x/n$ = sector width at point of interest, m.
h_e = effective release height, m. The effective release height is calculated as described in Section 7.9.4.

7.9.3 Relative Dispersion
D/Q (m^{-2})

Relative deposition of nuclides at downwind locations is calculated using the following equation:

$$D/Q = \sum_{j=1}^{9} \sum_{k=1}^{7} \frac{f_{jk}\, DR}{(2\pi x/n)} \qquad (7.13)$$

where:

f_k = joint relative frequency of occurrence of winds in windspeed class j and stability class k, blowing toward this exposure point, expressed as a fraction.
DR = relative deposition rate, m^{-1} (from Figure 7.5). The choice of figures is governed by the effective release height calculation described in Section 7.9.4. A linear interpolation is used for effluent release heights that fall in between the given curves.
x = downwind distance, m.
n = number of sectors, 16.
$2\pi x/n$ = sector width at point of interest, m.

7.9.4 Effective Release Height

For effluents exhausted from release points that are higher than twice the height of adjacent structures (elevated releases) the effective release height is determined by the following equation, consistent with Regulatory Guide 1.111

$$h_e = h_s + h_{pr} - h_t - c$$

where:

c = downwash correction factor for low relative exit velocity,
= $3(1.5-W_o/u)d$,
where
W_o = the vertical plume exit velocity, m/s.
u = mean wind speed at the height of the release, m/s.
d = inside diameter of the release point, m.
NOTE: If c is less than zero, it is set equal to zero.

h_{pr} = plume rise above the release point, m.
h_s = physical height of release point, m.
h_t = maximum terrain height between release point and receptor location, m.

For effluents released from points less than the height of adjacent structures, a ground level release is assumed ($h_e = 0$).

For effluents released from points at the level of or above adjacent structures, but lower than elevated release points, releases are treated as follows:

Case 1 - elevated if $W_o/u \geq 5$.
Case 2 - ground level ($h_e = 0$) if $W_o/u \leq 1$.
Case 3 - split level if $1 < w_o/u < 5$.

Under Case 3 a split level dispersion approach is implemented using a model that requires for each release point two JFDs, one for elevated releases and one for ground level releases. The summation of the elevated and ground level JFDs account for the total period of record. Releases are considered to be elevated $100(1-E_t)$ percent of the time and ground level 100 E_t percent of the time where the entrainment coefficient, E_t, is defined by

$E_t = 2.58 - 1.58(W_o/u)$ for $1 < W_o/u \leq 1.5$
$E_t = 0.3 - 0.06(W_o/u)$ for $1.5 < W_o/u \leq 5$

Table 7.1

BFN - OFFSITE RECEPTOR LOCATION DATA

POINT	DISTANCE from plant (m)		Elev above plant grade (m)	GROUND LEVEL X/Q (s/m³)	GROUND LEVEL D/Q (1/m²)	ELEVATED X/Q (s/m³)	ELEVATED D/Q (1/m²)
Site Boundary	1525	N	7	1.60E-06	5.64E-09	N/A	N/A
Site Boundary	1300	NNE	4	7.88E-07	1.97E-09	N/A	N/A
Site Boundary	1250	NE	7	4.52E-07	1.56E-09	N/A	N/A
Site Boundary	1450	ENE	0	7.30E-07	2.92E-09	N/A	N/A
Site Boundary	1375	E	0	8.24E-07	4.04E-09	N/A	N/A
Site Boundary	1575	ESE	0	4.56E-07	3.28E-09	N/A	N/A
Site Boundary	5600	SE	-6	7.61E-08	3.63E-10	N/A	N/A
Site Boundary	2875	SSE	-6	4.86E-07	1.77E-09	N/A	N/A
Site Boundary	2550	S	-6	8.27E-07	2.24E-09	N/A	N/A
Site Boundary	2425	SSW	-6	1.08E-06	2.92E-09	N/A	N/A
Site Boundary	2300	SW	-6	6.87E-07	1.75E-09	N/A	N/A
Site Boundary	2500	WSW	-6	6.38E-07	1.14E-09	N/A	N/A
Site Boundary	2550	W	-6	6.70E-07	1.25E-09	N/A	N/A
Site Boundary	3325	WNW	-6	3.69E-07	9.07E-10	N/A	N/A
Site Boundary	2275	NW	-6	1.69E-06	4.92E-09	N/A	N/A
Site Boundary	1650	NNW	-6	1.84E-06	5.29E-09	N/A	N/A
Air Dose Point	6100	NW	-6	N/A	N/A	2.08E-08	4.75E-10
Garden	1830	NNW	34	1.57E-06	4.46E-09	N/A	1.13E-09
Garden	4437	E	19	N/A	N/A	9.50E-09	N/A
Milk Cow	8045	N	34	1.47E-07	3.16E-10	N/A	2.30E-10
Milk Cow	10975	NNW	34	N/A	N/A	1.69E-08	N/A

NOTE: For quarterly dose calculations, doses will also be calculated for all locations identified in the most recent land use census, and for any additional points deemed necessary.

Table 7.2

EXPECTED ANNUAL ROUTINE ATMOSPHERIC RELEASES FROM ONE UNIT AT BFN

	Building Vents (Ci/yr/Unit)			Stack (Ci/yr/Unit)	
Isotope	Reactor Complex Vent	Radwaste Building Vent	Turbine Building Vent	Gland Seal and Offgas	MVP
Kr-85m	6E+0	< 1	2E+0	1.66E+4	0.0E+0
Kr-85	-	-	-	6.3E+2	-
Kr-87	6E+0	< 1	9.5E+1	7.47E+2	0.0E+0
Kr-88	9E+0	< 1	1.02E+2	1.35E+4	0.0E+0
Kr-89	1E+0	3.4E+1	5.03E+2	4.10E+3	0.0E+0
Xe-131m	-	-	-	3.09E+2	0.0E+0
Xe-133m	0E+0	6.0E+1	0E+0	8.51E+2	0.0E+0
Xe-133	1.03E+2	2.94E+2	5.81E+2	9.47E+4	3.0E+2
Xe-135m	1.11E+2	6.67E+2	4.64E+2	9.17E+2	0.0E+0
Xe-135	1.73E+2	3.28E+2	6.72E+2	5.99E+2	2.0E+2
Xe-137	7.8E+1	1.13E+2	3.86E+2	5.04E+3	0.0E+0
Xe-138	1.2E+1	2E+0	1.18E+3	3.15E+3	0.0E+0
I-131 I	5.94E-2	5.0E-3	1.56E-2	4.1E-3	8.5E-3
I-132 I	5.94E-1	5.0E-2	1.79E-1	4.69E-2	9.73E-2
I-133 I	2.97E-1	2.5E-2	1.23E-1	3.23E-2	6.71E-2
I-134 I	1.49E+0	1.25E-1	2.67E-2	7.0E-3	1.45E-2
I-135 I	5.94E-1	5.0E-2	1.23E-1	3.23E-2	6.71E-2
I-131 O	3.16E-2	2.9E-2	6.5E-3	3.32E-2	2.74E-1
I-132 O	3.16E-1	2.9E-1	7.44E-2	3.80E-1	3.14E+0
I-133 O	1.58E-1	1.45E-1	5.13E-2	2.62E-1	2.16E+0
I-134 O	7.90E-1	7.25E-1	1.11E-2	5.68E-2	4.69E-1
I-135 O	3.16E-1	2.90E-1	5.13E-2	2.61E-1	2.16E+0
Cr-51	3E-3	9E-4	1E-3	1E-4	0.0E+0
Mn-54	3E-3	5E-3	2E-3	4E-5	0.0E+0
Co-58	2E-3	4E-4	9E-5	2E-5	0.0E+0
Fe-59	1E-4	8E-4	4E-4	2E-4	0.0E+0
Co-60	3E-2	6E-3	3E-3	1E-5	0.0E+0
Zn-65	3E-3	2E-4	4E-4	9E-5	0.0E+0
Sr-89	1E-2	3E-1	*	*	0.0E+0
Sr-90	2E-3	4E-3	*	*	0.0E+0
Nb-95	3E-4	2E-4	9E-6	8E-5	0.0E+0
Zr-95	1E-4	1E-4	8E-6	8E-5	0.0E+0
Ru-103	3E-5	1E-4	2E-4	1E-4	0.0E+0
Ag-110m	7E-6	*	*	*	0.0E+0
Sb-124	3E-5	3E-4	6E-5	8E-5	0.0E+0
Cs-134	5E-3	3E-4	5E-4	2E-5	0.0E+0
Cs-136	2E-3	5E-5	1E-4	9E-8	0.0E+0
Cs-137	7E-3	4E-4	2E-3	7E-4	0.0E+0
Ba-140	4E-3	5E-4	2E-2	8E-3	0.0E+0
Ce-141	4E-4	2E-4	2E-3	2E-5	0.0E+0
Ce-144	5E-6	*	*	4E-6	0.0E+0
Ar-41	2.5E+1	0E+0	0E+0	0E+0	0.0E+0
C-14	0E+0	0E+0	0E+0	9.5E+0	0.0E+0
H-3	0E+0	9.5E+0	0E+0	0E+0	0.0E+0

* Not available.

I denotes nonorganic iodine (elemental, particulate, HIO), O denotes organic iodine.

Table 7.3 (1 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class A (Delta-T≤ -1.9 degrees C per 100 m)
BROWNS FERRY NUCLEAR PLANT
January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.04	0.12	0.05	0.0	0.0	0.21
NNE	0.0	0.0	0.0	0.05	0.19	0.10	0.0	0.0	0.34
NE	0.0	0.0	0.0	0.04	0.06	0.0	0.0	0.0	0.10
ENE	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01
E	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.01
ESE	0.0	0.01	0.11	0.17	0.02	0.0	0.0	0.0	0.31
SE	0.0	0.03	1.11	0.40	0.02	0.0	0.0	0.0	1.56
SSE	0.0	0.04	0.52	0.10	0.02	0.0	0.0	0.0	0.68
S	0.0	0.01	0.38	0.11	0.04	0.0	0.0	0.0	0.54
SSW	0.0	0.0	0.04	0.05	0.01	0.0	0.0	0.0	0.10
SW	0.0	0.0	0.05	0.04	0.0	0.0	0.0	0.0	0.09
WSW	0.0	0.0	0.04	0.07	0.04	0.0	0.0	0.0	0.15
W	0.0	0.0	0.01	0.05	0.05	0.01	0.0	0.0	0.12
WNW	0.0	0.0	0.02	0.03	0.09	0.06	0.0	0.0	0.20
NW	0.0	0.0	0.0	0.02	0.17	0.11	0.0	0.0	0.30
NNW	0.0	0.0	0.01	0.01	0.06	0.09	0.02	0.0	0.19
Sub-total	0.0	0.09	2.29	1.19	0.90	0.42	0.02	0.0	4.91

Total hours of valid stability observations - 25935
Total hours of Stability Class A - 1262
Total hours of valid wind direction-wind speed-Stability Class A - 1259
Total hours calm - 0

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 6.8 mph

Table 7.3 (2 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class B (-1.9 < Delta-T ≤ -1.7 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
NN	0.0	0.0	0.05	0.09	0.30	0.04	0.01	0.0	0.49
NNE	0.0	0.0	0.05	0.07	0.27	0.05	0.0	0.0	0.44
NE	0.0	0.0	0.04	0.02	0.09	0.01	0.0	0.0	0.16
ENE	0.0	0.01	0.01	0.01	0.01	0.0	0.0	0.0	0.04
E	0.0	0.0	0.02	0.01	0.0	0.0	0.0	0.0	0.03
ESE	0.0	0.02	0.10	0.04	0.0	0.0	0.0	0.0	0.16
SE	0.0	0.13	0.64	0.09	0.02	0.0	0.0	0.0	0.88
SSE	0.0	0.09	0.31	0.02	0.01	0.0	0.0	0.0	0.43
S	0.0	0.05	0.42	0.07	0.02	0.0	0.0	0.0	0.56
SSW	0.0	0.02	0.07	0.01	0.0	0.0	0.0	0.0	0.10
SW	0.0	0.0	0.17	0.02	0.0	0.0	0.0	0.0	0.19
WSW	0.0	0.0	0.11	0.13	0.05	0.01	0.0	0.0	0.30
W	0.0	0.02	0.04	0.17	0.17	0.03	0.0	0.0	0.43
WNW	0.0	0.0	0.07	0.11	0.23	0.08	0.04	0.0	0.53
NW	0.0	0.0	0.01	0.07	0.27	0.13	0.01	0.0	0.49
NNW	0.0	0.0	0.0	0.07	0.19	0.12	0.0	0.0	0.38
Sub-total	0.0	0.34	2.11	1.00	1.63	0.47	0.06	0.0	5.61

Total hours of valid stability observations - 25935
Total hours of Stability Class B - 1445
Total hours of valid wind direction-wind speed-Stability Class B - 1440
Total hours calm - 0

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 7.2 mph

Table 7.3 (3 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class C (-1.7 < Delta-T≤ -1.5 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.01	0.08	0.11	0.21	0.02	0.0	0.0	0.43
NNE	0.0	0.01	0.07	0.09	0.17	0.20	0.0	0.0	0.36
NE	0.0	0.0	0.03	0.08	0.05	0.0	0.0	0.0	0.16
ENE	0.0	0.0	0.02	0.02	0.0	0.0	0.0	0.0	0.04
E	0.0	0.0	0.03	0.02	0.0	0.0	0.0	0.0	0.05
ESE	0.0	0.01	0.05	0.02	0.0	0.0	0.0	0.0	0.08
SE	0.0	0.17	0.29	0.09	0.01	0.0	0.0	0.0	0.56
SSE	0.0	0.12	0.17	0.04	0.01	0.0	0.0	0.0	0.34
S	0.0	0.11	0.25	0.04	0.02	0.0	0.0	0.0	0.42
SSW	0.0	0.03	0.06	0.01	0.0	0.0	0.0	0.0	0.10
SW	0.0	0.03	0.12	0.03	0.01	0.0	0.0	0.0	0.19
WSW	0.0	0.0	0.11	0.07	0.07	0.0	0.0	0.0	0.25
W	0.0	0.0	0.05	0.12	0.10	0.02	0.01	0.0	0.30
WNW	0.0	0.01	0.12	0.13	0.17	0.07	0.04	0.0	0.54
NW	0.0	0.0	0.05	0.09	0.22	0.10	0.01	0.0	0.47
NNW	0.0	0.0	0.02	0.08	0.18	0.10	0.0	0.0	0.38
Sub-total	0.0	0.50	1.52	1.04	1.22	0.33	0.06	0.0	4.67

Total hours of valid stability observations - 25935
Total hours of Stability Class C 1202
Total hours of valid wind direction-wind speed-Stability Class C - 1197
Total hours calm - 0

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 7.0 mph

Table 7.3 (4 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION
Stability Class D (-1.5 < Delta-T≤ -0.5 degrees C per 100 m)
BROWNS FERRY NUCLEAR PLANT
January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.19	0.41	0.53	1.00	0.37	0.01	0.0	2.51
NNE	0.01	0.20	0.56	0.58	1.18	0.18	0.01	0.0	2.72
NE	0.01	0.12	0.38	0.43	0.52	0.01	0.0	0.0	1.47
ENE	0.0	0.26	0.23	0.15	0.05	0.01	0.0	0.0	0.70
E	0.0	0.20	0.31	0.17	0.05	0.0	0.0	0.0	0.73
ESE	0.0	0.24	0.51	0.30	0.08	0.0	0.0	0.0	1.13
SE	0.02	1.16	1.31	0.83	0.26	0.0	0.0	0.0	3.58
SSE	0.01	0.99	0.99	0.26	0.11	0.02	0.0	0.0	2.38
S	0.0	0.92	1.17	0.34	0.17	0.0	0.0	0.0	2.60
SSW	0.0	0.45	0.29	0.08	0.04	0.0	0.0	0.0	0.86
SW	0.0	0.24	0.29	0.09	0.02	0.01	0.0	0.0	0.65
WSW	0.0	0.32	0.70	0.29	0.33	0.11	0.0	0.0	1.75
W	0.0	0.18	0.55	0.62	0.63	0.22	0.03	0.0	2.23
WNW	0.0	0.13	0.39	0.42	1.10	0.82	0.22	0.01	3.09
NW	0.0	0.04	0.28	0.38	1.01	0.87	0.14	0.02	2.74
NNW	0.0	0.13	0.40	0.55	1.54	0.74	0.05	0.0	3.41
Sub-total	0.05	5.77	8.77	6.02	8.09	3.36	0.46	0.03	32.55

Total hours of valid stability observations - 25935
Total hours of Stability Class D - 8438
Total hours of valid wind direction-wind speed-Stability Class D - 8341
Total hours calm - 1

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 7.1 mph

Table 7.3 (5 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class E (-0.5 < Delta-T ≤ 1.5 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.04	0.47	0.54	0.43	0.41	0.05	0.01	0.0	1.95
NNE	0.05	0.61	0.74	0.55	0.47	0.04	0.0	0.0	2.46
NE	0.05	0.57	0.63	0.42	0.27	0.02	0.0	0.0	1.96
ENE	0.05	0.71	0.45	0.17	0.08	0.02	0.0	0.0	1.48
E	0.04	0.61	0.74	0.16	0.07	0.0	0.0	0.0	1.62
ESE	0.03	0.76	1.01	0.53	0.16	0.01	0.0	0.0	2.50
SE	0.11	2.04	1.75	0.92	0.55	0.02	0.0	0.0	5.39
SSE	0.07	1.16	0.78	0.48	0.33	0.04	0.0	0.0	2.86
S	0.05	1.03	0.74	0.44	0.63	0.14	0.01	0.0	3.04
SSW	0.02	0.52	0.14	0.08	0.06	0.01	0.0	0.0	0.83
SW	0.04	0.30	0.07	0.02	0.03	0.0	0.0	0.0	0.46
WSW	0.01	0.53	0.60	0.14	0.11	0.04	0.0	0.0	1.43
W	0.02	0.37	0.77	0.42	0.27	0.04	0.0	0.0	1.89
WNW	0.03	0.15	0.13	0.11	0.22	0.09	0.02	0.0	0.75
NW	0.02	0.17	0.20	0.14	0.25	0.09	0.02	0.0	0.89
NNW	0.05	0.41	0.48	0.54	0.59	0.09	0.01	0.0	2.17
Sub-total	0.68	10.41	9.77	5.55	4.50	0.70	0.07	0.0	31.68

Total hours of valid stability observations - 25935
Total hours of Stability Class E - 8264
Total hours of valid wind direction-wind speed-Stability Class E - 8098
Total hours calm - 3

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 5.0 mph

Table 7.3 (6 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class F (1.5 < Delta-T≤ 4.0 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.05	0.36	0.52	0.28	0.06	0.0	0.0	0.0	1.27
NNE	0.05	0.51	0.66	0.34	0.11	0.0	0.0	0.0	1.67
NE	0.07	0.34	0.27	0.18	0.01	0.0	0.0	0.0	0.87
ENE	0.03	0.53	0.33	0.05	0.0	0.0	0.0	0.0	0.94
E	0.01	0.59	0.52	0.03	0.0	0.0	0.0	0.0	1.15
ESE	0.0	0.52	0.22	0.0	0.0	0.0	0.0	0.0	0.74
SE	0.09	0.97	0.48	0.17	0.13	0.01	0.0	0.0	1.85
SSE	0.05	0.54	0.34	0.17	0.25	0.02	0.01	0.0	1.38
S	0.03	0.29	0.18	0.20	0.27	0.01	0.0	0.0	0.98
SSW	0.03	0.13	0.03	0.0	0.01	0.0	0.0	0.0	0.20
SW	0.0	0.09	0.03	0.0	0.0	0.0	0.0	0.0	0.12
WSW	0.0	0.09	0.07	0.0	0.0	0.0	0.0	0.0	0.16
W	0.02	0.09	0.06	0.0	0.01	0.0	0.0	0.0	0.18
WNW	0.01	0.08	0.01	0.0	0.0	0.0	0.0	0.0	0.10
NW	0.01	0.08	0.04	0.01	0.0	0.0	0.0	0.0	0.14
NNW	0.05	0.27	0.27	0.16	0.05	0.0	0.0	0.0	0.80
Sub-total	0.50	5.48	4.03	1.59	0.90	0.04	0.01	0.0	12.55

Total hours of valid stability observations - 25935
Total hours of Stability Class F - 3268
Total hours of valid wind direction-wind speed-Stability Class F - 3223
Total hours calm - 2

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 4.0 mph

Table 7.3 (7 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class G (Delta-T> 4.0 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.07	0.76	0.32	0.02	0.0	0.0	0.0	0.0	1.17
NNE	0.05	0.83	0.51	0.18	0.02	0.0	0.0	0.0	1.59
NE	0.04	0.34	0.12	0.02	0.0	0.0	0.0	0.0	0.52
ENE	0.04	0.48	0.18	0.02	0.0	0.0	0.0	0.0	0.72
E	0.02	0.52	0.34	0.0	0.0	0.0	0.0	0.0	0.88
ESE	0.01	0.18	0.01	0.0	0.0	0.0	0.0	0.0	0.20
SE	0.08	0.43	0.09	0.04	0.03	0.0	0.0	0.0	0.67
SSE	0.03	0.44	0.31	0.16	0.08	0.0	0.0	0.0	1.02
S	0.05	0.09	0.12	0.10	0.04	0.0	0.0	0.0	0.40
SSW	0.05	0.05	0.01	0.0	0.0	0.0	0.0	0.0	0.11
SW	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01
WSW	0.02	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.04
W	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.02
WNW	0.01	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.03
NW	0.04	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.08
NNW	0.05	0.23	0.12	0.03	0.0	0.0	0.0	0.0	0.43
Sub-total	0.57	4.45	2.13	0.57	0.17	0.0	0.0	0.0	7.89

Total hours of valid stability observations - 25935
Total hours of Stability Class G - 2056
Total hours of valid wind direction-wind speed-Stability Class G - 2019
Total hours calm - 4

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T measured between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Mean wind speed = 3.2 mph

Table 7.3 (8 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Disregarding Stability Class

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

	Wind Speed (mph)								
	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.02	0.19	0.38	0.64	2.07	2.47	0.61	0.06	6.44
NNE	0.0	0.13	0.33	0.60	2.46	2.69	0.50	0.04	6.75
NE	0.0	0.12	0.35	0.64	2.16	1.85	0.58	0.02	5.72
ENE	0.02	0.14	0.32	0.36	1.15	0.95	0.34	0.04	3.32
E	0.0	0.22	0.47	0.45	0.99	0.43	0.08	0.01	2.65
ESE	0.01	0.23	0.53	0.66	1.79	1.63	0.42	0.09	5.36
SE	0.02	0.36	1.26	1.36	3.25	3.20	1.54	0.69	11.68
SSE	0.01	0.38	1.20	1.22	2.97	2.59	1.16	0.59	10.12
S	0.02	0.40	0.90	1.05	2.53	2.40	1.03	0.43	8.76
SSW	0.0	0.31	0.65	0.69	1.73	1.77	0.73	0.19	6.07
SW	0.02	0.38	0.66	0.69	1.55	1.62	0.50	0.14	5.56
WSW	0.01	0.26	0.69	0.68	1.15	1.05	0.36	0.17	4.37
W	0.02	0.20	0.66	0.81	1.76	1.04	0.42	0.35	5.26
WNW	0.01	0.17	0.46	0.69	2.03	1.54	0.76	0.30	5.96
NW	0.02	0.19	0.49	0.70	1.80	2.01	0.96	0.28	6.45
NNW	0.01	0.22	0.28	0.41	1.66	2.13	0.70	0.13	5.54
Sub-total	0.19	3.90	9.63	11.65	31.05	29.37	10.69	3.53	100.01

Total hours of valid wind observations - 25784
Total hours of observations - 26280
Recoverability percentage - 98.1
Total hours calm - 2

All columns and calm total 100 percent of joint valid observations

Meteorological facility: located 1.3 km ESE of BFN
Wind speed and direction measured at the 92.63 meter level
Mean wind speed = 12.0 mph

Table 7.3 (9 of 22)
JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION
Stability Class A (Delta-T≤ -1.9 degrees C per 100 m)
BROWNS FERRY NUCLEAR PLANT
Part 1 of 2 ground level release mode
January 1, 1977 - December 31, 1979

Wind Speed (mph)

	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.0	0.02	0.01	0.0	0.0	0.03
NNE	0.0	0.0	0.0	0.0	0.0	0.03	0.02	0.0	0.0	0.05
NE	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.01
ENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.02
SE	0.0	0.0	0.0	0.05	0.04	0.01	0.0	0.0	0.0	0.10
SSE	0.0	0.0	0.0	0.03	0.02	0.01	0.0	0.0	0.0	0.06
S	0.0	0.0	0.0	0.02	0.02	0.01	0.0	0.0	0.0	0.05
SSW	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01
SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.02
W	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.01
WNW	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.02
NW	0.0	0.0	0.0	0.0	0.0	0.02	0.02	0.0	0.0	0.04
NNW	0.0	0.0	0.0	0.0	0.0	0.01	0.02	0.02	0.0	0.05
Sub-total	0.0	0.0	0.0	0.10	0.12	0.15	0.08	0.02	0.0	0.47

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class A - 133.1
Total hours of ground level Stability Class A - 127.5

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind direction measured at 10.42 meter level
Wind speed measured at 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (10 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class B (-1.9 < Delta T ≤ -1.7 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 1 of 2 ground level release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.01	0.05	0.01	0.01	0.0	0.08
NNE	0.0	0.0	0.0	0.0	0.01	0.05	0.01	0.0	0.0	0.07
NE	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.01
ENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01
SE	0.0	0.0	0.0	0.02	0.02	0.01	0.0	0.0	0.0	0.05
SSE	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.02
S	0.0	0.0	0.0	0.02	0.01	0.01	0.0	0.0	0.0	0.04
SSW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.02	0.01	0.0	0.0	0.0	0.03
W	0.0	0.0	0.0	0.0	0.01	0.02	0.02	0.01	0.0	0.06
WNW	0.0	0.0	0.0	0.0	0.01	0.03	0.02	0.03	0.0	0.09
NW	0.0	0.0	0.0	0.0	0.01	0.04	0.03	0.0	0.0	0.08
NNW	0.0	0.0	0.0	0.0	0.0	0.03	0.04	0.0	0.0	0.07
Sub-total	0.0	0.0	0.0	0.05	0.12	0.26	0.13	0.05	0.0	0.61

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class B - 185.1
Total hours of ground level Stability Class B - 163.4

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind direction measured at 10.42 meter level
Wind speed measured at 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (11 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class C (-1.7 < Delta-T≤ -1.5 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 1 of 2 ground level release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.01	0.03	0.0	0.0	0.0	0.04
NNE	0.0	0.0	0.0	0.0	0.01	0.02	0.0	0.0	0.0	0.03
NE	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.02
ENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.02
SSE	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0	0.03
S	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0	0.03
SSW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.02
W	0.0	0.0	0.0	0.0	0.01	0.01	0.01	0.01	0.0	0.04
WNW	0.0	0.0	0.0	0.0	0.01	0.02	0.02	0.03	0.0	0.08
NW	0.0	0.0	0.0	0.0	0.01	0.03	0.02	0.01	0.0	0.07
NNW	0.0	0.0	0.0	0.0	0.01	0.02	0.03	0.0	0.0	0.06
Sub-total	0.0	0.0	0.0	0.03	0.11	0.17	0.08	0.05	0.0	0.44

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class C - 259.0
Total hours of ground level Stability Class C - 106.3

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind direction measured at 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (12 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class D (-1.5 < Delta-T≤ -0.5 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 1 of 2 ground level release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.01	0.04	0.15	0.10	0.01	0.0	0.31
NNE	0.0	0.0	0.0	0.01	0.05	0.18	0.05	0.01	0.0	0.30
NE	0.0	0.0	0.0	0.01	0.04	0.08	0.0	0.0	0.0	0.13
ENE	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0	0.03
E	0.0	0.0	0.0	0.01	0.02	0.01	0.0	0.0	0.0	0.04
ESE	0.0	0.0	0.0	0.03	0.04	0.01	0.0	0.0	0.0	0.08
SE	0.0	0.0	0.01	0.11	0.13	0.06	0.0	0.0	0.0	0.31
SSE	0.0	0.0	0.02	0.09	0.06	0.05	0.02	0.0	0.0	0.24
S	0.0	0.0	0.02	0.09	0.06	0.06	0.0	0.0	0.0	0.23
SSW	0.0	0.0	0.01	0.02	0.01	0.01	0.0	0.0	0.0	0.05
SW	0.0	0.0	0.0	0.01	0.01	0.0	0.01	0.0	0.0	0.03
WSW	0.0	0.0	0.0	0.03	0.03	0.06	0.04	0.0	0.0	0.16
W	0.0	0.0	0.0	0.02	0.06	0.10	0.09	0.02	0.0	0.29
WNW	0.0	0.0	0.0	0.0	0.03	0.16	0.19	0.14	0.01	0.53
NW	0.0	0.0	0.0	0.0	0.03	0.15	0.23	0.10	0.02	0.53
NNW	0.0	0.0	0.0	0.01	0.05	0.25	0.19	0.04	0.0	0.54
Sub-total	0.0	0.0	0.6	0.46	0.67	1.34	0.92	0.32	0.03	3.80

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class D - 13904.1
Total hours of ground level Stability Class D - 968.6

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind direction measured at 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (13 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class E (-0.5<Delta-T≤ 1.5 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 1 of 2 ground level release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.04	0.06	0.07	0.02	0.01	0.0	0.20
NNE	0.0	0.0	0.01	0.06	0.07	0.08	0.02	0.0	0.0	0.24
NE	0.0	0.0	0.01	0.06	0.06	0.05	0.01	0.0	0.0	0.19
ENE	0.0	0.0	0.02	0.04	0.03	0.01	0.01	0.0	0.0	0.11
E	0.0	0.0	0.02	0.07	0.02	0.01	0.0	0.0	0.0	0.12
ESE	0.0	0.0	0.02	0.08	0.07	0.03	0.0	0.0	0.0	0.20
SE	0.0	0.0	0.08	0.22	0.16	0.18	0.02	0.0	0.0	0.66
SSE	0.0	0.0	0.05	0.12	0.12	0.19	0.04	0.0	0.0	0.52
S	0.0	0.0	0.06	0.10	0.09	0.27	0.13	0.01	0.0	0.66
SSW	0.0	0.0	0.02	0.02	0.02	0.02	0.01	0.0	0.0	0.09
SW	0.0	0.0	0.01	0.0	0.0	0.01	0.0	0.0	0.0	0.02
WSW	0.0	0.0	0.01	0.05	0.02	0.03	0.02	0.0	0.0	0.13
W	0.0	0.0	0.01	0.06	0.05	0.05	0.01	0.0	0.0	0.18
WNW	0.0	0.0	0.0	0.01	0.01	0.04	0.02	0.01	0.0	0.09
NW	0.0	0.0	0.0	0.01	0.02	0.04	0.03	0.01	0.0	0.11
NNW	0.0	0.0	0.0	0.03	0.07	0.10	0.02	0.01	0.0	0.23
Sub-total	0.0	0.0	0.32	0.97	0.87	1.18	0.36	0.05	0.0	3.75

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class E - 7920.6
Total hours of ground level Stability Class E - 957.9

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind direction measured at 10.42 meter level
Wind speed measured at 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (14 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class F (1.5 < Delta-T ≤ 4.0 degrees C per 100 m)

Part 1 of 2 ground level release mode

BROWNS FERRY NUCLEAR PLANT

January 1, 1977 - December 31, 1979

Wind Speed (mph)

	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.01	0.06	0.04	0.01	0.0	0.0	0.0	0.12
NNE	0.0	0.0	0.01	0.08	0.05	0.02	0.0	0.0	0.0	0.16
NE	0.0	0.0	0.01	0.03	0.03	0.0	0.0	0.0	0.0	0.07
ENE	0.0	0.0	0.02	0.03	0.01	0.0	0.0	0.0	0.0	0.06
E	0.0	0.0	0.01	0.04	0.0	0.0	0.0	0.0	0.0	0.05
ESE	0.0	0.0	0.02	0.02	0.0	0.0	0.0	0.0	0.0	0.04
SE	0.0	0.0	0.05	0.06	0.03	0.06	0.01	0.0	0.0	0.21
SSE	0.0	0.0	0.04	0.06	0.05	0.18	0.02	0.01	0.0	0.36
S	0.0	0.0	0.02	0.03	0.04	0.11	0.01	0.0	0.0	0.21
SSW	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01
SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.01
WNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.01	0.03	0.02	0.01	0.0	0.0	0.0	0.07
Sub-total	0.0	0.0	0.21	0.45	0.27	0.39	0.04	0.01	0.0	1.37

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class F - 2385.0
Total hours of ground level Stability Class F - 357.0

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind speed measured at 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (15 of 22)
SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION
Stability Class G (Delta-T> 4.0 degrees C per 100 m)
Part 1 of 2 ground level release mode
BROWNS FERRY NUCLEAR PLANT
January 1, 1977 - December 31, 1979

		Wind Speed (mph)								
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.02	0.04	0.0	0.0	0.0	0.0	0.0	0.06
NNE	0.0	0.0	0.02	0.06	0.03	0.0	0.0	0.0	0.0	0.11
NE	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
ENE	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
E	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
ESE	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01
SE	0.0	0.0	0.03	0.01	0.01	0.02	0.0	0.0	0.0	0.07
SSE	0.0	0.0	0.04	0.05	0.03	0.06	0.0	0.0	0.0	0.18
S	0.0	0.0	0.01	0.02	0.02	0.01	0.0	0.0	0.0	0.06
SSW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.01	0.01	0.08	0.0	0.0	0.0	0.0	0.02
Sub-total	0.0	0.0	0.17	0.22	0.09	0.09	0.0	0.0	0.0	0.57

Total hours of valid observations - 25482.0
Total hours of ground level release - 2832.4
Total hours of Stability Class G - 694.7
Total hours of ground level Stability Class G - 151.7

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 10.03 and 45.30 meters
Wind speed and direction measured at the 10.42 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (16 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class A (Delta-T≤ -1.9 degrees C per 100 m)
BROWNS FERRY NUCLEAR PLANT
Part 2 of 2 elevated release mode
January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSW	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01
SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class A - 133.1
Total hours of elevated Stability Class A - 5.6

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind direction measured at 45.67 meter level
Wind speed measured at 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (17 of 22)

SPLIT JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class B (-1.9 < Delta-T ≤ -1.7 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 2 of 2 elevated release mode

January 1, 1977 - December 31, 1979

		Wind Speed (mph)								
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
SSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSW	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.01
SW	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01
WSW	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.02
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	0.0	0.01	0.01	0.01	0.03	0.0	0.0	0.0	0.06

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class B - 185.1
Total hours of elevated stability class B - 21.8

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind direction measured at 45.67 meter level
Wind speed measured at 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (18 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class C (-1.7 < Delta-T≤ -1.5 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 2 of 2 elevated release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNE	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.01
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESE	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0	0.03
SE	0.0	0.0	0.02	0.05	0.01	0.0	0.0	0.0	0.0	0.08
SSE	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.04
S	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
SSW	0.0	0.0	0.0	0.02	0.02	0.01	0.0	0.0	0.0	0.05
SW	0.0	0.0	0.0	0.05	0.05	0.02	0.01	0.0	0.0	0.13
WSW	0.0	0.0	0.0	0.0	0.03	0.05	0.01	0.0	0.0	0.09
W	0.0	0.0	0.0	0.0	0.01	0.03	0.02	0.02	0.0	0.08
WNW	0.0	0.0	0.0	0.0	0.0	0.02	0.02	0.0	0.0	0.04
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.01
NNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	0.0	0.03	0.18	0.14	0.14	0.07	0.02	0.0	0.58

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class C - 259.0
Total hours of elevated Stability Class C - 152.7

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind speed and direction measured at the 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (19 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION
Stability Class D (-1.5 < Delta-T ≤ -0.5 degrees C per 100 m)
BROWNS FERRY NUCLEAR PLANT
Part 2 of 2 elevated release mode
January 1, 1977 - December 31, 1979

Wind Speed (mph)

	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.12	0.40	0.62	1.49	0.87	0.12	0.0	3.62
NNE	0.0	0.01	0.13	0.46	0.72	1.88	0.91	0.05	0.0	4.16
NE	0.0	0.0	0.09	0.36	0.48	1.04	0.14	0.02	0.0	2.13
ENE	0.0	0.01	0.11	0.24	0.23	0.23	0.04	0.01	0.0	0.87
E	0.0	0.01	0.10	0.20	0.28	0.25	0.05	0.01	0.0	0.90
ESE	0.0	0.01	0.22	0.52	0.68	1.07	0.16	0.0	0.0	2.66
SE	0.0	0.01	0.67	1.66	0.89	1.75	0.84	0.16	0.01	5.99
SSE	0.0	0.01	0.48	0.90	0.63	1.49	1.08	0.26	0.02	4.87
S	0.0	0.0	0.34	0.99	0.67	0.99	0.93	0.33	0.02	4.27
SSW	0.0	0.01	0.20	0.52	0.37	0.69	0.34	0.11	0.0	2.24
SW	0.0	0.01	0.24	0.79	0.43	0.49	0.32	0.05	0.0	2.33
WSW	0.0	0.02	0.16	0.51	0.57	0.57	0.27	0.08	0.0	2.18
W	0.0	0.0	0.07	0.36	0.80	1.34	0.55	0.16	0.01	3.29
WNW	0.0	0.0	0.09	0.33	0.48	1.25	0.94	0.32	0.01	3.42
NW	0.0	0.0	0.07	0.36	0.55	1.40	1.44	0.37	0.01	4.20
NNW	0.0	0.0	0.09	0.29	0.53	1.36	1.15	0.19	0.0	3.61
Sub-total	0.0	0.10	3.18	8.89	8.93	17.29	10.03	2.24	0.08	50.74

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class D - 13904.1
Total hours of elevated Stability Class D - 12935.5

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind speed and direction measured at the 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (20 of 22)
JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION
Stability Class E (-0.5 < Delta-T≤ 1.5 degrees C per 100 m)
BROWNS FERRY NUCLEAR PLANT
Part 2 of 2 elevated release mode
January 1, 1977 - December 31, 1979

Wind Speed (mph)

	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.13	0.22	0.31	0.80	0.15	0.0	0.0	1.61
NNE	0.0	0.0	0.15	0.24	0.39	1.04	0.28	0.0	0.0	2.10
NE	0.0	0.01	0.11	0.25	0.39	0.88	0.18	0.0	0.0	1.82
ENE	0.0	0.0	0.20	0.21	0.33	0.39	0.10	0.0	0.0	1.23
E	0.0	0.0	0.09	0.24	0.30	0.55	0.06	0.0	0.0	1.24
ESE	0.0	0.01	0.29	0.58	0.86	1.10	0.09	0.01	0.0	2.94
SE	0.0	0.02	0.41	1.04	1.02	1.37	0.55	0.08	0.01	4.50
SSE	0.0	0.01	0.23	0.60	0.54	0.87	0.59	0.14	0.01	2.99
S	0.0	0.01	0.14	0.49	0.32	0.70	0.34	0.05	0.0	2.05
SSW	0.0	0.0	0.11	0.28	0.30	0.48	0.19	0.01	0.0	1.37
SW	0.0	0.01	0.17	0.27	0.28	0.29	0.09	0.0	0.0	1.11
WSW	0.0	0.01	0.12	0.25	0.24	0.28	0.06	0.0	0.0	0.96
W	0.0	0.0	0.09	0.19	0.26	0.34	0.05	0.0	0.0	0.93
WNW	0.0	0.0	0.06	0.13	0.11	0.20	0.04	0.01	0.0	0.55
NW	0.0	0.0	0.09	0.14	0.13	0.31	0.08	0.0	0.0	0.75
NNW	0.0	0.0	0.12	0.21	0.16	0.52	0.16	0.0	0.0	1.17
Sub-total	0.0	0.08	2.51	5.34	5.94	10.12	3.01	0.30	0.02	27.32

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class E - 7920.9
Total hours of elevated Stability Class E - 6962.9

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind speed and direction measured at the 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (21 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class F (1.5 < Delta-T ≤ 4.0 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 2 of 2 elevated release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.03	0.08	0.06	0.34	0.05	0.0	0.0	0.56
NNE	0.0	0.0	0.04	0.06	0.11	0.42	0.21	0.0	0.0	0.84
NE	0.0	0.0	0.04	0.10	0.15	0.40	0.12	0.0	0.0	0.81
ENE	0.0	0.0	0.04	0.11	0.11	0.29	0.07	0.0	0.0	0.62
E	0.0	0.0	0.03	0.07	0.11	0.32	0.02	0.0	0.0	0.55
ESE	0.0	0.0	0.13	0.26	0.24	0.24	0.0	0.0	0.0	0.87
SE	0.0	0.0	0.13	0.38	0.30	0.19	0.0	0.0	0.0	1.00
SSE	0.0	0.0	0.09	0.11	0.12	0.14	0.03	0.0	0.0	0.49
S	0.0	0.0	0.08	0.11	0.13	0.21	0.03	0.0	0.0	0.56
SSW	0.0	0.0	0.04	0.12	0.14	0.24	0.01	0.0	0.0	0.55
SW	0.0	0.0	0.04	0.09	0.10	0.06	0.0	0.0	0.0	0.29
WSW	0.0	0.0	0.03	0.07	0.06	0.05	0.0	0.0	0.0	0.21
W	0.0	0.01	0.04	0.04	0.05	0.04	0.0	0.0	0.0	0.18
WNW	0.0	0.0	0.02	0.04	0.01	0.01	0.0	0.0	0.0	0.08
NW	0.0	0.0	0.03	0.04	0.03	0.02	0.0	0.0	0.0	0.12
NNW	0.0	0.0	0.02	0.02	0.04	0.10	0.0	0.0	0.0	0.18
Sub-total	0.0	0.01	0.83	1.70	1.76	3.07	0.54	0.0	0.0	7.91

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class F - 2385.0
Total hours of elevated Stability Class F - 2028.0

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind speed and direction measured at the 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.3 (22 of 22)

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION

Stability Class G (Delta-T> 4.0 degrees C per 100 m)

BROWNS FERRY NUCLEAR PLANT

Part 2 of 2 elevated release mode

January 1, 1977 - December 31, 1979

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.0	0.0	0.0	0.0	0.02	0.06	0.01	0.0	0.0	0.09
NNE	0.0	0.0	0.01	0.02	0.04	0.11	0.04	0.0	0.0	0.22
NE	0.0	0.0	0.02	0.02	0.03	0.12	0.02	0.0	0.0	0.21
ENE	0.0	0.0	0.0	0.02	0.02	0.07	0.02	0.0	0.0	0.13
E	0.0	0.0	0.0	0.02	0.01	0.04	0.0	0.0	0.0	0.07
ESE	0.0	0.01	0.05	0.15	0.07	0.01	0.0	0.0	0.0	0.29
SE	0.0	0.0	0.12	0.20	0.13	0.04	0.0	0.0	0.0	0.49
SSE	0.0	0.0	0.03	0.06	0.06	0.02	0.0	0.0	0.0	0.17
S	0.0	0.0	0.02	0.07	0.06	0.01	0.0	0.0	0.0	0.16
SSW	0.0	0.0	0.0	0.02	0.02	0.06	0.0	0.0	0.0	0.10
SW	0.0	0.0	0.01	0.01	0.03	0.02	0.0	0.0	0.0	0.07
WSW	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01
W	0.0	0.0	0.01	0.0	0.01	0.0	0.0	0.0	0.0	0.02
WNW	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.02
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.01	0.01	0.0	0.01	0.0	0.0	0.0	0.03
Sub-total	0.0	0.01	0.31	0.60	0.50	0.57	0.09	0.0	0.0	2.08

Total hours of valid observations - 25482.0
Total hours of elevated releases - 22649.6
Total hours of Stability Class G - 694.7
Total hours of elevated Stability Class G - 543.1

Meteorological facility: located 1.3 km ESE of BFN
Stability based on Delta-T between 45.30 and 89.60 meters
Wind speed and direction measured at the 45.67 meter level
Effluent velocity = 12.60 m/s

Table 7.4
DOSE FACTORS FOR SUBMERSION IN NOBLE GASES

	Submersion dose mrem/yr per $\mu Ci/m^3$		Air dose mrad/yr per $\mu Ci/m^3$	
	DFB_i	DFS_i	$DF_{\gamma i}$	$DF_{\beta i}$
Kr-83m	7.56E-02	---	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

Reference:
Regulatory Guide 1.109, Table B-1.

Table 7.5
SECTOR ELEMENTS CONSIDERED FOR POPULATION DOSES

Range of Sector Element	Midpoint of Sector Element
Site boundary - 1 mile	0.8 mile
1 - 2 miles	1.5 miles
2 - 3 miles	2.5 miles
3 - 4 miles	3.5 miles
4 - 5 miles	4.5 miles
5 - 10 miles	7.5 miles
10 - 20 miles	15 miles
20 - 30 miles	25 miles
30 - 40 miles	35 miles
40 - 50 miles	45 miles

Table 7.6

BFN 50-MILE POPULATION WITHIN EACH SECTOR ELEMENT

	Distance to Midpoint of Sector Element									
	0.8	1.5	2.5	3.5	4.5	7.5	15	25	35	45
N	0	10	55	35	85	670	1515	2615	10660	3690
NNE	0	5	15	65	55	915	2990	2230	3125	3420
NE	0	5	25	45	88	4180	14180	6625	5385	12625
ENE	0	15	50	40	70	1310	4990	9615	13860	5425
E	0	0	30	10	40	945	1910	73405	75125	4610
ESE	0	0	5	0	0	165	1880	2535	7465	9575
SE	0	0	0	0	20	10390	30945	4660	6230	13850
SSE	0	0	0	0	50	1630	6250	11630	15175	18945
S	0	0	20	35	90	1250	3805	1800	4475	3730
SSW	0	0	60	75	175	845	5895	1270	1490	2535
SW	0	0	20	35	90	685	2970	2280	2725	10675
WSW	0	0	35	15	135	295	3060	3005	11545	3755
W	0	0	25	5	30	625	2960	6830	35070	4785
WNW	0	0	0	25	55	50	885	9300	39875	5545
NW	0	0	0	0	5	345	4345	5215	5485	3260
NNW	0	5	35	25	20	625	2090	2440	12350	7360

Table 7.7 (1 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
C-14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Cr-51	0.00E+00	0.00E+00	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	0.00E+00	4.95E-06	7.87E-07	0.00E+00	1.23E-06	1.75E-04	9.67E-06
Mn-56	0.00E+00	1.55E-10	2.29E-11	0.00E+00	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	0.00E+00	0.00E+00	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	0.00E+00	0.00E+00	1.27E-04	2.35E-05
Co-57	0.00E+00	8.65E-08	8.39E-08	0.00E+00	0.00E+00	4.62E-05	3.93E-06
Co-58	0.00E+00	1.98E-07	2.59E-07	0.00E+00	0.00E+00	1.16E-04	1.33E-05
Co-60	0.00E+00	1.44E-06	1.85E-06	0.00E+00	0.00E+00	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	0.00E+00	0.00E+00	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	0.00E+00	0.00E+00	7.00E-07	1.54E-06
Cu-64	0.00E+00	1.83E-10	7.69E-11	0.00E+00	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	0.00E+00	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	0.00E+00	5.27E-12	1.15E-07	2.04E-09
Zn-69m	1.02E-09	2.45E-09	2.24E-10	0.00E+00	1.48E-09	2.38E-06	1.71E-05
Br-82	0.00E+00	0.00E+00	1.69E-06	0.00E+00	0.00E+00	0.00E+00	1.30E-06
Br-83	0.00E+00	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.90E-08
Br-84	0.00E+00	0.00E+00	3.91E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-13
Br-85	0.00E+00	0.00E+00	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.69E-05	7.37E-06	0.00E+00	0.00E+00	0.00E+00	2.08E-06
Rb-88	0.00E+00	4.84E-08	2.41E-08	0.00E+00	0.00E+00	0.00E+00	4.18E-19
Rb-89	0.00E+00	3.20E-08	2.12E-08	0.00E+00	0.00E+00	0.00E+00	1.16E-21
Sr-89	3.80E-05	0.00E+00	1.09E-06	0.00E+00	0.00E+00	1.75E-04	4.37E-05
Sr-90	1.24E-02	0.00E+00	7.62E-04	0.00E+00	0.00E+00	1.20E-03	9.02E-05
Sr-91	7.74E-09	0.00E+00	3.13E-10	0.00E+00	0.00E+00	4.56E-06	2.39E-05
Sr-92	8.43E-10	0.00E+00	3.64E-11	0.00E+00	0.00E+00	2.06E-06	5.38E-06
Y-90	2.61E-07	0.00E+00	7.01E-09	0.00E+00	0.00E+00	2.12E-05	6.32E-05
Y-91m	3.26E-11	0.00E+00	1.27E-12	0.00E+00	0.00E+00	2.40E-07	1.66E-10
Y-91	5.78E-05	0.00E+00	1.55E-06	0.00E+00	0.00E+00	2.13E-04	4.81E-05
Y-92	1.29E-09	0.00E+00	3.77E-11	0.00E+00	0.00E+00	1.96E-06	9.19E-06
Y-93	1.18E-08	0.00E+00	3.26E-10	0.00E+00	0.00E+00	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	0.00E+00	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	0.00E+00	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	0.00E+00	9.67E-07	6.31E-05	1.30E-05
Nb-97	2.78E-11	7.03E-12	2.56E-12	0.00E+00	8.18E-12	3.00E-07	3.02E-08
Mo-99	0.00E+00	1.51E-08	2.87E-09	0.00E+00	3.64E-08	1.14E-05	3.10E-05
Tc-99m	1.29E-13	3.64E-13	4.63E-12	0.00E+00	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	0.00E+00	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	0.00E+00	8.23E-08	0.00E+00	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	0.00E+00	3.89E-11	0.00E+00	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	0.00E+00	1.09E-06	0.00E+00	1.67E-05	1.17E-03	1.14E-04
Ag-110m	1.35E-06	1.25E-06	7.43E-07	0.00E+00	2.46E-06	5.79E-04	3.78E-05

Table 7.7 (2 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.00E+00	3.10E-04	5.08E-05
Sb-125	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.00E+00	2.18E-04	1.26E-05
Te-125m	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127m	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129m	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131m	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.00E+00	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.00E+00	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.00E+00	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.00E+00	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.00E+00	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.00E+00	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	0.00E+00	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	0.00E+00	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	0.00E+00	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	0.00E+00	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	0.00E+00	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	0.00E+00	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	0.00E+00	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	0.00E+00	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	0.00E+00	0.00E+00	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	0.00E+00	0.00E+00	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	0.00E+00	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	0.00E+00	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	0.00E+00	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	0.00E+00	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	0.00E+00	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	0.00E+00	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	0.00E+00	0.00E+00	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	0.00E+00	8.75E-09	4.70E-06	1.49E-05

Reference:

Regulatory Guide 1.109, Table E-7.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 8.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 7.7 (3 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
C-14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	0.00E+00	0.00E+00	0.00E+00	1.16E-05
Cr-51	0.00E+00	0.00E+00	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	0.00E+00	6.39E-06	1.05E-06	0.00E+00	1.59E-06	2.48E-04	8.35E-06
Mn-56	0.00E+00	2.12E-10	3.15E-11	0.00E+00	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	0.00E+00	0.00E+00	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	0.00E+00	0.00E+00	1.91E-04	2.23E-05
Co-57	0.00E+00	1.18E-07	1.15E-07	0.00E+00	0.00E+00	7.33E-05	3.93E-06
Co-58	0.00E+00	2.59E-07	3.47E-07	0.00E+00	0.00E+00	1.68E-04	1.19E-05
Co-60	0.00E+00	1.89E-06	2.48E-06	0.00E+00	0.00E+00	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	0.00E+00	0.00E+00	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	0.00E+00	0.00E+00	1.17E-06	4.59E-06
Cu-64	0.00E+00	2.54E-10	1.06E-10	0.00E+00	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	0.00E+00	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	0.00E+00	7.53E-12	1.98E-07	3.56E-08
Zn-69m	1.44E-09	3.39E-09	3.11E-10	0.00E+00	2.06E-09	3.92E-06	2.14E-05
Br-82	0.00E+00	0.00E+00	2.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	4.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.38E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	2.21E-06
Rb-88	0.00E+00	6.82E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	3.65E-15
Rb-89	0.00E+00	4.40E-08	2.91E-08	0.00E+00	0.00E+00	0.00E+00	4.22E-17
Sr-89	5.43E-05	0.00E+00	1.56E-06	0.00E+00	0.00E+00	3.02E-04	4.64E-05
Sr-90	1.35E-02	0.00E+00	8.35E-04	0.00E+00	0.00E+00	2.06E-03	9.56E-05
Sr-91	1.10E-08	0.00E+00	4.39E-10	0.00E+00	0.00E+00	7.59E-06	3.24E-05
Sr-92	1.19E-09	0.00E+00	5.08E-11	0.00E+00	0.00E+00	3.43E-06	1.49E-05
Y-90	3.73E-07	0.00E+00	1.00E-08	0.00E+00	0.00E+00	3.66E-05	6.99E-05
Y-91m	4.63E-11	0.00E+00	1.77E-12	0.00E+00	0.00E+00	4.00E-07	3.77E-09
Y-91	8.26E-05	0.00E+00	2.21E-06	0.00E+00	0.00E+00	3.67E-04	5.11E-05
Y-92	1.84E-09	0.00E+00	5.36E-11	0.00E+00	0.00E+00	3.35E-06	2.06E-05
Y-93	1.69E-08	0.00E+00	4.65E-10	0.00E+00	0.00E+00	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	0.00E+00	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	0.00E+00	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	0.00E+00	1.25E-06	9.39E-05	1.21E-05
Nb-97	3.92E-11	9.72E-12	3.55E-12	0.00E+00	1.14E-11	4.91E-07	2.71E-07
Mo-99	0.00E+00	2.11E-08	4.03E-09	0.00E+00	5.14E-08	1.92E-05	3.36E-05
Tc-99m	1.73E-13	4.83E-13	6.24E-12	0.00E+00	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	0.00E+00	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	0.00E+00	1.12E-07	0.00E+00	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	0.00E+00	5.42E-11	0.00E+00	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	0.00E+00	1.55E-06	0.00E+00	2.38E-05	2.01E-03	1.20E-04
Ag-110m	1.73E-06	1.64E-06	9.99E-07	0.00E+00	3.13E-06	8.44E-04	3.41E-05

Table 7.7 (4 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.00E+00	4.81E-04	4.98E-05
Sb-125	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.00E+00	3.42E-04	1.24E-05
Te-125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.00E+00	6.70E-05	9.38E-06
Te-127m	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129m	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131m	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	0.00E+00	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.00E+00	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.00E+00	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.00E+00	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.00E+00	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.00E+00	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	0.00E+00	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	0.00E+00	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	0.00E+00	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	0.00E+00	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	0.00E+00	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	0.00E+00	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	0.00E+00	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	0.00E+00	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	0.00E+00	0.00E+00	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	0.00E+00	0.00E+00	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	0.00E+00	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	0.00E+00	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	0.00E+00	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	0.00E+00	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	0.00E+00	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	0.00E+00	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	0.00E+00	0.00E+00	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	0.00E+00	1.25E-08	8.11E-06	1.65E-05

Reference:

Regulatory Guide 1.109, Table E-8.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 7.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 7.7 (5 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C-14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Cr-51	0.00E+00	0.00E+00	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	0.00E+00	1.16E-05	2.57E-06	0.00E+00	2.71E-06	4.26E-04	6.19E-06
Mn-56	0.00E+00	4.48E-10	8.43E-11	0.00E+00	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	0.00E+00	0.00E+00	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	0.00E+00	0.00E+00	3.43E-04	1.91E-05
Co-57	0.00E+00	2.44E-07	2.88E-07	0.00E+00	0.00E+00	1.37E-04	3.58E-06
Co-58	0.00E+00	4.79E-07	8.55E-07	0.00E+00	0.00E+00	2.99E-04	9.29E-06
Co-60	0.00E+00	3.55E-06	6.12E-06	0.00E+00	0.00E+00	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	0.00E+00	0.00E+00	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	0.00E+00	0.00E+00	2.21E-06	2.27E-05
Cu-64	0.00E+00	5.39E-10	2.90E-10	0.00E+00	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	0.00E+00	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	0.00E+00	1.58E-11	3.84E-07	2.75E-06
Zn-69m	4.26E-09	7.28E-09	8.59E-10	0.00E+00	4.22E-09	7.36E-06	2.71E-05
Br-82	0.00E+00	0.00E+00	5.66E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	1.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.36E-05	3.09E-05	0.00E+00	0.00E+00	0.00E+00	2.16E-06
Rb-88	0.00E+00	1.52E-07	9.90E-08	0.00E+00	0.00E+00	0.00E+00	4.66E-09
Rb-89	0.00E+00	9.33E-08	7.83E-08	0.00E+00	0.00E+00	0.00E+00	5.11E-10
Sr-89	1.62E-04	0.00E+00	4.66E-06	0.00E+00	0.00E+00	5.83E-04	4.52E-05
Sr-90	2.73E-02	0.00E+00	1.74E-03	0.00E+00	0.00E+00	3.99E-03	9.28E-05
Sr-91	3.28E-08	0.00E+00	1.24E-09	0.00E+00	0.00E+00	1.44E-05	4.70E-05
Sr-92	3.54E-09	0.00E+00	1.42E-10	0.00E+00	0.00E+00	6.49E-06	6.55E-05
Y-90	1.11E-06	0.00E+00	2.99E-08	0.00E+00	0.00E+00	7.07E-05	7.24E-05
Y-91m	1.37E-10	0.00E+00	4.98E-12	0.00E+00	0.00E+00	7.60E-07	4.64E-07
Y-91	2.47E-04	0.00E+00	6.59E-06	0.00E+00	0.00E+00	7.10E-04	4.97E-05
Y-92	5.50E-09	0.00E+00	1.57E-10	0.00E+00	0.00E+00	6.46E-06	6.46E-05
Y-93	5.04E-08	0.00E+00	1.38E-09	0.00E+00	0.00E+00	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	0.00E+00	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	0.00E+00	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	0.00E+00	2.33E-06	1.66E-04	1.00E-05
Nb-97	1.16E-10	2.08E-11	9.74E-12	0.00E+00	2.31E-11	9.23E-07	7.52E-06
Mo-99	0.00E+00	4.66E-08	1.15E-08	0.00E+00	1.06E-07	3.66E-05	3.42E-05
Tc-99m	4.81E-13	9.41E-13	1.56E-11	0.00E+00	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	0.00E+00	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	0.00E+00	2.90E-07	0.00E+00	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	0.00E+00	1.50E-10	0.00E+00	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	0.00E+00	4.57E-06	0.00E+00	4.97E-05	3.87E-03	1.16E-04
Ag-110m	4.56E-06	3.08E-06	2.47E-06	0.00E+00	5.74E-06	1.48E-03	2.71E-05

Table 7.7 (6 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.00E+00	8.76E-04	4.43E-05
Sb-125	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.00E+00	6.27E-04	1.09E-05
Te-125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.00E+00	1.29E-04	9.13E-06
Te-127m	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.00E+00	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.00E+00	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.00E+00	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.00E+00	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.00E+00	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.00E+00	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	0.00E+00	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	0.00E+00	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	0.00E+00	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	0.00E+00	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	0.00E+00	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	0.00E+00	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	0.00E+00	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	0.00E+00	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	0.00E+00	0.00E+00	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	0.00E+00	0.00E+00	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	0.00E+00	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	0.00E+00	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	0.00E+00	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	0.00E+00	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	0.00E+00	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	0.00E+00	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	0.00E+00	0.00E+00	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	0.00E+00	2.63E-08	1.57E-05	1.73E-05

Reference:

Regulatory Guide 1.109, Table E-9.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 6.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 7.7 (7 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
C-14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E+05	5.53E-05	0.00E+00	0.00E+00	0.00E+00	1.15E-05
Cr-51	0.00E+00	0.00E+00	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	0.00E+00	1.81E-05	3.56E-06	0.00E+00	3.56E-06	7.14E-04	5.04E-06
Mn-56	0.00E+00	1.10E-09	1.58E-10	0.00E+00	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	0.00E+00	0.00E+00	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	0.00E+00	0.00E+00	7.25E-04	1.77E-05
Co-57	0.00E+00	4.65E-07	4.58E-07	0.00E+00	0.00E+00	2.71E-04	3.47E-06
Co-58	0.00E+00	8.71E-07	1.30E-06	0.00E+00	0.00E+00	5.55E-04	7.95E-06
Co-60	0.00E+00	5.73E-06	8.41E-06	0.00E+00	0.00E+00	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	0.00E+00	0.00E+00	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	0.00E+00	0.00E+00	5.80E-06	3.58E-05
Cu-64	0.00E+00	1.34E-09	5.53E-10	0.00E+00	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	0.00E+00	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	0.00E+00	2.87E-11	1.05E-06	9.44E-06
Zn-69m	8.98E-09	1.84E-08	1.67E-09	0.00E+00	7.45E-09	1.91E-05	2.92E-05
Br-82	0.00E+00	0.00E+00	9.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	2.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.36E-04	6.30E-05	0.00E+00	0.00E+00	0.00E+00	2.17E-06
Rb-88	0.00E+00	3.98E-07	2.05E-07	0.00E+00	0.00E+00	0.00E+00	2.42E-07
Rb-89	0.00E+00	2.29E-07	1.47E-07	0.00E+00	0.00E+00	0.00E+00	4.87E-08
Sr-89	2.84E-04	0.00E+00	8.15E-06	0.00E+00	0.00E+00	1.45E-03	4.57E-05
Sr-90	2.92E-02	0.00E+00	1.85E-03	0.00E+00	0.00E+00	8.03E-03	9.36E-05
Sr-91	6.83E-08	0.00E+00	2.47E-09	0.00E+00	0.00E+00	3.76E-05	5.24E-05
Sr-92	7.50E-09	0.00E+00	2.79E-10	0.00E+00	0.00E+00	1.70E-05	1.00E-04
Y-90	2.35E-06	0.00E+00	6.30E-08	0.00E+00	0.00E+00	1.92E-04	7.43E-05
Y-91m	2.91E-10	0.00E+00	9.90E-12	0.00E+00	0.00E+00	1.99E-06	1.68E-06
Y-91	4.20E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	1.75E-03	5.02E-05
Y-92	1.17E-08	0.00E+00	3.29E-10	0.00E+00	0.00E+00	1.75E-05	9.04E-05
Y-93	1.07E-07	0.00E+00	2.91E-09	0.00E+00	0.00E+00	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	0.00E+00	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	0.00E+00	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	0.00E+00	3.37E-06	3.42E-04	9.05E-06
Nb-97	2.44E-10	5.21E-11	1.88E-11	0.00E+00	4.07E-11	2.37E-06	1.92E-05
Mo-99	0.00E+00	1.18E-07	2.31E-08	0.00E+00	1.89E-07	9.63E-05	3.48E-05
Tc-99m	9.98E-13	2.06E-12	2.66E-11	0.00E+00	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	0.00E+00	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	0.00E+00	4.85E-07	0.00E+00	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	0.00E+00	2.93E-10	0.00E+00	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	0.00E+00	7.77E-06	0.00E+00	7.61E-05	8.26E-03	1.17E-04
Ag-110m	7.13E-06	5.16E-06	3.57E-06	0.00E+00	7.80E-06	2.62E-03	2.36E-05

Table 7.7 (8 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.00E+00	1.89E-03	4.22E-05
Sb-125	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.00E+00	1.17E-03	1.05E-05
Te-125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.00E+00	3.19E-04	9.22E-06
Te-127m	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-09	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129m	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131m	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	0.00E+00	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.00E+00	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.00E+00	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.00E+00	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.00E+00	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.00E+00	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	0.00E+00	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	0.00E+00	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	0.00E+00	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	0.00E+00	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	0.00E+00	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	0.00E+00	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	0.00E+00	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	0.00E+00	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	0.00E+00	0.00E+00	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	0.00E+00	0.00E+00	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	0.00E+00	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	0.00E+00	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	0.00E+00	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	0.00E+00	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	0.00E+00	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	0.00E+00	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	0.00E+00	0.00E+00	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	0.00E+00	4.73E-08	4.25E-05	1.78E-05

Reference:

Regulatory Guide 1.109, Table E-10.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 5.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Figure 7.1
OFFGAS SYSTEM AND SGTS EFFLUENT MONITORING

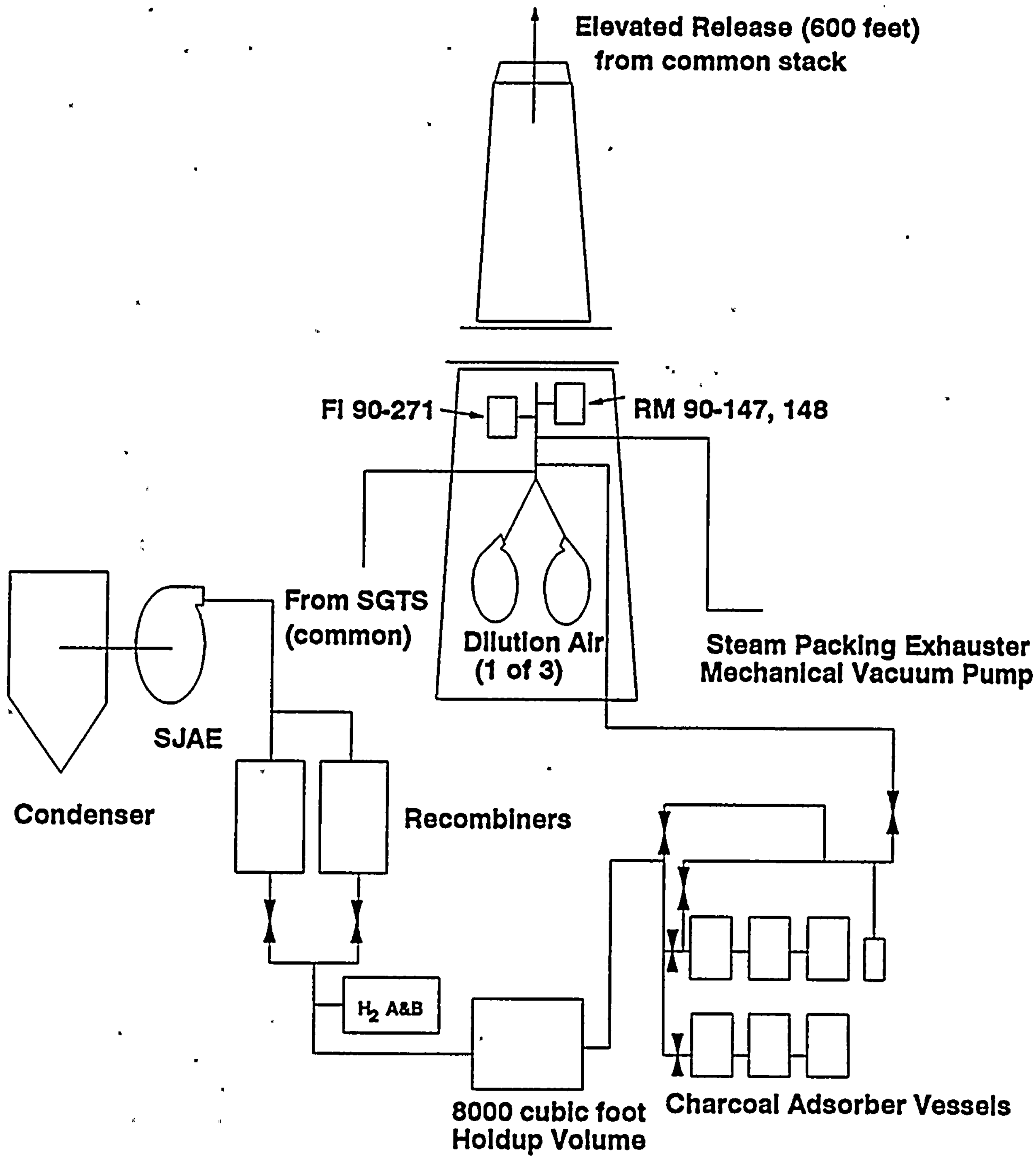
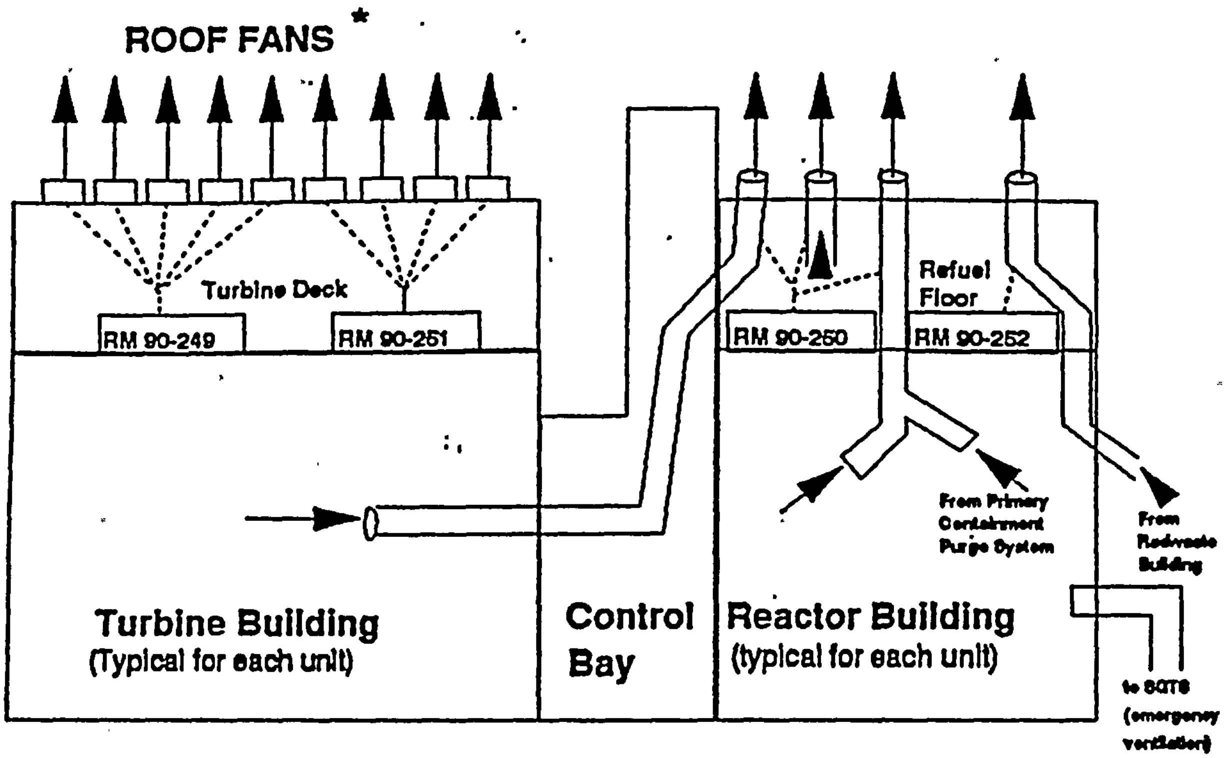
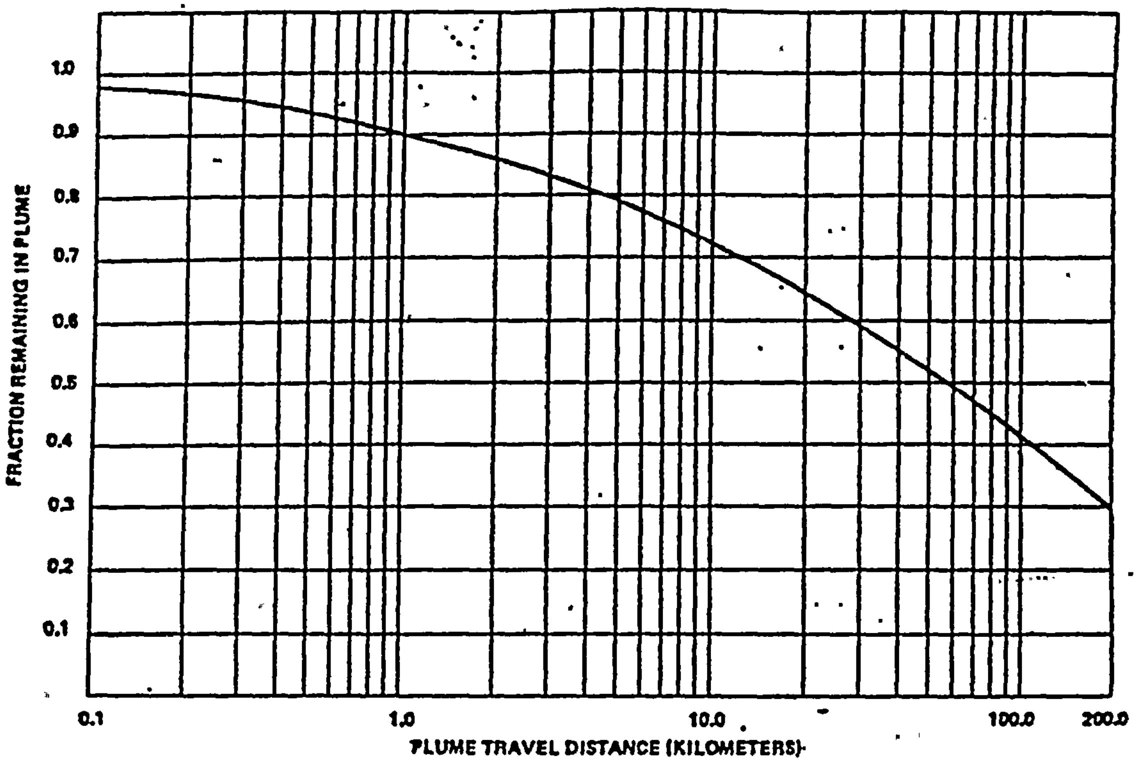


Figure 7.2
NORMAL BUILDING VENTILATION



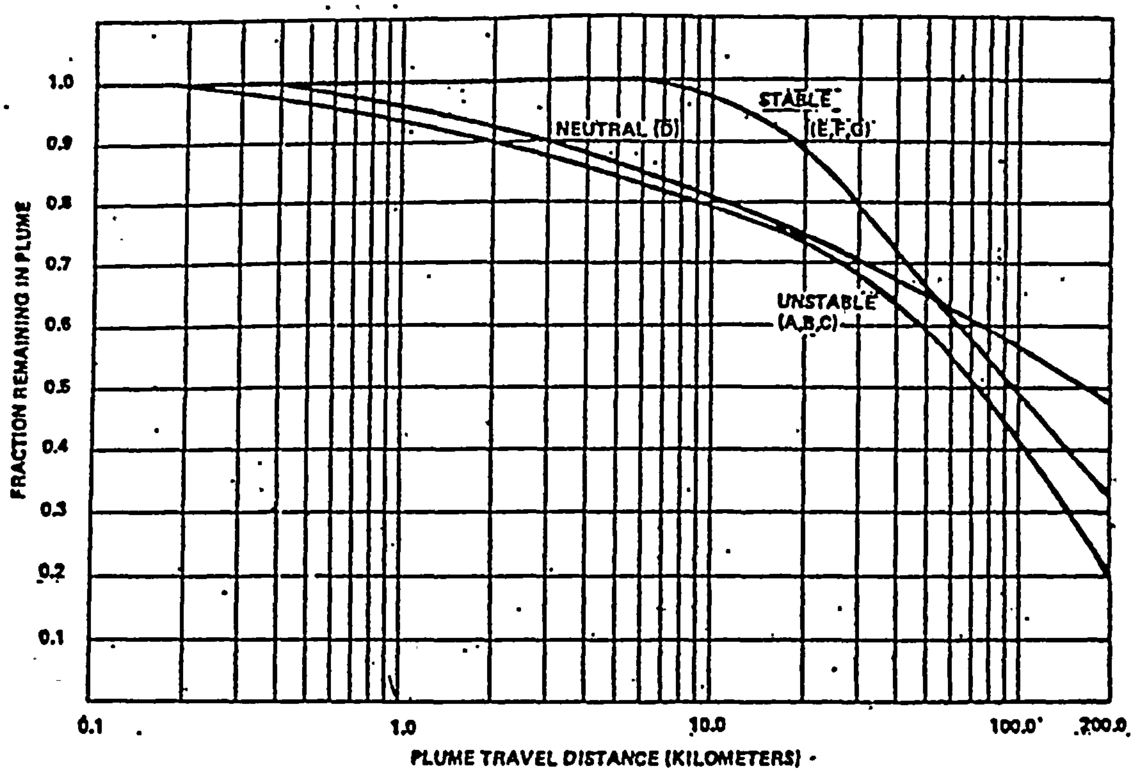
* Used seasonally to control temperature

Figure 7.3
PLUME DEPLETION EFFECT
(Page 1 of 4)



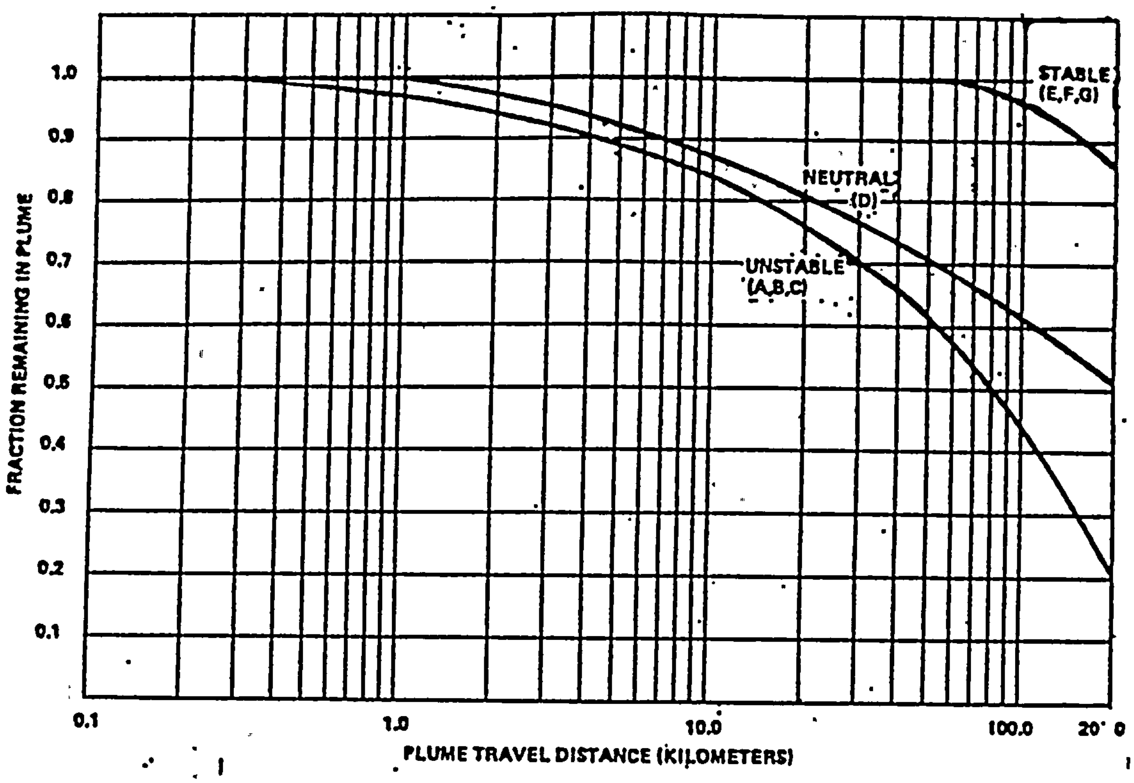
Plume Depletion Effect for Ground-Level Releases (All Atmospheric Stability Classes)

Figure 7.3
PLUME DEPLETION EFFECT
(Page 2 of 4)



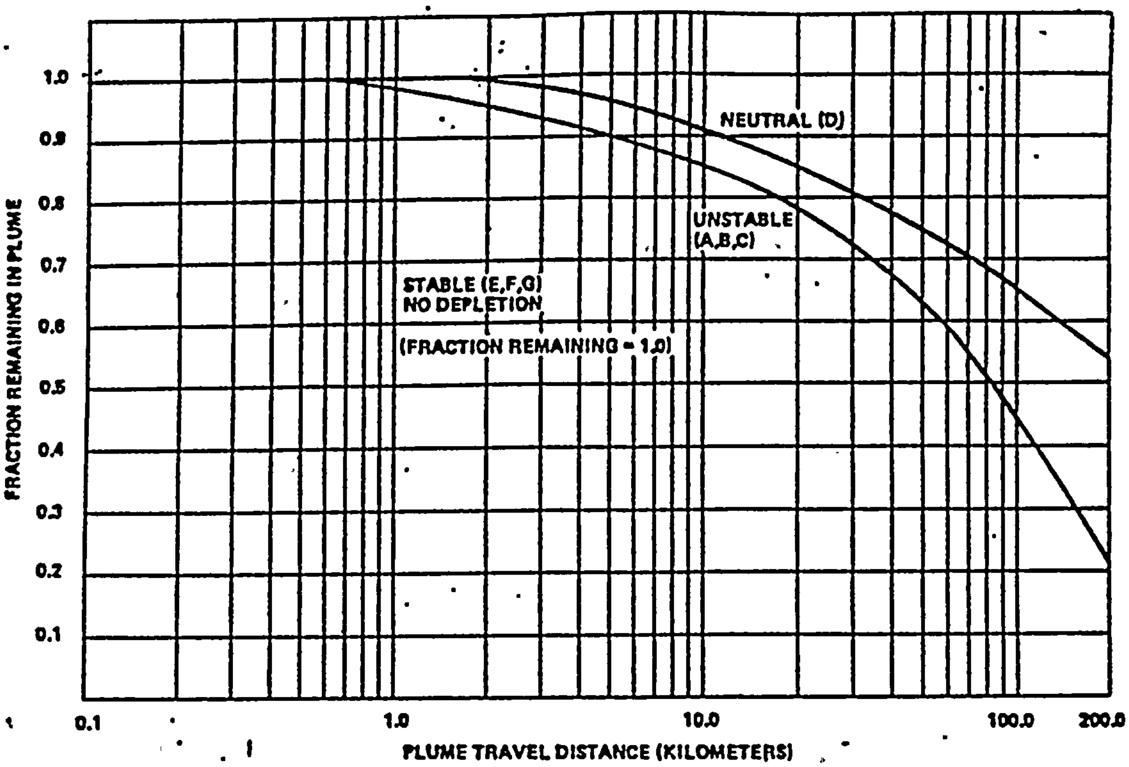
Plume Depletion Effect for 30-m Releases.(Letters denote Pasquill Stability Class).

Figure 7.3
PLUME DEPLETION EFFECT
(Page 3 of 4)



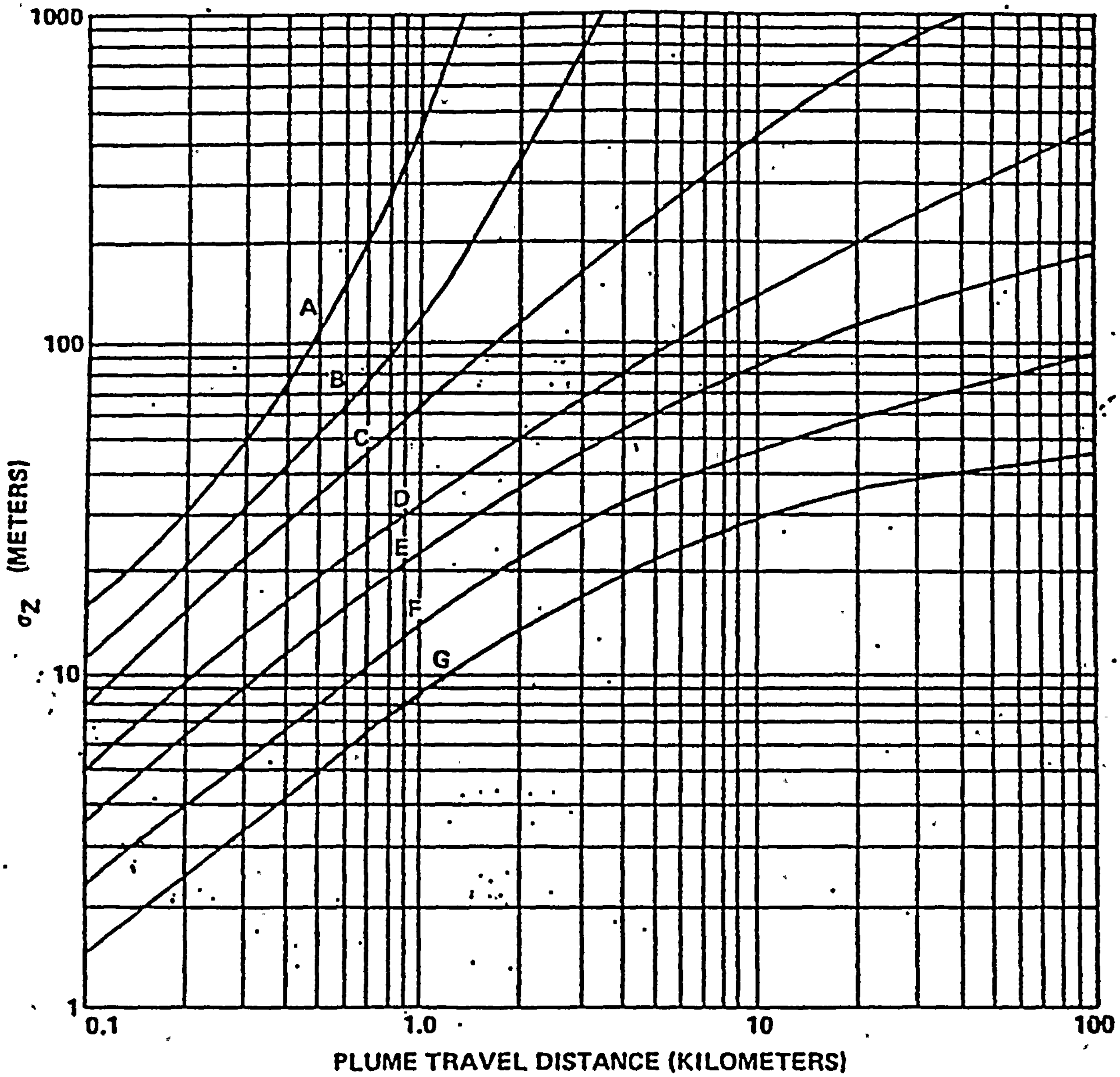
Plume Depletion Effect for 60-m Releases (Letters denote Pasquill Stability Class)

Figure 7.3
PLUME DEPLETION EFFECT
(Page 4 of 4)



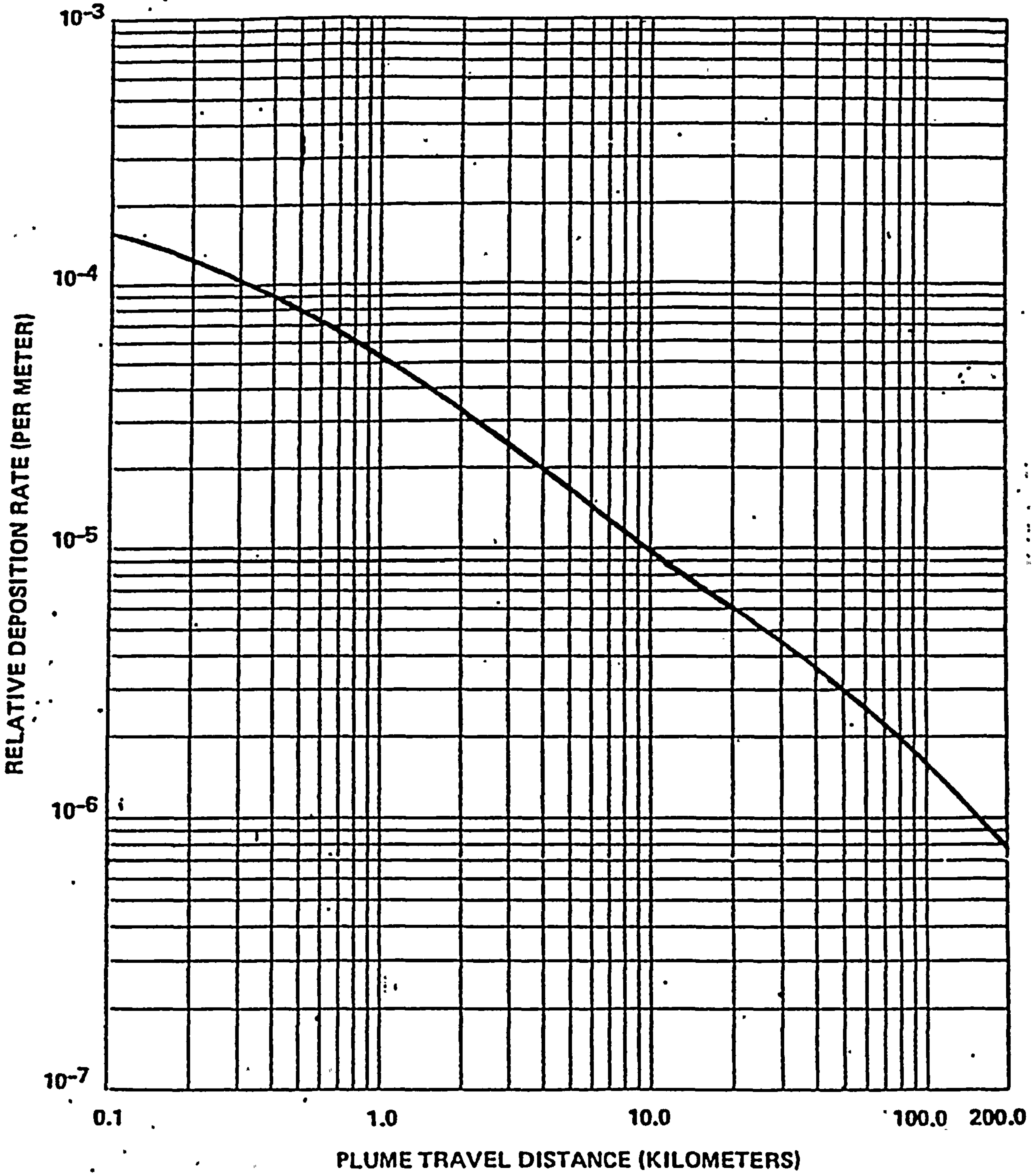
Plume Depletion Effect for 100-m Releases (Letters denote Pasquill Stability Class)

Figure 7.4
VERTICAL STANDARD DEVIATION OF MATERIAL IN A PLUME



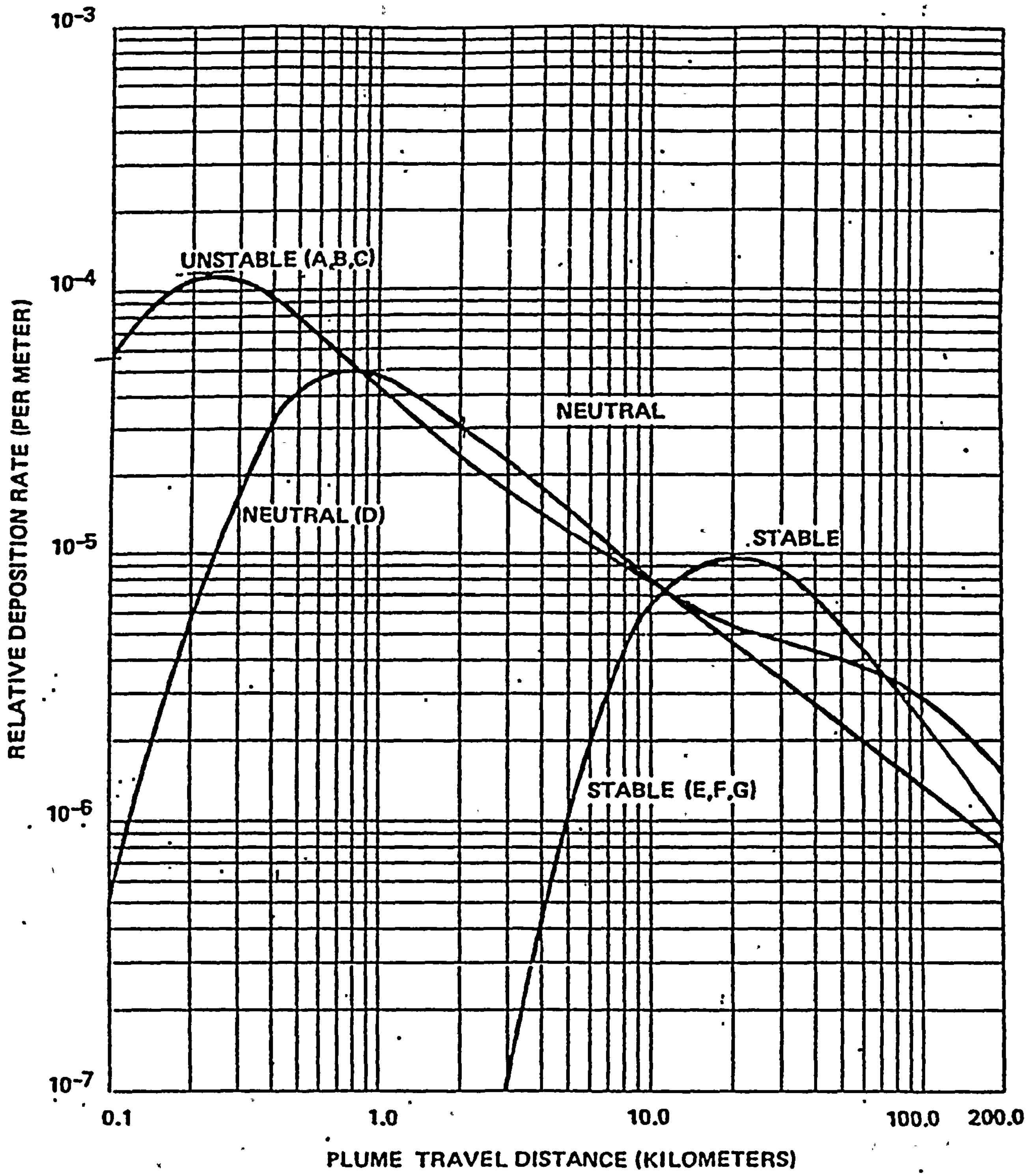
Vertical Standard Deviation of Material in a Plume (Letters denote Pasquill Stability Class)

Figure 7.5
RELATIVE DEPOSITION
(Page 1 of 4)



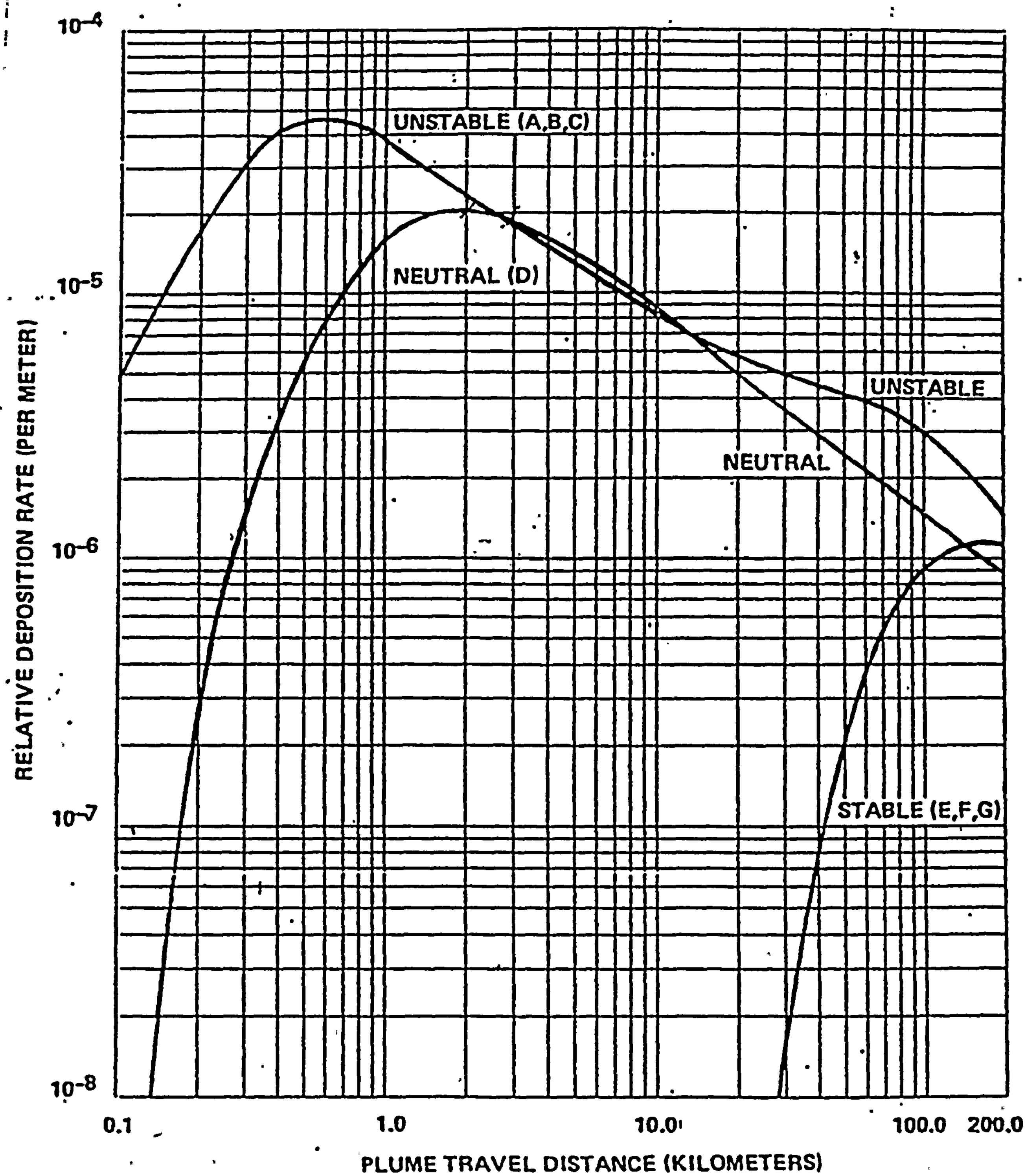
Relative Deposition for Ground-Level Releases (All Atmospheric Stability Classes)

Figure 7.5
RELATIVE DEPOSITION
(Page 2 of 4)



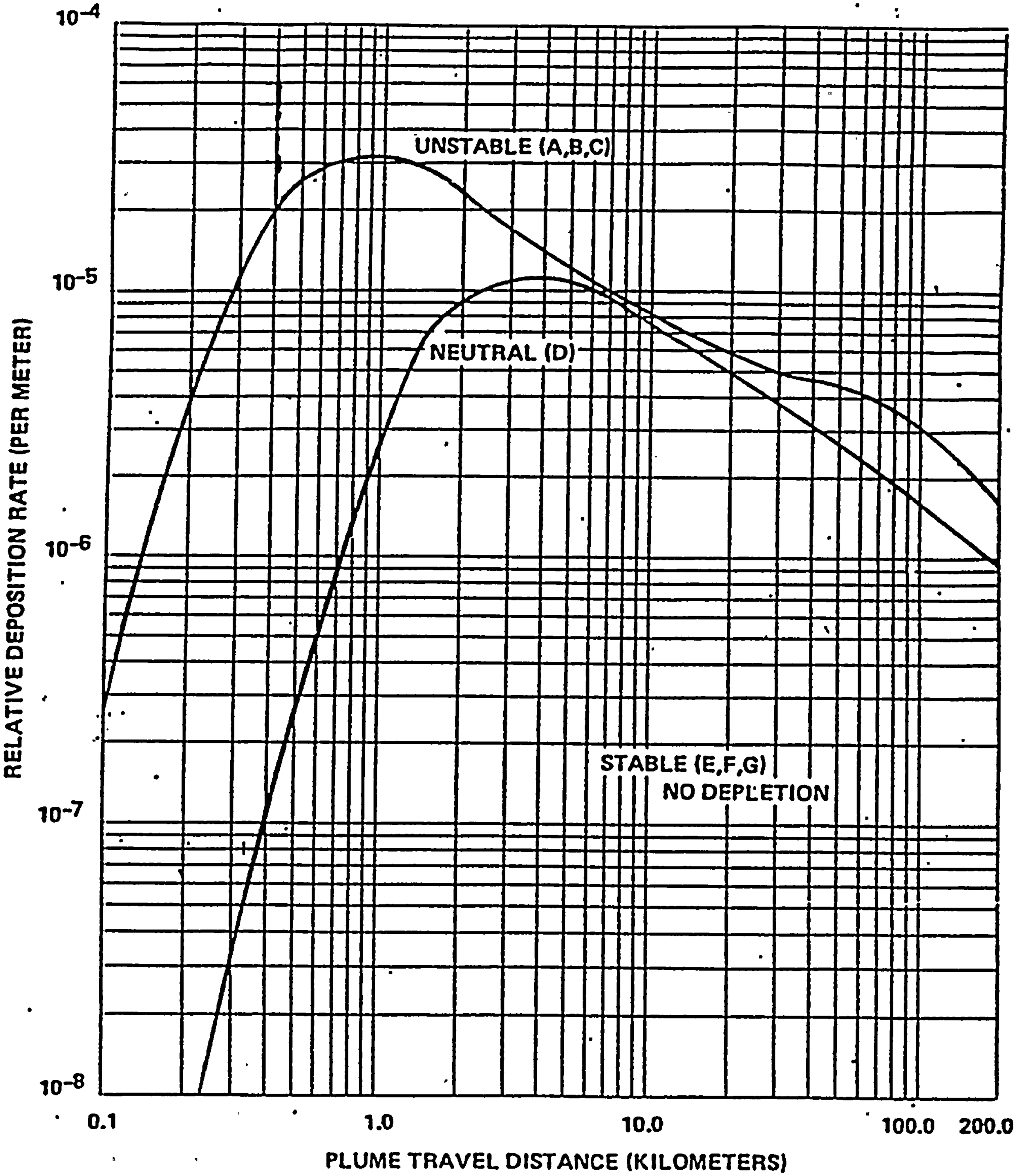
Relative Deposition for 30-m Releases (Letters denote Pasquill Stability Class)

Figure 7.5
RELATIVE DEPOSITION
(Page 3 of 4)



Relative Deposition for 60-m Releases (Letters denote Pasquill Stability Class)

Figure 7.5
RELATIVE DEPOSITION
(Page 4 of 4)



Relative Deposition for 100-m Releases (Letters denote Pasquill Stability Class)

SECTION 8.0

TOTAL DOSE

8.0 TOTAL DOSE

To determine compliance with 40 CFR 190, the annual dose contributions to the maximum individual from BFN radioactive effluents and all other nearby uranium fuel cycle sources will be considered. The annual dose to the maximum individual will be conservatively estimated by: first, summing the total body air submersion dose, and the critical organ dose (except thyroid) from gaseous effluents; the total body dose, and critical organ dose (except thyroid) from liquid effluents for each quarter calculated in accordance with Sections 6.6 and 7.7. Then to this sum for each quarter is added any identifiable increase in direct radiation dose levels attributable to the plant as determined by the environmental monitoring program outlined in Section 9.0. These quarterly sums are then conservatively summed for the four calendar quarters to estimate the maximum individual dose for the year. This dose is compared to the limit in Control 3.2.3, i.e., 25 mrem per year to the total body or any organ (except thyroid), to determine compliance.

The total annual thyroid dose to the maximum individual will be conservatively estimated in the following manner. For each calendar quarter, a total dose will be obtained by summing the total body gaseous submersion dose, the gaseous thyroid dose, the liquid total body dose, and the liquid thyroid dose. To this sum for each quarter is added any identifiable increase in direct radiation dose levels attributable to the plant as determined by the environmental monitoring program outlined in Section 9.0. These quarterly sums are then added together to estimate the maximum individual thyroid dose for the year. This dose is compared to the limit in Control 3.2.3, i.e., 75 mrem per year to determine compliance.

SECTION 9.0

ENVIRONMENTAL MONITORING PROGRAM

9.1 MONITORING PROGRAM DESCRIPTION

An environmental radiological monitoring program as described in Tables 9.1, 9.2 and 9.3 and in Figures 9.1, 9.2, and 9.3 shall be conducted. Results of this program shall be reported in accordance with ODCM Administrative Control 5.1.

The atmospheric environmental radiological monitoring program shall consist of 10 monitoring stations from which samples of air particulates and radioiodine shall be collected.

The terrestrial monitoring program shall consist of the collection of milk, soil, drinking water, and food crops. In addition, direct gamma radiation levels will be measured at 40 or more locations in the vicinity of the plant.

The reservoir sampling program shall consist of the collection of samples of surface water, sediment, and fish.

9.2 DETECTION CAPABILITIES

Analytical techniques shall be such that the detection capabilities listed in Table 2.3-2 are achieved.

9.3 LAND USE CENSUS

A land use survey shall be conducted in accordance with the requirements in Control 1.3.2. The results of the survey shall be reported in the Annual Radiological Environmental Operating Report.

9.4 INTERLABORATORY COMPARISON PROGRAM

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the NRC. A summary of the results obtained in the intercomparison shall be included in the Annual Radiological Environmental Operating Report (or the EPA program code designation may be provided).

If analyses are not performed as required corrective actions taken to prevent a recurrence shall be reported in the Annual Radiological Environmental Operating Report.

Table 9.1 (1 of 5)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE Particulates	6 samples from locations (in different sectors) at or near the site boundary (LM-1, LM-2, LM-3, LM-4, LM-6, and LM-7) 2 samples from control locations greater than 10 miles from the plant (RM-1 and RM-6) 3 samples from locations in communities approximately 10 miles from the plant (PM-1, PM-2 and PM-3)	Continuous sampler operation with sample collection as required by dust loading but at least once per 7 days.	Particulate sampler. Analyze for gross beta radioactivity ≥24 hrs following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is >10 times the average of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 31 days.
Radioiodine	Same locations as air particulates	Continuous sampler operation with charcoal canister collection at least once per 7 days	I-131 every 7 days
SOIL	Samples from same locations as air particulates	Once every year	Gamma scan, Sr-89, Sr-90 once per year
DIRECT	2 or more dosimeters placed at locations (in different sectors) at or near the site boundary in each of the 16 sectors	At least once per 92 days	Gamma dose once per 92 days

Table 9.1 (2 of 5)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
DIRECT (continued)	2 or more dosimeters placed at stations located approximately 5 miles from the plant in each of the 16 sectors	At least once per 92 days.	Gamma dose once per 92 days.
	2 or more dosimeters in at least 8 additional locations of special interest		
WATERBORNE			
Surface	1 sample upstream (TRM 305.0) 1 sample immediately downstream of discharge (TRM 293.5) 1 sample downstream from plant (TRM 285.2)	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[a].	Gamma scan at least once per 31 days. Composite for tritium at least once per 92 days
Drinking	1 sample at the first potable surface water supply downstream from the plant (TRM 282.6)	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[a,b]	Gross beta and gamma scan at least once per 31 days. Composite for Sr-89, Sr-90 and tritium at least once per 92 days.

[a] Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

[b] This assumes that the nearest drinking water intake is >3.0 mile downstream of the plant discharge. If a drinking water intake is constructed within 3.0 miles downstream of the plant discharge, sampling and analysis shall be every 2 weeks.

Table 9.1 (3 of 5)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Drinking (continued)	3 additional samples of potable surface water downstream from the plant (TRM 274.9, TRM 259.8, and TRM 259.5) 1 sample at a control location (TRM 306)	Grab sample taken at least once per 31 days.	Gross beta and gamma scan at least once per 31 days. Composite for Sr-89 and Sr-90 and tritium at least once per 92 days
	1 additional sample at a control location[c] (TRM 305)	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[a]	
GROUND	1 sample adjacent to the plant (well #6)	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days.	Composite for gamma scan, Sr-89, Sr-90, and tritium at least once per 92 days.
	1 sample at a control location upgradient from the plant (Farm Bn)	Grab sample taken at least once per 31 days.	Composite for gamma scan, Sr-89, Sr-90, and tritium at least once per 92 days.
AQUATIC Sediment	2 samples upstream from discharge point (TRM 297.0 and TRM 307.52)	At least once per 184 days	Gamma scan, Sr-89, and Sr-90 analyses

[a] Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

[c] The surface water control sample shall be considered a control for the drinking water sample.

Table 9.1 (4 of 5)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Sediment (continued)	1 sample in immediate down-stream area of discharge point (TRM 293.7)	At least once per 184 days	Gamma scan, Sr-89 and Sr-90 analyses
	2 additional samples down-stream from the plant(TRM 288.78 and 277.98)		
INGESTION Milk	At least 2 samples from dairy farms in the immediate vicinity of the plant (Farms B and Bn)	At least once per 15 days when animals are on pasture; at least once per 31 days at other times.	Gamma scan and I-131 on each sample. Sr-89 and Sr-90 at least once per 31 days
	At least 1 sample from control lo-cations (Farm Gl or Be)		
Fish	3 samples repre-senting commercial and game species in Guntersville Reservoir above the plant	At least once per 184 days	Gamma scan at least once per 184 days on edible portions.
	3 samples repres-enting commercial and game species in Wheeler Reservoir near the plant		

Table 9.1 (5 of 5)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Clams	1 sample down-stream from the discharge 1 sample upstream from the plant. (No permanent stations established; depends on availability of clams).	At least once per 184 days.	Gamma scan on flesh only
Fruits & Vegetables	Samples of food crops such as corn, green beans, tomatoes, and potatoes grown at private gardens and/or farms in the immediate vicinity of the plant 1 sample of each of the same foods grown at greater than 10 miles distance from the plant	At least once per year at time of harvest	Gamma scan on edible portion
Vegetation (pasturage)	Samples from farms producing milk but not providing a milk sample (Farm T). Control sample from 1 control dairy farm (Farm G1)	Once per 31 days	I-131, gamma scan once per 31 days. Sr-89 and Sr-90 analysis on the last monthly sample of each quarter.

Table 9.2

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

Map Location Number [a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected[b]
1	PM-1	NW	13.8	I	AP, CF, S
2	PM-2	NE	10.9	I	AP, CF, S
3	PM-3	SSE	7.5	I	AP, CF, S
4	LM-7	W	2.1	I	AP, CF, S
5	RM-1	W	31.3	C	AP, CF, S
6	RM-6	E	24.2	C	AP, CF, S
7	LM-1	N	1.0	I	AP, CF, S
8	LM-2	NNE	0.9	I	AP, CF, S
9	LM-3	ENE	0.9	I	AP, CF, S
10	LM-4	NNW	1.7	I	AP, CF, S
11	LM-6	SSW	3.0	I	AP, CF, S
12	Farm B	NNW	6.8	I	M
13	Farm Bn	N	5.0	I	M, W
18	Farm Gl	WSW	35	C	M, V
22	Well #6	NW	0.02	I	W
23	TRM[c] 282.6	–	11.4[d]	I	PW
24	TRM 303.0	–	12.0	C	PW
25	TRM 259.6	–	34.4[d]	I	PW
26	TRM 274.9	–	19.1[d]	I	PW
27	TRM 285.2	–	8.8[d]	I	SW
28	TRM 293.5	–	0.5[d]	I	SW
29	TRM 305.0	–	11.0[d]	C[e]	SW
30	TRM 307.52	–	13.52	C	SD
31	TRM 293.7	–	0.3[d]	I	SD
32	TRM 288.78	–	5.22[d]	I	SD
33	TRM 277.98	–	16.02[d]	I	SD
34	Farm Be	NW	28.8	C	M
36	Farm T	WNW	3.2	I	V
37	TRM 297.0	–	3.0[d]	C	SD
	Wheeler Reservoir (TRM 275-349)			I/C	F, CL
	Guntersville Reservoir (TRM 349-424)			I	F
70	TRM 259.8	–	34.2[d]	I	PW

a See Figures 9.1, 9.2, and 9.3

b Sample codes:

AP = Air particulate filter; S = Soil; SD = Sediment
CF = Charcoal Filter; SW = Surface Water; CL = Clams
F = Fish; V = Vegetation; PW = Public Water
W = Well Water; M = Milk

c TRM = Tennessee River Mile

d Miles from plant discharge (TRM 294)

e Also used as a control for public water

Table 9.3
THERMOLUMINESCENT DOSIMETRY LOCATIONS

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)
1	NW-3	NW	13.8	Off
2	NE-3	NE	10.9	Off
3	SSE-2	SSE	7.5	Off
5	W-3	W	31.3	Off
6	E-3	E	24.2	Off
7	N-1	N	1.0	On
8	NNE-1	NNE	0.9	On
9	ENE-1	ENE	0.9	On
10	NNW-2	NNW	1.7	On
38	N-2	N	5.0	Off
39	NNE-2	NNE	0.7	On
40	NNE-3	NNE	5.2	Off
41	NE-1	NE	0.8	On
42	NE-2	NE	5.0	Off
43	ENE-2	ENE	6.2	Off
44	E-1	E	0.8	On
45	E-2	E	5.2	Off
46	ESE-1	ESE	0.9	On
47	ESE-2	ESE	3.0	Off
48	SE-1	SE	0.5	On
49	SE-2	SE	5.4	Off
50	SSE-1	SSE	5.1	Off
51	S-1	S	3.1	Off
52	S-2	S	4.8	Off
53	SSW-2	SSW	3.0	Off
54	SSW-2	SSW	4.4	Off
55	SW-1	SW	1.9	On
56	SW-2	SW	4.7	Off
57	SW-3	SW	6.0	Off
58	WSW-1	WSW	2.7	Off
59	WSW-2	WSW	5.1	Off
60	WSW-3	WSW	10.5	Off
61	W-1	W	1.9	On
62	W-2	W	4.7	Off
63	W-4	W	32.1	Off
64	WNW-1	WNW	3.3	Off
65	WNW-2	WNW	4.4	Off
66	NW-1	NW	2.2	Off
67	NW-2	NW	5.3	Off
68	NNW-1	NNW	1.0	On
69	NNW-3	NNW	5.2	Off

[a]TLDs designated onsite are those located two miles or less from the plant. TLDs designated offsite are those located more than two miles from the plant.

Figure 9.1
ENVIRONMENTAL RADIOLOGICAL SAMPLING LOCATIONS
WITHIN 1 MILE OF THE PLANT

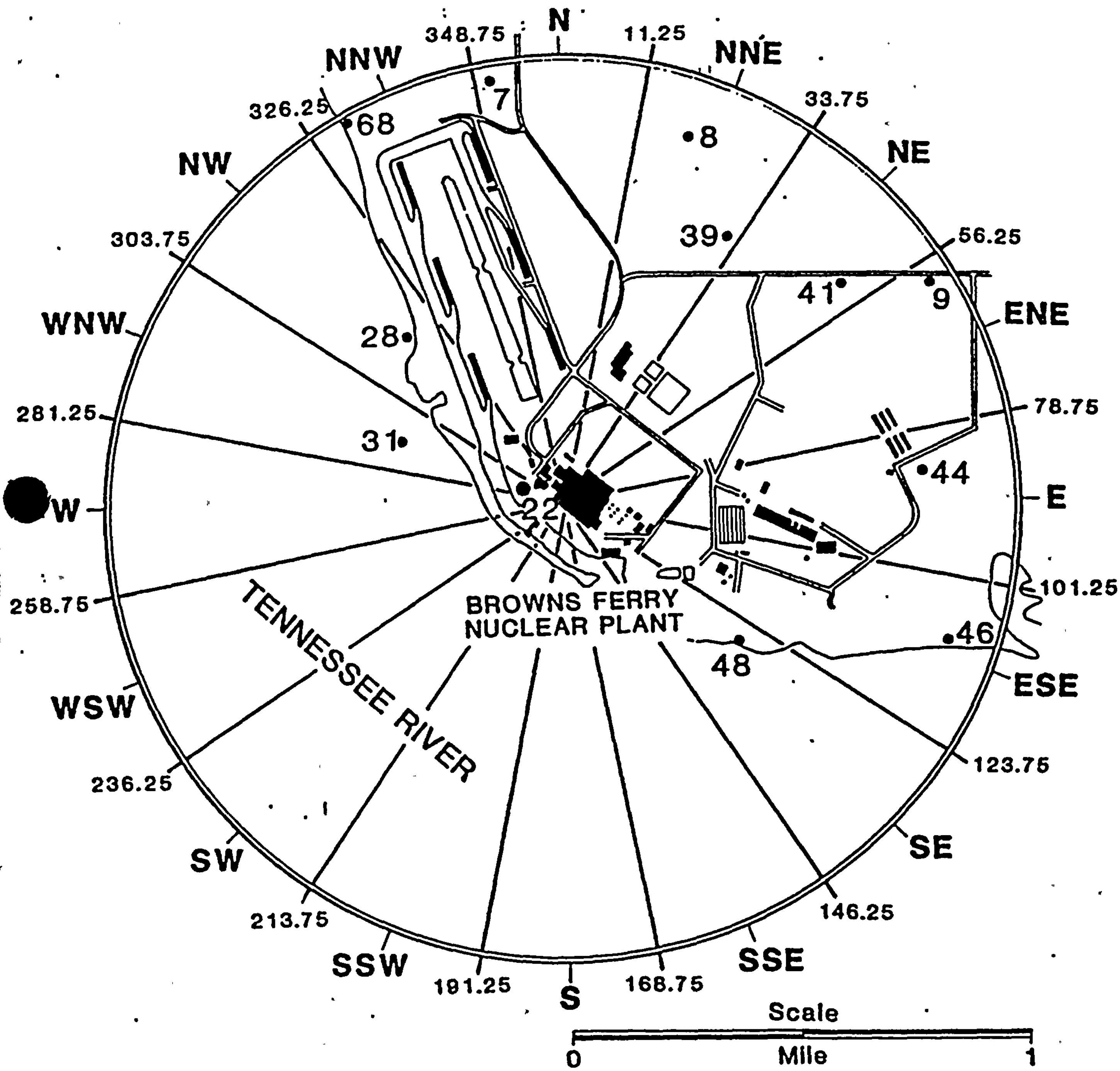


Figure 9.2
ENVIRONMENTAL RADIOLOGICAL SAMPLING LOCATIONS
FROM 1 TO 5 MILES FROM THE PLANT

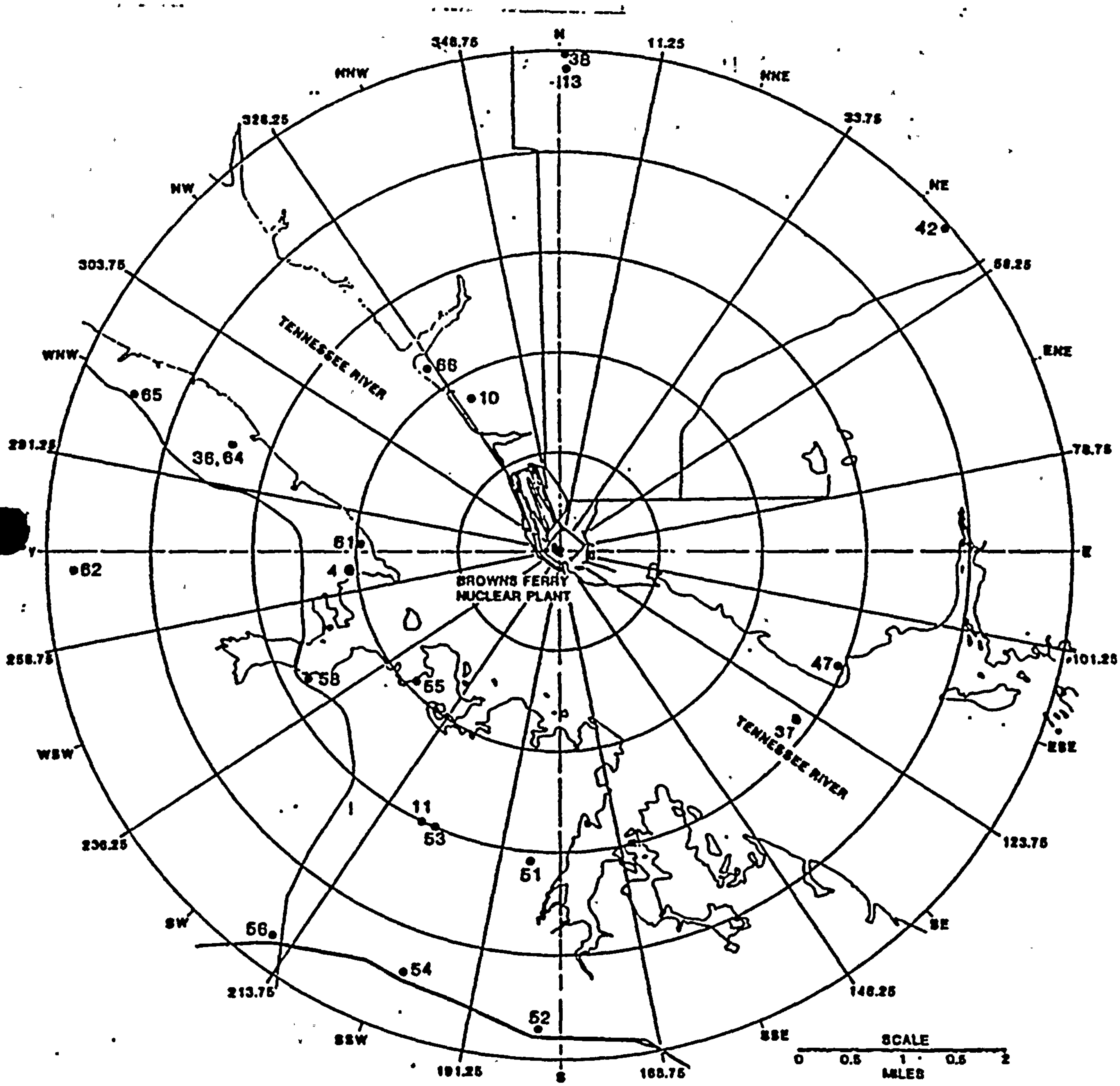


Figure 9.3
ENVIRONMENTAL RADIOLOGICAL SAMPLING LOCATIONS
GREATER THAN 5 MILES FROM THE PLANT