9.0 OFFSITE DOSE CALCULATION SYSTEM*

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* Chapter 9.0 refers to the real-time dose assessment capabilities and is not to be considered a part of the Offsite Dose Calculation Manual (ODCM) referred to in the Technical Specifications.

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9.0 OFFSITE DOSE CALCULATION SYSTEM*

9.1 INTRODUCTION

Under certain circumstances it may be desirable (or necessary) to obtain an offsite radiological dose assessment using the actual, real-time meteorological conditions. Personnel at a Commonwealth Edison Company (CECo) nuclear power plant have access to real-time meteorology not only for their own station but to all other CECo nuclear stations. In addition, forecasted meteorological data are available.

There are five computer models (A, B, C, Track, and Liquid), each with a specific purpose, which may be used to evaluate the offsite dose assessment. The A Model produces initial transport and dispersion estimates within 15 minutes following the classification of an incident. The C Model consists of a series of short calculation programs based on the Gaussian straight-line plume model, allowing for the computation of refined estimates of the offsite dose through the manual entry capability. This model allows for the calculation of offsite dose under lake breeze conditions of plume fumigation and trapping. The Track Model, an adjunct to the C Model, is used to characterize flow regimes, especially under lake breeze conditions. Its objective is to follow accurately an emission throughout its lifetime within the 10-mile emergency planning zone. These three models have been described in detail in the CECo document: "Offsite Dose Calculation System: A Meteorological Monitoring, Offsite Dose Calculation Program for Emergency Preparedness at Operating Nuclear Power Plants," Revision 3, February 1982.

* This chapter is not to be considered a part of the ODCM referred to in the Technical Specifications.

This section of the ODCM describes the CECo B Model, a historical model which documents all releases from multiple release periods and changing meteorological conditions for the duration of the incident. Conditions at the centerline of a straight-line Gaussian plume are used for release periods of less than 8 hours. The meandering plume model (uniform distribution over a 22½° sector) are used for release periods greater than 8 hours. Lake effects as incorporated into the B Model are described in Section 9.4.

This portion of the ODCM also describes a method to calculate the impact of an unplanned radioactive release to the aquatic environment (Section 9.5).

9.2 NOBLE GASES

9.2.1 Gamma Whole Body Dose

9.2.1.1 Straight-Line Gaussian Plume Model

The relative concentration of material at any point in a straight-line, gaussian plume is given by Equation 3.115 in "Meteorology and Atomic Energy" (M&AE) (Reference 6.7), reproduced here as Equation 9.1.

$$\chi/Q = (2\pi\sigma_y\sigma_z u)^{-1} \exp\left(\frac{-y^2}{2\sigma_y^2}\right)\left\{\exp\left[\frac{-(z-h)^2}{2\sigma_z^2}\right] + \exp\left[\frac{-(z+h)^2}{2\sigma_z^2}\right]\right\} \qquad (9.1)$$

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

The relative downwind concentration at point (x, y, z)

x Downwind Distance (m)

The distance, parallel to the wind direction, from the release point to the point of interest.

y Transverse Distance (m)

The distance, perpendicular to the direction in which the wind is blowing, from the release point to the point of interest.

z Vertical Distance (m)

The distance above the ground to the point of interest.

σ_y Horizontal Dispersion Coefficient (m)

The horizontal dispersion coefficient for use in the atmospheric dispersion models. (See Table 7.1-7.)

σ_z Vertical Dispersion Coefficient (m)

The vertical dispersion coefficient for use in the atmospheric dispersion models. (See Table 7.1-7.)

u Wind Speed (m/sec)

The wind speed (in the x-direction).

h Release Height (m)

The height of the release above ground level.

Both σ_y and σ_z are functions of the downwind distance, x, and the atmospheric stability class.

The gamma dose rate from a point monoenergetic source is given by Equation 7.34 in M&AE, reproduced here as Equation 9.2.

$$D'_\gamma(E_\gamma, r) = 0.0404\ \mu_a\ q\ E_\gamma\ (1+k\mu r)\ \exp(-\mu r)/r^2 \qquad (9.2)$$

$D'_\gamma(E_\gamma, r)$ Gamma Dose Rate (rad/sec)

The tissue dose rate due to a point source in air. The source is monoenergetic with energy, E_γ, and a distance, r, away.

E_γ Gamma Ray Energy (MeV/dis)

The gamma ray energy released per disintegration.

	r	Distance	(m)
		The distance between the point of interest and the point source.	

μ_a	Energy Absorption Coefficient	(1/m)
	The gamma ray energy absorption coefficient for air.	
q	Source Strength	(Ci)
	The point source strength expressed in curies.	
μ	Total Absorption Coefficient	(1/m)
	The gamma ray total absorption coefficient for air.	
k	Ratio	
	$k = (\mu - \mu_a)/\mu_a$	
0.0404	Constant This constant reconciles the units of this equation. This constant includes the factor 1.11 for the ratio of electron density of tissue to that of air.	

Both μ and μ_a are functions of the gamma ray energy.

The differential unit source strength in the plume is given by Equation 9.3.

$$dq = Q(\chi/Q)\ dx\ dy\ dz \tag{9.3}$$

dq	Differential Source Strength	(Ci)
	The source in a unit volume expressed in curies.	

Q	Release Rate	(Ci/sec)
	The release rate of material.	
dx dy dz	Volume Element	(m^3)
	The differential volume element.	

The differential dose rate at any point at ground level along the centerline of the plume (x_o, 0, 0) from a volume element at any other point (x, y, z) may then be obtained by combining Equations 9.1, 9.2, and 9.3.

$$d D'_\gamma(E_\gamma, r) = 0.0404 \, \mu_a \, Q \, (\chi/Q) \, E_\gamma \, (1+k\mu r) \, \frac{\exp(-\mu r)}{r^2} \, dx \, dy \, dz \tag{9.4}$$

The distance r is given by Equation 9.5.

$$r^2 = (x-x_o)^2 + y^2 + z^2 \tag{9.5}$$

The total dose at (x_o, 0, 0) due to the entire plume is then obtained by integrating Equation 9.4 over the full extent of the plume; namely, over x from 0 to infinity; over y from minus to plus infinity; and over z from 0 to infinity. It is not possible to obtain a closed-form solution for the integrals of Equation 9.4; the values of the integrals must be obtained by using numerical techniques.

The total dose integrals of Equation 9.4 are a function of release height, downwind range, atmospheric stability class, and the gamma ray energy. As these evaluations are lengthy, a library of these integrals was calculated for two release heights (0 and 100 meters); six downwind ranges (400 to 16,090 meters); seven atmospheric stability classes; and a range of gamma ray energies. Then knowing the gamma ray spectrum associated with radiodecay of specific noble gas nuclides of interest, a dose kernel can be calculated for each nuclide. These dose kernels are defined, such that the total gamma dose rate at points of interest may be determined from Equation 9.6.

$$D'_{\gamma}(R) = \sum_i \frac{Q_i \exp(-\lambda_i R/3600u)}{u} K_i(h,R,S) \qquad (9.6)$$

$D'_{\gamma}(R)$ — Gamma Dose Rate (mrad/hr)

The ground level gamma dose rate at downwind distance, R, due to gamma emitting airborne radioactivity.

R — Downwind Distance (m)

The downwind distance of interest. (The downwind distance was denoted as x_o in Equation 9.5.)

Q_i — Release Rate (μCi/sec)

The release rate of nuclide i.

λ_i — Radiodecay Constant (1/hr)

The radioactive decay constant for nuclide i. See Table 7.1-9.

3600 — Conversion Constant (sec/hr)

Converts hours to seconds.

$K_i(h,R,S)$ — Dose Kernel $\frac{(\text{mrad/hr})(\text{m/sec})}{\mu\text{Ci/sec}}$

The finite cloud dose kernel, a function of release height (h); downwind range (R); stability class (S); and nuclide i released.

The dose kernels have been evaluated for 15 noble gas nuclides and an 0.8 MeV pseudonuclide (to approximate a "gross" release) and are presented in Table 9.2-1.

If one obtains the wind speed, direction, and stability class from the meteorological tower, and has an estimate of the release rate Q_i, then with Equation 9.6 and the data of Table 9.2-1, an offsite dose rate at any downwind distance of interest may be quickly estimated.

Similarly, an offsite dose may be estimated from the following:

$$D_\gamma (R) = 1.11 \sum_i A_i \frac{\exp(- \lambda_i R/3600u)}{u} \frac{K_i(h,R,S)}{3600} \qquad (9.7)$$

D_γ (R)	Gamma Dose The time integrated dose at downwind distance R.	(mrem)
1.11	Conversion Constant Converts mrad (air) to mrem (tissue).	(mrem/mrad)
A_i	Accumulative Release The accumulative release of nuclide i over the time period of interest.	(µCi)

9.2.1.2 Meandering Plume Model

The ground level dose rate due to a plume meandering within a 22½° angular sector may be evaluated in a manner similar to that described in the previous subsection.

It can be shown that if the term:

$$\int_0^1 \exp\left[-(y + \frac{R\theta}{2} - R\theta t)^2/2\sigma_y^{\,2}\right] dt$$

is substituted for the term:

$$\exp(-y^2/2\sigma_y^{\,2})$$

in Equation 9.1, then the revised Equations 9.1 and 9.4 will describe the dose rate due to the meandering plume. The term θ in the above expression is the angular sector over which the plume is assumed to meander. Again, the total rate from the entire plume is obtained by numerical integration techniques and kernels for use in the dose rate and dose Equations 9.6 and 9.7 have been determined. The "K" kernels have been determined for 2 release heights (0 and 100 meters); 6 downwind ranges (400 to 16,090 meters); 7 atmospheric stability classes; 15 noble gas nuclides; and 1 pseudonuclide (0.8 MeV gamma ray, 34 minute half-life); these data are given in Table 9.2-2. If one obtains the wind, speed, direction, and stability class from the meteorological tower, and has an estimate of the release rate Q_i, then with Equation 9.6 and the data of Table 9.2-2, an offsite dose rate at any downwind distance of interest may be quickly estimated. And similarly, using Equation 9.7, an offsite dose may be determined.

9.2.1.3 Population Doses

The whole body population dose in downwind sectors to a distance of 10 miles from the station may also be of relevance in emergency planning considerations. Such a sector population may be calculated as follows:

$$D_\gamma^*(\theta) = \sum_{j=1}^{5} P_j(\theta) \left[D_\gamma(R_j) \times D_\gamma(R_{j+1}) \right]^{1/2} \Big/ 1000 \qquad (9.8)$$

$D_\gamma^*(\theta)$ — Whole Body Population Dose (man-rem)

The gamma whole body dose to the population in angular sector θ.

$P_j(\theta)$ — Population (persons)

The population in radial sector j and angular sector θ. See Table 9.2-3.

$D_\gamma(R_j)$ Gamma Dose (mrad)

The gamma dose to an individual at downwind distance R_j. (From Equation 9.7.)

R_j Radial Sector Boundary Distance (m)

The distance to inner radial boundary of the population sector. The values of R_j are the same as used in Tables 9.2-1, 9.2-2, 9.2-4, and 9.2-5; namely, 400, 800, 1609, 3218, and 8045 meters, respectively. The distance to the outermost sector is 16,090 meters. No population is presumed to be present in the 0-400 meter sector.

1000 Conversion Constant (mrem/rem)

Converts mrem to rem.

The term $\left[D_\gamma(R_j) \times D_\gamma(R_{j+1}) \right]^{1/2}$ in Equation 9.8 is the geometric mean dose in the angular sector bounded by R_j and R_{j+1}.

9.2.2 Skin Dose

The dose rate to the skin (see Subsection 2.1.1) is due to two components; gamma rays and beta rays. The gamma component is determined from Equation 9.6; the beta component is determined from the following equation:

$$D'_\beta(R) = \frac{1}{8760} \sum_i \bar{L}_i \left[\left(\chi/Q \right)_s Q'_{is} + \left(\chi/Q \right)_g Q'_{ig} \right] \quad (9.9)$$

$D'_\beta(R)$ Skin Dose Rate (mrem/hr)

The dose rate at (R) to the skin due to beta-emitting airborne radioactivity.

8760	Conversion Constant Converts years to hours.	(hr/yr)
$\bar{L}_i$	Beta Skin Dose Constant The skin dose factor due to beta emissions for each identified noble gas radionuclide i. This factor accounts for the attenuation of beta radiation during passage through 7 mg/cm^2 of dead skin. Values for specific nuclides are given in Table 7.1-13.	($mrem/yr/\mu Ci/m^3$)
$(\chi/Q)_s$	Relative Effluent Concentration, Stack Release The relative effluent concentration at ground level due to stack releases.	(sec/m^3)
$(\chi/Q)_g$	Relative Effluent Concentration, Ground Level Release The relative effluent concentration at ground level due to ground level releases.	(sec/m^3)
Q'_{is}	Release Rate From Stack, Adjusted for Radiodecay The release rate for radionuclide i from a stack adjusted for radiodecay in transit.	($\mu Ci/sec$)

$$Q'_{is} = Q_{is} \times \exp(-\lambda_i R/3600u_s) \qquad (9.10)$$

Q_{is}	Release Rate From Stack The release rate of radionuclide i from the stack.	($\mu Ci/sec$)
u_s	Wind Speed, Stack Elevation The wind speed at the elevation of the top of the stack.	(m/sec)

Q'_{ig} Release Rate, Ground Level, Adjusted for Radiodecay (μCi/sec)

The release rate for radionuclide i at ground level, adjusted for radiodecay in transit.

$$Q'_{ig} = Q_{ig} \times \exp(-\lambda_i R/3600u_g) \tag{9.11}$$

Q_{ig} Release Rate at Ground Level (μCi/sec)

The release rate of radionuclide i at ground level.

u_g Wind Speed, Ground Level (m/sec)

The wind speed at the lowest position on the meteorological tower.

The relative concentration, χ/Q, is a function of downwind range, atmospheric stability class, release height, meander model, and wind speed. To preclude extensive table look-ups, a table of the parameter ($u\chi/Q$) has been prepared for the same two release heights (0 and 100 meters); six downwind ranges (400 to 16,090 meters); and seven atmospheric stability classes used to develop the whole body dose kernels.

9.2.2.1 χ/Q Modeling

Two models are considered for χ/Q evaluations. The first is the straight-line gaussian plume model considered for times less than 8 hours after an accident. The ground level relative concentration for a plume directly overhead is given by the following equations:

$$u_s \left(\chi/Q\right)_s = \frac{1}{\pi\sigma_y\sigma_z} \exp -\left(\frac{h^2}{2\sigma_z{}^2}\right) \tag{9.12}$$

$$u_g \left(\chi/Q\right)_g = \frac{1}{\pi S_y S_z} \tag{9.13}$$

σ_y Horizontal Dispersion Coefficient (m)

The horizontal dispersion coefficient for use in the atmospheric dispersion models. (See Table 7.1-7.)

σ_z Vertical Dispersion Coefficient (m)

The vertical dispersion coefficient for use in the atmospheric dispersion models. (See Table 7.1-7.)

h Effluent Release Height (m)

The height above grade at which the effluent is effectively released.

S_y Corrected Horizontal Dispersion Coefficient (m)

The horizontal dispersion coefficient corrected for building wake effects.

$$S_y = \left(\sigma_y^2 + A/_{2\pi}\right)^{1/2} \qquad (9.14)$$

A Building Cross-Sectional Area

The effective building cross-sectional area determining the downwind wake effect.

S_z Corrected Vertical Dispersion Coefficient (m)

The vertical dispersion coefficient corrected for building wake effects.

$$S_z = \left(\sigma_z^2 + A/_{2\pi}\right)^{1/2} \qquad (9.15)$$

The values of S_y and S_z are further limited by the condition:

$$S_y \leq \sqrt{3}\sigma_y \tag{9.16}$$

$$S_z \leq \sqrt{3}\sigma_z \tag{9.17}$$

The second model is for the case of a meandering plume to be used for times greater than 8 hours after an accident or other times when deemed appropriate. The ground level relative concentrations at the centerline of the sector are given by the following equations:

$$u_s \left(\chi/Q \right)_s = \frac{2.032}{R\sigma_z} \exp -\left(\frac{h^2}{2\sigma_z^2} \right) \tag{9.18}$$

$$u_g \left(\chi/Q \right)_g = \frac{2.032}{R\ S_z} \tag{9.19}$$

The values of $(u\chi/Q)$ for the straight-line gaussian plume are given in Table 9.2-4. The values of $(u\chi/Q)$ for the meandering plume are given in Table 9.2-5.

If one obtains the wind speed, direction, and stability class from the meteorological tower, the downwind χ/Q may be calculated as follows:

$$\left(\chi/_Q \right)_s = \frac{1}{u_s} \left(u\chi/_Q \right)_s \tag{9.20}$$

$$\left(\chi/_Q \right)_g = \frac{1}{u_g} \left(u\chi/_Q \right)_g \tag{9.21}$$

Values of $u\chi/_Q$ are taken from Tables 9.2-4 or 9.2-5; the wind speed u_s or u_g is from the upper or lower level of the meteorological tower as is appropriate for the release.

The formulations of $(u\chi/Q)$ have been heretofore developed assuming that a single stability class determination is applicable for describing both horizontal and vertical dispersion. And this formulation is consistent with data available in historical meteorological data files. However, when real-time meteorological information is available, data to support a more accurate straight-line gaussian plume modeling scheme is available.

The vertical differential temperature measurements, ΔT, (indicative of dispersion in the vertical direction) will be used to determine the "vertical stability class" which, in turn, determines σ_z. The vane directional variation measurement, σ_θ, is more indicative of horizontal dispersion; therefore, σ_θ will be used to determine a "horizontal stability class" which, in turn, determines σ_y. Rather than developing tables of all possible combinations of σ_y and σ_z, the numerical effect of these differing atmospheric conditions is consolidated into a single correction term. The corrected $(u\chi/Q)$ is determined as follows:

$$(u\chi/Q)_{corrected} = C(\sigma_\theta, \Delta T) \times (u\chi/Q) \qquad (9.22)$$

$(u\chi/Q)$ — Normalized Dispersion Factor $(1/m^2)$

The value of $(u\chi/Q)$ from Table 9.2-4 for the distance of interest and stability class as determined from the meteorological tower differential temperature measurements.

$(u\chi/Q)_{corrected}$ — Corrected Normalized Dispersion Factor $(1/m^2)$

The value of $(u\chi/Q)$ corrected for differing horizontal and vertical stability classes.

$C(\sigma_\theta, \Delta T)$ Correction Factor

The correction factor to account for a difference in stability class as determined by the ΔT and σ_θ methods. See Table 9.2-6.

These correction factors were readily derivable for use in $(u\chi/Q)$ formulation. However, an equivalent correction factor for use in the finite cloud models (Subsection 9.2.1) is not easily derivable. But because of the poor gamma attenuating properties of air, the effect of modest additional dispersion on the cloud would have little effect on the final value of the kernel. Hence a correction for the gamma dose kernel will not be pursued further.

9.2.2.2 Skin Dose Assessment

Combining Equation 9.9 with Equations 9.10, 9.11, 9.20, and 9.21 (and 9.22, if applicable) results in the final expression for beta skin dose rate:

$$D'_\beta(R) = \frac{1}{8760} \sum_i \bar{L}_i \left[\frac{1}{u_s} \left(u\chi/Q \right)_s Q_{is} \exp(-\lambda_i R/3600 u_s) + \frac{1}{u_g} \left(u\chi/Q \right)_g Q_{ig} \exp(-\lambda_i R/3600 u_g) \right] \quad (9.23)$$

The total skin dose rate is obtained by adding the gamma component from Equation 9.6 and the beta component from Equation 9.23:

$$D'_{skin}(R) = D'_\gamma(R) + D'_\beta(R) \quad (9.24)$$

$D'_{skin}(R)$ Skin Dose Rate (mrem/hr)

The dose rate, at downwind distance R, to the skin due to beta and gamma rays.

A beta skin dose may be obtained from the following equation (which follows from Equation 9.23):

$$D_\beta(R) = \frac{1}{8760 \times 3600} \sum_i \bar{L}_i \left[\frac{1}{u_s} \left(u\chi/Q\right)_s A_{is} \exp(-\lambda_i R/3600u_s) + \frac{1}{u_g} \left(u\chi/Q\right)_g A_{ig} \exp(-\lambda_i R/3600u_g) \right] \quad (9.25)$$

$D_\beta(R)$ Beta Skin Dose (mrem)

The dose at downwind distance R to the skin due to beta rays.

A total skin dose may be obtained by combining the results of Equations 9.7 and 9.25.

$$D_{skin}(R) = D_\gamma(R) + D_\beta(R) \quad (9.26)$$

$D_{skin}(R)$ Skin Dose (mrem)

The skin dose at (R) due to gamma and beta rays emitted from airborne radionuclides.

9.2.3 Symbols Used in Section 9.2

SYMBOL	NAME	UNIT
χ/Q	Relative Downwind Concentration	(sec/m^3)
x	Downwind Distance	(m)
y	Transverse Distance	(m)
z	Vertical Distance	(m)
σ_y	Horizontal Dispersion Coefficient	(m)
σ_z	Vertical Dispersion Coefficient	(m)
u	Wind Speed	(m/sec)
h	Effluent Release Height	(m)
$D'_\gamma(E_\gamma, r)$	Gamma Dose Rate	(rad/sec)
E_γ	Gamma Ray Energy	(MeV/dis)
r	Distance	(m)
μ_a	Energy Absorption Coefficient	(1/m)
q	Source Strength	(Ci)
k	Ratio	
μ	Total Absorption Coefficient	(1/m)
dq	Differential Source Strength	(Ci)
Q	Release Rate	(Ci/sec)
dx dy dz	Volume Element	(m^3)
$D'_\gamma(R)$	Gamma Dose Rate	(mrad/hr)
R	Downwind Distance	(m)
Q_i	Release Rate	(μCi/sec)
λ_i	Radiodecay Constant	(1/hr)

SYMBOL	NAME	UNIT
K_i (h,R,S)	Dose Kernel	$\frac{(\text{mrad/hr})(\text{m/sec})}{\mu\text{Ci/sec}}$
$D_\gamma(R)$	Gamma Dose	(mrad)
A_i	Accumulative Release	(μCi)
θ	Angular Sector	
$D^*_\gamma(\theta)$	Whole Body Population Dose	(man-rem)
$P_j(\theta)$	Population	(persons)
$D_\gamma(R_j)$	Gamma Dose	(mrad)
R_j	Radial Sector Boundary Distance	(m)
D'_β (R)	Beta Skin Dose Rate	(mrem/hr)
$\bar{L}_i$	Beta Skin Dose Constant	(mrem/yr per μCi/m^3)
$(\chi/Q)_s$	Relative Effluent Concentration, Stack Release	(sec/m^3)
Q'_{is}	Release Rate From Stack, Adjusted for Radiodecay	(μCi/sec)
Q_{is}	Release Rate From Stack	(μCi/sec)
u_s	Wind Speed, Stack Elevation	(m/sec)
$(\chi/Q)_g$	Relative Effluent Concentration, Ground Level	(sec/m^3)
Q'_{ig}	Release Rate, Ground Level, Adjusted for Radiodecay	(μCi/sec)
Q_{ig}	Release Rate at Ground Level	(μCi/sec)
u_g	Wind Speed, Ground Level	(m/sec)
S_y	Corrected Horizontal Dispersion Coefficient	(m)
A	Building Cross-Sectional Area	(m^2)
S_z	Corrected Vertical Dispersion Coefficient	(m)
ΔT	Vertical Differential Temperature	(°C)

SYMBOL	NAME	UNIT
$(u\chi/Q)$	Normalized Dispersion Factor	$(1/m^2)$
$(u\chi/Q)_{corrected}$	Corrected Normalized Dispersion Factor	$(1/m^2)$
$C(\sigma_\theta, \Delta T)$	Correction Factor	
$(u\chi/Q)_s$	Dispersion Factor, Stack Release	$(1/m^2)$
$(u\chi/Q)_g$	Dispersion Factor, Ground Release	$(1/m^2)$
$D'_{skin}(R)$	Skin Dose Rate	(mrem/hr)
$D_\beta(R)$	Beta Skin Dose	(mrem)
$D_{skin}(R)$	Skin Dose	(mrem)

9.2.4 Constants Used in Section 9.2

NUMERICAL VALUE	NAME	UNIT
0.0404	Constant	
3600	Conversion Constant	(sec/hr)
1000	Conversion Constant	(mrem/rem)
8760	Conversion Constant	(hr/yr)
2.032	Constant	
1.11	Conversion Constant	(mrem/mrad)

TABLE 9.2-1

FINITE CLOUD GAMMA TISSUE DOSE KERNEL

STRAIGHT-LINE GAUSSIAN PLUME MODEL

Kr-83m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	9.960-08	1.514-08	2.368-09	1.266-09	5.536-10	2.961-10
B	2.711-07	6.870-08	1.707-08	4.291-09	7.362-10	3.937-10
C	5.435-07	1.557-07	4.396-08	1.251-08	2.374-09	6.753-10
D	1.311-06	4.127-07	1.337-07	4.600-08	1.171-08	4.239-09
E	2.544-06	8.341-07	2.723-07	9.754-08	2.733-08	1.085-08
F	5.628-06	1.849-06	6.031-07	2.223-07	6.575-08	2.740-08
G	1.287-05	4.414-06	1.476-06	5.491-07	1.634-07	6.825-08

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.864-08	1.430-08	2.358-09	1.261-09	5.513-10	2.948-10
B	1.344-08	3.503-08	1.475-08	4.156-09	7.330-10	3.920-10
C	1.634-10	2.111-08	2.508-08	1.068-08	2.305-09	6.700-10
D	6.950-11	1.323-10	1.017-08	1.584-08	8.162-09	3.595-09
E	6.601-11	7.028-11	1.283-09	8.634-09	1.010-08	6.269-09
F	6.415-11	6.331-11	6.503-11	6.078-10	4.226-09	5.168-09
G	6.389-11	6.257-11	5.870-11	5.032-11	4.551-11	7.098-10

TABLE 9.2-1 (Cont'd)

Kr-85m

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.216-06	9.999-07	1.515-07	8.268-08	3.644-08	1.951-08
B	8.016-06	3.142-06	9.953-07	2.738-07	4.837-08	2.593-08
C	1.192-05	5.519-06	2.178-06	7.425-07	1.534-07	4.435-08
D	1.878-05	9.843-06	4.719-06	2.111-06	6.561-07	2.570-07
E	2.623-05	1.458-05	7.460-06	3.638-06	1.304-06	5.784-07
F	3.824-05	2.191-05	1.183-05	6.195-06	2.474-06	1.187-06
G	5.654-05	3.335-05	1.889-05	1.048-05	4.495-06	2.262-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.468-06	8.471-07	1.511-07	8.245-08	3.634-08	1.946-08
B	2.145-06	1.952-06	8.746-07	2.658-07	4.824-08	2.587-08
C	1.916-06	2.000-06	1.455-06	6.470-07	1.492-07	4.408-08
D	1.861-06	1.734-06	1.533-06	1.113-06	4.972-07	2.230-07
E	1.896-06	1.790-06	1.578-06	1.252-06	7.131-07	3.929-07
F	1.914-06	1.846-06	1.664-06	1.329-06	8.199-07	5.128-07
G	1.928-06	1.891-06	1.772-06	1.492-06	9.489-07	5.974-07

TABLE 9.2-1 (Cont'd)

Kr-85

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0 (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.893-08	1.159-08	2.062-09	1.138-09	5.051-10	2.708-10
B	9.031-08	3.723-08	1.272-08	3.700-09	6.694-10	3.598-10
C	1.333-07	6.325-08	2.622-08	9.592-09	2.092-09	6.137-10
D	2.104-07	1.106-07	5.425-08	2.521-08	8.301-09	3.372-09
E	2.951-07	1.634-07	8.439-08	4.203-08	1.582-08	7.228-09
F	4.314-07	2.465-07	1.328-07	7.037-08	2.888-08	1.422-08
G	6.348-07	3.764-07	2.126-07	1.181-07	5.087-08	2.623-08

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.983-08	1.091-08	2.054-09	1.134-09	5.036-10	2.700-10
B	2.691-08	2.413-08	1.127-08	3.591-09	6.676-10	3.587-10
C	2.470-08	2.519-08	1.823-08	8.439-09	2.036-09	6.097-10
D	2.437-08	2.277-08	1.995-08	1.435-08	6.475-09	2.958-09
E	2.482-08	2.361-08	2.091-08	1.651-08	9.346-09	5.140-09
F	2.507-08	2.435-08	2.219-08	1.802-08	1.121-08	6.927-07
G	2.523-08	2.489-08	2.353-08	2.026-08	1.34[illegible]-08	8.526-09

TABLE 9.2-1 (Cont'd)

Kr-87

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.376-05	3.534-06	6.898-07	3.868-07	1.752-07	9.433-08
B	2.509-05	1.064-05	3.854-06	1.206-06	2.313-07	1.252-07
C	3.696-05	1.772-05	7.626-06	2.930-06	6.961-07	2.118-07
D	5.854-05	3.073-05	1.528-05	7.270-06	2.505-06	1.059-06
E	8.247-05	4.542-05	2.354-05	1.193-05	4.596-06	2.163-06
F	1.214-04	6.877-05	3.693-05	1.971-05	8.194-06	4.091-06
G	1.799-04	1.057-04	5.930-05	3.290-05	1.435-05	7.353-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	8.584-06	3.340-06	6.865-07	3.853-07	1.745-07	9.400-08
B	7.809-06	7.076-06	3.444-06	1.172-06	2.304-07	1.247-07
C	7.215-06	7.385-06	5.441-06	2.606-06	6.783-07	2.103-07
D	7.135-06	6.737-06	5.966-06	4.346-06	2.007-06	9.414-07
E	7.260-06	6.968-06	6.240-06	5.016-06	2.875-06	1.600-06
F	7.327-06	7.169-06	6.593-06	5.454-06	3.491-06	2.177-06
G	7.372-06	7.315-06	6.959-06	6.079-06	4.170-06	2.725-06

TABLE 9.2-1 (Cont'd)

Kr-88

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.115 05	8.313-06	1.678-06	9.466-07	4.311-07	2.324-07
B	5.643-05	2.427-05	9.040-06	2.911-06	5.685-07	3.082-07
C	9.319-05	4.003-05	1.754-05	6.895-06	1.693-06	5.205-07
D	1.324-04	6.921-05	3.460-05	1.665-05	5.866-06	2.519-06
E	1.876-04	1.025-04	5.308-05	2.709 05	1.056 05	5.045-06
F	2.785-04	1.561-04	8.328-05	4.452-05	1.861-05	9.375-06
G	4.169-04	2.420-04	1.344-04	7.426-05	3.248 05	1.660-05

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.967-05	7.873-06	1.670-06	9.427-07	4.294 07	2.315-07
B	1.796-05	1.636-05	8.108-06	2.830-06	5.663-07	3.070-07
C	1.664-05	1.707-05	1.268-05	6.161-06	1.650-06	5.167-07
D	1.649-05	1.564 05	1.392-05	1.019-05	4.754-06	2.252-06
E	1.677-05	1.616 05	1.455-05	1.178-05	6.791 06	3.797-06
F	1.692-05	1.661 05	1.534-05	1.280-05	8.297-06	5.191-06
G	1.702-05	1.693-05	1.616-05	1.422-05	9.314-06	6.549-06

TABLE 9.2-1 (Cont'd)

Kr-89

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.969-05	7.589-06	1.507-06	8.457-07	3.832-07	2.064-07
B	5.402-05	2.299-05	8.376-CS	2.632-06	5.059-07	2.738-07
C	7.958-05	3.821-05	1.650-05	6.377-06	1.521-06	4.632-07
D	1.261-04	6.620-05	3.296-05	1.572-05	5.442-06	2.306-06
E	1.777-04	9.783-05	5.073-05	2.573-05	9.953-06	4.695-06
F	2.617-04	1.482-04	7.957-05	4.248-05	1.769-05	8.851-06
G	3.878-04	2.279-04	1.273-04	7.090-05	3.091-05	1.587-05

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.858-05	7.267-06	1.500-06	8.423-07	3.818-07	2.056-07
B	1.693-05	1.534-05	7.489-06	2.558-06	5.040-07	2.728-07
C	1.566-05	1.602-05	1.181-05	5.676-06	1.482-06	4.599-07
D	1.550-05	1.465-05	1.297-05	9.451-06	4.369-06	2.053-06
E	1.577-05	1.515-05	1.358-05	1.092-05	6.262-06	3.485-06
F	1.591-05	1.558-05	1.434-05	1.188-05	7.619-06	4.751-06
G	1.601-05	1.590-05	1.513-05	1.324-05	9.110-06	5.962-06

TABLE 9.2-1 (Cont'd)

Kr-90

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.079-05	1.038-05	2.001-06	1.120-06	5.057-07	2.721-07
B	7.456-05	3.147-05	1.131-05	3.512-06	6.681-07	3.611-07
C	1.100-04	5.258-05	2.250-05	8.596-06	2.023-06	6.119-07
D	1.744-04	9.141-05	4.531-05	2.146-05	7.363-06	3.036-06
E	2.458-04	1.352-04	6.995-05	3.532-05	1.356-05	6.364-06
F	3.619-04	2.049-04	1.099-04	5.853-05	2.424-05	1.210-05
G	5.365-04	3.151-04	1.767-04	9.787-05	4.254-05	2.180-05

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.537-05	9.805-06	1.992-06	1.116-06	5.029-07	2.711-07
B	2.301-05	2.087-05	1.010-05	3.412-06	6.656-07	3.597-07
C	2.122-05	2.175-05	1.601-05	7.637-06	1.970-06	6.075-07
D	2.097-05	1.979-05	1.753-05	1.270-05	5.881-06	2.749-06
E	2.133-05	2.046-05	1.832-05	1.472-05	8.430-06	4.686-06
F	2.153-05	2.105-05	1.935-05	1.599-05	1.021-05	6.368-06
G	2.166-05	2.148-05	2.04[illegible]-05	1.782-05	1.219-05	7.949-06

TABLE 9.2-1 (Cont'd)

Xe-131m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	7.141-07	1.208-07	1.927-08	1.036-08	4.541-09	2.429-09
B	1.653-06	5.043-07	1.354-07	3.490-08	6.035-09	3.230-09
C	2.822-06	1.031-06	3.312-07	9.974-08	1.938-08	5.535-09
D	5.280-06	2.226-06	8.765-07	3.360-07	9.163-08	3.399-08
E	8.320-06	3.758-06	1.575-06	6.530-07	2.021-07	8.346-08
F	1.379-05	6.548-06	2.890-06	1.286-06	4.384-07	1.944-07
G	2.296-05	1.152-05	5.408-06	2.557-06	9.258-07	4.246-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.699-07	1.141-07	1.921-08	1.033-08	4.527-09	2.422-09
B	2.073-07	2.766-07	1.177-07	3.385-08	6.017-09	3.220-09
C	1.183-07	2.250-07	2.000-07	8.573-08	1.884-08	5.499-09
D	9.423-08	1.022-07	1.433-07	1.377-07	6.569-08	2.903-08
E	9.314-08	9.197-08	1.001-07	1.165-07	8.742-08	5.110-08
F	9.233-08	8.978-08	8.450-08	7.702-08	6.818-08	5.364-08
G	9.251-08	9.053-08	8.446-08	7.071-08	4.778-08	3.609-08

TABLE 9.2-1 (Cont'd)

Xe-133m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.268-06	2.415-07	3.977-08	2.157-08	9.483-09	5.076-09
B	2.705-06	9.182-07	2.687-07	7.191-08	1.260-08	6.748-09
C	4.392-06	1.755-06	6.195-07	1.994-07	4.014-08	1.155-08
D	7.774-06	3.520-06	1.496-06	6.151-07	1.793-07	6.855-08
E	1.183-05	5.086-06	2.555-06	1.131-06	3.750-07	1.605-07
F	1.894-05	9.471-06	4.451-06	2.100-06	7.646-07	3.514-07
G	3.058-05	1.601-05	7.920-06	3.941-06	1.517-06	7.228-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	6.965-07	2.276-07	3.965-08	2.150-08	9.457-09	5.062-09
B	4.922-07	5.359-07	2.350-07	6.978-08	1.256-08	6.728-09
C	3.735-07	4.913-07	3.941-07	1.727-07	3.904-08	1.148-08
D	3.431-07	3.343-07	3.486-07	2.869-07	1.325-07	5.908-08
E	3.467-07	3.318-07	3.120-07	2.849-07	1.833-07	1.039-07
F	3.483-07	3.371-07	3.081-07	2.564-07	1.792-07	1.230-07
G	3.503-07	3.438-07	3.223-07	2.722-07	1.771-07	1.177-07

TABLE 9.2-1 (Cont'd)

Xe-133

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609	3218.	8045	16090.
A	1.463-06	2.707-07	4.385-08	2.370-08	1.040-08	5.564-09
B	3.091-06	1.056-06	3.019-07	7.940-08	1.382-08	7.396-09
C	4.935-06	2.016-06	7.085-07	2.232-07	4.420-08	1.[illegible]67-08
D	8.463-[illegible]	3.974-06	1.717-06	7.036-07	2.021-07	7.643-08
E	1.253-05	6.28[illegible]	2.903-06	1.297-06	4.274-07	1.818-07
F	1.937-05	1.016-05	4.961-06	2.389-06	8.737-07	4.008-07
G	3.018-05	1.654-05	8.560-06	4.382-06	1.721-06	8.223-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	7.964-07	2.553-07	4.373-08	2.364-08	1.037-08	5.549-09
B	5.714-07	6.105-07	2.633-07	7.706-08	1.378-08	7.378-09
C	4.357-07	5.629-07	4.460-07	1.928-07	4.300-08	1.259-08
D	3.954-07	3.848-07	3.963-07	3.225-07	1.480-07	6.562-08
E	3.993-07	3.806-07	3.561-07	3.209-07	2.048-07	1.160-07
F	4.010-07	[illegible].364-07	3.505-07	2.880-07	1.989-07	1.364-07
G	4.034-07	3.945-07	3.668-07	3.044-07	1.932-07	1.280-07

TABLE 9.2-1 (Cont'd)

Xe-135m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS)					
	400.	800.	1609.	3218.	8045.	16090.
A	9.576-06	2.263-06	4.026-07	2.222-07	9.863-08	5.288-08
B	1.775-05	7.280-06	2.483-06	7.224-07	1.307-07	7.026-08
C	2.629-05	1.240-05	5.123-06	1.873-06	4.085-07	1.198-07
D	4.171-05	2.178-05	1.064-05	4.929-06	1.621-06	6.584-07
E	5.873-05	3.230-05	1.659-05	8.225-06	3.093-06	1.412-06
F	8.632-05	4.895-05	2.621-05	1.383-05	5.656-06	2.781-06
G	1.277-04	7.517-05	4.218-05	2.330-05	9.994-06	5.143-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS)					
	400.	800.	1609.	3218.	8045.	16090.
A	5.827-06	2.130-06	4.011-07	2.215-07	9.835-08	5.272-08
B	5.229-06	4.712-06	2.199-06	7.011-07	1.304-07	7.004-08
C	4.785-06	4.903-06	3.558-06	1.648-06	3.975-07	1.191-07
D	4.716-06	4.412-06	3.879-06	2.799-06	1.264-06	5.776-07
E	4.803-06	4.571-06	4.054-06	3.217-06	1.823-06	1.003-06
F	4.850-06	4.712-06	4.296-06	3.493-06	2.179-06	1.349-06
G	4.882-06	4.816-06	4.554-06	3.924-06	2.598-06	1.655-06

TABLE 9.2-1 (Cont'd)

Xe-135

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	6.212-06	1.376-06	2.352-07	1.287-07	5.683-08	3.044-08
B	1.166-05	4.658-06	1.518-06	4.244-07	7.543-08	4.046-08
C	1.726-05	8.082-06	3.255-06	1.136-06	2.383-07	6.915-08
D	2.713-05	1.428-05	6.907-06	3.144-06	9.964-07	3.948-07
E	3.789-05	2.109-05	1.086-05	5.348-06	1.952-06	8.743-07
F	5.503-05	3.167-05	1.713-05	9.023-06	3.651-06	1.767-06
G	8.047-05	4.807-05	2.731-05	1.520-05	6.557-06	3.328-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.690-06	1.294-06	2.344-07	1.283-07	5.668-08	3.036-08
B	3.269-06	2.941-06	1.337-06	4.118-07	7.522-08	4.035-08
C	2.959-06	3.046-06	2.206-06	9.928-07	2.319-07	6.872-08
D	2.896-06	2.697-06	2.365-06	1.706-06	7.624-07	3.437-07
E	2.952-06	2.792-06	2.461-06	1.942-06	1.098-06	6.033-07
F	2.981-06	2.881-06	2.606-06	2.090-06	1.287-06	7.988-07
G	3.002-06	2.950-06	2.773-06	2.353-06	1.515-06	9.541-07

TABLE 9.2-1 (Cont'd)

Xe-137

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.191-06	1.003-06	1.815-07	1.005-07	4.478-08	2.403-08
B	7.729-06	3.193-06	1.099-06	3.240-07	5.931-08	3.192-08
C	1.141-05	5.416-06	2.256-06	8.300-07	1.840-07	5.435-08
D	1.801-05	9.465-06	4.648-06	2.166-06	7.176-07	2.933-07
E	2.527-05	1.399-05	7.226-06	3.607-06	1.360-06	6.241-07
F	3.698-05	2.110-05	1.137-05	6.028-06	2.476-06	1.221-06
G	5.445-05	3.225-05	1.820-05	1.011-05	4.367-06	2.244-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.560-06	9.449-07	1.808-07	1.001-07	4.464-08	2.395-08
B	2.309-06	2.076-06	9.752-07	3.145-07	5.913-08	3.181-08
C	2.119-06	2.165-06	1.573-06	7.316-07	1.791-07	5.393-08
D	2.090-06	1.957-06	1.719-06	1.240-06	5.620-07	2.579-07
E	2.128-06	2.027-06	1.799-06	1.428-06	8.095-07	4.463-07
F	2.149-06	2.090-06	1.907-06	1.553-06	9.714-07	6.019-07
G	2.163-06	2.136-06	2.021-06	1.743-06	1.159-06	7.415-07

TABLE 9.2-1 (Cont'd)

Xe-138

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0 (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.936-05	4.978-06	9.696-07	5.441-07	2.459-07	1.323-07
B	3.532-05	1.496-05	5.426-06	1.699-06	3.248-07	1.756-07
C	5.211-05	2.494-05	1.074-05	4.121-06	9.808-07	2.975-07
D	8.274-05	4.329-05	2.150-05	1.023-05	3.530-06	1.491-06
E	1.169-04	6.409-05	3.315-05	1.679-05	6.460-06	3.047-06
F	1.726-04	9.731-05	5.206-05	2.774-05	1.151-05	5.764-06
G	2.569-04	1.502-04	8.381-05	4.636-05	2.021-05	1.031-05

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.208-05	4.708-06	9.650-07	5.419-07	2.450-07	1.319-07
B	1.098-05	9.959-06	4.849-06	1.651-06	3.236-07	1.750-07
C	1.014-05	1.039-05	7.664-06	3.666-06	9.5[illegible]-07	2.954-07
D	1.002-05	9.466-06	8.393-06	6.119-06	2.828-06	1.326-06
E	1.020-05	9.796-06	8.772-06	7.001-06	4.048-06	2.255-06
F	1.029-05	1.007-05	9.262-06	7.670-06	4.916-06	3.008-06
G	1.035-05	1.027-05	9.773-06	8.543-06	5.869-06	3.839-06

TABLE 9.2-1 (Cont'd)

Ar-41

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.273-05	5.898-06	1.141-06	6.398-07	2.885-07	1.552-07
B	4.131-05	1.760-05	6.411-06	2.007-06	3.812-07	2.060-07
C	6.090-05	2.922-05	1.253-05	4.879-06	1.156-06	3.491-07
D	9.673-05	5.063-05	2.520-05	1.201-05	4.170-06	1.762-06
E	1.366-04	7.494-05	3.879-05	1.967-05	7.618-06	3.596-06
F	2.01[illegible]-04	1.138-04	6.090-05	3.249-05	1.350-05	6.788-06
G	2.997-04	1.755-04	9.810-05	5.427-05	2.360-05	1.212-05

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.425-05	5.573-06	1.136-06	6.373-07	2.874-07	1.546-07
B	1.300-05	1.177-05	5.731-06	1.949-06	3.798-07	2.051-07
C	1.204-05	1.230-05	9.052-06	4.341-06	1.126-06	3.467-07
D	1.193-05	1.126-05	9.966-06	7.244-06	3.345-06	1.567-06
E	1.213-05	1.165-05	1.044-05	8.390-06	4.798-06	2.666-06
F	1.224-05	1.198-05	1.103-05	9.146-06	5.851-06	3.642-06
G	1.232 05	1.222-05	1.164 05	1.020 05	7.016-06	4.580-06

TABLE 9.2-1 (Cont'd)

0.8 MeV

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.608-05	3.998-06	7.336-07	4.076-07	1.818-07	9.756-08
B	2.943-05	1.235-05	4.349-06	1.309-06	2.408-07	1.296-07
C	4.341-05	2.072-05	8.772-06	3.302-06	7.449-07	2.206-07
D	6.871-05	3.607-05	1.782-05	8.374-06	2.837-06	1.173-06
E	9.656-05	5.333-05	2.758-05	1.384-05	5.301-06	2.457-06
F	1.416-04	8.065-05	4.337-05	2.305-05	9.509-06	4.741-06
G	2.087-04	1.234-04	6.963-05	3.862-05	1.667-05	8.621-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	9.964-06	3.765-06	7.305-07	4.061-07	1.812-07	9.723-08
B	9.048-06	8.142-06	3.869-06	1.270-06	2.399-07	1.291-07
C	8.352-06	8.511-06	6.198-06	2.920-06	7.250-07	2.191-07
D	8.264-06	7.756-06	6.824-06	4.921-06	2.243-06	1.035-06
E	8.413-06	8.036-06	7.157-06	5.701-06	3.234-06	1.783-06
F	8.493-06	8.276-06	7.585-06	6.224-06	3.918-06	2.425-06
G	8.547-06	8.451-06	8.021-06	6.974-06	4.706-06	3.026-06

TABLE 9.2-2

FINITE CLOUD GAMMA TISSUE DOSE KERNEL

MEANDERING PLUME MODEL

Kr-83m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS)					
	400.	800.	1609.	3218.	8045.	16090.
A	8.185-08	1.276-08	1.966-09	1.027-09	4.328-10	2.244-10
B	1.834-07	5.027-08	1.242-08	3.030-09	4.931-10	2.520-10
C	2.762-07	9.138-08	2.630-08	7.260-09	1.290-09	3.462-10
D	3.955-07	1.503-07	5.366-08	1.857-08	4.489-09	1.534-09
E	5.507-07	1.779-07	6.940-08	2.616-08	7.186-09	2.731-09
F	9.762-07	2.617-07	8.624-08	3.580-08	1.098-08	4.496-09
G	1.399-06	4.255-07	1.298-07	4.521-08	1.526-08	6.588-09

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS)					
	400.	800.	1609.	3218.	8045.	16090.
A	4.210-08	1.214-08	1.958-09	1.022-09	4.310-10	2.234-10
B	1.057-08	2.663-08	1.083-08	2.941-09	4.911-10	2.508-10
C	1.360-10	1.368-08	1.546-08	6.249-09	1.254-09	3.437-10
D	5.780-11	8.044-11	4.648-09	6.766-09	3.193-09	1.313-09
E	5.228-11	3.926-11	4.249-10	2.623-09	2.802-09	1.627-09
F	4.922-11	3.163-11	2.106-11	1.306-10	8.106-10	9.258-10
G	4.820-11	2.911-11	1.586-11	9.434-12	6.733-12	8.527-11

TABLE 9.2-2 (Cont'd)

Kr-85m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.663-06	7.804-07	1.275-07	6.744-08	2.858-08	1.483-08
B	6.256-06	2.450-06	7.454-07	1.957-07	3.256-08	1.665-08
C	8.066-06	3.729-06	1.386-06	4.412-07	8.389-08	2.283-08
D	9.878-06	5.066-06	2.234-06	9.092-07	2.554-07	9.347-08
E	1.130-05	5.559-06	2.560-06	1.113-06	3.562-07	1.477-07
F	1.354-05	6.467-06	2.822-06	1.301-06	4.566-07	2.044-07
G	1.577-05	7.541-06	3.287-06	1.438-06	5.354-07	2.502-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.241-06	7.394-07	1.269-07	6.713-08	2.844-08	1.476-08
B	1.899-06	1.576-06	6.603-07	1.901-07	3.240-08	1.657-08
C	1.672-06	1.489-06	9.516-07	3.874-07	8.161-08	2.265-08
D	1.583-06	1.204-06	8.244-07	5.027-07	1.968-07	8.175-08
E	1.584-06	1.163-06	7.158-07	4.283-07	2.026-07	1.026-07
F	1.584-06	1.140-06	6.583-07	3.563-07	1.661-07	9.331-08
G	1.588-06	1.132-06	6.350-07	3.269-07	1.383-07	7.433-08

TABLE 9.2-2 (Cont'd)

Kr-85

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.309-08	1.019-08	1.749-09	9.313-10	3.964-10	2.058-10
B	7.144-08	2.960-08	9.690-09	2.666-09	4.516-10	2.311-10
C	9.119-08	4.382-08	1.716-08	5.802-09	1.150-09	3.163-10
D	1.110-07	5.854-08	2.670-08	1.118-08	3.270-09	1.233-09
E	1.271-07	6.403-08	3.037-08	1.340-08	4.399-09	1.862-09
F	1.525-07	7.418-08	3.331-08	1.539-08	5.481-09	2.484-09
G	1.781-07	8.658-08	3.846-08	1.684-08	6.314-09	2.972-09

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.746-08	9.646-09	1.742-09	9.273-10	3.945-10	2.048-10
B	2.432-08	1.989-08	8.657-09	2.591-09	4.494-10	2.300-10
C	2.214-08	1.942-08	1.228-08	5.142-09	1.120-09	3.139-10
D	2.136-08	1.670-08	1.138-08	6.712-09	2.590-09	1.090-09
E	2.145-08	1.644-08	1.038-08	6.012-09	2.705-09	1.352-09
F	2.152-08	1.631-08	9.866-09	5.302-09	2.354-09	1.278-09
G	2.160-08	1.628-08	9.665-09	5.022-09	2.079-09	1.090-09

TABLE 9.2-2 (Cont'd)

Kr-87

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.215-05	3.144-06	5.931-07	3.189-07	1.377-07	7.171-08
B	1.989-05	8.546-06	2.983-06	8.821-07	1.569-07	8.051-08
C	2.530-05	1.242-05	5.094-06	1.811-06	3.868-07	1.096-07
D	3.074-05	1.644-05	7.721-06	3.317-06	1.002-06	3.893-07
E	3.525-05	1.795-05	8.737-06	3.924-06	1.305-06	5.627-07
F	4.236-05	2.078-05	9.554-06	4.469-06	1.588-06	7.274-07
G	4.960-05	2.426-05	1.099-05	4.867-06	1.800-06	8.530-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	7.911-06	2.984-06	5.904-07	3.175-07	1.371-07	7.136-08
B	7.082-06	5.897-06	2.688-06	8.585-07	1.561-07	8.012-08
C	6.497-06	5.794-06	3.754-06	1.625-06	3.772-07	1.088-07
D	6.285-06	5.062-06	3.548-06	2.110-06	8.163-07	3.488-07
E	6.314-06	5.008-06	3.295-06	1.939-06	8.554-07	4.252-07
F	6.337-06	4.982-06	3.168-06	1.757-06	7.692-07	4.098-07
G	6.362-06	4.980-06	3.121-06	1.686-06	6.987-07	3.625-07

TABLE 9.2-2 (Cont'd)

Kr-88

Kernel Units Are (mrad/hr)(m/sec)(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.753-05	7.440-06	1.449-06	7.821-07	3.391-07	1.766-07
B	4.481-05	1.961-05	7.044-06	2.141-06	3.861-07	1.983-07
C	5.690-05	2.824-05	1.183-05	4.300-06	9.437-07	2.696-07
D	6.912-05	3.720-05	1.772-05	7.695-06	2.361-06	9.282-07
E	7.940-05	4.060-05	2.001-05	9.049-06	3.032-06	1.318-06
F	9.571-05	4.700-05	2.185-05	1.026-05	3.647-06	1.679-06
G	1.125-04	5.500-05	2.509-05	1.115-05	4.107-06	1.952-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.814-05	7.066-06	1.442-06	7.787-07	3.375-07	1.758-07
B	1.633-05	1.371-05	6.374-06	2.085-06	3.843-07	1.974-07
C	1.504-05	1.351-05	8.841-06	3.876-06	9.209-07	2.675-07
D	1.458-05	1.191-05	8.441-06	5.027-06	1.945-06	8.359-07
E	1.465-05	1.181-05	7.904-06	4.673-06	2.042-06	1.013-06
F	1.471-05	1.177-05	7.644-06	4.282-06	1.861-06	9.839-07
G	1.477-05	1.177-05	7.551-06	4.132-06	1.709-06	8.830-07

TABLE 9.2-2 (Cont'd)

Kr-89

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.621-05	6.844-06	1.296-06	6.973-07	3.013-07	1.569-07
B	4.285-05	1.849-05	6.486-06	1.926-06	3.432-07	1.761-07
C	5.446-05	2.682-05	1.104-05	3.945-06	8.451-07	2.397-07
D	6.614-05	3.545-05	1.670-05	7.187-06	2.178-06	8.479-07
E	7.587-05	3.871-05	1.889-05	8.488-06	2.830-06	1.222-06
F	9.121-05	4.480-05	2.065-05	9.655-06	3.434-06	1.575-06
G	1.068-04	5.233-05	2.374-05	1.050-05	3.889-06	1.844-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.712-05	6.495-06	1.290-06	6.943-07	2.999-07	1.561-07
B	1.535-05	1.280-05	5.850-06	1.875-06	3.415-07	1.753-07
C	1.411-05	1.259-05	8.162-06	3.541-06	8.243-07	2.379-07
D	1.366-05	1.103-05	7.738-06	4.597-06	1.778-06	7.603-07
E	1.372-05	1.092-05	7.202-06	4.237-06	1.864-06	9.261-07
F	1.377-05	1.087-05	6.936-06	3.849-06	1.681-06	8.942-07
G	1.383-05	1.087-05	6.839-06	3.698-06	1.531-06	7.937-07

TABLE 9.2-2 (Cont'd)

Kr-90

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.596-05	9.220-06	1.717-06	9.224-07	3.975-07	2.068-07
B	5.904-05	2.524-05	8.737-06	2.5[illegible]4-06	4.526-07	2.322-07
C	7.515-05	3.677-05	1.499-05	5.297-06	1.122-06	3.164-07
D	9.136-05	4.874-05	2.281-05	9.756-06	2.937-06	1.137-06
E	1.048-04	5.325-05	2.584-05	1.156-05	3.842-06	1.652-06
F	1.260-04	6.166-05	2.827-05	1.318-05	4.688-06	2.145-06
G	1.475-04	7.205-05	3.254-05	1.436-05	5.329-06	2.522-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.336-05	8.747-06	1.709-06	9.183-07	3.956-07	2.058-07
B	2.084-05	1.736-05	7.868-06	2.495-06	4.505-07	2.311-07
C	1.908-05	1.702-05	1.101-05	4.746-06	1.094-06	3.139-07
D	1.845-05	1.483-05	1.038-05	6.165-06	2.385-06	1.017-06
E	1.853-05	1.465-05	9.611-06	5.650-06	2.498-06	1.243-06
F	1.859-05	1.457-05	9.230-06	5.102-06	2.236-06	1.194-06
G	1.867-05	1.456-05	9.038-06	4.889-06	2.024-06	1.051-06

TABLE 9.2-2 (Cont'd)

Xe-131m

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	5.987-07	1.028-07	1.607-08	8.426-09	3.558-09	1.845-09
B	1.193-06	3.769-07	9.946-08	2.476-08	4.054-09	2.072-09
C	1.662-06	6.382-07	2.019-07	5.831-08	1.056-08	2.845-09
D	2.200-06	9.527-07	3.740-07	1.383-07	3.529-08	1.232-08
E	2.702-06	1.079-06	4.544-07	1.836-07	5.378-08	2.111-08
F	3.547-06	1.377-06	5.291-07	2.323-07	7.627-08	3.249-08
G	4.454-06	1.786-06	6.851-07	2.730-07	9.724-08	4.374-08

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.259-07	9.764-08	1.601-08	8.388-09	3.541-09	1.836-09
B	1.737-07	2.145-07	8.709-08	2.402-08	4.034-09	2.061-09
C	9.738-08	1.544-07	1.255-07	5.047-08	1.027-08	2.822-09
D	7.551-08	6.365-08	6.997-08	5.984-08	2.577-08	1.062-08
E	7.247-08	5.216-08	3.944-08	3.702-08	2.443-08	1.328-08
F	7.054-08	4.733-08	2.830-08	1.861-08	1.337-08	9.664-09
G	6.993-08	4.547-08	2.4[illegible]-08	1.353-08	6.619-09	4.415-09

TABLE 9.2-2 (Cont'd)

Xe-133m

Kernel Units Are (mrad/hr)(m/sec)(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.081-06	2.077-07	3.334-08	1.757-08	7.435-09	3.857-09
B	2.015-06	7.008-07	1.996-07	5.123-08	8.470-09	4.331-09
C	2.722-06	1.130-06	3.864-07	1.176-07	2.192-08	5.942-09
D	3.500-06	1.620-06	6.690-07	2.591-07	6.947-08	2.490-08
E	4.194-06	1.811-06	7.925-07	3.311-07	1.011-07	4.081-08
F	5.342-06	2.230-06	9.021-07	4.043-07	1.367-07	5.958-08
G	6.550-06	2.785-06	1.120-06	4.631-07	1.680-07	7.682-08

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	6.234-07	1.970-07	3.320-08	1.749-08	7.399-09	3.838-09
B	4.269-07	4.246-07	1.758-07	4.974-08	8.429-09	4.309-09
C	3.214-07	3.541-07	2.530-07	1.027-07	2.132-08	5.895-09
D	2.886-07	2.268-07	1.817-07	1.276-07	5.224-08	2.164-08
E	2.859-07	2.106-07	1.375-07	9.525-08	5.175-08	2.708-08
F	2.842-07	2.032-07	1.192-07	6.762-08	3.599-08	2.229-08
G	2.841-07	2.005-07	1.130-07	5.889-08	2.568-08	1.461-08

TABLE 9.2-2 (Cont'd)

Xe-133

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.244-06	2.319-07	3.668-08	1.929-08	8.152-09	4.228-09
B	2.309-06	8.023-07	2.231-07	5.647-08	9.287-09	4.748-09
C	3.102-06	1.294-06	4.386-07	1.312-07	2.412-08	6.516-09
D	3.952-06	1.847-06	7.633-07	2.943-07	7.809-08	2.773-08
E	4.675-06	2.059-06	9.015-07	3.765-07	1.148-07	4.611-08
F	5.842-06	2.504-06	1.021-06	4.591-07	1.555-07	6.777-08
G	7.019-06	3.065-06	1.254-06	5.238-07	1.906-07	8.731-08

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	7.099-07	2.200-07	3.654-08	1.920-08	8.113-09	4.208-09
B	4.924-07	4.808-07	1.962-07	5.481-08	9.242-09	4.725-09
C	3.697-07	4.007-07	2.838-07	1.141-07	2.345-08	6.465-09
D	3.266-07	2.521-07	2.012-07	1.419-07	5.819-08	2.401-08
E	3.221-07	2.294-07	1.483-07	1.047-07	5.755-08	3.020-08
F	3.190-07	2.183-07	1.245-07	7.202-08	3.945-08	2.466-08
G	3.185-07	2.139-07	1.158-07	6.066-08	2.711-08	1.573-08

TABLE 9.2-2 (Cont'd)

Xe-135m

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	8.424-06	1.988-06	3.415-07	1.818-07	7.740-08	4.019-08
B	1.401-05	5.783-06	1.890-06	5.204-07	8.818-08	4.512-08
C	1.792-05	8.575-06	3.351-06	1.132-06	2.244-07	6.177-08
D	2.185-05	1.148-05	5.225-06	2.185-06	6.382-07	2.407-07
E	2.507-05	1.256-05	5.949-06	2.621-06	8.595-07	3.636-07
F	3.016-05	1.459-05	6.532-06	3.015-06	1.072-06	4.857-07
G	3.530-05	1.707-05	7.560-06	3.302-06	1.237-06	5.819-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	5.360-06	1.882-06	3.400-07	1.810-07	7.703-08	3.999-08
B	4.720-06	3.879-06	1.689-06	5.058-07	8.775-08	4.490-08
C	4.284-06	3.776-06	2.396-06	1.003-06	2.186-07	6.128-08
D	4.129-06	3.232-06	2.210-06	1.308-06	5.053-07	2.127-07
E	4.146-06	3.181-06	2.012-06	1.169-06	5.274-07	2.637-07
F	4.158-06	3.155-06	1.911-06	1.028-06	4.574-07	2.487-07
G	4.174-06	3.148-06	1.872-06	9.735-07	4.032-07	2.116-07

TABLE 9.2-2 (Cont'd)

Xe-135

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	5.423-06	1.197-06	1.983-07	1.051-07	4.458-08	2.313-08
B	9.150-06	3.656-06	1.142-06	3.038-07	5.079-08	2.598-08
C	1.175-05	5.514-06	2.090-06	6.778-07	1.305-07	3.560-08
D	1.435-05	7.439-06	3.316-06	1.366-06	3.890-07	1.437-07
E	1.640-05	8.151-06	3.789-06	1.659-06	5.357-07	2.237-07
F	1.962-05	9.457-06	4.168-06	1.926-06	6.796-07	3.056-07
G	2.281-05	1.100-05	4.835-06	2.121-06	7.917-07	3.709-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.368-06	1.134-06	1.974-07	1.046-07	4.437-08	2.302-08
B	2.913-06	2.389-06	1.014-06	2.951-07	5.054-08	2.585-08
C	2.603-06	2.294-06	1.455-06	5.969-07	1.269-07	3.533-08
D	2.485-06	1.906-06	1.295-06	7.775-07	3.024-07	1.261-07
E	2.491-06	1.856-06	1.148-06	6.758-07	3.133-07	1.578-07
F	2.495-06	1.829-06	1.071-06	5.759-07	2.631-07	1.457-07
G	2.502-06	1.820-06	1.040-06	5.355-07	2.244-07	1.194-07

TABLE 9.2-2 (Cont'd)

Xe-137

Kernel Units Are (mrad/hr)(m/sec)(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	3.689-06	8.835-07	1.544-07	8.235-08	3.516-08	1.826-08
B	6.111-06	2.542-06	8.399-07	2.342-07	4.005-08	2.051-08
C	7.800-06	3.756-06	1.481-06	5.040-07	1.013-07	2.804-08
D	9.494-06	5.013-06	2.295-06	9.647-07	2.834-07	1.074-07
E	1.088-05	5.482-06	2.609-06	1.154-06	3.795-07	1.610-07
F	1.305-05	6.351-06	2.860-06	1.325-06	4.712-07	2.139-07
G	1.524-05	7.411-06	3.302-06	1.449-06	5.417-07	2.552-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.356-06	8.370-07	1.537-07	8.199-08	3.499-08	1.818-08
B	2.086-06	1.713-06	7.513-07	2.276-07	3.985-08	2.041-08
C	1.899-06	1.673-06	1.064-06	4.476-07	9.868-08	2.782-08
D	1.831-06	1.438-06	9.862-07	5.835-07	2.254-07	9.512-08
E	1.839-06	1.417-06	9.011-07	5.244-07	2.355-07	1.176-07
F	1.845-06	1.405-06	8.573-07	4.641-07	2.058-07	1.114-07
G	1.852-06	1.403-06	8.403-07	4.402-07	1.824-07	9.554-08

TABLE 9.2-2 (Cont'd)

Xe-138

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.708-05	4.434-06	8.332-07	4.483-07	1.933-07	1.006-07
B	2.800-05	1.203-05	4.200-06	1.243-06	2.201-07	1.129-07
C	3.563-05	1.748-05	7.175-06	2.547-06	5.444-07	1.538-07
D	4.334-05	2.314-05	1.087-05	4.664-06	1.411-06	5.479-07
E	4.972-05	2.528-05	1.230-05	5.520-06	1.838-06	7.922-07
F	5.984-05	2.927-05	1.345-05	6.289-06	2.235-06	1.024-06
G	7.018-05	3.420-05	1.548-05	6.851-06	2.536-06	1.201-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.113-05	4.203-06	8.294-07	4.463-07	1.924-07	1.001-07
B	9.951-06	8.303-06	3.786-06	1.209-06	2.191-07	1.124-07
C	9.124-06	8.151-06	5.289-06	2.286-06	5.309-07	1.527-07
D	8.823-06	7.117-06	4.996-06	2.970-06	1.149-06	4.909-07
E	8.864-06	7.040-06	4.640-06	2.732-06	1.204-06	5.986-07
F	8.895-06	7.004-06	4.462-06	2.475-06	1.082-06	5.767-07
G	8.929-06	7.000-06	4.397-06	2.376-06	9.825-07	5.099-07

TABLE 9.2-2 (Cont'd)

Ar-41

Kernel Units Are (mrad/hr)(m/sec)/(µCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.008-05	5.251-06	9.794-07	5.266-07	2.267-07	1.179-07
B	3.278-05	1.417-05	4.961-06	1.465-06	2.581-07	1.324-07
C	4.166-05	2.053-05	8.453-06	3.011-06	6.406-07	1.805-07
D	5.061-05	2.713-05	1.278-05	5.488-06	1.664-06	6.468-07
E	5.810-05	2.963-05	1.446-05	6.476-06	2.165-06	9.340-07
F	6.993-05	3.430-05	1.581-05	7.361-06	2.629-06	1.205-06
G	8.201-05	4.012-05	1.818-05	8.005-06	2.980-06	1.412-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.314-05	4.982-06	9.750-07	5.243-07	2.256-07	1.173-07
B	1.180-05	9.820-06	4.473-06	1.426-06	2.569-07	1.317-07
C	1.085-05	9.673-06	6.253-06	2.702-06	6.247-07	1.791-07
D	1.052-05	8.496-06	5.947-06	3.515-06	1.357-06	5.793-07
E	1.057-05	8.420-06	5.544-06	3.243-06	1.424-06	7.071-07
F	1.061-05	8.386-06	5.346-06	2.950-06	1.284-06	6.829-07
G	1.066-05	8.386-06	5.274-06	2.837-06	1.169-06	6.059-07

TABLE 9.2-2 (Cont'd)

0.8 MeV

Kernel Units Are (mrad/hr)(m/sec)/(μCi/sec)

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	1.418-05	3.529-06	6.249-07	3.340-07	1.427-07	7.413-08
B	2.331-05	9.872-06	3.333-06	9.467-07	1.625-07	8.323-08
C	2.967-05	1.445-05	5.797-06	2.010-06	4.101-07	1.138-07
D	3.604-05	1.920-05	8.901-06	3.765-06	1.121-06	4.288-07
E	4.135-05	2.098-05	1.010-05	4.470-06	1.485-06	6.342-07
F	4.967-05	2.431-05	1.106-05	5.101-06	1.828-06	8.328-07
G	5.806-05	2.842-05	1.275-05	5.557-06	2.091-06	9.869-07

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	9.169-06	3.344-06	6.222-07	3.325-07	1.420-07	7.377-08
B	8.182-06	6.742-06	2.990-06	9.206-07	1.617-07	8.283-08
C	7.494-06	6.620-06	4.221-06	1.792-06	3.996-07	1.129-07
D	7.253-06	5.764-06	3.974-06	2.336-06	9.005-07	3.812-07
E	7.287-06	5.700-06	3.671-06	2.126-06	9.436-07	4.698-07
F	7.314-06	5.669-06	3.519-06	1.908-06	8.360-07	4.491-07
G	7.344-06	5.664-06	3.462-06	1.823-06	7.509-07	3.911-07

TABLE 9.2-3

POPULATION DISTRIBUTION

DRESDEN STATION*

SECTOR	RANGE, METERS				
	400-800	800-1,609	1,609-3,218	3,218-8,045	8,045-16,090
N	0	0	3	789	303
NNE	0	0	3	186	2,763
NE	0	0	9	1,979	1,929
ENE	0	6	6	0	743
E	0	12	0	12	1,196
ESE	0	15	33	15	573
SE	0	15	279	810	4,655
SSE	0	96	6	63	320
S	0	0	6	18	3,750
SSW	0	0	6	207	1,313
SW	0	0	0	48	288
WSW	0	0	0	27	68
W	0	0	3	33	8,118
WNW	0	0	0	48	657
NW	0	0	6	303	407
NNW	0	3	6	39	301

* Environmental Report, Supplement 1, Appendix A.

TABLE 9.2-3 (Cont'd)

LASALLE COUNTY STATION*

SECTOR	RANGE, METERS				
	400-800	800-1,609	1,609-3,218	3,218-8,045	8,045-16,090
N	0	0	3	7	2,014
NNE	0	0	0	63	1,078
NE	0	0	0	370	1,119
ENE	0	0	0	25	260
E	0	0	3	44	560
ESE	0	0	0	41	350
SE	0	0	3	36	275
SSE	0	0	0	49	526
S	0	0	0	39	512
SSW	0	3	9	49	475
SW	0	0	3	25	1,299
WSW	0	3	18	31	269
W	0	0	15	39	753
WNW	0	0	13	32	965
NW	0	0	0	110	1,703
NNW	0	0	6	48	3,339

* Environmental Report, OL Stage, Figures 2.1-6 and 2.1-7.

TABLE 9.2-3 (Cont'd)

QUAD-CITIES STATION*

SECTOR	RANGE, METERS				
	400-800	800-1,609	1,609-3,218	3,218-8,045	8,045-16,090
N	0	14	45	315	641
NNE	0	2	25	2,050	7,799
NE	0	2	15	315	217
ENE	0	2	5	215	582
E	0	0	0	22	412
ESE	0	0	0	23	610
SE	0	10	10	95	420
SSE	0	25	25	570	629
S	0	0	10	350	2,867
SSW	0	0	5	845	3,170
SW	0	0	0	195	425
WSW	0	0	0	120	315
W	0	0	0	240	610
WNW	0	0	0	165	847
NW	0	0	0	65	630
NNW	0	0	0	65	710

* Figure 3, Environmental Report, Supplement 3; 1976 data.

TABLE 9.2-3 (Cont'd)

ZION STATION*

SECTOR	RANGE, METERS				
	400-800	800-1,609	1,609-3,218	3,218-8,045	8,045-16,090
N	0	99	353	1,954	19,934
NNE	0	0	0	0	0
NE	0	0	0	0	0
ENE	0	0	0	0	0
E	0	0	0	0	0
ESE	0	0	0	0	0
SE	0	0	0	0	0
SSE	0	0	0	0	0
S	0	0	0	1,320	70,146
SSW	0	0	999	10,995	77,242
SW	0	0	1,264	12,514	18,768
WSW	0	204	847	9,956	2,643
W	0	440	1,349	10,069	874
WNW	0	302	2,571	6,310	521
NW	0	64	1,635	7,918	1,415
NNW	0	82	452	4,841	33,749

* 1975 Estimate Based on Question Q2.4, Amendment 14 to the FSAR, August 14, 1971.

TABLE 9.2-4

RELATIVE EFFLUENT CONCENTRATION, STRAIGHT-LINE GAUSSIAN PLUME MODEL

$(u\chi/Q)$, $1/m^2$

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE (METERS) 400.	800.	1609.	3218.	8045.	16090.
A	4.970-05	7.794-06	1.104-06	5.910-07	2.585-07	1.382-07
B	1.062-04	3.068-05	6.305-06	8.970-07	3.437-07	1.838-07
C	1.990-04	6.735-05	1.984-05	6.010-06	1.255-06	4.066-07
D	3.607-04	1.552-04	5.739-05	2.075-05	5.406-06	1.969-06
E	5.164-04	2.632-04	1.084-04	4.241-05	1.241-05	4.994-06
F	9.523-04	4.246-04	2.018-04	8.758-05	2.835-05	1.219-05
G	2.625-03	8.238-04	3.879-04	1.945-04	6.974-05	3.127-05

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE (METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.116-05	7.322-06	1.101-06	5.885-07	2.572-07	1.376-07
B	8.207-06	1.729-05	5.781-06	6.922-07	3.421-07	1.829-07
C	2.097-07	9.773-06	1.396-05	5.103-06	1.210-06	4.011-07
D	4.313-13	1.621-07	4.670-06	7.462-06	3.809-06	1.678-06
E	1.082-21	1.353-10	4.944-07	3.904-06	5.149-06	2.925-06
F	0.000	1.676-19	6.203-10	2.357-07	1.933-06	2.410-06
G	0.000	0.000	1.150-19	1.193-11	3.820-08	3.342-07

TABLE 9.2-5

RELATIVE EFFLUENT CONCENTRATION, MEANDERING PLUME MODEL

$(u\chi/Q)$, $1/m^2$

RELEASE HEIGHT = 0. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	6.647-05	9.587-06	1.263-06	6.313-07	2.525-07	1.263-07
B	1.087-04	2.853-05	5.433-06	7.209-07	2.525-07	1.263-07
C	1.589-04	4.796-05	1.302-05	3.671-06	7.006-07	2.121-07
D	2.156-04	7.940-05	2.666-05	8.941-06	2.125-06	7.236-07
E	2.675-04	9.932-05	3.620-05	1.304-05	3.472-06	1.305-06
F	4.254-04	1.248-04	4.768-05	1.871-05	5.481-06	2.199-06
G	7.033-04	2.064-04	6.228-05	2.552-05	8.126-06	3.389-06

RELEASE HEIGHT = 100. (METERS)

STABILITY CLASS	DOWNWIND DISTANCE(METERS) 400.	800.	1609.	3218.	8045.	16090.
A	2.756-05	8.946-06	1.257-06	6.283-07	2.513-07	1.257-07
B	8.065-06	1.609-05	4.964-06	7.164-07	2.513-07	1.257-07
C	1.565-07	6.819-06	9.251-06	3.111-06	6.749-07	2.092-07
D	2.266-13	7.967-08	2.144-06	3.236-06	1.496-06	6.162-07
E	4.042-22	4.726-11	1.614-07	1.192-06	1.471-06	7.640-07
F	0.000	4.042-20	1.398-10	4.966-08	3.727-07	4.402-07
G	0.000	0.000	1.555-20	1.507-12	4.417-09	2.723-08

TABLE 9.2-6

SPLIT SIGMA CORRECTION FACTORS, $C(\sigma_\theta, \Delta T)$

STABILITY CLASS DETERMINED BY DIFFERENTIAL TEMPERATURE, ΔT*	STABILITY CLASS DETERMINED BY HORIZONTAL VARIATION, σ_θ*						
	A	B	C	D	E	F	G
A	1.0	1.330	1.751	2.487	3.497	5.067	7.605
B	0.752	1.0	1.317	1.870	2.630	3.810	5.719
C	0.571	0.759	1.0	1.420	1.997	2.893	4.343
D	0.402	0.535	0.704	1.0	1.406	2.037	3.058
E	0.286	0.380	0.501	0.711	1.0	1.449	2.175
F	0.197	0.263	0.346	0.491	0.690	1.0	1.501
G	0.132	0.175	0.230	0.327	0.460	0.666	1.0

* See Table 7.1-5.

9.3 RADIOIODINES, "PARTICULATES", AND OTHER (NONNOBLE GAS) RADIONUCLIDES

9.3.1 Inhalation Dose

The method of calculating the dose rate to internal organs due to inhalation of airborne radioactive material is described in Subsection 2.1.2 of this manual. Presently, only ground level or elevated releases will be considered. Following Equation 2.18, then, the present case may be written as follows:

$$D'_{ja} = \frac{10^6}{8760} R_a \sum_i DFA_{ija} \left[\left(X/Q \right)_s Q'_{is} + \left(X/Q \right)_g Q'_{ig} \right] \qquad (9.27)$$

D'_{ja} Dose Rate (mrem/hr)
The dose rate to organ j, age group a.

10^6 Conversion Constant (pCi/μCi)
Converts μCi to pCi.

R_a Inhalation Rate (m^3/yr)
The inhalation rate for individuals of age group a.

DFA_{ija} Inhalation Dose Factor (mrem/pCi)
The inhalation dose commitment factor for radionuclide i, organ j, and age group a. See Table 7.1-1.

Combining Equation 9.27 with Equations 9.10, 9.11, 9.20, and 9.21 (and 9.22, if applicable) results in the final equation as follows:

$$D'_{ja} = \frac{10^6}{8760} R_a \sum_i DFA_{ija} \left[\frac{1}{u_s} \left(uX/Q \right)_s Q_{is} \exp(-\lambda_i R/3600 u_s) + \frac{1}{u_g} \left(uX/Q \right)_g Q_{ig} \exp(-\lambda_i R/3600 u_g) \right] \qquad (9.28)$$

If one has an estimate of the release rate Q, then, using Equation 9.28, the information from the meteorological tower, and the data of Tables 7.1-1 and 9.2-4 or 9.2-5 (as appropriate), one can quickly estimate downwind inhalation dose rates.

(NOTE...The "dose rate" determined by Equation 9.28 is not an instantaneous dose rate but the dose commitment (mrem) received per hour of exposure. The actual dose delivered to the organ of interest is delivered over a period of time which is dependent on metabolism, radiodecay half-life, and biological half-life.)

An offsite dose (dose commitment) may be estimated from the following:

$$D_{ja} = \frac{10^6}{8760 \times 3600} R_a \sum_i DFA_{ija} \left[\frac{1}{u_s} \left(u\chi/Q \right)_s A_{is} \exp(-\lambda_i R/3600 u_s) + \frac{1}{u_g} \left(u\chi/Q \right)_g A_{ig} \exp(-\lambda_i R/3600 u_g) \right] \quad (9.29)$$

D_{ja} — Inhalation Dose (mrem)
The time integrated dose to organ j, age group a, caused by inhalation of airborne radionuclides.

A_{is} — Accumulative Release, Stack (μCi)
The accumulative release from the stack of nuclide i over the time period of interest.

A_{ig} — Accumulative Release, Ground Level (μCi)
The accumulative release, at ground level, of nuclide i over the time period of interest.

9.3.2 Symbols Used in Section 9.3

SYMBOL	NAME	UNIT
D'_{ja}	Dose Rate	(mrem/hr)
R_a	Inhalation Rate	(m^3/yr)
DFA_{ija}	Inhalation Dose Factor	(mrem/pCi)
$(\chi/Q)_s$	Relative Effluent Concentration, Stack Release	(sec/m^3)
$(\chi/Q)_g$	Relative Effluent Concentration, Ground Level	(sec/m^3)
Q'_{is}	Release Rate From Stack, Adjusted For Radiodecay	(μCi/sec)
Q'_{ig}	Release Rate at Ground Level, Adjusted for Radiodecay	(μCi/sec)
u	Wind Speed	(m/sec)
u_s	Wind Speed, Stack Elevation	(m/sec)
$(u\chi/Q)_s$	Dispersion Factor, Stack Release	(1/m^2)
Q_{is}	Release Rate from Stack	(μCi/sec)
R	Downwind Distance	(m)
u_g	Wind Speed, Ground Level	(m/sec)
$(u\chi/Q)_g$	Dispersion Factor, Ground Release	(1/m^2)
Q_{ig}	Release Rate at Ground Level	(μCi/sec)
λ_i	Radiodecay Constant	(1/hr)
D_{ja}	Inhalation Dose	(mrem)
A_{is}	Accumulative Release, Stack	(μCi)
A_{ig}	Accumulative Release, Ground Level	(μCi)

9.3.3 Constants Used in Section 9.3

NUMERICAL VALUE	NAME	UNIT
10^6	Conversion Constant	(pCi/μCi)
8760	Conversion Constant	(hr/yr)
3600	Conversion Constant	(sec/hr)

9.4 LAKE BREEZE EFFECTS (ZION STATION ONLY)

Currently recommended meteorological programs and diffusion methods for nuclear power plants located in coastal zones were recently reviewed for the U.S. Nuclear Regulatory Commission (Reference 6.20, NUREG-0936). Among certain deficiencies in guidelines and procedures noted in this document were "failure to consider the role of coastal internal boundary layers, specifications for tower locations and instrument heights, (and) methods for classifying atmospheric stability...." Included were recommendations for changes to the guidelines.

An atmospheric dispersion model has been developed to account for boundary layer conditions that could occur at the Zion plant. The model development essentially followed the various methods itemized in the reference cited. Conservatively high ground level concentrations result from the model when compared to standard dispersion calculations.

9.4.1 The Boundary Layer

Continuous measurements of the boundary layer in the vicinity of the Zion Plant are not available. Indeed, aside from a few intensive short-term studies of lake shore dispersion in the vicinity, no boundary layer data exist. Consequently, readily available meteorological measurements representing a 2-year period were used in conjunction with the boundary Equation (1), found in NUREG-0936, to infer the existence and location of the boundary.

The equation was evaluated subject to the following assumptions and conditions:

a. friction velocity $u^* = 1$ mps;
b. wind speed of at least 6 mps;
c. land-water temperature contrast at least 5° F;

d. air mass stability was estimated by the 250- to 125-foot differential temperature measured on the Zion tower; and
e. wind direction was onshore.

The results are shown in Figure 9.4-1. In summary, the boundary was computed to occur roughly 10% of the hours annually (876/8760). Of those hours it occurred well above the release point 95% of the time (832 hours). The remaining 10% of the time (44 hours) it was below the release point leading to potential fumigation downwind (cf. Table 9.4-1).

It should be noted that the existing meteorological tower is located entirely within the calculated boundary. For all practical cases, then, the measurements from the tower can be assumed to represent the boundary layer conditions and not be partway in the boundary layer and partway in the "lake" air (a caution referred to in NUREG-0936).

9.4.2 Dispersion Model

9.4.2.1 Dispersion Conditions

When a boundary height, variable both in time and inland fetch, is taken into account, four downwind zones with different dispersion characteristics emerge. The dispersion equations differ for the four cases summarized below (cf. Figure 9.4-2):

Case 1. The boundary layer is located above the release point. Consequently, vertical dispersion is limited by the boundary and the ground at all ranges downwind to 10 miles (the downwind extent of the model evaluation). Boundary layer dispersion is characterized by meteorological tower measurements (Figure 9.4-2, Case 1).

Case 2. The boundary layer is located below the release point. This can lead to three distinct cases depending on the downwind range in question (Figure 9.4-2, Case 2).

Case 2.1 Dispersion at downwind distances from the release point to the point X_1, beneath which the bottom of the plume intersects the boundary. The plume is embedded in the relatively turbulent-free lake air.

Case 2.2 Dispersion at downwind distances from point X_1 to the point X_2, beneath which the top of the plume intersects the boundary. In this zone, fumigation is assumed to occur. The effluent is uniformly distributed in the vertical.

Case 2.3 Dispersion at downwind distances beyond the point X_2. Here, limited mixing occurs due to the plume being trapped beneath the boundary. Here also the effluent is uniformly distributed in the vertical.

9.4.2.2 Results

The model was evaluated at various downwind distances to 10 miles, to yield the "worst case" values. The highest concentrations were due either to Case 1 or Case 2.2. The remaining cases were, therefore, eliminated as possible worst cases.

9.4.2.3 Required Forecast Inputs to Model

The lake effects model requires a variety of inputs. Some are used to determine whether or not a boundary exists.

Others are used to select the limited mixing or the fumigation mode. The inputs used to decide whether lake effects will occur are:

a. hour of day,
b. wind direction,
c. wind speed, and
d. temperature contrast between lake and land.

The additional input used to select the appropriate dispersion mode is air mass stability.

9.4.2.3.1 Hour Of Day

The internal boundary is assumed to develop, in part, in response to heating being transferred upward from the earth's surface into the air. Thus, the time of day is limited to those daylight hours beginning several hours after sunrise to late afternoon. It is during this time that the sun has its greatest effect and air temperature near the ground reaches its maximum.

9.4.2.3.2 Wind Direction

The populated areas subject to an accidental release are restricted to the landward region exclusive of the lake. Consequently, the wind must flow onshore before an overland internal boundary can develop.

9.4.2.3.3 Wind Speed

The boundary forms only after an onshore wind has developed, and cannot form in the absence of wind. Thus, some minimum speed greater than zero is necessary for the formation to occur. Moreover, field studies have suggested that optimum conditions for a boundary to mature imply a maximum wind speed beyond which the boundary presumably cannot be maintained. Thus, the wind speed seems to be constrained to fall between both a lower and an upper bound.

9.4.2.3.4 Temperature Contrast Between Lake and Land

The temperature differential between the air over the water and that over land precedes the formation of the boundary and appears to be a major factor in the vertical slope of the boundary. Nominal temperature differentials in the Chicago-Zion area have been found to be on the order of 6° to 7° Celsius. It is probable that there is some value below which the boundary will not form. Since it is not known at this time, a value equal to approximately one-half of the nominal differential is used in the present model.

The additional model input used to select the appropriate dispersion mode is air mass stability. Field studies have shown that the optimum condition is near neutral (dry adiabatic lapse rate).

Boundary formations appear to be discouraged under extreme conditions of stability. It should be noted that the air mass parameter referred to here represents the synoptic scale and not the underlying boundary layer.

Daytime hours are those beginning 1 hour after sunrise and ending 1 hour before sunset (CST). Wind speed and direction are taken directly from the 35-foot level of the meteorological tower. These signals will be hardwired into the process computer. Signals representing the temperature differential between the lake and land and air mass stability are not directly available. Instead they are determined from a variety of meteorological reporting stations and provided by the meteorological consultant. Predicted hourly differentials and stability factors are also prepared by the consultant.

Precalculated "worst case" values of ground level concentrations have been tabulated and stored in the process computer for immediate access. The appropriate value is indicated by the meteorological data (actual or forecast). The results are listed in Table 9.4-2.

9.4.3 Dose Models

For simplicity of programming, the Zion lake breeze model uses a semi-infinite plume model in place of the finite plume model previously discussed. Both the whole body dose and skin dose calculations are described using this method.

9.4.3.1 Whole Body Dose from Noble Gases

A whole body dose may be calculated using the precalculated "worst case" values of relative ground level concentration, whole body dose factors, and actual plant emissions. The equation becomes:

$$D_\gamma(R) = 3.17 \times 10^{-8} \sum_i (\chi/Q)\ A_i\ \bar{X}_i\ \exp\left(-\ \lambda_i\ R/3600\ u_g\right) \qquad (9.30)$$

$D_\gamma(R)$ — Whole Body Gamma Ray Dose (mrem)
Whole body gamma ray dose at the downwind distance R.

3.17×10^{-8} — Conversion Constant (years/second)
Converts seconds to years.

(χ/Q) — Relative Effluent Concentration (sec/m^3)
The relative effluent concentration at ground level.

A_i — Accumulative Release (μCi)
The accumulative release of nuclide i over the time period of interest.

$\overline{X}_i$ Whole Body Gamma Dose Factor (mrem/yr per $\mu Ci/m^3$)

The whole body gamma dose factor for a semi-infinite cloud of the radionuclide i. Values are found in Table 7.1-13.

λ_i Radiodecay Constant (1/hr)

The radioactive decay constant for nuclide i. See Table 7.1-9.

u_g Wind Speed, Ground Level (m/sec)

The wind speed at the lowest position on the meteorological tower.

In cases where σ_Θ values are used to infer horizontal plume width, given in Table 9.4-2, the χ/Q values must be multiplied by the appropriate factor given in Table 9.2-6. These factors are independent of the lake breeze model and should be applied any time σ_Θ values are used.

9.4.3.2 Skin Dose from Noble Gases

A skin dose may be calculated using the precalculated "worst case" values of relative ground level concentrations, beta skin dose factors, gamma air dose factors, and actual plant emissions. The equation becomes:

$$D_{skin}(R) = 3.17 \times 10^{-8} \, (\chi/Q) \sum_i A_i (1.11 X_i + \overline{L}_i) \exp(-\lambda_i R/3600 \, u_g) \tag{9.31}$$

$D_{skin}(R)$	Skin Dose at Distance R.	(mrem)
1.11	Conversion Constant Converts mrad (air) to mrem (tissue).	(mrem/mrad)
X_i	Gamma Air Dose Factor Gamma air dose factor for a uniform semi-infinite cloud of the radionuclide i. Values are found in Table 7.1-13.	(mrad/yr per $\mu Ci/m^3$)
$\bar{L}_i$	Beta Skin Dose Factor Beta skin dose factor for a semi-infinite cloud of the radionuclide i. Values are found in Table 7.1-13.	(mrem/yr per $\mu Ci/m^3$)

9.4.3.3 Inhalation Dose from the Nonnoble Gases

The inhalation dose rate and dose from the radioiodines, "particulates," and other (nonnoble gas) radionuclides during lake effect conditions are computed using Equations 9.28 and 9.29, respectively, except that χ/Q is used in lieu of $(1/u_s)\ (u\chi/Q)_s$ or $(1/u_g)\ (u\chi/Q)_g$. The χ/Q values of Table 9.4-2, as adjusted by the σ_θ-dependent factors of Table 9.2-6, are used in the calculations.

9.4.4 Symbols Used in Section 9.4

SYMBOL	NAME	UNIT
$D_\gamma(R)$	Whole Body Gamma Ray Dose	(mrem)
(X/Q)	Relative Effluent Concentration	(sec/m^3)
A_i	Accumulative Release	(μCi)
$\overline{X}_i$	Whole Body Gamma Dose Factor	(mrem/yr per μCi/m^3)
λ_i	Radiodecay Constant	(1/hr)
R	Downwind Range	(m)
u_g	Wind Speed, Ground Level	(m/sec)
$D_{skin}(R)$	Skin Dose at Distance R	(mrem)
X_i	Gamma Air Dose Factor	(mrad/yr per μCi/m^3)
$\overline{L}_i$	Beta Skin Dose Factor	(mrem/yr per μCi/m^3)

9.4.5 Constants Used in Section 9.4

NUMERICAL VALUE	NAME	UNIT
3.17×10^{-8}	Conversion Constant	(years/second)
3600	Conversion Constant	(sec/hr)
1.11	Conversion Constant	(mrem/mrad)

TABLE 9.4-1

ESTIMATED FREQUENCIES OF OCCURRENCE*

(Hours Per Year - Percent)

ZION STATION

NO LAKE EFFECTS	90
LAKE EFFECTS	10
	100

LAKE EFFECT TRAPPING	9
LAKE EFFECT - FUMIGATION	1
	10

*Based on 1978-1979 Hourly Measurements (March through September)

TABLE 9.4-2

RELATIVE CONCENTRATION (X/Q) (sec/m^3)

		RANGE (meters)					
		402	804	1609	3218	8045	16090
Case 1.	Stability A	4.6E-5	1.6E-5	5.2E-6	2.4E-6	7.2E-7	2.8E-7
	Stability B	4.4E-5	2.6E-5	8.9E-6	3.5E-6	1.0E-6	3.9E-7
	Stability C	2.5E-5	4.2E-5	1.8E-5	5.9E-6	1.5E-6	5.6E-7
	Stability D	5.5E-7	1.8E-5	3.1E-5	1.7E-5	5.2E-6	2.0E-6
	Stability E	3.4E-12	1.8E-6	2.2E-5	2.6E-5	1.0E-5	4.7E-6
	Stability F	9.6E-23	1.6E-9	2.4E-6	1.3E-5	1.5E-5	8.0E-6
	Stability G	4.8E-81	1.1E-17	1.3E-9	5.5E-7	5.3E-6	7.1E-6
Case 2.	(All Stabilities)	3.5E-4	2.1E-4	1.1E-4	5.3E-5	1.8E-5	7.0E-6

Note: Maximum X/Q values for each range have been underscored.

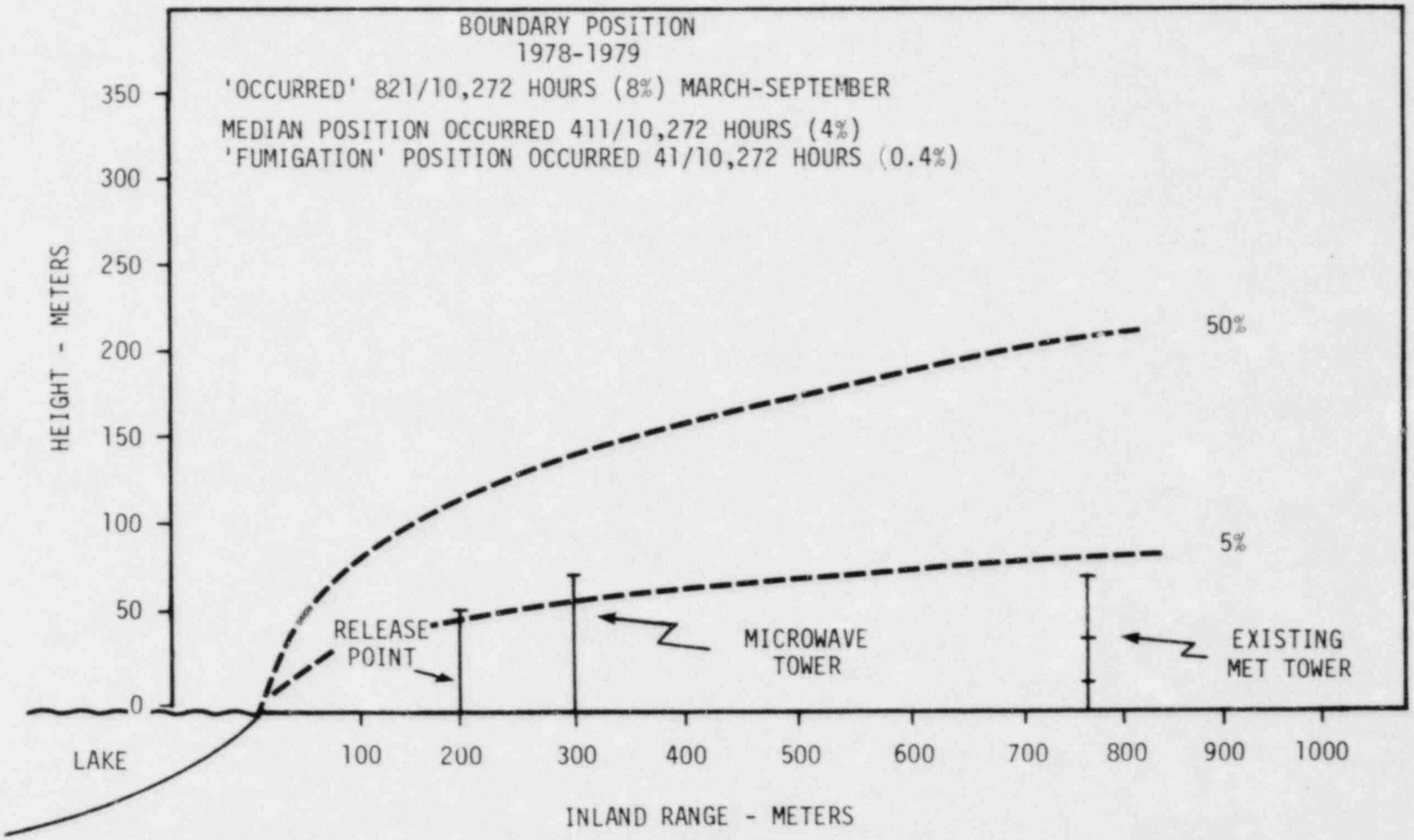
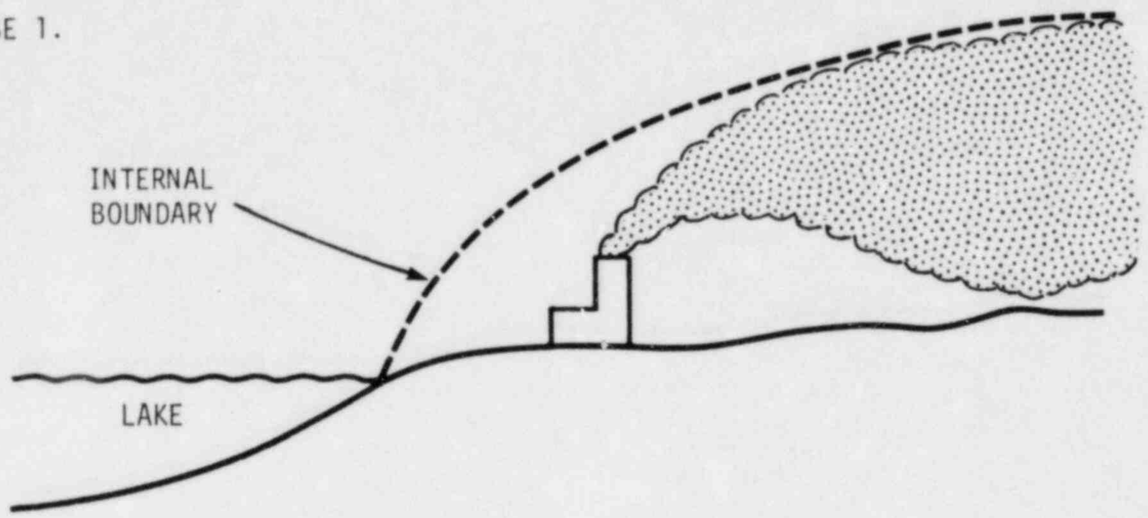


FIGURE 9.4-1
BOUNDARY POSITION

CASE 1.



CASE 2.

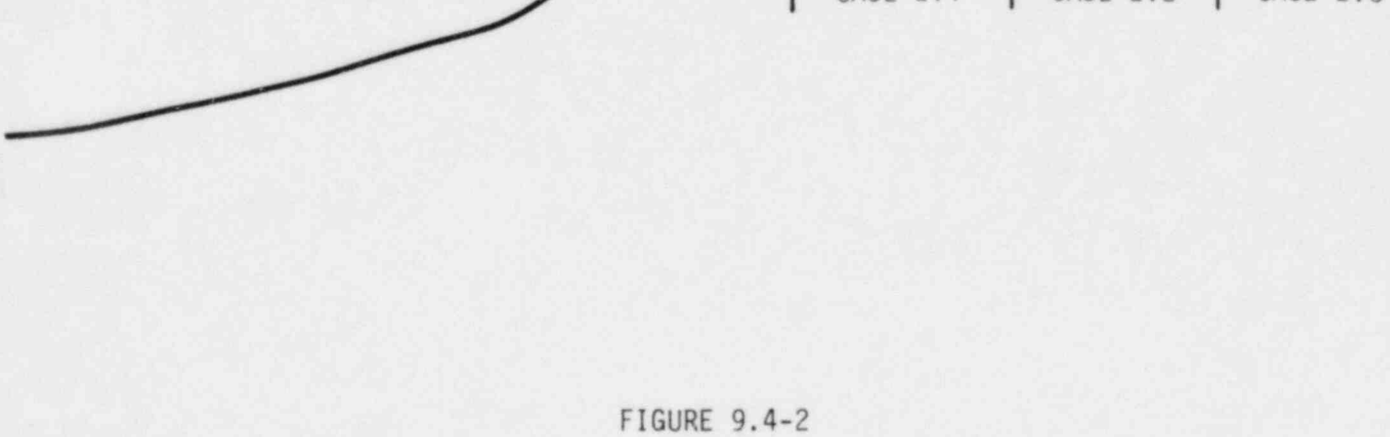


FIGURE 9.4-2

ATMOSPHERIC DISPERSION WITH LAKE EFFECTS

9.5 LIQUID RELEASES

Doses due to the unplanned releases of radioactivity to the aquatic environment are determined using the 10 CFR 50, Appendix I model described in Section 2.2 of this manual. For use in emergency situations, however, the adult is assumed to consume only water from the contaminated environment.