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POPDOSE-SR: A ROUTINE-RELEASE ATMOSPHERIC POPULATION DOSE MODEL USED AT SRS

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ABSTRACT

POPDOSE-SR is a PC version of the dosimetry code POPGASP, which was used to calculate doses to the offsite population for routine atmospheric releases of radioactive material at the Savannah River Site (SRS). Complete code description, verification of models, and user's manual have been included in this report. Minimal input is required to run the program, and site-specific parameters are used when possible.

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POPDOSE-SR: A ROUTINE RELEASE ATMOSPHERIC DOSE MODEL USED AT SRS

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1. INTRODUCTION

POPDOSE-SR is used to calculate dose to the surrounding Savannah River Site (SRS) population following routine releases of atmospheric radioactivity. POPDOSE-SR is a personal computer (PC) version of POPGASP, which resided on the IBM Mainframe. POPDOSE-SR follows US Nuclear Regulatory Commission (USNRC) Regulatory Guides 1.109 and 1.111. (USNRC 1977a,1977b). The bases for POPDOSE-SR are USNRC developed codes XOQDOQ (Sagendorf, Goll, and Sandusky 1982) and GASPAR (Eckerman et al. 1980). For use at SRS, these two codes were combined into one, and site specific parameters were added where possible. POPGASP has been verified for use at SRS, and with the change to POPDOSE-SR on the PC, the verification process was repeated to ensure proper execution of the code. Code description and user's manual also has been included. Transference of POPGASP to the PC will allow for greater ease of execution and greater reliability of code access.

2. CODE DESCRIPTION

POPDOSE-SR contains the following modules (or subroutines): PGPROTEM, PGPREXOQ, XOQDOQ, PGPOP90, PGPRGAS, and, RGASPAR. A brief summary of each subroutine follows.

PGPROTEM –input template is read, printed, and written to a file.

PGPREXOQ –reads in data pertaining to boundary coordinates, terrain, and meteorology.

XOQDOQ –calculates the relative air concentrations (χ/Qs) and relative deposition rates (D/Qs) for radial rings out to 50 miles.

PGPOP90 –calculates the 50-mile offsite population in a radial arc format centered on user entered coordinates

PGPRGAS –reads site information and agricultural data for use in the population dose calculations.

RGASPAR –calculates pathway and organ specific doses and writes the unformatted data to an output file.

The main modules (XOQDOQ and RGASPAR) will be discussed in detail. It is important to note that XOQDOQ and RGASPAR were originally written as two different programs and were not designed to work together. As a result, some of the calculations performed in RGASPAR are to modify results from XOQDOQ so that they may be used correctly to calculate dose.

2.1. XOQDOQ

The XOQDOQ computer program was developed for use by the USNRC to evaluate atmospheric releases from commercial nuclear power operations. The calculations performed by XOQDOQ are those established in the USNRC Regulatory Guide 1.111 for the release of an effluent from a stack or vent under conditions of constant wind direction. A straight-line Gaussian plume model is used, and the plume is assumed to be depleted by dry deposition and radioactive decay.

XOQDOQ was originally developed by J. Sagendorf, National Oceanic and Atmospheric Administration (NOAA) and J. Gnoll, USNRC (Sagendorf, Goll, and Sandusky 1982). XOQDOQ was modified by W. Pillinger in 1983 and 1984 for use at SRS. The changes were primarily associated with expanding arrays and changing read/write statements to make it possible for XOQDOQ to calculate relative concentrations (1) at specific points along the SRS boundary for “maximum” and “average” individuals, and (2) within compass sector regions for population dose assessments. In addition, an option was invoked which constrains sector-arc average relative air concentrations (χ/Qs) to values less than plume centerline χ/Qs (Bauer 1991).

Additional modifications were made by L. Bauer in 1990. The subroutines called by XOQDOQ to calculate χ/Qs from short-term releases were removed from the code. XOQDOQ is not the best available code for estimating χ/Qs from purges or process upsets. This step prevented the unauthorized use of XOQDOQ for such calculations (Bauer 1991).

2.1.1. Descriptions of Input Data Files for XOQDOQ

All of the data files called upon by XOQDOQ are identified in Appendix A. The two types of data calls made by XOQDOQ include the regional terrain data and the SRS meteorological data.

2.1.1.1. Regional Terrain data

The height of the plume as it travels from the release point may be adjusted to account for changes in terrain. The terrain file is a binary file called ‘TPGY100.bin’. This terrain database is a product of Oak Ridge National Laboratories and contains elevations above mean sea level referenced by coordinates of latitude and longitude. These data are used to develop an array of maximum changes in elevation, relative to the release point’s elevations. This array is then called to determine the reduction in plume height required for a specific compass sector and downwind location. The plume height is reduced to account for the fact that if the plume is traveling in a straight line and a receptor is standing on elevated ground, they are closer to the plume.

2.1.1.2. SRS Meteorological data

XOQDOQ has the ability to access wind speed, wind direction, and atmospheric stability data collected from one of the seven onsite meteorological towers. The towers are instrumented at 61 meters above ground level, which is the height of the primary reactor and separations area stacks. The towers are equipped with cup anemometers to measure wind speed, and with bivanes to measure the horizontal and vertical components of wind direction. Currently, XOQDOQ accesses data files representing meteorological data for the period of 1992-1996. The meteorological monitoring program in use at the SRS has been described in more detail in Parker and Addis (1993). The collection and quality assurance of these data are the responsibility of the Nonproliferation Technology Section (NTS) of SRTC.

XOQDOQ uses meteorological data in the form of joint frequency distributions of wind direction, wind speed range, and atmospheric stability class for each of the sixteen 22.5 degree compass sectors. The turbulence-typing scheme used is the Pasquill-Gifford stability classification system.

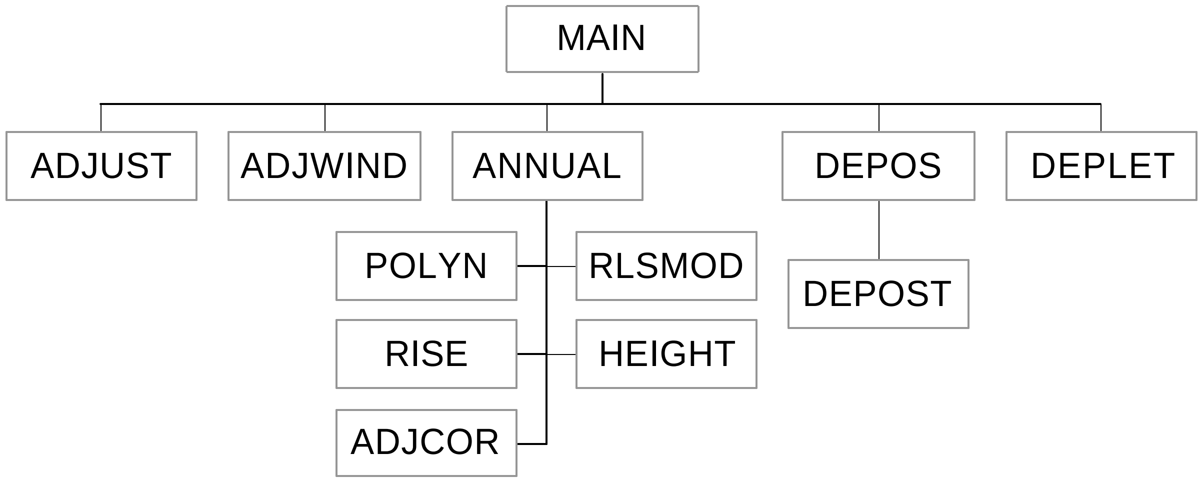
The USNRC recommends the collection of mixing height data. Mixing, sometimes called inversion, height is the distance above the ground in which the plume is essentially trapped due to temperature inversion. Vertical diffusion is typically limited to the value of the mixing height within XOQDOQ. Mixing height is not routinely measured onsite and is not a user-specified variable in XOQDOQ. The maximum vertical plume dispersion allowed by the code is 1000 m. Regional compiled data show that monthly average mixing heights are generally greater than this value except during the months of December and January (Garrett 1981). Although the averages for these winter months were found to be lower than 1000 m, this will not significantly impact the calculation of annual average χ/Qs because the vertical diffusion limitation only effects a small percentage of the wind speed and stability class combinations over the five year meteorological data period.

2.1.2. XOQDOQ Code Structure

The structure of XOQDOQ is shown in Figure 1 for all of the main subroutines. The calculations performed by major subroutines are described in the following sections. More detailed discussions of XOQDOQ's treatment of depletion, deposition, and plume rise also follow.

XOQDOQ is programmed such that it can be used by POPDOSE-SR or MAXDOSE-SR – the program that determines dose to the maximally exposed individual following routine releases of radioactivity (Simpkins 1999).

Figure 1. XOQDOQ Code Structure



2.1.3. XOQDOQ Subroutine Descriptions and Methodology

ADJUST -This subroutine adjusts effective plume height to correct for terrain changes using the terrain file that was discussed above. Such modifications are required to establish which series of depletion/deposition curves are to be read at a given downwind location.

ADJWIND - Provides a wind speed correction factor, CORR, when the release height does not equal the height at which the wind speed is measured. The correction factor is defined below.

$$CORR = \left(\frac{SL}{PL}\right)^{EX} \qquad (1)$$

where

SL desired wind height, m

PL measured wind height, 61 m

EX 0.25 (stability classes A, B, C, D)
0.50 (stability classes E, F, G)

ANNUAL - Calculates annual-average ground level and elevated relative air concentrations (χ/Qs) and deposition concentrations (D/Qs) for a uniform distribution of effluent across the compass sector. For an elevated release, the χ/Q values are calculated as follows:

$$\frac{\chi}{Q}(x,k) = 2.032\sum_{ij}\frac{JFD_{ijk}DEC_i(x)DEPL_{ij}(x,k)}{u_i(x)\sigma_{z_j}(x)x}e^{-0.5\left(\frac{h_e}{\sigma_{z_j}(x)}\right)^2} \qquad (2)$$

where

χ/Q(x,k)	relative air concentration at x meters in the kth 22.5 degree compass sector, s/m^3
i	wind speed class (1-6) corresponding to the ranges shown in Table 1
j	atmospheric stability class (1-7) corresponding to Pasquill-Gifford stability classes A-G

A, B, C	Unstable
D	Neutral
E, F, G	Stable

$u_i(x)$	midpoint of the ith wind speed class (see Table 1), m/s
$\sigma_{zj}(x)$	vertical plume spread due to ambient free-stream turbulence as determined by subroutine POLYN, m
JFD_{ijk}	joint frequency distribution of wind speed and atmospheric stability observations – percent of time over five year period that stability class j and wind speed range i occur in sector k
$DEPL_{ij}(x,k)$	plume depletion factor as determined by subroutine DEPLET
h_e	effective plume height as defined by subroutines RISE and HEIGHT, m
$DEC_i(x)$	radioactive decay, $e^{-(0.693t/T)}$
t	travel time=x/(86400*u_i), days
T	half-life of the radioactive material, days
x	downwind or travel distance, m

A correction for recirculation and stagnation is available for equation 2, but has been excluded since the factor is set to unity for SRS calculations.

Table 1. Wind Speed Classes and Ranges

Wind Speed Class	Wind Speed Range (m/s)	Wind Speed Range Midpoint – u (m/s)
1	0≤u≤2	1.0
2	2<u≤4	3.0
3	4<u≤6	5.0
4	6<u≤8	7.0
5	8<u≤12	9.0
6	12<u≤14.1	13.05

For the ground-level releases, the larger value from the following two equations is used for specific downwind locations.

$$\frac{\chi}{Q}(x,k) = \frac{2.032}{x}\sum_{ijk}\frac{JFD_{ijk}DEC_i(x)DEPL_{ij}(x,k)}{u_i(x)\sqrt{3}\sigma_{zj}(x)} \tag{3}$$

$$\frac{\chi}{Q}(x,k) = \frac{2.032}{x}\sum_{ijk}\frac{JFD_{ijk}DEC(x)DEPL_{ij}(x,k)}{u_i(x)\sqrt{\sigma^2_{zj}(x) + cD^2/\pi}} \tag{4}$$

where

c defined constant, 0.5 (USNRC 1977b)

D building height used to evaluate dispersion due to building wake effects

Subroutine ANNUAL also calculates relative concentrations and deposition for ten downwind segments in each of the 16 compass sectors which is needed for the population dose calculations. The computed value represents an average value for the downwind directional sector bounded by the range of the region. The method used by ANNUAL to calculate a segment average χ/Q is shown in Equation 5. A similar equation is also used to calculate segment average D/Qs.

$$\frac{\overline{\chi}}{Q}seg(k) = \frac{R_1\frac{\chi}{Q}(R_1,k) + R_2\frac{\chi}{Q}(R_2,k) + R_3\frac{\chi}{Q}(R_3,k)}{R_1 + R_2 + R_3} \tag{5}$$

where

$\frac{\overline{\chi}}{Q}seg(k)$ average χ/Q for the segment in compass sector k, s/m^3

$\frac{\overline{\chi}}{Q}(R_n, k)$ χ/Q at downwind distance R_n for compass sector k, s/m^3

$R_{1,3}$ downwind distance of the segment boundaries, m

R_2 downwind distance of the midpoint, m

These segment average values are used to calculate population doses for a given region.

DEPOS - This subroutine calculates D/Qs (relative deposition per unit area). DEPOS uses the same distance information as ANNUAL.

$$\frac{D}{Q}(x,k) = \frac{\sum_{ij} D_{ij} f_{ij}(k)}{(2\pi/16)x} \qquad (6)$$

$\frac{D}{Q}(x,k)$ average relative deposition per unit area at a downwind distance x and direction k, m^{-2}

D_{ij} relative deposition rate from Figures 7 through 10 of the USNRC Regulatory Guide 1.111 for the ith wind speed class and the jth stability class, m^{-1}

$f_{ij}(k)$ joint probability of the ith wind speed class, jth stability class, and kth wind direction sector

x downwind distance, m

DEPOST – This subroutine solves the polynomial regression equations for the deposition curves of USNRC Regulatory Guide 1.111 in order to define a value to D_{ij} defined above. For details on the methodology see USNRC Regulatory Guide 1.111 (USNRC 1977b)

POLYN - This subroutine calculates values of vertical and horizontal plume spread as a function of downwind distance. Vertical plume spread is calculated using the following equation:

$$\sigma_{z_j}(x) = ax^b + c \qquad (7)$$

where

a,b,c coefficients, derived by Eimutis and Konicek (1972), which are functions of stability class and distance - values are shown in Table 2.

x downwind distance, m

Table 2. Values used to Calculate Vertical Diffusion Coefficients (see Eq 7)

Pasquill Category	**Valid Range (m)**								
	< 100 m			**100 - 1000 m**			**> 1000 m**		
	a	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**
A	0.192	0.936	0	0.00066	1.941	9.27	0.00024	2.094	-9.6
B	0.156	0.922	0	0.0382	1.149	3.3	0.055	1.098	2.0
C	0.116	0.905	0	0.113	0.911	0.0	0.113	0.911	0.0
D	0.079	0.881	0	0.222	0.725	-1.7	1.26	0.516	-13
E	0.063	0.871	0	0.211	0.678	-1.3	6.73	0.305	-34
F	0.053	0.814	0	0.086	0.74	-.035	18.05	0.18	-48.6

The horizontal plume spread is calculated using the following equation

$$\sigma_{y_j}(x) = Ax^{0.9031} \tag{8}$$

Where A is represented by the values that are shown in Table 3 as a function of Pasquill's atmospheric stability categories and x is the downwind distance in meters (Eimutis and Konicek 1972).

Table 3. Values of A for Horizontal Diffusion Coefficients

Pasquill Category	**A**
A	0.3658
B	0.2751
C	0.2089
D	0.1471
E	0.1046
F	0.0722

The vertical and horizontal diffusion coefficients for stability class G are determined using the following equation:

$$\sigma_Z(G) = 2A\log10(F) - A\log10(E) \tag{9}$$

where E and F are the horizontal diffusion coefficient values for stability classes E and F, respectively.

RLSMOD - Invoked for mixed-mode releases. RLSMOD evaluates the need for an entrainment factor, E, by computing the ratio of the plume exit velocity to the wind speed. If a mixed-mode release is indicated, the proportion of the plume considered to be elevated and the proportion considered to be ground level are determined by the following relationships:

$$\begin{aligned} E_t &= 1.0 && \text{for } w/u < 1.0 \\ E_t &= 2.58 - 1.58(w/u) && \text{for } 1.0 \le w/u \le 1.5 \\ E_t &= 0.3 - 0.06(w/u) && \text{for } 1.5 < w/u < 5.0 \\ E_t &= 0.0 && \text{for } w/u \ge 5.0 \end{aligned} \tag{10}$$

where

E_t fraction of the time the release is ground level

w plume exit velocity, m/s

u average wind speed at vent height, m/s

RISE - Plume rise, h_{pr}, is calculated using the formula of Briggs (1969). Plume rise due to momentum and buoyancy is considered. At SRS, atmospheric releases are considered to be ambient temperature plumes, and therefore, plume rise may be considered to be exclusively a function of momentum.

The formulae of Briggs (1969) are based on the effective stack height method in which plume rise is artificially decoupled from dispersion. The principal site-specific parameters upon which plume rise depends are effluent exit velocity, wind speed, stack diameter, and stack height.
The specific empirical relationships recognized by RISE for h_{pr} as a function of momentum are:

For stability classes A, B, C, D, the smaller value from the following two equations is used:

$$h_{pr} = 1.44\left(\frac{w}{u}\right)^{2/3}\left(\frac{x}{d}\right)^{1/3} d \tag{11}$$

$$h_{pr} = 3\left(\frac{w \bullet d}{u}\right) \tag{12}$$

where

w effluent exit velocity, m/s

u wind speed at release height, m/s

x downwind distance, m

d stack diameter, m

If the effluent velocity is less than 1.5*wind speed, then plume rise height is further corrected as follows

$$h_{pr} = h_{pr} - 3(1.5 - w / u) \bullet d \tag{13}$$

For stability classes E, F, G, the smallest value from the following equations is used:

$$h_{pr} = 1.44 \left(\frac{w}{u} \right)^{2/3} \left(\frac{x}{d} \right)^{1/3} d \tag{14}$$

$$h_{pr} = 3 \left(\frac{w \bullet d}{u} \right) \tag{15}$$

$$h_{pr} = 4 \left(\frac{F_m}{s} \right)^{0.25} \tag{16}$$

$$h_{pr} = 1.5 \left(\frac{F_m}{u} \right)^{1/3} s^{-1/6} \tag{17}$$

where F_m is the momentum flux parameter, m^4/s^2

$$F_m = \left(\frac{w \bullet d}{2} \right)^2 \tag{18}$$

s acceleration per unit vertical displacement for adiabatic motion in the atmosphere, by stability class - see below, s^{-2}

E	8.75E-04 s^{-2}
F	1.75E-03 s^{-2}
G	2.45E-03 s^{-2}

If the effluent velocity is less than 1.5*wind speed, then plume rise height is further corrected as follows

$$h_{pr} = h_{pr} - 3(1.5 - w/u) \bullet d \qquad (19)$$

HEIGHT - An effective plume height, h_e is calculated by XOQDOQ using Equation 20. HEIGHT linearly interpolates an h_t for a given downwind distance x, based on the highest elevation between the source and the given downwind distance.

$$h_e = h_s + h_{pr} - h_t \quad (h_e \geq 0) \qquad (20)$$

h_e effective plume height, m

h_s physical stack height, m

h_{pr} plume rise, m

h_t terrain height, m

ADJCOR - Keeps track of the cross-over heights (discussed in next section) which each plume passes for each direction, wind-speed class, and stability category. This subroutine determines which depletion and deposition adjustment factors derived in ADJUST should be used. XOQDOQ's treatment of depletion and depositions are described more fully in a subsection below.

2.1.3.1. Depletion

Plume depletion by XOQDOQ is automatic whenever 8-day decayed χ/Qs are calculated. Plume depletion via ground surface absorption is assumed by Markee (1967) to be a function of eddy diffusivity and wind velocity. By establishing vertical profiles of these variables, Markee was able to estimate vertical plume concentration profiles for a variety of release conditions. The results of studies were used by the USNRC to develop depletion factors for general use. Depletion curves for release heights of 0, 30, 60, and 100 meters, expressed as a function of atmospheric stability class were published in the USNRC Regulatory Guide 1.111.

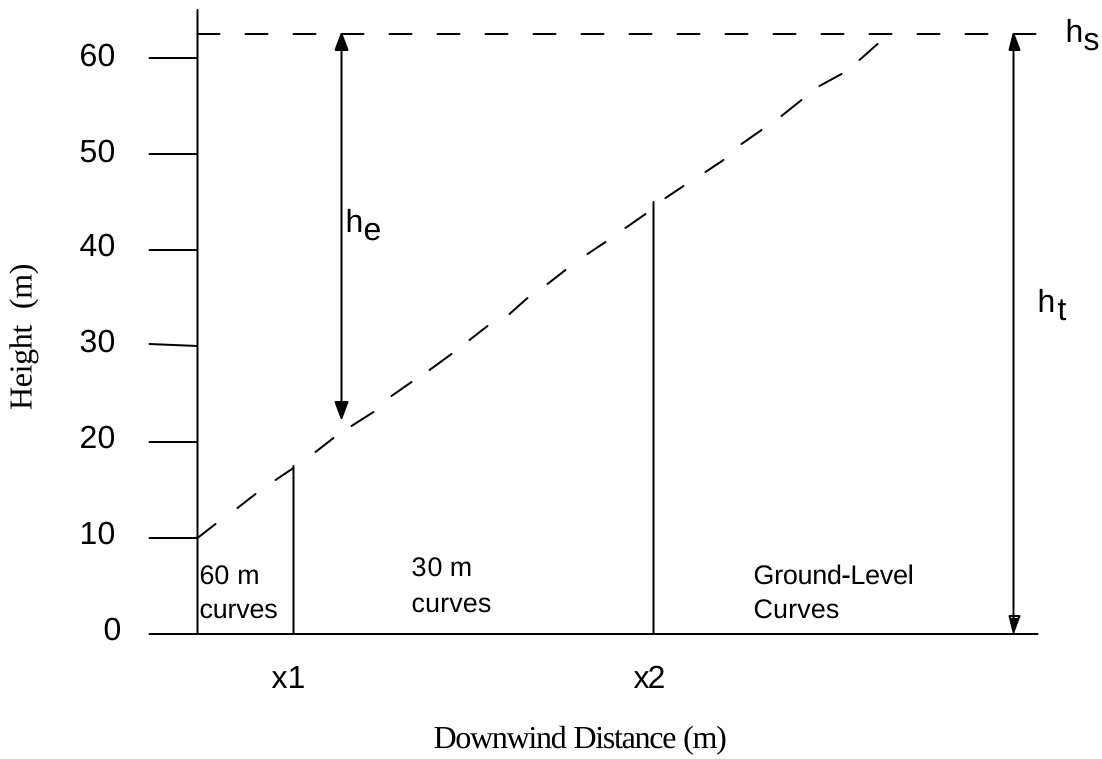
XOQDOQ decreases the total mass in the plume at progressive downwind distances by solving the polynomial regression equations of the depletion curves described above. Because depletion factors are a function of plume height, XOQDOQ uses subroutines ADJCOR and ADJUST to track the plume and modify the depletion factors as terrain features (and therefore, effective plume heights) change with increasing distance. This often dictates that more than one set of depletion curves be used. The downwind distances at which it is necessary to change from one set of curves to another are referred to in XOQDOQ as cross-over points.

XOQDOQ's treatment of depletion is shown in Figure 2 for a 60-m release. The depletion factors of USNRC Regulatory Guide 1.111 would be adjusted by XOQDOQ as shown in Figure 3.

2.1.3.2. Deposition

Relative deposition is calculated in XOQDOQ based on deposition velocities (v_d) measured by Pelletier and Zimbrick (1970) as a function of wind speed. The data collected are specific to the vegetation, wind velocity, temperature, and humidity profiles of the northwest desert.

Figure 2. XOQDOQ Treatment of Cross-Over Points (Bauer 1991)



$X<x_1$	Stability-class-specific depletion factors taken from their respective 60-m curves. No adjustment necessary.
$x_1 \le X \le x_2$	Once the plume passes a cross-over point, depletion factor adjustments are required. Depletion factors for distances in this range are adjusted by adding to them the difference between the 60-m and 30-m depletion factors evaluated at the cross-over point, x_1.

$X \geq x_2$ At this point, the depletion factors are adjusted by adding to them the difference in the 60- and 30- m curves at x_1 as well as the difference between the 30-m and ground-level curves at x_2.

The deposition curves developed by the USNRC from the Pelletier and Zimbrick data have not shown to be equally applicable to all sites. Also, the USNRC position does not address the roles of such parameters as particle size distribution, solubility, roughness length for particulates or surface area, surface moisture, and stoma openings for gases. However, to follow USNRC Guidance these curves are used.

XOQDOQ uses the deposition curves of the USNRC Regulatory Guide 1.111 to determine relative deposition rates. Deposition rates are considered to be functions of the distance from the source, release height and atmospheric stability. XOQDOQ estimates relative deposition per unit area by multiplying the relative deposition rate by the fraction of the release transported into the sector. This value must then be divided by the arc length of the sector at the distance of interest.

As required for the depletion factors, XOQDOQ makes adjustments in the deposition factors to account for changes in plume height. The adjustments made at the cross-over points can be categorized by looking at Figure 2.

2.1.4. XOQDOQ Results

The results of the subprogram XOQDOQ include the following for each radial arc:

$\frac{\chi}{Q}$ -relative air concentration (s/m^3)

$\left(\frac{\chi}{Q}\right)_D$ -relative air concentration decayed by 2.26 days (s/m^3). This is a holdover from US Nuclear Regulatory Guide 1.111 when all noble gases were conservatively assumed to have a half life of 2.26 days.

$\left(\frac{\chi}{Q}\right)_{DD}$ -relative air concentration decayed for 8.0 days and corrected for depletion using the curves discussed above (s/m^3). This is a holdover from US Nuclear Regulatory Guide 1.111 when all radioiodines were assumed to have a half-life of 8.0 days. When this concentration is used in conjunction with the real half-life of the radionuclide, the 8.0 day decay is removed.

$\frac{D}{Q}$ - relative deposition per unit area 1/m^2

These results of XOQDOQ are written to a file for later use by RGASPAR to calculate the population dose.

2.2. RGASPAR

The GASPAR code (Eckerman et. al. 1980) was written in 1977 by Oak Ridge National Laboratory for the USNRC. The models in GASPAR calculate radionuclide-specific atmospheric concentrations, deposition rates, concentrations in foodstuffs, and radiation dose to individuals and populations resulting from chronic releases of radionuclides to the atmosphere (USNRC 1977a). For use at SRS GASPAR is called RGASPAR within POPDOSE. The atmospheric transport models that feed RGASPAR are contained in XOQDOQ (USNRC 1977b, Sagendorf, Goll, and Sandusky 1982).

2.2.1. Description of Input Files for RGASPAR

The data files used by RGASPAR (AGRIMMV.DAT and DOSEFACT.DAT) are described in Appendix A.

2.2.2. RGASPAR Code Structure

The RGASPAR program diagram in Figure 3 shows the interactions between modules relative to data transfer for all of the main subroutines. RGASPAR is arranged so that it operates in either MAXDOSE-SR or POPDOSE-SR to calculate radiation doses to humans resulting from atmospheric releases of radionuclides.

2.2.3. RGASPAR Subroutine Descriptions and Methodology

BLKDAT- reads in various data that are needed for dose calculations - most of which is element specific (i.e. stable element transfer factors for milk and meat).

REDDF –reads in dose factor libraries. Dose factors are based on DOE/EH-0070 and DOE/EH-0071 (USDOE 1988a and 1988b), which are for external and internal exposure, respectively. For external exposure, values are also taken from Hamby (1991b and 1991c) which includes daughter products that are in equilibrium with the parent.

REDSIT- used to read in array data for meat, milk, and agricultural productivity that could be used for population runs.

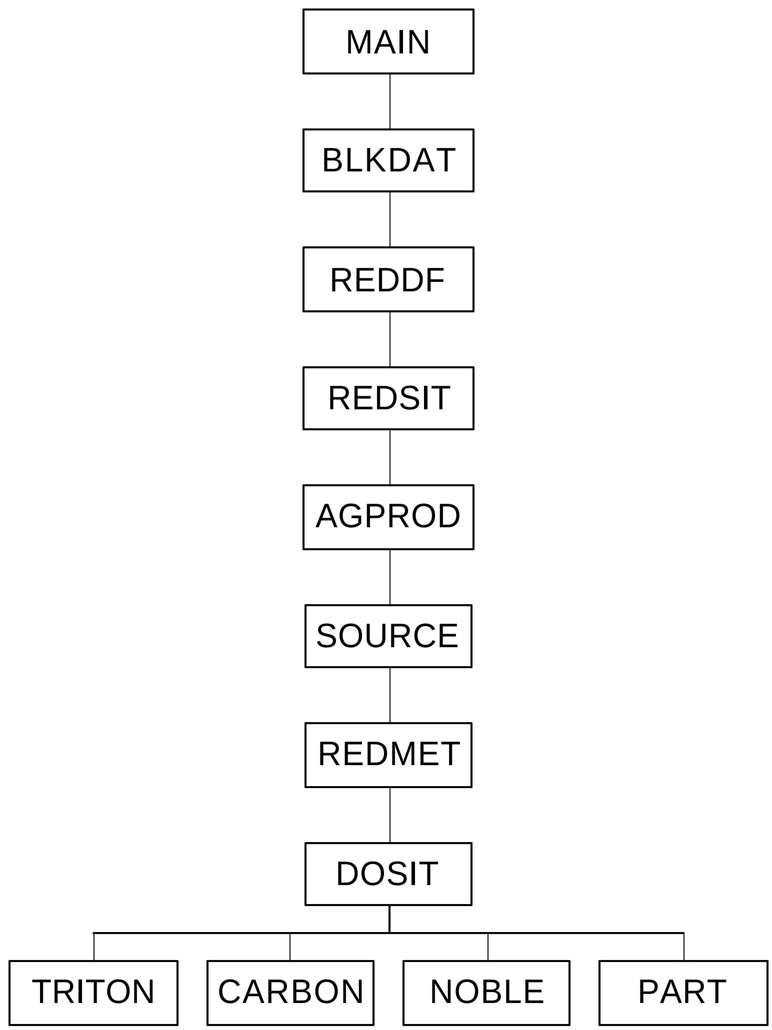
PRINTM – prints meteorological and site data.

AGPROD - calculates agricultural productivities for a fifty-mile array.

SOURCE - checks source term to ensure dose factor is available for all radionuclides that are included.

REDMET- reads in meteorological data, relative air concentrations, and deposition rates as calculated by XOQDOQ.

Figure 3. RGASPAR Code Layout



DOSIT – subroutine where the bulk of the calculations are performed. Calls the following subroutines that calculate dose based on which radionuclide is being considered.

TRITON - calculates tritium dose.

CARBON – calculates carbon dose.

NOBLE – calculates dose from noble gases.

PART – calculates dose from particulates.

Following the dose calculations there are a series of subroutines that store the output.

For radionuclide transport at the SRS, actual radioactive decay is calculated for each nuclide released to the atmosphere. RGASPAR accepts only four outputs from the XOQDOQ computer code: 1) sector arc relative air concentration, χ/Q; 2) sector arc relative air concentration decayed by 2.26 days, χ_D/Q; 3) sector arc relative air concentration decayed and depleted for 8 days, χ_{DD}/Q; and 4) sector arc relative deposition, D/Q. The nondecayed χ /Q and the 2.26 day decayed χ_D/Q are used to calculate the travel time from the source to the receptor (see section on deposition).

2.2.3.1. Nuclide Concentrations In The Atmosphere

2.2.3.1.1. Tritium and Carbon-14

Downwind atmospheric concentrations, χ_i, of tritium and carbon-14 are estimated using

$$\chi_i = \frac{\chi}{Q} \bullet Q_i \bullet 10^6 \bullet 3.17x10^{-8} \qquad (21)$$

where

χ_i air concentration, μCi/m^3

χ/Q relative air concentration from XOQDOQ, s/m^3

Q_i release amount by radionuclide, Ci/yr

3.17E-08 conversion factor, yr/s

10^6 conversion factor, uCi/Ci

Since both tritium and carbon-14 have relatively long half-lives, radiological decay is not taken into account when estimating downwind concentration for these nuclides.

2.2.3.1.2. Noble Gases

Air concentrations of noble gases are estimated by,

$$\chi_i = \frac{\chi}{Q} \bullet Q_i \bullet 10^6 \bullet 3.17x10^{-8} \bullet e^{-\lambda_t t} \tag{22}$$

where

λ radioactive decay constant, 1/s

t decay time during transit, s

Where the exponential accounts for radioactive decay during transit to the receptor. The value of t is determined in the same manner later in the calculation of the deposition rate (see Equation 27).

2.2.3.1.3. Radioiodines

Radioiodine concentrations in the atmosphere are determined using,

$$\chi_i = \left\{ \frac{\chi}{Q} \bullet (1 - F_I) + \frac{\chi_{DD}}{Q} \bullet F_I \bullet e^{31.62t} \right\} \bullet Q_i \bullet e^{-\lambda_t t} \tag{23}$$

where

χ_{DD}/Q decayed and depleted concentration taken from XOQDOQ, s/m^3

F_I fraction of iodine that is elemental, unitless

The factor in brackets calculates a weighted relative air concentration accounting for the deposition of the elemental fraction. The positive rate coefficient (31.62) negates decay from the generic 8-day half life that was already applied to the χ/Q within XOQDOQ. An exponential term is also included in this equation to account for the actual radioactive decay during plume transit.

2.2.3.1.4. Other Nuclides

Air concentrations of the remaining nuclides (those not considered above), are calculated using,

$$\chi_i = \frac{\chi_{DD}}{Q} \bullet Q_i \bullet 10^6 \bullet 3.17x10^{-8} \bullet e^{(31.62 - \lambda_t)t} \tag{24}$$

where all terms have been defined previously. Again, the positive rate coefficient in the exponential term (31.62 yr^{-1}) negates the decay from the 8-day half life that was already applied to the χ/Q within XOQDOQ.

2.2.3.2. Deposition

Deposition of iodines and particulates can occur by several mechanisms. The primary removal mechanism of atmospheric material is gravitational settling or contact with the ground, vegetation, or other ground cover such as buildings (dry deposition). Wet deposition occurs whereby gases and particulates are removed from an atmospheric plume by precipitive scavenging (rain, sleet, snow). For long-term averages, such as those calculated in POPDOSE-SR, dose calculations considering only dry deposition usually are not changed significantly by the consideration of wet deposition (USNRC 1977b). Wet deposition should be considered at sites that have a well-defined rainy season corresponding to the grazing season (USNRC 1977b).

Average monthly rainfall rates range between 2.5 and 5 inches per month (Hunter 1990). The SRS does not have a rainy season, however, the months of November and December typically have less rain than other months. Since there is not a well-defined rainy season, wet deposition would be insignificant at the SRS for long-term averages and, therefore, is not considered in POPDOSE-SR.

Dry deposition of tritium, carbon-14 and the noble gases is not considered. Specific activity models for tritium and carbon-14 utilize atmospheric concentrations to estimate vegetation concentrations.

2.2.3.2.1. Radioiodine

Deposition rates, d_i, of iodine radioisotopes are estimated using,

$$d_i = \frac{D}{Q} \bullet Q_i \bullet F_I \bullet 10^6 \bullet e^{-\lambda_i t} \tag{25}$$

where

D/Q	relative deposition value from XOQDOQ, $1/m^2$
Q_i	radionuclide release rate, Ci/yr
F_I	fraction of iodine assumed to be elemental, unitless
λ_i	nuclide-specific decay constant, yr^{-1}
t	plume travel time from the source to the receptor, yr

The parameter t is the average time required for the effluent to reach the receptor (site boundary for maximum individual). The XOQDOQ subroutine calculates a decayed and a non-decayed χ/Q. The decayed χ /Q is obtained by assuming the effluent is radioactive with a half-life of 2.26 days

(USNRC 1977b). The value of t is found by solving the radioactive decay equation used in XOQDOQ to calculate a 2.26 day decayed relative air concentration,

$$\frac{\chi_D}{Q} = \frac{\chi}{Q} e^{-(112\,\mathrm{yr}^{-1})t} \tag{26}$$

where the value 112 yr^{-1} is the decay constant for a 2.26 day half-life. The plume travel time (in years) is then,

$$t = \frac{\ln\left(\dfrac{\chi_D/Q}{\chi/Q}\right)}{\left(\dfrac{\ln 2 \bullet 365\mathrm{d}}{2.26\mathrm{d} \bullet 1\mathrm{yr}}\right)} \tag{27}$$

The plume travel time is used in subsequent equations to account for radioactive decay, ground deposition, and plume depletion.

2.2.3.2.2. Other Nuclides.

Deposition rates for all remaining nuclides are determined using

$$d_i = \frac{D}{Q} \bullet Q_i \bullet 10^6 \bullet e^{(31.62-\lambda_i)t} \tag{28}$$

where all parameters have been previously defined. The deposition equilibrium coefficient for iodine (31.62 yr^{-1}) is applied to all other nuclides as well. Deposition is modeled for all radionuclides, except for tritium, carbon-14 and noble gases.

2.2.3.3. Nuclide Concentration In Vegetation

2.2.3.3.1. Tritium

A specific activity model describes the uptake of tritium in vegetation. Tritium concentrations in vegetation are determined directly from the concentrations of tritium in atmospheric moisture. Equilibrium is assumed to be achieved in a short time relative to an annual release. The concentration of tritium in vegetation, C_T^V, is determined by

$$C_T^V = \frac{\chi_T \bullet 0.75 \bullet 0.5}{H} \tag{29}$$

where

C^V_T concentration in vegetation, µCi/g

χ_T atmospheric concentration, µCi/m^3

0.75 fraction of plant mass that is water (USNRC 1977a), unitless

0.5 concentration ratio of plant tritium to atmospheric tritium (Hamby and Bauer 1994), unitless

H annual average absolute humidity (11 g/m^3 for SRS) (Hamby 1990)

Studies (Bauer and Hamby 1991, Hamby 1993) have shown that dose estimates for the vegetation consumption pathway are sensitive to the parameters in this model. Therefore, a site-specific value was determined for the plant-tritium-to-atmospheric-tritium model (Hamby and Bauer 1994).

2.2.3.3.2. Carbon 14

The carbon-14 model for vegetation concentrations is similar to the tritium model. The following equation is used to estimate the concentration:

$$C_C^V = \frac{\chi_c \bullet F_t \bullet 0.11}{0.00016} \tag{30}$$

where

χ_c atmospheric concentration, µCi/m^3

F_t 0.5 - ratio of the total annual release time to the total annual time during which photosynthesis occurs (taken to be 4380 hrs) (USNRC 1977a), unitless

0.11 fraction of total plant mass that is natural carbon (USNRC 1977a), unitless

0.00016 concentration of natural carbon in the atmosphere (USNRC 1977a), unitless

2.2.3.3.3. Other Nuclides

The concentration of other nuclides in vegetation is determined using

$$C_i^V = d_i \bullet \left[\frac{r_i(1-e^{-\lambda_i^w t_e})}{Y_V \lambda_i^w} + \frac{B_i^v(1-e^{-\lambda_i t_b})}{P \bullet \lambda_i} \right] \bullet e^{-\lambda_i t_h} \tag{31}$$

where

d_i deposition rate-determined earlier, mCi/m^{3}yr

r_i fraction of the nuclide deposited that remains on the surface of the plant (USNRC 1977a), unitless

λ_i^w represents both weathering and radioactive loses (USNRC 1977a), 1/yr

t_e crop exposure time (Hamby 1991a), yr

Y_v crop productivity (Hamby 1991a), kg/m^2

B_i^v element-specific soil/plant uptake ratio (USNRC 1977a), unitless

λ_i radioactive decay constant, 1/yr

t_b time over which the buildup of radionuclides occurs (user entered), yr

P surface soil density (USNRC 1977a), kg/m^2

t_h hold-up time after harvest (allowing decay before consumption) (Hamby 1991 a),yr

The two expressions in the brackets account for contamination via foliar deposition and root uptake, respectively. All particulate nuclides are assume to be fully retained on vegetation (r=1) while only 20% of the iodines are retained (r=0.2) (USNRC 1977a). The loss constant, λ_i^w accounts for losses through physical weathering (14 day half-life) and radioactive decay. Values of Y_v, t_e, and t_h vary depending on the type of crop and whether the vegetation is for human consumption or is to be used as fodder (Hamby 1991a).

Concentrations in four types of vegetation are calculated in RGASPAR. These four types along with their associated parameter values are given in Table 4. Noble gases are assumed not to concentrate or deposit on vegetation.

Table 4. Parameters for Vegetation Concentrations

Parameter	**Other Vegetables**	**Leafy Vegetables**	**Pasture Grass**	**Stored Feed**	**Reference**
r (iodines)	0.2	same	same	same	USNRC 1977a
r (particulates)	1.0	same	same	same	USNRC 1977a
λ_w (yr^{-1})	18.07+λ_i	same	same	same	USNRC 1977a
t_e (yr)	0.192	0.192	0.0822	0.192	Hamby 1991a
Y_v (kg/m^2)	0.7	0.7	1.8	0.7	Hamby 1991a
B_i	element specific	same	same	same	USNRC 1977a
λ_ι (yr^{-1})	nuclide specific	same	same	same	USNRC 1977a
t_b (yr)	scenario specific	same	same	same	User entered
P (kg/m^2)	240	same	same	same	USNRC 1977a

t_h (yr)	0.164	0.00274	0	0.247	Hamby 1991a
d_i (mCi/m^{3}yr	nuclide specific	same	same	same	From XOQDOQ

2.2.3.4. Nuclide Concentrations In Meat And Milk

Concentrations of radionuclides in meat and milk are determined from feed concentrations, fodder intake rates, and element-specific feed-to-meat/feed-to-milk transfer factors. The equations for meat and milk concentration estimates are essentially identical with the exception of feed transfer coefficient. Concentrations are estimated using,

$$C_i^{meat} = C_i^{fodder} \bullet F_i^b \bullet Q_F \bullet e^{-\lambda_i t_e} \tag{32}$$

$$C_i^{milk} = C_i^{fodder} \bullet F_i^m \bullet Q_F \bullet e^{-\lambda_i t_f} \tag{33}$$

where

C_i^{fodder} nuclide concentration in cattle feed (determined below), Ci/kg

F_i^b and F_i^m feed transfer coefficients for beef cow and milk cow, respectively (USNRC 1977a), (d/kg or d/L)

Q_F cattle feed rate, kg/d

t_s and t_f transport time for meat and milk, respectively, s

Values for these parameters are listed in Table 5.

Table 5. Parameters in RGASPAR for Meat and Milk Ingestion Dose Calculations (Hamby 1991a)

Parameter	**Meat**	**Milk (cow)**
Feed consumption rate (kg/d)	44	44
Milking/Slaughter to consumption (d)	6	2
Fraction of year on pasture	1.00	1.00
Fraction intake from pasture*	0.75	0.56

*while on pasture

The nuclide concentration in fodder is estimated based on the fraction of time cattle spend on pasture and the fraction of that time that is spent consuming fresh pasture grass. The next equation calculates fodder concentration by weighting the concentration of pasture grass and stored feed.

$$C_i^{fodder} = f_p f_s C_i^p + \left[f_p(1-f_s) + (1-f_p) \right] C_i^s \tag{34}$$

C_i^p concentration in pasture grass, Ci/kg

C_i^s concentration in stored feed, Ci/kg

f_p fraction of time cattle spend on pasture (Hamby 1991a), unitless

f_s fraction of time that cattle eat fresh grass while on pasture (Hamby 1991a), unitless

2.2.3.5. Shine Dose

2.2.3.5.1. Plume Shine

Population dose is estimated using average plume concentrations in each of 160 sector/annulus segments; 16 sectors and 10 annuli with distance ranges of 0-1, 1-2, 2-3, 3-4, 4-5, 5-10, 10-20, 20-30, 30-40, and 40-50 miles. Population dose from plume shine is calculated using the following equation:

$$D_i^p = \chi_i \bullet SF \bullet DF_i^p \bullet 1yr \bullet \sum_{k=1}^{160} (\chi_{ik} \bullet N_k) \qquad (35)$$

where

SF shielding factor accounting for the fraction of time spent indoors (0.5 for population)

DF_i^p nuclide specific plume-shine dose factor, mrem m^3/yr μCi

χ_{ik} atmospheric concentration of nuclide I in area-segment k (Ci/m^3)

N_k number of people (all ages) residing in segment k

2.2.3.5.2. Ground-Shine

Ground-shine doses are calculated for all particulate, gamma-emitting nuclides. The population dose accounts for buildup over the plant lifetime and is given by,

$$D_i^g = SF \bullet DF_i^g \bullet \frac{1 - e^{-\lambda_i t_b}}{\lambda_i} \bullet 1yr \sum_{k=1}^{160} (d_{ik} \bullet N_k) \qquad (36)$$

where

DF_i^g nuclide-specific ground-shine dose factor

d_{ik} deposition rate of nuclide I in segment k, $1/m^2$

All other terms are previously defined. The exponential term accounts for the ground-surface buildup and subsequent radiological decay. Nuclide specific doses are summed for the total dose.

2.2.3.6. Inhalation Dose

Inhalation dose is determined for the population assuming a constant breathing rate and a constant concentration throughout the year of exposure. The nuclide-specific population dose is estimated by,

$$D_h^{inh} = BR \bullet DF_i^{inh} \bullet 1000\left[\frac{mrem}{rem}\right] \bullet 1yr \sum_{k=1}^{160} \left(\chi_{ik} \bullet N_k\right) \quad (37)$$

where

BR breathing rate, 8000 m^3/yr (USNRC 1977a)

DF_i^{inh} nuclide specific dose conversion factor, rem/µCi

χ_{ik} atmospheric concentration of nuclide I in area-segment k (Ci/m^3)

2.2.3.6.1. Food Ingestion Dose

Dose to the population is estimated for ingestion of foodstuffs including vegetables, meat, and milk. Radionuclide intake through the vegetation consumption pathway considers vegetables as being classified as either "leafy" or "other." The "other" category includes fruits, grains, produce, and below ground vegetables.

ALARA population dose is calculated by RGASPAR based on the assumption that the food consumed by the population within 50 miles of the SRS center is produced in the 50-mile region. If production rates exceed consumption needs, food is exported from the region (consumption of which is included in the NEPA dose estimate). Equations for the estimation of population dose via consumption of vegetables, meat, and milk are given below.

$$D_{ip}^{veg} = DF_{ip}^{ing} \bullet 1yr \bullet U_p^v \bullet N \bullet \sum_{k=1}^{160}\left[C_{ik}^{veg} \bullet \frac{VEG_k}{VEGT}\right] \quad (38)$$

$$D_{ip}^{meat} = DF_{ip}^{ing} \bullet 1yr \bullet U_p^f \bullet N \bullet \sum_{k=1}^{160}\left[C_{ik}^{meat} \bullet \frac{MET_k}{METT}\right] \quad (39)$$

$$D_{ip}^{milk} = DF_{ip}^{ing} \bullet 1yr \bullet U_p^m \bullet N \bullet \sum_{k=1}^{160}\left[C_{ik}^{milk} \bullet \frac{MLK_k}{MLKT}\right] \quad (40)$$

where

D_{ip}^{ing}	ingestion dose conversion factors (USDOE 198b), rem/Ci
U_p	consumption rates of the various media (Hamby 1991a), kg
N	number of persons served by the total production within an 80-km radius of the site (Hamby 1991a)
C_{ik}	average concentration of nuclide I in vegetation, meat, or milk within area-segment k (calculated from XOQDOQ output), Ci/kg
VEG_k	mass of vegetables produced in that sector arc (Hamby 1991a), kg
VEGT	total mass of vegetables produced (Hamby 1991a), kg
MET_k	mass of beef produced in that sector arc (Hamby 1991a), kg
METT	total mass of beef produced (Hamby 1991a), kg
MLK_k	mass of milk produced in that sector arc (Hamby 1991a), liters
MLKT	total mass of milk produced (Hamby 1991a), liters

The consumption of homegrown leafy vegetables is not considered when calculating population dose. Therefore, the rate for vegetable consumption is that for non-leafy or produce. Table 6 has the consumption and population parameters used for estimating population dose. The expressions that follow the summation symbols in Equations 38-40 provide a weighted nuclide concentration for estimating the average nuclide concentrations in foods within the dose assessment region. The dose conversion factor for ingestion is nuclide specific and is the same value for vegetable, meat and milk consumption.

Table 6. Consumption and population parameters for estimation of vegetable, meat, and milk population dose (Hamby 1991a)

Parameter	Units	Vegetable	Meat	Milk
Consumption Rate	kg/yr	163	43	120
Pop Served	persons	3.09E05	3.39E05	9.25E05
Total Production	kg	5.041E07	1.457E07	1.110E08

2.2.4. RGASPAR Results

The results of RGASPAR contain the dose estimates by pathway, organ, and radionuclide. A summary table also shows the total estimated dose. Doses are shown for both ALARA and NEPA methodologies. NEPA population doses are typically higher because they account for the export of food beyond the 50-mile radius and the dose to the US population as a result of this. For typical runs, the ALARA output should be used since the NEPA assumptions are overly conservative.

3. VERIFICATION OF MODELS

To verify POPDOSE-SR written in FORTRAN 90 for the PC, comparisons were made with POPGASP written in FORTRAN 77 for the IBM Mainframe, which has been fully verified. POPGASP was executed for eight test cases with varying radionuclides and input parameters. These results were compared to those from POPDOSE-SR, which was executed for the same test cases. The input for the test cases is shown in Table 6. The results of the comparison are shown in Table 7. The results from POPGASP and POPDOSE-SR are nearly identical. In order to ensure that POPDOSE-SR was operating correctly, an additional number of test cases were executed and compared to POPGASP.

Table 6. Test Cases for POPDOSE-SR

Parameter	1	2	3	4	5	6	7	8
Operating Period (yr)	1	50	100	201	50	201	1	100
Grade Elevation (ft)	300	0	0	1000	300	0	1000	0
Meteorological Databases	F	C	H	P	H	K	A	D
Release Coordinate (E)	53970	46200	63380	64800	58000	41000	51860	20330
Release Coordinate (N)	78020	67600	71900	43800	62000	53500	106670	65080
Ground-level or Elevated	Elevated	Ground	Ground	Ground	Elevated	Elevated	Elevated	Ground
Vent Air Velocity (m/s)	20	0	0	0	0	5	0	0
Vent Inside Diameter (m)	10	0	0	0	0	10	0	0
Release Height (m)	-5	0	0	0	-5	-100	-50	0
Building Height (m)	0	100	100	0	0	50	25	0
Vertical X-Section (m^2)	500	0	500	0	500	0	250	500
Selected Wind Height (m)	5	10	10	10	5	10	50	10
Heat Emission Rate (cal/s)	100	100	0	0	0	100	100	0
Elemental Iodines	0.5	1	0	1	0.5	0	0.5	1
Source Nuclides Activity (Ci, each)	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci

	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci	Cs-137, 1 Ci U-238, 1 Ci

During initial comparisons, the two codes were not in agreement and POPDOSE-SR was not executing properly for some of the test cases. Detailed comparisons demonstrated that differences in FORTRAN versions were the problem. Changes were made to POPDOSE-SR as needed to achieve agreement between the codes. One subroutine that was used with POPGASP could not be located for use with POPDOSE-SR. Only the executable was available. This subroutine, called SRP, was created from its inverse subroutine SRPLL. The subroutine SRPLL takes site coordinates in northing and easting and converts it the longitudinal and latitudinal coordinates and SRP was coded to perform the inverse of this function. This subroutine was verified by comparisons with spreadsheet calculations.

Table 7. Results of Test Case Comparisons

Test #	POPGASP	POPDOSE-SR	% Diff
1	131	131	0.0%
2	83.6	83.6	0.0%
3	63.5	63.6	0.2%
4	77.9	77.9	0.0%
5	74.7	74.7	0.0%
6	120	120	0.0%
7	84.1	84.1	0.0%
8	96.4	96.4	0.0%

The parameters for the additional test cases are shown in Table 8. The results of this comparison are shown in Table 9. Looking at Table 9 the only test case with a noticeable difference is Test Case Number 10. The primary difference is in how the relative deposition values are calculated at greater distances. Due to changes in compilers on the mainframe, the actual difference could not be traced. A known IBM mainframe compiler error that could set values to zero for certain instances is the suspected discrepancy in the mainframe version. This difference could be seen for radionuclides in which the dominant pathway involves the use of deposition values (ground shine, and ingestion pathways) which is typically not the case at SRS.

4. USER'S MANUAL

4.1. First-time user instructions

POPDOSE-SR runs from an executable file created using Compaq Visual FORTRAN Version 6.0. All necessary files are contained with one folder called 'DOSEMODELS.' These files can be loaded directly from a CD that was prepared to set up the directories correctly. Once the proper files have been loaded, to execute the program, select ‘Dosemodels’ from the ‘Programs’ Menu of your Start button.

4.2. Input Instructions

The user can provide input for POPDOSE-SR using a simple graphical user interface (GUI). The GUI is also used for MAXDOSE-SR, which is used for maximally exposed individual dose calculations. Each of the inputs is discussed below in detail. Once all of the inputs have been entered, the user simply clicks on the ‘Run POPDOSE Model’ button to execute the program. The output can be launched from this same interface and the input can be saved.

Figure 4 shows the GUI used to execute POPDOSE-SR.

Table 8. Additional Test Cases

Parameter	CASE 9	CASE 10	CASE 11	CASE 12
Operating Period (yrs)	201	15	300	1
Grade Elevation(ft)	100	0	1000	0
Met Database	A	C	D	F
Release Coordinate(E)	51192	15186	20870	53488
Release Coordinate(N)	106600	67004	65223	76571
Vent Air Velocity (m/s)	0	20	0	5
Vent Inside Diameter (m)	0	5	0	0
Release Height (m)	0	61	0	-50
Building Height (m)	100	0	100	100
Vertical X-Section (sq. m)	0	0	100	15
Selected Wind Ht. (m)	100	61	0	50
Heat Emission Rate (cal/s)	0	0	1	0
Elemental Iodine	1	0.5	1.0	0.00
Source Term (Ci/yr)	1Ci of each Xe-135 H-3 Co-60 I-131 Cs-137 Ra-226 U-238 Pu-239	1Ci of each of the first 100 rads listed in POPGASP except for H-3	1 Ci of each of the following I-135,Cs-134m,Cs-134, Cs-135,Cs-136,Cs-137,Cs-138,Cs-139,Ba-139,Ba-140,Ba-141,Ba-142,La-140,La-141,La-142,Ce-141,Ce-143,Ce-144,Pr-143,Pr-144,Nd-147,Pm-147,Pm-148m,Pm-148,Pm-149,Pm-151,Sm-151,Sm-153,Eu-152,Eu-154,Eu-155,Eu-156,Tb-160, Ho-166m,W-181,W-185,W-187,Pb-210,Bi-210,Po-210,Ra-223,Ra-224,Ra-225,Ra-226,Ra-228,Ac-225,Ac-227,Th-227,Th-228,Th-229,Th-230,Th-232,Th-234,Pa-231,Pa-233,U-232,U-233,U-234,U-235,U-236,U-237,U-238,Np-237,Np-238,Np-239,Pu-238,Pu-239,Pu-240,Pu-241,Pu-242,Pu-244,Am-241,Am-242m,Am-243,Cm-242,Cm-243,Cm-244,Cm-245,Cm-246,Cm-247,Cm-248,Cm-252	1 Ci of each of the following Ar-41,Xe-135,Xe-137, H-3,Be-10,C-14,N-13,F-18,Na-24,P-32,S-35,Cr-51,Mn-54,Fe-55,Ni-59,Zn-69,Se-79,Sr-89,Sr-90,Zr-95,Nb-95,Tc-99m,Ru-106,Sn-126,Sb-124,Cs-134m,La-140,Ce-144,Pb-210,Th-228,U-233,Np-237,Cf-252

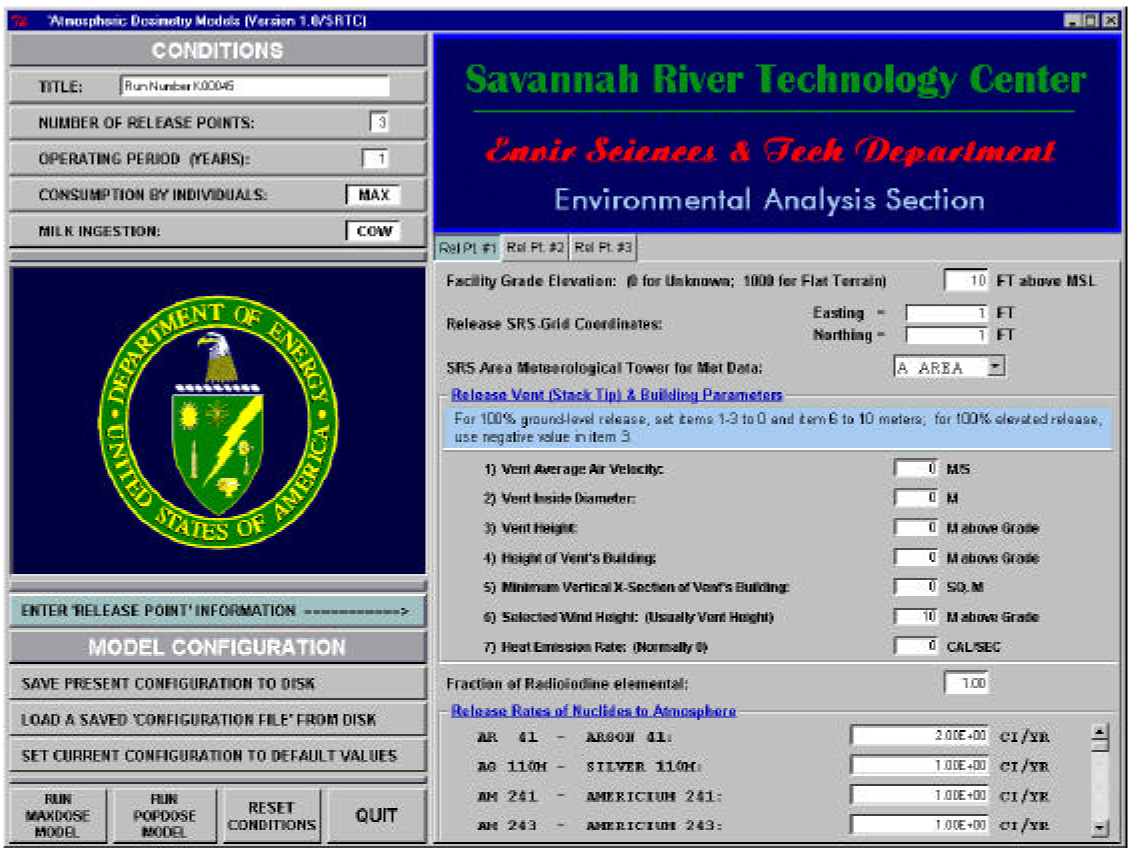
Table 8 continued. Additional Test Cases

Parameter	**CASE 13**	**CASE 14**	**CASE 15**	**CASE 16**
Operating Period (yrs)	201	201	1	201
Grade Elevation(ft)	100	0	1000	300
Met Database	H	K	P	T
Release Coordinate(E)	61765	41088	64901	17863
Release Coordinate(N)	73078	54884	45500	71358
Vent Air Velocity (m/s)	20	0	0	25
Vent Inside Diameter (m)	10	0	0	0
Release Height (m)	-5	0	-50	-100
Building Height (m)	0	0	100	50
Vertical X-Section (sq. m)	500	10	200	0
Selected Wind Ht. (m)	5	0	50	100
Heat Emission Rate (cal/s)	1	0.5	100	0
Elemental Iodine	1.00	1.00	0.5	1.00
Source Term (Ci/yr)	1 Ci of each: Ar-41,Xe-138,Na-22,Ca-41,Fe-59,Co-57,Co-58,Ni-65,Cu-64,Zn-65,Br-82,Rb-86,Sr-92,Y-91m,Zr-93,Nb-93m,Nb-95,Mo-93,Tc-101,Ru-103,Pd-107,Ag-110m,Cd-113m,Sn-123,Sb-124,Te-125m,I-130,Cs-135,Ba-139,La-142,Pr-143,Nd-147,Pm-147,Pm-151,Sm-151,Eu-154,Tb-160,Ho-166m,W-185,Pb-210,Bi-210,Po-210,Ra-228,Ac-225,Th-228,Th-229,Th-232,U-235,Np-238, Pu-240,Am-243	1Ci of each: Ar-41,Kr-89,Xe-138,H-3,Co-58,Ni-65,Br-83,Y-93,Ru-105,Sb-127,Te-132,I-133,Cs-136,Cs-137,Ce-144,Eu-154,W-187,Ra-225,Th-234,U-234,U-236,Pu-244,Cm-244,Cm-248	1Ci of each: H-3,C-14,Co-60, Sr-89, Sr-90, I-129, I-131,Cs-137,U-238,Pu-239	1 Ci or each: Ar-41,I-131,I-133,Cs-134,Pb-210,Bi-210,Po-210,Ac-227

Table 9. Additional Test Case Comparisons

Test #	POPGASP	POPDOSE-SR	% Diff
9	6.82E+02	6.82E+02	0.00%
10	2.29E+01	2.46E+01	7.00%
11	7.67E+03	7.68E+03	0.13%
12	5.99E+02	5.99E+02	0.00%
13	2.06E+03	2.07E+03	0.49%
14	1.87E+03	1.87E+03	0.00%
15	2.89E+02	2.89E+02	0.00%
16	3.22E+00	3.22E+00	0.00%

Figure 4. Graphical User Interface Used to Execute POPDOSE-SR



The following contains a detailed discussion of each of the input parameters.

TITLE:

The user can enter any type of descriptor for the run in the space provided. This title will appear at the top of most of the output pages.

NUMBER OF RELEASE POINTS:

This input is used primarily for MAXDOSE. For use with POPDOSE, only one release point can be considered. If more than one is entered, only the first will be considered.

OPERATING PERIOD (YEARS):

Enter the operating period in years. This is the length of time that the facility has been operating. Per USNRC Regulatory Guide 1.109, deposition buildup is assumed to occur for half of this period. The user should enter '201' to obtain a 100-yr environmental dose commitment.

CONSUMPTION BY INDIVIDUALS:

This input toggles between 'max' and 'ave' however, it is only used for MAXDOSE and has no effect on POPDOSE output.

MILK INGESTION:

This is used for MAXDOSE and has no effect on POPDOSE output – cow milk ingestion is assumed for POPDOSE.

SELECT RADIONUCLIDES:

Next is a list of radionuclides for the user to choose from. Clicking on the radionuclide names serves as a toggle to select or deselect the radionuclide.

Once all of the radionuclides have been selected, the user is to click on the button below the radionuclide list entitled 'ENTER RELEASE POINT INFORMATION.' This button activates the right side of the screen where more input can be entered.

Facility Grade Elevation: (0 for Unknown; 1000 for Flat Terrain)

Enter the facility grade elevation in feet above sea level. If '1000' is selected the terrain database will not be accessed to adjust for release height as the plume travels downwind.

Release SRS-Grid Coordinates: Easting =
Northing =

Enter the release coordinates in the site conventional system of Easting and Northing with units of feet. Table 10 shows the stack location for some of the major facilities onsite.

Table 10. Stack Coordinates for Major Facilities Onsite

Stack Location	**Easting**	**Northing**
A	51863	106670
D	20330	65080
F	53970	78020
H	63380	71900
K	41000	53500
L	50460	45910
M	50040	104830
P	64800	43800

SRS Area Meteorological Tower for Met Data:

Use the pulldown menu to select the meteorological tower that you wish to be accessed. Ideally, pick the one that is closest and has similar terrain

1) Vent Average Air Velocity

Enter the stack exit velocity in m/s. This will be used to calculate plume rise due to momentum of the plume. This parameter is typically set equal to '0' for conservatism.

2) Vent Inside Diameter:

Enter the inside diameter of the stack/vent. This parameter will also be used to calculate plume rise effects.

3) Vent Height:

Enter the height of the release in meters above grade. If the release is 100% elevated, use a negative sign in front of the number.

4) Height of Vent's Building:

Enter the height of building. This number is used in equation 4 to determine if the building effects plume dispersion.

5) Minimum Vertical X-Section of Vent's Building:

Enter the vertical cross-section of the building in square meters.

6) Selected Wind Height: (Usually Vent Height)

Enter the height to which the wind speed will be adjusted. This is usually the release height, unless the release is from ground level and then a wind speed height of 10 m is usually assumed. Wind measurements at SRS are taken at 61 m and a correction factor is applied (See Equation 1) to adjust the wind speed according to the appropriate height.

7) Heat Emission Rate: (Normally 0)

Enter heat emission rate, if known, in cal/s. This parameter is used for plume rise due to buoyancy effects.

Fraction of Radioiodine elemental:

Enter the fraction of radioiodine that is elemental, if known. This is used in Equations 23 and 25 to calculate the deposition rates and atmospheric concentrations of radioiodine.

Next a list is populated with the radionuclides that were preselected. Enter the release amount for each radionuclide in Ci/yr.

Once all of the input has been entered, using the right side of the screen under 'MODEL CONFIGURATION', the user may save the present configuration are reset conditions to do an additional run. Also previously saved runs may be reloaded and ran.

4.3. Output Files Generated

For each POPDOSE-SR run, several different output files are generated that contain a variety of data. The files that the user would find most useful is the 'POPDOSE.doc' file. This file can be launched directly from the GUI. This file will be discussed in greater detail below. All output files reside in 'C:\POPDOSE\output.' All other files can be opened using Microsoft Word, and may be used for debugging purposes.

4.3.1. POPDOSE.DOC

This file contains all the input and output that a user would need to verify a run. Once the file is opened, change the page layout to landscape for ease in viewing. Printing this file in its entirety would provide all the necessary information to reproduce the run for quality assurance purposes. A sample of the output is attached as Appendix B. Most of the output is self-explanatory, but a brief discussion follows.

First, the input template is echoed just as the user entered it. This can be helpful, especially if something was entered incorrectly. A complete copy of the meteorological joint frequency distribution follows with averages and summaries at the end. Next, a table of terrain height is displayed as a function of distance from the release location and sector. Annual average χ/Qs are displayed with three different categories: no decay, undepleted; 2.26-day decay, undepleted; and 8.0-day decay and depleted. Relative deposition also is shown. Each of these tables is shown as a function of distance and sector.

A table containing relative air concentrations and relative depositions for each of the 320 equally spaced boundary locations is shown next in tabular form. Next, usage factors are displayed followed by a listing of many of the constants used by POPDOSE-SR. Population data is displayed along with population consumption factors. Committed Effective Dose Equivalents (CEDEs) for the population are shown for a variety of pathways and organs, broken down by radionuclide. The first dose table shows a total summary by pathway. The tables that follow show radionuclide and organ-specific doses for the following pathways: plume shine, ground shine, vegetable consumption, meat consumption, cow milk consumption, and inhalation. The last table shows the total dose for all pathways summed together by radionuclide and organ. First the population dose values are shown for ALARA methodologies and then using NEPA methodologies. NEPA population doses are typically higher because they account for the export of food beyond the 50-mile radius and the dose to the US population as a result of this. For typical runs, the ALARA output should be used since the NEPA assumptions are overly conservative.

5. CONCLUSIONS

POPDOSE-SR is performing as expected and producing correct results for a wide range of test cases. Minimal input is required by the user and output is available in an easily interpreted form.

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APPENDIX A. POPDOSE-SR DATA FILES

Appendix A. POPDOSE-SR Data Files

The following contains brief descriptions of the data files used by POPDOSE-SR.

AGRIMMV.DAT

This file contains agricultural parameters for all sectors onsite. This information is used for population dose calculations. Milk, meat, and vegetable production are included for each sector and for 10 arcs which are bracketed by the following distances (in miles) from the center of the site: 0.5-1, 1-2, 2-3, 3-4, 4-5, 5-10, 10-20, 20-30, 30-40, and 40-50. This data is taken from Hamby (1991a).

DOSEFACT.DAT

This file contains the dose conversion factors used to calculate dose to the maximally exposed offsite individual. The first several entries are for the noble gases whose dose conversion factors have been modified to include contribution from the daughters as per Hamby (1991b). Dose conversion factors for all other radionuclides are shown next.

SITEINFO.DAT

This data file contains a small amount of site specific information like relative humidity, soil density and fractions of foods home produced.

METEOROLOGICAL DATA Files

Meteorological data files exist for each of the seven towers onsite. They are in the form of a joint frequency distribution by wind speed and stability class. Average wind speeds are also included in the files although they are not used by POPDOSE-SR.

POPULATION DATA File

GRIDTOT.DAT is a population file that contains a grid of 120x120 starting at 82.625 32.251 with incremental distances corresponding to 0.0166667. This file is used in the PGPOP90 subroutine to determine a radial arc distribution of population centered on the release point of interest. The population data is based on 1980 census data.

APPENDIX B. SAMPLE OUTPUT FILE

```
1
 $$$$$$$$$ USER INPUT DATA TEMPLATE FOR THE POPGASP PROGRAM $$$$$$$$$$$$
 $                                                                     $
 $ INSTRUCTIONS --                                                     $
 $                                                                     $
 $ 1. SEE DPST-  -    FOR PROGRAM DESCRIPTION.                         $
 $                                                                     $
 $ 2. COPY THIS TEMPLATE INTO YOUR EDIT LIBRARY,  AS A RENAMED MEMBER. $
 $                                                                     $
 $ 3. BEGINNING AT LINE #61, DELETE ANY LINES THAT LIST NUCLIDES       $
 $    WHICH ARE NOT RELEASED, RETAINING NO MORE THAN 100 NUCLIDES.     $
 $                                                                     $
 $ 4. TO FACILITATE DATA ENTRY, PLACE A SPF HARDWARE TAB IN COLUMN 53  $
 $    (VIA 'TABS LINE COMMAND')  AND ENABLE TERMINAL-KEY TABBING TO    $
 $    COLUMN 54 (VIA "COMMAND ===> TABS ON ALL")     -- SEE THE IBM    $
 $    SPF MANUAL FOR DETAILS.                                          $
 $                                                                     $
 $ 5. ENTER YOUR INPUT, "RIGHT-JUSTIFIED" INTO  EACH FIELD  THAT IS    $
 $    FOLLOWED IMMEDIATELY BY A QUESTION MARK (?).   FIELDS FOLLOWED   $
 $    BY AN ASTERISK (*) CONTAIN STANDARD VALUES NOT NORMALLY ALTERED. $
 $                                                                     $
 $      EXCEPT FOR THE TITLE ENTRY, ALL FIELDS BEGIN IN COLUMN 54;     $
 $     THE (FORTRAN) FIELD FORMAT IS SPECIFIED AFTER THE "?" OR "*".   $
 $     THE "?" OR "*" MAY BE DELETED  (OR REPLACED)  AS THE DATA IS    $
 $     ENTERED.                                                        $
 $                                                                     $
 $ 6. SAVE THE RESULTING MEMBER, AND THEN SUBMIT THE JOB VIA USE OF    $
 $    DSN=TENVT.TMECA.JCL(POPGASP).                                    $
                                                                       $
 TITLE   = <POPGASP TEST CASE NUMBER 1             ?  (40A1)           $
                                                                       $
        OPERATING PERIOD, YEARS, OR USE 201 YEARS  =   1* (F3.0)       $
        TO OBTAIN 100-YEAR ENVIRONMENTAL DOSE                          $
        COMMITMENT PER YEAR OF OPERATION                               $
                                                                       $
        FACILITY GRADE ELEVATION, FT ABOVE MSL     =  300? (F4.0)      $
        (0 FOR UNKNOWN; 1000 FOR FLAT TERRAIN OR                       $
         A GROUND-LEVEL RELEASE)                                       $
                                                                       $
        RELEASE SRP-GRID COORDINATES, FT:  EASTING =  53970? (F6.0)    $
```

```
                                         NORTHING =  78020? (F6.0)    $
                                                                      $
       SRP AREA METEOROLOGICAL TOWER FOR MET DATA = F? (A1)           $
       (A,C,D,F,H,K,P OR T FOR TV TOWER)                              $
                                                                      $
 RELEASE VENT (STACK TIP) AND BUILDING PARAMETERS                     $
 (FOR 100% GROUND-LEVEL RELEASE, SET ITEMS 1-3 TO                     $
  0 AND ITEM 6 TO 10 METERS; FOR 100% ELEVATED                        $
  RELEASE, USE NEGATIVE VALUE IN ITEM 3);                             $
    1. VENT AVERAGE AIR VELOCITY, M/S            =   20.? (F5.0)      $
    2. VENT INSIDE DIAMETER, M                   =   10.? (F5.0)      $
    3. VENT HEIGHT, M ABOVE GRADE                =   -5.? (F5.0)      $
    4. HEIGHT OF VENT'S BLDG, M ABOVE GRADE      =    0.? (F5.0)      $
    5. MIN. VERT. X-SECTION OF VENT'S BLDG, SQ M  =  500.? (F5.0)     $
    6. SELECTED WIND HEIGHT (USUALLY VENT HEIGHT) =    5.? (F5.0)     $
    7. HEAT EMISSION RATE, CAL/S (NORMALLY 0 )    =  100.* (F5.0)     $
                                                                      $
 FRACTION OF EACH RELEASED RADIOIODINE THAT IS                        $
 CONSIDERED TO BE ELEMENTAL (REPLACE IF KNOWN)     = 0.50* (F4.0)     $
                                                                      $
 RELEASE RATES OF NUCLIDES TO ATMOSPHERE, CI/YR:                      $
  AR  41                                  AR  41 =  1.00E-00? (E9.0) $
  H    3                                  H    3 =  1.00E-00? (E9.0) $
  I  133                                  I  133 =  1.00E-00? (E9.0) $
  CS 137                                  CS 137 =  1.00E-00? (E9.0) $
  U  238                                  U  238 =  1.00E-00? (E9.0) $
```

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00
42718 WIND STATS F_AREA 60MIN 62M 92-96 STABILITY FROM SIGMA A

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS A

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.227	0.288	0.332	0.325	0.290	0.213	0.232	0.281	0.295	0.288	0.337	0.379	0.379	0.255	0.215	0.213	4.551
4.00	0.419	0.405	0.405	0.471	0.424	0.386	0.342	0.379	0.400	0.454	0.529	0.751	0.618	0.391	0.297	0.339	7.011
6.00	0.515	0.098	0.030	0.049	0.044	0.056	0.035	0.042	0.091	0.047	0.084	0.077	0.098	0.094	0.087	0.136	1.585
8.00	0.131	0.028	0.009	0.000	0.000	0.000	0.005	0.009	0.009	0.000	0.005	0.000	0.002	0.012	0.009	0.037	0.258
12.00	0.016	0.000	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.005	0.002	0.000	0.000	0.002	0.002	0.007	0.040
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	1.31	0.82	0.78	0.85	0.76	0.66	0.61	0.71	0.80	0.79	0.96	1.21	1.10	0.75	0.61	0.73	13.44

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS B

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.075	0.082	0.080	0.091	0.030	0.061	0.063	0.044	0.056	0.075	0.077	0.091	0.108	0.042	0.059	0.047	1.082
4.00	0.307	0.330	0.300	0.368	0.339	0.201	0.155	0.155	0.192	0.234	0.365	0.620	0.424	0.222	0.138	0.140	4.490
6.00	0.171	0.246	0.131	0.112	0.147	0.073	0.040	0.103	0.122	0.159	0.185	0.267	0.246	0.183	0.096	0.091	2.371
8.00	0.009	0.066	0.007	0.005	0.016	0.005	0.009	0.021	0.002	0.023	0.016	0.061	0.047	0.070	0.030	0.014	0.403
12.00	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.002	0.000	0.007	0.000	0.014	0.012	0.007	0.059
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.56	0.74	0.52	0.58	0.53	0.34	0.27	0.32	0.38	0.49	0.64	1.05	0.82	0.53	0.33	0.30	8.40

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS C

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.070	0.056	0.073	0.103	0.066	0.040	0.042	0.063	0.049	0.054	0.108	0.112	0.094	0.056	0.042	0.059	1.086
4.00	0.211	0.494	0.510	0.475	0.375	0.283	0.232	0.281	0.344	0.342	0.674	0.770	0.520	0.258	0.171	0.206	6.145
6.00	0.110	0.475	0.332	0.421	0.349	0.194	0.147	0.213	0.255	0.272	0.672	0.742	0.534	0.323	0.169	0.112	5.321
8.00	0.007	0.138	0.080	0.080	0.073	0.035	0.070	0.080	0.049	0.117	0.229	0.398	0.386	0.318	0.070	0.007	2.137
12.00	0.000	0.044	0.002	0.009	0.012	0.000	0.002	0.014	0.014	0.026	0.066	0.164	0.248	0.192	0.040	0.005	0.838
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.000	0.000	0.014
TOTAL	0.40	1.21	1.00	1.09	0.87	0.55	0.49	0.65	0.71	0.81	1.75	2.19	1.79	1.15	0.49	0.39	15.54

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS D

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.016	0.049	0.115	0.091	0.047	0.049	0.084	0.094	0.068	0.068	0.112	0.077	0.077	0.042	0.044	0.030	1.065
4.00	0.089	0.494	1.608	1.032	0.637	0.421	0.464	0.527	0.569	0.485	0.735	0.726	0.602	0.379	0.272	0.229	9.268
6.00	0.068	0.765	1.896	1.456	0.730	0.531	0.555	0.810	0.885	0.590	1.070	0.934	0.805	0.625	0.229	0.112	12.063
8.00	0.002	0.272	0.721	0.499	0.103	0.094	0.208	0.419	0.253	0.265	0.452	0.328	0.763	0.567	0.054	0.002	5.000
12.00	0.000	0.061	0.061	0.126	0.021	0.005	0.033	0.101	0.061	0.077	0.096	0.054	0.447	0.206	0.002	0.000	1.351

14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.030	0.016	0.000	0.000	0.052
TOTAL	0.18	1.64	4.40	3.20	1.54	1.10	1.35	1.95	1.84	1.48	2.47	2.12	2.72	1.84	0.60	0.37	28.80

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS E

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.014	0.030	0.028	0.021	0.035	0.052	0.061	0.054	0.056	0.040	0.037	0.049	0.026	0.019	0.026	0.548
4.00	0.044	0.243	1.306	0.613	0.335	0.454	0.543	0.758	0.810	0.700	0.709	0.691	0.613	0.494	0.309	0.201	8.825
6.00	0.014	0.562	1.898	1.313	0.581	0.438	0.616	1.053	1.142	0.890	0.993	1.086	1.079	0.765	0.377	0.176	12.983
8.00	0.002	0.187	0.222	0.258	0.028	0.019	0.016	0.068	0.061	0.110	0.140	0.096	0.185	0.047	0.014	0.005	1.458
12.00	0.000	0.000	0.002	0.023	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.06	1.01	3.46	2.24	0.96	0.95	1.23	1.94	2.07	1.76	1.88	1.91	1.93	1.33	0.72	0.41	23.84

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS F

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.002	0.009	0.002	0.002	0.000	0.016	0.016	0.007	0.007	0.007	0.005	0.002	0.005	0.005	0.005	0.091
4.00	0.009	0.063	0.227	0.110	0.073	0.143	0.178	0.236	0.234	0.248	0.293	0.337	0.229	0.169	0.140	0.091	2.781
6.00	0.012	0.136	0.363	0.375	0.304	0.304	0.335	0.316	0.384	0.529	0.520	0.623	0.468	0.346	0.279	0.119	5.412
8.00	0.000	0.014	0.021	0.070	0.056	0.021	0.012	0.002	0.016	0.056	0.042	0.028	0.026	0.009	0.005	0.007	0.386
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.02	0.22	0.62	0.56	0.44	0.47	0.54	0.57	0.64	0.84	0.86	0.99	0.73	0.53	0.43	0.22	8.67

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS G

UMX-M/S	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.005
4.00	0.000	0.014	0.037	0.014	0.002	0.033	0.019	0.028	0.016	0.040	0.021	0.033	0.021	0.016	0.014	0.026	0.335
6.00	0.007	0.019	0.052	0.091	0.070	0.110	0.066	0.037	0.047	0.059	0.061	0.096	0.047	0.049	0.047	0.035	0.892
8.00	0.000	0.000	0.002	0.016	0.009	0.012	0.016	0.000	0.000	0.005	0.002	0.002	0.000	0.000	0.000	0.002	0.068
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.01	0.03	0.09	0.12	0.08	0.15	0.10	0.07	0.07	0.10	0.09	0.13	0.07	0.07	0.06	0.06	1.30

TOTAL HOURS CONSIDERED ARE 42718

WIND MEASURED AT 62.0 METERS.

OVERALL WIND DIRECTION FREQUENCY

WIND DIRECTION:	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
FREQUENCY:	2.5	5.7	10.9	8.6	5.2	4.2	4.6	6.2	6.5	6.3	8.6	9.6	9.2	6.2	3.2	2.5	100.0

OVERALL WIND SPEED FREQUENCY

MAX WIND SPEED (M/S): 2.000 4.000 6.000 8.000 12.000 14.100

AVE WIND SPEED (M/S):	1.000	3.000	5.000	7.000	10.000	13.050
WIND SPEED FREQUENCY:	8.43	38.85	40.63	9.71	2.32	0.07

TERRAIN HEIGHTS IN METERS AS A FUNCTION OF DIRECTION AND DISTANCE FROM THE SITE:

	DIRECTION															
DISTANCE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1609.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3218.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4828.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6437.4	0.0	0.0	0.0	0.0	0.6	15.2	11.0	17.4	16.1	0.9	0.0	0.0	0.0	3.4	0.0	0.0
8046.8	0.0	0.0	0.0	0.0	0.6	15.2	19.2	28.0	23.5	10.7	0.0	0.0	0.6	12.2	6.4	0.0
9656.1	0.0	0.0	0.0	0.0	0.6	15.2	25.9	30.5	29.9	10.7	4.6	0.0	6.4	12.2	6.4	0.0
11265.5	0.0	0.0	0.0	0.0	0.6	15.2	28.9	30.5	31.1	10.7	6.1	1.2	6.4	12.2	6.4	0.0
12874.8	0.0	0.0	0.0	0.0	0.6	15.2	33.5	47.2	47.5	10.7	6.1	2.7	6.4	12.2	6.4	0.0
14484.1	0.0	0.0	0.0	0.0	0.6	15.2	33.5	47.2	48.8	10.7	10.1	4.3	6.4	12.2	6.4	0.0
16093.5	0.0	0.0	0.0	0.0	0.6	15.2	33.5	47.2	48.8	19.2	15.8	6.7	6.4	12.2	6.4	0.0
19312.2	0.0	0.0	0.0	0.0	0.6	15.2	33.5	48.8	48.8	30.5	30.5	11.0	6.4	12.2	9.1	0.0
22530.9	0.0	0.0	0.0	0.0	0.6	18.9	33.5	48.8	60.0	30.5	33.5	15.2	6.4	12.2	9.1	0.0
25749.6	0.0	0.0	0.0	0.0	0.6	18.9	47.8	60.9	60.9	46.9	34.1	23.5	6.4	12.2	9.1	6.1
28968.3	0.0	0.0	0.0	3.0	7.6	18.9	48.8	60.9	70.1	52.7	34.1	23.5	6.4	12.2	9.1	6.1
32187.0	0.0	0.0	0.0	12.8	16.5	18.9	48.8	60.9	73.1	52.7	34.1	23.5	6.4	12.2	9.1	6.1
40233.7	0.0	3.0	15.2	15.2	33.5	39.6	67.9	76.2	76.2	60.9	45.7	23.5	6.4	12.2	9.1	6.1
48280.5	0.0	21.3	18.3	18.6	60.6	61.9	79.2	94.5	82.9	68.9	54.2	23.5	6.4	12.2	9.1	6.1
56327.2	6.1	21.3	18.3	42.7	67.0	73.1	79.2	112.7	105.4	79.2	60.9	23.5	6.4	12.2	9.1	6.1
64374.0	6.1	21.3	30.5	42.7	67.0	73.1	79.2	112.7	112.7	79.2	60.9	23.5	6.4	12.2	9.1	6.1
72420.7	6.1	21.3	30.5	42.7	67.0	77.7	79.2	112.7	112.7	115.8	66.1	23.5	6.4	12.2	9.1	6.1
80467.5	6.1	21.3	30.5	42.7	73.1	91.4	79.2	112.7	112.7	115.8	73.1	30.5	6.4	12.2	9.1	6.1

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

NO DECAY, UNDEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	2.22E-06	5.69E-07	2.59E-07	1.53E-07	7.68E-08	4.78E-08	3.33E-08	2.50E-08	1.96E-08	1.60E-08	1.34E-08
SSW	7.92E-06	2.59E-06	1.31E-06	8.11E-07	4.22E-07	2.68E-07	1.90E-07	1.43E-07	1.14E-07	9.29E-08	7.79E-08
SW	2.04E-05	7.24E-06	3.76E-06	2.36E-06	1.24E-06	7.98E-07	5.68E-07	4.32E-07	3.43E-07	2.82E-07	2.37E-07
WSW	1.46E-05	5.10E-06	2.63E-06	1.65E-06	8.66E-07	5.55E-07	3.95E-07	3.00E-07	2.38E-07	1.95E-07	1.64E-07
W	8.32E-06	2.88E-06	1.48E-06	9.26E-07	4.87E-07	3.12E-07	2.22E-07	1.69E-07	1.34E-07	1.10E-07	9.29E-08
WNW	7.69E-06	2.87E-06	1.51E-06	9.54E-07	5.08E-07	3.28E-07	2.35E-07	1.80E-07	1.46E-07	1.20E-07	1.01E-07
NW	9.09E-06	3.40E-06	1.79E-06	1.13E-06	6.01E-07	3.88E-07	2.78E-07	2.12E-07	1.72E-07	1.42E-07	1.19E-07
NNW	1.21E-05	4.45E-06	2.33E-06	1.47E-06	7.80E-07	5.03E-07	3.59E-07	2.74E-07	2.22E-07	1.82E-07	1.53E-07
N	1.25E-05	4.59E-06	2.40E-06	1.52E-06	8.04E-07	5.18E-07	3.72E-07	2.85E-07	2.29E-07	1.88E-07	1.58E-07
NNE	1.19E-05	4.45E-06	2.34E-06	1.48E-06	7.85E-07	5.07E-07	3.63E-07	2.77E-07	2.22E-07	1.83E-07	1.56E-07
NE	1.47E-05	5.27E-06	2.73E-06	1.71E-06	9.05E-07	5.80E-07	4.14E-07	3.15E-07	2.50E-07	2.06E-07	1.73E-07
ENE	1.54E-05	5.54E-06	2.87E-06	1.80E-06	9.51E-07	6.11E-07	4.35E-07	3.31E-07	2.64E-07	2.17E-07	1.83E-07
E	1.40E-05	4.93E-06	2.55E-06	1.59E-06	8.38E-07	5.37E-07	3.83E-07	2.91E-07	2.31E-07	1.90E-07	1.60E-07
ESE	9.56E-06	3.43E-06	1.78E-06	1.12E-06	5.91E-07	3.80E-07	2.71E-07	2.06E-07	1.65E-07	1.36E-07	1.15E-07
SE	5.79E-06	2.14E-06	1.12E-06	7.04E-07	3.74E-07	2.42E-07	1.73E-07	1.32E-07	1.06E-07	8.69E-08	7.41E-08
SSE	4.10E-06	1.47E-06	7.62E-07	4.79E-07	2.54E-07	1.64E-07	1.17E-07	8.97E-08	7.16E-08	5.89E-08	4.97E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	1.15E-08	6.55E-09	4.45E-09	2.65E-09	1.88E-09	1.45E-09	1.17E-09	9.80E-10	8.40E-10	7.34E-10	6.51E-10
SSW	6.67E-08	3.71E-08	2.46E-08	1.40E-08	9.48E-09	7.05E-09	5.54E-09	4.52E-09	3.79E-09	3.25E-09	2.83E-09
SW	2.03E-07	1.13E-07	7.50E-08	4.25E-08	2.85E-08	2.11E-08	1.64E-08	1.33E-08	1.11E-08	9.50E-09	8.24E-09
WSW	1.41E-07	7.85E-08	5.22E-08	2.96E-08	2.01E-08	1.48E-08	1.16E-08	9.42E-09	7.88E-09	6.74E-09	5.86E-09
W	7.97E-08	4.46E-08	2.97E-08	1.70E-08	1.16E-08	8.58E-09	6.73E-09	5.49E-09	4.61E-09	3.95E-09	3.44E-09
WNW	8.71E-08	4.91E-08	3.29E-08	1.89E-08	1.28E-08	9.55E-09	7.51E-09	6.13E-09	5.15E-09	4.42E-09	3.86E-09
NW	1.02E-07	5.75E-08	3.84E-08	2.20E-08	1.49E-08	1.10E-08	8.64E-09	7.04E-09	5.90E-09	5.06E-09	4.40E-09
NNW	1.32E-07	7.36E-08	4.90E-08	2.79E-08	1.89E-08	1.39E-08	1.09E-08	8.87E-09	7.43E-09	6.35E-09	5.52E-09
N	1.36E-07	7.59E-08	5.06E-08	2.89E-08	1.95E-08	1.44E-08	1.13E-08	9.19E-09	7.69E-09	6.58E-09	5.73E-09
NNE	1.34E-07	7.54E-08	5.04E-08	2.89E-08	1.96E-08	1.45E-08	1.14E-08	9.30E-09	7.80E-09	6.69E-09	5.83E-09
NE	1.48E-07	8.39E-08	5.59E-08	3.18E-08	2.16E-08	1.60E-08	1.25E-08	1.02E-08	8.57E-09	7.34E-09	6.40E-09
ENE	1.57E-07	8.85E-08	5.94E-08	3.40E-08	2.31E-08	1.72E-08	1.35E-08	1.11E-08	9.28E-09	7.96E-09	6.95E-09
E	1.37E-07	7.73E-08	5.15E-08	2.93E-08	1.99E-08	1.47E-08	1.16E-08	9.42E-09	7.90E-09	6.77E-09	5.89E-09
ESE	9.88E-08	5.53E-08	3.68E-08	2.10E-08	1.42E-08	1.06E-08	8.28E-09	6.75E-09	5.66E-09	4.85E-09	4.22E-09
SE	6.40E-08	3.61E-08	2.42E-08	1.39E-08	9.48E-09	7.06E-09	5.55E-09	4.54E-09	3.81E-09	3.27E-09	2.86E-09

SSE 4.28E-08 2.43E-08 1.63E-08 9.51E-09 6.53E-09 4.88E-09 3.85E-09 3.16E-09 2.66E-09 2.29E-09 2.00E-09
ALL ELEVATED RELEASES.

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

NO DECAY, UNDEPLETED
CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.80E-07	8.07E-08	3.38E-08	1.98E-08	1.34E-08	6.71E-09	2.71E-09	1.45E-09	9.81E-10	7.35E-10
SSW	1.37E-06	4.40E-07	1.92E-07	1.14E-07	7.82E-08	3.81E-08	1.43E-08	7.09E-09	4.53E-09	3.25E-09
SW	3.91E-06	1.29E-06	5.75E-07	3.45E-07	2.38E-07	1.16E-07	4.35E-08	2.12E-08	1.34E-08	9.52E-09
WSW	2.74E-06	9.01E-07	3.99E-07	2.39E-07	1.65E-07	8.06E-08	3.04E-08	1.49E-08	9.46E-09	6.75E-09
W	1.55E-06	5.07E-07	2.25E-07	1.35E-07	9.32E-08	4.58E-08	1.74E-08	8.64E-09	5.51E-09	3.96E-09
WNW	1.57E-06	5.27E-07	2.38E-07	1.46E-07	1.02E-07	5.03E-08	1.93E-08	9.61E-09	6.15E-09	4.43E-09
NW	1.85E-06	6.24E-07	2.81E-07	1.72E-07	1.20E-07	5.90E-08	2.25E-08	1.11E-08	7.07E-09	5.07E-09
NNW	2.42E-06	8.10E-07	3.63E-07	2.22E-07	1.54E-07	7.56E-08	2.86E-08	1.40E-08	8.90E-09	6.36E-09
N	2.50E-06	8.35E-07	3.76E-07	2.29E-07	1.59E-07	7.80E-08	2.95E-08	1.45E-08	9.22E-09	6.59E-09
NNE	2.42E-06	8.15E-07	3.67E-07	2.23E-07	1.56E-07	7.73E-08	2.95E-08	1.46E-08	9.33E-09	6.70E-09
NE	2.84E-06	9.41E-07	4.19E-07	2.52E-07	1.74E-07	8.58E-08	3.26E-08	1.61E-08	1.03E-08	7.36E-09
ENE	2.99E-06	9.89E-07	4.41E-07	2.65E-07	1.83E-07	9.07E-08	3.48E-08	1.73E-08	1.11E-08	7.98E-09
E	2.65E-06	8.72E-07	3.87E-07	2.32E-07	1.60E-07	7.91E-08	3.01E-08	1.48E-08	9.45E-09	6.78E-09
ESE	1.85E-06	6.14E-07	2.74E-07	1.66E-07	1.15E-07	5.68E-08	2.15E-08	1.06E-08	6.77E-09	4.86E-09
SE	1.16E-06	3.89E-07	1.75E-07	1.06E-07	7.41E-08	3.70E-08	1.42E-08	7.10E-09	4.55E-09	3.28E-09
SSE	7.93E-07	2.64E-07	1.19E-07	7.19E-08	4.99E-08	2.49E-08	9.70E-09	4.91E-09	3.17E-09	2.29E-09

AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.44E+00	5.44E+00	5.44E+00	5.44E+00	5.44E+00	5.44E+00	5.44E+00	5.44E+00	1.63E+00	1.13E-01
SSW	6.12E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00	2.66E+00	0.00E+00	0.00E+00
SW	6.80E+00	6.80E+00	6.80E+00	6.80E+00	6.80E+00	6.80E+00	6.80E+00	1.81E+00	0.00E+00	0.00E+00
WSW	6.56E+00	6.56E+00	6.56E+00	6.56E+00	6.56E+00	6.56E+00	3.65E+00	0.00E+00	0.00E+00	0.00E+00
W	6.36E+00	6.36E+00	6.36E+00	6.03E+00	5.75E+00	5.75E+00	3.20E+00	0.00E+00	0.00E+00	0.00E+00
WNW	6.72E+00	6.72E+00	6.72E+00	2.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NW	6.90E+00	6.90E+00	6.90E+00	2.49E+00	3.85E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NNW	6.95E+00	6.95E+00	6.95E+00	2.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
N	6.98E+00	6.98E+00	5.60E+00	1.33E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NNE	6.95E+00	6.95E+00	6.95E+00	6.45E+00	2.28E+00	7.27E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NE	6.53E+00	6.53E+00	6.53E+00	6.53E+00	6.53E+00	1.79E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ENE	6.47E+00	6.47E+00	6.47E+00	6.47E+00	6.47E+00	3.28E+00	1.69E-01	0.00E+00	0.00E+00	0.00E+00
E	6.40E+00	6.40E+00	6.40E+00	6.40E+00	6.08E+00	1.93E+00	8.21E-01	8.21E-01	8.21E-01	8.21E-01
ESE	6.46E+00	6.46E+00	6.46E+00	4.62E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

SE	6.73E+00	6.73E+00	6.73E+00	6.73E+00	3.55E+00	1.02E+00	3.03E-01	9.91E-02	9.91E-02	9.91E-02
SSE	6.41E+00	6.41E+00	6.41E+00	6.41E+00	6.41E+00	6.41E+00	2.94E+00	8.73E-01	8.73E-01	8.73E-01

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

2.260 DAY DECAY, UNDEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	2.22E-06	5.67E-07	2.58E-07	1.52E-07	7.61E-08	4.72E-08	3.28E-08	2.45E-08	1.92E-08	1.56E-08	1.30E-08
SSW	7.91E-06	2.59E-06	1.30E-06	8.07E-07	4.19E-07	2.65E-07	1.87E-07	1.41E-07	1.11E-07	9.10E-08	7.61E-08
SW	2.04E-05	7.22E-06	3.75E-06	2.35E-06	1.23E-06	7.89E-07	5.61E-07	4.25E-07	3.37E-07	2.76E-07	2.31E-07
WSW	1.46E-05	5.09E-06	2.62E-06	1.64E-06	8.60E-07	5.49E-07	3.90E-07	2.95E-07	2.34E-07	1.91E-07	1.61E-07
W	8.31E-06	2.87E-06	1.48E-06	9.21E-07	4.84E-07	3.09E-07	2.19E-07	1.66E-07	1.32E-07	1.08E-07	9.07E-08
WNW	7.68E-06	2.86E-06	1.50E-06	9.48E-07	5.04E-07	3.24E-07	2.32E-07	1.76E-07	1.43E-07	1.18E-07	9.88E-08
NW	9.08E-06	3.39E-06	1.78E-06	1.12E-06	5.95E-07	3.83E-07	2.73E-07	2.08E-07	1.68E-07	1.38E-07	1.16E-07
NNW	1.21E-05	4.44E-06	2.32E-06	1.46E-06	7.73E-07	4.96E-07	3.54E-07	2.69E-07	2.17E-07	1.78E-07	1.49E-07
N	1.25E-05	4.58E-06	2.39E-06	1.51E-06	7.97E-07	5.12E-07	3.67E-07	2.80E-07	2.24E-07	1.83E-07	1.54E-07
NNE	1.18E-05	4.43E-06	2.33E-06	1.47E-06	7.78E-07	5.01E-07	3.58E-07	2.72E-07	2.17E-07	1.78E-07	1.52E-07
NE	1.47E-05	5.25E-06	2.72E-06	1.71E-06	8.97E-07	5.74E-07	4.08E-07	3.09E-07	2.45E-07	2.01E-07	1.69E-07
ENE	1.54E-05	5.52E-06	2.86E-06	1.79E-06	9.43E-07	6.04E-07	4.29E-07	3.26E-07	2.59E-07	2.12E-07	1.78E-07
E	1.40E-05	4.92E-06	2.54E-06	1.58E-06	8.32E-07	5.31E-07	3.77E-07	2.86E-07	2.27E-07	1.86E-07	1.56E-07
ESE	9.54E-06	3.42E-06	1.77E-06	1.11E-06	5.86E-07	3.75E-07	2.67E-07	2.03E-07	1.62E-07	1.33E-07	1.12E-07
SE	5.79E-06	2.13E-06	1.11E-06	7.00E-07	3.71E-07	2.39E-07	1.70E-07	1.30E-07	1.03E-07	8.48E-08	7.21E-08
SSE	4.09E-06	1.46E-06	7.58E-07	4.75E-07	2.52E-07	1.62E-07	1.15E-07	8.78E-08	6.98E-08	5.73E-08	4.82E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	1.11E-08	6.27E-09	4.20E-09	2.43E-09	1.67E-09	1.25E-09	9.82E-10	8.00E-10	6.66E-10	5.66E-10	4.88E-10
SSW	6.50E-08	3.56E-08	2.33E-08	1.29E-08	8.53E-09	6.18E-09	4.73E-09	3.76E-09	3.07E-09	2.57E-09	2.18E-09
SW	1.98E-07	1.09E-07	7.11E-08	3.91E-08	2.56E-08	1.84E-08	1.40E-08	1.10E-08	8.96E-09	7.45E-09	6.29E-09
WSW	1.37E-07	7.56E-08	4.96E-08	2.74E-08	1.81E-08	1.31E-08	9.95E-09	7.89E-09	6.44E-09	5.37E-09	4.55E-09
W	7.76E-08	4.28E-08	2.82E-08	1.57E-08	1.04E-08	7.52E-09	5.75E-09	4.57E-09	3.74E-09	3.12E-09	2.65E-09
WNW	8.46E-08	4.69E-08	3.10E-08	1.73E-08	1.14E-08	8.26E-09	6.31E-09	5.01E-09	4.10E-09	3.42E-09	2.90E-09
NW	9.91E-08	5.47E-08	3.59E-08	1.99E-08	1.30E-08	9.36E-09	7.12E-09	5.62E-09	4.57E-09	3.80E-09	3.21E-09
NNW	1.27E-07	7.01E-08	4.60E-08	2.53E-08	1.66E-08	1.19E-08	9.01E-09	7.11E-09	5.77E-09	4.79E-09	4.04E-09
N	1.32E-07	7.25E-08	4.76E-08	2.63E-08	1.73E-08	1.24E-08	9.41E-09	7.44E-09	6.05E-09	5.03E-09	4.25E-09
NNE	1.30E-07	7.20E-08	4.74E-08	2.64E-08	1.74E-08	1.25E-08	9.53E-09	7.56E-09	6.16E-09	5.13E-09	4.35E-09
NE	1.44E-07	8.03E-08	5.27E-08	2.92E-08	1.92E-08	1.38E-08	1.06E-08	8.37E-09	6.83E-09	5.69E-09	4.82E-09
ENE	1.52E-07	8.49E-08	5.62E-08	3.13E-08	2.07E-08	1.50E-08	1.15E-08	9.11E-09	7.45E-09	6.22E-09	5.29E-09
E	1.33E-07	7.41E-08	4.87E-08	2.70E-08	1.78E-08	1.28E-08	9.78E-09	7.76E-09	6.33E-09	5.28E-09	4.48E-09
ESE	9.61E-08	5.30E-08	3.48E-08	1.93E-08	1.27E-08	9.19E-09	7.01E-09	5.56E-09	4.54E-09	3.79E-09	3.21E-09
SE	6.21E-08	3.45E-08	2.28E-08	1.27E-08	8.40E-09	6.07E-09	4.64E-09	3.68E-09	3.01E-09	2.51E-09	2.13E-09

SSE 4.13E-08 2.30E-08 1.52E-08 8.57E-09 5.69E-09 4.11E-09 3.15E-09 2.50E-09 2.04E-09 1.70E-09 1.44E-09
ALL ELEVATED RELEASES.

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

2.260 DAY DECAY, UNDEPLETED
CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.79E-07	8.00E-08	3.34E-08	1.94E-08	1.31E-08	6.43E-09	2.49E-09	1.26E-09	8.01E-10	5.67E-10
SSW	1.37E-06	4.37E-07	1.90E-07	1.12E-07	7.64E-08	3.67E-08	1.33E-08	6.22E-09	3.77E-09	2.57E-09
SW	3.90E-06	1.28E-06	5.67E-07	3.39E-07	2.32E-07	1.12E-07	4.02E-08	1.86E-08	1.11E-08	7.47E-09
WSW	2.73E-06	8.95E-07	3.94E-07	2.35E-07	1.61E-07	7.77E-08	2.82E-08	1.32E-08	7.93E-09	5.38E-09
W	1.54E-06	5.03E-07	2.22E-07	1.33E-07	9.10E-08	4.41E-08	1.61E-08	7.58E-09	4.59E-09	3.13E-09
WNW	1.56E-06	5.23E-07	2.34E-07	1.43E-07	9.91E-08	4.82E-08	1.77E-08	8.32E-09	5.03E-09	3.43E-09
NW	1.84E-06	6.18E-07	2.76E-07	1.68E-07	1.16E-07	5.62E-08	2.04E-08	9.45E-09	5.65E-09	3.81E-09
NNW	2.41E-06	8.03E-07	3.58E-07	2.17E-07	1.49E-07	7.21E-08	2.60E-08	1.20E-08	7.14E-09	4.80E-09
N	2.49E-06	8.28E-07	3.71E-07	2.24E-07	1.54E-07	7.46E-08	2.70E-08	1.25E-08	7.47E-09	5.04E-09
NNE	2.41E-06	8.08E-07	3.62E-07	2.18E-07	1.52E-07	7.40E-08	2.70E-08	1.26E-08	7.59E-09	5.14E-09
NE	2.83E-06	9.33E-07	4.13E-07	2.47E-07	1.69E-07	8.23E-08	3.00E-08	1.40E-08	8.41E-09	5.70E-09
ENE	2.98E-06	9.81E-07	4.35E-07	2.60E-07	1.79E-07	8.71E-08	3.21E-08	1.51E-08	9.15E-09	6.24E-09
E	2.64E-06	8.65E-07	3.82E-07	2.28E-07	1.56E-07	7.60E-08	2.77E-08	1.29E-08	7.79E-09	5.29E-09
ESE	1.85E-06	6.09E-07	2.70E-07	1.63E-07	1.12E-07	5.45E-08	1.98E-08	9.26E-09	5.59E-09	3.80E-09
SE	1.16E-06	3.85E-07	1.72E-07	1.04E-07	7.21E-08	3.54E-08	1.30E-08	6.12E-09	3.70E-09	2.52E-09
SSE	7.89E-07	2.61E-07	1.17E-07	7.02E-08	4.84E-08	2.36E-08	8.77E-09	4.15E-09	2.51E-09	1.70E-09

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

8.000 DAY DECAY, DEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	2.10E-06	5.19E-07	2.31E-07	1.33E-07	6.50E-08	3.94E-08	2.69E-08	1.97E-08	1.52E-08	1.22E-08	1.00E-08
SSW	7.49E-06	2.37E-06	1.17E-06	7.09E-07	3.58E-07	2.21E-07	1.53E-07	1.13E-07	8.81E-08	7.09E-08	5.85E-08
SW	1.93E-05	6.61E-06	3.35E-06	2.06E-06	1.05E-06	6.59E-07	4.59E-07	3.41E-07	2.66E-07	2.15E-07	1.78E-07
WSW	1.38E-05	4.65E-06	2.34E-06	1.44E-06	7.34E-07	4.58E-07	3.19E-07	2.37E-07	1.85E-07	1.49E-07	1.23E-07
W	7.87E-06	2.63E-06	1.32E-06	8.10E-07	4.13E-07	2.58E-07	1.79E-07	1.34E-07	1.04E-07	8.43E-08	6.98E-08
WNW	7.27E-06	2.62E-06	1.34E-06	8.34E-07	4.30E-07	2.71E-07	1.90E-07	1.42E-07	1.14E-07	9.18E-08	7.61E-08
NW	8.60E-06	3.10E-06	1.59E-06	9.87E-07	5.09E-07	3.20E-07	2.24E-07	1.67E-07	1.33E-07	1.08E-07	8.94E-08
NNW	1.14E-05	4.06E-06	2.08E-06	1.28E-06	6.61E-07	4.15E-07	2.90E-07	2.16E-07	1.72E-07	1.39E-07	1.15E-07
N	1.18E-05	4.19E-06	2.14E-06	1.32E-06	6.81E-07	4.27E-07	3.00E-07	2.25E-07	1.77E-07	1.43E-07	1.19E-07
NNE	1.12E-05	4.06E-06	2.08E-06	1.29E-06	6.65E-07	4.18E-07	2.93E-07	2.19E-07	1.72E-07	1.39E-07	1.17E-07
NE	1.39E-05	4.81E-06	2.43E-06	1.50E-06	7.66E-07	4.79E-07	3.34E-07	2.49E-07	1.94E-07	1.57E-07	1.30E-07
ENE	1.46E-05	5.05E-06	2.56E-06	1.58E-06	8.06E-07	5.04E-07	3.51E-07	2.62E-07	2.05E-07	1.65E-07	1.37E-07
E	1.33E-05	4.50E-06	2.27E-06	1.39E-06	7.10E-07	4.43E-07	3.09E-07	2.30E-07	1.79E-07	1.45E-07	1.20E-07
ESE	9.04E-06	3.13E-06	1.59E-06	9.77E-07	5.01E-07	3.13E-07	2.19E-07	1.63E-07	1.28E-07	1.04E-07	8.65E-08
SE	5.48E-06	1.95E-06	9.94E-07	6.15E-07	3.17E-07	1.99E-07	1.40E-07	1.04E-07	8.18E-08	6.63E-08	5.56E-08
SSE	3.87E-06	1.34E-06	6.78E-07	4.18E-07	2.15E-07	1.35E-07	9.47E-08	7.08E-08	5.54E-08	4.49E-08	3.73E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	8.48E-09	4.56E-09	2.94E-09	1.61E-09	1.06E-09	7.68E-10	5.87E-10	4.67E-10	3.81E-10	3.18E-10	2.70E-10
SSW	4.93E-08	2.58E-08	1.63E-08	8.50E-09	5.37E-09	3.75E-09	2.79E-09	2.16E-09	1.73E-09	1.42E-09	1.18E-09
SW	1.50E-07	7.88E-08	4.96E-08	2.58E-08	1.62E-08	1.12E-08	8.28E-09	6.37E-09	5.07E-09	4.13E-09	3.43E-09
WSW	1.04E-07	5.47E-08	3.45E-08	1.80E-08	1.14E-08	7.91E-09	5.85E-09	4.52E-09	3.60E-09	2.95E-09	2.45E-09
W	5.90E-08	3.11E-08	1.97E-08	1.03E-08	6.55E-09	4.57E-09	3.39E-09	2.63E-09	2.10E-09	1.72E-09	1.44E-09
WNW	6.44E-08	3.42E-08	2.17E-08	1.14E-08	7.25E-09	5.07E-09	3.77E-09	2.92E-09	2.34E-09	1.92E-09	1.60E-09
NW	7.56E-08	4.00E-08	2.53E-08	1.33E-08	8.36E-09	5.82E-09	4.31E-09	3.33E-09	2.66E-09	2.17E-09	1.81E-09
NNW	9.72E-08	5.12E-08	3.23E-08	1.69E-08	1.06E-08	7.36E-09	5.44E-09	4.20E-09	3.34E-09	2.73E-09	2.27E-09
N	1.00E-07	5.28E-08	3.34E-08	1.75E-08	1.10E-08	7.64E-09	5.65E-09	4.36E-09	3.48E-09	2.84E-09	2.36E-09
NNE	9.91E-08	5.24E-08	3.33E-08	1.75E-08	1.10E-08	7.70E-09	5.71E-09	4.42E-09	3.53E-09	2.89E-09	2.41E-09
NE	1.10E-07	5.84E-08	3.69E-08	1.93E-08	1.22E-08	8.49E-09	6.29E-09	4.87E-09	3.89E-09	3.18E-09	2.65E-09
ENE	1.16E-07	6.16E-08	3.93E-08	2.07E-08	1.31E-08	9.15E-09	6.80E-09	5.28E-09	4.22E-09	3.46E-09	2.89E-09
E	1.01E-07	5.39E-08	3.40E-08	1.78E-08	1.12E-08	7.83E-09	5.81E-09	4.50E-09	3.59E-09	2.94E-09	2.45E-09
ESE	7.31E-08	3.85E-08	2.44E-08	1.28E-08	8.06E-09	5.61E-09	4.16E-09	3.22E-09	2.57E-09	2.11E-09	1.76E-09
SE	4.73E-08	2.51E-08	1.60E-08	8.43E-09	5.35E-09	3.74E-09	2.78E-09	2.16E-09	1.73E-09	1.41E-09	1.18E-09

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SSE 3.16E-08 1.69E-08 1.08E-08 5.74E-09 3.66E-09 2.57E-09 1.91E-09 1.49E-09 1.19E-09 9.79E-10 8.19E-10
ALL ELEVATED RELEASES.
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USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

8.000 DAY DECAY, DEPLETED
CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.51E-07	6.88E-08	2.74E-08	1.54E-08	1.01E-08	4.71E-09	1.66E-09	7.74E-10	4.68E-10	3.19E-10
SSW	1.23E-06	3.75E-07	1.55E-07	8.88E-08	5.88E-08	2.68E-08	8.84E-09	3.80E-09	2.18E-09	1.42E-09
SW	3.50E-06	1.10E-06	4.65E-07	2.68E-07	1.79E-07	8.17E-08	2.68E-08	1.14E-08	6.42E-09	4.15E-09
WSW	2.46E-06	7.68E-07	3.23E-07	1.86E-07	1.24E-07	5.68E-08	1.87E-08	8.01E-09	4.55E-09	2.96E-09
W	1.38E-06	4.32E-07	1.82E-07	1.05E-07	7.01E-08	3.22E-08	1.07E-08	4.63E-09	2.65E-09	1.73E-09
WNW	1.40E-06	4.49E-07	1.92E-07	1.13E-07	7.64E-08	3.54E-08	1.19E-08	5.13E-09	2.94E-09	1.92E-09
NW	1.66E-06	5.31E-07	2.27E-07	1.33E-07	8.98E-08	4.14E-08	1.38E-08	5.89E-09	3.35E-09	2.18E-09
NNW	2.16E-06	6.90E-07	2.94E-07	1.72E-07	1.16E-07	5.30E-08	1.75E-08	7.46E-09	4.23E-09	2.74E-09
N	2.23E-06	7.11E-07	3.04E-07	1.78E-07	1.19E-07	5.48E-08	1.81E-08	7.74E-09	4.39E-09	2.85E-09
NNE	2.17E-06	6.94E-07	2.97E-07	1.73E-07	1.17E-07	5.43E-08	1.81E-08	7.80E-09	4.45E-09	2.90E-09
NE	2.55E-06	8.01E-07	3.38E-07	1.96E-07	1.30E-07	6.03E-08	2.01E-08	8.60E-09	4.90E-09	3.20E-09
ENE	2.68E-06	8.43E-07	3.56E-07	2.06E-07	1.38E-07	6.38E-08	2.14E-08	9.26E-09	5.31E-09	3.48E-09
E	2.37E-06	7.43E-07	3.13E-07	1.81E-07	1.20E-07	5.56E-08	1.85E-08	7.93E-09	4.53E-09	2.95E-09
ESE	1.66E-06	5.23E-07	2.22E-07	1.29E-07	8.67E-08	3.99E-08	1.32E-08	5.68E-09	3.24E-09	2.12E-09
SE	1.04E-06	3.31E-07	1.42E-07	8.24E-08	5.57E-08	2.60E-08	8.74E-09	3.78E-09	2.17E-09	1.42E-09
SSE	7.09E-07	2.25E-07	9.60E-08	5.58E-08	3.74E-08	1.74E-08	5.93E-09	2.60E-09	1.50E-09	9.83E-10

SNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00
42718 WIND STATS F_AREA 60MIN 62M 92-96 STABILITY FROM SIGMA A

***************RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS**************

DIRECTION FROM SITE	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
						DISTANCES IN MILES					
S	3.18E-09	2.28E-09	1.49E-09	9.97E-10	4.87E-10	3.06E-10	2.14E-10	1.60E-10	1.25E-10	1.01E-10	8.41E-11
SSW	3.89E-09	2.84E-09	1.95E-09	1.39E-09	7.46E-10	4.98E-10	3.62E-10	2.77E-10	2.20E-10	1.79E-10	1.49E-10
SW	3.25E-09	2.49E-09	1.90E-09	1.53E-09	9.45E-10	6.81E-10	5.17E-10	4.06E-10	3.27E-10	2.68E-10	2.22E-10
WSW	3.55E-09	2.66E-09	1.93E-09	1.48E-09	8.62E-10	6.04E-10	4.51E-10	3.51E-10	2.81E-10	2.30E-10	1.91E-10
W	3.05E-09	2.24E-09	1.55E-09	1.12E-09	6.12E-10	4.13E-10	3.02E-10	2.32E-10	1.84E-10	1.50E-10	1.25E-10
WNW	2.18E-09	1.60E-09	1.11E-09	8.02E-10	4.38E-10	2.95E-10	2.16E-10	1.66E-10	1.32E-10	1.08E-10	8.94E-11
NW	1.94E-09	1.44E-09	1.02E-09	7.57E-10	4.28E-10	2.94E-10	2.18E-10	1.69E-10	1.35E-10	1.10E-10	9.13E-11
NNW	2.38E-09	1.78E-09	1.28E-09	9.66E-10	5.57E-10	3.87E-10	2.88E-10	2.24E-10	1.79E-10	1.46E-10	1.22E-10
N	2.66E-09	1.97E-09	1.40E-09	1.04E-09	5.86E-10	4.03E-10	2.98E-10	2.30E-10	1.84E-10	1.50E-10	1.25E-10
NNE	2.95E-09	2.17E-09	1.50E-09	1.09E-09	5.92E-10	3.99E-10	2.92E-10	2.24E-10	1.78E-10	1.45E-10	1.21E-10
NE	4.72E-09	3.47E-09	2.41E-09	1.75E-09	9.56E-10	6.46E-10	4.73E-10	3.64E-10	2.89E-10	2.36E-10	1.96E-10
ENE	6.24E-09	4.55E-09	3.09E-09	2.17E-09	1.14E-09	7.56E-10	5.45E-10	4.15E-10	3.29E-10	2.68E-10	2.22E-10
E	5.22E-09	3.84E-09	2.67E-09	1.93E-09	1.06E-09	7.15E-10	5.23E-10	4.02E-10	3.20E-10	2.61E-10	2.17E-10
ESE	3.43E-09	2.53E-09	1.76E-09	1.28E-09	7.00E-10	4.74E-10	3.47E-10	2.67E-10	2.12E-10	1.73E-10	1.44E-10
SE	2.02E-09	1.47E-09	9.91E-10	6.93E-10	3.61E-10	2.37E-10	1.70E-10	1.30E-10	1.02E-10	8.33E-11	6.93E-11
SSE	2.00E-09	1.44E-09	9.59E-10	6.57E-10	3.33E-10	2.15E-10	1.53E-10	1.15E-10	9.09E-11	7.38E-11	6.13E-11

DIRECTION FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
						DISTANCES IN MILES					
S	7.13E-11	3.83E-11	2.50E-11	1.39E-11	9.11E-12	7.10E-12	5.67E-12	4.61E-12	3.82E-12	3.20E-12	2.71E-12
SSW	1.26E-10	6.70E-11	4.33E-11	2.35E-11	1.52E-11	1.15E-11	9.08E-12	7.35E-12	6.09E-12	5.12E-12	4.38E-12
SW	1.87E-10	9.89E-11	6.32E-11	3.37E-11	2.14E-11	1.56E-11	1.21E-11	9.78E-12	8.14E-12	6.89E-12	5.96E-12
WSW	1.61E-10	8.54E-11	5.48E-11	2.94E-11	1.88E-11	1.39E-11	1.09E-11	1.08E-11	8.79E-12	7.33E-12	6.26E-12
W	1.06E-10	5.61E-11	3.62E-11	1.96E-11	1.27E-11	9.61E-12	1.23E-11	9.43E-12	7.51E-12	6.12E-12	5.47E-12
WNW	7.55E-11	4.02E-11	2.59E-11	1.40E-11	9.07E-12	7.72E-12	9.94E-12	8.71E-12	6.85E-12	5.53E-12	4.35E-12
NW	7.71E-11	4.12E-11	2.65E-11	1.53E-11	1.25E-11	1.36E-11	1.18E-11	8.98E-12	7.04E-12	5.66E-12	4.64E-12
NNW	1.03E-10	5.54E-11	4.16E-11	3.59E-11	2.51E-11	2.13E-11	1.42E-11	1.04E-11	8.27E-12	6.75E-12	5.61E-12
N	1.05E-10	5.72E-11	4.39E-11	4.04E-11	3.18E-11	2.20E-11	1.49E-11	1.07E-11	8.56E-12	6.99E-12	5.81E-12
NNE	1.02E-10	5.43E-11	3.50E-11	2.04E-11	1.85E-11	1.97E-11	1.44E-11	1.27E-11	9.98E-12	7.29E-12	6.06E-12
NE	1.66E-10	8.81E-11	5.68E-11	3.08E-11	2.02E-11	1.94E-11	1.92E-11	1.58E-11	1.25E-11	1.02E-11	9.30E-12
ENE	1.88E-10	1.00E-10	6.49E-11	3.54E-11	2.30E-11	1.75E-11	1.39E-11	1.14E-11	9.47E-12	8.03E-12	6.92E-12
E	1.83E-10	9.75E-11	6.28E-11	3.40E-11	2.19E-11	1.65E-11	1.28E-11	1.03E-11	8.43E-12	7.02E-12	5.93E-12
ESE	1.22E-10	6.47E-11	4.17E-11	2.26E-11	1.46E-11	1.09E-11	8.54E-12	6.87E-12	5.65E-12	4.73E-12	4.02E-12
SE	5.86E-11	3.13E-11	2.02E-11	1.11E-11	7.19E-12	5.49E-12	4.34E-12	3.52E-12	2.92E-12	2.45E-12	2.10E-12
SSE	5.19E-11	2.78E-11	1.80E-11	9.93E-12	6.47E-12	4.97E-12	3.94E-12	3.19E-12	2.63E-12	2.20E-12	1.87E-12

SNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 11/18/00

42718 WIND STATS F_AREA 60MIN 62M 92-96 STABILITY FROM SIGMA A

*******************RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS*******************

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.45E-09	5.20E-10	2.17E-10	1.26E-10	8.45E-11	3.97E-11	1.42E-11	7.06E-12	4.61E-12	3.20E-12
SSW	1.90E-09	7.79E-10	3.64E-10	2.21E-10	1.49E-10	6.95E-11	2.42E-11	1.15E-11	7.36E-12	5.14E-12
SW	1.87E-09	9.57E-10	5.16E-10	3.27E-10	2.23E-10	1.03E-10	3.48E-11	1.58E-11	9.83E-12	6.92E-12
WSW	1.89E-09	8.84E-10	4.52E-10	2.82E-10	1.92E-10	8.86E-11	3.03E-11	1.40E-11	1.00E-11	7.37E-12
W	1.51E-09	6.37E-10	3.03E-10	1.85E-10	1.25E-10	5.82E-11	2.02E-11	1.15E-11	9.51E-12	6.29E-12
WNW	1.08E-09	4.56E-10	2.17E-10	1.32E-10	8.96E-11	4.17E-11	1.45E-11	8.97E-12	8.35E-12	5.48E-12
NW	9.96E-10	4.42E-10	2.19E-10	1.35E-10	9.15E-11	4.27E-11	1.66E-11	1.26E-11	9.06E-12	5.69E-12
NNW	1.25E-09	5.72E-10	2.89E-10	1.80E-10	1.22E-10	5.97E-11	3.23E-11	1.94E-11	1.07E-11	6.78E-12
N	1.36E-09	6.05E-10	2.99E-10	1.84E-10	1.25E-10	6.20E-11	3.73E-11	2.17E-11	1.11E-11	7.02E-12
NNE	1.47E-09	6.16E-10	2.93E-10	1.79E-10	1.21E-10	5.63E-11	2.28E-11	1.72E-11	1.21E-11	7.63E-12
NE	2.35E-09	9.94E-10	4.75E-10	2.90E-10	1.97E-10	9.14E-11	3.19E-11	1.96E-11	1.55E-11	1.06E-11
ENE	3.00E-09	1.20E-09	5.49E-10	3.30E-10	2.23E-10	1.04E-10	3.65E-11	1.75E-11	1.14E-11	8.05E-12
E	2.60E-09	1.10E-09	5.26E-10	3.21E-10	2.18E-10	1.01E-10	3.51E-11	1.65E-11	1.03E-11	7.03E-12
ESE	1.71E-09	7.28E-10	3.49E-10	2.13E-10	1.44E-10	6.72E-11	2.33E-11	1.09E-11	6.88E-12	4.74E-12
SE	9.65E-10	3.80E-10	1.72E-10	1.03E-10	6.95E-11	3.24E-11	1.14E-11	5.48E-12	3.53E-12	2.46E-12
SSE	9.33E-10	3.53E-10	1.54E-10	9.13E-11	6.15E-11	2.88E-11	1.02E-11	4.96E-12	3.19E-12	2.21E-12

ALL ELEVATED RELEASES.

PHYSICAL CONSTANTS

AREA OF ANULAR SECTIONS AT GIVEN MILES

10013	2	3	4	5	10	20	30	40	50
5.08E+05	1.53E+06	2.54E+06	3.56E+06	4.58E+06	3.81E+07	1.53E+08	2.54E+08	3.56E+08	4.58E+08

PLIFE	SF	SSF	VHS	VNA	FID
1.58E+07	7.00E-01	5.00E-01	2.70E+19	3.80E+18	5.00E-01

USAGE CONSTANTS

FOR POPULATION DOSES

VARIABLE	INFANTS + CHILDREN	TEENAGERS	ADULTS
AVINH	3.70E+03	8.00E+03	8.00E+03
AVLVEG	8.50E+00	1.40E+01	2.10E+01
AVMET	1.70E+01	2.70E+01	4.30E+01
AVMLK	1.86E+02	2.18E+02	1.20E+02
AVVEG	1.71E+02	2.05E+02	1.63E+02
POPF	0.00E+00	0.00E+00	1.00E+00

FOR INDIVIDUAL DOSES

VARIABLE	INFANTS	CHILDREN	TEENAGERS	ADULTS
SLVEG	0.00E+00	1.70E+01	2.80E+01	4.30E+01
SPINH	1.40E+03	3.70E+03	8.00E+03	8.00E+03
SPMET	0.00E+00	3.00E+01	4.80E+01	8.10E+01
SPMLK	2.44E+02	2.44E+02	2.97E+02	2.30E+02
SPVEG	0.00E+00	2.76E+02	3.34E+02	2.76E+02

THE US POPULATION FOR THE YEAR 2000 IS ESTIMATED AS 3.00E+08

<POPGASP TEST CASE NUMBER 1

(1990 CENSUS ABOUT N 78020., E 53970.)

SITE POPULATION DATA

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E+03	2.14E+04	9.20E+03	6.68E+03	1.05E+04	4.99E+04
NNE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.33E+02	1.78E+03	2.08E+03	4.10E+03	1.71E+04	2.53E+04
NE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.00E+00	1.55E+03	2.73E+03	5.24E+03	1.14E+04	2.10E+04
ENE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E+03	4.66E+03	5.18E+03	3.19E+04	4.50E+04
E	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	4.78E+03	5.09E+03	1.09E+04	5.51E+03	2.63E+04
ESE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.17E+03	2.58E+03	2.84E+03	2.89E+03	1.05E+04
SE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.63E+02	4.54E+03	6.38E+03	1.04E+04	2.19E+04
SSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.65E+02	6.84E+02	1.04E+03	2.51E+03	4.60E+03
S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.45E+02	1.60E+03	6.72E+03	3.56E+03	1.24E+04
SSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.00E+00	7.80E+02	2.19E+03	4.80E+03	2.59E+03	1.04E+04
SW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+02	1.17E+03	4.58E+03	2.09E+03	2.71E+03	1.07E+04
WSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E+02	1.52E+03	4.47E+03	2.58E+03	6.15E+03	1.48E+04
W	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E+02	6.03E+03	1.05E+04	8.95E+03	6.96E+03	3.27E+04
WNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E+03	5.07E+03	1.30E+05	3.25E+04	1.48E+04	1.84E+05
NW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+03	1.52E+04	8.13E+04	9.38E+03	3.30E+03	1.10E+05
NNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E+03	1.97E+04	1.12E+04	6.88E+03	3.34E+03	4.23E+04
TOTAL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.43E+03	8.60E+04	2.77E+05	1.16E+05	1.36E+05	6.22E+05

MAN'S MILK PRODUCTION ABOUT SRS 1990 (L/Y)

SITE MILK PRODUCTION, LITERS

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.20E+04	6.90E+04	1.00E+06	5.30E+06	6.41E+06
NNE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.20E+04	6.90E+04	2.10E+05	5.00E+05	8.21E+05
NE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.20E+04	1.00E+06	2.70E+06	2.00E+06	5.73E+06
ENE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+04	1.20E+06	4.40E+06	5.20E+06	1.08E+07
E	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+04	1.40E+06	3.90E+06	4.90E+06	1.02E+07
ESE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+04	5.60E+05	3.00E+04	4.90E+05	1.10E+06
SE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+03	0.00E+00	0.00E+00	0.00E+00	2.50E+03
SSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E+05	8.60E+05	1.20E+06	1.20E+06	3.74E+06
S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+06	2.10E+06	3.00E+06	3.50E+06	9.60E+06
SSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.90E+05	3.80E+06	7.40E+06	7.60E+06	1.98E+07
SW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.90E+05	2.20E+06	5.80E+06	4.80E+06	1.38E+07
WSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.90E+05	1.70E+06	2.40E+06	3.50E+06	8.59E+06
W	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.70E+05	1.30E+06	2.20E+06	3.60E+06	7.77E+06
WNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E+05	1.10E+06	1.20E+06	2.00E+06	4.53E+06
NW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.20E+04	3.80E+05	1.40E+06	1.00E+06	2.82E+06

NNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.20E+04	6.90E+04	1.70E+06	3.40E+06	5.21E+06
TOTAL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.63E+06	1.78E+07	3.85E+07	4.90E+07	1.11E+08

<POPGASP TEST CASE NUMBER 1

MAN'S MEAT PRODUCTION ABOUT SRS 1990 (KG/Y)

SITE ANNUAL MEAT PRODUCTION, KGR

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E+04	8.80E+04	2.50E+05	9.80E+05	1.37E+06
NNE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E+04	8.80E+04	2.00E+05	4.10E+05	7.51E+05
NE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.10E+04	1.70E+05	3.50E+05	4.50E+05	1.04E+06
ENE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E+04	2.00E+05	4.60E+05	5.70E+05	1.31E+06
E	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E+04	1.90E+05	3.40E+05	5.10E+05	1.12E+06
ESE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E+04	1.90E+05	2.20E+05	2.50E+05	7.43E+05
SE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E+05	2.10E+05	2.60E+05	3.00E+05	8.90E+05
SSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+05	1.90E+05	2.60E+05	2.90E+05	8.50E+05
S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.40E+04	1.50E+05	2.00E+05	2.70E+05	7.14E+05
SSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.50E+04	1.80E+05	2.90E+05	3.90E+05	9.55E+05
SW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.50E+04	1.70E+05	2.70E+05	3.20E+05	8.55E+05
WSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.50E+04	1.60E+05	2.30E+05	4.00E+05	8.85E+05
W	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.80E+04	1.00E+05	2.10E+05	4.10E+05	7.78E+05
WNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E+04	6.20E+04	1.30E+05	2.90E+05	5.30E+05
NW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E+04	8.00E+04	2.80E+05	2.70E+05	6.83E+05
NNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E+04	8.80E+04	3.30E+05	6.20E+05	1.09E+06
TOTAL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E+06	2.32E+06	4.28E+06	6.73E+06	1.46E+07

MAN'S VEGETATION PRODUCTION ABOUT SRS 1990 (KG/Y)

SITE VEGETATION PRODUCTION, KGR

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	6.00E+05	8.40E+05	8.70E+05	2.67E+06
NNE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	6.00E+05	5.10E+05	6.30E+03	1.48E+06
NE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	6.90E+05	1.00E+06	5.00E+05	2.55E+06
ENE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	6.60E+05	1.20E+06	1.50E+06	3.72E+06
E	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	5.90E+05	8.50E+05	1.40E+06	3.20E+06
ESE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	2.20E+06	1.90E+06	1.10E+06	5.56E+06
SE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+06	4.50E+06	3.00E+06	1.10E+06	1.11E+07
SSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E+06	2.90E+06	3.60E+06	1.10E+06	9.30E+06
S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.20E+04	5.40E+05	8.40E+05	9.70E+05	2.42E+06
SSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+02	1.20E+05	2.50E+05	1.10E+05	4.80E+05
SW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+02	7.80E+02	2.20E+03	3.10E+05	3.13E+05
WSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+02	5.80E+02	9.90E+02	2.90E+03	4.82E+03
W	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E+04	2.30E+04	1.70E+04	5.20E+04	1.37E+05
WNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E+05	3.80E+04	4.50E+05	1.10E+06	1.85E+06
NW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+05	4.30E+05	8.40E+05	1.10E+06	2.73E+06

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  NNW 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 3.60E+05 6.00E+05 8.40E+05 1.10E+06 2.90E+06
TOTAL 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 7.46E+06 1.45E+07 1.61E+07 1.23E+07 5.04E+07
 AGRICULTURAL PRODUCTIVITY

  PRODUCT     CAP USE   PRODUCTION  EXPORT     T.POP SERVED
 VEGETATION   1.63E+02   5.04E+07   0.00E+00   3.09E+05
 MILK         1.20E+02   1.11E+08   3.64E+07   9.25E+05
 MEAT         4.30E+01   1.46E+07   0.00E+00   3.39E+05
 <POPGASP TEST CASE NUMBER 1
 JOB CONTROL(JC)- 0  1  0  1  0  0  0  0  0  0
 FRACTIONS OF:
 LEAFY VEGETABLES FROM GARDEN(FV)-1.00  YEAR MILK COWS/BEEF ANIMALS/GOATS ON PASTURE(FP/FB/FGT)-1.00/1.00/0.79
 OTHER EDIBLES FROM GARDEN(FG)-0.76     MILK COW/BEEF/GOAT DAILY INTAKE FROM PASTURE(FPF/FBF/FPG)-0.56/0.75/0.85
 HUMIDITY (G/M**3)- 11.40
                                        DISTANCE TO EAST COAST (MILES)- 1.15E+03
   <POPGASP TEST CASE NUMBER 1
 UML = 1.00E+00 JC1 = 0 JC2 = 0
 NUCLIDE     CI/YR
 18AR 41   1.00E+00
  1H   3   1.00E+00
 53I 133   1.00E+00
 55CS137   1.00E+00
 92U 238   1.00E+00
    5 5.00000000E+00


 <POPGASP TEST CASE NUMBER 1
   <POPGASP TEST CASE NUMBER 1

  RELEASE, ENVIRONS INVENTORY, AND ANNUAL PATHWAY INVENTORIES-CI

  NUCLIDE RELEASE  ENVIRON   GROUND VEGETATION  MILK     MEAT
+----------------------------------------------------------------+
*  AR 41  1.00E+00 3.02E-04 0.00E+00 0.00E+00 0.00E+00 0.00E+00 *
*  H   3  1.00E+00 4.94E-01 0.00E+00 4.62E-07 4.20E-07 7.13E-08 *
*  I 133  1.00E+00 3.43E-03 4.22E-04 1.03E-11 8.22E-09 6.80E-11 *
*  CS137  1.00E+00 4.98E-01 1.63E-01 7.45E-06 5.38E-06 1.96E-07 *
*  U 238  1.00E+00 5.01E-01 1.64E-01 7.46E-06 2.25E-07 1.67E-08 *
+----------------------------------------------------------------+
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<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)

PATHWAY	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
PLUME	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	8.65E-05
	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.02%
GROUND	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	4.35E-01
	0.09%	16.17%	4.62%	99.78%	0.42%	13.65%	0.01%	99.93%
INHAL	1.28E+02	3.65E-02	3.33E-02	1.77E-04	3.11E-02	2.17E-01	1.07E+03	1.77E-04
	98.13%	4.92%	1.28%	0.15%	0.11%	24.65%	99.94%	0.04%
VEGET	2.09E+00	3.87E-01	2.22E+00	2.91E-05	2.79E+01	3.58E-01	3.58E-01	2.91E-05
	1.60%	52.18%	85.44%	0.02%	96.69%	40.66%	0.03%	0.01%
COW MILK	2.16E-01	1.88E-01	2.12E-01	1.78E-05	7.34E-01	1.76E-01	1.74E-01	1.78E-05
	0.17%	25.36%	8.14%	0.01%	2.54%	19.97%	0.02%	0.00%
MEAT	1.36E-02	1.02E-02	1.36E-02	4.49E-06	7.12E-02	9.43E-03	9.41E-03	4.49E-06
	0.01%	1.37%	0.52%	0.00%	0.25%	1.07%	0.00%	0.00%
TOTAL	1.31E+02	7.42E-01	2.60E+00	1.20E-01	2.89E+01	8.79E-01	1.07E+03	4.35E-01

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)

PATHWAY	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
PLUME	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	2.69E-04
	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%
GROUND	4.17E-01	4.17E-01	4.17E-01	4.17E-01	4.17E-01	4.17E-01	4.17E-01	1.51E+00
	0.21%	12.05%	3.55%	98.37%	0.32%	11.72%	0.03%	99.53%
INHAL	1.92E+02	5.61E-02	5.13E-02	1.77E-03	4.81E-02	3.74E-01	1.60E+03	1.77E-03
	94.52%	1.62%	0.44%	0.42%	0.04%	10.53%	99.80%	0.12%
VEGET	9.24E+00	1.72E+00	9.83E+00	2.40E-03	1.24E+02	1.58E+00	1.58E+00	2.40E-03
	4.55%	49.62%	83.78%	0.57%	95.71%	44.56%	0.10%	0.16%
COW MILK	1.40E+00	1.23E+00	1.38E+00	1.41E-03	4.77E+00	1.14E+00	1.13E+00	1.41E-03
	0.69%	35.43%	11.74%	0.33%	3.69%	32.04%	0.07%	0.09%
MEAT	5.84E-02	4.39E-02	5.81E-02	1.19E-03	3.00E-01	4.07E-02	4.06E-02	1.19E-03
	0.03%	1.27%	0.50%	0.28%	0.23%	1.15%	0.00%	0.08%
TOTAL	2.03E+02	3.46E+00	1.17E+01	4.23E-01	1.29E+02	3.55E+00	1.60E+03	1.51E+00

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = *TOTAL*

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
AR 41	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	8.65E-05
	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.02%
H 3	2.29E-04	2.29E-04	2.29E-04	2.29E-04	2.29E-04	2.29E-04	2.29E-04	2.29E-04
	0.00%	0.03%	0.00%	0.19%	0.00%	0.03%	0.00%	0.05%
I 133	5.95E-03	3.28E-04	3.28E-04	3.28E-04	3.28E-04	1.88E-01	3.28E-04	2.65E-03
	0.00%	0.04%	0.01%	0.27%	0.00%	21.36%	0.00%	0.61%
CS137	7.17E-01	7.42E-01	6.93E-01	1.20E-01	6.91E-01	6.91E-01	6.95E-01	4.31E-01
	0.55%	99.90%	26.66%	99.40%	2.39%	78.59%	0.07%	99.07%
U 238	1.30E+02	1.34E-04	1.91E+00	1.34E-04	2.82E+01	1.34E-04	1.07E+03	1.10E-03
	99.45%	0.02%	73.31%	0.11%	97.61%	0.02%	99.93%	0.25%
TOTAL	1.31E+02	7.42E-01	2.60E+00	1.20E-01	2.89E+01	8.79E-01	1.07E+03	4.35E-01

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = PLUME

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
AR 41	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	8.65E-05
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
TOTAL	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	3.39E-05	8.65E-05

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = GROUND

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
I 133	3.28E-04	3.28E-04	3.28E-04	3.28E-04	3.28E-04	3.28E-04	3.28E-04	2.65E-03
	0.27%	0.27%	0.27%	0.27%	0.27%	0.27%	0.27%	0.61%
CS137	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	4.31E-01
	99.61%	99.61%	99.61%	99.61%	99.61%	99.61%	99.61%	99.14%
U 238	1.34E-04	1.34E-04	1.34E-04	1.34E-04	1.34E-04	1.34E-04	1.34E-04	1.10E-03
	0.11%	0.11%	0.11%	0.11%	0.11%	0.11%	0.11%	0.25%
TOTAL	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	4.35E-01

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = INHAL

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04
	0.00%	0.49%	0.53%	100.00%	0.57%	0.08%	0.00%	100.00%
I 133	5.57E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E-01	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	85.63%	0.00%	0.00%
CS137	3.42E-02	3.63E-02	3.31E-02	0.00E+00	3.10E-02	3.10E-02	3.52E-02	0.00E+00
	0.03%	99.51%	99.47%	0.00%	99.43%	14.29%	0.00%	0.00%
U 238	1.28E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+03	0.00E+00
	99.97%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
TOTAL	1.28E+02	3.65E-02	3.33E-02	1.77E-04	3.11E-02	2.17E-01	1.07E+03	1.77E-04

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = VEGET

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05
	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%
I 133	1.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.49E-06	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CS137	3.72E-01	3.87E-01	3.58E-01	0.00E+00	3.58E-01	3.58E-01	3.58E-01	0.00E+00
	17.84%	99.99%	16.09%	0.00%	1.28%	99.99%	99.99%	0.00%
U 238	1.71E+00	0.00E+00	1.86E+00	0.00E+00	2.76E+01	0.00E+00	0.00E+00	0.00E+00
	82.16%	0.00%	83.91%	0.00%	98.72%	0.00%	0.00%	0.00%
TOTAL	2.09E+00	3.87E-01	2.22E+00	2.91E-05	2.79E+01	3.58E-01	3.58E-01	2.91E-05

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = COW MILK

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	1.78E-05	1.78E-05	1.78E-05	1.78E-05	1.78E-05	1.78E-05	1.78E-05	1.78E-05
	0.00%	0.00%	0.00%	100.00%	0.00%	0.01%	0.01%	100.00%
I 133	5.53E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-03	0.00E+00	0.00E+00
	0.03%	0.00%	0.00%	0.00%	0.00%	1.07%	0.00%	0.00%
CS137	1.81E-01	1.88E-01	1.74E-01	0.00E+00	1.74E-01	1.74E-01	1.74E-01	0.00E+00
	83.84%	99.99%	82.11%	0.00%	23.68%	98.92%	99.99%	0.00%
U 238	3.48E-02	0.00E+00	3.78E-02	0.00E+00	5.60E-01	0.00E+00	0.00E+00	0.00E+00
	16.13%	0.00%	17.88%	0.00%	76.32%	0.00%	0.00%	0.00%
TOTAL	2.16E-01	1.88E-01	2.12E-01	1.78E-05	7.34E-01	1.76E-01	1.74E-01	1.78E-05

<POPGASP TEST CASE NUMBER 1
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = MEAT

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	4.49E-06	4.49E-06	4.49E-06	4.49E-06	4.49E-06	4.49E-06	4.49E-06	4.49E-06
	0.03%	0.04%	0.03%	100.00%	0.00%	0.05%	0.05%	100.00%
I 133	6.80E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.31E-05	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.25%	0.00%	0.00%
CS137	9.80E-03	1.02E-02	9.41E-03	0.00E+00	9.41E-03	9.41E-03	9.41E-03	0.00E+00
	71.82%	99.96%	69.24%	0.00%	13.22%	99.71%	99.95%	0.00%
U 238	3.84E-03	0.00E+00	4.17E-03	0.00E+00	6.18E-02	0.00E+00	0.00E+00	0.00E+00
	28.14%	0.00%	30.72%	0.00%	86.78%	0.00%	0.00%	0.00%
TOTAL	1.36E-02	1.02E-02	1.36E-02	4.49E-06	7.12E-02	9.43E-03	9.41E-03	4.49E-06

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = *TOTAL*

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
AR 41	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	2.69E-04
	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%
H 3	6.78E-03	6.78E-03	6.78E-03	6.78E-03	6.78E-03	6.78E-03	6.78E-03	6.78E-03
	0.00%	0.20%	0.06%	1.60%	0.00%	0.19%	0.00%	0.45%
I 133	1.08E-02	7.38E-04	7.38E-04	7.38E-04	7.38E-04	3.35E-01	7.38E-04	5.96E-03
	0.00%	0.02%	0.00%	0.17%	0.00%	9.42%	0.00%	0.39%
CS137	3.33E+00	3.45E+00	3.22E+00	4.15E-01	3.21E+00	3.21E+00	3.22E+00	1.50E+00
	1.64%	99.77%	27.40%	98.09%	2.49%	90.37%	0.20%	98.89%
U 238	1.99E+02	4.67E-04	8.51E+00	4.67E-04	1.26E+02	4.67E-04	1.60E+03	3.83E-03
	98.35%	0.01%	72.53%	0.11%	97.51%	0.01%	99.80%	0.25%
TOTAL	2.03E+02	3.46E+00	1.17E+01	4.23E-01	1.29E+02	3.55E+00	1.60E+03	1.51E+00

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = PLUME

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
AR 41	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	2.69E-04
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
TOTAL	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	2.69E-04

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = GROUND

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
I 133	7.38E-04	7.38E-04	7.38E-04	7.38E-04	7.38E-04	7.38E-04	7.38E-04	5.96E-03
	0.18%	0.18%	0.18%	0.18%	0.18%	0.18%	0.18%	0.40%
CS137	4.15E-01	4.15E-01	4.15E-01	4.15E-01	4.15E-01	4.15E-01	4.15E-01	1.50E+00
	99.71%	99.71%	99.71%	99.71%	99.71%	99.71%	99.71%	99.35%
U 238	4.67E-04	4.67E-04	4.67E-04	4.67E-04	4.67E-04	4.67E-04	4.67E-04	3.83E-03
	0.11%	0.11%	0.11%	0.11%	0.11%	0.11%	0.11%	0.25%
TOTAL	4.17E-01	4.17E-01	4.17E-01	4.17E-01	4.17E-01	4.17E-01	4.17E-01	1.51E+00

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = INHAL

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03
	0.00%	3.16%	3.45%	100.00%	3.68%	0.47%	0.00%	100.00%
I 133	9.78E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-01	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	87.15%	0.00%	0.00%
CS137	5.11E-02	5.43E-02	4.95E-02	0.00E+00	4.63E-02	4.63E-02	5.27E-02	0.00E+00
	0.03%	96.84%	96.55%	0.00%	96.32%	12.38%	0.00%	0.00%
U 238	1.92E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.60E+03	0.00E+00
	99.97%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
TOTAL	1.92E+02	5.61E-02	5.13E-02	1.77E-03	4.81E-02	3.74E-01	1.60E+03	1.77E-03

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = VEGET

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	2.40E-03	2.40E-03	2.40E-03	2.40E-03	2.40E-03	2.40E-03	2.40E-03	2.40E-03
	0.03%	0.14%	0.02%	100.00%	0.00%	0.15%	0.15%	100.00%
I 133	2.87E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.77E-06	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CS137	1.65E+00	1.71E+00	1.58E+00	0.00E+00	1.58E+00	1.58E+00	1.58E+00	0.00E+00
	17.84%	99.86%	16.09%	0.00%	1.28%	99.85%	99.85%	0.00%
U 238	7.59E+00	0.00E+00	8.25E+00	0.00E+00	1.22E+02	0.00E+00	0.00E+00	0.00E+00
	82.14%	0.00%	83.89%	0.00%	98.72%	0.00%	0.00%	0.00%
TOTAL	9.24E+00	1.72E+00	9.83E+00	2.40E-03	1.24E+02	1.58E+00	1.58E+00	2.40E-03

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = COW MILK

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	1.41E-03	1.41E-03	1.41E-03	1.41E-03	1.41E-03	1.41E-03	1.41E-03	1.41E-03
	0.10%	0.12%	0.10%	100.00%	0.03%	0.12%	0.12%	100.00%
I 133	2.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.05E-03	0.00E+00	0.00E+00
	0.02%	0.00%	0.00%	0.00%	0.00%	0.71%	0.00%	0.00%
CS137	1.18E+00	1.22E+00	1.13E+00	0.00E+00	1.13E+00	1.13E+00	1.13E+00	0.00E+00
	83.77%	99.88%	82.03%	0.00%	23.67%	99.17%	99.88%	0.00%
U 238	2.26E-01	0.00E+00	2.46E-01	0.00E+00	3.64E+00	0.00E+00	0.00E+00	0.00E+00
	16.12%	0.00%	17.87%	0.00%	76.30%	0.00%	0.00%	0.00%
TOTAL	1.40E+00	1.23E+00	1.38E+00	1.41E-03	4.77E+00	1.14E+00	1.13E+00	1.41E-03

<POPGASP TEST CASE NUMBER 1
NEPA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = MEAT

NUCLIDE	EFF.D.E.	GI-LLI	B.MAR.	LIVER	B.SURF.	THYROID	LUNG	SKIN
H 3	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03
	2.04%	2.71%	2.05%	100.00%	0.40%	2.93%	2.93%	100.00%
I 133	1.88E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.38E-05	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.16%	0.00%	0.00%
CS137	4.11E-02	4.27E-02	3.95E-02	0.00E+00	3.95E-02	3.95E-02	3.95E-02	0.00E+00
	70.38%	97.29%	67.85%	0.00%	13.16%	96.92%	97.07%	0.00%
U 238	1.61E-02	0.00E+00	1.75E-02	0.00E+00	2.59E-01	0.00E+00	0.00E+00	0.00E+00
	27.58%	0.00%	30.10%	0.00%	86.44%	0.00%	0.00%	0.00%
TOTAL	5.84E-02	4.39E-02	5.81E-02	1.19E-03	3.00E-01	4.07E-02	4.06E-02	1.19E-03

POPDOSE-SR: A ROUTINE RELEASE ATMOSPHERIC POPULATION DOSE MODEL USED AT SRS

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