CCC-608

OAK RIDGE NATIONAL LABORATORY

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY

RSIC COMPUTER CODE COLLECTION

MILDOS-AREA

Calculation of Radiation Dose from Uranium Recovery Operations for Large-Area Sources

Contributed by

Argonne National Laboratory
Argonne, Illinois
through the
DOE Energy Science and Technology Software Center
Oak Ridge, Tennessee

RADIATION SHIELDING INFORMATION CENTER

Documentation for CCC-608/MILDOS-AREA Code Package

PAGE

(Total Pages 134; June 1992)

RSIC CODE PACKAGE CCC-608

1. NAME AND TITLE

MILDOS-AREA: Calculation of Radiation Dose from Uranium Recovery Operations for Large-Area Sources.

MILDOS-AREA is a revision of the CCC-398/MILDOS code, incorporating enhanced capabilities for handling large area source dispersion and updated dosimetry calculations.

2. CONTRIBUTOR

Argonne National Laboratory, Argonne, Illinois under sponsorship of DOE-EM through DOE Energy Science and Technology Software Center, Oak Ridge, Tennessee.

3. CODING LANGUAGE AND COMPUTER

Fortran 77; IBM PC, PC 386, PC 486.

4. NATURE OF PROBLEM SOLVED

MILDOS-AREA estimates the radiological impacts of airborne emissions from uranium mining and milling facilities or any other large-area source involving emissions of radioisotopes of the uranium-238 series. Wind frequency data are provided by the user. The transport model includes the mechanisms of dry deposition of particulates, resuspension, radioactive decay and progeny ingrowth, and plume reflection. Deposition buildup and ingrowth of radioactive progeny are considered in estimating surface concentrations, which are modified by radioactive transformation, weathering, and other environmental processes. MILDOS-AREA allows the user to vary the emission rates of the sources as a step-function of time. Impacts to humans through such pathways as inhalation, external exposure, and ingestion are estimated based on calculated annual average air concentrations of nuclides. Individual, total individual, annual population, and environmental dose commitments are calculated with conversion factors derived from recommendations of the International Commission on Radiological Protection (ICRP) and Oak Ridge National Laboratory. Age-specific dose factors are calculated.

A validation study of MILDOS-AREA was conducted using measured Rn-222 concentration and flux data from the Monticello, Utah uranium mill tailings impoundment. The results of this study demonstrated that use of MILDOS-AREA can result in generally good agreement between model-generated and measured Rn-222 concentrations.

5. METHOD OF SOLUTION

A sector-average Gaussian plume-dispersion model is used to compute concentrations of radioactive materials from fixed-point sources. Area sources are calculated either with the original MILDOS virtual-point method or a finite-element integration method. A choice of vertical-dispersion coefficients is available; the Briggs dispersion coefficients are most appropriate for a tall source, such as a uranium mill plant stack, while the Martin-Tickvart coefficients provide a more realistic representation for near-ground level sources, such as a mill tailings pond.

6. RESTRICTIONS OR LIMITATIONS

Maxima of 300 nodes, 48 individual receptors, 10 sources (point or area) and 10 time steps. The current version is applicable only to uranium-238 series nuclides.

7. TYPICAL RUNNING TIME

Two to 10 minutes are required on an IBM PS/2 Model 80. On a PC 486 (33 Mhz), SAMPLE.DAT ran in about 16 seconds.

8. COMPUTER HARDWARE REQUIREMENTS

An IBM PC or compatible computer with 500 Kbytes of memory, math coprocessor, and a hard disk. A printer capable of producing 132-column output is needed.

9. COMPUTER SOFTWARE REQUIREMENTS

Lahey Fortran 77 v3.0 under MS DOS 3.1 was used to create the executable file included in the package.

10. REFERENCE

Y. C. Yuan, J. H. C. Wang, and A. Zielen, "MILDOS-AREA: An Enhanced Version of MILDOS for Large-Area Sources," ANL/ES-161 (June 1989).

11. CONTENTS OF CODE PACKAGE

Included is one DS/HD (1.2MB) diskette, including the source code, executable file and sample cases.

12. DATE OF ABSTRACT

June 1992.

KEYWORDS: AIRBORNE; AIR-GROUND INTERFACE; ENVIRONMENTAL DOSE; INTERNAL DOSE; GAUSSIAN PLUME MODEL; MICROCOMPUTER; RADIOACTIVITY

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ANL/ES-161

MILDOS-AREA: AN ENHANCED VERSION OF MILDOS FOR LARGE-AREA SOURCES

by

Y.C. Yuan,* J.H.C. Wang,‡ and A. Zielen

Energy and Environmental Systems Division

June 1989

work sponsored by

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FOREWORD

The computer program MILDOS-AREA is a revision of the MILDOS code developed by the Pacific Northwest Laboratory from the Argonne National Laboratory Uranium Dispersion and Dosimetry (UDAD) code. MILDOS was designed to compute environmental radiation doses from uranium recovery operations. The MILDOS-AREA code provides improved capability for handling large-area sources and updates the dosimetry calculations of the original MILDOS code. The new code is designed for use on an IBM or IBM-compatible personal computer. An interim version, MILDOS-ANL, that has been available on a limited basis includes only some of the changes found in the current version of MILDOS-AREA.

CONTENTS

ACKNOWLEDGMENTS

The authors were assisted in this work by many experts from the scientific community. Special thanks are due to K.F. Eckerman (Oak Ridge National Laboratory) for providing the age-specific internal dose conversion factors and reviewing the dosimetry models; Roger Nelson (Jacobs Engineering, Inc.), J.M. Bounds, Frank Kornegay, F.R. O'Donnell (Oak Ridge National Laboratory), and J. Wing (DOE) for providing valuable review of the methodology used in this document; K. Karp (UNC Geotech) for providing measured radon concentration and flux data from the Monticello, Utah, mill tailings site for use in the code validation study; S.L. Giardini (then at Argonne National Laboratory [ANL]) for assisting in preparation of an earlier draft version of this report; R.G. Williams (ANL) for providing data on state average annual agricultural production; and Brad Micklich (ANL) for conducting the validation study. Finally, we thank John DePue (ANL) for his editorial assistance.

TABLES (Cont'd)

provides the user with the option of using a finite-element integration method for area sources. A choice of vertical-dispersion coefficients also is available in MILDOS-AREA: Briggs (recommended for elevated sources) or Martin-Tickvart (recommended for ground-level sources). The latter is an option added to the new code.

Wind-frequency data are provided by the user. The transport model includes the mechanisms of dry deposition of particulates, resuspension, radioactive decay and progeny ingrowth, and plume reflection. Deposition buildup and ingrowth of radioactive progeny are considered in estimating surface concentrations, which are modified by radioactive transformation, weathering, and other environmental processes. MILDOS-AREA allows the user to vary the emission rates of the sources as a step function of time. Thus, the changing processes (including shutdown) throughout the operational lifetime of one or more source facilities can be simulated.

Impacts to humans through such pathways as inhalation, external exposure (from ground concentrations and cloud immersion), and ingestion (of vegetables, meat, and milk) are estimated based on calculated annual average air concentrations of radionuclides. Individual dose commitments, total individual dose commitments (considering all radionuclides), and annual population dose commitments (regional, extraregional, total, and cumulative) are available from the MILDOS-AREA code. Dose commitments (including age-specific considerations) are calculated with conversion factors derived from recommendations of the International Commission on Radiological Protection (ICRP) and Oak Ridge National Laboratory. These factors are provided internally to the program and are not part of user input.

In addition to discussing new and modified routines, this report also presents (1) a brief discussion of the theory behind the finite-element integration technique and other modifications, (2) information concerning the input required, (3) instructions for installing and using the new code on PCs, and (4) sample problems. Appendix A summarizes information on program structure and data transfer in MILDOS-AREA.

This report is intended to *supplement*, not *replace*, the information provided in the user's manual for MILDOS, prepared by Strenge and Bander (1981). Accordingly, the user is expected to be familiar with the original version of MILDOS.

MILDOS-AREA: AN ENHANCED VERSION OF MILDOS FOR LARGE-AREA SOURCES

by

Y.C. Yuan, J.H.C. Wang, and A. Zielen

ABSTRACT

The MILDOS-AREA computer code is a modified version of the MILDOS code, which estimates the radiological impacts of airborne emissions from uranium mining and milling facilities or any other large-area source involving emissions of radioisotopes of the uranium-238 series. MILDOS-AREA is designed for execution on personal computers. The modifications incorporated in the MILDOS-AREA code provide enhanced capabilities for calculating doses from large-area sources and update dosimetry calculations. The major revision from the original MILDOS code is the treatment of atmospheric dispersion from area sources: MILDOS-AREA substitutes a finite-element integration approach for the virtual-point method (the algorithm used in the original MILDOS code) when specified by the user. Other revisions include the option of using Martin-Tickvart dispersion coefficients in place of Briggs coefficients for a given source, consideration of plume reflection, and updated internal dosimetry calculations based on the most recent recommendations of the International Commission on Radiation Protection and the age-specific dose calculation methodology developed by Oak Ridge National Laboratory. This report also discusses changes in computer code structure incorporated into MILDOS-AREA, summarizes data input requirements, and provides instructions for installing and using the program on personal computers.

1 INTRODUCTION

Argonne National Laboratory (ANL) has developed the MILDOS-AREA code by modifying the MILDOS code developed by Strenge and Bander (1981) to evaluate radiological impacts of uranium processing facilities. The changes are intended to provide enhanced capability to compute doses from large-area sources and to incorporate recent changes in methods for dosimetry calculations. The revised program is designed for use on IBM or IBM-compatible personal computers (PCs).

A sector-averaged Gaussian plume-dispersion model is used to compute concentrations of radioactive materials from fixed-point sources. In the original MILDOS code, area sources are handled by a virtual-point method. The new MILDOS-AREA code

The integrand in Eq. 1 is related to a point-source relative-release concentration, $(\frac{\chi}{Q})_p \ (\vec{r}_p - \vec{r}_s)$, by

$$\chi_p \ (\vec{r}_p - \vec{r}_s) = Q(\vec{r}_s) \ (\frac{\chi}{Q})_p \ (\vec{r}_p - \vec{r}_s) \tag{2}$$

where:

$Q(\vec{r}_s)$ = the source strength at $\vec{r}_s$.

Substitution of Eq. 2 into Eq. 1 yields

$$\chi(\vec{r}_p) = \int_A Q(\vec{r}_s) \ (\frac{\chi}{Q})_p \ (\vec{r}) \ dA \tag{3}$$

where:

$\vec{r} = \vec{r}_p - \vec{r}_s$.

The integration of Eq. 3 can be performed using the finite-element method (Yuan 1979). In this method, the problem domain (the total area A of the source) is first partitioned into contiguous subdomains. The area A must be divided into a number of connecting, but nonoverlapping, subareas or finite elements a_i (i = 1, 2, ..., n) such that for each element, a uniform source strength $Q_i = Q(\vec{r}_i)$ may be assumed. Equation 3 can thus be rewritten as

$$\chi(\vec{r}_p) = \sum_{i=1}^{n} \int_{a_i} Q_i (\frac{\chi}{Q})_p \ (\vec{r}) \ da_i \tag{4}$$

where:

$$\sum_{i=1}^{n} a_i = A.$$

Once the subdivisions of the source area have been designated, an approximate source relative-release concentration is then sought through use of piecewise polynomials with appropriate continuity conditions across interelement boundaries:

$$(\frac{\chi}{Q})_p \ (\vec{r}) \approx \sum_{j=1}^{m} h_j \ (\vec{r}) \ (\frac{\chi}{Q})_p \ (\vec{r}_j) \tag{5}$$

where:

$h_j \ (\vec{r})$ = the basis function having support only over the element for which $\vec{r}_j$ is one of m vertices.

2 THEORETICAL BACKGROUND FOR PROGRAM MODIFICATIONS

This chapter briefly discusses the theoretical foundations of the principal changes incorporated into MILDOS-AREA. The first subsection introduces the finite-element integration approach for treating atmospheric dispersion from area sources and outlines the formulation of the new atmospheric dispersion model for area sources. Subsequent subsections present the rationale for the changes made in the methods used to compute vertical-dispersion coefficients, concentrations, source strength, mixing height, and dose conversion factors.

2.1 ATMOSPHERIC DISPERSION FROM AREA SOURCES

The conventional Gaussian plume model is an analytic solution for the atmospheric dispersion of a point source. A virtual-point method was used in the original MILDOS code to apply the model further to an area source. However, that method provides only a rough approximation of conditions. To simulate accurately the size and shape of a large-area source and to improve the efficiency of the computations, a finite-element integration scheme has been incorporated as an option in the MILDOS-AREA code. A major advantage of the finite-element method is that it permits the large-area sources to be partitioned into triangles, rectangles, or elements of other arbitrarily selected shapes. Thus, curved or irregular boundaries can be accurately described with a minimum number of mesh points. The theoretical bases for applying the finite-element integration method to atmospheric dispersion from large-area sources are described below.

At a receptor location of interest, the atmospheric concentration of particulates or gases from an area source can be determined by integrating a point-source dispersion concentration over the entire source area:

$$\chi(\vec{r}_p) = \int_A \chi_p \, (\vec{r}_p - \vec{r}_s) \, dA \tag{1}$$

where:

$\chi(\vec{r}_p)$ = the air concentration at receptor $\vec{r}_p$ due to the area source,

A = the area of the source, and

$\chi_p \, (\vec{r}_p - \vec{r}_s)$ = the air concentration at receptor $\vec{r}_p$ resulting from a point source with location $\vec{r}_s$.

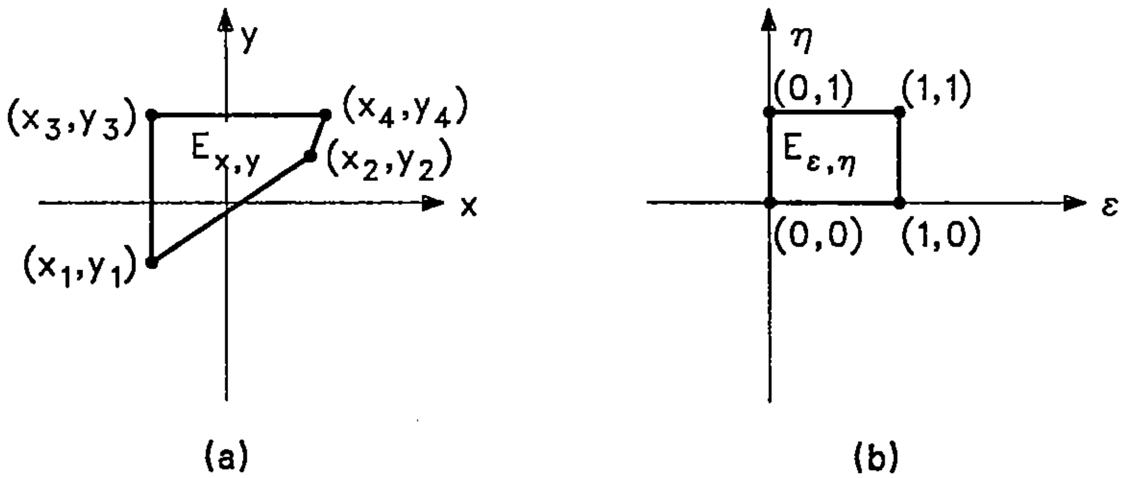


FIGURE 2.1 Isoparametric Transformation from a Quadrilateral to a Rectangle (a = original coordinates, b = isoparametrically transformed coordinates)

The coordinate change between $E_{x,y}$ and $E_{\xi,\eta}$ is given by

$$\begin{aligned} x(\xi,\eta) &= x_1 + (x_2 - x_1)\xi + (x_3 - x_1)\eta + (x_4 - x_3 - x_2 + x_1)\xi\eta \\ y(\xi,\eta) &= y_1 + (y_2 - y_1)\xi + (y_3 - y_1)\eta + (y_4 - y_3 - y_2 + y_1)\xi\eta. \end{aligned} \tag{9}$$

With the adoption of these new coordinates in Eqs. 7 and 8, the concentration χ will vary linearly along the element edges, thus ensuring continuity. Equation 8 becomes

$$\begin{aligned} \chi(\xi,\eta) &= \sum_{k=1}^{4} h_k (\xi,\eta)\ \chi\ (\xi_k,\ \eta_k) \\ &= (1 - \xi)\ (1 - \eta)\ \chi(0,0) + \xi\ (1 - \eta)\ \chi(1,0) \\ &\quad + (1 - \xi)\ \eta\ \chi(0,1) + \xi\ \eta\ \chi(1,\ 1). \end{aligned} \tag{10}$$

The basis functions and the trial functions now have been formulated, and the receptor air concentration from the dispersion of the total area source now can be calculated using Eq. 6. The transformation of the double integral in that equation is given by

$$\iint_{a_i} h_j\ (x,y)\ dxdy = \int_0^1\int_0^1 h_j\ [x(\xi,\eta),\ y(\xi,\eta)]\ J(\xi,\eta)\ d\xi\ d\eta \tag{11}$$

The unknown coefficients in the polynomial approximation, in this case the $(\frac{\chi}{Q})_p$ $(\vec{r}_j)$, are typically nodal values of the dependent variable and are known as trial functions. Substituting Eq. 5 into Eq. 4 gives

$$\chi(\vec{r}_p) \approx \sum_{i=1}^{n} \left[\sum_{j=1}^{m} < h_j (\vec{r}) > (\frac{\chi}{Q})_{p,j} \right] Q_i \quad (6)$$

where:

$$< h_j (\vec{r}) > = \int_{a_i} h_j (\vec{r})\, da_i$$

$$= \iint_{a_i} h_j (x,y)\, dx\, dy.$$

The number of nodes per element depends on the shape of the element and the degree of accuracy desired. Triangles and rectangles are the shapes most commonly used in finite-element analysis. Of the two, triangles are better for approximating a curved boundary; otherwise, however, use of rectangles can simplify data input while maintaining a high degree of accuracy. Therefore, for a large-area source, rectangles are usually the better choice. The simplest trial function for rectangular elements is based on functions that are piecewise bilinear in each rectangle:

$$\chi(x,y) = a_1 + a_2 x + a_3 y + a_4 xy. \quad (7)$$

The four coefficients a_j can be determined by substituting the values of χ at the four vertices. Equation 7 can also be written as

$$\chi(x,y) = \sum_{j=1}^{4} h_j (x,y)\, \chi_j (x_j, y_j) \quad (8)$$

where:

$$h_j (x,y) = \begin{cases} 1, & x = x_j,\ y = y_j \\ 0 & \text{at other nodes.} \end{cases}$$

To combine the advantages of triangular and rectangular elements, MILDOS-AREA uses quadrilateral elements. A polynomial with four coefficients as shown in Eqs. 7 and 8 could be applied to a general quadrilateral, but the piecewise bilinear functions generally would not be continuous from one element to the next. It is necessary to use an isoparametric transformation to change coordinates in such a manner that the element becomes a rectangle. This isoparametric transformation is illustrated in Fig. 2.1.

The values $C_1, \ldots, C_4$ are estimated by subdividing a reference area into finite elements. The most convenient choice is the quadrilateral element in the polar (r,θ) coordinate system, with two straight edges of the element lying along two adjacent wind directions of the meteorological data set. This is shown in Fig. 2.2, where a point source of *ith* unit source strength is assumed to be located at the center ($\vec{r}_s$) and where elements are constructed according to the standard 16 wind directions and 45 distances (r_n)* in the current version of the code. With this arrangement, the nodal values ($C_1, \ldots, C_4$) can be computed using the Gaussian dispersion model from a point source. The elements essentially are equivalent to simple rectangular elements, because r or θ is constant on the sides of each element. The nodal values are given by

$$(\frac{\chi}{Q})_p \ (r,\theta) = \sum_{j=1}^{4} g_j \ (r,\theta) \ (\frac{\chi}{Q})_{p,j} \tag{13a}$$

$$= b_1 + b_2 \ \theta + b_3 \ \ln(r) + b_4 \theta \ln \ (r) \tag{13b}$$

or

$$= b_1 + b_2 \ \theta + b_3 \ r + b_4 \ \theta r \tag{13c}$$

where, again, the values of b_j are determined by the values of $(\frac{\chi}{Q})$ at the vertices. The expression in Eq. 13a is essentially a weighted average of $C_1, \ldots, C_4$, with the relative weights depending on the location of (r,θ) within the element. The natural logarithm of r (Eq. 13b) is used as the default option in the code because of the exponential nature of the relationship between concentration and distance from a point source. Equation 13c is also implemented in the code as an alternative.

After the point-source relative-release concentrations are approximated for each element, they are multiplied by the source strength for that same element. Then, as seen in Eq. 6, these products are summed over all the elements, yielding the desired concentration value χ for $\vec{r}_p = (x,y)$.

To simplify the task of entering detailed element coordinates for area sources, an automeshing algorithm has been developed as an option in the code. With this option, instead of entering every required value for each element, the user needs only to enter the vertex coordinates of the bounding quadrilateral area. The program then automatically generates topographically equal-intervaled meshes for the area according to the number of elements specified by the user. For example, a 12-element (3 x 4) quadrilateral area is entered as four corner nodes, and NEX (3) and NEY (4) specify the number of elements on bottom and left sides (or topographical x and y directions). Figure 2.3 illustrates the nodes.

*Default values for r_n are (in meters) 0, 10, 15, 20, 30, 40, 50, 60, 80, 100, 150, 200, 300, 400, 600, 800, 1,000, 1,200, 1,600, 1,800, 2,000, 3,000, 4,000, 5,000, 6,000, 7,000, 8,000, 9,000, 10,000, 15,000, 20,000, 25,000, 30,000, 35,000, 40,000, 45,000, 50,000, 60,000, 70,000, 80,000, 100,000, 120,000, 140,000, and 160,000.

where J is the Jacobian determinant:

$$J = \frac{\partial x}{\partial \xi}\frac{\partial y}{\partial \eta} - \frac{\partial x}{\partial \eta}\frac{\partial y}{\partial \xi} . \quad (12)$$

Substitution of Eq. 9 into Eq. 12 gives

$$J = A + B\xi + C\eta$$

where:

$A = X21 \cdot Y31 - X31 \cdot Y21,$

$B = X21 \cdot YA - Y21 \cdot XA,$ and

$C = Y31 \cdot XA - X31 \cdot YA,$

and where:

$X21 = x_2 - x_1,$

$X31 = x_3 - x_1,$

$Y21 = y_2 - y_1,$

$Y31 = y_3 - y_1,$

$XA = x_4 - x_3 - x_2 + x_1,$ and

$YA = y_4 - y_3 - y_2 + y_1.$

Expression 11 is found to be equivalent to

$$(AI + BI + CI)\,C_1 + (AI + 2 \cdot BI + CI)\,C_2 + (AI + BI + 2 \cdot CI)\,C_3 + [AI + 2 \cdot (BI + CI)]\,C_4,$$

where:

$AI = A/4,$

$BI = B/12,$

$CI = C/12,$ and

C_1, C_2, C_3, C_4 = the values of $(\frac{X}{Q})_{p,j}$, for j = 1 to 4, respectively.

2.2 VERTICAL-DISPERSION COEFFICIENTS FOR GROUND-LEVEL SOURCES

The empirical expression used to calculate the vertical-dispersion coefficient (σ_z) in the original version of MILDOS is based primarily on data for aboveground sources. The resulting Briggs dispersion coefficients are most appropriate for a tall source, such as a power-plant stack, and are less appropriate for ground-level sources, such as tailings piles (Gifford 1976). A more suitable formula for the latter class of sources is given by Martin and Tickvart (1968):

$$\sigma_z = Ax^B + C \tag{14}$$

where the constants A, B, and C are as defined in Table 2.1 for each stability class and for three ranges of the downwind distance, x. An additional advantage of the Martin-Tickvart coefficients is that Eq. 14 can be used to compute dispersion coefficients for downwind distances of less than 100 m, thus providing a more realistic representation of pollutant dispersion for near-source receptors.

2.3 PLUME REFLECTION

Physical boundaries (the atmospheric mixing layer and the ground surface) are important considerations in assessing atmospheric dispersion at great distances from the sources or for near-ground emissions. This is because the rate of dispersion across the boundaries (ground surface and top of the mixing layer) is small compared with the rate of dispersion within the mixing layer. In MILDOS-AREA, the plume is conservatively assumed to be reflected by the boundaries. From Powell et al. (1979), the straight-line, crosswind-integrated Gaussian equation for a plume with vertical distribution limited by reflections may be written as

$$\chi(x) = \frac{Q}{\bar{u}(\pi x/8)z} \tag{15a}$$

where:

$$z^1 = \begin{cases} \dfrac{1}{\sqrt{\pi/2}\,\sigma_z} \exp\left[-\tfrac{1}{2}\left(\dfrac{H}{\sigma_z}\right)^2\right] + \exp\left[-\tfrac{1}{2}\left(\dfrac{2L-H}{\sigma_z}\right)^2\right] + \exp\left[-\tfrac{1}{2}\left(\dfrac{2L+H}{\sigma_z}\right)^2\right] & \text{(15b)} \\[2ex] \dfrac{1}{\sqrt{\pi/2}\,\sigma_z} \exp\left[-\tfrac{1}{2}\left(\dfrac{H}{\sigma_z}\right)^2\right] & \text{(15c)} \\[2ex] L^{-1} & \text{(15d)} \end{cases}$$

and where:

$\bar{u}$ = average wind speed,

x = downwind distance,

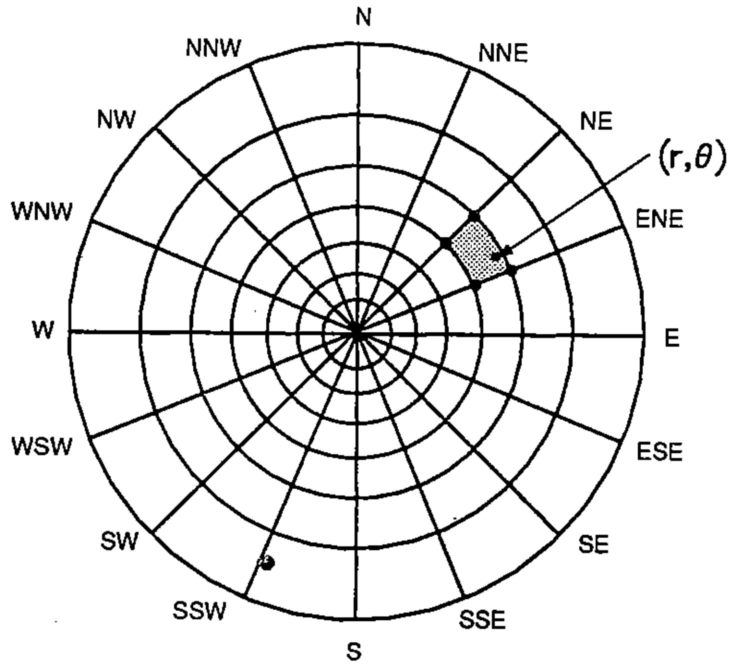


FIGURE 2.2 Annulus/Sector Reference Area for a Given Point (r,θ) Relative to a Point Source of Unit Strength at Point (0,0)

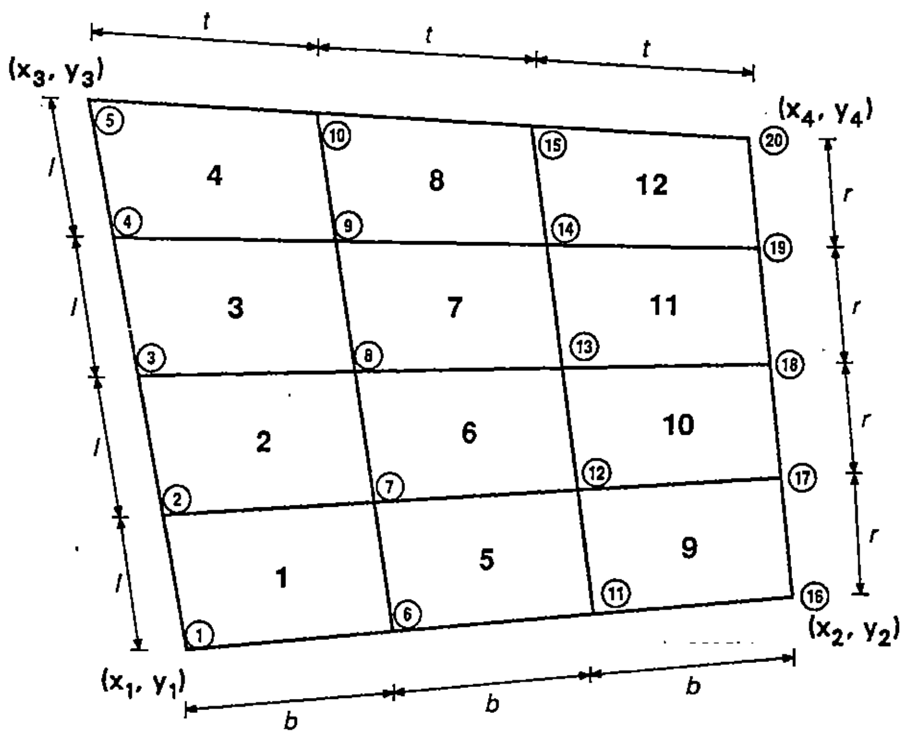


FIGURE 2.3 Automatic Meshing of a Large Quadrilateral Area (node numbers are enclosed in a circle, and the element numbers are noted at the center of each element)

z = receptor height,

L = mixing height, and

H = relative receptor height (the difference between the effective stack height and receptor height).

Equations 15c and 15d are the simpler asymptotic forms used in the previous version of MILDOS, i.e., reflections from the top of the mixing layer were ignored when σ_z was small compared to L, and the even distribution was assumed when σ_z was on the order of L. These two simpler evaluations are used in MILDOS-AREA instead of the more complex (and hence more extensively computed) Eq. 15b subject to the following conditions:

1. The simple Gaussian distribution, Eq. 15c, may be used where

$$\frac{\sigma_z}{L} \leq r_1 = \frac{\sqrt{1-H/L}}{1.20}$$

2. The even distribution, Eq. 15d, may be used

   a. for $0 \leq H/L < 0.5$, where

$$\frac{\sigma_z}{L} \geq r_2 = -2.37\left(\frac{H}{L}\right)^2 + 0.489\left(\frac{H}{L}\right) + 0.756 \text{ and}$$

   b. for $0.5 \leq H/L < 1.0$, where

$$\frac{\sigma_z}{L} \geq r_2 = -2.37\left(\frac{H}{L}\right)^2 + 4.25\left(\frac{H}{L}\right) - 1.13.$$

If none of these conditions holds, Eq. 15b is used. Equation 15b is a simplification of an equation involving a summation to account for the effects of multiple reflections. The assumption of one reflection from the ground and one from the top of the mixing layer inherent in Eq. 15b leads to a truncation error of not more then 3% (Powell et al. 1979).

2.4 DECREASE IN SOURCE STRENGTH DUE TO DRY DEPOSITION

The concentration in the plume is depleted by the mechanisms of dry deposition, wet deposition, and radioactive decay. To simplify the data-entry requirements, only dry deposition is considered to be a significant deposition process in the plume concentration calculations for the MILDOS-AREA code. Equations 1.2-18 through 2.2-22 in the MILDOS user's manual (Strenge and Bander 1981) have been modified to reflect the

TABLE 2.1 Values of Constants Used to Estimate Martin-Tickvart Vertical-Dispersion Coefficients

Downwind Distance (m)	Stability Class[a]	Constant		
		A	B	C
>1,000	A	0.00024	2.094	-9.6
	B	0.055	1.098	2.0
	C	0.113	0.911	0
	D	1.26	0.516	-13
	E	6.73	0.305	-34
	F	18.05	0.18	-48.6
1,000-100	A	0.00066[b]	1.941	9.27
	B	0.0382[c]	1.149	3.3
	C	0.113	0.911	0
	D	0.222	0.725	-1.7
	E	0.211	0.678	-1.3
	F	0.086	0.74	-0.35
<100	A	0.192	0.936	0
	B	0.156	0.922	0
	C	0.116	0.905	0
	D	0.079	0.881	0
	E	0.063	0.871	0
	F	0.053	0.814	0

[a] A = extremely unstable, B = moderately unstable, C = slightly unstable, D = neutral, E = moderately stable, F = very stable.

[b] Changed from the value of 0.0015, which was a typographical error in the original work.

[c] Changed from the value of 0.028, which was a typographical error in the original work.

Source: Modified from Eimutis and Konicek 1972.

2.5 AVERAGE MIXING HEIGHT

In the original MILDOS code, only one equation is provided to calculate the annual average height of the mixing layer, without considering the effect of atmospheric stability. MILDOS-AREA computes the mean annual mixing height, L, based on the mean annual morning and afternoon mixing heights, L_{am} and L_{pm}, supplied by the user. As in a U.S. Environmental Protection Agency (1978) workbook of air quality models:

$L = 1.5\ L_{pm}$, for an extremely unstable atmosphere, and

$L = (L_{am} + L_{pm})/2$, for a neutral atmosphere.

For the other unstable classes, L is taken to be equal to L_{pm}. The mixing height L does not apply to the cases of stable atmosphere.

2.6 INTERNAL DOSE CONVERSION FACTORS

Internal dose can not be measured directly; it is inferred from estimates of intake by application of radiation physics and mathematical models of translocation and metabolism of the radioactive material in the body. Since development of the original MILDOS code, metabolism data bases and concepts of radiation quantity and radiation bioeffect have changed substantially. The MILDOS-AREA code incorporates the new information but maintains the same simplicity of dose factor form as provided in the original MILDOS code. The methods used in MILDOS-AREA to compute internal doses are described below.

2.6.1 Inhalation

The inhalation dose factors incorporated into MILDOS-AREA are calculated using the dosimetric model from the International Commission on Radiological Protection (ICRP) Publication 30 (ICRP 1979). Values of committed dose equivalent (H_{50}) per unit intake given in the ICRP report are for a radionuclide with an activity median aerodynamic diameter (AMAD) of 1 μm (Table 2.2). Values of H_{50} for an aerosol with a different AMAD can be estimated by the following:

$$\frac{H_{50}(\text{AMAD})}{H_{50}(1\ \mu\text{m})} = f_{N-P}\left(\frac{D_{N-P}(\text{AMAD})}{D_{N-P}(1\ \mu\text{m})}\right) + f_{T-B}\left(\frac{D_{T-B}(\text{AMAD})}{T_{T-B}(1\ \mu\text{m})}\right) + f_{P}\left(\frac{D_{P}(\text{AMAD})}{D_{P}(1\ \mu\text{m})}\right) \qquad (20)$$

where:

f_i = fraction of the committed dose equivalent in the reference tissue resulting from deposition in respiratory region i (Table 2.3),

D_i = deposition probabilities in respiratory region i for a given AMAD (ICRP Task Group on Lung Dynamics 1966), and changes described in Sec. 2.3 of this manual. Let the vertical-dispersion coefficient equal to

$$\sigma_z(x_1) = r_1 L, \; \sigma_z(x_2) = r_2 L \tag{17}$$

where:

r_1, r_2, and L are as defined in Sec. 2.3.

The transformed equations become

$$Q(x) = Q(0) \exp\left[\frac{-V_d}{\bar{u}} F_1 (0, x)\right] \text{ for } x \le x_1, \tag{18a}$$

$$Q(x) = Q(0) \exp\left\{\frac{-V_d}{\bar{u}}\left[F_1 (0, x_1) + F_2 (x_1, x)\right]\right\} \tag{18b}$$

for $x_1 < x \le x_2$, and

$$Q(x) = Q(0) \exp\left\{\frac{V_d}{\bar{u}}\left[F_1 (0, x_1) + F_2 (x_1, x_2) + \frac{x-x_2}{L}\right]\right\} \tag{18c}$$

for $x > x_2$

where:

Q(0) = source strength at x = 0, and

Q(x) = source strength at x.

In this case

$$F_1 (x_a, x_b) = \int_{x_a}^{x_b} \frac{\exp[-\frac{1}{2}(H/\sigma_z)^2]}{\sigma_z} dx, \text{ and} \tag{19a}$$

$$F_2 (x_a, x_b) = \int_{x_a}^{x_b} \frac{\exp[-\frac{1}{2}(\frac{H}{\sigma_z})^2] + \exp[-\frac{1}{2}(\frac{2L-H}{\sigma_z})^2] + \exp[-\frac{1}{2}(\frac{2L-H}{\sigma_z})^2]}{\sigma_z} dx \tag{19b}$$

Integration of Eqs. 19a and 19b is computed numerically using the Newton-Cotes routine in the code.

TABLE 2.2 Tissue Dose Factors (H_{50}) for AMAD of 1 μm (rem/μCi)

Isotope/ Class[a]	Bone	Average Lung[b]	Liver	Kidney	Isotope/ Class[a]	Bone	Average Lung[b]	Liver	Kidney
U-238					Pb-210				
D	36.2	1.04	0.0821	14.8	D	74.0	1.04	55.5	26.3
W	10.9	52.5	0.0249	4.48	W	–[c]	–	–	–
Y	3.74	984	0.0116	1.58	Y	–	–	–	–
U-234					Bi-210				
D	40.3	1.18	0.0925	16.7	D	0.000566	0.0651	0.00155	0.210
W	12.2	59.2	0.0278	5.03	W	0.00829	1.60	0.0226	0.788
Y	4.18	1100	0.00988	1.77	Y	–	–	–	–
Th-230					Po-210				
D	–	–	–	–	D	2.09	0.821	8.10	44.0
W	7,990	59.6	13.2	1.51	W	0.74	48.1	2.31	14.0
Y	3,220	1110	5.59	0.636	Y	–	–	–	–
Ra-226									
D	28.1	59.6	0.377	0.377					
W	–	–	–	–					
Y	–	–	–	–					

[a]In inhalation dosimetry, inhaled materials are assumed to belong to one of three discrete inhalation classes, according to how rapidly they are removed from the respiratory passages. The inhalation classes are designated as D (removal accomplished in days), W (weeks), and Y (years). A set of parameter values for the dynamics of removal exists for each class.

[b]Values are the average of those for the individual regions as classified by the ICRP.

[c]In ICRP classification, some elements do not have all three inhalation classes. For conservatism, the dose factors for unassigned classes in MILDOS-AREA are assumed to be the same as those of the next classes. For example, the dose factors of class D of Th-230 are assigned the same values as those of class W.

i = respiratory region index (N-P, T-B, and P represent the nasal-pharyngeal, trachea-bronchus, and pulmonary regions, respectively).

Because the relationship between the AMAD and the dose factor of effective dose equivalent is irregular, the dose factor for a given AMAD is calculated by linear interpolation from a calculated 12-point AMAD data set given in Table 2.4. For example, the dose factor of effective dose equivalent for Ra-226 of 4-μm AMAD is

$$5.29\ \text{rem}/\mu\text{Ci} + (4.34\ \text{rem}/\mu\text{Ci} - 5.29\ \text{rem}/\mu\text{Ci}) \times (4\ \mu\text{m} - 3\ \mu\text{m})/(5\ \mu\text{m} - 3\ \mu\text{m})$$

$$= 4.82\ \text{rem}/\mu\text{Ci}$$

The piecewise linear approximation from the 12-point AMAD values provides reasonably accurate description of the effective dose equivalent factor as a function of particle size.

2.6.2 Age Correction

Age-specific dose factors are calculated using the methodology from ICRP Publications 26 and 30 (ICRP 1977, 1979) and a report prepared by Oak Ridge National Laboratory for the Nuclear Regulatory Commission (Cristy et al. 1986). The dose factors derived by Cristy et al. (Tables 2.5 and 2.6) are incorporated into MILDOS-AREA as multipliers to calculate the age-specific correction for the ingestion and inhalation dose factors. For inhalation dose factors, Cristy et al. tabulated age-specific factors only for three AMADs -- 0.3, 1, and 5 μm. In MILDOS-AREA, the age-specific factors are assumed to be a step function of particle size. For AMADs of less than 0.6 μm, between 0.6 and 3 μm, and greater than 3 μm, the correction factors derived by Cristy et al. for 0.3, 1, and 5 μm, respectively, are used.

TABLE 2.4 Inhalation Effective Dose Equivalent Factors[a] (rem/μCi)

AMAD (μm)	U-238			U-234			Th-230			Ra-226		
	D	W	Y	D	W	Y	D	W	Y	D	W	Y
0.1	4.18	16.3	284	4.57	18.4	318	-[b]	588	611	19.4	-	-
0.15	3.48	14.4	253	3.88	16.2	283	-	465	543	17.1	-	-
0.20	3.04	13.1	231	3.39	14.7	258	-	393	494	15.4	-	-
0.30	2.79	11.4	199	3.11	12.8	223	-	365	428	13.5	-	-
0.50	2.57	9.31	161	2.86	10.5	181	-	340	350	11.1	-	-
1.00	2.45	7.01	118	2.73	7.89	133	-	326	262	8.57	-	-
2.00	2.51	4.86	77.3	2.80	5.47	86.6	-	330	180	6.25	-	-
3.00	2.61	3.95	59.4	2.90	4.44	66.5	-	339	144	5.29	-	-
5.00	2.74	3.03	41.3	3.05	3.40	46.2	-	356	109	4.34	-	-
10.00	2.87	2.13	23.6	3.20	2.39	26.5	-	364	75.0	3.41	-	-
20.00	2.68	1.23	8.58	2.98	1.37	9.61	-	302	43.5	2.38	-	-
50.00	2.57	0.712	0.071	2.87	0.792	0.0782	-	266	25.7	1.80	-	-

AMAD (μm)	Pb-210			Bi-218			Po-210		
	D	W	Y	D	W	Y	D	W	Y
0.1	14.9	-	-	0.0421	0.541	-	15.8	18.6	-
0.15	12.4	-	-	0.0360	0.470	-	13.1	16.1	-
0.20	10.8	-	-	0.0320	0.423	-	11.4	14.4	-
0.30	10.0	-	-	0.0287	0.372	-	10.5	12.7	-
0.50	9.35	-	-	0.0251	0.313	-	9.76	10.8	-
1.00	9.24	-	-	0.0220	0.251	-	9.50	8.84	-
2.00	9.86	-	-	0.0201	0.198	-	9.97	7.23	-
3.00	10.4	-	-	0.0198	0.178	-	10.5	6.63	-
5.00	11.2	-	-	0.0196	0.158	-	11.1	6.08	-
10.00	11.9	-	-	0.0195	0.139	-	11.8	5.54	-
20.00	11.3	-	-	0.0174	0.109	-	11.1	4.42	-
50.00	11.0	-	-	0.0163	0.0924	-	10.7	3.79	-

[a]The effective dose equivalents are calculated using the ICRP-30 weighting factors.

[b]In ICRP classification, some elements do not have all three inhalation classes. For conservatism, the dose factors for unassigned classes in MILDOS-AREA are assumed to be the same as those of adjacent classes. For example, the dose factors assigned to class D of Th-230 are the same as for class W.

TABLE 2.3 Values of the Factors $f_{N-P}/f_{T-P}/f_P$

Isotope/ Tissue	Inhalation Class D	W	Y	Isotope/ Tissue	Inhalation Class D	W	Y
U-238				Pb-210			
Bone	33/16/51	30/29/41	7/ 2/91	Bone	36/15/49	-[a]	-
Lung	3/ 2/95	0/ 0/100	0/ 0/100	Lung	36/15/49	-	-
Liver	33/16/51	30/29/41	5/ 1/94	Liver	36/15/49	-	-
Kidney	33/16/51	30/29/41	7/ 2/91	Kidney	35/15/50	-	-
U-234				Bi-210			
Bone	33/16/51	30/29/41	7/ 2/91	Bone	31/15/54	63/11/26	-
Lung	3/ 2/95	0/ 0/100	0/ 0/100	Lung	6/ 3/91	0/ 0/100	-
Liver	33/16/51	30/29/41	5/ 1/94	Liver	31/15/54	63/11/26	-
Kidney	33/16/51	30/29/41	7/ 2/91	Kidney	31/15/54	42/36/22	-
Th-230				Po-210			
Bone	-	25/33/42	6/ 2/92	Bone	34/16/50	37/29/34	-
Lung	-	1/ 1/98	0/ 0/100	Lung	5/ 5/90	0/ 0/100	-
Liver	-	25/33/42	6/ 2/92	Liver	34/16/50	37/29/34	-
Kidney	-	25/33/42	6/ 2/92	Kidney	34/16/50	37/29/34	-
Ra-226							
Bone	38/22/40	-	-				
Lung	0/ 0/100	-	-				
Liver	38/22/40	-	-				
Kidney	38/22/40	-	-				

[a]In ICRP classification, some elements do not have all three inhalation classes. For conservatism, the f-values for unassigned classes in MILDOS-AREA are assumed to be the same as those of adjacent classes. For example, the f-values assigned to class D of Th-230 are the same as those of class W.

TABLE 2.6 Relative Age-Specific Dose Factors (normalized to an adult) from Inhalation

	Size/Class								
	0.3 μm			1.0 μm			5.0 μm		
Category	D	W	Y	D	W	Y	D	W	Y
U-238									
Effective									
Infant	21.0	12.0	4.8	22.0	14.0	4.8	23.0	17.0	4.8
Child	2.9	3.3	2.3	2.9	3.3	2.3	2.9	3.3	2.3
Teenager	1.8	1.5	1.2	1.8	1.6	1.2	1.8	1.7	1.2
Bone									
Infant	4.3	5.1	1.9	4.4	5.4	2.1	4.5	6.0	3.2
Child	0.96	1.0	1.4	0.96	1.0	1.4	0.97	1.0	1.3
Teenager	2.7	3.0	1.7	2.8	3.1	1.8	2.8	3.2	2.2
Lung									
Infant	13.0	12.0	4.7	13.0	12.0	4.7	13.0	12.0	4.8
Child	3.4	3.4	2.3	3.4	3.4	2.3	3.4	3.4	2.3
Teenager	1.5	1.5	1.2	1.5	1.5	1.2	1.4	1.5	1.2
Liver									
Infant	11.0	13.0	4.4	12.0	14.0	5.0	12.0	16.0	7.7
Child	3.1	3.2	2.2	3.1	3.3	2.3	3.2	3.4	2.6
Teenager	1.4	1.5	1.1	1.4	1.6	1.2	1.4	1.6	1.3
Kidney									
Infant	11.0	13.0	4.1	11.0	14.0	4.8	12.0	15.0	7.8
Child	2.8	2.9	2.1	2.8	2.9	2.1	2.8	3.0	2.4
Teenager	1.4	1.5	1.1	1.4	1.5	1.2	1.4	1.6	1.3
U-234									
Effective									
Infant	22.0	12.0	4.8	22.0	14.0	4.8	23.0	17.0	4.8
Child	2.9	3.4	2.3	2.9	3.4	2.3	2.9	3.3	2.3
Teenager	1.8	1.5	1.2	1.8	1.6	1.2	1.8	1.7	1.2
Bone									
Infant	4.3	5.1	1.9	4.4	5.5	2.1	4.5	6.0	3.2
Child	0.96	1.0	1.4	0.96	1.0	1.4	0.97	1.0	1.2
Teenager	2.7	3.0	1.7	2.8	3.1	1.8	2.8	3.2	2.2
Lung									
Infant	13.0	12.0	4.8	13.0	12.0	4.8	13.0	12.0	4.8
Child	3.4	3.4	2.3	3.5	3.4	2.3	3.5	3.4	2.3
Teenager	1.5	1.5	1.2	1.5	1.5	1.2	1.4	1.5	1.2
Liver									
Infant	11.0	13.0	4.6	12.0	14.0	5.3	12.0	16.0	8.3
Child	3.1	3.3	2.3	3.2	3.3	2.4	3.2	3.4	2.7
Teenager	1.4	1.5	1.1	1.4	1.6	1.2	1.4	1.6	1.3

TABLE 2.5 Relative Age-Specific Dose Factors (normalized to an adult) from Ingestion

Isotope/ Age Group	Dose Factor			
	Effective	Bone	Liver	Kidney
U-238				
Infant	63	12	32	32
Child	3.9	1.3	4.4	3.9
Teenager	3.1	4.9	2.5	2.5
U-234				
Infant	63	13	33	33
Child	4	1.3	4.4	3.9
Teenager	3.1	4.9	2.5	2.5
Th-234				
Infant	63	12	32	32
Child	3.9	1.3	4.4	3.9
Teenager	3.1	4.9	2.5	2.5
Th-230				
Infant	46	33	170	140
Child	2.8	2.5	6.6	6.1
Teenager	2.2	2.5	2.7	2.7
Ra-226				
Infant	16	4.3	25	9.8
Child	1.8	0.99	3.9	1.9
Teenager	3.2	4.3	2.4	3
Pb-210				
Infant	6.1	2.3	16	13
Child	1.7	0.97	3.9	3.4
Teenager	2.2	2.9	2.1	2.1
Bi-210				
Infant	6.1	2.3	16	13
Child	1.7	0.97	3.9	3.4
Teenager	2.2	2.9	2.1	2.1
Po-210				
Infant	41	78	28	24
Child	4.7	4.9	4.3	3.7
Teenager	2.5	3.9	2.3	2.2

TABLE 2.6 (Cont'd)

	Size/Class								
	0.3 μm			1.0 μm			5.0 μm		
Category	D	W	Y	D	W	Y	D	W	Y
Ra-226 (Cont'd)									
Lung									
Infant	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Child	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Teenager	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Liver									
Infant	13.0	13.0	13.0	15.0	15.0	15.0	17.0	17.0	17.0
Child	3.0	3.0	3.0	3.1	3.1	3.1	3.3	3.3	3.3
Teenager	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9
Kidney									
Infant	5.1	5.1	5.1	5.7	5.7	5.7	6.7	6.7	6.7
Child	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.6
Teenager	1.7	1.7	1.7	2.0	2.0	2.0	2.3	2.3	2.3
Pb-210									
Effective									
Infant	2.4	2.4	2.4	2.5	2.5	2.5	2.7	2.7	2.7
Child	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Teenager	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3
Bone									
Infant	0.91	0.91	0.91	0.97	0.97	0.97	1.1	1.1	1.1
Child	0.69	0.69	0.69	0.71	0.71	0.71	0.72	0.72	0.72
Teenager	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8
Lung									
Infant	6.0	6.0	6.0	6.4	6.4	6.4	7.0	7.0	7.0
Child	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9
Teenager	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Liver									
Infant	6.3	6.3	6.3	6.7	6.7	6.7	7.3	7.3	7.3
Child	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9
Teenager	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Kidney									
Infant	5.1	5.1	5.1	5.4	5.4	5.4	5.9	5.9	5.9
Child	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6
Teenager	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Bi-210									
Effective									
Infant	2.4	2.4	2.4	2.5	2.5	2.5	2.7	2.7	2.7
Child	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Teenager	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3

TABLE 2.6 (Cont'd)

	Size/Class								
	0.3 μm			1.0 μm			5.0 μm		
Category	D	W	Y	D	W	Y	D	W	Y
U-234 (Cont'd)									
Kidney									
Infant	11.0	13.0	4.1	11.0	14.0	4.8	12.0	16.0	7.9
Child	2.8	2.9	2.1	2.8	2.9	2.1	2.8	3.0	2.4
Teenager	1.4	1.5	1.1	1.4	1.6	1.2	1.4	1.6	1.3
Th-230									
Effective									
Infant	1.8	1.8	2.9	1.8	1.8	2.9	1.7	1.7	2.8
Child	1.1	1.1	1.6	1.1	1.1	1.6	1.1	1.1	1.5
Teenager	0.91	0.91	1.1	0.91	0.91	1.1	0.89	0.89	1.0
Bone									
Infant	1.2	1.2	1.1	1.2	1.2	1.1	1.2	1.2	1.3
Child	0.98	0.98	0.97	0.98	0.98	0.97	0.98	0.98	0.98
Teenager	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lung									
Infant	11.0	11.0	4.8	11.0	11.0	4.8	9.9	9.9	4.8
Child	3.3	3.3	2.3	3.3	3.3	2.3	3.0	3.0	2.3
Teenager	1.5	1.5	1.2	1.5	1.5	1.2	1.4	1.4	1.2
Liver									
Infant	5.2	5.2	3.1	5.3	5.3	3.4	5.4	5.4	4.8
Child	2.6	2.6	1.9	2.6	2.6	1.9	2.6	2.6	2.1
Teenager	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1
Kidney									
Infant	4.5	4.5	2.8	4.6	4.6	3.1	4.7	4.7	4.3
Child	2.4	2.4	1.8	2.4	2.4	1.8	2.4	2.4	2.0
Teenager	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1
Ra-226									
Effective									
Infant	12.0	12.0	12.0	12.0	12.0	12.0	11.0	11.0	11.0
Child	3.1	3.1	3.1	3.0	3.0	3.0	2.4	2.4	2.4
Teenager	1.6	1.6	1.6	1.7	1.7	1.7	2.1	2.1	2.1
Bone									
Infant	2.6	2.6	2.6	2.7	2.7	2.7	3.0	3.0	3.0
Child	0.85	0.85	0.85	0.85	0.85	0.85	0.87	0.87	0.87
Teenager	3.1	3.1	3.1	3.2	3.2	3.2	3.4	3.4	3.4

3 PROGRAM VALIDATION AND OTHER CONSIDERATIONS

3.1 PROGRAM VALIDATION

A validation study of MILDOS-AREA was conducted using measured Rn-222 concentration and flux data from the Monticello, Utah, uranium mill tailings impoundments. This site was selected because of the availability of a large body of measured radon concentration and flux data. The results of the validation study (detailed in Appendix B) demonstrated that use of MILDOS-AREA can result in generally good agreement between model-generated and measured Rn-222 concentrations.

3.2 PROGRAM LIMITATIONS

The current version of MILDOS-AREA allows the user to define a maximum of 10 sources (point or area), 48 individual receptors, and 10 time steps. The number of sources has been reduced from the 20 allowed in the original MILDOS code because in the revised code a large-area source is considered as a single source rather than as two or more virtual-point sources. Nonetheless, a large-area source now can be subdivided into smaller areas or elements, the number of which is limited by the maximum number of nodes allowed (300). This means that a square source may not contain more than 16 elements on a side; such an arrangement produces $(16 + 1)^2 = 289$ nodes. A square with 17 elements on a side (289 elements) would require $(17 + 1)^2 = 324$ nodes, thus exceeding the maximum.

MILDOS-AREA considers the same radionuclides (those in the U-238 decay series) as does MILDOS. These radionuclides are U-238, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Pb-210, Bi-210, and Po-210. However, with proper modification of the code and of the necessary data base associated with each radionuclide of interest, the code also could be used to treat other radionuclides.

3.3 ACCURACY AND PERFORMANCE OF MILDOS-AREA

In contrast to the original MILDOS, which could be used only on a mainframe computer, MILDOS-AREA is designed for use on an IBM or IBM-compatible personal computer (PC). There is no loss of capability in the PC operation. In fact, MILDOS-AREA is easier to use; more flexible in handling the large amounts of printer output; and although slower in execution, usually exhibits a better net turnaround time does than the original MILDOS. One of the notable features of MILDOS-AREA is the efficiency of the finite-element integration computations.

3.3.1 Accuracy and Efficiency of Finite-Element Computations

Table 3.1 summarizes the results (in terms of percent error) of several executions designed to demonstrate the efficiency and accuracy attained using only a small number of area elements. What is more notable is the computer efficiency of

TABLE 2.6 (Cont'd)

Category	0.3 µm D	0.3 µm W	0.3 µm Y	1.0 µm D	1.0 µm W	1.0 µm Y	5.0 µm D	5.0 µm W	5.0 µm Y
Bi-210 (Cont'd)									
Bone									
Infant	0.91	0.91	0.91	0.97	0.97	0.97	1.1	1.1	1.1
Child	0.69	0.69	0.69	0.71	0.71	0.71	0.72	0.72	0.72
Teenager	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8
Lung									
Infant	6.0	6.0	6.0	6.4	6.4	6.4	7.0	7.0	7.0
Child	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9
Teenager	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Liver									
Infant	6.3	6.3	6.3	6.7	6.7	6.7	7.3	7.3	7.3
Child	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9
Teenager	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Kidney									
Infant	5.1	5.1	5.1	5.4	5.4	5.4	5.9	5.9	5.9
Child	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6
Teenager	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
Po-210									
Effective									
Infant	13.0	14.0	14.0	13.0	15.0	15.0	15.0	18.0	18.0
Child	3.3	3.5	3.5	3.3	3.5	3.5	3.4	3.7	3.7
Teenager	1.4	1.6	1.6	1.4	1.6	1.6	1.5	1.7	1.7
Bone									
Infant	24.0	33.0	33.0	25.0	36.0	36.0	26.0	40.0	40.0
Child	3.4	3.8	3.8	3.5	3.9	3.9	3.5	4.0	4.0
Teenager	2.1	2.4	2.4	2.1	2.5	2.5	2.2	2.7	2.7
Lung									
Infant	11.0	12.0	12.0	11.0	12.0	12.0	9.9	12.0	12.0
Child	3.4	3.4	3.4	3.3	3.4	3.4	3.3	3.4	3.4
Teenager	1.3	1.5	1.5	1.3	1.5	1.5	1.2	1.5	1.5
Liver									
Infant	9.1	12.0	12.0	9.5	14.0	14.0	10.0	15.0	15.0
Child	3.0	3.2	3.2	3.0	3.3	3.3	3.0	3.4	3.4
Teenager	1.3	1.5	1.5	1.3	1.5	1.5	1.3	1.6	1.6
Kidney									
Infant	7.9	11.0	11.0	8.2	12.0	12.0	8.7	13.0	13.0
Child	2.6	2.8	2.8	2.6	2.9	2.9	2.7	3.0	3.0
Teenager	1.2	1.5	1.5	1.3	1.5	1.5	1.3	1.6	1.6

TABLE 3.2 MILDOS-AREA Execution Times

	Time (seconds)			
Test Problem	IBM-XT	IBM PS/2 Model 80	Compaq 386/20	IBM-3033[a]
SAMPLE.DAT	525	96	49.8	5.50
TESTC1.DAT	3,042	478	307.4	48.91
TESTC2.DAT	3,058	481	308.3	49.18

[a]CPU seconds, all others are total elapsed time.

finite-element integration approach for two area sources. The second problem, TESTC1.DAT, is a more realistic example that closely resembles the first sample problem in the MILDOS code manual (Strenge and Bander 1981). The problem includes two point sources, one area source (the ore pad) using the virtual-point method of the original MILDOS, and three tailings area sources using the new finite-element integration. The third problem, TESTC2.DAT, is identical to TESTC1.DAT except the last tailings area is defined as a crescent instead of a rectangle, and manual node numbering is used. The results listed in Table 3.2 indicate that even for the slowest computer tested, the IBM-XT, the most complicated test problem was completed in less than an hour.

3.4 DATA CONSTANTS

In MILDOS-AREA, parameters are initialized using a block-data routine, FRESH, and DATA statements in several subroutines. The initial values of input variables are given as defaults in the tables of Chapter 4, which describe the NAMELIST parameters.

Except for internal dose calculation, the values of internally defined, or *hard-coded*, parameters have not changed from MILDOS to MILDOS-AREA. These values are given in several tables at the end of Sec. 3.0 of the original MILDOS user's manual (Strenge and Bander 1981).

3.5 ERROR HANDLING

As in MILDOS, the input parameters are not validated in MILDOS-AREA. The user should carefully examine the first several output reports, which echo the program's interpretation of the NAMELIST input.

4 DATA-INPUT PREPARATION

To execute MILDOS-AREA, the user must supply, in order, a NAMELIST called INDATA, a title-card set, and a NAMELIST called NWAREA for each large-area source. INDATA has been slightly expanded in the new version; both new and original parameters are described in Sec. 4.1. Input of titles has not changed, but information concerning titles is repeated in Sec. 4.2. NWAREA is a new NAMELIST described in Sec. 4.3. Instructions on use of the FORTRAN NAMELIST are provided in Sec. 4.1 of the MILDOS user's manual (Strenge and Bander 1981) or in an IBM FORTRAN reference manual.

4.1 NAMELIST INDATA

The MILDOS-AREA parameters provided through NAMELIST INDATA can be classified as shown in Table 4.1. The parameters in each category are described in the following subsections, with emphasis on the new parameters added to MILDOS-AREA.

TABLE 4.1 Classification of MILDOS-AREA Parameters Provided through NAMELIST INDATA

Data Category	INDATA Parameters[a]
Job control	IFTODO, IRTYPE, JC
Source terms	FRADON, IPACT, NSORCE, PACT, QAJUST, SORCE, FAS*, SRNS*, HDP*, PTSZ*, PTSZFC*, IPSOL*
Meteorology	FREQ, DMM*, DMA*,
Food-pathway parameters	FFORI, FFORP, FHAYI, FHAYP, FPR
Population distribution	IPOP, PAJUST
Individual receptors	IADD, XRECEP
Time history	NSTEP, TSTART, TSTEP

[a]New parameters are marked with an asterisk (*).

4.1.1 Job-Control Parameters

The three job-control arrays used by MILDOS-AREA are described in Table 4.2. If any element of the array IRTYPE is set to 10, JC(7) must be set to 1. When JC(4) = 1, doses are printed for the pathways and organs listed in Table 4.3. The grid system for population doses is shown in Fig. 4.1.

4.1.2 Source-Term Parameters

Table 4.4 describes the original and the new source-term parameters. The three new parameters are listed at the end of the table. Either the SRNS array or SORCE (9,j) must be set by the user so that a release rate is always specified for Rn-222.

The array IPACT has no default values, so the values must be given explicitly by the user. Certain source parameters initialized to 0, such as NSORCE, also must be assigned values by the user, because the default values are not valid or sensible.

The maximum number of area sources has been reduced from 20 to 10. This change is reflected in the dimensions of SORCE, IPACT, and QAJUST.

The user can select to use the virtual-point-source method for an area source by setting SORCE(10,j) < 5000. This option is useful in the case where source and receptor heights differ significantly, thus violating the assumption of flatness inherent in the finite-element integration method.

A virtual-point area source or a finite element should be no larger in size than s^2, where: $s = 2x \tan(\pi/16)$, and x is the distance between the closest receptor and the center of the source or element. Larger areas should be subdivided accordingly.

Figure 4.2 shows the locations of reference radon releases represented by the elements of FRADON. The characteristics of particle-size distributions for determining the appropriate value at which to set SORCE(11,j) are summarized in Table 4.5.

4.1.3 Meteorological Parameters

The FREQ array and two mixing heights (DMM, DMA) constitute the user-supplied meteorological parameters, as shown in Table 4.6. The values of DMM and DMA must be specified by the user, because there are no defaults for these parameters.

The wind data should be taken at a reference height of no greater than 10 m for the tailings application. If the available data are for a much higher reference height, a conversion must be made using an appropriate (power or logarithmic) formula. (The wind-erosion routine, TAILPS, assumes a reference height of 1 m.)

TABLE 4.2 Job-Control Parameters[a]

Parameter (dimension)	Type	Description
IFTODO(10)	Integer	This array controls calculation and printing of doses for each of NSTEP time steps. When IFTODO(i) = 1, doses will be calculated and printed for time step i. Default: IFTODO(i) = 0.
IRTYPE(48)	Integer	This array of control integers is used to specify the output reports requested for each of the IADD locations. For a given receptor location i: IRTYPE(i) < 0, suppresses printing. IRTYPE(i) = 0, performs a 10 CFR 20 check on air concentrations and print a report. IRTYPE(i) = 1, prints doses totaled over all exposure pathways. IRTYPE(i) = 10, prints doses for each exposure pathway and total doses. If IRTYPE(i) has any positive value other than 0, 1, or 10, a default value of 1 is used. If no value is specified, IRTYPE is set at -1 to suppress printing. When IRTYPE(i) is set at 1 or 10, reports are printed for total dose commitments and for 40 CFR 190 dose commitments.
JC(10)	Integer	This job-control-integer array is used to select options for the current calculation. An option is selected by setting the appropriate value to 1. Default: JC(i) = 0. Use is described below. JC(1) = 1, uses the internal windblown dusting-rate algorithm (subroutine TAILPS) in calculating all sources j having SORCE(10,j) greater than or equal to 2,000. If JC(1) = 0, then default dusting values are used for sources with SORCE(10,j) ≥ 2,000. JC(2) = 1, computes the 100-year environmental-dose commitments. If JC(2) = 0, the annual population-dose commitments are computed. JC(3) = 1, prints total air concentrations (pCi/m^3), ground concentrations (pCi/m^3), and total deposition rates (pCi/[m^2·s]) for each spatial interval (see Fig. 4.1).

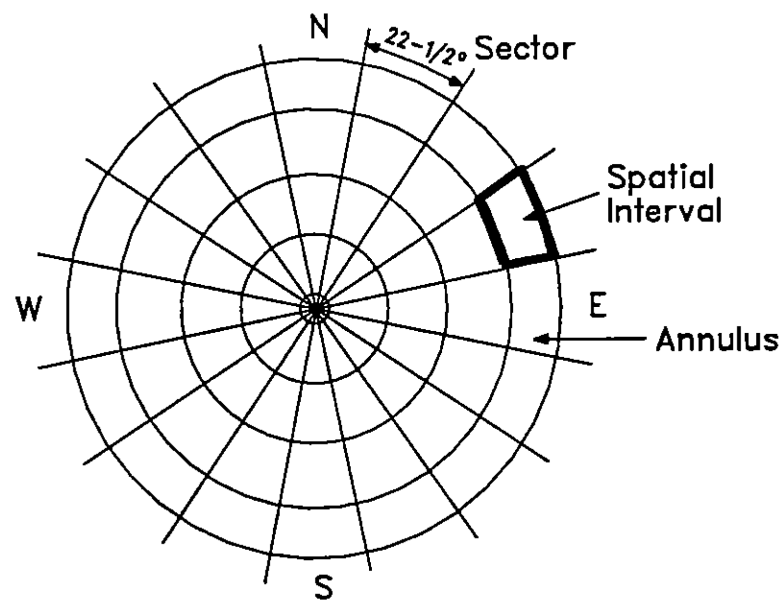
TABLE 4.2 (Cont'd)

Parameter (dimension)	Type	Description
JC(10) (Cont'd)		JC(4) = 1, prints annual population doses for each spatial interval. Reports are printed for each pathway and organ listed in Table 4.3. If JC(4) = 0, then only a summary table is printed for the population within 80 km and the extraregional population. JC(5) = 1, prints the normalized dispersion-factor (χ/Q) arrays. The outputs include the air concentration normalized by the release rate of U-238 for each source, receptor, and particle size and for Rn-222 and six daughters for each source and receptor. The units are: $\frac{pCi/m^3 \text{ (air concentration)}}{pCi/s \text{ (release rate)}}$ This option will generate lengthy output when several sources and receptor locations are specified. JC(6) = 1, prints a table of dose conversion factors for various pathways, organs, and isotopes. Other information printed includes particle sizes, density, age groups, environmental concentration factors, and time-step-dependent variables. JC(7) = 1, prints total dose commitments (mrem/yr) and 40 CFR 190 dose commitments by age group, pathway, and organ for each receptor location and time step. If JC(7) $\neq$ 1, the pathway data are not printed, and only total dose commitments are printed for each location. This parameter overrides report requests made through the parameter IRTYPE(i). If a full dose printout for any location is desired, JC(7) must be set at 1. JC(8) = 1, includes the milk pathway in the calculation of doses at receptor locations. If JC(8) $\neq$ 1, the milk pathway is not included or printed.

TABLE 4.2 (Cont'd)

Parameter (dimension)	Type	Description
JC(10) (Cont'd)		JC(9) = 1, prints particulate concentrations for air (pCi/^{3}) and ground (pCi/m^2) at each receptor location. Also printed are particle-size data for particulates (U-238, Th-230, Ra-226, and Pb-210), concentrations of radon and daughters (Rn-222, Po-218, Pb-214, Bi-214, Pb-210, Bi-210, and Po-210), and ground concentrations from radon daughters (Po-218, Pb-214, Bi-214, and Pb-210). JC(10), not currently in use.

Source: Modified from Strenge and Bander 1981.



(Facility at Center of Grid)

FIGURE 4.1 Population-Dose Grid-System Definition (Source: Modified from Strenge and Bander 1981)

TABLE 4.3 Population-Dose Outputs for JC(4) = 1

Exposure Pathway	Dose of Interest
Inhalation	Effective dose equivalent Bone Mass average lung Bronchial epithelium
Ground exposure[a]	Effective dose equivalent
Cloud exposure[a]	Effective dose equivalent
Vegetable ingestion	Effective dose equivalent Bone
Meat ingestion	Effective dose equivalent Bone
Milk ingestion	Effective dose equivalent Bone

[a]For external gamma exposure, whole-body dose equivalent is assumed to be the effective dose equivalent.

TABLE 4.4 Source-Term Parameters

Parameter (dimension)	Type	Description
FRADON(4)	Real	The fraction of radon releases attributable to each of the following sites: FRADON(1) - Casper, Wyo. FRADON(2) - Falls City, Texas FRADON(3) - Grants, N.M. FRADON(4) - Wellpinit, Wash. Each value must be between 0 and 1, and the four values must sum to exactly 1. This array is used to determine impact to populations outside the 80-km radius. See Fig. 4.2 for the locations of these sites. Default: FRADON(i) = 0.0.

TABLE 4.4 (Cont'd)

Parameter (dimension)	Type	Description
IPACT(10)	Integer	This array assigns mixes defined by PACT(i,k) to each area source j. A value of IPACT(j) = i causes mix i to be used for material in area source j. IPACT must have nonnegative integer values ≤ 3.
NSORCE	Integer	The number of effluent sources to be defined for the current case. 1 ≤ NSORCE ≤ 10 (maximum).
PACT(3,4)	Real	Defines up to three isotopic-composition mixes for characterizing area-source particulate releases. The values given for PACT(i,k) represent the specific activity (pCi/g) for radionuclide k in mix i, where: k = 1 for U-238 k = 2 for Th-230 k = 3 for Ra-226 k = 4 for Pb-210 Default: PACT (i,k) = 0.0.
QAJUST (10,2,10)	Real	Provides adjustment factors for particulate and radon emissions for each source and time step. Use is as follows: QAJUST(i,1,j), adjustment factor for the particulate activities defined for source j that are released during time step i; QAJUST (i,2,j), adjustment factor for radon activity defined for source j that is released during time step i. Default: QAJUST(i,k,j) = 0.0.
SORCE (12,10)	Real	Data defined for each effluent source term j: SORCE(1,j) = x coordinate (km) for source j. A positive value indicates east and a negative value indicates west of the facility center. SORCE(2,j) = y coordinate (km) for source j. A positive value indicates north and a negative value indicates south of the facility center. SORCE(3,j) = elevation (m) of source j. A positive value indicates above and a negative value indicates below the elevation of the facility center. SORCE(4,j) = area (km^2) of source j. A value of 0 should be used for point sources, such as stacks.

TABLE 4.4 (Cont'd)

Parameter (dimension)	Type	Description
SORCE (10,12) (Cont'd)		SORCE(5,j) = annual average release rate (Ci/yr) of U-238 for source j.
		SORCE(6,j) = annual average release rate (Ci/yr) of Th-230 for source j.
		SORCE(7,j) = annual average release rate (Ci/yr) of Ra-226 for source j.
		SORCE(8,j) = annual average release rate (Ci/yr) of Pb-210 for source j.
		SORCE(9,j) = annual average release rate (Ci/yr) of Rn-222 gas for source j. This value is computed by the program using input values of SRNS when SORCE(10,j) ≥ 2,000.
		SORCE(10,j) = identification number for source j. For a value of SORCE(10,j) ≥ 2,000, the code will generate source terms for particulate releases (U-238, Th-230, Ra-226, and Pb-210) for source j (subroutine TAILPS). This option is used for area sources, and any user-supplied numbers for SORCE(5-8,j) will be ignored. For area sources with SORCE(10,j) ≥ 5,000, finite-element area-source integration will be used.
		SORCE(11,j) = assigned particle-size distribution-set number for source j. The valid values are 1, 2, or 3. Table 4.5 summarizes the characteristics of each particle-size distribution.
		SORCE(12,j) = product of stack inside diameter (m) and effluent exit velocity (m/s) for source j, m^2/s. Area sources should have SORCE(12,j) set to 0.
		All default values for SORCE array are 0.0.

TABLE 4.4 (Cont'd)

Parameter (dimension)	Type	Description
FAS(3)	Real	Defines up to three fixed particulate-release rates [corresponding to the three isotopic-composition mixes PACT (i,k)] for characterizing area-source particulate releases ($g/m^2 \cdot s$). Used along with PACT to compute SORCE(5-8,j). FAS(i) < 0.0 and SORCE(10,j) ≥ 2,000 cause the code to generate wind-erosion source terms for particulate releases. Default: FAS(i) = -1.
SRNS(3)	Real	Defines up to three radon-release rates for characterizing area-source radon releases ($pCi/m^2 \cdot s$). Used to compute SORCE(9,j). Default: SRNS(i) = 0.
HDP	Real	If source height (m) is below this value, program uses Martin-Tickvart σ_z values; otherwise, Briggs coefficients are used. Default: HDP = 50.
LOGLNR	Integer	Defines the option for calculating air concentration in radial direction. LOGLNR = 1 for logarithmic approximately (Eq. 13b). LOGLNR = 2 for linear approximation (Eq. 13c). Default: LOGLNR = 1.
PTSZ(5)	Real	Defines up to four AMADs (μm) for AMAD distribution set. Default values are 1.5, 3.0, 7.7 and 54 μm. PTSZ(5) is reserved for radon-daughter-attached aerosol, 0.3 μm.
PTSZFC(4,3)	Real	Defines AMAD distribution for up to four AMADs and three distribution sets. Defaults: 0, 1.0, 0, 0; 1.0, 0, 0, 0; and 0, 0, 0.3, 0.7.
IPSOL(7)	Integer	Defines solubility classes for radioisotopes. Defaults: 3, 3, 3, 2, 2, 2, 2.

Source: Modified from Strenge and Bander 1981.

FIGURE 4.2 Geographical Locations of Reference Radon-Release Sites for Continental Population Doses (Source: Modified from Strenge and Bander 1981)

TABLE 4.5 AMAD Distribution-Set Characteristics

Set Number	Density (g/cm^3)	Particle Size (μm)	AMAD (μm)	Percentage of Material	Source Types
1	8.9	1	3	100	Yellowcake dryer packaging or equivalent
2	2.4	1	1.5	100	Crushers, grinders, rod mills, conveyers, fine-ore blending, and other mill-process sources
3	2.4	5	7.7	30	Tailings, ore-storage piles
	2.4	35	54	70	

Source: Modified from Strenge and Bander 1981.

TABLE 4.6 Meteorological Parameters

Parameter (dimensions)	Type	Description
FREQ(16,6,6)	Real	Fractional joint frequency of occurrence of wind direction (16), windspeed class (6), and atmospheric-stability class (6), dimensionless.[a] $\text{FREQ}(i,j,k) \geq 0, \quad \sum_{i,j,k} \text{FREQ}(i,j,k) = 1.00$
DMM, DMA	Real	Annual average morning and afternoon mixing heights (m).[b]

[a]Values should be derived from data taken at a height of 10 m or less (see Sec. 4.1.3).

[b]Estimates of values for the continental United States can be obtained from Holzworth 1972.

Source: Modified from Strenge and Bander 1981.

4.1.4 Remaining INDATA Parameters

The remaining data categories in NAMELIST INDATA are described in Tables 4.7-4.12. Table 4.7 explains the food-pathway parameters, and Table 4.8 gives suggested values of food-production rates in each state. Table 4.9 explains the population-distribution parameters, and Table 4.10 gives the projected U.S. population to the year 2050. Ratios of PAJUST can be determined from the data of Table 4.10. Tables 4.11 and 4.12 explain the parameters in the categories of individual receptors and time history, respectively.

The default values for the array PAJUST (1.0) imply constant population with respect to the base year (1980) and must be overridden by the user to more realistically represent U.S. demography. IADD and NSTEP have invalid defaults of 0, and must be set by the user. TSTART has no default, and also must be specified by the user.

4.2 TITLE CARDS

Immediately after the card that signals the end of INDATA, the title cards follow in the exact order and quantity shown in Table 4.13. The order of the source, receptor, and time-step labels must correspond to the order of definition for arrays SORCE, XRECEP, and TSTEP, respectively. Labels that exceed the allowed length are truncated.

TABLE 4.7 Food-Pathway Parameters

Parameter (dimension)	Type	Description
FFORI	Real	Fraction of total annual livestock feed requirements assumed to be satisfied by pasture grass, used for calculating individual doses. Default value is 0.5.
FFORP	Real	Fraction of total annual livestock feed requirements assumed to be satisfied by pasture grass, used for calculating population doses. Default value is 0.5.
FHAYI	Real	Fraction of total annual livestock feed requirements assumed to be satisfied by locally grown stored feed, used for calculating individual doses. Default value is 0.5.
FHAYP	Real	Fraction of total annual livestock feed requirements assumed to be satisfied by locally grown stored feed, used for calculating population doses. Default value is 0.5.
FPR(3)	Real	Areal food-production rate in $kg/(yr \cdot km^2)$ for (1) vegetables, (2) meat, and (3) milk in the region around the facility. Suggested values are given in Table 4.8. Default: FPR(i) = 0.0.

Source: Modified from Strenge and Bander 1981.

4.3 NAMELIST NWAREA

For each area source for which IPACT(j) ≠ 0 (i.e., for which a particulate mix is specified), a subset of the parameters listed in Table 4.14 must be provided in a separate NWAREA NAMELIST. In each such NAMELIST, NEX is always specified. If NEX ≠ 0 (an automeshing option for a quadrilateral area), then NEY and VERTEX must also be specified, and the remaining parameters skipped. If NEX = 0 (an option for any shaped area), then NAS, NODE, NNODE, XS, and YS are specified, and NEY and VERTEX are skipped.

The subset consisting of NEX, NEY, and VERTEX is used in the program to assign node numbers and coordinates automatically in the case of a quadrilaterally shaped source. For an irregularly shaped source, the node numbers and coordinates must be specified by the user. The node-number sequence proceeds from bottom to top, left to right, as shown in Fig. 4.3. This order is consistent with the vertex-number sequence in the large quadrilateral area source (Fig. 2.3). Appendix C presents sample problems illustrating both automatic and manual node numbering.

TABLE 4.8 Average Annual Agricultural Productivity by State

State	Average Productivity (kg/yr·km^2)		
	Crops	Meat	Dairy
Alabama	5.53 E+03	2.26 E+03	6.28 E+02
Alaska	2.49 E-02	3.49 E-03	1.69 E-02
Arizona	2.16 E+03	3.31 E+02	9.64 E+02
Arkansas	1.58 E+04	4.31 E+03	1.23 E+03
California	1.38 E+04	1.09 E+03	5.23 E+03
Colorado	1.27 E+04	1.13 E+03	8.31 E+02
Connecticut	6.19 E+02	8.48 E+02	3.29 E+03
Delaware	7.70 E+04	2.64 E+04	6.58 E+03
Florida	2.20 E+04	1.28 E+03	2.52 E+03
Georgia	1.04 E+04	2.93 E+03	1.41 E+03
Hawaii	1.61 E+03	1.02 E+03	1.87 E+03
Idaho	1.42 E+04	3.21 E+02	1.26 E+03
Illinois	2.66 E+05	5.41 E+03	6.75 E+03
Indiana	1.80 E+05	7.12 E+03	8.07 E+03
Iowa	2.89 E+05	1.59 E+04	1.14 E+04
Kansas	8.45 E+04	5.40 E+03	2.61 E+03
Kentucky	2.82 E+04	1.75 E+03	5.82 E+03
Louisiana	6.79 E+03	6.19 E+02	1.20 E+03
Maine	1.12 E+03	1.20 E+02	3.04 E+02
Maryland	3.57 E+04	6.48 E+03	1.14 E+04
Massachusetts	5.55 E+02	1.91 E+02	1.64 E+03
Michigan	2.35 E+04	6.72 E+02	4.85 E+03
Minnesota	7.93 E+04	3.17 E+03	1.24 E+04
Mississippi	1.11 E+04	1.91 E+03	1.37 E+03
Missouri	4.48 E+04	3.68 E+03	4.89 E+03
Montana	1.20 E+04	5.46 E+02	2.67 E+02
Nebraska	1.20 E+05	6.89 E+03	2.81 E+03
Nevada	1.47 E+02	2.25 E+01	5.09 E+01
New Hampshire	8.53 E+01	5.44 E+01	5.83 E+02
New Jersey	6.21 E+03	3.05 E+02	2.22 E+03
New Mexico	1.58 E+03	4.00 E+02	7.10 E+02
New York	8.24 E+03	6.26 E+02	1.24 E+04
North Carolina	1.53 E+04	3.14 E+03	1.99 E+03
North Dakota	8.37 E+04	1.04 E+03	2.34 E+03
Ohio	8.72 E+04	3.26 E+03	1.14 E+04
Oklahoma	2.29 E+04	2.85 E+03	2.19 E+03
Oregon	4.22 E+03	2.64 E+02	6.82 E+02
Pennsylvania	1.04 E+04	1.77 E+03	1.04 E+04
Rhode Island	1.19 E+03	1.92 E+02	7.10 E+02

TABLE 4.8 (Cont'd)

State	Average Productivity (kg/yr·km^2) Crops	Meat	Dairy
South Carolina	8.03 E+03	9.30 E+02	9.50 E+02
South Dakota	4.54 E+04	2.89 E+03	3.66 E+03
Tennessee	1.59 E+04	1.76 E+03	4.69 E+03
Texas	1.71 E+04	2.55 E+03	1.98 E+03
Utah	4.94 E+02	1.06 E+02	4.61 E+02
Vermont	6.58 E+02	3.36 E+02	1.19 E+04
Virginia	1.02 E+04	1.71 E+03	3.37 E+03
Washington	1.99 E+04	6.62 E+02	3.28 E+03
West Virginia	1.25 E+03	3.74 E+02	5.85 E+02
Wisconsin	3.73 E+04	2.08 E+03	3.70 E+04
Wyoming	3.12 E+03	3.45 E+02	1.34 E+02
U.S. Total	2.43 E+04	1.34 E+03	2.92 E+03

Source: Based on data from U.S. Bureau of the Census 1984.

TABLE 4.9 Population-Distribution Parameters

Parameter (dimensions)	Type	Description
IPOP(12,16)	Integer	Population-distribution data. IPOP(i,j) gives the population in the spatial interval defined by the ith distance interval and the jth direction, where j = 1 indicates north. Default: IPOP(i,j) = 0.
PAJUST(10)	Real	Ratio of the U.S. population during each time step to that during the base year (1980). A value must be given for each of the NSTEP time steps in order. These values are used to obtain the proper continental population doses as a function of the time of exposure. See Table 4.10 to determine ratios.

Source: Modified from Strenge and Bander 1981.

TABLE 4.10 Projected Population of the United States, 1980-2050[a]

Year	Population (millions)	Year	Population (millions)
1980	227.7	1992	253.9
1981	229.8	1993	255.9
1982	232.0	1994	257.8
1983	234.2	1995	259.6
1984	236.4	1996	261.4
1985	238.6	1997	263.1
1986	240.9	1998	264.8
1987	243.1	1999	266.4
1988	245.4	2000	268.0
1989	247.6	2025	301.0
1990	249.7	2050	308.9
1991	251.8		

[a]All data are for midyear.

Source: Modified from U.S. Bureau of the Census 1982.

TABLE 4.11 Individual Receptor-Location Parameters

Parameter (dimensions)	Type	Description
IADD	Integer	This parameter specifies the number of locations for which individual doses will be calculated: 1 ≤ IADD ≤ 48.
XRECEP(3,48)	Real	This array gives coordinates of each receptor location. For each receptor i, the data are entered as follows: XRECEP(1,i) -- distance (km) to the east (positive value) or west (negative value) of the facility center. XRECEP(2,i) -- distance (km) to the north (positive) or south (negative) of the facility center. XRECEP(3,i) -- elevation (m) of the receptor above (positive) or below (negative) the elevation of the facility center. Default: XRECEP(k,i) = 0.0.

Source: Modified from Strenge and Bander 1981.

TABLE 4.12 Time-History Parameters

Parameter (dimension)	Type	Description
NSTEP	Integer	Number of time steps used to define the facility lifetime. 1 ≤ NSTEP ≤ 10 (maximum).
TSTART	Real	Year of initial effluent release, in year A.D. Fractional values (noninteger) are used to account for startup during a year, e.g., 1980.5 would indicate startup at the beginning of July 1980.
TSTEP(10)	Real	The length of each time step, in number of years. The number of values to be given is equal to NSTEP. A minimum value of 2 years is assumed, i.e., if a smaller value is given it will be set to 2 years. Default: TSTEP(i) = 5.0.

Source: Modified from Strenge and Bander 1981.

TABLE 4.13 Order of Title Cards

Number of Cards	Label Name	Columns	Format	Description
1	REGION	1-24	A24	Region identification
	METSET	31-54	A24	Meteorological-data identification
NSORCE	QNAME(j)	1-20	A20	Label for source j
IADD	XNAME(i)	1-20	A20	Label for individual receptor location i
NSTEP	TNAME(k)	1-20	A20	Time step k identification label

TABLE 4.14 Large-Area-Source Parameters

Parameter (dimensions)	Type	Description
NEX	Integer	Number of elements in x (E-W) or approximate x direction.
NEY	Integer	Number of elements in y (N-S) or approximate y direction.
VERTX(2,4)	Real	Vertex coordinates of quadrilateral source (m). VERTX(1,j) = x coordinate of vertex j.[a] VERTX(2,j) = y coordinate of vertex j.[a]
Enter positive values for the preceding parameters only for a quadrilaterally shaped source. An automeshing algorithm will be performed for the source. Otherwise, set NEX = 0 and enter the parameters below instead of NEY and VERTX		
NAS	Integer	Number of area-source elements.
NODE(4,300)	Integer	Four spatial node numbers for each quadrilateral element. See Fig. 4.3 for sequence.
NNODE	Integer	Total number of nodes (maximum 300).
XS(300)	Real	X-coordinates of nodes (m).
YS(300)	Real	Y-coordinates of nodes (m).

[a]See Fig. 2.3 for j sequence.

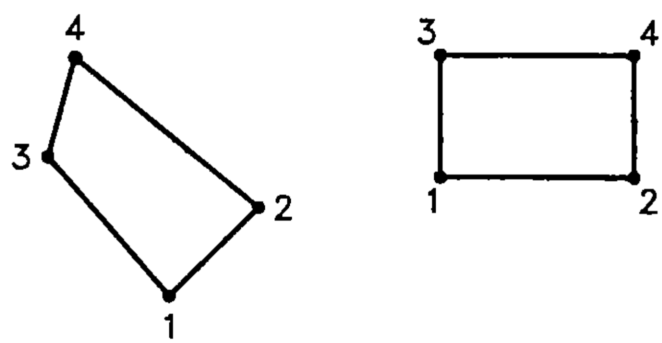


FIGURE 4.3 Node Numbering for Quadrilateral Elements

5 INSTALLATION AND USE OF MILDOS-AREA

Steps and commands for installation and use of MILDOS-AREA on a personal computer are summarized in the following sections. The MILDOS-AREA code contains a number of calls specific to the Lahey FORTRAN 77 Language System (F77L, Version 3.0). Lahey FORTRAN was used because it currently is the only PC-DOS compiler that supports NAMELIST input.

5.1 INSTALLING MILDOS-AREA

An IBM (or compatible) microcomputer with a hard disk drive and approximately 500K of memory is required for MILDOS-AREA. A DOS 3.1 or equivalent operating system, a mathematics coprocessor, and a printer capable of 132-column output are needed. Most PC printers have a condensed print option (17 characters per inch) that is satisfactory.

The code is distributed either on a single 360K, 5.25-inch or a 1.4M, 3.5-inch diskette. In addition to executable modules, the diskette contains the FORTRAN source code for all MILDOS-AREA programs and three sample problems (SAMPLE.DAT, TESTC1.DAT, TESTC2.DAT) (see Appendix C). The steps for installing the code are as follows:

1. Assuming the hard disk is the C disk, move to the C disk drive with the DOS commands:

   C:

   CD\

2. Issue the DOS command:

   PROMPT PG

   This adds the current subdirectory to the DOS prompt.

3. Create a subdirectory called MILDOS on the hard disk. Move to the new subdirectory using the commands:

   MD MILDOS

   CD\MILDOS

   The prompt "C:\MILDOS>" should appear on the monitor.

4. Insert either distribution diskette into the A disk drive and issue the command:

   COPY A:*.*

   to copy all necessary files to the hard disk.

5. In the case of the 5.25-inch diskettes, the MILDOS-AREA system is stored in a special, compacted format to fit onto a single 360K diskette. To complete the installation for the 5.25-inch diskette only, enter the command:

   INSTALL

At this point, all of the executable modules and files needed to run MILDOS-AREA will be on the hard disk. However, successful execution of the code will require a CONFIG.SYS file in the root directory of the hard disk that contains at least the following:

FILES=20

BUFFERS=16

SHELL=C:\COMMAND.COM /P/E:256

A CONFIG.SYS consisting of the above lines will be found in the \MILDOS directory. This may be copied directly by the command:

COPY C:\MILDOS\CONFIG.SYS C:\

or an existing CONFIG.SYS may be modified with a suitable editor, such as EDLIN. Note that the 256 in the SHELL command sets the size of the DOS environment-string table. If an out-of-memory environment error occurs, increase the size of the E parameter. A system reboot (Ctrl-Alt-Del) is needed whenever changes are made to the CONFIG.SYS file.

5.2 EXECUTING MILDOS-AREA

The prompts (in boldface) and responses to start executing MILDOS-AREA are:

C:\> cd\mildos

C:\MILDOS> mildos

A single optional command line argument, the name of the user-prepared input data file, may also be included. For example:

C:\MILDOS> mildos mysite.dat

If the data file name is not supplied on the command line, the user will be prompted for its input before calculations start. The file name also can contain drive and path information up to a maximum of 24 characters; otherwise, the customary defaults of current drive and directory apply. The data file name is a part of the header on all pages of MILDOS-AREA output.

The actual start of MILDOS-AREA is a banner screen with a brief definition of the code. This is followed by a printer setup series that allows the user to set the printer for 132-column output if desired.

If there was no command line argument, the user will then be prompted to input the run-dependent data file name. If there is a null input ("Enter" key only), the default file SAMPLE.DAT supplied with the distribution diskette will be used.

The program next echoes the name of the file that it will open for data input. If the file open and data input are successful, a brief series of progress reports will appear on the monitor screen ending with:

MILDOS complete, elapsed time = xxxxx.xxxx seconds.

The user can abort a run at any prior to the above completion message with a Ctrl-Break (hold down Ctrl key and press Break key). However, execution probably will not stop immediately.

5.3 VIEWING OUTPUT

Instead of providing direct printer output, MILDOS-AREA produces a hard disk file named MILDOS.REP. This output file is overwritten with every execution of the code. Thus, the user should examine and, if desired, save some or all of the output into a selected disk file before starting a new run.

To provide for easy viewing of MILDOS.REP with optional hard copy and selective saving of the file, the utility program PAGER.EXE is included on the distribution diskette. PAGER is a useful program for viewing any ASCII file, particularly FORTRAN printer files that contain control characters in column 1 of each line.

PAGER, with MILDOS.REP as the input file, is loaded automatically by MILDOS.BAT, the DOS batch file that executes MILDOS-AREA. This occurs as soon as MILMAIN, the MILDOS-AREA FORTRAN module, completes normally. The viewing process starts by displaying the first page of MILDOS.REP. This is a table of contents, and it has been added to the original MILDOS output for user convenience. A typical table of contents is shown with the computer output in Sec. C.3 of Appendix C.

As soon as PAGER completes reading in the entire file, which is indicated in the status line at the bottom of the screen, any page of MILDOS.REP may be viewed by entering the page number and pressing "Enter" or "F10." On-line help on the use of PAGER, primarily key strokes to aid in the page display, is available at any time by pressing the F1 function key. Function keys F7 and F8 can be used to produce hard copy and to save selected portions of the output (see Sec. 5.4). Pressing "Esc" exits PAGER and returns the user to the normal DOS prompt. This terminates the MILDOS-AREA run. PAGER can be executed independently by entering PAGER at the DOS prompt. The name of the ASCII file to be viewed can be included as an optional command line argument. For example:

C:\MILDOS> pager mysite.rep

PAGER will prompt for the name of the file to be viewed if it is omitted from the command line. The independent use of PAGER is a convenient method of retrieving an old MILDOS-AREA run that has been saved. And, of course, MILDOS.REP can be viewed to check the last MILDOS-AREA output without rerunning the code.

5.4 PRODUCING HARD COPY AND SAVING SELECTED OUTPUT

At any time while viewing a file via PAGER, hard copy can be produced by pressing the F7 or F8 function keys. The F8 key produces an immediate copy of the current screen page only.

The F7 function key is a more versatile but complicated option. The user is first informed of the current hard copy destination (LPT1 for normal printer or a disk file name) and allowed to make a change, if desired. If an existing disk file is selected, the user can specify to overwrite or append. The following series of options can then be exercised repeatedly (until "Esc"):

- Enter the first and last page numbers, separated by a space or comma, to print (or save). Enter a single page number to print that page only.
- Press "Enter" key only to print current page (current page number will be displayed on screen).
- Press "D" or "d" to print entire document (file).
- Press "P" or "p" to pass ASCII control characters to the printer.
- Press "Esc" to resume normal PAGER viewing of the file.

To preserve an option of an earlier PAGER version, the "*" key is identical to F7.

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APPENDIX A:

PROGRAM STRUCTURE

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PROGRAM STRUCTURE

This appendix summarizes information on program structure and data transfer in MILDOS-AREA. Twenty-seven FORTRAN modules (plus block data) constitute the program MILDOS-AREA, an increase of 11 modules over the original MILDOS code. The hierarchy of the modules is described in Sec. A.1, and details of each new module are given in Sec. A.2. Significant changes to preexisting modules are discussed in Sec. A.3.

Also referenced by MILDOS-AREA are five routines specific to the Lahey F77L FORTRAN Language System:

DATE:	Returns system date as MM/DD/YY,
GETCL:	Returns DOS command line input, i.e., file name of input data,
NBLANK:	Returns last nonblank position in a character string,
TIMER:	Returns count of 0.01 second ticks since midnight,
UNDERO:	Stores zero and suppresses arithmetic underflow error message.

Eleven labeled common blocks provide for most of the data transfer between modules. Two common blocks (DEPY and GDATA) have been eliminated. Four new common blocks (AREA, CHAR, DOSINH, and PTDISP) have been added and are described in Sec. A.4.

A.1 HIERARCHY

The calling sequence of the new and modified modules is given in Fig. A.1, and corresponding module functions are listed in Table A.1. Modules that are unchanged from the previous version of MILDOS are not shown.

A.2 NEW MODULES

The new modules in MILDOS are described in alphabetical order. The descriptions include purpose of the module, functions performed, calling routine, argument list, common-block usage, and subordinate modules.

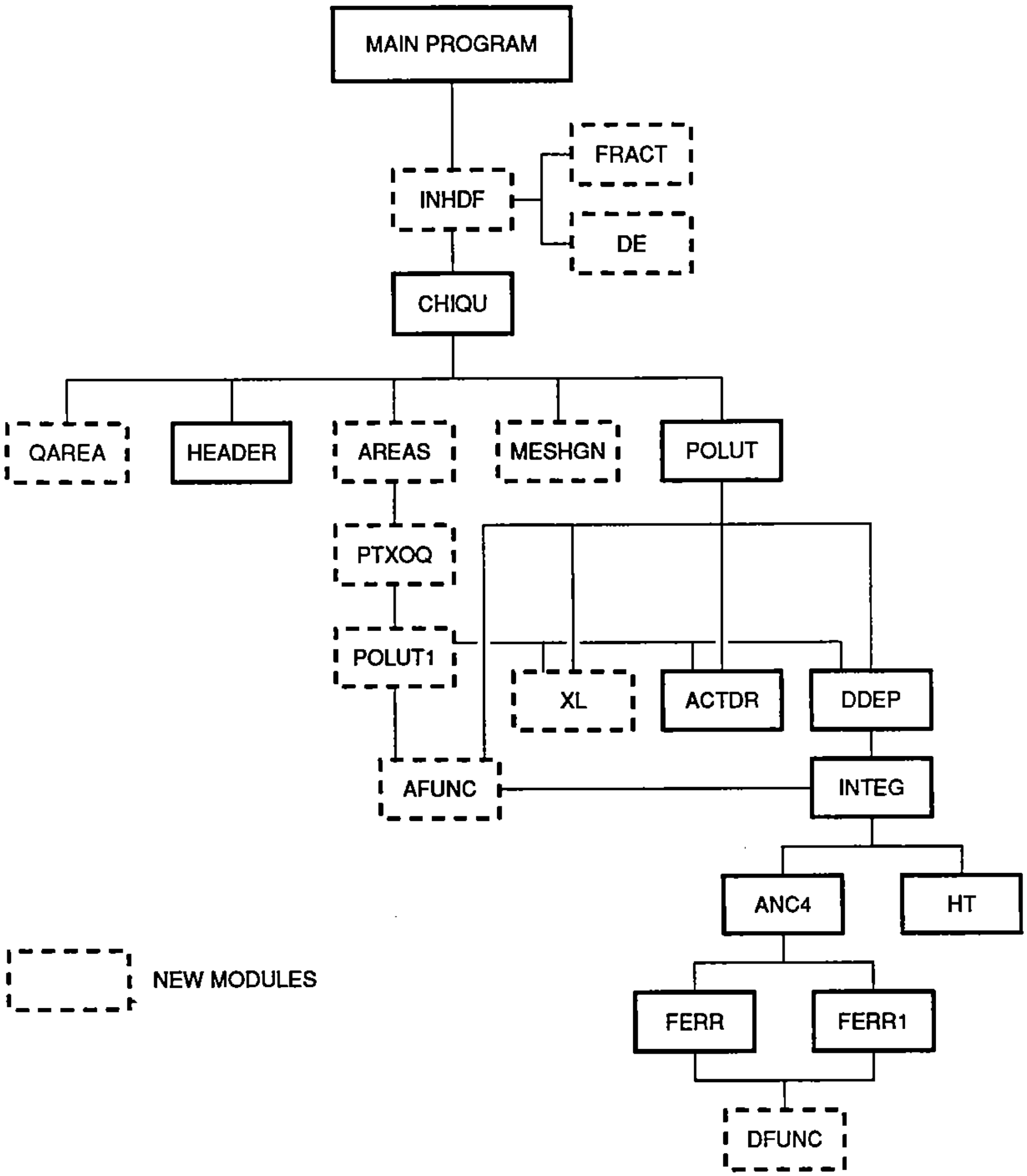

FIGURE A.1 Hierarchy Diagram of New (dashed boxes) and Modified (solid boxes) Modules (functions are listed in Table A.1) (Modified from Strenge and Bander 1981)

TABLE A.1 Functions of New and Modified MILDOS Modules[a]

Module[b]	Function
ACTDR	Computes Rn-222 decay and progeny ingrowth
AFUNC*	Computes vertical dispersion coefficient as a function of downwind distance
ANC4	Utility numerical integration routine
AREAS*	Computes air concentrations at each location of interest due to a large area source
CHIQU	Calculates normalized air concentrations (particulates and gases) for each source
DDEP	Computes source depletion factors
DE*	Calculates inhalation dose factors
DFUNC*	Double precision version of AFUNC
FERR	Function F_1 for evaluation of source depletion
FERR1	Function F_2 for evaluation of source depletion
FRACT*	Computes particulate deposition fraction in lung compartments
HEADER	Prints a new page heading
HT	Computes effective stack height
INHDF*	Calculates inhalation dose factors
INTEG	Performs numerical integration for source depletion
MESHGN*	Automatic meshing routine for a large quadrilateral area source.
POLUT	Computes normalized air concentrations at each location of interest due to a point (or virtual point) source
POLUT1*	Computes normalized air concentrations (including resuspension) for each wind speed class
PTXOQ*	Computes normalized air concentrations for each reference point in a polar grid
QAREA*	Calculates the area of a quadrilateral area source
XL*	Computes distance from the source that corresponds to a limiting value of the vertical dispersion coefficient

[a]Modules are listed alphabetically; see Fig. A.1 for a schematic diagram of the relationships among the modules.

[b]An asterisk (*) identifies a new module.

A.2.1 Function AFUNC

Function AFUNC, along with DFUNC, is similar to a function of the same name from UDAD-IX (Momeni et al. 1979). AFUNC calculates the vertical-dispersion coefficient $\sigma_z(x)$, where x represents downwind distance and is the lone argument of AFUNC. For elevated sources, this routine uses the same empirical formula as is used in the original version of MILDOS. For ground-level sources, the formula described in Sec. 2.2 of this manual is applied. The constants of the formula are stored in the common block ADATA. AFUNC is called by POLUT, POLUT1, and INTEG.

A.2.2 Subroutine AREAS

Subroutine AREAS incrementally computes air concentrations from a large-area source at receptor points designated by the program and by the user. AREAS is invoked by CHIQU, which passes along the IPACT value associated with the source in question. Also passed are the mean annual morning and afternoon mixing heights. The common blocks ADATA, BDATA, PTDISP, and AREA are used by the AREAS subroutine. AREAS calls PTXOQ to compute normalized air concentrations at polar reference points. These concentrations are used to calculate weighted averages for the nodes of the finite elements.

A.2.3 Function DE

Function DE, called within subroutine INHDF, calculates the inhalation dose conversion factor for different isotopes, particle AMADs, and reference tissues. The common block DOSINH is used by DE.

Except for the effective dose equivalent, the inhalation dose factors for organs are calculated by the ICRP 30 nominal dose factors (at 1 μm) and the adjustment of AMAD (see ICRP 1979, Part 1) by Eq. 20.

A.2.4 Function DFUNC

Function DFUNC is the double-precision version of AFUNC (described in Sec. A.2.1). The constants for the empirical formula used by DFUNC are stored in the common block DSTBZ. Common block ADATA is also used by DFUNC. DFUNC is called by FERR and FERR1.

A.2.5 Subroutine FRACT

Based on the ICRP deposition lung model (ICRP Task Group on Lung Dynamics 1966), the subroutine FRACT calculates the initial deposition fractions of inhaled aerosols in three lung regions (nasal-pharyngeal [N-P]), (trachea-bronchus [T-B]), and (pulmonary [P]). This subroutine is called by INHDF with input of AMAD. No common blocks are used by FRACT.

A.2.6 Subroutine INHDF

In BLOCK DATA, the function DCFA and its equivalent arrays in the original MILDOS are replaced by array IPSOL (in COMMON/BDATA/) and by variables in COMMON/DOSINH/. Common blocks ADATA and DDATA are also used. The new variables are used with the added routines to calculate the DCFA array based on the characteristics of inhaled particles. These characteristics are inhalation class and AMAD. The AMAD is equal to the product of the particle size and the square root of the density.

This subroutine calculates DCFA [(mrem/yr)/(pCi/m^3)] from inhalation dose conversion factors (rem/μCi), which were input in BLOCK DATA in the original MILDOS code, for different AMADs, isotopes, and reference tissues. The calculation is based on the ICRP 30 (ICRP 1979) dose factors used with the ICRP deposition lung model. This routine performs the following two tasks:

- Evaluates deposition fractions -- The subroutine FRACT is called to calculate initial deposition fractions at different lung regions for inhaled aerosols.

- Calculates dose factor -- The functions DE and DFINT are used to calculate inhalation dose factors, DCFA (DCFA = 7.3 × DE for dose equivalent of reference tissue).

A.2.7 Subroutine MESHGN

To facilitate the use of finite-element methodology for area sources, the input of each node and element is simplified to the description of a large quadrilateral area, i.e., vertex coordinates and divisions on two adjacent sides. This subroutine generates meshes automatically. These meshes later are used in subroutine AREAS. The detailed algorithm is presented in Sec. 2.1. Common blocks ADATA and DSTBZ are used by MESHGN.

A.2.8 Subroutine POLUT1

This routine computes the normalized air-concentration increment for a particular source, atmospheric-stability class, wind direction, windspeed, and receptor. POLUT1 is the finite-element version of POLUT; the modules are parallel in terms of functions performed. POLUT1 is called by PTXOQ to compute arrays XOQP(5,45,6) and XOQR(7,45,6). Array XOQP(5,45,6) provides normalized air concentrations for up to 5 particle-size classes, 45 distances from the source, and 6 windspeed classes. Array XOQR(7,45,6) provides the same as above except for seven radionuclides (Rn-222 and progeny) rather than particle-size classes.

POLUT1 has three arguments: PSORC, DNWIND, and IRD. PSORC is the wind-erosion source term; DNWIND is one of the 45 selected downwind distances; and IRD is the index number of that downwind distance. POLUT1 uses the common blocks ADATA, INTG, and PTDISP and calls the subroutines AFUNC, DDEP, XL, and ACTDR.

A.2.9 Subroutine PTXOQ

This subroutine calculates normalized air concentrations for points in a polar reference grid about the source. PTXOQ is invoked by AREAS to compute arrays PXOQ(5,45,16) and RXOQ(7,45,16). Array PXOQ(5,45,16) provides normalized air concentrations for up to 5 particle-size classes, 45 distances from the source, and 16 wind directions. Array RXOQ(7,45,16) provides the same, except for seven radionuclides (Rn-222 and progeny) rather than five particle-size classes.

The IPACT value associated with the source in question and the mean annual morning and afternoon mixing heights are the three arguments of PTXOQ. PTXOQ uses the common blocks ADATA, BDATA, AREA, and PTDISP and calls POLUT1 to access the straight-line, crosswind-integrated Gaussian dispersion model used in the former version of MILDOS.

A.2.10 Function QAREA

Function QAREA calculates the area of a quadrilaterally shaped region by simple trapezoidal rule. The function is called by subroutine CHIQU to automatically correct the emission rate of area sources. No common blocks are used.

A.2.11 Subroutine XL

This subroutine back-computes the downwind distance associated with a particular limiting value of σ_z. POLUT and POLUT1 both use XL in parallel code. XL has three arguments: X, the returned downwind distance; XL1, the σ_z value of interest; and H, the effective plume height. If H ≥ HDP, the σ_z is taken as a Briggs coefficient. Otherwise, σ_z is assumed to be a Martin-Tickvart coefficient. XL uses the common block ADATA.

A.3 CHANGED MODULES

To accommodate the new modules and new approaches taken by MILDOS-AREA, several MILDOS modules have undergone significant alterations in coding. In each case, the purpose of the module has not changed. (Table A.1 contains brief descriptions of module functions.) Any changes in functions performed, calling routine, argument list, common-block usage, and subordinate modules are noted in this section. The affected modules are discussed in alphabetical order.

A.3.1 Subroutine CHIQU

CHIQU now has three additional arguments, DMM (mean annual morning mixing height), DMA (mean annual afternoon mixing height), and KPAGE (current output report page number). CHIQU uses these to compute DM (mean annual mixing height) for point sources or small-area sources, according to the method discussed in Sec. 2.5. For large-area sources, CHIQU passes along DMM and DMA to subroutine AREAS, which in turn sends them to PTXOQ to perform the computation instead. Consequently, another common block, AREA, is used by CHIQU.

A whole new section of code in CHIQU is devoted to large-area sources. In it, the new NAMELIST NWAREA is read in and, if specified, nodes are automatically numbered and assigned coordinates by calling subroutine MESHGN. Subroutine AREAS is then called to perform finite-element integration for the area source.

A.3.2 Subroutine DDEP

DDEP evaluates the sum of integrals used in Eqs. 18a-c, Sec. 2.4. POLUT and POLUT1, after calling DDEP, use the sum to compute the plume-depletion factor. DDEP has the following new argument list:

- DNWIND -- Distance (m) downwind to receptor,
- X1, X2 -- See Eq. 17, Sec. 2.4, and
- PHT -- Effective plume height (m) at receptor location.

Numerous calls to INTEG are coded in DDEP, a subset of which is executed depending on the relative positions of X1, X2, and DNWIND.

A.3.3 Function FERR

FERR evaluates the integral in Eq. 19a, Sec. 2.4. FERR now calls DFUNC rather than directly computing the vertical-dispersion coefficient.

A.3.4 Function FERR1

This function evaluates the integral in Eq. 19b, Sec. 2.4, which is now more complex than in the original MILDOS. FERR1 now also uses DFUNC.

A.3.5 Subroutine HEADER

HEADER now has two arguments, LUN (logical unit number) and IPAGE (the current page number). The arguments are needed because HEADER supplies page headers for two output files: a table of contents (LUN = 3, MILDOS.REP) and the regular

MILDOS output (LUN = 2, MILDOS.OUT). MILDOS.OUT is eventually appended to MILDOS.REP and then deleted by MILDOS.BAT, the DOS batch file that executes MILDOS-AREA. In the calling programs, IPAGE is replaced by KPAGE for LUN = 2 and by LPAGE for LUN = 3. The initial KPAGE is computed in MILMAIN.FOR from the number of lines and pages needed for the table of contents.

The input data file name is now included in the header lines, and the METSET field has been expanded from 16 to 24 characters.

A.3.6 Subroutine INTEG

Subroutine INTEG now calls AFUNC for computing an *average* vertical-dispersion coefficient. INTEG now computes DH1 and DH2 instead of DX1 and stores them in DSTBZ for use by FERR1.

A.3.7 Subroutine POLUT

This subroutine incorporates the changes described in Sec. 2.3. For the concentration calculations, the minimum downwind distance is taken to be 10 m (as is the case in POLUT1). POLUT calls AFUNC and XL in addition to DDEP and ACTDR. Common blocks ADATA and INTG are used by POLUT.

A.3.8 Subroutines POPDOS, UNIDOS, and WRITER

Each of these subroutines now has a single argument, KPAGE, the entry point page number to be used in calls to HEADER.

A.4 COMMON BLOCKS

All common blocks have been reordered to ensure proper boundary alignments; particularly, REAL*8 items (if any) have been moved to the beginning of common blocks, and INTEGER*2 items have been placed at the end. All integers, unless explicitly declared as INTEGER*4, are 16-bits in MILDOS-AREA.

All character data are now defined as character strings, and most such items have been placed in the new common block CHAR. CHAR appears in MILDOS (main), CHIQU, FRESH (block data), HEADER, POPDOS, UNIDOS, and WRITER.

In common block BDATA, arrays RXQ(10,240,4) and RXQRN(10,240,7) are now defined as RXQ(4,240,10) and RXQRN(7,240,10). This corrects a design inefficiency in the original code.

Two new common blocks used to transfer data between the new modules are AREA and PTDISP. AREA contains parameters characterizing a large-area source and appears in the modules MILDOS (main), FRESH (block data), CHIQU, PTXOQ, and

AREAS. The common block AREA also contains an array of 17 angles ($0-2\pi$) AN, and an array of 45 distances (0-160 km) RN, to construct a reference polar grid around the source. The values in these arrays are set in block data FRESH.

PTDISP contains the normalized air-concentration arrays XOQP, XOQR, PXOQ, and RXOQ. PTDISP is used in the modules PTXOQ, AREAS, and POLUT1.

One additional common block, DOSINH, contains data needed to calculate inhalation dose factors, DCFA.

A.5 REFERENCES

International Commission on Radiological Protection, 1979, *Limits for Intakes of Radionuclides by Workers* (adopted July 1978), ICRP Publication 30.

ICRP Task Group on Lung Dynamics, 1966, *Deposition and Retention Models for Internal Dosimetry of Human Respiratory Tract*, Health Physics, *12*:173-207.

Momeni, M.H., Y.C. Yuan, and A.J. Zielen, 1979, *The Uranium Dispersion and Dosimetry (UDAD) Code*, Report NUREG/CR-0553, ANL/ES-72, Argonne National Laboratory, Argonne, Ill., for U.S. Nuclear Regulatory Commission, Washington, D.C.

Strenge, D.L., and T.J. Bander, 1981, *MILDOS - A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations*, Report NUREG/CR-2011, PNL-3767, Pacific Northwest Laboratory, Richland, Wash., for the U.S. Nuclear Regulatory Commission, Washington, D.C.

APPENDIX B:

VALIDATION OF MILDOS-AREA AND COMPARISON WITH AIRDOS-EPA

APPENDIX B:

VALIDATION OF MILDOS-AREA AND COMPARISON WITH AIRDOS-EPA

Airborne Rn-222 concentrations and working levels calculated with the MILDOS-AREA program were compared both with measured concentration data and with results from the current version of the computer code AIRDOS-EPA (Moore 1979, as updated in 1988). The site selected for use in this validation study was the Monticello, Utah, uranium mill tailings impoundments area. A large body of radon flux and concentration measurements exist for this site against which models can be validated. The code AIRDOS-EPA was chosen for comparison with MILDOS-AREA because AIRDOS-EPA is widely used to calculate atmospheric dispersion of radionuclides from a variety of sources. The measured radon concentrations and site-specific modeling data used in this validation study were provided by UNC Geotech.

Results of the source and dispersion modeling in MILDOS-AREA are generally in good agreement with measured Rn-222 concentrations. Table B.1 compares Rn-222 concentrations measured at the Monticello site with the values calculated using MILDOS-AREA. The model-calculated concentrations are within 50% or less of measured values in most cases. In cases where the measured values are several times those estimated by MILDOS-AREA, the radon detectors that made the actual measurements may have been situated near localized hot spots, which may be prevalent over large sources emitting high radon fluxes. These results indicate that the source and dispersion treatment used in MILDOS-AREA is accurate and capable of reproducing measured data.

The comparison between Rn-222 concentrations and working level estimates calculated by the MILDOS-AREA and AIRDOS-EPA codes is more straightforward (Table B.2). In AIRDOS-EPA, sources are always circular and situated at the origin. For the Monticello site, where a number of large, physically separated sources are involved, the source in AIRDOS-EPA is taken to be a circular area at the origin of the same total area and source strength as the separate sources modeled in MILDOS-AREA. Radon-222 concentrations calculated by the two codes are in very good agreement for distances greater than about 1 km from the origin. However, for distances very close to the origin, the AIRDOS-EPA results are much higher (as much as 50% higher for some locations) than MILDOS-AREA results. This difference is due to the source-description limitations inherent in the AIRDOS-EPA code.

Of more interest is the comparison of estimated working levels, which are used to estimate health effects in many cases. Near the source, AIRDOS-EPA estimates larger working levels than does MILDOS-AREA, even though the Rn-222 concentrations estimated by AIRDOS-EPA are smaller. At large distances, where the Rn-222 concentrations calculated by the two codes are equal, MILDOS-AREA estimates larger working levels.

TABLE B.1 Comparison between Measured Rn-222 Concentrations and MILDOS-AREA Calculated Concentrations and Working Levels for Monticello, Utah

Location[a]	Annual Average Measured Rn-222 (pCi/L)	MILDOS-AREA Calculation	
		Rn-222 (pCi/L)[b]	WL
Acid pile	3.40 ± 0.37	2.41	1.77E-4
East pile	4.83 ± 0.47	2.53	2.87E-4
Vanadium pile	4.53 ± 0.45	4.01	3.93E-4
Carbonate pile	6.44 ± 0.55	5.54	3.21E-4
ST-1	1.73 ± 0.24	0.57	6.23E-5
ST-2	2.34 ± 0.29	1.88	1.22E-4
ST-3	1.11 ± 0.11	0.67	9.09E-5
ST-4	1.18 ± 0.11	0.50	4.57E-5
ST-5	1.24 ± 0.15	1.36	2.78E-4
ST-6	1.98 ± 0.17	1.94	3.32E-4
ST-7	2.28 ± 0.27	2.48	2.83E-4
ST-8	2.57 ± 0.23	0.80	1.07E-4
ST-9	0.49 ± 0.05	0.63	9.82E-5
ST-10	0.26 ± 0.03	0.43	2.59E-5
ST-11	0.48 ± 0.06	0.44	2.72E-5
ST-12	0.34 ± 0.04	0.46	4.59E-5
ST-13	0.41 ± 0.05	0.45	4.33E-5
ST-14	0.46 ± 0.06	0.44	3.53E-5
ST-15	0.46 ± 0.05	0.45	4.55E-5

[a]The locations designated by the code "ST" represent sites at which measurements were made.

[b]Includes background of 0.41 pCi/L.

The differences in working level values can be understood by considering the methods used by the two codes to calculate working levels from concentrations. To determine the radon daughter equilibrium fraction at grid locations, AIRDOS-EPA linearly interpolates between preset values in a spatial mesh. The limiting values are 27% for 200 m and less and 70% for 20,000 m and greater. MILDOS-AREA employs a direct calculation of working levels based on actual radon daughter concentrations. The results above indicate that equilibrium fractions are less than 27% at small distances, and greater than 70% (approaching 100%) at very large distances from the source. Thus, in AIRDOS-EPA the estimated health effects for maximally exposed individuals, who are generally close to the source, will be too high in many cases. Conversely, the magnitude of health effects for persons at larger distances will be underestimated.

TABLE B.2 Comparison of AIRDOS-EPA and MILDOS-AREA Radon Concentrations and Working Levels for Monticello, Utah, Site

Wind Blowing Toward	Distance from Center of Source (m)	Air Concentrations (pCi/L)		Working Levels	
		AIRDOS-EPA	MILDOS-AREA	AIRDOS-EPA	MILDOS-AREA
ENE	200	1.8	1.87	4.9E-3	3.17E-4
ENE	600	2.9E-1	3.36E-1	8.4E-4	2.17E-4
ENE	1,200	1.4E-1	1.21E-1	4.3E-4	1.45E-4
ENE	2,000	5.7E-2	5.81E-2	2.0E-4	1.04E-4
ENE	3,200	2.6E-2	2.89E-2	1.0E-4	7.33E-5
ENE	5,000	1.3E-2	1.43E-2	6.0E-5	5.08E-5
ENE	7,000	8.1E-3	8.52E-3	4.0E-5	3.81E-5
ENE	9,000	5.5E-3	5.78E-3	3.0E-5	3.05E-5
ENE	15,000	2.5E-3	2.64E-3	1.6E-5	1.86E-5
ENE	30,000	8.7E-4	8.96E-4	6.1E-6	8.14E-6
ENE	50,000	4.0E-4	4.04E-4	2.8E-6	3.93E-6
ENE	70,000	2.3E-4	2.38E-4	1.6E-6	2.34E-6
NE	200	1.8	1.19	5.0E-3	3.14E-4
NE	600	2.1E-1	1.89E-1	6.1E-4	1.28E-4
NE	1,200	3.2E-2	4.85E-2	1.0E-4	6.02E-5
NE	2,000	1.4E-2	1.95E-2	1.7E-5	3.62E-5
NE	3,200	6.2E-3	8.60E-3	2.4E-5	2.29E-5
NE	5,000	3.2E-3	3.95E-3	1.4E-5	1.47E-5
NE	7,000	1.9E-3	2.26E-3	9.5E-6	1.06E-5
NE	9,000	1.3E-3	1.50E-3	7.1E-6	8.18E-6
NE	15,000	6.0E-4	6.62E-4	3.9E-6	4.74E-6
NE	30,000	2.1E-4	2.20E-4	1.4E-6	1.98E-6
NE	50,000	9.4E-5	9.77E-5	6.5E-7	9.46E-7
NE	70,000	5.5E-5	5.72E-5	3.9E-7	5.63E-7
NNE	200	1.8	8.81E-1	5.0E-3	2.54E-4
NNE	600	1.4E-1	1.37E-1	4.2E-4	8.28E-5
NNE	1,200	4.2E-2	4.43E-2	1.4E-4	4.63E-5
NNE	2,000	1.8E-2	2.01E-2	6.3E-5	3.07E-5
NNE	3,200	8.3E-3	9.64E-3	3.2E-5	2.08E-5
NNE	5,000	4.2E-3	4.66E-3	1.9E-5	1.40E-5
NNE	7,000	2.5E-3	2.75E-3	1.3E-5	1.05E-5
NNE	9,000	1.7E-3	1.85E-3	9.4E-6	8.36E-6
NNE	15,000	7.9E-4	8.37E-4	5.2E-6	5.16E-6
NNE	30,000	2.7E-4	2.84E-4	1.9E-6	2.38E-6
NNE	50,000	1.3E-4	1.28E-4	8.7E-7	1.20E-6
NNE	70,000	7.4E-5	7.54E-2	5.2E-7	7.34E-7

TABLE B.2 (Cont'd)

Wind Blowing Toward	Distance from Center of Source (m)	Air Concentrations (pCi/L)		Working Levels	
		AIRDOS-EPA	MILDOS-AREA	AIRDOS-EPA	MILDOS-AREA
N	200	1.7	8.42E-1	4.7E-3	2.21E-4
N	600	1.5E-1	1.52E-2	4.5E-4	8.47E-5
N	1,200	4.8E-2	4.98E-2	1.5E-4	4.88E-5
N	2,000	2.0E-2	2.26E-2	7.1E-5	3.26E-5
N	3,200	9.4E-3	1.09E-2	3.7E-5	2.22E-5
N	5,000	4.8E-3	5.30E-3	2.1E-5	1.49E-5
N	7,000	2.9E-3	3.12E-3	1.4E-5	1.11E-5
N	9,000	2.0E-3	2.11E-3	1.1E-5	8.85E-6
N	15,000	9.1E-4	9.55E-4	5.9E-6	5.49E-6
N	30,000	3.1E-4	3.24E-4	2.2E-6	2.60E-6
N	50,000	1.4E-4	1.46E-4	1.0E-6	1.35E-6
N	70,000	8.5E-5	8.63E-5	5.9E-7	8.32E-7

In summary, the dispersion treatment in MILDOS-AREA computes radionuclide concentration values that generally are in good agreement with measured values and that are in very good agreement with concentrations calculated using AIRDOS-EPA for distances beyond the point where the limitations in AIRDOS-EPA source geometry are unimportant. Differences in the way that the two codes treat radon daughter equilibrium fractions cause differences in estimated working levels and in individual and population health effects based on working levels.

REFERENCE

Moore, R.E., et al., 1979, *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides*, U.S. Environmental Protection Agency, Report EPA 520/1-79-009 (reprint of Oak Ridge National Laboratory Report ORNL-5532), Office of Radiation Programs, Washington, D.C., Dec.

APPENDIX C:

SAMPLE PROBLEMS AND OUTPUT

APPENDIX C:

SAMPLE PROBLEMS AND OUTPUT

C.1 INTRODUCTION

Three sample problems are presented in this appendix to illustrate the use of the program MILDOS-AREA. New features of the program are emphasized. The first sample problem includes two hypothetical area sources: one emitting at a constant rate of release and the other wind-eroded and thus emitting at a variable rate of release. Situated around these sources are four receptor locations. The hypothetical situation is depicted diagrammatically in Fig. C.1. The data input file (SAMPLE.DAT) needed to execute MILDOS-AREA and selected sample results of the calculation of radiological impacts to the four hypothetical receptors are presented in Secs. C.2 and C.3, respectively.

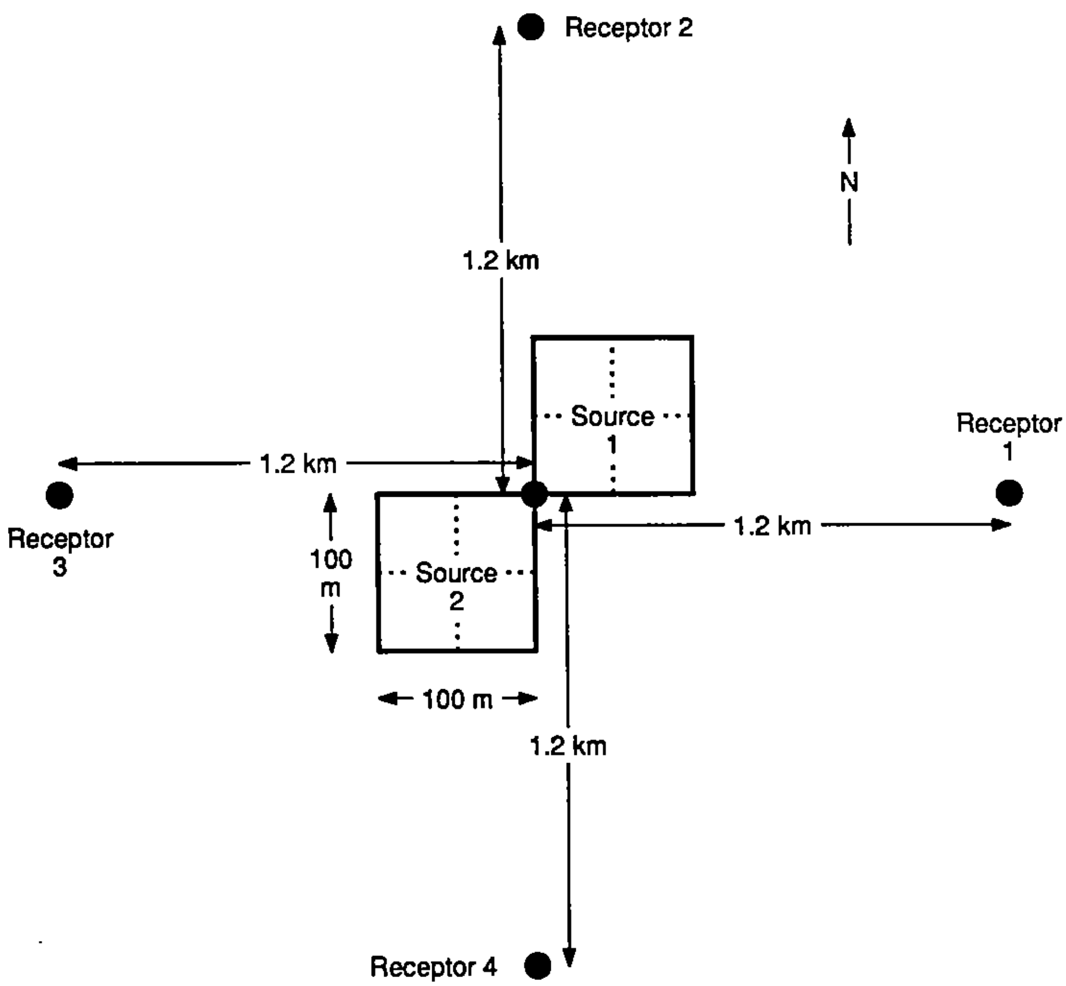

FIGURE C.1 Schematic Diagram of Hypothetical Situation for SAMPLE.DAT Problem

The second sample problem resembles the first sample problem in the MILDOS user's guide (Strenge and Bander 1981), with only slight modification. This problem also demonstrates automatic node numbering. The detailed input information is explained in the original user's guide. Section C.4 shows the input listing (TESTC1.DAT) for the second sample problem. For easy cross-reference, the parameters are arranged in the same order as described in the tables of Sec. 4. For further clarity, the sources and receptors are described in Tables C.1 and C.2, respectively.

The two fence boundary receptor locations have been moved slightly from their positions in the problem presented in the original MILDOS user's guide. The fence boundary in the eastern sector has been moved 440 m west to make it closer to the third tailings pile. The fence boundary in the south-southeastern sector has been shifted 160 m to the south to ensure that is off tailings pile #3. Each tailings area is assumed to be square and is divided into four finite elements, as designated in the NWAREA namelists of Sec. C.3. Since NEX ≠ 0, automatic node numbering is in effect for all three piles. Section C.5 contains selected output from execution of this problem.

The third sample problem resembles the second problem with the exception that the last area source is irregularly shaped and requires manual node numbering. Figure C.2 is an xy-grid layout of the Sierra Madre Mill region, showing the source and receptor locations for the second and third problems. In this diagram, the third tailings pile is represented two ways -- as square (sample problem two) and as irregularly shaped (sample problem three). The crescent-like shape is divided into five quadrilaterals, and the nodes are numbered according to the bottom-to-top, left-to-right rule. (The elements are numbered in like manner for consistency, but may be numbered in any fashion.) Table C.2 shows the meanings of the receptor abbreviations on the diagram. Section C.6 contains the listing of the input (TESTC2.DAT) for this third sample problem. The input for this problem is almost the same as in Sec. C.4, except the area for tailings pile #3 is slightly larger (0.840 km^2 instead of 0.827 km^2), and the corresponding NWAREA namelist has been redefined. Now,

```
     NEX = 0,

     NAS = 5,

   NNODE = 13,

    NODE = 1, 2, 3, 4, 3, 4, 5, 6, 5, 6, 9, 10, 7, 8, 11, 12, 8, 10, 12, 13,

      XS = 1200., 1600., 1200., 1600., 1200., 1600., 200., 800., 1200., 1600.,
           600., 800., 1000.,

      YS = -2200., -1800., 2*-1600., 2*-1200., 4*-800., 3*-400.
```

for the third tailings pile. The selected output report for this example of manual node numbering is given in Sec. C.7.

TABLE C.1 Source Descriptions for Sample Problem 2

Parameter	Source						Variable Name
	Yellowcake Stack	Ore Pad	Grizzly Dump-Hopper	Tailings Piles 1	Tailings Piles 2	Tailings Piles 3	
Location							
East-west (km)	0	0.4E	0.2E	1.39E	1.30W	1.09E	SORCE(1,i)
North-south (km)	0	0.4N	0.2N	0.98N	0.84S	0.98S	SORCE(2,i)
Elevation (m)	20.0	6.0	0	-10.0	-10.0	-10.0	SORCE(3,i)
Area (km^2)	0	0.16	0	0.143	0.270	0.827	SORCE(4,i)
Particle Size Set	1	3	2	3	3	3	SORCE(11,i)
Release Rates (Ci/yr)							
U-238	4.14×10^{-2}	4.08×10^{-2}	2.60×10^{-2}	5.67×10^{-3}	1.61×10^{-2}	6.56×10^{-2}	SORCE(5,i)
Th-230	2.16×10^{-3}	4.08×10^{-2}	2.60×10^{-2}	1.35×10^{-1}	3.82×10^{-1}	1.56	SORCE(6,i)
Ra-226	8.62×10^{-5}	4.08×10^{-2}	2.60×10^{-2}	1.41×10^{-1}	4.01×10^{-1}	1.64	SORCE(7,i)
Pb-210	8.62×10^{-5}	4.08×10^{-2}	2.60×10^{-2}	1.41×10^{-1}	4.01×10^{-1}	1.64	SORCE(8,i)
Rn-222	0	1.09×10^{3}	4.16×10^{1}	1.28×10^{3}	3.64×10^{3}	1.49×10^{4}	SORCE(9,i)
Stack Data							
Velocity (m/s)	17.0	0	0	0	0	0	SORCE(12,i)
Diameter (m)	1.0	0	0	0	0	0	SORCE(12,i)
Tailings Activity Mix Set	0	0	0	1	2	3	IPACT(i)

Source: Modified from Strenge and Bander 1981.

TABLE C.2 Receptor Locations for Sample Problems 2 and 3

Receptor[a]	Locations Relative to Mill Center: East-West[b] (km)	North-South[c] (km)	Elevation[d] (m)
Fence boundary E (FB E)[e]	1.600	-0.200	8.8
Fence boundary SSE (FB SSE)	1.080	-1.600	2.4
Grazing E (G E)	2.560	0.0	3.7
Grazing ESE (G ESE)	2.584	-0.890	-1.4
Nearest resident NNW (NR NNW)	-0.448	1.466	12.3
Nearest resident in the prevailing wind direction (NR PWD)	2.168	2.168	10.2

[a]See Fig. C.2 for receptor locations.

[b]A positive number indicates east and a negative number west.

[c]A positive number indicates north and negative number south.

[d]A positive number indicates elevation above that of the mill center, and a negative number indicates elevation below that of the mill center.

[e]Coding in parentheses corresponds to receptor locations shown in Fig. C.2.

Source: Modified from Strenge and Bander 1981.

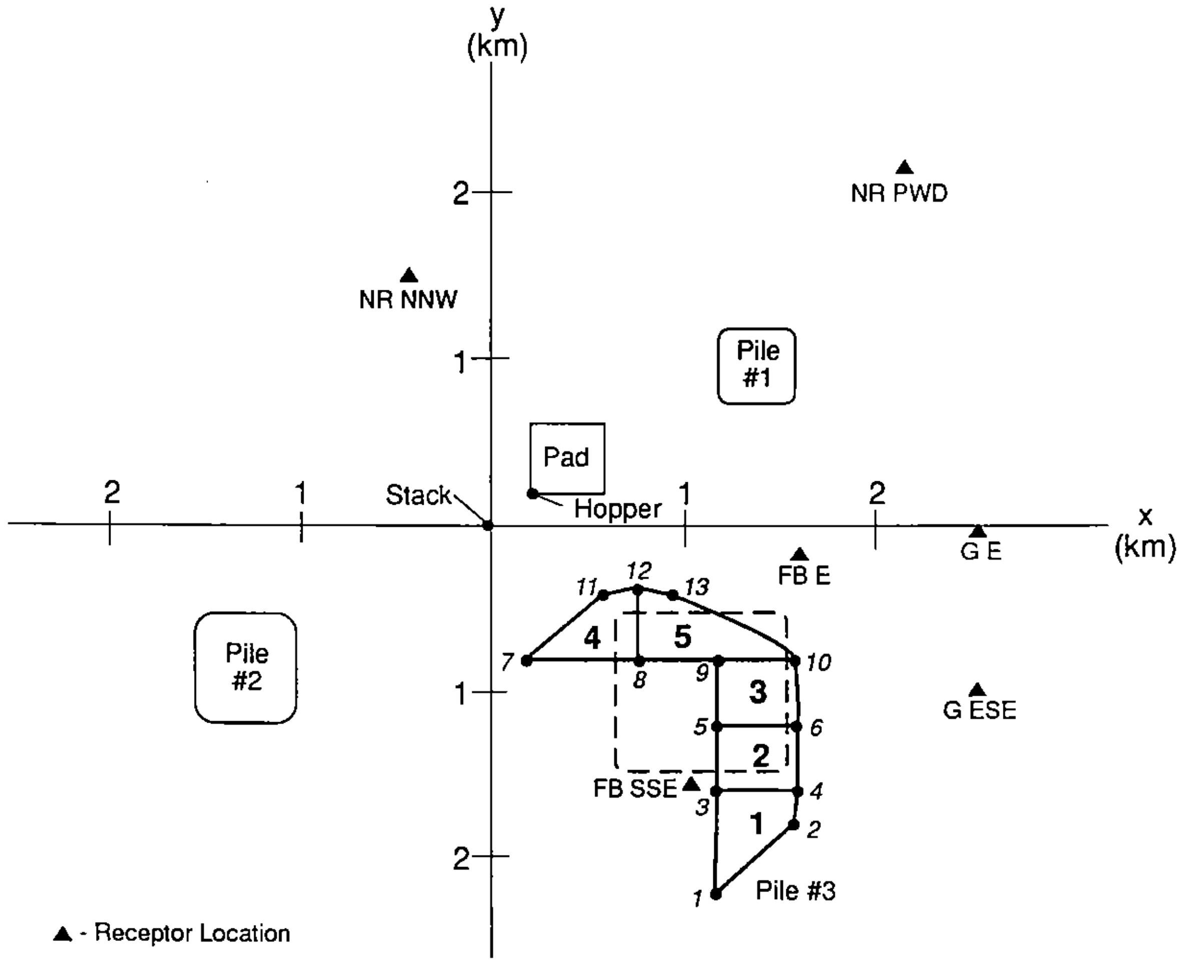

FIGURE C.2 Spatial Orientation of Sources and Receptors for TESTC1.DAT (dashed pile #3) and TESTC2.DAT (solid pile #3) Problems (see Table C.2 for meanings of receptor abbreviations)

C.2 LISTING OF TEST PROBLEM SAMPLE.DAT

```
&INDATA
ACTRAT = 2.5 , DMA = 1300 , DMM = 800 ,
FAS = .0001 , -.0001 , .0001 ,
FFORI = .5 , FFORP = .5 , FHAYI = .5 , FHAYP = .5 ,
FPR = 12000 , 1600 , 6000 ,
FRADON = 4*.25,
FREQ =
.00038, .00011, .00021, .00009, .00018, 2*.00013,
.00006, .00027, 2*.00006, .00009, .00006, .0001,
.00006, .0001, .00021, 2*.00027, 2*.00021, 2*.00007,
.00014, .00041, 2*.00014, .00021, .00014, 0,
.00014, 65*0, .00181, .00115, .0014, .00158,
.00168, .0006, .00128, .00095, .00361, .00176,
.00068, .00096, .00093, .00058, .00107, .00056,
.00199, .00103, .00151, .00116, .00082, .00062,
.00082, .00123, .00253, .00123, .0011, .00082,
.00158, .00055, .00103, .00089, 2*.00082, 2*.00055,
.00021, .00007, .00034, .00075, .00199, .00041,
.00062, .00041, .00048, .00069, .00055, .00027,
48*0, .00068, .00053, .00067, .00052, .0006,
.00032, .00062, .00074, .00171, .00068, .00056,
.00034, .00028, .00029, .00059, .00028, .00329,
.00219, .00206, 2*.00096, .00062, .0011, .00089,
.00514, .00212, .00069, .00075, .00151, .00103,
2*.00089, .00404, .00253, .00233, .00137, .00048,
.00007, .00055, .00281, .01062, .00288, .00103,
.00116, .00411, .00377, .00315, .00185, 2*.00027,
.00034, .00027, 3*0, .00069, .00226, .00014,
2*.00021, .00116, .00158, .00075, .00021, 12*0,
.00007, .00021, .00007, 17*0, .00709, .00308,
.00332, .00296, .0026, .00169, .0022, .00229,
.0073, .00197, .0021, .00129, .00175, .00136,
.0018, .00166, .02028, .00849, .00692, .00377,
.00233, .00199, .00397, .00514, .02124, .00617,
.00377, .00356, .00466, .00411, .005, .00507,
.02041, .01103, .00527, .0026, .0013, .00103,
.00349, .01048, .05747, .01178, .00432, .00486,
.01671, .0163, .01075, .00692, .00836, .00849,
.0063, .00158, .00027, .00041, .00151, .0087,
.05439, .01212, .00185, .00322, .03213, .05556,
.02466, .00425, .00075, .00062, .00041, .00007,
0, .00007, 0, .00055, .00459, .00123,
.00014, .00027, .00699, .01932, .00521, .00062,
2*0, .00007, 5*0, .00014, 2*0, .00007,
.00178, .00384, .00069, .00021, .01075, .00438,
.00503, .0052, .00552, .00354, .00582, .00553,
.02371, .00944, .00799, .00475, .00635, .00556,
.00604, .00493, .01226, .00329, .00356, .00308,
.00185, .00178, .00267, .00521, .02048, .00856,
.00541, .00527, .00644, .0063, .00562, .00377,
.0061, .00178, .0011, .00048, .00014, 2*.00007,
.0013, .00767, .00116, .00096, .00158, .00788,
.00795, .00349, .00151, 144*0,
HDP = 50 , IADD = 4 ,
IFTODO = 2*1, 8*0,
```

```
IPACT = 1, 2, 8*0,
IPOP =
572, 286, 401, 515, 221, 3178,
6078, 4842, 7011, 7959, 9705, 9708,
1145, 286, 1603, 1288, 221, 4073,
6789, 9505, 12220, 14591, 15101, 15552,
1145, 1288, 1402, 258, 779, 4073,
6789, 9505, 12220, 13210, 12551, 14482,
1145, 1431, 1202, 1545, 221, 883,
1472, 3921, 8870, 14092, 15611, 16542,
572, 1431, 2003, 258, 221, 883,
1472, 2060, 2649, 3238, 5900, 8403,
572, 1431, 2003, 773, 221, 883,
1472, 2060, 2649, 3238, 3826, 4415,
572, 143, 21, 26, 221, 883,
1472, 2060, 2707, 3677, 4761, 6404,
916, 215, 21, 26, 221, 883,
1472, 2060, 3296, 4995, 5904, 6812,
286, 143, 200, 26, 221, 883,
1472, 2060, 2721, 4995, 5904, 6812,
12, 15, 21, 26, 221, 883,
2068, 3870, 3656, 4995, 5904, 6812,
12, 15, 21, 26, 221, 1360,
3460, 4844, 6143, 6304, 6368, 6812,
12, 15, 21, 26, 370, 2076,
3460, 4844, 4789, 4665, 4838, 5162,
114, 15, 21, 26, 519, 2076,
3460, 4844, 2809, 3214, 3798, 4382,
114, 15, 21, 26, 519, 2009,
2904, 3677, 4427, 4092, 3798, 4382,
229, 15, 21, 44, 519, 1476,
2348, 3287, 4226, 5166, 5841, 6384,
286, 15, 21, 26, 260, 1409,
2348, 3287, 4226, 6121, 7718, 7256,
IPSOL = 3*3, 4*2,
IRTYPE = 7*10, 41*-1,
JC = 2*0, 2*1, 0, 4*1, 0,
NSORCE = 2 , NSTEP = 2 ,
PACT = 12*100,
PAJUST = 10*1,
PTSZ = 1.5, 3, 7.7, 54, .3,
PTSZFC = 0, 1, 2*0, 1, 5*0, .3, .7,
QAJUST = 200*1,
SORCE =
3*0, .000557, 4*.01, 1, 5001, 1,
4*0, .000557, 4*.01, 1, 5002, 3,
97*0,
SRNS = 3*1,
TSTART = 1985 , TSTEP = 3, 100, 8*0,
XRECEP =
1.2, 3*0, 1.2, 0, -1.2, 3*0, -1.2, 133*0,
&END
SAMPLE SITE                    METEOROLOGIC STATION
DISPOSAL PILE
WIND-ERODED AREA
E RESIDENT
N RESIDENT
```

```
W RESIDENT
S RESIDENT
3-YEAR ACTION PERIOD
100-YR MAINTENANCE
 &NWAREA
 NEX = 2 , NEY = 2 ,
 VERTX =
 2*0, 100, 2*0, 3*100,
 &END
 &NWAREA
 NEX = 2 , NEY = 2 ,
 VERTX =
 2*-100, 0, 2*-100, 3*0,
 &END
```

C.3 SELECTED OUTPUT FROM TEST PROBLEM SAMPLE.DAT

REGION: SAMPLE SITE　　CODE: MILDOS-AREA (03/89)　　PAGE 1
METSET: METEOROLOGIC STATION　　DATA: SAMPLE.DAT　　04/01/89

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METSET: METEOROLOGIC STATION DATA: SAMPLE.DAT 04/01/89
JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.19110,0.24865,0.28024,0.23216,0.04119,0.00680

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	0.0380	0.0110	0.0210	0.0090	0.0180	0.0130	0.0130	0.0060	0.0270	0.0060	0.0060	0.0090	0.0060	0.0100	0.0060	0.0100	0.2090
5.5	0.0210	0.0270	0.0270	0.0210	0.0210	0.0070	0.0070	0.0140	0.0410	0.0140	0.0140	0.0210	0.0140	0.0000	0.0140	0.0000	0.2630
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0590	0.0380	0.0480	0.0300	0.0390	0.0200	0.0200	0.0200	0.0680	0.0200	0.0200	0.0300	0.0200	0.0100	0.0200	0.0100	0.4720
STABILITY CLASS 2																	
1.5	0.1810	0.1150	0.1400	0.1580	0.1680	0.0600	0.1280	0.0950	0.3610	0.1760	0.0680	0.0960	0.0930	0.0580	0.1070	0.0560	2.0600
5.5	0.1990	0.1030	0.1510	0.1160	0.0820	0.0620	0.0820	0.1230	0.2530	0.1230	0.1100	0.0820	0.1580	0.0550	0.1030	0.0890	1.8910
10.0	0.0820	0.0820	0.0550	0.0550	0.0210	0.0070	0.0340	0.0750	0.1990	0.0410	0.0620	0.0410	0.0480	0.0690	0.0550	0.0270	0.9530
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.4620	0.3000	0.3460	0.3290	0.2710	0.1290	0.2440	0.2930	0.8130	0.3400	0.2400	0.2190	0.2990	0.1820	0.2650	0.1720	4.9040
STABILITY CLASS 3																	
1.5	0.0680	0.0530	0.0670	0.0520	0.0600	0.0320	0.0620	0.0740	0.1710	0.0680	0.0560	0.0340	0.0280	0.0290	0.0590	0.0280	0.9410
5.5	0.3290	0.2190	0.2060	0.0960	0.0960	0.0620	0.1100	0.0890	0.5140	0.2120	0.0690	0.0750	0.1510	0.1030	0.0890	0.0890	2.5090
10.0	0.4040	0.2530	0.2330	0.1370	0.0480	0.0070	0.0550	0.2810	1.0620	0.2880	0.1030	0.1160	0.4110	0.3770	0.3150	0.1850	4.2750
15.5	0.0270	0.0270	0.0340	0.0270	0.0000	0.0000	0.0000	0.0690	0.2260	0.0140	0.0210	0.0210	0.1160	0.1580	0.0750	0.0210	0.8360
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0070	0.0210	0.0070	0.0000	0.0350
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.8280	0.5520	0.5400	0.3120	0.2040	0.1010	0.2270	0.5130	1.9730	0.5820	0.2490	0.2460	0.7130	0.6880	0.5450	0.3230	8.5960
STABILITY CLASS 4																	
1.5	0.7090	0.3080	0.3320	0.2960	0.2600	0.1690	0.2200	0.2290	0.7300	0.1970	0.2100	0.1290	0.1750	0.1360	0.1800	0.1660	4.4460
5.5	2.0280	0.8490	0.6920	0.3770	0.2330	0.1990	0.3970	0.5140	2.1240	0.6170	0.3770	0.3560	0.4660	0.4110	0.5000	0.5070	10.6470
10.0	2.0410	1.1030	0.5270	0.2600	0.1300	0.1030	0.3490	1.0480	5.7470	1.1780	0.4320	0.4860	1.6710	1.6300	1.0750	0.6920	18.4720
15.5	0.8360	0.8490	0.6300	0.1580	0.0270	0.0410	0.1510	0.8700	5.4390	1.2120	0.1850	0.3220	3.2130	5.5560	2.4660	0.4250	22.3800
21.5	0.0750	0.0620	0.0410	0.0070	0.0000	0.0070	0.0000	0.0550	0.4590	0.1230	0.0140	0.0270	0.6990	1.9320	0.5210	0.0620	4.0840
28.0	0.0000	0.0000	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0140	0.0000	0.0000	0.0070	0.1780	0.3840	0.0690	0.0210	0.6800
ALL	5.6890	3.1710	2.2290	1.0980	0.6500	0.5190	1.1170	2.7160	14.5130	3.3270	1.2180	1.3270	6.4020	10.0490	4.8110	1.8730	60.7090
STABILITY CLASS 5																	
1.5	1.0750	0.4380	0.5030	0.5200	0.5520	0.3540	0.5820	0.5530	2.3710	0.9440	0.7990	0.4750	0.6350	0.5560	0.6040	0.4930	11.4540
5.5	1.2260	0.3290	0.3560	0.3080	0.1850	0.1780	0.2670	0.5210	2.0480	0.8560	0.5410	0.5270	0.6440	0.6300	0.5620	0.3770	9.5550
10.0	0.6100	0.1780	0.1100	0.0480	0.0140	0.0070	0.0070	0.1300	0.7670	0.1160	0.0960	0.1580	0.7880	0.7950	0.3490	0.1510	4.3240
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	2.9110	0.9450	0.9690	0.8760	0.7510	0.5390	0.8560	1.2040	5.1860	1.9160	1.4360	1.1600	2.0670	1.9810	1.5150	1.0210	25.3330
STABILITY CLASS 6																	
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	9.9490	5.0060	4.1320	2.6450	1.9150	1.3080	2.4640	4.7460	22.5530	6.1850	3.1630	2.9820	9.5010	12.9100	7.1560	3.3990	100.0140

```
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```

INDIVIDUAL RECEPTOR LOCATION DATA, 4 LOCATIONS INPUT THIS RUN

I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE	I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE
1	E RESIDENT	1.20	0.00	0.00	1.20	10	3	W RESIDENT	-1.20	0.00	0.00	1.20	10
2	N RESIDENT	0.00	1.20	0.00	1.20	10	4	S RESIDENT	0.00	-1.20	0.00	1.20	10

MISCELLANEOUS INPUTABLE PARAMETER VALUES

DMM	DMA	TSTART	FFORI	FHAYI	FFORP	FHAYP	FPR(1)	FPR(2)	FPR(3)	ACTRAT
800.0	1300.0	1985.00	0.50	0.50	0.50	0.50	12000.00	1600.00	6000.00	2.50

```
IPACT EQUALS 1, 2,

JC EQUALS   0, 0, 1, 1, 0, 1, 1, 1, 1, 0

TIME STEP DATA....        STEP NAMES        LENGTH, YRS    IFTODO
                   1  3-YEAR ACTION PERIOD      3.00          1
                   2  100-YR MAINTENANCE      100.00          1

XRHO EQUALS   1.5,  2.5,  3.5,  4.5,  7.5,  15.0,  25.0,  35.0,  45.0,  55.0,  65.0,  75.0,

HDP EQUALS  50.0
```

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POPULATION DISTRIBUTION

KILOMETERS	N 0.0	NNE 22.5	NE 45.0	ENE 67.5	E 90.0	ESE 112.5	SE 135.0	SSE 157.5	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
1.0- 2.0	572	1145	1145	1145	572	572	572	916	286	12	12	12	114	114	229	286
2.0- 3.0	286	286	1288	1431	1431	1431	143	215	143	15	15	15	15	15	15	15
3.0- 4.0	401	1603	1402	1202	2003	2003	21	21	200	21	21	21	21	21	21	21
4.0- 5.0	515	1288	258	1545	258	773	26	26	26	26	26	26	26	26	44	26
5.0-10.0	221	221	779	221	221	221	221	221	221	221	221	370	519	519	519	260
10.0-20.0	3178	4073	4073	883	883	883	883	883	883	883	1360	2076	2076	2009	1476	1409
20.0-30.0	6078	6789	6789	1472	1472	1472	1472	1472	1472	2068	3460	3460	3460	2904	2348	2348
30.0-40.0	4842	9505	9505	3921	2060	2060	2060	2060	2060	3870	4844	4844	4844	3677	3287	3287
40.0-50.0	7011	12220	12220	8870	2649	2649	2707	3296	2721	3656	6143	4789	2809	4427	4226	4226
50.0-60.0	7959	14591	13210	14092	3238	3238	3677	4995	4995	4995	6304	4665	3214	4092	5166	6121
60.0-70.0	9705	15101	12551	15611	5900	3826	4761	5904	5904	5904	6368	4838	3798	3798	5841	7718
70.0-80.0	9708	15552	14482	16542	8403	4415	6404	6812	6812	6812	6812	5162	4382	4382	6384	7256
1.0-80.0	50476	82374	77702	66935	29090	23543	22947	26821	25723	28483	35586	30278	25278	25984	29556	32973

TOTAL 1-80 KM POPULATION IS 613749 PERSONS

FINITE ELEMENT DATA FOR SOURCE NO. 1: IPX= 1 ID= 5001

VERTEX (M) = 0.0000E+00 0.0000E+00 1.0000E+02 0.0000E+00 0.0000E+00 1.0000E+02 1.0000E+02 1.0000E+02

AREA SOURCE ELEMENT NO. =	1	NODES=	1	4	2	5
AREA SOURCE ELEMENT NO. =	2	NODES=	2	5	3	6
AREA SOURCE ELEMENT NO. =	3	NODES=	4	7	5	8
AREA SOURCE ELEMENT NO. =	4	NODES=	5	8	6	9

NODAL COORDINATES (M):

NODE NO. =	1	XS=	0.0000E+00	YS=	0.0000E+00
NODE NO. =	2	XS=	0.0000E+00	YS=	5.0000E+01
NODE NO. =	3	XS=	0.0000E+00	YS=	1.0000E+02
NODE NO. =	4	XS=	5.0000E+01	YS=	0.0000E+00
NODE NO. =	5	XS=	5.0000E+01	YS=	5.0000E+01
NODE NO. =	6	XS=	5.0000E+01	YS=	1.0000E+02
NODE NO. =	7	XS=	1.0000E+02	YS=	0.0000E+00
NODE NO. =	8	XS=	1.0000E+02	YS=	5.0000E+01
NODE NO. =	9	XS=	1.0000E+02	YS=	1.0000E+02

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NUMBER OF SOURCES= 2

NO.	KM X	KM Y	M Z	KM2 AREA	U-238	Th-230	CI/YEAR Ra-226	Pb-210	Rn-222	ID	PSIZE SET	M/SEC EXIT VEL	SOURCE NAME
1	0.00	0.00	0.00	0.0100	7.89E-03	7.89E-03	7.89E-03	7.89E-03	3.16E-01	5001	1	0.00E+00	DISPOSAL PILE
2	0.00	0.00	0.00	0.0100	9.65E-02	9.65E-02	9.65E-02	9.65E-02	3.16E-01	5002	3	0.00E+00	WIND-ERODED AREA

INPUT TAILS ACTIVITIES, PCI/G

SET	URANIUM	THORIUM	RADIUM	LEAD
1	1.00E+02	1.00E+02	1.00E+02	1.00E+02
2	1.00E+02	1.00E+02	1.00E+02	1.00E+02
3	1.00E+02	1.00E+02	1.00E+02	1.00E+02

AMAD AND FRACTIONAL DISTRIBUTION

SET	1.5	3.0	7.7	54.0
1	0.000	1.000	0.000	0.000
2	1.000	0.000	0.000	0.000
3	0.000	0.000	0.300	0.700

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 2 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 3.00YRS	TSTEP 2 100.00YRS	TSTEP 3 0.00YRS	TSTEP 4 0.00YRS	TSTEP 5 0.00YRS	TSTEP 6 0.00YRS	TSTEP 7 0.00YRS	TSTEP 8 0.00YRS	TSTEP 9 0.00YRS	TSTEP10 0.00YRS
1	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
2	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 2 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 3.00YRS	TSTEP 2 100.00YRS	TSTEP 3 0.00YRS	TSTEP 4 0.00YRS	TSTEP 5 0.00YRS	TSTEP 6 0.00YRS	TSTEP 7 0.00YRS	TSTEP 8 0.00YRS	TSTEP 9 0.00YRS	TSTEP10 0.00YRS
1	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
2	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

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METSET: METEOROLOGIC STATION DATA: SAMPLE.DAT 04/01/89

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF INFANT

AMAD= 1.5 Im	U-238	U-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
EFFECTIV	3.42E+03	3.85E+03	4.68E+03	6.49E+02	1.74E+02	4.10E+00	8.80E+02
BONE	4.84E+01	5.41E+01	2.17E+04	5.92E+02	5.47E+02	7.03E-02	2.10E+02
AVG.LUNG	2.69E+04	3.08E+04	3.10E+04	4.17E+03	5.07E+01	5.96E+01	3.36E+03
LIVER	3.51E-01	3.23E-01	1.16E+02	4.42E+01	2.83E+03	1.32E+00	2.54E+02
KIDNEY	4.67E+01	5.23E+01	1.21E+01	1.68E+01	1.08E+03	3.48E+01	1.32E+03

AMAD= 3.0 Im	U-238	U-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
EFFECTIV	2.08E+03	2.33E+03	3.05E+03	4.63E+02	1.90E+02	3.25E+00	7.26E+02
BONE	3.56E+01	3.98E+01	1.57E+04	6.64E+02	5.94E+02	8.98E-02	2.37E+02
AVG.LUNG	1.70E+04	1.94E+04	1.96E+04	2.63E+03	5.51E+01	3.77E+01	2.12E+03
LIVER	2.48E-01	2.38E-01	8.41E+01	4.95E+01	3.08E+03	1.69E+00	2.88E+02
KIDNEY	3.44E+01	3.86E+01	8.73E+00	1.88E+01	1.16E+03	4.13E+01	1.49E+03

AMAD= 7.7 Im	U-238	U-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
EFFECTIV	1.11E+03	1.25E+03	1.85E+03	3.08E+02	2.28E+02	2.91E+00	7.61E+02
BONE	3.60E+01	4.02E+01	1.18E+04	8.37E+02	7.46E+02	1.27E-01	3.00E+02
AVG.LUNG	7.50E+03	8.38E+03	8.46E+03	1.14E+03	6.67E+01	1.78E+01	9.16E+02
LIVER	2.30E-01	2.47E-01	7.57E+01	6.37E+01	3.71E+03	2.30E+00	3.52E+02
KIDNEY	3.71E+01	4.20E+01	7.71E+00	2.51E+01	1.39E+03	5.34E+01	1.85E+03

AMAD=54.0 Im	U-238	U-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
EFFECTIV	2.49E+00	2.74E+00	5.25E+02	1.45E+02	2.17E+02	1.82E+00	4.98E+02
BONE	2.04E+01	2.28E+01	6.11E+03	7.79E+02	7.13E+02	1.40E-01	2.66E+02
AVG.LUNG	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.38E+01	0.00E+00	0.00E+00
LIVER	1.09E-01	1.40E-01	3.92E+01	5.93E+01	3.55E+03	2.53E+00	3.12E+02
KIDNEY	2.10E+01	2.38E+01	3.99E+00	2.34E+01	1.32E+03	4.75E+01	1.64E+03

AMAD= 0.3 Im	U-238	U-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
EFFECTIV	6.97E+03	7.81E+03	9.06E+03	1.18E+03	1.75E+02	6.52E+00	1.30E+03
BONE	8.37E+01	9.35E+01	4.21E+04	5.42E+02	5.39E+02	4.04E-02	1.75E+02
AVG.LUNG	5.84E+04	6.67E+04	6.73E+04	9.03E+03	5.00E+01	1.21E+02	7.29E+03
LIVER	6.15E-01	5.35E-01	2.06E+02	3.64E+01	2.80E+03	7.62E-01	1.98E+02
KIDNEY	7.63E+01	8.55E+01	2.12E+01	1.43E+01	1.09E+03	2.51E+01	1.10E+03

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INGESTION DOSE CONVERSION FACTORS, MREM PER PCI INGESTED

AGE GROUP	TISSUE	U-238	U-234	Th-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
INFANT	EFFECTIV	1.61E-02	1.79E-02	8.57E-04	2.51E-02	2.11E-02	3.11E-02	3.88E-05	7.95E-02
INFANT	BONE	4.49E-02	5.43E-02	9.24E-07	4.39E-02	1.09E-01	1.86E-01	6.00E-07	3.29E-02
INFANT	LIVER	2.72E-04	3.15E-04	4.93E-07	3.74E-03	8.48E-03	3.62E-01	7.52E-06	4.48E-02
INFANT	KIDNEY	4.93E-02	5.71E-02	4.38E-07	3.53E-04	3.32E-03	1.35E-01	2.86E-04	2.23E-01
CHILD	EFFECTIV	9.95E-04	1.14E-03	5.30E-05	1.53E-03	2.38E-03	8.67E-03	1.08E-05	9.12E-03
CHILD	BONE	4.86E-03	5.43E-03	1.00E-07	3.32E-03	2.50E-02	7.86E-02	2.53E-07	2.07E-03
CHILD	LIVER	3.74E-05	4.20E-05	6.78E-08	1.45E-04	1.32E-03	8.81E-02	1.83E-06	6.88E-03
CHILD	KIDNEY	6.01E-03	6.75E-03	5.34E-08	1.54E-05	6.44E-04	3.54E-02	7.48E-05	3.44E-02
TEENAGE	EFFECTIV	7.90E-04	8.80E-04	4.22E-05	1.20E-03	4.22E-03	1.12E-02	1.40E-05	4.85E-03
TEENAGE	BONE	1.83E-02	2.05E-02	3.77E-07	3.32E-03	1.09E-01	2.35E-01	7.57E-07	1.65E-03
TEENAGE	LIVER	2.13E-05	2.39E-05	3.85E-08	5.94E-05	8.14E-04	4.75E-02	9.87E-07	3.68E-03
TEENAGE	KIDNEY	3.85E-03	4.33E-03	3.43E-08	6.80E-06	1.02E-03	2.18E-02	4.62E-05	2.04E-02
ADULT	EFFECTIV	2.55E-04	2.84E-04	1.36E-05	5.46E-04	1.32E-03	5.10E-03	6.36E-06	1.94E-03
ADULT	BONE	3.74E-03	4.18E-03	7.70E-08	1.33E-03	2.53E-02	8.10E-02	2.61E-07	4.22E-04
ADULT	LIVER	8.51E-06	9.55E-06	1.54E-08	2.20E-05	3.39E-04	2.26E-02	4.70E-07	1.60E-03
ADULT	KIDNEY	1.54E-03	1.73E-03	1.37E-08	2.52E-06	3.39E-04	1.04E-02	2.20E-05	9.29E-03

ENVIRONMENTAL CONCENTRATION FACTORS

CONCENTRATION FACTOR	FOOD TYPE	U-238	Th-230	Ra-226	Pb-210
BIV, DIMENSIONLESS	ED.ABG.	2.50E-03	4.20E-03	1.40E-02	4.00E-03
BIV, DIMENSIONLESS	POTATO	2.50E-03	4.20E-03	3.00E-03	4.00E-03
BIV, DIMENSIONLESS	BELOW G.	2.50E-03	4.20E-03	1.40E-02	4.00E-03
BIV, DIMENSIONLESS	FORAGE	2.50E-03	4.20E-03	1.80E-02	2.80E-02
BIV, DIMENSIONLESS	ST. FEED	2.50E-03	4.20E-03	8.20E-02	3.60E-02
FBI, PCI/KG PER PCI/DAY	MEAT	3.40E-04	2.00E-04	5.10E-04	7.10E-04
FMI, PCI/L PER PCI/DAY	MILK	6.10E-04	5.00E-06	5.90E-04	1.20E-04
FRACTION IN ED PORTION	ED.ABG.	1.00E+00	1.00E+00	1.00E+00	1.00E+00
FRACTION IN ED PORTION	POTATO	1.00E-01	1.00E-01	1.00E-01	1.00E-01
FRACTION IN ED PORTION	BELOW G.	1.00E-01	1.00E-01	1.00E-01	1.00E-01
FRACTION IN ED PORTION	FORAGE	1.00E+00	1.00E+00	1.00E+00	1.00E+00
FRACTION IN ED PORTION	ST. FEED	1.00E+00	1.00E+00	1.00E+00	1.00E+00

TIME STEP DEPENDENT VARIABLES

NO.	TIME STEP NAME	PAJUST	GFACT U-238	GFACT Th-230	GFACT Ra-226	GFACT Pb-210	TFACT U-238	TFACT Th-230	TFACT Ra-226	TFACT Pb-210
1	3-YEAR ACTION PERIOD	1.000E+00	9.274E+07	9.274E+07	9.268E+07	8.857E+07	1.622E+00	1.622E+00	1.622E+00	1.618E+00
2	100-YR MAINTENANCE	1.000E+00	1.707E+09	1.707E+09	1.679E+09	6.943E+08	1.638E+00	1.638E+00	1.638E+00	1.624E+00

XPFACT=2.640E+02   GPFACT(4)=1.707E+09 1.707E+09 1.679E+09 6.943E+08   TPFACT(4)=1.638E+00 1.638E+00 1.638E+00 1.624E+00

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TIME STEP NUMBER 1, 3-YEAR ACTION PERIOD DURATION IN YRS IS... 3.0

CONCENTRATION DATA FOR THE N DIRECTION, THETA EQUALS 0.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	5.239E-04	5.239E-04	5.239E-04	5.227E-04	6.857E-02	6.203E-02	2.528E-02	1.052E-02	8.078E-09	2.313E-07
2.5	2.259E-04	2.259E-04	2.259E-04	2.254E-04	3.281E-02	3.117E-02	1.649E-02	9.408E-03	1.354E-08	1.508E-07
3.5	1.169E-04	1.169E-04	1.169E-04	1.166E-04	1.854E-02	1.812E-02	1.145E-02	7.882E-03	1.757E-08	1.061E-07
4.5	7.289E-05	7.289E-05	7.288E-05	7.272E-05	1.236E-02	1.223E-02	8.544E-03	6.481E-03	2.021E-08	8.008E-08
7.5	2.859E-05	2.859E-05	2.859E-05	2.853E-05	5.577E-03	5.571E-03	4.512E-03	3.807E-03	2.329E-08	4.282E-08
15.0	8.239E-06	8.239E-06	8.238E-06	8.219E-06	1.960E-03	1.961E-03	1.805E-03	1.640E-03	2.250E-08	1.729E-08
25.0	3.278E-06	3.278E-06	3.278E-06	3.270E-06	9.124E-04	9.129E-04	8.874E-04	8.486E-04	2.000E-08	8.604E-09
35.0	1.791E-06	1.791E-06	1.791E-06	1.787E-06	5.517E-04	5.520E-04	5.468E-04	5.355E-04	1.807E-08	5.338E-09
45.0	1.136E-06	1.136E-06	1.135E-06	1.133E-06	3.776E-04	3.778E-04	3.772E-04	3.737E-04	1.657E-08	3.695E-09
55.0	8.032E-07	8.032E-07	8.032E-07	8.013E-07	2.824E-04	2.825E-04	2.830E-04	2.819E-04	1.540E-08	2.777E-09
65.0	5.868E-07	5.868E-07	5.868E-07	5.854E-07	2.173E-04	2.174E-04	2.182E-04	2.181E-04	1.440E-08	2.144E-09
75.0	4.481E-07	4.481E-07	4.481E-07	4.471E-07	1.733E-04	1.734E-04	1.742E-04	1.745E-04	1.356E-08	1.712E-09

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	2.996E+02	2.996E+02	2.994E+02	2.994E+02	0.000E+00	2.994E+02	2.994E+02	2.994E+02	2.147E-03
2.5	1.292E+02	1.292E+02	1.291E+02	1.291E+02	0.000E+00	1.291E+02	1.291E+02	1.291E+02	3.597E-03
3.5	6.682E+01	6.682E+01	6.678E+01	6.678E+01	0.000E+00	6.679E+01	6.679E+01	6.679E+01	4.668E-03
4.5	4.168E+01	4.167E+01	4.165E+01	4.165E+01	0.000E+00	4.166E+01	4.166E+01	4.166E+01	5.370E-03
7.5	1.635E+01	1.635E+01	1.634E+01	1.634E+01	0.000E+00	1.634E+01	1.634E+01	1.634E+01	6.189E-03
15.0	4.711E+00	4.711E+00	4.708E+00	4.708E+00	0.000E+00	4.709E+00	4.709E+00	4.709E+00	5.980E-03
25.0	1.874E+00	1.874E+00	1.873E+00	1.873E+00	0.000E+00	1.874E+00	1.874E+00	1.874E+00	5.314E-03
35.0	1.024E+00	1.024E+00	1.023E+00	1.023E+00	0.000E+00	1.024E+00	1.024E+00	1.024E+00	4.802E-03
45.0	6.493E-01	6.493E-01	6.489E-01	6.489E-01	0.000E+00	6.492E-01	6.492E-01	6.492E-01	4.404E-03
55.0	4.593E-01	4.593E-01	4.590E-01	4.590E-01	0.000E+00	4.592E-01	4.592E-01	4.592E-01	4.092E-03
65.0	3.355E-01	3.355E-01	3.353E-01	3.353E-01	0.000E+00	3.355E-01	3.355E-01	3.355E-01	3.827E-03
75.0	2.562E-01	2.562E-01	2.561E-01	2.561E-01	0.000E+00	2.562E-01	2.562E-01	2.562E-01	3.602E-03

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	5.239E-06	5.239E-06	5.239E-06	5.227E-06
2.5	2.259E-06	2.259E-06	2.259E-06	2.254E-06
3.5	1.169E-06	1.169E-06	1.169E-06	1.166E-06
4.5	7.289E-07	7.289E-07	7.288E-07	7.272E-07
7.5	2.859E-07	2.859E-07	2.859E-07	2.853E-07
15.0	8.239E-08	8.239E-08	8.238E-08	8.226E-08
25.0	3.278E-08	3.278E-08	3.278E-08	3.276E-08
35.0	1.791E-08	1.791E-08	1.791E-08	1.792E-08
45.0	1.136E-08	1.136E-08	1.135E-08	1.138E-08
55.0	8.032E-09	8.032E-09	8.032E-09	8.060E-09
65.0	5.868E-09	5.868E-09	5.868E-09	5.897E-09
75.0	4.481E-09	4.481E-09	4.481E-09	4.511E-09

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TIME STEP NUMBER 1, 3-YEAR ACTION PERIOD　　DURATION IN YRS IS... 3.0

. EXPOSURE PATHWAY IS INHAL.　　EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	6.396E-01	1.379E-01	1.000E-01	8.011E-02	1.349E-02	5.588E-02	4.253E-02	1.851E-02	1.700E-02	1.365E-02	1.216E-02	9.294E-03
NNE	4.622E-01	4.484E-02	1.236E-01	6.004E-02	3.843E-03	1.952E-02	1.261E-02	9.533E-03	7.708E-03	6.475E-03	4.873E-03	3.819E-03
NE	2.348E-01	1.037E-01	5.504E-02	6.068E-03	6.653E-03	9.186E-03	5.729E-03	4.229E-03	3.360E-03	2.523E-03	1.723E-03	1.497E-03
ENE	2.283E-01	1.123E-01	4.661E-02	3.631E-02	1.938E-03	2.126E-03	1.360E-03	1.934E-03	2.722E-03	3.015E-03	2.407E-03	1.925E-03
E	2.664E-01	2.818E-01	2.042E-01	1.646E-02	5.602E-03	6.598E-03	4.457E-03	3.443E-03	2.828E-03	2.457E-03	3.287E-03	3.589E-03
ESE	2.982E-01	3.314E-01	2.466E-01	6.055E-02	7.079E-03	8.563E-03	5.891E-03	4.591E-03	3.795E-03	3.314E-03	2.887E-03	2.565E-03
SE	1.789E-01	1.978E-02	1.524E-03	1.188E-03	4.033E-03	4.739E-03	3.202E-03	2.474E-03	2.076E-03	2.006E-03	1.907E-03	1.967E-03
SSE	2.002E-01	1.871E-02	9.036E-04	6.783E-04	2.156E-03	2.359E-03	1.524E-03	1.148E-03	1.152E-03	1.225E-03	1.051E-03	9.208E-04
S	1.469E-01	3.274E-02	2.385E-02	1.938E-03	6.437E-03	7.261E-03	4.718E-03	3.539E-03	2.915E-03	3.735E-03	3.182E-03	2.770E-03
SSW	2.870E-03	1.584E-03	1.151E-03	8.897E-04	2.959E-03	3.390E-03	3.162E-03	3.246E-03	1.952E-03	1.893E-03	1.640E-03	1.449E-03
SW	2.382E-03	1.299E-03	9.308E-04	7.116E-04	2.314E-03	4.001E-03	4.014E-03	3.083E-03	2.493E-03	1.820E-03	1.351E-03	1.110E-03
WSW	1.663E-03	8.739E-04	6.077E-04	4.546E-04	2.368E-03	3.579E-03	2.301E-03	1.749E-03	1.096E-03	7.564E-04	5.746E-04	4.696E-04
W	1.205E-02	6.419E-04	4.324E-04	3.158E-04	2.195E-03	2.258E-03	1.432E-03	1.093E-03	4.043E-04	3.298E-04	2.870E-04	2.547E-04
WNW	8.955E-03	4.739E-04	3.216E-04	2.367E-04	1.679E-03	1.673E-03	9.039E-04	6.076E-04	4.558E-04	2.950E-04	1.982E-04	1.734E-04
NW	3.057E-02	8.353E-04	5.803E-04	7.344E-04	3.171E-03	2.412E-03	1.473E-03	1.113E-03	9.021E-04	7.780E-04	6.412E-04	5.342E-04
NNW	6.900E-02	1.544E-03	1.107E-03	8.484E-04	3.279E-03	5.037E-03	3.314E-03	2.529E-03	2.060E-03	2.110E-03	1.944E-03	1.397E-03

TOTAL DOSE COMMITMENT IS 5.491E+00 PERSON-REM/YR

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METSET: METEOROLOGIC STATION DATA: SAMPLE.DAT 04/01/89

TIME STEP NUMBER 1, 3-YEAR ACTION PERIOD DURATION IN YRS IS... 3.0

SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 1--DOSES SHOWN ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	5.491E+00	3.898E+01	3.128E+01	1.306E+00	9.457E-01	5.184E-01
GROUND	2.719E-01	2.719E-01	2.719E-01	2.719E-01	2.719E-01	2.719E-01
CLOUD	1.892E-03	1.892E-03	1.892E-03	1.892E-03	1.892E-03	1.892E-03
VEG. ING	1.061E+00	1.285E+01	1.061E+00	2.979E+00	2.772E+00	1.061E+00
MEAT ING	2.211E-02	2.740E-01	2.211E-02	6.756E-02	5.849E-02	2.211E-02
MILK ING	4.457E-02	5.833E-01	4.457E-02	6.989E-02	1.066E-01	4.457E-02
RNPLUS50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTALS	6.892E+00	5.296E+01	3.268E+01	4.696E+00	4.156E+00	1.920E+00

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUND	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CLOUD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
VEG. ING	4.462E-01	5.405E+00	4.462E-01	1.253E+00	1.166E+00	4.462E-01
MEAT ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MILK ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RNPLUS50	5.018E-03	6.738E-02	1.120E-03	5.018E-03	5.018E-03	3.519E-02
TOTALS	4.513E-01	5.472E+00	4.474E-01	1.258E+00	1.171E+00	4.814E-01

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	5.491E+00	3.898E+01	3.128E+01	1.306E+00	9.457E-01	5.184E-01
GROUND	2.719E-01	2.719E-01	2.719E-01	2.719E-01	2.719E-01	2.719E-01
CLOUD	1.892E-03	1.892E-03	1.892E-03	1.892E-03	1.892E-03	1.892E-03
VEG. ING	1.507E+00	1.826E+01	1.507E+00	4.231E+00	3.937E+00	1.507E+00
MEAT ING	2.211E-02	2.740E-01	2.211E-02	6.756E-02	5.849E-02	2.211E-02
MILK ING	4.457E-02	5.833E-01	4.457E-02	6.989E-02	1.066E-01	4.457E-02
RNPLUS50	5.018E-03	6.738E-02	1.120E-03	5.018E-03	5.018E-03	3.519E-02
TOTALS	7.344E+00	5.844E+01	3.313E+01	5.953E+00	5.327E+00	2.402E+00

REGION: SAMPLE SITE CODE: MILDOS-AREA (03/89) PAGE 30
METSET: METEOROLOGIC STATION DATA: SAMPLE.DAT 04/01/89
TIME STEP NUMBER 1, 3-YEAR ACTION PERIOD DURATION IN YRS IS... 3.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

			AIRBORNE CONCENTRATIONS, PCI/M3				GROUND CONCENTRATIONS, PCI/M2			
NO.	NAME	PTSZ	U-238	Th-230	Ra-226	Pb-210	U-238	Th-230	Ra-226	Pb-210
1	E RESIDENT	1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	E RESIDENT	2	3.386E-04	3.386E-04	3.386E-04	3.378E-04	1.936E+02	1.936E+02	1.935E+02	1.935E+02
1	E RESIDENT	3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	E RESIDENT	4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	CONCENTRATION TOTALS		3.386E-04	3.386E-04	3.386E-04	3.378E-04	1.936E+02	1.936E+02	1.935E+02	1.935E+02
2	N RESIDENT	1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	N RESIDENT	2	8.014E-04	8.014E-04	8.014E-04	7.995E-04	4.582E+02	4.582E+02	4.579E+02	4.579E+02
2	N RESIDENT	3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	N RESIDENT	4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	CONCENTRATION TOTALS		8.014E-04	8.014E-04	8.014E-04	7.995E-04	4.582E+02	4.582E+02	4.579E+02	4.579E+02
3	W RESIDENT	1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	W RESIDENT	2	7.760E-05	7.760E-05	7.760E-05	7.742E-05	4.437E+01	4.437E+01	4.434E+01	4.434E+01
3	W RESIDENT	3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	W RESIDENT	4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	CONCENTRATION TOTALS		7.760E-05	7.760E-05	7.760E-05	7.742E-05	4.437E+01	4.437E+01	4.434E+01	4.434E+01
4	S RESIDENT	1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	S RESIDENT	2	3.585E-04	3.585E-04	3.585E-04	3.577E-04	2.050E+02	2.050E+02	2.049E+02	2.049E+02
4	S RESIDENT	3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	S RESIDENT	4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	CONCENTRATION TOTALS		3.585E-04	3.585E-04	3.585E-04	3.577E-04	2.050E+02	2.050E+02	2.049E+02	2.049E+02

REGION: SAMPLE SITE   CODE: MILDOS-AREA (03/89)   PAGE 31
METSET: METEOROLOGIC STATION   DATA: SAMPLE.DAT   04/01/89
TIME STEP NUMBER 1, 3-YEAR ACTION PERIOD   DURATION IN YRS IS... 3.0

INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER CONCENTRATIONS

	AIRBORNE CONCENTRATIONS, PCI/M3								GROUND CONCENTRATIONS, PCI/M2			
NO.	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	Bi-210	Po-210	WL	Po-218	Pb-214	Bi-214	Pb-210
1	3.345E-02	2.725E-02	8.509E-03	2.885E-03	1.686E-09	1.187E-12	2.411E-17	8.197E-08	2.158E-02	2.158E-02	2.158E-02	4.480E-04
2	9.933E-02	8.682E-02	3.014E-02	1.042E-02	6.115E-09	4.309E-12	8.760E-17	2.811E-07	6.877E-02	6.877E-02	6.877E-02	1.625E-03
3	1.862E-02	1.807E-02	7.791E-03	2.829E-03	1.680E-09	1.187E-12	2.416E-17	6.866E-08	1.431E-02	1.431E-02	1.431E-02	4.465E-04
4	5.361E-02	4.826E-02	1.674E-02	5.722E-03	3.341E-09	2.351E-12	4.777E-17	1.559E-07	3.822E-02	3.822E-02	3.822E-02	8.878E-04

REGION: SAMPLE SITE CODE: MILDOS-AREA (03/89) PAGE 32
METSET: METEOROLOGIC STATION DATA: SAMPLE.DAT 04/01/89
TIME STEP NUMBER 1, 3-YEAR ACTION PERIOD DURATION IN YRS IS... 3.0

NUMBER 1 NAME=E RESIDENT X= 1.2KM, Y= 0.0KM, Z= 0.0M, DIST= 1.2KM, IRTYPE=10

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	2.99E+00	5.84E+00	2.06E+01	1.18E+00	9.44E-01	0.00E+00
INFANT	GROUND	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03
INFANT	CLOUD	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08
INFANT	VEG. ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MEAT ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MILK ING	4.45E-01	1.43E+00	5.15E-01	5.15E-01	1.03E+00	0.00E+00
INFANT	TOTALS	3.44E+00	7.28E+00	2.11E+01	1.70E+00	1.98E+00	1.20E-03

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	1.41E+00	4.92E+00	9.62E+00	4.77E-01	3.24E-01	0.00E+00
CHILD	GROUND	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03
CHILD	CLOUD	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08
CHILD	VEG. ING	1.37E-01	6.87E-01	5.55E-01	5.55E-01	4.78E-01	0.00E+00
CHILD	MEAT ING	1.88E-02	9.37E-02	8.60E-02	8.60E-02	6.82E-02	0.00E+00
CHILD	MILK ING	4.63E-02	2.93E-01	1.16E-01	1.16E-01	1.55E-01	0.00E+00
CHILD	TOTALS	1.62E+00	6.00E+00	1.04E+01	1.24E+00	1.03E+00	1.20E-03

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGE	INHAL.	8.47E-01	5.47E+00	4.98E+00	2.08E-01	1.63E-01	0.00E+00
TEENAGE	GROUND	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03
TEENAGE	CLOUD	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08
TEENAGE	VEG. ING	2.21E-01	3.70E+00	4.95E-01	4.95E-01	4.90E-01	0.00E+00
TEENAGE	MEAT ING	2.95E-02	4.87E-01	7.52E-02	7.52E-02	6.81E-02	0.00E+00
TEENAGE	MILK ING	6.17E-02	1.31E+00	7.48E-02	7.48E-02	1.19E-01	0.00E+00
TEENAGE	TOTALS	1.16E+00	1.10E+01	5.63E+00	8.54E-01	8.41E-01	1.20E-03

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
ADULT	INHAL.	7.23E-01	5.13E+00	4.12E+00	1.72E-01	1.24E-01	0.00E+00
ADULT	GROUND	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03
ADULT	CLOUD	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08
ADULT	VEG. ING	1.25E-01	1.53E+00	3.23E-01	3.23E-01	3.06E-01	0.00E+00
ADULT	MEAT ING	2.14E-02	2.64E-01	6.21E-02	6.21E-02	5.46E-02	0.00E+00
ADULT	MILK ING	1.17E-02	1.76E-01	1.85E-02	1.85E-02	2.68E-02	0.00E+00
ADULT	TOTALS	8.82E-01	7.10E+00	4.52E+00	5.76E-01	5.13E-01	1.20E-03

C.4 LISTING OF TEST PROBLEM TESTC1.DAT

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JC=1,0,1,2*0,2*1,0,1,0,
FRADON=0.86,0.06,0.04,0.04,
IPACT=3*0,1,2,3,4*0,
NSORCE=6,
PACT=11.4,17.1,22.8,271.0,407.0,542.5,284.4,427.1,570.0,284.4,427.1,570.0,
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 1.0,2*1.502,2*2.004,5*0.0,  1.0,2*1.502,2*2.004,5*0.0,
 0.3,1.0,8*0.0,  2*1.0,4*.007,4*0.0,
 0.0,2*0.3,1.0,6*0.,     0.0,3*1.0,2*0.005,4*0.0,
 3*0.0,2*0.3,5*0.0,     3*0.0,2*1.0,0.004,4*0.0,
 80*0.0,
SORCE=
 2*0.0,20.0,0.0,4.1388E-2,2.1556E-3,2*8.6225E-5,0.0,1101,1.0,17.0,
 2*0.40,6.0,0.16,4*4.084E-2,1089.74,1201,3.0,0.0,
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FPR=320,1400,230,
IPOP=
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 2*0,3,1,4*0,1,2*0,1000,
PAJUST=1.021,1.041,1.063,1.111,1.175,1.206,4*0.0,
IADD=6,
XRECEP=
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 1.08,-1.6,2.4,
 2.56,0.0,3.7,
 2.584,-0.89,-1.4,
 -0.448,1.466,12.3,
 2.168,2.168,10.2,
NSTEP=6,TSTART=1980,TSTEP=2.25,2.0,2.25,5.0,8.0,5.0,4*0.0,
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&END
Sierra Madre Mill            Casper Wyoming
Yellowcake Stack
Ore Pad
Grizzly Dump-Hopper
Tailings Area 1
Tailings Area 2
Tailings Area 3
Fence Boundary E
Fence Boundary SSE
Grazing E
Grazing ESE
```

```
Nearest Resident (NNW)
Nearest Res in Pre. Windr.
After 2.25 Years
After 4.25 Years
After 6.50 Years
After 11.5 Years
After 19.5 Years
After 24.5 Years
 &NWAREA
 NEX=2, NEY=2,
 VERTX=
   1203.9,785.9,1582.1,785.9,1203.9,1164.1,1582.1,1164.1,
 &END
 &NWAREA
 NEX=2, NEY=2,
 VERTX=
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 &END
 &NWAREA
 NEX=2, NEY=2,
 VERTX=
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 &END
```

C.5 SELECTED OUTPUT FROM TEST PROBLEM TESTC1.DAT

REGION: Sierra Madre Mill　　CODE: MILDOS-AREA (03/89)　　PAGE 1
METSET: Casper Wyoming　　DATA: TESTC1.DAT　　04/18/89

TABLE OF CONTENTS

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 2
METSET: Casper Wyoming DATA: TESTC1.DAT 04/18/89
JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.05734,0.21073,0.28176,0.26134,0.13153,0.05734

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	0.0069	0.0240	0.0103	0.0240	0.0171	0.0103	0.0069	0.0411	0.0137	0.0206	0.0240	0.0240	0.0377	0.0171	0.0206	0.0103	0.3086
5.5	0.0137	0.0274	0.0206	0.0069	0.0137	0.0206	0.0137	0.0617	0.0069	0.0206	0.0069	0.0274	0.0548	0.0343	0.0000	0.0206	0.3498
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0206	0.0514	0.0309	0.0309	0.0308	0.0309	0.0206	0.1028	0.0206	0.0412	0.0309	0.0514	0.0925	0.0514	0.0206	0.0309	0.6584
STABILITY CLASS 2																	
1.5	0.0554	0.0507	0.0374	0.0421	0.0960	0.0424	0.0665	0.0651	0.0977	0.0410	0.0618	0.0445	0.1126	0.0402	0.0208	0.0644	0.9386
5.5	0.0959	0.1233	0.0685	0.0411	0.1233	0.1165	0.1302	0.1165	0.2124	0.1028	0.1576	0.1370	0.1370	0.0959	0.0548	0.1096	1.8224
10.0	0.0685	0.0617	0.0685	0.0411	0.0617	0.0206	0.0548	0.0274	0.0548	0.0685	0.0822	0.1096	0.1781	0.0685	0.0754	0.0822	1.1236
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.2198	0.2357	0.1744	0.1243	0.2810	0.1795	0.2515	0.2090	0.3649	0.2123	0.3016	0.2911	0.4277	0.2046	0.1510	0.2562	3.8846
STABILITY CLASS 3																	
1.5	0.0186	0.0133	0.0115	0.0118	0.0366	0.0186	0.0127	0.0037	0.0282	0.0186	0.0186	0.0292	0.0179	0.0273	0.0320	0.0028	0.3014
5.5	0.0959	0.1370	0.0959	0.1028	0.1781	0.0959	0.1233	0.0822	0.1507	0.0959	0.0959	0.1713	0.2398	0.1302	0.0754	0.0617	1.9320
10.0	0.2535	0.1850	0.1576	0.1713	0.2329	0.1918	0.1233	0.0822	0.1233	0.1987	0.3699	0.6439	0.4727	0.2261	0.1644	0.1576	3.7542
15.5	0.0274	0.0137	0.0137	0.0137	0.0343	0.0343	0.0137	0.0000	0.0343	0.0959	0.2055	0.1713	0.1918	0.0343	0.0411	0.0685	0.9935
21.5	0.0000	0.0069	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0137	0.0069	0.0343	0.0343	0.0411	0.0206	0.0000	0.0000	0.1578
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0069	0.0137	0.0069	0.0000	0.0000	0.0000	0.0275
ALL	0.3954	0.3559	0.2787	0.2996	0.4819	0.3406	0.2730	0.1681	0.3502	0.4160	0.7311	1.0637	0.9702	0.4385	0.3129	0.2906	7.1664
STABILITY CLASS 4																	
1.5	0.0792	0.1053	0.0854	0.0741	0.0598	0.0592	0.0548	0.0268	0.0548	0.0336	0.0411	0.0530	0.0679	0.0816	0.0430	0.1009	1.0205
5.5	0.5412	0.5823	0.4453	0.3220	0.4110	0.3220	0.1918	0.1302	0.1918	0.1233	0.2055	0.3357	0.3357	0.2398	0.1439	0.4521	4.9736
10.0	1.1440	1.4249	1.0207	0.8768	0.9248	0.4932	0.3014	0.1370	0.2124	0.6302	1.4180	2.1304	1.7468	0.5412	0.5206	0.5001	14.0225
15.5	1.1097	1.4865	1.0275	0.6508	1.0001	0.5480	0.1987	0.0548	0.3699	3.0826	6.5420	5.1993	1.9318	0.9453	0.5891	0.4042	25.1403
21.5	0.2809	0.3768	0.1713	0.0617	0.2261	0.0822	0.0411	0.0137	0.1781	2.6716	5.0075	2.2126	0.9248	0.4042	0.2398	0.1028	12.9952
28.0	0.1028	0.1028	0.0274	0.0000	0.0137	0.0069	0.0000	0.0000	0.0411	1.4797	2.2469	0.9727	0.5206	0.1165	0.0411	0.0343	5.7065
ALL	3.2578	4.0786	2.7776	1.9854	2.6355	1.5115	0.7878	0.3625	1.0481	8.0210	15.4610	10.9037	5.5276	2.3286	1.5775	1.5944	63.8586
STABILITY CLASS 5																	
1.5	0.3723	0.1668	0.1431	0.1104	0.1608	0.1124	0.0635	0.0583	0.1221	0.1124	0.1448	0.2996	0.5746	0.2607	0.2023	0.2606	3.1647
5.5	1.1098	0.8974	0.6439	0.5480	0.6234	0.3563	0.3083	0.1919	0.3014	0.3152	0.5275	1.2741	2.0140	0.9865	0.9042	0.9933	11.9952
10.0	0.3425	0.3014	0.2809	0.2877	0.4042	0.3083	0.1165	0.0480	0.0548	0.4042	1.0892	2.8223	1.9044	0.4042	0.2466	0.2603	9.2755
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	1.8246	1.3656	1.0679	0.9461	1.1884	0.7770	0.4883	0.2982	0.4783	0.8318	1.7615	4.3960	4.4930	1.6514	1.3531	1.5142	24.4354
STABILITY CLASS 6																	
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	5.7182	6.0872	4.3295	3.3863	4.6176	2.8395	1.8212	1.1406	2.2621	9.5223	18.2861	16.7059	11.5110	4.6745	3.4151	3.6863	100.0034

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METSET: Casper Wyoming   DATA: TESTC1.DAT   04/18/89

INDIVIDUAL RECEPTOR LOCATION DATA, 6 LOCATIONS INPUT THIS RUN

I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE	I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE
1	Fence Boundary E	1.60	-0.20	8.80	1.61	0	4	Grazing ESE	2.58	-0.89	-1.40	2.73	10
2	Fence Boundary SSE	1.08	-1.60	2.40	1.93	0	5	Nearest Resident (NN	-0.45	1.47	12.30	1.53	10
3	Grazing E	2.56	0.00	3.70	2.56	10	6	Nearest Res in Pre.	2.17	2.17	10.20	3.07	10

MISCELLANEOUS INPUTABLE PARAMETER VALUES

DMM	DMA	TSTART	FFORI	FHAYI	FFORP	FHAYP	FPR(1)	FPR(2)	FPR(3)	ACTRAT
150.0	1550.0	1980.00	0.50	0.50	0.50	0.50	320.00	1400.00	230.00	2.50

IPACT EQUALS 0, 0, 0, 1, 2, 3,

JC EQUALS 1, 0, 1, 0, 0, 1, 1, 0, 1, 0

TIME STEP DATA....

	STEP NAMES	LENGTH, YRS	IFTODO
1	After 2.25 Years	2.25	0
2	After 4.25 Years	2.00	0
3	After 6.50 Years	2.25	0
4	After 11.5 Years	5.00	0
5	After 19.5 Years	8.00	1
6	After 24.5 Years	5.00	1

XRHO EQUALS 1.5, 2.5, 3.5, 4.5, 7.5, 15.0, 25.0, 35.0, 45.0, 55.0, 65.0, 75.0,

HDP EQUALS 50.0

REGION: Sierra Madre Mill
METSET: Casper Wyoming

CODE: MILDOS-AREA (03/89)
DATA: TESTC1.DAT

04/18/89

POPULATION DISTRIBUTION

KILOMETERS	N 0.0	NNE 22.5	NE 45.0	ENE 67.5	E 90.0	ESE 112.5	SE 135.0	SSE 157.5	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
1.0- 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0- 3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0- 4.0	1	2	1	3	2	1	1	2	4	3	1	3	2	1	2	3
4.0- 5.0	5	3	2	0	1	3	0	0	2	1	3	0	2	1	1	1
5.0-10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0-20.0	15	14	1	0	3	0	1	0	1	1	2	1	0	3	0	0
20.0-30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.0-40.0	0	40	15	10	1	4	2	0	0	25	8	9	0	4	5	0
40.0-50.0	4	27	14	8	3	2	0	1	10	4	27	6	3	0	0	1
50.0-60.0	8	10	4	1	0	0	0	0	0	0	0	0	0	0	0	0
60.0-70.0	14	300	800	327	50	0	0	0	17	254	322	145	89	0	0	0
70.0-80.0	400	250	97	655	422	0	0	25893	37372	0	0	0	0	0	427	1000
1.0-80.0	447	646	934	1004	482	10	4	25896	37406	288	363	164	96	9	435	1005

TOTAL 1-80 KM POPULATION IS 69189 PERSONS

FINITE ELEMENT DATA FOR SOURCE NO. 4: IPX= 1 ID= 5001

VERTEX (M) = 1.2039E+03 7.8590E+02 1.5821E+03 7.8590E+02 1.2039E+03 1.1641E+03 1.5821E+03 1.1641E+03

AREA SOURCE ELEMENT NO. = 1	NODES=	1	4	2	5
AREA SOURCE ELEMENT NO. = 2	NODES=	2	5	3	6
AREA SOURCE ELEMENT NO. = 3	NODES=	4	7	5	8
AREA SOURCE ELEMENT NO. = 4	NODES=	5	8	6	9

NODAL COORDINATES (M):

NODE NO. =	XS=	YS=
1	1.2039E+03	7.8590E+02
2	1.2039E+03	9.7500E+02
3	1.2039E+03	1.1641E+03
4	1.3930E+03	7.8590E+02
5	1.3930E+03	9.7500E+02
6	1.3930E+03	1.1641E+03
7	1.5821E+03	7.8590E+02
8	1.5821E+03	9.7500E+02
9	1.5821E+03	1.1641E+03

FINITE ELEMENT DATA FOR SOURCE NO. 5: IPX= 2 ID= 5002

VERTEX (M) = -1.5598E+03 -1.1038E+03 -1.0402E+03 -1.1038E+03 -1.5598E+03 -5.8420E+02 -1.0402E+03 -5.8420E+02

AREA SOURCE ELEMENT NO. =	1	NODES=	1	4	2	5
AREA SOURCE ELEMENT NO. =	2	NODES=	2	5	3	6
AREA SOURCE ELEMENT NO. =	3	NODES=	4	7	5	8
AREA SOURCE ELEMENT NO. =	4	NODES=	5	8	6	9

NODAL COORDINATES (M):

NODE NO. =	1	XS= -1.5598E+03	YS= -1.1038E+03
NODE NO. =	2	XS= -1.5598E+03	YS= -8.4400E+02
NODE NO. =	3	XS= -1.5598E+03	YS= -5.8420E+02
NODE NO. =	4	XS= -1.3000E+03	YS= -1.1038E+03
NODE NO. =	5	XS= -1.3000E+03	YS= -8.4400E+02
NODE NO. =	6	XS= -1.3000E+03	YS= -5.8420E+02
NODE NO. =	7	XS= -1.0402E+03	YS= -1.1038E+03
NODE NO. =	8	XS= -1.0402E+03	YS= -8.4400E+02
NODE NO. =	9	XS= -1.0402E+03	YS= -5.8420E+02

FINITE ELEMENT DATA FOR SOURCE NO. 6: IPX= 3 ID= 5003

VERTEX (M) = 6.3730E+02 -1.4297E+03 1.5467E+03 -1.4297E+03 6.3730E+02 -5.2030E+02 1.5467E+03 -5.2030E+02

AREA SOURCE ELEMENT NO. = 1	NODES=	1	4	2	5
AREA SOURCE ELEMENT NO. = 2	NODES=	2	5	3	6
AREA SOURCE ELEMENT NO. = 3	NODES=	4	7	5	8
AREA SOURCE ELEMENT NO. = 4	NODES=	5	8	6	9

NODAL COORDINATES (M):

NODE NO. = 1	XS= 6.3730E+02	YS= -1.4297E+03
NODE NO. = 2	XS= 6.3730E+02	YS= -9.7500E+02
NODE NO. = 3	XS= 6.3730E+02	YS= -5.2030E+02
NODE NO. = 4	XS= 1.0920E+03	YS= -1.4297E+03
NODE NO. = 5	XS= 1.0920E+03	YS= -9.7500E+02
NODE NO. = 6	XS= 1.0920E+03	YS= -5.2030E+02
NODE NO. = 7	XS= 1.5467E+03	YS= -1.4297E+03
NODE NO. = 8	XS= 1.5467E+03	YS= -9.7500E+02
NODE NO. = 9	XS= 1.5467E+03	YS= -5.2030E+02

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NUMBER OF SOURCES= 6

NO.	KM X	KM Y	M Z	KM2 AREA	U-238	Th-230	CI/YEAR Ra-226	Pb-210	Rn-222	ID	PSIZE SET	M/SEC EXIT VEL	SOURCE NAME
1	0.00	0.00	20.00	0.0000	4.14E-02	2.16E-03	8.62E-05	8.62E-05	0.00E+00	1101	1	1.70E+01	Yellowcake Stack
2	0.40	0.40	6.00	0.1600	4.08E-02	4.08E-02	4.08E-02	4.08E-02	1.09E+03	1201	3	0.00E+00	Ore Pad
3	0.20	0.20	0.00	0.0000	2.60E-02	2.60E-02	2.60E-02	2.60E-02	4.16E+01	1301	2	0.00E+00	Grizzly Dump-Hopper
4	1.39	0.98	-10.00	0.1430	5.67E-03	1.35E-01	1.41E-01	1.41E-01	1.28E+03	5001	3	0.00E+00	Tailings Area 1
5	-1.30	-0.84	-10.00	0.2700	1.61E-02	3.82E-01	4.01E-01	4.01E-01	3.64E+03	5002	3	0.00E+00	Tailings Area 2
6	1.09	-0.98	-10.00	0.8270	6.56E-02	1.56E+00	1.64E+00	1.64E+00	1.49E+04	5003	3	0.00E+00	Tailings Area 3

INPUT TAILS ACTIVITIES, PCI/G

SET	URANIUM	THORIUM	RADIUM	LEAD
1	1.14E+01	2.71E+02	2.84E+02	2.84E+02
2	1.71E+01	4.07E+02	4.27E+02	4.27E+02
3	2.28E+01	5.43E+02	5.70E+02	5.70E+02

AMAD AND FRACTIONAL DISTRIBUTION

SET	1.5	3.0	7.7	54.0
1	0.000	1.000	0.000	0.000
2	1.000	0.000	0.000	0.000
3	0.000	0.000	0.300	0.700

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 6 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 2.25YRS	TSTEP 2 2.00YRS	TSTEP 3 2.25YRS	TSTEP 4 5.00YRS	TSTEP 5 8.00YRS	TSTEP 6 5.00YRS	TSTEP 7 0.00YRS	TSTEP 8 0.00YRS	TSTEP 9 0.00YRS	TSTEP10 0.00YRS
1	1.000E+00	1.500E+00	1.500E+00	2.000E+00	2.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	3.000E-01	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5	0.000E+00	3.000E-01	3.000E-01	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6	0.000E+00	0.000E+00	0.000E+00	3.000E-01	3.000E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 6 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 2.25YRS	TSTEP 2 2.00YRS	TSTEP 3 2.25YRS	TSTEP 4 5.00YRS	TSTEP 5 8.00YRS	TSTEP 6 5.00YRS	TSTEP 7 0.00YRS	TSTEP 8 0.00YRS	TSTEP 9 0.00YRS	TSTEP10 0.00YRS
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	1.000E+00	1.000E+00	7.000E-03	7.000E-03	7.000E-03	7.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5	0.000E+00	1.000E+00	1.000E+00	1.000E+00	5.000E-03	5.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6	0.000E+00	0.000E+00	0.000E+00	1.000E+00	1.000E+00	4.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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TIME STEP NUMBER 5, After 19.5 Years DURATION IN YRS IS... 8.0

CONCENTRATION DATA FOR THE N DIRECTION, THETA EQUALS 0.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	1.391E-03	8.376E-04	8.083E-04	8.063E-04	5.631E+01	5.154E+01	2.056E+01	9.730E+00	1.304E-05	1.936E-04
2.5	5.608E-04	2.899E-04	2.756E-04	2.749E-04	2.841E+01	2.763E+01	1.501E+01	9.038E+00	1.814E-05	1.383E-04
3.5	3.205E-04	1.644E-04	1.561E-04	1.557E-04	1.989E+01	1.963E+01	1.235E+01	8.392E+00	2.318E-05	1.142E-04
4.5	2.087E-04	1.085E-04	1.032E-04	1.029E-04	1.512E+01	1.502E+01	1.036E+01	7.551E+00	2.700E-05	9.616E-05
7.5	8.467E-05	4.620E-05	4.417E-05	4.406E-05	8.225E+00	8.215E+00	6.577E+00	5.308E+00	3.245E-05	6.161E-05
15.0	2.389E-05	1.445E-05	1.395E-05	1.392E-05	3.428E+00	3.429E+00	3.142E+00	2.822E+00	3.406E-05	2.999E-05
25.0	9.103E-06	5.927E-06	5.760E-06	5.746E-06	1.687E+00	1.688E+00	1.638E+00	1.566E+00	3.190E-05	1.588E-05
35.0	4.823E-06	3.301E-06	3.220E-06	3.212E-06	1.053E+00	1.053E+00	1.042E+00	1.020E+00	2.967E-05	1.017E-05
45.0	3.008E-06	2.132E-06	2.086E-06	2.080E-06	7.371E-01	7.375E-01	7.351E-01	7.274E-01	2.775E-05	7.200E-06
55.0	2.065E-06	1.513E-06	1.484E-06	1.480E-06	5.585E-01	5.588E-01	5.590E-01	5.561E-01	2.614E-05	5.484E-06
65.0	1.512E-06	1.127E-06	1.107E-06	1.104E-06	4.366E-01	4.369E-01	4.380E-01	4.372E-01	2.472E-05	4.301E-06
75.0	1.157E-06	8.754E-07	8.606E-07	8.585E-07	3.529E-01	3.531E-01	3.544E-01	3.546E-01	2.349E-05	3.483E-06

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	7.740E+03	2.108E+04	2.167E+04	2.167E+04	0.000E+00	2.171E+04	2.171E+04	2.171E+04	1.484E+01
2.5	2.610E+03	8.378E+03	8.635E+03	8.635E+03	0.000E+00	8.657E+03	8.657E+03	8.657E+03	2.015E+01
3.5	1.408E+03	4.326E+03	4.456E+03	4.456E+03	0.000E+00	4.471E+03	4.471E+03	4.471E+03	2.549E+01
4.5	8.811E+02	2.552E+03	2.626E+03	2.626E+03	0.000E+00	2.638E+03	2.638E+03	2.638E+03	2.954E+01
7.5	3.330E+02	8.277E+02	8.495E+02	8.495E+02	0.000E+00	8.560E+02	8.560E+02	8.560E+02	3.535E+01
15.0	8.757E+01	1.743E+02	1.780E+02	1.780E+02	0.000E+00	1.807E+02	1.807E+02	1.807E+02	3.694E+01
25.0	3.210E+01	5.318E+01	5.406E+01	5.406E+01	0.000E+00	5.539E+01	5.539E+01	5.539E+01	3.453E+01
35.0	1.669E+01	2.482E+01	2.514E+01	2.514E+01	0.000E+00	2.598E+01	2.598E+01	2.598E+01	3.209E+01
45.0	1.028E+01	1.420E+01	1.435E+01	1.435E+01	0.000E+00	1.494E+01	1.494E+01	1.494E+01	2.999E+01
55.0	7.000E+00	9.289E+00	9.372E+00	9.372E+00	0.000E+00	9.814E+00	9.814E+00	9.814E+00	2.824E+01
65.0	5.080E+00	6.433E+00	6.478E+00	6.478E+00	0.000E+00	6.824E+00	6.824E+00	6.824E+00	2.670E+01
75.0	3.859E+00	4.712E+00	4.739E+00	4.739E+00	0.000E+00	5.018E+00	5.018E+00	5.018E+00	2.537E+01

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	2.398E-05	2.037E-05	2.017E-05	2.016E-05
2.5	7.874E-06	6.414E-06	6.334E-06	6.374E-06
3.5	4.283E-06	3.669E-06	3.635E-06	3.696E-06
4.5	2.707E-06	2.439E-06	2.424E-06	2.499E-06
7.5	1.046E-06	1.032E-06	1.031E-06	1.126E-06
15.0	2.826E-07	3.052E-07	3.063E-07	4.078E-07
25.0	1.052E-07	1.143E-07	1.148E-07	2.102E-07
35.0	5.508E-08	5.937E-08	5.959E-08	1.485E-07
45.0	3.408E-08	3.626E-08	3.638E-08	1.195E-07
55.0	2.325E-08	2.471E-08	2.479E-08	1.031E-07
65.0	1.690E-08	1.766E-08	1.770E-08	9.184E-08
75.0	1.286E-08	1.324E-08	1.326E-08	8.372E-08

REGION: Sierra Madre Mill   CODE: MILDOS-AREA (03/89)   PAGE 41
METSET: Casper Wyoming   DATA: TESTC1.DAT   04/18/89

TIME STEP NUMBER 5, After 19.5 Years   DURATION IN YRS IS... 8.0

SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 5--DOSES SHOWN ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	7.371E-01	4.951E+00	2.609E+00	1.841E+00	9.131E-01	9.361E+01
GROUND	2.651E-01	2.651E-01	2.651E-01	2.651E-01	2.651E-01	2.651E-01
CLOUD	7.822E-01	7.822E-01	7.822E-01	7.822E-01	7.822E-01	7.822E-01
VEG. ING	5.379E+00	6.430E+01	5.379E+00	1.628E+01	1.355E+01	5.379E+00
MEAT ING	7.389E-01	9.065E+00	7.389E-01	2.356E+00	1.927E+00	7.389E-01
MILK ING	2.102E-01	2.832E+00	2.102E-01	4.187E-01	4.156E-01	2.102E-01
RNPLUS50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTALS	8.112E+00	8.220E+01	9.984E+00	2.195E+01	1.786E+01	1.010E+02

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUND	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CLOUD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
VEG. ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MEAT ING	2.185E+00	2.681E+01	2.185E+00	6.965E+00	5.699E+00	2.185E+00
MILK ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RNPLUS50	1.736E+02	2.361E+03	3.947E+01	1.736E+02	1.736E+02	1.136E+03
TOTALS	1.758E+02	2.388E+03	4.165E+01	1.806E+02	1.793E+02	1.138E+03

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	7.371E-01	4.951E+00	2.609E+00	1.841E+00	9.131E-01	9.361E+01
GROUND	2.651E-01	2.651E-01	2.651E-01	2.651E-01	2.651E-01	2.651E-01
CLOUD	7.822E-01	7.822E-01	7.822E-01	7.822E-01	7.822E-01	7.822E-01
VEG. ING	5.379E+00	6.430E+01	5.379E+00	1.628E+01	1.355E+01	5.379E+00
MEAT ING	2.924E+00	3.587E+01	2.924E+00	9.321E+00	7.626E+00	2.924E+00
MILK ING	2.102E-01	2.832E+00	2.102E-01	4.187E-01	4.156E-01	2.102E-01
RNPLUS50	1.736E+02	2.361E+03	3.947E+01	1.736E+02	1.736E+02	1.136E+03
TOTALS	1.839E+02	2.470E+03	5.163E+01	2.025E+02	1.972E+02	1.239E+03

REGION: Sierra Madre Mill　　CODE: MILDOS-AREA (03/89)　　PAGE 42
METSET: Casper Wyoming　　DATA: TESTC1.DAT　　04/18/89
TIME STEP NUMBER 5, After 19.5 Years　　DURATION IN YRS IS... 8.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

			AIRBORNE CONCENTRATIONS, PCI/M3				GROUND CONCENTRATIONS, PCI/M2			
NO.	NAME	PTSZ	U-238	Th-230	Ra-226	Pb-210	U-238	Th-230	Ra-226	Pb-210
1	Fence Boundary E	1	1.114E-03	1.114E-03	1.114E-03	1.111E-03	3.319E+03	3.319E+03	3.307E+03	3.307E+03
1	Fence Boundary E	2	2.896E-03	1.508E-04	6.033E-06	6.019E-06	8.631E+03	4.495E+02	1.792E+01	1.792E+01
1	Fence Boundary E	3	1.022E-03	1.200E-02	1.258E-02	1.255E-02	2.757E+03	2.891E+04	3.021E+04	3.021E+04
1	Fence Boundary E	4	6.659E-04	1.291E-02	1.356E-02	1.352E-02	1.434E+04	2.657E+05	2.782E+05	2.782E+05
	CONCENTRATION TOTALS		5.698E-03	2.618E-02	2.726E-02	2.719E-02	2.905E+04	2.984E+05	3.118E+05	3.118E+05
2	Fence Boundary SSE	1	3.723E-04	3.723E-04	3.723E-04	3.714E-04	1.109E+03	1.109E+03	1.105E+03	1.105E+03
2	Fence Boundary SSE	2	9.059E-04	4.718E-05	1.887E-06	1.883E-06	2.700E+03	1.406E+02	5.604E+00	5.604E+00
2	Fence Boundary SSE	3	4.705E-04	5.033E-03	5.275E-03	5.262E-03	1.282E+03	1.215E+04	1.269E+04	1.269E+04
2	Fence Boundary SSE	4	3.178E-04	5.877E-03	6.171E-03	6.156E-03	6.903E+03	1.209E+05	1.265E+05	1.265E+05
	CONCENTRATION TOTALS		2.066E-03	1.133E-02	1.182E-02	1.179E-02	1.199E+04	1.343E+05	1.403E+05	1.403E+05
3	Grazing E	1	6.901E-04	6.901E-04	6.901E-04	6.884E-04	2.056E+03	2.056E+03	2.049E+03	2.049E+03
3	Grazing E	2	1.700E-03	8.852E-05	3.541E-06	3.532E-06	5.065E+03	2.638E+02	1.051E+01	1.051E+01
3	Grazing E	3	5.350E-04	4.601E-03	4.816E-03	4.805E-03	1.496E+03	1.137E+04	1.186E+04	1.186E+04
3	Grazing E	4	2.854E-04	4.129E-03	4.332E-03	4.321E-03	6.530E+03	8.680E+04	9.079E+04	9.079E+04
	CONCENTRATION TOTALS		3.210E-03	9.509E-03	9.842E-03	9.818E-03	1.515E+04	1.005E+05	1.047E+05	1.047E+05
4	Grazing ESE	1	3.150E-04	3.150E-04	3.150E-04	3.142E-04	9.385E+02	9.384E+02	9.351E+02	9.351E+02
4	Grazing ESE	2	7.244E-04	3.773E-05	1.509E-06	1.505E-06	2.159E+03	1.124E+02	4.481E+00	4.481E+00
4	Grazing ESE	3	2.640E-04	2.433E-03	2.547E-03	2.541E-03	7.359E+02	6.039E+03	6.301E+03	6.301E+03
4	Grazing ESE	4	1.525E-04	2.251E-03	2.362E-03	2.356E-03	3.491E+03	4.755E+04	4.974E+04	4.974E+04
	CONCENTRATION TOTALS		1.456E-03	5.036E-03	5.226E-03	5.213E-03	7.325E+03	5.464E+04	5.698E+04	5.698E+04
5	Nearest Resident (NN	1	2.143E-04	2.143E-04	2.143E-04	2.138E-04	6.386E+02	6.386E+02	6.363E+02	6.363E+02
5	Nearest Resident (NN	2	4.986E-04	2.597E-05	1.039E-06	1.036E-06	1.486E+03	7.738E+01	3.084E+00	3.084E+00
5	Nearest Resident (NN	3	1.555E-04	1.682E-04	1.688E-04	1.684E-04	5.277E+02	2.034E+03	2.102E+03	2.102E+03
5	Nearest Resident (NN	4	3.186E-05	5.036E-05	5.126E-05	5.116E-05	1.316E+03	1.310E+04	1.364E+04	1.364E+04
	CONCENTRATION TOTALS		9.002E-04	4.588E-04	4.355E-04	4.344E-04	3.969E+03	1.585E+04	1.638E+04	1.638E+04
6	Nearest Res in Pre.	1	6.748E-04	6.748E-04	6.747E-04	6.731E-04	2.011E+03	2.010E+03	2.003E+03	2.003E+03
6	Nearest Res in Pre.	2	1.193E-03	6.215E-05	2.486E-06	2.480E-06	3.556E+03	1.852E+02	7.382E+00	7.382E+00
6	Nearest Res in Pre.	3	4.465E-04	1.396E-03	1.446E-03	1.442E-03	1.371E+03	5.127E+03	5.303E+03	5.303E+03
6	Nearest Res in Pre.	4	2.152E-04	1.019E-03	1.061E-03	1.058E-03	5.845E+03	3.341E+04	3.471E+04	3.471E+04
	CONCENTRATION TOTALS		2.530E-03	3.151E-03	3.184E-03	3.176E-03	1.278E+04	4.073E+04	4.203E+04	4.203E+04

REGION: Sierra Madre Mill   CODE: MILDOS-AREA (03/89)   PAGE 43
METSET: Casper Wyoming   DATA: TESTC1.DAT   04/18/89
TIME STEP NUMBER 5, After 19.5 Years   DURATION IN YRS IS... 8.0

INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER CONCENTRATIONS

	AIRBORNE CONCENTRATIONS, PCI/M3								GROUND CONCENTRATIONS, PCI/M2			
NO.	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	Bi-210	Po-210	WL	Po-218	Pb-214	Bi-214	Pb-210
1	1.144E+03	6.346E+02	9.636E+01	2.318E+01	1.140E-05	7.655E-09	1.606E-13	1.229E-03	5.027E+02	5.027E+02	5.027E+02	1.931E+01
2	3.358E+03	1.500E+03	1.644E+02	3.105E+01	1.432E-05	1.129E-08	3.186E-13	2.494E-03	1.188E+03	1.188E+03	1.188E+03	2.063E+01
3	4.980E+02	3.780E+02	8.780E+01	3.237E+01	3.010E-05	3.620E-08	1.302E-12	9.552E-04	2.994E+02	2.994E+02	2.994E+02	3.911E+01
4	6.565E+02	5.274E+02	1.409E+02	5.040E+01	4.032E-05	4.251E-08	1.375E-12	1.446E-03	4.178E+02	4.178E+02	4.178E+02	5.073E+01
5	4.965E+01	4.605E+01	1.899E+01	9.350E+00	1.360E-05	2.584E-08	1.456E-12	1.786E-04	3.648E+01	3.648E+01	3.648E+01	1.521E+01
6	1.057E+02	9.073E+01	2.888E+01	1.445E+01	2.564E-05	5.683E-08	3.641E-12	2.938E-04	7.186E+01	7.186E+01	7.186E+01	2.938E+01

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 44
METSET: Casper Wyoming DATA: TESTC1.DAT 04/18/89
TIME STEP NUMBER 5, After 19.5 Years DURATION IN YRS IS... 8.0

NUMBER 1 NAME=Fence Boundary E X= 1.6KM, Y= -0.2KM, Z= 8.8M, DIST= 1.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

	U-238	U-234	Th-230	Ra-226	Rn-222(WL)	Pb-210	Bi-210	Po-210
CONC., PCI/M3	5.70E-03	5.70E-03	2.62E-02	2.73E-02	1.23E-03	2.72E-02	2.72E-02	2.72E-02
MPC, PCI/M3	5.00E+00	4.00E+00	8.00E-02	2.00E+00	3.33E-02	4.00E+00	2.00E+02	7.00E+00
FRACTION OF MPC	1.14E-03	1.42E-03	3.27E-01	1.36E-02	3.69E-02	6.80E-03	1.36E-04	3.88E-03

SUM OF FRACTIONS EQUALS 3.91E-01

NUMBER 2 NAME=Fence Boundary SSE X= 1.1KM, Y= -1.6KM, Z= 2.4M, DIST= 1.9KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

	U-238	U-234	Th-230	Ra-226	Rn-222(WL)	Pb-210	Bi-210	Po-210
CONC., PCI/M3	2.07E-03	2.07E-03	1.13E-02	1.18E-02	2.49E-03	1.18E-02	1.18E-02	1.18E-02
MPC, PCI/M3	5.00E+00	4.00E+00	8.00E-02	2.00E+00	3.33E-02	4.00E+00	2.00E+02	7.00E+00
FRACTION OF MPC	4.13E-04	5.17E-04	1.42E-01	5.91E-03	7.49E-02	2.95E-03	5.90E-05	1.68E-03

SUM OF FRACTIONS EQUALS 2.28E-01

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 45
METSET: Casper Wyoming DATA: TESTC1.DAT 04/18/89
TIME STEP NUMBER 5, After 19.5 Years DURATION IN YRS IS... 8.0

NUMBER 3 NAME=Grazing E X= 2.6KM, Y= 0.0KM, Z= 3.7M, DIST= 2.6KM, IRTYPE=10

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	3.91E+01	1.14E+02	1.88E+02	3.96E+01	3.10E+01	0.00E+00
INFANT	GROUND	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01
INFANT	CLOUD	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07
INFANT	VEG. ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MEAT ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	TOTALS	3.95E+01	1.14E+02	1.88E+02	3.99E+01	3.14E+01	3.75E-01

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	1.72E+01	8.17E+01	8.76E+01	1.51E+01	1.01E+01	0.00E+00
CHILD	GROUND	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01
CHILD	CLOUD	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07
CHILD	VEG. ING	1.69E+01	8.56E+01	7.42E+01	7.42E+01	5.54E+01	0.00E+00
CHILD	MEAT ING	2.52E+00	1.27E+01	1.20E+01	1.20E+01	8.89E+00	0.00E+00
CHILD	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	3.70E+01	1.80E+02	1.74E+02	1.02E+02	7.47E+01	3.75E-01

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGE	INHAL.	1.07E+01	9.69E+01	4.53E+01	6.82E+00	5.24E+00	0.00E+00
TEENAGE	GROUND	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01
TEENAGE	CLOUD	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07
TEENAGE	VEG. ING	2.78E+01	4.56E+02	6.61E+01	6.61E+01	5.64E+01	0.00E+00
TEENAGE	MEAT ING	4.00E+00	6.55E+01	1.05E+01	1.05E+01	8.85E+00	0.00E+00
TEENAGE	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	4.29E+01	6.19E+02	1.22E+02	8.38E+01	7.08E+01	3.75E-01

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
ADULT	INHAL.	9.30E+00	8.53E+01	3.75E+01	5.22E+00	3.72E+00	0.00E+00
ADULT	GROUND	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01	3.75E-01
ADULT	CLOUD	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07	8.68E-07
ADULT	VEG. ING	1.58E+01	1.93E+02	4.31E+01	4.31E+01	3.59E+01	0.00E+00
ADULT	MEAT ING	2.92E+00	3.60E+01	8.69E+00	8.69E+00	7.15E+00	0.00E+00
ADULT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	2.84E+01	3.15E+02	8.96E+01	5.74E+01	4.71E+01	3.75E-01

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 46
METSET: Casper Wyoming DATA: TESTC1.DAT 04/18/89
TIME STEP NUMBER 5, After 19.5 Years DURATION IN YRS IS... 8.0

NUMBER 3 NAME=Grazing E X= 2.6KM, Y= 0.0KM, Z= 3.7M, DIST= 2.6KM, IRTYPE=10

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	7.65E+01	1.14E+02	1.88E+02	3.96E+01	3.11E+01	6.22E+02
INFANT	GROUND	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01
INFANT	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
INFANT	VEG. ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MEAT ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	TOTALS	9.61E+01	1.33E+02	2.08E+02	5.92E+01	5.06E+01	6.42E+02
AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	5.46E+01	8.17E+01	8.76E+01	1.52E+01	1.01E+01	6.22E+02
CHILD	GROUND	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01
CHILD	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
CHILD	VEG. ING	1.69E+01	8.57E+01	7.42E+01	7.42E+01	5.54E+01	0.00E+00
CHILD	MEAT ING	2.52E+00	1.27E+01	1.20E+01	1.20E+01	8.89E+00	0.00E+00
CHILD	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	9.3[illegible]+01	2.00E+02	1.93E+02	1.21E+02	9.40E+01	6.42E+02
AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGE	INHAL.	4.81E+01	9.69E+01	4.53E+01	6.83E+00	5.24E+00	6.22E+02
TEENAGE	GROUND	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01
TEENAGE	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
TEENAGE	VEG. ING	2.78E+01	4.56E+02	6.61E+01	6.61E+01	5.64E+01	0.00E+00
TEENAGE	MEAT ING	4.00E+00	6.55E+01	1.05E+01	1.05E+01	8.85E+00	0.00E+00
TEENAGE	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	9.95E+01	6.38E+02	1.42E+02	1.03E+02	9.01E+01	6.42E+02
AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
ADULT	INHAL.	4.66E+01	8.53E+01	3.75E+01	5.23E+00	3.73E+00	6.22E+02
ADULT	GROUND	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01	1.91E+01
ADULT	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
ADULT	VEG. ING	1.58E+01	1.93E+02	4.31E+01	4.31E+01	3.59E+01	0.00E+00
ADULT	MEAT ING	2.92E+00	3.60E+01	8.69E+00	8.69E+00	7.16E+00	0.00E+00
ADULT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	8.50E+01	3.34E+02	1.09E+02	7.66E+01	6.64E+01	6.42E+02

C.6 LISTING OF TEST PROBLEM TESTC2.DAT

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JC=1,0,1,2*0,2*1,0,1,0,
FRADON=0.86,0.06,0.04,0.04,
IPACT=3*0,1,2,3,4*0,
NSORCE=6,
PACT=11.4,17.1,22.8,271.0,407.0,542.5,284.4,427.1,570.0,284.4,427.1,570.0,
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 1.0,2*1.502,2*2.004,5*0.0,  1.0,2*1.502,2*2.004,5*0.0,
 1.0,2*1.502,2*2.004,5*0.0,  1.0,2*1.502,2*2.004,5*0.0,
 0.3,1.0,8*0.0,  2*1.0,4*.007,4*0.0,
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 3*0.0,2*0.3,5*0.0,     3*0.0,2*1.0,0.004,4*0.0,
 80*0.0,
SORCE=
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 2*0.40,6.0,0.16,4*4.084E-2,1089.74,1201,3.0,0.0,
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FPR=320,1400,230,
IPOP=
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IADD=6,
XRECEP=
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 1.08,-1.6,2.4,
 2.56,0.0,3.7,
 2.584,-0.89,-1.4,
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 2.168,2.168,10.2,
NSTEP=6,TSTART=1980,TSTEP=2.25,2.0,2.25,5.0,8.0,5.0,4*0.0,
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PTSZ=1.5,3.0,7.7,54.0,0.3,
PTSZFC=0.0,1.0,2*0.0,1.0,5*0.0,0.3,0.7,
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Sierra Madre Mill            Casper Wyoming
Yellowcake Stack
Ore Pad
Grizzly Dump-Hopper
Tailings Area 1
Tailings Area 2
Tailings Area 3
Fence Boundary E
Fence Boundary SSE
Grazing E
Grazing ESE
```

```
Nearest Resident (NNW)
Nearest Res in Pre. Windr.
After 2.25 Years
After 4.25 Years
After 6.50 Years
After 11.5 Years
After 19.5 Years
After 24.5 Years
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 NEX=2, NEY=2,
 VERTX=
   1203.9,785.9,1582.1,785.9,1203.9,1164.1,1582.1,1164.1,
 &END
 &NWAREA
 NEX=2, NEY=2,
 VERTX=
  -1559.8,-1103.8,-1040.2,-1103.8,-1559.8,-584.2,-1040.2,-584.2,
 &END
 &NWAREA
 NEX=0, NAS=5, NNODE=13,
 NODE=
   1,2,3,4,3,4,5,6,5,6,9,10,7,8,11,12,8,10,12,13,
 XS=
   .12E4,.16E4,.12E4,.16E4,.12E4,.16E4,.20E3,.80E3,.12E4,.16E4,.60E3,
   .80E3,.10E4,
 YS=
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 &END
```

C.7 SELECTED OUTPUT FROM TEST PROBLEM TESTC2.DAT

REGION: Sierra Madre Mill   CODE: MILDOS-AREA (03/89)   PAGE 1
METSET: Casper Wyoming   DATA: TESTC2.DAT   04/18/89

TABLE OF CONTENTS

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 2
METSET: Casper Wyoming DATA: TESTC2.DAT 04/18/89
JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.05734,0.21073,0.28176,0.26134,0.13153,0.05734

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	0.0069	0.0240	0.0103	0.0240	0.0171	0.0103	0.0069	0.0411	0.0137	0.0206	0.0240	0.0240	0.0377	0.0171	0.0206	0.0103	0.3086
5.5	0.0137	0.0274	0.0206	0.0069	0.0137	0.0206	0.0137	0.0617	0.0069	0.0206	0.0069	0.0274	0.0548	0.0343	0.0000	0.0206	0.3498
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0206	0.0514	0.0309	0.0309	0.0308	0.0309	0.0206	0.1028	0.0206	0.0412	0.0309	0.0514	0.0925	0.0514	0.0206	0.0309	0.6584
STABILITY CLASS 2																	
1.5	0.0554	0.0507	0.0374	0.0421	0.0960	0.0424	0.0665	0.0651	0.0977	0.0410	0.0618	0.0445	0.1126	0.0402	0.0208	0.0644	0.9386
5.5	0.0959	0.1233	0.0685	0.0411	0.1233	0.1165	0.1302	0.1165	0.2124	0.1028	0.1576	0.1370	0.1370	0.0959	0.0548	0.1096	1.8224
10.0	0.0685	0.0617	0.0685	0.0411	0.0617	0.0206	0.0548	0.0274	0.0548	0.0685	0.0822	0.1096	0.1781	0.0685	0.0754	0.0822	1.1236
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.2198	0.2357	0.1744	0.1243	0.2810	0.1795	0.2515	0.2090	0.3649	0.2123	0.3016	0.2911	0.4277	0.2046	0.1510	0.2562	3.8846
STABILITY CLASS 3																	
1.5	0.0186	0.0133	0.0115	0.0118	0.0366	0.0186	0.0127	0.0037	0.0282	0.0186	0.0186	0.0292	0.0179	0.0273	0.0320	0.0028	0.3014
5.5	0.0959	0.1370	0.0959	0.1028	0.1781	0.0959	0.1233	0.0822	0.1507	0.0959	0.0959	0.1713	0.2398	0.1302	0.0754	0.0617	1.9320
10.0	0.2535	0.1850	0.1576	0.1713	0.2329	0.1918	0.1233	0.0822	0.1233	0.1987	0.3699	0.6439	0.4727	0.2261	0.1644	0.1576	3.7542
15.5	0.0274	0.0137	0.0137	0.0137	0.0343	0.0343	0.0137	0.0000	0.0343	0.0959	0.2055	0.1713	0.1918	0.0343	0.0411	0.0685	0.9935
21.5	0.0000	0.0069	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0137	0.0069	0.0343	0.0343	0.0411	0.0206	0.0000	0.0000	0.1578
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0069	0.0137	0.0069	0.0000	0.0000	0.0000	0.0275
ALL	0.3954	0.3559	0.2787	0.2996	0.4819	0.3406	0.2730	0.1681	0.3502	0.4160	0.7311	1.0637	0.9702	0.4385	0.3129	0.2906	7.1664
STABILITY CLASS 4																	
1.5	0.0792	0.1053	0.0854	0.0741	0.0598	0.0592	0.0548	0.0268	0.0548	0.0336	0.0411	0.0530	0.0679	0.0816	0.0430	0.1009	1.0205
5.5	0.5412	0.5823	0.4453	0.3220	0.4110	0.3220	0.1918	0.1302	0.1918	0.1233	0.2055	0.3357	0.3357	0.2398	0.1439	0.4521	4.9736
10.0	1.1440	1.4249	1.0207	0.8768	0.9248	0.4932	0.3014	0.1370	0.2124	0.6302	1.4180	2.1304	1.7468	0.5412	0.5206	0.5001	14.0225
15.5	1.1097	1.4865	1.0275	0.6508	1.0001	0.5480	0.1987	0.0548	0.3699	3.0826	6.5420	5.1993	1.9318	0.9453	0.5891	0.4042	25.1403
21.5	0.2809	0.3768	0.1713	0.0617	0.2261	0.0822	0.0411	0.0137	0.1781	2.6716	5.0075	2.2126	0.9248	0.4042	0.2398	0.1028	12.9952
28.0	0.1028	0.1028	0.0274	0.0000	0.0137	0.0069	0.0000	0.0000	0.0411	1.4797	2.2469	0.9727	0.5206	0.1165	0.0411	0.0343	5.7065
ALL	3.2578	4.0786	2.7776	1.9854	2.6355	1.5115	0.7878	0.3625	1.0481	8.0210	15.4610	10.9037	5.5276	2.3286	1.5775	1.5944	63.8586
STABILITY CLASS 5																	
1.5	0.3723	0.1668	0.1431	0.1104	0.1608	0.1124	0.0635	0.0583	0.1221	0.1124	0.1448	0.2996	0.5746	0.2607	0.2023	0.2606	3.1647
5.5	1.1098	0.8974	0.6439	0.5480	0.6234	0.3563	0.3083	0.1919	0.3014	0.3152	0.5275	1.2741	2.0140	0.9865	0.9042	0.9933	11.9952
10.0	0.3425	0.3014	0.2809	0.2877	0.4042	0.3083	0.1165	0.0480	0.0548	0.4042	1.0892	2.8223	1.9044	0.4042	0.2466	0.2603	9.2755
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	1.8246	1.3656	1.0679	0.9461	1.1884	0.7770	0.4883	0.2982	0.4783	0.8318	1.7615	4.3960	4.4930	1.6514	1.3531	1.5142	24.4354
STABILITY CLASS 6																	
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	5.7182	6.0872	4.3295	3.3863	4.6176	2.8395	1.8212	1.1406	2.2621	9.5223	18.2861	16.7059	11.5110	4.6745	3.4151	3.6863	100.0034

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INDIVIDUAL RECEPTOR LOCATION DATA, 6 LOCATIONS INPUT THIS RUN

I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE	I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE
1	Fence Boundary E	1.60	-0.20	8.80	1.61	0	4	Grazing ESE	2.58	-0.89	-1.40	2.73	10
2	Fence Boundary SSE	1.08	-1.60	2.40	1.93	0	5	Nearest Resident (NW	-0.45	1.47	12.30	1.53	10
3	Grazing E	2.56	0.00	3.70	2.56	10	6	Nearest Res in Pre.	2.17	2.17	10.20	3.07	10

MISCELLANEOUS INPUTABLE PARAMETER VALUES

DMM	DMA	TSTART	FFORI	FHAYI	FFORP	FHAYP	FPR(1)	FPR(2)	FPR(3)	ACTRAT
150.0	1550.0	1980.00	0.50	0.50	0.50	0.50	320.00	1400.00	230.00	2.50

IPACT EQUALS 0, 0, 0, 1, 2, 3,

JC EQUALS 1, 0, 1, 0, 0, 1, 1, 0, 1, 0

TIME STEP DATA....

	STEP NAMES	LENGTH, YRS	IFTODO
1	After 2.25 Years	2.25	0
2	After 4.25 Years	2.00	0
3	After 6.50 Years	2.25	0
4	After 11.5 Years	5.00	0
5	After 19.5 Years	8.00	1
6	After 24.5 Years	5.00	1

XRHO EQUALS 1.5, 2.5, 3.5, 4.5, 7.5, 15.0, 25.0, 35.0, 45.0, 55.0, 65.0, 75.0,

HDP EQUALS 50.0

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POPULATION DISTRIBUTION

KILOMETERS	N 0.0	NNE 22.5	NE 45.0	ENE 67.5	E 90.0	ESE 112.5	SE 135.0	SSE 157.5	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
1.0- 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0- 3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0- 4.0	1	2	1	3	2	1	1	2	4	3	1	3	2	1	2	3
4.0- 5.0	5	3	2	0	1	3	0	0	2	1	3	0	2	1	1	1
5.0-10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0-20.0	15	14	1	0	3	0	1	0	1	1	2	1	0	3	0	0
20.0-30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.0-40.0	0	40	15	10	1	4	2	0	0	25	8	9	0	4	5	0
40.0-50.0	4	27	14	8	3	2	0	1	10	4	27	6	3	0	0	1
50.0-60.0	8	10	4	1	0	0	0	0	0	0	0	0	0	0	0	0
60.0-70.0	14	300	800	327	50	0	0	0	17	254	322	145	89	0	0	0
70.0-80.0	400	250	97	655	422	0	0	25893	37372	0	0	0	0	0	427	1000
1.0-80.0	447	646	934	1004	482	10	4	25896	37406	288	363	164	96	9	435	1005

TOTAL 1-80 KM POPULATION IS 69189 PERSONS

FINITE ELEMENT DATA FOR SOURCE NO. 4:   IPX= 1 ID= 5001

VERTEX (M) = 1.2039E+03 7.8590E+02 1.5821E+03 7.8590E+02 1.2039E+03 1.1641E+03 1.5821E+03 1.1641E+03

AREA SOURCE ELEMENT NO. =	1	NODES= 1	4	2	5
AREA SOURCE ELEMENT NO. =	2	NODES= 2	5	3	6
AREA SOURCE ELEMENT NO. =	3	NODES= 4	7	5	8
AREA SOURCE ELEMENT NO. =	4	NODES= 5	8	6	9

NODAL COORDINATES (M):

NODE NO. =	1	XS= 1.2039E+03	YS= 7.8590E+02
NODE NO. =	2	XS= 1.2039E+03	YS= 9.7500E+02
NODE NO. =	3	XS= 1.2039E+03	YS= 1.1641E+03
NODE NO. =	4	XS= 1.3930E+03	YS= 7.8590E+02
NODE NO. =	5	XS= 1.3930E+03	YS= 9.7500E+02
NODE NO. =	6	XS= 1.3930E+03	YS= 1.1641E+03
NODE NO. =	7	XS= 1.5821E+03	YS= 7.8590E+02
NODE NO. =	8	XS= 1.5821E+03	YS= 9.7500E+02
NODE NO. =	9	XS= 1.5821E+03	YS= 1.1641E+03

FINITE ELEMENT DATA FOR SOURCE NO. 5: IPX= 2 ID= 5002

VERTEX (M) = -1.5598E+03 -1.1038E+03 -1.0402E+03 -1.1038E+03 -1.5598E+03 -5.8420E+02 -1.0402E+03 -5.8420E+02

AREA SOURCE ELEMENT NO. = 1	NODES=	1	4	2	5
AREA SOURCE ELEMENT NO. = 2	NODES=	2	5	3	6
AREA SOURCE ELEMENT NO. = 3	NODES=	4	7	5	8
AREA SOURCE ELEMENT NO. = 4	NODES=	5	8	6	9

NODAL COORDINATES (M):

NODE NO. = 1	XS= -1.5598E+03	YS= -1.1038E+03
NODE NO. = 2	XS= -1.5598E+03	YS= -8.4400E+02
NODE NO. = 3	XS= -1.5598E+03	YS= -5.8420E+02
NODE NO. = 4	XS= -1.3000E+03	YS= -1.1038E+03
NODE NO. = 5	XS= -1.3000E+03	YS= -8.4400E+02
NODE NO. = 6	XS= -1.3000E+03	YS= -5.8420E+02
NODE NO. = 7	XS= -1.0402E+03	YS= -1.1038E+03
NODE NO. = 8	XS= -1.0402E+03	YS= -8.4400E+02
NODE NO. = 9	XS= -1.0402E+03	YS= -5.8420E+02

FINITE ELEMENT DATA FOR SOURCE NO. 6: IPX= 3 ID= 5003

AREA SOURCE ELEMENT NO. =	1	NODES=	1	2	3	4
AREA SOURCE ELEMENT NO. =	2	NODES=	3	4	5	6
AREA SOURCE ELEMENT NO. =	3	NODES=	5	6	9	10
AREA SOURCE ELEMENT NO. =	4	NODES=	7	8	11	12
AREA SOURCE ELEMENT NO. =	5	NODES=	8	10	12	13

NODAL COORDINATES (M):

NODE NO. =	1	XS= 1.2000E+03	YS= -2.2000E+03
NODE NO. =	2	XS= 1.6000E+03	YS= -1.8000E+03
NODE NO. =	3	XS= 1.2000E+03	YS= -1.6000E+03
NODE NO. =	4	XS= 1.6000E+03	YS= -1.6000E+03
NODE NO. =	5	XS= 1.2000E+03	YS= -1.2000E+03
NODE NO. =	6	XS= 1.6000E+03	YS= -1.2000E+03
NODE NO. =	7	XS= 2.0000E+02	YS= -8.0000E+02
NODE NO. =	8	XS= 8.0000E+02	YS= -8.0000E+02
NODE NO. =	9	XS= 1.2000E+03	YS= -8.0000E+02
NODE NO. =	10	XS= 1.6000E+03	YS= -8.0000E+02
NODE NO. =	11	XS= 6.0000E+02	YS= -4.0000E+02
NODE NO. =	12	XS= 8.0000E+02	YS= -4.0000E+02
NODE NO. =	13	XS= 1.0000E+03	YS= -4.0000E+02

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NUMBER OF SOURCES= 6

NO.	KM X	KM Y	M Z	KM2 AREA	U-238	Th-230	CI/YEAR Ra-226	Pb-210	Rn-222	ID	PSIZE SET	M/SEC EXIT VEL	SOURCE NAME
1	0.00	0.00	20.00	0.0000	4.14E-02	2.16E-03	8.62E-05	8.62E-05	0.00E+00	1101	1	1.70E+01	Yellowcake Stack
2	0.40	0.40	6.00	0.1600	4.08E-02	4.08E-02	4.08E-02	4.08E-02	1.09E+03	1201	3	0.00E+00	Ore Pad
3	0.20	0.20	0.00	0.0000	2.60E-02	2.60E-02	2.60E-02	2.60E-02	4.16E+01	1301	2	0.00E+00	Grizzly Dump-Hopper
4	1.39	0.98	-10.00	0.1430	5.67E-03	1.35E-01	1.41E-01	1.41E-01	1.28E+03	5001	3	0.00E+00	Tailings Area 1
5	-1.30	-0.84	-10.00	0.2700	1.61E-02	3.82E-01	4.01E-01	4.01E-01	3.64E+03	5002	3	0.00E+00	Tailings Area 2
6	1.09	-0.98	-10.00	0.8400	6.66E-02	1.58E+00	1.67E+00	1.67E+00	1.51E+04	5003	3	0.00E+00	Tailings Area 3

INPUT TAILS ACTIVITIES, PCI/G

SET	URANIUM	THORIUM	RADIUM	LEAD
1	1.14E+01	2.71E+02	2.84E+02	2.84E+02
2	1.71E+01	4.07E+02	4.27E+02	4.27E+02
3	2.28E+01	5.43E+02	5.70E+02	5.70E+02

AMAD AND FRACTIONAL DISTRIBUTION

SET	1.5	3.0	7.7	54.0
1	0.000	1.000	0.000	0.000
2	1.000	0.000	0.000	0.000
3	0.000	0.000	0.300	0.700

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 6 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 2.25YRS	TSTEP 2 2.00YRS	TSTEP 3 2.25YRS	TSTEP 4 5.00YRS	TSTEP 5 8.00YRS	TSTEP 6 5.00YRS	TSTEP 7 0.00YRS	TSTEP 8 0.00YRS	TSTEP 9 0.00YRS	TSTEP10 0.00YRS
1	1.000E+00	1.500E+00	1.500E+00	2.000E+00	2.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	3.000E-01	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5	0.000E+00	3.000E-01	3.000E-01	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6	0.000E+00	0.000E+00	0.000E+00	3.000E-01	3.000E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 6 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 2.25YRS	TSTEP 2 2.00YRS	TSTEP 3 2.25YRS	TSTEP 4 5.00YRS	TSTEP 5 8.00YRS	TSTEP 6 5.00YRS	TSTEP 7 0.00YRS	TSTEP 8 0.00YRS	TSTEP 9 0.00YRS	TSTEP10 0.00YRS
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	1.000E+00	1.000E+00	7.000E-03	7.000E-03	7.000E-03	7.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5	0.000E+00	1.000E+00	1.000E+00	1.000E+00	5.000E-03	5.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6	0.000E+00	0.000E+00	0.000E+00	1.000E+00	1.000E+00	4.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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TIME STEP NUMBER 5, After 19.5 Years   DURATION IN YRS IS... 8.0

CONCENTRATION DATA FOR THE N DIRECTION, THETA EQUALS 0.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	1.391E-03	8.375E-04	8.082E-04	8.063E-04	5.565E+01	5.090E+01	2.034E+01	9.642E+00	1.334E-05	1.915E-04
2.5	5.608E-04	2.901E-04	2.758E-04	2.751E-04	2.819E+01	2.740E+01	1.491E+01	8.982E+00	1.833E-05	1.373E-04
3.5	3.205E-04	1.640E-04	1.558E-04	1.554E-04	1.972E+01	1.946E+01	1.226E+01	8.339E+00	2.334E-05	1.133E-04
4.5	2.087E-04	1.081E-04	1.028E-04	1.025E-04	1.500E+01	1.490E+01	1.029E+01	7.510E+00	2.716E-05	9.555E-05
7.5	8.466E-05	4.603E-05	4.399E-05	4.388E-05	8.192E+00	8.183E+00	6.561E+00	5.301E+00	3.265E-05	6.147E-05
15.0	2.388E-05	1.444E-05	1.394E-05	1.390E-05	3.438E+00	3.440E+00	3.153E+00	2.834E+00	3.434E-05	3.010E-05
25.0	9.103E-06	5.936E-06	5.769E-06	5.755E-06	1.698E+00	1.699E+00	1.649E+00	1.577E+00	3.222E-05	1.599E-05
35.0	4.823E-06	3.310E-06	3.230E-06	3.222E-06	1.062E+00	1.062E+00	1.050E+00	1.028E+00	3.000E-05	1.026E-05
45.0	3.008E-06	2.139E-06	2.093E-06	2.088E-06	7.440E-01	7.445E-01	7.421E-01	7.343E-01	2.807E-05	7.268E-06
55.0	2.066E-06	1.519E-06	1.490E-06	1.486E-06	5.640E-01	5.644E-01	5.645E-01	5.616E-01	2.645E-05	5.538E-06
65.0	1.512E-06	1.132E-06	1.112E-06	1.109E-06	4.412E-01	4.415E-01	4.425E-01	4.418E-01	2.502E-05	4.346E-06
75.0	1.158E-06	8.795E-07	8.648E-07	8.627E-07	3.568E-01	3.570E-01	3.583E-01	3.585E-01	2.378E-05	3.521E-06

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	7.740E+03	2.108E+04	2.167E+04	2.167E+04	0.000E+00	2.171E+04	2.171E+04	2.171E+04	1.512E+01
2.5	2.610E+03	8.381E+03	8.638E+03	8.638E+03	0.000E+00	8.660E+03	8.660E+03	8.660E+03	2.033E+01
3.5	1.408E+03	4.323E+03	4.453E+03	4.453E+03	0.000E+00	4.468E+03	4.468E+03	4.468E+03	2.564E+01
4.5	8.810E+02	2.548E+03	2.622E+03	2.622E+03	0.000E+00	2.634E+03	2.634E+03	2.634E+03	2.969E+01
7.5	3.329E+02	8.261E+02	8.478E+02	8.478E+02	0.000E+00	8.543E+02	8.543E+02	8.543E+02	3.554E+01
15.0	8.756E+01	1.741E+02	1.779E+02	1.779E+02	0.000E+00	1.806E+02	1.806E+02	1.806E+02	3.721E+01
25.0	3.210E+01	5.322E+01	5.410E+01	5.410E+01	0.000E+00	5.544E+01	5.544E+01	5.544E+01	3.483E+01
35.0	1.669E+01	2.487E+01	2.519E+01	2.519E+01	0.000E+00	2.603E+01	2.603E+01	2.603E+01	3.239E+01
45.0	1.029E+01	1.424E+01	1.439E+01	1.439E+01	0.000E+00	1.498E+01	1.498E+01	1.498E+01	3.028E+01
55.0	7.001E+00	9.315E+00	9.400E+00	9.400E+00	0.000E+00	9.847E+00	9.847E+00	9.847E+00	2.853E+01
65.0	5.080E+00	6.454E+00	6.500E+00	6.500E+00	0.000E+00	6.850E+00	6.850E+00	6.850E+00	2.698E+01
75.0	3.860E+00	4.729E+00	4.756E+00	4.756E+00	0.000E+00	5.039E+00	5.039E+00	5.039E+00	2.564E+01

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	2.398E-05	2.038E-05	2.018E-05	2.017E-05
2.5	7.874E-06	6.427E-06	6.347E-06	6.388E-06
3.5	4.283E-06	3.657E-06	3.622E-06	3.684E-06
4.5	2.706E-06	2.424E-06	2.408E-06	2.484E-06
7.5	1.046E-06	1.025E-06	1.024E-06	1.120E-06
15.0	2.825E-07	3.045E-07	3.057E-07	4.080E-07
25.0	1.052E-07	1.145E-07	1.149E-07	2.113E-07
35.0	5.509E-08	5.956E-08	5.980E-08	1.496E-07
45.0	3.408E-08	3.642E-08	3.654E-08	1.207E-07
55.0	2.325E-08	2.483E-08	2.491E-08	1.042E-07
65.0	1.690E-08	1.776E-08	1.780E-08	9.282E-08
75.0	1.286E-08	1.332E-08	1.334E-08	8.465E-08

REGION: Sierra Madre Mill   CODE: MILDOS-AREA (03/89)   PAGE 41
METSET: Casper Wyoming   DATA: TESTC2.DAT   04/18/89

TIME STEP NUMBER 5, After 19.5 Years   DURATION IN YRS IS... 8.0

SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 5--DOSES SHOWN ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	7.426E-01	5.003E+00	2.613E+00	1.866E+00	9.254E-01	9.518E+01
GROUND	2.689E-01	2.689E-01	2.689E-01	2.689E-01	2.689E-01	2.689E-01
CLOUD	7.939E-01	7.939E-01	7.939E-01	7.939E-01	7.939E-01	7.939E-01
VEG. ING	4.877E+00	5.825E+01	4.877E+00	1.478E+01	1.236E+01	4.877E+00
MEAT ING	6.719E-01	8.235E+00	6.719E-01	2.145E+00	1.758E+00	6.719E-01
MILK ING	1.913E-01	2.565E+00	1.913E-01	3.809E-01	3.843E-01	1.913E-01
RNPLUS50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTALS	7.545E+00	7.512E+01	9.415E+00	2.024E+01	1.649E+01	1.020E+02

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUND	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CLOUD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
VEG. ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MEAT ING	1.987E+00	2.435E+01	1.987E+00	6.342E+00	5.197E+00	1.987E+00
MILK ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RNPLUS50	1.760E+02	2.393E+03	4.000E+01	1.760E+02	1.760E+02	1.151E+03
TOTALS	1.779E+02	2.418E+03	4.199E+01	1.823E+02	1.812E+02	1.153E+03

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	7.426E-01	5.003E+00	2.613E+00	1.866E+00	9.254E-01	9.518E+01
GROUND	2.689E-01	2.689E-01	2.689E-01	2.689E-01	2.689E-01	2.689E-01
CLOUD	7.939E-01	7.939E-01	7.939E-01	7.939E-01	7.939E-01	7.939E-01
VEG. ING	4.877E+00	5.825E+01	4.877E+00	1.478E+01	1.236E+01	4.877E+00
MEAT ING	2.659E+00	3.258E+01	2.659E+00	8.486E+00	6.955E+00	2.659E+00
MILK ING	1.913E-01	2.565E+00	1.913E-01	3.809E-01	3.843E-01	1.913E-01
RNPLUS50	1.760E+02	2.393E+03	4.000E+01	1.760E+02	1.760E+02	1.151E+03
TOTALS	1.855E+02	2.493E+03	5.140E+01	2.025E+02	1.976E+02	1.255E+03

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 42
METSET: Casper Wyoming DATA: TESTC2.DAT 04/18/89
TIME STEP NUMBER 5, After 19.5 Years DURATION IN YRS IS... 8.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

			AIRBORNE CONCENTRATIONS, PCI/M3				GROUND CONCENTRATIONS, PCI/M2			
NO.	NAME	PTSZ	U-238	Th-230	Ra-226	Pb-210	U-238	Th-230	Ra-226	Pb-210
1	Fence Boundary E	1	1.114E-03	1.114E-03	1.114E-03	1.111E-03	3.319E+03	3.319E+03	3.307E+03	3.307E+03
1	Fence Boundary E	2	2.896E-03	1.508E-04	6.033E-06	6.019E-06	8.631E+03	4.495E+02	1.792E+01	1.792E+01
1	Fence Boundary E	3	7.833E-04	6.321E-03	6.614E-03	6.598E-03	2.205E+03	1.578E+04	1.645E+04	1.645E+04
1	Fence Boundary E	4	3.875E-04	6.286E-03	6.597E-03	6.581E-03	8.753E+03	1.327E+05	1.388E+05	1.388E+05
	CONCENTRATION TOTALS		5.181E-03	1.387E-02	1.433E-02	1.430E-02	2.291E+04	1.522E+05	1.586E+05	1.586E+05
2	Fence Boundary SSE	1	3.723E-04	3.723E-04	3.723E-04	3.714E-04	1.109E+03	1.109E+03	1.105E+03	1.105E+03
2	Fence Boundary SSE	2	9.059E-04	4.718E-05	1.887E-06	1.883E-06	2.700E+03	1.406E+02	5.604E+00	5.604E+00
2	Fence Boundary SSE	3	4.689E-04	4.994E-03	5.233E-03	5.220E-03	1.278E+03	1.206E+04	1.259E+04	1.259E+04
2	Fence Boundary SSE	4	3.148E-04	5.807E-03	6.097E-03	6.083E-03	6.844E+03	1.195E+05	1.251E+05	1.251E+05
	CONCENTRATION TOTALS		2.062E-03	1.122E-02	1.170E-02	1.168E-02	1.193E+04	1.328E+05	1.388E+05	1.388E+05
3	Grazing E	1	6.901E-04	6.901E-04	6.901E-04	6.884E-04	2.056E+03	2.056E+03	2.049E+03	2.049E+03
3	Grazing E	2	1.700E-03	8.852E-05	3.541E-06	3.532E-06	5.065E+03	2.638E+02	1.051E+01	1.051E+01
3	Grazing E	3	5.292E-04	4.465E-03	4.673E-03	4.662E-03	1.482E+03	1.105E+04	1.153E+04	1.153E+04
3	Grazing E	4	2.808E-04	4.021E-03	4.219E-03	4.208E-03	6.439E+03	8.464E+04	8.853E+04	8.853E+04
	CONCENTRATION TOTALS		3.200E-03	9.265E-03	9.586E-03	9.562E-03	1.504E+04	9.801E+04	1.021E+05	1.021E+05
4	Grazing ESE	1	3.150E-04	3.150E-04	3.150E-04	3.142E-04	9.385E+02	9.384E+02	9.351E+02	9.351E+02
4	Grazing ESE	2	7.244E-04	3.773E-05	1.509E-06	1.505E-06	2.159E+03	1.124E+02	4.481E+00	4.481E+00
4	Grazing ESE	3	3.100E-04	3.525E-03	3.695E-03	3.686E-03	8.421E+02	8.564E+03	8.947E+03	8.947E+03
4	Grazing ESE	4	1.991E-04	3.359E-03	3.526E-03	3.518E-03	4.427E+03	6.981E+04	7.306E+04	7.306E+04
	CONCENTRATION TOTALS		1.548E-03	7.238E-03	7.538E-03	7.520E-03	8.366E+03	7.942E+04	8.295E+04	8.295E+04
5	Nearest Resident (NN	1	2.143E-04	2.143E-04	2.143E-04	2.138E-04	6.386E+02	6.386E+02	6.363E+02	6.363E+02
5	Nearest Resident (NN	2	4.986E-04	2.597E-05	1.039E-06	1.036E-06	1.486E+03	7.738E+01	3.084E+00	3.084E+00
5	Nearest Resident (NN	3	1.555E-04	1.695E-04	1.703E-04	1.698E-04	5.278E+02	2.037E+03	2.106E+03	2.106E+03
5	Nearest Resident (NN	4	3.190E-05	5.151E-05	5.247E-05	5.237E-05	1.317E+03	1.312E+04	1.366E+04	1.366E+04
	CONCENTRATION TOTALS		9.003E-04	4.613E-04	4.381E-04	4.371E-04	3.970E+03	1.587E+04	1.641E+04	1.641E+04
6	Nearest Res in Pre.	1	6.748E-04	6.748E-04	6.747E-04	6.731E-04	2.011E+03	2.010E+03	2.003E+03	2.003E+03
6	Nearest Res in Pre.	2	1.193E-03	6.215E-05	2.486E-06	2.480E-06	3.556E+03	1.852E+02	7.382E+00	7.382E+00
6	Nearest Res in Pre.	3	4.441E-04	1.337E-03	1.384E-03	1.381E-03	1.365E+03	4.991E+03	5.160E+03	5.160E+03
6	Nearest Res in Pre.	4	2.130E-04	9.669E-04	1.007E-03	1.004E-03	5.801E+03	3.237E+04	3.362E+04	3.362E+04
	CONCENTRATION TOTALS		2.525E-03	3.041E-03	3.068E-03	3.060E-03	1.273E+04	3.956E+04	4.079E+04	4.079E+04

REGION: Sierra Madre Mill CODE: MILDOS-AREA (03/89) PAGE 43
METSET: Casper Wyoming DATA: TESTC2.DAT 04/18/89
TIME STEP NUMBER 5, After 19.5 Years DURATION IN YRS IS... 8.0

INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER CONCENTRATIONS

	AIRBORNE CONCENTRATIONS, PCI/M3								GROUND CONCENTRATIONS, PCI/M2			
NO.	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	Bi-210	Po-210	WL	Po-218	Pb-214	Bi-214	Pb-210
1	8.745E+02	5.656E+02	1.035E+02	2.693E+01	1.412E-05	1.026E-08	2.389E-13	1.208E-03	4.480E+02	4.480E+02	4.480E+02	2.185E+01
2	3.753E+03	1.277E+03	1.301E+02	2.731E+01	1.429E-05	1.193E-08	3.390E-13	2.076E-03	1.011E+03	1.011E+03	1.011E+03	2.060E+01
3	4.507E+02	3.445E+02	8.383E+01	3.202E+01	3.084E-05	3.811E-08	1.405E-12	8.993E-04	2.729E+02	2.729E+02	2.729E+02	3.980E+01
4	6.858E+02	5.247E+02	1.293E+02	4.485E+01	3.605E-05	3.962E-08	1.376E-12	1.363E-03	4.156E+02	4.156E+02	4.156E+02	4.674E+01
5	5.001E+01	4.635E+01	1.912E+01	9.435E+00	1.418E-05	2.871E-08	1.758E-12	1.799E-04	3.671E+01	3.671E+01	3.671E+01	1.576E+01
6	1.045E+02	8.994E+01	2.909E+01	1.476E+01	2.703E-05	6.206E-08	4.138E-12	2.952E-04	7.124E+01	7.124E+01	7.124E+01	3.067E+01

REGION: Sierra Madre Mill   CODE: MILDOS-AREA (03/89)   PAGE 44
METSET: Casper Wyoming   DATA: TESTC2.DAT   04/18/89
TIME STEP NUMBER 5, After 19.5 Years   DURATION IN YRS IS... 8.0

NUMBER 1 NAME=Fence Boundary E   X= 1.6KM, Y= -0.2KM, Z= 8.8M, DIST= 1.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

	U-238	U-234	Th-230	Ra-226	Rn-222(WL)	Pb-210	Bi-210	Po-210
CONC., PCI/M3	5.18E-03	5.18E-03	1.39E-02	1.43E-02	1.21E-03	1.43E-02	1.43E-02	1.43E-02
MPC, PCI/M3	5.00E+00	4.00E+00	8.00E-02	2.00E+00	3.33E-02	4.00E+00	2.00E+02	7.00E+00
FRACTION OF MPC	1.04E-03	1.30E-03	1.73E-01	7.17E-03	3.63E-02	3.58E-03	7.15E-05	2.04E-03

SUM OF FRACTIONS EQUALS 2.25E-01

NUMBER 2 NAME=Fence Boundary SSE   X= 1.1KM, Y= -1.6KM, Z= 2.4M, DIST= 1.9KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

	U-238	U-234	Th-230	Ra-226	Rn-222(WL)	Pb-210	Bi-210	Po-210
CONC., PCI/M3	2.06E-03	2.06E-03	1.12E-02	1.17E-02	2.08E-03	1.17E-02	1.17E-02	1.17E-02
MPC, PCI/M3	5.00E+00	4.00E+00	8.00E-02	2.00E+00	3.33E-02	4.00E+00	2.00E+02	7.00E+00
FRACTION OF MPC	4.12E-04	5.15E-04	1.40E-01	5.85E-03	6.23E-02	2.92E-03	5.84E-05	1.67E-03

SUM OF FRACTIONS EQUALS 2.14E-01

REGION: Sierra Madre Mill　　CODE: MILDOS-AREA (03/89)　　PAGE 45
METSET: Casper Wyoming　　DATA: TESTC2.DAT　　04/18/89
TIME STEP NUMBER 5, After 19.5 Years　　DURATION IN YRS IS... 8.0

NUMBER 3 NAME=Grazing E　　X= 2.6KM, Y= 0.0KM, Z= 3.7M, DIST= 2.6KM, IRTYPE=10

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	3.85E+01	1.11E+02	1.87E+02	3.85E+01	3.02E+01	0.00E+00
INFANT	GROUND	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01
INFANT	CLOUD	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07
INFANT	VEG. ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MEAT ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	TOTALS	3.89E+01	1.11E+02	1.87E+02	3.89E+01	3.06E+01	3.66E-01

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	1.70E+01	7.98E+01	8.69E+01	1.47E+01	9.85E+00	0.00E+00
CHILD	GROUND	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01
CHILD	CLOUD	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07
CHILD	VEG. ING	1.65E+01	8.34E+01	7.22E+01	7.22E+01	5.39E+01	0.00E+00
CHILD	MEAT ING	2.45E+00	1.23E+01	1.17E+01	1.17E+01	8.66E+00	0.00E+00
CHILD	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	3.63E+01	1.76E+02	1.71E+02	9.90E+01	7.28E+01	3.66E-01

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGE	INHAL.	1.06E+01	9.46E+01	4.50E+01	6.64E+00	5.10E+00	0.00E+00
TEENAGE	GROUND	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01
TEENAGE	CLOUD	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07
TEENAGE	VEG. ING	2.71E+01	4.44E+02	6.44E+01	6.44E+01	5.49E+01	0.00E+00
TEENAGE	MEAT ING	3.90E+00	6.38E+01	1.02E+01	1.02E+01	8.62E+00	0.00E+00
TEENAGE	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	4.19E+01	6.03E+02	1.20E+02	8.16E+01	6.90E+01	3.66E-01

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
ADULT	INHAL.	9.15E+00	8.33E+01	3.72E+01	5.08E+00	3.63E+00	0.00E+00
ADULT	GROUND	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01
ADULT	CLOUD	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07	8.52E-07
ADULT	VEG. ING	1.54E+01	1.88E+02	4.20E+01	4.20E+01	3.50E+01	0.00E+00
ADULT	MEAT ING	2.84E+00	3.51E+01	8.46E+00	8.46E+00	6.97E+00	0.00E+00
ADULT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	2.78E+01	3.07E+02	8.80E+01	5.59E+01	4.59E+01	3.66E-01

REGION: Sierra Madre Mill   CODE: MILDOS-AREA (03/89)   PAGE 46
METSET: Casper Wyoming   DATA: TESTC2.DAT   04/18/89
TIME STEP NUMBER 5, After 19.5 Years   DURATION IN YRS IS... 8.0

NUMBER 3 NAME=Grazing E   X= 2.6KM, Y= 0.0KM, Z= 3.7M, DIST= 2.6KM, IRTYPE=10

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	7.23E+01	1.11E+02	1.87E+02	3.86E+01	3.03E+01	5.63E+02
INFANT	GROUND	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01
INFANT	CLOUD	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01
INFANT	VEG. ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MEAT ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INFANT	TOTALS	9.14E+01	1.30E+02	2.06E+02	5.77E+01	4.93E+01	5.82E+02

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	5.08E+01	7.98E+01	8.69E+01	1.48E+01	9.86E+00	5.63E+02
CHILD	GROUND	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01
CHILD	CLOUD	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01
CHILD	VEG. ING	1.65E+01	8.34E+01	7.23E+01	7.23E+01	5.40E+01	0.00E+00
CHILD	MEAT ING	2.45E+00	1.23E+01	1.17E+01	1.17E+01	8.66E+00	0.00E+00
CHILD	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	8.88E+01	1.95E+02	1.90E+02	1.18E+02	9.16E+01	5.82E+02

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGE	INHAL.	4.44E+01	9.46E+01	4.50E+01	6.65E+00	5.11E+00	5.63E+02
TEENAGE	GROUND	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01
TEENAGE	CLOUD	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01
TEENAGE	VEG. ING	2.71E+01	4.44E+02	6.44E+01	6.44E+01	5.49E+01	0.00E+00
TEENAGE	MEAT ING	3.90E+00	6.39E+01	1.02E+01	1.02E+01	8.62E+00	0.00E+00
TEENAGE	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	9.44E+01	6.22E+02	1.39E+02	1.00E+02	8.78E+01	5.82E+02

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ADULT	GROUND	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01	1.87E+01
ADULT	CLOUD	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01	4.23E-01
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ADULT	MILK ING	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	8.03E+01	3.26E+02	1.07E+02	7.46E+01	6.47E+01	5.82E+02

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