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MILDOS - A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations

Prepared by D. L. Strenge, T. J. Bander

Pacific Northwest Laboratory
Operated by
Battelle Memorial Institute

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Prepared by
D. L. Strenge, T. J. Bander

Pacific Northwest Laboratory
Richland, WA 99352

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Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
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PREFACE

The computer program MILDOS was designed as a primary licensing and evaluation tool and is expected to provide basic input to critical licensing, regulatory and policy decisions. The current version of MILDOS was developed from version IV of the Argonne National Laboratory (ANL) computer program UDAD, (Uranium Dispersion And Dosimetry). Version IX of UDAD is documented as NUREG/CR-0553 (Momeni et al. 1979). The preparation of MILDOS was performed by staff of the Nuclear Regulatory Commission under the direction of Giorgio Gnugnoli and Dan Martin. The models and assumptions on which the MILDOS program is based are described in the U.S. Nuclear Regulatory Commission Draft Regulatory Guide RH 802-4 (USNRC 1979) and portions of the UDAD document. The user is encouraged to be familiar with the mathematical models to aid in preparation of input as detailed in Section 2.

A copy of the MILDOS program can be obtained from USNRC using the request form provided on page v, accompanied with a blank computer tape. The tape will be returned containing the MILDOS program and a sample problem. A listing of the code, and sample problem input and output will also be included.

This form should be mailed along with the reel of tape to:

James A. Shields
Mail Stop P-624
U.S. Nuclear Regulatory Commission
Washington, DC 20555

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

REQUEST FOR THE MILDOS CODE

This form should be used to request a copy of the U.S. Nuclear Regulatory Commission's MILDOS computer code for radiological impact evaluation. Please provide the following information in order to facilitate distribution:

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Organization: ______________________________

Requestor's Address: ______________________________

Date of Request: ______________________________

This request must be accompanied by a 2400-foot reel of magnetic tape. Unless otherwise requested, the tape will be written as follows:

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-- 80 characters per record

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If a different format is required, please indicate it below:

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The charge for processing this request is fifty-one dollars ($51.00) including postage. An additional charge of ten dollars ($10.00) should be remitted, if Express Mail return is desired. Please indicate below whether Express Mail return is desired. For requests outside the continental United States, any additional postage or customs fees must be paid by the requestor. Payment may be in the form of a check or purchase order made to the order of the U. S. Nuclear Regulatory Commission.

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ABSTRACT

The MILDOS Computer Code estimates impacts from radioactive emissions from uranium milling facilities. These impacts are presented as dose commitments to individuals and the regional population within an 80 km radius of the facility. Only airborne releases of radioactive materials are considered: releases to surface water and to groundwater are not addressed in MILDOS. This code is multi-purposed and can be used to evaluate population doses for NEPA assessments, maximum individual doses for predictive 40 CFR 190 compliance evaluations, or maximum offsite air concentrations for predictive evaluations of 10 CFR 20 compliance.

Emissions of radioactive materials from fixed point source locations and from area sources are modeled using a sector-averaged Gaussian plume dispersion model, which utilizes user-provided wind frequency data. Mechanisms such as deposition of particulates, resuspension, radioactive decay and ingrowth of daughter radionuclides are included in the transport model. Annual average air concentrations are computed, from which subsequent impacts to humans through various pathways are computed. Ground surface concentrations are estimated from deposition buildup and ingrowth of radioactive daughters. The surface concentrations are modified by radioactive decay, weathering and other environmental processes. The MILDOS Computer Code allows the user to vary the emission sources as a step function of time by adjusting the emission rates, which includes shutting them off completely. Thus the results of a computer run can be made to reflect changing processes throughout the facility's operational lifetime.

The pathways considered for individual dose commitments and for population impacts are:

- Inhalation
- External exposure from ground concentrations
- External exposure from cloud immersion
- Ingestion of vegetables
- Ingestion of meat
- Ingestion of milk.

Dose commitments are calculated using dose conversion factors, which are ultimately based on recommendations of the International Commission on Radiological Protection (ICRP). These factors are fixed internally in the code, and are not part of the input option.

Dose commitments which are available from the code are as follows:

- Individual dose commitments for use in predictive 40 CFR 190 compliance evaluations (Radon and short-lived daughters are excluded)

- Total individual dose commitments (impacts from all available radionuclides are considered)

- Annual population dose commitments (regional, extraregional, total and cummulative).

This model is primarily designed for uranium mill facilities, and should not be used for operations with different radionuclides or processes.

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

This report describes the use of the computer program MILDOS for the purpose of calculating doses to humans resulting from uranium milling activities. It is used by the staff of the Nuclear Regulatory Commission to perform routine radiological impact and compliance evaluations for various uranium recovery operations. The present MILDOS code was developed as an outgrowth of the staff's work with version IV of the Uranium Dispersion and Dosimetry (UDAD) code developed by Argonne National Laboratory. An expanded version of the code, version IX of UDAD, is documented as NUREG/CR-0553 (Momeni et al. 1979). MILDOS uses the dispersion models of UDAD IV to determine the incremental normalized concentrations due to each source and radionuclide as a function of the meteorology. The total concentrations and dose determinations have been rewritten from that of UDAD IV to reflect the NRC's requirements.

Models are included in MILDOS to consider both point sources (stacks, vents) and area sources (ore pads, tailings areas). Release of particulates are limited to consideration of ^{238}U, ^{230}Th, ^{226}Ra and ^{210}Pb. Other radionuclides are implicitly accounted for under the secular equilibrium assumption. Gaseous releases are limited to consideration of ^{222}Rn plus ingrowth of daughters. Exposure pathways of concern are assumed to be inhalation of airborne radioactive material, ingestion of vegetables, meat and milk contaminated via deposition, and external exposure to radiation emitted by airborne activity and activity deposited on ground surfaces. Liquid exposure pathways are not treated by the MILDOS code.

The dose to exposed individuals is calculated for comparison with requirements of both 40 CFR Part 190 and 10 CFR Part 20.

The Environmental Protection Agency (EPA) regulation, 40 CFR Part 190, addresses individual radiation doses from all pathways and all nuclear fuel cycle facilities combined, except exposure from radon and its daughters is excluded. The regulation 10 CFR Part 20 states that all radiation exposure be kept "as low as reasonably achievable" (ALARA). For ALARA evaluations all releases, including radon and its daughters, are considered for calculation of population doses as well as individual doses. Population doses are calculated for the region (within 80 km) of the mill center, and for the continental U.S. (from radon and its daughters only). A summary of the models and doses considered by MILDOS are described in Section 2.

The remainder of the report gives information on the computer program including input preparation, a sample problem and program design information.

2.0 PROGRAM DESCRIPTION

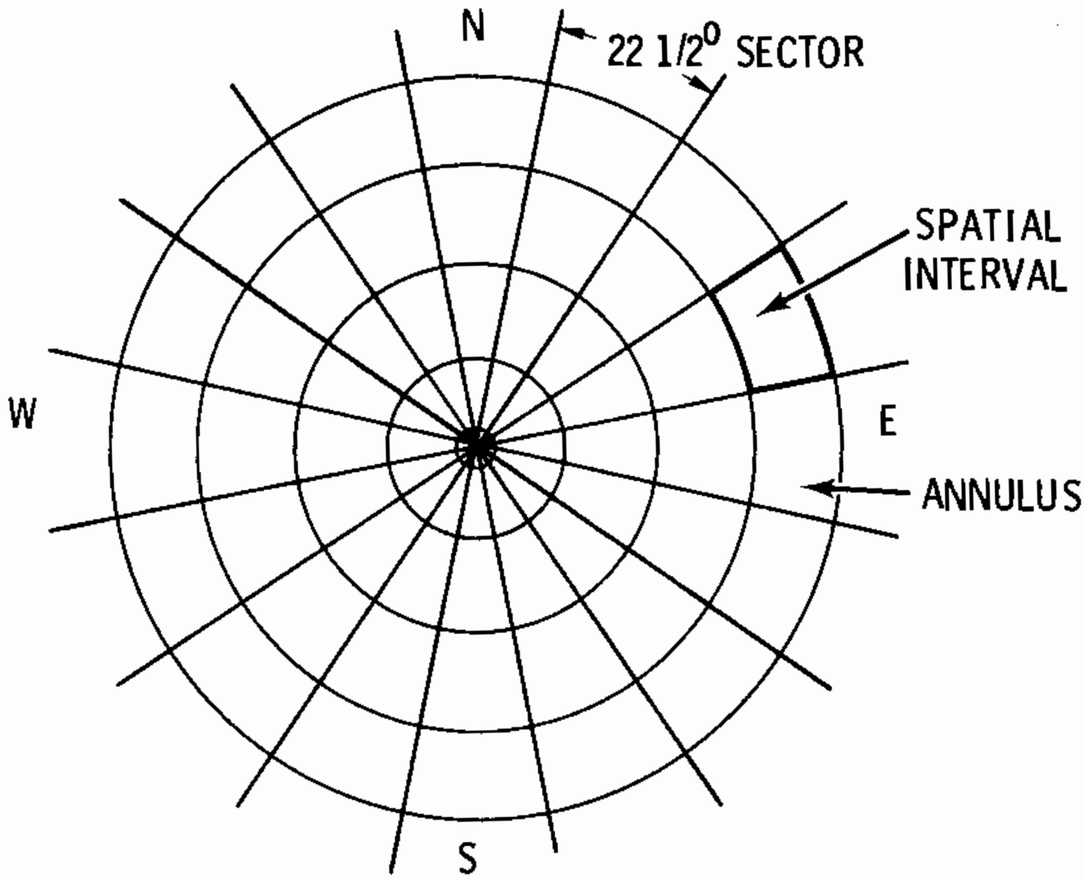
This section describes the purpose of the computer program MILDOS and the mathematical models used. The program calculates radiation exposure to individual and the population from releases of particulates and gases from uranium milling operations.

The physical description of the mill site includes a grid of twelve concentric distance intervals (within 80 km) and sixteen angular intervals based on the sixteen compass directions (N, NNE, etc.). Figure 2.0-1 illustrates the grid system and nomenclature. The mill center is at the center of the grid. Source and receptor locations are defined relative to the mill center by specifying distances on a cartesian grid with east represented by the positive abscissa and north by the positive ordinate. The elevation with reference to the mill center is also defined.

2.1 Source Description

Sources can be defined by the user to represent each significant radionuclide release point for the mill under consideration. The locations of the radiation sources are defined relative to the mill center on the cartesian grid system mentioned above. Typical sources include yellowcake stacks, crushers, grinders, conveyers, rod mills, fine ore blending, tailings areas and ore pads. Radionuclide releases are defined for each source for particulates and radon gas. The ^{238}U decay chain is assumed to be the only significant source of radiation for uranium milling operations. The contribution from the ^{235}U chains is less than 5% of that from the ^{238}U chain. Particulate releases are defined to include the radionuclides ^{238}U, ^{230}Th, ^{226}Ra and ^{210}Pb. The gaseous releases are defined for ^{222}Rn with ingrowth of short-lived daughter products also considered. These ^{222}Rn daughters include ^{218}Po, ^{214}Pb, ^{214}Bi, ^{210}Pb and ^{210}Po. The dosimetry model accounts for releases and ingrowth of other radionuclides using assumptions of secular equilbrium.

The time history of release for each source is defined for the life of the mill and post operational periods. Typically, a uranium mill will operate for a period of years during which there will be radon and particulate releases from the ore storage pile, the mill itself, and the tailings disposal area. During this operational period releases from tailings areas can be limited by wetting the piles to inhibit air suspension by wind action. Upon completion of the actual milling operation, the tailings pile is normally allowed to dry by natural evaporation until it is ready for stabilization. During this period there are essentially no releases from the ore pad or the mill. However, as the tailings pile dries radon and particulate releases from this source may increase, reaching a maximum prior to stabilization. After stabilization and reclamation of the tailings area, there should be no further particulate releases. However, small quantities of radon may continue to be released to the atmosphere for long periods.



(FACILITY AT CENTER OF GRID)

FIGURE 2.0-1 Population Dose Grid System Definition

2.2 Atmospheric Transport and Diffusion

Models for dispersion, transport, deposition and resuspension of particulates and gases in the atmosphere are given in this section. Wind suspension of tailings dust is considered as a potential source of airborne contamination. The vertical flux rate from area sources is calculated by MILDOS using the UDAD model. This model calculates the vertical flux as a function of windspeed, surface roughness, tailings density, average tailing grain diameter and tailings water content.

The equations for calculation of wind suspension of tailings material are as follows, where the vertical and horizontal flux are for particles smaller than 20 μm in diameter.

$$q_v = q_h \left(\frac{C_v}{C_h}\right) \frac{1}{u_{*t}^3} \left[\left(\frac{U*}{U_{*t}}\right)^{(p/3)} -1 \right] \qquad (2.2\text{-}1)$$

where

q_v • vertical flux of particulate material, gm $m^{-2}sec^{-1}$

q_h • horizontal flux of particulate material, gm $m^{-1}sec^{-1}$

C_v • coefficient of proportionality for vertical flux, $2x10^{-6}$ gm $m^{-2}sec^{-1}$

C_h • empirical constant to relate shear velocity to horizontal flux, 10^2 gm $m^{-4}sec^2$

$u*$ • shear velocity, m sec^{-1}

u_{*t} • threshold shear velocity, m sec^{-1}

p • percent of tailing mass that has a diameter smaller than 20 μm

The values of C_V and C_h are those given by Gillette (1973). The wind velocity profile near the surface is described by Bagnold (1941) as:

$$u_z = 2.5\ u_* \ln \left(\frac{z}{z_o}\right) \qquad (2.2\text{-}2)$$

where

u_z • wind velocity at height z, m sec^{-1}
z • height at which wind is measured, m
z_0 • characteristics surface roughness height, m

In calculating the shear velocity $u*$, the ratio (z/z_0) is assumed to be constant and equal to 100.

The threshold shear velocity for the initiation of saltation is given by the following expression (Bagnold, 1941) as modified by Belly (1964) to consider the influence of moisture.

$$u_{*t} = C_t \sqrt{\frac{\rho_s - \rho}{\rho}\ gd}\ (1.8 + 0.6 \log_{10} W) \qquad (2.2\text{-}3)$$

where

C_t • dimensionless coefficient of 0.1 in value

ρ_s • density of particle, gm m^{-3}

ρ • density of air, gm m^{-3}

g • gravitational acceleration, m sec^{-2}

d • average diameter of saltating particle, m

W • water content expressed in weight percent

The horizontal flux is calculated by the following equation proposed by Lettan and reported by Gillette (1973)

$$q_h = C_h u_*^2 (u_* - u_{*t}) \quad (2.2\text{-}4)$$

For u_* less than u_{*t}, the horizontal flux is taken to be zero.

The radioactivity of radionuclide i released from the tailings surface, E_i (pCi per year), is dependent on the wind speeds, their frequency of occurrence, and the total tailings area:

$$E_i = A \sum_u f_u q_v(u) \frac{I_{20}}{F_{20}} (3.156 \times 10^7 \frac{sec}{yr}) \quad (2.2\text{-}5)$$

where

A • tailings area, m^2

f_u • frequency of wind speed u

$q_v(u)$ • vertical flux for wind speed, u, gm m^{-2} sec^{-1}

I_{20} • specific activity of radionuclide i with diameter less than 20 µm, pCi gm^{-1}

F_{20} • activity fraction of suspended particulates less than 20 µm in diameter

The specific activity for particles with diameter less than 20 µm is obtained from the bulk specific activity for all particles times an activity ratio factor, which MILOOS assumes to be 2.5.

The parameter values for estimating particulate flux from tailings piles are given in Table 2.2-1.

TABLE 2.2-1. Particulate Release Rate Parameters

Parameter	Value Used
z_0	1 cm
ρ_s	2.4 gm cm^{-3}
d	0.03 cm
W	0.1
p	3.0
F_{20}	0.5

The specific activity, I_{20}, is computed based on inputed values of bulk specific activity for each radionucide and an activity ratio of 2.5.

Atmospheric dispersion of effluents is modeled using the straight line crosswind-integrated Gaussian dispersion model. The ground level air concentration at a receptor which is downwind a distance x and crosswind a distance y for a pollutant i from a source j is given by:

$$\chi(x,y,i,j,s) = \frac{Q(i,j,y,s)}{\sqrt{\pi/2}\ \sigma_z \bar{u}\ (\pi x/8)} \exp\left(- \frac{h^2}{2\ \sigma_z^2}\right) \tag{2.2-6}$$

where

$\chi(x,y,i,j,s)$ • ground level air concentration, Ci m^{-3}

x • downwind distance, m

y • crosswind distance, m

i • pollutant i

j • source j

s • particle size

Q(i,j,y,s) • emission rate, Ci sec-1

σ_z • vertical standard deviation of plume concentration, m

$\bar{u}$ • average windspeed, m sec^{-1}

h • effective height of plume centerline, m

$\pi x/8$ • sector width at distance x, m

The vertical dispersion, σ_z, as a function of downwind distance x is calculated using the following empirical expression (Briggs 1974; Gifford 1976).

$$\sigma_z = (ax)\ (1 + bx)^c \qquad (2.2\text{-}7)$$

The constants, a, b, and c are given in Table 2.2-2 as a function of atmospheric stability. For distances less than 100 meters from source to receptor the value of σ_z at 100 meters is used.

The effect of mixing layer height on dispersion is considered only for unstable and neutral conditions (Pasquill A-D), as stable conditions limit the plume dispersion in the vertical direction. Equation 2.2-7 is used to calculate vertical dispersion out to a downwind distance x_L, at which σ_z = 0.47L, where L is the vertical distance from the ground to the base of the stable atmosphere layer (mixing layer height). At the base of the stable layer, the concentration of the radionuclide will be one-tenth of that at the plume centerline, for the distance x_L. At distances between x_L and $2x_L$, the concentration (for non-stable conditions) is determined by a linear interpolation between Equation 2.2-6 and Equation 2.2-8.

$$\chi(x,i,j) = \frac{Q(i,j)}{\frac{\pi}{8}\ x\ L\ \bar{u}} \qquad (2.2\text{-}8)$$

where

L • mixing layer height.

TABLE 2.2-2. Stability Class Parameters for Equation 2.2-7

Stability Class	Pasquill Type	a	b	c
1 Extremely unstable	A	0.20	0.0	1.0
2 Moderately unstable	B	0.12	0.0	1.0
3 Slightly unstable	C	0.08	0.0002	-0.5
4 Neutral	D	0.06	0.0015	-0.5
5 Moderately stable	E	0.03	0.0003	-1.0
6 Very stable	F	0.016	0.0003	-1.0

The mixing layer height L varies greatly with the season, day to day, and also diurnally. An estimate of mixing height for a given location can be made from figures presented in Holsworth 1972. The annual average height for the mixing layer L can be estimated from:

$$\frac{1}{L} = \frac{1}{2}\left(\frac{1}{L_{AM}} + \frac{1}{L_{PM}}\right) \quad (2.2\text{-}9)$$

where

L_{AM} • mean annual morning mixing height, m

L_{PM} • mean annual afternoon mixing height, m

The average annual mixing layer is provided by the user or a default value of 1000 meters is used. For downwind distances greater than $2x_L$, Equation 2.2-8 is used to calculate concentrations.

The six wind speed categories have the following averages in miles per hour: 1.5, 5.5, 10.0, 15.5, 21.5, and 28.0.

The effective plume height, h, takes into account plume rise due to effluent momentum from a stack or vent and also vertical movement due to particle settling. The rise due to momentum is based on the model of Holland (1953):

$$h_m = 1.5 \frac{VD}{\bar{u}} \quad (2.2\text{-}10)$$

where

V • effluent exit velocity, m sec^{-1}

D • inside diameter of stack, m

$\bar{u}$ • average windspeed, m sec^{-1}

The vertical settling is based on a "tilted plume model" where the downward movement of the plume is given by:

$$h_v = \frac{x\ V_s}{\bar{u}} \quad (2.2\text{-}11)$$

where V_s is the settling velocity and is calculated from:

$$V_s(m/s) = 3x10^{-5}\ \rho_s d^2 \quad (2.2\text{-}12)$$

where

d • particle diameter, m

ρ_s • density of particle, gm cm^{-3}

For settling velocities less than 0.01 meter per second, the vertical settling is ignored. The effective plume height is thus:

$$h = h_s + h_m - h_v - h_r \qquad (2.2\text{-}13)$$

where

h_s • stack height above mill center, m

h_r • elevation of receptor above mill center (negative if below mill center), m

For population exposure calculations within 80 km, the concentrations are evaluated at the midpoint of each spatial interval, and applies to all points within that sector, see Figure 2.0-1. However for individual receptor locations the concentration is weighted by the distance from the midline of the sector. This is calculated by adjusting the source strength to be:

$$Q(i,j,y) = \frac{(\frac{\pi}{8} x - y)}{\frac{\pi}{8} x} Q(i,j,o) \qquad (2.2\text{-}14)$$

Thus any receptor within 22-1/2° (one sector width) in either direction from the centerline of the wind direction sector receives some concentration. All other receptors receive zero. Area sources are given an additional lateral dispersion by using a "virtual point source" method. The size of the area source is provided by the user in km^2 and is then converted to a square source of equivalent area. The distance to the "virtual point", taken upwind from the area source is calculated by:

$$X_{vp} = \frac{8}{\pi} S \qquad (2.2\text{-}15)$$

where

S • length of the side of an equivalent square source

This distance is added to the downwind distance when calculating the sector width, see Figure 2.2-1. It is recommended by the NRC that area sources larger than 0.1 km^2 be partitioned into area sources of size less than or equal 0.1 km^2. This limits the virtual point source distance to 0.8 km or less.

For receptors that cannot "see" the entire area source, a correction factor is applied. This factor is the ratio of that portion of the square source area within the 22.5 degree sector located upwind from the receptor (assuming the receptor is on the centerline of the sector) to that of the total source area, see Figure 2.2-1.

Multiplying the concentrations by the fractional joint frequency of occurrence of wind speed, wind direction, and atmospheric stability factors in the meteorology at the site, the annual average concentration at receptor k for pollutant i from all sources j is calculated from:

$$<\chi(i,k)> = \sum_j \sum_f f\chi(x,y,i,j) \qquad (2.2\text{-}16)$$

where

f • fractional joint frequency of occurrence by wind speed, wind direction, and atmospheric stability

Plume depletion due to ground deposition is also incorporated in the calculations. This deposition is estimated using an effective deposition velocity for each particle size class. The deposition rate has been empirically defined by Chamberlain (1953) as:

$$\dot{w}_s = <\chi(s)> V_d(s) \qquad (2.2\text{-}17)$$

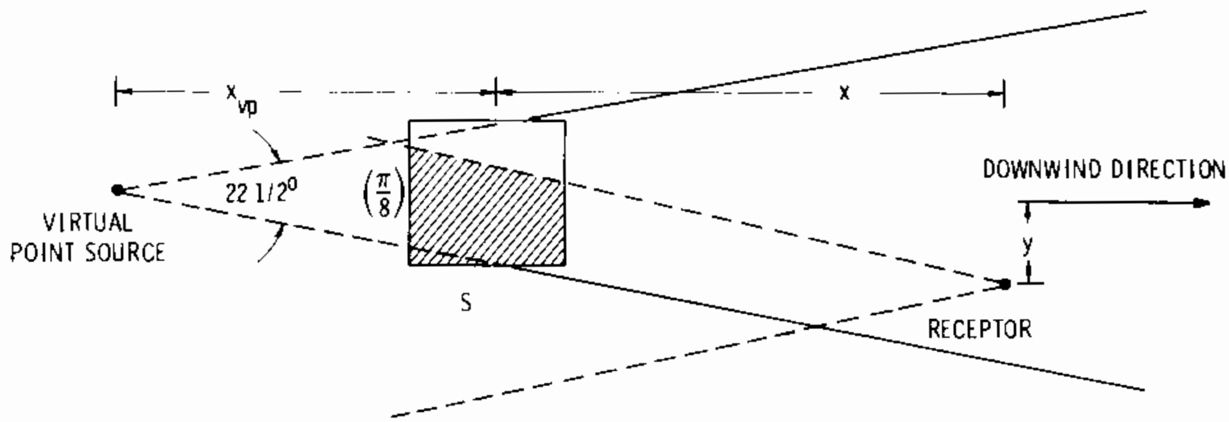
where

$\dot{w}_s$ • deposition rate, Ci $m^{-2}sec^{-1}$

$<\chi(s)>$ • average air concentration of particles of size s, Ci m^{-3}

$V_d(s)$ • deposition velocity for particles of size s, m sec^{-1}

For particles with settling velocities less than 0.01 m sec^{-1}, the deposition velocity is set to 0.01 m sec^{-1}. For particles with settling velocities greater than 0.01 m sec^{-1}, the deposition velocity is assumed equal to the calculated settling velocity, see Equation 2.2-12. Table 2.2-3 defines the particle size categories used in MILDOS and indicates the radionuclide particle size combinations for which air concentrations are explicitly computed.



S^2 • AREA SOURCE (km^2)

x_{vp} • DISTANCE FROM CENTER OF AREA SOURCE TO VIRTUAL POINT SOURCE

x • DOWNWIND DISTANCE TO RECEPTOR

y • CROSSWING DISTANCE TO RECEPTOR

Figure 2.2-1. Area Source as "Seen" by Receptor

The decrease in source strength due to deposition is calculated using Chamberlain (1953). For unstable and neutral atmospheric stability the calculations are divided into the same distance intervals as the concentration calculations, Equation 2.2-6 and 2.2-8.

$$Q(x) = Q(o) \exp \left[\left(-\frac{V_d}{u} \right) F_1(o,x) \right] \quad \text{for } x \le x_1 \qquad (2.2\text{-}18)$$

$$Q(x) = Q(o) \exp \left\{ \left(-\frac{V_d}{u} \right) \left[F_1(o,x_L) + F_2(x_L, x) + \frac{(x-x_L)^2}{2x_L\ L} \right] \right\}$$

$$\text{for } x_L < x \le 2x_L \qquad (2.2\text{-}19)$$

$$Q(x) = Q(o) \exp \left\{ \left(-\frac{V_d}{u} \right) \left[F_1(o,x_L) + F_2\ (x_L,\ 2x_L) + \frac{X_L}{2L} + \frac{x-2x_L}{L} \right] \right\}$$

$$\text{for } x > 2x_L \qquad (2.2\text{-}20)$$

where

$$F_1\ (x_1,x_2) = \int_{x_1}^{x_2} \frac{\exp \left[-\frac{1}{2} \left(\frac{h}{\sigma_z} \right)^2 \right]}{\sigma_z} dx \qquad (2.2\text{-}21)$$

TABLE 2.2-3. Particle Size Category Characteristics and Isotope-Particle Size Combinations for Which Air Concentrations are Explicitly Computed

Particle Size Category (p)*	Diameter Range, μm	Mean Diameter, μm	Density gm cm^{-3}
1	--	1.0	8.9
2	--	1.0	2.4
3	1 to 10	5.0	2.4
4	10 to 80	35.0	2.4
5	--	--	--

Isotope-Particle Size Combinations**

i	Isotope (i)	p = 1	p = 2	p = 3	p = 4	p = 5
1	U-238	CE	CE	CE	CE	--
2	Th-234	se	se	se	se	--
3	Pa-234	se	se	se	se	--
4	U-234	se	se	se	se	--
5	Th-230	CE	CE	CE	CE	--
6	Ra-226	CE	CE	CE	CE	--
7	Rn-222***	se	se	se	se	--
8	Po-218	se	se	se	se	CE
9	Pb-214	se	se	se	se	CE
10	Bi-214	se	se	s3	se	CE
11	Po-214	se	se	se	se	se
12	Pb-210	CE	CE	CE	CE	CE
13	Bi-210	se	se	se	se	CE
14	Po-210	se	se	se	se	CE

* In this analysis particle size groups are assigned to effluents as follows: p=1 for yellowcake dust; p=2 for fugitive ore dust; p=3 (30 percent) and p=4 (70 percent) for fugitive tailings dust; and p=5 for air ingrowth concentrations of Rn-222 particulate daughters.

** The entry "CE" denotes "calculated explicitly." The entry "se" denotes "secular equilibrium" in which case the air concentration of the indicated isotope, in the particular size category, is assumed to be identical to that of the first parent for which it is explicitly calculated.

*** The air concentration of Rn-222 is also computed; Rn-222 is an inert gas and no particle size is assigned.

$$F_2(x_1,x_2) = \int_{x_1}^{x_2} \frac{(2x_L - x)}{\sigma_z x_L} \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right] dx \qquad (2.2\text{-}22)$$

and

$Q(o)$ • source strength at $x = o$

$Q(x)$ • source strength at x

For stable conditions equation 2.2-18 is used to calculate the effective source strength. The integrals F_1 and F_2 are evaluated numerically using the fourth Newton-Cotes closed integration formula (see Section A.3.3).

With suspension of previously deposited material (resuspension) is considered as a potentially significant exposure pathway. The air concentration due to resuspension is calculated using a time dependent and particle dependent resuspension factor, which, for deposits of age t years, is defined by:

$$R_s(t) = \left(\frac{0.01}{V_d(s)}\right) 10^{-5} \exp(-\lambda_R t) \text{ for } t \le 1.82 \text{ yr} \qquad (2.2\text{-}23)$$

$$R_s(t) = \left(\frac{0.01}{V_d(s)}\right) 10^{-9} \text{ for } t > 1.82 \text{ yr} \qquad (2.2\text{-}24)$$

where

$R_s(t)$ • ratio of the resuspended air concentration to the ground concentration, at t years after deposition, m^{-1}

$\frac{0.01}{V_d(s)}$ • ratio of minimum deposition velocity, 0.01 m sec^{-1} to deposition velocity of particle size s

10^{-5} • initial resuspension value, m^{-1}

λ_R • assumed decay constant of resuspension factor, 5.06 yr^{-1} (equivalent to a weathering half-time of 50 days)

10^{-9} • final resuspension value, m^{-1}

The annual average resuspended air concentration is given by:

$$\chi_R(x,y,i,j,s) = \chi(s)10^{-7} \left\{ \frac{1-\exp\left[-(\lambda_i^* + \lambda_R)t\right]}{(\lambda_i^* + \lambda_R)} \right\} (3.156 \times 10^7)$$

for $t \leq 1.82$ yr (2.2-25)

$$\chi_R(x,y,i,j,s) = \chi(s)\,(0.01) \left\{ 10^{-5} \left[\frac{1-\exp\left[-(\lambda_i^* + \lambda_R)(1.82)\right]}{(\lambda_i^* + \lambda_R)} \right] + 10^{-9} \left[\frac{\exp(-1.82\lambda_i^*) - \exp(-\lambda_i^* t)}{\lambda_i^*} \right] \right\} (3.156 \times 10^7)$$

for $t > 1.82$ yr (2.2-26)

where

λ_i^* • the effective removal constant for radionuclide i on soil, yr^{-1}

3.156×10^7 • sec yr^{-1}

Particulate daughters of ^{222}Rn (particle size 5 in Table 2.2-3) are assumed not to be depleted because of deposition and are also assumed not to be resuspended. In order to compute inhalation doses, the total air concentration of each radionuclide at each receptor (as a function of particle size) is computed as the sum of the air concentration from all sources and the resuspended air concentration.

$$\chi_T = \chi + \chi_R \qquad (2.2\text{-}27)$$

Since radon has a half-life of 3.82 days, its decay during transport in the atmosphere is important. The radon source strength is corrected for radioactive decay by:

$$Q\,(\text{radon},j,x) = Q\,(\text{radon},j,o)\,\exp\,(-\lambda_r \tau) \qquad (2.2\text{-}28)$$

where

Q(radon,j,o) • source strength of radon, Ci

τ • transit time = $\frac{x}{\bar{u}}$, sec

λ_r • decay rate = $\frac{\ln 2}{T_r}$, sec^{-1}

T_r • half-life of radon, sec

x • downwind distance, m

The concentration of radon daughters in the air is given by:

$$\chi_n = \chi_1 \left(\prod_{i=2}^{n} \lambda_i \right) \left\{ \sum_{i=1}^{n} \left[\frac{\exp\,(-\lambda_i \tau)}{\prod\limits_{\substack{j=1 \\ j \neq i}}^{n} (\lambda_j - \lambda_i)} \right] \right\} \qquad n = 2, \ldots 7 \tag{2.2-29}$$

where

χ_1 • concentration of radon, Ci m^{-3}

λ_i • decay rate = $\frac{\ln 2}{T_i}$, sec^{-1}

T_i • half-life of i^{th} daughter, sec

n • the daughters of radon (see Table 2.2-3, p=5)

Since the half-life of ^{214}Po is so short, it is not included.

2.3 Exposure Pathways

The air and ground concentrations at each location of interest are used to calculate radiation doses to individuals and the population for the pathways shown in Figure 2.3-1 (USNRC 1979). Pathways shown in this Figure result from airborne releases of radioactivity: liquid exposure pathways are not considered because there are usually no discharges to surface waters from uranium recovery operations. A detailed description of the environmental pathway models and equations follow. Suggested parameter values are provided in reference USNRC 1979.

Material deposited on the ground is assumed to contribute to external radiation exposure and ingestion exposure from intake of contaminated food products. Inhalation of resuspended material is also included through the total air concentration term. The ground concentration is assumed to increase from the constant deposition source terms and to decrease from environmental loss of availability processes such as downward migration in soil and chemical bonding. The concentrations of radionuclide i due to constant deposition over time interval t is calculated as

$$\chi_g(i,t) = \frac{1 - \exp\left[-(\lambda_i + \lambda_e)t\right]}{\lambda_i + \lambda_e} \sum_s \chi(i,s)\, V_d(s) \tag{2.3-1}$$

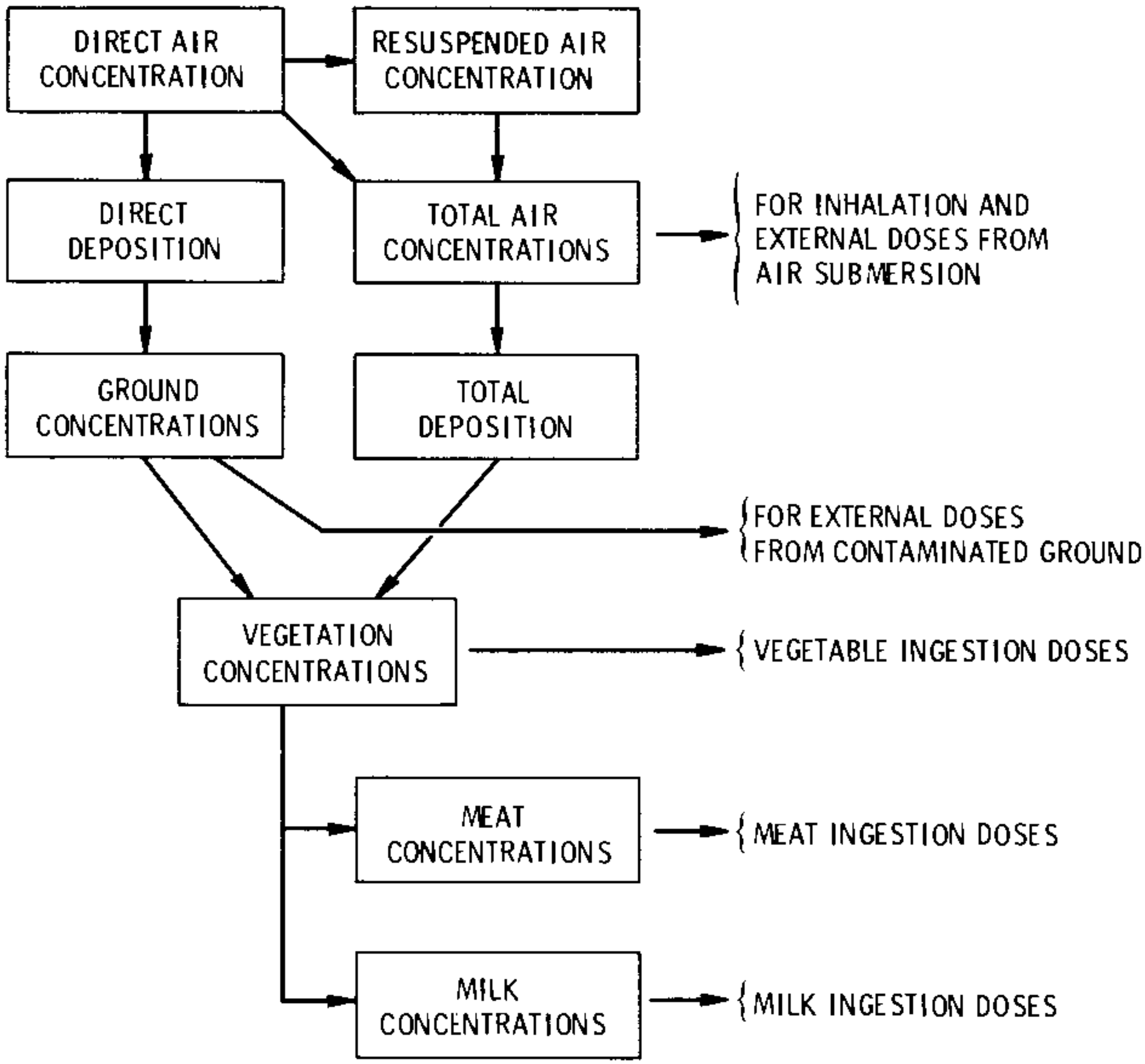


FIGURE 2.3-1 MILDOS Exposure Pathway Diagram

where

$\chi_g(i,t)$ • ground surface concentration of radionuclide i at time t, (pCi m^{-2}),

t • time interval over which deposition has occurred, sec,

λ_e • assumed rate constant for environmental loss, sec^{-1},

λ_i • radioactive decay constant, sec^{-1},

$\chi(i,s)$ • direct annual average air concentration of radionuclide i associated with particle size fraction s, pCi m^{-3},

V_d • deposition velocity of particle size fraction s, m/sec.

Environmental losses are described by a rate constant corresponding to a fifty year half-time. Resuspension is not treated as a loss term. Ground concentrations are calculated for ^{238}U, ^{230}Th, ^{226}Ra and ^{210}Pb. The incremental ingrowth of ^{210}Pb from ^{226}Ra, $\Delta\chi_g$, on the ground is calculated from:

$$\Delta\chi_g(^{210}Pb, t) = \frac{\lambda_{Pb}}{\lambda^*_{Ra}} \left\{\sum_s \chi(^{226}Ra, s)\, V_d(s)\right\} \bullet \left\{\frac{1 - e^{-\lambda^*_{Pb}t}}{\lambda^*_{Pb}} + \frac{e^{-\lambda^*_{Pb}t} - e^{-\lambda^*_{Ra}t}}{\lambda^*_{Pb} - \lambda^*_{Ra}}\right\} \qquad (2.3\text{-}2)$$

where

λ_{Pb} • decay rate of ^{210}Pb, sec^{-1},

λ^*_{Ra} • effective rate constant for loss by radioactive decay and migration of ground-deposited radium and is equal to $\lambda_{Ra} + \lambda_e$, sec^{-1}, where λ_{Ra} is the decay rate of radium and λ_e corresponds to a 50-year half-life for loss of environmental availability,

$\chi(^{226}Ra, s)$ • direct annual average air concentration of radium associated with particle size fraction s, pCi m^{-3},

λ^*_{Pb} • equals $\lambda_{Pb} + \lambda_e$, sec^{-1}, and parallels the explanation of λ^*_{Ra}.

Exposure to contaminated ground results in dose from external radiations. An occupancy factor of 100% is assumed for this external exposure pathway.

Inhalation doses are calculated from the total annual average air concentration; direct air concentration (Equation 2.2-6) plus resuspended air concentration (Equation 2.2-25 or 2.2-26).

The concentration of radionuclides in vegetation is calculated from total air concentrations and ground concentrations for five categories of plants:

- edible above-ground vegetables
- potatoes
- other edible below-ground vegetables
- pasture grass } for meat and milk ingestion pathway only
- hay }

The total deposition rate to plants for determining plant concentrations is given by Equation 2.2-17.

Vegetation concentrations are calculated as follows.

$$C_v(i) = \dot{w}_s F_r E_v \left[\frac{1 - e^{-\lambda_w t_v}}{Y_v \lambda_w} \right] + \chi_{g(i)} \frac{B_v(i)}{\rho_p} \qquad (2.3\text{-}3)$$

where

$C_v(i)$ • concentration of radionuclide i in vegetation v (pCi kg^{-1}),

F_r • fraction of the total deposition retained on plant surfaces, 0.2 (dimensionless),

E_v • fraction of foliar deposition reaching edible portions of vegetation v (dimensionless),

λ_w • decay constant accounting for weathering losses (assumed to have a 14 day half-time), (sec^{-1}),

t_v • duration of exposure while growing of vegetation v (sec).

Y_v • yield density of vegetation v (kg m^{-2})

$B_v(i)$ • soil-to-plant transfer coefficient for radionuclide i and vegetation v (dimensionless),

ρ_p • soil areal density for plowing (240 kg m^{-2}).

The value of E_v is assumed to be 1.0 for all above ground vegetation and 0.1 for all below-ground vegetables. The value of t_v is taken to be 60 days, except for pasture grass where a value of 30 days is assumed. The yield density, Y_v, is assumed to be 2 kg m^{-2}, except for pasture grass where a value of 0.75 kg m^{-2} is used.

The radionuclide concentrations in meat (beef) and milk are calculated from pasture grass and hay (stored feed) concentrations using feed-to-meat and feed-to-milk transfer factors. Consideration is also given to the fraction of the animals total intake satisfied by each feed type (grazing and stored feed). These fractions are defined by the user for calculation of both individual doses and population doses.

The equation used to estimate radionuclide concentrations in meat is

$$C_b(i) = QF_b(i)\left[F_{pg}C_{pg}(i) + F_hC_h(i)\right] \qquad (2.3\text{-}4)$$

where

$C_b(i)$ • average concentration of radionuclide i in meat (pCi kg^{-1}),

$C_h(i)$ • concentration of radionuclide i in hay (or other stored feed), (pCi kg^{-1}),

$C_{pg}(i)$ • concentration of radionuclide i in pasture grass (pCi kg^{-1}),

$F_b(i)$ • feed-to-meat transfer coefficient for radionuclide i (pCi kg^{-1} per pCi day^{-1} ingested),

F_{pg}, F_h • the fractions of the total annual feed requirement assumed to be satisfied by pasture grass or locally grown stored feed (hay), respectively (dimensionless),

Q • feed ingestion rate, 50 kg day^{-1}

The equation used to estimate milk concentrations from cows ingesting contaminated feed is

$$C_m(i) = QF_m(i)\left[F_{pg}C_{pg}(i) + F_hC_h(i)\right] \qquad (2.3\text{-}5)$$

where

$C_m(i)$ • average concentration of radionuclide i in milk (in pCi ℓ^{-1}),

$F_m(i)$ • feed-to-milk transfer coefficient for radionuclide i (pCi ℓ^{-1} per pCi day^{-1} ingested).

To estimate the average media concentrations during the final year of mill operation, the value of the time parameter t in Equations 2.2-26 and 2.3-1 is set to T_O year where T_O is the operational lifetime. This gives concentration values for the end of the final year. During the final prereclamation year exposure results from postoperational releases and residual contamination due to releases during the period of mill operation. Because there are no direct air releases during the prereclamation period, contamination results only from residual ground and resuspended air concentrations. Ground concentrations at the end of the mill operation period are calculted using Equation 2.3-1 with the value of t set to T_0, the operational lifetime. The ground concentration at the end of the final prereclamation year is then calculated as:

$$\chi_g(i,T_d) = \chi_g(i,T_o) \exp\left[-\lambda_i^* T_d\right] \qquad (2.3\text{-}6)$$

where

$\chi_g(i,T_o)$ • ground concentration of radionuclide i at the time of mill shutdown (pCi m^{-2}),

$\chi_g(i,T_d)$ • residual ground concentration of radionuclide i resulting from operational releases at the end of the T_o year drying period (pCi m^{-2}),

T_d • duration of time required to dry the tailings pile prior to reclamation (yr).

Residual resuspended air concentrations resulting from operational releases are determined for the end of the final prereclamation year by

$$\chi_R\ (x,y,i,j,s,\ T_d) = 0.01\ \chi(s,i)\ 10^{-9}(\exp -\lambda_i^* T_d\ ) \left[\frac{1 - \exp(-\lambda_i^* T_o)}{\lambda_i^*}\right] (3.156 \times 10^7) \qquad (2.3\text{-}7)$$

where

$\chi(s,i)$ • direct air concentration of radionuclide i in particle size s at location (x,j) resulting from operational releases (pCi m^{-3}),

$\chi_R(x,y,i,j,s,T_d)$ • residual resuspended air concentration of radionuclide i in particle size s resulting from operational releases at the end of the T_d -year drying period (pCi m^{-3}).

2.4 Dose Calculations

Radiation doses are calculated by MILDOS for evaluating:

- compliance with 40 CFR Part 190, EPA Radiation Protection Standard
- compliance with 10 CFR Part 20, NRC Radiation Protection Standard
- overall environmental impact required by the National Environmental Policy Act (NEPA).

Doses to maximum exposed individuals are calculated to determine compliance with the CFR criteria. The NEPA evaluation also requires calculation of exposure of populations. All dose calculations consider the exposure pathways described above with one exception: the 40 CFR Part 190 evaluation excludes doses from radon and its daughters. However radon daughters (^{210}Pb specifically) produced after release of radon parents are included when significant.

Doses are calculated from air, ground and food concentrations using dose conversion factors (provided internal to the program in Block Data). The doses at a given location are calculated by multiplying the media concentration by the appropriate dose conversion factor and summing over all radionuclides of importance. Population doses are calculated as the sum of population times dose for each spatial interval. The dose conversion factors are listed in Figure C.2-1, output pages 5 and 6.

Internal dose conversion factors give the 50 year dose commitment from one year of uptake normalized to unit air concentration, (mrem year^{-1} per Ci m^{-3}). For inhalation doses, the conversion factors are calculated by the Argonne National Laboratory computer program UDAD (Momeni 1979) in accordance with the Task Group on Lung Dynamics lung model (TGLM) of the International Commission on Raidological Protection (ICRP 1966; ICRP 1972). Inhalation dose conversion factors for the lung are weighted averages over the nasopharyngeal, tracheobronchial, lymph and pulmonary regions as defined for the TGLM. Dose conversion factors are provided as a function of particle size and organ for the radionuclides ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Pb and ^{210}Po. For ^{222}Rn and short-lived daughters the dose to the bronchial epithelium is also calculated.

Inhalation doses are computed by the equation:

$$d_\ell(inh) = \sum_s \sum_i x(s,i)\ DCF_{i\ell s}(inh) \qquad (2.4\text{-}1)$$

where

$d_\ell(inh)$ • inhalation dose to organ ℓ, at location (x,j), (mrem yr^{-1}),

$DCF_{i\ell s}(inh)$ • inhalation dose conversion factor for radionuclide i, organ ℓ, and particle size s (mrem yr^{-1} per pCi m^{-3}).

Ingestion dose conversion factors (Hoenes and Soldat 1977) are provided for four age groups and several organs for the radionuclides ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Pb and ^{210}Po. These dose conversion factors are based on the ICRP Publication 2 (1959) ingestion model. The dose conversion factor for ^{226}Ra (Fletcher and Dotson 1971) is based on models recommended in ICRP Publication 10A (1971). The calculation of ingestion doses from consumption of vegetables includes a factor of 0.5 to account for loss of contamination during food preparation.

The annual radionuclide intake via ingestion is calculated as

$$I_{ik} = U_{mk}C_m(i) + U_{bk}C_b(i) + 0.5 \sum_v U_{vk}C_v(i) \quad (2.4\text{-}2)$$

where

I_{ik} • activity ingestion rate of radionuclide i by an individual in age group k (pCi yr^{-1}),

U_{mk}, U_{bk} • milk (ℓ yr^{-1}) and meat (kg yr^{-1}) ingestion rates for age group k,

U_{vk} • ingestion rate of vegetable category v for age group (kg yr^{-1}),

0.5 • the fraction of vegetable activity remaining after food preparation (dimensionless).

Ingestion doses are then computed by

$$d_{\ell k}(ing) = \sum_i I_{ik} DCF_{i\ell k}(ing) \quad (2.4\text{-}3)$$

where

$d_{\ell k}(ing)$ • ingestion dose for organ ℓ, age group k (mrem yr^{-1}),

$DCF_{i\ell k}(ing)$ • ingestion dose conversion factor for radionuclide i, organ ℓ, and age group k (mrem pCi^{-1} ingested).

The dose from external exposure to contaminated ground is calculated assuming 100 percent occupancy at a given receptor location. A structural shielding factor of 0.825 is applied to account for indoor occupancy 14 hours per day at a shielding factor of 0.7.

The external dose to an individual is given by:

$$d_\ell(ext) = 0.825 \sum_i \left[\chi_g(i) DCF_{i\ell}(gnd) + DCF_{i\ell}(cld) \; \chi_T \right] \quad (2.4\text{-}4)$$

where

χ_T • total air concentration of radionuclide i in size fraction s at given location

$d_\ell(ext)$ • external dose to organ ℓ (mrem yr^{-1}),

$DCF_{i\ell}(cld)$ • dose conversion factor for external exposure to the cloud for radionuclide i and organ ℓ (mrem yr^{-1} pCi^{-1} m^3)

$DCF_{i\ell}(gnd)$ • dose conversion factor for ground exposure for radionuclide i and organ ℓ (mrem yr^{-1} per pCi m^{-2}),

0.825 • effective reduction factor of structural shielding for indoor exposure periods.

Individual doses are calculated at each receptor location defined by the user. These locations are normally defined to represent locations where high exposures are likely. The maximum doses to individuals are usually calculated for the last year of mill operation and for the last year of tailings pile drying prior to stabilization. However, doses can be computed for any time period.

Two types of population doses may be calculated at the option of the user: the annual population dose commitment or the 100 year environmental dose commitment. The annual population dose commitment gives the dose received by the population from one year of exposure and consumption with a 50 year dose commitment period (for the material in the body from the first year's consumption). The environmental dose commitment (EDC) concept of EPA (1974) considers future exposure and consumption of residual environmental contamination. The two types of population doses are calculated in a similar manner except that total uptake for the annual population dose is calculated for one year and the total uptake for the EDC are calculated for a period of one hundred years. The radiological impacts from a given release are integrated over a period of 100 years following the release.

Population doses are calculated for the region (within the 80 km grid) for the mill operation time period and the tailings drying period (post-operational, prestabilization). These doses include contributions from particulate releases and ^{222}Rn releases. Annual population doses from transcontinental transport of ^{222}Rn are evaluated for all three mill-life-cycle time periods (above plus post stabilization).

Inhalation and external doses to the regional population are calculated by the following procedures.

- For each spatial interval of the grid doses to the average individual are calculated (based on air and ground concentrations at the interval midpoint)

- Individual doses are multiplied by the population within the spatial interval
- The total dose is then calculated as the sum over all spatial intervals.

The population dose from inhalation and external exposure in the site region is calculated by the following equations.

$$M_{\ell}(inh + ext) = 10^{-3} \sum_{a} P_a\left[d_{\ell}(inh) + d_{\ell}(ext)\right] \qquad (2.4\text{-}5)$$

where

$M_{\ell}(inh + ext)$ • population doses from inhalation and external pathways (person-rem-yr^{-1})

P_a • population residing in spatial interval a (at location, see Figure 2.0-1)

a • indicates summation at over all spatial intervals

10^{-3} • conversion from mrem to rem

The total population dose from ingestion pathways is calculated on the basis of the regional agricultural productivity rather than population. This is because the total activity in the food determines the doses rather than the number of people exposed. Ingestion population doses are calculated by the following procedure.

- The productivity rate (kg yr^{-1} per m^2) of each food category is assigned (vegetables, meat and milk) by the user.
- For each spatial interval the activity concentrations in each food type are calculated and multiplied by the production rate and the interval area to find the total activity in each food for the spatial interval.
- The total activity for the region is determined by summing over all spatial intervals.
- Population doses are determined assuming all food produced in the region is consumed by a population with the same age distribution as the U.S. population.

The population doses from ingestion is calculated by the following equations. First the gross activity in each food type is calculated by:

$$Q_{fi} = \sum_{a} G_{fa} A_a C_{fa}(i) \qquad (2.4\text{-}6)$$

where

A_a • area of spatial interval a (km^2)

$C_{fa}(i)$ • concentration of radionuclide i in spatial interval a in food type f where f represents m for milk, b for meat and v for vegetables ($Ci\ kg^{-1}$ or $Ci\ \ell^{-1}$)

G_{fa} • production rate of food type f in spatial interval a ($kg\ yr^{-1}\ km^{-2}$ or $\ell\ yr^{-1}\ km^{-2}$)

Q_{fi} • gross activity content of radionuclide i in food f ($pCi\ yr^{-1}$)

The consumption by each age group in the population is calculated using weighting factors F_{fk} defined as follows (see Table 3.3-8).

$$F_{fk} = \frac{F_{pk}\ U_{fk}}{\sum_k F_{pk}\ U_{fk}} \tag{2.4-7}$$

where

F_{fk} • fraction of the production of food type f ingested by individual in age group k (dimensionless)

F_{pk} • fraction of the regional population belonging to age group k (dimensionless)

U_{fk} • average consumption rate of food type f for an individual in age group k ($kg\ yr^{-1}$ or $\ell\ yr^{-1}$).

The region population ingestion dose from all food categories is calculated by:

$$M_\ell(ing) = 10^{-3} \sum_f \sum_i \sum_k E_f Q_{fi} F_{fk} DCF_{i\ell k}(ing) \tag{2.4-8}$$

where

E_f • fraction of activity remaining on food type f after preparation for eating (dimensionless)

$M_\ell(ing)$ • regional population dose to organ ℓ from ingestion (person rem yr^{-1})

Population doses to the North American continent from ^{222}Rn are calculated using estimates of population dose resulting from 1000 Ci releases from four specific locations in the western United States:

- Casper, Wyoming
- Falls City, Texas
- Grants, New Mexico
- Wellpinit, Washington

Data is contained within MILDOS for each of these sites giving the continental population dose that would result from release during the calendar year 1978. The user may select any one of the four sites as representative of the site under study or a weighted average of the four sites may be used. For projected releases in future years doses are assumed to be proportional to the U.S. population increase. The user supplies population increase factors (relative to 1978) for each time period of interest.

The regional and continental population doses are calculated on an annual basis for milling, pile drying and postreclamation phases. The total radiological impact due to emissions during the first two phases is estimated by multiplying the annual impacts by the duration and summing. The total population dose to the regional and continental population is calculated by

$$M_\ell = M_\ell\ (inh + ext) + M_\ell(ing) + M_\ell(Rn) \qquad (2.4\text{-}9)$$

where

M_ℓ • total population dose to organ ℓ (person rem yr^{-1})

$M_\ell(Rn)$ • continental population dose to organ ℓ from radon (person rem yr^{-1})

A technical review of the dispersion and dose models used in MILDOS has been performed by Horst and Soldat (1981). In their document the models are evaluated to determine if they represent adequate application of the state-of-the-art in predicting environmental impacts.

3.0 PROGRAM CONSIDERATIONS

This section describes details of the computer program useful to users such as program limitations and execution time estimates. Details of the program structure are given in Appendix A. Computer specific requirements are given in Appendix C.

3.1 Program Limitations

Three major features of the calculations performed by MILDOS rely on definitions made by the user. These are definition of:

- source terms for significant releases,
- time steps for describing the mill life-cycle,
- individual receptor locations

The current version of MILDOS allows the user to define a maximum of twenty source terms, ten timesteps and forty-eight individual receptor locations.

The radionuclides considered by MILDOS are those in the uranium-238 decay series: ^{235}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{222}Rn, ^{218}Po, ^{214}Pb, ^{214}Bi, ^{210}Pb and ^{210}Po. The user does not have the option to include additional radionuclides through input parameters.

3.2 Execution Time

The MILDOS program runs rapidly with typical execution times of less than 1 minute. The sample problem described in Appendix C requires about 46 seconds on the CDC 7600 computer at Brookhaven National Laboratory.

The execution time depends mainly on the type and number of sources specified and on the fraction of non-zero values given in the meteorological data set (see array FREQ in Section 4.2). Other parameters having a minor effect on execution time include the number of time steps, the number of individual receptors and output report requests. Three types of sources are generally defined in using MILDOS:

- point source with particulate release only
- point source with particulate and ^{222}Rn release
- area source with particulate and ^{222}Rn release

TABLE 3.2-1. MILDOS Execution Time Tests

Source Types						Execution Time	
Point, Particulate P_p	Point, Radon/ Particulate P	Area, Radon/ Particulate A	Met. Data Fraction F	Number of Timesteps	Number of Receptors	Estimate	Actual
1	--	--	0.49	1	1	3.4	3.31
--	1	--	0.49	1	1	7.4	7.53
--	--	1	0.49	1	1	9.8	10.16
1	--	--	0.49	6	1	3.4	4.93
1	--	--	0.49	1	6	3.4	3.64
1	2	--	0.49	3	3	18.1	16.31
--	1	--	1.0	1	5	15.0	17.40
1	1	3	0.49	3	30	40.2	37.30
1	2	3	0.49	1	1	47.5	41.96
1	2	3	0.49	6	6	47.5	45.87

Several test runs were performed to determine the effect of input parameters on execution time. Results of these tests are indicated in Table 3.2-1. This table also indicates the calculated execution times based on the following equation.

$$T = F\ (7\ P_p + 15\ P + 20A)$$

where

T • execution time, seconds

P_p • number of points sources with particulate releases only,

P • number of point sources with particulate and radon releases

A • number of area sources with particulate and radon releases,

F • fraction of meteorological data set entries that are non-zero.

This equation gives an approximate execution time that will be within 50% (high or low) for most cases.

3.3 Data Constants

Parameters are initialized in MILDOS using a block data procedure labeled FRESH and specification statements in several subroutines. This section lists the initial values given to parameters of interest to the user. These parameters include input variables and constants used in several of the models.

The input parameters are initialized to values indicated in Table 3.3-1. This table lists the parameters which can be defined by the user through the NAMELIST input data set INDATA (see Section 4.2).

The atmospheric transport model for particulates used by MILDOS requires data on the particle size distribution and density. Table 3.3-2 lists values assumed by MILDOS for these parameters.

The exposure pathway model requires radionuclide transfer factors for vegetables, meat and milk. The vegetable ingestion pathway uses the soil-to-plant transfer factor (dimensionless). The meat and milk ingestion pathways use feed-to-meat and feed-to-milk transfer factors which relate animal intake to animal product (meat or milk) contamination levels. Values used for these parameters are defined in Table 3.3-3 (USNRC 1980).

Dose conversion factors are defined for inhalation, ingestion and external exposure pathways. Dose conversion factors are set in block data FRESH. Values for these factors are defined in Tables 3.3-4 thru 3.3-6 (USNRC 1980).

TABLE 3.3-1. Values assumed by MILDOS for NAMELIST INDATA Parameters

Parameter	Type	Initial Value in Block Data FRESH
Job Control		
IFTODO	Integer	0 (10 values)
IRTYPE	Integer	-1 (48 values)
JC	Integer	0 (10 values)
Source Terms		
FRADON	Real	0.0 (4 values)
IPACT	Integer	Not Set
NSORCE	Integer	0
PACT	Real	0.0 (12 values)
QAJUST	Real	0.0 (400 values)
SORCE	Real	0.0 (240 values)
Meteorology		
DM	Real	1000. meters
FREQ	Real	0.0 (576 values)
Food Pathway Parameters		
FFORI	Real	0.5 dimensionless
FFORP	Real	0.5 dimensionless
FHAYI	Real	0.5 dimensionless
FHAYP	Real	0.5 dimensionless
FPR	Real	0.0 (3 values)
Population Distribution		
IPOP	Integer	0 (192 values)
PAJUST	Real	1.0 dimensionless (10 values)
Individual Receptors		
IADD	Integer	0
XRECEP	Real	0.0 (144 values)
Time History		
NSTEP	Integer	0
TSTART	Real	Not Set
TSTEP	Real	5.0 years (10 values)

TABLE 3.3-2. Particle Size Parameter Values

Particulate Group	Density, gm/cm^3 PDEN	Particle Size Fraction PTS7FC Particle size (μm)	1.0	1.0	5.0	35.0
1	8.9		1.0	0.0	0.0	0.0
2	2.4		0.0	1.0	0.0	0.0
3	2.4		0.0	0.0	0.3	0.7

Intake of radionuclides by individuals via ingestion is dependent on food consumption rates. The vegetable, meat and milk consumption rates used in MILDOS (for individual dose calculations) are listed in Table 3.3-7 for four age groups: infant, child, teen and adult. Data in Table 3.3-7 is stored internally in the data array UOF in labeled common block FDATA.

For population doses the total vegetable consumption is assumed to be 78.3% from above ground vegetables, 19.6% from potatoes and 2.1% from other below ground vegetables (parameter FGBVT defined in subroutine POPDOS, Appendix B).

In estimating the fraction of the regional food production that is consumed within the region, MILDOS uses the age dependent food consumption rates shown in Table 3.3-8. The total per capita consumption values are defined in subroutine POPDOS as parameter array PCCR. The fraction of the regional production eaten by each age group for each food type is given in Table 3.3-9 (USNRC 1977). Data is defined in subroutine POPDOS as parameter array FIK.

The population dose to the North American continent from ^{222}Rn releases is based on precalculated dose estimates for 1000 Ci releases from four sites. (See section 2.4). These dose factors are given in Table 3.3-10 (USRNC 1979) and are defined in subroutine POPDOS as the array parameter RADPOP.

3.4 Error Handling

There are no tests performed on input parameters in MILDOS. The user is required to provide valid data within defined ranges for necessary parameters. An output report is prepared giving values for input parameters as read by the computer. The user should check these reports carefully to ensure that the input data was interpreted correctly. Improper definition of parameters may or may not be apparent in the results. Some errors will cause abnormal run termination while others may not be noticeable.

TABLE 3.3-3. Food Pathway Transfer Coefficients

Pathway	Transfer Coefficients by Element U	Th	Ra	Pb
Soil-to-Plant (BIV)				
Above Ground Vegetables	2.5×10^{-3}	4.2×10^{-3}	1.4×10^{-2}	4.0×10^{-3}
Potatoes	2.5×10^{-3}	4.2×10^{-3}	3.0×10^{-3}	4.0×10^{-3}
Other 8elow Ground Vegetables	2.5×10^{-3}	4.2×10^{-3}	1.4×10^{-2}	4.0×10^{-3}
Pasture Grass	2.5×10^{-3}	4.2×10^{-3}	1.8×10^{-2}	2.8×10^{-2}
Stored Feed	2.5×10^{-3}	4.2×10^{-3}	8.2×10^{-2}	3.6×10^{-2}
Feed-to-8eef (FBI) (pCi/kg per PCi/day)	3.4×10^{-4}	2.0×10^{-4}	5.1×10^{-4}	7.1×10^{-4}
Feed-to-Milk (FMI) (pCi/ℓ per pCi/day)	6.1×10^{-4}	5.0×10^{-6}	5.9×10^{-4}	1.2 x 10-4

TABLE 3.3-4. Ingestion Dose Conversion Factors

Age Group	Organ	Internal Dose Conversion Factors by Organ and Age, mrem per pCi ingested							
		238U	234U	234Th	230Th	226RA*	210PB	210BI	210PO
Infant	Wh. Bod	3.33E-04	3.80E-04	2.00E-08	1.06E-04	1.07E-02	2.38E-03	3.58E-07	7.41E-04
	Bone	4.47E-03	4.88E-03	6.92E-07	3.80E-03	9.44E-02	5.28E-02	4.16E-06	3.10E-03
	Liver	0.	0.	3.77E-08	1.90E-04	4.76E-05	1.42E-02	2.68E-05	5.93E-03
	Kidney	9.28E-04	1.06E-03	1.39E-07	9.12E-04	8.71E-04	4.33E-02	2.08E-04	1.26E-02
Child	Wh. Bod	1.94E-04	2.21E-04	9.88E-09	9.91E-05	9.87E-03	2.09E-03	1.69E-07	3.67E-04
	8one	3.27E-03	3.57E-03	3.42E-07	3.55E-03	8.76E-02	4.75E-02	1.97E-06	1.52E-03
	Liver	0.	0.	1.51E-08	1.78E-04	1.84E-05	1.22E-02	1.02E-05	2.43E-03
	Kidney	5.24E-04	5.98E-04	8.01E-08	8.67E-04	4.88E-04	3.67E-02	1.15E-04	7.56E-03
Teenager	Wh. Bod	6.49E-05	7.39E-05	3.31E-09	6.00E-05	5.00E-03	7.01E-04	5.66E-08	1.23E-04
	8one	1.09E-03	1.19E-03	1.14E-07	2.16E-03	4.90E-02	1.81E-02	6.59E-07	5.09E-04
	Liver	0.	0.	6.68E-09	1.23E-04	8.13E-06	5.44E-03	4.51E-06	1.07E-03
	Kidney	2.50E-04	2.85E-04	3.81E-08	5.99E-04	2.32E-04	1.72E-02	5.48E-05	3.60E-03
Adult	Wh. Bod	4.54E-05	5.17E-05	2.13E-09	5.70E-05	4.60E-03	5.44E-04	3.96E-08	8.59E-05
	Bone	7.67E-04	8.36E-04	8.01E-08	2.06E-03	4.60E-02	1.53E-02	4.61E-07	3.56E-04
	Liver	0.	0.	4.71E-09	1.17E-04	5.74E-06	4.37E-03	3.18E-06	7.56E-04
	Kidney	1.75E-04	1.99E-04	2.67E-08	5.65E-04	1.63E-04	1.23E-02	3.83E-05	2.52E-03

* Adult whole body and bone dose conversion factors for Ra-226 have been obtained from Momeni et al. (1979) and are based on applicable models and data from ICRP (1966). Ra-226 whole body and bone dose conversion factors for other age groups have been computed by assuming the same proportion to adult whole body and bone dose factors as given in Hoenes and Soldat (1977). All other dose conversion factors are from Hoenes and Soldat (1977) directly.

TABLE 3.3-5. Inhalation Dose Conversion Factors

	mrem/yr per pCi/m^3					
Particle Size = 0.3 Microns	PB210	P0210				
Whole Body	7.46E+00	1.29E+00				
Bone	2.32E+02	5.24E+00				
Kidney	1.93E+02	3.87E+01				
Liver	5.91E+01	1.15E+01				
Mass Average Lung	6.27E+01	2.66E+02				
Particle Size = 1.0 Microns Oensity = 8.9 g/cm^3	U238	U234	TH230	RA226	PB210	P0210
Whole Body	9.82E+00	1.12E+01	1.37E+02	3.58E+01	4.66E+00	5.95E-01
Bone	1.66E+02	1.81E+02	4.90E+03	3.58E+02	1.45E+02	2.43E+00
Kidney	3.78E+01	4.30E+01	1.37E+03	1.26E+00	1.21E+02	1.79E+01
Liver	0.0	0.0	2.82E+02	4.47E-02	3.69E+01	5.34E+00
Mass Average Lung	1.07E+3	1.21E+3	2.37E+03	4.88E+03	5.69E+02	3.13E+02
Particle Size = 1.0 Microns Density = 2.4 g/cm^3	U238	U234	TH230	RA226	PB210	P0210
Whole Body	4.32E+00	4.92E+00	1.66E+02	3.09E+01	4.36E+00	4.71E-01
Bone	7.92E+01	7.95E+01	5.95E+03	3.09E+02	1.35E+02	1.92E+00
Kidney	1.66E+01	1.89E+01	1.67E+03	1.09E+00	1.13E+02	1.42E+01
Liver	0.0	0.0	3.43E+02	3.87E-02	3.45E+01	4.22E+00
Mass Average Lung	1.58E+02	1.80E+02	3.22E+03	6.61E+03	7.72E+02	4.20E+02
Particle Size = 5.0 Microns Density = 2.4 g/cm^3	U238	U234	TH230	RA226	PB210	P0210
Whole Body	1.16E+00	1.32E+00	1.01E+02	4.00E+01	4.84E+00	7.10E-01
Bone	1.96E+01	2.14E+01	3.60E+03	4.00E+02	1.50E+02	2.89E+00
Kidney	4.47E+00	5.10E+00	1.00E+03	1.41E+00	1.25E+02	2.13E+01
Liver	0.0	0.0	2.07E+02	4.97E-02	3.83E+01	6.36E+00
Mass Average Lung	1.24E+03	1.42E+03	1.38E+03	2.84E+03	3.30E+02	1.88E+02
Particle Size = 35.0 Microns Density = 2.4 g/cm^3	U238	U234	TH230	RA226	P8210	P0210
Whole Body	7.92E-01	9.02E-01	5.77E+01	3.90E+01	4.43E+00	7.28E-01
Bone	1.34E+01	1.46E+01	2.07E+03	3.90E+02	1.38E+02	2.96E+00
Kidney	3.05E+00	3.47E+00	5.73E+02	1.38E+00	1.15E+02	2.19E+01
Liver	0.0	0.0	1.19E+02	4.85E-02	3.51E+01	6.52E+00
Mass Average Lung	3.33E+02	3.80E+02	3.71E+02	7.64E+02	8.70E+01	5.75E+01

TABLE 3.3-6. Dose Conversion Factors for External Exposure

Dose Factors for External Doses from Air Concentrations, mrem/yr per pCi/m^3	
Isotope	Whole Body*
U238**	1.23E-04
TH230	3.59E-06
RA226	4.90E-05
RN222	2.83E-06
PO218	6.34E-07
PB214	1.67E-03
BI214	1.16E-02
PB210	1.43E-05

Dose Factors for External Doses from Ground Concentrations, mrem/yr per pCi/m^3	
Isotope	Whole Body*
U238**	3.70E-06
TH230	6.12E-07
Ra226	9.47E-07
RN222	5.03E-08
PO-218	1.10E-08
PB214	3.16E-05
BI214	1.85E-04
PB210	2.27E-06

* Doses to internal body organs are assumed to be the same as computed for the whole body.

** Dose factors for ^{238}U include contributions from daughters ^{234}Th, ^{234m}Pa and ^{234}U

TABLE 3.3-7. Food Consumption Rates

Food Type	Ingestion Rates by Age Group: Infant	Child	Teen	Adult
Vegetables (kg/yr)	--	47.8	76.1	105.
Meat (kg/yr)	--	27.6	44.8	78.3
Milk (l/yr)	208.	208.	246.	130.

TABLE 3.3-8. Age Distribution of Population, Average and Per Capita Consumption Rates and Fractions

Age Group	Fraction of Population[a]	Average Total Consumption Rates, kg/yr[b]		
		Vegetables	Meat	Milk
Infants	0.0179	0.	0.	207.6
Children	0.1647	238.1	48.7	234.8
Teenagers	0.1957	306.4	78.0	291.4
Adults	0.6217	285.5	127.9	176.3
Per Capita Average:[c]		276.7	102.8	209.0

[a]Age fractions given reflect average values for the entire U.S. population indicated by 1970 census data, as reported in EPA (1973).

[b]Consumption rates given are average values taken from Fletcher and Dotson (1971) and are not appropriate to use for the calculation of maximum individual doses.

[c]Per capita consumption rates shown are weighted averages over all age groups. They are used for determining the fractions of regional food production potentially consumed by the regional population.

TABLE 3.3-9. Food Consumption by Age Group

Age Group	Fraction of Regional Production Ingested by Each Age Group		
	Vegetables	Meat	Milk
Infants	0.0	0.0	0.0178
Children	0.1418	0.0780	0.1850
Teenagers	0.2167	0.1485	0.2728
Adults	0.6415	0.7735	0.5244

TABLE 3.3-10. Continental Population Dose Factors

Release Site	Population Doses Resulting from a 1-kCi Release of ^{222}Rn During 1978, organ-rem			
	Bronchial Epithelium	Whole Body	Pulmonary Lung	Bone
Casper, Wyoming	56.	8.8	2.0	120.
Falls City, Texas	72.	5.8	1.6	77.
Grants, New Mexico	52.	8.2	1.8	110.
Wellpinit, Washington	43.	9.0	1.7	120.

The sample problem input deck in Section C.1 results in five system generated diagnostic messages related to the NAMELIST input procedure. The messages are not significant. They are caused by specifying a parameter name on one card without giving any constants on the same card. The diagnostics are not shown in the sample problem output listing in Section C.2.

4.0 DATA INPUT PREPARATION

To execute the computer program MILDOS the user must supply two card sets: a NAMELIST INDATA set followed by a title card set. All integer and floating point data is given in the NAMELIST set while the title card set contains the alphanumeric labels. The FORTRAN NAMELIST statement provides a simplified means of supplying input data to a computer program. Use of the NAMELIST procedure permits the reading of input without the need of format specification. A general description of the NAMELIST input procedure is given in Section 4.1. Details of the NAMELIST INDATA parameters are given in Section 4.2. The title card set is described in Section 4.3.

4.1 Use of NAMELIST

The NAMELIST data input procedure is available with FORTRAN compilers on most large computing systems. The description which follows is thought to be generally applicable to most systems. For detailed information on specific systems the user is referred to system FORTRAN reference manuals.

The use of the NAMELIST procedure can best be described by the following set of usage rules.

1. The first column, and only the first column, of each NAMELIST card is not read by NAMELIST. This column can be used as a label to indicate the order of the cards or it can be left blank.

2. The first card of the set must begin with a blank in column one and a dollar sign, "$", in column two followed by the set name. For MILDOS the set name is INDATA and the first card contains $INDATA in columns 2-8. The next column must be blank (column 9 for MILDOS).

3. The data set is ended by "$END". On many systems just the dollar sign is sufficient.

4. Data entries are made by giving the parameter name, an equal sign and the data value to be assigned to the named parameter. Allowable forms of parameter specification are as follows:

    a. Name = constant
    b. Array Name = set of constants
    c. Array Name (subscripts) = set of constants

    An example of the first form would be to set the parameter NSORCE equal to 8:

    NSORCE = 8,

The second and third forms are used to set data into arrays. Note that for these forms, data values cannot be skipped. The set of constants consists of one or more data values separated by commas. As an example consider the array IRTYPE with the first 15 (dimensioned 48) values to be set as follows:

Positions 1-5 set to 1
Positions 6-10 set to 10
Positions 11-15 set to 1

The entry would be as follows:

IRTYPE = 1,1,1,1,1,10,10,10,10,10,1,1,1,1,1,33*0,

or,

IRTYPE(1) = 5*1, 5*10, 5*1, 33*0,

Both of the examples have the same effect.

The repeat form 33*0 indicates that the value 0 is to be entered 33 times. In the example this fills the remaining array positions with zero. This repeat form can be used with both forms of array specifications. The third form (with a named subscript) is generally used only when the data specification does not start with the first element of the array. For example, IRTYPE (6) = 5*10 set positions 6-10 of array IRTYPE to 10.

The number of data values in the set of constants must be less than or equal to the size of the array. When the third form is used the number of data values must be less than or equal to the space between the named element and the end of the array. For example only 33 values can be specified when the array name is given as:

IRTYPE(16)

because this array is dimensioned 48.

5. Every data value must be followed by a comma, and no data values may be skipped, except at the beginning or end of the array.

6. Variables can be specified in any order.

7. The order of element entry for multiple dimensioned arrays follows the FORTRAN array convention wherein the first subscript is varied most rapidly followed by the second subscript. For a double dimensioned array B(I,J) where I and J represent the array dimensions the position of element B(i,j) is given by

$$i + (j-1)I$$

Thus, B(3,4) is in position 18 for I = 5 and J = 5.

For a triple dimensioned array A(I,J,K) the position of element A (i,j,k) is given by

$$i + (j-1)I + (k-1)IJ$$

As an example consider the NAMELIST variable FREQ(16,6,6) for MILDOS. The position of element FREQ(i,j,k) is given by

$$i + (j-1)\ 16 + (k-1)\ 96$$

8. Parameters not named in the input set are left unchanged; therefore, the initial values of Table 3.3-1 are invoked.

4.2 Definition of NAMELIST Parameters

The MILDOS parameters supplied through the NAMELIST data set INDATA can be classified into seven categories as follows:

Data Category	NAMELIST Parameter Names
Job Control	IFTODO, IRTYPE, JC
Source Terms	FRADON, IPACT, NSORCE, PACT, QAJUST, SORCE
Meteorology	DM, FREQ
Food Pathway Parameters	FFORI, FFORP, FHAYI, FHAYP, FPR
Population Distribution	IPOP, PAJUST
Individual Receptors	IADD, XRECEP
Time History	NSTEP, TSTART, TSTEP

Parameters for each of these categories are described in the following sections.

4.2.1 Job Control Parameters

Three job control integer arrays are used by MILDOS; IFTODO, IRTYPE and JC. The array IFTODO is used in conjunction with the time history data and controls calculation and printing of doses for each time step. The array IRTYPE requests output reports for each individual receptor location (see Section 4.2.6). The array JC controls selection of calculational options and report selections. Usage of these arrays is described in Table 4.2-1. The user is reminded that the value for JC(7) must be 1 if any element of the array IRTYPE is set to 10. Element JC(4) selects printing of population doses. Doses are printed for the pathways and organs indicated in Table 4.2-2.

4.2.2 Source Term Parameters

Multiple release points may be defined as input to the MILDOS program. The number defined for a run is specified by the parameter NSORCE. The location, rate of release and characteristics of each release are defined in the array SORCE. Additional data is defined for area sources such as tailings piles where wind suspension is the main driving force for entry to the atmosphere. The sample area source isotopic composition mixes (specific activity in pCi gm^{-1}) are defined in array PACT. Three composition mixes may be defined to represent different ore mixes. The array IPACT then assigns these composition mixes to represent each area source as appropriate. Area sources are indicated by a value of SORCE(10,i) greater than 2000 for a source i. A "virtual point source" method is used to describe dispersion from area sources. Area sources larger than 0.1 km^2 should be broken down to smaller area source.

The population dose to persons beyond the 80 km radius is estimated from radon releases characterized by the nearest of the following sites:

Casper, Wyoming
Falls City, Texas
Grants, New Mexico
Wellpinit, Washington

The array FRADON is used to select the radon release characteristics for one of the above sites or as a geographic weighted average of the above sites.

TABLE 4.2-1. Job Control Parameters

(Dimension) Parameter	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.
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, perform a 10 CFR 20 check on air concentrations and print a report IRTYPE(i) = 1, print doses totaled over all exposure pathways. IRTYPE(i) = 10, print 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 to -1 to suppress printing. When IRTYPE(i) is set to 1 or 10 reports are printed for total dose commitments and for 40 CFR 190 dose commitments.
JC(10)	Integer	Job control integer array to select options for the current calculation. An option is selected by setting the appropriate value to 1. Usage is as follows: JC(1)=1, use the internal dusting rate algorithm (subroutine TAILPS), utilizing the input array FREQ for all sources j having SORCE(10,j) greater than or equal to 2000. If JC(1)=0, then default values are used for sources with SORCE (10, j) ≥ 2000. JC(2)=1, compute the 100 year environmental dose commitments. If JC(2) = 0, the annual population dose commitments are computed. JC(3)=1, print total air concentrations (pCi m^{-3}), ground concentrations (pCi m^{-2}), and total deposition rates (pCi m^{-2} sec^{-1}) for each spatial interval (see Figure 2.0-1).

TABLE 4.2-1. (Cont'd)

(Dimension) Parameter	Type	Description
		JC(4)=1, print annual population doses for each spatial interval. Reports are printed for each pathway and organ listed in Table 4.2-2. If JC(4) $\neq$ 1 then only a summary table is printed for the 80 km population and the extra-regional population.
		JC(5)=1, print the normalized dispersion factor (X/Q) arrays. The outputs include the air concentration normalized by the release rate of ^{238}U for each source, receptor and particle size; and for ^{222}Rn and 6 daughters for each source and receptor. Units are: $\frac{\text{pCi m}^{-3}\text{ (air concentration)}}{\text{pCi sec}^{-1}\text{ (release rate)}}$ This option will generate lengthy output when several sources and receptor locations are specified.
		JC(6)=1, print 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, print total dose commitments (mrem/yr) and 40 CFR Part 190 dose commitments by age group, pathway and organ for each receptor location and timestep. If JC(7) $\neq$ 1, then the pathway data are not printed; 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, then JC(7) must be set to 1.
		JC(8)=1, include the milk pathway in calculation of doses at receptor locations. If JC(8) $\neq$ 1, then the milk pathway is not included or printed.

TABLE 4.2-1. (Cont'd)

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

TABLE 4.2-2. Population Dose Tables for JC(4)=1

Exposure Pathway	Organ of Interest
Inhalation	Whole Body Bone Mass Average Lung Bronchial Epithelium
Ground Exposure	Whole Body
Cloud Exposure	Whole Body
Vegetable Ingestion	Whole Body Bone
Meat Ingestion	Whole Body Bone
Milk Ingestion	Whole Body Bone

The release rate during each time period (see Section 4.2.7) is defined by the array QAJUST which is used to adjust the release data in the SORCE array. This flexibility in source term specification is necessary over the lifetime of a uranium mill to account for transitions in operations. For example, as one tailings trench is filled, stabilized and reclaimed, the source strength should be adjusted accordingly.

Particle size distribution data is used in the atmospheric transport calculation by MILDOS. Three particle size distribution sets are available as internal data in MILDOS. The element SORCE(11,i) selects one of these sets to represent each source i. Characteristics of each set are given in Table 4.2-3. (Default values are given in Table 3.3-2).

TABLE 4.2-3. Particle Size Distribution Set Characteristics

Set Number	Density g/cm^3	Percent of Material by Particle Size (μm) 1.0	5.0	35.0	Source Types
1	8.9	100	0.0	0.0	Yellowcake dryer packaging
2	2.4	100	0.0	0.0	Crushers, grinders rod mills, conveyers, fine ore blending and other mill process sources
3	2.4	0.0	30	70	Tailings, ore storage piles

The element SORCE(12,i) gives the product of exit velocity times stack diameter for source i. Stacks, vents and blending areas have exit velocities while ore pads and tailings area do not.

Detailed descriptions of each parameter in the source term set is provided in Table 4.2-4.

4.2.3 Meteorological Parameters

Average meteorological data characteristic at the mill center is required as input to MILDOS. The data array FREQ is used to provide the annual average fractional frequency of occurrence of windspeed, wind direction and atmospheric stability. Data is supplied for

- sixteen wind directions in the order
  N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW.

- six wind speed classifications in the order
  0-13, 4-6, 7-10, 11-16, 17-21, > 21 (knots)
  0-13, 4-7, 8-12, 13-18, 19-24, > 24 (mph)
  .67, 2.5, 4.5, 6.9, 9.6, 12.5 (average m sec^{-1})

The average wind speed values (m sec^{-1}) are provided in array UU in block data FRESH.

- six Pasquill atmospheric stability categories in the order
  A - extremely unstable
  B - moderately unstable
  C - slightly unstable
  D - neutral
  E - moderately stable
  F - very stable

The wind direction is the direction the wind is from. These data are available from the National Weather Service for locations with meteorological towers and stations.

In addition to the joint frequency array, the annual average mixing height, DM, is also given. Table 4.2-5 describes the meteorological parameters.

TABLE 4.2-4. Source Term Parameters

Parameter (Dimensions)	Type	Description
FRADON(4)	Real	The fraction of radon releases attributable to each of the following sites: FRADON(1) - Casper, Wyoming FRADON(2) - Falls City, Texas FRADON(3) - Grants, New Mexico FRADON(4) - Wellpinit, Washington Each value must be between zero and one and the four values must sum to exactly one. This array is used to determine impact to populations outside the 80 km radius. See Figure 4.2-1 for the geographical location of the above sites.
IPACT(20)	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 non-negative integer values ≤ 3.
NSORCE	Integer	The number of effluent sources to be defined for the current case. $1 \leq$ NSORCE ≤ 20. (Maximum of 20).
PACT(3,4)	Real	Defines up to three isotopic composition mixes for characterizing of area source particulate releases. The values given for PACT(i,k) represents the specific activity (in pico curies gm^{-1}) for radionuclide k in mix i where k=1 for ^{238}U k=2 for ^{230}Th k=3 for ^{226}Ra k=4 for ^{210}Pb
QAJUST (10,2,20)	Real	Adjustment factors for particulate and radon emissions for each source and timestep. Usage is as follows: QAJUST(i,1,j), adjustment factor for the particulate activities defined for source j that are released during timestep i (see SORCE), QAJUST(i,2,j), adjustment factor for radon activity defined for source j that is released during timestep i.

TABLE 4.2-4. (Cont'd)

Parameter (Dimensions)	Type	Description
SORCE(12,20)	Real	Data defined for each effluent sorce term j:
		SORCE(1,j) = x coordinate for source j, kilometers. A positive value indicates east and a negative value indicates west of the mill center.
		SORCE(2,j) = y coordinate for source j, kilometers. A positive value indicates north and a negative value indicates south of the mill center.
		SORCE(3,j) = elevation of source j, meters, above or below (negative values) the mill center.
		SORCE(4,j) = areas of source j in square kilometers. A value of zero should be used for point sources such as stacks.
		SORCE(5,j) = annual average release rate of ^{238}U for source j, curies/year.
		SORCE(6,j) = annual average release rate of ^{230}Th for source j, curies/year.
		SORCE(7,j) = annual average release rate of ^{226}Ra for source j, curies/year.
		SORCE(8,j) = annual average release rate of ^{210}Pb for source j, curies/year.
		SORCE(9,j) = annual average release rate of ^{222}Rn gas from source j, curies/year.

TABLE 4.2-4. (Cont'd)

Parameter (Dimensions)	Type	Description
		SORCE(10,j) = identification number for source j. A value of SORCE(10,j) ≥ 2000 causes the code to generate source terms for particulate releases (^{238}U, ^{230}Th, ^{226}Ra and ^{210}Pb) for source j (subroutine TAILPS). This option is generally used for area sources. Values for ^{222}Rn gas must always be supplied by the user. For SORCE(10,j) ≥2000, any user supplied numbers for SORCE(5-8,j) will be ignored.
		SORCE(11,j) = assigned particle size distribution set number for source j. The valid values are 1, 2 or 3. Table 4.2-3 summarizes the characteristics of each particle size distribution.
		SORCE(12,j) = product of stack inside diameter(m) and effluent exit velocity (m sec^{-1}) for source j, m^2 sec^{-1}. Area sources should have SORCE (12,j) set to zero.

All default values for SORCE array are 0.0.

TABLE 4.2-5. 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. FREQ(i,j,k) $\geq$ 0, $\sum_{i,j,k}$ FREQ(i,j,k) $\approx$ 1.00
DM	Real	Annual average mixing height, meters. (If not specificied by user, program uses default value of 1000 meters).

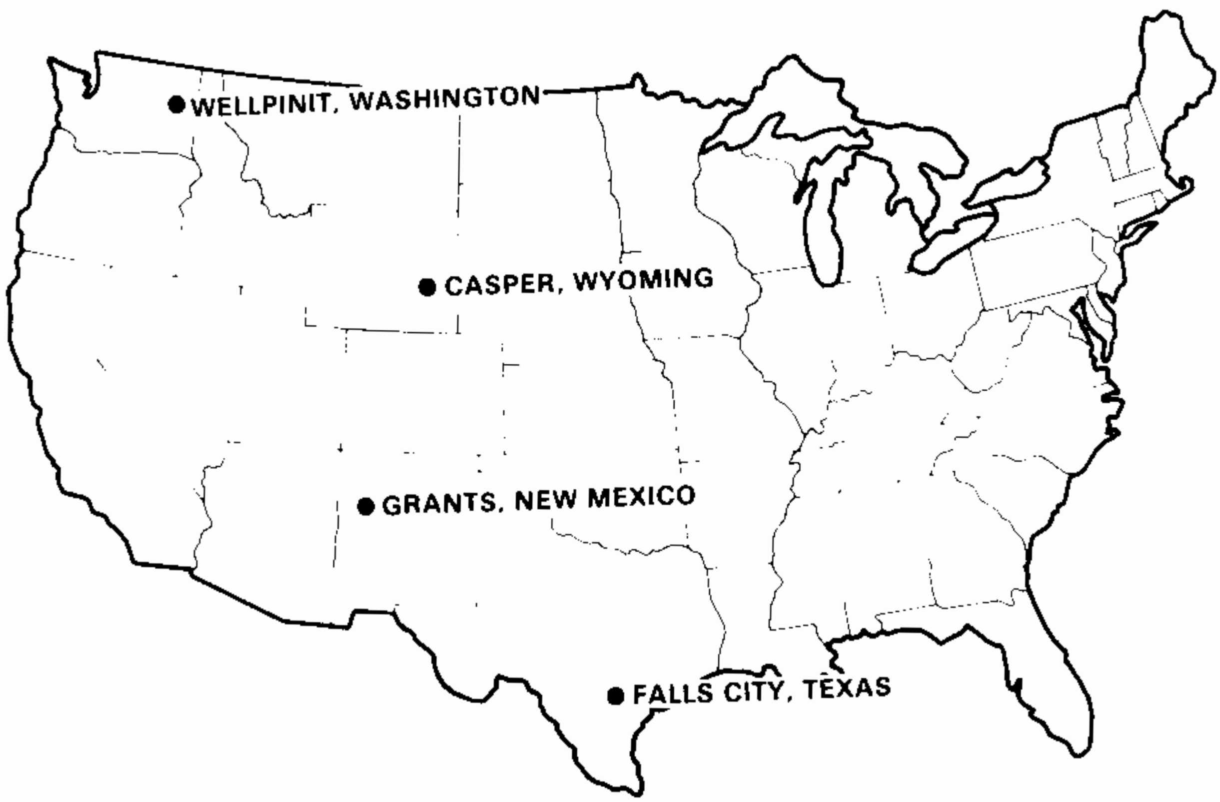


FIGURE 4.2-1. Geographical Locations of Reference Radon Release Sites for Continental Population Doses

4.2.4 Pathway Parameters

Several parameters used in the food pathway model are to be supplied by the user. Four parameters are required for the animal product pathway describing the feeding habits of livestock near the mill site. The parameters FFORI and FFORP give the fraction of total annual feed requirements that are provided as pasture grass for the individual doses and population doses, respectively. The parameters FHAYI and FHAYP give the fraction of total annual food requirements that are provided as locally grown stored hay for the individual doses and population doses, respectively. These numbers are fractions that must be entered as non-negative real numbers between zero and one. A default value of 0.5 is used for any of the above parameters that are not supplied in the input set. Further restrictions on the parameters are

$$\mathrm{FFORI} + \mathrm{FHAYI} \leq 1.0$$

and

$$\mathrm{FFORP} + \mathrm{FHAYP} \leq 1.0$$

The array parameter FPR gives the food production rate for the region for three food types: vegetables, meat and milk. These rates may be selected from Table 4.2-6 which gives food production rates for various states where mining and milling operations are prevalent.

The food pathway parameters are presented in Table 4.2-7.

4.2.5 Population Distribution Parameters

The population distribution within 80 km of the mill center is provided by the integer array IPOP. This array gives the number of people living in each of twelve distance intervals in sixteen downwind directions (see Figure 2.0-1). The distance intervals are (km):1-2, 2-3, 3-4, 4-5, 5-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80. The direction representations are the same as those defined for the meteorological parameter FREQ (i.e., beginning with the north sector).

The population dose calculations beyond 80 km are based on total U.S. population growth relative to the year 1978. The array PAJUST gives the relative population during each time step compared to the 1978 population. Projected populations of the U.S. are given in Table 4.2-8 as taken from USNRC (1979). Population distribution parameters are described in Table 4.2-9.

TABLE 4.2-6. Average Agricultural Productivity Factors for Various States

State	State-Average Productivity* (kg/yr per km^2) Vegetables	Meat	Milk
Arizona	580	1,040	1,130
Colorado	2,800	3,200	1,400
Idaho	14,200	2,000	3,400
Montana	1,800	2,000	370
Nevada	18	510	230
New Mexico	280	1,150	460
South Dakota	2,400	6,400	3,600
Texas	1,200	5,300	2,100
Utah	370	790	1,800
Washington	10,700	1,600	6,000
Wyoming	320	1,400	230

* Data presented are based on an NRC staff survey.

4.2.6 Individual Receptor Location Parameters

The user may define up to a maximum of thirty locations where doses to individuals will be calculated such as non-restricted locations subject to 10 CFR 20 air concentration limits. The parameter IADD gives the number of individual receptor locations to be considered and the array XRECEP gives coordinates defining the locations. These parameters are described in Table 4.2-10.

TABLE 4.2-7. Food Pathway Parameters

Parameter (Dimensions)	Type	Description
FFORI	Real	Fraction of total annual feed requirements assumed to be satisfied by pasture grass used for calculation of individual doses. Default value is 0.5
FFORP	Real	Fraction of total annual feed requirements assumed to be satisfied by pasture grass, used for calculation of population doses. Oefault value is 0.5.
FHAYI	Real	Fraction of total annual 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 feed requirements assumed to be satisfied by locally grown stored feed, used for calculation of population doses. Oefault value is 0.5.
FPR(3)	Real	Areal food production rate for 1) vegetables, 2) meat and 3) milk in the region of the mill site. (Suggested values are given in Table 4.2-6).

TABLE 4.2-8. Projected Population of the United States, 1978-2100

Year	Projected U.S. Population, millions	Year	Projected U.S. Population, millions
1978	218.4	1992	247.4
1979	220.2	1993	249.3
1980	222.2	1994	251.1
1981	224.2	1995	252.8
1982	226.3	1996	254.4
1983	228.5	1997	255.9
1984	230.7	1998	257.5
1985	232.9	1999	258.9
1986	235.1	2000	260.4
1987	237.2	2025	287.5
1988	239.4	2050	291.1
1989	241.5	2075	291.9
1990	243.5	2100	293.0
1991	245.5		

TABLE 4.2-9. 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 i-th distance interval and the j-th direction, where j = 1 indicates north.
PAJUST(10)	Real	Ratio of the U.S. population during each time step to that during the year 1978. A value must be given for each of the NSTEP timesteps in order. These values are used to obtain the proper continental population doses as a function of the time of exposure.

TABLE 4.2-10. Individual Receptor Location Parameters

Parameter (Dimensions)	Type	Description
IADD	Integer	This parameter specifies the number of location for which individual doses will be calculated $1 \leq$ IADD ≤ 48.
XRECEP(3,48)	Real	This array gives coordinates of each individual receptor location. For each receptor i, the data is entered as follows: XRECEP(i,i), distance in kilometers to the east (positive value) or west (negative value) of the mill center. XRECEP(2,i), distance in kilometers to the north (positive value) or south (negative value) of the mill center. XRECEP(3,i), elevation of the receptor in meters above (positive value) or below (negative value) the mill center elevation.

4.2.7 Time History Parameters

This data set describes the time history of the mill operation. The year of initial release is given by parameter TSTART. The mill lifetime is divided into timesteps based on transition points in the mill life and tailings management plans, such as changing from a dry grinding to a semi-autogenous grinding. Up to 10 timesteps can be defined. The number of timesteps is specified by NSTEP and the length of each timestep is given in array TSTEP. A minimum value of 2 years is allowed for each defined timestep to accommodate mechanisms such as resuspension. The time history parameters are described in Table 4.2-11.

Remember to insert a "$END" (starting in the 2nd column) card at the end of the NAMELIST parameter cards.

4.3 Title Cards

The NAMELIST card set is followed by a set of title cards which contain descriptive labels used on output reports. The title card set contains four types of label information as follows:

- identification of the region and meteorological data
- source identification
- identification of individual receptor locations
- timestep identification

The region and meteological data information is contained on one card with the following format.

Name	Columns	Format	Description
REGION(6)	1-24	6A4	Region identification
METSET(4)	31-46	4A4	Meteorological data identification

TABLE 4.2-11. Time History Parameters

Parameter (Dimensions)	Type	Description
NSTEP	Integer	Number of timesteps used to define the mill lifetime. $1 \leq NSTEP \leq 10$. (maximum of 10).
TSTART	Real	Year of initial effluent release in years A.D. Fractional values (non-integer) are used to account for startup during a year i.e. 1980.5 would indicate startup at the beginning of July 1980.
TSTEP(10)	Real	The length of each timestep in years. The number of values to be given is equal to NSTEP (see below). A minimum value of 2 years is assumed, i.e., if a smaller value is given it will be set to 2 years.

The variable NSORCE defines the number of sources to be considered. The labels for each of the NSORCE sources are read one per card on the next NSORCE cards with the following format:

Name	Columns	Format	Description
QNAME(5,j)	1-20	5A4	Label for source j.

Exactly NSORCE cards must be given or there will be confusion in headings and labels throughout the output.

The number of individual receptor locations to be considered is given by the NAMELIST variable IADD. Identification of the individual receptor locations is given one per card on the next IADD cards. The format is:

Name	Columns	Format	Description
XNAME(5,i)	1-20	5A4	Label for individual receptor location i

The number of these cards must be exactly IADD or confusion in output headings will result.

The number of timesteps is given by the NAMELIST variable NSTEP. Descriptive labels for each timestep are provided on the next NSTEP cards, one label per card, with the following format:

Name	Columns	Format	Description
TNAME(5,k)	1-20	5A4	Timestep k identification label

There must be exactly NSTEP of these cards.

The order of the labels within each of the last three sets must coincide with the order in which each item was defined: the source labels must agree with array SORCE; the receptor labels must agree with array XRECEP; and the timestep data must agree with array TSTEP. Labels exceeding the column limitations are truncated (i.e., extra characters are ignored). The title card set completes the input for MILDOS. Some type of end-of-data card may be required at the end of the data set depending on requirements of the computer system being used.

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*Available for purchase from the National Technical Information Service, Springfield, VA 22161.

**Available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and/or the National Technical Information Service, Springfield, VA 22161.

APPENDIX A - PROGRAM STRUCTURE

This appendix provides information related to program structure and data transfer used by MILDDS. The information is presented to aid in the understanding of the program by persons desiring to make modifications or updates to the present version.

The program MILDOS is composed of sixteen modules including the main program, subroutines and functions. Nine systems routines are also referenced. Data transfer is performed mainly through ten labeled common blocks. The hierarchy of the modules is described in Section A.1 and details of each module are given in Section A.3. The labeled common blocks are described in Section A.2.

A.1 HIERARCHY

The hierarchy of the sixteen modules in the MILDOS program is shown in Figures A.1-1 and A.1-2. These diagrams indicate calling sequence and give a brief description of the purpose of each module. Control logic is not indicated in these figures. A more detailed description of each module is given in Section A.3.

In addition to the sixteen modules shown in the hierarchy diagram nine systems routines are used by MILDOS. These routines are standard FORTRAN functions except for subroutine SYSTEMC and function DATE. These two routines, specific to CDC computers, are used only in the main program MILDOS. The function DATE returns a ten character word giving the current day-of-year (month/day/year). The system routine SYSTEMC is called to suppress printing of a diagnostic message for argument underflow for the EXP function.

A.2 COMMON BLOCKS

The majority of data transfers between modules is handled through labeled common blocks. MILDOS uses ten labeled common blocks with usage as indicated in Table A.2-1. The general purpose of each common block is given below.

Common Block	Type of Parameters
ADATA	Meteorological, source, receptor, dispersion
BDATA	Source, receptor, particle size
CDATA	Source, timestep, options, adjustment factors
DDATA	Dose factor, exposure pathway
EDATA	Population, radon release, population dose
FDATA	Receptor, exposure pathway
GDATA	Page title, headings
DEPY	Particle deposition results
DSTBZ	Dispersion (for particle deposition)
INTG	Particle deposition.

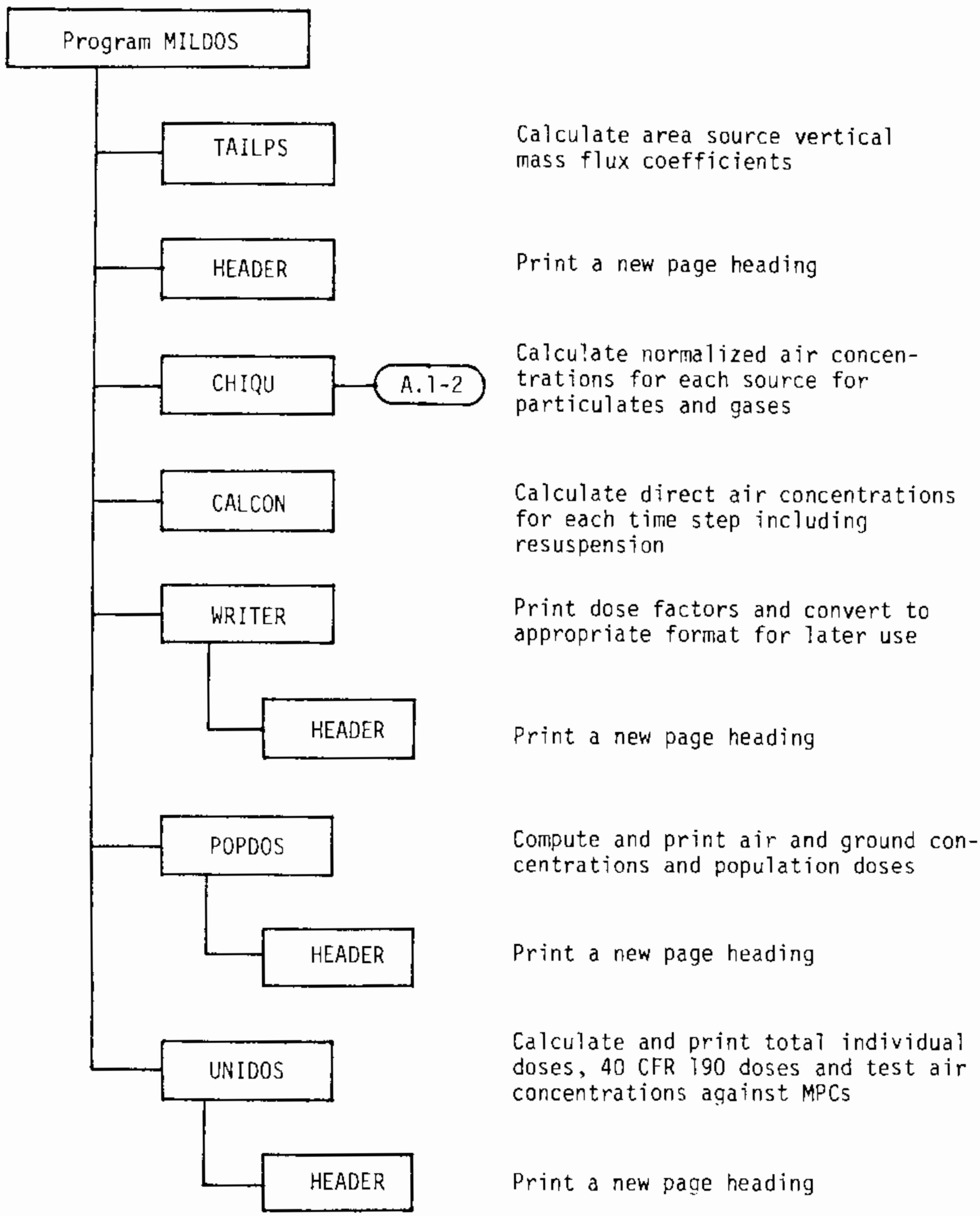

FIGURE A.1-1 Hierarchy Diagram for Main Program MILDOS

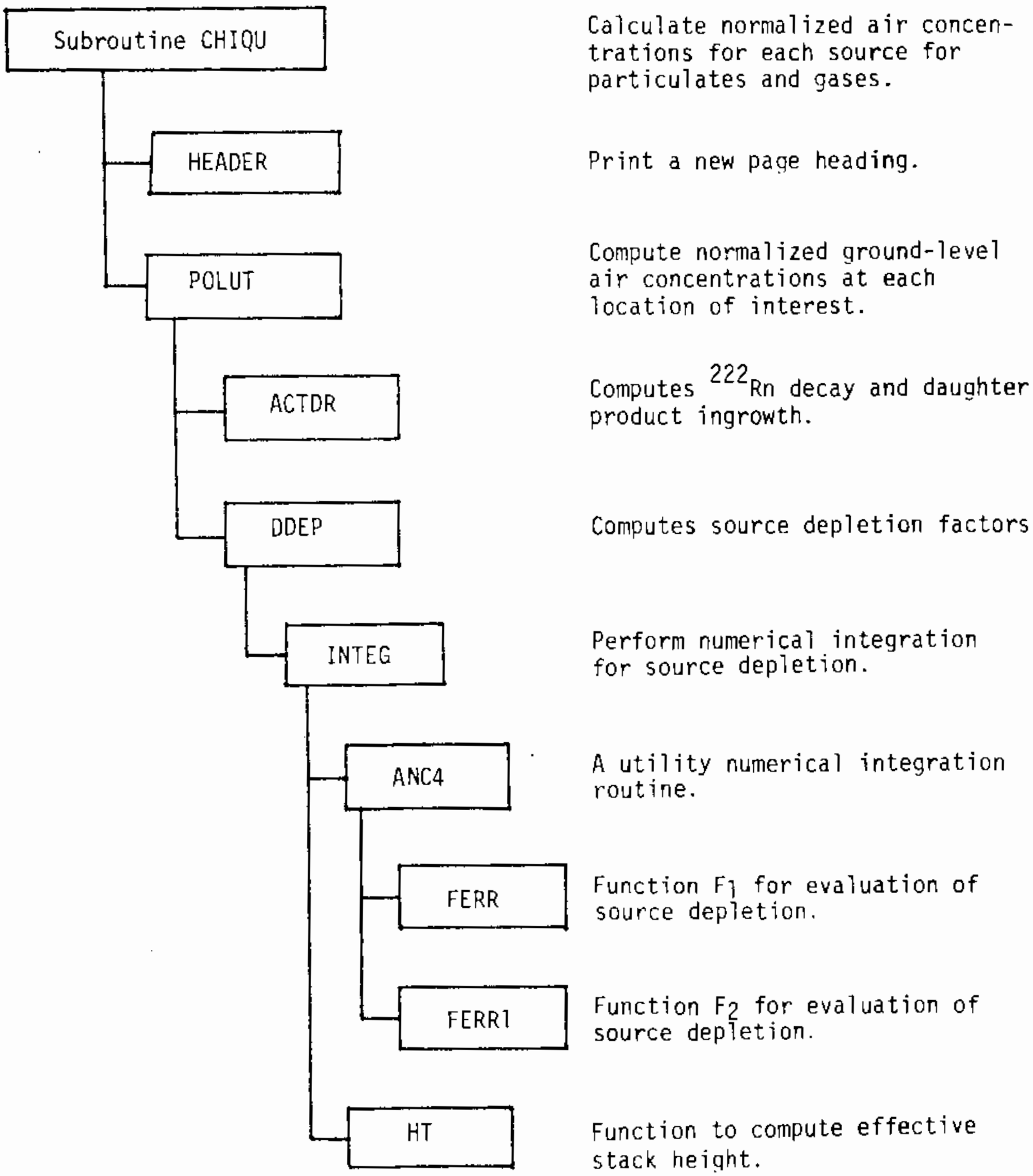

FIGURE A.1-2 Hierarchy Diagram for Subroutine CHIQU

TABLE A.1-1 Labeled Common Block Usage in MILDOS

Module name	ADATA	BDATA	CDATA	DDATA	EDATA	FDATA	GDATA	DEPY	DSTBZ	INTG
MILDOS	used	used	used	used	used	used	used	--	--	--
FRESH (block data)	used	used	used	used	used	used	used	--	--	--
ACTOR	used	--	--	--	--	--	--	--	--	--
ANC4	--	--	--	--	--	--	--	--	--	--
CALCON	--	used	used	--	--	--	--	--	--	--
CHIQU	used	used	--	--	--	--	--	--	--	--
DDEP	used	--	--	--	--	--	--	used	--	used
FERR	--	--	--	--	--	--	--	--	used	--
FERR1	--	--	--	--	--	--	--	--	used	--
HEADER	--	--	--	--	--	--	used	--	--	--
HT	used	--	--	--	--	--	--	--	--	--
INTEG	used	--	--	--	--	--	--	--	used	used
POLUT	used	--	--	--	--	--	--	used	--	--
POPDOS	--	used	used	used	used	--	--	--	--	--
TAILPS	--	--	--	--	--	--	--	--	--	--
UNIDOS	--	used	used	used	--	used	--	--	--	--
WRITER	--	--	used	used	used	used	--	--	--	--

Note: Any variations or changes to any array's dimensions, or addition or deletion of variables in any module's common block must be exactly duplicated in all other modules which reference the same common block.

A.3 Description of Modules

This section presents information on each of the sixteen modules of MILDOS useful to the programmers desiring to make modifications to MILDOS. The information provided in the sections which follow includes:

- purpose of module
- functions performed
- calling routine
- argument list
- common block usage
- subordinate modules

The main program (module MILDOS) is described first followed by other subroutines and functions in alphabetical order.

A.3.1 Main Program MILDOS

The main program controls input of all user supplied data, prints reports of input data, calls subordinate routines to perform calculations, and performs intermediate calculations. The following modules are referenced:

- TAILPS - calculate vertical mass flux coefficients (TAILP) which are used to compute activity releases from exposed tailings surfaces (area sources).
- HEADER - print page heading showing descriptive titles (for the site and meteorological data set), date and page number.
- CHIQU - compute normalized air concentrations for particulates (RXQ array) and gaseous (RXQRN array) releases, sec/m^3.
- CALCON - calculate air concentrations and ground concentrations for each radionuclide.
- WRITER - write dose conversion factor reports, and other pathway and timestep information.

- POPDOS - calculate and print requested population doses (both 100-year EDC and annual) and concentrations.
- UNIDOS - calculate total individual doses, 40 CFR 190 individual doses, and check air concentrations against 10 CFR 20 MPC values as requested.

A call to subroutine HEADER is made to write headings for each new page. HEADER is called from several subroutines.

Each execution of MILDOS allows one set of data to be analysed: multiple cases are not allowed.

MILDOS references the seven labeled common blocks: ADATA, BDATA, CDATA, DDATA, EDATA, FDATA AND GDATA. These common blocks transmit input parameters needed in MILDOS. These same common blocks are referenced in the block data set FRESH where many parameter values are initialized.

A.3.2. Subroutine ACTDR

This subroutine calculates decayed activities for ^{222}Rn and its daughters (see Equations 2.2-28 and 2.2-29). This routine is called by subroutine POLUT. Decay parameters are supplied through labeled common block ADATA. The two argument list parameters have the following uses:

Parameter	Description
TIME	Time period over which the decay and daughter ingrowth is to be calculated, seconds.
N1	Number of decay chain members to be considered including the parent. N1 is set to 7 in the call statement. $2 \leq N1 \leq 7$.

The results of the calculation are returned through array ACTIV(7) which gives the activity of each radionuclide relative to one curie of ^{222}Rn present at time zero. The radionuclides in the decay chain as currently defined in MILDOS are:

Chain member	Radionuclide
1	^{222}Rn
2	^{218}Po
3	^{214}Pb
4	^{214}Bi
5	^{210}Pb
6	^{210}Bi
7	^{210}Po

A.3.3 Function ANC4

This function is a numerical integration routine used to evaluate the integrals F_1 and F_2 (see Equations 2.2-21 and 2.2-22) used in calculating the source depletion factor. ANC4 is called by subroutine INTEG. The argument list for ANC4 is:

Argument	Description
A1	Lower limit of integration (distance from source)
B1	Upper limit of integration (distance from source)
EP	Error criteria for determining completion of numerical integration iterations. A value of 1×10^{-4} is supplied in the calling subroutine INTEG.
M	This output parameter gives the number of points used in the integral evaluation.
N	This integer selects the criteria used for determining completion of the integration. $1 \leq N \leq 3$. The uses of N are as follows: N = 1; the value of EP determines when to stop iterating on integration. N = 2; the value of EP weighted by the current value of the integration estimate determines when to stop iterating on integration. N = 3; the value of EP weighted by the maximum value of the function being integrated determines when to stop iterating on integration.
FUN	This is the function to be evaluated. Two functions are used: FERR for evaluation of F_1 and FERR1 for evaluation of F_2.

The function ANC4 uses a Newton Cotes formula (Hillstrom, 1968)* to evaluate the integral. The closed fourth Newton-Cotes formula used in MILDOS estimates the integral of a function by dividing the interval of integration into four subintervals. The function values at each end of

* Hillstrom, K. 1968. ANC4, 05/360 Fortran IV Routine for Adaptive Quadrature Using the Fourth Newton Cotes Formula. ANL-D158,S. Argonne National Laboratory, Argonne, Illinois.

the subintervals are used to estimate the integral of the function. The subintervals are then further subdivided and a comparison between the integral estimate using these subintervals and the former estimate is made. If the comparison satisfies the error criterion supplied to the subroutine ANC4, then the integral is taken as the second estimate. If the error criterion is not satisfied, further subdivisions are made up to a maximum of thirty levels.

A.3.4 Subroutine CALCON

Subroutine CALCON calculates air concentrations and ground concentrations needed to compute requested doses. All data transfer is performed through labeled common blocks BDATA and CDATA. For the specified time step, ISTEP, the following data arrays are calculated:

Array	Description
TPSZ(4,4,240)	Air concentration (including resuspension) for 4 particle size groups, 4 radionuclides (^{238}U, ^{230}Th, ^{226}Ra and ^{210}Pb) and 240 receptor locations (192 for the 12 x 16 spatial interval grid plus 48 for individual receptors) pCi m^{-3}.
CISUM(7,240)	Direct air concentration from all sources for radon and daughters and for each receptor location (as defined for TPSZ above), pCi m^{-3}.
CGIP(4,4,240)	Ground concentrations (pCi m^{-2}) for 4 particle size groups, 4 radionuclides and 240 receptor locations (as defined for TPSZ above).
CGXRN(4,240)	Ground concentrations (pCi m^{-2}) for radon daughters for each receptor location (as defined for TPSZ above).

When 100 year environmental population dose commitments are to be calculated, concentrations (TPSZ, CGIP and CGXRN) are calculated for the 192 spatial intervals in the 80 km grid. The 100 year values are calculated when JC(2)=1, as described in Section 4.2. Calculations are always made for the individual receptor locations.

A.3.5. Subroutine CHIQU

This subroutine computes normalized air concentrations for transport of material in each particle size fraction and for radon and each daughter radionuclide. CHIQU is called by the main program MILDOS. Two labeled common blocks are referenced by CHIQU: ADATA and BDATA. The argument list parameter NPRINT is used to cause printing of calculated normalized air concentrations. A report is printed when NPRINT = 1. This parameter is supplied by the user as JC(5) as described in Section 4.2.

The calculated air concentrations are returned through common block BDATA as arrays RXQ and RXQRN:

> RXQ(20, 240, 4) - normalized air concentration for particulates in 4 size fractions for each of 20 sources and at each receptor location (240 = 192 spatial grid points plus 48 individual receptor locations), sec m^{-3},
>
> RXQRN(20, 240, 7) - normalized air concentration for ^{222}Rn and six daughters (^{218}Po, ^{214}Pb, ^{214}Bi, ^{210}Pb, ^{210}Bi and ^{210}Po), twenty sources and 240 receptor locations (as defined for RXQ above), sec m^{-3}.

The subroutine POLUT is called by CHIQU to generate normalized air concentration values for one combination of source term, atmospheric stability class, wind direction, receptor location and wind speed. Radon decay and daughter ingrowth is handled in subroutine POLUT.

A.3.6 Subroutine DDEP

This subroutine calculates the fraction of material remaining in the plume after depletion by dry deposition processes. DDEP evaluates the depletion factor as defined by Equations 2.2-18 through 2.2-20. The evaluation is made as a function of windspeed class and particle size fraction for a given source, receptor location and atmospheric stability class.

DDEP is called by subroutine POLUT with the following argument list:

Parameter	Description
SIGZ	Standard deviation of the plume concentration distribution in the vertical direction at the receptor location for the given atmospheric stability class, meters.
DNWIND	Downwind distance to the receptor location, meters.
X1	Starting point (nearest the source) for the integration over distance, meters. (If less than 100 meters, X1 is set to 100 meters.)
PHT	Effective plume height at the receptor location, meters.
L1	Atmospheric stability class index.

The integral evaluation is performed through calls to subroutine INTEG.

Three labeled common blocks are referenced by DDEP as follows:

- ADATA • to provide basic data,
- INTG • to communicate with the integration routine INTEG,
- DEPY • to return results to the calling routine POLUT.

The calculated depletion factors are transmitted in two arrays QXQR and QXQ:

QXQR(j) - fraction of material remaining in the plume for deposition at 0.01m sec^{-1} for each windspeed class j,

QXQ(i,j) - fraction of material remaining in the plume for deposition at calculated deposition velocities for each particle size class i and windspeed class j.

The array QXQ is used in POLUT to calculate the air concentration of particulates. The array QXQR is not used outside of DDEP.

A.3.7 Function FERR

This function is used to evaluate the kernel of the integral F_1 in Equation 2.2-21. The argument list parameter X (meters) is the downwind distance at which the evaluation is to be made. The labeled common block DSTBZ is used to provide necessary data parameters for the evaluation. FERR is named as an external function in subroutine INTEG and is called through the integration routine ANC4.

A.3.8 Function FERR1

This function is used to evaluate the kernel of the integral F_2 in Equation 2.2-22. The argument list parameter X (meters) is the downwind distance at which the evaluation is to be made. The labeled common block DSTBZ is used to provide necessary data parameters. FERR1 is named as an external function in subroutine INTEG and is called through the integration routine ANC4.

A.3.9 Subroutine HEADER

This subroutine writes a new page heading at the beginning of each output report. Data are transmitted through labeled common block GDATA. The following parameters are printed in the heading.

Parameter	Format	Description
REGION(6)	6A4	Descriptive title for site identification,
TODAY	A10	Current date expressed as MM/DD/YY,
METSET(4)	4A4	Descriptive title for the meteorological data set,
KPAGE	I4	Current page number.

The page count index KPAGE is initialized in block data FRESH and is incremented on each call to subroutine HEADER.

A.3.10 Function HT

This function calculates the effective plume height by the tilted plume model. This model is described by Equation 2.2-11. The argument list parameters have the following uses:

Parameter	Description
I	Particle size fraction index,
PHT	Effective plume height corrected for plume rise (if applicable),
XP	Downwind distance, meters, for the current evaluation,
U	Average windspeed, m sec^{-1}, for the windspeed class of interest.

This function is called by subroutine INTEG in conjunction with the plume depletion calculation. The function value returned, HT, is actually the square of the calculated effective height.

A.3.11 Subroutine INTEG

This subroutine controls integration for evaluation of plume depletion factors. The function ANC4 is used to perform the numerical integration. The two external functions FERR and FERR1 are referenced (through ANC4) to evaluate the functions F_1 and F_2, respectively. The four argument list parameters have the following uses:

Parameter	Description
INDEX	Control integer to select evaluation function: INDEX $\leq$ 1 for F_1 (function FERR) INDEX > 1 for F_2 (function FERR1)
XI	Starting downwind integration distance, m.
XN	Ending downwind integration distance, m.
PHT	Effective plume height, m.

The function HT is used to evaluate the effective plume height correction using the titled plume model for particulate settling. Intermediate parameters in the evaluation of plume depletion factors are transmitted to the calling routine DDEP through the labeled common block INTG using parameters SUM and SUMP. The labeled common block ADATA is also used by INTEG.

A.3.12 Subroutine POLUT

This subroutine calculates the increments to normalized air concentration for one combination of source term, atmospheric stability class, wind direction, receptor location and windspeed class. The appropriate increments are summed and stored in arrays TPSZ and CISUM, which are then used to evaluate RXQ and RXQRN in subroutine CHIQU. Specific calculations made include:

- distance between source and receptor (virtual source distance for area sources),
- plume rise correction to effective plume height,
- plume height correction for particle settling (tilted plume model),
- vertical dispersion parameter, σ_z, at the downwind distance,
- nearness of plume to mixing height,
- plume depletion by particulate deposition (subroutine DDEP),
- radon decay and daughter radionuclide ingrowth (subroutine ACTDR).

POLUT is called by subroutine CHIQU with one argument, the parameter array, PSORC. This array gives the source strength for the current source and each radionuclide: ^{238}U, ^{230}Th, ^{226}Ra and ^{210}Pb. The source strength represents the average annual release rate in Ci $year^{-1}$.

Common blocks ADATA and DEPY are used by subroutine POLUT. Common block DEPY is used to receive intermediate parameters from subroutine DDEP.

The subroutine DDEP is called to calculate plume depletion factors and the subroutine ACTDR is called to calculate radioactive decay and daughter product ingrowth for ^{222}Rn.

A.3.13 Subroutine POPDOS

This subroutine computes all requested population doses and prints reports. Data transfer is through labeled common blocks BDATA, CDATA, DDATA, and EDATA. Subroutine HEADER is called for each report heading. Output reports are illustrated in the sample problem output listings in Sections C.2 and C.4. Reports are printed as requested by the user through control integers described in Section 4.2.1.

A.3.14 Subroutine TAILPS

This subroutine computes the vertical mass flux coefficients used to calculate releases from area sources. TAILPS is called by the main program. The two argument list parameters have the following use:

Parameter	Description
TAILP(6)	This six member array returns vertical mass flux coefficients for each of the six windspeed classes. Units are g cm^{-2} sec^{-1}.
UU(6)	This six membered array supplies average windspeed values for each windspeed class. Units are m/sec. Values for UU are defined in block data FRESH. These values correspond to the windspeed ranges used in defining the meteorological data array FREQ.

This module implements Equations 2.2-1 through 2.2-4. These equations use the following parameter values

- surface roughness height z_0 = 1 cm
- characteristic windspeed height z = 100 cm
- density of tailings grains ρ_s = 2.4 g cm^{-3}
- average grain diameter d = 300 μm
- percent of tailings mass that has a diameter smaller than 20μm, p = 3.0

A.3.15 Subroutine UNIDOS

The reports printed by this subroutine present the ultimate output for the MILDOS program including detailed and summary information for 10 CFR 20 and 40 CFR 190 impacts and MPC comparisons. Data transfered is through labeled common blocks BDATA, CDATA, DDATA and FDATA. The subroutine HEADER is called to print a page heading for each report. Sample output reports are illustrated in the sample problem output listings in Sections C.2 and C.4.

A.3.16 Subroutine WRITER

This subroutine writes a report of dose conversion factors and combines dose conversion factors for more efficient use in dose calculations. Terrestrial pathway environmental concentration factors are also listed. The subroutine HEADER is called to write a report heading. Data are supplied through labeled common blocks CDATA, DDATA, EDATA and FDATA.

APPENDIX B - COMPUTER PROGRAM LISTING

This appendix presents a listing of the FORTRAN code for the computer program MILDOS. The listing of the main program (MILDOS) is given first followed by the other modules in alphabetical order in Figure B.0-1. A listing of the block data procedure FRESH is given in Figure B.0-2.

FIGURE B.0-1. Program MILDOS Listing

```
      PROGRAM MILDOS(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)               MILDOS
C         THIS IS PROGRAM MILDOS, REVISION 0       ...CREATED JULY79      MILDOS
C                                                                         MILDOS
C******************** ************************************************** MILDOS
C                                                                         MILDOS
C     MILDOS IS A COMPREHENSIVE COMPUTER CODE FOR THE EVALUATION OF       MILDOS
C     RADIOLOGICAL IMPACTS RESULTING FROM URANIUM MILLING OPERATIONS.     MILDOS
C                                                                         MILDOS
C     THIS CODE IS CURRENTLY EMPLOYED BY THE NRC STAFF IN THE PERFORM-    MILDOS
C     ANCE OF LICENSING EVALUATIONS WITH RESPECT TO URANIUM MILLS AND     MILDOS
C     OTHER FRONT-END FUEL CYCLE FACILITIES. IT IS AVAILABLE TO THE       MILDOS
C     PUBLIC. FOR INFORMATION CONTACT O. MARTIN OR G. GNUGNOLI BY PHONE   MILDOS
C     AT 301-427-4103 OR WRITE TO U.S.NRC, WASHINGTON, D.C. 20555.        MILDOS
C                                                                         MILDOS
C     MILDOS IS AN NRC ADAPTATION OF VERSION IV OF THE ARGONNE NATIONAL   MILDOS
C     LABORATORY URANIUM DISPERSION AND DOSIMETRY (UDAD) CODE.            MILDOS
C                                                                         MILDOS
C******************** ************************************************** MILDOS
       REAL HLM,ACTIV,GMAT,DUMMY,DATE,TODAY                               MILDOS
C                                                                         MILDOS
      LEVEL 2, NSORCE,NRECEP,TPSZ,CISUM,IPACT,PACT,PDEN,DUST20,ACTRAT,    MILDOS
     1 PTSZ20,RXQ,RXQRN,PTSZ,QNAME                                        MILDOS
C                                                                         MILDOS
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),       MILDOS
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),      MILDOS
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,     MILDOS
     3 ISORCI,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,          MILDOS
     4 PINK(4,4),RINK(7)                                                  MILDOS
C                                                                         MILDOS
      COMMON/BDATA/NSORCE,NRECEP,TPSZ(4,4,240),CISUM(7,240),IPACT(20),    MILDOS
     1 PACT(3,4),PDEN(4),DUST20(6),ACTRAT,PTSZ20,RXQ(20,240,4),           MILDOS
     2 RXQRN(20,240,7),PTSZ(4),QNAME(5,20)                                MILDOS
C                                                                         MILDOS
      COMMON/CDATA/QAJUST(10,2,20),DEPVEL(4),CPY(5,20),ISTEP,IRCV,IADD,   MILDOS
     1 ALN2,TSTEP(10),ALF(6),GFACT(4,10),GPFACT(4),TFACT(4,10),NSTEP,     MILDOS
     2 TPFACT(4),CGIP(4,4,240),CGXRN(4,240),JC(10),XPFACT                 MILDOS
C                                                                         MILDOS
      COMMON/DDATA/WLFACT(3),DCFA(5,7,5),DCFGP(4),DCFCP(4),DCFGR(5),      MILDOS
     1 DCFCR(5),DCFF(8,4,4),BIV(4,5),FBI(4),FMI(4),QF,SHIELD,RF(3),       MILDOS
     2 FREP(4,5),TISSUE(6),PATH(8),SRHO,WHL,TSTART,IFTODO(10),            MILDOS
     3 TNAME(5,10)                                                        MILDOS
C                                                                         MILDOS
      COMMON/EDATA/FFORP,FHAYP,FPR(3),IPOP(12,16),WINDR(16),XRHO(12),     MILDOS
     1 IPTOT,FRADON(4),PAJUST(10),PDREG(6,8,10),PDXREG(6,8,10),           MILDOS
     2 PDTOT(6,8,10)                                                      MILDOS
C                                                                         MILDOS
      COMMON/FDATA/XNAME(5,48),FFORI,FHAYI,IRTYPE(48),XRECEP(3,48),       MILDOS
     1 DIST(48),UOF(4,3) FBVT(4,3)                                        MILDOS
C                                                                         MILDOS
      COMMON/GDATA/METSET(4),REGION(6),KPAGE,TODAY                        MILDOS
C                                                                         MILDOS
      DIMENSION FREQWS(6),IARY(5),IPBD(16),UUMPH(6),TAILP(6),TA(16),      MILDOS
     1  TB(16),TD(16),TINC(16),HFLFE(7),NUMBER(10),RHALF(6),THETAS(16)    MILDOS
C******************** ************************************************** MILDOS
      DATA IARY/5*0/                                                      MILDOS
      DATA FREQWS/6*0./                                                   MILDOS
      DATA IPBD/16*0/                                                     MILDOS
      DATA UUMPH/1.50,5. 0,10.0,15.5,21.5,28.0/                           MILDOS
      DATA TAILP/0.,0.,3.920E-5,9.6753E-4,5.7046E-3,2.0750E-2/            MILDOS
      DATA HFLFE/3.03E5,1.83E2,1.608E3,1.194E3,7.038E8,4.329E5,1.196E7/   MILDOS
      DATA NUMBER/1,2,3,4,5,6,7,8,9,10/                                   MILDOS
      DATA RHALF/4.47E9,7.7E4,1.6E3,2.23E1,1.372E-2,3.789E-1/             MILDOS
C******************** ************************************************** MILDOS
      NAMELIST/INDATA/FREQ,NSORCE,SORCE,DM,PACT,IPACT,TSTART,IFTODO,FPR,  MILDOS
     1  FFORI,FHAYI,FFORP,FHAYP,IADD,IRTYPE,IPOP,JC,XRECEP,QAJUST,TSTEP,  MILDOS
     2  NSTEP,FRADON,PAJUST                                               MILDOS
C******************** ************************************************** MILDOS
C                                                                         MILDOS
```

FIGURE B.0-1. (Continued)

```
      READ(5,INDATA)                                                    MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
      IF(EOF(5).NE.0) STOP                                              MILDOS
      READ(5,4010)(REGION(I),I=1,6),(METSET(I),I=1,4)                   MILDOS
      READ(5,4020)((QNAME(I,J),I=1,5),J=1,NSORCE)                       MILDOS
      READ(5,4020)((XNAME(I,J),I=1,5),J=1,IADD)                         MILDOS
      READ(5,4020)((TNAME(I,J),I=1,5),J=1,NSTEP)                        MILDOS
C******************** ************************************************* MILDOS
C                         GLOSSARY OF INPUT DATA                        MILDOS
C******************** ************************************************* MILDOS
C     FREQ(I,J,K) IS THE FRACTIONAL JOINT FREQUENCY OF WIND FROM DIREC- MILDOS
C       TION I, IN WIND SPEED CLASS J, IN STABILITY CLASS K             MILDOS
C                                                                       MILDOS
C     NSORCE IS THE NUMBER OF EFFLUENT SOURCES INPUT                    MILDOS
C                                                                       MILDOS
C     SORCE(I,J) IS SOURCE TERM DATA FOR SOURCE J                       MILDOS
C       SORCE(1,J) IS THE X LOCATION COORDINATE, KM                     MILDOS
C       SORCE(2,J) IS THE Y LOCATION COORDINATE, KM                     MILDOS
C       SORCE(3,J) IS THE Z (HEIGHT) COORDINATE, M                      MILDOS
C       SORCE(4,J) IS THE SOURCE AREA, KM2                              MILDOS
C       SORCE(5-9,J) ARE RELEASE RATES OF U-238, TH-230, RA-226, PB-210, MILDOS
C         AND RN-222, RESPECTIVELY, CI/YR --PARTICULATE RELEASE RATES   MILDOS
C         RECOMPUTED BY CODE IFF SORCE(10,J)=2000 OR HIGHER.            MILDOS
C       SORCE(10,J) IS THE SOURCE ID NUMBER                             MILDOS
C       SORCE(11,J) IS THE ASSIGNED PARTICLE SIZE DISTRIBUTION, INTEGER MILDOS
C       SORCE(12,J) IS THE PRODUCT OF THE EXIT VELOCITY AND THE         MILDOS
C         STACK DIAMETER,M**2/SEC                                       MILDOS
C     DM IS THE ANNUAL AVERAGE ATMOSPHERIC MIXING HEIGHT, M             MILDOS
C                                                                       MILDOS
C     PACT(I,J) IS THE BULK SPECIFIC ACTIVITY OF ISOTOPE J IN SOURCE I, MILDOS
C       J=1-4 FOR U-238, TH-230, RA-226, AND PB-210, RESPECTIVELY, PCI/G MILDOS
C                                                                       MILDOS
C     IPACT(I) IS THE PACT VALUE SET ASSIGNED FOR SOURCE NUMBER I       MILDOS
C                                                                       MILDOS
C     TSTART IS THE YEAR EFFLUENT RELEASES BEGIN, E.G., 1981.5          MILDOS
C                                                                       MILDOS
C     IFTODO(I) MUST EQUAL 1 FOR CALCULATION AND PRINT OF DOSE AND      MILDOS
C       CONCENTRATION DATA FOR TIME STEP I                              MILDOS
C                                                                       MILDOS
C     FPR(I) IS THE AREAL FOOD PRODUCTION RATE OF FOOD TYPE I, I=1-3    MILDOS
C       FOR VEGETABLES, MEAT, AND MILK, RESPECTIVELY, KG/KM2-YR         MILDOS
C                                                                       MILDOS
C     FFORI IS THE FRACTION OF ANNUAL ANIMAL FEED OBTAINED BY GRAZING,  MILDOS
C       FOR USE IN CALCULATING INDIVIDUAL DOSES                         MILDOS
C                                                                       MILDOS
C     FHAYI IS THE FRACTION OF ANNUAL ANIMAL FEED CONSISTING OF LOCALLY MILDOS
C       GROWN STORED FEED, FOR USE IN CALCULATING INDIVIDUAL DOSES      MILDOS
C                                                                       MILDOS
C     FFORP AND FHAYP ARE SAME AS FFORI AND FHAYI EXCEPT THAT THEY ARE  MILDOS
C       FOR USE IN CALCULATING POPULATION DOSES                         MILDOS
C                                                                       MILDOS
C     IADD IS THE NUMBER OF INDIVIDUAL RECEPTOR LOCATIONS INPUT         MILDOS
C                                                                       MILDOS
C     IRTYPE(I) SPECIFIES DESIRED OUTPUT FOR INDIVIDUAL RECEPTOR I      MILDOS
C       IRTYPE(I=NEGATIVE NUMBER FOR NO PRINT                           MILDOS
C       IRTYPE(I)=0 FOR 10CFR20 MPC COMPLIANCE CHECK                    MILDOS
C       IRTYPE(I)=1 FOR PRINT OF TOTAL DOSES OVER ALL PATHWAYS, ONLY    MILDOS
C       IRTYPE(I)=10 FOR PRINT OF DOSES BY EXPOSURE PATHWAY (NOT ALLOWED MILDOS
C         UNLESS JC(7)=1 )                                              MILDOS
C                                                                       MILDOS
C     IPOP(I,J) IS THE INPUT POPULATION FOR ANNULUS I,IN DIRECTION J    MILDOS
C                                                                       MILDOS
C     JC(I) MUST BE INPUT AS 1 TO UTILIZE PROGRAM OPTION I              MILDOS
C       JC(1)=1 TO USE TAILPS SUBROUTINE (VALUES OF TAILP IN ABOVE DATA MILDOS
C         STATEMENT USED OTHERWISE, IF NEEDED)                          MILDOS
C       JC(2)=1 TO COMPUTE 100-YR ENVIRONMENTAL DOSE COMMITMENTS        MILDOS
C       JC(3)=1 TO OBTAIN POPDOS CONCENTRATION DATA PRINT               MILDOS
```

FIGURE B.0-1. (Continued)

```
C       JC(4)=1 TO OBTAIN POPDOS DOSE PRINT BY GRID SEGMENT              MILDOS
C       JC(5)=1 TO OBTAIN CHIQU PRINT OF X/Q DATA                        MILDOS
C       JC(6)=1 TO OBTAIN WRITER PRINT OF DOSE AND OTHER FACTORS         MILDOS
C       JC(7)=1 TO OBTAIN UNIDOS PRINT OF DOSES BY EXPOSURE PATHWAY      MILDOS
C       JC(8)=1 TO INCLUDE MILK PATHWAY IN UNIDOS CALCULATIONS           MILDOS
C       JC(9)=1 TO OBTAIN UNIDOS PRINT OF CONCENTRATION DATA             MILDOS
C       JC(10) IS NOT CURRENTLY IN USE                                   MILDOS
C                                                                        MILDOS
C     XRECEP(I,J)IS A LOCATION COORDINATE FOR INDIVIDUAL RECEPTOR J      MILDOS
C       XRECEP(1,J) IS THE X COORDINATE, KM                              MILDOS
C       XRECEP(2,J) IS THE Y COORDINATE, KM                              MILDOS
C       XRECEP(3,J) IS THE Z COORDINATE, M                               MILDOS
C                                                                        MILDOS
C     QAJUST(I,J,K) IS A FACTOR FOR MULTIPLYING THE INPUT SOURCE         MILDOS
C       STRENGTH OF SOURCE K TO GET THE DESIRED SOURCE STRENGTH OF       MILDOS
C       SOURCE K FOR THE DURATION OF TIME STEP I# J=1 FOR PARTICULATES   MILDOS
C       AND J=2 FOR RADON                                                MILDOS
C                                                                        MILDOS
C     TSTEP(I) IS THE DURATION OF TIME STEP I, YRS                       MILDOS
C                                                                        MILDOS
C     NSTEP IS THE NUMBER OF TIME STEPS TO BE UTILIZED                   MILDOS
C                                                                        MILDOS
C     FRADON(I) IS THE FRACTION OF RADON RELEASES FOR WHICH DOSES BEYOND MILDOS
C       80 KM ARE CALCULATED USING DOSE/KCI COEFFICIENTS FOR RELEASE     MILDOS
C       POINT I# I=1-4 FOR CASPER, FALLS CITY, GRANTS, AND WELLPINIT     MILDOS
C                                                                        MILDOS
C     PAJUST(I) IS THE RATIO OF THE U.S. POPULATION DURING TIME STEP I   MILDOS
C       TO THAT DURING THE YEAR 1978                                     MILDOS
C                                                                        MILDOS
C***************  FORMATTED ALPHAMERIC INPUT DATA (NAMES)  ************* MILDOS
C     FIRST CARD---                                                      MILDOS
C       REGION(6)=NAME OF PLACE (COL. 1-24)                              MILDOS
C       METSET(4)=MET DATA SOURCE (COL. 31-46)                           MILDOS
C                                                                        MILDOS
C     NEXT NSORCE CARDS---                                               MILDOS
C       QNAME(5,J)=NAME OF SOURCE J (COL. 1-20, 1 CARD/NAME)             MILDOS
C                                                                        MILDOS
C     NEXT IADD CARDS---                                                 MILDOS
C       XNAME(5,J)=NAME OF IRECEP J (COL. 1-20, 1 CARD/NAME)             MILDOS
C                                                                        MILDOS
C     NEXT NSTEP CARDS--                                                 MILDOS
C       TNAME(5,J)=NAME OF TIME STEP J (COL. 1-20, 1 CARD/NAME)          MILDOS
C                                                                        MILDOS
C******************** ************************************************** MILDOS
C                                                                        MILDOS
      TODAY=DATE(DUMMY)                                                  MILDOS
      CALL SYSTEMC(115,IARY)                                             MILDOS
      ALN2=ALOG(2.0)                                                     MILDOS
      KRHO=12                                                            MILDOS
      IFTAIL=0                                                           MILDOS
C                                                                        MILDOS
      DO 10 I=1,7                                                        MILDOS
   10 HLM(I)=ALN2/HFLFE(I)                                               MILDOS
C                                                                        MILDOS
      DO 20 I=1,7                                                        MILDOS
      DO 20 J=1,7                                                        MILDOS
      GMAT(J,I)=HLM(J)-HLM(I)                                            MILDOS
   20 GMAT(I,J)=-GMAT(J,I)                                               MILDOS
C                                                                        MILDOS
      DO 30 I=1,NSORCE                                                   MILDOS
      IF(SORCE(4,I).LE.0.0) SORCE(4,I)=1.0E-6                            MILDOS
      ID=SORCE(10,I)                                                     MILDOS
      IF(ID.GE.2000) IFTAIL=1                                            MILDOS
   30 CONTINUE                                                           MILDOS
C                                                                        MILDOS
      IF(IFTAIL.NE.1) GO TO 40                                           MILDOS
      IF(JC(1).NE.1) GO TO 40                                            MILDOS
C******************** ************************************************** MILDOS
```

FIGURE B.0-1. (Continued)

```
C                                                                       MILDOS
      CALL TAILPS(TAILP,UU)                                             MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
C                                                                       MILDOS
C     SUBROUTINE TAILPS COMPUTES VALUES OF TAILP(IWS)# THEY ARE THE     MILDOS
C     VERTICAL MASS FLUX COEFFICIENTS USED TO COMPUTE CURIE RELEASES    MILDOS
C     FROM EXPOSED TAILINGS SURFACES.                                   MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
 40   QPTAIL=0.0                                                        MILDOS
C                                                                       MILDOS
      DO 60 IWS=1,6                                                     MILDOS
      DO 50 ISTAB=1,6                                                   MILDOS
      DO 50 IWD=1,16                                                    MILDOS
 50   FREQWS(IWS)=FREQWS(IWS)+FREQ(IWD,IWS,ISTAB)                       MILDOS
      QPTAIL=QPTAIL+TAILP(IWS)*FREQWS(IWS)                              MILDOS
      DUST20(IWS)=TAILP(IWS)                                            MILDOS
 60   CONTINUE                                                          MILDOS
C                                                                       MILDOS
      DO 80 I=1,NSORCE                                                  MILDOS
      ID=SORCE(10,I)                                                    MILDOS
      IF(ID.LT.2000) GO TO 80                                           MILDOS
      IPX=IPACT(I)                                                      MILDOS
      QPX=QPTAIL*SORCE(4,I)*31.56*ACTRAT/PTSZ20                         MILDOS
      DO 70 J=5,8                                                       MILDOS
 70   SORCE(J,I)=PACT(IPX,J-4)*QPX                                      MILDOS
 80   CONTINUE                                                          MILDOS
C******************** ************************************************* MILDOS
C                                                                       MILDOS
      CALL HEADER                                                       MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
C                                                                       MILDOS
C     SUBROUTINE HEADER PRINTS THE PAGE HEADING SHOWING REGION, DATE,   MILDOS
C     METSET AND PAGE NUMBER. IT IS CALLED FOR EACH NEW PAGE PRINTED.   MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
      PRINT 4030,NSORCE                                                 MILDOS
      PRINT 4040                                                        MILDOS
      PRINT 4050                                                        MILDOS
      PRINT 4060                                                        MILDOS
C                                                                       MILDOS
      DO 90 I=1,NSORCE                                                  MILDOS
      ID=SORCE(10,I)                                                    MILDOS
      IK=SORCE(11,I)                                                    MILDOS
 90   PRINT 4070,I,(SORCE(J,I),J=1,9),ID,IK,SORCE(12,I),(QNAME(J,I),J=1, MILDOS
     15)                                                                MILDOS
C                                                                       MILDOS
      PRINT 4080,(PTSZ(I),I=1,4)                                        MILDOS
      DO 100 I=1,3                                                      MILDOS
 100  PRINT 4090,I,(PACT(I,J),J=1,4),I,(PTSZFC(J,I),J=1,4),PDEN(I)      MILDOS
      IF(NSORCE.LT.12) GO TO 105                                        MILDOS
C******************** ************************************************* MILDOS
C                                                                       MILDOS
      CALL HEADER                                                       MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
 105  CONTINUE                                                          MILDOS
      PRINT 4100, NSTEP,(NUMBER(I),I=1,10),(TSTEP(I),I=1,10)            MILDOS
      PRINT 4110                                                        MILDOS
      DO 110 K=1,NSORCE                                                 MILDOS
 110  PRINT 4120,K,(QAJUST(I,1,K),I=1,10)                               MILDOS
C                                                                       MILDOS
      PRINT 4130,NSTEP,(NUMBER(I),I=1,10),(TSTEP(I),I=1,10)             MILDOS
      PRINT 4110                                                        MILDOS
      DO 120 K=1,NSORCE                                                 MILDOS
 120  PRINT 4120, K,(QAJUST(I,2,K),I=1,10)                              MILDOS
```

FIGURE B.0-1. (Continued)

```
C******************** ************************************************* MILDOS
C                                                                       MILDOS
      CALL HEADER                                                       MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
      PRINT 4140, (FREQWS(I),I=1,6)                                     MILDOS
      PRINT 4150, (WINDR(K),K=1,16)                                     MILDOS
      PRINT 4060                                                        MILDOS
      TTC=0.0                                                           MILDOS
      TTE=0.0                                                           MILDOS
      DO 160 I=1,6                                                      MILDOS
      PRINT 4160, I                                                     MILDOS
      DO 140 J=1,6                                                      MILDOS
      DO 130 K=1,16                                                     MILDOS
      TINC(K)=FREQ(K,J,I)*100.0                                         MILDOS
      TA(J)=TA(J)+TINC(K)                                               MILDOS
  130 TB(K)=TB(K)+TINC(K)                                               MILDOS
      PRINT 4170, UUMPH(J),(TINC(K),K=1,16),TA(J)                       MILDOS
      TTC=TTC+TA(J)                                                     MILDOS
  140 TA(J)=0.0                                                         MILDOS
      PRINT 4180, (TB(K),K=1,16),TTC                                    MILDOS
      PRINT 4060                                                        MILDOS
      TTE=TTE+TTC                                                       MILDOS
      TTC=0.0                                                           MILDOS
      DO 150 K=1,16                                                     MILDOS
      TD(K)=TD(K)+TB(K)                                                 MILDOS
  150 TB(K)=0.0                                                         MILDOS
  160 CONTINUE                                                          MILDOS
      PRINT 4180, (TD(K),K=1,16),TTE                                    MILDOS
C******************** ************************************************* MILDOS
C                                                                       MILDOS
      CALL HEADER                                                       MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
      DO 170 I=1,IADD                                                   MILDOS
  170 DIST(I)=SQRT(XRECEP(1,I)**2+XRECEP(2,I)**2)                       MILDOS
C                                                                       MILDOS
      PRINT 4190, IADD                                                  MILDOS
      PRINT 4200                                                        MILDOS
      PRINT 4210                                                        MILDOS
      INK=IADD/2                                                        MILDOS
      IMP=INK*2                                                         MILDOS
      IF(IMP.LT.IADD) INK=INK+1                                         MILDOS
      DO 190 I=1,IADD                                                   MILDOS
      IT=I*2                                                            MILDOS
      IX=I+INK                                                          MILDOS
      IF(IT.GT.IADD) GO TO 180                                          MILDOS
      PRINT 4220, I,(XNAME(J,I),J=1,5),(XRECEP(J,I),J=1,3),DIST(I),     MILDOS
     1  IRTYPE(I),IX,(XNAME(J,IX),J=1,5),(XRECEP(J,IX),J=1,3),DIST(IX), MILDOS
     2  IRTYPE(IX)                                                      MILDOS
      GO TO 190                                                         MILDOS
  180 CONTINUE                                                          MILDOS
      ITT=IT-1                                                          MILDOS
      IF(ITT.GT.IADD) GO TO 190                                         MILDOS
      PRINT 4220, I,(XNAME(J,I),J=1,5),(XRECEP(J,I),J=1,3),DIST(I),     MILDOS
     1  IRTYPE(I)                                                       MILDOS
  190 CONTINUE                                                          MILDOS
C                                                                       MILDOS
      PRINT 4210                                                        MILDOS
      PRINT 4230                                                        MILDOS
      PRINT 4240                                                        MILDOS
      PRINT 4250, DM,TSTART,FFORI,FHAYI,FFORP,FHAYP,(FPR(I),I=1,3),     MILDOS
     1  ACTRAT,(IPACT(I),I=1,NSORCE)                                    MILDOS
      PRINT 4260, (JC(I),I=1,10)                                        MILDOS
      PRINT 4270                                                        MILDOS
      DO 200 I=1,NSTEP                                                  MILDOS
      IF(TSTEP(I).LT.2.0) TSTEP(I)=2.0                                  MILDOS
  200 PRINT 4280, I,(TNAME(IM,I),IM=1,5),TSTEP(I),IFTODO(I)             MILDOS
```

FIGURE B.0-1. (Continued)

```
      PRINT 4290, (XRHO(I),I=1,KRHO)                                    MILDOS
C                                                                       MILDOS
      IPTOT=0                                                           MILDOS
      DO 220 I=1,12                                                     MILDOS
      DO 210 J=1,16                                                     MILDOS
      IPBD(J)=IPBD(J)+IPOP(I,J)                                         MILDOS
  210 IPTOT=IPTOT+IPOP(I,J)                                             MILDOS
  220 CONTINUE                                                          MILDOS
C                                                                       MILDOS
      DO 230 ND=1,16                                                    MILDOS
  230 THETAS(ND)=(ND-1)*022.5)                                          MILDOS
C******************** ************************************************* MILDOS
C                                                                       MILDOS
      CALL HEADER                                                       MILDOS
C                                                                       MILDOS
C******************** ************************************************* MILDOS
      PRINT 4300                                                        MILDOS
      PRINT 4310, WINDR                                                 MILDOS
      PRINT 4320, THETAS                                                MILDOS
      PRINT 4060                                                        MILDOS
      DEL=0.5                                                           MILDOS
      DO 240 I=1,12                                                     MILDOS
      IF(I.EQ.5) DEL=2.5                                                MILDOS
      IF(I.GT.5) DEL=5.0                                                MILDOS
      DIN=XRHO(I)-DEL                                                   MILDOS
      DOUT=XRHO(I)+DEL                                                  MILDOS
      PRINT 4330                                                        MILDOS
  240 PRINT 4340, DIN,DOOT,(IPOP(I,J),J=1,16)                           MILDOS
C                                                                       MILDOS
      DIN=1.0                                                           MILDOS
      DOUT=80.0                                                         MILDOS
      PRINT 4060                                                        MILDOS
      PRINT 4330                                                        MILDOS
      PRINT 4340, DIN,DOOT,(IPBD(J),J=1,16)                             MILDOS
      PRINT 4350, IPTOT                                                 MILDOS
C                                                                       MILDOS
      DO 250 J=1,NSORCE                                                 MILDOS
      SORCE(4,J)=1000.0*SQRT(SORCE(4,J))                                MILDOS
      DO 250 I=5,9                                                      MILDOS
  250 SORCE(I,J)=SORCE(I,J)*(1.0E12)/(3.156E7)                          MILDOS
C                                                                       MILDOS
      IRECEP=0                                                          MILDOS
      IF(IPTOT.LE.0) GO TO 270                                          MILDOS
      DPI=3.1459265/8.0                                                 MILDOS
C                                                                       MILDOS
      DO 260 ND=1,16                                                    MILDOS
      THETA=(ND-1)*DPI                                                  MILDOS
      CTH=COS(THETA)                                                    MILDOS
      STH=SIN(THETA)                                                    MILDOS
      DO 260 NR=1,12                                                    MILDOS
      IRECEP=IRECEP+1                                                   MILDOS
      RECEPT(1,IRECEP)=XRHO(NR)*STH                                     MILDOS
      RECEPT(2,IRECEP)=XRHO(NR)*CTH                                     MILDOS
  260 ZRECEP(IRECEP)=0                                                  MILDOS
C                                                                       MILDOS
  270 NRECEP=IRECEP                                                     MILDOS
      IRCV=NRECEP                                                       MILDOS
      IF(IADD.EQ.0) GO TO 290                                           MILDOS
C                                                                       MILDOS
      DO 280 IR=1,IADD                                                  MILDOS
      NR=IRCV+IR                                                        MILDOS
      RECEPT(1,NR)=XRECEP(1,IR)                                         MILDOS
      RECEPT(2,NR)=XRECEP(2,IR)                                         MILDOS
  280 ZRECEP(NR)=XRECEP(3,IR)                                           MILDOS
C                                                                       MILDOS
  290 NRECEP=NRECEP+IADD                                                MILDOS
      NPRINT=JC(5)                                                      MILDOS
C******************** ************************************************* MILDOS
```

FIGURE B.0-1. (Continued)

```
C                                                                       MILDOS
      CALL CHIQU(NPRINT)                                                MILDOS
C                                                                       MILDOS
C******************** ************************************************** MILDOS
C                                                                       MILDOS
C     SUBROUTINE CHIQU HAS COMPUTED RXQ(ISORCE,IRECEP,PTSZ) IN SEC/M3   MILDOS
C     FOR U-238 AND RXQRN(ISORCE,IRECEP,ISOTOPE) IN SEC/M3 FOR RN-222   MILDOS
C     AND 6 DAUGHTERS. RESULTS ARE PRINTED IFF JC(5)=1.                 MILDOS
C                                                                       MILDOS
C******************** ************************************************** MILDOS
      DO 300 I=1,4                                                      MILDOS
  300 DEPVEL(I)=VDEP(I)                                                 MILDOS
C                                                                       MILDOS
      DO 310 IS=1,NSORCE                                                MILDOS
      DO 310 IJ=5,9                                                     MILDOS
      I=IJ-4                                                            MILDOS
  310 CPY(I,IS)=SORCE(IJ,IS)*(3.156E7/1.0E12)                           MILDOS
C                                                                       MILDOS
      DO 320 IX=1,4                                                     MILDOS
  320 ALF(IX)=ALN2/RHALF(IX)                                            MILDOS
      ELRC=ALN2/50.0                                                    MILDOS
      DO 340 IX=1,4                                                     MILDOS
      ALF(IX)=ALF(IX)+ELRC                                              MILDOS
      DO 330 IT=1,NSTEP                                                 MILDOS
      TEXP=ALF(IX)*TSTEP(IT)                                            MILDOS
      IF(TEXP.LE.1.0E-5) GO TO 330                                      MILDOS
      TEXP=1.0-EXP(-TEXP)                                               MILDOS
  330 GFACT(IX,IT)=TEXP/ALF(IX)*(3.156E7)                               MILDOS
      TEXP=ALF(IX)*100.0                                                MILDOS
      IF(TEXP.LE.1.0E-5) GO TO 340                                      MILDOS
      TEXP=1.0-EXP(-TEXP)                                               MILDOS
  340 GPFACT(IX)=TEXP/ALF(IX)*(3.156E7)                                 MILDOS
C                                                                       MILDOS
      RLRC=ALN2/(50.0/365.25)                                           MILDOS
      TEE=1.8189887                                                     MILDOS
      DO 360 IX=1,4                                                     MILDOS
      TALF=ALF(IX)+RLRC                                                 MILDOS
      FIX=(1.0-EXP(-TALF TEE))*3.156E2/TALF                             MILDOS
      TPFACT(IX)=FIX+(EXP(-ALF(IX)*TEE)-EXP(-ALF(IX)*100.0))*.03156/ALF( MILDOS
     1IX)                                                               MILDOS
      DO 350 IT=1,NSTEP                                                 MILDOS
      TT=TSTEP(IT)                                                      MILDOS
      FOX=(EXP(-ALF(IX)*TEE)-EXP(-ALF(IX)*TT))*(3.156E-2)/ALF(IX)       MILDOS
  350 TFACT(IX,IT)=1.0+(0.01*(FIX+FOX))                                 MILDOS
  360 TPFACT(IX)=1.0+(0. 1*TPFACT(IX))                                  MILDOS
C                                                                       MILDOS
      DO 380 IR=1,NRECEP                                                MILDOS
      DO 370 IX=1,4                                                     MILDOS
      DO 370 IP=1,4                                                     MILDOS
  370 CGIP(IP,IX,IR)=0.0                                                MILDOS
      DO 380 IX=1,6                                                     MILDOS
  380 CGXRN(IX,IR)=0.0                                                  MILDOS
C                                                                       MILDOS
      XPFACT=(1.0/HLM(2))                                               MILDOS
      ISTEP=0                                                           MILDOS
C******************** ************************************************** MILDOS
  390 ISTEP=ISTEP+1                                                     MILDOS
      IF(ISTEP.GT.NSTEP) GO TO 430                                      MILDOS
C******************** ************************************************** MILDOS
C                                                                       MILDOS
      CALL CALCON                                                       MILDOS
C                                                                       MILDOS
C******************** ************************************************** MILDOS
C                                                                       MILDOS
C     SUBROUTINE CALCON HAS COMPUTED TPSZ(PTSZ,ISOTOPE,IRECEP) IN PCI/M3 MILDOS
C     INCLUDING RESUSPENSION, CISUM(ISOTOPE,IRECEP), CGIP(PTSZ,ISOTOPE,  MILDOS
C     IRECEP) IN PCI/M2 (FOR PARTICULATE RELEASES), AND CGXRN (ISOTOPE,  MILDOS
C     IRECEP) IN PCI/M2 (FOR RADON RELEASE DAUGHTERS), FOR TSTEP=ISTEP.  MILDOS
```

FIGURE B.0-1. (Continued)

```
C                                                                         MILDOS
C********************* *************************************************** MILDOS
      IF(ISTEP.GT.1) GO TO 400                                            MILDOS
C********************* *************************************************** MILDOS
C                                                                         MILDOS
      CALL WRITER                                                         MILDOS
C                                                                         MILDOS
C********************* *************************************************** MILDOS
C                                                                         MILDOS
C     WRITER PRINTS DOSE FACTORS AND MORE, AND CONVERTS DOSE FACTORS TO  MILDOS
C     A MORE APPROPRIATE FORMAT FOR LATER USE. NO PRINT UNLESS JC(6)=1.  MILDOS
C                                                                         MILDOS
C********************* *************************************************** MILDOS
  400 CONTINUE                                                            MILDOS
      IF(IRCV.LE.0) GO TO 410                                             MILDOS
C********************* *************************************************** MILDOS
C                                                                         MILDOS
      CALL POPDOS                                                         MILDOS
C                                                                         MILDOS
C********************* *************************************************** MILDOS
C                                                                         MILDOS
C     SUBROUTINE POPDOS HAS COMPUTED CAI(ISOTOPE,IRECEP) IN PCI/M3 AND   MILDOS
C     CGI(ISOTOPE,IRECEP) IN PCI/M2, AND POPULATION DOSES FROM ALL EXPO- MILDOS
C     SURE PATHWAYS.                                                      MILDOS
C                                                                         MILDOS
C     ALL CONCENTRATIONS AND DOSES ARE COMPUTED TO YIELD 100-YEAR         MILDOS
C     ENVIRONMENTAL DOSE COMMITMENTS IFF JC(2)=1.                         MILDOS
C                                                                         MILDOS
C     POPDOS CONCENTRATION DATA IS PRINTED IFF JC(3)=1.                   MILDOS
C     ONLY SUMMARY POPDOS DOSE PRINT UNLESS JC(4)=1.                      MILDOS
C                                                                         MILDOS
C********************* *************************************************** MILDOS
  410 CONTINUE                                                            MILDOS
      IF(IRCV.GE.NRECEP) GO TO 420                                        MILDOS
      IF(IADD.EQ.0) GO TO 420                                             MILDOS
      IF(IFTODO(ISTEP).NE.1) GO TO 420                                    MILDOS
C********************* *************************************************** MILDOS
C                                                                         MILDOS
      CALL UNIDOS                                                         MILDOS
C                                                                         MILDOS
C********************* *************************************************** MILDOS
C                                                                         MILDOS
C     SUBROUTINE UNIDOS HAS COMPUTED TOTAL AND 40CFR190 DOSES TO INDI-   MILDOS
C     VIDUALS AND HAS CHECKED AIR CONCENTRATIONS AGAINST 10CFR20 MPCS,   MILDOS
C     AS SPECIFIED BY INPUT VALUES OF IRTYPE(IRECEP).                    MILDOS
C                                                                         MILDOS
C     UNIDOS CONCENTRATION DATA IS PRINTED IFF JC(9)=1.                   MILDOS
C     DOSES BY PATHWAY PRINTED IFF JC(7)=1 AND IRTYPE(IRECEP)=10.        MILDOS
C                                                                         MILDOS
C********************* *************************************************** MILDOS
  420 CONTINUE                                                            MILDOS
      IF(ISTEP.EQ.10) GO TO 430                                           MILDOS
      GO TO 390                                                           MILDOS
C                                                                         MILDOS
  430 CONTINUE                                                            MILDOS
C********************* *************************************************** MILDOS
 4010 FORMAT(6A4,6X,4A4)                                                  MILDOS
 4020 FORMAT(5A4)                                                         MILDOS
 4030 FORMAT(1H0,'NUMBER OF SOURCES=',I2)                                 MILDOS
 4040 FORMAT(1H-,7X,'KM',5X,'KM',7X,'M',7X,'KM2',24X,'CI/YEAR',29X,      MILDOS
     1 'PSIZE',2X,'M**2/SEC')                                             MILDOS
 4050 FORMAT(' NO.',5X,'X',6X,'Y',7X,'Z',6X,'AREA',5X,'U-238',4X,        MILDOS
     1'TH-230',4X,'RA-226',4X,'PB-210',4X,'RN-222',5X,'ID',4X,'SET',3X,  MILDOS
     2'DIA*EX VEL',3X,'SOURCE NAME')                                      MILDOS
 4060 FORMAT(1X,132('-'))                                                 MILDOS
 4070 FORMAT(1H ,I2,3F8.2,F8.4,1X,1P5E10.2,2X,2I5,1PE12.2,3X,5A4)        MILDOS
 4080 FORMAT(1H0,20X,'INPUT TAILS ACTIVITIES, PCI/G',22X,'PARTICLE SIZES MILDOS
     1 AND FRACTIONAL DISTRIBUTION ',/14X,'SET URANIUM   THORIUM    RADI MILDOS
```

FIGURE B.0-1. (Continued)

```
    2UM     LEAD  ' 16X 'SET ',4F7.1,6X,'PDEN',/14X,2(42('-'),16X))       MILDOS
4090 FORMAT(14X,I2,1P4E10.2,16X,I2,3X,0P4F7.3,2X,F6.3)                    MILDOS
4100 FORMAT(1H0,21X,'PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME ST MILDOS
    1EP, ',     I2,' TIME STEP(S) USED FOR THIS RUN',/2X,'SOURCE',10(4X MILDOS
    2,'TSTEP',I2,1X),/2X,'NUMBER',2X,10(F6.2,'YRS',3X))                 MILDOS
4110 FORMAT(2X,126('-'))                                                  MILDOS
4120 FORMAT(4X,I2,5X,10(1PE9.3,3X))                                       MILDOS
4130 FORMAT(1H0,11X,'RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP,',  MILDOS
    1 I2,' TIME STEP(S) USED FOR THIS RUN',/2X,'SOURCE',10(4X,'TSTEP',  MILDOS
    2 I2,1X),/2X,'NUMBER',2X,10(F6.2,'YRS',3X))                         MILDOS
4140 FORMAT(1H ,4X,'JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WH  MILDOS
    1ERE WIND IS FROM',2X,'FREQWS=',5(F7.5,','),F7.5)                   MILDOS
4150 FORMAT(1H ,'MPH',16(2X,A4,1X),5X,'TOTALS')                           MILDOS
4160 FORMAT(1H ,1X,'STABILITY CLASS ',I1)                                 MILDOS
4170 FORMAT(1H ,F4.1,16(F7.4),2X,F8.4)                                    MILDOS
4180 FORMAT(1H ,'ALL ',16F7.4,2X,F8.4)                                    MILDOS
4190 FORMAT(1H0,1X,32('-'),'INDIVIDUAL RECEPTOR LOCATION DATA, ',I3,1X, MILDOS
    1 'LOCATIONS INPUT THIS RUN',31('-'))                               MILDOS
4200 FORMAT(2X,2(' I     LOCATION NAMES     X(KM)  Y(KM)   Z(M) DIST(KM MILDOS
    1) TYPE     '))                                                     MILDOS
4210 FORMAT(2X,126('-'))                                                  MILDOS
4220 FORMAT(2(2X,I2,2X,5A4,4(F7.2),3X,I3,3X))                             MILDOS
4230 FORMAT(1H0,45X,'MISCELLANEOUS INPUTTABLE PARAMETER VALUES')         MILDOS
4240 FORMAT(1H0,5X,'     DM         TSTART      FFORI       FHAYI       MILDOS
    1FFORP       FHAYP       FPR(1)       FPR(2)       FPR(3)      ACTRAT MILDOS
    2    ',/5X,120('-'))                                                MILDOS
4250 FORMAT(6X,10(F9.2,3X),//5X,'IPACT EQUALS',4D(I2,','))               MILDOS
4260 FORMAT(1H0,4X,'JC EQUALS   ',9(I2,','),I2)                           MILDOS
4270 FORMAT(1H0,4X,'TIME STEP DATA....',7X,'STEP NAMES',9X,              MILDOS
    1 'LENGTH, YRS',4X,'IFTODO')                                        MILDOS
4280 FORMAT(21X,I2,2X,5A4,7X,F6.2,8X,I2)                                  MILDOS
4290 FORMAT(1H0,4X,'XRHO EQUALS ',12(F6.1,','))                          MILDOS
4300 FORMAT(1H0,T53,'POPULATION DISTRIBUTION')                            MILDOS
4310 FORMAT(1H0,T13,']',5X,16(A4,3X))                                     MILDOS
4320 FORMAT(1X,'KILOMETERS ] ',16F7.1)                                    MILDOS
4330 FORMAT(12X,']')                                                      MILDOS
4340 FORMAT(1H ,F4.1,'-',F4.1,2X,']',1X,16I7)                             MILDOS
4350 FORMAT(1H0,40X,'TOTAL 1-80 KM POPULATION IS',I7,' PERSONS')         MILDOS
C********************* ***************************************************** MILDOS
     STOP                                                               MILDOS
     END                                                                MILDOS
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE ACTDR (TIME,N1)                                          ACTDR
      REAL HLM,GMAT,ACTIV,EHLM(7),X,Y,Z                                   ACTDR
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),       ACTDR
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),      ACTDR
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,     ACTDR
     3 ISORC1,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,          ACTDR
     4 PINK(4,4),RINK(7)                                                  ACTDR
C                                                                         ACTDR
C    CALCULATE ACTIVITY AT TIME ' TIME'                                   ACTDR
      N=N1                                                                ACTDR
      DO 20 I=1,N                                                         ACTDR
      X=-HLM(I)*TIME                                                      ACTDR
C     FOLLOWING GUARDS AGAINST UNDERFLOW ERROR FOR DEXP(X)                ACTDR
      IF(-X.LT.(1.5E2))GOTO10                                             ACTDR
      EHLM(I)=0.E0                                                        ACTDR
      GO TO 20                                                            ACTDR
   10 EHLM(I)=EXP(X)                                                      ACTDR
   20 CONTINUE                                                            ACTDR
      ACTIV(1)=EHLM(1)                                                    ACTDR
      DO 60 I=2,N                                                         ACTDR
      Y=1.0                                                               ACTDR
      DO 30 J=2,I                                                         ACTDR
   30 Y=Y*HLM(J)                                                          ACTDR
      ACTIV(I)=0.E0                                                       ACTDR
      DO 50 K=1,I                                                         ACTDR
      Z=EHLM(K)                                                           ACTDR
      DO 40 J=1,I                                                         ACTDR
      IF (K.EQ.J) GO TO 40                                                ACTDR
      Z=Z/GMAT(J,K)                                                       ACTDR
   40 CONTINUE                                                            ACTDR
      ACTIV(I)=ACTIV(I)+Z                                                 ACTDR
   50 CONTINUE                                                            ACTDR
      ACTIV(I)=ACTIV(I)*0                                                 ACTDR
   60 CONTINUE                                                            ACTDR
      RETURN                                                              ACTDR
      RETURN                                                              ACTDR
      END                                                                 ACTDR
```

FIGURE B.0-1. (Continued)

```
C     ADAPTIVE INTEGRATION USING NEWTON-COTES NO. 4                      ANC4
      FUNCTION ANC4(A1,B1,EP,M,N,FUN)                                    ANC4
      REAL A1,B1,EP,FUN,A,B,EPS,ESUM,TSUM,DA,XB,SX,FA,F1,FS,F3,FM,F2     ANC4
     *,FT,F4,FB,FTP,FBP,FMAX,FTST,EST,AEST,EST1,EST2,AEST1,AEST2,ABSAR,D ANC4
     *ELTA,DIFF,DAFT,SUM                                                 ANC4
      DIMENSION F2(30),F4(30),FTP(30),FBP(30),FTST(5),EST2(30),NRTR(30)  ANC4
      DIMENSION AEST2(30),XB(30)                                         ANC4
C     THE PARAMETER SETUP FOR THE INITIAL CALL                           ANC4
      IF(N.LE.0)GO TO 210                                                ANC4
      IF(N.GT.3)GO TO 211                                                ANC4
      A=A1                                                               ANC4
      B=B1                                                               ANC4
      EPS=EP*63.0E0                                                      ANC4
      ESUM=0.0E0                                                         ANC4
      TSUM=0.0E0                                                         ANC4
      LVL=1                                                              ANC4
      DA=B-A                                                             ANC4
      FA=FUN(A)                                                          ANC4
      FS=FUN((3.0E0*A+B)/4.0E0)                                          ANC4
      FM=FUN((A+B)*0.5E0)                                                ANC4
      FT=FUN((A+3.0E0*B)/4.0E0)                                          ANC4
      FB=FUN(B)                                                          ANC4
      M=5                                                                ANC4
      FMAX=ABS(FA)                                                       ANC4
      FTST(1)=FMAX                                                       ANC4
      FTST(2)=ABS(FS)                                                    ANC4
      FTST(3)=ABS(FM)                                                    ANC4
      FTST(4)=ABS(FT)                                                    ANC4
      FTST(5)=ABS(FB)                                                    ANC4
      DO 100 I=2,5                                                       ANC4
      IF(FMAX.GE.FTST(I))GO TO 100                                       ANC4
      FMAX=FTST(I)                                                       ANC4
  100 CONTINUE                                                           ANC4
      EST=(7.0E0*(FA+FB) 32.0E0*(FS+FT)+12.0E0*FM)*DA/90.0E0             ANC4
      ABSAR=(7.0E0*(FTST(1)+FTST(5))+32.0E0*(FTST(2)+FTST(4))+12.0E0*FTS ANC4
     *T(3))*DA/90.0E0                                                    ANC4
      AEST=ABSAR                                                         ANC4
C     1=RECUR                                                            ANC4
    1 SX=(DA/(2.0E0**LVL))/90.0E0                                        ANC4
      F1=FUN((7.0E0*A+B)/8.0E0)                                          ANC4
      F3=FUN((5.0E0*A+3.0E0*B)/8.0E0)                                    ANC4
      F2(LVL)=FUN((3.0E0*A+5.0E0*B)/8.0E0)                               ANC4
      F4(LVL)=FUN((A+7.0E0*B)/8.0E0)                                     ANC4
      EST1=SX*(7.0E0*(F0*FS)                                             ANC4
      FBP(LVL)=FB                                                        ANC4
      FTP(LVL)=FT                                                        ANC4
      XB(LVL)=B                                                          ANC4
      EST2(LVL)=SX*(7.0E0*(FM+FB)+32.0E0*(F2(LVL)+F4(LVL))+12.0E0*FT)    ANC4
      SUM=EST1+EST2(LVL)                                                 ANC4
      FTST(1)=ABS(F1)                                                    ANC4
      FTST(2)=ABS(F2(LVL))                                               ANC4
      FTST(3)=ABS(F3)                                                    ANC4
      FTST(4)=ABS(F4(LVL))                                               ANC4
      FTST(5)=ABS(FM)                                                    ANC4
      AEST1=SX*(7.0E0*(ABS(FA)+FTST(5))+32.0E0*(FTST(1)+FTST(3))+12.0E0* ANC4
     *ABS(FS))                                                           ANC4
      AEST2(LVL)=SX*(7.050*(FTST(5)+ABS(FB))+32.0E0*(FTST(2)+FTST(4))+12 ANC4
     *.0E0*ABS(FT))                                                      ANC4
      ABSAR=ABSAR-AEST+AEST1+AEST2(LVL)                                  ANC4
      M=M+4                                                              ANC4
      GO TO (201,200,202),N                                              ANC4
  200 DELTA=ABSAR                                                        ANC4
      GO TO 205                                                          ANC4
  210 PRINT 39                                                           ANC4
   39 FORMAT(' ERROR RETURN-N.LE.0')                                     ANC4
      RETURN                                                             ANC4
  211 PRINT 40                                                           ANC4
   40 FORMAT(' ERROR RETURN-N.GT.3')                                     ANC4
```

FIGURE B.0-1. (Continued)

```
      RETURN                                                    ANC4
  201 DELTA=1.0E0                                               ANC4
      GO TO 205                                                 ANC4
  202 DO 203 I=1,4                                              ANC4
      IF(FMAX.GE.FTST(I))GO TO 203                              ANC4
      FMAX=FTST(I)                                              ANC4
  203 CONTINUE                                                  ANC4
      DELTA=FMAX                                                ANC4
  205 DAFT=EST-SUM                                              ANC4
      DIFF=ABS(DAFT)                                            ANC4
      DAFT=DAFT/63.0E0                                          ANC4
      IF(DIFF-EPS*DELTA)6,6,3                                   ANC4
    3 IF(LVL-30)4,2,2                                           ANC4
    6 IF(LVL-1)2,4,2                                            ANC4
C       2=UP                                                    ANC4
    2 A=B                                                       ANC4
      ESUM=ESUM+DAFT                                            ANC4
      TSUM=TSUM+SUM                                             ANC4
    9 LVL=LVL-1                                                 ANC4
      L=NRTR(LVL)                                               ANC4
      IF(L.LT.1.OR.L.GT.2) GO TO 4                              ANC4
      GO TO (11,12),L                                           ANC4
C       11=R1,12=R2                                             ANC4
    4 NRTR(LVL)=1                                               ANC4
      EST=EST1                                                  ANC4
      AEST=AEST1                                                ANC4
      FB=FM                                                     ANC4
      FT=F3                                                     ANC4
      FM=FS                                                     ANC4
      FS=F1                                                     ANC4
      B=(A+B)/2.0E0                                             ANC4
      EPS=EPS/2.0E0                                             ANC4
    7 LVL=LVL+1                                                 ANC4
      GO TO 1                                                   ANC4
   11 NRTR(LVL)=2                                               ANC4
      FA=FB                                                     ANC4
      FS=F2(LVL)                                                ANC4
      FM=FTP(LVL)                                               ANC4
      FT=F4(LVL)                                                ANC4
      FB=FBP(LVL)                                               ANC4
      B=XB(LVL)                                                 ANC4
      EST=EST2(LVL)                                             ANC4
      AEST=AEST2(LVL)                                           ANC4
      GO TO 7                                                   ANC4
   12 EPS=2.0E0*EPS                                             ANC4
      IF(LVL-1)5,5,9                                            ANC4
    5 ANC4=TSUM-ESUM                                            ANC4
      RETURN                                                    ANC4
      END                                                       ANC4
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE CALCON                                                 CALCON
C******************** ************************************************* CALCON
C******************** ************************************************* CALCON
      LEVEL 2, NSORCE,NRECEP,TPSZ,CISUM,IPACT,PACT,PDEN,DUST20,ACTRAT,  CALCON
     1 PTSZ20,RXQ,RXQRN,PTSZ,QNAME                                      CALCON
C                                                                       CALCON
      COMMON/BDATA/NSORCE,NRECEP,TPSZ(4,4,240),CISUM(7,240),IPACT(20),  CALCON
     1 PACT(3,4),PDEN(4),DUST20(6),ACTRAT,PTSZ20,RXQ(20,240,4),         CALCON
     2 RXQRN(20,240,7),PTSZ(4),QNAME(5,20)                              CALCON
C                                                                       CALCON
      COMMON/CDATA/QAJUST(10,2,20),DEPVEL(4),CPY(5,20),ISTEP,IRCV,IADD, CALCON
     1 ALN2,TSTEP(10),ALF(6),GFACT(4,10),GPFACT(4),TFACT(4,10),NSTEP,   CALCON
     2 TPFACT(4),CGIP(4,4,240),CGXRN(4,240),JC(10),XPFACT               CALCON
C                                                                       CALCON
      DIMENSION DC(4),TEMPO(4,4),TEMPI(4)                               CALCON
C******************** ************************************************* CALCON
      SPY=3.156E7                                                       CALCON
      QFACTR=1.0E12/SPY                                                 CALCON
      IT=ISTEP                                                          CALCON
C                                                                       CALCON
      DO 30 IR=1,NRECEP                                                 CALCON
      DO 20 IX=1,7                                                      CALCON
      CISUM(IX,IR)=0.0                                                  CALCON
      IF(IX.GT.4) GO TO 20                                              CALCON
      DO 10 IP=1,4                                                      CALCON
 10   TPSZ(IP,IX,IR)=0.0                                                CALCON
 20   CONTINUE                                                          CALCON
 30   CONTINUE                                                          CALCON
C                                                                       CALCON
      DO 60 IR=1,NRECEP                                                 CALCON
      DO 60 IS=1,NSORCE                                                 CALCON
      DO 50 IX=1,7                                                      CALCON
      ANK=CPY(5,IS)*QAJUST(IT,2,IS)*QFACTR*RXQRN(IS,IR,IX)              CALCON
      CISUM(IX,IR)=CISUM(IX,IR)+ANK                                     CALCON
      IF(IX.GT.4) GO TO 50                                              CALCON
      DO 40 IP=1,4                                                      CALCON
      ANK=CPY(IX,IS)*QAJUST(IT,1,IS)*QFACTR*RXQ(IS,IR,IP)               CALCON
 40   TPSZ(IP,IX,IR)=TPSZ(IP,IX,IR)+ANK                                 CALCON
 50   CONTINUE                                                          CALCON
 60   CONTINUE                                                          CALCON
C******************** ************************************************* CALCON
C     WE NOW HAVE DIRECT AIR CONCENTRATIONS COMPUTED. NOW MUST COMPUTE  CALCON
C     NEW GROUND AND TOTAL AIR CONCENTRATIONS. IF JC(2)=1  COMPUTED     CALCON
C     POPULATION DOSES WILL BE 100-YEAR ENVIRONMENTAL DOSE COMMITMENTS. CALCON
C******************** ************************************************* CALCON
      RALAM=ALF(3)*100.0                                                CALCON
      PBLAM=ALF(4)*100.0                                                CALCON
      PBEXP=(1.-EXP(-PBLAM)/ALF(4))                                     CALCON
      PBEXP=PBEXP+(EXP(-RALAM)-EXP(-PBLAM))/(ALF(3)-ALF(4))             CALCON
      LDLAM=ALN2*3.156E7/(2.23E01)                                      CALCON
      PBEXP=PBEXP*LDLAM/ALF(3)                                          CALCON
      IRB=1                                                             CALCON
      IF(IRCV.GT.0.AND.JC(2).EQ.1) IRB=IRCV+1                           CALCON
      IF(IRB.EQ.1) GO TO 110                                            CALCON
C******************** ************************************************* CALCON
C     NOW COMPUTE CONCENTRATIONS FOR EDC CALCULATIONS.                  CALCON
C******************** ************************************************* CALCON
      DO 100 IR=1,IRCV                                                  CALCON
      DO 70 IX=1,3                                                      CALCON
      CGXRN(IX,IR)=0.003*CISUM(2,IR)*XPFACT                             CALCON
      DO 70 IP=1,4                                                      CALCON
      CGIP(IP,IX,IR)=DEPVEL(IP)*TPSZ(IP,IX,IR)*GPFACT(IX)               CALCON
      ADJST=PBEXP*DEPVEL(IP)*TPSZ(IP,3,IR)                              CALCON
      IF(IX.EQ.3) CGIP(IP,4,IR)=CGIP(IP,IX,IR)+ADJST                    CALCON
 70   CONTINUE                                                          CALCON
C                                                                       CALCON
      CGXRN(4,IR)=0.003*CISUM(5,IR)*GPFACT(4)                           CALCON
      DO 90 IP=1,4                                                      CALCON
```

FIGURE B.0-1. (Continued)

```
      DO 80 IX=1,3                                                      CALCON
 80   TPSZ(IP,IX,IR)=TPSZ(IP,IX,IR)*TPFACT(IX)                          CALCON
 90   TPSZ(IP,4,IR)=TPSZ(IP,3,IR)                                       CALCON
 100  CONTINUE                                                          CALCON
C********************* ***************************************************** CALCON
C     NOW COMPUTE CONCENTRATIONS FOR NORMAL CALCULATIONS.                CALCON
C********************* ***************************************************** CALCON
 110  IRE=NRECEP                                                        CALCON
      IF(IRE.LE.IRCV) GO TO 190                                         CALCON
      TEE=TSTEP(ISTEP)                                                  CALCON
C                                                                       CALCON
      DO 120 IX=1,4                                                     CALCON
      DC(IX)=EXP(-TEE*ALF(IX))                                          CALCON
 120  CONTINUE                                                          CALCON
      PBFAC=((1.-DC(4))/ALF(4)) + ((DC(3)-DC(4))/ALF(3)-ALF(4)))        CALCON
      PBFAC = (LDLAM/ALF(3))*PBFAC                                      CALCON
C                                                                       CALCON
      DO 180 IR=IRB,IRE                                                 CALCON
      DO 140 IP=1,4                                                     CALCON
      DO 130 IX=1,3                                                     CALCON
 130  TEMPO(IP,IX)=DC(IX)*CGIP(IP,IX,IR)                                CALCON
 140  TEMPO(IP,4)=TEMPO(IP,3)                                           CALCON
      DO 150 IX=1,3                                                     CALCON
 150  TEMPI(IX)=0.0                                                     CALCON
      TEMPI(4)=CGXRN(4,IR)*DC(4)                                        CALCON
      DO 160 IX=1,3                                                     CALCON
      CGXRN(IX,IR)=0.003*CISUM(2,IR)*XPFACT                             CALCON
      DO 160 IP=1,4                                                     CALCON
      CGIP(IP,IX,IR)=DEPVEL(IP)*TPSZ(IP,IX,IR)*GFACT(IX,IT)+TEMPO(IP,IX) CALCON
      IF(IX.EQ.3) CGIP(IP,4,IR)=CGIP(IP,IX,IR)                          CALCON
 160  CONTINUE                                                          CALCON
      CGXRN(4,IR)=0.003*CISUM(5,IR)*GFACT(4,IT)+TEMPI(4)                CALCON
      DO 170 IX=1,4                                                     CALCON
      DO 170 IP=1,4                                                     CALCON
 170  TPSZ(IP,IX,IR)=TPSZ(IP,IX,IR)*TFACT(IX,IT)+TEMPO(IP,IX)/(1.0E9)   CALCON
 180  CONTINUE                                                          CALCON
C                                                                       CALCON
 190  CONTINUE                                                          CALCON
C********************* ***************************************************** CALCON
C     SUBROUTINE CALCON HAS COMPUTED VALUES OF TPSZ, CISUM, CGIP, AND   CALCON
C     CGXRN FOR TIME STEP ISTEP. TPSZ AND CGIP ARE FOR PARTICULATES     CALCON
C     ONLY# TPSZ VALUES INCLUDE RESUSPENSION. CISUM AND CGXRN ARE FOR   CALCON
C     RADON AND INGROWN DAUGHTERS ONLY. PARTICULATE AND RADON COMPO-    CALCON
C     NENTS ARE KEPT SEPARATE TO PERFORM 40CFR190 CALCULATIONS IN UNIDOS CALCON
C********************* ***************************************************** CALCON
      RETURN                                                            CALCON
      END                                                               CALCON
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE CHIQU(NPRINT)                                          CHIQU
C******************** **************************************************** CHIQU
      REAL HLM,ACTIV,GMAT                                               CHIQU
C                                                                       CHIQU
      LEVEL 2, NSORCE,NRECEP,TPSZ,CISUM,IPACT,PACT,PDEN,DUST20,ACTRAT,  CHIQU
     1 PTSZ20,RXQ,RXQRN,PTSZ,QNAME                                      CHIQU
C                                                                       CHIQU
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),     CHIQU
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),    CHIQU
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,   CHIQU
     3 ISORC1,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,        CHIQU
     4 PINK(4,4),RINK(7)                                                CHIQU
C                                                                       CHIQU
      COMMON/BDATA/NSORCE,NRECEP,TPSZ(4,4,240),CISUM(7,240),IPACT(20),  CHIQU
     1 PACT(3,4),PDEN(4),DUST20(6),ACTRAT,PTSZ20,RXQ(20,240,4),         CHIQU
     2 RXQRN(20,240,7),PTSZ(4),QNAME(5,20)                              CHIQU
C                                                                       CHIQU
C                                                                       CHIQU
      DIMENSION PSORC(4)                                                CHIQU
C******************** **************************************************** CHIQU
      IF(NPRINT.NE.1) GO TO 10                                          CHIQU
C******************** **************************************************** CHIQU
C                                                                       CHIQU
      CALL HEADER                                                       CHIQU
C                                                                       CHIQU
C******************** **************************************************** CHIQU
      PRINT 1000                                                        CHIQU
C                                                                       CHIQU
 10   CONTINUE                                                          CHIQU
      DO 330  IS=1,NSORCE                                               CHIQU
      ISORC1=IS                                                         CHIQU
      ID=SORCE(10,IS)                                                   CHIQU
      KS=SORCE(11,IS)                                                   CHIQU
      KSORCE=KS                                                         CHIQU
      IFLAG=0                                                           CHIQU
      IPX=IPACT(IS)                                                     CHIQU
C                                                                       CHIQU
      DO 100  IP=1,4                                                    CHIQU
      IF(PTSZFC(IP,KS).EQ.0.0) GO TO 100                                CHIQU
      VDEP(IP)=0.01                                                     CHIQU
      VSET(IP)=(3.0E-5)*PDEN(KS)*((PTSZ(IP))**2)                        CHIQU
      IF(VSET(IP).GT.0.01) VDEP(IP)=VSET(IP)                            CHIQU
      NPE=IP                                                            CHIQU
      IF(IFLAG.NE.0)  GO TO 100                                         CHIQU
      IFLAG=1                                                           CHIQU
      NPS=IP                                                            CHIQU
 100  CONTINUE                                                          CHIQU
C                                                                       CHIQU
      JFLAG=IFLAG                                                       CHIQU
      IF(IFLAG.EQ.0) GO TO 130                                          CHIQU
      NPP=NPS                                                           CHIQU
      DO 110  I=NPS,NPE                                                 CHIQU
      IF(PTSZFC(I,KS).EQ.0.0) GO TO 110                                 CHIQU
      IF(VSET(I).GT.0.01) GO TO 120                                     CHIQU
 110  CONTINUE                                                          CHIQU
C                                                                       CHIQU
      JFLAG=0                                                           CHIQU
 120  NPP=I                                                             CHIQU
 130  CONTINUE                                                          CHIQU
C                                                                       CHIQU
      DO 160 IR=1,NRECEP                                                CHIQU
      DO 160  I=1,7                                                     CHIQU
      CISUM(I,IR)=0.0                                                   CHIQU
      IF(I.GT.4) GO TO 150                                              CHIQU
      DO 140 IP=1,4                                                     CHIQU
      TPSZ(IP,I,IR)=0.0                                                 CHIQU
 140  CONTINUE                                                          CHIQU
 150  CONTINUE                                                          CHIQU
```

FIGURE B.0-1. (Continued)

```
 160  CONTINUE                                                              CHIQU
C                                                                           CHIQU
      DO 170 I=1,4                                                          CHIQU
      PSORC(I)=SORCE(I+4,IS)                                                CHIQU
 170  CONTINUE                                                              CHIQU
C******************** ************************************************** CHIQU
C     BIG LOOP OVER POLUO BEGINS NEXT. TPSZ AND CISUM ARRAYS HAVE           CHIQU
C     BEEN ZEROED OUT ABOVE. THEY WILL NOW BE VALUED AS THE INCREMENTAL     CHIQU
C     AIR CONCENTRATIONS DUE TO SOURCE IS.                                  CHIQU
C******************** ************************************************** CHIQU
      DO 270 JSTAB=1,6                                                      CHIQU
      ISTAB=JSTAB                                                           CHIQU
C                                                                           CHIQU
      DO 270 JWD=1,16                                                       CHIQU
      IWD=JWD                                                               CHIQU
C                                                                           CHIQU
      DO 270 IR=1,NRECEP                                                    CHIQU
      IRECEP=IR                                                             CHIQU
C                                                                           CHIQU
      DO 180 I=1,6                                                          CHIQU
      IWSE=7-I                                                              CHIQU
      IF(FREQ(IWD,IWSE,ISTAB).GT.0.0) GO TO 190                             CHIQU
 180  CONTINUE                                                              CHIQU
 190  IWSB=1                                                                CHIQU
      DO 260 JWS=1,6                                                        CHIQU
      IWS=JWS                                                               CHIQU
      IF(FREQ(IWD,IWS,ISTAB).LE.0.0) GO TO 260                              CHIQU
      IF(ID.LT.2000) GO TO 210                                              CHIQU
      DO 200 I=1,4                                                          CHIQU
      PSORC(I)=PACT(IPX,I)*DUST20(IWS)*(SORCE(4,IS)**2)*ACTRAT/PTSZ20       CHIQU
 200  CONTINUE                                                              CHIQU
 210  CONTINUE                                                              CHIQU
      IFPART=0                                                              CHIQU
      IFRN=0                                                                CHIQU
C******************** ************************************************** CHIQU
C                                                                           CHIQU
      CALL POLUT(PSORC)                                                     CHIQU
C                                                                           CHIQU
C******************** ************************************************** CHIQU
C     SUBROUTINE POLUT COMPUTES THE VALUES OF THE  ARRAYS PINK AND RINK.    CHIQU
C     PINK AND RINK ARE USED TO INCREMENT TPSZ AND CISUM, RESPECTIVELY.     CHIQU
C******************** ************************************************** CHIQU
      IF(IFPART.NE.1) GO TO 230                                             CHIQU
      DO 220 I=NPS,NPE                                                      CHIQU
      DO 220 J=1,4                                                          CHIQU
 220  TPSZ(I,J,IR)=TPSZ(I,J,IR)+PINK(I,J)                                   CHIQU
 230  CONTINUE                                                              CHIQU
      IF(IFRN.NE.1) GO TO 250                                               CHIQU
      DO 240 I=1,7                                                          CHIQU
 240  CISUM(I,IR)=CISUM(I,IR)+RINK(I)                                       CHIQU
 250  CONTINUE                                                              CHIQU
      IWSB=IWSB+1                                                           CHIQU
 260  CONTINUE                                                              CHIQU
C                                                                           CHIQU
 270  CONTINUE                                                              CHIQU
C******************** ************************************************** CHIQU
C     TPSZ AND CISUM HAVE NOW BEEN VALUED AS THE INCREMENTAL AIR            CHIQU
C     CONCENTRATIONS DUE TO SOURCE IS. THEY WILL NOW BE USED TO             CHIQU
C     ESTABLISH VALUES OF RXQ AND RXQRN FOR SOURCE IS.                      CHIQU
C******************** ************************************************** CHIQU
      DO 320 IR=1,NRECEP                                                    CHIQU
      IF(SORCE(5,IS).LE.0.0) GO TO 290                                      CHIQU
      DO 280 IP=1,4                                                         CHIQU
      IF(PTSZFC(IP,KS).LE.0.0) GO TO 280                                    CHIQU
      RXQ(IS,IR,IP)=TPSZ(IP,1,IR)/SORCE(5,IS)                               CHIQU
 280  CONTINUE                                                              CHIQU
 290  CONTINUE                                                              CHIQU
      IF(SORCE(9,IS).LE.0.0) GO TO 310                                      CHIQU
```

FIGURE B.0-1. (Continued)

```
      DO 300 I=1,7                                                      CHIQU
  300 RXQRN(IS,IR,I)=CISUM(I,IR)/SORCE(9,IS)                            CHIQU
  310 CONTINUE                                                          CHIQU
  320 CONTINUE                                                          CHIQU
C                                                                       CHIQU
  330 CONTINUE                                                          CHIQU
C********************* ************************************************* CHIQU
C     VALUES OF RXQ AND RXQRN HAVE NOW BEEN COMPUTEO FOR ALL SOURCES    CHIQU
C     AS REQUIREO. THEY WILL BE USED BY SUBROUTINE CALCON TO CALCULATE  CHIQU
C     NEW DIRECT AIR CONCENTRATIONS FOR EACH TIME STEP. RXQ AND RXQRN   CHIQU
C     ARE PRINTED BY FOLLOWING ROUTINE IFF JC(5)=NPRINT=1.              CHIQU
C********************* ************************************************* CHIQU
      IF(NPRINT.NE.1) RETURN                                            CHIQU
C                                                                       CHIQU
      LL=4                                                              CHIQU
      DO 350 IS=1,NSORCE                                                CHIQU
      DO 35D IR=1,NRECEP                                                CHIQU
      IF(LL.LT.60) GO TO 340                                            CHIQU
C********************* ************************************************* CHIQU
C                                                                       CHIQU
      CALL HEADER                                                       CHIQU
C                                                                       CHIQU
C********************* ************************************************* CHIQU
      PRINT 1000                                                        CHIQU
      LL=4                                                              CHIQU
  340 PRINT 1010, IS,IR,(RXQ(IS,IR,IP),IP=1,4),(RXQRN(IS,IR,IX),IX=1,7) CHIQU
      LL=LL+1                                                           CHIQU
  350 CONTINUE                                                          CHIQU
      RETURN                                                            CHIQU
C********************* ************************************************* CHIQU
 1000 FORMAT(1H ,28X,'RELATIVE DISPERSION FACTORS, CHI/Q VALUES, IN ',  CHIQU
     1 'PCI/M3 PER PCI/SEC (SEC/M3)',/3X,'IS   IR',4X,'PTSZ 1',5X,      CHIQU
     2 'PTSZ 2',5X,'PTSZ 3',5X,'PTSZ 4',5X,'RN-222',5X,'PO-218',5X,     CHIQU
     3 'PB-214',5X,'BI-214',5X,'PB-210',5X,'BI-210',5X,'PO-210')        CHIQU
 1010 FORMAT(1H ,2X,I2,2X,I3,11(2X,1PE9.3))                             CHIQU
C********************* ************************************************* CHIQU
      END                                                               CHIQU
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE DDEP (SIGZ,DNWIND,X1,PHT,L1)                           DDEP
      REAL HLM,ACTIV,GMAT                                               DDEP
      COMMON/INTG/SUMP(5,6),SUM,H,L,XL                                  DDEP
      COMMON/DEPY/QXQ(5,6),QXQR(6)                                      DDEP
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),     DDEP
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),    DDEP
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,   DDEP
     3 ISORC1,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,        DDEP
     4 PINK(4,4),RINK(7)                                                DDEP
C                                                                       DDEP
      L=L1                                                              DDEP
      H=PHT**2                                                          DDEP
      XL=X1                                                             DDEP
      SZ100=OA(L)*100.*(1.+OB(L)*100.)**OC(L)                           DDEP
      SUM=100.*EXP(-H*0.5/(SZ100**2))/SZ100                             DDEP
      IF (JFLAG.EQ.0) GO TO 20                                          DDEP
      XP=50.                                                            DDEP
      DO 10 I=NPP,NPE                                                   DDEP
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 10                             DDEP
      DO 5 J=IWS,IWSE                                                   DDEP
      HP=PHT-XP*VSET(I)/UU(J)                                           DDEP
      IF (HP.LT.0.0) HP=0.0                                             DDEP
      SUMP(I,J)=100.*EXP(-HP*HP*0.5/(SZ100*SZ100))/SZ100                DDEP
    5 CONTINUE                                                          DDEP
   10 CONTINUE                                                          DDEP
   20 IF (DNWIND.LE.100.) GO TO 70                                      DDEP
      IF (L.GT.4) GO TO 60                                              DDEP
      IF (SIGZ.LT.0.47*DM) GO TO 60                                     DDEP
      IF (DNWIND.LE.X1) GO TO 60                                        DDEP
      IF (X1.LT.100.) X1=100.                                           DDEP
      CALL INTEG (0,100.,X1,PHT)                                        DDEP
      XM=DNWIND                                                         DDEP
      IF (DNWIND.GT.2.*X1) XM=2.*X1                                     DDEP
      CALL INTEG (1,X1,XM,PHT)                                          DDEP
      DSUM=(XM-X1)**2/(2.*X1*DM)                                        DDEP
      SUM=SUM+DSUM                                                      DDEP
      IF (JFLAG.EQ.0) GO TO 40                                          DDEP
      DO 30 I=NPP,NPE                                                   DDEP
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 30                             DDEP
      DO 25 J=IWS,IWSE                                                  DDEP
      SUMP(I,J)=SUMP(I,J)+DSUM                                          DDEP
   25 CONTINUE                                                          DDEP
   30 CONTINUE                                                          DDEP
   40 IF (DNWIND.LE.2.*X1) GO TO 90                                     DDEP
      XL=2.*X1                                                          DDEP
      DSUM=(DNWIND-XL)/DM                                               DDEP
      SUM=SUM+DSUM                                                      DDEP
      IF (JFLAG.EQ.0) GO TO 90                                          DDEP
      DO 50 I=NPP,NPE                                                   DDEP
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 50                             DDEP
      DO 45 J=IWS,IWSE                                                  DDEP
      SUMP(I,J)=SUMP(I,J)+DSUM                                          DDEP
   45 CONTINUE                                                          DDEP
   50 CONTINUE                                                          DDEP
      GO TO 90                                                          DDEP
   60 CALL INTEG (0,100.,DNWIND,PHT)                                    DDEP
      GO TO 90                                                          DDEP
   70 SUM=SUM*DNWIND/100.                                               DDEP
      IF (JFLAG.EQ.0) GO TO 90                                          DDEP
      XP=DNWIND/2.                                                      DDEP
      DO 80 I=NPP,NPE                                                   DDEP
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 80                             DDEP
      DO 75 J=IWS,IWSE                                                  DDEP
      HP=PHT-XP*VSET(I)/UU(J)                                           DDEP
      IF (HP.LT.0.0) HP=0.0                                             DDEP
      SUMP(I,J)=DNWIND*EXP(-HP*HP*0.5/(SZ100*SZ100))/SZ100              DDEP
   75 CONTINUE                                                          DDEP
   80 CONTINUE                                                          DDEP
```

```
   90 CONTINUE                                                   DDEP
      F=SQRT(2.0/3.141593)                                       DDEP
      DO 100 J=IWS,IWSE                                          DDEP
      WDF=F*0.01*SUM/UU(J)                                       DDEP
      IF (WDF.GT.60.) WDF=60.                                    DDEP
  100 QXQR(J)=EXP(-WDF)                                          DDEP
      IF (IFLAG.EQ.0) GO TO 130                                  DDEP
      DO 110 I=NPS,NPE                                           DDEP
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 110                     DDEP
      DO 105 J=IWS,IWSE                                          DDEP
      QXQ(I,J)=QXQR(J)                                           DDEP
  105 CONTINUE                                                   DDEP
  110 CONTINUE                                                   DDEP
      IF (JFLAG.EQ.0) GO TO 130                                  DDEP
      DO 12D I=NPP,NPE                                           DDEP
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 120                     DDEP
      DO 115 J=IWS,IWSE                                          DDEP
      WDFP=F*VDEP(I)*SUMP(I,J)/UU(J)                             DDEP
      IF (WDFP.GT.60.) WDFP=60.                                  DDEP
      QXQ(I,J)=EXP(-WDFP)                                        DDEP
  115 CONTINUE                                                   DDEP
  120 CONTINUE                                                   DDEP
  130 RETURN                                                     DDEP
      END                                                        DDEP
```

```
      FUNCTION FERR (X)                                          FERR
C     IMPLICIT REAL*8 (A-H,O-Z)                                  FERR
      COMMON/DSTBZ/DOA,DOB,DOC,DH,DX1                            FERR
      SIZ=DOA*X*(1.0+DOB*X)**DOC                                 FERR
      FERR=EXP(-DH/(2.0*SIZ**2))/SIZ                             FERR
      RETURN                                                     FERR
      END                                                        FERR
```

```
      FUNCTION FERR1 (X)                                         FERR1
C     IMPLICIT REAL*8 (A-H,D-Z)                                  FERR1
      COMMON/DSTBZ/DOA,DOB,DOC,DH,DX1                            FERR1
      SIZ=DOA*X*(1.0+DOB'X)**DOC                                 FERR1
      FERR1=(2.0*DX1-X)*5XP(-DH/(2.0*SIZ**2))/SIZ                FERR1
      RETURN                                                     FERR1
      END                                                        FERR1
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE HEADER                                                  HEADER
C********************* ***************************************************** HEADER
      REAL TODAY,METSET                                                  HEADER
      COMMON/GDATA/METSET(4),REGION(6),KPAGE,TODAY                       HEADER
C********************* ***************************************************** HEADER
C                                                                        HEADER
C     SUBROUTINE HEADER PRINTS THE HEADING AT THE TOP OF EVERY PAGE.     HEADER
C                                                                        HEADER
C********************* ***************************************************** HEADER
      KPAGE=KPAGE+1                                                      HEADER
      PRINT 10, (REGION(I),I=1,6),TODAY                                  HEADER
      PRINT 20, (METSET(I),I=1,4),KPAGE                                  HEADER
      RETURN                                                             HEADER
C********************* ***************************************************** HEADER
 10   FORMAT(1H1,'REGION=',6A4,29X,'CODE=MILDOS,REVO (7/79)',21X,        HEADER
     1 'DATE=',A10)                                                      HEADER
 20   FORMAT(1X,'METSET=',4A4,81X,'PAGE NO. ',I4)                        HEADER
C********************* ***************************************************** HEADER
      END                                                                HEADER
```

```
      FUNCTION HT (I,PHT,XP,U)                                           HT
      REAL HLM,ACTIV,GMAT                                                HT
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),      HT
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),     HT
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,    HT
     3 ISORC1,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,         HT
     4 PINK(4,4),RINK(7)                                                 HT
C                                                                        HT
      HH=PHT-XP*VSET(I)/U                                                HT
      IF (HH.LT.0.0) HH=0.0                                              HT
      HT=HH**2                                                           HT
      RETURN                                                             HT
      END                                                                HT
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE INTEG (INDEX,XI,XN,PHT)                                INTEG
      EXTERNAL FERR,FERR1                                               INTEG
      REAL HLM,ACTIV,GMAT                                               INTEG
      REALDOA,DOB,DOC,DH,DX1,DXI,DXN,EP,FERR,FERR1                      INTEG
      COMMON/INTC/SUMP(5 6),SUM,H,L,XL                                  INTEG
C                                                                       INTEG
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCF(12,20),DM,HLM(7),     INTEG
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),   INTEG
     2 GDSCAL,QSCALF,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,  INTEG
     3 ISORC1,KSORCF,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,       INTEG
     4 PINK(4,4),RINK(7)                                               INTEG
C                                                                       INTEG
      COMMON/DSTBZ/DOA,DOB,DOC,DH,DX1                                   INTEG
      FUNC(A,B,C)=EXP((-A+B)*0.5/(C*C))                                 INTEG
      IF (XI.GT.XN) GO TO 70                                            INTEG
      DXI=DBLE(XI)                                                      INTEG
      DXN=DBLE(XN)                                                      INTEG
      DX1=DBLE(XL)                                                      INTEG
      DH=DBLE(H)                                                        INTEG
      DOA=DBLE(OA(L))                                                   INTEG
      DOB=DBLE(OB(L))                                                   INTEG
      DOC=DBLE(OC(L))                                                   INTEG
      EP=1.0E-4                                                         INTEG
      IF (INDEX.EQ.1) GO TO 10                                          INTEG
      DSUM=ANC4(DXI,DXN,EP,M,1,FERR)                                    INTEG
      GO TO 20                                                          INTEG
   10 DSUM=ANC4(DXI,DXN,EP,M,1,FERR1)/DX1                               INTEG
   20 SUM=SUM+DSUM                                                      INTEG
      IF (JFLAG.EQ.0) RETURN                                            INTEG
      XP=(XI+XN)/2.                                                     INTEG
      SZBAR=OA(L)*XP*(1.+OB(L)*XP)**OC(L)                               INTEG
      DO 60 I=NPP,NPE                                                   INTEG
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 60                             INTEG
      DO 55 J=IWS,IWSE                                                  INTEG
      U=UU(J)                                                           INTEG
      XM=PHT*U/VSET(I)                                                  INTEG
      IF (XM.LE.XI) GO TO 40                                            INTEG
      IF (XM.GE.XN) GO TO 30                                            INTEG
      XP1=(XI+XM)/2.                                                    INTEG
      HP=HT(I,PHT,XP1,U)                                                INTEG
      HP=HP*((XM-XI)/(XN-XI))**2                                        INTEG
      GO TO 50                                                          INTEG
   30 HP=HT(I,PHT,XP,U)                                                 INTEG
      GO TO 50                                                          INTEG
   40 HP=0.0                                                            INTEG
   50 SUMP(I,J)=SUMP(I,J)+DSUM*FUNC(HP,H,SZBAR)                         INTEG
   55 CONTINUE                                                          INTEG
   60 CONTINUE                                                          INTEG
      RETURN                                                            INTEG
   70 PRINT 80                                                          INTEG
      STOP                                                              INTEG
C                                                                       INTEG
C                                                                       INTEG
   80 FORMAT('1','ERROR IN SUBROUTINE INTEG, XI.GT.XN')                 INTEG
      END                                                               INTEG
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE POLUT (PSORC)                                          POLUT
      LOGICAL SGTDMX                                                    POLUT
C                                                                       POLUT
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),     POLUT
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),    POLUT
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,   POLUT
     3 ISORC1,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,        POLUT
     4 PINK(4,4),RINK(7)                                                POLUT
C                                                                       POLUT
      COMMON/DEPY/QXQ(5,6),QXQR(6)                                      POLUT
      DIMENSION COSWD(16),SINWD(16),PSORC(4)                            POLUT
      DIMENSION PHTP(5),C1P(5),C3P(5),ARG1P(5)                          POLUT
      EQUIVALENCE (IWNDIR,IWD)                                          POLUT
C     SINWD(IWNDIR)=SIN((PI*FLOAT(IWNDIR-1))/8)                         POLUT
      DATA SINWD/0.0,.38268,.70711,.92388,1.0,.92388,.70711,.38268,0.0, POLUT
     1     -.38268,-.70711,-.92388,-1.0,-.92388,-.70711,-.38268/        POLUT
C     COSWD(IWNDIR)=COS((PI*FLOAT(IWNDIR-1))/8)                         POLUT
      DATA COSWD/1.0,.92388,.70711,.38268,0.0,-.38268,-.70711,-.92388,  POLUT
     1     -1.0,-.92388,-.70711,-.38268,0.0,.38268,.70711,.92388/       POLUT
      DATA PI4,PI8/.7853982,.3926991/                                   POLUT
      SDIAM=SORCE(4,ISORC1)                                             POLUT
      SRAD=SDIAM/2.                                                     POLUT
      PSFACT=FREQ(IWD,IWS,ISTAB)                                        POLUT
      DNWIND=GDSCAL*((SORCE(2,ISORC1)-RECEPT(2,IRECEP))*COSWD(IWNDIR)+(S POLUT
     1ORCE(1,ISORC1)-RECEPT(1,IRECEP))*SINWD(IWNDIR))                   POLUT
      X=DNWIND+SDIAM/PI8                                                POLUT
      IF (SDIAM.GT.100.) GO TO 10                                       POLUT
      IF (X) 250,250,20                                                 POLUT
   10 IF (SRAD+DNWIND) 250,250,20                                       POLUT
   20 CXWIND=GDSCAL*ABS((SORCE(2,ISORC1)-RECEPT(2,IRECEP))*SINWD(IWNDIR) POLUT
     1-(SORCE(1,ISORC1)-RECEPT(1,IRECEP))*COSWD(IWNDIR))                POLUT
      Y=X*PI8                                                           POLUT
      IF (Y.LE.CXWIND) GO TO 250                                        POLUT
      IF (SRAD.GT.ABS(DNWIND)) GO TO 30                                 POLUT
      IF (SDIAM.LE.(DNWIND*PI8)) GO TO 40                               POLUT
      Q=QSCALE*((PI8*X-SDIAM)/SDIAM)                                    POLUT
      DNWIND=SQRT((DNWIND*DNWIND)+(SRAD*SRAD))                          POLUT
C     FROM DNWIND=((4.*DNWIND**2.+SDIAM**2.)**.5)/2.                    POLUT
      X=2.*DNWIND                                                       POLUT
      IF (CXWIND-(SRAD+X*PI8)) 50,50,250                                POLUT
   30 Q=QSCALE*(PI4*(X*X 4.08*X*SDIAM+4.1616*SDIAM*SDIAM))/(SRAD*SRAD*16 POLUT
     1.)                                                                POLUT
C     FROM Q=QSCALE*(.1965*(X-2.040*SDIAM)**2.)/SDIAM**2.               POLUT
      DNWIND=SINWD(3)*(DNWIND+SRAD)                                     POLUT
C     WHERE SINWD(3) = SIN(PI8*2) OR SIN(PI/4) OR .70711                POLUT
      X=DNWIND*2.                                                       POLUT
      IF (CXWIND-SRAD) 50,50,250                                        POLUT
   40 Q=QSCALE                                                          POLUT
   50 Q=Q*(Y-CXWIND)/Y                                                  POLUT
C   CORRECTION SUGGESTED BY APCO -- JANUARY 1971                        POLUT
      IF (X.LT.100.0) X=100.0                                           POLUT
C                                                                       POLUT
      U=UU(IWS)                                                         POLUT
      L=ISTAB                                                           POLUT
      Y=100.0*Q/U                                                       POLUT
      IF (Y.LE.0.0) GO TO 250                                           POLUT
      DWINDD=DNWIND                                                     POLUT
      L1=L                                                              POLUT
C   **********                                                          POLUT
C   BRIGGS PLUME RISE FORMULATION & JANUARY 1971                        POLUT
      HS=SORCE(3,ISORC1)                                                POLUT
C***  ADD HOLLAND-STUMKE-MOSES/CARSON RISE IF VDD@0.0                   POLUT
C***  NOTE THAT VDD IS SORCE(12,ISORC1)                                 POLUT
      IF (SORCE(12,ISORC1).GT.0.0) HS=HS+1.5*SORCE(12,ISORC1)/U         POLUT
      PHT=HS                                                            POLUT
      IF (ZRECEP(IRECEP).NE.0) PHT=PHT-ZRECEP(IRECEP)                   POLUT
C   **********                                                          POLUT
      IF (PHT.LT.0.0) PHT=0.0                                           POLUT
```

FIGURE B.0-1. (Continued)

```
      IF (IFLAG.EQ.0) GO TO 90                                          POLUT
      DO 80 I=NPS,NPE                                                   POLUT
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 80                             POLUT
      IF (VSET(I).LE.0.01) GO TO 60                                     POLUT
      PHTP(I)=PHT-DNWIND*VSET(I)/U                                      POLUT
      GO TO 70                                                          POLUT
   60 PHTP(I)=PHT                                                       POLUT
   70 IF (PHTP(I).LE.0.04 PHTP(I)=0.0                                   POLUT
   80 CONTINUE                                                          POLUT
   90 IF (DNWIND.LT.100.) DNWIND=100.                                   POLUT
      SIGZ=OA(L)*DNWIND*Y1.+OB(L)*DNWIND)**OC(L)                        POLUT
      ARG1=(-.5*PHT**2)/USIGZ**2)                                       POLUT
      IF (IFLAG.EQ.0) GO TO 110                                         POLUT
      DO 100 I=NPS,NPE                                                  POLUT
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 100                            POLUT
      ARG1P(I)=(-.5*PHTP(I)**2)/(SIGZ**2)                               POLUT
  100 CONTINUE                                                          POLUT
  110 SGTDMX=.TRUE.                                                     POLUT
      IF (L.GT.4) GO TO 170                                             POLUT
      IF (SIGZ.LT..47*DMH GO TO 170                                     POLUT
      X1=0.47*DM/OA(L)                                                  POLUT
      IF (L.LT.3) GO TO 120                                             POLUT
      X1=X1*X1                                                          POLUT
      X11=X1*OB(L)/2.                                                   POLUT
      X1=X11+(X11*X11+X1)**0.5                                          POLUT
  120 IF (X.GE.X1*2.) GO TO 130                                         POLUT
      XD=2.*X1                                                          POLUT
      SGTDMX=.FALSE.                                                    POLUT
      GO TO 140                                                         POLUT
  130 XD=X                                                              POLUT
  140 C2=(.0255*Y)/(DM*XD)                                              POLUT
      IF (.NOT.SGTDMX) GO TO 160                                        POLUT
      C3=C2                                                             POLUT
      IF (IFLAG.EQ.0) GO TO 200                                         POLUT
      DO 150 I=NPS,NPE                                                  POLUT
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 150                            POLUT
      C3P(I)=C2                                                         POLUT
  150 CONTINUE                                                          POLUT
      GO TO 200                                                         POLUT
  160 XD=X1                                                             POLUT
      GO TO 180                                                         POLUT
  170 XD=X                                POLUT
  180 IF (ABS(ARG1).GT.60.) ARG1=-60.                                   POLUT
      C1=(.0203*Y)/(SIGZ*XD)*EXP(ARG1)                                  POLUT
      C3=C1                                                             POLUT
      IF (.NOT.SGTDMX) C3=C1-((X-X1)/X1)*(C1-C2)                        POLUT
      IF (IFLAG.EQ.0) GO TO 200                                         POLUT
      DO 190 I=NPS,NPE                                                  POLUT
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 190                            POLUT
      IF (ABS(ARG1P(I)).GT.60.) ARG1P(I)=-60.                           POLUT
      AREXP=EXP(ARG1P(I))                                               POLUT
      C1P(I)=(.0203*Y)/(SIGZ*XD)*AREXP                                  POLUT
      C3P(I)=C1P(I)                                                     POLUT
      IF (.NOT.SGTDMX) C3P(I)=C1P(I)-((X-X1)/X1)*(C1P(I)-C2)            POLUT
  190 CONTINUE                                                          POLUT
C   HALF-LIFE MODIFICATION FOR RADON222                                 POLUT
  200 TIME=DNWIND/U                                                     POLUT
      CONCRN=SORCE(9,ISORC1)                                            POLUT
      IF (IFLAG.EQ.0) GO TO 230                                         POLUT
      IF (IWSB.GT.1) GO TO 210                                          POLUT
      CALL DDEP (SIGZ,DWINDD,X1,PHT,L1)                                 POLUT
  210 DO 220 I=NPS,NPE                                                  POLUT
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 220                            POLUT
      DO 215 II=1,4                                                     POLUT
  215 PINK(I,II)=C3P(I)*PTSZFC(I,KSORCE)*PSORC(II)*OXO(I,IWS)*PSFACT    POLUT
  220 CONTINUE                                                          POLUT
      IFPART=1                                                          POLUT
  230 IF(CONCRN.EQ.0.0) GO TO 250                                       POLUT
```

FIGURE B.0-1. (Continued)

```
      CALL ACTDR(TIME,7)                                              POLUT
      IFRN=1                                                          POLUT
      FIX=PSFACT*C3*CONCRN                                            POLUT
      DO 240 I=1,7                                                    POLUT
  240 RINK(I)=FIX*ACTIV(I)                                            POLUT
  250 RETURN                                                          POLUT
      END                                                             POLUT
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE POPDOS                                                 POPDOS
C******************** ***************************************************POPDOS
      LEVEL 2, NSORCE,NRECEP,TPSZ,CISUM,IPACT,PACT,PDEN,DUST20,ACTRAT,  POPDOS
     1 PTSZ20,RXQ,RXQRN,PTSZ,QNAME                                      POPDOS
C                                                                       POPDOS
      COMMON/BDATA/NSORCE,NRECEP,TPSZ(4,4,240),CISUM(7,240),IPACT(20),  POPDOS
     1 PACT(3,4),PDEN(4),DUST20(6),ACTRAT,PTSZ20,RXQ(20,240,4),         POPDOS
     2 RXQRN(20,240,7),PTSZ(4),QNAME(5,20)                              POPDOS
C                                                                       POPDOS
      COMMON/CDATA/QAJUST(10,2,20),DEPVEL(4),CPY(5,20),ISTEP,IRCV,IADD, POPDOS
     1 ALN2,TSTEP(10),ALF(6),GFACT(4,10),GPFACT(4),TFACT(4,10),NSTEP,   POPDOS
     2 TPFACT(4),CGIP(4,4,240),CGXRN(4,240),JC(10),XPFACT               POPDOS
C                                                                       POPDOS
      COMMON/DDATA/WLFACT(3),DCFA(5,7,5),DCFGP(4),DCFCP(4),DCFGR(5),    POPDOS
     1 DCFCR(5),DCFF(8,4,4),BIV(4,5),FBI(4),FMI(4),OF,SHIELD,RF(3),     POPDOS
     2 FREP(4,5),TISSUE(6),PATH(8),SRHO,WHL,TSTART,IFTODO(10),          POPDOS
     3 TNAME(5,10)                                                      POPDOS
C                                                                       POPDOS
      COMMON/EDATA/FFORP,FHAYP,FPR(3),IPOP(12,16),WINDR(16),XRHO(12),   POPDOS
     1 IPTOT,FRADON(4),PAJUST(10),PDREG(6,8,10),PDXREG(6,8,10),         POPDOS
     2 PDTOT(6,8,10)                                                    POPDOS
C                                                                       POPDOS
      DIMENSION AREA(12),PCCR(3),FIK(4,3),FGBVT(3),CAI(10,192),         POPDOS
     1  DRI(4,192),DOSTYP(6,2),PD(6,6),PWD(12,16),CIF(4,7),             POPDOS
     2  SUMTOT(4,3),CBFT(4,3),PFA(3,12,16),PFB(3,12,16),PFC(3,12,16),   POPDOS
     3  PFD(3,12,16),RADPOP(4,4),RADNAM(4),RADDCF(4),POPRAD(6),FOODP(3), POPDOS
     4  FOODC(3),FRACON(3)                                              POPDOS
C******************** ***************************************************POPDOS
      DATA AREA/0.589,0.982,1.374,1.767,14.73,58.9,98.2,137.4,176.7,    POPDOS
     1  216.0,255.3,294.5/                                              POPDOS
      DATA PCCR/276.7,102.8,209.0/                                      POPDOS
      DATA FIK/0.0,  0.1418,0.2167,0.6415,                              POPDOS
     1         0.0,   0.0780,0.1485,0.7735,                             POPDOS
     2         0.0178,0.1850,0.2728,0.5244/                             POPDOS
      DATA FGBVT/0.783,0.196,0.021/                                     POPDOS
      DATA DOSTYP/10H100-YEAR E,10HNVIRONMENT,10HAL DOSE CO,            POPDOS
     1            10HMMITMENTS,,10H PERSON-RE,10HM/YEAR    ,            POPDOS
     2            10HANNUAL POP,10HULATION DO,10HSE COMMITM,            POPDOS
     3            10HENTS, PERS,10HON-REM PER,10H YEAR     /            POPDOS
      DATA RADPOP/8.8,120.,2.0,56.,                                     POPDOS
     1            5.8, 77.,1.6,72.,                                     POPDOS
     2            8.2,110.,1.8,52.,                                     POPDOS
     3            9.0,120.,1.7,43./                                     POPDOS
      DATA RADNAM/10HCASPER    ,10HFALLS CITY,10HGRANTS    ,            POPDOS
     1            10HWELLPINIT /                                        POPDOS
C******************** ***************************************************POPDOS
      IF(IRCV.NE.192) RETURN                                            POPDOS
      IT=ISTEP                                                          POPDOS
C                                                                       POPDOS
      DO 60 IR=1,IRCV                                                   POPDOS
      DO 10 IX=1,10                                                     POPDOS
      CAI(IX,IR)=0.0                                                    POPDOS
      IF(IX.EQ.10) GO TO 10                                             POPDOS
      CGI(IX,IR)=0.0                                                    POPDOS
      IF(IX.GT.4) GO TO 10                                              POPDOS
      DRI(IX,IR)=0.0                                                    POPDOS
 10   CONTINUE                                                          POPDOS
C                                                                       POPDOS
      DO 20 IX=1,4                                                      POPDOS
      DO 20 IP=1,4                                                      POPDOS
      CAI(IX,IR)=CAI(IX,IR)+TPSZ(IP,IX,IR)                              POPDOS
      DRI(IX,IR)=DRI(IX,IR)+DEPVEL(IP)*TPSZ(IP,IX,IR)                   POPDOS
 20   CGI(IX,IR)=CGI(IX,IR)+CGIP(IP,IX,IR)                              POPDOS
C                                                                       POPDOS
      DRI(4,IR)=DRI(4,IR)+(0.003)*CISUM(5,IR)                           POPDOS
      PLUS=CGI(3,IR)                                                    POPDOS
      DO 40 IX=5,9                                                      POPDOS
      IXX=IX-4                                                          POPDOS
```

FIGURE B.0-1. (Continued)

```
      CAI(IX,IR)=CISUM(IXX,IR)                                       POPDOS
      IF(IX.GT.5) GO TO 30                                           POPDOS
      CGI(5,IR)=PLUS                                                 POPDOS
      GO TO 40                                                       POPDOS
 30   IF(IX.GT.8) PLUS=0.0                                           POPDOS
      CGI(IX,IR)=CGXRN(IXX-1,IR)+PLUS                                POPDOS
 40   CONTINUE                                                       POPDOS
C                                                                    POPDOS
      DO 50 IW=1,3                                                   POPDOS
      IWX=IW+1                                                       POPDOS
 50   CAI(10,IR)=CAI(10,IR)+WLFACT(IW)*CISUM(IWX,IR)                 POPDOS
 60   CONTINUE                                                       POPDOS
C******************** ************************************************ POPDOS
C                                                                    POPDOS
C     WE HAVE NOW COMPUTED TOTAL AIR CONCS, CAI(IX,IR),IX=U-238,TH-230, POPDOS
C       RA-226, AND PB-210 (PARTICULATES ONLY), RN-222,PO-218,PB-214,   POPDOS
C       BI-214,PB-210,AND WL (RADON ONLY). ALL IN PCI/M3 EXCEPT WL.     POPDOS
C                                                                    POPDOS
C     DRI(IX,IR) IS TOTAL DEPOSITION RATE, PCI/M2-SEC, FOR U-238,      POPDOS
C       TH-230,RA-226,AND PB-210, INCLUDING RN DAUGHTER.               POPDOS
C                                                                    POPDOS
C     CGI(IX,IR) IS GROUND CONC., PCI/M2 FOR U-238, TH-230, RA-226,    POPDOS
C       AND PB-210 (PARTICULATES), RN-222, PO-218, PB-214, BI-214, AND  POPDOS
C       PB-210 (FROM RN RELEASES AND RA-226 DECAY).                    POPDOS
C                                                                    POPDOS
C     NOW WE TEST JC(3) FOR CONCENTRATION PRINT AND PROCEED.           POPDOS
C                                                                    POPDOS
C******************** ************************************************ POPDOS
      IF(JC(3).NE.1) GO TO 120                                       POPDOS
      IWDMAX=1                                                       POPDOS
      RNMAX=CAI(5,4)                                                 POPDOS
      DO 70 IW=2,16                                                  POPDOS
      IRX=IW*12-8                                                    POPDOS
      IF(CAI(5,IRX).LT.RNMAX) GO TO 70                               POPDOS
      IWDMAX=IW                                                      POPDOS
      RNMAX=CAI(5,IRX)                                               POPDOS
 70   CONTINUE                                                       POPDOS
C                                                                    POPDOS
      DO 110 IZ=1,16,4                                               POPDOS
      IW=IZ                                                          POPDOS
C******************** ************************************************ POPDOS
C                                                                    POPDOS
 75   CALL HEADER                                                    POPDOS
C                                                                    POPDOS
C******************** ************************************************ POPDOS
      PRINT 2000, ISTEP,(TNAME(I,ISTEP),I=1,5),TSTEP(ISTEP)          POPDOS
      DEGREE=22.5*(IW-1)                                             POPDOS
      PRINT 2010, WINDR(IW),DEGREE                                   POPDOS
      PRINT 2020                                                     POPDOS
      PRINT 2030                                                     POPDOS
      IRB=(IW-1)*12+1                                                POPDOS
      IRE=IRB+11                                                     POPDOS
      ID=0                                                           POPDOS
C                                                                    POPDOS
      DO 80 IR=IRB,IRE                                               POPDOS
      ID=ID+1                                                        POPDOS
      PRINT 2040, XRHO(ID),(CAI(IX,IR),IX=1,10)                      POPDOS
 80   CONTINUE                                                       POPDOS
C                                                                    POPDOS
      PRINT 2050                                                     POPDOS
      PRINT 2060                                                     POPDOS
      ID=0                                                           POPDOS
      DO 90 IR=IRB,IRE                                               POPDOS
      ID=ID+1                                                        POPDOS
      PRINT 2070, XRHO(ID),(CGI(IX,IR),IX=1,9)                       POPDOS
 90   CONTINUE                                                       POPDOS
C                                                                    POPDOS
      PRINT 2080                                                     POPDOS
```

FIGURE B.0-1. (Continued)

```
      PRINT 2090                                                         POPDOS
      ID=0                                                               POPDOS
      DO 100 IR=IRB,IRE                                                  POPDOS
      ID=ID+1                                                            POPDOS
      PRINT 2100, XRHO(ID),(ORI(IX,IR),IX=1,4)                           POPDOS
  100 CONTINUE                                                           POPDOS
C                                                                        POPDOS
      IF(IWDMAX.LE.IW) GO TO 110                                         POPDOS
      IF(IWDMAX.GE.IW+4) GO TO 110                                       POPDOS
      IW=IWDMAX                                                          POPDOS
      GO TO 75                                                           POPDOS
  110 CONTINUE                                                           POPDOS
C                                                                        POPDOS
  120 CONTINUE                                                           POPDOS
C******************** ************************************************** POPDOS
C                                                                        POPDOS
C     WE CAN NOW PROCEED TO DOSE CALCULATIONS, PRINTING OUT TABLES AND   POPDOS
C       SUMMARY IF JC(4)=1. OTHERWISE SUMMARY ONLY.  MUST ITERATE        POPDOS
C       OVER PATH (L), ORGAN(J), DIRECTION (IW), DISTANCE (ID),          POPDOS
C       ISOTOPE (IX), PTSZ (IP), AND AGE (K).                            POPDOS
C                                                                        POPDOS
C******************** ************************************************** POPDOS
      DO 130 L=1,6                                                       POPDOS
      DO 130 J=1,6                                                       POPDOS
  130 PD(J,L)=0.0                                                        POPDOS
C                                                                        POPDOS
      ILK=2                                                              POPDOS
      IF(JC(2).EQ.1) ILK81                                               POPDOS
C                                                                        POPDOS
      L=1                                                                POPDOS
      DO 170 J=1,5                                                       POPDOS
      DO 140 IW=1,16                                                     POPDOS
      DO 140 ID=1,12                                                     POPDOS
  140 PWD(ID,IW)=0.0                                                     POPDOS
C                                                                        POPDOS
      IR=0                                                               POPDOS
      DO 160 IW=1,16                                                     POPDOS
      DO 160 ID=1,12                                                     POPDOS
      IR=IR+1                                                            POPDOS
      DO 150 IX=1,4                                                      POPDOS
      DO 150 IP=1,4                                                      POPDOS
      PWD(ID,IW)=PWD(ID,IW)+DCFA(IP,IX,J)*TPSZ(IP,IX,IR)                 POPDOS
  150 CONTINUE                                                           POPDOS
      ABC=CISUM(5,IR)*DCFA(5,5,J)                                        POPDOS
      ABC=ABC+CISUM(6,IR)*DCFA(5,6,J)                                    POPDOS
      ABC=ABC+CISUM(7,IR)*DCFA(5,7,J)                                    POPDOS
      PWD(ID,IW)=(PWD(ID,IW)+ABC)*IPOP(ID,IW)*(0.001)                    POPDOS
      PD(J,L)=PD(J,L)+PWD(ID,IW)                                         POPDOS
  160 CONTINUE                                                           POPDOS
C                                                                        POPDOS
      IF(JC(4).NE.1) GO TO 170                                           POPDOS
      IF(J.GT.3) GO TO 170                                               POPDOS
      GO TO 1000                                                         POPDOS
  170 CONTINUE                                                           POPDOS
C                                                                        POPDOS
      J=6                                                                POPDOS
      IR=0                                                               POPDOS
      DO 180 IW=1,16                                                     POPDOS
      DO 180 ID=1,12                                                     POPDOS
      IR=IR+1                                                            POPDOS
      PWD(ID,IW)=CISUM(1=IR)*(0.625)*IPOP(ID,IW)*(0.001)                 POPDOS
      PD(J,L)=PD(J,L)+PWD(ID,IW)                                         POPDOS
  180 CONTINUE                                                           POPDOS
C                                                                        POPDOS
      IF(JC(4).NE.1) GO TO 190                                           POPDOS
      GO TO 1000                                                         POPDOS
  190 CONTINUE                                                           POPDOS
C                                                                        POPDOS
```

FIGURE B.0-1. (Continued)

```
      J=1                                                               POPDOS
      DO 290 L=2,3                                                      POPDOS
      IR=0                                                              POPDOS
      DO 280 IW=1,16                                                    POPDOS
C                                                                       POPDOS
      DO 280 ID=1,12                                                    POPDOS
      IR=IR+1                                                           POPDOS
      ABC=0.0                                                           POPDOS
      IF(L.EQ.3) GO TO 230                                              POPDOS
C                                                                       POPDOS
      DO 220 IX=1,9                                                     POPDOS
      IF(IX.GT.4) GO TO 200                                             POPDOS
      DCF=DCFGP(IX)                                                     POPDOS
      GO TO 210                                                         POPDOS
  200 DCF=DCFGR(IX-4)                                                   POPDOS
  210 ABC=ABC+DCF*CGI(IX,IR)                                            POPDOS
  220 CONTINUE                                                          POPDOS
      GO TO 270                                                         POPDOS
C                                                                       POPDOS
  230 CONTINUE                                                          POPDOS
      DO 260 IX=1,9                                                     POPDOS
      IF(IX.GT.4) GO TO 240                                             POPDOS
      DCF=DCFCP(IX)                                                     POPDOS
      GO TO 250                                                         POPDOS
  240 DCF=DCFCR(IX-4)                                                   POPDOS
  250 ABC=ABC+DCF*CAI(IX,IR)                                            POPDOS
  260 CONTINUE                                                          POPDOS
C                                                                       POPDOS
  270 CONTINUE                                                          POPDOS
      PWD(ID,IW)=ABC*IPOP(ID,IW)*SHIELD*(0.001)                         POPDOS
      PD(J,L)=PD(J,L)+PWD(ID,IW)                                        POPDOS
  280 CONTINUE                                                          POPDOS
C                                                                       POPDOS
      IF(JC(4).NE.1) GO TO 290                                          POPDOS
      GO TO 1000                                                        POPDOS
  290 CONTINUE                                                          POPDOS
C                                                                       POPDOS
      DO 300 L=2,3                                                      POPDOS
      DO 300 J=2,6                                                      POPDOS
      PD(J,L)=PD(1,L)                                                   POPDOS
  300 CONTINUE                                                          POPDOS
C******************** ************************************************* POPDOS
C                                                                       POPDOS
C     WE HAVE COMPUTED PD(J,L) FOR J=1,6 AND FOR L=1,3. NOW COMPUTE     POPDOS
C       POPULATION DOSES FROM FOOD INGESTION PATHWAYS.                  POPDOS
C                                                                       POPDOS
C******************** ************************************************* POPDOS
      WLAMDA=ALN2/WHL                                                   POPDOS
      TICK=(1.0-EXP(-30.*WLAMDA))/WLAMDA*(24.*3600.)*(0.2/0.75)         POPDOS
      TOCK=(1.0-EXP(-60.*WLAMDA))/WLAMDA*(24.*3600.)*(0.2/2.0)          POPDOS
C                                                                       POPDOS
      DO 310 IX=1,4                                                     POPDOS
      DO 310 IC=1,3                                                     POPDOS
      SUMTOT(IX,IC)=0.0                                                 POPDOS
  310 CONTINUE                                                          POPDOS
C                                                                       POPDOS
      IR=0                                                              POPDOS
      DO 380 IW=1,16                                                    POPDOS
      DO 380 ID=1,12                                                    POPDOS
      IR=IR+1                                                           POPDOS
      AOS=AREA(ID)                                                      POPDOS
C                                                                       POPDOS
      DO 330 IV=1,5                                                     POPDOS
      TEX=TICK                                                          POPDOS
      IF(IV.NE.4) TEX=TOCK                                              POPDOS
C                                                                       POPDOS
      DO 320 IX=1,4                                                     POPDOS
  320 CIF(IX,IV)=DRI(IX,IR)*TEX*FREP(IX,IV)+CGI(IX,IR)*BIV(IX,IV)/SRHO  POPDOS
```

FIGURE B.0-1. (Continued)

```
C                                                                   POPDOS
      CIF(4,IV)=CIF(4,IV)+CGI(9,IR)*BIV(4,IV)/SRHO                  POPDOS
  330 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      DO 350 IX=1,4                                                 POPDOS
      ABC=FFORP*CIF(IX,4)+FHAYP*CIF(IX,5)                           POPDOS
      CIF(IX,6)=ABC*QF*FBI(IX)                                      POPDOS
      CIF(IX,7)=ABC*QF*FMI(IX)                                      POPDOS
      CBFT(IX,1)=0.0                                                POPDOS
C                                                                   POPDOS
      DO 340 IV=1,3                                                 POPDOS
  340 CBFT(IX,1)=CBFT(IX,1)+FGBVT(IV)*CIF(IX,IV)                    POPDOS
C                                                                   POPDOS
      CBFT(IX,2)=CIF(IX,6)                                          POPDOS
      CBFT(IX,3)=CIF(IX,7)                                          POPDOS
  350 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      DO 360 IC=1,3                                                 POPDOS
      PFA(IC,ID,IW)=0.0                                             POPDOS
      PFB(IC,ID,IW)=0.0                                             POPDOS
      PFC(IC,ID,IW)=0.0                                             POPDOS
      PFD(IC,ID,IW)=0.0                                             POPDOS
  360 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      DO 370 IC=1,3                                                 POPDOS
      PFA(IC,ID,IW)=PFA(IC,ID,IW)+AOS*FPR(IC)*CBFT(1,IC)*RF(IC)     POPDOS
      PFB(IC,ID,IW)=PFB(IC,ID,IW)+AOS*FPR(IC)*CBFT(2,IC)*RF(IC)     POPDOS
      PFC(IC,ID,IW)=PFC(IC,ID,IW)+AOS*FPR(IC)*CBFT(3,IC)*RF(IC)     POPDOS
      PFD(IC,ID,IW)=PFD(IC,ID,IW)+AOS*FPR(IC)*CBFT(4,IC)*RF(IC)     POPDOS
C                                                                   POPDOS
      DO 370 IX=1,4                                                 POPDOS
      SUMTOT(IX,IC)=SUMTOT(IX,IC)+AOS*FPR(IC)*CBFT(IX,IC)*RF(IC)    POPDOS
  370 CONTINUE                                                      POPDOS
C                                                                   POPDOS
  380 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      DO 420 L=4,6                                                  POPDOS
      IC=L-3                                                        POPDOS
      DO 420 J=1,4                                                  POPDOS
C                                                                   POPDOS
      DO 400 IW=1,16                                                POPDOS
      DO 400 ID=1,12                                                POPDOS
      ABC=0.0                                                       POPDOS
C                                                                   POPDOS
      DO 390 IK=1,4                                                 POPDOS
      ABC=ABC+PFA(IC,ID,IW)*FIK(IK,IC)*DCFF(1,J,IK)*(0.001)         POPDOS
      ABC=ABC+PFB(IC,ID,IW)*FIK(IK,IC)*DCFF(2,J,IK)*(0.001)         POPDOS
      ABC=ABC+PFC(IC,ID,IW)*FIK(IK,IC)*DCFF(3,J,IK)*(0.001)         POPDOS
      ABC=ABC+PFD(IC,ID,IW)*FIK(IK,IC)*DCFF(4,J,IK)*(0.001)         POPDOS
  390 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      PWD(ID,IW)=ABC                                                POPDOS
      PD(J,L)=PD(J,L)+PWD(ID,IW)                                    POPDOS
  400 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      IF(JC(4).NE.1) GO TO 420                                      POPDOS
      IF(J.GT.2) GO TO 420                                          POPDOS
      GO TO 1000                                                    POPDOS
  410 CONTINUE                                                      POPDOS
C                                                                   POPDOS
  420 CONTINUE                                                      POPDOS
C                                                                   POPDOS
      DO 430 L=4,6                                                  POPDOS
      PD(5,L)=PD(4,L)                                               POPDOS
      PD(4,L)=PD(3,L)                                               POPDOS
      PD(6,L)=PD(1,L)                                               POPDOS
      PD(3,L)=PD(1,L)                                               POPDOS
  430 CONTINUE                                                      POPDOS
```

```
C                                                                         POPDOS
      DO 440 JX=1,4                                                       POPDOS
      RADDCF(JX)=0.0                                                      POPDOS
C                                                                         POPDOS
      DO 440 LX=1,4                                                       POPDOS
      RADDCF(JX)=RADDCF(JX)+RADPOP(JX,LX)*FRADON(LX)                      POPDOS
 440  CONTINUE                                                            POPDOS
C                                                                         POPDOS
      CPYRN=0.0                                                           POPDOS
C                                                                         POPDOS
      DO 450 IS=1,NSORCE                                                  POPDOS
      CPYRN=CPYRN+CPY(5,IS)*QAJUST(ISTEP,2,IS)                            POPDOS
 450  CONTINUE                                                            POPDOS
C                                                                         POPDOS
      POPRAD(1)=CPYRN*RADDCF(1)*(0.001)*PAJUST(ISTEP)                     POPDOS
      POPRAD(2)=CPYRN*RADDCF(2)*(0.001)*PAJUST(ISTEP)                     POPDOS
      POPRAD(3)=CPYRN*RADDCF(3)*(0.001)*PAJUST(ISTEP)                     POPDOS
      POPRAD(4)=CPYRN*RADDCF(1)*(0.001)*PAJUST(ISTEP)                     POPDOS
      POPRAD(5)=CPYRN*RADDCF(1)*(0.001)*PAJUST(ISTEP)                     POPDOS
      POPRAD(6)=CPYRN*RADDCF(4)*(0.001)*PAJUST(ISTEP)                     POPDOS
C                                                                         POPDOS
      AOS=(3.1415927)*(80.*80.-1.)                                        POPDOS
C                                                                         POPDOS
      DO 460 IC=1,3                                                       POPDOS
      FOODP(IC)=AOS*FPR(+C)                                               POPDOS
      FOODC(IC)=IPTOT*PCCR(IC)                                            POPDOS
      FRACON(IC)=FOODC(IC)/FOODP(IC)                                      POPDOS
      IF(FRACON(IC).GT=1HO) FRACON(IC)=1.0                                POPDOS
 460  CONTINUE                                                            POPDOS
C                                                                         POPDOS
      DO 490 IJ=1,6                                                       POPDOS
C                                                                         POPDOS
      DO 480 IL=1,6                                                       POPDOS
      IF(IL.GT.3) GO TO 470                                               POPDOS
      PDREG(IJ,IL,ISTEP)=PD(IJ,IL)                                        POPDOS
      PDXREG(IJ,IL,ISTEP'=0.0                                             POPDOS
      PDTOT(IJ,IL,ISTEP)=PD(IJ,IL)                                        POPDOS
      GO TO 480                                                           POPDOS
 470  CONTINUE                                                            POPDOS
C                                                                         POPDOS
      IC=IL-3                                                             POPDOS
      PDREG(IJ,IL,ISTEP)=PD(IJ,IL)*FRACON(IC)                             POPDOS
      PDTOT(IJ,IL,ISTEP)=PD(IJ,IL)                                        POPDOS
      PDXREG(IJ,IL,ISTEP'=PD(IJ,IL)*(1.0-FRACON(IC))                      POPDOS
 480  CONTINUE                                                            POPDOS
C                                                                         POPDOS
      PDREG(IJ,7,ISTEP)=0.0                                               POPDOS
      PDXREG(IJ,7,ISTEP)=POPRAD(IJ)                                       POPDOS
      PDTOT(IJ,7,ISTEP)=POPRAD(IJ)                                        POPDOS
 490  CONTINUE                                                            POPDOS
C                                                                         POPDOS
      DO 500 IJ=1,6                                                       POPDOS
      PDREG(IJ,8,ISTEP)=0.0                                               POPDOS
      PDXREG(IJ,8,ISTEP)=0.0                                              POPDOS
      PDTOT(IJ,8,ISTEP)=0.0                                               POPDOS
C                                                                         POPDOS
      DO 500 IL=1,7                                                       POPDOS
      PDREG(IJ,8,IT)=PDREG(IJ,8,IT)+PDREG(IJ,IL,IT)                       POPDOS
      PDXREG(IJ,8,IT)=PDOREG(IJ,8,IT)+PDXREG(IJ,IL,IT)                    POPDOS
      PDTOT(IJ,8,IT)=PDTOT(IJ,8,IT)+PDTOT(IJ,IL,IT)                       POPDOS
 500  CONTINUE                                                            POPDOS
C********************* ************************************************** POPDOS
C                                                                         POPDOS
C     PROCEED WITH SUMMARY PRINT OF POPULATION DOSES/YR FOR THIS TSTEP.   POPDOS
C                                                                         POPDOS
C********************* ************************************************** POPDOS
C                                                                         POPDOS
      CALL HEADER                                                         POPDOS
```

FIGURE B.0-1. (Continued)

```
C                                                                       POPDOS
C******************** ************************************************** POPDOS
      PRINT 2000, ISTEP,(TNAME(I,ISTEP),I=1,5),TSTEP(ISTEP)             POPDOS
      PRINT 2150, ISTEP,(DOSTYP(I,ILK),I=1,6)                           POPDOS
      PRINT 2160                                                        POPDOS
      PRINT 2170, (TISSUE(I),I=1,6)                                     POPDOS
C                                                                       POPDOS
      DO 510 IL=1,8                                                     POPDOS
      ILX=IL                                                            POPDOS
      IF(IL.EQ.7) ILX=8                                                 POPDOS
      IF(IL.EQ.8) ILX=7                                                 POPDOS
      IF(IL.EQ.8) PRINT 2200                                            POPDOS
      PRINT 2180, PATH(ILX), (PDREG(IJ,IL,IT),IJ=1,6)                   POPDOS
  510 CONTINUE                                                          POPDOS
C                                                                       POPDOS
      PRINT 2190                                                        POPDOS
      PRINT 2170, (TISSUE(I),I=1,6)                                     POPDOS
C                                                                       POPDOS
      DO 520 IL=1,8                                                     POPDOS
      ILX=IL                                                            POPDOS
      IF(IL.EQ.7) ILX=8                                                 POPDOS
      IF(IL.EQ.8) ILX=7                                                 POPDOS
      IF(IL.EQ.8) PRINT 2200                                            POPDOS
      PRINT 2180, PATH(ILX),(PDXREG(IJ,IL,IT),IJ=1,6)                   POPDOS
  520 CONTINUE                                                          POPDOS
C                                                                       POPDOS
      PRINT 2210                                                        POPDOS
      PRINT 2170, (TISSUE(I),I=1,6)                                     POPDOS
C                                                                       POPDOS
      DO 530 IL=1,8                                                     POPDOS
      ILX=IL                                                            POPDOS
      IF(IL.EQ.7) ILX=8                                                 POPDOS
      IF(IL.EQ.8) ILX=7                                                 POPDOS
      IF(IL.EQ.8) PRINT 2200                                            POPDOS
      PRINT 2180, PATH(ILX), (PDTOT(IJ,IL,IT),IJ=1,6)                   POPDOS
  530 CONTINUE                                                          POPDOS
C******************** ************************************************** POPDOS
C                                                                       POPDOS
C     SUMMARY TABLE OF ANNUAL POPULATION DOSES FOR THIS TSTEP HAS BEEN  POPDOS
C     COMPUTED, PRINTED AND STORED. NOW RETURN TO MILDOS MAIN UNLESS    POPDOS
C     ILK=1 AND ISTEP=NSTEP.                                            POPDOS
C                                                                       POPDOS
C******************** ************************************************** POPDOS
      IF(ILK.NE.1) RETURN                                               POPDOS
      IF(ISTEP.NE.NSTEP) RETURN                                         POPDOS
C******************** ************************************************** POPDOS
C                                                                       POPDOS
C     NOW PROCEED TO COM7UTE AND PRINT ENVIRONMENTAL DOSE COMMITMENTS    POPDOS
C     INTEGRATED OVER ALL TSTEPS.                                       POPDOS
C                                                                       POPDOS
C******************** ************************************************** POPDOS
      DO 550 IJ=1,6                                                     POPDOS
      DO 540 IM=1,3                                                     POPDOS
      PD(IM,IJ)=0.0                                                     POPDOS
  540 CONTINUE                                                          POPDOS
C                                                                       POPDOS
      DO 550 ITS=1,NSTEP                                                POPDOS
      PDREG(IJ,8,ITS)=PDREG(IJ,8,ITS)*TSTEP(ITS)                        POPDOS
      PDXREG(IJ,8,ITS)=PDXREG(IJ,8,ITS)*TSTEP(ITS)                      POPDOS
      PDTOT(IJ,8,ITS)=PDTOT(IJ,8,ITS)*TSTEP(ITS)                        POPDOS
      PD(1,IJ)=PD(1,IJ)+PDREG(IJ,8,ITS)                                 POPDOS
      PD(2,IJ)=PD(2,IJ)+PDXREG(IJ,8,ITS)                                POPDOS
      PD(3,IJ)=PD(3,IJ)+PDTOT(IJ,8,ITS)                                 POPDOS
  550 CONTINUE                                                          POPDOS
C******************** ************************************************** POPDOS
C                                                                       POPDOS
      CALL HEADER                                                       POPDOS
C                                                                       POPDOS
```

FIGURE B.0-1. (Continued)

```
C******************** ************************************************* POPDOS
      PRINT 2220                                                        POPDOS
      PRINT 2230                                                        POPDOS
      PRINT 2240, (TISSUE(I),I=1,6)                                     POPDOS
      TS=TSTART                                                         POPDOS
C                                                                       POPDOS
      DO 560 ITS=1,NSTEP                                                POPDOS
      TE=TS+TSTEP(ITS)                                                  POPDOS
      PRINT 2250, ITS,TS,TE,TSTEP(ITS),PATH(7),(PDREG(IJ,8,ITS),IJ=1,6) POPDOS
 560  TS=TE                                                             POPDOS
C                                                                       POPDOS
      PRINT 2260                                                        POPDOS
      PRINT 2270, NSTEP,(PD(1,IJ),IJ=1,6)                               POPDOS
      PRINT 2280                                                        POPDOS
      PRINT 2240, (TISSUE(I),I=1,6)                                     POPDOS
      TS=TSTART                                                         POPDOS
C                                                                       POPDOS
      DO 570 ITS=1,NSTEP                                                POPDOS
      TE=TS+TSTEP(ITS)                                                  POPDOS
      PRINT 2250, ITS,TS,TE,TSTEP(ITS),PATH(7),(PDXREG(IJ,8,ITS),IJ=1,6) POPDOS
 570  TS=TE                                                             POPDOS
C                                                                       POPDOS
      PRINT 2260                                                        POPDOS
      PRINT 2270, NSTEP,(PD(2,IJ),IJ=1,6)                               POPDOS
      PRINT 2290                                                        POPDOS
      PRINT 2240, (TISSUE(I),I=1,6)                                     POPDOS
      TS=TSTART                                                         POPDOS
C                                                                       POPDOS
      DO 580 ITS=1,NSTEP                                                POPDOS
      TE=TS+TSTEP(ITS)                                                  POPDOS
      PRINT 2250, ITS,TS,TE,TSTEP(ITS),PATH(7),(PDTOT(IJ,8,ITS),IJ=1,6) POPDOS
 580  TS=TE                                                             POPDOS
C                                                                       POPDOS
      PRINT 2260                                                        POPDOS
      PRINT 2270, NSTEP,(PD(3,IJ),IJ=1,6)                               POPDOS
C                                                                       POPDOS
      GO TO 620                                                         POPDOS
C                                                                       POPDOS
 1000 CONTINUE                                                          POPDOS
C******************** ************************************************* POPDOS
C                                                                       POPDOS
      CALL HEADER                                                       POPDOS
C                                                                       POPDOS
C******************** ************************************************* POPDOS
      PRINT 2000, ISTEP,(TNAME(I,ISTEP),I=1,5),TSTEP(ISTEP)             POPDOS
      PRINT 2110, PATH(L),TISSUE(J),(DOSTYP(I,ILK),I=1,6),              POPDOS
     1      (XRHO(I),I=1,12)                                            POPDOS
C                                                                       POPDOS
      DO 590 IA=1,16                                                    POPDOS
 590  PRINT 2120, WINDR(IA),(PWD(IB,IA),IB=1,12)                        POPDOS
C                                                                       POPDOS
      PRINT 2130, PD(J,L)                                               POPDOS
C                                                                       POPDOS
      IF(L.GT.1) GO TO 600                                              POPDOS
      IF(J.LT.6) GO TO 170                                              POPDOS
      GO TO 190                                                         POPDOS
      GO TO 190                                                         POPDOS
C                                                                       POPDOS
 600  CONTINUE                                                          POPDOS
      IF(L.GT.3) GO TO 610                                              POPDOS
      GO TO 290                                                         POPDOS
C                                                                       POPDOS
 610  PRINT 2140                                                        POPDOS
      GO TO 410                                                         POPDOS
C******************** ************************************************* POPDOS
 620  CONTINUE                                                          POPDOS
      RETURN                                                            POPDOS
C******************** ************************************************* POPDOS
```

FIGURE B.0-1. (Continued)

```
2000 FORMAT(1H0,28X,'TIME STEP NUMBER',I2,', ',5A4,10X,'DURATION IN YRS POPDOS
    1 IS...',F5.1)                                                        POPDOS
2010 FORMAT(1H0,32X,'CONCENTRATION DATA FOR THE',1X,A4,'DIRECTION, THET POPDOS
    1A EQUALS ',F5.1,' DEGREES')                                          POPDOS
2020 FORMAT(1H0,46X,'TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL')           POPDOS
2030 FORMAT(1H ,' XRHO, KM',5X,'U-238',7X,'TH-230',6X,'RA-226',6X,       POPDOS
    1'PB-210',6X,'RN-22 ',6X,'PO-218',6X,'PB-214',6X,'BI-214',6X,         POPDOS
    2 'PB-210',8X,'WL',/1X,132('-'))                                      POPDOS
2040 FORMAT(1H ,2X,F4.1,4X,10(2X,1PE9.3,1X))                             POPDOS
2050 FORMAT(1H0,48X,'GROUND SURFACE CONCENTRATIONS, PCI/M2')             POPDOS
2060 FORMAT(1H ,7X,'XRHO, KM',5X,'U-238',7X,'TH-230',6X,'RA-226',6X,     POPDOS
    1 'PB-210',6X,'RN-222',6X,'PO-218',6X,'PB-214',6X,'BI-214',6X,        POPDOS
    2 'PB-210',/7X,120('-'))                                              POPDOS
2070 FORMAT(1H ,8X,F4.1,4X,9(2X,1PE9.3,1X))                              POPDOS
2080 FORMAT(1H0,49X,'TOTAL DEPOSITION RATES, PCI/M2-SEC')                POPDOS
2090 FORMAT(1H ,37X,'XRHO, KM',5X,'U-238',7X,'TH-230',6X,'RA-226',6X,    POPDOS
    1 'PB-210',/37X,60('-'))                                              POPDOS
2100 FORMAT(1H ,38X,F4.1,4X,4(2X,1PE9.3,1X))                             POPDOS
2110 FORMAT(1H0,34X,'EXPOSURE PATHWAY IS ',A8,10X,'EXPOSED ORGAN IS ',   POPDOS
    1 A8,//27X,'DOSES SHOWN BELOW ARE ',6A10,//9X,12(6X,'XRHO'),/2X,      POPDOS
    2 'DIRECTION',2X,12(2X,F4.1,4X),/1X,131('-'))                         POPDOS
2120 FORMAT(1H ,4X,A4,3X,12(1X,1PE9.3))                                  POPDOS
2130 FORMAT(1H0,15X,'TOTAL DOSE COMMITMENT IS ',1PE9.3,' PERSON-REM/YR' POPDOS
    1)                                                                    POPDOS
2140 FORMAT(1H0,40X,'WARNING--POPULATION FOOD INGESTION DOSES SHOWN',    POPDOS
    1          /42X,'ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL' POPDOS
    2          ,/42X,'FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED POPDOS
    3        ',/,42X,'BY THE POPULATION OF THIS REGION. SEE SUMMARY',    POPDOS
    4          /,42X,'TABLE FOR THIS INFORMATION.')                       POPDOS
2150 FORMAT('0','SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR ',       POPDOS
    1 'TSTEP',I2,'--DOSES SHOWN ARE ',6A10)                               POPDOS
2160 FORMAT('0',/,44X,'DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS',   POPDOS
    1 /,17X,98('-'))                                                      POPDOS
2170 FORMAT(17X,'PATHWAY ',6(7X,A8),/,17X,98('-'))                        POPDOS
2180 FORMAT(17X,A8,6(6X,1PE9.3))                                          POPDOS
2190 FORMAT('0',/,44X,'DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS',   POPDOS
    1 /,17X,98('-'))                                                      POPDOS
2200 FORMAT(17X,98('-'))                                                  POPDOS
2210 FORMAT('0',/,46X,'TOTAL DOSES COMPUTED OVER ALL POPULATIONS',       POPDOS
    1 /,17X,98('-'))                                                      POPDOS
2220 FORMAT('0',20X,'COMPLETE SUMMARY OF COMPUTED ENVIRONMENTAL DOSE ', POPDOS
    1 'COMMITMENTS, INTEGRATED OVER ALL TIME STEPS')                      POPDOS
2230 FORMAT('0',20X,'100-YEAR ENVIRONMENTAL DOSE COMMITMENTS RECEIVED', POPDOS
    1 ' BY PEOPLE WITHIN 80 KILOMETERS, PERSON-REM',/,2X,129('-'))        POPDOS
2240 FORMAT(' ',1X,'NO.',4X,'T-START',6X,'T-END',7X,'T-LONG',5X,         POPDOS
    1 'PATHWAY',1X,6(5X,A8),/,2X,129('-'))                                POPDOS
2250 FORMAT(' ',1X,I2,3(5X,F7.2),5X,A8,6(4X,1PE9.3))                      POPDOS
2260 FORMAT(' ',1X,129('-'))                                              POPDOS
2270 FORMAT(' ',1X,'TOTALS OVER ALL',I2,' TIME STEPS',23X,6(4X,1PE9.3)) POPDOS
2280 FORMAT('0',20X,'100-YEAR ENVIRONMENTAL DOSE COMMITMENTS RECEIVED', POPDOS
    1 ' BY PEOPLE BEYOND 80 KILOMETERS, PERSON-REM',/,2X,129('-'))        POPDOS
2290 FORMAT('0',20X,'GRAND TOTAL 100-YEAR ENVIRONMENTAL DOSE COMMITMENT POPDOS
    1S RECEIVED OVER ALL POPULATIONS, PERSON-REM',/,2X,129('-'))          POPDOS
C******************** *************************************************** POPDOS
      END                                                                 POPDOS
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE TAILPS(TAILP,UU)                                           TAILPS
      REALHLM,GMAT,ACTIV                                                    TAILPS
      DIMENSION TAILP(6),UU(6)                                              TAILPS
      DATA DRHO,DM,A,Z,ZO,P,W/2.4,0.03,0.1,100.,1.0,3.,0.1/                 TAILPS
      FST=A*(1.8+0.6*ALOG10(W))                                             TAILPS
      FST=FST*((DRHO-1.23E-3)*DM/1.22E-6)**0.5                              TAILPS
      DO 10 I=1,6                                                           TAILPS
      FS=UU(I)*1.0E2/(2.5*ALOG(Z/ZO))                                       TAILPS
      QH=1.0E-6*(FS**2.)*(FS-FST)                                           TAILPS
      IF (QH.LE.0.0) QH=0.0                                                 TAILPS
      TAILP(I)=QH*(2.E-4/(FST**3.))*((FS/FST)**(P/3.)-1.)*1.0E4             TAILPS
   10 CONTINUE                                                              TAILPS
      RETURN                                                                TAILPS
      END                                                                   TAILPS
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE UNIDOS                                                 UNIDOS
C******************** ************************************************* UNIDOS
      LEVEL 2, NSORCE,NRECEP,TPSZ,CISUM,IPACT,PACT,PDEN,DUST20,ACTRAT,  UNIDOS
     1 PTSZ20,RXQ,RXQRN,PTSZ,QNAME                                      UNIDOS
C                                                                       UNIDOS
      COMMON/BDATA/NSORCE,NRECEP,TPSZ(4,4,240),CISUM(7,240),IPACT(20),  UNIDOS
     1 PACT(3,4),PDEN(4),DUST20(6),ACTRAT,PTSZ20,RXQ(20,240,4),         UNIDOS
     2 RXQRN(20,240,7),PTSZ(4),QNAME(5,20)                              UNIDOS
C                                                                       UNIDOS
      COMMON/CDATA/QAJUST(10,2,20),DEPVEL(4),CPY(5,20),ISTEP,IRCV,IADD, UNIDOS
     1 ALN2,TSTEP(10),ALF(6),GFACT(4,10),GPFACT(4),TFACT(4,10),NSTEP,   UNIDOS
     2 TPFACT(4),CGIP(4,4,240),CGXRN(4,240),JC(10),XPFACT               UNIDOS
C                                                                       UNIDOS
      COMMON/DDATA/WLFACT(3),DCFA(5,7,5),DCFGP(4),DCFCP(4),DCFGR(5),    UNIDOS
     1 DCFCR(5),DCFF(8,4,4),BIV(4,5),FBI(4),FMI(4),QF,SHIELD,RF(3),     UNIDOS
     2 FREP(4,5),TISSUE(6),PATH(8),SRHO,WHL,TSTART,IFTODO(10),          UNIDOS
     3 TNAME(5,10)                                                      UNIDOS
C                                                                       UNIDOS
      COMMON/FDATA/XNAME,5,48),FFORI,FHAYI,IRTYPE(48),XRECEP(3,48),     UNIDOS
     1 DIST(48),UOF(4,3),FBVT(4,3)                                      UNIDOS
C                                                                       UNIDOS
      DIMENSION EMPC(8),CAIP(4,4),CAI(4),DRI(4),CARN(7),CGI(4),CGRN(4), UNIDOS
     1 FMPC(9),CON(8),DJKL(6,4,7),ACTING(4,3,4),CIV(4,7),AGE(4)         UNIDOS
C******************** ************************************************* UNIDOS
      DATA EMPC/5.0,4.0,0.08,2.0,0.0333,4.0,200.,7.0/                   UNIDOS
      DATA AGE/8HINFANT  ,8HCHILD   ,8HTEENAGER,8HADULT   /             UNIDOS
C******************** ************************************************* UNIDOS
      MILK=JC(8)                                                        UNIDOS
      IF(MILK.NE.1) MILK=0                                              UNIDOS
      IT=ISTEP                                                          UNIDOS
      WLAMDA=ALN2/WHL                                                   UNIDOS
      TICK=(1.0-EXP(-30.*WLAMDA))/WLAMDA*(24.*3600.)*(0.2/0.75)         UNIDOS
      TOCK=(1.0-EXP(-60.*WLAMDA))/WLAMDA*(24.*3600.)*(0.2/2.0)          UNIDOS
C******************** ************************************************* UNIDOS
C     EXIT TO CONCENTRATION PRINT IFF JC(9)=1                           UNIDOS
C******************** ************************************************* UNIDOS
      IF(JC(9).EQ.1) GO TO 370                                          UNIDOS
    1 CONTINUE                                                          UNIDOS
C******************** ************************************************* UNIDOS
C     PROCEED WITH INDIVIDUAL RECEPTOR DOSE AND MPC CALCULATIONS        UNIDOS
C                                                                       UNIDOS
      IPAGE=1                                                           UNIDOS
      DO 360 IRA=1,IADD                                                 UNIDOS
      IR=IRA+IRCV                                                       UNIDOS
      IRT=IRTYPE(IRA)                                                   UNIDOS
      IF(IRT.LT.0) GO TO 360                                            UNIDOS
      IF(JC(7).NE.1.AND.IRT.GT.0) IRT=1                                 UNIDOS
C                                                                       UNIDOS
      DO 20 IX=1,7                                                      UNIDOS
      CARN(IX)=0.0                                                      UNIDOS
      IF(IX.GT.4) GO TO 20                                              UNIDOS
      CAI(IX)=0.0                                                       UNIDOS
      DRI(IX)=0.0                                                       UNIDOS
      CGI(IX)=0.0                                                       UNIDOS
      CGRN(IX)=0.0                                                      UNIDOS
      DO 10 IP=1,4                                                      UNIDOS
      CAIP(IP,IX)=TPSZ(IP,IX,IR)                                        UNIDOS
      CAI(IX)=CAI(IX)+CAIP(IP,IX)                                       UNIDOS
      DRI(IX)=DRI(IX)+DEPVEL(IP)*CAIP(IP,IX)                            UNIDOS
      CGI(IX)=CGI(IX)+CGIP(IP,IX,IR)                                    UNIDOS
   10 CONTINUE                                                          UNIDOS
   20 CONTINUE                                                          UNIDOS
C******************** ************************************************* UNIDOS
C     CONCENTRATION DATA IS NOW SUITABLE FOR 40CFR190 CALCULATIONS      UNIDOS
C******************** ************************************************* UNIDOS
      LAP=1                                                             UNIDOS
      GO TO 50                                                          UNIDOS
C                                                                       UNIDOS
```

FIGURE B.0-1. (Continued)

```
 30   CONTINUE                                                       UNIDOS
      DO 40 IX=1,7                                                   UNIDOS
      CARN(IX)=CISUM(IX,IR)                                          UNIDOS
      IF(IX.GT.4) GO TO 40                                           UNIDOS
      CGRN(IX)=CGXRN(IX,IR)                                          UNIDOS
 40   CONTINUE                                                       UNIDOS
      DRI(4)=DRI(4)+(0.003)*CISUM(5,IR)                              UNIDOS
      LAP=2                                                          UNIDOS
C********************* ************************************************** UNIDOS
C     CONCENTRATIONS ARE NOW SUITABLE FOR TOTAL DOSE OR MPC CALCU-   UNIDOS
C     LATIONS                                                        UNIDOS
C********************* ************************************************** UNIDOS
 50   CONTINUE                                                       UNIDOS
C********************* ************************************************** UNIDOS
C     NOW PROCEED WITH DOSE CALCULATIONS (GO TO 80) IF IRTYPE IS     UNIDOS
C       GREATR THAN ZERO (LAP=1 FOR 40CFR190, LAP=2 FOR TOTAL DOSES) UNIDOS
C     IF IRTYPE=0 PROCEED DIRECTLY WITH MPC CHECKING BY ROUTINE BELOW, UNIDOS
C       IF LAP=2. IF LAP=1 RETURN TO 30 TO PICK UP RADON CONTRIBUTIONS UNIDOS
C********************* ************************************************** UNIDOS
      IF(IRT.NE.0) GO TO 80                                          UNIDOS
      IF(LAP.EQ.1) GO TO 30                                          UNIDOS
      FMPC(9)=0.0                                                    UNIDOS
      WL=0.0                                                         UNIDOS
      DO 60 IX=1,3                                                   UNIDOS
      WL=WL+WLFACT(IX)*CARN(IX+1)                                    UNIDOS
 60   CONTINUE                                                       UNIDOS
      FMPC(1)=CAI(1)/EMPC(1)                                         UNIDOS
      FMPC(2)=CAI(1)/EMPC(2)                                         UNIDOS
      FMPC(3)=CAI(2)/EMPC(3)                                         UNIDOS
      FMPC(4)=CAI(3)/EMPC(4)                                         UNIDOS
      FMPC(5)=WL/EMPC(5)                                             UNIDOS
      FMPC(6)=(CAI(4)+CARN(5))/EMPC(6)                               UNIDOS
      FMPC(7)=(CAI(4)+CARN(6))/EMPC(7)                               UNIDOS
      FMPC(8)=(CAI(4)+CARN(7))/EMPC(8)                               UNIDOS
      DO 70 IX=1,8                                                   UNIDOS
      CON(IX)=FMPC(IX)*EMPC(IX)                                      UNIDOS
      FMPC(9)=FMPC(9)+FMPC(IX)                                       UNIDOS
 70   CONTINUE                                                       UNIDOS
      IF(IPAGE.NE.1) GO TO 75                                        UNIDOS
      IPAGE=2                                                        UNIDOS
C********************* ************************************************** UNIDOS
C                                                                    UNIDOS
      CALL HEADER                                                    UNIDOS
C                                                                    UNIDOS
C********************* ************************************************** UNIDOS
      PRINT 2000, ISTEP,(TNAME(I,ISTEP),I=1,5),TSTEP(ISTEP)          UNIDOS
      GO TO 76                                                       UNIDOS
 75   IPAGE=1                                                        UNIDOS
 76   CONTINUE                                                       UNIDOS
      PRINT 2010, IRA,(XNAME(I,IRA),I=1,5),(XRECEP(I,IRA),I=1,3),    UNIDOS
     1  DIST(IRA),IRT                                                UNIDOS
      PRINT 2020                                                     UNIDOS
      PRINT 2030                                                     UNIDOS
      PRINT 2040, (CON(IX),IX=1,8)                                   UNIDOS
      PRINT 2050, (EMPC(IX),IX=1,8)                                  UNIDOS
      PRINT 2060, (FMPC(IX),IX=1,8)                                  UNIDOS
      PRINT 2070, FMPC(9)                                            UNIDOS
C     MPC PRINT COMPLETED, EXIT TO LOOP END FOR NEW IRECEP           UNIDOS
      GO TO 360                                                      UNIDOS
C********************* ************************************************** UNIDOS
C     DOSE CALCULATION ROUTINES FOLLOW BELOW. IP=PARTICLE SIZE,      UNIDOS
C       IX=ISOTOPE, J=ORGAN, K=AGE, L=PATHWAY, USUALLY               UNIDOS
C********************* ************************************************** UNIDOS
 80   CONTINUE                                                       UNIDOS
      DO 90 IJ=1,6                                                   UNIDOS
      DO 90 IK=1,4                                                   UNIDOS
      DO 90 IL=1,7                                                   UNIDOS
      DJKL(IJ,IK,IL)=0.0                                             UNIDOS
```

FIGURE B.0-1. (Continued)

```
 90   CONTINUE                                                          UNIDOS
C     NOW CALCULATE INHALATION DOSES FROM PARTICULATES                  UNIDOS
      L=1                                                               UNIDOS
      K=1                                                               UNIDOS
      DO 110 J=1,5                                                      UNIDOS
      DO 100 IX=1,4                                                     UNIDOS
      DO 100 IP=1,4                                                     UNIDOS
      DJKL(J,K,L)=DJKL(J,K,L)+CAIP(IP,IX)*DCFA(IP,IX,J)                UNIDOS
 100  CONTINUE                                                          UNIDOS
      ABC=CARN(5)*DCFA(5,5,J)+CARN(6)*DCFA(5,6,J)+CARN(7)*DCFA(5,7,J)  UNIDOS
      DJKL(J,K,L)=DJKL(J,K,L)+ABC                                      UNIDOS
 110  CONTINUE                                                          UNIDOS
C     NOW CALCULATE RADON DAUGHTER BRONCHIAL EPITHELIUM DOSE            UNIDOS
      DJKL(6,K,L)=0.625*CARN(1)                                        UNIDOS
C     NOW ASSIGN INHALATION DOSES COMPUTED FOR K=1 TO OTHER AGES        UNIDOS
      DO 120 J=1,6                                                      UNIDOS
      DO 120 IK=2,4                                                     UNIDOS
      DJKL(J,IK,L)=DJKL(J,K,L)                                         UNIDOS
 120  CONTINUE                                                          UNIDOS
C     NOW COMPUTE EXTERNAL DOSES FROM GROUND AND CLOUD                  UNIDOS
      J=1                                                               UNIDOS
      DO 190 L=2,3                                                      UNIDOS
      ABC=0.0                                                           UNIDOS
      IF(L.EQ.3) GO TO 160                                              UNIDOS
      DO 130 IX=1,4                                                     UNIDOS
      ABC=ABC+CGI(IX)*DCFGP(IX)                                        UNIDOS
 130  CONTINUE                                                          UNIDOS
      IF(LAP.EQ.1) GO TO 140                                            UNIDOS
      ABC=ABC+CGI(3)*(DCFGR(1)+DCFGR(2)+DCFGR(3)+DCFGR(4))             UNIDOS
 140  CONTINUE                                                          UNIDOS
      DO 150 IX=1,4                                                     UNIDOS
      IXX=IX+1                                                          UNIDOS
      ABC=ABC+CGRN(IX)*DCFGR(IXX)                                      UNIDOS
 150  CONTINUE                                                          UNIDOS
C     HAVE NOW COMPUTED WHOLE BODY DOSE FROM GROUND                     UNIDOS
      GO TO 180                                                         UNIDOS
C                                                                       UNIDOS
 160  DO 170 IX=1,4                                                     UNIDOS
      ABC=ABC+CAI(IX)*DCFCP(IX)                                        UNIDOS
      ABC=ABC+CARN(IX)*DCFCR(IX)                                       UNIDOS
 170  CONTINUE                                                          UNIDOS
      ABC=ABC+CARN(5)*DCFCR(5)                                         UNIDOS
C     HAVE NOW COMPUTED WHOLE BODY DOSE FROM CLOUD                      UNIDOS
 180  CONTINUE                                                          UNIDOS
      DJKL(J,K,L)=ABC*SHIELD                                           UNIDOS
 190  CONTINUE                                                          UNIDOS
C     NOW ASSIGN COMPUTED EXTERNAL WHOLE BODY DOSES TO ALL ORGANS, AGES UNIDOS
      DO 200 IJ=1,6                                                     UNIDOS
      DO 200 IK=1,4                                                     UNIDOS
      DO 200 L=2,3                                                      UNIDOS
 200  DJKL(IJ,IK,L)=DJKL(J,K,L)                                        UNIDOS
C********************* ************************************************* UNIDOS
C     NOW PROCEED TO CALCULATE FOOD INGESTION DOSES. FIRST STEP IS      UNIDOS
C     TO ZERO OUT ACTING ARRAY# ACTING(IX,IC,IK)= PCI/YR OF IX INGESTED UNIDOS
C     IN FOOD IC BY AGE IK                                              UNIDOS
C********************* ************************************************* UNIDOS
      DO 210 IX=1,4                                                     UNIDOS
      DO 210 IC=1,3                                                     UNIDOS
      DO 210 IK=1,4                                                     UNIDOS
 210  ACTING(IX,IC,IK)=0.0                                              UNIDOS
C                                                                       UNIDOS
      DO 230 IV=1,5                                                     UNIDOS
      TEX=TICK                                                          UNIDOS
      IF(IV.NE.4) TEX=TOCK                                              UNIDOS
      DO 220 IX=1,4                                                     UNIDOS
 220  CIV(IX,IV)=DRI(IX)*TEX*FREP(IX,IV)+CGI(IX)*BIV(IX,IV)/SRHO       UNIDOS
 230  CIV(4,IV)=CIV(4,IV)+CGRN(4)*BIV(4,IV)/SRHO                       UNIDOS
C                                                                       UNIDOS
```

FIGURE B.0-1. (Continued)

```
      DO 250 IX=1,4                                                     UNIDOS
      ABC=FFORI*CIV(IX,4)+FHAYI*CIV(IX,5)                               UNIDOS
      CIV(IX,6)=ABC*QF*FBI(IX)                                          UNIDOS
      CIV(IX,7)=ABC*QF*FMI(IX)                                          UNIDOS
      DO 250 IK=1,4                                                     UNIDOS
      ACTING(IX,1,IK)=0.                                                UNIDOS
      DO 240 IV=1,3                                                     UNIDOS
      ACTING(IX,1,IK)=ACTING(IX,1,IK)+UOF(IK,1)*FBVT(IK,IV)             UNIDOS
     1 *CIV(IX,IV)*RF(1)                                                UNIDOS
  240 CONTINUE                                                          UNIDOS
      ACTING(IX,2,IK)=UOF(IK,2)*CIV(IX,6)*RF(2)                         UNIDOS
  250 ACTING(IX,3,IK)=UOF(IK,3)*CIV(IX,7)*RF(3)                         UNIDOS
C     ACTING VALUES ARE COMPUTED, NOW CALCULATE DOSES                   UNIDOS
      DO 260 L=4,6                                                      UNIDOS
      IC=L-3                                                            UNIDOS
      DO 260 J=1,4                                                      UNIDOS
      DO 260 K=1,4                                                      UNIDOS
      DO 260 IX=1,4                                                     UNIDOS
  260 DJKL(J,K,L)=DJKL(J,K,L)+ACTING(IX,IC,K)*DCFF(IX,J,K)              UNIDOS
C     NOW REORGANIZE ORGAN SEQUENCING FOR CONSISTENCY, AND ASSIGN       UNIDOS
C     WHOLE BODY DOSE TO LUNG AND BRONCHI                               UNIDOS
      DO 270 L=4,6                                                      UNIDOS
      DO 270 K=1,4                                                      UNIDOS
      DJKL(6,K,L)=DJKL(1,K,L)                                           UNIDOS
      DJKL(5,K,L)=DJKL(4,K,L)                                           UNIDOS
      DJKL(4,K,L)=DJKL(3,K,L)                                           UNIDOS
      DJKL(3,K,L)=DJKL(1,K,L)                                           UNIDOS
  270 CONTINUE                                                          UNIDOS
C********************* ************************************************ UNIDOS
C     ALL DOSES FOR ALL EXPOSURE PATHWAYS ARE NOW COMPUTED. TOTAL       UNIDOS
C     DOSES OVER ALL PATHWAYS ARE COMPUTED BELOW                        UNIDOS
C********************* ************************************************ UNIDOS
      DO 280 J=1,6                                                      UNIDOS
      DO 280 K=1,4                                                      UNIDOS
      DO 280 L=1,6                                                      UNIDOS
      DJKL(J,K,7)=DJKL(J,K,7)+DJKL(J,K,L)                               UNIDOS
  280 CONTINUE                                                          UNIDOS
C********************* ************************************************ UNIDOS
C     DOSE PRINT ROUTINES FOLLOW BELOW                                  UNIDOS
C********************* ************************************************ UNIDOS
      IF(IRT.NE.10) IRT=1                                               UNIDOS
      INK=LAP+IRT+IPAGE                                                 UNIDOS
      IF(INK.EQ.4.OR.INK.EQ.5) GO TO 290                                UNIDOS
C********************* ************************************************ UNIDOS
C                                                                       UNIDOS
      CALL HEADER                                                       UNIDOS
C                                                                       UNIDOS
C********************* ************************************************ UNIDOS
      PRINT 2000, IT,(TNAME(I,IT),I=1,5),TSTEP(IT)                      UNIDOS
C                                                                       UNIDOS
  290 CONTINUE                                                          UNIDOS
      IF(LAP.EQ.1) GO TO 300                                            UNIDOS
      IF(IPAGE.EQ.IRT) NPAGE=2                                          UNIDOS
      IF(IPAGE.NE.IRT) NPAGE=1                                          UNIDOS
      IPAGE=NPAGE                                                       UNIDOS
  300 CONTINUE                                                          UNIDOS
      IF(LAP.EQ.2.AND.IRT.EQ.1) GO TO 310                               UNIDOS
      PRINT 2010, IRA,(XNAME(I,IRA),I=1,5),(XRECEP(I,IRA),I=1,3),       UNIDOS
     1 DIST(IRA),IRT                                                    UNIDOS
  310 CONTINUE                                                          UNIDOS
      IF(LAP.EQ.1) PRINT 2080                                           UNIDOS
      IF(LAP.EQ.2) PRINT 2090                                           UNIDOS
      IF(IRT.EQ.10) GO TO 330                                           UNIDOS
      PRINT 2100, (TISSUE(I),I=1,6)                                     UNIDOS
C                                                                       UNIDOS
      DO 320 K=1,4                                                      UNIDOS
      PRINT 2120, AGE(K),PATH(7),(DJKL(J,K,7),J=1,6)                    UNIDOS
  320 CONTINUE                                                          UNIDOS
```

FIGURE B.0-1. (Continued)

```
      GO TO 350                                                          UNIDOS
C                                                                        UNIDOS
 330  CONTINUE                                                           UNIDOS
      DO 340 K=1,4                                                       UNIDOS
      PRINT 2100, (TISSUE(I),I=1,6)                                      UNIDOS
      DO 340 L=1,7                                                       UNIDOS
      IF(L.EQ.7) PRINT 2110                                              UNIDOS
      PRINT 2120, AGE(K),PATH(L),(DJKL(J,K,L),J=1,6)                     UNIDOS
 340  CONTINUE                                                           UNIDOS
C                                                                        UNIDOS
 350  CONTINUE                                                           UNIDOS
      IF(LAP.EQ.1) GO TO 30                                              UNIDOS
C                                                                        UNIDOS
 360  CONTINUE                                                           UNIDOS
      GO TO 460                                                          UNIDOS
C********************* ************************************************* UNIDOS
C     UNIDOS CONCENTRATION PRINT ROUTINE FOLLOWS BELOW.                  UNIDOS
C********************* ************************************************* UNIDOS
 370  CONTINUE                                                           UNIDOS
C********************* ************************************************* UNIDOS
C     PROCEED WITH PRINT OF PARTICULATE-ONLY CONCENTRATION DATA          UNIDOS
C********************* ************************************************* UNIDOS
      LL=0                                                               UNIDOS
      DO 420 IRA=1,IADD                                                  UNIDOS
C                                                                        UNIDOS
      IR=IRA+IRCV                                                        UNIDOS
      DO 380 IX=1,4                                                      UNIDOS
      CAI(IX)=0.0                                                        UNIDOS
      CGI(IX)=0.0                                                        UNIDOS
 380  CONTINUE                                                           UNIDOS
C                                                                        UNIDOS
      IF(LL.LE.53.AND.IRA.NE.1) GO TO 390                                UNIDOS
C********************* ************************************************* UNIDOS
C                                                                        UNIDOS
      CALL HEADER                                                        UNIDOS
C                                                                        UNIDOS
C********************* ************************************************* UNIDOS
      PRINT 2000, IT,(TNAME(I,IT),I=1,5),TSTEP(IT)                       UNIDOS
      PRINT 2130                                                         UNIDOS
      LL=9                                                               UNIDOS
C                                                                        UNIDOS
 390  CONTINUE                                                           UNIDOS
      DO 410 IP=1,4                                                      UNIDOS
      PRINT 2140, IRA,(XNAME(I,IRA),I=1,5),IP,(TPSZ(IP,IX,IR),IX=1,4),   UNIDOS
     1 (CGIP(IP,IX,IR),IX=1,4)                                           UNIDOS
      DO 400 IX=1,4                                                      UNIDOS
      CAI(IX)=CAI(IX)+TPSZ(IP,IX,IR)                                     UNIDOS
      CGI(IX)=CGI(IX)+CGIP(IP,IX,IR)                                     UNIDOS
 400  CONTINUE                                                           UNIDOS
 410  CONTINUE                                                           UNIDOS
      PRINT 2150, (CAI(IX),IX=1,4),(CGI(IX),IX=1,4)                      UNIDOS
      LL=LL+6                                                            UNIDOS
 420  CONTINUE                                                           UNIDOS
C********************* ************************************************* UNIDOS
C     PROCEED WITH PRINT OF RADON AND DAUGHTER CONCENTRATION DATA        UNIDOS
C********************* ************************************************* UNIDOS
C                                                                        UNIDOS
      CALL HEADER                                                        UNIDOS
C                                                                        UNIDOS
C********************* ************************************************* UNIDOS
      PRINT 2000, IT,(TNAME(I,IT),I=1,5),TSTEP(IT)                       UNIDOS
      PRINT 2160                                                         UNIDOS
C                                                                        UNIDOS
      DO 450 IRA=1,IADD                                                  UNIDOS
      IR=IRA+IRCV                                                        UNIDOS
      WL=0.0                                                             UNIDOS
      DO 440 IX=1,3                                                      UNIDOS
```

FIGURE B.0-1. (Continued)

```
      IXX=IX+1                                                          UNIDOS
      WL=WL+CISUM(IXX,IR)*WLFACT(IX)                                    UNIDOS
  440 CONTINUE                                                          UNIDOS
      PRINT 2170, IRA,(CISUM(I,IR),I=1,7),WL,(CGXRN(I,IR),I=1,4)        UNIDOS
  450 CONTINUE                                                          UNIDOS
C********************* ************************************************** UNIDOS
C     CONCENTRATION PRINT OPTION HAS BEEN EXECUTED# RETURN FOR DOSE     UNIDOS
C     CALCULATIONS AND MPC CHECKING                                     UNIDOS
C********************* ************************************************** UNIDOS
      GO TO 1                                                           UNIDOS
C********************* ************************************************** UNIDOS
  460 CONTINUE                                                          UNIDOS
      RETURN                                                            UNIDOS
C********************* ************************************************** UNIDOS
 2000 FORMAT(' ',28X,'TIME STEP NUMBER',I2,', ',5A4,10X,'DURATION IN YRS UNIDOS
     1 IS...',F5.1)                                                     UNIDOS
 2010 FORMAT(1H0,'NUMBER ',I2,2X,'NAME=',5A4,2X,'X=',F6.1,'KM, Y=',F6.1, UNIDOS
     1 'KM, Z=',F6.1,'M, DIST=',F6.1,'KM, IRTYPE=',I2)                  UNIDOS
 2020 FORMAT('0',47X,'RESULTS OF MPC CHECK AT THIS LOCATION',/,6X,      UNIDOS
     1 119('-'))                                                        UNIDOS
 2030 FORMAT(6X,21X,'U-238 ',7X,'U-234 ',7X,'TH-230',7X,'RA-226',5X,    UNIDOS
     1 'RN-222(WL)',5X,'PB-210',7X,'BI-210',7X,'PO-210',/,6X,119('-'))  UNIDOS
 2040 FORMAT('0',5X,'CONC., PCI/M3',2X,8(5X,1PE8.2))                    UNIDOS
 2050 FORMAT('0',5X,'MPC, PCI/M3',4X,8(5X,1PE8.2))                      UNIDOS
 2060 FORMAT(1H0,5X,'FRACTION OF MPC',8(5X,1PE8.2),//,6X,119('-'))      UNIDOS
 2070 FORMAT(1H0,5X,'SUM OF FRACTIONS EQUALS ',1PE8.2)                  UNIDOS
 2080 FORMAT(1H0,31X,'40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR ',  UNIDOS
     1 'THIS LOCATION, MREM/YR',/13X,106('-'))                          UNIDOS
 2090 FORMAT(1H0,//29X,'TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR  ',  UNIDOS
     1 'THIS LOCATION, MREM/YR',/13X,106('-'))                          UNIDOS
 2100 FORMAT(1H0,15X,'AGE',10X,'PATHWAY ',6(6X,A8),/13X,106('-'))       UNIDOS
 2110 FORMAT(13X,106('-'))                                              UNIDOS
 2120 FORMAT(1H ,13X,A8,6X,A8,6(6X,1PE8.2))                             UNIDOS
 2130 FORMAT(1H0,41X,'INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS',/, UNIDOS
     1 40X,'AIRBORNE CONCENTRATIONS, PCI/M3',22X,'GROUND CONCENTRATIONS, UNIDOS
     2 PCI/M2',/,X,'NO.',9X,'NAME',8X,'PTSZ',6X,'U-238',7X,'TH-230',7X, UNIDOS
     3 'RA-226',7X,'PB-210',8X,'U-238',7X,'TH-230',7X,'RA-226',7X,      UNIDOS
     4 'PB-210',/,X,'--- ',19('-'),' ----',3X,48('-'),4X,48('-'))       UNIDOS
 2140 FORMAT(1X,I2,2X,5A4,I3,8(4X,1PE9.3))                              UNIDOS
 2150 FORMAT(4X,'CONCENTRATION TOTALS',4X,8(4X,1PE9.3),/,1X,'--- ',     UNIDOS
     1 19('-'),' ----',3X,48('-'),4X,48('-'))                           UNIDOS
 2160 FORMAT(1H0,36X,'INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER ',   UNIDOS
     1 'CONCENTRATIONS',/,34X,'AIRBORNE CONCENTRATIONS, PCI/M3',30X,    UNIDOS
     2 'GROUND CONCENTRATIONS, PCI/M2',/,3X,'NO.',5X,'RN-222',4X,       UNIDOS
     3 'PO-218',4X,'PB-214',4X,'BI-214',4X,'PB-210',4X,'BI-210',4X,     UNIDOS
     4 'PO-210',7X,'WL',5X,'PO-218',4X,'PB-214',4X,'BI-214',4X,'PB-210', UNIDOS
     5 /,3X,'---',3X,79('-'),1X,39('-'))                                UNIDOS
 2170 FORMAT(3X,I2,3X,12(1X,1PE9.3))                                    UNIDOS
C********************* ************************************************** UNIDOS
      END                                                               UNIDOS
```

FIGURE B.0-1. (Continued)

```
      SUBROUTINE WRITER                                                  WRITER
C******************** ************************************************** WRITER
      COMMON/CDATA/QAJUST(10,2,20),DEPVEL(4),CPY(5,20),ISTEP,IRCV,IADD,  WRITER
     1 ALN2,TSTEP(10),ALF(6),GFACT(4,10),GPFACT(4),TFACT(4,10),NSTEP,    WRITER
     2 TPFACT(4),CGIP(4,4,240),CGXRN(4,240),JC(10),XPFACT                WRITER
C                                                                        WRITER
      COMMON/DDATA/WLFACT(3),DCFA(5,7,5),DCFGP(4),DCFCP(4),DCFGR(5),     WRITER
     1 DCFCR(5),DCFF(8,4,4),BIV(4,5),FBI(4),FMI(4),OF,SHIELD,RF(3),      WRITER
     2 FREP(4,5),TISSUE(6),PATH(8),SRHO,WHL,TSTART,IFTODO(10),           WRITER
     3 TNAME(5,10)                                                       WRITER
C                                                                        WRITER
      COMMON/EDATA/FFORP,FHAYP,FPR(3),IPOP(12,16),WINDR(16),XRHO(12),    WRITER
     1 IPTOT,FRADON(4),PAJUST(10),PDREG(6,8,10),PDXREG(6,8,10),          WRITER
     2 PDTOT(6,8,10)                                                     WRITER
C                                                                        WRITER
      COMMON/FDATA/XNAME(5,48),FFORI,FHAYI,IRTYPE(48),XRECEP(3,48),      WRITER
     1 DIST(48),UOF(4,3),FBVT(4,3)                                       WRITER
C                                                                        WRITER
      DIMENSION PSZ(5),PRHO(5),AMO(7),AGE(4),AMAS(8),AVEG(5)             WRITER
C                                                                        WRITER
      DATA PSZ/2*1.0,5.0,35.0,0.3/                                       WRITER
      DATA PRHO/8.9,3*2.4,1.0/                                           WRITER
      DATA AMO/6HU-238 ,6HU-234 ,6HTH-230,6HRA-226,6HPB-210,6HBI-210,    WRITER
     1  6HPO-210/                                                        WRITER
      DATA AGE/8HINFANT  ,8HCHILD   ,8HTEENAGE ,8HADULT   /              WRITER
      DATA AVEG/8HED.ABG. ,8HPOTATO  ,8HBELOW G.,8HFORAGE  ,8HST. FEED/  WRITER
      DATA AMAS/6HU-238 ,6HU-234 ,6HTH-234,6HTH-230,6HRA-226,6HPB-210,   WRITER
     1  6HBI-210,6HPO-210/                                               WRITER
C******************** ************************************************** WRITER
C                                                                        WRITER
      IF(JC(6).NE.1) GO TO 40                                            WRITER
      CALL HEADER                                                        WRITER
C                                                                        WRITER
C******************** ************************************************** WRITER
      PRINT 1000                                                         WRITER
      DO 20 IP=1,5                                                       WRITER
      PRINT 1010, PSZ(IP),PRHO(IP),(AMO(I),I=1,7)                        WRITER
      DO 20 IJ=1,5                                                       WRITER
      IF(IP.EQ.5) GO TO 10                                               WRITER
      PRINT 1020, TISSUE(IJ),(DCFA(IP,IX,IJ),IX=1,7)                     WRITER
      GO TO 20                                                           WRITER
 10   PRINT 1030, TISSUE(IJ),(DCFA(IP,IX,IJ),IX=5,7)                     WRITER
 20   CONTINUE                                                           WRITER
C                                                                        WRITER
      PRINT 1040                                                         WRITER
      PRINT 1050, (DCFGP(I),I=1,4),(DCFGR(I),I=1,4)                      WRITER
      PRINT 1060, (DCFCP(I),I=1,4),(DCFCR(I),I=1,4)                      WRITER
      PRINT 1070, (WLFACT(I),I=1,3)                                      WRITER
C******************** ************************************************** WRITER
C                                                                        WRITER
      CALL HEADER                                                        WRITER
C                                                                        WRITER
C******************** ************************************************** WRITER
      PRINT 1080                                                         WRITER
      PRINT 1090, (AMAS(I),I=1,8)                                        WRITER
      DO 30 IK=1,4                                                       WRITER
      PRINT 1100                                                         WRITER
      DO 30 IJ = 1, 4                                                    WRITER
      ILABEL=IJ                                                          WRITER
      IF(IJ.GT.2) ILABEL=IJ+1                                            WRITER
      PRINT 1110,AGE(IK),TISSUE(ILABEL),(DCFF(IX,IJ,IK),IX=1,8)          WRITER
 30   CONTINUE                                                           WRITER
 40   CONTINUE                                                           WRITER
C******************** ************************************************** WRITER
C                                                                        WRITER
C     WE NOW MANIPULATE DCFA AND DCFF FOR EASIER USE LATER.              WRITER
C                                                                        WRITER
C******************** ************************************************** WRITER
```

FIGURE B.0-1. (Continued)

```
      DO 50 IP=1,4                                                      WRITER
      DO 50 IJ=1,5                                                      WRITER
      DCFA(IP,1,IJ)=DCFA(IP,1,IJ)+DCFA(IP,2,IJ)                         WRITER
      DCFA(IP,2,IJ)=DCFA(IP,3,IJ)                                       WRITER
      DCFA(IP,3,IJ)=DCFA(IP,4,IJ)                                       WRITER
 50   DCFA(IP,4,IJ)=DCFA(IP,5,IJ)+DCFA(IP,6,IJ)+DCFA(IP,7,IJ)           WRITER
C                                                                       WRITER
      DO 60 IK=1,4                                                      WRITER
      DO 60 IJ=1,4                                                      WRITER
      DCFF(1,IJ,IK)=DCFF(1,IJ,IK)+DCFF(2,IJ,IK)+DCFF(3,IJ,IK)           WRITER
      DCFF(2,IJ,IK)=DCFF(4,IJ,IK)                                       WRITER
      DCFF(3,IJ,IK)=DCFF(5,IJ,IK)                                       WRITER
 60   DCFF(4,IJ,IK)=DCFF(6,IJ,IK)+DCFF(7,IJ,IK)+DCFF(8,IJ,IK)           WRITER
C                                                                       WRITER
      IF(JC(6).NE.1) RETURN                                             WRITER
C                                                                       WRITER
      PRINT 1120, AMO(1),(AMO(I),I=3,5)                                 WRITER
      DO 70 IV=1,5                                                      WRITER
 70   PRINT 1130, AVEG(IV),(BIV(IX,IV),IX=1,4)                          WRITER
C                                                                       WRITER
      PRINT 1140, (FBI(IX),IX=1,4)                                      WRITER
      PRINT 1150, (FMI(IX),IX=1,4)                                      WRITER
      PRINT 1150, (FMI(IX),IX=1,4)                                      WRITER
      DO 80 IV=1,5                                                      WRITER
 80   PRINT 1160, AVEG(IV),(FREP(IX,IV),IX=1,4)                         WRITER
C                                                                       WRITER
      PRINT 1170                                                        WRITER
      PRINT 1180, AMO(1),(AMO(I),I=3,5),AMO(1),(AMO(I),I=3,5)           WRITER
      DO 90 ITS=1,NSTEP                                                 WRITER
      PRINT 1190, ITS,(TNAME(I,ITS),I=1,5),PAJUST(ITS),(GFACT(I,ITS),I=1 WRITER
     1,4),(TFACT(I,ITS),9=1,4)                                          WRITER
 90   CONTINUE                                                          WRITER
      PRINT 1200, XPFACTY(GPFACT(I),I=1,4),(TPFACT(I),I=1,4)            WRITER
C                                                                       WRITER
      RETURN                                                            WRITER
C********************* ************************************************* WRITER
 1000 FORMAT(1H ,40X,'INHALATION DOSE CONVERSION FACTORS, MR/YR PER ',  WRITER
     1 'PCI/M3',/)                                                      WRITER
 1010 FORMAT(1HO, 4X,'SIZE=',F4.1,'UM, RHO=',F3.1,4X,6(A6,9X),A6,/5X,   WRITER
     1 121('-'))                                                        WRITER
 1020 FORMAT(13X,A8,7(7X,1PE8.2))                                       WRITER
 1030 FORMAT(13X,A8,4(15X),3(7X,1PE8.2))                                WRITER
 1040 FORMAT(1HO,43X,'EXTERNAL WHOLE BODY DOSE CONVERSION FACTORS',/,   WRITER
     1 32X,'U-238 ',7X,' H-230',7X,'RA-226',7X,'PB-210',7X,'RN-222',7X, WRITER
     2 'PO-218',7X,'PB-214',7X,'BI-214',/2X,128('-'))                   WRITER
 1050 FORMAT(2X,'GROUND, MR/YR PER PCI/M2',8(5X,1PE8.2))                WRITER
 1060 FORMAT(2X,'CLOUD, MR/YR PER PCI/M3 ',8(5X,1PE8.2))                WRITER
 1070 FORMAT(2X,'WORKING LEVEL CONCENTRATION FACTORS, WL PER PCI/M3',   WRITER
     1 3(5X,8('.')),3(5X,1PE8.2))                                       WRITER
 1080 FORMAT(1HO,38X,'INGESTION DOSE CONVERSION FACTORS, MR PER PCI ',  WRITER
     1 'INGESTED',/)                                                    WRITER
 1090 FORMAT(4X,'AGE GROUP',4X,'TISSUE',1X,8(7X,A6))                    WRITER
 1100 FORMAT(4X,125('-'))                                               WRITER
 1110 FORMAT(4X,A8,5X,A8,8(5X,1PE8.2))                                  WRITER
 1120 FORMAT(1HO,47X,'ENVIRONMENTAL CONCENTRATION FACTORS',/,17X,       WRITER
     1 'CONCENTRATION FACTOR',9X,'FOOD TYPE',2X,4(7X,A6,2X),/,17X,      WRITER
     2 98('-'))                                                         WRITER
 1130 FORMAT(17X,'BIV, DIMENSIONLESS',12X,A8,4(7X,1PE8.2))              WRITER
 1140 FORMAT(17X,'FBI, PCI/KG PER PCI/DAY',7X,'MEAT',4X,4(7X,1PE8.2))   WRITER
 1150 FORMAT(17X,'FMI, PCI/L PER PCI/DAY',8X,'MILK',4X,4(7X,1PE8.2))    WRITER
 1160 FORMAT(17X,'FRACTION IN ED PORTION',8X,A8,4(7X,1PE8.2))           WRITER
 1170 FORMAT(1HO,50X,'TIME STEP DEPENDENT VARIABLES')                   WRITER
 1180 FORMAT(9X,'NO.',4X,'TIME STEP NAME',5X,'PAJUST',2X,4(3X,'GFACT',  WRITER
     1 2X),4(3X,'TFACT',2X),/,43X,8(2X,A6,2X),/9X,114('-'))             WRITER
 1190 FORMAT(9X,I2,2X,5A4,9(1X,1PE9.3))                                 WRITER
 1200 FORMAT(//6X,'XPFACT=',1PE9.3,3X,'GPFACT(4)=',4(1PE9.3,1X),        WRITER
     1 2X,'TPFACT(4)=',4(1PE9.3,1X))                                    WRITER
C********************* ************************************************* WRITER
      END
```

FIGURE B.0-2. Block Data FRESH Listing

```
      BLOCK DATA FRESH                                                    FRESH
C******************** ************************************************** FRESH
      LEVEL 2, NSORCE,NRECEP,TPSZ,CISUM,IPACT,PACT,PDEN,DUST20,ACTRAT,    FRESH
     1 PTSZ20,RXQ,RXQRN,PTSZ,QNAME                                        FRESH
C                                                                         FRESH
      COMMON/ADATA/PTSZFC(4,3),FREQ(16,6,6),SORCE(12,20),DM,HLM(7),       FRESH
     1 VDEP(4),GMAT(7,7),VSET(4),ACTIV(7),ZRECEP(240),RECEPT(2,240),      FRESH
     2 GDSCAL,QSCALE,OA(6),OB(6),OC(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,     FRESH
     3 ISORC1,KSORCE,IWD,IWS,ISTAB,IWSE,IWSB,IRECEP,IFPART,IFRN,          FRESH
     4 PINK(4,4),RINK(7)                                                  FRESH
C                                                                         FRESH
      COMMON/BDATA/NSORCE,NRECEP,TPSZ(4,4,240),CISUM(7,240),IPACT(20),    FRESH
     1 PACT(3,4),PDEN(4),DUST20(6),ACTRAT,PTSZ20,RXQ(20,240,4),           FRESH
     2 RXQRN(20,240,7),POSZ(4),QNAME(5,20)                                FRESH
C                                                                         FRESH
      COMMON/CDATA/QAJUST(10,2,20),DEPVEL(4),CPY(5,20),ISTEP,IRCV,IADD,   FRESH
     1 ALN2,TSTEP(10),ALF(6),GFACT(4,10),GPFACT(4),TFACT(4,10),NSTEP,     FRESH
     2 TPFACT(4),CGIP(4,4,240),CGXRN(4,240),JC(10),XPFACT                 FRESH
C                                                                         FRESH
      COMMON/DDATA/WLFACT(3),DCFA(5,7,5),DCFGP(4),DCFCP(4),DCFGR(5),      FRESH
     1 DCFCR(5),DCFF(8,4,4),BIV(4,5),FBI(4),FMI(4),OF,SHIELD,RF(3),       FRESH
     2 FREP(4,5),TISSUE(6),PATH(8),SRHO,WHL,ISTART,IFTODO(10),            FRESH
     3 TNAME(5,10)                                                        FRESH
C                                                                         FRESH
      COMMON/EDATA/FFORP,FHAYP,FPR(3),IPOP(12,16),WINDP(16),XRHO(12),     FRESH
     1 IPTOT,FRADON(4),PAJUST(10),PDPEG(6,8,10),PDXREG(6,8,10),           FRESH
     2 PDTOT(6,8,10)                                                      FRESH
C                                                                         FRESH
      COMMON/FDATA/XNAMEY5,48),FFORI,FHAYI,IRTYPE(48),XRECEP(3,48),       FRESH
     1 DIST(48),UOF(4,3),FBVT(4,3)                                        FRESH
C                                                                         FRESH
      COMMON/GDATA/METSFT(4),REGION(6),KPAGE,TODAY                        FRESH
C******************** ************************************************** FRESH
C                                                                         FRESH
C     FRESH INITIALIZES THE VALUES OF ITEMS IN COMMON BLOCKS A THRU G.    FRESH
C                                                                         FRESH
C******************** ************************************************** FRESH
C     SET UP ADATA VALUES                                                 FRESH
C                                                                         FRESH
      DATA PTSZFC/1.0,4*0.0,1.0,4*0.0,0.3,0.7/                            FRESH
      DATA FREQ/576*0/                                                    FRESH
      DATA SORCE/240*0/                                                   FRESH
      DATA DM,GDSCAL,QSCALE/1000.,1000.,1.0/                              FRESH
      DATA ZRECEP/240*0.0/                                                FRESH
      DATA RECEPT/480*0.0/                                                FRESH
      DATA OA/0.2,0.12,0.08,0.06,0.03,0.016/                              FRESH
      DATA OB/0.0,0.0,2.E-4,1.5E-3,3.E-4,3.E-4/                           FRESH
      DATA OC/1.0,1.0,-0.5,-0.5,-1.0,-1.0/                                FRESH
      DATA UU/.67056, 2.45872, 4.47040, 6.92912, 9.61136, 12.51712/       FRESH
C                                                                         FRESH
C     SET UP BDATA VALUES                                                 FRESH
C                                                                         FRESH
      DATA NSORCE,NRECEP/2*0/                                             FRESH
      DATA TPSZ/3840*0.0/                                                 FRESH
      DATA CISUM/1680*0.0/                                                FRESH
      DATA PACT/12*0.0/                                                   FRESH
      DATA PDEN/8.9,3*2.4/                                                FRESH
      DATA PDEN/8.9,3*2.4/                                                FRESH
      DATA ACTRAT,PTSZ20/2.5,0.5/                                         FRESH
      DATA RXQ/19200*0.0/                                                 FRESH
      DATA RXQRN/33600*0.0/                                               FRESH
      DATA PTSZ/1.0,1.0,5.0,35.0/                                         FRESH
C                                                                         FRESH
C     SET UP CDATA VALUE2                                                 FRESH
C                                                                         FRESH
      DATA QAJUST/400*0.0/                                                FRESH
      DATA IRCV,IADD,NSTEP/3*0/                                           FRESH
      DATA TSTEP/10*5.0/                                                  FRESH
```

FIGURE B.0-2. (Continued)

```
      DATA CGIP/3840*0.0/                                               FRESH
      DATA CGXRN/960*0.0/                                               FRESH
      DATA JC/10*0/                                                     FRESH
C                                                                       FRESH
C     SET UP DDATA VALUE2                                               FRESH
C                                                                       FRESH
      DATA ((DCFA(1,IX,J),IX=1,7),J=1,5)/                               FRESH
     1 9.82E00,1.12E01,1.37E02,3.58E01,4.66E00,0.00E00,5.95E-1,         FRESH
     2 1.66E02,1.81E02,4.90E03,3.58E02,1.45E02,0.00E00,2.43E00,         FRESH
     3 1.07E03,1.21E03,2.37E03,4.88E03,5.69E02,0.00E00,3.13E02,         FRESH
     4 0.00E00,0.00E00,2.82E02,4.47E-2,3.69E01,0.00E00,5.34E00,         FRESH
     5 3.78E01,4.30E01,1.37E03,1.26E00,1.21E02,0.00E00,1.79E01/         FRESH
      DATA ((DCFA(2,IX,J),IX=1,7),J=1,5)/                               FRESH
     1 4.32E00,4.92E00,1.66E02,3.09E01,4.36E00,0.00E00,4.71E-1,         FRESH
     2 7.92E01,7.95E01,5.95E03,3.09E02,1.35E02,0.00E00,1.92E00,         FRESH
     3 1.58E02,1.80E02,3.22E03,6.61E03,7.72E02,0.00E00,4.20E02,         FRESH
     4 0.00E00,0.00E00,3.43E02,3.87E-2,3.45E01,0.00E00,4.22E00,         FRESH
     5 1.66E01,1.89E01,1.67E03,1.09E00,1.13E02,0.00E00,1.42E01/         FRESH
      DATA ((DCFA(3,IX,J),IX=1,7),J=1,5)/                               FRESH
     1 1.16E00,1.32E00,1.01E02,4.00E01,4.84E00,0.00E00,7.10E-1,         FRESH
     2 1.96E01,2.14E01,3.60E03,4.00E02,1.50E02,0.00E00,2.89E00,         FRESH
     3 1.24E03,1.42E03,1.38E03,2.84E03,3.30E02,0.00E00,1.88E02,         FRESH
     4 0.00E00,0.00E00,2.07E02,4.97E-2,3.83E01,0.00E00,6.36E00,         FRESH
     5 4.47E00,5.10E00,1.00E03,1.41E00,1.25E02,0.00E00,2.13E01/         FRESH
      DATA ((DCFA(4,IX,J),IX=1,7),J=1,5)/                               FRESH
     1 7.92E-1,9.02E-1,5.77E01,3.90E01,4.43E00,0.00E00,7.28E-1,         FRESH
     2 1.34E01,1.46E01,2.07E03,3.90E02,1.38E02,0.00E00,2.96E00,         FRESH
     3 3.33E02,3.80E02,3.71E02,7.64E02,8.70E01,0.00E00,5.75E01,         FRESH
     4 0.00E00,0.00E00,1.19E02,4.85E-2,3.51E01,0.00E00,6.52E00,         FRESH
     5 3.05E00,3.47E00,5.73E02,1.38E00,1.15E02,0.00E00,2.19E01/         FRESH
      DATA ((DCFA(5,IX,J),IX=1,4),J=1,5)/20*0.0/                        FRESH
      DATA ((DCFA(5,IX,J),J=1,5),IX=5,7)/7.46,232.,62.7,59.1,193.,5*0.0, FRESH
     1                           1.29,5.24,266.,11.5,38.7/              FRESH
C                                                                       FRESH
      DATA DCFGP/3.70E-6,6.12E-7,9.47E-7,2.27E-6/                       FRESH
      DATA DCFGR/5.03E-8,1.10E-8,3.16E-5,1.85E-4,2.27E-6/               FRESH
      DATA DCFCP/1.23E-4,3.59E-6,4.90E-5,1.43E-5/                       FRESH
      DATA DCFCR/2.83E-6,6.34E-7,1.67E-3,1.16E-2,1.43E-5/               FRESH
      DATA WLFACT/1.03E-6,5.07E-6,3.73E-6/                              FRESH
C                                                                       FRESH
      DATA DCFF/                                                        FRESH
     A3.33E-4,3.80E-4,2.00E-8,1.06E-4,1.07E-2,2.38E-3,3.58E-7,7.41E-4,  FRESH
     B4.47E-3,4.88E-3,6.92E-7,3.80E-3,9.44E-2,5.28E-2,4.16E-6,3.10E-3,  FRESH
     C0.0  ,0.0     ,3.77E-8,1.90E-4,4.76E-5,1.42E-2,2.68E-5,5.93E-3,   FRESH
     D9.28E-4,1.06E-3,1.39E-7,9.12E-4,8.71E-4,4.33E-2,2.08E-4,1.26E-2,  FRESH
     E1.94E-4,2.21E-4,9.88E-9,9.91E-5,9.87E-3,2.09E-3,1.69E-7,3.67E-4,  FRESH
     F3.27E-3,3.57E-3,3.42E-7,3.55E-3,8.76E-2,4.75E-2,1.97E-6,1.52E-3,  FRESH
     G0.0   ,0.0     ,1.51E-8,1.78E-4,1.84E-5,1.22E-2,1.02E-5,2.43E-3,  FRESH
     H5.24E-4,5.98E-4,8.01E-8,8.67E-4,4.88E-4,3.67E-2,1.15E-4,7.56E-3,  FRESH
     I6.49E-5,7.39E-5,3.31E-9,6.00E-5,5.00E-3,7.01E-4,5.66E-8,1.23E-4,  FRESH
     J1.09E-3,1.19E-3,1.14E-7,2.16E-3,4.90E-2,1.81E-2,6.59E-7,5.09E-4,  FRESH
     K0.0    ,0.0    ,6.68E-9,1.23E-4,8.13E-6,5.44E-3,4.51E-6,1.07E-3,  FRESH
     L2.50E-4,2.85E-4,3.81E-8,5.99E-4,2.32E-4,1.72E-2,5.48E-5,3.60E-3,  FRESH
     M4.54E-5,5.17E-5,2.13E-9,5.70E-5,4.60E-3,5.44E-4,3.96E-8,8.59E-5,  FRESH
     N7.67E-4,8.36E-4,8.01E-8,2.06E-3,4.60E-2,1.53E-2,4.61E-7,3.56E-4,  FRESH
     O  0.0,0.0      ,4.71E-9,1.17E-4,5.74E-6,4.37E-3,3.18E-6,7.56E-4,  FRESH
     P1.75E-4,1.99E-4,2.67E-8,5.65E-4,1.63E-4,1.23E-2,3.83E-5,2.52E-3/  FRESH
      DATA BIV/2.5E-3,4.2E-3,1.4E-2,4.0E-3,                             FRESH
     1         2.5E-3,4.2E-3,3.0E-3,4.0E-3,                             FRESH
     2         2.5E-3,4.2E-3,1.4E-2,4.0E-3,                             FRESH
     3         2.5E-3,4.2E-3,1.8E-2,2.8E-2,                             FRESH
     4         2.5E-3,4.2E-3,8.2E-2,3.6E-2/                             FRESH
      DATA FBI/3.4E-4,2.0E-4,5.1E-4,7.1E-4/                             FRESH
      DATA FMI/6.1E-4,5.0E-6,5.9E-4,1.2E-4/                             FRESH
      DATA QF,SHIELD,SRHO,WHL/50.0,0.825,240.,14.0/                     FRESH
      DATA RF/0.5,2*1.0/                                                FRESH
      DATA FREP/4*1.0,8*0.1,8*1.0/                                      FRESH
      DATA TISSUE/8HWH.BODY ,8HBONE    ,8HAVG.LUNG,8HLIVER   ,          FRESH
```

FIGURE B.0-2. (Continued)

```
     1                 8HKIDNEY  ,8HBRONCHI /                                FRESH
      DATA PATH/8HINHAL.  ,8HGROUND  ,8HCLOUD   ,8HVEG.ING.,                 FRESH
     1          8HMEAT ING,8HMILK ING,8HTOTALS  ,8HRNPLUS50/                 FRESH
      DATA IFTODO/10*0/                                                      FRESH
      DATA TNAME/50*'TIME'/                                                  FRESH
C                                                                            FRESH
C     SET UP EDATA VALUES                                                    FRESH
C                                                                            FRESH
      DATA FFORP,FHAYP/0.5,0.5/                                              FRESH
      DATA FPR/3*0.0/                                                        FRESH
      DATA IPOP/192*0/                                                       FRESH
      DATA WINDR/4HN   ,4HNNE ,4HNE  ,4HENE ,4HE   ,4HESE ,4HSE  ,           FRESH
     1 4HSSE ,4HS   ,4HSSW ,4HSW  ,4HWSW ,4HW   ,4HWNW ,4HNW  ,4HNNW /       FRESH
      DATA XRHO/1.5,2.5,3.5,4.5,7.5,15.,25.,35.,45.,55.,65.,75./             FRESH
      DATA FRADON/4*0.0/                                                     FRESH
      DATA PAJUST/10*1.0/                                                    FRESH
      DATA PDREG/48D*D.0/                                                    FRESH
      DATA PDXREG/480*0.0/                                                   FRESH
      DATA PDTOT/48D*0.0/                                                    FRESH
C                                                                            FRESH
C     SET UP FDATA VALUE2                                                    FRESH
      DATA XNAME/240*'XNAM'/                                                 FRESH
      DATA FFORI,FHAYI/2*0.5/                                                FRESH
      DATA IRTYPE/48*-1/                                                     FRESH
      DATA XRECEP/144*0.0/                                                   FRESH
      DATA DIST/48*0.0/                                                      FRESH
      DATA UOF/  D.0, 47.8, 76.1,105.3,                                      FRESH
     1           0.0, 27.6, 44.8, 78.3,                                      FRESH
     2         208.0,208.0,246.0,130.0/                                      FRESH
      DATA FBVT/0.000,0.360,0.379,0.378,                                     FRESH
     1          0.D00,D.567,0.554,0.573,                                     FRESH
     2          0.000,0.073,0.067,0.049/                                     FRESH
C                                                                            FRESH
C     SET UP GDATA VALUE2                                                    FRESH
C                                                                            FRESH
      DATA METSET/4*'AERO'/                                                  FRESH
      DATA REGION/6*'AREA'/                                                  FRESH
      DATA KPAGE/0/                                                          FRESH
C******************** ************************************************** FRESH
      END                                                                    FRESH
```

APPENDIX C - Sample Problem

This section provides an illustration of the use of the computer program MILDOS. Section C.1 defines a sample problem including 1) a description of the site to be modeled and 2) the corresponding data cards prepared to represent the problem to the MILDOS program. The output reports prepared by MILDOS are described in Section C.2. Additional options of the MILDOS program are illustrated by a second sample problem in Section C.3. This sample problem is a shortened version of the first sample problem. Output from the second sample problem is described in Section C.4.

C.1 Sample Problem One Input

The first sample problem considers releases from the hypothetical Sierra Madre mill site. The problem considers six sources, six time steps and six receptor locations. Descriptive titles for each of these parameters are shown in Table C.1-1.

Table C.1-1 Sample Problem Title Information

Sources	Receptor Locations	Timesteps
Yellowcake Stack Ore Pad	Fence Boundry E	After 2.25 years
Grizzly Dump-Hopper	Fence Boundary SSE	After 4.25 years
Tailings Area 1	Grazing E	After 6.5 years
Tailings Area 2	Grazing ESE	After 11.5 years
Tailings Area 3	Nearest Resident- NNW	After 19.5 years
	Nearest Resident in Prevailing Wind Direction	After 14.5 years

These titles appear on input data cards following the NAMELIST card set INDATA as described in Section 4.2. In addition to the above titles, the title of the meteorological data set is entered as "Casper Wyoming".

The problem description information is discussed in conjunction with the input card listing shown in Figure C.1-1. The order of the discussion follows the order given in Section 4.2 for description of input parameters.

C.1.1 Job Control Parameters

The control parameter arrays IFTODO, IRTYPE and JC are set as follows:

- IFTODO = 0, 0, 0, 0, 1, 1, to cause calculation and printing of doses after the fifth and sixth time periods,
- IRTYPE = 0, 0, 1, 10, 10, 10, to request printing of total dose summary report after location 3 and total doses (over all pathways) for the last three individual receptor locations (see Table C.1-1),
- JC = 1, 0, 1, 0, 0, 1, 1, 0, 1, to select the following options:

  JC(1) - use internal dusting rate algorithm for area sources,

  JC(3) - print total air concentrations, ground concentrations, and deposition rates for each spatial interval,

  JC(6) - print dose conversion factors, environmental concentration factors and timestep dependent parameters,

  JC(7) - print reports of total dose commitments and 40 CFR 190 dose commitments for each receptor location requested by the parameter IRTYPE,

  JC(9) - print particulate concentrations for air and ground at each individual receptor location.

See Table 4.2-1 for full description of options.

C.1.2 Source Term Parameters

The location and characteristics of the six release sources are indicated in Table C.1-2. The release rates in this table are average release values to be used with the parameter QAJUST to calculate actual release rates for each timestep and source for particulates and radon. The corresponding adjustment factors (QAJUST) are shown in Table C.1-3. The tailings activity mix set values given in Table C.1-2 assign tailings composition mix sets for each area source. The composition of each mix set is given in Table C.1-4. The data in this table is entered as input parameter PACT.

The continental population doses are generated using the representative site fractions given in Table C.1-5 (as input parameter FRADON).

```
$INDATA
IFTODO=4*0,2*1,4*0,
IRTYPE=2*0,1,3*10,
JC=1,0,1,2*0,2*1,0,1,0,
FRADON= 0.86,0.06,0.04,0.04,
IPACT=3*0,1,2,3,14*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,
QAJUST=
 1.0,2*1.5,2*2.0,15*0.,
 1.0,2*1.502,2*2.004,5*0.0,  1.0,2*1.502,2*2.004502,2*2.004,5*0.0,  1.0,2*1.502,2*2.004,5*0.0,
 0.3,1.0,8*0.,  2*1.0,4*.007,4*0.0,
 0.0,2*0.3,1.0,6*0.,  0.0,3*1.0,2*.005,4*0.0,
 3*0.0,2*0.3,5*0.0,  3*0.0,2*1.0,0.004,4*0.0,
 280*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,
  2*0.20,.0,0.0,4*2.602E-2,41.64,1301,2.0,0.0,
   1.393,0.975,-10.0,0.143,4*1.0,1281.5,2001,3.0,0.0,
   -1.30,-.844,-10.0,0.270,4*1.0,3636.80,2002,3.0,0.0,
   1.092,-0.975,-10.0,0.827,4*1.0,14863.23,2003,3.0,0.0,
FREQ=
0.000069,0.000240,0.000103,0.000240,0.000171,0.000103,0.000069,0.000411,
0.000137,0.000206,0.000240,0.000240,0.000377,0.000171,0.000206,0.000103,
0.000137,0.000274,0.000206,0.000069,0.000137,0.000206,0.000137,0.000617,
0.000069,0.000206,0.000069,0.000274,0.000548,0.000343,0.000000,0.000206,
64*0.0,0.000554,0.000507,0.000374,0.000421,0.000960,0.000424,0.000665,0.000651,
 0.000977,0.000410,0.000618,0.000445,0.001126,0.000402,0.000208,0.000644,
0.000959,0.001233,0.000685,0.000411,0.001233,0.001165,0.001302,0.001165,
0.002124,0.001028,0.001576,0.001370,0.001370,0.000959,0.000548,0.001096,
0.000685,0.000617,0.000685,0.000411,0.000617,0.000206,0.000548,0.000274,
0.000548,0.000685,0.000822,0.001096,0.001781,0.000685,0.000754,0.000822,
48*0.0,0.000186,0.000133,0.000115,0.000118,0.000366,0.000186,0.000127,0.000037,
0.000282,2*0.000186,0.000292,0.000179,0.000273,0.000320,0.000028,
0.000959,0.001370,0.000959,0.001028,0.001781,0.000959,0.001233,0.000822,
0.001507,0.000959,0.000959,0.001713,0.002398,0.001302,0.000754,0.000617,
0.002535,0.001850,0.001576,0.001713,0.002329,0.001918,0.001233,0.000822,
0.001233,0.001987,0.003699,0.006439,0.004727,0.002261,0.001644,0.001576,
0.000274,0.000137,0.000137,0.000137,0.000343,0.000343,0.000137,0.000000,
0.000343,0.000959,0.002055,0.001713,0.001918,0.000343,0.000411,0.000685,
0.0,0.000069,6*0.0,0.000137,0.000069,2*0.000343,0.000411,0.000206,12*0.0,
0.000069,0.000137,0.000069,3*0.000000,
0.000792,0.001053,0.000854,0.000741,0.000598,0.000592,0.000548,0.000268,
0.000548,0.000336,0.000411,0.000530,0.000679,0.000816,0.000430,0.001009,
0.005412,0.005823,0.004453,0.003220,0.004110,0.003220,0.001918,0.001302,
0.001918,0.001233,0.002055,0.003357,0.003357,0.002398,0.001439,0.004521,
0.011440,0.014249,0.010207,0.008768,0.009248,0.004932,0.003014,0.001370,
0.002124,0.006302,0.014180,0.021304,0.017468,0.005412,0.005206,0.005001,
0.011097,0.014865,0.010275,0.006508,0.010001,0.005480,0.001987,0.000548,
0.003699,0.030826,0.065420,0.051993,0.019318,0.009453,0.005891,0.004042,
0.002809,0.003768,0.001713,0.000617,0.002261,0.000822,0.000411,0.000137,
0.001781,0.026716,0.050075,0.022126,0.009248,0.004042,0.002398,0.001028,
0.001028,0.001028,0.000274,0.000000,0.000137,0.000069,0.000000,0.000000,
0.000411,0.014797,0.022469,0.009727,0.005206,0.001165,0.000411,0.000343,
0.003723,0.001668,0.001431,0.001104,0.001608,0.001124,0.000635,0.000583,
0.001221,0.001124,0.001448,0.002996,0.005746,0.002607,0.002023,0.002606,
0.011098,0.008974,0.006439,0.005480,0.006234,0.003563,0.003083,0.001919,
0.003014,0.003152,0.005275,0.012741,0.020140,0.009865,0.009042,0.009933,
0.003425,0.003014,0.002809,0.002877,0.004042,0.003083,0.001165,0.000480,
0.000548,0.004042,0.010892,0.028223,0.019044,0.004042,0.002466,0.002603,
  144*0.0,
DM=850.0,
FFORI=0.50,FHAYI=0.00,FFORP=0.50,FHAYP=0.50,
FPR= 320.0,1400.0,230.0,
IPOP=
 2*0,1,5,0,15,2*0,4,8,14,400,
 2*0,2,3,0,14,0,40,27,10,300,250,
```

FIGURE C.1-1 Sample Problem One Input Listing

FIGURE C.1-1. (Continued)

```
 2*0,1,2,0,1,0,15,14,4,800,97,
 2*0,3,4*0,10,8,1,327,655,
 2*0,2,1,0,3,0,1,3,0,50,422,
 2*0,1,3,3*0,4,2,3*0,
 2*0,1,2*0,1,0,2,4*0,
2*0,2,5*0,1,2*0,25893,
 2*0,4,2,0,1,2*0,10,0,17,37372,
 2*0,3,1,0,1,0,25,4,0,254,0,
 2*0,1,3,0,2,0,8,27,0,322,0,
 2*0,3,2*0,1,0,9,6,0,145,0,
 2*0,2*2,4*0,3,0,89,0,
 2*0,2*1,0,3,0,4,4*0,
 2*0,2,1,3*0,5,3*0,427,
 2*0,3,1,4*0,1,2*0,1000,
PAJUST=1.039,1.059,1.081,1.129,1.189,1.215,4*0.0,
IADD=6 ,
XRECEP=
 2.040,-0.200,8.8,
 1.08,-1.440,2.4,
   2.56,00.0,3.7,           2.584,-0.890,-1.4,
          -0.448,1.466,12.3,  2.168,2.168,10.2,
NSTEP=6,TSTEP=2.25,2.0,2.25,5.0,8.0,5.0,4*0.0,
TSTART= 1980.0
$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 6.5  YEARS
AFTER 11.5 YEARS
AFTER 19.5 YEARS
AFTER 24.5 YEARS
```

TABLE C.1-2. Source Description Parameters

Parameter	Source						Variable Name
	Yellowcake Stack	Ore Pad	Grizzly Dump-Hopper	1	2	3	
Location:							
East-West (km)	0.0	0.4E	0.2E	1.39E	0.30W	1.09E	SORCE(1, i)
North-South(km)	0.0	0.4N	0.4N	0.98N	0.84S	0.98S	SORCE(2, i)
Elevation (m)	20.0	6.0	0.0	-10.0	-10.	-10.0	SORCE(3, i)
Area (km^2)	--	0.16	0.0	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):							
^{238}U	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)
^{230}Th	2.16×10^{-3}	4.08×10^{-2}	2.60×10^{-2}	1.35×10^{-1}	3.82×10^{-1}	1.56×10^{0}	SORCE(6, i)
^{226}Ra	8.62×10^{-5}	4.08×10^{-2}	2.60×10^{-2}	1.41×10^{-1}	4.01×10^{-1}	1.64×10^{0}	SORCE(7, i)
^{210}Pb	8.62×10^{-5}	4.08×10^{-2}	2.60×10^{-2}	1.41×10^{-1}	4.01×10^{-1}	1.64×10^{0}	SORCE(8, i)
^{222}Rn	0.0	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/sec)	17.0	0.0	0.0	0.0	0.0	0.0	SORCE(12,i)
Diameter (m)	1.0	0.0	0.0	0.0	0.0	0.0	SORCE(12,i)
Tailings Activity Mix Set	0	0	0	1	2	3	IPACT(i)

Table C.1-3 Sample Problem Release Adjustment Factors

Source	Particulate Release Factors Time Step 1	2	3	4	5	6
1-Yellowcake Stack	1.0	1.5	1.5	2.0	2.0	0.0
2-Ore Pad	1.0	1.502	1.502	2.004	2.004	0.0
3-Grizzly Dump-Hopper	1.0	1.502	1.502	2.004	2.004	0.0
4-Tailings Area 1	0.3	1.0	0.0	0.0	0.0	0.0
5-Tailings Area 2	0.0	0.3	0.3	1.0	0.0	0.0
6-Tailings Area 3	0.0	0.0	0.0	0.3	0.3	0.0

	Radon Release Factors Time Step 1	2	3	4	5	6
1-Yellowcake Stack	0.0	0.0	0.0	0.0	0.0	0.0
2-Ore Pad	1.0	1.502	1.502	2.004	2.004	0.0
3-Grizzly Dump-Hopper	1.0	1.502	1.502	2.004	2.004	0.0
4-Tailings Area 1	1.0	1.0	0.007	0.007	0.007	0.007
5-Tailings Area 2	0.0	1.0	1.0	1.0	0.005	0.005
6-Tailings Area 3	0.0	0.0	0.0	1.0	1.0	0.004

Table C.1-4 Tailing Mix Activities

Set Number	Tailings Activities, pCi/g Uranium	Thorium	Radium	Lead
1	11.4	271.	284.	284.
2	17.1	407.	427.	427.
3	22.8	543.	570.	570.

Table C.1-5 Radon Release Fractions for Continental Doses

Representative Site	Equivalent Release Fraction
Casper, Wyoming	0.86
Falls City, Texas	0.06
Grants, New Mexico	0.04
Wellpinit, Washington	0.04

C.1.3 Meteorological Parameters

The annual average joint frequency of occurrence meteorological data set is entered through the array FREQ. A listing of this data is given in the sample output listing in Section C.2 (output page 2) and will not be repeated here. The average annual mixing layer height is 850 meters (input parameter DM).

C.1.4 Pathway Parameters

The four pathway parameters describing annual animal feed requirements are set as indicated in Table C.1-6. Because the default value for these parameters is 0.5, it is only necessary to give the value of FHAYI = 0.0 in the input set. However all values are given for completeness (see Figure C.1-1). The regional food production rates (kg/yr per km^2) for Wyoming (see Table 4.2-6) are: vegetables - 320., meat - 1400., and milk - 230. The food production rates are entered through the array FPR.

Table C.1-6 Sample Problem Animal Feed Requirements

Feed Type	Fraction of Intake	Parameter
Individual Dose:		
Forage	0.5	FFORI
Stored Feed	0.0	FHAYI
Population Dose:		
Forage	0.5	FFORP
Stored Feed	0.5	FHAYP

C.1.5 Population Distribution Parameters

The population within each of the 192 spatial intervals about the site is given in input array IPOP. A table of population data is given in the sample problem output listing (see Section C.2, output page 4) and will not be repeated here.

The changes in total U.S. population during each time step is required for the continental population dose calculation. The parameter PAJUST gives the ratio of the population at the end of each timestep to the 1978 population. The values used for the sample problem are listed in Table C.1-7 and were calculated from data given in Table 4.2-8.

Table C.1-7 Sample Problem Population Growth Factors

Time Step	Population factor
1-After 2.25 Years	1.039
2-After 4.25 Years	1.059
3-After 6.5 Years	1.081
4-After 11.5 Years	1.129
5-After 19.5 Years	1.189
6-After 24.5 Years	1.215

C.1.6 Individual Receptor Location Parameters

The location of the six individual receptors is given through the input array XRECEP. Table C.1-8 presents the location coordinates to be used.

Table C.1-8 Sample Problem Receptor Locations

	Locations Relative to Mill Center		
Receptor	East-West(km)	North-South(km)	Elevation(m)
Fence Boundary E	2.040	-0.200	8.8
Fence Boundary SSE	1.080	-1.440	2.4
Grazing E	2.560	0.0	3.7
Grazing ESE	2.584	-0.890	-1.4
Nearest Resident NNW	-0.448	1.466	12.3
Nearest Resident in the Prevailing Wind Direction	2.168	2.168	10.2

C.1.7 Time History Parameters

The time steps given in Table C.1-1 are described through input array TSTEP. Values given are the duration of each time step in years as indicated in Table C.1-9. The start of the first time step is defined as 1980 by the input parameter TSTART.

Table C.1-9 Sample Problem Time Steps

Time Step	Duration, Years
1-After 2.25 Years	2.25
2-After 4.25 Years	2.0
3-After 6.5 Years	2.25
4-After 11.5 Years	5.0
5-After 19.5 Years	8.0
6-After 24.5 Years	5.0

C.2 Sample Problem One Output

Execution of sample problem one results in fifty-nine pages of output reports. A summary of information given on each page is presented in Table C.2-1. A listing of selected portions of the output is given in Figure C.2-1. Specific items of interest on the output reports are indicated by circled numbers and are discussed below.

Page 1

Each page has the same heading giving site name (item 1, parameter REGION), meteorological data set name (item 2, parameter METSET), program version (item 3), current date (item 4) and page number (item 5). The table marked as item 6 gives values provided in input array SORCE. The source names (item 7) are supplied on title cards as QNAME. Tailing activity mixes (item 8) are supplied as array PACT and particle size fraction data (item 9) are defined internally in block data FRESH as array PTSZFC. Source strength factors for particulates (item 10) and radon (item 11) are provided as input parameter QAJUST.

Page 2

This page gives the percent joint frequency of occurrence of wind speed, direction and atmospheric stability. The percent values are generated internal to the program from the fractional (decimal) values provided by the used in the input array FREQ (Σ FREQ$\approx$1.00). The total fractional frequency for each wind speed is given as FREQWS (item 12). Totals by stability and direction are also indicated in the table. The direction is the direction the wind is from.

Page 3

This report gives additional input information. Data for each individual receptor location is given first (item 13). This data is entered as XRECEP with titles given as XNAME. Other input parameters are given by name (item 14).

Table C.2-1 Sample Problem One Output Reports

Page Number	Description of Report
1	Input source description data
2	Input meteorological data
3	Input receptor and timestep data
4	Input population data
5	Inhalation and external dose conversion factors
6	Ingestion dose conversion factors, environmental concentrations factors and timestep dependent variables.
7	Air and ground concentrations and total deposition rates for timestep 1 and direction N
8*	Same as page 7 for timestep 1 and direction ENE
9*	Same as page 7 for timestep 1 and direction E
10*	Same as page 7 for timestep 1 and direction S
11*	Same as page 7 for timestep 1 and direction W
12	Annual population dose summary for timestep 1
13*	Same as page 7 for timestep 2 and direction N
14*	Same as page 7 for timestep 2 and direction ENE
15*	Same as page 7 for timestep 2 and direction E
16*	Same as page 7 for timestep 2 and direction S
17*	Same as page 7 for timestep 2 and direction W

Table C.2-1 cont'd.

18*	Same as page 12 for timestep 2
19*	Same as page 7 for timestep 3 and direction N
20*	Same as page 7 for timestep 3 and direction ENE
21*	Same as page 7 for time step 3 and direction E
22*	Same as page 7 for timestep 3 and direction S
23*	Same as page 7 for timestep 3 and direction W
24*	Same as page 12 for timestep 3
25*	Same as page 7 for timestep 4 and direction N
26*	Same as page 7 for timestep 4 and direction E
27*	Same as page 7 for timestep 4 and direction S
28*	Same as page 7 for timestep 4 and direction W
29*	Same as page 12 for timestep 4
30*	Same as page 7 for timestep 5 and direction N
31*	Same as page 7 for timestep 5 and direction E
32*	Same as page 7 for timestep 5 and direction S
33*	Same as page 7 for timestep 5 and direction W
34*	Same as page 12 for timestep 5
35	Particulate concentrations at receptor locations for timstep 5
36	Radon and daughter concentrations at receptor locations for timestep 5
37	Results of MPC checks at receptor locations for timestep 5
38	40 CFR 190 dose commitment totals and total annual dose commitments at receptor 3 for timestep 5
39	40 CFR 190 dose commitments at receptor 4 for timestep 5
40	Total annual dose commitments at receptor 4 for timestep 5
41*	Same as page 39 for receptor 5
42*	Same as page 40 for receptor 5
43*	Same as page 39 for receptor 6
44*	Same as page 40 for receptor 6
45*	Same as page 7 for timestep 6 and direction N
46*	Same as page 7 for timestep 6 and direction E
47*	Same as page 7 for timestep 6 and direction S
48*	Same as page 7 for timestep 6 and direction W
49*	Same as page 12 for timestep 6
50*	Same as page 35 for timestep 6
51*	Same as page 36 for timestep 6
52*	Same as page 37 for timestep 6
53*	Same as page 38 for timestep 6 and receptor 3
54*	Same as page 39 for timestep 6 and receptor 4
55*	Same as page 40 for timestep 6 and receptor 4
56*	Same as page 39 for timestep 6 and receptor 5
57*	Same as page 40 for timestep 6 and receptor 5
58*	Same as page 39 for timestep 6 and receptor 5
59*	Same as page 40 for timestep 6 and receptor 6

* These pages are repetitious and are not included in the output listing of Figure C.2-1.

FIGURE C.2-1. Sample Problem One Output Listing

REGION=SIERRA MADRE MILL (1)
METSET=CASPER WYOMING (2)
NUMBER OF SOURCES= 6

(3) CODE=MILDOS,REVO (7,79)

(4) DATE= 2/17/81
PAGE NO. 1 (5)

NO.	KM X	KM Y	M Z	KM2 AREA	U-238 (6)	TH-230	CI/YEAR RA-226	PB-210	RN-222	ID	PSIZE SET	M/SEC EXIT VEL	SOURCE NAME (7)
1	0.00	0.00	20.00	.0000	4.14E-02	2.16E-03	8.62E-05	8.62E-05	0.	1101	1	1.70E+01	YELLOWCAKE STACK
2	.40	.40	6.00	.1600	4.08E-02	4.08E-02	4.08E-02	4.08E-02	1.09E+03	1201	3	0.	ORE PAD
3	.20	.20	0.00	.0000	2.60E-02	2.60E-02	2.60E-02	2.60E-02	4.16E+01	1301	2	0.	GRIZZLY PUMP-HOPPER
4	1.39	.98	-10.00	.1430	5.67E-03	1.35E-01	1.41E-01	1.41E-01	1.28E+03	2001	3	0.	TAILINGS AREA 1
5	-1.30	-.84	-10.00	.2700	1.61E-02	3.82E-01	4.01E-01	4.01E-01	3.64E+03	2002	3	0.	TAILINGS AREA 2
6	1.09	-.98	-10.00	.8270	6.56E-02	1.56E+00	1.64E+00	1.64E+00	1.49E+04	2003	3	0.	TAILINGS AREA 3

INPUT TAILS ACTIVITIES, PCI/G (8)

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

PARTICLE SIZES AND FRACTIONAL DISTRIBUTION (9)

SET	1.0	1.0	5.0	35.0	PDEN
1	1.000	0.000	0.000	0.000	8.900
2	0.000	1.000	0.000	0.000	2.400
3	0.000	0.000	.300	.700	2.400

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 6 TIME STEP(S) USED FOR THIS RUN. (10)

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.	0.	0.	0.	0.
2	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.	0.	0.	0.	0.
3	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.	0.	0.	0.	0.
4	3.000E-01	1.000E+00	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	3.000E-01	3.000E-01	1.000E+00	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	3.000E-01	3.000E-01	0.	0.	0.	0.	0.

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 6 TIME STEP(S) USED FOR THIS RUN 0. 5::::KL (11)

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.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.	0.	0.	0.	0.
3	1.000E+00	1.502E+00	1.502E+00	2.004E+00	2.004E+00	0.	0.	0.	0.	0.
4	1.000E+00	1.000E+00	7.000E-03	7.000E-03	7.000E-03	7.000E-03	0.	0.	0.	0.
5	0.	1.000E+00	1.000E+00	1.000E+00	5.000E-03	5.000E-03	0.	0.	0.	0.
6	0.	0.	0.	1.000E+00	1.000E+00	4.000E-03	0.	0.	0.	0.

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) (12) DATE= 2/17/81
METSET=CASPER WYOMING PAGE NO. 2

JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS= .05734, .21073, .28176, .26134, .13153, .05734

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	.0069	.0240	.0103	.0240	.0171	.0103	.0069	.0411	.0137	.0206	.0240	.0240	.0377	.0171	.0206	.0103	.3086
5.5	.0137	.0274	.0206	.0069	.0137	.0206	.0137	.0617	.0069	.0206	.0069	.0274	.0548	.0343	0.0000	.0206	.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	.0206	.0514	.0309	.0309	.0308	.0309	.0206	.1028	.0206	.0412	.0309	.0514	.0925	.0514	.0206	.0309	.6584
STABILITY CLASS 2																	
1.5	.0554	.0507	.0374	.0421	.0960	.0424	.0665	.0651	.0977	.0410	.0618	.0445	.1126	.0402	.0208	.0644	.9386
5.5	.0959	.1233	.0685	.0411	.1233	.1165	.1302	.1165	.2124	.1028	.1576	.1370	.1370	.0959	.0548	.1096	1.8224
10.0	.0685	.0617	.0685	.0411	.0617	.0206	.0548	.0274	.0548	.0685	.0822	.1096	.1781	.0685	.0754	.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	.2198	.2357	.1744	.1243	.2810	.1795	.2515	.2090	.3649	.2123	.3016	.2911	.4277	.2046	.1510	.2562	3.8846
STABILITY CLASS 3																	
1.5	.0186	.0133	.0115	.0118	.0366	.0186	.0127	.0037	.0282	.0186	.0186	.0292	.0179	.0273	.0320	.0028	.3014
5.5	.0959	.1370	.0959	.1028	.1781	.0959	.1233	.0822	.1507	.0959	.0959	.1713	.2398	.1302	.0754	.0617	1.9320
10.0	.2535	.1850	.1576	.1713	.2329	.1918	.1233	.0822	.1233	.1987	.3699	.6439	.4727	.2261	.1644	.1576	3.7542
15.5	.0274	.0137	.0137	.0137	.0343	.0343	.0137	0.0000	.0343	.0959	.2055	.1713	.1918	.0343	.0411	.0685	.9935
21.5	0.0000	.0069	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0137	.0069	.0343	.0343	.0411	.0206	0.0000	0.0000	.1578
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0069	.0137	.0069	0.0000	0.0000	0.0000	.0275
ALL	.3954	.3559	.2787	.2996	.4819	.3406	.2730	.1681	.3502	.4160	.7311	1.0637	.9702	.4385	.3129	.2906	7.1664
STABILITY CLASS 4																	
1.5	.0792	.1053	.0854	.0741	.0598	.0592	.0548	.0268	.0548	.0336	.0411	.0530	.0679	.0816	.0430	.1009	1.0205
5.5	.5412	.5823	.4453	.3220	.4110	.3220	.1918	.1302	.1918	.1233	.2055	.3357	.3357	.2398	.1439	.4521	4.9736
10.0	1.1440	1.4249	1.0207	.8768	.9248	.4932	.3014	.1370	.2124	.6302	1.4180	2.1304	1.7468	.5412	.5206	.5001	14.0225
15.5	1.1097	1.4865	1.0275	.6508	1.0001	.5480	.1987	.0548	.3699	3.0826	6.5420	5.1993	1.9318	.9453	.5891	.4042	25.1403
21.5	.2809	.3768	.1713	.0617	.2261	.0822	.0411	.0137	.1781	2.6716	5.0075	2.2126	.9248	.4042	.2398	.1028	12.9952
28.0	.1028	.1028	.0274	0.0000	.0137	.0069	0.0000	0.0000	.0411	1.4797	2.2469	.9727	.5206	.1165	.0411	.0343	5.7065
ALL	3.2578	4.0786	2.7776	1.9854	2.6355	1.5115	.7878	.3625	1.0481	8.0210	15.4610	10.9037	5.5276	2.3286	1.5775	1.5944	63.8586
STABILITY CLASS 5																	
1.5	.3723	.1668	.1431	.1104	.1608	.1124	.0635	.0583	.1221	.1124	.1448	.2996	.5746	.2607	.2023	.2606	3.1647
5.5	1.1098	.8974	.6439	.5480	.6234	.3563	.3083	.1919	.3014	.3152	.5275	1.2741	2.0140	.9865	.9042	.9933	11.9952
10.0	.3425	.3014	.2809	.2877	.4042	.3083	.1165	.0480	.0548	.4042	1.0892	2.8223	1.9044	.4042	.2466	.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	.9461	1.1884	.7770	.4883	.2982	.4783	.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

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL — CODE=MILDOS,REVO (7/79) — DATE= 2/17/81

METSET=CASPER WYOMING — PAGE NO. 3

(13)

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	2.04	-.20	8.80	2.05	0	4	GRAZING ESE	2.58	-.89	-1.40	2.73	10
2	FENCE BOUNDARY SSE	1.08	-1.44	2.40	1.80	0	5	NEAREST RESIDENT ®NN	-.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

(14) MISCELLANEOUS INPUTTABLE PARAMETER VALUES

DM	TSTART	FFORI	FHAYI	FFORP	FHAYP	FPR(1)	FPR(2)	FPR(3)	ACTRAT
850.00	1980.00	.50	0.00	.50	.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....

(15)

	STEP NAMES	LENGTH, YRS	IFTODO
1	AFTER 2.25 YEARS	2.25	0
2	AFTER 4.25 YEARS	2.00	0
3	AFTER 6.5 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

(16)

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,

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL
METSET=CASPER WYOMING

CODE=MILDOS,REVO (7/79)

DATE= 2/17/81
PAGE NO. 4

POPULATION DISTRIBUTION

(17)

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
0.0-60.0	8	10	4	1	0	0	0	0	0	0	0	0	0	0	0	0
0.0-70.0	14	300	800	327	50	0	0	0	17	254	322	145	89	0	0	0
0.0-80.0	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

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 2/17/81
METSET=CASPER WYOMING PAGE NO. 5

(18) INHALATION DOSE CONVERSION FACTORS, MR/YR PER PCI/M3

SIZE= 1.0UM, RHO=8.9	U-238	U-234	TH-230	RA-226	PB-210	BI-210	PO-210
WH.BODY	9.82E+00	1.12E+01	1.37E+02	3.58E+01	4.66E+00	0.	5.95E-01
BONE	1.66E+02	1.81E+02	4.90E+03	3.58E+02	1.45E+02	0.	2.43E+00
AVG.LUNG	1.07E+03	1.21E+03	2.37E+03	4.88E+03	5.69E+02	0.	3.13E+02
LIVER	0.	0.	2.82E+02	4.47E-02	3.69E+01	0.	5.34E+00
KIDNEY	3.78E+01	4.30E+01	1.37E+03	1.26E+00	1.21E+02	0.	1.79E+01
SIZE= 1.0UM, RHO=2.4	U-238	U-234	TH-230	RA-226	PB-210	BI-210	PO-2101
WH.BODY	4.32E+00	4.92E+00	1.66E+02	3.09E+01	4.36E+00	0.	4.71E-01
BONE	7.92E+01	7.95E+01	5.95E+03	3.09E+02	1.35E+02	0.	1.92E+00
AVG.LUNG	1.58E+02	1.80E+02	3.22E+03	6.61E+03	7.72E+02	0.	4.20E+02
LIVER	0.	0.	3.43E+02	3.87E-02	3.45E+01	0.	4.22E+00
KIDNEY	1.66E+01	1.89E+01	1.67E+03	1.09E+00	1.13E+02	0.	1.42E+01
SIZE= 5.0UM, RHO=2.4	U-238	U-234	TH-230	RA-226	PB-210	BI-210	PO-2101
WH.BODY	1.16E+00	1.32E+00	1.01E+02	4.00E+01	4.84E+00	0.	7.10E-01
BONE	1.96E+01	2.14E+01	3.60E+03	4.00E+02	1.50E+02	0.	2.89E+00
AVG.LUNG	1.24E+03	1.42E+03	1.38E+03	2.84E+03	3.30E+02	0.	1.88E+02
LIVER	0.	0.	2.07E+02	4.97E-02	3.83E+01	0.	6.36E+00
KIDNEY	4.47E+00	5.10E+00	1.00E+03	1.41E+00	1.25E+02	0.	2.13E+01
SIZE=35.0UM, RHO=2.4	U-238	U-234	TH-230	RA-226	PB-210	BI-210	PO-2101
WH.BODY	7.92E-01	9.02E-01	5.77E+01	3.90E+01	4.43E+00	0.	7.28E-01
BONE	1.34E+01	1.46E+01	2.07E+03	3.90E+02	1.38E+02	0.	2.96E+00
AVG.LUNG	3.33E+02	3.80E+02	3.71E+02	7.64E+02	8.70E+01	0.	5.75E+01
LIVER	0.	0.	1.19E+02	4.85E-02	3.51E+01	0.	6.52E+00
KIDNEY	3.05E+00	3.47E+00	5.73E+02	1.38E+00	1.15E+02	0.	2.19E+01
SIZE= .3UM, RHO=1.0	U-238	U-234	TH-230	RA-226	PB-210	BI-210	PO-2101
WH.BODY					7.46E+00	0.	1.29E+00
BONE					2.32E+02	0.	5.24E+00
AVG.LUNG					6.27E+01	0.	2.66E+02
LIVER					5.91E+01	0.	1.15E+01
KIDNEY					1.93E+02	0.	3.87E+01

(19) EXTERNAL WHOLE BODY DOSE CONVERSION FACTORS

	U-238	TH-230	RA-226	PB-210	RN-222	PO-218	PB-214	BI-214
GROUND, MR/YR PER PCI/M2	3.70E-06	6.12E-07	9.47E-07	2.27E-06	5.03E-08	1.10E-08	3.16E-05	1.85E-04
CLOUD, MR/YR PER PCI/M3	1.23E-04	3.59E-06	4.90E-05	1.43E-05	2.83E-06	6.34E-07	1.67E-03	1.16E-02
(20) WORKING LEVEL CONCENTRATION FACTORS, WL PER PCI/M3			....	....	....	1.03E-06	5.07E-06	3.73E-06

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL
METSET=CASPER WYOMING

CODE=MILDOS,REVO (7/79)

DATE= 2/17/81
PAGE NO. 6

(21) INGESTION DOSE CONVERSION FACTORS, MR PER PCI INGESTED

AGE GROUP	TISSUE	U-238	U-234	TH-234	TH-230	RA-226	PB-210	BI-210	PO-210
INFANT	INHAL.	3.27E-03	3.57E-03	3.42E-07	3.55E-03	8.76E-02	4.75E-02	1.97E-06	1.52E-03
INFANT	INHAL.	3.27E-03	3.57E-03	3.42E-07	3.55E-03	8.76E-02	4.75E-02	1.97E-06	1.52E-03
CHILD	INHAL.	1.09E-03	1.19E-03	1.14E-07	2.16E-03	4.90E-02	1.81E-02	6.59E-07	5.09E-04
CHILD	INHAL.	1.09E-03	1.19E-03	1.14E-07	2.16E-03	4.90E-02	1.81E-02	6.59E-07	5.09E-04
TEENAGE	INHAL.	7.67E-04	8.36E-04	8.01E-08	2.06E-03	4.60E-02	1.53E-02	4.61E-07	3.56E-04
TEENAGE	INHAL.	7.67E-04	8.36E-04	8.01E-08	2.06E-03	4.60E-02	1.53E-02	4.61E-07	3.56E-04
ADULT	INHAL.	2.50E-03	4.20E-03	1.40E-02	4.00E-03	2.50E-03	4.20E-03	1.80E-02	2.80E-02
ADULT	INHAL.	2.50E-03	4.20E-03	1.40E-02	4.00E-03	2.50E-03	4.20E-03	1.80E-02	2.80E-02

ENVIRONMENTAL CONCENTRATION FACTORS

(22) 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
FPI, 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

(24) TIME STEP DEPENDENT VARIABLES (25)

NO.	TIME STEP NAME (23)	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	AFTER 2.25 YEARS	1.061E+00	6.991E+07	6.991E+07	6.988E+07	6.754E+07	1.622E+00	1.622E+00	1.622E+00	1.618E+00
2	AFTER 4.25 YEARS	1.075E+00	6.225E+07	6.225E+07	6.223E+07	6.037E+07	1.622E+00	1.622E+00	1.622E+00	1.618E+00
3	AFTER 6.5 YEARS	1.092E+00	6.991E+07	6.991E+07	6.988E+07	6.754E+07	1.622E+00	1.622E+00	1.622E+00	1.618E+00
4	AFTER 11.5 YEARS	1.129E+00	1.525E+08	1.525E+08	1.523E+08	1.413E+08	1.622E+00	1.622E+00	1.622E+00	1.619E+00
5	AFTER 19.5 YEARS	1.191E+00	2.390E+08	2.390E+08	2.386E+08	2.121E+08	1.623E+00	1.623E+00	1.623E+00	1.619E+00
6	AFTER 24.5 YEARS	1.231E+00	1.525E+08	1.525E+08	1.523E+08	1.413E+08	1.622E+00	1.622E+00	1.622E+00	1.619E+00

(26) 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

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REV0 (7/79) DATE= 2/17/81
METSET=CASPER WYOMING PAGE NO. 7

TIME STEP NUMBER 1, AFTER 2.25 YEARS DURATION IN YRS IS... 2.3

(27) 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	6.879E-04	4.363E-04	4.230E-04	4.220E-04	2.492E+01	2.133E+01	6.131E+00	2.049E+00	1.304E-06	6.070E-05
2.5	2.759E-04	1.396E-04	1.324E-04	1.321E-04	8.610E+00	8.077E+00	3.322E+00	1.558E+00	1.686E-06	3.097E-05
3.5	1.574E-04	7.287E-05	6.841E-05	6.825E-05	4.163E+00	4.058E+00	2.135E+00	1.247E+00	2.145E-06	1.965E-05
4.5	1.033E-04	4.721E-05	4.425E-05	4.415E-05	2.974E+00	2.935E+00	1.797E+00	1.191E+00	2.886E-06	1.658E-05
7.5	4.343E-05	1.966E-05	1.840E-05	1.836E-05	1.411E+00	1.407E+00	1.076E+00	8.406E-01	4.102E-06	1.004E-05
15.0	1.329E-05	6.113E-06	5.733E-06	5.720E-06	5.730E-01	5.733E-01	5.233E-01	4.676E-01	5.203E-06	4.988E-06
25.0	5.497E-06	2.591E-06	2.437E-06	2.432E-06	3.028E-01	3.030E-01	2.947E-01	2.825E-01	5.535E-06	2.860E-06
35.0	3.039E-06	1.453E-06	1.369E-06	1.366E-06	2.003E-01	2.004E-01	1.987E-01	1.952E-01	5.599E-06	1.942E-06
45.0	1.932E-06	9.331E-07	8.803E-07	8.783E-07	1.472E-01	1.473E-01	1.471E-01	1.460E-01	5.583E-06	1.442E-06
55.0	1.335E-06	6.509E-07	6.147E-07	6.133E-07	1.153E-01	1.153E-01	1.156E-01	1.153E-01	5.543E-06	1.135E-06
65.0	9.749E-07	4.798E-07	4.536E-07	4.526E-07	9.384E-02	9.390E-02	9.422E-02	9.424E-02	5.485E-06	9.259E-07
75.0	7.497E-07	3.730E-07	3.531E-07	3.523E-07	7.887E-02	7.892E-02	7.925E-02	7.938E-02	5.431E-06	7.792E-07

(28)

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	5.113E+02	4.587E+02	4.557E+02	4.557E+02	4.557E+02	4.726E+02	4.726E+02	4.726E+02	2.642E-01
2.5	1.684E+02	1.199E+02	1.173E+02	1.173E+02	1.173E+02	1.237E+02	1.237E+02	1.237E+02	3.415E-01
3.5	9.126E+01	5.737E+01	5.555E+01	5.555E+01	5.555E+01	5.876E+01	5.876E+01	5.876E+01	4.345E-01
4.5	5.817E+01	3.754E+01	3.643E+01	3.643E+01	3.643E+01	3.875E+01	3.875E+01	3.875E+01	5.847E-01
7.5	2.334E+01	1.543E+01	1.500E+01	1.500E+01	1.500E+01	1.612E+01	1.612E+01	1.612E+01	8.311E-01
15.0	6.815E+00	4.481E+00	4.354E+00	4.354E+00	4.354E+00	4.808E+00	4.808E+00	4.808E+00	1.054E+00
25.0	2.750E+00	1.775E+00	1.723E+00	1.723E+00	1.723E+00	1.963E+00	1.963E+00	1.963E+00	1.121E+00
35.0	1.494E+00	9.459E-01	9.164E-01	9.164E-01	9.164E-01	1.075E+00	1.075E+00	1.075E+00	1.134E+00
45.0	9.359E-01	5.826E-01	5.635E-01	5.635E-01	5.635E-01	6.802E-01	6.802E-01	6.802E-01	1.131E+00
55.0	6.388E-01	3.922E-01	3.789E-01	3.789E-01	3.789E-01	4.703E-01	4.703E-01	4.703E-01	1.123E+00
65.0	4.615E-01	2.802E-01	2.705E-01	2.705E-01	2.705E-01	3.448E-01	3.448E-01	3.448E-01	1.111E+00
75.0	3.514E-01	2.121E-01	2.046E-01	2.046E-01	2.046E-01	2.671E-01	2.671E-01	2.671E-01	1.100E+00

(29)

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	TH-230	RA-226	PB-210
1.5	1.186E-05	1.064E-05	1.057E-05	1.055E-05
2.5	3.905E-06	2.781E-06	2.721E-06	2.720E-06
3.5	2.117E-06	1.331E-06	1.289E-06	1.293E-06
4.5	1.349E-06	8.707E-07	8.453E-07	8.520E-07
7.5	5.413E-07	3.579E-07	3.481E-07	3.596E-07
15.0	1.581E-07	1.039E-07	1.010E-07	1.164E-07
25.0	6.379E-08	4.118E-08	3.998E-08	5.649E-08
35.0	3.465E-08	2.194E-08	2.127E-08	3.801E-08
45.0	2.171E-08	1.351E-08	1.308E-08	2.980E-08
55.0	1.482E-08	9.097E-09	8.793E-09	2.540E-08
65.0	1.078E-08	6.499E-09	6.276E-09	2.272E-08
75.0	8.151E-09	4.920E-09	4.748E-09	2.103E-08

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL   CODE=MILDOS,REVO (7/79)   DATE= 2/17/81
METSET=CASPER WYOMING   PAGE NO. 12

TIME STEP NUMBER 1, AFTER 2.25 YEARS   DURATION IN YRS IS... 2.3

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

(30)

PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	2.072E-02	6.070E-01	8.332E-01	7.452E-02	2.821E-01	9.539E+00
GROUND	1.139E-02	1.139E-02	1.139E-02	1.139E-02	1.139E-02	1.139E-02
CLOUD	1.634E-01	1.634E-01	1.634E-01	1.634E-01	1.634E-01	1.634E-01
VEG.ING.	3.690E-01	4.503E+00	3.690E-01	4.514E-01	1.407E+00	3.690E-01
MEAT ING	4.023E-02	5.135E-01	4.023E-02	6.310E-02	1.909E-01	4.023E-02
MILK ING	2.894E-02	2.973E-01	2.894E-02	8.599E-03	2.973E-02	2.894E-02
RNPLUS50	0.	0.	0.	0.	0.	0.
TOTALS	6.336E-01	6.096E+00	1.446E+00	7.724E-01	2.084E+00	1.015E+01

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

(31)

PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	0.	0.	0.	0.	0.	0.
GROUND	0.	0.	0.	0.	0.	0.
CLOUD	0.	0.	0.	0.	0.	0.
VEG.ING.	0.	0.	0.	0.	0.	0.
MEAT ING	1.190E-01	1.518E+00	1.190E-01	1.866E-01	5.645E-01	1.190E-01
MILK ING	0.	0.	0.	0.	0.	0.
RNPLUS50	2.157E+01	2.934E+02	4.904E+00	2.157E+01	2.157E+01	1.411E+02
TOTALS	2.169E+01	2.949E+02	5.023E+00	2.176E+01	2.213E+01	1.412E+02

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

(32)

PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	2.072E-02	6.070E-01	8.332E-01	7.452E-02	2.821E-01	9.539E+00
GROUND	1.139E-02	1.139E-02	1.139E-02	1.139E-02	1.139E-02	1.139E-02
CLOUD	1.634E-01	1.634E-01	1.634E-01	1.634E-01	1.634E-01	1.634E-01
MEAT ING	1.592E-01	2.032E+00	1.592E-01	2.497E-01	7.555E-01	1.59E-01
MILK ING	2.894E-02	2.973E-01	2.894E-02	8.599E-03	2.973E-02	2.894E-02
RNPLUS50	2.157E+01	2.934E+02	4.904E+00	2.157E+01	2.157E+01	1.411E+02
TOTALS	2.232E+01	3.010E+02	6.469E+00	2.253E+01	2.422E+01	1.514E+02

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 2/17/81
METSET=CASPER WYOMING PAGE NO. 35
TIME STEP NUMBER 5, AFTER 19.5 YEARS DURATION IN YRS IS... 8.0

(33) INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS (34)

NO.	NAME	PTSZ	AIRBORNE CONCENTRATIONS, PCI/M3 U-238	TH-230	RA-226	PB-210	GROUND CONCENTRATIONS, PCI/M2 U-238	TH-230	RA-226	PB-210
1	FENCE BOUNDARY E	1	1.985E-03	1.034E-04	4.135E-06	4.125E-06	5.916E+03	3.081E+02	1.228E+01	1.228E+01
1	FENCE BOUNDARY E	2	9.048E-04	9.048E-04	9.048E-04	9.026E-04	2.696E+03	2.696E+03	2.686E+03	2.686E+03
1	FENCE BOUNDARY E	3	5.825E-04	4.163E-03	4.353E-03	4.342E-03	1.652E+03	1.041E+04	1.084E+04	1.084E+04
1	FENCE BOUNDARY E	4	4.121E-04	5.857E-03	6.145E-03	6.130E-03	9.562E+03	1.250E+05	1.307E+05	1.307E+05
	CONCENTRATION TOTALS		3.884E-03	1.103E-02	1.141E-02	1.138E-02	1.983E+04	1.384E+05	1.442E+05	1.442E+05
2	FENCE BOUNDARY SSE	1	9.082E-04	4.730E-05	1.892E-06	1.887E-06	2.707E+03	1.410E+02	5.618E+00	5.618E+00
2	FENCE BOUNDARY SSE	2	4.908E-04	4.908E-04	4.907E-04	4.895E-04	1.462E+03	1.462E+03	1.457E+03	1.457E+03
2	FENCE BOUNDARY SSE	3	3.846E-04	2.796E-03	2.923E-03	2.916E-03	1.089E+03	6.983E+03	7.273E+03	7.273E+03
2	FENCE BOUNDARY SSE	4	2.977E-04	5.016E-03	5.265E-03	5.253E-03	6.708E+03	1.059E+05	1.108E+05	1.108E+05
	CONCENTRATION TOTALS		2.081E-03	8.350E-03	8.681E-03	8.660E-03	1.197E+04	1.145E+05	1.196E+05	1.196E+05
3	GRAZING E	1	1.582E-03	8.239E-05	3.296E-06	3.287E-06	4.715E+03	2.455E+02	9.786E+00	9.786E+00
3	GRAZING E	2	7.509E-04	7.509E-04	7.509E-04	7.490E-04	2.237E+03	2.237E+03	2.229E+03	2.229E+03
3	GRAZING E	3	4.278E-04	2.938E-03	3.071E-03	3.064E-03	1.219E+03	7.426E+03	7.732E+03	7.732E+03
3	GRAZING E	4	2.799E-04	3.876E-03	4.066E-03	4.056E-03	6.550E+03	8.354E+04	8.736E+04	8.736E+04
	CONCENTRATION TOTALS		3.041E-03	7.648E-03	7.891E-03	7.872E-03	1.472E+04	9.345E+04	9.733E+04	9.733E+04
4	GRAZING ESE	1	6.813E-04	3.549E-05	1.419E-06	1.416E-06	2.031E+03	1.058E+02	4.215E+00	4.215E+00
4	GRAZING ESE	2	2.903E-04	2.903E-04	2.903E-04	2.896E-04	8.651E+02	8.650E+02	8.619E+02	8.619E+02
4	GRAZING ESE	3	2.279E-04	1.900E-03	1.988E-03	1.983E-03	6.431E+02	4.807E+03	5.012E+03	5.012E+03
4	GRAZING ESE	4	1.705E-04	2.638E-03	2.768E-03	2.762E-03	3.943E+03	5.699E+04	5.963E+04	5.963E+04
	CONCENTRATION TOTALS		1.370E-03	4.863E-03	5.048E-03	5.036E-03	7.482E+03	6.277E+04	6.550E+04	6.550E+04
5	NEAREST RESIDENT @NN	1	4.624E-04	2.408E-05	9.633E-07	9.609E-07	1.378E+03	7.177E+01	2.860E+00	2.860E+00
5	NEAREST RESIDENT @NN	2	2.513E-04	2.513E-04	2.513E-04	2.506E-04	7.487E+02	7.486E+02	7.460E+02	7.460E+02
5	NEAREST RESIDENT @NN	3	1.766E-04	1.960E-04	1.970E-04	1.965E-04	5.826E+02	1.922E+03	1.982E+03	1.982E+03
5	NEAREST RESIDENT @NN	4	7.631E-05	1.127E-04	1.145E-04	1.143E-04	2.638E+03	1.854E+04	1.927E+04	1.927E+04
	CONCENTRATION TOTALS		9.666E-04	5.841E-04	5.638E-04	5.624E-04	5.347E+03	2.128E+04	2.200E+04	2.200E+04
6	NEAREST RES IN PRE.	1	1.052E-03	5.478E-05	2.191E-06	2.186E-06	3.134E+03	1.632E+02	6.506E+00	6.506E+00
6	NEAREST RES IN PRE.	2	6.578E-04	6.578E-04	6.578E-04	6.562E-04	1.960E+03	1.960E+03	1.953E+03	1.953E+03
6	NEAREST RES IN PRE.	3	4.366E-04	1.308E-03	1.354E-03	1.351E-03	1.330E+03	4.590E+03	4.742E+03	4.742E+03
6	NEAREST RES IN PRE.	4	3.565E-04	1.482E-03	1.542E-03	1.538E-03	9.592E+03	4.641E+04	4.815E+04	4.815E+04
	CONCENTRATION TOTALS		2.503E-03	3.503E-03	3.555E-03	3.547E-03	1.602E+04	5.312E+04	5.485E+04	5.485E+04

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 2/17/81
METSET=CASPER WYOMING PAGE NO. 36
TIME STEP NUMBER 5, AFTER 19.5 YEARS DURATION IN YRS IS... 8.0

INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER CONCENTRATIONS (36)

	AIRBORNE CONCENTRATIONS, PCI/M3 (35)								GROUND CONCENTRATIONS, PCI/M2			
NO.	RN-222	PO-218	PB-214	BI-214	PB-210	BI-210	PO-210	(37) WL	PO-218	PB-214	BI-214	PB-210
1	4.641E+02	3.326E+02	7.081E+01	2.178E+01	1.367E-05	1.106E-08	2.703E-13	7.829E-04	2.635E+02	2.635E+02	2.635E+02	2.123E+01
2	8.341E+02	4.539E+02	6.736E+01	1.378E+01	6.810E-06	6.018E-09	1.822E-13	8.605E-04	3.595E+02	3.595E+02	3.595E+02	1.284E+01
3	3.361E+02	2.682E+02	6.961E+01	2.660E+01	2.398E-05	2.694E-08	8.818E-13	7.284E-04	2.125E+02	2.125E+02	2.125E+02	3.192E+01
4	3.959E+02	3.209E+02	8.823E+01	3.234E+01	2.569E-05	2.621E-08	8.187E-13	8.985E-04	2.542E+02	2.542E+02	2.542E+02	3.542E+01
5	4.608E+01	4.288E+01	1.800E+01	8.955E+00	1.242E-05	2.146E-08	1.064E-12	1.688E-04	3.396E+01	3.396E+01	3.396E+01	1.399E+01
6	9.798E+01	8.488E+01	2.754E+01	1.386E+01	2.386E-05	4.960E-08	2.895E-12	2.787E-04	6.723E+01	6.723E+01	6.723E+01	2.739E+01

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 2/17/81
METSET=CASPER WYOMING PAGE NO. 37

(38) TIME STEP NUMBER 5, AFTER 19.5 YEARS DURATION IN YRS IS... 8.0

NUMBER 1 NAME=FENCE BOUNDARY E X= 2.0KM, Y= -.2KM, Z= 8.8M, DIST= 2.0KM, IRTYPE= 0 (39)

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	3.88E-03	3.88E-03	1.10E-02	1.14E-02	7.83E-04	1.14E-02	1.14E-02	1.14E-02
MPC, PCI/M3	5.00E+00	4.00E+00	3.00E-01	2.00E+00	3.33E-02	4.00E+00	2.00E+02	7.00E+00
FRACTION OF MPC	7.77E-04	9.17E-04	3.68E-02	5.70E-03	2.35E-02	2.85E-03	5.69E-05	1.63E-03

SUM OF FRACTIONS EQUALS 7.23E-02 (40)

NUMBER 2 NAME=FENCE BOUNDARY SSE X= 1.1KM, Y= -1.4KM, Z= 2.4M, DIST= 1.8KM, 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	2.08E-03	2.08E-03	8.35E-03	8.68E-03	8.60E-04	8.67E-03	8.66E-03	8.66E-03
MPC, PCI/M3	5.00E+00	4.00E+00	3.00E-01	2.00E+00	3.33E-02	4.00E+00	2.00E+02	7.00E+00
FRACTION OF MPC	4.16E-04	5.20E-04	2.78E-02	4.34E-03	2.58E-02	2.17E-03	4.33E-03	1.24E-03

SUM OF FRACTIONS EQUALS 6.24E-02

FIGURE C.2-1. (Continued)

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EGION=SIERRA MADRE MILL                              CODE=MILDOS,REV0 (7/79)                          DATE= 2/17/81
METSET=CASPER WYOMING                                                                                 PAGE NO.  38
                    (41) 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=1 (42)
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40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANTS	TOTALS	6.67E+00	7.81E+01	3.88E+01	3.99E+00	1.41E+01	5.62E+00
CHILD	TOTALS	1.61E+01	1.85E+02	4.82E+01	1.50E+01	4.83E+01	1.50E+01
TEENAGER	TOTALS	1.19E+01	1.49E+02	4.41E+01	1.13E+01	3.85E+01	1.09E+01
ADULT	TOTALS	1.25E+01	1.60E+02	4.46E+01	1.19E+01	3.74E+01	1.14E+01

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

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	2.45E+01	9.59E+01	5.66E+01	2.18E+01	3.19E+01	2.33E+02
CHILD	TOTALS	3.38E+01	2.03E+02	6.60E+01	3.28E+01	6.61E+01	2.43E+02
TEENAGER	TOTALS	2.97E+01	1.66E+02	6.19E+01	2.91E+01	5.63E+01	2.39E+02
ADULT	TOTALS	3.03E+01	1.77E+02	6.24E+01	2.97E+01	5.52E+01	2.39E+02

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 02/17/81
METSET=CASPER WYOMING PAGE NO. 39
TIME STEP NUMBER 5, AFTER 19.5 YEARS DURATION IN YRS IS... 8.0

NUMBER 4 NAME=GRAZING ESE X= 2.6KM, Y= -.9KM, Z= -1.4M, DIST= 2.7KM, IRTYPE=10

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

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	0.
INFANT	GROUND	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01
INFANT	CLOUD	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07
INFANT	VEG.ING.	0.	0.	0.	0.	0.	0.
INFANT	MEAT ING	0.	0.	0.	0.	0.	0.
INFANT	MILK ING	3.54E+00	3.32E+01	3.54E+00	1.32E+00	3.96E+00	3.54E+00
INFANT	TOTALS	4.41E+00	5.06E+01	2.22E+01	2.58E+00	8.91E+00	3.77E+00

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	0.
CHILD	GROUND	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01
CHILD	CLOUD	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07
CHILD	VEG.ING.	6.15E+00	6.88E+01	6.15E+00	7.01E+00	2.17E+01	6.15E+00
CHILD	MEAT ING	4.78E-01	5.66E+00	4.78E-01	7.45E-01	2.28E+00	4.78E-01
CHILD	MILK ING	3.23E+00	3.05E+01	3.23E+00	9.52E-01	3.05E+00	3.23E+00
CHILD	TOTALS	1.07E+01	1.22E+02	2.85E+01	9.97E+00	3.20E+01	1.01E+01

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGER	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	0.
TEENAGER	GROUND	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01
TEENAGER	CLOUD	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07
TEENAGER	VEG.ING.	4.82E+00	5.67E+01	4.82E+00	5.19E+00	1.70E+01	4.82E+00
TEENAGER	MEAT ING	3.58E-01	4.41E+00	3.58E-01	5.39E-01	1.74E+00	3.58E-01
TEENAGER	MILK ING	1.90E+00	1.95E+01	1.90E+00	5.01E-01	1.70E+00	1.90E+00
TEENAGER	TOTALS	7.95E+00	9.80E+01	2.58E+01	7.49E+00	2.54E+01	7.31E+00

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
ADULT	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	0.
ADULT	GROUND	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01
ADULT	CLOUD	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07	4.17E-07
ADULT	VEG.ING.	5.97E+00	7.14E+01	5.97E+00	5.66E+00	1.68E+01	5.97E+00
ADULT	MEAT ING	5.57E-01	6.98E+00	5.57E-01	7.43E-01	2.18E+00	5.57E-01
ADULT	MILK ING	9.18E-01	9.58E+00	9.18E-01	2.08E-01	6.40E-01	9.18E-01
ADULT	TOTALS	8.31E+00	1.05E+02	2.61E+01	7.88E+00	2.46E+01	7.67E+00

FIGURE C.2-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 02/17/81
METSET=CASPER WYOMING PAGE NO. 40
TIME STEP NUMBER 5, AFTER 19.5 YEARS DURATION IN YRS IS... 8.0

NUMBER 4 NAME=GRAZING ESE X= 2.6KM, Y= -.9KM, Z= -1.4M, DIST= 2.7KM, IRTYPE=10

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

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	2.47E+02
INFANT	GROUND	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+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.	0.	0.	0.	0.	0.
INFANT	MEAT ING	0.	0.	0.	0.	0.	0.
INFANT	MILK ING	3.54E+00	3.32E+01	3.54E+00	1.32E+00	3.96E+00	3.54E+00
INFANT	TOTALS	1.66E+01	6.28E+01	3.44E+01	1.48E+01	2.11E+01	2.63E+02

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
CHILD	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	2.47E+02
CHILD	GROUND	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01
CHILD	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
CHILD	VEG.ING.	6.15E+00	6.88E+01	6.15E+00	7.02E+00	2.17E+01	6.15E+00
CHILD	MEAT ING	4.78E-01	5.66E+00	4.78E-01	7.46E-01	2.28E+00	4.78E-01
CHILD	MILK ING	3.23E+00	3.05E+01	3.23E+00	9.52E-01	3.06E+00	3.23E+00
CHILD	TOTALS	2.29E+01	1.35E+02	4.07E+01	2.22E+01	4.42E+01	2.70E+02

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
TEENAGER	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	2.47E+02
TEENAGER	GROUND	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01
TEENAGER	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
TEENAGER	VEG.ING.	4.82E+00	5.67E+01	4.82E+00	5.19E+00	1.70E+01	4.82E+00
TEENAGER	MEAT ING	3.58E-01	4.41E+00	3.58E-01	5.39E-01	1.75E+00	3.58E-01
TEENAGER	MILK ING	1.90E+00	1.95E+01	1.90E+00	5.01E-01	1.70E+00	1.90E+00
TEENAGER	TOTALS	2.01E+01	1.10E+02	3.80E+01	1.97E+01	3.76E+01	2.67E+02

AGE	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
ADULT	INHAL.	6.38E-01	1.72E+01	1.85E+01	1.03E+00	4.73E+00	2.47E+02
ADULT	GROUND	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01
ADULT	CLOUD	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
ADULT	VEG.ING.	5.97E+00	7.14E+01	5.97E+00	5.67E+00	1.69E+01	5.97E+00
ADULT	MEAT ING	5.57E-01	6.98E+00	5.57E-01	7.43E-01	2.18E+00	5.57E-01
ADULT	MILK ING	9.18E-01	9.58E+00	9.18E-01	2.08E-01	6.40E-01	9.18E-01
ADULT	TOTALS	2.05E+01	1.18E+02	3.83E+01	2.01E+01	3.68E+01	2.67E+02

Timestep data (TSTEP) and the control array IFTODO are listed with timestep titles (TNAME) as item 15. The distance from the mill center to the midpoint of each distance interval is printed as XRHO (item 16). These distance values are internal to the program.

Page 4

This report gives the population distribution data supplied in data array IPOP. The direction titles (item 17) correspond to downwind directions with north represented as 0.0 degrees. The total population for the region (80 km radius) is calculated and printed at the bottom of this report.

Page 5

This report presents inhalation dose conversion factors (item 18), external dose conversion factors (item 19) and working level concentration factors (item 20). These values are defined internally in block data FRESH.

Page 6

This report lists ingestion dose conversion factors (item 21), environmental concentration factors (item 22) and several timestep dependent variables. The ingestion dose factors and environmental concentration factors are supplied internally in block data FRESH. The timestep dependent data includes input population adjustment array PAJUST (item 23) and several parameters calculated in the main program for use in calculating environmental concentrations (items 24, 25 and 26).

Page 7

This report contains calculated air concentrations, which includes resuspension, (item 27), ground surface concentrations (item 28), and deposition rates (item 29) for the first timestep and for the north (N) direction. This report is printed as the result of setting the parameter JC(3) to 1. A report of this type is printed for each combination of timestep and major compass direction (N, E, S and W) and for the direction with the maximum ^{222}Rn air concentration at a distance of 4.5km (fourth distance interval). The maximum for the first three time steps corresponds to the ENE direction causing pages 8, 14 and 20 to be printed.

Page 12

This report gives annual population dose commitments for the last year of timestep 1 for the population within 80km (item 30), the continental population (item 31) and the total population (item 32). This is a summary table; a detailed table is printed if JC (4) = 1.

Page 35

This report gives particulate radionuclide concentrations at each individual receptor location for each particle size group. A table is given for air concentrations, which includes resuspension, (item 33) and ground concentrations (item 34). A report of this type is printed for each time step with IFTODO(i) = 1.

Page 36

This report gives air and ground concentrations at each individual receptor location for radon and daughters. Airborne concentrations (item 35) are given for the radionuclides radon and all daughters and the ground concentrations (item 36) are only given for long-lived particulate radionuclides. The air concentration expressed in working levels is also printed (item 37). A report of this type is printed for each timestep for which IFTDDO(i) = 1.

Page 37

This report gives results of the MPC check at named individual receptor locations (item 38). A report is written for each receptor for which IRTYPE(i) = 0 (item 39). The sum of the fractional MPC values is also printed (item 40). This value should be less than one to be within MPC criteria.

Page 38

This report gives summary tables annual dose commitments computed according to 40 CFR 190 and the total annual dose commitments for timestep five and receptor location 3 (item 41). A report of this type is printed for each timestep with IFTODO = 1 and each receptor with IRTYPE = 1 (item 42) when JC(7) = 1. Individual dose commitments are reported by age group and exposed organ.

Page 39

This report gives annual dose commitments computed according to 40 CFR 190 for timestep five and receptor location 4. A report of this type is printed for each timestep with IFTODO = 1 and each receptor location with IRTYPE =10 when JC (7) = 1. Individual dose commitments are reported by age group, pathway and exposed organ.

Page 40

This report is similar to page 39 except the doses are total annual dose commitments. This report is printed whenever a report like page 39 is printed.

The sample problem does not include examples of all possible reports. When control parameter JC(2) is set to 1, the 100 year environmental dose commitments are calculated and printed. The report for this option is illustrated in the second sample problem (see Sections C.3 and C.4).

When the control parameter JC(4) is set to one, population dose commitments are reported for each spatial interval on the 80 km circular grid. A report is printed for each time step, exposure pathway and organ of interest. Use of this option can greatly increase the amount of output for a run. This option is illustrated in the second sample problem.

Setting the option JC(5) to 1 causes relative dispersion factors to be printed at each spatial interval and receptor location. One line is printed for each location giving dispersion factors for each particle size group, ^{222}Rn and each ^{222}Rn daughter. The output generated using this option can be quite lengthy and should be avoided. This option is illustrated in the second sample problem.

C.3 SAMPLE PROBLEM TWO INPUT

The second sample problem is similar to the first sample problem except that different options are selected and fewer sources and receptor locations are defined. A listing of the input cards is shown in Figure C.3-1. The following discussion of input for sample problem two only considers parameters that have been changed from sample problem one. Changes to job control parameters are as follows:

- JC = 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, to select the following options:

  JC (1) = 1; use internal dusting rate algorithm for area sources,

  JC (2) = 1; to calculate and print 100-year enviornmental dose commitments,

  JC (3) = 0; to not print concentration data requests,

  JC (4) = 1; to print detailed population dose reports

  JC (5) = 1; to print normalized dispersion factor data,

  JC (6) = 0; to not print dose conversion factor reports (pages 5 and 6 of sample problem one),

  JC (7) = 0; to not print total dose commitment reports requested by parameter IRTYPE,

  JC (8) = 0; don't include the milk pathway for individual receptor locations,

```
$INDATA
IFTODO=4*0,2*1,4*0,
IRTYPE=2*0,1,3*10,
JC=1,1,0,1,1,5*0,
FRADON= 0.86,0.06,0.04,0.04,
IPACT=3*0,1,2,3,14*0,
NSORCE=1,
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,
QAJUST=
 1.0,2*1.5,2*2.0,15*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,  1.0,2*1.502,2*2.004,5*0.0,
 0.3,1.0,8*0.,  2*1.0,4*.007,4*0.0,
 0.0,2*0.3,1.0,6*0.,  0.0,3*1.0,2*.005,4*0.0,
 3*0.0,2*0.3,5*0.0,  3*0.0,2*1.0,0.004,4*0.0,
 280*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,
  2*0.20,.0,0.0,4*2.602E-2,41.64,1301,2.0,0.0,
   1.393,0.975,-10.0,0.143,4*1.0,1281.5,2001,3.0,0.0,
   -1.30,-.844,-10.0,0.270,4*1.0,3636.80,2002,3.0,0.0,
   1.092,-0.975,-10.0,0.827,4*1.0,14863.23,2003,3.0,0.0,
FREQ=
0.000069,0.000240,0.000103,0.000240,0.000171,0.000103,0.000069,0.000411,
0.000137,0.000206,0.000240,0.000240,0.000377,0.000171,0.000206,0.000103,
0.000137,0.000274,0.000206,0.000069,0.000137,0.000206,0.000137,0.000617,
0.000069,0.000206,0.000069,0.000274,0.000548,0.000343,0.000000,0.000206,
64*0.0,0.000554,0.000507,0.000374,0.000421,0.000960,0.000424,0.000665,0.000651,
 0.000977,0.000410,0.000618,0.000445,0.001126,0.000402,0.000208,0.000644,
0.000959,0.001233,0.000685,0.000411,0.001233,0.001165,0.001302,0.001165,
0.002124,0.001028,0.001576,0.001370,0.001370,0.000959,0.000548,0.001096,
0.000685,0.000617,0.000685,0.000411,0.000617,0.000206,0.000548,0.000274,
0.000548,0.000685,0.000822,0.001096,0.001781,0.000685,0.000754,0.000822,
48*0.0,0.000186,0.000133,0.000115,0.000118,0.000366,0.000186,0.000127,0.000037,
0.000282,2*0.000186,0.000292,0.000179,0.000273,0.000320,0.000028,
0.000959,0.001370,0.000959,0.001028,0.001781,0.000959,0.001233,0.000822,
0.001507,0.000959,0.000959,0.001713,0.002398,0.001302,0.000754,0.000617,
0.002535,0.001850,0.001576,0.001713,0.002329,0.001918,0.001233,0.000822,
0.001233,0.001987,0.003699,0.006439,0.004727,0.002261,0.001644,0.001576,
0.000274,0.000137,0.000137,0.000137,0.000343,0.000343,0.000137,0.000000,
0.000343,0.000959,0.002055,0.001713,0.001918,0.000343,0.000411,0.000685,
0.0,0.000069,6*0.0,0.000137,0.000069,2*0.000343,0.000411,0.000206,12*0.0,
0.000069,0.000137,0.000069,3*0.000000,
0.000792,0.001053,0.000854,0.000741,0.000598,0.000592,0.000548,0.000268,
0.000548,0.000336,0.000411,0.000530,0.000679,0.000816,0.000430,0.001009,
0.005412,0.005823,0.004453,0.003220,0.004110,0.003220,0.001918,0.001302,
0.001918,0.001233,0.002055,0.003357,0.003357,0.002398,0.001439,0.004521,
0.011440,0.014249,0.010207,0.008768,0.009248,0.004932,0.003014,0.001370,
0.002124,0.006302,0.014180,0.021304,0.017468,0.005412,0.005206,0.005001,
0.011097,0.014865,0.010275,0.006508,0.010001,0.005480,0.001987,0.000548,
0.003699,0.030826,0.065420,0.051993,0.019318,0.009453,0.005891,0.004042,
0.002809,0.003768,0.001713,0.000617,0.002261,0.000822,0.000411,0.000137,
0.001781,0.026716,0.050075,0.022126,0.009248,0.004042,0.002398,0.001028,
0.001028,0.001028,0.000274,0.000000,0.000137,0.000069,0.000000,0.000000,
0.000411,0.014797,0.022469,0.009727,0.005206,0.001165,0.000411,0.000343,
0.003723,0.001668,0.001431,0.001104,0.001608,0.001124,0.000635,0.000583,
0.001221,0.001124,0.001448,0.002996,0.005746,0.002607,0.002023,0.002606,
0.011098,0.008974,0.006439,0.005480,0.006234,0.003563,0.003083,0.001919,
0.003014,0.003152,0.005275,0.012741,0.020140,0.009865,0.009042,0.009933,
0.003425,0.003014,0.002809,0.002877,0.004042,0.003083,0.001165,0.000480,
0.000548,0.004042,0.010892,0.028223,0.019044,0.004042,0.002466,0.002603,
  144*0.0,
DM=850.0,
FFORI=0.50,FHAYI=0.00,FFORP=0.50,FHAYP=0.50,
FPR= 320.0,1400.0,230.0,
IPOP=
 2*0,1,5,0,15,2*0,4,8,14,400,
```

FIGURE C.3-1. Sample Problem Two Input Listing

```
 2*0,2,3,0,14,0,40,27,10,300,250,
 2*0,1,2,0,1,0,15,14,4,800,97,
 2*0,3,4*0,10,8,1,327,655,
 2*0,2,1,0,3,0,1,3,0,50,422,
 2*0,1,3,3*0,4,2,3*0,
 2*0,1,2*0,1,0,2,4*0,
2*0,2,5*0,1,2*0,25893,
 2*0,4,2,0,1,2*0,10,0,17,37372,
 2*0,3,1,0,1,0,25,4,0,254,0,
 2*0,1,3,0,2,0,8,27,0,322,0,
 2*0,3,2*0,1,0,9,6,0,145,0,
 2*0,2*2,4*0,3,0,89,0,
 2*0,2*1,0,3,0,4,4*0,
 2*0,2,1,3*0,5,3*0,427,
 2*0,3,1,4*0,1,2*0,1000,
PAJUST=1.039,1.059,1.081,1.129,1.189,1.215,4*0.0,
IADD=1,
XRECEP=
 2.040,-0.200,8.8,
 1.08,-1.440,2.4,
   2.56,00.0,3.7,          2.584,-0.890,-1.4,
            -0.448,1.466,12.3,  2.168,2.168,10.2,
NSTEP=6,TSTEP=2.25,2.0,2.25,5.0,8.0,5.0,4*0.0,
TSTART= 1980.0
 $END
SIERRA MADRE MILL            CASPER WYOMING
YELLOWCAKE STACK
FENCE BOUNDARY E
AFTER 2.25 YEARS
AFTER 4.25 YEARS
AFTER 6.5  YEARS
AFTER 11.5 YEARS
AFTER 19.5 YEARS
AFTER 24.5 YEARS
```

FIGURE C. 3-1. (Continued)

JC (9) = 0; to not print particulate and ground concentrations at each individual receptor location.

- One source is specified for this sample problem. This source is identical to the first source for sample problem one. NSORCE is set to 1. Titles for the last 5 sources have been deleted.

- One receptor location is specified for this sample problem corresponding to the first receptor location of sample problem one. IADD is set to 1. Titles for the last 5 locations have been deleted.

Note that the sample problem two input card deck still contains parameters for all six sources and all six receptor locations.

However, only the first set of each is used by the program because NSORCE and IADD have been set to 1.

C.4. SAMPLE PROBLEM TWO OUTPUT

Execution of sample problem two results in eighty-nine pages of output reports. A summary of information given on each page is presented in Table C.4-1. A listing of selected output reports is given in Figure C.4-1. Specific items of interest are indicated by circled numbers on the output reports and are discussed below.

Page 1

This report gives input source information for one source (item 1). This source is the same as the first source of sample problem one and only includes particulate releases. The tails activities (item 2) and particle size data (item 3) are unchanged.

Page 2

Same as sample problem one.

Page 3

This report identifies one receptor location (item 4) and six timesteps. The receptor location is the same as the first receptor location of problem one and the timesteps are the same as those for problem one. One value of IPACT is listed (item 5) because only one source is defined.

Page 4

Same as sample problem one.

Page 5

This report (continued on pages 6, 7 and 8) gives the relative dispersion factors for each particle size, radon and radon daughter calculated at each receptor location. The total number of locations considered is the 192 spatial intervals (12 distance x 16 directions) plus one individual receptor (for a total 193 locations). Only one column (PTSZ 1) has non-zero values for the one source term defined. A report of this type is printed when JC (5) =1.

Page 9

This report gives 100-year enviornmental dose commitments (EDC) for timestep 1, inhalation uptake and whole body as the organ of interest. The table (item 6) gives population dose for each spatial interval. The EDC values are printed because JC (2) was set to 1. The detailed

TABLE C.4-1. Sample Problem Two Output Reports

Page Number	Description of Report
1	Input source description data
2	Input meteorology data
3	Input receptor and timestep data
4	Input population data
5	Dispersion factors for each receptor location
6-8*	Continuation of page 5
9-21	(Results for timestep 1)
9	100-year EDC to wholebody from inhalation
10*	100-year EDC to bone from inhalation
11*	100-year EDC to lung from inhalation
12*	100-year EDC to bronchi from inhalation
13*	100-year EDC to wholebody from external ground exposure
14*	100-year EDC to wholebody from external cloud exposure
15	100-year EDC to wholebody from vegetable ingestion
16*	100-year EDC to bone from vegetable ingestion
17*	100-year EDC to wholebody from meat ingestion
18*	100-year EDC to bone from meat ingestion
19*	100-year EDC to wholebody from milk ingestion
20*	100-year EDC to bone from milk ingestion
21	Summary report of 100-year EDC values for timestep 1
21-34*	Same as pages 9-21 for timestep 2
35-47*	Same as pages 9-21 for timestep 3
48-60*	Same as pages 9-21 for timestep 4
61-73*	Same as pages 9-21 for timestep 5
74*	Results of MPC check for receptor location 1 and timestep 5 (same as page 37 of sample problem 1)
75-87*	Same as pages 9-21 for timestep 6
88	Summary of EDC values integrated over all timesteps
89*	Same as page 74 for timestep 6

report (by pathway and organ) is printed because JC (4) was set to 1. Reports of this type are printed for each pathway and organ listed in Table 4.2-2. These reports are printed on pages 9 through 20. Zero values in these tables result for spatial intervals where no people reside. The table for inhalation dose to bronchi (page 12) is zero because no radon releases were specified for the source term. These 12 pages are repeated for each timestep.

Page 15

Ingestion pathway tables (pages 15-20) contain a footnote (item 7) warning that total production of the area is assumed to be eaten by the regional (80 km) population. No consideration is made for possible export of food for consumption outside the 80 km radius.

Page 21

This report summarizes the information in pages 9-20. This report also presents doses received by the population outside the 80 km radius (item 8). The totals reported on this page (item 9) represent data from pages 9 through 20 and are the sum of regional (item 10) and offisite (item 8) doses.

Reports similar to pages 9-21 are repeated for each timestep. The reports for timestep 6 are all zero because no releases are specified for this timestep. For timesteps 5 and 6 reports giving results of MPC checks are also printed (pages 74 and 89) because for these timesteps IFTODO was set to 1. These reports are similar to page 37 of sample problems one and are not repeated here.

Page 88

This report gives a complete summary of the 100-year EDC values received over all timesteps.

FIGURE C.4-1. Sample Problem Two Output Listing

```
REGION=SIERRA MADRE MILL                              CODE=MILDOS,REVO (7/79)                  DATE= 02/25/81
METSET=CASPER WYOMING                                                                          PAGE NO.    1

NUMBER OF SOURCES= 1 (1)
```

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	.0000	4.14E-02	2.16E-03	8.62E-05	8.62E-05	0.	1101	1	1.70E+01	YELLOWCAKE STACK

INPUT TAILS ACTIVITIES, PCI/G (2)

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

PARTICLE SIZES AND FRACTIONAL DISTRIBUTION (3)

SET	1.0	1.0	5.0	35.0	PDEN
1	1.000	0.000	0.000	0.000	8.900
2	0.000	1.000	0.000	0.000	2.400
3	0.000	0.000	.300	.700	2.400

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.	0.	0.	0.	0.

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.	0.	0.	0.	0.	0.	0.	0.	0.	0.

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 02/25/81
METSET=CASPER WYOMING PAGE NO. 2
JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WH ERE WIND IS FROM FREQWS= .05734, .21073, .28176, .26134, .13153, .05734

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	.0069	.0240	.0103	.0240	.0171	.0103	.0069	.0411	.0137	.0206	.0240	.0240	.0377	.0171	.0206	.0103	.3086
5.5	.0137	.0274	.0206	.0069	.0137	.0206	.0137	.0617	.0069	.0206	.0069	.0274	.0548	.0343	0.0000	.0206	.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	.0206	.0514	.0309	.0309	.0308	.0309	.0206	.1028	.0206	.0412	.0309	.0514	.0925	.0514	.0206	.0309	.6584
STABILITY CLASS 2																	
1.5	.0554	.0507	.0374	.0421	.0960	.0424	.0665	.0651	.0977	.0410	.0618	.0445	.1126	.0402	.0208	.0644	.9386
5.5	.0959	.1233	.0685	.0411	.1233	.1165	.1302	.1165	.2124	.1028	.1576	.1370	.1370	.0959	.0548	.1096	1.8224
10.0	.0685	.0617	.0685	.0411	.0617	.0206	.0548	.0274	.0548	.0685	.0822	.1096	.1781	.0685	.0754	.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	.2198	.2357	.1744	.1243	.2810	.1795	.2515	.2090	.3649	.2123	.3016	.2911	.4277	.2046	.1510	.2562	3.8846
STABILITY CLASS 3																	
1.5	.0186	.0133	.0115	.0118	.0366	.0186	.0127	.0037	.0282	.0186	.0186	.0292	.0179	.0273	.0320	.0028	.3014
5.5	.0959	.1370	.0959	.1028	.1781	.0959	.1233	.0822	.1507	.0959	.0959	.1713	.2398	.1302	.0754	.0617	1.9320
10.0	.2535	.1850	.1576	.1713	.2329	.1918	.1233	.0822	.1233	.1987	.3699	.6439	.4727	.2261	.1644	.1576	3.7542
15.5	.0274	.0137	.0137	.0137	.0343	.0343	.0137	0.0000	.0343	.0959	.2055	.1713	.1918	.0343	.0411	.0685	.9935
21.5	0.0000	.0069	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0137	.0069	.0343	.0343	.0411	.0206	0.0000	0.0000	.1578
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0069	.0137	.0069	0.0000	0.0000	0.0000	.0275
ALL	.3954	.3559	.2787	.2996	.4819	.3406	.2730	.1681	.3502	.4160	.7311	1.0637	.9702	.4385	.3129	.2906	7.1664
STABILITY CLASS 4																	
1.5	.0792	.1053	.0854	.0741	.0598	.0592	.0548	.0268	.0548	.0336	.0411	.0530	.0679	.0816	.0430	.1009	1.0205
5.5	.5412	.5823	.4453	.3220	.4110	.3220	.1918	.1302	.1918	.1233	.2055	.3357	.3357	.2398	.1439	.4521	4.9736
10.0	1.1440	1.4249	1.0207	.8768	.9248	.4932	.3014	.1370	.2124	.6302	1.4180	2.1304	1.7468	.5412	.5206	.5001	14.0225
15.5	1.1097	1.4865	1.0275	.6508	1.0001	.5480	.1987	.0548	.3699	3.0826	6.5420	5.1993	1.9318	.9453	.5891	.4042	25.1403
21.5	.2809	.3768	.1713	.0617	.2261	.0822	.0411	.0137	.1781	2.6716	5.0075	2.2126	.9248	.4042	.2398	.1028	12.9952
28.0	.1028	.1028	.0274	0.0000	.0137	.0069	0.0000	0.0000	.0411	1.4797	2.2469	.9727	.5206	.1165	.0411	.0343	5.7065
ALL	3.2578	4.0786	2.7776	1.9854	2.6355	1.5115	.7878	.3625	1.0481	8.0210	15.4610	10.9037	5.5276	2.3286	1.5775	1.5944	63.8586
STABILITY CLASS 5																	
1.5	.3723	.1668	.1431	.1104	.1608	.1124	.0635	.0583	.1221	.1124	.1448	.2996	.5746	.2607	.2023	.2606	3.1647
5.5	1.1098	.8974	.6439	.5480	.6234	.3563	.3083	.1919	.3014	.3152	.5275	1.2741	2.0140	.9865	.9042	.9933	11.9952
10.0	.3425	.3014	.2809	.2877	.4042	.3083	.1165	.0480	.0548	.4042	1.0892	2.8223	1.9044	.4042	.2466	.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	.9461	1.1884	.7770	.4883	.2982	.4783	.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

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL
METSET=CASPER WYOMING

CODE=MILDOS,REVO (7/79)

DATE= 02/25/81
PAGE NO. 3

(4)

INDIVIDUAL RECEPTOR LOCATION DATA, 1 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	2.04	-.20	8.80	2.05	0							

MISCELLANEOUS INPUTTABLE PARAMETER VALUES

DM	TSTART	FFORI	FHAYI	FFORP	FHAYP	FPR(1)	FPR(2)	FPR(3)	ACTRAT
850.00	1980.00	.50	0.00	.50	.50	320.00	1400.00	230.00	2.50

(5) IPACT EQUALS 0,
JC EQUALS 1, 1, 0, 1, 1, 0, 0, 0, 0, 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 6.5 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,

FIGURE C.4-1. Continued

REGION=SIERRA MADRE MILL
METSET=CASPER WYOMING

CODE=MILDOS,REVO (7/79)

DATE= 02/25/81
PAGE NO. 4

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

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REV0 (7/79) DATE= 02/25/81
METSET=CASPER WYOMING PAGE NO. 5

RELATIVE DISPERSION FACTORS, CHI/Q VALUES, IN PCI/M3 PER PCI/SEC (SEC/M3)

IS	IR	PTSZ 1	PTSZ 2	PTSZ 3	PTSZ 4	RN-222	PO-218	PB-214	BI-214	PB-210	BI-210	PO-210
1	1	1.394E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	7.040E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	3	4.265E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	4	2.880E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	5	1.250E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	6	3.829E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	7	1.560E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	8	8.532E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	9	5.383E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	10	3.694E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	11	2.682E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	12	2.049E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	13	3.515E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	14	1.679E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	15	1.008E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	16	6.832E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	17	3.052E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	18	9.990E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	19	4.318E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	20	2.458E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	21	1.599E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	22	1.126E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	23	8.368E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	24	6.592E-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	25	6.783E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	26	3.214E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	27	1.926E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	28	1.306E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	29	5.873E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	30	1.951E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	31	8.526E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	32	4.876E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	33	3.178E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	34	2.239E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	35	1.662E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	36	1.307E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	37	8.144E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	38	4.030E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	39	2.454E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	40	1.678E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	41	7.624E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	42	2.545E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	43	1.105E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	44	6.239E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	45	3.994E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	46	2.755E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	47	1.999E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	48	1.524E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	49	6.962E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	50	3.657E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	51	2.266E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	52	1.556E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	53	7.013E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	54	2.250E-08	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	55	9.348E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	56	5.099E-09	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL　　　　　CODE=MILDOS,REVO (7/79)　　　　　DATE= 02/25/81
METSET=CASPER WYOMING　　　　　PAGE NO. 9

TIME STEP NUMBER 1, AFTER 2.25 YEARS　　　　　DURATION IN YRS IS... 2.3

EXPOSURE PATHWAY IS INHAL.　　　　　EXPOSED ORGAN IS WH.BODY

DOSES SHOWN BELOW ARE 100-YEAR ENVIRONMENTAL DOSE COMMITMENTS, PERSON-REM/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	0.	0.	2.587E-06	8.736E-06	0.	3.484E-06	0.	0.	1.306E-07	1.793E-07	2.278E-07	4.971E-06
NNE	0.	0.	1.223E-05	1.243E-05	0.	8.484E-06	0.	5.964E-06	2.619E-06	6.833E-07	1.523E-05	9.998E-06
NE	0.	0.	1.169E-05	1.585E-05	0.	1.184E-06	0.	4.437E-06	2.699E-06	5.432E-07	8.064E-05	7.688E-06
ENE	0.	0.	4.466E-05	0.	0.	0.	0.	3.785E-06	1.938E-06	1.672E-07	3.965E-05	6.056E-05
E	0.	0.	2.750E-05	9.442E-06	0.	4.095E-06	0.	3.094E-07	5.774E-07	0.	4.586E-06	2.876E-05
(6) ESE	0.	0.	5.917E-06	1.215E-05	0.	0.	0.	4.867E-07	1.494E-07	0.	0.	0.
SE	0.	0.	4.614E-06	0.	0.	4.421E-07	0.	1.895E-07	0.	0.	0.	0.
SSE	0.	0.	1.108E-05	0.	0.	0.	0.	0.	6.457E-08	0.	0.	5.525E-04
S	0.	0.	2.997E-05	1.024E-05	0.	6.914E-07	0.	0.	8.891E-07	0.	7.060E-07	1.153E-03
SSW	0.	0.	2.024E-05	4.582E-06	0.	6.444E-07	0.	3.613E-06	3.596E-07	0.	1.099E-05	0.
SW	0.	0.	5.018E-06	1.023E-05	0.	9.498E-07	0.	8.449E-07	1.771E-06	0.	1.013E-05	0.
WSW	0.	0.	1.225E-05	0.	0.	3.900E-07	0.	7.876E-07	3.262E-07	0.	3.769E-06	0.
W	0.	0.	1.036E-05	7.034E-06	0.	0.	0.	0.	2.136E-07	0.	3.092E-06	0.
WNW	0.	0.	3.309E-06	2.246E-06	0.	9.348E-07	0.	2.828E-07	0.	0.	0.	0.
NW	0.	0.	4.375E-06	1.478E-06	0.	0.	0.	2.344E-07	0.	0.	0.	4.616E-06
NNW	0.	0.	4.136E-06	9.340E-07	0.	0.	0.	0.	1.912E-08	0.	0.	7.184E-06

TOTAL DOSE COMMITMENT IS 2.359E-03 PERSON-REM/YR

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 02/25/81
METSET=CASPER WYOMING PAGE NO. 15

TIME STEP NUMBER 1, AFTER 2.25 YEARS DURATION IN YRS IS... 2.3

EXPOSURE PATHWAY IS VEG.ING. EXPOSED ORGAN IS WH.BODY

DOSES SHOWN BELOW ARE 100-YEAR ENVIRONMENTAL DOSE COMMITMENTS, PERSON-REM/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	6.961E-06	5.860E-06	4.968E-06	4.314E-06	1.560E-05	1.912E-05	1.298E-05	9.937E-06	8.063E-06	6.764E-06	5.804E-06	5.114E-06
NNE	1.755E-05	1.398E-05	1.174E-05	1.023E-05	3.811E-05	4.987E-05	3.594E-05	2.862E-05	2.395E-05	2.062E-05	1.811E-05	1.646E-05
NE	3.387E-05	2.676E-05	2.244E-05	1.957E-05	7.333E-05	9.741E-05	7.097E-05	5.679E-05	4.760E-05	4.099E-05	3.596E-05	3.262E-05
ENE	4.066E-05	3.355E-05	2.858E-05	2.513E-05	9.519E-05	1.271E-04	9.201E-05	7.266E-05	5.982E-05	5.045E-05	4.326E-05	3.805E-05
E	3.476E-05	3.044E-05	2.640E-05	2.331E-05	8.756E-05	1.124E-04	7.781E-05	5.939E-05	4.752E-05	3.907E-05	3.272E-05	2.805E-05
ESE	1.492E-05	1.313E-05	1.136E-05	9.995E-06	3.705E-05	4.620E-05	3.118E-05	2.336E-05	1.844E-05	1.500E-05	1.247E-05	1.065E-05
SE	1.152E-05	1.020E-05	8.858E-06	7.810E-06	2.908E-05	3.639E-05	2.447E-05	1.819E-05	1.421E-05	1.143E-05	9.391E-06	7.921E-06
SSE	1.375E-05	1.226E-05	1.063E-05	9.349E-06	3.446E-05	4.232E-05	2.795E-05	2.055E-05	1.594E-05	1.276E-05	1.044E-05	8.780E-06
S	1.879E-05	1.660E-05	1.438E-05	1.264E-05	4.652E-05	5.690E-05	3.768E-05	2.795E-05	2.195E-05	1.783E-05	1.481E-05	1.270E-05
SSW	1.831E-05	1.526E-05	1.295E-05	1.131E-05	4.184E-05	5.303E-05	3.648E-05	2.775E-05	2.219E-05	1.830E-05	1.543E-05	1.343E-05
SW	1.346E-05	1.131E-05	9.633E-06	8.416E-06	3.106E-05	3.908E-05	2.674E-05	2.028E-05	1.619E-05	1.334E-05	1.123E-05	9.754E-06
WSW	1.098E-05	9.214E-06	7.840E-06	6.852E-06	2.535E-05	3.210E-05	2.209E-05	1.680E-05	1.342E-05	1.104E-05	9.272E-06	8.017E-06
W	1.405E-05	1.171E-05	9.943E-06	8.683E-06	3.209E-05	4.079E-05	2.833E-05	2.177E-05	1.758E-05	1.461E-05	1.239E-05	1.081E-05
WNW	8.882E-06	7.467E-06	6.353E-06	5.545E-06	2.040E-05	2.564E-05	1.769E-05	1.357E-05	1.096E-05	9.127E-06	7.753E-06	6.767E-06
NW	6.009E-06	4.977E-06	4.200E-06	3.650E-06	1.337E-05	1.691E-05	1.172E-05	9.000E-06	7.260E-06	6.030E-06	5.114E-06	4.448E-06
NNW	3.763E-06	3.133E-06	2.647E-06	2.306E-06	8.483E-06	1.077E-05	7.500E-06	5.801E-06	4.721E-06	3.956E-06	3.382E-06	2.956E-06

TOTAL DOSE COMMITMENT IS 4.391E-03 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN
(7) ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL
FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED
BY THE POPULATION OF THIS REGION. SEE SUMMARY
TABLE FOR THIS INFORMATION.

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL　　　　CODE=MILDOS,REVO (7/79)　　　　DATE= 02/25/81
METSET=CASPER WYOMING　　　　PAGE NO. 21

TIME STEP NUMBER 1, AFTER 2.25 YEARS　　　　DURATION IN YRS IS... 2.3
SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 1--DOSES SHOWN ARE 100-YEAR ENVIRONMENTAL DOSE COMMITMENTS, PERSON-REM/YEAR

(10)

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	2.359E-03	5.040E-02	2.018E-01	1.234E-03	1.274E-02	0.
GROUND	3.005E-03	3.005E-03	3.005E-03	3.005E-03	3.005E-03	3.005E-03
CLOUD	8.500E-09	8.500E-09	8.500E-09	8.500E-09	8.500E-09	8.500E-09
VEG.ING.	4.391E-03	7.191E-02	4.391E-03	5.568E-04	1.522E-02	4.391E-03
MEAT ING	2.979E-04	4.707E-03	2.979E-04	7.781E-05	1.082E-03	2.979E-04
MILK ING	4.255E-04	6.629E-03	4.255E-04	9.837E-06	1.281E-03	4.255E-04
RNPLUS50	0.	0.	0.	0.	0.	0.
TOTALS	1.048E-02	1.366E-01	2.099E-01	4.884E-03	3.333E-02	8.119E-03

(8)

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	0.	0.	0.	0.	0.	0.
GROUND	0.	0.	0.	0.	0.	0.
CLOUD	0.	0.	0.	0.	0.	0.
VEG.ING.	0.	0.	0.	0.	0.	0.
MEAT ING	8.809E-04	1.392E-02	8.809E-04	2.301E-04	3.199E-03	8.809E-04
MILK ING	0.	0.	0.	0.	0.	0.
RNPLUS50	0.	0.	0.	0.	0.	0.
TOTALS	8.809E-04	1.392E-02	8.809E-04	2.301E-04	3.199E-03	8.809E-04

(9)

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	2.359E-03	5.040E-02	2.018E-01	1.234E-03	1.274E-02	0.
GROUND	3.005E-03	3.005E-03	3.005E-03	3.005E-03	3.005E-03	3.005E-03
CLOUD	8.500E-09	8.500E-09	8.500E-09	8.500E-09	8.500E-09	8.500E-09
VEG.ING.	4.391E-03	7.191E-02	4.391E-03	5.568E-04	1.522E-02	4.391E-03
MEAT ING	1.179E-03	1.862E-02	1.179E-03	3.079E-04	4.280E-03	1.179E-03
MILK ING	4.255E-04	6.629E-03	4.255E-04	9.837E-06	1.281E-03	4.255E-04
RNPLUS50	0.	0.	0.	0.	0.	0.
TOTALS	1.136E-02	1.506E-01	2.108E-01	5.114E-03	3.653E-02	9.000E-03

FIGURE C.4-1. (Continued)

REGION=SIERRA MADRE MILL CODE=MILDOS,REVO (7/79) DATE= 02/25/81
METSET=CASPER WYOMING PAGE NO. 88

COMPLETE SUMMARY OF COMPUTED ENVIRONMENTAL DOSE COMMITMENTS, INTEGRATED OVER ALL TIME STEPS

100-YEAR ENVIRONMENTAL DOSE COMMITMENTS RECEIVED BY PEOPLE WITHIN 80 KILOMETERS, PERSON-REM

NO.	T-START	T-END	T-LONG	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
1	1980.00	1982.25	2.25	TOTALS	2.358E-02	3.075E-01	4.723E-01	1.099E-02	7.499E-02	1.827E-02
2	1982.25	1984.25	2.00	TOTALS	3.143E-02	4.099E-01	6.297E-01	1.465E-02	9.998E-02	2.436E-02
3	1984.25	1986.50	2.25	TOTALS	3.536E-02	4.612E-01	7.085E-01	1.648E-02	1.125E-01	2.740E-02
4	1986.50	1991.50	5.00	TOTALS	1.048E-01	1.366E+00	2.099E+00	4.884E-02	3.333E-01	8.119E-02
5	1991.50	1999.50	8.00	TOTALS	1.677E-01	2.186E+00	3.359E+00	7.814E-02	5.332E-01	1.299E-01
6	1999.50	2004.50	5.00	TOTALS	0.	0.	0.	0.	0.	0.
TOTALS OVER ALL 6 TIME STEPS					3.628E-01	4.731E+00	7.268E+00	1.691E-01	1.154E+00	2.811E-01

100-YEAR ENVIRONMENTAL DOSE COMMITMENTS RECEIVED BY PEOPLE BEYOND 80 KILOMETERS, PERSON-REM

NO.	T-START	T-END	T-LONG	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
1	1980.00	1982.25	2.25	TOTALS	1.982E-03	3.131E-02	1.982E-03	5.177E-04	7.197E-03	1.982E-03
2	1982.25	1984.25	2.00	TOTALS	2.643E-03	4.175E-02	2.643E-03	6.903E-04	9.596E-03	2.643E-03
3	1984.25	1986.50	2.25	TOTALS	2.973E-03	4.697E-02	2.973E-03	7.766E-04	1.079E-02	2.973E-03
4	1986.50	1991.50	5.00	TOTALS	8.809E-03	1.392E-01	8.809E-03	2.301E-03	3.199E-02	8.809E-03
5	1991.50	1999.50	8.00	TOTALS	1.409E-02	2.227E-01	1.409E-02	3.681E-03	5.118E-02	1.409E-02
6	1999.50	2004.50	5.00	TOTALS	0.	0.	0.	0.	0.	0.
TOTALS OVER ALL 6 TIME STEPS					3.050E-02	4.819E-01	3.050E-02	7.967E-03	1.107E-01	3.050E-02

GRAND TOTAL 100-YEAR ENVIRONMENTAL DOSE COMMITMENTS RECEIVED OVER ALL POPULATIONS, PERSON-REM

NO.	T-START	T-END	T-LONG	PATHWAY	WH.BODY	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
1	1980.00	1982.25	2.25	TOTALS	2.556E-02	3.388E-01	4.743E-01	1.151E-02	8.218E-02	2.025E-02
2	1982.25	1984.25	2.00	TOTALS	3.408E-02	4.517E-01	6.324E-01	1.534E-02	1.096E-01	2.700E-02
3	1984.25	1986.50	2.25	TOTALS	3.834E-02	5.082E-01	7.114E-01	1.726E-02	1.233E-01	3.037E-02
4	1986.50	1991.50	5.00	TOTALS	1.136E-01	1.506E+00	2.108E+00	5.114E-02	3.653E-01	9.000E-02
5	1991.50	1999.50	8.00	TOTALS	1.817E-01	2.409E+00	3.373E+00	8.182E-02	5.844E-01	1.440E-01
6	1999.50	2004.50	5.00	TOTALS	0.	0.	0.	0.	0.	0.
TOTALS OVER ALL 6 TIME STEPS					3.933E-01	5.213E+00	7.299E+00	1.771E-01	1.265E+00	3.116E-01

APPENDIX D - COMPUTER SPECIFIC INFORMATION

This appendix provides information useful to users of the MILDOS version operable on the CDC 7600 computer at Brookhaven National Laboratory. Section D.1 gives core storage requirements and Section D.2 gives two sample control card decks.

D.1 Storage Requirements

The computer program MILDOS requires 86K decimal words to execute on a CDC 7600 computer. The allocation is 27.2 K words in small core memory (SCM) and 85.5 K words in large core memory (LCM). The LCM space represents the labeled common block BDATA (see Appendix A, Section A.2).

D.2 System Control Requirements

The computer program MILDOS described in this report resides on the CDC 7600 system at Brookhaven National Laboratory. A sample control card deck is shown in Figure D.2-1. This deck will access the master MILDOS file and initiate program execution. The first two cards give accounting information. The "ATTACH" card accesses the master file and assigns a temporary name "FILE". The "SKIPF" command positions the file to the start of the binary execution element. The "COPYP" command copies the executable element to another temporary file "GO". The "RETURN" command terminates access to the master file for the current run. The "GO" command initiates execution of the program on the file GO. The end-of-file card (punched 7/8/9) separates control cards from the input data cards which follow.

The program may be updated and executed using the control cards listed in Figure D.2-2. This deck uses the UPDATE processor to modify the existing program library (file OLDPL) and generate a new FORTRAN deck COMPILE used as input to the FORTRAN compiler FTN. This compiler generates the executable file LGO which is then executed (LGO statement). UPDATE cards follow the first end-of-file card. Preparation of UPDATE cards is decribed in CDC system UPDATE Processor manuals.

```
BCMILD,T300,STMFZ,TPO,P1.
ACCOUNT(NAME,NUMBER)
ATTACH(FILE,MARTINMILDOSREV000,ID=ZZRNRC,MR=1)
SKIPF,FILE,2,17.
COPYP,FILE,GO.
RETURN,FILE.
GO.
@ END-OF-FILE
```

FIGURE D.2-1. Run Control Card Listing

```
BCMIL,T300,STMFZ,TPO,P1.
ACCOUNT(NAME,NUMBER)
ATTACH(OLDPL,MARTINMILDOSREV000,ID=ZZRNRC,MR=1)
UPDATE(F)
REWIND(COMPILE)
FTN(I=COMPLIE,R=0,L=0)
RETURN,FILE.
LGO.
@ END-OF-FILE
  PLACE UPDATE CARDS HERE.
@ END-OF-FILE
  PLACE INPUT DATA CARDS HERE
@ END-OF-FILE
```

FIGURE D.2-2. Update Control Card Listing

APPENDIX E. Verification of Computer Program

The verification of the MILDOS code has been divided into two parts, those calculations concerned with the concentration of radionuclides and those calculations concerned with the dose from the concentrations of radionuclides. Different test cases were performed on each part so that the numerical checks would be independent of each other.

E.1 Calculation of Radionuclide Concentrations

A test case containing two sources of pollutants was used to generate concentration values. The first source was an area source of one square kilometer located one kilometer East and one kilometer North of the mill center. The second source was a stack 100 meters in height located at two kilometers West and two kilometers South of the mill center. Particulate release rates from the area source were calculated by the MILDOS program with particle size distribution 3. The stack released 0.1 Ci/yr of ^{238}U and 500 Ci/yr of ^{222}Rn with particle size distribution 2 and no exit velocity.

Two additional receptors were included along with the 192 grid point receptors. One was located at 15 kilometers East of the mill center and another was located 5 kilometers North of the mill center.

The joint frequency wind data was selected so that only six entries were non-zero. The wind speed category and stability class index values were taken to be equal for the non-zero values (i.e., 1.5 mph windspeed occurred in stability class 1; 5.5 mph windspeed occurred in stability class 2, etc.). Also each combination occurred only once, thus only six wind directions occurred, which were N, NE, E, SE, S, and W. This gives the following non-zero elements in the array FREQ:FREQ(1,1,1), FREQ(3,2,2), FREQ(5,3,3), FREQ(7,4,4), FREQ(9,5,5), and FREQ(13,6,6). With this restricted wind data set the location of those grid points which should receive radionuclides was verified. This was accomplished by using Equation 2.2-14 to define the width of the plume for the stack source and using a virtual point source for the area source as presented in Figure 2.2-1.

The relative dispersion factors in picocuries/m^3 per picocurie/sec were spot checked for numerical accuracy using Equation 2.2-6 thru 2.2-8 describing the Gaussian dispersion of the sources. The conversion from these dispersion factors to air concentrations in picocuries/m^3 and ground surface concentrations in picocuries/m^2 were also spot checked for numerical accuracy.

Table E.1-1 gives the relative dispersion factor of radon from the stack source for various directions and distances from the center of the mill. The hand calculations and program generated values agree to the first significant figure. Differences in the second significant figure can be attributed to numerical round-off errors and approximations used in the computer program.

TABLE E.1-1. Relative Dispersion Factor for Stack Source and Radionuclide ^{222}Rn

Receptor* (direction-distance,km)	Hand Calculation ($pCi\ m^{-3}/pCi\ sec^{-1}$)	Program Value ($pCi\ m^{-3}/pCi\ sec^{-1}$)
N-75	2.6×10^{-9}	2.5×10^{-9}
E-3.5	1.2×10^{-10}	1.2×10^{-10}
E-75	9.5×10^{-10}	9.4×10^{-10}
S-2.5	9.2×10^{-13}	8.4×10^{-13}
S-75	6.4×10^{-9}	6.4×10^{-9}
SSW-4.5	3.6×10^{-7}	3.7×10^{-7}
SW-75	2.3×10^{-9}	2.2×10^{-9}
WSW-4.5	1.3×10^{-7}	1.2×10^{-7}
W-75	1.2×10^{-9}	1.1×10^{-9}

*Direction and distance are taken from the mill center.

The annual average concentrations in the N, E, S, SSW, and W directions for those distances in Table E.1-1 are simply calculated by multiplying the relative dispersion factors by the source strength and also multiplying by the appropriate units conversion factors to obtain the concentrations in pCi m^{-3}. These values in the program outputs have been verified.

E.2 Calculation of Doses

MILDOS is used to calculate doses from most environmental pathways by which uranium mill residues may reach man. Doses from internal and external radiation sources are calculated by organ for particulates and radon gas and its daughters. Internal sources are a consequence of inhalation of contaminated air and ingestion of contaminated foods. Doses calculated include 100-year dose commitments, 50-year dose commitments, and 40 CFR 190* doses. These doses are calculated for the population in an 80 km radius circle around the mill and for specific receptor points chosen by the user. In addition, U.S. population doses 80 km from the mill are calculated.

In order to simplify the hand calculations, all values in the joint frequency array were set to 1.74×10^{-3} and all entries in the population distribution array were set to 1.0. Two separate runs of MILDOS are required in order to check all of the possible dose outputs. One run calculates the concentration factors for computing 100-year environmental population dose commitments and the other run calculates the concentration factors for computing annual dose commitments.

The input for a sample MILDOS run is presented in Table E.2-1.

---

* This term is used to designate calculations which do not include dose from Rn or its daughters.

TABLE E.2-1. Input Data for Sample Problem

```
$INDATA
FREQ=576*1.74E-03,
NSORCE=2, SORCE=0.0,0.0,0.0,3.1416,1.0,1.0,1.0,1.0,1.0,1,1,1.0,
          SORCE=0.0,0.0,0.0,3.1416,1.0,1.0,1.0,1.0,1.0,1,1,2000.,
          PACT=10.0,2*0.0,10.0,2*0.0,10.0,2*0.0,10.0,2*0.0,
IPACT=1,  TSTART=1980.0,
IFT000=1,
FPR=10000.,1000.,1000., IADD=5, IRTYPE=-1,0,1,10,10,
IPOP=192*1.0,
JC=1,0,1,1,1,1,1,1,1,0,
XRECEP=0.0,10.0,0.0,0.0,10.0,0.0,0.0,10.0,0.0,0.0,10.0,0.0,
0.0,10.0,0.0,
QAJUST=1.0,19*0.0,1.0,1.0,19*0.0,1.0,
NSTEP=1,TSTEP=10.0,
FRADON=0.1,0.2,0.3,0.5, PAJUST=1.0$
TEST REGION                   TEST AREA
TEST SOURCE 1
RECEPTOR 1
RECEPTOR 2
RECEPTOR 3
RECEPTOR 4
RECEPTOR 5
AFTER 10 YEARS
```

Using the input from Table E.2-1 and the equations in Sections 2.3 and 2.4 a representative sample of the dose values calculated by MILDOS were verified by hand calculations. All the various pathways had at least one receptor (such as whole body, bone, liver, etc.) dose value hand calculated for the population within 80 km of the mill and beyond 80 km. Since the totals to the receptors of the populations within and beyond 80 km are simply the sum of the various pathways and the total dose received by all populations is the sum of the two distinct populations, these totals were easily verified by summing values in the output tables. For the individual receptors representative dose values were verified for the MPC check, the 40CFR190 annual dose commitments and the total annual dose commitment.

The authors would like to acknowledge the contributions of M. G. Zimmerman in performing the hand calculations for the verification of the dose values.

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T. J. Bander (10)
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L. C. Schwendiman
J. K. Soldat
D. L. Strenge (5)
B. E. Vaughan
E. C. Watson
Technical Information (3)
Publishing Coordination (2)

M. G. Zimmerman
Hanford Engineering Development
Laboratory
P.O. Box 1970
Richland, WA 99352

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16. ABSTRACT (200 words or less)

MILDOS is a Fortran Computer Code which calculates the dose commitments received by individuals and the general population within an 80 kilometer radius of an operating uranium recovery facility. In addition air and ground concentrations are presented for individual locations, as well as for a generalized population grid. Extra-regional population doses resulting from transport of radon and export of agricultural produce are also displayed. The transport of radiological emissions from point and area sources is predicted by using a sector-averaged Gaussian plume dispersion model. Mechanisms such as radioactive decay, plume depletion by deposition, ingrowth of daughter products and resuspension of deposited radionuclides are included in the transport model. Alterations in operation throughout the facility's lifetime can be accounted for in the input stream. The pathways considered are: inhalation; external exposure from ground shine and cloud immersion; and ingestion of vegetables, meat and milk. Dose commitments are calculated primarily on the basis of the recommendations of the International Commission on Radiological Protection (ICRP). Predictive 40 CFR 190 and 10 CFR 20 compliances are also performed. This computer code is designed primarily for uranium milling facilities and should not be used for operations with different radionuclides or processes.

17. KEY WORDS AND DOCUMENT ANALYSIS

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environmental impacts
radioactivity transport
airborne emissions
uranium milling

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