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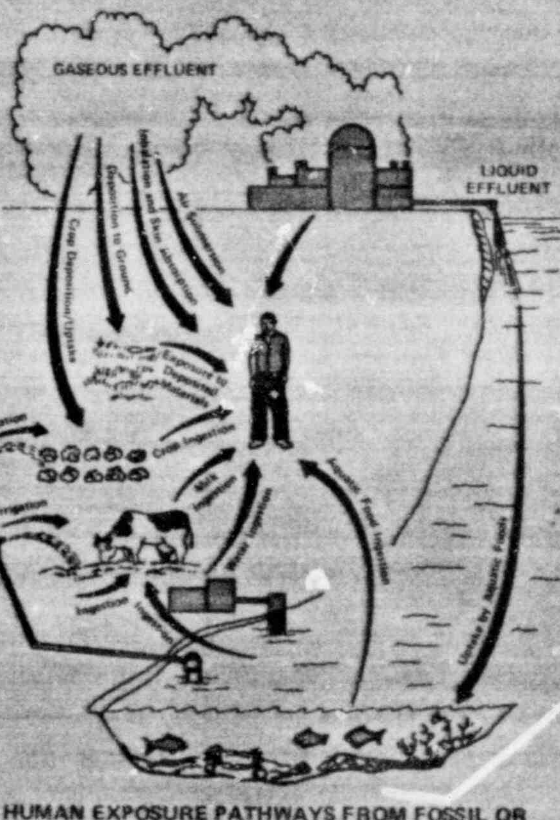
THE URANIUM DISPERSION AND DOSIMETRY (UDAD) CODE

by

Michael H. Momeni, Yuchien Yuan, and A. J. Zielen



HUMAN EXPOSURE PATHWAYS FROM FOSSIL OR NUCLEAR ENERGY PRODUCTION FACILITIES

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THE URANIUM DISPERSION AND DOSIMETRY (UDAD) CODE

Version IX,
A Comprehensive Computer Program to Provide Estimates of Potential Radiation Exposure to Individuals and to the General Population in the Vicinity of a Uranium Processing Facility

by

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and A. J. Zielen

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ABSTRACT

The Uranium Dispersion and Dosimetry (UDAD) Code provides estimates of potential radiation exposure to individuals and to the general population in the vicinity of a uranium processing facility. The UDAD Code incorporates the radiation dose from the airborne release of radioactive materials from uranium milling and processing facilities. It includes dosimetry of inhalation, ingestion and external exposures.

The removal of radioactive particles from a contaminated area such as uranium tailings by wind action is estimated from theoretical and empirical wind-erosion equations according to the wind speed, particle size distribution, and surface roughness and other parameters. Atmospheric concentrations of radioactivity from specific sources are calculated by means of a dispersion-deposition-resuspension model. Source depletion as a result of deposition, fallout of the heavier particulates, and radioactive decay and ingrowth of radon daughters are included in a sector-averaged Gaussian plume dispersion model. The average air concentration at any given receptor location is assumed to be constant during each annual release period, but to increase from year to year because of resuspension. Surface contamination is estimated by including buildup from deposition, ingrowth of radioactive daughters, and removal by radioactive decay, weathering and other environmental processes. Deposition velocity is estimated on the basis of particle size, density, and physical and chemical environmental conditions which influence the behavior of the smaller particles.

Calculation of the inhalation dose and dose rate to an individual is based on the ICRP Task Group Lung Model (TGLM). Estimates of the dose to the bronchial epithelium of the lung from inhalation of radon and its short-lived daughters are calculated based on a dose conversion factor from the BEIR report. External radiation exposure includes radiation from airborne radionuclides and exposure to radiation from contaminated ground. Terrestrial food pathways include vegetation, meat, milk, poultry, and eggs. Internal dosimetry is based on ICRP recommendations, with the option of using either a single or a multiple exponential retention model. In addition, individual dose commitments, population dose commitments and environmental dose commitments are computed.

Even though this code is dedicated to uranium mining and milling, it may be applied to dispersion of any other pollutant.

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ACKNOWLEDGEMENTS

UDAD is a result of the collective efforts of many of our colleagues. This code was used initially during 1976 for the radiological analysis for the environmental statement concerning the Bear Creek uranium mining and milling operations. Since then the code has evolved into the present version IX. In the preparation of this report the authors have been assisted by John Matteson, Dr. G. Das Shashikala, Dr. Norman Frigerio, Barbara Reider, Dr. George Montet, and G. Baldys. We acknowledge the assistance of Drs. P. Gustafson, C. J. Roberts, W. Kisieleski, S. Tyler, J. Ainsworth, H. Lucas, and P. Chee of Argonne National Laboratory, and Dr. B. Cohen of the University of Pennsylvania. The authors acknowledge the recommendations of the U.S. Nuclear Regulatory Commission staff, specifically those from P. Magno,* J. Kendig, D. Martin, H. Peterson, K. Eckerman, F. Congel, E. Branagan, R. Gotchy, E. Shum, and A. Song, and those from Christopher Nelson of the U.S. Environmental Protection Agency. Documentation of UDAD was prepared under NRC FIN #A20738 (B&R #10-19-03-06, new) contract with the U.S. Nuclear Regulatory Commission.

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*Now with USEPA.

<u>Note</u>: At present the USNRC uses a modified earlier version (UDAD-IV) for licensing.

<u>Note</u>: The authors would appreciate comments and suggestions from readers, particularly those who use the code, regarding revisions that would make the code more useful and convenient.

M. Momeni
May 1, 1979

CONTENTS

CONTENTS

FIGURES

TABLES

THE URANIUM DISPERSION AND DOSIMETRY (UDAD) CODE

Michael H. Momeni, Y. C. Yuan and A. J. Zielen

1. INTRODUCTION

The projected increasing demand for uranium fuel for the generation of electricity has focused considerable public and regulatory attention on the potential impacts of processing natural uranium. The radiological impact of uranium extraction is associated primarily with uranium-238 and its radioactive daughters present in the ore (Fig. 1.1). Although uranium-235 is the principal component of uranium fuel production, its abundance in natural uranium is only 0.72 percent. Compared to the ^{238}U decay series, the ^{235}U series contributes negligibly to the quantity of radioactivity dispersed.

Figure 1.2 depicts the principal components of the Uranium Dispersion and Dosimetry (UDAD) Code. Pathways of exposure are through atmospheric dispersion of radioactivity, from the surface of the ground, and via the surface and groundwater. These pathways result in exposure by inhalation of radionuclides in the air, ingestion of contaminated food and water, as well as exposure to gamma radiation from contaminated ground and air.

The computer code, Uranium Dispersion And Dosimetry (UDAD), was developed to provide comprehensive estimates of the potential radiation dose rate and dose to the standard man and the standard population in the vicinity (80 km) of a uranium processing facility such as a uranium mill or mine. The UDAD Code was applied initially in 1976 for the assessment of the radiological impact of Bear Creek (NRC 1977) uranium mining and milling project and was later expanded for generic evaluation of uranium milling in the United States. Since 1976 it has been applied to review of several other uranium mills for licensing and radiological evaluation.

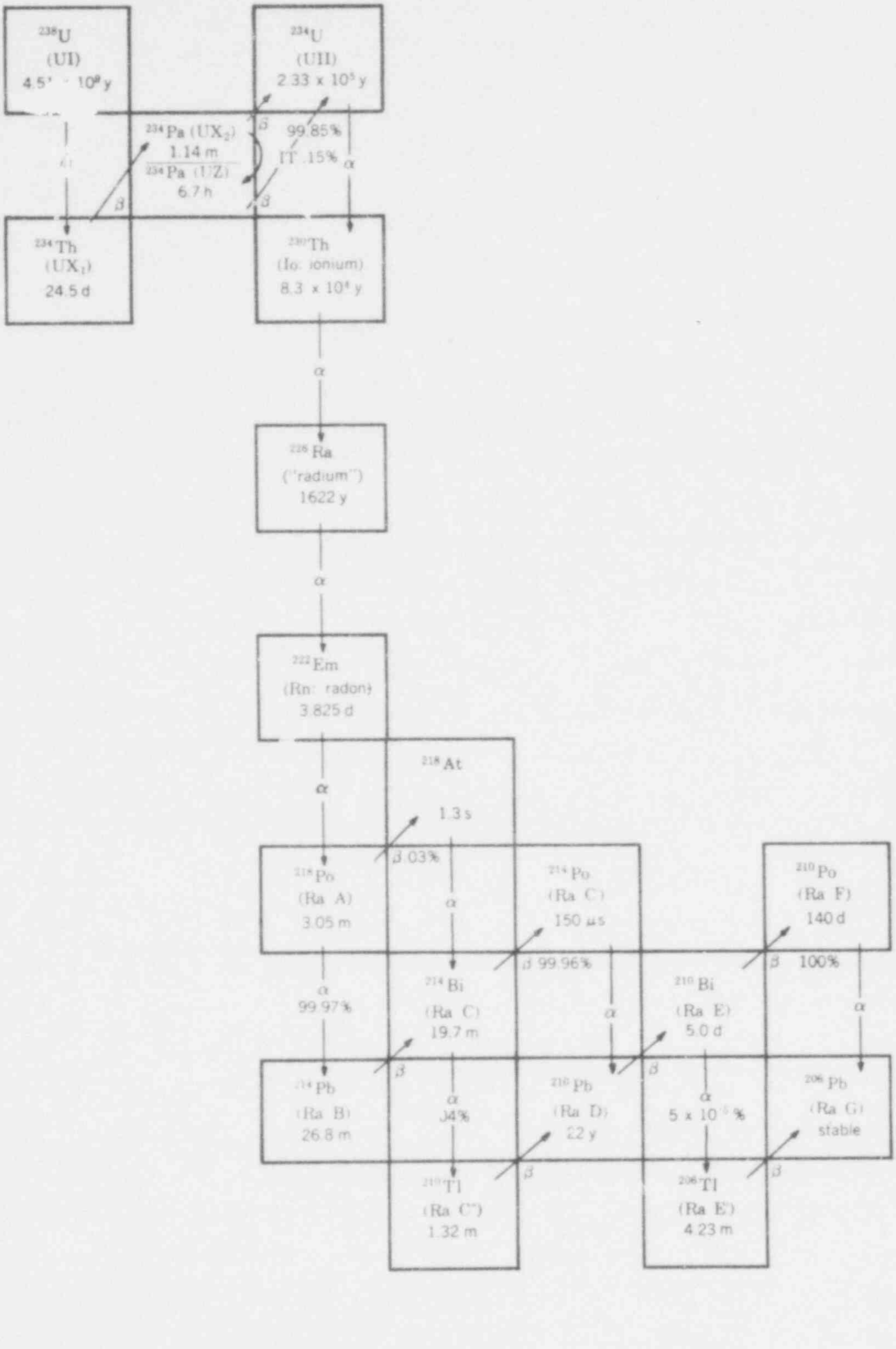

Fig. 1.1. The Uranium-238 Radioactive Decay Series.

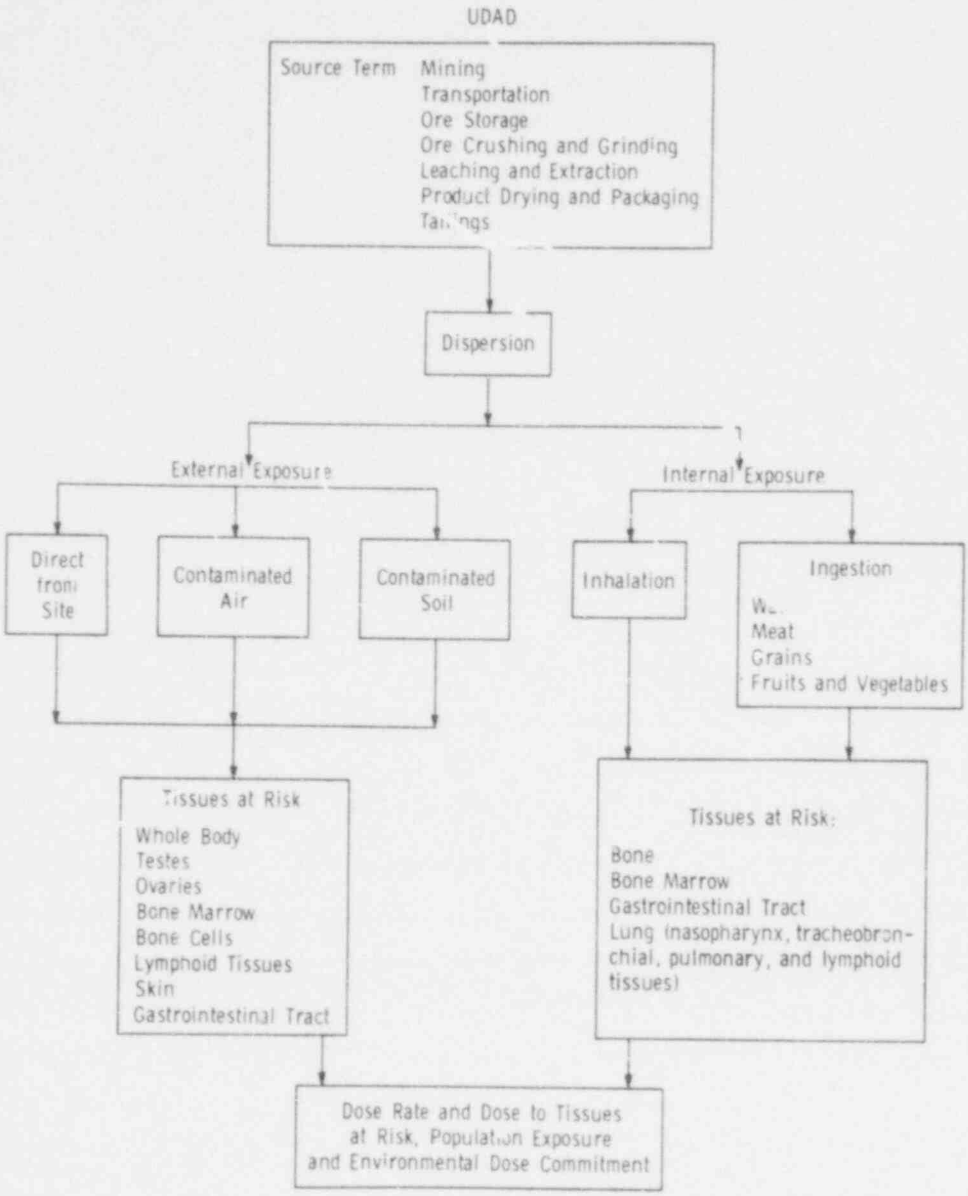

Fig. 1.2. The Uranium Dispersion and Dosimetry Code. External exposure by radiation directly from mines and mills and from the water from such facilities is not included in this code.

To assure consistency in the assessment methodology, a technical review group on radiological assessment for uranium mills was formed by the Nuclear Regulatory Commission (NRC) staff, the Environmental Protection Agency (EPA) and the Argonne National Laboratory (ANL) in early 1978 to discuss the detailed methodology for estimating dose rates, doses, and the environmental dose commitment. A summary of the group's suggestions is given in Appendix F. The current version of the UDAD code (version IX) incorporates the recommendations of this review group.

In addition, parallel field investigations of dispersion pathways carried out by Argonne National Laboratory, Battelle Pacific Northwest Laboratory, and Environmental Protection Agency (Las Vegas) have further resulted in modification, reinforcement, and testing of the present model. Further modifications in the code and choices of the values for the default values are anticipated as these investigations are completed. Even though this code is dedicated to dispersion and dosimetry of uranium mining, milling, and fuel processing, it may be applied to the dispersion of any pollutants.

The model is written in Fortran IV and is designed for installation on an IBM 370/195 (or equivalent) computer. Substantial effort has been taken to reduce the computer core storage and to improve the computational efficiency. Application of this model will require a general purpose computer, certain input data, the instructions contained in this report, and the program itself. Based on individual needs, several options of the model can be eliminated with appropriate control of the input. Default values (Sec. 11) have been incorporated into the model based on NRC-EPA-ANL review group and USNRC staff suggestions (App. F). These default values may be replaced by site-specific data whenever such data are available.

In the following chapters, the contents of the model are described, and their formulation and intended uses are discussed. Chapter 11 describes the structure of the program and gives input instructions. A sample problem to assist in operation of the program is given in Chapter 12.

Reference for Section 1

U.S. Nuclear Regulatory Commission, *Final Environmental Statement, Bear Creek Project*, Office of Nuclear Materials Safety and Safeguards, Docket No. 40-8452, NUREG-0129, June 1977.

2. DISPERSION: STABLE GASEOUS POLLUTANTS

The atmospheric dispersion techniques incorporated in UDAD consist of a Gaussian plume dispersion model modified to include ground deposition, resuspension, and radioactive decay and daughter ingrowth. The model is designed to predict ground-level air concentration and surface contamination resulting from continuous release of uranium-238 and its decay products into the atmosphere from point releases or multiple area sources.

2.1 ATMOSPHERIC DISPERSION OF STABLE GASEOUS POLLUTANTS

Atmospheric dispersion of the radioactive materials occurs by transport and turbulent diffusion process. Methodologies for estimating concentrations of airborne materials transported directly from a point source to a receptor point have been outlined by Pasquill (1974) and Haugen (1975). For a large diffusion time and homogeneous stationary conditions the random transport of a stable pollutant may be stated in the form of the simple Fickian differential equation under the central limit theorem of statistics (Batchelor 1949, Cramer 1958, Barad 1959).

The average plume concentration from an instantaneous single ground-level release, assuming independent diffusion in the three cartesian coordinate directions $\hat{X}$, $\hat{Y}$, $\hat{Z}$, is described by:

$$\chi(x,y,z;i,j) = \frac{Q(i,j)(2\pi)^{-3/2}}{(\sigma_x \sigma_y \sigma_z)} \exp\left\{-\left[\frac{(x-\bar{u}t)^2}{2\sigma_x^2} + \frac{y^2}{2\sigma_y^2} + \frac{z^2}{2\sigma_z^2}\right]\right\}, \qquad (2.1)$$

where: χ is the atmospheric concentration of the stable gaseous pollutant i at location (x,y,z) relative to the source of emission j at coordinate (0,0,0),

Q(i,j) is the point source strength in curies,

σ_x^2, σ_y^2, σ_z^2 are the variances of plume distribution in the directions $\hat{X},\hat{Y},\hat{Z}$, and

$\bar{u}$ is the average wind velocity in the direction of $\hat{X}$ diffused for a time period t reaching position (x,0,0).

The concentration of radioactivity from a ground-level source releasing activity at a continuous rate of Q′(Ci/sec) located at (0,0,0) is given by:

$$\bar{\chi}(x,y,z;i,j) = \frac{Q'(i,j)}{2\pi\sigma_y\sigma_z\bar{u}} \exp\left[-\left(\frac{y^2}{2\sigma_y^2} + \frac{z^2}{2\sigma_z^2}\right)\right] . \tag{2.2}$$

The diffusion along the $\hat{X}$ direction is practically negligible by comparison with the gross transport by the wind (Frenkiel 1953). Variances of plume distribution, σ_y^2 and σ_z^2, are only functions of x. For the sources of release not at the earth's surface but at elevation h(j), the correction for ground reflection results in:

$$\bar{\chi}(x,y,z;i,j) = \frac{Q'(i,j,h)}{2\pi\sigma_y\sigma_z\bar{u}} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \times$$

$$\left\{\exp\left[-\frac{[z-h(j)]^2}{2\sigma_z^2}\right] + \exp\left[-\frac{[z+h(j)]^2}{2\sigma_z^2}\right]\right\} . \tag{2.3}$$

For the receptors located at (x,y,0), i.e., for ground-level concentration, Eq. 2.3 simplifies to:

$$\bar{\chi}(x,y,z{=}0;i,j) = \frac{Q'(i,j(h))}{\pi\sigma_y\sigma_z\bar{u}} \exp\left[-\left(\frac{y^2}{2\sigma_y^2} + \frac{h^2(j)}{2\sigma_z^2}\right)\right] . \tag{2.4}$$

Integration of Eq. 2.4 over the direction $\hat{Y}$ results in a crosswind integrated concentration $\bar{\chi}_c$:

$$\bar{\chi}_c(x,y,z{=}0;i,j) = \frac{Q'(i,j(h))}{\sqrt{\pi/2}\;\sigma_z\bar{u}} \exp\left(-\frac{h^2(j)}{2\sigma_z^2}\right) . \tag{2.5}$$

A practical problem associated with the radiological assessment of a uranium processing plant is that of estimating the average pollutant concentration over a long time period, such as one year. Since the wind velocity and direction change over this long a period of time, the average concentration $\bar{\chi}_c$ must be normalized by the joint windspeed and direction frequency distribution. The concentration profile in the $\hat{Y}$ direction is assumed to be uniformly distributed over a sector. However, in a short time period the concentration will change as a result of changes in wind direction or intensity. The sector average ground-level concentration $<\chi(r,\theta,i,j)>$ in polar coordinates (r,θ) for a sector width $(2\pi r/n)$ from Eq. 2.5 is:

$$<\chi(r,\theta;i,j)> = \frac{nf(\theta)Q'(i,j)}{\pi\sqrt{2\pi}\ \sigma_z r\bar{u}} \exp\left[-\frac{h^2(j)}{2\sigma_z}\right], \qquad (2.6)$$

where: f is the wind frequency,
n is the number of sectors, and
(r,θ) is the polar coordinate of the geometric center of the sector.

The above formulation, Eq. 2.6, implies a uniform crosswind concentration over the sector width, $2\pi r/n$, from the source j and in the vertical direction Gaussian in distribution and centered at the effective release height $h(j)$. In UDAD $n = 16$ is used, which corresponds to $\Delta\theta = 22.5$ degrees.

2.2 ATMOSPHERIC STABILITY

The variance, σ_z^2, in the $\hat{Z}$ direction is a function of atmospheric stability. Six stability categories used in this code are based on the criteria stated by Pasquill (1961). The standard deviation of the vertical distribution of concentration, σ_z, increases with the downwind distance. The values of σ_z adopted in this code are those of Briggs (1974) and Gifford (1976).

The standard deviation of the plume width in the vertical direction, σ_z, may be empirically expressed by:

$$\sigma_z(r,s) = a_s r\left(1 + b_s r\right)^{c_s}, \qquad (2.7)$$

where a, b, and c are the constants for each stability class s. The values for these constants were obtained empirically and are given in Table 2.1. Since Eq. 2.7 predicts unreasonable σ_z values for small distances r, the

Table 2.1. Stability Class Parameters* for Equation 2.7

Conditions	*Pasquill Type Stability Class(s)*	*a*	*b*	*c*
Extremely unstable	A	0.20	0.0	1.0
Moderately unstable	B	0.12	0.0	1.0
Slightly unstable	C	0.08	2×10^{-4}	-0.5
Neutral	D	0.06	1.5×10^{-3}	-0.5
Moderately stable	E	0.03	3×10^{-4}	-1.0
Very stable	F	0.016	3×10^{-4}	-1.0

**Briggs 1974 and Gifford 1976.*

minimum distance alowed for Eq. 2.7 is 100 meters. For r < 100 m the σ_z value for r = 100 m is chosen.

2.3 ATMOSPHERIC DIFFUSION BOUNDARY

Vertical diffusion of pollutants is confined by the existence of stable atmospheric boundary at height ℓ. In UDAD the effects of mixing height are considered only for the unstable and neutral conditions (Table 2.1, classes A and D), as stable conditions limit the plume dispersion in the vertical direction. The standard deviation of the vertical distribution, σ_z, is predicted to increase in the downwind direction to a distance of r_1 at which $\sigma_z(r_1) = 0.47\ \ell$. At distance r_1 the concentration of pollutants at the base of the stable boundary layer will be one-tenth of the concentration at the plume center line.

For distances less than r_1, the concentration of the radioactivity in the vertical direction is assumed to be Gaussian in distribution. For distances greater than r_1 the effect of atmospheric trapping will increase with downwind distance. For distances greater than $2r_1$ the atmospheric concentration of the pollutant will be uniform below the mixing height ℓ. At these distances the concentration is calculated by:

$$\langle\chi(r;i,j)\rangle = \frac{nfQ'(i,j)}{2\pi r \ell \bar{u}} \quad . \tag{2.8}$$

For distances $r_1 < r < 2r_1$, the concentration is calculated by a linear interpolation between the Eqs. 2.6 and 2.8.

2.4 SEASONAL VARIATION OF MIXING BOUNDARY

The mixing layer height ℓ varies greatly between seasons, from day to day, and diurnally. Since accounting for all variations of ℓ is not practical in these computations, an annual average mixing layer $<\bar{\ell}>$ may be calculated from either:

$$\frac{1}{<\ell>} = \frac{1}{2}\left(\frac{1}{\bar{\ell}_1} + \frac{1}{\bar{\ell}_2}\right)$$

or

$$<\bar{\ell}> = w_1 l_1 + w_2 l_2 \ . \qquad (2.9)$$

where $\bar{\ell}_1$ and $\bar{\ell}_2$ are, respectively, the annual average morning and afternoon mixing heights, l_1 and l_2 are maximum and minimum annual average diurnal mixing heights, and w_1 and w_2 are weight factors. The average, $<\bar{\ell}>$, is inputed in the code.

2.5 WIND SPEED AND WIND DIRECTION

Wind speeds are assumed to be piecewise constant and are grouped in six classes. Wind directions are grouped into 16 compass angles of 22.5° circular sectors. The discontinuities at the sector boundaries which are created by the sector average approximation are smoothed using a linear interpolation of concentrations between the receptor sector and the adjacent sectors. For a point $P(r,\theta)$ located between two sectors θ_1 and θ_2 ($\theta_1 \le \theta \le \theta_2$) the concentration is computed by:

$$<\chi(r,\theta;i,j)> = \left(\frac{SW - C_1}{SW}\right) <\chi(r,\theta_1;i,j)> + \left(\frac{SW - C_2}{SW}\right) <\chi(r,\theta_2;i,j)> \ , \qquad (2.10)$$

where SW is the sector width at the receptor distance r, i.e., $SW = 2\pi r/n$, and C_1 and C_2 are the crosswind distances between the receptor and sectors defined by adjacent centerline angles θ_1 and θ_2.

2.6 PLUME RISE

Plume rise above the height of the source is a function of the effluent exit momentum, thermal buoyancy and the effect of molecular weight difference between the effluent and the ambient air. In UDAD the height of rise of an effluent (Δh) (Holland 1953) is given by:

$$\Delta h = \frac{1.5\ Vd}{\bar{u}} \qquad (2.11)$$

where: d is the stack diameter (meters), and

V is the efflux velocity (meters/second).

The thermal buoyancy term in the original formula is omitted from the above equation since for the uranium mill stacks its contribution is generally negligible compared to that of the momentum term.

2.7 AREA SOURCES

Not all sources of emission are point sources, such as uranium product dryer stacks. Other sources are large in extent and cannot be approximated as point sources for near receptors; for example, tailing retention areas and ore pads.

Large, irregular sources of area A are subdivided into smaller areas $a = A/m$. UDAD converts each source area "a" into either squares of width "d" or rectangles. A "virtual point source" is assumed to be located a distance of $d/z \cot(\Delta\theta/2)$ upwind from the center of the source area. $\Delta\theta$ is the sector angle of 22.5 degrees used to subtend the area width. For those receptors which cannot observe the emission from the total of the source area within the 22.5-degree sector, a multiplicative correction factor is generated. This factor is the ratio of that portion of the source area within the 22.5-degree sector located upwind from the receptor to that of the total source area.

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2.8 ANNUAL AVERAGE CONCENTRATION

The annual average concentration $<\chi(r,\theta;i)>$ for pollutant i from all sources j and representative windspeeds and directions is calculated from

$$<\chi(\vec{r};i)> = \sum_j \sum_W \sum_D \sum_S f(W,D,S)\bar{\chi}(\vec{r} - \vec{r}(j),\theta,W,D,S) \quad , \qquad (2.12)$$

where $f(W,D,S)$ is the normalized frequency for wind-sector direction D, the windspeed class W, and stability category S. $\bar{\chi}(\vec{r}-\vec{r}(j),W,D,S)$ is the contribution of source j located at $\vec{r}(j)$ to the concentration at receptor located at (r,θ) given by vector $\vec{r}$.

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3. AIRBORNE TRANSIT RADIOACTIVE DECAY

Radioactive decay and the ingrowth of radionuclides during the transit time that elapses as materials disperse from a source to a receptor are discussed in this section.

3.1 RADIOACTIVE DECAY AND INGROWTH

In the previous chapters the expressions for the atmospheric dispersion did not consider radioactive decay and ingrowth. Radioactive pollutants ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Pb, and ^{210}Po are sufficiently long-lived so that the transit time from the source to the 80-km distance considered in this code does not result in any detectable decay (<0.0001%). Thus, radioactive decay and ingrowth do not affect the concentrations of these radionuclides in the atmosphere. In UDAD, the decay and ingrowth of the short-lived radon (^{222}Rn) and its daughters (^{218}Po, ^{214}Pb, and ^{214}Bi) are calculated. The transit time τ during which radioactive decay occurs may be approximated by the ratio of the distance r traveled to the windspeed u, i.e., $\tau = r/u$. The radon source strength Q' (radon, j) may be corrected for radioactive decay by:

$$Q'(r,\theta;\text{radon},j) = Q_0'(\text{radon},j) \exp\left(-\frac{0.693\,\tau}{T_1}\right) \tag{3.1}$$

where T_1 is the radioactive half-life (3.82 days) of radon-222.

The ingrowth of radon daughters is dependent on the radioactive half-lives (Table 3.1) and transit time. The concentration of radon daughters in the air is given by:

$$\chi_n(r) = \chi_1(r)\left(\prod_{i=2}^{n} \frac{0.693}{T_i}\right)\left\{\sum_{i=1}^{n}\left[\frac{\exp\,(-0.693\; r/T_i u)}{\prod\limits_{\substack{j=1\\ j\neq i}}^{n} 0.693\left(\frac{1}{T_j} - \frac{1}{T_i}\right)}\right]\right\} \tag{3.2}$$

for n = 2,...7

Table 3.1. Radioactive Half-Life of Radon and Its Daughters

Radionuclide	*Half-Life*	*n*	E_n *(MeV)*	$L_n \times 10^6$ *(WL/pCi/m³)*
^{222}Rn	3.82 days	1	5.49	---
↓ α				
^{218}Po	3.05 minutes	2	6.00	1.03
↓ α				
^{214}Pb	26.8 minutes	3	---	5.07
↓ β				
^{214}Bi	19.7 minutes	4	---	3.73
↓ β				
^{214}Po	10^{-6} minutes		7.68	a/
↓ α				
^{210}Pb	22 years	5	---	---
↓ β				
^{210}Bi	5 days	6	---	---
↓ β				
^{210}Po	143 days	7	---	---

[a] *A negligible contribution.*

where i is the ith daughter radionuclide (Table 3.1). For lead-210 and polonium-210 produced from radon in transit, a deposition velocity of V_d = 0.003 m/sec is assumed (see Sec. 4.2).

3.2 WORKING LEVEL

Concentrations of short-lived radon daughters are sometimes expressed in working levels (WL) units. One "working level" is defined as any combination of short-lived radon daughters in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of alpha energy. Working levels in UDAD are calculated from

$$WL(r,\theta) = \sum_{n=2}^{4} L_n \chi_n(r,\theta) \tag{3.3}$$

where χ_n is nth (Table 3.1) radon daughter concentration in air calculated from Eq. (3.2) and L_n is the working level conversion factor of radon daughter n. Based on the definition of working level, L_n is given by:

$$L_n = \frac{3.7 \times 10^{-5} \sum_{j=n}^{4} E_n(\alpha)}{1.3 \times 10^5 \lambda_n} \tag{3.4}$$

or

$$L_n = \frac{2.846 \times 10^{-10}}{\lambda_n} \sum_{j=n}^{4} E_n(\alpha) \quad \frac{WL}{pCi/m^3} \tag{3.5}$$

where $E_n(\alpha)$ is the potential alpha energy for the nth radon daughter (Table 3.1).

4. DISPERSION: PARTICULATE POLLUTANTS

Dispersion of polydisperse pollutants emitted into the atmosphere may be altered by deposition of the airborne material upon the surface of the ground. The mechanisms of deposition include gravitational settling (fallout), precipitation scavenging (washout), surface impaction, electrostatic attraction and adsorption. Deposition and resuspension are dependent on the physical characteristics of the pollutants in addition to the wind strength and surface characteristics and topography. Even though other processes contribute to plume depletion, our attention has been focused on dry deposition.

4.1 PARTICULATE CHARACTERISTICS

By and large, the size, density and shape of particles are primary factors which determine the behavior of the airborne particulates. The size distribution of particles in the atmosphere is not constant and may change with altitude and atmospheric conditions. Although polydisperse particles in atmosphere have a continuous size distribution, in the "standard UDAD" (Version IX) the physical size distributions of particulates are entered using a class of five sizes along with pollutant density. Size distribution is entered individually for each source.

4.2 GROUND DEPOSITION AND SETTLING

Physical processes controlling deposition on the ground are not well understood. The deposition rate $\dot{W}_s$ has been empirically defined by (Chamberlain 1953):

$$\dot{W}_s = \langle \chi(s) \rangle V_d(s) \ . \qquad (4.1)$$

Since deposition rate is a function of size s, integration over all sizes results in:

$$\dot{W} = \int \langle\chi(s)\rangle V_d(s)\, ds \quad (4.2)$$

where $\langle\chi(s)\rangle$ is a time-averaged atmospheric concentration of a pollutant of size s and deposition velocity $V_d(s)$.

Airborne particulates of diameter d_p in the gravitation force F and with friction coefficient f experience a terminal settling or drift velocity V_s given by:

$$V_s = \frac{F}{f} \quad (4.3)$$

The gravitational field force F is given by:

$$F = \frac{\pi d_p^3}{6} (\rho_p - \rho) g , \quad (4.4)$$

where ρ and ρ_p are the gas and particle densities, respectively, and g is acceleration due to gravity. f is given by the Stokes law for friction resistance at low Reynolds numbers (R<1.0):

$$f = 3\pi\mu d_p / C , \quad (4.5)$$

where μ is the dynamic atmospheric viscosity and C is the slip correction factor. Thus:

$$V_s = \left[\frac{\pi d_p^3}{6} (\rho_p - \rho) g\right] \Big/ (3\pi\mu d_p / C) ,$$

$$V_s = \left[\frac{d_p^2 g(\rho_p - \rho) C}{18\mu}\right] ,$$

$$V_s = \frac{\rho_p g d_p^2 C}{18\mu}\left[1 - \frac{\rho}{\rho_p}\right] \simeq \frac{\rho_p g d_p^2 C}{18\mu} . \quad (4.6)$$

560 027

Usually ρ/ρ_p can be neglected in the above equation. The values for the slip correction factor (Davies 1945) are given in Table 4.1. For particles $d_p > 5$ µm, the slip correction factor is about unity. Thus, the settling velocity is calculated from:

$$V_s = 3 \times 10^{-5} \, d_p^2 \rho_p C \; , \qquad (4.7)$$

where V_s, d_p, and ρ_p are in m/sec, µm and g/cm^3, respectively. The default value for C is unity, but other values than the C = 1 can be inputed into Eq. 4.7 through NAMELIST (see Sec. 11).

Table 4.1. Depositional* Properties of Spherical Particles with Density 1 g/cm^3 at 20°C and One Atmospheric Pressure

Particle Diameter, µm	*Slip Correction Factor*	*V_s, cm/sec*
0.05	5.0	
0.1	2.9	8.6×10^{-5}
0.2	1.9	2.3×10^{-4}
0.5	1.3	1.0×10^{-3}
1.0	1.2	3.5×10^{-3}
2.0	1.1	1.3×10^{-2}
5.0	1.0	7.8×10^{-2}
10.0	1.0	3.1×10^{-1}
20.0	1.0	1.2
50.0	1.0	7.6
100.0	1 0	30.3

**Friedlander 1977.*

For fall velocities less than 1 cm/sec the vertical movement of the particle is largely dependent on the vertical turbulence and mean motion of the air, and the contribution from particle sedimentation is small. In the range where the sedimentation rate is significant (V_s = 1 to 100 cm/sec), the vertical distribution of particle concentration in the plume may be expressed by a variable effective plume height based on "tilting plume model":

$$h(r) = [h(0) - h_1(r)] - \frac{rV_s}{\bar{u}} \qquad \text{for } h(r) \geq 0\ , \tag{4.8}$$

where $h_1(r)$ is the ground elevation at downwind distance r.

Deposition velocity is a function of wind velocity in addition to particle size (Sehmel 1971). For particles with settling velocities $V_s \leq 0.01$ m/sec, UDAD used a deposition velocity $V_d = 0.01$ m/sec. For particles with $V_s > 0.01$ m/sec, the deposition velocity is assumed to be equal to the calculated settling velocity. For radon daughters, $V_s = 0.003$ m/sec is assumed.

Depletion of the plume by the process of settling and deposition discussed above results in decreased concentration at receptor locations at increasing distances from the point of release. Chemberlain (1953) modified the source term to correct for deposition to a reduced (depleted) source term to account for the observed decreased concentration. In UDAD the effective source strength Q(r) at a downwind distance r from the source Q(0) at r = 0 was derived from:

$$Q(r) = Q(0) \exp\left[(-V_d/u)F(0,r)\right] \qquad \text{for } r \leq r_\ell\ , \tag{4.9}$$

$$Q(r) = Q(0)\left\{-\left(\frac{V_d}{u}\right)\left[F_1(0,r_\ell) + F_2(r_\ell,r) + \frac{(r - r_\ell)^2}{2r_\ell \ell}\right]\right\}$$
$$\text{for } r_\ell < r \leq 2r_\ell\ , \tag{4.10}$$

$$Q(r) = Q(0)\left\{-\left(\frac{V_d}{u}\right)\left[F_1(0,r_\ell) + F_2(r_\ell,2r_\ell) + \frac{r_\ell}{2\ell} + \frac{r - 2r_\ell}{\ell}\right]\right\}$$
$$\text{for } r > 2r_\ell\ , \tag{4.11}$$

$$\text{where } F_1(r_1,r_2) = \int_{r_1}^{r_2} \left\{ \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right] \Big/ \sigma_z \right\} dr$$

$$\text{and} \quad F_2(r_1,r_2) = \int_{r_1}^{r_2} \left\{ \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right] (2r_\ell - r)/\sigma_z r_\ell \right\} dr \; .$$

These integrals are evaluated numerically in the program based on the fourth Newton-Cotes formula (Hillstrom 1968).

4.3 FUGITIVE DUST AND WIND EROSION

The mechanism of movement of particles from a contaminated area is dependent on wind velocity, soil properties, and the nature of the surface. Wind forces can generate three basic modes of particulate movement: surface creep, saltation, and airborne suspension. Surface creep involves particles ranging in size from 500 to 1000 μm. These particles are rolled along the surface by the push of strong winds and by exchange of momentum after impact with smaller particles in saltation. Saltation consists of individual particles jumping and lurching within a few centimeters of the ground. Particles that saltate are from 100 to 500 μm in size, depending on shape and density, and are quickly brought back to the ground by the gravitational force. Particles smaller than 100 μm may have a fall velocity lower than the upward velocity of the turbulent wind. Such particles are carried through the atmosphere for long periods and to great distances from their original location. The mechanism by which fine particles are lifted off the ground is different from that of saltation. It has been observed that samples of soil composed only of fine dust particles were extremely resistant to erosion by wind (Chepil 1945). In mixtures with coarser grains, however, these particles moved readily. It was concluded that suspension of fine dust in air is mainly the result of movement of grains in saltation.

The wind velocity profile near the surface can be described by the general equations (Bagnold 1941):

560 030

$$U^* = (\tau/\rho)^{\frac{1}{2}} \quad \text{or} \tag{4.12}$$

$$U^* = \frac{U_z}{2.5 \ln (z/z_0)} \tag{4.13}$$

where U^* is the shear velocity

τ is the surface shear stress,

ρ is the density of air,

z is the height above surface,

U_z is the wind velocity at height z, and

z_0 is the surface roughness height.

When the velocity of the wind along the surface exceeds a threshold, particle saltation begins. The initiation of saltation of particles has been investigated by Bagnold (1941), who obtained the following expression for the threshold value of the shear velocity, U_t^*:

$$U_t^* = A\sqrt{\frac{\alpha - \rho}{\rho} gd} \tag{4.14}$$

where α is the density of the grain,

ρ is the density of air,

g is the gravitational constant,

d is the diameter of the grain, and

A is the dimensionless coefficient of 0.1 in value.

The influence of moisture in the sand on the threshold velocity for grain movement has been investigated by Belly (1964). Based on his study, Eq. 4.14 may be modified as follows:

$$U_t^* = A\sqrt{\frac{\alpha - \rho}{\rho} gd}\ (1.8 + 0.6 \log_{10} W)\ , \tag{4.15}$$

where W is the water content expressed in weight by percent. In UDAD, for dry surface the default value for moisture is 0.1%.

The rate of horizontal particle movement by the saltation process in mass per unit width and unit time, q, was found by Bagnold to vary directly as the cube of the surface shear velocity (Bagnold 1941):

$$q = C_h \cdot U^{*3} \, , \tag{4.16}$$

where C_h is a constant dependent on the soil and surface conditions.

A modified relationship, proposed by Lettan and reported by Gillette (1973), for the horizontal flux was reported for various soil types under similar erosion conditions. This modification of Eq. 4.16 is given by:

$$q = CU^{*2} \, (U^* - U^*_t), \text{ for } U^* > U^*_t \, , \tag{4.17}$$

and

$$q = 0 \text{ for } U^* \leq U^*_t \, , \tag{4.18}$$

where the shear velocities U^* and U^*_t have units of cm/sec, the horizontal flux q has units of g/cm-sec, and C is 10^{-6}.

The wind pickup of fine particulate material (diameter $d \leq 20$ μm) from the soil surface has been investigated by Gillette (1973). He found that the vertical flux, expressed in mass per unit area and unit time, Φ^v_{20}, obeyed the empirical formula:

$$\Phi^v_{20} = C_v \left(U^* / U^*_t \right)^\eta \, , \tag{4.19}$$

where the coefficient of proportionality C_v is about 2×10^{-10}, and η is a constant dependent on the fraction of the fine particles in the soil.

Since vertical fluxes are never observed without horizontal fluxes, an assumption was made that for wind-eroding surfaces, the vertical flux is directly proportional to q. Travis (1974) derived the following relationship:

$$\Phi^v_{20} = q \left(\frac{C_v}{U^{*3}_t \; C_h} \right) \left(\frac{U^*}{U^*_t} \right)^{\eta - 3} \, , \tag{4.20}$$

where η is greater than three and increases as the number of suspendable particles per unit mass increases.

A linear curve fitting by Travis (1974) of Gillette's experimental field data for η as a function of the particle mass percentage less than 20 μm in diameter, p, yields the expression:

$$\eta = (p/3) + 3 \ . \tag{4.21}$$

Since the vertical flux must tend to zero as the suspended particle mass percentage p approaches zero, Eq. 4.20 was modified as follows:

$$\Phi_{20}^{v} = q\left(\frac{C_v}{U_t^* C_h}\right)\left[\left(\frac{U^*}{U_t^*}\right)^{(p/3)} - 1\right] . \tag{4.22}$$

The constants C_v and C_h were given by Gillette (1973) as approximately 2×10^{-10} and 10^{-6}, respectively.

For the particulate material having a diameter $d \leq 100$ μm in UDAD the total vertical flux Φ^v for radionuclide i, in activity, is estimated from:

$$\Phi^{v}(i) = \frac{\Phi_{20}^{v} \ I_{20}(i)}{F_{20}} \tag{4.23}$$

where $I_{20}(i)$ is specific activity of radionuclide i in the contaminated area with $d \leq 20$ μm; F_{20} is the activity fraction of suspended particles that are less than 20 μm in diameter. For each wind speed class, the release of radioactive particulates from a contaminated area is calculated for the average wind speed. The annual release of particulates is obtained from the contributions from each wind speed class.

The default values in UDAD for estimation of particulate flux from tailings piles in lieu of actual measurements are:

Surface roughness height z_0 = 1 cm,
Density of the tailings grains α = 2.4 g/cm^3,
Average grain diameter d = 300 μm, and
Percent of tailing mass that has a diameter smaller than 20 μm, p = 3.0

Activity fraction of $d \leq 20\ \mu m$ is $F_{20} = 0.4$.

4.4 RESUSPENSION CONCENTRATION

Particulate material deposited on the ground may re-enter the atmosphere by resuspension processes. The concentrations of resuspended particulates in the air are dependent on many environmental factors, such as the geometrical configuration of the land surface, the meteorological conditions, the characteristics of the deposited particulates, the parameters of the soil and the vegetation cover, the disturbance of contamination surfaces by human activity, and the time since deposition. The time factor is necessary to include the weathering processes which alter the physical and chemical states of the contaminant, attachment to host soil particles, downward migration through the soil profile by physical and chemical processes, and loss from the site.

The resuspension factor has been measured under a variety of conditions. For freshly deposited contaminants, the resuspension factor has been found to vary between 10^{-7}/m and 10^{-3}/m. For aged contaminants the resuspension factor is of the order of 10^{-9}/m.

On a contaminated surface, two processes may be assumed to contribute to the net interchange of material between the ground and the air--resuspension and deposition. The net surface flux from a contaminated surface to the air is:

$$F_z(x,y) = -V_d\chi(x,y) + \Lambda W(x,y) \ , \qquad (4.24)$$

where V_d is the deposition velocity (m/sec),

Λ the resuspension rate (sec^{-1}),

χ the air concentration (activity/m^3), and

W the surface contamination per unit area (activity/m^2).

For the conservative case of no weathering and in a steady-state condition of a uniformly distributed infinite contamination, the net flux is zero. Thus, the resuspension factor:

$$K = \chi/W \ , \tag{4.25}$$

can be expressed in terms of resuspension rate and deposition velocity:

$$K = \Lambda/V_d \ . \tag{4.26}$$

The resuspension rate, Λ, is the fraction resuspended from the surface per second and is highly dependent on the wind speed and the deposition surface. At heights near to the ground because of absence of experimental data, Λ is assumed to be independent of particle size. Thus:

$$\frac{K(d_1)}{K(d_2)} = \frac{V_d(d_2)}{V_d(d_1)} \ . \tag{4.27}$$

For small particles ($d < 10$ μm) with deposition velocity of 0.01 m/sec and assuming a resuspension factor of 10^{-5}/m, the resuspension factor for a 35-μm diameter particle size can be estimated as:

$$K(d{=}35\mu m) = \frac{10^{-5} \times 0.01}{0.0382} = 1.14 \times 10^{-6}/m \tag{4.28}$$

The resuspension factor is time dependent, and in UDAD the concentration from resuspension, $\langle\chi^R(r,\theta,t)\rangle$, is expressed as:

$$\langle\chi^R(r,\theta,t)\rangle = W(r,\theta,t)K(0) \exp(-\omega t) \tag{4.29}$$

where $W(r,\theta,t)$ is the surface contamination activity,
ω is the weathering process coefficient, and
$K(0)$ is the initial resuspension factor.

An estimate of the weathering process half-time is between 35 to 70 days. In UDAD, we have assumed that the default initial value of $K(0) = 10^{-5}$/m will diminish with a weathering half-time 50 days (default value) to $K_f = 10^{-9}$/m (default value) after a period of 1.82 years. This time the resuspension factor would remain constant. Radionuclides considered for resuspension in UDAD are those with long radioactive half-lives:

$$\underset{i=1}{\text{U-238}} \xrightarrow{\lambda_1} \underset{i=2}{\text{U-234}} \xrightarrow{\lambda_2} \underset{i=3}{\text{Th-230}} \xrightarrow{\lambda_3}$$

$$\underset{i=4}{\text{Ra-226}} \xrightarrow{\lambda_4} \underset{i=5}{\text{Pb-210}} \xrightarrow{\lambda_5} \underset{i=6}{\text{Po-210}} \xrightarrow{\lambda_6} \text{Pb-206}$$

The estimated surface contamination includes buildup of daughter products.

Resuspension radionuclide concentration $\langle\chi^R(r,\theta,t;s,i)\rangle$ for radionuclide i of particle size s is proportional to the initial plume concentration $\langle\chi(r,\theta;s,h)\rangle$:

$$\langle\chi^R(r,\theta,t;s,i)\rangle = \sum_{h=1}^{i}\left\{K(0)\langle\chi(r,\theta;s,h)\rangle v_d(s,h)\right.$$

$$\left.\left(\prod_{\nu=h+1}^{i}\lambda_\nu\right)\sum_{\nu=h}^{i}\left[\frac{1-\exp\left[-(\lambda_\nu+\mu+\omega)t\right]}{(\lambda_\nu+\mu+\omega)\prod\limits_{\substack{f=h\\ f\neq\nu}}^{i}(\lambda_f-\lambda_\nu)}\right]\right\} \qquad (4.30)$$

for $t \leq t_a$,

where ν and h are radionuclides in the chain of U-238 series (i=1,2...6) above,

λ_ν is the radioactive decay coefficient,

μ is the effective removal constant from the ground (denudation coefficient).

ω is the weathering process coefficient for the resuspension factor, and

t_a = 1.8 years.

For periods $t_a < t < t_e$, where t_e is the duration of continuous release (for example, a mill operation period), $\beta_\nu = \lambda_\nu + \mu + \omega$, and $\alpha_\nu = \lambda_\nu + \mu$.

$$<\chi^R(r,\theta,t;s,i)> = \sum_{h=1}^{i} k(0)<\chi(r,\theta;s,h)>V_d(s,h)$$

$$\left(\prod_{\nu=h+1}^{i} \lambda_\nu\right) \sum_{\nu=h}^{i} \left[\frac{1 - \exp\,(-\beta_\nu t_a)}{(\beta_\nu) \prod_{\substack{f=h \\ f\neq\nu}}^{i} (\lambda_f - \lambda_\nu)}\right] +$$

$$\sum_{h=1}^{i} \left\{k_f<\chi(r,\theta;s,h)>V_d(s,h)\left(\prod_{\nu=h+1}^{i} \lambda_\nu\right)\sum_{\nu=h}^{i} \left[\frac{\exp\,(-\alpha_\nu t_a) - \exp\,(-\alpha_\nu t)}{\alpha_\nu \prod_{\substack{f=h \\ f\neq\nu}} (\lambda_f - \lambda_\nu)}\right]\right\} \tag{4.31}$$

For $t_e < t \leq t_e + t_a$:

$$<\chi^R(r,\theta,t;s,i)> = \sum_{h=1}^{i} \left\{k_0<\chi(r,\theta;s,h)>V_d(s,h) \left(\prod_{\nu=h+1}^{i} \lambda_\nu\right)\right.$$

$$\left.\sum_{\nu=h}^{i} \left[\frac{\exp\,[-\beta_\nu(t - t_e)] - \exp\,(-\beta_\nu t_a)}{\beta_\nu \prod_{\substack{f=h \\ f\neq\nu}}^{i} (\lambda_f - \lambda_\nu)}\right]\right\} +$$

$$\sum_{h=1}^{i} \left\{k_f<\chi(r,\theta;s,h)>V_d(s,h) \left(\prod_{j=h+1}^{i} \lambda_\nu\right) \sum_{\nu=h}^{i} \left[\frac{\exp\,(-\alpha_\nu t_a) - \exp\,(-\alpha_\nu t)}{\alpha \prod_{\substack{f=h \\ f\neq\nu}}^{i} (\lambda_f - \lambda_\nu)}\right]\right\}. \tag{4.32}$$

For the period $t \geq t_e$ after operation:

$$<\chi^R(r,\theta,t;s,i)> = \sum_{h=1}^{i} \left\{k_f<\chi(r,\theta;s,h)>V_d(s,h)\right.$$

$$\left.\left(\prod_{\nu=h+1}^{i} \lambda_\nu\right) \sum_{\nu=h}^{i} \left[\frac{\exp\,[-\alpha_\nu(t - t_e) - \exp\,(-\alpha_\nu t)]}{\alpha_\nu \prod_{\substack{f=h \\ f\neq\nu}}^{n} (\lambda_h - \lambda_\nu)}\right]\right\}. \tag{4.33}$$

560 057

4.5 CONCENTRATION OF RADIONUCLIDES ON THE GROUND

The calculated concentrations of each radionuclide on the ground includes buildup from continuous deposition and ingrowth of radioactive daughters, radioactive decay and weathering processes.

The time-dependent concentration of each radionuclide on the ground $W(r,\theta,t,i)$ for $t \leq t_e$ is given by:

$$W(r,\theta,t;i) = \sum_{s=1} \sum_{h=1}^{i} \left\{ \langle \chi(r,\theta;s,h) \rangle V_d(s,h) \left(\prod_{\nu=h+1}^{i} \lambda_\nu \right) \sum_{\nu=h}^{i} \left[\frac{1 - \exp(-\alpha_\nu t)}{\alpha_\nu \prod\limits_{\substack{f=h \\ f \neq \nu}}^{i} (\lambda_f - \lambda_\nu)} \right] \right\} , \tag{4.34}$$

where $\alpha_\nu = \lambda_\nu + \mu$.

For $t > t_e$ the concentration is:

$$W(r,\theta,t;i) = \sum_{s=1} \sum_{h=1}^{i} \left\{ \langle \chi(r,\theta;s,h) \rangle V_d(s,h) \left(\prod_{\nu=h+1}^{i} \lambda_\nu \right) \sum_{\nu=h}^{i} \left[\frac{\exp[-\alpha_\nu(t - t_e) - \exp(-\alpha_\nu t)}{\alpha_\nu \prod\limits_{\substack{f=h \\ f \neq \nu}}^{i} (\lambda_f - \lambda_\nu)} \right] \right\} . \tag{4.35}$$

References for Section 4

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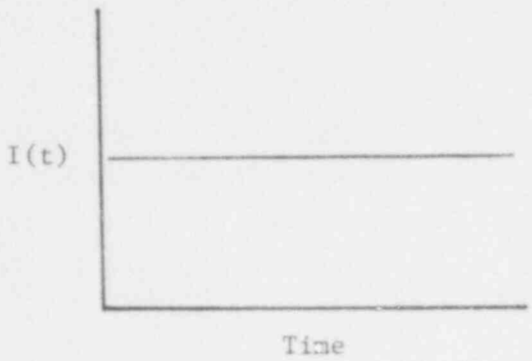
5. DOSIMETRY

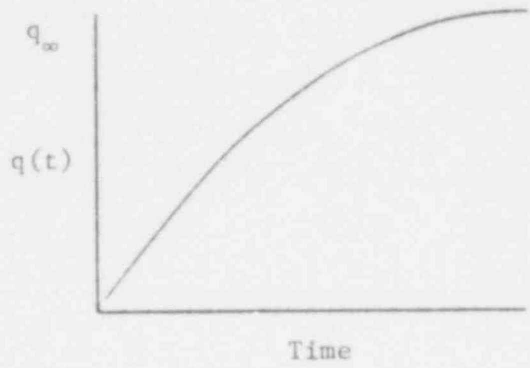
Potential radiological effects of dispersed effluents to an individual are dependent on the dose rate and dose, age at exposure, and sex. Dose rate (rate of absorption of radiation energy) to an organ is dependent on the pathways of exposure to the pollutants. In UDAD, pathways of exposure (Fig. 1.2) are divided broadly into external and internal routes. External exposure is that from sources located external to the exposed individual, such as from gamma radiation from radionuclides deposited on the ground. Internal exposure results from inhalation of airborne radionuclides and ingestion of food contaminated with the pollutants. Internal exposure is dependent on the rate of radionuclide intake by inhalation and ingestion, uptake from the blood pool, buildup of the daughter radionuclides, and retention in the body.

Exposure pathways are broadly divided into internal and external routes (Fig. 1.2). External exposure results from the absorption of gamma and beta radiation emitted directly from tailings, ore and yellowcake product storage, contaminated soil, and airborne radioactivity. Internal exposure results from the inhalation of airborne radionuclides and the ingestion of food contaminated with radioactive substances. The rate of clearance from the lung is dependent on the transportability of the radionuclide, which is a function of particle size, intrinsic solubility in the lung, interstitial fluid of the lung, and interaction of the inhaled particles with local lung environment (see references at the end of this chapter).

The dose rate to any organ in the body from internal pathways is a function of the elapsed time since initiation of exposure and the spatial distribution of the radionuclides. In UDAD-IX the average organ dose rates are estimated because data on the local distributions of radionuclides at the cellular level as a function of time are not available. Dose--time integration of dose rate--is dependent on rate of uptake from the systemic blood pool, the buildup of daughter radionuclides, and the retention of the radionuclides in tissue.

The following diagrams show the pattern of uptake as a result of a constant intake (I).





Chronic uptake at a constant rate of I(t) will result in a body burden, q(t), which will approach an equilibrium value, q_∞, after continuous intake (ICRP-6). However, for some nuclides in the ^{238}U series the duration of intake required to approach equilibrium is longer than human life expectancy. Uptake $[\frac{dq(t)}{dt}/I(t)]$ is age-dependent and is largest during skeletal ossification; i.e., in children and infants, for bone-seeking radionuclides. Uptake and retention for most radionuclides of interest are not known as a function of age. Hoenes and Soldat (1977) have estimated age-specific radiation dose commitments for several radionuclides.

For radiation workers, the maximum period of dose accumulation is about 50 years, but, for the general population, the exposure period can begin *in utero* and extend beyond the 70th year of age. The UDAD code calculates dose rate to reference man as a function of time over a period of 70 years.

Several radionuclides in the uranium-238 series (^{230}Th, ^{226}Ra) have both long physical half-lives and long biological retention periods relative to the human life span. For these radionuclides, the concentration of radioactivity in the tissues will increase with increasing duration of radioactivity intake and will approach an equilibrium level assuming a constant rate of radioactivity intake. An interruption in the rate of intake, for example after decommissioning of the mill, will alter the ratio of uptake to intake values and will subsequently result in a decrease of the tissue concentration by relocation and excretion (Fig. 5.1). Within a 70-year life span the body burden of some radionuclides will not reach the state of radioactive equilibrium with the level of radioactivity intake--for example, thorium in bone. Also, the rate of uptake of the radioactivity in tissue, i.e., fraction of the radioactivity in the systemic blood incorporated in the tissue, may depend on one's physiological age. For example, radium uptake is a function of the rate of skeletal ossification and is higher from birth to maturity (about 20 years of age) than after skeletal maturity. Thus, the tissue concentration of radionuclides with long effective half-life will be dependent on the intake period and age during exposure. Age-dependence of radioactive uptake for humans is not known.

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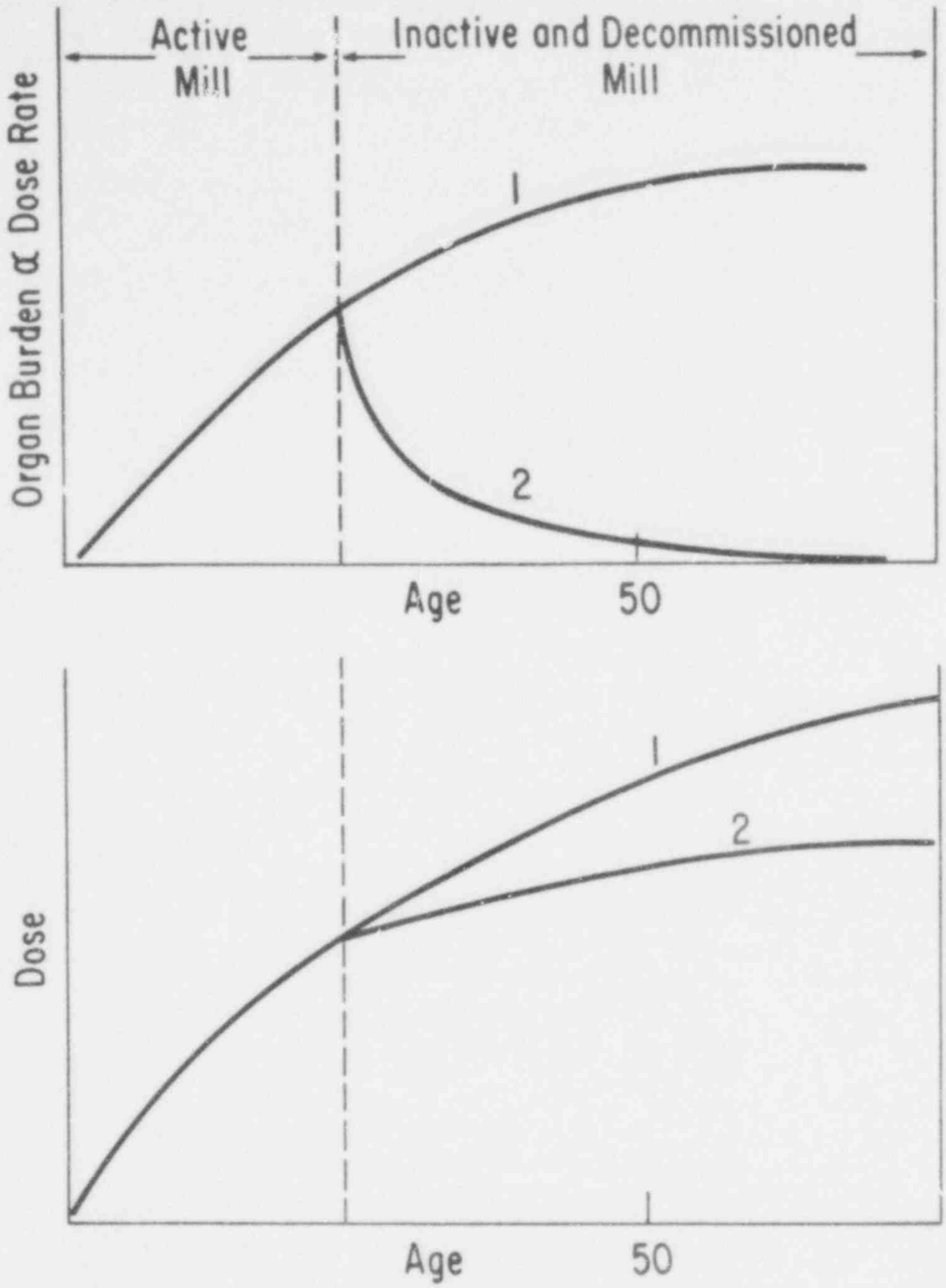

Fig. 5.1. Organ Burden as a Function of Duration (Age) of Continuous Radionuclide Intake. The dose rate at any age is proportional to the organ burden. Curve 1 shows the dose rate and dose as a result of continuous constant radionuclide intake from birth through old age. Because of the limited duration of mill operations, the concentration of radionuclides in the intake will decrease when mill operations cease, which results in decreased dose and dose rates (Curve 2).

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6. EXTERNAL EXPOSURE

Sources of external exposure are the indirect radiation from airborne radionuclides and ground-deposited radioactive substances plus the direct gamma and beta emissions from ore on the ore pads and in the mill circuit and the tailing at the disposal sites. In UDAD, direct exposure is not treated.

6.1 EXTERNAL EXPOSURE FROM AIRBORNE AND GROUND-DEPOSITED ACTIVITIES

The dose rate $\dot{D}_{ec}(r,\theta,t;\Psi)$ to tissue Ψ (Fig. 1.2) from indirect external exposure to airborne radionuclides is given by:

$$\dot{D}_{ec}(r,\theta,t;\Psi) = \sum_i \delta(i) R_c(i,\Psi) \langle\chi(r,\theta,t;i)\rangle \ , \qquad (6.1)$$

where $\delta(i)$ is the shielding factor for the radionuclide i from building structures,

$R_c(i,\psi)$ is the dose rate per unit concentration of i to the organ or tissue Ψ (dose rate factor), and

$\langle\chi(r,\theta,t;i)\rangle$ is the total average airborne concentration of i at time t and location (r,θ).

In UDAD a constant shielding factor for the entire uranium-238 series was assumed even though the shielding factor is dependent on the gamma energy of each member of the series. The dose rate is calculated from:

$$\dot{D}_{ec}(r,\theta,t;\Psi) = \delta \sum_i R_c(i,\Psi) \langle\chi(r,\theta,t;i)\rangle \ . \qquad (6.2)$$

Similarly, the dose rate $\dot{D}_{eg}(r,\theta,t;n)$ from ground-deposited radionuclides i is given by:

$$\dot{D}_{eg}(r,\theta,t;\Psi) = \sum_i \varepsilon(i) R_g(i,\Psi) \langle\Gamma(r,\theta,t;i)\rangle \ , \qquad (6.3)$$

where $\varepsilon(i)$ is the shielding factor for the radionuclide i,

$R_g(i,\Psi)$ is the dose rate per unit surface contamination, and

$<\Gamma(r,\theta,t;i)>$ is the total average surface contamination at location (r,θ) at time t by the radionuclide i. In UDAD, $\varepsilon(i) = \delta(i)$ = a constant, even though the shielding factor $\varepsilon(i)$ is not equivalent to R(i) because of dependence of the shielding factor on exposure geometry of the ground relative to the air.

The dose rate $\dot{D}_{eg}$ is calculated from:

$$\dot{D}_{eg}(r,\theta,t;\Psi) = \delta \sum_i R_g(i,\Psi)<\Gamma(r,\theta,t;i)> \ . \qquad (6.4)$$

Tables 6.1 and 6.2 give, respectively, the dose rate factors for airborne and ground-deposited radionuclides. These dose rate factors include contributions from beta particles and are mainly adopted from Trubey and Kaye (1973) compilations. $R_c(i,\Psi)$ dose rate conversion factors were calculated from a semi-infinite space containing homogeneous radionuclide distribution. These dose rate factors may overestimate gamma dose components, as the atmospheric dispersion is not homogeneous in distribution of concentration in the vertical direction. The $R_g(i,\Psi)$ values were calculated for a height of one meter from an infinite ground plume containing a homogeneous surface contamination of the radionuclide i. Geometric attenuation factors for each organ were estimated using the Monto Carlo calculation method of Poston and Snyder (1974).

Dose, i.e,. the time-integrated dose rate, is calculated from:

$$D(r,\theta;\Psi) = \int_{t_o}^{t_e} \dot{D}(r,\theta,t;\Psi)\ dt + \int_{t_e}^{(t-t_e)} \dot{D}(r,\theta,t;\Psi)\ dt \ . \qquad (6.5)$$

The dose to an individual is calculated for t_e, the duration of the active industrial operation, and for $(t - t_0)$ the period of occupancy at the site, where t_0 is the beginning year of industrial operation. The longest exposure period may correspond to a life-span exposure of 70 years ($\Delta t = t - t_0 = 70$ years). But in general, the exposed population is heterogeneous in age

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Table 6.1. External Dose Rate Factors (mrem/year/pCi/m^3) for Airborne Radionculides [$R_c(i,\Psi)$]

Pollutant(i)	Skin	Whole Body	Ovaries	Testes	Small Intestine	Lung	Red Marrow	Skeleton	Spleen
U238	1.00E-04	1.57E-06	2.92E-07	1.29E-06	2.43E-07	4.77E-07	1.35E-06	1.53E-06	3.22E-07
TH234	6.22E-04	5.24E-05	2.28E-05	4.85E-05	3.25E-05	4.29E-05	8.60E-05	9.33E-05	3.12E-05
PA234	7.63E-03	1.22E-04	9.57E-05	8.06E-05	7.36E-05	8.94E-05	9.83E-05	1.08E-04	8.73E-05
U234	1.36E-04	2.49E-06	6.64E-07	2.09E-06	5.99E-07	1.03E-06	2.64E-06	2.94E-06	7.34E-07
TH230	1.46E-04	3.59E-06	1.52E-06	3.17E-06	1.33E-06	2.10E-06	4.83E-06	5.31E-06	1.67E-06
RA226	1.79E-04	4.90E-05	2.63E-05	6.27E-05	3.44E-05	4.33E-05	6.98E-05	7.52E-05	3.93E-05
RN222	3.46E-06	2.83E-06	1.04E-06	3.14E-06	2.05E-06	2.67E-06	3.30E-06	3.46E-06	2.99E-06
PO218	8.18E-07	6.34E-07	3.88E-07	5.72E-07	4.91E-07	5.93E-07	6.34E-07	6.95E-07	6.34E-07
PB214	4.89E-03	1.67E-03	7.46E-04	1.94E-03	1.17E-03	1.52E-03	2.15E-03	2.29E-03	1.57E-03
BI214	1.95E-02	1.16E-02	9.13E-03	9.29E-03	8.86E-03	1.10E-02	1.17E-02	1.26E-02	1.15E-02
PO214	9.89E-07	7.66E-07	4.70E-07	6.92E-07	5.93E-07	7.17E-07	7.66E-07	8.40E-07	7.66E-07
PB210	3.94E-04	1.43E-05	7.56E-06	1.21E-05	5.31E-06	9.05E-06	2.23E-05	2.45E-05	7.27E-06
BI210	3.56E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6.2. External Dose Rate Factors (mrem/year/pci/m^2) for Ground-Deposited Radionuclides [$R_g(i,\Psi)$]

Pollutant(i)	Skin	Whole Body	Ovaries	Testes	Small Intestine	Lung	Red Marrow	Skeleton	Spleen
U238	2.13E-06	3.17E-07	5.89E-08	2.60E-07	4.90E-08	9.62E-08	2.73E-07	3.08E-07	6.49E-08
TH234	2.10E-06	1.66E-06	7.21E-07	1.53E-06	1.03E-06	1.36E-06	2.72E-06	2.96E-06	9.87E-07
PA234	1.50E-03	1.72E-06	1.17E-06	1.46E-06	1.32E-06	1.61E-06	1.77E-06	1.94E-06	1.58E-06
U234	2.60E-06	4.78E-07	1.27E-07	4.00E-07	1.15E-07	1.97E-07	5.05E-07	5.63E-07	1.40E-07
TH230	2.20E-06	6.12E-07	2.60E-07	5.40E-07	2.27E-07	3.59E-07	8.24E-07	9.06E-07	2.85E-07
RA226	1.16E-06	9.47E-07	5.07E-07	1.21E-06	6.63E-07	8.36E-07	1.35E-06	1.45E-06	7.58E-07
RN222	6.15E-08	5.03E-08	1.84E-08	5.59E-08	3.64E-08	4.76E-08	5.88E-08	6.15E-08	5.32E-08
PO218	1.42E-08	1.10E-08	6.73E-09	9.91E-09	8.50E-09	1.03E-08	1.10E-08	1.20E-08	1.10E-08
PB214	1.42E-04	3.16E-05	1.41E-05	3.66E-05	2.21E-05	2.88E-05	4.06E-05	4.32E-05	2.96E-05
BI214	1.20E-03	1.85E-04	1.47E-04	1.49E-04	1.42E-04	1.76E-04	1.86E-04	2.06E-04	1.85E-04
PO214	1.72E-08	1.33E-08	8.17E-09	1.20E-08	1.03E-08	1.25E-08	1.33E-08	1.46E-08	1.33E-08
PB210	6.65E-06	2.27E-06	1.20E-06	1.92E-06	8.45E-07	1.44E-06	3.56E-06	3.90E-06	1.16E-06
BI210	5.02E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

distribution and migratory. Thus, if D(r,θ,Δt=70;Ψ) is used for estimation of radiological effects, the results will be overly conservative.

References for Section 6

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7. INGESTION

Ingestion of contaminated food is a pathway of exposure to the gastrointestinal tract and to other tissues by absorption into the systemic blood pool. Figure 7.1 schematically depicts the significant food pathways from direct contamination of food such as vegetables, water and grains and from indirect contamination of food such as meat. In both cases, the food is contaminated by ground deposition of airborne radionuclides and from the use of contaminated water. The effects of ground deposition are cumulative because of the low rate of depletion from the soil partially due to the small amount of precipitation (rain and snow). Because of the limited available data on the variables affecting radionuclide concentrations in food, only four major ingestion pathways are included in the present version of UDAD. These specific pathways are via vegetation, meat, milk and poultry and eggs. For each region of food production, a centroid representing the average regional productivity is considered. The potential for food contamination by the effluents through ground deposition and water is computed. The regional food yield and the concentrations of the radionuclides for each centroid are utilized in the computation of the ingestion dose rate and dose and population exposure. Since water transport is not incorporated in this version of UDAD, dosimetry of water pathways is treated by introduction of nuclide concentrations (inputed) into the ingestion pathway.*

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*In earlier versions of UDAD, 21 food items were considered. But in this revision, the number was reduced because some items produced only relatively minor contributions to the ingestion pathway (e.g., fish--present mining and milling operations are not near large bodies of water) or could be combined (e.g., pork, mutton and beef). Vegetables were also grouped as above-ground (e.g., lettuce) and below-ground (e.g., potatoes) contributors. Like items were combined upon the recommendation of the USNRC.

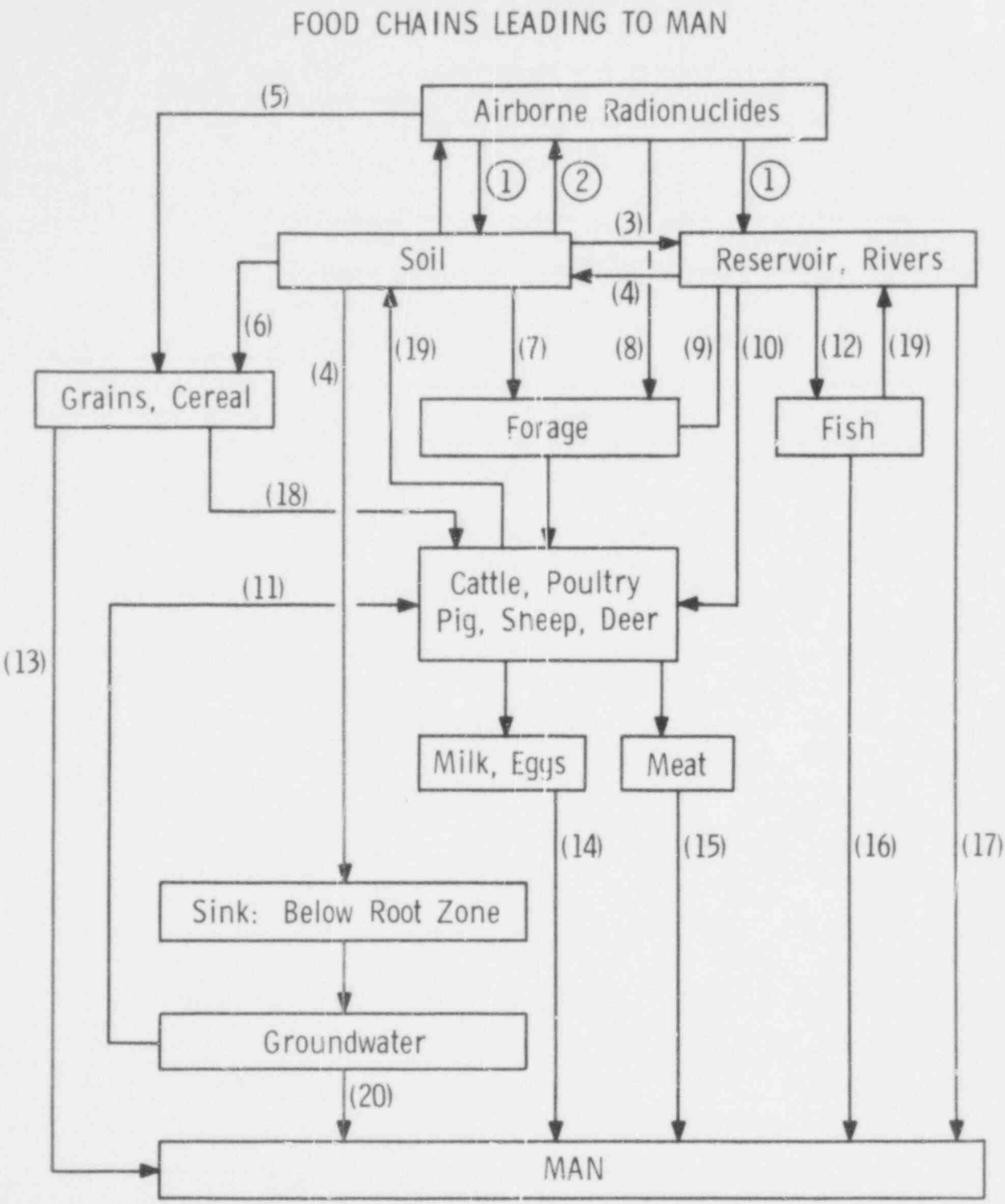

Fig. 7.1. Food Chains Leading to Man. In this version of UDAD pathways leading from reservoirs, rivers, fish, and groundwater are not explicitly calculated.

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7.1 RADIONUCLIDE CONCENTRATIONS IN VEGETATION AND PASTURES

The concentration of a radionuclide i in vegetation v or the pasture at a centroid (r,θ) from deposition on foliage and uptake from the prior contamination t in the soil is:

$$C(r,\theta,t;i,v) = 8.64 \times 10^4 \sum_s \langle \chi(r,\theta,t;i,s) \rangle$$

$$V_d(s) \left\{ \eta_v f_v [1 - \exp(\lambda_e(i) t_v)] / y_v \lambda_e(i) \right\} + \eta_v U_v(i) W(r,\theta,t;i)/\rho \ , \qquad (7.1)$$

where $V_d(s)$ is the deposition velocity from the total annual average airborne concentration χ for the effluents particles of size s,

η is the decontamination factor due to food processing, such as washing, peeling, etc., of the vegetation, but does not apply to forage, where $\eta = 1$.

f_v is the fraction of foliar deposition retained on the plant,

$\lambda_e(i) = \lambda(i) + \omega(i)$ is the effective removal constant of the radionuclide i from the plants, [$\lambda(i)$ is the radioactive decay coefficient and $\omega(i)$ is the weathering coefficient from the plant],

y_v is the yield factor (kg/m^2) per year,

t_v is the plant exposure period,

$U_v(i)$ is the plant uptake from the soil in pCi/kg of the plant per pCi/kg of the root zone soil,

ρ is the effective surface density of soil, and

$W(r,\theta,t;i)$ is the surface deposition concentration of radionuclide i throughout the time from start of deposition until harvest of the plant.

The default values for the Eq. 7.1 are:

$\eta = 0.5$ for vegetables consumed by man,

$\eta = 1.0$ for pasture and food crops consumed by the animals.

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$f_v = 0.2,$

$\omega(i) = 0.693/14$ days,

$y_v = 2.0$ kg/m^2 for crops,

$y_v = 0.75$ kg/m^2 for pasture,

$U_v(i)$ = default values given in Table 7.1, and

$\rho = 240$ kg/m^2 assuming a uniform mixing of all radionuclides in a plowlayer of 15 cm depth.

However, the value for any of these parameters (default value) may be changed based on site-specific conditions and availability of new data.

Table 7.1. Default Parameters of Food Intake for Standard Man Utilized in UDAD[a,b]

Pathway	*Average Exposed Individuals*	*Maximally Exposed Individuals*
Vegetables, kg/day[b]	0.28	0.77
Meat, kg/day	0.26	0.[illegible]0

[a]*These values are those for adults taken from Tables E-4 and E-5 of U.S. Nuclear Regulatory Commission Guide 1.109, Revision 1, October 1977.*

[b]*Does not include fruits or grain.*

Equation 7.1 can be applied to a variety of food crops, provided the appropriate parameters can be estimated. There is a wide range in the values for crop yield, time of exposure, factor for uptake from soil, translocation to edible parts of the plant, and effective surface density of soil. These parameters vary with the nuclide and the crop and depend heavily on location and soil properties. Since values of certain parameters could not be found in the literature for many of the nuclides of concern, in this model vegetation represents all vegetables and food crops. It is assumed that the concentration of radionuclides in the edible part of the plant is the same as the average concentration in overall plant.

7.2 RADIONUCLIDE CONCENTRATIONS IN MEAT, POULTRY, DAIRY AND EGGS

The radionuclide concentrations in meat (beef, mutton), poultry, dairy products and eggs are dependent on the animals total daily radionuclide intake from feeds (pastures, grains, stored feed), drinking water and inhalation. Inhalation rates for animals have been reported, but the transfer rates from inhalation for some of the radionuclides to the animal products are not known. Therefore, in this version of UDAD, contamination of the products from animal inhalation are not estimated. Based on the above consideration, the radionuclide concentrations in product k of the above animals, α, are expressed by:

$$C(r,\theta,t;i,\alpha(k)) = g(\alpha)\ F(i,\alpha(k)) \sum_j C_p(r,\theta,t;i,j)Q(\alpha,j) \ , \qquad (7.2)$$

where $C(r,\theta,t;i,\alpha(k))$ is the concentration of the radionuclide i in the product k of the animal α at centroid (r,θ) at time t,

$g(\alpha)$ is the fraction of the year animal α is on contaminated intake,

$F(i,\alpha(k))$ is the transfer coefficient of the radionuclide i to the product $\alpha(k)$,

$C_p(r,\theta,t;i,j)$ is the concentration of the radionuclide i from feed j at the centroid (r,θ), and

$Q(\alpha,j)$ is the consumption rate of the contaminated feed j by the animal α.

The default values adopted in this version of UDAD are:

$g(\alpha) = 0.5$ for all α

$F(i,\alpha(k))$ for meat/feed in days/kg are U (3.4×10^{-4}), Th (2.0×10^{-4}), Ra (4.0×10^{-3}), Pb (2.9×10^{-4}), and Po (1.2×10^{-2}).

$Q(\alpha,j) = 50$ kg/day for a pastured cow

$= 0.12$ kg/day of grain for poultry.

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The $C_p(r,\theta,t;i,j)$ is estimated from Eq. 7.1.

Because of lack of better input parameters, this version of UDAD assumes that cows consume only pasture grass and that poultry consumes only grain. The daily intake of the feed j is seasonally as well as climatically dependent on the site of the centroid. The transfer coefficient $F(i,\alpha(k))$ is the fraction of daily intake of the radionuclide i appearing in the product k of the animal α. Data reported on transfer coefficients are limited and not well documented. The transfer of radionuclides from air to plants through both leaves and soil and then to food products follows the methodology described in Regulatory Guide 1.109 except for Ra-226 (Scarano 1978).

7.3 INGESTION DOSIMETRY

The ingestion dose rate is estimated from the rate of radionuclide intake, rate of radioactive uptake, deposition, and the rate of clearance from each organ or tissue of interest, the rate of energy deposition in the organ and the organ weight. The rate of radioactivity intake is dependent on the daily food intake rate and the radionuclide concentrations in food. The radionuclide concentrations in foods are calculated based on the models described in the Sections 7.1 and 7.2. Since the radionuclides of concern in the ingestion pathway generally have long radioactive half-lives, loss and ingrowth in activity from radioactive decay during the time lag between production and consumption is not included.

The commonly used metabolic model and parameters for ingestion dose rate calculations are those presented in ICRP publication 2 (1959). The values utilized for metabolic pathways are selected from NRC report, Regulatory Guide 1.109 (1977). The ICRP model assumes that radioactivity retention in any organ follows a single-exponential function and is homogeneously distributed in the tissues. But recent experimental data seem to indicate multiple-exponential functions and a combination of exponential and power functions. The retention function is dependent on the age, health and metabolic state of the individual as well as the chemical form of the radionuclide. In UDAD, with the exception of computing dose rates to bone and whole body from ^{226}Ra, the metabolic models are those of ICRP 2 (1959). Dose rates for whole body and bone from radium-226 are calculated from a multiple-exponential retention model (ICRP-10A, 1971).

The burden, $Q(t;i,\Psi,j)$, of the radionuclide i in the organ or tissue Ψ from a continuous ingestion of the food type j at time t is given by:

$$\frac{dQ(t;i,\Psi,j)}{dt} = I(j)C(t,i,j)\ f_1(i)f_2^{\prime}(i,\Psi) - \lambda(i,\Psi)Q(t;i,\Psi,j)\ , \tag{7.3}$$

where $I(j)$ is the rate of intake of food type j,

$C(t;i,j)$ is the average concentration of radionuclide i in food j,

$f_1(i)$ is the fraction of the radionuclide i that reaches the bloodstream from ingestion,

$f_2^1(i,\Psi)$ is the fraction of $f_1(i)$ that reaches organ or tissue Ψ, and

$\lambda(i,\Psi)$ is the effective decay constant of the organ Ψ, i.e., $\lambda(i,\Psi) = \lambda(i) + \lambda(\Psi)$ where $\lambda(i)$ and $\lambda(\Psi)$ are, respectively, the radioactive and biological coefficient for the radionuclide i and organ Ψ.

The biological half-lives $T_b(i,\Psi)$ and the radioactive half-lives $T_r(i)$ are, respectively, $\left(\frac{0.693}{\lambda(i,\Psi)}\right)$ and $\left(\frac{0.693}{\lambda(i)}\right)$.

The solution of Eq. 7.3 is:

$$Q(t;i,\Psi,j) = Q(0;i,\Psi,j)\ e^{-\lambda(i,\Psi)t} +$$

$$\frac{I(j)C(t;i,j)\ f(i)f_2^{\prime}(i,\Psi)\left(1 - e^{-\lambda(i,\Psi)t}\right)}{\lambda(i,\Psi)}\ . \tag{7.4}$$

The dose rate $\dot{D}$ in rem/day for the organ Ψ from the radionuclide i is:

$$\dot{D}(t;i,\Psi,j) = \frac{51.2 \times 10^{-6}\ Q(t;i,\Psi,j)E(i,\Psi)}{W(\Psi,t)}\ , \tag{7.5}$$

where Q is the body burden of i from j in the organ h in pCi,

$E(i,\Psi)$ is the effective absorbed energy per disintegration for organ Ψ in $\frac{\text{MeV}\cdot\text{rem}}{\text{dis}\cdot\text{rad}}$, and

$W(\Psi,t)$ the weight of the organ h at time t in grams.

The time-integrated dose over the interval 0 - t, is given by:

$$D(t;i,\Psi,j) = \int_0^t \dot{D}(t;i,\Psi,j)\,dt \text{ (rem)} . \tag{7.6}$$

The solution of the Eq. 7.6 for an adult $[W(t,\Psi) = W(\Psi)]$ using the expression for organ or tissue burden and Eqs. 7.4 and 7.5 is:

$$D(t;i,\Psi,j) = \frac{51.2 \times 10^{-6}\ E(i,\Psi)}{\lambda(i,\Psi)\ W(\Psi)} \left\{ Q(0;i,\Psi,j)\left[\frac{1 - e^{-\lambda(i,\Psi)t}}{\lambda(i,\Psi)}\right]\right.$$

$$\left. + \frac{I(j)C(t,\Psi)\ f_i(i)f_5'(i,\Psi)}{\lambda(i,\Psi)}\left(t - \left[\frac{1 - e^{-\lambda(i,\Psi)t}}{\lambda(i,\Psi)}\right]\right)\right\} . \tag{7.7}$$

The total dose rate and dose from all radionuclides and all types of food intake are given by:

$$\dot{D}(t;\Psi) = \sum_j \sum_i \dot{D}(t;i,\Psi,j) \tag{7.8}$$

and

$$D(t;\Psi) = \sum_j \sum_i D(t;i,\Psi,j) , \tag{7.9}$$

from the Eqs. 7.5 and 7.7. For organs with subcompartments, such as bone with osteogenic and hematopoietic compartments, the total dose rate and dose are obtained by summations over compartments. The parameters used for the above equation are tabulated in Tables 7.1 and 7.2.

Table 7.2. Default Parameters of Internal Dose Rate Calculation

Nuclide (*i*)	*Organ* (Ψ)	$f_1(i)$	$f_2^1(i,h)$	T_r, *days*	T_b, *days*	*E*(*i*) (*QF*), *MeV rem/rad*
U-238	WB	10^{-2}	1.0	1.6×10^{12}	100	43
	Bone	10^{-2}	0.11	1.6×10^{12}	300	220
	Liver	10^{-2}	0.0	1.6×10^{12}	-	-
	Kidney	10^{-2}	0.11	1.6×10^{12}	15	43
U-234	WB	10^{-2}	1.0	9.1×10^{7}	100	49
	Bone	10^{-2}	0.11	9.1×10^{7}	300	240
	Liver	10^{-2}	0.0	9.1×10^{7}	-	-
	Kidney	10^{-2}	0.11	9.1×10^{7}	15	49
Th-230	WB	10^{-4}	1.0	2.9×10^{7}	5.7×10^{4}	48
	Bone	10^{-4}	0.7	2.9×10^{7}	7.3×10^{4}	240
	Liver	10^{-4}	0.05	2.9×10^{7}	5.7×10^{4}	48
	Kidney	10^{-4}	0.05	2.9×10^{7}	2.2×10^{4}	48
Ra-226	WB & Bone	0.3	0.54	5.9×10^{5}	0.398	110
			0.29	5.9×10^{5}	4.95	
			0.11	5.9×10^{5}	57.75	
			0.04	5.9×10^{5}	6.93×10^{2}	
			0.02	5.9×10^{5}	5.33×10^{3}	
	Liver	0.3	0.0004	5.9×10^{5}	10	110
	Kidney	0.3	0.002	5.9×10^{5}	10	110
Pb-210	WB	0.08	1.0	7.1×10^{3}	1.46×10^{3}	5.2
	Bone	0.08	0.28	7.1×10^{3}	3.65×10^{3}	29
	Liver	0.08	0.08	7.1×10^{3}	1947	10
	Kidney	0.08	0.14	7.1×10^{3}	531	10
Po-210	WB	0.06	1.0	138.4	30	55
	Bone	0.06	0.1	138.4	24	280
	Liver	0.06	0.17	138.4	41	55
	Kidney	0.06	0.07	138.4	70	55

References for Section 7

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8. INHALATION

The dose and dose rate to the lungs and other organs from inhalation of airborne radionuclides are dependent upon deposition rate, chemical form, translocation and retention. Deposition of airborne radionuclides on the epithelium of the respiratory system occurs through the mechanisms of impaction, sedimentation and diffusion. The fraction of the deposition is dependent on anatomical structure, aerodynamic size distribution of the inhaled aerosols and fraction of unattached ions on airborne particles (Morrow and Cassarett 1961; Morrow 1960; Blair et al. 1964). The dosimetry model in UDAD is based on the recommendations of the Task Group on Lung Dynamics for Committee II of the International Commission on Radiological Protection (1966).

The human respiratory tract is divided into three major regions corresponding to the sites of deposition of the radionuclides--the nasopharyngeal (NP), the tracheobronchial (TB), and the pulmonary (P) regions. Figure 8.1 depicts the schematic structure of the respiratory model. A fraction of the total activity inhaled is directly exhaled. The fraction of deposition of an aerosol is dependent on the activity median aerodynamic diameter (AMD). The deposition as a function of aerodynamic diameter for each region of the lung is graphically reported in ICRP (1966).

Activity in each region is cleared from the blood pool for redistribution and uptake by other tissues and organs (a,b,c). Further, a fraction of the activity deposited in each of the regions is cleared into the gastrointestinal tract (process b,d) for uptake by the blood pool (process j) and eventual excretion. A fraction of the activity from pulmonary region is transported into the lymph node system and cleared into the blood pool (i).

International Commission of Radiological Protection has classified inorganic compounds according to their relative rate of clearance from lung

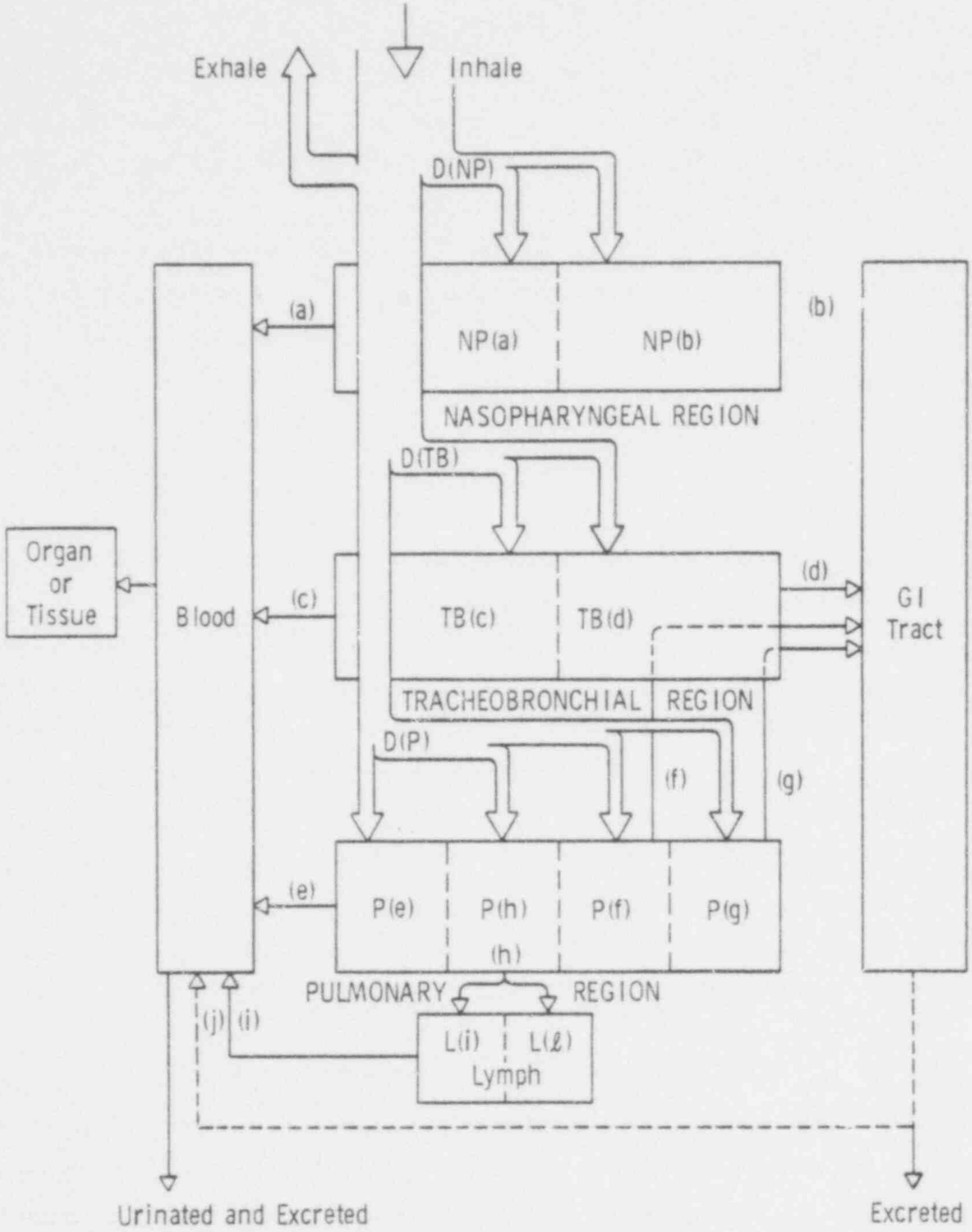

Fig. 8.1. Schematic Diagram of the Task Group Lung Model Used in UDAD.

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into three transportability classes: Y, W, and D. The classes correspond to materials that clear slowly (in terms of years, Y), moderately (in weeks, W), or rapidly (in days, D). Solubility classification of uranium compounds released during product drying operations is not constant throughout the whole uranium milling industry. It is dependent on the nature of chemical extraction and drying temperature. It is assumed that uranium, thorium and polonium are in class Y, and that radium and lead are in class W. The values of the clearance rates for each clearance pathway are given in Table 8.1. Recent studies (Kalkwarf 1978) may suggest that the above classification should be modified; in UDAD the default solubility classifications are based on the recommendations of ICRP 1966 (task group lung dynamics).

8.1 RESPIRATORY TRACT RETENTION OF INHALED PARTICLES

The rate of deposition of radioactive particulates in the subcompartments ϕ of the Ψ compartment of the respiratory tract at time t is:

$$\frac{dQ(t;i,\Psi(\phi)}{dt} = \lambda^e(i,\phi)\ Q(t;i,\Psi(\phi)) + F(i,\Psi)\ f(i,\phi) \ , \tag{8.1}$$

$$F(i,\Psi) = I \sum_z D_z(\Psi)\ \langle\chi(r,\theta,\bar{t};z,i)\rangle \ , \tag{8.2}$$

where $\lambda^e(i,\phi) = \lambda^b(i,\phi) + \lambda^r(i)$ is the effective removal constant of radionuclide i from the subcompartment ϕ. $\lambda^b(i,\phi)$ is the biological removal constant, and $\lambda^r(i)$ is the radioactive decay constant.

$Q(t;i,\Psi(\phi))$ is the burden of radionuclide i in the subcompartment ϕ of the Ψ compartment at time t,

$f(i,\phi)$ is the fraction removed from the ϕ subcompartment,

I is the air inhalation rate, and

$\langle\chi(r,\theta,\bar{t};i,z)\rangle$ is the average concentration within a time interval of the radionuclide i in the air with aerodynamic diameter z, $z = s\sqrt{\rho}$. s and ρ are, respectively, activity median diameter and density, and

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Table 8.1. Values of the Clearance Parameters, Biological Half-Life $T^b(i,\phi)$ (in days), and the Fraction Removed $f(i,\phi)$ for Each Translocation Class of Radionuclide i, from Subcompartment ϕ as Depicted in Figure 8.1 (Task Group Lung Model)

Respiratory Compartment	*Metabolic Pathway*	*Translocation Class D*		*Translocation Class W*		*Translocation Class Y*	
		$T^b(i,\phi)$	$f(i,\phi)$	$T^b(i,\phi)$	$f(i,\phi)$	$T^b(i,\phi)$	$f(i,\phi)$
NP:	a	0.01	0.5	0.01	0.1	0.01	0.01
	b	0.01	0.5	0.40	0.9	0.4	0.99
TB:	c	0.01	0.95	0.01	0.5	0.01	0.01
	d	0.2	0.05	0.2	0.5	0.2	0.99
P:	e	0.5	0.8	50.	0.15	500.	0.05
	f	-	-	1.	0.4	1.	0.4
	g	-	-	50.	0.4	500.	0.4
	h	0.5	0.2	50.	0.05	500.	0.15
L:	i	0.5	1.0	50.	1.	1000.	0.9

$D_z(\Psi)$ is the fraction of the inhaled particulate with aerodynamic diameter z deposited in the lung compartment Ψ.

The burden in $\Psi(\phi)$ from Eq. 8.1 is given by:

$$Q(t;i,\Psi(\phi)) = Q(0;i,\Psi(\phi))\ A_{0,\phi}(t;i) + F(i,\Psi)\ f(i,\phi)\ A_{1,\phi}(t;i)\ , \tag{8.3}$$

where

$$A_{0,\phi}(t;i) = \exp\ [-\lambda^e(i,\phi)t]\ , \tag{8.4}$$

and

$$A_{1,\phi}(t;i) = \frac{1 - \exp\ [-\lambda^e(i,\phi)t]}{\lambda^e(i,\phi)}\ . \tag{8.5}$$

For the NP and P compartments of the respiratory tract, the total tissue burden is the sum of the burdens resulting from deposition in the associated subcompartments in each. For the TB compartment, the burden is augmented by the processes f and g from the P compartment to the GI tract. The rate of change of the burden in the TB region as a result of these processes is:

$$\frac{dQ(t;i,TB(d))}{dt} = \sum_{\phi=f,g} \lambda^b(i,\phi)\ Q(t;i,P(\phi)) - \lambda^e(i,d)\ Q(t;i,TB(d))\ . \tag{8.6}$$

The additional burden in the tracheobronchial region, calculated by integration of Eq. 8.6, is:

$$Q(t;i,TB(d)) = Q(0;i,TB(d))\ A_{0,d}(t;i) + \sum_{\phi=f,g} \lambda^b(i,\phi) \left\{ \frac{P(i,P)\ f(i,\phi)}{\lambda^e(i,\phi)} \left[A_{1,d}(t;i) - A_{\phi,d}(t;i) \right] + Q(0;i,P(\phi))\ A_{\phi,d}(t;i) \right\}, \tag{8.7}$$

where

$$A_{\phi_1,\phi_2}(t;i) = \frac{[\exp\ (-\lambda^e(i,\phi_1)t) - \exp\ (-\lambda^e(i,\phi_2)t)]}{\lambda^e(i,\phi_2) - \lambda^e(i,\phi_1)}\ . \tag{8.8}$$

560 063

The total tissue burden for the TB region is the sum of the tissue burdens as estimated by Eqs. 8.3 and 8.7.

The rate of change of pulmonary lymph node burden is:

$$\frac{dQ(t;i,L(i))}{dt} = \lambda^b(i,h)\ f(i,i)\ Q(t;i,P(h)) - \lambda^e(i,i)\ Q(t;i,L(i))\ . \qquad (8.9)$$

The lymph burden from Eq. 8.9 is:

$$Q(t;i,L(i)) = Q(0;i,L(i)\ A_{0,i}(t;i) + \lambda^b(i,h)\ f(i,i)\left\{\frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)}\left[A_{1,i}(t;i) - A_{h,i}(t;i)\right] + Q(0;i,P(h))\ A_{h,i}(t;i)\right\} \qquad (8.10)$$

for class Y solubility with $\lambda^e(i,h) \neq \lambda^e(i,i)$.

For classes W and D solubility with $\lambda^e(i,h) = \lambda^e(i,i)$, the lymph burden is:

$$Q(t;i,L(i)) = Q(0;i,L(i))\ A_{0,i}(t;i) + \lambda^b(i,h)\ f(i,i)\left\{\frac{F(i,P)\ f(i,h)}{\lambda^e(i,i)}\left[A_{1,i}(t;i) - A_{0,i}(i;i)\right] + Q(0;i,P(h))\ t\ A_{0,i}(t;i)\right\}\ . \qquad (8.11)$$

For class Y solubility the additional material in $L(\ell)$ of the lymph nodes is:

$$Q(t;i,L(\ell)) = Q(0;i,L(\ell))\ A_{0,\ell}(t;i) + \lambda^b(i,h)(1 - f(i,i))\left\{\frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)}\left[A_{1,\ell}(t;i) - A_{h,\ell}(t;i)\right] + Q(0,i,P(h))\ A_{h,\ell}(t;i)\right\}\ . \qquad (8.12)$$

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for $$\lambda^e(i,\ell) = \lambda^r(i) \; . \tag{8.13}$$

The total burden in the lymph tissue is the sum of the two burdens estimated from Eqs. 8.10 or 8.11 and 8.12.

8.2 SYSTEMIC BLOOD ACTIVITY DISTRIBUTION TO ORGANS

The systemic blood pool is a common pathway for the distribution, accretion and reduction of radioactivity to and from organs. Organ burden is a result of the uptake and retention of radioactivity from the blood. In UDAD, the retention function from inhalation is assumed to be a single exponential function of time, except for ^{226}Ra in bone and whole body for which a multi-compartment exponential retention function is used.

Sources of blood activity and its distribution are schematically depicted in Figure 8.2. Based on this model the quantity of radioactivity that enters a given organ or tissue from the blood at any time t is assumed to be a constant fraction of the activity entering blood from the ingestion and inhalation pathways. ICRP II (1959) has designated this fraction f_2'. The rate of change of organ burden for the organ N or subcompartment n of the N is:

$$\frac{dQ(t;i,N(n))}{dt} = \sum_{\phi=a,c,e,i} \lambda^b(i,\phi)\; Q(t;i,\Psi(\phi)\; f_2'(i,N(n)) +$$

$$\sum_{\phi=b,d,f,g} \lambda^b(i,\phi)\; Q(t;i,\Psi(\phi))\; f_2'(i,N(n))f_1(i) -$$

$$\lambda^e(i,N(n))\; Q(t;i,N(n)) \; , \tag{8.14}$$

where f_1 is the fraction of the activity in the gut transported into the blood pool. Thus, the burden is:

$$Q(t;i,N(n)) = Q(0;i,N(n))\; A_{1,n}(t;i) +$$

$$\sum_{\phi=a,c,e} \lambda^b(i,\phi)\; f_2'(i,N(n))\; B_{\phi,n}(t;i) +$$

$$\sum_{\phi=b,d,f,g} \lambda^b(i,\phi)\; f_2'(i,N(n))\; f_1(i)\; B_{\phi,n}(t;i) + L_{N(n)}(t;i) \; , \tag{8.15}$$

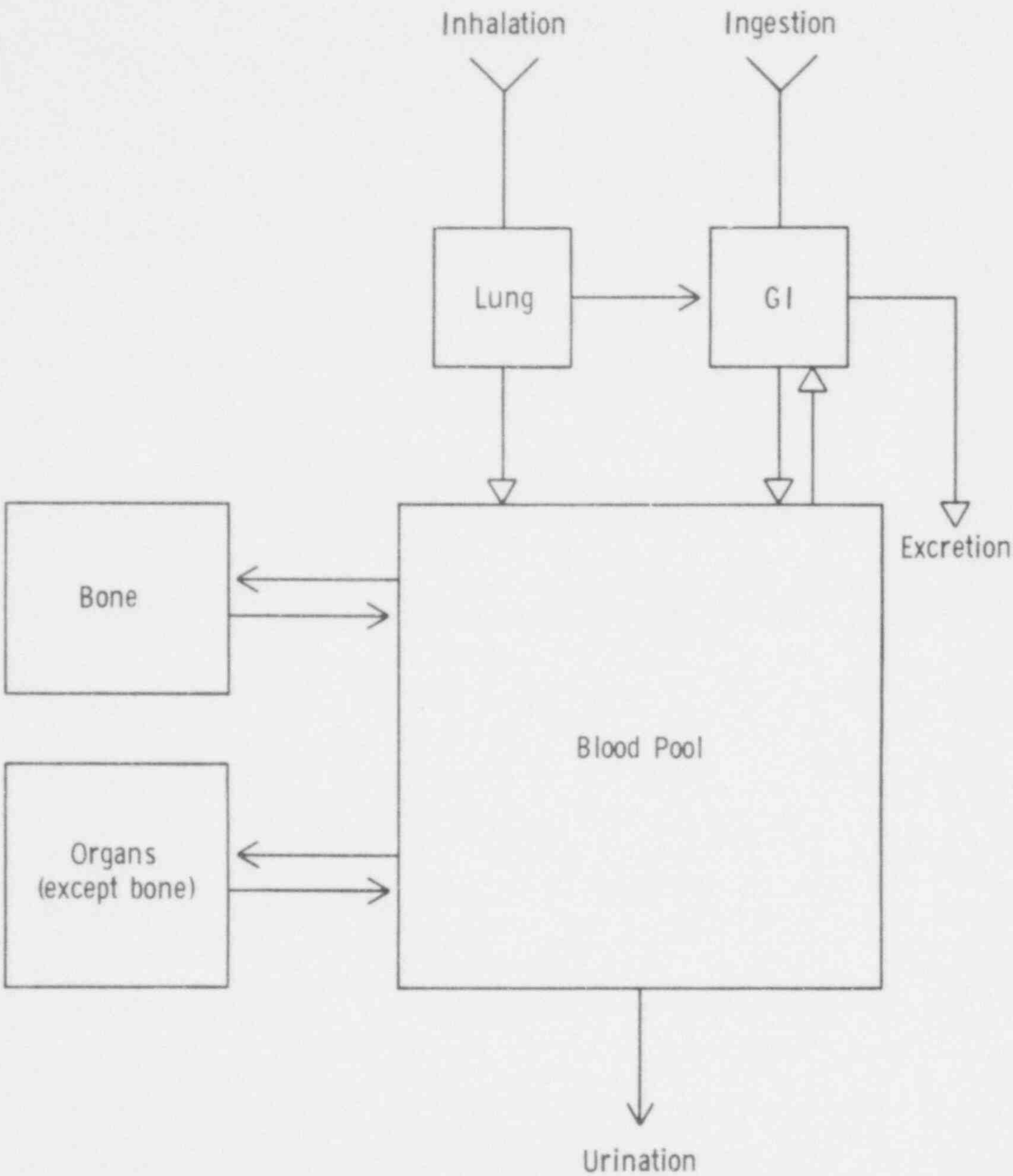

Fig. 8.2. Blood Pool System for Distributing
Radioactivity to Other Organs.

where

$$B_{\phi,n}(t;i) = \frac{F(i,\Psi(\phi))\ f(i,\phi)}{\lambda^e(i,z)} \left[A_{1,\phi}(t;i) - A_{\phi,n}(t;i)\right] +$$

$$Q(0;i,\Psi(\phi))\ A_{\phi,n}(t;i)\ . \qquad (8.16)$$

$L_n(t;i)$ is the contribution to the organ burden from material passing through the lymphatic system.

For class Y solubility $\lambda^e(i,L(i)) \neq \lambda^e(i,h)$,

$$L_{N(n)}(t;i) = \lambda^b(i,i)\ f_2'(i,N(n))\ Q(0;i,L(i))\ A_{i,n}(t;i) +$$

$$\lambda^b(i,h)\ \lambda^b(i,i)\ f(i,i)\ f_2'(i,N(n)) \left\{ \frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)} \right.$$

$$\left[\frac{A_{1,n}(t;i) - A_{i,n}(t;i)}{\lambda^e(i,i)} - \frac{A_{h,n}(t;i) - A_{i,n}(t;i)}{\lambda^e(i,i) - \lambda^e(i,h)}\right] +$$

$$\left. Q(0;i,P(h)) \left[\frac{A_{h,n}(t;i) - A_{i,n}(t;i)}{\lambda^e(i,i) - \lambda^e(i,h)}\right] \right\}. \qquad (8.17)$$

For classes D and W solubility $\lambda^e(i,i) = \lambda^e(i,h)$,

$$L_{N(n)}(t;i) = \lambda^b(i,i)\ f_2'(i,N(n))\ Q(0;i,i)\ A_{i,n}(t;i) +$$

$$\lambda^b(i,h)\ \lambda^b(i,i)\ f(i,i)\ f_2'(i,N(n)) \left\{ \frac{F(i,p)\ f(i,h)}{\lambda^e(i,h)} \right.$$

$$\left[\frac{A_{1,n}(t;i) - A_{i,n}(t;i)}{\lambda^e(i,i)} - \frac{t\ A_{0,i}(t;i) - A_{i,n}(t;i)}{\lambda^e(i,n) - \lambda^e(i,i)}\right] +$$

$$\left. Q(0;i,P(h)) \left[\frac{t\ A_{0,i}(t;i) - A_{i,n}(t;i)}{\lambda^e(i,n) - \lambda^e(i,i)}\right] \right\}. \qquad (8.18)$$

8.3 DOSE RATE AND DOSE

Dose rate to an organ or tissue is calculated from Eq. 7.5. The time-integrated doses are derived from Eqs. 7.5 and 7.6 using the organ or tissue burden given in previous subsections.

The dose to the NP region of the respiratory tract is:

$$D(t;i,NP) = \hat{D}(i,NP) \sum_{\phi=a,b} \left\{ \frac{F(i,NP)\ f(i,\phi)}{\lambda^e(i,\phi)} \left[t - A_{1,\phi}(t;i)\right] + Q(0;i,NP)\ A_{1,\phi}(t;i) \right\} \tag{8.19}$$

for

$$\hat{D}(i,\Psi) = \frac{51.2 \times 10^{-6}\ E(i,\Psi)}{W(\Psi)} \ . \tag{8.20}$$

The dose to the TB region is:

$$D(t;i,TB) = \hat{D}(i,TB) \left\{ \sum_{\phi=c,d} \left[\frac{F(i,TB)\ f(i,\phi)}{\lambda^e(i,\phi)} (t - A_{1,\phi}(t;i)) + Q(0;i,TB(\phi))\ A_{1,\phi}(t;i) \right] + Q(0;i,TB(d))\ A_{1,d}(t;i) + \sum_{\phi=f,g} \left[\frac{\lambda^b(i,\phi)\ F(i,P)\ f(i,\phi)}{\lambda^e(i,\phi)} \left[\frac{t - A_{1,d}(t;i)}{\lambda^e(i,d)} - \frac{A_{1,\phi}(t;i) - A_{1,d}(t;i)}{\lambda^e(i,d) - \lambda^e(i,\phi)} \right] + \lambda^b(i,\phi)\ Q(0;i,P(\phi)) \left[\frac{A_{1,\phi}(i;i) - A_{1,d}(t;i)}{\lambda^e(i,d) - \lambda^e(i,\phi)} \right] \right] \right\} . \tag{8.21}$$

The dose to the P region is:

$$D(t;i,P) = \hat{D}(i,P) \sum_{\phi=e,f,g,h} \left\{ \frac{F(i,P)\ f(i,\phi)}{\lambda^e(i,\phi)} \left[t - A_{1,\phi}(t;i)\right] + Q(0;i,P(\phi))\ A_{1,\phi}(t;i) \right\} \tag{8.22}$$

The dose to the lymph nodes is:

$$D(t;i,L) = \hat{D}(i,L) \Bigg\{ Q(0;i,L(i))\ A_{1,i}(t;i) + \lambda^b(i,h)\ f(i,i) \left[\frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)} \left(\frac{t - A_{1,i}(t;i)}{\lambda^e(i,i)} - \frac{A_{1,h}(t;i) - A_{1,i}(t;i)}{\lambda^e(i,i) - \lambda^e(i,h)} \right) + Q(0;i,P(h)) \left(\frac{A_{1,h}(t;i) - A_{1,i}(t;i)}{\lambda^e(i,i) - \lambda^e(i,h)} \right) \right] + Q(0,i,L(\ell))\ A_{1,\ell}(t;i) + \lambda^b(i,h)\ (1 - f(i,i)) \left[\frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)} \left(\frac{t - A_{1,\ell}(t;i)}{\lambda^r(i)} - \frac{A_{1,h}(t;i) - A_{1,\ell}(t;i)}{\lambda^r(i) - \lambda^e(i,h)} \right) + Q(0;i,P(h)) \left(\frac{A_{1,h}(t;i) - A_{1,\ell}(t;i)}{\lambda^r(i) - \lambda^e(i,h)} \right) \right] \Bigg\}, \qquad (8.23)$$

for solubility class Y, and

$$D(t;i,TB) = \hat{D}(i,TB) \Bigg\{ Q(0;i,L(i))\ A_{1,i}(t;i) + \lambda^b(i,h)\ f(i,i) \left[\frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)} \left(\frac{t(1 + A_{0,i}(t;i)) - 2A_{1,i}(t;i)}{\lambda^e(i,i)} \right) - Q(0;i,h) \left(\frac{t\ A_{0,i}(t;i) - A_{1,i}(t;i)}{\lambda^e(i,i)} \right) \right] \Bigg\} \qquad (8.24)$$

for solubility classes D and W.

For other organs and tissues, except for the GI tract, the time-integrated dose is:

$$D(t;i,N(n)) = \hat{D}(i,N) \Bigg\{ Q(0;i,N(n))\, A_{1,n}(t;i) + \sum_{\phi=a,c,e} \lambda^{b}(i,\phi)\, f_2'(i,N(n))\, B_{\phi,n}(t;i) + \sum_{\phi=b,d,f,g} \lambda^{b}(i,\phi)\, f_2'(i,N(n))\, f_1(i)\, B_{\phi,n}(t;i) + L_n(t;i) \Bigg\}, \qquad (8.25)$$

where

$$B_{\phi,n}(t;i) = \frac{F(i,\Psi(\phi))\, f(i,\phi)}{\lambda^{e}(i,\phi)} \left[\frac{t - A_{1,n}(t;i)}{\lambda^{e}(i,n)} - \frac{A_{1,\phi}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,\phi)} \right] + Q(0;i,\Psi(\phi)) \left[\frac{A_{1,\phi}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,\phi)} \right] \qquad (8.26)$$

and

$$L_n(t;i) = \lambda^{b}(i,i)\, f_2'(i,N(n)) \Bigg\{ Q(0;i,L(i)) \left[\frac{A_{1,i}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,i)} \right] + \lambda^{b}(i,h)\, f(i,i) \Bigg[\frac{F(i,P)\, f(i,h)}{\lambda^{e}(i,h)} \Bigg[\frac{1}{\lambda^{e}(i,i)} \left(\frac{t - A_{1,n}(t;i)}{\lambda^{e}(i,n)} - \frac{A_{1,i}(t,i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,i)} \right) - \frac{1}{\lambda^{e}(i,i) - \lambda^{e}(i,h)} \left(\frac{A_{1,h}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,h)} - \frac{A_{1,i}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,i)} \right) \Bigg] + \frac{Q(0;i,h)}{\lambda^{e}(i,i) - \lambda^{e}(i,h)} \left(\frac{A_{1,h}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,h)} - \frac{A_{1,i}(t;i) - A_{1,n}(t;i)}{\lambda^{e}(i,n) - \lambda^{e}(i,i)} \right) \Bigg] \Bigg\} \qquad (8.27)$$

for class Y solubility, and

$$L_n(t;i) = \lambda^b(i,i)\ f_2'(i,N(n)) \left\{ Q(0;i,L(i)) \left[\frac{A_{1,i}(t;i) - A_{1,n}(t;i)}{\lambda^e(i,n) - \lambda^e(i,i)}\right] + \right.$$

$$\lambda^b(i,h)\ f(i,i) \left[\frac{F(i,P)\ f(i,h)}{\lambda^e(i,h)} \left[\frac{1}{\lambda^e(i,i)} \left(\frac{t - A_{1,n}(t;i)}{\lambda^e(i,n)} - \frac{A_{1,i}(t,i) - A_{1,n}(t;i)}{\lambda^e(i,n) - \lambda^e(i,i)} \right) \right.\right.$$

$$\left. - \frac{1}{\lambda^e(i,n) - \lambda^e(i,i)} \left(\frac{A_{1,i}(t;i) - t\ A_{0,i}(t;i)}{\lambda^e(i,i)} - \frac{A_{1,i}(t;i) - A_{1,n}(t;i)}{\lambda^e(i,n) - \lambda^e(i,i)} \right) \right]$$

$$\left.\left. + \frac{Q(0;i,h)}{\lambda^e(i,n) - \lambda^e(i,i)} \left(\frac{A_{1,i}(t;i) - t\ A_{0,i}(t;i)}{\lambda^e(i,i)} - \frac{A_{1,i}(t;i) - A_{1,n}(t;i)}{\lambda^e(i,n) - \lambda^e(i,i)} \right) \right] \right\} \tag{8.28}$$

for classes D and W solubility.

The basis for dosimetry of the gastrointestinal tract is ICRP II (1959) and the references therein. The dose rate to each part of the gastrointestinal tract (stomach, small intestine, upper larger intestine, and lower large intestine) is a function of the radionuclide residence period and the quantity absorbed from the gut into the blood pool. In the ICRP II (1959) model of the gastrointestinal tract only absorption of radionuclides in the small intestine is considered.

The rate of radionuclides reaching the GI tract from the respiratory system is:

$$\frac{dQ(t;i,GI)}{dt} = \sum_{\phi=b,d,f,g} \lambda^b(i,\phi)\ Q(t;i,\phi) \tag{8.29}$$

The total amount entering the gastrointestinal tract, calculated by integration of Eq. 8.29 is:

$$Q(t;i,GI) = \sum_{\phi=b,d,f,g} \lambda^b(i,\phi) \left\{ \frac{F(i,\Psi(\phi))\ f(i,\phi)}{\lambda^e(i,\phi)} \right.$$

$$\left. \left[t - A_{1,\phi}(t;i)\right] + Q(0;i,\phi)\ A_{1,\phi}(t;i) \right\} . \tag{8.30}$$

The dose $D(t;i,GI(s))$ to the stomach from the inhaled radionuclide i appearing in the gastrointestinal tract is:

$$D(t;i,GI(s)) = \hat{D}(i,s)Q(t;i,GI)\left[\frac{1 - e^{-\lambda_r(i)\tau_s}}{\lambda_r(i)}\right], \tag{8.31}$$

where $\hat{D}(i,s)$ is the dose conversion factor, and

τ_s is the mean residence time of the radionuclide in the stomach.

The dose conversion factors calculated from Eq. 8.20 are reduced by one-half for all compartments of the GI tract because of geometric consideration.

The absorption of the radionuclide in the small intestine is assumed to be constant at a rate of λ_{f_1}:

$$\lambda_{f_1} = \frac{1}{\tau_{SI}} \ln\left[\frac{1}{1 - f_1}\right], \tag{8.32}$$

where f_1 is the fraction of the radioactivity absorbed into the blood pool, and

τ_{SI} is the mean residence period in the small intestine.

In UDAD τ_{SI} is assumed to be four hours. The dose to the small intestine $D_{SI}(t;i)$ is:

$$D(t;i,GI(SI)) = \hat{D}(i,SI)\ Q(t;i,GI)\ \exp\ (-\lambda^r(i)\tau_s)\left[\frac{1 - \exp\ (-\lambda^e(i,SI)\tau_{SI})}{\lambda^e(i,SI)}\right] \tag{8.33}$$

where

$$\lambda^e(i,SI) = \lambda^r(i) + \lambda_{f_1}\ . \tag{8.34}$$

The passage rate of material through the upper large intestine is assumed to be constant with a mean residence time τ_{ULI} of eight hours. The dose to the upper large intestine is:

$$D(t;i,GI(ULI)) = \hat{D}(i,ULI)\; Q(t;i,GI)\; (1 - f_1)\tau_{ULI}\; \exp\,(-\lambda^r(i)(\tau_s + \tau_{SI})) \tag{8.35}$$

The dose to the lower large intestine (LLI) is similar to that of the ULI except for the radioactive decay during passage through the ULI:

$$D(t;i,GI(LLI)) = \hat{D}(i,LLI)\; Q(t;i,GI)\; (1 - f_1)\tau_{LLI}\; \exp\,(-\lambda^r(i)(\tau_s + \tau_{SI} + \tau_{ULI})) \tag{8.36}$$

where τ_{LLI} is the mean residence time of 18 hours in the LLI.

8.4 RADON DOSIMETRY

The radiation dose from inhalation of radon and its daughters depends on their emitted alpha energies and radioactivities, on the body tissues they are retained in, and the period of time retained there. Earlier investigation have indicated that the radiation dose to the respiratory tract by inhalation of ^{222}Rn, a noble gas, is negligibly small compared with dose which results from the inhalation of the short-lived, non-gaseous decay products. The short-lived radon daughters ^{218}Po and ^{214}Po emit with 6.0 and 7.68 MeV energies, respectively. These nuclides emit alpha particles and are inhaled as ion or aerosol particles. They are deposited on the mucus layer covering the respiratory system. The radiation dose from the inhalation of radon and its daughters is dependent on the degree of equilibrium between radon and its daughters, and the physical state and sizes of the inhaled radioactive particles at the time of exposure.

The degree of equilibrium between radon and daughters in the atmosphere is a function of distance from the radon emanating source and the mean wind speed (Eq. 3.2). Inside a structure, the equilibrium condition is dependent on the air ventilation rate and the hold-up time. Attachment of the ions of radon daughters on the atmospheric aerosols is dependent on the atmospheric concentration of the airborne particles. These radon daughters behave as particulates during inhalation and deposition in the respiratory system. A review of problems of lung dosimetry of radon has been reported by Parker (1969).

In the present version of UDAD, the calculation of the radiation dose from inhalation of radon and its daughters is calculated for the bronchial epithelium of the tracheobronchial (TB) region. For indoor exposure, every 100 pCi/liter of Rn-222 present in air is assumed to be associated with 0.5 working level (WL) of short-lived radon daughters (Magno, 1978). For exposure to radon daughters outdoors the working level is calculated by Eq. 3.3. The radiation dose from inhalation is dependent on the breathing rate and the exposure duration. The exposure unit previously applied to the uranium miners is the working level month (WLM), i.e., the product of WL and the duration of exposure, normalized to a 172-hour working month exposure. But for the general population the exposure is continuous and the breathing rate is lower and shallower. In UDAD, for a continuous exposure to 1 WL for a year, a default value of 25 WLM is assumed (Magno, 1978). Conversion of WLM to a dose-equivalent of 5 rem/WLM is based on data provided by the committee on the Biological Effects of Ionizing Radiation (BEIR 1972). Under these conditions the annual average radiation dose rate to the bronchial epithelium of an individual is:

$$\dot{D}(r,\theta,t;Rn) = 0.625\ f_I \langle\chi(r,\theta,t;Rn)\rangle$$

$$+ 1.25 \times 10^5\ (1 - f_I) WL_0(r,\theta,t)\ , \tag{8.37}$$

where $\dot{D}(r,\theta,t;Rn)$ is the dose rate from radon daugnters in mrem/year,

f_I is the frequency of occupancy indoors,

0.625 is the conversion factor in mrem per pCi/m^3,

1.25×10^5 is the conversion factor in mrem/WL, and

$WL_0\ (r,\theta,t)$ is the outdoor working level.

References for Section 8

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9. POPULATION DOSE COMMITMENT

Population dose commitments from inhalation, ingestion and external exposure are calculated for the population within an 80-km radius of the release site. The 80-km region is divided into a number of subregions (sector-segments) according to the population distribution. The subregion population for the last year of operation is estimated from regional demography and is introduced as input data.

The population dose commitment is calculated from the average radionuclide concentration and the exposure rate for each subregion. The total population dose commitment $D^P(t;\Psi,k)$ is:

$$D^P(t;\Psi,k) = \sum_d \sum_i P_d(t)\hat{D}_{i\Psi k} C_{ik}(t;d) , \qquad (9.1)$$

where $P_d(t)$ is the population at time t within the subregion d,

$\hat{D}_{i\Psi k}$ is the individual dose commitment conversion factor to organ Ψ from the radionuclide i in pathway k, and

$C_{ik}(t;d)$ is the average concentration of the radionuclide i in the subregion d and pathway k.

The total population dose commitment from the ingestion pathway is calculated from the average radionuclide concentration in food. The radioactivity concentrations in foods that are produced within the 80-km radius are weighted and then averaged over the entire region. The weight factors are calculated from the concentrations in each food for each centroid by a food-utilization factor. This weight-average concentration of radionuclide i in food β is calculated by:

$$\langle C_{i\beta}(t) \rangle = \sum_\zeta C_{i\beta}(t;\zeta) U_{\zeta\beta} , \qquad (9.2)$$

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where $U_{\zeta\beta}$ is the ratio of contribution of food β from centroid ζ to the population within the 80-km radius to the total consumption of food β within the 80-km radius,

$\langle C_{i\beta}(t)\rangle$ is 80-km average concentration of nuclide i in food β, and

$C_{i\beta}(t,\zeta)$ is the concentration of radionuclide i in food β produced from centroid ζ.

The total population dose commitment from the ingestion pathway is then:

$$D^P(t;\Psi) = P(t)\sum_{\beta}\sum_{i}\hat{D}_{i\Psi}I_{\beta}\langle C_{i\beta}(t)\rangle \ , \tag{9.3}$$

where P(t) is the total population within the 80-km radius of the site at time t,

$\hat{D}_{i\Psi}$ is the dose commitment conversion factor for ingestion of radionuclide i for organ or tissue Ψ, a factor that converts the intake rate of radionuclide i to the radiation dose commitment to organ or tissue Ψ, and

I_{β} is the intake rate of food β for an average individual.

The dose commitment factor is a 50-year time integrated dose rate resulting from only one year of chronic uniform ingestion of one pCi per day. The default values of intake rates for average exposed individual are given in Table 11.3.

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10. ENVIRONMENTAL DOSE COMMITMENT

Contamination of the environment by long-lived radionuclides represents a long-term potential source of exposure to humans. The total radiological impact to a population following a given release is dependent on the sum of all doses to individuals over the entire time period the material persists in the environment in a state available for interaction with humans.

The environmental dose commitment is calculated in UDAD for the population within an 80-km radius of the release site. The environmental dose commitment for an organ or a tissue Ψ resulting from exposure to radionuclide i via pathway k is:

$$D^{e}_{i,\Psi,k} = \sum_{\zeta} \int_0^{t_f} P(\zeta,t) D^{a}_{i,\Psi,k}(\zeta,t)\, dt \ , \tag{10.1}$$

where $D^{e}_{i,\Psi,k}$ is the environmental dose commitment for organ Ψ, radionuclide i, pathway k for population exposure period t_f,

$P(\zeta,t)$ is the population associated with subregion ζ at time t, and

$D^{a}_{i,\Psi,k}(\zeta,t)$ is the average individual dose commitment for organ Ψ from radionuclide i via pathway k and subregion ζ, and time t.

The calculation of environmental dose commitments by Eq. 10.1 requires a population projection for each subregion. Since long-range estimation of a detailed population projection is difficult and somewhat impractical. In UDAD an average regional population growth rate is assumed and applied to all subregions. Thus, the population projection for a subregion is given by:

$$P(\zeta,t) = G(t) P(\zeta,t=0) \ , \tag{10.2}$$

where $G(t)$ is the function representing the average population growth rate in the subregion ζ, given by:

$$G(t) = \sum_{\zeta} P(\zeta,t) / \sum_{\zeta} P(\zeta,t=0) \ . \tag{10.3}$$

560 078

The average individual dose commitment to organ Ψ from an exposure pathway k in terms of concentration is:

$$D^{a}_{i,\Psi,k}(\zeta,t) = \hat{D}_{i,\Psi,k} C^{a}_{ik}(\zeta,t) \ , \tag{10.4}$$

where $C^{a}_{ik}(\zeta,t)$ is the average concentration of radionuclide i via pathway k at subregion ζ and time t, and

$\hat{D}_{i,\Psi,k}$ is the individual dose commitment conversion factor for organ Ψ, radionuclide i, and pathway k.

Substitution of the Eqs. 10.2 and 10.4 into Eq. 10.1 results in:

$$D^{e}_{i,\Psi,k} = \sum_{\zeta} \underline{P}(\zeta,t=0)\hat{D}_{i,\Psi,k} \int_{t_1}^{t_f} G(t) C^{a}_{i,k}(\zeta,t)\, dt \ . \tag{10.5}$$

Expression 10.5 is integrated over m fixed time steps. For each time step Δt the average population growth is estimated for the midpoint of the time interval by:

$$D^{e}_{i,\Psi,k} = \sum_{\zeta} P(\zeta,t=0) \sum_{\delta=1}^{m} G(\bar{t}_{\delta})\hat{D}_{i,\Psi,k} \int_{t_\delta}^{t_{\delta+1}} C^{a}_{i,k}(\zeta,t)\, dt \ , \tag{10.6}$$

where

$$\bar{t}_{\delta} = \frac{t_{\delta+1} + t_{\delta}}{2} \tag{10.7}$$

Total environmental dose commitment to organ Ψ from pathway k is obtained by summing the contribution from each radionuclide i:

$$D^{e}_{\Psi,k} = \sum_{i} D^{e}_{i,\Psi,k} \ . \tag{10.8}$$

The following equations are derived from Eq. 10.8 by integration of the radionuclide concentration for each time interval.

10.1 ENVIRONMENTAL DOSE COMMITMENT FROM INHALATION OF PARTICULATES

The inhalation pathway is designated by k = 1 (see Section 4).

$$D^{e}_{i,\Psi,k} = \sum_{\zeta} P(\zeta,t=0) \sum_{\delta=1}^{4} G(\bar{t}_{\delta}) \sum_{s=1} \hat{D}_{i,\Psi,1}(s) I_{i,\delta}(\zeta,s) \ , \tag{10.9}$$

where $I_{i,\delta}(\zeta,s)$ is defined as:

$$I_{i,\delta}(\zeta,s) = \int_{t_\delta}^{t_{\delta+1}} [\langle\chi(\zeta;s,i)\rangle + \langle\chi^R(\zeta,t;s,i)\rangle]\, dt \,. \tag{10.10}$$

For $\delta = 1$

$$I_{i,1}(\zeta,s) = t_a\langle\chi(\zeta;s,i)\rangle + \sum_{h=1}^{i} \left\{ k(0)\langle\chi(\zeta;s,h)\rangle \right.$$

$$\left. V_d(s,h)\left(\prod_{\ell=h+1}^{i} \lambda_\ell\right) \sum_{\ell=h}^{i} \left[\frac{t_a\beta_\ell - \left(1 - e^{-\beta_\ell t}\right)}{\beta_\ell^2 \prod\limits_{\substack{f=h \\ f\neq\ell}}^{i} (\lambda_f - \lambda_\ell)}\right]\right\} . \tag{10.11}$$

For $\delta = 2$

$$I_{i,2}(\zeta,s) = (t_e - t_a)\langle\chi(\zeta;s,i)\rangle + \sum_{h=1}^{i} \left\{ k(0)\langle\chi(\zeta;s,h)\rangle \right.$$

$$\left. V_d(s,h)\left(\prod_{\ell=h+1}^{i} \lambda_\ell\right) \sum_{\ell=h}^{i} \left[\frac{(t_e - t_a)\left(1 - e^{\beta_\ell t_a}\right)}{\beta_\ell \prod\limits_{\substack{f=h \\ f\neq\ell}}^{i} (\lambda_f - \lambda_\ell)}\right]\right\} +$$

$$\sum_{h=1}^{i} \left\{ K_f\langle\chi(\zeta;s,h)V_d(s,h)\left[\prod_{\ell=h+1}^{i} \lambda_\ell\right] \right.$$

$$\left. \sum_{\ell=h}^{i} \left[\frac{(t_e - t_a)\alpha_\ell e^{-\alpha_\ell t_a} - \left(e^{-\alpha_\ell t_a} - e^{-\alpha_\ell t_e}\right)}{\alpha_\ell^2 \prod\limits_{\substack{f=h \\ f\neq\ell}} (\lambda_f - \lambda_\ell)}\right]\right\} . \tag{10.12}$$

For $\delta = 3$

$$I_{i,3}(\zeta,s) = \sum_{h=1}^{i} \left\{ \kappa(0) <\chi(\zeta;s,h)> V_d(s,h) \left(\prod_{\ell=h+1}^{i} \lambda_\ell \right) \right.$$

$$\left. \sum_{\ell=h}^{i} \left[\frac{1 - e^{-\beta_\ell t_a} - \beta_\ell t_a \, e^{-\beta_\ell t_a}}{\beta_\ell^2 \prod_{\substack{f=h \\ f \neq \ell}}^{i} (\lambda_f - \lambda_\ell)} \right] \right\} + \sum_{h=1}^{i}$$

$$\left\{ k_f <\chi(\zeta;s,h) V_d(s,h) \left(\prod_{\ell=h+1}^{i} \lambda_h \right) \sum_{\ell=h}^{i} \right.$$

$$\left. \left[\frac{\alpha_\ell t_a \, e^{-\alpha_\ell t_a} - e^{-\alpha_\ell t_e} + e^{-\alpha_\ell (t_e + t_a)}}{\alpha_\ell^2 \prod_{\substack{f=h \\ f \neq \ell}} (\lambda_f - \lambda_\ell)} \right] \right\} . \qquad (10.13)$$

For $\delta = 4$

$$I_{i,4}(\zeta,s) = \sum_{h=1}^{i} \left\{ k_f <\chi(\zeta;s,h) V_d(s,h) \left(\prod_{\ell=h+1}^{i} \lambda_h \right) \sum_{\ell=h}^{i} \right.$$

$$\left. \left[\frac{e^{-\alpha_\ell t_a} - e^{-\alpha_\ell (t_f - t_e)} - e^{\alpha_\ell (t_e + t_a)} + e^{-\alpha_\ell t_f}}{\alpha_\ell^2 \prod_{\substack{f=h \\ f \neq \ell}}^{i} (\lambda_f - \lambda_\ell)} \right] \right\} . \qquad (10.14)$$

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10.2 ENVIRONMENTAL DOSE COMMITMENT FROM INHALATION OF RADON DAUGHTERS

For k = 2 ,

$$D^e_{TB,Rn,2} = t_e \sum_{\zeta} P(\zeta,t=0)G\left(\frac{t_e}{2}\right)\hat{D}_{TB,Rn}\langle\chi(\zeta;Rn)\rangle \; . \qquad (10.15)$$

10.3 ENVIRONMENTAL DOSE COMMITMENT FROM EXTERNAL EXPOSURES

For k = 3 for external exposures from radioactive materials in air:

$$D^e_{\Psi,i,3} = D^e_{\Psi,i,3}\Big|_p + D^e_{\Psi,i,3}\Big|_{Rn} \; , \qquad (10.16)$$

where

$$D^e_{\Psi,i,3}\Big|_p = \sum_{\zeta} P(\zeta,t=0)\left[\sum_{\delta=1}^{4} G(\bar{t}_\delta)\hat{D}_{\Psi,i,3} \sum_s I_{i,\delta}(\zeta,s)\right] \; . \qquad (10.17)$$

For radon and short-lived daughters in air:

$$D^e_{\Psi,i,3}\Big|_{Rn} = t_e \sum_{\zeta} P(\zeta,t=0)G\left(\frac{t_e}{2}\right)\hat{D}_{\Psi,i,3}\langle\chi(\zeta;i)\rangle \; . \qquad (10.18)$$

Similarly the environmental dose commitment from ground deposited activity (k = 4):

$$D^e_{\Psi,i,4} = \sum_{\zeta} P(\zeta,t=0) \sum_{\delta=1}^{2} G(\bar{t}_\delta)\hat{D}_{\Psi,i,4} I_{i,\delta}(\zeta,s) \; , \qquad (10.19)$$

where
$$I_{i,1}(\zeta) = \sum_{h=\ell}^{i} \left\{ \left[\sum_s \langle\chi(\zeta;s,h)\rangle V_d(s,h)\right]\left(\prod_{\ell=h+1}^{i} \lambda_\ell\right) \sum_{\ell=h}^{i} \left[\frac{t_e\alpha_\ell - \left(1 - e^{-\alpha_\ell t_e}\right)}{\alpha_\ell^2 \prod_{\substack{f=\ell \\ f\neq h}}^{i} (\lambda_f - \lambda_h)}\right]\right\} , \qquad (10.20)$$

and

$$I_{i,2}(\zeta) = \sum_{h=1}^{i} \left\{ \left[\sum_{s} \langle\chi(\zeta;s,h)\rangle V_d(s,h) \right] \left(\prod_{\ell=h+1}^{i} \lambda_\ell \right) \sum_{\ell=h}^{i} \right.$$

$$\left. \left[\frac{1 - e^{\alpha_\ell(t_f - t_e)} - e^{-\alpha_\ell t_e} e^{-\alpha_\ell t_f}}{\alpha_\ell^2 \prod_{\substack{f=\ell \\ f\neq h}}^{i} (\lambda_f - \lambda_h)} \right] \right\} . \qquad (10.21)$$

10.4 ENVIRONMENTAL DOSE COMMITMENT FROM INGESTION (k = 5)

The environmental dose commitment from ingestion of contaminated foods is obtained from integration of the Eq. 9.3:

$$D^e_{\Psi,5} = \int D^P(t,\Psi)\, dt . \qquad (10.22)$$

The integration results in:

$$D^e_{\Psi,5} = P(t=0) \left[\sum_{\delta=1} G(\bar{t}_\delta) \sum_{\beta} \sum_{i} \hat{D}_{\Psi,i,5} I_\beta \langle C_{i\beta}(\bar{t}_\delta)\rangle \right] \qquad (10.23)$$

where $$\langle C_{i\beta}(\bar{t}_\delta)\rangle = \sum_{\zeta} U_{\zeta\beta} \int_{t_\delta}^{t_{\delta+1}} C_{i\beta}(t;\zeta)\, dt . \qquad (10.24)$$

11. UDAD COMPUTATIONAL SYSTEM

Of the two major programs in UDAD, the first--MASTER--computes the atmospheric concentration, ground deposition, dose commitment, dose rate, and time-integrated dose from the data input. From the intake rates obtained, the second program--INTERNAL--computes the dose conversion factors for each tissue of interest.

The theoretical basis and default values for UDAD have been described in the previous sections. The UDAD computer program is written in Fortran IV. Appendix A provides a listing of this code. The execution "deck" for a sample problem is listed in Appendix B and selected portions of the computer output are presented in Appendix C. The sample problem utilizes a cataloged procedure (collection of job control statements) which is listed in Appendix D. This catalogued procedure is only suitable in Argonne's computer environment, but it can serve as a guideline for other IBM installations. The UDAD code has been organized to utilize the overlay feature of the linkage editor. It is not necessary to run the program in this manner; but if it is desired to do so, the required linkage editor input deck (EDT.SYSIN dataset) is listed in Appendix E.

UDAD is divided computationally into two major programs--MASTER and INTERNAL. Figure 11.1 depicts the substructure of the MASTER program, which reads in the input data and computes the atmospheric concentration, ground deposition, dose commitment, dose rate, and time-integrated dose. The calculations are printed as a series of tables, and selected values are stored in disk files for subsequent use by the independent plotting programs CONCPLOT and CONTOUR. The function of each subroutine in MASTER is described in Table 11.1.

Table 11.1. Functions of MASTER Subprograms

Subprogram	*Function*
ACT	Performs multiplication of a matrix and a vector.
ACTDR1	Computes ^{222}Rn decay and daughter products ingrowth.
ACTDR2	Computes factors in a matrix form for radioactive decay ingrowth and physical removal.
AFUNC	Computes standard deviation of plume concentration distribution in vertical direction.
ANC4	A utility numerical integration subroutine.
BLOCK DATA	Initializes program variables and arrays.
CONC	Computes average air and ground concentrations for a specific time interval.
DDEP	Computes source depletion factor.
DFUNC	Double precision version of AFUNC.
DOCOMT	Computes dose commitment values.
DOSAGE	Computes time-integrated dose and dose rate.
DOSPOP	Computes population dose commitment.
EVPDOS	Computes environmental dose commitment.
FERR	Evaluates function #1 for source depletion integration.
FERR1	Evaluates function #2 for source depletion integration.
FODOSE	Computes ingestion dose commitments, time-integrated dose, and dose rate.
FOOD	Computes radionuclide concentrations in foodstuff.
GROUND	Computes time dependent and time-integrated ground contamination values.
HEADER	Generates page headers.
HT	Function to compute effective stack height.
INTEG	Performs numerical integration for source depletion.
KSZFC	Determines if non-zero particle size activity fraction has been assigned for a given particle size index.
MAIN (UDAD)	Main driver of program. Initializes program variables, reads input, prints output, writes disk files.
NSNE	Function that selects proper series of dose conversion factors to be used for a given radionuclide.
PART1	Secondary driver for first part of UDAD: prints all input parameters, executes dispersion calculations.
POLUT	Computes ground-level atmospheric concentration from dispersion of source.
TAILPS	Computes suspension rate of wind blown particulates from an area source.
TAIRR	Computes time dependent and time-integrated air concentration.
VEGFOD	Computes radionuclide concentrations in vegetation.

The INTERNAL program computes the conversion factors for dose commitment, dose rate, and time-integrated dose from the inhalation and ingestion of radioactive materials. Radioactive intake rates are obtained from MASTER, and INTERNAL computes the dose factors for each tissue of interest. The substructure of the INTERNAL code is depicted in Figure 11.2, and the function of each subroutine is described in Table 11.2.

11.1 DESCRIPTION OF INPUT DATA

Input data for the UDAD code can be classified in five groups: source data, receptor data, meteorological data, pollutant data, and population data.

Source Data

Both area and point sources may be specified. For a large-area source it is recommended that one use a series of smaller area sources. This can be done automatically via the IDSQ parameter, which will break up a selected source into a specified number of equal squares. For each source the location, area, effective release height, average annual emission velocity, and the pollutant characteristics must be input. A maximum of 80 sources may be specified.

Receptor Data

The normal UDAD default is 240 receptor locations corresponding to the intersections in a grid pattern of 16 wind sectors and 15 radial distances. Any set of 0-15 radial distances in the range 0.1 to 99.9 km may be selected. A default series of 0.1 to 80 km is built into the program. In addition to the regular receptors, 0-60 selected extra receptor locations may be input by the user. For each selected extra receptor only one food item for ingestion dose estimate is allowed.

Meteorological Data

The stability wind-rose data, which describes the relative frequency of occurrence for each wind direction, wind speed class, and stability category

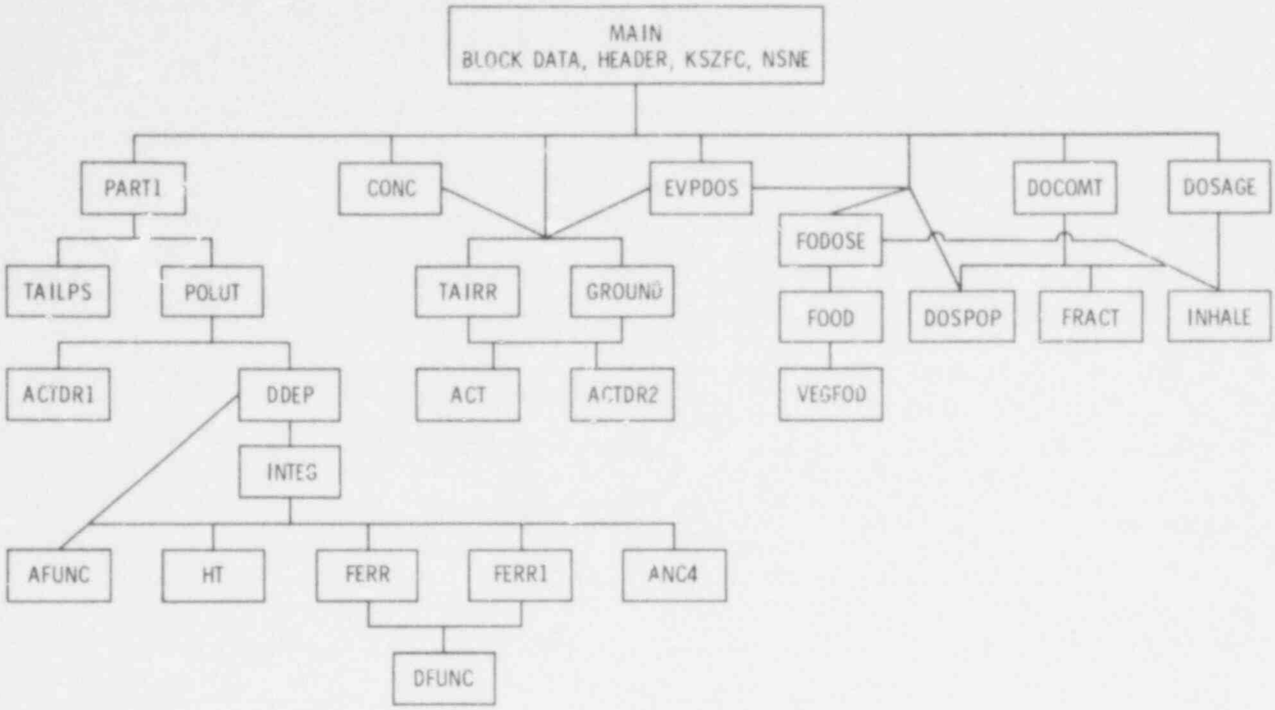

Fig. 11.1. Structure of MASTER.

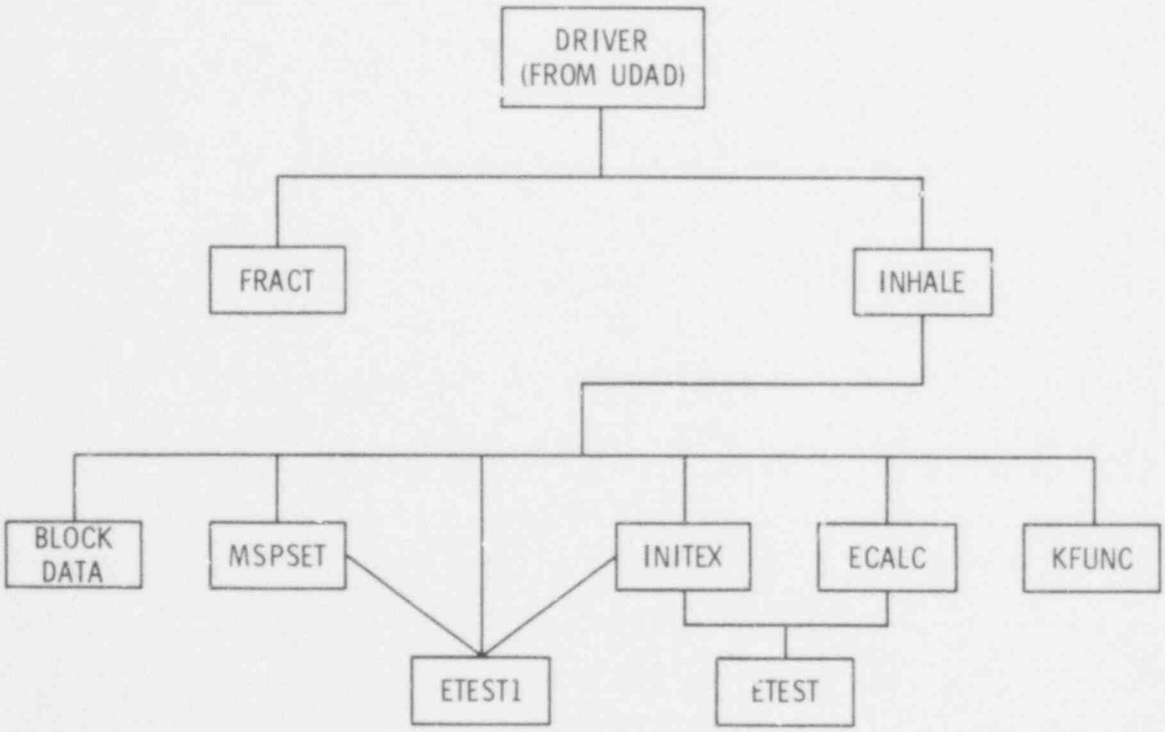

Fig. 11.2. Structure of INTERNAL.

Table 11.2. Functions of INTERNAL Subroutines

Subprogram	*Function*
BLOCK DATA	Initializes program variables and arrays.
ECALC	Evaluates and saves exponentials used by INHALE.
ETEST	Function to test for exponential overflow.
ETEST1	Function to evaluate expression: $[1 - \exp(-\lambda T)]/\lambda$
INITEX	Converts input half-life values to decay constants, calculates effective decay constants.
INHALE	Main driver of program; computes internal dose commitment factors, time-integrated dose, and dose rate.
KFUNC	Function to control respiratory tract flow.
FRACT	Computes deposited fraction in the lung subcompartments as a function of particle size.
MSPSET	Evaluates quantities needed for multiple subpath calculations.

combination as observed for the region, must be specified. The complete set of stability wind-rose data consists of 576 frequency values: a combination of 6 stability categories, 16 wind directions, and 6 wind speed classes.

Pollutant Data

For particulate pollutants the particle-size distribution, density, and deposition velocity must be specified. Up to five particle sizes and five size distributions may be input by the user.

Population Data

Population data for the 240 sector-segments corresponding to the 16 wind sectors and 15 radial distances may be specified. They are used for population-dose calculations.

11.2 INPUT DATA INSTRUCTIONS

This section describes the problem input data for the UDAD code. The first card always contains a single parameter, ISTEP, in column 1. ISTEP allows the calculations to be broken into multiple independent jobs. This is useful for cases involving many sources where computer time requirements could become excessive. In addition, it is possible to run several types of dosimetry calculations without rerunning the expensive dispersion computations. The allowed ISTEP values are:

0, do complete UDAD as one job.
1, stop at end of dispersion calculations; save all data.
2, resume UDAD where ISTEP=1 left off.
3, same as ISTEP=2 plus read in new dosage parameter values.
4, same as ISTEP=0 plus save all data as in ISTEP=1.

All other UDAD data is input via the unformatted NAMELIST READ statement. The following is a direct quote from the IBM Fortran IV Language manual:

Input data must be in a special form in order to be read using a NAMELIST list. The first character in each record to be read must be blank. The second character in the first record of a group of data records must be an &, immediately followed by the NAMELIST name. The NAMELIST name must be followed by a blank and must not contain any embedded blanks. This name is followed by data items separated by commas. (A comma after the last item is optional.) The end of a data group is signaled by &END.

The form of the data items in an input record is:

<u>symbolic name</u> = <u>constant</u>

The <u>symbolic name</u> may be an array element name or a variable name. Subscripts must be integer constants. The <u>constant</u> may be integer, real, literal, complex, or logical. (If the constants are logical, they may be the form of T or .TRUE. and F or .FALSE) *array name = set of constants (separated by commas)*

*The set of constants consists of constants of the type integer, real, literal, complex, or logical. The number of constants must be less than or equal to the number of elements in the array. Successive occurrences of the same constant can be represented in the form k*constant, where k is a nonzero integer constant specifying the number of times the constant is to occur.*

The variable names and array names specified in the input data set must appear in the NAMELIST list, but the order is not significant. A name that has been made equivalent to a name in the input data cannot be substituted for that name in the NAMELIST list. The list can contain names of items in COMMON but must not contain dummy argument names.

Each data record must begin with a blank followed by a complete variable or array name or constant. Embedded blanks are not permitted in names or constants. Trailing blanks after integers and exponents are treated as zeros.

A list and description of all NAMELIST input variables is presented in Table 11.3. There are two such sets: INDATA and NEWSET. NEWSET is used only in conjunction with ISTEP = 3 to input new parameter values. All NEWSET members are a subset of the INDATA list and are marked by an asterisk preceding the symbolic name. Array variables are indicated by a Fortran dimension in parentheses following the symbolic name. Variable types follow default Fortran first letter conventions except as indicated immediately below the symbolic name. UDAD default values will be used for any variable not included in the NAMELIST input.

11.3 OUTPUT DATASETS

UDAD uses three output data sets: Fortran reference numbers 8, 9, 10. This is in addition to the regular Fortran print file, reference number 6. The output datasets are used as follows:

FT08F001 Binary data used to construct concentration and working level

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Table 11.3. NAMELIST Variables

Symbolic Name	*Description*
&INDATA	This is the 2nd data deck card if ISTEP=0, 1, or 4.
&NEWSET	This is the 2nd data deck card if ISTEP=3
*BSV (6) (i)	Concentration factor for plant uptake of nuclide i from soil, pCi/kg (plant)/pCi/kg (soil). Default values: i=1 U238 2.5E-3, i=2 U234 2.5E-3, i=3 Th230 4.2E-3 i=4 Ra226 3.1E-4, i=5 Pb210 6.8E-2, i=6 Po210 1.5E-1
*DFACT	Decontamination factor for human consumed vegetation. Default value = 0.5.
DM	Annual average mixing depth, m. Default = 850.
*DV (2) (i)	Pastures and vegetation yields, kg/m2. Defaults: i=1 pastures 0.75, i=2 vegetation 2.0.
*E(10,12) (i,j)	Effective energy absorbed per disintegration (MEV*REM/DIS*RAD), where i and j denote the radionuclide and organ, respectively. Default values are based on ICRP reports.

j	Organ or body part
1	Nasopharyngeal
2	Tracheobronchial
3	Pulmonary
4	Whole body
5	Bone
6	Kidney
7	Liver
8	Stomach
9	Small intestine
10	Upper large intestine
11	Lower Large intestine
12	Lymph nodes

Default values:

j\i	U238	U234	Th230	Ra226	Pb210	Po210
1	4.3E+1	4.9E+1	4.8E+1	1.1E+2	6.1E-1	5.5E+1
2	4.3E+1	4.9E+1	4.8E+1	1.1E+2	4.8E-1	5.5E+1
3	4.3E+1	4.9E+1	4.8E+1	1.1E+2	8.3E+0	5.5E+1
4	4.3E+1	4.9E+1	4.8E+1	1.1E+2	5.2E+0	5.5E+1
5	2.2E+2	2.4E+2	2.4E+2	1.1E+2	2.9E+1	2.8E+2
6	4.3E+1	4.9E+1	4.8E+1	1.1E+2	1.0E+1	5.5E+1
7	4.3E+1	4.9E+1	4.8E+1	1.1E+2	1.0E+1	5.5E+1
8	4.3E-1	4.8E-1	4.7E-1	4.8E-1	2.7E-2	5.3E-1
9	4.3E-1	4.9E-1	4.7E-1	4.8E-1	4.5E-2	5.3E-1
10	4.3E-1	4.8E-1	4.7E-1	4.8E-1	1.9E-2	5.3E-1
11	4.3E-1	4.8E-1	4.7E-1	4.8E-1	1.9E-2	5.3E-1
12	4.3E+1	4.9E+1	4.8E+1	1.1E+2	2.5E+1	5.5E+1

*FCON (6,5) (i,j)	Stable element transfer data, day/kg, where i and j denote the radionuclide and the food item respectively. j values: 1=beef, 2=milk, 3=poultry, 4=eggs, 5=vegetation

Default values:

j\i	U238	U234	Th230	Ra226	Pb210	Po210
1	3.4E-4	3.4E-4	2.0E-4	4.0E-3	2.9E-4	1.2E-2
2	6.1E-4	6.1E-4	5.0E-6	4.5E-4	2.6E-4	1.4E-4
3	4.0E-3	4.0E-3	4.0E-3	5.0E-4	2.0E-3	4.0E-3
4	2.0E-3	2.0E-3	2.0E-3	2.0E-5	2.0E-3	1.8E-2
5	2.0E+0	2.0E+0	3.0E+1	5.0E+1	1.0E+2	5.0E+2

Table 11.3. Continued

Symbolic Name	*Description*
*P1 (10) (i)	Fraction of radionuclide i passing from GI tract to the blood. Default values are based on ICRP2. Defaults: i=1 U238 1.0E-2, i=2 U234 1.0E-2, i=3 Th230 1.0E-4, i=4 Ra226 3.0E-1, i=5 Pb210 8.0E-2, i=6 Po210 6.0E-2
*F2P (10,4) (i,j)	Fraction of radionuclide i passing from blood to body organ j. j values: 1=whole body, 2=bone, 3=kidney, 4=liver. Defaults:

j\i	U238	U234	Th230	Ra226	Pb210	Po210
1	1.0E+0	1.0E+0	1.0E+0	5.4E-1	1.0E+0	1.0E+0
2	1.1E-1	1.1E-1	7.0E-1	5.4E-1	2.8E-1	1.0E-1
3	1.1E-1	1.1E-1	5.0E-2	2.0E-3	1.4E-1	7.0E-2
4	0.0	0.0	5.0E-2	4.0E-4	8.0E-2	1.7E-1

Symbolic Name	*Description*
*F2PM (16)	Multiple subpath values of F2P, see MSPTAB. Defaults: 2.9E-1 1.1E-1 4.0E-2 2.0E-2 2.9E-1 1.1E-1 4.0E-2 2.0E-2 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
*FG	Grazing factor, default=0.5.
*FOODIN (2,3) (i,j)	Animal food ingestion rate, kg/day, where i and j denote the food category and animal type respectively. Defaults:

i\j	beef cattle	milk cows	poultry
water	50	60	0.3
pasture	50	50	0.12

Symbolic Name	*Description*
FREQ (16,6,6) (i,j,k)	Annual relative frequency of occurence for wind direction i, wind speed class j, and stablity class k. For each stability class and wind speed the frequencies are entered in a clockwise direction beginning with the north sector. No defaults; values must be input.
*FV (2) (i)	Fraction of deposition retained on plants. Default values: i=1 pasture 0.2, i=2 vegetation 0.2.
GROUPN(5,9) (i,j)	Any desired combination of 20 letters and numbers which will serve as an identifier on the printed output for the jth source type, i.e., mine, dryer, etc. (Card entry consists of groups of 4 characters, each enclosed in single quotation marks followed by a comma.)
IADD	Number of extra receptors, allowable range 0-60, default=0.
IDSQ (3,6) (i,j)	Identifies area sources to be broken up into equal size squares: i=1, SOURCE(10,k) or four digit identifier for kth source; i=2, number of squares in EW direction, i=3, number of squares in NS direction; all for jth source selected to be broken up. No defaults.
IDTAIL (5) (i)	Identification of up to 5 types of area source where the UDAD wind errosion equation will be used for particulate source estimation. Each ith value must be identical to the source type index of SORCE, i.e., the 2nd integer of SORCE(10,j) for the jth source. Area sources so selected may specify zero emission rate for all pollutants except Rn222. No defaults.

Table 11.3. Continued

Symbolic Name	*Description*
*IFODOS (60) (i)	Food pathway index for the ith extra receptor. 0=none, 1=meat, 2=milk, 3=poultry & eggs, 5=vegetation. Default=0.
IPOP (15,16) (i,j)	Population of sector-segment centered at ith radial distance and jth direction.
*IPSOL (10) (i)	Solubility class (1=Y, 2=W, 3=D) for ith radionuclide. Defaults: i=1 U238 1, i=2 U234 1, i=3 Th230 1, i=4 Ra226 2, i=4 Pb210 2, i=6 Po210 2.
*IRHO (6)	Specifies the six XRHO indices to be used for dosimetry tables. Default: 1, 3, 7, 8, 12, 15 corresponding to 0.1, 1, 5, 10, 50, 80 km.
*IYR (10)	Selects end year for intervals in time-integrated dose and dose rate calculations. Default: 1, 3, 5, 7, 10, 15, 20, 30, 50, 70 years.
*JC (9) (i)	Program control flags: 0 turns action off, 1 turns it on. Defaults = 0. i=1, writes disk file for concentration plots. i=2, writes disk file for isopleth plots. i=3, prints EFFECTIVE DISPERSION FACTOR tables. i=4, prints CONCENTRATION/MPC tables. i=5, prints dose commitment tables. i=6, prints time-integrated dose & dose rate tables. i=7, currently not in use. i=8, prints INDIVIDUAL SOURCE CONCENTRATION tables. i=9, currently not in use.
KRHO	Specifies number of radial distances to be used for regular receptor grid. Range 0-15, default = 15. If set to zero, only extra receptors will be used, which is frequently a convenient option.
*LON (10,4) REAL (i,j)	Effective half-life in days for radionuclide i and organ j. j values: 1=whole body, 2= bone, 3=kidney, 4=liver. Default values based IRCP reports. Defaults:

j\i	U238	U234	Th230	Ra226	Pb210	Po210
1	1.0E+2	1.0E+2	5.7E+4	4.0E-1	1.2E+3	2.5E+1
2	3.0E+2	3.0E+2	7.3E+4	4.0E-1	2.4E+3	2.0E+1
3	1.5E+1	1.5E+1	2.2E+4	1.0E+1	4.9E+2	4.6E+1
4	0.0	0.0	5.7E+4	1.0E+1	1.5E+3	3.2E+1

Symbolic Name	*Description*
*LONM (16) Real	Multiple subpath values of LON, see MSPTAB. Defaults: 4.95E+0 5.78E+1 6.93E+2 5.33E+3 4.95E+0 5.78E+1 6.93E+2 5.33E+3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
*LR (10) Real (i)	Radiological half-lifes in days for radionuclides of interest. Defaults: i=1 U238 1.6E12, i=2 U234 9.1E7, i=3 Th230 2.9E7 i=4 Ra226 5.9E5, i=5 Pb210 7.1E3, i=6 Po210 1.4E2
METSET (4) Real*8	Any desired combination of 32 letters and numbers which will serve as an identifier on the printed output for the source of the meteorological data set. (Card entry starts with a single quotation mark and ends with a single quotation mark followed by a comma.)

560 093

Table 11.3. Continued

Symbolic Name	*Description*
*MPC (7,5) Real(i,j)	Maximum permissible concentration (or any desired limit) for normalization on the isopleth concentraion map, pCi/m3, for radionuclide i and organ j. Default values based on ICRP2 values. j values: 1=whole body, 2=bone, 3=lung, 4=kidney, 5=liver. Defaults:

i\j	1	2	3	4	5
U238	6.0E+2	2.0E+2	5.0E+1	3.0E+1	0.0
U234	6.0E+2	2.0E+2	4.0E+1	4.0E+2	0.0
Th230	5.0E+0	8.0E-1	3.0E+0	2.0E+0	7.0E+0
Ra226	2.0E+1	1.0E-1	0.0	0.0	0.0
Pb210	4.0E+2	7.0E+1	8.0E+1	4.0E+1	1.0E+2
Po210	2.0E+3	2.0E+3	7.0E+1	2.0E+2	6.0E+2
Rn222	0.0	0.0	3.0E+3	0.0	0.0

Symbolic Name	*Description*
*MSPTAB (10,4) (i,j)	Multiple subpath table for radionuclides i and organs j where multiple sets of F2P and LON values are required. A zero value indicates no subpath, units value (1-9) gives number of additional subpatns, and value/10 is entry index in F2P and LON arrays. j values: 1=whole body, 2=bone, 3=kidney, 4=liver. Defaults:

j\i	U238	U234	Th230	Ra226	Pb210	Po210
1	0	0	0	14	0	0
2	0	0	0	54	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0

Symbolic Name	*Description*
*NNUC	Total number of radionuclides of interest. UDAD allowable range is 1-6, default is 6.
NSORCE	Total number of sources. Input value must be actual number described via SORCE parameter. If IDSQ feature is used, UDAD will adjust to a corrected NSORCE. The maximum number of sources, including IDSQ components, is 80.
OPTIME	Plant operation lifetime, years. Default=15.
PACT (4,5) (i,j)	Activity in pCi/g of radionuclide i of particle size<20 um diameter of area source j. The j index corresponds to IDTAIL(j). i values: 1=U238, 2=Th230, 3=Ra226, 4=Po210.
PDEN (5)	Densities of five specified particle source indices, g/cm3. Defaults: 8.9, 2.4, 2.4, 2.4, 2.4.
*PFIN (8) (i)	Fraction of ith food produced within the region of interest that is consumed by the local population in the region. i values: 1=meat, 2=milk, 3=poultry, 4=eggs, 5=vegetation, 6-8 not assigned. Defaults: all=1.0.
*PGTH (4) (i)	Population growth rate = population at year Y(i)/population at the reference year Yo when sources start to release. i=1, Y(i) = Yo + 1 i=2, Y(i) = Yo + (OPTIME + 1)/2 i=3, Y(i) = Yo + OPTIME + 1 i=4, Y(i) = Yo + OPTIME + YEVD/2 + 1 Defaults: all=1.0.
PHALF	Radionuclide removal half life from soil in years. Default=50.

Table 11.3. Continued

Symbolic Name	*Description*
PTAIL (7,5) (i,j)	Propterty of soil or tailings for the jth type of area source where j index corresponds to IDTAIL(j). i values: i=1, density of suspended particulates, gm/cm3. i=2, median diameter of the grain, cm. i=3, a dimensionless coefficient for grains with median diameter above 100 um, A=0.1. i=4, height above surface where wind speed measured, cm. i=5, surface roughness height, or height above surface where wind speed is zero, cm. i=6, particle mass percentage of soil < 20 um in diameter. i=7, water content in percent by weight. Defaults: (see table below)

j\i	1	2	3	4	5	6	7
1	2.4	0.03	0.1	100.0	1.0	3.0	0.1
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0

Symbolic Name	*Description*
PTSZ (5)	Activity particle sizes, diameter in microns. Defaults=0.
PTSZFC (5,5) (i,j)	Particle size activity fraction for ith size and jth source. The i and j indices correspond to PTSZ(i) and PDEN(j) respectively. Defaults=0.
PTSZ20 (5) (i)	Activity fraction of suspended particulates with particle size < 20 um for ith area source. The i index corresponds to IDTAIL(i). Defaults: all=0.4.
*PWFOD (60) (i)	Amount of kth food item produced at added receptor i/ total kth food item produced within the region of interest. Defaults: all=1.0.
REGION (6)	Any desired combination of 24 letters and numbers which will serve as in identifier of the overall problem on the printed output. (Card input format is the same as for METSET.)
RFI	Average occupancy factor for the population inside a structure for inhalation of Rn222 daughters. Default=1.0.
*RFIE	Average occupancy factor inside a structure for protection against external radiation. Default=0.583.
*RHO (2) (i)	Effective surface density of soil for growing pastures and and vegetation, kg/m2. Defaults: i=1 pastures 2.4E2, i=2 vegetation 2.4E2.
*RSALF	Resuspension factor decay half life in years, default=0.137.
*RSLIM	Deposition velocity corresponding to the input resuspension factors SUFI and SUFF. Default=0.01 m/sec.
*SHIED	External radiation shielding factor for inside of a structure. Default=0.5.
SLIM	Minimum settling velocity to account for plume tilting, m/sec. Default = 0.01.
SLIP (5) (i)	Slip correction factor, for ith particle size, defaults = 1.0.

Table 11.3. Continued

Symbolic Name	*Description*
SOURCE (12,80) (i,j)	Specification parameters for the jth source. i values: i=1, horizontal (EW) coordinate of source, km. i=2, vertical (NS) coordinate of source, km. i=3, effective release height of source, m. i=4, release area of source, km2 (zero for a point source). i=5, annual average U238 emission rate, Ci/year. i=6, annual average Th230 emission rate, Ci/year. i=7, annual average Ra226 emission rate, Ci/year. i=8, annual average Pb210 emission rate, Ci/year. i=9, annual average Rn222 emission rate, Ci/year. i=10, four digit integer for source j identification where the 1st integer is the source group index, the 2nd integer is the source type index, the 3rd & 4th integers represent the nth number of source falling into this source category. i=11, particle density index, corresponds to PDEN(k). i=12, exit velocity of source, m/sec.
SORCID (5,9) (i,j)	Any desired combination of 20 letters or numbers which will serve as an identifer on the printed output for the jth source group where j equals the 1st digit of SORCE(10,k) for the kth source. (Card entry is the same format as for GROUPN.)
*SUFF	Final resuspension factor. Default=1.0E-9/m.
*SUFI	Initial resuspension factor. Default=1.0E-5/m.
*TC (2) (i)	Plant exposure time, days. Defaults: i=1 pastures 30, i=2 vegetation 60.
*TW (2) (i)	Weathering removal half life, days. Defaults: i=1 pastures 14, i=2 vegetation 14.
VDEP (5) (i)	Deposition velocity, m/sec, for particle size PTSZ(i). Defaults: all=0.01.
*XIN (7) (i)	Maximum individual food consumption rate, kg/day. See XING for defaults.
*XING (7) (i)	Average individual food consumption rate, kg/day. Defaults:

	XIN	XING
i=1, meat	0.3	0.26
i=2, milk	0.85	0.33
i=3, poultry	0.2	0.1
i=4, eggs	0.08	0.08
i=5, vegetation	0.77	0.28

Symbolic Name	*Description*
XNAME (4,60) REAL*8 (i,j)	Any desired combination of 32 letters and numbers which which will serve as an identifer on the printed output for extra receptor j. (Card input format is the same as for GROUPN except use 8 character groups).
XRECEP (3,60) (i,j)	Coordinates and height of jth extra receptor. i=1, horizontal (EW) coordinate, km. i=2, vertical (NS) coordinate, km. i=3, height in m.
XRHO (15)	Fifteen radial distances to be used for regular receptor grid. Defaults: 0.1, 0.5, 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70, 80 km. (Note that actual numer of XRHO values used is set by KRHO).
*YDOC	Number of years to be used for internal dose commitment conversion factors. Default=50.
*YEVD	Number of years to be used for environmental dose commitment calculations. Default=100.

560 096

plots vs. distance. In the case of a multiple step UDAD job (ISTEP>0), this dataset also contains a dump of all data needed to restart the program.

FT09F001 EBCDIC file of log (concentration/MPC) and point coordinates used to construct isopleth plots. All records are 80 bytes.

FT10F001 Special print file, used to produce effective dispersion factor tables, 133 byte records.

11.4 PLOTTING PROGRAMS

CONCPLOT Program

CONCPLOT is a Fortran IV main program that uses the proprietary software package DISSPLA. The only input required is the FT08F001 disk file generated by UDAD. Log-log plots of distance vs. concentration in air and on the ground are produced for ^{238}U, ^{226}Ra, ^{210}Pb, and ^{222}Rn. A working-level plot is also prepared. Five curves are generated on each plot for directions theta, north, east, south and west, where theta is the direction of maximum dispersion.

CONTOUR Program

CONTOUR is a PL/1 program that serves as a data selector and generator for CONTOUR.BLACKBOX, an Argonne version of a proprietary contour mapping program. Input data are the FT09F001 disk file generated by UDAD and a 2- to 6-card user-supplied deck (ISO.SYSIN dataset of cataloged procedure). The output is one or two isopleth plots of log of concentration divided by MPC for selected tissues and radionuclides.

Input Data Instructions for CONTOUR

The first card indicates grid spacing and contour interval for the one or two isopleth plots produced for each selected organ and nuclide. Leave grid field blank to obtain default values; set grid field negative to omit plot type. First card also includes seldom-used options for including the extra receptors for contour generation and for linear instead of quadratic fit in interpolations.

1st card, PL/1 Format (4 F(5,2), 2 (X(4), F(1))):

Col	1- 5	Grid #1, default = 2 km squares.
	6-10	Contour interval #1, default = 0.25 log units.
	11-15	Grid #2, default = 20 km squares.
	16-20	Contour interval #2, default = 0.50 log units.
	25	Include additional receptors if = 1, default = 0.
	30	Linear interpolation if = 1, quadratic default if = 0.

Cards 2-6, Pl/1 Format (A(6), 7 (X(1), A(5))):

Col	1-6	'BODY', 'BONE', 'LUNG', 'KIDNEY', OR 'LIVER'.
	8-48	1 TO 7 nuclides in any order: 'U238', 'U234', 'TH230', 'RA226', 'PB210', 'PO210', 'RN222'.

Example of 20 km squares only for ^{238}U and ^{230}Th on whole body, ^{226}Ra on bone, and ^{222}Rn on lung:

```
//ISO.SYSIN  DD  *
  -1.
BODY   U238  TH230
BONE   RA226
LUNG   RN222
```

12. SAMPLE PROBLEM DESCRIPTION

A sample problem was selected for illustrating the actual application of the UDAD program. The sample problem considered is a typical uranium mill processing 1800 metric tons per day of an ore containing an average of 0.16% U_3O_8.

The procedures for calculating the source terms (annual release rates) utilized as input in UDAD are presented in the following subsections. The source terms are based on the selected mill operational parameters given in Table 12.1, and the calculated source terms are summarized in Table 12.2.

12.1 ORE PAD AND GRINDING OPERATIONS

Radon

The activity of ^{222}Rn available for release from the decay of ^{226}Ra from each gram of ore during storage on the ore pad is

$$^{222}\text{Rn activity} = EC_{Ra}\lambda T \ , \qquad (12.1)$$

where E is the emanating power, 0.2,

C_{Ra} is the concentration of ^{226}Ra in ore, 450 pCi/g,

λ is the decay constant for ^{222}Rn, 0.18/day, and

T is the storage time on ore pad, 10 days.

Since the ore processing rate is 1800 MT/day, the ^{222}Rn emission rate is:

$$0.2 \times 450 \times 0.181/\text{day} \times 10 \text{ days } \frac{\text{pCi}}{\text{g}} \times (1800 \times 365) \frac{\text{MT}}{\text{yr}}$$

$$\times 10^6 \frac{\text{g}}{\text{MT}} \times 10^{-12} \frac{\text{Ci}}{\text{pCi}} = 107 \text{ Ci/yr} \ . \qquad (12.2)$$

Table 12.1. Principal Characteristic Operational Parameters of the "Problem Mill" Utilized for the Calculation of Source Terms

Parameter	*Value*
Ore quality, U_3O_8	0.16 %
Ore activity, ^{238}U	450 pCi/g
^{230}Th	450 pCi/g
^{226}Ra	450 pCi/g
^{210}Pb	450 pCi/g
Ore process rate	1800 MT/yr
Operating days per year	365 days
Operating lifetime	15 years
Ore storage time	10 days
Dry tailing density	2.4 g/cm^3
Tailing activity, ^{238}U	45 pCi/g
^{230}Th	450 pCi/g
^{226}Ra	450 pCi/g
^{210}Pb	450 pCi/g
Tailing beach area	5×10^5 m^2
Yellowcake drying & packaging stack effluent, U_3O_8	0.7 kg/day

Table 12.2. Source Terms for the Problem Mill

Emission Source	*Emission Coordinates* x,m	y,m	z,m	*Area* m^2	*Emission Rate, Ci/yr* U-238	Th-230	Ra-226	Pb-210	Rn-222
Ore pad and grinding	0.0	0.1	5	0[a]	1.36×10^{-3}	1.36×10^{-3}	1.36×10^{-3}	1.36×10^{-3}	107
Product drying and packaging	0	0	15	0[a]	7.2×10^{-2}	3.58×10^{-3}	1.43×10^{-4}	1.43×10^{-4}	0.0
Tailings[b]	130	-270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	310	-270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	490	-270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	670	-270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	130	-90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	310	-90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	490	-90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	670	-90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	130	90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	310	90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	490	90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	670	90	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	130	270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	310	270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	490	270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}
	670	270	0	3.13×10^{4}	8.73×10^{-4}	1.18×10^{-2}	1.24×10^{-2}	1.24×10^{-2}	4.38×10^{2}

[a]Point source is assumed.

[b]70% of particulates emitted with median size of 35 μ (10 - 80 μ). 30% of particulates emitted with median size of 5 μ (0 - 10 μ).

Particulates

The amount of particulates released from ore pad storage, crushing, and grinding is based on the following assumptions:

From the ore pad,	1 MT/year
From the crushing operation,	0.25 g/MT of ore
From the grinding operation,	0.15 g/MT of ore

The total annual release is:

$$1\ \text{MT/year} + (0.25 + 0.15)\ \text{g/MT} \times 1800\ \text{MT/day} \times 365\ \text{days/year} \times 10^{-6}\ \text{MT/g} = 1.26\ \text{MT/year}\ . \tag{12.3}$$

The activity released annually is:

$$1.26\ \text{MT/year} \times 10^{6}\ \text{g/MT} \times 450\ \text{pCi/g} \times 10^{-12}\ \text{Ci/pCi} \times 2.4\ \left(\frac{\text{specific activity of released fraction}}{\text{average specific activity of ore}}\right) = 1.36 \times 10^{-3}\ \text{Ci/year}\ . \tag{12.4}$$

This is the activity of each of the radionuclides ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Pb, and ^{210}Po. It is assumed to be in the form of particulates having an activity median diameter of 1.0 μm.

12.2 YELLOWCAKE DRYING AND PACKAGING

Radon

The radon release from the drying and packaging processes is negligible.

Particulates

Yellowcake is assumed to contain ^{238}U, ^{230}Th, ^{226}Ra, ^{210}Pb, and ^{210}Po in the following ratio: 1:0.05:0.002:0.002:0.002.

Dust emission during product drying and packaging is controlled by passing the off-gas from the drying and packaging areas through a dust separation system before the gas is discharged through a roof stack.

Dust emission is assumed to be 0.7 kg U_3O_8 per day having an activity median diameter of 1.0 μm.

The ^{238}U emission rate is:

$$700 \frac{g}{day} \times 365 \frac{day}{yr} \times \frac{0.85 \text{ g U}}{g\ U_3O_8} \times 3.33 \times 10^{-7} \frac{Ci}{g} = 7.2 \times 10^{-2} \frac{Ci}{yr} . \quad (12.5)$$

The ^{230}Th emission rate is:

$$7.2 \times 10^{-2} \frac{Ci}{yr} \times 0.05 = 3.6 \times 10^{-3} \frac{Ci}{yr} . \quad (12.6)$$

The ^{226}Ra, ^{210}Pb, and ^{210}Po activity is:

$$7.2 \times 10^{-2} \frac{Ci}{yr} \times 0.002 = 1.4 \times 10^{-4} \frac{Ci}{yr} . \quad (12.7)$$

12.3 TAILINGS

Radon

The radon flux from beach area (i.e., area not covered by solution) is assumed on the average to be 1.0 pCi $^{222}Rn/m^2$-sec per pCi $^{226}Ra/g$ of tailings. With a ^{226}Ra concentration of about 450 pCi/g in the tailings the annual rate of radon release is:

$$450 \frac{pCi\ ^{226}Ra}{g\ tailing} \times 1.0 \left(\frac{pCi\ ^{222}Rn}{m^2\text{-sec}} \Big/ \frac{pCi\ ^{226}Ra}{g\ tailing}\right) \times 10^{-12} \frac{Ci}{pCi}$$

$$\times 5.0 \times 10^5\ m^2 \times 3.15 \times 10^7 \frac{sec}{yr} = 7 \times 10^3 \frac{Ci}{yr} . \quad (12.8)$$

Particulates

The release of radioactive particulates by wind erosion of tailings is a function of wind speed, area, concentration, and the distribution of radioactive concentrations. The emission rate is estimated using the equations described in Section 5.

The particulate release rates were calculated based on the following parameters:

Surface roughness height, z_0 = 1 cm

Density of tailings grains, α = 2.4 g/cm^3

Average grain diameter, d = 300 μm

Percent of tailings mass that is smaller than 20 μm, p = 3.0

Specific activity of radionuclide i in tailings with particle size less than 20 μm in diameter, I_{20}:

^{238}U	450 × 0.07 × 2.4 = 75.6 pCi/g
^{234}U	450 × 0.07 × 2.4 = 75.6 pCi/g
^{230}Th	450 × 0.95 × 2.4 = 1026 pCi/g
^{226}Ra	450 × 0.998 × 2.4 = 1078 pCi/g
^{210}Pb	450 × 0.998 × 2.4 = 1078 pCi/g
^{210}Po	450 × 0.998 × 2.4 = 1078 pCi/g

The activity fraction of suspended particulate for sizes less than 20 μm in diameter was assumed to be F_{20} = 0.4. Moisture in surface tailings was assumed to be the average W = 0.1%.

The sample problem input data together with the Job Control Cards required to run the program on IBM 370/195 are listed in Appendix B. The printed output and the concentration plots from the sample problem are provided in Appendix C.

APPENDIX A. COMPILER LISTING OF UDAD PROGRAMS

APPENDIX A. COMPILER LISTING OF UDAD PROGRAMS

```
FORTRAN IV G1  RELEASE 2.0          MAIN              DATE = 79078          16/02/04

            C*********************************************************************
            C                                                                    *
            C              URANIUM DISPERSION AND DOSIMETRY (UDAD)               *
            C                                                                    *
            C                     VERSION IX, 03/19/79                           *
            C                                                                    *
            C*********************************************************************
            C                                                                    *
            C  DISPERSION - DOSIMETERY AND EFFECTS OF URANIUM MINING & MILLING    *
            C                                                                    *
            C        MICHAEL H. MOMENI, YUCHIEN YUAN AND A. J. ZIELEN            *
            C                                                                    *
            C              DIVISION OF ENVIRONMENTAL IMPACT STUDIES              *
            C                                                                    *
            C                    ARGONNE NATIONAL LABORATORY                     *
            C                                                                    *
            C                                                                    *
            C A COMPREHENSIVE COMPUTER PROGRAM TO PROVIDE ESTIMATES OF POTENTIAL  *
            C RADIATION EXPOSURE TO INDIVIDUALS AND TO THE GENERAL POPULATION IN  *
            C          THE VICINITY OF A URANIUM PROCESSING FACILITY             *
            C                                                                    *
            C                                                                    *
            C*********************************************************************
            C
0001              REAL*8 METSET,XNAME,ORGAN,BREP,TODAY
0002              REAL*4 LON,LR,MPC,LONM
            C
            C     KEY TO COMMON BLOCKS:
            C
            C     UDADC1 - MOSTLY SELECTED NAMELIST DATA (+ A FEW OTHERS).  USED BY
            C              UDAD9,BLOCKDATA,DDEP,INTEG,POLUT,HEADER,TAIRR,GROUND,
            C              DOCOMT,DOSPOP,FODOSE,VEGFOD,EVFDOS,PART1,CONC,DOSAGE,FOOD
            C     UDADC2 - USED BY UDAD9,BLOCKDATA,DDEP,INTEG,HT,POLUT,TAILPS,
            C              PART1,AFUNC,DFUNC
            C     UDADC3 - USED BY UDAD9,BLOCKDATA,DOCOMT,DOSPOP,FODOSE,EVPDOS,
            C              DOSAGE,CONC
            C     UDADC4 - USED BY UDAD9,BLOCKDATA,POLUT,HEADER,TAIRR,GROUND,DOCOMT,
            C              DOSPOP,FODOSE,VEGFOD,PART1,CONC,DOSAGE
            C
            C     INHAL1 - INHALE PARAMETERS THAT ARE IN NAMELIST; USED BY UDAD9,
            C              DOCOMT,DOSAGE,CONC
            C     INHAL2 - INHALE PARAMETERS LOCAL TO INHALE PROGRAM SERIES
            C     INHAL3 - DERIVED INHALE DATA LOCAL TO INHALE PROGRAM SERIES
            C
            C     ATA    - LOCAL TO ACTDR2,ACT,TAIRR,GROUND
            C     CFOD   - LOCAL TO FODOSE,FOOD,VEGFOD
            C     DCFQ   - LOCAL TO DOCOMT AND DOSPOP
            C     DEPY   - LOCAL TO DDEP AND POLUT
            C     DSPRSN - LOCAL TO PART1,POLUT
            C     DSTBZ  - LOCAL TO INTEG,FERR,FERR1,DFUNC
            C     EVD    - LOCAL TO DOSPOP, EVPDOS, FODOSE
            C     INTG   - LOCAL TO DDEP AND INTEG
            C     QDCAY  - LOCAL TO TAIRR AND GROUND
            C     TCNGY  - LOCAL TO CONC, DOSAGE, AND FODOSE
            C
```

560 106

```
0003            COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
               1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
               2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
               3   PFIN(8),PWFOD(60),UPTIME,NPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
               4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
               5   FCON(6,5),RHO(2),DV(2),TH(2),TC(2),FV(2),BSV(6),YEVD
0004            COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
               1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
               2   ISORC1,KSORCE,IND,IWS,ISTAB,IW3D,IWSE
0005            COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),FBK(3),TA,
               1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
               2   WHO(3,2),FROM(5,4),DCONV(6,4)
0006            COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
               1   THETAS(16),WINDR(16),RHALF(6),FHALF,CF(4),PBDR(2,300),RN(300),
               2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
               3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0007            COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
               1   IPSOL(10),NNUC,NSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0008            DIMENSION CACTIV(5,300),CPOLUT(5,300),RF(7),RFLG(7),WLFACT(3),
               1    BUF1(1244),BUF3(443),BUF4(20454),T(16)
          C
0009            EQUIVALENCE (TCNGO(1,1),CACTIV(1,1)),(TCNGC(1,1),CPOLUT(1,1)),
               1   (BUF1(1),METSET(1)),(BUF3(1),ORGAN(1,1)),(BUF4(1),TODAY)
0010            DATA WLFACT/1.03E-6,5.07E-6,3.73E-6/
          C     ******************************************************************
          C
0011            NNUC=6
0012            ALN2=ALOG(2.)
          C
          C     KSMAX IS THE CURRENT DIMENSION OF PDEN ARRAY AND THUS THE MAX
          C     NUMBER OF SOURCE TYPES.  IPSMAX IS THE CURRENT DIMENSION OF
          C     THE PTSZ,VDEP,VSET ARRAYS AND THUS THE MAX NUMBER OF PARTICLE
          C     TYPES.  THESE INITIAL VALUES ARE ADJUSTED LATER ON BASIS OF ACTUAL
          C     USAGE.
          C
0013            KSMAX=5
0014            IPSMAX=5
          C
          C     ERRSET IS USED TO SUPPRESS EXPONENTIAL UNDERFLOW ERROR MESSAGES,
          C     WHICH CAN OCCUR FREQUENTLY IN UDAD BUT CAUSE NO HARM.
          C
0015            CALL ERRSET (208,256,-1,1,1)
0016            READ 410, ISTEP
0017            IF (ISTEP.GE.0.AND.ISTEP.LE.4) GO TO 10
0018            PRINT 400, ISTEP
0019            GO TO 360
          C
          C     ISTEP FEATURE ALLOWS UDAD9 TO BE BROKEN INTO MULTIPLE INDEPENDENT
          C     JOBS.  THIS IS USEFUL FOR CALCULATIONS INVOLVING MANY SOURCES
          C     WHERE COMPUTER TIME REQUIREMENTS WOULD OTHERWISE BECOME EXCESSIVE.
          C     A SECOND ADVANTAGE IS THAT DIFFERENT TYPES OF DOSAGE CALCULATIONS
          C     CAN BE MADE USING ISTEP=3 AND THE NEW PARAMETERS THAT CAN BE
          C     INPUT VIA NAMELIST/NEWSET - ALL WITHOUT RERUNNING ISTEP=1.
          C
          C     ISTEP=0, DO COMPLETE UDAD AS ONE JOB.
```

```
                 C      ISTEP=1, STOP UDAD AT END OF POLUT CALCULATIONS; SAVE ALL DATA.
                 C      ISTEP=2, RESUME UDAD WHERE ISTEP=1 LEFT OFF.
                 C      ISTEP=3, SAME AS ISTEP=2 PLUS READ IN NEW PARAMETERS VIA NEWSET.
                 C      ISTEP=4, SAME AS ISTEP=0 PLUS SAVE ALL DATA AS IN ISTEP=1.
                 C
 0020                10 IF (ISTEP.EQ.2.OR.ISTEP.EQ.3) GO TO 320
 0021                   CALL PART1 (IRCV,ISTEP)
 0022                   T(1)=0.0
 0023                   T(2)=TA
 0024                   IF (OPTIME.LE.TA) T(2)=OPTIME
 0025                   T(9)=TA
 0026                   T(10)=OPTIME
                 C      BECAUSE OF INITIALIZATION OF COMMON/GDCAY/, TAIRR MUST BE CALLED
                 C      BEFORE GROUND.
 0027                   CALL TAIRR (T,1.0,0)
 0028                   T(9)=0.0
 0029                   T(10)=OPTIME
 0030                   CALL GROUND (T(9),0)
 0031                   IOPTIM=OPTIME
 0032                   IF (IRCV.EQ.0) GO TO 100
                 C********* FIND THE DIRECTION OF MAXIMA DISPERSION
                 C********* USING RADON 222 CONCENTRATION AT MAX XRHO
                 C********* IF RADON 222=0, USE 1ST PARTICULATE
 0033                   K=0
 0034                   SUMAX=RN(KRHO)
 0035                   IF (SUMAX.GT.0.0) GO TO 20
 0036                   K=1
 0037                   SUMAX=TCNGC(1,KRHO)
 0038                20 IMX=1
 0039                   DO 60 I=2,16
 0040                   J=(I-1)*KRHO+KRHO
 0041                   IF (K) 30,30,40
 0042                30 SUMG=RN(J)
 0043                   GO TO 50
 0044                40 SUMG=TCNGC(1,J)
 0045                50 IF (SUMG.LE.SUMAX) GO TO 60
 0046                   SUMAX=SUMG
 0047                   IMX=I
 0048                60 CONTINUE
 0049                   DO 90 IT=1,16
 0050                   CALL HEADER (6)
 0051                   PRINT 530, THETAS(IT)
 0052                   PRINT 510
 0053                   PRINT 520
 0054                   PRINT 540
 0055                   PRINT 510
 0056                   DO 70 IR=1,KRHO
 0057                   KRECEP=(IT-1)*KRHO+IR
 0058                70 PRINT 560, XRHO(IR),(TCNGC(J,KRECEP),J=1,5),RN(KRECEP)
 0059                   PRINT 580, IOPTIM
 0060                   PRINT 550
 0061                   PRINT 510
 0062                   DO 80 IR=1,KRHO
 0063                   KRECEP=(IT-1)*KRHO+IR
 0064                80 PRINT 560, XRHO(IR),(TCNGO(J,KRECEP),J=1,5)
```

```
   90 CONTINUE
  100 DO 120 I=1,NRECEP
      SCA=0.0
      DO 110 J=1,3
  110 SCA=SCA+CISUM(J,I)*WLFACT(J)
  120 WL(I)=SCA
      IF (IRCV.EQ.0) GO TO 150
      IT=0
      DO 140 I=1,IRCV,KRHO
      IT=IT+1
      IF (MOD(IT,2).EQ.0) GO TO 130
      CALL HEADER (6)
  130 PRINT 530, THETAS(IT)
      PRINT 510
      PRINT 590
      PRINT 570
      PRINT 510
      DO 140 II=1,KRHO
      IP=II+I-1
  140 PRINT 560, XRHO(II),RN(IP),(CISUM(K,IP),K=1,3),WL(IP)
  150 IF (NRECEP.LE.IRCV) GO TO 200
      LL=60
      N=0
      IA=IRCV+1
      DO 170 IR=IA,NRECEP
      IF (LL.LT.60) GO TO 160
      CALL HEADER (6)
      PRINT 520
      PRINT 610
      PRINT 510
      LL=8
  160 N=N+1
      LL=LL+1
  170 PRINT 430, N,(XNAME(I,N),I=1,4),(XRECEP(I,N),I=1,3),(TCNGC(I,IR),I
     1=1,5),RN(IR),WL(IR)
      LL=60
      N=0
      DO 190 IR=IA,NRECEP
      IF (LL.LT.60) GO TO 180
      CALL HEADER (6)
      PRINT 580, IOPTIM
      PRINT 600
      PRINT 510
      LL=9
  180 N=N+1
      LL=LL+1
  190 PRINT 420, N,(XNAME(I,N),I=1,4),(XRECEP(I,N),I=1,3),(TCNGO(I,IR),I
     1=1,5)
  200 IF (JC(1).GT.0) WRITE (8) REGION,XRHO,IMX,TCNGC,TCNGO,RN,WL
      IF (JC(2).EQ.0.AND.JC(4).EQ.0) GO TO 310
      DO 300 IB=1,5
      LL=60
      IF (JC(2).EQ.1) WRITE (9,500) (BP(J,IB),J=1,3),REGION
      DO 300 KA=1,NRECEP
      DO 220 KC=1,7
```

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FORTRAN IV G1  RELEASE 2.0              MAIN              DATE = 79078          16/02/04

0118                KCT=KC
0119                IF (KC.GT.1) KCT=KCT-1
0120                IF (KC.LT.7) TCA=TCNGC(KCT,KA)
0121                IF (KC.EQ.7) TCA=RN(KA)
0122                IF (MPC(KC,IB).EQ.0) GO TO 210
0123                RF(KC)=TCA/MPC(KC,IB)
0124                IF (RF(KC).LE.0) RF(KC)=1.0E-50
0125                RFLG(KC)=ALOG10(RF(KC))
0126                GO TO 220
0127            210 RF(KC)=1.E10
0128                RFLG(KC)=10.0
0129            220 CONTINUE
0130                IF (JC(4).EQ.0) GO TO 290
0131                IF (LL.LT.60) GO TO 230
0132                CALL HEADER (6)
0133                PRINT 450, (BP(J,IB),J=1,3)
0134                PRINT 490
0135                PRINT 510
0136                LL=7
0137            230 GO TO (240,240,250,260,270),IB
0138            240 PRINT 460, KA,(RECEPT(J,KA),J=1,2),(RF(J),J=1,6)
0139                GO TO 280
0140            250 PRINT 470, KA,(RECEPT(J,KA),J=1,2),(RF(J),J=1,3),(RF(J),J=5,7)
0141                GO TO 280
0142            260 PRINT 470, KA,(RECEPT(J,KA),J=1,2),(RF(J),J=1,3),(RF(J),J=5,6)
0143                GO TO 280
0144            270 PRINT 480, KA,(RECEPT(J,KA),J=1,2),RF(3),(RF(J),J=5,6)
0145            280 LL=LL+1
              C ***
              C     JC(2) FLAG CONTROLS WRITING OF DATA TO DISK FILE FOR LATER USE
              C     BY ISOPLETH PLOT PROGRAM.
              C ***
0146            290 IF (JC(2).EQ.1) WRITE (9,620) KA,RECEPT(1,KA),RECEPT(2,KA),RFLG
0147            300 CONTINUE
0148            310 IF (ISTEP.EQ.0) GO TO 330
              C
              C     SAVE ALL DATA NEEDED TO RESUME PROGRAM
              C
0149                IF (JC(1).EQ.0) WRITE (8) REGION,XRHO,IMX,TCNGC,TCNGO,RN,WL
0150                WRITE (8) BUF1,BUF3,BUF4
0151                IF (ISTEP.EQ.1) GO TO 360
0152                GO TO 330
              C
              C     RETRIEVE ALL DATA NEEDED TO RESUME PROGRAM
              C
0153            320 READ (8) REGION,XRHO,IMX,TCNGC,TCNGO,RN,WL
0154                READ (8) BUF1,BUF3,BUF4
0155                CALL PART1 (IRCV,ISTEP)
0156                TA=ALOG(SUFF/SUFI)/(-ALN2/RSALF)
              C
              C     SPECIAL CALL TO TAIRR NEEDED TO INITIALIZE COMMON QDCAY
              C
0157                CALL TAIRR (T,1.0,-1)
0158                IRCV=16*KRHO
0159            330 CALL DOCONT (IRCV)
```

500 110

```
0160           IF (JC(5).EQ.0) GO TO 340
0161           CALL FODOSE (IRCV,0,1)
0162           CALL EVPDOS (IRCV,T)
0163       340 IF (JC(6).EQ.0) GO TO 350
0164           CALL CONC (IRCV)
0165           CALL DOSAGE (IRCV)
0166           CALL FODOSE (IRCV,0,10)
0167       350 PRINT 440
0168           IF (JC(1).EQ.1.AND.JC(2).EQ.1) GO TO 390
0169           IF (JC(1).EQ.1) GO TO 370
0170           IF (JC(2).EQ.1) GO TO 380
0171       360 STOP
0172       370 STOP 1
0173       380 STOP 2
0174       390 STOP 3
         C
         C
         C
0175       400 FORMAT(1H1,'ILLEGAL ISTEP =',I5)
0176       410 FORMAT(I1)
0177       420 FORMAT(1H ,I2,3X,4A8,1X,3F8.2,1P6E11.2)
0178       430 FORMAT(1H ,I2,3X,4A8,1X,3F6.1,1P7E10.2)
0179       440 FORMAT('1','NORMAL END OF PROGRAM')
0180       450 FORMAT('0',40X,'CONCENTRATION/MPC FOR ',3A4)
0181       460 FORMAT(' ',I4,5X,2F7.2,1P7E12.2)
0182       470 FORMAT(' ',I4,5X,2F7.2,1P3E12.2,12X,3E12.2)
0183       480 FORMAT(' ',I4,5X,2F7.2,24X,1PE12.2,12X,2E12.2)
0184       490 FORMAT('0','RECEPTOR',2X,'X(KM)',3X,'Y(KM)',6X,'238U',8X,'234U',
              1      7X,'230TH',7X,'226RA',7X,'210PB',7X,'210PO',7X,'222RN')
0185       500 FORMAT(3A4,12X,6A4)
0186       510 FORMAT(1X,132('-'))
0187       520 FORMAT('0',T49,'TOTAL CONCENTRATION IN AIR (PCI/M3)')
0188       530 FORMAT('0','THETA= ',F6.2,' DEGREE ANGLE')
0189       540 FORMAT('0','DISTANCE',6X,'238U',8X,'230TH',7X,'226RA',7X,'210PB',
              1 7X,'210PO',7X,'222RN')
0190       550 FORMAT('0','DISTANCE',6X,'238U',8X,'230TH',7X,'226RA',7X,'210PB',
              1 7X,'210PO')
0191       560 FORMAT(' ',1X,F7.2,1P10E12.2)
0192       570 FORMAT('-','DISTANCE',6X,'222RN',7X,'218PO',7X,'214PB',7X,'214BI',
              1 7X,' WL')
0193       580 FORMAT('-',T50,'TOTAL ACTIVITY ON GROUND (PCI/M2)',/
              1T47,'OPERATION LIFETIME DEPOSITION (',I2,' YEARS)')
0194       590 FORMAT('0',T47,' RADON DAUGHTERS (PCI/M3), AND WORK LEVEL')
0195       600 FORMAT('0 #',3X,'IDENTIFICATION',T43,'X(KM)   Y(KM)    Z(M)',
              1   T69,'U238',T79,'TH230',T90,'RA226',T101,'PB210',T112,'PO210')
0196       610 FORMAT('0 #',3X,'IDENTIFICATION',T43,'X(KM) Y(KM) Z(M)',T62,
              1   'U238',T72,'TH230',T82,'RA226',T92,'PB210',T102,'PO210',
              2   T112,'RN222',T124,'WL')
0197       620  FORMAT(I5,1P2E9.2,0P7F7.3)
0198            END
```

FORTRAN IV G1 RELEASE 2.0 BLK DATA DATE = 79078 16/02/04

```
0001       BLOCK DATA
0002       REAL*8 XNAME,ORGAN,BREP,METSET,TODAY
0003       REAL*4 MPC
0004       COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
          1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
          2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
          3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
          4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
          5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0005       COMMON/UDADC2/VSET(5),SDSCAL,QSCALE,LTYPE,
          1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
          2   ISORC1,KSORCE,IND,INS,ISTAB,INSB,INSE
0006       COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
          1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
          2   RHO(3,2),FROM(5,4),DCONV(6,4)
0007       COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
          1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PDDR(2,300),RN(300),
          2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNSC(5,300),
          3   TCNSO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0008       DATA RSLIM,RSALF/0.01,0.137/
0009       DATA SUFI,SUFF/1.0E-5,1.0E-9/
0010       DATA IPAGE/3*0/
0011       DATA CF/0.9,0.5,0.35,0.35/
0012       DATA RFI,SHIED,RFIE/1.0,0.5,0.583/
0013       DATA PGTH/4*1.0/
0014       DATA IFODOS/60*0/
0015       DATA PWFOD/60*1.0/
0016       DATA RN/300*0.0/
0017       DATA PFIN/8*1.0/
0018       DATA VSET/5*0.0/
0019       DATA PDEN/8.9,4*2.4/
0020       DATA QSCALE,SDSCAL/1.0,1000./
0021       DATA TPSZ/6000*0.0/
0022       DATA TCNSO/1500*0.0/
0023       DATA TCNSC/1500*0.0/
0024       DATA REGION/6*'    '/
0025       DATA OA/0.2,0.12,0.08,0.06,0.03,0.016/
0026       DATA OB/0.0,0.0,2.E-4,1.5E-3,3.E-4,3.E-4/
0027       DATA UU / .67056, 2.45872, 4.47040, 6.92912, 9.61136, 12.51712/
0028       DATA XRHO/0.1,0.5,1.,2.,3.,4.,5.,10.,20.,30.,40.,50.,
          1          60.,70.,80./
0029       DATA IRHO/1,3,7,8,12,15/
0030       DATA IYR/1,3,5,7,10,15,20,30,50,70/
0031       DATA VDEP/5*0.01/
0032       DATA PTSZFC/25*0.0/
0033       DATA PTSZ/5*0.0/
0034       DATA RHALF/4.51E9,2.48E5,8.0E4,1.622E3,21.,0.38/
0035       DATA PHALF/50./
0036       DATA XNAME/240*'        '/,XRECEP/180*0./,IPOP/240*0/
0037       DATA WINDR/4HN   ,4HNNE ,4HNE  ,4HENE ,4HE   ,4HESE ,4HSE  ,
          1     4HSSE ,4HS   ,4HSSW ,4HSW  ,4HWSW ,4HW   ,4HWNW ,4HNW  ,
          2     4HNNW /
0038       DATA ORGAN/'NASOPHAR','YNGEAL  ','        ',
          1          'TRACHEOB','RONCHIAL','        ',
          2          'PULMONAR','Y       ','        ',
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560 112

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                 3           'WHOLE BO','DY       ','         ',
                 4           'BONE     ','         ','         ',
                 5           'KIDNEY   ','         ','         ',
                 6           'LIVER    ','         ','         ',
                 7           'STOMACH  ','         ','         ',
                 8           'SMALL IN','TESTINE ','         ',
                 9           'UPPER LA','RGE INTE','STINE    ',
                 X           'LOWER LA','RGE INTE','STINE    ',
                 X           'LYMPH NO','DES      ','         '/
 0039             DATA BP/4HWHOL,4HE BO,4HDY  ,
                 1     4HBONE,4H    ,4H    ,
                 2     4HLUNG,4H    ,4H    ,
                 3     4HKIDN,4HEY  ,4H    ,
                 4     4HLIVE,4HR   ,4H    /
 0040             DATA MPC/6.0E2,6.0E2,5.0E0,2.0E1,4.0E2,2.0E3,0.0,
                 1         2.0E2,2.0E2,8.0E-1,1.0E-1,7.0E1,2.0E3,0.0,
                 2         5.0E1,4.0E1,3.0E0,0.0E0,8.0E1,7.0E1,3.0E3,
                 3         3.0E1,4.0E2,2.0E0,0.0E0,4.0E1,2.0E2,0.0,
                 4         0.0E0,0.0E0,7.0E0,0.0E0,1.0E2,6.0E2,0.0/
 0041             DATA DCFC/
                 1 1.00E8,1.57E6,2.92E5,1.29E6,2.43E5,4.77E5,1.35E6,1.53E6,3.22E5,
                 2 6.22E8,5.24E7,2.28E7,4.85E7,3.25E7,4.29E7,8.60E7,9.33E7,3.12E7,
                 3 7.63E9,1.22E8,9.57E7,8.06E7,7.36E7,8.94E7,9.83E7,1.03E8,8.73E7,
                 4 1.36E8,2.49E6,6.64E5,2.09E6,5.99E5,1.03E6,2.64E6,2.94E6,7.34E5,
                 5 1.46E8,3.59E6,1.52E6,3.17E6,1.33E6,2.10E6,4.83E6,5.31E6,1.67E6,
                 6 1.79E8,4.90E7,2.63E7,6.27E7,3.44E7,4.33E7,6.98E7,7.52E7,3.93E7,
                 7 3.46E6,2.83E6,1.04E6,3.14E6,2.05E6,2.67E6,3.30E6,3.46E6,2.99E6,
                 8 8.18E5,6.34E5,3.88E5,5.72E5,4.91E5,5.93E5,6.34E5,6.95E5,6.34E5,
                 9 4.89E9,1.67E9,7.46E8,1.94E9,1.17E9,1.52E9,2.15E9,2.29E9,1.57E9,
                 X 1.95E10,1.16E10,9.13E9,9.29E9,8.86E9,1.10E10,1.17E10,1.26E10,
                 X 1.15E10,
                 X 9.89E5,7.66E5,4.70E5,6.92E5,5.93E5,7.17E5,7.66E5,8.40E5,7.66E5,
                 X 3.94E8,1.43E7,7.56E6,1.21E7,5.31E6,9.05E6,2.23E7,2.45E7,7.27E6,
                 X 3.56E9,8*0.0/
 0042             DATA DCFG/
                 1 2.13E4,3.17E3,5.89E2,2.60E3,4.90E2,9.62E2,2.73E3,3.08E3,6.49E2,
                 2 2.10E4,1.66E4,7.21E3,1.53E4,1.03E4,1.36E4,2.72E4,2.96E4,9.87E3,
                 3 1.50E7,1.72E4,1.17E4,1.46E4,1.32E4,1.61E4,1.77E4,1.94E4,1.50E4,
                 4 2.60E4,4.78E3,1.27E3,4.00E3,1.15E3,1.97E3,5.05E3,5.63E3,1.40E3,
                 5 2.20E4,6.12E3,2.60E3,5.40E3,2.27E3,3.59E3,8.24E3,9.06E3,2.85E3,
                 6 1.16E4,9.47E3,5.07E3,1.21E4,6.63E3,8.36E3,1.35E4,1.45E4,7.58E3,
                 7 6.15E2,5.03E2,1.84E2,5.59E2,3.64E2,4.76E2,5.88E2,6.15E2,5.32E2,
                 8 1.42E2,1.10E2,6.73E1,9.91E1,8.50E1,1.03E2,1.10E2,1.20E2,1.10E2,
                 9 1.42E6,3.16E5,1.41E5,3.66E5,2.21E5,2.88E5,4.06E5,4.32E5,2.96E5,
                 X 1.20E7,1.85E6,1.47E6,1.49E6,1.42E6,1.76E6,1.88E6,2.06E6,1.85E6,
                 X 1.72E2,1.33E2,8.17E1,1.20E2,1.03E2,1.25E2,1.33E2,1.46E2,1.33E2,
                 X 6.65E4,2.27E4,1.20E4,1.92E4,8.45E3,1.44E4,3.56E4,3.90E4,1.16E4,
                 X 5.02E6,8*0.0/
 0043             DATA BPRTS/'SKIN','    ','    ','WHOL','E BO','DY  ',
                 1           'OVAR','IES ','    ','TEST','ES  ','    ',
                 2           'SM I','NTES','TINE','LUNG','    ','    ',
                 3           'RED ','MARR','OW  ','SKEL','ETON','    ',
                 4           'SPLE','EN  ','    '/
 0044             DATA FROM/'PART','ICUL','ATES','    ','    ',
                 1          'RADO','N   ','    ','    ','    ',
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FORTRAN IV G1  RELEASE 2.0            BLK DATA          DATE = 79078          16/02/04

                    2          'GROU','ND D','EPOS','ITIO','N   ',
                    3          'CLOU','D SU','BNER','SION','    '/
 0045                DATA WHO/'  IN','HALA','TION',
                    1          '    ','EXTE','RNAL'/
 0046                DATA XIN/0.3,0.85,0.2,0.08,0.77,0.0575,2.0/
 0047                DATA XING/0.26,0.3,0.1,0.08,0.28,0.0189,1.0/
 0048                DATA FOODIN/50.0,50.0,60.0,50.0,0.3,0.12/
 0049                DATA FCON/2*3.4E-4,2.0E-4,4.0E-3,2.9E-4,1.2E-2,
                    1          2*6.1E-4,5.0E-6,4.5E-4,2.6E-4,1.4E-4,
                    2          2*4.0E-3,4.0E-3,5.0E-4,2.0E-3,4.0E-3,
                    3          3*2.0E-3,2.0E-5,2.0E-3,1.8E-2,
                    4          2*2.0,30.0,50.0,100.0,500.0/
 0050                DATA RHO/2*2.4E2/
 0051                DATA DV/0.75,2.0/
 0052                DATA TH/2*14.0/
 0053                DATA TC/30.,60./
 0054                DATA FV/2*0.2/
 0055                DATA FG,DFACT/2*0.5/
 0056                DATA BSV/2*2.5E-3,4.2E-3,3.1E-4,6.8E-2,1.5E-1/
 0057                DATA BREP/'BRONCHIA','L EPITHE','LIUM    '/
 0058                DATA YDOC/50.0/
 0059                DATA METSET/4*'        '/
 0060                END
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FORTRAN IV G1  RELEASE 2.0              PART1              DATE = 79078          16/02/04

0001                  SUBROUTINE PART1 (IRCV,ISTEP)
             C
             C        SUBROUTINE TO EXECUTE 1ST PART OF UDAD CODE
             C
0002                  REAL*8 METSET,XNAME,TODAY,DATE1,DUMMY,ORGAN,BREP,WINDSP(6)
0003                  REAL*4 MPC,LON,LR,LONM
0004                  DIMENSION TAILP(6,5),FREQWS(6),PNID(2,7),PACT(4,5),CACTIV(5,300),
                     1   CPOLUT(5,300),TQ(80,5),PSORC(4),RF(7),IDTAIL(5),PTAIL(7,5),
                     2   PTSZ20(5),QPTAIL(5),COLSUM(7),GROUPN(5,9),SORCID(5,9),SLIP(5),
                     3   IDSQ(3,6),TEMP(12,80),JHIT(6),WORK(960),FKNOTS(16,7),IPOPC(17)
0005                  COMMON/UDADC1/METSET(4),XNAME(4,60),VDEF(5),PTSZFC(5,5),ALN2,
                     1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                     2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                     3   PFIN(8),FWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                     4   FDEN(5),FGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                     5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0006                  COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
                     1   OA(6),CD(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
                     2   ISORC1,KSORCE,IND,IWS,ISTAB,INSB,INSE
0007                  COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
                     1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BFRTS(3,9),
                     2   WHO(3,2),FROM(5,4),DCONV(6,4)
0008                  COMMON/UDADC4/TODAY,NFD,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                     1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
                     2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                     3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0009                  COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                     1   IPSOL(10),NNUC,MSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0010                  COMMON/DSFRSN/FREQ(16,6,6),SORCE(12,30)
0011                  EQUIVALENCE (TCNGO(1,1),CACTIV(1,1)),(TCNGC(1,1),CPOLUT(1,1))
0012                  EQUIVALENCE (WORK(1),TEMP(1,1),TQ(1,1),FKNOTS(1,1),IPOPC(1)),
                     1   (WORK(113),COLSUM(1))
0013                  DATA IDSQ/18*0/,JHIT/6*0/
0014                  DATA GROUPN/45*'    '/
0015                  DATA SORCID/45*'    '/
0016                  DATA BLANK/'    '/
0017                  DATA PNID/4HU238,4H    ,
                     1         4HU234,4H    ,
                     2         4HTH23,4H0   ,
                     3         4HRA22,4H6   ,
                     4         4HPB21,4H0   ,
                     5         4HPO21,4H0   ,
                     6         4HRN22,4H2   /
0018                  DATA WINDSP/8H 0 - 3  ,8H 4 - 6  ,8H 7 - 10 ,8H11 - 16 ,
                     1       8H17 - 21 ,8HOVER 21 /
0019                  DATA PTAIL/2.4,0.03,0.1,100.0,1.0,3.0,0.1,28*0.0/
0020                  DATA IDTAIL/5*0/
0021                  DATA PTSZ20/5*0.4/
0022                  DATA TAILP/30*0.0/
0023                  DATA SLIP/5*1.0/
0024                  NAMELIST/INDATA/REGION,METSET,DM,OPTIME,MPC,PDEN,KRHO,F2PM,
                     1  IADD,XRECEP,NSORCE,SORCE,XNAME,XRHO,FREQ,IPOP,MSPTAB,LONM,
                     2  JC,VDEP,PTSZFC,PTSZ,GROUPN,SORCID,IRHO,IYR,E,LON,LR,F1,F2P,
                     3  IPSOL,NNUC,IFODOS,PHALF,PACT,RFI,SHIED,IDTAIL,PTSZ20,PFIN,
                     4  FWFOD,PTAIL,PGTH,XIN,XING,FOODIN,FCON,RHO,DV,TW,TC,FV,SLIM,
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FORTRAN IV G1  RELEASE 2.0            PART1              DATE = 79089          16/40/37
                    5 BSV,FG,DFACT,RFIE,SUFI,SUFF,YEVD,RSLIM,RSALF,YDOC,IDSQ,SLIP
 0025                 NAMELIST/NEWSET/JC,IYR,IRHO,IFODOS,FWFOD,MSPTAB,F2FM,LOHM,NMUC,
                    1   E,LON,LR,F1,F2P,IPSOL,SHIED,PFIN,PGTH,XIN,XING,FOODIN,FCON,
                    2   RHO,DV,TH,TC,FV,BSV,FG,DFACT,RFIE,YEVD,RSLIM,DCFC,DCFG,
                    3   RSALF,YDOC,SUFI,SUFF
                C   ******************************************************************
 0026                 PRINT 1300
 0027                 PRINT 2690
 0028                 PRINT 1310
 0029                 PRINT 1320
 0030                 PRINT 1310
 0031                 PRINT 1330
 0032                 PRINT 1310
 0033                 PRINT 2690
 0034                 PRINT 1310
 0035                 PRINT 1340
 0036                 PRINT 1310
 0037                 PRINT 1310
 0038                 PRINT 1310
 0039                 PRINT 1350
 0040                 PRINT 1310
 0041                 PRINT 1360
 0042                 PRINT 1310
 0043                 PRINT 1370
 0044                 PRINT 1310
 0045                 PRINT 1310
 0046                 PRINT 1310
 0047                 PRINT 1310
 0048                 PRINT 2690
 0049                 IF (ISTEP.EQ.0) GO TO 20
 0050                 GO TO (20,1290,10,20),ISTEP
 0051              10 READ (5,NEWSET)
 0052                 GO TO 80
 0053              20 TODAY=DATE1(DUMMY)
 0054                 QFACTR=1.1574E7/365.
 0055                 IMX=1
 0056                 LSTAB=6
 0057                 LWD=16
 0058                 LWS=6
 0059                 NOPO=5
 0060                 YEVD=100.
 0061                 DN=550.0
 0062                 DO 30 L=1,9
                C
                C   JC FLAGS CONTROL PROGRAM EXECUTION AS FOLLOWS:
                C     JC(1)=1, WRITES BINARY FT08F001 FILE FOR CONCPLOT PROGRAM
                C     JC(2)=1, WRITES EBCDIC FT09F001 FILE FOR ISOPLETH PLOTS
                C     JC(3)=1, PRINTS EFFECTIVE DISPERSION FACTOR TABLES, FT10F001
                C     JC(4)=1, PRINTS CONCENTRATION/MPC TABLES
                C     JC(5)=1, PRINTS DOSE COMMITMENTS TABLES
                C     JC(6)=1, EXECUTES DOSAGE SUBROUTINE (BY-PASS IF =0)
                C     JC(7)=1, AVAILABLE
                C     JC(8)=1, PRINTS INDIVIDUAL SOURCE CONCENTRATION TABLES
                C     JC(9)=1, AVAILABLE
                C
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```
0062         30 JC(L)=0
0063            DO 40 L=1,240
0064            ZRECEP(L)=0.0
0065            DO 40 LL=1,2
          C     RECEPT  (1,IRECEP)=HORIZONTAL COMPONENT OF RECEPTOR
          C     RECEPT  (2,IRECEP)=  VERTICAL COMPONENT OF RECEPTOR
0066         40 RECEPT(LL,L)=0.0
0067            DO 50 I=1,5
0068            DO 50 J=1,300
0069         50 CISUM(I,J)=0.0
0070            IADD=0
0071            IPOLU1=1
0072            IPOLU2=NOPO
0073            NPOLUT=5
0074            NSORCE=0
0075            KRHO=15
0076            IPCV=0
0077            SLIM=0.01
0078            DO 60 J=1,16
0079            THETAS(J)=(J-1)*22.5
0080            DO 60 K=1,6
0081            DO 60 L=1,6
0082         60 FREQ(J,K,L)=0.0
0083            OPTIME=15.0
0084            READ (5,INDATA,END=70)
0085            GO TO 80
0086         70 STOP
          C
          C     CHECK VIA IDSQ IF ANY SOURCES ARE TO BE BROKEN UP INTO SPECIFIED
          C     NUMBER OF SQUARES IN X AND Y DIRECTION.  IDSQ(3,6):
          C        1ST INDEX = SOURCE(10,I), # OF X-DIRECTION SQUARES, # OF
          C                    Y-DIRECTION SQUARES.
          C        2ND INDEX = 1 TO 6 SITES SELECTED TO BE BROKEN INTO SQUARES.
          C
          C**** OUTPUT FOR INPUT NAMELIST VARIABLES ****
          C
0087         80 CALL HEADER (6)
0088            IF (ISTEP.NE.3) PRINT 1430
0089            IF (ISTEP.EQ.3) PRINT 1380
0090            PRINT 1900
0091            PRINT 1830, BSV
0092            PRINT 1750, DFACT
0093            IF (ISTEP.NE.3) PRINT 1760, DM
0094            PRINT 2040
0095            PRINT 1920, DV
0096            PRINT 2110
0097            PRINT 2120, E
0098            PRINT 1890
0099            PRINT 1830, FCON
0100            PRINT 1770, FG
0101            PRINT 1910
0102            PRINT 1920, FOODIN
0103            PRINT 1780
0104            PRINT 2070
0105            PRINT 1920, FV
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FORTRAN IV G1 RELEASE 2.0 PART1 DATE = 79078 16/02/04

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      PRINT 2150
      PRINT 2120, F1
      PRINT 2160
      PRINT 2120, F2P
      CALL HEADER (6)
      IF (ISTEP.NE.3) PRINT 1440
      IF (ISTEP.EQ.3) PRINT 1390
      PRINT 2200
      PRINT 1980, F2PM
      IF (ISTEP.EQ.3) GO TO 120
      PRINT 1790
      DO 90 J=1,9
      IF (GROUPN(1,J).EQ.BLANK) GO TO 100
   90 PRINT 1800, (GROUPN(K,J),K=1,5)
      GO TO 110
  100 PRINT 1810
  110 PRINT 1820, IADD
      PRINT 2030
      PRINT 2090, IDSQ
      PRINT 1530
      PRINT 2180, IDTAIL
  120 PRINT 1860
      PRINT 2180, IFODOS
      IF (ISTEP.NE.3) PRINT 1830
      PRINT 2170
      PRINT 2180, IPSOL
      PRINT 1840
      PRINT 2180, IRHO
      PRINT 1850
      PRINT 2180, IYR
      PRINT 2080
      PRINT 2180, JC
      PRINT 1540, KRHO
      CALL HEADER (6)
      IF (ISTEP.NE.3) PRINT 1440
      IF (ISTEP.EQ.3) PRINT 1390
      PRINT 2130
      PRINT 2120, LON
      PRINT 2210
      PRINT 1920, LONM
      PRINT 2140
      PRINT 2120, LR
      IF (ISTEP.NE.3) PRINT 1550, METSET
      PRINT 1560
      PRINT 1940, MPC
      PRINT 2190
      PRINT 2180, MSPTAB
      PRINT 2100, NNUC
      IF (ISTEP.EQ.3) GO TO 130
      PRINT 1570, NSORCE
      PRINT 1580, OPTIME
      PRINT 1970
      PRINT 1930, PACT
      PRINT 1590
      PRINT 2020, PDEN
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560 118

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      130 PRINT 2000, PFIN
          PRINT 1990
          PRINT 1980, PGTH
          IF (ISTEP.NE.3) PRINT 1600, PHALF
          CALL HEADER (6)
          IF (ISTEP.NE.3) GO TO 140
          PRINT 1390
          GO TO 150
      140 PRINT 1440
          PRINT 1960
          PRINT 1940, PTAIL
          PRINT 1610
          PRINT 2020, PTSZ
          PRINT 1620
          PRINT 2020, PTSZFC
          PRINT 2010
          PRINT 2020, PTSZ20
      150 PRINT 1870
          PRINT 2120, PWFOD
          IF (ISTEP.EQ.3) GO TO 160
          PRINT 1630, REGION
          PRINT 1640, RFI
      160 PRINT 1650, RFIE
          PRINT 2030
          PRINT 1920, RHO
          PRINT 1660, RSALF
          PRINT 1670, RSLIM
          PRINT 1680, SHIED
          IF (ISTEP.EQ.3) GO TO 170
          PRINT 1690, SLIM
          PRINT 1700
          PRINT 2020, SLIP
      170 CALL HEADER (6)
          LL=6
          IF (ISTEP.NE.3) GO TO 180
          PRINT 1390
          GO TO 230
      180 PRINT 1440
          PRINT 1710
          DO 190 J=1,NSORCE
          IDSET=SORCE(10,J)
          KSORCE=SORCE(11,J)
          LL=LL+1
          IF (LL.LE.58) GO TO 190
          CALL HEADER (6)
          PRINT 1440
          PRINT 1730
          LL=5
      190 PRINT 1720, (SORCE(K,J),K=1,9),IDSET,KSORCE,SOF     12,J)
          IF (LL.LE.55) GO TO 200
          CALL HEADER (6)
          PRINT 1440
          LL=4
      200 PRINT 1740
          LL=LL+2
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560 112

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      DO 210 J=1,9
      IF (SORCID(1,J).EQ.BLANK) GO TO 220
      LL=LL+1
      IF (LL.LE.58) GO TO 210
      CALL HEADER (6)
      PRINT 1440
      PRINT 1730
      LL=5
  210 PRINT 1800, (SORCID(K,J),K=1,5)
      GO TO 230
  220 PRINT 1810
  230 DO 380 J=1,12
      LL=LL+3
      IF (LL.LE.58) GO TO 240
      CALL HEADER (6)
      PRINT 1440
      LL=7
  240 GO TO (250,260,270,280,290,300,310,320,330,340,350,360),J
  250 PRINT 1450, SUFF
      GO TO 370
  260 PRINT 1460, SUFI
      GO TO 370
  270 PRINT 2[illegible]0
      PRINT 1920, TC
      GO TO 380
  280 PRINT 2050
      PRINT 1920, TH
      GO TO 380
  290 IF (ISTEP.EQ.3) GO TO 380
      PRINT 1470
      PRINT 2020, VDEP
      GO TO 380
  300 PRINT 1930
      PRINT 1940, XIN
      GO TO 380
  310 PRINT 1950
      PRINT 1940, XING
      GO TO 380
  320 IF (ISTEP.EQ.3) GO TO 380
      PRINT 1480
      PRINT 1490
      GO TO 380
  330 IF (ISTEP.EQ.3) GO TO 380
      PRINT 1500
      PRINT 1490
      GO TO 380
  340 IF (ISTEP.EQ.3) GO TO 380
      PRINT 1510
      PRINT 1520, XRHO
      GO TO 380
  350 PRINT 1410, YDOC
      GO TO 370
  360 PRINT 1420, YEVD
  370 LL=LL-1
  380 CONTINUE
```

```
      MORE=0
      DO 390 J=1,6
      IF (IDSQ(1,J).EQ.0) GO TO 400
C
C     JHIT ARRAY IS USED TO GUARANTEE AN IDSQ(1,J) VALUE IS USED ONLY
C     ONCE.  AFTER SUCH USE, JHIT(J) IS SET = 0.
C
      JHIT(J)=1
  390 MORE=MORE+IDSQ(2,J)*IDSQ(3,J)-1
  400 JMAX=J-1
      IF (NSORCE+MORE.GT.0.AND.NSORCE+MORE.LE.80) GO TO 410
      NSORCE=NSORCE+MORE
      PRINT 2590, NSORCE
      GO TO 70
  410 IF (IADD.GE.0.AND.IADD.LE.60) GO TO 420
      PRINT 2600, IADD
      GO TO 70
  420 DO 430 I=1,NSORCE
      IF (SORCE(4,I).LE.0.) SORCE(4,I)=1.0E-6
  430 CONTINUE
      TA=ALOG(SUFF/SUFI)/(-ALN2/RSALF)
      IF (KRHO.GT.15) KRHO=15
      DO 460 JT=1,5
      QPTAIL(JT)=0.0
      IF (IDTAIL(JT).EQ.0) GO TO 460
      CALL TAILPS (TAILP(1,JT),LWS,PTAIL(1,JT))
      DO 450 IWS=1,LWS
      FREQWS(IWS)=0.0
      DO 440 ISTAB=1,LSTAB
      DO 440 IWD=1,LWD
  440 FREQWS(IWS)=FREQWS(IWS)+FREQ(IWD,IWS,ISTAB)
  450 QPTAIL(JT)=QPTAIL(JT)+TAILP(IWS,JT)*FREQWS(IWS)
  460 CONTINUE
      IF (MORE.EQ.0) GO TO 540
C
C     BREAK UP SOURCES AS SPECIFIED BY IDSQ, GENERATING A NEW
C     SORCE(10,80) ARRAY IN TEMP(10,80).
C
      IDPREV=0
      NEW=0
      INEW=0
      DO 520 IOLD=1,NSORCE
      IDSET=SORCE(10,IOLD)
      ID=IDSET/100
      DO 470 J=1,JMAX
      IF (JHIT(J).EQ.0) GO TO 470
      IF (IDSQ(1,J).EQ.IDSET) GO TO 490
  470 CONTINUE
      INEW=INEW+1
      DO 480 K=1,12
  480 TEMP(K,INEW)=SORCE(K,IOLD)
      GO TO 520
  490 UNITS=FLOAT(IDSQ(2,J)*IDSQ(3,J))
      JHIT(J)=0
      DO 500 K=4,9
```

```
0318         500 SORCE(K,IOLD)=SORCE(K,IOLD)/UNITS
0319             SIDE=SQRT(SORCE(4,IOLD))
           C
           C     COMPUTE NEW ORIGIN (XORG,YORG) AS CENTER OF GENERATED LEFT-HAND
           C     LOWEST SQUARE.
           C
0320             XORG=SORCE(1,IOLD)-0.5*SIDE*FLOAT(IDSQ(2,J)-1)
0321             YORG=SORCE(2,IOLD)-0.5*SIDE*FLOAT(IDSQ(3,J)-1)
0322             IF (IDPREV.NE.ID) NEW=0
0323             IX2=IDSQ(2,J)
0324             IY2=IDSQ(3,J)
0325             DO 510 IY=1,IY2
0326             Y=YORG+FLOAT(IY-1)*SIDE
0327             DO 510 IX=1,IX2
0328             INEW=INEW+1
0329             NEW=NEW+1
0330             TEMP(1,INEW)=XORG+FLOAT(IX-1)*SIDE
0331             TEMP(2,INEW)=Y
0332             TEMP(10,INEW)=FLOAT(ID*100+NEW)
0333             DO 510 K=3,12
0334             IF (K.EQ.10) GO TO 510
0335             TEMP(K,INEW)=SORCE(K,IOLD)
0336         510 CONTINUE
0337         520 IDPREV=ID
0338             NSORCE=NSORCE+MORE
0339             DO 530 I=1,NSORCE
0340             DO 530 K=1,12
0341         530 SORCE(K,I)=TEMP(K,I)
0342         540 DO 580 I=1,NSORCE
0343             IDSET=SORCE(10,I)
0344             ID=IDSET/100
0345             IDG=MOD(ID,10)
0346             DO 550 JT=1,5
0347             IF (IDTAIL(JT).EQ.0) GO TO 550
0348             IF (IDG.EQ.IDTAIL(JT)) GO TO 560
0349         550 CONTINUE
0350             GO TO 580
0351         560 DO 570 J=5,8
0352         570 SORCE(J,I)=PACT(J-4,JT)*QPTAIL(JT)*SORCE(4,I)*31.536/PTSZ20(JT)
0353         580 CONTINUE
0354             IF (ISTEP.EQ.3) GO TO 1290
0355             CALL HEADER (6)
0356             PRINT 2310, NSORCE
0357             IDSMAX=0
0358             DO 590 I=1,NSORCE
0359             IDS=INT(SORCE(10,I))/1000
0360         590 IDSMAX=MAX0(IDS,IDSMAX)
0361             PRINT 2320
0362             LL=8
0363             DO 600 I=1,IDSMAX
0364             PRINT 2330, I,(SORCID(J,I),J=1,5)
0365         600 LL=LL+1
0366             PRINT 2340
0367             PRINT 2350
0368             PRINT 2570
```

```
0369              LL=LL+5
0370              DO 610 I=1,IPSMAX
0371              IF (PTSZ(I).EQ.0.0) GO TO 620
0372          610 CONTINUE
0373              GO TO 630
0374          620 IPSMAX=I-1
0375              IF (IPSMAX.EQ.0) IPSMAX=1
            C
            C     CHECK THAT PTSZFC(I,K) ARRAY  AS BEEN SET UP CORRECTLY WITH ONLY
            C     ONE PARTICLE DENSITY FOR A GIVEN I VALUE.  ALSO RESET KSMAX ON
            C     BASIS OF ACTUAL USAGE.
            C
0376          630 KS=1
0377              DO 650 I=1,IPSMAX
0378              MARK=0
0379              DO 650 K=1,KSMAX
0380              IF (PTSZFC(I,K).EQ.0.0) GO TO 650
0381              KS=MAX0(KS,K)
0382              IF (MARK.GT.0) GO TO 640
0383              MARK=1
0384              DEN=PDEN(K)
0385              GO TO 650
0386          640 IF (PDEN(K).EQ.DEN) GO TO 650
0387              PRINT 1400, I
0388              GO TO 70
0389          650 CONTINUE
0390              KSMAX=KS
0391              DO 690 I=1,NSORCE
0392              IDSET=SORCE(10,I)
0393              KSORCE=SORCE(11,I)
0394              IF (KSORCE.GE.1.AND.KSORCE.LE.KSMAX) GO TO 660
0395              PRINT 2550, KSORCE,IDSET
0396              GO TO 70
0397          660 ID=IDSET/100
0398              IDG=MOD(ID,10)
0399              IF (LL.LE.59) GO TO 670
0400              CALL HEADER (6)
0401              PRINT 2340
0402              PRINT 2350
0403              PRINT 2570
0404              LL=6
0405          670 PRINT 2360, I,(SORCE(J,I),J=1,9),IDSET,KSORCE,SORCE(12,I),(GROUPN(
             1J,IDG),J=1,5)
0406              LL=LL+1
0407              DO 690 IPS=1,IPSMAX
0408              IF (PTSZFC(IPS,KSORCE).EQ.0.0) GO TO 690
0409              IF (VSET(IPS).GT.0.0) GO TO 680
0410              VSET(IPS)=3.E-5*PDEN(KSORCE)*SLIP(IPS)*(PTSZ(IPS))**2
0411          680 IF (VSET(IPS).GT.VDEP(IPS)) VDEP(IPS)=VSET(IPS)
0412          690 CONTINUE
0413              IF (LL.LE.52-IPSMAX) GO TO 700
0414              CALL HEADER (6)
0415              LL=2
0416          700 PRINT 2370, (PDEN(J),J=1,KSMAX)
0417              PRINT 2380
```

560 123

```
0418              LL=LL+7
0419              DO 710 I=1,IFSMAX
0420              PRINT 2390, PTSZ(I),VDEP(I),VSET(I),(PTSZFC(I,J),J=1,KSMAX)
0421          710 LL=LL+1
0422              IF (LL+IADD.LE.52) GO TO 720
0423              CALL HEADER (6)
0424              LL=2
0425          720 PRINT 2400, IADD
0426              LL=LL+3
0427              IF (IADD.EQ.0) GO TO 750
0428              PRINT 2410
0429              LL=LL+5
0430              DO 740 I=1,IADD
0431              IF (LL.LE.59) GO TO 730
0432              CALL HEADER (6)
0433              PRINT 2410
0434              LL=5
0435          730 PRINT 2420, I,(XNAME(J,I),J=1,4),(XRECEP(J,I),J=1,3)
0436          740 LL=LL+1
0437          750 DO 760 J=1,6
0438              DO 760 K=1,16
0439          760 FKNOTS(K,J)=0.0
            C
            C     FKNOTS(K,J) IS FREQUENCY TOTAL FOR JTH WIND SPEED AND KTH WIND
            C     DIRECTION, SUMMED OVER ALL STABILITY CLASSES.  FKNOTS(K,7) IS
            C     THE FREQUENCY SUM OF ALL WIND SPEEDS FOR THE KTH DIRECTION.
            C
0440              DO 820 L=1,7
0441              CALL HEADER (6)
0442              IF (L.LE.6) PRINT 2430, L
0443              IF (L.EQ.7) PRINT 2440
0444              PRINT 2450, (WINDSP(I),I=1,6)
0445              PRINT 2570
0446              DO 770 J=1,7
0447          770 COLSUM(J)=0.0
0448              DO 810 K=1,16
0449              FKNOTS(K,7)=0.0
0450              IF (L.EQ.7) GO TO 790
0451              DO 780 J=1,6
0452              FKNOTS(K,J)=FKNOTS(K,J)+FREQ(K,J,L)
0453              COLSUM(7)=COLSUM(7)+FREQ(K,J,L)
0454              FKNOTS(K,7)=FKNOTS(K,7)+FREQ(K,J,L)
0455          780 COLSUM(J)=COLSUM(J)+FREQ(K,J,L)
0456              PRINT 2460, WINDR(K),(FREQ(K,J,L),J=1,6),FKNOTS(K,7)
0457              GO TO 810
0458          790 DO 800 L1=1,6
0459              DO 800 J=1,6
0460              FKNOTS(K,7)=FKNOTS(K,7)+FREQ(K,J,L1)
0461              COLSUM(J)=COLSUM(J)+FREQ(K,J,L1)
0462          800 COLSUM(7)=COLSUM(7)+FREQ(K,J,L1)
0463              PRINT 2460, WINDR(K),(FKNOTS(K,J),J=1,7)
0464          810 CONTINUE
0465              PRINT 1730
0466              PRINT 2570
0467          820 PRINT 2290, COLSUM
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560 124

```
      IF (COLSUM(7).GT.0.999.AND.COLSUM(7).LT.1.001) GO TO 830
      PRINT 2470
      GO TO 70
  830 CALL HEADER (6)
      PRINT 2480
      PRINT 2490, ((BP(I,J),I=1,3),J=1,5)
      DO 840 I=1,7
  840 PRINT 2500, (PNID(J,I),J=1,2),(MPC(I,J),J=1,5)
      IF (KRHO.EQ.0) GO TO 880
      DO 850 IT=1,17
  850 IPOPC(IT)=0
      CALL HEADER (6)
      PRINT 2530
      PRINT 2510, WINDR
      PRINT 2520, THETAS
      PRINT 2570
      DO 870 IR=1,KRHO
      D1=0.
      IF (IR.GT.1) D1=XRHO(IR-1)
      IPOPR=0
      DO 860 IT=1,16
      IPOPR=IPOPR+IPOP(IR,IT)
  860 IPOPC(IT)=IPOPC(IT)+IPOP(IR,IT)
      IPOPC(17)=IPOPC(17)+IPOPR
      PRINT 2540
  870 PRINT 2530, D1,XRHO(IR),(IPOP(IR,IT),IT=1,16),IPOPR
      PRINT 2570
      PRINT 2540
      D1=0.0
      PRINT 2530, D1,XRHO(KRHO),(IPOPC(IT),IT=1,17)
      TPOP=IPOPC(17)
  880 IF (NPOLUT.GT.0) IPOLU2=NPOLUT
      DO 890 I=1,80
      DO 890 J=1,5
  890 TQ(I,J)=0.0
      DO 900 ISORCE=1,NSORCE
C     CONVERT AREA TO SIDE LENGTH OF EQUIVALENT SQUARE.
      SORCE(4,ISORCE)=1000.*SQRT(SORCE(4,ISORCE))
      ID=SORCE(10,ISORCE)/100
      DO 900 IPOLUT=IPOLU1,IPOLU2
      SORCE(IPOLUT+4,ISORCE)=SORCE(IPOLUT+4,ISORCE)*QFACTR
  900 TQ(ID,IPOLUT)=SORCE(IPOLUT+4,ISORCE)+TQ(ID,IPOLUT)
C  CREATE RHO-THETA GRID FOR RHO=XRHO   & DELTA-THETA = PI/8
C  CENTERED ON 0,0 OF COORDINATE SYSTEM
      IRECEP=0
      IF (KRHO.EQ.0.OR.KRHO.GT.15) GO TO 920
      DPI=3.14159265/8.
      DO 910 NPI=1,16
      THETA=(NPI-1)*DPI
      CTH=COS(THETA)
      STH=SIN(THETA)
      DO 910 NRD=1,KRHO
      IRECEP=IRECEP+1
      RECEPT(1,IRECEP)=XRHO(NRD)*STH
  910 RECEPT(2,IRECEP)=XRHO(NRD)*CTH
```

560 125

FORTRAN IV G1 RELEASE 2.0 PART1 DATE = 79078 16/02/04

```
  920 NRECEP=IRECEP
      IRCV=IRECEP
      IA=IRCV+1
      IF (IADD.EQ.0) GO TO 940
      DO 930 I=1,IADD
      RECEPT(1,(NRECEP+I))=XRECEP(1,I)
      RECEPT(2,(NRECEP+I))=XRECEP(2,I)
  930 ZRECEP(NRECEP+I)=XRECEP(3,I)
      NRECEP=NRECEP+IADD
  940 NPB=IPSMAX
      NPL=1
      DO 1280 ISORC1=1,NSORCE
      ID=INT(SORCE(10,ISORC1))/100
      KSORCE=SORCE(11,ISORC1)
      IFLAG=0
      TPTSZ=0.0
      DO 950 IPS=1,IPSMAX
      IF (PTSZFC(IPS,KSORCE).EQ.0.0) GO TO 950
      NPE=IPS
      IF (IFLAG.NE.0) GO TO 950
      IFLAG=1
      NPS=IPS
  950 CONTINUE
      JFLAG=IFLAG
      NPP=NPS
      IF (IFLAG.EQ.0) GO TO 990
      DO 960 I=NPS,NPE
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 960
      IF (VSET(I).GE.SLIM) GO TO 970
  960 CONTINUE
      JFLAG=0
  970 NPP=I
      IF (NPS.LE.NPB) NPB=NPS
      IF (NPE.GE.NPL) NPL=NPE
      DO 980 I=NPS,NPE
  980 TPTSZ=TPTSZ+PTSZFC(I,KSORCE)
      IF (TPTSZ.LE.1.001.AND.TPTSZ.GE.0.999) GO TO 990
      PRINT 2560, I,KSORCE
      GO TO 70
  990 DO 1080 JSTAB=1,LSTAB
      ISTAB=JSTAB
      LTYPE=(ISTAB+1)/2-2
      DO 1080 JWD=1,LWD
      IWD=JWD
      DO 1080 IRECEP=1,NRECEP
      DO 1000 I=1,LWS
      IWSE=LWS-I+1
      IF (FREQ(IWD,IWSE,ISTAB).GT.0.0) GO TO 1010
 1000 CONTINUE
 1010 IWSB=1
      DO 1080 JWS=1,LWS
      IWS=JWS
      IF (FREQ(IWD,IWS,ISTAB).LE.0.0) GO TO 1080
      IDG=MOD(ID,10)
      DO 1020 JT=1,5
```

```
          IF (IDTAIL(JT).EQ.0) GO TO 1020
          IF (IDG.EQ.IDTAIL(JT)) GO TO 1030
     1020 CONTINUE
          GO TO 1050
     1030 DO 1040 I=1,4
     1040 FSORC(I)=PACT(I,JT)*TAILP(IWS,JT)*SORCE(4,ISORC1)**2/PTSZ20(JT)
          GO TO 1070
     1050 DO 1060 I=1,4
     1060 FSORC(I)=SORCE(I+4,ISORC1)
     1070 CALL POLUT (FSORC)
          IWSB=IWSB+1
     1080 CONTINUE
          IPS=ISORC1+1
          IF (IPS.GT.NSORCE) GO TO 1090
          IDN=INT(SORCE(10,IPS))/100
          IF (IDN.EQ.ID) GO TO 1280
     1090 IDS=ID/10
          IDG=MOD(ID,10)
          DO 1100 IRECEP=1,NRECEP
     1100 RN(IRECEP)=RN(IRECEP)+CPOLUT(5,IRECEP)
          DO 1110 I=1,5
          DO 1110 J=1,NRECEP
     1110 CISUM(I,J)=CISUM(I,J)+CACTIV(I,J)
          IF (JC(3).EQ.0.AND.JC(8).EQ.0) GO TO 1260
          IF (IRCV.EQ.0) GO TO 1190
          IT=0
          DO 1180 I=1,IRCV,KRHO
          IT=IT+1
          IF (JC(8).EQ.0) GO TO 1130
          IF (MOD(IT,2).EQ.0) GO TO 1120
          CALL HEADER (6)
          PRINT 2620, (SORCID(J,IDS),J=1,5),(GROUPN(J,IDG),J=1,5)
          PRINT 2610
          PRINT 2570
     1120 PRINT 2640, THETAS(IT)
          PRINT 2300
          PRINT 2670
          PRINT 2570
     1130 IF (JC(3).EQ.0) GO TO 1150
          IF (MOD(IT,2).EQ.0) GO TO 1140
          CALL HEADER (10)
          WRITE (10,2620) (SORCID(J,IDS),J=1,5),(GROUPN(J,IDG),J=1,5)
          WRITE (10,2630)
          WRITE (10,2570)
     1140 WRITE (10,2640) THETAS(IT)
          WRITE (10,2650)
          WRITE (10,2570)
     1150 DO 1180 II=1,KRHO
          IP=II+I-1
          DO 1170 J=1,5
          IF (TQ(ID,J).EQ.0) GO TO 1160
          RF(J)=CPOLUT(J,IP)/TQ(ID,J)
          GO TO 1170
     1160 RF(J)=0.0
     1170 CONTINUE
```

```
0630              IF (JC(3).GT.0) WRITE (10,2660) XRHO(II),(RF(J),J=1,5)
0631              IF (JC(8).EQ.0) GO TO 1180
0632              PRINT 2660, XRHO(II),(CPOLUT(J,IP),J=1,5),(CACTIV(JJ,IP),JJ=1,5)
0633         1180 CONTINUE
0634         1190 IF (IADD.EQ.0) GO TO 1260
0635              LL=60
0636              LLL=60
0637              K=0
0638              DO 1250 I=IA,NRECEP
0639              K=K+1
0640              IF (JC(8).EQ.0) GO TO 1210
0641              IF (LL.LT.60) GO TO 1200
0642              CALL HEADER (6)
0643              PRINT 2620, (SORCID(J,IDS),J=1,5),(GROUPN(J,IDG),J=1,5)
0644              PRINT 2220
0645              PRINT 2230
0646              PRINT 2240
0647              PRINT 2570
0648              LL=11
0649         1200 PRINT 2250, K,(XNAME(J,K),J=1,4),(CPOLUT(J,I),J=1,5),(CACTIV(J,I),
                 1J=1,5)
0650              LL=LL+1
0651         1210 IF (JC(3).EQ.0) GO TO 1250
0652              DO 1230 J=1,5
0653              IF (TQ(ID,J).EQ.0.) GO TO 1220
0654              RF(J)=CPOLUT(J,I)/TQ(ID,J)
0655              GO TO 1230
0656         1220 RF(J)=0.0
0657         1230 CONTINUE
0658              IF (LLL.LT.60) GO TO 1240
0659              CALL HEADER (10)
0660              WRITE (10,2620) (SORCID(J,IDS),J=1,5),(GROUPN(J,IDG),J=1,5)
0661              WRITE (10,2260)
0662              WRITE (10,2270)
0663              WRITE (10,2570)
0664              LLL=9
0665         1240 WRITE (10,2280) K,(XNAME(J,K),J=1,4),(XRECEP(J,K),J=1,3),(RF(J),J=
                 11,5)
0666              LLL=LLL+1
0667         1250 CONTINUE
0668         1260 DO 1270 IRECEP=1,NRECEP
0669              DO 1270 I=1,5
0670              CPOLUT(I,IRECEP)=0.0
0671         1270 CACTIV(I,IRECEP)=0.0
0672         1280 CONTINUE
0673         1290 RETURN
            C
            C
            C
0674         1300 FORMAT(1H1////////////)
0675         1310 FORMAT(31X,'*',T103,'*')
0676         1320 FORMAT(31X,'*',15X,'URANIUM DISPERSION AND DOSIMETRY (UDAD)',T103,
                 1   '*')
0677         1330 FORMAT(31X,'*',24X,'VERSION IX, 03/19/79',T103,'*')
0678         1340 FORMAT(31X,'*  A COMPREHENSIVE COMPUTER PROGRAM TO PROVIDE ESTIMAT
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                1ES OF POTENTIAL  *'/31X,'*  RADIATION EXPOSURE TO INDIVIDUALS AND
                2TO THE GENERAL POPULATION IN  *'/31X,'*',12X,'THE VICINITY OF A UR
                3ANIUM PROCESSING FACILITY',T103,'*')
0679       1350 FORMAT(31X,'*',11X,'MICHAEL H. MOMENI, YUCHIEN YUAN AND A. J. ZIEL
                1EN',T103,'*')
0680       1360 FORMAT(31X,'*',15X,'DIVISION OF ENVIRONMENTAL IMPACT STUDIES',
                1   T103,'*')
0681       1370 FORMAT(31X,'*',21X,'ARGONNE NATIONAL LABORATORY',T103,'*')
0682       1380 FORMAT('0NAMELIST NEWSET VALUES:')
0683       1390 FORMAT('0NAMELIST NEWEST VALUES (CONT.):')
0684       1400 FORMAT('0PTSZFC ERROR - MORE THAN ONE DENSITY FOR I =',I3)
0685       1410 FORMAT('0YDOC =',1PE9.2)
0686       1420 FORMAT('0YEVD =',1PE9.2)
0687       1430 FORMAT('0INITIAL NAMELIST INDATA VALUES:')
0688       1440 FORMAT('0INITIAL NAMELIST INDATA VALUES (CONT.):')
0689       1450 FORMAT('0SUFF =',1PE9.2)
0690       1460 FORMAT ('0SUFI =',1PE9.2)
0691       1470 FORMAT ('0VDEP(5):')
0692       1480 FORMAT ('0XNAME(4,60):')
0693       1490 FORMAT (6X,'COMPLETE LIST STARTS ON PAGE 7 (APPROXIMATELY)')
0694       1500 FORMAT ('0XRECEP(3,60):')
0695       1510 FORMAT ('0XRHO(15):')
0696       1520 FORMAT (1X,15F8.1)
0697       1530 FORMAT(1H0,'IDTAIL(5):')
0698       1540 FORMAT('0KRHO = ',I2)
0699       1550 FORMAT('0METSET(4):'/6X,4A8)
0700       1560 FORMAT('0MPC(7,5):')
0701       1570 FORMAT('0NSORCE = ',I2)
0702       1580 FORMAT('0OPTIME =',1PE9.2)
0703       1590 FORMAT('0PDEN(5):')
0704       1600 FORMAT('0PHALF =',1PE9.2)
0705       1610 FORMAT('0PTSZ(5):')
0706       1620 FORMAT ('0PTSZFC(5,5):')
0707       1630 FORMAT('0REGION(6):'/6X,6A4)
0708       1640 FORMAT('0RFI =',1PE9.2)
0709       1650 FORMAT('0RFIE =',1PE9.2)
0710       1660 FORMAT('0RSALF =',1PE9.2)
0711       1670 FORMAT('0RSLIM =',1PE9.2)
0712       1680 FORMAT('0SHIED =',1PE9.2)
0713       1690 FORMAT('0SLIM =',1PE9.2)
0714       1700 FORMAT('0SLIP(5):')
0715       1710 FORMAT('0SORCE(12,80):')
0716       1720 FORMAT(1X,1P9E12.2,0PI7,I5,1PE12.2)
0717       1730 FORMAT(1X)
0718       1740 FORMAT('0SORCID(5,9):')
0719       1750 FORMAT('0DFACT =',1PE9.2)
0720       1760 FORMAT('0DM =',1PE9.2)
0721       1770 FORMAT('0FG =',1PE9.2)
0722       1780 FORMAT('0FREQ(16,6,6):'/6X,'COMPLETE LIST STARTS ON PAGE 8 (APPROX
                1IMATELY)')
0723       1790 FORMAT('0GROUPN(5,9):')
0724       1800 FORMAT(6X,5A4)
0725       1810 FORMAT(6X,'REMAINING LINES ALL BLANK')
0726       1820 FORMAT('0IADD = ',I2)
0727       1830 FORMAT('0IPOP(15,16):'/6X,'COMPLETE LIST ON PAGE 16 (APPROXIMATELY
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                 1)')
0728        1840 FORMAT('0IRHO(6):')
0729        1850 FORMAT('0IYR(10):')
0730        1860 FORMAT(1H0,'IFODOS(60):')
0731        1870 FORMAT(1H0,'PNFOD(60):')
0732        1880 FORMAT (1X,1P6E13.2)
0733        1890 FORMAT(1H0,'FCON(6,5):')
0734        1900 FORMAT(1H0,'BSV(6):')
0735        1910 FORMAT(1H0,'FCODIN(2,3):')
0736        1920 FORMAT(1X,1P2E13.2)
0737        1930 FORMAT(1H0,'XIN(7):')
0738        1940 FORMAT(1X,1P7E13.2)
0739        1950 FORMAT(1H0,'XING(7):')
0740        1960 FORMAT(1H0,'PTAIL(7,5):')
0741        1970 FORMAT(1H0,'PACT(4,5):')
0742        1980 FORMAT(1X,1P4E13.2)
0743        1990 FORMAT(1H0,'PGTH(4):')
0744        2000 FORMAT(1H0,'PFIN(8):'/1X,1P8E13.2)
0745        2010 FORMAT(1H0,'PTS220(5):')
0746        2020 FORMAT(1X,1P5E13.2)
0747        2030 FORMAT(1H0,'RHO(2):')
0748        2040 FORMAT(1H0,'DV(2):')
0749        2050 FORMAT(1H0,'TH(2):')
0750        2060 FORMAT(1H0,'TC(2):')
0751        2070 FORMAT(1H0,'FV(2):')
0752        2080 FORMAT(1H0,'IDSQ(3,6):')
0753        2090 FORMAT(1X,3I5)
0754        2100 FORMAT(1H0,'NNUC =',I3)
0755        2110 FORMAT(1H0,'E(10,12):')
0756        2120 FORMAT(1X,1P10E13.2)
0757        2130 FORMAT(1H0,'LON(10,4):')
0758        2140 FORMAT(1H0,'LR(10):')
0759        2150 FORMAT(1H0,'F1(10):')
0760        2160 FORMAT(1H0,'F2P(10,4):')
0761        2170 FORMAT(1H0,'IFSOL(10):')
0762        2180 FORMAT(1X,10I5)
0763        2190 FORMAT(1H0,'NSPTAB(10,4):')
0764        2200 FORMAT(1H0,'F2PM(16):')
0765        2210 FORMAT(1H0,'LONM(16):')
0766        2220 FORMAT('0',27X,'INDIVIDUAL SOURCE CONCENTRATION (PCI/M3) AT EXTRA
                1RECEPTORS---NO RESUSPENSION')
0767        2230 FORMAT('-',37X,'<',10('-'),' PARTICULATES ',10('-'),'>     <',
                1   15('-'),' RADON AND DAUGHTERS ',16('-'),'>')
0768        2240 FORMAT('0 #   IDENTIFICATION',21X,'238U',5X,'230TH',4X,'226RA',
                1   4X,'210PB',9X,'222RN',4X,'218PO',4X,'214PB',4X,'214BI',4X,
                2   '210PB',4X,'210PO')
0769        2250 FORMAT(1X,I2,3X,4A8,1P4E9.2,5X,6E9.2)
0770        2260 FORMAT('0',39X,'EFFECTIVE DISPERSION FACTOR (SEC/M3) AT EXTRA RECE
                1PTORS')
0771        2270 FORMAT('- #   IDENTIFICATION',21X,'X(KM)   Y(KM)   Z(M)',6X,
                1   '238U',8X,'230TH',7X,'226RA',7X,'210PB',7X,'222RN')
0772        2280 FORMAT(1X,I2,3X,4A8,2F8.2,F7.1,1P5E12.2)
0773        2290 FORMAT('0',10X,'COLUMN TOTALS:',5X,6(4X,F8.5),7X,F8.5)
0774        2300 FORMAT(1H0,T12,'<',16('-'),' PARTICULATES ',16('-'),'><',
                1   26('-'),' RADON AND DAUGHTERS ',25('-'),'>')
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0775       2310 FORMAT('0','NUMBER OF SOURCES=',I4)
0776       2320 FORMAT(1H-,'ID/1000',4X,'SOURCE GROUPS'/1X,24('-'))
0777       2330 FORMAT(1X,I4,7X,5A4)
0778       2340 FORMAT('-',7X,'KM',5X,'KM',7X,'M',7X,'KM2',25X,'CI/YEAR',29X,
               1'FDEN',4X,'MSEC')
0779       2350 FORMAT('  #',6X,'X',6X,'Y',7X,'Z',6X,'AREA',7X,'238U',5X,
               1'230TH',5X,'226RA',5X,'210PB',5X,'222RN',5X,'ID',3X,'SET',3X,
               2'EXIT VEL',3X,'SOURCE TYPE')
0780       2360 FORMAT(' ',I2,2F8.2,F7.1,1X,1P6E10.2,0PI7,I4,1PE12.2,3X,5A4)
0781       2370 FORMAT('-',T44,'PARTICLE PARAMETERS AND FRACTIONAL DISTRIBUTIONS'
               1//T25,'DIAMETER,',4X,'DEPOSITION      SETTLING    |',16X,
               2'DENSITY, G/CM3'/T26,'MICRONS ',2(4X,'VEL., M/SEC'),'  |',
               3F7.2,4F9.2)
0782       2380 FORMAT(1X,T25,41('-'),'|',44('-'))
0783       2390 FORMAT(T25,F6.1,1X,1P2E15.2,'    |',0PF8.3,4F9.3)
0784       2400 FORMAT('-','ADDITIONAL RECEPTOR POINTS =',I4)
0785       2410 FORMAT('0 #',3X,'IDENTIFICATION',T43,'X(KM)   Y(KM)    Z(M)'/
               1   1X,63('-'))
0786       2420 FORMAT(1X,I2,3X,4A8,1X,3F8.2)
0787       2430 FORMAT('-',36X,'ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILIT
               1Y CLASS ',I1)
0788       2440 FORMAT('-',31X,'ANNUAL RELATIVE FREQUENCE OF OCCURENCE -- SUM OF A
               1LL STABILITY CLASSES')
0789       2450 FORMAT(1H0,59X,'WIND SPEED, KNOTS'/35X,67('-')/11X,'WIND DIRECTION
               1',10X,A8,5(4X,A8),5X,'ROW TOTALS')
0790       2460 FORMAT('0',16X,A4,9X,6(4X,F8.5),7X,F8.5)
0791       2470 FORMAT(1H0,'SUM OF WIND SPEED FREQUENCIES NOT WITHIN 0.1% LIMIT, J
               1OB ABORTED.')
0792       2480 FORMAT('-',45X,'MPC VALUES (PCI/M3), REF: ICRP2')
0793       2490 FORMAT('0',17X,'ELEMENT',4X,5(3A4,4X)/)
0794       2500 FORMAT(' ',17X,2A4,1P5(E11.2,5X))
0795       2510 FORMAT(1H0,T13,'|',4X,16(A4,3X),1X,'ROW')
0796       2520 FORMAT(1X,'KILOMETERS |',16F7.1,5X,'SUM')
0797       2530 FORMAT(1H ,F4.1,'-',F4.1,'  |',16I7,I8)
0798       2540 FORMAT(12X,'|')
0799       2550 FORMAT(1H0,'ERROR--ILLEGAL PARTICLE DENSITY SET, KSORCE =,',I3,
               1   ', FOR SORCE ID',F5.0)
0800       2560 FORMAT('0PTSZFC(I,K) CHECK TOTAL ERROR FOR I=',I2,' AND K=',I2)
0801       2570 FORMAT(1X,132('-'))
0802       2580 FORMAT(' ',T56,'POPULATION DISTRIBUTION')
0803       2590 FORMAT(1H0,'ERROR -- NUMBER OF SOURCES =',I4,
               1   ' NOT WITHIN 1-80 LIMITS')
0804       2600 FORMAT(1H0,'ERROR -- NUMBER OF ADDITIONAL RECEPTORS =',I4,
               1   ' NOT WITHIN 0-60 LIMITS')
0805       2610 FORMAT('0',37X,'INDIVIDUAL SOURCE CONCENTRATION (PCI/M3)---NO RESU
               1SPENSION')
0806       2620 FORMAT(' ',5A4,4X,5A4)
0807       2630 FORMAT('0',20X,'EFFECTIVE DISPERSION FACTOR (SEC/M3)')
0808       2640 FORMAT('0','THETA= ',F6.2,' DEGREE ANGLE')
0809       2650 FORMAT('0','DISTANCE',6X,'238U',8X,'230TH',7X,'226RA',7X,'210PB',
               1 7X,'222RN')
0810       2660 FORMAT(' ',1X,F7.2,1P10E12.2)
0811       2670 FORMAT('0','DISTANCE',6X,'238U',8X,'230TH',7X,'226RA',7X,'210PB',
               17X,'222RN',7X,'218PO',7X,'214PB',7X,'214BI',7X,'210PB',7X,'210PO')
0812       2680 FORMAT(1H0,'JC(9):')
0813       2690 FORMAT(31X,72('*'))
0814            END
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560 131

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FORTRAN IV G1  RELEASE 2.0             POLUT              DATE = 79078          16/02/04

0001              SUBROUTINE POLUT (PSORC)
0002              LOGICAL SGTDMX
0003              REAL*8 HLM,ACTIV,GMAT,XNAME,METSET,TODAY
0004              REAL*4 MPC
0005              COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                 1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                 2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                 3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                 4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                 5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0006              COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
                 1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
                 2   ISORC1,KSORCE,IWD,IWS,ISTAB,IWSB,IWSE
0007              COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                 1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
                 2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                 3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0008              COMMON/DEPY/QXQ(5,6)
0009              COMMON/DSFRSN/FREQ(16,6,6),SORCE(12,80)
0010              DIMENSION COSWD(16),SINWD(16),PSORC(4)
0011              DIMENSION PHTP(5),C1P(5),C3P(5),ARG1P(5)
0012              DIMENSION HLM(7),ACTIV(7),GMAT(7,7),HFLFE(7),CACTIV(5,300),
                 1   CPOLUT(5,300)
            C     SINWD(IWNDIR)=SIN((PI*FLOAT(IWNDIR-1))/8)
0013              DATA SINWD/0.0,.38268,.70711,.92388,1.0,.92388,.70711,.38268,0.0,
                 1    -.38268,-.70711,-.92388,-1.0,-.92388,-.70711,-.38268/
            C     COSWD(IWNDIR)=COS((PI*FLOAT(IWNDIR-1))/8)
0014              DATA COSWD/1.0,.92388,.70711,.38268,0.0,-.38268,-.70711,-.92388,
                 1    -1.0,-.92388,-.70711,-.38268,0.0,.38268,.70711,.92388/
0015              DATA PI4,PI8/.7853982,.3926991/
0016              DATA HFLFE/3.3005E5,183.0,1608.0,1182.0,6.6226E8,4.33E5,1.196E7/
0017              DATA INDEX/0/
0018              EQUIVALENCE (IWNDIR,IWD)
0019              EQUIVALENCE (TCNGO(1,1),CACTIV(1,1)),(TCNGC(1,1),CPOLUT(1,1))
0020              IF (INDEX.GT.0) GO TO 30
0021              INDEX=1
0022              X1=1.0
0023              DO 10 I=1,7
0024           10 HLM(I)=ALN2/HFLFE(I)
0025              DO 20 I=1,7
0026              DO 20 J=1,7
0027              GMAT(J,I)=HLM(J)-HLM(I)
0028           20 GMAT(I,J)=-GMAT(J,I)
0029           30 SDIAM=SORCE(4,ISORC1)
0030              SRAD=SDIAM/2.
0031              PSFACT=FREQ(IWD,IWS,ISTAB)
0032              DNWIND=GDSCAL*((SORCE(2,ISORC1)-RECEPT(2,IRECEP))*COSWD(IWNDIR)+(S
                 1ORCE(1,ISORC1)-RECEPT(1,IRECEP))*SINWD(IWNDIR))
0033              X=DNWIND+SDIAM/PI8
0034              IF (SDIAM.GT.100.) GO TO 40
0035              IF (X) 280,280,50
0036           40 IF (SRAD+DNWIND) 280,280,50
0037           50 CXWIND=GDSCAL*ABS((SORCE(2,ISORC1)-RECEPT(2,IRECEP))*SINWD(IWNDIR)
                 1-(SORCE(1,ISORC1)-RECEPT(1,IRECEP))*COSWD(IWNDIR))
0038              Y=X*PI8
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FORTRAN IV G1  RELEASE 2.0              POLUT               DATE = 79078          16/02/04
0039                IF (Y.LE.CXWIND) GO TO 280
0040                IF (SRAD.GT.ABS(DNWIND)) GO TO 60
0041                IF (SDIAM.LE.(DNWIND*PI8)) GO TO 70
0042                Q=QSCALE*((PI8*X-SDIAM)/SDIAM)
0043                DNWIND=SQRT((DNWIND*DNWIND)+(SRAD*SRAD))
              C     FROM DNWIND=((4.*DNWIND**2.+SDIAM**2.)**.5)/2.
0044                X=2.*DNWIND
0045                IF (CXWIND-(SRAD+X*PI8)) 80,80,280
0046             60 Q=QSCALE*(PI4*(X*X-4.08*X*SDIAM+4.1616*SDIAM*SDIAM))/(SRAD*SRAD*16
                   1.)
              C     FROM Q=QSCALE*(.1965*(X-2.040*SDIAM)**2.)/SDIAM**2.
0047                DNWIND=SINWD(3)*(DNWIND+SRAD)
              C     WHERE SINWD(3) = SIN(PI8*2) OR SIN(PI/4) OR .70711
0048                X=DNWIND*2.
0049                IF (CXWIND-SRAD) 80,80,280
0050             70 Q=QSCALE
0051             80 Q=Q*(Y-CXWIND)/Y
              C   CORRECTION SUGGESTED BY APCO -- JANUARY 1971
0052                IF (X.LT.100.0) X=100.0
              C
0053                U=UU(INS)
0054                Y=100.0*Q/U
0055                IF (Y.LE.0.0) GO TO 280
0056                DNWIDD=DNWIND
              C   **********
              C   BRIGGS PLUME RISE FORMULATION : JANUARY 1971
0057                HS=SORCE(3,ISORC1)
              C***  ADD HOLLAND-STUMKE-MOSES/CARSON RISE IF VDD>0.0
              C***  NOTE THAT VDD IS SORCE(12,ISORC1)
0058                IF (SORCE(12,ISORC1).GT.0.0) HS=HS+1.5*SORCE(12,ISORC1)/U
0059                PHT=HS
0060                IF (ZRECEP(IRECEP).NE.0) PHT=PHT-ZRECEP(IRECEP)
              C   **********
0061                IF (PHT.LT.0.0) PHT=0.0
0062                IF (IFLAG.EQ.0) GO TO 120
0063                DO 110 I=NPS,NPE
0064                IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 110
0065                IF (VSET(I).LT.VDEP(I)) GO TO 90
0066                PHTP(I)=PHT-DNWIND*VSET(I)/U
0067                GO TO 100
0068             90 PHTP(I)=PHT
0069            100 IF (PHTP(I).LE.0.0) PHTP(I)=0.0
0070            110 CONTINUE
0071            120 IF (DNWIND.LT.100.) DNWIND=100.
0072                SIGZ=AFUNC(DNWIND)
0073                ARG1=(-.5*PHT**2)/(SIGZ**2)
0074                IF (IFLAG.EQ.0) GO TO 140
0075                DO 130 I=NPS,NPE
0076                IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 130
0077                ARG1P(I)=(-.5*PHTP(I)**2)/(SIGZ**2)
0078            130 CONTINUE
0079            140 SOTDMX=.TRUE.
0080                IF (ISTAB.GT.4) GO TO 200
0081                IF (SIGZ.LT..47*DM) GO TO 200
0082                X1=0.47*DM/OA(ISTAB)
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0083           IF (ISTAB.LT.3) GO TO 150
0084           X1=X1*X1
0085           X11=X1*OB(ISTAB)/2.
0086           X1=X11+(X11*X11+X1)**0.5
0087       150 IF (X.GE.X1*2.) GO TO 160
0088           XD=2.*X1
0089           SGTDMX=.FALSE.
0090           GO TO 170
0091       160 XD=X
0092       170 C2=(.0255*Y)/(DM*XD)
0093           IF (.NOT.SGTDMX) GO TO 190
0094           C3=C2
0095           IF (IFLAG.EQ.0) GO TO 230
0096           DO 180 I=NPS,NPE
0097           IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 180
0098           C3P(I)=C2
0099       180 CONTINUE
0100           GO TO 230
0101       190 XD=X1
0102           GO TO 210
0103       200 XD=X
0104       210 IF (ABS(ARG1).GT.60.) ARG1=-60.
0105           C1=(.0203*Y)/(SIGZ*XD)*EXP(ARG1)
0106           C3=C1
0107           IF (.NOT.SGTDMX) C3=C1-((X-X1)/X1)*(C1-C2)
0108           IF (IFLAG.EQ.0) GO TO 230
0109           DO 220 I=NPS,NPE
0110           IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 220
0111           IF (ABS(ARG1P(I)).GT.60.) ARG1P(I)=-60.
0112           AREXP=EXP(ARG1P(I))
0113           C1P(I)=(.0203*Y)/(SIGZ*XD)*AREXP
0114           C3P(I)=C1P(I)
0115           IF (.NOT.SGTDMX) C3P(I)=C1P(I)-((X-X1)/X1)*(C1P(I)-C2)
0116       220 CONTINUE
         C   HALF-LIFE MODIFICATION FOR RADON222
0117       230 TIME=DMWIND/U
0118           CONCRN=SORCE(9,ISORC1)
0119           IF (IFLAG.EQ.0) GO TO 260
0120           IF (IWSB.GT.1) GO TO 240
0121           CALL DDEP (SIGZ,DWINDD,X1,PHT)
0122       240 DO 250 I=NPS,NPE
0123           IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 250
0124           DO 250 IPOLUT=1,4
0125           CONC=C3P(I)*PTSZFC(I,KSORCE)*PSORC(IPOLUT)*QXQ(I,IWS)*PSFACT
0126           TPSZ(I,IPOLUT,IRECEP)=TPSZ(I,IPOLUT,IRECEP)+CONC
0127           CPOLUT(IPOLUT,IRECEP)=CPOLUT(IPOLUT,IRECEP)+CONC
0128       250 CONTINUE
0129       260 IF (CONCRN.EQ.0.0) GO TO 280
0130           CALL ACTOR1 (TIME,7,HLM,ACTIV,GMAT,HLM)
0131           F1=PSFACT*C3
0132           F2=F1*CONCRN
0133           F3=F1*SNGL(ACTIV(1))
0134           DO 270 I=1,4
0135       270 CACTIV(I,IRECEP)=CACTIV(I,IRECEP)+SNGL(ACTIV(I+1))*F2
0136           CACTIV(5,IRECEP)=CACTIV(5,IRECEP)+SNGL(ACTIV(7))*F2
0137           CPOLUT(IPOLU2,IRECEP)=CPOLUT(IPOLU2,IRECEP)+SORCE(IPOLU2+4,ISORC1)
              1*F3
0138       280 RETURN
0139           END
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560 134

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FORTRAN IV G1  RELEASE 2.0             ACTDR1              DATE = 79078         16/02/04

0001              SUBROUTINE ACTDR1 (TIME,N1,HLM,ACTIV,GMAT,HLME)
0002              REAL*8 HLM(7),HLME(7),ACTIV(7),GMAT(7,7),EHLM(7),X,Y,Z
            C     CALCULATE 'CTIVITY AT TIME ' TIME'
0003              N=N1
0004              DO 20 I=1,N
0005              X=-HLME(I)*TIME
            C     FOLLOWING GUARDS AGAINST UNDERFLOW ERROR FOR DEXP(X)
0006              IF (-X.LT.(1.5D2)) GO TO 10
0007              EHLM(I)=0.D0
0008              GO TO 20
0009           10 EHLM(I)=DEXP(X)
0010           20 CONTINUE
0011              ACTIV(1)=EHLM(1)
0012              DO 60 I=2,N
0013              Y=1.0
0014              DO 30 J=2,I
0015           30 Y=Y*HLM(J)
0016              ACTIV(I)=0.D0
0017              DO 50 K=1,I
0018              Z=EHLM(K)
0019              DO 40 J=1,I
0020              IF (K.EQ.J) GO TO 40
0021              Z=Z/GMAT(J,K)
0022           40 CONTINUE
0023              ACTIV(I)=ACTIV(I)+Z
0024           50 CONTINUE
0025              ACTIV(I)=ACTIV(I)*Y
0026              IF (ACTIV(I).LT.0.D0) ACTIV(I)=0.D0
0027           60 CONTINUE
0028              RETURN
0029              END
```

```
FORTRAN IV G1  RELEASE 2.0          ACTDR2          DATE = 79078          16/02/04

0001            SUBROUTINE ACTDR2 (T,NT,R,E,INT)
0002            DIMENSION R(6),E(6),T(8)
0003            COMMON/ATA/AA(6,6),BB(6,6)
0004            DO 10 I=1,NT
0005            DO 10 J=1,NT
0006         10 AA(I,J)=0.0
0007            DO 80 N=1,NT
0008            DO 80 K=1,N
0009            DCAY=3.1535E7
0010            K1=K+1
0011            IF (K1.GT.N) GO TO 30
0012            DO 20 J=K1,N
0013         20 DCAY=DCAY*R(J)
0014         30 FACT=0.0
0015            DO 70 L=K,N
0016            IF (INT.GT.0) GO TO 40
0017            F1=ETEST(E(L),T(1))
0018            F1=(F1-ETEST(E(L),T(2)))/E(L)
0019            GO TO 50
0020         40 F1=T(1)*ETEST(E(L),T(2))-T(3)*ETEST(E(L),T(4))
0021            F1=F1+(ETEST(E(L),T(5))-ETEST(E(L),T(6))-ETEST(E(L),T(7))+ETEST(E(
               1L),T(8)))/E(L)
0022            F1=F1/E(L)
0023         50 F2=1.0
0024            DO 60 I=K,N
0025            IF (I.EQ.L) GO TO 60
0026            F2=(R(I)-R(L))*F2
0027         60 CONTINUE
0028         70 FACT=FACT+F1/F2
0029         80 AA(N,K)=DCAY*FACT
0030            RETURN
0031            END
```

```
FORTRAN IV G1  RELEASE 2.0          ACT             DATE = 79078          16/02/04

0001            SUBROUTINE ACT (X,XR)
0002            DIMENSION X(6),XR(6)
0003            COMMON/ATA/AA(6,6),BB(6,6)
0004            DO 10 IP=1,6
0005            XR(IP)=0.0
0006            DO 10 ID=1,IP
0007            XR(IP)=XR(IP)+AA(IP,ID)*X(ID)
0008         10 CONTINUE
0009            RETURN
0010            END
```

```
FORTRAN IV G1  RELEASE 2.0              DDEP                DATE = 79078           16/02/04

0001                    SUBROUTINE DDEP (SIGZ,DNWIND,X1,PHT)
0002                    REAL*8 METSET,XNAME
0003                    COMMON/INTG/SUMP(5,6),SUM,H,XL
0004                    COMMON/DEPY/QXQ(5,6)
0005                    COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                     1    PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                     2    IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                     3    PFIN(8),PUFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                     4    FDEN(5),FGTH(4),XIN(7),XING(7),FOCDIN(2,3),RSLIM,RSALF,YDOC,
                     5    FCON(6,5),RHO(2),DV(2),TM(2),TC(2),FV(2),BSV(6),YEVD
0006                    COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
                     1    OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
                     2    ISORC1,KSORCE,IWD,IHS,ISTAB,INSB,IHSE
0007                    DATA NCALL/0/
0008                    IF (NCALL.GT.0) GO TO 10
0009                    NCALL=1
0010                    F=SQRT(2.0/3.141593)
0011                 10 H=PHT**2
0012                    XL=X1
0013                    SZ100=AFUNC(100.)
0014                    SUM=100.*EXP(-H*0.5/(SZ100**2))/SZ100
0015                    IF (JFLAG.EQ.0) GO TO 30
0016                    XP=50.
0017                    DO 20 I=NPP,NPE
0018                    IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 20
0019                    DO 20 J=INS,INSE
0020                    HP=PHT-XP*VSET(I)/UU(J)
0021                    IF (HP.LT.0.0) HP=0.0
0022                    SUMP(I,J)=100.*EXP(-HP*HP*0.5/(SZ100*SZ100))/SZ100
0023                 20 CONTINUE
0024                 30 IF (DNWIND.LE.100.) GO TO 80
0025                    IF (ISTAB.GT.4) GO TO 70
0026                    IF (SIGZ.LT.0.47*DM) GO TO 70
0027                    IF (DNWIND.LE.X1) GO TO 70
0028                    IF (X1.LT.100.) X1=100.
0029                    CALL INTEG (0,100.,X1,PHT)
0030                    XM=DNWIND
0031                    IF (DNWIND.GT.2.*X1) XM=2.*X1
0032                    CALL INTEG (1,X1,XM,PHT)
0033                    DSUM=(XM-X1)**2/(2.*X1*DM)
0034                    SUM=SUM+DSUM
0035                    IF (JFLAG.EQ.0) GO TO 50
0036                    DO 40 I=NPP,NPE
0037                    IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 40
0038                    DO 40 J=INS,INSE
0039                    SUMP(I,J)=SUMP(I,J)+DSUM
0040                 40 CONTINUE
0041                 50 IF (DNWIND.LE.2.*X1) GO TO 100
0042                    XL=2.*X1
0043                    DSUM=(DNWIND-XL)/DM
0044                    SUM=SUM+DSUM
0045                    IF (JFLAG.EQ.0) GO TO 100
0046                    DO 60 I=NPP,NPE
0047                    IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 60
0048                    DO 60 J=IHS,INSE
```

FORTRAN IV G1 RELEASE 2.0 DDEP DATE = 79078 16/02/04

```
      SUMP(I,J)=SUMP(I,J)+DSUM
   60 CONTINUE
      GO TO 100
   70 CALL INTEG (0,100.,DNWIND,PHT)
      GO TO 100
   80 SUM=SUM*DNWIND/100.
      IF (JFLAG.EQ.0) GO TO 100
      XP=DNWIND/2.
      DO 90 I=NPP,NPE
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 90
      DO 90 J=IWS,IWSE
      HP=PHT-XP*VSET(I)/UU(J)
      IF (HP.LT.0.0) HP=0.0
      SUMP(I,J)=DNWIND*EXP(-HP*HP*0.5/(SZ100*SZ100))/SZ100
   90 CONTINUE
  100 CONTINUE
      DO 110 I=NPS,NPE
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 110
      TEMP=F*SUM*VDEP(I)
      DO 110 J=IWS,IWSE
      WDF=TEMP/UU(J)
      IF (WDF.GT.60.) WDF=60.0
      QXQ(I,J)=EXP(-WDF)
  110 CONTINUE
      IF (JFLAG.EQ.0) GO TO 130
      DO 120 I=NPP,NPE
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 120
      DO 120 J=IWS,IWSE
      WDFP=F*VDEP(I)*SUMP(I,J)/UU(J)
      IF (WDFP.GT.60.) WDFP=60.
      QXQ(I,J)=EXP(-WDFP)
  120 CONTINUE
  130 RETURN
      END
```

FORTRAN IV G1 RELEASE 2.0 INTEG DATE = 79078 16/02/04

```
      SUBROUTINE INTEG (INDEX,XI,XN,PHT)
      EXTERNAL FERR,FERR1
      REAL*8 METSET,XNAME
      REAL*8 DOA,DOB,DH,DX1,DXI,DXN,EP,FERR,FERR1
      COMMON/INTG/SUMP(5,6),SUM,H,XL
      COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
     1   PTSZ(5),REGION(6),XRECEP(3,60),DH,XRHO(15),KSMAX,IPSMAX,
     2   IFOP(15,16),JC(9),NSCRCE,IRHO(6),IYR(10),IFCDOS(60),RFI,SHIED,
     3   PFIN(8),FWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
     4   FDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
     5   FCON(6,5),RHO(2),DV(2),TH(2),TC(2),FV(2),BSV(6),YEVD
      COMMON/UDADC2/VSET(5),CDSCAL,QSCALE,LTYPE,
     1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
     2   ISORC1,KSORCE,IND,INS,ISTAB,INSB,INSE
      COMMON/DSTBZ/DOA,DOB,DH,DX1
      FUNC(A,B,C)=EXP((-A+B)*0.5/(C*C))
      IF (XI.GT.XN) GO TO 70
      DXI=DBLE(XI)
      DXN=DBLE(XN)
      DX1=DBLE(XL)
      DH=DBLE(H)
      DOA=DBLE(OA(ISTAB))
      DOB=DBLE(OB(ISTAB))
      EP=1.0D-4
      IF (INDEX.EQ.1) GO TO 10
      DSUM=ANC4(DXI,DXN,EP,M,1,FERR)
      GO TO 20
   10 DSUM=ANC4(DXI,DXN,EP,M,1,FERR1)/DX1
   20 SUM=SUM+DSUM
      IF (JFLAG.   .0) RETURN
      XP=(XI+XN)/2.
      SZBAR=AFUNC(XP)
      DO 60 I=NPP,NPE
      IF (PTSZFC(I,KSORCE).EQ.0.0) GO TO 60
      DO 60 J=INS,INSE
      U=UU(J)
      XM=PHT*U/VSET(I)
      IF (XM.LE.XI) GO TO 40
      IF (XM.GE.XN) GO TO 30
      XP1=(XI+XM)/2.
      HP=HT(I,PHT,XP1,U)
      HP=HP*((XM-XI)/(XN-XI))**2
      GO TO 50
   30 HP=HT(I,PHT,XP,U)
      GO TO 50
   40 HP=0.0
   50 SUMP(I,J)=SUMP(I,J)+DSUM*FUNC(HP,H,SZBAR)
   60 CONTINUE
      RETURN
   70 PRINT 80
      STOP
C
C
C
   80 FORMAT('1','ERROR IN SUBROUTINE INTEG, XI.GT.XN')
      END
```

```
FORTRAN IV G1  RELEASE 2.0              AFUNC              DATE = 79078           16/02/04

 0001                  FUNCTION AFUNC (X)
 0002                  COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
                      1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
                      2   ISORC1,KSORCE,IWD,IWS,ISTAB,IWSB,IWSE
 0003                  Y=OA(ISTAB)*X
 0004                  Y1=1.0+OB(ISTAB)*X
 0005                  IF (LTYPE) 10,20,30
                 C
                 C     NOTE THAT LTYPE=-1,-1,0,0,1,1 FOR ISTAB=1,2,3,4,5,6
                 C
 0006               10 AFUNC=Y*Y1
 0007                  RETURN
 0008               20 AFUNC=Y/SQRT(Y1)
 0009                  RETURN
 0010               30 AFUNC=Y/Y1
 0011                  RETURN
 0012                  END
```

```
FORTRAN IV G1  RELEASE 2.0              DFUNC              DATE = 79078           16/02/04

 0001                  FUNCTION DFUNC (X)
 0002                  REAL*8 DFUNC,X,Y,Y1,DOA,DOB,DH,DX1
 0003                  COMMON/DSTBZ/DOA,DOB,DH,DX1
 0004                  COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
                      1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,
                      2   ISORC1,KSORCE,IWD,IWS,ISTAB,IWSB,IWSE
 0005                  Y=DOA*X
 0006                  Y1=1.D0+DOB*X
 0007                  IF (LTYPE) 10,20,30
                 C
                 C     NOTE THAT LTYPE=-1,-1,0,0,1,1 FOR ISTAB=1,2,3,4,5,6
                 C
 0008               10 DFUNC=Y*Y1
 0009                  RETURN
 0010               20 DFUNC=Y/DSQRT(Y1)
 0011                  RETURN
 0012               30 DFUNC=Y/Y1
 0013                  RETURN
 0014                  END
```

```
FORTRAN IV G1  RELEASE 2.0              FERR              DATE = 79078           16/02/04

 0001                  FUNCTION FERR (X)                                                   1819.
 0002                  IMPLICIT REAL*8 (A-H,O-Z)                                           1820.
 0003                  COMMON/DSTBZ/DOA,DOB,DH,DX1                                         1821.
 0004                  SIZ=DFUNC(X)                                                        1822.
 0005                  FERR=DEXP(-DH/(2.D0*SIZ**2))/SIZ                                    1823.
 0006                  RETURN                                                              1824.
 0007                  END                                                                 1825.
```

```
FORTRAN IV G1  RELEASE 2.0              FERR1             DATE = 79078           16/02/04

 0001                  FUNCTION FERR1 (X)                                                  1826.
 0002                  IMPLICIT REAL*8 (A-H,O-Z)                                           1827.
 0003                  COMMON/DSTBZ/DOA,DOB,DH,DX1                                         1828.
 0004                  SIZ=DFUNC(X)                                                        1829.
 0005                  FERR1=(2.D0*DX1-X)*DEXP(-DH/(2.D0*SIZ**2))/SIZ                      1830.
 0006                  RETURN                                                              1831.
 0007                  END                                                                 1832.
```

```
FORTRAN IV G1  RELEASE 2.0              HT                DATE = 79078           16/02/04

 0001                  FUNCTION HT (I,FHT,XP,U)                                            1833.
 0002                  COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,                          1834.
                      1   OA(6),OB(6),UU(6),NPS,NPE,NPP,IFLAG,JFLAG,IPOLU2,                1835.
                      2   ISORC1,KSORCE,IWD,IWS,ISTAB,IWSB,IWSE                            1836.
 0003                  HH=FHT-XP*VSET(I)/U                                                 1837.
 0004                  IF (HH.LT.0.0) HH=0.0                                               1838.
 0005                  HT=HH**2                                                            1839.
 0006                  RETURN                                                              1840.
 0007                  END                                                                 1841.
```

```
FORTRAN IV G1  RELEASE 2.0            KSZFC              DATE = 79078          16/02/04

                 FUNCTION KSZFC (I)
            C
            C    FUNCTION SUBROUTINE TO CHECK IF PTSZFC(I,K) ARRAY HAS A NON-ZERO
            C    ELEMENT FOR GIVEN I AND IF SO, TO RETURN THE FIRST SUCH K VALUE.
            C    OTHERWISE, A ZERO IS RETURNED.
            C
                 REAL*8 METSET,XNAME
                 COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
               1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
               2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
               3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
               4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
               5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
                 DO 10 K=1,KSMAX
                 IF (PTSZFC(I,K).GT.0.0) GO TO 20
              10 CONTINUE
                 KSZFC=0
                 RETURN
              20 KSZFC=K
                 RETURN
                 END
```

```
FORTRAN IV G1  RELEASE 2.0            HEADER             DATE = 79078          16/02/04

                 SUBROUTINE HEADER (I)
                 REAL*8 TODAY,XNAME,METSET,VERSN
                 COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
               1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
               2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
               3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
               4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
               5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
                 COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
               1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
               2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
               3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
                 DATA VERSN/'UDAD 9  '/
                 J=3
                 IF (I.EQ.6) J=1
                 IF (I.EQ.10) J=2
                 IPAGE(J)=IPAGE(J)+1
                 WRITE (I,10) REGION,VERSN,TODAY,IPAGE(J)
                 WRITE (I,20) METSET
                 RETURN
            C
            C
            C
              10 FORMAT('1',6A4,20X,A8,24X,'DATE  ',A8,T112,'PAGE',I4)
              20 FORMAT(' ','METSET ',4A8)
                 END
```

```
FORTRAN IV G1  RELEASE 2.0            TAIRR             DATE = 79078          16/02/04

 0001                 SUBROUTINE TAIRR (T,DT,INT)
 0002                 REAL*8 METSET,XNAME,TODAY
 0003                 DIMENSION X(6),XR(6),T(16)
 0004                 DATA NCALL/0/
 0005                 COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                     1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                     2   IFOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                     3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                     4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                     5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
 0006                 COMMON/UDADC4/TODAY,NPB,NFL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                     1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
                     2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                     3   TCNOD(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
 0007                 COMMON/ATA/AA(6,6),BB(6,6)
 0008                 COMMON/QDCAY/RDCAY(6),EDCAY(6),SDCAY(6)
            C
            C         COMMON/QDCAY/IS INITIALIZED HERE AND THUS TAIRR MUST BE CALLED
            C         (BY UDAD9) PRIOR TO GROUND, WHICH ALSO USES QDCAY.
            C
 0009                 IF (NCALL.GT.0) GO TO 20
 0010                 NCALL=1
 0011                 DO 10 IP=1,6
 0012                 RDCAY(IP)=ALN2/RHALF(IP)
 0013                 EDCAY(IP)=RDCAY(IP)+ALN2/PHALF
 0014              10 SDCAY(IP)=EDCAY(IP)+ALN2/RSALF
 0015                 IF (INT.LT.0) RETURN
 0016              20 DO 30 IR=1,NRECEP
 0017                 DO 30 IP=1,5
 0018              30 TCNGC(IP,IR)=0.0
 0019                 DO 40 I=1,6
 0020                 DO 40 J=1,6
 0021              40 BB(I,J)=0.0
 0022                 IF (INT.GT.0) GO TO 50
 0023                 IF (T(2).LE.T(1)) GO TO 70
 0024              50 CALL ACTOR2 (T(1),6,RDCAY,SDCAY,INT)
 0025                 DO 60 I=1,6
 0026                 DO 60 J=1,I
 0027                 BB(I,J)=AA(I,J)*SUFI
 0028              60 AA(I,J)=0.0
 0029              70 IF (INT.GT.0) GO TO 80
 0030                 IF (T(10).LE.T(9)) GO TO 90
 0031              80 CALL ACTOR2 (T(9),6,RDCAY,EDCAY,INT)
 0032              90 DO 100 I=1,6
 0033                 DO 100 J=1,I
 0034             100 AA(I,J)=AA(I,J)*SUFF+BB(I,J)
 0035                 DO 110 IP=1,4
 0036             110 X(IP)=0.0
 0037                 DO 130 IR=1,NRECEP
 0038                 DO 120 IP=5,6
 0039             120 X(IP)=CISUM(IP-1,IR)*0.003
 0040                 CALL ACT (X,XR)
 0041                 DO 130 IP=1,2
 0042             130 PBDR(IP,IR)=XR(IP+4)+CISUM(IP+3,IR)*DT
 0043                 DO 160 IR=1,NRECEP
```

```
FORTRAN IV G1  RELEASE 2.0            TAIRR              DATE = 79078          16/02/04

              DO 160 I=NPB,NPL
              IF (KSZFC(I).EQ.0) GO TO 160
              RVDEP=RSLIM
              IF (VDEP(I).LT.RSLIM) RVDEP=VDEP(I)
              IU=1
              DO 140 IP=1,5
              IF (IP.GT.1) IU=IP-1
          140 X(IP)=TPSZ(I,IU,IR)*RVDEP
              X(6)=X(5)
              CALL ACT (X,XR)
              DO 150 IP=1,4
          150 TPSZR(I,IP,IR)=XR(IP+1)+TPSZ(I,IP,IR)*DT
          160 CONTINUE
              DO 180 IR=1,NRECEP
              DO 180 IP=1,5
              IU=IP
              IF (IP.EQ.5) IU=4
              DO 170 I=NPB,NPL
              IF (KSZFC(I).EQ.0) GO TO 170
              TCNGC(IP,IR)=TCNGC(IP,IR)+TPSZR(I,IU,IR)
          170 CONTINUE
              IF (IP.LT.4) GO TO 180
              TCNGC(IP,IR)=TCNGC(IP,IR)+PBDR(IP-3,IR)
          180 CONTINUE
              RETURN
              END
```

```
FORTRAN IV G1  RELEASE 2.0            GROUND              DATE = 79078         16/02/04

0001                SUBROUTINE GROUND (T,INT)
0002                REAL*8 XNAME,TODAY,METSET
0003                DIMENSION X(6),Y(6),T(8)
0004                COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                   1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                   2   IFOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                   3   PFIN(8),PMFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                   4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                   5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0005                COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                   1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),FDDR(2,300),RN(300),
                   2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                   3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0006                COMMON/ATA/AA(6,6),BB(6,6)
0007                COMMON/QDCAY/RDCAY(6),EDCAY(6),SDCAY(6)
             C
             C
0008                DO 10 JRECEP=1,NRECEP
0009                DO 10 IP=1,5
0010             10 TCNGO(IP,JRECEP)=0.0
0011                CALL ACTDR2 (T,6,RDCAY,EDCAY,INT)
0012                DO 60 JRECEP=1,NRECEP
0013                DO 20 IP=1,4
0014                DO 20 I=NPB,NPL
0015                IF (KSZFC(I).EQ.0) GO TO 20
0016                TCNGO(IP,JRECEP)=TCNGO(IP,JRECEP)+TPSZ(I,IP,JRECEP)*VDEP(I)
0017             20 CONTINUE
0018                DO 30 I=1,2
0019                IP=6-I
0020             30 TCNGO(IP,JRECEP)=TCNGO(4,JRECEP)+0.003*CISUM(IP,JRECEP)
0021                IU=1
0022                DO 40 IP=1,6
0023                IF (IP.GT.1) IU=IP-1
0024             40 X(IP)=TCNGO(IU,JRECEP)
0025                CALL ACT (X,Y)
0026                DO 50 IP=1,5
0027             50 TCNGO(IP,JRECEP)=Y(IP+1)
0028             60 CONTINUE
0029                RETURN
0030                END
```

```
0001            SUBROUTINE DOCOMT (IRCV)
0002            REAL*8 ORGAN,BREP,PID(13),NUKES(7),METSET,XNAME,TODAY
0003            REAL*4 LON,LR,MPC,LONM
0004            DIMENSION WORK(8),DOSE(6),DR(6),DK(3,5)
0005            COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
               1  PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
               2  IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
               3  PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
               4  PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
               5  FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0006            COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
               1  DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
               2  WHO(3,2),FROM(5,4),DCONV(6,4)
0007            COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
               1  THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
               2  CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
               3  TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1300)
0008            COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(16,4),
               1  IPSOL(10),NNUC,MSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0009            COMMON/DCFQ/DCFA(6,12,5),DCFPB(2,12)
0010            DATA PID/'U238    ','TH234   ','PA234   ','U234    ',
               1         'TH230   ','RA226   ','RN222   ','PO218   ',
               2         'PB214   ','BI214   ','PO214   ','PB210   ','BI210   '/
0011            DATA NUKES/' U238   ',' U234   ','TH230   ','RA226   ',
               1           'PB210   ','PO210   ','TOTAL   '/
          C*********************************************************************
          C*********************************************************************
          C
          C     COMPUTE INHALATION DOSE COMMITMENT FACTORS FOR PARTICULATE SIZES
          C     GIVEN IN PTSZ.   CALCULATIONS OBTAINED BY DOSE RATE AFTER YDOC
          C     YEARS OF CONTINUOUS INHALATION OF 1 PCI/M3.
          C
0012            IYDOC=YDOC
0013            MARK=0
0014            IOPT=0
0015            DEN=1.0
          C
          C     F=FACTOR TO CONVERT PCI/M3 PER YEAR INTO PCI, ASSUMING 20 CUBIC
          C     METERS INHALATION VOLUME PER DAY.
          C
0016            F=20.*365.25
0017            DO 40 I=NPB,NPL
0018            KS=KSZFC(I)
0019            IF (KS.EQ.0) GO TO 40
          C
          C     MARK=I MARKS INDEX IN PTSZ FOR 0.3 MICRON SIZE, WHICH IS NEEDED
          C     LATER FOR DCFPB.  MARK=0 IF 0.3 MICRON PARTICLE SIZE NOT USED.
          C     PDEN(KS) MUST ALSO EQUAL DEN FOR MARK=1.
          C
0020            IF (PTSZ(I).EQ.0.3.AND.PDEN(KS).EQ.DEN) MARK=I
0021            CALL FRACT (PTSZ(I),PDEN(KS),DK(1,I))
0022            DO 10 K=1,3
0023            DKF(K,I)=DK(K,I)*F
          C
          C     FOLLOWING REQUIRED BECAUSE OF PBK USAGE IN DOSAGE; OTHERWISE
```

```
           C      PBK REMAINS UNDEFINED IF PTSZ INCLUDES THE 0.3 MICRON SIZE.
           C
0024              IF (I.EQ.MARK) PBK(K)=DKF(K,I)
0025              DO 10 N=1,NNUC
0026           10 PALL(K,N)=DKF(K,I)
0027              DO 30 IB=1,12
0028              CALL INHALE (IB,PALL,0.0,YDOC,DOSE,DCFA(1,IB,I),IOPT,IERR,1)
           C
           C      CONVERT FROM REM TO MREM UNITS
           C
0029              DO 20 N=1,NNUC
0030           20 DCFA(N,IB,I)=DCFA(N,IB,I)*1000.
0031              IF (IERR.EQ.0) GO TO 30
0032              PRINT 650, PTSZ(I),(ORGAN(K,IB),K=1,3)
0033           30 CONTINUE
0034           40 CONTINUE
0035              IF (MARK.GT.0) GO TO 100
           C
           C      0.3 MICRON PARTICLE SIZE NEEDED FOR RN DAUGHTERS PB210 & PO210
           C
0036              SIZE=0.3
0037              CALL FRACT (SIZE,DEN,PBK)
0038              DO 50 K=1,3
0039              PBK(K)=PBK(K)*F
0040              DO 50 N=1,6
0041           50 PALL(K,N)=PBK(K)
0042              CALL HEADER (6)
0043              PRINT 660, IYDOC
0044              PRINT 670, SIZE,DEN,(NUKES(N),N=1,6)
0045              PRINT 680
0046              DO 90 IB=1,12
0047              CALL INHALE (IB,PALL,0.0,50.0,DOSE,DR,IOPT,IERR,1)
0048              IF (IERR.EQ.0) GO TO 60
0049              PRINT 650, SIZE,(ORGAN(K,IB),K=1,3)
0050           60 DO 70 N=1,6
0051           70 DR(N)=DR(N)*1000.
0052              DO 80 ID=1,2
0053           80 DCFPB(ID,IB)=DR(4+ID)
0054           90 PRINT 710, (ORGAN(J,IB),J=1,3),(DR(N),N=5,6)
0055              KOUNT=1
0056              GO TO 120
0057          100 DO 110 IB=1,12
0058              DO 110 ID=1,2
0059          110 DCFPB(ID,IB)=DCFA(4+ID,IB,MARK)
0060              KOUNT=0
0061          120 DO 150 I=NPB,NPL
0062              KS=KSZFC(I)
0063              IF (KS.EQ.0) GO TO 150
0064              KOUNT=KOUNT+1
0065              IF (MOD(KOUNT,3).NE.1) GO TO 130
0066              CALL HEADER (6)
0067              PRINT 660, IYDOC
0068          130 PRINT 670, PTSZ(I),PDEN(KS),(NUKES(N),N=1,NNUC)
0069              PRINT 680
0070              DO 140 IB=1,12
```

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FORTRAN IV G1  RELEASE 2.0            DOCOMT              DATE = 79078          16/02/04

0071              140 PRINT 700, (ORGAN(J,IB),J=1,3),(DCFA(N,IB,I),N=1,NNUC)
0072              150 CONTINUE
0073                  IF (MOD(KOUNT,3).EQ.0) CALL HEADER (6)
0074                  PRINT 720
0075                  PRINT 730, ((ORGAN(J,IB),J=1,2),IB=1,3)
0076                  PRINT 680
0077                  IF (MARK.GT.0) GO TO 170
0078                  DSUM=0.
0079                  DO 160 K=1,3
0080                  WORK(K)=PBK(K)/F
0081              160 DSUM=DSUM+WORK(K)
0082                  AEQUIV=SIZE*SQRT(DEN)
0083                  PRINT 740, SIZE,DEN,AEQUIV,(WORK(K),K=1,3),DSUM
0084              170 DO 190 I=NPB,NPL
0085                  KS=KSZFC(I)
0086                  IF (KS.EQ.0) GO TO 190
0087                  DSUM=0.
0088                  DO 180 K=1,3
0089              180 DSUM=DSUM+DK(K,I)
0090                  AEQUIV=PTSZ(I)*SQRT(PDEN(KS))
0091                  PRINT 740, PTSZ(I),PDEN(KS),AEQUIV,(DK(K,I),K=1,3),DSUM
0092              190 CONTINUE
0093                  DO 200 I=1,9
0094                  DO 200 J=1,13
0095                  DCFG(I,J)=DCFG(I,J)*1.0E-10
0096              200 DCFC(I,J)=DCFC(I,J)*1.0E-12
0097                  CALL HEADER (6)
0098                  PRINT 750
0099                  PRINT 780
0100                  PRINT 680
0101                  DO 210 I=1,13
0102              210 PRINT 770, PID(I),(DCFC(J,I),J=1,9)
0103                  PRINT 760
0104                  PRINT 780
0105                  PRINT 680
0106                  DO 220 I=1,13
0107              220 PRINT 770, PID(I),(DCFG(J,I),J=1,9)
                C
                C     COMPUTE INGESTION DOSE COMMITMENT FACTORS FOR WHOLE BODY, BONE,
                C     KIDNEY, AND LIVER BASED ON DOSE RATE AFTER YDOC YEARS CONTINUOUS
                C     INGESTION OF 1.0 PCI/DAY.
                C
0108                  DO 230 N=1,NNUC
0109              230 PALL(1,N)=365.25
0110                  DO 240 IB=4,7
0111                  CALL INHALE (IB,PALL,? ? YDOC,DOSE,DCONV(1,IB-3),0,IERR,2)
                C
                C     CONVERT FROM REM TO MREM UNITS
                C
0112                  DO 240 N=1,NNUC
0113              240 DCONV(N,IB-3)=1000.*DCONV(N,IB-3)
0114                  PRINT 630, IYDOC
0115                  PRINT 640, (NUKES(N),N=1,NNUC)
0116                  PRINT 680
0117                  DO 250 IB=4,7
```

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FORTRAN IV G1  RELEASE 2.0            DOCOMT             DATE = 79078         16/02/04

0118              250 PRINT 690, (ORGAN(J,IB),J=1,3),(DCONV(N,IB-3),N=1,NNUC)
0119                  SFACT=RFIE*SHIED+(1.-RFIE)
0120                  IF (JC(5).EQ.0) GO TO 620
0121                  IF (IRCV.EQ.0) GO TO 460
            C
            C         PRINT DOSE COMMITMENT TABLES (MREM/YEAR) FOR INHALATION
            C
0122                  ANGMAX=22.5*FLOAT(IMX-1)
0123                  DO 320 IB=1,12
0124                  CALL HEADER (6)
0125                  PRINT 790, (ORGAN(J,IB),J=1,3),ANGMAX
0126                  PRINT 800, (NUID(J,1),J=1,3),(FROM(J,1),J=1,3)
0127                  PRINT 820, (NUKES(N),N=1,NNUC),NUKES(7)
0128                  PRINT 680
0129                  DO 320 IT1=1,5
0130                  IF (IT1.GT.1) GO TO 260
0131                  IT=IMX
0132                  GO TO 270
            C
            C         SELECT ANGLES IMX,0,90,180,270
            C
0133              260 IT=(IT1-2)*4+1
0134              270 ANG=22.5*FLOAT(IT-1)
0135                  DO 320 IR=1,KRHO
0136                  DO 280 J=1,6
            C
            C         SELECT DISTANCES .1,1,5,10,50,80 KM
            C
0137                  IF (IRHO(J).EQ.IR) GO TO 290
0138              280 CONTINUE
0139                  GO TO 320
0140              290 DIST=XRHO(IR)
0141                  IRECEP=(IT-1)*KRHO+IR
0142                  IU=1
0143                  DSUM=0.
0144                  DO 310 N=1,NNUC
0145                  IF (N.GT.1) IU=N-1
0146                  IF (IU.GT.4) IU=4
0147                  DOSE(N)=0.
0148                  DO 300 I=NFB,NFL
0149                  IF (KSZFC(I).EQ.0) GO TO 300
0150                  DOSE(N)=DOSE(N)+DCFA(N,IB,I)*TPSZR(I,IU,IRECEP)
0151              300 CONTINUE
0152                  IF (N.LT.5) GO TO 310
0153                  DOSE(N)=DOSE(N)+DCFFB(N-4,IB)*FBDR(N-4,IRECEP)
0154              310 DSUM=DSUM+DOSE(N)
0155                  IF (IR.EQ.IRHO(1)) PRINT 830, ANG,DIST,(DOSE(N),N=1,NNUC),DSUM
0156                  IF (IR.GT.IRHO(1)) PRINT 840, DIST,(DOSE(N),N=1,NNUC),DSUM
0157              320 CONTINUE
            C
            C         COMPUTE AND PRINT BRONCHIAL EPITHELIUM DOSE RATE (LAP=1) AND
            C         WORKING LEVEL MONTH (LAP=2) FOR RN222.
            C
0158                  DO 340 LAP=1,2
0159                  CALL HEADER (6)
```

```
0160            PRINT 790, (BREP(J),J=1,3),ANGMAX
0161            IF (LAP.EQ.1) PRINT 800, (WHO(J,1),J=1,3),(FROM(J,2),J=1,2)
0162            IF (LAP.EQ.2) PRINT 810
0163            DO 340 II=1,2
0164            IS=(II-1)*8+1
0165            IE=IS+7
0166            PRINT 850, (THETAS(IC),IC=IS,IE)
0167            PRINT 860
0168            DO 340 IR=1,KRHO
0169            I=0
0170            DO 330 IT=IS,IE
0171            IRECEP=(IT-1)*KRHO+IR
0172            I=I+1
0173            IF (LAP.EQ.1) WORK(I)=0.625*RN(IRECEP)*RFI+1.25E5*(1.0-RFI)*WL(IRE
               1CEP)
0174            IF (LAP.EQ.2) WORK(I)=25.*((1.-RFI)*WL(IRECEP)+RFI*5.E-6*RN(IRECEP
               1))
0175        330 CONTINUE
0176        340 PRINT 870, XRHO(IR),WORK
          C
          C     COMPUTE AND PRINT DOSE RATE FROM GROUND DEPOSITION (LAP=1)
          C     AND CLOUD SUBMERSION (LAP=2)
          C
0177            DO 450 LAP=1,2
0178            DO 450 IB=1,9
0179            CALL HEADER (6)
0180            PRINT 830, (BFRTS(J,IB),J=1,3),ANGMAX
0181            PRINT 800, (WHO(J,2),J=1,3),(FROM(J,LAP+2),J=1,5)
0182            IF (LAP.EQ.2) GO TO 350
0183            PRINT 820, (NUKES(N),N=1,5),NUKES(7)
0184            GO TO 360
0185        350 PRINT 890, (NUKES(N),N=1,4),NUKES(7)
0186        360 PRINT 680
0187            DO 450 IT1=1,5
0188            IF (IT1.GT.1) GO TO 370
0189            IT=IMX
0190            GO TO 380
          C
          C     SELECT ANGLES IMX,0,90,180,270
          C
0191        370 IT=(IT1-2)*4+1
0192        380 ANG=22.5*FLOAT(IT-1)
0193            DO 450 IR=1,KRHO
0194            DO 390 J=1,6
          C
          C     SELECT DISTANCES .1,1,5,10,50,80 KM (OR SELECTED OTHERS IF
          C     SPECIAL IRHO INCLUDED IN NAMELIST INPUT)
          C
0195            IF (IRHO(J).EQ.IR) GO TO 400
0196        390 CONTINUE
0197            GO TO 450
0198        400 DIST=XRHO(IR)
0199            IRECEP=(IT-1)*KRHO+IR
0200            IU=1
0201            DSUM=0.
```

```
0202            DO 440 IP=1,5
0203            IF (IP.GT.1) IU=IP-1
0204            DOSE(IP)=0.
0205            CALL NSNE (IB,IP,NS,NE)
0206            DO 430 IC=NS,NE
0207            IF (LAP.EQ.2) GO TO 410
0208            DOSE(IP)=DOSE(IP)+TCNGO(IU,IRECEP)*DCFG(IB,IC)
0209            GO TO 430
0210        410 DOSE(IP)=DOSE(IP)+TCNGC(IU,IRECEP)*DCFC(IB,IC)
0211            IF (IP.NE.5) GO TO 430
0212            DO 420 IPP=1,3
0213        420 DOSE(IP)=DOSE(IP)+CISUM(IPP,IRECEP)*DCFC(IB,IPP+7)
0214            DOSE(IP)=DOSE(IP)+RN(IRECEP)*DCFC(IB,7)
0215        430 CONTINUE
0216            DOSE(IP)=SFACT*DOSE(IP)
0217        440 DSUM=DSUM+DOSE(IP)
0218            IF (IR.EQ.IRHO(1)) PRINT 830, ANG,DIST,(DOSE(N),N=1,5),DSUM
0219            IF (IR.GT.IRHO(1)) PRINT 840, DIST,(DOSE(N),N=1,5),DSUM
0220        450 CONTINUE
          C
          C     COMPUTE AND PRINT POPULATION DOSE COMMITMENTS
          C
0221            CALL DOSPOP (1.0,0,IRCV)
0222        460 IF (NRECEP.EQ.IRCV) GO TO 620
0223            KRCV=IRCV+1
          C
          C     PRINT DOSE COMMITMENT TABLES FOR EXTRA RECEPTORS
          C
0224            DO 500 IB=1,12
0225            LL=60
0226            DO 500 IRECEP=KRCV,NRECEP
0227            NR=IRECEP-IRCV
0228            IF (LL.LT.60) GO TO 470
0229            CALL HEADER (6)
0230            PRINT 900, (ORGAN(J,IB),J=1,3)
0231            PRINT 910, (WHO(J,1),J=1,3),(FROM(J,1),J=1,3)
0232            PRINT 930, (NUKES(N),N=1,NNUC),NUKES(7)
0233            PRINT 680
0234            LL=9
0235        470 DSUM=0.
0236            IU=1
0237            DO 490 N=1,NNUC
0238            IF (N.GT.1) IU=N-1
0239            IF (IU.GT.4) IU=4
0240            DOSE(N)=0.
0241            DO 480 I=NFB,NPL
0242            IF (KSZFC(I).EQ.0) GO TO 480
0243            DOSE(N)=DOSE(N)+DCFA(N,IB,I)*TPSZR(I,IU,IRECEP)
0244        480 CONTINUE
0245            IF (N.LT.5) GO TO 490
0246            DOSE(N)=DOSE(N)+DCFFB(N-4,IB)*PDDR(N-4,IRECEP)
0247        490 DSUM=DSUM+DOSE(N)
0248            PRINT 950, NR,(XNAME(I,NR),I=1,4),(XRECEP(I,NR),I=1,3),(DOSE(N),N=
               11,NNUC),DSUM
0249            LL=LL+1
```

```
0250            500 CONTINUE
              C
              C     PRINT RN222 BRONCHIAL EPITHELIUM DOSE RATES AND WORKING LEVEL
              C     MONTH FOR EXTRA RECEPTORS.
              C
0251                LL=60
0252                DO 520 IRECEP=KRCV,NRECEP
0253                NR=IRECEP-IRCV
0254                IF (LL.LT.60) GO TO 510
0255                CALL HEADER (6)
0256                PRINT 900, (BREP(J),J=1,3)
0257                PRINT 920
0258                PRINT 1000
0259                LL=9
0260            510 DOSE(1)=0.625*RN(IRECEP)
0261                WLM=25.*((1.-RFI)*WL(IRECEP)+RFI*5.E-6*RN(IRECEP))
0262                PRINT 970, NR,(XNAME(I,NR),I=1,4),(XRECEP(I,NR),I=1,3),DOSE(1),WLM
0263            520 LL=LL+1
              C
              C     PRINT DOSE RATES FROM GROUND (LAP=1) AND CLOUD (LAP=2)
              C     FOR EXTRA RECEPTORS
              C
0264                DO 610 LAP=1,2
0265                DO 610 IB=1,9
0266                LL=60
0267                DO 600 IRECEP=KRCV,NRECEP
0268                NR=IRECEP-IRCV
0269                IF (LL.LT.60) GO TO 550
0270                LL=9
0271                CALL HEADER (6)
0272                PRINT 930, (BPRTS(J,IB),J=1,3)
0273                PRINT 910, (WHO(J,2),J=1,3),(FROM(J,LAP+2),J=1,5)
0274                IF (LAP.EQ.2) GO TO 530
0275                PRINT 940
0276                GO TO 540
0277            530 PRINT 990
0278            540 PRINT 680
0279            550 IU=1
0280                DSUM=0
0281                DO 590 IP=1,5
0282                IF (IP.GT.1) IU=IP-1
0283                DOSE(IP)=0.
0284                CALL NSNE (IB,IP,NS,NE)
0285                DO 580 IC=NS,NE
0286                IF (LAP.EQ.2) GO TO 560
0287                DOSE(IP)=DOSE(IP)+TCNGO(IU,IRECEP)*DCFG(IB,IC)
0288                GO TO 580
0289            560 DOSE(IP)=DOSE(IP)+TCNGC(IU,IRECEP)*DCFC(IB,IC)
0290                IF (IP.NE.5) GO TO 580
0291                DO 570 IPP=1,3
0292            570 DOSE(IP)=DOSE(IP)+CISUM(IPP,IRECEP)*DCFC(IB,IPP+7)
0293                DOSE(IP)=DOSE(IP)+RN(IRECEP)*DCFC(IB,7)
0294            580 CONTINUE
0295                DOSE(IP)=DOSE(IP)*SFACT
0296            590 DSUM=DSUM+DOSE(IP)
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FORTRAN IV G1  RELEASE 2.0              DOCOMT              DATE = 79078           16/02/04

 0297                   PRINT 960, NR,(XNAME(I,NR),I=1,4),(XRECEP(I,NR),I=1,3),(DOSE(N),N=
                       11,5),DSUM
 0298                600 LL=LL+1
 0299                610 CONTINUE
 0300                620 RETURN
               C
               C
               C
 03                  630 FORMAT('-',T41,'INGESTION DOSE CONVERSION FACTORS (MREM/YEAR)/(PCI
                       1/DAY)'/T39,'DOSE RATE AFTER',I3,' YEARS CONTINUOUS INGESTION OF 1
                       2PCI/DAY')
 0302                640 FORMAT (1H0,T43,6(A8,4X))
 0303                650 FORMAT(1H0,'INHALATION COMMITMENT ERROR FOR PARTICLE SIZE =',F5.0,
                       1   ' FOR ',3A3)
 0304                660 FORMAT(1H0,T42,
                       1'INHALATION DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M3)'/T39,
                       2'DOSE RATE AFTER',I3,' YEARS CONTINUOUS INHALATION OF 1 PCI/M3'/)
 0305                670 FORMAT(1H0,'PARTICLE SIZE =',F6.1,' MICRONS    DENSITY =',F5.2,
                       1   T60,6(A8,4X))
 0306                680 FORMAT(1X,132('-'))
 0307                690 FORMAT(1X,3A8,12X,1P6E12.2)
 0308                700 FORMAT(1X,3A8,29X,1P6E12.2)
 0309                710 FORMAT(1X,3A8,77X,1P2E12.2)
 0310                720 FORMAT('-',T20,'DEPOSITION FRACTIONS IN LUNG MODEL SUBCOMPARTMENTS
                       1 AS A FUNCTION OF PARTICULATE SIZE AND DENSITY')
 0311                730 FORMAT(1H0,' SIZE    DENSITY    AERODYNAMIC EQUIV. DIAM.',4X,
                       1  3(2A8,4X),'TOTAL')
 0312                740 FORMAT(1X,F5.1,5X,F5.2,13X,F6.2,T54,F5.3,T75,F5.3,T92,
                       1   F5.3,T110,F5.3)
 0313                750 FORMAT('0',T44,'CLOUD DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M3)')
 0314                760 FORMAT('-',T44,
                       1   'GROUND DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M2)')
 0315                770 FORMAT(' ',A8,5X,1P9E13.2)
 0316                780 FORMAT('0','POLLUTANT',T22,'SKIN',T32,'WHOLE BODY',T47,'OVARIES',
                       1 T69,'TESTIES',T70,'SM INTESTINE',T87,'LUNG',T97,'RED MARROW',
                       2  T111,'SKELETON',T125,'SPLEEN')
 0317                790 FORMAT(' ',3A8,'ANGLE OF MAX DISPERSION = ',F5.1,' DEGREES')
 0318                800 FORMAT('-',33X,3A4,' DOSE COMMITMENTS (MREM/YEAR) FROM ',5A4)
 0319                810 FORMAT('-',53X,'RADON WORKING LEVEL MONTH')
 0320                820 FORMAT(1H0,'ANGLE',4X,'DISTANCE(KM)',T29,7(A8,4X))
 0321                830 FORMAT(1H0,F5.1,7X,F4.1,6X,1P7E12.2)
 0322                840 FORMAT(13X,F4.1,6X,1P7E12.2)
 0323                850 FORMAT('-',62X,'DEGREES'/'0',20X,'DISTANCE(KM)',2X,8(F5.1,5X))
 0324                860 FORMAT(' ',20X,91('-'))
 0325                870 FORMAT(' ',23X,F5.1,3X,1P8E10.2)
 0326                880 FORMAT(' ',3A4,12X,'ANGLE OF MAX DISPERSION = ',F5.1,' DEGREES')
 0327                890 FORMAT(1H0,'ANGLE',4X,'DISTANCE(KM)',T29,3(A8,4X),A8,1X,
                       1   'PO210-RN222',T89,A8)
 0328                900 FORMAT(1X,3A8)
 0329                910 FORMAT('-',24X,3A4,
                       1   ' DOSE COMMITMENTS (MREM/YEAR) AT EXTRA RECEPTORS FROM ',5A4)
 0330                920 FORMAT('-',19X,'INHALATION DOSE COMMITMENTS (MREM/YEAR) AND WORKIN
                       1G LEVEL MONTH AT EXTRA RECEPTORS FROM RADON')
 0331                930 FORMAT('0 #',3X,'IDENTIFICATION',T43,'X(KM)   Y(KM)    Z(M)',
                       1   T68,7(A8,1X))
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FORTRAN IV G1  RELEASE 2.0            DOCOMT              DATE = 79078          16/02/04

 0332              940 FORMAT('0 #',3X,'IDENTIFICATION',T43,'X(KM)   Y(KM)    Z(M)',
                      1   T69,'U238',T80,'U234',T90,'TH230',T101,'RA226',T112,'PB210',
                      2   T124,'TOTAL')
 0333              950 FORMAT(1X,I2,3X,4A8,1X,3F8.2,2X,1P7E9.2)
 0334              960 FORMAT(1X,I2,3X,4A8,1X,3F8.2,1P6E11.2)
 0335              970 FORMAT(24X,I2,3X,4A8,1X,3F8.2,1PE11.2,E12.2)
 0336              980 FORMAT(1X,3A4)
 0337              990 FORMAT('0 #',3X,'IDENTIFICATION',T43,'X(KM)   Y(KM)    Z(M)',
                      1   T69,'U238',T80,'U234',T90,'TH230',T101,'RA226',
                      2   T110,'PB210-RN222',T124,'TOTAL')
 0338             1000 FORMAT('0',24X,'#   IDENTIFICATION',T66,'X(KM)   Y(KM)    Z(M)',
                      12X,'DOSE RATE',6X,'WLM'/24X,85('-'))
 0339                   END
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FORTRAN IV G1  RELEASE 2.0            NSNE                DATE = 79078          16/02/04

 0001                   SUBROUTINE NSNE (IB,IP,NS,NE)
                 C
                 C      SUBROUTINE TO SET DO-LOOP LIMITS FOR CLOUD AND GROUND DOCOMT AND
                 C      DOSAGE CALCULATIONS.
                 C
 0002                   GO TO (10,20,20,30,40),IP
 0003                10 NS=1
 0004                   NE=3
 0005                   GO TO 50
 0006                20 NS=IP+2
 0007                   NE=NS
 0008                   GO TO 50
 0009                30 NS=6
 0010                   NE=11
 0011                   GO TO 50
 0012                40 NS=12
 0013                   NE=12
 0014                   IF (IB.EQ.1) NE=13
 0015                50 RETURN
 0016                   END
```

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FORTRAN IV G1  RELEASE 2.0              DOSPOP              DATE = 79078          16/02/04

0001                  SUBROUTINE DOSPOP (DT,INDEX,IRCV)
             C
             C        SUBROUTINE TO COMPUTE AND PRINT POPULATION DOSE COMMITMENTS
             C        (TOTAL DOSE RATE*POPULATION) FROM INHALATION, RADON (TRANCHEO-
             C        BRONCHIAL ONLY), EXTERNAL GROUND, AND EXTERNAL CLOUD.
             C
0002                  REAL*8 ORGAN,BREP,METSET,XNAME,TODAY
0003                  REAL*4 LON,LR,LONM
0004                  DIMENSION DCPOP(14,16),NOG(4)
0005                  COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                    1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                    2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                    3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                    4   PDEN(5),FGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                    5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0006                  COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),FDK(3),TA,
                    1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
                    2   WOO(3,2),FRCN(5,4),DCONV(6,4)
0007                  COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                    1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
                    2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                    3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),HL(300),FILLER(1800)
0008                  COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                    1   IPSOL(10),NNUC,NSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0009                  COMMON/DCFQ/DCFA(6,12,5),DCFPB(2,12)
0010                  COMMON/EVD/GEVD(9,2),CEVD(9,2),PEVD(12,2),RNEVD(2),PFDOSE(4,2)
0011                  DATA NOG/12,1,9,9/,NCALL/0/
0012                  IF (NCALL.GT.0) GO TO 40
0013                  DO 30 K=1,2
0014                  RNEVD(K)=0.0
0015                  DO 10 I=1,4
0016               10 PFDOSE(I,K)=0.0
0017                  DO 20 I=1,9
0018                  CEVD(I,K)=0.0
0019               20 GEVD(I,K)=0.0
0020                  DO 30 I=1,12
0021               30 PEVD(I,K)=0.0
0022                  NCALL=1
0023               40 IF (IRCV.EQ.0) RETURN
0024                  IPG=INDEX
0025                  IF (INDEX.EQ.0) IPG=3
0026                  IF (INDEX.EQ.0.OR.MOD(INDEX,2).EQ.0) GO TO 60
0027                  DO 50 IR=1,NRECEP
0028                  DO 50 IP=1,5
0029               50 TCNGO(IP,IR)=0.0
0030               60 DO 200 LAP=1,4
             C
             C        LAP =1 FOR INHALATION, =2 FOR RADON, =3 FOR GROUND, =4 FOR CLOUD
             C
0031                  K=(LAP-1)/2+1
0032                  N1=1
0033                  N2=NOG(LAP)
0034                  DO 200 I3=N1,N2
0035                  DO 70 I=1,14
0036                  DO 70 J=1,16
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FORTRAN IV G1  RELEASE 2.0            DOSPOP            DATE = 79078          16/02/04

0037          70 DCPOP(I,J)=0.0
0038             IF (INDEX.GE.1) GO TO 80
0039             CALL HEADER (6)
0040             IF (LAP.EQ.1) PRINT 350, (ORGAN(J,IB),J=1,3)
0041             IF (LAP.EQ.2) PRINT 350, (BREP(J),J=1,3)
0042             IF (LAP.GT.2) PRINT 360, (BPRTS(J,IB),J=1,3)
0043             PRINT 300, (WHO(J,K),J=1,3),(FROM(J,LAP),J=1,5)
0044          80 DO 200 IR=1,KRHO
0045             DO 200 IT=1,16
0046             IRECEP=(IT-1)*KRHO+IR
0047             IU=1
0048             DSUM=0.
0049             IF (LAP-2) 90,120,130
0050          90 DO 110 N=1,NNUC
0051             IF (N.GT.1) IU=N-1
0052             IF (IU.GT.4) IU=4
0053             DO 100 I=NPB,NPL
0054             IF (KSZFC(I).EQ.0) GO TO 100
0055             DSUM=DSUM+DCFA(N,IB,I)*TPSZR(I,IU,IRECEP)
0056         100 CONTINUE
0057             IF (N.LT.5) GO TO 110
0058             DSUM=DSUM+DCFPB(N-4,IB)*PBDR(N-4,IRECEP)
0059         110 CONTINUE
0060             GO TO 180
0061         120 DSUM=DSUM+(0.625*RN(IRECEP)*RFI+1.25E5*(1.-RFI)*WL(IRECEP))*DT
0062             GO TO 180
0063         130 DO 170 IP=1,5
0064             IF (IP.GT.1) IU=IP-1
0065             CALL NSNE (IB,IP,NS,NE)
0066             DO 160 IC=NS,NE
0067             IF (LAP.EQ.4) GO TO 140
0068             DSUM=DSUM+TCNGO(IU,IRECEP)*DCFG(IB,IC)
0069             GO TO 160
0070         140 DSUM=DSUM+TCNGC(IU,IRECEP)*DCFC(IB,IC)
0071             IF (IP.NE.5) GO TO 160
0072             DO 150 IPP=1,3
0073         150 DSUM=DSUM+CISUM(IPP,IRECEP)*DCFC(IB,IPP+7)*DT
0074             DSUM=DSUM+RN(IRECEP)*DCFC(IB,7)*DT
0075         160 CONTINUE
0076         170 DSUM=DSUM*SFACT
0077         180 IF (IR.EQ.KRHO) GO TO 190
           C
           C     DCPOP(14,16)  -  PRODUCT OF TOTAL DOSE COMMITMENT AND
           C                      POPULATION, UNITS = ORGAN*REM/YEAR
           C
           C        1ST INDEX = .1-.5,.5-1,1-2,2-3,3-4,4-5,5-10,10-20,20-30,30-40,
           C                    40-50,50-60,60-70,70-80 KM BANDS (DEFAULT VALUES)
           C       2ND INDEX = 16 ANGLES, 0 TO 337.5 DEGREES IN 22.5 DEG STEPS
           C
0078             DCPOP(IR,IT)=DSUM
0079             IF (IR.EQ.1) GO TO 200
           C
           C     COMPUTE AVERAGE TOTAL COMMITMENT FOR BAND
           C
0080         190 DCPOP(IR-1,IT)=(DCPOP(IR-1,IT)+DSUM)/2.
```

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FORTRAN IV G1  RELEASE 2.0            DOSFOP            DATE = 79078           16/02/04

0081             200 CONTINUE
0082                 TDSUM=0.0
0083                 DO 210 IR=2,KRHO
0084                 DO 210 IT=1,16
0085                 IF (IPOP(IR,IT).EQ.0) DCPOP(IR-1,IT)=0.
0086                 IF (IPOP(IR,IT).NE.0) DCPOP(IR-1,IT)=DCPOP(IR-1,IT)*FLOAT(IPOP(IR,
                    1IT))/1000.*PATH(IPG)
0087             210 TDSUM=TDSUM+DCPOP(IR-1,IT)
               C
               C     KASE=1 FOR POPULATION DOSE COMMITMENTS
               C     KASE=2 FOR ENVIRONMENTAL DOSE COMMITMENTS
               C
0088                 IF (INDEX.EQ.0) KASE=1
0089                 IF (INDEX.GT.0) KASE=2
0090                 GO TO (220,230,240,250),LAP
0091             220 PEVD(IB,KASE)=PEVD(IB,KASE)+TDSUM
0092                 GO TO 260
0093             230 RNEVD(KASE)=RNEVD(KASE)+TDSUM
0094                 GO TO 260
0095             240 GEVD(IB,KASE)=GEVD(IB,KASE)+TDSUM
0096                 GO TO 260
0097             250 CEVD(IB,KASE)=CEVD(IB,KASE)+TDSUM
0098             260 IF (INDEX.GT.0) GO TO 280
0099                 DO 270 LAP1=1,2
0100                 J1=(LAP1-1)*8+1
0101                 J2=J1+7
0102                 PRINT 310, (WINDR(J),J=J1,J2)
0103                 PRINT 320, (THETAS(J),J=J1,J2)
0104                 PRINT 330
0105                 DO 270 IR=2,KRHO
0106             270 PRINT 340, XRHO(IR-1),XRHO(IR),(DCPOP(IR-1,IT),IT=J1,J2)
0107                 PRINT 290, TDSUM
0108             280 CONTINUE
0109                 RETURN
               C
               C
               C
0110             290 FORMAT(//17X,'TOTAL POPULATION DOSE COMMITMENT =',1PE9.2,
                    1   ' ORGAN*REM/YEAR')
0111             300 FORMAT('-',26X,3A4,
                    1   ' POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR) FROM ',5A4/)
0112             310 FORMAT('-',T29,'|',8(6X,A4,1X))
0113             320 FORMAT(16X,'KILOMETERS   |',8(F9.1,2X))
0114             330 FORMAT(16X,101('-'))
0115             340 FORMAT(16X,F4.1,'-',F4.1,3X,'|',1P8E11.2)
0116             350 FORMAT(1X,3A8)
0117             360 FORMAT(1X,3A4)
0118                 END
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FORTRAN IV G1  RELEASE 2.0             FODOSE              DATE = 79078            16/02/04

0001              SUBROUTINE FODOSE (IRCV,INDEX,LOOPS)
0002              REAL*8 XNAME,METSET,TODAY,ORGAN,BREP
0003              DIMENSION WNIR(7),RING(6,60,10),RING1(6,7,10),G1(6,7),DOSE(6),
                 1   DR(6),PATH(4,7),IDENT(8,60),TINT(60,10,2),TPSZRY(5,4,90,10)
0004              COMMON/CFOD/GACT(6),AIRCON(5,6),CON(6,2),G(6),G4(6),RND(2)
0005              COMMON/TCNGY/TCNGCY(5,90,10),TCNGOY(5,90,10),PBDRY(2,90,10)
0006              COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                 1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                 2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                 3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                 4   FDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                 5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0007              COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
                 1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
                 2   WHO(3,2),FROM(5,4),DCONV(6,4)
0008              COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                 1   THETAS(16),WINDR(16),PHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
                 2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                 3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0009              COMMON/EVD/GEVD(9,2),CEVD(9,2),PEVD(12,2),RNEVD(2),PFDOSE(4,2)
0010              EQUIVALENCE (XNAME(1,1),IDENT(1,1)),(TPSZRY(1,1,1,1),TPSZ(1,1,1))
0011              DATA PATH/'MEAT','    ','    ','    ',
                 1          'DAIR','Y   ','    ','    ',
                 2          'POUL','TRY ','& EG','GS  ',
                 3          '    ','    ','    ','    ',
                 4          'VEGE','TATI','ON  ','    ',
                 5          'FISH','    ','    ','    ',
                 6          'WATE','R   ','    ','    '/
            C
            C        N=ORGAN OF REFERENCE
            C           1=TOTAL BODY, 2=BONE, 3=KIDNEY, 4=LIVER
            C        XIN(K): DAILY HUMAN FOOD CONSUMPTION OF FOOD K, KG/DY
            C        DOSE(I): DOSE DUE TO I FOR CURRENT ORGAN
            C        DR(I): DOSE RATE DUE TO I FOR CURRENT ORGAN
            C        DCONV(I,N): DOSE CONVERSION FACTOR FOR RADIONUCLIDE I AND
            C          ORGAN N, (MREM/YR)/(PCI/DAY)
            C        RING(I,IR,IY):  DAILY HUMAN INGESTION RATE, PCI/DAY, FOR
            C          NUCLIDE I, AT LOCATION IR, FOR INTERVAL IY.
            C        TINT(IR,IY,L): TIME INTEGRATED DOSE(L=1) AND DOSE RATE(L=2)
            C          AT LOCATION IR FOR INTERVAL IY FOR CURRENT ORGAN.
            C        G1 AND RING1 ARE USED FOR GENERAL POPULATION CALCULATIONS
            C
0012              IADD=NRECEP-IRCV
0013              IF (IADD.EQ.0) RETURN
0014              IFG=INDEX
0015              KASE=2
0016              IF (INDEX.GT.0) GO TO 10
0017              IFG=3
0018              KASE=1
0019           10 DO 20 K=1,7
0020           20 WNIR(K)=0.0
0021              DO 30 IR=1,IADD
0022              IPATH=IFODOS(IR)
0023              IF (IPATH.EQ.0) GO TO 30
0024              WNIR(IPATH)=WNIR(IPATH)+PWFOD(IR)
```

```
0025          30 CONTINUE
0026             DO 140 IY=1,LOOPS
0027             DO 40 K=1,7
0028             DO 40 I=1,6
0029          40 G1(I,K)=0
0030             DO 100 IR=1,IADD
            C
            C    LOOPS>1 ONLY FOR TIME INTEGRATED DOSE AND DOSE RATE CALCULATIONS
            C
0031             IF (LOOPS.EQ.1) IR1=IR+IRCV
0032             IF (LOOPS.GT.1) IR1=IR+30
0033             IPATH=IFODOS(IR)
0034             IF (IPATH.EQ.0) GO TO 100
0035             IU=1
0036             DO 70 IP=1,6
0037             IF (IP.GT.1) IU=IP-1
0038             IUU=IU
0039             IF (IP.NE.6) GO TO 50
0040             IU=4
0041             IUU=5
0042          50 DO 60 I=NFB,NFL
0043             IF (KSZFC(I).EQ.0) GO TO 60
0044             IF (LOOPS.EQ.1) AIRCON(I,IP)=TPSZR(I,IU,IR1)
0045             IF (LOOPS.GT.1) AIRCON(I,IP)=TPSZRY(I,IU,IR1,IY)
0046          60 CONTINUE
0047             IF (LOOPS.EQ.1) GACT(IP)=TCNGO(IUU,IR1)
0048             IF (LOOPS.GT.1) GACT(IP)=TCNGOY(IUU,IR1,IY)
0049          70 CONTINUE
0050             DO 80 ID=1,2
0051             IF (LOOPS.EQ.1) RND(ID)=PBDR(ID,IR1)
0052             IF (LOOPS.GT.1) RND(ID)=PBDRY(ID,IR1,IY)
0053          80 CONTINUE
0054             CALL FOOD (IR,IPATH)
0055             DO 90 I=1,6
0056             G1(I,IPATH)=G1(I,IPATH)+G(I)*FWFOD(IR)
0057             RING(I,IR,IY)=G(I)*XIN(IPATH)
0058             IF (IPATH.NE.3) GO TO 90
0059             G1(I,4)=G1(I,4)+G4(I)*FWFOD(IR)
0060             RING(I,IR,IY)=RING(I,IR,IY)+G4(I)*XIN(4)
0061          90 CONTINUE
0062         100 CONTINUE
0063             DO 120 K=1,7
0064             IF (WNIR(K).LE.1.0) GO TO 120
0065             DO 110 I=1,6
0066         110 G1(I,K)=G1(I,K)/WNIR(K)
0067         120 CONTINUE
0068             DO 140 K=1,7
0069             IF (K.EQ.4) GO TO 140
0070             DO 130 I=1,6
0071             RING1(I,K,IY)=G1(I,K)*XING(K)*PFIN(K)
0072             IF (K.EQ.3) RING1(I,K,IY)=RING1(I,K,IY)+G1(I,4)*XING(4)*PFIN(4)
0073         130 CONTINUE
0074         140 CONTINUE
0075             IF (LOOPS.GT.1) GO TO 230
            C
```

```
              C     START DOSE COMMITMENTS CALCULATIONS AND PRINT OUT OF RESULTS
              C
 0076               IF (INDEX.GE.1) GO TO 180
 0077               DO 170 N=1,4
 0078               LL=60
 0079               N1=N
 0080               IF (N.GT.2) N1=N1+1
 0081               DO 170 IR=1,IADD
 0082               IF (LL.LT.60) GO TO 150
 0083               CALL HEADER (6)
 0084               PRINT 650, (BP(I,N1),I=1,3)
 0085               PRINT 710
 0086               PRINT 660
 0087               PRINT 670
 0088               LL=9
 0089           150 IPATH=IFODOS(IR)
 0090               IF (IPATH.EQ.0) GO TO 170
 0091               TDOSE=0.0
 0092               DO 160 I=1,6
 0093               DOSE(I)=RING(I,IR,1)*DCONV(I,N)
 0094           160 TDOSE=TDOSE+DOSE(I)
 0095               PRINT 730, IR,(XNAME(J,IR),J=1,4),(PATH(J,IPATH),J=1,4),DOSE,TDOSE
 0096               LL=LL+1
 0097           170 CONTINUE
 0098               LL=60
 0099           180 DO 220 K=1,7
 0100               IF (INDEX.GE.1) GO TO 190
 0101               IF (LL.LT.55) GO TO 190
 0102               CALL HEADER (6)
 0103               PRINT 720
 0104               PRINT 680
 0105               PRINT 670
 0106               LL=8
 0107           190 IF (K.EQ.4) GO TO 220
 0108               DO 210 N=1,4
 0109               N1=N
 0110               IF (N.GT.2) N1=N1+1
 0111               TDOSE=0.0
 0112               DO 200 I=1,6
 0113               DOSE(I)=RING1(I,K,1)*DCONV(I,N)
 0114           200 TDOSE=TDOSE+DOSE(I)
 0115               IF (INDEX.GE.1) GO TO 210
 0116               IF (N.EQ.1) PRINT 690, (PATH(I,K),I=1,4),(BP(I,N1),I=1,3),DOSE,TDO
                   1SE
 0117               IF (N.GT.1) PRINT 700, (BP(I,N1),I=1,3),DOSE,TDOSE
 0118           210 PFDOSE(N,KASE)=PFDOSE(N,KASE)+TDOSE*TPOP/1000.*PGTH(IPG)
 0119               LL=LL+5
 0120           220 CONTINUE
 0121               GO TO 440
              C
              C     HERE FOR INGESTION TIME INTEGRATED DOSE AND DOSE RATE CALCULATIONS
              C
 0122           230 IOPTIM=OPTIME
 0123               DO 310 N=1,4
 0124               N1=N
```

560 160

```
0125              IF (N.GT.2) N1=N1+1
0126              DO 270 IR=1,IADD
0127              IF (IFODOS(IR).EQ.0) GO TO 270
0128              IOPT=0
0129              TDOSE=0.0
0130              DO 260 IY=1,10
0131              TINT(IR,IY,2)=0.0
0132              IF (IY.EQ.1) Y0=0.0
0133              IF (IY.GT.1) Y0=FLOAT(IYR(IY-1))
0134              DELTA=FLOAT(IYR(IY))-Y0
0135              DO 240 I=1,6
0136          240 PALL(1,I)=RING(I,IR,IY)*365.25
0137              CALL INHALE (N+3,PALL,Y0,DELTA,DOSE,DR,IOPT,IERR,2)
0138              IOPT=1
0139              DO 250 I=1,6
0140              TDOSE=TDOSE+DOSE(I)
0141          250 TINT(IR,IY,2)=TINT(IR,IY,2)+DR(I)
0142              TINT(IR,IY,1)=TDOSE
            C
            C     CONVERT FROM REM TO MREM UNITS
            C
0143              DO 260 L=1,2
0144          260 TINT(IR,IY,L)=TINT(IR,IY,L)*1000.0
0145          270 CONTINUE
            C
            C     PRINT TIME INTEGRATED DOSE (LAP=1) AND DOSE RATE (LAP=2)
            C
0146              DO 310 LAP=1,2
0147              LL=60
0148              DO 310 IR=1,IADD
0149              IF (LL.LT.60) GO TO 300
0150              CALL HEADER (6)
0151              PRINT 450, IOPTIM
0152              PRINT 650, (BP(I,N1),I=1,3)
0153              IF (LAP.EQ.2) GO TO 280
0154              PRINT 460
0155              PRINT 470, IYR
0156              GO TO 290
0157          280 PRINT 480
0158              PRINT 490
0159              PRINT 500, IYR(1),(IYR(J),IYR(J+1),J=1,9)
0160          290 PRINT 670
0161              LL=9
0162          300 IPATH=IFODOS(IR)
0163              IF (IPATH.EQ.0) GO TO 310
0164              PRINT 510, IR,(IDENT(J,IR),J=1,5),(PATH(J,IPATH),J=1,4),(TINT(IR,J
                 1,LAP),J=1,10)
0165          310 CONTINUE
            C
            C     HERE FOR POPULATION TOTAL TIME INTEGRATED DOSE AND DOSE RATES
            C     FROM INGESTION.  NOTE THAT FIRST INDEX OF TINT IF NOW USE FOR
            C     A PATHWAY & BODY PART INDEX AND TINT(28+N,IY,L) IS USED FOR
            C     OVERALL POPULATION VALUES.
            C
0166              DO 320 L=1,2
```

```
      DO 320 N=1,4
      DO 320 IY=1,10
  320 TINT(28+N,IY,L)=0.0
      DO 360 K=1,7
      IF (K.EQ.4) GO TO 360
      DO 350 N=1,4
      N1=N
      IF (N.GT.2) N1=N1+1
      TDOSE=0.0
      KN=(K-1)*4+N
      IOPT=0
      DO 350 IY=1,10
      TINT(KN,IY,2)=0.0
      IF (IY.EQ.1) Y0=0.0
      IF (IY.GT.1) Y0=FLOAT(IYR(IY-1))
      DELTA=FLOAT(IYR(IY))-Y0
      DO 330 I=1,6
  330 PALL(1,I)=RING1(I,K,IY)*365.25
      CALL INHALE (N+3,PALL,Y0,DELTA,DOSE,DR,IOPT,IERR,2)
      IOPT=1
      DO 340 I=1,6
      TDOSE=TDOSE+DOSE(I)
  340 TINT(KN,IY,2)=TINT(KN,IY,2)+DR(I)
      TINT(KN,IY,1)=TDOSE
      DO 350 L=1,2
      TINT(28+N,IY,L)=TINT(28+N,IY,L)+TINT(KN,IY,L)
  350 TINT(KN,IY,L)=TINT(KN,IY,L)*1000.
  360 CONTINUE
      WORK=TPOP*PGTH(IPG)
      DO 370 L=1,2
      DO 370 N=1,4
      DO 370 IY=1,10
  370 TINT(28+N,IY,L)=TINT(28+N,IY,L)*WORK
C
C     PRINT TOTAL TIME INTEGRATED DOSE (LAP=1) AND DOSE RATE (LAP=2)
C
      DO 400 LAP=1,2
      CALL HEADER (6)
      PRINT 450, IOPTIM
      IF (LAP.EQ.2) GO TO 380
      PRINT 520
      PRINT 530, IYR
      GO TO 390
  380 PRINT 540
      PRINT 550
      PRINT 560, IYR(1),(IYR(J),IYR(J+1),J=1,9)
  390 PRINT 670
      DO 400 K=1,7
      IF (K.EQ.4) GO TO 400
      DO 400 N=1,4
      KN=(K-1)*4+N
      N1=N
      IF (N.GT.2) N1=N1+1
      IF (N.EQ.1) PRINT 570, (PATH(I,K),I=1,4),(BP(I,N1),I=1,3),(TINT(KN
     1,IY,LAP),IY=1,10)
```

```
0218              IF (N.GT.1) PRINT 580, (BP(I,N1),I=1,3),(TINT(KN,IY,LAP),IY=1,10)
0219          400 CONTINUE
0220              IF (IRCV.EQ.0) GO TO 440
0221              CALL HEADER (6)
0222              PRINT 450, IOPTIM
0223              DO 430 LAP=1,2
0224              IF (LAP.EQ.2) GO TO 410
0225              PRINT 590
0226              PRINT 600, IYR
0227              GO TO 420
0228          410 PRINT 610
0229              PRINT 620
0230              PRINT 630, IYR(1),(IYR(J),IYR(J+1),J=1,9)
0231          420 PRINT 670
0232              DO 430 N=1,4
0233              N1=N
0234              IF (N.GT.2) N1=N1+1
0235          430 PRINT 640, (BP(I,N1),I=1,3),(TINT(28+N,IY,LAP),IY=1,10)
0236          440 RETURN
            C
            C
            C
0237          450 FORMAT(1X,'OPERATION TIME = ',I2,' YEARS')
0238          460 FORMAT('-',42X,'TOTAL TIME INTEGRATED DOSE (MREM) FROM INGESTION')
0239          470 FORMAT(1H0,' #  IDENTIFICATION',8X,'PATHWAY',T86,'YEARS'/T48,
                 1  9(I2,7X),I2)
0240          480 FORMAT('-',45X,'TOTAL DOSE RATE (MREM/YEAR) FROM INGESTION')
0241          490 FORMAT(1H0,' #  IDENTIFICATION',8X,'PATHWAY',T81,
                 1  'INTERVAL (YEARS)')
0242          500 FORMAT(1X,T47,'0-',I2,9(4X,I2,'-',I2))
0243          510 FORMAT(1X,I2,2X,5A4,2X,4A4,T44,1P10E9.2)
0244          520 FORMAT('-',27X,'TOTAL TIME INTEGRATED DOSE FOR GENERAL POPULATION
                 1(ORGAN*MREM) FROM INGESTION')
0245          530 FORMAT(1H0,'PATHWAY',T21,'ORGAN',T82,'YEARS'/T39,9(I2,8X),I2)
0246          540 FORMAT('-',30X,'TOTAL DOSE RATE FOR GENERAL POPULATION (ORGAN*MREM
                 1/YEAR) FROM INGESTION')
0247          550 FORMAT(1H0,'PATHWAY',T21,'ORGAN',T77,'INTERVAL (YEARS)')
0248          560 FORMAT(1X,T33,'0-',I2,9(5X,I2,'-',I2))
0249          570 FORMAT(1H0,4A4,3X,3A4,1X,1P10E10.2)
0250          580 FORMAT(20X,3A4,1X,1P10E10.2)
0251          590 FORMAT('-',34X,'POPULATION TOTAL TIME INTEGRATED DOSE (ORGAN*REM)
                 1FROM INGESTION')
0252          600 FORMAT(1H0,'ORGAN',T63,'YEARS'/T20,9(I2,8X),I2)
0253          610 FORMAT('-',37X,'POPULATION TOTAL DOSE RATE (ORGAN*REM/YEAR) FROM
                 1INGESTION')
0254          620 FORMAT(1H0,'ORGAN',T58,'INTERVAL (YEARS)')
0255          630 FORMAT(1X,T19,'0-',I2,9(5X,I2,'-',I2))
0256          640 FORMAT(1X,3A4,1X,1P10E10.2)
0257          650 FORMAT(1X,3A4)
0258          660 FORMAT(1H0,' #   IDENTIFICATION',T40,'PATHWAY',T60,'U238',
                 1   T70,'U234',T79,'TH230',T89,'RA226',T99,'PB210',T109,
                 2   'PO210',T119,'TOTAL')
0259          670 FORMAT(1X,132('-'))
0260          680 FORMAT(1H0,'PATHWAY',T21,'ORGAN',T39,'U238',T51,'U234',T62,
                 1   'TH230',T74,'RA226',T86,'PB210',T98,'PO210',T110,'TOTAL')
0261          690 FORMAT(1H0,4A4,3X,3A4,1P7E12.2)
0262          700 FORMAT(20X,3A4,1P7E12.2)
0263          710 FORMAT('-',44X,'DOSE COMMITMENTS FROM INGESTION (MREM/YEAR)')
0264          720 FORMAT('-',32X,'INGESTION DOSE COMMITMENTS FOR GENERAL POPULATION
                 1(ORGAN*MREM/YEAR)'/)
0265          730 FORMAT(1X,I2,3X,4A8,1X,4A4,1P7E10.2)
0266              END
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```
FORTRAN IV G1  RELEASE 2.0            FOOD               DATE = 79078          16/02/04

0001                 SUBROUTINE FOOD (IR,IDF)
0002                 REAL*8 METSET,XNAME
               C
               C*******DESCRIPTION OF VARIABLES
               C
               C        I=ISOTOPE. 1=U238, 2=U234, 3=TH230, 4=RA226, 5=PB210, 6=PO210
               C        J=TYPE OF ANIMAL FOOD
               C             1=WATER,2=FORAGE OR CROP
               C        K=TYPE OF HUMAN FOOD
               C             1:MEAT,2:MILK,3:POULTRY,4:EGGS,5:VEGETATIONS,6:FISH,7:WATER
               C        FOODIN(J,K):AMT OF FOOD J INGESTED DAILY BY ANIMAL K, IN KG/DY
               C        CON(I,J):CONCENTRATION OF ISOTOPE I IN ANIMAL FOOD J (PCI/KG)
               C        AIRIN(K):DAILY INTAKE OF AIR FOR ANIMAL K, IN M3
               C        A(I,K-2):CONCENTRATION FACTOR OF I IN HUMAN FOOD K
               C         G(I):AVG ACTIVITY OF I (PCI/KG) IN CURRENT FOOD K AT IR
               C         G4(I):CORRESPONDING G VALUE FOR EGGS IF K=3
               C       TAIR(I):CONCENTRATION OF I IN AIR(PCI/M3)
               C       AIRCON(J,I):CONCENTRATION OF I WITH PARTICLE SIZE J IN AIR(PCI/M3
               C        GACT(I):GROUND RADIONUCLIDE ACTIVITY,(PCI/M2)
               C        FCON(I,K):STABLE ELEMENT TRANSFER DATA OF ANIMAL K
               C
               C*******
               C
0003                 COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                   1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                   2   IFOP(15,16),JC(9),NSCRCE,IRHO(6),IYR(10),IFOODS(60),RFI,SHIED,
                   3   FFIN(8),PHFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                   4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                   5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0004                 COMMON/CFOD/GACT(6),AIRCON(5,6),CON(6,2),G(6),G4(6),RND(2)
               C
0005                 DO 10 I=1,6
0006              10 CON(I,1)=0.0
0007                 IF (IDF.EQ.6) GO TO 40
0008                 IFOD=1
0009                 IF (IDF.GT.2) IFOD=2
0010                 CALL VEGFOD (IFOD,IR,IDF)
0011                 IF (IDF.GT.3) RETURN
               C
               C*******PERFORM CALCULATIONS FOR EACH ISOTOPE
0012                 K=IDF
0013                 DO 30 I=1,6
               C****    CALCULATE CONCENTRATION OF I IN MEAT,POULTRY,MILK,EGGS,&FISH
0014                 SUM=0.0
0015                 DO 20 J=1,2
0016              20 SUM=SUM+CON(I,J)*FOODIN(J,K)
0017                 G(I)=FCON(I,K)*SUM
0018                 IF (K.EQ.3) G4(I)=FCON(I,4)*SUM
0019              30 CONTINUE
0020                 RETURN
0021              40 DO 50 I=1,6
0022              50 G(I)=FCON(I,5)*CON(I,1)
0023                 RETURN
0024                 END
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560 164

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FORTRAN IV G1  RELEASE 2.0           VEGFOD            DATE = 79078          16/02/04

0001                SUBROUTINE VEGFOD (IFOD,IR,IDF)
0002                REAL*8 METSET,XNAME,TODAY
0003                REAL*4 LAMDAH,LAMDAG,LON,LR,LONM
0004                DIMENSION DFODI(6,2)
0005                COMMON/CFOD/GACT(6),AIRCON(5,6),CON(6,2),G(6),G4(6),RND(2)
0006                COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                   1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                   2   IFOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                   3   FFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                   4   PDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                   5   FCON(6,5),RHO(2),DV(2),TH(2),TC(2),FV(2),BSV(6),YEVD
0007                COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                   1   THETAS(16),WINCR(16),RHALF(6),FHALF,CF(4),FODR(2,300),RN(300),
                   2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNSC(5,300),
                   3   TCNSO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0008                COMMON/INIAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                   1   IFSOL(10),NNUC,NSPTAB(10,4),F2FM(16),LONM(16),QNOM(16)
0009                DATA NCALL/0/
0010             10 IF (NCALL.GT.0) GO TO 30
0011                DO 20 J=1,2
0012                DFOD=365.25*8.64E4*FV(J)/DV(J)
0013                LAMDAH=365.25*ALN2/TH(J)
0014                TEMP=TC(J)/365.25
0015                DO 20 I=1,NNUC
0016                LAMDAG=LAMDAH+LR(I)
0017             20 DFODI(I,J)=DFOD*(1.0-EXP(-LAMDAG*TEMP))/LAMDAG
0018                NCALL=1
0019             30 DO 60 I=1,NNUC
0020                CON(I,2)=GACT(I)*BSV(I)/RHO(IFOD)
0021                DO 40 K=NPB,NPL
0022                IF (PTSZ(K).EQ.0.0) GO TO 40
0023                CON(I,2)=CON(I,2)+DFODI(I,IFOD)*AIRCON(K,I)*VDEP(K)
0024             40 CONTINUE
0025                IF (I.LT.5) GO TO 50
0026                CON(I,2)=CON(I,2)+RND(I-4)*0.003*DFODI(I,IFOD)
0027             50 CONTINUE
0028                IF (IDF.EQ.5) G(I)=DFACT*CON(I,2)
0029                IF (IFOD.EQ.2) GO TO 60
0030                CON(I,2)=CON(I,2)*FG
0031             60 CONTINUE
0032                RETURN
0033                END
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560 165

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FORTRAN IV G1  RELEASE 2.0              TAILPS              DATE = 79078          16/02/04

                    SUBROUTINE TAILPS (TAILP,LWS,PTAIL)
                    COMMON/UDADC2/VSET(5),GDSCAL,QSCALE,LTYPE,
                   1   OA(6),OB(6),UU(6),NPS,NPE,NFP,IFLAG,JFLAG,IPOLU2,
                   2   ISORC1,KSORCE,IWD,IWS,ISTAB,IWSB,IWSE
                    DIMENSION TAILP(6),PTAIL(7)
                    DRHO=PTAIL(1)
                    DM1=PTAIL(2)
                    A=PTAIL(3)
                    Z=PTAIL(4)
                    Z0=PTAIL(5)
                    P=PTAIL(6)
                    W=PTAIL(7)
                    FST=A*(1.8+0.6*ALOG10(W))
                    FST=FST*SQRT((DRHO-1.20E-3)*DM1/1.22E-6)
                    DO 10 I=1,LWS
                    FS=UU(I)*1.0E2/(2.5*ALOG(Z/Z0))
                    QH=1.0E-6*(FS**2.)*(FS-FST)
                    IF (QH.LE.0.0) QH=0.0
                 10 TAILP(I)=QH*(2.E-4/(FST**3.))*((FS/FST)**(P/3.)-1.)*1.0E4
                    RETURN
                    END
```

```
FORTRAN IV G1  RELEASE 2.0              EVPDOS              DATE = 79078          16/02/04

0001                SUBROUTINE EVPDOS (IRCV,T)
0002                REAL*8 METSET,XNAME,ORGAN,BREP
0003                DIMENSION T(16)
0004                COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                   1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                   2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                   3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                   4   FDEN(5),FGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                   5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0005                COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
                   1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
                   2   WHO(3,2),FROM(5,4),DCONV(6,4)
0006                COMMON/EVD/GEVD(9,2),CEVD(9,2),PEVD(12,2),RNEVD(2),PFDOSE(4,2)
0007                IF (IRCV.EQ.0) RETURN
0008                DO 120 INT=1,4
0009                DO 10 I=9,16
0010             10 T(I)=0.0
0011                GO TO (50,20,50,30),INT
0012             20 T(9)=OPTIME
0013                T(16)=OPTIME
0014                GO TO 40
0015             30 T(14)=YEVD
0016                T(15)=OPTIME
0017                T(16)=YEVD+OPTIME
0018             40 CALL GROUND (T(9),INT)
0019             50 DO 60 I=1,16
0020             60 T(I)=0.0
0021                GO TO (70,80,90,100),INT
0022             70 TA1=TA
0023                IF (OPTIME.LT.TA) TA1=OPTIME
0024                T(1)=TA1
0025                T(8)=TA1
0026                DT=TA1
0027                GO TO 110
0028             80 IF (OPTIME.LT.TA) GO TO 120
0029                T(1)=OPTIME-TA
0030                T(3)=T(1)
0031                T(4)=TA
0032                T(9)=T(1)
0033                T(10)=TA
0034                T(15)=TA
0035                T(16)=OPTIME
0036                DT=OPTIME-TA
0037                GO TO 110
0038             90 T(3)=TA
0039                T(4)=TA
0040                T(6)=TA
0041                T(9)=TA
0042                T(10)=TA
0043                T(15)=OPTIME
0044                T(16)=OPTIME+TA
0045                DT=0.0
0046                GO TO 110
0047            100 T(13)=TA
0048                T(14)=YEVD
```

FORTRAN IV G1 RELEASE 2.0 EVPDOS DATE = 79078 16/02/04

```
0049            T(15)=OPTIME+TA
0050            T(16)=OPTIME+YEVD
0051            DT=0.0
0052        110 CALL TAIRR (T,DT,INT)
0053            CALL DOSPOP (DT,INT,IRCV)
0054            CALL FODOSE (IRCV,INT,1)
0055        120 CONTINUE
0056            IYEVD=YEVD
0057            DO 220 KASE=1,2
0058            CALL HEADER (6)
0059            IF (KASE.EQ.1) PRINT 230
0060            IF (KASE.EQ.2) PRINT 240, IYEVD
0061            PRINT 250
0062            PRINT 260
0063            PRINT 270
0064            PRINT 280, BREP,RNEVD(KASE),RNEVD(KASE)
0065            DO 210 I=1,12
0066            K=[illegible]
0067            GO TO (140,150,160,180,180,130,190),K
0068        130 PRINT 290, (ORGAN(J,I),J=1,3),PEVD(I,KASE),PEVD(I,KASE)
0069            GO TO 210
0070        140 IEXT=6
0071            GO TO 200
0072        150 IEXT=2
0073            GO TO 170
0074        160 IEXT=8
0075        170 TOTAL=PEVD(I,KASE)+PFDOSE(I-3,KASE)+GEVD(IEXT,KASE)+CEVD(IEXT,KASE
               1)
0076            PRINT 300, (ORGAN(J,I),J=1,3),PEVD(I,KASE),PFDOSE(I-3,KASE),GEVD(I
               1EXT,KASE),CEVD(IEXT,KASE),TOTAL
0077            GO TO 210
0078        180 TOTAL=PEVD(I,KASE)+PFDOSE(I-3,KASE)
0079            PRINT 310, (ORGAN(J,I),J=1,3),PEVD(I,KASE),PFDOSE(I-3,KASE),TOTAL
0080            GO TO 210
0081        190 IEXT=5
0082        200 TOTAL=PEVD(I,KASE)+GEVD(IEXT,KASE)+CEVD(IEXT,KASE)
0083            PRINT 320, (ORGAN(J,I),J=1,3),PEVD(I,KASE),GEVD(IEXT,KASE),CEVD(IE
               1XT,KASE),TOTAL
0084        210 CONTINUE
0085            DO 220 I=1,9
0086            IF (I.EQ.2.OR.I.EQ.5.OR.I.EQ.6.OR.I.EQ.8) GO TO 220
0087            TOTAL=GEVD(I,KASE)+CEVD(I,KASE)
0088            PRINT 330, (BPRTS(J,I),J=1,3),GEVD(I,KASE),CEVD(I,KASE),TOTAL
0089        220 CONTINUE
0090            RETURN
          C
          C
          C
0091        230 FORMAT('-',T44,'POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR)')
0092        240 FORMAT('-',T39,'ENVIRONMENTAL (',I3,
               1 ' YEARS) DOSE COMMITMENTS (ORGAN*REM)')
0093        250 FORMAT('-','ORGAN',T37,2('INHALATION,      '),'INGESTION',T86,
               1 2('EXTERNAL,       '),' TOTAL')
0094        260 FORMAT(1X,T36,'PARTICULATES',T56,'RADON',T87,'GROUND',T104,
               1   'CLOUD')
0095        270 FORMAT(1X,132('-'))
0096        280 FORMAT(1H0,3A8,T52,1PE10.2,T116,E10.2)
0097        290 FORMAT(1H0,3A8,T36,1PE10.2,T116,E10.2)
0098        300 FORMAT(1H0,3A8,T36,1PE10.2,T68,E10.2,T84,E10.2,T100,E10.2,
               1   T116,E10.2)
0099        310 FORMAT(1H0,3A8,T36,1PE10.2,T68,E10.2,T116,E10.2)
0100        320 FORMAT(1H0,3A8,T36,1PE10.2,T84,E10.2,T100,E10.2,T116,E10.2)
0101        330 FORMAT(1H0,3A4,T84,1PE10.2,T100,E10.2,T116,E10.2)
0102            END
```

FORTRAN IV G1 RELEASE 2.0 CONC DATE = 79078 16/02/04

```
0001          SUBROUTINE CONC (IRCV)
        C
        C     SUBROUTINE TO CALCULATE CORRECTED CONCENTRATIONS IN CLOUD AND ON
        C     GROUND FOR SUBSEQUENT USE BY SUBROUTINE DOSAGE.  SELECTED RECEPTOR
        C     POINTS (ANGLES: IMX,0,90,180,270 AND AT IRHO DISTANCES) AND ALL
        C     EXTRA RECEPTORS ARE USED -- A MAX OF 90 LOCATIONS.  TEN
        C     CONCENTRATIONS ARE CALCULATED FOR EACH POINT, CORRESPONDING TO
        C     THE MID-POINT YEAR FOR EACH IYR INTEGRATION INTERVAL IN DOSAGE.
        C
0002          REAL*8 TODAY,METSET,XNAME,ORGAN,BREP
0003          REAL*4 LON,LR,LONM
0004          DIMENSION T(16),TPSZRY(5,4,90,10),TEMP(5,4,90,10)
0005          COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
             1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
             2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
             3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
             4   FDEN(5),PGTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
             5   FCON(6,5),RHO(2),DV(2),TW(2),TC(2),FV(2),BSV(6),YEVD
0006          COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
             1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
             2   WHO(3,2),FROM(5,4),DCONV(6,4)
0007          COMMON/UDADC4/TODAY,NPB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
             1   THETAS(16),WINDR(16),RHALF(6),PHALF,CF(4),PBDR(2,300),RN(300),
             2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
             3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0008          COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
             1   IPSOL(10),NNUC,NSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0009          COMMON/TCNGY/TCNGCY(5,90,10),TCNGOY(5,90,10),PBDRY(2,90,10)
0010          EQUIVALENCE (TPSZ(1,1,1),TPSZRY(1,1,1,1))
        C
        C
0011          IR2=30+NRECEP-IRCV
0012          YCHK=OPTIME+TA
0013          DO 120 J=1,10
        C
        C     YMID IS MIDPOINT YEAR FOR THE INTEGRATION TO BE DONE IN DOSAGE
        C
0014          IF (J.GT.1) GO TO 10
0015          YMID=FLOAT(IYR(1))/2.0
0016          GO TO 20
0017       10 YMID=FLOAT(IYR(J-1)+IYR(J))/2.0
0018       20 DT=1.0
0019          IF (YMID.GT.OPTIME) DT=0.0
0020          T(9)=0.0
0021          T(10)=YMID
0022          IF (YMID.GT.OPTIME) T(9)=YM[illegible]
0023          CALL GROUND (T(9),0)
0024          IF (YMID.GT.TA.OR.OPTIME.L[illegible]
0025          T(1)=0.0
0026          T(2)=YMID
0027          T(9)=0.0
0028          T(10)=0.0
0029          GO TO 60
0030       30 IF (YMID.GT.OPTIME) GO TO 40
0031          T(1)=0.0
```

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FORTRAN IV G1  RELEASE 2.0              CONC                DATE = 79078          16/02/04
0032              T(2)=TA
0033              T(9)=TA
0034              T(10)=YMID
0035              IF (YMID.LE.TA) T(2)=YMID
0036              GO TO 60
0037           40 IF (YMID.GT.YCHK) GO TO 50
0038              T(1)=YMID-OPTIME
0039              T(2)=TA
0040              IF (YMID.LE.TA) T(2)=YMID
0041              T(9)=TA
0042              T(10)=YMID
0043              GO TO 60
0044           50 T(1)=0.0
0045              T(2)=0.0
0046              T(9)=YMID-OPTIME
0047              T(10)=YMID
0048           60 CALL TAIRR (T,DT,0)
0049              IR0=1
0050              IF (IRCV.EQ.0) IR0=31
0051              DO 120 IR1=IR0,IR2
0052              IF (IR1.GT.30) GO TO 70
0053              IT1=(IR1-1)/6+1
0054              ID1=MOD(IR1-1,6)+1
0055              IF (IT1.EQ.1) IT=IMX
0056              IF (IT1.GT.1) IT=(IT1-2)*4+1
0057              ID=IRHO(ID1)
0058              IR=(IT-1)*KRHO+ID
0059              GO TO 80
0060           70 IR=IRCV+IR1-30
0061           80 DO 90 IP=1,5
0062              TCNGCY(IP,IR1,J)=TCNGC(IP,IR)
0063           90 TCNGOY(IP,IR1,J)=TCNGO(IP,IR)
0064              DO 100 IP=1,2
0065          100 PBDRY(IP,IR1,J)=PBDR(IP,IR)
0066              IP=1
0067              DO 120 I=NPB,NPL
0068              IF (KSZFC(I).EQ.0) GO TO 120
0069              DO 110 IP=1,4
0070          110 TEMP(I,IP,IR1,J)=TPSZR(I,IP,IR)
0071          120 CONTINUE
            C
            C     OVERWRITE COMMON/UDADC4/ STARTING AT TPSZ(1,1,1)
            C
0072              DO 140 I=NPB,NPL
0073              IF (KSZFC(I).EQ.0) GO TO 140
0074              DO 130 IP=1,4
0075              DO 130 IR1=IR0,IR2
0076              DO 130 J=1,10
0077          130 TPSZRY(I,IP,IR1,J)=TEMP(I,IP,IR1,J)
0078          140 CONTINUE
0079              RETURN
0080              END
```

```
0001          SUBROUTINE DOSAGE (IRCV)
        C
        C     SUBROUTINE TO COMPUTE:
        C       1)  TOTAL TIME INTEGRATED DOSE (SUMMED FOR ALL NUCLIDES)
        C       2)  TOTAL DOSE RATE
        C
        C     INTEGRATION IS BROKEN INTO 10 INTERVALS WITH END YEAR GIVEN BY IYR
        C     FOR EACH INTERVAL.  CONCENTRATIONS CORRECTED FOR RESUSPENSION
        C     ARE OBTAINED FROM SUBROUTINE CONC.  IN EACH CASE THE MIDPOINT
        C     YEAR OF THE INTEGRATION INTERVAL IS THE YEAR USED TO OBTAIN
        C     THE CORRECTED CONCENTRATION, WHICH IS THEN ASSUMED CONSTANT
        C     THROUGHOUT THE INTERVAL.  A MAX TOTAL OF 90 LOCATIONS ARE USED
        C     CORRESPONDING TO ANGLES IMX,0,90,180,270 AND THE 6 IRHO DISTANCES
        C     (SUBTOTAL=30 LOCATIONS) PLUS ALL THE EXTRA RECEPTORS (MAX OF 60).
        C
        C*********************************************************************
        C
        C     IMPORTANT VARIABLES:
        C
        C     TTID(90,10) - TOTAL TIME INTEGRATED DOSE (MREM), SUMMED FOR ALL
        C                   NUCLIDES, FOR CURRENT ORGAN.
        C
        C       1ST INDEX = RECEPTOR NUMBER
        C       2ND INDEX = YEARS SELECTED BY NAMELIST IYR (DEFAULT 1,3,5,7,10,
        C                   15,20,30,50,70).
        C
        C     TDR(90,10) - TOTAL DOSE RATE (MREM/YEAR) FOR CURRENT ORGAN,
        C                  SUMMED FOR ALL NUCLIDES.  INDICES SAME AS FOR TTID.
        C
        C       1ST INDEX = RECEPTOR NUMBER
        C       2ND INDEX = SELECTED YEARS (SEE TTID)
        C
        C     TCNGCY(5,90,10) - CORRECTED TCNGC CONCENTRATIONS (CLOUD) FOR EACH
        C                       INTEGRATION INTERVAL.
        C
        C       1ST INDEX = NUCLIDE (U238,TH230,RA226,PB210,PO210)
        C       2ND INDEX = RECEPTOR POINT
        C       3RD INDEX = MIDPOINT YEAR OF INTEGRATION PERIOD
        C
        C     TCNGOY(5,90,10) - CORRECTED TCNGO CONCENTRATIONS (GROUND) FOR EACH
        C                       INTEGRATION INTERVAL.
        C
        C       1ST INDEX = NUCLIDE (U238,TH230,RA226,PB210,PO210)
        C       2ND INDEX = RECEPTOR POINT
        C       3RD INDEX = MIDPOINT YEAR OF INTEGRATION PERIOD
        C
        C     TPSZRY(5,4,90,10) - TPSZR CONCENTRATIONS (CLOUD) FOR EACH
        C                         INTEGRATION INTERVAL.
        C
        C       1ST INDEX = PARTICLE SIZE
        C       2ND INDEX = NUCLIDE (U238,TH230,RA226,PB210)
        C       3RD INDEX = RECEPTOR POINT
        C       4TH INDEX = MIDPOINT YEAR OF INTEGRATION PERIOD
        C
        C     PALL(3,6) - TOTAL DEPOSIT (SUMMED OVER PARTICLE SIZES) AS PCI/YEAR
```

```
                C               FOR EACH NUCLIDE AND SUBCOMPARTMENT OF LUNG MODEL FOR
                C               CURRENT RECEPTOR AND INTEGRATION INTERVAL.
                C
                C         1ST INDEX = LUNG MODEL SUBCOMPARTMENT
                C         2ND INDEX = NUCLIDE (U238,U234,TH230,RA226,PB210,PO210)
                C
                C***********************************************************************
                C
0002                  REAL*8 ORGAN,BREP,XNAME,METSET,TODAY
0003                  REAL*4 LON,LR,LONM
0004                  DIMENSION TTID(90,10),TDR(90,10),DOSE(6),DR(6),TPSZRY(5,4,90,10)
0005                  COMMON/UDADC1/METSET(4),XNAME(4,60),VDEP(5),PTSZFC(5,5),ALN2,
                     1   PTSZ(5),REGION(6),XRECEP(3,60),DM,XRHO(15),KSMAX,IPSMAX,
                     2   IPOP(15,16),JC(9),NSORCE,IRHO(6),IYR(10),IFODOS(60),RFI,SHIED,
                     3   PFIN(8),PWFOD(60),OPTIME,MPC(7,5),FG,DFACT,RFIE,SUFI,SUFF,
                     4   PDEN(5),PSTH(4),XIN(7),XING(7),FOODIN(2,3),RSLIM,RSALF,YDOC,
                     5   FCON(6,5),RHO(2),DV(2),TH(2),TC(2),FV(2),BSV(6),YEVD
0006                  COMMON/UDADC3/ORGAN(3,12),BREP(3),DKF(3,5),PALL(3,6),PBK(3),TA,
                     1   DCFC(9,13),DCFG(9,13),TPOP,BP(3,5),SFACT,BPRTS(3,9),
                     2   WHO(3,2),FROM(5,4),DCONV(6,4)
0007                  COMMON/UDADC4/TODAY,NFB,NPL,NRECEP,IRECEP,KRHO,IMX,IPAGE(3),
                     1   THETAS(16),WINDR(16),RHALF(6),FHALF,CF(4),PEDR(2,300),RN(300),
                     2   CISUM(5,300),TPSZ(5,4,300),TPSZR(5,4,300),TCNGC(5,300),
                     3   TCNGO(5,300),RECEPT(2,300),ZRECEP(300),WL(300),FILLER(1800)
0008                  COMMON/INIAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                     1   IPSOL(10),NNUC,MSPTAB(10,4),F2FM(16),LONM(16),QNOM(16)
0009                  COMMON/TCNGY/TCNGCY(5,90,10),TCNGOY(5,90,10),PEDRY(2,90,10)
0010                  EQUIVALENCE (TPSZRY(1,1,1,1),TPSZ(1,1,1))
                C
                C***********************************************************************
                C
                C     NOTE THAT IMMEDIATELY PRIOR TO CALL OF DOSAGE (FROM UDAD),
                C     COMMON/UDADC4/ WAS OVERWRITTEN (IN SUBROUTINE CONC) BY ARRAY
                C     TPSZRY AS INDICATED BY EQUIVALENCE STATEMENT.
                C
                C***********************************************************************
                C
0011                  IOPTIM=OPTIME
0012                  IR2=30+NRECEP-IRCV
0013                  IR0=1
0014                  IF (IRCV.EQ.0) IR0=31
0015                  ANGMAX=22.5*FLOAT(IMX-1)
0016                  IBMAX=12
                C
                C     KASE=1  PARTICULATE INHALATION TIME INTEGRATED DOSE AND DOSE RATE
                C     KASE=2  RADON INHALATION TIME INTEGRATED DOSE AND DOSE RATE
                C     KASE=3  EXTERNAL DOSE AND DOSE RATE FROM GROUND DEPOSTION
                C     KASE=4  EXTERNAL DOSE AND DOSE RATE FROM CLOUD SUBMERSION
                C
0017                  DO 380 KASE=1,4
0018                  KASE1=(KASE-1)/2+1
0019                  IF (KASE.EQ.2) IBMAX=1
0020                  IF (KASE.GE.3) IBMAX=9
                C
                C     START MAIN TIME INTEGRATED DOSE AND DOSE RATE LOOP
```

560 172

```
      C
0021        DO 380 IB=1,IBMAX
0022        DO 150 IR1=IR0,IR2
0023        IF (KASE.EQ.1) GO TO 20
0024        IF (IR1.GT.30) GO TO 10
0025        IT1=(IR1-1)/6+1
0026        ID1=MOD(IR1-1,6)+1
0027        IF (IT1.EQ.1) IT=IMX
0028        IF (IT1.GT.1) IT=(IT1-2)*4+1
0029        ID=IRHO(ID1)
0030        IR=(IT-1)*KRHO+ID
0031        GO TO 20
0032     10 IR=IR1-30+IRCV
0033     20 DSUM=0.0
0034        IOPT=0
0035        DO 150 IY=1,10
0036        IF (IY.EQ.1) Y0=0.0
0037        IF (IY.GT.1) Y0=FLOAT(IYR(IY-1))
0038        DELTA=FLOAT(IYR(IY))-Y0
0039        IF (KASE-2) 30,90,110
      C
      C     CALCULATE DOSE AND DOSE RATE FROM PARTICULATE INHALATION
      C
0040     30 IP=1
0041        DO 50 N=1,NNUC
0042        IF (N.GT.1) IP=N-1
0043        IF (N.GT.4) IP=4
0044        DO 50 K=1,3
0045        PALL(K,N)=0.0
0046        DO 40 I=NPB,NPL
0047        IF (KSZFC(I).EQ.0) GO TO 40
0048        PALL(K,N)=PALL(K,N)+DKF(K,I)*TPSZRY(I,IP,IR1,IY)
0049     40 CONTINUE
0050        IF (IP.LT.4.) GO TO 50
0051        PALL(K,N)=PALL(K,N)+FBK(K)*PBDRY(N-4,IR1,IY)
0052     50 CONTINUE
0053        CALL INHALE (IB,PALL,Y0,DELTA,DOSE,DR,IOPT,IERR,1)
0054        IF (IERR.EQ.0) GO TO 60
0055        PRINT 390, Y0,IR1,(ORGAN(J,IB),J=1,3)
0056        GO TO 150
0057     60 IOPT=1
0058        DO 70 N=1,NNUC
0059     70 DSUM=DSUM+DOSE(N)
      C
      C     CONVERT FROM REM TO MREM UNITS
      C
0060        TTID(IR1,IY)=DSUM*1000.0
0061        TDR(IR1,IY)=DR(1)
0062        DO 80 N=2,NNUC
0063     80 TDR(IR1,IY)=TDR(IR1,IY)+DR(N)
0064        TDR(IR1,IY)=TDR(IR1,IY)*1000.0
0065        GO TO 150
      C
      C     HERE TO CALCULATE DOSE AND DOSE RATE FROM RADON INHALATION
      C
```

560 173

```
0066            90 IF (IYR(IY).LE.IOPTIM) GO TO 100
0067               RATE=0.0
0068               GO TO 140
0069           100 RATE=0.625*RN(IR)
0070               GO TO 140
            C
            C      HERE TO CALCULATE DOSE AND DOSE RATE FOR GROUND AND CLOUD
            C
0071           110 IU=1
0072               RATE=0.
0073               DO 130 IP=1,5
0074               IF (IP.GT.1) IU=IP-1
0075               CALL NSNE (IB,IP,NS,NE)
0076               DO 130 IC=NS,NE
0077               IF (KASE.EQ.3) RATE=RATE+TCNGOY(IU,IR1,IY)*DCFG(IB,IC)
0078               IF (KASE.EQ.4) RATE=RATE+TCNGCY(IU,IR1,IY)*DCFC(IB,IC)
0079               IF (IP.NE.5) GO TO 130
0080               IF (KASE.EQ.3) GO TO 130
0081               IF (IYR(IY).GT.IOPTIM) GO TO 130
0082               DO 120 IPP=1,3
0083           120 RATE=RATE+CISUM(IPP,IR)*DCFC(IB,IPP+7)+RN(IR)*DCFC(IB,7)
0084           130 CONTINUE
0085               RATE=RATE*SFACT
0086           140 DSUM=DSUM+RATE*DELTA
0087               TTID(IR1,IY)=DSUM
0088               TDR(IR1,IY)=RATE
0089           150 CONTINUE
0090               IF (IRCV.EQ.0) GO TO 280
            C
            C      PRINT TIME INTEGRATED DOSE (LAP=1)
            C      PRINT TOTAL DOSE RATE (LAP=2)
            C
0091               DO 270 LAP=1,2
0092               CALL HEADER (6)
0093               PRINT 400, IOPTIM,ANGMAX
0094               IF (KASE-2) 160,170,180
0095           160 PRINT 420, (ORGAN(J,IB),J=1,3)
0096               GO TO 190
0097           170 PRINT 420, (BREP(J),J=1,3)
0098               GO TO 190
0099           180 PRINT 430, (BPRTS(J,IB),J=1,3)
0100           190 IF (LAP.EQ.2) GO TO 200
0101               PRINT 440, (WHO(J,KASE1),J=1,3),(FROM(J,KASE),J=1,5)
0102               PRINT 490, IYR
0103               PRINT 500
0104               GO TO 210
0105           200 PRINT 480, (WHO(J,KASE1),J=1,3),(FROM(J,KASE),J=1,5)
0106               PRINT 450
0107               PRINT 460, IYR(1),(IYR(J),IYR(J+1),J=1,9)
0108               PRINT 500
0109           210 DO 270 IT1=1,5
0110               IF (IT1.EQ.1) IT=IMX
0111               IF (IT1.GT.1) IT=(IT1-2)*4+1
0112               ANG=22.5*FLOAT(IT-1)
0113               DO 270 IR=1,KRHO
```

```
FORTRAN IV G1  RELEASE 2.0              DOSAGE              DATE = 79078          16/02/04

0114                DO 220 ID1=1,6
0115                ID=IRHO(ID1)
0116                IF (ID.EQ.IR) GO TO 230
0117            220 CONTINUE
0118                GO TO 270
0119            230 DIST=XRHO(ID)
0120                IR1=6*(IY1-1)+ID1
0121                IF (ID1.GT.1) GO TO 250
0122                IF (LAP.EQ.2) GO TO 240
0123                PRINT 510, ANG,DIST,(TTID(IR1,IY),IY=1,10)
0124                GO TO 270
0125            240 PRINT 510, ANG,DIST,(TDR(IR1,IY),IY=1,10)
0126                GO TO 270
0127            250 IF (LAP.EQ.2) GO TO 260
0128                PRINT 520, DIST,(TTID(IR1,IY),IY=1,10)
0129                GO TO 270
0130            260 PRINT 520, DIST,(TDR(IR1,IY),IY=1,10)
0131            270 CONTINUE
0132                IF (IR2.LE.30) GO TO 380
          C
          C         PRINT TOTAL TIME INTEGRATED DOSE FOR EXTRA RECEPTORS (LAP=1)
          C
          C         PRINT TOTAL DOSE RATE FOR EXTRA RECEPTORS (LAP=2)
          C
0133            280 DO 370 LAP=1,2
0134                LL=60
0135                DO 370 IR1=31,IR2
0136                NR=IR1-30
0137                IF (LL.LT.60) GO TO 350
0138                CALL HEADER (6)
0139                IF (IRCV.GT.0) PRINT 400, IOPTIM,ANGMAX
0140                IF (IRCV.EQ.0) PRINT 410, IOPTIM
0141                IF (KASE-2) 290,300,310
0142            290 PRINT 420, (ORGAN(J,IB),J=1,3)
0143                GO TO 320
0144            300 PRINT 420, (BREP(J),J=1,3)
0145                GO TO 320
0146            310 PRINT 430, (BPRTS(J,IB),J=1,3)
0147            320 IF (LAP.EQ.2) GO TO 330
0148                PRINT 560, (WHO(J,KASE1),J=1,3),(FROM(J,KASE),J=1,5)
0149                PRINT 530, IYR
0150                GO TO 340
0151            330 PRINT 570, (WHO(J,KASE1),J=1,3),(FROM(J,KASE),J=1,5)
0152                PRINT 540
0153                PRINT 470, IYR(1),(IYR(J),IYR(J+1),J=1,9)
0154            340 PRINT 500
0155                LL=11
0156            350 IF (LAP.EQ.2) GO TO 360
0157                PRINT 550, NR,(XNAME(I,NR),I=1,4),(TTID(IR1,IY),IY=1,10)
0158                GO TO 370
0159            360 PRINT 550, NR,(XNAME(I,NR),I=1,4),(TDR(IR1,IY),IY=1,10)
0160            370 LL=LL+1
0161            380 CONTINUE
0162                RETURN
          C
```

560 175

```
FORTRAN IV G1  RELEASE 2.0           DOSAGE              DATE = 79078          16/02/04

                 C
                 C
0163               390 FORMAT(1H0,'DOSAGE ERROR FOR YEAR =',F5.1,' FOR GRID POINT =',
                      1   I3,' FOR ORGAN ',3A8)
0164               400 FORMAT(1X,'OPERATION TIME = ',I2,' YEARS',8X,
                      1    ' ANGLE OF MAXIMUM DISPERSION = ',F5.1,' DEGREES')
0165               410 FORMAT(1X,'OPERATION TIME = ',I2,' YEARS')
0166               420 FORMAT(1X,3A8)
0167               430 FORMAT(1X,3A4)
0168               440 FORMAT('-',33X,3A4,' TOTAL TIME INTEGATED DOSE (MREM) FROM ',5A4)
0169               450 FORMAT(1H0,'ANGLE    DISTANCE(KM)',T73,'INTERVAL (YEARS)')
0170               460 FORMAT(1X,T29,'0-',I2,9(6X,I2,'-',I2))
0171               470 FORMAT(1X,T47,'0-',I2,9(4X,I2,'-',I2))
0172               480 FORMAT('-',30X,3A4,' TOTAL DOSE RATE (MREM/YEAR) FROM ',5A4)
0173               490 FORMAT(1H0,'ANGLE    DISTANCE(KM)',T78,'YEARS'/T30,9(I2,9X),I2)
0174               500 FORMAT(1X,132('-'))
0175               510 FORMAT(1H0,F5.1,8X,F4.1,5X,1P10E11.2)
0176               520 FORMAT(14X,F4.1,5X,1P10E11.2)
0177               530 FORMAT('0',6X,'#',3X,'IDENTIFICATION',T86,'YEARS'/T47,9(I2,7X),I2)
0178               540 FORMAT('0',6X,'#',3X,'IDENTIFICATION',T81,'INTERVAL (YEARS)')
0179               550 FORMAT(' ',5X,I2,3X,4A8,1P10E9.2)
0180               560 FORMAT('-',19X,3A4,' TOTAL TIME INTEGRATED DOSE (MREM) AT EXTRA RE
                      1CEPTOR LOCATIONS FROM ',5A4)
0181               570 FORMAT('-',16X,3A4,' TOTAL DOSE RATE (MREM/YEAR) AT EXTRA RECEPTOR
                      1 LOCATIONS FROM ',5A4)
0182                   END
```

560 176

```
0001              FUNCTION ANC4(A1,B1,EP,M,N,FUN)
            C     ADAPTIVE INTEGRATION USING NEWTON-COTES NO. 4
0002              DOUBLE PRECISION ANC4,A1,B1,EP,FUN,A,B,EPS,ESUM,TSUM,DA,XB,SX,FA
                 1,F1,FS,F3,FM,F2,FT,F4,FB,FTP,FBP,FMAX,FTST,EST,AEST,EST1,EST2,AEST
                 21,AEST2,ABSAR,DELTA,DIFF,DAFT,SUM
0003              DIMENSION F2(30),F4(30),FTP(30),FBP(30),FTST(5),EST2(30),NRTR(30)
0004              DIMENSION AEST2(30),XB(30)
            C     THE PARAMETER SETUP FOR THE INITIAL CALL
0005              IF(N.LE.0)GO TO 210
0006              IF(N.GT.3)GO TO 211
0007              A=A1
0008              B=B1
0009              EPS=EP*63.0D0
0010              ESUM=0.0D0
0011              TSUM=0.0D0
0012              LVL=1
0013              DA=B-A
0014              FA=FUN(A)
0015              FS=FUN((3.0D0*A+B)/4.0D0)
0016              FM=FUN((A+B)*0.5D0)
0017              FT=FUN((A+3.0D0*B)/4.0D0)
0018              FB=FUN(B)
0019              M=5
0020              FMAX=DABS(FA)
0021              FTST(1)=FMAX
0022              FTST(2)=DABS(FS)
0023              FTST(3)=DABS(FM)
0024              FTST(4)=DABS(FT)
0025              FTST(5)=DABS(FB)
0026              DO 100 I=2,5
0027              IF(FMAX.GE.FTST(I))GO TO 100
0028              FMAX=FTST(I)
0029          100 CONTINUE
0030              EST=(7.0D0*(FA+FB)+32.0D0*(FS+FT)+12.0D0*FM)*DA/90.0D0
0031              ABSAR=(7.0D0*(FTST(1)+FTST(5))+32.0D0*(FTST(2)+FTST(4))+12.0D0*FTS
                 1T(3))*DA/90.0D0
0032              AEST=ABSAR
            C      1=RECUR
0033            1 SX=(DA/(2.0D0**LVL))/90.0D0
0034              F1=FUN((7.0D0*A+B)/8.0D0)
0035              F3=FUN((5.0D0*A+3.0D0*B)/8.0D0)
0036              F2(LVL)=FUN((3.0D0*A+5.0D0*B)/8.0D0)
0037              F4(LVL)=FUN((A+7.0D0*B)/8.0D0)
0038              EST1=SX*(7.0D0*(FA+FM)+32.0D0*(F1+F3)+12.0D0*FS)
0039              FBP(LVL)=FB
0040              FTP(LVL)=FT
0041              XB(LVL)=B
0042              EST2(LVL)=SX*(7.0D0*(FM+FB)+32.0D0*(F2(LVL)+F4(LVL))+12.0D0*FT)
0043              SUM=EST1+EST2(LVL)
0044              FTST(1)=DABS(F1)
0045              FTST(2)=DABS(F2(LVL))
0046              FTST(3)=DABS(F3)
0047              FTST(4)=DABS(F4(LVL))
0048              FTST(5)=DABS(FM)
0049              AEST1=SX*(7.0D0*(DABS(FA)+FTST(5))+32.0D0*(FTST(1)+FTST(3))+12.0D0
```

FORTRAN IV G1 RELEASE 2.0 ANC4 DATE = 78357 22/51/58

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                 X*DABS(FS))
0050              AEST2(LVL)=SX*(7.0D0*(FTST(5)+DABS(FB))+32.0D0*(FTST(2)+FTST(4))+1
                 X2.0D0*DABS(FT))
0051              ABSAR=ABSAR-AEST+AEST1+AEST2(LVL)
0052              M=M+4
0053              GO TO (201,200,202),N
0054          200 DELTA=ABSAR
0055              GO TO 205
0056          210 PRINT 39
0057           39 FORMAT(' ERROR RETURN-N.LE.0')
0058              RETURN
0059          211 PRINT 40
0060           40 FORMAT(' ERROR RETURN-N.GT.3')
0061              RETURN
0062          201 DELTA=1.0D0
0063              GO TO 205
0064          202 DO 203 I=1,4
0065              IF(FMAX.GE.FTST(I))GO TO 203
0066              FMAX=FTST(I)
0067          203 CONTINUE
0068              DELTA=FMAX
0069          205 DAFT=EST-SUM
0070              DIFF=DABS(DAFT)
0071              DAFT=DAFT/63.0D0
0072              IF(DIFF-EPS*DELTA)6,6,3
0073            3 IF(LVL-30)4,2,2
0074            6 IF(LVL-1)2,4,2
            C     2=UP
0075            2 A=B
0076              ESUM=ESUM+DAFT
0077              TSUM=TSUM+SUM
0078            9 LVL=LVL-1
0079              L=NRTR(LVL)
0080              GO TO (11,12),L
            C     11=R1,12=R2
0081            4 NRTR(LVL)=1
0082              EST=EST1
0083              AEST=AEST1
0084              FB=FM
0085              FT=F3
0086              FM=FS
0087              FS=F1
0088              B=(A+B)/2.0D0
0089              EPS=EPS/2.0D0
0090            7 LVL=LVL+1
0091              GO TO 1
0092           11 NRTR(LVL)=2
0093              FA=FB
0094              FS=F2(LVL)
0095              FM=FTP(LVL)
0096              FT=F4(LVL)
0097              FB=FBP(LVL)
0098              B=XB(LVL)
0099              EST=EST2(LVL)
0100              AEST=AEST2(LVL)
0101              GO TO 7
0102           12 EPS=2.0D0*EPS
0103              IF(LVL-1)5,5,9
0104            5 ANC4=TSUM-ESUM
0105              RETURN
0106              END
```

```
0001              SUBROUTINE INHALE (IB1,P1,TO1,T1,DOSE,DR,IOPT,IERR,KASE)
            C
            C     INHALATION DOSE MODEL, PROGRAMMED BY A. J. ZIELEN, EIS DIVISION,
            C     ARGONNE NATIONAL LABORATORY, 10/28/77, 1/30/78, 5/4/78, 5/26/78.
            C
            C     SUBROUTINE THAT CALCULATES, FOR SELECTED ORGANS, NUCLIDES, AND
            C     INTEGRATION PERIODS, THE TIME INTEGRATED DOSE AND DOSE RATE
            C     ARISING FROM THE INHALATION OF RADIONUCLIDE PARTICULATES.
            C     CALCULATIONS ARE BASED ON THE LUNG MODEL OF THE TASK GROUP ON LUNG
            C     DYNAMICS FOR COMMITTEE II OF THE INTERNATIONAL COMMISSION ON
            C     RADIOLOGICAL PROTECTION.
            C
            C     INGESTION MODEL (ADDED 5/26/78) THAT CALCULATES THE TIME
            C     INTEGRATED DOSE AND DOSE RATE FOR SELECTED ORGANS (WHOLE BODY,
            C     BONE, KIDNEY, LIVER) ARISING DURING AN INTERVAL OF CONTINUOUS
            C     INGESTION OF THE SELECTED RADIONUCLIDES.
            C
            C****************************** ARGUMENTS ****************************
            C
            C     IB=BODY PART INDEX, 1-12 (NASOPHARYNGEAL,TRACHEOBRONCHIAL,
            C        PULMONARY,WHOLE BODY,BONE,KIDNEY,LIVER,STOMACH,SMALL INTESTINE,
            C        UPPER LARGE INTESTINE,LOWER LARGE INTESTINE,LYMPH NODES).  IF
            C        IOPT=1, IB MUST EQUAL VALUE ON PREVIOUS CALL, I.E. IB1=IB.
            C
            C     P(3,10)=DEPOSITION AS PICOCURIES PER YEAR
            C       1ST INDEX=3 REGIONS OF RESPIRATORY TRACT MODEL: NASOPHARYNGEAL,
            C                 TRACHEOBRONCHICAL,PULMONARY.
            C       2ND INDEX=NUCLIDE.  BUILTIN DEFAULT VALUES ARE: U238,U234,TH230,
            C                 RA226,PB210,PO210.  HOWEVER, CALLING PROGRAM CAN USE
            C                 COMMON/INHAL1/ TO SUPPLY ANY SET OF 1 TO 10 NUCLIDES.
            C
            C     T0=INITIAL YEAR FOR DOSE INTEGRATION.  IF IOPT=1, INTEGRATION
            C        MUST RESUME WHERE PREVIOUS CALL ENDED, I.E. IT0 = T0 + T.
            C
            C     T=YEAR SPAN FOR DOSE INTEGRAL.
            C
            C     DOSE(10)=RETURNED TIME INTEGRATED DOSE (REM) FOR SELECTED
            C              NUCLIDES.
            C
            C     DR(10)=RETURNED DOSE RATE (AT END OF INTEGRATION PERIOD) AS
            C            REM/YEAR FOR SELECTED NUCLIDES.
            C
            C     IOPT=0 ON 1ST (OR ONLY) CALL FOR AN INTEGRATION.
            C         =1 ON SUBSEQUENT CALLS TO CONTINUE AN INTEGRATION.
            C
            C     IERR=ERROR FLAG, SET AT 1 IF PROBLEM OCCURS IN SUBROUTINE AND
            C          (DOSE(IP),IP=1,NNUC) SET AT 1.E-70 AND DR(IP) AT 0.
            C
            C     KASE=1 FOR INHALATION MODEL, =2 FOR INGESTION MODEL
            C
            C********************** IMPORTANT VARIABLES *************************
            C
            C   E(10,12)  -  ENERGY ABSORBED PER DISINTEGRATION (MEV*REM/DIS*RAD)
            C     1ST INDEX = NUCLIDE.
            C     2ND INDEX = BODY PART, SEE IB
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560 179

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C
C   EGI(10,4)  -  EXP(-LGI(IP)*TGI(IB-7))
C     LGI(IP)=LR(IP) EXCEPT SMALL INTESTINE WHERE LSI(IP) IS USED
C     TGI(IB-7)=GI TRACK TIME FOR IB = 8 TO 11 OR STOMACH, SMALL
C       INTESTINE, UPPER LARGE INTESTINE, LOWER LARGE INTESTINE
C
C   EGI1(10,4)  -  (1-EGI)/LGI
C
C   ELON(10,4,20)  -  EXP(-LON(IP,N)*T), MAX OF 20 T VALUES SAVED.
C
C   ELONM(MPMAX*20)  -  EXP(-LONM(IP,N)*T), SEE MSPTAB
C
C   ELP(10,9,20)  -  EXP(-LP(IP,J)*T), MAX OF 20 T VALUES SAVED.
C
C   ELR(10,20)  -  EXP(-LR(IP)*T), MAX OF 20 T VALUES SAVED.
C
C   FP(3,9)  -  FRACTION REMOVED FOR PATHWAYS A THRU I
C     1ST INDEX = SOLUBILITY CLASS
C     2ND INDEX = PATHWAY
C
C   F1(10)  -  FRACTION OF NUCLIDE PASSING FROM GI TRACT TO THE BLOOD.
C
C   F2P(10,4)  -  FRACTION OF NUCLIDE PASSING FROM BLOOD TO BODY ORGAN
C     1ST INDEX = NUCLIDE.
C     2ND INDEX = TOTAL BODY, BONE, KIDNEY, LIVER
C
C   F2PM(MPMAX)  -  MULTIPLE SUBPATH VALUES OF F2P, SEE MSPTAB
C
C   IPSOL(10)  -  SOLUBILITY CLASS (1 OR 2) FOR EACH NUCLIDE
C
C   LON(10,4)  -  LAMBDA(EFFECTIVE) FOR ORGANS
C     1ST INDEX = NUCLIDE
C     2ND INDEX = ORGAN: WHOLE BODY,BONE,KIDNEY,LIVER
C
C   LONM(MPMAX)  -  MULTIPLE SUBPATH LAMBDA(ORGAN), SEE MSPTAB
C
C   LP(10,9)  -  LAMBDA(EFFECTIVE) FOR PATHWAYS A THRU I
C     1ST INDEX= NUCLIDE
C     2ND INDEX= PATHWAY
C
C   LPB(3,9)  -  LAMBDA(BIOLOGICAL) FOR PATHWAYS A THRU I
C     1ST INDEX = SOLUBILITY CLASS
C     2ND INDEX = PATHWAY
C
C   LR(10)  -  LAMBDA(RADIOLOGICAL) FOR SELECTED NUCLIDES.
C
C   LSI(10)  -  LAMBDA(SMALL INTESTINE) FOR SELECTED NUCLIDES
C     BY DEFINITON: LSI(J)=LA+LR(J) WHERE
C     LA = (1/TGI(2))*ALOG(1/(1-F1(J))) AND TGI WILL BE DEFINED SHORTLY.
C
C   MPMAX  -  CURRENT MAX DIMENSION FOR F2PM, LONM, AND QNOM ARRAYS
C
C
C   MSPTAB(10,4)  -  MULTIPLE SUBPATH TABLE FOR NUCLIDES AND ORGANS
C     WHERE MULTIPLE SETS OF F2P, LON, AND QNO VALUES ARE REQUIRED.
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           C      A ZERO VALUE INDICATES NO SUBPATHS; UNITS VALUE (1-9) GIVES
           C      NUMBER OF ADDITIONAL SUBPATHS AND VALUE/10 INDICATES ENTRY
           C      POINT IN F2PM, LONM, AND QNOM ARRAYS.
           C       1ST INDEX=NUCLIDE
           C      2ND INDEX=ORGAN (WHOLE BODY, BONE, KIDNEY, LIVER)
           C
           C
           C    NNUC  -  NUMBER OF SELECTED NUCLIDES (1-10)
           C
           C    QASKO(10)  -  ACTIVITY AT START OF INTEGRATION PERIOD FOR ADDED DOSE
           C                    TO TB FROM P REGION VIA PATHS F & G TO THE GI TRACT,
           C                    FOR SELECTED NUCLIDES.
           C
           C    QIO(10)  -  ACTIVITY AT START OF INTEGRATION TIME IN LYMPH AREA I
           C                 FOR SELECTED NUCLIDES.
           C
           C    QJO(10,8)  -  ACTIVITY IN PATHWAY AT START OF INTEGRATION PERIOD
           C      1ST INDEX= NUCLIDE
           C      2ND INDEX = PATHWAYS A THRU H OF RESPIRATORY TRACT MODEL
           C
           C    QMO(10)  -  ACTIVITY AT START OF INTEGRATION IN LYMPH AREA M FOR
           C                 SELECTED NUCLIDES.
           C
           C    QNO(10,4)  -  ACTIVITY IN ORGAN AT START OF INTEGRATION PERIOD
           C      1ST INDEX = NUCLIDE
           C      2ND INDEX = ORGAN: TOTAL BODY, BONE, KIDNEY, LIVER
           C
           C    QNOM(MPMAX)  -  MULTIPLE SUBPATH VALUE OF QNO, SEE MSPTAB
           C
           C    TGI(4)  -  EXPOSURE TIME (NOT RESIDENT TIME) IN HOURS IN GI TRACT:
           C               STOMACH, SMALL INTESTINE, UPPER LARGE INTESTINE, LOWER
           C               LARGE INTESTINE
           C
           C    TLI(2)  -  RESIDENT TIME (HOURS) IN LARGE INTESTINE, UPPER & LOWER
           C
           C    W(12)  -  BODY PART WEIGHT IN GRAMS, SEE IB FOR ORDER
           C
           C    YEARS(20)  -  ARRAY OF SAVED YEAR VALUES TO CUT DOWN REEVALUATION
           C                   OF EXPONENTIALS.  INDEX CORRESPONDS TO T VALUES IN
           C                   ARRAYS ELON, ELONM, ELP, AND ELR.
           C
           C******************************************************************
           C
 0002             IMPLICIT REAL*4 (L)
 0003             DIMENSION W(12),QJO(10,8),QIO(10),QNO(4,10),P(3,10),QMO(10),
                 1   QASKO(10),P1(3,10),DOSE(10),DR(10),YEARS(20)
           C
           C       COMMON BLOCKS:
           C         INHAL1 - ALL PRIMARY DATA NEEDED FOR SELECTED NUCLIDES
           C         INHAL2 - PRIMARY DATA INDEPENDENT OF SELECTED NUCLIDES
           C         INHAL3 - NUCLIDE AND YEAR DEPENDENT EXPONENTIALS, DERIVED
           C                  FROM INHAL1 AND INHAL2 PARAMETERS.
           C
 0004             COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                 1   IPSOL(10),NNUC,MSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
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FORTRAN IV G1  RELEASE 2.0              INHALE              DATE = 78357            22/51/58

 0005                 COMMON/INHAL2/LPB(3,9),FP(3,9),TGI(4),TLI(2),EGI(10,4),EGI1(10,4),
                     1   LP(10,9),LSI(10),MPMAX,NCALL,MPEND
 0006                 COMMON/INHAL3/ELP(10,9,20),ELON(10,4,20),ELR(10,20),ELONM(320)
 0007                 DATA W/1.4,400.,600.,70000.,7000.,300.,1700.,250.,1100.,
                     1   135.,150.,15./
                C
                C     FACTOR=51.2E-6*365.25, DOSE CONVERSION FACTOR (REM/PCI/YEAR).
                C
 0008                 DATA FACTOR/0.0187008/,INIT/0/
                C
                C************************************************************************
                C
 0009                 IF (INIT [illegible].0) GO TO 20
 0010                 DO 10 J=1,20
 0011              10 YEARS(J)=0.0
 0012                 INIT=1
                C
                C     NCALL FEATURE NEEDED BECAUSE OF OVERLAY TECHNIQUE USED BY UDAD,
                C     WHICH CAN RESULT IN THE LOADING OF A FRESH COPY OF INHALE.  THIS
                C     RESETS TO INIT=0, BUT BECAUSE BLOCKDATA IS NOT REUSED, NCALL
                C     REMAINS AT 1 (SET IN INITEX).
                C
 0013                 IF (NCALL.GT.0) GO TO 20
 0014                 CALL INITEX
 0015              20 IF (IOPT.EQ.0) GO TO 40
 0016                 IF (IB1.EQ.IB) GO TO 30
 0017                 PRINT 1030, IB1,IB
 0018                 GO TO 60
 0019              30 T2=T0+T
 0020                 IF (T01.EQ.T2) GO TO 40
 0021                 PRINT 1040, T01,T2
 0022                 GO TO 60
 0023              40 IERR=0
                C
                C     CONVERT TO LOCAL VALUES FOR MORE EFFICIENT OPERATION
                C
 0024                 IB=IB1
 0025                 T0=T01
 0026                 T=T1
 0027                 IF (T0.LT.0.OR.T.LT.0) GO TO 50
 0028                 GO TO 80
 0029              50 PRINT 1050, T0,T
 0030              60 IERR=1
 0031                 DO 70 IP=1,NNUC
 0032              70 DOSE(IP)=1.E-70
 0033                 RETURN
                C
                C     CHECK IF EXPONENTIALS HAVE BEEN EVALUATED FOR T0 AND T
                C
 0034              80 DO 150 I=1,2
 0035                 IF (I.EQ.2) GO TO 100
 0036                 IF (T0.GT.0.0) GO TO 90
 0037                 IY0=0
 0038                 GO TO 150
 0039              90 TCHK=T0
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560 182

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0040              GO TO 110
0041          100 TCHK=T
0042          110 DO 120 J=1,20
0043              IF (YEARS(J).EQ.0.) GO TO 130
0044              IF (YEARS(J).EQ.TCHK) GO TO 140
0045          120 CONTINUE
0046              J=1
0047          130 YEARS(J)=TCHK
0048              CALL ECALC (J,TCHK)
0049          140 IF (I.EQ.1) IY0=J
0050              IF (I.EQ.2) IY=J
0051          150 CONTINUE
0052              IF (IB.GE.1.AND.IB.LE.12) GO TO 170
0053          160 PRINT 1060, IB
0054              GO TO 60
0055          170 KEND=3
0056              IF (KASE.EQ.2) KEND=1
0057              DO 180 K=1,KEND
0058              DO 180 IP=1,NNUC
0059          180 P(K,IP)=P1(K,IP)
0060              IF (KASE.EQ.1) GO TO 190
0061              IF (IB.LT.4.OR.IB.GT.7) GO TO 160
0062              GO TO 200
0063          190 J3=1
            C
            C     IN PATHWAYS DO LOOPS:
            C       J1=FIRST PATHWAY
            C       J2=LAST PATHWAY
            C       J3=STEP SIZE (1 OR 2)
            C
0064              GO TO (220,230,240),IB
0065              J2=8
0066              IF (IB.EQ.12) GO TO 250
0067              IF (IB.GT.7) GO TO 210
0068              J1=1
            C
            C     N=ORGAN NUMBER (1-4) WHOLE BODY,BONE,KIDNEY,LIVER
            C
0069          200 N=IB-3
0070              GO TO 260
0071          210 J1=2
0072              J3=2
0073              GO TO 260
0074          220 J1=1
0075              J2=2
0076              GO TO 260
0077          230 J1=3
0078              J2=7
0079              GO TO 260
0080          240 J1=5
0081              J2=8
0082              GO TO 260
0083          250 J1=8
0084          260 IF (T0.GT.0) GO TO 320
0085              DO 310 IP=1,NNUC
```

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0086            IF (IB.LE.3.OR.IB.GE.8) GO TO 290
0087            QN0(IP,N)=0.
0088            IF (MSPTAB(IP,N).EQ.0) GO TO 280
0089            MP1=MSPTAB(IP,N)/10
0090            MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0091            DO 270 MP=MP1,MP2
0092        270 QN0M(MP)=0.
0093        280 IF (KASE.EQ.2) GO TO 310
0094        290 DO 300 J=J1,J2,J3
0095        300 QJ0(IP,J)=0.
0096            QM0(IP)=0.
0097            QI0(IP)=0.
0098            QASK0(IP)=0.
0099        310 CONTINUE
0100            IF (KASE.EQ.2) GO TO 970
0101            GO TO 470
0102        320 IF (KASE.EQ.2) GO TO 940
0103            IF (IOPT.GT.0) GO TO 470
0104            DO 340 IP=1,NNUC
0105            ISOL=IPSOL(IP)
0106            DO 340 J=J1,J2,J3
0107            K=KFUNC(J)
          C
          C     QJ0 IS INITIAL CONC IN RESPECTIVE PATHWAY(J) FOR POLUTANT(IP)
          C
0108            QJ0(IP,J)=P(K,IP)*FP(ISOL,J)*ETEST1(LP(IP,J),T0)
0109            IF (IB.NE.2) GO TO 340
0110            IF (J.LE.4) GO TO 340
          C
          C     QASK0(IP) IS INITIAL AMOUNT OF ADDITIONAL MATERIAL IN REGION TB
          C     THAT WAS REMOVED FROM THE PULMONARY REGION VIA PROCESSES F AND G
          C     TO THE GI TRACT.
          C
0111            IF (J.GT.5) GO TO 330
0112            L4=LP(IP,4)
0113            E41=ETEST1(LP(IP,4),T0)
0114            E4=ELP(IP,4,IY0)
0115            QASK0(IP)=0.
0116            GO TO 340
0117        330 FJ=FP(ISOL,J)
0118            LJ=LP(IP,J)
0119            LBJ=LPB(ISOL,J)
0120            EJ=ELP(IP,J,IY0)
0121            QASK0(IP)=QASK0(IP)+LBJ*P(3,IP)*FJ/LJ*(E41-(EJ-E4)/(L4-LJ))
0122        340 CONTINUE
0123            IF (IB.LE.3.OR.(IB.GE.8.AND.IB.LT.12)) GO TO 470
0124            DO 460 IP=1,NNUC
0125            ISOL=IPSOL(IP)
0126            L8=LP(IP,8)
0127            L9=LP(IP,9)
0128            LB8=LPB(ISOL,8)
0129            LB9=LPB(ISOL,9)
0130            E9=ELP(IP,9,IY0)
0131            E8=ELP(IP,8,IY0)
0132            E91=ETEST1(LP(IP,9),T0)
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0133            F8=FP(ISOL,8)
0134            F9=FP(ISOL,9)
0135            IF (IB.EQ.12) GO TO 360
0136            QN0(IP,N)=0.
0137            EN=ELON(IP,N,IY0)
0138            LN=LON(IP,N)
0139            IF (LN.GT.0) EN1=ETEST1(LN,T0)
0140            IF (LN.LE.0) EN1=0.
0141            IF (MSPTAB(IP,N).EQ.0) GO TO 360
0142            MP1=MSPTAB(IP,N)/10
0143            MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0144            DO 350 MP=MP1,MP2
0145        350 QN0M(MP)=0.0
          C
          C     QI0 AND QM0 ARE INITIAL CONCENTRATIONS IN LYMPH AREAS I AND M
          C     FOR POLUTANT(IP)
          C
0146        360 ELR1=ETEST1(LR(IP),T0)
0147            QM0(IP)=LB8*(1.-F9)*P(3,IP)*F8/L8*(ELR1-(E8-ELR(IP,IY0))/(LR(IP)-L
               18))
0148            IF (L8.NE.L9) GO TO 370
0149            QI0(IP)=LB8*F9*F8*P(3,IP)/L8*(E91-T0*E9)
0150            GO TO 380
0151        370 QI0(IP)=LB8*F9*F8*P(3,IP)/L8*(E91-(E8-E9)/(L9-L8))
0152        380 IF (IB.EQ.12) GO TO 460
0153            DO 400 J=1,7
0154            K=KFUNC(J)
0155            LJ=LP(IP,J)
0156            LBJ=LPB(ISOL,J)
0157            EJ=ELP(IP,J,IY0)
0158            FJ=FP(ISOL,J)
          C     F1 FRACTION IS UNITY FOR PATHWAYS A,C,E
0159            F1TRUE=F1(IP)
0160            IF (MOD(J,2).GT.0.AND.J.LT.7) F1TRUE=1.0
0161            QN0(IP,N)=QN0(IP,N)+LBJ*F2P(IP,N)*F1TRUE*FJ*P(K,IP)/LJ*(EN1-(EJ-EN
               1)/(LN-LJ))
0162            IF (MSPTAB(IP,N).EQ.0) GO TO 400
0163            DO 390 MP=MP1,MP2
0164            CALL MSPSET (MP,IY0,T0,LNM,ENM,ENM1)
0165        390 QN0M(MP)=QN0M(MP)+LBJ*F2PM(MP)*F1TRUE*FJ*P(K,IP)/LJ*(ENM1-(EJ-ENM)
               1/(LNM-LJ))
0166        400 CONTINUE
0167            IF (L8.NE.L9) GO TO 410
0168            LIH=((LN-L9)*T0*E9-E9+EN)/(LN-L9)**2
0169            GO TO 420
0170        410 LIH=1./(L9-L8)*((E8-EN)/(LN-L8)-(E9-EN)/(LN-L9))
0171        420 L=LB9*F2P(IP,N)*(LB8*F9*(F8*P(3,IP)/L8*(1./L9*(EN1-(E9-EN)/(LN-L9)
               1)-LIH)))
0172            QN0(IP,N)=QN0(IP,N)+L
0173            IF (MSPTAB(IP,N).EQ.0) GO TO 460
0174            DO 450 MP=MP1,MP2
0175            CALL MSPSET (MP,IY0,T0,LNM,ENM,ENM1)
0176            IF (L8.NE.L9) GO TO 430
0177            LIH=((LNM-L9)*T0*E9-E9+EN)/(LNM-L9)**2
0178            GO TO 440
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0179          430 LIH=1./(L9-L8)*((E8-ENM)/(LNM-L8)-(E9-ENM)/(LNM-L9))
0180          440 L=LB9*F2PM(MP)*(LB8*F9*(F8*P(3,IP)/L8*(1./L9*(ENM1-(E9-ENM)/(LNM-L
                 19))-LIH)))
0181          450 QNOM(MP)=QNOM(MP)+L
0182          460 CONTINUE
0183          470 DO 680 IP=1,NNUC
0184              ISOL=IPSOL(IP)
0185              E9=ELP(IP,9,IY)
0186              E8=ELP(IP,8,IY)
0187              L8=LP(IP,8)
0188              L9=LP(IP,9)
0189              E91=ETEST1(L9,T)
0190              E81=ETEST1(L8,T)
0191              LB8=LPB(ISOL,8)
0192              LB9=LPB(ISOL,9)
0193              F8=FP(ISOL,8)
0194              F9=FP(ISOL,9)
0195              IF (IB.EQ.12) GO TO 630
0196              IF (IB.GE.4.AND.IB.LE.7) GO TO 520
0197              D=0.
0198              FIB=1.0
0199              DO 500 J=J1,J2,J3
0200              LJ=LP(IP,J)
0201              LBJ=LPB(ISOL,J)
0202              FJ=FP(ISOL,J)
0203              EJ1=ETEST1(LJ,T)
0204              IF (IB.GE.8) FIB=LBJ
0205              K=KFUNC(J)
0206              IF (IB.EQ.2.AND.J.GT.4) GO TO 480
0207              D=D+FIB*(QJ0(IP,J)*EJ1+(P(K,IP)*FJ/LJ)*(T-EJ1))
0208              GO TO 500
            C
            C     ADD EXTRA DOSE TO TB REGION BY MATERIAL BEING REMOVED FROM THE
            C     PULMONARY REGION VIA PROCESSES F AND G TO THE GI TRACT.
            C
0209          480 IF (J.GT.5) GO TO 490
0210              E41=ETEST1(LP(IP,4),T)
0211              L4=LP(IP,4)
0212              D=D+QASK0(IP)*E41
0213              GO TO 500
0214          490 CONTINUE
0215              IF (L4.EQ.0.OR.LJ.EQ.0.OR.L4.EQ.LJ) CALL PDUMP(LP(1,1),LP(10,9),5)
0216              D=D+LBJ*(P(3,IP)*FJ/LJ*(1./L4*(T-E41)-1./(L4-LJ)*(EJ1-E41))+QJ0(IP
                 1,J)*(1./(L4-LJ)*(EJ1-E41)))
0217          500 CONTINUE
0218              DOSE(IP)=FACTOR*D*E(IP,IB)/W(IB)
0219              IF (IB.LE.3) GO TO 680
0220              IF (IB.GE.10) GO TO 510
0221              DOSE(IP)=0.5*DOSE(IP)*EGI1(IP,IB-7)
0222              IF (IB.EQ.9) DOSE(IP)=DOSE(IP)*EGI(IP,1)
0223              GO TO 680
0224          510 DOSE(IP)=DOSE(IP)*(1.0-F1(IP))*TLI(IB-9)*EGI(IP,IB-7)
0225              GO TO 680
0226          520 LN=LON(IP,N)
0227              IF (LN.GT.0) GO TO 530
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FORTRAN IV G1  RELEASE 2.0              INHALE              DATE = 78357          22/51/58
0228                  DOSE(IP)=0.0
0229                  GO TO 680
0230              530 EN=ELON(IP,N,IY)
0231                  EN1=ETEST1(LN,T)
0232                  V8=(E81-EN1)/(LN-L8)
0233                  V9=(E91-EN1)/(LN-L9)
0234                  D=QN0(IP,N)*EN1
0235                  IF (MSPTAB(IP,N).EQ.0) GO TO 550
0236                  MP1=MSPTAB(IP,N)/10
0237                  MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0238                  DO 540 MP=MP1,MP2
0239                  CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0240              540 D=D+QN0M(MP)*ENM1
0241              550 DO 570 J=1,7
0242                  K=KFUNC(J)
0243                  LJ=LP(IP,J)
0244                  LBJ=LPB(ISOL,J)
0245                  EJ=ELP(IP,J,IY)
0246                  FJ=FP(ISOL,J)
0247                  EJ1=ETEST1(LJ,T)
              C       F1 FRACTION IS UNITY FOR PATHWAYS A,C,E
0248                  F1TRUE=F1(IP)
0249                  IF (MOD(J,2).GT.0.AND.J.LT.7) F1TRUE=1.0
0250                  D=D+LBJ*F2P(IP,N)*F1TRUE*(P(K,IP)*FJ/LJ*(1./LN*(T-EN1)-(EJ1-EN1)/(
                     1LN-LJ))+QJ0(IP,J)*(EJ1-EN1)/(LN-LJ))
0251                  IF (MSPTAB(IP,N).EQ.0) GO TO 570
0252                  DO 560 MP=MP1,MP2
0253                  CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0254              560 D=D+LBJ*F2PM(MP)*F1TRUE*(P(K,IP)*FJ/LJ*(1./LNM*(T-ENM1)-(EJ1-ENM1)
                     1/(LNM-LJ))+QJ0(IP,J)*(EJ1-ENM1)/(LNM-LJ))
0255              570 CONTINUE
0256                  IF (L8.NE.L9) GO TO 580
0257                  DL=LB9*F2P(IP,N)*(QI0(IP)/(LN-L9)*(E91-EN1)+LB8*F9*F8*P(3,IP)/L8*(
                     11./(L9*LN)*(T-EN1)-1./(L9*(LN-L9))*(E91-EN1)-(1./(LN-L9)**2)*((LN-
                     2L9)/(L9**2)*(1.0-E9-T*L9*E9)-E91+EN1))+LB8*F9*QJ0(IP,8)*((1.0/(LN-
                     3L9)**2)*((LN-L9)/(L9**2)*(1.0-E9-T*L9*E9)-E91+EN1)))
0258                  GO TO 590
0259              580 DL=QI0(IP)*V9
0260                  DL=DL+LB8*F9*P(3,IP)*F8/L8*(1./L9*((T-EN1)/LN-V9)-(V8-V9)/(L9-L8))
0261                  DL=DL+LB8*F9*QJ0(IP,8)*(V8-V9)/(L9-L8)
0262                  DL=LB9*F2P(IP,N)*DL
0263              590 IF (MSPTAB(IP,N).EQ.0) GO TO 620
0264                  DO 610 MP=MP1,MP2
0265                  CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0266                  DLM=0
0267                  IF (L8.NE.L9) GO TO 600
0268                  DL=LB9*F2PM(IP)*(QI0(IP)/(LNM-L9)*(E91-ENM1)+LB8*F9*F8*P(3,IP)/L8*
                     1(1./(L9*LNM)*(T-ENM1)-1./(L9*(LNM-L9))*(E91-ENM1)-(1./(LNM-L9)**2)
                     2*((LNM-L9)/(L9**2)*(1.0-E9-T*L9*E9)-E91+ENM1))+LB8*F9*QJ0(IP,8)*((
                     31.0/(LNM-L9)**2)*((LNM-L9)/(L9**2)*(1.0-E9-T*L9*E9)-E91+ENM1)))
0269                  GO TO 610
0270              600 DLM=QI0(IP)*V9
0271                  DLM=DLM+LB8*F9*P(3,IP)*F8/L8*(1./L9*((T-ENM1)/LNM-V9)-(V8-V9)/(L9-
                     1L8))
0272                  DLM=DLM+LB8*F9*QJ0(IP,8)*(V8-V9)/(L9-L8)
```

560 187

```
0273          DLM=LB9*F2PM(MP)*DLM
0274          DL=DL+DLM
0275      610 CONTINUE
0276      620 DOSE(IP)=(D+DL)*FACTOR*E(IP,IB)/W(IB)
0277          GO TO 680
     C
     C        CALCULATE LYMPH NODES DOSE
     C
0278      630 TI=(T-E91)/L9
0279          TE9I=(T*E9-E91)/L9
0280          ELR1=ETEST1(LR(IP),T)
     C
     C        NOTE THAT IT IS NOW NECESSARY TO EVALUATE THE FUNCTION:
     C
     C             TR = T/X - (1 - EXP(-X*T))/X**2    WHERE X=LR(IP)
     C
     C        WHICH IS INDETERMINATE FOR SMALL VALUES OF X*T.  BY POWER SERIES
     C        EXPANSION OF EXP(-X*T), THE FOLLOWING LIMIT IS FOUND:
     C
     C        TR=0.5*T*T(1 - XT/3 + (XT)**2/12 - (XT)**3/60 + (XT)**4/360 - ...)
     C
0281          XT=LR(IP)*T
0282          IF (XT.GT.(0.1)) GO TO 640
0283          TR=.5*T*T*(1.-XT/3.+(XT**2)/12.-(XT**3)/60.+(XT**4)/360.-(XT**5)/2
         1520.)
0284          GO TO 650
0285      640 TR=(T-ELR1)/LR(IP)
0286      650 TRH=(E81-ELR1)/(LR(IP)-L8)
0287          D=QI0(IP)*E91
0288          IF (L8.NE.L9) GO TO 660
0289          D=D+LB8*F9*(P(3,IP)*F8/L8*(TI+TE9I)-QJ0(IP,8)*TE9I)
0290          GO TO 670
0291      660 D=D+LB8*F9*(P(3,IP)*F8/L8*(TI-(E81-E91)/(L9-L8))+QJ0(IP,8)*(E81-E9
         11)/(L9-L8))
0292      670 D=D+QM0(IP)*ELR1+LB8*(1.-F9)*(P(3,IP)*F8/L8*(TR-TRH)+QJ0(IP,8)*TRH
         1)
0293          DOSE(IP)=D*FACTOR*E(IP,IB)/W(IB)
0294      680 CONTINUE
     C
     C        COMPUTE CURRENT QUANTITY OF RADIONUCLIDE IN APPROPRIATE PARTS
     C        OF MODEL (DETERMINED BY IB) IN CASE OF A CONTINUED INTEGRATION.
     C
0295          IF (IB.NE.2) GO TO 710
0296          DO 700 IP=1,NNUC
0297          ISOL=IPSOL(IP)
0298          DO 700 J=J1,J2,J3
0299          IF (J.LE.4) GO TO 700
     C
     C        QASK0(IP) IS CURRENT AMOUNT OF ADDITIONAL MATERIAL IN REGION TB
     C        THAT WAS REMOVED FROM THE PULMONARY REGION VIA PROCESSES F AND G
     C        TO THE GI TRACT.
     C
0300          IF (J.GT.5) GO TO 690
0301          L4=LP(IP,4)
0302          E41=ETEST1(L4,T)
```

FORTRAN IV G1 RELEASE 2.0 INHALE DATE = 78357 22/51/58

```
0303            E4=ELP(IP,4,IY)
0304            QASK0(IP)=QASK0(IP)*E4
0305            GO TO 700
0306        690 FJ=FP(ISOL,J)
0307            LJ=LP(IP,J)
0308            LBJ=LPB(ISOL,J)
0309            EJ=ELP(IP,J,IY)
0310            QASK0(IP)=QASK0(IP)+LBJ*P(3,IP)/LJ*FJ*(E41-(EJ-E4)/(L4-LJ))+LBJ*QJ
               10(IP,J)*(EJ-E4)/(L4-LJ)
0311        700 CONTINUE
0312        710 IF (IB.LE.3.OR.(IB.GE.8.AND.IB.LT.12)) GO TO 840
0313            DO 830 IP=1,NNUC
0314            ISOL=IPSOL(IP)
0315            L8=LP(IP,8)
0316            L9=LP(IP,9)
0317            LB8=LPB(ISOL,8)
0318            LB9=LPB(ISOL,9)
0319            E9=ELP(IP,9,IY)
0320            E8=ELP(IP,8,IY)
0321            F8=FP(ISOL,8)
0322            F9=FP(ISOL,9)
0323            IF (IB.EQ.12) GO TO 810
0324            EN=ELON(IP,N,IY)
0325            LN=LON(IP,N)
0326            IF (LN.GT.0) EN1=ETEST1(LN,T)
0327            IF (LN.LE.0) EN1=0.
0328            QN0(IP,N)=QN0(IP,N)*EN
0329            IF (MSPTAB(IP,N).EQ.0) GO TO 730
0330            MP1=MSPTAB(IP,N)/10
0331            MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0332            DO 720 MP=MP1,MP2
0333            CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0334        720 QN0M(MP)=QN0M(MP)*ENM
0335        730 DO 750 J=1,7
0336            K=KFUNC(J)
0337            LJ=LP(IP,J)
0338            LBJ=LPB(ISOL,J)
0339            EJ=ELP(IP,J,IY)
0340            FJ=FP(ISOL,J)
          C     F1 FRACTION IS UNITY FOR PATHWAYS A,C,E
0341            F1TRUE=F1(IP)
0342            IF (MOD(J,2).GT.0.AND.J.LT.7) F1TRUE=1.0
0343            QN0(IP,N)=QN0(IP,N)+LBJ*F2P(IP,N)*F1TRUE*(FJ*P(K,IP)/LJ*(EN1-(EJ-E
               1N)/(LN-LJ))+QJ0(IP,J)*(EJ-EN)/(LN-LJ))
0344            IF (MSPTAB(IP,N).EQ.0) GO TO 750
0345            DO 740 MP=MP1,MP2
0346            CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0347        740 QN0M(MP)=QN0M(MP)+LBJ*F2PM(MP)*F1TRUE*(FJ*P(K,IP)/LJ*(ENM1-(EJ-ENM
               1)/(LNM-LJ))+QJ0(IP,J)*(EJ-ENM)/(LNM-LJ))
0348        750 CONTINUE
0349            IF (L8.NE.L9) GO TO 760
0350            LIH=((LN-L9)*T*E9-E9+EN)/(LN-L9)**2
0351            GO TO 770
0352        760 LIH=1./(L9-L8)*((E8-EN)/(LN-L8)-(E9-EN)/(LN-L9))
0353        770 L=LB9*F2P(IP,N)*(QI0(IP)*(E9-EN)/(LN-L9)+LB8*F9*(F8*P(3,IP)/L8*(1.
```

```
                 1/L9*(EN1-(E9-EN)/(LN-L9))-LIH)+QJ0(IP,8)*LIH))
0354              QN0(IP,N)=QN0(IP,N)+L
0355              IF (MSPTAB(IP,N).EQ.0) GO TO 810
0356              IF (L8.EQ.L9) GO TO 790
0357              DO 780 MP=MP1,MP2
0358              CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0359              LIH=1./(L9-L8)*((E8-ENM)/(LNM-L8)-(E9-ENM)/(LNM-L9))
0360              L=LB9*F2PM(MP)*(QI0(IP)*(E9-ENM)/(LNM-L9)+LB8*F9*(F8*P(3,IP)/L8*(1
                 1./L9*(ENM1-(E9-ENM)/(LNM-L9))-LIH)+QJ0(IP,8)*LIH))
0361          780 QN0M(MP)=QN0M(MP)+L
0362              GO TO 810
0363          790 DO 800 MP=MP1,MP2
0364              CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0365              LIH=((LNM-L9)*T*E9-E9+ENM)/(LNM-L9)**2
0366              L=LB9*F2PM(MP)*(QI0(IP)*(E9-ENM)/(LNM-L9)+LB8*F9*(F8*P(3,IP)/L8*(1
                 1./L9*(ENM1-(E9-ENM)/(LNM-L9))-LIH)+QJ0(IP,8)*LIH))
0367          800 QN0M(MP)=QN0M(MP)+L
            C
            C     QI0 AND QM0 ARE CURRENT CONCENTRATIONS IN LYMPH AREAS I AND M
            C     FOR POLUTANT(IP)
            C
0368          810 ELR1=ETEST1(LR(IP),T)
0369              E91=ETEST1(L9,T)
0370              QM0(IP)=QM0(IP)*ELR(IP,IY)+LB8*(1.-F9)*P(3,IP)*F8/L8*(ELR1-(E8-ELR
                 1(IP,IY))/(LR(IP)-L8))+(1.-F9)*LB8*QJ0(IP,8)*(E8-ELR(IP,IY))/(LR(IP
                 2)-L8)
0371              IF (L8.NE.L9) GO TO 820
0372              QI0(IP)=QI0(IP)*E9+LB8*F9*F8*P(3,IP)/L9*(E91-T*E9)+LB8*F9*QJ0(IP,8
                 1)*T*E9
0373              GO TO 830
0374          820 QI0(IP)=QI0(IP)*E9+LB8*F9*F8*P(3,IP)/L8*(E91-(E8-E9)/(L9-L8))+LB8*
                 1F9*QJ0(IP,8)*(E8-E9)/(L9-L8)
0375          830 CONTINUE
0376          840 DO 850 IP=1,NNUC
0377              ISOL=IPSOL(IP)
0378              DO 850 J=J1,J2,J3
0379              K=KFUNC(J)
            C
            C     QJ0 IS CURRENT CONC IN RESPECTIVE PATHWAY(J) FOR POLUTANT(IP)
            C
0380          850 QJ0(IP,J)=QJ0(IP,J)*ELP(IP,J,IY)+P(K,IP)*FP(ISOL,J)*ETEST1(LP(IP,J
                 1),T)
            C
            C     CALCULATE DOSE RATE CURRENT AT END OF INTEGRATION PERIOD
            C
0381              DO 930 IP=1,NNUC
0382              IF (IB.GT.3.AND.IB.LT.8) GO TO 890
0383              IF (IB.EQ.12) GO TO 910
0384              IF (IB.NE.2) GO TO 860
0385              J2=4
0386              DR(IP)=QASK0(IP)
0387              GO TO 870
0388          860 DR(IP)=0.
0389          870 DO 880 J=J1,J2,J3
0390          880 DR(IP)=DR(IP)+QJ0(IP,J)
```

FORTRAN IV G1 RELEASE 2.0 INHALE DATE = 78357 22/51/58

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0391          GO TO 920
0392      890 DR(IP)=QNO(IP,IB-3)
0393          IF (MSPTAB(IP,IB-3).EQ.0) GO TO 920
0394          MP1=MSPTAB(IP,N)/10
0395          MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0396          DO 900 MP=MP1,MP2
0397      900 DR(IP)=DR(IP)+QNOM(MP)
0398          GO TO 920
0399      910 DR(IP)=QIO(IP)+QMO(IP)
0400      920 DR(IP)=DR(IP)*FACTOR*E(IP,IB)/W(IB)
0401          IF (IB.GT.7.AND.IB.LT.12) DR(IP)=DR(IP)/2.
0402      930 CONTINUE
0403          GO TO 1020
        C
        C     COMMENCE MAIN PORTION OF INGESTION CALCULATIONS
        C
0404      940 IF (ICPT.GT.0) GO TO 970
0405          DO 960 IP=1,NNUC
0406          LN=LON(IP,N)
0407          IF (LN.GT.0) EN1=ETEST1(LN,T0)
0408          IF (LN.LE.0) EN1=0.
0409          D1=P(1,IP)*F1(IP)
0410          QNO(IP,N)=D1*F2P(IP,N)*EN1
0411          IF (MSPTAB(IP,N).EQ.0) GO TO 960
0412          MP1=MSPTAB(IP,N)/10
0413          MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0414          DO 950 MP=MP1,MP2
0415          CALL MSPSET (MP,IY0,T0,LNM,ENM,ENM1)
0416      950 QNOM(MP)=D1*F2PM(MP)*ENM1
0417      960 CONTINUE
0418      970 DO 1010 IP=1,NNUC
0419          LN=LON(IP,N)
0420          IF (LN.GT.0) GO TO 980
0421          DOSE(IP)=0.0
0422          DR(IP)=0.0
0423          GO TO 1010
0424      980 EN=ELON(IP,N,IY)
0425          EN1=ETEST1(LN,T)
0426          D1=P(1,IP)*F1(IP)
0427          D=QNO(IP,N)*EN1+D1*F2P(IP,N)*(T-EN1)/LN
0428          QNO(IP,N)=QNO(IP,N)*EN+D1*F2P(IP,N)*EN1
0429          DM=0.0
0430          DRM=0.0
0431          IF (MSPTAB(IP,N).EQ.0) GO TO 1000
0432          MP1=MSPTAB(IP,N)/10
0433          MP2=MOD(MSPTAB(IP,N),10)+MP1-1
0434          DO 990 MP=MP1,MP2
0435          CALL MSPSET (MP,IY,T,LNM,ENM,ENM1)
0436          DM=DM+QNOM(MP)*ENM1+D1*F2PM(MP)*(T-ENM1)/LNM
0437          QNOM(MP)=QNOM(MP)*ENM+D1*F2PM(MP)*ENM1
0438      990 DRM=DRM+QNOM(MP)
0439     1000 DOSE(IP)=FACTOR*(D+DM)*E(IP,IB)/W(IB)
0440          DR(IP)=FACTOR*(QNO(IP,N)+DRM)*E(IP,IB)/W(IB)
0441     1010 CONTINUE
        C
0442     1020 RETURN
        C
        C
0443     1030 FORMAT(1H0,'CURRENT BODY PART =',I3,' AND PREVIOUS VALUE =',I3,
             1    ' MUST AGREE FOR A CONTINUED INTEGRATION.  ERROR EXIT.')
0444     1040 FORMAT(1H0,'STARTING YEAR =',F6.1,
             1    ' MUST AGREE WITH PREVIOUS ENDING =',F6.1,
             2    ' FOR A CONTINUED INTEGRATION.  ERROR EXIT.')
0445     1050 FORMAT(1H0,'INVALID T0 =',F6.1,' OR T = ',F6.1)
0446     1060 FORMAT(1H0,'BODY PART INDEX IB =',I4,' IS INVALID')
0447          END
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FORTRAN IV G1  RELEASE 2.0              BLK DATA           DATE = 78357          22/51/58

0001                    BLOCK DATA
0002                    IMPLICIT REAL*4 (L)
0003                    COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                       1  IPSOL(10),NNUC,MSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0004                    COMMON/INHAL2/LPB(3,9),FP(3,9),TGI(4),TLI(2),EGI(10,4),EGI1(10,4),
                       1  LP(10,9),LSI(10),MPMAX,NCALL,MPEND
0005                    DATA E/43.,49.,48.,110.,0.61,55.,4*0.,
                       1       43.,49.,48.,110.,0.48,55.,4*0.,
                       2       43.,49.,48.,110.,8.26,55.,4*0.,
                       3       43.,49.,48.,110.,5.2,55.,4*0.,
                       4       220.,240.,240.,110.,29.,280.,4*0.,
                       5       43.,49.,48.,110.,10.,55.,4*0.,
                       6       43.,49.,48.,110.,10.,55.,4*0.,
                       7       0.43,0.48,0.47,0.48,0.027,0.53,4*0.,
                       8       0.43,0.49,0.47,0.48,0.045,0.53,4*0.,
                       9       0.43,0.48,0.47,0.48,0.019,0.53,4*0.,
                       X       0.43,0.48,0.47,0.48,0.019,0.53,4*0.,
                       X       43.,49.,48.,110.,25.,55.,4*0./
                  C
                  C     NOTE THAT ALL LAMBDA DECAY CONSTANTS (LPB,LON,LR) ARE ACTUALLY
                  C     INPUT AS HALF-LIFE VALUES IN DAYS AND ARE CONVERTED TO DECAY
                  C     CONSTANTS IN SUBROUTINE INITEX.
                  C
0006                    DATA LPB/
                       1  3*0.01,
                       2  2*0.4,0.01,
                       3  3*0.01,
                       4  3*0.2,
                       5  500.0,50.0,0.5,
                       6  2*1.0,1.0E-50,
                       7  500.0,50.0,1.0E-50,
                       8  500.0,50.0,0.5,
                       9  1000.0,50.0,0.5/
0007                    DATA LON/100.,100.,5.7E4,0.398,1200.,25.,4*0.,
                       1         300.,300.,7.3E4,0.398,2400.,20.,4*0.,
                       2         15.0,15.0,2.2E4,10.,494.,46.,4*0.,
                       3          0.0, 0.0,5.7E4,10.,1500.,32.,4*0./
0008                    DATA LONM/4.95,57.75,693.,5330.8,
                       1         4.95,57.75,693.,5330.8,8*0.0/
0009                    DATA LR/1.6E12,9.1E7,2.9E7,5.9E5,7.1E3,138.4,4*0./
0010                    DATA FP/
                       1  0.01,0.1,0.5,
                       2  0.99,0.9,0.5,
                       3  0.01,0.5,0.95,
                       4  0.99,0.5,0.05,
                       5  0.05,0.15,0.8,
                       6  0.4,0.4,0.0,
                       7  0.4,0.4,0.0,
                       8  0.15,0.05,0.2,
                       9  0.9,1.0,1.0/
0011                    DATA F1/2*1.E-2,1.E-4,0.3,0.08,0.06,4*0./
0012                    DATA F2P/3*1.0,0.54,2*1.0,4*0.,
                       1        2*0.11,0.7,0.54,0.28,0.1,4*0.,
                       2        2*0.11,0.05,0.002,0.14,0.07,4*0.,
                       3        2*0.,0.05,0.0004,0.08,0.17,4*0./
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560 192

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FORTRAN IV G1  RELEASE 2.0            BLK DATA          DATE = 78357          22/51/58

 0013                  DATA F2PM/0.29,0.11,0.04,0.02,
                      1          0.29,0.11,0.04,0.02,8*0.0/
 0014                  DATA MSPTAB/3*0,14,6*0,
                      1            3*0,54,6*0,20*0/
 0015                  DATA IPSOL/3*1,3*2,4*0/
 0016                  DATA NNUC/6/
 0017                  DATA MPMAX/16/
 0018                  DATA NCALL/0/
                 C
                 C     TGI AND TLI ARE INPUT AS HOURS
                 C
 0019                  DATA TGI/1.0,4.0,5.0,13.0/
 0020                  DATA TLI/8.0,18.0/
 0021                  END
```

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FORTRAN IV G1  RELEASE 2.0             INITEX             DATE = 78357          22/51/58

 0001                 SUBROUTINE INITEX
                C
                C     SUBROUTINE TO CONVERT INPUT HALF-LIFE VALUES TO DECAY CONSTANTS.
                C
 0002                 IMPLICIT REAL*4 (L)
 0003                 REAL*8 ETEST1
 0004                 COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                     1   IPSOL(10),NNUC,MSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
 0005                 COMMON/INHAL2/LPB(3,9),FP(3,9),TGI(4),TLI(2),EGI(10,4),EGI1(10,4),
                     1   LP(10,9),LSI(10),MPMAX,NCALL,MPEND
 0006                 LN2=ALOG(2.)
 0007                 F=LN2*365.25
                C
                C     EVALUATE GI TRACT EXPONENTIALS.  FIRST CONVERT HALF-LIFE DATA
                C     READ IN AS DAYS TO LAMBDA IN RECIPROCAL YEARS.  NOTE THAT A
                C     SPECIAL CALCULATION IS NEEDED FOR LAMBDA OF THE SMALL INTESTINE;
                C     IN ALL OTHER CASES, THE RADIOACTIVE DECAY CONSTANT IS USED.
                C
 0008                 FACT=24.*365.25
 0009                 DO 10 IP=1,NNUC
 0010                 LR(IP)=F/LR(IP)
                C
                C     NOTE THAT CONVERSION FROM HOURS TO YEARS NEEDED FOR TGI & TLI
                C
 0011              10 LSI(IP)=FACT/TGI(2)*ALOG(1.0/(1.0-F1(IP)))+LR(IP)
 0012                 DO 20 J=1,4
 0013                 T=TGI(J)/FACT
 0014                 IF (J.GT.2) TLI(J-2)=TLI(J-2)/FACT
 0015                 DO 20 IP=1,NNUC
 0016                 LGI=LR(IP)
 0017                 IF (J.EQ.2) LGI=LSI(IP)
 0018                 EGI(IP,J)=ETEST(LGI,T)
 0019              20 EGI1(IP,J)=ETEST1(LGI,T)
                C
                C     CONVERT INPUT HALF-LIFE DAYS TO LAMBDA IN RECIPROCAL YEARS
                C     FOR BIOLOGICAL REMOVAL CONSTANT (LPB) AND EFFECTIVE ORGAN
                C     DECAY CONSTANT (LON).
                C
 0020                 DO 30 J=1,9
 0021                 DO 30 ISOL=1,3
 0022              30 LPB(ISOL,J)=F/LPB(ISOL,J)
 0023                 DO 40 N=1,4
 0024                 DO 40 IP=1,NNUC
 0025                 IF (LON(IP,N).EQ.0.) GO TO 40
 0026                 LON(IP,N)=F/LON(IP,N)
 0027              40 CONTINUE
                C
                C     SEARCH BACKWARDS THRU LONM FOR 1ST NON-ZERO VALUE.  THIS MARKS
                C     THE END OF ACTUAL MULTIPLE SUBPATH DATA IN USE.
                C
 0028                 DO 45 J=1,MPMAX
 0029                 J1=MPMAX+1-J
 0030                 IF (LONM(J1).GT.0.) GO TO 47
 0031              45 CONTINUE
 0032                 J1=0
```

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FORTRAN IV G1  RELEASE 2.0            INITEX           DATE = 78357         22/51/58

0033              47 MPEND=J1
0034                 IF (MPEND.EQ.0) GO TO 55
0035                 DO 50 J=1,MPEND
0036              50 LONM(J)=F/LONM(J)
               C
               C     CALCULATE EFFECTIVE DECAY CONSTANT (LP) FOR EACH PATHWAY:
               C     LP=LPB + LR
               C
0037              55 DO 60 IP=1,NNUC
0038                 ISOL=IPSOL(IP)
0039                 DO 60 J=1,9
0040              60 LP(IP,J)=LPB(ISOL,J)+LR(IP)
0041                 NCALL=1
0042                 RETURN
0043                 END
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FORTRAN IV G1  RELEASE 2.0            ECALC            DATE = 78357         22/51/58

0001                 SUBROUTINE ECALC (IY,T)
               C
               C     SUBROUTINE TO EVALUATE AND SAVE EXPONENTIALS USED BY INHALE
               C
0002                 COMMON/INHAL1/E(10,12),LON(10,4),LR(10),F1(10),F2P(10,4),
                    1   IPSOL(10),NNUC,MSPTAB(10,4),F2PM(16),LONM(16),QNOM(16)
0003                 COMMON/INHAL2/LPB(3,9),FP(3,9),TGI(4),TLI(2),EGI(10,4),EGI1(10,4),
                    1   LP(10,9),LSI(10),MPMAX,NCALL,MPEND
0004                 COMMON/INHAL3/ELP(10,9,20),ELON(10,4,20),ELR(10,20),ELONM(320)
0005                 DO 20 IP=1,NNUC
0006                 ELR(IP,IY)=ETEST(LR(IP),T)
0007                 DO 10 N=1,4
0008              10 ELON(IP,N,IY)=ETEST(LON(IP,N),T)
0009                 DO 20 J=1,9
0010              20 ELP(IP,J,IY)=ETEST(LP(IP,J),T)
0011                 DO 30 J=1,MPEND
0012              30 ELONM((J-1)*20+IY)=ETEST(LONM(J),T)
0013                 RETURN
0014                 END
```

```
FORTRAN IV G1  RELEASE 2.0            ETEST            DATE = 78357         22/51/58

0001                   FUNCTION ETEST (LAMB,T)
                C
                C      FUNCTION TO TEST FOR EXPONENTIAL OVERFLOW BEFORE EVALUATION OF
                C      EXP(-LAMB*T) AND TO RETURN EITHER THE EXPRESSION VALUE OR ZERO
                C      IF LAMB*T>150, WHICH WOULD PRODUCE A VALUE < 0.72E-65.
                C
0002                   REAL*4 LAMB
0003                   Q=LAMB*T
0004                   IF (Q.LT.150.) GO TO 10
0005                   ETEST=0.
0006                   RETURN
0007                10 ETEST=EXP(-Q)
0008                   RETURN
0009                   END
```

```
FORTRAN IV G1  RELEASE 2.0            ETEST1           DATE = 78357         22/51/58

0001                   FUNCTION ETEST1 (X,T)
                C
                C      FUNCTION TO EVALUATE EXPRESSION:  (1-EXP(-X*T))/X
                C      IN THE CASE OF SMALL VALUES OF X*T, DIRECT EVALUATION GIVES THE
                C      INACCURATE VALUE 0.0; HOWEVER, A MORE ACCURATE RESULT IS READILY
                C      OBTAINED BY POWER SERIES EXPANSION OF EXP(-X*T), I.E.:
                C      ETEST1= T*(1.0 - X*T/2 + (X*T)**2/6 - (X*T)**3/24 +...)
                C
0002                   REAL*8 ETEST1,DX,DT,DXT
0003                   DX=X
0004                   DT=T
0005                   DXT=DX*DT
                C
                C      REPEAT TEST MADE BY FUNCTION ETEST
                C
0006                   IF (DXT.GE.(1.73D2)) GO TO 20
0007                   IF (DXT.LT.(1.0D-5)) GO TO 10
0008                   ETEST1=(1.0D0-DEXP(-DXT))/DX
0009                   RETURN
0010                10 ETEST1=DT*(1.D0-DXT/2.D0+DXT**2/6.D0-DXT**3/2.4D1)
0011                   RETURN
0012                20 ETEST1=1.0D0/DX
0013                   RETURN
0014                   END
```

FORTRAN IV G1 RELEASE 2.0 KFUNC DATE = 78357 22/51/58

```
0001              FUNCTION KFUNC (J)
           C
           C      FUNCTION SUBROUTINE THAT RETURNS VALUE OF 1,2,3 CORRESPONDING
           C      TO SUBCOMPARTMENT OF RESPIRATORY TRACT MODEL
           C
0002              KFUNC=2
0003              IF (J.LE.2) KFUNC=1
0004              IF (J.GE.5) KFUNC=3
0005              RETURN
0006              END
```

FORTRAN IV G1 RELEASE 2.0 MSPSET DATE = 78357 22/51/58

```
0001              SUBROUTINE MSPSET (MP,JY,YEAR,LNM,ENM,ENM1)
           C
           C      SUBROUTINE TO EVALUATE QUANTITES NEEDED FOR MULTIPLE SUBPATH
           C      CALCULATIONS
           C
 002              IMPLICIT REAL*4 (L)
 003              COMMON/INHAL1/E( 10,12),LON( 10,4),LR( 10),F1( 10),F2P( 10,4),
                 1   IPSOL( 10),NNUC,MSPTAB( 10,4),F2PM( 16),LONM( 16),QNOM( 16)
0004              COMMON/INHAL2/LPB(3,9),FP(3,9),TGI(4),TLI(2),EGI( 10,4),EGI1( 10,4),
                 1   LP( 10,9),LSI( 10),MPMAX,NCALL,MPEND
0005              COMMON/INHAL3/ELP( 10,9,20),ELON( 10,4,20),ELR( 10,20),ELONM( 320)
0006              LNM=LONM(MP)
0007              ENM=ELONM((MP-1)*20+JY)
0008              ENM1=ETEST1(LNM,YEAR)
0009              RETURN
0010              END
```

```
FORTRAN IV G1  RELEASE 2.0            FRACT             DATE = 78357          22/51/58

0001                 SUBROUTINE FRACT (U,UD,DM)
               C
               C     SUBROUTINE TO CALCULATE FRACTION OF INHALATED MATERIAL DEPOSITED
               C     IN THE 3 SUBCOMPARTMENTS OF THE LUNG MODEL AS A FUNCTION OF
               C     PARTICLE SIZE.
               C
               C     CALCULATION BASED ON LINEAR DEPENDENCE OF THE PROBABILITY OF
               C     PARTICLE DEPOSITION VS. LOG OF PARTICLE SIZE AS OBSERVED BY THE
               C     TASK GROUP ON LUNG DEPOSITION.  A LEAST SQUARES FIT WAS MADE TO
               C     THEIR DATA TO OBTAIN EMPIRICAL PARAMETERS FOR THE NASOPHARYNGEAL
               C     & PULMONARY SUBCOMPARTMENTS.  FOR THE TRACHEOBRONCHIAL A CONSTANT
               C     DEPOSITION FRACTION OF 0.08 IS ASSUMED.
               C
               C     NOTE THAT THE SUM OF FRACTIONS DEPOSITED WILL EXCEED ONE FOR
               C     PARTICLE SIZES > 7.  WHEN THIS OCCURS, ALL COMPARTMENT FRACTIONS
               C     ARE NORMALIZED SO THAT THE SUM WILL BE 1.0.
               C
               C     ARGUMENTS:
               C        U  -  INPUT AERODYNAMIC EQUIVALENT PARTICLE DIAMETER IN MICRONS
               C
               C       UD  -  INPUT PARTICLE DENSITY IN G/CM3
               C
               C       DM  -  RETURNED FRACTIONS DEPOSITED IN NASOPHARYNGEAL,
               C              TRACHEOBRONCHIAL, AND PULMONARY SUBCOMPARMENTS.
               C
               C*********************************************************************
               C
0002                 DIMENSION DM(3),A(2),B(2)
0003                 DATA C/0.7071068/,A/-0.51015,-0.68804/,B/1.81355,-0.73032/
0004                 X=ALOG10(U*SQRT(UD))
0005                 DO 50 K=1,3
0006                 IF (K-2) 10,40,20
0007              10 J=1
0008                 GO TO 30
0009              20 J=2
0010              30 Y=A(J)+B(J)*X
               C
               C     QUANTITY DESIRED IS THE INTEGRAL OF THE NORMAL PROBABILITY
               C     FUNCTION FROM MINUS INFINITY TO Y.  THIS IS RELATED TO THE NORMAL
               C     ERROR FUNCTION, ERF, AS FOLLOWS:
               C
0011                 DM(K)=(1.0+ERF(Y*C))/2.0
0012                 GO TO 50
0013              40 DM(K)=0.08
0014              50 CONTINUE
0015                 T=DM(1)+DM(2)+DM(3)
0016                 IF (T.LE.1.0) RETURN
               C
               C     NORMALIZE COMPARTMENT FRACTIONS SO THAT TOTAL WILL BE 1.0
               C
0017                 DO 60 K=1,3
0018              60 DM(K)=DM(K)/T
0019                 RETURN
0020                 END
```

```
LEVEL 21.7 ( JAN 73 )                              OS/360  FORTRAN H

        COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
               C ***
               C      CONCPLOT  -  PROGRAMMED BY A. ZIELEN (3/23/77,11/11/77,5/11/78)
               C
               C      PROGRAM TO PREPARE CONCENTRATION IN AIR AND ON GROUND VS.
               C      DISTANCE PLOTS FROM DATA GENERATED BY UDAD5 PROGRAM.  PROGRAM
               C      ALSO PREPARES A WORKING LEVEL VS. DISTANCE PLOT.
               C
               C      INPUT DATA FOR CONCENTRATION PLOTS ARE THE ARRAYS TCNGC(I,M,L)
               C      FOR CLOUD AND TCNGO(I,M,L) FOR GROUND.  THE ACTUAL DIMENSION OF
               C      THESE ARRAYS IS TCNGC(5,300) AND TCNGO(5,300), AND THE 1ST 240
               C      POINTS FOR EACH POLUTANT FOLLOW THE M,L DISTRIBUTION GIVEN BELOW.
               C
               C      I = POLUTANT (U238,TH230,RA226,PB210,PO210)
               C      M = NORMAL KM DISTANCE  (.1,.5,1,2,3,4,5,10,20,30,40,50,60,70,80)
               C      L = ANGLE (0,22.5,45,67.5,90,112.5,135,157.5,180,202.5,225,247.5,
               C          270,292.5,315,337.5).
               C
               C      RN222 DATA (IN CLOUD ONLY) ARE OBTAINED FROM ARRAY RN(300), WHICH
               C      IS ACTUALLY ARRANGED IN CORE AS RN(M,L).   SIMILARLY, WORKING
               C      LEVEL DATA ARE OBTAINED FROM THE ARRAY WL(300).
               C
               C ***
  ISN 0002            INTEGER REGION(6),TITLE1(10),TITLE2(7),YLABEL(13,2),BLANK(20),
                     1   XLABEL(5)
  ISN 0003            LOGICAL*1 SITE(28)
  ISN 0004            DIMENSION TCNGC(5,300),TCNGO(5,300),RN(300),WL(300),LOC(7),
                     1   NUKE(3,6),XRHO(15),Y(15),IPA(50),BUF(1800,2)
  ISN 0005            EQUIVALENCE (BUF(1,1),TCNGC(1,1)),(BUF(1501,1),RN(1)),
                     1   (BUF(1,2),TCNGO(1,1)),(BUF(1501,2),WL(1)),
                     2   (LOC(1),SITE(1),REGION(1))
  ISN 0006            DATA TITLE1/'(C)O','NCEN','TRAT','ION:',' !EH','0.8)','238!',
                     1              'EXHX','(U)$','    '/
  ISN 0007            DATA TITLE2/'  !E','0.5)','(W)O','RKIN','G (L',')EVE','L$  '/
  ISN 0008            DATA YLABEL/'  !E','0.5)','(I)N',' AIR',' (()','P(C)','I/M!',
                     1              'EH0.','8)3!','EXHX',')!E.','5))$','    ',
                     2              '  !E','0.5)','(O)N',' GRO','UND ','(()P','(C)I',
                     3              '/M!E','H0.8',')2!E','XHX)','!E.5','))$ '/
  ISN 0009            DATA XLABEL/'(D)I','STAN','CE (','()KM',')$  '/
  ISN 0010            DATA NUKE/'238!','(U)$','    ',
                     1            '230!','(T)H','$   ',
                     2            '226!','(R)A','$   ',
                     3            '210!','(P)B','$   ',
                     4            '210!','(P)O','$   ',
                     5            '222!','(R)N','$   '/
  ISN 0011            DATA BLANK/20*'    '/
               C ***
               C      INPUT UDAD DATA
               C ***
  ISN 0012            READ (8) REGION,XRHO,IMX,TCNGC,TCNGO,RN,WL
               C ***
               C      SEARCH NAME OF SITE, FIND END, ENCLOSE IN (), END WITH $.
               C ***
  ISN 0013            DO 10 I=1,24
```

```
ISN 0014          J=25-I
ISN 0015          IF (SITE(J).NE.64) GO TO 20
ISN 0017       10 CONTINUE
ISN 0018          PRINT 230
ISN 0019          GO TO 220
ISN 0020       20 SITE(J+3)=91
ISN 0021          SITE(J+2)=93
ISN 0022          DO 30 I=1,J
ISN 0023          J1=J+1-I
ISN 0024       30 SITE(J1+1)=SITE(J1)
ISN 0025          SITE(1)=77
            C ***
            C     FILL REMAINING LOCATIONS WITH BLANKS
            C ***
ISN 0026          J1=J+4
ISN 0027          DO 35 I=J1,28
ISN 0028       35 SITE(I)=64
            C ***
            C     IMX IS THE INDEX(1-16) OF THE ANGLE FOR MAX DISPERSION
            C ***
ISN 0029          TMAX=22.5*FLOAT(IMX-1)
ISN 0030          ITMAX=TMAX
ISN 0031          PRINT 240, LOC,IMX,IMX,TMAX
            C ***
            C     START ACTUAL PLOT ROUTINE
            C ***
ISN 0032          CALL STRTPL
ISN 0033          CALL BGNPL (-1)
ISN 0034          CALL SCMPLX
ISN 0035          CALL BASALF ('L/CSTD')
ISN 0036          CALL MIXALF ('STAND')
ISN 0037          CALL MX3ALF ('L/CGR','*')
ISN 0038          CALL MX5ALF ('INSTR','!')
ISN 0039          CALL NOBRDR
ISN 0040          CALL SPLINE
ISN 0041          J=LINEST(IPA,50,4)
ISN 0042          CALL LINES ('*Q)$',IPA,1)
ISN 0043          CALL LINES ('(N)$',IPA,2)
ISN 0044          CALL LINES ('(E)$',IPA,3)
ISN 0045          CALL LINES ('(S)$',IPA,4)
ISN 0046          CALL LINES ('(W)$',IPA,5)
ISN 0047          XL=3.6
ISN 0048          YL=4.0
ISN 0049          YL1=YL-0.375
ISN 0050          CALL LOGSCL (XRHO(1),XRHO(15),XORG,XCYCLE,XL)
ISN 0051          IXTOTL=INT(XL/XCYCLE+0.5)
            C
            C     FOLLOWING ADJUSMENT TO XCYCLE NEEEDED BECAUSE LOGSCL ALWAYS ADDS
            C     AN EXTRA CYCLE TO ALLOW FOR LEGENDS, STORIES, ETC.
            C
ISN 0052          XCYCLE=XL/FLOAT(IXTOTL-1)
ISN 0053          LAP=0
ISN 0054          DO 210 KASE=1,2
            C ***
            C     KASE=1 FOR CLOUD CONCENTRATION (INCLUDING RADON)
```

```
                C      KASE=2 FOR GROUND CONCENTRATION (NO RADON) & WORKING LEVEL
                C ***
ISN 0055               DO 210 I=1,6
ISN 0056               IF (I.LT.6) Y1=BUF(I,KASE)
ISN 0058               IF (I.EQ.6) Y1=BUF(1501,KASE)
ISN 0060               IF (Y1.LE.0.0) GO TO 210
ISN 0062               IF (I.EQ.6.AND.KASE.EQ.2) GO TO 50
ISN 0064               DO 40 N=1,3
ISN 0065               N1=N+6
ISN 0066               IF (N.GT.1) N1=N+1
ISN 0068            40 TITLE1(N1)=NUKE(N,I)
ISN 0069            50 IF (MOD(LAP,2).EQ.0) CALL PHYSOR (1.4,2.1)
ISN 0071               IF (MOD(LAP,2).GT.0) CALL PHYSOR (6.5,2.1)
ISN 0073               YMIN=1.E75
ISN 0074               YMAX=-1.E75
ISN 0075               IF (I.EQ.6.AND.KASE.EQ.2) GO TO 60
ISN 0077               CALL TITLE (TITLE1,-100,XLABEL,100,YLABEL(1,KASE),100,XL,YL)
ISN 0078               GO TO 70
ISN 0079            60 CALL TITLE (TITLE2,-100,XLABEL,100,TITLE2,100,XL,YL)
                C ***
                C      SEARCH FOR MIN AND MAX ORDINATE VALUES TO SCALE PLOT
                C ***
ISN 0080            70 DO 110 L1=1,5
ISN 0081               IF (L1.GT.1) GO TO 80
ISN 0083               IF (MOD(IMX-1,4).EQ.0) GO TO 110
ISN 0085               L=IMX
ISN 0086               GO TO 90
ISN 0087            80 L=(L1-2)*4+1
ISN 0088            90 DO 100 M=1,15
ISN 0089               IF (I.LT.6) K=(L-1)*75+(M-1)*5+I
ISN 0091               IF (I.EQ.6) K=1500+(L-1)*15+M
ISN 0093               YMIN=AMIN1(YMIN,BUF(K,KASE))
ISN 0094           100 YMAX=AMAX1(YMAX,BUF(K,KASE))
ISN 0095           110 CONTINUE
                C
                C      FOLLOWING CODE ADDED TO LIMIT THE NUMBER OF LOG CYCLES.  IF
                C      THERE ARE TOO MANY, DISSPLA WILL NOT GENERATE A PLOT AND NO
                C      ERROR MESSAGE IS PRODUCED.
                C
ISN 0096               Y1=ALOG10(YMIN)
ISN 0097               Y2=ALOG10(YMAX)
ISN 0098               IF ((Y2-Y1).LE.7.) GO TO 120
ISN 0100               YMIN=EXP(2.302585*(Y2-7.))
ISN 0101           120 CALL LOGSCL (YMIN,YMAX,YORG,YCYCLE,YL)
ISN 0102               IYTOTL=1+INT(YL/YCYCLE+0.5)
ISN 0103               CALL LOGLOG (XORG,XCYCLE,YORG,YCYCLE)
ISN 0104               CALL RESET ('BLNK1')
ISN 0105               CALL MESSAG (LOC,100,0.2,3.7)
ISN 0106               CALL BLNK1 (0.0,XL,YL1,YL,0)
ISN 0107               CALL BLNK2 (0.1,1.35,0.1,1.75,1)
ISN 0108               ISYM=-2
ISN 0109               DO 180 L1=1,5
ISN 0110               ISYM=ISYM+2
ISN 0111               CALL MARKER (ISYM)
ISN 0112               IF (L1.GT.1) GO TO 130
```

```
      ISN 0114            L=IMX
      ISN 0115            GO TO 140
      ISN 0116        130 L=(L1-2)*4+1
      ISN 0117        140 DO 150 M=1,15
      ISN 0118            IF (I.LT.6) K=(L-1)*75+(M-1)*5+I
      ISN 0120            IF (I.EQ.6) K=1500+(L-1)*15+M
      ISN 0122        150 Y(M)=BUF(K,KASE)
      ISN 0123            DO 160 M=1,15
      ISN 0124            MMAX=16-M
      ISN 0125            IF (Y(MMAX).GE.YMIN) GO TO 170
      ISN 0127        160 CONTINUE
      ISN 0128            GO TO 180
      ISN 0129        170 CALL CURVE (XRHO,Y,MMAX,1)
      ISN 0130        180 CONTINUE
      ISN 0131            CALL RESET ('BLNK2')
      ISN 0132            IF (MOD(IMX,2).EQ.0) GO TO 190
      ISN 0134            CALL MESSAG ('*Q) = $',100,0.2,1.5)
      ISN 0135            CALL INTNO (ITMAX,'ABUT','ABUT')
      ISN 0136            GO TO 200
      ISN 0137        190 CALL MESSAG ('*Q) =$',100,0.2,1.5)
      ISN 0138            CALL REALNO (TMAX,1,'ABUT','ABUT')
      ISN 0139        200 CALL LEGEND (IPA,5,0.45,0.2)
      ISN 0140            CALL XLBAXS (BLANK,1,IXTOTL,XL,' ',-1,0.,YL)
      ISN 0141            CALL YLBAXS (BLANK,1,IYTOTL,YL,' ',-1,XL,0.)
      ISN 0142            IF (MOD(LAP,2).EQ.0) CALL ENDGR (-1)
      ISN 0144            IF (MOD(LAP,2).GT.0) CALL ENDPL (0)
      ISN 0146            LAP=LAP+1
      ISN 0147        210 CONTINUE
      ISN 0148            IF (MOD(LAP,2).GT.0) CALL ENDPL(0)
      ISN 0150            CALL DONEPL
      ISN 0151        220 STOP
                    C
                    C
                    C
      ISN 0152        230 FORMAT (1H0,'REGION ARRAY ALL BLANKS')
      ISN 0153        240 FORMAT(1H1,7A4,4X,'IMX =',I3,4X,'THETA(',I2,') =',F6.1)
      ISN 0154            END

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=00,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      153 ,PROGRAM SIZE =     19394

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                   81K BYTES OF CORE NOT USED
```

PL/I OPTIMIZING COMPILER   CONTOUR: PROC OPTIONS(MAIN);

SOURCE LISTING

```
STMT LEV NT

   1      0  CONTOUR: PROC OPTIONS(MAIN);
             /* PROCEDURE TO USE FT09F001 FILE FROM UDAD5 TO SELECT DATA AND       */
             /* GENERATE AN EXECUTION DECK FOR THE BLACKBOX ISOPLETH PLOT          */
             /* PROGRAM (A. ZIELEN, 4/12/78).                                      */
   2   1  0          DCL INDATA FILE SEQUENTIAL RECORD INPUT;
   3   1  0          DCL (OUTDATA,BLKBOX) FILE SEQUENTIAL RECORD OUTPUT;
   4   1  0          DCL BUF CHAR(80);
   5   1  0          DCL ORGAN1(5) CHAR(6)
                       INITIAL('BODY  ','BONE  ','LUNG  ','KIDNEY','LIVER ');
   6   1  0          DCL NUKE1(7) CHAR(5) INITIAL('U238 ','U234 ','TH230',
                       'RA226','PB210','PO210','RN222');
   7   1  0          DCL ORGAN CHAR(6);
   8   1  0          DCL NUKE(7) CHAR(5);
   9   1  0          DCL MAP(5,7) BIT(1);
             /* MAP(I,J) IS THE BIT MAP TO REGULATE OUTPUT:                        */
             /*   I = 1: BODY, = 2: BONE, = 3: LUNG, = 4: KIDNEY, = 5: LIVER       */
             /*   J = 1,2,3,4,5,6,7 FOR U238,U234,TH230,RA226,PB210,PO210,RN222    */
             /*   IN ALL CASES: 0 IF NOT ACTIVE, 1 IF ACTIVE                       */
  10   1  0          DCL (FLAG,FLAG1,FLAG2) BIT(1);
  11   1  0          DCL TEMP CHAR(80) VAR;
  12   1  0          DCL WORK(300) CHAR(80);
  13   1  0          DCL REGION CHAR(24);
  14   1  0          DCL I,I1,I2,J,J1,K,K1,KMAX,L,M,IADD,IFIT;
  15   1  0          DCL FORM(7) CHAR(12) INITIAL('F7.0,47X    ','7X,F7.0,40X ',
                       '14X,F7.0,33X','21X,F7.0,26X','28X,F7.0,19X',
                       '35X,F7.0,12X','42X,F7.0,5X ');
  16   1  0          DCL (XMIN(2),XMAX(2),XUNIT(2),DELTA(2)) DEC(6,2);
  17   1  0          OPEN FILE(INDATA),FILE(OUTDATA),FILE(BLKBOX);
  18   1  0          ON ENDFILE(SYSIN) GO TO GETLOG;
  19   1  0          DO I=1 TO 5;
  20   1  1            DO J=1 TO 7;
  21   1  2              MAP(I,J)='0'B;
  22   1  2            END;
  23   1  1          END;
             /*********************************************************************/
             /* READ INPUT DATA (2 TO 6 CARDS):                                    */
             /*                                                                    */
             /*   1ST CARD INDICATES GRID SPACING AND CONTOUR INVERVAL FOR THE     */
             /*   ONE OR TWO ISOPLETH PLOTS PRODUCED FOR EACH SELECTED ORGAN AND   */
             /*   NUCLIDE (SEE BELOW).  LEAVE GRID FIELD BLANK TO OBTAIN DEFAULT   */
             /*   VALUES.  SET GRID FIELD NEGATIVE TO OMIT PLOT TYPE.              */
             /*                                                                    */
             /*   1ST CARD ALSO INCLUDES OPTIONS ON INCLUDING EXTRA RECEPTORS      */
             /*   FOR CONTOUR GENERATION AND FOR LINEAR OR QUADRATIC FIT IN        */
             /*   INTERPOLATION.  1ST CARD FORMAT IS (4 F(5,2),2 (X4,F(1)):        */
             /*                                                                    */
```

```
PL/I OPTIMIZING COMPILER          CONTOUR: PROC OPTIONS(MAIN);

    STMT LEV NT

                  /*     COL  1- 5   GRID 1, DEFAULT = 2.00 KM SQUARES                  */
                  /*          6-10   INTERVAL 1, DEFAULT = 0.25 LOG UNITS               */
                  /*         11-15   GRID 2, DEFAULT = 20.00 KM SQUARES                 */
                  /*         16-20   INTERVAL 2, DEFAULT = 0.50 LOG UNITS               */
                  /*            25   INCLUDE ADDITIONAL RECEPTORS IF = 1 (DEFAULT = 0) */
                  /*            30   LINEAR INTERPOL. IF = 1 (QUADRATIC DEFAULT = 0)   */
                  /*                                                                   */
                  /*   ON EACH SUBSEQUENT CARD, ORGAN AND UP TO 7 SELECTED NUCLIDES.   */
                  /*   FORMAT IS A(6),7(X(1),A(5)), STARTING IN COL(1).                */
                  /*******************************************************************/
     24   1  0              GET EDIT(XUNIT(1),DELTA(1),XUNIT(2),DELTA(2),IADD,IFIT)
                              (COL(1), 4 F(5,2),2 (X(4),F(1)));
     25   1  0            DO M=1 TO 2;
     26   1  1              IF XUNIT(M) < 0 THEN GO TO ENDIN;
     27   1  1              IF XUNIT(M) = 0 THEN
                              DO;
     28   1  2                IF M=1 THEN DO;
     29   1  3                              XUNIT(1)=2.00;
     30   1  3                              DELTA(1)=0.25;
     31   1  3                            END;
     32   1  2                       ELSE DO;
     33   1  3                              XUNIT(2)=20.00;
     34   1  3                              DELTA(2)=0.50;
     35   1  3                            END;
     36   1  2              END;
     37   1  1              XMIN(M)=-4*XUNIT(M);
     38   1  1              XMAX(M)=4*XUNIT(M)-0.01;
     39   1  1  ENDIN:    END;
     40   1  0  LOOPO:    DO I=1 TO 5;
     41   1  1              GET EDIT(ORGAN,NUKE) (COL(1),A(6),7 (X(1),A(5)));
     42   1  1              DO I1 = 1 TO 5;
     43   1  2                IF ORGAN = ORGAN1(I1) THEN GO TO CONT;
     44   1  2              END;
     45   1  1              PUT SKIP LIST ('ORGAN ERROR IN FOLLOWING LINE:');
     46   1  1              PUT SKIP DATA (ORGAN,NUKE);
     47   1  1              PUT SKIP LIST ('ORGAN SET AT ''BODY''');
     48   1  1              I1=1;
     49   1  1  CONT:       FLAG='0'B;
     50   1  1              DO J = 1 TO 7;
     51   1  2                IF NUKE(J) = '     ' THEN GO TO CONT1;
     52   1  2                FLAG = '1'B;
     53   1  2                DO J1 = 1 TO 7;
     54   1  3                  IF NUKE(J)=NUKE1(J1) THEN
                                  DO;
     55   1  4                      MAP(I1,J1)='1'B;
     56   1  4                      GO TO CONT1;
     57   1  4                    END;
     58   1  3                END;
     59   1  2                PUT SKIP LIST('NUCLIDE ERROR AS FOLLOWS:');
```

```
PL/I OPTIMIZING COMPILER         CONTOUR: PROC OPTIONS(MAIN);

    STMT LEV NT

      60   1  2                 PUT SKIP DATA(ORGAN,NUKE(J));
      61   1  2                 PUT SKIP LIST('NUCLIDE SET TO U238');
      62   1  2                 MAP(I1,1)='1'B;
      63   1  2  CONT1:       END;
                              /* CHECK IF ALL NUKE(J) VALUES SET AT '       ' */
      64   1  1               IF FLAG THEN GO TO END0;
      65   1  1               PUT SKIP LIST('NUCLIDE ERROR AS FOLLOWS:');
      66   1  1               PUT SKIP DATA(ORGAN,NUKE);
      67   1  1               PUT SKIP LIST('NUCLIDE SET TO U238');
      68   1  1               MAP(I1,1)='1'B;
      69   1  1  END0:      END LOOP0;
                 /* COMMENCE READING LOG CONCENTRATIONS DATA FILE */
      70   1  0  GETLOG:  ON ENDFILE(INDATA) GO TO CONT4;
                          /* SPECIAL READ FOR 1ST RECORD IN FILE */
      71   1  0           READ FILE(INDATA) INTO(BUF);
      72   1  0           REGION=SUBSTR(BUF,25,24);
      73   1  0  LOOP1:   DO I1 = 1 TO 5;
      74   1  1             FLAG1='0'B;
      75   1  1             FLAG2='0'B;
      76   1  1             DO J1=1 TO 7;
      77   1  2               IF MAP(I1,J1) THEN FLAG1='1'B;
      78   1  2             END;
      79   1  1             IF ¬FLAG1 THEN GO TO END1;
      80   1  1             L=0;
      81   1  1             DO WHILE (L=0);
                              /* SEARCH FOR 1ST RECORD IN SUBSET OF FILE */
      82   1  2               TEMP=SUBSTR(BUF,1,12);
      83   1  2               L=INDEX(TEMP,ORGAN1(I1));
      84   1  2               READ FILE(INDATA) INTO(BUF);
      85   1  2             END;
      86   1  1  LOOP1A:    DO J1=1 TO 7;
      87   1  2               IF ¬MAP(I1,J1) THEN GO TO END1A;
                              /* FLAG2 SET AFTER DATA TRANSFERRED TO WORK */
      88   1  2               IF FLAG2 THEN GO TO CONT5;
      89   1  2               K=1;
      90   1  2               L=0;
      91   1  2  LOOP2:       DO WHILE (L=0);
      92   1  3                 IF I1<5 THEN
                                  DO;
                                    /* SEARCH FOR END OF SUBSET PORTION OF FILE */
      93   1  4                     TEMP=SUBSTR(BUF,1,12);
      94   1  4                     DO I2=I1+1 TO 5;
      95   1  5                       L=INDEX(TEMP,ORGAN1(I2));
      96   1  5                       IF L>0 THEN GO TO CONT4;
      97   1  5                     END;
      98   1  4                   END;
      99   1  3                 WORK(K)=BUF;
     100   1  3                 K=K+1;
     101   1  3                 READ FILE(INDATA) INTO(BUF);
```

```
PL/I OPTIMIZING COMPILER        CONTOUR: PROC OPTIONS(MAIN);

    STMT LEV NT

     102   1  3                 END LOOP2;
     103   1  2  CONT4:         KMAX=K-1;
     104   1  2                 IF IADD=0 THEN KMAX=240;
     105   1  2                 TEMP=REPEAT(' ',76);
     106   1  2                 TEMP=TEMP || 'END';
     107   1  2                 FLAG2='1'B;
                 /* SEARCH FOR END OF FILE SUBSET WITH LAST LEGAL DATA VALUE.       */
                 /* UNSATISFACTORY DATA SET AT '-50.000' BY UDAD5.                   */
     108   1  2  CONT5:         IF SUBSTR(WORK(KMAX),24+(J1-1)*7,7)¬='-50.000'
                                  THEN K1=KMAX;
     109   1  2                   ELSE
                                    DO K1=KMAX-2 TO 1 BY -1;
     110   1  3                       IF SUBSTR(WORK(K1+1),24+(J1-1)*7,7)¬='-50.000'
                                        THEN GO TO LOOP3;
     111   1  3                     END;
     112   1  2                 IF SUBSTR(WORK(1),24+(J1-1)*7,7)¬=' 10.000'
                                  THEN GO TO LOOP3;
     113   1  2                 PUT SKIP EDIT ('NO DATA FOR ',ORGAN1(I1),NUKE1(J1))
                                  (A,A(6),X(1),A(5));
     114   1  2                 MAP(I1,J1)='0'B;
     115   1  2                 GO TO END1A;
     116   1  2  LOOP3:         DO M=1 TO 2;
                                /* WRITE DATA FOR (NOMINAL) 8 AND 80 KM ISOPLETH PLOTS */
     117   1  3                   IF XUNIT(M)<0 THEN GO TO END3;
     118   1  3                   DO K=1 TO K1;
     119   1  4                     IF SUBSTR(WORK(K),24+(J1-1)*7,7)¬='-50.000'
                                      THEN WRITE FILE(OUTDATA) FROM(WORK(K));
     120   1  4                   END;
     121   1  3                   WRITE FILE(OUTDATA) FROM(TEMP);   /* ADD END CARD */
     122   1  3  END3:          END LOOP3;
     123   1  2  END1A:       END LOOP1A;
     124   1  1  END1:     END LOOP1;
                 /*                                                                  */
                 /* COMMENCE SECOND PART OF PROGRAM - CONSTRUCT EXECUTION DECK FOR   */
                 /* SYS1.PLOTPKG.CONTOUR.BLACKBOX                                    */
                 /*                                                                  */
     125   1  0  ILOOP:    DO I1=1 TO 5;
     126   1  1  JLOOP:       DO J1=1 TO 7;
     127   1  2                 IF ¬MAP(I1,J1) THEN GO TO ENDJ;
     128   1  2  MLOOP:         DO M=1 TO 2;
     129   1  3                   IF XUNIT(M)<0 THEN GO TO ENDM;
     130   1  3                   PUT STRING(BUF) EDIT('1 TITLE','LOG SAFETY FACTOR - ',
                                    ORGAN1(I1),'EIS') (A(7),X(3),A(20),A(6),
                                    X(32),A(3));
     131   1  3                   WRITE FILE(BLKBOX) FROM(BUF);
     132   1  3                   PUT STRING(BUF) EDIT('2 KEYS','1   1','8',IFIT)
                                    (A(6),X(13),A(5),X(25),A(1),X(7),F(1));
     133   1  3                   WRITE FILE(BLKBOX) FROM(BUF);
     134   1  3                   PUT STRING(BUF) EDIT('3 SCALE',XMIN(M),XMIN(M),XUNIT(M))
```

PL/I OPTIMIZING COMPILER CONTOUR: PROC OPTIONS(MAIN);

```
STMT LEV NT

                            (A(7),X(3),3 F(10,2));
 135   1  3               WRITE FILE(BLKBOX) FROM(BUF);
 136   1  3               PUT STRING(BUF) EDIT('4 GRID',DELTA(M),XMAX(M),XMAX(M))
                            (A(6),X(24),F(10,2),X(10),2 F(10,2));
 137   1  3               WRITE FILE(BLKBOX) FROM(BUF);
 138   1  3               PUT STRING(BUF) EDIT('5 POST','KM',REGION)
                            (A(6),X(16),A(2),A(24));
 139   1  3               WRITE FILE(BLKBOX) FROM(BUF);
 140   1  3               PUT STRING(BUF) EDIT('6 FORMAT','(5X,2E9.0,',FORM(J1),
                            ',A3)',NUKE1(J1))
                            (A(8),X(2),A(10),A(12),A(4),X(24),A(5));
 141   1  3               WRITE FILE(BLKBOX) FROM(BUF);
 142   1  3  ENDM:      END MLOOP;
 143   1  2  ENDJ:    END JLOOP;
 144   1  1          END ILOOP;
 145   1  0          PUT STRING(BUF) EDIT('8 STOP') (A(6));
 146   1  0          WRITE FILE(BLKBOX) FROM(BUF);
 147   1  0          END CONTOUR;
```

APPENDIX B. LISTING OF EXECUTION DECK FOR UDAD SAMPLE PROBLEM

```
//UDADSAMP JOB (F04183,25,0,12),ZIELEN,CLASS=C,PRTY=H
 CUA
//*MAIN ORG=LOCAL
//*FORMAT PR,DDNAME=,DEST=3800
//STEP1  EXEC  UDAD,FILE='B04183.UDADSAMP',
//    ISODISP='(OLD,CATLG)',CONDISP='(OLD,CATLG)'
//GO.SYSIN     DD  *
4
 &INDATA REGION='UDAD SAMPLE PROBLEM',
 METSET='SAMPLE METSET',
 IDTAIL(1)=3,
 IADD=45,
 XRECEP=
1 0.85,0.35,0.0,
2 1.0,0.5,0.0,
3 1.9,1.4,0.0,
4 8.8,3.6,0.0,
5 18.8,7.8,0.0,
V 18.8,7.8,0.0,
6 36.5,15.0,0.0,
7 12.0,21.8,0.0,
8 -2.4,20.6,0.0,
A -2.4,20.6,0.0,
9 -18.2,23.3,0.0,
1 -27.5,-2.5,0.0,
2 -35.2,-14.8,0.0,
3 -23.0,-22.4,0.0,
4 -7.4,-21.8,0.0,
5 -55.3,2.4,0.0,
B -55.3,2.4,0.0,
6 -67.5,-8.1,0.0,
7 -55.7,-46.4,0.0,
8 -23.3,-38.7,0.0,
9 27.8,-38.3,0.0,
C 27.8,-38.3,0.0,
1 -78.0,16.0,0.0,
2 33.0,35.0,0.0,
3 -65.0,-26.0,0.0,
4 -27.0,27.0,0.0,
5 -5.2,29.0,0.0,
6 14.0,35.0,0.0,
7 -23.0,59.0,0.0,
8 56.0,32.0,0.0,
9 -29.0,53.0,0.0,
1 65.0,0.0,0.0,
2 -60.0,50.0,0.0,
3 40.0,36.0,0.0,
4 -5.0,31.0,0.0,
5 -23.0,32.0,0.0,
6  65.0,24.0,0.0,
7 0.0,-45.0,0.0,
8 -45.0,-45.0,0.0,
9 38.7,33.3,0.0,
1 21.3,34.3,0.0,
2 -5.0,30.5,0.0,
3 -22.8,30.8,0.0,
4 -56.0,22.0,0.0,
5 -67.5,18.8,0.0,
 XNAME(1,1) ='FENCE PO','ST',
```

```
XNAME(1,2) ='TRAILER',
XNAME(1,3)='RANCH 1',
XNAME(1,4) ='RANCH 2',
XNAME(1,5) ='RANCH 3',
XNAME(1,6) ='RANCH 3V',
XNAME(1,7) ='RANCH 4',
XNAME(1,8) ='RANCH 5',
XNAME(1,9) ='RANCH 6',
XNAME(1,10) ='RANCH 6V',
XNAME(1,11) ='RANCH 7',
XNAME(1,12) ='RANCH 8',
XNAME(1,13) ='RANCH 9',
XNAME(1,14) ='RANCH 10',
XNAME(1,15) ='RANCH 11',
XNAME(1,16) ='RANCH 12',
XNAME(1,17) ='RANCH 12','V',
XNAME(1,18) ='RANCH 13',
XNAME(1,19) ='RANCH 14',
XNAME(1,20) ='RANCH 15',
XNAME(1,21) ='RANCH 16',
XNAME(1,22) ='RANCH 16','V',
XNAME(1,23) ='WEST CIT','Y',
XNAME(1,24) ='EAST CIT','Y',
XNAME(1,25) ='RED TOWN',
XNAME(1,26) ='BLUE TOW','N',
XNAME(1,27) ='BROWN TO','WN',
XNAME(1,28) ='GREEN TO','WN',
XNAME(1,29) ='ORANGE T','OWN',
XNAME(1,30) ='PURPLE T','OWN',
XNAME(1,31) ='WHITE TO','WN',
XNAME(1,32) ='E INDIAN','RES',
XNAME(1,33) ='E INDIAN','RES',
XNAME(1,34) ='EAST RUR','AL',
XNAME(1,35) ='NORTH RU','RAL',
XNAME(1,36) ='NW RURAL',
XNAME(1,37) ='WEST RUR','AL',
XNAME(1,38) ='SOUTH RU','RAL',
XNAME(1,39) ='SW RURAL',
XNAME(1,40) ='AGRICULT','URE 1',
XNAME(1,41) ='AGRICULT','URE 2',
XNAME(1,42) ='AGRICULT','URE 3',
XNAME(1,43) ='AGRICULT','URE 4',
XNAME(1,44) ='AGRICULT','URE 5',
XNAME(1,45) ='AGRICULT','URE 6',
 PWFCD= 2*0.0,3*0.0625,0.01,3*0.0625,0.005,6*0.0625,0.01,4*0.0625,
1  0.01,17*0.0,0.191,0.103,0.095,0.053,0.29,0.267,
 IFODOS= 2*0,3*1,5,3*1,5,6*1,5,4*1,5,17*0,6*5,
 PACT=75.6,1026.0,2*1078.0,16*0.,
 PTSZ20=0.4,4*0.0,
 IDSQ=1301,4,4,
 NSORCE=3,
 SORCE=
1 0.0,0.1,5.0,0.0,4*1.36E-3,107.,1101,3,0.
2 0.0,0.0,15.,0.0,7.2E-2,3.58E-3,2*1.43E-4,0.0,1201,1,0,
3 0.4,0.0,0.0,0.5,4*16.0,7.0E3,1301,2,0,
 PTSZ=1.0,1.0,5.0,35.0,0.0,
 PTSZFC=1.00,4*0.0,
A       0.0,0.0,0.3,0.7,0.0,
B       0.0,1.0,3*0.0,
C       10*0.0,
```

```
 VDEP=5*0.01,
 PDEN=8.9,4*2.4,
 OPTIME=15.0,
 SORCID(1,1)='UDAD',' SAM','PLE ','MILL',
 GROUPN(1,1)='ORE ','PAD ','& GR','INDI','NG',
 GROUPN(1,2)='DRYI','NG &',' PAC','KAGI','NG',
 GROUPN(1,3)='TAIL','ING',
 IPOP=
1  9*0,1008,2000,4*0,
2  9*0,8,500,4*0,
3  3*0,8,7*0,13000,3500,2*0
4  7*0,8,0,2*8,2*0,500,0,
5  13*0,2000,0,
6  15*0,
7  11*0,8,3*0,
8  15*0,
9  11*0,1000,3*0,
0 9*0,8,0,8,3*0,
1  10*0,8,2*0,2000,8,
2  10*0,8,2*0,500,1000,
3  9*0,8,2*0,2*8,10000,
4  13*0,4000,12000,
5  9*0,8,500,1000,2*0,300,
6  10*0,500,1000,500,500,0,
 FREQ=      0.0006,  0.0010,  0.0008,  0.0005,  0.0003,
A  0.0002,  0.0002,  0.0003,  0.0008,  0.0007,  0.0008,
B  0.0013,  0.0015,  0.0016,  0.0008,  0.0006,  0.0005,
C  0.0007,  0.0006,  0.0003,  0.0002,  0.0001,  0.0001,
D  0.0002,  0.0006,  0.0005,  0.0006,  0.0009,  0.0010,
E  0.0011,  0.0006,  0.0002,  64*0.0,
1           0.0017,  0.0028,  0.0027,  0.0015,  0.0022,
A  0.0004,  0.0010,  0.0,     0.0018,  0.0033,  0.0041,
B  0.0085,  0.0059,  0.0033,  0.0022,  0.0024,  0.0009,
C  0.0015,  0.0013,  0.0008,  0.0011,  0.0002,  0.0003,
D  0.0,     0.0009,  0.0017,  0.0022,  0.0045,  0.0031,
E  0.0017,  0.0012,  0.0013,  0.0010,  0.0006,  0.0002,
F  0.0008,  0.0006,  0.0001,  0.0001,  0.0002,  0.0007,
G  0.0014,  0.0017,  0.0022,  0.0020,  0.0009,  0.0007,
H  0.0002,  48*0.0,
2           0.0008,  0.0011,  0.0014,  0.0011,  0.0006,
A  0.0,     0.0002,  0.0002,  0.0012,  0.0010,  0.0020,
B  0.0021,  0.0026,  0.0010,  0.0006,  0.0005,  0.0020,
C  0.0026,  0.0034,  0.0026,  0.0014,  0.0001,  0.0006,
D  0.0005,  0.0029,  0.0023,  0.0045,  0.0052,  0.0062,
E  0.0025,  0.0014,  0.0011,  0.0024,  0.0024,  0.0014,
F  0.0030,  0.0023,  0.0007,  0.0005,  0.0006,  0.0025,
G  0.0052,  0.0074,  0.0085,  0.0071,  0.0034,  0.0010,
H  0.0021,  0.0003,  0.0003,  0.0005,  0.0,     0.0001,
I  0.0,     0.0001,  0.0,     0.0006,  0.0013,  0.0043,
J  0.0031,  0.0023,  0.0010,  0.0005,  0.0001,  9*0.0,
K  0.0008,  0.0009,  0.0021,  0.0005,  12*0.0,  0.0001,
L  0.0002,  0.0,     0.0001,  3*0.0,
3           0.0016,  0.0013,  0.0011,  0.0011,  0.0006,
A  0.0002,  0.0009,  0.0009,  0.0018,  0.0019,  0.0022,
B  0.0031,  0.0025,  0.0006,  0.0004,  0.0006,  0.0030,
C  0.0023,  0.0020,  0.0021,  0.0010,  0.0003,  0.0013,
D  0.0016,  0.0033,  0.0036,  0.0038,  0.0054,  0.0039,
E  0.0010,  0.0007,  0.0010,  0.0045,  0.0032,  0.0031,
F  0.0068,  0.0052,  0.0009,  0.0018,  0.0031,  0.0084,
G  0.0139,  0.0178,  0.0193,  0.0102,  0.0044,  0.0014,
```

```
H  0.0021,  0.0022,  0.0024,  0.0014,  0.0037,  0.0036,
I  0.0010,  0.0016,  0.0014,  0.0068,  0.0117,  0.0337,
J  0.0313,  0.0160,  0.0080,  0.0036,  0.0011,  0.0002,
K  0.0006,  0.0001,  0.0002,  0.0001,  0.0002,  0.0002,
L  0.0003,  0.0014,  0.0031,  0.0100,  0.0101,  0.0047,
M  0.0013,  0.0003,  0.0001,  0.0,     0.0001,  3*0.0,
N  0.0001,  0.0001,  0.0,     0.0002,  0.0007,  0.0013,
O  0.0021,  0.0002,  3*0.0,
4           0.0139,0.0115,0.0166,0.0153,0.0158,0.0154,0.0111,0.0100,
5           0.0231,0.0138,0.0218,0.0237,0.0123,0.0041,0.0031,0.0034,
6           0.0052,0.0044,0.0053,0.0050,0.0046,0.0036,0.0037,0.0038,
7           0.0075,0.0056,0.0071,0.0079,0.0048,0.0015,0.0011,0.0008,
8           0.0021,0.0015,0.0016,0.0030,0.0018,0.0002,0.0006,0.0014,
9           0.0052,0.0062,0.0083,0.0061,0.0034,0.0018,0.0015,0.0014,
1           48*0.0,
2           0.0045,0.0037,0.0047,0.0042,0.0042,0.0025,0.0031,0.0032,
2           0.0064,0.0043,0.0065,0.0079,0.0040,0.0010,0.0006,0.0007,
3           0.0023,0.0017,0.0014,0.0014,0.0018,0.0013,0.0016,0.0017,
4           0.0031,0.0015,0.0030,0.0037,0.0024,0.0007,0.0006,0.0006,
5           0.0004,0.0007,0.0006,0.0010,0.0006,0.0002,0.0004,0.0007,
6           0.0013,0.0022,0.0040,0.0050,0.0020,0.0008,0.0004,0.0006,
7           48*0.0,
 JC(1)=1,
 JC(2)=1,
 JC(3)=1,
 JC(4)=1,
 JC(5)=1,
 JC(6)=1,
 JC(8)=1,
 &END
//ISO.SYSIN  DD  *

BODY   U238  TH230
BONE   RA226
LUNG   RN222
/* END OF FILE
```

APPENDIX C. SELECTED PORTIONS OF COMPUTER OUTPUT FOR UDAD SAMPLE PROBLEM

APPENDIX C. SELECTED PORTIONS OF COMPUTER OUTPUT FOR UDAD SAMPLE PROBLEM

```
*******************************************************************
*                                                                 *
*             URANIUM DISPERSION AND DOSIMETRY (UDAD)             *
*                                                                 *
*                     VERSION IX, 12/22/78                        *
*                                                                 *
*******************************************************************
*                                                                 *
*  A COMPREHENSIVE COMPUTER PROGRAM TO PROVIDE ESTIMATES OF POTENTIAL  *
*  RADIATION EXPOSURE TO INDIVIDUALS AND TO THE GENERAL POPULATION IN  *
*         THE VICINITY OF A URANIUM PROCESSING FACILITY           *
*                                                                 *
*                                                                 *
*                                                                 *
*        MICHAEL H. MOMENI, YUCHIEN YUAN AND A. J. ZIELEN         *
*                                                                 *
*            DIVISION OF ENVIRONMENTAL IMPACT STUDIES             *
*                                                                 *
*                 ARGONNE NATIONAL LABORATORY                     *
*                                                                 *
*                                                                 *
*                                                                 *
*                                                                 *
*******************************************************************
```

560 213

```
UDAD SAMPLE PROBLEM                     UDAD 9                    DATE  12/26/78                 PAGE   1
METSET SAMPLE METSET

INITIAL NAMELIST INDATA VALUES:

BSV(6):
     2.50E-03    2.50E-03    4.20E-03    3.10E-04    6.80E-02    1.50E-01

DFACT = 5.00E-01

DM = 8.50E+02

DV(2):
     7.50E-01    2.00E+00

E(10,12):
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    6.10E-01    5.50E+01    0.0         0.0         0.0         0.0
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    4.80E-01    5.50E+01    0.0         0.0         0.0         0.0
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    8.26E+00    5.50E+01    0.0         0.0         0.0         0.0
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    5.20E+00    5.50E+01    0.0         0.0         0.0         0.0
     2.20E+02    2.40E+02    2.40E+02    1.10E+02    2.90E+01    2.80E+02    0.0         0.0         0.0         0.0
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    1.00E+01    5.50E+01    0.0         0.0         0.0         0.0
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    1.00E+01    5.50E+01    0.0         0.0         0.0         0.0
     4.30E-01    4.80E-01    4.70E-01    4.80E-01    2.70E-02    5.30E-01    0.0         0.0         0.0         0.0
     4.30E-01    4.90E-01    4.70E-01    4.80E-01    4.50E-02    5.30E-01    0.0         0.0         0.0         0.0
     4.30E-01    4.80E-01    4.70E-01    4.80E-01    1.90E-02    5.30E-01    0.0         0.0         0.0         0.0
     4.30E-01    4.80E-01    4.70E-01    4.80E-01    1.90E-02    5.30E-01    0.0         0.0         0.0         0.0
     4.30E+01    4.90E+01    4.80E+01    1.10E+02    2.50E+01    5.50E+01    0.0         0.0         0.0         0.0

FCON(6,5):
     3.40E-04    3.40E-04    2.00E-04    4.00E-03    2.90E-04    1.20E-02
     6.10E-04    6.10E-04    5.00E-06    4.50E-04    2.60E-04    1.40E-04
     4.00E-03    4.00E-03    4.00E-03    5.00E-04    2.00E-03    4.00E-03
     2.00E-03    2.00E-03    2.00E-03    2.00E-05    2.00E-03    1.80E-02
     2.00E+00    2.00E+00    3.00E+01    5.00E+01    1.00E+02    5.00E+02

FG = 5.00E-01

FOODIN(2,3):
     5.00E+01    5.00E+01
     6.00E+01    5.00E+01
     3.00E-01    1.20E-01

FREQ(16,6,6):
     COMPLETE LIST STARTS ON PAGE 8 (APPROXIMATELY)

FV(2):
     2.00E-01    2.00E-01

F1(10):
     1.00E-02    1.00E-02    1.00E-04    3.00E-01    8.00E-02    6.00E-02    0.0         0.0         0.0         0.0

F2P(10,4):
     1.00E+00    1.00E+00    1.00E+00    5.40E-01    1.00E+00    1.00E+00    0.0         0.0         0.0         0.0
     1.10E-01    1.10E-01    7.00E-01    5.40E-01    2.80E-01    1.00E-01    0.0         0.0         0.0         0.0
     1.10E-01    1.10E-01    5.00E-02    2.00E-03    1.40E-01    7.00E-02    0.0         0.0         0.0         0.0
     0.0         0.0         5.00E-02    4.00E-04    8.00E-02    1.70E-01    0.0         0.0         0.0         0.0
```

560 214

```
INITIAL NAMELIST INDATA VALUES (CONT.):

F2PM(16):
     2.90E-01     1.10E-01     4.00E-02     2.00E-02
     2.90E-01     1.10E-01     4.00E-02     2.00E-02
     0.0          0.0          0.0          0.0
     0.0          0.0          0.0          0.0

GROUPN(5,9):
     ORE PAD & GRINDING
     DRYING & PACKAGING
     TAILING
     REMAINING LINES ALL BLANK

IADD = 45

IDSQ(3,6):
 1301    4    4
    0    0    0
    0    0    0
    0    0    0
    0    0    0
    0    0    0

IDTAIL(5):
    3    0    0    0    0

IFODOS(60):
    0    0    1    1    1    5    1    1    1    5
    1    1    1    1    1    1    5    1    1    1
    1    5    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    5
    5    5    5    5    5    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0

IPOP(15,16):
     COMPLETE LIST ON PAGE 16 (APPROXIMATELY)

IPSOL(10):
    1    1    1    2    2    2    0    0    0    0

IRHO(6):
    1    3    7    8   12   15

IYR(10):
    1    3    5    7   10   15   20   30   50   70

JC(9):
    1    1    1    1    1    1    0    1    0

KRHO = 15
```

560 215

```
UDAD SAMPLE PROBLEM                        UDAD 9                    DATE  12/26/78                PAGE   3
METSET SAMPLE METSET

INITIAL NAMELIST INDATA VALUES (CONT.):

LON(10,4):
     1.00E+02    1.00E+02    5.70E+04    3.98E-01    1.20E+03    2.50E+01    0.0         0.0         0.0         0.0
     3.00E+02    3.00E+02    7.30E+04    3.98E-01    2.40E+03    2.00E+01    0.0         0.0         0.0         0.0
     1.50E+01    1.50E+01    2.20E+04    1.00E+01    4.94E+02    4.60E+01    0.0         0.0         0.0         0.0
     0.0         0.0         5.70E+04    1.00E+01    1.50E+03    3.20E+01    0.0         0.0         0.0         0.0

LONM(16):
     4.95E+00    5.78E+01    6.93E+02    5.33E+03
     4.95E+00    5.78E+01    6.93E+02    5.33E+03
     0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0

LR(10):
     1.60E+12    9.10E+07    2.90E+07    5.90E+05    7.10E+03    1.38E+02    0.0         0.0         0.0         0.0

METSET(4):
     SAMPLE METSET

MPC(7,5):
     6.00E+02    6.00E+02    5.00E+00    2.00E+01    4.00E+02    2.00E+03    0.0
     2.00E+02    2.00E+02    8.00E-01    1.00E-01    7.00E+01    2.00E+03    0.0
     5.00E+01    4.00E+01    3.00E+00    0.0         8.00E+01    7.00E+01    3.00E+03
     3.00E+01    4.00E+02    2.00E+00    0.0         4.00E+01    2.00E+02    0.0
     0.0         0.0         7.00E+00    0.0         1.00E+02    6.00E+02    0.0

MSPTAB(10,4):
    0    0    0   14    0    0    0    0    0    0
    0    0    0   54    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0

NNUC =  6

NSORCE =  3

OPTIME = 1.50E+01

PACT(4,5):
     7.56E+01    1.03E+03    1.08E+03    1.08E+03
     0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0

PDEN(5):
     8.90E+00    2.40E+00    2.40E+00    2.40E+00    2.40E+00

PFIN(8):
     1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00

PGTH(4):
     1.00E+00    1.00E+00    1.00E+00    1.00E+00

PHALF = 5.00E+01
```

560 216

```
INITIAL NAMELIST INDATA VALUES (CONT.):

PTAIL(7,5):
     2.40E+00    3.00E-02    1.00E-01    1.00E+02    1.00E+00    3.00E+00    1.00E-01
     0.0         0.0         0.0         0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0         0.0         0.0         0.0

PTSZ(5):
     1.00E+00    1.00E+00    5.00E+00    3.50E+01    0.0

PTSZFC(5,5):
     1.00E+00    0.0         0.0         0.0         0.0
     0.0         0.0         3.00E-01    7.00E-01    0.0
     0.0         1.00E+00    0.0         0.0         0.0
     0.0         0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0         0.0

PTSZ20(5):
     4.00E-01    0.0         0.0         0.0         0.0

PWFOD(60):
     0.0         0.0         6.25E-02    6.25E-02    6.25E-02    1.00E-02    6.25E-02    6.25E-02    6.25E-02    5.00E-03
     6.25E-02    6.25E-02    6.25E-02    6.25E-02    6.25E-02    6.25E-02    1.00E-02    6.25E-02    6.25E-02    6.25E-02
     6.25E-02    1.00E-02    0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         1.91E-01
     1.03E-01    9.50E-02    5.30E-02    2.90E-01    2.67E-01    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00
     1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00

REGION(6):
     UDAD SAMPLE PROBLEM

RFI = 1.00E+00

RFIE = 5.83E-01

RHO(2):
     2.40E+02    2.40E+02

RSALF = 1.37E-01

RSLIM = 1.00E-02

SHIED = 5.00E-01

SLIM = 1.00E-02
```

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UDAD SAMPLE PROBLEM                    UDAD 9                    DATE  12/26/78                PAGE   5
METSET SAMPLE METSET

INITIAL NAMELIST INDATA VALUES (CONT.):

SORCE(12,80):
    0.0        1.00E-01   5.00E+00   0.0        1.36E-03   1.36E-03   1.36E-03   1.36E-03   1.07E+02   1101   3   0.0
    0.0        0.0        1.50E+01   0.0        7.20E-02   3.53E-03   1.43E-04   1.43E-04   0.0        1201   1   0.0
    4.00E-01   0.0        0.0        5.00E-01   1.60E+01   1.60E+01   1.60E+01   1.60E+01   7.00E+03   1301   2   0.0

SORCID(5,9):
     UDAD SAMPLE MILL
     REMAINING LINES ALL BLANK

SUFF = 1.00E-09

SUFI = 1.00E-05

TC(2):
     3.00E+01     6.00E+01

TW(2):
     1.40E+01     1.40E+01

VDEP(5):
     1.00E-02     1.00E-02     1.00E-02     1.00E-02     1.00E-02

XIN(7):
     3.00E-01     8.50E-01     2.00E-01     8.00E-02     7.70E-01     5.75E-02     2.00E+00

XINS(7):
     2.60E-01     3.00E-01     1.00E-01     8.00E-02     2.80E-01     1.89E-02     1.00E+00

XNAME(4,60):
     COMPLETE LIST STARTS ON PAGE 7 (APPROXIMATELY)

XRECEP(3,60):
     COMPLETE LIST STARTS ON PAGE 7 (APPROXIMATELY)

XRHO(15):
     0.1    0.5    1.0    2.0    3.0    4.0    5.0    10.0    20.0    30.0    40.0    50.0    60.0    70.0    80.0

YDOC = 5.00E+01

YEVD = 1.00E+02
```

560 218

NUMBER OF SOURCES= 18

ID/1000	SOURCE GROUPS
1	UDAD SAMPLE MILL

#	KM X	KM Y	M Z	KM2 AREA	238U	230TH	CI/YEAR 226RA	210PB	222RN	ID	PDEN SET	MSEC EXIT VEL	SOURCE TYPE
1	0.0	0.10	5.0	1.00E-06	1.36E-03	1.36E-03	1.36E-03	1.36E-03	1.07E+02	1101	3	0.0	ORE PAD & GRINDING
2	0.0	0.0	15.0	1.00E-06	7.20E-02	3.58E-03	1.43E-04	1.43E-04	0.0	1201	1	0.0	DRYING & PACKAGING
3	0.13	-0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1301	2	0.0	TAILING
4	0.31	-0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1302	2	0.0	TAILING
5	0.49	-0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1303	2	0.0	TAILING
6	0.67	-0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1304	2	0.0	TAILING
7	0.13	-0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1305	2	0.0	TAILING
8	0.31	-0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1306	2	0.0	TAILING
9	0.49	-0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1307	2	0.0	TAILING
10	0.67	-0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1308	2	0.0	TAILING
11	0.13	0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1309	2	0.0	TAILING
12	0.31	0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1310	2	0.0	TAILING
13	0.49	0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1311	2	0.0	TAILING
14	0.67	0.09	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1312	2	0.0	TAILING
15	0.13	0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1313	2	0.0	TAILING
16	0.31	0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1314	2	0.0	TAILING
17	0.49	0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1315	2	0.0	TAILING
18	0.67	0.27	0.0	3.13E-02	8.73E-04	1.18E-02	1.24E-02	1.24E-02	4.38E+02	1316	2	0.0	TAILING

PARTICLE PARAMETERS AND FRACTIONAL DISTRIBUTIONS

DIAMETER, MICRONS	DEPOSITION VEL., M/SEC	SETTLING VEL., M/SEC	DENSITY, G/CM3 8.90	2.40	2.40
1.0	1.00E-02	2.67E-04	1.000	0.0	0.0
1.0	1.00E-02	7.20E-05	0.0	0.0	1.000
5.0	1.00E-02	1.80E-03	0.0	0.300	0.0
35.0	8.82E-02	8.82E-02	0.0	0.700	0.0

560 219

ADDITIONAL RECEPTOR POINTS = 45

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)
1	FENCE POST	0.85	0.35	0.0
2	TRAILER	1.00	0.50	0.0
3	RANCH 1	1.90	1.40	0.0
4	RANCH 2	8.80	3.60	0.0
5	RANCH 3	18.80	7.80	0.0
6	RANCH 3V	18.80	7.80	0.0
7	RANCH 4	36.50	15.00	0.0
8	RANCH 5	12.00	21.80	0.0
9	RANCH 6	-2.40	20.60	0.0
10	RANCH 6V	-2.40	20.60	0.0
11	RANCH 7	-18.20	23.30	0.0
12	RANCH 8	-27.50	-2.50	0.0
13	RANCH 9	-35.20	-14.80	0.0
14	RANCH 10	-23.00	-22.40	0.0
15	RANCH 11	-7.40	-21.80	0.0
16	RANCH 12	-55.30	2.40	0.0
17	RANCH 12V	-55.30	2.40	0.0
18	RANCH 13	-67.50	-8.10	0.0
19	RANCH 14	-55.70	-46.40	0.0
20	RANCH 15	-23.30	-38.70	0.0
21	RANCH 16	27.80	-38.30	0.0
22	RANCH 16V	27.80	-38.30	0.0
23	WEST CITY	-78.00	16.00	0.0
24	EAST CITY	33.00	35.00	0.0
25	RED TOWN	-65.00	-26.00	0.0
26	BLUE TOWN	-27.00	27.00	0.0
27	BROWN TOWN	-5.20	29.00	0.0
28	GREEN TOWN	14.00	35.00	0.0
29	ORANGE TOWN	-23.00	59.00	0.0
30	PURPLE TOWN	56.00	32.00	0.0
31	WHITE TOWN	-29.00	53.00	0.0
32	E INDIANRES	65.00	0.0	0.0
33	E INDIANRES	-60.00	50.00	0.0
34	EAST RURAL	40.00	36.00	0.0
35	NORTH RURAL	-5.00	31.00	0.0
36	NW RURAL	-23.00	32.00	0.0
37	WEST RURAL	-65.00	24.00	0.0
38	SOUTH RURAL	0.0	-45.00	0.0
39	SW RURAL	-45.00	-45.00	0.0
40	AGRICULTURE 1	38.70	33.30	0.0
41	AGRICULTURE 2	21.30	34.30	0.0
42	AGRICULTURE 3	-5.00	30.50	0.0
43	AGRICULTURE 4	-22.80	30.80	0.0
44	AGRICULTURE 5	-56.00	22.00	0.0
45	AGRICULTURE 6	-67.50	18.80	0.0

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 1

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00060	0.00050	0.0	0.0	0.0	0.0	0.00110
NNE	0.00100	0.00070	0.0	0.0	0.0	0.0	0.00170
NE	0.00080	0.00060	0.0	0.0	0.0	0.0	0.00140
ENE	0.00050	0.00030	0.0	0.0	0.0	0.0	0.00080
E	0.00030	0.00020	0.0	0.0	0.0	0.0	0.00050
ESE	0.00020	0.00010	0.0	0.0	0.0	0.0	0.00030
SE	0.00020	0.00010	0.0	0.0	0.0	0.0	0.00030
SSE	0.00030	0.00020	0.0	0.0	0.0	0.0	0.00050
S	0.00080	0.00060	0.0	0.0	0.0	0.0	0.00140
SSW	0.00070	0.00050	0.0	0.0	0.0	0.0	0.00120
SW	0.00080	0.00060	0.0	0.0	0.0	0.0	0.00140
WSW	0.00130	0.00090	0.0	0.0	0.0	0.0	0.00220
W	0.00150	0.00100	0.0	0.0	0.0	0.0	0.00250
WNW	0.00160	0.00110	0.0	0.0	0.0	0.0	0.00270
NW	0.00080	0.00060	0.0	0.0	0.0	0.0	0.00140
NNW	0.00060	0.00020	0.0	0.0	0.0	0.0	0.00080
COLUMN TOTALS:	0.01200	0.00820	0.0	0.0	0.0	0.0	0.02020

UDAD SAMPLE PROBLEM
METSET SAMPLE METSET

UDAD 9

DATE 12/26/78

PAGE 14

ANNUAL RELATIVE FREQUENCE OF OCCURENCE -- SUM OF ALL STABILITY CLASSES

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.02310	0.01390	0.01040	0.00250	0.00020	0.0	0.05010
NNE	0.02140	0.01320	0.00840	0.00270	0.00060	0.00010	0.04640
NE	0.02730	0.01400	0.00690	0.00190	0.00010	0.0	0.05020
ENE	0.02370	0.01220	0.01460	0.00370	0.00020	0.0	0.05440
E	0.02370	0.01010	0.01050	0.00370	0.00010	0.0	0.04810
ESE	0.01870	0.00560	0.00210	0.00100	0.00020	0.00010	0.02770
SE	0.01650	0.00760	0.00340	0.00170	0.00020	0.00010	0.02950
SSE	0.01460	0.00780	0.00600	0.00140	0.00030	0.0	0.03010
S	0.03510	0.01830	0.01810	0.00740	0.00140	0.00020	0.08050
SSW	0.02500	0.01520	0.02890	0.01300	0.00390	0.00080	0.08680
SW	0.03740	0.02120	0.03920	0.03800	0.01090	0.00150	0.14820
WSW	0.04660	0.02760	0.04110	0.03440	0.01220	0.00210	0.16400
W	0.02880	0.02140	0.02470	0.01830	0.00520	0.00030	0.09870
WNW	0.01160	0.00850	0.01130	0.00900	0.00130	0.0	0.04170
NW	0.00770	0.00560	0.00500	0.00410	0.00030	0.0	0.02270
NNW	0.00820	0.00500	0.00640	0.00120	0.00010	0.0	0.02090
COLUMN TOTALS:	0.36940	0.20720	0.23700	0.14400	0.03720	0.00520	1.00000

MPC VALUES (PCI/M3), REF: ICRP2

ELEMENT	WHOLE BODY	BONE	LUNG	KIDNEY	LIVER
U238	6.00E+02	2.00E+02	5.00E+01	3.00E+01	0.0
U234	6.00E+02	2.00E+02	4.00E+01	4.00E+02	0.0
TH230	5.00E+00	8.00E-01	3.00E+00	2.00E+00	7.00E+00
RA226	2.00E+01	1.00E-01	0.0	0.0	0.0
PB210	4.00E+02	7.00E+01	8.00E+01	4.00E+01	1.00E+02
PO210	2.00E+03	2.00E+03	7.00E+01	2.00E+02	6.00E+02
RN222	0.0	0.0	3.00E+03	0.0	0.0

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 16
METSET SAMPLE METSET

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	ROW SUM
0.0- 0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.1- 0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.5- 1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.0- 2.0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	8
2.0- 3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0- 4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0- 5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.0-10.0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	8
10.0-20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.0-30.0	1008	8	0	8	0	0	0	0	0	8	0	0	8	0	8	0	1048
30.0-40.0	2000	500	0	8	0	0	0	0	0	0	8	8	0	0	500	500	3524
40.0-50.0	0	0	13000	0	0	0	8	0	1000	8	0	0	0	0	1000	1000	16016
50.0-60.0	0	0	3500	0	0	0	0	0	0	0	0	0	8	0	0	500	4008
60.0-70.0	0	0	0	500	2	[illegible]	0	0	0	0	2000	500	8	4000	0	500	9508
70.0-80.0	0	0	0	0	[illegible]	0	0	0	0	0	8	1000	10000	12000	300	0	23308
0.0-80.0	3008	508	16508	524	2000	0	8	0	1000	16	2016	1508	10024	16000	1808	2500	57428

560 224

INDIVIDUAL SOURCE CONCENTRATION (PCI/M3)---NO RESUSPENSION

THETA= 0.0 DEGREE ANGLE

	PARTICULATES				RADON AND DAUGHTERS					
DISTANCE	238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
0.10	2.31E-03	2.31E-03	2.31E-03	2.31E-03	1.81E+02	6.16E+01	1.98E+00	5.83E-02	2.35E-09	0.0
0.50	7.78E-04	7.78E-04	7.78E-04	7.78E-04	8.75E+01	7.12E+01	1.05E+01	1.31E+00	2.31E-07	2.92E-16
1.00	1.43E-04	1.43E-04	1.43E-04	1.43E-04	2.24E+01	2.11E+01	7.13E+00	2.01E+00	8.96E-07	6.57E-15
2.00	2.85E-05	2.85E-05	2.85E-05	2.85E-05	6.40E+00	6.28E+00	3.75E+00	2.00E+00	2.23E-06	8.81E-14
3.00	1.16E-05	1.16E-05	1.16E-05	1.16E-05	3.27E+00	3.25E+00	2.41E+00	1.69E+00	3.26E-06	3.44E-13
4.00	6.26E-06	6.26E-06	6.26E-06	6.26E-06	2.09E+00	2.08E+00	1.72E+00	1.38E+00	4.00E-06	8.53E-13
5.00	3.90E-06	3.90E-06	3.90E-06	3.90E-06	1.50E+00	1.50E+00	1.31E+00	1.14E+00	4.52E-06	1.67E-12
10.00	9.26E-07	9.26E-07	9.26E-07	9.26E-07	5.78E-01	5.78E-01	5.54E-01	5.30E-01	5.55E-06	1.11E-11
20.00	2.25E-07	2.25E-07	2.25E-07	2.25E-07	2.41E-01	2.42E-01	2.39E-01	2.36E-01	5.76E-06	5.85E-11
30.00	1.01E-07	1.01E-07	1.01E-07	1.01E-07	1.48E-01	1.48E-01	1.48E-01	1.47E-01	5.72E-06	1.43E-10
40.00	5.69E-08	5.69E-08	5.69E-08	5.69E-08	1.05E-01	1.05E-01	1.05E-01	1.05E-01	5.65E-06	2.63E-10
50.00	3.64E-08	3.64E-08	3.64E-08	3.64E-08	7.99E-02	8.00E-02	8.03E-02	8.05E-02	5.57E-06	4.16E-10
60.00	2.51E-08	2.51E-08	2.51E-08	2.51E-08	6.40E-02	6.40E-02	6.43E-02	6.45E-02	5.49E-06	6.02E-10
70.00	1.83E-08	1.83E-08	1.83E-08	1.83E-08	5.28E-02	5.29E-02	5.31E-02	5.33E-02	5.41E-06	8.19E-10
80.00	1.40E-08	1.40E-08	1.40E-08	1.40E-08	4.47E-02	4.47E-02	4.49E-02	4.51E-02	5.33E-06	1.07E-09

THETA= 22.50 DEGREE ANGLE

	PARTICULATES				RADON AND DAUGHTERS					
DISTANCE	238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
0.10	2.98E-03	2.98E-03	2.98E-03	2.98E-03	2.41E+02	7.61E+01	2.38E+00	7.01E-02	2.82E-09	0.0
0.50	6.32E-04	6.32E-04	6.32E-04	6.32E-04	6.85E+01	5.24E+01	7.56E+00	9.44E-01	1.68E-07	2.12E-16
1.00	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.60E+01	1.44E+01	4.68E+00	1.31E+00	5.86E-07	4.32E-15
2.00	2.20E-05	2.20E-05	2.20E-05	2.20E-05	4.32E+00	4.16E+00	2.35E+00	1.25E+00	1.39E-06	5.53E-14
3.00	9.42E-06	9.42E-06	9.42E-06	9.42E-06	2.22E+00	2.19E+00	1.53E+00	1.06E+00	2.04E-06	2.17E-13
4.00	5.28E-06	5.28E-06	5.28E-06	5.28E-06	1.43E+00	1.42E+00	1.11E+00	8.73E-01	2.52E-06	5.39E-13
5.00	3.40E-06	3.40E-06	3.40E-06	3.40E-06	1.03E+00	1.03E+00	8.51E-01	7.22E-01	2.86E-06	1.06E-12
10.00	9.06E-07	9.06E-07	9.06E-07	9.06E-07	3.98E-01	3.98E-01	3.68E-01	3.44E-01	3.53E-06	7.08E-12
20.00	2.51E-07	2.51E-07	2.51E-07	2.51E-07	1.65E-01	1.66E-01	1.62E-01	1.57E-01	3.69E-06	3.73E-11
30.00	1.21E-07	1.21E-07	1.21E-07	1.21E-07	1.01E-01	1.01E-01	1.01E-01	9.95E-02	3.67E-06	9.12E-11
40.00	7.15E-08	7.15E-08	7.15E-08	7.15E-08	7.15E-02	7.15E-02	7.16E-02	7.13E-02	3.63E-06	1.68E-10
50.00	4.72E-08	4.72E-08	4.72E-08	4.72E-08	5.45E-02	5.46E-02	5.47E-02	5.47E-02	3.58E-06	2.65E-10
60.00	3.34E-08	3.34E-08	3.34E-08	3.34E-08	4.36E-02	4.36E-02	4.38E-02	4.39E-02	3.53E-06	3.84E-10
70.00	2.49E-08	2.49E-08	2.49E-08	2.49E-08	3.60E-02	3.60E-02	3.62E-02	3.63E-02	3.47E-06	5.22E-10
80.00	1.93E-08	1.93E-08	1.93E-08	1.93E-08	3.05E-02	3.05E-02	3.06E-02	3.07E-02	3.42E-06	6.79E-10

UDAD SAMPLE PROBLEM   UDAD 9   DATE 12/26/78   PAGE 25
METSET SAMPLE METSET
UDAD SAMPLE MILL   ORE PAD & GRINDING

INDIVIDUAL SOURCE CONCENTRATION (PCI/M3) AT EXTRA RECEPTORS---NO RESUSPENSION

#	IDENTIFICATION	<---------- PARTICULATES			---------->	<--------------- RADON AND DAUGHTERS					--------------->
		238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
1	FENCE POST	1.82E-04	1.82E-04	1.82E-04	1.82E-04	2.59E+01	2.33E+01	7.35E+00	2.01E+00	8.67E-07	5.99E-15
2	TRAILER	1.30E-04	1.30E-04	1.30E-04	1.30E-04	2.02E+01	1.86E+01	7.03E+00	2.33E+00	1.29E-06	1.40E-14
3	RANCH 1	2.68E-05	2.68E-05	2.68E-05	2.68E-05	5.61E+00	5.43E+00	3.36E+00	2.00E+00	2.78E-06	1.63E-13
4	RANCH 2	1.70E-06	1.70E-06	1.70E-06	1.70E-06	7.25E-01	7.25E-01	6.67E-01	6.22E-01	6.04E-06	1.09E-11
5	RANCH 3	4.29E-07	4.29E-07	4.29E-07	4.29E-07	2.84E-01	2.84E-01	2.78E-01	2.69E-01	6.50E-06	6.89E-11
6	RANCH 3V	4.29E-07	4.29E-07	4.29E-07	4.29E-07	2.84E-01	2.84E-01	2.78E-01	2.69E-01	6.50E-06	6.89E-11
7	RANCH 4	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.27E-01	1.27E-01	1.27E-01	1.26E-01	6.37E-06	2.87E-10
8	RANCH 5	2.00E-07	2.00E-07	2.00E-07	2.00E-07	1.47E-01	1.47E-01	1.45E-01	1.42E-01	4.16E-06	6.58E-11
9	RANCH 6	1.73E-07	1.73E-07	1.73E-07	1.73E-07	1.94E-01	1.94E-01	1.93E-01	1.90E-01	4.77E-06	5.12E-11
10	RANCH 6V	1.73E-07	1.73E-07	1.73E-07	1.73E-07	1.94E-01	1.94E-01	1.93E-01	1.90E-01	4.77E-06	5.12E-11
11	RANCH 7	3.49E-08	3.49E-08	3.49E-08	3.49E-08	6.96E-02	6.96E-02	6.97E-02	[illegible]	2.65E-06	6.21E-11
12	RANCH 8	6.88E-08	6.88E-08	6.88E-08	6.88E-08	1.05E-01	1.05E-01	1.05E-01	1.05E-01	3.73E-06	7.64E-11
13	RANCH 9	4.17E-08	4.17E-08	4.17E-08	4.17E-08	7.07E-02	7.08E-02	7.10E-02	[illegible]	3.66E-06	1.56E-10
14	RANCH 10	5.09E-08	5.09E-08	5.09E-08	5.09E-08	9.22E-02	9.23E-02	9.26E-02	9.26E-02	4.03E-06	1.19E-10
15	RANCH 11	9.82E-08	9.82E-08	9.82E-08	9.82E-08	1.09E-01	1.09E-01	[illegible]	[illegible]	3.10E-06	4.29E-11
16	RANCH 12	1.52E-08	1.52E-08	1.52E-08	1.52E-08	4.38E-02	4.38E-02	4.40E-02	4.42E-02	[illegible]	3.25E-10
17	RANCH 12V	1.52E-08	1.52E-08	1.52E-08	1.52E-08	4.38E-02	4.38E-02	4.40E-02	4.42E-02	[illegible]	3.25E-10
18	RANCH 13	1.19E-08	1.19E-08	1.19E-08	1.19E-08	3.57E-02	3.58E-02	3.59E-02	3.60E-02	3.55E-06	4.93E-10
19	RANCH 14	1.10E-08	1.10E-08	1.10E-08	1.10E-08	3.45E-02	3.45E-02	3.47E-02	3.48E-02	3.74E-06	6.01E-10
20	RANCH 15	2.82E-08	2.82E-08	2.82E-08	2.82E-08	5.43E-02	5.43E-02	5.45E-02	5.46E-02	3.37E-06	1.97E-10
21	RANCH 16	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.31E-02	1.31E-02	1.31E-02	1.31E-02	7.81E-07	4.97E-11
22	RANCH 16V	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.31E-02	1.31E-02	1.31E-02	1.31E-02	7.81E-07	4.97E-11
23	WEST CITY	5.17E-09	5.17E-09	5.17E-09	5.17E-09	2.66E-02	2.66E-02	2.67E-02	2.68E-02	3.22E-06	6.18E-10
24	EAST CITY	7.78E-08	7.78E-08	7.78E-08	7.78E-08	8.41E-02	8.41E-02	8.43E-02	8.41E-02	5.24E-06	3.57E-10
25	RED TOWN	1.26E-08	1.26E-08	1.26E-08	1.26E-08	3.35E-02	3.35E-02	3.37E-02	3.38E-02	3.47E-06	5.29E-10
26	BLUE TOWN	1.90E-08	1.90E-08	1.90E-08	1.90E-08	5.14E-02	5.15E-02	5.17E-02	5.17E-02	2.70E-06	1.14E-10
27	BROWN TOWN	7.56E-08	7.56E-08	7.56E-08	7.56E-08	1.15E-01	1.15E-01	1.15E-01	1.14E-01	4.26E-06	9.82E-11
28	GREEN TOWN	7.77E-08	7.77E-08	7.77E-08	7.77E-08	7.48E-02	7.49E-02	7.48E-02	7.44E-02	3.54E-06	1.44E-10
29	ORANGE TOWN	6.59E-09	6.59E-09	6.59E-09	6.59E-09	2.60E-02	2.60E-02	2.61E-02	2.62E-02	2.37E-06	2.90E-10
30	PURPLE TOWN	5.24E-08	5.24E-08	5.24E-08	5.24E-08	6.79E-02	6.79E-02	6.82E-02	6.83E-02	5.87E-06	7.22E-10
31	WHITE TOWN	7.49E-09	7.49E-09	7.49E-09	7.49E-09	2.88E-02	2.89E-02	2.90E-02	2.91E-02	2.47E-06	2.66E-10
32	E INDIANRES	3.44E-08	3.44E-08	3.44E-08	3.44E-08	3.78E-02	3.78E-02	3.79E-02	3.80E-02	3.32E-06	4.27E-10
33	E INDIANRES	3.57E-09	3.57E-09	3.57E-09	3.57E-09	2.19E-02	2.19E-02	2.20E-02	2.21E-02	2.58E-06	4.80E-10
34	EAST RURAL	6.62E-08	6.62E-08	6.62E-08	6.62E-08	7.65E-02	7.65E-02	7.67E-02	7.67E-02	5.39E-06	4.60E-10
35	NORTH RURAL	6.91E-08	6.91E-08	6.91E-08	6.91E-08	1.10E-01	1.10E-01	1.10E-01	1.09E-01	4.39E-06	1.17E-10
36	NW RURAL	1.91E-08	1.91E-08	1.91E-08	1.91E-08	4.95E-02	4.95E-02	4.97E-02	4.98E-02	2.61E-06	1.13E-10
37	WEST RURAL	3.51E-09	3.51E-09	3.51E-09	3.51E-09	2.75E-02	2.75E-02	2.77E-02	2.77E-02	2.92E-06	4.34E-10
38	SOUTH RURAL	2.75E-08	2.75E-08	2.75E-08	2.75E-08	5.79E-02	5.80E-02	5.82E-02	5.83E-02	3.61E-06	2.17E-10
39	SW RURAL	1.38E-08	1.38E-08	1.38E-08	1.38E-08	4.14E-02	4.14E-02	4.16E-02	4.18E-02	3.95E-06	4.96E-10
40	AGRICULTURE 1	7.46E-08	7.46E-08	7.46E-08	7.46E-08	8.32E-02	8.33E-02	8.35E-02	8.34E-02	5.50E-06	4.17E-10
41	AGRICULTURE 2	9.01E-08	9.01E-08	9.01E-08	9.01E-08	8.78E-02	8.79E-02	8.78E-02	8.74E-02	[illegible]	1.98E-10
42	AGRICULTURE 3	7.09E-08	7.09E-08	7.09E-08	7.09E-08	1.11E-01	1.11E-01	[illegible]	1.11E-01	4.37E-06	1.12E-10
43	AGRICULTURE 4	2.02E-08	2.02E-08	2.02E-08	2.02E-08	5.11E-02	5.12E-02	5.14E-02	5.14E-02	2.62E-06	1.07E-10
44	AGRICULTURE 5	4.16E-09	4.16E-09	4.16E-09	4.16E-09	3.18E-02	3.18E-02	[illegible]	3.21E-02	2.90E-06	3.24E-10
45	AGRICULTURE 6	5.35E-09	5.35E-09	5.35E-09	5.35E-09	2.97E-02	2.97E-02	[illegible]	3.00E-02	3.13E-06	4.63E-10

INDIVIDUAL SOURCE CONCENTRATION (PCI/M3)---NO RESUSPENSION

THETA= 0.0 DEGREE ANGLE

DISTANCE	PARTICULATES 238U	230TH	226RA	210PB	RADON AND DAUGHTERS 222RN	218PO	214PB	214BI	210PB	210PO
0.10	1.26E-02	6.27E-04	2.51E-05	2.51E-05	0.0	0.0	0.0	0.0	0.0	0.0
0.50	1.77E-02	8.80E-04	3.51E-05	3.51E-05	0.0	0.0	0.0	0.0	0.0	0.0
1.00	7.32E-03	3.64E-04	1.45E-05	1.45E-05	0.0	0.0	0.0	0.0	0.0	0.0
2.00	2.03E-03	1.01E-04	4.04E-06	4.04E-06	0.0	0.0	0.0	0.0	0.0	0.0
3.00	8.36E-04	4.41E-05	1.76E-06	1.76E-06	0.0	0.0	0.0	0.0	0.0	0.0
4.00	4.83E-04	2.40E-05	9.60E-07	9.60E-07	0.0	0.0	0.0	0.0	0.0	0.0
5.00	3.00E-04	1.49E-05	5.96E-07	5.96E-07	0.0	0.0	0.0	0.0	0.0	0.0
10.00	6.64E-05	3.30E-06	1.32E-07	1.32E-07	0.0	0.0	0.0	0.0	0.0	0.0
20.00	1.45E-05	7.19E-07	2.87E-08	2.87E-08	0.0	0.0	0.0	0.0	0.0	0.0
30.00	6.14E-06	3.05E-07	1.22E-08	1.22E-08	0.0	0.0	0.0	0.0	0.0	0.0
40.00	3.39E-06	1.68E-07	6.73E-09	6.73E-09	0.0	0.0	0.0	0.0	0.0	0.0
50.00	2.14E-06	1.06E-07	4.24E-09	4.24E-09	0.0	0.0	0.0	0.0	0.0	0.0
60.00	1.46E-06	7.25E-08	2.90E-09	2.90E-09	0.0	0.0	0.0	0.0	0.0	0.0
70.00	1.06E-06	5.25E-08	2.10E-09	2.10E-09	0.0	0.0	0.0	0.0	0.0	0.0
80.00	8.01E-07	3.98E-08	1.59E-09	1.59E-09	0.0	0.0	0.0	0.0	0.0	0.0

THETA= 22.50 DEGREE ANGLE

DISTANCE	PARTICULATES 238U	230TH	226RA	210PB	RADON AND DAUGHTERS 222RN	218PO	214PB	214BI	210PB	210PO
0.10	1.76E-02	8.75E-04	3.49E-05	3.49E-05	0.0	0.0	0.0	0.0	0.0	0.0
0.50	1.36E-02	6.77E-04	2.71E-05	2.71E-05	0.0	0.0	0.0	0.0	0.0	0.0
1.00	5.44E-03	2.71E-04	1.08E-05	1.08E-05	0.0	0.0	0.0	0.0	0.0	0.0
2.00	1.54E-03	7.66E-05	3.06E-06	3.06E-06	0.0	0.0	0.0	0.0	0.0	0.0
3.00	6.88E-04	3.42E-05	1.37E-06	1.37E-06	0.0	0.0	0.0	0.0	0.0	0.0
4.00	3.84E-04	1.91E-05	7.63E-07	7.63E-07	0.0	0.0	0.0	0.0	0.0	0.0
5.00	2.44E-04	1.21E-05	4.85E-07	4.85E-07	0.0	0.0	0.0	0.0	0.0	0.0
10.00	6.02E-05	2.99E-06	1.20E-07	1.20E-07	0.0	0.0	0.0	0.0	0.0	0.0
20.00	1.53E-05	7.63E-07	3.05E-08	3.05E-08	0.0	0.0	0.0	0.0	0.0	0.0
30.00	7.14E-06	3.55E-07	1.42E-08	1.42E-08	0.0	0.0	0.0	0.0	0.0	0.0
40.00	4.16E-06	2.07E-07	8.26E-09	8.26E-09	0.0	0.0	0.0	0.0	0.0	0.0
50.00	2.72E-06	1.35E-07	5.41E-09	5.41E-09	0.0	0.0	0.0	0.0	0.0	0.0
60.00	1.91E-06	9.51E-08	3.80E-09	3.80E-09	0.0	0.0	0.0	0.0	0.0	0.0
70.00	1.42E-06	7.05E-08	2.82E-09	2.82E-09	0.0	0.0	0.0	0.0	0.0	0.0
80.00	1.10E-06	5.46E-08	2.18E-09	2.18E-09	0.0	0.0	0.0	0.0	0.0	0.0

560 227

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 34
METSET SAMPLE METSET
UDAD SAMPLE MILL DRYING & PACKAGING

INDIVIDUAL SOURCE CONCENTRATION (PCI/M3) AT EXTRA RECEPTORS---NO RESUSPENSION

		<---------- PARTICULATES			---------->	<--------------- RADON AND DAUGHTERS					-------------->
#	IDENTIFICATION	238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
1	FENCE POST	1.09E-02	5.44E-04	2.17E-05	2.17E-05	0.0	0.0	0.0	0.0	0.0	0.0
2	TRAILER	7.75E-03	3.85E-04	1.54E-05	1.54E-05	0.0	0.0	0.0	0.0	0.0	0.0
3	RANCH 1	1.87E-03	9.28E-05	3.71E-06	3.71E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	RANCH 2	1.16E-04	5.79E-06	2.31E-07	2.31E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	RANCH 3	2.63E-05	1.31E-06	5.23E-08	5.23E-08	0.0	0.0	0.0	0.0	0.0	0.0
6	RANCH 3V	2.63E-05	1.31E-06	5.23E-08	5.23E-08	0.0	0.0	0.0	0.0	0.0	0.0
7	RANCH 4	7.64E-06	3.80E-07	1.52E-08	1.52E-08	0.0	0.0	0.0	0.0	0.0	0.0
8	RANCH 5	1.19E-05	5.92E-07	2.36E-08	2.36E-08	0.0	0.0	0.0	0.0	0.0	0.0
9	RANCH 6	1.11E-05	5.53E-07	2.21E-08	2.21E-08	0.0	0.0	0.0	0.0	0.0	0.0
10	RANCH 6V	1.11E-05	5.53E-07	2.21E-08	2.21E-08	0.0	0.0	0.0	0.0	0.0	0.0
11	RANCH 7	2.23E-06	1.11E-07	4.42E-09	4.42E-09	0.0	0.0	0.0	0.0	0.0	0.0
12	RANCH 8	4.28E-06	2.13E-07	8.50E-09	8.50E-09	0.0	0.0	0.0	0.0	0.0	0.0
13	RANCH 9	2.51E-06	1.25E-07	4.98E-09	4.98E-09	0.0	0.0	0.0	0.0	0.0	0.0
14	RANCH 10	3.12E-06	1.55E-07	6.19E-09	6.19E-09	0.0	0.0	0.0	0.0	0.0	0.0
15	RANCH 11	6.25E-06	3.11E-07	1.24E-08	1.24E-08	0.0	0.0	0.0	0.0	0.0	0.0
16	RANCH 12	8.89E-07	4.42E-08	1.77E-09	1.77E-09	0.0	0.0	0.0	0.0	0.0	0.0
17	RANCH 12V	8.89E-07	4.42E-08	1.77E-09	1.77E-09	0.0	0.0	0.0	0.0	0.0	0.0
18	RANCH 13	6.90E-07	3.43E-08	1.37E-09	1.37E-09	0.0	0.0	0.0	0.0	0.0	0.0
19	RANCH 14	6.37E-07	3.17E-08	1.27E-09	1.27E-09	0.0	0.0	0.0	0.0	0.0	0.0
20	RANCH 15	1.67E-06	8.32E-08	3.33E-09	3.33E-09	0.0	0.0	0.0	0.0	0.0	0.0
21	RANCH 16	9.11E-07	4.53E-08	1.81E-09	1.81E-09	0.0	0.0	0.0	0.0	0.0	0.0
22	RANCH 16V	9.11E-07	4.53E-08	1.81E-09	1.81E-09	0.0	0.0	0.0	0.0	0.0	0.0
23	WEST CITY	2.97E-07	1.48E-08	5.91E-10	5.91E-10	0.0	0.0	0.0	0.0	0.0	0.0
24	EAST CITY	4.46E-06	2.22E-07	8.85E-09	8.85E-09	0.0	0.0	0.0	0.0	0.0	0.0
25	RED TOWN	7.25E-07	3.61E-08	1.44E-09	1.44E-09	0.0	0.0	0.0	0.0	0.0	0.0
26	BLUE TOWN	1.18E-06	5.88E-08	2.35E-09	2.35E-09	0.0	0.0	0.0	0.0	0.0	0.0
27	BROWN TOWN	4.68E-06	2.32E-07	9.29E-09	9.29E-09	0.0	0.0	0.0	0.0	0.0	0.0
28	GREEN TOWN	4.51E-06	2.24E-07	8.95E-09	8.95E-09	0.0	0.0	0.0	0.0	0.0	0.0
29	ORANGE TOWN	3.93E-07	1.95E-08	7.80E-10	7.80E-10	0.0	0.0	0.0	0.0	0.0	0.0
30	PURPLE TOWN	2.98E-06	1.48E-07	5.92E-09	5.92E-09	0.0	0.0	0.0	0.0	0.0	0.0
31	WHITE TOWN	4.46E-07	2.22E-08	8.86E-10	8.86E-10	0.0	0.0	0.0	0.0	0.0	0.0
32	E INDIANRES	1.97E-06	9.77E-08	3.90E-09	3.90E-09	0.0	0.0	0.0	0.0	0.0	0.0
33	E INDIANRES	2.09E-07	1.04E-08	4.16E-10	4.16E-10	0.0	0.0	0.0	0.0	0.0	0.0
34	EAST RURAL	3.78E-06	1.88E-07	7.51E-09	7.51E-09	0.0	0.0	0.0	0.0	0.0	0.0
35	NORTH RURAL	4.24E-06	2.11E-07	8.41E-09	8.41E-09	0.0	0.0	0.0	0.0	0.0	0.0
36	NW RURAL	1.18E-06	5.86E-08	2.34E-09	2.34E-09	0.0	0.0	0.0	0.0	0.0	0.0
37	WEST RURAL	2.06E-07	1.02E-08	4.09E-10	4.09E-10	0.0	0.0	0.0	0.0	0.0	0.0
38	SOUTH RURAL	1.64E-06	8.18E-08	3.27E-09	3.27E-09	0.0	0.0	0.0	0.0	0.0	0.0
39	SW RURAL	8.06E-07	4.01E-08	1.60E-09	1.60E-09	0.0	0.0	0.0	0.0	0.0	0.0
40	AGRICULTURE 1	4.27E-06	2.12E-07	8.48E-09	8.48E-09	0.0	0.0	0.0	0.0	0.0	0.0
41	AGRICULTURE 2	5.21E-06	2.59E-07	1.03E-08	1.03E-08	0.0	0.0	0.0	0.0	0.0	0.0
42	AGRICULTURE 3	4.36E-06	2.17E-07	8.65E-09	8.65E-09	0.0	0.0	0.0	0.0	0.0	0.0
43	AGRICULTURE 4	1.25E-06	6.21E-08	2.48E-09	2.48E-09	0.0	0.0	0.0	0.0	0.0	0.0
44	AGRICULTURE 5	2.48E-07	1.23E-08	4.92E-10	4.92E-10	0.0	0.0	0.0	0.0	0.0	0.0
45	AGRICULTURE 6	3.11E-07	1.55E-08	6.18E-10	6.18E-10	0.0	0.0	0.0	0.0	0.0	0.0

560 228

METSET SAMPLE METSET
UDAD SAMPLE MILL TAILING

INDIVIDUAL SOURCE CONCENTRATION (PCI/M3)---NO RESUSPENSION

THETA= 0.0 DEGREE ANGLE

DISTANCE	PARTICULATES				RADON AND DAUGHTERS					
	238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
0.10	1.36E-04	1.84E-03	1.93E-03	1.93E-03	4.08E+03	2.97E+03	3.99E+02	5.50E+01	1.27E-05	3.52E-14
0.50	7.99E-05	1.08E-03	1.14E-03	1.14E-03	1.90E+03	1.62E+03	3.29E+02	6.34E+01	2.04E-05	9.93E-14
1.00	3.06E-05	4.16E-04	4.37E-04	4.37E-04	7.02E+02	6.67E+02	2.46E+02	7.88E+01	4.33E-05	5.27E-13
2.00	1.27E-05	1.73E-04	1.82E-04	1.82E-04	2.74E+02	2.69E+02	1.65E+02	9.08E+01	1.09E-04	5.09E-12
3.00	7.42E-06	1.01E-04	1.06E-04	1.06E-04	1.60E+02	1.59E+02	1.19E+02	8.47E+01	1.71E-04	1.97E-11
4.00	4.88E-06	6.62E-05	6.96E-05	6.96E-05	1.10E+02	1.10E+02	9.09E+01	7.35E+01	2.19E-04	4.93E-11
5.00	3.47E-06	4.71E-05	4.95E-05	4.95E-05	8.21E+01	8.20E+01	7.20E+01	6.26E+01	2.54E-04	9.76E-11
10.00	1.13E-06	1.54E-05	1.62E-05	1.62E-05	3.42E+01	3.42E+01	3.28E+01	3.14E+01	3.31E-04	6.77E-10
20.00	3.46E-07	4.70E-06	4.94E-06	4.94E-06	1.49E+01	1.49E+01	1.47E+01	1.45E+01	3.56E-04	3.65E-09
30.00	1.70E-07	2.31E-06	2.43E-06	2.43E-06	9.25E+00	9.25E+00	9.25E+00	9.22E+00	3.59E-04	9.02E-09
40.00	1.02E-07	1.39E-06	1.46E-06	1.46E-06	6.61E+00	6.61E+00	6.63E+00	6.63E+00	3.58E-04	1.67E-08
50.00	6.88E-08	9.33E-07	9.81E-07	9.81E-07	5.08E+00	5.08E+00	5.10E+00	5.11E+00	3.55E-04	2.66E-08
60.00	4.96E-08	6.73E-07	7.08E-07	7.08E-07	4.08E+00	4.09E+00	4.11E+00	4.12E+00	3.51E-04	3.87E-08
70.00	3.81E-08	5.17E-07	5.43E-07	5.43E-07	3.39E+00	3.39E+00	3.40E+00	3.42E+00	3.47E-04	5.27E-08
80.00	3.07E-08	4.16E-07	4.37E-07	4.37E-07	2.87E+00	2.87E+00	2.89E+00	2.90E+00	3.43E-04	6.88E-08

THETA= 22.50 DEGREE ANGLE

DISTANCE	PARTICULATES				RADON AND DAUGHTERS					
	238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
0.10	1.83E-04	2.48E-03	2.61E-03	2.61E-03	4.93E+03	3.36E+03	4.07E+02	5.27E+01	1.15E-05	2.84E-14
0.50	3.76E-04	5.10E-03	5.36E-03	5.36E-03	3.53E+03	2.65E+03	4.06E+02	6.36E+01	1.68E-05	5.92E-14
1.00	1.23E-04	1.68E-03	1.76E-03	1.76E-03	1.24E+03	1.14E+03	3.60E+02	1.00E+02	4.69E-05	4.37E-13
2.00	4.39E-05	5.96E-04	6.26E-04	6.26E-04	3.74E+02	3.63E+02	2.06E+02	1.07E+02	1.15E-04	4.52E-12
3.00	2.24E-05	3.05E-04	3.20E-04	3.20E-04	1.80E+02	1.78E+02	1.26E+02	8.56E+01	1.59E-04	1.60E-11
4.00	1.38E-05	1.88E-04	1.97E-04	1.97E-04	1.10E+02	1.10E+02	8.64E+01	6.77E+01	1.88E-04	3.80E-11
5.00	9.46E-06	1.28E-04	1.35E-04	1.35E-04	7.66E+01	7.64E+01	6.39E+01	5.42E+01	2.07E-04	7.24E-11
10.00	2.87E-06	3.90E-05	4.10E-05	4.10E-05	2.70E+01	2.70E+01	2.51E+01	2.35E+01	2.37E-04	4.61E-10
20.00	8.51E-07	1.16E-05	1.21E-05	1.21E-05	1.07E+01	1.07E+01	1.05E+01	1.01E+01	2.37E-04	2.37E-09
30.00	4.23E-07	5.74E-06	6.03E-06	6.03E-06	6.45E+00	6.45E+00	6.42E+00	6.34E+00	2.33E-04	5.76E-09
40.00	2.58E-07	3.50E-06	3.67E-06	3.67E-06	4.56E+00	4.56E+00	4.56E+00	4.54E+00	2.31E-04	1.06E-08
50.00	1.75E-07	2.38E-06	2.50E-06	2.50E-06	3.49E+00	3.49E+00	3.50E+00	3.50E+00	2.29E-04	1.69E-08
60.00	1.28E-07	1.74E-06	1.82E-06	1.82E-06	2.80E+00	2.80E+00	2.82E+00	2.82E+00	2.26E-04	2.46E-08
70.00	9.90E-08	1.34E-06	1.41E-06	1.41E-06	2.32E+00	2.32E+00	2.33E+00	2.34E+00	2.24E-04	3.36E-08
80.00	8.02E-08	1.09E-06	1.14E-06	1.14E-06	1.97E+00	1.97E+00	1.98E+00	1.99E+00	2.21E-04	4.38E-08

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 43
METSET SAMPLE METSET
UDAD SAMPLE MILL TAILING

INDIVIDUAL SOURCE CONCENTRATION (PCI/M3) AT EXTRA RECEPTORS---NO RESUSPENSION

#	IDENTIFICATION	<---------- PARTICULATES			---------->	<--------------- RADON AND DAUGHTERS					--------------->
		238U	230TH	226RA	210PB	222RN	218PO	214PB	214BI	210PB	210PO
1	FENCE POST	1.29E-03	1.75E-02	1.84E-02	1.84E-02	4.23E+03	3.22E+03	5.68E+02	1.01E+02	3.02E-05	1.31E-13
2	TRAILER	7.68E-04	1.04E-02	1.10E-02	1.10E-02	2.41E+03	2.06E+03	5.18E+02	1.21E+02	4.77E-05	3.32E-13
3	RANCH 1	1.29E-04	1.75E-03	1.84E-03	1.84E-03	4.17E+02	4.00E+02	2.31E+02	1.26E+02	1.52E-04	7.24E-12
4	RANCH 2	9.88E-06	1.34E-04	1.41E-04	1.41E-04	4.94E+01	4.94E+01	4.52E+01	4.21E+01	3.88E-04	6.38E-10
5	RANCH 3	2.46E-06	3.34E-05	3.51E-05	3.51E-05	1.84E+01	1.84E+01	1.80E+01	1.75E+01	4.14E-04	4.22E-09
6	RANCH 3V	2.46E-06	3.34E-05	3.51E-05	3.51E-05	1.84E+01	1.84E+01	1.80E+01	1.75E+01	4.14E-04	4.22E-09
7	RANCH 4	7.64E-07	1.04E-05	1.09E-05	1.09E-05	8.32E+00	8.33E+00	8.32E+00	8.28E+00	4.14E-04	1.83E-08
8	RANCH 5	8.60E-07	1.17E-05	1.23E-05	1.23E-05	9.48E+00	9.40E+00	9.35E+00	9.15E+00	2.68E-04	4.21E-09
9	RANCH 6	2.49E-07	3.37E-06	3.54E-06	3.54E-06	1.22E+01	1.22E+01	1.21E+01	1.20E+01	3.02E-04	3.28E-09
10	RANCH 6V	2.49E-07	3.37E-06	3.54E-06	3.54E-06	1.22E+01	1.22E+01	1.21E+01	1.20E+01	3.02E-04	3.28E-09
11	RANCH 7	4.07E-08	5.52E-07	5.80E-07	5.80E-07	4.50E+00	4.50E+00	4.51E+00	4.51E+00	1.74E-04	4.18E-09
12	RANCH 8	5.12E-08	6.95E-07	7.30E-07	7.30E-07	6.78E+00	6.79E+00	6.79E+00	6.76E+00	2.45E-04	5.17E-09
13	RANCH 9	3.15E-08	4.28E-07	4.50E-07	4.50E-07	4.53E+00	4.53E+00	4.59E+00	4.59E+00	2.40E-04	1.04E-08
14	RANCH 10	2.13E-08	2.89E-07	3.03E-07	3.03E-07	5.91E+00	5.91E+00	5.93E+00	5.93E+00	2.60E-04	7.72E-09
15	RANCH 11	1.09E-07	1.43E-06	1.55E-06	1.55E-06	7.07E+00	7.08E+00	7.06E+00	7.00E+00	2.01E-04	2.81E-09
16	RANCH 12	1.36E-08	1.85E-07	1.94E-07	1.94E-07	2.85E+00	2.85E+00	2.86E+00	2.87E+00	2.30E-04	2.16E-08
17	RANCH 12V	1.36E-08	1.85E-07	1.94E-07	1.94E-07	2.85E+00	2.85E+00	2.86E+00	2.87E+00	2.30E-04	2.16E-08
18	RANCH 13	1.04E-08	1.41E-07	1.49E-07	1.49E-07	2.33E+00	2.33E+00	2.34E+00	2.35E+00	2.33E-04	3.27E-08
19	RANCH 14	6.52E-09	8.85E-08	9.29E-08	9.29E-08	2.26E+00	2.26E+00	2.27E+00	2.28E+00	2.45E-04	3.96E-08
20	RANCH 15	2.64E-08	3.58E-07	3.76E-07	3.76E-07	3.58E+00	3.58E+00	3.59E+00	3.60E+00	2.23E-04	1.31E-08
21	RANCH 16	1.78E-08	2.42E-07	2.54E-07	2.54E-07	8.65E-01	8.66E-01	8.68E-01	8.68E-01	5.13E-05	3.22E-09
22	RANCH 16V	1.78E-08	2.42E-07	2.54E-07	2.54E-07	8.65E-01	8.66E-01	8.68E-01	8.68E-01	5.13E-05	3.22E-09
23	WEST CITY	7.13E-09	9.68E-08	1.02E-07	1.02E-07	1.73E+00	1.73E+00	1.74E+00	1.75E+00	2.11E-04	4.09E-08
24	EAST CITY	4.55E-07	6.18E-06	6.49E-06	6.49E-06	5.51E+00	5.51E+00	5.52E+00	5.51E+00	3.41E-04	2.30E-08
25	RED TOWN	1.05E-08	1.42E-07	1.49E-07	1.49E-07	2.16E+00	2.16E+00	2.17E+00	2.17E+00	2.24E-04	3.45E-08
26	BLUE TOWN	2.70E-08	3.66E-07	3.84E-07	3.84E-07	3.25E+00	3.25E+00	3.27E+00	3.27E+00	1.73E-04	7.44E-09
27	BROWN TOWN	1.12E-07	1.52E-06	1.60E-06	1.60E-06	7.30E+00	7.30E+00	7.30E+00	7.27E+00	2.72E-04	6.35E-09
28	GREEN TOWN	2.79E-07	3.79E-06	3.98E-06	3.98E-06	4.91E+00	4.91E+00	4.91E+00	4.88E+00	2.32E-04	9.35E-09
29	ORANGE TOWN	7.58E-09	1.03E-07	1.08E-07	1.08E-07	1.70E+00	1.70E+00	1.71E+00	1.71E+00	1.56E-04	1.92E-08
30	PURPLE TOWN	3.17E-07	4.31E-06	4.53E-06	4.53E-06	4.47E+00	4.48E+00	4.49E+00	4.50E+00	3.85E-04	4.68E-08
31	WHITE TOWN	9.64E-09	1.31E-07	1.37E-07	1.37E-07	1.89E+00	1.89E+00	1.90E+00	1.90E+00	1.62E-04	1.76E-08
32	E INDIANRES	1.20E-07	1.62E-06	1.70E-06	1.70E-06	2.47E+00	2.47E+00	2.48E+00	2.49E+00	2.16E-04	2.74E-08
33	E INDIANRES	7.56E-09	1.03E-07	1.08E-07	1.08E-07	1.43E+00	1.43E+00	1.44E+00	1.44E+00	1.70E-04	3.18E-08
34	EAST RURAL	3.97E-07	5.38E-06	5.66E-06	5.66E-06	5.02E+00	5.03E+00	5.04E+00	5.04E+00	3.52E-04	2.98E-08
35	NORTH RURAL	1.06E-07	1.44E-06	1.51E-06	1.51E-06	6.99E+00	6.99E+00	7.00E+00	6.98E+00	2.81E-04	7.55E-09
36	NW RURAL	2.37E-08	3.21E-07	3.37E-07	3.37E-07	3.22E+00	3.22E+00	3.23E+00	3.23E+00	1.72E-04	7.57E-09
37	WEST RURAL	7.88E-09	1.07E-07	1.12E-07	1.12E-07	1.80E+00	1.80E+00	1.81E+00	1.81E+00	1.92E-04	2.88E-08
38	SOUTH RURAL	1.74E-08	2.37E-07	2.49E-07	2.49E-07	3.69E+00	3.69E+00	3.71E+00	3.71E+00	2.29E-04	1.37E-08
39	SW RURAL	6.48E-09	8.80E-08	9.24E-08	9.24E-08	2.66E+00	2.66E+00	2.68E+00	2.69E+00	2.55E-04	3.22E-08
40	AGRICULTURE 1	4.45E-07	6.04E-06	6.34E-06	6.34E-06	5.47E+00	5.47E+00	5.49E+00	5.48E+00	3.60E-04	2.70E-08
41	AGRICULTURE 2	4.32E-07	5.86E-06	6.15E-06	6.15E-06	5.72E+00	5.72E+00	5.72E+00	5.69E+00	2.85E-04	1.28E-08
42	AGRICULTURE 3	1.08E-07	1.47E-06	1.54E-06	1.54E-06	7.09E+00	7.09E+00	7.10E+00	7.07E+00	2.80E-04	7.26E-09
43	AGRICULTURE 4	2.51E-08	3.41E-07	3.58E-07	3.58E-07	3.32E+00	3.32E+00	3.33E+00	3.34E+00	1.72E-04	7.16E-09
44	AGRICULTURE 5	9.80E-09	1.33E-07	1.40E-07	1.40E-07	2.08E+00	2.08E+00	2.09E+00	2.10E+00	1.91E-04	2.16E-08
45	AGRICULTURE 6	8.40E-09	1.14E-07	1.20E-07	1.20E-07	1.94E+00	1.94E+00	1.95E+00	1.95E+00	2.05E-04	3.07E-08

560 230

THETA= 0.0 DEGREE ANGLE

TOTAL CONCENTRATION IN AIR (PCI/M3)

DISTANCE	238U	230TH	226RA	210PB	210PO	222RN
0.10	2.45E-02	7.76E-03	6.93E-03	6.95E-03	6.93E-03	4.26E+03
0.50	3.01E-02	4.46E-03	3.17E-03	3.20E-03	3.17E-03	1.99E+03
1.00	1.22E-02	1.50E-03	9.66E-04	1.02E-03	9.68E-04	7.25E+02
2.00	3.37E-03	4.91E-04	3.48E-04	4.80E-04	3.54E-04	2.80E+02
3.00	1.47E-03	2.54E-04	1.94E-04	4.00E-04	2.02E-04	1.64E+02
4.00	8.03E-04	1.57E-04	1.25E-04	3.89E-04	1.36E-04	1.12E+02
5.00	4.99E-04	1.07E-04	8.78E-05	3.94E-04	1.01E-04	8.36E+01
10.00	1.11E-04	3.19E-05	2.80E-05	4.27E-04	4.48E-05	3.48E+01
20.00	2.44E-05	9.17E-06	8.43E-06	4.38E-04	2.65E-05	1.51E+01
30.00	1.04E-05	4.42E-06	4.13E-06	4.37E-04	2.23E-05	9.39E+00
40.00	5.76E-06	2.62E-06	2.47E-06	4.33E-04	2.06E-05	6.71E+00
50.00	3.64E-06	1.75E-06	1.66E-06	4.29E-04	1.96E-05	5.16E+00
60.00	2.49E-06	1.25E-06	1.20E-06	4.24E-04	1.90E-05	4.15E+00
70.00	1.81E-06	9.55E-07	9.16E-07	4.19E-04	1.85E-05	3.44E+00
80.00	1.37E-06	7.64E-07	7.36E-07	4.14E-04	1.82E-05	2.92E+00

TOTAL ACTIVITY ON GROUND (PCI/M2)
OPERATION LIFETIME DEPOSITION (15 YEARS)

DISTANCE	238U	230TH	226RA	210PB	210PO
0.10	6.71E+04	5.89E+04	5.87E+04	5.87E+04	5.87E+04
0.50	8.09E+04	3.40E+04	3.18E+04	3.18E+04	3.18E+04
1.00	3.26E+04	1.20E+04	1.10E+04	1.11E+04	1.11E+04
2.00	9.09E+03	4.42E+03	4.21E+03	4.32E+03	4.31E+03
3.00	3.99E+03	2.41E+03	2.34E+03	2.51E+03	2.51E+03
4.00	2.19E+03	1.51E+03	1.48E+03	1.71E+03	1.70E+03
5.00	1.37E+03	1.03E+03	1.02E+03	1.28E+03	1.28E+03
10.00	3.08E+02	2.95E+02	2.95E+02	6.38E+02	6.26E+02
20.00	6.80E+01	7.50E+01	7.57E+01	4.45E+02	4.32E+02
30.00	2.89E+01	3.24E+01	3.27E+01	4.04E+02	3.92E+02
40.00	1.59E+01	1.75E+01	1.77E+01	3.88E+02	3.76E+02
50.00	1.00E+01	1.08E+01	1.08E+01	3.78E+02	3.66E+02
60.00	6.84E+00	7.19E+00	7.23E+00	3.71E+02	3.59E+02
70.00	4.95E+00	5.15E+00	5.18E+00	3.64E+02	3.53E+02
80.00	3.75E+00	3.91E+00	3.93E+00	3.59E+02	3.47E+02

560 231

THETA= 0.0 DEGREE ANGLE

RADON DAUGHTERS (PCI/M3), AND WORK LEVEL

DISTANCE	222RN	218PO	214PB	214BI	WL
0.10	4.26E+03	3.04E+03	4.01E+02	5.51E+01	5.36E-03
0.50	1.99E+03	1.69E+03	3.40E+02	6.48E+01	3.70E-03
1.00	7.25E+02	6.88E+02	2.54E+02	8.08E+01	2.30E-03
2.00	2.80E+02	2.75E+02	1.68E+02	9.28E+01	1.48E-03
3.00	1.64E+02	1.63E+02	1.22E+02	8.64E+01	1.11E-03
4.00	1.12E+02	1.12E+02	9.26E+01	7.49E+01	8.64E-04
5.00	8.36E+01	8.35E+01	7.33E+01	6.37E+01	6.95E-04
10.00	3.48E+01	3.48E+01	3.34E+01	3.19E+01	3.24E-04
20.00	1.51E+01	1.51E+01	1.50E+01	1.48E+01	1.47E-04
30.00	9.39E+00	9.40E+00	9.40E+00	9.36E+00	9.23E-05
40.00	6.71E+00	6.71E+00	6.74E+00	6.74E+00	6.62E-05
50.00	5.16E+00	5.16E+00	5.18E+00	5.19E+00	5.10E-05
60.00	4.15E+00	4.15E+00	4.17E+00	4.18E+00	4.10E-05
70.00	3.44E+00	3.44E+00	3.46E+00	3.47E+00	3.40E-05
80.00	2.92E+00	2.92E+00	2.93E+00	2.94E+00	2.88E-05

THETA= 22.50 DEGREE ANGLE

RADON DAUGHTERS (PCI/M3), AND WORK LEVEL

DISTANCE	222RN	218PO	214PB	214BI	WL
0.10	5.17E+03	3.43E+03	4.10E+02	5.28E+01	5.81E-03
0.50	3.60E+03	2.70E+03	4.13E+02	6.46E+01	5.12E-03
1.00	1.25E+03	1.15E+03	3.65E+02	1.01E+02	3.42E-03
2.00	3.78E+02	3.67E+02	2.03E+02	1.08E+02	1.84E-03
3.00	1.82E+02	1.80E+02	1.27E+02	8.66E+01	1.15E-03
4.00	1.12E+02	1.11E+02	8.75E+01	6.86E+01	8.14E-04
5.00	7.77E+01	7.74E+01	6.48E+01	5.49E+01	6.13E-04
10.00	2.74E+01	2.74E+01	2.55E+01	2.39E+01	2.47E-04
20.00	1.08E+01	1.08E+01	1.06E+01	1.03E+01	1.03E-04
30.00	6.55E+00	6.55E+00	6.52E+00	6.44E+00	6.38E-05
40.00	4.63E+00	4.63E+00	4.63E+00	4.61E+00	4.55E-05
50.00	3.55E+00	3.55E+00	3.56E+00	3.56E+00	3.50E-05
60.00	2.85E+00	2.85E+00	2.85E+00	2.86E+00	2.81E-05
70.00	2.36E+00	2.36E+00	2.37E+00	2.38E+00	2.33E-05
80.00	2.00E+00	2.00E+00	2.01E+00	2.02E+00	1.93E-05

560 232

TOTAL CONCENTRATION IN AIR (PCI/M3)

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	U238	TH230	RA226	PB210	PO210	RN222	WL
1	FENCE POST	0.9	0.4	0.0	2.02E-02	2.97E-02	3.03E-02	3.03E-02	3.03E-02	4.26E+03	6.65E-03
2	TRAILER	1.0	0.5	0.0	1.40E-02	1.78E-02	1.80E-02	1.81E-02	1.80E-02	2.43E+03	5.26E-03
3	RANCH 1	1.9	1.4	0.0	3.29E-03	3.04E-03	3.04E-03	3.23E-03	3.05E-03	4.22E+02	2.08E-03
4	RANCH 2	8.8	3.6	0.0	2.08E-04	2.30E-04	2.32E-04	6.99E-04	2.52E-04	5.01E+01	4.43E-04
5	RANCH 3	18.8	7.8	0.0	4.75E-05	5.72E-05	5.79E-05	5.57E-04	7.88E-05	1.87E+01	1.78E-04
6	RANCH 3V	18.8	7.8	0.0	4.75E-05	5.72E-05	5.79E-05	5.57E-04	7.88E-05	1.87E+01	1.78E-04
7	RANCH 4	36.5	15.0	0.0	1.39E-05	1.77E-05	1.79E-05	5.17E-04	3.89E-05	8.45E+00	8.29E-05
8	RANCH 5	12.0	21.8	0.0	2.11E-05	2.03E-05	2.03E-05	3.43E-04	3.38E-05	9.62E+00	9.27E-05
9	RANCH 6	-2.4	20.6	0.0	1.88E-05	6.66E-06	6.08E-06	3.70E-04	2.14E-05	1.24E+01	1.21E-04
10	RANCH 6V	-2.4	20.6	0.0	1.88E-05	6.66E-06	6.08E-06	3.70E-04	2.14E-05	1.24E+01	1.21E-04
11	RANCH 7	-18.2	23.3	0.0	3.74E-06	1.13E-06	1.01E-06	2.10E-04	9.81E-06	4.57E+00	4.50E-05
12	RANCH 8	-27.5	-2.5	0.0	7.15E-06	1.59E-06	1.31E-06	2.96E-04	1.37E-05	6.89E+00	6.77E-05
13	RANCH 9	-35.2	-14.8	0.0	4.20E-06	9.66E-07	8.07E-07	2.89E-04	1.29E-05	4.65E+00	4.58E-05
14	RANCH 10	-23.0	-22.4	0.0	5.18E-06	8.04E-07	5.86E-07	3.13E-04	1.37E-05	6.00E+00	5.92E-05
15	RANCH 11	-7.4	-21.8	0.0	1.05E-05	3.07E-06	2.70E-06	2.45E-04	1.29E-05	7.18E+00	7.02E-05
16	RANCH 12	-55.3	2.4	0.0	1.49E-06	3.97E-07	3.44E-07	2.77E-04	1.20E-05	2.89E+00	2.86E-05
17	RANCH 12V	-55.3	2.4	0.0	1.49E-06	3.97E-07	3.44E-07	2.77E-04	1.20E-05	2.89E+00	2.86E-05
18	RANCH 13	-67.5	-8.1	0.0	1.16E-06	3.05E-07	2.63E-07	2.80E-04	1.21E-05	2.36E+00	2.34E-05
19	RANCH 14	-55.7	-46.4	0.0	1.06E-06	2.13E-07	1.71E-07	2.96E-04	1.26E-05	2.29E+00	2.27E-05
20	RANCH 15	-23.3	-38.7	0.0	2.81E-06	7.63E-07	6.63E-07	2.69E-04	1.19E-05	3.63E+00	3.59E-05
21	RANCH 16	27.8	-38.3	0.0	1.53E-06	4.92E-07	4.42E-07	6.23E-05	3.04E-06	8.78E-01	8.66E-06
22	RANCH 16V	27.8	-38.3	0.0	1.53E-06	4.92E-07	4.42E-07	6.23E-05	3.04E-06	8.78E-01	8.66E-06
23	WEST CITY	-78.0	16.0	0.0	5.03E-07	1.90E-07	1.75E-07	2.54E-04	1.09E-05	1.76E+00	1.74E-05
24	EAST CITY	33.0	35.0	0.0	8.11E-06	1.05E-05	1.07E-05	4.22E-04	2.80E-05	5.60E+00	5.51E-05
25	RED TOWN	-65.0	-26.0	0.0	1.22E-06	3.10E-07	2.65E-07	2.70E-04	1.17E-05	2.19E+00	2.17E-05
26	BLUE TOWN	-27.0	27.0	0.0	2.00E-06	7.21E-07	6.60E-07	2.09E-04	9.41E-06	3.30E+00	3.26E-05
27	BROWN TOWN	-5.2	29.0	0.0	7.90E-06	2.97E-06	2.74E-06	3.31E-04	1.65E-05	7.41E+00	7.28E-05
28	GREEN TOWN	14.0	35.0	0.0	7.91E-06	6.65E-06	6.61E-06	2.86E-04	1.84E-05	4.98E+00	4.89E-05
29	ORANGE TOWN	-23.0	59.0	0.0	6.61E-07	2.10E-07	1.88E-07	1.88E-04	8.09E-06	1.72E+00	1.71E-05
30	PURPLE TOWN	56.0	32.0	0.0	5.45E-06	7.33E-06	7.45E-06	4.71E-04	2.70E-05	4.54E+00	4.49E-05
31	WHITE TOWN	-29.0	53.0	0.0	7.53E-07	2.61E-07	2.37E-07	1.96E-04	8.47E-06	1.91E+00	1.89E-05
32	E INDIANRES	65.0	0.0	0.0	3.44E-06	2.85E-06	2.83E-06	2.63E-04	1.38E-05	2.51E+00	2.48E-05
33	E INDIANRES	-60.0	50.0	0.0	3.58E-07	1.90E-07	1.82E-07	2.05E-04	8.81E-06	1.45E+00	1.44E-05
34	EAST RURAL	40.0	36.0	0.0	6.89E-06	9.16E-06	9.31E-06	4.34E-04	2.72E-05	5.10E+00	5.03E-05
35	NORTH RURAL	-5.0	31.0	0.0	7.17E-06	2.79E-06	2.58E-06	3.42E-04	1.68E-05	7.10E+00	6.98E-05
36	NW RURAL	-23.0	32.0	0.0	1.98E-06	6.48E-07	5.83E-07	2.07E-04	9.27E-06	3.27E+00	3.22E-05
37	WEST RURAL	65.0	24.0	0.0	3.53E-07	1.96E-07	1.89E-07	2.31E-04	9.94E-06	1.82E+00	1.80E-05
38	SOUTH RURAL	0.0	-45.0	0.0	2.75E-06	5.62E-07	4.54E-07	2.77E-04	1.21E-05	3.75E+00	3.70E-05
39	SW RURAL	-45.0	-45.0	0.0	1.34E-06	2.31E-07	1.75E-07	3.07E-04	1.31E-05	2.70E+00	2.67E-05
40	AGRICULTURE 1	38.7	33.3	0.0	7.78E-06	1.03E-05	1.04E-05	4.44E-04	2.87E-05	5.55E+00	5.47E-05
41	AGRICULTURE 2	21.3	34.3	0.0	9.31E-06	1.01E-05	1.02E-05	3.53E-04	2.46E-05	5.81E+00	5.70E-05
42	AGRICULTURE 3	-5.0	30.5	0.0	7.37E-06	2.85E-06	2.64E-06	3.40E-04	1.68E-05	7.20E+00	7.08E-05
43	AGRICULTURE 4	-22.8	30.8	0.0	2.10E-06	6.88E-07	6.19E-07	2.08E-04	9.33E-06	3.37E+00	3.33E-05
44	AGRICULTURE 5	-56.0	22.0	0.0	4.25E-07	2.43E-07	2.35E-07	2.30E-04	9.92E-06	2.11E+00	2.09E-05
45	AGRICULTURE 6	-67.5	18.8	0.0	5.28E-07	2.19E-07	2.04E-07	2.47E-04	1.06E-05	1.97E+00	1.94E-05

560 233

TOTAL ACTIVITY ON GROUND (PCI/M2)
OPERATION LIFETIME DEPOSITION (15 YEARS)

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	U238	TH230	RA226	PB210	PO210
1	FENCE POST	0.85	0.35	0.0	8.01E+04	4.46E+05	4.66E+05	4.66E+05	4.66E+05
2	TRAILER	1.00	0.50	0.0	5.26E+04	2.60E+05	2.71E+05	2.71E+05	2.71E+05
3	RANCH 1	1.90	1.40	0.0	1.11E+04	4.08E+04	4.25E+04	4.27E+04	4.26E+04
4	RANCH 2	8.80	3.60	0.0	6.96E+02	2.63E+03	2.74E+03	3.14E+03	3.13E+03
5	RANCH 3	18.80	7.80	0.0	1.55E+02	5.57E+02	5.79E+02	1.01E+03	9.94E+02
6	RANCH 3V	18.80	7.80	0.0	1.55E+02	5.57E+02	5.79E+02	1.01E+03	9.94E+02
7	RANCH 4	36.50	15.00	0.0	4.36E+01	1.43E+02	1.48E+02	5.77E+02	5.63E+02
8	RANCH 5	12.00	21.80	0.0	6.50E+01	1.84E+02	1.90E+02	4.67E+02	4.58E+02
9	RANCH 6	-2.40	20.60	0.0	5.20E+01	5.33E+01	5.36E+01	3.66E+02	3.56E+02
10	RANCH 6V	-2.40	20.60	0.0	5.20E+01	5.33E+01	5.36E+01	3.66E+02	3.56E+02
11	RANCH 7	-18.20	23.30	0.0	1.02E+01	8.13E+00	8.06E+00	1.88E+02	1.82E+02
12	RANCH 8	-27.50	-2.50	0.0	1.91E+01	8.94E+00	8.46E+00	2.62E+02	2.53E+02
13	RANCH 9	-35.20	-14.80	0.0	1.12E+01	4.84E+00	4.54E+00	2.52E+02	2.44E+02
14	RANCH 10	-23.00	-22.40	0.0	1.38E+01	4.27E+00	3.80E+00	2.72E+02	2.64E+02
15	RANCH 11	-7.40	-21.80	0.0	2.87E+01	2.36E+01	2.34E+01	2.32E+02	2.25E+02
16	RANCH 12	-55.30	2.40	0.0	3.98E+00	1.81E+00	1.70E+00	2.40E+02	2.32E+02
17	RANCH 12V	-55.30	2.40	0.0	3.98E+00	1.81E+00	1.70E+00	2.40E+02	2.32E+02
18	RANCH 13	-67.50	-8.10	0.0	3.08E+00	1.25E+00	1.16E+00	2.42E+02	2.34E+02
19	RANCH 14	-55.70	-46.40	0.0	2.82E+00	9.27E-01	8.35E-01	2.55E+02	2.46E+02
20	RANCH 15	-23.30	-38.70	0.0	7.58E+00	4.64E+00	4.51E+00	2.35E+02	2.27E+02
21	RANCH 16	27.80	-38.30	0.0	4.13E+00	2.69E+00	2.62E+00	5.57E+01	5.40E+01
22	RANCH 16V	27.80	-38.30	0.0	4.13E+00	2.69E+00	2.62E+00	5.57E+01	5.40E+01
23	WEST CITY	-78.00	16.00	0.0	1.35E+00	8.90E-01	8.70E-01	2.19E+02	2.12E+02
24	EAST CITY	33.00	35.00	0.0	2.49E+01	7.69E+01	7.98E+01	4.33E+02	4.21E+02
25	RED TOWN	-65.00	-26.00	0.0	3.23E+00	1.24E+00	1.14E+00	2.33E+02	2.26E+02
26	BLUE TOWN	-27.00	27.00	0.0	5.47E+00	5.02E+00	5.02E+00	1.84E+02	1.78E+02
27	BROWN TOWN	-5.20	29.00	0.0	2.18E+01	2.15E+01	2.15E+01	3.04E+02	2.94E+02
28	GREEN TOWN	14.00	35.00	0.0	2.35E+01	5.39E+01	5.56E+01	2.96E+02	2.88E+02
29	ORANGE TOWN	-23.00	59.00	0.0	1.77E+00	9.91E-01	9.56E-01	1.62E+02	1.57E+02
30	PURPLE TOWN	56.00	32.00	0.0	1.66E+01	4.97E+01	5.15E+01	4.50E+02	4.37E+02
31	WHITE TOWN	-29.00	53.00	0.0	2.03E+00	1.37E+00	1.34E+00	1.69E+02	1.64E+02
32	E INDIANRES	65.00	0.0	0.0	9.82E+00	1.79E+01	1.84E+01	2.42E+02	2.35E+02
33	E INDIANRES	-60.00	50.00	0.0	9.83E-01	1.05E+00	1.05E+00	1.77E+02	1.71E+02
34	EAST RURAL	40.00	36.00	0.0	2.11E+01	6.47E+01	6.72E+01	4.32E+02	4.20E+02
35	NORTH RURAL	-5.00	31.00	0.0	1.98E+01	1.98E+01	1.99E+01	3.11E+02	3.02E+02
36	NW RURAL	-23.00	32.00	0.0	5.40E+00	4.22E+00	4.17E+00	1.82E+02	1.76E+02
37	WEST RURAL	-65.00	24.00	0.0	9.74E-01	1.15E+00	1.16E+00	2.00E+02	1.93E+02
38	SOUTH RURAL	0.0	-45.00	0.0	7.32E+00	2.85E+00	2.63E+00	2.40E+02	2.32E+02
39	SW RURAL	-45.00	-45.00	0.0	3.56E+00	1.07E+00	9.46E-01	2.65E+02	2.56E+02
40	AGRICULTURE 1	38.70	33.30	0.0	2.39E+01	7.43E+01	7.71E+01	4.49E+02	4.37E+02
41	AGRICULTURE 2	21.30	34.30	0.0	2.84E+01	7.95E+01	8.24E+01	3.77E+02	3.67E+02
42	AGRICULTURE 3	-5.00	30.50	0.0	2.03E+01	2.04E+01	2.04E+01	3.10E+02	3.01E+02
43	AGRICULTURE 4	-22.80	30.80	0.0	5.73E+00	4.54E+00	4.50E+00	1.82E+02	1.76E+02
44	AGRICULTURE 5	-56.00	22.00	0.0	1.18E+00	1.54E+00	1.57E+00	1.99E+02	1.93E+02
45	AGRICULTURE 6	-67.50	18.80	0.0	1.43E+00	1.16E+00	1.15E+00	2.13E+02	2.06E+02

POOR ORIGINAL

CONCENTRATION/MPC FOR WHOLE BODY

RECEPTOR	X(KM)	Y(KM)	238U	234U	230TH	226RA	210PB	210PO	222RN
1	0.0	0.10	4.08E-05	4.08E-05	1.55E-03	3.47E-04	1.74E-05	3.47E-06	
2	0.0	0.50	5.02E-05	5.02E-05	8.91E-04	1.59E-04	8.00E-06	1.59E-06	
3	0.0	1.00	2.03E-05	2.03E-05	3.00E-04	4.83E-05	2.55E-06	4.84E-07	
4	0.0	2.00	5.62E-06	5.62E-06	9.83E-05	1.74E-05	1.20E-06	1.77E-07	
5	0.0	3.00	2.45E-06	2.45E-06	5.08E-05	9.68E-06	1.00E-06	1.01E-07	
6	0.0	4.00	1.34E-06	1.34E-06	3.14E-05	6.24E-06	9.72E-07	6.80E-08	
7	0.0	5.00	8.32E-07	8.32E-07	2.14E-05	4.39E-06	9.86E-07	5.04E-08	
8	0.0	10.00	1.85E-07	1.85E-07	6.38E-06	1.40E-06	1.07E-06	2.24E-08	
9	0.0	20.00	4.07E-08	4.07E-08	1.83E-06	4.22E-07	1.09E-06	1.32E-08	
10	0.0	30.00	1.74E-08	1.74E-08	8.83E-07	2.06E-07	1.09E-06	1.12E-08	
11	0.0	40.00	9.61E-09	9.61E-09	5.25E-07	1.24E-07	1.08E-06	1.03E-08	
12	0.0	50.00	6.07E-09	6.07E-09	3.50E-07	8.30E-08	1.07E-06	9.82E-09	
13	0.0	60.00	4.15E-09	4.15E-09	2.51E-07	5.98E-08	1.06E-06	9.51E-09	
14	0.0	70.00	3.01E-09	3.01E-09	1.91E-07	4.58E-08	1.05E-06	9.27E-09	
15	0.0	80.00	2.29E-09	2.29E-09	1.53E-07	3.68E-08	1.03E-06	9.09E-09	
16	0.04	0.09	5.62E-05	5.62E-05	2.06E-03	4.56E-04	2.29E-05	4.56E-06	
17	0.19	0.46	3.96E-05	3.96E-05	2.08E-03	4.89E-04	2.45E-05	4.89E-06	
18	0.38	0.92	1.54E-05	1.54E-05	6.69E-04	1.53E-04	7.79E-06	1.53E-06	
19	0.77	1.85	4.35E-06	4.35E-06	2.26E-04	5.29E-05	2.99E-06	5.32E-07	
20	1.15	2.77	1.95E-06	1.95E-06	1.13E-04	2.69E-05	1.82E-06	2.73E-07	
21	1.53	3.70	1.09E-06	1.09E-06	6.89E-05	1.65E-05	1.39E-06	1.70E-07	
22	1.91	4.62	6.96E-07	6.96E-07	4.68E-05	1.13E-05	1.19E-06	1.18E-07	
23	3.83	9.24	1.73E-07	1.73E-07	1.39E-05	3.41E-06	8.84E-07	4.01E-08	
24	7.65	18.48	4.45E-08	4.45E-08	4.09E-06	1.01E-06	7.63E-07	1.61E-08	
25	11.48	27.72	2.08E-08	2.08E-08	2.02E-06	5.01E-07	7.28E-07	1.09E-08	
26	15.31	36.96	1.22E-08	1.22E-08	1.23E-06	3.05E-07	7.10E-07	8.90E-09	
27	19.13	46.19	7.98E-09	7.98E-09	8.33E-07	2.07E-07	6.99E-07	7.87E-09	
28	22.96	55.43	5.62E-09	5.62E-09	6.06E-07	1.51E-07	6.89E-07	7.26E-09	
29	26.79	64.67	4.18E-09	4.18E-09	4.68E-07	1.17E-07	6.80E-07	6.85E-09	
30	30.61	73.91	3.25E-09	3.25E-09	3.78E-07	9.47E-08	6.70E-07	6.57E-09	
31	0.07	0.07	7.18E-05	7.18E-05	2.13E-03	4.52E-04	2.26E-05	4.52E-06	
32	0.35	0.35	6.24E-05	6.24E-05	5.57E-03	1.37E-03	6.87E-05	1.37E-05	
33	0.71	0.71	2.46E-05	2.46E-05	2.20E-03	5.42E-04	2.72E-05	5.42E-06	
34	1.41	1.41	6.96E-06	6.96E-06	6.36E-04	1.57E-04	8.18E-06	1.57E-06	
35	2.12	2.12	3.13E-06	3.13E-06	3.07E-04	7.62E-05	4.34E-06	7.67E-07	
36	2.83	2.83	1.76E-06	1.76E-06	1.84E-04	4.58E-05	2.97E-06	4.64E-07	
37	3.54	3.54	1.13E-06	1.13E-06	1.24E-04	3.09E-05	2.33E-06	3.15E-07	
38	7.07	7.07	2.83E-07	2.83E-07	3.60E-05	9.06E-06	1.46E-06	9.90E-08	
39	14.14	14.14	7.29E-08	7.29E-08	1.04E-05	2.63E-06	1.20E-06	3.53E-08	
40	21.21	21.21	3.42E-08	3.42E-08	5.09E-06	1.29E-06	1.14E-06	2.19E-08	
41	28.28	28.28	2.01E-08	2.01E-08	3.06E-06	7.77E-07	1.11E-06	1.[illegible]8E-08	
42	35.36	35.36	1.33E-08	1.33E-08	2.07E-06	5.24E-07	1.09E-06	[illegible]E-08	
43	42.43	42.43	9.40E-09	9.40E-09	1.50E-06	3.80E-07	1.07E-06	1.[illegible]	
44	49.50	49.50	7.05E-09	7.05E-09	1.15E-06	2.93E-07	1.06E-06	1.17E-[illegible]	
45	56.57	56.57	5.53E-09	5.53E-09	9.30E-07	2.37E-07	1.04E-06	1.10E-08	
46	0.09	0.04	1.11E-04	1.11E-04	2.36E-03	4.54E-04	2.27E-05	4.54E-06	
47	0.46	0.19	7.05E-05	7.05E-05	6.71E-03	1.66E-03	8.31E-05	1.66E-05	
48	0.92	0.38	2.93E-05	2.93E-05	4.87E-03	1.24E-03	6.21E-05	1.24E-05	
49	1.85	0.77	8.05E-06	8.05E-06	9.69E-04	2.43E-04	1.26E-05	2.44E-06	
50	2.77	1.15	3.58E-06	3.58E-06	4.19E-04	1.05E-04	5.88E-06	1.05E-06	
51	3.70	1.53	2.00E-06	2.00E-06	2.37E-04	5.95E-05	3.78E-06	6.02E-07	
52	4.62	1.91	1.27E-06	1.27E-06	1.54E-04	3.87E-05	2.87E-06	3.95E-07	
53	9.24	3.83	3.17E-07	3.17E-07	4.20E-05	1.06E-05	1.71E-06	1.16E-07	

POOR ORIGINAL

INHALATION DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M3)
DOSE RATE AFTER 50 YEARS CONTINUOUS INHALATION OF 1 PCI/M3

PARTICLE SIZE = 0.3 MICRONS DENSITY = 1.00	U238	U234	TH230	RA226	PB210	PO210
NASOPHARYNGEAL					6.14E+00	5.52E+02
TRACHEOBRONCHIAL					4.46E-02	4.51E+00
PULMONARY					8.52E+01	4.21E+02
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
STOMACH					3.29E-02	5.05E-01
SMALL INTESTINE					1.25E-02	1.15E-01
UPPER LARGE INTESTINE					4.29E-02	9.34E-01
LOWER LARGE INTESTINE					3.86E-02	8.41E-01
LYMPH NODES					8.42E+02	1.01E+03

PARTICLE SIZE = 1.0 MICRONS DENSITY = 8.90	U238	U234	TH230	RA226	PB210	PO210
NASOPHARYNGEAL	4.18E+03	4.77E+03	4.67E+03	9.75E+03	5.41E+01	4.86E+03
TRACHEOBRONCHIAL	2.32E+00	2.64E+00	2.58E+00	4.82E+00	2.10E-02	2.16E+00
PULMONARY	1.75E+03	1.99E+03	1.95E+03	4.52E+02	3.37E+01	1.67E+02
WHOLE BODY	1.44E+00	1.64E+00	1.37E+02	3.97E+01	9.24E+00	1.77E+00
BONE	2.42E+01	2.64E+01	4.[illegible]E+03	3.97E+02	2.87E+02	7.22E+00
KIDNEY	5.53E+00	6.30E+00	1.37E+03	1.40E+00	2.39E+02	5.33E+01
LIVER	0.0	0.0	2.82E+02	4.94E-02	7.32E+01	1.59E+01
STOMACH	5.39E+00	6.01E+00	5.89E+00	3.49E-01	1.95E-02	3.28E-01
SMALL INTESTINE	1.22E+00	1.40E+00	1.34E+00	7.93E-02	7.40E-03	7.44E-02
UPPER LARGE INTESTINE	9.98E+00	1.11E+01	1.09E+01	6.46E-01	2.55E-02	6.07E-01
LOWER LARGE INTESTINE	8.98E+00	1.00E+01	9.81E+00	5.81E-01	2.29E-02	5.46E-01
LYMPH NODES	7.38E+04	8.41E+04	8.24E+04	1.49E+03	3.33E+02	4.01E+02

PARTICLE SIZE = 1.0 MICRONS DENSITY = 2.40	U238	U234	TH230	RA226	PB210	PO210
NASOPHARYNGEAL	2.85E+03	3.25E+03	3.18E+03	6.65E+03	3.69E+01	3.31E+03
TRACHEOBRONCHIAL	2.81E+00	3.21E+00	3.14E+00	6.09E+00	2.65E-02	2.71E+00
PULMONARY	2.37E+03	2.70E+03	2.65E+03	6.14E+02	4.58E+01	2.27E+02
WHOLE BODY	1.65E+00	1.87E+00	1.66E+02	3.40E+01	8.24E+00	1.54E+00
BONE	2.78E+01	3.03E+01	5.95E+03	3.40E+02	2.56E+02	6.29E+00
KIDNEY	6.33E+00	7.22E+00	1.67E+03	1.20E+00	2.13E+02	4.64E+01
LIVER	0.0	0.0	3.43E+02	4.22E-02	6.53E+01	1.38E+01
STOMACH	7.23E+00	8.07E+00	7.90E+00	3.92E-01	2.19E-02	3.55E-01
SMALL INTESTINE	1.64E+00	1.87E+00	1.80E+00	8.90E-02	8.31E-03	8.06E-02
UPPER LARGE INTESTINE	1.34E+01	1.49E+01	1.46E+01	7.26E-01	2.86E-02	6.57E-01
LOWER LARGE INTESTINE	1.21E+01	1.35E+01	1.32E+01	6.53E-01	2.57E-02	5.91E-01
LYMPH NODES	1.00E+05	1.14E+05	1.12E+05	2.02E+03	4.53E+02	5.45E+02

INHALATION DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M3)
DOSE RATE AFTER 50 YEARS CONTINUOUS INHALATION OF 1 PCI/M3

PARTICLE SIZE = 5.0 MICRONS DENSITY = 2.40	U238	U234	TH230	RA226	PB210	PO210
NASOPHARYNGEAL	5.48E+03	6.25E+03	6.12E+03	1.28E+04	7.09E+01	6.37E+03
TRACHEOBRONCHIAL	1.70E+00	1.94E+00	1.90E+00	3.28E+00	1.43E-02	1.50E+00
PULMONARY	1.02E+03	1.16E+03	1.13E+03	2.63E+02	1.96E+01	9.71E+01
WHOLE BODY	1.16E+00	1.32E+00	1.01E+02	4.47E+01	1.00E+01	1.96E+00
BONE	1.96E+01	2.14E+01	3.60E+03	4.47E+02	3.[illegible]1E+02	7.99E+00
KIDNEY	4.47E+00	5.10E+00	1.00E+03	1.57E+00	2.59E+02	5.89E+01
LIVER	0.0	0.0	2.07E+02	5.55E-02	7.93E+01	1.76E+01
STOMACH	3.22E+00	3.60E+00	3.52E+00	2.91E-01	1.63E-02	2.88E-01
SMALL INTESTINE	7.32E-01	8.34E-01	8.00E-01	6.62E-02	6.19E-03	6.54E-02
UPPER LARGE INTESTINE	5.96E+00	6.66E+00	6.52E+00	5.39E-01	2.13E-02	5.33E-01
LOWER LARGE INTESTINE	5.37E+00	5.99E+00	5.87E+00	4.85E-01	1.92E-02	4.79E-01
LYMPH NODES	4.29E+04	4.89E+04	4.79E+04	8.65E+02	1.94E+02	[illegible].33E+02

PARTICLE SIZE = 35.0 MICRONS DENSITY = 2.40	U238	U234	TH230	RA226	PB210	PO210
NASOPHARYNGEAL	5.94E+03	6.77E+03	6.63E+03	1.38E+04	7.68E+01	6.90E+03
TRACHEOBRONCHIAL	1.05E+00	1.19E+00	1.17E+00	1.68E+00	7.31E-03	8.01E-01
PULMONARY	2.67E+02	3.04E+02	2.98E+02	6.91E+01	5.16E+00	2.55E+01
WHOLE BODY	7.92E-01	9.02E-01	5.77E+01	4.40E+01	9.66E+00	1.93E+00
BONE	1.34E+01	1.46E+01	2.07E+03	4.40E+02	3.00E+02	7.84E+00
KIDNEY	3.05E+00	3.47E+00	5.73E+02	1.55E+00	2.50E+02	5.79E+01
LIVER	0.0	0.0	1.19E+02	5.47E-02	7.65E+01	1.73E+01
STOMACH	9.77E-01	1.09E+00	1.07E+00	2.07E-01	1.16E-02	2.19E-01
SMALL INTESTINE	2.22E-01	2.53E-01	2.43E-01	4.70E-02	4.40E-03	4.98E-02
UPPER LARGE INTESTINE	1.81E+00	2.02E+00	1.98E+00	3.83E-01	1.52E-02	4.06E-01
LOWER LARGE INTESTINE	1.63E+00	1.82E+00	1.78E+00	3.45E-01	1.36E-02	3.65E-01
LYMPH NODES	1.13E+04	1.29E+04	1.26E+04	2.27E+02	5.10E+01	6.14E+01

DEPOSITION FRACTIONS IN LUNG MODEL SUBCOMPARTMENTS AS A FUNCTION OF PARTICULATE SIZE AND DENSITY

SIZE	DENSITY	AERODYNAMIC EQUIV. DIAM.	NASOPHARYNGEAL	TRACHEOBRONCHIAL	PULMONARY	TOTAL
0.3	1.00	0.30	0.072	0.080	0.380	0.532
1.0	8.90	2.98	0.637	0.080	0.150	0.868
1.0	2.40	1.55	0.434	0.080	0.204	0.718
5.0	2.40	7.75	0.835	0.077	0.087	1.000
35.0	2.40	54.22	0.904	0.073	0.023	1.000

560 237

CLOUD DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M3)

POLLUTANT	SKIN	WHOLE BODY	OVARIES	TESTIES	SM INTESTINE	LUNG	RED MARROW	SKELETON	SPLEEN
U238	1.00E-04	1.57E-06	2.92E-07	1.29E-06	2.43E-07	4.77E-07	1.35E-06	1.53E-06	3.22E-07
TH234	6.22E-04	5.24E-05	2.28E-05	4.85E-05	3.25E-05	4.29E-05	8.60E-05	9.33E-05	3.12E-05
PA234	7.63E-03	1.22E-04	9.57E-05	8.06E-05	7.36E-05	8.94E-05	9.83E-05	1.08E-04	8.73E-05
U234	1.36E-04	2.49E-06	6.64E-07	2.09E-06	5.99E-07	1.03E-06	2.64E-06	2.94E-06	7.34E-07
TH230	1.46E-04	3.59E-06	1.52E-06	3.17E-06	1.33E-06	2.10E-06	4.83E-06	5.31E-06	1.67E-06
RA226	1.79E-04	4.90E-05	2.63E-05	6.27E-05	3.44E-05	4.33E-05	6.98E-05	7.52E-05	3.93E-05
RN222	3.46E-06	2.83E-06	1.04E-06	3.14E-06	2.05E-06	2.67E-06	3.30E-06	3.46E-06	2.99E-06
PO218	8.18E-07	6.34E-07	3.88E-07	5.72E-07	4.91E-07	5.93E-07	6.34E-07	6.95E-07	6.34E-07
PB214	4.89E-03	1.67E-03	7.46E-04	1.94E-03	1.17E-03	1.52E-03	2.15E-03	2.29E-03	1.57E-03
BI214	1.95E-02	1.16E-02	9.13E-03	9.29E-03	8.86E-03	1.10E-02	1.17E-02	1.26E-02	1.15E-02
PO214	9.89E-07	7.66E-07	4.70E-07	6.92E-07	5.93E-07	7.17E-07	7.66E-07	8.40E-07	7.66E-07
PB210	3.94E-04	1.43E-05	7.56E-06	1.21E-05	5.31E-06	9.05E-06	2.23E-05	2.45E-05	7.27E-06
BI210	3.56E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GROUND DOSE CONVERSION FACTORS (MREM/YEAR/PCI/M2)

POLLUTANT	SKIN	WHOLE BODY	OVARIES	TESTIES	SM INTESTINE	LUNG	RED MARROW	SKELETON	SPLEEN
U238	2.13E-06	3.17E-07	5.89E-08	2.60E-07	4.90E-08	9.62E-08	2.73E-07	3.08E-07	6.49E-08
TH234	2.10E-06	1.66E-06	7.21E-07	1.53E-06	1.03E-06	1.36E-06	2.72E-06	2.96E-06	9.87E-07
PA234	1.50E-03	1.72E-06	1.17E-06	1.46E-06	1.32E-06	1.61E-06	1.77E-06	1.94E-06	1.58E-06
U234	2.60E-06	4.78E-07	1.27E-07	4.00E-07	1.15E-07	1.97E-07	5.05E-07	5.63E-07	1.40E-07
TH230	2.20E-06	6.12E-07	2.60E-07	5.40E-07	2.27E-07	3.59E-07	8.24E-07	9.06E-07	2.85E-07
RA226	1.16E-06	9.47E-07	5.07E-07	1.21E-06	6.63E-07	8.36E-07	1.35E-06	1.45E-06	7.58E-07
RN222	6.15E-08	5.03E-08	1.84E-08	5.59E-08	3.64E-08	4.76E-08	5.88E-08	6.15E-08	5.32E-08
PO218	1.42E-08	1.10E-08	6.73E-09	9.91E-09	8.50E-09	1.03E-08	1.10E-08	1.20E-08	1.10E-08
PB214	1.42E-04	3.16E-05	1.41E-05	3.66E-05	2.21E-05	2.88E-05	4.06E-05	4.32E-05	2.96E-05
BI214	1.20E-03	1.85E-04	1.47E-04	1.49E-04	1.42E-04	1.76E-04	1.88E-04	2.06E-04	1.85E-04
PO214	1.72E-08	1.33E-08	8.17E-09	1.20E-08	1.03E-08	1.25E-08	1.33E-08	1.46E-08	1.33E-08
PB210	6.65E-06	2.27E-06	1.20E-06	1.92E-06	8.45E-07	1.44E-06	3.56E-06	3.90E-06	1.16E-06
BI210	5.02E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INGESTION DOSE CONVERSION FACTORS (MREM/YEAR)/(PCI/DAY)
DOSE RATE AFTER 50 YEARS CONTINUOUS INGESTION OF 1 PCI/DAY

	U238	U234	TH230	RA226	PB210	PO210
WHOLE BODY	1.66E-02	1.89E-02	2.10E-02	1.68E+00	1.92E-01	3.18E-02
BONE	2.80E-01	3.05E-01	7.53E-01	1.68E+01	5.98E+00	1.30E-01
KIDNEY	6.38E-02	7.27E-02	2.08E-01	5.94E-02	4.98E+00	9.56E-01
LIVER	0.0	0.0	4.32E-02	2.09E-03	1.52E+00	2.85E-01

METSET SAMPLE METSET
NASOPHARYNGEAL ANGLE OF MAX DISPERSION = 67.5 DEGREES

INHALATION DOSE COMMITMENTS (MREM/YEAR) FROM PARTICULATES

ANGLE	DISTANCE(KM)	U238	U234	TH230	RA226	PB210	PO210	TOTAL
67.5	0.1	2.78E+02	3.17E+02	6.43E+01	1.09E+02	6.04E-01	5.43E+01	8.23E+02
	1.0	7.60E+01	8.66E+01	1.54E+02	3.31E+02	1.84E+00	1.65E+02	8.15E+02
	5.0	3.26E+00	3.72E+00	4.83E+00	1.03E+01	5.91E-02	5.12E+00	2.72E+01
	10.0	8.14E-01	9.28E-01	1.31E+00	2.79E+00	1.84E-02	1.40E+00	7.27E+00
	50.0	3.86E-02	4.40E-02	7.14E-02	1.53E-01	3.88E-03	8.76E-02	3.98E-01
	80.0	1.62E-02	1.85E-02	3.19E-02	6.84E-02	3.30E-03	4.52E-02	1.84E-01
0.0	0.1	9.77E+01	1.11E+02	3.59E+01	6.76E+01	3.75E-01	3.37E+01	3.47E+02
	1.0	5.07E+01	5.78E+01	7.84E+00	1.13E+01	6.29E-02	5.63E+00	1.33E+02
	5.0	2.09E+00	2.38E+00	6.21E-01	1.12E+00	8.10E-03	5.66E-01	6.79E+00
	10.0	4.66E-01	5.31E-01	1.88E-01	3.59E-01	4.44E-03	1.88E-01	1.74E+00
	50.0	1.53E-02	1.74E-02	1.04E-02	2.12E-02	2.74E-03	2.05E-02	8.76E-02
	80.0	5.79E-03	6.60E-03	[illegible]-03	9.37E-03	2.59E-03	1.43E-02	4.32E-02
90.0	0.1	2.24E+02	2.55E+02	7.00E+01	1.28E+02	7.09E-01	6.37E+01	7.41E+02
	1.0	4.50E+01	5.13E+01	1.13E+02	2.42E+02	1.34E+00	1.21E+02	5.74E+02
	5.0	1.83E+00	2.09E+00	2.06E+00	4.33E+00	2.53E-02	2.16E+00	1.25E+01
	10.0	4.64E-01	5.28E-01	5.21E-01	1.09E+00	7.64E-03	5.51E-01	3.17E+00
	50.0	2.36E-02	2.69E-02	2.75E-02	5.78E-02	1.95E-03	3.50E-02	1.73E-01
	80.0	1.01E-02	1.15E-02	1.24E-02	2.61E-02	1.71E-03	1.89E-02	8.07E-02
180.0	0.1	7.97E+01	9.08E+01	3.03E+01	5.74E+01	3.18E-01	2.86E+01	2.87E+02
	1.0	3.23E+01	3.69E+01	5.18E+00	7.60E+00	4.25E-02	3.79E+00	8.58E+01
	5.0	1.31E+00	1.50E+00	2.41E-01	3.76E-01	3.42E-03	1.92E-01	3.62E+00
	10.0	2.83E-01	3.28E-01	5.85E-02	9.50E-02	2.17E-03	5.36E-02	8.26E-01
	50.0	9.23E-03	1.05E-02	2.60E-03	4.64E-03	1.71E-03	8.71E-03	3.74E-02
	80.0	3.51E-03	3.99E-03	1.13E-03	2.07E-03	1.64E-03	7.22E-03	1.96E-02
270.0	0.1	7.83E+01	8.92E+01	2.80E+01	5.24E+01	2.90E-01	2.61E+01	2.74E+02
	1.0	3.23E+01	3.69E+01	3.74E+00	4.42E+00	2.50E-02	2.21E+00	7.96E+01
	5.0	1.27E+00	1.45E+00	2.12E-01	3.17E-01	3.21E-03	1.63E-01	3.42E+00
	10.0	2.73E-01	3.11E-01	5.70E-02	9.34E-02	2.24E-03	[illegible].31E-02	7.90E-01
	50.0	8.35E-03	9.51E-03	2.84E-03	5.27E-03	1.80E-03	9.34E-03	3.71E-02
	80.0	3.19E-03	3.64E-03	1.23E-03	2.34E-03	1.72E-03	7.45E-03	1.98E-02

560 239

ANGLE OF MAX DISPERSION = 67.5 DEGREES

INHALATION DOSE COMMITMENTS (MREM/YEAR) FROM RADON

	DEGREES							
DISTANCE(KM)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5
0.1	2.66E+03	3.23E+03	3.75E+03	3.86E+03	3.94E+03	4.02E+03	3.81E+03	3.22E+03
0.5	1.24E+03	2.25E+03	4.01E+03	5.25E+03	5.52E+03	4.62E+03	2.56E+03	1.83E+03
1.0	4.53E+02	7.83E+02	1.33E+03	2.12E+03	1.63E+03	6.68E+02	4.65E+02	4.99E+02
2.0	1.75E+02	2.36E+02	2.96E+02	4.11E+02	2.62E+02	8.90E+01	5.21E+01	1.11E+02
3.0	1.02E+02	1.14E+02	1.48E+02	1.90E+02	1.15E+02	3.84E+01	2.37E+01	4.72E+01
4.0	7.00E+01	6.99E+01	9.32E+01	1.16E+02	6.77E+01	2.25E+01	1.43E+01	2.64E+01
5.0	5.23E+01	4.85E+01	6.63E+01	8.06E+01	4.63E+01	1.53E+01	9.93E+00	1.71E+01
10.0	2.17E+01	1.71E+01	2.50E+01	2.93E+01	1.63E+01	5.30E+00	3.56E+00	4.93E+00
20.0	9.44E+00	6.77E+00	1.04E+01	1.20E+01	6.52E+00	2.14E+00	1.44E+00	1.68E+00
30.0	5.87E+00	4.09E+00	6.35E+00	7.31E+00	3.99E+00	1.31E+00	8.85E-01	9.65E-01
40.0	4.19E+00	2.89E+00	4.51E+00	5.19E+00	2.83E+00	9.33E-01	6.30E-01	6.71E-01
50.0	3.22E+00	2.22E+00	3.45E+00	3.97E+00	2.16E+00	7.15E-01	4.83E-01	5.14E-01
60.0	2.59E+00	1.78E+00	2.77E+00	3.18E+00	1.73E+00	5.73E-01	3.88E-01	4.13E-01
70.0	2.15E+00	1.47E+00	2.29E+00	2.63E+00	1.43E+00	4.74E-01	3.22E-01	3.42E-01
80.0	1.82E+00	1.25E+00	1.94E+00	2.23E+00	1.21E+00	4.02E-01	2.73E-01	2.91E-01

	DEGREES							
DISTANCE(KM)	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.1	2.74E+03	2.49E+03	2.23E+03	2.09E+03	2.05E+03	2.09E+03	2.22E+03	2.46E+03
0.5	1.38E+03	1.04E+03	8.45E+02	7.29E+02	6.73E+02	6.53E+02	6.90E+02	8.14E+02
1.0	4.52E+02	3.93E+02	3.57E+02	3.17E+02	2.89E+02	2.68E+02	2.65E+02	2.90E+02
2.0	1.43E+02	1.32E+02	1.36E+02	1.25E+02	1.17E+02	1.03E+02	9.58E+01	[illegible]
3.0	7.77E+01	7.09E+01	7.71E+01	7.14E+01	6.75E+01	5.79E+01	5.37E+01	5.46E+01
4.0	5.11E+01	4.59E+01	5.17E+01	4.80E+01	4.57E+01	3.87E+01	3.57E+01	3.59E+01
5.0	3.72E+01	3.30E+01	3.81E+01	3.54E+01	3.40E+01	2.84E+01	2.62E+01	2.62E+01
10.0	1.46E+01	1.25E+01	1.54E+01	1.43E+01	1.40E+01	1.14E+01	1.04E+01	1.03E+01
20.0	6.14E+00	5.17E+00	6.59E+00	6.16E+00	6.10E+00	4.90E+00	4.42E+00	4.31E+00
30.0	3.78E+00	3.17E+00	4.10E+00	3.84E+00	3.82E+00	3.06E+00	2.74E+00	2.65E+00
40.0	2.69E+00	2.25E+00	2.93E+00	2.75E+00	2.74E+00	2.19E+00	1.96E+00	1.89E+00
50.0	2.07E+00	1.73E+00	2.26E+00	2.11E+00	2.11E+00	1.69E+00	1.50E+00	1.45E+00
60.0	1.66E+00	1.39E+00	1.81E+00	1.70E+00	1.69E+00	1.36E+00	1.21E+00	1.17E+00
70.0	1.38E+00	1.16E+00	1.50E+00	1.41E+00	1.40E+00	1.12E+00	1.00E+00	9.70E-01
80.0	1.17E+00	9.80E-01	1.27E+00	1.19E+00	1.19E+00	9.52E-01	8.50E-01	8.23E-01

560 240

METSET SAMPLE METSET
BRONCHIAL EPITHELIUM　　ANGLE OF MAX DISPERSION = 67.5 DEGREES

RADON WORKING LEVEL MONTH

DEGREES

DISTANCE(KM)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5
0.1	5.32E-01	6.47E-01	7.50E-01	7.72E-01	7.88E-01	8.05E-01	7.61E-01	6.43E-01
0.5	2.49E-01	4.50E-01	8.02E-01	1.05E+00	1.10E+00	9.23E-01	5.12E-01	3.66E-01
1.0	9.06E-02	1.57E-01	2.66E-01	4.25E-01	3.25E-01	1.34E-01	9.30E-02	9.99E-02
2.0	3.50E-02	4.73E-02	5.93E-02	8.22E-02	5.24E-02	1.[illegible]E-02	1.04E-02	2.22E-02
3.0	2.05E-02	2.28E-02	2.95E-02	3.80E-02	2.29E-02	[illegible].08E-03	4.74E-03	9.43E-03
4.0	1.40E-02	1.40E-02	1.86E-02	2.31E-02	1.35E-02	4.49E-03	2.87E-03	5.29E-03
5.0	1.05E-02	9.71E-03	1.33E-02	1.61E-02	9.26E-03	3.05E-03	1.99E-03	3.42E-03
10.0	4.35E-03	3.43E-03	5.00E-03	5.85E-03	3.26E-03	1.06E-03	7.12E-04	9.86E-04
20.0	1.89E-03	1.35E-03	2.07E-03	2.39E-03	1.30E-03	4.28E-04	2.89E-04	3.35E-04
30.0	1.17E-03	8.19E-04	1.27E-03	1.46E-03	7.98E-04	2.63E-04	1.77E-04	1.93E-04
40.0	8.39E-04	5.78E-04	9.02E-04	1.04E-03	5.66E-04	1.87E-04	1.26E-04	1.34E-04
50.0	6.45E-04	4.43E-04	6.91E-04	7.93E-04	4.32E-04	1.43E-04	9.67E-05	1.03E-04
60.0	5.19E-04	3.56E-04	5.54E-04	6.35E-04	3.46E-04	1.15E-04	7.77E-05	8.26E-05
70.0	4.30E-04	2.95E-04	4.58E-04	5.26E-04	2.86E-04	9.49E-05	6.44E-05	6.85E-05
80.0	3.65E-04	2.50E-04	3.89E-04	4.45E-04	2.42E-04	8.05E-05	5.47E-05	5.81E-05

DEGREES

DISTANCE(KM)	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.1	5.49E-01	4.98E-01	4.45E-01	4.18E-01	4.10E-01	4.18E-01	4.44E-01	4.93E-01
0.5	2.76E-01	2.08E-01	1.69E-01	1.46E-01	1.35E-01	1.31E-01	1.38E-01	1.63E-01
1.0	9.04E-02	7.87E-02	7.15E-02	6.34E-02	5.78E-02	5.35E-02	5.29E-02	5.80E-02
2.0	2.86E-02	2.65E-02	2.72E-02	2.51E-02	2.34E-02	2.06E-02	1.92E-02	1.99E-02
3.0	1.55E-02	1.42E-02	1.54E-02	1.43E-02	1.35E-02	1.16E-02	1.07E-02	1.09E-02
4.0	1.02E-02	9.18E-03	1.03E-02	9.60E-03	9.14E-03	7.73E-03	7.14E-03	7.19E-03
5.0	7.43E-03	6.60E-03	7.62E-03	7.08E-03	6.80E-03	5.68E-03	5.24E-03	5.23E-03
10.0	2.92E-03	2.51E-03	3.08E-03	2.86E-03	2.80E-03	2.28E-03	2.08E-03	2.05E-03
20.0	1.23E-03	1.03E-03	1.32E-03	1.23E-03	1.22E-03	9.81E-04	8.84E-04	8.62E-04
30.0	7.56E-04	6.33E-04	8.20E-04	7.68E-04	7.64E-04	6.12E-04	5.47E-04	5.31E-04
40.0	5.38E-04	4.51E-04	5.86E-04	5.49E-04	5.48E-04	4.39E-04	3.91E-04	3.78E-04
50.0	4.13E-04	3.47E-04	4.51E-04	4.22E-04	4.21E-04	3.38E-04	3.01E-04	2.91E-04
60.0	3.32E-04	2.79E-04	3.63E-04	3.40E-04	3.39E-04	2.71E-04	2.42E-04	2.34E-04
70.0	2.76E-04	2.31E-04	3.01E-04	2.81E-04	2.81E-04	2.25E-04	2.01E-04	1.94E-04
80.0	2.34E-04	1.96E-04	2.55E-04	2.39E-04	2.38E-04	1.90E-04	1.70E-04	1.65E-04

560 241

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 117
METSET SAMPLE METSET
SKIN ANGLE OF MAX DISPERSION = 67.5 DEGREES

EXTERNAL DOSE COMMITMENTS (MREM/YEAR) FROM GROUND DEPOSITION

ANGLE	DISTANCE(KM)	U238	U234	TH230	RA226	PB210	TOTAL
67.5	0.1	1.94E+02	3.36E-01	1.88E-01	1.12E+02	4.26E+01	3.50E+02
	1.0	7.26E+01	1.26E-01	5.63E-01	3.59E+02	1.36E+02	5.68E+02
	5.0	2.74E+00	4.73E-03	1.51E-02	9.57E+00	3.74E+00	1.61E+01
	10.0	6.76E-01	1.17E-03	3.71E-03	2.36E+00	1.04E+00	4.08E+00
	50.0	2.96E-02	5.12E-05	1.35E-04	8.56E-02	1.85E-01	3.01E-01
	80.0	1.20E-02	2.08E-05	5.09E-05	3.22E-02	1.59E-01	2.04E-01
0.0	0.1	7.16E+01	1.24E-01	9.18E-02	5.58E+01	2.11E+01	1.49E+02
	1.0	3.48E+01	6.01E-02	1.87E-02	1.05E+01	3.98E+00	4.93E+01
	5.0	1.46E+00	2.52E-03	1.61E-03	9.72E-01	4.63E-01	2.90E+00
	10.0	3.28E-01	5.67E-04	4.59E-04	2.81E-01	2.30E-01	8.40E-01
	50.0	1.07E-02	1.85E-05	1.68E-05	1.03E-02	1.36E-01	1.57E-01
	80.0	4.00E-03	6.91E-06	6.09E-06	3.74E-03	1.29E-01	1.37E-01
90.0	0.1	1.59E+02	2.75E-01	2.26E-01	1.38E+02	5.23E+01	3.50E+02
	1.0	4.61E+01	7.96E-02	4.12E-01	2.63E+02	9.97E+01	4.10E+02
	5.0	1.46E+00	2.52E-03	6.26E-03	3.96E+00	1.57E+00	6.99E+00
	10.0	3.60E-01	6.22E-04	1.41E-03	8.93E-01	4.18E-01	1.67E+00
	50.0	1.71E-02	2.95E-05	4.86E-05	3.05E-02	9.36E-02	1.41E-01
	80.0	7.17E-03	1.24E-05	1.85E-05	1.16E-02	8.34E-02	1.02E-01
180.0	0.1	5.82E+01	1.01E-01	8.28E-02	5.07E+01	1.92E+01	1.28E+02
	1.0	2.22E+01	3.83E-02	1.29E-02	7.29E+00	2.78E+00	3.23E+01
	5.0	8.99E-01	1.55E-03	5.45E-04	3.10E-01	1.85E-01	1.40E+00
	10.0	1.97E-01	3.41E-04	1.20E-04	6.84E-02	1.09E-01	3.75E-01
	50.0	6.27E-03	1.08E-05	3.54E-06	2.00E-03	8.59E-02	9.42E-02
	80.0	2.38E-03	4.11E-06	1.32E-06	7.43E-04	8.26E-02	8.57E-02
270.0	0.1	5.76E+01	9.95E-02	6.35E-02	3.83E+01	1.45E+01	1.10E+02
	1.0	2.20E+01	3.80E-02	7.38E-03	3.76E+00	1.45E+00	2.72E+01
	5.0	8.68E-01	1.50E-03	4.42E-04	2.45E-01	1.66E-01	1.28E+00
	10.0	1.87E-01	3.22E-04	1.11E-04	6.32E-02	1.11E-01	3.61E-01
	50.0	5.67E-03	9.80E-06	3.54E-06	2.02E-03	9.02E-02	9.79E-02
	80.0	2.16E-03	3.73E-06	1.29E-06	7.33E-04	8.64E-02	8.93E-02

METSET SAMPLE METSET
SKIN ANGLE OF MAX DISPERSION = 67.5 DEGREES

EXTERNAL DOSE COMMITMENTS (MREM/YEAR) FROM CLOUD SUBMERSION

ANGLE	DISTANCE(KM)	U238	U234	TH230	RA226	PB210-RN222	TOTAL
67.5	0.1	3.96E-04	6.45E-06	1.22E-06	1.58E-04	4.25E+00	4.25E+00
	1.0	1.04E-04	1.70E-06	2.52E-06	4.31E-04	7.02E+00	7.02E+00
	5.0	4.52E-06	7.36E-08	7.98E-08	1.35E-05	3.13E+00	3.13E+00
	10.0	1.13E-06	1.83E-08	2.17E-08	3.69E-06	1.41E+00	1.41E+00
	50.0	5.33E-08	8.68E-10	1.20E-09	2.05E-07	2.20E-01	2.20E-01
	80.0	2.23E-08	3.63E-10	5.39E-10	9.23E-08	1.24E-01	1.24E-01
0.0	0.1	1.45E-04	2.36E-06	8.02E-07	1.21E-04	4.32E+00	4.32E+00
	1.0	7.21E-05	1.17E-06	1.55E-07	1.68E-05	3.99E+00	3.99E+00
	5.0	2.96E-06	4.81E-08	1.11E-08	1.53E-06	2.27E+00	2.27E+00
	10.0	6.58E-07	1.07E-08	3.30E-09	4.88E-07	1.11E+00	1.11E+00
	50.0	2.15E-08	3.51E-10	1.81E-10	2.89E-08	1.79E-01	1.79E-01
	80.0	8.14E-09	1.32E-10	7.90E-11	1.28E-08	1.02E-01	1.02E-01
90.0	0.1	3.17E-04	5.16E-06	1.25E-06	1.75E-04	4.27E+00	4.27E+00
	1.0	6.11E-05	9.95E-07	1.83E-06	3.15E-04	4.89E+00	4.89E+00
	5.0	2.55E-06	4.16E-08	3.43E-08	5.71E-06	1.78E+00	1.78E+00
	10.0	6.47E-07	1.05E-08	8.72E-09	1.45E-06	7.83E-01	7.83E-01
	50.0	3.29E-08	5.36E-10	4.68E-10	7.81E-08	1.20E-01	1.20E-01
	80.0	1.41E-08	2.29E-10	2.11E-10	3.54E-08	6.75E-02	6.75E-02
180.0	0.1	1.17E-04	1.90E-06	6.41E-07	9.62E-05	4.63E+00	4.63E+00
	1.0	4.59E-05	7.47E-07	9.92E-08	1.08E-05	4.07E+00	4.07E+00
	5.0	1.86E-06	3.03E-08	4.53E-09	5.28E-07	1.62E+00	1.62E+00
	10.0	4.08E-07	6.65E-09	1.10E-09	1.34E-07	7.52E-01	7.52E-01
	50.0	1.31E-08	2.13E-10	4.79E-11	6.56E-09	1.15E-01	1.15E-01
	80.0	4.97E-09	8.09E-11	2.06E-11	2.91E-09	6.51E-02	6.51E-02
270.0	0.1	1.18E-04	1.92E-06	6.73E-07	1.02E-04	4.66E+00	4.66E+00
	1.0	4.60E-05	7.48E-07	7.71E-08	6.86E-06	3.90E+00	3.90E+00
	5.0	1.80E-06	2.94E-08	4.04E-09	4.50E-07	1.55E+00	1.55E+00
	10.0	3.87E-07	6.30E-09	1.06E-09	1.31E-07	7.32E-01	7.32E-01
	50.0	1.18E-08	1.92E-10	5.16E-11	7.40E-09	1.17E-01	1.17E-01
	80.0	4.52E-09	7.36E-11	2.22E-11	3.28E-09	6.63E-02	6.63E-02

560 243

INHALATION POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR) FROM PARTICULATES

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
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0- 2.0	0.0	0.0	2.15E+00	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	1.38E-01	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	3.33E-01	4.60E-03	0.0	1.19E-02	0.0	0.0	0.0	0.0
30.0-40.0	3.40E-01	1.53E-01	0.0	6.25E-03	0.0	0.0	0.0	0.0
40.0-50.0	0.0	0.0	5.68E+00	0.0	0.0	0.0	2.72E-04	0.0
50.0-60.0	0.0	0.0	1.07E+00	0.0	0.0	0.0	0.0	0.0
60.0-70.0	0.0	0.0	0.0	1.29E-01	2.26E-01	0.0	0.0	0.0
70.0-80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

KILOMETERS	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	0.0	1.33E-03	0.0	0.0	1.09E-03	0.0	8.12E-04	0.0
30.0-40.0	0.0	0.0	5.24E-04	6.55E-04	0.0	0.0	2.53E-02	2.32E-02
40.0-50.0	4.56E-02	4.42E-04	0.0	0.0	0.0	0.0	3.19E-02	2.91E-02
50.0-60.0	0.0	0.0	0.0	0.0	2.62E-04	0.0	0.0	1.04E-02
60.0-70.0	0.0	0.0	5.02E-02	1.47E-02	2.06E-04	6.30E-02	0.0	8.06E-03
70.0-80.0	0.0	0.0	1.68E-04	2.42E-02	2.15E-01	1.61E-01	4.48E-03	0.0

TOTAL POPULATION DOSE COMMITMENT = 1.10E+01 ORGAN*REM/YEAR

INHALATION POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR) FROM RADON

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
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0- 2.0	0.0	0.0	6.50E+00	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	4.39E-01	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	7.72E+00	4.35E-02	0.0	7.71E-02	0.0	0.0	0.0	0.0
30.0-40.0	1.01E+01	1.75E+00	0.0	5.00E-02	0.0	0.0	0.0	0.0
40.0-50.0	0.0	0.0	5.18E+01	0.0	0.0	0.0	4.45E-03	0.0
50.0-60.0	0.0	0.0	1.09E+01	0.0	0.0	0.0	0.0	0.0
60.0-70.0	0.0	0.0	0.0	1.45E+00	3.16E+00	0.0	0.0	0.0
70.0-80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

KILOMETERS	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	0.0	3.33E-02	0.0	0.0	3.97E-02	0.0	2.86E-02	0.0
30.0-40.0	0.0	0.0	2.81E-02	2.63E-02	0.0	0.0	1.17E+00	1.14E+00
40.0-50.0	2.38E+00	1.59E-02	0.0	0.0	0.0	0.0	1.73E+00	1.67E+00
50.0-60.0	0.0	0.0	0.0	0.0	1.52E-02	0.0	0.0	6.56E-01
60.0-70.0	0.0	0.0	3.32E+00	7.76E-01	1.24E-02	4.96E+00	0.0	5.35E-01
70.0-80.0	0.0	0.0	1.11E-02	1.30E+00	1.30E+01	1.25E+01	2.78E-01	0.0

TOTAL POPULATION DOSE COMMITMENT = 1.39E+02 ORGAN*REM/YEAR

560 245

EXTERNAL POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR) FROM GROUND DEPOSITION

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
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0- 2.0	0.0	0.C	9.14E-01	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	5.64E-02	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	2.04E-01	2.03E-03	0.0	5.06E-03	0.0	0.0	0.0	0.0
30.0-40.0	3.32E-01	8.36E-02	0.0	3.04E-03	0.0	0.0	0.0	0.0
40.0-50.0	0.0	0.0	3.18E+00	0.0	0.0	0.0	1.89E-04	0.0
50.0-60.0	0.0	0.0	7.13E-01	0.0	0.0	0.0	0.0	0.0
60.0-70.0	0.0	0.0	0.0	1.05E-01	2.05E-01	0.0	0.0	0.0
70.0-80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

KILOMETERS	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	0.0	8.38E-04	0.0	0.0	8.72E-04	0.0	0.0	0.0
30.0-40.0	0.0	0.0	8.37E-04	7.94E-04	0.0	0.0	6.71E-04	0.0
40.0-50.0	9.05E-02	6.43E-04	0.0	0.0	0.0	0.0	3.66E-02	3.35E-02
50.0-60.0	0.0	0.0	0.0	0.0	7.36E-04	0.0	6.39E-02	6.36E-02
60.0-70.0	0.0	0.0	1.94E-01	4.45E-02	7.19E-04	2.98E-01	0.0	3.09E-02
70.0-80.0	0.0	0.0	7.61E-04	8.73E-02	8.82E-01	8.76E-01	1.90E-02	3.02E-02
								0.0

TOTAL POPULATION DOSE COMMITMENT = 8.56E+00 ORGAN*REM/YEAR

EXTERNAL POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR) FROM CLOUD SUBMERSION

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
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0- 2.0	0.0	0.0	4.41E-02	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	1.82E-02	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	4.21E-01	2.33E-03	0.0	4.11E-03	0.0	0.0	0.0	0.0
30.0-40.0	5.57E-01	9.57E-02	0.0	2.73E-03	0.0	0.0	0.0	0.0
40.0-50.0	0.0	0.0	2.86E+00	0.0	0.0	0.0	2.46E-04	0.0
50.0-60.0	0.0	0.0	6.04E-01	0.0	0.0	0.0	0.0	0.0
60.0-70.0	0.0	0.0	0.0	8.07E-02	1.76E-01	0.0	0.0	0.0
70.0-80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

KILOMETERS	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
0.1- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0- 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0-10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.0-20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0-30.0	0.0	1.83E-03	0.0	0.0	2.18E-03	0.0	1.58E-03	0.0
30.0-40.0	0.0	0.0	1.56E-03	1.46E-03	0.0	0.0	6.51E-02	6.30E-02
40.0-50.0	1.32E-01	8.87E-04	0.0	0.0	0.0	0.0	9.63E-02	9.31E-02
50.0-60.0	0.0	0.0	0.0	0.0	8.47E-04	0.0	0.0	3.66E-02
60.0-70.0	0.0	0.0	1.85E-01	4.33E-02	6.91E-04	2.77E-01	0.0	2.98E-02
70.0-80.0	0.0	0.0	6.20E-04	7.25E-02	7.23E-01	6.95E-01	1.55E-02	0.0

TOTAL POPULATION DOSE COMMITMENT = 7.40E+00 ORGAN*REM/YEAR

560 247

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 166
METSET SAMPLE METSET
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INHALATION DOSE COMMITMENTS (MREM/YEAR) AT EXTRA RECEPTORS FROM PARTICULATES

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	U238	U234	TH230	RA226	PB210	PO210	TOTAL
1	FENCE POST	0.85	0.35	0.0	8.73E+01	9.95E+01	1.89E+02	4.05E+02	2.25E+00	2.02E+02	9.85E+02
2	TRAILER	1.00	0.50	0.0	6.04E+01	6.89E+01	1.13E+02	2.41E+02	1.34E+00	1.20E+02	6.04E+02
3	RANCH 1	1.90	1.40	0.0	1.40E+01	1.60E+01	1.91E+01	4.04E+01	2.25E-01	2.01E+01	1.10E+02
4	RANCH 2	8.80	3.60	0.0	8.90E-01	1.01E+00	1.44E+00	3.06E+00	1.98E-02	1.54E+00	7.95E+00
5	RANCH 3	18.80	7.80	0.0	2.04E-01	2.32E-01	3.55E-01	7.57E-01	7.26E-03	3.89E-01	1.94E+00
6	RANCH 3V	18.80	7.80	0.0	2.04E-01	2.32E-01	3.55E-01	7.57E-01	7.26E-03	3.89E-01	1.94E+00
7	RANCH 4	36.50	15.00	0.0	5.95E-02	6.78E-02	1.09E-01	2.33E-01	4.36E-03	1.28E-01	6.02E-01
8	RANCH 5	12.00	21.80	0.0	8.97E-02	1.02E-01	1.25E-01	2.64E-01	3.45E-03	1.39E-01	7.24E-01
9	RANCH 6	-2.40	20.60	0.0	7.87E-02	8.97E-02	3.95E-02	7.78E-02	2.67E-03	4.72E-02	3.36E-01
10	RANCH 6V	-2.40	20.60	0.0	7.87E-02	8.97E-02	3.95E-02	7.78E-02	2.67E-03	4.72E-02	3.36E-01
11	RANCH 7	-18.20	23.30	0.0	1.57E-02	1.79E-02	6.64E-03	1.28E-02	1.36E-03	1.12E-02	6.55E-02
12	RANCH 8	-27.50	-2.50	0.0	2.99E-02	3.40E-02	9.00E-03	1.63E-02	1.90E-03	1.50E-02	1.06E-01
13	RANCH 9	-35.20	-14.80	0.0	1.75E-02	2.00E-02	5.48E-03	1.00E-02	1.83E-03	1.17E-02	6.65E-02
14	RANCH 10	-23.00	-22.40	0.0	2.16E-02	2.46E-02	4.36E-03	7.06E-03	1.96E-03	1.08E-02	7.04E-02
15	RANCH 11	-7.40	-21.80	0.0	4.40E-02	5.01E-02	1.80E-02	3.44E-02	1.68E-03	2.28E-02	1.71E-01
16	RANCH 12	-55.30	2.40	0.0	6.24E-03	7.11E-03	2.27E-03	4.27E-03	1.72E-03	8.57E-03	3.02E-02
17	RANCH 12V	-55.30	2.40	0.0	6.24E-03	7.11E-03	2.27E-03	4.27E-03	1.72E-03	8.57E-03	3.02E-02
18	RANCH 13	-67.50	-8.10	0.0	4.84E-03	5.52E-03	1.74E-03	3.26E-03	1.74E-03	8.15E-03	2.52E-02
19	RANCH 14	-55.70	-46.40	0.0	4.44E-03	5.06E-03	1.19E-03	2.09E-03	1.83E-03	7.93E-03	2.25E-02
20	RANCH 15	-23.30	-38.70	0.0	1.18E-02	1.34E-02	4.40E-03	8.32E-03	1.69E-03	1.04E-02	4.99E-02
21	RANCH 16	27.80	-38.30	0.0	6.42E-03	7.32E-03	2.87E-03	5.55E-03	4.11E-04	4.21E-03	2.68E-02
22	RANCH 16V	27.80	-38.30	0.0	6.42E-03	7.32E-03	2.87E-03	5.55E-03	4.11E-04	4.21E-03	2.68E-02
23	WEST CITY	-78.00	16.00	0.0	2.11E-03	2.40E-03	1.11E-03	2.20E-03	1.57E-03	7.01E-03	1.64E-02
24	EAST CITY	33.00	35.00	0.0	3.48E-02	3.97E-02	6.47E-02	1.38E-01	3.29E-03	7.86E-02	3.60E-01
25	RED TOWN	-65.00	-26.00	0.0	5.08E-03	5.79E-03	1.76E-03	3.28E-03	1.68E-03	7.92E-03	2.55E-02
26	BLUE TOWN	-27.00	27.00	0.0	8.37E-03	9.54E-03	4.26E-03	8.40E-03	1.32E-03	9.02E-03	4.09E-02
27	BROWN TOWN	-5.20	29.00	0.0	3.32E-02	3.78E-02	1.76E-02	3.49E-02	2.21E-03	2.50E-02	1.51E-01
28	GREEN TOWN	14.00	35.00	0.0	3.36E-02	3.82E-02	4.07E-02	8.57E-02	2.19E-03	4.92E-02	2.50E-01
29	ORANGE TOWN	-23.00	59.00	0.0	2.77E-03	3.15E-03	1.22E-03	2.35E-03	1.16E-03	5.54E-03	1.62E-02
30	PURPLE TOWN	56.00	32.00	0.0	2.34E-02	2.67E-02	4.50E-02	9.63E-02	3.38E-03	5.88E-02	2.54E-01
31	WHITE TOWN	-29.00	53.00	0.0	3.16E-03	3.60E-03	1.53E-03	2.99E-03	1.22E-03	6.04E-03	1.85E-02
32	E INDIANRES	65.00	0.0	0.0	1.46E-02	1.66E-02	1.73E-02	3.64E-02	1.80E-03	2.42E-02	1.11E-01
33	E INDIANRES	-60.00	50.00	0.0	1.51E-03	1.72E-03	1.13E-03	2.32E-03	1.27E-03	5.92E-03	1.39E-02
34	EAST RURAL	40.00	36.00	0.0	2.96E-02	3.37E-02	5.63E-02	1.21E-01	3.27E-03	7.00E-02	3.13E-01
35	NORTH RURAL	-5.00	31.00	0.0	3.01E-02	3.43E-02	1.66E-02	3.30E-02	2.26E-03	2.43E-02	1.40E-01
36	NW RURAL	-23.00	32.00	0.0	8.31E-03	9.47E-03	3.80E-03	7.39E-03	1.31E-03	8.48E-03	3.88E-02
37	WEST RURAL	-65.00	24.00	0.0	1.49E-03	1.69E-03	1.18E-03	2.41E-03	1.43E-03	6.59E-03	1.48E-02
38	SOUTH RURAL	0.0	-45.00	0.0	1.15E-02	1.31E-02	3.15E-03	5.59E-03	1.73E-03	9.21E-03	4.42E-02
39	SW RURAL	-45.00	-45.00	0.0	5.60E-03	6.39E-03	1.26E-03	2.12E-03	1.90E-03	8.20E-03	2.55E-02
40	AGRICULTURE 1	38.70	33.30	0.0	3.34E-02	3.81E-02	6.32E-02	1.35E-01	3.41E-03	7.75E-02	3.51E-01
41	AGRICULTURE 2	21.30	34.30	0.0	3.98E-02	4.53E-02	6.20E-02	1.32E-01	2.84E-03	7.37E-02	3.55E-01
42	AGRICULTURE 3	-5.00	30.50	0.0	3.09E-02	3.52E-02	1.69E-02	3.36E-02	2.26E-03	2.46E-02	1.44E-01
43	AGRICULTURE 4	-22.80	30.80	0.0	8.81E-03	1.00E-02	4.03E-03	7.85E-03	1.31E-03	8.72E-03	4.08E-02
44	AGRICULTURE 5	-56.00	22.00	0.0	1.79E-03	2.04E-03	1.46E-03	3.01E-03	1.43E-03	6.85E-03	1.66E-02
45	AGRICULTURE 6	-67.50	18.80	0.0	2.21E-03	2.52E-03	1.29E-03	2.59E-03	1.53E-03	7.04E-03	1.72E-02

INHALATION DOSE COMMITMENTS (MREM/YEAR) AND WORKING LEVEL MONTH AT EXTRA RECEPTORS FROM RADON

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	DOSE RATE	WLM
1	FENCE POST	0.85	0.35	0.0	2.66E+03	5.32E-01
2	TRAILER	1.00	0.50	0.0	1.52E+03	3.04E-01
3	RANCH 1	1.90	1.40	0.0	2.64E+02	5.28E-02
4	RANCH 2	8.80	3.60	0.0	3.13E+01	6.26E-03
5	RANCH 3	18.80	7.80	0.0	1.17E+01	2.34E-03
6	RANCH 3V	18.80	7.80	0.0	1.17E+01	2.34E-03
7	RANCH 4	36.50	15.00	0.0	5.28E+00	1.06E-03
8	RANCH 5	12.00	21.80	0.0	6.01E+00	1.20E-03
9	RANCH 6	-2.40	20.60	0.0	7.75E+00	1.55E-03
10	RANCH 6V	-2.40	20.60	0.0	7.75E+00	1.55E-03
11	RANCH 7	-18.20	23.30	0.0	2.86E+00	5.71E-04
12	RANCH 8	-27.50	-2.50	0.0	4.30E+00	8.61E-04
13	RANCH 9	-35.20	-14.80	0.0	2.91E+00	5.81E-04
14	RANCH 10	-23.00	-22.40	0.0	3.75E+00	7.50E-04
15	RANCH 11	-7.40	-21.80	0.0	4.49E+00	8.98E-04
16	RANCH 12	-55.30	2.40	0.0	1.81E+00	3.61E-04
17	RANCH 12V	-55.30	2.40	0.0	1.81E+00	3.61E-04
18	RANCH 13	-67.50	-8.10	0.0	1.48E+00	2.95E-04
19	RANCH 14	-55.70	-46.40	0.0	1.43E+00	2.86E-04
20	RANCH 15	-23.30	-38.70	0.0	2.27E+00	4.54E-04
21	RANCH 16	27.80	-38.30	0.0	5.49E-01	1.10E-04
22	RANCH 16V	27.80	-38.30	0.0	5.49E-01	1.10E-04
23	WEST CITY	-78.00	16.00	0.0	1.10E+00	2.20E-04
24	EAST CITY	33.00	35.00	0.0	3.50E+00	6.99E-04
25	RED TOWN	-65.00	-26.00	0.0	1.37E+00	2.74E-04
26	BLUE TOWN	-27.00	27.00	0.0	2.06E+00	4.13E-04
27	BROWN TOWN	-5.20	29.00	0.0	4.63E+00	9.27E-04
28	GREEN TOWN	14.00	35.00	0.0	3.11E+00	6.23E-04
29	ORANGE TOWN	-23.00	59.00	0.0	1.08E+00	2.16E-04
30	PURPLE TOWN	56.00	32.00	0.0	2.84E+00	5.68E-04
31	WHITE TOWN	-29.00	53.00	0.0	1.20E+00	2.39E-04
32	E INDIANRES	65.00	0.0	0.0	1.57E+00	3.14E-04
33	E INDIANRES	-60.00	50.00	0.0	9.07E-01	1.81E-04
34	EAST RURAL	40.00	36.00	0.0	3.19E+00	6.38E-04
35	NORTH RURAL	-5.00	31.00	0.0	4.44E+00	8.87E-04
36	NW RURAL	-23.00	32.00	0.0	2.04E+00	4.08E-04
37	WEST RURAL	-65.00	24.00	0.0	1.14E+00	2.28E-04
38	SOUTH RURAL	0.0	-45.00	0.0	2.34E+00	4.68E-04
39	SW RURAL	-45.00	-45.00	0.0	1.69E+00	3.38E-04
40	AGRICULTURE 1	38.70	33.30	0.0	3.47E+00	6.94E-04
41	AGRICULTURE 2	21.30	34.30	0.0	3.63E+00	7.26E-04
42	AGRICULTURE 3	-5.00	30.50	0.0	4.50E+00	9.00E-04
43	AGRICULTURE 4	-22.80	30.80	0.0	2.11E+00	4.21E-04
44	AGRICULTURE 5	-56.00	22.00	0.0	1.32E+00	2.64E-04
45	AGRICULTURE 6	-67.50	18.80	0.0	1.23E+00	2.46E-04

560 249

EXTERNAL DOSE COMMITMENTS (MREM/YEAR) AT EXTRA RECEPTORS FROM GROUND DEPOSITION

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	U238	U234	TH230	RA226	PB210	TOTAL
1	FENCE POST	0.85	0.35	0.0	8.54E+01	1.48E-01	6.94E-01	4.43E+02	1.68E+02	6.97E+02
2	TRAILER	1.00	0.50	0.0	5.61E+01	9.69E-02	4.05E-01	2.58E+02	9.77E+01	4.12E+02
3	RANCH 1	1.90	1.40	0.0	1.18E+01	2.04E-02	6.36E-02	4.04E+01	1.54E+01	6.77E+01
4	RANCH 2	8.80	3.60	0.0	7.41E-01	1.28E-03	4.10E-03	2.60E+00	1.13E+00	4.48E+00
5	RANCH 3	18.80	7.80	0.0	1.65E-01	2.85E-04	8.68E-04	5.51E-01	3.63E-01	1.08E+00
6	RANCH 3V	18.80	7.80	0.0	1.65E-01	2.85E-04	8.68E-04	5.51E-01	3.63E-01	1.08E+00
7	RANCH 4	36.50	15.00	0.0	4.64E-02	8.02E-05	2.23E-04	1.41E-01	2.08E-01	3.96E-01
8	RANCH 5	12.00	21.80	0.0	6.92E-02	1.20E-04	2.86E-04	1.81E-01	1.68E-01	4.19E-01
9	RANCH 6	-2.40	20.60	0.0	5.54E-02	9.57E-05	8.31E-05	5.10E-02	1.32E-01	2.39E-01
10	RANCH 6V	-2.40	20.60	0.0	5.54E-02	9.57E-05	8.31E-05	5.10E-02	1.32E-01	2.39E-01
11	RANCH 7	-18.20	23.30	0.0	1.09E-02	1.88E-05	1.27E-05	7.67E-03	6.77E-02	8.63E-02
12	RANCH 8	-27.50	-2.50	0.0	2.04E-02	3.53E-05	1.39E-05	8.05E-03	9.43E-02	1.23E-01
13	RANCH 9	-35.20	-14.80	0.0	1.19E-02	2.06E-05	7.55E-06	4.32E-03	9.10E-02	1.07E-01
14	RANCH 10	-23.00	-22.40	0.0	1.47E-02	2.54E-05	6.65E-06	3.62E-03	9.82E-02	1.17E-01
15	RANCH 11	-7.40	-21.80	0.0	3.06E-02	5.29E-05	3.68E-05	2.23E-02	8.34E-02	1.36E-01
16	RANCH 12	-55.30	2.40	0.0	4.24E-03	7.32E-06	2.82E-06	1.62E-03	8.64E-02	9.22E-02
17	RANCH 12V	-55.30	2.40	0.0	4.24E-03	7.32E-06	2.82E-06	1.62E-03	8.64E-02	9.22E-02
18	RANCH 13	-67.50	-8.10	0.0	3.28E-03	5.67E-06	1.94E-06	1.10E-03	8.72E-02	9.15E-02
19	RANCH 14	-55.70	-46.40	0.0	3.01E-03	5.20E-06	1.44E-06	7.95E-04	9.18E-02	9.56E-02
20	RANCH 15	-23.30	-38.70	0.0	8.08E-03	1.40E-05	7.23E-06	4.29E-03	8.47E-02	9.70E-02
21	RANCH 16	27.80	-38.30	0.0	4.41E-03	7.62E-06	4.19E-06	2.50E-03	2.01E-02	2.70E-02
22	RANCH 16V	27.80	-38.30	0.0	4.41E-03	7.62E-06	4.19E-06	2.50E-03	2.01E-02	2.70E-02
23	WEST CITY	-78.00	16.00	0.0	1.44E-03	2.49E-06	1.39E-06	8.28E-04	7.89E-02	8.12E-02
24	EAST CITY	33.00	35.00	0.0	2.66E-02	4.60E-05	1.20E-04	7.60E-02	1.56E-01	2.59E-01
25	RED TOWN	-65.00	-26.00	0.0	3.44E-03	5.94E-06	1.93E-06	1.09E-03	8.41E-02	8.86E-02
26	BLUE TOWN	-27.00	27.00	0.0	5.83E-03	1.01E-05	7.82E-06	4.77E-03	6.62E-02	7.69E-02
27	BROWN TOWN	-5.20	29.00	0.0	2.32E-02	4.01E-05	3.35E-05	2.05E-02	1.09E-01	1.53E-01
28	GREEN TOWN	14.00	35.00	0.0	2.50E-02	4.32E-05	8.39E-05	5.29E-02	1.07E-01	1.85E-01
29	ORANGE TOWN	-23.00	59.00	0.0	1.89E-03	3.26E-06	1.54E-06	9.10E-04	5.84E-02	6.12E-02
30	PURPLE TOWN	56.00	32.00	0.0	1.76E-02	3.05E-05	7.74E-05	4.90E-02	1.62E-01	2.29E-01
31	WHITE TOWN	-29.00	53.00	0.0	2.16E-03	3.74E-06	2.14E-06	1.28E-03	6.10E-02	6.45E-02
32	E INDIANRES	65.00	0.0	0.0	1.05E-02	1.81E-05	2.79E-05	1.75E-02	8.72E-02	1.15E-01
33	E INDIANRES	-60.00	50.00	0.0	1.05E-03	1.81E-06	1.64E-06	1.01E-03	6.37E-02	6.57E-02
34	EAST RURAL	40.00	36.00	0.0	2.25E-02	3.89E-05	1.01E-04	6.39E-02	1.56E-01	2.42E-01
35	NORTH RURAL	-5.00	31.00	0.0	2.11E-02	3.64E-05	3.09E-05	1.90E-02	1.12E-01	1.52E-01
36	NW RURAL	-23.00	32.00	0.0	5.76E-03	9.95E-06	6.57E-06	3.97E-03	6.55E-02	7.52E-02
37	WEST RURAL	-65.00	24.00	0.0	1.04E-03	1.79E-06	1.79E-06	1.10E-03	7.20E-02	7.42E-02
38	SOUTH RURAL	0.0	-45.00	0.0	7.80E-03	1.35E-05	4.43E-06	2.50E-03	8.65E-02	9.68E-02
39	SW RURAL	-45.00	-45.00	0.0	3.80E-03	6.57E-06	1.66E-06	9.00E-04	9.54E-02	1.00E-01
40	AGRICULTURE 1	38.70	33.30	0.0	2.55E-02	4.41E-05	1.16E-04	7.34E-02	1.62E-01	2.61E-01
41	AGRICULTURE 2	21.30	34.30	0.0	3.02E-02	5.23E-05	1.24E-04	7.84E-02	1.36E-01	2.45E-01
42	AGRICULTURE 3	-5.00	30.50	0.0	2.17E-02	3.74E-05	3.17E-05	1.95E-02	1.12E-01	1.53E-01
43	AGRICULTURE 4	-22.80	30.80	0.0	6.10E-03	1.05E-05	7.08E-06	4.28E-03	6.57E-02	7.61E-02
44	AGRICULTURE 5	-56.00	22.00	0.0	1.26E-03	2.18E-06	2.41E-06	1.49E-03	7.17E-02	7.45E-02
45	AGRICULTURE 6	-67.50	18.80	0.0	1.52E-03	2.63E-06	1.80E-06	1.09E-03	7.69E-02	7.95E-02

560 250

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 188
METSET SAMPLE METSET
SKIN

EXTERNAL DOSE COMMITMENTS (MREM/YEAR) AT EXTRA RECEPTORS FROM CLOUD SUBMERSION

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	U238	U234	TH230	RA226	PB210-RN222	TOTAL
1	FENCE POST	0.85	0.35	0.0	1.19E-04	1.94E-06	3.07E-06	5.27E-04	6.86E+00	6.86E+00
2	TRAILER	1.00	0.50	0.0	8.31E-05	1.35E-06	1.84E-06	3.14E-04	7.06E+00	7.06E+00
3	RANCH 1	1.90	1.40	0.0	1.95E-05	3.17E-07	3.15E-07	5.30E-05	5.17E+00	5.17E+00
4	RANCH 2	8.80	3.60	0.0	1.23E-06	2.00E-08	2.38E-08	4.04E-06	1.50E+00	1.50E+00
5	RANCH 3	18.80	7.80	0.0	2.81E-07	4.58E-09	5.91E-09	1.01E-06	6.17E-01	6.17E-01
6	RANCH 3V	18.80	7.80	0.0	2.81E-07	4.58E-09	5.91E-09	1.01E-06	6.17E-01	6.17E-01
7	RANCH 4	36.50	15.00	0.0	8.21E-08	1.34E-09	1.83E-09	3.12E-07	2.91E-01	2.91E-01
8	RANCH 5	12.00	21.80	0.0	1.25E-07	2.03E-09	2.10E-09	3.53E-07	3.23E-01	3.23E-01
9	RANCH 6	-2.40	20.60	0.0	1.11E-07	1.81E-09	6.89E-10	1.06E-07	4.21E-01	4.21E-01
10	RANCH 6V	-2.40	20.60	0.0	1.11E-07	1.81E-09	6.89E-10	1.06E-07	4.21E-01	4.21E-01
11	RANCH 7	-18.20	23.30	0.0	2.21E-08	3.61E-10	1.17E-10	1.75E-08	1.58E-01	1.58E-01
12	RANCH 8	-27.50	-2.50	0.0	4.23E-08	6.89E-10	1.64E-10	2.28E-08	2.38E-01	2.38E-01
13	RANCH 9	-35.20	-14.80	0.0	2.48E-08	4.04E-10	9.99E-11	1.40E-08	1.61E-01	1.61E-01
14	RANCH 10	-23.00	-22.40	0.0	3.07E-08	5.00E-10	8.31E-11	1.02E-08	2.08E-01	2.08E-01
15	RANCH 11	-7.40	-21.80	0.0	6.21E-08	1.01E-09	3.17E-10	4.71E-08	2.46E-01	2.46E-01
16	RANCH 12	-55.30	2.40	0.0	8.83E-09	1.44E-10	4.11E-11	5.98E-09	1.01E-01	1.01E-01
17	RANCH 12V	-55.30	2.40	0.0	8.83E-09	1.44E-10	4.11E-11	5.98E-09	1.01E-01	1.01E-01
18	RANCH 13	-67.50	-8.10	0.0	6.85E-09	1.12E-10	3.16E-11	4.58E-09	8.23E-02	8.23E-02
19	RANCH 14	-55.70	-46.40	0.0	6.30E-09	1.03E-10	2.20E-11	2.98E-09	7.98E-02	7.98E-02
20	RANCH 15	-23.30	-38.70	0.0	1.66E-08	2.71E-10	7.89E-11	1.15E-08	1.26E-01	1.26E-01
21	RANCH 16	27.80	-38.30	0.0	9.08E-09	1.48E-10	5.09E-11	7.69E-09	3.04E-02	3.04E-02
22	RANCH 16V	27.80	-38.30	0.0	9.08E-09	1.48E-10	5.09E-11	7.69E-09	3.04E-02	3.04E-02
23	WEST CITY	-78.00	16.00	0.0	2.98E-09	4.85E-11	1.96E-11	3.04E-09	6.13E-02	6.13E-02
24	EAST CITY	33.00	35.00	0.0	4.80E-08	7.82E-10	1.0[illegible]E-09	1.86E-07	1.94E-01	1.94E-01
25	RED TOWN	-65.00	-26.00	0.0	7.20E-09	1.17E-10	3.20E-11	4.62E-09	7.63E-02	7.63E-02
26	BLUE TOWN	-27.00	27.00	0.0	1.18E-08	1.92E-10	7.46E-11	1.15E-08	1.15E-01	1.15E-01
27	BROWN TOWN	-5.20	29.00	0.0	4.68E-08	7.62E-10	3.08E-10	4.76E-08	2.56E-01	2.56E-01
28	GREEN TOWN	14.00	35.00	0.0	4.68E-08	7.62E-10	6.88E-10	1.15E-07	1.72E-01	1.72E-01
29	ORANGE TOWN	-23.00	59.00	0.0	3.91E-09	6.37E-11	2.17E-11	3.27E-09	6.01E-02	6.01E-02
30	PURPLE TOWN	56.00	32.00	0.0	3.22E-08	5.25E-10	7.58E-10	1.30E-07	1.58E-01	1.58E-01
31	WHITE TOWN	-29.00	53.00	0.0	4.46E-09	7.26E-11	2.70E-11	4.13E-09	6.67E-02	6.67E-02
32	E INDIANRES	65.00	0.0	0.0	2.04E-08	3.32E-10	2.95E-10	4.93E-08	8.73E-02	8.73E-02
33	E INDIANRES	-60.00	50.00	0.0	2.12E-09	3.45E-11	1.96E-11	3.16E-09	5.06E-02	5.06E-02
34	EAST RURAL	40.00	36.00	0.0	4.08E-08	6.64E-10	9.48E-10	1.62E-07	1.77E-01	1.77E-01
35	NORTH RURAL	-5.00	31.00	0.0	4.24E-08	6.91E-10	2.89E-10	4.50E-08	2.45E-01	2.45E-01
36	NW RURAL	-23.00	32.00	0.0	1.17E-08	1.91E-10	6.71E-11	1.02E-08	1.13E-01	1.13E-01
37	WEST RURAL	-65.00	24.00	0.0	2.09E-09	3.40E-11	2.03E-11	3.29E-09	6.36E-02	6.36E-02
38	SOUTH RURAL	0.0	-45.00	0.0	1.63E-08	2.65E-10	5.82E-11	7.91E-09	1.30E-01	1.30E-01
39	SW RURAL	-45.00	-45.00	0.0	7.95E-09	1.29E-10	2.38E-11	3.05E-09	9.42E-02	9.42E-02
40	AGRICULTURE 1	38.70	33.30	0.0	4.60E-08	7.50E-10	1.06E-09	1.82E-07	1.92E-01	1.92E-01
41	AGRICULTURE 2	21.30	34.30	0.0	5.51E-08	8.98E-10	1.04E-09	1.77E-07	2.00E-01	2.00E-01
42	AGRICULTURE 3	-5.00	30.50	0.0	4.36E-08	7.10E-10	2.95E-10	4.59E-08	2.49E-01	2.49E-01
43	AGRICULTURE 4	-22.80	30.80	0.0	1.24E-08	2.03E-10	7.11E-11	1.08E-08	1.17E-01	1.17E-01
44	AGRICULTURE 5	-56.00	22.00	0.0	2.52E-09	4.10E-11	2.51E-11	4.09E-09	7.36E-02	7.36E-02
45	AGRICULTURE 6	-67.50	18.80	0.0	3.12E-09	5.09E-11	2.27E-11	3.56E-09	6.85E-02	6.85E-02

560 251

DOSE COMMITMENTS FROM INGESTION (MREM/YEAR)

#	IDENTIFICATION	PATHWAY	U238	U234	TH230	RA226	PB210	PO210	TOTAL
3	RANCH 1	MEAT	6.45E-04	7.35E-04	1.78E-03	2.94E+00	2.95E-02	2.34E-01	3.21E+00
4	RANCH 2	MEAT	4.06E-05	4.62E-05	1.15E-04	1.90E-01	2.15E-03	1.58E-02	2.08E-01
5	RANCH 3	MEAT	9.03E-06	1.03E-05	2.43E-05	4.01E-02	6.76E-04	3.99E-03	4.48E-02
6	RANCH 3V	VEGETATION	6.32E-04	7.21E-04	2.92E-03	2.37E-01	6.65E-02	1.18E-02	3.20E-01
7	RANCH 4	MEAT	2.54E-06	2.90E-06	6.24E-06	1.03E-02	3.79E-04	1.62E-03	1.23E-02
8	RANCH 5	MEAT	3.79E-06	4.32E-06	8.02E-06	1.32E-02	3.10E-04	1.56E-03	1.51E-02
9	RANCH 6	MEAT	3.03E-06	3.45E-06	2.33E-06	3.71E-03	2.38E-04	8.80E-04	4.84E-03
10	RANCH 6V	VEGETATION	2.12E-04	2.42E-04	2.79E-04	2.19E-02	2.36E-02	3.19E-03	4.94E-02
11	RANCH 7	MEAT	5.96E-07	6.79E-07	3.55E-07	5.58E-04	1.21E-04	3.81E-04	1.06E-03
12	RANCH 8	MEAT	1.12E-06	1.27E-06	3.91E-07	5.86E-04	1.69E-04	5.20E-04	1.28E-03
13	RANCH 9	MEAT	6.53E-07	7.44E-07	2.12E-07	3.15E-04	1.63E-04	4.89E-04	9.68E-04
14	RANCH 10	MEAT	8.04E-07	9.16E-07	1.86E-07	2.63E-04	1.76E-04	5.24E-04	9.65E-04
15	RANCH 11	MEAT	1.68E-06	1.91E-06	1.03E-06	1.62E-03	1.50E-04	5.18E-04	2.29E-03
16	RANCH 12	MEAT	2.32E-07	2.64E-07	7.89E-08	1.18E-04	1.54E-04	4.55E-04	7.28E-04
17	RANCH 12V	VEGETATION	1.62E-05	1.85E-05	9.46E-06	6.97E-04	1.53E-02	1.85E-03	1.79E-02
18	RANCH 13	MEAT	1.79E-07	2.05E-07	5.45E-08	8.04E-05	1.56E-04	4.57E-04	6.94E-04
19	RANCH 14	MEAT	1.65E-07	1.88E-07	4.05E-08	5.78E-05	1.64E-04	4.80E-04	7.03E-04
20	RANCH 15	MEAT	4.42E-07	5.04E-07	2.03E-07	3.12E-04	1.51E-04	4.56E-04	9.21E-04
21	RANCH 16	MEAT	2.41E-07	2.75E-07	1.17E-07	1.82E-04	3.66E-05	1.14E-04	3.32E-04
22	RANCH 16V	VEGETATION	1.69E-05	1.93E-05	1.41E-05	1.07E-03	3.56E-03	4.46E-04	5.13E-03
40	AGRICULTURE 1	VEGETATION	9.78E-05	1.11E-04	3.89E-04	3.16E-02	2.89E-02	3.99E-03	6.51E-02
41	AGRICULTURE 2	VEGETATION	1.16E-04	1.32E-04	4.16E-04	3.37E-02	2.43E-02	3.48E-03	6.22E-02
42	AGRICULTURE 3	VEGETATION	8.30E-05	9.46E-05	1.07E-04	8.37E-03	1.99E-02	2.53E-03	3.10E-02
43	AGRICULTURE 4	VEGETATION	2.34E-05	2.67E-05	2.38E-05	1.84E-03	1.16E-02	1.43E-03	1.50E-02
44	AGRICULTURE 5	VEGETATION	4.84E-06	5.52E-06	8.09E-06	6.42E-04	1.27E-02	1.54E-03	1.49E-02
45	AGRICULTURE 6	VEGETATION	5.84E-06	6.66E-06	6.05E-06	4.69E-04	1.36E-02	1.65E-03	1.57E-02

INGESTION DOSE COMMITMENTS FOR GENERAL POPULATION (ORGAN*MREM/YEAR)

PATHWAY	ORGAN	U238	U234	TH230	RA226	PB210	PO210	TOTAL
MEAT	WHOLE BODY	3.85E-05	4.38E-05	1.05E-04	1.74E-01	1.88E-03	1.42E-02	1.90E-01
	BONE	6.49E-04	7.09E-04	3.77E-03	1.74E+00	5.84E-02	5.78E-02	1.86E+00
	KIDNEY	1.48E-04	1.69E-04	1.04E-03	6.12E-03	4.86E-02	4.27E-01	4.83E-01
	LIVER	0.0	0.0	2.17E-04	2.16E-04	1.49E-02	1.27E-01	1.42E-01
DAIRY	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POULTRY & EGGS	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEGETATION	WHOLE BODY	1.77E-05	2.02E-05	5.74E-05	4.64E-03	6.62E-03	8.72E-04	1.22E-02
	BONE	2.99E-04	3.27E-04	2.06E-03	4.64E-02	2.06E-01	3.55E-03	2.58E-01
	KIDNEY	6.83E-05	7.78E-05	5.68E-04	1.64E-04	1.71E-01	2.62E-02	1.98E-01
	LIVER	0.0	0.0	1.18E-04	5.78E-06	5.24E-02	7.81E-03	6.03E-02
FISH	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0

POPULATION DOSE COMMITMENTS (ORGAN*REM/YEAR)

ORGAN	INHALATION, PARTICULATES	INHALATION, RADON	INGESTION	EXTERNAL, GROUND	EXTERNAL, CLOUD	TOTAL
BRONCHIAL EPITHELIUM		1.39E+02				1.39E+02
NASOPHARYNGEAL	1.10E+01					1.10E+01
TRACHEOBRONCHIAL	7.46E-03					7.46E-03
PULMONARY	3.34E+00			2.93E-01	1.90E+00	5.53E+00
WHOLE BODY	1.79E-01		1.16E+01	3.20E-01	2.01E+00	1.41E+01
BONE	5.37E+00		1.22E+02	3.86E-01	2.26E+00	1.30E+02
KIDNEY	3.86E+00		3.91E+01			4.30E+01
LIVER	1.15E+00		1.16E+01			1.28E+01
STOMACH	5.45E-03					5.45E-03
SMALL INTESTINE	1.34E-03			2.31E-01	1.52E+00	1.75E+00
UPPER LARGE INTESTINE	9.76E-03					9.76E-03
LOWER LARGE INTESTINE	8.79E-03					8.79E-03
LYMPH NODES	7.56E+01					7.56E+01
SKIN				8.56E+00	7.40E+00	1.60E+01
OVARIES				2.31E-01	1.50E+00	1.73E+00
TESTES				2.75E-01	1.70E+00	1.98E+00
RED MARROW				3.54E-01	2.10E+00	2.45E+00
SPLEEN				3.03E-01	1.98E+00	2.28E+00

ENVIRONMENTAL (100 YEARS) DOSE COMMITMENTS (ORGAN*REM)

ORGAN	INHALATION, PARTICULATES	INHALATION, RADON	INGESTION	EXTERNAL, GROUND	EXTERNAL, CLOUD	TOTAL
BRONCHIAL EPITHELIUM		2.09E+03				2.09E+03
NASOPHARYNGEAL	1.66E+02					1.66E+02
TRACHEOBRONCHIAL	1.13E-01					1.13E-01
PULMONARY	5.04E+01			1.76E+01	2.85E+01	9.65E+01
WHOLE BODY	2.70E+00		1.92E+02	1.90E+01	3.02E+01	2.44E+02
BONE	8.07E+01		1.99E+03	2.25E+01	3.39E+01	2.13E+03
KIDNEY	5.80E+01		1.07E+03			1.12E+03
LIVER	1.73E+01		3.18E+02			3.36E+02
STOMACH	8.24E-02					8.24E-02
SMALL INTESTINE	2.02E-02			1.40E+01	2.28E+01	3.68E+01
UPPER LARGE INTESTINE	1.48E-01					1.48E-01
LOWER LARGE INTESTINE	1.33E-01					1.33E-01
LYMPH NODES	1.14E+03					1.14E+03
SKIN				3.50E+02	1.11E+02	4.61E+02
OVARIES				1.39E+01	2.24E+01	3.63E+01
TESTES				1.63E+01	2.56E+01	4.19E+01
RED MARROW				2.06E+01	3.15E+01	5.21E+01
SPLEEN				1.83E+01	2.97E+01	4.80E+01

560 255

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 204
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
NASOPHARYNGEAL

INHALATION TOTAL TIME INTEGATED DOSE (MREM) FROM PARTICULATES

ANGLE	DISTANCE(KM)	YEARS 1	3	5	7	10	15	20	30	50	70
67.5	0.1	7.95E+02	2.44E+03	4.08E+03	5.72E+03	8.19E+03	1.23E+04	1.23E+04	1.23E+04	1.24E+04	1.24E+04
	1.0	7.87E+02	2.41E+03	4.04E+03	5.67E+03	8.11E+03	1.22E+04	1.22E+04	1.22E+04	1.22E+04	1.23E+04
	5.0	2.63E+01	8.07E+01	1.35E+02	1.89E+02	2.71E+02	4.07E+02	4.08E+02	4.08E+02	4.09E+02	4.10E+02
	10.0	7.02E+00	2.15E+01	3.60E+01	5.06E+01	7.23E+01	1.09E+02	1.09E+02	1.09E+02	1.09E+02	1.09E+02
	50.0	3.83E-01	1.18E+00	1.97E+00	2.77E+00	3.96E+00	5.95E+00	5.96E+00	5.97E+00	5.99E+00	6.00E+00
	80.0	1.75E-01	5.41E-01	9.07E-01	1.27E+00	1.82E+00	2.74E+00	2.74E+00	2.75E+00	2.76E+00	2.76E+00
0.0	0.1	3.35E+02	1.03E+03	1.72E+03	2.41E+03	3.45E+03	5.18E+03	5.19E+03	5.19E+03	5.21E+03	5.22E+03
	1.0	1.29E+02	3.95E+02	6.61E+02	9.27E+02	1.33E+03	1.99E+03	2.00E+03	2.00E+03	2.00E+03	2.01E+03
	5.0	6.55E+00	2.01E+01	3.36E+01	4.72E+01	6.75E+01	1.01E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02
	10.0	1.68E+00	5.14E+00	8.61E+00	1.21E+01	1.73E+01	2.60E+01	2.60E+01	2.60E+01	2.61E+01	2.62E+01
	50.0	8.28E-02	2.57E-01	4.32E-01	6.07E-01	8.69E-01	1.31E+00	1.31E+00	1.31E+00	1.32E+00	1.32E+00
	80.0	4.00E-02	1.26E-01	2.12E-01	2.98E-01	4.27E-01	6.43E-01	6.44E-01	6.46E-01	6.49E-01	6.50E-01
90.0	0.1	7.15E+02	2.19E+03	3.67E+03	5.15E+03	7.37E+03	1.11E+04	1.11E+04	1.11E+04	1.11E+04	1.11E+04
	1.0	5.54E+02	1.70E+03	2.84E+03	3.99E+03	5.71E+03	8.57E+03	8.58E+03	8.60E+03	8.62E+03	8.63E+03
	5.0	1.21E+01	3.70E+01	6.20E+01	8.69E+01	1.24E+02	1.87E+02	1.87E+02	1.87E+02	1.88E+02	1.88E+02
	10.0	3.06E+00	9.37E+00	1.57E+01	2.20E+01	3.15E+01	4.73E+01	4.74E+01	4.74E+01	4.76E+01	4.76E+01
	50.0	1.66E-01	5.10E-01	8.55E-01	1.20E+00	1.72E+00	2.58E+00	2.58E+00	2.59E+00	2.60E+00	2.60E+00
	80.0	7.68E-02	2.38E-01	3.99E-01	5.59E-01	8.01E-01	1.20E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00
180.0	0.1	2.77E+02	8.50E+02	1.42E+03	2.00E+03	2.86E+03	4.29E+03	4.30E+03	4.30E+03	4.31E+03	4.32E+03
	1.0	8.29E+01	2.54E+02	4.25E+02	5.97E+02	8.54E+02	1.28E+03	1.28E+03	1.29E+03	1.29E+03	1.29E+03
	5.0	3.50E+00	1.07E+01	1.80E+01	2.52E+01	3.60E+01	5.41E+01	5.42E+01	5.43E+01	5.44E+01	5.45E+01
	10.0	7.97E-01	2.44E+00	4.09E+00	5.74E+00	8.22E+00	1.23E+01	1.24E+01	1.24E+01	1.24E+01	1.24E+01
	50.0	3.50E-02	1.09E-01	1.84E-01	2.59E-01	3.70E-01	5.57E-01	5.58E-01	5.60E-01	5.62E-01	5.63E-01
	80.0	1.78E-02	5.66E-02	9.55E-02	1.34E-01	1.93E-01	2.91E-01	2.91E-01	2.92E-01	2.94E-01	2.94E-01
270.0	0.1	2.65E+02	8.12E+02	1.36E+03	1.91E+03	2.73E+03	4.10E+03	4.10E+03	4.11E+03	4.12E+03	4.13E+03
	1.0	7.69E+01	2.36E+02	3.95E+02	5.54E+02	7.92E+02	1.19E+03	1.19E+03	1.19E+03	1.20E+03	1.20E+03
	5.0	3.30E+00	1.01E+01	1.70E+01	2.38E+01	3.40E+01	5.11E+01	5.12E+01	5.12E+01	5.14E+01	5.15E+01
	10.0	7.62E-01	2.34E+00	3.91E+00	5.49E+00	7.86E+00	1.18E+01	1.18E+01	1.18E+01	1.19E+01	1.19E+01
	50.0	3.46E-02	1.08E-01	1.82E-01	2.56E-01	3.68E-01	5.53E-01	5.54E-01	5.56E-01	5.57E-01	5.59E-01
	80.0	1.79E-02	5.72E-02	9.65E-02	1.36E-01	1.95E-01	2.94E-01	2.94E-01	2.96E-01	2.97E-01	2.98E-01

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
NASOPHARYNGEAL

INHALATION TOTAL DOSE RATE (MREM/YEAR) FROM PARTICULATES

ANGLE	DISTANCE(KM)	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
67.5	0.1	7.96E+02	8.21E+02	8.22E+02	8.22E+02	8.22E+02	8.23E+02	2.09E+00	1.88E+00	1.53E+00	1.16E+00
	1.0	7.89E+02	8.13E+02	8.14E+02	8.14E+02	8.14E+02	8.15E+02	2.07E+00	1.86E+00	1.51E+00	1.15E+00
	5.0	2.64E+01	2.72E+01	2.72E+01	2.72E+01	2.72E+01	2.72E+01	6.93E-02	6.24E-02	5.07E-02	3.84E-02
	10.0	7.03E+00	7.25E+00	7.26E+00	7.26E+00	7.26E+00	7.27E+00	1.86E-02	1.67E-02	1.36E-02	1.02E-02
	50.0	3.83E-01	3.97E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	1.19E-03	1.03E-03	7.88E-04	5.70E-04
	80.0	1.76E-01	1.83E-01	1.83E-01	1.83E-01	1.83E-01	1.83E-01	6.37E-04	5.33E-04	3.87E-04	2.67E-04
0.0	0.1	3.35E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	8.80E-01	7.93E-01	6.44E-01	4.88E-01
	1.0	1.29E+02	1.33E+02	1.33E+02	1.33E+02	1.33E+02	1.33E+02	3.39E-01	3.05E-01	2.48E-01	1.88E-01
	5.0	6.56E+00	6.77E+00	6.77E+00	6.78E+00	6.78E+00	6.78E+00	1.73E-02	1.56E-02	1.26E-02	9.57E-03
	10.0	1.68E+00	1.73E+00	1.73E+00	1.73E+00	1.74E+00	1.74E+00	4.55E-03	4.07E-03	3.27E-03	2.46E-03
	50.0	8.29E-02	8.72E-02	8.73E-02	8.74E-02	8.74E-02	8.75E-02	3.76E-04	3.02E-04	2.04E-04	1.31E-04
	80.0	4.00E-02	4.30E-02	4.30E-02	4.30E-02	4.31E-02	4.32E-02	2.58E-04	1.97E-04	1.20E-04	6.82E-05
90.0	0.1	7.16E+02	7.39E+02	7.39E+02	7.39E+02	7.40E+02	7.40E+02	1.88E+00	1.69E+00	1.38E+00	1.04E+00
	1.0	5.55E+02	5.72E+02	5.72E+02	5.73E+02	5.73E+02	5.73E+02	1.46E+00	1.31E+00	1.07E+00	8.07E-01
	5.0	1.21E+01	1.25E+01	1.25E+01	1.25E+01	1.25E+01	1.25E+01	3.18E-02	2.86E-02	2.33E-02	1.76E-02
	10.0	3.06E+00	3.16E+00	3.16E+00	3.16E+00	3.16E+00	3.16E+00	8.13E-03	7.30E-03	5.91E-03	4.46E-03
	50.0	1.66E-01	1.72E-01	1.72E-01	1.72E-01	1.73E-01	1.73E-01	5.34E-04	4.58E-04	3.47E-04	2.48E-04
	80.0	7.69E-02	8.04E-02	8.04E-02	8.05E-02	8.05E-02	8.06E-02	2.96E-04	2.45E-04	1.75E-04	1.18E-04
180.0	0.1	2.78E+02	2.86E+02	2.87E+02	2.87E+02	2.87E+02	2.87E+02	7.29E-01	6.57E-01	5.34E-01	4.05E-01
	1.0	8.30E+01	8.56E+01	8.57E+01	8.57E+01	8.57E+01	8.58E+01	2.18E-01	1.96E-01	1.60E-01	1.21E-01
	5.0	3.50E+00	3.61E+00	3.61E+00	3.62E+00	3.62E+00	3.62E+00	9.27E-03	8.34E-03	6.76E-03	5.11E-03
	10.0	7.98E-01	8.24E-01	8.24E-01	8.25E-01	8.25E-01	8.25E-01	2.19E-03	1.95E-03	1.56E-03	1.17E-03
	50.0	3.50E-02	3.72E-02	3.73E-02	3.73E-02	3.73E-02	3.74E-02	1.94E-04	1.51E-04	9.61E-05	5.76E-05
	80.0	1.78E-02	1.94E-02	1.94E-02	1.95E-02	1.95E-02	1.95E-02	1.45E-04	1.08E-04	6.20E-05	3.23E-05
270.0	0.1	2.65E+02	2.74E+02	2.74E+02	2.74E+02	2.74E+02	2.74E+02	6.96E-01	6.28E-01	5.10E-01	3.87E-01
	1.0	7.70E+01	7.94E+01	7.94E+01	7.95E+01	7.95E+01	7.96E+01	2.02E-01	1.82E-01	1.48E-01	1.12E-01
	5.0	3.31E+00	3.41E+00	3.41E+00	3.41E+00	3.42E+00	3.42E+00	8.77E-03	7.88E-03	6.38E-03	4.83E-03
	10.0	7.63E-01	7.88E-01	7.88E-01	7.88E-01	7.89E-01	7.89E-01	2.11E-03	1.87E-03	1.50E-03	1.12E-03
	50.0	3.47E-02	3.69E-02	3.70E-02	3.70E-02	3.70E-02	3.71E-02	1.98E-04	1.54E-04	9.69E-05	5.75E-05
	80.0	1.79E-02	1.96E-02	1.97E-02	1.97E-02	1.97E-02	1.97E-02	1.50E-04	1.12E-04	6.36E-05	3.28E-05

560 257

247

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 206
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
NASOPHARYNGEAL

INHALATION TOTAL TIME INTEGRATED DOSE (MREM) AT EXTRA RECEPTOR LOCATIONS FROM PARTICULATES

#	IDENTIFICATION	YEARS 1	3	5	7	10	15	20	30	50	70
1	FENCE POST	9.51E+02	2.92E+03	4.88E+03	6.85E+03	9.80E+03	1.47E+04	1.47E+04	1.48E+04	1.48E+04	1.48E+04
2	TRAILER	5.83E+02	1.79E+03	2.99E+03	4.20E+03	6.01E+03	9.03E+03	9.04E+03	9.05E+03	9.07E+03	9.09E+03
3	RANCH 1	1.06E+02	3.25E+02	5.45E+02	7.64E+02	1.09E+03	1.64E+03	1.64E+03	1.65E+03	1.65E+03	1.65E+03
4	RANCH 2	7.68E+00	2.36E+01	3.94E+01	5.53E+01	7.92E+01	1.19E+02	1.19E+02	1.19E+02	1.20E+02	1.20E+02
5	RANCH 3	1.88E+00	5.76E+00	9.64E+00	1.35E+01	1.93E+01	2.91E+01	2.91E+01	2.91E+01	2.92E+01	2.93E+01
6	RANCH 3V	1.88E+00	5.76E+00	9.64E+00	1.35E+01	1.93E+01	2.91E+01	2.91E+01	2.91E+01	2.92E+01	2.93E+01
7	RANCH 4	5.79E-01	1.78E+00	2.98E+00	4.18E+00	5.99E+00	8.99E+00	9.00E+00	9.02E+00	9.04E+00	9.06E+00
8	RANCH 5	6.98E-01	2.14E+00	3.59E+00	5.03E+00	7.20E+00	1.08E+01	1.08E+01	1.08E+01	1.09E+01	1.09E+01
9	RANCH 6	3.23E-01	9.92E-01	1.66E+00	2.33E+00	3.34E+00	5.01E+00	5.02E+00	5.03E+00	5.04E+00	5.05E+00
10	RANCH 6V	3.23E-01	9.92E-01	1.66E+00	2.33E+00	3.34E+00	5.01E+00	5.02E+00	5.03E+00	5.04E+00	5.05E+00
11	RANCH 7	6.24E-02	1.93E-01	3.24E-01	4.55E-01	6.51E-01	9.78E-01	9.80E-01	9.82E-01	9.84E-01	9.86E-01
12	RANCH 8	1.01E-01	3.13E-01	5.24E-01	7.36E-01	1.05E+00	1.58E+00	1.59E+00	1.59E+00	1.59E+00	1.60E+00
13	RANCH 9	6.30E-02	1.95E-01	3.28E-01	4.61E-01	6.60E-01	9.92E-01	9.94E-01	9.96E-01	9.99E-01	1.00E+00
14	RANCH 10	6.67E-02	2.07E-01	3.47E-01	4.83E-01	6.99E-01	1.05E+00	1.05E+00	1.05E+00	1.06E+00	1.06E+00
15	RANCH 11	1.64E-01	5.05E-01	8.45E-01	1.19E+00	1.70E+00	2.55E+00	2.55E+00	2.56E+00	2.57E+00	2.57E+00
16	RANCH 12	2.80E-02	8.80E-02	1.48E-01	2.08E-01	2.99E-01	4.49E-01	4.50E-01	4.52E-01	4.53E-01	4.54E-01
17	RANCH 12V	2.80E-02	8.80E-02	1.48E-01	2.08E-01	2.99E-01	4.49E-01	4.50E-01	4.52E-01	4.53E-01	4.54E-01
18	RANCH 13	2.32E-02	7.34E-02	1.24E-01	1.74E-01	2.49E-01	3.76E-01	3.76E-01	3.78E-01	3.79E-01	3.80E-01
19	RANCH 14	2.05E-02	6.53E-02	1.10E-01	1.55E-01	2.22E-01	3.35E-01	3.36E-01	3.37E-01	3.38E-01	3.39E-01
20	RANCH 15	4.71E-02	1.47E-01	2.46E-01	3.46E-01	4.95E-01	7.45E-01	7.46E-01	7.48E-01	7.50E-01	7.52E-01
21	RANCH 16	2.56E-02	7.90E-02	1.32E-01	1.86E-01	2.66E-01	4.00E-01	4.00E-01	4.01E-01	4.02E-01	4.03E-01
22	RANCH 16V	2.56E-02	7.90E-02	1.32E-01	1.86E-01	2.66E-01	4.00E-01	4.00E-01	4.01E-01	4.02E-01	4.03E-01
23	WEST CITY	1.48E-02	4.73E-02	8.00E-02	1.13E-01	1.62E-01	2.44E-01	2.44E-01	2.45E-01	2.46E-01	2.47E-01
24	EAST CITY	3.46E-01	1.06E+00	1.78E+00	2.50E+00	3.58E+00	5.37E+00	5.38E+00	5.39E+00	5.40E+00	5.41E+00
25	RED TOWN	2.35E-02	7.42E-02	1.25E-01	1.76E-01	2.52E-01	3.80E-01	3.80E-01	3.82E-01	3.83E-01	3.84E-01
26	BLUE TOWN	3.86E-02	1.20E-01	2.02E-01	2.83E-01	4.06E-01	6.10E-01	6.11E-01	6.13E-01	6.15E-01	6.16E-01
27	BROWN TOWN	1.44E-01	4.45E-01	7.45E-01	1.05E+00	1.50E+00	2.25E+00	2.25E+00	2.26E+00	2.26E+00	2.27E+00
28	GREEN TOWN	2.40E-01	7.38E-01	1.24E+00	1.73E+00	2.48E+00	3.73E+00	3.73E+00	3.74E+00	3.75E+00	3.76E+00
29	ORANGE TOWN	1.48E-02	4.70E-02	7.93E-02	1.12E-01	1.60E-01	2.41E-01	2.41E-01	2.42E-01	2.43E-01	2.44E-01
30	PURPLE TOWN	2.43E-01	7.49E-01	1.25E+00	1.76E+00	2.52E+00	3.79E+00	3.79E+00	3.80E+00	3.81E+00	3.82E+00
31	WHITE TOWN	1.70E-02	5.39E-02	9.07E-02	1.28E-01	1.83E-01	2.76E-01	2.76E-01	2.77E-01	2.78E-01	2.79E-01
32	E INDIANRES	1.06E-01	3.27E-01	5.49E-01	7.70E-01	1.10E+00	1.66E+00	1.66E+00	1.66E+00	1.67E+00	1.67E+00
33	E INDIANRES	1.25E-02	4.00E-02	6.76E-02	9.52E-02	1.37E-01	2.06E-01	2.06E-01	2.07E-01	2.08E-01	2.09E-01
34	EAST RURAL	3.01E-01	9.26E-01	1.55E+00	2.18E+00	3.12E+00	4.68E+00	4.69E+00	4.70E+00	4.71E+00	4.72E+00
35	NORTH RURAL	1.34E-01	4.14E-01	6.95E-01	9.75E-01	1.40E+00	2.10E+00	2.10E+00	2.10E+00	2.11E+00	2.11E+00
36	NW RURAL	3.66E-02	1.14E-01	1.91E-01	2.68E-01	3.85E-01	5.78E-01	5.79E-01	5.81E-01	5.82E-01	5.84E-01
37	WEST RURAL	1.33E-02	4.27E-02	7.21E-02	1.02E-01	1.46E-01	2.20E-01	2.20E-01	2.21E-01	2.22E-01	2.23E-01
38	SOUTH RURAL	4.15E-02	1.30E-01	2.18E-01	3.06E-01	4.38E-01	6.59E-01	6.60E-01	6.62E-01	6.64E-01	6.65E-01
39	SW RURAL	2.33E-02	7.39E-02	1.25E-01	1.75E-01	2.52E-01	3.79E-01	3.80E-01	3.81E-01	3.83E-01	3.83E-01
40	AGRICULTURE 1	3.37E-01	1.04E+00	1.74E+00	2.44E+00	3.49E+00	5.24E+00	5.25E+00	5.26E+00	5.27E+00	5.28E+00
41	AGRICULTURE 2	3.42E-01	1.05E+00	1.76E+00	2.47E+00	3.53E+00	5.31E+00	5.32E+00	5.33E+00	5.34E+00	5.35E+00
42	AGRICULTURE 3	1.37E-01	4.24E-01	7.10E-01	9.97E-01	1.43E+00	2.14E+00	2.15E+00	2.15E+00	2.16E+00	2.16E+00
43	AGRICULTURE 4	3.85E-02	1.20E-01	2.01E-01	2.82E-01	4.04E-01	6.08E-01	6.09E-01	6.10E-01	6.12E-01	6.14E-01
44	AGRICULTURE 5	1.50E-02	4.79E-02	8.09E-02	1.14E-01	1.64E-01	2.46E-01	2.47E-01	2.48E-01	2.49E-01	2.49E-01
45	AGRICULTURE 6	1.56E-02	4.97E-02	8.39E-02	1.18E-01	1.70E-01	2.55E-01	2.56E-01	2.57E-01	2.58E-01	2.59E-01

560 258

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
NASOPHARYNGEAL

INHALATION TOTAL DOSE RATE (MREM/YEAR) AT EXTRA RECEPTOR LOCATIONS FROM PARTICULATES

#	IDENTIFICATION	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
1	FENCE POST	9.53E+02	9.83E+02	9.83E+02	9.83E+02	9.84E+02	9.85E+02	2.50E+00	2.25E+00	1.83E+00	1.39E+00
2	TRAILER	5.84E+02	6.03E+02	6.03E+02	6.03E+02	6.03E+02	6.04E+02	1.53E+00	1.38E+00	1.12E+00	8.50E-01
3	RANCH 1	1.06E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02	2.79E-01	2.51E-01	2.04E-01	1.55E-01
4	RANCH 2	7.69E+00	7.94E+00	7.94E+00	7.94E+00	7.95E+00	7.95E+00	2.04E-02	1.83E-02	1.48E-02	1.12E-02
5	RANCH 3	1.88E+00	1.94E+00	1.94E+00	1.94E+00	1.94E+00	1.94E+00	5.11E-03	4.57E-03	3.66E-03	2.75E-03
6	RANCH 3V	1.88E+00	1.94E+00	1.94E+00	1.94E+00	1.94E+00	1.94E+00	5.11E-03	4.57E-03	3.66E-03	2.75E-03
7	RANCH 4	5.80E-01	6.00E-01	6.01E-01	6.01E-01	6.01E-01	6.02E-01	1.71E-03	1.50E-03	1.17E-03	8.56E-04
8	RANCH 5	6.99E-01	7.22E-01	7.22E-01	7.23E-01	7.23E-01	7.24E-01	1.95E-03	1.73E-03	1.38E-03	1.02E-03
9	RANCH 6	3.23E-01	3.35E-01	3.35E-01	3.35E-01	3.35E-01	3.35E-01	9.83E-04	8.55E-04	6.59E-04	4.79E-04
10	RANCH 6V	3.23E-01	3.35E-01	3.35E-01	3.35E-01	3.35E-01	3.35E-01	9.83E-04	8.55E-04	6.59E-04	4.79E-04
11	RANCH 7	6.25E-02	6.53E-02	6.54E-02	6.54E-02	6.54E-02	6.55E-02	2.42E-04	2.00E-04	1.42E-04	9.61E-05
12	RANCH 8	1.01E-01	1.06E-01	1.06E-01	1.06E-01	1.06E-01	1.06E-01	3.75E-04	3.13E-04	2.26E-04	1.55E-04
13	RANCH 9	6.31E-02	6.62E-02	6.63E-02	6.63E-02	6.64E-02	6.65E-02	2.73E-04	2.21E-04	1.52E-04	9.89E-05
14	RANCH 10	6.68E-02	7.02E-02	7.02E-02	7.03E-02	7.03E-02	7.04E-02	2.91E-04	2.36E-04	1.61E-04	1.05E-04
15	RANCH 11	1.64E-01	1.70E-01	1.70E-01	1.71E-01	1.71E-01	1.71E-01	5.21E-04	4.49E-04	3.41E-04	2.45E-04
16	RANCH 12	2.80E-02	3.00E-02	3.01E-02	3.01E-02	3.01E-02	3.02E-02	1.76E-04	1.35E-04	8.29E-05	4.75E-05
17	RANCH 12V	2.80E-02	3.00E-02	3.01E-02	3.01E-02	3.01E-02	3.02E-02	1.76E-04	1.35E-04	8.29E-05	4.75E-05
18	RANCH 13	2.32E-02	2.51E-02	2.51E-02	2.51E-02	2.52E-02	2.52E-02	1.65E-04	1.25E-04	7.40E-05	4.06E-05
19	RANCH 14	2.05E-02	2.24E-02	2.24E-02	2.24E-02	2.25E-02	2.25E-02	1.63E-04	1.22E-04	7.04E-05	3.70E-05
20	RANCH 15	4.72E-02	4.97E-02	4.98E-02	4.98E-02	4.98E-02	4.99E-02	2.23E-04	1.78E-04	1.19E-04	7.52E-05
21	RANCH 16	2.56E-02	2.67E-02	2.67E-02	2.67E-02	2.67E-02	2.68E-02	9.02E-05	7.60E-05	5.58E-05	3.88E-05
22	RANCH 16V	2.56E-02	2.67E-02	2.67E-02	2.67E-02	2.67E-02	2.68E-02	9.02E-05	7.60E-05	5.58E-05	3.88E-05
23	WEST CITY	1.48E-02	1.63E-02	1.63E-02	1.63E-02	1.64E-02	1.64E-02	1.33E-04	9.80E-05	5.50E-05	2.76E-05
24	EAST CITY	3.46E-01	3.59E-01	3.59E-01	3.59E-01	3.59E-01	3.59E-01	1.06E-03	9.20E-04	7.08E-04	5.14E-04
25	RED TOWN	2.35E-02	2.54E-02	2.54E-02	2.54E-02	2.54E-02	2.55E-02	1.62E-04	1.23E-04	7.35E-05	4.08E-05
26	BLUE TOWN	3.87E-02	4.07E-02	4.08E-02	4.08E-02	4.08E-02	4.09E-02	1.79E-04	1.43E-04	9.62E-05	6.14E-05
27	BROWN TOWN	1.44E-01	1.50E-01	1.50E-01	1.50E-01	1.51E-01	1.51E-01	5.01E-04	4.23E-04	3.12E-04	2.18E-04
28	GREEN TOWN	2.40E-01	2.49E-01	2.49E-01	2.49E-01	2.49E-01	2.49E-01	7.34E-04	6.38E-04	4.91E-04	3.56E-04
29	ORANGE TOWN	1.49E-02	1.61E-02	1.61E-02	1.61E-02	1.62E-02	1.62E-02	1.09E-04	8.18E-05	4.82E-05	2.62E-05
30	PURPLE TOWN	2.43E-01	2.53E-01	2.53E-01	2.53E-01	2.53E-01	2.53E-01	8.10E-04	6.91E-04	5.16E-04	3.65E-04
31	WHITE TOWN	1.71E-02	1.84E-02	1.84E-02	1.84E-02	1.85E-02	1.85E-02	1.17E-04	8.90E-05	5.33E-05	2.96E-05
32	E INDIANRES	1.06E-01	1.11E-01	1.11E-01	1.11E-01	1.11E-01	1.11E-01	3.75E-04	3.16E-04	2.31E-04	1.61E-04
33	E INDIANRES	1.25E-02	1.38E-02	1.38E-02	1.38E-02	1.38E-02	1.38E-02	1.09E-04	8.04E-05	4.55E-05	2.32E-05
34	EAST RURAL	3.01E-01	3.13E-01	3.13E-01	3.13E-01	3.13E-01	3.13E-01	9.48E-04	8.18E-04	6.23E-04	4.49E-04
35	NORTH RURAL	1.34E-01	1.40E-01	1.40E-01	1.40E-01	1.40E-01	1.40E-01	4.79E-04	4.02E-04	2.94E-04	2.04E-04
36	NW RURAL	3.66E-02	3.86E-02	3.86E-02	3.87E-02	3.87E-02	3.87E-02	1.73E-04	1.38E-04	9.20E-05	5.83E-05
37	WEST RURAL	1.33E-02	1.47E-02	1.47E-02	1.47E-02	1.47E-02	1.48E-02	1.21E-04	8.90E-05	4.98E-05	2.50E-05
38	SOUTH RURAL	4.16E-02	4.40E-02	4.40E-02	4.41E-02	4.41E-02	4.42E-02	2.12E-04	1.67E-04	1.09E-04	6.72E-05
39	SW RURAL	2.33E-02	2.53E-02	2.53E-02	2.54E-02	2.54E-02	2.54E-02	1.75E-04	1.31E-04	7.70E-05	4.14E-05
40	AGRICULTURE 1	3.38E-01	3.50E-01	3.50E-01	3.50E-01	3.51E-01	3.51E-01	1.05E-03	9.06E-04	6.94E-04	5.02E-04
41	AGRICULTURE 2	3.42E-01	3.55E-01	3.55E-01	3.55E-01	3.55E-01	3.55E-01	1.03E-03	8.95E-04	6.94E-04	5.07E-04
42	AGRICULTURE 3	1.38E-01	1.43E-01	1.43E-01	1.43E-01	1.43E-01	1.44E-01	4.86E-04	4.09E-04	3.00E-04	2.08E-04
43	AGRICULTURE 4	3.85E-02	4.06E-02	4.06E-02	4.07E-02	4.07E-02	4.07E-02	1.78E-04	1.43E-04	9.58E-05	6.11E-05
44	AGRICULTURE 5	1.51E-02	1.65E-02	1.65E-02	1.65E-02	1.65E-02	1.66E-02	1.25E-04	9.27E-05	5.30E-05	2.75E-05
45	AGRICULTURE 6	1.56E-02	1.71E-02	1.71E-02	1.71E-02	1.71E-02	1.72E-02	1.32E-04	9.82E-05	5.58E-05	2.86E-05

560 259

UDAD SAMPLE PROBLEM　　UDAD 9　　DATE 12/26/78　　PAGE 252
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS　　ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
BRONCHIAL EPITHELIUM

INHALATION TOTAL TIME INTEGATED DOSE (MREM) FROM RADON

ANGLE	DISTANCE(KM)	YEARS 1	3	5	7	10	15	20	30	50	70
67.5	0.1	3.86E+03	1.16E+04	1.93E+04	2.70E+04	3.86E+04	5.79E+04	5.79E+04	5.79E+04	5.79E+04	5.79E+04
	1.0	2.12E+03	6.37E+03	1.06E+04	1.49E+04	2.12E+04	3.19E+04	3.19E+04	3.19E+04	3.19E+04	3.19E+04
	5.0	8.06E+01	2.42E+02	4.03E+02	5.64E+02	8.06E+02	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03
	10.0	2.93E+01	8.78E+01	1.46E+02	2.05E+02	2.93E+02	4.39E+02	4.39E+02	4.39E+02	4.39E+02	4.39E+02
	50.0	3.97E+00	1.19E+01	1.98E+01	2.78E+01	3.97E+01	5.95E+01	5.95E+01	5.95E+01	5.95E+01	5.95E+01
	80.0	2.23E+00	6.68E+00	1.11E+01	1.56E+01	2.23E+01	3.34E+01	3.34E+01	3.34E+01	3.34E+01	3.34E+01
0.0	0.1	2.66E+03	7.99E+03	1.33E+04	1.86E+04	2.66E+04	3.99E+04	3.99E+04	3.99E+04	3.99E+04	3.99E+04
	1.0	4.53E+02	1.36E+03	2.26E+03	3.17E+03	4.53E+03	6.79E+03	6.79E+03	6.79E+03	6.79E+03	6.79E+03
	5.0	5.23E+01	1.57E+02	2.61E+02	3.66E+02	5.23E+02	7.84E+02	7.84E+02	7.84E+02	7.84E+02	7.84E+02
	10.0	2.17E+01	6.52E+01	1.09E+02	1.52E+02	2.17E+02	3.26E+02	3.26E+02	3.26E+02	3.26E+02	3.26E+02
	50.0	3.22E+00	9.67E+00	1.61E+01	2.26E+01	3.22E+01	4.84E+01	4.84E+01	4.84E+01	4.84E+01	4.84E+01
	80.0	1.82E+00	5.47E+00	9.11E+00	1.28E+01	1.82E+01	2.73E+01	2.73E+01	2.73E+01	2.73E+01	2.73E+01
90.0	0.1	3.94E+03	1.18E+04	1.97E+04	2.76E+04	3.94E+04	5.91E+04	5.91E+04	5.91E+04	5.91E+04	5.91E+04
	1.0	1.63E+03	4.88E+03	8.13E+03	1.14E+04	1.63E+04	2.44E+04	2.44E+04	2.44E+04	2.44E+04	2.44E+04
	5.0	4.63E+01	1.39E+02	2.31E+02	3.24E+02	4.63E+02	6.94E+02	6.94E+02	6.94E+02	6.94E+02	6.94E+02
	10.0	1.63E+01	4.88E+01	8.14E+01	1.14E+02	1.63E+02	2.44E+02	2.44E+02	2.44E+02	2.44E+02	2.44E+02
	50.0	2.16E+00	6.48E+00	1.08E+01	1.51E+01	2.16E+01	3.24E+01	3.24E+01	3.24E+01	3.24E+01	3.24E+01
	80.0	1.21E+00	3.64E+00	6.06E+00	8.48E+00	1.21E+01	1.82E+01	1.82E+01	1.82E+01	1.82E+01	1.82E+01
180.0	0.1	2.74E+03	8.23E+03	1.37E+04	1.92E+04	2.74E+04	4.11E+04	4.11E+04	4.11E+04	4.11E+04	4.11E+04
	1.0	4.52E+02	1.36E+03	2.26E+03	3.16E+03	4.52E+03	6.78E+03	6.78E+03	6.78E+03	6.78E+03	6.78E+03
	5.0	3.72E+01	1.11E+02	1.86E+02	2.60E+02	3.72E+02	5.57E+02	5.57E+02	5.57E+02	5.57E+02	5.57E+02
	10.0	1.46E+01	4.38E+01	7.30E+01	1.02E+02	1.46E+02	2.19E+02	2.19E+02	2.19E+02	2.19E+02	2.19E+02
	50.0	2.07E+00	6.20E+00	1.03E+01	1.45E+01	2.07E+01	3.10E+01	3.10E+01	3.10E+01	3.10E+01	3.10E+01
	80.0	1.17E+00	3.50E+00	5.84E+00	8.17E+00	1.17E+01	1.75E+01	1.75E+01	1.75E+01	1.75E+01	1.75E+01
270.0	0.1	2.05E+03	6.15E+03	1.02E+04	1.43E+04	2.05E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04
	1.0	2.89E+02	8.67E+02	1.45E+03	2.02E+03	2.89E+03	4.34E+03	4.34E+03	4.34E+03	4.34E+03	4.34E+03
	5.0	3.40E+01	1.02E+02	1.70E+02	2.38E+02	3.40E+02	5.10E+02	5.10E+02	5.10E+02	5.10E+02	5.10E+02
	10.0	1.40E+01	4.21E+01	7.01E+01	9.81E+01	1.40E+02	2.10E+02	2.10E+02	2.10E+02	2.10E+02	2.10E+02
	50.0	2.11E+00	6.32E+00	1.05E+01	1.47E+01	2.11E+01	3.16E+01	3.16E+01	3.16E+01	3.16E+01	3.16E+01
	80.0	1.19E+00	3.57E+00	5.95E+00	8.33E+00	1.19E+01	1.78E+01	1.78E+01	1.78E+01	1.78E+01	1.78E+01

560 260

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
BRONCHIAL EPITHELIUM

INHALATION TOTAL DOSE RATE (MREM/YEAR) FROM RADON

ANGLE	DISTANCE(KM)	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
67.5	0.1	3.86E+03	3.86E+03	3.86E+03	3.86E+03	3.86E+03	3.86E+03	0.0	0.0	0.0	0.0
	1.0	2.12E+03	2.12E+03	2.12E+03	2.12E+03	2.12E+03	2.12E+03	0.0	0.0	0.0	0.0
	5.0	8.06E+01	8.06E+01	8.06E+01	8.06E+01	8.06E+01	8.06E+01	0.0	0.0	0.0	0.0
	10.0	2.93E+01	2.93E+01	2.93E+01	2.93E+01	2.93E+01	2.93E+01	0.0	0.0	0.0	0.0
	50.0	3.97E+00	3.97E+00	3.97E+00	3.97E+00	3.97E+00	3.97E+00	0.0	0.0	0.0	0.0
	80.0	2.23E+00	2.23E+00	2.23E+00	2.23E+00	2.23E+00	2.23E+00	0.0	0.0	0.0	0.0
0.0	0.1	2.66E+03	2.66E+03	2.66E+03	2.66E+03	2.66E+03	2.66E+03	0.0	0.0	0.0	0.0
	1.0	4.53E+02	4.53E+02	4.53E+02	4.53E+02	4.53E+02	4.53E+02	0.0	0.0	0.0	0.0
	5.0	5.23E+01	5.23E+01	5.23E+01	5.23E+01	5.23E+01	5.23E+01	0.0	0.0	0.0	0.0
	10.0	2.17E+01	2.17E+01	2.17E+01	2.17E+01	2.17E+01	2.17E+01	0.0	0.0	0.0	0.0
	50.0	3.22E+00	3.22E+00	3.22E+00	3.22E+00	3.22E+00	3.22E+00	0.0	0.0	0.0	0.0
	80.0	1.82E+00	1.82E+00	1.82E+00	1.82E+00	1.82E+00	1.82E+00	0.0	0.0	0.0	0.0
90.0	0.1	3.94E+03	3.94E+03	3.94E+03	3.94E+03	3.94E+03	3.94E+03	0.0	0.0	0.0	0.0
	1.0	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03	0.0	0.0	0.0	0.0
	5.0	4.63E+01	4.63E+01	4.63E+01	4.63E+01	4.63E+01	4.63E+01	0.0	0.0	0.0	0.0
	10.0	1.63E+01	1.63E+01	1.63E+01	1.63E+01	1.63E+01	1.63E+01	0.0	0.0	0.0	0.0
	50.0	2.16E+00	2.16E+00	2.16E+00	2.16E+00	2.16E+00	2.16E+00	0.0	0.0	0.0	0.0
	80.0	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	0.0	0.0	0.0	0.0
180.0	0.1	2.74E+03	2.74E+03	2.74E+03	2.74E+03	2.74E+03	2.74E+03	0.0	0.0	0.0	0.0
	1.0	4.52E+02	4.52E+02	4.52E+02	4.52E+02	4.52E+02	4.52E+02	0.0	0.0	0.0	0.0
	5.0	3.72E+01	3.72E+01	3.72E+01	3.72E+01	3.72E+01	3.72E+01	0.0	0.0	0.0	0.0
	10.0	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01	0.0	0.0	0.0	0.0
	50.0	2.07E+00	2.07E+00	2.07E+00	2.07E+00	2.07E+00	2.07E+00	0.0	0.0	0.0	0.0
	80.0	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	0.0	0.0	0.0	0.0
270.0	0.1	2.05E+03	2.05E+03	2.05E+03	2.05E+03	2.05E+03	2.05E+03	0.0	0.0	0.0	0.0
	1.0	2.89E+02	2.89E+02	2.89E+02	2.89E+02	2.89E+02	2.89E+02	0.0	0.0	0.0	0.0
	5.0	3.40E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01	0.0	0.0	0.0	0.0
	10.0	1.40E+01	1.40E+01	1.40E+01	1.40E+01	1.40E+01	1.40E+01	0.0	0.0	0.0	0.0
	50.0	2.11E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00	0.0	0.0	0.0	0.0
	80.0	1.19E+00	1.19E+00	1.19E+00	1.19E+00	1.19E+00	1.19E+00	0.0	0.0	0.0	0.0

560 261

UDAD SAMPLE PROBLEM   UDAD $ DATE 12/26/78   PAGE 254
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS   ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
BRONCHIAL EPITHELIUM

INHALATION TOTAL TIME INTEGRATED DOSE (MREM) AT EXTRA RECEPTOR LOCATIONS FROM RADON

#	IDENTIFICATION	YEARS 1	3	5	7	10	15	20	30	50	70
1	FENCE POST	2.66E+03	7.98E+03	1.33E+04	1.86E+04	2.66E+04	3.99E+04	3.99E+04	3.99E+04	3.99E+04	3.99E+04
2	TRAILER	1.52E+03	4.56E+03	7.61E+03	1.06E+04	1.52E+04	2.28E+04	2.28E+04	2.28E+04	2.28E+04	2.28E+04
3	RANCH 1	2.64E+02	7.92E+02	1.32E+03	1.85E+03	2.64E+03	3.96E+03	3.96E+03	3.96E+03	3.96E+03	3.96E+03
4	RANCH 2	3.13E+01	9.39E+01	1.57E+02	2.19E+02	3.13E+02	4.70E+02	4.70E+02	4.70E+02	4.70E+02	4.70E+02
5	RANCH 3	1.17E+01	3.51E+01	5.85E+01	8.19E+01	1.17E+02	1.75E+02	1.75E+02	1.75E+02	1.75E+02	1.75E+02
6	RANCH 3V	1.17E+01	3.51E+01	5.85E+01	8.19E+01	1.17E+02	1.75E+02	1.75E+02	1.75E+02	1.75E+02	1.75E+02
7	RANCH 4	5.28E+00	1.58E+01	2.64E+01	3.70E+01	5.28E+01	7.92E+01	7.92E+01	7.92E+01	7.92E+01	7.92E+01
8	RANCH 5	6.01E+00	1.80E+01	3.01E+01	4.21E+01	6.01E+01	9.02E+01	9.02E+01	9.02E+01	9.02E+01	9.02E+01
9	RANCH 6	7.75E+00	2.33E+01	3.88E+01	5.43E+01	7.75E+01	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02
10	RANCH 6V	7.75E+00	2.33E+01	3.88E+01	5.43E+01	7.75E+01	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02
11	RANCH 7	2.86E+00	8.57E+00	1.43E+01	2.00E+01	2.86E+01	4.28E+01	4.28E+01	4.28E+01	4.28E+01	4.28E+01
12	RANCH 8	4.30E+00	1.29E+01	2.15E+01	3.01E+01	4.30E+01	6.46E+01	6.46E+01	6.46E+01	6.46E+01	6.46E+01
13	RANCH 9	2.91E+00	8.72E+00	1.45E+01	2.03E+01	2.91E+01	4.36E+01	4.36E+01	4.36E+01	4.36E+01	4.36E+01
14	RANCH 10	3.75E+00	1.13E+01	1.88E+01	2.63E+01	3.75E+01	5.63E+01	5.63E+01	5.63E+01	5.63E+01	5.63E+01
15	RANCH 11	4.49E+00	1.35E+01	2.24E+01	3.14E+01	4.49E+01	6.73E+01	6.73E+01	6.73E+01	6.73E+01	6.73E+01
16	RANCH 12	1.81E+00	5.42E+00	9.04E+00	1.26E+01	1.81E+01	2.71E+01	2.71E+01	2.71E+01	2.71E+01	2.71E+01
17	RANCH 12V	1.81E+00	5.42E+00	9.04E+00	1.26E+01	1.81E+01	2.71E+01	2.71E+01	2.71E+01	2.71E+01	2.71E+01
18	RANCH 13	1.48E+00	4.43E+00	7.38E+00	1.03E+01	1.48E+01	2.21E+01	2.21E+01	2.21E+01	2.21E+01	2.21E+01
19	RANCH 14	1.43E+00	4.29E+00	7.16E+00	1.00E+01	1.43E+01	2.15E+01	2.15E+01	2.15E+01	2.15E+01	2.15E+01
20	RANCH 15	2.27E+00	6.81E+00	1.13E+01	1.59E+01	2.27E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01
21	RANCH 16	5.49E-01	1.65E+00	2.74E+00	3.84E+00	5.49E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00
22	RANCH 16V	5.49E-01	1.65E+00	2.74E+00	3.84E+00	5.49E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00
23	WEST CITY	1.10E+00	3.30E+00	5.50E+00	7.69E+00	1.10E+01	1.65E+01	1.65E+01	1.65E+01	1.65E+01	1.65E+01
24	EAST CITY	3.50E+00	1.05E+01	1.75E+01	2.45E+01	3.50E+01	5.25E+01	5.25E+01	5.25E+01	5.25E+01	5.25E+01
25	RED TOWN	1.37E+00	4.11E+00	6.84E+00	9.58E+00	1.37E+01	2.05E+01	2.05E+01	2.05E+01	2.05E+01	2.05E+01
26	BLUE TOWN	2.06E+00	6.19E+00	1.03E+01	1.45E+01	2.06E+01	3.10E+01	3.10E+01	3.10E+01	3.10E+01	3.10E+01
27	BROWN TOWN	4.63E+00	1.39E+01	2.32E+01	3.24E+01	4.63E+01	6.95E+01	6.95E+01	6.95E+01	6.95E+01	6.95E+01
28	GREEN TOWN	3.11E+00	9.34E+00	1.56E+01	2.18E+01	3.11E+01	4.67E+01	4.67E+01	4.67E+01	4.67E+01	4.67E+01
29	ORANGE TOWN	1.08E+00	3.23E+00	5.39E+00	7.54E+00	1.08E+01	1.62E+01	1.62E+01	1.62E+01	1.62E+01	1.62E+01
30	PURPLE TOWN	2.84E+00	8.52E+00	1.42E+01	1.99E+01	2.84E+01	4.26E+01	4.26E+01	4.26E+01	4.26E+01	4.26E+01
31	WHITE TOWN	1.20E+00	3.59E+00	5.98E+00	8.38E+00	1.20E+01	1.79E+01	1.79E+01	1.79E+01	1.79E+01	1.79E+01
32	E INDIANRES	1.57E+00	4.70E+00	7.84E+00	1.10E+01	1.57E+01	2.35E+01	2.35E+01	2.35E+01	2.35E+01	2.35E+01
33	E INDIANRES	9.07E-01	2.72E+00	4.54E+00	6.35E+00	9.07E+00	1.36E+01	1.36E+01	1.36E+01	1.36E+01	1.36E+01
34	EAST RURAL	3.19E+00	9.56E+00	1.59E+01	2.23E+01	3.19E+01	4.78E+01	4.78E+01	4.78E+01	4.78E+01	4.78E+01
35	NORTH RURAL	4.44E+00	1.33E+01	2.22E+01	3.11E+01	4.44E+01	6.66E+01	6.66E+01	6.66E+01	6.66E+01	6.66E+01
36	NW RURAL	2.04E+00	6.12E+00	1.02E+01	1.43E+01	2.04E+01	3.06E+01	3.06E+01	3.06E+01	3.06E+01	3.06E+01
37	WEST RURAL	1.14E+00	3.42E+00	5.70E+00	7.98E+00	1.14E+01	1.71E+01	1.71E+01	1.71E+01	1.71E+01	1.71E+01
38	SOUTH RURAL	2.34E+00	7.02E+00	1.17E+01	1.64E+01	2.34E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01
39	SW RURAL	1.69E+00	5.07E+00	8.45E+00	1.18E+01	1.69E+01	2.54E+01	2.54E+01	2.54E+01	2.54E+01	2.54E+01
40	AGRICULTURE 1	3.47E+00	1.04E+01	1.74E+01	2.43E+01	3.47E+01	5.21E+01	5.21E+01	5.21E+01	5.21E+01	5.21E+01
41	AGRICULTURE 2	3.63E+00	1.09E+01	1.81E+01	2.54E+01	3.63E+01	5.44E+01	5.44E+01	5.44E+01	5.44E+01	5.44E+01
42	AGRICULTURE 3	4.50E+00	1.35E+01	2.25E+01	3.15E+01	4.50E+01	6.75E+01	6.75E+01	6.75E+01	6.75E+01	6.75E+01
43	AGRICULTURE 4	2.11E+00	6.32E+00	1.05E+01	1.48E+01	2.11E+01	3.16E+01	3.16E+01	3.16E+01	3.16E+01	3.16E+01
44	AGRICULTURE 5	1.32E+00	3.96E+00	6.60E+00	9.24E+00	1.32E+01	1.98E+01	1.98E+01	1.98E+01	1.98E+01	1.98E+01
45	AGRICULTURE 6	1.23E+00	3.68E+00	6.14E+00	8.60E+00	1.23E+01	1.84E+01	1.84E+01	1.84E+01	1.84E+01	1.84E+01

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
BRONCHIAL EPITHELIUM

INHALATION TOTAL DOSE RATE (MREM/YEAR) AT EXTRA RECEPTOR LOCATIONS FROM RADON

#	IDENTIFICATION	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
1	FENCE POST	2.66E+03	2.66E+03	2.66E+03	2.66E+03	2.66E+03	2.66E+03	0.0	0.0	0.0	0.0
2	TRAILER	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03	0.0	0.0	0.0	0.0
3	RANCH 1	2.64E+02	2.64E+02	2.64E+02	2.64E+02	2.64E+02	2.64E+02	0.0	0.0	0.0	0.0
4	RANCH 2	3.13E+01	3.13E+01	3.13E+01	3.13E+01	3.13E+01	3.13E+01	0.0	0.0	0.0	0.0
5	RANCH 3	1.17E+01	1.17E+01	1.17E+01	1.17E+01	1.17E+01	1.17E+01	0.0	0.0	0.0	0.0
6	RANCH 3V	1.17E+01	1.17E+01	1.17E+01	1.17E+01	1.17E+01	1.17E+01	0.0	0.0	0.0	0.0
7	RANCH 4	5.28E+00	5.28E+00	5.28E+00	5.28E+00	5.28E+00	5.28E+00	0.0	0.0	0.0	0.0
8	RANCH 5	6.01E+00	6.01E+00	6.01E+00	6.01E+00	6.01E+00	6.01E+00	0.0	0.0	0.0	0.0
9	RANCH 6	7.75E+00	7.75E+00	7.75E+00	7.75E+00	7.75E+00	7.75E+00	0.0	0.0	0.0	0.0
10	RANCH 6V	7.75E+00	7.75E+00	7.75E+00	7.75E+00	7.75E+00	7.75E+00	0.0	0.0	0.0	0.0
11	RANCH 7	2.86E+00	2.86E+00	2.86E+00	2.86E+00	2.86E+00	2.86E+00	0.0	0.0	0.0	0.0
12	RANCH 8	4.30E+00	4.30E+00	4.30E+00	4.30E+00	4.30E+00	4.30E+00	0.0	0.0	0.0	0.0
13	RANCH 9	2.91E+00	2.91E+00	2.91E+00	2.91E+00	2.91E+00	2.91E+00	0.0	0.0	0.0	0.0
14	RANCH 10	3.75E+00	3.75E+00	3.75E+00	3.75E+00	3.75E+00	3.75E+00	0.0	0.0	0.0	0.0
15	RANCH 11	4.49E+00	4.49E+00	4.49E+00	4.49E+00	4.49E+00	4.49E+00	0.0	0.0	0.0	0.0
16	RANCH 12	1.81E+00	1.81E+00	1.81E+00	1.81E+00	1.81E+00	1.81E+00	0.0	0.0	0.0	0.0
17	RANCH 12V	1.81E+00	1.81E+00	1.81E+00	1.81E+00	1.81E+00	1.81E+00	0.0	0.0	0.0	0.0
18	RANCH 13	1.48E+00	1.48E+00	1.48E+00	1.48E+00	1.48E+00	1.48E+00	0.0	0.0	0.0	0.0
19	RANCH 14	1.43E+00	1.43E+00	1.43E+00	1.43E+00	1.43E+00	1.43E+00	0.0	0.0	0.0	0.0
20	RANCH 15	2.27E+00	2.27E+00	2.27E+00	2.27E+00	2.27E+00	2.27E+00	0.0	0.0	0.0	0.0
21	RANCH 16	5.49E-01	5.49E-01	5.49E-01	5.49E-01	5.49E-01	5.49E-01	0.0	0.0	0.0	0.0
22	RANCH 16V	5.49E-01	5.49E-01	5.49E-01	5.49E-01	5.49E-01	5.49E-01	0.0	0.0	0.0	0.0
23	WEST CITY	1.10E+00	1.10E+00	1.10E+00	1.10E+00	1.10E+00	1.10E+00	0.0	0.0	0.0	0.0
24	EAST CITY	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	0.0	0.0	0.0	0.0
25	RED TOWN	1.37E+00	1.37E+00	1.37E+00	1.37E+00	1.37E+00	1.37E+00	0.0	0.0	0.0	0.0
26	BLUE TOWN	2.06E+00	2.06E+00	2.06E+00	2.06E+00	2.06E+00	2.06E+00	0.0	0.0	0.0	0.0
27	BROWN TOWN	4.63E+00	4.63E+00	4.63E+00	4.63E+00	4.63E+00	4.63E+00	0.0	0.0	0.0	0.0
28	GREEN TOWN	3.11E+00	3.11E+00	3.11E+00	3.11E+00	3.11E+00	3.11E+00	0.0	0.0	0.0	0.0
29	ORANGE TOWN	1.08E+00	1.08E+00	1.08E+00	1.08E+00	1.08E+00	1.08E+00	0.0	0.0	0.0	0.0
30	PURPLE TOWN	2.84E+00	2.84E+00	2.84E+00	2.84E+00	2.84E+00	2.84E+00	0.0	0.0	0.0	0.0
31	WHITE TOWN	1.20E+00	1.20E+00	1.20E+00	1.20E+00	1.20E+00	1.20E+00	0.0	0.0	0.0	0.0
32	E INDIANRES	1.57E+00	1.57E+00	1.57E+00	1.57E+00	1.57E+00	1.57E+00	0.0	0.0	0.0	0.0
33	E INDIANRES	9.07E-01	9.07E-01	9.07E-01	9.07E-01	9.07E-01	9.07E-01	0.0	0.0	0.0	0.0
34	EAST RURAL	3.19E+00	3.19E+00	3.19E+00	3.19E+00	3.19E+00	3.19E+00	0.0	0.0	0.0	0.0
35	NORTH RURAL	4.44E+00	4.44E+00	4.44E+00	4.44E+00	4.44E+00	4.44E+00	0.0	0.0	0.0	0.0
36	NW RURAL	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	0.0	0.0	0.0	0.0
37	WEST RURAL	1.14E+00	1.14E+00	1.14E+00	1.14E+00	1.14E+00	1.14E+00	0.0	0.0	0.0	0.0
38	SOUTH RURAL	2.34E+00	2.34E+00	2.34E+00	2.34E+00	2.34E+00	2.34E+00	0.0	0.0	0.0	0.0
39	SW RURAL	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	0.0	0.0	0.0	0.0
40	AGRICULTURE 1	3.47E+00	3.47E+00	3.47E+00	3.47E+00	3.47E+00	3.47E+00	0.0	0.0	0.0	0.0
41	AGRICULTURE 2	3.63E+00	3.63E+00	3.63E+00	3.63E+00	3.63E+00	3.63E+00	0.0	0.0	0.0	0.0
42	AGRICULTURE 3	4.50E+00	4.50E+00	4.50E+00	4.50E+00	4.50E+00	4.50E+00	0.0	0.0	0.0	0.0
43	AGRICULTURE 4	2.11E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00	0.0	0.0	0.0	0.0
44	AGRICULTURE 5	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00	0.0	0.0	0.0	0.0
45	AGRICULTURE 6	1.23E+00	1.23E+00	1.23E+00	1.23E+00	1.23E+00	1.23E+00	0.0	0.0	0.0	0.0

560 263

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 256
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL TIME INTEGATED DOSE (MREM) FROM GROUND DEPOSITION

ANGLE	DISTANCE(KM)	YEARS 1	3	5	7	10	15	20	30	50	70
67.5	0.1	1.29E+01	1.15E+02	3.16E+02	6.13E+02	1.24E+03	2.72E+03	4.41E+03	7.46E+03	1.24E+04	1.62E+04
	1.0	2.09E+01	1.87E+02	5.13E+02	9.97E+02	2.01E+03	4.42E+03	7.16E+03	1.21E+04	2.01E+04	2.62E+04
	5.0	5.92E-01	5.28E+00	1.45E+01	2.82E+01	[illegible].67E+01	1.25E+02	2.02E+02	3.42E+02	5.68E+02	7.39E+02
	10.0	1.51E-01	1.35E+00	3.71E+00	7.19E+00	1.45E+01	3.18E+01	5.14E+01	8.66E+01	1.43E+02	1.86E+02
	50.0	1.24E-02	1.10E-01	2.98E-01	5.72E-01	1.13E+00	2.43E+00	3.82E+00	6.07E+00	9.10E+00	1.11E+01
	80.0	8.83E-03	7.75E-02	2.10E-01	4.01E-01	7.88E-01	1.67E+00	2.60E+00	4.02E+00	5.73E+00	6.69E+00
0.0	0.1	5.47E+00	4.88E+01	1.34E+02	2.61E+02	5.25E+02	1.16E+03	1.87E+03	3.17E+03	5.27E+03	6.87E+03
	1.0	1.81E+00	1.62E+01	4.45E+01	8.64E+01	1.74E+02	3.83E+02	6.21E+02	1.05E+03	1.75E+03	2.28E+03
	5.0	1.07E-01	9.57E-01	2.63E+00	5.11E+00	1.03E+01	2.26E+01	3.65E+01	6.15E+01	1.02E+02	1.32E+02
	10.0	3.20E-02	2.84E-01	7.80E-01	1.51E+00	3.02E+00	6.60E+00	1.06E+01	1.76E+01	2.85E+01	3.65E+01
	50.0	6.99E-03	6.12E-02	1.65E-01	3.15E-01	6.17E-01	1.30E+00	2.01E+00	3.06E+00	4.23E+00	4.82E+00
	80.0	6.21E-03	5.42E-02	1.46E-01	2.78E-01	5.44E-01	1.14E+00	1.76E+00	2.64E+00	3.56E+00	3.97E+00
90.0	0.1	1.29E+01	1.15E+02	3.16E+02	6.14E+02	1.24E+03	2.72E+03	4.41E+03	7.46E+03	1.24E+04	1.62E+04
	1.0	1.51E+01	1.34E+02	3.70E+02	7.18E+02	1.45E+03	3.18E+03	5.16E+03	8.73E+03	1.45E+04	1.89E+04
	5.0	2.58E-01	2.30E+00	6.33E+00	1.23E+01	2.47E+01	5.44E+01	8.81E+01	1.49E+02	2.47E+02	3.22E+02
	10.0	6.23E-02	5.55E-01	1.52E+00	2.96E+00	5.94E+00	1.30E+01	2.11E+01	3.55E+01	5.85E+01	7.58E+01
	50.0	5.94E-03	5.23E-02	1.42E-01	2.72E-01	5.37E-01	1.15E+00	1.80E+00	2.83E+00	4.17E+00	5.01E+00
	80.0	4.48E-03	3.92E-02	1.06E-01	2.02E-01	3.98E-01	8.43E-01	1.31E+00	2.00E+00	2.82E+00	3.26E+00
180.0	0.1	4.72E+00	4.21E+01	1.16E+02	2.25E+02	4.53E+02	9.96E+02	1.62E+03	2.73E+03	4.55E+03	5.92E+03
	1.0	1.19E+00	1.06E+01	2.91E+01	5.66E+01	1.14E+02	2.51E+02	4.07E+02	6.88E+02	1.14E+03	1.49E+03
	5.0	5.20E-02	4.63E-01	1.27E+00	2.47E+00	4.96E+00	1.09E+01	1.76E+01	2.96E+01	4.88E+01	6.32E+01
	10.0	1.45E-02	1.29E-01	3.53E-01	6.82E-01	1.36E+00	2.96E+00	4.74E+00	7.80E+00	1.24E+01	1.58E+01
	50.0	4.26E-03	3.71E-02	9.99E-02	1.90E-01	3.73E-01	7.85E-01	1.21E+00	1.82E+00	2.47E+00	2.78E+00
	80.0	3.90E-03	3.41E-02	9.17E-02	1.75E-01	3.41E-01	7.17E-01	1.10E+00	1.64E+00	2.20E+00	2.44E+00
270.0	0.1	4.06E+00	3.62E+01	9.97E+01	1.94E+02	3.90E+02	8.58E+02	1.39E+03	2.35E+03	3.92E+03	5.10E+03
	1.0	1.00E+00	8.93E+00	2.46E+01	4.77E+01	9.61E+01	2.11E+02	3.43E+02	5.80E+02	9.65E+02	1.26E+03
	5.0	4.78E-02	4.26E-01	1.17E+00	2.27E+00	4.56E+00	1.00E+01	1.62E+01	2.71E+01	4.47E+01	5.78E+01
	10.0	1.41E-02	1.25E-01	3.41E-01	6.58E-01	1.31E+00	2.86E+00	4.56E+00	7.49E+00	1.19E+01	1.51E+01
	50.0	4.41E-03	3.86E-02	1.04E-01	1.98E-01	3.88E-01	8.16E-01	1.25E+00	1.89E+00	2.56E+00	2.87E+00
	80.0	4.07E-03	3.55E-02	9.57E-02	1.82E-01	3.56E-01	7.47E-01	1.15E+00	1.71E+00	2.29E+00	2.53E+00

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL DOSE RATE (MREM/YEAR) FROM GROUND DEPOSITION

ANGLE	DISTANCE(KM)	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
67.5	0.1	1.29E+01	5.10E+01	1.01E+02	1.49E+02	2.07E+02	2.97E+02	3.38E+02	3.05E+02	2.47E+02	1.88E+02
	1.0	2.09E+01	8.28E+01	1.63E+02	2.42E+02	3.37E+02	4.82E+02	5.49E+02	4.95E+02	4.02E+02	3.04E+02
	5.0	5.92E-01	2.34E+00	4.62E+00	6.84E+00	9.52E+00	1.36E+01	1.55E+01	1.40E+01	1.13E+01	8.55E+00
	10.0	1.51E-01	5.99E-01	1.18E+00	1.74E+00	2.42E+00	3.46E+00	3.93E+00	3.52E+00	2.83E+00	2.12E+00
	50.0	1.24E-02	4.86E-02	9.42E-02	1.37E-01	1.87E-01	2.59E-01	2.79E-01	2.24E-01	1.52E-01	9.77E-02
	80.0	8.83E-03	3.43E-02	6.61E-02	9.55E-02	1.29E-01	1.77E-01	1.86E-01	1.41E-01	8.56E-02	4.81E-02
0.0	0.1	5.47E+00	2.17E+01	4.27E+01	6.32E+01	8.81E+01	1.26E+02	1.44E+02	1.29E+02	1.05E+02	7.97E+01
	1.0	1.81E+00	7.18E+00	1.42E+01	2.10E+01	2.92E+01	4.18E+01	4.76E+01	4.29E+01	3.49E+01	2.64E+01
	5.0	1.07E-01	4.25E-01	8.37E-01	1.24E+00	1.72E+00	2.46E+00	2.79E+00	2.50E+00	2.01E+00	1.51E+00
	10.0	3.20E-02	1.26E-01	2.48E-01	3.64E-01	5.04E-01	7.15E-01	8.02E-01	7.01E-01	5.45E-01	3.99E-01
	50.0	6.99E-03	2.71E-02	5.20E-02	7.48E-02	1.01E-01	1.37E-01	1.42E-01	1.05E-01	5.86E-02	2.94E-02
	80.0	6.21E-03	2.40E-02	4.59E-02	6.60E-02	8.87E-02	1.20E-01	1.23E-01	8.80E-02	4.61E-02	2.04E-02
90.0	0.1	1.29E+01	5.10E+01	1.01E+02	1.49E+02	2.07E+02	2.97E+02	3.38E+02	3.05E+02	2.47E+02	1.88E+02
	1.0	1.51E+01	5.97E+01	1.18E+02	1.74E+02	2.43E+02	3.47E+02	3.96E+02	3.57E+02	2.90E+02	2.19E+02
	5.0	2.58E-01	1.02E+00	2.01E+00	2.98E+00	4.15E+00	5.93E+00	6.75E+00	6.07E+00	4.92E+00	3.72E+00
	10.0	6.23E-02	2.46E-01	4.85E-01	7.16E-01	9.95E-01	1.42E+00	1.61E+00	1.44E+00	1.15E+00	8.63E-01
	50.0	5.94E-03	2.32E-02	4.48E-02	6.50E-02	8.85E-02	1.22E-01	1.30E-01	1.03E-01	6.73E-02	4.17E-02
	80.0	4.48E-03	1.74E-02	3.34E-02	4.82E-02	6.51E-02	8.90E-02	9.27E-02	6.96E-02	4.09E-02	2.20E-02
180.0	0.1	4.72E+00	1.87E+01	3.69E+01	5.45E+01	7.59E+01	1.09E+02	1.24E+02	1.12E+02	9.07E+01	6.87E+01
	1.0	1.19E+00	4.70E+00	9.27E+00	1.37E+01	1.91E+01	2.74E+01	3.12E+01	2.81E+01	2.28E+01	1.73E+01
	5.0	5.20E-02	2.06E-01	4.05E-01	5.98E-01	8.31E-01	1.19E+00	1.34E+00	1.20E+00	9.61E-01	7.21E-01
	10.0	1.45E-02	5.72E-02	1.12E-01	1.64E-01	2.27E-01	3.20E-01	3.56E-01	3.06E-01	2.32E-01	1.67E-01
	50.0	4.24E-03	1.64E-02	3.14E-02	4.52E-02	6.08E-02	8.25E-02	8.45E-02	6.12E-02	3.28E-02	1.52E-02
	80.0	3.90E-03	1.51E-02	2.88E-02	4.14E-02	5.56E-02	7.51E-02	7.65E-02	5.45E-02	2.79E-02	1.18E-02
270.0	0.1	4.06E+00	1.61E+01	3.17E+01	4.70E+01	6.54E+01	9.36E+01	1.07E+02	9.62E+01	7.81E+01	5.92E+01
	1.0	1.00E+00	3.97E+00	7.82E+00	1.16E+01	1.61E+01	2.31E+01	2.63E+01	2.37E+01	1.92E+01	1.46E+01
	5.0	4.78E-02	1.89E-01	3.72E-01	5.49E-01	7.63E-01	1.09E+00	1.23E+00	1.10E+00	8.77E-01	6.57E-01
	10.0	1.41E-02	5.53E-02	[illegible]	1.59E-01	2.19E-01	3.08E-01	3.42E-01	2.93E-01	2.21E-01	1.57E-01
	50.0	4.41E-03	1.71E-02	[illegible]	4.70E-02	6.32E-02	8.57E-02	8.77E-02	6.33E-02	3.37E-02	1.54E-02
	80.0	4.07E-03	1.57E-02	3.01E-02	4.32E-02	5.79E-02	7.83E-02	7.97E-02	5.67E-02	2.89E-02	1.22E-02

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UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 258
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL TIME INTEGRATED DOSE (MREM) AT EXTRA RECEPTOR LOCATIONS FROM GROUND DEPOSITION

#	IDENTIFICATION	YEARS 1	3	5	7	10	15	20	30	50	70
1	FENCE POST	2.57E+01	2.29E+02	6.29E+02	1.22E+03	2.46E+03	5.41E+03	8.78E+03	1.49E+04	2.47E+04	3.22E+04
2	TRAILER	1.52E+01	1.35E+02	3.72E+02	7.23E+02	1.45E+03	3.20E+03	5.19E+03	8.78E+03	1.46E+04	1.90E+04
3	RANCH 1	2.49E+00	2.22E+01	6.11E+01	1.19E+02	2.39E+02	5.26E+02	8.53E+02	1.44E+03	2.40E+03	3.12E+03
4	RANCH 2	1.66E-01	1.48E+00	4.07E+00	7.90E+00	1.59E+01	3.49E+01	5.65E+01	9.52E+01	1.57E+02	2.04E+02
5	RANCH 3	4.12E-02	3.66E-01	1.00E+00	1.94E+00	3.89E+00	8.49E+00	1.36E+01	2.27E+01	3.67E+01	4.70E+01
6	RANCH 3V	4.12E-02	3.66E-01	1.00E+00	1.94E+00	3.89E+00	8.49E+00	1.36E+01	2.27E+01	3.67E+01	4.70E+01
7	RANCH 4	1.60E-02	1.41E-01	3.85E-01	7.40E-01	1.47E+00	3.17E+00	5.03E+00	8.10E+00	1.25E+01	1.54E+01
8	RANCH 5	1.63E-02	1.45E-01	3.96E-01	7.64E-01	1.53E+00	3.32E+00	5.30E+00	8.71E+00	1.38E+01	1.75E+01
9	RANCH 6	9.80E-03	8.64E-02	2.35E-01	4.52E-01	8.95E-01	1.92E+00	3.03E+00	4.83E+00	7.31E+00	8.94E+00
10	RANCH 6V	9.80E-03	8.64E-02	2.35E-01	4.52E-01	8.95E-01	1.92E+00	3.03E+00	4.83E+00	7.31E+00	8.94E+00
11	RANCH 7	3.76E-03	3.30E-02	8.93E-02	1.70E-01	3.35E-01	7.11E-01	1.10E+00	1.70E+00	2.40E+00	2.79E+00
12	RANCH 8	5.34E-03	4.69E-02	1.27E-01	2.42E-01	4.76E-01	1.01E+00	1.57E+00	2.41E+00	3.43E+00	3.98E+00
13	RANCH 9	4.76E-03	4.16E-02	1.12E-01	2.14E-01	4.21E-01	8.89E-01	1.37E+00	2.09E+00	2.89E+00	3.30E+00
14	RANCH 10	5.17E-03	4.52E-02	1.22E-01	2.33E-01	4.57E-01	9.65E-01	1.49E+00	2.27E+00	3.15E+00	3.59E+00
15	RANCH 11	5.70E-03	5.02E-02	1.36E-01	2.61E-01	5.17E-01	1.11E+00	1.74E+00	2.74E+00	4.07E+00	4.92E+00
16	RANCH 12	4.17E-03	3.65E-02	9.82E-02	1.87E-01	3.66E-01	7.70E-01	1.18E+00	1.78E+00	2.40E+00	2.68E+00
17	RANCH 12V	4.17E-03	3.65E-02	9.82E-02	1.87E-01	3.66E-01	7.70E-01	1.18E+00	1.78E+00	2.40E+00	2.68E+00
18	RANCH 13	4.16E-03	3.63E-02	9.78E-02	1.86E-01	3.64E-01	7.65E-01	1.17E+00	1.76E+00	2.36E+00	2.63E+00
19	RANCH 14	4.35E-03	3.80E-02	1.02E-01	1.95E-01	3.81E-01	8.00E-01	1.23E+00	1.84E+00	2.46E+00	2.73E+00
20	RANCH 15	4.32E-03	3.78E-02	1.02E-01	1.95E-01	3.82E-01	8.06E-01	1.24E+00	1.88E+00	2.60E+00	2.95E+00
21	RANCH 16	1.17E-03	1.02E-02	2.77E-02	5.30E-02	1.04E-01	2.22E-01	3.45E-01	5.33E-01	7.63E-01	8.94E-01
22	RANCH 16V	1.17E-03	1.02E-02	2.77E-02	5.30E-02	1.04E-01	2.22E-01	3.45E-01	5.33E-01	7.63E-01	8.94E-01
23	WEST CITY	3.70E-03	3.23E-02	8.70E-02	1.66E-01	3.24E-01	6.80E-01	1.04E+00	1.56E+00	2.08E+00	2.30E+00
24	EAST CITY	1.07E-02	9.41E-02	2.56E-01	4.91E-01	9.73E-01	2.09E+00	3.29E+00	5.23E+00	7.88E+00	9.60E+00
25	RED TOWN	4.02E-03	3.51E-02	9.46E-02	1.80E-01	3.52E-01	7.40E-01	1.14E+00	1.70E+00	2.29E+00	2.55E+00
26	BLUE TOWN	3.41E-03	2.99E-02	8.06E-02	1.54E-01	3.02E-01	6.37E-01	9.84E-01	1.50E+00	2.07E+00	2.36E+00
27	BROWN TOWN	6.56E-03	5.76E-02	1.56E-01	2.99E-01	5.88E-01	1.25E+00	1.95E+00	3.04E+00	4.40E+00	5.20E+00
28	GREEN TOWN	7.58E-03	6.68E-02	1.82E-01	3.49E-01	6.92E-01	1.49E+00	2.35E+00	3.74E+00	5.66E+00	6.92E+00
29	ORANGE TOWN	2.78E-03	2.43E-02	6.54E-02	1.24E-01	2.43E-01	5.12E-01	7.85E-01	1.18E+00	1.58E+00	1.75E+00
30	PURPLE TOWN	9.72E-03	8.55E-02	2.32E-01	4.44E-01	8.75E-01	1.87E+00	2.92E+00	4.56E+00	6.65E+00	7.92E+00
31	WHITE TOWN	2.92E-03	2.55E-02	6.88E-02	1.31E-01	2.56E-01	5.38E-01	8.27E-01	1.24E+00	1.67E+00	1.86E+00
32	E INDIANRES	4.97E-03	4.36E-02	1.18E-01	2.26E-01	4.45E-01	9.45E-01	1.47E+00	2.28E+00	3.27E+00	3.83E+00
33	E INDIANRES	2.99E-03	2.61E-02	7.04E-02	1.34E-01	2.62E-01	5.50E-01	8.43E-01	1.26E+00	1.69E+00	1.87E+00
34	EAST RURAL	1.01E-02	8.89E-02	2.42E-01	4.63E-01	9.17E-01	1.96E+00	3.08E+00	4.87E+00	7.25E+00	8.75E+00
35	NORTH RURAL	6.55E-03	5.75E-02	1.56E-01	2.98E-01	5.87E-01	1.25E+00	1.94E+00	3.01E+00	4.33E+00	5.09E+00
36	NW RURAL	3.35E-03	2.93E-02	7.91E-02	1.51E-01	2.96E-01	6.24E-01	9.63E-01	1.46E+00	2.02E+00	2.29E+00
37	WEST RURAL	3.38E-03	2.95E-02	7.95E-02	1.51E-01	2.96E-01	6.21E-01	9.52E-01	1.42E+00	1.90E+00	2.10E+00
38	SOUTH RURAL	4.34E-03	3.79E-02	1.02E-01	1.95E-01	3.82E-01	8.05E-01	1.24E+00	1.87E+00	2.56E+00	2.89E+00
39	SW RURAL	4.55E-03	3.97E-02	1.07E-01	2.04E-01	3.98E-01	8.37E-01	1.28E+00	1.92E+00	2.58E+00	2.87E+00
40	AGRICULTURE 1	1.08E-02	9.53E-02	2.59E-01	4.97E-01	9.84E-01	2.11E+00	3.32E+00	5.26E+00	7.89E+00	9.57E+00
41	AGRICULTURE 2	9.96E-03	8.79E-02	2.39E-01	4.60E-01	9.13E-01	1.97E+00	3.11E+00	4.98E+00	7.59E+00	9.33E+00
42	AGRICULTURE 3	6.58E-03	5.78E-02	1.56E-01	2.99E-01	5.89E-01	1.25E+00	1.95E+00	3.03E+00	4.36E+00	5.14E+00
43	AGRICULTURE 4	3.38E-03	2.96E-02	7.99E-02	1.52E-01	2.99E-01	6.31E-01	9.74E-01	1.48E+00	2.05E+00	2.33E+00
44	AGRICULTURE 5	3.39E-03	2.96E-02	7.97E-02	1.52E-01	2.97E-01	6.23E-01	9.56E-01	1.43E+00	1.92E+00	2.13E+00
45	AGRICULTURE 6	3.62E-03	3.16E-02	8.52E-02	1.62E-01	3.17E-01	6.65E-01	1.02E+00	1.53E+00	2.04E+00	2.26E+00

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL DOSE RATE (MREM/YEAR) AT EXTRA RECEPTOR LOCATIONS FROM GROUND DEPOSITION

#	IDENTIFICATION	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
1	FENCE POST	2.57E+01	1.02E+02	2.00E+02	2.96E+02	4.13E+02	5.91E+02	6.73E+02	6.07E+02	4.93E+02	3.73E+02
2	TRAILER	1.52E+01	6.00E+01	1.18E+02	1.75E+02	2.44E+02	3.49E+02	3.96E+02	3.59E+02	2.91E+02	2.21E+02
3	RANCH 1	2.49E+00	9.85E+00	1.94E+01	2.88E+01	4.01E+01	5.74E+01	6.54E+01	5.89E+01	4.78E+01	3.62E+01
4	RANCH 2	1.66E-01	6.57E-01	1.30E+00	1.91E+00	2.66E+00	3.80E+00	4.32E+00	3.87E+00	3.11E+00	2.34E+00
5	RANCH 3	4.12E-02	1.62E-01	3.18E-01	4.69E-01	6.49E-01	9.20E-01	1.03E+00	9.03E-01	7.03E-01	5.15E-01
6	RANCH 3V	4.12E-02	1.62E-01	3.18E-01	4.69E-01	6.49E-01	9.20E-01	1.03E+00	9.03E-01	7.03E-01	5.15E-01
7	RANCH 4	1.60E-02	6.26E-02	1.22E-01	1.78E-01	2.44E-01	3.40E-01	3.71E-01	3.07E-01	2.19E-01	1.48E-01
8	RANCH 5	1.63E-02	6.42E-02	1.26E-01	1.84E-01	2.54E-01	3.58E-01	3.97E-01	3.40E-01	2.57E-01	1.83E-01
9	RANCH 6	9.80E-03	3.83E-02	7.43E-02	1.08E-01	1.48E-01	2.06E-01	2.22E-01	1.80E-01	1.24E-01	8.11E-02
10	RANCH 6V	9.80E-03	3.83E-02	7.43E-02	1.08E-01	1.48E-01	2.06E-01	2.22E-01	1.80E-01	1.24E-01	8.11E-02
11	RANCH 7	3.76E-03	1.46E-02	2.81E-02	4.06E-02	5.49E-02	7.51E-02	7.84E-02	5.93E-02	3.53E-02	1.94E-02
12	RANCH 8	5.34E-03	2.03E-02	3.99E-02	5.77E-02	7.80E-02	1.07E-01	1.12E-01	8.45E-02	5.06E-02	2.80E-02
13	RANCH 9	4.76E-03	1.84E-02	3.54E-02	5.10E-02	6.87E-02	9.36E-02	9.68E-02	7.15E-02	4.04E-02	2.04E-02
14	RANCH 10	5.17E-03	2.00E-02	3.84E-02	5.54E-02	7.47E-02	1.02E-01	1.05E-01	7.77E-02	4.39E-02	2.23E-02
15	RANCH 11	5.70E-03	2.22E-02	4.30E-02	6.25E-02	8.52E-02	1.18E-01	1.26E-01	1.00E-01	6.67E-02	4.20E-02
16	RANCH 12	4.17E-03	1.61E-02	3.09E-02	4.44E-02	5.96E-02	8.03E-02	8.25E-02	5.93E-02	3.12E-02	1.39E-02
17	RANCH 12V	4.17E-03	1.61E-02	3.09E-02	4.44E-02	5.96E-02	8.03E-02	8.25E-02	5.93E-02	3.12E-02	1.39E-02
18	RANCH 13	4.16E-03	1.61E-02	3.07E-02	4.42E-02	5.93E-02	8.02E-02	8.18E-02	5.85E-02	3.03E-02	1.31E-02
19	RANCH 14	4.35E-03	1.68E-02	3.2[illegible]-02	4.62E-02	6.20E-02	8.38E-02	8.54E-02	6.09E-02	3.13E-02	1.33E-02
20	RANCH 15	4.32E-03	1.68E-02	3.21E-02	4.63E-02	6.23E-02	8.48E-02	8.74E-02	6.42E-02	3.56E-02	1.76E-02
21	RANCH 16	1.17E-03	4.54E-03	8.74E-03	1.26E-02	1.71E-02	2.35E-02	2.46E-02	1.88E-02	1.15E-02	6.54E-03
22	RANCH 16V	1.17E-03	4.54E-03	8.74E-03	1.26E-02	1.71E-02	2.35E-02	2.46E-02	1.88E-02	1.15E-02	6.54E-03
23	WEST CITY	3.70E-03	1.43E-02	2.74E-02	3.93E-02	5.27E-02	7.12E-02	7.24E-02	5.14E-02	2.62E-02	1.09E-02
24	EAST CITY	1.07E-02	4.17E-02	8.09E-02	1.18E-01	1.61E-01	2.23E-01	2.40E-01	1.94E-01	1.32E-01	8.59E-02
25	RED TOWN	4.02E-03	1.55E-02	2.97E-02	4.27E-02	5.74E-02	7.76E-02	7.92E-02	5.67E-02	2.94E-02	1.28E-02
26	BLUE TOWN	3.41E-03	1.32E-02	2.54E-02	3.66E-02	4.93E-02	6.71E-02	6.93E-02	5.11E-02	2.88E-02	1.45E-02
27	BROWN TOWN	6.56E-03	2.55E-02	4.92E-02	7.12E-02	9.67E-02	1.33E-01	1.40E-01	1.08E-01	6.79E-02	3.99E-02
28	GREEN TOWN	7.58E-03	2.96E-02	5.75E-02	8.37E-02	1.14E-01	1.59E-01	1.72E-01	1.40E-01	9.61E-02	6.30E-02
29	ORANGE TOWN	2.78E-03	1.07E-02	2.06E-02	2.95E-02	3.96E-02	5.37E-02	5.47E-02	3.91E-02	2.02E-02	8.73E-03
30	PURPLE TOWN	9.72E-03	3.79E-02	7.31E-02	1.06E-01	1.44E-01	1.98E-01	2.10E-01	1.64E-01	1.05E-01	6.31E-02
31	WHITE TOWN	2.92E-03	1.13E-02	2.16E-02	3.11E-02	4.17E-02	5.65E-02	5.76E-02	4.13E-02	2.15E-02	9.45E-03
32	E INDIANRES	4.97E-03	1.93E-02	3.72E-02	5.38E-02	7.29E-02	1.00E-01	1.05E-01	8.06E-02	4.95E-02	2.83E-02
33	E INDIANRES	2.99E-03	1.16E-02	2.21E-02	3.18E-02	4.26E-02	5.76E-02	5.86E-02	4.17E-02	2.13E-02	8.99E-03
34	EAST RURAL	1.01E-02	3.94E-02	7.63E-02	1.11E-01	1.51E-01	2.09E-01	2.24E-01	1.79E-01	1.19E-01	7.53E-02
35	NORTH RURAL	6.55E-03	2.55E-02	4.91E-02	7.11E-02	9.63E-02	1.32E-01	1.39E-01	1.07E-01	6.59E-02	3.81E-02
36	NW RURAL	3.35E-03	1.30E-02	2.49E-02	3.58E-02	4.83E-02	6.57E-02	6.78E-02	4.98E-02	2.78E-02	1.38E-02
37	WEST RURAL	3.38E-03	1.31E-02	2.50E-02	3.59E-02	4.81E-02	6.51E-02	6.62E-02	4.71E-02	2.40E-02	1.01E-02
38	SOUTH RURAL	4.34E-03	1.68E-02	3.22E-02	4.63E-02	6.23E-02	8.47E-02	8.70E-02	6.34E-02	3.45E-02	1.64E-02
39	SW RURAL	4.55E-03	1.76E-02	3.36E-02	4.83E-02	6.49E-02	8.78E-02	8.94E-02	6.39E-02	3.30E-02	1.42E-02
40	AGRICULTURE 1	1.08E-02	4.22E-02	8.18E-02	1.19E-01	1.62E-01	2.25E-01	2.42E-01	1.94E-01	1.31E-01	8.42E-02
41	AGRICULTURE 2	9.96E-03	3.90E-02	7.57E-02	1.10E-01	1.51E-01	2.11E-01	2.28E-01	1.87E-01	1.31E-01	8.71E-02
42	AGRICULTURE 3	6.58E-03	2.56E-02	4.93E-02	7.14E-02	9.67E-02	1.33E-01	1.40E-01	1.08E-01	6.67E-02	3.87E-02
43	AGRICULTURE 4	3.38E-03	1.31E-02	2.52E-02	3.62E-02	4.88E-02	6.65E-02	6.86E-02	5.06E-02	2.84E-02	1.42E-02
44	AGRICULTURE 5	3.39E-03	1.31E-02	2.51E-02	3.60E-02	4.83E-02	6.53E-02	6.65E-02	4.74E-02	2.44E-02	1.04E-02
45	AGRICULTURE 6	3.62E-03	1.40E-02	2.68E-02	3.84E-02	5.16E-02	6.97E-02	7.10E-02	5.05E-02	2.58E-02	1.09E-02

560 267

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 292
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL TIME INTEGATED DOSE (MREM) FROM CLOUD SUBMERSION

ANGLE	DISTANCE(KM)	YEARS 1	3	5	7	10	15	20	30	50	70
67.5	0.1	4.31E+00	1.29E+01	2.16E+01	3.02E+01	4.31E+01	6.47E+01	6.47E+01	6.47E+01	6.47E+01	6.47E+01
	1.0	7.05E+00	2.12E+01	3.53E+01	4.94E+01	7.05E+01	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02
	5.0	3.13E+00	9.39E+00	1.56E+01	2.19E+01	3.13E+01	4.69E+01	4.69E+01	4.69E+01	4.69E+01	4.69E+01
	10.0	1.41E+00	4.24E+00	7.06E+00	9.89E+00	1.41E+01	2.12E+01	2.12E+01	2.12E+01	2.12E+01	2.12E+01
	50.0	2.20E-01	6.60E-01	1.10E+00	1.54E+00	2.20E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00
	80.0	1.24E-01	3.72E-01	6.20E-01	8.68E-01	1.24E+00	1.86E+00	1.86E+00	1.86E+00	1.86E+00	1.86E+00
0.0	0.1	4.37E+00	1.31E+01	2.18E+01	3.06E+01	4.37E+01	6.55E+01	6.55E+01	6.55E+01	6.55E+01	6.55E+01
	1.0	4.00E+00	1.20E+01	2.00E+01	2.80E+01	4.00E+01	6.00E+01	6.00E+01	6.00E+01	6.00E+01	6.00E+01
	5.0	2.27E+00	6.81E+00	1.13E+01	1.59E+01	2.27E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01
	10.0	1.11E+00	3.34E+00	5.57E+00	7.79E+00	1.11E+01	1.67E+01	1.67E+01	1.67E+01	1.67E+01	1.67E+01
	50.0	1.80E-01	5.39E-01	8.98E-01	1.26E+00	1.80E+00	2.69E+00	2.69E+00	2.69E+00	2.69E+00	2.69E+00
	80.0	1.02E-01	3.05E-01	5.08E-01	7.12E-01	1.02E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00
90.0	0.1	4.33E+00	1.30E+01	2.17E+01	3.03E+01	4.33E+01	6.50E+01	6.50E+01	6.50E+01	6.50E+01	6.50E+01
	1.0	4.91E+00	1.47E+01	2.46E+01	3.44E+01	4.91E+01	7.37E+01	7.37E+01	7.37E+01	7.37E+01	7.37E+01
	5.0	1.78E+00	5.33E+00	8.88E+00	1.24E+01	1.78E+01	2.66E+01	2.66E+01	2.66E+01	2.66E+01	2.66E+01
	10.0	7.84E-01	2.35E+00	3.92E+00	5.48E+00	7.84E+00	1.18E+01	1.18E+01	1.18E+01	1.18E+01	1.18E+01
	50.0	1.20E-01	3.60E-01	6.00E-01	8.39E-01	1.20E+00	1.80E+00	1.80E+00	1.80E+00	1.80E+00	1.80E+00
	80.0	6.76E-02	2.03E-01	3.38E-01	4.73E-01	6.76E-01	1.01E+00	1.01E+00	1.01E+00	1.01E+00	1.01E+00
180.0	0.1	4.67E+00	1.40E+01	2.34E+01	3.27E+01	4.67E+01	7.01E+01	7.01E+01	7.01E+01	7.01E+01	7.01E+01
	1.0	4.08E+00	1.22E+01	2.04E+01	2.86E+01	4.08E+01	6.12E+01	6.12E+01	6.12E+01	6.12E+01	6.12E+01
	5.0	1.62E+00	4.86E+00	8.10E+00	1.13E+01	1.62E+01	2.43E+01	2.43E+01	2.43E+01	2.43E+01	2.43E+01
	10.0	7.53E-01	2.26E+00	3.76E+00	5.27E+00	7.53E+00	1.13E+01	1.13E+01	1.13E+01	1.13E+01	1.13E+01
	50.0	1.15E-01	3.46E-01	5.76E-01	8.06E-01	1.15E+00	1.73E+00	1.73E+00	1.73E+00	1.73E+00	1.73E+00
	80.0	6.51E-02	1.95E-01	3.26E-01	4.56E-01	6.51E-01	9.77E-01	9.77E-01	9.77E-01	9.77E-01	9.77E-01
270.0	0.1	4.69E+00	1.41E+01	2.35E+01	3.28E+01	4.69E+01	7.04E+01	7.04E+01	7.04E+01	7.04E+01	7.04E+01
	1.0	3.91E+00	1.17E+01	1.95E+01	2.73E+01	3.91E+01	5.86E+01	5.86E+01	5.86E+01	5.86E+01	5.86E+01
	5.0	1.56E+00	4.67E+00	7.78E+00	1.09E+01	1.56E+01	2.33E+01	2.33E+01	2.33E+01	2.33E+01	2.33E+01
	10.0	7.32E-01	2.20E+00	3.66E+00	5.13E+00	7.32E+00	1.10E+01	1.10E+01	1.10E+01	1.10E+01	1.10E+01
	50.0	1.17E-01	3.52E-01	5.87E-01	8.22E-01	1.17E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00
	80.0	6.63E-02	1.99E-01	3.32E-01	4.64E-01	6.63E-01	9.95E-01	9.95E-01	9.95E-01	9.95E-01	9.95E-01

560 268

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL DOSE RATE (MREM/YEAR) FROM CLOUD SUBMERSION

ANGLE	DISTANCE(KM)	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
67.5	0.1	4.31E+00	4.31E+00	4.31E+00	4.31E+00	4.31E+00	4.31E+00	1.49E-06	1.34E-06	1.09E-06	8.28E-07
	1.0	7.05E+00	7.05E+00	7.05E+00	7.05E+00	7.05E+00	7.05E+00	1.55E-06	1.39E-06	1.13E-06	8.58E-07
	5.0	3.13E+00	3.13E+00	3.13E+00	3.13E+00	3.13E+00	3.13E+00	5.24E-08	4.71E-08	3.80E-08	2.87E-08
	10.0	1.41E+00	1.41E+00	1.41E+00	1.41E+00	1.41E+00	1.41E+00	1.43E-08	1.32E-08	1.05E-08	7.81E-09
	50.0	2.20E-01	2.20E-01	2.20E-01	2.20E-01	2.20E-01	2.20E-01	1.80E-09	1.41E-09	9.13E-10	5.57E-10
	80.0	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.35E-09	1.01E-09	5.97E-10	3.22E-10
0.0	0.1	4.37E+00	4.37E+00	4.37E+00	4.37E+00	4.37E+00	4.37E+00	7.[illegible]1E-07	6.59E-07	5.36E-07	4.06E-07
	1.0	4.00E+00	4.00E+00	4.00E+00	4.00E+00	4.00E+00	4.00E+00	2.36[illegible]	2.13E-07	1.73E-07	1.31E-07
	5.0	2.27E+00	2.27E+00	2.27E+00	2.27E+00	2.27E+00	2.27E+00	1.23E-08	1.14E-08	9.14E-09	6.85E-09
	10.0	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	4.00E-09	3.43E-09	2.60E-09	1.86E-09
	50.0	1.80E-01	1.80E-01	1.80E-01	1.80E-01	1.80E-01	1.80E-01	1.06E-09	7.71E-10	4.22E-10	2.03E-10
	80.0	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01	9.43E-10	6.75E-10	3.51E-10	1.53E-10
90.0	0.1	4.33E+00	4.33E+00	4.33E+00	4.33E+00	4.33E+00	4.33E+00	1.34E-06	1.21E-06	9.81E-07	7.44E-07
	1.0	4.91E+00	4.91E+00	4.91E+00	4.91E+00	4.91E+00	4.91E+00	1.09E-06	9.83E-07	7.99E-07	6.05E-07
	5.0	1.78E+00	1.78E+00	1.78E+00	1.78E+00	1.78E+00	1.78E+00	2.40E-08	2.15E-08	1.74E-08	1.31E-08
	10.0	7.84E-01	7.84E-01	7.84E-01	7.84E-01	7.84E-01	7.84E-01	6.52E-09	5.77E-09	4.56E-09	3.39E-09
	50.0	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	8.84E-10	6.84E-10	4.29E-10	2.53E-10
	80.0	6.76E-02	6.76E-02	6.76E-02	6.76E-02	6.76E-02	6.76E-02	6.87E-10	5.11E-10	2.93E-10	1.53E-10
180.0	0.1	4.67E+00	4.67E+00	4.67E+00	4.67E+00	4.67E+00	4.67E+00	5.87E-07	5.29E-07	4.30E-07	3.26E-07
	1.0	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00	1.51E-07	1.36E-07	1.10E-07	8.37E-08
	5.0	1.62E+00	1.62E+00	1.62E+00	1.62E+00	1.62E+00	1.62E+00	6.84E-09	6.07E-09	4.83E-09	3.60E-09
	10.0	7.53E-01	7.53E-01	7.53E-01	7.53E-01	7.53E-01	7.53E-01	2.03E-09	1.71E-09	1.26E-09	8.85E-10
	50.0	1.15E-01	1.15E-01	1.15E-01	1.15E-01	1.15E-01	1.15E-01	6.42E-10	4.62E-10	2.44E-10	1.10E-10
	80.0	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	5.90E-10	4.20E-10	2.14E-10	8.95E-11
270.0	0.1	4.69E+00	4.69E+00	4.69E+00	4.69E+00	4.69E+00	4.69E+00	6.05E-07	5.46E-07	4.43E-07	3.36E-07
	1.0	3.91E+00	3.91E+00	3.91E+00	3.91E+00	3.91E+00	3.91E+00	1.39E-07	1.25E-07	1.02E-07	7.73E-08
	5.0	1.56E+00	1.56E+00	1.56E+00	1.56E+00	1.56E+00	1.56E+00	6.50E-09	5.76E-09	4.57E-09	3.40E-09
	10.0	7.32E-01	7.32E-01	7.32E-01	7.32E-01	7.32E-01	7.32E-01	1.99E-09	1.67E-09	1.23E-09	8.53E-10
	50.0	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	6.71E-10	4.82E-10	2.54E-10	1.13E-10
	80.0	6.63E-02	6.63E-02	6.63E-02	6.63E-02	6.63E-02	6.63E-02	6.17E-10	4.38E-10	2.23E-10	9.31E-11

560 269

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 294
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SKIN

EXTERNAL TOTAL TIME INTEGRATED DOSE (MREM) AT EXTRA RECEPTOR LOCATIONS FROM CLOUD SUBMERSION

#	IDENTIFICATION	YEARS 1	3	5	7	10	15	20	30	50	70
1	FENCE POST	6.91E+00	2.07E+01	3.45E+01	4.83E+01	6.91E+01	1.04E+02	1.04E+02	1.04E+02	1.04E+02	1.04E+02
2	TRAILER	7.09E+00	2.13E+01	3.54E+01	4.96E+01	7.09E+01	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02
3	RANCH 1	5.17E+00	1.55E+01	2.59E+01	3.62E+01	5.17E+01	7.76E+01	7.76E+01	7.76E+01	7.76E+01	7.76E+01
4	RANCH 2	1.50E+00	4.49E+00	7.49E+00	1.05E+01	1.50E+01	2.25E+01	2.25E+01	2.25E+01	2.25E+01	2.25E+01
5	RANCH 3	6.18E-01	1.85E+00	3.09E+00	4.32E+00	6.18E+00	9.26E+00	9.26E+00	9.26E+00	9.26E+00	9.26E+00
6	RANCH 3V	6.18E-01	1.85E+00	3.09E+00	4.32E+00	6.18E+00	9.26E+00	9.26E+00	9.26E+00	9.26E+00	9.26E+00
7	RANCH 4	2.91E-01	8.73E-01	1.45E+00	2.04E+00	2.91E+00	4.36E+00	4.36E+00	4.36E+00	4.36E+00	4.36E+00
8	RANCH 5	3.23E-01	9.68E-01	1.61E+00	2.26E+00	3.23E+00	4.84E+00	4.84E+00	4.84E+00	4.84E+00	4.84E+00
9	RANCH 6	4.21E-01	1.26E+00	2.11E+00	2.95E+00	4.21E+00	6.32E+00	6.32E+00	6.32E+00	6.32E+00	6.32E+00
10	RANCH 6V	4.21E-01	1.26E+00	2.11E+00	2.95E+00	4.21E+00	6.32E+00	6.32E+00	6.32E+00	6.32E+00	6.32E+00
11	RANCH 7	1.58E-01	4.75E-01	7.91E-01	1.11E+00	1.58E+00	2.37E+00	2.37E+00	2.37E+00	2.37E+00	2.37E+00
12	RANCH 8	2.38E-01	7.13E-01	1.19E+00	1.66E+00	2.38E+00	3.56E+00	3.56E+00	3.56E+00	3.56E+00	3.56E+00
13	RANCH 9	1.61E-01	4.84E-01	8.07E-01	1.13E+00	1.61E+00	2.42E+00	2.42E+00	2.42E+00	2.42E+00	2.42E+00
14	RANCH 10	2.08E-01	6.25E-01	1.04E+00	1.46E+00	2.08E+00	3.12E+00	3.12E+00	3.12E+00	3.12E+00	3.12E+00
15	RANCH 11	2.46E-01	7.38E-01	1.23E+00	1.72E+00	2.46E+00	3.69E+00	3.69E+00	3.69E+00	3.69E+00	3.69E+00
16	RANCH 12	1.01E-01	3.02E-01	5.04E-01	7.05E-01	1.01E+00	1.51E+00	1.51E+00	1.51E+00	1.51E+00	1.51E+00
17	RANCH 12V	1.01E-01	3.02E-01	5.04E-01	7.05E-01	1.01E+00	1.51E+00	1.51E+00	1.51E+00	1.51E+00	1.51E+00
18	RANCH 13	8.23E-02	2.47E-01	4.12E-01	5.76E-01	8.23E-01	1.23E+00	1.23E+00	1.23E+00	1.23E+00	1.23E+00
19	RANCH 14	7.98E-02	2.40E-01	3.99E-01	5.59E-01	7.98E-01	1.20E+00	1.20E+00	1.20E+00	1.20E+00	1.20E+00
20	RANCH 15	1.26E-01	3.79E-01	6.32E-01	8.85E-01	1.26E+00	1.90E+00	1.90E+00	1.90E+00	1.90E+00	1.90E+00
21	RANCH 16	3.05E-02	9.14E-02	1.52E-01	2.13E-01	3.05E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
22	RANCH 16V	3.05E-02	9.14E-02	1.52E-01	2.13E-01	3.05E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
23	WEST CITY	6.13E-02	1.84E-01	3.07E-01	4.29E-01	6.13E-01	9.20E-01	9.20E-01	9.20E-01	9.20E-01	9.20E-01
24	EAST CITY	1.94E-01	5.81E-01	9.68E-01	1.36E+00	1.94E+00	2.90E+00	2.90E+00	2.90E+00	2.90E+00	2.90E+00
25	RED TOWN	7.63E-02	2.29E-01	3.82E-01	5.34E-01	7.63E-01	1.14E+00	1.14E+00	1.14E+00	1.14E+00	1.14E+00
26	BLUE TOWN	1.15E-01	3.45E-01	5.74E-01	8.04E-01	1.15E+00	1.72E+00	1.72E+00	1.72E+00	1.72E+00	1.72E+00
27	BROWN TOWN	2.56E-01	7.67E-01	1.28E+00	1.79E+00	2.56E+00	3.83E+00	3.83E+00	3.83E+00	3.83E+00	3.83E+00
28	GREEN TOWN	1.72E-01	5.15E-01	8.58E-01	1.20E+00	1.72E+00	2.57E+00	2.57E+00	2.57E+00	2.57E+00	2.57E+00
29	ORANGE TOWN	6.01E-02	1.80E-01	3.00E-01	4.21E-01	6.01E-01	9.01E-01	9.01E-01	9.01E-01	9.01E-01	9.01E-01
30	PURPLE TOWN	1.58E-01	4.74E-01	7.90E-01	1.11E+00	1.58E+00	2.37E+00	2.37E+00	2.37E+00	2.37E+00	2.37E+00
31	WHITE TOWN	6.67E-02	2.00E-01	3.34E-01	4.67E-01	6.67E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
32	E INDIANRES	8.73E-02	2.62E-01	4.36E-01	6.11E-01	8.73E-01	1.31E+00	1.31E+00	1.31E+00	1.31E+00	1.31E+00
33	E INDIANRES	5.06E-02	1.52E-01	2.53E-01	3.54E-01	5.06E-01	7.59E-01	7.59E-01	7.59E-01	7.59E-01	7.59E-01
34	EAST RURAL	1.77E-01	5.31E-01	8.84E-01	1.24E+00	1.77E+00	2.65E+00	2.65E+00	2.65E+00	2.65E+00	2.65E+00
35	NORTH RURAL	2.45E-01	7.36E-01	1.23E+00	1.72E+00	2.45E+00	3.68E+00	3.68E+00	3.68E+00	3.68E+00	3.68E+00
36	NW RURAL	1.14E-01	3.41E-01	5.68E-01	7.95E-01	1.14E+00	1.70E+00	1.70E+00	1.70E+00	1.70E+00	1.70E+00
37	WEST RURAL	6.36E-02	1.91E-01	3.18E-01	4.45E-01	6.36E-01	9.54E-01	9.54E-01	9.54E-01	9.54E-01	9.54E-01
38	SOUTH RURAL	1.30E-01	3.91E-01	6.52E-01	9.13E-01	1.30E+00	1.96E+00	1.96E+00	1.96E+00	1.96E+00	1.96E+00
39	SW RURAL	9.43E-02	2.83E-01	4.71E-01	6.60E-01	9.43E-01	1.41E+00	1.41E+00	1.41E+00	1.41E+00	1.41E+00
40	AGRICULTURE 1	1.92E-01	5.77E-01	9.62E-01	1.35E+00	1.92E+00	2.89E+00	2.89E+00	2.89E+00	2.89E+00	2.89E+00
41	AGRICULTURE 2	2.00E-01	6.00E-01	9.99E-01	1.40E+00	2.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00
42	AGRICULTURE 3	2.49E-01	7.46E-01	1.24E+00	1.74E+00	2.49E+00	3.73E+00	3.73E+00	3.73E+00	3.73E+00	3.73E+00
43	AGRICULTURE 4	1.17E-01	3.52E-01	5.86E-01	8.20E-01	1.17E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00
44	AGRICULTURE 5	7.36E-02	2.21E-01	3.68E-01	5.15E-01	7.36E-01	1.10E+00	1.10E+00	1.10E+00	1.10E+00	1.10E+00
45	AGRICULTURE 6	6.85E-02	2.06E-01	3.45E-01	4.80E-01	6.85E-01	1.03E+00	1.03E+00	1.03E+00	1.03E+00	1.03E+00

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS ANGLE OF MAXIMUM DISPERSION = 67.5 DEGREES
SYTN

EXTERNAL TOTAL DOSE RATE (MREM/YEAR) AT EXTRA RECEPTOR LOCATIONS FROM CLOUD SUBMERSION

#	IDENTIFICATION	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
1	FENCE POST	6.91E+00	6.91E+00	6.91E+00	6.91E+00	6.91E+00	6.91E+00	1.87E-06	1.69E-06	1.37E-06	1.04E-06
2	TRAILER	7.09E+00	7.09E+00	7.09E+00	7.09E+00	7.09E+00	7.09E+00	1.14E-06	1.03E-06	8.38E-07	6.35E-07
3	RANCH 1	5.17E+00	5.17E+00	5.17E+00	5.17E+00	5.17E+00	5.17E+00	2.08E-07	1.87E-07	1.52E-07	1.15E-07
4	RANCH 2	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.61E-08	1.43E-08	1.14E-08	8.54E-09
5	RANCH 3	6.18E-01	6.18E-01	6.18E-01	6.18E-01	6.18E-01	6.18E-01	4.78E-09	4.09E-09	3.09E-09	2.20E-09
6	RANCH 3V	6.18E-01	6.18E-01	6.18E-01	6.18E-01	6.18E-01	6.18E-01	4.78E-09	4.09E-09	3.09E-09	2.20E-09
7	RANCH 4	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.21E-09	1.78E-09	1.20E-09	7.76E-10
8	RANCH 5	3.23E-01	3.23E-01	3.23E-01	3.23E-01	3.23E-01	3.23E-01	2.06E-09	1.72E-09	1.24E-09	8.53E-10
9	RANCH 6	4.21E-01	4.21E-01	4.21E-01	4.21E-01	4.21E-01	4.21E-01	1.38E-09	1.09E-09	7.11E-10	4.40E-10
10	RANCH 6V	4.21E-01	4.21E-01	4.21E-01	4.21E-01	4.21E-01	4.21E-01	1.38E-09	1.09E-09	7.11E-10	4.40E-10
11	RANCH 7	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	5.57E-10	4.14E-10	2.36E-10	1.22E-10
12	RANCH 8	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	8.08E-10	6.03E-10	3.49E-10	1.84E-10
13	RANCH 9	1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.61E-01	7.23E-10	5.30E-10	2.93E-10	1.43E-10
14	RANCH 10	2.08E-01	2.08E-01	2.08E-01	2.08E-01	2.08E-01	2.08E-01	7.79E-10	5.70E-10	3.13E-10	1.52E-10
15	RANCH 11	2.46E-01	2.46E-01	2.46E-01	2.46E-01	2.46E-01	2.46E-01	8.19E-10	6.35E-10	4.00E-10	2.37E-10
16	RANCH 12	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	6.33E-10	4.54E-10	2.36E-10	1.03E-10
17	RANCH 12V	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	6.33E-10	4.54E-10	2.36E-10	1.03E-10
18	RANCH 13	8.23E-02	8.23E-02	8.23E-02	8.23E-02	8.23E-02	8.23E-02	6.31E-10	4.50E-10	2.32E-10	9.92E-11
19	RANCH 14	7.98E-02	7.98E-02	7.98E-02	7.98E-02	7.98E-02	7.98E-02	6.58E-10	4.68E-10	2.39E-10	1.00E-10
20	RANCH 15	1.26E-01	1.26E-01	1.26E-01	1.26E-01	1.26E-01	1.26E-01	6.51E-10	4.73E-10	2.56E-10	1.21E-10
21	RANCH 16	3.05E-02	3.05E-02	3.05E-02	3.05E-02	3.05E-02	3.05E-02	1.79E-10	1.35E-10	8.00E-11	4.37E-11
22	RANCH 16V	3.05E-02	3.05E-02	3.05E-02	3.05E-02	3.05E-02	3.05E-02	1.79E-10	1.35E-10	8.00E-11	4.37E-11
23	WEST CITY	6.13E-02	6.13E-02	6.13E-02	6.13E-02	6.13E-02	6.13E-02	5.60E-10	3.97E-10	2.02E-10	8.34E-11
24	EAST CITY	1.94E-01	1.94E-01	1.94E-01	1.94E-01	1.94E-01	1.94E-01	1.55E-09	1.23E-09	8.00E-10	4.94E-10
25	RED TOWN	7.63E-02	7.63E-02	7.63E-02	7.63E-02	7.63E-02	7.63E-02	6.11E-10	4.36E-10	2.25E-10	9.68E-11
26	BLUE TOWN	1.15E-01	1.15E-01	1.15E-01	1.15E-01	1.15E-01	1.15E-01	5.10E-10	3.72E-10	2.02E-10	9.66E-11
27	BROWN TOWN	2.56E-01	2.56E-01	2.56E-01	2.56E-01	2.56E-01	2.56E-01	9.65E-10	7.30E-10	4.37E-10	2.41E-10
28	GREEN TOWN	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.06E-09	8.37E-10	5.46E-10	3.38E-10
29	ORANGE TOWN	6.01E-02	6.01E-02	6.01E-02	6.01E-02	6.01E-02	6.01E-02	4.21E-10	3.00E-10	1.54E-10	6.58E-11
30	PURPLE TOWN	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.46E-09	1.12E-09	6.83E-10	3.95E-10
31	WHITE TOWN	6.67E-02	6.67E-02	6.67E-02	6.67E-02	6.67E-02	6.67E-02	4.42E-10	3.16E-10	1.63E-10	7.03E-11
32	E INDIANRES	8.73E-02	8.73E-02	8.73E-02	8.73E-02	8.73E-02	8.73E-02	7.56E-10	5.71E-10	3.39E-10	1.86E-10
33	E INDIANRES	5.06E-02	5.06E-02	5.06E-02	5.06E-02	5.06E-02	5.06E-02	4.52E-10	3.21E-10	1.63E-10	6.79E-11
34	EAST RURAL	1.77E-01	1.77E-01	1.77E-01	1.77E-01	1.77E-01	1.77E-01	1.49E-09	1.17E-09	7.45E-10	4.49E-10
35	NORTH RURAL	2.45E-01	2.45E-01	2.45E-01	2.45E-01	2.45E-01	2.45E-01	9.68E-10	7.29E-10	4.31E-10	2.34E-10
36	NW RURAL	1.14E-01	1.14E-01	1.14E-01	1.14E-01	1.14E-01	1.14E-01	5.03E-10	3.66E-10	1.98E-10	9.39E-11
37	WEST RURAL	6.36E-02	6.36E-02	6.36E-02	6.36E-02	6.36E-02	6.36E-02	5.10E-10	3.62E-10	1.84E-10	7.60E-11
38	SOUTH RURAL	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.30E-01	6.57E-10	4.75E-10	2.54E-10	1.17E-10
39	SW RURAL	9.43E-02	9.43E-02	9.43E-02	9.43E-02	9.43E-02	9.43E-02	6.87E-10	4.89E-10	2.51E-10	1.06E-10
40	AGRICULTURE 1	1.92E-01	1.92E-01	1.92E-01	1.92E-01	1.92E-01	1.92E-01	1.58E-09	1.24E-09	8.04E-10	4.91E-10
41	AGRICULTURE 2	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	1.40E-09	1.12E-09	7.43E-10	4.70E-10
42	AGRICULTURE 3	2.49E-01	2.49E-01	2.49E-01	2.49E-01	2.49E-01	2.49E-01	9.71E-10	7.32E-10	4.34E-10	2.37E-10
43	AGRICULTURE 4	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	5.07E-10	3.70E-10	2.01E-10	9.60E-11
44	AGRICULTURE 5	7.36E-02	7.36E-02	7.36E-02	7.36E-02	7.36E-02	7.36E-02	5.11E-10	3.63E-10	1.85E-10	7.75E-11
45	AGRICULTURE 6	6.85E-02	6.85E-02	6.85E-02	6.85E-02	6.85E-02	6.85E-02	5.48E-10	3.89E-10	1.98E-10	8.25E-11

560 271

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 328
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS
WHOLE BODY

TOTAL TIME INTEGRATED DOSE (MREM) FROM INGESTION

#	IDENTIFICATION	PATHWAY	YEARS 1	3	5	7	10	15	20	30	50	70
3	RANCH 1	MEAT	4.34E-01	2.18E+00	4.67E+00	7.69E+00	1.30E+01	2.35E+01	3.07E+01	3.94E+01	4.83E+01	5.23E+01
4	RANCH 2	MEAT	2.80E-02	1.41E-01	3.02E-01	4.98E-01	8.42E-01	1.52E+00	1.99E+00	2.55E+00	3.13E+00	3.39E+00
5	RANCH 3	MEAT	5.99E-03	3.02E-02	6.50E-02	1.07E-01	1.82E-01	3.29E-01	4.33E-01	5.56E-01	6.83E-01	7.39E-01
6	RANCH 3V	VEGETATION	3.26E-02	1.90E-01	4.30E-01	7.32E-01	1.27E+00	2.35E+00	3.16E+00	4.10E+00	5.09E+00	5.58E+00
7	RANCH 4	MEAT	1.59E-03	8.15E-03	1.77E-02	2.94E-02	5.01E-02	9.13E-02	1.21E-01	1.57E-01	1.93E-01	2.09E-01
8	RANCH 5	MEAT	1.99E-03	1.01E-02	2.18E-02	3.61E-02	6.13E-02	1.11E-01	1.47E-01	1.89E-01	2.32E-01	2.51E-01
9	RANCH 6	MEAT	6.06E-04	3.15E-03	6.90E-03	1.16E-02	1.99E-02	3.65E-02	4.89E-02	6.38E-02	7.90E-02	8.55E-02
10	RANCH 6V	VEGETATION	4.45E-03	2.86E-02	6.74E-02	1.17E-01	2.08E-01	3.90E-01	5.31E-01	6.89E-01	8.41E-01	9.11E-01
11	RANCH 7	MEAT	1.15E-04	6.43E-04	1.46E-03	2.51E-03	4.45E-03	8.41E-03	1.16E-02	1.56E-02	1.95E-02	2.12E-02
12	RANCH 8	MEAT	1.32E-04	7.59E-04	1.75E-03	3.02E-03	5.38E-03	1.03E-02	1.43E-02	1.93E-02	2.42E-02	2.62E-02
13	RANCH 9	MEAT	9.11E-05	5.50E-04	1.29E-03	2.28E-03	4.12E-03	7.97E-03	1.13E-02	1.54E-02	1.94E-02	2.11E-02
14	RANCH 10	MEAT	8.74E-05	5.39E-04	1.28E-03	2.27E-03	4.12E-03	8.02E-03	1.14E-02	1.57E-02	1.98E-02	2.15E-02
15	RANCH 11	MEAT	2.78E-04	1.47E-03	3.25E-03	5.47E-03	9.47E-03	1.75E-02	2.37E-02	3.11E-02	3.86E-02	4.18E-02
16	RANCH 12	MEAT	5.99E-05	3.90E-04	9.48E-04	1.70E-03	3.13E-03	6.17E-03	8.87E-03	1.23E-02	1.56E-02	1.69E-02
17	RANCH 12V	VEGETATION	1.19E-03	9.51E-03	2.40E-02	4.33E-02	7.92E-02	1.52E-01	2.13E-01	2.76E-01	3.32E-01	3.54E-01
18	RANCH 13	MEAT	5.48E-05	3.65E-04	8.97E-04	1.62E-03	2.99E-03	5.93E-03	8.57E-03	1.19E-02	1.52E-02	1.64E-02
19	RANCH 14	MEAT	5.38E-05	3.65E-04	9.04E-04	1.64E-03	3.04E-03	6.04E-03	8.76E-03	1.22E-02	1.56E-02	1.69E-02
20	RANCH 15	MEAT	8.74E-05	5.25E-04	1.23E-03	2.17E-03	3.91E-03	7.56E-03	1.07E-02	1.46E-02	1.84E-02	1.99E-02
21	RANCH 16	MEAT	3.65E-05	2.03E-04	4.59E-04	7.87E-04	1.39E-03	2.62E-03	3.61E-03	4.83E-03	6.04E-03	6.55E-03
22	RANCH 16V	VEGETATION	3.98E-04	2.85E-03	6.98E-03	1.24E-02	2.23E-02	4.24E-02	5.86E-02	7.61E-02	9.19E-02	9.87E-02
40	AGRICULTURE 1	VEGETATION	5.79E-03	3.71E-02	8.75E-02	1.52E-01	2.70E-01	5.06E-01	6.91E-01	8.97E-01	1.10E+00	1.19E+00
41	AGRICULTURE 2	VEGETATION	5.73E-03	3.59E-02	8.37E-02	1.45E-01	2.55E-01	4.78E-01	6.50E-01	8.44E-01	1.04E+00	1.13E+00
42	AGRICULTURE 3	VEGETATION	2.48E-03	1.73E-02	4.20E-02	7.42E-02	1.33E-01	2.53E-01	3.49E-01	4.53E-01	5.49E-01	5.91E-01
43	AGRICULTURE 4	VEGETATION	1.07E-03	8.12E-03	2.02E-02	3.62E-02	6.57E-02	1.26E-01	1.75E-01	2.27E-01	2.73E-01	2.93E-01
44	AGRICULTURE 5	VEGETATION	9.86E-04	7.89E-03	2.00E-02	3.60E-02	6.59E-02	1.27E-01	1.77E-01	2.30E-01	2.76E-01	2.95E-01
45	AGRICULTURE 6	VEGETATION	1.03E-03	8.33E-03	2.11E-02	3.81E-02	6.98E-02	1.34E-01	1.88E-01	2.44E-01	2.93E-01	3.12E-01

METSET SAMPLE METSET
OPERATION TIME = 15 YEARS
WHOLE BODY

TOTAL DOSE RATE (MREM/YEAR) FROM INGESTION

#	IDENTIFICATION	PATHWAY	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
3	RANCH 1	MEAT	6.20E-01	1.08E+00	1.39E+00	1.62E+00	1.90E+00	2.25E+00	1.14E+00	6.72E-01	2.94E-01	1.39E-01
4	RANCH 2	MEAT	4.00E-02	6.95E-02	8.97E-02	1.05E-01	1.23E-01	1.46E-01	7.42E-02	4.38E-02	1.92E-02	9.04E-03
5	RANCH 3	MEAT	8.55E-03	1.49E-02	1.93E-02	2.27E-02	2.66E-02	3.16E-02	1.63E-02	9.69E-03	4.25E-03	1.99E-03
6	RANCH 3V	VEGETATION	5.10E-02	1.01E-01	1.36E-01	1.63E-01	1.94E-01	2.32E-01	1.26E-01	7.36E-02	3.57E-02	1.91E-02
7	RANCH 4	MEAT	2.27E-03	4.03E-03	5.28E-03	6.25E-03	7.38E-03	8.81E-03	4.79E-03	2.88E-03	1.29E-03	5.86E-04
8	RANCH 5	MEAT	2.84E-03	4.99E-03	6.49E-03	7.64E-03	8.98E-03	1.07E-02	5.63E-03	3.35E-03	1.48E-03	6.87E-04
9	RANCH 6	MEAT	8.61E-04	1.56E-03	2.07E-03	2.48E-03	2.94E-03	3.54E-03	2.03E-03	1.24E-03	5.59E-04	2.49E-04
10	RANCH 6V	VEGETATION	7.34E-03	1.59E-02	2.21E-02	2.70E-02	3.24E-02	3.90E-02	2.23E-02	1.24E-02	5.79E-03	2.74E-03
11	RANCH 7	MEAT	1.61E-04	3.18E-04	4.48E-04	5.55E-04	6.75E-04	8.30E-04	5.57E-04	3.51E-04	1.64E-04	6.88E-05
12	RANCH 8	MEAT	1.86E-04	3.75E-04	5.38E-04	6.72E-04	8.22E-04	1.02E-03	7.[illegible]7E-04	4.48E-04	2.11E-04	8.74E-05
13	RANCH 9	MEAT	1.27E-04	2.72E-04	4.04E-04	5.14E-04	6.38E-04	7.96E-04	5.92E-04	3.79E-04	1.81E-04	7.34E-05
14	RANCH 10	MEAT	1.21E-04	2.66E-04	4.01E-04	5.15E-04	6.41E-04	8.04E-04	6.11E-04	3.93E-04	1.83E-04	7.59E-05
15	RANCH 11	MEAT	3.94E-04	7.26E-04	9.80E-04	1.18E-03	1.41E-03	1.71E-03	1.02E-03	6.28E-04	2.87E-04	1.26E-04
16	RANCH 12	MEAT	8.22E-05	1.93E-04	3.00E-04	3.92E-04	4.93E-04	6.23E-04	4.97E-04	3.22E-04	1.55E-04	6.18E-05
17	RANCH 12V	VEGETATION	2.20E-03	5.69E-03	8.40E-03	1.05E-02	1.29E-02	1.56E-02	9.53E-03	5.02E-03	2.25E-03	8.99E-04
18	RANCH 13	MEAT	7.49E-05	1.81E-04	2.85E-04	3.75E-04	4.73E-04	6.01E-04	4.87E-04	3.17E-04	1.53E-04	6.06E-05
19	RANCH 14	MEAT	7.33E-05	1.81E-04	2.88E-04	3.80E-04	4.82E-04	6.13E-04	5.04E-04	3.28E-04	1.59E-04	6.27E-05
20	RANCH 15	MEAT	1.22E-04	2.59E-04	3.84E-04	4.89E-04	6.05E-04	7.55E-04	5.53E-04	3.57E-04	1.70E-04	6.92E-05
21	RANCH 16	MEAT	5.13E-05	1.00E-04	1.40E-04	1.73E-04	2.10E-04	2.58E-04	1.71E-04	1.07E-04	5.02E-05	2.11E-05
22	RANCH 16V	VEGETATION	6.95E-04	1.65E-03	2.37E-03	2.93E-03	3.57E-03	4.30E-03	2.55E-03	1.37E-03	6.26E-04	2.69E-04
40	AGRICULTURE 1	VEGETATION	9.51E-03	2.06E-02	2.88E-02	3.51E-02	4.22E-02	5.08E-02	2.90E-02	1.62E-02	7.61E-03	3.66E-03
41	AGRICULTURE 2	VEGETATION	9.30E-03	1.97E-02	2.73E-02	3.31E-02	3.97E-02	4.78E-02	2.70E-02	1.52E-02	7.20E-03	3.54E-03
42	AGRICULTURE 3	VEGETATION	4.26E-03	9.92E-03	1.42E-02	1.75E-02	2.12E-02	2.56E-02	1.51E-02	8.18E-03	3.75E-03	1.65E-03
43	AGRICULTURE 4	VEGETATION	1.92E-03	4.78E-03	6.98E-03	8.69E-03	1.05E-02	1.28E-02	7.74E-03	4.12E-03	1.86E-03	7.70E-04
44	AGRICULTURE 5	VEGETATION	1.82E-03	4.73E-03	6.99E-03	8.76E-03	1.07E-02	1.30E-02	7.94E-03	4.18E-03	1.88E-03	7.50E-04
45	AGRICULTURE 6	VEGETATION	1.92E-03	5.00E-03	7.40E-03	9.28E-03	1.14E-02	1.38E-02	8.43E-03	4.44E-03	1.99E-03	7.90E-04

560 273

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 736
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS

TOTAL TIME INTEGRATED DOSE FOR GENERAL POPULATION (ORGAN*MREM) FROM INGESTION

PATHWAY	ORGAN	YEARS 1	3	5	7	10	15	20	30	50	70
MEAT	WHOLE BODY	2.56E-02	1.29E-01	2.76E-01	4.55E-01	7.69E-01	1.39E+00	1.82E+00	2.33E+00	2.86E+00	3.10E+00
	BONE	2.09E-01	1.13E+00	2.49E+00	4.17E+00	7.16E+00	1.31E+01	1.74E+01	2.24E+01	2.75E+01	2.97E+01
	KIDNEY	2.41E-01	9.01E-01	1.63E+00	2.40E+00	3.65E+00	5.93E+00	6.80E+00	8.14E+00	1.03E+01	1.18E+01
	LIVER	7.30E-02	2.59E-01	4.63E-01	6.83E-01	1.04E+00	1.70E+00	1.97E+00	2.39E+00	3.03E+00	3.51E+00
DAIRY	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POULTRY & EGGS	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEGETATION	WHOLE BODY	1.02E-03	6.87E-03	1.65E-02	2.88E-02	5.15E-02	9.73E-02	1.34E-01	1.73E-01	2.11E-01	2.28E-01
	BONE	1.23E-02	9.20E-02	2.33E-01	4.27E-01	8.04E-01	1.62E+00	2.38E+00	3.39E+00	4.40E+00	4.84E+00
	KIDNEY	2.83E-02	1.93E-01	4.34E-01	7.18E-01	1.20E+00	2.11E+00	2.67E+00	3.24E+00	3.85E+00	4.14E+00
	LIVER	3.72E-03	2.83E-02	7.19E-02	1.31E-01	2.43E-01	4.79E-01	6.85E-01	9.25E-01	1.14E+00	1.25E+00
FISH	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

560 274

TOTAL DOSE RATE FOR GENERAL POPULATION (ORGAN*MREM/YEAR) FROM INGESTION

PATHWAY	ORGAN	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
MEAT	WHOLE BODY	3.66E-02	6.36E-02	8.20E-02	9.59E-02	1.12E-01	1.33E-01	6.76E-02	3.99E-02	1.75E-02	8.24E-03
	BONE	3.14E-01	5.83E-01	7.67E-01	9.07E-01	1.07E+00	1.28E+00	6.71E-01	3.83E-01	1.62E-01	7.24E-02
	KIDNEY	2.97E-01	3.39E-01	3.67E-01	3.91E-01	4.18E-01	4.58E-01	1.53E-01	1.33E-01	1.06E-01	7.85E-02
	LIVER	8.43E-02	9.48E-02	1.03E-01	1.11E-01	1.21E-01	1.34E-01	4.94E-02	4.06E-02	3.16E-02	2.35E-02
DAIRY	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POULTRY & EGGS	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEGETATION	WHOLE BODY	1.72E-03	3.88E-03	5.49E-03	6.73E-03	8.14E-03	9.81E-03	5.70E-03	3.14E-03	1.46E-03	6.70E-04
	BONE	2.21E-02	5.57E-02	8.41E-02	1.09E-01	1.40E-01	1.82E-01	1.32E-01	7.99E-02	3.48E-02	1.61E-02
	KIDNEY	5.02E-02	1.03E-01	1.31E-01	1.48E-01	1.66E-01	1.87E-01	8.09E-02	5.27E-02	2.85E-02	1.35E-02
	LIVER	6.52E-03	1.68E-02	2.54E-02	3.25E-02	4.08E-02	5.09E-02	3.42E-02	1.90E-02	8.93E-03	4.22E-03
FISH	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	WHOLE BODY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BONE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	KIDNEY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

UDAD SAMPLE PROPLEM UDAD 9 DATE 12/26/78 PAGE 338
METSET SAMPLE METSET
OPERATION TIME = 15 YEARS

POPULATION TOTAL TIME INTEGRATED DOSE (ORGAN*REM) FROM INGESTION

ORGAN	YEARS 1	3	5	7	10	15	20	30	50	70
WHOLE BODY	1.53E+00	7.79E+00	1.68E+01	2.78E+01	4.71E+01	8.53E+01	1.12E+02	1.44E+02	1.76E+02	1.91E+02
BONE	1.27E+01	7.02E+01	1.57E+02	2.64E+02	4.57E+02	8.43E+02	1.13E+03	1.48E+03	1.83E+03	1.98E+03
KIDNEY	1.54E+01	6.28E+01	1.18E+02	1.79E+02	2.78E+02	[illegible].61E+02	5.44E+02	6.54E+02	8.10E+02	9.18E+02
LIVER	4.41E+00	1.65E+01	3.07E+01	4.67E+01	7.38E+01	1.25E+02	1.53E+02	1.91E+02	2.40E+02	2.73E+02

POPULATION TOTAL DOSE RATE (ORGAN*REM/YEAR) FROM INGESTION

ORGAN	INTERVAL (YEARS) 0- 1	1- 3	3- 5	5- 7	7-10	10-15	15-20	20-30	30-50	50-70
WHOLE BODY	2.20E+00	3.87E+00	5.02E+00	5.90E+00	6.91E+00	8.20E+00	4.21E+00	2.47E+00	1.09E+00	5.12E-01
BONE	1.93E+01	3.67E+01	4.89E+01	5.83E+01	6.95E+01	8.38E+01	4.61E+01	2.69E+01	1.13E+01	5.08E+00
KIDNEY	1.99E+01	2.54E+01	2.86E+01	3.10E+01	3.35E+01	3.70E+01	1.35E+01	1.07E+01	7.70E+00	5.29E+00
LIVER	5.22E+00	6.41E+00	7.40E+00	8.26E+00	9.27E+00	1.06E+01	4.80E+00	3.42E+00	2.32E+00	1.59E+00

560 276

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 1
METSET SAMPLE METSET
UDAD SAMPLE MILL ORE PAD & GRINDING

EFFECTIVE DISPERSION FACTOR (SEC/M3)

THETA= 0.0 DEGREE ANGLE

DISTANCE	238U	230TH	226RA	210PB	222RN
0.10	5.35E-05	5.35E-05	5.35E-05	5.35E-05	5.35E-05
0.50	1.81E-05	1.81E-05	1.81E-05	1.81E-05	2.58E-05
1.00	3.32E-06	3.32E-06	3.32E-06	3.32E-06	6.61E-06
2.00	6.60E-07	6.60E-07	6.60E-07	6.60E-07	1.88E-06
3.00	2.69E-07	2.69E-07	2.69E-07	2.69E-07	9.64E-07
4.00	1.45E-07	1.45E-07	1.45E-07	1.45E-07	6.16E-07
5.00	9.05E-08	9.05E-08	9.05E-08	9.05E-08	4.42E-07
10.00	2.15E-08	2.15E-08	2.15E-08	2.15E-08	1.70E-07
20.00	5.21E-09	5.21E-09	5.21E-09	5.21E-09	7.11E-08
30.00	2.33E-09	2.33E-09	2.33E-09	2.33E-09	4.36E-08
40.00	1.32E-09	1.32E-09	1.32E-09	1.32E-09	3.09E-08
50.00	8.43E-10	8.43E-10	8.43E-10	8.43E-10	2.36E-08
60.00	5.81E-10	5.81E-10	5.81E-10	5.81E-10	1.83E-08
70.00	4.24E-10	4.24E-10	4.24E-10	4.24E-10	1.56E-08
80.00	3.23E-10	3.23E-10	3.23E-10	3.23E-10	1.32E-08

THETA= 22.50 DEGREE ANGLE

DISTANCE	238U	230TH	226RA	210PB	222RN
0.10	6.90E-05	6.90E-05	6.90E-05	6.90E-05	7.10E-05
0.50	1.47E-05	1.47E-05	1.47E-05	1.47E-05	2.02E-05
1.00	2.56E-06	2.56E-06	2.56E-06	2.56E-06	4.71E-06
2.00	5.11E-07	5.11E-07	5.11E-07	5.11E-07	1.27E-06
3.00	2.18E-07	2.18E-07	2.18E-07	2.18E-07	6.55E-07
4.00	1.23E-07	1.23E-07	1.23E-07	1.23E-07	4.22E-07
5.00	7.89E-08	7.89E-08	7.89E-08	7.89E-08	3.04E-07
10.00	2.10E-08	2.10E-08	2.10E-08	2.10E-08	1.17E-07
20.00	5.82E-09	5.82E-09	5.82E-09	5.82E-09	4.88E-08
30.00	2.80E-09	2.80E-09	2.80E-09	2.80E-09	2.98E-08
40.00	1.66E-09	1.66E-09	1.66E-09	1.66E-09	2.11E-08
50.00	1.09E-09	1.09E-09	1.09E-09	1.09E-09	1.61E-08
60.00	7.74E-10	7.74E-10	7.74E-10	7.74E-10	1.29E-08
70.00	5.76E-10	5.76E-10	5.76E-10	5.76E-10	1.06E-08
80.00	4.49E-10	4.49E-10	4.49E-10	4.49E-10	8.98E-09

560 277

EFFECTIVE DISPERSION FACTOR (SEC/M3) AT EXTRA RECEPTORS

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	238U	230TH	226RA	210PB	222RN
1	FENCE POST	0.85	0.35	0.0	4.22E-06	4.22E-06	4.22E-06	4.22E-06	7.62E-06
2	TRAILER	1.00	0.50	0.0	3.02E-06	3.02E-06	3.02E-06	3.02E-06	5.95E-06
3	RANCH 1	1.90	1.40	0.0	6.22E-07	6.22E-07	6.22E-07	6.22E-07	1.65E-06
4	RANCH 2	8.80	3.60	0.0	3.94E-08	3.94E-08	3.94E-08	3.94E-08	2.14E-07
5	RANCH 3	18.80	7.80	0.0	9.95E-09	9.95E-09	9.95E-09	9.95E-09	8.36E-08
6	RANCH 3V	18.80	7.80	0.0	9.95E-09	9.95E-09	9.95E-09	9.95E-09	8.36E-08
7	RANCH 4	36.50	15.00	0.0	3.04E-09	3.04E-09	3.04E-09	3.04E-09	3.74E-08
8	RANCH 5	12.00	21.80	0.0	4.64E-09	4.64E-09	4.64E-09	4.64E-09	4.32E-08
9	RANCH 6	-2.40	20.60	0.0	4.00E-09	4.00E-09	4.00E-09	4.00E-09	5.71E-08
10	RANCH 6V	-2.40	20.60	0.0	4.00E-09	4.00E-09	4.00E-09	4.00E-09	5.71E-08
11	RANCH 7	-18.20	23.30	0.0	8.10E-10	8.10E-10	8.10E-10	8.10E-10	2.05E-08
12	RANCH 8	-27.50	-2.50	0.0	1.59E-09	1.59E-09	1.59E-09	1.59E-09	3.10E-08
13	RANCH 9	-35.20	-14.80	0.0	9.66E-10	9.66E-10	9.66E-10	9.66E-10	2.08E-08
14	RANCH 10	-23.00	-22.40	0.0	1.18E-09	1.18E-09	1.18E-09	1.18E-09	2.72E-08
15	RANCH 11	-7.40	-21.80	0.0	2.28E-09	2.28E-09	2.28E-09	2.28E-09	3.22E-08
16	RANCH 12	-55.30	2.40	0.0	3.53E-10	3.53E-10	3.53E-10	3.53E-10	1.29E-08
17	RANCH 12V	-55.30	2.40	0.0	3.53E-10	3.53E-10	3.53E-10	3.53E-10	1.29E-08
18	RANCH 13	-67.50	-8.10	0.0	2.77E-10	2.77E-10	2.77E-10	2.77E-10	1.05E-08
19	RANCH 14	-55.70	-46.40	0.0	2.55E-10	2.55E-10	2.55E-10	2.55E-10	1.02E-08
20	RANCH 15	-23.30	-38.70	0.0	6.54E-10	6.54E-10	6.54E-10	6.54E-10	1.60E-08
21	RANCH 16	27.80	-38.30	0.0	3.66E-10	3.66E-10	3.66E-10	3.66E-10	3.85E-09
22	RANCH 16V	27.80	-38.30	0.0	3.66E-10	3.66E-10	3.66E-10	3.66E-10	3.85E-09
23	WEST CITY	-78.00	16.00	0.0	1.20E-10	1.20E-10	1.20E-10	1.20E-10	7.84E-09
24	EAST CITY	33.00	35.00	0.0	1.80E-09	1.80E-09	1.80E-09	1.80E-09	2.48E-08
25	RED TOWN	-65.00	-26.00	0.0	2.92E-10	2.92E-10	2.92E-10	2.92E-10	9.88E-09
26	BLUE TOWN	-27.00	27.00	0.0	4.42E-10	4.42E-10	4.42E-10	4.42E-10	1.52E-08
27	BROWN TOWN	-5.20	29.00	0.0	1.75E-09	1.75E-09	1.75E-09	1.75E-09	3.38E-08
28	GREEN TOWN	14.00	35.00	0.0	1.80E-09	1.80E-09	1.80E-09	1.80E-09	2.21E-08
29	ORANGE TOWN	-23.00	59.00	0.0	1.53E-10	1.53E-10	1.53E-10	1.53E-10	7.67E-09
30	PURPLE TOWN	56.00	32.00	0.0	1.22E-09	1.22E-09	1.22E-09	1.22E-09	2.00E-08
31	WHITE TOWN	-29.00	53.00	0.0	1.74E-10	1.74E-10	1.74E-10	1.74E-10	8.50E-09
32	E INDIANRES	65.00	0.0	0.0	7.98E-10	7.98E-10	7.98E-10	7.98E-10	1.11E-08
33	E INDIANRES	-60.00	50.00	0.0	8.28E-11	8.28E-11	8.28E-11	8.28E-11	6.45E-09
34	EAST RURAL	40.00	36.00	0.0	1.53E-09	1.53E-09	1.53E-09	1.53E-09	2.25E-08
35	NORTH RURAL	-5.00	31.00	0.0	1.60E-09	1.60E-09	1.60E-09	1.60E-09	3.23E-08
36	NW RURAL	-23.00	32.00	0.0	4.44E-10	4.44E-10	4.44E-10	4.44E-10	1.46E-08
37	WEST RURAL	-65.00	24.00	0.0	8.14E-11	8.14E-11	8.14E-11	8.14E-11	8.11E-09
38	SOUTH RURAL	0.0	-45.00	0.0	6.38E-10	6.38E-10	6.38E-10	6.38E-10	1.71E-08
39	SW RURAL	-45.00	-45.00	0.0	3.19E-10	3.19E-10	3.19E-10	3.19E-10	1.22E-08
40	AGRICULTURE 1	38.70	33.30	0.0	1.73E-09	1.73E-09	1.73E-09	1.73E-09	2.45E-08
41	AGRICULTURE 2	21.30	34.30	0.0	2.09E-09	2.09E-09	2.09E-09	2.09E-09	2.59E-08
42	AGRICULTURE 3	-5.00	30.50	0.0	1.64E-09	1.64E-09	1.64E-09	1.64E-09	3.28E-08
43	AGRICULTURE 4	-22.80	30.80	0.0	4.69E-10	4.69E-10	4.69E-10	4.69E-10	1.51E-08
44	AGRICULTURE 5	-56.00	22.00	0.0	9.64E-11	9.64E-11	9.64E-11	9.64E-11	9.37E-09
45	AGRICULTURE 6	-67.50	18.80	0.0	1.24E-10	1.24E-10	1.24E-10	1.24E-10	8.75E-09

EFFECTIVE DISPERSION FACTOR (SEC/M3)

THETA= 0.0 DEGREE ANGLE

DISTANCE	238U	230TH	226RA	210PB	222RN
0.10	5.53E-06	5.53E-06	5.53E-06	5.53E-06	0.0
0.50	7.75E-06	7.75E-06	7.75E-06	7.75E-06	0.0
1.00	3.21E-06	3.21E-06	3.21E-06	3.21E-06	0.0
2.00	8.91E-07	8.91E-07	8.91E-07	8.91E-07	0.0
3.00	3.88E-07	3.88E-07	3.88E-07	3.88E-07	0.0
4.00	2.12E-07	2.12E-07	2.12E-07	2.12E-07	0.0
5.00	1.31E-07	1.31E-07	1.31E-07	1.31E-07	0.0
10.00	2.91E-08	2.91E-08	2.91E-08	2.91E-08	0.0
20.00	6.34E-09	6.34E-09	6.34E-09	6.34E-09	0.0
30.00	2.69E-09	2.69E-09	2.69E-09	2.69E-09	0.0
40.00	1.48E-09	1.48E-09	1.48E-09	1.48E-09	0.0
50.00	9.35E-10	9.35E-10	9.35E-10	9.35E-10	0.0
60.00	6.39E-10	6.39E-10	6.39E-10	6.39E-10	0.0
70.00	4.63E-10	4.63E-10	4.63E-10	4.63E-10	0.0
80.00	3.51E-10	3.51E-10	3.51E-10	3.51E-10	0.0

THETA= 22.50 DEGREE ANGLE

DISTANCE	238U	230TH	226RA	210PB	222RN
0.10	7.71E-06	7.71E-06	7.71E-06	7.71E-06	0.0
0.50	5.97E-06	5.97E-06	5.97E-06	5.97E-06	0.0
1.00	2.38E-06	2.38E-06	2.38E-06	2.38E-06	0.0
2.00	6.74E-07	6.74E-07	6.74E-07	6.74E-07	0.0
3.00	3.01E-07	3.01E-07	3.01E-07	3.01E-07	0.0
4.00	1.68E-07	1.68E-07	1.68E-07	1.68E-07	0.0
5.00	1.07E-07	1.07E-07	1.07E-07	1.07E-07	0.0
10.00	2.64E-08	2.64E-08	2.64E-08	2.64E-08	0.0
20.00	6.72E-09	6.72E-09	6.72E-09	6.72E-09	0.0
30.00	3.13E-09	3.13E-09	3.13E-09	3.13E-09	0.0
40.00	1.82E-09	1.82E-09	1.82E-09	1.82E-09	0.0
50.00	1.19E-09	1.19E-09	1.19E-09	1.19E-09	0.0
60.00	8.38E-10	8.38E-10	8.38E-10	8.38E-10	0.0
70.00	6.21E-10	6.21E-10	6.21E-10	6.21E-10	0.0
80.00	4.81E-10	4.81E-10	4.81E-10	4.81E-10	0.0

540 279

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 18
METSET SAMPLE METSET
UDAD SAMPLE MILL DRYING & PACKAGING

EFFECTIVE DISPERSION FACTOR (SEC/M3) AT EXTRA RECEPTORS

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	238U	230TH	226RA	210PB	222RN
1	FENCE POST	0.85	0.35	0.0	4.79E-06	4.79E-06	4.79E-06	4.79E-06	0.0
2	TRAILER	1.00	0.50	0.0	3.39E-06	3.39E-06	3.39E-06	3.39E-06	0.0
3	RANCH 1	1.90	1.40	0.0	8.18E-07	8.18E-07	8.18E-07	8.18E-07	0.0
4	RANCH 2	8.80	3.60	0.0	5.10E-08	5.10E-08	5.10E-08	5.10E-08	0.0
5	RANCH 3	18.80	7.80	0.0	1.15E-08	1.15E-08	1.15E-08	1.15E-08	0.0
6	RANCH 3V	18.80	7.80	0.0	1.15E-08	1.15E-08	1.15E-08	1.15E-08	0.0
7	RANCH 4	36.50	15.00	0.0	3.35E-09	3.35E-09	3.35E-09	3.35E-09	0.0
8	RANCH 5	12.00	21.80	0.0	5.21E-09	5.21E-09	5.21E-09	5.21E-09	0.0
9	RANCH 6	-2.40	20.60	0.0	4.87E-09	4.87E-09	4.87E-09	4.87E-09	0.0
10	RANCH 6V	-2.40	20.60	0.0	4.87E-09	4.87E-09	4.87E-09	4.87E-09	0.0
11	RANCH 7	-18.20	23.30	0.0	9.75E-10	9.75E-10	9.75E-10	9.75E-10	0.0
12	RANCH 8	-27.50	-2.50	0.0	1.87E-09	1.87E-09	1.87E-09	1.87E-09	0.0
13	RANCH 9	-35.20	-14.80	0.0	1.10E-09	1.10E-09	1.10E-09	1.10E-09	0.0
14	RANCH 10	-23.00	-22.40	0.0	1.37E-09	1.37E-09	1.37E-09	1.37E-09	0.0
15	RANCH 11	-7.40	-21.80	0.0	2.74E-09	2.74E-09	2.74E-09	2.74E-09	0.0
16	RANCH 12	-55.30	2.40	0.0	3.89E-10	3.89E-10	3.89E-10	3.89E-10	0.0
17	RANCH 12V	-55.30	2.40	0.0	3.89E-10	3.89E-10	3.89E-10	3.89E-10	0.0
18	RANCH 13	-67.50	-8.10	0.0	3.02E-10	3.02E-10	3.02E-10	3.02E-10	0.0
19	RANCH 14	-55.70	-46.40	0.0	2.79E-10	2.79E-10	2.79E-10	2.79E-10	0.0
20	RANCH 15	-23.30	-38.70	0.0	7.33E-10	7.33E-10	7.33E-10	7.33E-10	0.0
21	RANCH 16	27.80	-33.30	0.0	3.99E-10	3.99E-10	3.99E-10	3.99E-10	0.0
22	RANCH 16V	27.80	-38.30	0.0	3.99E-10	3.99E-10	3.99E-10	3.99E-10	0.0
23	WEST CITY	-78.00	16.00	0.0	1.30E-10	1.30E-10	1.30E-10	1.30E-10	0.0
24	EAST CITY	33.00	35.00	0.0	1.95E-09	1.95E-09	1.95E-09	1.95E-09	0.0
25	RED TOWN	-65.00	-26.00	0.0	3.18E-10	3.18E-10	3.18E-10	3.18E-10	0.0
26	BLUE TOWN	-27.00	27.00	0.0	5.18E-10	5.18E-10	5.18E-10	5.18E-10	0.0
27	BROWN TOWN	-5.20	29.00	0.0	2.05E-09	2.05E-09	2.05E-09	2.05E-09	0.0
28	GREEN TOWN	14.00	35.00	0.0	1.97E-09	1.97E-09	1.97E-09	1.97E-09	0.0
29	ORANGE TOWN	-23.00	59.00	0.0	1.72E-10	1.72E-10	1.72E-10	1.72E-10	0.0
30	PURPLE TOWN	56.00	32.00	0.0	1.31E-09	1.31E-09	1.31E-09	1.31E-09	0.0
31	WHITE TOWN	-29.00	53.00	0.0	1.95E-10	1.95E-10	1.95E-10	1.95E-10	0.0
32	E INDIANRES	65.00	0.0	0.0	8.61E-10	8.61E-10	8.61E-10	8.61E-10	0.0
33	E INDIANRES	-60.00	50.00	0.0	9.17E-11	9.17E-11	9.17E-11	9.17E-11	0.0
34	EAST RURAL	40.00	36.00	0.0	1.66E-09	1.66E-09	1.66E-09	1.66E-09	0.0
35	NORTH RURAL	-5.00	31.00	0.0	1.85E-09	1.85E-09	1.85E-09	1.85E-09	0.0
36	NW RURAL	-23.00	32.00	0.0	5.16E-10	5.16E-10	5.16E-10	5.16E-10	0.0
37	WEST RURAL	-65.00	24.00	0.0	9.02E-11	9.02E-11	9.02E-11	9.02E-11	0.0
38	SOUTH RURAL	0.0	-45.00	0.0	7.21E-10	7.21E-10	7.21E-10	7.21E-10	0.0
39	SW RURAL	-45.00	-45.00	0.0	3.53E-10	3.53E-10	3.53E-10	3.53E-10	0.0
40	AGRICULTURE 1	38.70	33.30	0.0	1.87E-09	1.87E-09	1.87E-09	1.87E-09	0.0
41	AGRICULTURE 2	21.30	34.30	0.0	2.28E-09	2.28E-09	2.28E-09	2.28E-09	0.0
42	AGRICULTURE 3	-5.00	30.50	0.0	1.91E-09	1.91E-09	1.91E-09	1.91E-09	0.0
43	AGRICULTURE 4	-22.80	30.80	0.0	5.47E-10	5.47E-10	5.47E-10	5.47E-10	0.0
44	AGRICULTURE 5	-56.00	22.00	0.0	1.09E-10	1.09E-10	1.09E-10	1.09E-10	0.0
45	AGRICULTURE 6	-67.50	18.80	0.0	1.36E-10	1.36E-10	1.36E-10	1.36E-10	0.0

METSET SAMPLE METSET
UDAD SAMPLE MILL TAILING

EFFECTIVE DISPERSION FACTOR (SEC/M3)

THETA= 0.0 DEGREE ANGLE

DISTANCE	238U	230TH	226RA	210PB	222RN
0.10	3.06E-07	3.06E-07	3.06E-07	3.06E-07	1.84E-05
0.50	1.80E-07	1.80E-07	1.80E-07	1.80E-07	8.58E-06
1.00	6.92E-08	6.92E-08	6.92E-08	6.92E-08	3.16E-06
2.00	2.88E-08	2.88E-08	2.88E-08	2.88E-08	1.23E-06
3.00	1.67E-08	1.67E-08	1.67E-08	1.67E-08	7.23E-07
4.00	1.10E-08	1.10E-08	1.10E-08	1.10E-08	4.95E-07
5.00	7.84E-09	7.84E-09	7.84E-09	7.84E-09	3.70E-07
10.00	2.56E-09	2.56E-09	2.56E-09	2.56E-09	1.54E-07
20.00	7.82E-10	7.81E-10	7.81E-10	7.81E-10	6.70E-08
30.00	3.84E-10	3.84E-10	3.84E-10	3.84E-10	4.17E-08
40.00	2.31E-10	2.31E-10	2.31E-10	2.31E-10	2.98E-08
50.00	1.55E-10	1.55E-10	1.55E-10	1.55E-10	2.29E-08
60.00	1.12E-10	1.12E-10	1.12E-10	1.12E-10	1.84E-08
70.00	8.60E-11	8.60E-11	8.60E-11	8.60E-11	1.53E-08
80.00	6.93E-11	6.93E-11	6.93E-11	6.93E-11	1.29E-08

THETA= 22.50 DEGREE ANGLE

DISTANCE	238U	230TH	226RA	210PB	222RN
0.10	4.13E-07	4.13E-07	4.13E-07	4.13E-07	2.22E-05
0.50	8.48E-07	8.48E-07	8.48E-07	8.48E-07	1.59E-05
1.00	2.79E-07	2.79E-07	2.79E-07	2.79E-07	5.57E-06
2.00	9.91E-08	9.91E-08	9.91E-08	9.91E-08	1.68E-06
3.00	5.07E-08	5.07E-08	5.07E-08	5.07E-08	8.12E-07
4.00	3.12E-08	3.12E-08	3.12E-08	3.12E-08	4.97E-07
5.00	2.14E-08	2.14E-08	2.14E-08	2.14E-08	3.45E-07
10.00	6.49E-09	6.49E-09	6.49E-09	6.49E-09	1.22E-07
20.00	1.92E-09	1.92E-09	1.92E-09	1.92E-09	4.81E-08
30.00	9.55E-10	9.55E-10	9.55E-10	9.55E-10	2.91E-08
40.00	5.82E-10	5.82E-10	5.82E-10	5.82E-10	2.05E-08
50.00	3.96E-10	3.96E-10	3.96E-10	3.96E-10	1.57E-08
60.00	2.89E-10	2.89E-10	2.89E-10	2.89E-10	1.26E-08
70.00	2.24E-10	2.24E-10	2.24E-10	2.24E-10	1.05E-08
80.00	1.81E-10	1.81E-10	1.81E-10	1.81E-10	8.87E-09

560 281

UDAD SAMPLE PROBLEM UDAD 9 DATE 12/26/78 PAGE 27
METSET SAMPLE METSET
UDAD SAMPLE MILL TAILING

EFFECTIVE DISPERSION FACTOR (SEC/M3) AT EXTRA RECEPTORS

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)	238U	230TH	226RA	210PB	222RN
1	FENCE POST	0.85	0.35	0.0	2.92E-06	2.92E-06	2.92E-06	2.92E-06	1.91E-05
2	TRAILER	1.00	0.50	0.0	1.73E-06	1.73E-06	1.73E-06	1.73E-06	1.09E-05
3	RANCH 1	1.90	1.40	0.0	2.92E-07	2.92E-07	2.92E-07	2.92E-07	1.88E-06
4	RANCH 2	8.80	3.60	0.0	2.23E-08	2.23E-08	2.23E-08	2.23E-08	2.22E-07
5	RANCH 3	18.80	7.80	0.0	5.56E-09	5.56E-09	5.56E-09	5.56E-09	8.31E-08
6	RANCH 3V	18.80	7.80	0.0	5.56E-09	5.56E-09	5.56E-09	5.56E-09	8.31E-08
7	RANCH 4	36.50	15.00	0.0	1.72E-09	1.72E-09	1.72E-09	1.72E-09	3.75E-08
8	RANCH 5	12.00	21.80	0.0	1.94E-09	1.94E-09	1.94E-09	1.94E-09	4.27E-08
9	RANCH 6	-2.40	20.60	0.0	5.61E-10	5.61E-10	5.61E-10	5.61E-10	5.50E-08
10	RANCH 6V	-2.40	20.60	0.0	5.61E-10	5.61E-10	5.61E-10	5.61E-10	5.50E-08
11	RANCH 7	-18.20	23.30	0.0	9.18E-11	9.18E-11	9.18E-11	9.18E-11	2.03E-08
12	RANCH 8	-27.50	-2.50	0.0	1.16E-10	1.16E-10	1.16E-10	1.16E-10	3.05E-08
13	RANCH 9	-35.20	-14.80	0.0	7.12E-11	7.12E-11	7.12E-11	7.12E-11	2.06E-08
14	RANCH 10	-23.00	-22.40	0.0	4.80E-11	4.80E-11	4.80E-11	4.80E-11	2.66E-08
15	RANCH 11	-7.40	-21.80	0.0	2.46E-10	2.46E-10	2.46E-10	2.46E-10	3.19E-08
16	RANCH 12	-55.30	2.40	0.0	3.08E-11	3.08E-11	3.08E-11	3.08E-11	1.28E-08
17	RANCH 12V	-55.30	2.40	0.0	3.08E-11	3.08E-11	3.08E-11	3.08E-11	1.28E-08
18	RANCH 13	-67.50	-8.10	0.0	2.35E-11	2.35E-11	2.35E-11	2.35E-11	1.05E-08
19	RANCH 14	-55.70	-46.40	0.0	1.47E-11	1.47E-11	1.47E-11	1.47E-11	1.02E-08
20	RANCH 15	-23.30	-38.70	0.0	5.96E-11	5.96E-11	5.96E-11	5.96E-11	1.61E-08
21	RANCH 16	27.80	-38.30	0.0	4.02E-11	4.02E-11	4.02E-11	4.02E-11	3.90E-09
22	RANCH 16V	27.80	-38.30	0.0	4.02E-11	4.02E-11	4.02E-11	4.02E-11	3.90E-09
23	WEST CITY	-78.00	16.00	0.0	1.61E-11	1.61E-11	1.61E-11	1.61E-11	7.80E-09
24	EAST CITY	33.00	35.00	0.0	1.03E-09	1.03E-09	1.03E-09	1.03E-09	2.48E-08
25	RED TOWN	-65.00	-26.00	0.0	2.36E-11	2.36E-11	2.36E-11	2.36E-11	9.71E-09
26	BLUE TOWN	-27.00	27.00	0.0	6.09E-11	6.09E-11	6.09E-11	6.09E-11	1.47E-08
27	BROWN TOWN	-5.20	29.00	0.0	2.53E-10	2.53E-10	2.53E-10	2.53E-10	3.29E-08
28	GREEN TOWN	14.00	35.00	0.0	6.31E-10	6.31E-10	6.31E-10	6.31E-10	2.21E-08
29	ORANGE TOWN	-23.00	59.00	0.0	1.71E-11	1.71E-11	1.71E-11	1.71E-11	7.65E-09
30	PURPLE TOWN	56.00	32.00	0.0	7.17E-10	7.17E-10	7.17E-10	7.17E-10	2.02E-08
31	WHITE TOWN	-29.00	53.00	0.0	2.18E-11	2.18E-11	2.18E-11	2.18E-11	8.49E-09
32	E INDIANRES	65.00	0.0	0.0	2.70E-10	2.70E-10	2.70E-10	2.70E-10	1.11E-08
33	E INDIANRES	-60.00	50.00	0.0	1.71E-11	1.71E-11	1.71E-11	1.71E-11	6.44E-09
34	EAST RURAL	40.00	36.00	0.0	8.96E-10	8.96E-10	8.96E-10	8.96E-10	2.26E-08
35	NORTH RURAL	-5.00	31.00	0.0	2.39E-10	2.39E-10	2.39E-10	2.39E-10	3.15E-08
36	NW RURAL	-23.00	32.00	0.0	5.34E-11	5.34E-11	5.34E-11	5.34E-11	1.45E-08
37	WEST RURAL	-65.00	24.00	0.0	1.78E-11	1.78E-11	1.78E-11	1.78E-11	8.09E-09
38	SOUTH RURAL	0.0	-45.00	0.0	3.94E-11	3.94E-11	3.94E-11	3.94E-11	1.66E-08
39	SW RURAL	-45.00	-45.00	0.0	1.46E-11	1.46E-11	1.46E-11	1.46E-11	1.20E-08
40	AGRICULTURE 1	38.70	33.30	0.0	1.00E-09	1.00E-09	1.00E-09	1.00E-09	2.46E-08
41	AGRICULTURE 2	21.30	34.30	0.0	9.74E-10	9.74E-10	9.74E-10	9.74E-10	2.58E-08
42	AGRICULTURE 3	-5.00	30.50	0.0	2.44E-10	2.44E-10	2.44E-10	2.44E-10	3.19E-08
43	AGRICULTURE 4	-22.80	30.80	0.0	5.67E-11	5.67E-11	5.67E-11	5.67E-11	1.50E-08
44	AGRICULTURE 5	-56.00	22.00	0.0	2.21E-11	2.21E-11	2.21E-11	2.21E-11	9.37E-09
45	AGRICULTURE 6	-67.50	18.80	0.0	1.90E-11	1.90E-11	1.90E-11	1.90E-11	8.72E-09

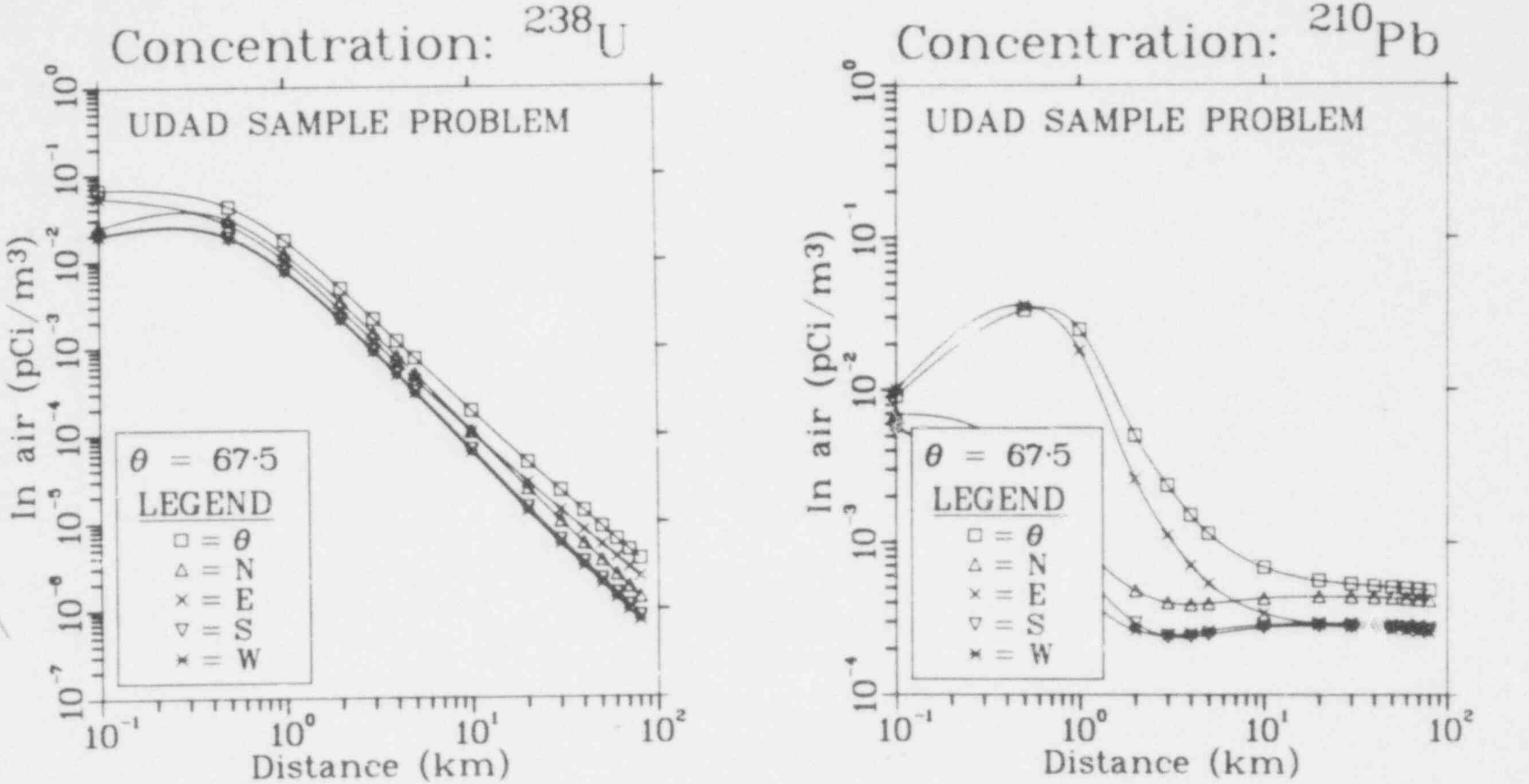


Fig. C.1. CONCPLOT Output--Concentration of ^{238}U and ^{210}Pb in Air for Sample Problem. Theta is direction of maximum dispersion.

283

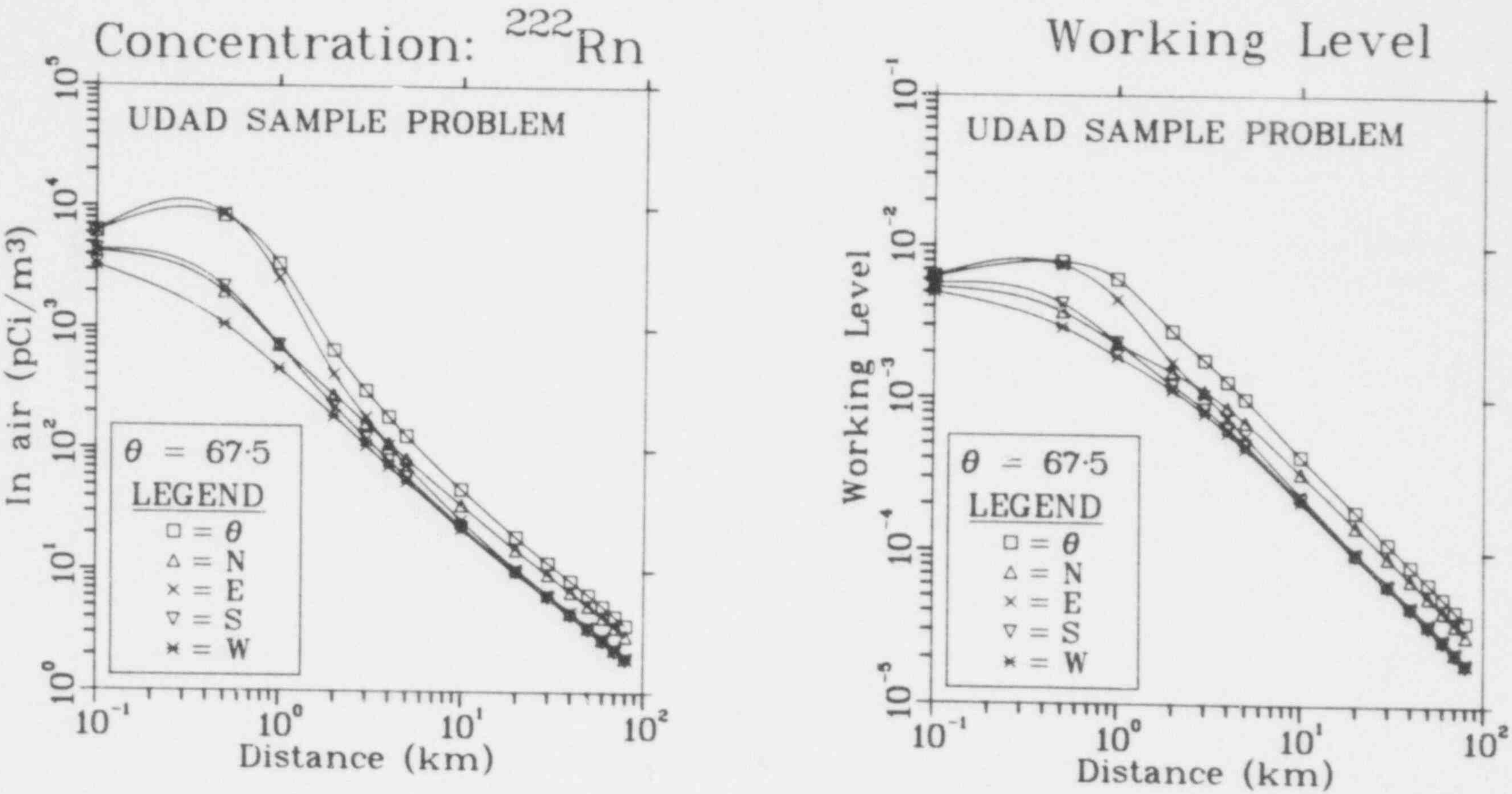
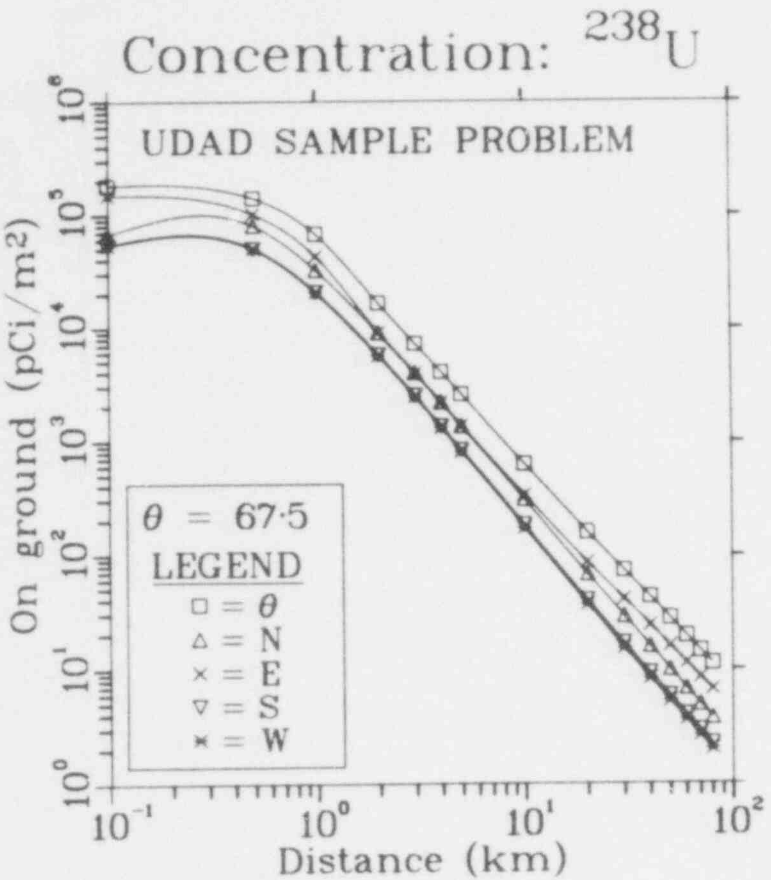
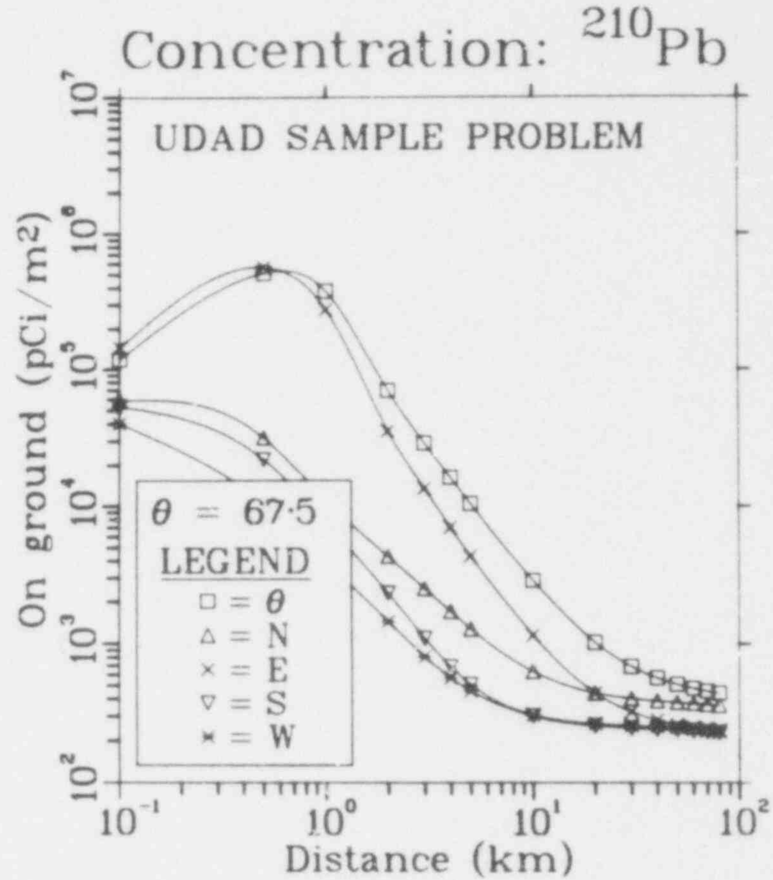


Fig. C.2. CONCPLOT Output--Concentration of ^{222}Rn in Air and Working Level for Sample Problem. Theta is direction of maximum dispersion.





560 285

Fig. C.3. CONCPLOT Output--Concentration of ^{238}U and ^{210}Pb on Ground for Sample Problem. Theta is direction of maximum dispersion.

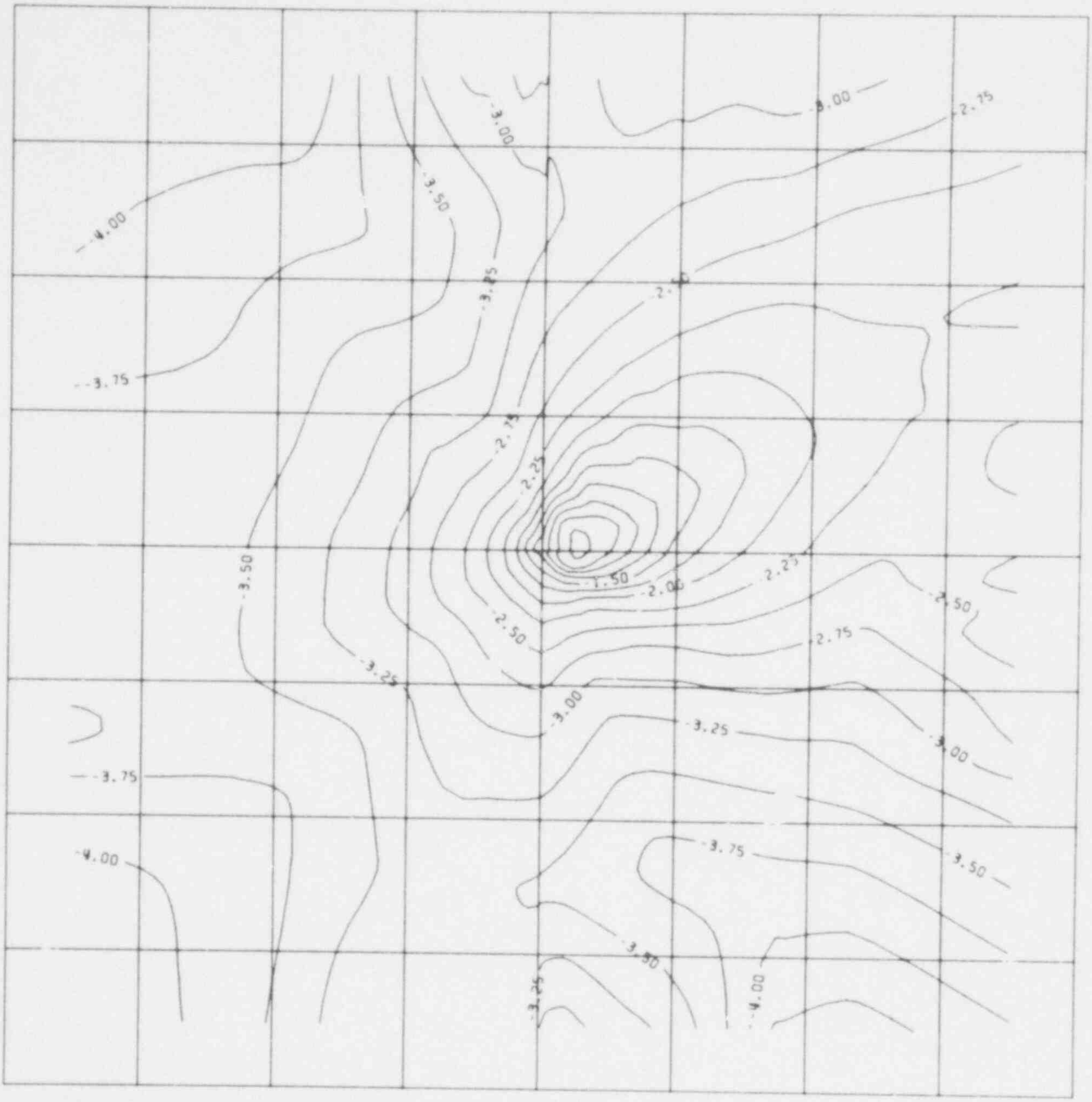


Fig. C.4. Sample Probl:m Isopleth Plot (2-km squares) for ^{226}Ra and Bone--Log of Concentration in Air Divided by MPC (maximum permissible concentration).

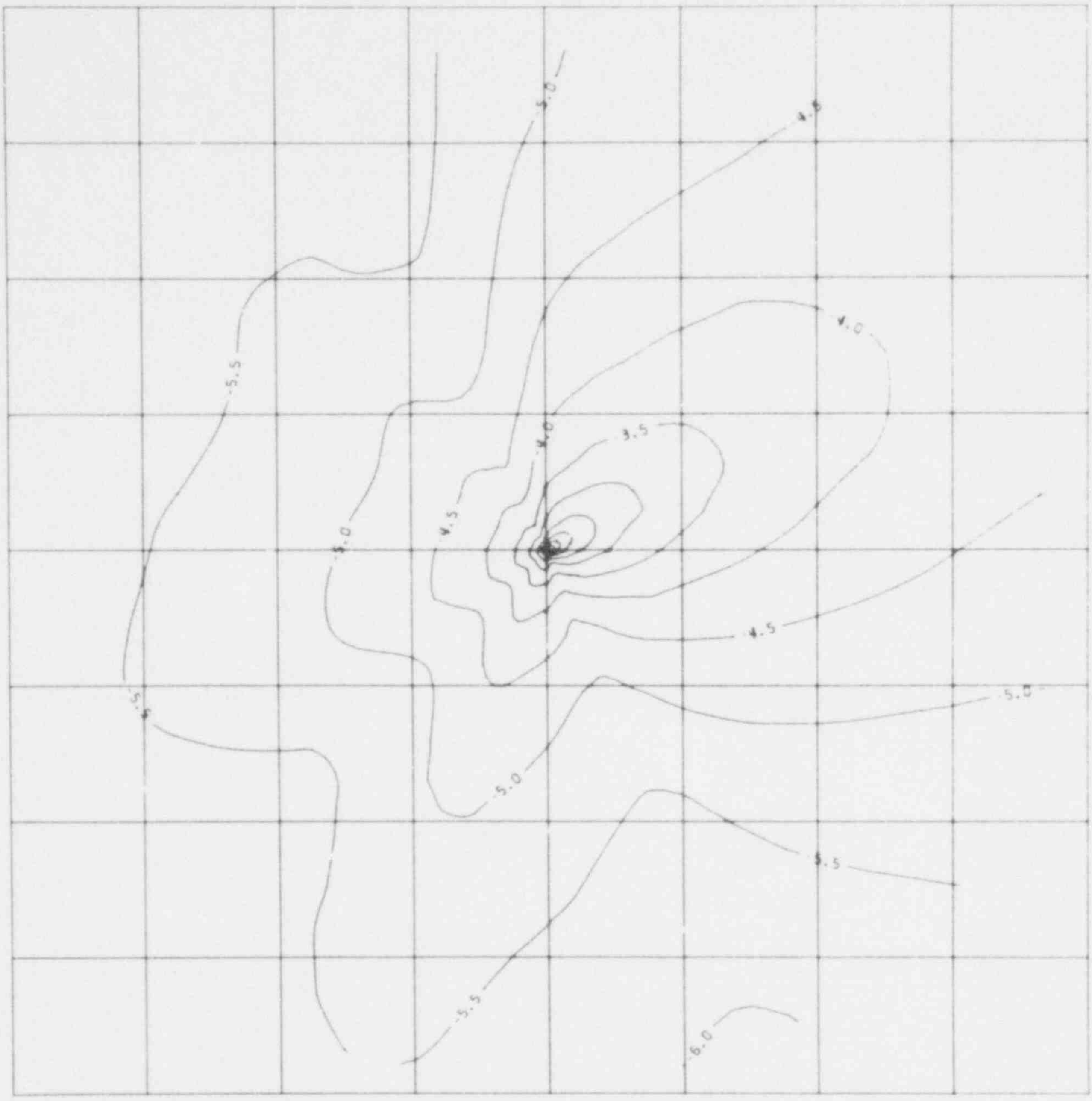


Fig. C.5. Sample Problem Isopleth Plot (20-km squares) for ^{226}Ra and Bone--Log of Concentration in Air Divided by MPC (maximum permissible concentration).

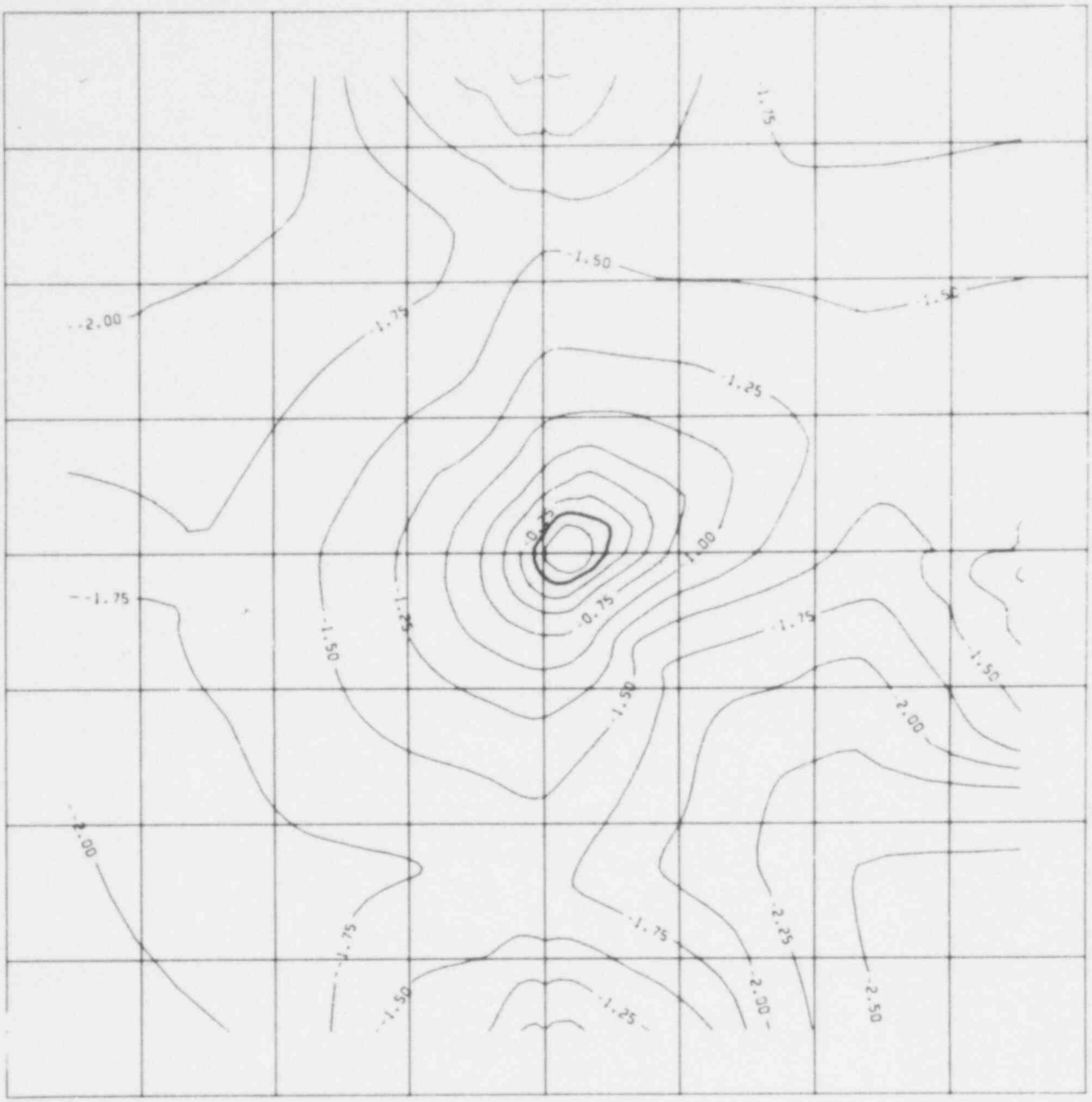


Fig. C.6. Sample Problem Isopleth Plot (2-km squares) for ^{222}Rn and Lung--Log of Concentration in Air Divided by MPC (maximum permissible concentration).

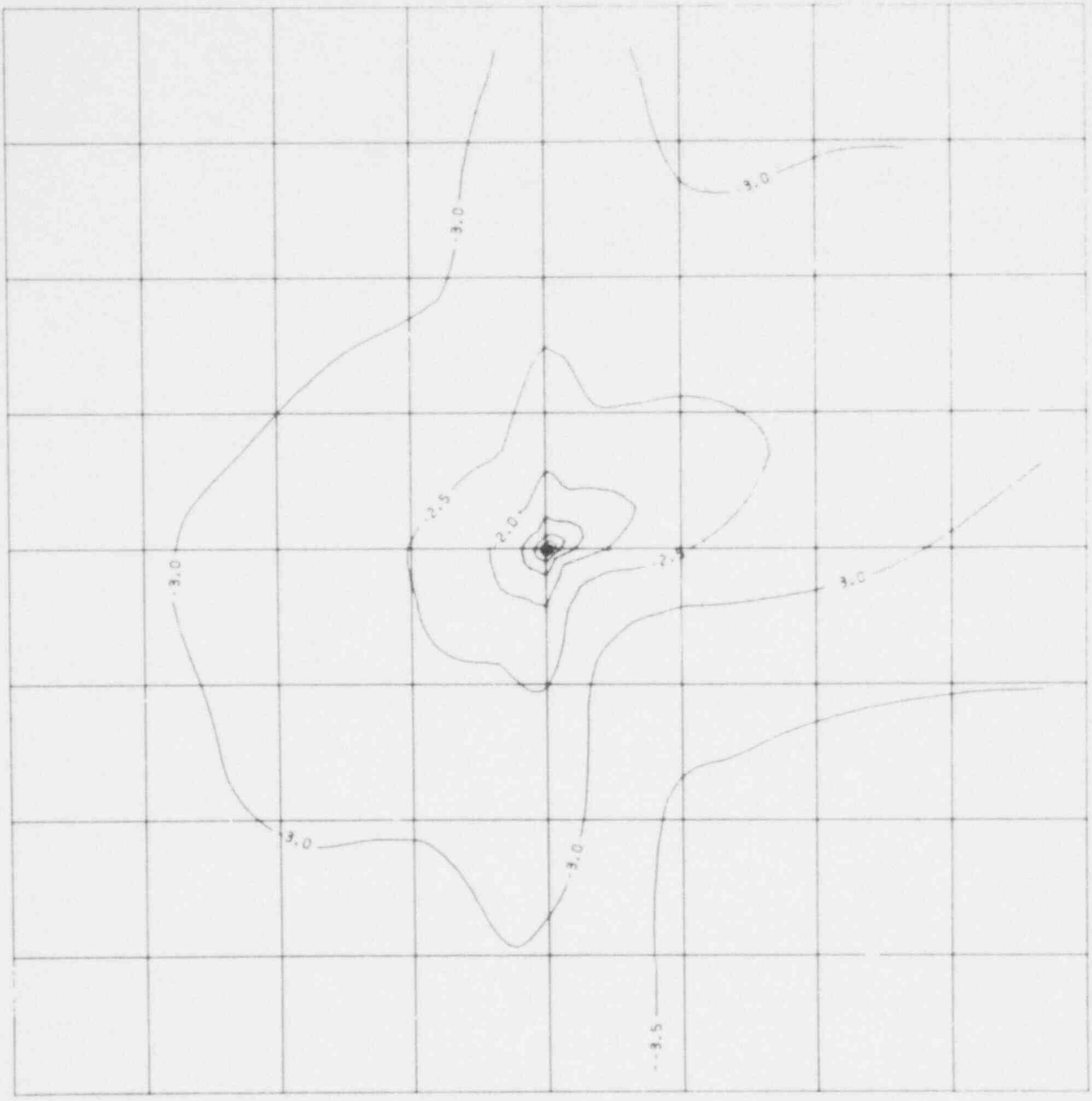


Fig. C.7. Sample Problem Isopleth Plot (20-km squares) for ^{222}Rn and Lung--Log of Concentration in Air Divided by MPC (maximum permissible concentration).

APPENDIX D. LISTING OF CATALOGED PROCEDURE UDAD

```
//UDAD   PROC   EDITOR=IEWL,E1ROOM='(CYL,4)',EDTOPTS=OVLY,
//   LSIZE='(300K,100K)',EDTREGN=320K,PRELIB='&DUMMYLIB',
//   POSTLIB='&DUMMYLIB',AMDLIB='&AMDLIB',LIBRARY='&FORTLIB',
//   LOAD='&G(G)',LDUNIT=SASCR,LDROOM='(CYL,(4,,1))',
//   LDDISP='(MOD,PASS)',GOIF='(5,LT,EDT)',GOREGN=320K,
//   MEMBER=UDAD9,GODISP8='(NEW,PASS)',FILE=,
//   GODISP9='(NEW,PASS)',CONDISP='(OLD,DELETE)',
//   ISODISP='(OLD,DELETE)',ISOREGN=280K,CONREGN=230K,
//   BOXDISP='(OLD,DELETE)'
//*****************************************************************
//*
//*  UDAD
//*
//*  THIS PROCEDURE EXECUTES THE ARGONNE URANIUM DISPERSION AND
//*  DOSIMETRY CODE (UDAD).  THE PROCEDURE WILL ALSO PRODUCE G1DATA
//*  PLOT FILES FOR GRAPHICS OUTPUT IF THE APPROPRIATE JC VALUES
//*  HAVE BEEN SET IN THE UDAD INPUT DATA.
//*
//*  REQUIRED PARAMETERS:
//*
//*    FILE
//*    GODISP8 AND GODISP9  -  ONLY IF UDAD PARAMETER ISTEP=1, 2, OR 3
//*    CONDISP AND ISODISP  -  ONLY IF UDAD PARAMETER ISTEP>1
//*
//*  USAGE:
//*
//*    //JOBNAME JOB (FNNNNN,30,0,10),USERNAME,CLASS=B,PRTY=H
//*      CUA
//*    //*MAIN ORG=LOCAL
//*    //*FORMAT PR,DDNAME=,DEST=3800
//*    //STEP1  EXEC  UDAD,FILE='BNNNNN.JOBNAME'
//*    //GO.SYSIN  DD  *
//*        (INPUT DATA FOR UDAD)
//*    //ISO.SYSIN DD  *   (INCLUDE ONLY IF ISOPLETH PLOTS TO BE MADE)
//*        (INPUT DATA FOR PROGRAM CONTOUR)
//*    /* END OF FILE
//*
//*    THE ABOVE JCL IS SUFFICIENT FOR UDAD IF ISTEP=0.  FOR OTHER
//*    ISTEP VALUES, REPLACE THE '//STEP1' CARD AS FOLLOWS.
//*
//*    ISTEP=1:
//*    //STEP1  EXEC  UDAD,FILE='BNNNNN.JOBNAME',
//*    //     GODISP8='(NEW,CATLG)',GODISP9='(NEW,CATLG)'
//*
//*    ISTEP=2 OR 3:
//*    //STEP1  EXEC  UDAD,FILE='BNNNNN.JOBNAME',
//*    //     GODISP8=SHR,GODISP9=SHR,CONDISP=SHR,ISODISP=SHR
//*
//*    ISTEP=4:
//*    //STEP1  EXEC  UDAD,FILE='BNNNNN.JOBNAME',
//*    //     CONDISP='(OLD,CATLG)',ISODISP='(OLD,CATLG)'
//*
//*  COMMENTS:
//*
//*    1) UNLESS OVERRIDDEN BY THE MEMBER PARAMETER, UDAD9 WILL BE THE
//*       VERSION EXECUTED.
//*
//*    2) TO ESTIMATE COMPUTER TIME FOR JOB CARD:
//*         22 SEC PER SOURCE FOR DISPERSION CALCULATIONS
```

```
//*         45 SEC FOR DOSIMETRY CALCULATIONS
//*         15 SEC FOR CONCENTRATION PLOTS
//*          8 SEC PER ISOPLETH PLOT
//*          3 MIN FOR WAIT TIME.
//*
//*    3) THE G1DATA PLOT DATASET NAMES WILL BE:
//*         BNNNNN.JOBNAME.PLOT.CONC  -  FOR CONCENTRATION PLOTS
//*         BNNNNN.JOBNAME.PLOT.ISO   -  FOR ISOPLETH PLOTS.
//*
//*  MAINTAINED BY A. ZIELEN, EIS DIVISION, BLDG. 10, A-121, EXT 2-3132
//*
//*********************************************************************
//*********************************************************************
//*
//*     COMMENCE MODIFIED FTXEG PROCEDURE WITH STEPS EDT AND GO FOR
//*     MAIN UDAD CODE.
//*
//*********************************************************************
//EDT   EXEC  PGM=&EDITOR,PARM='DCBS,LIST,MAP,&EDTOPTS,SIZE=&LSIZE',
//   REGION=&EDTREGN
//SYSLIB     DD  DISP=SHR,DSN=&FRELIB
//           DD  DISP=SHR,DSN=&AMDLIB
//           DD  DISP=SHR,DSN=&LIBRARY
//           DD  DISP=SHR,DSN=&POSTLIB
//SYSLIN     DD  DDNAME=SYSIN
//SYSLMOD    DD  DSN=&LOAD,UNIT=&LDUNIT,SPACE=&LDROOM,DISP=&LDDISP,
//   DCB=BLKSIZE=6144
//SYSPRINT  DD  SYSOUT=A,DCB=(LRECL=121,BLKSIZE=1210)
//SYSUT1     DD  SPACE=&E1ROOM,UNIT=(SASCR,SEP=(SYSLIN,SYSLMOD))
//A          DD  DISP=SHR,DSN=B04183.EISLIB.LOAD
//B          DD  DISP=SHR,DSN=SYS1.AMDLIB
//SYSIN      DD  DISP=SHR,DSN=B04183.EISLIB.CARD(&MEMBER)
//GO   EXEC PGM=*.EDT.SYSLMOD,COND=&GOIF,REGION=&GOREGN
//FT05F001  DD  DDNAME=SYSIN
//FT06F001  DD  SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1596)
//FT07F001  DD  SYSOUT=B
//FT08F001  DD  DISP=&GODISP8,UNIT=TSTEMP,DSN=&FILE..TEMP8,
//   DCB=(RECFM=VBS,BLKSIZE=6447),SPACE=(TRK,(10,10),RLSE)
//FT09F001  DD  DISP=&GODISP9,UNIT=TSTEMP,DSN=&FILE..TEMP9,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=2960),SPACE=(TRK,(10,10),RLSE)
//FT10F001  DD  SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1596)
//ISO   EXEC   PGM=LOADER,COND=((1,GE,GO),(3,LT,GO)),
//   PARM='MAP,PRINT,&LPARM,EP=PLISTART',REGION=&ISOREGN
//*********************************************************************
//*
//*     COMMENCE MODIFED PLOLG PROCEDURE WITH STEP ISO FOR PROGRAM
//*     CONTOUR.
//*
//*********************************************************************
//SYSLIB     DD  DISP=SHR,DSN=*.EDT.A
//           DD  DISP=SHR,DSN=&AMDLIB
//           DD  DISP=SHR,DSN=SYS1.PLIBASE
//           DD  DISP=SHR,DSN=&POSTLIB
//SYSLIN     DD  DISP=SHR,DSN=B04183.EISLIB.LOAD(CONTOUR)
//SYSLOUT    DD  SYSOUT=A,DCB=(LRECL=121,BLKSIZE=1573)
//SYSPNCH    DD  SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
//SYSPRINT   DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1511)
//SYSPUNCH   DD  SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
//INDATA     DD  DISP=&ISODISP,DSN=*.GO.FT09F001
//OUTDATA    DD  DISP=(NEW,PASS),UNIT=TSTEMP,DSN=&FILE..TEMP1,
```

```
//   SPACE=(TRK,(20,20),RLSE),DCB=(RECFM=FB,LRECL=80,BLKSIZE=2960)
//BLKBOX    DD  DISP=(NEW,PASS),UNIT=TSTEMP,DSN=&FILE..TEMP2,
//   SPACE=(TRK,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=2960)
//BOX   EXEC   PGM=G1DATA,REGION=&ISOREGN,COND=((1,GE,GO),(3,LT,GO))
//*****************************************************************
//*
//*     COMMENCE MODIFED STEP BOX FOR CONTOUR.BLACKBOX PROGRAM
//*     G1DATA.
//*
//*****************************************************************
//STEPLIB   DD  DISP=SHR,DSN=SYS1.PLOTPKG.CONTOUR.BLACKBOX
//FT05F001  DD  DISP=&BOXDISP,DSN=&FILE..TEMP2
//FT06F001  DD  SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1463)
//FT08F001  DD  DISP=&BOXDISP,DSN=&FILE..TEMP1
//FT09F001  DD  UNIT=SASCR,SPACE=(CYL,(2,1))
//FT10F001  DD  UNIT=SASCR,SPACE=(CYL,(2,1))
//GRAPHICS  DD  DISP=(NEW,CATLG),DSN=&FILE..PLOT.ISO,UNIT=TSTEMP,
//   SPACE=(6000,(40,40),RLSE)
//CON   EXEC   PGM=LOADER,COND=((0,EQ,GO),(2,EQ,GO),(3,LT,GO)),
//   PARM='MAP,PRINT,&LPARM,EP=MAIN',REGION=&CONREGN
//*****************************************************************
//*
//*     COMMENCE MODIFED FTXLG PROCEDURE WITH STEP CON FOR PROGRAM
//*     CONCPLOT.
//*
//*****************************************************************
//SYSLIB    DD  DISP=SHR,DSN=*.EDT.A
//          DD  DISP=SHR,DSN=&AMDLIB
//          DD  DISP=SHR,DSN=&LIBRARY
//          DD  DISP=SHR,DSN=SYS1.DISLIB
//FT05F001  DD  DDNAME=SYSIN
//FT06F001  DD  SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1596)
//FT07F001  DD  SYSOUT=B
//SYSLIN    DD  DISP=SHR,DSN=B04183.EISLIB.LOAD(CONCPLOT)
//          DD  DISP=SHR,DSN=SYS1.PLOTTER.G1DATA(PLOTTER)
//SYSLOUT   DD  SYSOUT=A,DCB=(LRECL=121,BLKSIZE=1573)
//FT08F001  DD  DISP=&CONDISP,DSN=*.GO.FT08F001
//GRAPHICS  DD  DISP=(NEW,CATLG),UNIT=TSTEMP,DSN=&FILE..PLOT.CONC,
//   SPACE=(6000,(90,40),RLSE)
//   PEND
```

560 292

APPENDIX E. LISTING OF JCL FOR OVERLAY EXECUTION OF PROGRAM UDAD

```
//EDT.A  DD  DISP=SHR,DSN=B04183.EISLIB.LOAD
//EDT.B  DD  DISP=SHR,DSN=SYS1.AMDLIB
//EDT.SYSIN  *
 ENTRY MAIN
 INCLUDE A(UDAD9,INHALE)
 OVERLAY ALPHA
 INCLUDE B(ANC4)
 INSERT PART1,TAILPS,POLUT,ACTDR1,DDEP,INTEG,FERR,FERR1,HT,INTG,DEPY,  X
               DSTBZ,DSPRSN,AFUNC,DFUNC
 OVERLAY ALPHA
 INSERT TAIRR,GROUND,ACT,ACTDR2,DOSPC  ATA,QDCAY,DCFQ,EVD,TCNGY,INHAL2,X
               NSNE
 OVERLAY BETA
 INSERT INHALE,INITEX,KFUNC,FRACT,MSPSET,ECALC,INHAL3,EVFDOS,FODOSE,   X
               FOOD,VEGFOD,CFOD
 OVERLAY GAMMA
 INSERT DOCOMT
 OVERLAY GAMMA
 INSERT DOSAGE
 OVERLAY BETA
 INSERT CONC
/*
```

APPENDIX F. CORRESPONDENCE FROM NRC TO ANL CONCERNING UDAD

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

FEB 8 1978

Dr. Walter E. Kisieleski
Division of Environmental Impact Studies
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Walt:

Enclosed is a proposed agenda for the meeting of the Review Group on Radiological Assessment for Uranium Mills to be held at ANL on February 22-23, 1978. The meeting should begin about 9 a.m. on February 22. Please note that the subject matter to be reviewed and discussed will deal primarily with atmospheric transport and inhalation dosimetry. The terrestrial pathway will be the subject of a subsequent meeting. We are looking forward to receiving the documentation of the terrestrial pathway in the near future.

Listed below are some suggestions for additional information which should be included in the documentation of the assessment methodology.

- Breathing Rates
- Shielding Factors
- Occupancy Factors
- n Factor (for bone)
- f_1 f_2 T_b Factors (only if these are different from ICRP II, e.g., ^{226}Ra)
- Organ weights for T-P and P regions of lung

Please let me know if you have any questions or suggestions on the proposed agenda.

Sincerely,

Paul J. Magno

Paul J. Magno
Fuel Reprocessing & Recycle Branch
Division of Fuel Cycle and
Material Safety

PROPOSED AGENDA FOR MEETING OF REVIEW GROUP
ON DOSE ASSESSMENT METHODOLOGY FOR URANIUM MILLS

February 22-23, 1978

I. Opening remarks on development of dose assessment methodology for uranium mills and the function of the Review Group (P. Magno).

II. Brief explanation of ANL methodology and the UDAD Code (M. Momeni).

III. General discussion of assessment methodology and UDAD Code.

IV. Specific subjects for detailed discussion:

   A. Atmospheric transport

      1. Deposition velocities (V_d) especially for radon-222 and daughters

      2. Modeling of area sources

      3. Resuspension

   B. Dosimetry

      1. Lung model

         a. Solubility categories

         b. Particle size distributions

      2. Radon-222 dosimetry

         a. Calculation of working levels

         b. Dose conversion factor

      3. Dose conversion for air submersion and ground deposition

         a. Daughter product ingrowth

      4. Calculation of population doses

         a. Environmental dose commitment

         b. Population projections

      5. Age dependent dose considerations

C. Miscellaneous minor technical items

V. Summary and conclusions

A. Recommendations

B. Identification of items requiring further clarification (if any)

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

MAR 10 1978

MEMORANDUM FOR: Distribution

FROM: Paul J. Magno
Fuel Reprocessing and Recycle Branch
Division of Fuel Cycle and Material Safety

SUBJECT: MINUTES OF MEETING OF REVIEW GROUP ON DOSE ASSESSMENT METHODOLOGY FOR URANIUM MILLS AT ARGONNE NATIONAL LABORATORY, FEBRUARY 22 AND 23, 1978

Participants:

NRC	Argonne National Lab.	EPA
Paul Magno, NMSS	Michael Momeni	Christopher Nelson
Frank Congel, NRR	Walter Kisieleski	
Daniel Martin, OSD	Yuchien Yuan	
	George Montet*	
	William Hallett*	

*Part time

Purpose of Meeting

To review and discuss the radiological assessment methodology to be used in the generic environmental impact statement on uranium milling (GEIS) and where necessary and appropriate, to make recommendations for changes in the methodology in order to make the assessment consistent with present NRC practices and policies and to increase its technical credibility.

Summary and Recommendations

The subject matter discussed and reviewed during the meeting included all items through Section IV B-2 on the attached Agenda. The remaining items will be included in the Agenda for the next meeting. The next meeting is tentatively scheduled for Silver Spring, MD on March 13 and 14, 1978.

As a result of this review, the Task Group made the following recommendations or requests:

(1) Atmospheric Transport Modeling

(a) The ANL staff should identify and document differences in their atmospheric transport mdoels from those in Regulatory Guides 1.111. (This is primarily for informational purposes and not to impose a requirement that the atmospheric transport model be <u>identical</u> to Regulatory Guide 1.111.)

(b) a deposition velocity (V_d) of 0.3 cm/sec should be used in modeling the atmospheric-transport of lead-210 formed from decay of radon-222.

(c) The area source model should be examined to ensure that the fraction of the source area not considered as contributing to source for wind from a given sector is taken into consideration for the adjacent sectors or that this contribution is not significant.

(2) Resuspension

The calculation of air concentrations (and doses) from resuspension should include polonium-210 which will be formed from ingrowth from lead-210.

(3) Solubility Categories for Lung Model

The ANL staff should continue to use the solubility categories for mill effluent presently incorporated into the dose calculational methodology. The choice of these categories are based on the recommendations of the Task Group on Lung Dynamics for Committee 2 of ICRP.

The importance of the choice of solubility category for yellowcake was discussed as it relates to compliance with 40 CFR 190. This choice is complicated because yellowcake is a mixture of ammonium diuranate and uranium oxide (in various and unknown amounts).

The review group considered three options related to solubility categories:

(a) continue to use the categories presently in the UDAD code which are based on ICRP (TGLM) and which assumes yellowcake is U_3O_8;

(b) based on preliminary data from the Battelle solubility studies, make "best judgments" on a solubility category for each of the various mill effluents;

(c) based on the Battelle work, make "best judgment" on solubility categories for the various effluents involved as mixture of categories for yellowcake (i.e., 25% class Y, 75% class W).

The review group concluded that the Battelle work was too preliminary at this time to justify a revision of the broad general categories formulated by the Task Group of ICRP Committee 2. However, the review group stressed the importance of these solubility studies and the need to continue this work as a priority project. When more definitive results are available these should be used in revising the presently utilized solubility categories.

(4) Particle Size Distributions

For filtered uranium mill effluents, an activity median aerodynamic diameter (AMAD) of 1 micron should be used in dose calculations. This value was chosen because it is suggested by the ICRP (TGLM) as the standard aerosol to be used when particle size distribution are not known.

For effluent from ore storage pads and tailings piles where measurement of these materials indicate the presence of relatively large size particles, the presently used particle size distributions (5 and 35 microns) should be continued to be used. The importance of obtaining actual measurement data on the particle size distributions was emphasized. When these data are available they should be used as a basis to revise the presently recommended values.

(5) Radon-222 Dosimetry

ANL should use the dose conversion factor developed by NRC for converting working level exposures to rem. This conversion factor will be developed using the rationale described in the Minutes of the Meeting of the Review Group on January 16, 1978 (copy attached).

The method for calculating working level exposures was not completely resolved. The main point requiring further resolution was the conversion of working levels (WL) to cumulative working level months per year (CWLM/year). This item will be further considered by the review group. prior to the next meeting with ANL and a recommendation will be developed.

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(7) Health Effects Calculations

ANL indicated that it would be providing the review group with a description of their methodology for calculating health effects from exposures to mill effluents. This description should be available in early March.

Paul J. Magno
Paul J. Magno
Fuel Reprocessing and
Recycle Branch
Division of Fuel Cycle
and Material Safety

Enclosure:
1. Minutes of Meeting on 01/16/78
2. Agenda on Feb. 22 & 23, 78 meeting.

(Omitted--same as agenda attached to preceding letter)

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

MAR 10 1978

MEMORANDUM FOR: Michael Momeni
Division of Environmental Impact Studies
Argonne National Laboratory

FROM: Paul J. Magno
Fuel Reprocessing and Recycle Branch

SUBJECT: CONVERSION FACTORS FOR RADON-222 DOSIMETRY FOR USE IN ASSESSMENT OF RADIATION DOSES FROM RELEASES OF RADON-222 FROM URANIUM MILLING ACTIVITIES

The Review Group on Dose Assessment Methodology for Uranium Mills has considered the subject conversion factors and their recommendations are presented below:

Calculation of Cumulative Working Level (CWL) Exposures

(1) 100 pCi/ℓ ^{222}Rn = 0.5 WL

(2) 1 WL = 25 CWLM/year for continuous (non-occupational) exposure

(3) 1 PCi/ℓ ^{222}Rn = 0.125 CWLM/year for continuous exposure.

This factor is based on exposures inside normally ventilated structures. All exposures should be calculated based on 100% occupancy inside a structure and therefore no credit should be given to lower working level concentrations in outside air. NOTE: The review group recognizes that this will result in a small overestimation of the exposure to a close-in resident of a uranium mill or tailings pile.

Conversion from Working Level Month (WLM) to Rem

The conversion factor from WLM to rem will be developed as described in the Minutes of the Review Group Meeting of January 16, 1978 (attached). However, until that factor has been established, calculation of doses from inhalation of radon-222 daughter shall be based on the following relationship:

1 WLM = 5 Rem (From BEIR Report)

NOTE: Any data for the GEIS which is developed using this conversion factor can be adjusted or normalized if necessary when the conversion factor based on health effect considerations is developed.

The above conversion factors should be used in calculating exposures from inhalation of radon-222 daughter products and should be incorporated into the UDAD Code.

Please let me know if you have any questions or need further direction concerning this matter.

Paul J. Magno

Paul J. Magno
Fuel Reprocessing and Recycle Branch
Division of Fuel Cycle & Material Safety

Enclosure:
Minutes of Mtg of 1/16/78

(Omitted--same as attachment to preceding memo)

JAN 29 1978

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MEMORANDUM FOR: Distribution

FROM: Paul J. Magno
Fuel Reprocessing and Recycle Branch

SUBJECT: REVIEW GROUP ON DOSE ASSESSMENT METHODOLOGY FOR URANIUM MILLS - MINUTES OF MEETING ON JANUARY 16, 1978

Attendees: Paul Magno, Fuel Reprocessing and Recycle Branch, NMSS
Frank Congel, Radiological Assessment Branch, NRR
Dan Martin, Environmental Standards Branch, OSD

Subject of Meeting:

The following subjects were discussed at the meeting:

(1) the method to be used in presenting or expressing exposures to the lung from inhalation of radon-222 daughter products and particulate dust released from uranium milling activities;

(2) dose conversion factors for converting working levels (WL) to dose;

(3) the need to consider exposures from radon-222 and short-lived daughter to organs other than the lung.

Summary of Meeting:

The question of how to present exposures to the lung from uranium mill effluents is somewhat complex because radon-222 daughter product exposures are best expressed in units of working level months rather than in rems and the region of the lung receiving the highest exposure is the bronchial epithelium. On the other hand, lung doses from inhalation of particulates containing uranium, radium, thorium and lead are expressed in units of rems and the region of the lung receiving the highest doses is the pulmonary region. Three possible ways of expressing these exposures were considered:

(1) present exposures from radon-220 short-lived daughters in units of working levels (WL) and exposures to particulates in units of rems. The organ of reference would be "lung."

(2) present exposures in units of rems to lung by summing doses to bronchial epithelium from radon-222 daughters and doses to the pulmonary region from particulates. This in essence involves summing doses to the highest exposed regions (i.e., tracheobronchial and pulmonary regions) from a specific source of exposure. This would require a dose conversion factor to convert WL exposures to

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units of rem for the bronchial epithelium;

(3) present exposures to specific regions of the lungs i.e., tracheo-bronchial and pulmonary. This would require dose conversion factors to convert WL exposures to units of rem for both the bronchial epithelium and the pulmonary region.

The review group agreed to adopt "option 2" above as the method to be used in expressing exposures to the lung.

The health effects (H.E.) resulting from radon-222 daughter product exposures will be calculated using risk factors based on H.E. per 10^6 working level months. The health effects resulting from exposures to particulates will be calculated using a risk factor based on H.E. per 10^6 man-rem. The dose conversion factor used to convert WLM to rem will be established so that the health effects calculated using the H.E./10^6 man-rem will give the same values as the H.E./10^6 WLM. Frank Congel, R. Gotchy and E. Branagan will work together in developing the health risk factors.

The working group also agreed on the following:

(a) because of the method to be used in expressing doses to the lung, there would be no need to calculate doses to the pulmonary region of the lung from radon-222 daughters;

(b) the doses to other body organs from radon-222 and short-lived daughters are relatively small compared to doses from the long-lived daughters (i.e., ^{210}Pb - ^{210}Po). Therefore, there would be no need to calculate doses to these other organs from radon-222 and short-lived daughters.

(Original signed by P. J. Magno)

Paul J. Magno
Fuel Reprocessing and
Recycle Branch
Division of Fuel Cycle
and Material Safety

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

MAR 1 7 1978

MEMORANDUM FOR: Distribution

FROM: H. J. Miller
Fuel Reprocessing and Recycle Branch

SUBJECT: MINUTES OF PROJECT REVIEW MEETING ON GENERIC ENVIRONMENTAL IMPACT STATEMENT (GEIS) ON URANIUM MILLING - MARCH 13 AND 14, 1978

Participant:

NRC	Argonne National Laboratory
H. Miller	C. Roberts
P. Magno	G. L. Montet
E. Branagan*	M. Momeni*
F. Congel (NRR)*	Yuchien Yuan*
R. Gotchy (NRR)*	W. Kisielski*
D. Martin (SD)*	
E. Shum*	
A. Soong*	

Purpose:

To review development of the generic environmental impact statement on uranium milling. Particular emphasis was given to development of the radiological assessment and health effects estimates as they will support establishing regulation on mill tailing management.

Summary of Discussion and Agreements:

The following summarizes the major discussion points and agreements of the meeting:

1. Contents, scope and purpose of the radiological assessment was reviewed. The discussion centered around minutes of the September 1977 review group meeting which outlined the approach to be taken in developing the assessment of radiological impacts

   The GEIS will provide support for regulation on mill tailings to replace the current interim criteria including limits on radon release and recommendations concerning land use control (e.g. land ownership). The need to include evaluation of risks to individuals on or near the reclaimed tailings pile for a range of radon control levels is, therefore, necessary.

The following general approach was agreed upon to do this:

a. Select a range of exposure levels for individuals occupying a residence on top of a reclaimed pile and at the site boundary (0.5 km). The individual on top of the pile represents a worst case scenario which could occur if there were no land-use restriction following reclamation of the tailings pile. The site boundary individual corresponds to the case of restricted land use. Selected exposure levels (levels above background inside structures) for evaluation will be:

   (1) 0.005 WL - limits established by EPA for Florida Phosphate

   (2) 0.01 WL - limits established by Surgeon General for DOE inactive mill tailings remedial actions

   (3) 10^{-6} risk equivalent - risk level used by EPA for establishing transuranic ground contamination standard

b. Calculate (1)exhalation rates which are equivalent to these exposure levels and (2) associated thicknesses of soils and clay cover required to obtain these control levels. Calculate range of costs which would be required to obtain the required level of control.

c. Utilize this evaluation of risk to limiting individuals and its results to provide one perspective in deciding what required radon control level should be. (Note no rigorous cost/benefit balance is being attempted here to establish a radon exhalation control level. Other considerations in setting required controls must and will include requirements for long-term stability, cumulative population exposures and health effects, and potential for human disruption of piles.)

d. Other specific points agreed to regarding this assessment include:

   (1) Radon inhalation exposure only will be considered for the individual on pile.

   (2) Exact cover types, thicknesses and combination will vary from site to site and region to region. Costs for cover will be generated for the model site with a range of costs presented to account for site specific and regional variations.

   (3) All exposure pathways will be considered for individuals at the site boundary, 0.7 km trailer and 2.0 permanent residence.

2. The radiological writeup will include a general discussion of radiological doses in terms of 40 CFR 190 requirements. That is, feasibility of meeting the limit, problems of enforcement, etc. will be discussed.

3. Health risks to individuals nearest the site will be calculated for exposure to radon and its daughters from inhalation only. Later attempt may be made to include risks associated with particulate inhalation, direct or ingestion pathways, if time and schedule permits following completion of other parts of the radiological assessment and appendices. Health risks to the average individual in the model region will be calculated in the same manner as for the nearest (maximum) individuals.

4. Population dose will be calculated in the manner agreed to in the September meeting. NRC will work with ANL to develop simple factors which will approximate a continuously changing particulate resuspension fraction. Selecting such a single factor will obviate the need to modify the UDAD code to calculate 100 year environmental population dose commitment.

   Another simplifying assumption in calculating the dose commitments will be to level population off after year 2000 at a level which conservatively approximates variable population projections.

5. Methods for estimating potential health effects were discussed. ANL (Momeni) presented a competing health risk model that is being developed by Argonne. The desirability of developing such a competing risk model was agreed to since it appears that it would more accurately represent health consequences. It was agreed, however, that health effects would be expressed for the draft GEIS in terms of absolute and relative risk models (or combination thereof).

   This decision is based on the following:

   a. Available funding and schedule constraints preclude completing development of the competing health risk model prior to issuance of the draft GEIS.

   b. National populations doses calculated from Oak Ridge/NOAA models (which will be the greatest contribution to the cumulative health effect estimate) is not presently in the form required to apply the c mpeting health risk model.

   c. The approach which will be taken for the draft GEIS is generally consistent with what was done in GESMO, WASH-1400 and the EPA transuranic standards guidance.

NRC will supply the risk estimators which should be used.

7. Priorities for completing remaining work in the radiological assessment and associated work are as follows:

   a. Immediate - To be done on a schedule supporting the draft GEIS.

      (1) Complete the radiological assessment. This involves calculation of doses, health risks, etc. as discussed above and in September 1977 review meeting minutes. No adjustments will be made to computer codes to do this assessment. Simplifying assumptions and hand calculations will be made as appropriate to complete this work.

      (2) Write up of the radiological assessment of both base case and alternatives.

      (3) Writeup of the assessment methodology and source term estimation methods to be incorporated in appendices. The level of detail provided in studies such as GESMO and Bettelle's decommissioning studies concerning radiological assessment methodology was agreed to be adequate.

      (4) Parameters (simple factors) which were identified as needing change as a result of methodology review group meetings will be entered into the computer code.

   b. Long-Range Efforts - The following will be completed independent of the remaining GEIS activities as additional funding (aside from supplemental funding for the GEIS) is identified and made available.

      (1) Development of competing risk health effects model and associated code and dose population computation changes needed to support it.

      (2) Revisions to the UDAD code to incorporate comments of the task force reviewing the assessment methodology. Agreements were made with regard to how the unresolved or incomplete work items resulting from the task force review will be dealt with to allow completion of the radiological assessment. These are in summary:

         (a) Radium transfer factors to be used in ingestion pathway. The assessment will be done using Regulatory Guide 1.109 transfer factors.

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(b) Incorporation of polonium into analysis. This will be done by making simplifying assumptions as opposed to computer code changes to complete the assessment in timely fashion.

(c) Correction of radium inhalation dose conversion formula. This correction involves using a power function as apposed to a single exponential for dose conversion. The effect of this correction will be approximated by assuming doses will be a factor of ten less than the values currently estimated by the UDAD code.

The possibility of resolving open items from the Task Force review using GEIS funds will be evaluated after all work required for the GEIS is sufficiently complete to be able to make better predictions of available resources.

H. J. Miller
Fuel Reprocessing and
Recycle Branch
Division of Fuel Cycle and
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Distribution:
G. Montet, ANL
P. Gustafson, ANL
C. Roberts, ANL
J. B. Martin
P. Magno

UNITED STATES
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MAR 2 3 1978

MEMORANDUM FOR: Distribution

FROM: Paul J. Magno
Fuel Reprocessing and Recycle Branch
Division of Fuel Cycle and Material Safety

SUBJECT: MINUTES OF MEETING OF REVIEW GROUP ON DOSE ASSESSMENT METHODOLOGY FOR URANIUM MILLS ON MARCH 13, 1978 AT SILVER SPRING, MARYLAND

Participants:

NRC	Argonne National Lab.	EPA
Paul Magno, NMSS	Michael Momeni	Christopher Nelson*
Frank Congel, NRR*	Walter Kisieleski	
Daniel Martin, OSD	Yuchien Yuan	
Keith Eckerman, NRR*	George Montet*	

*Part time

Purpose of Meeting

To review and discuss the radiological assessment methodology to be used in the generic environmental imapct statement on uranium milling (GEIS) and where necessary and appropriate, to make recommendations for changes in the methodology in order to make the assessment consistent with present NRC practices and policies and to increase its technical credibility.

Summary and Recommendations

The subject matter discussed and reviewed during the meeting included the following items:

(1) Calculational methodology for the terrestrial food pathway;
(2) Populations doses from food pathway;
(3) Environmental dose commitment concepts in population dose calculations;
(4) Miscellaneous items remaining from previous meeting.

Dose Calculations for Terrestrial Food Pathway

1. Although the UDAD code calculates concentrations of radionuclide in five (5) food categories as contrasted to the three (3) food

categories used by NRC in Regulatory Guide 1.109, no changes in the code were determined to be necessary. However, the two (2) additional separate food categories (poultry and eggs) will not be utilized in the food pathway assessment for uanium mills (see item below on food intake value). In other words although, the code has the capability to calculate concentrations in 5 food categories for the present assessment only 3 food categories (similar to 1.109) will be utilized.

2. Equation (2) which calculates concentrations of radionuclides in root vegetables as a separate sub-category of vegetation will be eliminated. Calculations of concentrations in vegetation will be carried out using equation (1) which is identical to equation C-5 in Regulatory Guide 1.109 (October 1977).

3. G, the effective surface density of soil will be changed from 300 kg/m^2 to 240 kg/m^2 to conform to Regulatory Guide 1.109.

4. λ_g, the effective removal constant from soil should be calculated in equation 4 based on the radiological half-life of the parent radionuclide in the decay chain and not on the half-life of the individual radionuclide independent of its parent.

5. The decontamination factor due to washing, peeling, etc. of vegetation should be changed from 0.25 to 0.5. This is based on a value judgment that only some of the food items under the vegetation category undergo these processes.

6. The Q_a factor should be removed from equation 5 since the inhalation of particulates by the cattle contribute a negligible amount to the daily intake.

7. The F_m transfer values for milk should be revised to incorporate the recommended values in UCRL-51939.

8. All of the F_f transfer values for meat need to be critically reviewed to determine their basis and appropriateness. This is a long-range goal. However, on a short-range basis, the values for radium-226 and polonium-210 should be reviewed to determine if more appropriate values should be used in the uranium mill radiological assessments. The f_m value for radium-226 is of particular importance since radium-226 is the critical nuclide in the food pathway for individuals living near uranium mills. Dan Martin working with Keith Eckerman will review the current values (on a short-term basis) to determine if changes should be made now.

9. Calculation of doses to the maximum exposed individuals should be made using the food intake values listed in Table E-5 of Regulatory Guide 1.109. However, this table should be used only as it would apply to uranium mill sites. Individuals should not be assigned intakes of food items or categories which are not or could not be raised at the site. Only the food items or categories actually identified at a site should be included in the individual's diet. For example, for most uranium mills, the milk, grain and fruit food items should be eliminated from the ingestion pathway.

10. Calculations of doses to the average individual should be based on the intake values in Table E-4 of Regulatory Guide 1.109. Site specific information should be used to determine the food items and categories to be utilized.

Populations Doses from Food Pathway

It is recommended that the population doses to a regional population (i.e., 50 miles) be calculated in a manner similar to Regulatory Guide 1.109 pages 34-35 (October 1977).

In general, it appears that the UDAD code is calculating the population doses in a manner essentially equivalent to the above except that instead of calculation of concentrations by sub-regions, UDAD calculates concentrations at specific location (i.e., ranches). The present UDAD code documentation does not include a description of the population dose methodology. A write-up of these calculational procedures will be prepared by ANL.

Environmental Dose Commitment

The review group recommended that population doses be calculated using the Environmental Dose Commitment (EDC) concept. The EDC is the dose delivered to an exposed population over an extended time period (i.e., 100, 1000 years, etc.) resulting from a unit release (i.e., a 1 year release) to the environment. The calculational methodology is described in the EPA report, "Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry," U.S. Environmental Protection Agency, EPA-520/4-73-002 (February 1974).

The ANL staff disagreed with this method of calculating the EDC primarily because it would not provide the proper input into the health effects calculational methodology now being developed. Therefore, no modification of the UDAD code for calculation of EDC will be made at this time. This issue will be resolved after decisions regarding health effects calculations are made.

MAR 2? 1978

Miscellaneous

1. Calculation of doses should include the contribution from polonium-210, a member of the uranium-238 decay series. (This is not a priority item and the necessary additions to UDAD should be made as time allows.)

2. The dose conversion factors for body organs for inhalation or radium-226 should be based on the same power retention function utilized for doses from ingestion.

3. A reference will be provided by ANL which supports the choice of organ weights for the lung.

The above changes to the UDAD code and basic radiological assessment methodology should be made in accordance with priorities established in meeting minutes of review session of March 13 and 14, 1978.

Paul J. Magno

Paul J. Magno
Fuel Reprocessing and
Recycle Branch
Division of Fuel Cycle
and Material Safety

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