PNL-4456
UC-41
6A

DITTY—A Computer Program for Calculating Population Dose Integrated Over Ten Thousand Years

B. A. Napier
R. A. Peloquin
D. L. Strenge

March 1986

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-4456

DISCLAIMER

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

NTIS Price Codes
Microfiche A01

Printed Copy

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
201-225	A010
226-250	A011
251-275	A012
276-300	A013

PNL-4456
UC-41

DITTY - A COMPUTER PROGRAM FOR CALCULATING POPULATION DOSE INTEGRATED OVER TEN THOUSAND YEARS

BA Napier
RA Peloquin
DL Strenge

March 1986

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

ABSTRACT

The computer program DITTY (Dose Integrated Over Ten Thousand Years) was developed by Pacific Northwest Laboratory for the U.S. Department of Energy to determine the collective dose from long term nuclear waste disposal sites resulting from the ground-water pathways. DITTY estimates the time integral of collective dose over a ten-thousand-year period for time-variant radionuclide releases to surface waters, wells, or the atmosphere.

This document includes the following information on DITTY: a description of the mathematical models, program designs, data file requirements, input preparation, output interpretations, sample problems, and program-generated diagnostic messages.

ACKNOWLEDGMENTS

The authors would like to thank those who have contributed support for the development of the DITTY computer program. Supporters include E. C. Watson, I. C. Nelson, and J. B. Burnham of Pacific Northwest Laboratory, and the POSECS program of Rockwell Hanford Operations. We are especially thankful to W. E. Kennedy, Jr., for the original formulation of the integrated dose calculation.

CONTENTS

1.0 INTRODUCTION

Many computer programs have been developed for environmental consequence analysis of radionuclide releases to air and surface waters. Several reviews of such models have been prepared in the past several years (Hoffman et al. 1977; Strenge et al. 1976; Fields 1982; Mills and Vogt 1983). The majority of these programs only consider the environmental consequences in the near term (0 to 100 years) following release to the environment. Such programs are useful for most nuclear fuel cycle facilities, except nuclear waste disposal sites which may have long-term impacts. The long transport times through waste barriers and groundwater aquifers require that longer time periods be considered. The computer program DITTY (Dose Integrated Over Ten Thousand Years) was, therefore, developed to calculate the total population exposure over long time periods.

Total population exposure is dependent on many parameters that are subject to large variations over thousands of years. Therefore, the user must realize that the calculated results from use of DITTY are only estimates and are limited in accuracy by the validity of the input assumptions. The time variant input parameters include: 1) air and water source terms, 2) atmospheric dispersion patterns, and 3) exposed population.

Source terms of DITTY may be defined for releases to the atmosphere or to water. Releases to water may be to wells or surface water via groundwater. The actual release rates are specified in an input file as the curies per year released for selected years following time zero for the calculation. One such data set is defined for each radionuclide of interest. Sophisticated groundwater transport programs are generally used to determine the time variant release rate following transport from a geologic repository to the environmental access point (well or surface water). A similar definition of release rate as a function of time is needed for atmospheric releases.

For releases to the atmosphere, estimates of dispersion patterns are needed to determine total exposure of the regional population. The purpose of the dispersion calculation is to provide estimates of ground-level air concentrations of released radioactivity as a function of distance and direction from the release location. The downwind air concentrations are related back to the release rate by use of "dispersion factors" which may be either supplied as input to the program or calculated by the program. When the program calculates the dispersion factors, meteorological data must be provided in the form of joint frequency of occurrence of windspeed, wind direction, and atmospheric stability. The dispersion calculation may be performed external to the program with the results entered through input, or joint frequency meteorological data may be supplied and dispersion factors will be calculated as a function of distance and direction. A straight-line crosswind-averaged Gaussian plume model is used for the dispersion calculation.

The regional population is defined for airborne and waterborne pathways as a function of time. For airborne pathways the population is defined as a function of distance and direction corresponding to the locations for which dispersion factors are given or calculated. A population-weighted dispersion factor is calculated as the sum of the product of population and dispersion factor for each location. Alternatively, the population-weighted factor may be calculated external to the program and supplied as input.

The time frame for the calculation is any 10,000-year period. This period is broken into 143 periods of 70 years each. The average release in each of these periods is calculated from source-term data provided, and the total population dose to selected organs is determined for each period. The activity present during any period is the sum of material released during that period (uniformly released over 70 years) and residual material in the environment from releases in previous periods. The dose is calculated for all contributing pathways of exposure, including external exposure, inhalation, and ingestion of contaminated water and foods.

Two versions of DITTY are currently available. One is for a mainframe VAX 780; the other is for an IBM Personal Computer. The models and solutions are identical in both cases. Minor variances between the codes exist. These variances are discussed in Appendix H.

2.0 MATHEMATICAL MODELS

This section describes the mathematical models and algorithms used in the DITTY program. The discussion is divided into five sections as follows:

- Source Terms - specification and use
- Airborne Release - modes for estimating average air concentrations downwind of the release, and definition of the exposed population
- Waterborne Release - model for definition of exposed populations
- Environmental Concentrations - models to estimate important environmental pathway concentrations
- Pathway Dose Calculations - models to determine total population doses from important pathways.

2.1 SOURCE TERMS

The environmental source terms represent the rate at which radionuclides enter the environment through airborne or waterborne routes. The generation of source terms is normally performed by sophisticated computer programs for groundwater transport. To interface easily with these programs, a general method for source-term specification was chosen: all radionuclide release-rate data are provided as time/rate data pairs. Each data pair gives a time (years after a reference time) and a release rate in curies per year for a given radionuclide. The data for each radionuclide are provided in a set of data pairs with up to 450 time points. Such a set is provided for each radionuclide of interest. Using this procedure, a different set of time points can be used for each radionuclide. Considering the great variation in transport properties among the radionuclides of interest in high-level waste, it is important to be able to specify releases over a range of time periods.

To use the release rate data within the 70-year increment calculational scheme, the release rate data are interpolated and integrated to give the total activity released in each 70-year increment.

A special option is included to describe an acute release to the environment at the beginning of the time period. This acute release can be selected for either airborne or waterborne pathways. No more than one acute release per computer simulation is allowed.

2.2 AIRBORNE RELEASE

To estimate the radiation dose received from releases to the atmosphere, it is necessary to consider atmospheric transport of radionuclides. The atmospheric processes transport the radionuclides throughout the region surrounding the release point. The resulting distribution of material is important in determining the radiation exposure received by members of the regional population through potential exposure pathways. This section describes the methods available for specifying and estimating atmospheric dispersion.

Calculation of population exposure is based on a spatial grid as illustrated in Figure 1. The population data set is specified as the number of people living within each area element of the grid at a given time. Sixteen directions and up to 10 distance intervals are used. The atmospheric dispersion calculation is based on joint frequency of occurrence data for wind speed, wind direction, and atmospheric stability for the site. One set of joint frequency data is given to be used with all population data. The downwind normalized air concentration is estimated for each area element using the long-term average equation provided by Slade (1968), as follows:

$$(\overline{X}/Q')_{ij} = \left(\frac{2}{\pi}\right)^{1/2} \sum_{\ell=1}^{\text{wind speed}} \sum_{m=1}^{\text{stability}} \frac{0.01\, f_{j\ell m} \exp\left[-h^2/2\, \sigma_{zmi}^2\right]}{(2\, X_i\, \pi/16)\, \sigma_{zmi}\, \overline{u}_\ell}$$

where

$(\overline{X}/Q')_{ij}$ = normalized air concentrations at the center of the area interval in direction j at distance i, sec/m^3

$f_{j\ell m}$ = joint frequency of occurrence for windspeed ℓ, stability m and direction j, %

h = height of release, m

σ_{zmi} = vertical standard deviation of air concentration for stability m at distance i, m

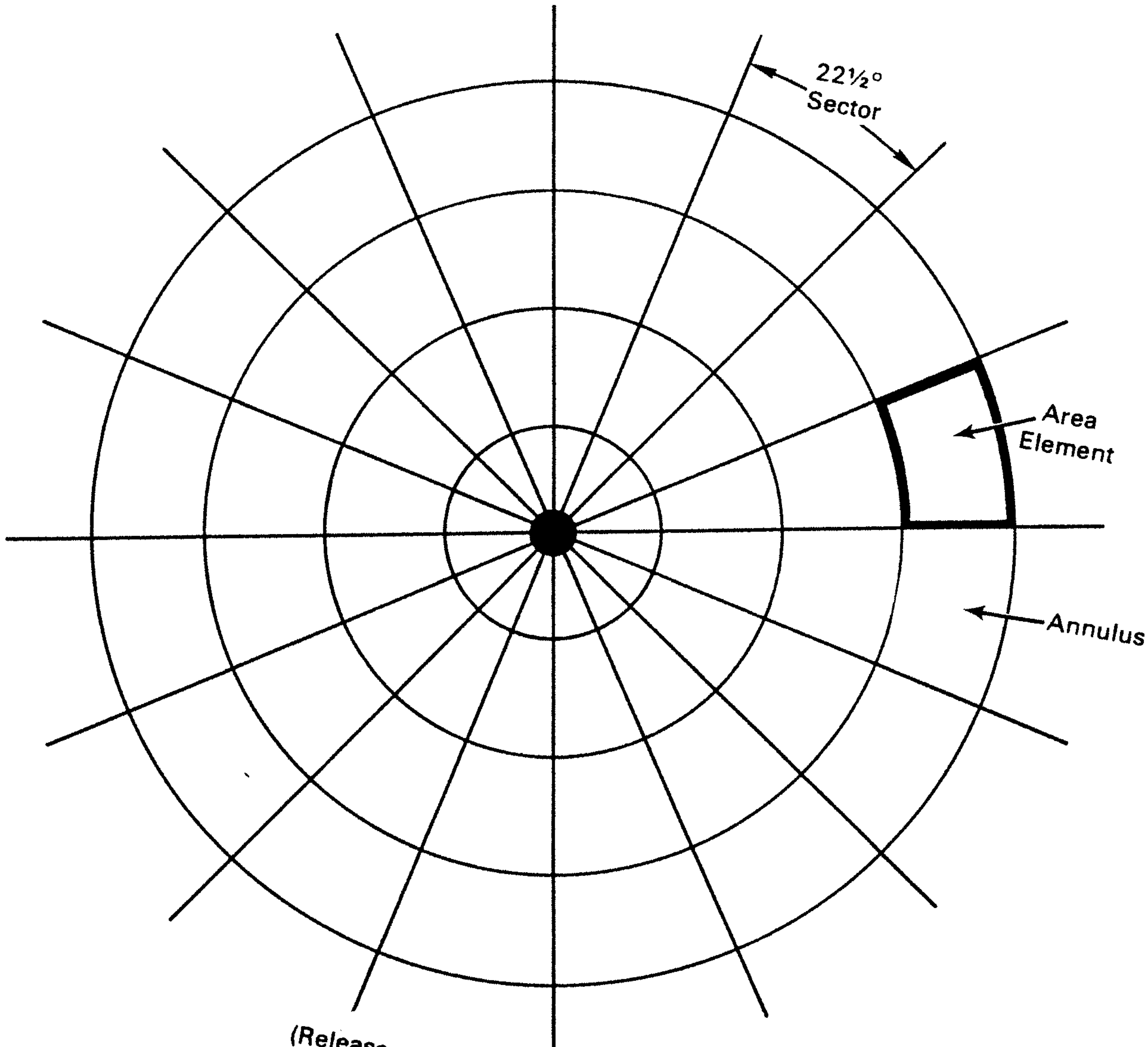


FIGURE 1. Population Dose Grid System Definition

X_i = downwind distance from release point to the midpoint of distance interval i, m

$\overline{u}_\ell$ = average wind speed ℓ, m/sec

0.01 = conversion from % to fraction

16 = number of directions (22.5° per sector)

The above equation represents the crosswind-integrated normalized air concentration also referred to as the dispersion factor. It assumes that the annual joint frequency data describe the directional dependence of downwind transport and that transport is uniform across each sector and in a straight line from the release to the location of interest. The vertical standard deviation, σ_{zmi}, is evaluated based on curves presented by Slade (1968). A somewhat arbitrary maximum value of 2000 m for σ_{zmi} provides a limit to vertical dispersion (as would be expected due to mixing height limitations). If values of normalized air concentrations are already known, they may be supplied as input rather than being calculated. The dispersion factors are used with the population distribution data to provide a population-weighted dispersion factor. The factor represents a population-weighted estimate of the average normalized air concentration for the region. The factor is calculated as follows:

$$PM(t) = \sum_{i=1}^{\text{directions}} \sum_{j=1}^{\text{distances}} P_{ij}(t)\ (\overline{\chi}/Q')_{ij}$$

where $PM(t)$ = population-exposure factor at time t, person-sec/m^3

$P_{ij}(t)$ = number of people living in the area interval in direction j at distance i at time t, persons

As the equation indicates, the population exposure factor is a function of time. Changes in population over the 10,000-year period will be the primary cause of change in the population-exposure factor. While climate changes may also affect the factor, such changes are difficult to predict and are not considered.

Two options are available for use of normalized air concentration values to determine population-exposed factors. When estimates of the total population change are known, the population exposure factor for the initial time may be calculated, and values for remaining time increments will then be calculated by ratio to population changes with time. If population distribution data are known as a function of time, they may be used to calculate population-exposure factors at each of the specified times, which are, in turn, interpolated for each 70-year increment.

Specification of population exposure factors can be by direct input of factors at defined time points or by calculation from defined meteorological data and population data. When population exposure values are input, interpolations are made to determine the values at the midpoint of each 70-year time increment.

2.3 WATERBORNE RELEASE

Pathways associated with waterborne releases include external exposure to contaminated water and sediment; ingestion exposure from drinking water, farm products (via irrigation), and aquatic foods; and inhalation of resuspended material after irrigation. The release of activity to water is described by a release rate in curies per year defined at specific times. The activity released is assumed to result in exposure of a regional population. Specification of the number of people exposed to waterborne pathways is performed similarly to definition of population for airborne pathways. The major difference is that only the total population is specified (spatial distribution is not needed).

Two methods are available for defining population data for waterborne release. The first method is to define the population exposed during each of the 143 70-year periods. The second method is to give the population present at specified times for interpolation at the midpoint of each 70-year period.

2.4 ENVIRONMENTAL CONCENTRATIONS

In estimating exposure of the regional population from airborne as well as waterborne releases, it is necessary to determine radionuclide concentrations in several environmental media and exposure-pathway media. This section describes models used to estimated air, water, soil, sediment and food concentrations for the important pathways. All concentrations (except soil and sediment) are expressed as time integrals over a 70-year period. This is done to facilitate dose calculations that use the concentration data.

Input to the pathway analysis is the total curies released in each 70-year time period. The total release is combined with population and dispersion parameters to estimate an environmental parameter for use in the exposure analysis. For airborne releases the value is calculated as:

$$A_c(i,t) = PM(t)\ \frac{3.16 \times 10^{-8}}{\lambda_{ri}} \int_{t_o}^{t_o + 70} a_i(t)dt$$

where $A_c(i,t)$ = population-weighted airborne release for radionuclide i over 70 years, person-Ci-yr^2/m^3

$PM(t)$ = population exposure factor for time period t, person-sec/m^3

λ_{ri} = radiological decay constant for radionuclide i, yr^{-1}

$a_i(t)$ = release rate of radionuclide i at time t, Ci/yr

3.169×10^{-8} = conversion factor, yr/sec

For waterborne releases, the water concentration parameter is calculated as:

$$W_c(i,t) = \frac{P(t)\ N\ M\ 1.119 \times 10^{-9}}{F_r\ \lambda_{ri}} \int_{t_o}^{t_o + 70} C(t)dt$$

where $W_c(i,t)$ = population-weighted water concentration for radionuclide i and time period t, person-Ci-yr^2/L

$P(t)$ = population exposed to water for time period t, persons

N = reconcentration factor, dimensionless

M = mixing ratio, dimensionless

F_r = flow rate of receiving water, ft^3/sec

$C(t)$ = release rate to the receiving water, Ci/yr, at time t

1.119×10^{-8} = conversion factor, $\frac{1}{28.31 \frac{L}{ft^3} \times 3.156 \times 10^7 \frac{sec}{yr}}$, $\frac{ft^3\ yr}{L\ sec}$

The airborne pathway analysis uses the air concentration parameter, $A_c(i,t)$, to determine several environmental concentrations:

- $S_{ca}(i,t)$, soil concentration parameter for radionuclide i at the end of the current period, person-Ci-yr/kg
- $L_{ca}(i,p,t)$, time integral of leaf concentration for radionuclide i and pathway p, from air deposition and resuspension over the current period t, person-Ci-yr^2/kg
- $P_{ca}(i,p,t)$, time integral of plant concentration for radionuclide i and pathway p, from air-deposited contaminants on plants and root uptake over the current period t, person-Ci-yr^2/kg.

The soil concentration parameter is calculated from the air concentration parameter assuming deposition to be at a uniform rate over the 70-year period:

$$S_{ca}(i,t) = \frac{A_c(i,t)\ V_{di}}{T\ 7.069 \times 10^9} \left(\frac{1-e^{-\lambda_b t}}{\lambda_b}\right)$$

where V_{di} = deposition velocity for radionuclide i, m/sec

T = length of period, years (taken as 70)

λ_b = environmental decay constant, yr^{-1}

7.069×10^9 = constant, 224 kg/m^2 x 3.156 x 10^7 sec/yr

The environmental decay constant, λ_b, is calculated as the sum of a radiological decay constant, λ_{ri}, and a soil removal constant for weathering, λ_{wi}. The soil removal constant is read from the Food Transfer Coefficient Library, FTRANSLIB, described in Appendix C. It is a correction for long-term leaching of deposited radionuclides out of the soil rooting and resuspension zones. The values given in FTRANSLIB for λ_{wi} are calculated using the formula of Baes and Sharp (1981);

$$\lambda_{wi} = \frac{P + I - E}{d\ (1 + \frac{\rho}{\Theta}\ k_{di})}$$

where P = total precipitation, cm/yr

I = total irrigation, cm/yr

E = total evapotranspiration, cm/yr

d = depth of the roofing zone, cm

ρ = soil bulk density, g/cm^3

Θ = soil volumetric water content, mL/cm^3, and

k_{di} = distribution coefficient for isotope i, mL/g.

For simplicity, the term P + I - E was approximated as an overwatering term, implying about 15 centimeters per year of percolation. The depth, d, was taken as 15 centimeters. Baes and Sharp (1981) show that the term $\frac{P}{\Theta}$ averages about 3. Thus, the soil removal constant for percolation can be considered to be inversely proportional to the soil distribution coefficient k_{di}. For the values presented in Appendix C in FTRANSLIB, the most conservative (largest) value of k_d identified in a wide range of literature was applied. The exponential expression represents the calculation of the amount of a radionuclide remaining after accumulation at a constant rate for T years. The rate of deposition is proportional to A_c/T. The actual calculation is performed by subroutine BCHAIN, which considers production of daughters in decay chains.

The time integral of leaf concentration is calculated from the air and soil concentration parameters assuming a constant soil concentration equal to the value at the end of the 70-year period. This is a conservative assumption. The equation is:

$$L_{ca}(i,p,t) = \frac{0.25\ V_{di}}{Y_p} [A_c(i,t) + 1.49 \times 10^{-8}\ S_{ca}(i,t)\ 70]$$

$$\frac{1 - e^{-\lambda_{ei} T_p /365}}{\lambda_{ei}}\ 3.156 \times 10^7$$

where Y_p = crop yield for food pathway p, kg/m^2

λ_{ei} = effective retention rate constant for radionuclide i, yr^{-1};

$\lambda_{ei} = \lambda_{ri} + 18.0838,\ yr^{-1}$

18.0838 = rate constant for a 14-day half time

T_p = growing period for food pathway p, days

0.25 = interception fraction, dimensionless

1.49×10^{-8} = conversion factor, $1 \times 10^{-9}\ (m^{-1}) \times 224/15\ \frac{kg}{m^2}$

365 = days per year

3.156×10^7 = seconds per year

The factor of 1×10^{-9} (m^{-1}) represents a resuspension factor assumed constant, characteristic of aged deposited material (Anspaugh 1975). The resuspended activity is assumed to deposit on the plants near the soil from which it was suspended. Downwind transport of resuspended activity is not considered. The factor of 224 is the soil area density to a depth of 15 cm of 224 kg/m^2, and 15 cm is the plow depth through which the contamination is distributed. This value is included so that only the top centimeter of material (1/15 of the total) is considered available for resuspension. The leaf concentration as calculated above represents the time integral over a 70-year period.

The concentration in edible parts of the plant includes material from direct deposition plus material from root uptake:

$$P_{ca}(i,p,t) = L_{ca}(i,p,t)\ T_{vp} + 70\ S_{ca}(i,t)\ B_{iv}$$

where $P_{ca}(i,p,t)$ = time integral of plant concentrations for plant type p for radionuclide i and time period t, person-Ci-yr^2/kg

T_{vp} = translocation factor of externally deposited radionuclides to edible parts of the plant, dimensionless

B_{iv} = concentration ratio for plant uptake of radionuclide i, Ci/kg (wet weight plant) per Ci/kg (dry weight soil)

Other terms are as previously defined.

The concentration used for calculating uptake by the population is the plant concentration for plant pathways. For animal pathways, the uptake is calculated as:

$$A_{ca}(i,p,t) = P_{ca}(i,p,t)\ S_{ip}\ Q_p$$

where $A_{ca}(i,p,t)$ = time integral of animal product concentration for radionuclide i, animal product p, and time period t, person-Ci-yr^2/kg, (person-Ci/yr^2/L for milk)

S_{ip} = transfer coefficient of radionuclide i from daily intake by animal to edible portion of animal product, Ci/L (milk) per Ci/day or Ci/kg (animal product) per Ci/day

Q_p = the consumption rate of contaminated feed or forage by the animal for animal product p, kg/day

The waterborne pathway analysis uses the water concentration $W_c(i,t)$ to determine the following environmental concentrations:

- $S_{cw}(i,t)$, soil concentration for radionuclide i at the end of the current period t for irrigation deposition, person-Ci-yr/kg
- $S_{dw}(i,t)$, sediment deposition concentration for radionuclide i at the end of the current period t for shoreline of contaminated water body, person-Ci-yr/m^2
- $L_{cw}(i,p,t)$, leaf concentrations for radionuclide i, plant type p, and time period t from irrigation deposition and resuspension, person-Ci-yr^2/kg
- $P_{cw}(i,p,t)$, plant concentration for radionuclide i and pathway p, from irrigation deposition onto plant and root uptake through soil, person-Ci-yr^2/kg.

The soil concentration at the end of the period is calculated assuming uniform deposition over the period.

$$S_{cw}(i,t) = \frac{W_c(i,t)\ I\ T_i}{T\ 224}\left(\frac{1 - e^{-\lambda_b T}}{\lambda_b}\right)$$

where I = irrigation rate, L/m^2 mo

T_i = irrigation period, mo/yr

224 = soil area density, kg/m^2

The exponential term represents the integral over the 70 year period T.

The concentration in the sediment is calculated similarly as:

$$S_{dw}(i,t) = W_c(i,t)\ 25300$$

where 25300 = constant to represent deposition to sediment, $L/m^2/yr$. The value of the sediment deposition constant (25300) was derived from radionuclide concentrations measured in water and sediment samples collected over a period of years in the Columbia River between Richland, Washington and the river mouth in Tillamook Bay, Oregon, 75 kilometers south of the river mouth (Nelson 1965; Toombs and Cutler 1968).

The concentration on leaves is calculated for contributions from direct irrigation deposition plus resuspension from soil:

$$L_{cw}(i,p,t) = \frac{0.25}{Y_p}\left[W_c(i,t) \cdot I \cdot 12 + S_{cw}(i,t) \cdot 70 \cdot 0.47\ V_{di}\right] \left(\frac{1 - e^{-\lambda_e T_p/365}}{\lambda_e}\right)$$

where 0.25 = plant retention factor, dimensionless

Y_p = plant yield for plant type p, kg/m^2

12 = unit conversion constant, mo/yr

0.47 = conversion factor for resuspension;

$0.47 = (10^{-9}\ m^{-1})\ (3.156 \times 10^7\ sec/yr)\ (224\ kg/m^2)\ (1/15)$

V_{di} = deposition velocity of resuspended activity, m/sec

λ_{ei} = environmental weathering constant for 14-day half time, yr^{-1}; 24-day half time, yr^{-1};

$\lambda_{ei} = \lambda_{ri} + 18.0838$

70 = length of period, yr

The concentration in edible parts of the plant is calculated for root uptake plus direct deposition as follows:

$$P_{cw}(i,p,t) = L_{cw}(i,p,t)\ T_{vp} + 70 \cdot S_{cw}(i,t)\ B_{iv}$$

where T_{vp} = translocation factor of externally deposited radionuclides to edible parts of plant, dimensionless

B_{iv} = concentration ratio for plant uptake of radionuclide i, Ci/kg (wet weight plant) per Ci/kg (dry weight soil)

The total uptake of plants during the 70-year period is given by the above plant concentration parameter. For animal products, the uptake is calculated for animal consumption of plants plus animal consumption of water:

$$A_{cw}(i,p,t) = S_{ip}\ [P_{cw}(i,p,t)\ Q_p + W_c(i,t)\ Q_{pw}]$$

where $A_{cw}(i,p,t)$ = time integral of animal product p, concentration in time t, for radionuclide i from waterborne pathways, person-Ci-yr^2/kg (person-Ci-yr^2/L for milk).

S_{ip} = transfer coefficient of radionuclide i from daily intake by animal to edible portion of animal product p, Ci/L (milk) per Ci/day or Ci/kg (animal product) per Ci/day

Q_p = the consumption rate of contaminated feed or forage by animal for animal type p, kg/day

Q_{pw} = the consumption rate of water by animal for animal type p, L/d

The time-integrated concentration in aquatic foods is calculated from the water concentrations as follows:

$$A_{fw}(i,p,t) = W_c(i,t)\ B_{ip}$$

where $A_{fw}(i,p,t)$ = time-integrated concentration of radionuclide i in aquatic food p, person-Ci-yr^2/kg

B_{ip} = bioaccumulation factor for radionuclide i and aquatic food p, Ci/kg per Ci/L

The time-integrated water concentration for the drinking water pathway is calculated as:

$$A_{dw}(i,t) = W_c(i,t)\ C_i$$

where $A_{dw}(i,t)$ = time-integrated of concentration in drinking water for radionuclide i and time period t, person-Ci-yr^2/L

C_i = water purification plant cleanup factor, dimensionless

The radionuclides tritium and carbon-14 are handled in a special manner. The concentrations of tritium or carbon-14 in environmental media (soil, plants, and animal products) are assumed to have the same specific activity (picocuries of radionuclide per kilogram of soluble element) as the contaminating medium (air or water). The fractional content of hydrogen or carbon in a plant or animal product is then used to compute the concentration of tritium or carbon-14 in the food product under consideration. Hydrogen contents in both the water and the nonwater (dry) portion of the food product are used when calculating the tritium concentration. It is assumed that plants obtain all their carbon from airborne carbon dioxide and that animals obtain all their carbon through ingestion of plants.

When carbon-14 is present only in the water used for irrigation, it is difficult to model its transfer to vegetation because plants acquire most of their carbon from the air. At this time, the transfer of carbon from the water to the air or soil has not yet been determined. Currently available models for carbon-14 uptake by plants from water use specific-activity models relating the activity in the plants directly to the activity in irrigation water. This is extremely conservative in that it assumes that plants receive all of their carbon from water. An interim model has been implemented in DITTY with the basis being the ratio of grams of carbon-14 to grams of total carbon in soil and a correction for the amount of carbon plants obtain from soil.

The concentration of tritium in vegetation, C_{Hv}, is calculated as:

$$C_{Hv} = 9C_{Hw}F_{hv}$$

where C_{Hw} = the concentration of tritium in the environmental water (pCi/L); for a water release C_{Hw} represents concentration in irrigation water; for an airborne release C_{Hw} represents concentration in airborne moisture; hence C_{Hw} = air concentration in $pCi(^3H)/m^3$ ÷ absolute humidity in $L \cdot m^{-3}$,

F_{hv} = the fraction of hydrogen in total vegetation (see Table 1); the coefficient 9 converts tritium concentration in environmental water to concentration in hydrogen

The concentration of tritium in the animal product, C_{Ha}, is:

$$C_{Ha} = \left[\frac{C_{HF}Q_F + C_{Haw}Q_{aw}}{F_{hf}Q_F + Q_{aw}/9} F_{ha}\right]$$

where C_{HF} = the concentration of tritium in feed or forage calculated in the equation above where now $C_{HF} = C_{Hv}$, pCi/kg

F_{hf} = the fraction of hydrogen in animal feed, where now $F_{hf} = F_{hv}$ (grain)

F_{ha} = the fraction of hydrogen in animal product (see Table 1)

C_{Haw} = the concentration of tritium in animal drinking water (set to 0 unless there is a release of water)

Similarly, the concentration of carbon-14 in vegetation from irrigation, C_{14Cv}, is:

$$C_{14Cv} = C_{Cw} \; I \; T_i \; \frac{0.1}{224(0.01)} \left(\frac{1-e^{-\lambda_b T}}{\lambda_b} \right)$$

where C_{14Cv} = the concentration of carbon-14 in the plant, pCi/kg

0.1 = the assumed uptake of 10% of plant carbon from soil

0.01 = the average fraction of soil that is carbon

The concentration of carbon-14 in vegetation from atmospheric contamination is

$$C_{14Cv} = C_{14Ca} \; F_{cv}$$

where C_{14Ca} = the air concentration of carbon -14 (pCi/m^3) ÷ the carbon concentration in air (kg/m^3)

F_{cv} = the fraction of carbon in total vegetation

The concentration of carbon-14 in the animal product is:

$$C_{14Ca} = \left[\frac{C_{14CF} Q_F + C_{14Caw} \; Q_{aw}}{F_{cf} \; Q_F + F_{cw} \quad A_{aw}} \right] F_{ca}$$

For an air release, C_{14Caw} is equal to zero, and since F_{cw} is very small compared with F_{cf}, this equation reduces to:

$$C_{14Ca} = C_{14CF} \; \frac{F_{ca}}{F_{cF}}$$

Table 1 contains the various parameters and fractions needed for these calculations.

TABLE 1. Generic Fractions and Concentrations of Hydrogen and Carbon in Vegetation, Animal Products, and Environmental Media

Food or Fodder	Water f_w	Carbon (dry) f_c	Hydrogen (dry) f_h	Carbon[(a)] (wet) F_{cv}, F_{ca}	Hydrogen[(b)] (wet) F_{hv}, F_{ha}
Fresh fruits, vegetables, grass	0.80	0.45	0.062	0.090	0.10
Grain, stored animal feed	0.12	0.45	0.062	0.40	0.068
Eggs	0.75	0.60	0.092	0.15	0.11
Milk	0.88	0.58	0.083	0.070	0.11
Beef	0.60	0.60	0.094	0.24	0.10
Pork	0.50	0.66	0.10	0.33	0.11
Poultry	0.70	0.67	0.087	0.20	0.10

Media	Concentration
Absolute Humidity	0.008 L/m^3
Concentrations of carbon in water	2.0×10^{-5} kg/L[(c)]
Concentrations of carbon in air	1.6×10^{-4} kg/m^3[(d)]
Fraction of soil that is carbon 0.03	
Soil moisture 0.1 L/kg	

(a) F_{cv} or $F_{ca} = f_c\ (1 - f_w)$.
(b) F_{hv} or $F_{ha} = f_w/9 + 9 + f_h(1 - f_w)$.
(c) Assumes a typical bicarbonate concentration of 100 mg/L.
(d) Assumes a typical atmospheric CO_2 concentration of 320 ppm_v.

The environmental parameters defined above are used to estimate doses during each 70-year period, as defined in the next section.

2.5 PATHWAY DOSE CALCULATIONS

The total dose received by the regional population is estimated as the sum of contributions from all pathways. The doses are calculated as the population dose received in each 70-year time period from material released to the environment during that period plus all previous periods. Precalculated dose conversion factors are used to estimate dose from uptake and environmental concentration. The exposure pathways are described in the following sections.

Doses can be calculated for up to six body "organs": total body, kidney, liver, bone, lungs, thyroid, and lower large intestine. Other organs may be included (up to a total of 10) through additions to File 10, DSFCT (see Appendix C).

2.5.1 Air Submersion

Contributions for external exposure from air submersion are included for: 1) submersion in the release plume, 2) submersion in resuspended activity from an initial airborne release, and 3) submersion in suspended activity from an initial irrigation water deposition. The dose is calculated as:

$$D_{oei} = D_{ei}\ \lambda_{ri}\ 3.156 \times 10^{7}\ [A_c(i,t) + 1.49 \times 10^{-8} \cdot 70\ (S_{ca}(i,t) + S_{cw}(i,t))]$$

where D_{oei} = population dose from air submersion to organ o from radionuclide i, person-rem

D_{ei} = external exposure dose conversion factor for air submersion, rem per Ci-sec/m^3

λ_{ri} = radiological decay constant for radionuclide i, yr^{-1}

3.156×10^7 = conversion factor, sec/yr

$A_c(i,t)$ = time-integrated air concentration of radionuclide i in time period t, person-Ci-yr^2/m^3

1.49×10^{-8} = resuspension factor constant, kg/m^3;

$$1.49 \times 10^{-8} = (1 \times 10^{-9}\ m^{-1})\ (224\ \frac{kg\ soil}{m^2})\ (1/15)$$

70 = time of exposure to resuspended activity, yr

$S_{ca}(i,t)$ = soil concentration from airborne release of radionuclide i at the end of time period t, person-Ci-yr/kg

$S_{cw}(i,t)$ = soil concentration from waterborne release of radionuclide i at the end of time period t, person-Ci-yr/kg

The contribution from deposited material is based on the concentration at the end of the current period. This concentration is assumed to occur throughout the period, which is a conservative assumption by no more than a factor of two. Resuspension is based on a constant resuspension factor of $10^{-9}\ m^{-1}$, representing resuspension of aged deposited material (Anspaugh 1975). The resuspended activity is assumed to expose individuals in the vicinity of the soil from which it was suspended. Downwind transport of resuspended activity is not considered. The decay constant, λ_{ri}, is included to convert the units of radionuclide concentration from mass to activity. The calculations are performed in units proportional to mass to meet requirements of the chain decay processor, BCHAIN.

2.5.2 Inhalation

Inhalation exposure includes contributions from the released airborne activity plus the resuspended activity from airborne and irrigation water deposition. The dose is calculated as:

$$D_{ohi} = D_{hio}\ 3.156 \times 10^{7}\ \lambda_{ri}\ [A_c(i,t) + 1.49 \times 10^{-8} \cdot 70\ (S_{ca}(i,t) + S_{cw}(i,t))]$$

where D_{ohi} = dose from inhalation exposure from organ o from radionuclide i, person-rem

D_{hio} = inhalation dose conversion factor for radionuclide i and organ o, rem per $Ci\text{-}sec/m^3$

and other terms are as previously defined.

2.5.3 Terrestrial Ingestion Pathways

Terrestrial pathways include ingestion of crops and animal products. The seven terrestrial ingestion pathways available are vegetables, grain, eggs, milk, beef, pork, and poultry. The dose for each pathway is calculated from the time-integrated food-product concentration. For plants the dose is calculated as:

$$D_{oti} = D_{gio}\ \lambda_{ri}\ U_p\ [P_{ca}(i,p,t) + P_{cw}(i,p,t)]$$

and for animal products, the dose is calculated as:

$$D_{oti} = D_{gio}\ \lambda_{ri}\ U_p\ [A_{ca}(i,p,t) + A_{cw}(i,p,t)]$$

where D_{oti} = dose from terrestrial ingestion pathways for organ o, person-rem

D_{gio} = ingestion dose conversion factor for radionuclide i and organ o, rem/Ci

U_p = the usage rate by humans of food product p, kg/yr (or L/yr for milk)

$P_{ca}(i,p,t)$ = time integral of plant concentration from airborne pathways for radionuclide i, plant type p, and time period t, person-Ci-yr^2/kg

$P_{cw}(i,p,t)$ = time integral of plant concentration from waterborne pathways for radionuclide i, plant type p, and time period t, person-Ci-yr^2/kg

$A_{ca}(i,p,t)$ = time integral of animal product concentration from airborne pathways for radionuclide i, animal product p, and time period t, person-Ci-yr^2/kg, (person-Ci-yr^2/L for milk)

$A_{cw}(i,p,t)$ = time integral of animal product concentration from waterborne pathways for radionuclide i, animal product p, and time period t, person-Ci-yr^2/kg, (person-Ci-yr^2/L for milk)

The total dose from terrestrial ingestion pathways is calculated by summing contributions from all plant and animal product food types.

2.5.4 Aquatic Ingestion Pathways

Ingestion pathways resulting from release of radionuclide to surface or groundwater include ingestion of drinking water and aquatic foods. The five pathways available are fish, crustacea, molluscs, water plants, and drinking water. The dose for each pathway is calculated from the time-integrated aquatic media concentration as follows for aquatic foods:

$$D_{oai} = D_{gio}\ \lambda_{ri}\ U_a\ A_{fw}(i,p,t)$$

and for drinking water:

$$D_{oai} = D_{gio}\ \lambda_{ri}\ U_a\ A_{dw}(i,t)$$

where D_{oai} = dose from ingestion of aquatic food or water for organ o, person-rem

U_a = the usage rate by humans of aquatic-food pathway a, kg/yr (L/yr for drinking water)

$A_{fw}(i,p,t)$ = time integral of aquatic food p, concentration for radionuclide i, in time period t, person-Ci-yr^2/kg

$A_{dw}(i,t)$ = time integral of drinking water concentration for radionuclide i in time period t, person-Ci-yr^2/L

2.5.5 External Exposures

External exposures result from proximity to contaminated ground, shoreline, and water. Swimming and shoreline doses are calculated from the time-integrated sediment concentration and water concentration:

$$D_{oew} = \lambda_{ri}\ [70\ S_{dw}(i,t)\ D_{os}\ U_{sh}\ W + W_c(i,t)\ D_{ow}\ U_{sw}]$$

where D_{oew} = dose from external exposure to shoreline and water for organ o, person-rem

D_{os} = external dose factor for organ o for exposure to concontaminated soil or shoreline, rem/hr per Ci/m^2

D_{ow} = external dose factor for organ o for submersion in contaminated water, rem/hr per Ci/L

U_{sh} = time of exposure to contaminated shoreline, hr/yr

U_{sw} = time of exposure to contaminated water, hr/yr

$S_{dw}(i,t)$ = sediment concentration for radionuclide i at the end of the current time period t, person-Ci-yr/m^2

$W_c(i,t)$ = time integral of water concentration for radionuclide i and time period t, person-Ci-yr^2/L

W = shore-width factor for shoreline exposure, dimensionless

70 = duration of exposure, yr

The shore-width factor is an approximate correction to the infinite-plane geometry of the external exposure factors. To correct for the actual geometry of a river bank or beach, a shore-width factor is applied corresponding to the particular exposure situation. Suggested shore-width factors are given in Table 2. Contamination of soil can result from deposition of airborne material or from irrigation with contaminated water. The dose from external exposure to contaminated soil is calculated as:

$$D_{oes} = \lambda_{ri}\ E_t\ D_{ow}\ 224\ 70\ [S_{ca}(i,t) + S_{cw}(it)]$$

where D_{oes} = dose from external exposure to soil for organ o, person-rem

E_t = time of exposure to contaminated ground, hr/yr

$S_{ca}(i,t)$ = soil concentration due to airborne deposition of radionuclide i at the end of time period t, person-Ci-yr/kg

$S_{cw}(i,t)$ = soil concentration due to waterborne deposition of radionuclide i at the end of time period t, person-Ci-yr/kg

224 = soil areal density, kg/m^2

70 = time of exposure period, yr

Other terms are as previously defined. Note that the external exposure is based on the soil concentration at the end of the current 70-year period.

This results in an over-estimation of dose when the deposition is uniform over the 70-year period.

TABLE 2. Shore-Width Factors

Exposure Situation	Shore-Width Factor (W)
Discharge canal bank	0.1
River shoreline	0.2
Lake shore	0.3
Nominal ocean site	0.5
Tidal basin	1.0

REFERENCES

Anspaugh, L. R., J. H. Shinn, P. L. Phelps and N. C. Kennedy. 1975. "Resuspension and Redistribution of Plutonium in Soils." Health Physics. 29:571-582.

Baes, C. F., and R. D. Sharp. 1981. Predicting Radionuclide Leaching From Root Zone Soil from Assessment Applications (Draft). CONF-810606, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Fields, D. E. 1982. EPA Liquid Release Health Impact Code: Feasibility Study. ORNL-5867, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Hoffman, F. O., C. W. Miller, D. L. Shaeffer and C. T. Garten, Jr. 1977. "Computer Codes for the Assessment of Radionuclides Released to the Environment." Nuclear Safety. 18(3):343-354.

Mills, M. and D. Vogt. 1983. A Summary of Computer Codes for Radiological Assessment. NUREG/CR-3209, U.S. Nuclear Regulatory Commission, Washington, D.C.

Napier, B. A., W. E. Kennedy, Jr., and J. K. Soldat. 1980. PABLM--A Computer Program to Calculate Accumulated Radiation Dose from Radionuclides in the Environment. PNL-3209, Pacific Northwest Laboratory, Richland, Washington.

Nelson, J. L. 1965. "Distribution of Sediments and Associated Radionuclides in the Columbia River Before Hanford," p. 3.80. In Hanford Radiological Sciences Research and Development Annual Report for 1964, D. W. Pearce and J. K. Green, Eds. BNWL-36, Pacific Northwest Laboratory, Richland, Washington.

Slade, D. H. (editor). 1968. Meteorology and Atomic Energy. U.S. Atomic Energy Commission, Washington, D.C.

Strenge, D. L., E. C. Watson and J. G. Droppo. 1976. Review of Calculational Models and Computer Codes for Environmental Dose Assessment of Radioactive Releases. BNWL-B-454, Pacific Northwest Laboratory, Richland, Washington.

Toombs, G. L., and P. B. Cutler (compilers). 1968. Comprehensive Final Report for the Lower Columbia River Environmental Survey in Oregon June 5, 1961 - July 31, 1967. Oregon State Board of Health, Division of Sanitation and Engineering, Portland, Oregon.

APPENDIX A

COMPUTER CODE DESIGN

APPENDIX A

COMPUTER CODE DESIGN

This appendix provides information on the computer code design useful to programmers desiring to make modifications to the program. The average user of the code will not need the information provided here. The following sections provide:

- code hierarchy diagrams (Section A.1)
- module specifications (Section A.2).

The computer program was developed for execution on the UNIVAC 1100/44 system operated by Boeing Computer Services for the Department of Energy at Richland, Washington. The programming language is ASCII FORTRAN as implemented by the UNIVAC FTN compiler. A listing of the FORTRAN source code is given in Appendix D.

A version of the code also exists in FORTRAN 77 for an IBM personal computer. The listing is essentially identical to that for the UNIVAC, and so is not also reproduced.

A.1 CODE HIERARCHY

The computer program DITTY is composed of 40 modules, including the main program. The calling sequence for the program is indicated in the hierarchy diagrams of Figure A.1. This diagram only indicates module calling sequences; module logic diagrams are given in Section A.3.

A.2 MODULE SPECIFICATIONS

This section provides summary information on each of the 40 modules of the computer program DITTY. The information presented on each module includes:

- module name
- calling module(s)
- primary function
- common block usage
- argument list
- subordinate modules
- detailed specifications

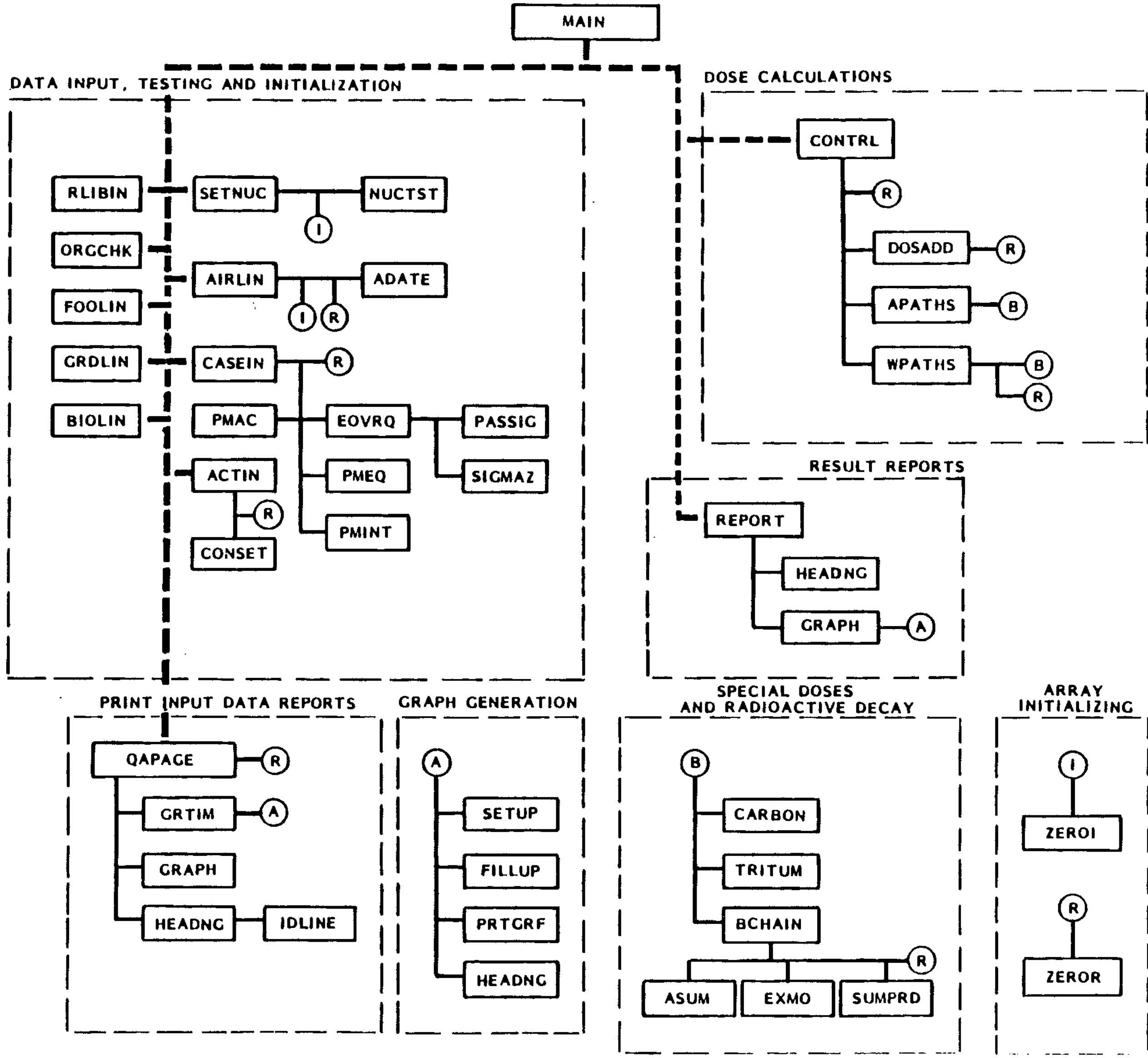


FIGURE A.1. DITTY Hierarchy Diagram--Module Calling Sequence from MAIN

The main program (module MAIN) is described first followed by the other modules in alphabetical order. All modules are included except for the special function IDLINE which is called from QAPAGE to print a descriptive line defining the version and preparation date of the program being executed.

A.2.1 Specifications for MAIN Program

Primary Function: This module controls input of data and case iterations.

Common Blocks Used: BIODAT, DECAY, DISPSN, DKAY, FODATA, NAMLST, OPTION, ORGID, PATHIN, SOURCE, TIMES, TITLES, VARYBL

Argument List: None

Subordinate Modules: RLIBIN, SETNUC, ORGCHK, AIRLIN, BIOLIN, FOOLIN, GRDLIN, CASEIN, ACTIN, QAPAGE, CONTRL, REPORT, ZEROI.

This module controls input of data and case iteration through calls to subroutines. The master data library RMDLIB is called first to provide radionuclide decay information. Next, the list of radionuclides and organs to be considered for the run are read. The subroutine SETNUC is called to select decay data for the input radionuclides and establish the master radionuclide list for the run (including necessary daughters of selected radionuclides). Three additional data libraries are read next to provide necessary data as follows:

Module	Data File Read
ARLIN	DSFCT, internal dose factors
FOOLIN	FTRANSLIB, food transfer coefficient data
GRDLIN	GRDFLIB, external dose factors

For each case to be run, the program calls subroutine CASEIN to read input from cards. Subroutine BIOLIN is called to read bioaccumulation factors for fresh or salt water. The subroutine ACTIN is called (if necessary) to establish release rate data arrays. A quality assurance report of input data is generated by subroutine QAPAGE. Then dose calculations are performed (subroutine CONTROL) and result reports are printed (subroutine REPORT).

An attempt is made to read a title card for the next case. An end-of-file on input at this point is the normal mode for termination of execution.

A.2.2 Specifications for Subroutine ACTIN
Called by MAIN

Primary Function: This subroutine reads release activity data for specified times for airborne or waterborne releases

Common Blocks Used: NUCNAM, TITLES

Argument List: IP, IAW, ITX, ITM, IBEG, IEND, CON

Subordinate Modules: CONSET, ZEROR

This subroutine reads release activity data from the appropriate input unit and then calls subroutine CONSET to set radionuclide release activities for each of the 143, 70-yr periods. Radionuclide names are compared with the master list names of common block NUCNAM.

The argument list parameters have the following uses:

Parameter	Description
IP	Pathway section index IP = 1 for airborne releases IP = 2 for waterborne releases
IAW	Control integer for input file specification IAW = 1 for card input IAW > 1 for permanent file input on unit 24 (waterborne) or unit 26 (airborne)
ITX	Maximum time increment index during which any releases are made for this mode (air or water). $1 \leq ITX \leq 143$ and $ITX \geq ITM$
ITM	Minimum time increment index during which any releases are made for this mode (air or water) $1 \leq ITM \leq 143$
IBEG(100)	The first time increment during which each radionuclide is released, $1 \leq IBEG(i) \leq 143$
IEND(100)	The last time increment during which each radionuclide is released, $1 \leq IEND(i) \leq 143$ and $IBEG(i) \leq IEND(i)$
CON(143,100)	Total activity released during each 70-yr period for 100 radionuclides, Ci.

A.2.3 Specifications for Subroutine AIRLIN
Called by MAIN

Primary Function: This subroutine reads internal (inhalation and ingestion) dose conversion factors

Common Blocks Used: DAY, DECAY DOSFAC, FLAGS, NUCNAM, ORGID, TITLES

Argument List: None

Subordinate Modules: ADATE (special system routine), ZEROI, ZEROR

This subroutine reads inhalation and ingestion dose conversion factors from the data file DSFCT on logical unit 18. The first three records provide descriptive information on the information to follow including a title that is printed in the input summary report (subroutine QAPAGE). Data for each radionuclide are then read sequentially. The flag array [INFLG(i)] is set to 1 if data are supplied for master list radionuclide i.

Each radionuclide read from DSFCT is compared to those in the master radionuclide list. If a radionuclide cannot be identified, an error message is printed and execution is stopped.

Index values for organs considered in the library are given at the beginning of the data file. These index values are compared to the master organ list read at the beginning of the main program. All master list organs must be included in the library list or execution will be terminated.

A.2.4 Specifications for Subroutine APATHS
Called by CONTROL

Primary Function: This module calculates environmental concentrations from atmospheric deposition

Common Blocks Used: DKAY, EDCN, FODATA, PATHIN, NUCNAM, VARYBL

Argument List: ITAX, ITIM

Subordinate Modules: BCHAIN, CARBON, TRITUM

This routine calculates the concentration of each radionuclide in the media of the following pathways from atmospheric deposition:

1. leafy vegetables
2. other vegetables
3. eggs
4. milk
5. beef
6. pork
7. poultry

Soil concentrations are also calculated. Separate subroutines are called to calculate the concentration of tritium and carbon 14. Radioactive decay is calculated by calls to subroutine BCHAIN.

The argument list parameters give the minimum (ITIM) and maximum (ITAX) time period during which any radionuclides are released to the atmosphere.

A.2.5 Specifications for Function ASUM

Called by BCHAIN

Primary Function: This function sums terms of an array

Common Blocks Used: None

Argument List: A, J

Subroutine Routines: None

This function calculates the sum of J terms of array A, as follows:

$$ASUM = \sum_{i=1}^{J} A(i)$$

A.2.6 Specifications for Subroutine BCHAIN

Called by APATHS, WPATHS

Primary Function: Calculate either radioactive decay and buildup for a chain of radionuclides for a given time period, allowing for nonradiological removal to a sink, or the time integral of the activity

Common Blocks Used: None

Argument List: NUC, T, KD, IFRM, AL, AB, AM, AO. INTGRL

Subordinate Routines: ZEROR, EXMO, ASUM, SUMPRD

This subroutine calculates amounts of radionuclides following radioactive decay, allowing for daughter buildup for a time period (T) for a chain of NUC radionuclides, or the time integral of the activity. The argument list parameters have the following uses:

Parameter	Description
NUC	Number of radionuclides in the decay chain. $1 \leq NUC \leq 9$
T	Time over which decay is to be considered. Units of T must be compatible with the units of the decay constants, AL.
DK(2,9)	Branching ratios: DK(1,i) = fraction of first parent decays resulting in production of chain member i DK(2,i) = fraction of second parent (if any) decays resulting in production of chain member i
IFRM(2,9)	Position in chain of parents for each chain member IFRM(1,i) = index of first parent for chain member i IFRM(2,i) = index of second parent for chain member i
AL(9)	Radiological decay constants for each chain member in units compatible with T
AB(9)	Sum of the radiological and nonradiological removal constants in units compatible with T
AM(9)	Initial quantity of each radionuclide in mass units (or Curie-seconds)
AO(9)	Final activity (or time integral) of each radionuclide
INTGRL	Control integer to calculate the time integral of activity when INTGRL > 0

A.2.7 Specifications for Subroutine BIOLIN

Called by MAIN

Primary Function: This subroutine reads values of the bioaccumulation factor for fish, molluscs, crustaceans, and water plants, as well as drinking water cleanup factors from the data file BIOAC (Unit 14)

Common Blocks Used: BIODAT, NUCNAM, TITLES

Argument List: None

Subordinate Routines: None

This subroutine is used to read (logical unit 14) data on the bioaccumulation of elements in aquatic organisms and the cleanup of drinking water by water treatment plants. The data are then arranged in arrays based on the order of the master list from routine SETNUC.

Data in the file are in the order:

Record	Format	Description
E	A2	Element Name
BF(1)	F9.1	Bioaccumulation factor for fish in salt water
BF(2)	F9.1	Bioaccumulation factor for crustacea in salt water
BF(3)	F9.1	Bioaccumulation factor for molluscs in salt water
BF(4)	F9.1	Bioaccumulation factor for water plants in salt water
BF(5)	F9.1	Bioaccumulation factor for fish in fresh water
BF(6)	F9.1	Bioaccumulation factor for crustacea in fresh water
BF(7)	F9.1	Bioaccumulation factor for molluscs in fresh water
BF(8)	F9.1	Bioaccumulation factor for water plants in fresh water
DW	F6.1	Drinking water cleanup factors (the fraction passing through a water treatment facility)

The parameter ISALT determines whether salt or fresh-water factors are used. Default is zero = fresh water.

A.2.9 Specifications for Subroutine CARBON

Called by APATHS, WPATHS

Primary Function: This subroutine calculates environmental concentrations of C-14 using a simplified specific-activity model. The specific-activity for plants from water uptake is calculated on basis of soil carbon and ten percent plant uptake

Common Blocks Used: BIODAT

Argument List: IST, IAW, WATCN, AIRCN, ANCONS, ANDRNK, CSOIL, EDIBL, AQUA, RIRR, MOYPR

Subordinate Routines: None

This subroutine calculates the concentration of C-14 from atmospheric deposition in leafy vegetables, other vegetables, eggs, milk, beef, pork, and poultry. The concentration of C-14 in environmental media for the following aquatic pathways is also calculated: fish, drinking water, sediment, and water for recreation and irrigation. Irrigation water in turn is assumed to contaminate vegetables, animal feed and drinking water, and the soil.

A.2.10 Specifications for Subroutine CASEIN

Called by MAIN

Primary Function: This subroutine controls input file reading plus input from population data file 22

Common Blocks Used: AIRCON, BIODAT, DISPSN, NAMLST, OPTION, PATHIN, POPU, TIMES, TITLES, VARYBL, NAMLST, TIMES, OPTION, DISPSN

Argument List: None

Subordinate Routines: EOVRQ, PMAC, PMEQ, PMINT, PMSET, ZEROR

This subroutine controls input of data for one case from the input file. Population data from file 22 are also read for input option IPOP = 3.

First, a namelist input record set is read to provide control parameters and small data arrays. When airborne releases are to be considered (IPATH $\neq$ 2) data for $\bar{x}/Q'$ calculation are read depending on the value of IEOQ. Also, $\bar{x}/Q'$ parameters are read in or calculated if necessary. Airborne population data are read as required (control integer IPOP) and population dispersion factors are calculated for each 70-yr increment.

If waterborne releases are to be considered (IPATH >1), the total population in each 70-yr period is set as necessary (control integer IPL).

A.2.11 Specifications for Subroutine CONSET Called by ACTIN

Primary Function: This subroutine establishes release data for one radionuclide for each 70-yr increment

Common Blocks Used: TIMES

Argument List: T, C, NT, IBEG, IEND, CONS

Subordinate Routines: None

This subroutine determines the total activity released during each 70-yr increment for one radionuclide. The release activity history data (times T_i and activity release rates C_i) are interpolated and integrated over each period. The beginning and ending time increments for release are also set. The argument list parameters have the following uses:

Parameter	Description
T(450)	Time points for specification of activity release rates, years since start of release calculation
C(450)	Activity released per year at each time point, Ci/yr
NT	Number of time points data is supplied for in arrays T and C, $2 \leq NT \leq 300$
IBEG	First 70-yr increment that has a nonzero release activity for the current radionuclide
IEND	Last 70-yr increment that has a nonzero release activity for the current radionuclide
CONS(143)	Total activity released in each of the 143 70-yr increments, Ci

The first value of CONS corresponds to the value CON(1,IN) in the calling routine ACTIN.

A.2.12 Specifications for Subroutine CONTRL
Called by MAIN

Primary Function: This routine controls the calling of the routines calculating environmental accumulation and decay of radionuclides, and calculation and summation of the resulting doses

Common Blocks Used: EDCN, OUTORG

Argument List: IAC, IPATH, ITAM, ITAX, ITWM, ITWX

Subordinate Routines: APATHS, DOSADD, WPATHS, ZEROR

For chronic releases, the incremental increase in the environmental concentration for each 70-yr block is calculated, using deposition from either air or water and decay of previously deposited nuclides. Doses for this time increment are calculated and added to the running total. A special preliminary step is taken for acute releases, for year one only, to account for maximized leafy deposition, before reverting back to the standard chronic mode. This routine controls the 143 step time loop.

A.2.13 Specifications for Subroutine DOSADD
Called by CONTRL

Primary Function: This routine calculates 70-yr incremental population doses from exposure to contaminated environmental media

Common Blocks Used: PATHIN, EDCN, RESULT, DOSFAC, GRDDAT, DKAY, ORGID, DOSIN, OUTORG

Argument List: ICUTE, ITT

Subordinate Routines: ZEROR

This routine calculates the 70-yr population dose increment for each 70-yr period and adds it to the running total. Additionally, running totals are kept for each organ. DOSADD saves the result from the time period of highest dose, along with the corresponding time. For acute releases, the dose saved is the 70-yr commitment from the first year of exposure. The doses are saved in common block RESULT. Required input variables are defined as:

1. From Common Block PATHIN:
   CONSUM(7): leafy vegetables, other vegetables, eggs, milk, beef, pork
   USAGE(7): fish, crustaceans, molluscs, plants, drinking water, shoreline, swimming
   EXTIME: hr/yr external exposure, avg.
   SW: shore width factor, default to 0.2

2. From Common Block EDCN:
   Water Pathways
   WATCON(100): water concentration
   SCONW(100): soil concentration from irrigation
   SEDCON(100): sediment concentration
   EDBCNW(7,100): terrestrial concentrations by pathway (see CONSUM)
   AQUATC(5,100): aquatic concentrations by pathway (see USAGE)
   Air Pathways
   AIRCON(100): atmospheric concentration from diffusion/disperson
   SLCON(100): soil concentration from fallout
   EDBCON(7,100): terrestrial concentrations by pathway (see CONSUM)
   **Note: all of these concentrations already contain the population values, as well as a factor of 1/AR

3. From Common Block GRDDAT:
   EDS(100): soil external factors, rem/hr per Ci/m^2
   EDW(100): water external factors, rem/hr per Ci/m^3
   EDA(100): air external factors, rem per $Ci\text{-}sec/m^3$

4. From Common Block DOSFAC:
   DFH(2,5,100): inhalation dose factors
   DFG(2,5,100): ingestion dose factors

Other pertinent points: Air concentrations used for the dose calculations include resuspension from the soil at a fraction of 10^{-9} m^{-1} from the top 1 cm of soil, as:

$$Ci/kg\ (10^{-9}\ m^{-1})(224\ kg/m^2)(1\ cm/15\ cm) = 1.49 \times 10^{-8}.$$

A.2.14 Specifications for Subroutine EOVRQ
Called by CASEIN

Primary Function: This subroutine calculates an annual average air concentration at each spatial interval midpoint

Common Blocks Used: AIRCON, DISPSN

Argument List: None

Subordinate Routines: PASSIG, SIGMAZ

This subroutine calculates an annual average air concentration at each spatial interval midpoint. The equation used is:

$$EOQ(IX,IT) = 0.02032 \sum_{i=1}^{NUBAR} \sum_{j=1}^{NMET} F(i,j,IT) \frac{\exp\left(-HS^2/(2 \cdot \sigma_z^{\,2}\right)}{X_{IX}\ \sigma_Z\ \bar{u}_i}$$

where EOQ(IX,IT) = air concentration at distance IX and in direction IT, sec/m^3

F(i,j,IT) = joint frequency of occurrence for windspeed i, stability j and direction IT

HS = effective height of release, m

σ_Z = crosswind vertical standard deviation of air concentration, m

X_{IX} = distance to position IX, m

$\bar{u}_i$ = windspeed i, m/sec

$$0.02032 = 0.1 * \frac{8}{\pi}\ \frac{2}{\pi}^{\ 1/2}$$

The dispersion parameter σ_z is calculated by subroutine PASSIG for Pasquill categories and by function SIGMAZ for Hanford stable categories.

A.2.15 Specifications for Function EXMO
Called by BCHAIN

Primary Function: The function calculates a value for the expression $(1 - e^{-\lambda t})/\lambda$.

Common Blocks Used: None

Argument List: AL, ARG

Subordinate Routines: None

This function calculates a value for the expression:

$$\frac{1 - e^{-\lambda t}}{\lambda}$$

The argument list is:

ARG = λt

AL = λ

The method used to evaluate the expression is determined by the value of ARG. When ARG is positive, an error message is printed and execution is stopped. When -ARG > 0.001, then the expression is evaluated as

$$\text{EXMO} = [1.0 - \text{EXP(ARG)}]/\text{AL}$$

When -ARG $\leq$0.001, the expression is evaluated as

$$\text{EXMO} = \sum_{n=1}^{I} \frac{(\lambda t)^n(-1)^{n-1}}{n!\lambda}$$

where I = integer value of 8-Log_{10}(-ARG) and I $\geq$ 2.

A.2.16 Specifications for Subroutine FILLUP Called by GRAPH

Primary Function: FILLUP is a graphing subroutine which sets points of the function array in the graphics printing array

Common Blocks Used: NUCNAM, PLOT

Argument List: FOFX, YINC, IN, NOAVE

Subordinate Routines: None

The subroutine FILLUP looks at each point in one function of the array FOFX. Up to eight functions may be superimposed on one graph. FILLUP selects a plotting symbol for each function. If two or more points are to occupy the same storage location, FILLUP will substitute the digit equal to the number of overlays from the plotting symbols for that location.

The printing array has a time (horizontal) dimension of 72 which corresponds to 144 periods. For most functions the average of two consecutive time points is plotted in one position. Some functions (i.e., population input data) where only a few points are plotted would be distorted if the average algorithm were used. The argument list parameter NOAVE allows the option of not averaging zero values with data points.

Each point is stored in the printing array based on the y-axis increment value, which is passed in the argument list. Testing is done to ascertain that no points are plotted outside the graph.

The argument list parameters have the following functions:

Parameter	Type	Description
FOFX(144,8)	REAL	Array of up to eight functions to be plotted versus time
YINC	REAL	Y-axis plotting increment
IN	INTEGER	Index of the function in FOFX to be placed in printing array
NOAVE	INTEGER	FLAG - if set to 1, do not average zeros into array

A.2.17 Specifications for Subroutine FOOLIN
Called by MAIN

Primary Functions: This subroutine reads in crop and animal food concentration ratios, deposition velocities, and soil percolation constants from data file FTRANSLIB

Common Blocks Used: FODATA, NUCNAM, TITLES

Argument List: None

Subordinate Routines: None

This subroutine reads data on the deposition velocity of radionuclides onto soil; the concentration ratios between soil and plants, and plants and animal products; and the factors describing the percolation of radionuclides out of the root zone into deeper soil. The data are then arranged into arrays based on the order of the master radionuclide list from routine SETNUC.

Data in the file are in the format:

Record	Format	Description
E	A2	Element Name
DVL	E9.2	Deposition velocity, m/s
CR(1)	E9.2	Soil/food CR, dimensionless
CR(2)	E9.2	Egg CR, day/kg
CR(3)	E9.2	Milk CR, day/L
CR(4)	E9.2	Beef CR, day/kg
CR(5)	E9.2	Pork CR, day/kg
CR(6)	E9.2	Poultry CR, day/kg
PERC	E9.2	Percolation constant, yr^{-1}

FOOLIN reads from the data file FTRANSLIB assigned to logical unit No. 12.

A.2.18 Specifications for Subroutine GRAPH
Called by QAPAGE, REPORT

Primary Function: This subroutine controls the printing of graphs of functions in relation to time

Common Blocks Used: NUCNAM, ORGID

Argument List: IYL, FOFX, NGRF, IORNUC, IFROM, NOAVE, IGRAW

Subordinate Routines: SETUP, FILLUP, PRTGRF

This subroutine is called by QAPAGE and REPORT to output a graph of a particular function. The function to be plotted versus 144, 70-yr time increments is passed in the array FOFX. Up to eight plots may be superimposed on one graph, though this feature is not currently being utilized.

Labels for the functions are stored in data statements and in some cases constructed from information passed in the argument list. There are seven label options selected by the value of the argument list parameter IYL as follows:

1. "total population"
2. "population dispersion factor"
3. "population for waterborne pathways"
4. "total curies per period"
5. "curies per period of radionuclide name"
6. "total organ dose"
7. "organ dose"

The radionuclide name or organ is determined by the value of the index parameter IORNUC which indicates the storage position in the appropriate character name array. The subroutine SETUP is called to ready the labels for printing.

The argument list parameters are outlined in the following table:

Parameter	Type	Description
IYL	INTEGER	Index of selected label for function
FOFX(144,8)	REAL	Array of Function(s) to be plotted versus time (144 70-yr periods). Up to eight plots may be superimposed on the graph
NGRF	INTEGER	Number of functions to be superimposed on this graph
IORNUC	INTEGER	Index of radionuclide or organ to be graphed. Used to include appropriate name in y-axis label
IFROM	INTEGER	Indicates calling subroutine: Ø = QAPAGE, 1 = REPORT. Used for page heading
NOAVE	INTEGER	If set to 1, do not average in zero values
IGRAW	INTEGER	Release message flag to be printed on graph: Ø = no message, 1 = air message, 2 = water message

The maximum value in the FOFX array is determined, the y-axis increment is calculated, and the y-axis tick mark values are calculated. For each plot the subroutine FILLUP is called to plot the function into the print array. PRTGRF is then called to print the graph.

A.2.19 Specifications for Subroutine GRDLIN
Called by MAIN

Primary Function: This subroutine reads in dose factors for external exposure to soil, water and air (data file GRDFLIB)

Common Blocks Used: GRDDAT, NUCNAM, TITLES

Argument List: None

Subordinate Routines: None

This subroutine is used to read in data on the external dose rate factors for exposure to contaminated soil, water, or air. Only the factors for total body dose are read in.

Since some data from the library are omitted, the read format is A2, A6, 9x, E9.2, 9x, 2E9.2 parameters are:

E	A2	Element Name
A	A6	Atomic weight, +D, and/or metastable designations
EDS	E9.2	External dose function from soil exposure, mrem/hr per pCi/m2
EDW	E9.2	External dose from swimming, mrem/hr per pCi/m^2
EDA	E9.2	External dose factor from air submersion, mrem/hr per pCi/m3

GRDLIN reads from data file GRDFLIB assigned to logical unit No. 16.

A.2.20 Specifications for Subroutine GRFIL
Called by QAPAGE

Primary Function: This subroutine transfers values in a 20-position array to be plotted versus time into corresponding positions in a 144-position array

Common Blocks Used: None

Argument List: IT, Y20, FOFX, NT

Subordinate Modules: None

This subroutine determines the ordinate position for plotting points in the function array Y20. The values are transferred into the 144-position plotting array FOX.

The argument list parameters have the following uses.

Parameter	Type	Description
IT(20)	INTEGER	Cross-index of subscripts corresponding to a 144-position array
Y20(20)	REAL	Input array to be plotted versus time
FOFX(144)	REAL	Output array corresponding to the 144-position time array
NT	INTEGER	Number of time periods in arrays IT and Y20

A.2.21 Specifications for Subroutine GRTIM
Called by QAPAGE

Primary Function: GRTIM is a graphing subroutine which selects the corresponding positions of a 144-position time array for the 20-position input time array

Common Blocks Used: TIMES

Argument List: T20, IT144, NT

Subordinate Modules: ZEROI

The array T20 gives times at which population data are supplied for air or water releases. To graph the population data in the same time configuration as the releases and doses it is necessary to locate the corresponding time position in a 144 element array. GRTIM selects those corresponding positions.

ZEROI initiates the 144-position time array. The testing parameter TT is initialized to the starting time (TZ) and the increment is set to 70 years.

The argument list parameters have the following uses:

Parameter	Type	Description
T20(20)	REAL	20-position time array. Corresponds to times at which population data are supplied
IT144(20)	INTEGER	20-position array of indices indicating in which position in a 144 point array, with 70-yr increments, the times in T20 should be plotted
NT	INTEGER	No. of times in the array T20

Each time in T20 is tested until its corresponding position is found in the 144-position array. The index of that position is stored in the array IT 144.

A.2.22 Specifications for Subroutine HEADNG
Called by QAPAGE, GRAPH, REPORT

Primary Function: This subroutine prints page headings for quality assurance pages and result reports

Common Blocks Used: TIMES, TITLES, DAY

Argument List: IFROM

Subordinate Modules: None

HEADNG prints appropriate page headings on output based on the value of the argument list parameter IFROM. When IFROM = Ø, the quality assurance heading is printed. When IFROM = 1, the report format is used. IDLINE is an RL UNIVAC-1100/44 subroutine which prints a message indicating the data and time of execution.

A.2.23 Specifications for Subroutine NUCTST
Called by SETNUC

Primary Function: This subroutine tests the input radionuclides list for unidentified radionuclides

Common Blocks Used: FLAGS, NUCNAM, SOURCE

Argument List: NIN

Subordinate Routines: IDLINE

NUCTST tests the integer array INFLG for unidentified radionuclides. If INFLG(i) $\leq$ 0, then radionuclide i of the input list was not found in the master data library RMDLIB. The name of each unidentified radionuclide is printed. If any unidentified radionuclides were found execution is stopped.

The total number of radionuclides required for this run is tested. If NUCS > 100 execution is stopped.

A.2.24 Specifications for Subroutine ORGCHK Called by MAIN

Primary Function: This subroutine checks the organ selection data for correctness

Common Blocks Used: ORGID

Argument List: None

Subordinate Routines: None

This subroutine checks the organ selection parameter KORG for correctness. Limitations on this parameter are as follows:

$$1 \leq \text{KORG}(i) \leq 23 \text{ for } 1 \leq i \leq \text{NORG}$$

$$\text{KORG}(i) \leq 0 \text{ for } i > \text{NORG}$$

The number of correct values given in KORG determines the number of organs to be considered, NORG. $1 \leq \text{NORG} \leq 5$.

A.2.25 Specifications for Subroutine PASSIG Called by EOVR

Primary Function: This subroutine calculates dispersion parameters for a given distance and Pasquill stability category

Common Blocks Used: None

Argument List: XX, IP, SY, SZ

Subordinate Routines: None

This subroutine interpolates stored data to determine dispersion parameters σ_y and σ_z for a Pasquill atmospheric stability category and a given distance. The argument list parameters have the following uses:

Parameter	Use
XX	Distance from the release point to the location at which dispersion parameters are to be determined, m
IP	Index to indicate which Pasquill stability category is to be used: IP = 1 for A, IP = 2 for B, IP = 3 for IP = 4 for D, IP = 5 for E and IP = 6 for F
SY	Crosswind horizontal standard deviation of plume concentration at the location of interest, m
SZ	Crosswind vertical standard deviation of plume concentration at the location of interest, m

Tabulated values are interpolated for the distance XX between 1 and 10^5 meters. In practical applications the distance XX should not be less than 100 meters or greater than 10^5 meters. The vertical dispersion parameter σ_z is limited to 2000 meters.

Tabulated values are provided for distances given in array DIST(20). Horizontal dispersion parameters are given for 6 stabilities and 20 distances in the array SIGY(6,20) and vertical dispersion parameters are given for the same stability/distance combinations in the array SIGZ(6,20).

A.2.26 Specifications for Subroutine PMAC Called by CASEIN

Primary Function: This subroutine interpolates population data at one time

Common Blocks Used: None

Argument List: NT, P, T, TZ, P1

Subordinate Routines: None

This subroutine interpolates NT values of population data array P as a function of time (array T) to return the population parameters P1 at time TZ. If TS is less than the first time, T(1), then P1 is set to P(1). If TZ is greater than the last time value, T(NT), then P1 is set to P(NT). The times of array T must be in increasing order.

A.2.27 Specifications for Subroutine PMEQ Called by CASEIN

Primary Function: This subroutine calculates a population dispersion factor from air concentrations and a population distribution

Common Blocks Used: AIRCON, POPU

Argument List: NDIST, PM

Subordinate Routines: None

This subroutine calculates a population dispersion factor based on the annual average air concentration array EOQ and the population distribution array POP. The number of distance intervals is supplied as NDIST and the number of directions (sectors) is taken as 16. The resulting population dispersion (PM) factor is returned through the argument list. PM is calculated as:

$$PM = \sum_{i=1}^{NDIST} \sum_{j=1}^{16} EOQ(i,j) * POP(i,j)$$

A.2.28 Specifications for Subroutine PMINT Called by CASEIN

Primary Function: This subroutine interpolates time vs. population dispersion factor arrays to determine population dispersion factors at each 70-yr increment midpoint

Common Blocks Used: None

Argument List: NT, TZ, T, PM1, PM

Subordinate Routines: None

This subroutine interpolates the population dispersion factor array PM1 (given as a function of time, T array) to determine the values for each 70-yr time increment in array PM. The argument list parameters have the following uses:

Parameter	Description
NT	Number of time periods for which data are supplied in arrays T and PM1. When NT $\leq$ 1 the first value of PM1 is used for all time increments
TZ	Time (years AD) at the start of the 10,000 year integration period
T(20)	Time points corresponding to definition of data in array PM1, years AD
PM1(20)	Population dispersion factor array to be interpolated, person-sec/m^3
PM(143)	Population dispersion factor array for each 70-yr period of the 10,000 yr integration period

A.2.29 Specifications for Subroutine PMSET Called by CASEIN

Primary Function: This subroutine establishes interpolation values for population dispersion factor options 2 and 5

Common Blocks Used: None

Argument List: NTA, POPT or PMI

Subordinate Routines: None

This subroutine calculates population dispersion values for each time period (NTA) used for interpolation. The values are calculated as:

$$PM1(i) = POPT(i) * \frac{PM1(1)}{POPT(1)}$$

A.2.30 Specifications for Subroutine PRTGRF
Called by GRAPH

Primary Function: PRTGRF is a graphing subroutine which prints the graph on the line printer

Common Blocks Used: Plot, times

Argument List: TY, YINC, IGRAW, IFROM

Subordinate Routines: HEADNG

This subroutine calls the subroutine HEADNG to print a page heading and then prints increment information and a message indicating an air or water release if applicable. The graph array is then printed with labels, borders, tick marks and tick mark values.

The argument list parameters have the following functions:

Parameter	Type	Description
TY(5)	REAL	Array containing y-axis tick values
YINC	REAL	Y-axis increment
IGRAW	INTEGER	Release message flag: Ø - no message 1 - air 2 - water
IFROM	INTEGER	Calling routine: (used by HEADNG) Ø - QAPAGE 1 - REPORT

A.2.31 Specifications for Subroutine QAPAGE
Called by MAIN

Primary Function: QAPAGE prints a report of input parameters

Common Blocks Used: BIODAT, DISPSN, NAMLST, NUCNAM, OPTION, ORGID, PATHIN, TITLES, VARYBL

Argument List: None

Subordinate Routines: HEADNG, GRAPH, GRFIL, GRTIM, ZEROR

QAPAGE prints a report of library information, terrestrial and aquatic pathways data, organ data, site grid information, and the selected radionuclides. Additionally, plots of population dispersion, population for each pathway, total activity of selected radionuclides, and the activity of each radionuclide may be printed.

Graph options are input as namelist parameters. Separate graphs are printed for each pathway where applicable. Graph option variables are set if greater than zero and control graph selection as follows:

Option	Additional Test	Graph
IGRPOP	None	Population data
IGRPM	IAIR > Ø	Population dispersion values
IGRPL	IWAT > Ø	Population for waterborne pathways
IGRTNV	IAIR > Ø	Total activity of radionuclides, air pathways
	IWAT > Ø	Total activity of radionuclides, water pathways
IGRNUC	IAIR > Ø	Separate graph of activity of each radionuclide's air releases
	IWAT > Ø	Separate graph of activity of each radionuclide's water releases

If the graph options IGRPOP, IGRNUC, or IGRPM are not set, a numeric report of that information is printed.

A.2.32 Specifications for Subroutine REPORT
Called by MAIN

Primary Function: This subroutine prints graphic reports of organ doses as a function of time, numerical reports of organ doses and a maximum dose period report

Common Blocks Used: NUCNAM, OPTION, ORGID, OUTORG, RESULT, TIMES

Argument List: None

Subordinate Modules: GRAPH, HEADNG

REPORT utilizes a group of graphing subroutines to plot organ doses as a function of time. A graph is printed for each organ by moving the doses into the array FOFX and calling the plot-control subroutine GRAPH.

A numeric report of the dose to each organ at each time period is printed followed by a report of each radionuclide's contribution to each organ during the maximum dose time period.

A.2.33 Specifications for Subroutine RLIBIN
Called by MAIN

Primary Function: This subroutine reads data from the master radionuclide data file

Common Blocks Used: DECAY, NAMES, TITLES

Argument List: None

Subordinate Routines: ZEROR

This subroutine reads from the radionuclide master data library, RMDLIB. Data read include radionuclide identification parameter arrays ELT and AW and radiological half-life and chain decay data.

In reading the data file this subroutine does several functions:

- the number of nuclides are counted, NUC
- decay constants are calculated, AL
- chain branching parameters are set, IFR, DKF
- chain lengths are set, NOFNUC

The radionuclide master data file is read from logical unit 10.

A.2.34 Specifications for Subroutine SETNUC
Calling by MAIN

Primary Function: This subroutine establishes the master list of radionuclides to be included in this run

Common Blocks Used: DECAY, DKAY, FLAGS, NAMES, NUCNAM, SOURCE

Argument List: None

Subordinate Routines: NUCTST, ZEROI

This subroutine compares the radionuclides of data file RMDLIB (radionuclide master data) with the input list of radionuclides. A master list of radionuclides is generated (including daughter radionuclides) for use during this run. Decay data are also put into data arrays for the selected radionuclides.

SETNUC calls NUCTST to determine if all master list radionuclides were found in data file RMDLIB.

A.2.35 Specifications for Subroutine SETUP
Called by GRAPH

Primary Function: SETUP is a graphing subroutine which prepares various arrays for printing

Common Blocks Used: PLOT

Argument List: YL, NL

Subordinate Routines: None

This subroutine stores tick marks in arrays, transfers the y-axis label to a single character array and centers it for vertical printing, blanks out the printing array and sets the vertical borders into the print array. The argument list variable YL is the selected y-axis label. NL indicates the number of characters in that label.

A.2.36 Specifications for Function SIGMAZ
Called by EOVRQ

Primary Function: This function calculates σ_z at a given location using the Hanford model

Common Blocks Used: None

Argument List: KS, IT

Subordinate Routines: None

The value of σ_z (m) is evaluated at the travel time distance, TT (seconds). When KS $\leq$ 0, moderately stable conditions are used, and when KS > 0 very stable conditions are used, the equation is

$$\sigma_z^2 = a[1 - \exp(-K^2T^2)] + bT$$

where T = TT, travel time, sec, and values for a, b and K^2 are as follows:

Parameter	Moderately Stable	Very Stable
a (m^2)	97	34
b (m^2/sec)	0.33	0.025
K^2 (sec^2)	2.5×10^{-4}	8.8×10^{-4}

A.2.37 Specifications for Function, SUMPRD
Called by BCHAIN

Primary Function: This function sums the term by term products of two arrays

Common Blocks Used: None

Argument List: J, A, B

Subordinate Routines: None

The function evaluates the expression:

$$\text{SUMPRD} = \sum_{i=1}^{J} A(i) * B(i)$$

A.2.38 Specifications for Subroutine TRITUM
Called by APATHS, WPATHS

Primary Function: This subroutine calculates environmental concentrations of H-3 using a specific-activity model

Common Blocks Used: BIODAT

Argument List: IST, IAW, WATCN, AIRCN, ANCONS, ANDRNK, CSOIL, EDIBL, AQUA

Subordinate Routines: None

This subroutine calculates the concentration of H-3 from atmospheric deposition in leafy vegetables, other vegetables, eggs, milk, beef, pork, and poultry. The concentration of H-3 in environmental media for the following aquatic pathways is also calculated: fish, drinking water, sediment, and water for recreational use and irrigation. Irrigation water in turn is assumed to contaminate vegetables, animal feed and drinking water, and the soil.

A.2.39 Specifications for Subroutine WPATHS
Called by CONTRL

Primary Function: This routine calculates environmental concentrations of radionuclides from aquatic pathways

Common Blocks Used: BIODAT, KDAY, EDCN, FODATA, NUCNAM, PATHIN, VARYBL

Argument List: ITIM, ITWX

Subordinate Routines: TRITUM, CARBON, BCHAIN, ZEROR

This routine calculates the concentrations of radionuclides in environmental media for the following aquatic pathways:

1. fish
2. drinking water
3. sediment
4. water for recreational use and irrigation

The irrigation water is in turn assumed to contaminate these pathways:

1. leafy vegetables
2. other vegetables
3. eggs through contaminated feed and water
4. milk through contaminated feed and water
5. beef through contaminated feed and water

6. pork through contaminated feed and water
7. poultry through contaminated feed and water
   as well as soil.

Much of this routine is similar to APATHS.

Concentrations for tritium and carbon-14 are calculated separately by calls to other routines.

A.2.40 Specifications for Subroutine ZEROI
Called by SETNUC and AIRLIN

Primary Function: This subroutine initializes an integer array to zero

Common Blocks Used: None

Argument List: N, K

Subordinate Routines: None

This subroutine sets the first N members of integer array K to zero.

A.2.41 Specifications for Subroutine ZEROR
Called by RLIBIN, AIRLIN, CASEIN, CONTRL, DOSADD, BCHAIN

Primary Function: This subroutine initializes a real value array to zero

Common Blocks Used: None

Argument List: N, A

Subordinate Routines: None

This subroutine sets the first N values of real array A to zero.

APPENDIX B

COMMON BLOCK DESCRIPTIONS

APPENDIX B

COMMON BLOCK DESCRIPTIONS

The computer program DITTY uses labeled common blocks for the majority of data transfers between modules. Table B.1 gives a summary of each common block and indicates the modules that use each block. A detailed description of the parameters in each common block is given in Tables B.2 to B.26. Table B.27 is an alphabetized list of all variables contained in common blocks and the name of the common block in which each variable resides.

The major difference between the mainframe and PC versions of DITTY is in the array specifications. One-hundred radionuclides may be processed simultaneously on the UNIVAC; the IBM version will only accept 25. All array dimensions of 100 have been reduced to 25 for the microcomputer version, as a space-saving measure. In addition, two new common blocks were added to implement the NAMELIST emulator. These are discussed in Appendix H.

TABLE B.1. DITTY Common Block Usage Summary

AIRCON
Description: Normalized air concentration factors
Used by: CASEIN, EOVRQ, PMEQ

BIODAT
Description: Bioaccumulation factors for aquatic pathways
Used by: MAIN, BIOLIN, CARBON, CASEIN, QAPAGE, TRITUM, WPATHS

DAY
Description: Date of the current run and heading information
Used by: AIRLIN, HEADNG

DECAY
Description: Master radionuclide data file input radionuclide decay data
Used by: MAIN, AIRLIN, RLIBIN, SETNUC

DISPSN
Description: Atmospheric dispersion data and parameters
Used by: MAIN, CASEIN, EOVRQ, QAPAGE

DKAY
Description: Radionuclide decay information for master list
Used by: MAIN, APATHS, DOSADD, SETNUC, WPATHS

DOSFAC
Description: Dose commitment factors
Used by: AIRLIN, DOSADD

EDCN
Description: Radionuclide concentrations in various media
Used by: APATHS, CONTRL, DOSADD, WPATHS

FLAGS
Description; Radionuclide selection control flags
Used by: AIRLIN, NUCTST, SETNUC

FODATA
Description: Data for terrestrial food pathways
Used by: MAIN, APATHS, FOOLIN, WPATHS

GRDDAT
Description: External dose conversion factors
Used by: DOSADD, GRDLIN

NAMES
Description: Master radionuclide data file input radionuclide names
Used by: RLIBIN, SETNUC

TABLE B.1. (contd)

NAMLST
  Description: Input parameters for population definition
  Used by: MAIN CASEIN, QAPAGE

NUCNAM
  Description: Radionuclide names in master list
  Used by: ACTIN, AIRLIN, APATHS, BIOLIN, FILLUP, FOOLIN, GRAPH, GRDLIN, QAPAGE, NUCTST, REPORT, SETNUC, WPATHS

OPTION
  Description: Input option parameters
  Used by: MAIN, CASEIN, QAPAGE, REPORT

ORGIO
  Description: Organ selection and name information
  Used by: MAIN, AIRLIN, DOSADD, GRAPH, QAPAGE, ORGCHK, REPORT

OUTORG
  Description: Array of organ doses as function of time used for graphic report
  Used by: CONTRL, DOSADD, REPORT

PATHIN
  Description: Namelist input data for food pathways
  Used by: MAIN, APATHS, CASEIN, DOSADD, QAPAGE, WPATHS

PLOT
  Description: Storage arrays for graphics
  Used by: FILLUP, PRTGRF, SETUP

POPU
  Description: Population distribution data
  Used by: CASEIN, PMEQ

RESULT
  Description: Calculated population doses
  Used by: DOSADD, REPORT

SOURCE
  Description: Input parameters for radionuclide master list
  Used by: MAIN, NUCTST, SETNUC

TIMES
  Description: Time reference points
  Used by: MAIN, CASEIN, CONSET, HEADNG, PRTGRF, REPORT

TABLE B.1. (contd)

TITLES
  Description: Data file and case titles
  Used by: MAIN, ACTIN, AIRLIN, BIOLIN, CASEIN, FOOLIN, GRDLIN, HEADNG, QAPAGE, RLIBIN

VARYBL
  Description: Calculated population and release data
  Used by: MAIN, APATHS, CASEIN, QAPAGE, WPATHS

TABLE B.2. Common Block AIRCON

Symbol & Dimension	Type	Definition/Values/Units
EOQ(10,16)	Real	Normalized time-integrated air concentration for each spatial interval, sec/m^3 (10 distances and 16 sectors).

TABLE B.3. Common Block BIODAT

Symbol & Dimension	Type	Definition/Values/Units
BIOACF(4,100)	Real	Bioaccumulation factors for each radionuclide for: 1. fish 2. crustacea 3. molluscs 4. water plants.
DWCF(100)	Real	Drinking water cleanup factors for each radionuclide (the fraction passing through a water treatment plant).
ISALT	Integer	Control integer for consideration of fresh or saltwater in bioaccumulation factors, ISALT = Ø, freshwater ISALT = 1, saltwater.
IOSALT	Integer	Value of ISALT for previous case; comparison with ISALT determines if different bioaccumulation factors need to be read in.

TABLE B.4. Common Block DAY

Symbol & Dimension	Type	Definition/Values/Units
DAIT	Char.	Eight characters name for day of year, MMDDYY: MM - month DD - day YY - year.
CHIPAT	Char.	Descriptive output for parameter IPATH.
CHIAC	Char.	Descriptive output for parameter IAC.

TABLE B.5. Common Block DECAY

Symbol & Dimension	Type	Definition/Values/Units
NUC	Integer	Number of radionuclides in the master library, RMDLIB. $1 \leq NUC \leq 300$.
NCH	Integer	Number of decay chains in the master library, RMDLIB. $1 \leq NCH \leq 200$.
NOFNUC(200)	Integer	Number of radionuclides in each decay chain. $1 < NOFNUC(i) \leq 9$. When NOFNUC(i) = 1, the radionuclide has no daughters.
NCHST(200)	Integer	Location in the master radionuclide list of the first member of a radionuclide chain; $1 \leq NCHST(i) \leq 300$.
IFR(2,300)	Integer	IFR(1,i) gives the chain member that is the first precursor to radionuclide i. IFR(2,i) gives the location of the second precursor. $IFR(1,i) \leq IFR(2,i)$.
DKF(2,300)	Integer	Fraction of first and second precursor that decay to this radionuclide.
AL(300)	Integer	Radiological decay constant for each radionuclide, $year^{-1}$.
NCHN(300)	Integer	Chain number of which each radionuclide is a member.

TABLE B.6. Common Block DISPSN

Symbol & Dimension	Type	Definition/Values/Units
NDIST	Integer	Number of distances considered for defining population and E/Q, $1 \leq NDIST \leq 10$.
DIST(1Ø)	Real	Distance from the release point to the center of each population ring, X_i, m. NDIST values must be given in increasing order.
NUBAR	Integer	Number of windspeed groups used for definition of joint frequency data, $1 \leq NUBAR \leq 8$.
UBAR(8)	Real	Average wind speed for each energy group, m/sec.
NMET	Integer	Number of atmospheric stability categories for definition of joint frequency data, $1 \leq NMET \leq 7$.
MET(7)	Integer	Atmospheric stability selection index. NMET values must be given for MET. Valid values are: 1 for Hanford very stable 2 for Hanford moderately stable 3 for Pasquill A 4 for Pasquill B 5 for Pasquill C 6 for Pasquill D 7 for Pasquill E 8 for Pasquill F.
F(8,7,16)	Real	Joint frequency of occurrence of atmospheric conditions for up to 8 wind speeds, 7 stabilities and 16 sectors, dimensionless.
HS	Real	Height of the stack, meters.

TABLE B.7. Common Block DKAY

Symbol & Dimension	Type	Definition/Values/Units
INUC	Integer	Number of radionuclides in master list $1 \leq$ INUC ≤ 100.
ICHN	Integer	Number of decay chains in the master list $1 \leq$ ICHN ≤ 100.
NOFN(100)	Integer	Number of radionuclides in each chain. $1 \leq$ NOFN(i) ≤ 9. When NOFN(i) = 1, the radionuclide has no daughters.
IFRM(2,100)	Integer	IFRM(1,i) gives the chain member that is the first precursor to radionuclide i. IFRM(2,i) gives the location of the second precursor. IFRM(1,i) > IFRM(2,i).
DK(2,100)	Integer	Fraction of first and second precursor that decay to this radionuclide; $0.0 \leq$ DK(i,j) $\leq$ 1.0.
AR(100)	Integer	Radiological decay constant for each radionuclide, years^{-1}.

TABLE B.8. Common Block DOSFAC

Symbol & Dimension	Type	Definition/Values/Units
DFH(2,5,100)	Real	Dose commitment factors for 2 dose periods for 5 organs for 100 nuclides, from INHALATION.
DFG(2,5,100)	Real	Dose commitment factors for 2 dose periods for 5 organs for 100 nuclides, from INGESTION.
		**Both of these are based on continuous exposure at a constant level for 70 years and 1 year. In other words, for intakes of 1 Ci/70 years.

TABLE B.9. Common Block ECDN

Symbol & Dimension	Type	Definition/Values/Units
WATCON(100)	Real	Water concentrations of radionuclides, weighted with decay constant and population, person-Ci-yr.
SCONW(100)	Real	Farm soil concentrations of radionuclides, weighted with decay constant and population, person-Ci-yr/kg.
SEDCON(100)	Real	River sediment concentrations of radionuclides, weighted with decay constant and population, person-Ci-yr/m^2.
EDBCNW(7,100)	Real	The concentration of radionuclides in the edible portion of the terrestrial plants and animals, weighted with decay constant and population, person-Ci-yr/kg, from irrigation deposition.
AQUATC(5,100)	Real	The concentration of radionuclides in the edible portion of the aquatic plants and animals, weighted with decay constant and population, person-Ci-yr/kg (or per liter for H_2O).
AIRCON(100)	Real	Atmospheric concentrations of radionuclides from dispersion/diffusion (no resuspension) weighted with decay constant and population, person-Ci-yr/m^3.
SLCON(100)	Real	The concentration in farm soil of radionuclides from atmospheric deposition, weighted with decay constant and population, person-Ci-yr/kg.
EDBCON(7,100)	Real	The concentration of radionuclides in the edible portion of terrestrial animals and plants from atmospheric deposition, weighted with decay constant and population, person-Ci-yr/kg.

TABLE B.10. Common Block FLAGS

Symbol & Dimension	Type	Definition/Values/Units
INFLG(100)	Integer	Control integer to indicate which master list radionuclides have dose factors supplied on input: Ø - no data given 1 - data supplied

TABLE B.11. Common Block FODATA

Symbol & Dimension	Type	Definition/Values/Units
DVEL(100)	Real	Deposition velocities, m/sec.
CRATIO(6,100)	Real	Concentration ratios for 1 - plants 2 - eggs 3 - milk 4 - beef 5 - port 6 - poultry.
AB(100)	Real	Soil removal percolation constant, yr^{-1}.

TABLE B.12. Common Block GRDDAT

Symbol & Dimension	Type	Definition/Values/Units
EDS(100)	Real	External dose factor for exposure to contaminated soil, rem/hr per Ci/m^2.
EDW(100)	Real	External dose factor for exposure to contaminated water, rem/hr per Ci/m^3.
EDA(100)	Real	External dose factor for submersion in contaminated air, rem/sec per Ci/m^3.

TABLE B.13. Common Block NAMES

Symbol & Dimension	Type	Definition/Values/Units
ELT(300)	Char.	Two-character element name for each radionuclide in the master radionuclide data library.
AW(300)	Char.	Six-character atomic weight symbol for each radionuclide in the master radionuclide data library. Isometric states are indicated by the letter M after the atomic weight. Daughter contributions are indicated by "+D" after the atomic weight and "M" if present.

TABLE B.14. Common Block NAMLST

Symbol & Dimension	Type	Definition/Values/Units
IEOQ	Integer	Control reading and calculation of atmospheric dispersion data.
IPA	Integer	Control method of specification of population dispersion factor.
IPOPL	Integer	Selects method for determining populations for waterborne releases.
IPL	Integer	Control method of specification of population data for acute water release.
NSECT	Integer	Number of sectors considered.
PMA	Real	Population dispersion factor for acute airborne release.
PPL	Real	Total population for acute waterborne release.
NTA	Integer	No. of time population data supplied in PM1, POPT, and T.
T(20)	Real	Times at which population data supplied, airborne, years A.D.
TL(20)	Real	Times at which population data supplied, waterborne, years A.D.
PM1(20)	Real	Population dispersion factor, airborne.
POPT(20)	Real	Total population, airborne release at each time in T.
PL1(20)	Real	Total population, water release, for each time in TL.
NTL	Integer	Number of times population data supplied in PL1 and TL.

TABLE B.15. Common Block NUCNAM

Symbol & Dimension	Type	Definition/Values/Units
NUCS	Integer	Number of radionuclides in the master list.
AWM(100)	Char.	Six-character atomic weight symbol for each radionuclide in the master list.
ELTM(100)	Char.	Two-character element name for each radionuclide in the master list.

TABLE B.16. Common Block OPTION

Symbol & Dimension	Type	Definition/Values/Units
IPOP	Integer	This control integer selects the method for determining population dispersion factors for airborne releases as follows: IPOP $\leq$ Ø; use previous values. IPOP = 1; supply all 144 values in array PM. IPOP = 2; read population data for the first time, T(1), and calculate PM. IPOP = 3; read population data for each time from file 22 and calculate PM for each time. IPOP = 4; supply population dispersion factors in array PM1 at times T and interpolate this data to generate PM values for each 70-yr increment. IPOP = 5; Use previous population distribution data but recalculate the fist time value for PM using new E/Q data. Default is IPOP = 4.
IPATH	Integer	This parameter selects pathways to be considered as follows: IPATH $\leq$ Ø; airborne and waterborne. IPATH = 1; airborne only. IPATH $\geq$ 2; waterborne only.
IAC	Integer	If IAC > Ø, consider an acute release period at the beginning of the first 70-yr period.
IWAT	Integer	Control integer set positive if waterborne release activity data are to be read.
IAIR	Integer	Control integer set positive if airborne release activity data are to be read.

TABLE B.16. (contd)

Symbol & Dimension	Type	Definition/Values/Units
LUA	Integer	Control integer to select logical unit device for reading of airborne release activity data: LUA = 1; use card input unit 5 LUA ≠ 1; use library file unit 26.
LUW	Integer	Control integer to select logical unit device for reading of waterborne release activity data: LUW = 1; use card input unit 5 LUW ≠ 1; use library file unit 24.
IGRPOP	Integer	Control integer set to one if graph of population distribution desired in input report. If zero, an abbreviated numeric report is printed. Default: IGRPOP = Ø.
IGRPM	Integer	Control integer set to one to print graph of population dispersion factor, airborne pathways, in input report. Default IGRPM = Ø.
IGRPL	Integer	Control integer set to one if graph of population disperson factor, waterborne pathways, is selected for input report. Default: IGRPL = Ø.
IGRTNU	Integer	Control integer to set to one if graph of total release of all radionuclides is desired in input report. Separate graphs will be printed for airborne and waterborne pathways depending on the values of IAIR and IWAT. Default: IGRTNU = Ø.
IGRNUC	Integer	Control integer set to one if graph of release of each radionuclide is to be included in the input report. Separate graphs will be printed for airborne and waterborne pathways depending on the values of IAIR and IWAT. If zero, a numeric report is printed. Default: IGRNUC = Ø.

TABLE B.16. (contd)

Symbol & Dimension	Type	Definition/Values/Units
IGRDOS	Integer	Control integer set to one if graph of dose to each organ is to be included in output report. Default: IGRDOS = 0.
ISPEC	Integer	Specialty option; set to one if selected. Default: ISPEC = 0.

TABLE B.17. Common Block ORGID

Symbol & Dimension	Type	Definition/Values/Units
LORG	Integer	Number of organs for which data is supplied in the inhalation and ingestion dose factor library DSFCT. $1 \leq LORG \leq 10$.
IORG(10)	Integer	Organ index values for which data is supplied in the inhalation and ingestion dose factor library DSFCT. $1 \leq IORG(i) \leq 23$.
NORG	Integer	Number of organs for which doses are to be calculated. $1 \leq NORG \leq 5$.
KORG(5)	Integer	Organ index values for which doses are to be calculated. The index values must be taken from values in index array IORG from the inhalation and ingestion library DSFCT.
MORG(5)	Integer	Position in IORG corresponding to selected organs. This array is set in subroutine ORGCHK.
ORGT(6)	Char.	Ten-character organ names for output. Extra array position used for specialty option heading.
ONAME(10)	Char.	Ten-character organ names for data in library DSFCT.

TABLE B.18. Common Block OUTORG

Symbol & Dimension	Type	Definition/Values/Units
DTOTAL(5,144)	Real	Total dose to each organ as a function of time.

TABLE B.19. Common Block PATHIN

Symbol & Dimension	Type	Definition/Values/Units
CONSUM(7)	Real	Consumption rates, kg/yr, for terrestrial paths: 1. leafy vegetables 2. other vegetables 3. eggs 4. milk 5. beef 6. pork 7. poultry.
USAGE(7)	Real	Consumption of exposure rates for aquatic paths 1. fish, kg/yr 2. crustaceans, kg/yr 3. molluscs, kg/yr 4. plants, kg/yr 5. drinking water, L/yr 6. shoreline exposure, hr/yr 7. swimming, hr/yr.
EXTIM	Real	Hours/year exposure time to contaminated soil.
SW	Real	Shore width factor for shoreline calculations.
GRWP(7)	Real	Growing periods (time above ground) for the drops or forage for the seven pathways associated with CONSUM.
YELD(7)	Real	The crop yield, kg/m^2, for the crops or forage associated with the seven CONSUM pathways.
MOPYR	Integer	The number of months per year irrigation occurs.
RECON	Real	Reconcentration ratio for water concentration calculation.
RM	Real	Mixing ratio for water concentration calculation.

TABLE B.19. (contd)

Symbol & Dimension	Type	Definition/Values/Units
CFLO	Real	River flow rate, ft^3/sec, for water concentration calculation.
RIRR	Real	Irrigation rate, L/m^2/month.

TABLE B.20. Common Block PLOT

Symbol & Dimension	Type	Definition/Values/Units
ARRAY(40,73)	Char.	Storage array for graph.
LABELY(40)	Char.	Storage array for the selected Y-axis label.
LABELX	Char.	X-axis label.
TICKY(40)	Char.	Array of Y-axis tick marks.
TICKX(73)	Char.	Array of X-axis tick marks.
LEGEND(40)	Char.	Array for radionuclide names for IGRTNU option.

TABLE B.21. Common Block POPU

Symbol & Dimension	Type	Definition/Values/Units
POP(10,16)	Real	Population within each spatial interval for 10 distances and 16 direction sections, P_{ij}, persons.

TABLE B.22. Common Block RESULT

Symbol & Dimension	Type	Definition/Values/Units
POPDOS(5,100)	Real	The population weighted integrated dose to 5 organs for 100 radionuclides.
MAXTIM	Integer	The dose integral period (70-yr period) during which the maximum dose rate occurs.
HIDOSE(5,100)	Real	The 70-yr dose increment larger than any other, for each of five organs; associated with MAXTIM.

TABLE B.23. Common Block SOURCE

Symbol & Dimension	Type	Definition/Values/Units
NIN	Integer	Number of radionuclides in the input inventory, 1 $\leq$ NIN $\leq$ NUC.
E(100)	Char.	Two-character names for input radionuclides; spelling must be identical to master radionuclides list.
A(100)	Char.	Six-character atomic weight symbol for each input radionuclide. Spelling must correspond to the master list spelling.

TABLE B.24. Common Block TIMES

Symbol & Dimension	Type	Definition/Values/Units
TZ	Real	Time (years A.D.) at beginning of 10,000-yr integration period.
TZR	Real	Beginning of the release history data, years A.D.

TABLE B.25. Common Block TITLES

Symbol & Dimension	Type	Definition/Values/Units
RMDTTL(20)	Char.	Title of RMDLIB.
IDFTTL(20)	Char.	Title of inhalation/ingestion D.F. library.
BIOTTL(40)	Char.	Title of bioaccumulation library (only parts 1-20 are title, 21-40 are units).
FTRTTL(60)	Char.	Title of transfer coefficient library (only parts 1-20 are title, 21-60 are units).
GRDTTL(20)	Char.	Title of external D.F. library for ground and swimming exposure.
CASTTL(20)	Char.	Case title.
PODTTL(20)	Char.	Title of population distribution library.
WRDTTL(20)	Char.	Title of waterborne release data library.
ARDTTL(20)	Char.	Title of airborne release data library.

TABLE B.26. Common Block VARYBL

Symbol & Dimension	Type	Definition/Values/Units
PM(144)	Real	Population dispersion factor, person-sec/m^3, for airborne releases for each time period. This is an effective population-weighted E/Q'.
PL(144)	Real	The total population for each time period, used in waterborne calculations.
ACTA(144,100)	Real	Activity released to air for each time increment for up to 100 radionuclides. Units are total curies released in each period to air.
ACTW(144,100)	Real	Activity released to water for each time increment for up to 100 radionuclides. Units are total curies released in each period to water.

TABLE B.27. DITTY Variables Contained in Common Blocks

Variable	Common	Variable	Common
A (100)	SOURCE	IAC	OPTION
AB (100)	FODATA	IAIR	OPTION
ACTA (144,100)	VARBYL	IBEGA (100)	BEGEND
ACTW (144,100)	VARBYL	IBEGW (100)	BEGEND
AIRCON (100)	EDCN	ICHN	DKAY
AL (300)	DECAY	IDFTTL (20)	TITLES
AQUATC (5,100)	EDCN	IENDA (100)	BEGEND
AR (100)	DKAY	IENDW (100)	BEGEND
ARDTTL (20)	TITLES	IEOQ	NAMLST
ARRAY (40,73)	PLOT	IFR (2,300)	DECAY
AW (300)	NAMES	IFRM (2,100)	DKAY
AWM (100)	NUCNAM	IGRDOS	OPTION
BIOACF (4,100)	BIODAT	IGRNUC	OPTION
BIOTTL (40)	TITLES	IGRPL	OPTION
CASTTL (20)	TITLES	IGRPM	OPTION
CFLO	PATHIN	IGRPOP	OPTION
CHIAC	DAY	IGRTNU	OPTION
CHIPAT	DAY	INFLG (100)	EDCN
CONSUM (7)	PATHIN	INUC	DKAY
CRATIO (6,100)	FODATA	IORG (10)	ORGID
DAIT	DAY	IOSALT	BIODAT
DFG (2,5,100)	DOSFAC	IPA	NAMLST
DFH (2,5,100)	DOSFAC	IPATH	OPTION
DIST (10)	DISPSN	IPL	NAMLST
DK (2,100)	DKAY	IPOP	OPTION
DKF (2,300)	DECAY	IPOPL	NAMLST
DOSINC (5,100)	DOSIN	ISALT	BIODAT
DTOTAL (5,144)	OUTORG	ISPEC	OPTION
DVEL (100)	FODATA	IWAT	OPTION
DWCF (100)	BIODAT	KORG (5)	ORGID
E (100)	SOURCE	LABELX	PLOT
EDA (100)	GRDDAT	LABELY (40)	PLOT
EDBCON (7,100)	EDCN	LEGEND (40)	PLOT
EDBCNW (7,100)	EDCN	LORG	OPTION
EDS (100)	GRDDAT	LUA	OPTION
EDW (100)	GRDDAT	LUW	OPTION
ELT (300)	NAMES	MAXIM	RESULT
ELTM (100)	NUCNAM	MET (7)	DISPSN
EOQ (10,16)	AIRCON	MORG (23)	ORGID
EXTIM	PATHIN	MOPYR	PATHIN
F (8,7,16)	DISPSN	NCH	DECAY
FIRTTL (60)	TITLES	NCHN (300)	DECAY
GRDTTL (20)	TITLES	NCHST (200)	DECAY
GRWP (7)	PATHIN	NDIST	DISPSN
HIDOSE (5,100)	RESULT	NIN	SOURCE
HS	DISPSN	NMET	DISPSN

TABLE B.27. (contd)

Variable	Common
NOFN (100)	DKAY
NOFNUC (200)	DECAY
NORG	ORGID
NSECT	NAMLST
NTA	NAMLST
NTL	NAMLST
NUBAR	DISPSN
NUC	DECAY
NUCS	NUCNAM
ORGT (5)	ORGID
ONAME (10)	ORGID
PL (144)	VARYBL
PL1 (20)	NAMLST
PM (144)	VARBYL
PM1 (20)	NAMLST
PMA	NAMLST
PODTTL (20)	TITLES
POP (10,16)	POPU
POPDOS (5,100)	RESULT
POPT (20)	NAMLST
PPL	NAMLST
RECON	PATHIN
RIRR	PATHIN
RM	PATHIN
RMDTTL (20)	TITLES
SCONW (100)	EDCN
SEDCON (100)	EDCN
SLCON (100)	EDCN
SW	PATHIN
T (20)	NAMLST
TICKX (73)	PLOT
TICKY (40)	PLOT
TL (20)	NAMLST
TZ	TIMES
TZR	TIMES
UBAR (8)	DISPSN
USAGE (7)	PATHIN
WATCON (100)	EDCN
WRDTTL (20)	TITLES
YELD (7)	PATHIN

APPENDIX C

DATA FILES

APPENDIX C

DATA FILES

Several data files are needed to execute DITTY. Additionally, some site-specific and case-specific data can be accessed from libraries as opposed to being input in the data stream.

Libraries are assigned logical unit numbers by the DITTY code. It is necessary to associate that number with the appropriate file prior to executing the code. Files that must always be attached to the run are:

Logical Unit No.	Library Name	Description	Reference Subroutine
10	RMDLIB	Master radionuclide library	RLIBIN
12	FTRANSLIB	Food transfer coefficient library	FOOLIN
14	BIOAC	Bioaccumulation factor library	BIOLIN
16	GRDFLIB	External exposure factors	GRDLIN
18	DSFCT	Internal dose conversions factors	AIRLIN

Files which may be utilized based on the value of a namelist input parameter are:

Logical Unit No.	Namelist Variable and Value	Description	Reference Subroutine
22	IPOP = 3	Population data for specified times	CASEIN
24	LUW = 1	Release data for aquatic pathways	ACTIN
26	LUA = 1	Release data for atmospheric pathways	ACTIN

The data in the files is set up such that additional data or changes to existing data may be made with little difficulty.

RADIONUCLIDE MASTER DATA FILE - RMDLIB (LOGICAL UNIT NO. 10)

The radionuclide master data file (RMDLIB) contains all radiological decay data used by DITTY. The file is organized into two sections. The first section contains radionuclides which are not members of decay chains, and also radionuclides singled out from chains with the "+D" (plus daughters) designation. Radionuclides in the first section are arranged by increasing atomic number. The second section of the file contains radionuclides organized into decay chains, ordered under the radionuclides highest in the chain. RMDLIB contains about 280 entries.

The first record of the file contains 80 characters of descriptive information used as identification in the input data report printed by subroutine QAPAGE. The remainder of the data records have the following information in the listed order:

1. alphabetic element symbol
2. atomic weight, also metastable, "M", and/or daughter, "+D", designation
3. radiological half-life, days
4. relative position in decay chain
5. precursor in decay chain
6. branching ratio from primary percursor
7. alternate precursor in decay chain
8. branching ratio from alternate precursor.

The RMDLIB FORTRAN format is (A2, A6, E10.2, 2I2, F7.4, I2, F7.4). Parameter No. 4 is also used to signal the end of the data file (≤ 0).

FOOD TRANSFER COEFFICIENT FILE--FTRANSLIB (LOGICAL UNIT NO. 12)

The FTRANSLIB contains factors used by DITTY in relating concentrations of elements in soil to concentrations in farm products produced on that soil, and relating concentrations in animal feed to concentrations in animal products. The file has entries for 63 elements arranged by increasing atomic number compatible with the order of RMDLIB.

The first record of FTRNSLIB is an 80-character title used for identification and printed in the subroutine QAPAGE. Subsequent records contain information for each element in the following order:

1. element name
2. deposition velocity, m/sec
3. soil/food concentration ratio, dimensionless
4. egg concentration radio, day/kg
5. milk concentration ratio, day/L
6. beef concentration ratio, day/kg
7. pork concentration ratio, day/kg
8. poultry concentration ratio, day/kg
9. percolation constant, yr^{-1}.

The FTRANSLIB FORTRAN format is (A2, 8E9.2). Reading of the file is terminated normally when the end-of-file is encountered.

AQUATIC BIOACCUMULATION FACTOR FILE--BIOAC (LOGICAL UNIT NO. 14)

This bioaccumulation factor file contains the aquatic pathway factors used by DITTY relating the concentration of nuclides in aquatic biota to the concentration of the nuclides in the water. There are separate factors for fresh and salt water. Also included is a factor for the clean-up of drinking water in water treatment plants. Units for all bioaccumulation factors and pCi/kg per pCi/L.

The file is organized as:

1. element name
2. bioaccumulation factor for in salt water
3. bioaccumulation factor for crustacea in salt water
4. bioaccumulation factor for molluscs in salt water
5. bioaccumulation factor for water plants in salt water
6. bioaccumulation factor for fish in fresh water
7. bioaccumulation factor for crustacea in fresh water
8. bioaccumulation factor for molluscs in fresh water
9. bioaccumulation factor for water plants in fresh water
10. drinking water cleanup factor (the fraction passing through a water treatment facility).

The BIOAC FORTRAN format is: (A2, 8F9.1, F6.1). The namelist input parameter ISALT determines if the salt- or fresh-water factors are used. Default is zero for fresh water.

The first record of the file is an 80-character descriptive title used for identification and printed in the input report by the subroutine QAPAGE, the file contains entries for 63 elements. Reading of BIOAC terminates normally when the end-of-file is encountered.

EXTERNAL DOSE FACTOR FILE--GRDLIB (LOGICAL UNIT NO. 16)

GRDLIB contains data on the dose rate factors for exposure to soil, water, and air. Factors for total body dose are read in and used by DITTY as an estimate of the dose to all internal organs. The information in GRDLIB used by DITTY is as follows:

1. element name
2. atomic weight, +D, and/or metastable designations
3. external dose factor from soil exposure, mrem/hr per pCi/m^2
4. external dose factor from swimming, mrem/hr per pCi/cm^3
5. external dose factor from air submersion, mrem/hr per pCi/m^3.

The GRDLIB FORTRAN format is: (A2, A6, 9X, E9.2, 9X, 2E9.2).

The first record in the file is an 80-character descriptive title used for identification and printed in the input report. Reading of the file terminates normally when the end-of-file is encountered. The GRDLIB file also contains dose factors for skin, which are not used by current versions of DITTY.

INTERNAL DOSE FACTOR FILE--DSFCT (LOGICAL UNIT NO. 18)

The DSFCT file contains dose commitment factors for inhalation and ingestion of 59 radionuclides for up to 10 organs for dose periods of 1 and 70 years.

The first record of the file contains the number of organs for which data is supplied (1 to 10) and the organ index values of those organs (1 to 23). Organs for which data are presently available in DSFCT and their indices are:

Organ Index	Organ Name
1	Total Body
3	Kidney
4	Liver

Organ Index	Organ Name
6	Bone
8	Lungs
16	Thyroid
23	LLI

The FORTRAN format for the first record is: (5X, I5, 10X, 10I3).

The second record in DSFCT is an 80-character descriptive title used for identification and is printed by the subroutine QAPAGE in the input report.

The third record of the file contains the organ names of the selected organs as listed above. The FORTRAN format for this record is: (10A8).

For each radionuclide there is a header record and a variable number of detail records containing the dose factors.

The header record for each radionuclide contains the following information:

1. element symbol
2. atomic weight symbol including metastable "M" and/or "+D" designation
3. the number of organs for which inhalation and ingestion dose commitment factors will be given, parameter LO.

The FORTRAN format for this record is: (A2, A6, I2).

There will be LO detail records for each radionuclide. Each record will contain the following data:

1. index of organ for which data is supplied
2. dose commitment factor from inhalation for 1 yr, Ci/yr
3. dose commitment factor from inhalation for 70 yr, Ci/70 yr
4. dose commitment factor from ingestion for 1 yr, Ci/yr
5. dose commitment factor from ingestion for 70 yr, Ci/70 yr

The FORTRAN format for the detail records is: (I2, 8X, 4E10.1).

Reading of the file is terminated when the value read for the parameter LO (header record) equals zero.

POPULATION DISTRIBUTION DATA FILE (LOGICAL UNIT NO. 22)

When the NAMELIST input parameter IPOP is set equal to three, population distribution data will be read from the file assigned to logical unit no. 22.

The first record in the file is an 80-character descriptive title which is used for identification and is printed in the input report.

Each set of population distribution data contains a header record specifying the date followed by 16 sector records.

The header record contains the date in years A.D. that the following population distribution has been projected for. The FORTRAN format for this record is (E10.2).

Following each header record are 16 detail records. Each record corresponds to a 22-1/2° site-grid sector. Care should be taken to ensure that population site-grid sectors correspond to the sectors used in specifying the meteorological data. Each sector record will have NDIST population values. NDIST is the number of distances considered and is a NAMELIST input parameter. The FORTRAN format is (10E8.1).

When population data is read from logical unit 22, the NAMELIST input parameter NTA must be set equal to the number of population data sets. Reading of the file will terminate when:

1. 20 population data sets have been read, or
2. the time of the population distribution data is beyond the time period considered in this case, or
3. NTA data sets have been read.

AIRBORNE ACTIVITY RELEASE HISTORY FILE (LOGICAL UNIT NO. 26)

If the NAMELIST parameter LUA is not equal to one, the airborne release activity will be read from the file assigned to logical unit 26.

The first record of the file is an 80-character descriptive title, used for identification.

The second record in the file is the number of radionuclides data are supplied for in the file. This parameter (NNACT) controls reading of the file. The FORTRAN format for this record is: (I5). $1 \leq$ NNACT ≤ 100.

There are NNACT data sets in the library. Each data set consists of a header record and a series of detail records with times and corresponding concentrations.

The header record contains the following information:

1. element symbol
2. atomic weight, also metastable and/or "+D" designator
3. number of times activity release data are supplied for, (NT) $1 \leq$ NT ≤ 450.

The FORTRAN format for the header record is: (A2, A6, 2X, I5).

There will be NT detail records in each data set. Each record contains the following data:

1. time since the beginning of the release history as number of years since TZR (NAMELIST input parameter)
2. curies of activity released.

The FORTRAN format for the detail record is: (2E10.2).

WATERBORNE ACTIVITY RELEASE HISTORY FILE (LOGICAL UNIT NO. 24)

When the parameter LUW (specified in NAMELIST) is not equal to one, waterborne release activity will be read from the file assigned to logical unit no. 24.

Reading of this file is identical to that of the airborne release file assigned to logical unit no. 26. For information, refer to the preceding section.

APPENDIX D

PROGRAM AND DATA FILE LISTINGS

APPENDIX D

PROGRAM AND DATA FILE LISTINGS

This appendix contains listings of each module for the computer program DITTY plus listings of the five required data files (RMDLIB, FTRANSLIB, BIOAC, GRDFLIB and DSFCT). The program listing (Figure D.1) starts with the main program module (MAIN), followed by the remaining modules in alphabetical order. The common blocks are then listed in alphabetical order. Usage of common blocks is indicated in each module by INCLUDE statements. The data file listings are given in Figures D.2 (RMDLIB), D.3 (FTRANSLIB), D.4 (BIOAC), D.5 (GRDFLIB), and D.6 (DSFCT).

```
C***********************************************************************
C                                                                      *
C     MAIN CONTROLS INPUT OF DATA AND CASE ITERATION                   *
C                                                                      *
C***********************************************************************
C
C     SUBORDINATE ROUTINES-- RLIBIN, SETNUC, ORGCHK, AIRLIN, BIOLIN,
C                            FOOLIN, GRDLIN, CASEIN, POPLIN, ACTIN,
C                            QAPAGE, CONTRL, REPORT
C     INPUTS-- NONE
C     INPUT COMMONS-- DKAY
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- BEGEND, BIODAT, DECAY, DISPSN, DKAY, NAMLIST,
C                      OPTION, ORGID, PATHIN, SOURCE, TIMES, TITLES,
C                      VARYBL, FODATA
C
C     Module of DITTY
C     VAX Version of 7-SEP-84  RAP
C-----------------------------------------------------------------------
C
      INCLUDE 'BIODAT.CMN'
      INCLUDE 'DECAY.CMN'
      INCLUDE 'DISPSN.CMN'
      INCLUDE 'DKAY.CMN'
      INCLUDE 'FODATA.CMN'
      INCLUDE 'NAMLST.CMN'
      INCLUDE 'OPTION.CMN'
      INCLUDE 'ORGID.CMN'
      INCLUDE 'PATHIN.CMN'
      INCLUDE 'SOURCE.CMN'
      INCLUDE 'TIMES.CMN'
      INCLUDE 'TITLES.CMN'
      INCLUDE 'VARYBL.CMN'
C
      DIMENSION  IBEGA(100), IBEGW(100), IENDA(100), IENDW(100)
C
C
C     SET PREVIOUS CASE VALUE OF ISALT TO ENSURE BIOACCUMULATION
C     LIBRARY IS READ IN FOR FIRST CASE--
      DATA IOSALT /-1/
C
C     SET DEFAULT VALUE FOR INPUT AND OUTPUT LOGICAL UNIT DEVICES--
      IUN = 5
      ION = 6
```

FIGURE D.1. DITTY Program Listing

```
C                                                                    C
SET NAMELIST DEFAULT VALUES--
      DATA IAC /0/
      DATA IAIR /0/
      DATA IWAT /0/
     DATA LUA /1/
      DATA LUW /1/
      DATA ISALT /0/
      DATA ISPEC /0/
C
      DATA TZ /2000./
      DATA TZR /2000./
C
      DATA NDIST /0/
      DATA NSECT /16/
C
      DATA IEOQ /0/
      DATA HS /0./
      DATA NMET /0/
      DATA NUBAR /0/
      DATA MET /7 * 0/
      DATA UBAR /8 * 0./
C
      DATA IPA /1/
      DATA IPL /1/
      DATA IPOP /4/
      DATA IPOPL /2/
      DATA NTA /1/
      DATA NTL /1/
      DATA PL /144 * 0./
      DATA PL1 /20 * 0./
      DATA PMA /0./
      DATA PPL /0./
      DATA TL /20 * 0./
      DATA POPT /20 * 0./
C
                DATA RECON /1.0/
                DATA RM /1.0/
C
      DATA IGRPOP /0/
      DATA IGRPM /0/
      DATA IGRPL /0/
      DATA IGRTNU /0/
      DATA IGRNUC /0/
      DATA IGRDOS /0/
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      CALL RLIBIN
C     TO READ MASTER RADIONUCLIDE DATA LIBRARY RMDLIB.
C
C     READ FIRST CASE TITLE RECORD--
      READ (IUN,1000,ERR=800,END=900) CASTTL
C
C     READ MASTER RADIONUCLIDE NAME LIST--
C
C     READ NUMBER OF RADIONUCLIDES - RECORD TYPE 2
      READ (IUN,2000,ERR=800,END=900) NIN
C
C     READ NAMES OF RADIONUCLIDES - RECORD TYPE 3
      READ (IUN,3000,ERR=800,END=900) (E(I), A(I), I = 1, NIN)
C
C     READ ORGAN SELECTION DATA--
      READ (IUN,4000,ERR=800,END=900) NORG
      READ (IUN,5000,ERR=800,END=900) (KORG(I), I = 1, NORG)
C
C
C
C
      CALL SETNUC
C     TO ESTABLISH MASTER RADIONUCLIDE LIST FOR THIS RUN.
C
C
      CALL ORGCHK
C     TO TEST INPUT ORGAN SELECTION DATA.
C
C
      CALL AIRLIN
C     TO READ AIR SUBMERSION/INHALATION AND INGESTION DOSE FACTORS.
C
C
      CALL FOOLIN
C     TO READ FOOD TRANSFER FACTOR DATA.
C
C
      CALL GRDLIN
C     TO READ GROUND AND WATER EXTERNAL EXPOSURE FACTORS.
C
C
C   SET AB TO SUM OF RADIOLOGICAL AND NON-RAD REMOVAL CONSTANTS
      DO 456 I = 1 ,INUC
        AB(I) = AB(I) + AR(I)
```

FIGURE D.1. DITTY Program Listing (continued)

```
  456 CONTINUE
C
C     LOOP UNTIL END-OF-FILE ENCOUNTERED ON INPUT--
  100 CONTINUE
C
        CALL CASEIN
C       TO READ DATA FOR ONE CASE.
C
C       IF DIFFERENT FROM PREVIOUS CASE--
        IF (ISALT .NE. IOSALT)    THEN
C
          CALL BIOLIN
C         TO READ IN BIOACCUMULATION FACTORS.
C
C         STORE VALUE OF ISALT FOR COMPARISON IN NEXT CASE--
          IOSALT = ISALT
C
        ENDIF
C
C
C       IF AIRBORNE RELEASE IS CONSIDERED--
        IF (IAIR .GT. 0)    CALL ACTIN (1, LUA, ITAX, ITAM,
     .                      IBEGA, IENDA, ACTA)
C       TO GENERATE NEW RELEASE RATE DATA FOR ATMOSPHERIC PATHWAYS.
C
C       IF WATERBORNE RELEASE IS CONSIDERED--
        IF (IWAT .GT. 0)     CALL ACTIN (2, LUW, ITWX, ITWM,
     .                       IBEGW, IENDW, ACTW)
C       TO GENERATE NEW RELEASE RATE DATA FOR AQUATIC PATHWAYS.
C
        CALL QAPAGE
C       TO WRITE INPUT SUMMARY REPORT.
C
        CALL CONTRL (IAC, IPATH, ITAM, ITAX, ITWM, ITWX)
C       TO CONTROL DOSE RESULT CALCULATIONS.
C
        CALL REPORT
C       TO WRITE RESULT REPORTS.
C
C       READ TITLE CARD FOR NEXT CASE--
        READ (IUN,1000,ERR=800,END=999) CASTTL
C
      GO TO 100
C     END OF LOOP--
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C     ERROR CONDITION--
  800 WRITE (ION,8000)
      STOP
C
C     PREMATURE END-OF-FILE
  900 WRITE (ION,9000)
      STOP
C
C
C     NORMAL TERMINATION--
  999 CALL EXIT
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (20A4)
C
 2000 FORMAT (I5)
C
 3000 FORMAT (A2, A6 )
C
 4000 FORMAT (I5)
C
 5000 FORMAT (10I3)
C
 8000 FORMAT ('0  READ ERROR ENCOUNTERED IN MAIN')
C
 9000 FORMAT ('0  PREMATURE END-OF-FILE ENCOUNTERED IN MAIN')
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module ACTIN

```
      SUBROUTINE ACTIN (IP, IAW, ITX, ITM, IBEG, IEND, CON)
C
C***********************************************************************
C                                                                      *
C     ACTIN READS RELEASE ACTIVITY TIME HISTORY DATA                   *
C                                                                      *
C***********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- CONSET
C     INPUTS-- IP, IAW
C     INPUT COMMONS-- NUCNAM
C     OUTPUTS-- ITM, IBEG, IEND, CON
C     OUTPUT COMMONS-- TITLES
C
C     Module of DITTY
C     VAX Version of 24-SEP-85  RAP
C
C-----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ----------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ----------------------------------------
C
C     IP          INTEGER    PATHWAY SELECTION INDEX: 1- AIRBORNE
C                            RELEASE, 2- WATERBORNE RELEASE
C     IAW         INTEGER    CONTROL FOR INPUT FILE SPECIFICATIONS:
C                            1- FOR CARD INPUT, 2- FOR PERMANENT FILE
C                            INPUT ON UNIT 26 OR UNIT 24
C     ITX         INTEGER    MAXIMUM TIME INCREMENT INDEX DURING WHICH
C                            ANY RELEASE WAS MADE FOR THIS MODE
C     ITM         INTEGER    MINIMUM TIME INCREMENT INDEX DURING WHICH
C                            ANY RELEASES WAS MADE FOR THIS MODE
C     IBEG(100)   INTEGER    1ST TIME INCRMENT DURING WHICH EACH
C                            RADIONUCLIDE IS RELEASED 1<=IBEG(I)<=144
C     IEND(100)   INTEGER    LAST TIME INCREMENT DURING WHICH EACH
C                            RADIONUCLIDE IS RELEASED 1<=IEND(I)<=144
C                            IBEG(I) <= IEND(I)
C     CON(144,100) REAL      TOTAL ACTIVITY RELEASED DURING EACH 70-
C                            YEAR PERIOD FOR 100 RADIONUCLIDES, CI
C
C-----------------------------------------------------------------------
```

FIGURE D.1. DITTY Program Listing (continued)

Module ACTIN

```
 C
       DIMENSION IBEG(100), IEND(100), CON(144,100)
       DIMENSION T(450), C(450)
 C
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'TITLES.CMN'
      INCLUDE 'OPTION.CMN'
C
       CHARACTER A*6, E*2
C
C     INITIALIZE ARRAYS AND CONTROL PARAMETERS--
       CALL ZEROI (100, IBEG)
       CALL ZEROI (100, IEND)
       CALL ZEROR (14400, CON)
       END = 0.
       ITX = 0
       ITM = 999
C
C     IF AIRBORNE RELEASE, SET LOGICAL UNIT DEVICE AND READ TITLE--
       IF (IP .EQ. 1)   THEN
         IF (IAW .EQ. 1)  THEN
           IUN = 5
         ELSE
           IUN = 26

           READ (IUN,2000,ERR=802,END=900) ARDTTL
         ENDIF
C
       ELSE
C     IF WATERBORNE RELASE, SET LOGICAL UNIT DEVICE AND READ TITLE--
         IF (IAW .EQ. 1)   THEN
           IUN = 5
         ELSE
           IUN = 24

           READ (IUN,2000,ERR=802,END=900) WRDTTL
          ENDIF
       ENDIF
C
C
C     READ IN NO. OF NUCLIDES DATA SUPPLIED FOR AND LOOP ON--
       READ (IUN,2001,ERR=804,END=900) NNACT

C
      DO 400 INN = 1, NNACT
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
   100 CONTINUE
C
C       READ NAME OF RADIONUCLIDE AND NO. OF TIME PERIODS--
         READ (IUN,1000,ERR=806,END=900) E, A, NT
C
C       CHECK IF NT IS WITHIN LIMITS--
         IF (NT .GT. 0)  THEN
           IF (NT .LE. 450)  THEN
C
             IN = 1
C
           ELSE
C
C            ERROR-CONDITION--
             WRITE (6,8001) NT, E, A
             STOP
C
           ENDIF
C
C
C         READ NT DATA RECORDS--
           READ (IUN,3000,ERR=800,END=900) (T(I), C(I), I = 1, NT)
           LNUC = 0
C
C         LOOP UNTIL IN > NUCS OR LNUC > 0--
   200     CONTINUE
C
C            IF RADIONUCLIDE IS IN MASTER LIBRARY--
             IF (E .EQ. ELTM(IN) )  THEN
               IF (A .EQ. AWM(IN))   THEN
C
                 LNUC = IN
C
                CALL CONSET (T,C,NT,IBEG(IN), IEND(IN), CON(1,IN))
C
               ENDIF
             ENDIF
C
             IN = IN + 1
C
           IF (IN .LE. NUCS  .AND.  LNUC .LE. 0)  GO TO 200
C         JUMP OUT OF LOOP IF MATCH FOUND OR LIBRARY EXHAUSTED--
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
        ELSE
          END = 2.
        ENDIF
C
C     IF NOT END-OF-FILE, READ RELEASE DATA FOR NEXT RADIONUCLIDE--
  400 CONTINUE
C
C
C
C     SET EARLIEST AND LATEST RELEASE INDEX OF ALL RADIONUCLIDES--
C
       DO 300 I = 1, NUCS
C
         IF (IBEG(I) .GT. 0)    THEN
           IF (IBEG(I) .LT. ITM)    ITM = IBEG(I)
         ENDIF
C
         IF (IEND(I) .GT. ITX)    ITX = IEND(I)
C
C
C
  300 CONTINUE
C
  999 RETURN

C
C
C     READ-ERROR ENCOUNTERED--
  800 WRITE (6,8000) NT, T(I), C(I)

      STOP
C
C     READ ERROR IN TITLE--
  802 WRITE (6,8002) ARDTTL, WRDTTL
      STOP
C
C     READ ERROR NO. OF RADIONUCLIDES--
  804 WRITE (6,8004) NNACT
      STOP
C
C     READ ERROR NUMBER OF TIME PERIODS--
  806 WRITE(6,8006) E, A, NT
      STOP
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C     PREMATURE END-OF-FILE ENCOUNTERED--
  900 WRITE (6,9000)
      STOP
C
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (A2, A6, 2X, I5)
C
 2000 FORMAT (20A4)
C
 3000 FORMAT (2E10.2)
C
 2001 FORMAT (I5)
C
 8000 FORMAT ('0 READ ERROR ENCOUNTERED IN  ACTIN'/
     .        '   N: ',I7,' T(N): ',1PG10.3, ' C(N): ',1PG10.3)
C
 8001 FORMAT ('0 NT FOR RADIONUCLIDE ', A2, A6, ' IS TOO LARGE, = ',I5)
C
 8002 FORMAT ('0 ERROR READING ACTIVITY LIBRARY FILE TITLE:'/
     .        ' ',20A4/' ',20A4)
C
 8004 FORMAT ('0 ERROR: NUMBER OF RADIONUCLIDES IN ACTIN,  NNACT=',I5)
C
 8006 FORMAT ('0 ERROR: NUMBER OF TIME PERIODS IN ACTIN'/
     .        ' RADIONUCLIDE : ',A2,A6,'   TIMES: ',I6)
C
 9000 FORMAT ('0 PREMATURE END-OF-FILE ENCOUNTERED IN  ACTIN')
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module AIRLIN

```
      SUBROUTINE AIRLIN
C
C*********************************************************************
C                                                                   *
C     AIRLIN READS INTERNAL DOSE CONVERSION FACTOR DATA             *
C                                                                   *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- ADATE, ZEROI, ZEROR
C     INPUTS-- NONE
C     INPUT COMMONS-- NUCNAM, DOSFAC
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- DECAY, FLAGS, ORGID, TITLES, DAY
C
C     Module of DITTY1
C     VAX Version of 13-SEP-84  RAP
C
C---------------------------------------------------------------------
C
      INCLUDE 'DECAY .CMN'
      INCLUDE 'FLAGS .CMN'
      INCLUDE 'DOSFAC.CMN'
      INCLUDE 'DAY   .CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'ORGID .CMN'
      INCLUDE 'TITLES.CMN'
C
      CHARACTER AA*6, EE*2
C
      DIMENSION MO(10), DH1(10), DH2(10), DG1(10), DG2(10)
C
C
C     ASSIGN LOGICAL UNIT DEVICE--
      IUN = 18
C
C     GET THE CURRENT TIME--
      CALL DATE (DAIT)
C
C     INITIALIZE CONTROL PARAMETER AND ARRAYS--
      KK = 0
      CALL ZEROR (1000, DFH)
      CALL ZEROR (1000, DFG)
      CALL ZEROI (23, MORG)
      CALL ZEROI (100,INFLG)
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C     READ TITLE, ORGAN DATA, AND NAMES--
      READ (IUN,1000,ERR=800,END=900) LORG, IORG, IDFTTL, ONAME
C
      IF (LORG .LT. 1  .OR.  LORG .GT. 10)   GO TO 801
C     ERROR CONDITION, STOP THE RUN
C
C     CHECK LIBRARY INDEX VALUES--
      DO 100 IO = 1, LORG
        IF (IORG(IO) .LE. 0  .OR.  IORG(IO) .GT. 23) GO TO 802
C       ERROR CONDITION, STOP THE RUN
  100 CONTINUE
C
C
C     FOR EACH SELECTED ORGAN--
      DO 200 KO = 1, NORG
C
C       CHECK IF INCLUDED IN MASTER LIBRARY--
        DO 300 IO = 1, LORG
C
          IF (KORG(KO) .EQ. IORG(IO) ) THEN
C
            MORG(IORG(IO)) = KO
            KK = 1
            ORGT(KO) = ONAME(IO)
C
          ENDIF
C
  300   CONTINUE
C
C
C       ERROR CONDITION--
        IF (KK .LE. 0)    THEN
          WRITE (6, 8003) KO
          STOP
        ELSE
          KK = 0
        ENDIF
C
  200 CONTINUE
C
C
C     LOOP UNTIL LO IS LESS THAN ZERO--
  400 CONTINUE
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C       READ FIRST RECORD FOR A RADIONUCLIDE--
        READ (IUN,2000,ERR=999,END=999)  EE, AA, LO
C
        IF (LO .GT. 0)   THEN
C
          IM = 0
          II = 0
C
C         READ ORGAN DATA INTO TEMPORARY ARRAY--
          DO 401 IO = 1, LO
            READ (IUN,3000,ERR=999,END=999) MO(IO),
     .      DH1(IO), DH2(IO), DG1(IO), DG2(IO)
  401     CONTINUE
C
C
C         LOOP UNTIL II > 0  OR IM => NUCS--
  500     CONTINUE
C
            IM = IM + 1
C
            IF (EE .EQ. ELTM(IM)  .AND.  AA .EQ. AWM(IM) )   THEN
C
              II = IM
              INFLG(IM) = 1
C
C             STORE LO LINES OF ORGAN DATA--
              DO 600 IO = 1, LO
C
C
                IF (MORG(MO(IO)) .GT. 0)  THEN
C
                  MOG= MORG(MO(IO))
C
                  DFH(1,MOG,II) = DH1(IO)
                  DFH(2,MOG,II) = DH2(IO)
                  DFG(1,MOG,II) = DG1(IO)
                  DFG(2,MOG,II) = DG2(IO)
C
                ENDIF
C
  600         CONTINUE
C
            ENDIF
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
          IF (II .LE. 0  .AND.  IM .LT. NUCS)  GO TO 500
C
        ENDIF
C
      IF (LO .GT. 0)  GO TO 400
C
C
C     CHECK FOR ERRORS--
  999 DO 700 IM = 1, NUCS
        IF (INFLG(IM) .LE. 0)  THEN
          WRITE (6,8004) IM, ELTM(IM), AWM(IM)
        ENDIF
  700 CONTINUE
C
C
        RETURN
C
C
C     ERROR CONDITIONS--
C
  800 WRITE (6, 8000)
      STOP
C
  801 WRITE (6, 8001) LORG
      STOP
C
  802 WRITE (6, 8002) IORG(IO)
      STOP
C
  900 WRITE (6, 9000)
      STOP
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (5X, I5, 10X, 10I3, / 20A4 / (8A10) )
C
 2000 FORMAT (A2, A6, I2)
C
 3000 FORMAT (I2, 8X, 4E10.1)
C
 8000 FORMAT ('0 READ ERROR ENCOUNTERED IN AIRLIN')
C
 8001 FORMAT ('0 NUMBER OF LIBRARY ORGANS INCORRECT, LORG: ', I5)
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
 8002 FORMAT ('0 BAD LIBRARY ORGAN INDEX VALUE, IORG(IO): ', I5)
C
 8003 FORMAT ('0 SELECTED ORGAN KO NOT IN LIBRARY. KO = ', I5)
C
 8004 FORMAT ('0 MASTER LIST RADIONUCLIDE ', I3, 3X, A2, A6,
     .         ' IS NOT IN DOSE FACTOR LIBRARY')
C
 9000 FORMAT ('0 PREMATURE END-OF-FILE ENCOUNTERED IN AIRLIN')
C
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE APATHS (ITIM, ITAX)
C
C**********************************************************************
C                                                                     *
C     APATHS CALCULATES ENVIRONMENTAL CONCENTRATIONS FROM ATMO-        *
C     SPHERIC DEPOSITION.                                             *
C                                                                     *
C**********************************************************************
C
C     CALLED BY-- CONTRL
C     SUBORDINATE ROUTINES-- TRITIUM, CARBON, BCHAIN
C     INPUTS-- ITIM, ITAX
C     INPUT COMMONS-- DKAY, FODATA, PATHIN, NUCNAM, VARYBL
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- EDCN
C
C     Module of DITTY
C     VAX Version of 19-NOV-84  RAP
C
C----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  --------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  --------------------------------------
C
C     ITIM        INTEGER
C     ITAX        INTEGER
C
C----------------------------------------------------------------------
C
      INCLUDE 'DKAY  .CMN'
      INCLUDE 'EDCN  .CMN'
      INCLUDE 'FODATA.CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'PATHIN.CMN'
      INCLUDE 'VARYBL.CMN'
C
      CHARACTER*2 CONSTC, CONSTH
C
      DIMENSION TRNL(7), ANCONS(7), RATE(100), DUMMY(100)
      DATA TRNL / 1.0, 0.1, 0.1, 1.0, 0.1, 0.1, 0.1/
      DATA ANCONS /0., 0., 0.12, 55., 68., 4.2, 0.12/
      DATA DUMMY /100 * 0./
      DATA DUMMY1 /0./
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      DATA CONST1 /3.169E-8/
C                                                                        C
     CONST2 = 224. * 3.156E+7
      DATA CONST2 /7.069E+9/
C
C     CONST3 = 0.69315 / 14. * 365.25
      DATA CONST3 /18.0838/
C
      DATA CONST4 /0.25/
      DATA CONST5 /3.156E+07/
      DATA CONST6 /365.25/
C
C     CONST7 /1.09E-09 * 224. / 15.
      DATA CONST7 /1.4933E-08/
C
      DATA ONE /1./
      DATA CONSTC /'C '/
      DATA CONSTH /'H '/
C
      JNUC = 0
C
C
C     FOR EACH DECAY CHAIN--
      DO 100 ICH = 1, ICHN
C
        J = NOFN(ICH)
        IST = JNUC + 1
        JNUC = JNUC + J
        K = IST + J - 1
C
C
C       FOR EACH NUCLIDE IN THE CHAIN--
        DO 200 I = IST, K
C
C         CALCULATE AIR CONCENTRATION OF NUCLIDE I, WEIGHTED BY POP-
C         ULATION AND RADIOLOGICAL DECAY CONSTANT,  PERSON-CI-YR/M**3
C
          AIRCON(I) = PM(ITIM) * ACTA(ITIM,I) * CONST1 / AR(I)
C
CC        IF (IAC.GT.0) PRINT 8883, I,ITIM,AIRCON(I)
CC   8883 FORMAT (' AIR CONCENTRATION (I,ITIM,AIRCON): ',2I5,2X,1PG10.3)
CC
 200    CONTINUE
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C       IF THIS ELEMENT IS 'H '--
        IF (ELTM(IST) .EQ.  CONSTH)  THEN
C
          CALL TRITUM (IST, 1, DUMMY1, AIRCON(IST), ANCONS, DUMMY,
     .                 SLCON(IST), EDBCON(1,IST), DUMMY)
C
        ELSE                                                            C
         IF THIS ELEMENT IS 'C '--
          IF (ELTM(IST) .EQ. CONSTC)  THEN
C
            CALL CARBON(IST, 1, DUMMY1, AIRCON(IST), ANCONS, DUMMY,
     .                 SLCON(IST), EDBCON(1,IST), DUMMY,
     .                RIRR, MOPYR)
C
          ELSE
C
C           SKIP OVER IF ACUTE RELEASE, FIRST YEAR--
            IF (ITIM .NE. 1)   THEN
C
CC              SKIP OVER IF FIRST TIME CHRONIC RELEASE--
CC              IF (ITIM .NE. 2)  THEN

C
C             DECAY PREVIOUS SOIL ACCUMULATION--
              CALL BCHAIN (J, 70., DK(1,IST), IFRM(1,IST), AR(IST),
     .                   AB(IST), SLCON(IST), SLCON(IST), 0)
C
CC              PRINT 8881, ITIM, SLCON(IST)
CC              8881 FORMAT (' IN APATHS   ITIM, SLCON: ',I5,3X,1PG10.3)
CC              ENDIF

C
C             IF THERE IS A RELEASE--
              IF (ITIM .LE. ITAX)   THEN
C
C               ADD IN INTEGRATED CONTRIBUTION FROM THIS 70-YR PERIOD--
                DO 300 I = IST, K
C
C                 CALCULATE DEPOSTION RATE, WEIGHTED BY POPULATION AND
C                 DECAY CONSTANT, PERSON-CI-YR / KG-YR
                  RATE(I) = AIRCON(I) * DVEL(I) / CONST2
C
  300           CONTINUE
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
            CALL BCHAIN (J, 70., DK(1,IST), IFRM(1,IST), AR(IST),
     .                   AB(IST), RATE(IST), RATE(IST), 1)
C
C           SUM PREVIOUS AND CURRENT DEPOSTIONS--
C
C           The following was added to correct population include in SLCON
            PMT = 1.0
            IF (ITIM .GT. 1) THEN
            IF (PM(ITIM-1) .GT. 0. .AND. PM(ITIM) .GT. 0.0) THEN
             PMT = PM(ITIM) / PM(ITIM-1)
            ENDIF
            ENDIF
C
           DO 400 I = IST, K
              SLCON(I) = SLCON(I) * PMT + RATE(I)
 400       CONTINUE
C
          ENDIF
        ELSE
C       FOR ACUTE FIRST YEAR RELEASE--
C
          DO 500 I = IST, K
C           CALCULATE ACUTE DEPOSTITION ON SOIL--
            SLCON(I) = AIRCON(I) * DVEL(I) / CONST2
CC
CC          PRINT 8882, I, SLCON(I), DVEL(I)
CC          8882 FORMAT (' ACUTE DEPOSITION: ',I5,3X,2(1PG10.3))
CC
 500      CONTINUE
C
          CALL BCHAIN (J, 1.0, DK(1,IST), IFRM(1,IST), AR(IST),
     .                 AB(IST), SLCON(IST), SLCON(IST), 0)
C
        ENDIF
C
C         CALCULATE PLANT AND ANIMAL CONCENTRATIONS--
C
C         FOR EACH NUCLIDE IN CHAIN--
          DO 600 I = IST, K
C
C           CALCULATE ENVIRONMENTAL REMOVAL CONSTANT--
            ENVLAM = AR(I) + CONST3
C
C           FOR EACH TERRESTRIAL PATHWAY--
            DO 700 IP = 1, 7
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
                IF (ITIM .EQ. 1)  THEN
C
C                 ACUTE LEAF CONCENTRATION--
                  RLFCON = CONST4 * AIRCON(I) * DVEL(I) * CONST5
     .                    / YELD(IP)
C
                ELSE
C
C                 CHRONIC LEAF CONCENTRATION--
               RLFC1 = CONST4 * (AIRCON(I)+SLCON(I)*CONST7)
     .                  * DVEL(I)
               RLFC2 = ONE - EXP (-ENVLAM * GRWP(IP)/CONST6)
               RLFCON = RLFC1 * RLFC2 / ENVLAM/YELD(IP)*CONST5              C

      IF (ITIM .EQ.2) THEN
      ENDIF
                ENDIF
C
C
                PLTCON = RLFCON* TRNL(IP) + SLCON(I) * CRATIO(1,I)
C
C               IF VEGATABLE PATHWAY--
                IF (IP .LE. 2)  THEN
C
                  EDBCON(IP,I) = PLTCON
C
                ELSE
C
                  EDBCON(IP,I) = PLTCON*ANCONS(IP)*CRATIO(IP-1,I)
C
                ENDIF
C
C
  700             CONTINUE
  600           CONTINUE
              ENDIF
            ENDIF
  100 CONTINUE
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module BCHAIN

```
      SUBROUTINE BCHAIN (NUC, T, DK, IFRM, AL, AB, AM, AO, INTGRL)
C
C***********************************************************************
C
C     BCHAIN CALCULATES DECAY FOR ONE CHAIN
C
C***********************************************************************
C
C     CALLED BY-- APATHS, WPATHS
C     SUBORDINATE ROUTINES-- ASUM, SUMPRD, ZEROR, EXMO
C     INPUTS-- NUC, T, DK, IFRM, AL, AB, AM, INTGRL
C     INPUT COMMONS-- NONE
C     OUTPUTS-- AO
C     OUTPUT COMMONS-- NONE
C
C     VAX Version of 11-OCT-85  RAP
C
C-----------------------------------------------------------------------
C
C
      REAL*8 A(45), SUMPR, ASUM, AMD, EXPO(9), ABD(9)
      REAL*8 ARG, TERM
      DIMENSION DK(2,9), IFRM(2,9), AL(9), AM(9), AO(9),
     .          AB(9)
C
C      CHANGE TO QUAD PRECISION
       DO 113 IJK = 1, 9
        ABD(IJK) = AB(IJK)
  113 CONTINUE
C
C      INITIALIZE COEFFICIENT ARRAY TO ZERO--
       N2N = NUC * (NUC-1) / 2 + NUC
C
C       CALL ZEROR (N2N, A)

      DO 100 IJK = 1, N2N
        A(IJK) = 0.0D0
  100 CONTINUE
C
C      DO LOOP ON CHAIN MEMBERS,  MAX = NUC--
       DO 5 J = 1, NUC
C
C        CALCULATE EXPONENTIAL FOR CURRENT NUCLIDE--
         ARG=-ABD(J) * T
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
       IF (INTGRL .GT. 0)    THEN
        IF (ARG .GT. 0.0D0) THEN
          PRINT 111, ARG
 111      FORMAT (' ERROR IN EXMO OF ACHAIN, POS ARG= '
     .              1PE10.3)
        ELSE
C          FORM IS:  (1 - DEXP (ARG) ) / AB   FOR INTGRL > 0

C          EXPO(J) = EXMO (ARG, AB(J) )

C
C          The following code was added to circumvent a VMS 4.2 error
C
          IF (-ARG .GT. 88.5) THEN
            EXPO(J) = 0.D0
          ELSE
            IF (-ARG .GT. 0.00001) THEN
              EXPO(J) = (1.0D0 - DEXP(ARG)) / ABD(J)
            ELSE
              FX = -(DLOG10(-ARG))
              I = 10 - IFIX(FX)
              IF (I .LT. 2)  I=2
              TERM = - ARG
              DO 13 IT = 2,I
                TERM = (TERM*ARG) /DFLOAT(IT)
                EXPO(J) = EXPO(J) + TERM/ABD(J)
 13           CONTINUE
            ENDIF
          ENDIF
        ENDIF
      ELSE
C        FORM IS EXP(ARG) FOR INTGRL = 0
        IF (-ARG .GT. 88.5) THEN
          EXPO(J) = 0.D0
        ELSE
          EXPO(J) = DEXP (ARG)
        ENDIF
      ENDIF
C
C      SET STARTING INDEX FOR TERM ARRAY A--
       JJ = J * (J-1) / 2
C
C      SET CHAIN POSITION MINUS ONE--
       J1 = J - 1
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
       IF(J1 .GT. 0)   THEN
C
         IMAX = MINO (J1, 2)
         DO 3 M = 1, J1
           DO 2 L = M, J1
            DO 1 I = 1, IMAX
C
               IF (IFRM(I,J) .EQ. L)    THEN
                 A(M+JJ) = A(M+JJ) + DK(I,J) * AL(L) * A(M+L * (L-1)/2)
               ENDIF
C
    1         CONTINUE
    2       CONTINUE
C
           A(M+JJ) = A(M+JJ) / (ABD(J) - ABD(M))

C
    3     CONTINUE
C
       ENDIF
C
C
      ASUM = 0.0D0
      IF (J1 .EQ. 0) GO TO 11
        DO 12 IRAP = 1, J1
          JK = JJ + IRAP
          ASUM = ASUM + A(JK)
   12   CONTINUE
   11 CONTINUE
C
C
C       A(J + JJ) = AM(J) - ASUM (J1, A(JJ+1) )

C
      AMD = AM(J)
      A(J+JJ) = AMD - ASUM
C
C       AO(J)= SUMPRD (J, EXPO, A(JJ + 1) )

C
      SUMPR = 0.0D0
      DO 8884 IN = 1, J
        JK = JJ + IN
        SUMPR = SUMPR + EXPO(IN) * A(JK)
```

FIGURE D.1. DITTY Program Listing (continued)

```
8884   CONTINUE
       AO(J) = SUMPR
C
    5 CONTINUE
C
      RETURN
       END
```

FIGURE D.1. DITTY Program Listing (continued)

Module BIOLIN

```
      SUBROUTINE BIOLIN
C
C*******************************************************************
C                                                                  *
C     BIOLIN READS VALUES OF THE BIOACCUMULATION FACTOR FOR FISH,  *
C     MOLLUSCS, CRUSTACEANS, AND WATER PLANTS, AS WELL AS DRINKING *
C     WATER CLEANUP FACTORS FROM THE LIBRARY FILE.                 *
C                                                                  *
C*******************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NONE
C     INPUT COMMONS-- NUCNAM
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- TITLES, BIODAT
C
C-------------------------------------------------------------------
C
      INCLUDE 'BIODAT.CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'TITLES.CMN'
C
      CHARACTER*2 E
C
      DIMENSION BF(8)
C
C     ASSIGN LOGICAL UNIT DEVICE NUMBERS--
      IUN = 14
C
C     READ TITLE AND HEADER RECORDS--
      READ (IUN,1000, ERR=800, END=900) BIOTTL
C
C     FRESH OR SALT WATER DOSE FACTORS TO BE USED?--
      IF (ISALT .EQ. 1)  THEN
        KSLT = 4
      ELSE
        KSLT = 0
      ENDIF
C
C     LOOP UNTIL END OF FILE--
  100 CONTINUE
C
C       READ DATA RECORD--
        READ (IUN,2000,ERR=800,END=999) E, (BF(I), I=1,8), DW
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C       IF RADIONUCLIDE FOUND IN MASTER LIBRARY, SET BIOACCUMULATION FACTORS--
        DO 200 J = 1, NUCS
C
          IF (E .EQ. ELTM(J) )  THEN
C
            DWCF(J) = DW
            DO 300 K = 1, 4
              BIOACF(K,J) = BF(K+KSLT)
  300       CONTINUE
C
          ENDIF
  200   CONTINUE
C
      GO TO 100
C     IF NOT END-OF-FILE, READ NEXT RECORD--
C
C
C     ERROR CONDITIONS--
C
C     READ ERROR ENCOUNTERED--
  800 WRITE (6, 8000)
      STOP
C
C     PREMATURE END-OF-FILE ENCOUNTERED--
  900 WRITE (6, 9000)
      STOP
C
C
C     NORMAL TERMINATION POINT--
  999 REWIND IUN
      RETURN
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (20A4)
C
 2000 FORMAT (A2, 8F9.1, F6.1)
C
 8000 FORMAT ('0 READ ERROR ENCOUNTERED IN BIOLIN')
C
 9000 FORMAT ('0 PREMATURE END-OF-FILE ENCOUNTERED IN BIOLIN')
C
     END
     SUBROUTINE CARBON (IST, IAW, WATCN, AIRCN, ANCONS, ANDRNK, CSOIL,
```

FIGURE D.1. DITTY Program Listing (continued)

```
     .                 EDIBL, AQUA, RIRR, MOPYR)
C
C*****************************************************************
C                                                                *
C     CARBON CALCULATES ENVIRONMENTAL CONCENTRATIONS OF C-14 USING     *
C     A SIMPLIFIED SPECIFIC-ACTIVITY MODEL.                      *
C                                                                *
C*****************************************************************
C
C     CALLED BY-- APATHS, WPATHS
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- IST, IAW, WATCN, AIRCN, ANCONS, ANDRNK,RIRR,MOPYR

C     INPUT COMMONS-- BIODAT
C     OUTPUTS-- CSOIL, EDIBL, AQUA
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 24-OCT-84   RAP
C
C-----------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ------------------------------------
C
C     IST         INTEGER
C     IAW         INTEGER
C     WATCN       REAL
C     AIRCN       REAL
C     ANCONS(7)   REAL
C     ANDRNK(7)   REAL
C     CSOIL       REAL
C     EDIBL(7)    REAL
C     AQUA(5)     REAL
C
C-----------------------------------------------------------------
C
      INCLUDE 'BIODAT.CMN'
C
```

FIGURE D.1. DITTY Program Listing (continued)

Module CARBON

```
C
      DIMENSION ANCONS(7), ANDRNK(7), EDIBL(7), AQUA(5)
C
      REAL MOPYR
C
      DATA C0 /2.0E-5/
      DATA C1 /1.6E-4/
      DATA C2 /0.09/
      DATA C3 /0.4/
      DATA C4 /0.09/
      DATA C5 /0.07/
      DATA C6 /0.24/
      DATA C7 /0.33/
      DATA C8 /0.20/
      DATA C9 /0.15/
C
      DATA Z1 /0.1/
      DATA Z2 /0.03/
      DATA SDEN /224./
      DATA SKG /0.01/
      DATA PKG /0.1/
      DATA RMV /1.25/
C
C
      CWAT = WATCN*RIRR*MOPYR*PKG*RMV/(SDEN*SKG)
      CAIR = AIRCN / C1
      CLEAF = CAIR + CWAT
      CSOIL = (CAIR + WATCN/C0) * Z2

C
      EDIBL(1) = CLEAF * C2
      EDIBL(2) = EDIBL(1)
      EDIBL(3) = C9 * CLEAF
      EDIBL(4) = C5 * CLEAF
      EDIBL(5) = C6 * CLEAF
      EDIBL(6) = C7 * CLEAF
      EDIBL(7) = C8 * CLEAF
C
      IF (IAW .EQ. 2)  THEN
C
        DO 100 I = 1, 4
          AQUA(I) = BIOACF(I,IST) * WATCN
  100   CONTINUE
C
        AQUA(5) = WATCN * DWCF(IST)
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      ENDIF
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module CASEIN

```
      SUBROUTINE CASEIN
C
C*********************************************************************
C                                                                    *
C     CASEIN CONTROLS CARD INPUT PLUS INPUT FROM POPULATION          *
C     DATA FILE 22.                                                  *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- EOVRQ, PMAC, PMEQ, PMINT, PMSET, ZEROR
C     INPUTS-- NONE
C     INPUT COMMONS-- NONE
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- AIRCON, BIODAT, DISPSN, NAMLST, OPTION, PATHIN,
C                      VARYBL, POPU, TIMES, TITLES
C
C     Module of DITTY1
C     VAX Version of 9-NOV-84  RAP
C
C---------------------------------------------------------------------
C
      INCLUDE 'AIRCON.CMN'
      INCLUDE 'BIODAT.CMN'
      INCLUDE 'DISPSN.CMN'
      INCLUDE 'NAMLST.CMN'
      INCLUDE 'OPTION.CMN'
      INCLUDE 'PATHIN.CMN'
      INCLUDE 'POPU.CMN'
      INCLUDE 'TIMES.CMN'
      INCLUDE 'TITLES.CMN'
      INCLUDE 'VARYBL.CMN'
C
C
      NAMELIST /INPUT/ IAC, IAIR, IPATH, IWAT, LUA, LUW, ISALT, TZ, TZR,
     .                 DIST, NDIST, NSECT, IEOQ, HS, NMET, NUBAR, MET,
     .                 UBAR, IPA, IPL, IPOP, NTA, NTL, PL, PL1, PM1, PM,
     .                 IPOPL, PMA, POPT, PPL, T, TL, CFLO, RECON, RM,
     .                 USAGE, CONSUM, EXTIM, GRWP, MOPYR, RIRR, YELD,
     .                 IGRPOP, IGRPM, IGRPL, IGRTNU, IGRNUC, IGRDOS
C
      DATA TEN4 /10000./
C
C     ASSIGN LOGICAL UNIT DEVICE NUMBERS--
    1 IUN = 5
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C
C     READ A NAMELIST INPUT DATA SET--
      READ (IUN,INPUT,ERR=800,END=900)
C
C     IF AIRBORNE RELEASES ARE TO BE CONSIDERED--
      IF (IPATH .LE. 1)   THEN
C
        IF (IEOQ .EQ. 1)  THEN
C
C         READ E/Q FOR EACH DISTANCE AND DIRECTION--
          CALL ZEROR (160, EOQ)
          DO 100 IS = 1, NSECT
            READ (IUN,1000,ERR=801,END=900) (EOQ(ID,IS), ID=1,NDIST)
  100     CONTINUE
C
       ELSE
C
          IF (IEOQ .EQ. 2)  THEN
C
            CALL ZEROR (896,F)
C
C           READ JOINT FREQUENCY DATA--
C
            DO 200 IU = 1, NUBAR
              DO 300 IM = 1, NMET
                READ (IUN,2000,ERR=802,END=900) (F(IU,IM,IT), IT=1,16)
  300         CONTINUE
  200       CONTINUE
C
            CALL EOVRQ
C           TO GENERATE E/Q.
C
          ELSE
C
            IF (IEOQ .EQ. 3)  THEN
C
              CALL EOVRQ
C             TO GENERATE E/Q.
C
            ENDIF
          ENDIF
        ENDIF
C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C       IF REQUIRED--
        IF (IPOP .EQ. 2)    THEN
C
          CALL ZEROR (160, POP)
          POPT(1) = 0.
C
C         TRANSFER INPUT TOTAL POPULATION--
         IF (NTA .GT. 0) THEN
           DO 602 I = 2, NTA
             POPT(I) = PM1(I)
 602       CONTINUE
         ENDIF
C
C         READ TIME OF AIRBORNE POPULATION DATA--

C         READ TIME(1)--
          READ (IUN,3000,ERR=803,END=900) T(1)
C
C         READ POPULATION DATA FOR TIME(1)--
          DO 400 IS = 1, 16
            READ (IUN,1000,ERR=804,END=900) (POP(I,IS), I=1,NDIST)
            DO 401 I = 1, NDIST
             POPT(1) = POPT(1) + POP(I,IS)
 401        CONTINUE
 400      CONTINUE
C
C         CALCULATE FIRST PM1 VALUE--
          CALL PMEQ (NDIST, PM1(1) )
C
          IF (NTA .GT. 1) CALL PMSET (NTA, POPT, PM1)
C
        ELSE
C
C
          IF (IPOP .EQ. 3)   THEN
C
            NTAT = 0
            CALL ZEROR (20, POPT)
C
C           READ LIBRARY TITLE RECORD--
            READ (22,4000,ERR=805,END=900) PODTTL
C
C
C           LOOP UNTIL NTAT = 20 OR T(NTAT) > TZ+10000 OR NTAT-1 = NTA
  500       CONTINUE
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
             NTAT = NTAT + 1
C
C            READ T(NTAT) FROM LIBRARY FILE 22--
             READ (22,3000,ERR=806,END=900) T(NTAT)
C
C            READ POPULATION DATA FOR TIME NTAT FROM LIBRARY FILE 22--
             DO 600 IS = 1, 16
               READ (22,1000,ERR=807,END=900) (POP(I,IS), I=1,NDIST)
               DO 601 I = 1, NDIST
                 POPT(NTAT) = POPT(NTAT) + POP(I,IS)
  601          CONTINUE
  600        CONTINUE
C
             CALL PMEQ (NDIST, PM1(NTAT) )
C
           IF (NTAT .LT. 20 .AND. T(NTAT) .LE. (TZ + TEN4)
     .         .AND. NTAT  .LT. NTA)  GO TO 500
C
         ELSE
           IF (IPOP .EQ. 5)    THEN
C
             CALL PMEQ (NDIST, PM1(1) )
             IF (NTA .GT. 1) CALL PMSET (NTA, POPT, PM1)
C
          ELSE
            IF (IPOP .EQ. 6) THEN
              DO 612 I = 2, 144
                PM(I) = 0.0
 612          CONTINUE
            ENDIF
C
          ENDIF
         ENDIF
        ENDIF
C
C
        IF (IPOP .GT. 1 .AND. IPOP .LT. 6) THEN
         CALL PMINT (NTA, TZ, T, PM1, PM(2) )
       ENDIF
C
        IF (IAC .GT. 0)   THEN
C
          IF (IPA .EQ. 1)  PM(1) = PMA
          IF (IPA .GT. 1)  CALL PMAC (NTA, PM1, T, TZ, PM(1) )
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
          ENDIF
C
        ENDIF
C
C
C
C       IF WATERBORNE RELEASES ARE TO BE CONSIDERED, TOTAL POPULATION IN
C       EACH 70 YEAR PERIOD IS SET IF NECESSARY--
C
        IF (IPATH .NE. 1)  THEN
          IF (IPOPL .EQ. 2)  CALL PMINT (NTL, TZ, TL, PL1, PL(2) )
C
          IF (IAC .GT. 0)   THEN
C
            IF (IPL .EQ. 1)  PL(1) = PPL
            IF (IPL .GT. 1) CALL PMAC (NTL, PL1, TL, TZ, PL(1) )
C
          ENDIF
C
        ENDIF
        RETURN
C
C       ERROR CONDITIONS--
C
  800 WRITE (6,8000)
      STOP
  801 WRITE (6,8001)
      STOP
  802 WRITE (6,8002)
      STOP
  803 WRITE (6,8003)
      STOP
  804 WRITE (6,8004)
      STOP
  805 WRITE (6,8005)
      STOP
  806 WRITE (6,8006)
      STOP
  807 WRITE (6,8007)
      STOP
C
  900 WRITE (6,9000)
      STOP
C
```

FIGURE D.1. DITTY Program Listing (continued)

Module CASEIN

```
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (10E8.1)
C
 2000 FORMAT (16F5.2)
C
 3000 FORMAT (E10.2)
C
 4000 FORMAT (20A4)
C
 8000 FORMAT ('0 NAMELIST READ ERROR ENCOUNTERED IN  CASEIN')
C
 8001 FORMAT ('0 E/Q READ ERROR ENCOUNTERED IN CASEIN')
C
 8002 FORMAT ('0 JOINT FREQUENCY READ ERROR ENCOUNTERED IN CASEIN')
C
 8003 FORMAT ('0 TIME(1) FOR AIRBORNE RELEASE POPULATION READ ERROR ',
    .        '  IN INPUT STREAM ENCOUNTERED IN CASEIN.')
C
 8004 FORMAT ('0 POPULATION FOR AIRBORNE RELEASE ERROR IN INPUT FILE ',
    .        '  ENCOUNTERED IN CASEIN.')
C
 8005 FORMAT ('0 POPULATION TITLE AIRBORNE RELEASE ERROR IN FILE 22 ',
    .        '  ENCOUNTERED IN CASEIN.')
C
 8006 FORMAT ('0 ERROR READING TIME IN FILE 22 ENCOUNTERED IN CASEIN.')
C
 8007 FORMAT ('0 ERROR READING POPULATION IN FILE 22 ENCOUNTERED IN ',
    .        '  CASEIN.')
C
 9000 FORMAT ('0 PREMATURE END OF FILE ENCOUNTERED IN  CASEIN')
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module CONSET

```
      SUBROUTINE CONSET (T, C, NT, IBEG, IEND, CONS)
C
C*********************************************************************
C
C     CONSET ESTABLISHES RELEASE DATA FOR ONE RADIONUCLIDE FOR THE
C     SEVENTY YEAR INCREMENT.
C
C*********************************************************************
C
C     CALLED BY--  ACTIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- T, C, NT
C     INPUT COMMONS-- TIMES
C     OUTPUTS-- IBEG, IEND, CONS
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 24-SEP-85  RAP
C
C---------------------------------------------------------------------
C
C                 ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  --------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  --------------------------------------
C
C     T(450)      REAL       TIME POINTS FOR SPECIFYING ACTIVITY RELEASE
C                            RATES, YEARS SINCE START OF CALCULATION
C     C(450)      REAL       ACTIVITY RELEASED PER YEAR AT EACH TIME
C                            POINT, CI/YR
C     NT          INTEGER    NO. OF TIME POINTS DATA SUPPLIED FOR IN
C                            ARRAYS T & C, 2 <= NT <= 300
C     IBEG        INTEGER    1ST 70-YR INCREMENT WITH A NON-ZERO RELEASE
C                            ACTIVITY FOR THE CURRENT RADIONUCLIDE
C     IEND        INTEGER    LAST 70-YR INCREMENT THAT HAS A NON-ZERO
C                            RELEASE ACTIVITY FOR THE CURRENT NUCLIDE
C     CONS(143)   REAL       TOTAL ACTIVITY RELEASED IN EACH OF THE 143
C                            70-YR INCREMENTS, CI
C
C---------------------------------------------------------------------
C
      DIMENSION T(450), C(450), CONS(144)
C
      INCLUDE 'TIMES.CMN'
     INCLUDE 'OPTION.CMN'
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C     INITIALIZE VARIABLES--
      IR = 1
      IRS = 0
      IEND = 0
      IBEG = 0
C
      S70 = 70.
      S35 = 35.
C
C     IF ACUTE RELEASE, SET CONS AND SKIP TO END OF SUBROUTINE--
      IF (T(1) .EQ. 0.0 .AND. T(2) .EQ. 1.0) THEN
       CONS(1) = C(1)
       IBEG = 0
       IEND = 1
       GO TO 500
      ENDIF
C
C
C     LOOP UNTIL IRS IS GREATER THAN 0   OR   IR IS GREATER THAN NT--
  100   IF (TZ .LT. T(IR) + TZR)    THEN
          IRS = IR
          IF (TZ+70. .GE. T(IR)+TZR)  IBEG = 1
        ELSE
          IR = IR + 1
        ENDIF
      IF (IRS .LE. 0  .AND.  IR .LE. NT)   GO TO 100
C
C
      IF (IR .LE. NT)    THEN
C
        IR = IRS
        IN = 1
        TIR = TZR + T(IR)
        IF (IBEG .LT. 1)    IBEG = IN
C
C       LOOP UNTIL IN IS GREATER THAN 143 OR IR IS GREATER THAN NT--
C
  200     T7B = TZ + 70. * FLOAT (IN - 1)
          T7E = T7B + 70.
          R = 0.
C
          IF (T7E .LE. TIR)    THEN
C
            IF (IR .GT. 1)    THEN
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
               CIR = C(IR)
               TIR = T(IR) + TZR
C
               SLOPE = (CIR -C(IR-1)) / (TIR - T(IR-1)-TZR)
C
               CONS(IN+1) = S35 * SLOPE * (T7E+ T7B)  +  S70 * CIR
     .                    - S70 * SLOPE * TIR
C
             ENDIF
C
             IN = IN + 1
C
           ELSE
C
             IF (IR .GT. 1)    THEN
C
               TIR = TZR + T(IR)
               C1 = C(IR-1)
               C2 = C(IR)
               T1 = TZR + T(IR-1)
               C7 = (C2 -C1) * (T7B - T1) / (TIR-T1) + C1
               R = (C2 + C7) * (TIR - T7B) / 2.
C
             ENDIF
C
             IR = IR + 1
C
             IF (IR .LE. NT)    THEN
C
               KEND = 0
C
C             LOOP UNTIL END IS GREATER THAN 0 OR IR IS GREATER THAN NT--
C
  300            TIR = TZR + T(IR)
C
                 IF (T7E .LE. TIR)    THEN
C
                   KEND = 1
                   C1 = C(IR-1)
                   C2 = C(IR)
                   T1 = TZR + T(IR-1)
                   C7 = (C2-C1) * (T7E - T1) / (TIR - T1) + C1
                   R = R + (C1 + C7) * (T7E - T1) / 2.
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
                ELSE
C
                  R = R + (C(IR) + C(IR-1)) * (T(IR) - T(IR-1)) / 2.
                  IR = IR + 1
C
                ENDIF
C
                IF (KEND .GT. 0) GO TO 400
                   IF (NT .LT. IR) GO TO 400
                 GO TO 300
  400 CONTINUE
C
            ENDIF
C
            CONS(IN+1) = R

           IN = IN + 1
            IEND = IN
C
          ENDIF
C
        IF (IN .LE. 143   .AND. IR .LE. NT) GO TO 200
C
      ENDIF
C
  500 CONTINUE
     RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module CONTRL

```
      SUBROUTINE CONTRL (IAC, IPATH, ITAM, ITAX, ITWM, ITWX)
C
C*****************************************************************
C                                                               *
C     THIS ROUTINE CONTROLS THE CALLING OF THE ROUTINES CALCULATING   *
C     ENVIRONMENTAL ACCUMULATION AND DECAY OF RADIONUCLIDES  AND      *
C     THE CALCULATION AND SUMATION OF RESULTING DOSES                 *
C                                                               *
C*****************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- APATHS, DOSADD, WPATHS, ZEROR
C     INPUTS-- IAC, IPATH, ITAM, ITAX, ITWM, ITWX
C     INPUT COMMONS-- NONE
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- EDCN, OUTORG
C
C     Module of DITTY
C     VAX Version of 12-SEP-84  RAP
C
C-----------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     IAC         INTEGER    IF > 0, CONSIDER AN ACUTE RELEASE PERIOD
C                            AT BEGINNING OF 70-YR PERIOD
C     IPATH       INTEGER    PATHWAY SELECTION: BOTH = 0, AIR = 1,
C                            WATER = 2
C     ITAM        INTEGER
C     ITAX        INTEGER
C     ITWM        INTEGER
C     ITWX        INTEGER
C
C-----------------------------------------------------------------
C
      INCLUDE 'EDCN.CMN'
      INCLUDE 'OUTORG.CMN'
      INCLUDE 'RESULT.CMN'
C
C     INITIALIZE CONCENTRATION ARRAYS--
      CALL ZEROR (100, SLCON)
      CALL ZEROR (100, AIRCON)
```

FIGURE D.1. DITTY Program Listing (continued)

```
      CALL ZEROR (700, EDBCON)
      CALL ZEROR (100, WATCON)
      CALL ZEROR (100, SCONW)
      CALL ZEROR (100, SEDCON)
      CALL ZEROR (700, EDBCNW)
      CALL ZEROR (500, AQUATC)
      CALL ZEROR (720, DTOTAL)
      CALL ZEROR (500, POPDOS)
C
C
      IF (IAC .GT. 0)  THEN
C
        IF (IPATH .LE. 1)  CALL APATHS (1, ITAX)
C       TO CALCULATE CONCENTRATIONS FROM ATMOSPHERIC DEPOSITION.
C
        IF (IPATH .NE. 1)  CALL WPATHS (1, ITWX)
C       TO CALCULATE CONCENTRATIONS FROM AQAUATIC PATHWAYS.
C
C       Third parameter added to call list to indicate acute/chronic case--
        CALL DOSADD (1, 1, IAC)
C       TO ACCUMULATE 70-YR INCREMENTAL DOSES.
C
      ENDIF
C
C
C     FOR EACH 70-YR TIME STEP FOR 10,000 YEARS--
      DO 100 ITT = 2, 144
C
        IF (IPATH .LE. 1 .AND. (ITT .GE. ITAM .OR. IAC .GT. 0))  THEN
          CALL APATHS (ITT, ITAX)
        ENDIF
C
        IF (IPATH .NE. 1 .AND. (ITT .GE. ITWM .OR. IAC .GT. 0))  THEN
          CALL WPATHS (ITT, ITWX)
        ENDIF
C
        CALL DOSADD (2, ITT, IAC)
C
C
  100 CONTINUE
C
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE DOSADD (ICUTE, ITT, IAC)
C
C*******************************************************************
C                                                                  *
C     DOSADDD CALCULATES 70-YEAR INCREMENTAL POPULATION DOSES      *
C     FROM EXPOSURE TO CONTAMINATED ENVIRONMENTAL MEDIA            *
C                                                                  *
C*******************************************************************
C
C     CALLED BY-- CNTRL
C     SUBORDINATE ROUTINES-- ZEROR
C     INPUTS-- ICUTE, ITT, IAC

C     INPUT COMMONS-- PATHIN, EDCN, DOSFAC, GRDDAT, DKAY, ORGID, DOSIN
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- RESULT, OUTORG
C
C     Module of DITTY
C     Version of 19-NOV-84  RAP
C
C-------------------------------------------------------------------
C
C                  ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ----------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ----------------------------------------
C
C     ICUTE       INTEGER    INDICATES IF ACUTE OR CHRONIC DOSE FACTORS
C                            ARE TO BE USED IN CALCULATIONS
C     ITT         INTEGER    INDEX OF 70-YR INCEREMENTS
C     IAC         INTEGER    ACUTE/CHRONIC INDEX
C
C-------------------------------------------------------------------
C
      INCLUDE 'PATHIN.CMN'
      INCLUDE 'EDCN.CMN'
      INCLUDE 'DKAY.CMN'
      INCLUDE 'ORGID.CMN'
      INCLUDE 'OUTORG.CMN'
      INCLUDE 'DOSFAC.CMN'
      INCLUDE 'GRDDAT.CMN'
      INCLUDE 'RESULT.CMN'
C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      DIMENSION DOSINC(5,100)
C
      DATA CONST1 /3.15E+07/
      DATA CONST2 /1.49E-8/
      DATA CONST3 /224./
C
      IF (ITT .EQ. 1 .OR. (ITT .EQ. 2 .AND. IAC .EQ. 0)) DMAX = 0.

C
      DXINC = 0.
C
      CALL ZEROR (500, DOSINC)
C
C
C     FOR EACH RADIONUCLIDE--
      DO 100 I = 1, INUC
C
        ARI = AR(I)
C
C       FOR EACH ORGAN--
        DO 200 IO = 1, NORG
C
C         ADD AIR SUBMERSION DOSE--
          DOSINC(IO,I) = DOSINC(IO,I) + EDA(I) * ARI
     .                  * CONST1 * (AIRCON(I)
     .                  + CONST2 * (SLCON(I) + SCONW(I)) )
C
C         ADD INHALATION DOSE--
          DOSINC(IO,I) = DOSINC(IO,I) +  DFH(ICUTE,IO,I)
     .                  * CONST1 * ARI * (AIRCON(I)
     .                  + CONST2 * (SLCON(I) + SCONW(I)) )
C
C         ADD TERRESTRIAL PATHWAY DOSES--
          DO 300 IP = 1, 7
            DOSINC(IO,I) = DOSINC(IO,I) + ARI * CONSUM(IP)
     .                    * DFG(ICUTE,IO,I)
     .                    * (EDBCON(IP,I) + EDBCNW(IP,I) )
  300     CONTINUE
C

C         ADD AQUATIC PATHWAY DOSES--
          DO 400 IWP = 1, 5
            DOSINC(IO,I) = DOSINC(IO,I) + ARI * USAGE(IWP)
     .                    * DFG(ICUTE,IO,I) * AQUATC(IWP,I)
```

FIGURE D.1. DITTY Program Listing (continued)

```
  400     CONTINUE
C
C         ADD SWIMMING AND SHORELINE--
          IF (SW .EQ. 0.0)    SW = 0.2
          DOSINC(IO,I) = DOSINC(IO,I) + (USAGE(6) * SEDCON(I) * SW
     .                    * EDS(I)  + USAGE(7) * WATCON(I) * EDW(I) )
     .                    * ARI
C
C         ADD SOIL EXTERNAL--
          DOSINC(IO,I) = DOSINC(IO,I) + EXTIM * ARI * EDS(I)
     .                    *  (SLCON(I) + SCONW(I)) * CONST3
C
C
C
          POPDOS(IO,I) = POPDOS(IO,I) + DOSINC(IO,I)

          DTOTAL(IO,ITT) = DTOTAL(IO,ITT) + DOSINC(IO,I)
C
  200   CONTINUE
C
        DXINC = DXINC + DOSINC(1,I)
C
  100 CONTINUE
C
C     FOR EACH ORGAN, ADD PREVIOUS DOSE TO TOTAL
      IF (ITT .GT. 1)    THEN
        DO 700 IO = 1, NORG
          DTOTAL(IO,ITT) = DTOTAL(IO,ITT) + DTOTAL(IO,ITT-1)
  700   CONTINUE
      ENDIF
C
C
C
C     CAPTURE PERIOD WITH HIGHEST DOSE RATE--
C
      IF (DXINC .GT. DMAX)   THEN
C
        MAXTIM  = ITT
        DMAX = DXINC
C
        DO 500 I = 1, INUC
          DO 600 IO = 1, NORG
C
            HIDOSE(IO,I) = DOSINC(IO,I)
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
  600     CONTINUE
  500   CONTINUE
C
      ENDIF
C
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE EOVRQ
C
C*********************************************************************
C                                                                    *
C     EOVRQ CALCULATES ANNUAL AVERAGE AIR CONCENTRATION AT EACH      *
C     SPATIAL INTERVAL MIDPOINT                                      *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- CASEIN
C     SUBORDINATE ROUTINES-- PASSIG, SIGMAZ
C     INPUTS-- NONE
C     INPUT COMMONS-- DISPSN
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- AIRCON
C
C---------------------------------------------------------------------
C
      INCLUDE 'DISPSN.CMN'
      INCLUDE 'AIRCON.CMN'
C
C     MESAGE IS USED TO OUTPUT ERROR MESSAGES--
      CHARACTER MESAGE*6
C
      DATA ZERO /0./
      DATA ONE /1./
      DATA IONE /1/
      DATA TWO /2./
      DATA ITWO /2/
C
C
      IF (NUBAR .LT. 1  .OR.  NUBAR .GT. 8)  THEN
        MESAGE = 'NUBAR'
        WRITE (6,1000) MESAGE, NUBAR
        IER = 1
      ELSE
        IER = 0
      ENDIF
C
      IF (NDIST .LT. 1  .OR.  NDIST .GT. 10)  THEN
        MESAGE = 'NDIST'
        IER = IER + 1
        WRITE (6, 1000) MESAGE, NDIST
      ENDIF
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      IF (NMET .LT. 1  .OR. NMET .GT. 7)  THEN
        MESAGE = 'NMET'
        IER = IER + 1
        WRITE (6, 1000) MESAGE, NMET
      ENDIF
C
C
      IF (IER .GT. 0)  STOP
C
C     FOR EACH DISTANCE--
      DO 100 IX = 1, NDIST
C
        X = DIST(IX)
C
C       FOR EACH STABILITY CATEGORY--
        DO 200 IS = 1, NMET
C
          IF (MET(IS) .GT. ITWO)  THEN
C
            IP = MET(IS) - ITWO
C
            CALL PASSIG (X, IP, SY, SZ)
C           TO INTERPOLATE PASQUILL CURVES FOR SY AND SZ FOR DISTANCE X
C           AND STABILITY IP.
C
            XSZ = X * SZ
C
            IF (HS .GT. ONE)  THEN
              EX = EXP( -HS * HS / (TWO * SZ * SZ) )
            ELSE
              EX = 1.0
            ENDIF
C
          ENDIF
C
C
C         FOR EACH WINDSPEED--
          DO 300 IU = 1, NUBAR
C
            IF (MET(IS) .LE. ITWO)  THEN
C
              IP = MET(IS) - IONE
              TT = X / UBAR(IU)
              SZ = SIGMAZ(IP,TT)
              XSZ = X * SZ
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
                IF (HS .GT. ONE)  THEN
                  EX = EXP ( - HS * HS / (TWO * SZ * SZ) )
                ELSE
                  EX = 1.0
                ENDIF
C
              ENDIF
C
C
              EQX = .02032 * EX / (UBAR (IU) * XSZ)
C
C             FOR EACH DIRECTION--
              DO 400 IT = 1, 16
C
                FF = F(IU,IS,IT)
                IF (FF .GT. ZERO)  EOQ(IX,IT) = EOQ(IX,IT)  +  EQX * FF
C
  400         CONTINUE
C
  300       CONTINUE
  200     CONTINUE
  100 CONTINUE
C
      RETURN
C
C
C     FORMAT STATMENTS--
C
 1000 FORMAT (10X, A6, ' IS OUT OF RANGE; ', I5)
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module FILLUP

```
      SUBROUTINE FILLUP (FOFX, YINC, IN, NOAVE)
C
C**********************************************************************
C                                                                     *
C     FILLUP PLOTS POINTS OF FOFX IN THE GRAPHICS ARRAY               *
C                                                                     *
C**********************************************************************
C
C     CALLED BY-- GRAPH
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- FOFX, YINC, NOAVE, IN
C     INPUT COMMONS-- NUCNAM
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- PLOT
C
C     Module of DITTY
C     VAX Version of 7-SEP-84  RAP
C
C-----------------------------------------------------------------------
C
C                 ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     FOFX        REAL       FUNCTION OF TIME ARRAY
C     YINC        REAL       Y PLOTTING INCREMENT
C     IN          INTEGER    INDEX OF FUNCTIONS TO BE PLACED IN PRINTING
C                            ARRAY
C     NOAVE       INTEGER    IF SET TO 1, DO NOT AVERAGE ZEROS INTO ARRAY
C
C-----------------------------------------------------------------------
C
      INCLUDE 'PLOT  .CMN'
      INCLUDE 'NUCNAM.CMN'
C
      LOGICAL NOFIND
C
      CHARACTER*1 THIS1, BLANK, POINT, MULT, AST
      CHARACTER*3 DASH
C
      DIMENSION POINT(8), MULT(9), FOFX(144,8)
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      DATA DASH /' - '/
      DATA AST /'*'/
      DATA BLANK /' '/
      DATA POINT /'X', 'O', '+', '=', '@', '-', '#', '$'/
      DATA MULT /'1', '2', '3', '4', '5', '6', '7', '8', '9'/
C
      DATA IY /40/
      DATA IX /73/
C
C
C     PLOT EACH POINT IN ARRAY--
C
      DO 100 I = 1, IX
C
        I2 = (I - 1) * 2
C
        IF ( I .EQ. 1)    THEN
C
C         FIRST VALUE OF ARRAY--
          R1 = FOFX(1,IN) / YINC
C
        ELSE
C
C
          IF ( I .EQ. IX)    THEN
C
C           LAST VALUE OF ARRAY--
            R1 = FOFX(144,IN) / YINC
C
          ELSE
C
C         FOR ALL OTHER POINTS--
C
          F1 = FOFX(I2,IN)
          F2 = FOFX(I2+1,IN)
C
          R1 = (F1 + F2) / YINC
C
          IF (NOAVE .GT. 0)    THEN
C
C           AVERAGE IF NEITHER POINT IS EQUAL TO ZERO--
            IF (F1 .GT. 0.  .AND.  F2 .GT. 0.)  THEN
              R1 = R1 * 0.5
            ENDIF
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
          ELSE
C
            R1 = R1 * 0.5
C
          ENDIF
        ENDIF
C
        ENDIF
C
        IR2 = IFIX (R1)
        R2 = FLOAT (IR2)
C
        IF (ABS(R1 - R2) .GT. .5)   IR2 = IR2 + 1
        IP = IY - IR2
        IF (IP .LT. 1)    IP = 1
        IF (IP .GT. 40)    IP = 40
C
        THIS1 = ARRAY(IP,I)
C
        IF (THIS1 .EQ. BLANK  .OR.  THIS1 .EQ. AST)  THEN
C
          ARRAY(IP,I) = POINT(IN)
C
        ELSE
C
          NOFIND = .TRUE.
C
          DO 200 K = 2, 9
            IF (THIS1 .EQ. MULT(K))  THEN
C
              ARRAY(IP,I) = MULT(K+1)
              NOFIND = .FALSE.
C
            ENDIF
  200     CONTINUE
C
          IF (NOFIND)   ARRAY(IP,I) = MULT(1)
C
        ENDIF
C
  100 CONTINUE
C     LEGEND(IN + 30) = MULT(IN) & DASH & ELTM(IN) & AWM(IN)
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE FOOLIN
C
C*********************************************************************
C                                                                    *
C     FOOLIN READS IN CROP AND ANIMAL FOOD CONCENTRATION RATIOS,     *
C     DEPOSITION VELOCITIES AND SOIL PERCOLATION CONSTANTS FROM      *
C     A LIBRARY FILE.                                                *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NONE
C     INPUT COMMONS-- NUCNAM
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- FODATA, TITLES
C
C---------------------------------------------------------------------
C
      INCLUDE 'FODATA.CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'TITLES.CMN'
C
      CHARACTER*2 E
      DIMENSION CR(6)
C
C     INITIALIZE LOGICAL UNIT DEVICES--
      IUN = 12
C
C     READ TITLE CARD-
      READ (IUN,1000,ERR=800,END=900) FTRTTL
C
C     LOOP UNTIL END-OF-FILE ENCOUNTERED--
  300 CONTINUE
C
C       READ DATA CARD--
        READ (IUN,2000,ERR=800,END=999) E, DVL, (CR(I),I=1,6), PERC
C
C       SEARCH FOR MATCHING RADIONUCLIDE IN MASTER LIBRARY--
        DO 100 J = 1, NUCS
C
          IF (E .EQ. ELTM(J))   THEN
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C           TRANSFER DATA INTO ARRAYS--
            DVEL(J) = DVL
            AB(J) = PERC
            DO 200 K = 1, 6
              CRATIO(K,J) = CR(K)
  200       CONTINUE
C
          ENDIF
  100   CONTINUE
C
C
C     IF NOT END-OF-FILE, READ NEXT CARD--
      GO TO 300
C
C
C     ERROR CONDITIONS--
C
  800 WRITE (6, 8000)
      STOP
C
  900 WRITE (6, 9000)
      STOP
C
C
C     NORMAL TERMINATION--
  999 RETURN
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (20A4)
C
 2000 FORMAT (A2, 8E9.2)
C
 8000 FORMAT ('0 READ ERROR ENCOUNTERED IN FOOLIN')
C
 9000 FORMAT ('0 PREMATURE END OF FILE ENCOUNTERED IN FOOLIN')
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE GRAPH (IYL, FOFX, NGRF, IORNUC, IFROM, NOAVE, IGRAW)
C
C***********************************************************************
C                                                                      *
C     GRAPH CONTROLS THE PRINTING OF GRAPHS OF FUNCTIONS IN            *
C     RELATION TO TIME                                                 *
C                                                                      *
C***********************************************************************
C
C     CALLED BY-- QAPAGE, REPORT
C     SUBORDINATE ROUTINES-- SETUP, FILLUP, PRTGRF, HEADNG
C     INPUTS-- IYL, FOFX, NGRF
C     INPUT COMMONS-- ORGID, NUCNAM
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 17-OCT-84  RAP
C
C-----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     IYL         INTEGER    INDEX OF FUNCTION LABEL ARRAY
C     FOFX        REAL       FUNCTION OF TIME ARRAY
C     NGRF        INTEGER    NUMBER OF FUNCTIONS TO BE SUPERIMPOSED
C                            ON THIS GRAPH
C     IORNUC      INTEGER    INDEX OF RADIONULIDE OR ORGAN TO BE GRAPHED
C     IFROM       INTEGER    CALLED FROM: 0 = QAPAGE, 1 = REPORT
C     NOAVE       INTEGER    IF SET TO 1, DO NOT AVERAGE IN ZERO VALUES
C     IGRAW       INTEGER    RELEASE MESSAGE FLAG; 0 = NO MESSAGE,
C                            1 = AIR MESSAGE, 2 = WATER MESSAGE
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ORGID.CMN'
     INCLUDE 'NUCNAM.CMN'
C
      CHARACTER YLABEL*1, YLAB5*1, YLAB7*1
C
     CHARACTER YLA*40
     DIMENSION YLA(7)
```

FIGURE D.1. DITTY Program Listing (continued)

```
      EQUIVALENCE (YLABEL(1,1), YLA(1))
C
      CHARACTER YL5*21, YL7*5
      DIMENSION YLAB5(21), YLAB7(5)
      EQUIVALENCE (YLAB5(1), YL5)
      EQUIVALENCE (YLAB7(1), YL7)
C
      CHARACTER*1 ORGT1, ELTM1, AWM1
      DIMENSION ORGT1(10,6), ELTM1(2,100), AWM1(6,100)
C
      EQUIVALENCE (ORGT1(1,1), ORGT(1))
      EQUIVALENCE (ELTM1(1,1), ELTM(1))
      EQUIVALENCE (AWM1(1,1), AWM(1))
C
       DIMENSION YLABEL(40,7), NYL(7), TY(5), FOFX(144,8)
C
       DATA YLA /'TOTAL POPULATION                        ',
     .          'POPULATION DISPERSION FACTOR - AIR      ',
     .          'POPULATION - WATER                      ',
     .          'TOTAL CURIES PER PERIOD                 ',
     .          '                                        ',
     .          'TOTAL ORGAN DOSE                        ',
     .          '                                        '/
C
      DATA YL5 /'CURIES PER PERIOD OF '/
      DATA YL7 /' DOSE'/
C
       DATA NYL /16, 34, 18, 23, 29, 16, 15/
C
C
       IF (IYL .EQ. 7)   THEN
        DO 500 I = 1,10
          YLABEL(I,7) = ORGT1(I,IORNUC)
 500    CONTINUE
        DO 501 I = 1,5
           YLABEL(I+10,7) = YLAB7(I)
 501    CONTINUE
      ENDIF
C
       IF (IYL .EQ. 5)    THEN
        DO 510 I = 1,21
          YLABEL(I,5) = YLAB5(I)
 510    CONTINUE
        DO 511 I = 1,2
          YLABEL(I+21,5) = ELTM1(I,IORNUC)
```

FIGURE D.1. DITTY Program Listing (continued)

```
 511   CONTINUE
       DO 512 I = 1,6
         YLABEL(I+23,5) = AWM1(I,IORNUC)
 512   CONTINUE
     ENDIF
C
C
      CALL SETUP (YLABEL(1,IYL), NYL(IYL))

C     TO STORE LABELS IN ARRAYS.
C
C     FIND MAXIMUM VALUE OF FOFX ARRAY--
C
      YMAX = 0.
      DO 300 IN = 1, NGRF
        DO 100 I = 1, 144
C
          IF (FOFX(I,IN) .GT. YMAX)   YMAX = FOFX(I,IN)
C
  100   CONTINUE
  300 CONTINUE
C
C
C     CALCULATE INCREMENT--
      YINC = YMAX / 40.
C
C     CHECK IF YINC IS ZERO OR VERY SAMLL AND SKIP--
     IF (YINC .LT. 1.0E-30) THEN
C
       WRITE (6,1000) (YLABEL(I,IYL),I=1,40)
C
     ELSE
C
C        FILL TICK VALUE ARRAY--

       DO 200 I = 1, 5

         J = I - 1

         TY(I) = YMAX - (8 * YINC * J)

 200   CONTINUE

C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C       FOR EACH FUNCTION--
       DO 400 IN = 1, NGRF
C
          CALL FILLUP (FOFX, YINC, IN, NOAVE)
C         TO PLOT FOFX FUNCTION IN ARRAY.
C
  400   CONTINUE
C
        CALL PRTGRF (TY, YINC, IGRAW, IFROM)
C       TO PRINT GRAPH.
C
     ENDIF
C
      RETURN
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (1X,A40, 'NOT PRINTED BECAUSE ALL ZERO.')
C
     END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE GRDLIN
C
C*********************************************************************
C                                                                    *
C     GRDLIN READS IN DOSE FACTORS FOR EXTERNAL EXPOSURE TO SOIL     *
C     AND WATER AND AIR                                              *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NONE
C     INPUT COMMONS-- NUCNAM
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- GRDDAT, TITLES
C
C---------------------------------------------------------------------
C
      LOGICAL NOTYET
C
      INCLUDE 'GRDDAT.CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'TITLES.CMN'
C
      CHARACTER A*6, E*2
C
      DATA CONST1 /1.0E9/
      DATA CONST2 /277778./
C
C     ASSIGN LOGICAL UNIT DEVICES--
      IUN = 16
C
C     READ TITLE CARD--
      READ (IUN,1000,ERR=800,END=900) GRDTTL
C
C     LOOP UNTIL END-OF-FILE ENCOUNTERED--
  100 CONTINUE
C
C
C       READ DATA CARD--
        READ (IUN,2000,ERR=800,END=999) E, A, DF1, DF2, DF3
C
C       SEARCH FOR MATCHING RADIONUCLIDE IN MASTER LIBRARY--
        INC = 1
        NOTYET = .TRUE.
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C       LOOP THROUGH MASTER LIBRARY--
  200   CONTINUE
C
          IF (E .EQ. ELTM(INC))  THEN
            IF (A .EQ. AWM(INC))  THEN
C             FOUND A MATCH--
C
              NOTYET = .FALSE.
              EDS(INC) = DF1 * CONST1
              EDW(INC) = DF2 * CONST1
              EDA(INC) = DF3 * CONST2
C
            ELSE
C             NO MATCH, CHECK NEXT LIBRARY ENTRY--
              INC = INC + 1
            ENDIF
C
          ELSE
C           NO MATCH, CHECK NEXT LIBRARY ENRTY--
            INC = INC + 1
          ENDIF
C
C       KEEP SEARCHING?
        IF (NOTYET .AND. INC .LE. NUCS)  GO TO 200
C
C     READ NEXT INPUT CARD--
      GO TO 100
C
C
C
C     ERROR CONDITIONS--
C
  800 WRITE (6, 8000)
      STOP
C
  900 WRITE (6, 9000)
      STOP
C
C
C     NORMAL TERMINATION--
  999 RETURN
C
C
C     FORMAT STATMENTS--
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
 1000 FORMAT (20A4)
C
 2000 FORMAT (A2, A6, 9X, E9.2, 9X, 2E9.2)
C
 8000 FORMAT (' READ ERROR ENCOUNTERED IN  GRDLIN')
C
 9000 FORMAT (' PREMATURE END OF FILE ENCOUNTERED IN  GRDLIN')
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module GRFIL

```
      SUBROUTINE GRFIL (IT, Y20, FOFX, NT)
C
C*********************************************************************
C                                                                   *
C      GRFIL TRANSFERS VALUES IN A 20-POSITION ARRAY TO BE PLOTTED VS  *
C      TIME INTO CORRESPONDING POSITIONS IN A 144-POSITION ARRAY       *
C                                                                   *
C*********************************************************************
C
C     CALLED BY-- QAPAGE
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- IT, Y20, NT
C     INPUT COMMONS-- NONE
C     OUTPUTS-- FOFX
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
C               ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     IT(20)      INTEGER    CROSS-INDEX OF SUBSCRIPTS CORRESPONDING
C                            TO A 144-POSITION ARRAY
C     Y20(20)     REAL       INPUT ARRAY TO BE PLOTTED VS TIME
C     FOFX(144)   REAL       OUTPUT ARRAY CORRESPONDING TO THE 144-
C                            POSITION TIME ARRAY
C     NT          INTEGER    NO. OF TIME PERIODS IN ARRAYS IT AND Y20
C
C-------------------------------------------------------------------------
C
      DIMENSION IT(20), Y20(20), FOFX(144)
C
C     INITIALIZE FLAG WHICH INDICATES IF MORE THAT ONE POINT IS TO BE
C     PLOTTED IN EACH TIME PERIOD--
      K = 0
C
C     LOOP ON NO. OF DATA POINTS IN INPUT ARRAY--
      DO 100 I = 2, NT
C
        IF (IT(I) .GT. IT(I-1))  THEN
C
          IF (K .EQ. 0)    THEN
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
            FOFX(IT(I-1)) = Y20(I-1)
C
          ELSE
C
            TSUM = 0.
C
            DO 200 L = 1, K
              TSUM = TSUM + Y20(I-L)
  200       CONTINUE
C
            FOFX(IT(I-1)) = TSUM / K
C
            K = 0
C
          ENDIF
C
        ELSE
C
          K = K + 1
C
        ENDIF
C
  100 CONTINUE
C
C     TAKE CARE OF LAST POINT--
C
      IF (K .EQ. 0)    THEN
C
        FOFX(IT(NT)) = Y20(NT)
C
      ELSE
C
        DO 300 L = 1, K
          TSUM = TSUM + Y20(I-L+1)
  300   CONTINUE
        FOFX(IT(NT)) = TSUM / K
C
      ENDIF
C
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE GRTIM (T20, IT144, NT)
C
C*********************************************************************
C                                                                    *
C     GRTIM SELECTS CORRESPONDING POSITION OF 144-POSITION TIME ARRAY  *
C     FOR 20-POSITION TIME ARRAYS FOR GRAPHING                       *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- QAPAGE
C     SUBORDINATE ROUTINES-- ZEROI
C     INPUTS-- T20, NT
C     INPUT COMMONS-- TIMES
C     OUTPUTS-- IT144
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     T20(20)     REAL       20 - POSITION TIME ARRAY. CORRESPONDS TO
C                            TIMES AT WHICH POPULATION DATA IS SUPPLIED.
C     IT144(20)   INTEGER    20 - POSITION ARRAY OF INDICES INDICATING
C                            WHICH POSITION IN A 144 POINT ARRAY WITH
C                            70 - YEAR INCREMENTS THE TIMES IN T20
C                            SHOULD BE PLOTTED.
C     NT          INTEGER    NO. OF TIMES IN THE ARRAY T20.
C
C---------------------------------------------------------------------
C
      INCLUDE 'TIMES.CMN'

C
      DIMENSION T20(20), IT144(20)
C
      CALL ZEROI (20, IT144)
C
      J = 1
      TT = TZ
      TINC = 70.
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      DO 100 I = 1, 20
        IF (J .GE. 144) THEN
          IT144(I) = 144
        ELSE
 200      CONTINUE
            IF (TT .LT. T20(I)) THEN
              J = J + 1
              TT = TT + 70.
              IF (J .GE. 144) IT144(I) = 144
            ELSE
              IF (J .EQ. 1) THEN
                IT144(I) = 1
              ELSE
                IT144(I) = J
              ENDIF
            ENDIF
          IF (J .LT. 144  .AND.  IT144(I) .EQ. 0) GO TO 200
C
        ENDIF
  100 CONTINUE
C
C
      RETURN
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module HEADNG

```
      SUBROUTINE HEADNG (IFROM)
C
C***********************************************************************
C                                                                      *
C     HEADNG OUTPUTS PAGE HEADINGS FOR QUALITY ASSURANCE PAGE AND      *
C     REPORTS                                                          *
C                                                                      *
C***********************************************************************
C
C     CALLED BY-- QAPAGE, GRAPH, REPORT
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NONE
C     INPUT COMMONS-- TIMES, TITLES, DAY
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 13-SEP-84  RAP
C
C***********************************************************************
C
      INCLUDE 'TIMES.CMN'
      INCLUDE 'TITLES.CMN'
      INCLUDE 'DAY.CMN'
C
        IF (IFROM .EQ. 0)    THEN
C         ROUTINE WAS CALLED FROM QAPAGE
          WRITE (6, 1000) DAIT
       ELSE
C         ROUTINE WAS CALLED FROM REPORT
          WRITE (6,2000) DAIT
       ENDIF
C
C       CALL IDLINE

C      TO PRINT 'EXECUTING' LINE.
C
       WRITE (6, 1001) CHIAC, CHIPAT
C
       WRITE (6, 1002) TZ
C
       WRITE (6, 1003) CASTTL
C
       RETURN
C
```

FIGURE D.1. DITTY Program Listing (continued)

Module HEADNG

```
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT ('1',/, 18X, 'QA PAGE FOR DITTY (VAX VERSION 1.0)',
    .        '  RUN ON ', A9)
C
 2000 FORMAT ('1',/, 18X,  'REPORT FOR DITTY (VAX VERSION 1.0)',
    .        ' RUN ON ', A9)
C
 1001 FORMAT (' ', 17X, 'INTEGRATED POPULATION DOSE CALCULATED FOR ',
     .                  A7, 1X, A22)
C
 1002 FORMAT (' ', 17X, '                          RELEASE FROM TIME ',
    .                  F5.0, ' A.D. ONWARD FOR ',
    .                  '10,000 YEARS')
C
 1003 FORMAT (' ', 17X, 'CASE TITLE: ', 20A4)
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE NUCTST
C
C*********************************************************************
C                                                                    *
C     NUCTST TESTS THE INPUT RADIONUCLIDE LIST FOR UNIDENTIFIED      *
C     RADIONUCLIDES.                                                 *
C                                                                    *
C*********************************************************************
C
C     CALLED BY--
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NIN
C     INPUT COMMONS-- SOURCE, FLAGS, NUCNAM
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     NIN         INTEGER    NO. OF RADIONUCLIDES INPUT FOR MASTER LIST
C
C---------------------------------------------------------------------
C
     INCLUDE 'FLAGS.CMN'
     INCLUDE 'NUCNAM.CMN'
     INCLUDE 'SOURCE.CMN'
C
C     INITIALIZE ERROR COUNTER--
      NUM = 0
C
C     FOR EACH INPUT RADIONUCLIDE--
      DO 100 IN = 1, NIN
C
C       CHECK IF NOT FOUND IN MASTER DATA LIBRARY--
        IF (INFLG(IN) .LE. 0)  THEN
C
          NUM = NUM + 1
          WRITE (6, 1000) IN, E(IN), A(IN)
C
        ENDIF
  100 CONTINUE
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C     CHECK FOR TOO MANY INPUT RADIONUCLIDES--
      IF (NUCS .GT. 100)   THEN
C
        WRITE (6, 2000) NUCS
        STOP
C
      ENDIF
C
C
C     STOP IF THERE ARE UNIDENTIFIED RADIONUCLIDES--
      IF (NUM .GT. 0)  STOP
C
C     RETURN
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT ('0 NUCLIDE ', I3, ' NOT FOUND, ', A2, A6)
C
 2000 FORMAT ('0 TOO MANY RADIONUCLIDES REQUIRED - ', I5)
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE ORGCHK
C
C*********************************************************************
C                                                                    *
C     ORGCHK CHECKS THE ORGAN SELECTION DATA FOR CORRECTNESS         *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NONE
C     INPUT COMMONS-- ORGID
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- ORGID
C
C---------------------------------------------------------------------
C
      INCLUDE 'ORGID .CMN'
C
C     ASSIGN LOGICAL UNIT DEVICE--
C
C     INITIALIZE ORGAN COUNTER, ERROR COUNTER--
      NORG = 0
      IER = 0
C
C
      DO 100 I = 1, 5
C
C       TEST IF WITHIN LIMITS--
        IF (KORG(I) .GT. 0)   THEN
          IF (KORG(I) .LE. 23)  THEN
C
            NORG = NORG + 1
C
          ELSE
C
            WRITE (6, 1000) KORG(I)
            IER = IER + 1
C
          ENDIF
        ENDIF
  100 CONTINUE
C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C     CHECK IF NO ORGANS ARE SPECIFIED--
      IF (NORG .LT. 1)   THEN
        WRITE (6, 2000) NORG
        IER = IER + 1
      ENDIF
C
C     IF THERE ARE NO ERRORS, RETURN; OTHERWISE STOP
      IF (IER .LE. 0)   THEN
        RETURN
      ELSE
        WRITE (6, 3000) IER
        STOP
      ENDIF
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT ('0 BAD VALUE FOR KORG(I) = ', I5)
 2000 FORMAT ('0 NO ORGANS SPECIFIED, NORG = ', I5)
 3000 FORMAT ('0 NUMBER OF ERRORS IN ORGCHK = ', I3)
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE PASSIG (XX, IP, SY, SZ)
C
C***********************************************************************
C
C     PASSIG CALCULATES DISPERSION PARAMETERS FOR A GIVEN DISTANCE
C     AND PASQUILL STABILITY CATEGORY.
C
C***********************************************************************
C
C     CALLED BY-- EOVRQ
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- XX, IPC
C     INPUT COMMONS-- NONE
C     OUTPUTS-- SY, SZ
C     OUTPUT COMMONS-- NONE
C
C-----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  --------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  --------------------------------------
C
C     XX          REAL       DISTANCE FROM THE RELEASE POINT TO THE
C                            CURRENT LOCATION, M
C     IP          INTEGER    PASQUILL STABILITY CATEGORY INDEX, 1 = A
C     SY          REAL       CROSSWIND HORIZONTAL STANDARD DEVIATION OF
C                            PLUME CONCENTRATION AT CURRENT LOCATION, M
C     SZ          REAL       CROSSWIND VERTICAL STANDARD DEVIATION OF
C                            PLUME CONC. AT LOCATION OF INTEREST, M
C
C-----------------------------------------------------------------------
C
C
      DIMENSION SIGY(6,20),SIGZ(6,20),DIST(20)
C
C     DISTANCES TO WHICH SY AND SZ DATA CORRESPOND--
      DATA DIST/0.0,1.E4,1.5E4,2.5E4,3.5E4,5.E4,7.E4,1.E5,1.5E5,2.5E5,
     1   3.5E5,5.E5,7.E5,1.E6,1.5E6,2.5E6,3.5E6,5.E6,7.E6,1.E7/
C
C     SIGMA Y DATA - 1 FOR TYPE A, 2 FOR TYPE B, ETC--
C
      DATA (SIGY(1,I),I=1,20)/100.,2.1E3,3.2E3,5.4E3,7.5E3,1.05E4,1.42E4
     1   ,2.E4,2.9E4,4.5E4,6.1E4,8.3E4,1.12E5,1.55E5,2.2E5,3.4E5,4.5E5,
```

FIGURE D.1. DITTY Program Listing (continued)

```
     2   6.2E5,8.2E5,1.1E6/
C
      DATA (SIGY(2,I),I=1,20)/100.,1.6E3,2.4E3,4.E3,5.5E3,7.6E3,1.06E4,
     1  1.48E4,2.15E4,3.4E4,4.6E4,6.3E4,8.4E4,1.2E5,1.68E5,2.6E5,3.5E5,
     2  4.7E5,6.4E5,8.5E5/
C
      DATA (SIGY(3,I),I=1,20)/100.,1.2E3,1.75E3,2.85E3,4.E3,5.5E3,7.6E3,
     1  1.06E4,1.55E4,2.4E4,3.3E4,4.5E4,6.1E4,8.5E4,1.2E5,1.85E5,2.5E5,
     2  3.4E5,4.7E5,6.3E5/
C
      DATA (SIGY(4,I),I=1,20)/100.,800.,1.2E3,1.95E3,2.65E3,3.7E3,5.1E3,
     1  7.2E3,1.04E4,1.6E4,2.25E4,3.1E4,4.2E4,5.7E4,7.1E4,1.25E5,1.7E5,
     2  2.3E5,3.E5,4.1E5/
C
      DATA (SIGY(5,I),I=1,20)/100.,600.,900.,1450.,2.E3,2.8E3,3.7E3,
     1  5.2E3,7.5E3,1.20E4,1.65E4,2.2E4,3.E4,4.1E4,5.7E4,8.8E4,1.18E5,
     2  1.6E5,2.1E5,2.8E5/
C
      DATA (SIGY(6,I),I=1,20)/100.,390.,600.,980.,1350.,1850.,2550.,
     13600.,5200.,8100.,1.1E4,1.53E4,2.1E4,2.8E4,4.E4,6.1E4,8.2E4,1.12E5
     2  ,1.48E5,2.E5/
C
C  SIGMA Z DATA - 1 FOR TYPE A, 2 FOR TYPE B, ETC.
C
      DATA (SIGZ(1,I),I=1,20)/100.,1500.,2250.,4300.,7.E3,1.35E4,2.7E4,
     1  6.7E4,2.E5,11*2.E5/
C
      DATA (SIGZ(2,I),I=1,20)/100.,1.E3,1500.,2550.,3700.,5700.,8600.,
     1  1.35E4,2.4E4,5.8E4,1.2E5,2.E5,8*2.E5/
C
      DATA (SIGZ(3,I),I=1,20)/100.,780.,1100.,1750.,2400.,3400.,4600.,
     16400.,9000.,1.4E4,1.9E4,2.6E4,3.4E4,4.4E4,6.E4,8.8E4,1.12E5,1.44E5
     2  ,1.78E5,2.E5/
C
      DATA (SIGZ(4,I),I=1,20)/100.,470.,680.,1050.,1400.,1900.,2500.,
     13300.,4300.,6200.,7600.,9500.,1.15E4,1.4E4,1.7E4,2.2E4,2.65E4,
     2  3.2E4,3.7E4,4.5E4/
C
      DATA (SIGZ(5,I),I=1,20)/100.,300.,430.,710.,940.,1300.,1700.,2200.
     1  ,2900.,4100.,5000.,6100.,7200.,8400.,9900.,1.17E4,1.3E4,1.4E4,
     2  1.55E4,1.7E4/
C
      DATA (SIGZ(6,I),I=1,20)/100.,140.,220.,400.,530.,760.,1000.,1350.,
     11770.,2500.,3000.,3500.,4100.,4700.,5500.,6400.,7200.,7900.,8600.,
     2  9400./
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      X=XX*100.
C
C     CALCULATE SY AND SZ FOR EACH X POSITION DESIRED--
      IDATA = 1
    1 IF(IDATA.GT.20) GO TO 7
C
  201 IF(X-DIST(IDATA)) 4,3,2
C
C     IF X IS GREATER THAN DISTANC--
    2 IDATA=IDATA+1
      GO TO 1
C
C     IF X IS EQUAL TO DISTANCE--
    3 SY=SIGY(IP,IDATA)
      SZ=SIGZ(IP,IDATA)
      GO TO 8
C
C     IF X IS LESS THAN DISTANCE--
    4 IF(IDATA.EQ.1) GO TO 3
      SY1=SIGY(IP,IDATA-1)
      SY2=SIGY(IP,IDATA)
      SZ1=SIGZ(IP,IDATA-1)
      SZ2=SIGZ(IP,IDATA)
      D1=DIST(IDATA-1)
      D2=DIST(IDATA)
      SY=SY1+(X-D1)*(SY2-SY1)/(D2-D1)
      SZ=SZ1+(X-D1)*(SZ2-SZ1)/(D2-D1)
      GO TO 8
C
C     IDATA IS GREATER THAN 20--
    7 SY=SIGY(IP,20)
      SZ=SIGZ(IP,20)
C
    8 SY=SY*.01
      SZ=SZ*.01
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE PMAC   (NT, P, T, TZ, P1)
C
C*********************************************************************
C                                                                    *
C     PMAC INTERPOLATES POPULATION DATA AT ONE TIME                  *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- CASEIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NT, P, T, TZ
C     INPUT COMMONS-- NONE
C     OUTPUTS-- P1
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     NT          INTEGER    NO. OF POPULATION VALUES CONSIDERED
C     P           REAL       POPULATION DATA ARRAY
C     T           REAL       TIME POINTS CORRESPONDING TO PM1
C     TZ          REAL       THE TIME AT START OF 10,000 INTEGRATION
C                            PERIOD, YEARS A.D.
C     P1          REAL
C
C---------------------------------------------------------------------
C
      DIMENSION P(20), T(20)
C
C     IF ONLY 1 POPULATION CONSIDERED OR TZ <= TO FIRST TIME--
      IF (NT .LE. 1  .OR.  TZ .LE. T(1) )  THEN
C
        P1 = P(1)
C
      ELSE
C
C       IF TZ GREATER THAN LAST VALUE--
        IF (TZ .GE. T(NT))   THEN
C
          P1 = P(NT)
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      ELSE
C
        N = 1
        IEND = 0
C
C       LOOP UNTIL IEND > 0--
  100   CONTINUE

          IF (TZ .LT. T(N) )  THEN
C
            P1 = P(N-1) + (P(N)-P(N-1)) * (TZ-T(N-1)) /(T(N) - T(N-1))
            IEND = 1
C
          ELSE
C
            N = N + 1
C
          ENDIF
C
C
        IF (IEND .LE. 0)  GO TO 100
C       END OF IEND LOOP.
C
      ENDIF
    ENDIF
C
    RETURN
    END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE PMEQ   (NDIST, PM)
C
C*********************************************************************
C                                                                    *
C     PMEQ CALCULATES A POPULATION DISPERSION FACTOR FROM AIR CON-   *
C     CENTRATIONS AND A POPULATION DISTRIBUTION.                     *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- CASEIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NDIST
C     INPUT COMMONS-- AIRCON, POPU
C     OUTPUTS-- PM
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     NDIST       INTEGER    NO. OF DISTANCE INTERVALS
C     PM          REAL       POPULATION DISPERSION FACTOR
C
C---------------------------------------------------------------------
C
      INCLUDE 'AIRCON.CMN'
      INCLUDE 'POPU.CMN'
C
      PM = 0.
C
C     FOR EACH DISTANCE--
      DO 100 IX = 1, NDIST
C                                                        (2
C       FOR EACH DIRECTION--
        DO 200 IT = 1, 16
C
          PM = PM + EOQ(IX,IT) * POP(IX,IT)
C
 200    CONTINUE
 100  CONTINUE
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

Module PMINT

```
      SUBROUTINE PMINT  (NT, TZ, T, PM1, PM)
C
C*********************************************************************
C                                                                    *
C     PMINT INTERPOLATES TIME VS. POPULATION DISPERSION FACTOR       *
C     ARRAYS TO DETERMINE POPULATION DISPERSION FACTORS AT EACH      *
C     70 YEAR INCREMENT MIDPOINT                                     *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- CASEIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NT, TZ, T PM1
C     INPUT COMMONS-- NONE
C     OUTPUTS-- PM
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ---------- --------- ---------------------------------------
C     PARAMETER  TYPE      DESCRIPTION
C     ---------- --------- ---------------------------------------
C
C     NT         INTEGER   NO. OF TIME PERIODS FOR WHICH DATA IS
C                          SUPPLIED IN ARRAYS T AND PM1.
C     TZ         REAL      TIME (YEARS A.D.) AT THE START OF THE
C                          10,000 YEAR INTEGRATION PERIOD.
C     T(20)      REAL      TIME POINTS CORRESPONDING TO DEFINITION
C                          OF DATA IN ARRAY PM1, YEARS A.D.
C     PM1(20)    REAL      POPULATION DISPERSION FACTOR ARRAY TO
C                          BE INTERPOLATED, PERSON-SEC/M**3
C     PM(144)    REAL      POPULATION DISPERSION FACTOR ARRAY FOR
C                          EACH 70-YR PERIOD OF THE 10,000 YR. PER.
C
C---------------------------------------------------------------------
C
      DIMENSION PM1(20), PM(144), T(20)
C
      IF (NT .LE. 1)   THEN
C
C       USE FIRST VALUE OF PM1 FOR ALL INCREMENTS--
        DO 100 I = 1, 144
          PM(I) = PM1(1)
  100   CONTINUE
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      ELSE
C
C       CALCULATE MIDPOINT--
        TT = TZ + 35.
C
C       INITIALIZE INDEXING VARIABLES--
        IT = 1
        II = 1
C
C       LOOP UNTIL IT > NT OR II > 144--
  200   CONTINUE
C
          IF (TT .LE. T(IT))   THEN
C
            IF (TT .EQ. T(IT)) THEN
C
              PM(II) = PM1(IT)
C
            ELSE
C
              IF (IT .EQ. 1)   THEN
C
                PM(II) = PM1(1)
C
              ELSE
C
                PM(II) = PM1(IT-1) + (TT - T(IT-1) ) /
     .                   (T(IT) - T(IT-1)) * (PM1(IT) - PM1(IT-1))
C
              ENDIF
            ENDIF
C
            II = II + 1
            TT = TT + 70.
C
          ELSE
C
            IT = IT + 1
C
          ENDIF
C
        IF (IT .LE. NT  .AND.  II .LE. 144)  GO TO 200
C       END OF LOOP.
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
        IF (IT .GT. NT  .AND.  II .LE. 144)   THEN
C
C         SET TO MAXIMUM VALUE--
          DO 300 I = II, 144
            PM(I) = PM1(NT)
  300     CONTINUE
C
        ENDIF
C
      ENDIF
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE PMSET  (NTA, POPT, PM1)
C
C***********************************************************************
C                                                                      *
C     PMSET ESTABLISHES INTERPOLATION VALUES FOR POPULATION            *
C     DISPERSION FACTOR OPTIONS TWO AND FIVE                           *
C                                                                      *
C***********************************************************************
C
C     CALLED BY--
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- NTA, POPT, PM1
C     INPUT COMMONS-- NONE
C     OUTPUTS-- PM1
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     Version of 7-SEP-84  RAP
C
C-----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     NTA         INTEGER    TIME PERIOD USED FOR INTERPOLATION
C     POPT(  )    REAL       POPULATION AT EACH TIME PERIOD
C     PM1(   )    REAL       POPULATION DISPERSION FACTOR FOR EACH
C                            TIME PERIOD
C-----------------------------------------------------------------------
C
      DIMENSION POPT(20), PM1(20)
      IF (POPT(1) .EQ. 0) THEN
        P1 = 0.
      ELSE
        P1 = PM1(1) / POPT(1)
      ENDIF

      DO 100 IT = 1, NTA
        PM1(IT) = P1 * POPT(IT)
  100 CONTINUE
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE PRTGRF (TY, YINC, IGRAW, IFROM)
C
C*******************************************************************
C                                                                 *
C     PRTGRF OUTPUTS THE GRAPH TO THE LINE PRINTER                *
C                                                                 *
C*******************************************************************
C
C     CALLED BY-- GRAPH
C     SUBORDINATE ROUTINES-- HEADING
C     INPUTS-- TY, YINC, IGRAW, IFROM
C     INPUT COMMONS-- PLOT, TIMES
C     OUTPUTS-- PRINTED, GRAPH
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 16-AUG-84  RAP
C
C--------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     TY(5)       REAL       ARRAY CONTAINING Y-AXIS TICK VALUES
C     YINC        REAL       Y-AXIS INCREMENT
C     IGRAW       INTEGER    RELEASE MESSAGE FLAG, 0 = NO MESSAGE,
C                            1 = AIR, 2 = WATER
C     IFROM       INTEGER    CALLING ROUTINE: 0 = QAPAGE, 1 = REPORT
C
C--------------------------------------------------------------------
C
      INCLUDE 'PLOT  .CMN'
      INCLUDE 'TIMES .CMN'
C
      CHARACTER ZERO*10, AST*1
C
      DIMENSION TY(5)
C
      DATA AST /'*'/
      DATA IY /40/
      DATA IX /73/
      DATA ZERO /'ZERO'/
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      TZ5 = TZ + 5000.
      TZ10 = TZ + 10000.
C
C
      CALL HEADNG (IFROM)
C     TO PRINT DITTY1 HEADING LINES.
C
C     PRINT INCREMENT INFORMATION
      WRITE (6,4000) YINC
C
C
C     PRINT AIR OR WATER RELEASE MESSAGE IF APPLICABLE--
      IF (IGRAW .GT. 0)   THEN
        IF (IGRAW .EQ. 1)  THEN
          WRITE (6,5000)
        ELSE
          WRITE (6,5001)
        ENDIF
      ENDIF
C
C
C     PRINT UPPER BORDER--
      WRITE (6,1000)
C
C     PRINT Y-AXIS INFORMATION AND ARRAY--
C
      K = 1
C
      DO 100 I = 1, IY
C
        IF (TICKY(I) .EQ. AST)   THEN
C
          WRITE (6,2000) LEGEND(I), LABELY(I), TY(K), TICKY(I),
     .                   (ARRAY(I,J), J = 1, IX)
          K = K + 1

        ELSE
C
          WRITE (6,2001) LEGEND(I), LABELY(I), TICKY(I),
     .                   (ARRAY(I,J), J = 1, IX)
C
        ENDIF
C
  100 CONTINUE
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C     PRINT LOWER BORDER, X-AXIS INFORMATION--
      WRITE (6,3000) ZERO
      WRITE (6,3001) (TICKX(J), J = 1, IX)
      WRITE (6,3002) TZ, TZ5, TZ10
      WRITE (6,3003) LABELX
C
C
      RETURN
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (50X, 73 ('*') )
C
 2000 FORMAT (A12, 22X, A1, 4X, 1PE10.2, 75A1)
 2001 FORMAT (A12, 22X, A1, 15X,         75A1)
C
 3000 FORMAT (40X, A10, 73 ('*') )
 3001 FORMAT (50X, 73A1)
 3002 FORMAT (42X, F10.0, 25X, F10.0, 25X, F10.0)
 3003 FORMAT (80X, A40)
C
 4000 FORMAT (// ' Y-AXIS INCREMENT = ', 1PE10.2 /
     .           ' X-AXIS INCREMENT =   70 YEARS'/)
C
 5000 FORMAT ('0 AIR RELEASE')
 5001 FORMAT ('0 WATER RELEASE')
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE QAPAGE
C
C*********************************************************************
C                                                                    *
C     QAPAGE PRINTS A REPORT OF INPUT PARAMETERS                     *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- HEADNG, GRAPH
C     INPUTS-- NONE
C     INPUT COMMONS-- BIODAT, DISPSN, NAMLST, NUCNAM, OPTION,
C                     ORGID, PATHIN, TITLES, VARYBL
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 9-NOV-84  RAP
C
C---------------------------------------------------------------------
C
      INCLUDE 'BIODAT.CMN'
      INCLUDE 'DAY.CMN'
      INCLUDE 'DISPSN.CMN'
      INCLUDE 'NAMLST.CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'OPTION.CMN'
      INCLUDE 'ORGID.CMN'
      INCLUDE 'PATHIN.CMN'
      INCLUDE 'POPU.CMN'
      INCLUDE 'TITLES.CMN'
      INCLUDE 'VARYBL.CMN'
C
      CHARACTER*5  CHISAL
      CHARACTER*16 CHTPA(7)
      CHARACTER*18 CHAPA(7), HDG1, HDG2
      CHARACTER*20 CHMET(9)
      CHARACTER*6  CHDIR(16)
C
      DIMENSION FOFX(144,8), IT144(20), PRACT(144), IPRIT(144)
C
      DATA CHTPA /'LEAFY VEGATABLES', 'OTHER VEGATABLES', 'EGGS',
     .            'MILK', 'BEEF', 'PORK', 'POULTRY'/
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      DATA CHAPA /'FISH', 'CRUSTACEA', 'MOLLUSES', 'PLANTS',
     .             'DRINKING WATER', 'SEDIMENT EXPOSURE',
     .             'SWIMMING TIME'/
 C
      DATA CHMET /'HANFORD MOD. STABLE', 'HANFORD VERY STABLE',
     .            'PASQUILL A', 'PASQUILL B', 'PASQUILL C', 'PASQUILL D',
     .             'PASQUILL E', 'PASQUILL F', 'PASQUILL G'/
 C
      DATA CHDIR /'NNE', 'NE', 'ENE', 'E', 'ESE', 'SE', 'SSE', 'S',
     .             'SSW', 'SW', 'WSW', 'W', 'WNW', 'NW', 'NNW', 'N'/
 C
      DATA HDG1 /'PERIOD ACTVITY    '/
      DATA HDG2 /'------ -------    '/
C
C     SET FLAG FOR HEADING SUBROUTINE--
      DATA IFROM /0/
 C
      IF (IAC .EQ. 0)   THEN
        CHIAC = 'CHRONIC'
      ELSE
        CHIAC = 'ACUTE'
      ENDIF
 C
      IF (IPATH .EQ. 0)  THEN
        CHIPAT = 'ATMOSPHERIC AND LIQUID'
      ELSE
        IF (IPATH .EQ. 1)  THEN
          CHIPAT = 'ATMOSPHERIC'
        ELSE
          CHIPAT = 'LIQUID'
        ENDIF
      ENDIF
 C
      IF (ISALT .EQ. 0)   THEN
        CHISAL = 'FRESH'
      ELSE
        CHISAL = 'SALT'
      ENDIF
 C
      IF (LUA .EQ. 1) THEN
       ARDTTL(1) = 'INPU'
       ARDTTL(2) = 'T   '
     ENDIF
C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      IF (LUW .EQ. 1) THEN
        WRDTTL(1) = 'INPU'
        WRDTTL(2) = 'T   '
      ENDIF
C
C
       CALL HEADNG (IFROM)
C      TO PRINT DITTY1 HEADING LINES.
C
C
C      PRINT LIBRARY INFORMATION--
C
       WRITE (6, 2000)
       WRITE (6, 2001) RMDTTL
       WRITE (6, 2002) (FTRTTL(I), I = 1, 20)
       WRITE (6, 2003) CHISAL, (BIOTTL(I), I = 1, 20)
       WRITE (6, 2004) GRDTTL
       WRITE (6, 2005) IDFTTL
       IF (IPOP .EQ. 3)   WRITE (6, 2006) PODTTL
       IF (IWAT .GT.0)    WRITE (6, 2007) WRDTTL
       IF (IAIR .GT. 0)   WRITE (6, 2008) ARDTTL
C
C
C      PRINT ORGAN DATA--
C
       WRITE (6, 5000)
       WRITE (6, 5001) (ORGT(I), I = 1, NORG)
C
C
C      PRINT MASTER RADIONUCLIDE CONTROL LIST--
C
       WRITE (6, 8000)
       WRITE (6, 8001) (ELTM(I), AWM(I), I = 1, NUCS)
C
C
C      PRINT INPUT POPULATION DATA--
C
       WRITE (6,9100)
C
       IF (IPATH .LT. 2 .AND. IAC .GT. 0) THEN
         IF (IPA .LE. 0) WRITE (6,9110)
         IF (IPA .EQ. 1) WRITE (6,9112) PMA
         IF (IPA .GT. 1) WRITE (6,9112) PM(1)
       ENDIF
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      IF (IPATH .LT. 2) THEN
C
        IF (IPOP .EQ. 0) WRITE (6,9120)
        IF (IPOP .EQ. 1) WRITE (6,9122)
C
        IF (IPOP .EQ. 2) THEN
          WRITE (6,9124) T(1), (DIST(I), I=1,NDIST)
          WRITE (6,9125)
          DO 222 IS = 1, 16
            WRITE (6,9126) CHDIR(IS), (POP(I,IS), I=1,NDIST)
  222     CONTINUE
          WRITE (6,9127)
          WRITE (6,9128) (T(I), POPT(I), I=1,NTA)
        ENDIF
C
        IF (IPOP .EQ. 3) WRITE (6,9130)
        IF (IPOP .EQ. 4 .OR. (IPOP .EQ. 3 .AND. NTA .GT. 0)) THEN
          WRITE (6,9132)
          WRITE (6,9128)(T(I), PM1(I), I=1,NTA)
        ENDIF
        IF (IPOP .EQ. 5) WRITE (6,9134)
        IF (IPOP .EQ. 6) WRITE (6,9136)
C
      ENDIF
C                                                                        C

      IF (IPATH .NE. 1 .AND. IAC .GT. 0) THEN
        IF (IPL .LE. 0) WRITE (6,9140)
        IF (IPL .EQ. 1) WRITE (6,9142) PPL
        IF (IPL .GT. 1) WRITE (6,9142) PL(1)
      ENDIF
C
      IF (IPATH .NE. 1) THEN
C
        IF (IPOPL .LE. 0) WRITE (6,9150)
        IF (IPOPL .EQ. 1) WRITE (6,9152)
        IF (IPOPL .EQ. 2) THEN
          WRITE (6,9153)
          WRITE (6,9128) (TL(I), PL1(I), I=1,NTL)
        ENDIF
      ENDIF
 C
 C     PRINT TERRESTRIAL AND AQUATIC PATHWAYS DATA--
 C
       WRITE (6, 3000)
```

FIGURE D.1. DITTY Program Listing (continued)

```
      WRITE (6, 3001)
      DO 100 I = 1, 7
        WRITE (6, 3002) CHTPA(I), GRWP(I), YELD(I), CONSUM(I),
     .                    CHAPA(I), USAGE(I)
  100 CONTINUE
      WRITE (6, 3003) EXTIM
C
C
C     PRINT WATERBORNE PARAMETERS--
C
      IF (IPATH .NE. 1)   THEN
        WRITE (6, 4000)
        WRITE (6, 4001) CFLO, MOPYR, RECON, RM, RIRR
      ENDIF
C
C
C     PRINT SITE GRID INFORMATION--
C
      IF (IEOQ .GT. 1)  THEN
C
        WRITE (6, 6000)
        WRITE (6, 6001) NSECT
        WRITE (6, 6002) NDIST, (DIST(I), I = 1, NDIST)
C
        IF (IPATH .LE. 1  .AND. IEOQ .EQ. 2)    THEN
          WRITE (6, 6100)
          WRITE (6, 6101) (CHDIR(I), I = 1, NSECT)
          DO 200 IU = 1, NUBAR
            WRITE (6, 6103)
            DO 300 IM = 1, NMET
              WRITE (6, 6102) UBAR(IU), CHMET(MET(IM)),
     .                        (F(IU,IM,I), I= 1, NSECT)
  300       CONTINUE
  200     CONTINUE
        ENDIF
C
        WRITE (6, 6200) HS
C
      ENDIF
C
C
C     PRINT RELEASE DATA IF GRPAH OPTION NOT SELECTED--
      IF (IGRNUC .EQ. 0)    THEN
C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
 C      IF AIR RELEASE--
        IF (IPATH .LT. 2)    THEN
 C
         WRITE (6,9010)
         WRITE (6,9011) HDG1, HDG1, HDG1, HDG1, HDG1, HDG1,
     .                  HDG2, HDG2, HDG2, HDG2, HDG2, HDG2
         DO 770 IN = 1, NUCS
           NPR = 0
           DO 771 IT = 1, 144
             IF (ACTA(IT,IN) .GT. 0 )  THEN
               NPR = NPR + 1
               IPRIT(NPR) = IT-1
               PRACT(NPR) = ACTA(IT,IN)
             ENDIF
  771      CONTINUE
           WRITE (6,9012)ELTM(IN),AWM(IN),(IPRIT(I),PRACT(I),I=1,NPR)
  770    CONTINUE
C
        ENDIF
C
C       IF WATER RELEASE--
        IF (IPATH .NE. 1)    THEN
C
           WRITE (6,9020)
           WRITE (6,9011) HDG1, HDG1, HDG1, HDG1, HDG1, HDG1,
     .                    HDG2, HDG2, HDG2, HDG2, HDG2, HDG2
           DO 780 IN = 1, NUCS
             NPR = 0
             DO 781 IT = 1, 144
               IF (ACTW(IT,IN) .GT. 0)  THEN
                 NPR = NPR + 1
                 IPRIT(NPR) = IT-1
                 PRACT(NPR) = ACTW(IT,IN)
               ENDIF
 781         CONTINUE
             WRITE (6,9012)ELTM(IN),AWM(IN),(IPRIT(I),PRACT(I),I=1,NPR)
 780       CONTINUE
         ENDIF
C
       ENDIF
C
C
C     PRINT GRAPH OF POPULATION DATA--
C     IF (IGRPOP .GT. 0)    THEN
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C       FIND CORRESPONDING TIME PERIODS IN 144-POSITITON TIME ARRAY--
C       CALL GRTIM (T, IT144, NTA)
C
C       FILL FUNCTION ARRAY TO CORRESPOND TO 144-POSITION TIME ARRAY--
C       CALL GRFIL (IT144, POPT, FOFX, NTA)
C
C       CALL GRAPH (1, FOFX, 1, 0, 0, 1, 0)
C
C      ENDIF

C
C
C      PRINT GRAPH OF POPULATION DISPERSION VALUES--
C
      IF (IGRPM .GT. 0)    THEN
C
       IF (IPATH .LT. 2)    THEN
         IF (IAC .GT. 0 .AND. IPOP .EQ. 6) GOTO 410
           DO 400 I = 1, 144

             FOFX(I,1) = PM(I)

 400       CONTINUE

           CALL GRAPH (2, FOFX, 1, 0, 0, 0, 0)

 410     CONTINUE
       ENDIF
C
       IF (IPATH .NE. 1) THEN
         DO 401 I = 1, 144
           FOFX(I,1) = PL(I)
 401     CONTINUE
         CALL GRAPH (3, FOFX, 1, 0, 0, 0, 0)
       ENDIF
C
      ELSE
C     PRINT NUMERIC REPORT OF PM--
C
C
        IF (IPATH .LT. 2)  THEN

          IF (IAC .GT. 0 .AND. IPOP .EQ. 6) GOTO 411
            WRITE (6,9030)
            WRITE (6,9031)
```

FIGURE D.1. DITTY Program Listing (continued)

```
          WRITE (6,9032) (I-1, PM(I), I=1,144)
 411    CONTINUE
      ENDIF
C
      IF (IPATH .NE. 1) THEN
        WRITE (6,9033)
        WRITE (6,9034)
        WRITE (6,9032) (I-1, PL(I), I=1,144)
      ENDIF
C
    ENDIF
C
C
C     PRINT GRAPH OF POPULATION FOR WATERBORNE PATHWAYS--
C
      IF (IGRPL .GT. 0)    THEN
        IF (IWAT .GT. 0)    THEN
C
          DO 500 I = 1, 144
            FOFX(I,1) = PL(I)
  500     CONTINUE
C
          CALL GRAPH (3, FOFX, 1, 0, 0, 0, 0)
C
        ENDIF
      ENDIF
C
C
C     PRINT GRAPH OF TOTAL ACTIVITY OF ALL SELECTED RADIONUCLIDES--
C
      IF (IGRTNU .GT. 0)    THEN
C
C       IF AIR RELEASE--
        IF (IPATH .LT. 2)    THEN

C
          CALL ZEROR (144, FOFX)
C
          DO 600 I = 1, 144
            DO 601 J = 1, NUCS
              FOFX(I,1) = FOFX(I,1) + ACTA(I,J)
  601       CONTINUE
  600     CONTINUE
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
          CALL GRAPH (4, FOFX, 1, 0, 0, 0, 1)
C
        ENDIF
C
C
C       IF WATER RELEASE--
        IF (IPATH .NE. 1)    THEN

C
          CALL ZEROR (144, FOFX)
C
          DO 700 I = 1, 144
            DO 701 J = 1, NUCS
              FOFX(I,1) = FOFX(I,1) + ACTW(I,J)
  701       CONTINUE
  700     CONTINUE
C
          CALL GRAPH (4, FOFX, 1, 0, 0, 0, 2)
C
        ENDIF
C
      ENDIF
C
C
C     PRINT GRAPH OF ACTIVITY OF EACH RADIONUCLIDE--
C
      IF (IGRNUC .GT. 0)    THEN
C
C       IF AIR RELEASE--
        IF (IPATH .LT. 2)    THEN

C
          DO 750 IN = 1, NUCS
            DO 751 IT = 1, 144
               FOFX(IT,1) = ACTA(IT,IN)
  751       CONTINUE
C
            CALL GRAPH (5, FOFX, 1, IN, 0, 0, 1)
C
  750     CONTINUE
C
        ENDIF
C
C
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C       IF WATER RELEASE--
        IF (IPATH .NE. 1)   THEN
C
          DO 760 IN = 1, NUCS
C
            DO 761 IT = 1, 144
              FOFX(IT,1) = ACTW(IT,IN)
  761       CONTINUE
C
            CALL GRAPH (5, FOFX, 1, IN, 0, 0, 2)
C
  760     CONTINUE
C
        ENDIF
C
      ENDIF
C
C     PRINT SIGNATURE LINES AND SKIP TO NEW PAGE--
C
      WRITE (6, 7000)
      WRITE (6, 7001)
C
      RETURN
C
C     FORMAT STATEMENTS--
C
 2000 FORMAT (//' ',     '*** DATA LIBRARIES USED:', 16X, '(FILE)')
 2001 FORMAT (' ', 19X, 'MASTER NUCLIDE DATA : (10)   ', 20A4)
 2002 FORMAT (' ', 13X, 'FOOD CONCENTRATION RATIOS : (12)   ', 20A4)
 2003 FORMAT (' ',  4X, A5, 'WATER BIOACCUMULATION FACTORS : (14)   ',
     .                  20A4)
 2004 FORMAT (' ', 14X, 'EXTERNAL EXPOSURE D.F.''S : (16)   ', 20A4)
 2005 FORMAT (' ', 11X, 'INHALATION/INGESTION D.F.''S : (18)   ', 20A4)
 2006 FORMAT (' ', 15X, 'POPULATION DISTRIBUTION : (22)   ', 20A4)
 2007 FORMAT (' ', 14X, 'WATERBORNE RELEASE DATA  : (24)   ', 20A4)
 2008 FORMAT (' ', 17X, 'AIRBORNE RELEASE DATA : (26)   ', 20A4)
C
 3000 FORMAT (//' ',     '*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE ',
     .                  'INDIVIDUAL:',
     .             20X, '*** AQUATIC PATHWAY DATA FOR AN AVERAGE ',
     .                  'INDIVIDUAL:')
 3001 FORMAT ('0',  6X, 'PATHWAY', 12X, 'GROWING PERIOD', 5X, 'YIELD',
     .              7X, 'CONSUMPTION', 16X, 'PATHWAY', 16X, 'USAGE'/
     .             30X, '(DAYS)', 8X, '(KG/M**2)',5X, '(KG/YR)',
```

FIGURE D.1. DITTY Program Listing (continued)

```
     .                 38X, '(KG OR HR/YR)')
 3002 FORMAT (' ',  6X, A16, 4X, 1PE10.2, 5X, 1PE10.2, 4X, 1PE10.2,
     .                 18X, A18, 3X, 1PE10.2)
 3003 FORMAT (' ',  6X, 'EXTERNAL EXPOSURE TIME, ', 1PE10.2, ' HR/YR')
C
 4000 FORMAT (//' ',     '*** LIQUID RELEASE DILUTION/MIXING PARAMETERS',
     .                 29X, '*** FARMING PARAMETERS')
 4001 FORMAT ('0',  6X, 'RIVER FLOW RATE, (FT3/SEC) : ', 1PE10.2,
     .                 35X, 'MONTHS / YEAR IRRIGATED : ', 1PE10.2/

     .                  7X, 'RECONCENTRATION RATIO      : ', 1PE10.2,
     .                 35X, 'IRRIGATION RATE' /
     .                  7X, 'MIXING RATIO               : ', 1PE10.2,
     .                 37X, '(LITERS/M**2/MONTH)   : ', 1PE10.2)
C
 5000 FORMAT (//' ',     '*** ORGANS CONSIDERED:')
 5001 FORMAT (' ',      5 ( 10X, A10) )
C
 6000 FORMAT (//' ',    '*** SITE GRID DEFINITION:')
 6001 FORMAT (' ', 6X, 'NUMBER PF SECTORS: ', I5)
 6002 FORMAT (' ', 6X, 'DISTANCES: ', I5 /
     .                    10 (2X, F10.0))
C
 6100 FORMAT (//' ',     '*** JOINT FREQUENCY DATA:')
 6101 FORMAT (' ',  2X, 'WIND SPEED', 5X, 'STABILITY', 5X, 16A6)
 6102 FORMAT (' ',  2X, F6.1, 9X, A10, 16F6.2)
 6103 FORMAT (' ')
C
 6200 FORMAT ('0',  6X, 'STACK HEIGHT: ', F6.2)
C
 7000 FORMAT (//// 15X, 'INPUT PREPARED BY:', 15X, 'DATE:',
     .                 15X, 'INPUT CHECKED BY:',  16X, 'DATE:'/
     .                 32X, 15('*'), 6X, 10('*'), 21X, 15('*'), 6X, 10('*'))
 7001 FORMAT ('1')
C
 8000 FORMAT (/' ',  '*** MASTER RADIONUCLIDE CONTROL LIST:')
 8001 FORMAT ( 7(10X, A2, A6) / )
C
 9010 FORMAT (//' *** AIR RELEASE OF EACH RADIONUCLIDE PER PERIOD - ',

     .          'CURIES (GRAPH OPTION TURNED OFF)')
 9011 FORMAT ('0', 3X, 'RADIONUCLIDE   ', 6(A18,1X),/
     .          ' ', 3X, '------------   ', 6(A18,1X))
 9012 FORMAT ('0', 7X, A2, A6, 2X, 6(I4,3X,1PG8.2,4X)/
     .          30(' ', 17X,        6(I4,3X,1PG8.2,4X)/))
```

FIGURE D.1. DITTY Program Listing (continued)

```
 9020 FORMAT ('0*** WATER RELEASE OF EACH RADIONCLIDE PER PERIOD - ',
     .        'CURIES (GRAPH OPTION TURNED OFF)')
C
 9030 FORMAT (// ' *** POPULATION DISPERSION FACTOR FOR AIRBORNE ',
     .           'RELEASE, PERSON-SEC/M**3')
 9031 FORMAT ('0', 5X, 6(' PERIOD     PM      ')/
     .             5X, 6('----------------- '))
 9032 FORMAT (30(' ', 6(2X, I5, 2X, 1PG10.2)/))

 9033 FORMAT (// ' *** POPULATION FOR WATERBORNE RELEASE')
 9034 FORMAT ('0', 5X, 6(' PERIOD     PL      ')/
     .             5X, 6('----------------- '))
C
 9100 FORMAT (//' *** POPULATION DATA:',/)
C
 9110 FORMAT ('     PREVIOUS INPUT VALUES USED FOR ACUTE AIRBORNE ',
     .        'RELEASE.'/)
C
 9112 FORMAT ('     POPULATION DISPERSION FACTOR FOR ACUTE AIRBORNE ',
     .        'RELEASE = ',1PG10.2/)
C
 9120 FORMAT ('     PREVIOUS INPUT VALUES USED FOR CHRONIC AIRBORNE ',
     .        'RELEASE.'/)
C
 9122 FORMAT ('     POPULATION-WEIGHTED E/Q VALUES WERE INPUT FOR EACH ',
     .        '70-YR, TIME PERIOD'/)
C
 9124 FORMAT ('     POPULATION FOR CHRONIC AIRBORNE RELEASE AT TIME ',
     .        F7.0,':'//
     .        '       SECTOR ',10(1PG10.2))
 9125 FORMAT ('       ------ ',10('  --------'))
 9126 FORMAT ('       ',A7,10(1PG10.2))
C
 9127 FORMAT ('0    POPULATION FOR CHRONIC AIRBORNE RELEASE AT THE ',
     .        'FOLLOWING TIMES A.D.:'//2X,5('     TIME   POPULATION')/
     ,                                 2X,5('    ------------------'))
C
 9128 FORMAT (30(2X,5(' ',F9.0,2X,1PG10.2)/))
C
 9130 FORMAT ('     POPULATION FOR CHRONIC AIRBORNE RELEASE READ FROM ',
     .        'FILE 22.'/)
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
 9132 FORMAT ('     POPULATION DISPERSION FACTORS FOR CHRONIC AIRBORNE',
     .       ' RELEASE AT THE ',
     .       'FOLLOWING TIMES A.D.:'//2X,5('    TIME   POP-DISP-FT')/
     ,                              2X,5('   -------------------'))
C
 9134 FORMAT ('     PREVIOUS POPULATION DATA USED FOR CHRONIC AIRBORNE ',
     .       'RELEASE. CHANGES MADE TO E/Q INPUT.'/
     .       '     POPULATION-WEIGHTED E/Q VALUES RECALCULATED.')
C
 9136 FORMAT ('     NO CHRONIC AIRBORNE RELEASE, CONSTATNT POPULATION '
     .       'ASSUMED.')
C
 9140 FORMAT ('     PREVIOUS POPULATION VALUES USED FOR ACUTE ',
     .       'WATERBORNE RELEASE.'/)
C
 9142 FORMAT ('     POPULATION FOR ACUTE WATERBORNE ',
     .       'RELEASE = ',1PG10.2/)
C
 9150 FORMAT ('     PREVIOUS POPULATION VALUES USED FOR CHRONIC ',
     .       'WATERBORNE RELEASE.'/)
C
 9152 FORMAT ('     POPULATION FOR CHRONIC ',
     .'WATERBORNE RELEASE WERE INPUT FOR EACH 70-YR. TIME PERIOD.'/)
C
 9153 FORMAT ('     POPULATION FOR CHRONIC WATERBORNE RELEASE AT THE ',
     .       'FOLLOWING TIMES A.D.:'//2X,5('     TIME   POPULATION')/
     .                              2X,5('    ------------------'))
C
 9154 FORMAT (5('   ',F7.0,2X,1PG10.2)/)
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE REPORT
C
C*********************************************************************
C                                                                    *
C     THIS SUBROUTINE PRINTS GRAPHIC REPORTS OF ORGAN DOSES AS A     *
C     FUNCTION OF TIME, NUMERICAL REPORTS OF ORGAN DOSES AND MAXIMUM *
C     DOSE PERIOD REPORT                                             *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- GRAPH, HEADNG
C     INPUTS-- NONE
C     INPUT COMMONS-- OUTORG, TIMES, RESULT, NUCNAM, ORGID, OPTION,
C                     VARYBL
C     OUTPUTS-- PRINTER GRAPHICS REPORT
C     OUTPUT COMMONS-- NONE
C
C     Module of DITTY
C     VAX Version of 22-AUG-85  RAP
C
C---------------------------------------------------------------------
C
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'OPTION.CMN'
      INCLUDE 'OUTORG.CMN'
      INCLUDE 'ORGID.CMN'
      INCLUDE 'TIMES.CMN'
      INCLUDE 'RESULT.CMN'
      INCLUDE 'VARYBL.CMN'
C
      DIMENSION FOFX(144,8), AVDOS(5,100), IPR(5,100), ITOT(5)
      DIMENSION THIDOS(5), TAVDOS(5)
C
      CHARACTER*127 LINE
      CHARACTER*18  LADD
      CHARACTER*1 CHL(127), LAD(18)
      EQUIVALENCE (CHL(1), LINE), (LAD(1), LADD)
C
C
      DATA IND /1/
      DATA IFROM /1/
C
      LINE = '         ----------        ----------       '
      LADD = '----------        '
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
      CALL ZEROR (500,AVDOS)
      CALL ZEROI (500,IPR)
C
      IF (ISPEC .GT. 0) THEN
         LIMIT = NORG + 1
       ELSE
         LIMIT = NORG
       ENDIF
       ORGT(NORG + 1) = 'PARAMETER'
C
C     SET LENGTH OF UNDERLINE--
      DO 301 IO = 1, NORG
        I = IO * 18 + 29
        I2 = I + 18
        III = 1
        DO 303 II = I, I2
          IF (II .GT. 127) GO TO 301
          IF (III .GT. 18) GO TO 301
          CHL(II) = LAD(III)
          III = III + 1
  303   CONTINUE
  301 CONTINUE
C                                                                              C
C     PRINT GRAPH OF DOSE TO EACH SELECTED ORGAN--
C
       IF (IGRDOS .GT. 0) THEN
         DO 100 IO = 1, NORG                                                    C

           DO 200 I = 1, 144
             FOFX(I,IND) = DTOTAL(IO,I)
  200      CONTINUE
C
           CALL GRAPH (7, FOFX, 1, IO, IFROM, 0, 0)
C          TO PRINT GRAPH FOR THIS ORGAN.
           WRITE (6,2004)
C
  100    CONTINUE
       ENDIF
C
C
C     PRINT NUMERIC REPORT OF DOSE TO EACH ORGAN FOR EACH TIME PERIOD--
C
       TT = TZ
       IPAGE = 50
```

FIGURE D.1. DITTY Program Listing (continued)

```
      INTL = 0
C
      DO 300 IT = 1, 144
C
      IF (IPAGE .GT. 48) THEN
        IF (IT .GT. 1) WRITE (6,2002) LINE
        CALL HEADNG (IFROM)

        WRITE (6,2000)
        WRITE (6,2002) LINE
        IF (ISPEC .GT. 0 )  WRITE (6, 3004)

        WRITE (6,2001) (ORGT(I), I=1, LIMIT)

        WRITE (6,2002) LINE
        IPAGE = 0
      ENDIF
C
      IF (IT .EQ. 1 .AND. IAC .GT. 0)    THEN
C
        WRITE (6,1001) (DTOTAL(IO,1), IO = 1, NORG)
        IPAGE = IPAGE + 1
C
      ELSE
C
          IF (ISPEC .GT. 0) THEN
C
           TOTAL = 0.

           TOTAL = DTOTAL(1,IT) + DTOTAL(2,IT)*0.05
     .           + DTOTAL(3,IT)*0.2 + DTOTAL(4,IT)*0.05

           WRITE (6,1000)IT,TT,(DTOTAL(IO,IT),IO=1,NORG), TOTAL
           IPAGE = IPAGE + 1
C
         ELSE
C
           IF (IT .EQ. 144) THEN
             ISAME = 1
           ELSE
             ISAME = 0
             DO 302 IO = 1, NORG
               IF (DTOTAL(IO,IT) .NE. DTOTAL(IO,IT-1))  ISAME = 1
  302        CONTINUE
           ENDIF
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
            IF (ISAME .EQ. 0) THEN
              IF (INTL .EQ. 0) THEN
                WRITE (6, 2010)
                INTL = 1
                IPAGE = IPAGE +1
              ENDIF
            ELSE
              WRITE (6,1000) IT, TT, (DTOTAL(IO,IT), IO = 1, NORG)
              INTL = 0
              IPAGE = IPAGE + 1
            ENDIF
C
          ENDIF
C
          IF (IT .EQ. 144) THEN
            WRITE (6,2002) LINE
            WRITE (6,2004)
          ENDIF
C
          TT = TT + 70.
C
        ENDIF
C
  300 CONTINUE
C
C
C
C     PRINT REPORT OF MAXIMUM DOSE TIME PERIOD--
C
      CALL HEADNG (IFROM)
      WRITE (6, 3000)
      WRITE (6, 3001)  MAXTIM
      WRITE (6, 3010)
      WRITE (6, 3005) (CHL(II), II=21,127)
      IF (ISPEC .GT. 0)  WRITE (6, 3004)
      WRITE (6, 3002) (ORGT(I), I = 1, LIMIT)
      WRITE (6, 3005) (CHL(II), II=21,127)
C
      DO 401 IO = 1, NORG
        THIDOS(IO) = 0.0
  401 CONTINUE
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      DO 400 IN = 1, NUCS
        IF (ISPEC .GT. 0) THEN
          TOTAL = 0.
          TOTAL = HIDOSE(1,IN) + HIDOSE(2,IN)*0.05 + HIDOSE(3,IN)*0.2
     .          + HIDOSE(4,IN)*0.05
          WRITE (6,3003) ELTM(IN), AWM(IN), (HIDOSE(IO,IN),IO=1,NORG),
     .                   TOTAL
        ELSE
          WRITE (6,3003) ELTM(IN), AWM(IN),
     .          (HIDOSE(IO,IN), IO = 1, NORG)
          DO 402 IO = 1, NORG
           THIDOS(IO) = THIDOS(IO) + HIDOSE(IO,IN)
 402      CONTINUE
        ENDIF
  400 CONTINUE
C
      WRITE (6,3005) (CHL(II), II=21,127)
      WRITE (6,3006) (THIDOS(IO), IO=1,NORG)
      WRITE (6,3005) (CHL(II), II=21,127)
      WRITE (6,2004)
C
C     THE FOLLOWING REPORT PRINTS AVERAGE INDIVIDUAL MAX INCREMENT--
C
      IF (IPATH .GT. 1) THEN
        WRITE (6,3011)
        WRITE (6,3005) (CHL(II), II=21,127)
        WRITE (6,3002) (ORGT(I), I=1,LIMIT)
        WRITE (6,3005) (CHL(II), II=21,127)
C
        DO 559 IO = 1, NORG
          TAVDOS(IO) = 0.0
 559    CONTINUE
C
        DO 500 IN = 1, NUCS
          DO 501 IO = 1, NORG
C
            IF (PL(MAXTIM) .GT. 0.0) THEN
              AVDOS(IO,IN) = HIDOSE(IO,IN) / PL(MAXTIM)
            ELSE
              AVDOS(IO,IN) = 0.0
            ENDIF
C
            TAVDOS(IO) = TAVDOS(IO) + AVDOS(IO,IN)
C
 501      CONTINUE
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
          WRITE (6,3003) ELTM(IN), AWM(IN), (AVDOS(IO,IN),IO=1,NORG)
C
  500   CONTINUE
C
        WRITE (6,3005) (CHL(II), II=21,127)
        WRITE (6,3006) (TAVDOS(IO),IO=1,NORG)
        WRITE (6,3005) (CHL(II), II=21,127)
        WRITE (6,2005)
C
      ENDIF
C
C
C     PRINT REPORT OF DOSE BY RADIONUCLIDE AND PERCENT OF TOTAL BY ORGAN--
C
      IF (NUCS .GT. 15 .OR. IPATH .GT. 1) CALL HEADNG(IFROM)
      WRITE (6,4000)
      WRITE (6,3005) (CHL(II), II= 21,127)
      WRITE (6,3002) (ORGT(I), I=1,LIMIT)
      WRITE (6,3005) (CHL(II), II=21,127)
C
      DO 600 IO = 1, NORG
C
        ITOT(IO) =  0
        IF (DTOTAL(IO,144) .GT. 0.0) THEN
          DO 601 IN = 1, NUCS
            IPR(IO,IN) = IFIX(POPDOS(IO,IN) / DTOTAL(IO,144) * 100.)
  601     CONTINUE
        ELSE
          DO 603 IN = 1, NUCS
            IPR(IO,IN) = 0
  603     CONTINUE
        ENDIF
C
CC        DO 604 IN = 1, NUCS
CC          ITOT(IO) = ITOT(IO) + IPR(IO,IN)
CC  604   CONTINUE
C
  600 CONTINUE
C
      DO 610 IN = 1, NUCS
        WRITE (6,4010) (ELTM(IN), AWM(IN), (IPR(IO,IN),
     .                 POPDOS(IO,IN), IO=1,NORG))
  610 CONTINUE
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      WRITE (6,3005) (CHL(II), II=21,127)
      WRITE (6,4020) (DTOTAL(IO,144),IO=1,NORG)
      WRITE (6,3005) (CHL(II), II=21,127)
      WRITE (6,2004)
C
C
      RETURN
C
C
C     FORMAT STATEMENTS--
C
 1000 FORMAT (11X, I10, 8X,  F10.0, 5( 8X, 1PE10.2))

 1001 FORMAT (16X, 'ACUTE     ', 13X, 5( 8X, 1PE10.2) /)

C
 2000 FORMAT (/ 18X, '* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A ',
     .       'FUNCTION OF TIME * * *' / )
 2001 FORMAT (13X, 'PERIOD', 15X,  'YEAR', 9X, 5( A10, 8X) )

 2002 FORMAT (' ', A127)

 2004 FORMAT (//,10X,
     .         ' Dose in units of person-rem; that is the cumulative ',
     .          'population dose received by the local population '/10X,
     .          '                                over 10,000 years ',
     .          'with an assumed 70-yr individual lifetime.')

 2005 FORMAT (//,10X,
     .         ' Dose in units of rem.')
 2010 FORMAT (10X,'   until ')
C
 3000 FORMAT (// 18X, '* * * MAXIMUM DOSE RATE REPORT * * *')

 3001 FORMAT (/ 18X, 'DOSE INTEGRAL PERIOD (70-YEAR) DURING WHICH ',
     .       'THE MAXIMUM DOSE RATE OCCURS = ', I8)
 3002 FORMAT (29X, 'NUCLIDE', 11X, 5(A10, 8X) )

 3003 FORMAT (30X, A2, A6, 1X, 5(8X, 1PG10.2) )
C
 3004 FORMAT (109X, 'HAZARD')

 3005 FORMAT (21X, 127A1)

 3006 FORMAT (30X,'Total    ',5(8X,1PG10.2))
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
 3010 FORMAT (///18X, '* * * MAXIMUM POPULATION DOSE INCREMENT TO ',
     .        'TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *' /)

 3011 FORMAT (///18X, '* * * MAXIMUM AVERAGE INDIVIDUAL DOSE INCREMENT',
     .        ' TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *'/)
C
 4000 FORMAT (//18X,'* * * PERCENT OF TOTAL DOSE TO ORGAN AND ',
     ,       'CUMULATIVE DOSE TO ORGAN BY RADIONUCLIDE * * *'///)

 4010 FORMAT (30X, A2, A6, 2X, 5(4X,I4,'% ',1PG8.1) )

 4020 FORMAT (30X,'Total      ',5(10X,1PG8.1) )
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE RLIBIN
C
C*********************************************************************
C                                                                    *
C   THIS SUBROUTINE READS A MASTER NUCLIDE DATA LIBRARY WITH CHAIN   *
C   DECAY DATA.                                                      *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- ZEROR
C     INPUTS-- NONE
C     INPUT COMMONS-- NONE
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- DECAY, NAMES, TITLES
C
C---------------------------------------------------------------------
C
      INCLUDE 'DECAY.CMN'
      INCLUDE 'NAMES.CMN'
      INCLUDE 'TITLES.CMN'
C
      DIMENSION IT(2), FR(2)
      CHARACTER A*6, E*2
C
C     INITIALIZE INDICES--
      CALL ZEROR (300, AL)
      AL2 = ALOG (2.)
      IMO=0
      NCH=0
      NUC=1
C
C     READ TITLE CARD--
      READ(10,200,END=99) RMDTTL
C
C     READ AND COUNT NUCLIDE ID AND DECAY DATA--
    1 READ(10,100,END=99) E,A,T,IM,IT(1),FR(1),IT(2),FR(2)
C
C     TEST FOR END OF LIBRARY--
C
      IF (IM .GT. 0)   GO TO 2
      NUC = NUC - 1
      IF (NUC .GT. 300)   GO TO 98
      IF (NUC .LT. 1)   GO TO 98
      RETURN
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
C     TEST FOR NEW CHAIN, IM = 1--
C
    2 IF (IM .GT. 1)   GO TO 3
C
C     FIRST MEMBER,  NEW CHAIN--
C
      NCH = NCH + 1
      NOFNUC(NCH) = 1
      IMO = 1
      NCHST(NCH) = NUC
      GO TO 4
C
C     DAUGHTER NUCLIDES--
C     TEST ORDER--
C
    3 IF (IM - IMO .NE. 1)   GO TO 97
      IMO = IM
      NOFNUC(NCH) = NOFNUC(NCH) + 1
      IFR(1,NUC) = IT(1)
      IFR(2,NUC) = IT(2)
      DKF(1,NUC) = FR(1)
      DKF(2,NUC) = FR(2)
C
C     SET DATA FOR CURRENT NUCLIDE--
C
    4 ELT(NUC) = E
      AW(NUC) = A
      AL(NUC) = AL2 * 365.25 / T
C     IMEM(NUC) = IM
      NCHN(NUC) = NCH
      NUC = NUC + 1
      GO TO 1


C
C     PRINT ERROR MESSAGES AND STOP--
C
   97 PRINT 500, NCH,IM
  500 FORMAT(1H1,' DECAY CHAIN',I4,' HAS IMPROPER ORDER. C'
     . 'URRENT MEMBER INDEX IS',I4)
      STOP
```

FIGURE D.1. DITTY Program Listing (continued)

```
   98 PRINT 300, NUC
  300 FORMAT(1H1,' IMPROPER NUMBER OF NUCLIDES IN MASTER L'
     . 'IBRARY, NUC=',I8)
      STOP
C
   99 PRINT 400
  400 FORMAT (1H1,' PREMATURE END OF FILE ENCOUNTERED IN RLIBIN')
      STOP

C
C     INPUT DATA FORMATS--
C
  100 FORMAT (A2, A6, E10.2, I2, 2 (I2, F7.4) )
  200 FORMAT (20A4)

      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE SETNUC
C
C*********************************************************************
C                                                                    *
C     SETNUC ESTABLISHES THE MASTER LIST OF RADIONUCLIDES TO BE      *
C     INCLUDED IN THIS RUN                                           *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- MAIN
C     SUBORDINATE ROUTINES-- NUCTST, ZEROI
C     INPUTS-- NONE
C     INPUT COMMONS-- DECAY, NAMES, SOURCE
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- DKAY, NUCNAM, FLAGS
C
C---------------------------------------------------------------------
C
     INCLUDE 'DECAY .CMN'
     INCLUDE 'DKAY  .CMN'
     INCLUDE 'NAMES .CMN'
     INCLUDE 'NUCNAM.CMN'
     INCLUDE 'SOURCE.CMN'
     INCLUDE 'FLAGS.CMN'

C
C     INITIALIZE PARAMETERS--
1     CALL ZEROI (100, INFLG)
      ICHN = 0
      INUC = 0
C
C     FOR EACH DECAY CHAIN IN THE MASTER RADIONUCLIDE LIBRARY--
      DO 100 IC = 1, NCH
C
        NCN = NOFNUC(IC)
        N1 = NCHST(IC)
        N2 = N1 + NCN - 1
        IONE = 0
        I = 0
C
        DO 200 IL = N1, N2
C
C         HAS A MEMBER OF THIS CHAIN BEEN FOUND BEFORE?--
          IF (IONE .EQ. 1)   THEN
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
            INUC = INUC + 1
C
            IFRM(1,INUC) = MAX (0, IFR(1,IL)-I )
            IFRM(2,INUC) = MAX (0, IFR(2,IL)-I )
C
            DK(1,INUC) = DKF(1,IL)
            DK(2,INUC) = DKF(2,IL)
C
            AR(INUC) = AL(IL)
            AWM(INUC) = AW(IL)
            ELTM(INUC) = ELT(IL)
C
          ENDIF
C
C
          IN = 1
          IEND = 0
C
C         LOOP UNTIL MASTER RADIONUCLIDE LIST EXHAUSED OR A MEMBER IS FOUND--
  300     CONTINUE
C
C           DO ATOMIC WEIGHT SYMBOLS MATCH?--
            IF (AW(IL) .EQ. A(IN) ) THEN
C
C             DO THE ELEMENT NAMES MATCH?--
              IF (ELT(IL) .EQ. E(IN) )  THEN
C
C               SET FLAG FOR THIS NUCLIDE FOUND--
                INFLG(IN) = 1
C
C               IF THIS IS FIRST MEMBER OF CHAIN TO BE FOUND--
                IF (IONE .LE. 0)   THEN
C
                  IONE = 1
                  I = IL - N1
C
                  INUC = INUC + 1
                  ICHN = ICHN + 1
                  IF (ICHN .GT. 0)  NOFN(ICHN) = NCN - I
C
                  IFRM(1,INUC) = MAX (0, IFR(1,IL) - I )
                  IFRM(2,INUC) = MAX (0, IFR(2,IL) - I )
C
                  DK(1,INUC) = DKF(1,IL)
                  DK(2,INUC) = DKF(2,IL)
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
                  AWM(INUC) = AW(IL)
                  ELTM(INUC) = ELT(IL)
                  AR(INUC) = AL(IL)
C
                ENDIF
C
C               STOP SEARCHING--
                IEND = 1
C
              ELSE
C               MATCH NOT FOUND, COMPARE WITH NEXT MASTER LIST RECORD--
                IN = IN + 1
              ENDIF
C
            ELSE
C             MATCH NOT FOUND; COMPARE WITH NEXT MASTER LIST RECORD--
              IN = IN + 1
            ENDIF
C
          IF (IEND .LT. 1  .AND.  IN .LE. NIN)  GO TO 300
C
  200   CONTINUE
  100 CONTINUE
C
C
      NUCS = INUC
      CALL NUCTST
C     TO DETERMINE IF ALL MASTER LIST RADIONUCLIDES WERE FOUND IN DATA LIBRARY
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE SETUP  ( YL1, NL   )
C
C**********************************************************************
C                                                                     *
C     SETUP FILLS THE Y-AXIS LABEL ARRAY, Y-AXIS TICK MARKS, AND      *
C     BLANKS OUT THE THE GRAPH STORAGE ARRAY                          *
C                                                                     *
C**********************************************************************
C
C     CALLED BY--  GRAPH
C     SUBORDINATE ROUTINES--  NONE
C     INPUTS-- YL1, NL

C     INPUT COMMONS-- NONE
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- PLOT
C
C     VAX Version of 17-OCT-84  RAP
C
C----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  --------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  --------------------------------------
C
C     YL          CHARACTER  SELECTED Y-AXIS LABEL
C     NL          INTEGER    NUMBER OF CHARACTERS IN SELECTED Y-AXIS
C                            LABEL
C
C----------------------------------------------------------------------
C
      INCLUDE 'PLOT.CMN'
C
      CHARACTER YL1*1, BLANK*1, AST*1, BLANK2*12
C
      DIMENSION YL1(40)
C
      DATA BLANK2 /'            '/
      DATA AST /'*'/
      DATA BLANK /' '/
      DATA IY /40/
      DATA IX /73/
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C     DATA TICKY /40 * ' '/
      DATA TICKX /73 * ' '/
      DATA TICKY(1) /'*'/
      DATA TICKY(9) /'*'/
      DATA TICKY(17) /'*'/
      DATA TICKY(25) /'*'/
      DATA TICKY(33) /'*'/
      DATA TICKX(1), TICKX(36), TICKX(73) /3 * '*'/
C
      DATA LABELX /'TIME  ---->'/
C
C
C     CENTER Y-AXIS LABEL--
C
      IS = (IY - NL) / 2

      IF (IS .GT. 0)  THEN
        DO 100 I = 1, IS
          LABELY(I) = BLANK
  100   CONTINUE
      ENDIF
C
C
C     TRANSFER SELECTED LABEL TO LABEL-Y ARRAY--

      DO 200 I = 1, NL
        IJ = IS + I
        LABELY(IJ) = YL1(I)
  200 CONTINUE
C
C     BLANK OUT REMAINDER OF LABELY ARRAY--
      IT = NL + IS + 1
      IF (IT .LT. IY)  THEN
        DO 700 I = IT, IY
          LABELY(I) = BLANK
  700   CONTINUE
      ENDIF
C
C
C
C
C     BLANK-OUT ARRAY--
C
      DO 500 I = 2, IX-1
        DO 400 J = 1, IY
```

FIGURE D.1. DITTY Program Listing (continued)

```
         ARRAY(J,I) = BLANK
  400   CONTINUE
  500 CONTINUE
C
C
C
C     SET VERTICAL BORDER INTO ARRAY--
C
      DO 600 J = 1, IY
        ARRAY(J,1) = AST
        ARRAY(J,73) = AST
  600 CONTINUE
C
C
C
C     BLANK OUT LEGEND ARRAY
C
      DO 800 I = 1,40
        LEGEND(I) = BLANK2
  800 CONTINUE
C
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      FUNCTION SIGMAZ (KS, TT)
C
C*********************************************************************
C
C     SIGMAZ CALCULATES SIGMA Z AT A GIVEN LOCATION.
C
C*********************************************************************
C
C     CALLED BY--  EOVRQ
C     SUBORDINATE ROUTINES--  NONE
C     INPUTS--  KS, TT
C     INPUT COMMONS--  NONE
C     OUTPUTS--  SIGMAZ
C     OUTPUT COMMONS-- NONE
C
C---------------------------------------------------------------------
C
      IF (KS .GT. 0) THEN
C
        EXPO = 8.8E-4 * TT * TT                                        $!
C
        SZ2 = 34. * (1. - EXP (-EXPO))   +  .025 * TT
C
C
      ELSE
C
        EXPO = 2.54E-4 * TT * TT
C
        SZ2 = 97. * (1. - EXP (-EXPO))   + .33 * TT
C
      ENDIF
C
C
      SIGMAZ = SQRT (SZ2)
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE TRITUM (IST, IAW, WATCN, AIRCN, ANCONS, ANDRNK, CSOIL,
     .                   EDIBL, AQUA)
C
C**********************************************************************
C                                                                     *
C     TRITUM CALCULATES ENVIRONMENTAL CONCENTRATIONS OF TRITIUM       *
C     USING A SPECIFIC-ACTIVITY MODEL.                                *
C                                                                     *
C**********************************************************************
C
C     CALLED BY-- APATHS, WPATHS
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- IST, IAW, WATCN, AIRCN, ANCONS, ANDRNK
C     INPUT COMMONS-- BIODAT
C     OUTPUTS-- CSOIL, EDIBL, AQUA
C     OUTPUT COMMONS-- NONE
C
C----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  --------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  --------------------------------------
C
C     IST         INTEGER
C     IAW         INTEGER
C     WATCN       REAL
C     AIRCN       REAL
C     ANCONS(7)   REAL
C     ANDRNK(7)   REAL
C     CSOIL       REAL
C     EDIBL(7)    REAL
C     AQUA(5)     REAL
C
C----------------------------------------------------------------------
C
      INCLUDE 'BIODAT.CMN'
C
C
      DIMENSION ANCONS(7), ANDRNK(7), EDIBL(7), AQUA(5)
C
C
      DATA H1 /9.0/
      DATA H2 /0.008/
      DATA H3 /0.0625/
```

FIGURE D.1. DITTY Program Listing (continued)

```
      DATA H4 /0.083/
      DATA H5 /0.094/
      DATA H6 /0.10/
      DATA H7 /0.087/
      DATA H8 /0.092/
C
      DATA W1 /0.80/
      DATA W2 /0.12/
      DATA W3 /0.80/
      DATA W4 /0.88/
      DATA W5 /0.60/
      DATA W6 /0.50/
      DATA W7 /0.70/
      DATA W8 /0.75/
C
      DATA Z1 /0.1/
      DATA Z2 /0.03/
C
      TAIR = AIRCN * H1 / H2
      TWAT = WATCN * H1
      CLEAF = TAIR + TWAT
      CSOIL = AIRCN * Z1 / H2  +  WATCN * Z1
C
      W1M = W1 / H1 + (1.0 - W1) * H3
      W2M = W2 / H1 + (1.0 - W2) * H3
      W3M = W3 / H1 + (1.0 - W3) * H3
C
      EDIBL(1) = CLEAF * W1M
C
      EDIBL(2) = EDIBL(1)
C
      EDIBL(3) = (ANCONS(3) * CLEAF * W2M  +  ANDRNK(3) * WATCN) /
     .           (ANCONS(3) * W2M  + ANDRNK(3) / H1) *
     .           (W8 / H1 + (1. - W8) * H8)
C
      EDIBL(4) = (ANCONS(4) * CLEAF * W3M  +  ANDRNK(4) * WATCN) /
     .           (ANCONS(4) * W3M  +  ANDRNK(4) / H1 ) *
     .           (W4 / H1  + (1. - W4) * H4)
C
      EDIBL(5) = (ANCONS(5) * CLEAF * W2M  +  ANDRNK(5) * WATCN) /
     .           (ANCONS(5) * W2M  + ANDRNK(5) /H1) *
     .           (W5 / H1  +  (1. - W5) * H5)
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
      EDIBL(6) = (ANCONS(6) * CLEAF * W2M  + ANDRNK(6) * WATCN) /
     .           (ANCONS(6) * W2M  + ANDRNK(6) / H1) *
     .           (W6 / H1  +  (1. - W6) * H6)
C
      EDIBL(7) = (ANCONS(7) * CLEAF * W2M  + ANDRNK(7) * WATCN) /
     .            (ANCONS(7) * W2M  + ANDRNK(7) / H1) *
     .            (W7 / H1  +  (1. - W7) * H7)
C
C
      IF (IAW .EQ. 2)  THEN
C
        DO 100 I = 1, 4
          AQUA(I) = BIOACF(I,IST) * WATCN
  100   CONTINUE
C
        AQUA(5) = WATCN * DWCF(IST)
C
      ENDIF
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
      SUBROUTINE WPATHS (ITIM, ITWX)
C
C*********************************************************************
C                                                                    *
C     WPATHS CALCULATES ENVIRONMENTAL CONCENTRATIONS OF RADIO-       *
C     NUCLIDES FROM AQUATIC PATHWAYS                                 *
C                                                                    *
C*********************************************************************
C
C     CALLED BY-- CONTRL
C     SUBORDINATE ROUTINES-- TRITIUM, CARBON, BCHAIN
C     INPUTS-- ITIM, ITWX
C     INPUT COMMONS-- FODATA, PATHIN, NUCNAM, BIODAT, DKAY, VARYBL
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- EDCN
C
C     Module of DITTY
C     VAX Version of 26-NOV-84  RAP
C
C---------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     ITIM        INTEGER
C     ITWX        INTEGER
C
C---------------------------------------------------------------------
C
      INCLUDE 'BIODAT.CMN'
      INCLUDE 'DKAY.CMN'
      INCLUDE 'EDCN.CMN'
      INCLUDE 'FODATA.CMN'
      INCLUDE 'PATHIN.CMN'
      INCLUDE 'NUCNAM.CMN'
      INCLUDE 'VARYBL.CMN'
C
C
      CHARACTER*2 CONSTH, CONSTC
      DIMENSION RATIRR(100), RATSED(100)
C
      DIMENSION TRNL(7), ANCONS(7), ANDRNK(7), DUMMY(100)
      DATA TRNL / 1.0, 0.1, 0.1, 1.0, 0.1, 0.1, 0.1/
```

FIGURE D.1. DITTY Program Listing (continued)

```
      DATA ANCONS /0., 0., 0.12, 55., 68., 4.2, 0.12/
      DATA ANDRNK /0., 0., 0.3, 60., 50., 10., 0.3/
C
      DATA CONST1 /1.119E-9/
      DATA CONST2 /224./
      DATA CONST3 /25300./
      DATA CONST5 /0.25/
      DATA CONST6 /365.25/
C
C     CONST4 = 0.69315 / 14. * 365.25
      DATA CONST4 /18.0838/
C
      DATA ONE /1./
      DATA CONSTC /'C '/
      DATA CONSTH /'H '/
C
      IF (RM .EQ. 0.0)     RM = 1.0
      IF (RECON .EQ. 0.0)    RECON = 1.0
C
      DO 101 I = 1, NUCS
        DUMMY(I) = AR(I)
  101 CONTINUE
C
      JNUC = 0
C
C
C     FOR EACH DECAY CHAIN--
      DO 100 ICH = 1, ICHN
C
        J = NOFN(ICH)
        IST = JNUC + 1
        JNUC = JNUC + J
        K = IST + J - 1
C
C
C       FOR EACH NUCLIDE IN THE CHAIN--
        DO 200 I = IST, K
          WATCON(I) = PL(ITIM) * RECON * RM * ACTW(ITIM,I) * CONST1 /
     .                CFLO / AR(I)
  200   CONTINUE
C
C       IF THIS ELEMENT IS 'H '--
        IF (ELTM(IST) .EQ.  CONSTH)  THEN
C
          CALL TRITUM (IST, 2, WATCON(IST), DUMMY1, ANCONS, ANDRNK,
```

FIGURE D.1. DITTY Program Listing (continued)

```
     .                 SCONW(IST), EDBCNW(1,IST), AQUATC(1,IST) )
C
        ELSE
C         IF THIS ELEMENT IS 'C '--
          IF (ELTM(IST) .EQ. CONSTC)  THEN
C
            CALL CARBON (IST, 2, WATCON(IST), DUMMY1, ANCONS, ANDRNK,
     .                    SCONW(IST), EDBCNW(1,IST), AQUATC(1,IST),
     .                   RIRR, MOPYR )
C
          ELSE
C
C           SKIP OVER IF ACUTE RELEASE, FIRST YEAR--
            IF (ITIM .NE. 1)   THEN
C
C             SKIP OVER IF FIRST TIME CHRONIC RELEASE--
              IF (ITIM .NE. 2)  THEN
C
C               DECAY PREVIOUS SOIL CONCENTRATIONS--
                CALL BCHAIN (J, 70., DK(1,IST), IFRM(1,IST), AR(IST),
     .                       AB(IST), SCONW(IST), SCONW(IST), 0)
C
C               WASH OUT PREVIOUS SEDIMENT CONCENTRATIONS (AND RE-
C               ESTABLISH EQUILIBRIUM WITH THIS PERIOD'S WATER
C               CONCENTRATION, IN FOLLOWING DO LOOP)
                CALL ZEROR ( 100, SEDCON )
C
              ENDIF
            ENDIF
C
C             IF THERE IS A RELEASE--
              IF (ITIM .LE. ITWX)   THEN
C
                TIME = 70.
                IOONE = 1
C
                IF (ITIM .EQ. 1)  THEN
                  TIME = 1.0
                  IOONE = 0
                ENDIF
C
                DO 300 I = IST, K
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C                 IRRIGATION DEPOSITION RATE, WEIGHTED BY POPULATION
C                 AND DECAY CONSTANT, PERSON-CI-YR/KG-YR
                  RATIRR(I) = WATCON(I) *  RIRR / CONST2 * MOPYR
C
C                 SEDIMENT DEPOSITION RATE IN PERSON-CI-YR/M**2-YR
                  RATSED(I) = WATCON(I) * CONST3
C
  300           CONTINUE
C
                CALL BCHAIN (J, TIME, DK(1,IST), IFRM(1,IST), AR(IST),
     .                       AB(IST), RATIRR(IST), RATIRR(IST), IOONE)
C
                CALL BCHAIN (J, TIME, DK(1,IST), IFRM(1,IST), AR(IST),
     .                        DUMMY(IST), RATSED(IST), RATSED(IST), 1)
C
C
C               The following code was added to correct population included
C               in soil concentration--
                PLC = 1.0
                IF (ITIM .GT. 1) THEN
                  IF (PL(ITIM) .GT. 0.0 .AND. PL(ITIM-1) .GT. 0.0) THEN
                    PLC = PL(ITIM) / PL(ITIM-1)
                  ENDIF
                ENDIF
C
C               SUM PREVIOUS AND CURRENT DEPOSITIONS--
                 DO 400 I = IST, K
C
                   SCONW(I) = SCONW(I) * PLC  + RATIRR(I)

                   SEDCON(I) = SEDCON(I) + RATSED(I)

 C
   400           CONTINUE
 C
               ENDIF
 C
 C
 C           CALCULATE PATHWAY CONCENTRATIONS--
             DO 500 I = IST, K
 C
 C             FIND ENVIRONMENTAL REMOVAL CONSTANT--
               ENVLAM = AR(I) + CONST4
 C
 C             LOOP ON TERRESTRIAL PATHWAYS--
               DO 600 IP = 1, 7
```

FIGURE D.1. DITTY Program Listing (continued)

```
C
                IF (ITIM .EQ. 1)   THEN
C
C                 ACUTE LEAF CONCENTRATION--
                  RLFCON = CONST5 * WATCON(I) * RIRR * 12. /
     .                    YELD(IP)
                ELSE
C
C                   CHRONIC LEAF CONCENTRATION--
                    RLFCON = CONST5 * (WATCON(I) * RIRR * 12.
     .                        + SCONW(I) * DVEL(I) * .47)
     .                        * (ONE - EXP (-ENVLAM * GRWP(IP)/CONST6))
     .                        / YELD(IP) / ENVLAM
C
                ENDIF
C
C
                PLTCON = RLFCON * TRNL(IP) + SCONW(I) * CRATIO(1,I)
C
C               IF VEGATABLE PATHWAY--
                IF (IP .LE. 2)  THEN
                   EDBCNW(IP,I) = PLTCON
                 ELSE
                   EDBCNW(IP,I) = (PLTCON * ANCONS(IP) + WATCON(I)
     .                          * ANDRNK(IP)) * CRATIO(IP-1,I)
                 ENDIF
C
  600         CONTINUE
C
C             LOOP ON AQUATIC PATHWAYS--
              DO 700 IWP = 1, 4
                AQUATC(IWP,I) = WATCON(I) * BIOACF(IWP,I)
  700         CONTINUE
C
C             DRINKING WATER--
              AQUATC(5,I) = WATCON(I) * DWCF(I)
C
  500       CONTINUE
          ENDIF
        ENDIF
  100 CONTINUE
C
      RETURN
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
C------------------------------------------------------------------------
C
      SUBROUTINE ZEROI(N,K)
C
C     THIS MODULE SETS N VALUES OF ARRAY K TO INTEGER ZERO.
C
C     Module of DITTY
C     Version of 14-MAY-84  RAP
C
C------------------------------------------------------------------------
C
      DIMENSION K(1)
C
      DO 1 J=1,N
        K(J)=0
    1 CONTINUE
C
      RETURN
C
C------------------------------------------------------------------------
C
      END
```

FIGURE D.1. DITTY Program Listing (continued)

```
C-----------------------------------------------------------------------
C
      SUBROUTINE ZEROR(N,A)
C
C
C     THIS MODULE SETS N VALUES OF ARRAY A TO REAL ZERO.
C
C     Module of DITTY
C     Version of 14-MAY-84  RAP
C
C-----------------------------------------------------------------------
C
      DIMENSION A(1)
C
      DO 1 J=1,N
        A(J)=0.
    1 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
C
```

FIGURE D.1. DITTY Program Listing (continued)

```
C-----------------------------------------------------------------------
C     AIRCON
C           DESCRIPTION: NORMALIZED AIR CONCENTRATION FACTORS
C           USED BY: CASEIN, EOVRQ, PMEQ
C-----------------------------------------------------------------------
C
      COMMON /AIRCON/ EOQ(10,16)
C
C     EOQ(10,16)     - NORMALIZED TIME INTEGRATED AIR CONCENTRATION FOR
C                      EACH SPATIAL INTERVAL, SEC/M**3 (10 DISTANCES
C                      AND 16 SECTORS)
C
C-----------------------------------------------------------------------
C     BIODAT
C           DESCRIPTION: BIOACCUMULATION FACTORS FOR AQUATIC PATHWAYS
C           USED BY: BIOLIN, CASEIN, MAIN, CARBON, QAPAGE, TRITUM, WPATHS
C-----------------------------------------------------------------------
C
      COMMON /BIODAT/ BIOACF(4,100), DWCF(100), ISALT, IOSALT
C
C     BIOACF(4,100) - BIOACCUMULATION FACTOR FOR:
C                           1. - FISH                3. - MOLLUSCS
C                           2. - CRUSTACEA           4. - WATER PLANTS
C     DWCF(100)      - DRINKING WATER CLEANUP FACTORS (THE FRACTION
C                      PASSING THROUGH A WATER TREATMENT PLANT.)
C
C     ISALT          - CONTROL INTEGER INDICATING WHETHER FRESH WATER
C                      (ISALT = 0) OR SALT WATER (ISALT = 1) BIOACCUM-
C                      LATION FACTORS ARE READ IN
C     IOSALT         - VALUE OF ISALT FOR PREVIOUS CASE; COMPARISON WITH
C                      ISALT DETERMINES IF DIFFERENT BIOACCUMULATION
C                      FACTORS NEED TO BE READ IN
C-----------------------------------------------------------------------
C     DAY                                                        $25a
C           DESCRIPTION: DATE OF THE CURRENT RUN AND HEADING INFO
C           USED BY: AIRLIN, HEADNG
C-----------------------------------------------------------------------
C
      COMMON /DAY/ DAIT, CHIAC, CHIPAT
C
      CHARACTER*9 DAIT
      CHARACTER*7 CHIAC
      CHARACTER*22 CHIPAT
C
C       DAIT         - EIGHT CHARACTER NAME FOR DAY OF YEAR, MMDDYY:
```

Figure D.1. DITTY Program Listing (continued)

```
C                        MM - MONTH,  DD - DAY,  YY - YEAR.
C       CHIAC          - IAC OUTPUT
C       CHIPAT         - IPATH OUTPUT
C
C-----------------------------------------------------------------------
C     DECAY
C          DESCRIPTION: DATA FILE INPUT RADIONUCLIDE DECAY DATA
C          USED BY: MAIN, AIRLIN, RLIBIN, SETNUC
C-----------------------------------------------------------------------
C
      COMMON /DECAY/ NUC, NCH, NOFNUC(200), NCHST(200), IFR(2,300),
     + DKF(2,300), AL(300), NCHN(300)
C
C       NUC            - NO. OF RADIONUCLIDES IN THE MASTER LIBRARY RMDLIB
C                        1 <= NUC => 300.
C       NCH            - NO. OF DECAY CHAINS IN THE MASTER LIBRARY RMDLIB
C                        1 <= NCH => 200.
C       NOFNUC(200)    - NO. OF RADIONUCLIDES IN EACH DECAY CHAIN. 1 <=
C                        NOFNUC(I) => 9. WHEN NOFNUC(I) = 1, NO DAUGHTERS.
C       NCHST(200)     - LOCATION IN THE MASTER RADIONUCLIDE LIST OF THE
C                        1ST MEMBER OF EACH CHAIN. 1 <= NCHST(I) => 300.
C       IFR(2,300)     - IFR(1,I) GIVES THE CHAIN MEMBER THAT IS THE 1ST
C                        PRECURSOR TO RADIONUCLIDE I. IFR(2,I) IS LOCATION
C                        OF 2ND PRECURSOR. IFR(1,I) < IFR(2,I) < IMEM(I)
C       DKF(2,300)     - FRACTION OF 1ST AND 2ND PRECURSOR THAT DECAYS TO
C                        THIS RADIONUCLIDE.
C       AL(300)        - RADIOLOGICAL DECAY CONSTANT FOR EACH RADIONUCLIDE
C                        YR ** -1.
C       NCHN(300)      - CHAIN NUMBER FOR EACH RADIONUCLIDE.
C
C-----------------------------------------------------------------------
C     DISPSN
C          DESCRIPTION: ATMOSPHERIC DISPERSION DATA AND PARAMETERS
C          USED BY: MAIN, CASEIN, EOVRQ, QAPAGE
C-----------------------------------------------------------------------
C
      COMMON /DISPSN/ NDIST, DIST(10), NUBAR, UBAR(8), NMET, MET(7),
     .                F(8,7,16), HS
C
C     NDIST          - NO. OF DISTANCES CONSIDERED FOR DEFINING POPULA-
C                      TION AND E/Q, 1<=NDIST<=10.
C     DIST(10)       - DISTANCE FROM THE RELEASE POINT TO THE CENTER OF
C                      POPULATION RING,X; M. MUST BE IN INCREASING ORDER,
C     NUBAR          - NO. OF WINDSPEED GROUPS USED FOR DEFINITION OF
C                      JOINT FREQUENCY DATA, 1<=NUBAR<=8.
```

Figure D.1. DITTY Program Listing (continued)

```
C      UBAR(8)          - AVERAGE WINDSPEED FOR EACH ENERGY GROUP, M/SEC.
C      NMET             - NO. OF ATMOSPHERIC STABILITY CATEGORIES FOR DEF-
C                         ITION OF JOINT FREQUENCY DATA, 1 <= NMET <= 7.
C      MET(7)           - ATMOSPHERIC STABILITY SELECTION INDEX. NMET VALUES
C                         MUST BE GIVEN FOR MET. VALID VALUES ARE:
C                           1 - HANFORD VERY STABLE         5 - PASQUILL C
C                           2 - HANFORD MODERATELY STABLE   6 - PASQUILL D
C                           3 - PASQUILL A                  7 - PASQUILL E
C                           4 - PASQUILL B                  8 - PASQUILL F
C      F(8,7,16)        - JOINT FREQUENCY OF OCCURRENCE OF ATMOSPHERIC CON-
C                         DITIONS FOR UP TO 8 WINDSPEEDS, 7 STABILITIES,
C                         AND 16 SECTORS, DIMENSIONLESS.
C      HS               - HEIGHT OF THE STACK, METERS
C
C-----------------------------------------------------------------------
C      DKAY
C            DESCRIPTION: RADIONUCLIDE DECAY INFORMATION FOR MASTER LIST
C            USED BY: MAIN, APATHS, DOSADD, SETNUC, WPATHS
C-----------------------------------------------------------------------
C
       COMMON /DKAY/ INUC, ICHN, NOFN(100), IFRM(2,100), DK(2,100),
     .               AR(100)
C
C      INUC             - NO. OF RADIONUCLIDES IN MASTER LIST, 1<=INUC<=100.
C      ICHN             - NO. OF DECAY CHAINS IN MASTER LIST, 1<=ICHN<=100.
C      NOFN(100)        - NO. OF RADIONUCLIDES IN EACH CHAIN. 1<=NOFN(I)<=9.
C      IFRM(2,100)      - IFRM(1,I) GIVES THE CHAIN MEMBER THAT IS THE FIRST
C                         PRECURSOR TO RADIONULCIDE I. IFRM(2,I) GIVES 2ND
C                         PRECURSOR.   IFARM(1,I)  <  IFRM(2,I)
C      DK(2,100)        - FRACTION OF 1ST & 2ND PRECURSOR THAT DECAY TO THIS
C                         RADIONUCLIDE, 0 <= DK(I,G) <= 1.0
C      AR(100)          - RADIOLOGICAL DECAY CONSTANT FOR EACH RADIONUCLIDE,
C                         YEARS ** -1
C
C-----------------------------------------------------------------------
C      DOSFAC
C            DESCRIPTION: DOSE COMMITMENT FACTORS
C            USED BY: AIRLIN, DOSADD
C-----------------------------------------------------------------------
C
       COMMON /DOSFAC/ DFH(2,5,100), DFG(2,5,100)
C
C      DFH(2,5,100)     - DOSE COMMITMENT FACTORS FOR 2 DOSE PERIODS FOR
C                         5 ORGANS, FOR 100 RADIONUCLIDES FROM INHALATION
C      DFG(2,5,100)     - DOSE COMMITMENT FACTORS FOR 2 DOSE PERIODS FOR
```

Figure D.1. DITTY Program Listing (continued)

```
C                     5 ORGANS, FOR 100 RADIONUCLIDES FROM INGESTION
C
C                     NOTE: BOTH OF THESE ARE BASED ON CONTINUOUS EX-
C                     POSURE AT A CONSTANT LEVEL FOR 70 YRS AND 1 YEAR.
C
C-----------------------------------------------------------------------
C     EDCN
C           DESCRIPTION: RADIONUCLIDE CONCENTRATIONS IN VARIOUS MEDIA
C           USED BY: APATHS, CONTRL, DOSADD, WPATHS
C-----------------------------------------------------------------------
C
      COMMON /EDCN/ WATCON(100), SCONW(100), SEDCON(100), EDBCNW(7,100),
     .              AQUATC(5,100), AIRCON(100), SLCON(100),
     .              EDBCON(7,100)
C
C                     NOTE: ALL EDCN PARAMETERS ARE WEIGHTED WITH
C                           DECAY CONSTANT AND POPULATION
C
C     WATCON(100)    - WATER CONCENTRATIONS OF RADIONUCLIDES,
C                      CI/L-PERSON-YR
C     SCONW(100)     - FARM SOIL CONCENTRATIONS OF RADIONUCLIDES,
C                      PERSON-CI--YR/KG
C     SEDCON(100)    - RIVER SEDIMENT CONCENTRATIONS OF RADIONUCLIDES,
C                      PERSON-CI-YR/M**2
C     EDBCNW(7,100) - CONCENTRATION OF RADIONUCLIDE IN THE EDIBLE
C                      PORTION OF THE TERRESTRIAL PLANTS AND ANIMALS,
C                      PERSON-CI-YR/KG FROM IRRIGATION DEPOSITION
C     AQUATC(5,100) - CONCENTRATION OF RADIONUCLIDES IN THE EDIBLE
C                      PORTION OF AQUATIC PLANTS AND ANIMALS,
C                      PERSON-CI-YR/KG (OR PER LITER H(2)0
C     AIRCON(100)    - ATMOSPHERIC CONCENTRATIONS OF RADIONUCLIDES FROM
C                      DISPERSION/DIFFUSION (NO RESUSPENSION),
C                      PERSON-CI-YR/M**3
C     SLCON(100)     - CONCENTRATION IN FARM SOIL OF RADIONUCLIDES FROM
C                      ATMOSPHERIC DEPOSITION, PERSON-CI-YR/KG
C     EDBCON(7,100) - CONCENTRATION OF RADIONUCLIDES IN THE EDIBLE
C                      PORTION OF TERRESTRIAL ANIMALS AND PLANTS FROM
C                      ATMOSPHERIC DEPOSITION, PERSON-CI-YR/KG
C-----------------------------------------------------------------------
C     FLAGS
C           DESCRIPTION: RADIONUCLIDE SELECTION CONTROL FLAGS
C           USED BY: AIRLIN, NUCTST, SETNUC
C-----------------------------------------------------------------------
C
      COMMON /FLAGS/  INFLG(100)
```

Figure D.1. DITTY Program Listing (continued)

```
C
C       INFLG(100)    - CONTROL INTEGER TO INDICATE WHICH MASTER LIST
C                       RADIONUCLIDE HAVE DOSE FACTORS SUPPLIED IN INPUT
C       NOTE:
C             <= 0 -- NO DATA GIVEN
C             > 0  -- DATA GIVEN
C
C-----------------------------------------------------------------------
C     FODATA
C           DESCRIPTION: DATA FOR TERRESTRIAL FOOD PATHWAYS
C           USED BY: MAIN, APATHS, FOOLIN, WPATHS
C-----------------------------------------------------------------------
C
      COMMON /FODATA/ DVEL(100), CRATIO(6,100), AB(100)
C
C     DVEL(100)      - DEPOSITION VELOCITIES, M/SEC
C     CRATIO(6,100) - CONCENTRATION RATIOS FOR:
C                       1- PLANTS      3- MILK        5- PORK
C                       2- EGGS        4- BEEF        6- POULTRY
C     AB(100)        - SOIL REMOVAL PERCOLATION CONSTANT, YEARS ** -1
C
C-----------------------------------------------------------------------
C     GRDDAT
C           DESCRIPTION: EXTERNAL DOSE CONVERSION FACTORS
C           USED BY: DOSADD, GRDLIN
C-----------------------------------------------------------------------
C
      COMMON /GRDDAT/ EDS(100), EDW(100), EDA(100)
C
C     EDS(100)       - EXTERNAL DOSE FACTOR FOR EXPOSURE TO CONTAMINATED
C                      SOIL, REM/HR PER CI/M**2
C     EDW(100)       - EXTERNAL DOSE FACTOR FOR EXPOSURE TO CONTAMINATED
C                      WATER, REM/HR PER CI/M**3
C     EDA(100)       - EXTERNAL DOSE FACTOR FOR SUBMERSION IN CONTAMINA-
C                      TED AIR, REM/SEC PER CI/M**3
C
C-----------------------------------------------------------------------
C     NAMES
C           DESCRIPTION: DATA FILE INPUT RADIONUCLIDE NAMES
C           USED BY: RLIBIN, SETNUC
C-----------------------------------------------------------------------
C
      COMMON /NAMES/  ELT(300),  AW(300)
C
      CHARACTER AW*6, ELT*2
```

Figure D.1. DITTY Program Listing (continued)

```
C
C       ELT(300)     - TWO CHARACTER ELEMENT NAME FOR EACH RADIONUCLIDE
C                      IN THE MASTER RADIONUCLIDE DATA LIBRARY.
C       AW(300)      - SIX CHARACTER ATOMIC WEIGHT SYMBOL FOR EACH RADI-
C                      ONUCLIDE IN THE MASTER RADIONUCLIDE DATA LIBRARY.
C                      ISOMERIC STATES ARE INDICATED BY THE LETTER M AF-
C                      TER THE ATOMIC WEIGHT. DAUGHTER CONTRIBUTIONS ARE
C                      INDICATED BY "+D" AFTER THE ATOMIC WEIGHT AND "M"
C                      IF PRESENT.
C
C-----------------------------------------------------------------------
C     NAMLST
C           DESCRIPTION: INPUT PARAMETERS FOR POPULATION DEFINITION
C           USED BY: MAIN,  CASEIN, QAPAGE
C-----------------------------------------------------------------------
C
      COMMON /NAMLST/  IEOQ, IPA, IPOPL, IPL, NSECT, PMA, PPL, NTA,
     .                 NTL, T(20), TL(20), PM1(20), POPT(20), PL1(20)
C
C     IEOQ       - CONTROLS READING & CALCULATION OF ATMOSPHERIC DISPERSION
C     IPA        - CONTROLS DEFINITION OF POPULATION DISPERSION FACTOR FOR
C                  AIR RELEASES
C     IPOPL      - CONTROLS DEFINITION OF POPULATION FOR WATERBORNE RELEASESS
C     IPL        - CONTROLS DEFINITION OF POPULATION FOR ACUTE WATERBORNE
C                  RELEASES
C     NSECT      - NUMBER OF SECTORS CONSIDERED
C     PMA        - POPULATION DISPERSION FACTOR FOR ACUTE WATERBORNE RELEASES
C     PPL        - TOTAL POPULATION FOR ACUTE WATERBORNE RELEASES
C     NTA        - NUMBER OF TIMES FOR WHICH DATA IS SUPPLIED IN ARRAYS PM1,
C                  POPT, AND T
C     T(20)      - TIMES AT WHICH AIRBORNE POPULATION DATA IS SUPPLIED,
C                  YEARS A.D.
C     TL(20)     - TIMES AT WHICH WATERBORNE POPULATION DATA IS SUPPLIED,
C                  YEARS A.D.
C     PM1(20)    - AIRBORNE POPULATION DISPERSION FACTOR
C     POPT(20)   - TOTAL POPULATION (AIRBORNE RELEASE) FOR EACH TIME IN ARRAY T
C     PL1(20)    - TOTAL POPULATION (WATERBORNE RELEASE) FOR EACH TIME IN
C                  ARRAY TL
C     NTL        - NUMBER OF TIMES FOR WHICH POPULATION DATA IS GIVEN IN
C                  ARRAYS PL1 AND TL
C
```

Figure D.1. DITTY Program Listing (continued)

```
C-----------------------------------------------------------------------
C     NUCNAM
C           DESCRIPTION: RADIONUCLIDE NAMES IN MASTER LIST
C           USED BY: ACTIN, AIRLIN, APATHS, BIOLIN, FILLUP, FOOLIN, GRAPH,
C                    GRDLIN, QAPAGE, NUCTST, REPORT, SETNUC, WPATHS
C-----------------------------------------------------------------------
C
      CHARACTER*2 ELTM
      CHARACTER*6 AWM
C
      COMMON /NUCNAM/ NUCS, AWM(100), ELTM(100)
C
C     NUCS          - NO. OF RADIONUCLIDES IN THE MASTER LIST.
C     AWM(100)      - 6 CHARACTER ATOMIC WEIGHT SYMBOL FOR EACH RADIO-
C                     NUCLIDE IN THE MASTER LIST.
C     ELTM(100)     - 2 CHARACTER ELEMENT NAME FOR EACH RADIONUCLIDE
C                     IN THE MASTER LIST.
C
C-----------------------------------------------------------------------
C     OPTION
C           DESCRIPTION: INPUT OPTION PARAMETERS
C           USED BY: CASEIN, QAPAGE, MAIN, CONTRL
C-----------------------------------------------------------------------
C
      COMMON /OPTION/  IPOP, IPATH, IAC, IWAT, IAIR, LUA, LUW, IGRNUC,
     .                 IGRPOP, IGRPM, IGRPL, IGRTNU, ISPEC, IGRDOS
C
C     IPOP           - SELECTS METHOD OF DETERMINING POPULATION DISPERSION
C                      FACTOR.
C     IPATH          - SELECTS PATHWAYS TO BE CONSIDERED.
C     IAC            - SET POSITIVE TO CONSIDER ACUTE RELEASE PERIOD.
C     IWAT           - SET POSITIVE IF WATER BORNE RELEASE ACTIVITY DATA
C                      IS TO BE READ.
C     IAIR           - SET POSITIVE IF AIR BORNE RELEASE ACTIVITY DATA IS
C                      TO BE READ.
C     LUA            - SELECT INPUT LOGICAL FILE UNIT FOR AIR BORNE RELEASE
C                      ACTIVITY.
C     LUW            - SELECT INPUT LOGICAL FILE UNIT FOR WATER BORNE RELEASE
C                      ACTIVITY.
C     IGRDOS         - SET TO 1 FOR GRAPH OF DOSE TO EACH ORGAN.
C     IGRNUC         - SET TO 1 TO GRAPH EACH RELEASE OF RADIONUCLIDE.
C     IGRPOP         - SET TO 1 TO GRAPH POPULATION DISTRIBUTION DATA.
C     IGRPM          - SET TO 1 TO GRAPH POPULATION DISPERSION FACTOR:
C                      AIRBORNE PATHWAYS.
```

Figure D.1. DITTY Program Listing (continued)

```
C     IGRPL          - SET TO 1 TO GRAPH POPULATION DISPERSION FACTOR:
C                      WATERBORNE PATHWAYS.
C     IGRTNU         - SET TO 1 TO GRAPH TOTAL RELEASE OF ALL RADIONUCLIDE
C     ISPEC          - SPECIALTY OPTION,SET TO 1 IF SELECTED
C
C-----------------------------------------------------------------------
C     ORGID
C           DESCRIPTION: NUCDFL LIBRARY DATA
C           USED BY: ORGCHK, AIRLIN, QAPAGE, REPORT, DOSADD
C-----------------------------------------------------------------------
C
      COMMON /ORGID/  LORG, IORG(10), NORG, KORG(5), MORG(23), ORGT(6),
     +                ONAME(10)
C
      CHARACTER*10 ORGT, ONAME
C
C       LORG         - NO. OF ORGANS FOR WHICH DATA IS SUPPLIED IN THE
C                      INHALATION AND INGESTION DOSE FACTOR LIBRARY DSFCT.
C                      1<=LORG<=10.
C       IORG(10)     - ORGAN INDEX VALUES FOR WHICH DATA IS SUPPLIED IN THE
C                      INHALATION & INGESTION DOSE FACTOR LIBRARY DSFCT.
C                      1<=IORG( )<=23.
C       NORG         - NO. OF ORGANS FOR WHICH DOSES ARE TO BE
C                      CALCULATED. 1<=NORG<=5.
C       KORG(5)      - ORGAN INDEX VALUES FOR WHICH DOSES ARE TO BE CALCULATED.
C                      THE INDEX VALUES MUST BE TAKEN FROM VALUES IN INDEX
C                      ARRAY IORG FROM THE INHALATION & INGESTION LIBRARY DSFCT.
C       MORG(23)     - POSITION IN IORG CORRESPONDING TO SELECTED ORGANS.  THIS
C                      ARRAY IS SET IN SUBROUTINE ORGCHK.
C       ORGT(6)      - TEN CHARACTER ORGAN NAMES FOR OUTPUT.
C       ONAME(10)    - TEN CHARACTER ORGAN NAMES FOR DATA IN LIBRARY DSFCT.
C
C-----------------------------------------------------------------
C      OUTORG
C            DESCRIPTION: ARRAY OF ORGAN DOSES AS A FUNCTION OF
C                         TIME, USED BY GRAPHING FOR REPORT
C            USED BY: CONTRL,  DOSADD, REPORT
C-----------------------------------------------------------------
C
      COMMON / OUTORG / DTOTAL (5,144)
C
C      DTOTAL(5,144)   - TOTAL DOSE TO EACH ORGAN AS A FUNCTION
C                        OF TIME
```

Figure D.1. DITTY Program Listing (continued)

```
C-------------------------------------------------------------
C     PATHIN
C           DESCRIPTION: NAMELIST DATA FOR CALCULATION
C           USED BY: MAIN, APATHS, CASEIN, DOSADD, QAPAGE, WPATHS
C-------------------------------------------------------------------
C
      COMMON /PATHIN/ CONSUM(7), USAGE(7), EXTIM, SW, GRWP(7), YELD(7),
     .                MOPYR, RECON, RM, CFLO, RIRR
C
      REAL MOPYR
C
C
C     CONSUM(7)     - CONSUMPTION RATES, KG/YR, FOR TERRESTRIAL PATHS
C     USAGE(7)      - CONSUMPTION OR EXPOSURE RATES FOR AQUATIC PATHS
C     EXTIM         - HOURS/YEAR EXPOSURE TIME TO CONTAMINATED SOIL
C     GRWP(7)       - SHORE WIDTH FACTOR FOR SHORELINE CALCULATIONS
C     YELD(7)       - CROP YIELD, KG/M**2 FOR THE CROPS OR FORAGE ASSO-
C                     CIATED WITH THE SEVEN 'CONSUM' PATHWAYS
C     MOPYR         - THE NO. OF MONTHS PER YEAR IRRIGATION OCCURS
C     RECON         - RECONCENTRATION RATIOS FOR WATER CONC. CALC.
C     RM            - MIXING RATIO FOR WATER CONC. CALCULATION
C     CFLO          - RIVER FLOW RATE, FT**3/SEC
C     RIRR          - IRRIGATION RATE, L/M**2/MONTH
C
C-------------------------------------------------------------------
C     PLOT
C           DESCRIPTION: STORAGE ARRAYS FOR GRAPHING
C           USED BY: SETUP, FILLUP, PRTGRF
C-------------------------------------------------------------------
C
      CHARACTER*1 ARRAY, LABELY, TICKY, TICKX
      CHARACTER*73  LABELX
      CHARACTER*12 LEGEND
C
      COMMON /PLOT/ ARRAY(40,73), LABELY(40), LABELX, TICKY(40),
     .              TICKX(73), LEGEND(40)
C
C     ARRAY(40,73)   - CHARACTER STORAGE ARRAY FOR GRAPH
C     LABELY(40)     - CHARACTER STORAGE ARRAY FOR SELECTED Y-AXIS LABEL
C     LABELX         - CHARACTER X-AXIS LABEL
C     TICKY(40)      - ARRAY OF Y-AXIS TICK MARKS
C     TICKX(73)      - ARRAY OF X-AXIS TICK MARKS
C
C     LEGEND(8)      - CHARACTER ARRAY FOR RADIONUCLIDE NAMES FOR
C                      IGRTNUC OPTION
```

Figure D.1. DITTY Program Listing (continued)

```
C-------------------------------------------------------------------
C     POPU
C           DESCRIPTION: SPATIAL POPULATION DATA
C           USED BY: CASEIN, PMEQ
C-------------------------------------------------------------------
C
      COMMON /POPU/  POP(10,16)
C
C       POP(10,16)    - POPULATION WITHIN EACH SPATIAL INTERVAL FOR 10
C                       DISTANCES AND 16 DIRECTION SECTORS.
C
C-------------------------------------------------------------------
C     RESULT
C           DESCRIPTION: CALCULATED POPULATION DOSES
C           USED BY: DOSADD, REPORT
C-------------------------------------------------------------------
C
      COMMON /DOSES/ POPDOS(5,100), MAXTIM, HIDOSE(5,100)
C
C     POPDOS(5,100) - THE POPULATION WEIGHTED INTEGRATED DOSE TO FIVE
C                     ORGANS FOR 100 RADIONUCLIDES
C     MAXTIM        - DOSE INTEGRAL PERIOD (70-YR PERIOD) DURING WHICH
C                     THE MAXIMUM DOSE RATE OCCURS
C     HIDOSE(5,100) - 70-YEAR DOSE INCREMENT LARGER THAN ANY OTHERS,
C                     ASSOCIATED WITH MAXTIM
C
C-------------------------------------------------------------------
C     SOURCE
C           DESCRIPTION: INPUT PARAMETERS FOR RADIONUCLIDE MASTER LIST
C           USED BY: MAIN, NUCTST, SETNUC
C-------------------------------------------------------------------
C
      COMMON /SOURCE/ NIN, E(100), A(100)
C
     CHARACTER*2 E
     CHARACTER*6 A
C
C
C-------------------------------------------------------------------
C     TIMES
C           DESCRIPTION: REFERENCE TIME PARAMETERS
C           USED BY: MAIN, CASEIN, CONSET, HEADNG, QAPAGE, PRTGRF,REPORT
C-------------------------------------------------------------------
C
      COMMON /TIMES/ TZ, TZR
```

Figure D.1. DITTY Program Listing (continued)

```
C-----------------------------------------------------------------------
C     TITLES
C           DESCRIPTION: LIBRARY TITLES AND CASE TITLE
C           USED BY: MAIN, ACTIN, AIRLIN, BIOLIN, CASEIN, FOOLIN, GRDLIN,
C                    HEADNG, QAPAGE, RLIBIN
C-----------------------------------------------------------------------
C
      CHARACTER*4  RMDTTL, IDFTTL, BIOTTL, FTRTTL, GRDTTL, CASTTL,
     .             PODTTL, WRDTTL, ARDTTL
C
      COMMON /TITLES/ RMDTTL(20), IDFTTL(20), BIOTTL(40), FTRTTL(60),
     .                GRDTTL(20), CASTTL(20), PODTTL(20), WRDTTL(20),
     .                ARDTTL(20)
C
C     RMDTTL(20)     - TITLE OF RMDLIB
C     IDFTTL(20)     - TITLE OF INHALATION/INGESTION D.F. LIBRARY
C     BIOTTL(40)     - TITLE OF BIOACCUMULATION LIBRARY, (ONLY ELEMENTS
C                      1 - 20 ARE TITLE, 21 - 40 ARE UNITS).
C     FTRTTL(60)     - TITLE OF TRANSFER COEFFICIENT LIBRARY, (ONLY
C                      ELEMENTS 1 - 20 ARE TITLE, 21 - 6 ARE UNITS).
C     GRDTTL(20)     - TITLE OF EXTERNAL D.F. LIBRARY FOR GROUND AND
C                      SWIMMING EXPOSURE.
C     CASTTL(20)     - CAST TITLE
C     PODTTL(20)     - TITLE OF POPULATION DISTRIBUTION LIBRARY
C     WRDTTL(20)     - TITLE OF WATERBORNE RELEASE DATA LIBRARY
C     ARDTTL(20)     - TITLE OF AIRBORNE RELEASE DATA LIBRARY
C
C-----------------------------------------------------------------------
C     VARYBL
C           DESCRIPTION: CALCULATED POPULATION AND RELEASE DATA
C           USED BY: MAIN, APATHS, CASEIN, QAPAGE, WPATHS
C-----------------------------------------------------------------------
C
      COMMON /VARYBL/ PM(144), PL(144), ACTA(144,100), ACTW(144,100)
C
C     PM(144)        - POPULATION DISPERSION FACTOR, PERSON-SEC/M**3
C                      FOR AIRBORNE RELEASES FOR EACH TIME PERIOD
C     PL(144)        - TOTAL POPULATION FOR EACH TIME PERIOD, USED IN
C                      WATERBORNE CALCULATIONS
C     ACTA(144,100) - ACTIVITY RTELEASED TO AIR FOR EACH TIME INCREMENT
C                      FOR UP TO 100 RADIONUCLIDES. UNITS ARE TOTAL CURIES
C                      RELEASED IN EACH PERIOD TO AIR
C     ACTW(144,100) - ACTIVITY RELEASED TO WATER FOR EACH TIME INCREMENT
C                      FOR UP TO 100 RADIONUCLIDES. UNITS ARE TOTAL CURIES
C                      RELEASED IN EACH PERIOD TO WATER.
```

Figure D.1. DITTY Program Listing (continued)

RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP

H 3	4.51E+3	1	0	0	11
BE10	5.84E+8	1	0	0	12
C 14	2.091E+6	1	0	0	12
N 13	6.92E-3	1	0	0	12
F 18	7.62E-2	1	0	0	11
NA22	9.50E+2	1	0	0	11
NA24	6.25E-1	1	0	0	11
P 32	1.43E+1	1	0	0	12
P 33	2.44E+1	1	0	0	12
S 35	8.72E+1	1	0	0	12
CL36	1.1E+8	1	0	0	11
K 40	4.67E11	1	0	0	11
AR39	9.83E+4	1	0	0	11
AR41	7.61E-2	1	0	0	11
CA41	5.11E+7	1	0	0	12
CA45	2.77E+1	1	0	0	12
SC46	8.38E+1	1	0	0	13
CR51	2.77E+1	1	0	0	13
MN54	3.12E+2	1	0	0	13
MN56	1.07E-1	1	0	0	13
FE55	9.86E+2	1	0	0	13
FE59	4.46E+1	1	0	0	13
CO57	2.71E+2	1	0	0	13
CO58	7.08E+1	1	0	0	13
CO60	1.92E+3	1	0	0	13
NI59	2.74E+7	1	0	0	13

Figure D-2. RMDLIB Data File

NI63	3.51E+4	1	0	0	13
NI65	1.05E-1	1	0	0	13
CU64	5.29E-1	1	0	0	13
ZN65	2.44E+2	1	0	0	13
SE75	1.2E+2	1	0	0	12
AS76	1.10E+0	1	0	0	12
SE79	2.37E+7	1	0	0	12
BR82	1.47E+0	1	0	0	11
BR83+D	9.96E-2	1	0	0	11
BR84	2.21E-2	1	0	0	11
SR85	6.5E+1	1	0	0	13
KR90	3.74E-4	1	0	0	11
KR91	1.13E-4	1	0	0	11
RB86	1.87E+1	1	0	0	11
RB89+D	1.06E-2	1	0	0	11
SR89+D	5.06E+1	1	0	0	13
SR90+D	1.04E+4	1	0	0	13
SR91+D	3.96E-1	1	0	0	13
SR92+D	1.13E-1	1	0	0	13
Y 91M+D	3.45E-2	1	0	0	13
ZR93+D	5.59E+8	1	0	0	13
ZR95+D	6.40E+1	1	0	0	13
ZR97+D	7.04E-1	1	0	0	13
MO93	3.65E+4	1	0	0	13
NB94	7.30E+6	1	0	0	13
MO99+D	2.75E+0	1	0	0	13

Figure D-2. RMDLIB Data File (continued)

TC101	9.86E-3	1	0	0	13
RU103+D	3.94E+1	1	0	0	13
RU105+D	1.85E-1	1	0	0	13
RU106+D	3.68E+2	1	0	0	13
PD107	2.37E+9	1	0	0	13
CD109	4.4E+2	1	0	0	13
AG110M+D	2.52E+2	1	0	0	13
AG111	7.45E+0	1	0	0	13
IN111	2.8E+0	1	0	0	13
CD113M	4.97E+3	1	0	0	13
SN117M	1.40E+1	1	0	0	13
SN119M	2.50E+2	1	0	0	13
SN121M	2.78E+4	1	0	0	13
SN123	1.29E+2	1	0	0	13
SN125+D	9.64E+0	1	0	0	13
SN126+D	3.65E+7	1	0	0	13
SB124	6.02E+1	1	0	0	13
SB125+D	1.01E+3	1	0	0	13
TE123M	1.17E+2	1	0	0	13
TE127M+D	1.09E+2	1	0	0	13
TE129M+D	3.36E+1	1	0	0	13
TE131M+D	1.25E+0	1	0	0	13
TE131+D	1.74E-2	1	0	0	13
TE132+D	3.26E+0	1	0	0	13
TE133M+D	3.85E-2	1	0	0	13
I 125+D	5.97E+1	1	0	0	12

Figure D-2. RMDLIB Data File (continued)

I 130	5.15E-1	1	0	0	12
I 131+D	8.04E+0	1	0	0	12
I 135+D	2.75E-1	1	0	0	12
CS136	1.31E+1	1	0	0	11
CS137+D	1.10E+4	1	0	0	11
CS139+D	6.53E-3	1	0	0	11
BA140+D	1.28E+1	1	0	0	13
CE143+D	1.38E+0	1	0	0	23
CE144+D	2.84E+2	1	0	0	23
PM148M+D	4.13E+1	1	0	0	23
PM149	2.21E+0	1	0	0	23
SM153	1.95E+0	1	0	0	23
EU152	4.97E+3	1	0	0	23
EU153	1.94E+0	1	0	0	23
EU154	3.14E+3	1	0	0	23
EU155	1.81E+3	1	0	0	23
EU156	1.52E+1	1	0	0	23
GD153	2.42E+2	1	0	0	23
TB160	7.23E+1	1	0	0	23
HO166M	4.38E+5	1	0	0	23
W 181	1.40E+2	1	0	0	23
W 185	7.51E+1	1	0	0	23
OS185	9.40E+1	1	0	0	23
OS191	1.5E+1	1	0	0	23
IR192	7.3E+1	1	0	0	23
HG203	4.66E+1	1	0	0	23
PB210+D	8.14E+3	1	0	0	23

Figure D-2. RMDLIB Data File (continued)

BI210+D	5.01E+0	1	0	0	23
RN222+D	3.82E+0	1	0	0	11
RA223+D	1.14E+1	1	0	0	23
RA224+D	3.66E+0	1	0	0	23
RA225+D	1.48E+1	1	0	0	23
RA226+D	5.84E+5	1	0	0	23
RA228+D	2.10E+3	1	0	0	23
AC227+D	7.95E+3	1	0	0	23
TH227+D	1.87E+1	1	0	0	23
TH228+D	6.99E+2	1	0	0	23
TH230+D	2.81E+7	1	0	0	23
TH232+D	5.13E12	1	0	0	23
PA231+D	1.19E+7	1	0	0	23
U 232+D	2.62E+4	1	0	0	23
U 233+D	5.79E+7	1	0	0	23
U 234	8.91E+7	1	0	0	23
U 235+D	2.59E11	1	0	0	23
U 236	8.55E+9	1	0	0	23
U 238+D	1.65E12	1	0	0	23
NP237+D	7.82E+8	1	0	0	23
PU236	1.04E+3	1	0	0	23
PU237	4.56E+1	1	0	0	23
PU241+D	5.26E+3	1	0	0	23
CM246	1.73E+6	1	0	0	23

Figure D-2. RMDLIB Data File (continued)

CM247+D	5.70E+9	1	0		0		23
CM248	1.24E+8	1	0		0		23
CF252	9.64E+2	1	0		0		23
ZN69M	5.73E-1	1	0		0		13
ZN69	3.96E-2	2	1	1.0	0		13
BR83	9.96E-2	1	0		0		11
KR83M	7.62E-2	2	1	1.0	0		11
BR85	1.99E-3	1	0		0		11
KR85M	1.87E-1	2	1	1.0	0		11
KR85	3.92E+3	3	2	0.211	0		11
KR87	5.30E-2	1	0		0		11
RB87	1.72E13	2	1	1.0	0		11
KR88	1.18E-1	1	0		0		11
RB88	1.24E-2	2	1	1.0	0		11
KR89	2.20E-3	1	0		0		11
RB89	1.06E-2	2	1	1.0	0		11
SR89	5.06E+1	3	2	1.0	0		13
Y 89M	1.86E-4	4	3	0.0002	0		13
SR90	1.04E+4	1	0		0		13
Y 90	2.67E+0	2	1	1.0	0		13
SR91	3.96E-1	1	0		0		13
Y 91M	3.45E-2	2	1	0.58	0		13
Y 91	5.85E+1	3	2	1.0	1	0.42	13
SR92	1.13E-1	1	0		0		13
Y 92	1.48E-1	2	1	1.0	0		13

Figure D-2. RMDLIB Data File (continued)

Y 93	4.21E-1	1 0		0		13
ZR93	5.59E+8	2 1	1.0	0		13
NB93M	4.97E+3	3 2	0.25	0		13
ZR95	6.40E+1	1 0		0		13
NB95M	3.61E+0	2 1	0.007	0		13
NB95	3.52E+1	3 2	1.0	1	0.993	13
ZR97	7.04E-1	1 0		0		13
NB97M	6.94E-4	2 1	0.946			13
NB97	5.01E-2	3 2	1.0	1	0.054	13
MO99	2.75E+0	1 0		0		13
TC99M	2.51E-1	2 1	0.868	0		13
TC99	7.78E+7	3 2	1.0	1	0.132	13
RU103	3.94E+1	1 0		0		13
PD103	1.70E+1	2 0		0		13
RH103M	3.90E-2	3 1	.9974	2	.9997	13
RU105	1.85E-1	1 0		0		13
RH105M	5.21E-4	2 1	0.28	0		13
RH105	1.47E+0	3 2	1.0	1	0.72	13
RU106	3.68E+2	1 0		0		13
RH106	3.46E-4	2 1	1.0	0		13
PD109M	5.43E-5	1 0		0		13
PD109	5.61E-1	2 1	1.0	0		13
AG109M	4.58E-4	3 2	1.0	0		13
AG110M	2.52E+2	1 0		0		13

Figure D-2. RMDLIB Data File (continued)

AG110	2.85E-4	2	1	0.0113	0			13
IN114M	5.00E+1	1	0		0			13
IN114	8.33E-4	2	1	1.0	0			13
CD115M	4.46E+0	1	0		0			13
CD115	2.23E+0	2	0		0			13
IN115M	1.88E-1	3	2	1.0	0			13
IN115	2.19E17	4	3	0.963	1	1.0		13
SN125	9.64E+0	1	0		0			13
SB125	1.01E+3	2	1	1.0	0			13
TE125M	5.80E+1	3	2	0.23	0			13
SN126	3.65E+7	1	0		0			13
SB126M	1.32E-2	2	1	1.0	0			13
SB126	3.75E-1	3	2	0.14	0			13
SB127	3.85E+0	1	0		0			13
TE127M	1.09E+2	2	1	0.139	0			13
TE127	3.90E-1	3	2	0.976	1	0.861		13
TE129M	3.36E+1	1	0		0			13
TE129	4.83E-2	2	1	1.0	0			13
I 129	5.73E+9	3	2	1.0	0			12
TE131M	1.25E+0	1	0		0			13
TE131	1.74E-2	2	1	0.222	0			13
I 131	8.04E+0	3	2	1.0	1	0.778		12
XE131M	1.19E+1	4	3	0.0109	0			11
TE132	3.26E+0	1	0		0			13
I 132	9.58E-2	2	1	1.0	0			12

Figure D-2. RMDLIB Data File (continued)

TE133M	3.85E-2	1	0		0		13
TE133	8.64E-3	2	1	0.13	0		13
I 133	8.67E-1	3	2	1.0	1	0.87	12
XE133M	2.19E+0	4	3	0.029	0		11
XE133	5.24E+0	5	4	1.0	3	0.971	11
TE134	2.90E-2	1	0		0		13
I 134	3.65E-2	2	1	1.0	0		12
CS134M	1.21E-1	1	0		0		11
CS134	7.53E+2	2	1	1.0	0		11
I 135	2.75E-1	1	0		0		12
XE135M	1.09E-2	2	1	0.166	0		11
XE135	3.78E-1	3	2	1.0	1	0.834	11
CS135	8.40E+8	4	3	1.0	0		11
XE137	2.66E-3	1	0		0		11
CS137	1.10E+4	2	1	1.0	0		11
BA137M	1.77E-3	3	2	0.946	0		13
XE138	9.84E-3	1	0		0		11
CS138	2.24E-2	2	1	1.0	0		11
XE139	4.98E-4	1	0		0		11
CS139	6.53E-3	2	1	1.0	0		11
BA139	5.74E-2	3	2	1.0	0		13
XE140	1.85E-4	1	0		0		11
CS140	7.64E-4	2	1	1.0	0		11
BA140	1.28E+1	3	2	1.0	0		13

Figure D-2. RMDLIB Data File (continued)

LA140	1.68E+0	4	3	1.0	0	23
BA141	1.27E-2	1	0		0	13
LA141	1.64E-1	2	1	1.0	0	23
CE141	3.25E+1	3	2	1.0	0	23
BA142	7.43E-3	1	0		0	13
LA142	6.44E-2	2	1	1.0	0	23
CE143	1.38E+0	1	0		0	23
PR143	1.36E+1	2	1	1.0	0	23
CE144	2.84E+2	1	0		0	23
PR144	1.20E-2	2	1	1.0	0	23
ND144	8.77E17	3	2	1.0	0	23
ND147	1.11E+1	1	0		0	23
PM147	9.58E+2	2	1	1.0	0	23
SM147	3.91E13	3	2	1.0	0	23
PM148M	4.13E+1	1	0		0	23
PM148	5.37E+0	2	1	1.0	0	23
PM151	1.18E+0	1	0		0	23
SM151	3.29E+4	2	1	1.0	0	23
W 187	9.95E-1	1	0		0	23
RE187	1.83E13	2	1	1.0	0	23
TH230	2.81E+7	1	0		0	23
RA226	5.84E+5	2	1	1.0	0	23
RN222	3.82E+0	3	2	1.0		11
PB210	8.14E+3	4	3	1.0	0	23
BI210	5.01E+0	5	4	1.0	0	23

Figure D-2. RMDLIB Data File (continued)

PO210	1.38E+2	6	5	1.0	0	23
U 232	2.62E+4	1	0		0	23
TH232	4.16E13	2	0		0	23
RA228	2.10E+3	3	2	1.0	0	23
AC228	2.55E-1	4	3	1.0	0	23
TH228	6.99E+2	5	4	1.0	1 1.0	23
RA224	3.66E+0	6	5	1.0	0	23
PB212	4.43E-1	7	6	1.0	0	23
BI212	4.20E-2	8	7	1.0	0	23
U 235	2.59E11	1	0		0	23
TH231	1.06E+0	2	1	1.0	0	23
PA231	1.19E+7	3	2	1.0	0	23
AC227	7.95E+3	4	3	1.0	0	23
TH227	1.87E+1	5	4	0.9862	0	23
FR223	1.51E-2	6	4	0.0138	0	23
RA223	1.14E+1	7	5	1.0	6 1.0	23
U 237	6.75E+0	1	0		0	23
NP237	7.82E+8	2	1	1.0	0	23
PA233	2.70E+1	3	2	1.0	0	23
U 233	5.79E+7	4	3	1.0	0	23
TH229	2.68E+6	5	4	1.0	0	23
RA225	1.48E+1	6	5	1.0	0	23
AC225	1.00E+1	7	6	1.0	0	23
U 238	1.65E12	1	0	0.0	0	23

Figure D-2. RMDLIB Data File (continued)

TH234	2.41E+1	2	1	1.0	0		23
PA234M	8.13E-4	3	2	1.0	0		23
PA234	2.81E-1	4	3	0.0013	0		23
AM242M	5.55E+4	1	0		0		23
AM242	6.68E-1	2	1	1.0	0		23
CM242	1.63E+2	3	2	0.827	0		23
PU242	1.41E+8	4	2	0.173	0		23
NP238	2.18E+0	5	0		0		23
PU238	3.21E+4	6	5	1.0	3	1.0	23
CM244	6.61E+3	1	0		0		23
PU244	3.02E10	2	0		0		23
U 240	5.88E-1	3	2	0.999	0		23
PU240	2.39E+6	4	3	1.0	1	1.0	23
CM247	5.70E+9	1	0		0		23
CM243	1.04E+4	2	0		0		23
PU243	2.06E-1	3	1	1.0	0		23
AM243	2.70E+6	4	3	1.0	2	0.0024	23
NP239	2.36E+0	5	4	1.0	0		23
PU239	8.91E+6	6	5	1.0	2	0.9976	23
CM245	3.10E+6	1	0		0		23
PU241	5.26E+3	2	1	1.0	0		23
AM241	1.58E+5	3	2	1.0	0		23
		0					

Figure D-2. RMDLIB Data File (continued)

*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***

ELT	DEP. VEL.	PLANT	EGG	MILK	BEEF	PORK	POULTRY	
	M/SEC	--	DAY/KG	DAY/L	DAY/KG	DAY/KG	DAY/KG	
H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0E-01
BE	1.0-03	4.7-04	2.0-02	2.0-06	8.0-04	1.0-02	4.0-01	5.0E-03
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0E-01
N	1.0-03	7.5+00	9.9-04	1.1-02	9.9-04	9.9-04	9.9-04	
F	1.0-02	2.0-02	9.9-04	7.0-03	2.0-02	9.0-02	9.9-04	
NA	1.0-03	5.0-02	2.0-01	4.0-02	5.0-02	1.0-01	1.0-02	
P	1.0-03	5.0+01	1.0+01	1.2-02	5.0-02	5.4-01	1.9-01	
AR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CA	1.0-03	4.0-02	1.0+00	8.0-03	3.3-03	3.3-03	3.3-03	1.7E-02
SC	1.0-03	1.1-03	9.9-04	2.5-06	6.0-03	1.0-02	4.0-03	
CR	1.0-03	2.5-04	9.9-04	1.1-03	9.9-04	9.9-04	9.9-04	
MN	1.0-03	3.0-02	1.0-01	1.0-04	5.0-03	2.0-02	1.1-01	
FE	1.0-03	4.0-04	1.0-01	6.0-04	2.0-02	5.0-03	1.0-03	
CO	1.0-03	9.4-03	1.0-01	5.0-04	1.0-03	5.0-03	1.0-03	2.3E-04
NI	1.0-03	1.9-02	1.0-01	3.4-03	1.0-03	5.0-03	1.0-03	2.3E-03
CU	1.0-03	1.3-01	2.0-01	7.0-03	1.0-02	1.5-02	2.0-03	
ZN	1.0-03	4.0-01	4.0-03	6.0-03	5.0-02	1.4-01	2.0-03	
AS	1.0-03	1.0-02	9.9-04	3.0-03	1.47-3	2.38-2	8.33-1	
SE	1.0-03	1.3+00	2.1+00	2.3-02	1.0+00	4.5-01	3.7-01	2.2E-02
BR	1.0-02	7.6-01	1.6+00	2.5-02	2.0-02	9.0-02	4.0-03	
KR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RB	1.0-03	1.3-01	3.0+00	1.0-02	1.5-01	2.0-01	2.0+00	
SR	1.0-03	2.0-01	4.0-01	1.5-03	3.0-04	7.3-03	9.0-04	4.5E-03
Y	1.0-03	2.5-03	5.0-04	5.0-06	5.0-03	5.0-03	5.0-04	
ZR	1.0-03	1.7-04	1.2-03	2.5-06	5.0-04	1.0-03	1.0-04	1.1E-04
NB	1.0-03	9.4-03	1.2-03	1.2-03	5.0-04	1.0-03	1.0-04	
MO	1.0-03	1.3-01	4.0-01	4.0-03	1.0-02	2.0-02	2.0-03	
TC	1.0-03	1.0	9.9-04	1.2-02	9.9-04	9.9-04	9.9-04	8.0E-01
RU	1.0-03	1.0-02	4.0-03	5.0-07	1.0-03	5.0-03	3.0-04	2.2E-02
RH	1.0-03	1.3+01	4.0-03	5.0-03	1.0-03	5.0-03	3.0-04	2.2E-02
PD	1.0-03	5.0+00	4.0-03	5.0-03	1.0-03	5.0-03	3.0-04	4.5E-03
AG	1.0-03	1.5-01	9.9-04	2.5-02	9.9-04	9.9-04	9.9-04	
CD	1.0-03	3.0-01	9.9-04	6.2-05	1.6-02	1.6-02	1.6-02	7.6E-04
SN	1.0-03	2.5-03	9.9-04	1.3-03	9.9-04	9.9-04	9.9-04	4.5E-03
SB	1.0-03	1.1-02	7.0-02	7.5-04	3.0-03	7.0-03	6.0-03	7.0E-02
TE	1.0-03	1.3+00	4.0-01	5.0-04	5.0-02	1.0-02	1.0-02	
I	1.0-02	2.0-02	1.6+00	1.0-02	2.0-02	9.0-02	4.0-03	7.0E-02
XE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CS	1.0-03	2.0-03	6.0-01	5.0-03	3.0-02	2.6-01	4.5+00	1.1E-04
BA	1.0-03	5.0-03	4.0-01	4.0-04	5.0-04	1.0-02	5.0-04	
LA	1.0-03	2.5-03	2.0-03	2.5-06	5.0-03	5.0-03	4.0-03	
CE	1.0-03	5.0-04	3.0-03	1.0-05	1.0-03	5.0-03	6.0-04	4.6E-04
PR	1.0-03	2.5-03	4.0-03	2.5-06	5.0-03	5.0-03	1.0-03	4.6E-04
ND	1.0-03	2.4-03	2.0-04	2.5-06	5.0-03	5.0-03	4.0-03	4.6E-04
PM	1.0-03	2.5-03	7.0-03	2.5-06	5.0-03	5.0-03	1.0-04	4.6E-04

Figure D-3. FTRANSLIB Data File

SM	1.0-03	2.5-03	7.0-03	2.5-06	5.0-03	5.0-03	4.0-03	4.6E-04
EU	1.0-03	2.5-03	7.0-03	2.5-06	5.0-03	5.0-03	4.0-03	4.6E-04
TB	1.0-03	2.6-03	7.0-03	2.5-06	5.0-03	5.0-03	4.0-03	4.6E-04
HO	1.0-03	2.6-03	7.0-03	2.5-06	5.0-03	5.0-03	4.0-03	7.6E-04
W	1.0-03	1.8-02	9.9-04	2.5-04	9.9-04	9.9-04	9.9-04	
IR	1.0-03	9.9-04	9.9-04	9.9-04	9.9-04	9.9-04	9.9-04	
HG	1.0-03	3.8-01	9.9-04	1.9-02	1.0-01	3.1+00	1.1-02	
PB	1.0-03	6.8-02	9.9-04	1.0-05	9.9-04	9.9-04	9.9-04	1.1E-04
BI	1.0-03	1.5-01	9.9-04	2.5-04	9.9-04	9.9-04	9.9-04	
PO	1.0-03	9.0-03	9.9-04	1.2-04	9.9-04	9.9-04	9.9-04	
RN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RA	1.0-03	1.4-03	2.0-05	2.0-04	9.9-04	9.9-04	9.9-04	2.3E-03
AC	1.0-03	2.5-03	2.0-03	2.5-06	5.0-03	1.0-02	4.0-03	
TH	1.0-03	4.2-03	2.0-03	2.5-06	5.0-03	1.0-02	4.0-03	2.3E-04
PA	1.0-03	2.5-03	2.0-03	2.5-06	5.0-03	1.0-02	4.0-03	4.6E-04
U	1.0-03	2.5-03	3.4-01	6.0-04	5.0-03	6.0-04	1.2-03	9.0E-03
NP	1.0-03	2.5-03	2.0-03	2.5-06	5.0-03	1.0-02	4.0-03	2.2E-02
PU	1.0-03	2.5-04	2.0-03	2.5-08	5.0-03	1.0-02	4.0-03	2.3E-04
AM	1.0-03	2.5-04	2.0-03	2.5-06	5.0-03	1.0-02	4.0-03	2.3E-04
CM	1.0-03	2.5-03	2.0-03	2.5-06	5.0-03	1.0-02	4.0-03	2.3E-04
CF	1.0-03	2.5-03	2.0-03	7.5-07	5.0-03	1.0-02	4.0-03	

Figure D-3. FTRANSLIB Data File (continued)

BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)

	FISH	CRUS.	MOLL.	ALGAE	FISH	CRUS.	MOLL.	ALGAE	FACTORS
H	1.0	1.0	1.0	1.0	.9	.9	.9	.9	1.0
BE	1000.0	10000.0	10000.0	10000.0	2.0	10.0	10.0	20.0	.2
C	1.0	1.0	1.0	1.0	4600.0	9100.0	9100.0	4600.0	1.0
N	.0	.0	.0	.0	.0	.0	.0	.0	1.0
F	4.0	4.0	4.0	1.0	10.0	100.0	100.0	2.0	.8
NA	1.0	1.0	1.0	1.0	100.0	200.0	200.0	500.0	.9
P	10000.0	10000.0	10000.0	100000.0	100000.0	20000.0	20000.0	500000.0	.4
AR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.0
CA	10.0	10.0	10.0	1.0	40.0	330.0	330.0	130.0	.2
SC	100.0	300.0	300.0	1000.0	2.0	1000.0	1000.0	10000.0	.3
CR	100.0	1000.0	1000.0	1000.0	20.0	2000.0	2000.0	4000.0	.9
MN	3000.0	10000.0	50000.0	10000.0	400.0	90000.0	90000.0	10000.0	.5
FE	1000.0	4000.0	20000.0	6000.0	100.0	3200.0	3200.0	1000.0	.2
CO	100.0	10000.0	300.0	100.0	50.0	200.0	200.0	200.0	.2
NI	500.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	.2
CU	1000.0	5000.0	5000.0	1000.0	50.0	400.0	400.0	2000.0	.6
ZN	5000.0	5000.0	50000.0	1000.0	2000.0	10000.0	10000.0	20000.0	.4
AS	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	.7
SE	10.0	10.0	10.0	100.0	170.0	170.0	170.0	1000.0	.8
BR	3.0	10.0	10.0	100.0	420.0	330.0	330.0	50.0	.8
KR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.0
RB	30.0	50.0	10.0	10.0	2000.0	1000.0	1000.0	1000.0	.9
SR	1.0	1.0	1.0	20.0	30.0	100.0	100.0	500.0	.2
Y	30.0	100.0	100.0	300.0	25.0	1000.0	1000.0	5000.0	.2
ZR	30.0	100.0	100.0	1000.0	3.3	6.7	6.7	1000.0	.7
NB	100.0	200.0	200.0	100.0	30000.0	100.0	100.0	800.0	.7
MO	10.0	100.0	100.0	100.0	10.0	10.0	10.0	1000.0	.9
TC	10.0	100.0	100.0	1000.0	15.0	5.0	5.0	40.0	.7
RU	3.0	100.0	100.0	1000.0	10.0	300.0	300.0	2000.0	.5
RH	10.0	100.0	100.0	100.0	10.0	300.0	300.0	200.0	.5
PD	10.0	100.0	100.0	100.0	10.0	300.0	300.0	200.0	.5
AG	1000.0	5000.0	5000.0	1000.0	2.3	770.0	770.0	200.0	.7
CD	100.0	3000.0	10000.0	10000.0	200.0	2000.0	2000.0	1000.0	.6
SN	3.0	3.0	3.0	10.0	3000.0	1000.0	1000.0	100.0	.7
SB	1000.0	1000.0	1000.0	10000.0	1.0	10.0	10.0	1500.0	.8
TE	10.0	10.0	100.0	1000.0	400.0	75.0	75.0	100.0	.8
I	20.0	100.0	100.0	10000.0	15.0	5.0	5.0	40.0	.8
XE	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.0
CS	30.0	50.0	10.0	10.0	2000.0	100.0	100.0	500.0	.9
BA	3.0	3.0	3.0	100.0	4.0	200.0	200.0	500.0	.4
LA	30.0	100.0	100.0	300.0	25.0	1000.0	1000.0	5000.0	.2
CE	30.0	100.0	100.0	300.0	1.0	1000.0	1000.0	4000.0	.2
PR	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2
ND	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2
PM	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2
SM	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2

Figure D-4. BIOAC Data File

*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***

H 3	.0E+00	.0E+00	.0E+00	.0E+00	.0E+00	.0E+00
BE10	.0E+00	.0E+00	2.9E-07	.0E+00	2.0E+00	3.0E+00
C 14	.0E+00	.0E+00	3.8E-09	.0E+00	1.4E-11	3.5E-09
N 13	8.8E-09	7.6E-09	2.6E-06	1.9E-06	8.5E-07	1.4E-06
F 18	8.0E-09	6.8E-09	2.3E-06	1.8E-06	8.2E-07	1.1E-06
NA22	1.8E-08	1.6E-08	4.8E-06	4.0E-06	1.8E-06	2.3E-06
NA24	2.9E-08	2.5E-08	9.3E-06	7.8E-06	3.5E-06	4.5E-06
P 32	.0E+00	.0E+00	6.8E-07	6.4E-09	3.0E-09	6.2E-07
P 33	.0E+00	.0E+00	2.2E-08	9.9E-11	4.3E-11	2.0E-08
AR39	.0E+00	.0E+00	1.3E-07	6.2E-10	3.3E-10	1.2E-07
AR41	.0E+00	.0E+00	3.2E-06	2.4E-06	1.1E-06	1.6E-06
CA41	4.0E-09	3.4E-09	8.5E-07	7.3E-07	2.0E+00	3.0E+00
SC46	1.5E-08	1.3E-08	4.3E-06	3.7E-06	1.7E-06	2.0E-06
CR51	2.6E-10	2.2E-10	6.4E-08	5.2E-08	2.4E-08	2.9E-08
MN54	6.8E-09	5.8E-09	1.8E-06	1.5E-06	7.0E-07	8.1E-07
MN56	1.3E-08	1.1E-08	4.6E-06	3.2E-06	1.5E-06	2.4E-06
FE55	.0E+00	.0E+00	3.6E-10	6.4E-11	3.5E-11	1.6E-09
FE59	9.4E-09	8.0E-09	2.6E-06	2.2E-06	1.0E-06	1.2E-06
CO57	1.0E-09	9.1E-10	2.7E-07	2.2E-07	1.0E-07	1.2E-07
CO58	8.2E-09	7.0E-09	2.3E-06	1.8E-06	8.2E-07	1.1E-06
CO60	2.0E-08	1.7E-08	5.4E-06	4.6E-06	2.0E-06	2.5E-06
NI59	.0E+00	.0E+00	3.4E-09	2.3E-09	2.0E+00	3.0E+00
NI63	.0E+00	.0E+00	.0E+00	.0E+00	.0E+00	.0E+00
NI65	4.3E-09	3.7E-09	1.9E-06	1.0E-06	4.8E-07	1.1E-06
CU64	1.7E-09	1.5E-09	5.2E-07	3.7E-07	1.7E-07	2.8E-07
ZN65	4.6E-09	4.0E-09	1.2E-06	1.1E-06	4.9E-07	5.6E-07
SE79	.0E+00	.0E+00	3.2E-09	3.4E-11	2.8E-06	3.3E-05
BR82	2.2E-08	1.9E-08	6.3E-06	5.3E-06	2.4E-06	2.9E-06
BR83+D	9.3E-11	6.4E-11	3.1E-07	1.7E-08	7.5E-09	2.7E-07
BR84	1.4E-08	1.2E-08	5.3E-06	3.5E-06	1.6E-06	3.0E-06
RB86	7.2E-10	6.3E-10	8.5E-07	1.7E-07	8.0E-08	6.8E-07
RB89+D	1.8E-08	1.5E-08	5.8E-06	4.5E-06	2.1E-06	2.8E-06
SR89+D	6.5E-13	5.6E-13	5.4E-07	4.6E-09	2.1E-09	4.9E-07
SR90+D	.0E+00	.0E+00	1.5E-07	5.4E-10	2.4E-10	1.3E-07
SR91+D	8.3E-09	7.1E-09	2.9E-06	1.9E-06	8.9E-07	1.6E-06
SR92+D	1.0E-08	9.0E-09	3.1E-06	2.6E-06	1.1E-06	1.3E-06
Y 91M+D	4.4E-09	3.8E-09	1.2E-06	1.0E-06	4.6E-07	5.6E-07
ZR93+D	.0E+00	.0E+00	.0E+00	.0E+00	1.3E-06	1.6E-05
ZR95+D	5.8E-09	5.0E-09	1.8E-06	1.5E-06	6.8E-07	8.4E-07
ZR97+D	6.4E-09	5.5E-09	2.4E-06	1.5E-06	6.9E-07	1.4E-06
MO93	9.3E-10	2.3E-11	2.9E-08	1.2E-09	2.0E+00	3.0E+00
MO99+D	2.2E-09	1.9E-09	9.1E-07	4.7E-07	2.2E-07	5.8E-07
TC101	3.0E-09	2.7E-09	1.2E-06	6.8E-07	3.6E-07	7.6E-07
RU103+D	4.2E-09	3.6E-09	1.1E-06	8.9E-07	4.1E-07	4.9E-07
RU105+D	5.1E-09	4.5E-09	1.8E-06	1.2E-06	5.4E-07	1.0E-06
RU106+D	1.8E-09	1.5E-09	1.9E-06	3.8E-07	1.7E-07	1.5E-06
PD107	.0E+00	.0E+00	.0E+00	.0E+00	5.9E-07	6.9E-06
AG110M+D	2.1E-08	1.8E-08	5.3E-06	4.9E-06	2.2E-06	2.4E-06

Figure D-5. GRDFLIB Data File

AG111	2.1E-10	1.8E-10	3.8E-07	4.8E-08	2.2E-08	3.2E-07
CD113M	2.6E-12	2.3E-12	1.4E-07	5.9E-10	1.2E-05	1.4E-04
SN123	6.5E-08	.0E+00	5.0E-07	.0E+00	2.0E+00	3.0E+00
SN125+D	6.6E-10	5.7E-10	1.1E-06	1.6E-07	7.3E-08	9.1E-07
SN126+D	1.0E-08	9.0E-09	6.0E-08	1.8E-08	1.3E-05	8.6E-04
SB124	1.5E-08	1.3E-08	4.5E-06	3.6E-06	1.6E-06	2.2E-06
SB125+D	3.5E-09	3.1E-09	9.5E-07	7.8E-07	3.6E-07	4.5E-07
TE127M+D	1.3E-12	1.1E-12	1.8E-09	2.6E-10	1.2E-10	1.6E-09
TE129M+D	9.0E-10	7.7E-10	7.4E-07	2.1E-07	9.4E-08	5.7E-07
TE131M+D	9.9E-09	8.4E-09	2.7E-06	2.2E-06	1.0E-06	1.3E-06
TE131+D	2.6E-06	2.2E-09	1.6E-06	7.4E-07	3.4E-07	1.1E-06
TE132+D	2.0E-09	1.7E-09	4.8E-07	4.0E-07	1.8E-07	2.3E-07
TE133M+D	1.7E-08	1.5E-08	5.0E-06	3.9E-06	1.8E-06	2.4E-06
I 130	1.7E-08	1.4E-08	4.8E-06	3.9E-06	1.8E-06	2.3E-06
I 131+D	3.4E-09	2.8E-09	9.3E-07	7.8E-07	3.1E-07	4.9E-07
I 135+D	1.4E-08	1.2E-08	4.0E-06	3.3E-06	1.5E-06	2.0E-06
CS136	1.7E-08	1.5E-08	4.8E-06	4.1E-06	1.9E-06	2.2E-06
CS137+D	4.9E-09	4.2E-09	1.4E-06	1.0E-06	4.7E-07	7.0E-07
CS139+D	7.2E-09	6.3E-09	3.2E-06	1.7E-06	8.0E-07	2.1E-06
BA140+D	2.4E-09	2.1E-09	7.6E-07	4.9E-07	2.2E-07	4.4E-07
CE143+D	2.5E-09	2.2E-09	1.0E-06	5.7E-07	2.6E-07	6.3E-07
CE144+D	3.7E-10	3.2E-10	1.4E-06	8.6E-08	4.0E-08	1.2E-06
PM148M+D	8.2E-08	1.4E-08	4.5E-06	3.7E-06	2.0E+00	3.0E+00
PM149	2.9E-11	2.5E-11	3.5E-07	1.5E-08	6.9E-09	3.1E-07
SM153	3.0E-10	2.7E-10	2.5E-07	6.5E-08	3.0E-08	2.0E-07
EU152	8.5E-09	7.4E-09	2.1E-06	1.8E-06	1.3E-05	2.5E-04
EU154	9.0E-09	7.8E-09	2.7E-06	2.1E-06	4.6E-05	6.6E-04
EU155	4.3E-10	3.8E-10	1.1E-07	9.0E-08	5.0E-06	6.6E-05
EU156	8.7E-09	7.6E-09	2.8E-06	2.1E-06	9.8E-07	1.5E-06
TB160	1.0E-08	8.6E-09	2.8E-06	2.4E-06	2.0E+00	3.0E+00
HO166M	1.0E-08	8.9E-09	2.8E-06	2.4E-06	2.0E+00	3.0E+00
W 181	2.8E-12	2.1E-12	6.8E-10	5.3E-10	2.5E-10	3.2E-10
W 185	.0E+00	.0E+00	7.9E-08	3.2E-10	1.4E-10	7.2E-08
PB210+D	1.7E-11	1.3E-11	3.6E-07	3.0E-09	2.7E-09	3.4E-07
BI210+D	.0E+00	.0E+00	3.5E-07	2.7E-09	1.3E-09	3.3E-07
RN222+D	1.5E-08	1.3E-08	5.0E-06	3.2E-06	1.5E-06	2.9E-06
RA223+D	1.8E-09	1.5E-09	1.3E-06	4.0E-07	2.0E+00	3.0E+00
RA224+D	1.0E-08	8.9E-09	3.5E-06	2.6E-06	2.0E+00	3.0E+00
RA225+D	1.2E-10	8.4E-11	6.3E-08	1.9E-08	2.0E+00	3.0E+00
RA226+D	1.5E-08	1.3E-08	5.0E-06	3.3E-06	1.5E-06	2.9E-06
RA228+D	1.4E-08	1.2E-08	4.8E-06	3.4E-06	2.0E+00	3.0E+00
AC227+D	2.4E-09	2.0E-09	6.3E-07	4.4E-07	2.0E+00	3.0E+00
TH227+D	6.3E-10	5.1E-10	1.6E-07	1.3E-07	2.0E+00	3.0E+00
TH228+D	1.0E-08	8.9E-09	3.5E-06	2.6E-06	2.0E+00	3.0E+00
TH230+D	1.0E-10	7.8E-12	4.4E-09	1.2E-09	5.5E-10	1.9E-09
TH232+D	4.0E-09	3.0E-09	4.8E-06	3.4E-06	2.0E+00	3.0E+00
PA231+D	2.7E-09	2.2E-09	7.0E-07	5.0E-07	2.0E+00	3.0E+00
U 232+D	2.7E-11	2.6E-12	1.1E-09	4.6E-10	2.0E-10	4.8E-10
U 233+D	7.5E-11	5.7E-12	2.9E-09	1.0E-09	4.7E-10	1.3E-09

Figure D-5. GRDFLIB Data File (continued)

U 234	5.1E-10	7.3E-12	1.2E-08	1.2E-09	5.2E-10	5.3E-09
U 235+D	2.1E-09	1.3E-09	3.8E-07	3.0E-07	1.4E-07	1.9E-07
U 236	1.3E-10	2.1E-13	3.1E-09	3.0E-12	1.2E-12	1.3E-09
U 238+D	6.3E-10	3.5E-10	9.3E-07	7.4E-08	3.4E-08	8.1E-07
NP237+D	1.6E-09	1.4E-09	4.5E-07	3.6E-07	1.4E-07	2.1E-07
PU241+D	6.8E-12	4.6E-12	9.5E-11	6.1E-11	2.8E-11	4.2E-11
CM246	1.5E-11	1.0E-12	3.3E-09	1.1E-10	3.6E-05	4.0E-02
CM247+D	2.6E-09	2.2E-09	7.5E-07	4.7E-07	2.0E+00	3.0E+00
CM248	5.2E-09	6.8E-09	4.7E-07	3.1E-07	2.0E+00	3.0E+00
CF252	7.2E-08	6.6E-08	1.7E-05	1.4E-05	.0E+00	.0E+00
ZN69M	3.4E-09	2.9E-09	1.2E-06	7.5E-07	3.4E-07	6.8E-07
ZN69	.0E+00	.0E+00	2.8E-07	1.6E-09	7.1E-10	2.5E-07
KR83M	4.2E-10	1.3E-11	9.4E-09	2.4E-11	.0E+00	7.6E-10
BR85	.0E+00	.0E+00	1.1E-06	1.4E-08	6.7E-09	9.7E-07
KR85M	.0E+00	.0E+00	5.1E-07	2.8E-07	1.3E-07	3.2E-07
KR85	.0E+00	.0E+00	1.8E-07	4.7E-09	2.2E-09	1.6E-07
KR87	.0E+00	.0E+00	4.6E-06	2.7E-06	1.3E-06	2.7E-06
RB87	.0E+00	.0E+00	2.5E-08	1.2E-10	2.0E+00	3.0E+00
KR88	.0E+00	.0E+00	7.7E-06	4.5E-06	2.1E-06	4.7E-06
RB88	4.0E-09	3.5E-09	3.6E-06	1.2E-06	5.6E-07	2.7E-06
KR89	.0E+00	.0E+00	6.8E-06	4.8E-06	3.8E-06	2.2E-06
SR90	.0E+00	.0E+00	1.5E-07	5.4E-10	2.4E-10	1.3E-07
Y 90	2.6E-12	2.2E-12	9.6E-07	1.3E-08	6.1E-09	8.6E-07
Y 91	2.7E-11	2.4E-11	5.7E-07	6.7E-09	3.1E-09	5.2E-07
Y 92	1.9E-09	1.6E-09	2.0E-06	4.6E-07	2.1E-07	1.6E-06
Y 93	7.8E-10	5.7E-10	1.4E-06	1.9E-07	8.7E-08	1.2E-06
NB93M	1.0E-10	8.2E-13	3.0E-09	2.2E-11	9.2E-12	1.2E-09
NB95	6.0E-09	5.1E-09	1.6E-06	1.4E-06	6.4E-07	7.5E-07
NB97	5.4E-09	4.6E-09	1.9E-06	1.2E-06	5.6E-07	1.1E-06
TC99M	1.1E-09	9.6E-10	2.7E-07	2.4E-07	1.1E-07	1.3E-07
TC99	.0E+00	.0E+00	2.6E-10	1.3E-10	5.8E-11	2.4E-08
RH105	7.7E-10	6.6E-10	3.0E-07	1.7E-07	7.8E-08	1.8E-07
RU106	1.8E-09	1.5E-09	1.9E-06	3.8E-07	1.7E-07	1.5E-06
PD109	4.0E-11	3.5E-11	3.4E-07	9.3E-09	4.3E-09	3.0E-07
CD115M	.0E+00	.0E+00	.0E+00	.0E+00	2.0E+00	3.0E+00
TE125M	4.8E-11	3.5E-11	1.5E-08	3.7E-09	1.7E-09	1.1E-08
SN126	1.0E-08	9.0E-09	6.0E-08	1.8E-08	1.3E-05	8.6E-04
SB126	1.0E-08	8.9E-09	3.3E-06	2.4E-06	5.0E-05	8.0E-05
SB127	6.6E-09	5.7E-09	1.8E-06	1.5E-06	6.7E-07	9.0E-07
TE127	1.1E-11	1.0E-11	1.7E-07	2.8E-09	1.2E-09	1.6E-07
TE129	8.4E-10	7.1E-10	7.0E-07	1.9E-07	8.7E-08	5.3E-07
I 129	7.5E-10	4.5E-10	3.3E-08	1.7E-08	1.8E-08	3.9E-08
XE131M	.0E+00	.0E+00	5.6E-08	6.2E-09	2.8E-09	4.8E-08
I 132	2.0E-08	1.7E-08	5.5E-06	4.4E-06	2.0E-06	2.7E-06
I 133	4.5E-09	3.7E-09	1.5E-06	9.6E-07	4.4E-07	8.8E-07
XE133M	.0E+00	.0E+00	1.0E-07	6.0E-08	2.7E-08	6.0E-08
XE133	.0E+00	.0E+00	1.1E-07	5.7E-08	2.5E-08	6.9E-08
TE134	1.2E-09	1.0E-09	3.5E-07	2.5E-07	1.2E-07	1.9E-07
I 134	1.9E-08	1.6E-08	5.5E-06	4.2E-06	2.0E-06	2.9E-06

Figure D-5. GRDFLIB Data File (continued)

CS134M	7.3E-10	6.2E-10	1.9E-07	1.6E-07	7.3E-08	9.1E-08
CS134	1.4E-08	1.2E-08	3.5E-06	2.9E-06	1.3E-06	1.7E-06
XE135M	.0E+00	.0E+00	1.0E-06	7.6E-07	3.5E-07	5.0E-07
XE135	.0E+00	.0E+00	7.9E-07	4.5E-07	2.1E-07	4.9E-07
CS135	.0E+00	.0E+00	1.1E-08	6.6E-11	2.8E-11	8.8E-09
XE137	.0E+00	.0E+00	2.1E-06	2.7E-07	1.2E-07	1.8E-06
CS137	4.9E-09	4.2E-09	1.4E-06	1.0E-06	4.7E-07	7.0E-07
XE138	.0E+00	.0E+00	3.4E-06	2.6E-06	3.0E-06	4.8E-06
CS138	2.4E-08	2.1E-08	5.7E-06	4.0E-06	1.8E-06	3.1E-06
BA139	2.7E-09	2.4E-09	1.0E-06	7.7E-08	3.7E-08	8.9E-07
LA140	1.7E-08	1.5E-08	5.3E-06	4.1E-06	1.9E-06	2.7E-06
BA141	4.9E-09	4.3E-09	2.4E-06	1.1E-06	5.2E-07	1.6E-06
LA141	2.8E-10	2.5E-10	1.0E-06	5.1E-08	2.3E-09	9.2E-07
CE141	6.2E-10	5.5E-10	2.4E-07	1.3E-07	5.9E-08	1.5E-07
BA142	9.0E-09	7.9E-09	3.0E-06	2.2E-06	1.0E-06	1.6E-06
LA142	1.8E-08	1.5E-08	5.9E-06	4.5E-06	2.0E-06	3.1E-06
PR143	.0E+00	.0E+00	2.8E-07	1.6E-09	7.5E-10	2.5E-07
CE144	3.7E-10	3.2E-10	1.4E-06	8.6E-08	4.0E-08	1.2E-06
PR144	2.3E-10	2.0E-10	1.3E-06	5.6E-08	2.6E-08	1.2E-06
ND147	1.2E-09	1.0E-09	5.0E-07	2.8E-07	1.3E-07	3.1E-07
PM147	.0E+00	.0E+00	1.3E-08	7.5E-11	3.3E-11	1.2E-08
PM148	5.3E-09	4.6E-09	2.0E-06	1.1E-06	5.2E-07	1.2E-06
PM151	2.3E-09	2.2E-09	8.4E-07	5.0E-07	2.3E-07	5.0E-07
SM151	2.1E-10	4.8E-11	1.9E-09	2.6E-10	2.7E-06	3.3E-05
W 187	3.6E-09	3.1E-09	1.2E-06	8.3E-07	3.8E-07	6.3E-07
TH230	1.0E-10	7.8E-12	4.4E-09	1.2E-09	5.5E-10	1.9E-09
RA226	1.5E-08	1.3E-08	5.0E-06	3.3E-06	1.5E-06	2.9E-06
RN222	1.5E-08	1.3E-08	5.0E-06	3.2E-06	1.5E-06	2.9E-06
PB210	1.7E-11	1.3E-11	3.6E-07	3.0E-09	2.7E-09	3.4E-07
BI210	.0E+00	.0E+00	3.5E-07	2.7E-09	1.3E-09	3.3E-07
PO210	6.2E-14	5.4E-14	1.7E-11	1.5E-11	8.0E-12	9.5E-12
U 232	2.7E-11	2.6E-12	1.1E-09	4.6E-10	2.0E-10	4.8E-10
TH232	4.0E-09	3.0E-09	4.8E-06	3.4E-06	2.0E+00	3.0E+00
RA228	1.4E-08	1.2E-08	4.8E-06	3.4E-06	2.0E+00	3.0E+00
TH228	1.0E-08	8.9E-09	3.5E-06	2.6E-06	2.0E+00	3.0E+00
U 235	2.1E-09	1.3E-09	3.8E-07	3.0E-07	1.4E-07	1.9E-07
PA231	2.7E-09	2.2E-09	7.0E-07	5.0E-07	2.0E+00	3.0E+00
AC227	2.4E-09	2.0E-09	6.3E-07	4.4E-07	2.0E+00	3.0E+00
U 237	2.3E-09	1.3E-09	3.4E-07	2.6E-07	1.2E-07	1.6E-07
NP237	1.6E-09	1.4E-09	4.5E-07	3.6E-07	1.4E-07	2.1E-07
PA233	1.5E-09	1.3E-09	4.0E-07	3.3E-07	8.5E-06	3.0E-05
U 233	7.5E-11	5.7E-12	2.9E-09	1.0E-09	4.7E-10	1.3E-09
TH229	2.7E-09	2.2E-09	1.3E-06	5.8E-07	2.0E+00	3.0E+00
AC225	1.8E-09	1.6E-09	1.1E-06	4.0E-07	2.0E+00	3.0E+00
U 238	6.3E-10	3.5E-10	9.3E-07	7.4E-08	3.4E-08	8.1E-07
TH234	1.3E-10	1.1E-10	8.7E-07	2.8E-08	5.8E-05	1.6E-04
AM242M	1.8E-10	2.6E-11	1.6E-07	5.1E-09	4.8E-05	1.8E-02
CM242	2.3E-11	5.5E-12	4.7E-09	3.4E-10	1.6E-10	2.1E-09
PU242	1.6E-11	1.1E-12	3.6E-09	1.1E-10	5.1E-11	1.6E-09

Figure D-5. GRDFLIB Data File (continued)

NP238	3.2E-09	2.8E-09	1.1E-06	7.7E-07	3.5E-07	5.7E-07
PU238	1.8E-11	1.3E-12	4.0E-09	1.5E-10	6.8E-11	1.7E-09
CM244	1.8E-11	2.9E-12	3.9E-09	2.6E-10	1.2E-10	1.7E-09
PU244	9.6E-10	8.9E-10	1.5E-07	1.3E-07	2.0E+00	3.0E+00
PU240	1.8E-11	1.3E-12	4.0E-09	1.4E-10	6.5E-11	1.7E-09
CM243	1.4E-09	1.2E-09	2.9E-07	2.5E-07	1.2E-07	1.3E-07
AM243	1.5E-09	1.3E-09	4.6E-07	3.1E-07	1.4E-07	2.5E-07
NP239	1.1E-09	9.5E-10	3.7E-07	2.4E-07	1.1E-07	2.1E-07
PU239	7.7E-12	7.9E-13	1.7E-09	1.2E-10	5.6E-11	7.6E-10
CM245	1.2E-09	9.5E-10	1.3E-07	9.6E-08	3.6E-05	4.3E-02
AM241	2.6E-10	1.8E-10	6.1E-08	3.9E-08	1.8E-08	2.7E-08

Figure D-5. GRDFLIB Data File (continued)

EU	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2
TB	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2
HO	100.0	1000.0	1000.0	1000.0	25.0	1000.0	1000.0	5000.0	.2
W	10.0	10.0	10.0	100.0	1200.0	10.0	10.0	1200.0	.9
IR	100.0	10000.0	300.0	100.0	50.0	200.0	200.0	200.0	.2
HG	1200.0	310.0	10000.0	34000.0	20000.0	20000.0	20000.0	34000.0	.5
PB	300.0	1000.0	1000.0	5000.0	100.0	100.0	100.0	200.0	.9
BI	15.0	1000.0	1000.0	10000.0	15.0	10.0	10.0	1500.0	.9
PO	300.0	5000.0	5000.0	2000.0	500.0	20000.0	20000.0	2000.0	.8
RN	1.0	1.0	1.0	1.0	57.0	1.0	1.0	1.0	.0
RA	50.0	100.0	100.0	100.0	50.0	250.0	250.0	2500.0	.7
AC	25.0	1000.0	1000.0	5000.0	25.0	1000.0	1000.0	5000.0	.7
TH	10000.0	2000.0	2000.0	3000.0	30.0	500.0	500.0	1500.0	.7
PA	10.0	10.0	10.0	6.0	11.0	110.0	110.0	1100.0	.7
U	10.0	10.0	10.0	67.0	2.0	60.0	60.0	.5	.7
NP	10.0	10.0	10.0	6.0	10.0	400.0	400.0	300.0	.7
PU	3.0	200.0	200.0	1000.0	3.5	100.0	100.0	350.0	.7
AM	25.0	1000.0	1000.0	5000.0	25.0	1000.0	1000.0	5000.0	.7
CM	25.0	1000.0	1000.0	5000.0	25.0	1000.0	1000.0	5000.0	.7
CF	25.0	1000.0	1000.0	5000.0	25.0	1000.0	1000.0	5000.0	.7

Figure D-6. DSFCT Data File

```
        5             1  6  8 16 23
INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)
TOTAL BODYBONE      LUNG      THYROID   GI-LLI

H 3      4
 1          1.7E-02   1.7E-02   6.1E-01   6.1E+01
 8          1.7E-02   1.7E-02   6.1E+01   6.1E+01
16          1.7E-02   1.7E-02   6.1E+01   6.1E+01
23          0.0       0.0       6.1E+01   6.1E+01
C 14     5
 1          7.9E-02   7.9E-02   5.7E+02   5.7E+02
 6          3.9E-01   3.9E-01   2.8E+03   2.8E+03
 8          7.9E-02   7.9E-02   5.7E+02   5.7E+02
16          7.9E-02   7.9E-02   5.7E+02   5.7E+02
23          6.5E-02   6.5E-02   5.7E+02   5.7E+02
CO60     3
 1          1.8       6.8E-01   4.7E+03   4.7E+03
 8          6.0E+02   6.7E+02   0.0       0.0
23          1.5       5.5       0.0       0.0
NI59     4
 1          6.2E-01   6.0E-01   1.6E+03   1.6E+03
 6          3.7       3.6       9.8E+03   9.3E+03
 8          9.2       8.9       0.0       0.0
23          2.6E-02   2.6E-02   0.0       0.0
NI63     4
 1          1.7       1.6       4.4E+03   4.2E+03
 6          5.0E+01   4.7E+01   1.3E+05   1.2E+05
 8          2.5E+01   2.4E+01   0.0       0.0
23          7.1E-02   7.1E-02   0.0       0.0
SE79     3
 1          6.6E-02   6.6E-02   4.4E+02   4.4E+02
 8          5.1       5.1       0.0       0.0
23          2.0E-02   2.0E-02   0.0       0.0
PD107    3
 1          5.2E-03   5.2E-03   9.4       9.4
 8          1.1E+01   1.0E+01   0.0       0.0
23          3.4E-02   3.4E-02   0.0       0.0
RA224+D  4
 1          4.4E+01   4.4E+01   3.2E+05   3.2E+05
 6          2.2E+02   2.2E+02   1.7E+06   1.7E+06
 8          4.9E+03   4.9E+03   0.0       0.0
23          3.0E+01   3.0E+01   0.0       0.0
U 234    4
 1          1.4E+02   1.4E+02   5.2E+04   5.1E+04
 6          2.3E+03   2.3E+03   8.4E+05   8.2E+05
 8          1.0E+05   1.0E+05   0.0       0.0
23          7.6       7.6       6.8E+04   6.8E+04
U 236    4
 1          1.4E+02   1.4E+02   5.0E+04   4.9E+04
```

Figure D-6. DSFCT Data File (continued)

6		2.2E+03	2.2E+03	8.0E+05	7.9E+05
8		9.8E+04	9.6E+04	0.0	0.0
23		7.1	7.1	0.0	0.0
U 238+D	4				
1		1.3E+02	1.3E+02	4.5E+04	4.5E+04
6		2.1E+03	2.1E+03	7.7E+05	7.5E+05
8		9.0E+04	8.8E+04	0.0	0.0
23		6.8	6.8	6.1E+04	6.1E+04
SR90	4				
1		4.0E+02	3.3E+02	1.0E+06	8.7E+05
6		5.9E+03	5.0E+03	3.9E+06	3.3E+06
8		1.5E+03	1.4E+03	0.0	0.0
23		2.6	2.6	7.8E+04	7.7E+04
Y 90	4				
1		2.4E-01	2.4E-01	2.6E-01	2.6E-01
6		9.1	9.1	9.6	9.6
8		6.7	6.7	0.0	0.0
23		3.8	3.8	1.1E+05	1.1E+05
ZR93	4				
1		1.1	1.1	1.1	1.1
6		4.4E+01	4.1E+01	4.2E+01	4.0E+01
8		2.9E+01	2.8E+01	0.0	0.0
23		9.2E-02	9.2E-02	0.0	0.0
NB93M	4				
1		2.2	2.1	2.1	2.0
6		2.7E+01	2.6E+01	2.6E+01	2.5E+01
8		4.1E+01	4.0E+01	0.0	0.0
23		1.4E-01	1.4E-01	0.0	0.0
ZR95	4				
1		6.7	6.7	6.5	6.4
6		3.1E+01	3.1E+01	3.0E+01	3.0E+01
8		7.7E+01	7.6E+01	0.0	0.0
23		1.1	1.1	0.0	0.0
NB95	4				
1		1.9	1.9	1.9	1.9
6		6.4	6.4	6.2	6.2
8		2.1E+01	2.1E+01	0.0	0.0
23		7.9E-01	7.9E-01	0.0	0.0
TC99	4				
1		1.2E-02	1.2E-02	5.0E+01	5.0E+01
6		3.0E-02	3.0E-02	1.3E+02	1.3E+02
8		1.1E+02	1.1E+02	1.6E+01	1.6E+01
23		2.3E-01	2.3E-01	6.8E+03	6.8E+03
RU106	4				
1		1.2	1.2	3.5E+02	3.5E+02
6		9.6	9.6	2.6E+03	2.8E+03
8		7.1E+02	7.0E+02	0.0	0.0
23		6.7	6.7	2.0E+05	2.0E+05
SN126	5				

Figure D-6. DSFCT Data File (continued)

1		5.1	5.1	2.4E+03	2.4E+03
6		1.3E+02	1.3E+02	8.5E+04	8.4E+04
8		1.3E+03	1.3E+03	0.0	0.0
16		1.0	1.0	5.0E+02	5.0E+02
23		9.2E-01	9.2E-01	0.0	0.0
SB126	5				
1		3.9E-02	3.9E-02	1.7E+01	1.7E+01
6		9.2E-02	9.2E-02	4.0E+01	4.0E+01
8		1.3	1.3	0.0	0.0
16		1.9E-03	1.9E-03	8.0E-01	8.0E-01
23		1.3	1.3	0.0	0.0
I 129	5				
1		1.3	1.3	9.2E+03	9.1E+03
6		4.5E-01	4.5E-01	3.3E+03	3.3E+03
8		9.9	9.9	0.0	0.0
16		1.0E+03	9.9E+02	7.2E+06	7.2E+06
23		1.7E-02	1.7E-02	5.0E+02	5.0E+02
CS135	4				
1		1.1	1.1	8.0E+03	8.0E+03
6		2.7	2.7	2.0E+04	2.0E+04
8		4.1E-01	4.1E-01	2.1E+03	2.0E+03
23		1.6E-02	1.6E-02	0.0	0.0
CS137	4				
1		9.9	9.8	7.1E+04	7.1E+04
6		1.1E+01	1.1E+01	8.0E+04	8.0E+04
8		2.6	2.5	1.3E+04	1.3E+04
23		8.0E-02	8.0E-02	2.3E+03	2.3E+03
SM151	4				
1		7.6E-01	7.3E-01	2.9	2.8
6		1.8E+01	1.7E+01	6.9E+01	6.3E+01
8		4.9E+01	4.8E+01	0.0	0.0
23		6.5E-01	6.5E-01	0.0	0.0
TH230	4				
1		2.0E+04	1.1E+04	7.7E+04	4.1E+04
6		6.6E+05	3.6E+05	2.5E+06	1.4E+06
8		1.0E+05	9.8E+04	0.0	0.0
23		7.5	7.5	0.0	0.0
RA226	4				
1		5.0E+04	3.3E+04	2.5E+08	1.7E+08
6		7.4E+04	4.4E+04	3.7E+09	2.2E+08
8		2.3E+05	2.2E+05	0.0	0.0
23		4.1E+01	4.1E+01	0.0	0.0
PB210	4				
1		2.4E+02	2.2E+02	5.4E+05	5.1E+05
6		7.6E+03	6.6E+03	1.5E+07	1.3E+07
8		8.5E+04	8.3E+04	0.0	0.0
23		6.7	6.7	0.0	0.0
BI210	4				
1		4.6E-01	4.6E-01	2.6E+02	2.6E+02

Figure D-6. DSFCT Data File (continued)

6		8.0E-01	8.0E-01	4.6E+02	4.6E+02
8		9.9E+02	9.9E+02	0.0	0.0
23		4.4	4.4	0.0	0.0
P0210	4				
1		4.2E+01	4.2E+01	8.6E+04	8.6E+04
6		1.8E+02	1.7E+02	3.6E+05	3.6E+05
8		2.5E+04	2.5E+04	0.0	0.0
23		7.5	7.5	0.0	0.0
U232	4				
1		8.1E+02	8.1E+02	3.0E+05	2.9E+05
6		1.1E+04	1.1E+04	4.1E+06	4.1E+06
8		3.9E+05	3.8E+05	0.0	0.0
23		8.3	8.3	0.0	0.0
TH232	4				
1		2.6E+04	1.4E+04	9.9E+04	5.2E+04
6		7.4E+05	4.0E+05	2.8E+06	1.5E+06
8		1.2E+05	1.2E+05	0.0	0.0
23		6.4	6.4	5.7E+04	5.7E+04
TH228	4				
1		4.9E-05	4.7E-05	0.0	0.0
6		1.4E-03	1.4E-03	0.0	0.0
8		5.0E-04	5.0E-04	0.0	0.0
23		7.9E-07	7.9E-07	0.0	0.0
BI212	4				
1		6.6E-12	6.6E-12	0.0	0.0
6		9.9E-12	9.9E-12	0.0	0.00
8		3.4E-09	3.4E-09	0.0	0.0
23		3.6E-14	3.6E-14	0.0	0.0
U 235	4				
1		1.3E+02	1.3E+02	4.9E+04	4.8E+04
6		2.2E+03	2.2E+03	8.0E+05	7.9E+05
8		9.6E+04	9.4E+04	0.0	0.0
23		9.6	9.6	8.7E+04	8.7E+04
TH231	4				
1		3.2E-03	3.2E-03	2.0E-02	2.0E-02
6		6.9E-02	6.9E-02	4.4E-01	4.4E-01
8		3.7E-01	3.7E-01	0.0	0.0
23		5.8E-01	5.8E-01	9.3E+03	9.3E+03
PA231	4				
1		5.6E+04	3.0E+04	2.1E+05	1.1E+05
6		1.3E+06	7.2E+05	5.0E+06	2.7E+06
8		1.5E+05	1.4E+05	0.0	0.0
23		8.9	8.9	0.0	0.0
AC227	4				
1		3.2E+04	2.3E+04	1.2E+05	8.6E+04
6		5.1E+05	3.6E+05	2.0E+06	1.4E+06
8		6.3E+05	6.1E+05	0.0	0.0
23		1.0E+01	1.0E+01	0.0	0.0
TH227	4				

Figure D-6. DSFCT Data File (continued)

1		3.1E-05	3.1E-05	0.0	0.0
6		1.1E-03	1.1E-03	0.0	0.0
8		5.1E-03	5.1E-03	0.0	0.0
23		2.4E-05	2.4E-05	0.0	0.0
NP237	4				
1		1.9E+04	1.0E+04	7.3E+04	4.0E+04
6		4.4E+05	2.4E+05	1.7E+06	9.0E+05
8		1.0E+05	1.0E+05	0.0	0.0
23		9.9	9.9	0.0	0.0
PA233	4				
1		5.3E-08	5.3E-08	0.0	0.0
6		3.1E-07	3.0E-07	0.0	0.0
8		2.4E-06	2.4E-06	0.0	0.0
23		5.4E-07	5.4E-07	0.0	0.0
U 233	4				
1		1.5E+02	1.5E+02	5.3E+04	5.3E+04
6		2.4E+03	2.4E+03	8.7E+05	8.6E+05
8		1.0E+05	1.0E+05	0.0	0.0
23		7.7	7.7	0.0	0.0
TH229	4				
1		1.4E+05	7.4E+04	5.3E+05	2.8E+05
6		2.9E+06	1.5E+06	1.1E+07	5.7E+06
8		5.7E+05	5.5E+05	0.0	0.0
23		6.4E+01	6.4E+01	0.0	0.0
RA225	4				
1		1.1E-04	1.1E-04	0.0	0.0
6		5.5E-04	5.4E-04	0.0	0.0
8		6.9E-03	6.9E-03	0.0	0.0
23		1.7E-05	1.7E-05	0.0	0.0
AM242M	4				
1		1.8E+04	1.1E+04	6.6E+04	4.0E+04
6		4.6E+05	2.6E+05	1.7E+06	9.9E+05
8		8.3E+04	8.1E+04	0.0	0.0
23		1.2E+01	1.2E+01	0.0	0.0
AM242	4				
1		8.9E+06	8.9E-06	0.0	0.0
6		2.0E-04	2.0E-04	0.0	0.0
8		6.1E-04	6.1E-04	0.0	0.0
23		1.0E-05	1.0E-05	0.0	0.0
CM242	4				
1		3.2E+02	3.2E+02	1.4E+03	1.4E+03
6		7.3E+03	7.2E+03	3.1E+04	3.1E+04
8		3.3E+04	3.3E+04	0.0	0.0
23		9.4	9.4	0.0	0.0
PU242	4				
1		2.2E+04	1.2E+04	2.5E+04	1.3E+04
6		4.4E+05	2.4E+05	5.0E+05	2.7E+05
8		1.1E+05	1.0E+05	0.0	0.0
23		8.1	8.1	7.3E+04	7.3E+04

Figure D-6. DSFCT Data File (continued)

PU238	4				
1		1.9E+04	1.1E+04	2.2E+04	1.2E+04
6		3.9E+05	2.3E+05	4.4E+05	2.6E+05
8		1.2E+05	1.1E+05	0.0	0.0
23		9.1	9.1	8.1E+04	8.1E+04
CM244	4				
1		8.1E+03	6.0E+03	3.1E+04	2.3E+04
6		2.0E+05	1.4E+05	7.4E+05	5.4E+05
8		1.2E+05	1.1E+05	0.0	0.0
23		9.4	9.4	0.0	0.0
PU240	4				
1		2.4E+04	1.2E+04	2.6E+04	1.4E+04
6		4.7E+05	2.6E+05	5.4E+05	2.9E+05
8		1.1E+05	1.1E+05	0.0	0.0
23		8.4	8.4	7.5E+04	7.5E+04
AM243	4				
1		1.8E+04	1.0E+04	6.7E+04	3.8E+04
6		4.7E+05	2.6E+05	1.8E+06	9.7E+05
8		1.1E+05	1.1E+05	0.0	0.0
23		1.1E+01	1.1E+01	0.0	0.0
NP239	4				
1		3.5E-08	3.5E-08	0.0	0.0
6		6.6E-07	6.6E-07	0.0	0.0
8		3.5E-06	3.5E-06	0.0	0.0
23		6.8E-06	6.8E-06	0.0	0.0
PU239	4				
1		2.3E+04	1.2E+04	2.6E+04	1.4E+04
6		4.7E+05	2.6E+05	5.4E+05	2.9E+05
8		1.1E+05	1.1E+05	0.0	0.0
23		8.3	8.3	7.4E+04	7.4E+04
CM245	4				
1		2.0E+04	1.1E+04	7.4E+04	4.1E+04
6		4.9E+05	2.7E+05	1.9E+06	1.0E+06
8		1.2E+05	1.1E+05	0.0	0.0
23		8.7	8.7	0.0	0.0
AM241	4				
1		1.8E+04	1.0E+04	6.7E+04	3.9E+04
6		4.7E+05	2.6E+05	1.8E+06	9.6E+05
8		1.2E+05	2.0E+05	0.0	0.0
23		1.0E+01	1.0E+01	8.3E+04	8.3E+04
PU241	4				
1		3.0E+02	2.2E+02	3.4E+02	2.6E+02
6		7.9E+03	6.0E+03	9.0E+03	6.8E+03
8		2.0E+02	1.9E+02	0.0	0.0
23		2.0E-1	1.9E-01	1.6E+03	1.6E+03
PU244	1				
1					
U 240	1				
1					
	0				

Figure D-6. DSFCT Data File (continued)

APPENDIX E

INPUT PREPARATION

APPENDIX E

INPUT PREPARATION

Use of the computer program DITTY requires proper assignment of several data files (described in Appendix C) and careful preparation of an input record file. This appendix describes preparation of the input record file. This file has been designed to allow efficient use of the computer program with minimum effort by the user in preparing input records. Each execution of DITTY can have an unlimited number of cases. An execution file for DITTY contains the following classes of records:

1) Host computer system commands to connect library files to the appropriate logical unit devices. (See Appendix C for details.)

2) Host computer system commands to connect user data files of population and release data to appropriate logical unit devices if this option is selected. (See Appendix C for details.)

3) Host computer system command to initiate execution of the DITTY program.

4) A master radionuclide control list defining any radionuclides to be considered in this set. Radionuclides considered in any of the cases is based on the interrelationship of several parameters:

   - time of release in relation to time period considered;
   - type of release (acute or chronic) and whether that type of release is considered in a particular problem of a set;
   - release pathway (airborne or waterborne) and whether that pathway is considered in a particular problem of the set;
   - input options of release data; whether release data is read for this case or whether release data is in effect from a previous problem.

   The radionuclide control list is entered as record types 2 and 3.

5) A list of organs of interest for this case. Doses to each of the selected organs will be calculated for all problems in this set. The list of organs is entered in the format of record types 4 and 5.

6) A group of records for each problem in the set consisting of the following types of records:

   - title for this case (Note: the title for the first case of a set is positioned before the master radionuclide list and the organ selection.);
   - a NAMELIST parameter set;
   - air concentration factors (record type 6), optional;
   - joint frequency data (record type 7), optional;
   - population distribution data (record types 8 and 9), optional;
   - activity airborne release data (record types 10, 11, and 12), optional;
   - activity waterborne release data (record types 10, 11, and 12), optional.

The order of the records is determined by control integers as indicated in the input record logic diagram of Figure E.1. This diagram should be referred to when preparing input records for DITTY. Each record type is discussed below.

The first record for each run is a type 1 title card for the first case as described in Table E.1.

TABLE E.1. Record Type 1, Case Titles

Variable	Columns	Format	Description
CASTTL(20)	1-80	20A4	Descriptive title for the current run to be printed on output report headings

At the beginning of each run names of all radionuclides to be considered are read. These names are used to select needed data from library files. The number of names is read (Record type 2) followed by the names of the

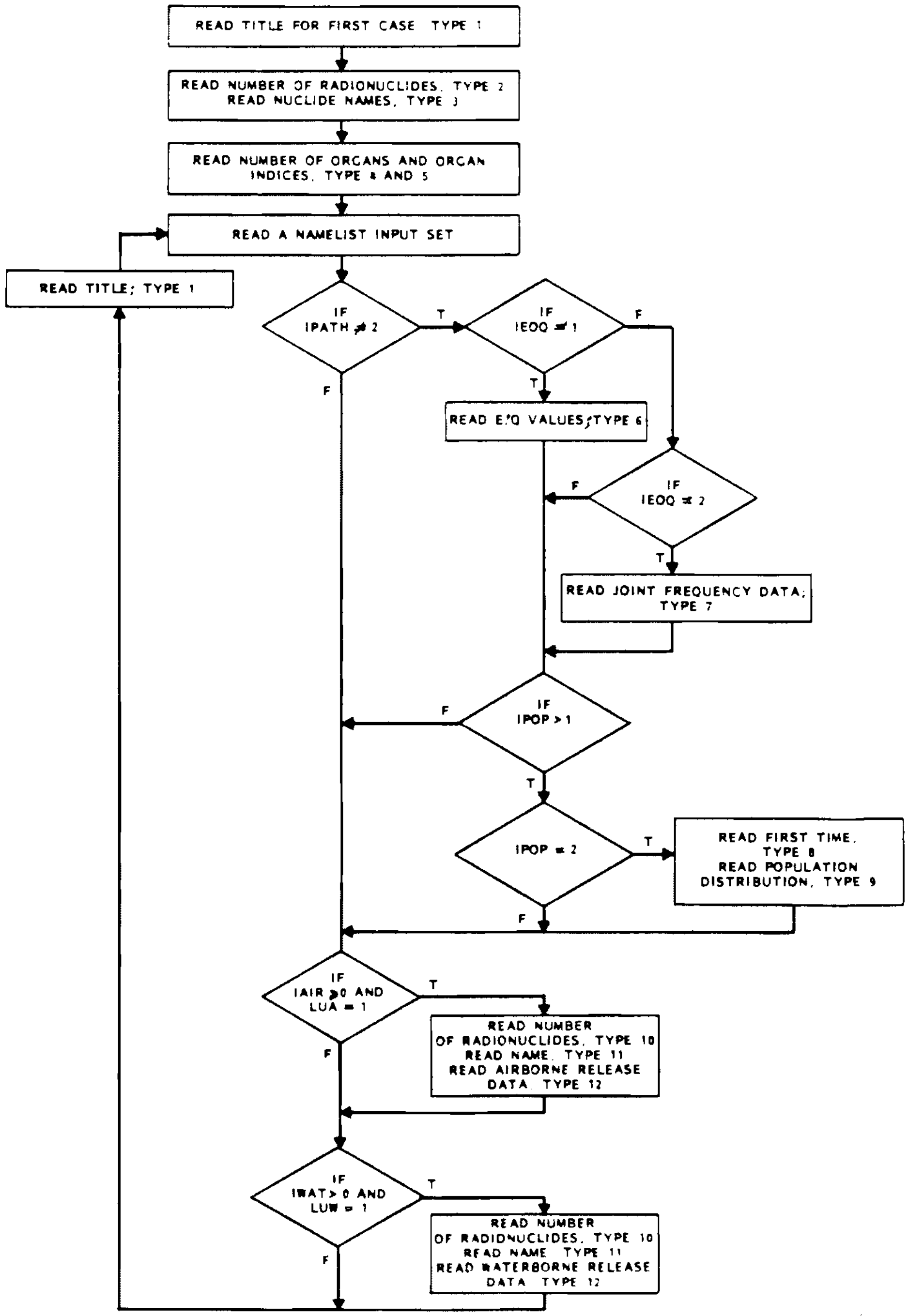


FIGURE E.1. DITTY Input Record Logic Diagram radionuclides (Record type 3). The data record formats are described in Table E.2. The maximum number of radionuclides allowed is 100 (25 for IBM-PC version). This number includes any unsolicited daughters which will automatically be added to the master list by the program. Addition of daughters is determined by decay chain information in the File 10 radionuclide data library (see Appendix C).

TABLE E.2. Record Types 2 and 3, Master Radionuclide Names

Parameter	Columns	Format	Description
Record Type 2			
NIN	1-5	I5	Number of radionuclide names to be read, $1 \leq NIN \leq 100$. ($1 \leq NIN \leq 25$ for IBM-PC)
Record Type 3			
E(i)	1-2	A2	Element symbol for a radionuclide.
A(i)	3-8	A6	Atomic weight symbol for the radionuclide.

The spelling of the radionuclide name symbols must correspond to the spelling given in the File 10 radionuclide data library.

After reading the radionuclide names the organs to be considered in this run are specified on record types 4 and 5. The number of organs and organ selection indices are given as described in Table E.3. A list of available organs and index values is given in Table E.4.

TABLE E.3. Record Types 4 and 5, Selected Organs

Parameter	Columns	Format	Description
Record Type 4			
NORG	1-5	I5	Number of organs to be considered during this run, $1 \leq NORG \leq 5$.
Record Type 5			
KORG(i)	1-3 4-6 . . 13-15	5I3	Organ index values for each organ to be considered. Values of KORG are to be selected from Table E.4 and should correspond to data available in the internal dose conversion factor data file.

TABLE E.4. Suggested Organ Index List

Organ of Reference	Index Value
Total body	1
Adrenals	9
Bone	6
Brain	16
Fat	7
GI Tract	
Stomach	20
Small intestine	21
Upper large intestine	22
Lower large intestine	23
Heart	18
Kidneys	3
Liver	4
Lungs	8
Muscle	14
Ovaries	11
Pancreas	17
Prostate	15
Skin	12
Spleen	5
Testes	10
Thyroid	16

The data records described above are read at the beginning of each run. The remaining records are read for each case as determined by input parameters. Control parameters and selected model parameters are read next in a NAMELIST INPUT record set. The first record of this set must begin with $INPUT in columns 2-7 and the last record must end with $END in any column except column 1. Each parameter is supplied by setting it equal to the desired value. For example, to set the parameter IPATH to 2, enter IPATH = 2 starting after column 8 on the first record. Array values are specified by including the array subscript. For example, to set position 2 of array LORG to 6 enter LORG(2) = 6. Each entry must be separated by a comma. The NAMELIST INPUT parameters recognized by "DITTY" are described in Table E.5 by the following categories:

- general control integers
- time references
- site grid description
- atmospheric disperson
- population description
- waterborne pathways
- terrestrial pathways (for airborne and waterborne releases)
- graphical output selection options.

Input requirements for the IBM-PC version of DITTY are essentially identical to those described for mainframe computers. The major difference is that all variables dimensioned to 100 for the mainframe version are only dimensional to 25 for the IBM-PC version. All other logic remains the same.

TABLE E.5. NAMELIST INPUT Parameters

A. General Control Integers

IAC	To consider an acute release period at the beginning of the first 70-yr period set IAC > 0. Default is IAC = 0.
IAIR	This parameter is set positive if airborne release activity data are to be read. Default is IAIR = 0.
IPATH	This parameter selects pathways to be considered as follows: IPATH $\leq$ 0; airborne and waterborne IPATH = 1; airborne only IPATH $\geq$ 2; waterborne only

TABLE E.5. (contd)

A. General Control Integers (contd)

No default value is specified for IPATH.

IWAT — This parameter is set positive if waterborne release activity data are to be read. Default is IWAT = 0.

LUA — This parameter selects the input logical file unit for reading of airborne release activity data as follows:

LUA = 1; use input unit 5
LUA ≠ 1; use data file unit 26

Default is LUA = 1.

LUW — This parameter selects the input logical file unit for reading of waterborne release activity data as follows:

LUW = 1; use card input unit 5
LUW ≠ 1; use library file unit 24

Default is LUW = 1.

ISALT — This parameter determines if fresh or saltwater factors are considered in bioaccumulation factors as follows:

ISALT = 0; freshwater
ISALT = 1; saltwater

Default is ISALT = 0

B. Time Reference Parameters

TZ — The beginning of the ten-thousand year dose period is given by this parameter in years A.D. Default is TZ = 2000.

TZR — The beginning of the release history data is given by this parameter in years A.D. TZR is used for both airborne and waterborne release data. Default is TZR = 2000. For acute exposure case TZR must be equal to TZ.

C. Site Grid Description Parameters

DIST(10) — These values represent the distance from the release point to the midpoint of each distance interval, meters. Default values are not specified for DIST.

TABLE E.5. (contd)

C. Site Grid Description Parameters (contd)

NDIST — This integer gives the number of distance intervals to be considered, $1 \leq NDIST \leq 10$. Default is NDIST = Ø.

NSECT — This integer gives the number of sectors to be considered in the calculation of population dispersion factors (PM) and in the atmospheric dispersion calculation. $1 \leq NSECT \leq 16$. Default is NSECT = 16.

D. Atmospheric Dispersion Parameters

IEOQ — This integer is used to control reading and calculation of atmospheric dispersion data as follows:

IEOQ $\leq$ 0; use previous data

IEOQ = 1; read normalized air concentrations from cards (Type 5)

IEOQ = 2; read joint frequency data from cards (Type 6) and calculate normalized air concentration

IEOQ = 3; use previous data to calculate normalized air concentration

IEOQ > 3; use previous data.

Default is IEOQ = 0.

HS — This parameter gives the effective release height for airborne release. HS is used when normalized air concentrations are to be calculated (IEOQ = 2 or 3). Default is HS = 0.

NMET — This integer gives the number of atmospheric stability categories to be considered in definition of the joint frequency data, Card Type 6. $1 \leq NMET \leq 7$. NMET is used when IEOQ = 2 or 3. Default is NMET = Ø.

NUBAR — This integer gives the number of windspeed groups used in definition of the joint frequency data, Card Type 6. $1 \leq NUBAR \leq 8$. NUBAR is used when IEOQ = 2 or 3. Default is NUBAR = Ø.

TABLE E.5. (contd)

MET(7) This integer array selects the atmospheric dispersion category for each of the NMET stability categories. Values for NMET(i) are as follows:

MET(i) = 1 for Hanford moderately stable
MET(i) = 2 for Hanford very stable
MET(i) = 3 for Pasquill A
MET(i) = 4 for Pasquill B
MET(i) = 5 for Pasquill C
MET(i) = 6 for Pasquill D
MET(i) = 7 for Pasquill E
MET(i) = 8 for Pasquill F
MET(i) = 9 for Pasquill G

Default values are MET(i) = 0.

UBAR(8) This array gives the average windspeed for each of the NUBAR windspeed groups, m/sec. Default values are zero.

E. Population Description Parameters

Population Parameters for Chronic Airborne Releases

Population dispersion factors are required for each 70-yr time increment of the 10,000 year integration period (143 increments). Six options are provided for generation of the population dispersion factors for chronic airborne releases.

METHOD ONE

The first method allows the user to supply all values through input (IPOP = 1).

METHOD TWO

The second method (IPOP = 2) uses an initial population distribution to generate the population dispersion factor for the first time increment. Then the increase in total population is supplied as a function of time and the program increases the population dispersion factor in proportion to the population increase. The user supplies the initial distribution in the input stream.

TABLE E.5. (contd)

METHOD THREE

The third method (IPOP = 3) uses population distributions at specified times read from data file unit 22. Population dispersion values are calculated for each specified time. These values are interpolated to determine the population dispersion values for each 70-yr increment.

METHOD FOUR

The fourth method (IPOP = 4) allows specification of population dispersion values at specified times. This data is interpolated to determine values for each 70-yr increment.

METHOD FIVE

The fifth method (IPOP = 5) uses the previous population distribution data but uses new E/Q data to generate the first time value for PM (air) or PL (water).

The second, third, and fifth methods use atmospheric dispersion data (E/Q values) as calculated in subroutine EOVRQ or supplied on input.

METHOD SIX

The sixth method (IPOP = 6) indicates that there is no chronic release. Use of this method ensures that population is specified properly for a case with an acute release only.

IPOP	This control integer selects method for determining population dispersion factors for airborne releases as follows:
	IPOP $\leq$ 0; use previous value. No additional population input required.
	IPOP = 1; supply all 144 values for array PM in NAMELIST INPUT.
	IPOP = 2; read population data for the first time, T(1), and calculate PM. Then generate PM for other times from population (PM1) and time (T) data by ratio with initial total population. Supply record types 8 and 9 plus NAMELIST INPUT prameters NTA, T, and PM1.

TABLE E.5. (contd)

IPOP = 3; read population data for each time from file 22 and calculate PM for each time. Both time, T, and population, POP, will be read from file 22. Plus <0Q.

IPOP = 4; supply population dispersion factors in array PM1 at times T and interpolate this data to generate PM values for each 70-yr increment. Supply values for NAMELIST INPUT parameters NTA, T, and PM1.

IPOP = 5; use previous population distribution data but recalculate the first time value for PM using new E/Q data. This method is similar to method 2 except no population data is read. No additional population input required.

IPOP = 6; There will be no chronic release during this case (IPA must be used).

IPOP > 6; not allowed.

Default is IPOP = 4.

NTA — This integer gives the number of times for which airborne population history data are supplied in arrays PM1 and T. $1 \le NTA \le 20$. Default is 1.

PM(144) — Population dispersion factor, person-sec/m^3 for airborne releases for each 70-yr period. This is an effective population-weighted E/Q.

PM1(20) — This array gives population dispersion factor data for airborne releases corresponding to times in array T. This data is used when IPATH $\le$ 1 and IPA > 1 or when IPOP = 2, 4 or 5. When IPOP = 2, the data represents total population at each time. When IPOP = 4, the data represents population dispersion factors. When IPOP = 5, previous data are used (the form is not important). When IPA > 1, the data represents population dispersion factors unless IPOP = 2 in which case total population values are given. Default values are not specified for PM1.

POPT(20) — This array gives total population for airborne releases at each time given in array T. POPT is used for IPATH $\le$ 1 and IPOP = 2 or 5. Default is all POPT values set to zero.

T(20) — This array gives times at which population data is supplied for airborne releases. Times are in years A.D. T is used when IPATH $\le$ 1 and IPOP = 2, 4, or 5 or IPA > 1.

TABLE E.5. (contd)

POPULATION PARAMETERS FOR ACUTE AIRBORNE RELEASES

IPA	This control integer indicates the method (see text for discussion of methods) for specification of the population dispersion factor for the acute release period for airborne releases. IPA $\leq$ 0; use previous values IPA = 1; use the value given for PMA IPA = 2; calculate the value for time TZ from calculated time history data; population data for chronic airborne release must be entered if this option is selected Default is IPA = 1.
PMA	This parameter is the population disperion factor for the acute airborne release period used when IAC > 0 and IPA = 1. Default value is PMA = 0.

POPULATION PARAMETERS FOR CHRONIC WATERBORNE RELEASES

IPOPL	This control integer selects the method for determining populations for waterborne release as follows: IPOPL $\leq$ 0; use previous PL values. No additional population input required. IPOPL = 1; supply all 144 values for array PL in NAMELIST INPUT. IPOPL = 2; supply total population value data in arrays PL1 and TL and generate PL values by interpolation. Provide values for NAMELIST INPUT parameters NTL, TL, and PL1. IPOPL > 2; not allowed. Default is IPOPL = 2.
NTL	This integer gives the number of times for which waterborne population history data are supplied in arrays PL1 and TL. 1 $\leq$ NTL $\leq$ 20. Default is 1.
PL(144)	This array gives total population for waterborne pathways for the acute period, PL(1) and each 70-yr period (143). Default is all values set to zero.
PL1(20)	This array gives total population for waterborne pathways corresponding to times in array TL. This data is used when IPL > 1 or when IPOPL = 2. Default is all PL1 values set to zero.

TABLE E.5. (contd)

TL(20) This array gives time at which population data is supplied for waterborne releases. Times are in years A.D. TL is used when IPATH $\neq$ 1 and either IPL > 1 or IPOPL = 2. Default values for TL are zero.

POPULATION PARAMETERS FOR ACUTE WATERBORNE RELEASES

IPL This control integer indicates the method for specification of population data for the acute release period for waterborne releases.

IPL $\leq$ 0; use previous values. No additional population required.
IPL = 1; use the value given for PPL
IPL > 1; calculate the value for time TZ from given population time history data. Population data for chronic waterborne release must be entered if this option is set >1.

Default is IPL = 1.

PPL This parameter is the total population for the acute waterborne release period used when IAC > 0 and IPL = 1. Default value is PPL = 0.

F. Waterborne Pathway Parameters

CFLO This parameter is used in the calculation of the dilution of liquid releases. It is the flow rate, in cubic feet per second (cfs) of the water into which the radionuclides are released. A default value is not specified for CFLO.

RECON This parameter is also used in the calculation of liquid dilution. It is used in particular cases where the inlet to a contamination facility is downstream of the outlet where reconcentration may occur. Default is 1.0.

RM This parameter is used in the calculation of liquid dilution where the receptor is near the release point. It relates the amount of the river flow actually mixed with the released radionuclides. 0 $\leq$ RM $\leq$ 1. Default is 1.0.

USAGE(7) This array contains input values of the consumption or exposure rates for the waterborne pathway parameters for individuals:

1. fish consumption, kg/yr
2. crustacea consumption, kg/yr
3. mollusc consumption, kg/yr
4. water plant consumption, kg/yr
5. drinking water consumption, L/yr
6. exposure to contaminated sediments, hr/yr
7. swimming in contaminated water, hr/yr.

TABLE E.5. (contd)

G. Terrestrial Pathway Parameters

CONSUM(7) This array contains values of consumption rates, kg/hr for the terrestrial pathways for individuals:

1. leafy vegetables
2. other vegetables
3. eggs
4. milk
5. beef
6. pork
7. poultry.

EXTIM This parameter relates the average time, hr/hr, that an individual spends exposed to surface soils contaminated by either atmospheric or irrigation deposition.

GRWP(7) The growing period (time of foliage above ground) for the 7 crops enumerated under the variable CONSUM. For the animal products, GRWP is the time above ground for feed or forage.

MOPYR This value is the months per year that irrigation is used on crops.

RIRR This parameter is the irrigation rate of the crops under CONSUM. Units are L/m^2/month. For the animal products, this is the irrigation rate of the animal forage crops.

YELD(7) This array contains the crop or forage yield, kg/m^2, for the 7 pathways under CONSUM.

H. Graphical Output Control Parameters

Some QA input data and results from DITTY1 calculations are presented as graphical functions of the data versus time. Various parameters may be plotted as described below.

IGRPOP If set, this parameter allows plotting of the total population affected by airborne releases against time if nonzero. If IGRPOP is equal to zero, an abbreviated numeric report of population data is printed. Default is IGRPOP = 0.

IGRPM This parameter allows plotting of the population weighted $\bar{\chi}/Q$ (PM) versus time if initialized. Default is IGRPM = 0.

IGRPL This parameter allows plotting of the total population affected by aquatic pathways if nonzero. Default is IGRPL = 0.

IGRTNU This parameter allows plotting of the total radionuclide release rate, in curies per 70-yr period versus time, if nonzero. Default is IGRTNU = 0.

When the population control integer IPOP is equal to 2, one set of population distribution data is read. This data set uses record of type 8 and 9 as described in Table E.8. One record of type 8 is read followed by NSECT records of type 9. Each type 9 record contains data for one sector and each distance interval.

When airborne release data are to be included in the input stream (IAIR > and ILUA = 1), the data are supplied on records of type 10, 11 and 12. One set of records is read for each radionuclide. Reading is terminated by placing a zero value for parameter NT of record type 11. These records are described in Table E.9.

TABLE E.8. Record Types 8 and 9, Population Distribution

Parameter	Columns	Format	Description
Record Type 8			
T(1)	1-10	E10.2	Time at which the population distribution data is defined, years A.D.
Record Type 9			
POP(10,i)	1-8	10E8.1	Population residing within each distance interval in sector 8, persons
	9-16		
	.		
	.		
	.		
	73-80		

When waterborne releases are to be included in the input stream (IWAT > 0 and LUW = 1), the data are read using record types 10, 11 and 12 as for the airborne release set.

Calculations are performed after input of necessary data. If additional cases are to be considered, the same card types are used based on new values given for the control parameters in the new NAMELIST set. Each succeeding case starts with input of a title card and a NAMELIST INPUT set.

TABLE E.5. (contd)

IGRNUC	This parameter allows plotting of the release rates of individual nuclides, curies per 70-yr period, versus time if nonzero. If IGRNUC is equal to zero a numeric report of release activity is printed for each radionuclide. Default is IGRNUC = 0.
IGRDOS	This parameter allows plotting of the dose to each organ versus time in the output if nonzero. Default: IGRDOS = Ø.

The NAMELIST parameter IEOQ controls input of atmospheric dispersion data. When IEOQ = 1, normalized air concentration data (E/Q) are read on records of type 6 as described in Table E.6. The number of records of this type to be read is equal to the number of sectors (NSECT from NAMELIST). Each record contains data for one sector.

TABLE E.6. Record Type 6, Air Concentrations

Parameter	Columns	Format	Description
EOQ(10,i)	1-8 9-16 . . . 73-80	10E8.1	Normalized air concentration values for each distance interval in a direction i, sec/m^3.

When IEOQ = 2, the normalized air concentration values are to be calculated from annual average meteorological data of joint frequency of occurrence of windspeed, atmospheric stability and wind direction. This data is read from records of type 7 as described in Table E.7. Each record contains data for one windspeed group, one stability and all (NSECT) sectors. The total number of records of this type is given by the product of NUBAR and NMET.

TABLE E.7. Record Type 7, Joint Frequency Data

Parameter	Columns	Format	Description
F(i,j,16)	1-5 6-10 . . . 76-80	16F5.2	Joint frequency meteorological data for windspeed group i, atmospheric stability group j and up to 16 sectors. Values are supplied as percent of time for persistence of each condition.

TABLE E.9. Record Types 10, 11 and 12, Radionuclides Release Data

Parameter	Columns	Format	Description
Record Type 10	(NNAT)		
	1-5	I5	Number of radionuclides activity release data are supplied for.
Record Type 11			
E	1-2	A2	Element symbol for the current radionuclide.
A	3-8	A6	Atomic weight symbol for the current radionuclide.
	9-10	2X	Blank
NT	11-15	I5	Number of times for which release rates will be supplied, NT $\leq$ 300. When NT $\leq$ 0, reading of activity release data is terminated. NT determines the number of records of type 12 to be read.
Record Type 12			
TA(i)	1-10	E10.2	Time at which the current release rate is defined; years since start of release based on parameter TZR.
C(i)	11-20	E10.2	Release rate, Ci/yr, for the current radionuclide at time TA(i).

APPENDIX F

SAMPLE PROBLEM

APPENDIX F
SAMPLE PROBLEM

DITTY SAMPLE PROBLEMS

Sample problems for DITTY are provided to:

1) familiarize the user with DITTY input preparation,
2) give examples of DITTY input and output,
3) create a basis for hand calculations and checking of the computer code logic, and
4) establish a reference for verification of future versions and modifications of DITTY.

Seven sample problems (i.e., cases) are included to give adequate coverage of the wide range of input options available to the user. The seven sample problems are organized into three sets of inputs. Each set is an execution file containing system control records, a master radionuclide list, indices of selected organs and input parameters for one or more sample problems. The organization of the execution file was presented in Appendix E. Sample Set 1 contains the first sample problem, Sample Set 2 contains Sample Problems Two, Three, and Four, and Sample Set 3 contains Sample Problems Five, Six, and Seven. Table F.1 summarizes input parameter usage in the sample problems.

Set One

The Sample Set 1 input file is shown in Figure F.1. Only one radionuclide (^{241}Am), one organ (total body), and one problem or case are considered in this set. All input for this set is contained in the execution file; no auxiliary files are used.

Set Two

Figure F.2 is the Sample Set 2 execution file. Sample Set 2 considers airborne release pathways. Radionuclide release data for ^{241}Am and ^{238}Pu is read for Sample Problem Two and used in Sample Problems Two and Three. (Note: the acute release of ^{241}Am is not considered in Sample Problem Two.) New

TABLE F.1. Sample Problem Input Parameter Values

Input Parameter	Sample Set 1	Sample Set 2			Sample Set 3		
	One	Two	Three	Four	Five	Six	Seven
IPATH	1	1	1	1	2	2	0
IAC	1	0	1	0	0	1	0
IAIR	1	1	0	1	-	-	1
LUA	1	1	-	0	-	-	1
IWAT	-	-	-	-	1	0	-
LUW	-	-	-	-	0	-	-
IPA	1	-	1	-	-	-	-
IPOP	6	4	0	2	-	-	2
IPL	-	-	-	-	-	2	-
IPOPL	-	-	-	-	2	0	-
IEOQ	-	-	-	2	-	-	2
NORG	1	2	2	2	5	5	5
KORG(n)	1	1,6	1,6	1,6	1,6,8, 16,23	1,6,8, 16,23	1,6,8, 16,23
Organs considered	T. Body	T. Body Bone	T. Body Bone	T. Body Bone	T. Body Bone Lung Thyroid LLI	T. Body Bone Lung Thyroid LLI	T. Body Bone Lung Thyroid LLI
Radionuclides released to air	^{241}Am	^{238}Pu	^{241}Am ^{238}Pu	^{90}Sr			^{90}Sr
Radionuclides released to water					^{90}Sr ^{129}I	^{90}Sr ^{129}I ^{14}C	^{90}Sr ^{129}I

```
!-------------------------------------------------------------------------
!
!      DITTY Sample Set 1 Execution File for ETRA VAX/CMS
!             Environmental Transport and Risk Assessment Group
!             ERA Section of EDS
!
!             Written by R. A. Peloquin  ETRA   Version of 22-AUG-85
!
!-------------------------------------------------------------------------
!
$ASSIGN RMDLIB.DAT FOR010
$ASSIGN FTRANSLIB.DAT FOR012
$ASSIGN BIOAC1.DAT FOR014
$ASSIGN GRDFLIB.DAT FOR016
$ASSIGN DSFCT.DAT FOR018
$RUN disk1:[etra]ditty
Sample Problem One - Airborne release in first period only, acute exposure
    1
AM241
    1
  1
 $INPUT
  IPATH=1, IAC=1, IAIR=1, LUA=1, IPOP=6,
  TZ=1990., TZR=1990.,
  IPA=1, PMA=1.0E-4,
  EXTIM=2920.,
  GRWP(1)= 90., 90., 90., 30., 90., 90., 90.,
  YELD(1) = 1.5, 2.5, .84, 1.3, 0.84, 0.84, 0.84,
  RIRR = 150., MOPYR = 3,
  CONSUM(1)=15., 279., 20., 230., 40., 30., 8.5,
 $END
    1
AM241        2    1
     0.       1.0E+04
     1.       .0
$!
$!
$!------------------------------------------------------------------------
```

FIGURE F.1. Sample Set 1 Input

```
!------------------------------------------------------------------------------
!
!       DITTY Sample Set 2 Execution File for ETRA VAX/CMS
!               Environmental Transport and Risk Assessment Group
!               ERA Section of EDS
!
!               Written by R. A. Peloquin  ETRA   Version of 22-AUG-85
!
!------------------------------------------------------------------------------
!
$ASSIGN RMDLIB.DAT FOR010
$ASSIGN FTRANSLIB.DAT FOR012
$ASSIGN BIOAC1.DAT FOR014
$ASSIGN GRDFLIB.DAT FOR016
$ASSIGN DSFCT.DAT FOR018
$assign dit_sam2.pop for022
$assign dit_sam2.inv for026  (13)
$RUN disk1:[etra]DITTY
Sample Problem Two - Airborne release, chronic exposure
    3
AM241
PU238
SR90
    2
  1  6
 $INPUT
  IPATH=1, IAIR=1, LUA=1, TZ=1990., TZR=1990.,
  IPOP=4, NTA=4, T(1)=3000., 6000., 9000., 12000.,
  PM1(1)=2.0E-4, 3.0E-4, 4.0E-4, 3.0E-4,
  EXTIM=2920., GRWP(1)= 90., 90., 90., 30., 90., 90., 90.,
  YELD(1) = 1.5, 2.5, .84, 1.3, 0.84, 0.84, 0.84,
  RIRR = 150., MOPYR = 3,
  CONSUM(1)=15., 279., 20., 230., 40., 30., 8.5, $END
    2
AM241         2
     0.       1.0E+04  (3)
     1.       .0
PU238         10
  1000.       1.0
  1500.       1.5
  2000.       2.0
  2500.       3.0
  3000.       3.0
  3500.       2.5
  4000.       2.0
  4500.       1.8
  5000.       1.5
  5500.       1.0
Sample Problem Three - Airborne release, acute and chronic exposure
 $INPUT
   IAC=1, IAIR=0, IPA=1, PMA=1.0E-04, IPOP=0,  (8)
   IGRPM=1, IGRDOS=1,
 $END
```

FIGURE F.2. Sample Set 2 Input

```
Sample Problem Four - Airborne release, release data from file, IPOP=2
 $INPUT
   IAC=0, IAIR=1, LUA=0,
   IEOQ=2, HS=0.0,  NMET=4,  NUBAR=6,  NDIST=9,  NSECT=16,
   MET(1)=2,1,6,4,
   UBAR(1)= 0.8, 2.5, 4.5, 6.9, 9.5, 12.5,
   DIST(1)=  805., 2414., 4023., 5632., 7241., 1.2E4, 2.4E4, 4.0E4, 5.6E4,
   IPOP=2, NTA=5, T(2)=4000., 6000., 9000., 12000.,
   PM1(2) = 5.0E5, 1.0E6, 1.50E6, 1.00E6,
   IGRPM=0, IGRTNU=0, IGRDOS=0, $END
 .07  .05  .06  .06  .07  .11  .07  .11  .06  .08  .07  .10  .09  .14  .10  .08   14
 .33  .27  .32  .30  .36  .72  .45  .54  .44  .59  .54  .67  .68  .77  .63  .79
 .55  .54  .41  .42  .36  .48  .27  .25  .20  .27  .24  .25  .33  .41  .50  .54
 .79  .74  .33  .28  .44  .39  .17  .20  .15  .15  .21  .18  .15  .30  .39  .55
 .04  .03  .01  .02  .02  .14  .15  .10  .17  .18  .26  .47  .44  .39  .15  .04
 .24  .26  .20  .26  .44  .68  .62  .63  .56  .90 1.70 2.48 2.45 2.29  .93  .36
 .28  .21  .16  .20  .34  .28  .17  .20  .21  .25  .30  .45  .81  .96  .63  .39
1.12  .78  .53  .54  .60  .66  .34  .35  .50  .52  .48  .43  .65 1.25 1.33 1.16
 .00  .00  .00  .00  .00  .02  .03  .01  .02  .05  .39  .21  .78  .43  .01  .00
 .07  .02  .03  .06  .11  .21  .39  .25  .28  .62 1.74 2.48 4.06 2.50  .46  .11
 .16  .05  .03  .04  .08  .10  .11  .09  .27  .32  .53  .65 1.23 1.02  .32  .14
 .46  .18  .08  .09  .06  .08  .08  .08  .27  .50  .76  .30  .75 1.33  .42  .34
 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .01  .00  .01  .00  .00  .00
 .01  .01  .00  .00  .00  .03  .04  .11  .17  .43  .65  .34 1.42  .93  .04  .01
 .04  .05  .01  .00  .01  .01  .04  .08  .30  .60  .52  .38 1.33  .86  .09  .06
 .16  .06  .00  .00  .00  .00  .03  .02  .15  .48  .67  .25  .64  .80  .07  .06
 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00
 .00  .02  .00  .00  .00  .01  .03  .04  .11  .19  .09  .02  .25  .14  .00  .01
 .01  .02  .00  .00  .00  .00  .00  .05  .17  .35  .17  .05  .62  .65  .02  .01
 .01  .00  .00  .00  .00  .00  .00  .00  .06  .32  .29  .05  .32  .57  .01  .03
 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00
 .00  .00  .00  .00  .00  .00  .01  .00  .06  .09  .02  .00  .02  .00  .00  .00
 .00  .00  .00  .00  .00  .00  .00  .01  .11  .13  .06  .01  .08  .11  .00  .00
 .00  .00  .00  .00  .00  .00  .00  .00  .02  .17  .08  .01  .11  .21  .01  .00
    1984.
      0.       0.       0.       0.       0.    631.  11039.    867.    158.    15
      0.       0.       0.       0.       0.    557.  17391.   1071.    456.
      0.       0.       0.       0.       0.    980.   2972.  14922.   5188.
      0.       0.       0.       0.       0.    396.    509.   3836.  80329.
      0.       0.       0.       0.       0.    244.    769.   1038.    572.
      0.       0.       0.       0.       0.    233.    243.    408.   1098.
      0.       0.       0.       0.       0.     28.    474.    246.   4318.
      0.       0.       0.       0.       0.     21.   1122.    498.   2910.
      0.       0.       0.       0.       0.      5.    796.   1052.  17014.
      0.       0.       0.       0.       0.    308.   6606.   2653.    704.
      0.       0.       0.       0.       0.    288.   1798.   2536.   1012.
      0.       0.       0.       0.       0.    142.    428.    623.    977.
      0.       0.       0.       0.       0.    321.   1830.    155.    348.
      0.       0.       0.       0.       0.      4.  37974.  51102.    948.
      0.       0.       0.       0.       0.   2113.   1303.    341.   2308.
      0.       0.       0.       0.       0.   1136.   1815.     56.    610.
$!----------------------------------------------------------------------
```

FIGURE F.2. (contd)

radionuclide release data is read for Sample Problem Four. Release data is read both from the execution file and from an auxiliary file. Doses are calculated for total body and bone in each case. Sample Problem Three is a combination of Sample Problems One and Two. The dose totals from Sample Problems One and Two should equal the doses in Sample Problem Three.

Set Three

The Sample Set 3 execution file is shown in Figure F.3. Both waterborne and airborne pathways are considered in this set. Waterborne release data is read from an auxiliary file in Sample Problem Five and used for Sample Problems Five, Six, and Seven. (Note: the acute release of ^{14}C is only considered [IAC=1] in Sample Problem Six.) Waterborne release data is read both from the execution file (^{90}Sr and ^{129}I) and from an auxiliary file (^{14}C). Airborne release data (^{238}Pu) is read from the execution file. Additional ^{238}Pu airborne release data is read for Sample Problem Seven from the execution file. Doses to total body, bone, lung, thyroid, and the lower large intestine of the GI-tract are calculated in this set. Sample Problem Seven is a composite of Sample Problems Four and Five. The dose totals from Sample Problems Four and Five should equal the dose received in Sample Problem Seven.

Computer System commands have been included with each sample set as an aid to user. These system commands are for the VAX-11/780 computer. The user is responsible for appropriate syntax and file assignments on the host computer.

The input and output listings of the sample problems have been annotated with circled numbers to clarify the following discussion. These annotations are referred to as "item #n" in the text. An index of all annotations is given in Table F.2.

```
!------------------------------------------------------------------------
!
!      DITTY Sample Set 3 Execution File for ETRA VAX/CMS
!             Environmental Transport and Risk Assessment Group
!             ERA Section of EDS
!
!             Written by R. A. Peloquin  ETRA   Version of 22-AUG-85
!
!------------------------------------------------------------------------
!
$ASSIGN RMDLIB.DAT FOR010
$ASSIGN FTRANSLIB.DAT FOR012
$ASSIGN BIOAC1.DAT FOR014
$ASSIGN GRDFLIB.DAT FOR016
$ASSIGN DSFCT.DAT FOR018
$assign dit_sam3.inv for024   (22)
$RUN disk1:[etra]DITTY
Sample Problem Five - Waterborne release, chronic exposure
    4
I 129
SR90
C 14
PU238
    5
  1  6  8 16 23                                                        (21)
 $INPUT
  IAC=0, IWAT=1, IPATH=2, LUW=2, TZ=1990., TZR=1990., IPOPL=2, NTL=6,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  CFLO=120000.,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,279.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,2.5,0.84,1.3,3*0.84,
 $END
Sample Problem Six - Waterborne release, acute and chronic exposure
 $INPUT
   IAC=1, IWAT=0, IPOPL=0, IPA=2, PPL=2.E5                            (27)
 $END
Sample Problem Seven - Airborne and waterborne release, chronic exposure
 $INPUT
  IAC=0, IPATH=0, IAIR=1, LUA=1, IPOP=2,                              (29)
  NTA=5, T(2)=4000., 6000., 9000., 12000.,
  PM1(2)=5.0E5, 1.0E6, 1.5E6, 1.0E6,
  IEOQ=2, HS=0.0,  NMET=4,  NUBAR=6,  NDIST=9,  NSECT=16,
  MET(1)=2,1,6,4,
  UBAR(1)= 0.8, 2.5, 4.5, 6.9, 9.5, 12.5,
  IGRTNU=1
  DIST(1)=  805., 2414., 4023., 5632., 7241., 1.2E4, 2.4E4, 4.0E4, 5.6E4,
 $END
```

FIGURE F.3. Sample Set 3 Input

```
 .07  .05  .06  .06  .07  .11  .07  .11  .06  .08  .07  .10  .09  .14  .10  .08
 .33  .27  .32  .30  .36  .72  .45  .54  .44  .59  .54  .67  .68  .77  .63  .79
 .55  .54  .41  .42  .36  .48  .27  .25  .20  .27  .24  .25  .33  .41  .50  .54
 .79  .74  .33  .28  .44  .39  .17  .20  .15  .15  .21  .18  .15  .30  .39  .55
 .04  .03  .01  .02  .02  .14  .15  .10  .17  .18  .26  .47  .44  .39  .15  .04
 .24  .26  .20  .26  .44  .68  .62  .63  .56  .90 1.70 2.48 2.45 2.29  .93  .36
 .28  .21  .16  .20  .34  .28  .17  .20  .21  .25  .30  .45  .81  .96  .63  .39
1.12  .78  .53  .54  .60  .66  .34  .35  .50  .52  .48  .43  .65 1.25 1.33 1.16
 .00  .00  .00  .00  .00  .02  .03  .01  .02  .05  .39  .21  .78  .43  .01  .00
 .07  .02  .03  .06  .11  .21  .39  .25  .28  .62 1.74 2.48 4.06 2.50  .46  .11
 .16  .05  .03  .04  .08  .10  .11  .09  .27  .32  .53  .65 1.23 1.02  .32  .14
 .46  .18  .08  .09  .06  .08  .08  .08  .27  .50  .76  .30  .75 1.33  .42  .34
 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .01  .00  .01  .00  .00  .00
 .01  .01  .00  .00  .00  .03  .04  .11  .17  .43  .65  .34 1.42  .93  .04  .01
 .04  .05  .01  .00  .01  .01  .04  .08  .30  .60  .52  .38 1.33  .86  .09  .06
 .16  .06  .00  .00  .00  .00  .03  .02  .15  .48  .67  .25  .64  .80  .07  .06
 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00
 .00  .02  .00  .00  .00  .01  .03  .04  .11  .19  .09  .02  .25  .14  .00  .01
 .01  .02  .00  .00  .00  .00  .00  .05  .17  .35  .17  .05  .62  .65  .02  .01
 .01  .00  .00  .00  .00  .00  .00  .00  .06  .32  .29  .05  .32  .57  .01  .03
 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00
 .00  .00  .00  .00  .00  .00  .01  .00  .06  .09  .02  .00  .02  .00  .00  .00
 .00  .00  .00  .00  .00  .00  .00  .01  .11  .13  .06  .01  .08  .11  .00  .00
 .00  .00  .00  .00  .00  .00  .00  .00  .02  .17  .08  .01  .11  .21  .01  .00
     1984.
      0.       0.       0.       0.       0.     631.  11039.    867.    158.
      0.       0.       0.       0.       0.     557.  17391.   1071.    456.
      0.       0.       0.       0.       0.     980.   2972.  14922.   5188.
      0.       0.       0.       0.       0.     396.    509.   3836.  80329.
      0.       0.       0.       0.       0.     244.    769.   1038.    572.
      0.       0.       0.       0.       0.     233.    243.    408.   1098.
      0.       0.       0.       0.       0.      28.    474.    246.   4318.
      0.       0.       0.       0.       0.      21.   1122.    498.   2910.
      0.       0.       0.       0.       0.       5.    796.   1052.  17014.
      0.       0.       0.       0.       0.     308.   6606.   2653.    704.
      0.       0.       0.       0.       0.     288.   1798.   2536.   1012.
      0.       0.       0.       0.       0.     142.    428.    623.    977.
      0.       0.       0.       0.       0.     321.   1830.    155.    348.
      0.       0.       0.       0.       0.       4.  37974.  51102.    948.
      0.       0.       0.       0.       0.    2113.   1303.    341.   2308.
      0.       0.       0.       0.       0.    1136.   1815.     56.    610.
    1
SR90          5      30
  1000.     100.
  1500.     200.
  1800.     200.
  2000.     150.
  3000.       0.
$!--------------------------------------------------------------------------
```

FIGURE F.3. (contd)

TABLE F.2. Sample Problems Annotation Index

Item Number	Figure Number	Description
1	F.1	Specification of an acute release, Sample Problem One
2	F.4	Resulting cumulative dose, Sample Problem One
3	F.2	Specification of an acute release, Sample Problem Two
4	F.5	Airborne population dispersion factors as input
5	F.5	Airborne population dispersion factors interpolated for each 70-year time period
6	F.5	Radionuclide release interpolated for each 70-year time period
7	F.5	Resulting cumulative dose, Sample Problem Two
8	F.2	Use of NAMELSIT to change parameter values for subsequent cases in a set
9	F.6	Population dispersion graphic report
10	F.6	Resulting cumulative dose to total body graphic report, Sample Problem Three
11	F.6	Maximum dose rate report, Sample Problem Three
12	F.6	Percent of total dose to organ by radionuclide, Sample Problem Three
13	F.2	Assignment of airborne release auxiliary file (lun 26)
14	F.2	Input of joint frequency data
15	F.2	Input of initial population distribution
16	F.8	Report of initial population distribution
17	F.8	Report of input population dispersion factors
18	F.8	Report of population dispersion factors calculated for the 144 70-year time periods
19	F.8	Joint frequency data report
20	F.8	Resulting cumulative dose, Sample Problem Four
21	F.3	Sample Problem Five input
22	F.3	Assignment of waterborne release auxiliary file (lun 24)
23	F.9	Specification of an acute release, Sample Problem Five
24	F.10	Resulting cumulative dose, Sample Problem Five
25	F.10	Maximum dose rate report, Sample Problem Five
26	F.10	Percent of total dose report, Sample Problem Five
27	F.3	Sample Problem Six input

TABLE F.2 (contd)

Item Number	Figure Number	Description
28	F.11	Resulting cumulative dose, Sample Problem Six
29	F.3	Sample Problem Seven input
30	F.3	Release data input, Sample Problem Six
31	F.12	Resulting cumulative dose, Sample Problem Seven

SAMPLE PROBLEM ONE

The first sample problem attempts to acquaint the user with DITTY execution on an elementary level. It is suggested that this problem be executed before proceeding to the remaining sample problems.

The user specifies a case title (Record type 1), the master radionuclide list (Record types 2 and 3), selected organs (Record types 4 and 5), NAMELIST INPUT parameters (see Table E.5), and the radionuclide release data (Record types 10, 11, and 12) for a single case as shown in Figure F.1.

Sample Problem One simulates acute exposure (IAC=1) to an airborne release (IPATH=1) of ^{241}Am in the calendar year of 1990 (TZ). Release data is entered for this case (IAIR=1) in the execution file (LUA=1). A value is provided (IPA=1) for the population dispersion factor (PMA=1.0×10^{-4}). Constant population is assumed (IPOP=6) for this acute release. Generic values are used for terrestrial pathway parameters (EXTIM, GRWP, YELD, RIRR, MOPYR, and CONSUM).

The user should note the method used to specify an acute release. The acute release data history begins in year 1990 (TZR). For an acute release, this date must be the same year as the beginning of the 10,000 year integration period (TZ). The acute release of 10,000 curies of ^{241}Am is entered as a time off-set from the start of the release data history of 0 (item #1 in Figure F.1). When specifying an acute release, a release of 0.0 curies must be entered at year 1 of the release history data to turn off the acute exposure.

In this sample set only dose to total body is calculated. A cumulative population dose of 18,000 person-rem is received by the local population over 10,000 years as shown in Figure F.4 (item #2).

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem One - Airborne release in first period only, acute exposure

*** DATA LIBRARIES USED: (FILE)

MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)
AIRBORNE RELEASE DATA :	(26)	INPUT

*** ORGANS CONSIDERED:
TOTAL BODY

*** MASTER RADIONUCLIDE CONTROL LIST:
AM241

*** POPULATION DATA:

POPULATION DISPERSION FACTOR FOR ACUTE AIRBORNE RELEASE = 1.00E-04
NO CHRONIC AIRBORNE RELEASE, CONSTATNT POPULATION ASSUMED.

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	0.00E+00
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	0.00E+00
SEDIMENT EXPOSURE	0.00E+00
SWIMMING TIME	0.00E+00

*** AIR RELEASE OF EACH RADIONUCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

RADIONUCLIDE	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY
AM241	0	1.00E+04										

INPUT PREPARED BY: ****************** DATE: 2/5/86 ********** INPUT CHECKED BY: Bruce Napier **************** DATE: 5 Feb 86 **********

FIGURE F.4. Sample Problem One Output

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem One - Airborne release in first period only, acute exposure

* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A FUNCTION OF TIME * * *

PERIOD	YEAR	TOTAL BODY
ACUTE		1.84E+04
until		
144	11930.	1.84E+04

2

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.4. (contd)

(blank)

SAMPLE PROBLEM TWO

Sample Problem Two is the first of three problems in Sample Set 2. The DITTY execution file for Sample Set 2 is shown in Figure F.2.

Sample Problem Two simulates chronic exposure to an airborne release (IPATH=1) of ^{238}Pu. The 10,000 year integration period begins in calendar year 1990 (TZ). Population dispersion values (PM1) are estimated at four (NTA=4) times (T) during the 10,000 year period. Generic values are used for terrestrial pathway parameters (EXTIM, GRWP, YELD, RIRR, MOPYR, and CONSUM).

Radionuclide release data is read (IAIR=1) from the execution file (LUA-=1). The starting time of the release history is year 1990 A.D. (TZR). A varying quantity of 1.0 to 3.0 curies of ^{238}Pu (see #3 in Figure F.2) is released to the atmosphere during calendar years 2990 (1000 + 1990) through 7490 (5500 + 1990). Note that ^{241}Am acute release data is also entered at this time. ^{241}Am is not considered in Sample Problem Two because an acute release (IAC) is not specified. The ^{241}Am release is considered in Sample Problem Three.

Figure F.5 is partial output from Sample Problem Two. In addition to a report of input parameters, tables of population dispersion, as entered (item #4) and as interpolated for each 70-year time period (item #5), are included. Radionuclide releases as interpolated for each 70-year time period are listed (item #6). The cumulative dose report (item #7) shows doses of 27,000 person-rem to total body and 5.7×10^5 person-rem to bone at the end of the 10,000-year integration period.

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Two - Airborne release, chronic exposure

*** DATA LIBRARIES USED:

	(FILE)	
MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)
AIRBORNE RELEASE DATA :	(26)	INPUT

*** ORGANS CONSIDERED:
TOTAL BODY BONE

*** MASTER RADIONUCLIDE CONTROL LIST:
SR90 Y 90 PU238 AM241

*** POPULATION DATA:

POPULATION DISPERSION FACTORS FOR CHRONIC AIRBORNE RELEASE AT THE FOLLOWING TIMES A.D.:

TIME	POP-DISP-FT	TIME	POP-DISP-FT	TIME	POP-DISP-FT	TIME	POP-DISP-FT	TIME	POP-DISP-FT
3000.	2.00E-04	60000.	3.00E-04	90000.	4.00E-04	120000.	3.00E-04		

4

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	0.00E+00
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	0.00E+00
SEDIMENT EXPOSURE	0.00E+00
SWIMMING TIME	0.00E+00

FIGURE F.5. Sample Problem Two Output

*** AIR RELEASE OF EACH RADIONUCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

6

RADIONUCLIDE	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY
SR90												
Y 90												
PU238	15	51.	16	76.	17	81.	18	86.	19	91.	20	96.
	21	1.00E+02	22	1.05E+02	23	1.10E+02	24	1.15E+02	25	1.20E+02	26	1.25E+02
	27	1.30E+02	28	1.35E+02	29	1.40E+02	30	1.49E+02	31	1.59E+02	32	1.69E+02
	33	1.79E+02	34	1.88E+02	35	1.98E+02	36	2.08E+02	37	2.10E+02	38	2.10E+02
	39	2.10E+02	40	2.10E+02	41	2.10E+02	42	2.10E+02	43	2.10E+02	44	2.07E+02
	45	2.02E+02	46	1.97E+02	47	1.92E+02	48	1.87E+02	49	1.82E+02	50	1.77E+02
	51	1.73E+02	52	1.68E+02	53	1.63E+02	54	1.58E+02	55	1.53E+02	56	1.48E+02
	57	1.43E+02	58	1.39E+02	59	1.37E+02	60	1.35E+02	61	1.33E+02	62	1.31E+02
	63	1.30E+02	64	1.28E+02	65	1.25E+02	66	1.22E+02	67	1.19E+02	68	1.17E+02
	69	1.14E+02	70	1.11E+02	71	1.08E+02	72	1.04E+02	73	1.00E+02	74	95.
	75	90.	76	85.	77	80.	78	75.	79	41.		
AM241	0	1.00E+04										

*** POPULATION DISPERSION FACTOR FOR AIRBORNE RELEASE, PERSON-SEC/M**3

5

PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM
0	0.00E+00	1	2.00E-04	2	2.00E-04	3	2.00E-04	4	2.00E-04	5	2.00E-04
6	2.00E-04	7	2.00E-04	8	2.00E-04	9	2.00E-04	10	2.00E-04	11	2.00E-04
12	2.00E-04	13	2.00E-04	14	2.00E-04	15	2.00E-04	16	2.02E-04	17	2.05E-04
18	2.07E-04	19	2.09E-04	20	2.12E-04	21	2.14E-04	22	2.17E-04	23	2.19E-04
24	2.21E-04	25	2.23E-04	26	2.26E-04	27	2.28E-04	28	2.31E-04	29	2.33E-04
30	2.35E-04	31	2.38E-04	32	2.40E-04	33	2.42E-04	34	2.44E-04	35	2.47E-04
36	2.49E-04	37	2.51E-04	38	2.54E-04	39	2.56E-04	40	2.59E-04	41	2.61E-04
42	2.63E-04	43	2.66E-04	44	2.68E-04	45	2.70E-04	46	2.73E-04	47	2.75E-04
48	2.77E-04	49	2.80E-04	50	2.82E-04	51	2.84E-04	52	2.87E-04	53	2.89E-04
54	2.91E-04	55	2.94E-04	56	2.96E-04	57	2.98E-04	58	3.01E-04	59	3.03E-04
60	3.05E-04	61	3.08E-04	62	3.10E-04	63	3.12E-04	64	3.15E-04	65	3.17E-04
66	3.19E-04	67	3.22E-04	68	3.24E-04	69	3.26E-04	70	3.28E-04	71	3.31E-04
72	3.33E-04	73	3.35E-04	74	3.38E-04	75	3.40E-04	76	3.43E-04	77	3.45E-04
78	3.47E-04	79	3.50E-04	80	3.52E-04	81	3.54E-04	82	3.57E-04	83	3.59E-04
84	3.61E-04	85	3.64E-04	86	3.66E-04	87	3.68E-04	88	3.70E-04	89	3.73E-04
90	3.75E-04	91	3.77E-04	92	3.80E-04	93	3.82E-04	94	3.84E-04	95	3.87E-04
96	3.89E-04	97	3.91E-04	98	3.94E-04	99	3.96E-04	100	3.99E-04	101	3.99E-04
102	3.97E-04	103	3.94E-04	104	3.92E-04	105	3.90E-04	106	3.87E-04	107	3.85E-04
108	3.83E-04	109	3.80E-04	110	3.78E-04	111	3.76E-04	112	3.73E-04	113	3.71E-04
114	3.69E-04	115	3.66E-04	116	3.64E-04	117	3.62E-04	118	3.60E-04	119	3.57E-04
120	3.55E-04	121	3.53E-04	122	3.50E-04	123	3.48E-04	124	3.46E-04	125	3.43E-04
126	3.41E-04	127	3.39E-04	128	3.36E-04	129	3.34E-04	130	3.32E-04	131	3.29E-04
132	3.27E-04	133	3.25E-04	134	3.22E-04	135	3.20E-04	136	3.18E-04	137	3.15E-04
138	3.13E-04	139	3.11E-04	140	3.08E-04	141	3.06E-04	142	3.04E-04	143	3.01E-04

INPUT PREPARED BY: [illegible] DATE: 2/5/86 INPUT CHECKED BY: Bruce Napier DATE: 5 Feb 86

FIGURE F.5. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Two - Airborne release, chronic exposure

* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A FUNCTION OF TIME * * *

PERIOD	YEAR	TOTAL BODY	BONE
1	1990.	0.00E+00	0.00E+00
until			
16	3040.	1.13E+02	2.36E+03
17	3110.	2.82E+02	5.89E+03
18	3180.	4.64E+02	9.69E+03
19	3250.	6.59E+02	1.38E+04
20	3320.	8.67E+02	1.81E+04
21	3390.	1.09E+03	2.28E+04
22	3460.	1.33E+03	2.77E+04
23	3530.	1.58E+03	3.30E+04
24	3600.	1.84E+03	3.85E+04
25	3670.	2.12E+03	4.44E+04
26	3740.	2.42E+03	5.05E+04
27	3810.	2.73E+03	5.70E+04
28	3880.	3.05E+03	6.38E+04
29	3950.	3.39E+03	7.09E+04
30	4020.	3.75E+03	7.84E+04
31	4090.	4.14E+03	8.65E+04
32	4160.	4.55E+03	9.51E+04
33	4230.	4.99E+03	1.04E+05
34	4300.	5.47E+03	1.14E+05
35	4370.	5.98E+03	1.25E+05
36	4440.	6.51E+03	1.36E+05
37	4510.	7.08E+03	1.48E+05
38	4580.	7.66E+03	1.60E+05
39	4650.	8.25E+03	1.72E+05
40	4720.	8.84E+03	1.85E+05
41	4790.	9.43E+03	1.97E+05
42	4860.	1.00E+04	2.10E+05
43	4930.	1.06E+04	2.23E+05
44	5000.	1.13E+04	2.35E+05
45	5070.	1.19E+04	2.48E+05
46	5140.	1.25E+04	2.61E+05
47	5210.	1.31E+04	2.73E+05
48	5280.	1.36E+04	2.85E+05
49	5350.	1.42E+04	2.97E+05
50	5420.	1.48E+04	3.09E+05
51	5490.	1.53E+04	3.20E+05
52	5560.	1.58E+04	3.31E+05
53	5630.	1.64E+04	3.42E+05
54	5700.	1.69E+04	3.53E+05
55	5770.	1.74E+04	3.64E+05
56	5840.	1.79E+04	3.74E+05

FIGURE F.5. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Two - Airborne release, chronic exposure

* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A FUNCTION OF TIME * * *

PERIOD	YEAR	TOTAL BODY	BONE	
57	5910.	1.84E+04	3.84E+05	
58	5980.	1.88E+04	3.94E+05	
59	6050.	1.93E+04	4.04E+05	
60	6120.	1.98E+04	4.13E+05	
61	6190.	2.02E+04	4.23E+05	
62	6260.	2.07E+04	4.32E+05	
63	6330.	2.11E+04	4.41E+05	
64	6400.	2.16E+04	4.51E+05	
65	6470.	2.20E+04	4.60E+05	
66	6540.	2.24E+04	4.69E+05	
67	6610.	2.29E+04	4.78E+05	
68	6680.	2.33E+04	4.87E+05	
69	6750.	2.37E+04	4.95E+05	
70	6820.	2.41E+04	5.04E+05	
71	6890.	2.45E+04	5.12E+05	
72	6960.	2.49E+04	5.21E+05	
73	7030.	2.53E+04	5.29E+05	
74	7100.	2.56E+04	5.36E+05	
75	7170.	2.60E+04	5.44E+05	
76	7240.	2.63E+04	5.51E+05	
77	7310.	2.67E+04	5.57E+05	
78	7380.	2.70E+04	5.64E+05	
79	7450.	2.72E+04	5.70E+05	
80	7520.	2.74E+04	5.73E+05	
until 144	12000.	2.74E+04	5.73E+05	7

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.5. (contd)

SAMPLE PROBLEM THREE

Sample Problem Three is a composite of the acute and chronic exposure scenarios defined in Sample Problems One and Two. Input parameters from Sample Problem Two remain in effect except for changes to NAMELIST parameters (item #8 in Figure F.2). The parameter IAC is set to 1 to activate the dose calculation for acute exposure. Release data for the previous sample problem is used (AIR=0). Previous population data for chronic exposure is used (IPOP=0). A population dispersion factor for the acute exposure period is added (IPA=1, PMA=1.0E-04). Graphic reports of population dispersion (IGRPM) and cumulative dose (IGRDOS) are requested.

Figure F.6 shows partial output from Sample Problem Three. A graph of the population dispersion factors as interpolated for each 70-year time period is included in the report (item #9). The graphic report of the cumulative dose to total body is shown (item #10). Item #11 indicates the maximum population dose rate report. The dose integral period during which the maximum dose rate for total body occurred during time period 1. Time period 1 is actually not a 70-year time period but the 1-year acute exposure time period. Included is a report of dose received during the stated time period by radionuclide and organ. A final report (see #12) identifies the percentage of total dose and cumulative dose by radionuclide and organ over the entire 10,000-year integration period.

A cumulative dose of 46,000 person-rem to total body is reported. This result equals the sum of dose to total body from Sample Problem One (acute exposure) and Sample Problem Two (chronic exposure). Total body doses of 18,000 and 27,000 person-rem are calculated in Sample Problem One and Two, respectively, for a total dose of 46,000 person-rem. Fifty-nine percent of the dose to total body was a result of exposure to ^{238}Pu while 40% of the total dose to total body was a result of exposure to ^{241}Am. A cumulative dose to bone of 1.1×10^6 is reported in Sample Problem Three, 54% of the dose resulting from exposure to ^{238}Pu and 45% of the dose resulting from ^{241}Am.

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Three - Airborne release, acute and chronic exposure

*** DATA LIBRARIES USED:

	(FILE)	
MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)

*** ORGANS CONSIDERED:
TOTAL BODY BONE

*** MASTER RADIONUCLIDE CONTROL LIST:
SR90 Y 90 PU238 AM241

*** POPULATION DATA:
POPULATION DISPERSION FACTOR FOR ACUTE AIRBORNE RELEASE = 1.00E-04
PREVIOUS INPUT VALUES USED FOR CHRONIC AIRBORNE RELEASE.

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	0.00E+00
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	0.00E+00
SEDIMENT EXPOSURE	0.00E+00
SWIMMING TIME	0.00E+00

*** AIR RELEASE OF EACH RADIONUCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

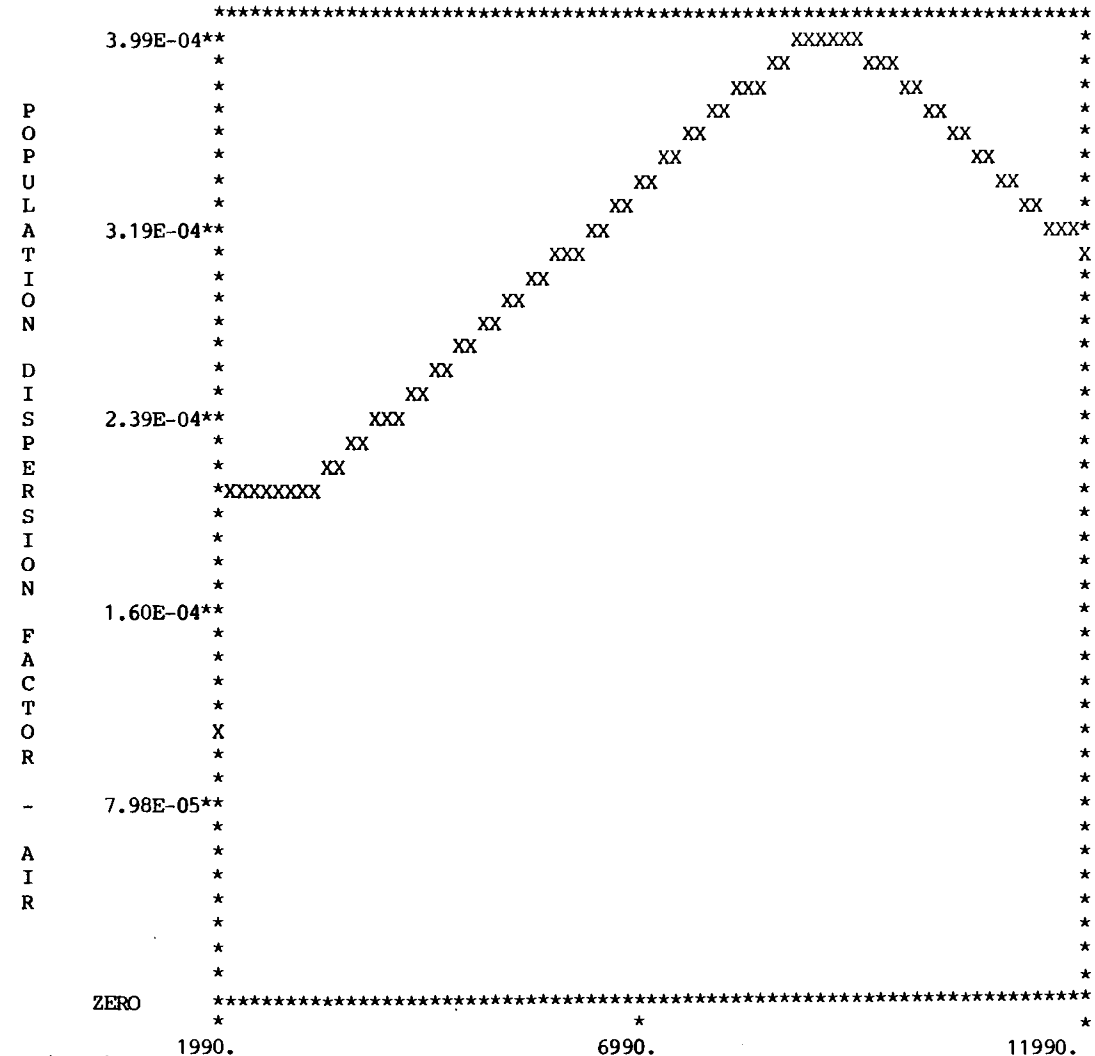
RADIONUCLIDE	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTIVITY
SR90												
Y 90												
PU238	15	51.	16	76.	17	81.	18	86.	19	91.	20	96.
	21	1.00E+02	22	1.05E+02	23	1.10E+02	24	1.15E+02	25	1.20E+02	26	1.25E+02
	27	1.30E+02	28	1.35E+02	29	1.40E+02	30	1.49E+02	31	1.59E+02	32	1.69E+02
	33	1.79E+02	34	1.88E+02	35	1.98E+02	36	2.08E+02	37	2.10E+02	38	2.10E+02
	39	2.10E+02	40	2.10E+02	41	2.10E+02	42	2.10E+02	43	2.10E+02	44	2.07E+02
	45	2.02E+02	46	1.97E+02	47	1.92E+02	48	1.87E+02	49	1.82E+02	50	1.77E+02
	51	1.73E+02	52	1.68E+02	53	1.63E+02	54	1.58E+02	55	1.53E+02	56	1.48E+02
	57	1.43E+02	58	1.39E+02	59	1.37E+02	60	1.35E+02	61	1.33E+02	62	1.31E+02
	63	1.30E+02	64	1.28E+02	65	1.25E+02	66	1.22E+02	67	1.19E+02	68	1.17E+02
	69	1.14E+02	70	1.11E+02	71	1.08E+02	72	1.04E+02	73	1.00E+02	74	95.
	75	90.	76	85.	77	80.	78	75.	79	41.		
AM241	0	1.00E+04										

FIGURE F.6. Sample Problem Three Output

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Three - Airborne release, acute and chronic exposure

9

Y-AXIS INCREMENT = 9.98E-06
X-AXIS INCREMENT = 70 YEARS



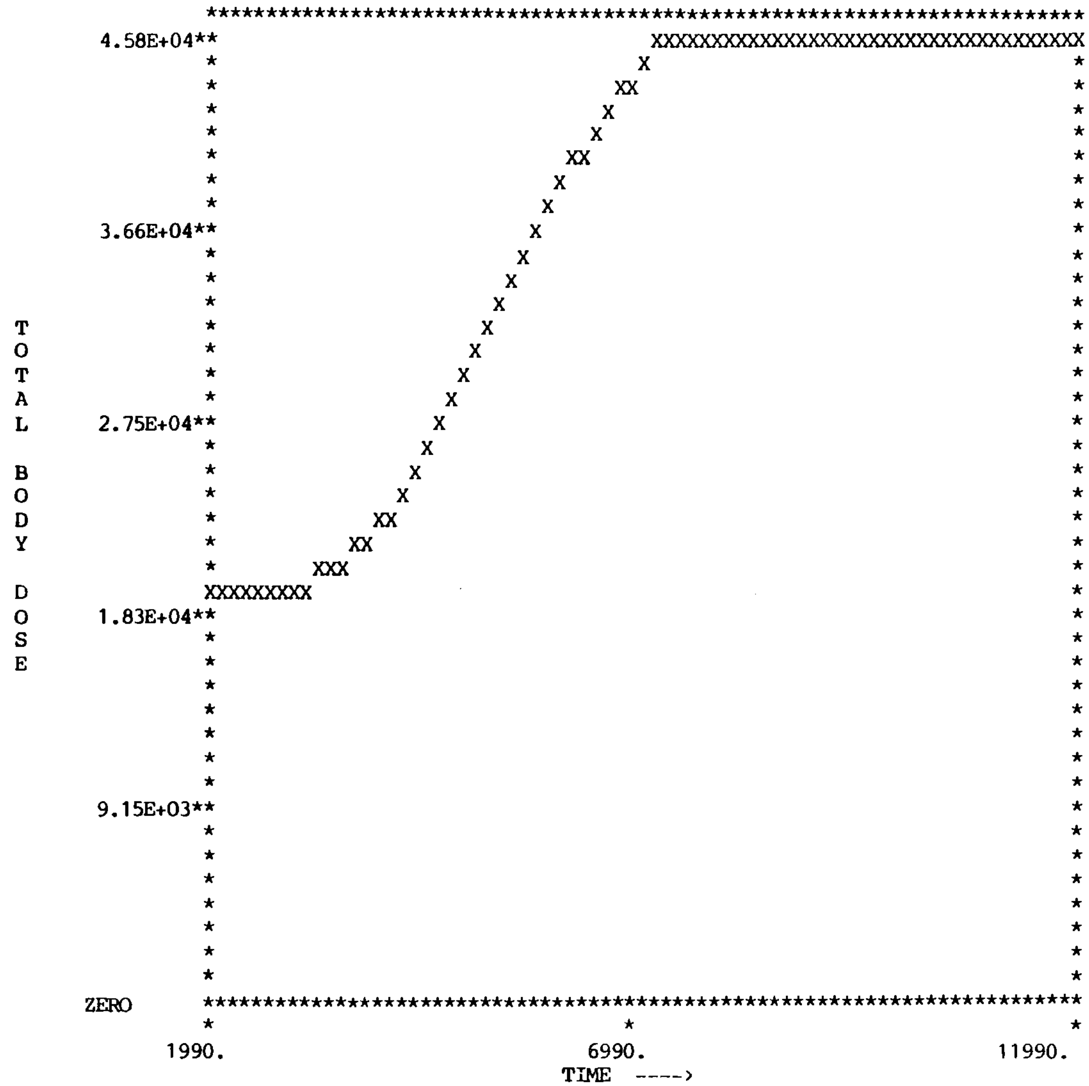
INPUT PREPARED BY: *************** DATE: 2/5/86 **********
INPUT CHECKED BY: Bruce Napier *************** DATE: 5 Feb 86 **********

FIGURE F.6. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Three - Airborne release, acute and chronic exposure

10

Y-AXIS INCREMENT = 1.14E+03
X-AXIS INCREMENT = 70 YEARS



Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.6. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE ATMOSPHERIC RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Three - Airborne release, acute and chronic exposure

* * * MAXIMUM DOSE RATE REPORT * * *
DOSE INTEGRAL PERIOD (70-YEAR) DURING WHICH THE MAXIMUM DOSE RATE OCCURS = 1

11

* * * MAXIMUM POPULATION DOSE INCREMENT TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE
SR90	0.00E+00	0.00E+00
Y 90	0.00E+00	0.00E+00
PU238	0.00E+00	0.00E+00
AM241	1.84E+04	4.80E+05
Total	1.84E+04	4.80E+05

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

* * * PERCENT OF TOTAL DOSE TO ORGAN AND CUMULATIVE DOSE TO ORGAN BY RADIONUCLIDE * * *

12

NUCLIDE	TOTAL BODY		BONE	
SR90	0%	0.0E+00	0%	0.0E+00
Y 90	0%	0.0E+00	0%	0.0E+00
PU238	59%	2.7E+04	54%	5.7E+05
AM241	40%	1.8E+04	45%	4.8E+05
Total		4.6E+04		1.1E+06

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.6. (contd)

SAMPLE PROBLEM FOUR

The fourth sample problem demonstrates some alternative input options for airborne releases. Normalized air concentrations are calculated from input meteorological data (IEQ=2). Population dispersion factors are calculated from input population data (IPOP=2).

Sample Problem Four considers on airborne release of ^{90}Sr. The acute exposure pathway is deactivated (IAC=0). Terrestrial pathway parameter values from the previous cases remain in effect. Average annual meteorological data entered through NAMELIST INPUT consists of site grid description parameters (NDIST, DIST, NSECT) and atmospheric dispersion parameters (HS, NMET, MET, NUBAR, UBAR). Population data entered through NAMELIST INPUT consists of a set (NTA) of population dispersion factors (PM1) at specified times (T). Release data will be input (IAIR=1) from an auxiliary file (LUA=0). Graphical report options are deactivated. The airborne release file is assigned to logical unit device 26 (item #13 in Figure F.2). Figure F.7 shows the file containing release data for Sample Problem Four. Joint frequency data (Record type 6) follows the NAMELIST INPUT record set (item #14 in Figure F.8). Finally, the initial population distribution is included in the format of Record types 8 and 9 (item #15 in Figure F.2).

Reports of population and atmospheric dispersion input are included in the QA PAGE report for DITTY as shown in Figure F.8. Reports of the initial population distribution (item #16) and population dispersion factors as input (item #17) are followed by a report of the calculated population dispersion factors that is used for each 70-year time period (item #18). Item #19 points to the joint frequency data report.

A cumulative dose of 1.7×10^6 and 1.5×10^7 person-rem for total body and bone, respectively, is reported for Sample Problem Four (item #20 in Figure F.8).

```
Strontium release for DITTY Sample Problem Four
    1
SR90          5
  1000.     100.
  1500.     200.
  1800.     200.
  2000.     150.
  3000.       0.
```

FIGURE F.7. Inventory File for Sample Set 2

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 4-FEB-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Four - Airborne release, release data from file, IPOP=2

*** DATA LIBRARIES USED: (FILE)

MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)
AIRBORNE RELEASE DATA :	(26)	Strontium release for DITTY Sample Problem Four

*** ORGANS CONSIDERED:
TOTAL BODY BONE

*** MASTER RADIONUCLIDE CONTROL LIST:
SR90 Y 90 PU238 AM241

*** POPULATION DATA:

POPULATION FOR CHRONIC AIRBORNE RELEASE AT TIME 1984.:

SECTOR	8.05E+02	2.41E+03	4.02E+03	5.63E+03	7.24E+03	1.20E+04	2.40E+04	4.00E+04	5.60E+04	
NNE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.31E+02	1.10E+04	8.67E+02	1.58E+02	16
NE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.57E+02	1.74E+04	1.07E+03	4.56E+02	
ENE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.80E+02	2.97E+03	1.49E+04	5.19E+03	
E	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.96E+02	5.09E+02	3.84E+03	8.03E+04	
ESE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E+02	7.69E+02	1.04E+03	5.72E+02	
SE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.33E+02	2.43E+02	4.08E+02	1.10E+03	
SSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	28.	4.74E+02	2.46E+02	4.32E+03	
S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	21.	1.12E+03	4.98E+02	2.91E+03	
SSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.0	7.96E+02	1.05E+03	1.70E+04	
SW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.08E+02	6.61E+03	2.65E+03	7.04E+02	
WSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.88E+02	1.80E+03	2.54E+03	1.01E+03	
W	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E+02	4.28E+02	6.23E+02	9.77E+02	
WNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.21E+02	1.83E+03	1.55E+02	3.48E+02	
NW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.0	3.80E+04	5.11E+04	9.48E+02	
NNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E+03	1.30E+03	3.41E+02	2.31E+03	
N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+03	1.82E+03	56.	6.10E+02	

POPULATION FOR CHRONIC AIRBORNE RELEASE AT THE FOLLOWING TIMES A.D.:

TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	
1984.	2.95E+05	40000.	5.00E+05	60000.	1.00E+06	90000.	1.50E+06	120000.	1.00E+06	17

FIGURE F.8. Sample Problem Four Output

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	0.00E+00
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	0.00E+00
SEDIMENT EXPOSURE	0.00E+00
SWIMMING TIME	0.00E+00

*** SITE GRID DEFINITION:

NUMBER PF SECTORS: 16

DISTANCES: 9

805. 2414. 4023. 5632. 7241. 12000. 24000. 40000. 56000.

19

*** JOINT FREQUENCY DATA:

WIND SPEED	STABILITY	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
0.8	HANFORD VE	0.07	0.05	0.06	0.06	0.07	0.11	0.07	0.11	0.06	0.08	0.07	0.10	0.09	0.14	0.10	0.08
0.8	HANFORD MO	0.33	0.27	0.32	0.30	0.36	0.72	0.45	0.54	0.44	0.59	0.54	0.67	0.68	0.77	0.63	0.79
0.8	PASQUILL D	0.55	0.54	0.41	0.42	0.36	0.48	0.27	0.25	0.20	0.27	0.24	0.25	0.33	0.41	0.50	0.54
0.8	PASQUILL B	0.79	0.74	0.33	0.28	0.44	0.39	0.17	0.20	0.15	0.15	0.21	0.18	0.15	0.30	0.39	0.55
2.5	HANFORD VE	0.04	0.03	0.01	0.02	0.02	0.14	0.15	0.10	0.17	0.18	0.26	0.47	0.44	0.39	0.15	0.04
2.5	HANFORD MO	0.24	0.26	0.20	0.26	0.44	0.68	0.62	0.63	0.56	0.90	1.70	2.48	2.45	2.29	0.93	0.36
2.5	PASQUILL D	0.28	0.21	0.16	0.20	0.34	0.28	0.17	0.20	0.21	0.25	0.30	0.45	0.81	0.96	0.63	0.39
2.5	PASQUILL B	1.12	0.78	0.53	0.54	0.60	0.66	0.34	0.35	0.50	0.52	0.48	0.43	0.65	1.25	1.33	1.16
4.5	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.01	0.02	0.05	0.39	0.21	0.78	0.43	0.01	0.00
4.5	HANFORD MO	0.07	0.02	0.03	0.06	0.11	0.21	0.39	0.25	0.28	0.62	1.74	2.48	4.06	2.50	0.46	0.11
4.5	PASQUILL D	0.16	0.05	0.03	0.04	0.08	0.10	0.11	0.09	0.27	0.32	0.53	0.65	1.23	1.02	0.32	0.14
4.5	PASQUILL B	0.46	0.18	0.08	0.09	0.06	0.08	0.08	0.08	0.27	0.50	0.76	0.30	0.75	1.33	0.42	0.34
6.9	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
6.9	HANFORD MO	0.01	0.01	0.00	0.00	0.00	0.03	0.04	0.11	0.17	0.43	0.65	0.34	1.42	0.93	0.04	0.01
6.9	PASQUILL D	0.04	0.05	0.01	0.00	0.01	0.01	0.04	0.08	0.30	0.60	0.52	0.38	1.33	0.86	0.09	0.06
6.9	PASQUILL B	0.16	0.06	0.00	0.00	0.00	0.00	0.03	0.02	0.15	0.48	0.67	0.25	0.64	0.80	0.07	0.06
9.5	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.5	HANFORD MO	0.00	0.02	0.00	0.00	0.00	0.01	0.03	0.04	0.11	0.19	0.09	0.02	0.25	0.14	0.00	0.01
9.5	PASQUILL D	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.05	0.17	0.35	0.17	0.05	0.62	0.65	0.02	0.01
9.5	PASQUILL B	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.32	0.29	0.05	0.32	0.57	0.01	0.03
12.5	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.5	HANFORD MO	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.09	0.02	0.00	0.02	0.00	0.00	0.00
12.5	PASQUILL D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.13	0.06	0.01	0.08	0.11	0.00	0.00
12.5	PASQUILL B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.17	0.08	0.01	0.11	0.21	0.01	0.00

STACK HEIGHT: 0.00

FIGURE F.8. (contd)

*** AIR RELEASE OF EACH RADIONUCLIDE PER PERIOD CURIES (GRAPH OPTION TURNED OFF)

RADIONUCLIDE	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY
SR90	15	5.25E+03	16	8.19E+03	17	9.17E+03	18	1.02E+04	19	1.11E+04	20	1.21E+04
	21	1.31E+04	22	1.39E+04	23	1.40E+04	24	1.40E+04	25	1.40E+04	26	1.40E+04
	27	1.30E+04	28	1.18E+04	29	1.06E+04	30	9.82E+03	31	9.08E+03	32	8.35E+03
	33	7.61E+03	34	6.88E+03	35	6.14E+03	36	5.41E+03	37	4.67E+03	38	3.94E+03
	39	3.20E+03	40	2.47E+03	41	1.73E+03	42	9.98E+02	43	2.70E+02		
Y 90												
PU238												
AM241												

*** POPULATION DISPERSION FACTOR FOR AIRBORNE RELEASE, PERSON-SEC/M**3

18

PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM
0	1.00E-04	1	5.96E-03	2	6.10E-03	3	6.25E-03	4	6.39E-03	5	6.53E-03
6	6.67E-03	7	6.81E-03	8	6.96E-03	9	7.10E-03	10	7.24E-03	11	7.38E-03
12	7.52E-03	13	7.67E-03	14	7.81E-03	15	7.95E-03	16	8.09E-03	17	8.23E-03
18	8.38E-03	19	8.52E-03	20	8.66E-03	21	8.80E-03	22	8.94E-03	23	9.09E-03
24	9.23E-03	25	9.37E-03	26	9.51E-03	27	9.65E-03	28	9.80E-03	29	9.94E-03
30	1.02E-02	31	1.06E-02	32	1.09E-02	33	1.13E-02	34	1.16E-02	35	1.20E-02
36	1.23E-02	37	1.27E-02	38	1.30E-02	39	1.34E-02	40	1.37E-02	41	1.41E-02
42	1.44E-02	43	1.48E-02	44	1.51E-02	45	1.55E-02	46	1.58E-02	47	1.62E-02
48	1.65E-02	49	1.69E-02	50	1.72E-02	51	1.76E-02	52	1.79E-02	53	1.83E-02
54	1.86E-02	55	1.90E-02	56	1.93E-02	57	1.97E-02	58	2.00E-02	59	2.02E-02
60	2.05E-02	61	2.07E-02	62	2.09E-02	63	2.11E-02	64	2.14E-02	65	2.16E-02
66	2.18E-02	67	2.21E-02	68	2.23E-02	69	2.25E-02	70	2.28E-02	71	2.30E-02
72	2.32E-02	73	2.35E-02	74	2.37E-02	75	2.39E-02	76	2.42E-02	77	2.44E-02
78	2.46E-02	79	2.49E-02	80	2.51E-02	81	2.53E-02	82	2.56E-02	83	2.58E-02
84	2.60E-02	85	2.63E-02	86	2.65E-02	87	2.67E-02	88	2.70E-02	89	2.72E-02
90	2.74E-02	91	2.77E-02	92	2.79E-02	93	2.81E-02	94	2.84E-02	95	2.86E-02
96	2.88E-02	97	2.91E-02	98	2.93E-02	99	2.95E-02	100	2.98E-02	101	2.98E-02
102	2.96E-02	103	2.94E-02	104	2.91E-02	105	2.89E-02	106	2.87E-02	107	2.84E-02
108	2.82E-02	109	2.80E-02	110	2.77E-02	111	2.75E-02	112	2.73E-02	113	2.70E-02
114	2.68E-02	115	2.66E-02	116	2.63E-02	117	2.61E-02	118	2.59E-02	119	2.56E-02
120	2.54E-02	121	2.52E-02	122	2.49E-02	123	2.47E-02	124	2.45E-02	125	2.42E-02
126	2.40E-02	127	2.38E-02	128	2.35E-02	129	2.33E-02	130	2.31E-02	131	2.28E-02
132	2.26E-02	133	2.24E-02	134	2.21E-02	135	2.19E-02	136	2.17E-02	137	2.14E-02
138	2.12E-02	139	2.10E-02	140	2.08E-02	141	2.05E-02	142	2.03E-02	143	2.01E-02

INPUT PREPARED BY: ************** DATE: 2/5/86 ********** INPUT CHECKED BY: Bruce Napier ************** DATE: 5 Feb 86 **********

FIGURE F.8. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 4-FEB-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Four - Airborne release, release data from file, IPOP=2

* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A FUNCTION OF TIME * * *

PERIOD	YEAR	TOTAL BODY	BONE	
1	1990.	0.00E+00	0.00E+00	
until				
16	3040.	3.01E+04	2.70E+05	
17	3110.	7.78E+04	6.99E+05	
18	3180.	1.32E+05	1.19E+06	
19	3250.	1.93E+05	1.74E+06	
20	3320.	2.62E+05	2.35E+06	
21	3390.	3.37E+05	3.03E+06	
22	3460.	4.20E+05	3.78E+06	
23	3530.	5.10E+05	4.58E+06	
24	3600.	6.01E+05	5.41E+06	
25	3670.	6.94E+05	6.24E+06	
26	3740.	7.89E+05	7.09E+06	
27	3810.	8.84E+05	7.95E+06	
28	3880.	9.75E+05	8.76E+06	
29	3950.	1.06E+06	9.51E+06	
30	4020.	1.13E+06	1.02E+07	
31	4090.	1.21E+06	1.08E+07	
32	4160.	1.28E+06	1.15E+07	
33	4230.	1.34E+06	1.21E+07	
34	4300.	1.40E+06	1.26E+07	
35	4370.	1.46E+06	1.31E+07	
36	4440.	1.51E+06	1.36E+07	
37	4510.	1.56E+06	1.40E+07	
38	4580.	1.61E+06	1.44E+07	
39	4650.	1.64E+06	1.48E+07	
40	4720.	1.67E+06	1.50E+07	
41	4790.	1.70E+06	1.53E+07	
42	4860.	1.72E+06	1.54E+07	
43	4930.	1.73E+06	1.55E+07	
44	5000.	1.73E+06	1.55E+07	
until				
144	12000.	1.73E+06	1.55E+07	20

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.8. (contd)

SAMPLE PROBLEM FIVE

Sample Problem Five is the first of three problems in Sample Set 3. Chronic exposure to a water release of ^{90}Sr and ^{129}I is simulated during this scenario. Input for Sample Problem Five is shown in Figure F.3 (item #21).

NAMELIST INPUT parameters for this sample problem specify that release data is entered (IWAT=1) from an auxiliary file (LUW=0). Total population (PL1) for six (NTL=6) times (TL) during the 10,000-year integration period are specified. Generic terrestrial and waterborne pathway parameter values are used (USAGE, CONSUM, EXTIM, GRWP, MOPYR, RIRR, YELD).

The waterborne release file for Sample Problem Five is shown in Figure F.9. This file must be assigned to lun 24 (item #22 in Figure F.3). Release data is included for ^{14}C, ^{90}Sr, and ^{129}I. The ^{14}C release will not be considered in this sample problem because it is specified as an acute release (item #23 in Figure F.9) and the acute exposure pathway (IAC=0) is not selected (item #21 in Figure F.3). The ^{14}C release will be considered in a following sample problem.

Cumulative doses estimates in units of person-rem for Sample Problem Five are 1.2×10^4 total body, 3.8×10^4 to bone, 7.5×10^2 to lung, 1.2×10^6 to thyroid, and 1.7×10^3 to the lower large intestine of the GI tract (item #24 in Figure F.10). The maximum dose rate increment (to total body) occurs during dose integral period nine (item #25 in Figure F.10). The maximum dose rate report for waterborne pathways includes maximum dose increments for both population dose and maximum individual dose. Eighty-one percent of the dose to total body and 96% of the dose to bone is due to ^{90}Sr (item #26 in Figure F.10). Ninety-nine percent of the dose to lung and thyroid is due to ^{129}I. ^{90}Sr and ^{129}I are each responsible for half of the dose to the lower large intestine of the GI tract.

```
Waterborne release data for sample set #3
    3
C 14        2                         23
0.            .75E+6
1.                0.
I 129       3
9000.         1.0
10000.        1.0
10001.        0.
SR90       21
5.1852E+023.5094E-22
5.2199E+022.1156E-01
5.2546E+026.9540E-01
5.2893E+027.1749
5.3240E+025.1563
5.3587E+024.4288
5.3934E+021.0549E-03
5.4281E+027.9938
5.4628E+026.6183
5.4975E+026.0509
5.5322E+024.5113
5.5669E+022.5153
5.6016E+021.3844
5.6363E+027.7096E-01
5.6710E+024.2537E-01
5.7057E+021.9468E-01
5.7404E+021.0359E-01
5.7751E+024.3661E-02
5.8098E+021.9646E-02
5.8445E+021.0873E-03
5.8792E+024.1130E-25
```

FIGURE F.9. Inventory File for Sample Set 3

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Five - Waterborne release, chronic exposure

*** DATA LIBRARIES USED:

	(FILE)	
MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)
WATERBORNE RELEASE DATA :	(24)	Waterborne release data for sample set #3

*** ORGANS CONSIDERED:
TOTAL BODY　BONE　LUNG　THYROID　GI-LLI

*** MASTER RADIONUCLIDE CONTROL LIST:
C 14　SR90　Y 90　I 129　PU238

*** POPULATION DATA:

POPULATION FOR CHRONIC WATERBORNE RELEASE AT THE FOLLOWING TIMES A.D.:

TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	TIME	POPULATION
1990.	2.95E+05	21000.	3.92E+05	22000.	4.31E+05	23000.	4.70E+05	29900.	1.27E+06
119000.	4.93E+06								

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	3.00E-01
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	4.38E+02
SEDIMENT EXPOSURE	1.70E+01
SWIMMING TIME	1.70E+01

*** LIQUID RELEASE DILUTION/MIXING PARAMETERS

RIVER FLOW RATE, (FT3/SEC) :	1.20E+05
RECONCENTRATION RATIO :	1.00E+00
MIXING RATIO :	1.00E+00

*** FARMING PARAMETERS

MONTHS / YEAR IRRIGATED :	6.00E+00
IRRIGATION RATE (LITERS/M**2/MONTH) :	1.50E+02

FIGURE F.10. Sample Problem Five Output

*** WATER RELEASE OF EACH RADIONCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

RADIONUCLIDE	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY
C 14	0	7.50E+05										
SR90	8	1.60E+02	9	8.0								
Y 90												
I 129	129	30.	130	70.	131	70.	132	70.	133	70.	134	70.
	135	70.	136	70.	137	70.	138	70.	139	70.	140	70.
	141	70.	142	70.	143	61.						
PU238												

*** POPULATION FOR WATERBORNE RELEASE

PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL
0	0.00E+00	1	3.26E+05	2	3.87E+05	3	4.17E+05	4	4.45E+05	5	4.76E+05
6	5.57E+05	7	6.39E+05	8	7.20E+05	9	8.02E+05	10	8.83E+05	11	9.65E+05
12	1.05E+06	13	1.13E+06	14	1.21E+06	15	1.28E+06	16	1.31E+06	17	1.34E+06
18	1.37E+06	19	1.39E+06	20	1.42E+06	21	1.45E+06	22	1.48E+06	23	1.51E+06
24	1.54E+06	25	1.57E+06	26	1.60E+06	27	1.62E+06	28	1.65E+06	29	1.68E+06
30	1.71E+06	31	1.74E+06	32	1.77E+06	33	1.80E+06	34	1.83E+06	35	1.85E+06
36	1.88E+06	37	1.91E+06	38	1.94E+06	39	1.97E+06	40	2.00E+06	41	2.03E+06
42	2.06E+06	43	2.08E+06	44	2.11E+06	45	2.14E+06	46	2.17E+06	47	2.20E+06
48	2.23E+06	49	2.26E+06	50	2.29E+06	51	2.31E+06	52	2.34E+06	53	2.37E+06
54	2.40E+06	55	2.43E+06	56	2.46E+06	57	2.49E+06	58	2.52E+06	59	2.54E+06
60	2.57E+06	61	2.60E+06	62	2.63E+06	63	2.66E+06	64	2.69E+06	65	2.72E+06
66	2.75E+06	67	2.77E+06	68	2.80E+06	69	2.83E+06	70	2.86E+06	71	2.89E+06
72	2.92E+06	73	2.95E+06	74	2.98E+06	75	3.00E+06	76	3.03E+06	77	3.06E+06
78	3.09E+06	79	3.12E+06	80	3.15E+06	81	3.18E+06	82	3.21E+06	83	3.23E+06
84	3.26E+06	85	3.29E+06	86	3.32E+06	87	3.35E+06	88	3.38E+06	89	3.41E+06
90	3.44E+06	91	3.46E+06	92	3.49E+06	93	3.52E+06	94	3.55E+06	95	3.58E+06
96	3.61E+06	97	3.64E+06	98	3.67E+06	99	3.69E+06	100	3.72E+06	101	3.75E+06
102	3.78E+06	103	3.81E+06	104	3.84E+06	105	3.87E+06	106	3.90E+06	107	3.92E+06
108	3.95E+06	109	3.98E+06	110	4.01E+06	111	4.04E+06	112	4.07E+06	113	4.10E+06
114	4.13E+06	115	4.15E+06	116	4.18E+06	117	4.21E+06	118	4.24E+06	119	4.27E+06
120	4.30E+06	121	4.33E+06	122	4.36E+06	123	4.38E+06	124	4.41E+06	125	4.44E+06
126	4.47E+06	127	4.50E+06	128	4.53E+06	129	4.56E+06	130	4.59E+06	131	4.61E+06
132	4.64E+06	133	4.67E+06	134	4.70E+06	135	4.73E+06	136	4.76E+06	137	4.79E+06
138	4.82E+06	139	4.84E+06	140	4.87E+06	141	4.90E+06	142	4.93E+06	143	4.93E+06

INPUT PREPARED BY: R.A. Peloquin DATE: 2/5/86 INPUT CHECKED BY: Bruce Napier DATE: 5 Feb 86

FIGURE F.10. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Five - Waterborne release, chronic exposure

* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A FUNCTION OF TIME * * *

PERIOD	YEAR	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
1	1990.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
until						
9	2550.	7.97E+03	3.02E+04	2.72E-01	1.86E-01	7.17E+02
10	2620.	9.47E+03	3.59E+04	3.27E-01	2.24E-01	8.51E+02
11	2690.	9.68E+03	3.67E+04	3.35E-01	2.30E-01	8.71E+02
12	2760.	9.71E+03	3.68E+04	3.37E-01	2.31E-01	8.73E+02
13	2830.	9.72E+03	3.69E+04	3.37E-01	2.31E-01	8.74E+02
14	2900.	9.72E+03	3.69E+04	3.37E-01	2.31E-01	8.74E+02
15	2970.	9.72E+03	3.69E+04	3.37E-01	2.31E-01	8.74E+02
16	3040.	9.72E+03	3.69E+04	3.37E-01	2.31E-01	8.74E+02
17	3110.	9.72E+03	3.69E+04	3.37E-01	2.31E-01	8.74E+02
until						
130	11020.	9.78E+03	3.69E+04	2.17E+01	3.42E+04	8.98E+02
131	11090.	9.93E+03	3.70E+04	7.21E+01	1.15E+05	9.53E+02
132	11160.	1.01E+04	3.71E+04	1.23E+02	1.96E+05	1.01E+03
133	11230.	1.02E+04	3.72E+04	1.74E+02	2.77E+05	1.07E+03
134	11300.	1.04E+04	3.72E+04	2.26E+02	3.59E+05	1.12E+03
135	11370.	1.06E+04	3.73E+04	2.78E+02	4.42E+05	1.18E+03
136	11440.	1.07E+04	3.74E+04	3.30E+02	5.25E+05	1.24E+03
137	11510.	1.09E+04	3.75E+04	3.82E+02	6.08E+05	1.30E+03
138	11580.	1.10E+04	3.76E+04	4.35E+02	6.92E+05	1.36E+03
139	11650.	1.12E+04	3.77E+04	4.88E+02	7.77E+05	1.42E+03
140	11720.	1.13E+04	3.78E+04	5.42E+02	8.62E+05	1.47E+03
141	11790.	1.15E+04	3.79E+04	5.95E+02	9.47E+05	1.53E+03
142	11860.	1.17E+04	3.80E+04	6.49E+02	1.03E+06	1.59E+03
143	11930.	1.18E+04	3.81E+04	7.04E+02	1.12E+06	1.65E+03
144	12000.	1.20E+04	3.82E+04	7.51E+02	1.19E+06	1.71E+03

24

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.10. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Five - Waterborne release, chronic exposure

* * * MAXIMUM DOSE RATE REPORT * * *
DOSE INTEGRAL PERIOD (70-YEAR) DURING WHICH THE MAXIMUM DOSE RATE OCCURS = 9

25

* * * MAXIMUM POPULATION DOSE INCREMENT TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR90	7.97E+03	3.02E+04	8.51E-02	9.84E-06	7.05E+02
Y 90	0.19	0.19	0.19	0.19	11.
I 129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PU238	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.97E+03	3.02E+04	0.27	0.19	7.17E+02

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

* * * MAXIMUM AVERAGE INDIVIDUAL DOSE INCREMENT TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR90	1.11E-02	4.20E-02	1.18E-07	1.37E-11	9.79E-04
Y 90	2.59E-07	2.61E-07	2.59E-07	2.59E-07	1.55E-05
I 129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PU238	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.11E-02	4.20E-02	3.77E-07	2.59E-07	9.95E-04

Dose in units of rem.

* * * PERCENT OF TOTAL DOSE TO ORGAN AND CUMULATIVE DOSE TO ORGAN BY RADIONUCLIDE * * *

26

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00
SR90	81% 9.7E+03	96% 3.7E+04	0% 0.1	0% 1.0E-05	50% 8.6E+02
Y 90	0% 0.2	0% 0.2	0% 0.2	0% 0.2	0% 1.4E+01
I 129	18% 2.3E+03	3% 1.3E+03	99% 7.5E+02	99% 1.2E+06	48% 8.3E+02
PU238	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00
Total	1.2E+04	3.8E+04	7.5E+02	1.2E+06	1.7E+03

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.10. (contd)

SAMPLE PROBLEM SIX

Sample Problem Six is similar to Sample Problem Five with the addition of an acute release of ^{14}C. Input for this problem is shown in Figure F.3 (item #27).

Previous release data is used (IWAT=0) and the acute exposure pathway activated (IAC=1) in Sample Problem Six. It should be noted that the ^{14}C acute release data was input with Sample Problem Five but not used because the acute exposure pathway was not turned on. Previous population data is used for chronic exposure (IPOPL=0). Population data for acute exposure is entered in the NAMELIST INPUT set (IPA, PPL).

A cumulative dose to total body of 1.5×10^4 person-rem is reported in Sample Problem Six (item #28 in Figure F.11). Twenty percent of this dose is due to exposure to ^{14}C, 64% is due to ^{90}Sr, and 15% is due to ^{129}I. Cumulative dose estimates in units of person-rem to bone, lung, thyroid and the lower large intestine of the GI tract are 5.3×10^4, 3.8×10^3, 1.2×10^6, and 4.7×10^3, respectively.

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Six - Waterborne release, acute and chronic exposure

*** DATA LIBRARIES USED: (FILE)

MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)

*** ORGANS CONSIDERED:
TOTAL BODY BONE LUNG THYROID GI-LLI

*** MASTER RADIONUCLIDE CONTROL LIST:
C 14 SR90 Y 90 I 129 PU238

*** POPULATION DATA:

POPULATION FOR ACUTE WATERBORNE RELEASE = 2.00E+05

PREVIOUS POPULATION VALUES USED FOR CHRONIC WATERBORNE RELEASE.

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	3.00E-01
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	4.38E+02
SEDIMENT EXPOSURE	1.70E+01
SWIMMING TIME	1.70E+01

*** LIQUID RELEASE DILUTION/MIXING PARAMETERS

RIVER FLOW RATE, (FT3/SEC) : 1.20E+05
RECONCENTRATION RATIO : 1.00E+00
MIXING RATIO : 1.00E+00

*** FARMING PARAMETERS

MONTHS / YEAR IRRIGATED : 6.00E+00
IRRIGATION RATE
(LITERS/M**2/MONTH) : 1.50E+02

FIGURE F.11. Sample Problem Six Output

*** WATER RELEASE OF EACH RADIONCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

RADIONUCLIDE	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY	PERIOD	ACTIVITY
C 14	0	7.50E+05										
SR90	8	1.60E+02	9	8.0								
Y 90												
I 129	129	30.	130	70.	131	70.	132	70.	133	70.	134	70.
	135	70.	136	70.	137	70.	138	70.	139	70.	140	70.
	141	70.	142	70.	143	61.						
PU238												

*** POPULATION FOR WATERBORNE RELEASE

PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL
0	2.00E+05	1	3.26E+05	2	3.87E+05	3	4.17E+05	4	4.45E+05	5	4.76E+05
6	5.57E+05	7	6.39E+05	8	7.20E+05	9	8.02E+05	10	8.83E+05	11	9.65E+05
12	1.05E+06	13	1.13E+06	14	1.21E+06	15	1.28E+06	16	1.31E+06	17	1.34E+06
18	1.37E+06	19	1.39E+06	20	1.42E+06	21	1.45E+06	22	1.48E+06	23	1.51E+06
24	1.54E+06	25	1.57E+06	26	1.60E+06	27	1.62E+06	28	1.65E+06	29	1.68E+06
30	1.71E+06	31	1.74E+06	32	1.77E+06	33	1.80E+06	34	1.83E+06	35	1.85E+06
36	1.88E+06	37	1.91E+06	38	1.94E+06	39	1.97E+06	40	2.00E+06	41	2.03E+06
42	2.06E+06	43	2.08E+06	44	2.11E+06	45	2.14E+06	46	2.17E+06	47	2.20E+06
48	2.23E+06	49	2.26E+06	50	2.29E+06	51	2.31E+06	52	2.34E+06	53	2.37E+06
54	2.40E+06	55	2.43E+06	56	2.46E+06	57	2.49E+06	58	2.52E+06	59	2.54E+06
60	2.57E+06	61	2.60E+06	62	2.63E+06	63	2.66E+06	64	2.69E+06	65	2.72E+06
66	2.75E+06	67	2.77E+06	68	2.80E+06	69	2.83E+06	70	2.86E+06	71	2.89E+06
72	2.92E+06	73	2.95E+06	74	2.98E+06	75	3.00E+06	76	3.03E+06	77	3.06E+06
78	3.09E+06	79	3.12E+06	80	3.15E+06	81	3.18E+06	82	3.21E+06	83	3.23E+06
84	3.26E+06	85	3.29E+06	86	3.32E+06	87	3.35E+06	88	3.38E+06	89	3.41E+06
90	3.44E+06	91	3.46E+06	92	3.49E+06	93	3.52E+06	94	3.55E+06	95	3.58E+06
96	3.61E+06	97	3.64E+06	98	3.67E+06	99	3.69E+06	100	3.72E+06	101	3.75E+06
102	3.78E+06	103	3.81E+06	104	3.84E+06	105	3.87E+06	106	3.90E+06	107	3.92E+06
108	3.95E+06	109	3.98E+06	110	4.01E+06	111	4.04E+06	112	4.07E+06	113	4.10E+06
114	4.13E+06	115	4.15E+06	116	4.18E+06	117	4.21E+06	118	4.24E+06	119	4.27E+06
120	4.30E+06	121	4.33E+06	122	4.36E+06	123	4.38E+06	124	4.41E+06	125	4.44E+06
126	4.47E+06	127	4.50E+06	128	4.53E+06	129	4.56E+06	130	4.59E+06	131	4.61E+06
132	4.64E+06	133	4.67E+06	134	4.70E+06	135	4.73E+06	136	4.76E+06	137	4.79E+06
138	4.82E+06	139	4.84E+06	140	4.87E+06	141	4.90E+06	142	4.93E+06	143	4.93E+06

INPUT PREPARED BY: [illegible] DATE: 2/5/86 INPUT CHECKED BY: [illegible] DATE: 5 Feb 86

FIGURE F.11. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Six - Waterborne release, acute and chronic exposure

* * * CUMULATIVE DOSE TO SELECTED ORGANS AS A FUNCTION OF TIME * * *

PERIOD	YEAR	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
ACUTE		3.02E+03	1.48E+04	3.02E+03	3.02E+03	3.02E+03
until						
9	2480.	1.10E+04	4.51E+04	3.02E+03	3.02E+03	3.74E+03
10	2550.	1.25E+04	5.08E+04	3.02E+03	3.02E+03	3.87E+03
11	2620.	1.27E+04	5.16E+04	3.02E+03	3.02E+03	3.89E+03
12	2690.	1.27E+04	5.17E+04	3.02E+03	3.02E+03	3.90E+03
13	2760.	1.27E+04	5.17E+04	3.02E+03	3.02E+03	3.90E+03
14	2830.	1.27E+04	5.17E+04	3.02E+03	3.02E+03	3.90E+03
15	2900.	1.27E+04	5.17E+04	3.02E+03	3.02E+03	3.90E+03
16	2970.	1.27E+04	5.17E+04	3.02E+03	3.02E+03	3.90E+03
17	3040.	1.27E+04	5.17E+04	3.02E+03	3.02E+03	3.90E+03
until						
130	10950.	1.28E+04	5.17E+04	3.04E+03	3.73E+04	3.92E+03
131	11020.	1.30E+04	5.18E+04	3.09E+03	1.18E+05	3.98E+03
132	11090.	1.31E+04	5.19E+04	3.15E+03	1.99E+05	4.03E+03
133	11160.	1.33E+04	5.20E+04	3.20E+03	2.80E+05	4.09E+03
134	11230.	1.34E+04	5.21E+04	3.25E+03	3.62E+05	4.15E+03
135	11300.	1.36E+04	5.22E+04	3.30E+03	4.45E+05	4.20E+03
136	11370.	1.37E+04	5.23E+04	3.35E+03	5.28E+05	4.26E+03
137	11440.	1.39E+04	5.24E+04	3.40E+03	6.11E+05	4.32E+03
138	11510.	1.40E+04	5.25E+04	3.46E+03	6.95E+05	4.38E+03
139	11580.	1.42E+04	5.25E+04	3.51E+03	7.80E+05	4.44E+03
140	11650.	1.44E+04	5.26E+04	3.56E+03	8.65E+05	4.50E+03
141	11720.	1.45E+04	5.27E+04	3.62E+03	9.50E+05	4.56E+03
142	11790.	1.47E+04	5.28E+04	3.67E+03	1.04E+06	4.62E+03
143	11860.	1.49E+04	5.29E+04	3.73E+03	1.12E+06	4.68E+03
144	11930.	1.50E+04	5.30E+04	3.77E+03	1.20E+06	4.73E+03

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.11. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 27-JAN-86
INTEGRATED POPULATION DOSE CALCULATED FOR ACUTE LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Six - Waterborne release, acute and chronic exposure

* * * MAXIMUM DOSE RATE REPORT * * *
DOSE INTEGRAL PERIOD (70-YEAR) DURING WHICH THE MAXIMUM DOSE RATE OCCURS = 9

* * * MAXIMUM POPULATION DOSE INCREMENT TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR90	7.97E+03	3.02E+04	8.51E-02	9.84E-06	7.05E+02
Y 90	0.19	0.19	0.19	0.19	11.
I 129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PU238	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.97E+03	3.02E+04	0.27	0.19	7.17E+02

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

* * * MAXIMUM AVERAGE INDIVIDUAL DOSE INCREMENT TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR90	1.11E-02	4.20E-02	1.18E-07	1.37E-11	9.79E-04
Y 90	2.59E-07	2.61E-07	2.59E-07	2.59E-07	1.55E-05
I 129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PU238	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.11E-02	4.20E-02	3.77E-07	2.59E-07	9.95E-04

Dose in units of rem.

* * * PERCENT OF TOTAL DOSE TO ORGAN AND CUMULATIVE DOSE TO ORGAN BY RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	20% 3.0E+03	28% 1.5E+04	80% 3.0E+03	0% 3.0E+03	63% 3.0E+03
SR90	64% 9.7E+03	69% 3.7E+04	0% 0.1	0% 1.0E-05	18% 8.6E+02
Y 90	0% 0.2	0% 0.2	0% 0.2	0% 0.2	0% 1.4E+01
I 129	15% 2.3E+03	2% 1.3E+03	19% 7.5E+02	99% 1.2E+06	17% 8.3E+02
PU238	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00	0% 0.0E+00
Total	1.5E+04	5.3E+04	3.8E+03	1.2E+06	4.7E+03

28

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.11. (contd)

SAMPLE PROBLEM SEVEN

The final sample problem combines the chronic exposure scenarios in Sample Problems Four (airborne pathways) and Five (waterborne pathways). Dose totals for Sample Problem Seven should equal the sum of doses from Sample Problems Four and Five. Input for this sample problem is shown in Figure F.3 (item #29).

The acute exposure pathway is deactivated (IAC=0). Meteorological and airborne population data is input in the same format as for Sample Problem Four. ^{238}Pu airborne release data (item #30 in Figure F.3) are read from the execution file (IAIR=1, LUA=1). Graphical reports of the total radionuclide release over time is requested (IGRTNU=1). This report for the airborne release is shown in Figure F.12 (item #31). A similar report is generated for the waterborne releases.

Total cumulative doses of 1.7×10^6 person-rem to total body and 1.6×10^7 person-rem to bone are reported for Sample Problem Seven (item #32 in Figure F.12).

QA PAGE FOR DITTY (VAX VERSION 1.0) RUN ON 4-FEB-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC AND LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Seven - Airborne and waterborne release, chronic exposure

*** DATA LIBRARIES USED: (FILE)

MASTER NUCLIDE DATA :	(10)	RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 19-MAR-85 RAP
FOOD CONCENTRATION RATIOS :	(12)	*** FOOD TRANSFER COEFFICIENT LIBRARY RAP / 9-24-85 (Tc Update) ***
FRESHWATER BIOACCUMULATION FACTORS :	(14)	BIOACCUMULATION FACTOR LIBRARY FOR FOOD,PABLM,MAXI BA NAPIER (28-NOV-83/RAP)
EXTERNAL EXPOSURE D.F.'S :	(16)	*** GRDFLIB FOR FOOD, 15 MARCH 1978, BA NAPIER ***
INHALATION/INGESTION D.F.'S :	(18)	INTERNAL DOSE CONVERSION FACTOR LIBRARY FOR DITTY1 REV. 1-20-81 (BAN/DLS/RAP)
AIRBORNE RELEASE DATA :	(26)	INPUT

*** ORGANS CONSIDERED:
TOTAL BODY   BONE   LUNG   THYROID   GI-LLI

*** MASTER RADIONUCLIDE CONTROL LIST:
C 14   SR90   Y 90   I 129   PU238

*** POPULATION DATA:

POPULATION FOR CHRONIC AIRBORNE RELEASE AT TIME 1984.:

SECTOR	8.05E+02	2.41E+03	4.02E+03	5.63E+03	7.24E+03	1.20E+04	2.40E+04	4.00E+04	5.60E+04
NNE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.31E+02	1.10E+04	8.67E+02	1.58E+02
NE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.57E+02	1.74E+04	1.07E+03	4.56E+02
ENE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.80E+02	2.97E+03	1.49E+04	5.19E+03
E	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.96E+02	5.09E+02	3.84E+03	8.03E+04
ESE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E+02	7.69E+02	1.04E+03	5.72E+02
SE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.33E+02	2.43E+02	4.08E+02	1.10E+03
SSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	28.	4.74E+02	2.46E+02	4.32E+03
S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	21.	1.12E+03	4.98E+02	2.91E+03
SSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.0	7.96E+02	1.05E+03	1.70E+04
SW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.08E+02	6.61E+03	2.65E+03	7.04E+02
WSW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.88E+02	1.80E+03	2.54E+03	1.01E+03
W	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E+02	4.28E+02	6.23E+02	9.77E+02
WNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.21E+02	1.83E+03	1.55E+02	3.48E+02
NW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.0	3.80E+04	5.11E+04	9.48E+02
NNW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E+03	1.30E+03	3.41E+02	2.31E+03
N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+03	1.82E+03	56.	6.10E+02

POPULATION FOR CHRONIC AIRBORNE RELEASE AT THE FOLLOWING TIMES A.D.:

TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	TIME	POPULATION	TIME	POPULATION
1984.	2.95E+05	40000.	5.00E+05	60000.	1.00E+06	90000.	1.50E+06	120000.	1.00E+06

PREVIOUS POPULATION VALUES USED FOR CHRONIC WATERBORNE RELEASE.

FIGURE F.12. Sample Problem Seven Output

*** TERRESTRIAL PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	GROWING PERIOD (DAYS)	YIELD (KG/M**2)	CONSUMPTION (KG/YR)
LEAFY VEGATABLES	9.00E+01	1.50E+00	1.50E+01
OTHER VEGATABLES	9.00E+01	2.50E+00	2.79E+02
EGGS	9.00E+01	8.40E-01	2.00E+01
MILK	3.00E+01	1.30E+00	2.30E+02
BEEF	9.00E+01	8.40E-01	4.00E+01
PORK	9.00E+01	8.40E-01	3.00E+01
POULTRY	9.00E+01	8.40E-01	8.50E+00

EXTERNAL EXPOSURE TIME, 2.92E+03 HR/YR

*** AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL:

PATHWAY	USAGE (KG OR HR/YR)
FISH	3.00E-01
CRUSTACEA	0.00E+00
MOLLUSES	0.00E+00
PLANTS	0.00E+00
DRINKING WATER	4.38E+02
SEDIMENT EXPOSURE	1.70E+01
SWIMMING TIME	1.70E+01

*** LIQUID RELEASE DILUTION/MIXING PARAMETERS

RIVER FLOW RATE, (FT3/SEC) : 1.20E+05
RECONCENTRATION RATIO : 1.00E+00
MIXING RATIO : 1.00E+00

*** FARMING PARAMETERS

MONTHS / YEAR IRRIGATED : 6.00E+00
IRRIGATION RATE (LITERS/M**2/MONTH) : 1.50E+02

*** SITE GRID DEFINITION:

NUMBER PF SECTORS: 16
DISTANCES: 9

805. 2414. 4023. 5632. 7241. 12000. 24000. 40000. 56000.

*** JOINT FREQUENCY DATA:

WIND SPEED	STABILITY	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
0.8	HANFORD VE	0.07	0.05	0.06	0.06	0.07	0.11	0.07	0.11	0.06	0.08	0.07	0.10	0.09	0.14	0.10	0.08
0.8	HANFORD MO	0.33	0.27	0.32	0.30	0.36	0.72	0.45	0.54	0.44	0.59	0.54	0.67	0.68	0.77	0.63	0.79
0.8	PASQUILL D	0.55	0.54	0.41	0.42	0.36	0.48	0.27	0.25	0.20	0.27	0.24	0.25	0.33	0.41	0.50	0.54
0.8	PASQUILL B	0.79	0.74	0.33	0.28	0.44	0.39	0.17	0.20	0.15	0.15	0.21	0.18	0.15	0.30	0.39	0.55
2.5	HANFORD VE	0.04	0.03	0.01	0.02	0.02	0.14	0.15	0.10	0.17	0.18	0.26	0.47	0.44	0.39	0.15	0.04
2.5	HANFORD MO	0.24	0.26	0.20	0.26	0.44	0.68	0.62	0.63	0.56	0.90	1.70	2.48	2.45	2.29	0.93	0.36
2.5	PASQUILL D	0.28	0.21	0.16	0.20	0.34	0.28	0.17	0.20	0.21	0.25	0.30	0.45	0.81	0.96	0.63	0.39
2.5	PASQUILL B	1.12	0.78	0.53	0.54	0.60	0.66	0.34	0.35	0.50	0.52	0.48	0.43	0.65	1.25	1.33	1.16
4.5	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.01	0.02	0.05	0.39	0.21	0.78	0.43	0.01	0.00
4.5	HANFORD MO	0.07	0.02	0.03	0.06	0.11	0.21	0.39	0.25	0.28	0.62	1.74	2.48	4.06	2.50	0.46	0.11
4.5	PASQUILL D	0.16	0.05	0.03	0.04	0.08	0.10	0.11	0.09	0.27	0.32	0.53	0.65	1.23	1.02	0.32	0.14
4.5	PASQUILL B	0.46	0.18	0.08	0.09	0.06	0.08	0.08	0.08	0.27	0.50	0.76	0.30	0.75	1.33	0.42	0.34
6.9	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
6.9	HANFORD MO	0.01	0.01	0.00	0.00	0.00	0.03	0.04	0.11	0.17	0.43	0.65	0.34	1.42	0.93	0.04	0.01
6.9	PASQUILL D	0.04	0.05	0.01	0.00	0.01	0.01	0.04	0.08	0.30	0.60	0.52	0.38	1.33	0.86	0.09	0.06
6.9	PASQUILL B	0.16	0.06	0.00	0.00	0.00	0.00	0.03	0.02	0.15	0.48	0.67	0.25	0.64	0.80	0.07	0.06
9.5	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.5	HANFORD MO	0.00	0.02	0.00	0.00	0.00	0.01	0.03	0.04	0.11	0.19	0.09	0.02	0.25	0.14	0.00	0.01
9.5	PASQUILL D	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.05	0.17	0.35	0.17	0.05	0.62	0.65	0.02	0.01
9.5	PASQUILL B	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.32	0.29	0.05	0.32	0.57	0.01	0.03
12.5	HANFORD VE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.5	HANFORD MO	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.09	0.02	0.00	0.02	0.00	0.00	0.00
12.5	PASQUILL D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.13	0.06	0.01	0.08	0.11	0.00	0.00
12.5	PASQUILL B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.17	0.08	0.01	0.11	0.21	0.01	0.00

FIGURE F.12. (contd)

*** POPULATION DISPERSION FACTOR FOR AIRBORNE RELEASE, PERSON-SEC/M**3

PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM	PERIOD	PM
0	0.00E+00	1	5.96E-03	2	6.10E-03	3	6.25E-03	4	6.39E-03	5	6.53E-03
6	6.67E-03	7	6.81E-03	8	6.96E-03	9	7.10E-03	10	7.24E-03	11	7.38E-03
12	7.52E-03	13	7.67E-03	14	7.81E-03	15	7.95E-03	16	8.09E-03	17	8.23E-03
18	8.38E-03	19	8.52E-03	20	8.66E-03	21	8.80E-03	22	8.94E-03	23	9.09E-03
24	9.23E-03	25	9.37E-03	26	9.51E-03	27	9.65E-03	28	9.80E-03	29	9.94E-03
30	1.02E-02	31	1.06E-02	32	1.09E-02	33	1.13E-02	34	1.16E-02	35	1.20E-02
36	1.23E-02	37	1.27E-02	38	1.30E-02	39	1.34E-02	40	1.37E-02	41	1.41E-02
42	1.44E-02	43	1.48E-02	44	1.51E-02	45	1.55E-02	46	1.58E-02	47	1.62E-02
48	1.65E-02	49	1.69E-02	50	1.72E-02	51	1.76E-02	52	1.79E-02	53	1.83E-02
54	1.86E-02	55	1.90E-02	56	1.93E-02	57	1.97E-02	58	2.00E-02	59	2.02E-02
60	2.05E-02	61	2.07E-02	62	2.09E-02	63	2.11E-02	64	2.14E-02	65	2.16E-02
66	2.18E-02	67	2.21E-02	68	2.23E-02	69	2.25E-02	70	2.28E-02	71	2.30E-02
72	2.32E-02	73	2.35E-02	74	2.37E-02	75	2.39E-02	76	2.42E-02	77	2.44E-02
78	2.46E-02	79	2.49E-02	80	2.51E-02	81	2.53E-02	82	2.56E-02	83	2.58E-02
84	2.60E-02	85	2.63E-02	86	2.65E-02	87	2.67E-02	88	2.70E-02	89	2.72E-02
90	2.74E-02	91	2.77E-02	92	2.79E-02	93	2.81E-02	94	2.84E-02	95	2.86E-02
96	2.88E-02	97	2.91E-02	98	2.93E-02	99	2.95E-02	100	2.98E-02	101	2.98E-02
102	2.96E-02	103	2.94E-02	104	2.91E-02	105	2.89E-02	106	2.87E-02	107	2.84E-02
108	2.82E-02	109	2.80E-02	110	2.77E-02	111	2.75E-02	112	2.73E-02	113	2.70E-02
114	2.68E-02	115	2.66E-02	116	2.63E-02	117	2.61E-02	118	2.59E-02	119	2.56E-02
120	2.54E-02	121	2.52E-02	122	2.49E-02	123	2.47E-02	124	2.45E-02	125	2.42E-02
126	2.40E-02	127	2.38E-02	128	2.35E-02	129	2.33E-02	130	2.31E-02	131	2.28E-02
132	2.26E-02	133	2.24E-02	134	2.21E-02	135	2.19E-02	136	2.17E-02	137	2.14E-02
138	2.12E-02	139	2.10E-02	140	2.08E-02	141	2.05E-02	142	2.03E-02	143	2.01E-02

*** POPULATION FOR WATERBORNE RELEASE

PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL	PERIOD	PL
0	1.99E-02	1	3.26E+05	2	3.87E+05	3	4.17E+05	4	4.45E+05	5	4.76E+05
6	5.57E+05	7	6.39E+05	8	7.20E+05	9	8.02E+05	10	8.83E+05	11	9.65E+05
12	1.05E+06	13	1.13E+06	14	1.21E+06	15	1.28E+06	16	1.31E+06	17	1.34E+06
18	1.37E+06	19	1.39E+06	20	1.42E+06	21	1.45E+06	22	1.48E+06	23	1.51E+06
24	1.54E+06	25	1.57E+06	26	1.60E+06	27	1.62E+06	28	1.65E+06	29	1.68E+06
30	1.71E+06	31	1.74E+06	32	1.77E+06	33	1.80E+06	34	1.83E+06	35	1.85E+06
36	1.88E+06	37	1.91E+06	38	1.94E+06	39	1.97E+06	40	2.00E+06	41	2.03E+06
42	2.06E+06	43	2.08E+06	44	2.11E+06	45	2.14E+06	46	2.17E+06	47	2.20E+06
48	2.23E+06	49	2.26E+06	50	2.29E+06	51	2.31E+06	52	2.34E+06	53	2.37E+06
54	2.40E+06	55	2.43E+06	56	2.46E+06	57	2.49E+06	58	2.52E+06	59	2.54E+06
60	2.57E+06	61	2.60E+06	62	2.63E+06	63	2.66E+06	64	2.69E+06	65	2.72E+06
66	2.75E+06	67	2.77E+06	68	2.80E+06	69	2.83E+06	70	2.86E+06	71	2.89E+06
72	2.92E+06	73	2.95E+06	74	2.98E+06	75	3.00E+06	76	3.03E+06	77	3.06E+06
78	3.09E+06	79	3.12E+06	80	3.15E+06	81	3.18E+06	82	3.21E+06	83	3.23E+06
84	3.26E+06	85	3.29E+06	86	3.32E+06	87	3.35E+06	88	3.38E+06	89	3.41E+06
90	3.44E+06	91	3.46E+06	92	3.49E+06	93	3.52E+06	94	3.55E+06	95	3.58E+06
96	3.61E+06	97	3.64E+06	98	3.67E+06	99	3.69E+06	100	3.72E+06	101	3.75E+06
102	3.78E+06	103	3.81E+06	104	3.84E+06	105	3.87E+06	106	3.90E+06	107	3.92E+06
108	3.95E+06	109	3.98E+06	110	4.01E+06	111	4.04E+06	112	4.07E+06	113	4.10E+06
114	4.13E+06	115	4.15E+06	116	4.18E+06	117	4.21E+06	118	4.24E+06	119	4.27E+06
120	4.30E+06	121	4.33E+06	122	4.36E+06	123	4.38E+06	124	4.41E+06	125	4.44E+06
126	4.47E+06	127	4.50E+06	128	4.53E+06	129	4.56E+06	130	4.59E+06	131	4.61E+06
132	4.64E+06	133	4.67E+06	134	4.70E+06	135	4.73E+06	136	4.76E+06	137	4.79E+06
138	4.82E+06	139	4.84E+06	140	4.87E+06	141	4.90E+06	142	4.93E+06	143	4.93E+06

FIGURE F.12. (contd)

STACK HEIGHT: 0.00

*** AIR RELEASE OF EACH RADIONUCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

RADIONUCLIDE	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY
C 14												
SR90	15	5.25E+03	16	8.19E+03	17	9.17E+03	18	1.02E+04	19	1.11E+04	20	1.21E+04
	21	1.31E+04	22	1.39E+04	23	1.40E+04	24	1.40E+04	25	1.40E+04	26	1.40E+04
	27	1.30E+04	28	1.18E+04	29	1.06E+04	30	9.82E+03	31	9.08E+03	32	8.35E+03
	33	7.61E+03	34	6.88E+03	35	6.14E+03	36	5.41E+03	37	4.67E+03	38	3.94E+03
	39	3.20E+03	40	2.47E+03	41	1.73E+03	42	9.98E+02	43	2.70E+02		
Y 90												
I 129												
PU238												

*** WATER RELEASE OF EACH RADIONCLIDE PER PERIOD - CURIES (GRAPH OPTION TURNED OFF)

RADIONUCLIDE	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY	PERIOD	ACTVITY
C 14	0	7.50E+05										
SR90	8	1.60E+02	9	8.0								
Y 90												
I 129	129	30.	130	70.	131	70.	132	70.	133	70.	134	70.
	135	70.	136	70.	137	70.	138	70.	139	70.	140	70.
	141	70.	142	70.	143	61.						
PU238												

INPUT PREPARED BY: ************** DATE: 2/5/86 ********** INPUT CHECKED BY: ************** DATE: 5 Feb 86 **********

FIGURE F.12. (contd)

REPORT FOR DITTY (VAX VERSION 1.0) RUN ON 4-FEB-86
INTEGRATED POPULATION DOSE CALCULATED FOR CHRONIC ATMOSPHERIC AND LIQUID
RELEASE FROM TIME 1990. A.D. ONWARD FOR 10,000 YEARS
CASE TITLE: Sample Problem Seven - Airborne and waterborne release, chronic exposure

* * * MAXIMUM DOSE RATE REPORT * * *
DOSE INTEGRAL PERIOD (70-YEAR) DURING WHICH THE MAXIMUM DOSE RATE OCCURS = 27

* * * MAXIMUM POPULATION DOSE INCREMENT TO TOTAL BODY BY ORGAN AND RADIONUCLIDE * * *

NUCLIDE	TOTAL BODY	BONE	LUNG	THYROID	GI-LLI
C 14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR90	9.56E+04	8.59E+05	1.85E+05	8.83E-03	4.93E+03
Y 90	2.98E-14	3.00E-14	2.99E-14	2.98E-14	1.79E-12
I 129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PU238	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	9.56E+04	8.59E+05	1.85E+05	8.83E-03	4.93E+03

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

* * * PERCENT OF TOTAL DOSE TO ORGAN AND CUMULATIVE DOSE TO ORGAN BY RADIONUCLIDE * * * 31

NUCLIDE	TOTAL BODY		BONE		LUNG		THYROID		GI-LLI	
C 14	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00
SR90	99%	1.7E+06	99%	1.6E+07	99%	3.4E+06	0%	0.2	99%	9.0E+04
Y 90	0%	0.2	0%	0.2	0%	0.2	0%	0.2	0%	1.4E+01
I 129	0%	2.3E+03	0%	1.3E+03	0%	7.5E+02	99%	1.2E+06	0%	8.3E+02
PU238	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00
Total		1.7E+06		1.6E+07		3.4E+06		1.2E+06		9.1E+04

Dose in units of person-rem; that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

FIGURE F.12. (contd)

APPENDIX G

DIAGNOSTIC MESSAGES

APPENDIX G

DIAGNOSTIC MESSAGES

The computer program DITTY contains several read error tests and internal tests on input data. For each error condition detected a diagnostic message is printed prior to termination of execution. The messages printed by DITTY are listed in alphabetized order in Table G.1. Also provided is the name of the module the message is printed from, the severity of the error (F for fatal or I for informative), and a brief description of the cause of the error.

TABLE G.1. DITTY Diagnostic Messages

Module	Severity	Message/Cause
AIRLIN	F	"Bad library organ index value, IGRG (IO): ___" The organ selection index array IORG has a value out of range, 1 ≤ IORG (IO) ≤ 23. The values are read from the internal dose conversion factor data file (logical unit 18).
ORGCHK	F	"Bad value for KORG (I) = ___" A value in the master organ index array is out of range, 1 ≤ KORG ≤ 23.
RLIBIN	F	"Decay chain ___ has improper order. Current member index is ___" Chain decay data in master radionuclide data file (logical unit) is out of order. Check the values of the chain member indices for increasing order within chains.
CASEIN	F	"E/Q read error encountered in CASEIN" An error occurred when reading of chi/Q values was attempted from the input stream (logical unit 5), record type 6.
EXMO	F	"Error in function EXMO, positive arg = ___" A positive value was passed to function EXMO through the first argument position, ARG. This parameter must be less than or equal to zero. This message is an indication of serious problems in basic radionuclide data arrays.

TABLE G.1. (contd)

Module	Severity	Message/Cause
CASEIN	F	"Error reading population in file 22 encountered in CASEIN" An error occurred while reading population data was being read from the library population file (logical unit 22).
RLIBIN	F	"Improper number of nuclides in master library, NUC = ___" The number of radionuclides encountered in the master radionuclide data file was out of range. $1 \leq NUC \leq 300$.
AIRLIN	I	"Master list radionuclide ___ ___ is not in dose factor library" A radionuclide specified in the master list was not found in the internal dose conversion factor data library. This radionuclide is not considered in the calculation.
CASEIN	F	"NAMELIST read error encountered in CASEIN." An error occurred when an attempt was made to read the INPUT NAMELIST data set from the input stream (logical unit 5). Check INPUT data set for improper format.
EOVRQ	F	"NDIST is out of range; ___" The value of the NAMELIST parameter NDIST is out of range; $1 \leq NDIST \leq 10$.
EOVRQ	F	"NMET is out of range; ___" The value of the NAMELIST parameter NMET is out of range, $1 \leq NMET \leq 7$.
ORGCHK	F	"No organs specified, NORG = ___" The value give for NORG in the master organ input data (logical unit 5) was less than one.
ACTIN	F	"NT for radionuclide ___ is too large = ___" The value of NT (number of times for which release data is to be read) is greater than 300 for the given radionuclide (read from logical unit 5, 24, 26 depending on values of the control integers IP and IAW).

TABLE G.1. (contd)

Module	Severity	Message/Cause
EOVRO	F	"NUBAR is out of range; ___" The value of the NAMELIST parameter NUBAR is out of range, $1 \leq$ NUBAR ≤ 8.
NUCTST	F	"Nuclide ___ not found ___" The named radionuclide read from input (logical unit 5) did not match any of the master radionuclides also supplied on the input file.
ORGCHK	F	"Number of errors in ORGCHK = " Errors were detected in the master organ input data (logical unit 5). This message is always preceeded by other messages.
AIRLIN	F	"Number of library organs incorrect, LORG: ___" The value of LORG read from the internal organ dose conversion factor data file (logical unit 18) was out of range, $1 \leq$ LORG ≤ 10.
CASEIN	F	"Population for airborne release error in input file." An error occurred with the attempted read of population data, record type 9, from the input stream (logical unit 5).
CASEIN	F	"Population title airborne release error in file 22." An error occurred when either an attempt was made to open the file assigned to logic unit 22 or when an attempt was made to read the title (first line) of the file.
ACTIN	F	"Premature end-of-file encountered in ACTIN" An attempt was made to read beyond the end of data on the release rate input file (logical unit 5, 24 or 26 depending on control integers IP and IAW).
AIRLIN	F	"Premature end-of-file encountered in IARLIN" An attempt was made to read beyond the end of data on the internal dose conversion factor data file (logical unit 18).

TABLE G.1. (contd)

Module	Severity	Message/Cause
BIOLIN	F	"Premature end-of-file encountered in BIOLIN" An attempt was made to read beyond the end of data on the bioaccumulation factor data file (logical unit 14).
CASEIN	F	"Premature end-of-file encountered in CASEIN" An attempt was made to read beyond the end of data on the input file (logical unit 5).
FOOLIN	F	"Premature end-of-file encountered in FOOLIN" An attempt was made to read beyond the end of data on the food transfer coefficient data library (logical unit 12).
GRDLIN	F	"Premature end-of-file encountered in GRDLIN" An attempt was made to read beyond the end of data on the external dose conversion factor data file (logical unit 16).
MAIN	F	"Premature end-of-file encountered in MAIN" An input file (logical unit 5) read attempt was made beyond the end of data in the file.
RLIBIN	F	"Premature end-of-file encountered in RLIBIN" An attempt was made to read beyond the end of data on the master radionuclide data file (logical unit 10).
ACTIN	F	"Read error encountered in ACTIN" A read attempt resulted in an error condition on the release data file (logical unit 5, 24, or 26 depending on control integers IP and IAW).
AIRLIN	F	"Read error encountered in AIRLIN" A read attempt resulted in an error condition on the internal dose conversion factor data file (logical unit 18).

TABLE G.1. (contd)

Module	Severity	Message/Cause
BIOLIN	F	"Read error encountered in BIOLIN" A read attempt resulted in an error condition on the bioaccumulation factor data file (logical unit 14).
FOOLIN	F	"Read error encountered in FOOLIN" A read attempt resulted in an error condition on the food transfer coefficient data library (logical unit 12).
GRDLIN	F	"Read error encountered in GRDLIN" A read attempt resulted in an error condition on the external dose conversion factor data file (logical unit 16).
MAIN	F	"Read error encountered in MAIN" A read attempt resulted in an error condition on the input file (logical unit 5).
AIRLIN	F	"Selected organ KO not in library, KO = ___" A value read from the internal dose conversion factor data file (logical unit 18) was specified incorrectly. Values must correspond to values in the master organ list, KORG.
CASEIN	F	"TIME(1) for airborne release population read error in input stream encountered in CASEIN."
NUCTST	F	"Too many radionuclides required" More than 100 radionuclides were specified in the master list on the input file (logical unit 5).

APPENDIX H

VAX IBM PC CODE VARIATIONS

APPENDIX H

VAX IBM PC CODE VARIATIONS

A few minor differences exist between the mainframe and IBM-PC versions of DITTY. These are:

1. An emulator for the FORTRAN statement NAMELIST was written for user input instructions compatibility between the VAX and IBM PC versions of DITTY. The emulator consists of the following components:

   - Common Block NMCHR - contains arrays for storing variable names
   - Common Block NMLST - contains flags and indices of NAMELIST parameters; also contains general purpose variables for storing NAMELIST parameter values
   - Subroutine DECOD - reads NAMELIST input from the user's input file, decodes the variable names, and stores input values into general purpose parameters
   - Subroutine NAMLS - interface between the calling program and the subroutine DECOD. NAMLS sets up the cross-reference between NAMELIST parameters in the calling program and the general purpose variables stored in common blocks NMCHR and NMLST that are used by DECOD.

In the calling program, the NAMELIST statement and the READ of the NAMELIST input set are removed. A call to the subroutine NAMLS replaces these statements. Two parameters are passed to NAMLS: LUNI (the logical unit number to which the input file is assigned) and NAM (the character name of the NAMELIST set to be read).

2. The total number of radionuclides considered in any one case was reduced in the IBM-PC version to 25. This resulted in a 75% decrease in storage requirements for a number of large arrays, permitting DITTY to fit onto machines having as little as 256K of available memory.

3. The functions ASUM and SUMPRD were incorporated directly into the decay processor routine BCHAIN. The coding of BCHAIN was simply increased with the actual coding of the two functions.

COMMON BLOCK Modules

```
C---------------------------------------------------------------------
C     NMLST
C          DESCRIPTION:  "NAMELIST" EMULATOR PARAMETERS
C          USED BY:  NAMLST, DECOD
C---------------------------------------------------------------------
C
      COMMON /NMLST/ NINT,       NREL,       NRAR,            NIAR,
     .               IVAL(24),   RVAL(11),   RVALA(144,13),   IVALA(7,1),
     .                                       MAXR(13),        MAXI(1),
     .               IFLI(24),   IFLR(11),   IFLRA(144,13),   IFLIA(7,1)
C
C
C     IVAL()       - Value of variable CHINT() in corresponding array position
C     RVAL()       - Value of variable CHREL() in corresponding array position
C     RVALA(j,i)   - Value of variable CHRAR(i) in array position j.  Note:
C                    j must be set equal to the largest array position used
C                    in any array of the NAMELIST record set
C     IVALA(j,i)   - Value of variable CHIAR(i) in array position j.
C
C     MAXR()       - Dimension of CHRAR()
C     MAXI()       - Dimension of CHIAR()
C
C     IFLI()       - Flag set if a value was input for variable CHINT() in the
C                    NAMELIST record set
C     IFLR()       - Flag set if a value was input for variable CHREL() in the
C                    NAMELIST record set
C     IFLRA(j,i    - Flag set if a value was input for variable CHRAR(i),
C                    array position j in the NAMELIST record set
C     IFLIA(j,i)   - Flag set if a value was input for variable CHIAR(i),
C                    array position j in the NAMELIST record set
C
C     NINT         - Number of variables in the type integer array
C     NREL         - Number of variables in the type real array
C     NRAR         - Number of variables in the type real dimensioned array
C     NIAR         - Number of variables in the type integer dimensioned array
C
C---------------------------------------------------------------------
C     NMCHR
C          DESCRIPTION:  "NAMELIST" EMULATOR PARAMETERS, CHARACTER TYPE
C          USED BY:  NAMLST, DECOD
C---------------------------------------------------------------------
C
      COMMON /NMCHR/ CHINT(24),  CHREL(11),  CHRAR(13),  CHIAR(1)
C
      CHARACTER*6 CHINT, CHREL, CHRAR, CHIAR
```

FIGURE H.1. IBM PC Code Additions

```
C
C     CHINT()       - Names of variables in integer array
C     CHREL()       - Names of variables in real array
C     CHRAR()       - Names of dimensioned real variables
C     CHIAR()       - Names of dimensioned integer variables
C
C-----------------------------------------------------------------------------
```

FIGURE H.1. IBM PC Code Additions (continued)

```
      SUBROUTINE NAMLS (LUNI, NAM)
C
C***********************************************************************
C
C     THIS SUBROUTINE WAS WRITTEN AS AN INTERFACE TO THE NAMELIST FORTRAN
C     STATEMENT EMULATOR DECOD.
C
C***********************************************************************
C
C     CALLED BY-- CASEIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- LUNI, NAM
C     INPUT COMMONS-- OPTION, BIODAT, TIMES, DISPSN, NAMLST, VARYBL, PATHIN,
C                     NMLST
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- OPTION, BIODAT, TIMES, DISPSN, NAMLST, VARYBL, PATHIN
C
C     Module of DITTY
C     IBM PC Version of 8-NOV-84  RAP
C
C-----------------------------------------------------------------------
C
C                ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ----------  ---------  ---------------------------------------
C     PARAMETER   TYPE       DESCRIPTION
C     ----------  ---------  ---------------------------------------
C
C     LUNI        INTEGER    Logical unit number to which the input
C                            file is assigned, passed through to DECOD
C
C     NAM         CHARACTER  Name of this input set
C
C-----------------------------------------------------------------------
C
$INCLUDE: 'OPTION.CMN'
$INCLUDE: 'BIODAT.CMN'
$INCLUDE: 'TIMES.CMN'
$INCLUDE: 'DISPSN.CMN'
$INCLUDE: 'VARYBL.CMN'
$INCLUDE: 'PATHIN.CMN'
$INCLUDE: 'NAMLST.CMN'
C
$INCLUDE: 'NMLST.CMN'
$INCLUDE: 'NMCHR.CMN'
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
      CHARACTER NAM*6
C
C-----------------------------------------------------------------------
C
C     Set number of variables for integer, real, real array, & integer array--
C
      NINT = 24
      NREL = 11
      NRAR = 13
      NIAR = 1
C
C-----------------------------------------------------------------------
C
C     Set integer variable names into CHINT array--
C
      CHINT(1)= 'IAC   '
      CHINT(2)= 'IAIR  '
      CHINT(3)= 'IPATH '
      CHINT(4)= 'IWAT  '
      CHINT(5)= 'LUA   '
      CHINT(6)= 'LUW   '
      CHINT(7)= 'ISALT '
      CHINT(8)= 'NDIST '
      CHINT(9)= 'NSECT '
      CHINT(10)= 'IEOQ  '
      CHINT(11)= 'NMET  '
      CHINT(12)='NUBAR '
      CHINT(13)='IPA   '
      CHINT(14)='IPL   '
      CHINT(15)='IPOP  '
      CHINT(16)='NTA   '
      CHINT(17)='NTL   '
      CHINT(18)='IPOPL '
      CHINT(19)='IGRPOP'
      CHINT(20)='IGRPM '
      CHINT(21)='IGRPL '
      CHINT(22)='IGRTNU'
      CHINT(23)='IGRNUC'
      CHINT(24)='IGRDOS'
C
C     Initialize integer value and flag arrays--
C
      DO 333 I = 1, NINT
        IVAL(I) = 0
        IFLI(I) = 0
```

FIGURE H.1. IBM PC Code Additions (continued)

```
  333 CONTINUE
C
C------------------------------------------------------------------------
C
C     Set real variable names into CHREL array--
C
      CHREL(1) = 'TZ     '
      CHREL(2) = 'TZR    '
      CHREL(3) = 'HS     '
      CHREL(4) = 'PMA    '
      CHREL(5) = 'PPL    '
      CHREL(6) = 'CFLO   '
      CHREL(7) = 'RECON  '
      CHREL(8) = 'RM     '
      CHREL(9) = 'EXTIM  '
      CHREL(10)= 'MOPYR  '
      CHREL(11)= 'RIRR   '
C
C     Initialize real value and flag arrays--
C
      DO 335 I = 1, NREL
        RVAL(I) = 0.0
        IFLR(I) = 0
  335 CONTINUE
C
C------------------------------------------------------------------------
C
C     Set real array variable names into CHRAR array--
C
      CHRAR(1) = 'DIST   '
      CHRAR(2) = 'UBAR   '
      CHRAR(3) = 'PL     '
      CHRAR(4) = 'PL1    '
      CHRAR(5) = 'PM1    '
      CHRAR(6) = 'PM     '
      CHRAR(7) = 'POPT   '
      CHRAR(8) = 'USAGE  '
      CHRAR(9) = 'CONSUM'
      CHRAR(10)= 'GRWP   '
      CHRAR(11)= 'YELD   '
      CHRAR(12)= 'T      '
      CHRAR(13)= 'TL     '
C
C     Set number of elements in each real array--
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
      MAXR(1) = 10
      MAXR(2) = 8
      MAXR(3) = 144
      MAXR(4) = 20
      MAXR(5) = 20
      MAXR(6) = 144
      MAXR(7) = 20
      MAXR(8) = 7
      MAXR(9) = 7
      MAXR(10)= 7
      MAXR(11)= 7
      MAXR(12) = 20
      MAXR(13) = 20
C
C     Initialize real array value and flag arrays--
C
      DO 336 I = 1, NRAR
        DO 334 J = 1, MAXR(I)
          RVALA(J,I) = 0.0
          IFLRA(J,I) = 0
  334   CONTINUE
  336 CONTINUE
C
C-----------------------------------------------------------------------
C
C     Set integer array names into CHIAR array--
C
      CHIAR(1) = 'MET   '
C
C     Set number of elements in integer arrays--
C
      MAXI(1) = 7
C
C     Initialize integer array value and flag arrays--
C
      DO 337 I = 1, NIAR
        DO 338 J = 1, MAXI(I)
          IVALA(J,I) = 0
          IFLIA(J,I) = 0
  338   CONTINUE
  337 CONTINUE
C
C-----------------------------------------------------------------------
C
      CALL DECOD (LUNI, NAM)
```

FIGURE H.1. IBM PC Code Additions (continued)

```
C
C-----------------------------------------------------------------------
C
      WRITE (3,8100) NINT, NREL, NRAR, NIAR
      DO 800 I = 1, NINT
        WRITE (3,8000) CHINT(I), IFLI(I), IVAL(I)
  800 CONTINUE
C
      DO 801 I = 1, NREL
        WRITE (3,8001) CHREL(I), IFLR(I), RVAL(I)
  801 CONTINUE
C
C
      DO 806 I = 1, NRAR
        WRITE(3,8003) CHRAR(I)
        DO 807 J = 1, 2
          WRITE(3,8005) IFLRA(J,I), RVALA(J,I)
  807   CONTINUE
  806 CONTINUE
C
      DO 803 I = 1, NIAR
        WRITE(3,8003) CHIAR(I)
        DO 804 J = 1, MAXI(I)
          WRITE(3,8004) IFLIA(J,I), IVALA(J,I)
  804   CONTINUE
  803 CONTINUE
C
 8100 FORMAT ('       VAR    FLAG  VALUE', 4I4)
 8000 FORMAT ('      ',A6,2X,I4,2X,I5)
 8001 FORMAT ('      ',A6,2X,I4,2X,1PE8.2)
 8003 FORMAT ('      ',A6)
 8004 FORMAT ('              ',I4,2X,I5)
 8005 FORMAT ('              ',I4,2X,1PE8.2)
C
C
C     If flag set, transfer integer values into variables--
C
      IF (IFLI(1) .GT. 0) IAC    = IVAL(1)
      IF (IFLI(2) .GT. 0) IAIR   = IVAL(2)
      IF (IFLI(3) .GT. 0) IPATH  = IVAL(3)
      IF (IFLI(4) .GT. 0) IWAT   = IVAL(4)
      IF (IFLI(5) .GT. 0) LUA    = IVAL(5)
      IF (IFLI(6) .GT. 0) LUW    = IVAL(6)
      IF (IFLI(7) .GT. 0) ISALT  = IVAL(7)
      IF (IFLI(8) .GT. 0) NDIST  = IVAL(8)
```

FIGURE H.1. IBM PC Code Additions (continued)

```
      IF (IFLI(9) .GT. 0) NSECT  = IVAL(9)
      IF (IFLI(10).GT. 0) IEOQ   = IVAL(10)
      IF (IFLI(11).GT. 0) NMET   = IVAL(11)
      IF (IFLI(12).GT. 0) NUBAR  = IVAL(12)
      IF (IFLI(13).GT. 0) IPA    = IVAL(13)
      IF (IFLI(14).GT. 0) IPL    = IVAL(14)
      IF (IFLI(15).GT. 0) IPOP   = IVAL(15)
      IF (IFLI(16).GT. 0) NTA    = IVAL(16)
      IF (IFLI(17).GT. 0) NTL    = IVAL(17)
      IF (IFLI(18).GT. 0) IPOPL  = IVAL(18)
      IF (IFLI(19).GT. 0) IGRPOP = IVAL(19)
      IF (IFLI(20).GT. 0) IGRPM  = IVAL(20)
      IF (IFLI(21).GT. 0) IGRPL  = IVAL(21)
      IF (IFLI(22).GT. 0) IGRTNU = IVAL(22)
      IF (IFLI(23).GT. 0) IGRNUC = IVAL(23)
      IF (IFLI(24).GT. 0) IGRDOS = IVAL(24)
C
C-----------------------------------------------------------------------------
C
C     If flag set, transfer real values to parameter--
C
      IF (IFLR(1) .GT. 0) TZ     = RVAL(1)
      IF (IFLR(2) .GT. 0) TZR    = RVAL(2)
      IF (IFLR(3) .GT. 0) HS     = RVAL(3)
      IF (IFLR(4) .GT. 0) PMA    = RVAL(4)
      IF (IFLR(5) .GT. 0) PPL    = RVAL(5)
      IF (IFLR(6) .GT. 0) CFLO   = RVAL(6)
      IF (IFLR(7) .GT. 0) RECON  = RVAL(7)
      IF (IFLR(8) .GT. 0) RM     = RVAL(8)
      IF (IFLR(9) .GT. 0) EXTIM  = RVAL(9)
      IF (IFLR(10).GT. 0) MOPYR  = RVAL(10)
      IF (IFLR(11).GT. 0) RIRR   = RVAL(11)
C
C-----------------------------------------------------------------------------
C
C     If flag set, transfer real array values to parameter arays--
C
      DO 111 J = 1, MAXR(1)
        IF (IFLRA(J,1) .GT. 0) DIST(J)  = RVALA(J,1)
  111 CONTINUE
C
      DO 112 J = 1, MAXR(2)
        IF (IFLRA(J,2) .GT. 0) UBAR(J)  = RVALA(J,2)
  112 CONTINUE
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
      DO 113 J = 1, MAXR(3)
        IF (IFLRA(J,3) .GT. 0) PL(J)     = RVALA(J,3)
  113 CONTINUE
C
      DO 114 J = 1, MAXR(4)
        IF (IFLRA(J,4) .GT. 0) PL1(J)    = RVALA(J,4)
  114 CONTINUE
C
      DO 115 J = 1, MAXR(5)
        IF (IFLRA(J,5) .GT. 0) PM1(J)    = RVALA(J,5)
  115 CONTINUE
C
      DO 116 J = 1, MAXR(6)
        IF (IFLRA(J,6) .GT. 0) PM(J)     = RVALA(J,6)
  116 CONTINUE
C
      DO 117 J = 1, MAXR(7)
        IF (IFLRA(J,7) .GT. 0) POPT(J)   = RVALA(J,7)
  117 CONTINUE
C
      DO 118 J = 1, MAXR(8)
        IF (IFLRA(J,8) .GT. 0) USAGE(J)  = RVALA(J,8)
  118 CONTINUE
C
      DO 119 J = 1, MAXR(9)
        IF (IFLRA(J,9) .GT. 0) CONSUM(J)= RVALA(J,9)
  119 CONTINUE
C
      DO 120 J = 1, MAXR(10)
        IF (IFLRA(J,10) .GT. 0) GRWP(J) = RVALA(J,10)
  120 CONTINUE
C
      DO 121 J = 1, MAXR(11)
        IF (IFLRA(J,11) .GT. 0) YELD(J) = RVALA(J,11)
  121 CONTINUE
C
      DO 122 J = 1, MAXR(12)
      IF (IFLRA(J,12) .GT. 0)  T(J)     = RVALA(J,12)
  122 CONTINUE
C
      DO 123 J = 1, MAXR(13)
        IF (IFLRA(J,13) .GT. 0) TL(J)   = RVALA(J,13)
  123 CONTINUE
C
C-----------------------------------------------------------------------
```

FIGURE H.1. IBM PC Code Additions (continued)

```
C
C     If flag set, transfer integer array values to parameter arays--
C
      DO 131 J = 1, MAXI(1)
        IF (IFLIA(J,1) .GT. 0) MET(J)  = IVALA(J,1)
  131 CONTINUE
C
C-----------------------------------------------------------------------
C
      RETURN
      END
```

FIGURE H.1. IBM PC Code Additions (continued)

Module DECOD

```
      SUBROUTINE DECOD (LUNI, NAM)
C
C***********************************************************************
C
C     THIS SUBROUTINE WAS WRITTEN TO EMULATE THE NAMELIST FORTRAN STATE-
C     MENT ON THE IBM PC WITH MICROSOFT FORTRAN TO MAXIMIZE CODE
C     COMPATIBILITY.
C
C***********************************************************************
C
C     CALLED BY-- CASEIN
C     SUBORDINATE ROUTINES-- NONE
C     INPUTS-- LUNI, NAM
C     INPUT COMMONS-- NONE
C     OUTPUTS-- NONE
C     OUTPUT COMMONS-- NMLST
C
C     Module of DITTY
C     IBM PC Version of 11-NOV-84  RAP
C
C-----------------------------------------------------------------------
C
C                 ARGUMENT LIST PARAMETER DESCRIPTIONS
C     ---------- --------- -----------------------------------------------
C     PARAMETER  TYPE      DESCRIPTION
C     ---------- --------- -----------------------------------------------
C
C     LUNI       INTEGER   Logical unit number to which the input
C                          file is assigned
C
C     NAM        CHARACTER Name of this input set
C
C-----------------------------------------------------------------------
C
C                     INTERNAL VARIABLE PARAMETER DESCRIPTIONS
C     ---------- --------- -----------------------------------------------
C     PARAMETER  TYPE      DESCRIPTION
C     ---------- --------- -----------------------------------------------
C
C     CHNUM      CHARACTER Character representation of allowable numeric
C                          input
```

FIGURE H.1. IBM PC Code Additions (continued)

```
C
C     CHR           CHARACTER  Character array of LINE, equivalenced to LINE
C                              dimensioned array
C
C     IAR           INTEGER    Flag set if this variable is an array
C
C     IAR1          INTEGER    Beginning index of subscript string
C
C     IAR2          INTEGER    Ending index of subscript string
C
C     IEND          INTEGER    Intermediate ending index of string
C
C     IFIRST        INTEGER    Flag set after first line of NAMELIST record
C                              set read.
C
C     IFND          INTEGER    Flag set to indicate the following:
C                                1 - End of NAMELIST set found
C                                2 - End of variable name found
C
C     INDX          INTEGER    Index of this variable in variable array
C
C     IST           INTEGER    Begining index of current character string
C
C     ITAB          INTEGER    Index of target location in compressed CHR array
C
C     ITYP          INTEGER    Index of variable type:
C                                1- Integer, 2-Real, 3-Real Array
C
C     LINE          CHARACTER  Current line of NAMELIST record set.  LINE
C                              is equivalenced with the array CHR to allow
C                              both line and character manipulation
C
C     REDNAM        CHARACTER  Name of NAMELIST record set constructed from
C                              input file
C
C     VNAM          CHARACTER  Variable name from input file
C
C
C-----------------------------------------------------------------------------
C
```

FIGURE H.1. IBM PC Code Additions (continued)

Module DECOD

```
C                              DECOD Logic
C
C    ------------------------------------------------------------------------
C   |    |  read a line from the input file                                  |
C   |    |-------------------------------------------------------------------|
C   |    | then \          if this is first line of set              / else  |
C   |    |-------------------------------------------------------------------|
C   |    |  find and verify set name                                 |  null |
C   |    |-------------------------------------------------------------------|
C   |    |  remove spaces from line and count number of characters in line   |
C   |    |-------------------------------------------------------------------|
C   |    |       do until entire line is decoded                             |
C   |    |     --------------------------------------------------------------|
C   |    |    | then \       if last variable was dimensioned        / else  |
C   |    |    |--------------------------------------------------------------|
C   |    |    |  check for additional values, set flag               |  null |
C   |    |    |--------------------------------------------------------------|
C   |    |    | then \     if additional values flag clear           / else  |
C   |    |    |--------------------------------------------------------------|
C   |    |    |  search for "=" to signal end of variable name       |       |
C   |    |    |  search for parens in variable name                  |       |
C   |    |    |------------------------------------------------------|       |
C   |    |    | then \    if parens found in variable name    / else |       |
C   |    |    |------------------------------------------------------|       |
C   |    |    |  determine and test subscript value         |  null  |       |
C   |    |    |------------------------------------------------------|       |
C   |    |    |  test variable name against approved lists, set type |  null |
C   |    |    |--------------------------------------------------------------|
C   |    |    | then \   if add. flag set or valid name flag set     / else  |
C   |    |    |--------------------------------------------------------------|
C   |    |    |  determine & store value, set change flag            |  null |
C   |     -------------------------------------------------------------------|
C   |       do until $END encountered                                        |
C    ------------------------------------------------------------------------
C
C
C---- variable definition ---------------------------------------------------
C
$INCLUDE: 'NMLST.CMN'
$INCLUDE: 'NMCHR.CMN'
C
      CHARACTER NAM*6, REDNAM*6, VNAM*6, LINE*80, CHR*1
C
      CHARACTER*80 ISCRT
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
      CHARACTER*1 DOLLAR, EQUAL, SPACE, COMMA, LPRN, RPRN, ASTRIK
      DIMENSION CHR(80)
      EQUIVALENCE (LINE, CHR(1))
C
      DIMENSION CHNUM (12)
      CHARACTER*1 CHNUM
      DATA CHNUM /'1','2','3','4','5','6','7','8','9','0','E','.'/
C
      DATA DOLLAR, EQUAL, SPACE, COMMA, LPRN, RPRN, ASTRIK /'$', '=',
     .       ' ',   ',',   '(',  ')',   '*'  /
C
      IFIRST = 0
      IFND = 0
      IADD = 0
      ITYP = 0
      ISUB = 0
C
C#### read a line from input file and set beginning location index ##########
C
  100 CONTINUE
C
      READ (LUNI,1000) LINE
C
C     Set beginning character index--
      IST = 1
C
C
C#### if first line, find and verify set name ###############################
C
      IF (IFIRST .LT. 1) THEN
C
C       Search for dollar sign--
        DO 122 I = IST, 80
          IF (CHR(I) .EQ. DOLLAR) GOTO 123
  122   CONTINUE
C
C       Dollar sign not found, error condition--
        GOTO 901
C
  123   CONTINUE
        IST = I + 1
C
C       Search for space to signal end of name--
        DO 126 I = IST, IST+7
          IF (CHR(I) .EQ. SPACE) GOTO 127
```

FIGURE H.1. IBM PC Code Additions (continued)

```
  126   CONTINUE
C
C       Error determining NAMELIST set name--
C       GOTO 902
C
  127   CONTINUE
        IND = I - 1
C
C       Construct and verify name--
C
        WRITE (REDNAM,1001) (CHR(I), I=IST,IND)
C
C       Name of NAMELIST record set does not match anticipated set--
        IF (REDNAM .NE. NAM) GOTO 903
C
C       Set beginning location index past name--
        IST = IND +2
C
C       Set first line flag--
        IFIRST = 1
C
      ENDIF
C
C
C#### remove spaces from line and count number of characters in line #########
C
      ITAB = 0
      DO 110 I = IST, 80
        IF (CHR(I) .NE. SPACE) THEN
          CHR(I-ITAB) = CHR(I)
          IF (ITAB .NE. 0) CHR(I) = ' '
        ELSE
          ITAB = ITAB + 1
        ENDIF
  110 CONTINUE
C
C
C     Determine number of characters in string--
C
      DO 120 I = 80, 1, -1
        IF (CHR(I) .NE. SPACE) THEN
          NC=I
          GOTO 121
        ENDIF
  120 CONTINUE
```

FIGURE H.1. IBM PC Code Additions (continued)

```
  121 CONTINUE
C
C
C     Check if character count is valid--
      IF (NC .LT. 1 .OR. NC .GT. 80) GOTO 900
C
C
C#### do until entire line of input is decoded ###############################
C
  125   CONTINUE
C
C         Skip if set name only is on this line--
          IF (IST .GE. NC) GOTO 100
C
C         Check for $END--
          IF (CHR(IST) .EQ. DOLLAR) THEN
            IFND = 1
            GOTO 999
          ENDIF
C
C-------- if last variable was dimensioned, check for additional values -----
C
C         Turn additional values flag off--
          IADD = 0
          IFLG = 0
C
          IF (ITYP .GT. 2) THEN
C
            DO 145 I = 1, 10
              IF (CHR(IST) .EQ. CHNUM(I)) IFLG = 1
  145       CONTINUE
            IF (CHR(IST) .EQ. CHNUM(12)) IFLG = 1
C
            IF (IFLG .EQ. 1) THEN
              IADD = 1
              IAR2 = IST-2
              ISUB = ISUB+1
            ENDIF
  146       CONTINUE
C
          ENDIF
C
C-------- if additional values flag clear, determine & test name, subscript--
C
          IF (IADD .LT. 1) THEN
```

FIGURE H.1. IBM PC Code Additions (continued)

```
C
C          Search for equal sign--
C
           IFLG = 0
           DO 130 I = IST, NC
             IF (CHR(I) .EQ. EQUAL)  THEN
               IFLG = 1
               IND = I-1
             ENDIF
             IF (IFLG .GT. 0) GOTO 131
  130      CONTINUE
  131      CONTINUE
C
C
C---------- search for parens in variable name, test subscript if found ------
C
           IAR=0
           IAR1 = 0
           IAR2 = 0
C
           DO 140 I = IST, IND
             IF (CHR(I) .EQ. LPRN) IAR1=I
  140      CONTINUE
           IF (IAR1 .GT. 0) IAR=1
C
           IF (IAR .GT. 0) THEN
C          this is an array, so determine subscript--
C
C            find right paren--
             DO 150 I = IAR1+1, IND
               IF (CHR(I) .EQ. RPRN) IAR2=I
  150        CONTINUE
C
C            no right paren found, error condition--
             IF (IAR2 .LT. 2) GOTO 905
C
C            determine subscript value--
             WRITE (ISCRT,1001) (CHR(I), I=IAR1+1,IAR2-1)
             READ (ISCRT,*, ERR=910) ISUB
C
             IND = IAR1 - 1
C
           ENDIF
```

FIGURE H.1. IBM PC Code Additions (continued)

```
C
C---------- test variable name against approved list, set variable type ------
C
C
          ITYP = 0
          INDX = 0
C
          IF (CHR(IST) .EQ. COMMA) IST = IST+1
          IF (CHR(IST) .EQ. SPACE) IST = IST+1
          IF (IND+1-IST .GT. 7) GOTO 909
C
          WRITE (VNAM,1001) (CHR(I), I=IST,IND)
C
          DO 200 I = 1, NINT
            IF (VNAM .EQ. CHINT(I)) THEN
              ITYP = 1
              INDX = I
              GOTO 250
            ENDIF
  200     CONTINUE
C
          DO 210 I = 1, NREL
            IF (VNAM .EQ. CHREL(I)) THEN
              ITYP = 2
              INDX = I
              GOTO 250
            ENDIF
  210     CONTINUE
C
          DO 220 I = 1, NRAR
            IF (VNAM .EQ. CHRAR(I)) THEN
              ITYP = 3
              INDX = I
              GOTO 250
            ENDIF
  220     CONTINUE
C
          DO 240 I = 1, NIAR
            IF (VNAM .EQ. CHIAR(I)) THEN
              ITYP = 4
              INDX = I
              GOTO 250
            ENDIF
  240     CONTINUE
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
  250       CONTINUE
C
C           Variable name not found in valid arrays--
            IF (ITYP .LT. 1 .OR. ITYP .GT. 4) GOTO 906
C
C           Check for valid subscript--
            IF (IAR .GT. 0) THEN
              IF (ISUB .LT. 0 .OR. ISUB .GT. MAXR(INDX)) GOTO 904
            ENDIF
C
          ENDIF
C
C
C-------- determine and store variable value, set change flag ---------------
C
            IAST = 0
            MULT = 1
C
            IF (IAR .GT. 0) IND = IAR2
            IEN = 0
C
            DO 400 I = IND+2, NC
              IF (CHR(I) .EQ. DOLLAR) THEN
                IFND = 1
                IEN = I-1
                GOTO 401
              ENDIF
              IF (CHR(I) .EQ. COMMA) THEN
                IEN = I-1
                GOTO 401
              ENDIF
              IF (CHR(I) .EQ. ASTRIK) IAST = I
  400       CONTINUE
            IEN = NC
C
  401       CONTINUE
C
C
C           Separate out multiplier--
            IF (IAST .GT. 0) THEN
              WRITE (ISCRT,1001) (CHR(I),I=IND+2, IAST-1)
              READ (ISCRT,*,ERR=912) MULT
              IND = IAST-1
            ENDIF
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
C          Remove decimal from integer fields--
           IF (ITYP .EQ. 1 .OR. ITYP .EQ. 4) THEN
             IF (CHR(IEN) .EQ. CHNUM(12)) IEN = IEN-1
           ENDIF
C
C
C          Print value to scratch file--
C
           WRITE (3,8711) (CHR(I),I=IND+2,IEN)
 8711      FORMAT ('    ',6A1)
C
           WRITE (ISCRT,1001) (CHR(I), I=IND+2, IEN)
C
           IF (ITYP .EQ. 1 .OR. ITYP .EQ. 4) THEN
             READ (ISCRT,*, ERR=907) IVAL1
             WRITE (3,8715) IVAL1
 8715        FORMAT (' IVAL1: ',I5)
           ENDIF
C
           IF (ITYP .EQ. 2 .OR. ITYP .EQ. 3) THEN
             READ (ISCRT,*, ERR=908) RVAL1
           WRITE (3,8712) RVAL1
 8712      FORMAT (' RVAL1: ', 1PE10.3)
           ENDIF
C
C
C
C          Store value in proper array--
C
           IF (ITYP .EQ. 1) THEN
             IVAL(INDX) = IVAL1
             IFLI(INDX) = 1
           ENDIF
C
           IF (ITYP .EQ. 2) THEN
             RVAL(INDX) = RVAL1
             IFLR(INDX) = 1
           ENDIF
C
           IF (ITYP .EQ. 3) THEN
             DO 410 I = 1, MULT
               RVALA(ISUB,INDX) = RVAL1
               IFLRA(ISUB,INDX) = 1
               IF (I .LT. MULT) ISUB = ISUB+1
  410        CONTINUE
```

FIGURE H.1. IBM PC Code Additions (continued)

```
          ENDIF
C
          IF (ITYP .EQ. 4) THEN
            DO 411 I = 1, MULT
              IVALA(ISUB,INDX) = IVAL1
              IFLIA(ISUB,INDX) = 1
              IF (I .LT. MULT) ISUB = ISUB + 1
  411       CONTINUE
          ENDIF
C
C######## check if more decoding necessary for this line ##################
C
          IST = IEN + 1
          IF (CHR(IST) .EQ. COMMA) IST = IST+1
          IF (CHR(IST) .EQ. DOLLAR) IFND = 1
C
          IF (IST .LT. NC .AND. IFND .NE. 1) GOTO 125
C
C######## check if another line of input should be read ####################
C
      IF (IST .GE. NC .AND. IFND .NE. 1) GOTO 100
C
C
C##########################################################################
C
  999 CONTINUE
      RETURN
C
C
C---- format statements -----------------------------------------------------
C
 1000 FORMAT (A80)
 1001 FORMAT (80A1)
 1002 FORMAT (A6)
C
C---- error conditions -------------------------------------------------------
C
  900 CONTINUE
      WRITE (*, 9000) NC
 9000 FORMAT (' Invalid character count of input line. NC: ',I4)
      STOP
C
  901 CONTINUE
      WRITE (*, 9001)
 9001 FORMAT (' Initial $ not found in first line of NAMELIST ',
```

FIGURE H.1. IBM PC Code Additions (continued)

```
     .        'record set.')
      STOP
C
  902 CONTINUE
      WRITE (*, 9002)
 9002 FORMAT (' Error determining NAMELIST set name.')
      STOP
C
  903 CONTINUE
      WRITE (*, 9003)
 9003 FORMAT (' Input NAMELIST set name dose not anticipated set name.')
      STOP
C
  904 CONTINUE
      WRITE (*,9004) (CHR(I),I=IST,IND), ISUB
 9004 FORMAT (' Subscript out of range in NAMELIST input variable ',
     .        10A1,' Subscript= ',I5)
      STOP
C
  905 CONTINUE
      WRITE (*,9005) (CHR(I), I=IST,IND)
 9005 FORMAT (' Missing right paren in NAMELIST input variable: ',10A1)
      STOP
C
  906 CONTINUE
      WRITE (*,9006) VNAM
 9006 FORMAT (' Invalid variable name in NAMELIST input.  Name = ',A6)
      STOP
C
  907 CONTINUE
      WRITE (*,9007) (CHR(I),I=IND+2, IEN)
 9007 FORMAT (' Error converting following string to integer: ',10A1)
      STOP
C
C
  908 CONTINUE
      WRITE (*,9008) (CHR(I),I=IND+2, IEN)
 9008 FORMAT (' Error converting following string to real: ',10A1)
      STOP
C
  909 CONTINUE
      WRITE (*,9009) (CHR(I), I=IST,IND)
 9009 FORMAT (' Error in length of variable name: ',20A1)
      STOP
C
```

FIGURE H.1. IBM PC Code Additions (continued)

```
  910 CONTINUE
      WRITE (*,9010) (CHR(I),I=IST,IND)
 9010 FORMAT (' Error converting subscript to integer for NAMELIST ',
     .        ' variable ',10A1)
      STOP
C
  911 CONTINUE
      WRITE (*,9011) IAR2
 9011 FORMAT (' Invalid beginning index for array element, IAR2=',I4)
      STOP
C
  912 CONTINUE
      WRITE (*,9012)
 9012 FORMAT (' Error converting string to multiplier.')
      STOP
C
C---------------------------------------------------------------------------
C
      END
```

FIGURE H.1. IBM PC Code Additions (continued)

DISTRIBUTION

No. of Copies	
OFFSITE	
2	DOE Technical Information Center
ONSITE	
3	DOE Richland Operations Office
	R. A. Holten
	E. A. Bracken
	J. J. White
51	Pacific Northwest Laboratory
	V. L. Brouns
	J. B. Burnham (10)
	D. W. Dragnich
	C. E. Elderkin
	J. M. Hales
	P. C. Hays
	W. E. Kennedy, Jr.
	W. W. Laity
	B. A. Napier (20)
	I. C. Nelson
	R. A. Peloquin
	R. G. Schreckhise
	J. G. Stephan
	J. A. Stottlemyre
	D. L. Strenge
	R. E. Wildung
	Publishing Coordination (2)
	Technical Information (5)