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Prepared by B.A. Napier, R. A. Peloquin, W. E. Kennedy, Jr., S. M. Neuder

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ABSTRACT

Because of uncertainties associated with assessing the potential risks from onsite burials of radioactive waste, the U. S. Nuclear Regulatory Commission (NRC) has amended its regulations to provide greater assurance that buried radioactive material will not present a hazard to public health and safety. The amended regulations now require licensees to apply for approval of proposed procedures for onsite disposal pursuant to 10 CFR 20.302. The NRC technically reviews these requests on a case-by-case basis. These technical reviews require modeling potential pathways to man and projecting radiation dose commitments. This document contains a summary of our efforts to develop human-intrusion scenarios and to modify a version of the MAXI computer program for potential use by the NRC in reviewing applications for onsite radioactive waste disposal. The documentation of the ONSITE/MAXI computer program is written for two audiences. The first (Audience A) includes persons concerned with the mathematical models and computer algorithms. The second (Audience B) includes persons concerned with exercising the computer program and scenarios for specific onsite disposal applications. Five sample problems are presented and discussed to assist the user in operating the computer program. Summaries of the input and output for the sample problems are included along with a discussion of the hand calculations performed to verify the correct operation of the computer program.

Computer listings of the ONSITE/MAXI1 computer program with an abbreviated data base listing are included as Appendix 1 to this document. Finally, complete listings of the data base with listings of the special codes used to create the data base are included in Appendix 2 as a microfiche attachment to this document.

ACKNOWLEDGMENTS

The authors would like to thank all of those individuals who have helped make this study possible. The historical development of the MAXI computer program included major contributions from Ed Watson, Glenn Hoenes, and Joe Soldat of Pacific Northwest Laboratory. We greatly appreciate the guidance, assistance, and encouragement offered by these individuals in the development of the methods and philosophy applied in this report. We would also like to thank Norma Van Houten for her contributions in typing, organizing, and correcting the draft and final manuscripts of this document.

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INTRUDER DOSE PATHWAY ANALYSIS FOR THE ONSITE DISPOSAL OF RADIOACTIVE WASTES: THE ONSITE/MAXI1 COMPUTER PROGRAM

1. INTRODUCTION

In January 1981, the U.S. Nuclear Regulatory Commission (NRC) amended its regulation in order to minimize the risks associated with onsite land disposal of radioactive materials by licensees. Current regulations require that disposal of radioactive materials by licensees, unless otherwise authorized, be specifically approved by the NRC pursuant to Section 20.302(a) of 10 CFR Part 20 (1984). This regulation states:

> "Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and locations of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures."

The current policy of the NRC is to review all proposed onsite burials on a case-by-case basis. Technical assessments of proposed onsite disposals may at times require modeling of the potential pathways to man and projecting the magnitude of potential radiation dose commitments. The objective of this project is to modify an existing pathway-to-man computer program, MAXI (Napier et al. 1979), for use by the NRC Waste Management staff for conducting human-intrusion, dose-pathway analyses for onsite burial of low-activity radioactive wastes. As part of this effort, specific human intrusion scenarios have been developed that consider various potential combinations of direct exposure to penetrating radiation, inhalation of airborne radionuclides, ingestion of agricultural products raised in contaminated soil, and ingestion of radionuclides in drinking water. These scenarios are activated by running the ONSITE/MAXI1 computer software package.

The ONSITE/MAXI1 software package contains four computer codes. ONSITE is the interactive user interface that allows the end-user to simply and efficiently create and use the radiation exposure scenarios. MAXI1 is then used with the scenario information to calculate the maximum annual dose to the exposed individual from selected pathways. MAXI2 generates intermediate dose conversion factors for food pathways. These factors are stored in data files. MAXI3 calculates the data files containing intermediate dose conversion factors for aquatic pathways.

In addition, data files are provided that contain inhalation and external dose conversion factors. These factors are calculated using codes external to the ONSITE/MAXI1 software package. The inhalation dose conversion factors are calculated using the DACRIN (Houston, Strenge and Watson 1974) computer program. The external dose conversion factors for various waste disposal geometries are calculated using the ISOSHLD (Engel, Greenborg and Hendrickson 1966) shielding program.

This report documents the resulting computer software package. The documentation of the ONSITE/MAXI1 computer software package has been written for two major audiences. The first audience (Audience A) includes persons concerned with the mathematical models and computer algorithms considered for onsite disposal of radioactive wastes, and the second audience (Audience B) includes persons concerned with exercising the computer program and exposure scenarios to obtain results for specific applications. This document is designed to function both as an instructional and a reference document.

Section 2 contains information useful to Audience A concerning the mathematical models and computer algorithms used in the ONSITE/MAXI1 computer programs. Section 3 contains information useful to Audience B concerning the procedures for executing ONSITE/MAXI1 computer programs, including a discussion of sample problems and hand calculations performed to verify correct operation of the computer program. Section 4 contains additional details on the structure and organization of the computer programs and is provided for individuals who may be interested in such details and those who wish to modify the computer programs. In addition, appendices are provided that present listings of the computer programs, data libraries, and dose conversion factors. Page-edge tabs have been provided as reference points for Audiences A and B. To use these tabs, simply fan the pages of the document until the appropriate page-edge tab is located.

1.1 References

Code of Federal Regulations. 1984. Title 10, Part 20, "Standards for Protection Against Radiation."

Houston, J. R., D. L. Strenge and E. C. Watson. 1974. DACRIN - A Computer Program for Calculating Organ Dose from Acute or Chronic Radionuclide Inhalation. BNWL-B-389, Pacific Northwest Laboratory, Richland, Washington.

Engel, R. L., J. Greenborg, and M. M. Hendrickson. 1966 ISOSHLD - A Computer Code for General Purpose Isotope Shielding Analysis. BNWL-236, Pacific Northwest Laboratory, Richland, Washington.

Napier, B. A., G. R. Hoenes, W. E. Kennedy, Jr., and E. C. Watson. 1979. "The Maximum Annual Dose Resulting from Residual Radioactive Contamination." Paper presented at the 24th Annual Meeting of the Health Physics Society, July 8-13, 1979, Philadelphia, Pennsylvania. PNL-SA-7496, Pacific Northwest Laboratory, Richland, Washington.

2. MATHEMATICAL MODELS AND COMPUTER SOFTWARE FOR ASSESSING ONSITE DISPOSAL IMPACTS

This section contains descriptions of the radiation-exposure scenarios, mathematical models, computer programs, and data bases for assessing the potential doses to intruders at onsite waste disposal sites using the ONSITE/MAXI1 computer programs. The information in this section is designed to be useful to Audience A, as identified in Section 1, concerning the ONSITE/MAXI1 computer software package. First, the method used for assessing potential doses to intruders is presented, followed by a discussion of the computer implementation of that method, and a description of the associated data base.

2.1 Definition and Solution of the Problem

In the Draft and Final Environmental Impact Statements in support of 10 CFR Part 61 (U.S. NRC 1981; U.S. NRC 1982), the NRC modeled the potential exposure pathways to man from buried radioactive wastes. In their analysis, the NRC identified four human-intrusion scenarios to account for the actions of man after the loss of institutional controls (U.S. NRC 1981, App. H, p. H-15):

- Intruder-Construction Scenario. An individual excavates at an abandoned disposal site to build a house.
- Intruder-Discovery Scenario. This scenario is a subset of the intruder-construction scenario and also involves excavation into a closed site. The time over which the excavation proceeds is reduced compared to the intruder-construction scenario.
- Intruder-Agriculture Scenario. An individual lives in a house built on a closed disposal site surrounded by contaminated soil resulting from the intruder-construction scenario. The individual consumes vegetables grown in the contaminated soil.
- Intruder-Well Scenario. An individual uses contaminated water from an onsite well.

The disposal limits that result are based on an annual 500-mrem total-body dose to the maximally exposed individual who intrudes after 100 years of site control. Of the four human-intrusion scenarios defined, only the intruder-construction and intruder-agriculture scenarios control the determination of disposal limits.

AUDIENCE A

For the assessment of risks associated with onsite disposal, an approach similar to that applied in the DEIS in support of 10 CFR Part 61 is used. That is, radiation-exposure scenarios are established for the maximally exposed individual (an intruder) and a means of determining the resulting radiation dose is provided.

Five scenarios are identified as being of potential interest in assessing doses to intruders at onsite disposal sites.

(1) External Exposure Scenario. An individual is assumed to work in an area previously used for onsite disposal. Surface soil contamination, wastes buried at depths of 0.5 m or 1.0 m, or entry into a room (or vault) that is used for waste storage or disposal are considered.

(2) External Exposure Plus Inhalation Scenario. An individual is assumed to work in an area with limited surface-soil contamination.

(3) Agricultural Scenario. An individual is assumed to raise his annual diet (or a fraction of it) in soil contaminated by the onsite disposal of radioactive wastes. External exposure and inhalation of resuspended radionuclides in soil are considered.

(4) Irrigation/Drinking-Water Scenario. An individual is assumed to use a water supply contaminated by radionuclides from an onsite disposal site for irrigation and/or drinking. In addition, external exposure and inhalation of resuspended radionuclides that are deposited on the surface of the soil by the irrigation water are considered.

(5) User-Defined Scenario. The user may construct his own scenario by selecting exposure pathways and defining conditions described in the ONSITE/MAXI1 computer software package.

This section contains descriptions of the pathway analysis models used for these scenarios with a definition of the required environmental criteria, descriptions of the scenarios as they are implemented, and descriptions of the mathematical models.

2.1.1 Applying the Pathway Analysis Models

The above scenarios can be simulated with the pathway analysis mathematical models. When viewed as a collection, the interrelationships of these models are complex. An overview of the pathway analysis methods at this point in the discussion will facilitate understanding of the model application.

Programs in the ONSITE/MAXI1 computer software package can be used to calculate dose conversion factors for a given setting or "environment." The MAXI1 computer program uses these factors during subsequent scenario simulations to calculate dose to man for selected exposure pathways. An "environment" defines radionuclides that are likely to be present at a waste site, general agricultural and aquatic practices of the geographical area, and the general lifestyle of the intruder. For example, the "environment" might establish that the intruder grows a garden on the disposal site. The amount of produce, including animal products grown on the site and consumed by the maximum individual, would be defined. Scenarios can then be defined within the context of the "environment." A scenario indicates pathways of interest, further defines the life style of the maximum individual, identifies the source and location of the contamination, and quantifies the inventory. A scenario modifies the maximum individual's life style assumptions by indicating amounts of exposure and by applying percentage factors to established dose rates.

The definition of the "environment" is an intermediate step that simplifies scenario creation and streamlines scenario executions. Scenario creations are simplified because the number of parameters that must be defined is substantially reduced. Scenarios execute more efficiently because many repetitive calculations have been eliminated. Dose conversion factors that apply to the defined "environment" are created by auxiliary programs in the software package (MAXI2 and MAXI3) and are stored in the data base where they can be accessed during the scenario simulations controlled by the main computer program, MAXI1.

The following sections contain discussions of the defined "environment" and the mathematical models to be used for the five intruder scenarios, and the mathematical models to be used for onsite disposal sites.

2.1.2 Onsite Disposal "Environment" Description

The "environment" defined for onsite disposal assumes intruder activity at an onsite low-level waste disposal site. The reference "environment" is based on a site with an area of 1 ha; however, area correction factors may be included to consider smaller sites. The intruder may be exposed to radioactive contamination via any of the following pathways: external exposure, inhalation of resuspended contaminants, ingestion of farm products grown on a contaminated site, consumption of drinking water from a contaminated well, or ingestion of aquatic food products from a contaminated water source. For external exposure, wastes may be located on the surface, buried at 0.5 or 1.0 meter depths, or stored in a room-type structure. The intruder's entire diet for the reference "environment" consists of vegetables, fruits, and animal products grown on the site. Table 2.1-1 contains a listing of the intruder's terrestrial food product diet and Table 2.1-2 contains a listing of the intruder's aquatic food product diet for the reference "environment." The intruder is assumed to drink 1.2 liters of water per day from a contaminated well. Contaminated farm products may result from radioactive wastes located on the soil surface or from irrigation with contaminated water. The radionuclides expected to be of interest in the reference "environment" are listed in Table 2.1-3. This list includes 100 radionuclides that might come from the use of radiopharmaceuticals or industrial sources, or from wastes generated as part of the commercial nuclear fuel cycle.

Table 2.1-1. Parameters Used for Calculation of Radiation Dose Factors from Consumption of Foods

Food	Growing Period (days)	Yield (kg/m^2)	Holdup (days)[a]	Consumption (kg/year)[b]
Leafy vegetables	90	1.5	1	9.5
Other aboveground vegetables	60	0.70	1	9.5
Root vegetables	90	9.0	1	76
Fruit	90	1.7	10	42
Wheat and grain	90	0.72	10	51
Eggs	90	0.84[c]	2	19
Milk	30	1.3 [c]	2	110[d]
Beef	90	0.84[c]	15	39
Pork	90	0.84[c]	15	29
Poultry	90	0.84[c]	2	8.5

(a) Time between harvest and consumption.
(b) These rates are obtained from Regulatory Guide 1.109 (U.S. NRC 1977) and prorated by food category using the fraction of total consumed by an average individual as calculated from Napier (Table 8 1981).
(c) Yield of animal feeds (i.e., grain or pasture grass).
(d) Units of liters/year.

Table 2.1-2. Parameters Used for Calculation of Radiation Doses from Drinking Water and Aquatic Foods

Pathway	Mixing Ratio	Holdup (days)[a]	Consumption	Consumption Units
Fish	1.0	1.0	6.9[b]	kg/yr
Drinking Water	1.0	1.0	438[c]	L/yr

(a) Time between harvest and consumption.
(b) Rate obtained from Regulatory Guide 1.109 (U.S. NRC 1977).
(c) Rate based on scenario assumption of 1.2 L/d.

Table 2.1-3. Radionuclides Considered in the ONSITE Disposal "Environment"

Radionuclide	Radionuclide	Radionuclide
^{3}H	^{144}Ce+D	^{137m}Ba
^{14}C	^{152}Eu	^{141}Ce
^{22}Na	^{154}Eu	^{151}Sm
^{32}P	^{160}Tb	^{235}U
^{33}P	^{185}Os	^{231}Th
^{35}S	^{191}Os	^{231}Pa
^{36}Cl	^{192}Ir	^{227}Ac
^{40}K	^{203}Hg	^{227}Th
^{45}Ca	^{210}Pb+D	^{223}Fr
^{46}Sc	^{226}Ra+D	^{223}Ra
^{51}Cr	^{228}Th+D	^{237}Np
^{54}Mn	^{230}Th+D	^{233}Pa
^{55}Fe	^{232}Th+D	^{233}U
^{59}Fe	^{233}U+D	^{229}Th
^{57}Co	^{234}U	^{225}Ra
^{60}Co	^{235}U+D	^{225}Ac
^{59}Ni	^{238}U+D	^{238}U
^{63}Ni	^{237}Np+D	^{234}Th
^{65}Zn	^{241}Pu+D	^{234m}Pa
^{75}Se	^{89}Sr	^{234}Pa
^{85}Sr	^{89m}Y	^{242}Pu
^{90}Sr+D(a)	^{90}Sr	^{238}Np
^{93}Mo	^{90}Y	^{238}Pu
^{94}Nb	^{99}Mo	^{244}Cm
^{106}Ru+D	^{99m}Tc	^{244}Pu
^{109}Cd	^{99}Tc	^{240}U
^{110m}Ag+D	^{103}Ru	^{240}Pu
^{111}In	^{103m}Rh	^{243}Cm
^{124}Sb	^{103}Pd	^{243}Pu
^{125}Sb+D	^{129}I	^{243}Am
^{125}I+D	^{134}Cs	^{239}Np
^{131}I+D	^{135}Cs	^{239}Pu
^{137}Cs+D	^{137}Cs	^{241}Pu
		^{241}Am

(a) Where +D means plus short-lived daughters in equilibrium.

2.1.3 Onsite Disposal Scenario Descriptions

Five scenarios are identified for onsite disposal in Section 2.1.1. They are designed for use in assessing doses to intruders at onsite disposal sites with default site size of 1 ha. These scenarios are defined within the "environment" described in Section 2.1.2. Detailed descriptions of the scenarios as they are parameterized for simulation are given below.

(1) External Exposure Scenario. An individual is assumed to work for 2000 h/yr in a 1 ha area previously used for onsite disposal. External exposure factor files are supplied to consider surface-soil contamination, buried wastes at depths of 0.5 m or 1.0 m, or entry into a room (or vault) that is used for waste storage or disposal. For soil contamination, the inventory is modified by a factor of 0.2 to account for dilution. Only total-body dose is calculated. The user selects the location of the waste (e.g., surface, buried, or stored) and supplies the waste inventory. The user may modify the amount of radioactive decay before exposure, the dilution of the waste (during exhumation activities), the reference site size, and the duration of exposure.

(2) External Exposure Plus Inhalation Scenario. An individual is assumed to work for 2000 h/yr in a 1 ha area with surface-soil contamination resulting from a waste exhumation event. Air concentrations of radionuclides are calculated using a resuspension equation by Anspaugh et al. (1975). For the resuspension equation, the age of the contamination at the beginning of the scenario is assumed to be 0.0 and the top 1.0 centimeter of the contaminated surface soil is assumed to be available for resuspension. Doses to total body, bone, lungs, thyroid, and the lower large intestine (LLI) of the GI tract are calculated. The dilution factor (accounting for exhumation activities) applied to the inventory is 0.2. The user provides the waste inventory. The user may modify the amount of radioactive decay before exposure, the duration of the exposure, the reference site size, and the inventory dilution factor. He may also optionally select a mass-loading equation, and specify fewer organs. This scenario is similar to the intruder-construction scenario described in the DEIS for 10 CFR Part 61 (U.S. NRC 1981).

(3) Agricultural Scenario. An individual is assumed to raise his entire diet in a 1 ha area of soil contaminated by the onsite disposal of radioactive wastes. The individual is assumed to be exposed 2000 h/yr by external exposure and by inhalation of resuspended radionuclides in soil. Again, the air concentration resulting from resuspension is calculated using the equation by Anspaugh et al. (1975) with parameters presented for Scenario 2. Doses to total body, bone, lungs, thyroid, and LLI are calculated. The user furnishes the waste inventory to which a dilution factor of 0.2 is applied. Modifications can be made to the amount of radioactive decay before exposure, the duration of the exposure, the fraction of the total diet grown on the

site, the reference site size, and the dilution of the waste. As in the previous scenarios, the user may substitute the mass-loading model and specify fewer organs. This scenario is similar to the intruder-agriculture scenario described in the DEIS for 10 CFR Part 61 (U.S. NRC 1981).

(4) Irrigation/Drinking-Water Scenario. An individual is assumed to use a water supply contaminated by radionuclides from an onsite disposal site for irrigation and/or drinking. The user is required to input the concentration of each radionuclide in the water supply. The exposed individual is assumed to irrigate his field at a rate of 150 $L/m^2/mo$ during a six-month growing season. The site is assumed to be irrigated with contaminated water for 10 years prior to the beginning of the scenario. The individual obtains his entire diet (or a fraction of it) from a 1 ha irrigated field, and drinks 1.2 L of water per day from a contaminated water source. In addition, he is assumed to be exposed 2000 h/yr by external exposure and inhalation of resuspended radionuclides that are deposited on the surface of the soil by the irrigation water. Doses to total body, bone, lungs, thyroid and LLI are considered. Irrigation and drinking water may be from the same or separate water supplies. When providing the inventory, the user is asked for radionuclide concentration in drinking and irrigation water separately. Irrigation or drinking water can be individually simulated by entering zero concentrations for the other pathway. The user may modify the irrigation rate, the length of the irrigation season, the time of irrigation prior to the scenario, the fraction of diet grown with contaminated irrigation water, the consumption of drinking water, the times of exposure, the resuspension equation selection, the reference site size, and the organ selection.

(5) User-Defined Scenario. The user may construct his own scenario by selecting exposure pathways and defining conditions associated with each pathway.

2.1.4 Mathematical Models

Equations are arranged to aid understanding of the model as a whole. Consequently equations contain both environment-defined and scenario-defined parameters as distinguished in Section 2.1.1. The origin of the parameters will be discussed when applicable for each equation.

The fundamental relationship for calculating radiation doses to people from any radionuclide exposure pathway is given in Equation 2.1 (Soldat, Robinson, and Baker 1974)

$$R_{ipr} = C_{ip} \, U_p \, D_{ipr} \tag{2.1}$$

where

R_{ipr} = the radiation dose equivalent or committed radiation dose equivalent from radionuclide i via exposure pathway p to organ r (rem)

C_{ip} = concentration of radionuclide i in the media of exposure pathway p; for calculations involving airborne radionuclides, C_{ip} is replaced with the term X_i, which represents the average airborne concentration of radionuclide i (pCi/m^3, pCi/L, or pCi/kg)

U_p = usage parameter (exposure rate or intake rate) associated with exposure pathway p (h/yr, L/yr, or kg/yr)

D_{ipr} = radiation dose equivalent factor or the committed dose equivalent factor for radionuclide i exposure pathway p and organ r to convert the concentration and usage parameters to the radiation dose equivalent or to the committed radiation dose equivalent (mrem/pCi)

An analysis of radiation doses from separate exposure pathways requires a determination of the radionuclide concentrations and exposure rate or intake rate associated with each exposure pathway. For external exposure, the concentration of radionuclides and the duration of exposure must be quantified. For ingestion of farm products grown on a contaminated site, the radionuclide concentration in separate food products must be determined by accounting for root transfer from soil, dry deposition from air on leaves, or animal consumption of contaminated forage or feed. The annual diet for the maximally exposed individual, and the holdup time between harvest and consumption must also be determined.

For inhalation, the airborne concentration of resuspended radionuclides can be determined directly from the ground concentration using a mass-loading factor, resuspension factor, or resuspension rate analysis (Anspaugh et al. 1975). Site-specific parameters can be used to determine the exposure pathways and the radionuclide mixture, pathway concentrations, and exposure or intake rates.

Parts of this relationship are calculated in three MAXI codes as follows:

C_{ip} • Concentrations are calculated in MAXI. Some terms in the equations were calculated in MAXI2 (for food pathways) and MAXI3 (aquatic pathways) and the results are located in the data base. These terms will be identified as each equation is discussed.

U_p • Default (assumed maximum) usage terms are applied in MAXI2 (food pathways) and MAXI3 (aquatic pathways) and the resulting factors are stored in the data files. A modification factor can be applied to this term in MAXI1 to reduce the exposure conditions.

D_{ipr} • This term is applied in MAXI2 for food pathways and MAXI3 for aquatic pathways in the generation of the data files accessed by MAXI1.

Calculation of the annual dose to an organ of reference by the MAXI1 computer program requires the dose equivalent from exposure during the year of interest plus the annual dose resulting from previous years of intake. The general expression for annual dose calculations is deduced by inspecting the annual dose equations for the first three years of continuous exposure. The annual dose for the first year to an organ of reference is simply the summation of the radiation dose equivalents from all internal and external exposure pathways. For the second year, the annual dose is calculated by the following expression (Kennedy et al. 1979):

$$A_2 = R_2^* + (R_{1,2} - R_{1,1}) \qquad (2.2)$$

where

A_2 = the annual dose during the second year from all exposure pathways to the organ of reference, mrem

R_2^* = the radiation dose equivalent in the second year to the organ of reference from all internal and external exposure pathways from intake and exposure in the second year, mrem

$R_{1,2}$ = the committed dose equivalent to the organ of reference for the first two years from radionuclides internally deposited during intake from exposure pathways in the first year, mrem

$R_{1,1}$ = the radiation dose equivalent to the organ of reference for the first year from radionuclides internally deposited during intake from exposure pathways in the first year (no external component to the dose equivalent), mrem.

The second-year annual dose to an organ of reference (A_2 in Equation 2.2) is the summation of the radiation dose equivalents from all exposure pathways during the second year and the dose equivalent delivered during the second year from the radionuclides internally deposited in that organ during the first year. The term in parentheses in Equation 2.2 is the expression for the dose equivalent to the organ of reference from radionuclides deposited in that organ during the first year. It is found by subtracting the first-year dose equivalent, resulting from internally deposited radionuclides, from the second-year committed dose equivalent. The mathematical expression for the annual dose to an organ of reference in the third year of continuous exposure is (Kennedy et al. 1979):

$$A_3 = R_3^* + (R_{1,3} - R_{1,2}) + (R_{2,2} - R_{2,1}) \qquad (2.3)$$

where

A_3 = the annual dose during the third year from all exposure pathways to the organ of reference, mrem

R_3^* = the radiation dose equivalent in the third year to the organ of reference from all internal and external exposure pathways from intake and exposure in the third year, mrem.

In Equation 2.3, the terms $R_{1,3}$, $R_{1,2}$ and $R_{2,1}$ are similar in form, each containing two subscripts. The first subscript defines the year of intake or exposure after the start of continuous exposure, and the second defines the number of years used in calculating the committed dose equivalent. The quantity in the first parentheses is the dose equivalent to the organ of reference in the third year from radionuclides deposited during the first year of continuous exposure (i.e., the difference between the third-year committed dose equivalent and the second-year committed dose equivalent). The quantity in the second parentheses is the dose equivalent in the third year to the organ of reference from radionuclides deposited during the second year of continuous exposure (i.e., the difference between the second-year committed dose equivalent and the first-year committed dose equivalent).

The general expression for calculating the annual dose to an organ of reference during any year after the start of continuous exposure is expressed as (Kennedy et al. 1979):

$$A_t = R_t^* + \sum_{i=1}^{t-1} R_{i,(t-i+1)} - R_{i,(t-i)} \qquad (2.4)$$

where

A_t = the annual dose during the year t from all exposure pathways to the organ of reference, mrem

R_t^* = the radiation dose equivalent in year t to the organ of reference from all internal and external exposure pathways from intake and exposure in the year t, mrem.

The summation term in Equation 2.4 represents the dose equivalent delivered to the organ of reference in year t from radionuclides deposited in the organ from intake in all previous years since the start of continuous exposure. This term is valid only for positive integer values of t. For t equal to 1, the summation term is zero.

The annual dose, A_t, to the organ of reference is calculated for each value of t from 1 to 50, and the maximum annual dose is determined by inspection. Experience with this method to date indicates 50 years to be a suitable maximum value of t; however, higher maximum values are not precluded. The radiation dose equivalent terms required by Equation 2.4 are determined from Equation 2.1 using existing radiation dose computer programs for pertinent radiation-exposure pathways. Details about the methods of calculating the radionuclide concentrations in various media, C_{ip} from Equation 2.1, are given in Sections 2.1.4.1 through 2.1.4.5.

No special algorithms or numerical techniques are employed by the ONSITE/MAXI1 computer programs apart from those required to solve Equation 2.4. However, special formulations for some of the parameters in Equation 2.1 are available in the exposure scenario analysis. Other formulations are directly included in the calculation of the dose conversion factors used by MAXI1. The following sections contain discussions of optional and default equations that are incorporated into the ONSITE/MAXI1 software package.

2.1.4.1 Dose From Ingestion of Food Products

The dose conversion factors for the ingestion of food products accessed by the MAXI1 computer program are obtained from data files that were generated by the MAXI2 computer program for the onsite disposal environment. The dose from any food pathway is given by Equation 2.1. Radionuclides can be deposited on the leaves of plants directly from the air or from irrigation water, and can be taken up by the plant roots.

For direct deposition from the air, Equation 2.5 is used to describe the deposition of airborne particulate radionuclides directly onto food products and onto the ground.

$$d_i^a = 86{,}400\ \overline{X}_i\ V_{di} \qquad (2.5)$$

where

d_i^a = deposition rate or flux of radionuclide i, pCi/(m^2-day)

86,400 = dimensional conversion factor, seconds/day

$\overline{X}_i$ = average air concentration of radionuclide i is estimated using either the mass-loading or resuspension factor as pCi/m^3

V_{di} = deposition velocity of radionuclide i, m/second, is assumed in MAXI1 to be 1×10^{-3} m/sec for all particles.

The MAXI1 computer program permits selection of two methods for calculating the average air concentration. These methods are mass-loading and resuspension analysis. The mass-loading method uses the product of the surface soil radionuclide concentration and the average mass-loading of dust or particulate material in the atmosphere. In the absence of data for a particular site, a value of 1×10^{-4} g/m^3 has been suggested for predictive purposes (EPA 1977; Anspaugh et al. 1975). This value is used in this report for the annual average mass-loading factor. Annual arithmetic averages around the United States vary from 9×10^{-6} to 7.9×10^{-5} g/m^3 (Anspaugh et al. 1977).

For resuspension, the average airborne concentration is the product of a resuspension factor and the surface contamination level as shown in Equation 2.6.

$$\overline{X} = S_f \, S_A \qquad (2.6)$$

where

$\overline{X}$ = average airborne concentration, pCi/m^3

S_f = resuspension factor, m^{-1}

S_A = surface radioactivity, pCi/m^2.

The MAXI1 computer program permits the use of a time-dependent resuspension factor (S_f) as given by Anspaugh et al. (1975):

$$S_f = 10^{-4} \, e^{-\lambda \sqrt{t}} + 10^{-9} \qquad (2.7)$$

where

S_f = resuspension factor, m^{-1}

10^{-4} = resuspension factor at time t = 0, m^{-1}

λ = effective decay constant controlling the availability of material for resuspension, 0.15 day$^{-1/2}$

t = time after deposition, days

10^{-9} = resuspension factor after 17 years, m^{-1}.

The second term in Equation 2.7 (10^{-9}) is added based on the assumption that there is no further measurable decrease in the resuspension factor process after about 17 years, the longest period for which data are available.

For deposition on plant leaves or soil from irrigation, the deposition rate in pCi/m^2-day d_i^I for radionuclide i from irrigation water onto the ground, is defined by Equation 2.8.

$$d_i^I = C_{iw} \, I \tag{2.8}$$

where

d_i^I = deposition rate or flux of radionuclides applied with irrigation water, (pCi/m^2-day)

C_{iw} = concentration of radionuclide i in the water used for irrigation, pCi/L

I = irrigation rate; the amount of water sprinkled on a unit area of field in one day, L/(m^2-day).

The concentration of radioactive material in vegetation resulting from direct deposition onto plant foliage and uptake of radionuclides previously deposited in the soil is determined by Equation 2.9.

$$C_{iv} = \left[\frac{\left(d_i^a + d_i^I\right) r \, T_v \left(1 - \exp\left[-\lambda_{Ei} t_e\right]\right)}{y_v \, \lambda_{Ei}} + \frac{\left(d_i^a + d_i^I\right) f_t B_{vi} \left(1 - \exp\left[-\lambda_i t_b\right]\right)}{p \, \lambda_i} + \frac{0.15 f_t C_{si} B_{vi}}{p} + \frac{f_w C_{ti} B_{vi}}{\rho}\right] \exp\left(-\lambda_i t_h\right) \tag{2.9}$$

where

C_{iv} = concentration of radionuclide i in the edible portion of the vegetation, pCi/kg

d_i^a = previously defined (see Equation 2.5), pCi/(m^2-day)

r = factor of deposition retained on the vegetation (dimensionless), taken to be 0.25

T_v = factor for translocation of externally deposited radionuclides to the edible parts of the vegetation (dimensionless). For simplicity, this parameter is assumed to be independent of the radionuclide and is assigned values of 1 for leafy vegetables and fresh forage and 0.1 for all other produce, including grain

λ_i = radiological decay constant for radionuclide i, days^{-1}

λ_{Ei} = the effective removal constant for radionuclide i, days^{-1}; $\lambda_{Ei} = \lambda_i + \lambda_w$

λ_w = weathering removal constant for vegetation, days^{-1}; taken to be (0.693/14) days^{-1}

Y_v = vegetation yield, kg (wet weight)/m^2

B_{vi} = concentration factor for uptake of radionuclide i from the soil in vegetation v, pCi/kg (wet weight) per pCi/kg soil (dry)

t_b = time for buildup of radionuclides in the soil, days; assumed to be 50 years for irrigation

t_e = time of exposure of aboveground vegetation to contamination during growing season, days

f_t = fraction of the roots in the plow layer of soil (dimensionless)

t_h = holdup time between harvest and food consumption; days

p = soil "surface density," kg (dry soil)/m^2; a value of 224 kg/m^2 is used assuming the contaminated ground is plowed to a depth of 15 cm (Napier et al. 1980)

C_{si} = concentration of radionuclide i available for plant uptake from the waste contained in the plow layer (top 15 cm of soil), pCi/m^3

0.15 = plow layer, m

f_w = fraction of the roots that penetrate the waste trenches (dimensionless)

C_{ti} = concentration of radionuclide i available for plant uptake from the subsurface waste zone, pCi/m^3

ρ = bulk soil density of subsurface material, kg/m^3

The first term inside the brackets of Equation 2.9 relates to the concentration resulting from direct deposition of resuspended material and irrigation on foliage during the growing season. The second term relates to the plant uptake from the soil and reflects the deposition from irrigation. The third and fourth terms account for uptake of waste material contained in the top 0.15 m of soil and below this layer, respectively. Specific values used for the parameters in Equation 2.9 located in data libraries are found in Napier et al. (1980).

The following terms of Equation 2.9 are located in the MAXI1 computer code:

$$d_i^a + d_i^i \qquad d_i^i f_t \qquad 0.15 f_t \qquad f_w C_{ti}$$

The leaf mechanism dose rate factors generated by the MAXI2 computer code are included in the data library and are accessed by MAXI1. The following terms of Equation 2.9 are included in those factors:

$$\frac{r\, T_v \,(1 - \exp\,[-\,{}_{Ei} t_e])}{Y_v \;\lambda_{Ei}} \qquad \frac{B_{vi}\,(1 - \exp\,[-\lambda_i t_b])}{p \lambda_i}$$

The soil mechanism dose rate factors generated by the MAXI2 computer code are included in the data library and are accessed by MAXI1. The following terms of Equation 2.9 are included in those factors:

$$\frac{C_{si} B_{vi}}{p} \qquad \left(\frac{B_{vi}}{\rho}\right) \exp\,(-\lambda_i t_h)$$

The radionuclide concentration in animal products such as meat, milk, and eggs is dependent on the amount of contaminated forage or feed eaten by the animal. This concentration is described by Equation 2.10.

$$C_{ia} = S_{ia}\left[C_{if}\; Q_f + C_{iaw}\; Q_{aw}\right] \qquad (2.10)$$

where

C_{ia} = concentration of radionuclide i in the animal product, pCi/kg or pCi/L

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

C_{if} = concentration of radionuclide i in feed or forage, pCi/kg; calculated from Equation 2.9

Q_f = animal consumption rate of contaminated feed or forage, kg/day

C_{iaw} = concentration of radionuclide i in the water consumed by animals, pCi/L; assumed to be the same as the irrigation water, C_{iw} (see Equation 2.8)

Q_{aw} = consumption rate of the contaminated water by the animal, L/day.

Specific values of the parameters used in Equation 2.10 are given in Napier et al. (1980).

The dose to an organ of the exposed individual resulting from the ingestion of food products raised in the soil at an onsite disposal site (R_{Ir} in mrem) is found using a modified version of Equation 2.1. This general relationship is shown in Equation 2.11.

$$R_{Ir} = U_p \, f_D \sum_{i=1}^{n} C_{ip} \, A_c^I \, D_{ipr} \qquad (2.11)$$

where

f_D = the fraction of the total diet grown on the site

A_c^I = the area correction factor for internal exposure pathways, and where U_p, C_{ip}, and D_{ipr} are for ingestion and are generally defined in Equation 2.1.

The data libraries for the ONSITE/MAXI1 computer program are based on a minimum site area of 1 ha. To account for the limited exposure potential from smaller disposal areas, site area correction factors are required. For example, the amount of agricultural products raised on a site depends upon the intensity of the farming and the types of crops raised. A small site may produce a large fraction of the seasonal fruit and vegetable diet with intensive farming, but be unable to provide enough forage and grain to support a milk cow or other animals. Thus, while a large fraction of the seasonal fruit and vegetable diet may be raised on a small site, the total quantity raised may only equal a small fraction of the total annual diet.

In determining area correction factors for the MAXI1 computer program, consideration is first given to the default pathway conditions and then to variable exposure conditions as a function of site area. For the default conditions, the individual's entire diet, as defined in Regulatory Guide 1.109 (U.S. NRC 1977), is assumed to be raised on the 1 ha site. This diet consists of fruits and vegetables and meat and animal products. The air concentrations used for the inhalation calculations are for resuspension resulting from large areas of distributed surface contamination.

Because of the large variability that may exist in the exposure conditions at any given site, we have defined default site area correction factors that modify the default exposure pathway assumptions provided in the scenario analysis.

For the ingestion and inhalation pathway, the correction factors are in the form of a step function as shown in Figure 2.1-1. This function assumes five steps of potential exposure versus site area ranging from small to large sites. The steps of total exposure are: 1) 10% for sites with areas less than 50 m^2, 2) 25% for sites with areas between 50 and 200 m^2, 3) 50% for sites with areas between 200 and 1,000 m^2, 4) 75% for sites with areas between 1,000 and 10,000 m^2, and 5) 100% for sites larger than 10,000 m^2 (or 1 ha).

A step function is used rather than a continuous curve because of the inherent uncertainty in predicting the future actions of individuals. The step function allows consideration of small areas without forcing extreme conservatism on larger areas. That is, it implies that the small areas may be intensely farmed for vegetables, whereas the larger areas may be less efficiently used (i.e., in raising cattle).

2.1.4.2 Dose From Ingestion of Drinking Water

Dose conversion factors for ingestion of drinking water used in MAXI1 are calculated using the MAXI3 computer program and the results are stored in the data files. The dose R_{wr} in mrem, from ingestion of water containing radionuclides, is calculated from Equation 2.12.

$$R_{wr} = U_w \sum_{i=1}^{n} C_{idw} \exp(-\lambda_i t_h) D_{ir} f_{dw} \qquad (2.12)$$

where

U_w = annual consumption of contaminated drinking water, L

C_{idw} = the concentration of radionuclide i in the drinking water (input by user), pCi/L

λ_i = radiological decay constant for radionuclide i, $days^{-1}$

t_h = transit time required for radionuclide to reach the point of exposure, days

D_{ir} = radiation dose equivalent factor for ingestion, mrem/pCi

f_{dw} = drinking water cleanup factor (for municipal water supplies).

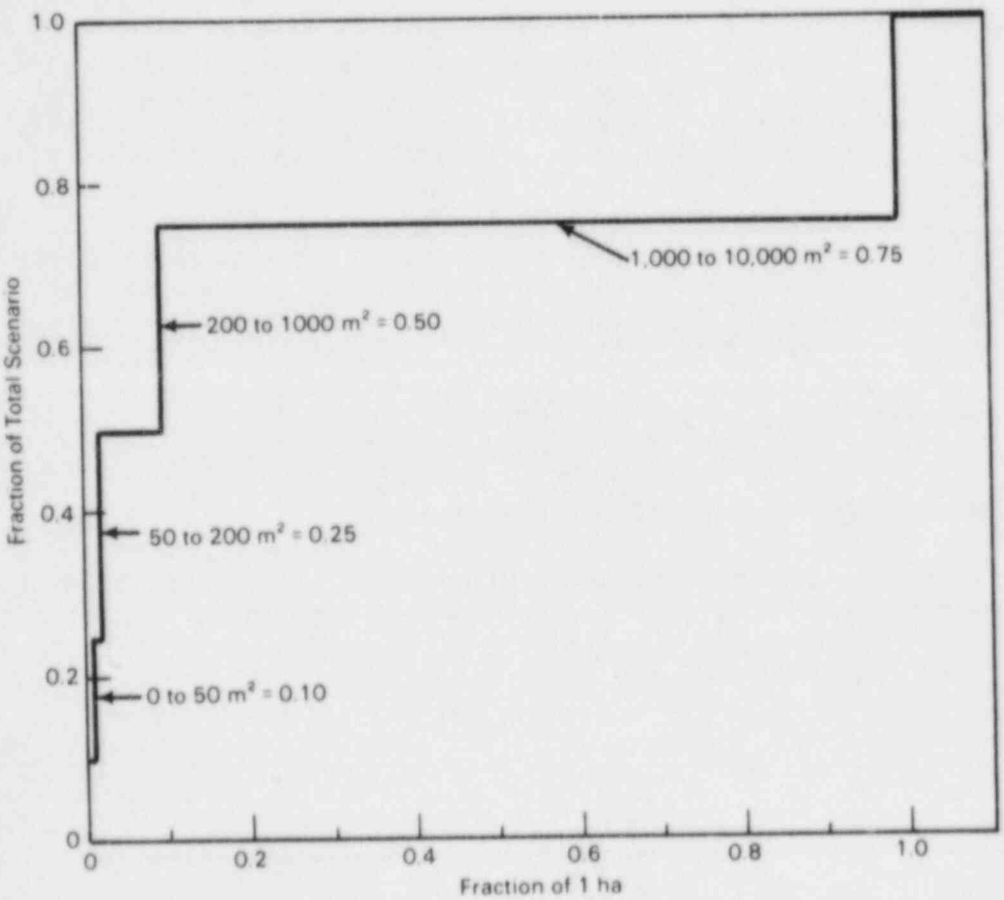

Figure 2.1-1. Area Correction Factors for the Ingestion and Inhalation Pathways

The drinking-water dose rate factors calculated by the MAXI3 computer code are included in a data library and are addressed by MAXI1. The following terms in Equation 2.11 are included in those factors:

$$U_w \qquad \exp\left(-\lambda_i t_h\right) D_{ir}\ f_{dw}$$

2.1.4.3 Dose From Inhalation

Dose conversion factors for inhalation used in MAXI1 are calculated using the DACRIN (Houston, Strenge, and Watson 1974) computer program and stored in the data files. The inhalation dose, R_{hr} in mrem, is calculated using Equation 2.13.

$$R_{hr} = VTt_m \sum_{i=1}^{n} \left(\bar{X}_i \bullet A_c^I\right) \bullet D_{ir} \tag{2.13}$$

where

V = ventilation rate of exposed individual, m^3/sec

T = duration of exposure to the airborne radionuclide concentration, seconds.

t_m = modification factor applied to T to adjust time if exposure or breathing rate of 230 cc/sec (ICRP 1975)

D_{ir} = radiation dose equivalent factor for inhalation from the DACRIN (Houston, Strenge, and Watson 1974) computer code, mrem/pCi

$\bar{X}_i$ = the annual average airborne concentration of radionuclide i, pCi/m^3

A_c^I = the area correction factor for internal exposure pathways as discussed in Section 2.1.4.1 and shown in Figure 2.1-1.

The following terms of Equation 2.13 are found in the MAXI1 computer code:

$$\bar{X}_i \qquad t_m \qquad A_c^I$$

The inhalation dose rate factors calculated by the DACRIN (Houston, Strenge, and Watson 1974) computer code are included in a data library and are addressed by MAXI1. The following terms in Equation 2.12 are included in those factors.

$$D_{ir} \qquad VT$$

2.1.4.4 Dose From External Radiation

Annual doses resulting from exposure to surface- and subsurface-soil contamination or exposure in a reference room (or vault) are calculated using a modified version of Section 2.2.1.2. The modified dose equation for external exposure is shown in Equation 2.14.

$$R_{er} = U_p \sum_{i=1}^{n} D_{ir} A_c^E C_{ip} \tag{2.14}$$

where

A_c^E = the area correction factor for external exposure, and where U_p, D_{ir}, and C_{ip} are for external exposure and are generally defined in Equation 2.1.

For external exposure, a sensitivity study was conducted for various beta-gamma emitters to determine the exposure rate versus source area. The results of the calculations are shown in Figure 2.1-2. Since the curves in Figure 2.1-2 are parallel, there appears to be a uniform correction for reduced site area over a large range of source energies. Thus, we have determined the ratio of the exposure rates (for small to large area sources) and plotted the results versus the fractional hectare of source area as shown in Figure 2.1-3. This figure defines the area correction factors for the external exposure pathway. We have approximated this curve in the ONSITE computer program as the sum of four line segments as shown in Figure 2.1-4.

The dose conversion factors for external exposure model several types of exposure conditions. These include surface-soil contamination (using either plane- or slab-source models), subsurface-soil contamination (using slab sources at depths of 0.5 and 1.0 m from the soil surface), and a finite disk source of contamination deposited on the floor or a wall in a waste-storage room or vault. These dose conversion factors are in tissue at a point 1 m above the ground surface. The direct exposure rates encountered by the intruder for various contamination levels in a waste-storage room or vault are calculated using the model developed for decommissioning a reference room at a BWR (Oak et al. 1980). All of the external dose equivalent factors are calculated for the radionuclides of concern using the ISOSHLD (Engel et al. 1966; Simmons et al. 1967) computer program.

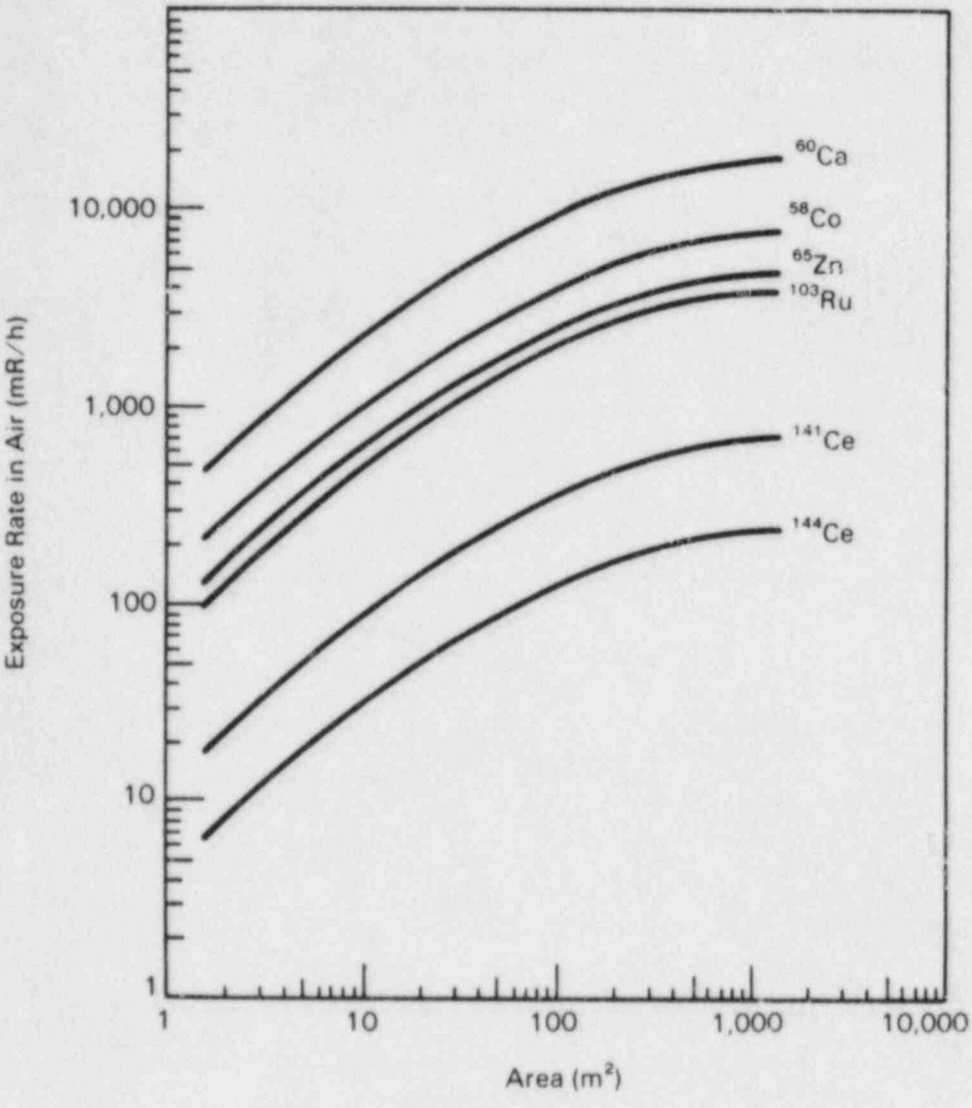

Figure 2.1-2. Exposure Rate Versus Source Area

2.1.4.5 Dose From Ingestion of Aquatic Foods

As an option to the MAXI1 computer program, doses resulting from the ingestion of aquatic food products taken from a river contaminated by radionuclides may be considered. These dose factors are calculated using the MAXI3 computer program and stored in the data files. A description of the calculation is included although none of the default human-intrusion scenarios defined for onsite disposal consider this pathway.

Concentrations of radionuclides in aquatic foods are directly related to the concentrations of the radionuclides in water. Equilibrium ratios between the two concentrations, called bioaccumulation factors, are taken from Soldat, Robinson, and Baker (1974). The dose (R_{afr}) in mrem from consumption of aquatic food containing radionuclides is calculated from Equation 2.15.

$$R_{afr} = U_{af} \sum_{i=1}^{n} C_{iw} \exp(-\lambda_i t_h) D_{ir} \left[B_{xi} + B_{yi} + B_{zi}\right] \tag{2.15}$$

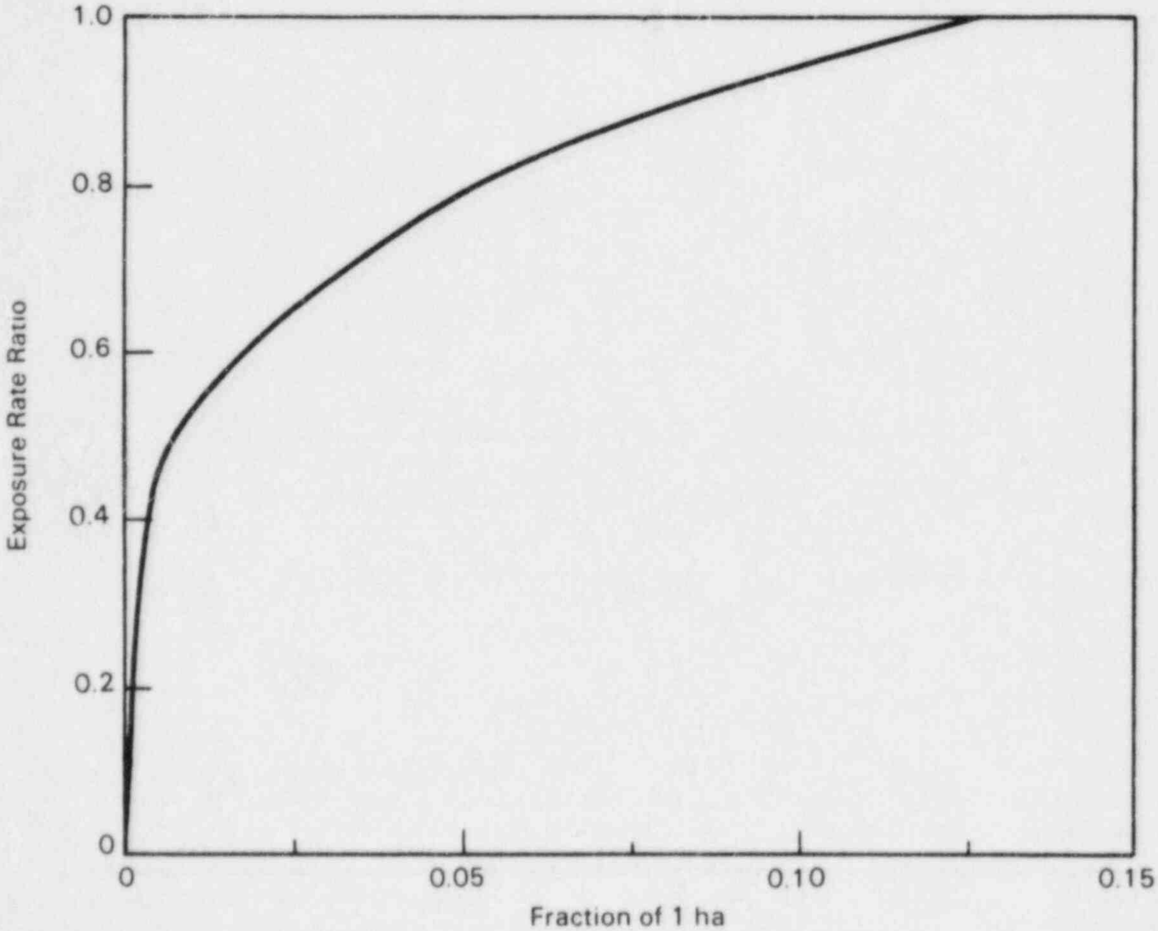

Figure 2.1-3. Exposure Rate Ratio Versus Fractional Hectare of Source Area

where

U_{af} = annual consumption of contaminated aquatic foods, kg

C_{iw} = the concentration of radionuclide i in the water, pCi/L

B_{xi}, B_{yi}, B_{zi} = the bioaccumulation factor for radionuclide i, for: x = fish, y = invertebrates, and z = algae, pCi/kg per pCi/L

D_{ir} = radiation dose equivalent factor for ingestion, mrem/pCi

λ_i = radiological decay constant for radionuclide i, $days^{-1}$

t_h = holdup time between harvest and food consumption, days.

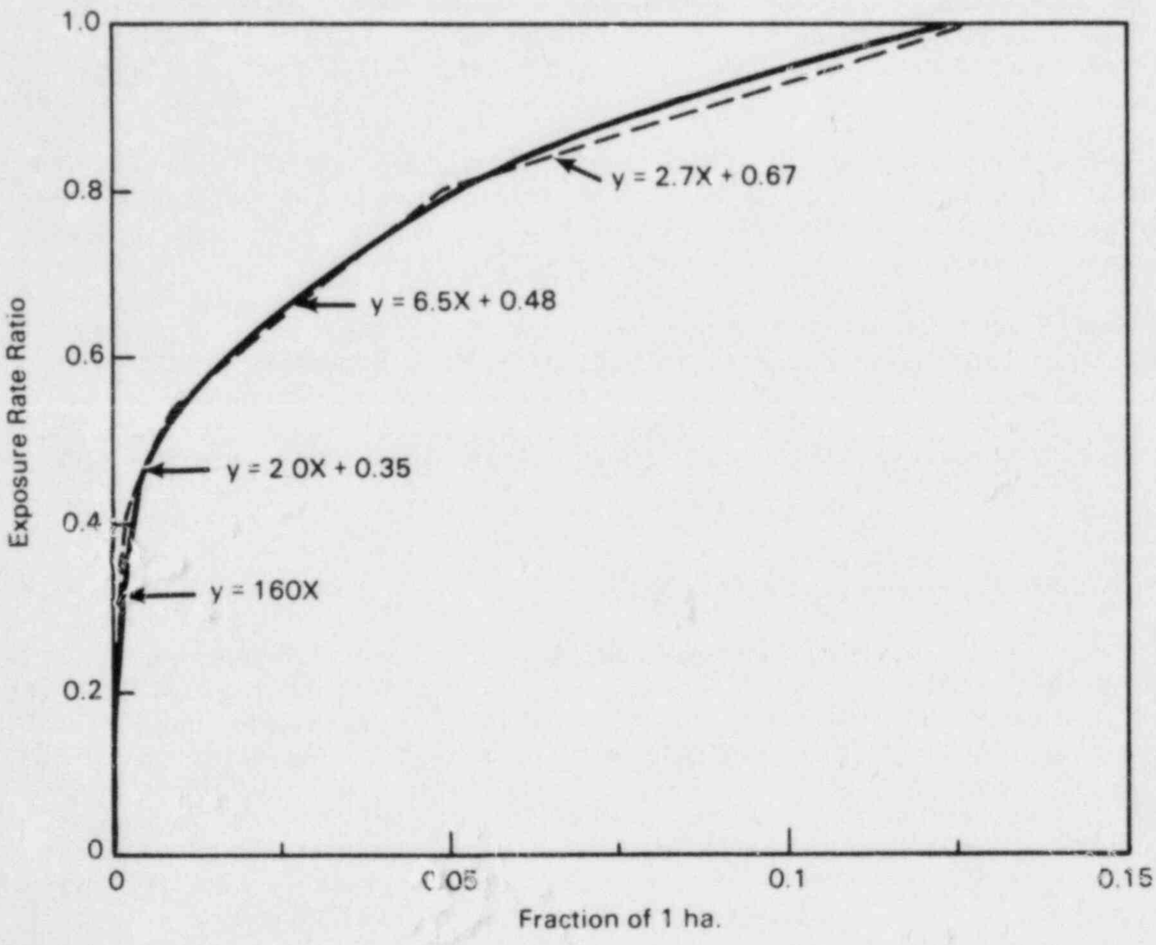

Figure 2.1-4. Area Correction Factors for External Exposure

The following term in Equation 2.15 is located in the MAXI1 computer code:

$$C_{iw}$$

Aquatic foods' dose rate factors calculated by the MAXI3 computer code are included in a data library for access by MAXI1. Included in those factors are the following terms of Equation 2.15:

$$U_{af} \qquad \exp\left(-\lambda_i t_h\right) D_{ir} \left[B_{xi} + B_{yi} + B_{zi}\right]$$

2.2 Computer Implementation

Estimates of the maximum annual radiation doses resulting from the exposure scenarios described in Section 2.1.1 can be made using environment-specific information and computer codes contained in the ONSITE/MAXI1 software package.

The package contains two primary computer programs, ONSITE and MAXI1, as well as an extensive data base. Two additional programs, MAXI2 and MAXI3 are included to allow modification of the data base. Figure 2.2-1 depicts the general process flow of the ONSITE/MAXI1 software.

The data base contains dose conversion factors applicable to the onsite disposal environment described in Section 2.1.2. This data base is discussed in detail in Section 2.3. The following sections contain descriptions of the ONSITE/MAXI1 computer programs, an overview of software operation and a discussion of capabilities, restrictions, and execution performance of the software.

2.2.1 Computer Programs Descriptions

The ONSITE/MAXI1 software package contains four computer codes as shown in Figure 2.2-1. ONSITE is an interactive user interface that allows the end-user to simply and efficiently create and use the radiation-exposure scenarios. MAXI1 is then used with the scenario information to calculate the maximum annual dose to an exposed individual from selected pathways. MAXI2 generates intermediate dose conversion factors for food pathways that are stored in the data files. MAXI3 calculates the data files containing intermediate dose conversion factors for aquatic pathways. The following sections contain descriptions of each of the computer codes:

2.2.1.1 ONSITE Computer Program Description

ONSITE is an interactive computer program that allows the user to access or create radiation-exposure scenarios used to estimate the dose-to-man resulting from onsite disposal of radioactive wastes. The software solicits scenario information from the user, controls parameter modification, selects the appropriate data libraries for running MAXI1, and constructs the input file for MAXI1. ONSITE was designed to make the creation

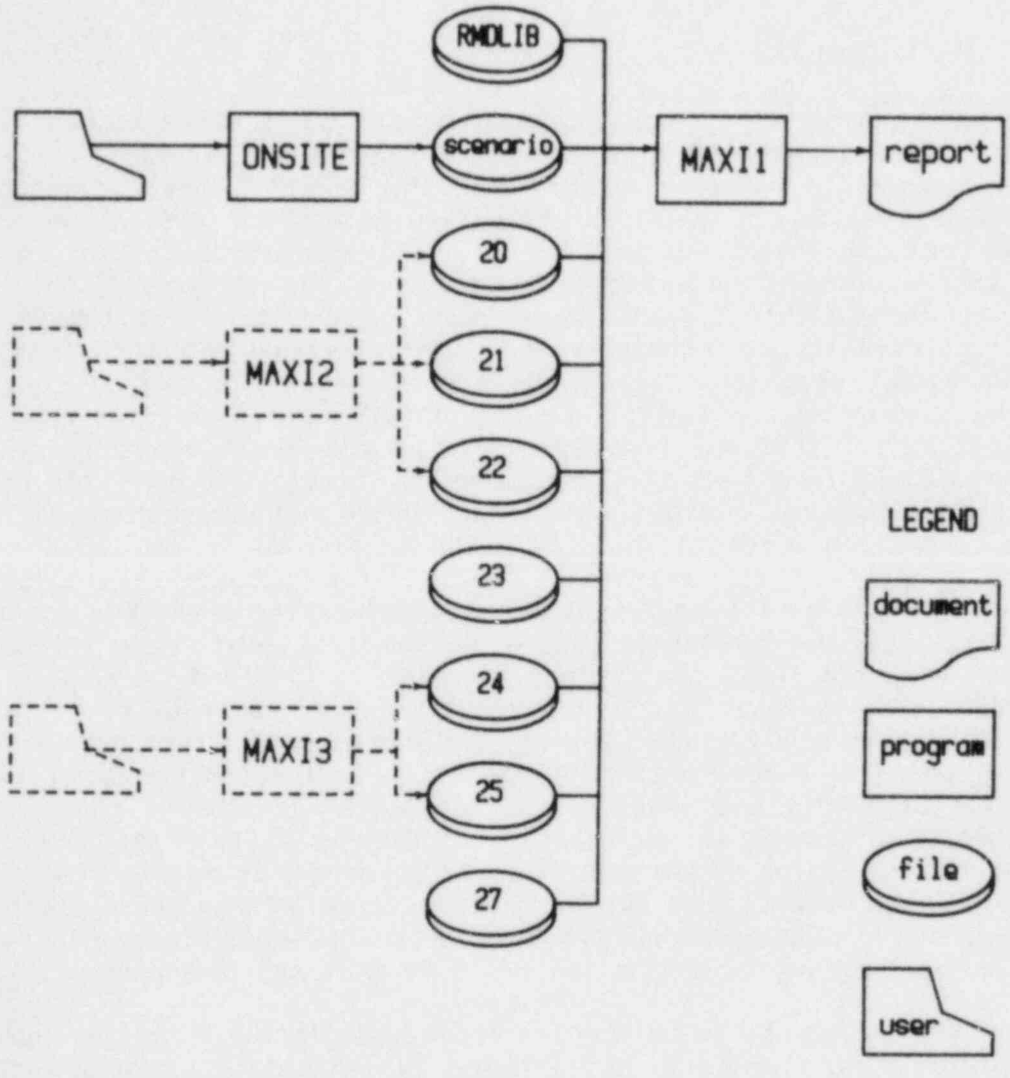

Figure 2.2-1. ONSITE/MAXI1 Software Process Flow Chart

and execution of a specific scenario as easy for the user as possible. If the default "environment" is used, ONSITE is the only computer program that the user needs to interact with because this interaction automatically produces results from MAXI1. The ONSITE program gives the user the option of changing any parameters of selected pathways used in the radiation-exposure scenarios. Each parameter is described in terms that should be meaningful to the end-user. The dimensional units and the upper and lower bounds of each parameter are displayed for each parameter. Each value entered by the user is tested against upper and lower limits when applicable. If the value is not accepted, the user is asked to re-enter the value. Default (or assumed maximum) values and conditions are activated by a null entry (e.g., simply pressing the <return> key on the terminal).

2.2.1.2 MAXI1 Computer Program Description

The computer program MAXI1 is used to calculate the maximum annual dose to an exposed individual from a large number of exposure pathways. This program uses dose conversion factors from the DACRIN (Houston, Strenge, and Watson 1974) computer program for estimating doses from inhalation of airborne radionuclides. The dose conversion factors from DACRIN are based on the International Commission on Radiological Protection's (ICRP) Task Group Lung Model (TGLM) (Health Phys. 1966). For ingestion pathways, for either food products or drinking water, dose conversion factors from the MAXI2 and MAXI3 computer programs are used by MAXI1. These dose conversion factors all rely on the dosimetry model of ICRP Committee II as reported in ICRP Publication 2 (1959). For external exposure, dose conversion factors from the ISOSHLD (Engel et al. 1966; Simmons et al. 1967) are used by MAXI1. These factors relate the radionuclide source strength to the dose rate in tissue 1 m above an infinite plane or slab of contamination. External dose conversion factors are supplied for surface-soil contamination, and for slabs of buried contamination at depths of either 0.5 or 1.0 m. External dose conversion factors from an optional room exposure condition are also available. These factors are intended to model doses to an intruder who may enter a room (or vault) used for storage of radioactive wastes. The room model was originally developed for a study concerning decommissioning of a reference Boiling Water Reactor (BWR) (Oak et al. 1980). A sensitivity analysis for the dose rate response of ^{60}Co surface contamination in a room of various sizes indicated a dose rate increase of a factor of two or less from small to large rooms (Oak et al. 1980, p. F-16). Thus, dose factors for a room of 100 m^3 volume are assumed to be represented by a plane source that appears to provide a reasonable estimate of the dose resulting in most sizes of rooms that may be encountered.

Exposure pathways that can be modeled include 1) direct external exposure to contaminated soil or building surfaces, 2) inhalation of resuspended material, and 3) ingestion of contaminated foods and aquatic products. The time of the maximum dose rate to individual organs of reference is calculated and the annual dose for that organ is reported.

2.2.1.3 MAXI2 Computer Program Description

The onsite disposal "environment" (Section 2.1.2) is applicable to all the scenarios presented in Section 2.1.3. MAXI2 need be used only when a different "environment" is defined. MAXI2 generates dose conversion factors to account for deposition on farm or garden soil and crops. Leaf mechanism dose rate factors are written to a computer file assigned to logical unit 20. The computer file assigned to logical unit 21, called FILE21, contains dose conversion factors to account for deposition onto soil in which food crops are grown. MAXI2 also generates external dose rate factors for exposure to soil surface contamination. These factors are written to the computer file assigned to logical unit 22, called FILE22. The computer code ISOSHLD (Engel et al. 1966; Simmons et al. 1967) is used to calculate surface external dose rate factors. A listing of the MAXI2 code is found in Appendix 2.B. The input files to MAXI2 that generated the dose conversion factors for the onsite disposal "environment" are included in Appendix 2.B as an example of code usage. MAXI2 is a specialized version of the FOOD (Napier, et al. 1980) computer program. The user is referred to that document for theoretical and operational information. Differences between the MAXI2 and FOOD computer codes are discussed in Section 3.1.2.

2.2.1.4 MAXI3 Computer Program Description

MAXI3 was used to define drinking-water and aquatic food-pathway factors for the onsite disposal "environment" described in Section 2.1.2. This "environment" is applicable to all the scenarios presented in Section 2.1.3. MAXI3 need be executed only when a different "environment" is considered. MAXI3 generates dose conversion factors for contaminated drinking water and aquatic food harvested from contaminated water. Drinking-water dose conversion factors are written to a computer file assigned to logical unit 24, called FILE24. The computer file assigned to logical unit 25, called FILE25, contains dose conversion factors to account for ingestion of comtaminated aquatic food products. A listing of the MAXI3 code is found in Appendix 2.C. The input files to MAXI3 that generated the dose conversion factors for the onsite disposal "environment" are shown in Appendix 2.C as an example of code usage. MAXI3 is a specialized version of the ARRRG (Napier, et al. 1980) computer program. The user may reference that document for theoretical and operational information on MAXI3. Differences between the MAXI3 and ARRRG computer programs are discussed in Section 3.1.2.

2.2.2 Operation of the ONSITE/MAXI1 Software Package

Section 3 contains a detailed discussion of the operation of the ONSITE/MAXI1 software package. A theoretical overview of software operation is presented here. Three levels of operation will be defined and the software process flow will be presented.

2.2.2.1 Levels of Operation

This software package implements the scenarios discussed in Section 2.1.3. The user is asked to supply information specific to the selected scenario and system information as defined in Section 3.1. No further interaction between the user and the software is necessary. The scenario will be executed and a report prepared automatically. This is the principal intended scope of the ONSITE/MAXI1 software package. However, the user is allowed to use the software for a wider range of applications. Three levels of operation have been defined to clarify this extended use of the software.

<u>Level 1</u>. The ONSITE/MAXI1 software package is designed to be used for assessing impacts from the onsite disposal of low-level wastes. This is the intended principal use of the software package. The data base contains information on the "environment" described in Section 2.1.2. Five scenarios have been defined that may be executed within the context of that "environment." The ONSITE program is used to select and establish parameters for a scenario. The user is assisted during scenario creation by a restricted set of parameters and restricted ranges of values for each parameter.

<u>Level 2</u>. The user may define a different "environment" by using the MAXI2 and MAXI3 computer codes. The ONSITE program can then be used to evaluate the five defined scenarios within the context of the newly created "environment." It is the user's responsibility to determine the validity of the "environment" and the appropriateness of the defined scenarios to this new "environment."

<u>Level 3</u>. The user creates a new "environment" with the MAXI2 and MAXI3 computer codes and establishes scenarios by manipulating MAXI1 input parameters directly. This level of operation should not be attempted without a thorough understanding of MAXI1 theory and operation because the interrelationships between MAXI1 input parameters are complex. The user must determine the validity of the "environment" and the scenarios, and the appropriateness of scenario application to the "environment."

2.2.2.2 Software Process Flow

Figure 2.2-1 depicts the general process flow of the ONSITE/MAXI1 software. The process flow details for each of the three levels of operation are discussed blow.

<u>Level 1</u>. The user executes the ONSITE program, inputting scenario selection and inventory. ONSITE allows parameter modification for selected pathways. A computer file that parameterizes the scenario is created by ONSITE. That file, the master radionuclide library, and the files that define the onsite disposal "environment" will be accessed by MAXI1. MAXI1 produces a printed report of dose estimates.

Level 2. The user first defines an "environment" by executing MAXI2 and MAXI3. The computer data files describe the newly created environment. The ONSITE code is then executed as in Level 1.

Level 3. The user defines an "environment" as in Level 2. The user bypasses the ONSITE program and creates the input stream for MAXI1 using a system editor.

2.2.3 Capabilities, Restrictions and Performance

The capabilities and inherent restrictions of the ONSITE/MAXI computer implementation are discussed for the following areas: "environment"/scenario definition, pathway selection/parameter modification, inventory selection, and organ selection. Capabilities and restrictions vary depending on the level of operation. Operation level are noted with each comment below.

2.2.3.1 "Environment"/Scenario Definition.

Levels 1-3. Section 2.2.2.1 defines three levels of ONSITE/MAXI1 software usage. User responsibilities concerning definition of the "environment," the scenarios, and their interrelationships are noted at each of the levels.

2.2.3.2 Exposure Pathway Selection/Parameter Modification

Levels 1-2. Five default scenarios have been implemented in this application. The user is allowed to change parameter values for each exposure pathway considered. Default pathways have been established for Scenarios 1-4. Scenario 5 allows the user to select any combination of exposure pathways and exposure conditions.

Level 3. Any of the defined exposure pathways may be selected. Allowable pathways are external exposure from surface and/or buried wastes, ingestion of farm products grown on contaminated soil, ingestion of drinking water from a contaminated source, and ingestion of contaminated aquatic food products. Any associated parameter values may be modified.

2.2.3.3 Inventory Selection

Levels 1-3. No default inventory has been established. Up to a total of 50 radionuclides may be considered. The default libraries for use in Level 1 contain information on 100 radionuclides. Several of these radionuclides (shown in Table 2.1-3) are listed with a +D (plus daughters) designation. For these radionuclides, the energies of the short-lived daughters in equilibrium with the parent radionuclides are included in the organ dose and external dose calculations. For other radionuclides, chain decay calculations are performed and daughters are permitted to reach their equilibrium values.

Level 1. The inventory is restricted to radionuclides appearing in Table 2.1-3.

Levels 2-3. Dose conversion factors are created for up to 100 radionuclides defined in the "environment." Different radionuclides than those included in the reference "environment" may be included at this level of operation. Subsequent scenarios are restricted to this set of radionuclides.

2.2.3.4 Organ Selection

Level 1. Doses to the following organs may be considered: total body, bone, lung, thyroid, and the lower large intestine (LLI) of the GI tract.

Levels 2-3. Dose conversion factors are generated for up to five organs defined in the "environment". These organs can be selected from the allowable organs discussed in Section 4.5. Dose conversion factors are based on data for each radionuclide in the radionuclide master library (RMDLIB), the organ data library (ORGLIB) and transfer factor libraries (FTRANSLIB, GRDFLIB, BIOAC). The user must determine if ORGLIB has sufficient data for each selected organ.

2.3 Data Base

The user is assisted in the appropriate use of the data base by the computer program ONSITE. ONSITE asks the user questions that are applicable to the scenario under construction. From the responses to those questions, ONSITE selects the appropriate files from the data base. An understanding of the detailed information which follows is not necessary for the successful execution of ONSITE/MAXI1. The intended audience is those interested in the organization and content of the data base and Level 2 and Level 3 users (defined in Section 2.2.2.1) who are defining a different "environment."

The ONSITE/MAXI1 data base is composed of eleven data files. The relationship of the data base to the computer codes is depicted in Figure 2.2-1. RMDLIB is the master radionuclide library containing chain decay and translocation class information. The balance of the files contain dose conversion factors for various pathways.

2.3.1 Radionuclide Master Library for MAXI1 - RMDLIB

The radionuclide master data library (RMDLIB) contains all radiological decay data used by MAXI. The library is organized into two sections. The first section contains radionuclides that 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 library contains radionuclides organized into decay chains ordered under the radionuclides highest in the chain. RMDLIB contains about 280 entries.

The first record of the library contains 80 characters of descriptive information used as identification in the input data report printed by MAXI1. The balance of the data records have the following information:

- Column 1 - Alphabetic element symbol
- Column 2 - Atomic weight, also metastable (m) and/or plus daughters (+D) designation
- Column 3 - Radiological half-life, days
- Column 4 - Index of relative position in decay chain (0 is highest position)
- Column 5 - Index of precursor in decay chain (as identified in column 4 of the precursor)
- Column 6 - Branching ratio for primary precursor
- Column 7 - Index of alternate precursor in decay chain
- Column 8 - Branching ratio for alternate precursor
- Column 9 - Translocation class assignment for soluble state of element
- Column 10 - Translocation class assignment for insoluble state of element

Translocation refers to the rate at which radionuclides are transported by body fluids from the lungs to the blood and GI tract after inhalation. For inhalation calculations, translocation classifications are made for each organ based on the usage of the Task Group Lung Model (ICRP 1966). The translocation indices used in RMDLIB refer to the following classes as defined in ICRP (1966):

Index 1 • Class D Materials. A maximum clearance half-time of less than a day.

Index 2 • Class W Materials. A maximum clearance half-time ranging from a few days to a few months.

Index 3 • Class Y Materials. A maximum clearance half-time of from six months to a few years.

ONSITE/MAXI1 assumes that for inhalation all elements are insoluble for the lungs and soluble for the other organs. This assumption tends to maximize the organ dose. The translocation classification for soluble and insoluble will be read by the ONSITE computer code and applied to each organ according to the above assumption. The default translocation assignments may be modified by the user during scenario creation.

The RMDLIB FORTRAN format is (A2, A6, E10.2, 2I2, F7.4, I2, F7.4, 22X,2I1). The parameter in column four is used to signal the end of the data library (<=0). A listi · of the library is located in Appendix 1.C. ONSITE reads a shortened version of RMDLIB containing only those radionuclides defined for the onsite disposal environment entitled RMDONS (listed in Appendices 1.C and 2.A).

2.3.2 Leaf Mechanism Dose Rate Factors - FILE20

The file assigned to logical unit 20, called FILE20, contains "environment"-specific leaf-mechanism dose rate factors for 1 pCi per cubic meter in air. Each record of the file contains dose rate factors of one radionuclide for selected organs. The file is arranged into sets of records for each year. The sets are delimited by a blank record. The file organization, corresponding MAXI1 variable names, and FORTRAN formats of FILE20 are as follows:

Line 1	• Descriptive title, TIT20; (20A4).
Line 2	• Type descriptor, ID; number of years of data, NYRL; number of isotopes, NISOL; number of organs, NORGL; (5X, A4, 3I5).
Line 3	• Index of organs, KORGLS(i), for i ranging from one to NORGL; (5I5).

The following set of records follows for each year of data (k); a total of NYRL sets:

Line A	• Blank line
Next NISOL lines	• One line for each isotope (i) containing: element symbol as in the master radionuclide library, ELTLS(i); atomic number as in the master radionuclide library, AWLS(i); dose rate factor for KORGLS(j) where j ranges from one to NORGL, DINCL(k,i,j); (A2, A6, 5E12.2).

FILE20 contains dose rate factors for five organs for 100 radionuclides for fifty years. The organs are total body, bone, lungs, thyroid, and the lower large intestine of the GI tract. Consumption parameters included in the dose conversion factors are listed in Table 2.1-1. The radionuclides considered are listed in Table 2.1-3. The first page of this default file is printed in Appendix 1.C. A complete listing of the default file is given in Appendix 2.A.

When creating a new "environment," the computer code MAXI2 is used to generate this file. MAXI2 is a special version of the FOOD computer code (Napier et al. 1980). The user is referred to that document for detailed information. Instructions for executing MAXI2 are given in Section 3.1.2. MAXI2 outputs leaf-mechanism dose rate factors to the file assigned to logical unit 20. The MAXI2 input file that generated FILE20 for the onsite disposal "environment" is listed in Appendix 2.B.

2.3.3 Soil Mechanism Dose Rate Factors - FILE21

The file assigned to logical unit 21, called FILE21, contains "environment" -specific soil-mechanism dose rate factors for 1 pCi per square meter in soil. Each record of the file contains dose rate factors of one radionuclide for selected organs. The file is arranged into sets of records for each year.

The sets are delimited by a blank record. The file organization, corresponding MAXI1 variable names, and FORTRAN formats of FILE21 is as follows:

Line 1 • Descriptive title, TIT21; (20A4).

Line 2 • Type descriptor, ID;
number of years of data, NYRS;
number of isotopes, NISOS;
number of organs, NORGS; (5X, A4, 3I5).

Line 3 • Index of organs, KORGLS(i),
for i ranging from one to NORGS; (5I5).

The following set of records follows for each year of data (k); a total of NYRS sets:

Line A • Blank line

Next NISOS lines • One line for each isotope (i) containing:
element symbol as in the master radionuclide library, ELTLS(i);
atomic number as in the master radionuclide library, AWLS(i);
dose rate factor for KORGLS(j) where j ranges from one to NORGS, DINCS(k,i,j);
(A2, A6, 5E12.2).

FILE21 contains dose rate factors for five organs for 100 radionuclides for fifty years. The organs are total body, bone, lungs, thyroid, and the lower large intestine of the GI tract. Consumption parameters included in the dose conversion factors are listed in Table 2.1-1. The radionuclides considered are listed in Table 2.1-3. The first page of this file is printed in Appendix 1.C. A complete listing of the file is in Appendix 2.A.

MAXI2, a special version of the FOOD computer (Napier et al. 1980), generates this file. The user is referred to the FOOD program documentation for detailed information. Instructions for executing MAXI2 are located in Section 3.1.2. The input submitted to MAXI2 to generate the FILE21 is given in Appendix 2.B. MAXI2 prints a report of input parameters and outputs soil-mechanism dose rate factors to the file assigned to logical unit 21 in the format described above.

2.3.4 Surface External Exposure Mechanism Dose Rate Factors

The file assigned to logical unit 22 contains external dose rate factors. Two files are available for considering surface contamination in the onsite disposal "environment." These files are based on the location of the waste. The files are:

"PLANSOURC" - An infinite plane of soil contamination,

"ROOM" - surface contamination on the walk, floor, and ceiling of a room.

The organization, corresponding MAXI1 variable names, and FORTRAN formats of these files are as follows:

Line 1	•	Descriptive title, TIT22; (20A4).
Line 2	•	Type descriptor, ID; number of isotopes, NISOX; (5X, A4, I5).
Next NISOX lines	•	For each isotope (i): element symbol as in master radionuclide library, ELTX(i); atomic number as is master radionuclide library, AWX(i); external exposure dose rate factor, DFXT(i); CA2, A6, E7.1).

The data files "PLANSOURC" and "ROOM" are printed in Appendices 1.C and 2.A. When establishing a new "environment," the user may use the ISOSHLD (Engel et al. 1966; Simmons et al. 1967), MAXI2, or other compatible computer programs to generate external dose rate factors. A file in the above format will probably have to be hand-generated from the results of the shielding calculations. MAXI1 anticipates external dose rate factors in units of mrem/yr per pCi/m^2. Both "PLANSOURC" and "ROOM" were generated using the ISOSHLD computer program.

2.3.5 Inhalation Dose Rate Factors - FILE23

The file assigned to logical unit 23 called FILE23, contains inhalation dose rate factors for 1 pCi per cubic meter of air. The file is arranged into sets of records for each isotope. Each isotope set contains three solubility class subsets. Each solubility class subset is comprised of a variable number of records, one record per year. Each record contains data on up to five organs. The file organization, corresponding MAXI1 variable names, and FORTRAN formats of FILE23 are as follows:

- Line 1 — • Number of radionuclides in library, NDI; descriptive title, TIT23; (I5, 15X,15A4).
- Line 2 — • Index of organs, IDORG(i), for i ranging from 1 to 5, i=0 indicates data for less than five organs; (5I5).

This set of records follows for each radionuclide(k), a total of NDI sets:

- Line A — • Element symbol as in the master radionuclide library, ELTD;
  atomic number as in the master radionuclide library, AWD;
  number of years of data solubility class 1, N1;
  number of years of data solubility class 2, N2;
  number of years of data solubility class 3, N3;
  (A2, A6, 2X, 3I5).
- Next N1 lines — • For translocation class 1, one record contains inhalation dose rate factors for five organs (j), DIN(1,i,j); (10x, 5E10.2).
- Next N2 lines — • For translocation class 2, one record contains inhalation dose rate factors for five organs (j), DIN(2,i,j); (10x, 5E10.2).
- Next N3 lines — • For translocation class 3, one record contains inhalation dose rate factors for five organs (j), DIN(3,i,j); (10x, 5E10.2).

The file contains dose rate factors of 130 radionuclides for five organs for a varying number of translocation classes and a varying number of years. The organs are total body, bone, lungs, thyroid, and the lower large intestine of the GI tract. Dose rate factors are based on a breathing rate of 230 cc/sec. The first page of this file is printed in Appendix 1.D.5. A complete listing is located in Appendix 2.A. FILE23 is created by a special version of the computer code DACRIN (Houston, Strenge, Watson. 1974). This library is not "environment"-specific and consequently should not need to be recreated by the user. The input to DACRIN that created FILE23 is shown in Appendix 2.D.

2.3.6 Aquatic Foods Dose Rate Factors - FILE24

The file assigned to logical unit 24, called FILE24, contains "environment" -specific aquatic foods dose rate factor for 1 pCi per liter of river water. Each record of the file contains dose rate factors of one radionuclide for selected organs. The file is arranged into sets of records for each year. The sets are delimited by a blank record. The file organization, corresponding MAXI1 variable names, and FORTRAN formats of FILE24 are as follows:

Line 1	• Descriptive title, TIT24; (20A4).
Line 2	• Type descriptor, ID; number of years of data, NYRA; number of isotopes, NISOA; number of organs, NORGA; (5X, A4, 3I5).
Line 3	• Index of organs. KORGA(i), for i ranging from one to NORGA; (5I5).

The following set of records follows for each year of data (k); a total of NYRA sets:

Line A	• Blank line
Next NISOA lines	• One line for each isotope (i) containing: element symbol as in the master radionuclide library, ELTA(i); atomic number as in the master radionuclide library, AWAW(i); dose rate factor for KORGA(j) where j ranges from one to NORGA, DINCA(k,i,j); (A2, A6, 5E12.2).

FILE24 contains dose rate factors for five organs for 100 radionuclides for fifty years. The organs are total body, bone, lungs, thyroid, and the lower large intestine of the GI tract. Consumption rates are given in

Table 2.1-2. Radionuclides included are listed in Table 2.1-3. The first page of this file is printed in Appendix 1.C. A complete listing of the file is located in Appendix 2.A.

FILE24 is generated by the MAXI3 computer code. MAXI3 is a special version of the ARRRG computer code (Napier et al. 1980). The user is referred to that document for detailed information. Instructions for executing MAXI3 are given in Section 3.1.2. The input to MAXI3 that generated the aquatic foods dose rate factors in FILE24 is given in Appendix 2.C.

2.3.7 Drinking-Water Dose Rate Factors - FILE25

The file assigned to logical unit 25, called FILE25, contains "environment"-specific drinking-water dose rate factors for 1 pCi per liter of drinking water. Each record of the file contains dose rate factors of one radionuclide for selected organs. The file is arranged into sets of records for each year. The sets are delimited by blank records. The file organization, corresponding MAXI1 variable names, and FORTRAN format of FILE25 are as follows:

- Line 1 • Descriptive title, TIT25; (20A4).
- Line 2 • Type descriptor, ID; number of years of data, NYRW; number of isotopes, NISOW; number of organs, NORGW; (5X, A4, 3I5).
- Line 3 • Index of organs, KORGW(i), for i ranging from 1 to NORGW; (5I5).

The following set of records follows for each year of data (k); a total of NYRW sets:

- Line A • Blank line
- Next NISOW lines • One line for each isotope (i) containing: element symbol as in the master radionuclide library, ELTW(i); atomic number as in the master radionuclide library, AWW(i); dose rate factor for KORGW(j) where j ranges from one to NORGW, DINCW(k,i,j); (A2, A6, 5E12.2).

FILE25 contains dose rate factors for five organs for 100 radionuclides for fifty years. The organs are total body, bone, lungs, thyroid, and the lower large intestine of the GI tract. Consumption rates are given in

Table 2.1-2. The radionuclides considered are listed in Table 2.1-3. The first page of this file is printed in Appendix 1.C. A complete listing of the file is in Appendix 2.A.

The computer code MAXI3 generates FILE25. MAXI3 is a special version of the ARRRG computer code (Napier et al. 1980). The user is referred to that document for detailed information. Instructions for executing MAXI3 are given in Section 3.1.2. The MAXI3 input file that generated the dose rate factors in FILE25 is given in Appendix 2.C.

2.3.8 Buried Waste External Dose Rate Factors

Three files are available for considering buried waste in the onsite disposal "environment." The files are based on the location (relative depth from the surface) of the waste. The three optional files are:

- "VOLSOURC" - infinite surface slab source (waste thickness of 1 m)
- "BURIEDHF" - infinite slab source buried in soil with an overburden depth of 0.5 meters (waste thickness of 1 m)
- "BURIED1" - infinite slab source buried in soil with an overburden depth of 1.0 meters (waste thickness of 1 m)

ONSITE assigns the appropriate file to logical unit 27 based on the waste location selected by the user. The factors in these files relate the radionuclide source strength to the dose rate in tissue 1 m away. These factors are for 1 pCi per cubic meter for the waste. Each record of the file contains dose rate factors for one radionuclide. The file organization, corresponding MAXI1 variable names, and FORTRAN formats of the optional files are as follows:

Line 1	• Descriptive title, TIT27; (20A4).
Line 2	• Type descriptor, ID; number of isotopes, NISODX; (5X, A4, I5).
Next NISODX lines	• For each isotope (i) element symbol as in master radionuclide library, ELTDX(i); atomic number as is master radionuclide library, AWDX(i); dose rate factor in air, DFDXT(i); (A2, A6, E7.1)

The three onsite disposal "environment" files are listed in Appendices 1.C and 2.A. These files are created by the ISOSHLD (Engel et al. 1966; Simmons et al. 1967) computer program.

2.4 References

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3. PROCEDURES

User instructions and technical details on use of the ONSITE/MAXI1 software package are presented in this section. Instructions are given for user interaction with each of the computer codes. Detailed information on input parameters is included for reference. Outputs from the computer programs are described. Five sample problems are included with a discussion of the hand calculations performed to verify the correct operation of the computer code. Program-generated error messages and corresponding corrective actions for the ONSITE and MAXI1 computer codes are also listed.

This section is written primarily for the user who interacts with the ONSITE program to execute one of the scenarios presented in Section 2.1.3. Before interacting directly with the other codes in the software package, the user should be familiar with Section 2.2, Computer Implementation.

The following conventions will be used in this manual to distinguish exact user input from instructions and from computer program displays.

- **<cr>** • These symbols indicate that the keyboard key labeled **RETURN** should be pressed when encountered in the manual. This is analogous to the carriage return for those of you more familiar with typewriters than computers.

- **boldface** • Boldface print designates information entered at the terminal by the user. NOTE: In the appendices, information entered by the user is underlined.

- **CAPITAL LETTERS** • When capital letters in boldface type are encountered, the user should type in the boldface letters exactly as shown.

- **lower-case letters** • When lower-case letters are encountered in boldface type, the user should substitute scenario-specific information or a unique name.

3.1 User Instructions

The ONSITE/MAXI1 software package is installed on the Brookhaven CDC 6600 MFA and 7600 MFZ computers. It is necessary to obtain an account name, password, and problem number to use this computer. The user is responsible for obtaining the above privileges to access the ONSITE/MAXI1 software.

Three levels of software operation are presented in Section 2.2.2. At Level 1, the ONSITE program is used to establish and exercise a scenario within the context of the "environment" described in Section 2.1.2. At Level 2, a different "environment" can be established with the MAXI2 and MAXI3 programs. At Level 3, the user interacts directly with the MAXI1 program to set up scenarios for an "environment" created with MAXI2 and MAXI3 programs.

The following three subsections correspond to these levels, respectively.

3.1.1 Creating and Executing a Scenario - ONSITE (Level 1 User)

To establish and execute a scenario, the user need only type

ATTACH,PROCFIL,ID=ONSITE,MR=1 <cr>
BEGIN,ON <cr>

to access the interactive program.

ONSITE first introduces itself and displays general instructions on use of the program. A menu describing the available scenarios is displayed. The five scenarios are:

(1) External-Exposure Scenario
(2) External-Exposure Plus Inhalation Scenario
(3) Agricultural Scenarios
(4) Irrigation/Drinking-Water Scenario
(5) User-Defined Scenario

A brief description of the selected scenario is displayed. The user may change the scenario selection at this point. This allows the user to interactively review all scenario descriptions before making a final decision for a specific simulation.

The user is queried for a descriptive title, the start time of the simulation, and the level of detail presented in the output reports. The user may execute the scenario as it was described in Section 2.1.3 or modify parameters associated with exposure pathways included in the selected scenario. If changes are to be made, ONSITE will set parameter values based on the user's response to questions. Default values are displayed for each parameter, and the user's input is tested to determine if it is within bounds. Before the user is asked to supply the inventory, an opportunity is provided to review all of the entered parameters. This enables the user to correct any mistakes or make changes.

When the user is satisfied with the parameter selection, the source term is entered by radionuclide. Radionuclides should be selected from Table 2.1-3. MAXI1 accepts radionuclide names only as they appear in RMDONS, listed in

Appendix 1.C.9. Inhalation exposure calculations require a translocation class assignment for each organ for each radionuclide. Default assignments have been made. The user may review and/or modify these assignments. The concentration of the radionuclides in the source term may be entered in various units selected by the user. A screen report of the inventory is displayed when the user has completed inventory input. The user is then allowed to 1) modify the displayed inventory, and then 2) add radionuclides to the inventory.

ONSITE provides assistance to the user during scenario creation. This manual should not be necessary during normal executions. The following features are incorporated into the ONSITE software:

- Parameter descriptions and default values for each of the five scenarios are stored in the code.
- Only applicable parameters are reviewed for each scenario.
- Questions are "English-phrased". A strong effort has been made to refrain from computer jargon. The code attempts to ask questions meaningful to the end user and logically establishes required parameter values.
- Values entered at the terminal by the user are tested against minimum and maximum allowable limits. If a value is determined to be outside the allowable limits, the user is asked to supply another value.
- Default values are installed with a null entry (i.e., pressing the <return> key).
- When a "YES/NO" question is asked of the user, the default condition is always displayed first (e.g., (N/Y) indicates that a null entry is equivalent to a "no" response).
- Review of collections of parameters (e.g., agricultural and/or inhalation pathway parameters may be bypassed during scenario modification).
- Radiological inventory input is tested against a shortened version of the master radionuclide library, RMDONS. This establishes that information is available in the data base for the source term in question and that the user entered the radionuclide name in a recognizable form.
- Radiological inventory input is tested against the previously entered input to ensure that an entry is not duplicated.
- Upon the completion of input, the radiological inventory is displayed. The user is given the opportunity to first modify and then add to the inventory.

- Default organ translocation classes are assigned.
- Input is free-formatted as specified in ANSI-FORTRAN-77.
- The user may review and/or modify scenario parameters until satisfied with the selection.

Upon completion of the ONSITE program, the user is asked to supply a CDC account name and problem number. This information is used to prepare control statements for the MAXI1 execution. The MAXI execution file created by ONSITE will be in the user's work area under the name TAPE7.

The user should then enter the following command:

BEGIN, DONE <cr>

This command will catalog the execution file, submit the file to the MFZ computer for processing, and prepare the work area for another run.

The user will be prompted to enter a unique filename in the following manner:

F FILENAME FOR SCENARIO: **filename <cr>**

The user is then asked to supply a unique read key for the file as follows:

R READ KEY FOR FILE: **readkey <cr>**

This key will protect the user's account name and problem number. The MAXI1 execution file will be stored as a permanent file under the name specified by the user. The permanent file will have an ID of ONSITE and a retention period of ten days. This two-step procedure allows the user to access the input file prior to execution.

Because of extended core memory requirements, there may be a delay in the MAXI1 executions. When the files have been executed, (the job names will appear under OUTPUT FILES in the FILES command response), the user may use the SEND command procedure to direct output to the RJE terminal in SS-056. To start the procedure, enter:

BEGIN,SEND <cr>

The procedure will respond with the following request:

F NAME OF OUTPUT FILE TO BE PRINTED: **jobname <cr>**

The user should enter the jobname as it appears in the FILES command response. The SEND procedure then requests a name that will be printed on the banner page of the output. The user may use any five-character sequence to identify the run. The format of the request is as follows:

N FIVE CHARACTER NAME TO IDENTIFY RUN: **name <cr>**

3.1.2 Creating an "Environment" - MAXI2 and MAXI3 (Level 2 User)

MAXI2 is a specialized version of the FOOD (Napier et al. 1980) computer program. MAXI3 is a specialized version of the ARRRG (Napier et al. 1980) computer code. The user is referred to the ARRRG and FOOD document for user instructions, with the following exceptions:

- Only the following NAMELIST parameters are used by MAXI2:

NEXT	HLDUP	KORG
KFDTYP	CON	T2
GRWP	TRNS	POP
YELD	EXTIM	IPOP

- Only the following NAMELIST parameters are used by MAXI3:

NEXT	KORG	USAG
KPTHWY	PLIFE	ISALT
T2	HLDUP	

- Release parameter records need only list the radionuclide name, ELTI(i) and AWI(i) in FORTRAN A2, A6 format.

- Special versions of the data libraries used by MAXI2 and MAXI3 are included in the ONSITE/MAXI software package. These libraries contain information in the radionuclides listed in Table 2.1-3. The library FTRANSLIB contains elemental deposition velocities to account for deposition of resuspended radioactive materials. Transfer coefficients in FTRANLIB for ^{3}H and ^{14}C are taken from Regulatory Guide 1.109 (U.S. NRC 1977). The libraries included in this package are:

RMDLIB	BIOAC
ORGLIB	FTRANSLIB
GRDFLIB	

  RMDLIB is also used by MAXI1.

- Files must be assigned to the following logical unit devices to obtain dose rate factor output:

Logical Unit No.	File Description	Corresponding ONSITE/MAXI File
20	MAXI2 leaf mechanisms	FILE20
21	MAXI2 soil mechanisms	FILE21
22	MAXI2 surface external mechanisms	PLANSOURC
24	MAXI3 aquatic food-product mechanisms	FILE24
25	MAXI3 drinking-water mechanisms	FILE25

MAXI2 and MAXI3 will print reports of input parameters. Output file organization is presented in Section 2.3. Output reports (as provided by FOOD and ARRRG) are not printed.

Sample input files to MAXI2 and MAXI3 and listed in Appendices 2.B and 2.C, respectively.

The ONSITE/MAXI1 data base contains the "environment" described in Section 2.1.2. File names generated by MAXI2 and MAXI3 must not conflict with those currently in the data base. It is suggested that all files be renamed so that the different "environment" can be established without sacrificing the integrity of the ONSITE/MAXI data base.

3.1.3 Interacting Directly with MAXI1 (Level 3 User)

A user may establish a scenario by interacting directly with the MAXI1 computer program. Because of the complexity of the MAXI1 input parameters, the user must have a thorough understanding of MAXI1 theory and coding before attempting this interaction. All necessary information for MAXI1 execution is included in this manual. The user is referred to Sections 2.2, 2.3, 3.2, 4.4 and 4.5 for further information on executing MAXI1.

3.2 Input Parameters

Information in this section is not necessary for successful execution of the ONSITE program. It is included for reference. The default parameter values assigned to each scenario are given in Table 3.2-1. The input variables for ONSITE/MAXI1 are described in Table 3.2-2. The name of each parameter is followed by the number of elements (and specification if it is an array), the data type classification, and a description. The parameter description includes the function of the parameter, the dimensional units, and the minimum and maximum allowable values if applicable. The parameters are listed in alphabetical order.

Table 3.2-1. Scenario Default Parameter Values

	Scenarios				
	External Exposure	**External Exposure and Inhalation**	**Agricultural**	**Irrigation/ Drinking Water**	**User Defined**
Pathways:					
External Exposure to Buried Waste (IEXT)	1	0	0	0	1
External Exposure to Surface Waste (ISUR)	0	1	1	1	1
Food Consumption (IFOD)	0	0	1	1	1
Drinking Water Consumption (IWAT)	0	0	0	1	1
Aquatic Food Product Consumption (IARG)	0	0	0	0	1
Air Submission (IAIR)	0	0	0	0	0
Hours of Exposure:					
To External	2000.	2000.	2000.	2000.	8766.
To Inhalation	0	2000.	2000.	2000.	8766.
Waste Dilution Factor	.2	.2	.2	1.0	.2
Resuspension Model:	NA	Anspaugh	Anspaugh	Anspaugh	Mass loading
Age of contamination (yrs)	NA	0	0	0	-1
Thickness of surface soil layer available (cm)	NA	1.0	1.0	1.0	NA
Fraction of Diet Grown on Site	0.0	0.0	0.0	1.0	1.0
Years of Prior Irrigation of Site	0	0	0	10	0
Selected Organs	Total body	Total body, bone, lungs, thyroid, GI tract	Total body, bone, lungs, thyroid, GI tract	Total body, bone, lungs, thyroid, GI tract	Total body, bone, lungs, thyroid, GI tract
No. of Years After Waste is Disposed That:					
Scenario Begins	0	0	0	0	0
Scenario Ends	50	50	50	50	50
Site Size (ha)	1.0	1.0	0.05	1.0	1.0

Table 3.2-2. ONSITE/MAXI1 Parameter Descriptions

Parameter Name	NAMELIST Set/No. Array Elements	Data Type	Description
AGE	INPUT	Real	Anspaugh model. Average age of surface contamination at the beginning of the calculation in years.
AREAEX	INPUT	Real	Area correction factor for external pathways to account for the limited exposure potential from smaller disposal sites. This parameter is calculated by ONSITE based on the size of the site, FRSIZ. (Default value is 1.0)
AREAIN	INPUT	Real	Area correction factor for internal pathways to account for the limited exposure potential from smaller disposal sites. This parameter is calculated by ONSITE based on the size of the site, FRSIZ. (Default value is 1.0)
AWI	(100)	Alpha	Two-character element symbol of each radionuclide in the source term.
DEN	INPUT	Real	Mass-loading model. Soil density in grams per cubic meter. (Default value is 1.0E+6)
ELTI	(100)	Alpha	Atomic number of this radionuclide. Input may be up to six characters in length and include metastable (m) and daughter (+D) designation (e.g., TE127m+D).
FRSIZ	INPUT	Real	Disposal site size in terms of fractional hectares. (Default value is 1.0)
I22	INPUT	Integer	Index of source computer program of the external dose rate factors in the file assigned to logical unit 22: 0 - ISOSHLD 1 - MAXI2

Table 3.2-2. ONSITE/MAXII Parameter Descriptions - Continued

Parameter Name	NAMELIST Set/No. Array Elements	Data Type	Description
			If I22=0, MAXI1 will set XFACT = 5.844E-11. If I22=1, MAXI1 will set XFACT = 1.0. (Default value is 0)
IARG	INPUT	Integer	Consumption of aquatic food products from a contaminated river pathway: 0 - pathway not selected 1 - pathway selected
IEXT	INPUT	Integer	External exposure and crop root penetration for deeply buried waste: 0 - pathway not selected 1 - pathway selected
IFOD	INPUT	Integer	Farm products ingestion pathway: 0 - pathway not selected 1 - pathway selected
IMO	INPUT	Integer	The number of months per year that crops are irrigated. (Default value is 6)
INHAL		Integer	Inhalation from resuspension pathway: 0 - pathway not selected 1 - pathway selected
ION	INPUT	Integer	Control parameter set to indicate that input was created by the ONSITE program. Used to control parameter printing in QAPAGE. ION is set to 1 by ONSITE. (Default value is 0)
IOUT	INPUT	Integer	Output class index: 0 - print tables of maximum annual doses per organ with radionuclide and pathway contribution

Table 3.2-2. ONSITE/MAXI1 Parameter Descriptions - Continued

Parameter Name	NAMELIST Set/No. Array Elements	Data Type	Description
			1 - prints above table and a running summary of the annual doses listed by organ and total only 2 - prints above summaries and gives all annual tables by organ, pathway, and radionuclide
IRR		Integer	Number of years irrigation accumulates radionuclides on the site prior to beginning the dose calculation.
IRS		Integer	Index of the selected default scenario: 1 - external exposure 2 - external exposure plus inhalation from resuspension 3 - external exposure from agricultural activities 4 - use of contaminated water for irrigation and/or drinking 5 - user-created
ISUR	INPUT	Integer	External exposure to surface contamination: 0 - not selected 1 - selected If this parameter is set to 0, XFACT will be set to 1.0 in MAXI1. (Default value is 1)
IT1	INPUT	Integer	The year after waste disposal when intrusion occurs and the annual dose calculation begins. This parameter allows for correct chain decay of source term. (Default value is 1)
IT2	INPUT	Integer	Number of years of annual dose calculations. The maximum allowed is 49 + IT1. (Default value is 50)

Table 3.2-2. ONSITE/MAXI1 Parameter Descriptions - Continued

Parameter Name	NAMELIST Set/No. Array Elements	Data Type	Description
IWAT	INPUT	Integer	Drinking water ingestion from well water pathway: 0 - pathway not selected 1 - pathway selected
KORG	INPUT (5)	Integer	Indices of selected organs. Indices must be arranged in ascending order as discussed in Section 4. Total body must be included.
M3M2	INPUT	Integer	Surface source term input: 0 - permits input of pCi/square meter 1 - permits input of pCi/cubic meter 2 - permits input of pCi/kilogram of soil (Default value is 1)
NIN		Integer	Number of radionuclides in the source term. ONSITE calculates this number.
NORG	INPUT	Integer	Number of organs to be considered. Total body must always be considered as one of the five selected organs. NOTE: $1 \leq$ NORG ≤ 5.
Q	(100)	Real	Contamination deposited on the site at start of calculation. Units as specified by M3M2.
QI	(100)	Real	Irrigation/river release source term in units of pCi/L. May be used in Scenarios 4 and 5.
QJ	(100)	Real	Drinking water source term in units of pCi/L. May be used in Scenarios 4 and 5.
RF1	INPUT	Real	The fraction of total roots in top 15 cm of the soil. (Default value is 1.0)

Table 3.2-2. ONSITE/MAXI1 Parameter Descriptions - Continued

Parameter Name	NAMELIST Set/No. Array Elements	Data Type	Description
RF2	INPUT	Real	The fraction of total roots entering the buried waste below the top 15 cm plow layer of soil. (Default value is 0.0) Note: RF1+RF2 $\leq$1.0.
RINH	INPUT	Real	RINH modifies the hours of inhalation per year from 8660 hours per year to case-specific values and modifies breathing rate. ONSITE asks for the number of hours of inhalation per year and computes this number.
RIRR	INPUT	Real	Irrigation rate in liters per square meter per month. (Default value is 0.0 - no irrigation)
RPF	INPUT	Real	This parameter value is calculated by ONSITE (RPF = RPF1 * RPF2) unless RPF is zero or unspecified; in that case RPF = RPF1.
RPF1	INPUT	Real	This is a ratio of waste concentration in surface to subsurface soils. (Default value is 1.0)
RPF2	INPUT	Real	Fraction of the total diet grown on the site. (Default value is 1.0)
SRDIL	INPUT	Real	Inventory dilution factor. (Default value is 1.0)
XDPT	INPUT	Real	Anspaugh resuspension model. Fraction of the soil plow-layer thickness available for resuspension. (Default value is 0.067)
XF2	Input	Real	Number of hours of external exposure to surface contamination. This parameter will modify XFACT by XF2/8766 in MAXI1. (Default value is 2000)

Table 3.2-2. ONSITE/MAXI1 Parameter Descriptions - Continued

Parameter Name	NAMELIST Set/No. Array Elements	Data Type	Description
XMLF	INPUT	Real	Mass-loading resuspension model. Mass-loading factor in grams per cubic meter. (Default value is 1E-4)

The reference "environment" used to calculate the dose factor files in the data libraries is based on a uniformly contaminated site of 1 ha. To modify the default site area for consideration of smaller sites, the user is asked to enter the site size in terms of fractional hectares. As an example, if we wish to model a site of 150 m^3, we would enter a fractional site size of 0.015 (150 m^2/10,000 m^2). The site area correction factor automatically applied by the ONSITE computer program to the ingestion and inhalation pathways is 0.25 as shown in Figure 2.1-1. This factor implies that only 25% of the total annual diet is raised on a site of 150 m^2 and that the local air concentration resulting from resuspension is 25% of that resulting from a larger (1 ha) site. For direct exposure, the site area correction factor applied by the ONSITE computer program for this case is about 0.5 as shown in Figure 2.1-3. This factor implies that the direct exposure source strength from a site of 150 m^2 is 50% of the source strength resulting from an infinite slab or plane. In addition to applying the site area correction factors, the user may still modify the hours of exposure and the other scenario-specific pathway assumptions.

3.3 Output Descriptions

ONSITE produces a system execution file containing logical unit/file assignments, the system command to execute MAXI1, and input for MAXI1 defining the scenario specified by the user while interacting with ONSITE.

MAXI1 generates a printer report that contains a complete description of parameters and their values and tables of maximum annual doses per organ. The user may select from three levels of detail in the results reporting:

- tables of maximum annual doses per organ with radionuclide and pathway contribution
- the tables listed above and a running summary of the annual doses listed by organ and total only
- the above summaries and all annual tables by organ, pathway, and radionuclide.

The parameter IOUT controls printer report selection. Usually IOUT=0 will provide the user with adequate results. Examples of output from MAXI1 are included for each of the sample problems in Section 3.4.

3.4 Sample Problems

Five sample problems are presented and discussed to assist the user in various types of executions. An attempt has been made to cover a typical range of scenarios for which the code package was intended. The complete set of input and output for each of the sample problems is listed.

3.4.1 Sample Problem One

The first sample problem is designed to exercise the external-exposure scenario. For this sample problem, a licensee is assumed to dispose of 500 m^3 of radioactive waste in a burial area onsite. The waste is assumed to contain an average of 0.1 Ci/m^3 of ^{60}Co buried to a depth of 0.5 m over a 1 ha site. The sample problem is to determine the doses to an intruder 10 years after the wastes are buried. The solution is found by running the ONSITE default external exposure scenario for subsurface waste with default exposure conditions and the ^{60}Co waste inventory. A summary of the ONSITE interactive session used to develop the runstream for Sample Problem One is shown in Figure 3.4-1. The output resulting from this sample problem is shown in Figure 3.4-2. The maximum annual total-body dose to the intruder resulting for this sample problem is about 0.04 rem/yr. Hand calculations were performed for this sample problem. The results verified the code operation in calculating radioactive decay, soil concentrations, and total-body dose for the external-exposure pathway.

3.4.2 Sample Problem Two

The second sample problem is designed to exercise the external exposure plus inhalation scenario. For this sample problem, a licensee is assumed to dispose of 500 m^3 of waste onsite containing 0.1 Ci/m^3 of ^{60}Co and 0.01 Ci/m^3 of ^{90}Sr+D. The wastes are assumed to contaminate a 1 ha site. Default conditions for resuspension are assumed except that the intruder is assumed to be exposed for 3000 h/yr instead of 2000 h/yr. Sample Problem Two is to determine the doses to the intruder 10 years after the wastes are buried. The solution is found by running the ONSITE external exposure plus inhalation default scenario with the specified conditions and waste inventory. A summary of the ONSITE interactive session used to develop the runstream for Sample Problem Two is shown in Figure 3.4-3. The output resulting for this sample is shown in Figure 3.4-4. The maximum annual doses resulting for this sample problem are about 16 rem/yr to total body, 22 rem/yr to bone, 37 rem/yr to lung, 16 rem/yr to thyroid, and 16 rem/yr to GI (LLI).

```
##########################################################################
#                                                                        #
#                        ====================                            #
#                            ONSITE/MAXI                                 #
#                        ====================                            #
#                                                                        #
#          This interactive program will assist you in the creation      #
#          of scenarios for assessment of onsite disposal of low-        #
#          level waste.  Doses to man through the specified pathways     #
#          will be simulated by the computer program MAXI.               #
#                                                                        #
#          The following notes may be of interest:                       #
#          When you have finished reading, press <return> <cr>           #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#          1) If the default condition is selected, you need only        #
#          press <return>. YES-or-NO questions are designated by         #
#          (Y/N) and should be answered with a Y or N. The default       #
#          condition is always listed first.                             #
#                                                                        #
#          2) The values you enter will be tested against reasonable     #
#          limits and if they are not accepted you will be asked to      #
#          supply another value.                                         #
#                                                                        #
#          When you have finished reading, press <return> <cr>           #
#                                                                        #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#          The following scenarios have been defined:                    #
#                                                                        #
#          1 - External exposure                                         #
#          2 - External exposure plus inhalation from resuspension       #
#          3 - Agricultural activities                                   #
#          4 - Use of well water for irrigation and drinking water       #
#          5 - User-created scenario                                     #
#                                                                        #
#                                                                        #
#          To select a scenario or for additional information            #
#          on a scenario enter 1, 2, 3, 4, or 5: 1 <cr>                  #
#                                                                        #
##########################################################################
```

Figure 3.4-1. Sample Problem One Interactive Session

```
##########################################################################
#                                                                        #
#                                                                        #
#          SCENARIO 1:  External Exposure                                #
#                                                                        #
#          This scenario can be used alone or as part of Scenarios 2     #
#          and 3.  Occupational conditions of 2000 h/yr of external      #
#          exposure are assumed.  Waste may be located on the surface    #
#          buried at 0.5 m, buried at 1.0 m, or stored.                  #
#                                                                        #
#                                                                        #
#          Scenario 1 is now selected. Do you wish to change             #
#          this selection (N/Y): <cr>                                    #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#   Enter a descriptive title to identify this case:                     #
#                                                                        #
#   SAMPLE PROBLEM ONE                                                   #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#                                                                        #
#   This scenario begins    1 years after the waste is                   #
#   disposed.                                                            #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? Y <cr>                       #
#                                                                        #
#   Enter new value: 10 <cr>                                             #
#                                                                        #
#                                                                        #
#   This scenario will end   59 years after the waste is                 #
#   disposed. OK? (Y/N) <cr>                                             #
#                                                                        #
##########################################################################
```

Figure 3.4-1. Sample Problem One Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#   Three types of printer reports are available:                        #
#                                                                        #
#       0- Tables of maximum annual dose per organ with radionuclide and #
#           pathway contribution                                         #
#       1- Table above plus annual doses by organ and total              #
#       2- Table above plus annual doses by organ, pathway & radionuclide #
#                                                                        #
#   The current selection is: 0                                          #
#                                                                        #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#    In this scenario, wastes may be:                                    #
#                                                                        #
#                      1 -On surface                                     #
#                      2 -Buried at 0.5 m                                #
#                      3 -Buried at 1.0 m                                #
#                      4 -Stored waste                                   #
#                                                                        #
#   The current selection is: 2                                          #
#                                                                        #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#                                                                        #
#                                                                        #
#              ============================================             #
#                                                                        #
#             Do you wish to modify any parameter values for             #
#             Scenario 1 (N/Y) ? <cr>                                    #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################
```

Figure 3.4-1. Sample Problem One Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#   The size of the site in terms of fractional hectares                 #
#   (ie., 10000 sq m), is   1.00                                         #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
#                                                                        #
#   The inventory will automatically be adjusted by the                  #
#   appropriate area correction factor for each exposure                 #
#   pathway based on a  site size of   1.00     hectares.                #
#                                                                        #
#   ====================================================================#
#   Do you wish to review or change the above parameters  (N/Y) <cr>     #
##########################################################################

##########################################################################
#                                                                        #
#   The surface/buried inventory may be entered as:                      #
#                                                                        #
#                 1 - pCi                                                #
#                 2 - uCi                                                #
#                 3 - mCi                                                #
#                 4 -  Ci                                                #
#                                                                        #
#   The currect selection is: 1                                          #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? Y <cr>                       #
#   Enter new value: 4 <cr>                                              #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#   The contamination deposited on the site at start of                  #
#   calculation may be entered in the following units:                   #
#                                                                        #
#                 0 -  Ci /square meter                                  #
#                 1 -  Ci /cubic meter                                   #
#                 2 -  Ci /Kg of soil                                    #
#                                                                        #
#   The current selection is: 1                                          #
#                                                                        #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
##########################################################################
```

Figure 3.4-1. Sample Problem One Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#                                                                        #
#   The surface/buried inventory dilution factor is:   0.20              #
#   (range = 0.0 to 1.0E+20)                                             #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#                                                                        #
#   Do you wish to review or change any of the above parameters (N/Y) <cr> #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#   The following questions pertain to the radionuclide                  #
#   inventory.  After inputting the inventory, enter                     #
#   "99" for element name to signal to the program that                  #
#   you are finished.                                                    #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#                                                                        #
#   Press <return> when you have finished reading: <cr>                  #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#   Enter new 2-character element  (99=finished): CO <cr>                #
#                                                                        #
#   Atomic number input can be up to 6 characters long.                  #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#                                                                        #
#   Enter atomic number: 60 <cr>                                         #
#                                                                        #
#   Enter the quantity of CO60    buried at    the site at start of      #
#   calculation (units:  Ci /cubic meter    ) : .1 <cr>                  #
#                                                                        #
#   ==================================================================== #
#   Enter new 2-character element  (99=finished): 99 <cr>                #
#                                                                        #
##########################################################################
```

Figure 3.4-1. Sample Problem One Interactive Session (Continued)

```
################################################################################
#                                                                              #
#                       Surface/Buried                          Drinking       #
#                            Ci             Irrigation           Water         #
#            Radionuclide  /cubic meter       Ci /1              Ci /1         #
#            ------------  ----------     ----------        ----------         #
#             C060             0.10         0.00E+00          0.00E+00         #
#                                                                              #
#   ========================================================================== #
#   Do you wish to review or change the above   parameters (N/Y)? <cr>         #
#   Do you wish to add radionuclides to the above inventory? <cr>              #
################################################################################
```

(The above interactive session generates the following file.)

```
account-name,STMFZ,CM160000,EC400,T177.
ACCOUNT,account-name,problem-number,problem-number.
 ATTACH,TAPE20,FILE20,ID=ZZRNRC.
 ATTACH,TAPE21,FILE21,ID=ZZRNRC.
 ATTACH,TAPE24,FILE24,ID=ZZRNRC.
 ATTACH,TAPE25,FILE25,ID=ZZRNRC.
 ATTACH,TAPE22,PLANSOURC,ID=ZZRNRC.
 ATTACH,TAPE27,BURIEDHF,ID=ZZRNRC.
 ATTACH,TAPE10,RMDLIB,ID=ZZRNRC.
 ATTACH,TAPE23,FILE23,ID=ZZRNRC.
 ATTACH,ABS,MAXI1ABS,ID=ZZRNRC.
 COPY,ABS,LGO.
 RETURN,ABS.
 MAP,OFF.
 LDSET,PRESET=ZERO.
LGO.
{eor   }
  SAMPLE PROBLEM ONE
 $INPUT  NEXT=1,
   IFOD=0,IARG=0,IWAT=0,IEXT=1,
   ISUR=0, IAIR=0,
   RPF1=  0.        , RPF2=   1.00     ,
   RINH=  0.000000, DILF=  1.00     , XF2=  .200E+04,
   M3M2= 1, INTRUD=0, I22=0,
   IT1=  10, IT2=  59, NORG= 1, KORG(1)= 1,
   SRDIL=  .200     , FRSIZ=  1.00     , AREAIN=  1.00
   AREAEX=   1.00     ,
   IOUT= 0, ION=1, $END
    1    0
C060    11311  1.00E+11  0.         0.         0.
{eor   }
{eof   }
```

Figure 3.4-1. Sample Problem One Interactive Session (Continued)

```
MAXI - Maximum Annual Dose Calculation Version VAX2.2 25-APR-84
            Executed on  3-MAY-84  at 07:38:10  .
Case title:  SAMPLE PROBLEM ONE
------------------------------------------------------------------------------

RADIONUCLIDE CHAIN LIBRARY USED:      RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 6-APR-84  RAP
DOSE FACTOR FILES USED FOR THIS CASE:
        *27  ISOSHLD EXTERNAL: ONSITE/BIOPORT EXTERNAL DRFS (BURIED AT 0.5 M) 9-APR

DOSES CALCULATED FROM   10 TO   59 YEARS FOLLOWING TIME ZERO

PATHWAYS INITIALIZED FOR DOSE CALCULATIONS:
         FARM PRODUCT INGESTION:                 OFF
         INHALATION OF RESUSPENDED MATERIAL:OFF
         AQUATIC FOODS INGESTION:                OFF
         DRINKING WATER INGESTION:               OFF
         CONTINUING ATMOSPHERIC DEPOSITION      OFF
         EXTERNAL FROM BURIED WASTES             ON
         EXTERNAL FROM SURFACE DEPOSITS:         OFF

FARM PRODUCT PARAMETERS USED:
         FRACTION OF ROOTS IN UPPER SOIL:  0.10E+01
         FRACTION OF ROOTS IN BURIED WASTE 0.00E+00
         FRACTION OF TOTAL DIET GROWN ON SITE:  1.00E+00

SPECIAL PARAMETERS INITIALIZED:

     INVENTORY DILUTION FACTOR: 2.00E-01
     DECAY OF RIVER RELEASE SOURCE TERM NOT PERFORMED
     DECAY OF AIR RELEASE SOURCE TERM NOT PERFORMED
     SITE X/Q:  0.00E+00
     SPECIAL INHALATION MODEL NOT USED
     SIZE OF THE SITE:  1.00000 FRACTIONAL HECTARES
     INTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
     EXTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00

     IRRIGATION RATE:  0.00E+00L/M**2/MO
     MONTHS PER YEAR IRRIGATED:    6
     RIVER DILUTION FACTOR:  1.00E+00YR/L
     YEARS OF IRRIGATION WITH CONTAMINATED WATER PRIOR TO
          THE DOSE CALCULATIONS:    0

EXTERNAL EXPOSURE PARAMETERS USED:
         RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL TO SUBSURFACE SOIL  0.00E+00
         NUMBER OF HOURS OF EXPOSURE TO EXTERNAL  CONTAMINATION  2.00E+03
         SURFACE DEPOSITS DRFS FROM ISOSHLD; MODIFICATION FACTOR: 5.844E-11

ORGANS FOR WHICH DOSES ARE CALCULATED (SAME ORDER AS SOLUBILITIES GIVEN BELOW):

             TOTAL BODY

             INPUT PREPARED BY  R.A. Peloquin              DATE 25-MAY-84
                                =====================           =========

             INPUT CHECKED BY   W.E. Kennedy Jr.           DATE 5/25/84
                                =====================           =========
```

Figure 3.4-2. Sample Problem One Output

RELEASE TERMS NUCLIDE	ORGAN SOLUBILITY CLASSES					SOIL SOURCE (PCI/M**3)	IRRIGATATION/AQUATIC (PCI/L)	DRINKING WATER (PCI/L)	ATM. RELEASE (CI/YR)
CO 60	1	0	0	0	0	2.00E+10	0.00E+00	0.00E+00	0.00E+00

```
*******************PLEASE NOTE ANY SPECIAL CONSIDERATIONS IN THIS SPACE*******************
*                                                                                        *
*                                                                                        *
******************************************************************************************
```

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 10

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	0.00E+00	5.35E+09	0.00E+00	0.00E+00	0.00E+00

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 59

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	0.00E+00	8.38E+06	0.00E+00	0.00E+00	0.00E+00

SAMPLE PROBLEM ONE

MAXI, Version VAX2.2 25-APR-84 executed on 3-MAY-84 at 07:38:10

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FORTOTAL BODY

	EXPOSURE PATHWAY										
RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	0.00E+00	0	0.00E+00	0	3.96E-02	100	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	0.00E+00	0	3.96E-02	100	0.00E+00	0	0.00E+00	0	3.96E-02

Figure 3.4-2. Sample Problem One Output (Continued)

```
                    ====================
                        ONSITE/MAXI
                    ====================

        This interactive program will assist you in the creation
        of scenarios for assessment of onsite disposal of low-
        level waste.  Doses to man through the specified pathways
        will be simulated by the computer program MAXI.

        The following notes may be of interest:
        When you have finished reading, press <return> <cr>
```

```
        1) If the default condition is selected, you need only
        press <return>. YES-or-NO questions are designated by
        (Y/N) and should be answered with a Y or N. The default
        condition is always listed first.

        2) The values you enter will be tested against reasonable
        limits and if they are not accepted you will be asked to
        supply another value.

        When you have finished reading, press <return> <cr>
```

```
       The following scenarios have been defined:

        1 - External exposure
        2 - External exposure plus inhalation from resuspension
        3 - Agricultural activities
        4 - Use of well water for irrigation and drinking water
        5 - User-created scenario


        To select a scenario or for additional information
        on a scenario enter 1, 2, 3, 4, or 5: 2 <cr>
```

Figure 3.4-3. Sample Problem Two Interactive Session

```
SCENARIO 2:  External Exposure plus Inhalation from Resuspension

This scenario assumes surface contamination results over a
limited area. The scenario defaults to 2000 h/yr exposure
to surface contamination and inhalation.  The Anspaugh
resuspension model is used. User may define the fraction
of soil in the top 15 cm containing buried waste (defaults
to 0.2).

Scenario 2 is now selected. Do you wish to change
this selection (N/Y): <cr>
```

```
Enter a descriptive title to identify this case:

SAMPLE PROBLEM TWO <cr>
```

```
This scenario begins    1 years after the waste is
disposed.
----------------------------------------------------------------------
Do you wish to change this value (N/Y)? Y <cr>
Enter new value: 10 <cr>


This scenario will end   59 years after the waste is
disposed. OK? (Y/N) <cr>
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#   Three types of printer reports are available:                        #
#                                                                        #
#       0- Tables of maximum annual dose per organ with radionuclide and #
#           pathway contribution                                         #
#       1- Table above plus annual doses by organ and total              #
#       2- Table above plus annual doses by organ, pathway and radionuclide#
#                                                                        #
#   The current selection is: 0                                          #
#                                                                        #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#                                                                        #
#                ==========================================              #
#                Do you wish to modify any parameter values for          #
#                Scenario 2 (N/Y) ? Y <cr>                               #
#                                                                        #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#   Do you wish to review or change ext. exposure parameters (N/Y) Y <cr> #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#    Did you use MAXI2 to generate a special external exposure           #
#    dose rate factor file for this scenario?  (default=0)               #
#                                                                        #
#                0 - no                                                  #
#                1 - yes                                                 #
#                                                                        #
#                                                                        #
#   -------------------------------------------------------------------- #
#                                                                        #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
#                                                                        #
##########################################################################
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
################################################################################
#                                                                              #
#                                                                              #
#   The number of hours of exposure to external contamination                  #
#   per year is  2.000E+03   (range = 0.0 to 8766.)                            #
#                                                                              #
#                                                                              #
#   -------------------------------------------------------------------------  #
#                                                                              #
#   Do you wish to change this value (N/Y)?  Y <cr>                            #
#                                                                              #
#   Enter new value: 3000 <cr>                                                 #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   =========================================================================  #
#                                                                              #
#   Do you wish to review or change inhalation  parameters (N/Y)  Y <cr>       #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#   The number of hours of inhalation of contamination                         #
#   per year is  2.016E+03  (range = 0.0 to 8766.)                             #
#                                                                              #
#                                                                              #
#   -------------------------------------------------------------------------  #
#                                                                              #
#   Do you wish to change this value (N/Y)?  Y <cr>                            #
#                                                                              #
#   Enter new value:  3000 <cr>                                                #
#                                                                              #
#                                                                              #
################################################################################
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
####################################################################
#                                                                  #
#   Two resuspension models are available:                         #
#                                                                  #
#         1 - Anspaugh                                             #
#         2 - Mass Loading                                         #
#                                                                  #
#   The selected model is 1                                        #
#                                                                  #
#                                                                  #
#   -------------------------------------------------------------- #
#                                                                  #
#   Do you wish to change this value (N/Y)? <cr>                   #
#                                                                  #
####################################################################

####################################################################
#                                                                  #
#                                                                  #
#   The number of years that contamination existed                 #
#   on the surface at the start of the scenario  is                #
#   0.000E+00 years.   (range = 0.0 to 25.0)                       #
#                                                                  #
#                                                                  #
#   -------------------------------------------------------------- #
#                                                                  #
#   Do you wish to change this value (N/Y)? <cr>                   #
#                                                                  #
#                                                                  #
#                                                                  #
####################################################################

####################################################################
#                                                                  #
#                                                                  #
#   The top  1.0 cm. of the contaminated surface soil              #
#   layer is available for resuspension  (range = 0.0 to 15.0)     #
#                                                                  #
#                                                                  #
#   -------------------------------------------------------------- #
#                                                                  #
#   Do you wish to change this value (N/Y)? <cr>                   #
#                                                                  #
#                                                                  #
#                                                                  #
#                                                                  #
####################################################################
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#                                                                        #
#   Do you wish to review or change organ  parameters (N/Y) <cr>         #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#   The size of the site in terms of fractional hectares                 #
#   (ie., 10000 sq m), is   1.00     .                                   #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
#   The inventory will automatically be adjusted by the                  #
#   appropriate area correction factor for each exposure                 #
#   pathway based on a  site size of   1.00     hectares.                #
#                                                                        #
#   ==================================================================== #
#   Do you wish to review or change   the above      parameters (N/Y) <cr> #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#    The surface/buried inventory may be entered as:                     #
#                 1 - pCi                                                #
#                 2 - uCi                                                #
#                 3 - mCi                                                #
#                 4 -  Ci                                                #
#                                                                        #
#   The currect selection is: 1                                          #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? Y <cr>                       #
#                                                                        #
#   Enter new value: 4 <cr>                                              #
#                                                                        #
##########################################################################
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#   The contamination deposited on the site at start of                  #
#   calculation may be entered in the following units:                   #
#                                                                        #
#              0 -  Ci /square meter                                     #
#              1 -  Ci /cubic meter                                      #
#              2 -  Ci /Kg of soil                                       #
#                                                                        #
#   The current selection is: 1                                          #
#                                                                        #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#   The surface/buried inventory dilution factor is:   0.20              #
#   (range = 0.0 to 1.0E+20)                                             #
#                                                                        #
#   -------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                         #
#                                                                        #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#                                                                        #
#   Do you wish to review or change any of the above parameters (N/Y) <cr> #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#                                                                        #
#   Do you wish to review and/or change solubility classification        #
#   for each organ for each radionuclide.  The default assump-           #
#   tion is elements are insoluble for lung and soluble for all          #
#   other organs. (N/Y) <cr>                                             #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#                                                                        #
#   The following questions pertain to the radionuclide                 #
#   inventory.  After inputting the inventory, enter                    #
#   "99" for element name to signal to the program that                 #
#   you are finished.                                                    #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#                                                                        #
#   Press <return> when you have finished reading: <cr>                 #
#                                                                        #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#                                                                        #
#   ==================================================================== #
#   Enter new 2-character element  (99=finished): CO <cr>               #
#                                                                        #
#   Atomic number input can be up to 6 characters long.                 #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#                                                                        #
#   Enter atomic number: 60 <cr>                                         #
#                                                                        #
#   Enter the quantity of CO60    deposited on the site at start of     #
#   calculation (units:  Ci /cubic meter    ) : .1 <cr>                 #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#   Enter new 2-character element  (99=finished): SR <cr>               #
#                                                                        #
#   Atomic number input can be up to 6 characters long.                 #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#   Enter atomic number: 90+D <cr>                                       #
#                                                                        #
#   Enter the quantity of SR90+D  deposited on the site at start of     #
#   calculation (units:  Ci /cubic meter    ) : .01 <cr>                #
#                                                                        #
#   ==================================================================== #
#   Enter new 2-character element  (99=finished): 99 <cr>               #
#                                                                        #
##########################################################################
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
################################################################################
#                                                                              #
#                        Surface/Buried                        Drinking        #
#                              Ci             Irrigation         Water         #
#           Radionuclide  /cubic meter          Ci /1            Ci /1         #
#           ------------   ----------        ----------       ----------       #
#            CO60           0.10              0.00E+00          0.00E+00       #
#            SR90+D         1.00E-02          0.00E+00          0.00E+00       #
#                                                                              #
#   =========================================================================  #
#   Do you wish to review or change the above   parameters (N/Y) <cr>          #
#   Do you wish to add radionuclides to the above inventory? <cr>              #
################################################################################
```

(The above interactive session generates the following file.)

```
account-name,STMFZ,CM160000,EC400,T177.
ACCOUNT,account-name,problem-number,problem-number.
 ATTACH,TAPE20,FILE20,ID=ZZRNRC.
 ATTACH,TAPE21,FILE21,ID=ZZRNRC.
 ATTACH,TAPE24,FILE24,ID=ZZRNRC.
 ATTACH,TAPE25,FILE25,ID=ZZRNRC.
 ATTACH,TAPE22,PLANSOURC,ID=ZZRNRC.
 ATTACH,TAPE27,VOLSOURC,ID=ZZRNRC.
 ATTACH,TAPE10,RMDLIB,ID=ZZRNRC.
 ATTACH,TAPE23,FILE23,ID=ZZRNRC.
 ATTACH,ABS,MAXI1ABS,ID=ZZRNRC.
 COPY,ABS,LGO.
 RETURN,ABS.
 MAP,OFF.
 LDSET,PRESET=ZERO.
 LGO.
{eor   }
 SAMPLE PROBLEM TWO
 $INPUT  NEXT=1,
   IFOD=0,IARG=0,IWAT=0,IEXT=1,ISUR=0, IAIR=0, RPF1=  0., RPF2=1.00,
   AGE= 0., XDPT=.670E-01,RINH=.342231, DILF=1.00, XF2=.300E+04,
   M3M2= 1, INTRUD=0, I22=0,
   IT1=  10, IT2=  59, NORG= 5, KORG(1)= 1, 6, 8,16,23,
   SRDIL=  .200     , FRSIZ=  1.00     , AREAIN=  1.00     ,
   AREAEX=   1.00    ,    IOUT= 0, ION=1, $END
    2    0
CO60     11311  1.00E+11  0.        0.        0.
SR90+D   11311  1.00E+10  0.        0.        0.
{eor   }
{eof   }
```

Figure 3.4-3. Sample Problem Two Interactive Session (Continued)

```
                    MAXI - Maximum Annual Dose Calculation Version VAX2.2 25-APR-84
                                   Executed on  3-MAY-84  at 07:40:56  .
                    Case title:SAMPLE PROBLEM TWO
                   ------------------------------------------------------------------------------

RADIONUCLIDE CHAIN LIBRARY USED:      RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 6-APR-84  RAP
DOSE FACTOR FILES USED FOR THIS CASE:
          *23  DACRIN-INHALATION:     DOS: DOSE INCREMENT FILE ONSITE/BIOPORT ENV. 16-APR-84 RAP
          *27  ISOSHLD EXTERNAL: ONSITE/BIOPORT  VOLUME SOURCE SURFACE EXTERNAL DRFS

DOSES CALCULATED FROM    10 TO    59 YEARS FOLLOWING TIME ZERO

PATHWAYS INITIALIZED FOR DOSE CALCULATIONS:                      SPECIAL PARAMETERS INITIALIZED:
          FARM PRODUCT INGESTION:            OFF
          INHALATION OF RESUSPENDED MATERIAL:ON
          AQUATIC FOODS INGESTION:           OFF                      INVENTORY DILUTION FACTOR: 2.00E-01
          DRINKING WATER INGESTION:          OFF                      DECAY OF RIVER RELEASE SOURCE TERM NOT PERFORMED
          CONTINUING ATMOSPHERIC DEPOSITION  OFF                      DECAY OF AIR RELEASE SOURCE TERM NOT PERFORMED
          EXTERNAL FROM BURIED WASTES        ON                       SITE X/Q:  0.00E+00
          EXTERNAL FROM SURFACE DEPOSITS:    OFF                      SPECIAL INHALATION MODEL NOT USED
                                                                      SIZE OF THE SITE:  1.00000 FRACTIONAL HECTARES
                                                                      INTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
                                                                      EXTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
FARM PRODUCT PARAMETERS USED:
          FRACTION OF ROOTS IN UPPER SOIL:  0.10E+01                  IRRIGATION RATE:  0.00E+00L/M**2/MO
          FRACTION OF ROOTS IN BURIED WASTE 0.00E+00                  MONTHS PER YEAR IRRIGATED:    6
          FRACTION OF TOTAL DIET GROWN ON SITE:  1.00E+00             RIVER DILUTION FACTOR:  1.00E+00YR/L
                                                                      YEARS OF IRRIGATION WITH CONTAMINATED WATER PRIOR TO
                                                                      THE DOSE CALCULATIONS:    0
EXTERNAL EXPOSURE PARAMETERS USED:
          RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL TO SUBSURFACE SOIL  1.00E+00
          NUMBER OF HOURS OF EXPOSURE TO EXTERNAL  CONTAMINATION  3.00E+03
          SURFACE DEPOSITS DRFS FROM ISOSHLD; MODIFICATION FACTOR: 5.844E-11

INHALATION PARAMETERS USED:
          MODIFICATION FACTOR , RINH:  3.42E-01
               (EQUIVALENT TO BREATHING RATE OF 230 CC/SEC FOR  3000. HR/YR)
          RESUSPENSION MODEL USED FOR CALCULATING AIR CONCENTRATION: ANSPAUGH
          AVERAGE AGE OF MATERIAL ON GROUND AT TIME ZERO:  0.00E+00 YEARS
          TOP  1.0 CM OF THE CONTAMINATED SURFACE LAYER IS AVAILABLE FOR RESUSPENSION.

ORGANS FOR WHICH DOSES ARE CALCULATED (SAME ORDER AS SOLUBILITIES GIVEN BELOW):

               TOTAL BODY          BONE                LUNGS               THYROID             GI-LLI
```

Figure 3.4-4. Sample Problem Two Output

INPUT PREPARED BY R.A. Peloquin DATE 25 MAY 84

INPUT CHECKED BY W.E. Kennedy, Jr. DATE 5/25/84

RELEASE TERMS NUCLIDE	ORGAN SOLUBILITY CLASSES	SOIL SOURCE (PCI/M**3)	IRRIGATATION/AQUATIC (PCI/L)	DRINKING WATER (PCI/L)	ATM. RELEASE (CI/YR)
CO 60	1 1 3 1 1	2.00E+10	0.00E+00	0.00E+00	0.00E+00
SR 90+D	1 1 3 1 1	2.00E+09	0.00E+00	0.00E+00	0.00E+00

SOIL, AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 10

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	8.03E+08	5.35E+09	5.38E+03	0.00E+00	0.00E+00
SR 90+D	2.35E+08	1.57E+09	1.58E+03	0.00E+00	0.00E+00

SOIL, AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 59

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	1.26E+06	8.38E+06	8.42E-05	0.00E+00	0.00E+00
SR 90+D	7.14E+07	4.76E+08	4.78E-03	0.00E+00	0.00E+00

SAMPLE PROBLEM TWO

MAXI, Version VAX2.2 25-APR-84 executed on 3-MAY-84 at 07:40:56

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FORTOTAL BODY

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	9.57E-02	25	1.61E+01	99	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	2.87E-01	74	9.88E-03	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	3.83E-01	2	1.61E+01	97	0.00E+00	0	0.00E+00	0	1.64E+01

Figure 3.4-4. Sample Problem Two Output (Continued)

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 11 FOR BONE

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	0.00E+00	0	1.41E+01	99	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	8.33E+00	100	9.64E-03	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	8.33E+00	37	1.41E+01	62	0.00E+00	0	0.00E+00	0	2.24E+01

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 11 FOR LUNGS

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	1.43E+01	62	1.41E+01	99	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	8.41E+00	37	9.64E-03	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	2.27E+01	61	1.41E+01	38	0.00E+00	0	0.00E+00	0	3.68E+01

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FOR THYROID

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	0.00E+00	0	1.61E+01	99	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	0.00E+00	0	9.88E-03	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	0.00E+00	0	1.61E+01	100	0.00E+00	0	0.00E+00	0	1.61E+01

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FOR LLI

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	8.65E-02	65	1.61E+01	99	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	4.48E-02	34	9.88E-03	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	1.31E-01	0	1.61E+01	99	0.00E+00	0	0.00E+00	0	1.62E+01

Figure 3.4-4. Sample Problem Two Output (Continued)

3.4.3 Sample Problem Three

The third sample is designed to exercise the agricultural exposure scenario. For this problem, a licensee is assumed to dispose of 50 m^3 of waste containing 0.1 Ci/m^3 of both ^{60}Co and $^{137}Cs+D$, and 0.01 Ci/m^3 of $^{90}Sr+D$. Default conditions are assumed except that only 0.05 ha is assumed to be contaminated by the disposal of wastes. Sample Problem Three is to determine the doses to the intruder 10 years after the wastes are buried. The solution is found by running the ONSITE agricultural scenario with the specified conditions and waste inventory. A summary of the ONSITE interactive session used to develop the runstream for Sample Problem Three is shown in Figure 3.4-5. The output resulting for this sample problem is shown in Figure 3.4-6. The maximum annual doses resulting for this sample problem are about 22 rem/yr to total body, 56 rem/yr to bone, 20 rem/yr to lungs, 13 rem/yr to thyroid, and 17 rem/yr to GI(LLI). Doses to total body, and bone are controlled by ingestion of farm crops, while the doses to lungs, thyroid, and GI(LLI) are controlled by external exposure. Hand calculations verified the code operation in calculating radioactive decay, soil concentrations, air concentrations, external dose, inhalation dose, and ingestion dose from consumption of garden crops.

3.4.4 Sample Problem Four

The fourth sample problem is designed to exercise the irrigation/drinking-water scenario. For this problem, a licensee is assumed to dispose of wastes that result in ^{60}C, ^{129}I, $^{90}Sr+D$, and $^{238}U+D$ in an offsite well. The water concentrations are 10 pCi/L of each radionuclide. In addition, an offsite river-water concentration of 0.1 pCi/L of each of these radionuclides is assumed. The individual is assumed to use the well water for drinking and the river water for irrigation. The sample problem is to determine the doses that result to this individual from using these contaminated water sources. The solution is found by running the ONSITE irrigation/drinking-water scenario with the specified conditions and source terms. A summary of the ONSITE interactive session used to develop the runstream for Sample Problem Four is shown in Figure 3.4-7. The output resulting for this sample problem is shown in Figure 3.4-8. The maximum annual doses resulting for Sample Problem Four are about 0.0016 rem/yr to total body, 0.0077 rem/yr to bone 8.0×10^{-6} rem/yr to lungs, 0.028 rem/yr to thyroid, and 3.5×10^{-4} rem/yr to GI(LII). Hand calculations verified the code operation for all of the decay, radionuclide concentrations and dose estimates for all of the exposure pathways considered.

```
##############################################################################
#                                                                            #
#                           ====================                             #
#                               ONSITE/MAXI                                  #
#                           ====================                             #
#                                                                            #
#           This interactive program will assist you in the creation         #
#           of scenarios for assessment of onsite disposal of low-           #
#           level waste.  Doses to man through the specified pathways        #
#           will be simulated by the computer program MAXI.                  #
#                                                                            #
#           The following notes may be of interest:                          #
#           When you have finished reading, press <return> <cr>              #
#                                                                            #
##############################################################################
```

```
##############################################################################
#                                                                            #
#           1) If the default condition is selected, you need only           #
#           press <return>. YES-or-NO questions are designated by            #
#           (Y/N) and should be answered with a Y or N. The default          #
#           condition is always listed first.                                #
#                                                                            #
#           2) The values you enter will be tested against reasonable        #
#           limits and if they are not accepted you will be asked to         #
#           supply another value.                                            #
#                                                                            #
#           When you have finished reading, press <return> <cr>              #
#                                                                            #
#                                                                            #
##############################################################################
```

```
##############################################################################
#                                                                            #
#          The following scenarios have been defined:                        #
#                                                                            #
#           1 - External exposure                                            #
#           2 - External exposure plus inhalation from resuspension          #
#           3 - Agricultural activities                                      #
#           4 - Use of well water for irrigation and drinking water          #
#           5 - User-created scenario                                        #
#                                                                            #
#                                                                            #
#           To select a scenario or for additional information               #
#           on a scenario enter 1, 2, 3, 4, or 5: 3 <cr>                     #
#                                                                            #
##############################################################################
```

Figure 3.4-5. Sample Problem Three Interactive Session

```
SCENARIO 3: Agricultural Activities
This scenario assumes surface contamination (as in Scenario
2) with farming; defaults to 2000 h/yr exposure to surface
contamination and inhalation.  Anspaugh resuspension model
is used.  Scenario defaults to total diet of fruits, veg-
atables, and animal products grown on the site.  The user
may specify the percentage of soil containing waste in the
top 15 cm.

Scenario 3 is now selected. Do you wish to change
this selection (N/Y): <cr>
```

```
Enter a descriptive title for this case:
SAMPLE PROBLEM THREE <cr>
```

```
This scenario begins    1 years after the waste is
disposed.
----------------------------------------------------------------------
Do you wish to change this value (N/Y)? Y <cr>
Enter new value: 10 <cr>


This scenario will end   59 years after the waste is
disposed. OK? (Y/N) <cr>
```

Figure 3.4-5. Sample Problem Three Interactive Session (Continued)

```
###############################################################################
#                                                                             #
#   Three types of printer reports are available:                             #
#                                                                             #
#       0- Tables of maximum annual dose per organ with radionuclide and     #
#            pathway contribution                                             #
#       1- Table above plus annual doses by organ and total                  #
#       2- Table above plus annual doses by organ, pathway and radionuclide#
#                                                                             #
#                                                                             #
#   The current selection is: 0                                               #
#   ----------------------------------------------------------------         #
#   Do you wish to change this value (N/Y)? <cr>                              #
#                                                                             #
###############################################################################

###############################################################################
#                                                                             #
#                                                                             #
#                                                                             #
#                  ==============================================             #
#                                                                             #
#                 Do you wish to modify any parameter values for             #
#                 Scenario 3 (N/Y) ? <cr>                                     #
#                                                                             #
#                                                                             #
#                                                                             #
#                                                                             #
#                                                                             #
#                                                                             #
###############################################################################

###############################################################################
#                                                                             #
#   The size of the site in terms of fractional hectares                     #
#   (ie., 10000 sq m), is   1.00                                              #
#   ------------------------------------------------------------------------ #
#                                                                             #
#   Do you wish to change this value?                                         #
#   Enter new value: .05 <cr>                                                 #
#                                                                             #
#   The inventory will automatically be adjusted by the                      #
#   appropriate area correction factor for each exposure                     #
#   pathway based on a  site size of  5.000E-02 hectares.                     #
#   ======================================================================== #
#   Do you wish to review or change   the above parameters (N/Y) <cr>        #
###############################################################################
```

Figure 3.4-5. Sample Problem Three Interactive Session (Continued)

```
################################################################################
#                                                                              #
#   The surface/buried inventory may be entered as:                            #
#                                                                              #
#                 1 - pCi                                                      #
#                 2 - uCi                                                      #
#                 3 - mCi                                                      #
#                 4 -  Ci                                                      #
#                                                                              #
#   The currect selection is: 1                                                #
#   ------------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)?  Y <cr>                            #
#   Enter new value: 4 <cr>                                                    #
#                                                                              #
################################################################################
```

```
################################################################################
#                                                                              #
#   The contamination deposited on the site at start of                        #
#   calculation may be entered in the following units:                         #
#                                                                              #
#                 0 -  Ci /square meter                                        #
#                 1 -  Ci /cubic meter                                         #
#                 2 -  Ci /Kg of soil                                          #
#                                                                              #
#   The current selection is: 1                                                #
#                                                                              #
#   ------------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                               #
#                                                                              #
################################################################################
```

```
################################################################################
#                                                                              #
#   The surface/buried inventory dilution factor is:    0.20                   #
#   (range = 0.0 to 1.0E+20)                                                   #
#                                                                              #
#   ------------------------------------------------------------------------- #
#                                                                              #
#   Do you wish to change this value (N/Y)? <cr>                               #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################
```

Figure 3.4-5. Sample Problem Three Interactive Session (Continued)

```
===========================================================================
Do you wish to review or change any of the above parameters (N/Y) <cr>



Do you wish to review and/or change solubility classification
for each organ for each radionuclide.  The default assump-
tion is elements are insoluble for lung and soluble for all
other organs. (N/Y) <cr>
```

```
The following questions pertain to the radionuclide
inventory.  After inputting the inventory, enter
"99" for element name to signal to the program that
you are finished.


===========================================================================

Press <return> when you have finished reading: <cr>
```

```
===========================================================================

Enter new 2-character element  (99=finished): CO <cr>

Atomic number input can be up to 6 characters long.
Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)

Enter atomic number: 60 <cr>


Enter the quantity of CO60    deposited on the site at start of
calculation (units:  Ci /cubic meter    ) : .1 <cr>
```

Figure 3.4-5. Sample Problem Three Interactive Session (Continued)

```
################################################################################
#    =========================================================================#
#                                                                              #
#   Enter new 2-character element  (99=finished): SR <cr>                      #
#                                                                              #
#   Atomic number input can be up to 6 characters long.                        #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)     #
#                                                                              #
#   Enter atomic number: 90+D <cr>                                             #
#                                                                              #
#   Enter the quantity of SR90+D  deposited on the site at start of            #
#   calculation (units:  Ci /cubic meter    ) : .01 <cr>                       #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#   Enter new 2-character element  (99=finished): CS <cr>                      #
#                                                                              #
#   Atomic number input can be up to 6 characters long.                        #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)     #
#   Enter atomic number: 137+D <cr>                                            #
#                                                                              #
#   Enter the quantity of CS137+D deposited on the site at start of            #
#   calculation (units:  Ci /cubic meter    ) : .1 <cr>                        #
#                                                                              #
#   ========================================================================= #
#   Enter new 2-character element  (99=finished): 99 <cr>                      #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                        Surface/Buried                          Drinking      #
#                              Ci             Irrigation           Water       #
#              Radionuclide  /cubic meter        Ci /1             Ci /1       #
#              ------------  ----------     ----------        ----------       #
#               CO60           0.10          0.00E+00          0.00E+00        #
#               SR90+D         1.00E-02      0.00E+00          0.00E+00        #
#               CS137+D        0.10          0.00E+00          0.00E+00        #
#                                                                              #
#   ========================================================================= #
#   Do you wish to review or change the above   parameters (N/Y) <cr>          #
#   Do you wish to add radionuclides to the above inventory? <cr>              #
#                                                                              #
################################################################################
```

Figure 3.4-5. Sample Problem Three Interactive Session (Continued)

(This interactive session generates the following file.)

```
account-name,STMFZ,CM160000,EC400,T177.
ACCOUNT,account-name,problem-number,problem-number.
 ATTACH,TAPE20,FILE20,ID=ZZRNRC.
 ATTACH,TAPE21,FILE21,ID=ZZRNRC.
 ATTACH,TAPE24,FILE24,ID=ZZRNRC.
 ATTACH,TAPE25,FILE25,ID=ZZRNRC.
 ATTACH,TAPE22,PLANSOURC,ID=ZZRNRC.
 ATTACH,TAPE27,VOLSOURC,ID=ZZRNRC.
 ATTACH,TAPE10,RMDLIB,ID=ZZRNRC.
 ATTACH,TAPE23,FILE23,ID=ZZRNRC.
 ATTACH,ABS,MAXI1ABS,ID=ZZRNRC.
 COPY,ABS,LGO.
 RETURN,ABS.
 MAP,OFF.
 LDSET,PRESET=ZERO.
 LGO.
{eor   }
 SAMPLE PROBLEM THREE
 $INPUT  NEXT=1,
   IFOD=1,IARG=0,IWAT=0,IEXT=0,
   ISUR=1, IAIR=0,
   RIRR=  150.     , IMO=6, RF1=  1.00     , RF2= 0.
   RPF1=   1.00     , RPF2=   1.00     ,
   AGE= 0.          , XDPT=  .670E-01,
   RINH=    .250000, DILF=  1.00     , XF2=  .200E+04,
   M3M2= 1, INTRUD=0, I22=0,
   IT1=  10, IT2=  59, NORG= 5, KORG(1)= 1, 6, 8,16,23,
   SRDIL=  .200     , FRSIZ=  .500E-01, AREAIN=  .500     ,
   AREAEX=    .805     ,
   IOUT= 0, ION=1, $END
    3    0
CO60    11311  1.00E+11  0.         0.         0.
SR90+D  11311  1.00E+10  0.         0.         0.
CS137+D 11111  1.00E+11  0.         0.         0.
{eor   }
{eof   }
```

Figure 3.4-5. Sample Problem Three Interactive Session (Continued)

```
                    MAXI - Maximum Annual Dose Calculation Version VAX2.2 25-APR-84
                                   Executed on  3-MAY-84  at 08:07:59  .
                    Case title:SAMPLE PROBLEM THREE
                    ---------------------------------------------------------------------------------

RADIONUCLIDE CHAIN LIBRARY USED:      RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 6-APR-84  RAP
DOSE FACTOR FILES USED FOR THIS CASE:
         *20  FOOD-LEAF:              Leaf Incremental Dose Factors for the ONSITE/BIOPORT
         *21  FOOD-SOIL:              Soil Incremental Dose Factors for the ONSITE/BIOPORT
         *22  SHALLOW EXTERNAL:       ONSITE/BIOPORT EXTERNAL DRFS FOR SURFACE (PLANE SOUR
         *23  DACRIN-INHALATION:      DOS) DOSE INCREMENT FILE ONSITE/BIOPORT ENV. 16-APR-84 RAP

DOSES CALCULATED FROM   10 TO   59 YEARS FOLLOWING TIME ZERO

PATHWAYS INITIALIZED FOR DOSE CALCULATIONS:                 SPECIAL PARAMETERS INITIALIZED:
         FARM PRODUCT INGESTION:              ON
         INHALATION OF RESUSPENDED MATERIAL:ON
         AQUATIC FOODS INGESTION:             OFF          INVENTORY DILUTION FACTOR: 2.00E-01
         DRINKING WATER INGESTION:            OFF          DECAY OF RIVER RELEASE SOURCE TERM NOT PERFORMED
         CONTINUING ATMOSPHERIC DEPOSITION    OFF          DECAY OF AIR RELEASE SOURCE TERM NOT PERFORMED
         EXTERNAL FROM BURIED WASTES          OFF          SITE X/Q:  0.00E+00
         EXTERNAL FROM SURFACE DEPOSITS:      ON           SPECIAL INHALATION MODEL NOT USED
                                                           SIZE OF THE SITE:  0.05000 FRACTIONAL HECTARES
                                                           INTERNAL PATHWAY AREA CORRECTION FACTOR: 5.00E-01
                                                           EXTERNAL PATHWAY AREA CORRECTION FACTOR: 8.05E-01
FARM PRODUCT PARAMETERS USED:
         FRACTION OF ROOTS IN UPPER SOIL:  0.10E+01        IRRIGATION RATE:  1.50E+02L/M**2/MO
         FRACTION OF ROOTS IN BURIED WASTE 0.00E+00        MONTHS PER YEAR IRRIGATED:    6
         FRACTION OF TOTAL DIET GROWN ON SITE:  1.00E+00   RIVER DILUTION FACTOR:  1.00E+00YR/L
                                                           YEARS OF IRRIGATION WITH CONTAMINATED WATER PRIOR TO
                                                               THE DOSE CALCULATIONS:    0
EXTERNAL EXPOSURE PARAMETERS USED:
         RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL TO SUBSURFACE SOIL  1.00E+00
         NUMBER OF HOURS OF EXPOSURE TO EXTERNAL  CONTAMINATION  2.00E+03
         SURFACE DEPOSITS DRFS FROM ISOSHLD; MODIFICATION FACTOR: 5.844E-11

INHALATION PARAMETERS USED:
         MODIFICATION FACTOR , RINH:  2.30E-01
              (EQUIVALENT TO BREATHING RATE OF 230 CC/SEC FOR  2016. HR/YR)
         RESUSPENSION MODEL USED FOR CALCULATING AIR CONCENTRATION: ANSPAUGH
         AVERAGE AGE OF MATERIAL ON GROUND AT TIME ZERO:  0.00E+00 YEARS
         TOP  1.0 CM OF THE CONTAMINATED SURFACE LAYER IS AVAILABLE FOR RESUSPENSION.

ORGANS FOR WHICH DOSES ARE CALCULATED (SAME ORDER AS SOLUBILITIES GIVEN BELOW):

              TOTAL BODY          BONE              LUNGS              THYROID            GI-LLI
```

Figure 3.4-6. Sample Problem Three Output

INPUT PREPARED BY R.A. Peloquin DATE 25-MAY-84

INPUT CHECKED BY W. E. Kennedy, Jr. DATE 5/25/84

RELEASE TERMS NUCLIDE	ORGAN SOLUBILITY CLASSES	SOIL SOURCE (PCI/M**3)	IRRIGATATION/AQUATIC (PCI/L)	DRINKING WATER (PCI/L)	ATM. RELEASE (CI/YR)
CO 60	1 1 3 1 1	2.00E+10	0.00E+00	0.00E+00	0.00E+00
SR 90+D	1 1 3 1 1	2.00E+09	0.00E+00	0.00E+00	0.00E+00
CS 137+D	1 1 1 1 1	2.00E+10	0.00E+00	0.00E+00	0.00E+00

```
********************PLEASE NOTE ANY SPECIAL CONSIDERATIONS IN THIS SPACE********************
*                                                                                           *
*                                                                                           *
*                                                                                           *
*********************************************************************************************
```

SOIL, AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 10

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	8.03E+08	0.00E+00	5.38E+03	0.00E+00	0.00E+00
SR 90+D	2.35E+08	0.00E+00	1.58E+03	0.00E+00	0.00E+00
CS 137+D	2.38E+09	0.00E+00	1.60E+04	0.00E+00	0.00E+00

SOIL, AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 59

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	1.26E+06	0.00E+00	8.42E-05	0.00E+00	0.00E+00
SR 90+D	7.14E+07	0.00E+00	4.78E-03	0.00E+00	0.00E+00
CS 137+D	7.72E+08	0.00E+00	5.17E-02	0.00E+00	0.00E+00

Figure 3.4-6. Sample Problem Three Output (Continued)

SAMPLE PROBLEM THREE

MAXI, Version VAX2.2 25-APR-84 executed on 3-MAY-84 at 08:07:59 .

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FORTOTAL BODY

EXPOSURE PATHWAY

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%
CO60	1.14E-01	1	3.22E-02	6	7.41E+00	57	0.00E+00	0	0.00E+00	0
SR90+D	1.26E+00	14	9.64E-02	20	4.80E-03	0	0.00E+00	0	0.00E+00	0
CS137+D	7.34E+00	84	3.42E-01	72	5.37E+00	42	0.00E+00	0	0.00E+00	0

TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	8.72E+00	39	4.70E-01	2	1.28E+01	58	0.00E+00	0	0.00E+00	0	2.20E+01

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 27 FOR BONE

EXPOSURE PATHWAY

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%
CO60	0.00E+00	0	0.00E+00	0	7.88E-01	17	0.00E+00	0	0.00E+00	0
SR90+D	5.04E+01	99	7.36E-01	99	3.17E-03	0	0.00E+00	0	0.00E+00	0
CS137+D	1.95E-01	0	8.37E-06	0	3.63E+00	82	0.00E+00	0	0.00E+00	0

TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	5.06E+01	90	7.36E-01	1	4.42E+00	7	0.00E+00	0	0.00E+00	0	5.58E+01

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 11 FOR LUNGS

EXPOSURE PATHWAY

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%
CO60	0.00E+00	0	4.81E+00	62	6.49E+00	55	0.00E+00	0	0.00E+00	0
SR90+D	0.00E+00	0	2.82E+00	36	4.68E-03	0	0.00E+00	0	0.00E+00	0
CS137+D	9.19E-01	100	4.46E-02	0	5.25E+00	44	0.00E+00	0	0.00E+00	0

TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	9.19E-01	4	7.68E+00	37	1.17E+01	57	0.00E+00	0	0.00E+00	0	2.03E+01

Figure 3.4-6. Sample Problem Three Output (Continued)

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FOR THYROID

	EXPOSURE PATHWAY										
RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	0.00E+00	0	0.00E+00	0	7.41E+00	57	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	0.00E+00	0	4.80E-03	0	0.00E+00	0	0.00E+00	0	
CS137+D	0.00E+00	0	0.00E+00	0	5.37E+00	42	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	0.00E+00	0	1.28E+01	100	0.00E+00	0	0.00E+00	0	1.28E+01

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FOR LLI

	EXPOSURE PATHWAY										
RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	1.12E+00	30	2.91E-02	59	7.41E+00	57	0.00E+00	0	0.00E+00	0	
SR90+D	2.21E+00	59	1.50E-02	30	4.80E-03	0	0.00E+00	0	0.00E+00	0	
CS137+D	4.02E-01	10	4.61E-03	9	5.37E+00	42	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	3.74E+00	22	4.87E-02	0	1.28E+01	77	0.00E+00	0	0.00E+00	0	1.66E+01

Figure 3.4-6. Sample Problem Three Output (Continued)

```
################################################################################
#                                                                              #
#                              ===================                             #
#                                  ONSITE/MAXI                                 #
#                              ===================                             #
#                                                                              #
#          This interactive program will assist you in the creation            #
#          of scenarios for assessment of onsite disposal of low-              #
#          level waste.  Doses to man through the specified pathways           #
#          will be simulated by the computer program MAXI.                     #
#                                                                              #
#          The following notes may be of interest:                             #
#          When you have finished reading, press <return>. <cr>                #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#          1) If the default condition is selected, you need only              #
#          press <return>. YES-or-NO questions are designated by               #
#          (Y/N) and should be answered with a Y or N. The default             #
#          condition is always listed first.                                   #
#                                                                              #
#          2) The values you enter will be tested against reasonable           #
#          limits and if they are not accepted you will be asked to            #
#          supply another value.                                               #
#                                                                              #
#          When you have finished reading, press <return> <cr>                 #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#          The following scenarios have been defined:                          #
#                                                                              #
#          1 - External exposure                                               #
#          2 - External exposure plus inhalation from resuspension             #
#          3 - Agricultural activities                                         #
#          4 - Use of well water for irrigation and drinking water             #
#          5 - User-created scenario                                           #
#                                                                              #
#                                                                              #
#          To select a scenario or for additional information                  #
#          on a scenario enter 1, 2, 3, 4, or 5: 4 <cr>                        #
#                                                                              #
################################################################################
```

Figure 3.4-7. Sample Problem Four Interactive Session

```
################################################################################
#                                                                              #
#         SCENARIO 4:  Irrigation and Drinking Water                           #
#                                                                              #
#         This scenario accounts for the use of well or river water            #
#         for irrigation and drinking.  Assumes an irrigation rate             #
#         of 150 l/sq m/mo for 6 months. Defaults to Anspaugh model            #
#         for inhalation. Assumes total diet and 1.2 liters/day of             #
#         drinking water.                                                      #
#                                                                              #
#                                                                              #
#         Scenario 4 is now selected. Do you wish to change                    #
#         this selection (N/Y): <cr>                                           #
#                                                                              #
################################################################################
```

```
################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   Enter a descriptive title to identify this case:                           #
#   SAMPLE PROBLEM FOUR <cr>                                                   #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################
```

```
################################################################################
#                                                                              #
#   This scenario begins    1 years after the waste is                         #
#   disposed.                                                                  #
#   -------------------------------------------------------------------------  #
#                                                                              #
#   Do you wish to change this value (N/Y)? Y <cr>                             #
#   Enter new value: 10 <cr>                                                   #
#                                                                              #
#                                                                              #
#   This scenario will end   59 years after the waste is                       #
#   disposed. OK? (Y/N) <cr>                                                   #
#                                                                              #
#                                                                              #
################################################################################
```

Figure 3.4-7. Sample Problem Four Interactive Session (Continued)

```
################################################################################
#                                                                              #
#   Three types of printer reports are available:                              #
#                                                                              #
#       0- Tables of maximum annual dose per organ with radionuclide and       #
#           pathway contribution                                               #
#       1- Table above plus annual doses by organ and total                    #
#       2- Table above plus annual doses by organ, pathway and radionuclide#
#                                                                              #
#   The current selection is: 0                                                #
#                                                                              #
#   -------------------------------------------------------------------------- #
#   Do you wish to change this value (N/Y)? <cr>                               #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                  ==============================================              #
#                                                                              #
#                 Do you wish to modify any parameter values for               #
#                 Scenario 4 (N/Y) ? <cr>                                      #
#                                                                              #
#                                                                              #
#                                                                              #
#   ========================================================================== #
#                                                                              #
#   Do you wish to review or change any of the above parameters (N/Y) <cr> #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   Do you wish to review and/or change solubility classification              #
#   for each organ for each radionuclide.  The default assump-                 #
#   tion is elements are insoluble for lung and soluble for all                #
#   other organs. (N/Y) <cr>                                                   #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################
```

Figure 3.4-7. Sample Problem Four Interactive Session (Continued)

```
###############################################################################
#                                                                             #
#                                                                             #
#   The following questions pertain to the radionuclide                       #
#   inventory.  After inputting the inventory, enter                          #
#   "99" for element name to signal to the program that                       #
#   you are finished.                                                         #
#                                                                             #
#                                                                             #
#   ========================================================================= #
#                                                                             #
#   Press <return> when you have finished reading: <cr>                       #
#                                                                             #
#                                                                             #
###############################################################################

###############################################################################
#    Enter new 2-character element  (99=finished): CO <cr>                    #
#                                                                             #
#   Atomic number input can be up to 6 characters long.                       #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)    #
#   Enter atomic number: 60 <cr>                                              #
#                                                                             #
#    To consider only irrigation or only drinking water contamination,        #
#   enter zero quantity for the  other pathway.                               #
#                                                                             #
#   Enter the concentration of CO60     in the irrigation water at start of#
#   calculation (units: pCi/liter): .1 <cr>                                   #
#   Enter the concentration of CO60     in the drinking water at start of     #
#   calculation (units: pCi/liter):  10 <cr>                                  #
###############################################################################

###############################################################################
#    Enter new 2-character element  (99=finished): SR <cr>                    #
#                                                                             #
#   Atomic number input can be up to 6 characters long.                       #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)    #
#   Enter atomic number: 90+D <cr>                                            #
#                                                                             #
#    To consider only irrigation or only drinking water contamination,        #
#   enter zero quantity for the  other pathway.                               #
#                                                                             #
#   Enter the concentration of SR90+D   in the irrigation water at start of#
#   calculation (units: pCi/liter): .1 <cr>                                   #
#   Enter the concentration of SR90+D   in the drinking water at start of     #
#   calculation (units: pCi/liter): 10 <cr>                                   #
###############################################################################
```

Figure 3.4-7. Sample Problem Four Interactive Session (Continued)

```
##########################################################################
#    Enter new 2-character element  (99=finished): I <cr>               #
#                                                                        #
#   Atomic number input can be up to 6 characters long.                  #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#   Enter atomic number: 129 <cr>                                        #
#                                                                        #
#    To consider only irrigation or only drinking water contamination,   #
#   enter zero quantity for the  other pathway.                          #
#                                                                        #
#   Enter the concentration of I 129    in the irrigation water at start of#
#   calculation (units: pCi/liter):  .1 <cr>                             #
#   Enter the concentration of I 129    in the drinking water at start of  #
#   calculation (units: pCi/liter):  10 <cr>                             #
##########################################################################

##########################################################################
#    Enter new 2-character element  (99=finished): U <cr>                #
#                                                                        #
#   Atomic number input can be up to 6 characters long.                  #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#   Enter atomic number: 238+D <cr>                                      #
#                                                                        #
#    To consider only irrigation or only drinking water contamination,   #
#   enter zero quantity for the  other pathway.                          #
#                                                                        #
#   Enter the concentration of U 238+D  in the irrigation water at start of#
#   calculation (units: pCi/liter): .1 <cr>                              #
#   Enter the concentration of U 238+D  in the drinking water at start of  #
#   calculation (units: pCi/liter):  10 <cr>                             #
##########################################################################

##########################################################################
#   Enter new 2-character element  (99=finished): 99 <cr>                #
#                                                                        #
#                     Surface/Buried                      Drinking       #
#                          pCi          Irrigation          Water        #
#          Radionuclide  /cubic meter     pCi /1           pCi /1        #
#          ------------   ----------    ----------      ----------       #
#           CO60           0.00E+00      0.10             10.            #
#           SR90+D         0.00E+00      0.10             10.            #
#           I 129          0.00E+00      0.10             10.            #
#           U 238+D        0.00E+00      0.10             10.            #
#   ==================================================================== #
#   Do you wish to review or change the above       parameters (N/Y) <cr> #
#   Do you wish to add radionuclides to the above inventory? <cr>         #
##########################################################################
```

Figure 3.4-7. Sample Problem Four Interactive Session (Continued)

(This interactive session generates the following file.)

```
account-name,STMFZ,CM160000,EC400,T177.
ACCOUNT,account-name,problem-number,problem-number.
 ATTACH,TAPE20,FILE20,ID=ZZRNRC.
 ATTACH,TAPE21,FILE21,ID=ZZRNRC.
 ATTACH,TAPE24,FILE24,ID=ZZRNRC.
 ATTACH,TAPE25,FILE25,ID=ZZRNRC.
 ATTACH,TAPE22,PLANSOURC,ID=ZZRNRC.
 ATTACH,TAPE27,VOLSOURC,ID=ZZRNRC.
 ATTACH,TAPE10,RMDLIB,ID=ZZRNRC.
 ATTACH,TAPE23,FILE23,ID=ZZRNRC.
 ATTACH,ABS,MAXI1ABS,ID=ZZRNRC.
 COPY,ABS,LGO.
 RETURN,ABS.
 MAP,OFF.
 LDSET,PRESET=ZERO.
 LGO.
{eor   }
 SAMPLE PROBLEM FOUR
 $INPUT  NEXT=1,
   IFOD=1,IARG=0,IWAT=1,IEXT=0,
   ISUR=1, IAIR=0,
   RIRR=  150.     , IMO=6, RF1=  1.00     , RF2= 0.        ,
   RPF1=   1.00    , RPF2=   1.00    ,
   IDKWAT=0,
   AGE= 0.         , XDPT=  .670E-01,
   PINH=    .230000, DILF=  1.00     , XF2=  .200E+04,
   M3M2= 1, INTRUD=0, I22=0,
   IT1= 10, IT2=  59, NORG= 5, KORG(1)= 1, 6, 8,16,23,
   SRDIL=  .200    , FRSIZ=  1.00     , AREAIN=  1.00     ,
   AREAEX=   1.00    ,
   IOUT= 0, ION=1, $END
    4   10
CO60     11311  0.         .10       10.      0.
SR90+D   11311  0.         .10       10.      0.
I 129    11211  0.         .10       10.      0.
U 238+D  22322  0.         .10       10.      0.
{eor   }
{eof   }
```

Figure 3.4-7. Sample Problem Four Interactive Session (Continued)

```
MAXI - Maximum Annual Dose Calculation Version VAX2.2 25-APR-84
                    Executed on 11-MAY-84  at 11:32:41  .
Case title:SAMPLE PROBLEM FOUR
--------------------------------------------------------------------------------

RADIONUCLIDE CHAIN LIBRARY USED:      RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 6-APR-84  RAP
DOSE FACTOR FILES USED FOR THIS CASE:
          *20  FOOD-LEAF:             Leaf Incremental Dose Factors for the ONSITE/BIOPORT
          *21  FOOD-SOIL:             Soil Incremental Dose Factors for the ONSITE/BIOPORT
          *22  SHALLOW EXTERNAL:      ONSITE/BIOPORT EXTERNAL DRFS FOR SURFACE (PLANE SOUR
          *23  DACRIN-INHALATION:     DOS) DOSE INCREMENT FILE ONSITE/BIOPORT ENV. 16-APR-84 RAP
          *25  ARRRG-DRINK H20:       Incremental Drinking Water Dose Factors - ONSITE/BIO

DOSES CALCULATED FROM   10 TO   59 YEARS FOLLOWING TIME ZERO

PATHWAYS INITIALIZED FOR DOSE CALCULATIONS:                 SPECIAL PARAMETERS INITIALIZED:
          FARM PRODUCT INGESTION:             ON
          INHALATION OF RESUSPENDED MATERIAL:ON
          AQUATIC FOODS INGESTION:            OFF              INVENTORY DILUTION FACTOR: 2.00E-01
          DRINKING WATER INGESTION:           ON               DECAY OF RIVER RELEASE SOURCE TERM NOT PERFORMED
          CONTINUING ATMOSPHERIC DEPOSITION   OFF              DECAY OF AIR RELEASE SOURCE TERM NOT PERFORMED
          EXTERNAL FROM BURIED WASTES         OFF              SITE X/Q:  0.00E+00
          EXTERNAL FROM SURFACE DEPOSITS:     ON               SPECIAL INHALATION MODEL NOT USED
                                                               SIZE OF THE SITE:  1.00000 FRACTIONAL HECTARES
                                                               INTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
                                                               EXTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
FARM PRODUCT PARAMETERS USED:
          FRACTION OF ROOTS IN UPPER SOIL:  0.10E+01           IRRIGATION RATE:  1.50E+02L/M**2/MO
          FRACTION OF ROOTS IN BURIED WASTE 0.00E+00           MONTHS PER YEAR IRRIGATED:    6
          FRACTION OF TOTAL DIET GROWN ON SITE:  1.00E+00      RIVER DILUTION FACTOR:  1.00E+00YR/L
                                                               YEARS OF IRRIGATION WITH CONTAMINATED WATER PRIOR TO
                                                                    THE DOSE CALCULATIONS:   10
EXTERNAL EXPOSURE PARAMETERS USED:
          RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL TO SUBSURFACE SOIL  1.00E+00
          NUMBER OF HOURS OF EXPOSURE TO EXTERNAL  CONTAMINATION  2.00E+03
          SURFACE DEPOSITS DRFS FROM ISOSHLD; MODIFICATION FACTOR: 5.844E-11

INHALATION PARAMETERS USED:
          MODIFICATION FACTOR , RINH:  2.30E-01
               (EQUIVALENT TO BREATHING RATE OF 230 CC/SEC FOR  2016. HR/YR)
          RESUSPENSION MODEL USED FOR CALCULATING AIR CONCENTRATION: ANSPAUGH
          AVERAGE AGE OF MATERIAL ON GROUND AT TIME ZERO:  0.00E+00 YEARS
          TOP  1.0 CM OF THE CONTAMINATED SURFACE LAYER IS AVAILABLE FOR RESUSPENSION.

ORGANS FOR WHICH DOSES ARE CALCULATED (SAME ORDER AS SOLUBILITIES GIVEN BELOW):

               TOTAL BODY          BONE                LUNGS               THYROID             GI-LLI
```

Figure 3.4-8. Sample Problem Four Output

INPUT PREPARED BY R.A. Peloquin DATE 25 MAY 84

INPUT CHECKED BY W. E. Kennedy, Jr. DATE 5/25/84

RELEASE TERMS NUCLIDE	ORGAN SOLUBILITY CLASSES					SOIL SOURCE (PCI/M**3)	IRRIGATATION/AQUATIC (PCI/L)	DRINKING WATER (PCI/L)	ATM. RELEASE (CI/YR)
CO 60	1	1	3	1	1	0.00E+00	1.00E-01	1.00E+01	0.00E+00
SR 90+D	1	1	3	1	1	0.00E+00	1.00E-01	1.00E+01	0.00E+00
U 238+D	2	2	3	2	2	0.00E+00	1.00E-01	1.00E+01	0.00E+00
I 129	1	1	2	1	1	0.00E+00	1.00E-01	1.00E+01	0.00E+00

```
*******************PLEASE NOTE ANY SPECIAL CONSIDERATIONS IN THIS SPACE*******************
*                                                                                        *
*                                                                                        *
******************************************************************************************
```

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 10

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	4.89E+02	0.00E+00	4.08E-07	1.00E-01	1.00E+01
SR 90+D	8.58E+02	0.00E+00	7.15E-07	1.00E-01	1.00E+01
U 238+D	9.90E+02	0.00E+00	8.25E-07	1.00E-01	1.00E+01
I 129	9.90E+02	0.00E+00	8.25E-07	1.00E-01	1.00E+01

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 59

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	6.38E+02	0.00E+00	4.28E-08	1.00E-01	1.00E+01
SR 90+D	2.80E+03	0.00E+00	1.88E-07	1.00E-01	1.00E+01
U 238+D	5.40E+03	0.00E+00	3.62E-07	1.00E-01	1.00E+01
I 129	5.40E+03	0.00E+00	3.62E-07	1.00E-01	1.00E+01

Figure 3.4-8. Sample Problem Four Output (Continued)

SAMPLE PROBLEM FOUR

MAXI, Version VAX2.2 25-APR-84 executed on 11-MAY-84 at 11:32:41 .

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 59 FORTOTAL BODY

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	2.42E-07	0	5.32E-13	0	7.32E-06	94	0.00E+00	0	4.12E-06	0	
SR90+D	5.17E-04	98	4.90E-10	59	7.11E-08	0	0.00E+00	0	8.99E-04	83	
U 238+D	2.85E-06	0	3.27E-10	39	3.60E-07	4	0.00E+00	0	1.39E-04	12	
I 129	2.78E-06	0	4.66E-12	0	3.10E-08	0	0.00E+00	0	3.22E-05	3	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	5.22E-04	32	8.21E-10	0	7.78E-06	0	0.00E+00	0	1.07E-03	66	1.60E-03

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 59 FOR BONE

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	0.00E+00	0	7.32E-06	94	0.00E+00	0	0.00E+00	0	
SR90+D	1.93E-03	97	7.30E-09	57	7.11E-08	0	0.00E+00	0	3.35E-03	58	
U 238+D	4.81E-05	2	5.45E-09	42	3.60E-07	4	0.00E+00	0	2.35E-03	41	
I 129	9.89E-07	0	1.13E-13	0	3.10E-08	0	0.00E+00	0	1.14E-05	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	1.97E-03	25	1.27E-08	0	7.78E-06	0	0.00E+00	0	5.71E-03	74	7.69E-03

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 59 FOR LUNGS

	EXPOSURE PATHWAY										
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	2.11E-10	0	7.32E-06	94	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	2.00E-09	0	7.11E-08	0	0.00E+00	0	0.00E+00	0	
U 238+D	0.00E+00	0	2.29E-07	99	3.60E-07	4	0.00E+00	0	0.00E+00	0	
I 129	0.00E+00	0	2.59E-11	0	3.10E-08	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	2.31E-07	2	7.78E-06	97	0.00E+00	0	0.00E+00	0	8.01E-06

Figure 3.4-8. Sample Problem Four Output (Continued)

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 59 FOR THYROID

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	0.00E+00	0	0.00E+00	0	7.32E-06	94	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	0.00E+00	0	7.11E-08	0	0.00E+00	0	0.00E+00	0	
U 238+D	0.00E+00	0	0.00E+00	0	3.60E-07	4	0.00E+00	0	0.00E+00	0	
I 129	2.18E-03	100	3.75E-09	100	3.10E-08	0	0.00E+00	0	2.53E-02	100	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	2.18E-03	7	3.75E-09	0	7.78E-06	0	0.00E+00	0	2.53E-02	92	2.75E-02

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 59 FOR LLI

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	2.30E-06	4	4.62E-13	2	7.32E-06	94	0.00E+00	0	3.91E-05	13	
SR90+D	4.30E-05	87	3.59E-12	16	7.11E-08	0	0.00E+00	0	6.78E-05	23	
U 238+D	3.81E-06	7	1.77E-11	81	3.60E-07	4	0.00E+00	0	1.86E-04	63	
I 129	1.49E-07	0	4.64E-14	0	3.10E-08	0	0.00E+00	0	1.73E-06	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	4.92E-05	14	2.18E-11	0	7.78E-06	2	0.00E+00	0	2.95E-04	83	3.52E-04

Figure 3.4-8. Sample Problem Four Output (Continued)

3.4.5 Sample Problem Five

The fifth and final sample problem is designed to exercise the user-defined scenario option. This problem is intended to exercise the maximum number of exposure conditions that can be considered by the MAXI1 program in a single run. For this problem, the general exposure conditions described in Sample Problem Four are considered with the addition of ingestion of aquatic foods (fish obtained from a river) and root penetration into deeply buried wastes. The radionuclide concentrations in well and river water defined in Sample Problem Four, are used for the liquid pathways. A deep waste concentration of 0.1 Ci/m^3 of each of ^{60}Co, ^{129}I, and ^{238}U+D plus 0.001 Ci/m^3 of ^{90}Sr+D is also assumed. The site is assumed to cover 1 ha. The wastes are assumed to be buried for 10 years prior to the start of farming and they are assumed to be located 1.0 m from the surface. It is further assumed that about 40% of the roots from the garden crops penetrate to this depth (based on information in Napier 1982). For the user-defined scenario, the air concentration used to estimate inhalation dose is calculated using a mass-loading equation instead of the time-dependent resuspension equation. Also, the individual's total diet is assumed to be grown using the contaminated water supply. The sample problem is to determine the doses to an individual residing on a site containing deeply buried wastes who also uses contaminated water supplies. The solution to this problem is found by running the ONSITE user-defined scenario with the specified source terms and conditions. A summary of the interactive session used to develop the runstream for Sample Problem Five is shown in Figure 3.4-9. The output resulting for this sample problem is shown in Figure 3.4-10. The maximum annual doses resulting for Sample Problem Five are about 1.5 rem/yr to total body, 6.2 rem/yr to bone, 2.0×10^{-4} rem/yr to lungs, 245 rem/yr to thyroid, and 0.43 rem/yr to GI(LLI). Ingestion of farm products whose roots penetrate the deeply buried wastes control the doses to total body, bone, thyroid, and GI(LLI). The dose to lungs is controlled by the external exposure pathway. Hand calculations verified the code operation for the radioactive decay, radionuclide concentrations, and dose estimates for all of the exposure pathways considered.

```
######################################################################
#                                                                    #
#                     ====================                           #
#                         ONSITE/MAXI                                #
#                     ====================                           #
#                                                                    #
#          This interactive program will assist you in the creation #
#          of scenarios for assessment of onsite disposal of low-    #
#          level waste.  Doses to man through the specified pathways #
#          will be simulated by the computer program MAXI.           #
#                                                                    #
#          The following notes may be of interest:                   #
#          When you have finished reading, press <return> <cr>       #
#                                                                    #
######################################################################

######################################################################
#                                                                    #
#                                                                    #
#          1) If the default condition is selected, you need only    #
#          press <return>. YES-or-NO questions are designated by     #
#          (Y/N) and should be answered with a Y or N. The default   #
#          condition is always listed first.                         #
#                                                                    #
#          2) The values you enter will be tested against reasonable #
#          limits and if they are not accepted you will be asked to  #
#          supply another value.                                     #
#                                                                    #
#          When you have finished reading, press <return> <cr>       #
#                                                                    #
######################################################################

######################################################################
#                                                                    #
#          The following scenarios have been defined:                #
#                                                                    #
#          1 - External exposure                                     #
#          2 - External exposure plus inhalation from resuspension   #
#          3 - Agricultural activities                               #
#          4 - Use of well water for irrigation and drinking water   #
#          5 - User-created scenario                                 #
#                                                                    #
#                                                                    #
#          To select a scenario or for additional information        #
#               on a scenario enter 1, 2, 3, 4, or 5: 5 <cr>         #
#                                                                    #
######################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session

```
##############################################################################
#                                                                            #
#                                                                            #
#          SCENARIO 5:  User Defined  Scenario                               #
#                                                                            #
#          This scenario defaults to a full year of exposure to              #
#          external contamination and a full year of inhalation.             #
#          The user may specify any parameters to define a scenario.         #
#                                                                            #
#          Scenario 5 is now selected. Do you wish to change                 #
#          this selection (N/Y): <cr>                                        #
#                                                                            #
#                                                                            #
##############################################################################
```

```
##############################################################################
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#   Enter a descriptive title to identify this case:                         #
#   SAMPLE PROBLEM FIVE <cr>                                                 #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
##############################################################################
```

```
##############################################################################
#                                                                            #
#   This scenario begins    1 years after the waste is                       #
#   disposed.                                                                #
#   ------------------------------------------------------------------------ #
#                                                                            #
#   Do you wish to change this value (N/Y)? Y <cr>                           #
#   Enter new value: 10 <cr>                                                 #
#                                                                            #
#                                                                            #
#   This scenario will end   59 years after the waste is                     #
#   disposed. OK? (Y/N) <cr>                                                 #
#                                                                            #
#                                                                            #
#                                                                            #
##############################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
###########################################################################
#                                                                         #
#  Three types of printer reports are available:                          #
#                                                                         #
#     0- Tables of maximum annual dose per organ with radionuclide and    #
#          pathway contribution                                           #
#     1- Table above plus annual doses by organ and total                 #
#     2- Table above plus annual doses by organ, pathway and radionuclide#
#                                                                         #
#  The current selection is: 0                                            #
#                                                                         #
#  ---------------------------------------------------------------------- #
#  Do you wish to change this value (N/Y)? <cr>                           #
#                                                                         #
###########################################################################
```

```
###########################################################################
#                                                                         #
#   In this scenario, wastes may be:                                      #
#                                                                         #
#                       1 -On surface                                     #
#                       2 -Buried at 0.5 m                                #
#                       3 -Buried at 1.0 m                                #
#                       4 -Stored waste                                   #
#                                                                         #
#  The current selection is: 1                                            #
#                                                                         #
#  ---------------------------------------------------------------------- #
#  Do you wish to change this value (N/Y)?  Y <cr>                        #
#  Enter new value: 3 <cr>                                                #
###########################################################################
```

```
###########################################################################
#                                                                         #
#        Do you wish to consider external exposure to surface             #
#        contamination? (Y/N)    <cr>                                     #
#                                                                         #
#                                                                         #
#        Do you wish to consider external exposure and crop               #
#        penetration to deeply buried waste? (Y/N)    <cr>                #
#                                                                         #
#                                                                         #
#        Do you wish to consider farm product ingestion ?                 #
#        (Y/N)    <cr>                                                    #
#                                                                         #
#                                                                         #
###########################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
        Do you wish to consider drinking water ingestion
        from a contaminated well? (Y/N)   <cr>


        Do you wish to consider consumption of aquatic
        food from a contaminated river? (Y/N)   <cr>
```

```
  ======================================================================

  Do you wish to review or change agricultural parameters (N/Y) Y <cr>
```

```
  The fraction of total roots in top 15 cm of the soil is   1.00
    (range = 0.0 to 1.0)

  -------------------------------------------------------------------

  Do you wish to change this value (N/Y)?  Y <cr>

  Enter new value: .6 <cr>
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   The fraction of total roots entering the buried waste                      #
#   below the top 15 cm plow layer of soil is  0.000E+00                       #
#   (range = 0.0 to 1.0).                                                      #
#                                                                              #
#   -------------------------------------------------------------------------- #
#                                                                              #
#   Do you wish to change this value (N/Y)?  Y <cr>                            #
#                                                                              #
#   Enter new value: .4 <cr>                                                   #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   The fraction of the total diet grown on the site  is   1.00                #
#    (range = 0.0 to 1.0)                                                      #
#                                                                              #
#                                                                              #
#   -------------------------------------------------------------------------- #
#                                                                              #
#   Do you wish to change this value (N/Y)? <cr>                               #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#   The irrigation rate in liters per square meter per month is   150.         #
#     (range = 0.0 to 1000.)                                                   #
#                                                                              #
#                                                                              #
#   -------------------------------------------------------------------------- #
#                                                                              #
#   Do you wish to change this value (N/Y)? <cr>                               #
#                                                                              #
#                                                                              #
################################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

The number of months per year that crops are irrigated is 6
(range = 0 to 12)

Do you wish to change this value (N/Y)? **<cr>**

The number of years prior to the beginning of dose
calculations that irrigation accumulates radionuclides
is 0 (range = 0 to 1000)

Do you wish to change this value (N/Y)? **Y <cr>**

Enter new value: **10 <cr>**

Do you wish to review/modify external exposure parameters? (N/Y) **<cr>**

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#   Did you use MAXI2 to generate a special external exposure            #
#    dose rate factor file for this scenario?  (default=0)               #
#                                                                        #
#               0 - no                                                   #
#               1 - yes                                                  #
#                                                                        #
#                                                                        #
#   -------------------------------------------------------------------- #
#                                                                        #
#   Do you w sh to change this value (N/Y)? <cr>                         #
#                                                                        #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#   The number of hours of exposure to external contamination            #
#   per year is  8.766E+03   (range = 0.0 to 8766.)                      #
#                                                                        #
#                                                                        #
#   -------------------------------------------------------------------- #
#                                                                        #
#   Do you wish to change this value (N/Y)? Y <cr>                       #
#                                                                        #
#   Enter new value: 2000 <cr>                                           #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################

##########################################################################
#                                                                        #
#                                                                        #
#                                                                        #
#   ==================================================================== #
#                                                                        #
#   Do you wish to review or change inhalation parameters (N/Y) Y <cr>   #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
#                                                                        #
##########################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
###########################################################################
#                                                                         #
#                                                                         #
#   The number of hours of inhalation of contamination                    #
#   per year is  8.766E+03  (range = 0.0 to 8766.)                        #
#                                                                         #
#                                                                         #
#   --------------------------------------------------------------------- #
#                                                                         #
#   Do you wish to change this value (N/Y)?  Y <cr>                       #
#                                                                         #
#   Enter new value: 2000 <cr>                                            #
#                                                                         #
#                                                                         #
###########################################################################

###########################################################################
#                                                                         #
#                                                                         #
#   Two resuspension models are available:                                #
#          1 - Anspaugh                                                   #
#          2 - Mass Loading                                               #
#                                                                         #
#   The selected model is 2                                               #
#                                                                         #
#                                                                         #
#   --------------------------------------------------------------------- #
#                                                                         #
#   Do you wish to change this value (N/Y)? <cr>                          #
#                                                                         #
###########################################################################

###########################################################################
#                                                                         #
#   The density of [illegible] 1.0E+06 grams per cubic meter.             #
#    (range = 1.E5 [illegible]                                            #
#                                                                         #
#                                                                         #
#   --------------------------------------------------------------------- #
#                                                                         #
#   Do you wish to chang[illegible] (N/Y)? <cr>                           #
#                                                                         #
#                                                                         #
#                                                                         #
#                                                                         #
#                                                                         #
###########################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
##############################################################################
#                                                                            #
#                                                                            #
#                                                                            #
#   The Mass Loading Factor is    1.0E-04 grams per cubic meter.             #
#    (range = 1.E-7 to 0.1)                                                  #
#                                                                            #
#                                                                            #
#   ---------------------------------------------------------------------   #
#                                                                            #
#   Do you wish to change this value (N/Y)? <cr>                             #
#                                                                            #
#                                                                            #
#                                                                            #
##############################################################################

##############################################################################
#                                                                            #
#                                                                            #
#                                                                            #
#   ====================================================================    #
#                                                                            #
#   Do you wish to review or change organ  parameters (N/Y) <cr>             #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
#                                                                            #
##############################################################################

##############################################################################
#                                                                            #
#   The size of the site in terms of fractional hectares                     #
#   (ie., 10000 sq m), is   1.00     .                                       #
#                                                                            #
#   ---------------------------------------------------------------------   #
#   Do you wish to change this value (N/Y)? <cr>                             #
#                                                                            #
#   The inventory will automatically be adjusted by the                      #
#   appropriate area correction factor for each exposure                     #
#   pathway based on a  site size of   1.00     hectares.                    #
#                                                                            #
#   ====================================================================    #
#   Do you wish to review or change   the above      parameters (N/Y) <cr>  #
##############################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
This scenario assumes both surface contamination and
contamination from buried or stored waste.  What is
the ratio of waste concentration in the surface to
subsurface soils?  (Range = 0.0 to 1.0)
The current selection is:   1.00

------------------------------------------------------------------------
Do you wish to change this value (N/Y)? Y <cr>

Enter new value: 0 <cr>
```

```
The surface/buried inventory may be entered as:
               1 - pCi
               2 - uCi
               3 - mCi
               4 -  Ci
The currect selection is: 1

------------------------------------------------------------------------

Do you wish to change this value (N/Y)?  Y <cr>
Enter new value: 4 <cr>
```

```
The contamination deposited on the site at start of
calculation may be entered in the following units:

               0 -  Ci /square meter
               1 -  Ci /cubic meter
               2 -  Ci /Kg of soil

The current selection is: 1

------------------------------------------------------------------------
Do you wish to change this value (N/Y)? <cr>
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   The surface/buried inventory dilution factor is:   0.20                    #
#   (range = 0.0 to 1.0E+20)                                                   #
#                                                                              #
#                                                                              #
#   -------------------------------------------------------------------------- #
#                                                                              #
#   Do you wish to change this value (N/Y)? <cr>                               #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#   Do you wish to review or change any of the above parameters (N/Y) <cr>    #
#                                                                              #
#                                                                              #
#                                                                              #
#                                                                              #
#   Do you wish to review and/or change solubility classification             #
#   for each organ for each radionuclide.  The default assump-                #
#   tion is elements are insoluble for lung and soluble for all               #
#   other organs. (N/Y) <cr>                                                   #
#                                                                              #
#                                                                              #
################################################################################

################################################################################
#                                                                              #
#                                                                              #
#                                                                              #
#   The following questions pertain to the radionuclide                       #
#   inventory.  After inputting the inventory, enter                          #
#   "99" for element name to signal to the program that                       #
#   you are finished.                                                          #
#                                                                              #
#                                                                              #
#   ========================================================================== #
#                                                                              #
#   Press <return> when you have finished reading: <cr>                        #
#                                                                              #
################################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
################################################################################
#                                                                              #
#                                                                              #
#    Enter new 2-character element  (99=finished): CO <cr>                     #
#                                                                              #
#   Atomic number input can be up to 6 characters long.                        #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)     #
#                                                                              #
#   Enter atomic number: 60 <cr>                                               #
#                                                                              #
#   Enter the quantity of CO60    deposited on the site at start of            #
#   calculation (units:  Ci /cubic meter    ) : .1 <cr>                        #
#                                                                              #
#                                                                              #
################################################################################
```

```
################################################################################
#                                                                              #
#                                                                              #
#    To consider only irrigation or only drinking water contamination,         #
#   enter zero quantity for the  other pathway.                                #
#                                                                              #
#   Enter the concentration of CO60     in the irrigation water at start of    #
#   calculation (units: pCi/liter): .1 <cr>                                    #
#                                                                              #
#   Enter the concentration of CO60     in the drinking water at start of      #
#   calculation (units: pCi/liter): 10 <cr>                                    #
#                                                                              #
#                                                                              #
#                                                                              #
################################################################################
```

```
################################################################################
#                                                                              #
#   Enter new 2-character element  (99=finished): I <cr>                       #
#                                                                              #
#   Atomic number input can be up to 6 characters long.                        #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D)     #
#                                                                              #
#   Enter atomic number: 129 <cr>                                              #
#                                                                              #
#                                                                              #
#   Enter the quantity of I 129   deposited on the site at start of            #
#   calculation (units:  Ci /cubic meter    ) : .1 <cr>                        #
#                                                                              #
#                                                                              #
################################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
##############################################################################
#                                                                            #
#    To consider only irrigation or only drinking water contamination,       #
#   enter zero quantity for the  other pathway.                              #
#                                                                            #
#                                                                            #
#   Enter the concentration of I 129    in the irrigation water at start of#
#   calculation (units: pCi/liter): .1 <cr>                                  #
#                                                                            #
#                                                                            #
#   Enter the concentration of I 129    in the drinking water at start of   #
#   calculation (units: pCi/liter): 10 <cr>                                  #
#                                                                            #
#                                                                            #
##############################################################################

##############################################################################
#                                                                            #
#                                                                            #
#   Enter new 2-character element  (99=finished): SR <cr>                    #
#                                                                            #
#   Atomic number input can be up to 6 characters long.                      #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#                                                                            #
#   Enter atomic number: 90+D <cr>                                           #
#                                                                            #
#                                                                            #
#   Enter the quantity of SR90+D  deposited on the site at start of          #
#   calculation (units:  Ci /cubic meter    ) : .001 <cr>                    #
#                                                                            #
##############################################################################

##############################################################################
#                                                                            #
#                                                                            #
#    To consider only irrigation or only drinking water contamination,       #
#   enter zero quantity for the  other pathway.                              #
#                                                                            #
#                                                                            #
#   Enter the concentration of SR90+D   in the irrigation water at start of#
#   calculation (units: pCi/liter): .1 <cr>                                  #
#                                                                            #
#                                                                            #
#   Enter the concentration of SR90+D   in the drinking water at start of   #
#   calculation (units: pCi/liter):  10 <cr>                                 #
#                                                                            #
##############################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
##########################################################################
#                                                                        #
#   Enter new 2-character element  (99=finished): U <cr>                #
#                                                                        #
#   Atomic number input can be up to 6 characters long.                  #
#   Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
#                                                                        #
#   Enter atomic number: 238+D <cr>                                      #
#                                                                        #
#                                                                        #
#   Enter the quantity of U 238+D deposited on the site at start of      #
#   calculation (units:  Ci /cubic meter    ) : .1 <cr>                  #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#    To consider only irrigation or only drinking water contamination,  #
#   enter zero quantity for the  other pathway.                          #
#                                                                        #
#   Enter the concentration of U 238+D  in the irrigation water at start of#
#   calculation (units: pCi/liter): .1                                   #
#                                                                        #
#   Enter the concentration of U 238+D  in the drinking water at start of #
#   calculation (units: pCi/liter):  10                                  #
#                                                                        #
#   ==================================================================  #
#   Enter new 2-character element  (99=finished): 99                     #
#                                                                        #
##########################################################################
```

```
##########################################################################
#                                                                        #
#                        Surface/Buried                     Drinking    #
#                              Ci             Irrigation      Water     #
#               Radionuclide  /cubic meter       Ci /l         Ci /l     #
#               ------------  ----------     ----------    ----------  #
#                C060          0.10           0.10          10.          #
#                I 129         0.10           0.10          10.          #
#                SR90+D        1.00E-03       0.10          10.          #
#                U 238+D       0.10           0.10          10.          #
#                                                                        #
#   ==================================================================== #
#   Do you wish to review or change the above   parameters (N/Y) <cr>    #
#   Do you wish to add radionuclides to the above inventory?  <cr>      #
#                                                                        #
##########################################################################
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

(This interactive session generates the following file.)

```
account-name,STMFZ,CM160000,EC400,T177.
ACCOUNT,account-name,problem-number,problem-number.
 ATTACH,TAPE20,FILE20,ID=ZZRNRC.
 ATTACH,TAPE21,FILE21,ID=ZZRNRC.
 ATTACH,TAPE24,FILE24,ID=ZZRNRC.
 ATTACH,TAPE25,FILE25,ID=ZZRNRC.
 ATTACH,TAPE22,PLANSOURC,ID=ZZRNRC.
 ATTACH,TAPE27,BURIED1,ID=ZZRNRC.
 ATTACH,TAPE10,RMDLIB,ID=ZZRNRC.
 ATTACH,TAPE23,FILE23,ID=ZZRNRC.
 ATTACH,ABS,MAXI1ABS,ID=ZZRNRC.
 COPY,ABS,LGO.
 RETURN,ABS.
 MAP,OFF.
 LDSET,PRESET=ZERO.
 LGO.
{eor   }
 SAMPLE PROBLEM FIVE
 $INPUT  NEXT=1,
   IFOD=1,IARG=1,IWAT=1,IEXT=1,
   ISUR=1, IAIR=0,
   RIRR=  150.    , IMO=6, RF1=  .600    , RF2=  .400    ,
   RPF1=  0.        , RPF2=   1.00    ,
   IDKWAT=0,
   AGE=-1, DEN=  .100E+07, XMLF=  .100E-03,
   RINH=   .228154, DILF=  1.00    , XF2=  .200E+04,
   M3M2= 1, INTRUD=0, I22=0,
   IT1=  10, IT2=  59, NORG= 5, KORG(1)= 1, 6, 8,16,23,
   SRDIL=  .200    , FRSIZ=  1.00    , AREAIN=  1.00    ,
   AREAEX=   1.00    ,
   IOUT= 0, ION=1, $END
    4   10
C060    11311  1.00E+11   .10       10.      0.
I 129   11211  1.00E+11   .10       10.      0.
SR90+D  11311  1.00E+09   .10       10.      0.
U 238+D 22322  1.00E+11   .10       10.      0.
{eor   }
{eof   }
```

Figure 3.4-9. Sample Problem Five Interactive Session (Continued)

```
                    MAXI - Maximum Annual Dose Calculation Version VAX2.2 25-APR-84
                                  Executed on 11-MAY-84  at 13:48:25  .
                    Case title:SAMPLE PROBLEM FIVE
                    ---------------------------------------------------------------------------

RADIONUCLIDE CHAIN LIBRARY USED:      RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 6-APR-84  RAP
DOSE FACTOR FILES USED FOR THIS CASE:
          *20  FOOD-LEAF:               Leaf Incremental Dose Factors for the ONSITE/BIOPORT
          *21  FOOD-SOIL:               Soil Incremental Dose Factors for the ONSITE/BIOPORT
          *22  SHALLOW EXTERNAL:        ONSITE/BIOPORT EXTERNAL DRFS FOR SURFACE (PLANE SOUR
          *23  DACRIN-INHALATION:       DOS) DOSE INCREMENT FILE ONSITE/BIOPORT ENV. 16-APR-84 RAP
          *24  ARRRG-FISH:              Incremental Aquatic Foods Dose Factors - ONSITE/BIOP
          *25  ARRRG-DRINK H20:         Incremental Drinking Water Dose Factors - ONSITE/BIO
          *27  ISOSHLD EXTERNAL: ONSITE/BIOPORT  EXTERNAL DRF (BURIED AT 1.0 M) 9-APR

DOSES CALCULATED FROM   10 TO   59 YEARS FOLLOWING TIME ZERO

PATHWAYS INITIALIZED FOR DOSE CALCULATIONS:                  SPECIAL PARAMETERS INITIALIZED:
          FARM PRODUCT INGESTION:            ON
          INHALATION OF RESUSPENDED MATERIAL:ON
          AQUATIC FOODS INGESTION:           ON                   INVENTORY DILUTION FACTOR: 2.00E-01
          DRINKING WATER INGESTION:          ON                   DECAY OF RIVER RELEASE SOURCE TERM NOT PERFORMED
          CONTINUING ATMOSPHERIC DEPOSITION  OFF                  DECAY OF AIR RELEASE SOURCE TERM NOT PERFORMED
          EXTERNAL FROM BURIED WASTES        ON                   SITE X/Q:  0.00E+00
          EXTERNAL FROM SURFACE DEPOSITS:    ON                   SPECIAL INHALATION MODEL NOT USED
                                                                  SIZE OF THE SITE:  1.00000 FRACTIONAL HECTARES
                                                                  INTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
                                                                  EXTERNAL PATHWAY AREA CORRECTION FACTOR: 1.00E+00
FARM PRODUCT PARAMETERS USED:
          FRACTION OF ROOTS IN UPPER SOIL:  0.60E+00              IRRIGATION RATE:  1.50E+02L/M**2/MO
          FRACTION OF ROOTS IN BURIED WASTE 0.40E+00              MONTHS PER YEAR IRRIGATED:     6
          FRACTION OF TOTAL DIET GROWN ON SITE:  1.00E+00         RIVER DILUTION FACTOR:  1.00E+00YR/L
                                                                  YEARS OF IRRIGATION WITH CONTAMINATED WATER PRIOR TO
                                                                       THE DOSE CALCULATIONS:   10
EXTERNAL EXPOSURE PARAMETERS USED:
          RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL TO SUBSURFACE SOIL  0.00E+00
          NUMBER OF HOURS OF EXPOSURE TO EXTERNAL  CONTAMINATION  2.00E+03
          SURFACE DEPOSITS DRFS FROM ISOSHLD; MODIFICATION FACTOR: 5.844E-11

INHALATION PARAMETERS USED:
          MODIFICATION FACTOR , RINH:  2.28E-01
               (EQUIVALENT TO BREATHING RATE OF 230 CC/SEC FOR  2000. HR/YR)
          RESUSPENSION MODEL USED FOR CALCULATING AIR CONCENTRATION: MASS LOADING
          SOIL DENSITY, G/M**3:  1.00E+06
          MASS LOADING FACTOR, G/M**3:  1.00E-04

ORGANS FOR WHICH DOSES ARE CALCULATED (SAME ORDER AS SOLUBILITIES GIVEN BELOW):

               TOTAL BODY          BONE              LUNGS              THYROID             GI-LLI
```

Figure 3.4-10. Sample Problem Five Output

INPUT PREPARED BY R.A. Peloquin DATE 23 MAY 84

INPUT CHECKED BY W. E. Kennedy, Jr. DATE 5/25/84

RELEASE TERMS NUCLIDE	ORGAN SOLUBILITY CLASSES					SOIL SOURCE (PCI/M**3)	IRRIGATATION/AQUATIC (PCI/L)	DRINKING WATER (PCI/L)	ATM. RELEASE (CI/YR)
CO 60	1	1	3	1	1	2.00E+10	1.00E-01	1.00E+01	0.00E+00
SR 90+D	1	1	3	1	1	2.00E+08	1.00E-01	1.00E+01	0.00E+00
U 238+D	2	2	3	2	2	2.00E+10	1.00E-01	1.00E+01	0.00E+00
I 129	1	1	2	1	1	2.00E+10	1.00E-01	1.00E+01	0.00E+00

```
*******************PLEASE NOTE ANY SPECIAL CONSIDERATIONS IN THIS SPACE*******************
*                                                                                        *
*                                                                                        *
*                                                                                        *
******************************************************************************************
```

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 10

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	4.89E+02	5.35E+09	3.26E-07	1.00E-01	1.00E+01
SR 90+D	8.58E+02	1.57E+08	5.72E-07	1.00E-01	1.00E+01
U 238+D	9.90E+02	2.00E+10	6.60E-07	1.00E-01	1.00E+01
I 129	9.90E+02	2.00E+10	6.60E-07	1.00E-01	1.00E+01

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 59

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	6.38E+02	8.38E+06	4.26E-07	1.00E-01	1.00E+01
SR 90+D	2.80E+03	4.76E+07	1.87E-06	1.00E-01	1.00E+01
U 238+D	5.40E+03	2.00E+10	3.60E-06	1.00E-01	1.00E+01
I 129	5.40E+03	2.00E+10	3.60E-06	1.00E-01	1.00E+01

Figure 3.4-10. Sample Problem Five Output (Continued)

SAMPLE PROBLEM FIVE

MAXI, Version VAX2.2 25-APR-84 executed on 11-MAY-84 at 13:48:25 .

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 30 FORTOTAL BODY

EXPOSURE PATHWAY

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	8.86E-04	0	5.16E-12	0	2.10E-05	90	2.04E-07	0	4.12E-06	0	
SR90+D	1.08E+00	71	2.51E-09	59	5.05E-08	0	2.55E-05	92	7.60E-04	81	
U 238+D	1.25E-01	8	1.65E-09	39	2.27E-06	9	1.45E-06	5	1.39E-04	14	
I 129	3.11E-01	20	2.36E-11	0	1.60E-08	0	4.18E-07	1	3.22E-05	3	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	1.52E+00	99	4.20E-09	0	2.33E-05	0	2.76E-05	0	9.35E-04	0	1.52E+00

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 30 FOR BONE

EXPOSURE PATHWAY

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	0.00E+00	0	0.00E+00	0	2.10E-05	90	0.00E+00	0	0.00E+00	0	
SR90+D	4.02E+00	64	3.75E-08	57	5.05E-08	0	9.52E-05	79	2.83E-03	54	
U 238+D	2.11E+00	33	2.72E-08	42	2.27E-06	9	2.46E-05	20	2.35E-03	45	
I 129	1.11E-01	1	5.74E-13	0	1.60E-08	0	1.48E-07	0	1.14E-05	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	6.24E+00	99	6.47E-08	0	2.33E-05	0	1.20E-04	0	5.19E-03	0	6.25E+00

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FOR LUNGS

EXPOSURE PATHWAY

RADIONUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINKING WATER REM	%	
CO60	0.00E+00	0	4.19E-10	0	1.98E-04	98	0.00E+00	0	0.00E+00	0	
SR90+D	0.00E+00	0	1.38E-09	1	2.42E-08	0	0.00E+00	0	0.00E+00	0	
U 238+D	0.00E+00	0	9.26E-08	98	2.15E-06	1	0.00E+00	0	0.00E+00	0	
I 129	0.00E+00	0	3.79E-11	0	5.68E-09	0	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	0.00E+00	0	9.44E-08	0	2.00E-04	99	0.00E+00	0	0.00E+00	0	2.01E-04

Figure 3.4-10. Sample Problem Five Output (Continued)

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 17 FOR THYROID

	EXPOSURE PATHWAY									
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER	
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%
CO60	0.00E+00	0	0.00E+00	0	8.32E-05	97	0.00E+00	0	0.00E+00	0
SR90+D	0.00E+00	0	0.00E+00	0	3.49E-08	0	0.00E+00	0	0.00E+00	0
U 238+D	0.00E+00	0	0.00E+00	0	2.19E-06	2	0.00E+00	0	0.00E+00	0
I 129	2.45E+02	100	1.09E-08	100	9.29E-09	0	3.29E-04	100	2.53E-02	100

TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	2.45E+02	99	1.09E-08	0	8.54E-05	0	3.29E-04	0	2.53E-02	0	2.45E+02

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 10 FOR LLI

	EXPOSURE PATHWAY									
	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER	
RADIONUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%
CO60	1.17E-01	27	3.49E-12	7	1.98E-04	98	1.93E-06	31	3.91E-05	13
SR90+D	1.30E-01	30	1.08E-11	23	2.42E-08	0	2.28E-06	36	6.78E-05	23
U 238+D	1.67E-01	38	3.09E-11	68	2.15E-06	1	1.94E-06	31	1.86E-04	63
I 129	1.67E-02	3	8.39E-14	0	5.68E-09	0	2.24E-08	0	1.73E-06	0

TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	TOTAL
	4.30E-01	99	4.53E-11	0	2.00E-04	0	6.17E-06	0	2.95E-04	0	4.31E-01

Figure 3.4-10. Sample Problem Five Output (Continued)

3.5 Error and Recovery

To further ease the user interaction with the ONSITE/MAXI1 computer program, error-checking and recovery capabilities have been added. The following paragraphs describe the error and recovery procedures that have been built into the ONSITE/MAXI1 computer program.

3.5.1 Error and Recovery - ONSITE

ONSITE has extensive error-checking and interactive recovery capabilities. Most input values are tested against minimum and maximum allowable limits. If a value does not fall within the allowable limits, the user is asked immediately to reenter that value.

ONSITE will display error messages if an invalid file name is selected by the user or if the program is enable to locate and access a data base file. The following messages are displayed by ONSITE. Details of the error condition are discussed and appropriate corrective actions are suggested.

"Error opening radionuclide library." The program could not access the radionuclide library, RMDONS. Refer this problem to the person maintaining the ONSITE/MAXI1 computer package.

"Premature end-of-file discovered in library." The program expected additional data in the master radionuclide library, RMDONS. Refer this problem to the person maintaining the ONSITE/MAXI1 computer package.

3.5.2 Error and Recovery - MAXI1

MAXI1 generates the following error messages listed with the source-code module in parentheses. Extended explanations and corrective actions are included, if applicable.

DIAGNOSTIC 1: END OF FILE ON INPUT, STOP (MAIN). The program expected additional input. Suggestion: check use of variable NEXT.

DIAGNOSTIC 2: ERROR ON NAMELIST INPUT (MAIN). The program encountered an error while reading the NAMELIST. Suggestions: check spelling of variable names, check for proper punctuation, verify that column one is blank in each record, and check for "$END" terminating statement.

DIAGNOSTIC 3: ERROR IN NUMBER OF NUCLIDES. INPUT, NONUC= n1, MAXIMUM ALLOWED IS n2 (MAIN). The program attempts to read NONUC radionuclide data records. Suggestions: verify that NONUC equals the number of radionuclide inventory records, check that NONUC is not greater than the maximum allowed, and verify format of NONUC record (I5?).

DIAGNOSTIC 4: END OF INPUT FOR THIS RUN, NORMAL TERMINATION (MAIN). This message is not an error condition; this message is printed to indicate a successful completion of the execution.

DIAGNOSTIC 5: DECAY CHAIN n1 HAS IMPROPER ORDER. CURRENT MEMBER INDEX IS n2. (RLIBIN). This message indicates a problem with a decay chain organization while reading the master radionuclide library. Its occurrence indicates that (1) an unsuccessful update was made to the library, or (2) that the file has been corrupted. In either case, refer the problem to the person maintaining the data base.

DIAGNOSTIC 6: IMPROPER NUMBER OF NUCLIDES IN MASTER LIBRARY, NUC = n (RLIBIN). The program expected to find n records in the radionuclide master library. This message indicates that (1) an unsuccessful update was made to the library, or (2) that the file has been corrupted. In either case, refer the problem to the person maintaining the data base.

DIAGNOSTIC 7: END OF FILE ON MASTER LIBRARY UNIT 10. STOP (RLIBIN). The program expected additional records in the master radionuclide library. This message indicates that (1) an unsuccessful update was made to the library, or (2) that the file has been corrupted. In either case, refer the problem to the person maintaining the data base.

DIAGNOSTIC 8: NUMBER OF ISOTOPES FOR DFREAD OUT OF BOUNDS followed by five values which are:

First value - (NISOL) number read in File 20 for leaf DRFs.
Second value - (NISOS) number read in File 21 for soil DRFs.
Third value - (NISOX) number read in File 22 for external-exposure DRFs.
Fourth value - (NISOA) number read in File 24 for aquatic-food DRFs.
Fifth value - (NISOW) number read in File 25 for drinking-water DRFs.

(DFREAD). There is an error in one of the dose rate factor files. The number of isotopes listed in the file does not agree with the specified number also read from the file.

DIAGNOSTIC 9: NUMBER OF YEARS FOR DFREAD OUT OF BOUNDS followed by four values which are:

First value - (NYRL) number read in File 20 for leaf DRFs.
Second value - (NYRS) number read in File 21 for soil DRFs.
Third value - (NYRA) number read in File 24 for aquatic-food DRFs.
Fourth value - (NYRW) number read in File 25 for drinking-water DRFs.

(DFREAD). One of the dose rate factor files is in error. The number of years listed does not correspond to the number of years specified in the beginning of the file.

DIAGNOSTIC 10: NUMBER OF ORGANS OUT OF BOUNDS FOR DFREAD followed by four values which are:

First value - (NORGL) number read in File 20 for leaf DRFs.
Second value - (NORGS) number read in File 21 for soil DRFs.
Third value - (NORGA) number read in File 24 for aquatic-food DRFs.
Fourth value - (NORGW) number read in File 25 for drinking-water DRFs.

(DFREAD). One of the dose rate factor files is in error. The number of organs listed does not correspond to the number of organs specified at the beginning of the file.

DIAGNOSTIC 11: UNIDENTIFIED NUCLIDE name (IDNUC). The program did not find a radionuclide with this name when it checked the master radionuclide library. Suggestions: check spelling of name and verify that "name" is included in the master radionuclide library (checking both sections of the library).

DIAGNOSTIC 12: THERE ARE UNIDENTIFIED NUCLIDES, ISTOP = n (IDNUC). This message will appear after Diagnostic 11, giving the total number (n) of radionuclide names that were not identified in the master radionuclide library. The program will not execute until all name discrepancies have been resolved. Be sure to change the number of radionuclides (NONUC) if any radionuclides are eliminated at this time.

DIAGNOSTIC 13: TOO MANY NUCLIDES ATTEMPTED IN SUBROUTINE SETDAT. INUC = n (SETDAT). More than the maximum allowable number of radionuclides were encountered. This may have been caused by the automatic building in of daughters into the decay chain by the program.

DIAGNOSTIC 14: TEST INUC.NE.NONUC=END - PNTO (PNTO). This error condition occurs when number of radionuclides encountered does not equal the maximum index set.

3.6 References

Napier, B. A., R. L. Roswell, W. E. Kennedy, Jr. and D. L. Strenge. 1980. ARRRG and FOOD - Computer Programs for Calculating Radiation Dose to Man from Radionuclides in the Environment. PNL-3180, Pacific Northwest Laboratory, Richland, Washington.

U.S. Nuclear Regulatory Commission (NRC). 1977. Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I. Regulatory Guide 1.119, Rev.1, U.S. NRC, Washington, D.C.

4. PROGRAMMING DETAIL

The information in this section is not necessary for a theoretical or operational understanding of the ONSITE/MAXI1 computer software package. It is included for those who wish to gain a better understanding of the structure and organization of the computer codes and for the programmer who must maintain or modify the software package.

The organization of the code modules and descriptions of all modules are presented in this section. Flow charts of the program control and simulation control are included. The use of the data arrays, common blocks, and data constants is tabulated for each of the programs. The organization of the input files is presented and the parameters of MAXI1 that are not reviewed by ONSITE are identified and described.

4.1 Program Hierarchy and Structure

ONSITE/MAXI1 is a package of two separate computer codes and a data base. All the computer codes have been designed in modular fashion and are written to meet ANSI-FORTRAN-77 standards. The hierarchical organization of code modules is presented graphically followed by tables describing each module.

MAXI1 is controlled by the module named MAIN and calls twenty-one subroutines and one function. The code module hierarchy of MAXI1 is presented in Figure 4.1-1. Descriptions of the modules are given in Table 4.1-1.

Table 4.1-1. MAXI1 Module Summary

Module Name	**Major Function and Description of Module**
ACHAIN	Calculates radiological decay for one radionuclide chain. (Subroutine called by SOLCON and WATER.)
AFACT	Calculates a resuspension factor using the Anspaugh model. (Subroutine called by PADOS.)
AIRDIS	Decays the atmospheric release source term, if necessary. (Subroutine called by PADOS.)
ANDOS	Calculates annual doses. (Subroutine called by MAIN.)
ASUM	Sums the terms of an array. (Function called by ACHAIN.)

Table 4.1-1. MAXI1 Module Summary (Continued)

Module Name	Major Function and Description of Module
DFREAD	Reads dose rate factor libraries, except inhalation. (Subroutine called by MAIN)
DUMMY	Reads past unused entries in inhalation dose rate factor library. (Subroutine called by INSET.)
IDNUC	Identifies input radionuclides in the inventory. (Subroutine called by MAIN.)
INSET	Reads the inhalation dose rate factor library. (Subroutine called by MAIN.)
MAIN	Controls library and parameter input, data organization, dose calculations, report printing and successive case handling. (Controlling module.)
MAXDOS	Calculates maximum annual dose. (Subroutine called by MAIN.)
MLOAD	Calculates a mass-loading factor. (Subroutine called by PADOS.)
OUTPUT	Prints report of results. (Subroutine called by MAIN.)
PADOS	Calculates pathway doses. (Subroutine called by MAIN.)
PNTO	Prints the resulting time dependent soil, air, irrigation-water and drinking-water concentrations. (Subroutine called by PADOS.)
QAPAGE	Prints a report of input variables. (Subroutine called by MAIN.)
RDSUB	Initializes inventory arrays and sets input inventory data into arrays. This subroutine is used only when special option is set. (Subroutine called by MAIN.)

Table 4.1-1. MAXI1 Module Summary (Continued)

Module Name	Major Function and Description of Module
RLIBIN	Reads master radionuclide library with chain decay. (Subroutine called by MAIN.)
SETDAT	Stores data for this radionuclide in arrays (Subroutine called by MAIN.)
SOLCON	Calculates the soil concentration accounting for both radioactive decay and deposition of radionuclides in irrigation water. (Subroutine called by PADOS.)
WATER	Decays the water release source term, if necessary. (Subroutine called by PADOS.)
ZEROI	Initializes an integer array to zero. (Subroutine called by IDNUC and SETDAT.)
ZEROR	Initializes a real array to zero. (Subroutine called by SETDAT, INSET, PADOS, ANDOS, and MAXDOS.)
CHANGE	Query if user requests parameter value change; and if so, input new value, test if within allowable limits, and repeat if not accepted. (Subroutine called by ONSITE, RADIN, QUANTI, and MODIF.)

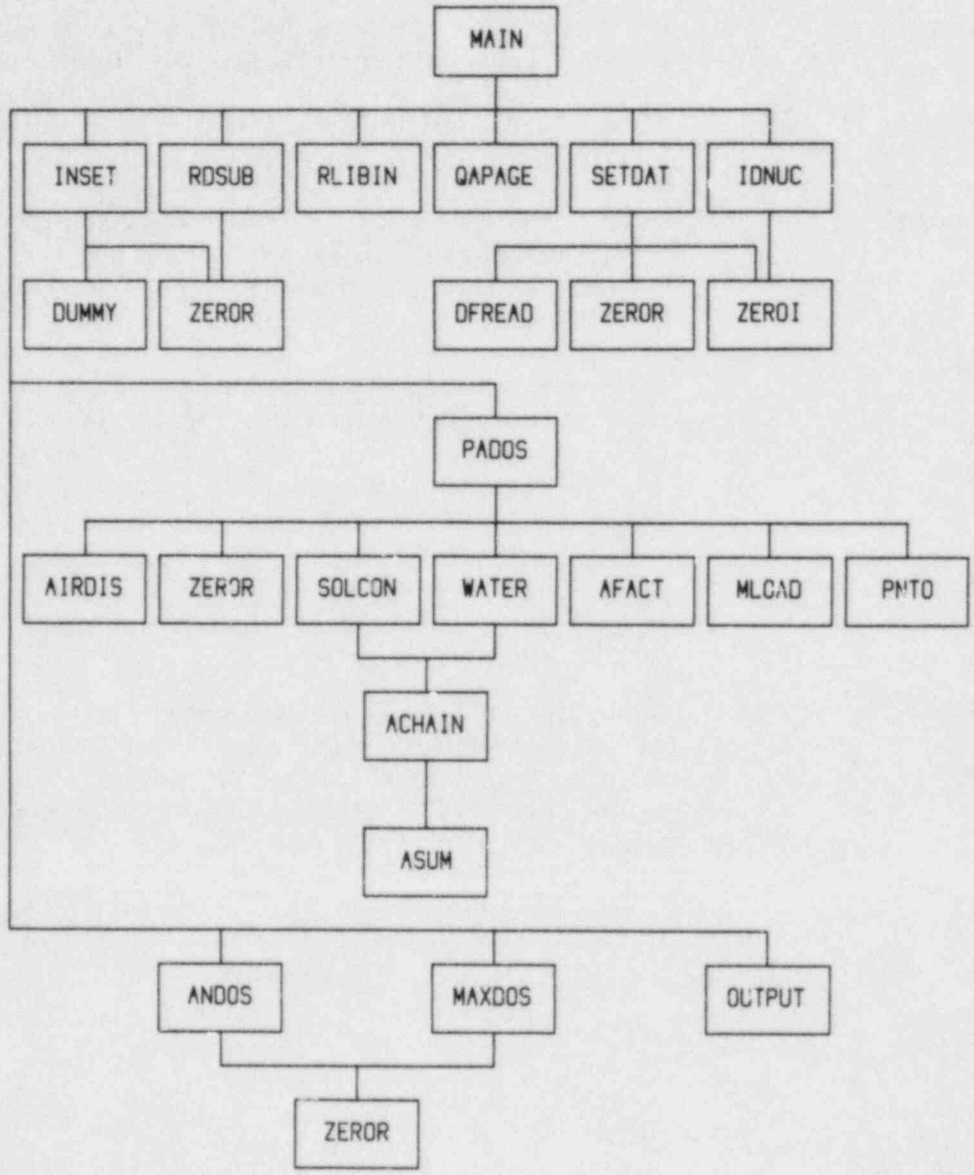

Figure 4.1-1. MAXI1 Design Hierarchy

The interactive program ONSITE is organized into twelve modules; ONSITE, the control program, and 11 subroutines. Figure 4.1-2 depicts the module hierarchy of ONSITE. Table 4.1-2 presents a summary of the modules.

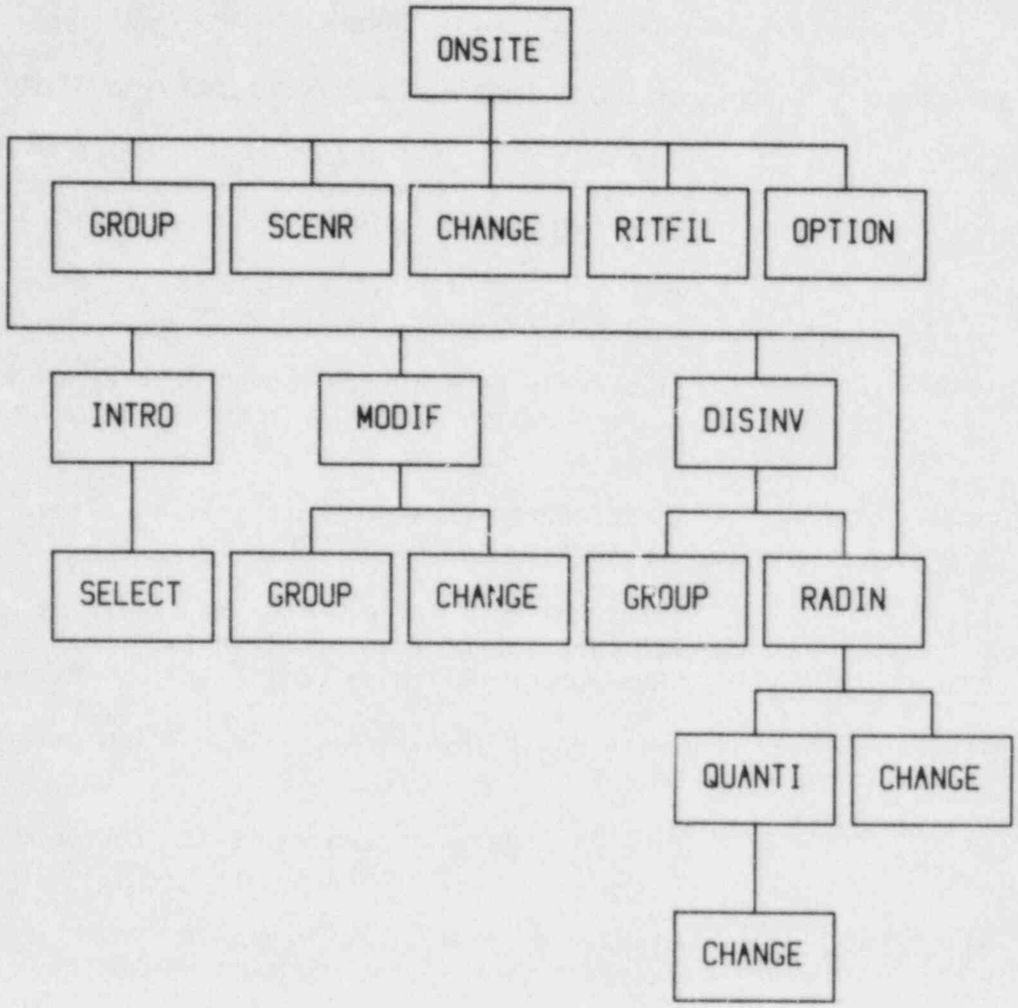

Figure 4.1-2. ONSITE Design Hierarchy

Table 4.1-2. ONSITE Module Summary

Module Name	Major Function and Description of Module
DISINV	Display report of radionuclide inventory and control modification and additions to the inventory. (Subroutine called by ONSITE.)
GROUP	Query if user wishes to review/modify any of a given collection of parameters. (Subroutine called by MODIF, ONSITE, and DISINV.)
INTRO	Display introductory message, instructions, and scenario descriptions on screen. (Subroutine called by ONSITE.)

Table 4.1-2. ONSITE Module Summary (Continued)

Module Name	Major Function and Description of Module
MODIF	Display for review and/or modification applicable parameters for each scenario; establish modified parameter values. (Subroutine called by ONSITE.)
ONSITE	Control program functions and review general parameters. (Controlling module.)
OPTION	Allow user to modify selected pathway options in a user-created scenario. (Subroutine called by ONSITE.)
QUANTI	Input source terms for each radionuclide. (Subroutine called by RADIN.)
RADIN	Input and test radiological source term; allow modification of translocation indices, if selected. (Subroutine called by ONSITE and DISINV.)
RITFIL	Write MAXI1 input file. (Subroutine called by ONSITE.)
SCENR	Establish default parameters for the selected scenario. (Subroutine called by ONSITE.)
SELECT	Display menu of scenario selection and input user's choice. (Subroutine called by INTRO.)

4.2 Computer Program Flow

The logic of the computer programs in the ONSITE/MAXI software package is depicted using flow-charting techniques described by Chapin (1974). The reader is presented concise overviews of the program control logic and the calculation control logic. Detailed flow charts are not provided for the following reasons: 1) the codes are modularly designed, 2) the logic within each module is readily apparent, and 3) each module is enhanced with comments. Figure 4.2-1 depicts MAXI1 program control logic and Figure 4.2-2 summarizes MAXI1 dose calculation logic. The program logic of ONSITE is charted in Figure 4.2-3.

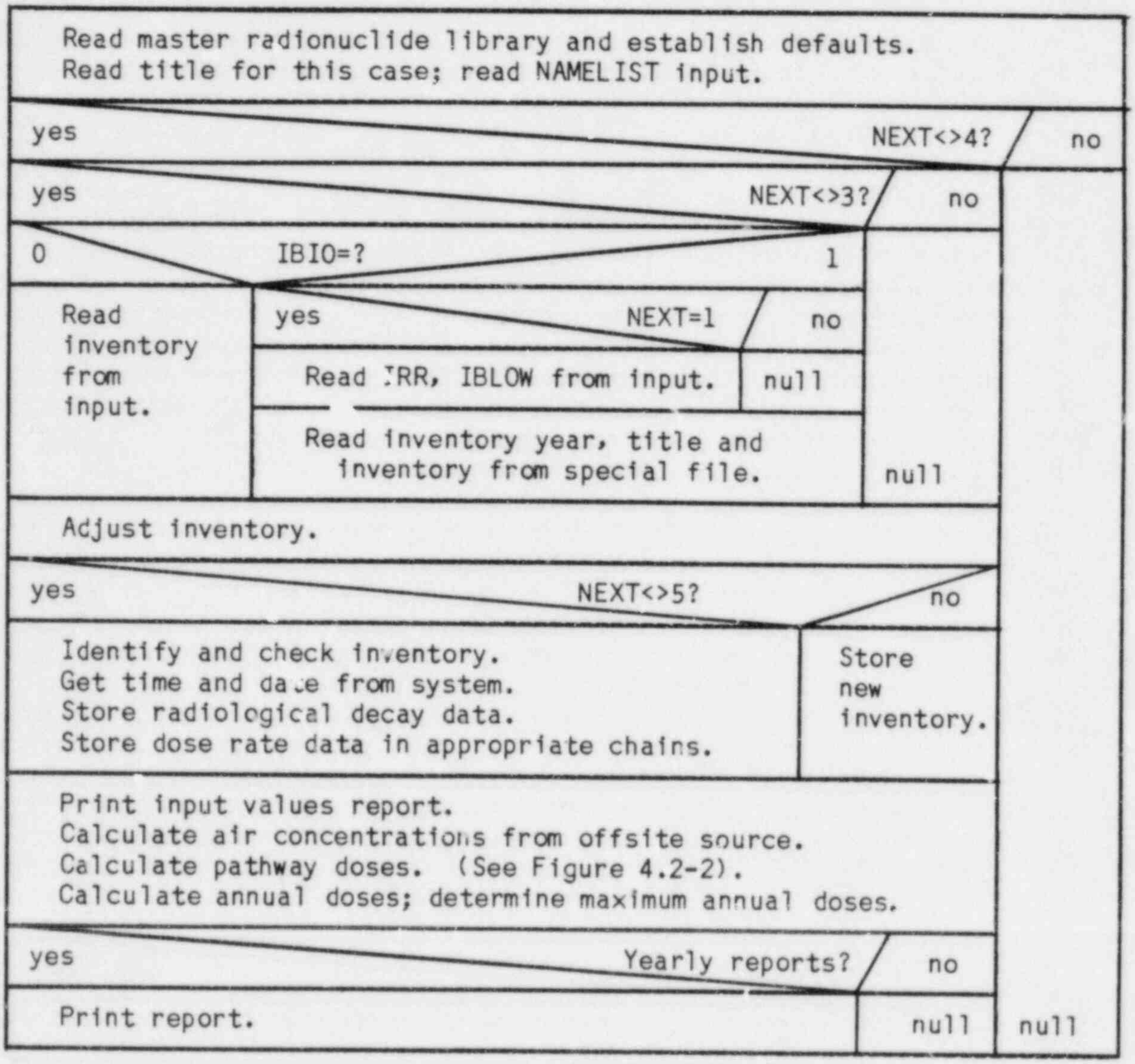

Figure 4.2-1. MAXI1 Program Control Flow Chart

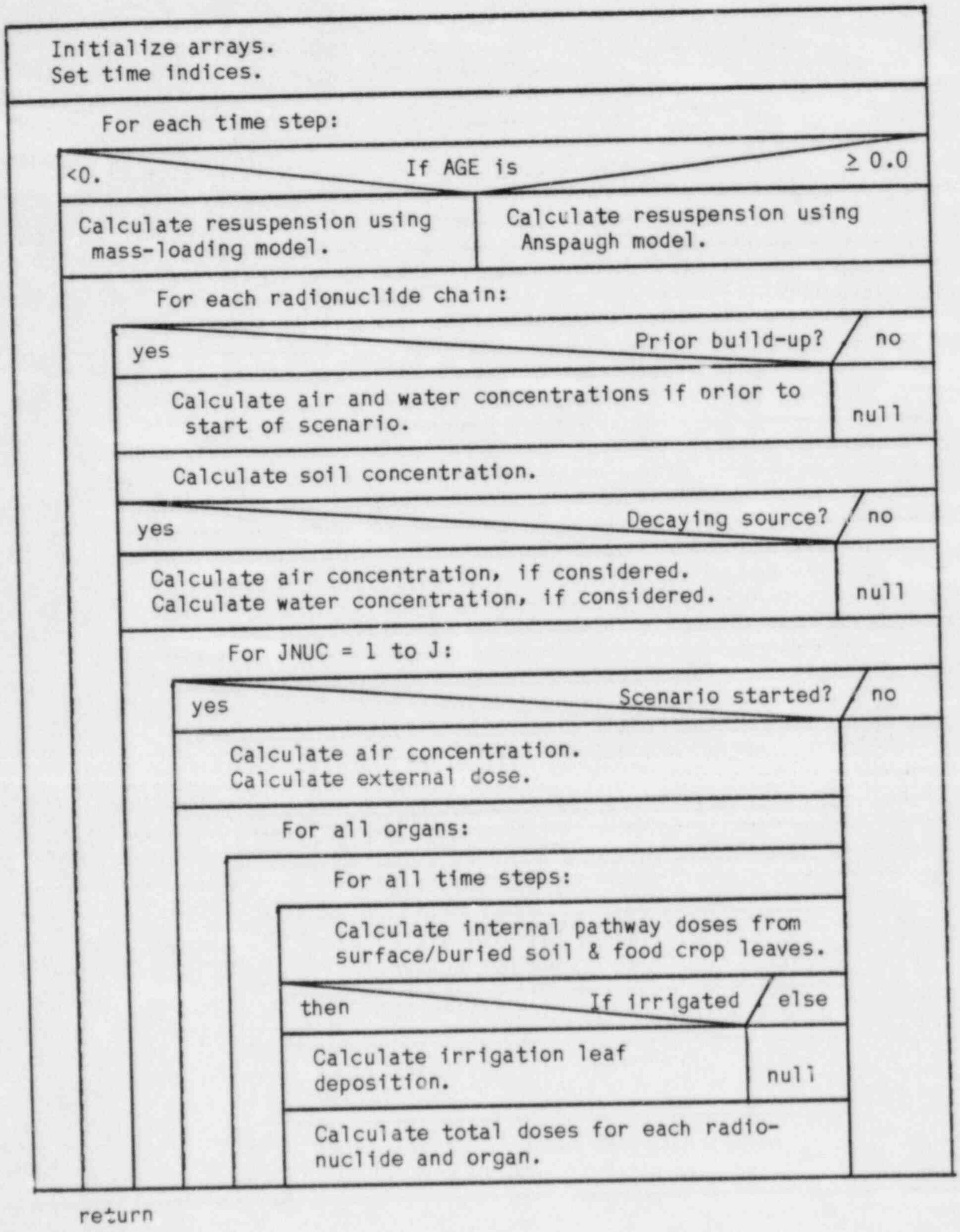

Figure 4.2-2. MAXI1 Dose Calculation Flow Chart

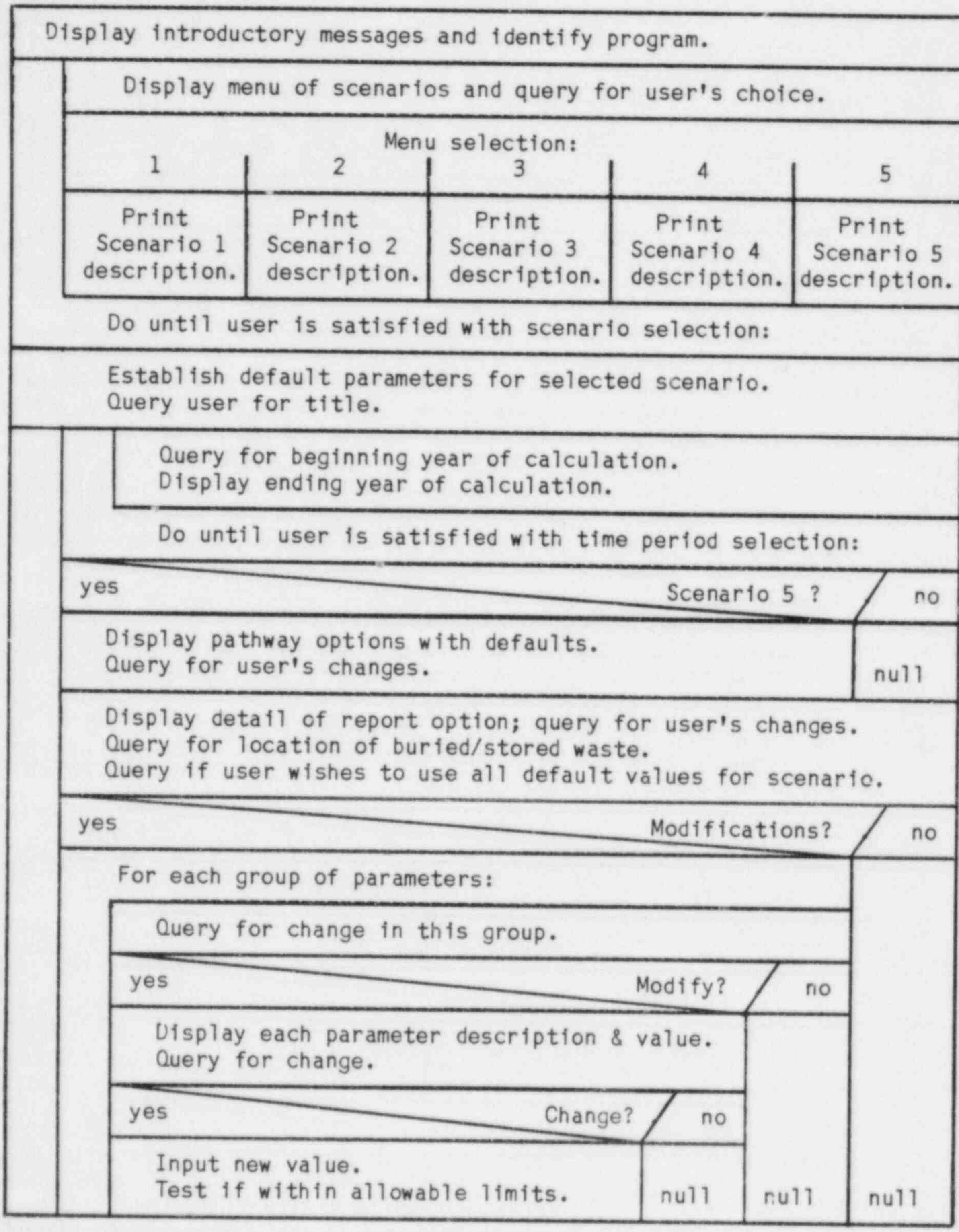

Figure 4.2-3. ONSITE Program Control Flow Chart

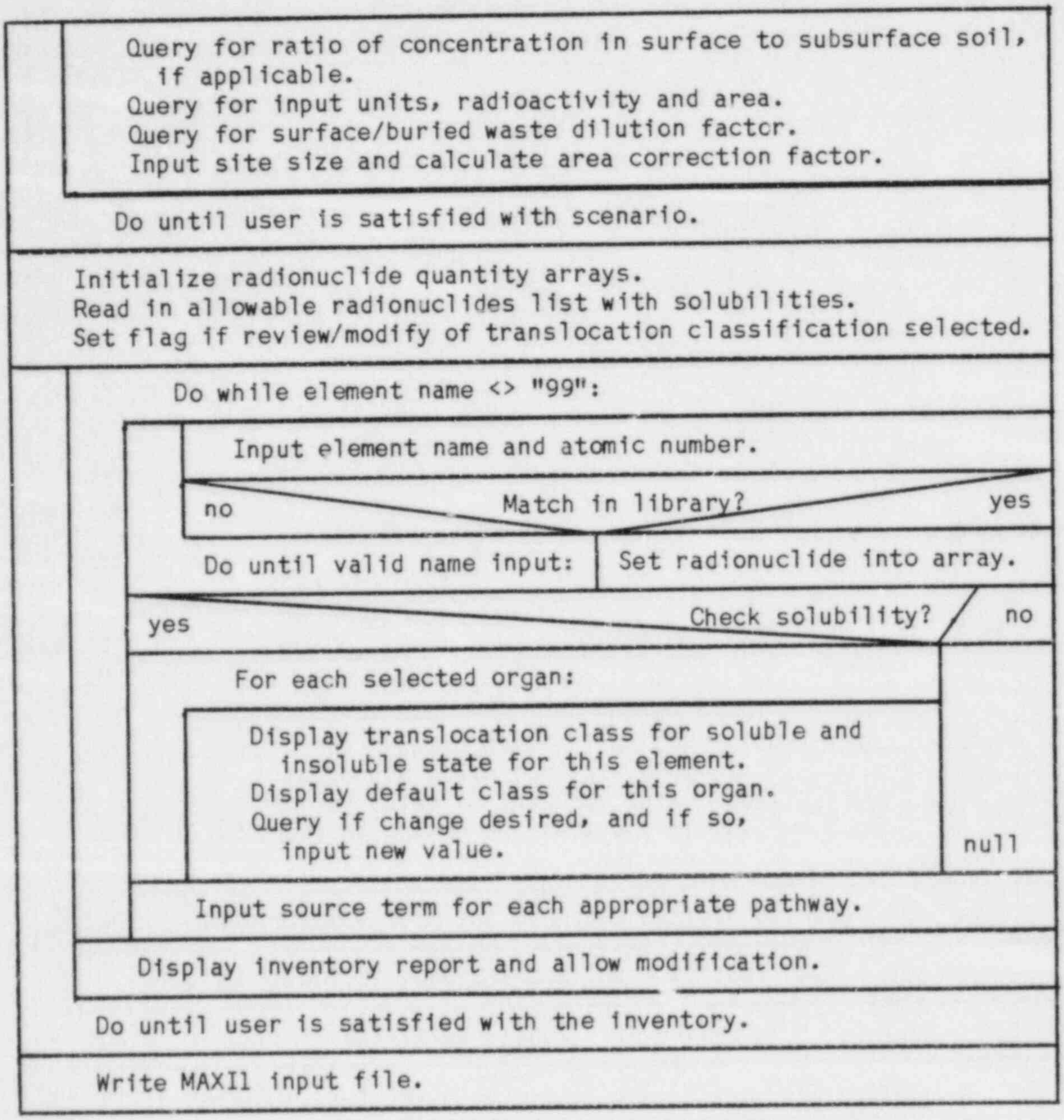

Figure 4.2-3. ONSITE Program Flow Chart (Continued)

4.3 Program Data and Data Structures

This section contains tables of the data arrays, common block definition and usage, and data constants for MAXI1 and ONSITE. The arrays are identified and their locations given in Tables 4.3-1 and 4.3-2. Common block usage is described in Tables 4.3-3 and 4.3-4. Data constants are identified and the assigned values are listed and described in Tables 4.3-5 and 4.3-6.

An attempt has been made to use variable and module names consistently throughout the package.

Table 4.3-1. MAXI1 Data Arrays

Array Name	Number of Elements	Common Block	Module Location
A	(1)		ASUM, SUMPRD, ZEROR
A	(45)		ACHAIN
AARDOS	(50,5)	DOSE1	
ADADOS	(50,5)	DOSE1	
ADWDOS	(50,5)	DOSE1	
AEXDOS	(50)	DOSE1	
AFDOS	(50,5)	DOSE1	
AIDOS	(50,50,5)	DATA2	
AIRCON	(50)		PADOS, PNTO
AIRFA	(50)		AFACT, MLOAD, PADOS
AL	(50)	DATA1	
AL	(9)		ACHAIN
AM	(50)	DATA1	
AM	(9)		ACHAIN
AMI	(50)	DATA1	PNTO
AMJ	(50)	DATA1	PNTO
AMK	(50)		PADOS, WATER, SOLCON
AML	(50)	THIRDS	
AMM	(50)		PADOS, SOLCON, AIRDIS
AMT	(50)		PADOS, PNTO, SOLCON
AO	(9)		ACHAIN, PADOS, SOLCON
ARDOS	(50,50,5)	DOSE1	
ARDW	(50,50,5)	DATA2	
ARGF	(50,50,5)	DATA2	
AW	(300)	RLIB	IDNUC
AWAW	(100)	FREAD	
AWDX	(100)	FREAD	
AWI	(50)		MAIN, IDNUC, SETDAT
AWLS	(100)	FREAD	
AWO	(50)	DATA1	PNTO
AWW	(100)	FREAD	
AWX	(100)	FREAD	
B	(1)	SUMPRD	
DADOS	(50,50,5)	DOSE1	
DEDXT	(50,50,5)	DATA2	
DEXT	(50)	DATA2	
DFDOS	(50,50,5)	DATA2	
DFDXT	(100)	FREAD	
DFXT	(100)	FREAD	
DIN	(3,50,5)		INSET
DK	(2,50)	DATA1	

Table 4.3-1. MAXI1 Data Arrays (Continued)

Array Name	Number of Elements	Common Block	Module Location
DK	(2,9)		ACHAIN
DKF	(2,300)	RLIB	
DWDOS	(50,50,5)	DOSE1	
ELT	(300)	RLIB	IDNUC
ELTA	(100)	FREAD	
ELTDX	(100)	FREAD	
ELTI	(50)		MAIN, IDNUC, SETDAT
ELTLS	(100)	FREAD	
ELTO	(50)	DATA1	PNTO
ELTX	(100)	FREAD	
EXDOS	(50,50)	DOSE1	
EXMO	(9)		ACHAIN
FADOS	(50,50,5)		MAIN
FDOS	(50,50,5)	DOSE1	
FR	(2)		RLIBIN
IDORG	(5)		INSET
IFR	(2,300)	RLIB	
IFRM	(2,50)	DATA1	
IFRM	(2,9)		ACHAIN
IMEM	(300)	RLIB	
INDOS	(50,50,5)	DATA2	
IOFNUC	(50)	DATA1	
IT	(2)		RLIBIN
K	(1)		ZEROI
KORG	(5)		MAIN, INSET, OUTPUT, QAPAGE, SETDAT
KORGA	(5)		MAIN, DFREAD, SETDAT
KORGLS	(5)		MAIN, DFREAD, SETDAT
KORGW	(5)		MAIN, DFREAD, SETDAT
MAXD	(5)	MXTIM	MAIN
MAXTIM	(5)	MXTIM	
NCHN	(300)	RLIB	IDNUC
NFLAG	(300)		MAIN, IDNUC, SETDAT
NFLAGC	(200)		MAIN, IDNUC, SETDAT
NOFNUC	(200)	RLIB	
NSOLD	(5,50)		MAIN, SETDAT
NTR	(5,50)		MAIN, INSET, QAPAGE, SETDAT
ONA	(5)		OUTPUT
ONAME	(23)		OUTPUT, QAPAGE
Q	(50)		MAIN, SETDAT
QAPR	(50)		MAIN, QAPAGE, SETDAT
QI	(50)		MAIN, SETDAT
QJ	(50)		MAIN, SETDAT
QK	(50)	THIRDS	
SOILCN	(50)	DATA1	PNTO
TIT20	(13)	TITLR	

Table 4.3-1. MAXI1 Data Arrays (Continued)

Array Name	Number of Elements	Common Block	Module Location
TIT21	(13)	TITLR	
TIT22	(13)	TITLR	
TIT24	(13)	TITLR	
TIT25	(13)	TITLR	
TIT27	(13)	TITLR	
TITLDI	(15)		MAIN, QAPAGE
TITLE1	(20)	JUNK	
TITLR	(20)		MAIN, QAPAGE, RLIBIN
TR	(300)	RLIB	
X	(100000)		MAIN

Table 4.3-2. ONSITE Data Arrays

Array Name	Number of Elements	Common Block	Module Location
A	(300)		RADIN
ANS	(2)		OPTION
AWI	(100)	INV	
CL	(3)		RADIN
E	(300)		RADIN
ELTI	(100)	INV	
EXTFAC	(2,4)		ONSITE
GNAME	(2)		ONSITE, MODIF, GROUP
IDORG	(5)		RADIN
IS	(2)		RADIN
KORG	(5)	VARYBL	
NS	(5,300)		RADIN
NSOLD	(5,100)	INV	
NVU	(4)	DESC	
NVUNIT	(4)	VARVBL	
ORG	(23)		RADIN
Q	(100)	INV	
QI	(100)	INV	
QJ	(100)	INV	
QK	(100)	INV	
TITL	(20)	DESC	
UNITS	(2,3)	DESC	
WHERE	(3,2)		QUANTI

Table 4.3-3. MAXI1 Common Block Definition and Usage

Common Block Name	Variables		Used by Module
DATA1	ELTO(50)	IFOD	MAIN
	AWO(50)	IARG	AIRDIS
	IOFNUC(50)	IWAT	ANDOS
	NONUC	DK(2,50)	DFREAD
	IFRM(2,50)	RIRR	INSET
	AL(50)	RPF	OUTPUT
	AM(50)	XMLF	PADOS
	SOILCN(50)	DILF	QAPAGE
	ICHN	IMO	SETDAT
	AMI(50)	DEN	SOLCON
	AMJ(50)	IEXT	WATER
DATA2	DFDOS(50,50,5)		MAIN
	AIDOS(50,50,5)		INSET
	INDOS(50,50,5)		PADOS
	DEXT(50)		SETDAT
	ARGF(50,50,5)		
	ARDW(50,50,5)		
	DEDXT(50)		
DOSE1	EXDOS(50,50)		MAIN
	AEXDOS(50)		ANDOS
	FDOS(50,50,5)		MAXDOS
	FADOS(50,50,5)		OUTPUT
	DADOS(50,50,5)		PADOS
	ARDOS(50,50,5)		
	DWDOS(50,50,5)		
	AFDOS(50,5)		
	ADADOS(50,5)		
	ADOS(50,5)		
	AARDOS(50,5)		
	ADWDOS(50,5)		

Table 4.3-3. MAXI1 Common Block Definition and Usage (Continued)

Common Block Name	Variables		Used by Module	
FREAD	ELTLS(100)	NYRL	MAIN	
	AWLS(100)	NYRS	DFREAD	
	ELTX(100)	NORGL	SETDAT	
	AWX(100)	NORGS		
	DFXT(100)	NISOL		
	ELTA(100)	NISOS		
	AWAW(100)	NYRW		
	ELTW(100)	NYRA		
	AWW(100)	NORGW		
	ELTDX(100)	NORGA		
	AWDX(100)	NISOW		
	DFDXT(100)	NISOA		
	NISODX			
JUNK	DD		MAIN	PADOS
	IT1		ANDOS	QAPAGE
	IT2		MAXDOS	
	TITLE1(20)		OUTPUT	
MXTIM	MAXTIM(5)		MAIN	
	MAXD(5)		MAXDOS	
			OUTPUT	
RLIB	ELT(300)	NCHST(200)	MAIN	
	AW(300)	IFR(2,300)	RLIBIN	
	TR(300)	DKF(2,300)	SETDAT	
	NUC	IMEM(300)		
	NCHN(300)	NCH		
	NOFNUC(200)			
THIRDS	QK(50)	IAIR	MAIN	QAPAGE
	AML(50)	IDKAIR	AIRDIS	SETDAT
	XQSITE	IBLOW	PADOS	
TITLS	TIT20(13)	TIT24(13)	DFREAD	
	TIT21(13)	TIT25(13)	QAPAGE	
	TIT22(13)	TIT27(13)		

Table 4.3-4. ONSITE Common Block Definition and Usage

Common Block Name	Variables		Used by Module		
AREA	FRSIZ	AREAEX	ONSITE		
	AREAIN		RITFIL		
DESC	TITL(20)		ONSITE	QUANTI	CHANGE
	UNITS(2,3)		SCENR	RITFIL	SELECT
	NVU(4)		MODIF	OPTION	GROUP
			RADIN	INTRO	
FLAG	ISUR		ONSITE	QUANTI	CHANGE
	IRS		SCENR	RITFIL	SELECT
	ILOC		MODIF	OPTION	GROUP
	INUT		RADIN	INTRO	
INV	NIN	ELTI(100)	ONSITE	INTRO	
	AWI(100)	QK(100)	SCENR	CHANGE	
	NSOLD(5,100)		MODIF	SELECT	
	Q(100)		RADIN	GROUP	
	QI(100)		QUANTI	OPTION	
	QJ(100)		RITFIL		
IOVAR	SCRN		ONSITE	QUANTI	SELECT
	OUT		SCENR	RITFIL	GROUP
	OUTFIL		MODIF	OPTION	
	KEY		INTRO	CHANGE	
VARYBL	IFOD	RIRR	ONSITE		
	RPF	IMO	SCENR		
	RF1	RF2	MODIF		
	IARG	IWAT	RADIN		
	IDKWAT	IEXT	QUANTI		
	IAIR	XQSITE	RITFIL		
	IDKAIR	XFACT	OPTION		
	AGE	XDPT	INTRO		
	DEN	XMLF	CHANGE		
	RINH	DILF	SELECT		
	M3M2	INTRUD	GROUP		
	IT1	IT2			
	NORG	KORG(5)			
	IOUT	NEXT			
	RPF1	RPF2			
	XF	INHAL			
	IRR	SRDIL			
	NVUNIT(4)				

Table 4.3-5. MAXI1 Data Constants

Constant Name	Constant Value	Module Location	Description
ONAME(n)	'organ name'	OUTPUT QAPAGE	Organ titles for report: 'organ name' as it appears in Table 4.5-3.
Unnamed	1.0×10^9	AFACT	Resuspension factor after 17 years, in units of m^{-1}, used with Anspaugh model. (See Equation 2.7)
Unnamed	0.15	MLOAD	Correction factor for units in PADOS with SOILCN in pCi/m^2.
Unnamed	3.15×10^4	SOLCON	Air concentration time and deposition velocity conversion factor: 3.15×10^7 sec/yr $\times 1.0 \times 10^{-3}$ m/sec.
Unnamed	3.175×10^4	MAIN	Air concentration conversion factor from Ci/yr to pCi/m^3.
Unnamed	1.0×10^{-4}	AFACT	Resuspension factor - Anspaugh model. (See Equation 2.7)
Unnamed	-2.87	AFACT	Effective decay constant used in the Anspaugh equation. (See Equation 2.7)
Unnamed	5.844×10^{-11}	PADOS	Unit conversion factor: (rem/mrem) (hr/yr) (Ci/pCi) ($m^2/0.15m^3$).
Unnamed	1.0×10^{-3}	PADOS	Air deposition velocity for all resuspended particles, m/sec.
Unnamed	2.635×10^6	PADOS	Number of seconds in a month.
Unnamed	365.25	SETDAT	Number of days in a year.
Unnamed	0.693	SETDAT	Natural log of 2.0.
Unnamed	5	MAIN	Logical unit number of the input file.
Unnamed	6	QAPAGE OUTPUT PNTO	Logical unit number of the input file.

Table 4.3-5. MAXI1 Data Constants (Continued)

Constant Name	Constant Value	Module Location	Description
Unnamed	10	RLIBIN	Logical unit number of the master radionuclide library.
Unnamed	20	DFREAD	Logical unit number of the leaf-mechanism dose rate factors file.
Unnamed	21	DFREAD	Logical unit number of the soil-mechanism dose rate factors file.
Unnamed	22	DFREAD	Logical unit number of the surface external exposure dose rate factors file.
Unnamed	23	INSET	Logical unit number of the inhalation dose rate factors file.
Unnamed	24	DFREAD	Logical unit number of the aquatic foods dose rate factors file.
Unnamed	25	DFREAD	Logical unit number of the drinking-water dose rate factors file.
Unnamed	27	DFREAD	Logical unit number of the buried-waste external-exposure dose rate factors file.
Unnamed	30	MAIN	Logical unit number of the inventory file. This is used only when IBIO=1.
Unnamed	40	OUTPUT	Logical unit number of output plot/summary file. This is used only when IBIO=1.

Table 4.3-6. ONSITE Data Constants

Constant Name	Constant Value	Module Location	Description
SCRN	1	ONSITE CHANGE	Logical unit number of the computer terminal.
OUT	7	ONSITE	Logical unit number of the output file from ONSITE.
XFACT	5.844E-11	SCENR	Unit conversion factor: (hr/yr/mrem) (ci/pCi) 0.15.
DILF	1.0	SCENR	River dilution factor.
INTRUD	1	SCENR	Special inhalation model option not manipulated by ONSITE.
UNITS(2,3)	"/square meter" "/cubic meter" "/Kg of soil"	ONSITE	Source-term input units corresponding to the index M3M2.
ORG(23)	"organ name"	RADIN	Organ titles for translocation class review: "organ name" arranged as indexed in Table 4.5-3.
ANS(2)	"(N/Y)" "(Y/N)"	OPTION	Default response logically selected for pathway selection based on the value of the option flag.
EXTFAC	"On Surface" "Buried at 0.5 " "Buried at 1.0 m" "Stored Waste"	ONSITE	Description of waste location for external exposure calculations.
NVU	"pCi" "mCi" " Ci" "Ci"	ONSITE	Description of input unit selection for source term.
NVUNIT	1.0 1.0×10^3 1.0×10^6 1.0×10^9	ONSITE	Source-term input units modification factor, corresponds to constant NVU.

4.4 Input File Organization

The ONSITE computer program relieves the typical user of the need to be concerned with the details of input file organization. Only the Level 3 User (see Sections 2.2.2 and 3.1), that is the user who wishes to interact directly with the MAXI1 program to set up unique scenarios, needs further information about the MAXI1 program. The following descriptions will assist the Level 3 User in setting up proper input for the MAXI1 code. The information in Section 2.4, Section 4.5, and this section will assist the Level 3 User in appropriate parameter selection and organization.

The MAXI1 execution file contains system commands to assign appropriate files from the data base and to run the MAXI1 code. The file also contains MAXI1 input; an identifying title, NAMELIST input, and the source term. The organization of the MAXI1 execution file is detailed in Table 4.4-1.

MAXI1 uses the FORTRAN NAMELIST set INPUT for entering parameter values. For this set, the first NAMELIST record must be blank in column one; "$INPUT" must be located in columns 2-8 and may optionally be followed by data items. The data items are separated by commas and the last item must be followed by "$END". The data items must have one of the three following forms:

(1) Parameter Name = Constant. The parameter name may be either subscripted or not.

(2) Array Name = Set of Constants (separated by commas). The number of constants may be less than, but not greater than, the number of elements in the array, and must be in the same order as the array is stored, i.e., the first subscript changes most rapidly.

(3) Subscripted Parameter = Set of Constants (separated by commas). The set of constants will be placed in consecutive array elements, starting with the element designated by the subscripted parameter.

Data items that are set via the NAMELIST statement are identified in Table 3.2.3-1 and Table 4.5-1 by the name of the set (e.g., INPUT) in the second column.

MAXI1 can handle consecutive cases in an execution. Each case is preceded by an 80-character one-line title, and NAMELIST statements and parameters. The original inventory is used in all subsequent cases. The parameter NEXT handles successive cases. The end of the run is signaled by a dummy title record and the NAMELIST INPUT parameter set to 4. The output from the ONSITE sample problem interaction sessions are examples of MAXI1 input file organization (see Figures in Section 3).

Table 4.4-1. MAXI1 Execution File Organization

File Position	Variable/Description/Format
First nl lines	• Logical unit/file assignment statements to assign the master radionuclide file and selected dose rate factor files for logical units 20-25 and logical unit 27.
Following line	• System command to execute MAXI1
Next line	• Identifying title, up to 80 characters
Following n lines	• NAMELIST set INPUT as described above
Next line	• NIN (number of radionuclides, including daughters) (I5)
	• IRR (number of years of irrigation prior to calculation) (I5)
	• IBLOW (number of years contaminant blew onto site prior to calculation) (I5)
Next NIN lines	• For each radionuclide n, one line contains the following information: AWI(n) - atomic element symbol (A2) ELTI(n) - atomic number (A6) NSOLD(1,n) - first organ (I1) NSOLD(2,n) - second organ (I1) NSOLD(3,n) - third organ (I1) NSOLD(4,n) - fourth organ (I1) NSOLD(5,n) - fifth organ (I1) Q(n) - contamination deposited on the site (E10.2) QI(n) - river release source term (E10.2) QJ(n) - drinking-water release source term (E10.2) QK(n) - atmospheric release source term (E10.2) Note: NSOLD is the translocation classification index for selected organs where: 1 = Class D 2 = Class W 3 = Class Y.

4.5 Additional Parameter Descriptions

The Level 3 User may utilize the MAXI1 computer code for a wide range of applications. A primary criteria in the development of the scenarios and the ONSITE computer code is that the code package should be easy to use. Consequently, some of the options that have little application to low-level waste storage are not manipulated by the ONSITE code. The Level 3 User may use these options and parameters when manually establishing MAXI1 input files. MAXI1 parameters not manipulated by ONSITE are listed and described in Table 4.5-1. Table 4.5-2 lists the organs used by the MAXI1 code and the organ reference index associated with each organ.

Table 4.5-1. Additional Parameter Descriptions: MAXI1

Parameter Name	NAMELIST Set/Number Array Elements	Data Type	Description
DILF	INPUT	Real	River dilution factor in units of $(1/yr)^{-1}$ to convert input river source term of pCi/yr to pCi/L. (Default value: 1.0 - no modification)
IAIR	INPUT	Integer	Will there by continuing atmospheric deposition? 0 - no 1 - yes (Default value: 0)
IBIO	INPUT	Integer	Not used in this application. (Default value: 0)
IBLOW		Integer	Number of years contaminants blew onto the site prior to the beginning of the dose calculation. (Default value: 0)
IBYR		Integer	Special input/output parameter not used in this application. (Default value: 0)
IDKAIR	INPUT	Integer	Decay the air-release source term for IT2-IT1 years, starting at the beginning of the scenario? 0 - no 1 - yes (Default value: 0)

Table 4.5-1. Additional Parameter Descriptions: MAXI1 (Continued)

Parameter Name	NAMELIST Set/Number Array Elements	Data Type	Description
IDKWAT	INPUT	Integer	Decay the irrigation and aquatic food-release term for IT2-IT1 years, starting at the beginning of the scenario? 0 - no 1 - yes (Default value: 0)
INTRUD	INPUT	Integer	Special inhalation model selection: 0 - model not selected 1 - model selected (allows a one-year exposure with annual doses) (Default value: 0
NEXT	INPUT	Integer	Case control index: 1 - this is the first case: read libraries, NAMELIST INPUT, and inventory; perform calculations and prepare for following cases 2 - not used by MAXI1 3 - this is a subsequent case; read title and NAMELIST INPUT, perform calculations, and prepare for following case 4 - end execution; previous title record was a dummy record 5 - special case handling not used in this application.
QK	(100)	Real	Atmospheric release source term in pCi/yr. Not used in this application.
XQSITE	INPUT	Real	Chi/q value at the site. (Default value: 0.0)
XFACT	INPUT	Real	This parameter has three functions: it can be used to turn off the surface external pathway (XFACT=0.); it can modify the units of the surface external DRF file assigned to logical unit 22 allowing use of ISOSHLD generated files (XFACT=1.0 for MAXI2 generated file 22, XFACT=5.844E-11

Table 4.5-1. Additional Parameter Descriptions: MAXI1 (Continued)

Parameter Name	NAMELIST Set/Number Array Elements	Data Type	Description
(cont)			for ISOSHLD generated file 22); and it can modify the number of hours of exposure per year (based on a full year of exposure or 8766 h/yr = 1.0). ONSITE uses the parameters ISUR, I22, and XF2 to simplify input of this parameter. MAXI1 will calculate XFACT only if values have been entered in NAMELIST INPUT for ISUR, I22, and XF2. This logic allows the user to enter a value for XFACT through the NAMELIST statement.

Table 4.5-2. Organ Selection

1 - Total body	9 - Adrenals	17 - Pancreas
2 - Body water	10 - Testes	18 - Heart
3 - Kidneys	11 - Ovaries	19 - GI tract
4 - Liver	12 - Skin	20 - Stomach
5 - Spleen	13 - Brain	21 - Small intestine
6 - Bone	14 - Muscle	22 - Upper large intestine
7 - Fat	15 - Prostrate	23 - Lower large intestine
8 - Lungs	16 - Thyroid	

4.6 CDC Computer-Code Installation

The installation of the ONSITE/MAXI1 software package on the Control Data Corporation (CDC) computers at Brookhaven National Laboratories is discussed in this section. Computer operation-system interfacing on the CDC computers is largely transparent to the user due to procedures included with this software package. These command level procedures are discussed in Section 4.6.1. Software security procedures established on the CDC are discussed in Section 4.6.2. Conversion of the computer codes for execution on the CDC is discussed in Section 4.6.3.

The ONSITE/MAXI1 software package is installed on the Brookhaven National Laboratory CDC 6600 (MFA) and CDC 7600 (MFZ) computers. The package has been modified to execute under INTERCOM Version 4 software control. The MFA computer uses the NOS/BE 1 operating system and the MFZ computer uses the SCOPE Version 2.1 operating system. The source code is compiled with the FTN5 FORTRAN compiler. The contents of the ONSITE/MAXI software packages are listed in Table 4.6-1. Files residing on MFA have been backed up in duplicate on library tapes K355 and K1916. Files residing on MFZ have been backed up in duplicate on library tapes K1917 and K1918. Backup tapes were created with the DUMPF system command. MAXI1, MAXI2, and MAXI3 were developed on a UNIVAC 1100/70 computer. The ONSITE computer code was developed on a Zenith-89 microcomputer. The software package was assembled, debugged, and tested on a VAX-11/780 computer.

4.6.1 Command Level Procedures

Three interactive Cyber Control Language (CCL) procedures have been written to handle most of the operating-system interface for the ONSITE/MAXI1

Table 4.6-1. Contents of the ONSITE/MAXI1 Software Package

Filename	Computer	Identification	File Type
PROCFIL	MFA	ONSITE	Command level procedure
ONSITE	MFA	ONSITEDB	FORTRAN source code
MAXI1	MFA	ONSITEDB	Batch process file for MFZ containing compilation directives and FORTRAN source code
MAXI2	MFA	ONSITEDB	FORTRAN source code
MAXI3	MFA	ONSITEDB	FORTRAN source code
ONSITEABS	MFA	ONSITEDB	Machine executable code
MAXI1ABS	MFZ	ZZRNRC	Machine executable code
MAXI2ABS	MFA	ONSITEDB	Machine executable code
MAXI3ABS	MFA	ONSITEDB	Machine executable code
RMDONS	MFA	ONSITEDB	Sequential data
RMDLIB	MFZ	ZZRNRC	Sequential data
FILE20	MFZ	ZZRNRC	Sequential data
FILE21	MFZ	ZZRNRC	Sequential data
PLANSOURC	MFZ	ZZRNRC	Sequential data
ROOM	MFZ	ZZRNRC	Sequential data
FILE23	MFZ	ZZRNRC	Sequential data
FILE24	MFZ	ZZRNRC	Sequential data
FILE25	MFZ	ZZRNRC	Sequential data
VOLSOURC	MFZ	ZZRNRC	Sequential data
BURIEDHF	MFZ	ZZRNRC	Sequential data
BURIED1	MFZ	ZZRNRC	Sequential data
ORGLIB	MFA	ONSITEDB	Sequential data
FTRANSLIB	MFA	ONSITEDB	Sequential data
GRDFLIB	MFA	ONSITEDB	Sequential data
BIOAC	MFA	ONSITEDB	Sequential data
ONFOR	MFA	ONSITEDB	Batch compilation
M2FOR	MFA	ONSITEDB	Batch compilation
M3FOR	MFA	ONSITEDB	Batch compilation

executions. Instructions for using these procedures are given in Section 3.1.1. The first CCL procedure, named ON, performs the necessary system-level commands to attach files, connect the files INPUT and OUTPUT to the terminal screen, and execute the ONSITE computer program. The second CCL procedure, named DONE, solicits a unique filename and a read-protection key from the user. DONE then catalogs the ONSITE-generated file with the user-supplied name, removes interim files from the user's work area, and disconnects the files INPUT and OUTPUT from the terminal screen. A third procedure, named SEND, routes an output file from the batch process output queue to the Remote Job Entry (RME) printer at the SS-056 Computer Operations Facility, Willste Building, Silver Spring, Maryland. A listing of the file containing these procedures is located in Appendix 1.D.1.

4.6.2 Software Security

All files in the ONSITE/MAXI1 software package have been protected against modification, extension, deletion, and performance of control functions by passwords. These passwords are not necessary for execution of any of the codes in the ONSITE/MAXI1 software package. Requests for access to the passwords should be directed to the NRC Project Manager. Execution files created by ONSITE contain user identification and account information. These files are protected against read-access by a user-supplied password as discussed in Section 3.1.1.

4.6.3 Computer-Code Conversion

Most changes to the codes in the ONSITE/MAXI1 software package were the result of minor syntax variations in the hardware and FORTRAN compilers. The only major change in the CDC version of the software package is the coding of the module RITFIL of the ONSITE computer code. A listing of the CDC version of RITFIL is located in Appendix 1.D.2.

4.7 References

Chapin, N. 1974. "New Format for Flowcharts," Software - Practice and Experience, Vol. 4, pp. 341-357, John Wiley and Sons Ltd., London, England.

APPENDIX 1.A

COMPUTER CODE LISTING - MAXI1

APPENDIX 1.A COMPUTER CODE LISTING - MAXI1

```
C-----------------------------------------------------------------
C
C   Program Title:  MAXI1
C
C   Developed for:  U.S. Nucear Regulatory Commission
C
C                   Office of Nuclear Regulatory Material Safety &
C                      Safeguards
C                   Division of Waste Management
C                            and
C                   Office of Nuclear Regulatory Research
C                   Division of Health, Siting, and Waste Management
C
C   Date:           May 31, 1984
C
C   NRC Contacts:   Dr. Stan Neuder  (NMSS)
C                      Phone: 301-427-4607
C                   Dr. John Randall  (NRR)
C                      Phone: 301-427-4633
C
C   Code Developer: B.A. Napier, R.A. Peloquin, W.E. Kennedy, Jr.
C                   Pacific Northwest Laboratory
C                   Richland, WA      509-375-3849 (WEK)
C
C
C   This program was prepared for an agency of the United States
C   Government.  Neither the United States government nor any agency
C   thereof, or any of their employees, make any warranty, expressed
C   or implied, or assumes any legal liability or responsibility for
C   any third party's use, or the results of such use, of any portion
C   of this program or represents that its use by such third party
C   would not infringe privately owned rights.
C
C
C----------------------------------------------------------------------
C
C
      PROGRAM MAXI1
C
C     THIS PROGRAM IS DESIGNED TO CALCULATE ANNUAL RADIATION DOSES FROM
C     INGESTION, INHALATION, EXTERNAL SURFACE CONTAMINATION,
C     AND AQUEOUS FOOD AND WATER INGESTION RESULTING
C     FROM RESIDUAL RADIOACTIVITY AT DECOMMISSIONED NUCLEAR FACILITIES
C     AND WASTE STORAGE SITES.
C
C     Version of 25-APR-84  RAP
C
C---------------------------------------------------------------------
C
```

```
      COMMON/THIRDS/QK(50),AML(50),XQSITE,IAIR,IDKAIR,IBLOW
C
      COMMON/RLTB/ELT(300),AW(300),TR(300),NUC,NCH,NCHN(300),NOFNUC(200)
     .,NCHST(200),IFR(2,300),DKF(2,300),IMEM(300)
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/DATA2/DFDOS(50,50,5),AIDOS(50,50,5),INDOS(50,50,5),
     .DEXT(50),ARGF(50,50,5),ARDW(50,50,5),DEDXT(50)
C
      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),
     .FADOS(50,50,5),DADOS(50,50,5),
     .ARDOS(50,50,5),DWDOS(50,50,5),
     .AFDOS(50,5),ADADOS(50,5) ADOS(50,5),
     .AARDOS(50,5),ADWDOS(50,5)
C
      COMMON/MXTIM/MAXTIM(5),MAXD(5)
C
      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
      DIMENSION KORG(5),NTR(5,50),TITLR(20),TITLDI(15),NSOLD(5,50)
      DIMENSION TITLIN(40)
      DIMENSION Q(50),ELTI(50),AWI(50)
      DIMENSION QI(50),QJ(50),QAPR(50)
      DIMENSION NFLAG(300),NFLAGC(200)
C
C
      CHARACTER AW*6,AWO*6,AWI*6
      CHARACTER AWLS*6,AWX*6,AWAW*6,AWW*6,AWDX*6
      CHARACTER DDTT*9, TODAY*10, CLOCK*10
      REAL*4 INDOS
C
      DATA AST /'**  '/
C
C NAMELIST INPUT PARAMETERS
C
      NAMELIST/INPUT/IEXT,XFACT,IOUT,IT1,IT2,KORG,NORG,XDPT,NEXT
     .,AGE,IFOD,IARG,IWAT,RIRR,RPF,XMLF,M3M2,DILF,IMO,DEN,
     .RF1,RF2,RINH,INTRUD,IDKWAT,IAIR,XQSITE,IDKAIR,
     . RPF1, RPF2, ISUR, I22, XF2, SRDIL, IBIO,
     . FRSIZ, AREAIN, AREAEX, ION
C
C     LAST TWO LINES OF NAMELIST INPUT SPECIFIC TO VAX ONSITE/BIOPORT
C     VERSION
C
C     MAXIMUM NUMBER OF RADIONUCLIDES THAT CAN BE CONSIDERED
      NMAX=50
```

```
C     GET DATE AND TIME
      CALL DATE(TODAY)
      CALL TIME(CLOCK)
C
C READ MASTER DATA LIBRARY FOR RADIONUCLIDE AND CHAIN DECAY DATA
C
      CALL RLIBIN(TITLR)
C
C
C READ CASE SPECIFIC INPUT
C
      DEN=100.
      IMO=6
      IFOD=1
      IARG=1
      IWAT=1
      IAIR=1
      XQSITE=0.0
      IDKAIR=0
      RPF=1.
      RPF1=1.0
      RPF2=0.0
      RIRR=0.0
      XMLF=0.01
      M3M2=0
      DILF=1.0
      AGE=-1.0
      IDKWAT=0
      RIM=1.0
      XDPT=0.067
      XFACT=1.0
      ISUR=1
      I22=1
      XF2=0.0
      IT1=1
      RF1=1.0
      RF2=0.0
      RINH=1.0
      IEXT=0
      INTRUD=0
      IT2=50
      SRDIL=1.0
C
      KORG(1)=1
      KORG(2)=6
      KORG(3)=8
      KORG(4)=16
      KORG(5)=23
      NORG=5
```

```
      IBIO = 0
      ION = 0
C
      FRSIZ = 1.0
      AREAIN = 1.0
      AREAEX = 1.0
C
C
C     RPF1= OLD RPF
C     RPF2= FRACTION OF TOTAL DIET GROWN ON SITE
C     RPF=RPF1 : IF RPF2>0. THEN RPF = RPF1*RPF2
C     ONLY RPF IS USED IN THE CALCULATION; RPF1, RPF2 USED FOR QA PAGE  -RAP
C
C     ISUR, I22, AND XF2 ARE THE ONSITE PARAMETERS EQUIVELENT TO XFACT
C        ISUR = SURFACE CONTAMINATION (0-NOT CONSIDERED, 1-CONSIDERED)
C        I22  = INDEX OF SURFACE CONTAMINATION SOURCE (0-ISOSHLD, 2-MAXI2)
C        XF2  = NO.OF HOURS/YEAR PERSON IS EXPOSED TO EXTERNAL CONTAMINATION
C
C     CODE LOGIC HAS BEEN ARRANGED SO THAT THE USER MAY STILL INPUT "XFACT"
C     THROUGH NAMELIST.  XFACT WILL ONLY BE SET BY MAXI1 IF VALUES HAVE BEEN
C     INPUT FOR ISUR, I22, AND XF1
C
    1 READ(5,50,END=99) TITLE1
      READ(UNIT=5,NML=INPUT,ERR=97)
      IF(NEXT.EQ.4)GO TO 95
C
C   SET RIM VALUES BY M3M2
C
      IF(M3M2.EQ.1) RIM=0.15
      IF(M3M2.EQ.2) RIM=224.
C
C   IF ONSITE INPUT, SET XFACT BASED ON VALUES OF ISUR, I22, AND XF2
      IF (ISUR .EQ. 0) THEN
        XFACT = 0.0
      ELSE
        IF (I22 .EQ. 0)  XFACT = 5.844E-11
        IF (XF2 .GT. 0.) XFACT = XFACT * (XF2/8766.)
      ENDIF
C
C   IF ONSITE, SET RPF ELSE SET RPF1=RPF
      IF (RPF2 .GT. 0.) THEN
        RPF = RPF1 * RPF2
      ELSE
        RPF1 = RPF
        RPF2 = 1.0
      ENDIF
C
C READ NEW ISOTOPE SELECTION
C NOTE:  SUCCESSIVE CASES USE THE INITIAL INVENTORY
```

```
C IF NOT BIOPORT INPUT , DO STANDARD INVENTORY INPUT
      IF (IBIO .NE. 1) THEN
C
        IF(NEXT.EQ.3) GO TO 100
        READ(5,200,END=99) NIN, IRR, IBLOW
        IF(NIN.GT.NMAX.OR.NIN.LT.1) GO TO 98
C
        READ(5,300,END=99)(ELTI(I),AWI(I),(NSOLD(J,I),J=1,5),Q(I),
     .                    QI(I),QJ(I),QK(I),I=1,NIN)
C
      ELSE
C     USE SPECIAL INVENTORY INPUT ROUTINE FROM BIOPORT
C
        IF (NEXT .EQ. 1) THEN
C         FIRST TIME THROUGH
          READ(5,201) IRR, IBLOW
          READ(30,202) (TITLIN(IRAP),IRAP=1,10)
C            PRINT 202, (TITLIN(IRAP),IRAP=1,40)
        ENDIF
C
C       READ BIOPORT YEAR FOR REPORTS
        READ (30,205) IBYR
C         PRINT 205, IBYR
C
C       USE ALTERNATE INVENTORY INPUT (* SIGNALS END THIS YEAR)
C
        NIN=0
        I=1
C
  153   CONTINUE
          READ (30,301,END=99) ELTI(I),AWI(I),(NSOLD(J,I),J=1,5),
                               Q(I), QI(I), QJ(I)
C
C          PRINT 8801, ELTI(I),AWI(I),Q(I),AST
C 8801     FORMAT (' AS READ:',A4,':',A6,E10.3,':',A4,':')
C
          IF (ELTI(I) .EQ. AST) GO TO 152
          I = I + 1
          NIN = NIN + 1
        GO TO 153
C
  152   CONTINUE
C
      ENDIF

      DO 150 I=1,NIN
      Q(I) = Q(I) * SRDIL
  150 QI(I)=QI(I)*DILF
C
```

```
C  IMPORTANT NOTE: THE ORDER OF NSOLD ON THE INVENTORY CARDS
C  ABSOLUTELY MUST MATCH THAT OF THE INPUT ORDER OF KORG
C  IN THE INPUT NAMELIST!!
C
C     DO THE FOLLOWING FOR STANDARD EXECUTION:
      IF (NEXT .NE. 5) THEN
C
        CALL IDNUC(NUC,ELT,AW,ELTI,AWI,NIN,NCHN,NFLAG,NFLAGC)
C
C       CALL DATE OF RUN
C
        CALL DATE(TODAY)
        CALL TIME(CLOCK)
C
C       CALL SETDAT TO SET DATA IN CHAINS
        CALL SETDAT(ELTI,AWI,NFLAG,NFLAGC,Q,
     .              KORG,NORG,NSOLD,NTR,QI,QJ,RIM,
     .              QAPR,ISUR)
C
C       SET INHALATION DATA ARRAY
        CALL INSET(NORG,KORG,NTR,TITLDI)
C
 100    CONTINUE
C
      ELSE
C
C       THIS IS SUBSEQUENT BIOPORT RUN, USE SPECIAL INITIALIZATION
        CALL RDSUB (Q, QI, QJ, NFLAG, QAPR, RIM)
C
      ENDIF
C
C CALL QAPAGE TO PRINT BACK PARAMETERS USED
C
      CALL QAPAGE(RF1,RF2,INTRUD,IDKWAT,XFACT,IRR,RINH,XDPT,AGE,
     .M3M2,KORG,NORG,NTR,TITLR,TITLDI,QAPR,RPF1,RPF2,ISUR,I22,
     .XF2,SRDIL,IBIO,IBYR,TITLIN,NEXT,FRSIZ,AREAIN,AREAEX,ION)
C
C  SET AIR CONCENTRATIONS FROM OFF-SITE SOURCES
C
      IF(IAIR.NE.1)GO TO 160
      DO 151 I=1,NONUC
 151  AML(I)=AML(I)*XQSITE*3.175E4
 160  CONTINUE
C
C CALCULATE PATHWAY DOSES
C
      CALL PADOS(XFACT,NORG,XDPT,AGE,IRR,RF1,RF2,RINH,INTRUD,IDKWAT,
     .           XF2, RPF1, RPF2, AREAIN, AREAEX)
C
```

```
C CALCULATE ANNUAL DOSES
C
      CALL ANDOS(NORG)
C
C DETERMINE MAXIMUM ANNUAL DOSE
C
      CALL MAXDOS(NORG)
C
C PRINT OUTPUT RESULTS PAGE
C
      CALL OUTPUT (NORG,IOUT,KORG,IBIO,IBYR,NEXT)
C
C  RECOVER AML FOR FUTURE CASES
C
      IF(IAIR.NE.1)GO TO 180
      DO 170 I=1,NONUC
  170 AML(I)=AML(I)/(XQSITE*3.175E4)
  180 CONTINUE
C
  50  FORMAT(20A4)
  200 FORMAT(3I5)
  201 FORMAT(2I5)
  202 FORMAT(20A4)
  205 FORMAT(1X,I5)
  300 FORMAT(A2,A6,5I1,4E10.2)
  301 FORMAT(1X,A2,A6,5I1,4E10.2)
C
C     IF(NEXT.GT.1) GO TO 1
      GO TO 1
C
C
   95 PRINT 400
      STOP
   99 PRINT 600
  600 FORMAT(1H1,' DIAGNOSTIC 1: END OF FILE ON INPUT, STOP')
      STOP
   97 PRINT 700
  700 FORMAT(' DIAGNOSTIC 2: ERROR ON NAMELIST INPUT')
      STOP
   98 PRINT 800,NIN,NMAX
  800 FORMAT(1H1,' DIAGNOSTIC 3: ERROR IN NUMBER OF NUCLIDES  ',
     .'INPUT, NONUC=',I3,'MAXIMUM ALLOWED IS,'I4)
  400 FORMAT(1H1,'DIAGNOSTIC 4: END OF INPUT FOR THIS RUN, NORMAL ',
     .'TERMINATION')
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE ACHAIN(NUC,T,DK,IFRM,AL,AM,AO)
C
C     THIS SUBROUTINE IS THE HEART OF THE CHAIN DECAY PROCEDURE.
C     IT REQUIRES THE COMPLEX INFRASTRUCTURE OF RLIBIN,SETDAT.PADOS.
C
C     Module of MAXI1
C     Version of 24-MAY-84
C
C-----------------------------------------------------------------------
C
C
      REAL*8 A(45), SUMPR
      DIMENSION DK(2,9),IFRM(2,9),AL(9),AM(9),AO(9),EXPO(9)
C
C  INITIALIZE COEFFICIENT ARRAY TO ZERO
C
      N2N=NUC*(NUC-1)/2+NUC
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
      EXPO(J)=EXP(-AL(J)*T)
      JJ=J*(J-1)/2
      J1=J-1
      IF(J1.LE.0) GO TO 4
      IMAX=MIN0(J1,2)
      DO 3 M=1,J1
      DO 2 L=M,J1
      DO 1 I=1,IMAX
      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
    1 CONTINUE
    2 CONTINUE
      A(M+JJ)=A(M+JJ)/(AL(J)-AL(M))
    3 CONTINUE
C
C   4 CONTINUE
C     ASUM = 0.0
C     IF (J1 .EQ. 0) GO TO 11
C       DO 12 IRAP = 1, J1
C         JK = JJ + IRAP
```

```
C         ASUM = ASUM + A(JK)
C  12   CONTINUE
C  11 CONTINUE
C
    4 A(J+JJ)=AM(J)-ASUM(J1,A(JJ+1))
C
      A(J+JJ) = AM(J) - ASUM
C
C      AO(J)=SUMPRD(J,EXPO,A(JJ+1))
C      THE VAX HAS A PROBLEM WITH THIS CODE- USR THE FOLLOWING:
C
      SUMPR = 0.0
      DO 8884 IN = 1,J
        JK = JJ + IN
        SUMPR = SUMPR + EXPO(IN) * A(JK)
 8884 CONTINUE
      AO(J) = SUMPR
C
    5 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE AFACT(AITIM,AIRFA,ITIME,XDPT)
C
C     THIS SUBROUTINE CALCAULATES A RESUSPENSION FACTOR USING THE ANSPAUGH
C     MODEL WITH A LOWER LIMIT OF 1.0E-9.
C
C     Module of MAXI1
C     Version of 25-APR-84
C
C-----------------------------------------------------------------------
C
C
      DIMENSION AIRFA(50)
C
    1 CONTINUE
C
      IF(AITIM.GT.25) GO TO 10
      AIRFA(ITIME)=1.0E-4*(EXP(-2.87*(SQRT(AITIM))))+1.0E-9
      AIRFA(ITIME)=AIRFA(ITIME)*XDPT
      GO TO 30
   10 AIRFA(ITIME)=1.0E-9*XDPT
   30 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE AIRDIS(IDKA,INUC,JTIME,AMM,J)
C
C     THIS SUBROUTINE IS USED TO DECAY THE ATMOSPHERIC RELEASE SOURCE TERM
C     IF NECESSARY.  USED FOR CASES WITH OFF-SITE AIRBORNE SOURCES
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/THIRDS/QK(50),AML(50),XQSITE,IAIR,IDKAIR,IBLOW
C
      CHARACTER*6 AWO
      DIMENSION AMM(50)
C
C  IF NOT DECAYING SOURCE, SET AMM=AML
C
      IST=INUC+1
      K=IST+J-1
      IF(IDKA.NE.0)GO TO 10
      DO 100 I=IST,K
  100 AMM(I)=AML(I)
      GO TO 90
C
C  DECAY ONE-MEMBER CHAINS
C
   10 IF(J.GT.1)GO TO 20
      AMM(IST)=AML(IST)*EXP(-AL(IST)*JTIME)
      GO TO 90
C
C CALL CHAIN DECAY ROUTINE
C
   20 DO 200 I=IST,K
  200 AMM(I)=AML(I)/AL(I)
      CTIME=JTIME
      CALL ACHAIN(J,CTIME,DK(1,IST),IFRM(1,IST),AL(IST),AMM(IST),
     .AMM(IST))
      DO 300 I=IST,K
  300 AMM(I)=AMM(I)*AL(I)
C
   90 RETURN
C-----------------------------------------------------------------------
      END
```

```
C-------------------------------------------------------------------------
C
      SUBROUTINE ANDOS(NORG)
C
C     THIS SUBROUTINE IS USED TO CALCULATE ANNUAL DOSES
C
C     Module of MAXI1
C     Version of 25-APR-84
C
C-------------------------------------------------------------------------
C
C
      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),
     .FADOS(50,50,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
     .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),
     .AARDOS(50,5),ADWDOS(50,5)
C
      CHARACTER*9 DDTT
      CHARACTER*6 AWO
      CHARACTER*10 TODAY, CLOCK
C
      ITIME=0
      CALL ZEROR(250,AFDOS)
      CALL ZEROR(250,ADADOS)
      CALL ZEROR(250,AARDOS)
      CALL ZEROR(250,ADWDOS)
C
C
      DO 100 JTIME=IT1,IT2
C
      ITIME=ITIME+1
C
      DO 200 INUC=1,NONUC
      DO 300 IORG=1,NORG
C
C  CALCULATE TOTAL FOOD PRODUCT DOSES
C
      FDOS(ITIME,INUC,IORG)=FDOS(ITIME,INUC,IORG)+FADOS(ITIME,INUC,IORG
     .     )
C
C CALCULATE TOTAL FOOD PRODUCT DOSES SUMMED OVER ALL NUCLIDES
C
      AFDOS(ITIME,IORG)=AFDOS(ITIME,IORG)+FDOS(ITIME,INUC,IORG)
```

```
C CALCULATE TOTAL INHALATION'DOSE SUMMED OVER ALL NUCLIDES
C
      ADADOS(ITIME,IORG)=ADADOS(ITIME,IORG)+DADOS(ITIME,INUC,IORG)
C
C   CALCULATE TOTAL AQUEOUS FOOD DOSES
C
      AARDOS(ITIME,IORG)=AARDOS(ITIME,IORG)
     .                   +ARDOS(ITIME,INUC,IORG)
C
C   CALCULATE TOTAL DRINKING WATER DOSE
C
      ADWDOS(ITIME,IORG)=ADWDOS(ITIME,IORG)
     .                   +DWDOS(ITIME,INUC,IORG)
C
  300 CONTINUE
  200 CONTINUE
C
C
C CALCULATE ANNUAL DOSES
C
      DO 400 IORG=1,NORG
C
      ADOS(ITIME,IORG)=AFDOS(ITIME,IORG)+ADADOS(ITIME,IORG)+AEXDOS(ITIME
     .                 )+AARDOS(ITIME,IORG)+ADWDOS(ITIME,IORG)
C
  400 CONTINUE
  100 CONTINUE
C
C      DEBUG PRINT STATEMENT--
C      ITIME=0
C      DO 101 JTIME=IT1,IT2
C      ITIME=ITIME+1
C      PRINT 8881,JTIME,(ADOS(ITIME,IORG),IORG=1,NORG)
C 8881 FORMAT(' JTIME, ADOS: ',I4,5E10.3)
C  101 CONTINUE
C
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      FUNCTION ASUM(J,A)
C
C     This function sums an array, called by ACHAIN
C
C     Module of MAXI1
C     Version of 25-APR-84 RAP
C
C-----------------------------------------------------------------------
C
C
      DIMENSION A(1)
C
      ASUM=0.
      IF(J.LE.0) GO TO 2
      DO 1 I=1,J
      ASUM=ASUM+A(I)
    1 CONTINUE
C
    2 RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE DFREAD (IRAP,E,A,NORG,KORG,INUC)
C
C     This subroutine reads dose conversion factors from assigned
C     libraries for the surrent radionuclide.
C
C     Module of MAXI1
C     Version of 11-MAY-84 RAP
C
C-----------------------------------------------------------------------
C
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/TITLS/TIT20(13),TIT21(13),TIT22(13),TIT24(13),
     .TIT25(13),TIT27(13)
C
C     COMMON/FREAD/ELTLS(100),AWLS(100),ELTX(100),AWX(100),
C    .DFXT(100),
C    .NYRL,NYRS,NORGL,NORGS,NISOL,NISOS,NISOX,
C    .NYRW,NYRA,NORGW,NORGA,NISOW,NISOA,ELTA(100),AWAW(100),
C    .ELTW(100),AWW(100),ELTDX(100),AWDX(100),DFDXT(100),NISODX
C
C
      COMMON /DATA2/ DFDOS(50,50,5),AIDOS(50,50,5),INDOS(50,50,5),
     .               DEXT(50),ARGF(50,50,5),ARDW(50,50,5),DEDXT(50)
C
      REAL INDOS
      DIMENSION KORGLS(5),KORGA(5),KORGW(5)
      DIMENSION KORG(5)
C
      DIMENSION DINCL(5), DINCS(5), DINCA(5),
     .          DINCW(5)
C
      CHARACTER*6 AWLS,AWX,AWO,AWAW,AWW,AWDX,A
C
C  READ LEAF AND SOIL MECHANISM DATA
C
  500 CONTINUE
C
      IF (IRAP .EQ. 4) GO TO 63
      IF (IRAP .EQ. 5) GO TO 64
C
      IF (IRAP .EQ. 1) THEN
        REWIND 20
        REWIND 21
```

```
        READ(20,600)TIT20
  600   FORMAT(13A4)
        READ(20,1)ID,NYRL,NISOL,NORGL
        READ(20,7)(KORGLS(I),I=1,NORGL)
        READ(21,600)TIT21
        READ(21,1)ID,NYRS,NISOS,NORGS
        READ(21,7)(KORGLS(I),I=1,NORGS)
    1   FORMAT(5X,A4,3I5)
    7   FORMAT(5I5)
      ENDIF
C
      IF (IRAP .EQ. 2) THEN
        REWIND 24
        READ(24,600)TIT24
        READ(24,1)ID,NYRA,NISOA,NORGA
        READ(24,7)(KORGA(I),I=1,NORGA)
      ENDIF
C
      IF (IRAP .EQ. 3) THEN
        REWIND 25
        READ(25,600)TIT25
        READ(25,1)ID,NYRW,NISOW,NORGW
        READ(25,7)(KORGW(I),I=1,NORGW)
      ENDIF
C
   51 CONTINUE
C
C   LEAF,SOIL,AQUEOUS FOOD AND DRINKING WATER DATA IN BLOCKS
C
      IF (IRAP .EQ. 1) NYR = NYRL
      IF (IRAP .EQ. 2) NYR = NYRA
      IF (IRAP .EQ. 3) NYR = NYRW
C
      DO 15 IYR=1,NYR
      IF(IRAP.NE.1) GO TO 56
      READ(20,25)
      READ(21,25)
   56 IF(IRAP.NE.2) GO TO 57
      READ(24,25)
   57 IF(IRAP.NE.3) GO TO 58
      READ(25,25)
   58 CONTINUE
   25 FORMAT(1X)
C
      IF (IRAP .NE. 1) GO TO 60
      DO 10 ISO = 1, NISOL
        READ(20,2) ELTLS,AWLS,(DINCL(IOR), IOR=1,NORGL)
        READ(21,2) ELTLS,AWLS,(DINCS(IOR), IOR=1,NORGL)
        IF (ELTLS.NE.E .OR. AWLS.NE.A) GO TO 501
```

```
        DO 502 IORG = 1, NORG
          DO 503 IOR = 1, NORGL
            IF (KORG(IORG).NE.KORGLS(IOR)) GO TO 504
              DFDOS(IYR,INUC,IORG)=DINCS(IOR)
              AIDOS(IYR,INUC,IORG)=DINCL(IOR)
  504       CONTINUE
  503     CONTINUE
  502   CONTINUE
        GO TO 15
  501   CONTINUE
   10 CONTINUE
   60 CONTINUE
C
C
      IF (IRAP .NE. 2) GO TO 61
      DO 11 ISO = 1, NISOA
        READ(24,2) ELTA,AWAW,(DINCA(IOR), IOR=1,NORGA)
C        WRITE(6,8871) IYR,ELTA,AWAW,(DINCA(IOR),IOR=1,NORGA)
C 8871   FORMAT(/' READ YR: ',I4,2X,A2,A6,2X,5E10.2)
        IF (ELTA.NE.E .OR. AWAW.NE.A) GO TO 511
          DO 512 IORG = 1, NORG
            DO 513 IOR = 1, NORGA
              IF (KORG(IORG).NE.KORGA(IOR)) GO TO 514
                ARGF(IYR,INUC,IORG)=DINCA(IOR)
C                WRITE(6,8870) IYR,INUC,IORG,ARGF(IYR,INUC,IORG)
C 8870           FORMAT(' IYR, INUC, IORG: ',3I5,2X,1PE10.2)
  514       CONTINUE
  513     CONTINUE
  512   CONTINUE
        GO TO 15
  511   CONTINUE
   11 CONTINUE
   61 CONTINUE
C
C
      IF (IRAP .NE. 3) GO TO 62
      DO 12 ISO=1,NISOW
        READ(25,2)ELTW,AWW,(DINCW(IOR), IOR=1,NORGW)
    2   FORMAT (A2,A6,5E12.2)
        IF (ELTW.NE.E .OR. AWW.NE.A) GO TO 521
          DO 522 IORG = 1, NORG
            DO 523 IOR = 1, NORGW
              IF (KORG(IORG).NE.KORGW(IOR)) GO TO 524
                ARDW(IYR,INUC,IORG)=DINCW(IOR)
  524       CONTINUE
  523     CONTINUE
  522   CONTINUE
        GO TO 15
  521   CONTINUE
```

```
   12 CONTINUE
   6? CONTINUE
C
   15 CONTINUE
      GO TO 65
C
C READ EXTERNAL EXPOSURE MECHANISM DATA
C
   63 CONTINUE
      REWIND 22
      READ(22,600)TIT22
      READ(22,3)ID,NISOX
    3 FORMAT(5X,A4,1I5)
      DO 20 ISO=1,NISOX
        READ(22,4)ELTX,AWX,DFXT
        IF (ELTX.NE.E .OR. AWX.NE.A) GO TO 531
          DEXT(INUC) = DFXT
          GO TO 65
  531   CONTINUE
   20 CONTINUE
C
      GO TO 65
C
   64 CONTINUE
      REWIND 27
      READ(27,600)TIT27
      READ(27,3) ID,NISODX
      DO 30 ISO=1,NISODX
        READ(27,5) ELTDX,AWDX,DFDXT
        WRITE(6,5)ELTDX,AWDX,DFDXT
        IF (ELTDX.NE.E .OR. AWDX.NE.A) GO TO 541
          DEDXT(INUC) = DFDXT
          GO TO 65
  541   CONTINUE
   30 CONTINUE
   31 CONTINUE
    4 FORMAT(A2,A6,E7.1)
    5 FORMAT(A2,A6,E7.1)
C
   65 CONTINUE
C
C  PRINT DIAGNOSTIC MESSAGES, IF ANY, AND STOP
C
       IF(NISOL.GT.100.OR.NISOS.GT.100.OR.NISOX.GT.100)
      .GO TO 100
       IF(NISOA.GT.100.OR.NISOW.GT.100) GO TO 100
       IF(NYRL.GT.50.OR.NYRS.GT.50.OR.NYRA.GT.50.OR.NYRW.GT.50)
      .GO TO 200
C
```

```
      IF(NORGL.GT.5.OR.NORGS.GT.5.OR.NORGA.GT.5.OR.NORGW.GT.5)
     .GO TO 300
C
      RETURN
C
  100 PRINT 101,NISOL,NISOS,NISOX,NISOA,NISOW
      GO TO 400
  200 PRINT 201,NYRL,NYRS,NYRA,NYRW
      GO TO 400
  300 PRINT 301,NORGL,NORGS,NORGA,NORGW
  400 STOP
  101 FORMAT(1H1,' DIAGNOSTIC 8: NUMBER OF ISOTOPES FOR DFREAD OUT OF BO
     .UNDS',/,5(5X,I5))
  201 FORMAT(1H1,' DIAGNOSTIC 9: NUMBER OF YEARS FOR DFREAD OUT OF BOUND
     .S',/,4(5X,I5))
  301 FORMAT(1H1,' DIAGNOSTIC 10:NUMBER OF ORGANS OUT OF BOUNDS FOR DFRE
     .AD',/,4(5X,I5))
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE DUMMY(N)
C
C     THIS ROUTINE READS PAST UNUSED ENTRIES IN FILE 23
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C----------------------------------------------------------------------
C
C
      DO 100 I = 1,N
        READ(23,10)
   10   FORMAT (1X)
  100 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE IDNUC(NUC,ELT,AW,ELTI,AWI,NIN,NCHN,NFLAG,NFLAGC)
C
C    THIS MODULE IDENTIFIES NUCLIDES IN INPUT INVENTORY
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      DIMENSION NFLAGC(200),NCHN(300)
      DIMENSION ELT(300),AW(300),ELTI(50),AWI(50),NFLAG(300)
      CHARACTER AW*6,AWI*6
C
C  INITIALIZE COUNT INDEX ON UNIDENTIFIED NUCLIDES
    4 CONTINUE
      ISTOP=0
C
C  LOOP ON NUCLIDES INPUT.  TEST AGAINST MASTER LIST.
C
      CALL ZEROI(200,NFLAGC)
      CALL ZEROI(300,NFLAG)
      DO 3 IN=1,NIN
      DO 1 IL=1,NUC
      ILN=IL
      IF(ELT(IL).NE.ELTI(IN)) GO TO 1
      IF(AW(IL).EQ.AWI(IN)) GO TO 2
      IF(AW(IL).EQ.AWI(IN)) GO TO 2
    1 CONTINUE
C
C  NO MATCH IN LIBRARY FOR INPUT NUCLIDE.  PRINT NAME OF UNKNOWN NUCLIDE
      ISTOP=ISTOP+1
      PRINT 100, ELTI(IN),AWI(IN)
      GO TO 3
    2 NFLAG(IL)=IN
      NFLAGC(NCHN(IL))=1
    3 CONTINUE
      IF(ISTOP.LT.1) RETURN
C
C  PRINT TOTAL NUMBER OF UNKNOWN NUCLIDES AND STOP.
C
      PRINT 200, ISTOP
  100 FORMAT(1H0,' DIAGNOSTIC 11: UNIDENTIFIED NUCLIDE ',A2,A6)
  200 FORMAT(1H0,' DIAGNOSTIC 12: THERE WERE UNIDENTIFIED NUCLIDES, ',
     .'ISTOP =',I3)
      STOP
C-------------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE INSET(NORG,KORG,NTR,TITLDI)
C
C     INSET reads the inhalation dose conversion factor file from the
C     file assigned to logical unit 23.
C
C     Module of MAXI1
C     Version of 25-APR-84   RAP
C
C-----------------------------------------------------------------------
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/DATA2/DFDOS(50,50,5),AIDOS(50,50,5),INDOS(50,50,5),DEXT(50)
     .,ARGF(50,50,5),ARDW(50,50,5),DEDXT(50)
C
      DIMENSION NTR(5,50),KORG(5),IDORG(5),TITLDI(15),DIN(3,51,5)
C
      CHARACTER AWO*6,AWD*6
      REAL*4 INDOS
C
    1 CONTINUE
      CALL ZEROR(12500,INDOS)
      READ(23,10)NDI,TITLDI
   10 FORMAT(I5,15X,15A4)
      READ(23,11)(IDORG(I),I=1,5)
   11 FORMAT(5I5)
C
C  LOOP ON NUCLIDES IN DACRIN-GENERATED FILE 23
C
      DO 100 IDI=1,NDI
C
      READ(23,12)ELTD,AWD,N1,N2,N3
   12 FORMAT(A2,A6,2X,3I5)
      ICHK=0
C
C  MATCH WITH DESIRED NUCLIDES, INCLUDING DAUGHTERS
C
      DO 200 INUC=1,NONUC
C
      IF(ELTD.NE.ELTO(INUC).OR.AWD.NE.AWO(INUC)) GO TO 200
      ICHK=1
C  READ ALL DATA FOR FOUND NUCLIDE INTO TEMPORARY ARRAY LOCATION
C
      IF(N1.LE.0) GO TO 50
      READ(23,13)((DIN(1,IYR,IOR),IOR=1,5),IYR=1,N1)
```

```
   50 IF(N2.LE.0) GO TO 55
      READ(23,13)((DIN(2,IYR,IOR),IOR=1,5),IYR=1,N2)
   55 IF(N3.LE.0) GO TO 60
      READ(23,13)((DIN(3,IYR,IOR),IOR=1,5),IYR=1,N3)
   60 CONTINUE
   13 FORMAT(10X,5E10.2)
C
      IF (N1 .GT. 50) N1=50
      IF (N2 .GT. 50) N2=50
      IF (N3 .GT. 50) N3=50

C  IDENTIFY ORGAN AND SOLUBILITY CLASS AND SET
C
      DO 300 IORG=1,NORG
      DO 400 JORG=1,5
      IF(IDORG(JORG).NE.KORG(IORG)) GO TO 400
C
      IF(NTR(IORG,INUC).EQ.2) GO TO 420
      IF(NTR(IORG,INUC).EQ.3) GO TO 430
  410 IF(N1.EQ.0) GO TO 300
      DO 411 IYR=1,N1
  411 INDOS(IYR,INUC,IORG)=DIN(1,IYR,JORG)
      GO TO 300
  420 IF(N2.EQ.0) GO TO 300
      DO 421 IYR=1,N2
  421 INDOS(IYR,INUC,IORG)=DIN(2,IYR,JORG)
      GO TO 300
  430 IF(N3.EQ.0) GO TO 300
      DO 431 IYR=1,N3
  431 INDOS(IYR,INUC,IORG)=DIN(3,IYR,JORG)
      GO TO 300
  400 CONTINUE
  300 CONTINUE
  200 CONTINUE
C
C  IF NO NUCLIDE MATCH IN 200 LOOP, READ PAST LIBRARY DATA
C
      N4=N1+N2+N3
      IF(ICHK.EQ.0) CALL DUMMY(N4)
C
  100 CONTINUE
      RETURN
C
C-----------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE MAXDOS(NORG)
C
C     This subroutine finds the maximum dose for each organ.
C
C     Module of MAXI1
C     Verison of 25-APR-84
C
C-----------------------------------------------------------------------
C
      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),FADOS(50,50
     .,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
     .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),
     .AARDOS(50,5),ADWDOS(50,5)
C
      COMMON/MXTIM/MAXTIM(5),MAXD(5)
      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
      CHARACTER*9 DDTT
      CHARACTER*10 TODAY, CLOCK
      REAL*4 MAXID(5)
C
      CALL ZEROR(5,MAXID)
C
      ITIME=0
      DO 2 I=1,5
      MAXTIM(I)=1
    2 CONTINUE
      DO 100 JTIME=IT1,IT2
      ITIME=ITIME+1
      DO 200 IORG=1,NORG
      IF(ADOS(ITIME,IORG).GT.MAXID(IORG)) GO TO 50
      GO TO 60
   50 MAXID(IORG)=ADOS(ITIME,IORG)
      MAXTIM(IORG)=ITIME
      MAXD(IORG)=JTIME
   60 CONTINUE
  200 CONTINUE
  100 CONTINUE
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C------------------------------------------------------------------------
C
      SUBROUTINE MLOAD(ITIME,DEN,XMLF,AIRFA)
C
C     This subroutine calculates resuspension using the mass loading
C     equation.
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C--------------------------------------------------------------------------
C
C
      DIMENSION AIRFA(50)
C
    1 CONTINUE
C
      AIRFA(ITIME)=XMLF/DEN/0.15
C
      RETURN
C
C--------------------------------------------------------------------------
C
      END
```

APPENDIX 1.A   COMPUTER CODE LISTING - MAXI1

```
C-----------------------------------------------------------------------
C
      SUBROUTINE OUTPUT(NORG,IOUT,KORG,IBIO,IBYR,NEXT)
C
C     This subroutine prints a report of MAXI1 results.
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON /JUNK/ DDTT, IT1, IT2, TITLE1(20), TODAY, CLOCK
C
      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),
     .FADOS(50,50,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
     .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),AARDOS(50,5),
     .ADWDOS(50,5)
C
      COMMON/MXTIM/MAXTIM(5),MAXD(5)
C
      DIMENSION ONAME(23),ONA(5),KORG(5)
C
      CHARACTER*10 ONAME, ONA
      CHARACTER*6 AWO
      CHARACTER*9 DDTT
      CHARACTER*10 TODAY, CLOCK
C
      DATA(ONAME(I),I=1,23)/'TOTAL BODY','BODY WATER',' KIDNEYS  ','  LI
     .VER   ','  SPLEEN  ','   BONE   ','   FAT    ','  LUNGS   ',' ADRE
     .NALS ','  TESTES  ',' OVARIES  ','   SKIN   ','  BRAIN   ','  MUSC
     .LE   ','PROSTATE  ',' THYROID  ',' PANCREAS ','  HEART   ',' GI-TRA
     .CT ',' STOMACH  ','    SI    ','   ULI    ','   LLI    '/
C
C PRINT TITLES FOR SUMMARY BY ORGAN AND RADIONUCLIDE (IOUT=0)
C
      DO 100 IORG=1,NORG
      IF (NONUC .GT. 20 .OR. IORG .EQ. 1) WRITE(6, 10)
      IF (NONUC .GT. 20 .OR. IORG .EQ. 1) WRITE(6, 11) TITLE1
      IF (NONUC .GT. 20 .OR. IORG .EQ. 1) WRITE(6, 12) TODAY, CLOCK
      IF (IBIO .GT. 0) WRITE(6, 27) IBYR
C
      ONA(IORG)=ONAME(KORG(IORG))
      WRITE(6, 13) MAXD(IORG),ONA(IORG)
      WRITE(6, 14)
```

```
      DO 200 INUC=1,NONUC
      K=MAXTIM(IORG)
C
      ATEMP = AFDOS(K,IORG)
      IPFD = 0
      IF (ATEMP .GT. 0.) IPFD=FDOS(K,INUC,IORG)/ATEMP*100
C
      ATEMP = ADADOS(K,IORG)
      IPDAD = 0
      IF (ATEMP .GT. 0.) IPDAD=DADOS(K,INUC,IORG)/ATEMP*100
C
      IPEX = 0
      IF (AEXDOS(K) .GT. 0.) IPEX=EXDOS(K,INUC)/AEXDOS(K)*100
C
      ATEMP = AARDOS(K,IORG)
      IARG = 0
      IF (ATEMP .GT. 0.) IARG=ARDOS(K,INUC,IORG)/ATEMP*100
C
      ATEMP = ADWDOS(K,IORG)
      IDWD = 0
      IF (ATEMP .GT.0.) IDWD=DWDOS(K,INUC,IORG)/ATEMP*100
C
      WRITE(6, 15) ELTO(INUC),AWO(INUC),FDOS(K,INUC,IORG),
     .IPFD,DADOS(K,INUC,IORG),IPDAD,
     .EXDOS(K,INUC),IPEX,
     .ARDOS(K,INUC,IORG),IARG,DWDOS(K,INUC,IORG),IDWD
C
  200 CONTINUE
C
      IPAF = 0
      IPAD = 0
      IPAX = 0
      IAGD = 0
      IDWA = 0
      ATEMP = ADOS(K,IORG)
C
      IF (ATEMP .LE. 0.) GO TO 201
C
        IPAF=AFDOS(K,IORG)/ATEMP*100
        IPAD=ADADOS(K,IORG)/ATEMP*100
        IPAX=AEXDOS(K)/ATEMP*100
        IAGD=AARDOS(K,IORG)/ATEMP*100
        IDWA=ADWDOS(K,IORG)/ATEMP*100
C
  201 CONTINUE
C
      WRITE(6, 16) AFDOS(K,IORG),IPAF,ADADOS(K,IORG),
     .IPAD,AEXDOS(K),IPAX,
     .AARDOS(K,IORG),IAGD,ADWDOS(K,IORG),IDWA,ADOS(K,IORG)
```

```
  100 CONTINUE
C
   10 FORMAT(1H1)
   11 FORMAT(4X,20A4)
C
   12 FORMAT(/,25X,'MAXI, Version VAX2.2 25-APR-84',
     .' executed on ',A10,' at ',A10,'.')
C
   13 FORMAT(/,1X,'MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR',
     .I5,' FOR',A10)
   14 FORMAT(//,28X,'EXPOSURE PATHWAY',/,17X,'INGESTION',11X,
     .'INHALATION',10X,'EXTERNAL',
     .12X,'AQUATIC FOOD',8X,'DRINKING WATER',
     ./,1X,'RADIONUCLIDE',3X,
     .5(' REM ',9X,'%',5X),/,1X,12('-'),3X,5(16('-'),4X),/)
C
   15 FORMAT(3X,A2,A6,5X,5(1PE9.2E2,2X,I4,5X))
C
   16 FORMAT(1X,112('-'),/,5X,'TOTALS',6X,'INGESTION',4X,'%',
     .6X,'INHALATION',4X,'%',6X,'EXTERNAL',5X,'%',
     .6X,'AQUATIC FOOD',1X,'%',5X,'DRINKING WATER',1X,
     .'%',6X,'TOTAL',
     .//,16X,5(1PE9.2E2,2X,I4,5X),1PE9.2E2)
C
   27 FORMAT(1X,'DOSE RESULTING FROM CONCENTRATIONS AT YEAR ', I5,
     .' OF BIOPORT SIMULATION.')
C
C
C PRINT DOSE BY ORGAN TO FILES FOR PLOTTING IF BIOPORT INPUT
C
      IF (IBIO .EQ. 1) THEN
C
          IU = 40
C
          IF (NEXT .EQ. 1) THEN
            WRITE (IU,31) TITLE1,(ONA(IORG),IORG=1,NORG)
          ENDIF
C
          WRITE (IU,32) IBYR, (ADOS(MAXTIM(IORG),IORG),IORG=1,NORG)
C
      ENDIF
C
   31 FORMAT (' ',20A4,//,1X,'Year      ',5(2X,A10)/
     .        ' ----------  ----------  ----------  ----------  '
     .        '----------  ----------')
C
   32 FORMAT (' ',I10,5(2X,E10.3))
C
C
```

```
C TEST ON OUTPUT CLASS AND CONTINUE
C
      IF(IOUT.EQ.0) GO TO 999
C
C PRINT A TABULATION OF ANNUAL DOSES BY ORGAN (IOUT=1)
C
      WRITE(6, 10)
      WRITE(6, 11) TITLE1
      WRITE(6, 12)  TODAY, CLOCK
      WRITE(6, 20) IT2
      WRITE(6, 21) (ONA(IORG),IORG=1,NORG)
C
C LOOP ON YEARS AND ORGANS
C
      ITIME=0
      DO 300 JTIME=IT1,IT2
      ITIME=ITIME+1
      WRITE(6, 22) JTIME,(ADOS(ITIME,IORG),IORG=1,NORG)
  300 CONTINUE
   20 FORMAT(/,2X,'ANNUAL DOSE SUMMARY FOR ',I5,' YEARS')
   21 FORMAT(2X,'YEAR',5X,5(A10,2X))
   22 FORMAT(1X,I5,5X,5(1PE9.2E2,3X))
C
C PRINT LONG OUTPUT BY PATHWAY, ORGAN, AND YEAR (IOUT.GT.1)
C
      IF(IOUT.LT.2)GO TO 999
      ITIME=0
      DO 500 JTIME=IT1,IT2
      ITIME=ITIME+1
      DO 600 IORG=1,NORG
C
C PRINT TITLES
C
      WRITE(6, 10)
      WRITE(6, 11) TITLE1
      WRITE(6, 12)  TODAY, CLOCK
      WRITE(6, 25) JTIME,ONA(IORG)
      WRITE(6, 14)
C
C     LOOP ON RADIONUCLIDES
      DO 700 INUC=1,NONUC
C
      ATEMP=AFDOS(ITIME,IORG)
      IPFD = 0
      IF (ATEMP .GT. 0.) IPFD=FDOS(ITIME,INUC,IORG)/ATEMP*100
C
      ATEMP=ADADOS(ITIME,IORG)
      IPDAD=0
      IF (ATEMP .GT. 0.) IPDAD=DADOS(ITIME,INUC,IORG)/ATEMP*100
```

```
      ATEMP=AEXDOS(ITIME)
      IPEX = 0
      IF (ATEMP .GT. 0.) IPEX=EXDOS(ITIME,INUC)/ATEMP*100
C
      ATEMP = AARDOS(ITIME,IORG)
      IARG = 0
      IF (ATEMP .GT. 0.) IARG=ARDOS(ITIME,INUC,IORG)/ATEMP*100
C
      ATEMP = ADWDOS(ITIME,IORG)
      IDWD = 0
      IF (ATEMP .GT. 0.) IDWD=DWDOS(ITIME,INUC,IORG)/ATEMP*100
C
      WRITE(6, 15) ELTO(INUC),AWO(INUC),FDOS(ITIME,INUC,IORG),
     .IPFD,DADOS(ITIME,INUC,IORG),
     .IPDAD,EXDOS(ITIME,INUC),IPEX,
     .ARDOS(ITIME,INUC,IORG),IARG,DWDOS(ITIME,INUC,IORG),IDWD
C
  700 CONTINUE
C
      IPAF = 0
      IPAD = 0
      IPAX = 0
      IAGD = 0
      IDWA = 0
      ATEMP = ADOS(ITIME,IORG)
C
      IF (ATEMP .LE. 0.) GO TO 701
        IPAF=AFDOS(ITIME,IORG)/ATEMP*100
        IPAD=ADADOS(ITIME,IORG)/ATEMP*100
        IPAX=AEXDOS(ITIME)/ATEMP*100
        IAGD=AARDOS(ITIME,IORG)/ATEMP*100
        IDWA=ADWDOS(ITIME,IORG)/ATEMP*100
  701 CONTINUE
C
      WRITE(6, 16) AFDOS(ITIME,IORG),IPAF,ADADOS(ITIME,IORG),
     .IPAD,AEXDOS(ITIME),IPAX,
     .AARDOS(ITIME,IORG),IAGD,ADWDOS(ITIME,IORG),IDWA,
     .ADOS(ITIME,IORG)
  600 CONTINUE
  500 CONTINUE
   25 FORMAT(/,13X,'ANNUAL DOSE SUMMARY FOR YEAR',I5,1X,
     .'AND ORGAN',A10)
  999 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE PADOS(XFACT,NORG,XDPT,AGE,IRR,RF1,RF2,RINH,INTRUD,
     .IDKWAT,XF2, RPF1, RPF2, AREAIN, AREAEX)
C
C     PADOS calculates doses for each pathway.
C
C     Module of MAXI1
C     Version of 26-APR-84  RAP
C
C-----------------------------------------------------------------------
C
C
      COMMON/THIRDS/QK(50),AML(50),XQSITE,IAIR,IDKAIR,IBLOW
C
      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
      COMMON/DATA2/DFDOS(50,50,5),AIDOS(50,50,5),INDOS(50,50,5),
     .DEXT(50),ARGF(50,50,5),ARDW(50,50,5),DEDXT(50)
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),FADOS(50,50
     .,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
     .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),AARDOS(50,5),
     .ADWDOS(50,5)
C
      DIMENSION AMM(50)
      DIMENSION AIRFA(50),AIRCON(50),AO(50),AMT(50),AMK(50)
C
      REAL*4 INDOS
C
      CHARACTER*9 DDTT
      CHARACTER*10 TODAY, CLOCK
      CHARACTER*6 AWO
C
C INITIALIZE DAT ARRAYS
C
      CALL ZEROR(12500,ARDOS)
      CALL ZEROR(12500,DWDOS)
      CALL ZEROR(50,AO)
      CALL ZEROR(50,SOILCN)
      CALL ZEROR(50,AIRFA)
      CALL ZEROR(50,AIRCON)
      CALL ZEROR(50,AEXDOS)
      CALL ZEROR(12500,FDOS)
      CALL ZEROR(12500,FADOS)
```

```
      CALL ZEROR(12500,DADOS)
C
      IDKA=IDKAIR
C
C MASTER LOOP ON TIME
C
      ITIM2=0
      ITA=IT1-IBLOW
      ITW=IT1-IRR
      ITIME=-MAX(IRR,IBLOW)
      ITM=IT1+ITIME
      DO 50 JTIME=ITM,IT2
      IF(INTRUD.NE.0.AND.JTIME.GT.IT1)GO TO 50
      ITIM2=ITIM2+1
      ITIME=ITIME+1
      N=ITIME-1
      IF(ITIM2.EQ.1) AITIME=JTIME
      IF(ITIM2.GT.1)AITIME=1.0
      BITIME=JTIME+AGE-ITM
C
C   CALL RESUSPENSION OR MASS LOADING FACTOR
C
      IF(ITIME.LE.0) GO TO 10
      IF(AGE.GE.0)
     .CALL AFACT(BITIME,AIRFA,ITIME,XDPT)
      IF(AGE.LT.0) CALL MLOAD(ITIME,DEN,XMLF,AIRFA)
   10 CONTINUE
      INUC=0
C     LOOP ON CHAINS
      DO 200 ICH=1,ICHN
C
C   SET IRRIGATION AND AQUATIC FOOD WATER CONC TO AMK
C   ONCE, IF CONSTANT SOURCE
C   EVERY TIME, IF DECAYING SOURCE
C
      J=IOFNUC(ICH)
      IF(JTIME.EQ.ITA)CALL AIRDIS(IDKA,INUC,JTIME,AMM,J)
      IF(JTIME.EQ.ITW)CALL WATER(IDKWAT,INUC,JTIME,AMK,J)
C
C  SET SOIL CONC, DEPENDENT ON IRRIGATION, SUBSURFACE, ETC.
C
      CALL SOLCON(ITIM2,ICH,INUC,AITIME,J,AO,JTIME,AMT,IT1,AMK,AMM,
     .            RPF1)
C
      IF(IDKA.NE.0.AND.JTIME.GE.ITA)CALL AIRDIS(1,INUC,JTIME,AMM,J)
C
      IF(IDKWAT.NE.0.AND.JTIME.GE.ITW)CALL WATER(1,INUC,JTIME,AMK,J)
C
C
```

```
      DO 290 JNUC=1,J
C
      INUC=INUC+1
      IF(JTIME.LT.IT1) GO TO 290
C
C CALCULATE AIR CONCENTRATIONS
C
      AIRCON(INUC)=SOILCN(INUC)*AIRFA(ITIME)+AMM(INUC)
C
C CALCULATE EXTERNAL TOTAL BODY DOSES
C
      EXDOS(ITIME,INUC)=DEXT(INUC)*SOILCN(INUC)*XFACT*AREAEX
     .     +DEDXT(INUC)*AMT(INUC)*5.844E-11*XF2/8766.*AREAEX
C
C WHERE 5.844E-11=(HR/YR*REM/MREM*CI/PCI)/0.15
C
C
C CALCULATE EXTERNAL DOSE SUMMED OVER ALL NUCLIDES AND DAUGHTERS
C
      AEXDOS(ITIME)=AEXDOS(ITIME)+EXDOS(ITIME,INUC)
C
C CALCULATE INTERNAL PATHWAY DOSES
C
      DO 300 IORG=1,NORG
      M=50-N
      DO 400 ITTIM=1,M
C
         IR = ITTIM+N
C
      FDOS(ITTIM+N,INUC,IORG)=FDOS(ITTIM+N,INUC,IORG)+DFDOS(ITTIM,INUC
     .,IORG)*SOILCN(INUC)*RF1*RPF2*AREAIN
     .+DFDOS(ITTIM,INUC,IORG)*AMT(INUC)*RF2*RPF2*AREAIN
C
      FADOS(ITTIM+N,INUC,IORG)=FADOS(ITTIM+N,INUC,IORG)+AIDOS(ITTIM,INUC
     .,IORG)*AIRCON(INUC)*RPF2*AREAIN
C
C  IRRIGATION LEAF DEPOSITION, AIR DEPOSITION VELOCITY IS ASSUMED
C  TO BE 1E-3 FOR ALL RESUSPENDED PARTICLES
C  THIS REQUIRES A SPECIAL LIBRARY OF DEP VELOCITIES FOR FOOD FILGEN!!
C
      IF(RIRR.LE.0.0)GO TO 500
C
      FADOS(ITTIM+N,INUC,IORG)=FADOS(ITTIM+N,INUC,IORG)+
     .AIDOS(ITTIM,INUC,IORG)*AMK(INUC)*RIRR/2.635E6/1.0E-3*RPF2
C
  500 CONTINUE
C
      DADOS(ITTIM+N,INUC,IORG)=DADOS(ITTIM+N,INUC,IORG)+INDOS(ITTIM,INUC
     .                              ,IORG)*AIRCON(INUC)*RINH*AREAIN
```

```
      ARDOS(ITTIM+N,INUC,IORG)=ARDOS(ITTIM+N,INUC,IORG)
     .                         +ARGF(ITTIM,INUC,IORG)*AMK(INUC)
C
      DWDOS(ITTIM+N,INUC,IORG)=DWDOS(ITTIM+N,INUC,IORG)
     .                         +ARDW(ITTIM,INUC,IORG)*AMJ(INUC)
C
  400 CONTINUE
  300 CONTINUE
  290 CONTINUE
  200 CONTINUE
C
C      CALL SOILCN, AIRCON PRINTOUT--
C      IF (JTIME .NE. IT2) GOTO 8878
C        DO 8879 IRAP = 1, 50
C         PRINT 8877,(DADOS(IRAP,INU,3),INU=1,NONUC)
C 8877    FORMAT(' DADOS: ',3E10.3)
C 8879   CONTINUE
C 8878 CONTINUE
C
      IF(JTIME.EQ.IT1.OR.JTIME.EQ.IT2)
     .CALL PNTO(SOILCN,AIRCON,INUC,NONUC,JTIME,ELTO,AWO,AMK,AMJ,AMT)
C
  50  CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C------------------------------------------------------------------------
C
      SUBROUTINE PNTO (SOILCN,AIRCON,INUC,NONUC,JTIME,ELTO,AWO,AMI,AMJ,
                      AMT)
C
C
C     THIS SUBROUTINE IS USED TO PRINT THE RESULTING TIME DEPENDENT
C     SOIL, AIR, IRRIGATION WATER, AND DRINKING WATER CONCENTRATIONS
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C------------------------------------------------------------------------
C
      DIMENSION AIRCON(50),SOILCN(50),ELTO(50),AWO(50)
      DIMENSION AMI(50),AMJ(50),AMT(50)
      CHARACTER*6 AWO
C
      IF (NONUC.GT.20 .OR. JTIME .EQ. 1) THEN
        WRITE (6,51)
      ELSE
        WRITE (6,52)
      ENDIF
C
      WRITE (6,50) JTIME
      IF(INUC.NE.NONUC) GO TO 200
C
      DO 100 JNUC=1,NONUC
      AMT(JNUC)=AMT(JNUC)/.15
      WRITE (6,60) ELTO(JNUC),AWO(JNUC),SOILCN(JNUC),AMT(JNUC),
     .AIRCON(JNUC),AMI(JNUC),AMJ(JNUC)
      AMT(JNUC)=AMT(JNUC)*.15
  100 CONTINUE
C
      RETURN
  200 WRITE (6,70)
C
   50 FORMAT(1H ,30X,'SOIL,AIR, AND WATER CONCENTRATION SUMMARY',
     .' FOR THE YEAR',I6,//,10X,'RADIONUCLIDE',5X,'SURFACE SOIL',
     .5X,'DEEP SOIL',8X,'AIR',9X,'IRRIGATION',4X,
     .'DRINKING WATER',/,31X,'PCI/M2',8X,'PCI/M3',10X,
     .'PCI/M3',9X,'PCI/L',11X,'PCI/L',/)
   51 FORMAT (1H1)
   52 FORMAT (////)
   60 FORMAT(13X,A2,1X,A6,3X,5(5X,1PE10.2E2))
   70 FORMAT(///,3X,'DIAGNOSTIC 14: TEST, INUC.NE.NONUC=END -  ',
     .'FROM PNTO')
C
      STOP
C------------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE QAPAGE(RF1,RF2,INTRUD,IDKWAT,XFACT,IRR,RINH,XDPT,AGE,
     .M3M2,KORG,NORG,NTR,TITLR,TITLDI,QAPR,RPF1,RPF2,ISUR,I22,
     .XF2, SRDIL, IBIO, IBYR, TITLIN, NEXT, FRSIZ, AREAIN, AREAEX, ION)
C
C     This subroutine prints a report of input parameter values.
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      COMMON/THIRDS/QK(50),AML(50),XQSITE,IAIR,IDKAIR,IBLOW
C
      COMMON/TITLS/TIT20(13),TIT21(13),TIT22(13),TIT24(13),
     .TIT25(13),TIT27(13)
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
      DIMENSION KORG(5),NTR(5,50),TITLR(20),TITLDI(15),TITLIN(40)
C
      CHARACTER DDTT*9,FDK*13,FINTRD*8,TINHL*12,ONAME*10,FM3M2*5
      CHARACTER FDJ*13
      CHARACTER AWO*6
      CHARACTER*10 TODAY, CLOCK
C
      DIMENSION ONAME(23),QAPR(50)
C
      DATA (ONAME(I),I=1,23)/'TOTAL BODY','BODY WATER','KIDNEYS',
     .'LIVER','SPLEEN','BONE','FAT','LUNGS','ADRENALS','TESTES',
     .'OVARIES','SKIN','BRAIN','MUSCLE','PROSTATE','THYROID','PANCREAS',
     .'HEART','GI','STOMACH','SMALL INT','GI-ULI','GI-LLI'/
C
C     IF THIS IS A SUBSEQUENT BIOPORT RUN, SKIP DOWN TO INVENTORY
      IF (NEXT .EQ. 5) GOTO 200
C
      WRITE(6,19)
   19 FORMAT(1H1)
C
      WRITE(6,1) TODAY, CLOCK, TITLE1
    1 FORMAT(T27,'MAXI - Maximum Annual Dose Calculation Version ',
     .'VAX2.2 25-APR-84',/,
     .T45,'Executed on ',A10,' at ',A10,'.'/,
     .T27,'Case title:',20A4,/)
```

```
C     CALL IDLINE
      WRITE(6,18)
   18 FORMAT(25X,80('-'),/)
C
C LIBRARIES USED
C
      WRITE(6,1000)TITLR
 1000 FORMAT(5X,'RADIONUCLIDE CHAIN LIBRARY USED: ',4X,20A4,/,5X,
     .'DOSE FACTOR FILES USED FOR THIS CASE:')
C
      IF (IFOD .GT. 0) WRITE (6,1001) TIT20, TIT21
 1001 FORMAT(15X,'*20  FOOD-LEAF:',
     .13X,13A4,/,15X,'*21  FOOD-SOIL:',13X,15A4)
C
      IF (XFACT .NE. 0.) WRITE (6,1002) TIT22
 1002 FORMAT (15X,'*22  SHALLOW EXTERNAL:',6X,15A4)
C
      IF (RINH .GT. 0.0) WRITE (6,1003) TITLDI
 1003 FORMAT (15X,'*23  DACRIN-INHALATION:',5X,15A4)
C
      IF (IARG .GT. 0) WRITE (6,1004) TIT24
 1004 FORMAT (15X,'*24  ARRRG-FISH:',12X,15A4)
C
      IF (IWAT .GT. 0) WRITE (6,1005) TIT25
 1005 FORMAT (15X,'*25  ARRRG-DRINK H20:  ',5X,15A4)
C
      IF(IEXT.GT.0) WRITE(6,3) TIT27
    3 FORMAT(15X,'*27  ISOSHLD EXTERNAL: ',15A4)
C
      IF (IBIO .GT. 0) WRITE (6,1006) TITLIN
 1006 FORMAT (/,15X, 'BIOPORT INVENTORY FROM: ',/
     .         30X,20A4,/,30X,20A4)
C
      WRITE(6,21)IT1,IT2
   21 FORMAT(/,5X,'DOSES CALCULATED FROM',I5,' TO',I5,
     .' YEARS FOLLOWING TIME ZERO',/)
C
C PATHWAYS AND PARAMETERS USED
C
      FLAG20='OFF'
      FLAG22='OFF'
      FLAG23='OFF'
      FLAG24='OFF'
      FLAG25='OFF'
      FLAG27='OFF'
      FLAG28='OFF'
      FDK='NOT PERFORMED'
      FDJ='NOT PERFORMED'
      FINTRD='NOT USED'
```

```
      (FOD.NE.0)FLAG20='ON '
       INH.NE.0.0)FLAG23='ON '
      (IARG.NE.0)FLAG24='ON '
      .F(IWAT.NE.0)FLAG25='ON '
      IF(IEXT.NE.0)FLAG27='ON '
      IF(XFACT.NE.0.0)FLAG22='ON '
      IF(IAIR.EQ.1)FLAG28='ON '
      IF(INTRUD.NE.0)FINTRD='USED      '
      IF(IDKWAT.NE.0)FDK='PERFORMED     '
      IF(IDKAIR.EQ.1)FDJ='PERFORMED     '
C
      WRITE(6,4)FLAG20,FLAG23,FLAG24,SRDIL,FLAG25,FDK,FLAG28,FDJ,
     .FLAG27,XQSITE,FLAG22,FINTRD
    4 FORMAT(5X,'PATHWAYS INITIALIZED FOR DOSE CALCULATIONS:',T65,
     .'SPECIAL PARAMETERS INITIALIZED:',/,15X,'FARM PRODUCT INGESTION:',
     .T51,A3,/,15X,'INHALATION OF RESUSPENDED MATERIAL:',A3,/
     .,15X,'AQUATIC FOODS INGESTION:',T51,A3,
     .T70,'INVENTORY DILUTION FACTOR:',1PE9.2E2,/,
     .15X,'DRINKING WATER INGESTION:',T51,A3,T70,'DECAY OF RIVER ',
     .'RELEASE SOURCE TERM ',A13,/,
     .15X,'CONTINUING ATMOSPHERIC DEPOSITION  'A3,T70,'DECAY OF ',
     .'AIR RELEASE SOURCE TERM '.A13,/,
     .15X,'EXTERNAL FROM BURIED WASTES  ',T51,A3,
     .T70,'SITE X/Q: ',1PE9.2E2,/
     .15X,'EXTERNAL FROM SURFACE DEPOSITS:',T51,A3,T70,
     .'SPECIAL INHALATION MODEL ',A8)
C
      IF (ION .GT. 0) WRITE (6,1055) FRSIZ,AREAIN,AREAEX
 1055 FORMAT(T70,'SIZE OF THE SITE:',F9.5,' FRACTIONAL HECTARES'/,
     .T70,'INTERNAL PATHWAY AREA CORRECTION FACTOR:',1PE9.2E2/
     .T70,'EXTERNAL PATHWAY AREA CORRECTION FACTOR:',1PE9.2E2)
C
C FARM PRODUCT PARAMETERS
C
      WRITE(6,5)RF1,RIRR,RF2,IMO,RPF2,DILF,IRR
    5 FORMAT('0',4X,'FARM PRODUCT PARAMETERS USED:',/,
     .15X,'FRACTION OF ROOTS IN UPPER SOIL:',0PE10.2E2,
     .T65,'IRRIGATION RATE:',1PE10.2E2,'L/M**2/MO',/
     .15X,'FRACTION OF ROOTS IN BURIED WASTE',0PE9.2E2,
     .T65,'MONTHS PER YEAR IRRIGATED:',I5,/
     .15X,'FRACTION OF TOTAL DIET GROWN ON SITE:',1PE10.2E2,
     .T65,'RIVER DILUTION FACTOR:',1PE10.2E2,'YR/L',/
     .T65,'YEARS OF IRRIGATION WITH CONTAMINATED WATER PRIOR TO',/
     .T70,'THE DOSE CALCULATIONS:',I5)
C
C EXTERNAL PATH PARAMTERS
      IF (FLAG22.EQ.'OFF' .AND. FLAG27 .EQ. 'OFF') GO TO 100
      WRITE (6,1060)
 1060 FORMAT ('0',4X,'EXTERNAL EXPOSURE PARAMETERS USED:')
```

```
      WRITE (6,1065) RPF1
 1065 FORMAT (15X,'RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL ',
     .'TO SUBSURFACE SOIL', 1PE10.2E2)
C
      IF (XF2 .GT. 0.0) WRITE (6,1070) XF2
 1070 FORMAT (15X,'NUMBER OF HOURS OF EXPOSURE TO EXTERNAL ',
     .' CONTAMINATION', 1PE10.2E2)
      IF (XF2 .EQ. 0.0) WRITE (6,1075) XFACT
 1075 FORMAT (15X,'XFACT MODIFICATION: ',1PE10.2E2)
      IF (I22 .EQ. 0) WRITE (6,1080)
 1080 FORMAT(15X, 'SURFACE DEPOSITS DRFS FROM ISOSHLD; '
     .,'MODIFICATION FACTOR: 5.844E-11')
C
  100 CONTINUE
C
C AIR PATH PARAMETERS
C
      IF (FLAG23 .EQ. 'OFF') GO TO 101
C
      WRITE (6,1090)
 1090 FORMAT ('0',4X,'INHALATION PARAMETERS USED:')
C
      RIN = RINH * 8766.
      WRITE (6,1095) RINH,RIN
 1095 FORMAT (15X,'MODIFICATION FACTOR , RINH:', 1PE10.2E2,
     ./20X,'(EQUIVALENT TO BREATHING RATE OF 230 CC/SEC FOR ',0PF6.0,
     .' HR/YR)')
C
      TINHL='ANSPAUGH    '
      IF(AGE.LT.0.0)TINHL='MASS LOADING'
      WRITE(6,6)TINHL
    6 FORMAT(15X,'RESUSPENSION MODEL USED FOR CALCULATING AIR ',
     .'CONCENTRATION: ',A12)
C
      AVCM = XDPT * 15.0
C
      IF(AGE.GE.0.0)WRITE(6,7)AGE,AVCM
    7 FORMAT(15X,'AVERAGE AGE OF MATERIAL ON GROUND AT TIME ZERO:',
     .1PE10.2E2,' YEARS',/,15X,'TOP ',0PF4.1,' CM OF THE ',
     .'CONTAMINATED SURFACE LAYER IS AVAILABLE FOR RESUSPENSION.',
     .1PE10.2E2//)
C
      IF(AGE.LT.0.0)WRITE(6,8)DEN,XMLF
    8 FORMAT(15X,'SOIL DENSITY, G/M**3:',1PE10.2E2,/,15X,
     .'MASS LOADING FACTOR, G/M**3:',1PE10.2E2,//)
  101 CONTINUE
C
C ORGANS
C
```

```
      WRITE(6,9)(ONAME(KORG(I)),I=1,NORG)
    9 FORMAT(' ',/
     .5X,'ORGANS FOR WHICH DOSES ARE CALCULATED (SAME ORDER AS',
     .' SOLUBILITIES GIVEN BELOW):',//,10X,5(10X,A10))
C
C SIGN-OFF
      WRITE(6,10)
   10 FORMAT(//,20X,'INPUT PREPARED BY',25X,'DATE',/,37X,25('='),4X,
     .10('='),//,20X,'INPUT CHECKED BY',26X,'DATE',/,37X,25('='),4X,
     .10('='))
C RELEASES
C
      ID = 'YR'
      IDL = INT(DILF)
      IF (IDL .EQ. 1) ID = 'L '
C
      FM3M2='M**2)'
      IF(M3M2.EQ.1)FM3M2='M**3)'
      IF(M3M2.EQ.2)FM3M2='KG  )'
C
  200 CONTINUE
C
      IF (IBIO .GT. 0) THEN
        WRITE (6,1011) IBYR
 1011   FORMAT ('1 INVENTORY FOR YEAR ',I5,' OF BIOPORT SIMULATION.')
      ELSE
        WRITE (6,1012)
 1012   FORMAT ('1')
      ENDIF
C
      WRITE(6,11)FM3M2, ID
   11 FORMAT(1H ,5X,'RELEASE TERMS ',T56,'SOIL SOURCE',T70,'IRRIGAT',
     .'ATION/AQUATIC',T92,'DRINKING WATER',T110,'ATM. RELEASE',/,
     .10X,'NUCLIDE',10X,'ORGAN SOLUBILITY CLASSES',5X,'(PCI/',A5,10X,
     .'(PCI/',A2,')',9X,'(PCI/L)',10X,'(CI/YR)',/)
C
      DO 13 I=1,NONUC
      WRITE(6,12)ELTO(I),AWO(I),(NTR(J,I),J=1,5),QAPR(I),AMI(I),AMJ(I)
     .,AML(I)
   12 FORMAT(10X,A2,1X,A6,8X,5I4,4(8X,1PE10.2E2))
   13 CONTINUE
C
C NOTE BOX
      IF (NEXT .EQ. 5) GOTO 201
      IBOX=50-NONUC
      IF(IBOX.LT.6)GO TO 20
      WRITE(6,14)
   14 FORMAT(/,20X,20('*'),'PLEASE NOTE ANY SPECIAL CONSIDERATIONS IN',
     .' THIS SPACE',20('*'))
```

```
      IBX=IBOX-2
      IF(IBX.GT.20)IBX=20
      DO 16 I=1,IBX
      WRITE(6,15)
   15 FORMAT(20X,'*',90X,'*')
   16 CONTINUE
      WRITE(6,17)
   17 FORMAT(20X,92('*'))
C
  201 CONTINUE
   20 RETURN
C
C-----------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE RDSUB (Q, QI, QJ, NFLAG, QAPR, RIM)
C
C     THIS ROUTINE INITIALIZES SUBSEQUENT INVENTORIES GENERATED BY THE
C     BIOPORT COMPUTER.  THE RADIONUCLIDES AND THEIR ORDER MUST BE
C     THE SAME AS INPUT FOR THE FIRST EXECUTION.  IT IS ALSO NECESSARY THAT
C     RADIONUCLIDES BE ARRANGED IN CHAINS AS THEY APPEAR IN RMDLIB.
C     THIS IS TRANSPARENT TO THE BIOPORT USER, BUT MUST BE CAREFULLY
C     CONSIDERED IF THIS ROUTINE IS ADAPTED TO OTHER USES.  USER BEWARE!
C
C     THIS ROUTINE ELIMINATES REREADING OF THE DOSE FACTOR LIBRARIES
C     TO REDUCE EXECUTION TIME.
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      COMMON /DATA1/ ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     . IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     . IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      DIMENSION Q(50), QAPR(50), QI(50), QJ(50), NFLAG(300)
      CHARACTER*6 AWO
C
      CALL ZEROR (50, AM)
      CALL ZEROR (50,QAPR)
      CALL ZEROR (50,AMI)
      CALL ZEROR (50,AMJ)
C
C     SET INPUT INVENTORY INTO CORRESPONDING CHAIN POSITION:
C
      DO 100 IL = 1, NONUC
C
C        IF (NFLAG(IL) .GT. 0) THEN
          IN = IL
          AM(IL) = Q(IN) * RIM
          QAPR(IL) = Q(IN)
          AMI(IL) = QI(IN)
          AMJ(IL) = QJ(IN)
C        ENDIF
C
  100 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE RLIBIN(TITLR)
C
C     THIS SUBROUTINE READS A MASTER NUCLIDE DATA LIBRARY WITH CHAIN
C     DECAY DATA.
C
C     Module of MAXI1
C     Version of 25-APR-84
C
C-----------------------------------------------------------------------
C
      COMMON/RLIB/ELT(300),AW(300),TR(300),NUC,NCH,NCHN(300),NOFNUC(200)
     .,NCHST(200),IFR(2,300),DKF(2,300),IMEM(300)
      DIMENSION TITLR(20),IT(2),FR(2)
C
      CHARACTER AW*6,A*6
C
C     INITIALIZE INDICES
C
      IMO=0
      NCH=0
      NUC=1
C
C  READ TITLE CARD
C
      READ(10,200,END=99) TITLR
C
C   READ AND COUNT NUCLIDE ID AND DECAY DATA.
C
    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
C
      RETURN
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
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
      TR(NUC)=T
      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,' DIAGNOSTIC 5: DECAY CHAIN',I4,' HAS IMPROPER ORDER. C
     .URRENT MEMBER INDEX IS',I4)
      STOP
   98 PRINT 300, NUC
  300 FORMAT(1H1,' DIAGNOSTIC 6: IMPROPER NUMBER OF NUCLIDES IN MASTER L
     .IBRARY, NUC=',I8)
      STOP
   99 PRINT 400
  400 FORMAT(1H1,' DIAGNOSTIC 7: END OF FILE ON MASTER LIBRARY UNIT 10')
      STOP
C
C  INPUT DATA FORMATS
C
  100 FORMAT(A2,A6,E10.2,I2,2(I2,F7.4))
  200 FORMAT(20A4)
C
C-----------------------------------------------------------------------
C
      END
```

```
C---------------------------------------------------------------------------
C
      SUBROUTINE SETDAT   (ELTI,AWI,NFLAG,NFLAGC,Q,
     .                     KORG,NORG,NSOLD,NTR,QI,QJ,RIM,
     .                     QAPR,ISUR)
C
C     This subroutine stores decay and dose factor data for each
C     radionuclide in the inventory.
C
C     Module of MAXI1
C     Version of 11-MAY-84  RAP
C
C---------------------------------------------------------------------------
C
      COMMON/THIRDS/QK(50),AML(50),XQSITE,IAIR,IDKAIR,IBLOW
C
      COMMON/RLIB/ELT(300),AW(300),TR(300),NUC,NCH,NCHN(300),NOFNUC(200)
     .,NCHST(200),IFR(2,300),DKF(2,300),IMEM(300)
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      COMMON/DATA2/DFDOS(50,50,5),AIDOS(50,50,5),INDOS(50,50,5),
     .DEXT(50),ARGF(50,50,5),ARDW(50,50,5),DEDXT(50)
C
      DIMENSION ELTI(50),AWI(50),NFLAG(300),NFLAGC(200),Q(50)
      DIMENSION QI(50),QJ(50),QAPR(50)
      DIMENSION KORG(5), NSOLD(5,50), NTR(5,50)
C
      CHARACTER*6 AW,AWLS,AWX,AWI,AWO,AWAW,AWW,AWDX,A
      REAL INDOS
C
      INUC=0
      ICHN=0
C
      CALL ZEROR(50,ELTO)
C     CALL ZEROR(50,AWO)
C
      DO 8881 IRAP = 1,50
        AWO(IRAP) = '      '
 8881 CONTINUE
C
      CALL ZEROI(50,IOFNUC)
      CALL ZEROR(50,AL)
      CALL ZEROR(50,AM)
      CALL ZEROI(250,NTR)
C
C
```

```
C  LOOP ON ALL CHAINS FROM MASTER LIBRARY
C
      DO 20 IC=1,NCH
C
C
C  IF THIS CHAIN IS NOT USED, THEN SKIP TO 20
C
      IF(NFLAGC(IC).NE.1)GO TO 20
C
      ICHN=ICHN+1
      NCN=NOFNUC(IC)
      N1=NCHST(IC)
      N2=N1+NCN-1
      IONE=0
      I=0
C
C  LOOP ON ALL NUCLIDES IN ACTIVE CHAIN
C
      DO 15 IL=N1,N2
C
C  CAPTURE ALL DAUGHTERS
C
      IF(IONE.EQ.1)GO TO 10
C
C  IF THIS NUCLIDE AT THE FRONT OF THE CHAIN IS NOT SPECIFIED, SKIP.
C
      IF(NFLAG(IL).EQ.0)GO TO 14
      IONE=1
C
C  SET ALL DATA FOR THIS NUCLIDE FROM INPUT AND EXTERNAL FILES
C
   10 INUC=INUC+1
      IF(INUC.GT.50)GO TO 97
C
C  RADIOLOGICAL DATA
C
      IFRM(1,INUC)=MAX(0,IFR(1,IL)-I)
      IFRM(2,INUC)=MAX(0,IFR(2,IL)-I)
      DK(1,INUC)=DKF(1,IL)
      DK(2,INUC)=DKF(2,IL)
      AL(INUC)=0.693/TR(IL)*365.25
      IF(NFLAG(IL).EQ.0)GO TO 16
      NFIL=NFLAG(IL)
      AM(INUC)=Q(NFIL)*RIM
      QAPR(INUC)=Q(NFIL)
      AMI(INUC)=QI(NFIL)
      AMJ(INUC)=QJ(NFIL)
      AMK(INUC)=QK(NFIL)
   16 CONTINUE
```

```
C     DEBUG PRINT STATEMENT--
C      PRINT 8888, INUC, ELT(IL), AW(IL)
C 8888 FORMAT (' INUC: ',I5,1X,A2,A6)
C
      ELTO(INUC)=ELT(IL)
      AWO(INUC)=AW(IL)
C
C     ORGAN SOLUBILITY DATA--
      DO 250 JORG=1,NORG
  250 NTR(JORG,INUC)=NSOLD(JORG,NFIL)
c
      IRAP=0
      E=ELTO(INUC)
      A=AWO(INUC)
C
C     LEAF AND SOIL MECHANISM DATA
      IF (IFOD .EQ. 0) GO TO 30
        IRAP = 1
        CALL DFREAD(IRAP,E,A,NORG,KORG,INUC)
   30 CONTINUE
C
C     AQUATIC FOOD DATA
      IF (IARG .EQ. 0) GO TO 40
        IRAP= 2
        CALL DFREAD(IRAP,E,A,NORG,KORG,INUC)
   40 CONTINUE
C
C     DRINKING WATER DATA
      IF (IWAT .EQ. 0) GO TO 50
        IRAP= 3
        CALL DFREAD(IRAP,E,A,NORG,KORG,INUC)
   50 CONTINUE
C
C     SURFACE EXTERNAL DATA
      IF (ISUR .EQ. 0) GO TO 60
        IRAP = 4
        CALL DFREAD(IRAP,E,A,NORG,KORG,INUC)
   60 CONTINUE
C
C     BURIED/STORED DATA
      IF (IEXT .EQ. 0) GO TO 70
        IRAP = 5
        CALL DFREAD(IRAP,E,A,NORG,KORG,INUC)
   70 CONTINUE
C
      GO TO 15
C
C  INCREMENT INDEX TO SKIP UNUSED CHAIN MEMBERS
   14 I=IMEM(IL)
```

```
   15 CONTINUE
C
C  SET NUMBER OF NUCLIDES IN REDUCED CHAIN
C
      IOFNUC(ICHN)=NCN-I
C
C     PRINT 8872,IOFNUC(ICHN),ICHN,NCN,I
C8872 FORMAT(" AT 15 IN SETDAT (IOFNUC,ICHN,NCN,I): ",4I4)
C
C
   20 CONTINUE
C
      NONUC=INUC
C
      RETURN
C
C
   97 WRITE(6,98)INUC
   98 FORMAT(1H1,' DIAGNOSTIC 13:TOO MANY NUCLIDES ATTEMPTED IN SUBROUTI
     .NE SETDAT. INUC=',I5)
      STOP
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE SOLCON  (ITIM2,ICH,INUC,AITIME,J,AO,JTIME,AMT,IT1,
     .                    AMK,AMM, RPF1)
C
C     THIS SUBROUTINE IS USED TO CALCULATE THE SOIL CONCENTRATION OF
C     BOTH THE DECAYING SURFACE CONTAMINATION AND DEPOSITED
C     CONTAMINATION FROM IRRIGATION
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
      CHARACTER*6 AWO
C
      DIMENSION AMM(50)
      DIMENSION AO(50),AMK(50),AMT(50)
C
      IST=INUC+1
      IF(J.EQ.1) GO TO 150
      GO TO 160
C
C   DECAY ONE MEMBER CHAINS AND CORRECT FOR IRRIGATION BUILDUP AND
C   'PLOW FACTOR', THE MULTIPLICATIVE RATIO BETWEEN
C   BURIED AND SURFACE WASTE
C
  150 AO(IST)=AO(IST)+AMK(IST)*RIRR*IMO+AMM(IST)*3.15E4
      AO(IST)=AO(IST)*EXP(-AL(IST))
      SOILCN(IST)=AM(IST)*RPF1*EXP(-AL(IST)*JTIME)+AO(IST)
      IF(IEXT.NE.1) GO TO 170
C
C  SETS AMT IF ON
      IF(JTIME.GE.IT1) AMT(IST)=AM(IST)*EXP(-AL(IST)*JTIME)
      GO TO 170
  160 CONTINUE
      K=IST+IOFNUC(ICH)-1
C
C   CALL CHAIN DECAY
C
      DO 100 I=IST,K
      IF(ITIM2.EQ.1)
     .SOILCN(I)=(AM(I)*RPF1)/AL(I)
      IF(ITIM2.GT.1)
     .SOILCN(I)=(SOILCN(I)+AMK(I)*RIRR*IMO+3.15E4*AMM(I))/AL(I)
  100 CONTINUE
```

```
      CALL ACHAIN(J,AITIME,DK(1,IST),IFRM(1,IST),AL(IST),SOILCN(IST),
     .SOILCN(IST))
      DO 200 I=IST,K
      SOILCN(I)=SOILCN(I)*AL(I)
  200 CONTINUE
      IF(JTIME.LT.IT1) GO TO 170
C
      IF(IEXT.NE.1) GO TO 170
C
C  THIS SEGMENT SETS AMT, AMOUNT OF DEEPLY BURIED WASTE
C
      DO 300 I=IST,K
      AM(I)=AM(I)/AL(I)
 300  CONTINUE
      ATIM=JTIME
      CALL ACHAIN(J,ATIM,DK(1,IST),IFRM(1,IST),AL(IST),AM(IST),AMT(IST)
     .)
      DO 310 I=IST,K
      AM(I)=AM(I)*AL(I)
      AMT(I)=AMT(I)*AL(I)
  310 CONTINUE
  170 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE WATER(IDKWAT,INUC,JTIME,AMK,J)
C
C     THIS SUBROUTINE IS USED TO DECAY THE WATER RELEASE SOURCE
C     TERM IF NECCESSARY.  USED FOR OVERFLOW RELEASE CASES.
C
C     Module of MAXI1
C     Version of 25-APR-84
C
C-----------------------------------------------------------------------
C
      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
     &IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
     &IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
      CHARACTER*6 AWO
      DIMENSION AMK(50)
C
1     CONTINUE
C   IF NOT DECAYING WATER SOURCE, SET AMK=AMI
C
      IST=INUC+1
      K=IST+J-1
      IF(IDKWAT.NE.0)GO TO 10
      DO 100 I=IST,K
100   AMK(I)=AMI(I)
      GO TO 90
C
C  DECAY ONE MEMBER CHAINS
C
10    IF(J.GT.1)GO TO 20
      AMK(IST)=AMI(IST)*EXP(-AL(IST)*JTIME)
      GO TO 90
C
C   CALL CHAIN DECAY ROUTINE
C
20    DO 200 I=IST,K
200   AMI(I)=AMI(I)/AL(I)
      CTIME=JTIME
      CALL ACHAIN(J,CTIME,DK(1,IST),IFRM(1,IST),AL(IST),AMI(IST),
     &AMK(IST))
      DO 300 I=IST,K
      AMI(I)=AMI(I)*AL(I)
300   AMK(I)=AMK(I)*AL(I)
C
90    RETURN
C-----------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE ZEROI(N,K)
C
C     THIS MODULE SETS N VALUES OF ARRAY K TO INTEGER ZERO.
C
C     Module of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      DIMENSION K(N)
C
      DO 1 J=1,N
      K(J)=0
    1 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE ZEROR(N,A)
C
C     THIS MODULE SETS N VALUES OF ARRAY A TO REAL ZERO.
C
C     Modue of MAXI1
C     Version of 25-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      DIMENSION A(N)
C
      DO 1 J=1,N
      A(J)=0.
    1 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

APPENDIX 1.B

<u>COMPUTER CODE LISTING - ONSITE</u>

APPENDIX 1.B COMPUTER CODE LISTING - ONSITE

```
C------------------------------------------------------------------------
C
C   Program Title:  ONSITE
C
C   Developed for:  U.S. Nucear Regulatory Commission
C                   Office of Nuclear Material Safety & Safeguards
C                   Division of Waste Management
C
C   Date:           May 31, 1984
C
C   NRC Contact:    Dr. Stan Neuder
C                   Phone: 301-427-4607
C
C   Code Developer: B.A. Napier, R.A. Peloquin, W.E. Kennedy, Jr.
C                   Pacific Northwest Laboratory
C                   Richland, WA      509-375-3849 (WEK)
C
C
C   This program was prepared for an agency of the United States
C   Government.  Neither the United States government nor any agency
C   thereof, or any of their employees, make any warranty, expressed
C   or implied, or assumes any legal liability or responsibility for
C   any third party's use, or the results of such use, of any portion
C   of this program or represents that its use by such third party
C   would not infringe privately owned rights.
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
C     ONSITE is the interactive user/system interface for the ONSITE
C     Disposal Version of the MAXI1 computer code.  ONSITE creates
C     a file containing the JCL and input stream for MAXI1.
C
C     Version of 1-MAY-84  RAP
C
C     The program ONSITE includes the following modules:
C
C          CHANGE - to query if parameter is to be changed, and if so,
C                   to input the new value
C          DISINV - to display and control modifications to the
C                   user-entered inventory
C          GROUP - to determine if changes are required for a group
C                  of parameters
C          INTRO - to display introductory message
C          MODIF - to modify selected scenario parameters
C          QUANTI - to read in source term this radionuclide
C          RADIN - to read in and test radiological inventory
C          RITFIL - to write MAXI1 JCL and input stream
C          SELECT - to select and test scenario option
C          SCENR - to establish scenario default parameters
```

```
C     Program variable descriptions --
C          IRS - Index of scenario used for default values
C          ICFLAG - CHANGE subroutine passing flag: (returned)
C                   0 - no change requested
C                   1 - change requested
C          IGFLAG - GROUP subroutine flag:  (returned)
C                   0 - no change requested in this group
C                   1 - change requested in this group
C          ITFLAG  - CHANGE subroutine passing flag: (sent)
C                   1 - integer value
C                   2 - real value
C                   3 - double precision value
C          IX - CHANGE subrouotine passing parameter - integer value
C          IH - CHANGE passing parameter - maximum allowable integer input
C          IL - CHANGE passing parameter - minimum allowable integer input
C          GNAME(2) - Real*8 name of subgroup passed to GROUP
C          RX - CHANGE subroutine passing parameter - real value
C          RH - CHANGE passing parameter - maximum allowable real input
C          RL - CHANGE passing parameter - minimum allowable real input
C          R8X _ CHANGE subroutine passing parameter - real*8 value
C
C---- data definition and intialization ---------------------------------------
C
      INCLUDE 'ONSITE.CMN'
      REAL*8 R8X, GNAME(2), EXTFAC(2,4)
C
      DATA KEY, SCRN, OUT, IRS, IMOD, IBS  /5,6,7,1,0,1/
      DATA EXTFAC /'On surfa','ce      ',
     .            'Buried a','t 0.5 m ',
     .            'Buried a','t 1.0 m ',
     .            'Stored w','aste    '/
C
      DATA NVU /'pCi ','uCi ','mCi ',' Ci '/
      DATA NVUNIT /1.0, 1.0E+3, 1.0E+6, 1.0E+12/
      DATA UNITS /'/square ','meter   ',
     .           '/cubic m','eter    ',
     .           '/Kg of s','oil     '/
C
C---- introduce program, describe scenarios to user, & establish defaults ----
C
      CALL INTRO
      CALL SCENR
C
C---- input time and required parameters ---------------------------------------
C
      WRITE (SCRN,1100)
 1100 FORMAT (' ',20(/),' ',
     .'Enter a descriptive title to identify this case: ')
      READ (KEY,1101) (TITL(I), I=1,20)
 1101 FORMAT (20A4)
```

```
  200 CONTINUE
C
      WRITE (SCRN,1110) IT1
 1110 FORMAT (' ',20(/),' ',
     .'This scenario begins ',I4,' years after the waste is'
     ./' disposed.')
      CALL CHANGE ((1), ICFLAG, IX, (0), (9999), RX, RL, RH, R8X)
      IF (ICFLAG.EQ.1) IT1 = IX
C
      IT2 = IT1 + 49
      WRITE (SCRN,1111) IT2
 1111 FORMAT (' ',
     .'This scenario will end ',I4,' years after the waste is'/
     .' disposed. OK? (Y/N)')
      READ (KEY, 8001) IDUM
      IF (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n') GO TO 200
C
      WRITE (SCRN,1120)
      WRITE (SCRN,1121) IOUT
C
 1120 FORMAT (' ',14(/),' ',
     .'Three types of printer reports are available:'//
     .'     0- Tables of maximum annual dose per organ with radio',
     .'nuclide and'/'          pathway contribution'/
     .'     1- Table above plus annual doses by organ and total'/
     .'     2- Table above plus annual doses by organ, pathway and',
     .' radionuclide')
C
 1121 FORMAT (//' ',
     .'The current selection is:',I2)
      CALL CHANGE ((1), ICFLAG, IX, (1), (3), RX, RL, RH, R8X)
      IF (ICFLAG.EQ.1) IOUT = IX
C
      IF (IRS .GT. 1 .AND. IRS .LT. 5) GO TO 304
C
C---- if scenario 1 or 5, find out where the wastes are located and set flags
C
        IF (IEXT .EQ. 0) GO TO 304
          WRITE (SCRN,1210)
          DO 302 I = 1, 4
            WRITE (SCRN, 1211) I, (EXTFAC(J,I),J=1,2)
 302      CONTINUE
          WRITE (SCRN,1212) ILOC
C
 1210     FORMAT (' ',14(/),' ',
     .    ' In this scenario, wastes may be:'//)
 1211     FORMAT(20X,I2,' -',2A8)
 1212     FORMAT (//,' The current selection is: ',I1)
          CALL CHANGE ((1),ICFLAG,IX,(1),(4),RX,RL,RH,R8X)
          IF (ICFLAG .EQ. 1) ILOC = IX
```

```
  304   CONTINUE
C
C---- query if changes are desired to scenarios & modify --------------------
C
      IF (IRS .LT. 5) GO TO 111
        IMOD=1
        CALL OPTION
        GO TO 100
  111 CONTINUE
C
      WRITE (SCRN,1001) IRS
 1001 FORMAT (' ',
     .14X,44('#')//14X,'Do you wish to modify any parameter values for'
     ./14X,'Scenario ',I1,' (N/Y) ?')
      READ (KEY,8001) IDUM
 8001 FORMAT (A1)
      WRITE (SCRN,1002)
 1002 FORMAT (' ',14(/))
C
      IF (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y') IMOD =1
  100 CONTINUE
      IF (IMOD .EQ. 1) CALL MODIF
C
C
C---- set area correction factor ----------------------------------------
C
  400 CONTINUE
      IF (IRS .EQ. 4) GO TO 401
C
C
          WRITE (SCRN,1300) FRSIZ
 1300     FORMAT (' ',14(/),' ',
     .    'The size of the site in terms of fractional hectares'/
     .    ' (ie., 10000 sq m), is ',1PG10.3,'.')
          CALL CHANGE ((2),ICFLAG,IX,IL,IH,RX,(1.E-35),(1.E35),R8X)
          IF (ICFLAG.EQ.1) FRSIZ = RX
C
C
          WRITE (SCRN,1301) FRSIZ
 1301     FORMAT (////' ',
     .'The inventory will automatically be adjusted by the'/
     .' appropriate area correction factor for each exposure'/
     .' pathway based on a  site size of ', 1PG10.3, ' hectares.'/)
C
C
       GNAME(1) = '  the ab'
       GNAME(2) = 'ove     '
       CALL GROUP (IGFLAG, GNAME)
       IF (IGFLAG.EQ.1) GO TO 400
C
```

```
      IF (FRSIZ .GE. 1.0) THEN
        AREAIN = 1.0
      ELSE
        IF (FRSIZ .GE. 0.1) THEN
          AREAIN = 0.75
        ELSE
          IF (FRSIZ .GE. 0.02) THEN
            AREAIN = 0.50
          ELSE
            IF (FRSIZ .GE. 0.005) THEN
              AREAIN = 0.25
            ELSE
              AREAIN = 0.10
            ENDIF
          ENDIF
        ENDIF
      ENDIF
C
      IF (FRSIZ .GE. 0.125) THEN
        AREAEX = 1.0
      ELSE
        IF (FRSIZ .GE. 0.05) THEN
          AREAEX = 2.7 * FRSIZ + 0.67
        ELSE
          IF (FRSIZ .GE. 0.01) THEN
            AREAEX = 6.5 * FRSIZ + 0.48
          ELSE
            IF (FRSIZ .GE. 0.0025) THEN
              AREAEX = 20.0 * FRSIZ + 0.35
            ELSE
              AREAEX = 160.0 * FRSIZ
            ENDIF
          ENDIF
        ENDIF
      ENDIF
C
  401 CONTINUE
C
C----- input ratio and inventory units ------------------------------------
C
      IF (ISUR .EQ. 1 .AND. IEXT .EQ. 1) THEN
        WRITE (SCRN,1220) RPF1
 1220   FORMAT (' ',14(/),' ',
     .  'This scenario assumes both surface contamination and'/
     .  ' contamination from buried or stored waste.  What is'/
     .  ' the ratio of waste concentration in the surface to'/
     .  ' subsurface soils?  (Range = 0.0 to 1.0)'/
     .  ' The current selection is: ', 1PG10.3)
        CALL CHANGE ((2),ICFLAG,IX,IL,IH,RX,(0.0),(1.0),R8X)
        IF (ICFLAG .EQ. 1) RPF1 = RX
```

```
      ELSE
        IF (ISUR .EQ. 1) RPF1 = 1.0
        IF (IEXT .EQ. 1) RPF1 = 1.0
      ENDIF
C
      IF (IRS .EQ. 4) GO TO 300
C
      WRITE (SCRN,1230)
C
      DO 131 I = 1, 4
        WRITE (SCRN,1231) I, NVU(I)
  131 CONTINUE
C
      WRITE (SCRN, 1232) INUT
 1230 FORMAT(' ',24(/),' ',
     .'The surface/buried inventory may be entered as: '//)
 1231 FORMAT(15X, I1,' - ',A4)
 1232 FORMAT(//' ',
     .'The currect selection is: ',I1)
C
      CALL CHANGE ((1),ICFLAG, IX, (1), (4), RX,RL,RH,R8X)
      IF (ICFLAG .EQ. 1) INUT = IX
C
        WRITE (SCRN,1200)
        DO 142 I = 1, 3
          IM3 = I - 1
          WRITE (SCRN,1201) IM3, NVU(INUT), (UNITS(J,I),J=1,2)
  142   CONTINUE
        WRITE (SCRN,1202) M3M2
C
 1200   FORMAT (' ',14(/),' ',
     .  'The contamination deposited on the site at start of'/
     .  ' calculation may be entered in the following units:'//)
 1201   FORMAT (15X, I1,' - ',A4,2A8)
 1202   FORMAT (//, ' The current selection is: ',I1)
C
        CALL CHANGE ((1),ICFLAG,IX,(0),(2),RX,RL,RH,R8X)
        IF (ICFLAG .EQ. 1) M3M2 = IX
C
  300 CONTINUE
C
      IF (IRS .EQ. 4) GO TO 301
C
        WRITE (SCRN,1250) SRDIL
 1250   FORMAT(' ',14(/),' ',
     .  'The surface/buried inventory dilution factor is: ',1PG10.2/
     .  ' (range = 0.0 to 1.0E+20)')
        CALL CHANGE ((2),ICFLAG,IX,IL,IH,RX, (0.0),(1.E20),R8X)
        IF (ICFLAG .EQ. 1) SRDIL = RX
  301 CONTINUE
```

```
C---- allow user to review parameters before entering the inventory ---------
C
      GNAME(1) = 'any of t'
      GNAME(2) = 'he above'
      CALL GROUP (IGFLAG,GNAME)
      IF (IGFLAG .EQ. 1) THEN
        IMOD = 0
        GO TO 200
      ENDIF
C
C---- input inventory and write file ----------------------------------------
C
      CALL RADIN
      CALL DISINV
      CALL RITFIL
C
C---- end of program --------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
C     ONSITE.CMN include file of common blocks for the ONSITE computer
C     program
C
C     Version of 28-MAY-84 RAP
C
C-----------------------------------------------------------------------
C
      COMMON /VARYBL/ IFOD, RIRR,RPF, IMO, RF1, RF2, IARG, IWAT,
     .                IDKWAT, IEXT, IAIR, XQSITE, IDKAIR,
     .                ISUR, I22, XF2,
     .                AGE, XDPT, DEN, XMLF, RINH, DILF, M3M2, INTRUD,
     .                IT1, IT2, NORG, KORG(5), IOUT, NEXT,
     .                RPF1, RPF2, INHAL, IRR, SRDIL, NVUNIT(4)
      REAL NVUNIT
C
      COMMON /INV/ NIN, ELTI(100), AWI(100), NSOLD(5,100),
     .             Q(100), QI(100), QJ(100), QK(100)
      REAL*8 AWI
      INTEGER ELTI
C
      COMMON /FLAG/  IRS, ILOC, INUT, IARL, IWRL
C
C          IRS - INDEX OF SELECTED SCENARIO
C          ILOC - INDEX OF LOCATION OF THE WA.TE:
C                 1) SURFACE
C                 2) BURIED AT 0.5 M
C                 3) BURIED AT 1.0 M
C                 4) STORED
C          INUT - INDEX OF RADIOLOGICAL UNITS INPUT FOR ARRAYS
C                 NVU (DESCRIPTION) AND NVUNIT(MOD. FACTOR)
C          IARL - SET IF SURFACE/BURIED CONTAMINATION
C          IWRL - SET IF LIQUID CONTAMINATION
C
      COMMON /AREA/ FRSIZ, AREAIN, AREAEX
C
C          FRSIZ - SIZE OF THE SITE IN FRACTIONAL HECTARES
C          AREAIN - AREA CORRECTION FACTOR FOR INTERNAL PATHWAYS
C          AREAEX - AREA CORRECTION FACTOR FOR EXTERNAL PATHWAYS
C
      COMMON /DESC/ TITL(20), UNITS(2,3), NVU(4)
      REAL*8 UNITS
      REAL*4 TITL, NVU
C
      COMMON /IOVAR/  SCRN, OUT, OUTFIL, KEY
      CHARACTER*15 OUTFIL
      INTEGER SCRN, OUT
C
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE CHANGE (ITFLAG, ICFLAG, IX, IL, IH, RX, RL, RH, R8X)
C
C          CHANGE is called to query if parameter is to be changed,
C          and if so, to input the new value  and test if within the limits.
C
C          This subroutine will handle integer, real and alphanumeric
C          input and will test the limits on integer and real input.
C          Alphanumeric input is read into the real*8 variable.
C
C          ICFLAG - CHANGE subroutine passing flag: (returned)
C                   0 - no change requested
C                   1 - change requested
C          ITFLAG  - CHANGE subroutine passing flag: (received)
C                   1 - integer value
C                   2 - real value
C                   3 - alphanumeric input - real*8
C          IX - new integer value (returned)
C          IH - maximum allowable integer input (received)
C          IL - minimum allowable integer input (received)
C          RX - new real value (returned)
C          RH - maximum allowable real input (received)
C          RL - minimum allowable real input (received)
C          R8X - real*8 alphanumeric string input (returned)
C
C     Module of ONSITE
C     Version of 17-APR-84  RAP
C
C-----------------------------------------------------------------------
C
C
      INCLUDE 'ONSITE.CMN'
      REAL*8 R8X
C
      ICFLAG = 0
      WRITE (SCRN,1000)
 1000 FORMAT (//' ',70('-'),//
     .' Do you wish to change this value (N/Y)?')
      READ (KEY,8001) IY
 8001 FORMAT (A1)
C
      IF (IY .NE. 'Y' .AND. IY .NE. 'y') GO TO 700
C
        ICFLAG = 1
  100   CONTINUE
C
          WRITE (SCRN, 1010)
 1010     FORMAT (' '/' Enter new value: ')
C
```

```
C                                                    integer input
          IF (ITFLAG .NE. 1) GO TO 200
            READ (KEY,*) IX
            IF (IX .LT. IL .OR. IX .GT. IH) GO TO 100
            GO TO 700
  200     CONTINUE
C
C                                                    real input
          IF (ITFLAG .NE. 2) GO TO 300
            READ (KEY,*) RX
            IF (RX .LT. RL .OR. RX .GT. RH) GO TO 100
            GO TO 700
  300     CONTINUE
C
C                                                    real*8 alpha input
          IF (ITFLAG .NE. 3) GO TO 400
            READ (KEY,8003) R8X
  400     CONTINUE
C
  700 CONTINUE
C
      WRITE (SCRN,1001)
 1001 FORMAT (' ',24(/))
C
      RETURN
C
C ---- format statements ----
C
 8003 FORMAT (A8)
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE DISINV
C
C     This subroutine displays the radionuclide inventory, allows the user
C     to first modify quantities in the inventory, and then to add radio-
C     nuclides to the list. If changes or additions are requested, the
C     inventory will be redisplayed; the user does not return from this
C     subroutine until satisfied with the inventory.
C
C     Module of ONSITE
C     Version of 24-APR-84
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
      REAL*8 GNAME(2)
C
  300 CONTINUE
C
        WRITE (SCRN,1000) NVU(INUT), (UNITS(J,M3M2+1),J=1,2), NVU(INUT),
     .                    NVU(INUT)
 1000   FORMAT(///T24,'Surface/Buried', T57,'Drinking'/
     .  T29, A4, T41, 'Irrigation        Water'/
     .  T11,'Radionuclide',T25,A8,A5, T43,A4,'/1', T58,A4,'/1',/
     .  T11,'------------',3X,3('----------',5X))
C
        DO 100 I = 1, NIN
          WRITE (SCRN,1001) ELTI(I), AWI(I), Q(I), QI(I), QJ(I)
  100   CONTINUE
 1001   FORMAT(11X,A2,A6,3(5X,1PG10.2))
C
        GNAME(1) = 'the abov'
        GNAME(2) = 'e       '
        CALL GROUP (IGFLAG,GNAME)
        IF (IGFLAG .NE. 0)  THEN
C
          IMOD = 1
          WRITE (SCRN,1011)
 1011     FORMAT (//' You may now modify the quantity of selected'/
     .             ' radionuclides.  To delete a radionuclide,'/
     .             ' enter zero quantity.'////)
C
          DO 200 I = 1, NIN
            WRITE (SCRN,1010) ELTI(I), AWI(I), Q(I), NVU(INUT),
     .      (UNITS(J,M3M2+1),J=1,2), QI(I), NVU(INUT), QJ(I), NVU(INUT)
 1010       FORMAT (//' Radionuclide ',A2,A6,':  '//
     .              '      Surface/Buried: ',1PG10.2,1X,A4,A8,A5/
     .              '      Irrigation:     ',1PG10.2,1X,A4,'/1'/
     .              '      Drinking Water: ',1PG10.2,1X,A4,'/1')
```

```
          CALL GROUP(IGFLAG,GNAME)
          IF (IGFLAG .NE. 0) CALL QUANTI (I)
  200   CONTINUE
C
C
      ELSE
C
        IMOD = 0
C
      ENDIF
C
C
      WRITE (SCRN,1020)
 1020 FORMAT (///' Do you wish to add radionuclides to the above'
     .           ' inventory?')
      READ (KEY,8001) IY
 8001 FORMAT (A1)
C
      IF (IY .EQ. 'Y' .OR. IY .EQ. 'y') THEN
        IMOD = 1
        CALL RADIN
      ENDIF
C
C
      IF (IMOD .EQ. 1) GO TO 300
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE GROUP (IGFLAG, GNAME)
C
C     This subroutine introduces a new category of parameters and allows
C     the user of skipping edits to that entire group of parameters.
C
C     Parameters:
C
C          IGFLAG - flag returned to calling program to indicate user
C                   preferance concerning this group:
C                        0 - do not change any parameters
C                        1 - display/query this parameter group
C
C          GNAME - description of parameter group passed from calling
C                  program (Real*8)
C
C     Module of ONSITE
C     Version of 17-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
      REAL*8 GNAME(2)
      IGFLAG = 0
C
      WRITE (SCRN,1000)  (GNAME(I),I=1,2)
 1000 FORMAT (' ',1(/),' ',70('#')//
     . ' Do you wish to review or change ', 2A8,
     . ' parameters (N/Y)')
C
      READ (KEY,8003) IDUM
 8003 FORMAT (A1)
      IF (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y') IGFLAG = 1
C
      RETURN
C
C-----------------------------------------------------------------------
C
      END
```

```
C
C-----------------------------------------------------------------------
C
      SUBROUTINE INTRO
C
C     This subroutine displays introductory messages, describes
C     available scenarios, and queries for user's selection.
C
C     Module of ONSITE
C     Version of 17-APR-84  RAP
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
C
      WRITE (SCRN,2000)
 2000 FORMAT (' ',24(/),30X, 19('=')/34X,'ONSITE/MAXI'/30X,
     . 19('='),//////)
C
      WRITE (SCRN,2011)
 2011 FORMAT (14X,'This interactive program will assist you ',
     .'in the creation'/
     .14X,'of scenarios for assessment of onsite disposal of low-'/
     .14X,'level waste.  Doses to man through the specified pathways '/
     .14X,'will be simulated by the computer program MAXI.'///
     .14X,'The following notes may be of interest:')
C
      WRITE (SCRN,2010)
      READ (KEY,8003) IDUM
C
      WRITE (SCRN,2001)
 2001 FORMAT (' ', 24(/),
     .14X,'1) If the default condition is selected, you need only'/
     .14X,'press <return>. YES-or-NO questions are designated by'/
     .14X,'(Y/N) and should be answered with a Y or N. The default'/
     .14X,'condition is always listed first.')
C
      WRITE (SCRN,2002)
 2002 FORMAT ('0',
     .13X,'2) The values you enter will be tested against reasonable'/
     .14X,'limits and if they are not accepted you will be asked to'/
     .14X,'supply another value.')
C
      WRITE (SCRN,2010)
 2010 FORMAT (/14X,'When you have finished reading, press <return>')
      READ (KEY,8003) IDUM
 8003 FORMAT (A8)
C
C
```

```
C---- loop until user is satisfied with scenario selection ------------------
C
  100 CONTINUE
C
      CALL SELECT
C
      IF (IRS .EQ. 1) WRITE (SCRN,2100)
 2100 FORMAT (' ',24(/),
     .14X,'SCENARIO 1:  External Exposure'//
     .14X,'This scenario can be used alone or as part of Scenarios 2'/
     .14X,'and 3.  Occupational conditions of 2000 h/yr of external'/
     .14X,'exposure are assumed.  Waste may be located on the surface,'/
     .14X,'buried at 0.5 m, buried at 1.0 m, or stored.')
C
      IF (IRS .EQ. 2) WRITE (SCRN,2200)
 2200 FORMAT (' ',24(/),
     .14X,'SCENARIO 2:  External Exposure plus Inhalation from Resus',
     .    'pension'//
     .14X,'This scenario assumes surface contamination results over a'/
     .14X,'limited area. The scenario defaults to 2000 h/yr exposure'/
     .14X,'to surface contamination and inhalation.  The Anspaugh')
      IF (IRS .EQ. 2) WRITE (SCRN,2201)
 2201 FORMAT (14X,
     .    'resuspension model is used. User may define the fraction'/
     .14X,'of soil in the top 15 cm containing buried waste (defaults'/
     .14X,'to 0.2).')
C
      IF (IRS .EQ. 3) WRITE (SCRN, 2300)
 2300 FORMAT (' ',24(/),
     .14X,'SCENARIO 3: Agricultural Activities'//
     .14X,'This scenario assumes surface contamination (as in Scenario'/
     .14X,'2) with farming; defaults to 2000 h/yr exposure to surface')
      IF (IRS .EQ. 3) WRITE (SCRN, 2301)
 2301 FORMAT (14X,
     .    'contamination and inhalation.  Anspaugh resuspension model'/
     .14X,'is used.  Scenario defaults to total diet of fruits, veg-'/
     .14X,'atables, and animal products grown on the site.  The user'/
     .14X,'may specify the percentage of soil containing waste in the'/
     .14X,'top 15 cm.')
C
      IF (IRS .EQ. 4) WRITE (SCRN, 2400)
 2400 FORMAT (' ',24(/),
     .14X,'SCENARIO 4:  Irrigation and Drinking Water'//
     .14X,'This scenario accounts for the use of well or river water'/
     .14X,'for irrigation and drinking.  Assumes an irrigation rate')
      IF (IRS .EQ. 4) WRITE (SCRN, 2401)
 2401 FORMAT (14X,
     .    'of 150 l/sq m/mo for 6 months. Defaults to Anspaugh model'/
     .14X,'for inhalation. Assumes total diet and 1.2 liters/day of'/
     .14X,'drinking water.')
```

```
C
C
      IF (IRS .EQ. 5) WRITE (SCRN,2500)
 2500 FORMAT (' ',24(/),
     .14X,'SCENARIO 5:  User Defined  Scenario'//
     .14X,'This scenario defaults to a full year of exposure to'/
     .14X,'external contamination and a full year of inhalation.'/
     .14X,'The user may specify any parameters to define a scenario.')
C
      WRITE (SCRN,2600) IRS
 2600 FORMAT (' ',2(/),
     .14X,'Scenario ',I1,' is now selected. Do you wish to change'/
     .14X,'this selection (N/Y):')
      READ (KEY,8004) IDUM
 8004 FORMAT (A1)
      IF (IDUM .NE. 'Y' .AND. IDUM .NE. 'y') RETURN
C
      GO TO 100
C
C
C-----------------------------------------------------------------------
C
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE MODIF
C
C     This subroutine allows the user to change selected parameters of
C     Scenarios 1 through 4 or to create a scenario (Scenario 5).
C
C     Module of ONSITE
C     Version of 24-APR-84  RAp
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
      REAL*8 R8X, GNAME(2)
C
C------ review/query/modify agricultural parameters -----------------------
C
      IF (IFOD .EQ. 0) GO TO 100
 1000 CONTINUE
C
      GNAME(1) = 'agricult'
      GNAME(2) = 'ural    '
      CALL GROUP (IGFLAG, GNAME)
      IF (IGFLAG .EQ. 0) GO TO 100
C
C     ---- skip roots is Scenario 3, assumes surface contamination ----
      IF (IRS .EQ. 3) GO TO 122
C
      IF (IRS .EQ. 1 .AND. ILOC .EQ. 4) THEN
C       ----- set parameters for room model -----
        RF1 = 0.
        RF2 = 1.
      ELSE
C
  120 CONTINUE
        WRITE (SCRN,1120) RF1
 1120   FORMAT (' ',20(/),' ',
     .  'The fraction of total roots in top 15 cm of the soil is ',
     .  1PG10.3,/
     .  '   (range = 0.0 to 1.0)')
        CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0), (1.0), R8X)
        IF (ICFLAG.EQ.1) RF1 = RX
C
        WRITE (SCRN,1130) RF2
 1130   FORMAT (' ',
     .  'The fraction of total roots entering the buried waste '/
     .  ' below the top 15 cm plow layer of soil is ', 1PG10.3,
     .  '   (range = 0.0 to 1.0)')
        CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0), (1.0), R8X)
        IF (ICFLAG.EQ.1) RF2 = RX
```

```
      RF = RF1 + RF2
      IF (RF .GT. 1.0) WRITE (SCRN,1140)
1140  FORMAT (///' !!! The previous two fraction cannot be greater ',
     .'than 1.0:  REENTER !!!')
      IF (RF .GT. 1.0) GO TO 120
      ENDIF
 122  CONTINUE
C
C
      WRITE (SCRN,1160) RPF2
1160  FORMAT (' ',20(/),' ',
     .'The fraction of the total diet grown on the site ',
     .' is ', 1PG10.3,/'  (range = 0.0 to 1.0)')
      CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0), (1.0), R8X)
      IF (ICFLAG.EQ.1) RPF2 = RX
C
      IF (IWAT .EQ. 0) GOTO 100
      WRITE (SCRN,1100) RIRR
1100  FORMAT (' ',
     .'The irrigation rate in liters per square meter per month is ',
     .1PG10.3,/
     .'   (range = 0.0 to 1000.)')
      CALL CHANGE((2),ICFLAG,IX,IL,IH,RX,(0.0),(1000.0),R8X)
      IF (ICFLAG.EQ.1) RIRR = RX
C
      IF (RIRR .EQ. 0.0) GO TO 110
        WRITE (SCRN,1110) IMO
1110    FORMAT (' ',
     .  'The number of months per year that crops are irrigated is ',
     .  I2,/
     .  '   (range = 0 to 12)')
        CALL CHANGE ((1), ICFLAG, IX, (0), (12), RX, RL, RH, R8X)
        IF (ICFLAG.EQ.1) IMO=IX
 110  CONTINUE
C
      WRITE (SCRN,1111) IRR
1111  FORMAT (' ',
     .'The number of years prior to the beginning of dose '/
     .' calculations that irrigation accumulates radionuclides'/
     .' is ',I4,'   (range = 0 to 1000)')
      CALL CHANGE ((1), ICFLAG, IX, (0), (1000), RX,RL,RH,R8X)
      IF (ICFLAG.EQ.1) IRR=IX
C
 100  CONTINUE
C
C
C------ review/query/modify external exposure  parameters ------------------
C
      IF (IEXT .EQ. 0 .AND. ISUR .EQ. 0) GO TO 200
C
```

```
      GNAME(1) = 'ext. exp'
      GNAME(2) = 'osure   '
      CALL GROUP (IGFLAG, GNAME)
      IF (IGFLAG .EQ. 0) GO TO 200
C
      IF (ISUR .EQ. 0) GO TO 210
        WRITE (SCRN,1210) I22
 1210   FORMAT (' ',20(/),' ',
     .  'Did you use MAXI2 to generate a special external exposure'/
     .  '  dose rate factor file for this scenario?  (default=',
     .  I1,')',//
     .  15X,'0 - no'/15X,'1 - yes')
        CALL CHANGE ((1), ICFLAG, IX, (0), (1), RX,RL,RH,R8X)
        IF (ICFLAG.EQ.1) I22 = IX
  210 CONTINUE
C
      WRITE (SCRN,1200) XF2
 1200 FORMAT (' ',20(/),' ',
     . 'The number of hours of exposure to external contamination ',
     . /' per year is ',1PG10.3,'   (range = 0.0 to 8766.)')
      CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0),(8766.), R8X)
      IF (ICFLAG.EQ.1) XF2 = RX
C
  200 CONTINUE
C
C------ review/query/modify inhalation exposure parameters ------------------
C
      IF (INHAL .EQ. 0) GO TO 300
      GNAME(1) = 'inhalati'
      GNAME(2) = 'on      '
      CALL GROUP (IGFLAG, GNAME)
      IF (IGFLAG .EQ. 0) GO TO 300
C
      RIN = RINH * 8766.
      WRITE (SCRN,1301) RIN
 1301 FORMAT (' ',20(/),' ',
     . 'The number of hours of inhalation of contamination ',
     . /' per year is ',1PG10.3,'  (range = 0.0 to 8766.)')
      CALL CHANGE ((2),ICFLAG,IX,IL,IH,RX,(0.0),(8766.),R8X)
      IF (ICFLAG .EQ.1) RIN = RX
      RINH = RIN / 8766.
C
      WRITE (SCRN,1300) INHAL
 1300 FORMAT (' ',20(/),' ',
     . 'Two resuspension models are available: '/
     . '          1 - Anspaugh'/
     . '          2 - Mass Loading'/
     . /' The selected model is ',I1)
      CALL CHANGE ((1), ICFLAG, IX, (1), (2), RX, RL, RH, R8X)
      IF (ICFLAG.EQ.1) INHAL = IX
```

```
      IF (INHAL .EQ. 2) GO TO 310
C
        WRITE (SCRN,1310) AGE
 1310   FORMAT (' ',
     .  'The number of years that contamination existed'/
     .  ' on the surface at the start of the scenario ',
     .  ' is ',1PG10.3,' years.   (range = 0.0 to 25.0)')
        CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0),(25.0), R8X)
        IF (ICFLAG.EQ.1) AGE = RX
C
        AVCM = XDPT * 15.0
C
        WRITE (SCRN,1320) AVCM
 1320   FORMAT (' ',
     .  'The top ',F4.1,' cm. of the contaminated surface soil'/
     .  ' layer is available for resuspension  (range = 0.0 to 15.0)')
        CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0),(15.0), R8X)
        IF (ICFLAG.EQ.1) XDPT = RX/15.
C
  310 CONTINUE
C
C
      IF (INHAL .EQ. 1) GO TO 320
C
        WRITE (SCRN,1330) DEN
 1330   FORMAT (' ',
     .  'The density of the soil is ',1PG10.1,' grams per cubic '
     .  'meter.'/'  (range = 1.E5 to 5.0E7)')
        CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (1.E5),(5.E7), R8X)
        IF (ICFLAG.EQ.1) DEN = RX
C
        WRITE (SCRN,1340) XMLF
 1340   FORMAT (' ',
     .  'The Mass Loading Factor is ',1PG10.1,' grams per cubic '
     .  'meter.'/'  (range = 1.E-7 to 0.1')
        CALL CHANGE ((2), ICFLAG, IX,IL,IH, RX, (1.E-7),(0.1), R8X)
        IF (ICFLAG.EQ.1) XMLF = RX
C
  320 CONTINUE
  300 CONTINUE
C
C
C------ review/query/modify organ parameters ------------------------------
C
C
      GNAME(1) = 'organ   '
      GNAME(2) = '        '
      CALL GROUP (IGFLAG, GNAME)
      IF (IGFLAG .EQ. 0) GO TO 800
C
```

```
      WRITE (SCRN,1800) NORG
 1800 FORMAT (' ',20(/),' ',
     . 'The number of organs considered is ',I2,'  (range = 1 to 5)'/
     . ' Total body must always be one of the selected organs.')
      CALL CHANGE ((1), ICFLAG, IX, (1), (5), RX, RL, RH, R8X)
      IF (ICFLAG.EQ.1) NORG = IX
C
C
      DO 810 I = 1, NORG
        WRITE (SCRN,1810)
        WRITE (SCRN,1812)
        WRITE (SCRN,1811) I, KORG(I)
 1810   FORMAT (' ',
     .  'The available organs are:'//
     .  '  1-Total body    9-Adrenals    17-Pancreas'/
     .  '  2-Body water   10-Testes      18-Heart'/
     .  '  3-Kidneys      11-Ovaries     19-GI'/
     .  '  4-Liver        12-Skin        20-Stomach'/
     .  '  5-Spleen       13-Brain       21-Small intestine')
 1812   FORMAT (' ',
     .  ' 6-Bone          14-Muscle      22-Upper large intestine'/
     .  '  7-Fat          15-Prostrate   23-Lower large intestine'/
     .  '  8-Lungs        16-Thyroid'//
     .  ' The ONSITE dose rate factor files have data on total body'/
     .  ' bone, lungs, thyroid, and LLI.  If you wish to use other')
 1811   FORMAT (' ',
     .  'organs, a new environment must be created.  See Section 2.2'/
     .  ' of the Users Manual.'//
     .  ' The current selection for organ ',I2,' is ',I2)
        CALL CHANGE ((1), ICFLAG, IX, (1), (23), RX, RL, RH, R8X)
        IF (ICFLAG.EQ.1) KORG(I) = IX
  810 CONTINUE
C
  800 CONTINUE
      RETURN
C
C-----------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------------
C
      SUBROUTINE OPTION
C
C     This subroutine allows the user to select various exposure
C     pathways for the construction of a scenario.
C
C     Module of ONSITE
C     Version of 17-APR-84  RAP
C
C-----------------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
      REAL*8 ANS(2)
      DATA ANS /'(N/Y)   ','(Y/N)   '/
C
      IA = 1
      IF (ISUR .EQ. 1) IA = 2
      WRITE (SCRN,2002) ANS(IA)
 2002 FORMAT (' ',24(/), 14X,
     .    'Do you wish to consider external exposure to surface'/
     .14X,'contamination? ',A8)
      READ (KEY,8004) IDUM
C
      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) ISUR=1
      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) ISUR=0
C
      IA = 1
      IF (IEXT .EQ. 1) IA=2
      WRITE (SCRN,2004) ANS(IA)
 2004 FORMAT (' ', 24(/), 14X,
     .     'Do you wish to consider external exposure and crop '/
     .14X,'penetration to deeply buried waste? ',A8)
      READ (KEY,8004) IDUM
 8004 FORMAT (A1)
C
      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) IEXT=1
      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) IEXT=0
C
        IA = 1
        IF (IFOD .EQ. 1) IA=2
        WRITE (SCRN,2005) ANS(IA)
 2005   FORMAT (' ', 24(/), 14X,
     .       'Do you wish to consider farm product ingestion ?'/
     .  14X, A8)
        READ (KEY,8004) IDUM
C
        IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) IFOD=1
        IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) IFOD=0
```

```
      IA = 1
      IF (IWAT .EQ. 1) IA=2
      WRITE (SCRN,2006) ANS(IA)
 2006 FORMAT (' ', 24(/), 13X,
     .     'Do you wish to consider drinking water ingestion '/
     . 14X,'from a contaminated well? ', A8)
      READ (KEY,8004) IDUM
C
      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) IWAT=1
      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) IWAT=0
C
      IA = 1
      IF (IARG .EQ. 1) IA=2
      WRITE (SCRN,2007) ANS(IA)
 2007 FORMAT (' ', 24(/), 13X,
     .     'Do you wish to consider consumption of aquatic'/
     . 14X,'food from a contaminated river? ', A8)
      READ (KEY,8004) IDUM
C
      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) IARG=1
      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) IARG=0
C
 2000 CONTINUE
C
      RETURN
C
C-----------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE QUANTI (I)
C
C     This subroutine requests the quantity of the current radionuclide
C     for each of the selected pathways.
C
C     Module of ONSITE
C     Version of 1-MAY-84  RAP
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
      REAL*8 R8X
      DIMENSION  WHERE(3,2)
C
      DATA WHERE /'depo','site','d on',
     .            'buri','ed a','t   '/
C
C
  202 CONTINUE
C
        IF (IRS .EQ. 4) GO TO 206
C
          IF (M3M2 .LT. 0 .OR. M3M2 .GT. 2) M3M2 = 0
C
          IF (ISUR .EQ. 1 .OR. ILOC .EQ. 4) THEN
            IA = 1
          ELSE
            IA = 2
          ENDIF
C
          WRITE (SCRN,1050) ELTI(I), AWI(I), (WHERE(J,IA),J=1,3),
     .                      NVU(INUT),(UNITS(J,M3M2+1), J=1,2)
 1050     FORMAT (//' ',
     .    'Enter the quantity of ',A2,A6,3A4,' the site at',
     .    ' start of'/' calculation (units: ', A4, 2A8,') :')
          READ (KEY,*) RX
          IF (RX .LT. 0.) GO TO 202
          Q(I) = RX
  206   CONTINUE
C
        IF (IRS .LT. 4) GO TO 301
C
        WRITE (SCRN,1052)
 1052   FORMAT (' ',14(/),' ',
     .  ' To consider only irrigation or only drinking water '
     .  'contamination,'/
     .  ' enter zero quantity for the  other pathway.')
```

```
  304   CONTINUE
C
          WRITE (SCRN,1060) ELTI(I), AWI(I)
 1060     FORMAT (//' ',
     .    'Enter the concentration of ',A2,A6,' in the irrigation ',
     .    'water at start of'/' calculation (units: pCi/liter):')
          READ (KEY,*) RX
C
        IF (RX .LT. 0.) GO TO 304
C
        QI(I) = RX
        IF (QI(I) .GT. 0.) IWRL=1
C
  302   CONTINUE
C
          WRITE (SCRN,1070) ELTI(I), AWI(I)
 1070     FORMAT (//' ',
     .    'Enter the concentration of ',A2,A6,' in the drinking water',
     .    ' at start of'/' calculation (units: pCi/liter):')
          READ (KEY,*) RX
        IF (RX .LT. 0.) GO TO 302
        QJ(I) = RX
        IF (QJ(I) .GT. 0.) IWRL=1
C
C
  301   CONTINUE
C
C
        RETURN
C
C-----------------------------------------------------------------------------
        END
```

```
C--------------------------------------------------------------------------
C
      SUBROUTINE RADIN
C
C     This subroutine controls input of the radionuclide master library
C     and user radiological inventory input
C
C     Module of ONSITE
C     Version of 24-APR-84
C
C--------------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
      REAL*8 R8X,  ORG(23), CL(3)
      DIMENSION E(300), A(300), NS(2,300), IS(2), IDORG(5)
      REAL*8 A
      INTEGER E
C
      DATA ORG /'tot body','body H2O','kidneys ','liver   ','spleen  ',
     .          'bone    ','fat     ','lungs   ','adrenals','testes  ',
     .          'ovaries ','skin    ','brain   ','muscle  ','prostrat',
     .          'thyroid ','pancreas','heart   ','GI      ','stomach ',
     .          'sm. int.','ULI     ','LLI     '/
C
      DATA IDORG / 1,6,8,16,23/
      DATA NIN, I /0,0/
      DATA IS /'  ','in'/
      DATA CL /'Class D ','Class W ','Class Y '/
      DATA FIRTIM /0/
C
C---- read in radionuclide library --------------------------------------
C
      IF (FIRTIM .EQ. 0) THEN
C
      NUC = 1
      READ(10,8003) IDUM
 8003 FORMAT (A8)
C
  100 CONTINUE
         READ(10,1001,END=992) E(NUC), A(NUC), IM, (NS(J,NUC),J=1,2)
 1001    FORMAT(A2,A8,8X,I2,41X,2I1)
         IF (IM .EQ. 0) GO TO 200
         NUC = NUC + 1
      GO TO 100
C
  200 CONTINUE
      ENDIF
C
C---- set flag if translocation review/check desired -----------------------
      IF (FIRTIM .EQ. 0) THEN
      ITC = 0
```

```
      IF (INHAL .EQ. 0 ) GO TO 410
        WRITE (SCRN,4101)
 4101   FORMAT (' ',20(/),' ',
     . 'Do you wish to review and/or change solubility classification'
     . /' for each organ for each radionuclide.  The default assump-'
     . /' tion is elements are insoluble for lung and soluble for all'
     . /' other organs. (N/Y)')
        READ (KEY,8001) IDUM
        IF (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y') ITC = 1
  410 CONTINUE
      ENDIF
C
C--- test if this is original or additional inventory and set flags ---------
C
      IF (FIRTIM .EQ. 0) THEN
        NIN = 0
        I = 0
      ELSE
        I = NIN
      ENDIF
C
C---- initialize quantity arrays ---------------------------------------------
C
      IF (FIRTIM .EQ. 0) THEN
      DO 610 IQ = 1, 100
        Q(IQ) = 0.
        QI(IQ) = 0.
        QJ(IQ) = 0.
        QK(IQ) = 0.
  610 CONTINUE
      ENDIF
C
C---- signal beginning of inventory input ------------------------------------
C
  208 CONTINUE
        WRITE (SCRN,1100)
 1100   FORMAT (' ',20(/),' ',
     . 'The following questions pertain to the radionuclide '/
     . ' inventory.  After inputting the inventory, enter'/
     . ' "99" for element name to signal to the program that '/
     . ' you are finished.'///, ' ',70('#')//
     . ' Press <return> when you have finished reading:')
        READ (KEY,8001) IDUM
 8001   FORMAT (A1)
C
C
C---- input name and source terms for each radionuclide --------------------
C
  149   CONTINUE
C
```

```
      WRITE (SCRN,2400)
 2400 FORMAT (' ',10(/),' ',70('#'),///)
C
  300 CONTINUE
C
        ICFLAG = 1
C
        WRITE (SCRN, 1010)
 1010   FORMAT (//' Enter new 2-character element ',
     .  ' (99=finished): ')
        READ (KEY,8005) IZ
 8005   FORMAT (A2)
        IF (IZ .EQ. '99') GO TO 148
C
        WRITE (SCRN, 1011)
 1011   FORMAT ('0Atomic number input can be up to ',
     .  '6 characters long.'/
     .  ' Include metastable (M) and daughter (+D) designation,',
     .  ' (i.e., TE127M+D)'//
     .  ' Enter atomic number: ')
        READ (KEY,8003) R8X
C
        DO 140 IX = 1, NUC
          IF (IZ .EQ. E(IX) .AND. R8X .EQ. A(IX)) GO TO 142
  140   CONTINUE
        WRITE (SCRN,2401)
 2401   FORMAT (///' ???? Radionuclide not found in library, ',
     .  'try again ????'//)
      GOTO 300
C
  142 CONTINUE
C
      DO 144 IN = 1, NIN
        IF (ELTI(IN) .EQ. IZ .AND. AWI(IN) .EQ. R8X) THEN
          WRITE (SCRN,2402)
 2402     FORMAT (///'???? Radionuclide aready included, try ',
     .    'again ????'//)
          GO TO 300
        ENDIF
  144 CONTINUE
C
      IXS = IX
      NIN = NIN + 1
      I = I + 1
      ELTI(I)=IZ
      AWI(I)=R8X
      DO 143 J = 1, 5
        NSOLD(J,I) = NS(1,IXS)
        IF (KORG(J) .EQ. 8)  NSOLD(J,I) = NS(2,IXS)
  143 CONTINUE
```

```
         IF (ITC .EQ. 0) GO TO 210
           DO 212 J = 1,5
             WRITE (SCRN,2020) ELTI(I)
 2020        FORMAT (' ',4(/),' ',
     .       'Element ',A2,' Translocation Classification:'/)
             DO 213 K = 1,2
               WRITE (SCRN,2021) K, CL(NS(K,IXS)), IS(K)
  213        CONTINUE
 2021        FORMAT (5X, I2,' - ',A8,' for ',A2,'soluble')
             WRITE (SCRN,2022) ELTI(I), AWI(I), CL(NSOLD(J,I)),
     .                         ORG(KORG(J))
 2022        FORMAT (//' The translocation index for ',A2,A6,' is ',
     .       A8,' for ',A8/
     .       ' To change enter index.')
             CALL CHANGE ((1), ICFLAG, IX, (1), (3), RX,RL,RH,R8X)
             IF (ICFLAG .EQ. 1) NSOLD(J,I) = NS(IX,IXS)
  212      CONTINUE
  210    CONTINUE
C
         CALL QUANTI (I)
       GO TO 149
C
  148 CONTINUE
      FIRTIM = 1
C
C
      RETURN
C
C--------- error messages --------------------------------------------------
C
  990 WRITE (SCRN,9000)
 9000 FORMAT (' Error opening radionuclide library.')
      STOP
C
  992 WRITE (SCRN,9002)
 9002 FORMAT (' Premature end-of-file discovered in library')
C
C
C---------------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE RITFIL
C
C     This subroutine writes a file with input parameters and
C     system commands for MAXI1.  RITFIL is called by the program
C     ONSITE.
C
C     Module of ONSITE
C     Version of 1-MAY-84  RAP
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
  200 CONTINUE
C
C---- assign library files to logical unit devices ---------------------
C
C     IF (IFOD .GT. 0) WRITE (OUT, 3010)
      WRITE (OUT,3010)
 3010 FORMAT ('ASSIGN [BIO.NEW]FILE20.DAT FOR020'/
     .        'ASSIGN [BIO.NEW]FILE21.DAT FOR021')
C
C     IF (IARG .GT. 0) WRITE (OUT, 3020)
      WRITE (OUT,3020)
 3020 FORMAT ('ASSIGN [BIO.NEW]FILE24.DAT FOR024')
C
C     IF (IWAT .GT. 0) WRITE (OUT, 3030)
      WRITE (OUT,3030)
 3030 FORMAT ('ASSIGN [BIO.NEW]FILE25.DAT FOR025')
C
      WRITE (OUT, 3040)
 3040 FORMAT ('ASSIGN [BIO.NEW]PLANSOURC.SUR FOR022')
C
      IF (ILOC .EQ. 1) WRITE (OUT, 3044)
 3044 FORMAT ('ASSIGN [BIO.NEW]VOLSOURC.SUR FOR027')
C
      IF (ILOC .EQ. 2) WRITE (OUT, 3041)
 3041 FORMAT ('ASSIGN [BIO.NEW]BURIEDHF.DAT FOR027')
C
      IF (ILOC.EQ. 3) WRITE (OUT, 3042)
 3042 FORMAT ('ASSIGN [BIO.NEW]BURIED1.DAT FOR027')
C
      IF (ILOC .EQ. 4) WRITE (OUT, 3043)
 3043 FORMAT ('ASSIGN [BIO.NEW]ROOM.DAT FOR027')
C
      WRITE (OUT, 3050)
 3050 FORMAT ('ASSIGN [BIO.NEW]RMDLIB.DAT FOR010'/
     .        'ASSIGN [BIO.NEW]FILE23.DAT FOR023')
```

```
C---- calculate output values -------------------------------------------
C
      RPF = RPF1
      IF (RPF2 .GT. 0.) RPF = RPF1 * RPF2
C
      IF (INHAL .EQ. 0) RINH = 0.0
      IF (INHAL .EQ. 2) AGE = -1.0
C
C---- execute command, title, and NAMELIST --------------------------------
C
      WRITE (OUT, 3100) (TITL(I), I=1,20)
 3100 FORMAT ('RUN [BIO.NEW]MAXI1'/20A4/' $INPUT  NEXT=1,')
C
      WRITE (OUT, 3110) IFOD, IARG, IWAT, IEXT, ISUR, IAIR
 3110 FORMAT ('    IFOD=',I1,', IARG=',I1,', IWAT=',I1,', IEXT=',I1,/
     .        '    ISUR=',I1,', IAIR=',I1,',')
C
      IF (IFOD .GT. 0) WRITE (OUT, 3120) RIRR, IMO, RF1, RF2
 3120 FORMAT ('    RIRR=',G10.3,', IMO=',I1,
     .        ', RF1=',G10.3,', RF2=',G10.3,',')
C
      WRITE (OUT,3022) RPF1, RPF2
 3022 FORMAT ('    RPF1= ',G10.3,', RPF2= ',G10.3,',')
C
      IF (IWAT .GT. 0) WRITE (OUT,3130) IDKWAT
 3130 FORMAT ('    IDKWAT=',I1,',')
C
      IF (IAIR .GT. 0) WRITE (OUT,3140) XQSITE, IDKAIR
 3140 FORMAT ('    XQSITE=',G10.3,', IDKAIR=',I1,',')
C
      IF (INHAL .EQ. 1) WRITE (OUT, 3150) AGE, XDPT
 3150 FORMAT ('    AGE=',G10.3,', XDPT=',G10.3,',')
C
      IF (INHAL .EQ. 2) WRITE (OUT, 3160) DEN, XMLF
 3160 FORMAT ('    AGE=-1, DEN=',G10.3,', XMLF=',G10.3,',')
C
      WRITE (OUT, 3170) RINH, DILF, XF2
 3170 FORMAT ('    RINH=',F10.6,', DILF=',G10.3,', XF2=',G10.3,',')
C
      WRITE (OUT,3180) M3M2, INTRUD, I22
 3180 FORMAT ('    M3M2=',I2,', INTRUD=',I1,', I22=',I1,',')
C
      WRITE (OUT,3190) IT1, IT2, NORG, (KORG(I),I=1,NORG)
 3190 FORMAT ('    IT1=',I4,', IT2=',I4,', NORG=',I2,
     .        ', KORG(1)=',5(I2,',') )
C
      WRITE (OUT,3192) SRDIL, FRSIZ, AREAIN, AREAEX
 3192 FORMAT('   SRDIL=',G10.3,', FRSIZ=',G10.3,', AREAIN=',G10.3,','/
     .       '   AREAEX= ',G10.3,',')
C
```

```
      WRITE (OUT, 3200) IOUT
 3200 FORMAT ('   IOUT=',I2,', ION=1, $END')
C
C--- adjust inventory to proper units and write to file ---------------------
C
      WRITE (OUT, 3300) NIN, IRR
 3300 FORMAT (2I5)
C
      DO 100 I = 1, NIN
        Q(I) = Q(I) * NVUNIT(INUT)
        WRITE (OUT, 3400) ELTI(I), AWI(I), (NSOLD(J,I),J=1,5),
     .                    Q(I), QI(I), QJ(I), QK(I)
 3400   FORMAT (A2,A6,5I1,4(1PG10.2))
  100 CONTINUE
C
C
      RETURN
C
C--- error routines ---------------------------------------------------------
C
  992 WRITE (SCRN,9920)
 9920 FORMAT ('0Error in opening output file')
      GO TO 200
C
  994 WRITE (SCRN,9940)
 9940 FORMAT ('0Error in closing output file')
      STOP
C
C
C---------------------------------------------------------------------------
      END
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE SCENR
C
C     This subroutine establishes default parameter values for the
C     selected scenario.
C
C     Module of ONSITE
C     Version of  2-MAY-84  RAP
C
C-----------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
C
      DATA NEXT,IOUT /1,0/
      DATA IFOD, IWAT, IARG, IEXT, IAIR, INHAL, ISUR / 1,1,0,1,0,1,1 /
      DATA NORG, KORG / 5, 1,6,8,16,23 /
      DATA IT1, IT2 / 1,50 /
      DATA RIRR, RPF1, RPF2, RPF, IMO / 150., 1.0, 1.0, 0.2, 6 /
      DATA RF1, RF2 / 1.0, 0.0 /
      DATA IDKWAT, IDKAIR, XQSITE / 0, 0, 0.0 /
      DATA XF2, I22, RINH / 2000.0, 0, .23 /
      DATA AGE, XDPT, DEN, XMLF / 0.0, 0.067, 1.0E+6, 1.0E-04 /
      DATA DILF, M3M2 / 1.0, 1 /
      DATA INTRUD, IBS, ILOC, IRR / 0, 1, 1, 0 /
      DATA SRDIL, INUT /0.2, 1/
      DATA FRSIZ, AREAIN, AREAEX /1.0, 1.0, 1.0/
C
      IF (IRS .EQ. 1) ILOC=2
      IF (IRS .LT. 3) IFOD=0
      IF (IRS .LT. 4) IWAT=0
      IF (IRS .EQ. 1) ISUR=0
      IF (IRS .EQ. 2) ISUR=0
      IF (IRS .EQ. 3) IEXT=0
      IF (IRS .EQ. 4) IEXT=0
      IF (IRS .EQ. 5) IARG=1
      IF (IRS .EQ. 5) XF2=8766.
      IF (IRS .EQ. 4) IRR = 10
      IF (IRS .EQ. 5) RINH = 1.0
      IF (IRS .EQ. 5) INHAL=2
      IF (IRS .EQ. 1) INHAL=0
      IF (IRS .EQ. 1) RINH=0.0
      IF (IRS .EQ. 1) NORG=1
C
      RETURN
C
C-----------------------------------------------------------------------
C
   END
```

```
C-----------------------------------------------------------------------------
C
      SUBROUTINE SELECT
C
C     This subroutine prints a menu of scenario selection for the
C     user and then test validity of the user input.
C
C     Module of ONSITE
C     Version of 17-APR-84  RAP
C
C-----------------------------------------------------------------------------
C
      INCLUDE 'ONSITE.CMN'
C
      WRITE (SCRN,2004)
 2004 FORMAT (' ', 24(/), 13X,
     .    'The following scenarios have been defined:'//
     .14X,'1 - External exposure'/
     .14X,'2 - External exposure plus inhalation from resuspension'/
     .14X,'3 - Agricultural activities '/
     .14X,'4 - Use of well water for irrigation and drinking water'/
     .14X,'5 - User-created scenario'//)
C
  100 CONTINUE
      WRITE (SCRN,2006)
 2006 FORMAT(14X,'To select a scenario or for additional information'/
     .14X,'on a scenario enter 1, 2, 3, 4, or 5: ')
C
      READ (KEY,*) IRS
      IF (IRS .LT. 1  .OR. IRS .GT. 5) GO TO 100
C
      RETURN
C
C-----------------------------------------------------------------------------
      END
```

APPENDIX 1.C

ABBREVIATED DATA BASE LISTING

CONTENTS

Radionuclide Master Library for MAXI - RMDLIB

RADIONUCLIDE MASTER DATA LIBRARY /w TRANSLOCATION CLASSES, 6-APR-84 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
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
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
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
BI210+D	5.01E+0	1	0		0	23
RN222+[illegible]	3.8[illegible]E+0	1	0		0	11
RA223[illegible]	[illegible]4E+1	1	0		0	23
RA[illegible]	[illegible]6E+0	1	0		0	23
[illegible]	1.48E+1	1	0		0	23
[illegible]+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
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
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	1	.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
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
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
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
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
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					

Leaf Incremental Dose Factors for ONSITE/BIOPORT Environment - 16-APR-84 RAP

LEAF 50 99 5

1 6 8 16 23

H 3	1.44E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C 14	1.67E-05	7.31E-05	0.00E+00	0.00E+00	1.17E-05
NA22	1.27E-03	0.00E+00	0.00E+00	0.00E+00	8.24E-04
P 32	1.23E-04	3.18E-03	0.00E+00	0.00E+00	4.20E-04
P 33	3.14E-05	8.46E-04	0.00E+00	0.00E+00	6.83E-05
S 35	1.94E-04	4.31E-04	0.00E+00	0.00E+00	0.00E+00
CL36	1.55E+00	0.00E+00	0.00E+00	0.00E+00	4.07E-01
K 40	5.23E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-01
CA45	1.90E-05	8.57E-04	0.00E+00	0.00E+00	6.85E-05
SC46	1.91E-08	3.36E-08	0.00E+00	0.00E+00	3.91E-04
CR51	1.40E-08	0.00E+00	2.88E-08	8.33E-09	4.34E-06
MN54	6.36E-06	0.00E+00	0.00E+00	0.00E+00	1.22E-04
FE55	1.14E-06	5.28E-06	1.71E-06	0.00E+00	1.31E-05
FE59	2.41E-05	2.79E-05	1.75E-05	0.00E+00	2.94E-04
CO57	2.17E-06	0.00E+00	0.00E+00	0.00E+00	3.82E-05
CO60	3.68E-05	0.00E+00	0.00E+00	0.00E+00	3.63E-04
NI59	3.47E-06	1.77E-05	0.00E+00	0.00E+00	9.76E-06
NI63	9.45E-06	2.41E-04	0.00E+00	0.00E+00	2.66E-05
ZN65	7.04E-05	4.71E-05	0.00E+00	0.00E+00	2.46E-04
SE75	2.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR85	4.03E-05	3.34E-05	0.00E+00	0.00E+00	0.00E+00
SR90+D	4.29E-04	1.60E-03	0.00E+00	0.00E+00	7.50E-04
MO93	2.98E-06	0.00E+00	0.00E+00	0.00E+00	2.04E-05
NB94	1.12E-07	0.00E+00	0.00E+00	0.00E+00	3.64E-04
RU106+D	2.39E-06	1.83E-05	0.00E+00	0.00E+00	1.40E-03
CD109	2.00E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG110M+D	3.86E-06	6.41E-06	0.00E+00	0.00E+00	3.01E-03
IN111	1.20E-09	2.18E-09	0.00E+00	4.88E-10	9.84E-06
SB124	7.11E-06	1.68E-05	1.38E-05	4.71E-08	6.22E-04
SB125+D	3.18E-06	1.04E-05	9.09E-06	1.56E-08	1.91E-04
I 125+D	7.36E-05	3.43E-04	0.00E+00	6.03E-02	8.66E-06
I 131+D	3.05E-05	3.75E-05	0.00E+00	1.74E-02	1.61E-05
CS137+D	9.00E-04	9.08E-04	1.43E-04	0.00E+00	4.93E-05
CE144+D	8.24E-08	1.31E-06	0.00E+00	0.00E+00	1.29E-03
EU152	6.03E-08	1.59E-07	0.00E+00	0.00E+00	2.25E-04
EU154	8.72E-08	5.58E-07	0.00E+00	0.00E+00	4.80E-04
TB160	2.82E-08	2.24E-07	0.00E+00	0.00E+00	3.10E-04
OS185	9.01E-05	0.00E+00	0.00E+00	0.00E+00	3.18E-03
OS191	7.33E-06	0.00E+00	0.00E+00	0.00E+00	8.51E-04
IR192	8.51E-06	0.00E+00	0.00E+00	0.00E+00	6.98E-04
HG203	2.35E-04	0.00E+00	0.00E+00	0.00E+00	3.72E-04
PB210+D	3.82E-04	5.51E-03	0.00E+00	0.00E+00	4.43E-04
RA226+D	3.34E-02	3.36E-02	0.00E+00	0.00E+00	2.83E-03
TH228+D	2.12E-05	6.26E-04	0.00E+00	0.00E+00	4.87E-03
TH230+D	5.11E-06	1.80E-04	0.00E+00	0.00E+00	5.32E-04
TH232+D	6.62E-06	2.00E-04	0.00E+00	0.00E+00	4.53E-04

Onsite Disposal Environment FILE21 (Soil), page 1

Soil Incremental Dose Factors for ONSITE/BIOPORT Environment - 16-APR-84 RAP
SOIL 50 99 5
1 6 8 16 23

H 3	3.54E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C 14	4.66E-09	2.04E-08	0.00E+00	0.00E+00	3.27E-09
NA22	2.12E-09	0.00E+00	0.00E+00	0.00E+00	1.37E-09
P 32	5.14E-07	1.33E-05	0.00E+00	0.00E+00	1.76E-06
P 33	1.16E-07	3.13E-06	0.00E+00	0.00E+00	2.53E-07
S 35	4.61E-09	1.02E-08	0.00E+00	0.00E+00	0.00E+00
CL36	1.33E-04	0.00E+00	0.00E+00	0.00E+00	3.50E-05
K 40	3.24E-05	0.00E+00	0.00E+00	0.00E+00	3.52E-06
CA45	5.17E-11	2.33E-09	0.00E+00	0.00E+00	1.86E-10
SC46	2.69E-15	4.73E-15	0.00E+00	0.00E+00	5.49E-11
CR51	4.47E-16	0.00E+00	9.23E-16	2.67E-16	1.39E-13
MN54	2.20E-11	0.00E+00	0.00E+00	0.00E+00	4.21E-10
FE55	4.61E-14	2.14E-13	6.94E-14	0.00E+00	5.30E-13
FE59	1.20E-12	1.39E-12	8.71E-13	0.00E+00	1.46E-11
CO57	2.25E-12	0.00E+00	0.00E+00	0.00E+00	3.96E-11
CO60	3.69E-11	0.00E+00	0.00E+00	0.00E+00	3.64E-10
NI59	4.91E-12	2.50E-11	0.00E+00	0.00E+00	1.38E-12
NI63	1.33E-11	3.40E-10	0.00E+00	0.00E+00	3.76E-11
ZN65	2.00E-09	1.34E-09	0.00E+00	0.00E+00	6.98E-09
SE75	2.99E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR85	8.44E-10	6.99E-10	0.00E+00	0.00E+00	0.00E+00
SR90+D	7.88E-09	2.94E-08	0.00E+00	0.00E+00	1.38E-08
MO93	2.79E-11	0.00E+00	0.00E+00	0.00E+00	1.91E-10
NB94	1.00E-13	0.00E+00	0.00E+00	0.00E+00	3.28E-10
RU106+D	2.85E-12	2.18E-11	0.00E+00	0.00E+00	1.67E-09
CD109	6.66E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG110M+D	1.95E-11	3.23E-11	0.00E+00	0.00E+00	1.52E-08
IN111	1.16E-13	2.09E-13	0.00E+00	4.68E-14	9.45E-10
SB124	9.24E-12	2.18E-11	1.79E-11	6.12E-14	8.08E-10
SB125+D	3.58E-12	1.17E-11	1.03E-11	1.76E-14	2.16E-10
I 125+D	8.80E-11	4.10E-10	0.00E+00	7.21E-08	1.04E-11
I 131+D	5.63E-11	6.93E-11	0.00E+00	3.21E-08	2.97E-11
CS137+D	1.28E-10	1.29E-10	2.03E-11	0.00E+00	7.00E-12
CE144+D	4.93E-15	7.84E-14	0.00E+00	0.00E+00	7.71E-11
EU152	1.72E-14	4.53E-14	0.00E+00	0.00E+00	6.40E-11
EU154	2.49E-14	1.59E-13	0.00E+00	0.00E+00	1.37E-10
TB160	9.58E-15	7.60E-14	0.00E+00	0.00E+00	1.05E-10
OS185	3.21E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-08
OS191	3.57E-11	0.00E+00	0.00E+00	0.00E+00	4.15E-09
IR192	9.65E-12	0.00E+00	0.00E+00	0.00E+00	7.91E-10
HG203	6.25E-09	0.00E+00	0.00E+00	0.00E+00	9.90E-09
PB210+D	3.01E-09	4.33E-08	0.00E+00	0.00E+00	3.48E-09
RA226+D	5.23E-09	5.26E-09	0.00E+00	0.00E+00	4.42E-10
TH228+D	1.03E-11	3.03E-10	0.00E+00	0.00E+00	2.36E-09
TH230+D	2.43E-12	8.59E-11	0.00E+00	0.00E+00	2.54E-10
TH232+D	3.16E-12	9.56E-11	0.00E+00	0.00E+00	2.16E-10

Onsite Disposal Environment Surface Soil PLANSOURC (External)

ONSITE/BIOPORT EXTERNAL DRFS FOR SURFACE (PLANE SOURCE) 10-APR-84 RAP

	PLAN 100
H 3	0.0
C 14	6.2E-04
NA22	4.3E+02
P 32	9.2E-01
P 33	9.4E-01
S 35	0.0
CL36	2.8E-01
K 40	5.7E+01
CA45	2.8E-03
SC46	7.2E+02
CR51	1.1E+01
MN54	2.9E+02
FE55	0.0
FE59	4.0E+02
CO57	2.1E+01
CO60	8.6E+02
NI59	0.0
NI63	2.5E-14
ZN65	2.2E+02
SE75	9.2E+01
SR85	1.8E+02
SR90+D	1.9
MO93	1.4
NB94	5.3E+02
RU106+D	8.9E+02
CD109	7.6
AG110M+D	1.0E+03
IN111	7.6E+01
SB124	7.2E+02
SB125+D	1.7E+02
I 125+D	8.8E-01
I 131+D	1.2E+02
CS137+D	2.1E+02
CE144+D	1.7E+01
EU152	4.0E+02
EU154	4.3E+02
TB160	3.8E+02
OS185	2.5E+02
OS191	7.9
IR192	2.5E+02
HG203	4.7E+01
PB210+D	3.4E-01
RA226+D	1.3
TH228+D	3.3E+01
TH230+D	1.3
TH232+D	3.2E+02
U 233+D	4.2
U 234	6.9E-02
U 235+D	8.9E+01

Onsite Disposal Environment Surface Soil PLANSOURC (External), continued

U 238+D	5.0
NP237+D	6.6E+01
PU241+D	1.1
SR89	5.7E-01
Y 89M	0.0
SR90	3.0E-02
Y 90	1.9
MO99	4.8E+01
TC99M	1.9E+01
TC99	4.0E-03
RU103	1.8E+02
RH103M	5.1E-02
PD103	2.8E-01
I 129	4.3E-01
CS134	6.0E+02
CS135	1.3E-03
CS137	4.1E-02
BA137M	2.2E+02
CE141	1.0E+01
SM151	2.4E-04
U 235	2.0E+01
TH231	1.3
PA231	8.6
AC227	1.3E-02
TH227	2.5E+01
FR223	7.6
RA223	2.6E+01
NP237	1.9
PA233	6.0E+01
U 233	4.2E-03
TH229	1.8
RA225	6.8E-01
AC225	1.7
U 238	9.8E-03
TH234	7.5E-01
PA234M	2.9
PA234	6.3E+02
PU242	8.1E-04
NP238	2.0E+02
PU238	2.9E-03
CM244	1.8E-03
PU244	6.8E-07
U 240	3.4E-02
PU240	2.7E-03
CM243	2.5E+01
PU243	2.7
AM243	3.6
NP239	2.9E+01
PU239	2.9E-03
PU241	2.9E-12
AM241	1.1

Onsite Disposal Environment Stored Waste ROOM (External)

ONSITE/BIOPORT ROOM MODEL EXTERNAL DRFS 10-APR-84 RAP

	ROOM 100
H 3	0.0
C 14	6.2E-04
NA22	5.1E+02
P 32	9.8E-01
P 33	1.0
S 35	0.0
CL36	2.8E-01
K 40	7.0E+01
CA45	2.8E-03
SC46	8.4E+02
CR51	1.2E+01
MN54	3.3E+02
FE55	0.0
FE59	4.7E+02
CO57	2.1E+01
CO60	1.0E+03
NI59	0.0
NI63	2.5E-14
ZN65	2.7E+02
SE75	9.6E+01
SR85	2.0E+02
SR90+D	2.1
MO93	1.4
NB94	6.0E+02
RU106+D	1.0E+03
CD109	7.6
AG110M+D	1.2E+03
IN111	7.8E+01
SB124	8.6E+02
SB125+D	1.9E+02
I 125+D	8.8E-01
I 131+D	1.3E+02
CS137+D	2.3E+02
CE144+D	2.9E+01
EU152	4.7E+02
EU154	4.9E+02
TB160	4.4E+02
OS185	2.7E+02
OS191	8.0
IR192	2.7E+02
HG203	4 9E+01
PB210+D	3.5E-01
RA226+D	1.3
TH228+D	3.4E+01
TH230+D	1.3
TH232+D	3.8E+02
U 233+D	4.3
U 234	6.9E-02
U 235+D	8.3E+01

Onsite Disposal Environment Stored Waste ROOM (external), continued

U 238+D	5.6
NP237+D	7.1E+01
PU241+D	1.1
SR89	6.1E-01
Y 89M	0.0
SR90	3.0E-02
Y 90	2.1
MO99	5.4E+01
TC99M	1.9E+01
TC99	4.0E-03
RU103	2.0E+02
RH103M	5.1E-02
PD103	2.8E-01
I 129	4.3E-01
CS134	6.7E+02
CS135	1.3E-03
CS137	4.2E-02
BA137M	2.4E+02
CE141	1.0E+01
SM151	2.4E-04
U 235	2.0E+01
TH231	1.3
PA231	9.3
AC227	1.3E-02
TH227	2.6E+01
FR223	8.0
RA223	2.7E+01
NP237	2.0
PA233	6.5E+01
U 233	4.2E-03
TH229	1.9
RA225	6.8E-01
AC225	1.7
U 238	9.8E-03
TH234	7.6E-01
PA234M	3.4
PA234	7.2E+02
PU242	8.1E-04
NP238	2.4E+02
PU238	2.9E-03
CM244	1.8E-03
PU244	6.8E-07
U 240	3.4E-02
PU240	2.7E-03
CM243	2.6E+01
PU243	2.7
AM243	3.6
NP239	3.0E+01
PU239	2.9E-03
PU241	2.9E-12
AM241	1.1

Onsite Disposal Environment FILE23 (Air), page 1

130 DACRIN (DIFDOS) DOSE INCREMENT FILE ONSITE/BIOPORT ENV. 16-APR-84 RAP

1	6	8	16	23		
H 3		0	0	2		
H 3	1 1	1.05E-06	.00	1.05E-06	1.05E-06	.00
H 3	1 2	5.32E-08	.00	5.32E-08	5.32E-08	.00
C 14		4	0	0		
C 14	1 1	2.39E-06	1.05E-05	2.39E-06	2.39E-06	2.06E-06
C 14	1 2	1.01E-07	1.97E-06	1.01E-07	1.01E-07	1.23E-10
C 14	1 3	.00	3.51E-09	.00	.00	.00
C 14	1 4	.00	6.37E-12	.00	.00	.00
NA22		2	4	27		
NA22	1 1	7.25E-05	0.00E+00	5.01E-05	0.00E+00	1.15E-05
NA22	1 2	3.33E-06	0.00E+00	9.90E-08	0.00E+00	6.88E-10
NA22	2 1	6.82E-05	0.00E+00	2.37E-03	0.00E+00	3.62E-05
NA22	2 2	6.65E-06	0.00E+00	5.32E-04	0.00E+00	1.35E-06
NA22	2 3	2.88E-08	0.00E+00	2.57E-06	0.00E+00	6.24E-09
NA22	2 4	1.82E-10	0.00E+00	1.23E-08	0.00E+00	3.27E-11
NA22	3 1	5.80E-05	0.00E+00	6.03E-03	0.00E+00	3.71E-05
NA22	3 2	6.21E-06	0.00E+00	7.40E-03	0.00E+00	1.87E-06
NA22	3 3	1.84E-06	0.00E+00	3.42E-03	0.00E+00	8.29E-07
NA22	3 4	9.47E-07	0.00E+00	1.58E-03	0.00E+00	3.83E-07
NA22	3 5	4.96E-07	0.00E+00	7.28E-04	0.00E+00	1.77E-07
NA22	3 6	2.65E-07	0.00E+00	3.37E-04	0.00E+00	8.17E-08
NA22	3 7	1.43E-07	0.00E+00	1.55E-04	0.00E+00	3.76E-08
NA22	3 8	7.85E-08	0.00E+00	7.18E-05	0.00E+00	1.74E-08
NA22	3 9	4.36E-08	0.00E+00	3.31E-05	0.00E+00	8.03E-09
NA22	310	2.45E-08	0.00E+00	1.52E-05	0.00E+00	3.69E-09
NA22	311	1.39E-08	0.00E+00	7.05E-06	0.00E+00	1.72E-09
NA22	312	7.97E-09	0.00E+00	3.25E-06	0.00E+00	7.86E-10
NA22	313	4.61E-09	0.00E+00	1.51E-06	0.00E+00	3.64E-10
NA22	314	2.67E-09	0.00E+00	6.91E-07	0.00E+00	1.67E-10
NA22	315	1.57E-09	0.00E+00	3.20E-07	0.00E+00	8.00E-11
NA22	316	9.09E-10	0.00E+00	1.49E-07	0.00E+00	3.64E-11
NA22	317	5.38E-10	0.00E+00	6.71E-08	0.00E+00	1.46E-11
NA22	318	3.20E-10	0.00E+00	3.17E-08	0.00E+00	1.09E-11
NA22	319	1.82E-10	0.00E+00	1.49E-08	0.00E+00	0.00E+00
NA22	320	1.16E-10	0.00E+00	5.59E-09	0.00E+00	3.64E-12
NA22	321	6.55E-11	0.00E+00	3.73E-09	0.00E+00	0.00E+00
NA22	322	3.64E-11	0.00E+00	1.86E-09	0.00E+00	0.00E+00
NA22	323	2.18E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NA22	324	1.46E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NA22	325	7.28E-12	0.00E+00	1.86E-09	0.00E+00	0.00E+00
NA22	326	7.28E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NA22	327	7.28E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
P 32		2	2	2		
P 32	1 1	3.79E-05	9.79E-04	4.18E-05	0.00E+00	2.58E-05
P 32	1 2	2.18E-06	5.89E-05	7.98E-08	0.00E+00	1.53E-09
P 32	2 1	2.56E-05	6.62E-04	5.85E-04	0.00E+00	6.96E-05
P 32	2 2	1.57E-06	4.24E-05	2.55E-05	0.00E+00	2.90E-07
P 32	3 1	2.30E-05	5.95E-04	7.15E-04	0.00E+00	7.77E-05

Incremental Aquatic Foods Dose Factors - ONSITE/BIOPORT Env. - 16-APR-84 RAP
FISH 50 92 5
1 6 8 16 23

H 3	2.61E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C 14	1.76E-05	7.72E-05	0.00E+00	0.00E+00	1.24E-05
NA22	1.80E-05	0.00E+00	0.00E+00	0.00E+00	1.17E-05
P 32	4.64E-03	1.20E-01	0.00E+00	0.00E+00	1.58E-02
P 33	9.20E-04	2.48E-02	0.00E+00	0.00E+00	2.00E-03
CA45	4.76E-07	2.14E-05	0.00E+00	0.00E+00	1.71E-06
SC46	4.08E-10	7.18E-10	0.00E+00	0.00E+00	8.34E-06
CR51	1.23E-09	0.00E+00	2.55E-09	7.37E-10	3.84E-07
MN54	2.42E-06	0.00E+00	0.00E+00	0.00E+00	4.64E-05
FE55	8.21E-08	3.82E-07	1.24E-07	0.00E+00	9.45E-07
FE59	2.37E-06	2.75E-06	1.73E-06	0.00E+00	2.90E-05
CO57	1.21E-07	0.00E+00	0.00E+00	0.00E+00	2.13E-06
CO60	1.96E-06	0.00E+00	0.00E+00	0.00E+00	1.93E-05
NI59	2.12E-07	1.08E-06	0.00E+00	0.00E+00	5.96E-07
NI63	5.77E-07	1.47E-05	0.00E+00	0.00E+00	1.63E-06
ZN65	4.29E-05	2.87E-05	0.00E+00	0.00E+00	1.50E-04
SE75	2.78E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR85	1.48E-06	1.22E-06	0.00E+00	0.00E+00	0.00E+00
SR90+D	1.30E-05	4.85E-05	0.00E+00	0.00E+00	2.28E-05
MO93	9.20E-08	0.00E+00	0.00E+00	0.00E+00	6.28E-07
NB94	2.52E-06	0.00E+00	0.00E+00	0.00E+00	8.23E-03
RU106+D	9.71E-08	7.42E-07	0.00E+00	0.00E+00	5.69E-05
CD109	3.55E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG110M+D	2.77E-08	4.59E-08	0.00E+00	0.00E+00	2.16E-05
SB124	3.56E-07	8.43E-07	6.91E-07	2.36E-09	3.12E-05
SB125+D	1.30E-07	4.25E-07	3.72E-07	6.38E-10	7.83E-06
I 125+D	1.52E-06	7.07E-06	0.00E+00	1.24E-03	1.78E-07
I 131+D	1.38E-06	1.70E-06	0.00E+00	7.86E-04	7.26E-07
CS137+D	6.06E-04	6.12E-04	9.65E-05	0.00E+00	3.32E-05
CE144+D	1.11E-09	1.76E-08	0.00E+00	0.00E+00	1.73E-05
EU152	1.98E-09	5.23E-09	0.00E+00	0.00E+00	7.40E-06
EU154	2.87E-09	1.84E-08	0.00E+00	0.00E+00	1.58E-05
TB160	1.13E-09	8.95E-09	0.00E+00	0.00E+00	1.24E-05
IR192	5.39E-07	0.00E+00	0.00E+00	0.00E+00	4.42E-05
HG203	6.29E-04	0.00E+00	0.00E+00	0.00E+00	9.95E-04
PB210+D	5.63E-05	8.12E-04	0.00E+00	0.00E+00	6.52E-05
RA226+D	2.84E-03	2.85E-03	0.00E+00	0.00E+00	2.40E-04
TH228+D	1.40E-06	4.13E-05	0.00E+00	0.00E+00	3.21E-04
TH230+D	3.29E-07	1.16E-05	0.00E+00	0.00E+00	3.43E-05
TH232+D	4.27E-07	1.29E-05	0.00E+00	0.00E+00	2.92E-05
U 233+D	1.08E-05	1.17E-04	0.00E+00	0.00E+00	2.21E-05
U 234	1.05E-05	8.69E-05	0.00E+00	0.00E+00	2.17E-05
U 235+D	9.89E-06	8.32E-05	0.00E+00	0.00E+00	2.75E-05
U 238+D	9.25E-06	7.96E-05	0.00E+00	0.00E+00	1.94E-05
NP237+D	2.45E-07	5.63E-06	0.00E+00	0.00E+00	3.31E-05
PU241+D	2.94E-09	8.19E-08	0.00E+00	0.00E+00	5.17E-07

Onsite Disposal Environment FILE25 (Drink), page 1

Incremental Drinking Water Dose Factors - ONSITE/BIOPORT Env. 16-APR-84 RAP

H2O 50 92 5

1 6 8 16 23

H 3	2.57E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C 14	2.40E-07	1.05E-06	0.00E+00	0.00E+00	1.68E-07
NA22	6.54E-06	0.00E+00	0.00E+00	0.00E+00	4.24E-06
P 32	1.18E-06	3.05E-05	0.00E+00	0.00E+00	4.02E-06
P 33	2.34E-07	6.29E-06	0.00E+00	0.00E+00	5.09E-07
CA45	1.15E-07	5.16E-06	0.00E+00	0.00E+00	4.12E-07
SC46	3.70E-10	6.50E-10	0.00E+00	0.00E+00	7.55E-06
CR51	9.15E-10	0.00E+00	1.89E-09	5.46E-10	2.84E-07
MN54	1.78E-07	0.00E+00	0.00E+00	0.00E+00	3.41E-06
FE55	9.25E-09	4.30E-08	1.39E-08	0.00E+00	1.06E-07
FE59	2.68E-07	3.10E-07	1.95E-07	0.00E+00	3.26E-06
CO57	2.45E-08	0.00E+00	0.00E+00	0.00E+00	4.31E-07
CO60	3.97E-07	0.00E+00	0.00E+00	0.00E+00	3.91E-06
NI59	2.39E-08	1.22E-07	0.00E+00	0.00E+00	6.72E-08
NI63	6.50E-08	1.66E-06	0.00E+00	0.00E+00	1.83E-07
ZN65	5.38E-07	3.60E-07	0.00E+00	0.00E+00	1.88E-06
SE75	6.40E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR85	4.39E-07	3.63E-07	0.00E+00	0.00E+00	0.00E+00
SR90+D	3.87E-06	1.44E-05	0.00E+00	0.00E+00	6.78E-06
MO93	7.83E-08	0.00E+00	0.00E+00	0.00E+00	5.35E-07
NB94	3.73E-09	0.00E+00	0.00E+00	0.00E+00	1.22E-05
RU106+D	7.38E-08	5.64E-07	0.00E+00	0.00E+00	4.33E-05
CD109	5.68E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG110M+D	2.63E-08	4.36E-08	0.00E+00	0.00E+00	2.05E-05
SB124	3.49E-07	8.27E-07	6.78E-07	2.31E-09	3.06E-05
SB125+D	1.27E-07	4.16E-07	3.65E-07	6.25E-10	7.68E-06
I 125+D	1.17E-06	5.46E-06	0.00E+00	9.60E-04	1.38E-07
I 131+D	1.06E-06	1.31E-06	0.00E+00	6.07E-04	5.61E-07
CS137+D	1.68E-05	1.70E-05	2.68E-06	0.00E+00	9.22E-07
CE144+D	1.03E-09	1.63E-08	0.00E+00	0.00E+00	1.60E-05
EU152	6.68E-10	1.76E-09	0.00E+00	0.00E+00	2.49E-06
EU154	9.67E-10	6.19E-09	0.00E+00	0.00E+00	5.33E-06
TB160	3.80E-10	3.01E-09	0.00E+00	0.00E+00	4.17E-06
IR192	1.09E-07	0.00E+00	0.00E+00	0.00E+00	8.95E-06
HG203	9.97E-07	0.00E+00	0.00E+00	0.00E+00	1.58E-06
PB210+D	2.05E-05	2.95E-04	0.00E+00	0.00E+00	2.37E-05
RA226+D	1.34E-03	1.34E-03	0.00E+00	0.00E+00	1.13E-04
TH228+D	8.35E-07	2.46E-05	0.00E+00	0.00E+00	1.92E-04
TH230+D	1.97E-07	6.93E-06	0.00E+00	0.00E+00	2.05E-05
TH232+D	2.55E-07	7.72E-06	0.00E+00	0.00E+00	1.74E-05
U 233+D	1.03E-05	1.12E-04	0.00E+00	0.00E+00	2.12E-05
U 234	1.01E-05	8.31E-05	0.00E+00	0.00E+00	2.07E-05
U 235+D	9.47E-06	7.96E-05	0.00E+00	0.00E+00	2.63E-05
U 238+D	8.85E-06	7.62E-05	0.00E+00	0.00E+00	1.86E-05
NP237+D	2.00E-07	4.59E-06	0.00E+00	0.00E+00	2.70E-05
PU241+D	2.73E-09	7.59E-08	0.00E+00	0.00E+00	4.80E-07

Onsite Disposal Environment VOLSOURC (External)

ONSITE/BIOPORT VOLUME SOURCE SURFACE EXTERNAL DRFS 10-APR-84 RAP

	VOLU 100
H 3	0.0
C 14	6.2E-04
NA22	5.1E+02
P 32	9.8E-01
P 33	1.0
S 35	0.0
CL36	2.8E-01
K 40	7.0E+01
CA45	2.8E-03
SC46	8.4E+02
CR51	1.2E+01
MN54	3.3E+02
FE55	0.0
FE59	4.7E+02
CO57	2.1E+01
CO60	1.0E+03
NI59	0.0
NI63	2.5E-14
ZN65	2.7E+02
SE75	9.6E+01
SR85	2.0E+02
SR90+D	2.1
MO93	1.4
NB94	6.0E+02
RU106+D	1.0E+03
CD109	7.6
AG110M+D	1.2E+03
IN111	7.8E+01
SB124	8.6E+02
SB125+D	1.9E+02
I 125+D	8.8E-01
I 131+D	1.3E+02
CS137+D	2.3E+02
CE144+D	2.9E+01
EU152	4.7E+02
EU154	4.9E+02
TB160	4.4E+02
OS185	2.7E+02
OS191	8.0
IR192	2.7E+02
HG203	4.9E+01
PB210+D	3.5E-01
RA226+D	1.3
TH228+D	3.4E+01
TH230+D	1.3
TH232+D	3.8E+02
U 233+D	4.3
U 234	6.9E-02
U 235+D	8.3E+01

U 238+D	5.6
NP237+D	7.1E+01
PU241+D	1.1
SR89	6.1E-01
Y 89M	0.0
SR90	3.0E-02
Y 90	2.1
MO99	5.4E+01
TC99M	1.9E+01
TC99	4.0E-03
RU103	2.0E+02
RH103M	5.1E-02
PD103	2.8E-01
I 129	4.3E-01
CS134	6.7E+02
CS135	1.3E-03
CS137	4.2E-02
BA137M	2.4E+02
CE141	1.0E+01
SM151	2.4E-04
U 235	2.0E+01
TH231	1.3
PA231	9.3
AC227	1.3E-02
TH227	2.6E+01
FR223	8.0
RA223	2.7E+01
NP237	2.0
PA233	6.5E+01
U 233	4.2E-03
TH229	1.9
RA225	6.8E-01
AC225	1.7
U 238	9.8E-03
TH234	7.6E-01
PA234M	3.4
PA234	7.2E+02
PU242	8.1E-04
NP238	2.4E+02
PU238	2.9E-03
CM244	1.8E-03
PU244	6.8E-07
U 240	3.4E-02
PU240	2.7E-03
CM243	2.6E+01
PU243	2.7
AM243	3.6
NP239	3.0E+01
PU239	2.9E-03
PU241	2.9E-12
AM241	1.1

Onsite Disposal Environment BURIEDHF (External)

ONSITE/BIOPORT EXTERNAL DRFS (BURIED AT 0.5 M) 9-APR-84 RAP

0.5M	100
H 3	0.0
C 14	1.2E-12
NA22	1.8
P 32	4.3E-04
P 33	1.5E-03
S 35	0.0
CL36	9.3E-06
K 40	3.9E-01
CA45	1.9E-10
SC46	2.3
CR51	2.8E-03
MN54	4.4E-01
FE55	0.0
FE59	1.6
CO57	8.4E-06
CO60	3.7
NI59	0.0
NI63	0.0
ZN65	9.4E-01
SE75	1.5E-02
SR85	1.1E-01
SR90+D	1.7E-03
MO93	3.5E-34
NB94	6.1E-01
RU106+D	2.6
CD109	5.5E-08
AG110M+D	2.6
IN111	1.3E-03
SB124	4.2
SB125+D	1.1E-01
I 125+D	1.2E-34
I 131+D	4.0E-02
CS137+D	1.4E-01
CE144+D	1.2E-01
EU152	1.6
EU154	1.4
TB160	1.1
OS185	2.0E-01
OS191	2.2E-06
IR192	9.0E-02
HG203	1.1E-03
PB210+D	5.0E-05
RA226+D	1.3E-04
TH228+D	1.6E-03
TH230+D	1.3E-04
TH232+D	1.1
U 233+D	1.4E-05
U 234	1.9E-08
U 235+D	8.3E-03

Onsite Disposal Environment BURIEDHF (External), continued

U 238+D	1.2E-02
NP237+D	1.6E-02
PU241+D	2.6E-09
SR89	1.8E-04
Y 89M	0.0
SR90	5.5E-07
Y 90	1.7E-03
MO99	4.4E-02
TC99M	7.6E-06
TC99	7.8E-10
RU103	1.1E-01
RH103M	2.8E-26
PD103	9.3E-06
I 129	6.3E-13
CS134	8.0E-01
CS135	3.4E-11
CS137	4.4E-06
BA137M	1.5E-01
CE141	4.3E-06
SM151	1.8E-19
U 235	8.7E-05
TH231	1.0E-07
PA231	1.9E-03
AC227	4.3E-09
TH227	2.4E-03
FR223	2.2E-03
RA223	3.9E-03
NP237	2.7E-08
PA233	1.6E-02
U 233	6.5E-19
TH229	7.1E-07
RA225	4.3E-09
AC225	1.4E-05
U 238	5.2E-18
TH234	4.6E-08
PA234M	9.1E-03
PA234	1.6
PU242	2.8E-27
NP238	7.5E-01
PU238	8.4E-10
CM244	6.2E-27
PU244	0.
U 240	1.1E-13
PU240	8.4E-10
CM243	3.5E-04
PU243	2.1E-04
AM243	8.5E-10
NP239	7.9E-04
PU239	8.4E-10
PU241	0.0
AM241	2.6E-09

Onsite Disposal Environment BURIED1 (External)

ONSITE/BIOPORT EXTERNAL DRF (BURIED AT 1.0 M) 9-APR-84 RAP

1.0M	100
H 3	0.0
C 14	1.1E-19
NA22	9.2E-03
P 32	9.1E-07
P 33	6.7E-06
S 35	0.0
CL36	3.0E-09
K 40	3.0E-03
CA45	1.2E-16
SC46	1.0E-02
CR51	8.9E-07
MN54	7.9E-04
FE55	0.
FE59	7.3E-03
CO57	5.4E-12
CO60	1.8E-02
NI59	0.0
NI63	0.0
ZN65	4.6E-03
SE75	1.0E-05
SR85	7.7E-05
SR90+D	7.7E-06
MO93	0.
NB94	9.4E-04
RU106+D	2.1E-02
CD109	7.2E-16
AG110M+D	1.4E-02
IN111	4.3E-08
SB124	4.8E-02
SB125+D	8.7E-05
I 125+D	0.0
I 131+D	2.1E-05
CS137+D	1.2E-04
CE144+D	2.0E-03
EU152	9.5E-03
EU154	6.6E-03
TB160	4.9E-03
OS185	2.2E-04
OS191	1.4E-12
IR192	4.9E-05
HG203	3.5E-08
PB210+D	4.1E-08
RA226+D	9.1E-08
TH228+D	2.9E-06
TH230+D	9.1E-08
TH232+D	5.7E-03
U 233+D	4.6E-10
U 234	1.2E-14
U 235+D	3.0E-06

Onsite Disposal Environment BURIED1 (External), continued

U 238+D	5.2E-05
NP237+D	5.7E-06
PU241+D	1.6E-15
SR89	2.8E-07
Y 89M	0.0
SR90	1.5E-10
Y 90	7.7E-06
MO99	6.6E-05
TC99M	4.9E-12
TC99	1.3E-14
RU103	7.9E-05
RH103M	0.0
PD103	3.0E-09
I 129	4.2E-20
CS134	2.1E-03
CS135	1.9E-17
CS137	4.1E-09
BA137M	1.3E-04
CE141	9.3E-11
SM151	7.8E-30
U 235	2.6E-09
TH231	6.0E-14
PA231	6.0E-07
AC227	2.7E-15
TH227	6.5E-07
FR223	3.6E-06
RA223	1.7E-06
NP237	1.6E-16
PA233	5.7E-06
U 233	1.1E-33
TH229	4.6E-13
RA225	1.2E-13
AC225	4.6E-10
U 238	8.5E-33
TH234	1.6E-14
PA234M	3.6E-05
PA234	8.2E-03
PU242	0.0
NP238	3.2E-03
PU238	5.4E-16
CM244	0.0
PU244	0.0
U 240	6.4E-21
PU240	5.4E-16
CM243	1.1E-08
PU243	6.7E-08
AM243	4.3E-19
NP239	1.5E-07
PU239	5.4E-16
PU241	0.
AM241	1.6E-15

Onsite Disposal Environment Selected Radionuclides - RMDONS

ONSITE/BIOPORT RADIONUCLIDE MASTER DATA LIBRARY 23-MAY-84 RAP

H 3	4.51E+3	1	0	0	4.8	11
C 14	2.091E+6	1	0	0	5.5	12
NA22	9.50E+2	1	0	0	5.0E-2	11
P 32	1.43E+1	1	0	0	5.0E+1	12
P 33	2.44E+1	1	0	0	5.0E+1	12
S 35	8.72E+1	1	0	0	5.9E-1	12
CL36	1.1E+8	1	0	0	5.0	11
K 40	4.67E11	1	0	0	3.6E-1	11
CA45	1.65E+2	1	0	0	4.0E-2	12
SC46	6.5E+1	1	0	0	1.1E-3	13
CR51	2.77E+1	1	0	0	2.5E-4	13
MN54	3.12E+2	1	0	0	3.0E-2	13
FE55	9.86E+2	1	0	0	4.0E-4	13
FE59	4.46E+1	1	0	0	4.0E-4	13
CO57	2.71E+2	1	0	0	9.4E-3	13
CO60	1.92E+3	1	0	0	9.4E-3	13
NI59	2.74E+7	1	0	0	1.9E-2	13
NI63	3.51E+4	1	0	0	1.9E-2	13
ZN65	2.44E+2	1	0	0	4.0E-1	13
SE75	1.20E+2	1	0	0	1.3	12
SR85	6.5E+1	1	0	0	2.0E-1	13
SR90+D	1.04E+4	1	0	0	2.0E-1	13
MO93	3.65E+4	1	0	0	1.3E-1	13
NB94	7.30E+6	1	0	0	9.4E-3	13
RU106+D	3.68E+2	1	0	0	1.0E-2	13
CD109	4.40E+2	1	0	0	3.0E-1	13
AG110M+D	2.52E+2	1	0	0	1.5E-1	13
IN111	2.8E+0	1	0	0	2.5E-1	13
SB124	6.02E+1	1	0	0	1.1E-2	13
SB125+D	1.01E+3	1	0	0	1.1E-2	13
I 125+D	5.97E+1	1	0	0	2.0E-2	12
I 131+D	8.04E+0	1	0	0	2.0E-2	12
CS137+D	1.10E+4	1	0	0	2.0E-3	11
CE144+D	2.84E+2	1	0	0	5.0E-4	23
EU152	4.97E+3	1	0	0	2.5E-3	23
EU154	3.14E+3	1	0	0	2.5E-3	23
TB160	7.2E+1	1	0	0	2.6E-3	23
OS185	9.40E+1	1	0	0	5.0E-2	23
OS191	1.5E+1	1	0	0	5.0E-2	23
IR192	7.30E+1	1	0	0	9.4E-3	23
HG203	4.66E+1	1	0	0	3.8E-1	23
PB210+D	8.14E+3	1	0	0	6.8E-2	23
RA226+D	5.84E+5	1	0	0	1.4E-3	23
TH228+D	6.97E+2	1	0	0	4.2E-3	23
TH230+D	2.81E+7	1	0	0	4.2E-3	23
TH232+D	5.13E12	1	0	0	4.2E-3	23
U 233+D	5.79E+7	1	0	0	2.5E-3	23
U 234	8.91E+7	1	0	0	2.5E-3	23
U 235+D	2.59E11	1	0	0	2.5E-3	23
U 238+D	1.65E12	1	0	0	2.5E-3	23

NP237+D	7.82E+8	1	0		0		2.5E-3	23
PU241+D	5.26E+3	1	0		0		2.5E-4	23
SR89	5.06E+1	1	0		0		2.0E-1	23
Y 89M	1.86E-4	2	1	0.0002	0		2.5E-3	13
SR90	1.04E+4	1	0		0		2.0E-1	13
Y 90	2.67E+0	2	1	1.0	0		2.5E-3	13
MO99	2.75E+0	1	0		0		1.3E-1	13
TC99M	2.51E-1	2	1	0.868	0		2.5E-1	13
TC99	7.78E+7	3	2	1.0	1	0.132	2.5E-1	13
RU103	3.94E+1	1	0		0		1.0E-2	13
RH103M	3.90E-2	2	0		0		1.3E+1	13
PD103	1.70E+1	3	1	.9974	0	.9997	5.0	13
I 129	5.71E+9	1	0		0		2.0E-2	12
CS134	7.53E+2	1	0	1.0	0		2.0E-3	11
CS135	8.40E+8	1	0		0		2.0E-3	11
CS137	1.10E+4	1	0		0		2.0E-3	11
BA137M	1.77E-3	2	1	0.946	0		5.0E-3	13
CE141	3.25E+1	1	0		0		5.0E-4	23
SM151	3.29E+4	1	0		0		2.5E-3	23
U 235	2.59E11	1	0		0		2.5E-3	23
TH231	1.06E+0	2	1	1.0	0		4.2E-3	23
PA231	1.19E+7	3	2	1.0	0		2.5E-3	23
AC227	7.95E+3	4	3	1.0	0		2.5E-3	23
TH227	1.87E+1	5	4	0.9862	0		4.2E-3	23
FR223	1.51E-2	6	4	0.0138	0		0	23
RA223	1.14E+1	7	5	1.0	6	1.0	1.4E-3	23
NP237	7.82E+8	1	0		0		2.5E-3	23
PA233	2.70E+1	2	1	1.0	0		2.5E-3	23
U 233	5.79E+7	3	2	1.0	0		2.5E-3	23
TH229	2.68E+6	4	3	1.0	0		4.2E-3	23
RA225	1.48E+1	5	4	1.0	0		1.4E-3	23
AC225	1.00E+1	6	5	1.0	0		1.4E-3	23
U 238	1.65E12	1	0	0.0	0		2.5E-3	23
TH234	2.41E+1	2	1	1.0	0		4.2E-3	23
PA234M	8.13E-4	3	2	1.0	0		2.5E-3	23
PA234	2.81E-1	4	3	0.0013	0		2.5E-3	23
PU242	1.41E+8	1	0		0		2.5E-4	23
NP238	2.18E+0	2	0		0		2.5E-3	23
PU238	3.21E+4	3	2	1.0			2.5E-4	23
CM244	6.61E+3	1	0		0		2.5E-3	23
PU244	3.02E10	2	0		0		2.5E-4	23
U 240	5.88E-1	3	2	0.999	0		2.5E-3	23
PU240	2.39E+6	4	3	1.0	1	1.0	2.5E-4	23
CM243	1.04E+4	1	0		0		2.5E-3	23
PU243	2.06E-1	2	0	1.0	0		2.5E-4	23
AM243	2.70E+6	3	2	1.0	1	0.0024	2.5E-4	23
NP239	2.36E+0	4	3	1.0	0		2.5E-3	23
PU239	8.91E+6	5	4	1.0	1	0.9976	2.5E-4	23
PU241	5.26E+3	1	0		0		2.5E-4	23
AM241	1.58E+5	2	1	1.0	0		2.5E-4	23
		0						

APPENDIX 1.D

CDC Computer Installation

CONTENTS

APPENDIX 1.D.1 CDC Command Level Procedure - PROCFIL

```
.PROC,ON.
ATTACH,ABS,ONSITEABS,ID=ONSITEDB.
COPY,ABS,LGO.
RETURN,ABS.
ATTACH,TAPE10,RMDONS,ID=ONSITEDB,MR=1.
REWIND,TAPE10.
CONNECT,OUTPUT.
CONNECT,INPUT.
CONNECT,TAPE5.
CONNECT,TAPE6.
REWIND,LGO.
LGO.
REVERT.
*EOR
.PROC,DONE*I,F"FILENAME FOR SCENARIO"=(*F),
  R"READ PASSWORD FOR FILE"=(*A).
CATALOG,TAPE7,F,ID=ONSITE,RP=10,RD=R.
BATCH,TAPE7,INPUT,HERE.
RETURN,TAPE7.
RETURN,TAPE10.
DISCONT,OUTPUT.
DISCONT,INPUT.
DISCONT,TAPE5.
DISCONT,TAPE6.
RETURN LGO.
FILES.
REVERT.
*EOR
.PROC,SEND*I,F"NAME OF OUTPUT FILE TO BE PRINTED:"=(*F),
   N"FIVE CHARACTER NAME TO IDENTIFY RUN"=(*A).
BATCH,F,LOCAL.
REQUEST,X,*Q.
REWIND,F.
COPY,F,X.
ROUTE,X,DC=PR,FID=*N,TID=KT.
RETURN X.
FILES.
REVERT.
*EOR
*EOF
```

```
C-----------------------------------------------------------------------
C
      SUBROUTINE RITFIL
C
C     THIS SUBROUTINE WRITES A FILE WITH INPUT PARAMETERS AND
C     SYSTEM COMMANDS FOR MAXI1.
C
C     MODULE OF ONSITE
C     VERSION OF 26-APR-84  RAP
C
C-----------------------------------------------------------------------
C
C      INCLUDE 'ONSITE.CMN'
C-----------------------------------------------------------------------
C
      COMMON /VARYBL/ IFOD, RIRR,RPF, IMO, RF1, RF2, IARG, IWAT,
     .                IDKWAT, IEXT, IAIR, XQSITE, IDKAIR,
     .                ISUR, I22, XF2,
     .                AGE, XDPT, DEN, XMLF, RINH, DILF, M3M2, INTRUD,
     .                IT1, IT2, NORG, KORG(5), IOUT, NEXT,
     .                RPF1, RPF2, INHAL, IRR, SRDIL, NVUNIT(4)
      REAL NVUNIT
C
      COMMON /INV/ NIN, ELTI(100), AWI(100), NSOLD(5,100),
     .             Q(100), QI(100), QJ(100), QK(100)
      REAL AWI
      INTEGER ELTI
C
      COMMON /FLAG/  IRS, ILOC, INUT, IARL, IWRL
C
       COMMON /AREA/ FRSIZ, AREAIN, AREAEX
C
       COMMON /DESC/ TITL(20), UNITS(2,3), NVU(4)
       CHARACTER*8 UNITS
       CHARACTER*4 TITL, NVU
C
       COMMON /IOVAR/  SCRN, OUT, OUTFIL, KEY
C      CHARACTER*15 OUTFIL
       INTEGER SCRN, OUT
C
C-----------------------------------------------------------------------
C
C
  200 CONTINUE
      WRITE (SCRN,4000)
 4000 FORMAT (' ',10(/),' ',
     .14X,'ENTER YOUR CDC ACCOUNT NAME:' )
      READ (KEY,4001) ACNT
 4001 FORMAT (A10)
      WRITE (SCRN,4002)
```

```
 4002 FORMAT ('0',14X,'ENTER YOUR CDC PROBLEM NO:')
      READ (KEY,4001) PRBLM
C
C---- INSERT JOB CONTROL RECORDS FOR BATCH PROCESSING ------------------
C
      WRITE (OUT,3000) ACNT,ACNT, PRBLM, PRBLM
 3000 FORMAT (A5,',STMFZ,CM160000,EC400,T177.'/
     .'ACCOUNT,',A7,',',A4,',',A4,'.')
C
C---- ASSIGN LIBRARY FILES TO LOGICAL UNIT DEVICES ---------------------

C     IF (IFOD .GT. 0) WRITE (OUT, 3010)
      WRITE (OUT,3010)
C
C 3010 FORMAT ('ASSIGN [BIO.NEW]FILE20.DAT FOR020'/
C     .         'ASSIGN [BIO.NEW]FILE21.DAT FOR021')
C
 3010 FORMAT (' ATTACH,TAPE20,FILE20,ID=ZZRNRC.'/
     .         ' ATTACH,TAPE21,FILE21,ID=ZZRNRC.'/
     .         ' REWIND,TAPE20.'/
     .         ' REWIND,TAPE21.')
C
C     IF (IARG .GT. 0) WRITE (OUT, 3020)
      WRITE (OUT,3020)
C
C3020 FORMAT ('ASSIGN [BIO.NEW]FILE24.DAT FOR024')
 3020 FORMAT (' ATTACH,TAPE24,FILE24,ID=ZZRNRC.'/
     .          ' REWIND,TAPE24.')
C
C     IF (IWAT .GT. 0) WRITE (OUT, 3030)
      WRITE (OUT,3030)
C
C3030 FORMAT ('ASSIGN [BIO.NEW]FILE25.DAT FOR025')
 3030 FORMAT (' ATTACH,TAPE25,FILE25,ID=ZZRNRC.'/
     .         ' REWIND,TAPE25.')
C
      IF (ILOC .EQ. 4) THEN
        WRITE (OUT, 3240)
      ELSE
        WRITE (OUT, 3040)
      ENDIF
C
C3240 FORMAT ('ASSIGN [BIO.NEW]ROOM.DAT FOR022')
 3240 FORMAT (' ATTACH,TAPE22,ROOM,ID=ZZRNRC.'/
     .         ' REWIND,TAPE22.')
C
C3040 FORMAT ('ASSIGN [BIO.NEW]PLANSOURC.SUR FOR022')
 3040 FORMAT (' ATTACH,TAPE22,PLANSOURC,ID=ZZRNRC.'/
     .         ' REWIND,TAPE22.')
C
```

```
      IF (ILOC .EQ. 1) WRITE (OUT, 3044)
C3044 FORMAT ('ASSIGN [BIO.NEW]VOLSOURCE.SUR FOR027')
 3044 FORMAT (' ATTACH,TAPE27,VOLSOURC,ID=ZZRNRC.'/
     .       ' REWIND,TAPE27.')
C
      IF (ILOC .EQ. 2) WRITE (OUT, 3041)
C3041 FORMAT ('ASSIGN [BIO.NEW]BURIEDHF.DAT FOR027')
 3041 FORMAT (' ATTACH,TAPE27,BURIEDHF,ID=ZZRNRC.'/
     .       ' REWIND,TAPE27.')
C
      IF (ILOC.EQ. 3) WRITE (OUT, 3042)
C3042 FORMAT ('ASSIGN [BIO.NEW]BURIED1.DAT FOR027')
 3042 FORMAT (' ATTACH,TAPE27,BURIED1,ID=ZZRNRC.'/
     .       ' REWIND,TAPE27.')
C
      WRITE (OUT, 3050)
C
C3050 FORMAT ('ASSIGN [BIO.NEW]RMDLIB.DAT FOR010'/
C    .       'ASSIGN [BIO.NEW]FILE23.DAT FOR023')
 3050 FORMAT (' ATTACH,TAPE10,RMDLIB,ID=ZZRNRC.'/
     .       ' ATTACH,TAPE23,FILE23,ID=ZZRNRC.'/
     .        ' REWIND,TAPE10.'/
     .        ' REWIND,TAPE23.')
C
C
C---- CALCULATE OUTPUT VALUES ------------------------------------------
C
      RPF = RPF1
      IF (RPF2 .GT. 0.) RPF = RPF1 * RPF2
C
      IF (INHAL .EQ. 0) RINH = 0.0
      IF (INHAL .EQ. 2) AGE = -1.0
C
C
C---- EXECUTE COMMAND, TITLE, AND NAMELIST -----------------------------
C
C
C
      WRITE (OUT, 3100)
C
C3100 FORMAT ('RUN [BIO.NEW]MAXI1'/20A4/' $INPUT  NEXT=1,')
 3100 FORMAT (' ATTACH,ABS,MAXI1ABS,ID=ZZRNRC.'/
     .        ' COPY,ABS,LGO.'/
     .        ' RETURN,ABS.'/
     .        ' MAP,OFF.'/
     .        ' ATTACH,LIB1,FTN5LIB,CY=590.'/
     .        ' ATTACH,LIB2,SYSLIB7,CY=590.'/
     .        ' LIBRARY,LIB1,LIB2.'/
     .        ' LDSET,PRESET=ZERO.'/
     .        ' LGO.')
```

```
      ENDFILE OUT
      BACKSPACE OUT
C
      WRITE (OUT,3101) (TITL(I), I=1,20)
 3101 FORMAT (' ', 20A4/,' $INPUT  NEXT=1,')
C
C
      WRITE (OUT, 3110) IFOD, IARG, IWAT, IEXT, ISUR, IAIR
 3110 FORMAT ('   IFOD=',I1,',IARG=',I1,',IWAT=',I1,',IEXT=',I1,','/
     .        '   ISUR=',I1,', IAIR=',I1,',')
C
      IF (IFOD .GT. 0) WRITE (OUT, 3120) RIRR, IMO, RF1, RF2
 3120 FORMAT ('   RIRR=',G10.3,', IMO=',I1,
     .        ', RF1=',G10.3,', RF2=',G10.3,',')
C
      WRITE (OUT,3022) RPF1, RPF2
 3022 FORMAT ('   RPF1= ',G10.3,', RPF2= ',G10.3,',')
C
      IF (IWAT .GT. 0) WRITE (OUT,3130) IDKWAT
 3130 FORMAT ('   IDKWAT=',I1,',')
C
      IF (IAIR .GT. 0) WRITE (OUT,3140) XQSITE, IDKAIR
 3140 FORMAT ('   XQSITE=',G10.3,', IDKAIR=',I1,',')
C
      IF (INHAL .EQ. 1) WRITE (OUT, 3150) AGE, XDPT
 3150 FORMAT ('   AGE=',G10.3,', XDPT=',G10.3,',')
C
      IF (INHAL .EQ. 2) WRITE (OUT, 3160) DEN, XMLF
 3160 FORMAT ('   AGE=-1, DEN=',G10.3,', XMLF=',G10.3,',')
C
      WRITE (OUT, 3170) RINH, DILF, XF2
 3170 FORMAT ('   RINH=',F10.6,', DILF=',G10.3,', XF2=',G10.3,',')
C
      WRITE (OUT,3180) M3M2, INTRUD, I22
 3180 FORMAT ('   M3M2=',I2,', INTRUD=',I1,', I22=',I1,',')
C
      WRITE (OUT,3190) IT1, IT2, NORG, (KORG(I),I=1,NORG)
 3190 FORMAT ('   IT1=',I4,', IT2=',I4,', NORG=',I2,
     .        ', KORG(1)=',5(I2,',') )
C
      WRITE (OUT,3192) SRDIL, FRSIZ, AREAIN, AREAEX
 3192 FORMAT('   SRDIL=',G10.3,', FRSIZ=',G10.3,', AREAIN=',G10.3,','/
     .       '   AREAEX= ',G10.3,',')
C
      WRITE (OUT, 3200) IOUT
 3200 FORMAT ('   IOUT=',I2,', ION=1, $END')
C
C--- ADJUST INVENTORY TO PROPER UNITS AND WRITE TO FILE ---------------
C
      WRITE (OUT, 3300) NIN, IRR
```

```
 3300 FORMAT (2I5)
C
      DO 100 I = 1, NIN
        Q(I) = Q(I) * NVUNIT(INUT)
        WRITE (OUT, 3400) ELTI(I), AWI(I), (NSOLD(J,I),J=1,5),
     .                    Q(I), QI(I), QJ(I), QK(I)
 3400   FORMAT (A2,A6,5I1,4(1PG10.2))
  100 CONTINUE
C
C--- CLOSE FILE AND RETURN ---------------------------------------------
C
      ENDFILE OUT
      CLOSE (UNIT=OUT)
C
      RETURN
C
C--- ERROR ROUTINES ----------------------------------------------------
C
  992 WRITE (SCRN,9920)
 9920 FORMAT ('0ERROR IN OPENING OUTPUT FILE')
      GO TO 200
C
  994 WRITE (SCRN,9940)
 9940 FORMAT ('0ERROR IN CLOSING OUTPUT FILE')
      STOP
C
C
C-----------------------------------------------------------------------
      END
```

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13. ABSTRACT (200 words or less)
The ONSITE/MAXI1 computer software package was developed for use by NRC in reviewing license applications for onsite disposal of radioactive waste. The ONSITE/MAXI1 package (June 1984 version) permits dose pathway analysis for scenarios of an intruder into the disposed waste. The integrated software package consists of the ONSITE and MAXI1 computer programs, a data base of dose factors and radioactive decay information, two auxiliary computer programs (MAXI2 and MAXI3) that allow modification of the data base, and system procedures that both control program execution and reduce user interaction with the computer operating system. The interactive program ONSITE is used to generate input for MAXI1, which is then used to calculate the maximum annual dose to an exposed individual. Five representative human-intrusion scenarios are presented in the ONSITE program. The ONSITE program assists the user in defining a scenario by including default values for the various parameters, logically presenting applicable parameters for user modification in "English-phrased" statements, and testing user input against allowable parameter ranges. ONSITE-generated files may then be directly submitted for MAXI1 execution. Exposure pathways that can be evaluated in MAXI1 include direct external exposure to contaminated soil or building surfaces, inhalation of resuspended material, and ingestion of drinking water or terrestrial or aquatic foods.

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