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Supplement No. 1

Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXI1 Computer Program

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Pacific Northwest Laboratory
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Prepared for
**U.S. Nuclear Regulatory
Commission**

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Manuscript Completed: April 1985
Date Published: May 1986

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NRC FIN B2478

PREFACE

The document entitled Intruder Dose Pathway Analysis of the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXI1 Computer Program (1984) by Napier et al. summarizes our initial efforts to develop human-intrusion scenarios and a modified version of the MAXI computer program for potential use by the NRC in reviewing applications for onsite radioactive waste disposal. This document is a supplement to that document and summarizes our efforts to further modify and improve the ONSITE/MAXI1 software package. To facilitate cross-referencing, it follows the same format. Notable improvements to the software package include the capability to account for shielding conditions that represent noncompacted trash wastes and the option to indicate alternative land-use conditions. This supplement contains a description of the implementation of these modifications. In addition, a series of discussions are included in an attempt to increase the user's understanding of the scenarios and dose calculation methods. These discussions respond to frequently asked questions about the mathematical models and use of the software.

Computer listings of the ONSITE/MAXI1 computer program are included as Appendices A and B of this document. Appendix C lists external exposure dose-rate factor libraries.

A second supplement to the 1984 NUREG document is planned for publication in late 1986. The second supplement will include ICRP-26/30 internal dose conversion factors and modifications for operations on a personal computer.

EXECUTIVE SUMMARY

Pacific Northwest Laboratory prepared this document as a supplement to a previous document that describes the ONSITE/MAXII computer software package (Intruder Dose Pathway Analysis for the Onsite Disposal Radioactive Wastes: The ONSITE/MAXII Computer Program, 1984, by Napier et al.). The objective of this project is to modify an existing pathway-to-man computer program, the MAXI computer program, for use by the U.S. Nuclear Regulatory Commission (NRC) in reviewing all proposed onsite burials of radioactive materials by its licensees. Because of uncertainties associated with assessing the potential risks from onsite burials of radioactive waste, the NRC amended its regulations to provide greater assurance that buried radioactive material will not present a hazard to public health and safety. The current policy of the NRC is to review all proposed onsite burials of radioactive waste on a case-by-case basis. As part of our earlier work on this project, specific human intrusion scenarios were 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/MAXII computer software package.

As a continuation of our earlier efforts, enhancements to the ONSITE/MAXII computer software package and revisions to the documentation were made to more fully explain the computer software. The program enhancements account for additional optional shielding factors that could influence external exposure to penetrating radiation and provide options for alternative land-use conditions that permit the user to select from a complete diet, meat diet, or vegetable diet. Expanded descriptions of the radiation exposure scenarios and mathematical models are also included to assist the user in understanding the operation of the computer programs. These program enhancements and expanded model descriptions are discussed in Section 2 of this supplement.

The ONSITE/MAXII software package has been installed on both CDC^(a) 6600-7600 and VAX^(b) 780 computers, and the ONSITE computer program has also been installed on the IBM^(c) PC. The original documentation for the ONSITE/MAXII software provided detailed instructions for operation on the CDC 6600-7600 computer (Napier et al. 1984). Section 3 of this document contains a description of the procedures used to operate the software on the VAX780 computer. A sample problem that demonstrates the stored waste sub-set of the External Exposure Scenario is also given in Section 3. Except for the system-level commands, the operation of the ONSITE/MAXII

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software is identical on both the CDC and VAX computers, and full verification and test problems have been completed. The changes and enhancements made to the software have not altered the structure or operation of the computer programs; thus, the structure and operation discussed in Napier et al. (1984) have not been repeated in this document. A complete listing of the MAXII and ONSITE computer programs along with a complete listing of the data libraries used to model a wide variety of external exposure conditions are provided in the appendices of the document. The organization of this supplement roughly follows the arrangement of the original ONSITE/MAXII document to facilitate cross-referencing.

ACKNOWLEDGMENTS

The authors would like to thank all of those individuals who 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 like to thank Dave Huizenga for his review of the ONSITE/MAXI software package and documentation and Joe Soldat for his review of this manuscript. We appreciate the comments and critiques of other ONSITE/MAXI users, and we attempted to respond to their questions in this report. We would also like to thank Norma Van Houten and Cathie Jordon for typing, correcting, and printing this manuscript, and Kathi Hanson for editing.

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1.0 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 (NRC 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, MAXI1 (Napier et al. 1979), for use by the NRC Waste Management staff when they conduct human-intrusion, dose-pathway analyses for onsite burial of low-level radioactive wastes. As part of an earlier effort on this project, specific human-intrusion scenarios were developed for 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 (Napier et al. 1984). These scenarios are activated by running the ONSITE/MAXI1 computer software package. As a continuation of earlier work, enhancements to the ONSITE/MAXI1 computer software package and revisions to the documentation have been made to explain the computer software. Program enhancements add optional shielding factors in the direct exposure pathway scenarios and options for alternative land-use conditions that permit the user to select from a combined diet, meat diet, or vegetable diet.

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 generates 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 based on the Task Group on Lung Dynamics Model (TGLM) and revisions to the metabolic data for plutonium and other actinides developed by the International Commission on Radiological Protection (ICRP 1966; ICRP 1972). They are calculated using a version of the DACRIN (Houston, Strenge and Watson 1974) computer program. The external dose-conversion factors for various waste disposal geometries and conditions are calculated using the ISOSHLD (Engel, Greenborg and Hendrickson 1966) shielding program.

This supplement to Napier et al. (1984) describes the enhancements added to the ONSITE/MAXI1 software package since the original document was published in October 1984. Notable improvements to the software package include the ability to account for shielding conditions that represent noncompacted trash wastes and the option to indicate alternative land-use conditions. Expanded descriptions of the scenarios and mathematical models are also included to assist the user in understanding the operation of the computer programs.

The organization of this supplement closely follows the outline of Napier et al. (1984). To facilitate cross-referencing, major sections of the two documents are parallel. Appendices in this supplement contain the current listings of all external dose-rate factor files and the modified versions of the ONSITE and MAXI1 computer programs.

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2.0 MATHEMATICAL MODELS AND COMPUTER SOFTWARE FOR ASSESSING ONSITE DISPOSAL IMPACTS - ENHANCEMENTS AND FURTHER DISCUSSIONS

This section discusses enhancements to the radiation-exposure scenarios, mathematical models, computer programs, and data bases for assessing potential doses to intruders of onsite disposal sites as presented in Napier et al. (1984).

2.1 DEFINITION AND SOLUTION OF THE PROBLEM

As described in Napier et al. (1984), an approach similar to that applied in the Draft and Final Environmental Impact Statement in support of 10 CFR Part 61 (NRC 1981; NRC 1982) is used to assess risks associated with onsite disposal. That is, radiation-exposure scenarios for the maximally exposed individual (an intruder) are established and the resulting radiation dose is determined.

Five scenarios are identified for 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. Only external exposure to direct penetrating radiation is considered. Optional data libraries permit the user to select from 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. A sub-set of this scenario is the Stored Waste Scenario, which is described in detail in Section 2.1.5.
2. External Exposure Plus Inhalation Scenario. An individual is assumed to work in an area with limited surface-soil contamination. This individual is exposed to direct penetrating radiation and inhales resuspended radionuclides that are present in the surface soil.
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 from surface soil are also considered.
4. Irrigation/Drinking-Water Scenario. An individual is assumed to irrigate and/or drink from a water supply contaminated by radionuclides from an onsite disposal site. 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/MAXII computer software package.

The remainder of this section describes the enhancements that have been made to the original ONSITE/MAXII computer software package.

2.1.1 Alternative Land-Use Conditions

Additional agricultural scenario options have been developed to consider alternative land-use conditions. The original agricultural scenario assumed the intruder raised vegetables, fruit, and livestock for meat and dairy products on the waste disposal site. This original scenario is referred to as the combined diet option. Two alternative types of land-use may now be considered by the software user. The first alternative land-use option, referred to as vegetable diet option, assumes the intruder grows only vegetables and fruits on the waste disposal site. The second alternative land-use option assumes the intruder uses the waste disposal site only for grazing of livestock. In this second option, referred to as the meat diet option, the intruder's diet consists of meat and dairy products obtained from the livestock raised on the disposal site.

Diet parameters are "environment"-specific in that intruder diet parameters are used to calculate dose-conversion factors that are subsequently used in the onsite disposal scenarios (Napier et al. 1984, Sections 2.1.1 and 2.1.2). Diet parameters are reflected in the leaf and soil mechanism dose-rate factors [Napier et al. 1984, Equation (2.9)] used by MAXII. In order to implement the alternative land-use conditions, additional files of leaf mechanism dose-rate factors (Napier et al. 1984, Section 2.3.2) and soil mechanism dose-rate factors (Napier et al. 1984, Section 2.3.3) were developed. The parameters used to generate these dose-rate factors for selected foods are listed in Napier et al. (1984, Table 2.1-1). The vegetable diet option consists of leafy, other aboveground, and root vegetables as well as fruits and grains. The meat diet option consists of eggs, milk, beef, pork, and poultry. The implementation of the additional agricultural land-use options into the ONSITE/MAXII software package is further discussed in Section 2.2.1.

The diets considered in the alternative land-use options have been shown to affect the doses resulting from the agricultural scenario. Table 2.1-1 contains the fractional contribution of the meat and vegetable diet to total-body dose-rate factors during the first year of exposure for selected radionuclides. Selecting the vegetable diet option or the meat diet option may change the magnitude of the organ dose, the dominant pathway, the dominant radionuclide in a given mixture, and the year of maximum exposure. To demonstrate these possible changes, Table 2.1-2 summarizes the results of Sample Problem Three (Napier et al. 1984) when executed with the meat diet option, the vegetable diet option, and the combined diet option for three selected organs.

2.1.2 Diet Correction Factor and Area Correction Factor Relationship

In Section 2.1.1, one method for adjusting the diet (selection of diet option) of the site intruder was described. The ONSITE/MAXII computer

TABLE 2.1-1. Fractional Contribution of Meat and Vegetable Diet to Total-Body Dose-Rate Factors During the First Year of Exposure for Selected Radionuclides

<u>Radionuclide</u>	<u>Leaf Mechanism</u>		<u>Soil Mechanism</u>	
	<u>Meat Diet</u>	<u>Vegetable Diet</u>	<u>Meat Diet</u>	<u>Vegetable Diet</u>
^3H	0.7	0.3	0.3	0.7
^{14}C	0.8	0.2	0.4	0.6
^{60}Co	0.1	0.9	0.3	0.7
$^{90}\text{Sr}+\text{D}^{(a)}$	0.3	0.7	0.1	0.9
$^{137}\text{Cs}+\text{D}$	0.7	0.3	0.4	0.6
$^{238}\text{U}+\text{D}$	0.2	0.8	0.1	0.9

(a) +D means plus short-lived radioactive decay products.

TABLE 2.1-2. Results of Sample Problem Three for the Three Land-Use Diet Options

<u>Organ</u>	<u>Diet Option</u>	<u>Total Dose (rem)</u>	<u>Dominant Pathway</u>	<u>Dominant Radionuclide</u>	<u>Maximum Year</u>
Total-Body	Meat	1.8+1 ^(b)	External	^{60}Co	10
	Vegetable	1.8+1	Ingestion	$^{90}\text{Sr}+\text{D}$	22
	Combined	2.2+1	External	^{60}Co	10
Bone	Meat	1.9+1	External	^{60}Co	10
	Vegetable	5.3+1	Ingestion	$^{90}\text{Sr}+\text{D}$	27
	Combined	5.6+1	Ingestion	$^{90}\text{Sr}+\text{D}$	27
Lower Large Intestine of GI-Tract	Meat	1.3+1	External	^{60}Co	10
	Vegetable	1.6+1	External	^{60}Co	10
	Combined	1.7+1	External	^{60}Co	10

(a) Napier et al. (1984), Section 3.4.3.

(b) Where 1.8+1 indicates 1.8×10^{-1} .

programs contain two additional methods for adjusting the diet of the intruder. One method indicates the size of the waste disposal site in fractional hectares. Based on the indicated site size, an area correction factor is applied as discussed in Napier et al. (1984, Section 2.1.4.1). The second method directly indicates the portion of the intruder's diet that is grown on the waste disposal site (referred to as diet correction factor). These three methods allow substantial flexibility in scenario construction when considering the agricultural pathways. However, it is important for the user to understand the relationships among these three methods so they can be properly applied.

The area correction factor and the diet correction factor are both multipliers that modify the intruder's selected diet. Minor changes have been made to the ONSITE computer program to ensure that the user cannot inadvertently apply both a diet correction factor and an area correction factor. The order of questions during the input process has been rearranged so the question concerning the area correction factor is presented before the query about the diet correction factor. If the user selects a waste disposal site size of less than a hectare, indicating that an area correction factor is to be applied, the option to apply a diet correction factor is bypassed. Computer implementation of these modifications is discussed in Section 2.2.1.

2.1.3 Resuspension and Inhalation Area Correction Factor

The original documentation of the ONSITE/MAXII computer program (Napier et al. 1984) accounted for sites of limited size. The document developed and discussed area correction factors that were intended to reduce the default exposure pathway conditions to account for sites with areas less than 1 ha. These factors applied to the direct exposure pathway and the combined ingestion and inhalation pathways. A sensitivity study was used for developing the direct exposure pathway area correction factors. A step function area correction factor relationship was assumed for both ingestion and inhalation (as shown in Figures 2.1-1 and 2.1-4 of Napier et al. 1984). After careful consideration of the potential magnitude of the area correction for inhalation factors, it was determined that the area correction developed for the direct exposure pathway should be applied for the inhalation pathway, instead of the assumed step function used for ingestion. This is because many of the experiments relating air and soil concentrations were performed on sites of limited size (i.e., sites with areas of 1 ha or less) (Sehmel 1974; Milham et al. 1976; Sehmel and Lloyd 1976). Thus, it is perhaps not unreasonable to assume that the area correction factor would approach 1.0 for a relatively small site (0.1 to 0.2 ha). The revised area correction factors for direct exposure and inhalation are shown in Figure 2.1-1 and the area correction factors used for ingestion are shown in Figure 2.1-2. The computer implementation of these modifications is discussed in Section 2.2.4.

FIGURE 2.1-1. Area Correction Factors for the External Exposure and Inhalation Pathways

FIGURE 2.1-2. Area Correction Factors for the Ingestion Pathway

2.1.4 External Exposure Sensitivity Studies

When developing the external-exposure libraries used by the ONSITE/MAXII computer program, certain simplifying assumptions were made. This section discusses the sensitivity of the results based on these assumptions. Two primary assumptions are evaluated in the sensitivity studies:

- The effect of waste form density is determined by comparing the external-exposure factors, originally calculated for a waste form density of 1.8, with factors calculated for densities of 1.0, and 0.6 g/cm³.
- The effect of the slab-source thickness is determined by comparing the external-exposure factors calculated for 1-m-thick and 3-m-thick slabs.

The sensitivity studies were performed using modified input parameters with the ISOSHLD computer program (Engel et al. 1966; Simmons et al. 1967). A summary of the results generated is shown in Table 2.1-3 for selected radionuclides based on a constant source strength of 1 Ci/m³ of each radionuclide. These results show there is a strong dependence on waste form density; that is, for a constant source strength, the less the waste density, the greater the calculated dose rate. However, for each waste density there is little dependence on slab thickness.

TABLE 2.1-3. Sensitivity Study Results for the External Exposure Pathway - mrem/hr per Ci/m³ for Selected Waste Form Densities and Slab Thicknesses with 0.0 m Overburden

Radionuclide	1.8 g/cm ³		1.0 g/cm ³		0.6 g/cm ³	
	Slab Thickness:		Slab Thickness:		Slab Thickness:	
	1 m	3 m	1 m	3 m	1 m	3 m
²² Na	514	514	964	966	1600	1630
⁵¹ Cr	12	12	28	28	470	471
⁵⁴ Mn	327	327	684	684	1140	1150
⁵⁷ Co	21	21	70	70	117	117
⁶⁰ Co	1000	1000	1930	1930	3200	3270
⁹⁰ Sr+D	2	2	6	6	9	9
¹³¹ I	133	133	323	323	539	541
¹³⁴ Cs	674	674	1500	1500	2470	2500
¹³⁷ Cs+D	241	241	573	573	935	942

Based on this result, the ONSITE/MAXII computer program has been modified to permit the user to select the waste form density when performing external-exposure calculations. The possible waste form densities that the user may select are 1.8 g/cm^3 (the approximate density of soil), 1.0 g/cm^3 (the density of water), or 0.6 g/cm^3 (the approximate density of noncompacted trash waste forms). No corrections for slab thickness are included in the external-exposure data libraries.

2.1.5 Stored Waste Scenario Description

As stated in Section 2.1, the Stored Waste Scenario is a sub-set of the External-Exposure Scenario in which the user selects the stored waste dose-conversion factor files instead of the surface or buried waste files. Including this scenario permits the user to consider cases where wastes are disposed of in a storage building, vault, or cave, and where an intruder would only receive external exposure from penetrating radiation. This type of scenario was first considered in a document on decommissioning by Oak et al. (1980). The dose-conversion factor files used to model this case are based on an intruder located 3 m away from a storage area with dimensions of 3 m high by 10 m wide by 3 m deep. Because it is difficult to anticipate potential variation of stored waste conditions and exposure geometries, dose-conversion factors for only one selected geometry have been developed. However, the user may select the waste density (as described in Section 2.1.4) and exposure duration and develop his own modeling assumptions. The effects of reflected gamma energy from distant walls or surfaces in the storage facility are not included because shielding calculations have shown that the dominant contributor to the dose rate will be from "line-of-sight" with the stored wastes (Blizard 1962). For photon energies greater than about 1 Mev, the incremental contribution from reflected radiation would be about 1%. For lower photon energies, the incremental contribution would be as high as 15% (Jaeger 1968). Also, it is impossible to completely model the large potential for variable conditions at real waste storage facilities. A description of the data base containing the optional external-exposure files is included in Section 2.3.4, and an example problem showing the input and output used to run this scenario using ONSITE/MAXII is given in Section 3.4.

2.1.6 Comparison of Maximum Annual Dose to Committed Dose Equivalent

As stated in Napier et al. (1984), 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)

$$R_{ipr} = C_{ip} U_p D_{ipr} \quad (2.1)$$

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 ; (pCi/m³, pCi/L, or pCi/kg) for calculations involving airborne radionuclides, C_{ip} is replaced with the term, X , which represents the average airborne concentration of radionuclide, i .

U_p = usage parameter (exposure rate or intake rate) associated with exposure pathway, p (hr/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)

Analyzing radiation doses from separate exposure pathways requires determining the radionuclide concentrations and exposure rate or intake rate associated with each exposure pathway.

Site-specific parameters can be used to determine the exposure pathways, the radionuclides, and the exposure or intake rates. 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 uptake from soil, dry deposition from air onto plant surfaces, 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 (Ansbaugh et al. 1975).

Calculating the annual dose to an organ of reference using the MAXII 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 3 years of continuous exposure. For the first year, the annual dose 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):

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

where

- A_2 = the annual dose to the organ of reference during the second year from all exposure pathways, rem
- 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):

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

where

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

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

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 as 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 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 of Napier et al. (1984).

The annual dose, A_t , defined by Equation (2.4), is then compared to the 50-year committed dose equivalent. The radiation dose-commitment accounts for the dose received over a specified amount of time from intake during one year of exposure. The common dose commitment period used in most applications is 50 years, to account for the average adult lifetime; however, any

time period may be used. To provide a simple illustrative comparison, a dose commitment period of 3 years will be considered. It should be noted that the same general conclusions reached for the 3-year commitment also apply to the 50-year commitment.

As an example, the annual dose in the third year after the start of continuous exposure, based on Equation (2.3), is considered. First, the term R_3 is replaced with the term $D_{3,3}$. This new term represents the dose equivalent during the third year from all intake and external exposure occurring during the third year. Next, the $(R_{1,3} - R_{1,2})$ term is replaced with the term $D_{1,3}$, representing the dose delivered in the third year after intake in the first year; and the $(R_{2,2} - R_{2,1})$ term is replaced with the term $D_{2,3}$, representing the dose delivered in the third year after intake in the second year. Equation (2.3), or the expression for the annual dose during the third year, is now expressed as:

$$A_3 = D_{3,3} + D_{1,3} + D_{2,3} \quad (2.5)$$

where

$D_{3,3}$ = the dose equivalent during the third year from all internal and external exposure occurring in the third year of continuous exposure

$D_{1,3}$ = the dose equivalent in the third year resulting from intake in the first year of continuous exposure

$D_{2,3}$ = the dose equivalent in the third year resulting from intake in the second year of continuous exposure

and where A_3 is as defined for Equation (2.3).

The dose received during the first 3 years of continuous exposure, at a constant rate of intake by ingestion or inhalation, is graphically represented in Figure 2.1-3. The size of the boxes is used to show the relative dose received in any specified year from a particular year of intake. The dose received in the first year is shown as one box, labeled $D_{1,1}$; the dose received in the second year is shown as two boxes, labeled $D_{1,2}$ and $D_{2,2}$; and the dose received in the third year is shown as three boxes, labeled $D_{1,3}$, $D_{2,3}$, and $D_{3,3}$. The 3-year dose commitment is the sum of the bottom row of boxes shown in Figure 2.1-2, or $(D_{1,1} + D_{1,2} + D_{1,3})$.

For conditions of constant intake over the 3-year period, the top row of boxes are of equal size, or $D_{1,1} = D_{2,2} = D_{3,3}$. Because the effective half-life of a radionuclide is constant, the dose received in the year following the intake is reduced by a constant amount. This is shown in Figure 2.1-2 as $D_{1,2} = D_{2,3}$. Both the annual dose in the third year and the 3-year dose commitment contain the term $D_{1,3}$. Thus, it can be seen from the sizes of the boxes in Figure 2.1-3, for the condition of constant

intake, that the annual dose in the third year and the 3-year dose commitment are equal.

In addition, Lindell (1985) recently demonstrated the equality between the collective dose commitment from one year of intake and exposure and the highest future annual collective dose under steady-state conditions for a period of continuous exposure at a constant rate. The condition of constant intake is met when the radionuclide of concern has a long physical half-life. For those radionuclides, MAXI1 reports the maximum annual dose as occurring in the last year (50th year) of continuous exposure. Thus, for a 50-year exposure situation, the maximum annual dose and the 50-year committed dose equivalent are equal.

For short-lived radionuclides, or those with effective half-lives of a few months or less, essentially all of the dose is received in the first year; thus, the first-year dose equals both the maximum annual dose and the 50-year committed dose equivalent.

The external-exposure pathway is considered along with inhalation and sometimes ingestion of food products for the scenarios of interest to the assessment of onsite disposal of radioactive wastes. The external-exposure pathway does not result in a dose during subsequent years; that is, the first-year dose and the 50-year commitment are equal for external exposure. Thus, for radionuclides and/or exposure scenarios dominated by the external-exposure pathway, the maximum annual dose peaks in the first year and equals (or closely approximates) the 50-year dose commitment.

FIGURE 2.1-3. Equality Between the Dose Commitment and the Annual Dose Under Continuous Exposure Conditions of Constant Annual Intake

Experience with the MAXII computer program indicates that, for mid-lived radionuclides (those with half-lives of 1-50 years) and for scenarios of interest to onsite disposal (which include the external-exposure pathway), the maximum annual dose will approximate the 50-year committed dose equivalent quite closely. The closeness of the comparison will depend on the relative contribution of the exposure pathways considered in the scenario analysis.

As an example of the comparison of the maximum annual dose with the 50-year dose commitment, an independent derivation of the 10 CFR Part 61 (NRC 1984) low-level waste disposal limits was performed using the MAXII computer program (Kennedy and Napier 1984). Major differences in the 50-year dose commitment and the maximum annual dose would result in significant differences in the calculated low-level waste disposal limits. The MAXII derivation used the intruder construction and intruder agriculture scenarios, as defined in the Draft Environmental Impact Statement (DEIS) in support of 10 CFR Part 61 (NRC 1981).

Disposal limits are listed in 10 CFR Part 61 (NRC 1984) for three classes of commercial radioactive wastes: A, B, and C. Class A wastes have minimum stability requirements, low levels of radioactivity, and their limits reflect 100 years of radioactive decay that would occur during an institutional control period. Class B wastes permit higher activity levels and must meet more rigorous waste-form requirements to ensure stability after disposal. Class C wastes are required to have a stable waste form, a package with higher integrity than required for Class A or B wastes, and their limits reflect 500 years of radioactive decay. Disposed Class C wastes are further assumed to provide ten times more protection from intrusion than disposed Class A wastes.

The results of the derivation of the Class A and Class C disposal limits using the MAXII computer code, based on maximum annual dose instead of the 50-year dose commitment as used by NRC, are shown in Table 2.1-4. By carefully following the scenario descriptions given in the (NRC 1981) and correctly accounting for radioactive decay, the results generated by MAXII generally compare closely to the 10 CFR 61 disposal limits. The comparison is very close for short to mid half-life radionuclides (i.e., half-lives less than 30 years). The notable exceptions to this close agreement are the disposal limits for ⁹⁹Tc and the Class C disposal limit for ¹³⁷Cs where our values are about ten times the 10 CFR 61 values. The difference in the ⁹⁹Tc concentrations a drinking-water scenario, rather than the intruder scenarios, for results from the NRC's use of the 10 CFR 61 value.

The general agreement of MAXII calculated values with the 10 CFR 61 disposal limits, accounting for minor modeling differences, indicates the 50-year dose commitment and the maximum annual dose are quite close for most radionuclides.

TABLE 2.1-4. Comparison of 10 CFR Part 61 and Calculated Low-Level Waste Disposal Concentrations

Radionuclide	10 CFR Part 61 Concentration (Ci/m ³)		Calculated Concentration (Ci/m ³)	
	Class A	Class C	Class A	Class C
¹⁴ C	0.8	8	0.8	8
⁶⁰ Co	700	--(a)	400	--(a)
⁵⁹ Ni	2.2	22	1	10
⁶³ Ni	3.5	700	1	200
⁹⁰ Sr+D ^(b)	0.04	7000	0.03	5000
⁹⁹ Tc	0.3	3	3	30
¹³⁷ Cs+D ^(b)	1	4500	0.3	30000
²³⁹ Pu	10 ^(c)	100 ^(c)	30 ^(c)	300 ^(c)

(a) Dashes indicate that no Class C limits are established (i.e., the concentration is limited only by practical considerations including the stability of the waste form, internal heat generation, and handling).

(b) +D means plus short-lived daughters.

(c) Units for ²³⁹Pu are in nCi/g.

2.1.7 MAXII Time Line

To fully understand the scenario construction flexibility of the ONSITE/MAXII computer software package, the user must understand the relationships between the times the scenario events are assumed to occur. Figure 2.1-4 contains the "MAXII time line" and is shown in order to graphically relate: 1) the time at which the radionuclide inventory is disposed of at the site, 2) the optional period of radionuclide decay before the beginning of the intruder scenario, 3) the optional period when build-up of radionuclides may occur due to irrigation with contaminated water, and 4) the beginning of the intruder scenario which is also the beginning of the dose calculation period. In Figure 2.1-4, the inventory is assumed to be disposed of at the site at time 0. The intruder scenario and the dose calculation period begin at time IT1, as discussed in Napier et al. (1984). The intruder scenario and dose calculation period ends at time IT2, always (IT1 + 50). If IT1 is greater than 0, there will be IT1 years of radionuclide decay before the intruder scenario begins. In addition, (IT1 - m) is the length of time that radionuclides may build up via irrigation before the dose calculation period begins. The MAXII parameter IRR is equivalent to the period (IT1 - m). The MAXII control parameters that the user may manipulate are IT1, IT2, and IRR.

FIGURE 2.1-4. MAXI1 Time Line

2.1.8 Derivation of Area Correction Factors for Ingestion Pathway

The total diet of a "maximum individual", taken from Napier (1981) is used to construct the step function of Figure 2.1-2. The step function allows consideration of area-intensive practices for small areas without forcing extreme conservatism on larger areas.

A small area is assumed to be intensely farmed for vegetables. An area of about 50 m² is required for an individual to grow a year's supply of leafy and other aboveground vegetables. An additional area of about 150 m² is required to grow a year's supply of root vegetables and grains. Larger areas are required for orchards. About 800 to 1800 m² is required to grow a year's supply of food for a single pig. An area greater than 1 ha is required to support one milk cow.

The percentage of the total diet that each of these foods supplies is also derived from Napier (1981). The above-ground vegetables comprise about 5 to 10% of the total intake. Grains and root vegetables make up about 15%. Fruit comprises about 30% and beef and milk products about 25%. These percentages, combined with the areas required for their production, provide the step function curve shown in Figure 2.1-2.

The combination of dietary components is based on a logical progression of garden size versus production. Small areas are assumed to be intensely cultivated for garden vegetables. As the plot size increases, other foods are added. A small orchard and domestic animals are assumed, in addition, as plot size allows. Cattle are only assumed for areas large enough to support them. The step function is used to connect the points rather than a curve. This allows for more efficient agricultural practices and partial dietary contributions of the various crops. Because the true production-versus-area curve would connect the lower points, the step function is a conservative upper bound.

2.2 COMPUTER IMPLEMENTATION OF SCENARIO AND MODEL ENHANCEMENTS

The ONSITE/MAXII model enhancements described in the previous section have been implemented in the computer software package. The following sections contain detailed descriptions of the software changes and are intended to supplement the original ONSITE/MAXII document (Napier et al. 1984).

2.2.1 Expanded Land-Use And Diet Modification Options

As discussed in Section 2.1.1, the ONSITE/MAXII software has been modified to include three optional diets for the intruder: 1) the combined diet, 2) the vegetable diet, and 3) the meat diet. These diet options are based on the diet listed in Regulatory Guide 1.109 (NRC 1977). Figure 2.2-1 contains the ONSITE input screen that permits the user to select the intruder's diet. Based on the user's response to this input screen, the ONSITE program automatically assigns the appropriate dose-rate factor files.

The R.G. 1.109 diet raised onsite may be either:

1 - Total diet	(plant and animal products)
2 - Vegetable product diet	(plant only)
3 - Animal product diet	(milk, eggs, and meat only)

The default selection is 1.

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

FIGURE 2.2-1. Example of the ONSITE Diet Option
Input Screen

2.2.2 Waste Density Options for External Exposure

As described in Section 2.1.4, a study was conducted to determine the sensitivity of the external-exposure doses to the assumptions used in generating the dose-conversion factor files. The results of the sensitivity study indicated that results were strongly dependent on the density of the disposed waste. As a result, the ONSITE/MAXII software package was modified to permit the user to select external dose-rate factors that correspond to one of three optional waste densities. Figure 2.2-2 displays the question asked of the user by the ONSITE computer program. Three files of external-exposure dose-rate factors, corresponding to the waste densities of 1.8, 1.0, and 0.6 g/cm³, have been generated for each waste location option. Based on the user's response to the question in Figure 2.2-2, the ONSITE program will automatically assign the appropriate external-exposure dose-rate factor files.

The waste density may be either:

- 1 - 1.8 g/cu cm (soil)
- 2 - 1.0 g/cu cm (water)
- 3 - 0.6 g/cu cm (0.5 water + 0.1 carbon)

The default selection is 1.

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

FIGURE 2.2-2. Example of the ONSITE Waste
Density Option Input Screen

2.2.3 Incidental Surface Contamination for External Exposure and Inhalation Pathways

An additional waste configuration has been added to allow the user to simulate the external-exposure conditions resulting from incidental surface contamination. External dose-rate factors for an infinite plane of contamination on the soil surface, 15 cm thick, have been made available to the ONSITE user. Previously, these external dose-rate factors were used for agricultural scenarios. However, the user could not explicitly assign the file containing these dose-rate factors. Figure 2.2-3 depicts the ONSITE program input screen that permits the user to select the 15-cm surface-soil files that can be used with area correction factors to model incidental surface contamination situations. To simulate an incidental surface contamination, the user selects Item 1, "On surface (15 cm thick)" from the menu. The waste location screen contains additional word changes that clarify the available waste configurations.

In this scenario, waste location and depth may be:

- 1 - On surface (15 cm thick)
- 2 - On surface (1 m thick)
- 3 - Overburden of 0.5 m (1 m thick)
- 4 - Overburden of 1.0 m (1 m thick)
- 5 - Stored waste (1 m thick)

See Table 2.3-1 of NUREG/CR-3620 Supplement.
The current selection is: 2

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

FIGURE 2.2-3. Example of the ONSITE External
Exposure Option Input Screen

2.2.4 Inhalation Area Correction Factor

The modified area correction factor for inhalation used by the ONSITE/MAXII computer software package is discussed in Section 2.1.3. The computer program was modified to consider the same area correction factor for both the direct exposure and inhalation pathways. Figure 2.1-1 shows this area correction factor relationship between site size and external-exposure rate. As shown in the figure, we have approximated this curve in the ONSITE computer program as the sum of four line segments. This modification is automatically activated when the user identifies a site area of less than 1 ha.

2.3 DATA BASE EXPANSION

Additional files of leaf mechanism, soil mechanism, and external-exposure dose-rate factors were developed to expand the capabilities of the ONSITE/MAXII computer programs. These enhancements to the ONSITE/MAXII data base are part of the modifications described in this supplementary document and are described in the following sections.

2.3.1 Leaf Mechanism Dose-Rate Factors

Three files are now provided that contain "environment"-specific leaf mechanism dose-rate factors. These factors are based on 1 pCi of each radionuclide per cubic meter of air. The user can provide any concentration of radionuclides in air as input to the ONSITE program. The file names and their descriptions are as follows:

- VEG20 - Vegetable diet option consisting of fruit, vegetables and grains grown on the disposal site
- MEAT20 - Meat diet option consisting of meat and dairy products obtained from livestock grazed on the disposal site
- FILE20 - Combined diet option consisting of fruit, vegetables, grains, and meat and dairy products raised on the disposal site

The ONSITE computer program assigns one of these files to logical unit 20 based on the user's answer to the question shown in Figure 2.2-1. The file format is described in Napier et al. (1984, Section 2.3.2). An updated version of FILE20 (dated 4/85) is included in the software package.

2.3.2 Soil Mechanism Dose-Rate Factors

The ONSITE/MAXII user may select from three optional files containing "environment"-specific soil mechanism dose-rate factors that are based on 1 pCi of radionuclide per cubic meter in air. The file names and their descriptions are as follows:

- VEG21 - Vegetable diet option consisting of fruit, vegetables, and grains grown on the disposal site
- MEAT21 - Meat diet consisting of meat and dairy products obtained from livestock grazed on the disposal site
- FILE21 - Combined diet option consisting of fruits, vegetables, grains, and meat and dairy products raised on the disposal site

The ONSITE computer program assigns one of these files to logical unit 21 based on user's answer to the question shown in Figure 2.2-1. The file format is described in Napier et al. (1984, Section 2.3.3). An updated version of FILE21 (dated 4/85) is included in the software package.

2.3.3 External-Exposure Mechanism Dose-Rate Factors

The ONSITE/MAXI1 data base includes 15 files containing external-exposure dose-rate factors for 1 pCi of radionuclide per cubic meter in air. These factors relate the radionuclide source strength to the dose rate in tissue 1 m away. The file names, logical unit assignments, waste density, and descriptions are summarized in Table 2.3-1. The format of these files are described in Napier et al. (1984, Sections 2.3.4 and 2.3.8). Listings of the external-exposure dose-rate files are in Appendix C.

The external-exposure dose-rate factors were created by the ISOSHLD (Engel, Greenborg and Hendrickson 1966; Simmons et al. 1967) computer program. Table 2.3-2 summarizes the ISOSHLD parameter values used to approximate each waste configuration. To reduce errors, an automated process was used to generate the external-exposure dose-rate factor files. This process consisted of the following:

- a standardized ISOSHLD input file
- a modified version of the ISOSHLD computer program that produces dose-rate factors to a formatted computer file
- a utility computer program that reads the ISOSHLD-generated file, adds daughter factors to parent when necessary, and writes a MAXI1-formatted file.

Files listed in Table 2.3-1 replace the files named PLANSOURC, ROOM, VDLSOURC, BURIEDHF, and BURIED1.

As noted in Table 2.3-1, external-exposure dose-rate factor files may be assigned to either logical unit 22 or 27. Files assigned to logical units 22 and 27 perform essentially the same functions. Historically, input to FILE22 was defined as dose factors with units of rem/yr per pCi/m², while input to FILE27, assumed to be generated by ISOSHLD, was defined in terms

of mrem/yr per pCi/m³. The MAXI1 code operates internally in soil concentration units of pCi/m², defined by the root and leaf pathway factors from MAXI2 (FOOD). Whenever the external doses are calculated, the soil concentration units are converted to be compatible with the dose factors. File assignments to logical units 22 and 27 are maintained in the present versions of MAXI1 to allow simultaneous consideration of two distinct source geometries (e.g., surface and buried soil, contaminated soil and a point source, etc.).

TABLE 2.3-1. Dose-Rate Factor Files for External Exposure

<u>File Name</u>	<u>Logical Unit Assignment</u>	<u>Waste Density (gm/cm³)</u>	<u>Description</u>
PLANE A	22	1.8	Infinite plane of soil contamination, waste thickness of 15 cm
PLANE B	22	1.0	
PLANE C	22	0.6	
VOL SOURCA	27	1.8	Infinite surface slab source, waste extends to a depth of 1.0 m
VOL SOURCB	27	1.0	
VOL SOURCC	27	0.6	
BURIEDHFA	27	1.8	Infinite slab source, buried in soil with an overburden depth of 0.5 m, waste thickness of 1.0 m
BURIEDHFB	27	1.0	
BURIEDHFC	27	0.6	
BURIED1A	27	1.8	Infinite slab source, buried in soil with an overburden depth of 1.0 m, waste thickness of 1.0 m
BURIED1B	27	1.0	
BURIED1C	27	0.6	
STOREDA	27	1.8	Rectangular slab source, 10.0 m x 3.0 m, waste thickness of 1.0 m
STOREDB	27	1.0	
STOREDC	27	0.6	

TABLE 2.3-2. ISOSHL D Parameter Values Used for External Dose-Rate Factors

ISOSHL D Parameter	Plane Source At Surface	Slab Source			Stored Waste
		At Surface	0.5 m Overburden	1.0 m Overburden	
IGEOM	5	5	5	5	10
ANGL (degrees)	90.0	90.0	90.0	90.0	90.0
X (cm)	115.0	200.0	250.0	300.0	400.0
Y (cm)					300.0
SLTH (cm)					1000.0
NSHLD	3	3	4	4	3
SHIELD 1:					
T(1) (cm)	15.0	100.0	100.0	100.0	100.0
Material	(a)	(a)	(a)	(a)	(a)
Density (g/cm ³)	(a)	(a)	(a)	(a)	(a)
SHIELD 2:					
T(2) (cm)	95.0	95.0	50.0	100.0	295.0
Material	air	air	concrete ^(b)	concrete ^(b)	air
Density	0.00129	0.00129	1.8	1.8	0.00129
SHIELD 3:					
T(3) (cm)	5.0	5.0	95.0	95.0	5.0
Material	skin	skin	air	air	skin
Density	1.0	1.0	1.00129	0.00129	1.0
SHIELD 4:					
T(4) (cm)			5.0	5.0	
Material			skin	skin	
Density			1.0	1.0	
WEIGHT (C1)	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	30.0
NTHETA					6
NPSI					5
DELR					0.2

(a) External dose-rate factors were generated for the following waste densities:

- 1) 1.8 g/cm³ (material: concrete)
- 2) 1.0 g/cm³ (material: water)
- 3) 0.6 g/cm³ (materials: 0.5 g/cm³ + 0.1 g/cm³ carbon)

(b) The electronic density of soil is approximated by that of concrete.

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3.0 PROCEDURES

The ONSITE/MAXII software package has been installed on both CDC^(a) 6600-7600 and VAX^(b) 780 computers, and the ONSITE computer program has also been installed on the IBM^(c) PC. The user instructions for the ONSITE/MAXII computer software package (Napier et al. 1984) are written for the CDC computer. User instructions for the VAX computer are presented in this section to complete the documentation for both computer systems. This section also contains detailed discussions of selected input parameters, enhanced input features of the ONSITE computer program, and a sample problem considering the stored waste sub-set of the External Exposure Scenario. It should be noted that, except for the system-level commands, the operation of the ONSITE/MAXII computer software is identical on both the VAX and CDC computers, and that full verification and test problems have been completed.

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

- <cr>** - When encountered in the manual, this symbol indicates that the keyboard key labeled **RETURN** should be pressed. This is analogous to the carriage return for those 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 unique identifiers.

3.1 USER INSTRUCTIONS FOR THE VAX COMPUTER

Instructions for using the ONSITE/MAXII software package on a VAX computer are included below. A file named ONSITE.COM must reside in the user's directory. The ONSITE.COM should contain the following commands:

-
- (a) IBM is a registered trademark of International Business Machines Corporation, Boca Raton, Florida.
 - (b) VAX is a trademark of Digital Equipment Corporation, Nashua, New Hampshire.
 - (c) IBM is a registered trademark of International Business Machines Corporation, Boca Raton, Florida.

```
ASSIGN SYS$COMMAND FOR005
ASSIGN RMDONS.DAT FOR010
ASSIGN MAXI1.COM FOR007
RUN ONSITE
```

To execute ONSITE on the VAX computer, type:

```
ONSITE <cr>
```

Upon completion of ONSITE, the user may execute MAXI1 either interactively or in a batch processing mode. To execute MAXI1 interactively, type:

```
@MAXI1 <cr>
```

To submit MAXI1 for batch processing with printed output, type:

```
SUBMIT MAXI1 <cr>
```

If the user wishes to edit the MAXI1 input file before execution, type:

```
EDIT MAXI1.COM <cr>
```

To save the MAXI1 input file, type:

```
RENAME MAXI1.COM newname.ext <cr>
```

where "newname.ext" is a user-selected file name.

3.2 INPUT PARAMETERS - FURTHER DISCUSSION

This section contains a summary of the default parameter values for the ONSITE waste disposal scenarios, the sample problem parameter values, and comments included to clarify the intended use of selected parameters. Information in this section is not necessary for successful execution of the ONSITE program. It is included for reference and to provide a more complete set of documentation. Because of the enhancements documented in this manual, the default parameter values assigned to each scenario have been modified as shown in Table 3.2-1. This table is intended to replace Table 3.2-1 of Napier et al. (1984).

The five ONSITE/MAXI1 sample problems (Napier et al. 1984) closely parallel the five onsite disposal scenarios. Consequently, it is easy to confuse sample problem conditions with default onsite disposal scenario default conditions. In order for the user to more easily distinguish between the two, a table of parameter values used in the sample problems is included. Table 3.2-2 gives parameter values for each of the five sample problems documented in Napier et al. (1984).

TABLE 3.2-1. Scenario Default Parameter Values

Pathways	Scenarios				
	External Exposure	External Exposure Plus Inhalation	Agricultural	Irrigation/ Drinking Water	User Defined
External exposure to slab source of waste (IEXT)	1	1	0	0	1
External exposure to an infinite plane of waste (ISUR)	0	0	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 submersion (IAIR)	0	0	0	0	0
Hours of exposure:					
To external	2000.0	2000.0	2000.0	2000.0	8766.0
To inhalation	0	2000.0	2000.0	2000.0	8766.0
Waste dilution factor (SRDIL)	0.2	0.2	0.2	0.2	0.2
Resuspension Model:	NA	Anspaugh	Anspaugh	Anspaugh	Mass loading
Age of contamination (yr) (AGE)	NA	0	0	0	-1
Thickness of surface soil layer available (cm)	NA	1.0	1.0	1.0	NA
Ratio of waste concentration in surface to subsurface soil (RPF1)	NA	NA	NA	NA	1.0
Fraction of total roots in top 15 cm of soil (RF1)	NA	NA	1.0	1.0	1.0
Fraction of total roots in subsurface soil (RF2)	NA	NA	0.0	0.0	0.0
Fraction of diet grown on site (RDF2)	NA	NA	1.0	1.0	1.0
Years of prior irrigation of site (IRR)	0	0	0	10	0
Selected organs (KORG)	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 (IT1)	1	1	1	10	1
Scenario ends (IT2)	50	50	50	59	50
Site size (ha) (FRSIZ)	1.0	1.0	1.0	1.0	1.0

TABLE 3.2-2. Sample Problem Parameter Values

Pathways	Sample Problem				
	1	2	3	4	5
External exposure to slab source of waste (IEXT)	1	1	0	0	1
External exposure to an infinite plane of waste (ISUR)	0	0	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 submersion (IAIR)	0	0	0	0	0
Hours of exposure:					
To external	2000.0	3000.0	2000.0	2000.0	2000.0
To inhalation	0	3000.0	2000.0	2000.0	2000.0
Waste dilution factor (SRDIL)	0.2	0.2	0.2	0.2	0.2
Resuspension Model:	NA	Anspaugh	Anspaugh	Anspaugh	Mass loading
Age of contamination (yr) (AGE)	NA	0	0	0	NA
Thickness of surface soil layer available (cm)	NA	1.0	1.0	1.0	NA
Ratio of waste concentration in surface to subsurface soil (RPF1)	NA	NA	NA	NA	0.0
Fraction of total roots in top 15 cm of soil (RF1)	NA	NA	1.0	1.0	0.6
Fraction of total roots in subsurface soil (RF2)	NA	NA	0.0	0.0	0.4
Fraction of diet grown on site (RDF2)	NA	NA	1.0	1.0	1.0
Years of prior irrigation of site (IRR)	0	0	0	10	10
Selected organs (KORG)	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 (IT1)	10	10	10	10	10
Scenario ends (IT2)	59	59	59	59	59
Site size (ha) (FRSIZ)	1.0	1.0	0.05	1.0	1.0

Selected ONSITE input screens have been revised to clarify the use of the input parameters. Figure 3.2-1 depicts the revised ONSITE input screen for the radionuclide inventory modification factor SRDIL. Figure 3.2-2 shows the modified ONSITE input screen for the contamination/soil mixing parameter RPF1. The RPF1 parameter is used only when contamination is assumed to be present in both the surface and subsurface soil. The first two onsite disposal scenarios (external exposure and inhalation) assume contaminated subsurface soil. The third and fourth scenarios (agricultural and irrigation) assume contaminated surface soil. Only the fifth scenario (user defined) allows consideration of both surface and subsurface soil contamination. The RPF1 parameter may be a useful parameter when modeling more complex agricultural scenarios. For instance, the waste may be deeply buried, but mixing with the surface soil may occur to produce a diluted waste concentration in the surface soil. For this situation, fractions of the plant roots may enter both contaminated soil zones.

The radionuclide inventory modification factor is: 0.20
(range = (0.0 to 1.0E+20, usually 0.0 to 1.0)

This factor will be used as a multiplier of all input concentrations. It is a handy parameter to correct units or make other changes (such as dilution of inventory with clean soil).

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

FIGURE 3.2-1. Revised ONSITE Input Screen for Radionuclide Inventory Modification Factor - SRDIL

This scenario assumes contamination to both surface (top 15 cm) and subsurface soil. Concentrations you input will be assumed to be in the subsurface soil.

What is the ratio of waste concentration in the surface to subsurface soils?

(Range = 0.0 to 10.0 for spills, usually 0.0 to 1.0 to allow redistribution from buried material to surface)

The current selection is: 1.00

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

FIGURE 3.2-2. Revised ONSITE Input Screen for Soil Contamination Distribution Parameter - RPF1

Selected input parameters for ONSITE/MAXII are described in Table 3.2-3. Descriptions are given in greater detail than in Napier et al. (1984).

TABLE 3.2-3. ONSITE/MAXII Parameter Descriptions

Parameter Name	NAMelist Set/No. Array Elements	Data Type	Description
AGE	INPUT	Real	Anspaugh model. Average age in years of surface contamination at the beginning of the calculation in years. This factor accounts for environmental weathering. This parameter is set to -1 to select the mass-loading resuspension model. (Default value is 0)
AREAEX	INPUT	Real	Area correction factor for external and inhalation pathways to account for the limited potential for exposure 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 ingestion pathways to account for the limited potential for exposure from smaller disposal sites. This parameter is calculated by ONSITE based on the size of the site, FRSIZ. (Default value is 1.0)
IEXT	INPUT	Integer	External exposure and crop-root penetration pathway for waste modeled as a slab source. Waste may be stored aboveground, buried at the soil surface, or buried with a soil overburden. Allowable values are: 0 - pathway not selected 1 - pathway selected
ISUR	INPUT	Integer	Option to consider external exposure to surface contamination modeled as a plane source. This pathway is selected to consider either a waste

TABLE 3.2-3. (Contd)

Parameter Name	NAMelist Set/No. Array Elements	Data Type	Description
ISUR, contd			<p>spill or agricultural activities as defined in Scenarios 3 and 4. Allowable values are:</p> <p>0 - pathway not selected 1 - pathway selected</p> <p>If this parameter is set to 0, XFACT will be set to 1.0 in MAXIL. (Default value is 1)</p>
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 or IRR, whichever is greater)
RPF1	INPUT	Real	This is a ratio of waste concentration in surface to subsurface soils. This parameter is used only when contamination is assumed to be present in both surface (top 15 cm) and subsurface soil. RPF1 allows redistribution of the waste in the soil. Ranges: 1.0 to 10.0 for incidental surface contamination, 0.0 to 1.0 for buried to surface redistribution. (Default value is 1.0)
RPF2	INPUT	Real	Fraction of the total selected diet grown on the site. RPF2 must be greater than 0.0. (Default value is 1.0)
SRDIL	INPUT	Real	Inventory modification factor. This factor is used as a multiplier of all input concentrations. It is a parameter used to correct units or make other changes (such as dilution of inventory with clean soil. Range: 0.0 to 1.0×10^{20} used to correct units, 0.0 to 1.0 as a dilution factor. (Default value is 1.0)

3.3 ENHANCED INPUT FEATURES

Two major enhancements have been added to the input procedure of the ONSITE computer program: 1) error checking of user input and 2) an on-line table of acceptable radionuclide nomenclature. All user input is now read in FORTRAN CHARACTER format and checked for invalid entries before converting to a numeric format. This virtually eliminates user-caused program crashes. Figure 3.3-1 contains the list of radionuclides from which dose-rate factors are available in the ONSITE/MAXII software package. This table is displayed at the beginning of the inventory entry and then optionally throughout the inventory entry period to assist the user with the input requirements.

Radionuclide inventory must be from the following list:

H 3	C 14	NA22	P 32	P 33
S 35	CL36	K 40	CA45	SC46
CR51	MN54	FE55	FE59	CO57
CO60	NI59	NI63	ZN65	SE75
SR85	SR90+D	MO93	NB94	RU106+D
CD109	AG110M+D	IN111	SB124	SB125+D
I 125+D	I 131+D	CS137+D	CE144+D	EU152
EU154	TB160	OS185	OS191	IR192
HG203	PB210+D	RA226+D	TH228+D	TH230+D
TH232+D	U 233+D	U 234	U 235+D	U 238+D
NP237+D	PU241+D	SR89	Y 89M	SR90
Y 90	MO99	TC99M	TC99	RU103
PD103	RH103M	I 129	CS134	CS135
CS137	BA137M	CE141	SM151	U 235
TH231	PA231	AC227	TH227	FR223
RA223	NP237	PA233	U 233	TH229
RA225	AC225	U 238	TH234	PA234M
PA234	PU242	NP238	PU238	CM244
PU244	U 240	PU240	CM243	PU243
AM243	NP239	PU239	PU241	AM241

Press any key to continue... <cr>

FIGURE 3.3-1. Input Screen of Radionuclides Considered
in the ONSITE/MAXII Software Package

3.4 SAMPLE PROBLEM - STORED WASTE SCENARIO

As discussed in Section 2.1, the Stored Waste Scenario is a sub-set of the External Exposure Scenario. To activate the stored waste option, the user simply selects the stored waste external-exposure dose-conversion factors (option 5 in Figure 2.2-3), as discussed in Section 2.1.5. To further document this option, a sample problem is included in this section. For this sample problem, a licensee is assumed to dispose of 100 m³ of non-compacted waste in drums in an aboveground storage facility. The waste is assumed to contain an average of 0.1 Ci/m³ of ⁶⁰Co and have a density of 1.0 g/cm³. The resulting dose to an intruder who enters the storage facility a few weeks after the wastes are disposed of and stays there for 500 h of exposure is determined by running the ONSITE default external-exposure scenario with the user responses shown in the ONSITE interactive session given in Figure 3.4-1 (on the next page). It should be noted that the ONSITE program asks for an inventory modification factor and that a value of 0.2 is used for the sample problem. This factor accounts for the mixing of the radioactive waste with nonradioactive materials like drums or packaging materials or noncontaminated soil for the case of land disposal. For consistency with the other sample problems given in Napier et al.(1984), the factor of 0.2 is used; however, more appropriate values for stored waste may be closer to 1.0 and may be substituted by the user. ONSITE also asks about the site size, but for the stored waste scenario this question has little meaning. The area correction question is left in ONSITE for the stored waste option to provide the user with another level to account for conditions that might further reduce the external-exposure pathway. The output for this sample problem is shown in Figure 3.4-2. The total-body dose to the intruder for this sample problem is about 6.1 rem/yr.

REFERENCES

Napier, B. A., R. A. Peloquin, W. E. Kennedy, Jr. and S. M. Neuder. 1984. Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXII Computer Program. NUREG/CR-3620. U.S. Nuclear Regulatory Commission, Washington, D.C.

```

#####
#
#               =====
#               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. Input for the Stored Waste Scenario Sample Problem


```

#####
#
#
#       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:
#       Stored Waste Sub-set of the External Exposure Scenario <cr>
#
#
#
#
#
#
#####

#####
#
#       Three 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
#       4- Table above plus maximum by organ and radionuclide
#
#       The current selection is: 0
#
#       -----
#       Do you wish to change this value (N/Y)? <cr>
#
#####

```

FIGURE 3.4-1. (Contd)

```

#####
#
#   In this scenario, waste location and depth may be:
#
#       1 - On surface          (15 cm thick)
#       2 - On surface          (1 m thick)
#       3 - Overburden of 0.5 m (1 m thick)
#       4 - Overburden of 1.0 m (1 m thick)
#       5 - Stored waste        (1 m thick)
#
#   See Table 2.3-1 of NUREG/CR-3620 Supplement.
#   The current selection is: 3
#   -----
#   Do you wish to change this value (N/Y)? Y <cr>
#   Enter new value: 5 <cr>
#####

#####
#
#
#
#
#   The size of the site in terms of fractional hectares
#   (i.e., 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 site size parameters (N/Y)<cr>
#
#
#
#####

```

FIGURE 3.4-1. (Contd)

```

#####
#
#
#      =====
#
#      Do you wish to review/modify any pathway
#      parameter values for Scenario 1 (N/Y) ? Y <cr>
#
#      =====
#
#      Do you wish to review or change ext. exposure parameters (N/Y) Y <cr>
#
#####

#####
#
#
#      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: 500 <cr>
#
#####

#####
#
#
#      The waste density may be either:
#
#          1 - 1.8 g/cu cm (soil)
#          2 - 1.0 g/cu cm (water)
#          3 - 0.6 g/cu cm (0.5 water + 0.1 carbon)
#
#      The default selection is 1.
#
#      -----
#
#      Do you wish to change this value (N/Y)? Y <cr>
#      Enter new value: 2 <cr>
#
#####

```

FIGURE 3.4-1. (Contd)

```

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

#####
#
#
#
# The dose calculations begin      1 years after the waste is
# disposed.
#
# -----
# Do you wish to change this value (N/Y)? Y <cr>
# Enter new value: 0 <cr>
#
#
# The dose calculations will end      49 years after the waste is
# disposed. OK? (Y/N) <cr>
#
#####

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

```

FIGURE 3.4-1. (Contd)

```

#####
#
# 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
#
# Usually 0 for surface contamination and 1 for buried
# contamination. The current selection is: 1
#
# -----
# Do you wish to change this value (N/Y)? <cr>
#
#####

#####
#
#
# The radionuclide inventory modification factor is: 0.20
# (range = 0.0 to 1.0E+20, usually 0.0 to 1.0)
#
# This factor will be used as a multiplier of all input
# concentrations. It is a handy parameter to correct units
# or make other changes (such as dilution of inventory with
# clean soil).
#
# -----
# 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>
#
#
#
#
#####

```

FIGURE 3.4-1. (Contd)

```

#####
# Radionuclide inventory must be from the following list: #
# H 3 C 14 NA22 P 32 P 33 #
# S 35 CL36 K 40 CA45 SC46 #
# CR51 MN54 FE55 FE59 CO57 #
# CO60 NI59 NI63 ZN65 SE75 #
# SR85 SR90+D MO93 NB94 RU106+D #
# CD109 AG110M+D IN111 SB124 SB125+D #
# I 125+D I 131+D CS137+D CE144+D EU152 #
# EU154 TB160 OS185 OS191 IR192 #
# HG203 PB210+D RA226+D TH228+D TH230+D #
# TH232+D U 233+D U 234 U 235+D U 238+D #
# NP237+D PU241+D SR89 Y 89M SR90 #
# Y 90 MO99 TC99M TC99 RU103 #
# PD103 RH103M I 129 CS134 CS135 #
# CS137 BA137M CE141 SM151 U 235 #
# TH231 PA231 AC227 TH227 FR223 #
# RA223 NP237 PA233 U 233 TH229 #
# RA225 AC225 U 238 TH234 PA234M #
# PA234 PU242 NP238 PU238 CM244 #
# PU244 U 240 PU240 CM243 PU243 #
# AM243 NP239 PU239 PU241 AM241 #
# Press any key to continue... <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 (98=list, 99=finished): C0 <cr> #
# #
# Mass number input can be up to 6 characters long. #
# Include metastable (M) and daughter (+D) designation, (i.e., TE127M+D) #
# #
# Enter mass number: 60 <cr> #
# #
# Enter the quantity of C060 buried at the site at start of #
# calculation (units: Ci /cubic meter ) : .1 <cr> #
# #
#####

```

FIGURE 3.4-1. (Contd)

```

#####
#
#
# Enter new 2-character element (98=list, 99=finished): 99 <cr>
#
#
#
#           Surface/Buried           Drinking
#           C1           Irrigation   Water
#           Radionuclide /cubic meter C1 /1   C1 /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 (N/Y) ? <cr>
#
#
#####

```

(The above interactive session generates the following file.)

```

SET DEF DISK1:[INTRUD.LIB]
ASSIGN FILE20.DAT FOR020
ASSIGN FILE21.DAT FOR021
ASSIGN FILE24.DAT FOR024
ASSIGN FILE25.DAT FOR025
ASSIGN PLANEA.DAT FOR022
ASSIGN STOREDB.DAT FOR027
ASSIGN RMDLIB.DAT FOR010
ASSIGN FILE23.DAT FOR023
RUN DISK1:[INTRUD.TAP]MAXI1
Stored Waste Sub-set of the External Exposure Scenario
$INPUT NEXT=1,
  IFOD=0, IARG=0, IWAT=0, IEXT=1,
  ISUR=0, IAIR=0,
  RPF1= 0.00 , RPF2= 1.00 ,
  RINH= 0.000000, DILF= 1.00 , XF2= 500. ,
  M3M2= 1, INTRUD=0, I22=0,
  IT1= 0, IT2= 49, NORG= 1, KORG(1)= 1,
  SRDIL= 0.200 , FRSIZ= 1.00 , AREAIN= 1.00 ,
  AREAEX= 1.00 ,
  IOUT= 0, ION=1, $END
  1 0
C060 11311 1.00E+11 0.00E+00 0.00E+00 0.00E+00

```

FIGURE 3.4-1. (Contd)

MAXI - Maximum Annual Dose Calculation Version VAX2.2 2-APR-85
 Executed on 15-MAY-85 at 14:58:18
 Case title: Stored Waste Sub-set of the External Exposure Scenario

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

DOSE FACTOR FILES USED FOR THIS CASE:

*27 ISOSHL D EXTERNAL: STORED: 1.0 M THICK FINITE SLAB (DEN: H2O 1.0) MR/HR

DOSES CALCULATED FROM 0 TO 49 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

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

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: 0.00E+00
 NUMBER OF HOURS OF EXPOSURE TO EXTERNAL CONTAMINATION: 5.00E+02
 SURFACE DEPOSITS DRFS FROM ISOSHL D: MODIFICATION FACTOR: 5.844E-11

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

TOTAL BODY

INPUT PREPARED BY _____ DATE _____
 =====

INPUT CHECKED BY _____ DATE _____
 =====

FIGURE 3.4-2. Output from the Stored Waste Scenario Sample Problem

Stored Waste Sub-set of the External Exposure Scenario

MAXI, Version VAX2.2 2-APR-85 executed on 15-MAY-85 at 14:58:18 .

RELEASE TERMS NUCLIDE	ORGAN SOLUBILITY CLASSES	SOIL SOURCE (PCI/M**3)	IRRIGATION/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 0

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	0.00E+00	2.00E+10	0.00E+00	0.00E+00	0.00E+00

SOIL,AIR, AND WATER CONCENTRATION SUMMARY FOR THE YEAR 49

RADIONUCLIDE	SURFACE SOIL PCI/M2	DEEP SOIL PCI/M3	AIR PCI/M3	IRRIGATION PCI/L	DRINKING WATER PCI/L
CO 60	0.00E+00	3.13E+07	0.00E+00	0.00E+00	0.00E+00

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 0 FORTOTAL BODY

RADIONUCLIDE	INGESTION		EXPOSURE PATHWAY INHALATION		EXTERNAL		AQUATIC FOOD		DRINKING WATER		TOTAL
	REM	%	REM	%	REM	%	REM	%	REM	%	
CO60	0.00E+00	0	0.00E+00	0	6.10E+00	100	0.00E+00	0	0.00E+00	0	
TOTALS	INGESTION	%	INHALATION	%	EXTERNAL	%	AQUATIC FOOD	%	DRINKING WATER	%	
	0.00E+00	0	0.00E+00	0	6.10E+00	100	0.00E+00	0	0.00E+00	0	6.10E+00

DIAGNOSTIC 1: END OF FILE ON INPUT, STOP
FORTRAN STOP

FIGURE 3.4-2. (Contd)

4.0 PROGRAMMING DETAIL

The changes and enhancements made to the ONSITE/MAXII computer software package that are discussed in this supplement have not substantially altered the structure, organization, or operation of the computer programs. The changes made to the ONSITE and MAXII computer programs are summarized below.

One additional subroutine, RDLIST, was added to ONSITE. RDLIST is called by RADIN to display the table of available radionuclides. Minor changes have been made to the following ONSITE subroutines: ONSITE, CHANGE, DISINV, MODIF, QUANTI, RADIN, RITFIL, and SCENR. Two parameters, IWD and IDT, were added to the ONSITE Common Block FLAG to store the selected waste density and diet options, respectively. Changes were also made to the MAXII subroutine PADOS to apply the appropriate area correction factor for inhalation pathways. In addition, changes were made to QAPAGE and OUTPUT to record the date of this modification.

The VAX version of the MAXII computer program is listed in Appendix A. There are two notable differences between the VAX and CDC versions of MAXII. First, two different algorithms are used by the two versions to read the dose rate factor files. These algorithms are contained in the subroutines DFREAD and SETDAT. The difference concerns a trade-off between the amount of computer memory (CDC version) versus the amount of central processing time (VAX version) required for input operations. This mechanism is transparent to the user. The second difference is the addition of a fourth output option with the VAX version. The additional report summarizes the maximum year of exposure by radionuclide and organ.

As an additional quality assurance step, the sample problems described in Napier et al. (1984) were run with the new version of the software and the results were compared with those previously documented. This was done to assure that no unpredictable changes or programming errors occurred during the software enhancement. A comparison was also made between the VAX and CDC versions of the software to assure that both versions gave the same results. The sample problems documented in Napier et al. (1984) were used in these comparisons because hand calculations verified that the software was correctly doing all of the calculations. The results of these comparisons verified that both the VAX and CDC versions of the enhanced software package were operating correctly.

REFERENCES

Napier, B. A., R. A. Peloquin, W. E. Kennedy, Jr., and S. M. Neuder. 1984. Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXII Computer Program. NUREG/CR-3620. U.S. Nuclear Regulatory Commission, Washington, D.C.

5.0 ERRATA

The following corrections were included in the ONSITE/MAXII software package since the original document was published in October 1984.

5.1 UNITS CONVERSION - ONSITE

In the ONSITE computer program (Napier et al. 1984), the correction factor for units of mCi to pCi was changed from 1.0×10^6 to 1.0×10^9 . This factor is stored in the third element of the array NVUNIT and initialized with a DATA statement.

5.2 RUTHENIUM-103 DECAY CHAIN - RMDLIB/RMDONS

The ^{103}Ru decay chain in the files RMDLIB and RMDONS (Appendix 1.C, Napier et al. 1984) was corrected to read as follows:

RU103	3.94E+1	1	0	0
PD103	1.70E+1	2	0	0
RH103M	3.90E-2	3	1	.9974 2 .9997

5.3 STRONTIUM-90 - ORGLIB

A correction was made to the organ data file ORGLIB. The biological half-life of ^{90}Sr was updated from 1.3×10^4 to 4.0×10^3 days for total body and from 1.8×10^4 to 4.0×10^3 days for bone. The versions of FILE20, FILE21, FILE24, and FILE25 dated 4/85 contain dose rate factors for ^{90}Sr with this shorter biological half-life. This change affects only ^{90}Sr , the biological half-life of $^{90}\text{Sr}+\text{D}$ (the data entry that includes the short-lived daughter ^{90}Y) was correct.

REFERENCES

Napier, B. A., R. A. Peloquin, W. E. Kennedy, Jr., and S. M. Neuder. 1984. Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXII Computer Program. NUREG/CR-3620. U.S. Nuclear Regulatory Commission, Washington, D.C.

APPENDIX A

COMPUTER CODE LISTING - MAX11

APPENDIX A COMPUTER CODE LISTING - MAXI1

C-----
C
C Program Title: MAXI1
C
C Developed for: U.S. Nuclear 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: 301-427-4533
C
C
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
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 May 31, 1985
C
C
C

APPENDIX A COMPUTER CODE LISTING - MAX11

```

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
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),MAXPM(50,5)
C
COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C-----
C
C Added for fast execution version (original)
C
COMMON/FREAD/ELTLS(100),AWLS(100),ELTX(100),AWX(100),
.DEXT(100),
.NYRL,NYRS,NORGL,NORGS,NISOL,NISOS,NISOX,
.NYRW,NYRA,NORGW,NORGA,NISOW,NISOA,ELTA(100),AWAW(100),
.ELTW(100),AWW(100),ELTDX(100),AWDX(100),DFDXT(100),NISODX
C
DIMENSION X(100000)
DIMENSION DINCL(50,100,5),DINCS(50,100,5),
.DINCA(50,100,5),DINCW(50,100,5)
DIMENSION KORGLS(5),KORGA(5),KORGW(5)
C-----
C
DIMENSION KORG(5),NTR(5,50),TITLR(20),TITLDI(15),NSOLD(5,50)
DIMENSION TITLIN(40)
C
DIMENSION Q(50),ELTI(50),AWI(50)
DIMENSION QI(50),QJ(50),QAPR(50)
DIMENSION NFLAG(300),NFLAGC(200)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
  EQUIVALENCE (DINCL,X),(X(1),EXDOS),(X(2501),AEXDOS),
. (X(2551),FDOS)
  EQUIVALENCE (X(25001),DINCS),(X(15051),FADOS),(X(27551),DADOS)
  EQUIVALENCE (X(50001),DINCA),(X(40051),ARDOS),
. (X(52551),DWDOS),(X(65051),AFDOS),(X(65301),ADADOS),
. (X(65551),ADOS)
  EQUIVALENCE (X(75001),DINCW),(X(65801),AARDOS),
. (X(66051),ADWDOS)
C
  DATA AST /'*** 1/'
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,
. FR Siz,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
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 READ CASE SPECIFIC INPUT
C
  DEN=100.
  IMO=6
  IFOD=1
  IARG=1
  IWAT=1
  IAIR=1
  XQSITE=0.0
  IDKAIR=0

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
C
IBIO = 0
ION = 0
FRSIZ = 1.0
AREAIN = 1.0
AREAEX = 1.0
C
C
C
RPF1= OLD RPF
RPF2= FRACTION OF TOTAL DIET GROWN ON SITE
RPF=RPF1 : IF RPF2>0. THEN RPF = RPF1*RPF2
ONLY RPF IS USED IN THE CALCULATION; RPF1, RPF2 USED FOR QA PAGE -RAP
C
ISUR, I22, AND XF2 ARE THE ONSITE PARAMETERS EQUIVELENT TO XFACT
ISUR = SURFACE CONTAMINATION (0-NOT CONSIDERED, 1-CONSIDERED)
I22 = INDEX OF SURFACE CONTAMINATION SOURCE (0-ISOSHL, 2-MAXI2)
XF2 = NO.OF HOURS/YEAR PERSON IS EXPOSED TO EXTERNAL CONTAMINATION
C

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
C      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
C      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
C      IF NOT BIOPORT INPUT , DO STANDARD INVENTORY INPUT
C      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

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

      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
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
C 152  CONTINUE
C
      ENDIF
C
      DO 150 I=1,NIN
        Q(I) = Q(I) * SRDIL
C 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
        CALL DATE(TODAY)
        CALL TIME(CLOCK)
C
C

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

C READ AND SET DATA ARRAYS
C
      CALL DFREAD(DINCL,DINCS,KORGLS,DINCA,DINCH,KORGA,KORGW)
C
C CALL SETDAT TO SET DATA IN CHAINS
C
      CALL SETDAT(ELTI,AWI,NFLAG,NFLAGC,Q,DINCL,DINCS,
        .KORG,KORGLS,NORG,NSOLD,NTR,QI,QJ,RIM,
        .DINCA,DINCH,KORGA,KORGW,QAPR)
C
C
C      SET INHALATION DATA ARRAY
      CALL INSET(NORG,KORG,NTR,TITLDI)
C
100  CONTINUE
C
C
      ELSE
C
      THIS IS SUBSEQUENT BIOPORT RUN, USE SPECIAL INITIALIZATION
      CALL RDSUB (Q, QI, QJ, NFLAG, QAPR, RIM)
C
      ENDIF
C
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,NONUC)

```

APPENDIX A COMPUTER CODE LISTING - MAXII

```

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
        IF (XQSITE .GT. 0.) THEN
          AML(I)=AML(I)/(XQSITE*3.175E4)
        ELSE
          AML(I)=0.0
        ENDIF
      170 CONTINUE
      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
      STDP
      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

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C-----
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 7-FEB-85 RAP
C-----
C
C
C      REAL*8 A(45), SUMPR, ASUM, AMD, EXPO(9), ALD(9), ARG
C      DIMENSION DK(2,9),IFRM(2,9),AL(9),AM(9),AO(9)
C
C      CONVERT AL TO DOUBLE PRECISION
C      DO 113 IJK = 1, 9
C          ALD(IJK) = DBLE(AL(IJK))
C 113 CONTINUE
C
C      INITIALIZE COEFFICIENT ARRAY TO ZERO
C
C      N2N=NUC*(NUC-1)/2+NUC
C      CALL ZEROR(N2N,A)
C      DO 100 IJK = 1, N2N
C          A(IJK) = 0.0D0
C 100 CONTINUE
C
C      DO LOOP ON CHAIN MEMBERS,  MAX = NUC
C      DO 5 J=1,NUC
C
C      CALCULATE EXPONENTIAL FOR CURRENT NUCLIDE
C      ARG = -ALD(J) * T
C      EXPO(J)=DEXP(ARG)
C      JJ=J*(J-1)/2
C      J1=J-1
C      IF(J1.LE.0) GO TO 4
C      IMAX=MIN0(J1,2)
C      DO 3 M=1,J1
C      DO 2 L=M,J1
C      DO 1 I=1,IMAX
C      IF(IFRM(I,J).EQ.L) THEN
C          A(M+JJ)=A(M+JJ)+DK(I,J)*AL(L)*A(M+L*(L-1)/2)
C      ENDIF
C 1 CONTINUE
C 2 CONTINUE
C      A(M+JJ)=A(M+JJ)/(ALD(J)-ALD(M))
C 3 CONTINUE
C

```


APPENDIX A COMPUTER CODE LISTING - MAX11

```

4 CONTINUE
  ASUM = 0.0D0
  IF (J1 .EQ. 0) GO TO 11
    DO 12 IRAP = 1, J1
      JK = JJ + IRAP
      ASUM = ASUM + A(JK)
12 CONTINUE
11 CONTINUE
C
C   4 A(J+JJ)=AM(J)-ASUM(J1,A(JJ+1))
C
  AMD = AM(J)
  A(J+JJ) = AMD - ASUM
C
C   AO(J)=SUMPRD(J,EXPO,A(JJ+1))
C   THE VAX HAS A PROBLEM WITH THIS CODE- USR THE FOLLOWING:
C
  SUMPR = 0.0D0
  DO 8884 IN = 1,J
    JK = JJ + IN
    SUMPR = SUMPR + EXPO(IN) * A(JK)
8884 CONTINUE
  AO(J) = SUMPR
C
C   5 CONTINUE
C
  RETURN
C
C-----
C
  END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```
C-----
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
C      1 CONTINUE
C
C      IF(AITIM.GT.25) GO TO 10
C      AIRFA(ITIME)=1.0E-4*(EXP(-2.87*(SQRT(AITIM))))+1.0E-9
C      AIRFA(ITIME)=AIRFA(ITIME)*XDPT
C      GO TO 30
C 10 AIRFA(ITIME)=1.0E-9*XDPT
C 30 CONTINUE
C
C      RETURN
C
C-----
C
C      END
```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C-----
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      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
C      .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
C      .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
C      COMMON/THIRDS/OK(50),AML(50),XQSITE,IAIR,IDKAIR,IBLOW
C
C      CHARACTER*6 AWO
C      DIMENSION AMM(50)
C
C      IF NOT DECAYING SOURCE, SET AMM=AML
C
C      IST=INUC+1
C      K=IST+J-1
C      IF(IDKA.NE.0)GO TO 10
C      DO 100 I=IST,K
100  AMM(I)=AML(I)
C      GO TO 90
C
C      DECAY ONE-MEMBER CHAINS
C
C      10 IF(J.GT.1)GO TO 20
C      AMM(IST)=AML(IST)*EXP(-AL(IST)*JTIME)
C      GO TO 90
C
C      CALL CHAIN DECAY ROUTINE
C
C      20 DO 200 I=IST,K
200  AMM(I)=AML(I)/AL(I)
C      CTIME=JTIME
C      CALL ACHAIN(J,CTIME,DK(1,IST),IFRM(1,IST),AL(IST),AMM(IST),
C      .AMM(IST))
C      DO 300 I=IST,K
300  AMM(I)=AMM(I)*AL(I)
C
C      90 RETURN
C-----
C
C      END

```

APPENDIX A COMPUTER CODE LISTING -- MAXI1

```

C-----
C
C      SUBROUTINE ANDOS(NORG)
C
C      THIS SUBROUTINE IS USED TO CALCULATE ANNUAL AND PATHWAY DOSES
C
C      Module of MAXI1
C      Version of 19-JUN-84
C-----
C
C      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
C      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
C      .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
C      .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
C      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),
C      .FADOS(50,50,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
C      .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),
C      .AARDOS(50,5),ADWDOS(50,5)
C
C      COMMON /NEW RPT/ PATHOT(50,50,5)
C
C      CHARACTER*9 DDTT
C      CHARACTER*6 AWO
C      CHARACTER*10 TODAY, CLOCK
C
C      ITIME=0
C      CALL ZEROR(250,AFDOS)
C      CALL ZEROR(250,ADADOS)
C      CALL ZEROR(250,AARDOS)
C      CALL ZEROR(250,ADWDOS)
C      CALL ZEROR(12500,PATHOT)
C
C      DO 100 JTIME=IT1,IT2
C
C      ITIME=ITIME+1
C
C      DO 200 INUC=1,NONUC
C      DO 300 IORG=1,NORG
C
C      CALCULATE TOTAL FOOD PRODUCT DOSES
C
C      FDOS(ITIME,INUC,IORG)=FDOS(ITIME,INUC,IORG)+FADOS(ITIME,INUC,IORG)
C      .
C
C      CALCULATE TOTAL FOOD PRODUCT DOSES SUMMED OVER ALL NUCLIDES
C
C      AFDOS(ITIME,IORG)=AFDOS(ITIME,IORG)+FDOS(ITIME,INUC,IORG)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C   CALCULATE TOTAL INHALATION DOSE SUMMED OVER ALL NUCLIDES
C   ADADOS(ITIME,IORG)=ADADOS(ITIME,IORG)+DADOS(ITIME,INUC,IORG)
C   CALCULATE TOTAL AQUEOUS FOOD DOSES
C   AARDOS(ITIME,IORG)=AARDOS(ITIME,IORG)
C   .               +ARDOS(ITIME,INUC,IORG)
C   CALCULATE TOTAL DRINKING WATER DOSE
C   ADWDOS(ITIME,IORG)=ADWDOS(ITIME,IORG)
C   .               +DWDOS(ITIME,INUC,IORG)
C   Calculate pathway totals for each organ, nuclide, and time
C   PATHOT(ITIME,INUC,IORG) = FDOS(ITIME,INUC,IORG)
C   .               + DADOS(ITIME,INUC,IORG)
C   .               + ARDOS(ITIME,INUC,IORG)
C   .               + DWDOS(ITIME,INUC,IORG)
C   .               + EXDOS(ITIME,INUC)
C   PRINT 8888, PATHOT(ITIME,INUC,IORG)
C 8888 FORMAT (' PATHOT: ',E10.2)
C   300 CONTINUE
C   200 CONTINUE
C   CALCULATE ANNUAL DOSES
C   DO 400 IORG=1,NORG
C   ADOS(ITIME,IORG)=AFDOS(ITIME,IORG)+ADADOS(ITIME,IORG)+AEXDOS(ITIME
C   .               )+AARDOS(ITIME,IORG)+ADWDOS(ITIME,IORG)
C   400 CONTINUE
C   100 CONTINUE
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   RETURN
C   -----
C   END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C-----
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
C      ASUM=0.
C      IF(J.LE.0) GO TO 2
C      DO 1 I=1,J
C      ASUM=ASUM+A(I)
C 1 CONTINUE
C
C 2 RETURN
C-----
C
C      END
C      SUBROUTINE DFREAD(DINCL,DINCS,KORGLS,DINCA,DINCW,KORGA,KORGW)
C
C      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
C      .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
C      .IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
C      COMMON/TITLS/TIT20(13),TIT21(13),TIT22(13),TIT24(13),
C      .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      DIMENSION KORGLS(5),KORGA(5),KORGW(5)
C      DIMENSION DINCL(50,100,5),DINCS(50,100,5),DINCA(50,100,5),
C      .DINCW(50,100,5)
C      CHARACTER*6 AWLS,AWX,AWO,AWAW,AWW,AWDX
C
C      READ LEAF AND SOIL MECHANISM DATA
C
C 500 CONTINUE
C      READ(20,600)TIT20
C 600 FORMAT(13A4)

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

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)
   READ(24,600)TIT24
   READ(24,1)ID,NYRA,NISOA,NORGA
   READ(24,7)(KORGA(I),I=1,NORGA)
   READ(25,600)TIT25
   READ(25,1)ID,NYRW,NISOW,NORGW
   READ(25,7)(KORGW(I),I=1,NORGW)
51  CONTINUE
C
C  LEAF,SOIL,AQUEOUS FOOD AND DRINKING WATER DATA IN BLOCKS
C
   DO 15 IYR=1,NYRL
   IF(IFOD.EQ.0) GO TO 56
   READ(20,25)
   READ(21,25)
56  IF(IARG.EQ.0) GO TO 57
   READ(24,25)
57  IF(IWAT.EQ.0) GO TO 58
   READ(25,25)
58  CONTINUE
25  FORMAT(1X)
   DO 10 ISO=1,NISOS
   IF(IFOD.EQ.0)GO TO 60
   READ(20,2)ELTLS(ISO),AWLS(ISO),(DINCL(IYR,ISO,IOR),IOR=1,NORGL)
   READ(21,2)ELTLS(ISO),AWLS(ISO),(DINCS(IYR,ISO,IOR),IOR=1,NORGS)
10  CONTINUE
60  IF(IARG.EQ.0) GO TO 61
   DO 11 ISO=1,NISOA
   READ(24,2)ELTA(ISO),AWAW(ISO),(DINCA(IYR,ISO,IOR),
   .IOR=1,NORGA)
11  CONTINUE
61  IF(IWAT.EQ.0) GO TO 15
   DO 12 ISO=1,NISOW
   READ(25,2)ELTW(ISO),AWW(ISO),(DINOW(IYR,ISO,IOR),
   .IOR=1,NORGW)
   2  FORMAT(A2,A6,5E12.2)
12  CONTINUE
15  CONTINUE
C
C  READ EXTERNAL EXPOSURE MECHANISM DATA
C
   READ(22,600)TIT22
   READ(22,3)ID,NISOX
   3  FORMAT(5X,A4,1I5)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

      DO 20 ISO=1,NISOX
20  READ(22,4)ELTX(ISO),AWX(ISO),DFXT(ISO)
      IF(IEXT.NE.1) GO TO 31
      READ(27,600)TIT27
      READ(27,3) ID,NISODX
      DO 30 ISO=1,NISODX
      READ(27,5) ELTDX(ISO),AWDX(ISO),DFDXT(ISO)
30  CONTINUE
31  CONTINUE
      4  FORMAT(A2,A6,E7.1)
      5  FORMAT(A2,A6,E7.1)
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
      IF(NORGL.GT.5.OR.NORGS.GT.5.OR.NORGA.GT.5.OR.NORGW.GT.5)
      .GO TO 300
      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))
      END

```


APPENDIX A COMPUTER CODE LISTING - MAXI1

```
C-----  
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  
C          READ(23,10)  
C      10  FORMAT (1X)  
C      100 CONTINUE  
C  
C      RETURN  
C  
C-----  
C  
C      END
```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

C-----
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 MAX11
C      Version of 25-APR-84   RAP
C-----
C
C      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
C      .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
C      .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)
C      .,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
C      REAL*4 INDOS
1  CONTINUE
    CALL ZEROR(12500,INDOS)
    READ(23,10)NDI,TITLDI
10  FORMAT(15,15X,15A4)
    READ(23,11)(IDORG(I),I=1,5)
11  FORMAT(5I5)
C
C  LOOP ON NUCLIDES IN DACRIN-GENERATED FILE 23
C
C      DO 100 IDI=1,NDI
C
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
C      DO 200 INUC=1,NONUC
C
C      IF(ELTD.NE.ELTO(INUC).OR.AWD.NE.AWO(INUC)) GO TO 200
    ICHK=1
C
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)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
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
    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(ICKK.EQ.0) CALL DUMMY(N4)
100 CONTINUE
C    DO 501 IYR = 1, 10
C        DO 500 INUC = 1, NONUC
C            PRINT 8892, (INDOS(IYR,INUC,IORG), IORG=1,5)
C 8892    FORMAT (' ',5E11.3)
C 500 CONTINUE
C        PRINT 8893
C 8893    FORMAT (' ')
C 501 CONTINUE
C
    RETURN
C
C-----
C
    END

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

C-----
C
C      SUBROUTINE MAXDOS(NORG, NONUC)
C
C      This subroutine finds the maximum dose for each organ.
C
C      Module of MAX11
C      Verison of 29-JUN-84
C-----
C
C
C      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),FADOS(50,50
C      .,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
C      .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),
C      .AARDOS(50,5),ADWDOS(50,5)
C
C      COMMON/MXTIM/MAXTIM(5),MAXD(5),MAXPM(50,5)
C
C      COMMON /NEW RPT/ PATHOT(50,50,5)
C
C      COMMON/JUNK/DDTT,IT1,IT2,TITLE1(20),TODAY,CLOCK
C
C      CHARACTER*10 TODAY, CLOCK
C      CHARACTER*9 DDTT
C
C      REAL*4 MAXID(5), MAXPTH(50,5)
C
C      CALL ZEROR(5,MAXID)
C      CALL ZEROR(250,MAXPTH)
C      CALL ZEROI(250,MAXPM)
C
C      ITIME=0
C      DO 2 I=1,5
C      MAXTIM(I)=1
C      DO 211 INUC = 1, NONUC
C      PRINT 8881, INUC, I, NONUC
C8881  FORMAT (' INUC, I, NONUC: ',3I5)
C      MAXPM(INUC,I) = 1
C      211 CONTINUE
C      2 CONTINUE
C
C      DO 100 JTIME=IT1,IT2
C      ITIME=ITIME+1
C      DO 200 IORG=1,NORG
C      IF(ADOS(ITIME,IORG).GT.MAXID(IORG)) GO TO 50
C      GO TO 60
C50  MAXID(IORG)=ADOS(ITIME,IORG)
C      MAXTIM(IORG)=ITIME
C      MAXD(IORG)=JTIME

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```
C
  60 CONTINUE
    DO 210 INUC = 1, NONUC
      IF (PATHOT(ETIME,INUC,IORG) .GT. MAXPTH(INUC,IORG) ) THEN
        MAXPTH(INUC,IORG) = PATHOT(ETIME,INUC,IORG)
        MAXPM(INUC,IORG) = ETIME
      ENDIF
    210 CONTINUE
C
  200 CONTINUE
  100 CONTINUE
    RETURN
C
C-----
C
  END
```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```
C-----  
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  
C      1 CONTINUE  
C  
C      AIRFA(ITIME)=XMLF/DEN/0.15  
C  
C      RETURN  
C-----  
C  
C      END
```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C-----
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 2-APR-85 RAP
C-----
C
C
C      COMMON/DATA1/ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
C      .IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
C      .IFOD,IARG,IWAT,RIIR,RPF,XMLF,DILF,IMO,DEN,IEXT
C
C      COMMON /JUNK/ DDTT, IT1, IT2, TITLE1(20), TODAY, CLOCK
C
C      COMMON/DOSE1/EXDOS(50,50),AEXDOS(50),FDOS(50,50,5),
C      .FADOS(50,50,5),DADOS(50,50,5),ARDOS(50,50,5),DWDOS(50,50,5),
C      .AFDOS(50,5),ADADOS(50,5),ADOS(50,5),AARDOS(50,5),
C      .ADWDOS(50,5)
C
C      COMMON/MXTIM/MAXTIM(5),MAXD(5),MAXPM(50,5)
C
C      COMMON /NEWRPT/ PATHOT(50,50,5)
C
C      DIMENSION ONAME(23),ONA(5),KORG(5)
C
C      CHARACTER*10 ONAME, ONA
C      CHARACTER*6 AWO
C      CHARACTER*9 DDTT
C      CHARACTER*10 TODAY, CLOCK
C
C      DATA(ONAME(I),I=1,23)/'TOTAL BODY','BODY WATER',' KIDNEYS ',' L1
C      .VER ',' SPLEEN ',' BONE ',' FAT ',' LUNGS ',' ADRE
C      .NALS ',' TESTES ',' OVARIES ',' SKIN ',' BRAIN ',' MUSC
C      .LE ',' PROSTATE ',' THYROID ',' PANCREAS ',' HEART ',' GI-TRA
C      .CT ',' STOMACH ',' SI ',' ULI ',' LLI '/'
C
C      PRINT TITLES FOR SUMMARY BY ORGAN AND RADIONUCLIDE (IOUT=0)
C
C      DO 100 IORG=1,NORG
C      IF (NONUC .GT. 20 .OR. IORG .EQ. 1) WRITE(6, 10)
C      IF (NONUC .GT. 20 .OR. IORG .EQ. 1) WRITE(6, 11) TITLE1
C      IF (NONUC .GT. 20 .OR. IORG .EQ. 1) WRITE(6, 12) TODAY, CLOCK
C      IF (IBIO .GT. 0) WRITE(6, 27) IBYR
C
C      ONA(IORG)=ONAME(KORG(IORG))
C      WRITE(6, 13) MAXD(IORG),ONA(IORG)

```


APPENDIX A COMPUTER CODE LISTING - MAX11

```

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
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
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
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)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

11 FORMAT(4X,20A4)
C
12 FORMAT(/,25X,'MAXI, Version VAX2.2 2-APR-85',
  . ' 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),/)
15 FORMAT(3X,A2,A6,5X,5(1PE9.2E2,2X,I4,5X))
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)
27 FDMAT(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 PRINT MAXIMUM DOSE BY ALL PATHWAYS FOR EACH YEAR AND ORGAN REPORT
C IF (IOUT .EQ. 4) THEN
  WRITE (6, 10)
  WRITE (6, 12) TODAY, CLOCK
  WRITE (6, 33) TITLE1, (ONA(IORG), IORG=1,NORG)
C

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

      DO 70 INUC = 1, NONUC
        WRITE (6,34) ELTO(INUC), AWO(INUC),
          (MAXPM(INUC,I), PATHOT(MAXPM(INUC,I),INUC,I),
          I = 1, NORG)
70    CONTINUE
      ENDIF
C
33  FORMAT (' ',20A4,/,/,15X,
          ' MAXIMUM DOSE BY NUCLIDE AND ORGAN SUMMED OVER ALL ',
          'PATHWAYS'//
          ' Radio-      ',5(5X,A10,2X),/
          ' Nuclide    ',5(2X,'Year',2X,'Dose (rem)')/
          '-----'
          '-----'
          '-----',/)
C
34  FORMAT (' ',A2,A6,2X, 5(2X,I4, 2X,1PE10.3))
C
C
C TEST ON OUTPUT CLASS AND CONTINUE
C
      IF(IOUT.EQ.0 .OR. IOUT.EQ.4) GO TO 999
C
C PRINTA 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 PRINT TITLES

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
C
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
C
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

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

701 CONTINUE
C
    WRITE(6, 16) AFDOS(ETIME, IORG), IPAF, ADADOS(ETIME, IORG),
    .IPAD, AEXDOS(ETIME), IPAX,
    .AARDOS(ETIME, IORG), IAGD, ADWDOS(ETIME, IORG), IDWA,
    .ADOS(ETIME, IORG)
600 CONTINUE
500 CONTINUE
    25 FORMAT(/, 13X, 'ANNUAL DOSE SUMMARY FOR YEAR', I5, 1X,
    . 'AND ORGAN', A10)
999 CONTINUE
C
C
    RETURN
C
C-----
C
    END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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 2-APR-85  RAP
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),1CHN,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
  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)
  IDKA=IDKAIR
C

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

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)
    IF(IDKWAT.NE.0.AND.JTIME.GE.ITW)CALL WATER(1,INUC,JTIME,AMK,J)
C
    DO 290 JNUC=1,J
C
    INUC=INUC+1
    IF(JTIME.LT.IT1) GO TO 290
C
C CALCULATE AIR CONCENTRATIONS
C

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

AIRCON(INUC)=SOILCN(INUC)*AIRFA(ETIME)+AMM(INUC)
C
C CALCULATE EXTERNAL TOTAL BODY DOSES
C
      EXDOS(ETIME,INUC)=DEXT(INUC)*SOILCN(INUC)*XFACT*AREAEX
      .      +DEXT(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(ETIME)=AEXDOS(ETIME)+EXDOS(ETIME,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
C
      DADOS(ITTIM+N,INUC,IOrg)=DADOS(ITTIM+N,INUC,IOrg)+INDOS(ITTIM,INUC
      .,IOrg)*AIRCON(INUC)*RINH*AREAEX
C
      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

```


APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
C      IF (JTIME.EQ.IT1.OR.JTIME.EQ.IT2)
C      .CALL PNT0(SOILCN, AIRCON, INUC, NONUC, JTIME, EL TO, AWO, AMK, AMJ, AMT)
C
C 50  CONTINUE
C
C      RETURN
C
C-----
C
C      END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C-----
C
C      SUBROUTINE PNT0 (SOILCN,AIRCON,INUC,NUC,JTIME,ELTO,AWO,AMI,AMJ,
C      .               AMT)
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)
C      DIMENSION AMI(50),AMJ(50),AMT(50)
C      CHARACTER*6 AWO
C      IF (NUC.GT.20 .OR. JTIME .EQ. 1) THEN
C        WRITE (6,51)
C      ELSE
C        WRITE (6,52)
C      ENDIF
C
C      WRITE (6,50) JTIME
C      IF (INUC.NE.NUC) GO TO 200
C      DO 100 JNUC=1,NUC
C        AMT(JNUC)=AMT(JNUC)/.15
C        WRITE (6,60) ELTO(JNUC),AWO(JNUC),SOILCN(JNUC),AMT(JNUC),
C        .AIRCON(JNUC),AMI(JNUC),AMJ(JNUC)
C        AMT(JNUC)=AMT(JNUC)*.15
C      100 CONTINUE
C
C      RETURN
C      200 WRITE (6,70)
C      50 FORMAT(1H ,30X,'SOIL,AIR, AND WATER CONCENTRATION SUMMARY',
C      . ' FOR THE YEAR',I6,/,10X,'RADIONUCLIDE',5X,'SURFACE SOIL',
C      .5X,'DEEP SOIL',8X,'AIR',9X,'IRRIGATION',4X,
C      . 'DRINKING WATER',/,31X,'PCI/M2',8X,'PCI/M3',10X,
C      . 'PCI/M3',9X,'PCI/L',11X,'PCI/L',/)
C
C      51 FORMAT (1H1)
C      52 FORMAT (////)
C      60 FORMAT(13X,A2,1X,A6,3X,5(5X,1PE10.2E2))
C      70 FORMAT(///,3X,'DIAGNOSTIC 14: TEST, INUC.NE.NUC=END - ',
C      . 'FROM PNT0')
C
C      STOP
C
C-----
C
C      END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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 2-APR-85  RAP
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
      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
C
1  FORMAT(T27,'MAXI - Maximum Annual Dose Calculation Version ',
      . 'VAX2.2 2-APR-85',/,
      . T45,'Executed on ',A10,' at ',A10,'.',/,
      . T27,'Case title:',20A4,/)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C
C   CALL IDLINE
C   WRITE(6,18)
18  FORMAT(25X,80(' '),/)
C
C LIBRARIES USED
C
C   WRITE(6,1000)TITLR
1000 FORMAT(5X,'RADIONUCLIDE CHAIN LIBRARY USED: ',4X,20A4,/,5X,
. 'DOSE FACTOR FILES USED FOR THIS CASE:')
C
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
C   IF (XFACT .NE. 0.) WRITE (6,1002) TIT22
1002 FORMAT (15X,'*22  SHALLOW EXTERNAL:',6X,15A4)
C
C   IF (RINH .GT. 0.0) WRITE (6,1003) TITLDI
1003 FORMAT (15X,'*23  DACRIN-INHALATION:',5X,15A4)
C
C   IF (IARG .GT. 0) WRITE (6,1004) TIT24
1004 FORMAT (15X,'*24  ARRRG-FISH:',12X,15A4)
C
C   IF (IWAT .GT. 0) WRITE (6,1005) TIT25
1005 FORMAT (15X,'*25  ARRRG-DRINK H2O: ',5X,15A4)
C
C   IF(IEXT.GT.0) WRITE(6,3) TIT27
3  FORMAT(15X,'*27  ISOSHLD EXTERNAL: ',15A4)
C
C   IF (IBIO .GT. 0) WRITE (6,1006) TITLIN
1006 FORMAT (/ ,15X, 'BIOPORT INVENTORY FROM: ',/
. 30X,20A4,/,30X,20A4)
C
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
C   FLAG20='OFF'
C   FLAG22='OFF'
C   FLAG23='OFF'
C   FLAG24='OFF'
C   FLAG25='OFF'
C   FLAG27='OFF'
C   FLAG28='OFF'
C   FDK='NOT PERFORMED'
C   FDJ='NOT PERFORMED'
C   FINTRD='NOT USED'

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

IF(IFOD.NE.0)FLAG20='ON '
IF(RINH.NE.0.0)FLAG23='ON '
IF(IARG.NE.0)FLAG24='ON '
IF(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 PARAMETERS
C
IF (FLAG22.EQ.'OFF' .AND. FLAG27 .EQ. 'OFF') GO TO 100
WRITE (6,1060)
1060 FORMAT ('0',4X,'EXTERNAL EXPOSURE PARAMETERS USED:')

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

        WRITE (6,1065) RPF1
1065  FORMAT (15X,'RATIO OF EXTERNAL CONTAMINATION IN SURFACE SOIL ',
        . 'TO SUBSURFACE SOIL', 1PE10.2E2)
        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 ISOSHL; '
        ., '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 ('O',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
      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//)
      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))

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

C
C SIGN-OFF
C
    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
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
C
    IF (NEXT .EQ. 5) GOTO 201
C
    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

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```
      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

APPENDIX A COMPUTER CODE LISTING - MAX11

```

C-----
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 MAX11
C      Version of 25-APR-84  RAP
C-----
C
C      COMMON /DATA1/ ELTO(50),AWO(50),IOFNUC(50),NONUC,DK(2,50),
C      . IFRM(2,50),AL(50),AM(50),SOILCN(50),ICHN,AMI(50),AMJ(50),
C      . IFOD,IARG,IWAT,RIRR,RPF,XMLF,DILF,IMO,DEN,IEXT
C      DIMENSION Q(50), QAPR(50), QI(50), QJ(50), NFLAG(300)
C      CHARACTER*6 AWO
C
C      CALL ZEROR (50, AM)
C      CALL ZEROR (50,QAPR)
C      CALL ZEROR (50,AMI)
C      CALL ZEROR (50,AMJ)
C
C      SET INPUT INVENTORY INTO CORRESPONDING CHAIN POSITION:
C
C      DO 100 IL = 1, NONUC
C
C          IF (NFLAG(IL) .GT. 0) THEN
C
C              IN = IL
C              AM(IL) = Q(IN) * RIM
C              QAPR(IL) = Q(IN)
C              AMI(IL) = QI(IN)
C              AMJ(IL) = QJ(IN)
C
C          ENDIF
C
C      100 CONTINUE
C
C      RETURN
C-----
C
C      END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

C-----
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)
C      ,NCHST(200),IFR(2,300),DKF(2,300),IMEM(300)
C      DIMENSION TITLR(20),IT(2),FR(2)
C
C      CHARACTER AW*6,A*6
C
C      INITIALIZE INDICES
C
C      IMO=0
C      NCH=0
C      NUC=1
C
C      READ TITLE CARD
C
C      READ(10,200,END=99) TITLR
C
C      READ AND COUNT NUCLIDE ID AND DECAY DATA.
C
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
C      IF(IM.GT.0) GO TO 2
C      NUC=NUC-1
C      IF(NUC.GT.300) GO TO 98
C      IF(NUC.LT.1) GO TO 98
C
C      RETURN
C
C      TEST FOR NEW CHAIN, IM = 1
C
C      2 IF(IM.GT.1) GO TO 3
C
C      FIRST MEMBER, NEW CHAIN
C
C      NCH=NCH+1
C      NOFNUC(NCH)=1
C      IMO=1

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

      NCHST(NCH)=NUC
      GO TO 4
C
C DAUGHTER NUCLIDES
C TEST ORDER
C
      3 IF(IM-IMO.NE.1) GO TO 97
      IMO=IM
      NOFNUC(NCH)=NOFNUC(NCH)+1
      IFR(1,NUC)=IT(1)
      IFR(2,NUC)=IT(2)
      DKF(1,NUC)=FR(1)
      DKF(2,NUC)=FR(2)
C
C SET DATA FOR CURRENT NUCLIDE.
C
      4 ELT(NUC)=E
      AW(NUC)=A
      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
      SUBROUTINE SETDAT(ELTI,AWI,NFLAG,NFLAGC,Q,DINCL,DINCS,
      .KORG,KORGLS,NORG,NSOLD,NTR,QI,QJ,RIM,DINCA,DINCW,
      .KORGA,KORGW,QAPR)
C

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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/FREAD/ELTLS(100),AWLS(100),ELTX(100),AWX(100),
.DFXT(100),
.NYRL,NYRS,NORGL,NORGS,NISOL,NISOS,NISOX,
.NYRW,NYRA,NORGW,NORGA,NISOW,NISOA,ELTA(100),AWAW(100),
.ELTW(100),AWW(100),ELTDX(100),AWDX(100),DFDXT(100),NISODX
C
DIMENSION DINCL(50,100,5),DINCS(50,100,5),
.DINCA(50,100,5),DINCW(50,100,5)
DIMENSION KORG(5),KORGLS(5),NSOLD(5,50),NTR(5,50),
.KORGA(5),KORGW(5)
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
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)
C
CHARACTER*6 AW,AWLS,AWX,AWI,AWO,AWAW,AWW,AWDX
REAL*4 INDOS
C
INUC=0
ICHN=0
CALL ZEROR(50,ELTO)
C
CALL ZEROR(50,AWO)
DO 8881 IRAP = 1,50
    AWO(IRAP) = ' '
8881 CONTINUE
CALL ZEROI(50,IOFNUC)
CALL ZEROR(50,AL)
CALL ZEROR(50,AM)
CALL ZEROI(250,NTR)
C
C LOOP ON ALL CHAINS FROM MASTER LIBRARY
C
DO 20 IC=1,NCH
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)

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

      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)
      AML(INUC)=QK(NFIL)
      16 CONTINUE
      ELTO(INUC)=ELT(IL)
      AWO(INUC)=AW(IL)
C
C  ORGAN SOLUBILITY DATA
C
      DO 250 JORG=1,NORG
      250 NTR(JORG,INUC)=NSOLD(JORG,NFIL)
C
C  LEAF AND SOIL MECHANISM DATA
C
      IF(IFOD.EQ.0) GO TO 30
      DO 100 ISOLS=1,NISOL

```

APPENDIX A COMPUTER CODE LISTING - MAX11

```

      IF(ELTLS(ISOLS).NE.ELTO(INUC).OR.AWLS(ISOLS).NE.AWO(INUC))
      .GO TO 100
      DO 201,IORG=1,NORG
      DO 200 IOR=1,NORGL
      IF(KORG(IORG).NE.KORGLS(IOR))GO TO 200
      DO 200 IYR=1,NYRL
      DFDOS(IYR,INUC,IORG)=DINCS(IYR,ISOLS,IOR)
      AIDOS(IYR,INUC,IORG)=DINCL(IYR,ISOLS,IOR)
200 CONTINUE
201 CONTINUE
      GO TO 101
100 CONTINUE
101 CONTINUE
      30 IF(IARG.EQ.0) GO TO 40
C
C   AQUEOUS FOOD PATHWAY DATA
C
      DO 39 ISOA=1,NISOA
      IF(ELTA(ISOA).NE.ELTO(INUC).OR.AWAW(ISOA).NE.AWO(INUC))
      .GO TO 39
      DO 31 IORG=1,NORG
      DO 32 IOR=1,NORGA
      IF(KORG(IORG).NE.KORGA(IOR)) GO TO 32
      DO 32 IYR=1,NYRA
      ARGF(IYR,INUC,IORG)=DINCA(IYR,ISOA,IOR)
32 CONTINUE
31 CONTINUE
      GO TO 40
39 CONTINUE
40 IF(IWAT.EQ.0) GO TO 50
C
C   DRINKING WATER PATHWAY
C
      DO 49 ISOW=1,NISOW
      IF(ELTW(ISOW).NE.ELTO(INUC).OR.AWW(ISOW).NE.AWO(INUC))
      .GO TO 49
      DO 41 IORG=1,NORG
      DO 42 IOR=1,NORGW
      IF(KORG(IORG).NE.KORGW(IOR)) GO TO 42
      DO 42 IYR=1,NYRW
      ARDW(IYR,INUC,IORG)=DINCW(IYR,ISOW,IOR)
42 CONTINUE
41 CONTINUE
      GO TO 50
49 CONTINUE
50 CONTINUE
C
C   EXTERNAL MECHANISM DATA
C

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

      IF(IEXT.GT.1) GO TO 350
      DO 300 ISOX=1,NISOX
      IF(ELTX(ISOX).NE.ELTO(INUC).OR.AWX(ISOX).NE.AWO(INUC))GO TO 300
      DEXT(INUC)=DFXT(ISOX)
      GO TO 301
300 CONTINUE
301 CONTINUE
      IF(IEXT.NE.1) GO TO 350
      DO 400 ISODX=1,NISODX
      IF(ELTDX(ISODX).NE.ELTO(INUC).OR.AWDX(ISODX).NE.AWO(INUC))
      .GO TO 400
      DEDXT(INUC)=DFDXT(ISODX)
      GO TO 401
400 CONTINUE
401 CONTINUE
350 CONTINUE
C
      GO TO 15
C
C INCREMENT INDEX TO SKIP UNUSED CHAIN MEMBERS
C
      14 I=IMEM(IL)
C
      15 CONTINUE
C
C SET NUMBER OF NUCLIDES IN REDUCED CHAIN
C
      IOFNUC(ICHN)=NCN-I
C
      20 CONTINUE
      NONUC=INUC
      RETURN
97 WRITE(6,98)INUC
98 FORMAT(1H1,' DIAGNOSTIC 13:TOO MANY NUCLIDES ATTEMPTED IN SUBROUTI
      .NE SETDAT. INUC=',I5)
      STOP
      END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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
C
      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)

```


APPENDIX A COMPUTER CODE LISTING - MAX11

```

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
FUNCTION SUMPRD(J,A,B)
    DIMENSION A(1),B(1)
    SUMPRD=0
    DO 1 I=1,J
        SUMPRD=SUMPRD+A(I)*B(I)
1 CONTINUE
    RETURN
END

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```

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

```

APPENDIX A COMPUTER CODE LISTING - MAXI1

```
C-----
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
C      DO 1 J=1,N
C      K(J)=0
C      1 CONTINUE
C
C      RETURN
C-----
C
C      END
```

APPENDIX A COMPUTER CODE LISTING - MAXI1

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


APPENDIX B

COMPUTER CODE LISTING - ONSITE

APPENDIX B COMPUTER CODE LISTING - ONSITE

Program Title: ONSITE

Developed for: U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety & Safeguards
Division of Waste Management

Date: March 29, 1985

NRC Contact: Dr. Stan Neuder
Phone: 301-427-4533

Code Developer: B.A. Napier, R.A. Peloquin, W.E. Kennedy, Jr.
Pacific Northwest Laboratory
Richland, WA 509-375-3849 (WEK)

This program was prepared for an agency of the United States Government. Neither the United States government nor any agency thereof, or any of their employees, make any warranty, expressed or implied, or assumes any legal liability or responsibility for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

ONSITE is the interactive user/system interface for the ONSITE Disposal Version of the MAXII computer code. ONSITE creates a file containing the JCL and input stream for MAXII.

Version of 3-APR-85 RAP

The program ONSITE includes the following modules:

- CHANGE - to query if parameter is to be changed, and if so, to input the new value
- DISINV - to display and control modifications to the user-entered inventory
- GROUP - to determine if changes are required for a group of parameters
- INTRO - to display introductory message
- MODIF - to modify selected scenario parameters
- QUANTI - to read in source term this radionuclide
- RADIN - to read in and test radiological inventory
- RDLIST - to display the radionuclide master list
- RITFIL - to write MAXII JCL and input stream
- SELECT - to select and test scenario option
- SCENR - to establish scenario default parameters

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C
C   Program variable descriptions --
C       IDT - selected diet option
C       IWD - selected waste density option
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 subroutine 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 initialization -----
C
C       INCLUDE 'ONSITE.CMN'
C
C       REAL*8 R8X, GNAME(2), EXTFAC(4,5)
C
C       DATA KEY, SCRIN, OUT, IRS, IMOD, IBS /5,6,7,1,0,1/
C       DATA EXTFAC /'On surfa','ce      ',' (15 c','m thick)',
C       .             'On surfa','ce      ',' (1 ','m thick)',
C       .             'Overburd','en of 0.','5 m (1 ','m thick)',
C       .             'Overburd','en of 1.','0 m (1 ','m thick)',
C       .             'Stored w','aste    ',' (1 ','m thick)'/
C
C       DATA NVU /'pCi ','uCi ','mCi ',' Ci '/
C       DATA NVUNIT /1.0, 1.0E+6, 1.0E+9, 1.0E+12/
C
C       DATA UNITS /'/square ','meter  ',
C       .             '/cubic m','eter   ',
C       .             '/Kg of s','oil    '/
C
C
C----- introduce program, describe scenarios to user, & establish defaults -----
C
C       CALL INTRO
C       CALL SCENR
C

```


APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C----- input title -----
C
      WRITE (SCRN,1100)
1100 FORMAT (' ',20('/),' ',
      . 'Enter a descriptive title to identify this case: ')
      READ (KEY,1101) (TITL(1), I=1,20)
1101 FORMAT (20A4)
C
C----- review return comes to this location -----
      201 CONTINUE
C
C
C----- input report option -----
C
      WRITE (SCRN,1120)
      WRITE (SCRN,1121) IOUT
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'//
      . '      4- Table above plus maximum by organ and radionuclide')
1121 FORMAT (// ' ',
      . 'The current selection is:',I2)
      CALL CHANGE ((1), ICFLAG, IX, (1), (4), RX, RL, RH, R8X)
      IF (ICFLAG.EQ.1) IOUT = IX
C
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, 5
        WRITE (SCRN, 1211) I, (EXTFAC(J,I),J=1,4)
302    CONTINUE
      WRITE (SCRN,1212) ILOC
C
1210    FORMAT (' ',14('/),' ',
      . 'In this scenario, waste location and depth may be: '//)
1211    FORMAT(15X,I2,' - ', 4A8)
1212    FORMAT (//, ' See Table 2.3-1 of NUREG/CR-3620 Supplement.'//
      . 'The current selection is: ',I1)
      CALL CHANGE ((1),ICFLAG,IX,(1),(5),RX,RL,RH,R8X)
      IF (ICFLAG .EQ. 1) ILOC = IX
C
304    CONTINUE

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C
C----- if user-defined scenario, select pathways -----
C
      IF (IRS .LT. 5) GO TO 111
      IMOD=1
      CALL OPTION
      GO TO 100
111 CONTINUE
C
C----- set area correction factor -----
C
400 CONTINUE
      IF (IRS .EQ. 4) GO TO 401
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-30),(1.E30),R8X)
      IF (ICFLAG.EQ.1) FRSIZ = RX
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
      GNAME(1) = 'site siz'
      GNAME(2) = 'e      '
      CALL GROUP (IGFLAG, GNAME)
C
      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. 0.002) THEN
            AREAIN = 0.50
          ELSE
            IF (FRSIZ .GE. 0.005) THEN
              AREAIN = 0.25
            ELSE
              AREAIN = 0.10
            ENDIF
          ENDIF
        ENDIF
      ENDIF
      ENDIF
      ENDIF
      ENDIF

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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
  ENDIF
  ENDIF
  ENDIF
C
  401 CONTINUE
C
C----- modify pathway parameters -----
C
  WRITE (SCRN,1001) IRS
1001 FORMAT (' ',10('/),' ',
    .14X,44('#')//14X,'Do you wish to review/modify any pathway '
    .//14X,'parameter values for 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
C
  100 CONTINUE
  IF (IMOD .EQ. 1) CALL MODIF
C
C----- start and end times -----
C
  200 CONTINUE
C
  IF (IT1 .LT. IRR) IT1 = IRR
  WRITE (SCRN,1110) IT1
1110 FORMAT (' ',20('/),' ',
    .'The dose calculations begin ',I4,' years after the waste is'
    ./' disposed.')
  IF (IRR .GT. 0) WRITE (SCRN,1112)
1112 FORMAT (' See Section 3.1 in NUREG/CR-3620 Supplement. ')
  CALL CHANGE ((1), ICFLAG, IX, IRR, (9999), RX, RL, RH, R8X)
  IF (ICFLAG.EQ.1) IT1 = IX

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C      IT2 = IT1 + 49
      WRITE (SCRN,1111) IT2
1111  FORMAT (' ',
      . 'The dose calculations 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
C
C----- input ratio and inventory units -----
C
C
      IF (ISUR .EQ. 1 .AND. IEXT .EQ. 1) THEN
C
      WRITE (SCRN,1220) RPF1
1220  FORMAT (' ',14('/),' ',
      . 'This scenario assumes contamination to both surface ',
      . '(top 15 cm)'/
      . ' and subsurface soil. Concentrations you input will ',
      . ' be assumed to '/
      . ' be in the subsurface soil.'//
      . ' What is the ratio of waste concentration in the surface '/
      . ' to subsurface soils?'//
      . ' (Range = 0.0 to 10.0 for spills, usually 0.0 to 1.0 to '/
      . ' allow redistribution from buried material to surface)'//
      . ' The current selection is: ', 1PG10.3)
      CALL CHANGE ((2),ICFLAG,IX,IL,IH,RX,(0.0),(10.0),R8X)
      IF (ICFLAG .EQ. 1) RPF1 = RX
C
      ELSE
C
      IF (ISUR .EQ. 1) RPF1 = 1.0
      IF (IEXT .EQ. 1) RPF1 = 0.0
C
      ENDIF
C
      IF (IRS .EQ. 4) GO TO 300
C
      WRITE (SCRN,1230)
      DO 131 I = 1, 4
        WRITE (SCRN,1231) I, NVU(I)
131  CONTINUE
      WRITE (SCRN, 1232) INUT
C
1230  FORMAT(' ',24('/),' ',
      . 'The surface/buried inventory may be entered as: '//)
1231  FORMAT(15X, I1,' - ',A4)
1232  FORMAT('// ' ',
      . 'The current selection is: ',I1)

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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
        IMB = I - 1
        WRITE (SCRN,1201) IMB, 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 (//, ' Usually 0 for surface contamination and ',
.      ' 1 for buried'
.      ' contamination. The current selection is: ',I1)
    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 radionuclide inventory modification factor is: ',1PG10.2/
.      ' (range = 0.0 to 1.0E+20, usually 0.0 to 1.0)'//
.      ' This factor will be used as a multiplier of all input'
.      ' concentrations. It is a handy parameter to correct units'
.      ' or make other changes (such as dilution of inventory with'
.      ' clean soil).')
    CALL CHANGE ((2),ICFLAG,IX,IL,IH,RX, (0.0),(1.E20),R8X)
    IF (ICFLAG .EQ. 1) SRDIL = RX
301  CONTINUE
C
C
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 201
    ENDIF
C
C
C---- input inventory and write file -----
C

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

CALL RADIN
CALL DISINV
CALL RITFIL
C
C----- end of program -----
C
      WRITE (SCRN,8000)
8000 FORMAT (' ',20('/),
      .10X,'To execute MAXI1 on the VAX interactively, type: '//
      .10X,'          @MAXI1'////
      .10X,'To execute MAXI1 on the VAX and have printed output, type: '//
      .10X,'          SUBMIT MAXI1'////
      .10X,'To edit the MAXI1 input file, type: '//
      .10X,'          EDIT MAXI1.COM'////
      .10X,'To save the MAXI1 input file, type: '//
      .10X,'          RENAME MAXI1.COM newname.COM'//
      .10X,'where "newname" is a unique filename of your choice.'//
C
C
      END
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
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, IWD, IDT
C
C          IRS - INDEX OF SELECTED SCENARIO
C          ILOC - INDEX OF LOCATION OF THE WASTE:
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          IWD - INDEX OF SELECTED WASTE DENSITY
C          IDT - INDEX OF SELECTED DIET

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

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

C-----

C

COMMON /IOVAR/ SCRN, OUT, OUTFIL, KEY

CHARACTER*15 OUTFIL

INTEGER SCRN, OUT

C

C-----

C

VERSION OF 21-FEB-85 RAP

C-----

C

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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                   2 - input only, not change (received)
C      IDUM        - logical unit number of scratch file used for conversion
C      IFLAG()     - acceptable/not acceptable flag for each character of
C                   input string
C      IH          - maximum allowable integer input (received)
C      IL          - minimum allowable integer input (received)
C      ITFLAG      - CHANGE subroutine passing flag: (received)
C                   1 - integer value
C                   2 - real value
C                   3 - alphanumeric input - real*8
C      IVAL()      - ASCII value of each character of input string
C      IVL        - ASCII value of current character of input string
C      IX          - new integer value (returned)
C      LETTER()    - array containing each character of input string
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      WORD        - input string
C      WRDLEN      - number of characters in input string
C
C      Module of ONSITE
C      IBM-PC Version of 22-FEB-85 RAP
C-----
C
C      INCLUDE 'ONSITE.CMN'
C
C      REAL*8 R8X
C
C      DIMENSION IVAL(10), IFLAG(10)
C
C      INTEGER WRDLEN
C      CHARACTER*10 WORD
C      CHARACTER*1 LETTER(10)
C      EQUIVALENCE (WORD, LETTER(1))

```


APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C
C      IDUM = 3
C
C
C      ---- this is input only, not a change ----
C
C      IF (ICFLAG .EQ. 2) THEN
C          ICFLAG = 2
C          GOTO 200
C      ENDIF
C
C      ---- query if change requested ----
C
C      ICFLAG = 0
C      WRITE (SCRN,1000)
1000  FORMAT (// ' ',70(' '),//
C          . ' Do you wish to change this value (N/Y)? ' )
C      READ (KEY,8001) IY
8001  FORMAT (A1)
C
C      IF (IY .NE. 'Y' .AND. IY .NE. 'y') GO TO 700
C
C      ICFLAG = 1
100   CONTINUE
C
C      WRITE (SCRN, 1010)
1010  FORMAT ( ' ' / ' Enter new value: ' )
C
C      ---- input response as a character string ----
C
C      200   CONTINUE
C
C      READ (SCRN,8010) WORD
C
C      IF (ITFLAG .EQ. 3) GO TO 700
C
C      WRDLEN = 0
C      DO 500 I = 1, 10
C
C          WRDLEN = WRDLEN + 1
C          IFLAG(I) = 0
C          IVL = ICHAR(LETTER(I))
C          IVAL(I) = IVL
C
C      ---- all numerals are valid ----
C          IF (IVL .LT. 48) IFLAG(I) = 1
C          IF (IVL .GT. 57) IFLAG(I) = 1
C
C          IF (IFLAG(I) .GT. 0) THEN
C

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C      ---- space is OK, but quit scan ----
      IF (IVL .EQ. 32) THEN
          IFLAG(I) = 2
          WRDLEN = I-1
          GOTO 501
      ENDIF

C
C      ---- reset for leading sign ----
      IF (IVL .EQ. 45 .AND. I .EQ. 1) IFLAG(I) = 0
      IF (IVL .EQ. 43 .AND. I .EQ. 1) IFLAG(I) = 0

C
C      ---- E is allowable -----
      IF (IVL .EQ. 69) THEN
          IF ( I .NE. 1 .AND. ITFLAG .EQ. 2) IFLAG(I) = 0
      ENDIF

C
C      ---- Decimal point is allowable ----
      IF (IVL .EQ. 46) IFLAG(I) = 0

C      ENDIF

C
500      CONTINUE
501      CONTINUE

C
      IF (WRDLEN .LT. 1) WRDLEN = 1
      IF (IVAL(WRDLEN) .EQ. 69) IFLAG(I) = 1

C
      IGOOD = 1
      DO 502 I = 1, WRDLEN
          IF (IFLAG(I) .GT. 0) IGOOD = 0
502      CONTINUE

C
      IF (IGOOD .EQ. 1) THEN
          WRITE (IDUM,8010) WORD
8010      FORMAT (A10)
          BACKSPACE IDUM

C
          IF (ITFLAG .EQ. 1) THEN
              READ (IDUM,*,ERR=100,END=100) IX
              IF (IX .LT. IL .OR. IX .GT. IH) GOTO 100
          ENDIF

C
          IF (ITFLAG .EQ. 2) THEN
              READ (IDUM,*,ERR=100,END=100) RX
              IF (RX .LT. RL .OR. RX .GT. RH) GOTO 100
          ENDIF

C
      ELSE
          GOTO 100
      ENDIF

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```
C
  700 CONTINUE
C
    WRITE (SCRN,1001)
  1001 FORMAT (' ',10(/))
C
    RETURN
C
C ---- format statements ----
C
  8003 FORMAT (A8)
C-----
C
    END
```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
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 21-FEB-85 RAP
C-----
C
C      INCLUDE 'ON SITE.CMN'
C      REAL*8 GNAME(2)
C
C      300 CONTINUE
C
C      WRITE (SCRN,1000) NVU(INUT), (UNITS(J,M3M2+1),J=1,2), NVU(INUT),
C      NVU(INUT)
C      1000 FORMAT(///T24,'Surface/Buried', T57,'Drinking'/
C      . T29, A4, T41, 'Irrigation      Water'/
C      . T11,'Radionuclide',T25,A8,A5, T43,A4,'/1', T58,A4,'/1',/
C      . T11,'-----',3X,3('-----',5X))
C
C      DO 100 I = 1, NIN
C      WRITE (SCRN,1001) ELTI(I), AWI(I), Q(I), QI(I), QJ(I)
C      100 CONTINUE
C      1001 FORMAT(11X,A2,A6,3(5X,1PG10.2))
C
C      GNAME(1) = 'the above'
C      GNAME(2) = 'e'
C      CALL GROUP (IGFLAG,GNAME)
C      IF (IGFLAG .NE. 0) THEN
C
C      IMOD = 1
C      WRITE (SCRN,1011)
C      1011 FORMAT (///' You may now modify the quantity of selected'/
C      . ' radionuclides. To delete a radionuclide,/'
C      . ' enter zero quantity.'////)
C
C      DO 200 I = 1, NIN
C      WRITE (SCRN,1010) ELTI(I), AWI(I), Q(I), NVU(INUT),
C      (UNITS(J,M3M2+1),J=1,2), QI(I), NVU(INUT), QJ(I), NVU(INUT)
C      1010 FORMAT (///' Radionuclide ',A2,A6,': '///
C      . ' Surface/Buried: ',1PG10.2,1X,A4,A8,A5/
C      . ' Irrigation: ',1PG10.2,1X,A4,'/1'/
C      . ' Drinking Water: ',1PG10.2,1X,A4,'/1')

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

      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 (N/Y) ?')
      READ (KEY,8001) IY
8001  FDMAT (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-----
      END

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
C
C      SUBROUTINE GROUP (IGFLAG, GNAME)
C
C      This subroutine introduces a new category of parameters and allows
C      the user the option of skipping edits to that entire group of
C      parameters.
C
C      Parameters:
C
C          IGFLAG - flag returned to calling program to indicate user
C                  preference 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 3-APR-85  RAP
C-----
C
C      INCLUDE 'ONSITE.CMN'
C      REAL*8 GNAME(2)
C      IGFLAG = 0
C
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
C      READ (KEY,8003) IDUM
8003 FORMAT (A1)
      IF (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y') IGFLAG = 1
C
C      RETURN
C-----
C
C      END

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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 'ON SITE.COMN'
C
C
C      WRITE (SCRN,2000)
2000 FORMAT (' ',24('/),30X, 19('=')/34X,'ON SITE/MAXI'/30X,
. 19('=')////////)
C
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
C      WRITE (SCRN,2010)
      READ (KEY,8003) IDUM
C
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
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
C      WRITE (SCRN,2010)
2010 FORMAT (/14X,'When you have finished reading, press <return>')
      READ (KEY,8003) IDUM
      8003 FORMAT (A8)
C
C----- loop until user is satisfied with scenario selection -----
C

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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,'etables, 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
    IF (IRS .EQ. 5) WRITE (SCRN,2500)

```


APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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

```
      END
```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
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 3-APR-85  RAP
C-----
C
C----- include common blocks, define variables and initialize -----
C
C      INCLUDE 'ON SITE.CMN'
C
C      REAL*8 R8X, GNAME(2)
C
C----- review/query/modify agricultural parameters -----
C
C      IF (IFOD .EQ. 0) GO TO 100
1000  CONTINUE
C
C      GNAME(1) = 'agricult'
C      GNAME(2) = 'ural'
C      CALL GROUP (IGFLAG, GNAME)
C      IF (IGFLAG .EQ. 0) GO TO 100
C
C      ---- skip roots is Scenario 3, assumes surface contamination ----
C      IF (IRS .EQ. 3) GO TO 122
C
C      IF (IRS .EQ. 1 .AND. ILOC .EQ. 4) THEN
C      ---- set parameters for room model ----
C      RF1 = 0.
C      RF2 = 1.
C      ELSE
120  CONTINUE
C      WRITE (SCRN,1120) RF1
1120  FORMAT (' ',20('/),' ',
C      . 'The fraction of total roots in top 15 cm of the soil is ',
C      . 1PG10.3,/
C      . ' (range = 0.0 to 1.0)')
C      CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0), (1.0), R8X)
C      IF (ICFLAG.EQ.1) RF1 = RX
C      WRITE (SCRN,1130) RF2
1130  FORMAT (' ',
C      . 'The fraction of total roots entering the buried waste '/
C      . ' below the top 15 cm plow layer of soil is ', 1PG10.3,
C      . ' (range = 0.0 to 1.0)')
C      CALL CHANGE ((2), ICFLAG, IX, IL, IH, RX, (0.0), (1.0), R8X)

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

        IF (ICFLAG.EQ.1) RF2 = RX
C
    RF = RF1 + RF2
    IF (RF .GT. 1.0) WRITE (SCRN,1140)
1140  FORMAT (///' !!! The sum of the previous two fractions cannot '/
      . ' be greater than 1.0: REENTER !!!')
    IF (RF .GT. 1.0) GO TO 120
    ENDIF
122  CONTINUE
C
    WRITE (SCRN,1166) IDT
1166  FORMAT (' ',20('/),' ',
      . 'The R.G. 1.109 diet raised onsite may be either: '//
      . 9X, ' 1 - Total diet (plant and animal products)'/,
      . 9X, ' 2 - Vegetable product diet (plant only)'/,
      . 9X, ' 3 - Animal product diet (milk, eggs, and meat only)',
      . '//, ' The default selection is ',I2,'.')
    CALL CHANGE ((1),ICFLAG, IX, (1), (3), RX,RL,RH,R8X)
    IF (ICFLAG.EQ.1) IDT = IX
C
    IF (FRSIZ .LT. 1.0) GOTO 1161
    WRITE (SCRN,1160) RPF2
1160  FORMAT (' ',20('/),' ',
      . 'The fraction of the selected 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
1161  CONTINUE
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

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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
100   CONTINUE
C----- review/query/modify external exposure parameters -----
C
      IF (IEXT .EQ. 0 .AND. ISUR .EQ. 0) GO TO 200
      GNAME(1) = 'ext. exp'
      GNAME(2) = 'osure '
      CALL GROUP (IGFLAG, GNAME)
      IF (IGFLAG .EQ. 0) GO TO 200
      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
      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
      WRITE (SCRN,1201) IWD
1201  FORMAT (' ',20('/),' ',
.      'The waste density may be either: '//
.      10X,' 1 - 1.8 g/cu cm (soil)'/
.      10X,' 2 - 1.0 g/cu cm (water)'/
.      10X,' 3 - 0.6 g/cu cm (0.5 water + 0.1 carbon) '//
.      ' The default selection is ',I2,')')
      CALL CHANGE ((1), ICFLAG, IX, (1), (3), RX,RL,RH,R8X)
      IF (ICFLAG.EQ.1) IWD = IX
200   CONTINUE
C----- review/query/modify inhalation exposure parameters -----
C
      IF (INHAL .EQ. 0) GO TO 300
C
      GNAME(1) = 'inhalati'
      GNAME(2) = 'on '
      CALL GROUP (IGFLAG, GNAME)
      IF (IGFLAG .EQ. 0) GO TO 300
      RIN = RINH * 8766.

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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

C
IF (INHAL.EQ. 2) GO TO 310

C
WRITE (SCRN,1310) AGE
1310  FORMAT (' ',
.      'The number of years that contamination existed'/
.      ' on the surface, to account for environmental'/
.      ' weathering, 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
AVCM = XDPT * 15.0
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.
310  CONTINUE

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
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

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C
320  CONTINUE
300  CONTINUE
C
C----- review/query/modify organ parameters -----
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, RBX)
      IF (ICFLAG.EQ.1) NORG = IX
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 (1)total',
.      'body, (6)bone,'/
.      '(8)lungs, (16)thyroid, and (23)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 no. ',I2,' is ',I2)
      CALL CHANGE ((1), ICFLAG, IX, (1), (23), RX, RL, RH, RBX)
      IF (ICFLAG.EQ.1) KORG(I) = IX
810  CONTINUE
C
800  CONTINUE
      RETURN
C
C-----
      END

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
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 'ON SITE.CMN'
C
C      REAL*8 ANS(2)
C      DATA ANS /'(N/Y)  ', '(Y/N)  '/
C
C      IA = 1
C      IF (ISUR .EQ. 1) IA = 2
C      WRITE (SCRN,2002) ANS(IA)
2002 FORMAT (' ',24('/), 14X,
.      'Do you wish to consider external exposure to surface'/
.14X,'contamination? ',A8)
C      READ (KEY,8004) IDUM
C      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) ISUR=1
C      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) ISUR=0
C
C      IA = 1
C      IF (IEXT .EQ. 1) IA=2
C      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)
C      READ (KEY,8004) IDUM
8004 FORMAT (A1)
C      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) IEXT=1
C      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) IEXT=0
C
C      IA = 1
C      IF (IFOD .EQ. 1) IA=2
C      WRITE (SCRN,2005) ANS(IA)
2005 FORMAT (' ', 24('/), 14X,
.      'Do you wish to consider farm product ingestion ?'/
.14X, A8)
C      READ (KEY,8004) IDUM
C      IF (IA .EQ. 1 .AND. (IDUM .EQ. 'Y' .OR. IDUM .EQ. 'y')) IFOD=1
C      IF (IA .EQ. 2 .AND. (IDUM .EQ. 'N' .OR. IDUM .EQ. 'n')) IFOD=0
C
C      IA = 1
C      IF (IWAT .EQ. 1) IA=2

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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
      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
      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

```


APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
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 22-FEB-85  RAP
C-----
C
C      INCLUDE 'ON SITE.CMN'
C
C      REAL*8 R8X
C      DIMENSION WHERE(3,2)
C
C      DATA WHERE /'depo','site','d on',
C      .           'bur','ed a','t' '/'
C
C202 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. 5) THEN
C          IA = 1
C      ELSE
C          IA = 2
C      ENDIF
C
C      WRITE (SCRN,1050) ELTI(I), AWI(I), (WHERE(J,IA),J=1,3),
C      .           NVU(INUT),(UNITS(J,M3M2+1), J=1,2)
C1050  FORMAT (// ' ',
C      .      'Enter the quantity of ',A2,A6,3A4,' the site at',
C      .      ' start of'/' calculation (units: ', A4, 2A8,') :')
C      CALL CHANGE((2),(2),IX,IL,IH,RX,(0.),(1.E30), R8X)
C      Q(I) = RX
C206  CONTINUE
C
C      IF (IRS .LT. 4) GO TO 301
C
C      WRITE (SCRN,1052)
C1052  FORMAT (' ',14('/),' ',
C      .      ' To consider only irrigation or only drinking water '
C      .      'contamination,/'
C      .      ' enter zero quantity for the other pathway.')
```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

CALL CHANGE ((2),(2), IX,IL,IH, RX, (0.), (1.E30), R8X)
QI(I) = RX
IF (QI(I) .GT. 0.) IWRL=1
C
302  CONTINUE
      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):')
      CALL CHANGE ((2),(2), IX,IL,IH, RX, (0.0), (1.E30), R8X)
      QJ(I) = RX
      IF (QJ(I) .GT. 0.) IWRL=1

301  CONTINUE
C
C      RETURN
C
C-----
      END

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
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 3-APR-85
C-----
C
C      INCLUDE 'ONSITE.CMN'
C
C      REAL*8 R8X,  ORG(23), CL(3)
C      DIMENSION E(300), A(300), NS(2,300), IS(2), IDORG(5)
C      REAL*8 A
C      INTEGER E
C
C      DATA ORG / 'tot body', 'body H2O', 'kidneys ', 'liver ', 'spleen ',
C      .          'bone ', 'fat ', 'lungs ', 'adrenals', 'testes ',
C      .          'ovaries ', 'skin ', 'brain ', 'muscle ', 'prostrat',
C      .          'thyroid ', 'pancreas', 'heart ', 'GI ', 'stomach ',
C      .          'sm. int.', 'ULI ', 'LLI ' /
C
C      DATA IDORG / 1,6,8,16,23/
C      DATA NIN, I /0,0/
C      DATA IS /' ', 'in'/
C      DATA CL / 'Class D ', 'Class W ', 'Class Y ' /
C      DATA FIRTIM /0/
C
C----- read in radionuclide library -----
C
C      IF (FIRTIM .EQ. 0) THEN
C
C      NUC = 1
C      READ(10,8003) IDUM
C8003  FORMAT (A8)
C
C      100 CONTINUE
C          READ(10,1001,END=992) E(NUC), A(NUC), IM, (NS(J,NUC),J=1,2)
C1001  FORMAT(A2,A8,8X,I2,41X,2I1)
C          IF (IM .EQ. 0) GO TO 200
C          NUC = NUC + 1
C          GO TO 100
C
C      200 CONTINUE
C      ENDIF
C
C----- set flag if translocation review/check desired -----

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

      READ (KEY,8001) IDUM
8001  FORMAT (A1)
C
C---- input name and source terms for each radionuclide -----
C
      149  CONTINUE
C
          WRITE (SCRN,2400)
2400  FORMAT (' ',10('/),' ',70('#'),///)
300    CONTINUE
          ICFLAG = 1
          WRITE (SCRN, 1010)
1010  FORMAT (// ' Enter new 2-character element ',
.      ' (98=list, 99=finished): ')
          READ (KEY,8005) IZ
8005  FORMAT (A2)
          IF (IZ .EQ. ' ') GO TO 149
          IF (IZ .EQ. '99') GO TO 148
          IF (IZ .EQ. '98') THEN
              CALL RDLIST (E,A)
              GOTO 149
          ENDIF
C
          WRITE (SCRN, 1011)
1011  FORMAT ('O Mass number input can be up to ',
.      '6 characters long.'/
.      ' Include metastable (M) and daughter (+D) designation,',
.      ' (i.e., TE127M+D)')//
.      ' Enter mass 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 already included, try ',
.      'again ???')//
                  GO TO 300
              ENDIF
144  CONTINUE
C

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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
C
    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

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
C
C      SUBROUTINE RDLIST (E,A)
C
C      This subroutine displays the radionuclide master list
C      when requested.
C
C      Module of ONSITE
C      Version of 14-FEB-85
C-----
C
C      INCLUDE 'ON SITE.CMN'
C      REAL E(300)
C      REAL*8 A(300)
C
C      300 CONTINUE
C
C      WRITE (SCRN,1000)
1000  FORMAT(///' Radionuclide inventory must be from the '
      .      'following list:')
C
C
C      DO 100 IN = 1, 96, 5
C      WRITE (SCRN,1001) (E(I), A(I), I=IN, IN+4)
100   CONTINUE
1001  FORMAT( 5(5X,A2,A6))
C
C
C      WRITE (SCRN,1020)
1020  FORMAT (' Press any key to continue...')
      READ (KEY,8001) IY
8001  FORMAT (A1)
C
C
C      RETURN
C-----
C
      END

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
C
C      SUBROUTINE RITFIL
C
C      This subroutine writes a file with input parameters and
C      system commands for MAX11. RITFIL is called by the program
C      ONSITE.
C
C      Module of ONSITE
C      INTRUD Version of 26-MAR-85  RAP
C-----
C
C      INCLUDE 'ON SITE.CMN'
C
C      200 CONTINUE
C
C----- assign library files to logical unit devices -----
C
C      WRITE (OUT, 3009)
C      3009 FORMAT ('SET DEF DISK1:[INTRUD.LIB]')
C
C      IF (IDT .LT. 2) WRITE (OUT, 3010)
C      3010 FORMAT ('ASSIGN FILE20.DAT FOR020'/
C      .          'ASSIGN FILE21.DAT FOR021')
C
C      IF (IDT .EQ. 2) WRITE (OUT, 3011)
C      3011 FORMAT ('ASSIGN VEG20.DAT FOR020'/
C      .          'ASSIGN VEG21.DAT FOR021')
C
C      IF (IDT .EQ. 3) WRITE (OUT, 3012)
C      3012 FORMAT ('ASSIGN MEAT20.DAT FOR020'/
C      .          'ASSIGN MEAT21.DAT FOR021')
C
C
C      IF (IARG .GT. 0) WRITE (OUT, 3020)
C      WRITE (OUT,3020)
C      3020 FORMAT ('ASSIGN FILE24.DAT FOR024')
C
C      IF (IWAT .GT. 0) WRITE (OUT, 3030)
C      WRITE (OUT,3030)
C      3030 FORMAT ('ASSIGN FILE25.DAT FOR025')
C
C      WRITE (OUT,8200)
C      8200 FORMAT ('ASSIGN PLANEA.DAT FOR022')
C
C      IF (ILOC .EQ. 1 .AND. IWD .EQ. 1) WRITE (OUT, 3040)
C      3040 FORMAT ('ASSIGN PLANEA.DAT FOR022')
C
C      IF (ILOC .EQ. 1 .AND. IWD .EQ. 2) WRITE (OUT,3088)

```


APPENDIX B COMPUTER CODE LISTING - ONSITE

```

3088 FORMAT ('ASSIGN PLANE.B.DAT FOR022')
C
    IF (ILOC .EQ. 1 .AND. IWD .EQ. 3) WRITE (OUT,3089)
3089 FORMAT ('ASSIGN PLANE.C.DAT FOR022')
C
    WRITE (OUT, 8201)
8201 FORMAT ('ASSIGN VOLSOURCA.DAT FOR027')
C
    IF (ILOC .EQ. 2 .AND. IWD .EQ. 1) WRITE (OUT, 3044)
3044 FORMAT ('ASSIGN VOLSOURCA.DAT FOR027')
C
    IF (ILOC .EQ. 2 .AND. IWD .EQ. 2) WRITE (OUT, 3031)
3031 FORMAT ('ASSIGN VOLSOURCB.DAT FOR027')
C
    IF (ILOC .EQ. 2 .AND. IWD .EQ. 3) WRITE (OUT, 3032)
3032 FORMAT ('ASSIGN VOLSOURCC.DAT FOR027')
C
C
    IF (ILOC .EQ. 3 .AND. IWD .EQ. 1) WRITE (OUT, 3041)
3041 FORMAT ('ASSIGN BURIEDHFA.DAT FOR027')
C
    IF (ILOC .EQ. 3 .AND. IWD .EQ. 2) WRITE (OUT, 3033)
3033 FORMAT ('ASSIGN BURIEDHFA.DAT FOR027')
C
    IF (ILOC .EQ. 3 .AND. IWD .EQ. 3) WRITE (OUT, 3034)
3034 FORMAT ('ASSIGN BURIEDHFB.DAT FOR027')
C
C
    IF (ILOC .EQ. 4 .AND. IWD .EQ. 1) WRITE (OUT, 3042)
3042 FORMAT ('ASSIGN BURIED1A.DAT FOR027')
C
    IF (ILOC .EQ. 4 .AND. IWD .EQ. 2) WRITE (OUT, 3035)
3035 FORMAT ('ASSIGN BURIED1B.DAT FOR027')
C
    IF (ILOC .EQ. 4 .AND. IWD .EQ. 3) WRITE (OUT, 3036)
3036 FORMAT ('ASSIGN BURIED1C.DAT FOR027')
C
    IF (ILOC .EQ. 5 .AND. IWD .EQ. 1) WRITE (OUT, 3037)
3037 FORMAT ('ASSIGN STOREDA.DAT FOR027')
C
    IF (ILOC .EQ. 5 .AND. IWD .EQ. 2) WRITE (OUT, 3038)
3038 FORMAT ('ASSIGN STOREDB.DAT FOR027')
C
    IF (ILOC .EQ. 5 .AND. IWD .EQ. 3) WRITE (OUT,3039)
3039 FORMAT ('ASSIGN STOREDC.DAT FOR027')
C
    WRITE (OUT, 3050)
3050 FORMAT ('ASSIGN RMDLIB.DAT FOR010'/
    .      'ASSIGN FILE23.DAT FOR023')
C

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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) (TITL(I), I=1,20)
3100 FORMAT ('RUN DISK1:[INTRUD.TAP]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, FR Siz, AREAIN, AREAEX

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

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 23-MAR-85 RAP
C-----
      INCLUDE 'ON SITE.CMN'
C
C----- set default values per scenario -----
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, 2, 0 /
      DATA SRDIL, INUT /0.2, 1/
      DATA FRISZ, AREAIN, AREAEX /1.0, 1.0, 1.0/
      DATA IWD, IDT /1,1/
C
      IF (IRS .EQ. 1) ILOC=3
      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
      END

```

APPENDIX B COMPUTER CODE LISTING - ONSITE

```

C-----
C-----
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 'ON SITE.CMN'
C
C      WRITE (SCRN,2004)
2004 FORMAT (' ', 24('/), 13X,
C      .      'The following scenarios have been defined: '//
C      .14X,'1 - External exposure'//
C      .14X,'2 - External exposure plus inhalation from resuspension'//
C      .14X,'3 - Agricultural activities '//
C      .14X,'4 - Use of well water for irrigation and drinking water'//
C      .14X,'5 - User-created scenario'//)
C
C      100 CONTINUE
C      WRITE (SCRN,2006)
2006 FORMAT(14X,'To select a scenario or for additional information'//
C      .14X,'on a scenario enter 1, 2, 3, 4, or 5: ')
C
C      READ (KEY,*) IRS
C      IF (IRS .LT. 1 .OR. IRS .GT. 5) GO TO 100
C
C      RETURN
C-----
C
C      END

```


APPENDIX C

EXTERNAL EXPOSURE DOSE RATE FACTOR LIBRARIES

CONTENTS

PLANE A.....	C.1
PLANE B.....	C.3
PLANE C.....	C.5
STOREDA.....	C.7
STOREDB.....	C.9
STOREDC.....	C.11
VOL SOURCE A.....	C.13
VOL SOURCE B.....	C.15
VOL SOURCE C.....	C.17
BURIEDHFA.....	C.19
BURIEDHFB.....	C.21
BURIEDHFC.....	C.23
BURIED1A.....	C.25
BURIED1B.....	C.27
BURIED1C.....	C.29

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - PLANE A

ONSITE/MAXI 15 CM. PLANE SOURCE ON SURFACE (DEN: CONCRETE/1.8) MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	6.2E-04
NA22	4.3E+02
P 32	9.2E-01
P 33	2.8E-03
S 35	0.0E+00
CL36	7.5E-02
K 40	5.7E+01
CA45	2.8E-03
SC46	7.2E+02
CR51	1.1E+01
MN54	2.9E+02
FE55	0.0E+00
FE59	4.0E+02
CO57	2.1E+01
CO60	8.6E+02
NI59	0.0E+00
NI63	1.4E-05
ZN65	2.2E+02
SE75	9.2E+01
SR85	1.8E+02
SR90+D	1.9E+00
MO93	1.4E+00
NB94	5.3E+02
RU106+D	4.1E+01
CD109	7.6E+00
AG110M+D1	1.1E+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	4.2E+02
TB160	3.8E+02
OS185	2.5E+02
OS191	7.9E+00
IR192	2.5E+02
HG203	4.7E+01
PB210+D	3.4E-01
RA226+D	4.7E+02
TH228+D	1.2E+03
TH230+D	1.7E-02
TH232+D	7.4E-01
U 233+D	4.2E-03
U 234	6.9E-02
U 235+D	2.1E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - PLANE A

U 238+D	4.9E+00
NP237+D	6.2E+01
PU241+D	1.1E+00
SR89	5.7E-01
Y 89M	3.7E+00
SR90	3.0E-02
Y 90	1.9E+00
M099	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	1.3E+00
PA231	8.6E+00
AC227	1.3E-02
TH227	2.5E+01
FR223	7.6E+00
RA223	2.6E+01
NP237	1.9E+00
PA233	6.0E+01
U 233	4.2E-03
TH229	1.8E+00
RA225	6.8E-01
AC225	1.7E+00
U 238	9.8E-03
TH234	7.5E-01
PA234M	2.9E+00
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	4.7E-02
PU240	2.7E-03
CM243	2.5E+01
PU243	2.7E+00
AM243	3.6E+00
NP239	2.9E+01
PU239	2.9E-03
PU241	2.9E-12
AM241	1.1E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - PLANE B

ONSITE/MAXI 15 CM. PLANE SOURCE ON SURFACE (DEN: WATER 1.0) MR/HR 26-JUN-85
100

H 3	0.0E+00
C 14	5.2E-03
NA22	6.4E+02
P 32	2.3E+00
P 33	5.1E-02
S 35	0.0E+00
CL36	1.8E-02
K 40	8.8E+01
CA45	1.8E-02
SC46	1.1E+03
CR51	2.3E+01
MN54	4.8E+02
FE55	0.0E+00
FE59	5.8E+02
CO57	6.2E+01
CO60	1.3E+03
NI59	0.0E+00
NI63	2.9E-13
ZN65	3.4E+02
SE75	2.2E+02
SR85	3.7E+02
SR90+D	4.7E+00
MO93	1.3E+01
NB94	9.4E+02
RU106+D	8.0E+01
CD109	2.6E+01
AG110M+D	1.8E+03
IN111	2.0E+02
SB124	1.2E+03
SB125+D	3.4E+02
I 125+D	1.2E+01
I 131+D	2.6E+02
CS137+D	3.9E+02
CE144+D	3.4E+01
EU152	6.5E+02
EU154	6.8E+02
TB160	6.0E+02
OS185	4.7E+02
OS191	2.7E+01
IR192	5.4E+02
HG203	1.2E+02
PB210+D	1.4E+00
RA226+D	7.6E+02
TH228+D	1.9E+03
TH230+D	7.7E-02
TH232+D	4.2E+00
U 233+D	3.2E-02
U 234	2.6E-01
U 235+D	6.1E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - PLANE B

U 238+D	9.3E+00
NP237+D	1.4E+02
PU241+D	6.4E+00
SR89	1.6E+00
Y 89M	5.3E+00
SR90	1.3E-01
Y 90	4.6E+00
MO99	9.2E+01
TC99M	5.5E+01
TC99	2.4E-02
RU103	3.7E+02
RH103M	8.7E-01
PD103	4.7E+00
I 129	6.2E+00
CS134	1.1E+03
CS135	9.6E-03
CS137	1.6E-01
BA137M	4.1E+02
CE141	3.2E+01
SM151	4.4E-03
U 235	5.6E+01
TH231	5.4E+00
PA231	1.9E+01
AC227	4.0E-02
TH227	6.0E+01
FR223	2.3E+01
RA223	6.4E+01
NP237	7.8E+00
PA233	1.3E+02
U 233	3.2E-02
TH229	5.8E+00
RA225	5.4E+00
AC225	5.0E+00
U 238	5.6E-02
TH234	2.6E+00
PA234M	4.6E+00
PA234	1.0E+03
PU242	6.5E-03
NP238	2.9E+02
PU238	1.3E-02
CM244	1.5E-02
PU244	1.2E-05
U 240	2.7E-01
PU240	1.1E-02
CM243	6.7E+01
PU243	8.1E+00
AM243	1.4E+01
NP239	7.6E+01
PU239	1.1E-02
PU241	5.0E-11
AM241	6.4E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - PLANEC

ONSITE/MAXI 15 CM. PLANE SOURCE ON SURF. (DEN: H2O:CARBON/.5,.1)MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	8.3E-03
NA22	7.8E+02
P 32	3.1E+00
P 33	2.8E-02
S 35	0.0E+00
CL36	4.0E-01
K 40	1.1E+02
CA45	2.8E-02
SC46	1.4E+03
CR51	2.9E+01
MN54	6.0E+02
FE55	0.0E+00
FE59	7.2E+02
CO57	8.4E+01
CO60	1.6E+03
NI59	0.0E+00
NI63	3.3E-04
ZN65	4.1E+02
SE75	3.0E+02
SR85	4.8E+02
SR90+D	6.3E+00
MO93	2.1E+01
NB94	1.2E+03
RU106+D	1.0E+02
CD109	3.6E+01
AG110M+D	2.2E+03
IN111	2.7E+02
SB124	1.5E+03
SB125+D	4.3E+02
I 125+D	2.0E+01
I 131+D	3.4E+02
CS137+D	4.8E+02
CE144+D	4.4E+01
EU152	8.0E+02
EU154	8.4E+02
TB160	7.5E+02
OS185	5.8E+02
OS191	3.8E+01
IR192	6.9E+02
HG203	1.5E+02
PB210+D	2.1E+00
RA226+D	9.4E+02
TH228+D	2.2E+03
TH230+D	1.1E-01
TH232+D	6.1E+00
U 233+D	4.9E-02
U 234	3.7E-01
U 235+D	8.4E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - PLANEC

U 238+D	1.2E+01
NP237+D	1.8E+02
PU241+D	9.5E+00
SR89	2.1E+00
Y 89M	6.6E+00
SR90	1.9E-01
Y 90	6.1E+00
MO99	1.1E+02
TC99M	7.6E+01
TC99	3.6E-02
RU103	4.6E+02
RH103M	1.5E+00
PD103	8.2E+00
I 129	1.0E+01
CS134	1.3E+03
CS135	1.5E-02
CS137	2.2E-01
BA137M	5.1E+02
CE141	4.5E+01
SM151	7.6E-03
U 235	7.6E+01
TH231	8.0E+00
PA231	2.6E+01
AC227	5.5E-02
TH227	7.9E+01
FR223	3.1E+01
RA223	8.6E+01
NP237	1.1E+01
PA233	1.7E+02
U 233	4.9E-02
TH229	8.1E+00
RA225	8.1E+00
AC225	6.8E+00
U 238	8.1E-02
TH234	3.6E+00
PA234M	5.8E+00
PA234	1.3E+03
PU242	9.8E-03
NP238	3.7E+02
PU238	1.8E-02
CM244	2.2E-02
PU244	2.2E-05
U 240	5.0E-01
PU240	1.6E-02
CM243	9.0E+01
PU243	1.1E+01
AM243	2.1E+01
NP239	1.0E+02
PU239	1.6E-02
PU241	9.1E-11
AM241	9.5E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - STOREDA

ONSITE/MAXI - STORED: 1.0 M THICK FINITE SLAB (DEN: soil 1.8) MR/HR 26-JUN-85

	100
H 3	7.6E-15
C 14	1.0E-04
NA22	1.7E+02
P 32	3.4E-01
P 33	6.3E-04
S 35	0.0E+00
CL36	2.5E-02
K 40	2.2E+01
CA45	6.4E-04
SC46	2.8E+02
CR51	4.1E+00
MN54	1.1E+02
FE55	0.0E+00
FE59	1.5E+02
CO57	8.2E+00
CO60	3.3E+02
NI59	0.0E+00
NI63	1.2E-06
ZN65	8.7E+01
SE75	3.6E+01
SR85	7.0E+01
SR90+D	7.3E-01
MO93	1.3E-01
NB94	2.0E+02
RU106+D	1.6E+01
CD109	2.2E+00
AG110M+D	4.0E+02
IN111	2.9E+01
SB124	2.8E+02
SB125+D	6.4E+01
I 125+D	7.4E-02
I 131+D	4.7E+01
CS137+D	7.7E+01
CE144+D	6.4E+00
EU152	1.6E+02
EU154	1.6E+02
TB160	1.5E+02
OS185	9.3E+01
OS191	2.8E+00
IR192	9.8E+01
HG203	1.8E+01
PB210+D	1.0E-01
RA226+D	1.8E+02
TH228+D	4.9E+02
TH230+D	4.7E-03
TH232+D	2.0E-01
U 233+D	6.4E-04
U 234	2.4E-02
U 235+D	8.0E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - STOREDA

U 238+D	1.8E+00
NP237+D	2.4E+01
PU241+D	3.0E-01
SR89	2.1E-01
Y 89M	1.4E+00
SR90	9.5E-03
Y 90	7.2E-01
M099	1.8E+01
TC99M	7.4E+00
TC99	1.0E-03
RU103	6.9E+01
RH103M	4.0E-03
PD103	3.2E-02
I 129	3.8E-02
CS134	2.3E+02
CS135	2.6E-04
CS137	1.4E-02
BA137M	8.2E+01
CE141	4.0E+00
SM151	1.8E-05
U 235	7.6E+00
TH231	3.9E-01
PA231	3.3E+00
AC227	5.0E-03
TH227	9.5E+00
FR223	2.7E+00
RA223	9.7E+00
NP237	5.6E-01
PA233	2.3E+01
U 233	6.4E-04
TH229	7.0E-01
RA225	7.3E-02
AC225	5.7E-01
U 238	2.6E-03
TH234	2.3E-01
PA234M	1.1E+00
PA234	2.4E+02
PU242	8.6E-05
NP238	7.9E+01
PU238	9.1E-04
CM244	1.9E-04
PU244	7.9E-09
U 240	7.6E-03
PU240	8.9E-04
CM243	9.8E+00
PU243	8.8E-01
AM243	1.0E+00
NP239	1.1E+01
PU239	1.0E-03
PU241	2.9E-14
AM241	3.0E-01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - STOREDB

ONSITE/MAXI - STORED: 1.0 M THICK FINITE SLAB (DEN: H2O 1.0) MR/HR 26-JUN-85

100
H 3 7.3E-12
C 14 3.4E-03
NA22 3.0E+02
P 32 1.1E+00
P 33 1.1E-02
S 35 0.0E+00
CL36 1.5E-01
K 40 4.5E+01
CA45 1.1E-02
SC46 5.3E+02
CR51 9.8E+00
MN54 2.2E+02
FE55 0.0E+00
FE59 2.8E+02
CO57 2.7E+01
CO60 6.1E+02
NI59 0.0E+00
NI63 1.4E-04
ZN65 1.6E+02
SE75 9.7E+01
SR85 1.7E+02
SR90+D 2.2E+00
MO93 7.9E+00
NB94 4.3E+02
RU106+D 3.6E+01
CD109 1.7E+01
AG110M+D8.4E+02
IN111 8.8E+01
SB124 5.7E+02
SB125+D 1.6E+02
I 125+D 8.2E+00
I 131+D 1.2E+02
CS137+D 1.8E+02
CE144+D 1.6E+01
EU152 3.1E+02
EU154 3.2E+02
TB160 2.8E+02
OS185 2.2E+02
OS191 1.4E+01
IR192 2.3E+02
HG203 5.1E+01
PB210+D 7.6E-01
RA226+D 3.7E+02
TH228+D 9.3E+02
TH230+D 5.1E-02
TH232+D 2.8E+00
U 233+D 2.0E-02
U 234 1.4E-01
U 235+D 2.8E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - STOREDB

U 238+D	4.8E+00
NP237+D	6.4E+01
PU241+D	4.3E+00
SR89	7.8E-01
Y 89M	2.5E+00
SR90	7.3E-02
Y 90	2.2E+00
MO99	4.2E+01
TC99M	2.4E+01
TC99	1.5E-02
RU103	1.6E+02
RH103M	6.2E-01
PD103	3.4E+00
I 129	4.3E+00
CS134	4.9E+02
CS135	6.2E-03
CS137	8.5E-02
BA137M	1.9E+02
CE141	1.4E+01
SM151	3.2E-03
U 235	2.5E+01
TH231	3.5E+00
PA231	8.8E+00
AC227	1.9E-02
TH227	2.7E+01
FR223	1.2E+01
RA223	3.1E+01
NP237	5.2E+00
PA233	5.9E+01
U 233	2.0E-02
TH229	2.6E+00
RA225	3.1E+00
AC225	2.8E+00
U 238	3.7E-02
TH234	1.6E+00
PA234M	2.2E+00
PA234	4.9E+02
PU242	3.7E-03
NP238	1.4E+02
PU238	6.4E-03
CM244	8.3E-03
PU244	6.6E-06
U 240	1.9E-01
PU240	5.4E-03
CM243	2.9E+01
PU243	4.9E+00
AM243	9.3E+00
NP239	3.3E+01
PU239	5.9E-03
PU241	2.8E-11
AM241	4.3E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - STOREDC

ONSITE/MAXI - STORED: 1.0 M FINITE SLAB (DEN: H2O:CARBON/.5,.1) MR/HR 26-JUN-85

	100
H 3	5.6E-14
C 14	9.1E-04
NA22	4.8E+02
P 32	1.5E+00
P 33	4.3E-03
S 35	0.0E+00
CL36	1.3E-01
K 40	6.7E+01
CA45	4.3E-03
SC46	8.3E+02
CR51	1.6E+01
MN54	3.6E+02
FE55	0.0E+00
FE59	4.4E+02
CO57	4.4E+01
CO60	9.5E+02
NI59	0.0E+00
NI63	2.3E-05
ZN65	2.5E+02
SE75	1.6E+02
SR85	2.7E+02
SR90+D	3.0E+00
MO93	1.6E+00
NB94	6.9E+02
RU106+D	5.7E+01
CD109	9.3E+00
AG110M+D	1.3E+03
IN111	1.4E+02
SB124	8.9E+02
SB125+D	2.4E+02
I 125+D	1.4E+00
I 131+D	1.8E+02
CS137+D	2.8E+02
CE144+D	2.3E+01
EU152	4.8E+02
EU154	5.0E+02
TB160	4.4E+02
OS185	3.3E+02
OS191	1.5E+01
IR192	3.8E+02
HG203	8.1E+01
PB210+D	5.1E-01
RA226+D	5.7E+02
TH228+D	1.4E+03
TH230+D	2.8E-02
TH232+D	1.6E+00
U 233+D	5.8E-03
U 234	1.5E-01
U 235+D	4.1E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - STOREDC

U 238+D	5.8E+00
NP237+D	9.2E+01
PU241+D	2.4E+00
SR89	9.3E-01
Y 89M	3.9E+00
SR90	5.2E-02
Y 90	3.0E+00
MO99	6.6E+01
TC99M	3.9E+01
TC99	6.3E-03
RU103	2.6E+02
RH103M	1.0E-01
PD103	5.8E-01
I 129	7.2E-01
CS134	7.7E+02
CS135	2.0E-03
CS137	7.0E-02
BA137M	3.0E+02
CE141	2.1E+01
SM151	5.0E-04
U 235	3.9E+01
TH231	1.9E+00
PA231	1.3E+01
AC227	2.5E-02
TH227	4.1E+01
FR223	1.3E+01
RA223	4.1E+01
NP237	2.7E+00
PA233	9.0E+01
U 233	5.8E-03
TH229	3.8E+00
RA225	6.8E-01
AC225	2.5E+00
U 238	2.1E-02
TH234	9.8E-01
PA234M	3.3E+00
PA234	7.7E+02
PU242	8.2E-04
NP238	2.2E+02
PU238	5.2E-03
CM244	1.8E-03
PU244	8.4E-08
U 240	5.7E-02
PU240	5.0E-03
CM243	4.7E+01
PU243	3.6E+00
AM243	5.0E+00
NP239	5.4E+01
PU239	5.9E-03
PU241	2.1E-13
AM241	2.4E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - VOL SOURCA

ONSITE/MAXI 1.0 M THICK VOL. SOURCE ON SURF. (DEN: CONCRETE/1.8)MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	6.2E-04
NA22	5.1E+02
P 32	9.8E-01
P 33	2.8E-03
S 35	0.0E+00
CL36	7.7E-02
K 40	7.0E+01
CA45	2.8E-03
SC46	8.4E+02
CR51	1.2E+01
MN54	3.3E+02
FE55	0.0E+00
FE59	4.7E+02
CO57	2.1E+01
CO60	1.0E+03
NI59	0.0E+00
NI63	1.4E-05
ZN65	2.7E+02
SE75	9.6E+01
SR85	2.0E+02
SR90+D	2.1E+00
MO93	1.4E+00
NB94	6.0E+02
RU106+D	4.6E+01
CD109	7.6E+00
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	1.9E+01
EU152	4.7E+02
EU154	4.9E+02
TB160	4.4E+02
OS185	2.7E+02
OS191	8.0E+00
IR192	2.7E+02
HG203	4.9E+01
PB210+D	3.5E-01
RA226+D	5.5E+02
TH228+D	1.6E+03
TH230+D	1.7E-02
TH232+D	7.4E-01
U 233+D	4.2E-03
U 234	6.9E-02
U 235+D	2.1E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - VOLSOURCA

U 238+D	5.6E+00
NP237+D	6.7E+01
PU241+D	1.1E+00
SR89	6.1E-01
Y 89M	4.4E+00
SR90	3.0E-02
Y 90	2.1E+00
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	1.3E+00
PA231	9.3E+00
AC227	1.3E-02
TH227	2.6E+01
FR223	8.0E+00
RA223	2.7E+01
NP237	2.0E+00
PA233	6.5E+01
U 233	4.2E-03
TH229	1.9E+00
RA225	6.8E-01
AC225	1.7E+00
U 238	9.8E-03
TH234	7.6E-01
PA234M	3.4E+00
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	4.7E-02
PU240	2.7E-03
CM243	2.6E+01
PU243	2.8E+00
AM243	3.6E+00
NP239	3.0E+01
PU239	2.9E-03
PU241	2.9E-12
AM241	1.1E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - VOLSOURCE

ONSITE/MAXI 1.0 M THICK VOL. SOURCE ON SURF. (DEN: WATER 1.0) MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	5.4E-03
NA22	9.6E+02
P 32	2.8E+00
P 33	5.9E-02
S 35	0.0E+00
CL36	1.9E-02
K 40	1.5E+02
CA45	1.9E-02
SC46	1.6E+03
CR51	2.8E+01
MN54	6.8E+02
FE55	0.0E+00
FE59	8.7E+02
CO57	7.0E+01
CO60	1.9E+03
NI59	0.0E+00
NI63	2.9E-13
ZN65	5.1E+02
SE75	2.7E+02
SR85	4.8E+02
SR90+D	5.8E+00
MO93	1.3E+01
NB94	1.3E+03
RU106+D	1.1E+02
CD109	2.8E+01
AG110M+D	2.6E+03
IN111	2.3E+02
SB124	1.8E+03
SB125+D	4.6E+02
I 125+D	1.2E+01
I 131+D	3.3E+02
CS137+D	5.4E+02
CE144+D	4.6E+01
EU152	9.6E+02
EU154	9.8E+02
TB160	8.6E+02
OS185	6.5E+02
OS191	3.0E+01
IR192	6.7E+02
HG203	1.4E+02
PB210+D	1.6E+00
RA226+D	1.2E+03
TH228+D	3.1E+03
TH230+D	8.3E-02
TH232+D	4.4E-00
U 233+D	3.4E-02
U 234	2.9E-01
U 235+D	7.0E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - VOL SOURCE

U 238+D	1.2E+01
NP237+D	1.7E+02
PU241+D	6.8E+00
SR89	1.9E+00
Y 89M	7.8E+00
SR90	1.4E-01
Y 90	5.6E+00
MO99	1.3E+02
TC99M	6.3E+01
TC99	2.5E-02
RU103	4.8E+02
RH103M	8.8E-01
PD103	4.8E+00
I 129	6.2E+00
CS134	1.5E+03
CS135	1.0E-02
CS137	1.7E-01
BA137M	5.7E+02
CE141	3.6E+01
SM151	4.4E-03
U 235	6.4E+01
TH231	5.8E+00
PA231	2.4E+01
AC227	4.5E-02
TH227	7.1E+01
FR223	2.6E+01
RA223	7.6E+01
NP237	8.5E+00
PA233	1.6E+02
U 233	3.4E-02
TH229	6.5E+00
RA225	5.6E+00
AC225	5.6E+00
U 238	5.9E-02
TH234	2.8E+00
PA234M	6.5E+00
PA234	1.5E+03
PU242	6.8E-03
NP238	4.3E+02
PU238	1.4E-02
CM244	1.5E-02
PU244	1.2E-05
U 240	2.8E-01
PU240	1.2E-02
CM243	7.7E+01
PU243	9.1E+00
AM243	1.5E+01
NP239	8.8E+01
PU239	1.2E-02
PU241	5.0E-11
AM241	6.8E+00

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - VOL SOURCC

ONSITE/MAXI 1.0 M THICK VOL. SOURCE ON SURF. (DEN: H2O:CARBON/.5,.1) 26-JUN-85

	100
H 3	0.0E+00
C 14	9.3E-03
NA22	1.6E+03
P 32	4.7E+00
P 33	3.2E-02
S 35	0.0E+00
CL36	5.2E-01
K 40	2.4E+02
CA45	3.2E-02
SC46	2.7E+03
CR51	4.7E+01
MN54	1.1E+03
FE55	0.0E+00
FE59	1.4E+03
CO57	1.2E+02
CO60	3.2E+03
NI59	0.0E+00
NI63	3.5E-04
ZN65	8.4E+02
SE75	4.5E+02
SR85	8.1E+02
SR90+D	9.7E+00
MO93	2.3E+01
NB94	2.2E+03
RU106+D	1.8E+02
CD109	4.7E+01
AG110M+D4	3E+03
IN111	3.9E+02
SB124	3.0E+03
SB125+D	7.5E+02
I 125+D	2.1E+01
I 131+D	5.5E+02
CS137+D	8.8E+02
CE144+D	7.7E+01
EU152	1.6E+03
EU154	1.6E+03
TB160	1.4E+03
OS185	1.1E+03
OS191	5.0E+01
IR192	1.1E+03
HG203	2.3E+02
PB210+D	2.7E+00
RA226+D	1.9E+03
TH228+D	5.0E+03
TH230+D	1.4E-01
TH232+D	7.5E+00
U 233+D	5.8E-02
U 234	4.8E-01
U 235+D	1.2E+02

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - VOLSOURCE

U 238+D	2.1E+01
NP237+D	2.8E+02
PU241+D	1.2E+01
SR89	3.1E+00
Y 89M	1.3E+01
SR90	2.4E-01
Y 90	9.4E+00
M099	2.1E+02
TC99M	1.1E+02
TC99	4.2E-02
RU103	8.0E+02
RH103M	1.5E+00
PD103	8.4E+00
I 129	1.1E+01
CS134	2.5E+03
CS135	1.7E-02
CS137	2.9E-01
BA137M	9.3E+02
CE141	6.1E+01
SM151	7.8E-03
U 235	1.1E+02
TH231	9.8E+00
PA231	4.0E+01
AC227	7.5E-02
TH227	1.2E+02
FR223	4.4E+01
RA223	1.3E+02
NP237	1.4E+01
PA233	2.7E+02
U 233	5.8E-02
TH229	1.1E+01
RA225	9.6E+00
AC225	9.4E+00
U 238	1.0E-01
TH234	4.7E+00
PA234M	1.1E+01
PA234	2.5E+03
PU242	1.2E-02
NP238	7.2E+02
PU238	2.3E-02
CM244	2.6E-02
PU244	2.1E-05
U 240	6.0E-01
PU240	2.0E-02
CM243	1.3E+02
PU243	1.6E+01
AM243	2.6E+01
NP239	1.5E+02
PU239	2.1E-02
PU241	9.1E-11
AM241	1.2E+01

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIEDHFA

ONSITE/MAXI BURIED AT 0.5 M (DENSITY: CONCRETE 1.8) MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	1.2E-12
NA22	1.8E+00
P 32	4.2E-04
P 33	2.5E-06
S 35	0.0E+00
CL36	1.9E-10
K 40	3.9E-01
CA45	1.9E-10
SC46	2.3E+00
CR51	2.8E-03
MN54	4.4E-01
FE55	0.0E+00
FE59	1.6E+00
CO57	8.4E-06
CO60	3.7E+00
NI59	0.0E+00
NI63	0.0E+00
ZN65	9.3E-01
SE75	1.5E-02
SR85	1.1E-01
SR90+D	1.7E-03
MO93	3.5E-34
NB94	6.1E-01
RU106+D	6.2E-02
CD109	5.5E-08
AG110M+D	2.7E+00
IN111	1.3E-03
SB124	4.2E+00
SB125+D	1.1E-01
I 125+D	1.2E-34
I 131+D	4.0E-02
CS137+D	1.5E-01
CE144+D	1.1E-01
EU152	1.6E+00
EU154	1.4E+00
TB160	1.1E+00
OS185	2.0E-01
OS191	2.2E-06
IR192	9.0E-02
HG203	1.1E-03
PB210+D	5.0E-05
RA226+D	2.4E+00
TH228+D	2.4E+01
TH230+D	3.1E-14
TH232+D	3.9E-16
U 233+D	6.5E-19
U 234	1.9E-08
U 235+D	8.7E-05

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIEDHFA

U 238+D	1.2E-02
NP237+D	1.6E-02
PU241+D	2.6E-09
SR89	1.8E-04
Y 89M	1.4E-02
SR90	5.5E-07
Y 90	1.7E-03
MO99	4.4E-02
TC99M	7.5E-06
TC99	7.8E-10
RU103	1.1E-01
RH103M	2.7E-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	1.6E+00
PU242	2.7E-27
NP238	7.4E-01
PU238	8.4E-10
CM244	6.2E-27
PU244	0.0E+00
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	0.0E+00
AM241	2.6E-09

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIEDHFB

ONSITE/MAXI 1.0 M THICK BURIED AT 0.5 M (DEN: WATER 1.0) MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	4.0E-12
NA22	3.5E+00
P 32	9.5E-04
P 33	6.7E-06
S 35	0.0E+00
CL36	6.2E-10
K 40	8.2E-01
CA45	6.3E-10
SC46	4.5E+00
CR51	7.0E-03
MN54	9.8E-01
FE55	0.0E+00
FE59	3.0E+00
CO57	2.8E-05
CO60	7.0E+00
NI59	0.0E+00
NI63	0.0E+00
ZN65	1.8E+00
SE75	3.9E-02
SR85	2.7E-01
SR90+D	3.6E-03
MO93	2.2E-33
NB94	1.4E+00
RU106+D	1.3E-01
CD109	2.0E-07
AG110M+D5	6.6E+00
IN111	3.8E-03
SB124	8.6E+00
SB125+D	2.6E-01
I 125+D	7.6E-34
I 131+D	9.9E-02
CS137+D	3.4E-01
CE144+D	2.2E-01
EU152	3.2E+00
EU154	2.6E+00
TB160	2.2E+00
OS185	4.6E-01
OS191	7.2E-06
IR192	2.3E-01
HG203	3.1E-03
PB210+D	1.2E-D4
RA226+D	4.9E+00
TH228+D	4.6E+01
TH230+D	1.4E-13
TH232+D	2.1E-15
U 233+D	3.5E-18
U 234	6.4E-08
U 235+D	2.5E-04

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIEDHFB

U 238+D	2.4E-02
NP237+D	4.0E-02
PU241+D	8.7E-09
SR89	4.3E-04
Y 89M	2.5E-02
SR90	1.4E-06
Y 90	3.6E-03
MO99	1.0E-01
TC99M	2.5E-05
TC99	2.4E-09
RU103	2.7E-01
RH103M	1.8E-25
PD103	2.3E-05
I 129	2.2E-12
CS134	1.8E+00
CS135	1.1E-10
CS137	1.1E-05
BA137M	3.6E-01
CE141	1.4E-05
SM151	8.2E-19
U 235	2.5E-04
TH231	3.5E-07
PA231	4.8E-03
AC227	1.4E-08
TH227	6.1E-03
FR223	5.1E-03
RA223	1.0E-02
NP237	9.3E-08
PA233	4.0E-02
U 233	3.5E-18
TH229	2.4E-06
RA225	1.3E-08
AC225	4.1E-05
U 238	2.8E-17
TH234	1.5E-07
PA234M	1.7E-02
PA234	3.3E+00
PU242	1.8E-26
NP238	1.4E+00
PU238	2.8E-09
CM244	4.1E-26
PU244	0.0E+00
U 240	3.6E-13
PU240	2.8E-09
CM243	1.0E-03
PU243	5.3E-04
AM243	3.4E-09
NP239	2.1E-03
PU239	2.8E-09
PU241	0.0E+00
AM241	8.7E-09

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIEDHFC

ONSITE/MAXI 1.0 M THICK BURIED @0.5 M (DEN: H2O/CARBON 0.5/0.1)MR/HR 26-JUN-85

100
H 3 0.0E+00
C 14 6.7E-12
NA22 5.8E+00
P 32 1.6E-03
P 33 1.0E-09
S 35 0.0E+00
CL36 1.9E-05
K 40 1.3E+00
CA45 1.0E-09
SC46 7.4E+00
CR51 1.2E-02
MN54 1.6E+00
FE55 0.0E+00
FE59 4.9E+00
CO57 4.7E-05
CO60 1.2E+01
NI59 0.0E+00
NI63 1.2E-21
ZN65 2.9E+00
SE75 6.6E-02
SR85 4.6E-01
SR90+D 5.9E-03
MO93 3.9E-33
NB94 2.3E+00
RU106+D 2.1E-01
CD109 3.3E-07
AG110M+D9.1E+00
IN111 6.4E-03
SB124 1.4E+01
SB125+D 4.3E-01
I 125+D 1.3E-33
I 131+D 1.6E-01
CS137+D 5.5E-01
CE144+D 3.6E-01
EU152 5.2E+00
EU154 4.3E+00
TB160 3.7E+00
OS185 7.5E-01
OS191 1.2E-05
IR192 3.8E-01
HG203 5.2E-03
PB210+D 2.0E-04
RA226+D 2.1E-03
TH228+D 1.2E+01
TH230+D 2.4E-13
TH232+D 3.6E-15
U 233+D 5.9E-18
U 234 1.1E-07
U 235+D 4.2E-04

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIEDHFC

U 238+D	3.9E-02
NP237+D	6.7E-02
PU241+D	1.5E-08
SR89	7.1E-04
Y 89M	4.2E-02
SR90	2.4E-06
Y 90	5.9E-03
M099	1.6E-01
TC99M	4.2E-05
TC99	4.1E-09
RU103	4.6E-01
RH103M	3.1E-25
PD103	3.9E-05
I 129	3.6E-12
CS134	2.9E+00
CS135	1.9E-10
CS137	1.8E-05
BA137M	5.8E-01
CE141	2.4E-05
SM151	1.4E-18
U 235	4.2E-04
TH231	5.8E-07
PA231	8.0E-03
AC227	2.4E-08
TH227	1.0E-02
FR223	8.4E-03
RA223	1.7E-02
NP237	1.6E-07
PA233	6.7E-02
U 233	5.9E-18
TH229	4.0E-06
RA225	2.1E-08
AC225	6.9E-05
U 238	4.7E-17
TH234	2.6E-07
PA234M	2.8E-02
PA234	5.4E+00
PU242	3.1E-26
NP238	2.3E+00
PU238	4.7E-09
CM244	7.0E-26
PU244	0.0E+00
U 240	3.0E-07
PU240	4.7E-09
CM243	1.7E-03
PU243	8.9E-04
AM243	5.7E-09
NP239	3.5E-03
PU239	4.7E-09
PU241	0.0E+00
AM241	1.5E-08

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIED1A

ONSITE/MAXI 1.0 M THICK BURIED AT 1.0 M (DEN: SOIL 1.8) MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	1.1E-19
NA22	9.2E-03
P 32	9.1E-07
P 33	1.7E-09
S 35	0.0E+00
CL36	1.2E-16
K 40	3.0E-03
CA45	1.2E-16
SC46	1.0E-02
CR51	8.9E-07
MN54	7.9E-04
FE55	0.0E+00
FE59	7.3E-03
CO57	5.4E-12
CO60	1.8E-02
NI59	0.0E+00
NI63	0.0E+00
ZN65	4.6E-03
SE75	1.0E-05
SR85	7.7E-05
SR90+D	7.7E-06
MO93	0.0E+00
NB94	9.4E-04
RU106+D	4.9E-04
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	0.0E+00
I 131+D	2.1E-05
CS137+D	1.3E-04
CE144+D	1.9E-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	2.3E-02
TH228+D	6.5E-01
TH230+D	1.4E-25
TH232+D	6.4E-31
U 233+D	1.1E-33
U 234	1.2E-14
U 235+D	2.6E-09

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIED1A

U 238+D	5.3E-05
NP237+D	5.7E-06
PU241+D	1.6E-15
SR89	2.8E-07
Y 89M	5.8E-05
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	0.0E+00
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-15
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	0.0E+00
NP238	3.2E-03
PU238	5.4E-16
CM244	0.0E+00
PU244	0.0E+00
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	0.0E+00
AM241	1.6E-15

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIED1B

ONSITE/MAXI 1.0 M THICK BURIED AT 1.0 M (DEN: WATER 1.0) MR/HR 26-JUN-85

	100
H 3	0.0E+00
C 14	3.3E-19
NA22	1.7E-02
P 32	1.8E-06
P 33	4.4E-09
S 35	0.0E+00
CL36	3.6E-16
K 40	6.4E-03
CA45	3.7E-16
SC46	1.9E-02
CR51	2.2E-06
MN54	1.8E-03
FE55	0.0E+00
FE59	1.4E-02
CO57	1.7E-11
CO60	3.4E-D2
NI59	0.0E+00
NI63	0.0E+00
ZN65	8.7E-03
SE75	2.5E-05
SR85	1.9E-04
SR90+D	1.5E-05
MO93	0.0E+00
NB94	2.1E-03
RU106+D	9.3E-04
CD109	2.4E-15
AG110M+D3	0.0E-02
IN111	1.2E-07
SB124	9.4E-02
SB125+D	1.9E-04
I 125+D	0.0E+00
I 131+D	4.7E-05
CS137+D	2.7E-04
CE144+D	3.7E-03
EU152	1.9E-02
EU154	1.2E-02
TB160	9.2E-03
OS185	4.8E-04
OS191	4.3E-12
IR192	1.2E-04
HG203	9.7E-08
PB210+D	9.3E-08
RA226+D	4.6E-02
TH228+D	1.2E-00
TH230+D	5.5E-25
TH232+D	2.7E-30
U 233+D	4.5E-33
U 234	3.8E-14
U 235+D	7.2E-09

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIED1B

U 238+D	9.9E-05
NP237+D	1.4E-05
PU241+D	5.0E-15
SR89	5.7E-07
Y 89M	1.1E-04
SR90	3.8E-10
Y 90	1.5E-05
M099	1.4E-04
TC99M	1.5E-11
TC99	3.5E-14
RU103	1.9E-04
RH103M	0.0E+00
PD103	7.3E-09
I 129	1.3E-19
CS134	4.6E-03
CS135	5.9E-17
CS137	9.0E-09
BA137M	2.8E-04
CE141	2.3E-10
SM151	2.8E-29
U 235	7.2E-09
TH231	1.9E-13
PA231	1.5E-06
AC227	8.4E-15
TH227	1.6E-06
FR223	8.1E-06
RA223	4.3E-06
NP237	4.9E-15
PA233	1.4E-05
U 233	4.5E-33
TH229	1.4E-12
RA225	3.3E-13
AC225	1.3E-09
U 238	3.6E-32
TH234	4.8E-14
PA234M	6.7E-05
PA234	1.6E-02
PU242	0.0E+00
NP238	5.8E-03
PU238	1.7E-15
CM244	0.0E+00
PU244	0.0E+00
U 240	2.0E-20
PU240	1.7E-15
CM243	3.0E-08
PU243	1.6E-07
AM243	1.5E-18
NP239	3.7E-07
PU239	1.7E-15
PU241	0.0E+00
AM241	5.0E-15

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIED1C

ONSITE/MAXI 1.0 M THICK BURIED AT 1.0 M (DEN: WATER/CARBON 0.5/0.1) 26-JUN-85

	100
H 3	0.0E+00
C 14	5.5E-19
NA22	2.8E-02
P 32	3.0E-06
P 33	5.8E-16
S 35	0.0E+00
CL36	8.2E-09
K 40	1.0E-02
CA45	6.2E-16
SC46	3.1E-02
CR51	3.6E-06
MN54	3.0E-03
FE55	0.0E+00
FE59	2.2E-02
CO57	2.8E-11
CO60	5.7E-02
NI59	0.0E+00
NI63	0.0E+00
ZN65	1.4E-02
SE75	4.2E-05
SR85	3.2E-04
SR90+D	2.5E-05
MO93	0.0E+00
NB94	3.5E-03
RU106+D	1.5E-03
CD109	4.0E-15
AG110M+D	4.8E-02
IN111	2.0E-07
SB124	1.5E-01
SB125+D	3.2E-04
I 125+D	0.0E+00
I 131+D	7.7E-05
CS137+D	4.3E-04
CE144+D	5.9E-03
EU152	3.1E-02
EU154	2.1E-02
TB160	1.5E-02
OS185	7.9E-04
OS191	7.3E-12
IR192	2.0E-04
HG203	1.6E-07
PB210+D	1.5E-07
RA226+D	6.3E-07
TH228+D	9.3E-02
TH230+D	9.3E-25
TH232+D	4.6E-30
U 233+D	7.7E-33
U 234	6.5E-14
U 235+D	1.2E-08

APPENDIX C - EXTERNAL DOSE RATE FACTOR LIBRARIES - BURIED1C

U 238+D	1.6E-04
NP237+D	2.3E-05
PU241+D	8.5E-15
SR89	9.5E-07
Y 89M	1.8E-04
SR90	6.4E-10
Y 90	2.5E-05
M099	2.3E-04
TC99M	2.5E-11
TC99	5.9E-14
RU103	3.2E-04
RH103M	0.0E+00
PD103	1.2E-08
I 129	2.2E-19
CS134	7.5E-03
CS135	1.0E-16
CS137	1.5E-08
BA137M	4.6E-04
CE141	3.9E-10
SM151	4.7E-29
U 235	1.2E-08
TH231	3.1E-13
PA231	2.5E-06
AC227	1.4E-14
TH227	2.7E-06
FR223	1.3E-05
RA223	7.1E-06
NP237	8.3E-15
PA233	2.3E-05
U 233	7.7E-33
TH229	2.4E-12
RA225	5.5E-13
AC225	2.1E-09
U 238	6.2E-32
TH234	8.1E-14
PA234M	1.1E-04
PA234	2.6E-02
PU242	0.0E+00
NP238	9.6E-03
PU238	2.8E-15
CM244	0.0E+00
PU244	0.0E+00
U 240	4.5E-11
PU240	2.8E-15
CM243	5.1E-08
PU243	2.8E-07
AM243	2.6E-18
NP239	6.2E-07
PU239	2.8E-15
PU241	0.0E+00
AM241	8.5E-15

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Publishing Coordination (2)
Technical Information (5)

NRC FORM 335 (7-77)		U.S. NUCLEAR REGULATORY COMMISSION BIBLIOGRAPHIC DATA SHEET		1. REPORT NUMBER (Assigned by DDC) NUREG/CR-3620, Supp. No. 1 PNL-4054	
4. TITLE AND SUBTITLE (Add Volume No., if appropriate) Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXII Computer Program				2. (Leave blank)	
7. AUTHOR(S) W. E. Kennedy, Jr., R. A. Peloquin, B. A. Napier/PNL S. M. Neuder/NRC				5. DATE REPORT COMPLETED MONTH April YEAR 1985	
9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Pacific Northwest Laboratory P.O. Box 999 Richland, WA 99352				DATE REPORT ISSUED MONTH May YEAR 1986	
12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Division of Waste Management Office of Nuclear Material Safety and Safeguards U.S. Nuclear Regulatory Commission Washington, D.C. 20555				6. (Leave blank)	
10. PROJECT/TASK/WORK UNIT NO.				8. (Leave blank)	
11. CONTRACT NO. FIN B2478				13. TYPE OF REPORT	
15. SUPPLEMENTARY NOTES				14. (Leave blank)	
16. ABSTRACT (200 words or less) The document entitled Intruder Dose Pathway Analysis of the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXII Computer Program (1984) by Napier et al. summarizes our initial efforts to develop human-intrusion scenarios and a modified version of the MAXII computer program for potential use by the NRC in reviewing applications for onsite radioactive waste disposal. This document is a supplement to that document and summarizes our efforts to further modify and improve the ONSITE/MAXII software package. To facilitate cross-referencing, it follows the same format. Notable improvements to the software package include the capability to account for shielding conditions that represent noncompacted trash wastes and the option to indicate alternative land-use conditions. This supplement contains a description of the implementation of these modifications. In addition, a series of discussions are included in an attempt to increase the user's understanding of the scenarios and dose calculation methods. These discussions respond to frequently asked questions about the mathematical models and use of the software. Computer listings of the ONSITE/MAXII computer program are included as Appendices A and B of this document. Appendix C lists external exposure dose-rate factor libraries.					
17. KEY WORDS AND DOCUMENT ANALYSIS ONSITE/MAXII computer program onsite radioactive waste disposal				17a. DESCRIPTORS	
17b. IDENTIFIERS/OPEN-ENDED TERMS					
18. AVAILABILITY STATEMENT Unlimited				19. SECURITY CLASS (This report) Unclassified	
20. SECURITY CLASS (This page) Unclassified				21. NO. OF PAGES	
22. PRICE \$				23. PRICE	