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GASPAR II - Technical Reference and User Guide

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Pacific Northwest Laboratories
Operated by
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Prepared for
U.S. Nuclear Regulatory Commission

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[redacted]

ABSTRACT

This report describes the computer program GASPAR II used by the staff of the U.S. Nuclear Regulatory Commission to perform environmental dose analyses for releases of radioactive effluents from nuclear power plants into the atmosphere. The analyses estimate radiation dose to individuals and population groups from inhalation, ingestion (terrestrial foods), and external-exposure (ground and plume) pathways. The calculated doses provide information for National Environmental Policy Act (NEPA) evaluations and for determining compliance with Appendix I of 10 CFR 50 (the "ALARA" philosophy).

The report also instructs the user in preparing input to the program, describes the mathematical models that are used, and supplies detailed information on program structure and parameters used to modify the program.

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EXECUTIVE SUMMARY

This report presents a technical description of the GASPAR II computer program and instructions for its use. The GASPAR II computer program was developed by the Nuclear Regulatory Commission to estimate radiation doses to individuals and population groups from radionuclide releases as airborne effluents from light-water nuclear reactors during routine operation. This report contains three main parts: 1) a user guide, 2) a description of mathematical models used in GASPAR II, and 3) technical information on program structure for installation or modification of the program.

USER INFORMATION

The user manual portion of this report (Chapter 2.0) provides information needed to prepare input for the GASPAR II program for the purpose of simulating a user-defined release and exposure scenario. Three sample problems are used to illustrate input preparation and the resulting output reports. The sample problems illustrate most of the options available with the program. Error messages generated by GASPAR II are described, along with the cause and resulting program action (stop or continue) for each error message.

MATHEMATICAL MODELS

The mathematical models described in Chapter 3.0 include models used to represent atmospheric dispersion and exposure-pathway models used to calculate radiation dose to selected groups at various locations in the environment.

Diffusion and transport of released radionuclides in the atmosphere are described by user-defined atmospheric dispersion factors for the region within 50 mi of the site. Beyond 50 mi, simple models are used to estimate population exposures for selected nondepositing radionuclides.

The exposure pathway models estimate the radiation dose to selected individuals and population groups. The exposure pathways considered in GASPAR II are:

- external exposure to contaminated ground
- external exposure to noble gas radionuclides in the airborne plume
- inhalation of air
- ingestion of farm products grown in contaminated soil.

Included in the dose calculations are an "ALARA" analysis ("as low as reasonably achievable"; based on exposure of people within 50 mi) and a "NEPA" analysis (in accordance with the National Environmental Policy Act of 1969; based on exposure of all people in the United States from effluents from the site). A special "cost-benefit" table is also prepared representing the sum of ALARA population doses (total-body and thyroid) at all locations for all pathways. In addition, site-specific unit dose factors may be reported giving dose to individuals normalized to unit air concentration.

DETAILED PROGRAM INFORMATION

Information on the installation of GASPAR II on a new system and on modification of the program is provided for use by experienced programmers. This program information includes details of program structure, data transfer, data files, and modules. The structure information includes the calling-sequence hierarchy, locations (modules) of data record input, and locations (modules) of output-report preparation. Data transfers are performed through common blocks and argument lists. Parameters in each common block and argument list are fully described. A summary of each of the 23 GASPAR II modules is given, and a global dictionary that describes the usage of all major parameters throughout the program is provided. A summary of changes made to GASPAR II as a result of the current technical review and documentation effort is also included.

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FIGURES

TABLES

LISTINGS

1.0 INTRODUCTION

The GASPAR II computer program estimates radiation doses to individuals and population groups from radionuclide releases as airborne effluents from light-water nuclear reactors during routine operation. This report contains a user guide (Chapter 2.0), a description of mathematical models (Chapter 3.0), and detailed information on the program structure that is useful for installing or modifying the program (Chapter 4.0).

The GASPAR II program begins with user-defined source terms (represented as Ci/yr released for selected radionuclides) and atmospheric dispersion estimates. These parameters define the air and ground concentrations to be used as the basis of radiation dose calculations in the exposure pathway models. The exposure pathway models included in GASPAR II are:

- external exposure to airborne activity in the released plume
- external exposure to deposited activity on the ground
- inhalation of airborne activity in the released plume
- ingestion of contaminated agricultural products - leafy vegetables, vegetables (including grains), meat, and milk.

Population dose calculations are made for two types of analyses. An "ALARA" analysis (as low as reasonably achievable) is performed based on exposure of people within 50 mi of the site. In addition, a "NEPA" analysis (National Environmental Policy Act) is performed based on exposure of all people in the United States from effluents from the site. The NEPA analysis includes the contribution to population dose from excess agricultural production within 50 mi that is exported to populations beyond 50 mi. GASPAR II also performs a special population-dose analysis, which is printed as a "cost-benefit" table, giving a summary of the total population dose by radionuclide for total-body and thyroid exposure. The population doses are calculated as weighted sums of doses to three age groups: child, teen, and adult. The calculations use the population fraction for each age group and age-specific dose factors and exposure-pathway intake parameters.

Individual doses are calculated and printed for each exposure pathway and for four age groups: infant, child, teen, and adult. The individual dose estimates are performed for specific locations defined by the user. The individual dose calculations represent a maximally exposed individual and use exposure-pathway parameter values that tend to maximize the dose. This is in contrast to the population dose calculations that use average values for exposure pathway parameters.

In addition to population and individual dose estimates, GASPAR II also performs the calculations defined for the PARTS computer program (NRC 1978). These calculations represent site-specific dose factors normalized to unit release (μCi/sec), unit atmospheric dispersion (sec/m^3), and deposition (m^{-2}) parameter values. Two types of factors are calculated: 1) factors used for implementation of 10 CFR 20, and 2) factors used for implementation of 10 CFR 50. The basis for the calculation of these factors and all GASPAR II calculations is taken from Regulatory Guide 1.109 (NRC 1977). The differences between the two analyses are minor. The 10 CFR 20 analysis considers only the infant age group and inhalation, ground exposure, and cow-milk ingestion pathways. The 10 CFR 50 analysis considers all age groups and pathways, including the ingestion of goat milk.

Several changes have been made to the GASPAR II program as a result of the current technical review and documentation effort. While no changes have been made in the mathematical models used in GASPAR II, some parameter values and dose factors have been updated. Problems run on the earlier versions of GASPAR should give similar results if run on GASPAR II, except for proportional differences due to dose-factor changes. A summary of changes is given in Appendix C.

2.0 USER GUIDE

This chapter describes the use of the computer program GASPAR II in performing environmental dose analyses. Instructions for preparing input to the program are given in Section 2.1, and output reports generated by the program are described in Section 2.2. Three sample problems are presented in Section 2.3 to help users understand the program. Section 2.4 contains a summary of program-generated error messages.

2.1 INPUT INSTRUCTIONS

This section provides information needed to prepare case input for the GASPAR II program for the purpose of simulating a user-defined release scenario. The information is presented with the assumption that the user has no familiarity with the internal workings of the GASPAR II program. However, the instructions encompass only preparation of the record images for the input file; the GASPAR II program is assumed to be available on a mainframe computer, and job control information is assumed to be provided by the user or by the computer support group at the user's facility.

All input to GASPAR II is provided via an input record file as formatted records. These records are of two main types: case-specific parameters and block data parameters. The case-specific parameters include those parameters that may differ for each application and those for which it is difficult to assign default values. A few of the case-specific parameters have default values that may either be retained or changed by the user. The block data parameters include radionuclide constants and data for the various exposure parameters that are not likely to be site- or case-specific. Default values are supplied for all of these parameters.

The order of all formatted input records in the sequential input file is defined in Figure 2.1. The record types indicated in the figure refer to case-specific input records, as defined in Section 2.1.1. The optional input records identified in the figure as "Read Block Data Change Records" are defined in Section 2.1.2. The input records identified as "Read Dose-Factor

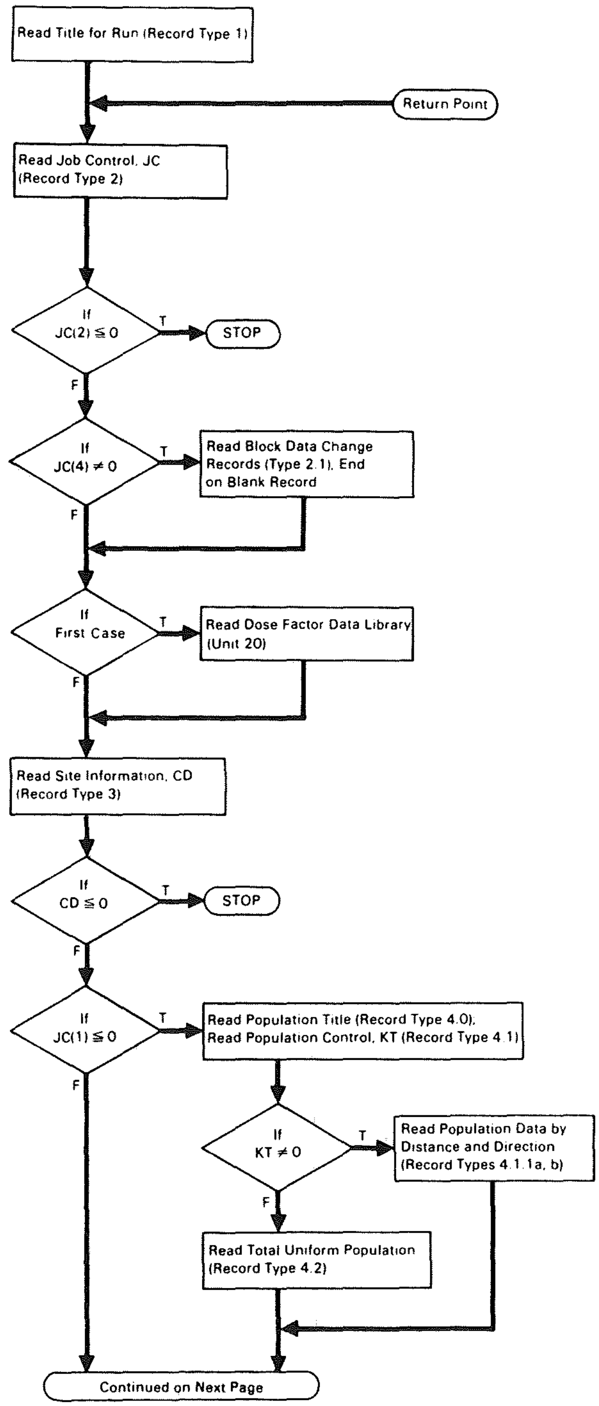


FIGURE 2.1. Logic Diagram of Formatted Input Records in GASPAR II

FIGURE 2.1. (Contd)

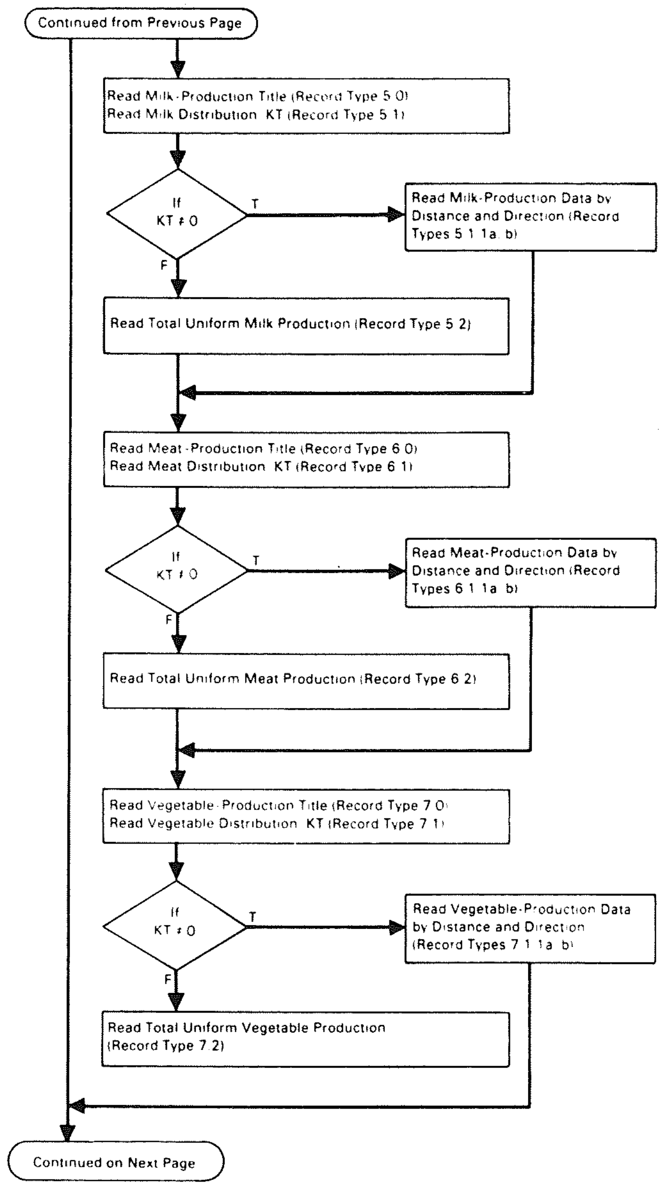
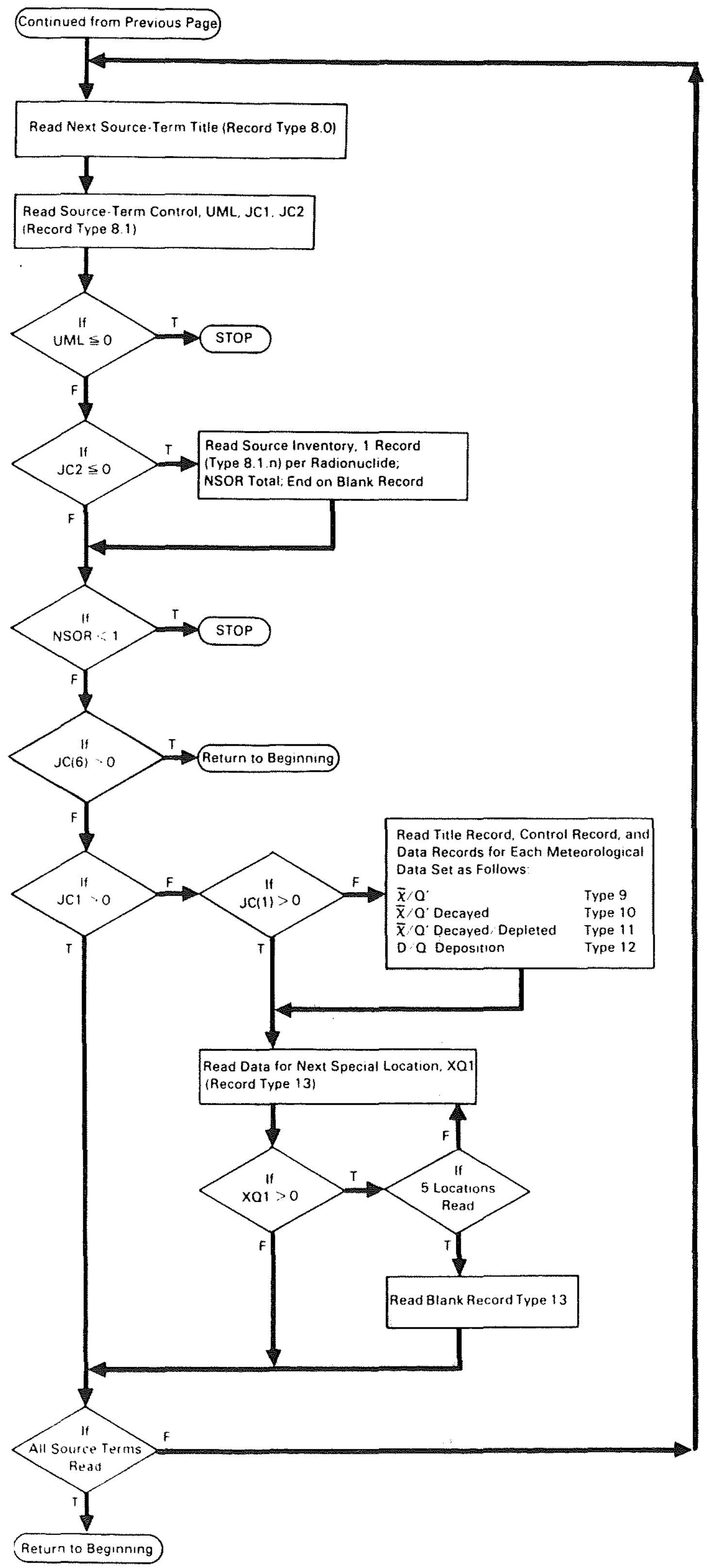


FIGURE 2.1. (Contd)



Data Library" represent input of a special data file containing dose conversion factors and radiological constants. This special data file is described in Section 4.5 and is not discussed in this section because the user will not generally need to modify the data in the file.

Each formatted record will consist of 80 or less data characters as required and defined for the specific record types. Refer to Figure 2.1 when preparing the input record file to ensure that the read control information parameters (JC, CD, KT, JC1, JC2, and XQ1) are used properly and that all necessary records are included. Be sure to include blank records at the required locations because repeated source-term and special-location record reads are ended by the reading of a blank record card.

2.1.1 Case-Specific Input Records

GASPAR II uses 13 record sets, each set being composed of one or more distinct record types. These are defined in this section in terms of record format, parameter definitions, parameter names, and default values (if any). The user may change some of the default values using optional input records. Other default values may be changed using block data change records (see Section 2.1.2). See Figure 2.1 for the required order for specifying record types in the input file.

The parameters may be of three types: character, integer, or real. Character parameters are usually defined with an alphanumeric format (represented as "A"). Such parameters are generally used for descriptive titles and may contain any combination of letters, numbers, and special symbols (+, -, ;, $, %, etc.), but should not contain computer control characters such as end-of-file markers. Integer parameters are defined as whole numbers and are right justified in the format field, with no letters or special symbols other than "+" or "-." Real (or floating-point) parameters are generally specified as numbers containing a floating decimal point ("F" format). They may also be defined in exponential ("E" format) notation. For example, to define a real value of 150, the following notations would be acceptable: 150, 150.0, 1.5E+2, 1.5+2, and 1.5E2. The first two are examples of "F" format, and the last three are examples of "E" format. Note that for "E" formats the exponent (2 in the example) must be right justified in the parameter field. In the following description of record types, real parameters are defined by "E" formats. When "E" formats are specified, the parameter value may be provided using either "E" or "F" notations. This is a general rule and depends on the characteristics of the computer being used.

The following discussion presents detailed information on the preparation of each input record type. A summary reference table containing information on all record types is presented at the end of this section (Table 2.14).

Record Type 1.0: Case Title

The first record of each case provides a descriptive title for the release scenario that follows. The first two characters of this record are not used by the program and may be left blank or used as desired (i.e., as a case index). The descriptive title is entered on the remaining 78 positions of the record. The record format is 2X,78A1. This descriptive title is printed in the heading of several output reports (see Section 2.2) and on the banner page.

Record Set 2.0: Job Control Flags

Record type 2.0 contains the job control array JC, which consists of seven integer values used to select various options available with the GASPAR II computer program. The read statement for this record type tests for an end-of-file (i.e., no more input records in the input-record file). When an end-of-file is encountered, the run is stopped. This is the normal mode used to terminate a run. Also, the second integer value, JC(2), which contains the number of source terms or release points to be considered, is tested and if found to be less than or equal to zero (or blank) the run is stopped. Usage of the seven job control flags and the format of record type 2.0 is described in Table 2.1.

Default values for several parameters are set in the block data module of GASPAR II. The user has the option to change some of the default values through block data change records (type 2.1). These records are described in Section 2.1.2. The control flag JC(4) is set positive when block data change records are to be read.

TABLE 2.1. Record Type 2.0 Description

Parameter Name	Format	Columns	Description
JC(1)	I2	1-2	Controls selection of the type of calculations to be performed: JC(1)=0, calculate population doses JC(1)>0, calculate individual doses only. Note that when JC(1)=0, individual doses may also be calculated if special location records are given (record type 13).
JC(2)	I2	3-4	Number of source terms or release points to be considered for the current case; $1 \leq JC(2) \leq 10$. If $JC(2) \leq 0$, stop run. JC(2) has no effect when JC(6)>0.
JC(3)	I2	5-6	Controls printing of detailed information from multiple source terms: JC(3)=0, print reports of cumulative doses for each source term JC(3)>0, print reports following the last source term only.
JC(4)	I2	7-8	Controls input of block data change record: If JC(4)>0, read a set of block data change records (see Section 2.1.2).
JC(5)	I2	9-10	Controls printing of data contained in the dose-factor library: If JC(5)>0, print reports. Note: uses of this parameter available in previous versions of GASPAR are no longer supported because the dose-factor file is always read from an alternate input unit. Values in the dose-factor file can only be changed by editing the file before execution (see Section 4.5 for a description of the data file).
JC(6)	I2	11-12	Controls selection of the PARTS calculation option: JC(6)>0, select calculation option. When the PARTS calculation is desired, set JC(1)=1 to avoid specification of population dose information.
JC(7)	I2	13-14	Controls selection of the input unit from which meteorological data (record sets 9-12) will be read: JC(7)=0, read data from input with rest of the records JC(7)>0, read input from unit 7.

Record Type 3.0: Site-Specific Information

Record type 3.0 contains parameters that should be determined locally by measurement or estimated regionally for the site. Most of the parameters are related to agricultural exposure pathways. This record is described in

Table 2.2. Specifications of a zero value will result in the use of conservative default values for parameters except CD (distance to the northeast corner of the U.S.). A zero value for CD will cause termination of the run. Where only individual doses are to be calculated, give a dummy positive value for CD. This parameter is used in the NEPA population dose calculation. Default values for parameters of record type 3.0 are given in Table 2.3. Evaluation of parameters related to crop and pasture growing season can be estimated using Figure 2.2, as provided in Eckerman et al. (1980). In the figure, the numeric values indicated by the isopleths represent the months per year that pasture is available for milk cows and beef cattle. Add an additional month for goats. The growing period for leafy vegetables is estimated using the indicated value as follows:

- subtract 3 from indicated times of 5 through 8 mo
- subtract 2 from indicated times of 9 mo
- use directly indicated time of 10 or more mo.

TABLE 2.2. Record Type 3.0 Description

Parameter Name	Format	Columns	Description
CD	E8.0	1-8	Distance (in mi) from the site to the northeast corner of the U.S.; CD>0. If CD≦0, stop run. Provide a dummy value for individual-dose-only runs.
FV	E8.0	9-16	Fraction of the year that leafy vegetables are grown.
FP	E8.0	17-24	Fraction of the year that milk cows are on pasture.
FG	E8.0	25-32	Fraction of the maximum individual's vegetable intake that is from his own garden.
FPF	E8.0	33-40	Fraction of milk-cow feed intake that is from pasture while on pasture.
H	E8.0	41-48	Average absolute humidity over the growing season. (When H=0 or blank, default is 8 g/m^3.)
T	E8.0	49-56	Average temperature over the growing season (°F). T is used only to calculate absolute humidity. If T is supplied, H must be supplied as relative humidity (%). Otherwise set T=0 or blank.
FGT	F6.0	57-62	Fraction of the year that goats are on pasture.
FPG	F6.0	63-68	Fraction of goat-feed intake that is from pasture while on pasture.
FB	F6.0	69-74	Fraction of the year that beef cattle are on pasture.
FBF	F6.0	75-80	Fraction of beef-cattle feed intake that is from pasture while the cattle are on pasture.

TABLE 2.3. Record Type 3.0 Default Parameter Values

Parameter Name	Default Value
CD	None
FV	1.0
FP	1.0
FG	0.76
FPF	1.0
H	8.0 g/m^3
T	None
FGT	1.0
FPG	1.0
FB	1.0
FBF	1.0

Record Set 4: Population Data

Record set 4 provides population-distribution data for the site. The first record of the set is a title record with descriptive information (format 2X,78A1). Information for this record could include plant name, year of projected population, and total population within 50 mi. The next record (type 4.1) contains control data for specification of the population distribution. Data for this record type are described in Table 2.4. Two options are available for specification of the population distribution: 1) by distance and direction, and 2) uniformly over the 50-mi region. If data are to be given as a function of distance and direction (KT=10 on record type 4.1), then 16 sets of records types 4.1.na and 4.1.nb follow record type 4.1. Information on each of these pairs is described in Table 2.5. When population is to be defined uniformly for the 50-mi region, record type 4.2 is provided containing the total population within 50 mi as parameter PERSON in columns 1-10, format E10.0.

Population distribution data are required by GASPAR II only when a population dose calculation has been requested [see parameter JC(1) on record type 2.0]. The 50-mi population distribution is defined for 160 area elements bounded by 16 compass direction sections (N, NNE, etc.) and 10 distance

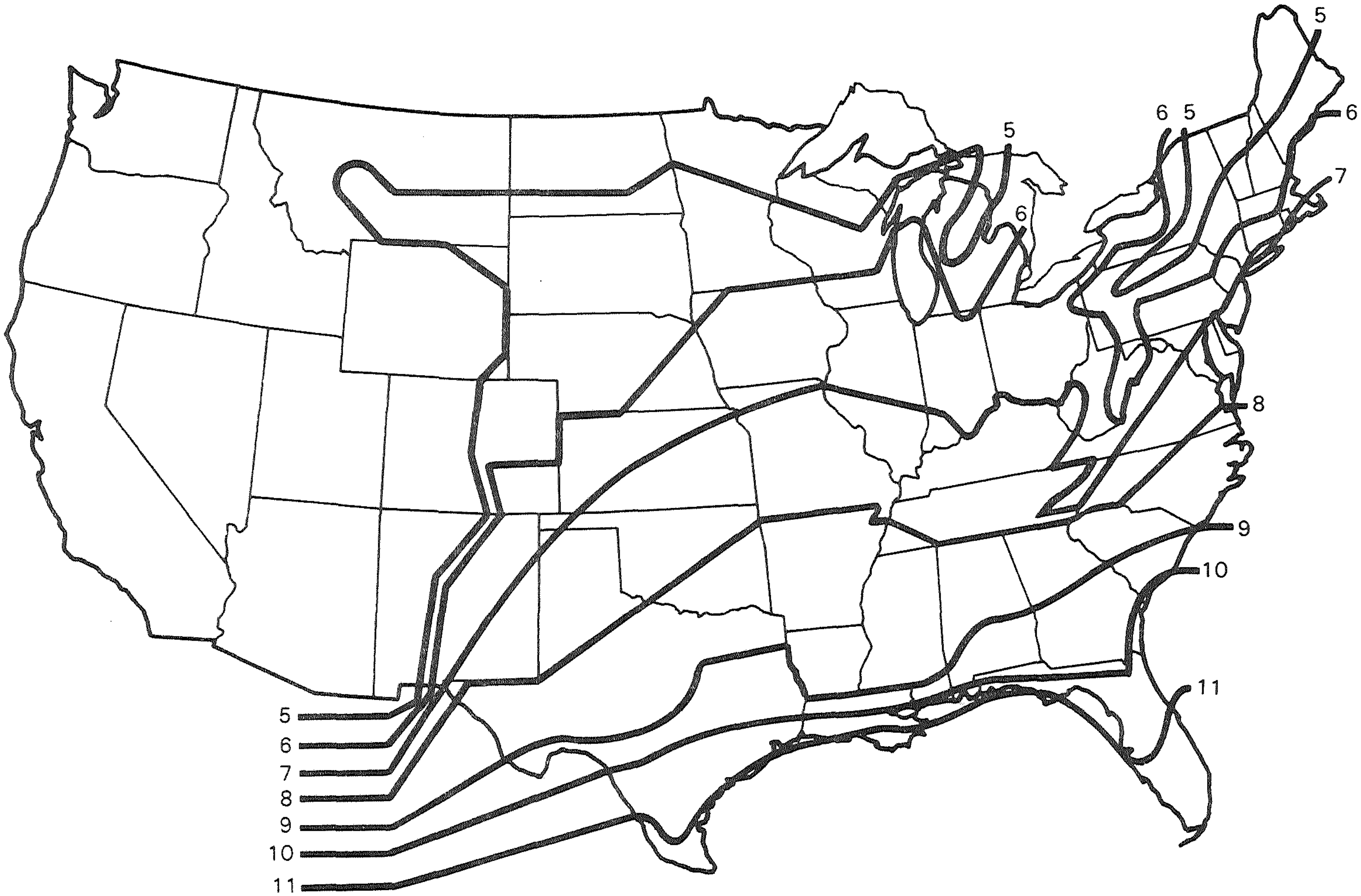


FIGURE 2.2. Geographic Characterization of Agricultural Growing Season (Pasture Grazing, mo/yr)

TABLE 2.4. Record Type 4.1 Description

Parameter Name	Format	Columns	Description
IDAT	I5	1-5	Control parameter to indicate the compass sector for which population data will start: IDAT=0, north IDAT=1, south.
KC	I5	6-10	Number of population data values on the first data record (type 4.1.na). Each of the 16 sectors requires 10 entries, one for each downwind distance. Each pair of sector records will require 10-KC values on the second record (type 4.1.nb). KC is not used if KT = 0. (The default and maximum value for KC is 7.)
KT	I5	11-15	Control parameter to indicate how the population distribution data will be defined: KT=0, uniform distribution; read record type 4.2 KT=10, input by distance and direction; read record types 4.1.na through 4.1.nb for each of the 16 directions (KT is set to 10 if a value other than zero is given).

TABLE 2.5. Record Types 4.1.na and 4.1.nb Descriptions

Parameter Name	Format	Columns	Description
Record Type 4.1.na			
-	3A1	1-3	Compass direction for population data on this record set (N, NNE, etc.). The first set must be either north or south according to the value given to IDAT on record type 4.1. (This field is not actually read.)
POP(1)	E10.0	11-20	Population in subregion 1 (0-1 mi).
POP(2)	E10.0	21-30	Population in subregion 2 (1-2 mi).
.	.	.	.
POP(KC)	E10.0	to 71-80 max	Population in subregion KC.
Record Type 4.1.nb			
POP(KC+1)	E10.0	1-10	Population in subregion KC+1.
.	.	.	.
POP(10)	E10.0	to 71-80 max	Population in subregion 10 (40-50 mi).

intervals (1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 mi). The 16 sets of record types 4.1.na and 4.1.nb correspond to the 16 compass directions. Each data set contains data for the 10 distance intervals.

Record Set 5: Milk Production Data

Record set 5 provides data on the distribution of milk production for the 50-mi region. Input of these data directly parallels input records for the population distribution data (record set 4). Milk production data are supplied to array ZMILK (instead of array POP) in units of L produced per yr at each distance and direction. When total production is to be defined, parameter ZMLKT represents total production of milk within 50 mi (L/yr). Records in this data set are summarized in Table 2.6. This table also gives information for record sets 6 and 7 - meat and vegetable production, respectively. Input options defined for population data input are also available for production data input.

Record Set 6: Meat Production Data

Record set 6 provides data on the distribution of meat production for the 50-mi region. Input of these data directly parallels input records for the population distribution and milk production, as shown in Table 2.6. Meat production is given as kg/yr.

Record Set 7: Vegetable Production Data

Record set 7 provides data on the distribution of vegetable production for the 50-mi region. Input records for vegetable production directly parallel input records for population distribution, as shown in Table 2.6. Vegetable production is given as kg/yr.

TABLE 2.6. Record Sets 4, 5, 6, and 7 Summary Descriptions

Population Record Type (Key Parameter)	Milk Production Record Type (Key Parameter)	Meat Production Record Type (Key Parameter)	Vegetable Production Record Type (Key Parameter)
4.0	5.0	6.0	7.0
4.1	5.1	6.1	7.1
4.1.na (POP)	5.1.na (ZMILK)	6.1.na (ZMEAT)	7.1.na (ZVEGT)
4.1.nb (POP)	5.1.nb (ZMILK)	6.1.nb (ZMEAT)	7.1.nb (ZVEGT)
4.2 (PERSON)	5.2 (ZMLKT)	6.2 (ZMETT)	7.2 (ZVEGTT)

Record Set 8: Source-Term Data

Record set 8 defines the activity of radionuclides released for each source term. One record set of this type is required for each source term requested [see parameter JC(2) on record type 2.0]. This record set consists of a title record (8.0), a source-term control record (8.1), and optional additional records (8.1.n, where n is the number of radionuclides considered). The title record contains 80 characters of descriptive information defined by the user (format 10A4). The first 40 characters of this record are saved for use in report headings in array LST. Record type 8.1 contains control information and a multiplication factor, as described in Table 2.7. Note that two of the parameters on this record are used to control subsequent input (JC1 and JC2).

When a release inventory is to be supplied (JC2 0), additional records of type 8.1.n are supplied that identify the radionuclides to be included in the source term and also supply the annual release rate (Ci) of each radionuclide. One record of type 8.1.n is given for each radionuclide, as described in Table 2.8. Up to 33 radionuclides may be provided for each source term.

TABLE 2.7. Record Type 8.1 Description

Parameter Name	Format	Columns	Description
UML	E10.0	1-10	Source-term multiplier, to be applied to each radionuclide release (e.g., at a 2 unit site, UML can be 2.0) (QQ on record type 8.1.n): If UML≦0, stop run unless PARTS calculation has been requested [JC(6) on record type 2.0].
JC1	I1	20	Control parameter for input of meteorological data for the current source term: If JC1=0, use new meteorological data If JC1>0, use previous data. The first source term for each run must read new meteorological data.
JC2	I1	30	Control parameter for input of radionuclide release data: If JC2>0, use previous release data. The first source term of each run must include release data (record type 8.1.n).
PURGE	F6.2	40-45	This parameter is used in the ^{14}C individual-dose calculation if the release is a purge. PURGE (hr) is the total annual release time for purges: PURGE≦0; not used PURGE>0; use value given (see Section 3.2.3.1).

TABLE 2.8. Record Type 8.1.n Description

Parameter Name	Format	Columns	Description
IA	A2	3-4	Element symbol, left justified.
IM	5A1	5-9	Radionuclide mass number including "M" for metastable state, as appropriate.
QQ	E10.0	11-20	Release rate of the current radionuclide (Ci/yr). The value given is multiplied by the source-term multiplication factor (UML on record type 8.1).

Reading of inventory records is terminated by a blank record. Radionuclides specified in the inventory are limited to those for which dosimetry data are provided in data libraries. Table 2.9 lists radionuclides included in the current dose-factor library (see Section 4.5 for a description of the data library). In addition to these radionuclides, fourteen noble gas radionuclides may be specified: ^{41}Ar, ^{83m}Kr, ^{85m}Kr, ^{85}Kr, ^{87}Kr, ^{88}Kr, ^{89}Kr, ^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, ^{135}Xe, ^{137}Xe, and ^{138}Xe. Dosimetric data for these noble gas radionuclides are provided in data statements internal to GASPAR II and are included in output report type 3d (see Section 2.2.3).

Record Set 9: Meteorological Data (Undecayed/Undepleted)

Input record set 9 provides atmospheric dispersion factors (sec/m^3) to be used with population dose calculations. This data set may be provided on the standard input unit or as an alternate input file (unit 7). Parameter JC(7) on record type 2.0 controls the input location for this data set. The data set consists of a title record (9.0), a control record (9.1), and pairs of data records [9.1.na and 9.1.nb, where n varies over the number of sectors (always 16) for which data are provided].

The title record contains 78 characters of descriptive information (format 2X,78A1) for the current meteorological data array, such as data source, date, release height, release point, etc. The control record (type 9.1) identifies how the meteorological data are provided, as indicated in Table 2.10. Note that when meteorological data input is from the alternate file, record type 9.1 is not provided because the alternate file as generated by the XOQDOQ program always starts with the south sector and contains 7 data values on the first of each sector record pair.

TABLE 2.9. Radionuclides in Dose-Factor Data Library

^{3}H	^{89}Sr	^{125}Sb	^{141}Ce	^{229}Th
^{10}Be	^{90}Sr	^{126}Sb	^{143}Ce	^{230}Th
^{14}C	^{91}Sr	^{127}Sb	^{144}Ce	^{232}Th
^{13}N	^{92}Sr	^{125m}Te	^{143}Pr	^{234}Th
^{18}F	^{90}Y	^{127m}Te	^{144}Pr	^{231}Pa
^{22}Na	^{91m}Y	^{127}Te	^{147}Nd	^{233}Pa
^{24}Na	^{91}Y	^{129m}Te	^{147}Pm	^{232}U
^{32}P	^{92}Y	^{129}Te	^{148m}Pm	^{233}U
^{41}Ca	^{93}Y	^{131m}Te	^{148}Pm	^{234}U
^{46}Sc	^{93}Zr	^{131}Te	^{149}Pm	^{235}U
^{51}Cr	^{95}Zr	^{132}Te	^{151}Pm	^{236}U
^{54}Mn	^{97}Zr	^{133m}Te	^{151}Sm	^{237}U
^{56}Mn	^{93m}Nb	^{134}Te	^{153}Sm	^{238}U
^{55}Fe	^{95}Nb	^{129}I	^{152}Eu	^{237}Np
^{59}Fe	^{97}Nb	^{130}I	^{154}Eu	^{238}Np
^{57}Co	^{93}Mo	^{131}I	^{155}Eu	^{239}Np
^{58}Co	^{99}Mo	^{132}I	^{156}Eu	^{238}Pu
^{60}Co	^{99m}Tc	^{133}I	^{160}Tb	^{239}Pu
^{59}Ni	^{99}Tc	^{134}I	^{166m}Ho	^{240}Pu
^{63}Ni	^{101}Tc	^{135}I	^{181}W	^{241}Pu
^{65}Ni	^{103}Ru	^{134m}Cs	^{185}W	^{242}Pu
^{64}Cu	^{105}Ru	^{134}Cs	^{187}W	^{244}Pu
^{65}Zn	^{106}Ru	^{135}Cs	^{210}Pb	^{241}Am
^{65m}Zn	^{105}Rh	^{136}Cs	^{210}Bi	^{242m}Am
^{69}Zn	^{107}Pd	^{137}Cs	^{210}Po	^{243}Am
^{79}Se	^{109}Pd	^{138}Cs	^{223}Ra	^{242}Cm
^{82}Br	^{110m}Ag	^{139}Cs	^{224}Ra	^{243}Cm
^{83}Br	^{111}Ag	^{139}Ba	^{225}Ra	^{244}Cm
^{84}Br	^{113m}Cd	^{140}Ba	^{226}Ra	^{245}Cm
^{85}Br	^{115m}Cd	^{141}Ba	^{228}Ra	^{246}Cm
^{86}Rb	^{123}Sn	^{142}Ba	^{225}Ac	^{247}Cm
^{87}Rb	^{125}Sn	^{140}La	^{227}Ac	^{248}Cm
^{88}Rb	^{126}Sn	^{141}La	^{227}Th	^{252}Cf
^{89}Rb	^{124}Sb	^{142}La	^{228}Th	

The array of dispersion data is provided on sixteen pairs of records (9.1.na and 9.1.nb), one pair for each sector. Each pair contains values for the 10 downwind distances. These record pairs are described in Table 2.11 and are similar to the format for population data (record set 4).

Record sets 10, 11, and 12 always accompany record set 9. The procedure for preparation of XOQDOQ-generated files for use by GASPAR II is described in Section 2.1.3.

TABLE 2.10. Record Type 9.1 Description

Parameter Name	Format	Columns	Description
IDAT	I5	1-5	Control parameter to indicate which downwind sector the data start on: IDAT=0, north IDAT=1, south.
KC	I5	6-10	Control parameter to indicate how many data values will be included on the first data record (type 9.1.na); $2 \leq KC \leq 7$. (Normally KC will be set to 7.)

TABLE 2.11. Record Types 9.1.na and 9.1.nb Descriptions

Parameter Name	Format	Columns	Description
Record Type 9.1.na			
-	3A1	1-3	Compass direction for meteorological data on this record pair (N, NNE, etc.). The first set is either N or S depending on the value given to IDAT on record type 9.1.
XQ(n,1)	2X,E10.0	6-15	Data value for undepleted/undecayed X/Q (sec/m^3) for the interval 1 (0-1 mi).
XQ(n,2)	E10.0	16-25	Data value for interval 2 (1-2 mi).
.	.	.	.
XQ(n,KC)	E10.0	to 66-75 max	Data value for interval KC.
Record Type 9.1.nb			
XQ(n,KC+1)	E10.0	1-10	Data value for interval KC+1.
.	.	.	.
XQ(n,10)	E.10.0	to 71-80 max	Data value for interval 10.

Record Set 10: Meteorological Data (Decayed/Undepleted)

Record set 10 provides atmospheric dispersion parameters (sec/m^3) for population dose calculations. The factors include radiological decay in transit corresponding to noble gas radionuclide ^{133m}Xe (2.26-day half-life). Input of this data set directly parallels that of record set 9. Correspondence between record set 9 and sets 10, 11, and 12 is indicated in Table 2.12. Input of record set 10 is from the same unit as defined for record set 9 [see parameter JC(7) on record type 2.0].

TABLE 2.12. Record Sets 10, 11, and 12 Summary Descriptions

Information Type	Reference Format Record Type	Record Set 10 Corresponding Record Type	Record Set 11 Corresponding Record Type	Record Set 12 Corresponding Record Type
Title	9.0	10.0	11.0	12.0
Control	9.1	10.1	11.1	12.1
Data	9.1.na	10.1.na	11.1.na	12.1.na
Data	9.1.nb	10.1.nb	11.1.nb	12.1.nb
Key Parameter	XQ	XQD	XQDD	DEP
Units	sec/m^3	sec/m^3	sec/m^3	m^{-2}/yr

Record Set 11: Meteorological Data (Decayed/Depleted)

Record set 11 provides atmospheric dispersion factors (sec/m^3) with decay and depletion for use in population dose calculations. Radiological decay in transit is included corresponding to radioiodine ^{131}I (8-day half-life). Input of this record set parallels that of set 9, as indicated in Table 2.12.

Record Set 12: Meteorological Data (Deposited)

Record set 12 provides ground deposition factors (m^{-2}/yr) for use in population dose calculations. The factors include no radiological decay. Input of this record set parallels that of record set 9, as indicated in Table 2.12.

Record Type 13.0: Special-Location Meteorological Data

Record type 13.0 provides meteorological parameters for special locations for which individual doses are to be calculated. One record is needed for each location with a maximum of five locations. Data on record type 13.0 are described in Table 2.13. A blank record must follow the last record of type 13.0. If only population doses are to be calculated, then one blank record type 13.0 must be provided.

Results of individual dose calculations for multiple release terms are summed by location over all release terms. Therefore, it is important that records of type 13.0 for each source term correspond to the same special location. For example, the first location for each source term must always represent the same special location for a given pass through GASPAR II.

TABLE 2.13. Record Type 13.0 Description

Parameter Name	Format	Columns	Description
JS(n)	I2	1-2	Control parameter for printing of detailed results for the current pathway n: If JS(n)=0, parameter JSS controls printing (see below) If JS(n)=1, no detailed reports are printed.
NAME(n)	2A8	3-18	Descriptive name for the current special location n.
IDIR(n)	A4	19-22	Compass direction from site to special location (N, NNE, etc.).
DIST(n)	F7.0	23-29	Distance from site to special location (mi). Distances may be supplied in units of m also; the program will automatically convert from m to mi (in this case values less than 50 are not allowed).
XQ1(n)	E10.0	30-39	Atmospheric dispersion factor ($\bar{\chi}$/Q') undecayed and undepleted for the current location (sec/m^3).
XQD1(n)	E10.0	40-49	Atmospheric dispersion factor ($\bar{\chi}$/Q') decayed and undepleted for the current location (sec/m^3).
XQDD1(n)	E10.0	50-59	Atmospheric dispersion factor ($\bar{\chi}$/Q')decayed and depleted for the current location (sec/m^3).
DEP1(n)	E10.0	60-69	Ground deposition factor (D/Q) undecayed for the current location (m^{-2}/yr).
JSS(n,1)	I1	70	Report control switch for plume exposure for current location: If JSS(n,1)≦0, print detailed reports If JSS(n,1)>0, omit printing of detailed reports.
JSS(n,2)	I1	71	Report control switch for ground-exposure pathway: If JSS(n,2)≦0, print detailed reports If JSS(n,2)>0, omit printing of detailed reports.
JSS(n,3)	I1	72	Report control switch for vegetable-ingestion pathway: If JSS(n,3)≦0, print detailed reports If JSS(n,3)>0, omit printing of detailed reports.
JSS(n,4)	I1	73	Report control switch for meat-ingestion pathway: If JSS(n,4)≦0, print detailed reports If JSS (n,4>0, omit printing of detailed reports.
JSS(n,5)	I1	74	Report control switch for cow-milk ingestion pathway: If JSS(n,5)≦0, print detailed reports If JSS(n,5)>0, omit printing of detailed reports.
JSS(n,6)	I1	75	Report control switch for goat-milk ingestion pathway: If JSS(n,6)≦0, print detailed reports If JSS(n,6)>0, omit printing of detailed reports.
JSS(n,7)	I1	76	Report control switch for inhalation pathway: If JSS(n,7)≦0, print detailed reports If JSS(n,7)>0, omit printing of detailed reports.

The distance from the source term to the special location may be defined in mi or m. Any numerical value greater than 50 is converted to m; therefore, distances greater than 50 mi cannot be entered as mi.

The special location records are read from the same input unit as the meteorological data for the population doses (record sets 9, 10, 11, and 12). Parameter JC(7) on record type 2.0 defines the input location.

The report control switches JS and JSS allow the user to determine which reports will be included in the output. If all report controls switches are zero, then all reports are printed for the given special location. If switch JS(n) is set to zero, print control is transferred to the JSS array. [Note: for a given location the JSS array has no effect if JS(n) is set to 1.] These print control switches are useful in reducing the number of output reports generated. If JS(n) is set to 1, only summary reports are printed.

Table 2.14 provides a summary of all input record types for quick reference.

TABLE 2.14. Summary of Record Types

Record Type and Description	Format	Columns	Parameter Description
1.0 - Run title	78A1	2-80	ITITLE(78) - title array.
2.0 - Job control	I2	1-2	JC(1) - population/individual dose: if =0, both; if >0, individual only.
	I2	3-4	JC(2) - number of source terms.
	I2	5-6	JC(3) - print control: if >0, print cumulative reports.
	I2	7-8	JC(4) - read control: if >0, read block data change records.
	I2	9-10	JC(5) - print control: if >0, print dose-factor library data.
	I2	11-12	JC(6) - PARTS control: if >0, perform PARTS calculation.
	I2	13-14	JC(7) - meteorological data input unit control: if =0, standard input; if >0, input from unit 7.
3.0 - Site data	E8.0	1-8	CD - distance to NE U.S. (mi).
	E8.0	9-16	FV - fraction of time leafy vegetables are grown.
	E8.0	17-24	FP - fraction of time milk cows are on pasture.
	E8.0	25-32	FG - fraction of individual vegetable consumption from home garden.

TABLE 2.14. (Contd)

Record Type and Description	Format	Columns	Parameter Description
	E8.0	33-40	FPF - fraction of milk-cow feed from pasture.
	E8.0	41-48	H - absolute humidity (g/m^3) or relative humidity (%).
	E8.0	49-56	T - average growing-period temperature (°F).
	F6.0	57-62	FGT - fraction of time milk goats are on pasture.
	F6.0	63-68	FPG - fraction of goat feed from pasture.
	F6.0	69-74	FB - fraction of time beef cattle are on pasture.
	F6.0	75-80	FBF - fraction of beef-cattle feed from pasture.
4.0 - Population title	78A1	2-80	LS - title for population data.
4.1 - Population control	I5	1-5	IDAT - compass direction specification for input data: if =0, north; if =1, south.
	I5	6-10	KC - number of data values on first record: 2≤KC≤7.
	I5	11-15	KT - population definition flag: if =0, uniform distribution; if =10, input by distance and direction.
4.1.na - Population data (POP array)	3A1	1-3	Compass direction (not read).
	E10.0	11-20	Population in first region (0-1 mi).
	.	.	.
	.	.	.
	.	.	.
	E10.0	to 71-80 max	Population in region KC.
4.1.nb - Population data (POP array)	E10.0	1-10	Population in region KC+1.
	.	.	.
	.	.	.
	.	.	.
	E10.0	to 71-80 max	Population in region 10.
4.2 - Total population	E10.0	1-10	PERSON - total population within 50 mi.
Set 5 - Milk-production data	Same as record set 4, for milk production input; ZMILK array, and ZMLKT total production.		
Set 6 - Meat-production data	Same as record set 4, for meat production input; ZMEAT array, and ZMETT total production.		
Set 7 - Vegetable-production data	Same as record set 4, for vegetable production input; ZVEGT array, and ZVEGTT total production.		
8.0 - Source title	10A4	1-40	LST - title for current source term.
8.1 - Source control	E10.0	1-10	UML - source multiplication factor.
	I1	20	JC1 - meteorological data input control: if =1, use previous data; if =0, read new data.

TABLE 2.14. (Contd)

Record Type and Description	Format	Columns	Parameter Description
	I1	30	JC2 - radionuclide release data input control: if =0, read new data; if >0, use previous data.
	F6.2	40-45	PURGE - purge time (hr/yr).
8.1.n - Radionuclide release rate	A2	3-4	IA - element symbol.
	5A1	5-9	IM - mass number.
	E10.0	11-20	QQ - radionuclide release rate (Ci/yr).
9.0 - Meteorological data title (undecayed/ undepleted)	78A1	3-80	LS - title array for current meteorological data.
9.1 - Meteorological data input control	I5	1-5	IDAT - compass direction specification for input data: if =0, north; if =1, south.
	I5	6-10	KC - number of data values on first record: $2 \leq KC \leq 7$.
9.1.na - Meteorological data (undepleted/ undecayed)	3A1	1-3	Compass direction (not read).
	E10.0	6-15	XQ(n,1) - $\bar{\chi}/Q'$ for distance 1 for sector n (sec/m^3).
	. . .	. . .	. . .
	E10.0	to 66-75 max	XQ(n,KC) - $\bar{\chi}/Q'$ for distance KC.
9.1.nb - Meteorological data continuation record	E10.0	1-10	XQ(n,KC+1) - $\bar{\chi}/Q'$ for distance KC+1.
	. . .	. . .	. . .
	E10.0	to 71-80 max	XQ(n,10) - $\bar{\chi}/Q'$ for distance 10.
Set 10	Same as set 9, for decayed and undepleted meteorological data array; XQD.		
Set 11	Same as set 9, for decayed and depleted meteorological data array; XQDD.		
Set 12	Same as set 9, for ground deposition meteorological data array; DEP.		
13.n - Individual dose location data	I2	1-2	JS(n) - print control: if =1, print no detailed reports; if =0, printing controlled by JSS array.
	2A8	3-18	NAME(n) - location name.
	A4	19-22	IDIR(n) - compass direction for current location.
	F7.0	23-29	DIST(n) - distance to current location (mi or m).
	E10.0	30-39	XQ1(n) - $\bar{\chi}/Q'$ undecayed/undepleted (sec/m^3).
	E10.0	40-49	XQD1(n) - $\bar{\chi}/Q'$ decayed/undepleted (sec/m^3).
	E10.0	50-59	XQDD1(n) - $\bar{\chi}/Q'$ decayed/depleted (sec/m^3).

TABLE 2.14. (Contd)

Record Type and Description	Format	Columns	Parameter Description
	E10.0	60-69	DEP1(n) - ground deposition data (m^{-2}/yr).
	I1	70	JSS(n,1) - print control: if =0, print plume-exposure results; if >0, omit report.
	I1	71	JSS(n,2) - print control: if =0, print ground-exposure results; if >0, omit report.
	I1	72	JSS(n,3) - print control: if =0, print vegetable-ingestion results; if >0, omit report.
	I1	73	JSS(n,4) - print control: if =0, print meat-ingestion results; if >0, omit report.
	I1	74	JSS(n,5) - print control: if =0, print cow-milk ingestion results; if >0, omit report.
	I1	75	JSS(n,6) - print control: if =0, print goat-milk ingestion results; if >0, omit report.
	I1	76	JSS(n,7) - print control: if =0, print inhalation results; if >0, omit report.

2.1.2 Block Data Change Records

The GASPAR II program allows the user to change values for several parameters that have been defined in the block data module, BLKDATA. The parameters that may be changed are associated with common blocks PHYS (physical data), TRANFR (pathway transfer factors), and USAGE (pathway usage parameters). Most parameters in these common blocks are independent of site characteristics.

To cause block data change records to be read, set the control parameter JC(4) on record type 2.0 to a positive value. The change records use a special code to indicate 1) which common block will be modified; 2) which parameter in the common block is to be modified; and 3) if the parameter is an array, which value(s) of the parameter array is to be modified. The format for the block data change record is given in Table 2.15. The first parameter on the record, NCOM, selects the common block to be changed. The second parameter, N, gives the position of the parameter in the common block. This position index is defined in Table 2.16 for all parameters in the three common

TABLE 2.15. Block Data Change Record Descriptions

Parameter Name	Format	Columns	Descriptions
NCOM	A1	1	Single-character indicator of the common block to be changed: P - PHYS T - TRANFR U - USAGE. Any other value will be treated as a blank, and reading of change records will stop.
N	I4	2-5	Index of the variable in the current common block to be changed. See Table 2.16 for index definitions.
I1	I4	6-9	For variable arrays, I1 gives the array position of the first value to be changed.
I2	I4	10-13	For variable arrays, I2 gives the array position of the last value to be changed. If left blank, I2 is set to I1, and one value is changed. The number of values changed is calculated as I2-I1+1.
Parameter changed	6E10.0	21-30 . . . 71-80	New data values to replace default values for the parameter defined by NCOM, N, I1, and I2.

TABLE 2.16. Parameter Index Values for Block Data Change Records

Index Number	Variable Name	Default Value	Units	Description/Reference in NRC (1977)
Common Block PHYS				
1	AREA	Array, 10 values	m^2	Area in m^2 of annular sections inside 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 mi.
2	PLIFE	6.31E8	sec (20 yr)	Midpoint of reactor operation lifetime (t_b: 1.109-14).[a]
3	SF	.7	none	External radiation shielding factor for individuals (S_F: 1.109-68).
4	SSF	.5	none	External radiation shielding factor for population (1.109-68).
5	VHS	2.7E+19	L (liters)	Volume of the hydrosphere, i.e., top 75 m of the oceans.
6	VNA	3.8E+18	m^3	Volume of the atmosphere.
7	FID	0.5	none	Fraction of iodine that deposits (1.109-26).
Common Block TRANFR				
1	BLDAY	60	days	Exposure time of vegetation (for human consumption) to plume (t_e: 1.109-68).

(a) Typical reference referring to the page number in Regulatory Guide 1.109, Rev. 1 (NRC 1977).

TABLE 2.16. (Contd)

Index Number	Variable Name	Default Value	Units	Description/Reference in NRC (1977)
2	COWIN	50	kg/day	Ingestion rate for cows (Q_F: 1.109-38).
3	GOATIN	6.	kg/day	Ingestion rate for goats (Q_F: 1.109-38).
4	IGOT	Array, 14 values	none	Atomic numbers for which goat-milk transfer rates are known (1.109-38).
5	PARTUP	0.2	none	Retention fraction of particulates other than iodine on vegetables (1.109-26).
6	REMVEG	5.73E-07	1/sec	Removal constant corresponding to 14 days (λ_w: 1.109-4).
7	SD	240	kg/m^3	Effective surface density for soil (P: 1.109-3).
8	SOIL	Array, 100 values	none	Soil transfer parameters (B_{iv}: 1.109-37).
9	VIORET	1.0	none	Retention fraction of iodine on vegetables (r: 1.109-26).
10	YA1	0.70	kg/m^2	Pasture grass density (Y_v: 1.109-69).
11	YA2	2.0	kg/m^2	Other crop density (Y_v: 1.109-69).
12	YV	2.0	kg/m^2	Garden vegetation density (Y_v: 1.109-69).
13	ZGMLK	Array, 14 values	days/L	Goat-milk transfer parameters (F_m: 1.109-38).
14	ZMET	Array, 100 values	days/kg	Meat transfer parameters (F_f: 1.109-37).
15	ZMLK	Array, 100 values	days/L	Cow-milk transfer parameters (F_m: 1.109-37).
6	TIM	Array, 8 values	sec	Eight holdup and transport times as follows:
	TIM(1)	1.73E06	sec (20 days)	Transport - meat to population (1.109-32).
	TIM(2)	3.46E05	sec (4 days)	Transport - milk to population (1.109-32).
	TIM(3)	1.21E06	sec (14 days)	Transport - vegetables to population (1.109-32).
	TIM(4)	5.18E06	sec (60 days)	Holdup - vegetation to individual (t_h: 1.109-69).
	TIM(5)	1.73E05	sec (2 days)	Transport - milk to individual (t_f: 1.109-27).
	TIM(6)	8.64E04	sec (1 day)	Holdup - leafy vegetables to individual (t_b: 1.109-69).
	TIM(7)	2.59E06	sec (30 days)	Exposure time of plume to pasture grass (t_e: 1.109-68).
	TIM(8)	7.78E06	sec (90 days)	Storage time for animal feed (t_h: 1.109-69).

TABLE 2.16. (Contd)

Index Number	Variable Name	Default Value	Units	Description/Reference in NRC (1977)
Common Block USAGE				
(For population dose calculations - 1.109-39):				
1	AVINH	3700., 8000., 8000.	m^3/yr	Average inhalation rates for three age groups: 1) children and infants, 2) teens, and 3) adults.
2	AVLVEG	10., 20., 30.	kg/yr	Average leafy vegetable intake for three age groups (not currently used).
3	AVMET	37., 59., 95.	kg/yr	Average meat intake for three age groups.
4	AVMLK	170., 200., 110.	L/yr	Average milk intake for three age groups.
5	AVVEG	200., 240., 190.	kg/yr	Average vegetable intake for three age groups.
6	POPF	.18, .11, .71	none	Fraction of population in three age groups.
7	USPOP	2.8E08	persons	Estimated U.S. population for the year 2010.
(For individual dose calculations - 1.109-40):				
8	SLVEG	0., 26., 42., 64.	kg/yr	Leafy vegetable intake for four age groups: 1) infant, 2) child, 3) teen, and 4) adult.
9	SPINH	1400., 3700., 8000., 8000.	m^3/yr	Inhalation rates for four age groups.
10	SPMET	0., 41., 65., 110.	kg/yr	Meat intake for four age groups.
11	SPMLK	330., 330., 400., 310.	L/yr	Milk intake for four age groups.
12	SPVEG	0., 520., 630., 520.	kg/yr	Vegetable intake for four age groups.

blocks. If the parameter to be changed is an array of values, the specific values or sequence of values to be changed may be identified with the I1 and I2 index parameters. I1 indicates the starting position in the array to be changed, and I2 indicates the last position to be changed. The number of data values to be read is calculated as I2-I1+1. If this value is greater than 6, additional records are read (format 8E10.0) until the necessary number of values have been read. I1 must be 1 or greater for arrays. I2 must not be greater than 100. If I2 is left blank it is set equal to I1, and one value is changed. For example, if seven values of an array are to be changed starting with the fifth value, I1 is set to 5, and I2 is set to 11. For single-value parameters, I1 and I2 should be left blank or set to zero. Examples of block data change records are provided in Sample Problem 3 (see Section 2.3.3).

When changes are made during a run, the changes remain in effect throughout the remainder of the run, unless changed later using block data change records. However, the changes are not permanent to the program, as the original default values will be used for subsequent runs (new executions of the program).

2.1.3 Alternate Meteorological Data File

Meteorological data may be provided to GASPAR II through the standard input file or on an alternate input file. The user can specify which file the input will be read from with parameter JC(7) on record type 2.0. The purpose of the alternate file is to allow the user to make use of meteorological data files generated by the XOQDOQ computer program (Sagendorf et al. 1982). The file generated by XOQDOQ must be edited before it can be used as input to GASPAR II. To illustrate the modifications, a copy of the XOQDOQ file before and after modification is shown in Listings 2.1 and 2.2, respectively. This file is used by Sample Problem 2 in Section 2.3.2. Changes required to the original file are indicated on Listing 2.1. Changes include:

1. reduction of descriptive information to one title record for each data set (record types 9.0, 10.0, 11.0, and 12.0)
2. selection of five or less individual location records (type 13.0) and elimination of unused location records
3. editing of individual location records to add print control switches if desired (parameters JS and JSS)
4. addition of a blank record following the individual location records.

2.2 OUTPUT REPORTS

The GASPAR II program prepares up to 27 types of output reports; seven reports are related to input parameters used for the run, and 20 reports

LISTING 2.1. Alternate Meteorological Data File as Generated by XOQDOQ

```
SAMPLE: JFD 4/4/77 TO 4/4/79 TO 4/1/80 TO 3/31/81 HT=10.0 DELTA T=U-L CLM=.27
RAD WASTE BUILDING: CONTINUOUS GROUND LEVEL RELEASE
 NO DECAY,  UNDEPLETED                                                          <--- Edit to 1 Line
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
   S  7.435E-06 1.643E-06 5.009E-07 2.548E-07 1.598E-07 7.241E-08 2.712E-08
 1.387E-08 9.027E-09 6.575E-09
 SSW  1.033E-05 2.303E-06 7.077E-07 3.618E-07 2.277E-07 1.038E-07 3.929E-08
 2.027E-08 1.326E-08 9.691E-09
  SW  1.043E-05 2.292E-06 6.947E-07 3.521E-07 2.202E-07 9.934E-08 3.691E-08
 1.877E-08 1.217E-08 8.836E-09
 WSW  8.717E-06 1.917E-06 5.814E-07 2.947E-07 1.843E-07 8.315E-08 3.091E-08
 1.572E-08 1.020E-08 7.407E-09
   W  8.705E-06 1.917E-06 5.820E-07 2.952E-07 1.847E-07 8.341E-08 3.103E-08
 1.579E-08 1.024E-08 7.440E-09
 WNW  7.796E-06 1.716E-06 5.206E-07 2.640E-07 1.651E-07 7.452E-08 2.770E-08
 1.408E-08 9.126E-09 6.626E-09
  NW  7.770E-06 1.688E-06 5.054E-07 2.542E-07 1.580E-07 7.052E-08 2.572E-08
 1.287E-08 8.254E-09 5.946E-09
 NNW  8.502E-06 1.853E-06 5.558E-07 2.799E-07 1.741E-07 7.783E-08 2.845E-08
 1.426E-08 9.154E-09 6.600E-09
   N  9.149E-06 2.005E-06 6.048E-07 3.056E-07 1.906E-07 8.559E-08 3.152E-08
 1.590E-08 1.025E-08 7.412E-09
 NNE  8.572E-06 1.871E-06 5.619E-07 2.832E-07 1.763E-07 7.890E-08 2.890E-08
 1.451E-08 9.327E-09 6.731E-09
  NE  1.026E-05 2.257E-06 6.840E-07 3.467E-07 2.168E-07 9.778E-08 3.630E-08
 1.843E-08 1.193E-08 8.659E-09
 ENE  9.999E-06 2.201E-06 6.688E-07 3.395E-07 2.126E-07 9.605E-08 3.579E-08
 1.823E-08 1.183E-08 8.593E-09
   E  8.072E-06 1.762E-06 5.336E-07 2.703E-07 1.690E-07 7.619E-08 2.830E-08
 1.439E-08 9.326E-09 6.773E-09
 ESE  8.410E-06 1.853E-06 5.648E-07 2.874E-07 1.802E-07 8.170E-08 3.060E-08
 1.565E-08 1.018E-08 7.412E-09
  SE  9.196E-06 2.035E-06 6.224E-07 3.172E-07 1.992E-07 9.049E-08 3.401E-08
 1.744E-08 1.136E-08 8.284E-09
 SSE  7.033E-06 1.557E-06 4.763E-07 2.427E-07 1.524E-07 6.923E-08 2.602E-08
 1.334E-08 8.695E-09 6.339E-09
RAD WASTE BUILDING: CONTINUOUS GROUND LEVEL RELEASE
   2.260 DAY DECAY,  UNDEPLETED                                                 <--- Edit to 1 Line
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
   S  7.389E-06 1.623E-06 4.900E-07 2.470E-07 1.535E-07 6.795E-08 2.396E-08
 1.138E-08 6.940E-09 4.765E-09
 SSW  1.022E-05 2.254E-06 6.809E-07 3.423E-07 2.120E-07 9.274E-08 3.158E-08
 1.434E-08 8.428E-09 5.630E-09
  SW  1.036E-05 2.261E-06 6.779E-07 3.401E-07 2.106E-07 9.259E-08 3.223E-08
 1.513E-08 9.157E-09 6.256E-09
 WSW  8.644E-06 1.886E-06 5.639E-07 2.821E-07 1.742E-07 7.602E-08 2.596E-08
 1.191E-08 7.077E-09 4.771E-09
   W  8.645E-06 1.891E-06 5.675E-07 2.848E-07 1.763E-07 7.747E-08 2.687E-08
 1.255E-08 7.552E-09 5.138E-09
 WNW  7.742E-06 1.692E-06 5.075E-07 2.546E-07 1.575E-07 6.915E-08 2.394E-08
 1.115E-08 6.709E-09 4.563E-09
  NW  7.741E-06 1.676E-06 4.988E-07 2.495E-07 1.543E-07 6.791E-08 2.387E-08
 1.138E-08 6.977E-09 4.813E-09
 NNW  8.455E-06 1.833E-06 5.449E-07 2.720E-07 1.679E-07 7.344E-08 2.538E-08
 1.186E-08 7.151E-09 4.872E-09
   N  9.088E-06 1.979E-06 5.905E-07 2.953E-07 1.824E-07 7.978E-08 2.750E-08
 1.279E-08 7.698E-09 5.245E-09
 NNE  8.531E-06 1.854E-06 5.526E-07 2.765E-07 1.709E-07 7.510E-08 2.623E-08
 1.242E-08 7.577E-09 5.216E-09
  NE  1.021E-05 2.238E-06 6.736E-07 3.392E-07 2.108E-07 9.351E-08 3.326E-08
 1.601E-08 9.881E-09 6.861E-09
 ENE  9.955E-06 2.182E-06 6.584E-07 3.320E-07 2.065E-07 9.178E-08 3.274E-08
 1.580E-08 9.766E-09 6.790E-09
   E  8.048E-06 1.752E-06 5.281E-07 2.664E-07 1.659E-07 7.397E-08 2.668E-08
 1.305E-08 8.147E-09 5.706E-09
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ESE  8.372E-06 1.836E-06 5.557E-07 2.808E-07 1.749E-07 7.791E-08 2.788E-08
1.347E-08 8.327E-09 5.786E-09
 SE  9.118E-06 2.001E-06 6.037E-07 3.037E-07 1.883E-07 8.281E-08 2.864E-08
1.328E-08 7.953E-09 5.392E-09
SSE  6.971E-06 1.531E-06 4.615E-07 2.321E-07 1.438E-07 6.318E-08 2.180E-08
1.007E-08 6.004E-09 4.052E-09
RAD WASTE BUILDING: CONTINUOUS GROUND LEVEL RELEASE
  8.000 DAY DECAY,    DEPLETED                                               Edit to 1 Line
CORRECTED USING STANDARD OPEN TERRAIN FACTORS
  S  6.660E-06 1.405E-06 4.048E-07 1.974E-07 1.196E-07 5.061E-08 1.643E-08
7.239E-09 4.185E-09 2.751E-09
SSW  9.243E-06 1.964E-06 5.691E-07 2.784E-07 1.688E-07 7.150E-08 2.309E-08
1.005E-08 5.724E-09 3.706E-09
 SW  9.343E-06 1.959E-06 5.609E-07 2.726E-07 1.646E-07 6.930E-08 2.228E-08
9.732E-09 5.592E-09 3.658E-09
WSW  7.803E-06 1.637E-06 4.686E-07 2.275E-07 1.373E-07 5.767E-08 1.842E-08
7.970E-09 4.537E-09 2.942E-09
  W  7.796E-06 1.639E-06 4.699E-07 2.285E-07 1.380E-07 5.812E-08 1.868E-08
8.143E-09 4.668E-09 3.046E-09
WNW  6.982E-06 1.467E-06 4.203E-07 2.042E-07 1.233E-07 5.191E-08 1.666E-08
7.250E-09 4.150E-09 2.705E-09
 NW  6.966E-06 1.446E-06 4.095E-07 1.977E-07 1.188E-07 4.970E-08 1.584E-08
6.899E-09 3.971E-09 2.606E-09
NNW  7.618E-06 1.585E-06 4.494E-07 2.171E-07 1.304E-07 5.451E-08 1.729E-08
7.473E-09 4.267E-09 2.779E-09
  N  8.194E-06 1.714E-06 4.885E-07 2.366E-07 1.425E-07 5.971E-08 1.901E-08
8.223E-09 4.691E-09 3.050E-09
NNE  7.682E-06 1.601E-06 4.548E-07 2.199E-07 1.323E-07 5.540E-08 1.766E-08
7.673E-09 4.402E-09 2.880E-09
 NE  9.194E-06 1.932E-06 5.538E-07 2.694E-07 1.628E-07 6.874E-08 2.224E-08
9.800E-09 5.676E-09 3.742E-09
ENE  8.962E-06 1.884E-06 5.414E-07 2.638E-07 1.596E-07 6.750E-08 2.192E-08
9.684E-09 5.619E-09 3.709E-09
  E  7.238E-06 1.510E-06 4.326E-07 2.105E-07 1.273E-07 5.381E-08 1.750E-08
7.775E-09 4.537E-09 3.011E-09
ESE  7.537E-06 1.585E-06 4.572E-07 2.232E-07 1.353E-07 5.738E-08 1.871E-08
8.295E-09 4.822E-09 3.186E-09
 SE  8.232E-06 1.738E-06 5.017E-07 2.449E-07 1.484E-07 6.277E-08 2.028E-08
8.859E-09 5.074E-09 3.306E-09
SSE  6.295E-06 1.330E-06 3.838E-07 1.873E-07 1.135E-07 4.799E-08 1.550E-08
6.765E-09 3.873E-09 2.521E-09
          DEPOSITION
RAD WASTE BUILDING: CONTINUOUS GROUND LEVEL RELEASE                          Edit to 1 Line
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
  S  1.911E-08 3.913E-09 1.022E-09 4.588E-10 2.596E-10 9.982E-11 2.888E-11
1.145E-11 6.112E-12 3.783E-12
SSW  2.284E-08 4.679E-09 1.222E-09 5.486E-10 3.104E-10 1.194E-10 3.453E-11
1.369E-11 7.308E-12 4.523E-12
 SW  2.888E-08 5.915E-09 1.544E-09 6.935E-10 3.923E-10 1.509E-10 4.365E-11
1.730E-11 9.238E-12 5.718E-12
WSW  2.482E-08 5.083E-09 1.327E-09 5.960E-10 3.372E-10 1.297E-10 3.751E-11
1.487E-11 7.939E-12 4.914E-12
  W  2.225E-08 4.558E-09 1.190E-09 5.345E-10 3.023E-10 1.163E-10 3.364E-11
1.333E-11 7.119E-12 4.406E-12
WNW  1.960E-08 4.014E-09 1.048E-09 4.707E-10 2.663E-10 1.024E-10 2.962E-11
1.174E-11 6.270E-12 3.881E-12
 NW  2.073E-08 4.247E-09 1.109E-09 4.980E-10 2.817E-10 1.083E-10 3.134E-11
1.242E-11 6.633E-12 4.106E-12
NNW  2.055E-08 4.209E-09 1.099E-09 4.935E-10 2.792E-10 1.074E-10 3.106E-11
1.231E-11 6.574E-12 4.069E-12
  N  2.384E-08 4.882E-09 1.275E-09 5.724E-10 3.238E-10 1.245E-10 3.603E-11
1.428E-11 7.625E-12 4.720E-12
NNE  2.468E-08 5.055E-09 1.320E-09 5.927E-10 3.353E-10 1.289E-10 3.730E-11
1.479E-11 7.896E-12 4.887E-12
 NE  2.842E-08 5.822E-09 1.520E-09 6.826E-10 3.862E-10 1.485E-10 4.296E-11
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LISTING 2.1. (Contd)

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1.703E-11 9.093E-12 5.628E-12
ENE  3.050E-08 6.247E-09 1.631E-09 7.325E-10 4.144E-10 1.593E-10 4.610E-11
1.827E-11 9.757E-12 6.039E-12
  E  3.367E-08 6.896E-09 1.800E-09 8.085E-10 4.574E-10 1.759E-10 5.089E-11
2.017E-11 1.077E-11 6.666E-12
ESE  3.024E-08 6.195E-09 1.617E-09 7.263E-10 4.109E-10 1.580E-10 4.571E-11
1.812E-11 9.675E-12 5.988E-12
 SE  2.621E-08 5.370E-09 1.402E-09 6.296E-10 3.562E-10 1.370E-10 3.962E-11
1.570E-11 8.386E-12 5.191E-12
SSE  1.670E-08 3.421E-09 8.931E-10 4.011E-10 2.269E-10 8.727E-11 2.525E-11
1.001E-11 5.343E-12 3.307E-12
RAD WASTE BUILDING: CONTINUOUS GROUND LEVEL RELEASE
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
  A  SITE BNDRY      S 1640.0 3.538E-06 3.506E-06 3.085E-06 8.852E-09
  A  SITE BNDRY    SSW 1820.0 3.856E-06 3.789E-06 3.330E-06 8.109E-09
  A  SITE BNDRY     SW 2090.0 2.781E-06 2.745E-06 2.380E-06 7.226E-09
  A  SITE BNDRY    WSW 1890.0 2.944E-06 2.902E-06 2.538E-06 8.004E-09
  A  SITE BNDRY      W 2120.0 2.251E-06 2.221E-06 1.924E-06 5.373E-09
  A  SITE BNDRY    WNW 2740.0 1.131E-06 1.111E-06 9.454E-07 2.508E-09
  A  SITE BNDRY     NW 2500.0 1.358E-06 1.346E-06 1.147E-06 3.323E-09
  A  SITE BNDRY    NNW 2370.0 1.683E-06 1.663E-06 1.426E-06 3.758E-09
  A  SITE BNDRY      N 1780.0 3.557E-06 3.519E-06 3.082E-06 8.954E-09
  A  SITE BNDRY    NNE 1310.0 7.113E-06 7.074E-06 6.299E-06 2.051E-08
  A  SITE BNDRY     NE 1140.0 1.146E-05 1.141E-05 1.024E-05 3.202E-08
  A  SITE BNDRY    ENE 1320.0 8.146E-06 8.104E-06 7.210E-06 2.484E-08
  A  SITE BNDRY      E 1660.0 3.695E-06 3.679E-06 3.224E-06 1.512E-08
  A  SITE BNDRY    ESE 1780.0 3.276E-06 3.252E-06 2.842E-06 1.136E-08
  A  SITE BNDRY     SE 1820.0 3.412E-06 3.364E-06 2.949E-06 9.305E-09
  A  SITE BNDRY    SSE 1720.0 2.987E-06 2.946E-06 2.593E-06 6.849E-09
  A  NRST RESID    WSW 1931.0 2.799E-06 2.758E-06 2.409E-06 7.580E-09
  A  NRST RESID      W 2414.0 1.674E-06 1.649E-06 1.416E-06 3.888E-09
  A  NRST RESID    WNW 3058.0 8.912E-07 8.737E-07 7.373E-07 1.921E-09
  A  NRST RESID      N 1860.0 3.202E-06 3.166E-06 2.766E-06 8.006E-09
  A  NRST RESID      E 1980.0 2.426E-06 2.413E-06 2.089E-06 9.652E-09
  A  NRST RESID     SE 5310.0 3.496E-07 3.354E-07 2.714E-07 7.044E-10
  A  VEG GRDN      WSW 2253.0 1.958E-06 1.924E-06 1.664E-06 5.147E-09
  A  VEG GRDN       NW 3862.0 5.306E-07 5.237E-07 4.300E-07 1.165E-09
  A  MILK COW       SW 8000.0 1.833E-07 1.744E-07 1.347E-07 3.119E-10
  A  MILK COW       SE 7403.0 1.902E-07 1.795E-07 1.410E-07 3.353E-10
  A  MEAT ANML      SW 4989.0 4.378E-07 4.244E-07 3.434E-07 8.947E-10
  A  MEAT ANML      NW 6276.0 2.041E-07 1.999E-07 1.562E-07 3.822E-10
TURBINE BUILDING: CONTINUOUS GROUND LEVEL RELEASE NO TERRAIN
 NO DECAY,  UNDEPLETED
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
  S  5.289E-06 1.224E-06 4.028E-07 2.130E-07 1.366E-07 6.368E-08 2.467E-08
1.285E-08 8.438E-09 6.180E-09
SSW  7.311E-06 1.669E-06 5.534E-07 2.952E-07 1.904E-07 8.963E-08 3.523E-08
1.856E-08 1.226E-08 9.024E-09
 SW  7.411E-06 1.735E-06 5.691E-07 2.994E-07 1.913E-07 8.857E-08 3.396E-08
1.756E-08 1.147E-08 8.374E-09
WSW  6.258E-06 1.454E-06 4.745E-07 2.495E-07 1.593E-07 7.377E-08 2.829E-08
1.464E-08 9.570E-09 6.987E-09
  W  6.221E-06 1.450E-06 4.744E-07 2.497E-07 1.596E-07 7.397E-08 2.841E-08
1.471E-08 9.614E-09 7.020E-09
WNW  5.545E-06 1.298E-06 4.254E-07 2.239E-07 1.431E-07 6.627E-08 2.542E-08
1.314E-08 8.586E-09 6.265E-09
 NW  5.540E-06 1.331E-06 4.317E-07 2.244E-07 1.420E-07 6.479E-08 2.423E-08
1.229E-08 7.928E-09 5.732E-09
NNW  6.080E-06 1.453E-06 4.714E-07 2.454E-07 1.555E-07 7.106E-08 2.666E-08
1.354E-08 8.750E-09 6.333E-09
  N  6.534E-06 1.548E-06 5.041E-07 2.637E-07 1.677E-07 7.712E-08 2.922E-08
1.496E-08 9.713E-09 7.055E-09
NNE  6.130E-06 1.460E-06 4.741E-07 2.471E-07 1.567E-07 7.174E-08 2.699E-08
1.374E-08 8.892E-09 6.443E-09
 NE  7.270E-06 1.711E-06 5.612E-07 2.952E-07 1.885E-07 8.726E-08 3.341E-08
```

Delete

Delete

Delete

Add Blank Line

Edit to 1 Line

LISTING 2.1. (Contd)

```
1.725E-08 1.125E-08 8.206E-09
ENE  7.072E-06 1.658E-06 5.456E-07 2.877E-07 1.841E-07 8.543E-08 3.286E-08
1.703E-08 1.114E-08 8.134E-09
  E  5.759E-06 1.351E-06 4.427E-07 2.325E-07 1.483E-07 6.857E-08 2.623E-08
1.355E-08 8.847E-09 6.455E-09
ESE  5.943E-06 1.387E-06 4.584E-07 2.425E-07 1.555E-07 7.244E-08 2.803E-08
1.460E-08 9.574E-09 7.007E-09
 SE  6.484E-06 1.506E-06 4.988E-07 2.647E-07 1.701E-07 7.953E-08 3.094E-08
1.617E-08 1.063E-08 7.792E-09
SSE  4.966E-06 1.150E-06 3.807E-07 2.020E-07 1.298E-07 6.072E-08 2.363E-08
1.235E-08 8.122E-09 5.955E-09
TURBINE BUILDING: CONTINUOUS GROUND LEVEL RELEASE NO TERRAIN
  2.260 DAY DECAY,  UNDEPLETED
CORRECTED USING STANDARD OPEN TERRAIN FACTORS
```

Edit to 1 Line

```
  S  5.257E-06 1.209E-06 3.943E-07 2.067E-07 1.313E-07 5.981E-08 2.183E-08
1.057E-08 6.504E-09 4.492E-09
SSW  7.235E-06 1.636E-06 5.337E-07 2.802E-07 1.779E-07 8.038E-08 2.849E-08
1.324E-08 7.874E-09 5.298E-09
 SW  7.362E-06 1.712E-06 5.557E-07 2.894E-07 1.830E-07 8.260E-08 2.967E-08
1.417E-08 8.646E-09 5.937E-09
WSW  6.207E-06 1.432E-06 4.614E-07 2.396E-07 1.511E-07 6.775E-08 2.392E-08
1.119E-08 6.715E-09 4.555E-09
  W  6.179E-06 1.431E-06 4.633E-07 2.414E-07 1.527E-07 6.890E-08 2.470E-08
1.175E-08 7.137E-09 4.883E-09
WNW  5.507E-06 1.282E-06 4.155E-07 2.164E-07 1.369E-07 6.171E-08 2.208E-08
1.048E-08 6.363E-09 4.353E-09
 NW  5.520E-06 1.321E-06 4.261E-07 2.202E-07 1.387E-07 6.237E-08 2.248E-08
1.087E-08 6.701E-09 4.640E-09
NNW  6.047E-06 1.438E-06 4.627E-07 2.388E-07 1.502E-07 6.718E-08 2.385E-08
1.131E-08 6.869E-09 4.700E-09
  N  6.492E-06 1.529E-06 4.930E-07 2.553E-07 1.609E-07 7.211E-08 2.561E-08
1.212E-08 7.351E-09 5.034E-09
NNE  6.101E-06 1.448E-06 4.666E-07 2.415E-07 1.522E-07 6.842E-08 2.457E-08
1.181E-08 7.255E-09 5.017E-09
 NE  7.239E-06 1.698E-06 5.531E-07 2.891E-07 1.835E-07 8.355E-08 3.067E-08
1.502E-08 9.345E-09 6.522E-09
ENE  7.041E-06 1.644E-06 5.376E-07 2.816E-07 1.790E-07 8.173E-08 3.012E-08
1.479E-08 9.223E-09 6.446E-09
  E  5.742E-06 1.343E-06 4.382E-07 2.292E-07 1.456E-07 6.656E-08 2.472E-08
1.229E-08 7.731E-09 5.440E-09
ESE  5.916E-06 1.375E-06 4.513E-07 2.372E-07 1.511E-07 6.918E-08 2.560E-08
1.260E-08 7.860E-09 5.493E-09
 SE  6.431E-06 1.483E-06 4.848E-07 2.541E-07 1.613E-07 7.304E-08 2.620E-08
1.241E-08 7.504E-09 5.119E-09
SSE  4.924E-06 1.131E-06 3.695E-07 1.936E-07 1.228E-07 5.556E-08 1.987E-08
9.374E-09 5.645E-09 3.833E-09
TURBINE BUILDING: CONTINUOUS GROUND LEVEL RELEASE NO TERRAIN
  8.000 DAY DECAY,    DEPLETED
CORRECTED USING STANDARD OPEN TERRAIN FACTORS
```

Edit to 1 Line

```
  S  4.737E-06 1.046E-06 3.254E-07 1.651E-07 1.022E-07 4.449E-08 1.494E-08
6.711E-09 3.916E-09 2.589E-09
SSW  6.542E-06 1.423E-06 4.452E-07 2.273E-07 1.413E-07 6.175E-08 2.073E-08
9.224E-09 5.312E-09 3.464E-09
 SW  6.636E-06 1.482E-06 4.595E-07 2.318E-07 1.429E-07 6.176E-08 2.049E-08
9.105E-09 5.274E-09 3.468E-09
WSW  5.601E-06 1.241E-06 3.827E-07 1.928E-07 1.188E-07 5.120E-08 1.688E-08
7.442E-09 4.275E-09 2.788E-09
  W  5.571E-06 1.238E-06 3.830E-07 1.933E-07 1.193E-07 5.156E-08 1.711E-08
7.596E-09 4.393E-09 2.882E-09
WNW  4.965E-06 1.109E-06 3.435E-07 1.733E-07 1.069E-07 4.618E-08 1.530E-08
6.782E-09 3.916E-09 2.567E-09
 NW  4.964E-06 1.138E-06 3.497E-07 1.745E-07 1.068E-07 4.563E-08 1.492E-08
6.586E-09 3.813E-09 2.512E-09
NNW  5.445E-06 1.242E-06 3.812E-07 1.903E-07 1.165E-07 4.977E-08 1.621E-08
7.108E-09 4.086E-09 2.672E-09
```

```
  N  5.850E-06 1.323E-06 4.072E-07 2.042E-07 1.254E-07 5.382E-08 1.764E-08
7.754E-09 4.457E-09 2.913E-09
NNE  5.491E-06 1.249E-06 3.837E-07 1.919E-07 1.176E-07 5.037E-08 1.650E-08
7.276E-09 4.204E-09 2.762E-09
 NE  8.514E-06 1.464E-06 4.543E-07 2.294E-07 1.416E-07 6.132E-08 2.047E-08
9.176E-09 5.359E-09 3.550E-09
ENE  6.337E-06 1.418E-06 4.417E-07 2.236E-07 1.382E-07 6.002E-08 2.012E-08
9.052E-09 5.297E-09 3.515E-09
  E  5.162E-06 1.156E-06 3.589E-07 1.810E-07 1.117E-07 4.839E-08 1.622E-08
7.320E-09 4.304E-09 2.870E-09
ESE  5.325E-06 1.186E-06 3.710E-07 1.883E-07 1.167E-07 5.086E-08 1.715E-08
7.743E-09 4.541E-09 3.017E-09
 SE  5.804E-06 1.286E-06 4.021E-07 2.045E-07 1.268E-07 5.518E-08 1.847E-08
8.231E-09 4.760E-09 3.120E-09
SSE  4.445E-06 9.814E-07 3.068E-07 1.560E-07 9.671E-08 4.209E-08 1.408E-08
6.272E-09 3.625E-09 2.375E-09
          DEPOSITION
TURBINE BUILDING: CONTINUOUS GROUND LEVEL RELEASE NO TERRAIN
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
```

Edit to 1 Line

```
  S  1.911E-08 3.913E-09 1.022E-09 4.588E-10 2.596E-10 9.982E-11 2.888E-11
1.145E-11 6.112E-12 3.783E-12
SSW  2.284E-08 4.679E-09 1.222E-09 5.486E-10 3.104E-10 1.194E-10 3.453E-11
1.369E-11 7.308E-12 4.523E-12
 SW  2.888E-08 5.915E-09 1.544E-09 6.935E-10 3.923E-10 1.509E-10 4.365E-11
1.730E-11 9.238E-12 5.718E-12
WSW  2.482E-08 5.083E-09 1.327E-09 5.960E-10 3.372E-10 1.297E-10 3.751E-11
1.487E-11 7.939E-12 4.914E-12
  W  2.225E-08 4.558E-09 1.190E-09 5.345E-10 3.023E-10 1.163E-10 3.364E-11
1.333E-11 7.119E-12 4.406E-12
WNW  1.960E-08 4.014E-09 1.048E-09 4.707E-10 2.663E-10 1.024E-10 2.962E-11
1.174E-11 6.270E-12 3.881E-12
 NW  2.073E-08 4.247E-09 1.109E-09 4.980E-10 2.817E-10 1.083E-10 3.134E-11
1.242E-11 6.633E-12 4.106E-12
NNW  2.055E-08 4.209E-09 1.099E-09 4.935E-10 2.792E-10 1.074E-10 3.106E-11
1.231E-11 6.574E-12 4.069E-12
  N  2.384E-08 4.882E-09 1.275E-09 5.724E-10 3.238E-10 1.245E-10 3.603E-11
1.428E-11 7.625E-12 4.720E-12
NNE  2.468E-08 5.055E-09 1.320E-09 5.927E-10 3.353E-10 1.289E-10 3.730E-11
1.479E-11 7.896E-12 4.887E-12
 NE  2.842E-08 5.822E-09 1.520E-09 6.826E-10 3.862E-10 1.485E-10 4.296E-11
1.703E-11 9.093E-12 5.628E-12
ENE  3.050E-08 6.247E-09 1.631E-09 7.325E-10 4.144E-10 1.593E-10 4.610E-11
1.827E-11 9.757E-12 6.039E-12
  E  3.367E-08 6.896E-09 1.800E-09 8.085E-10 4.574E-10 1.759E-10 5.089E-11
2.017E-11 1.077E-11 6.666E-12
ESE  3.024E-08 6.195E-09 1.617E-09 7.263E-10 4.109E-10 1.580E-10 4.571E-11
1.812E-11 9.675E-12 5.988E-12
 SE  2.621E-08 5.370E-09 1.402E-09 6.296E-10 3.562E-10 1.370E-10 3.962E-11
1.570E-11 8.386E-12 5.191E-12
SSE  1.670E-08 3.421E-09 8.931E-10 4.011E-10 2.269E-10 8.727E-11 2.525E-11
1.001E-11 5.343E-12 3.307E-12
TURBINE BUILDING: CONTINUOUS GROUND LEVEL RELEASE NO TERRAIN
 CORRECTED USING STANDARD OPEN TERRAIN FACTORS
```

Delete

```
 A  SITE BNDRY     S 1820.0 2.016E-06 1.997E-06 1.745E-06 6.782E-09
 A  SITE BNDRY   SSW 2030.0 2.138E-06 2.099E-06 1.831E-06 6.150E-09
 A  SITE BNDRY    SW 2170.0 1.929E-06 1.904E-06 1.646E-06 6.577E-09
 A  SITE BNDRY   WSW 1900.0 2.176E-06 2.147E-06 1.875E-06 7.898E-09
```

Delete

```
 A  SITE BNDRY     W 2120.0 1.694E-06 1.673E-06 1.448E-06 5.373E-09
 A  SITE BNDRY   WNW 2740.0 8.836E-07 8.696E-07 7.391E-07 2.508E-09
 A  SITE BNDRY    NW 2500.0 1.099E-06 1.090E-06 9.286E-07 3.323E-09
 A  SITE BNDRY   NNW 2370.0 1.341E-06 1.326E-06 1.137E-06 3.758E-09
 A  SITE BNDRY     N 1780.0 2.690E-06 2.664E-06 2.332E-06 8.954E-09
 A  SITE BNDRY   NNE 1310.0 5.182E-06 5.155E-06 4.589E-06 2.051E-08
 A  SITE BNDRY    NE 1140.0 8.025E-06 7.990E-06 7.165E-06 3.202E-08
 A  SITE BNDRY   ENE 1320.0 5.789E-06 5.759E-06 5.124E-06 2.484E-08
```

Delete

LISTING 2.1. (Contd)

```
A  SITE BNDRY    E 1660.0 2.747E-06 2.735E-06 2.397E-06 1.512E-08
A  SITE BNDRY  ESE 1910.0 2.047E-06 2.032E-06 1.767E-06 9.497E-09
A  SITE BNDRY   SE 1960.0 2.095E-06 2.066E-06 1.801E-06 7.711E-09
A  SITE BNDRY  SSE 2870.0 7.146E-07 6.993E-07 5.943E-07 1.909E-09
A  NRST RESID  WSW 1931.0 2.097E-06 2.069E-06 1.805E-06 7.580E-09
A  NRST RESID    W 2414.0 1.279E-06 1.261E-06 1.082E-06 3.888E-09
A  NRST RESID  WNW 3058.0 7.077E-07 6.951E-07 5.858E-07 1.921E-09
A  NRST RESID    N 1860.0 2.434E-06 2.409E-06 2.103E-06 8.006E-09   <-- Delete
A  NRST RESID    E 1980.0 1.843E-06 1.834E-06 1.588E-06 9.652E-09
A  NRST RESID   SE 5310.0 2.906E-07 2.796E-07 2.258E-07 7.044E-10
A  VEG GRDN    WSW 2253.0 1.483E-06 1.461E-06 1.261E-06 5.147E-09
A  VEG GRDN     NW 3862.0 4.538E-07 4.480E-07 3.678E-07 1.165E-09
A  MILK COW     SW 8000.0 1.604E-07 1.528E-07 1.180E-07 3.119E-10
A  MILK COW     SE 7403.0 1.628E-07 1.542E-07 1.208E-07 3.353E-10
A  MEAT ANML    SW 4989.0 3.690E-07 3.579E-07 2.895E-07 8.947E-10
                                                                    <-- Add Blank Line
```

present results of the various calculations. The number of reports generated for a given calculation is variable and is controlled by input information (as described in Section 2.1).

This section presents examples of the 27 report types, as taken from the sample problems presented in Section 2.3, and describes the major features and purpose of each report. Table 2.17 is a summary list of the 27 report types. Items of special interest on the sample output reports are marked by circled numbers. These circled numbers are not generated by the computer, but have been added to aid in the discussion of the report.

2.2.1 Report 1: Banner Page

The first page of output for every GASPAR II run is a banner page, as shown in Listing 2.3 for Sample Problem 1. The version identification (item 1) describes the system on which GASPAR II is being run and the date the program was installed (revision date). Version identification is set internally in the main program of GASPAR II during installation of the program on the computer system. The title of the run (item 2) is printed using information supplied on input record type 1.0. The current date (item 3) is evaluated by a system routine and is not controllable by the user.

2.2.2 Report Type 2: Block Data Change Summary

Three reports of type 2 are printed by GASPAR II giving current values for all parameters in common blocks TRANFR (report type 2a), PHYS (report type

LISTING 2.2. Alternate Meteorological Data File as Modified for Input to GASPAR II

```
  SAMPLE MET FILE, RAD WASTE BLDG  NO DECAY,  UNDEPLETED
  S  7.435E-06 1.643E-06 5.009E-07 2.548E-07 1.598E-07 7.241E-08 2.712E-08
1.387E-08 9.027E-09 6.575E-09
SSW  1.033E-05 2.303E-06 7.077E-07 3.618E-07 2.277E-07 1.038E-07 3.929E-08
2.027E-08 1.326E-08 9.691E-09
 SW  1.043E-05 2.292E-06 6.947E-07 3.521E-07 2.202E-07 9.934E-08 3.691E-08
1.877E-08 1.217E-08 8.836E-09
WSW  8.717E-06 1.917E-06 5.814E-07 2.947E-07 1.843E-07 8.315E-08 3.091E-08
1.572E-08 1.020E-08 7.407E-09
  W  8.705E-06 1.917E-06 5.820E-07 2.952E-07 1.847E-07 8.341E-08 3.103E-08
1.579E-08 1.024E-08 7.440E-09
WNW  7.796E-06 1.716E-06 5.206E-07 2.640E-07 1.651E-07 7.452E-08 2.770E-08
1.408E-08 9.126E-09 6.626E-09
 NW  7.770E-06 1.688E-06 5.054E-07 2.542E-07 1.580E-07 7.052E-08 2.572E-08
1.287E-08 8.254E-09 5.946E-09
NNW  8.502E-06 1.853E-06 5.558E-07 2.799E-07 1.741E-07 7.783E-08 2.845E-08
1.426E-08 9.154E-09 6.600E-09
  N  9.149E-06 2.005E-06 6.048E-07 3.056E-07 1.906E-07 8.559E-08 3.152E-08
1.590E-08 1.025E-08 7.412E-09
NNE  8.572E-06 1.871E-06 5.619E-07 2.832E-07 1.763E-07 7.890E-08 2.890E-08
1.451E-08 9.327E-09 6.731E-09
 NE  1.026E-05 2.257E-06 6.840E-07 3.467E-07 2.168E-07 9.778E-08 3.630E-08
1.843E-08 1.193E-08 8.659E-09
ENE  9.999E-06 2.201E-06 6.688E-07 3.395E-07 2.126E-07 9.605E-08 3.579E-08
1.823E-08 1.183E-08 8.593E-09
  E  8.072E-06 1.762E-06 5.336E-07 2.703E-07 1.690E-07 7.619E-08 2.830E-08
1.439E-08 9.326E-09 6.773E-09
ESE  8.410E-06 1.853E-06 5.648E-07 2.874E-07 1.802E-07 8.170E-08 3.060E-08
1.565E-08 1.018E-08 7.412E-09
 SE  9.196E-06 2.035E-06 6.224E-07 3.172E-07 1.992E-07 9.049E-08 3.401E-08
1.744E-08 1.136E-08 8.284E-09
SSE  7.033E-06 1.557E-06 4.763E-07 2.427E-07 1.524E-07 6.923E-08 2.602E-08
1.334E-08 8.695E-09 6.339E-09
  SAMPLE   2.260 DAY DECAY,  UNDEPLETED
  S  7.389E-06 1.623E-06 4.900E-07 2.470E-07 1.535E-07 6.795E-08 2.396E-08
1.138E-08 6.940E-09 4.765E-09
SSW  1.022E-05 2.254E-06 6.809E-07 3.423E-07 2.120E-07 9.274E-08 3.158E-08
1.434E-08 8.428E-09 5.630E-09
 SW  1.036E-05 2.261E-06 6.779E-07 3.401E-07 2.106E-07 9.259E-08 3.223E-08
1.513E-08 9.157E-09 6.256E-09
WSW  8.644E-06 1.886E-06 5.639E-07 2.821E-07 1.742E-07 7.602E-08 2.596E-08
1.191E-08 7.077E-09 4.771E-09
  W  8.645E-06 1.891E-06 5.675E-07 2.848E-07 1.763E-07 7.747E-08 2.687E-08
1.255E-08 7.552E-09 5.138E-09
WNW  7.742E-06 1.692E-06 5.075E-07 2.546E-07 1.575E-07 6.915E-08 2.394E-08
1.115E-08 6.709E-09 4.563E-09
 NW  7.741E-06 1.676E-06 4.988E-07 2.495E-07 1.543E-07 6.791E-08 2.387E-08
1.138E-08 6.977E-09 4.813E-09
NNW  8.455E-06 1.833E-06 5.449E-07 2.720E-07 1.679E-07 7.344E-08 2.538E-08
1.186E-08 7.151E-09 4.872E-09
  N  9.088E-06 1.979E-06 5.905E-07 2.953E-07 1.824E-07 7.978E-08 2.750E-08
1.279E-08 7.698E-09 5.245E-09
NNE  8.531E-06 1.854E-06 5.526E-07 2.765E-07 1.709E-07 7.510E-08 2.623E-08
1.242E-08 7.577E-09 5.216E-09
 NE  1.021E-05 2.238E-06 6.736E-07 3.392E-07 2.108E-07 9.351E-08 3.326E-08
1.601E-08 9.881E-09 6.861E-09
ENE  9.955E-06 2.182E-06 6.584E-07 3.320E-07 2.065E-07 9.178E-08 3.274E-08
1.580E-08 9.766E-09 6.790E-09
  E  8.048E-06 1.752E-06 5.281E-07 2.664E-07 1.659E-07 7.397E-08 2.668E-08
1.305E-08 8.147E-09 5.706E-09
ESE  8.372E-06 1.836E-06 5.557E-07 2.808E-07 1.749E-07 7.791E-08 2.788E-08
1.347E-08 8.327E-09 5.786E-09
 SE  9.118E-06 2.001E-06 6.037E-07 3.037E-07 1.883E-07 8.281E-08 2.864E-08
1.328E-08 7.953E-09 5.392E-09
SSE  6.971E-06 1.531E-06 4.615E-07 2.321E-07 1.438E-07 6.318E-08 2.180E-08
```

LISTING 2.2. (Contd)

```
1.007E-08 6.004E-09 4.052E-09
  SAMPLE   8.000 DAY DECAY,    DEPLETED
  S  6.660E-06 1.405E-06 4.048E-07 1.974E-07 1.196E-07 5.061E-08 1.643E-08
7.239E-09 4.185E-09 2.751E-09
SSW  9.243E-06 1.964E-06 5.691E-07 2.784E-07 1.688E-07 7.150E-08 2.309E-08
1.005E-08 5.724E-09 3.706E-09
 SW  9.343E-06 1.959E-06 5.609E-07 2.726E-07 1.646E-07 6.930E-08 2.228E-08
9.732E-09 5.592E-09 3.658E-09
WSW  7.803E-06 1.637E-06 4.686E-07 2.275E-07 1.373E-07 5.767E-08 1.842E-08
7.970E-09 4.537E-09 2.942E-09
  W  7.796E-06 1.639E-06 4.699E-07 2.285E-07 1.380E-07 5.812E-08 1.868E-08
8.143E-09 4.668E-09 3.046E-09
WNW  6.982E-06 1.467E-06 4.203E-07 2.042E-07 1.233E-07 5.191E-08 1.666E-08
7.250E-09 4.150E-09 2.705E-09
 NW  6.966E-06 1.446E-06 4.095E-07 1.977E-07 1.188E-07 4.970E-08 1.584E-08
6.899E-09 3.971E-09 2.606E-09
NNW  7.618E-06 1.585E-06 4.494E-07 2.171E-07 1.304E-07 5.451E-08 1.729E-08
7.473E-09 4.267E-09 2.779E-09
  N  8.194E-06 1.714E-06 4.885E-07 2.366E-07 1.425E-07 5.971E-08 1.901E-08
8.223E-09 4.691E-09 3.050E-09
NNE  7.682E-06 1.601E-06 4.548E-07 2.199E-07 1.323E-07 5.540E-08 1.766E-08
7.673E-09 4.402E-09 2.880E-09
 NE  9.194E-06 1.932E-06 5.538E-07 2.694E-07 1.628E-07 6.874E-08 2.224E-08
9.800E-09 5.676E-09 3.742E-09
ENE  8.962E-06 1.884E-06 5.414E-07 2.638E-07 1.596E-07 6.750E-08 2.192E-08
9.684E-09 5.619E-09 3.709E-09
  E  7.238E-06 1.510E-06 4.326E-07 2.105E-07 1.273E-07 5.381E-08 1.750E-08
7.775E-09 4.537E-09 3.011E-09
ESE  7.537E-06 1.585E-06 4.572E-07 2.232E-07 1.353E-07 5.738E-08 1.871E-08
8.295E-09 4.822E-09 3.186E-09
 SE  8.232E-06 1.738E-06 5.017E-07 2.449E-07 1.484E-07 6.277E-08 2.028E-08
8.859E-09 5.074E-09 3.306E-09
SSE  6.295E-06 1.330E-06 3.838E-07 1.873E-07 1.135E-07 4.799E-08 1.550E-08
6.765E-09 3.873E-09 2.521E-09
  SAMPLE          DEPOSITION
  S  1.911E-08 3.913E-09 1.022E-09 4.588E-10 2.596E-10 9.982E-11 2.888E-11
1.145E-11 6.112E-12 3.783E-12
SSW  2.284E-08 4.679E-09 1.222E-09 5.486E-10 3.104E-10 1.194E-10 3.453E-11
1.369E-11 7.308E-12 4.523E-12
 SW  2.888E-08 5.915E-09 1.544E-09 6.935E-10 3.923E-10 1.509E-10 4.365E-11
1.730E-11 9.238E-12 5.718E-12
WSW  2.482E-08 5.083E-09 1.327E-09 5.960E-10 3.372E-10 1.297E-10 3.751E-11
1.487E-11 7.939E-12 4.914E-12
  W  2.225E-08 4.558E-09 1.190E-09 5.345E-10 3.023E-10 1.163E-10 3.364E-11
1.333E-11 7.119E-12 4.406E-12
WNW  1.960E-08 4.014E-09 1.048E-09 4.707E-10 2.663E-10 1.024E-10 2.962E-11
1.174E-11 6.270E-12 3.881E-12
 NW  2.073E-08 4.247E-09 1.109E-09 4.980E-10 2.817E-10 1.083E-10 3.134E-11
1.242E-11 6.633E-12 4.106E-12
NNW  2.055E-08 4.209E-09 1.099E-09 4.935E-10 2.792E-10 1.074E-10 3.106E-11
1.231E-11 6.574E-12 4.069E-12
  N  2.384E-08 4.882E-09 1.275E-09 5.724E-10 3.238E-10 1.245E-10 3.603E-11
1.428E-11 7.625E-12 4.720E-12
NNE  2.468E-08 5.055E-09 1.320E-09 5.927E-10 3.353E-10 1.289E-10 3.730E-11
1.479E-11 7.896E-12 4.887E-12
 NE  2.842E-08 5.822E-09 1.520E-09 6.826E-10 3.862E-10 1.485E-10 4.296E-11
1.703E-11 9.093E-12 5.628E-12
ENE  3.050E-08 6.247E-09 1.631E-09 7.325E-10 4.144E-10 1.593E-10 4.610E-11
1.827E-11 9.757E-12 6.039E-12
  E  3.367E-08 6.896E-09 1.800E-09 8.085E-10 4.574E-10 1.759E-10 5.089E-11
2.017E-11 1.077E-11 6.666E-12
ESE  3.024E-08 6.195E-09 1.617E-09 7.263E-10 4.109E-10 1.580E-10 4.571E-11
1.812E-11 9.675E-12 5.988E-12
 SE  2.621E-08 5.370E-09 1.402E-09 6.296E-10 3.562E-10 1.370E-10 3.962E-11
1.570E-11 8.386E-12 5.191E-12
```

```
SSE  1.670E-08 3.421E-09 8.931E-10 4.011E-10 2.269E-10 8.727E-11 2.525E-11
1.001E-11 5.343E-12 3.307E-12
 A  SITE BNDRY      S 1640.0 3.538E-06 3.506E-06 3.085E-06 8.852E-09 111111
 A  SITE BNDRY    WSW 1890.0 2.944E-06 2.902E-06 2.538E-06 8.004E-09 111111
 A  SITE BNDRY      W 2120.0 2.251E-06 2.221E-06 1.924E-06 5.373E-09 111111

  SAMPLE TURBINE BLDG  NO DECAY,  UNDEPLETED
  S  5.289E-06 1.224E-06 4.028E-07 2.130E-07 1.366E-07 6.368E-08 2.467E-08
1.285E-08 8.438E-09 6.180E-09
SSW  7.311E-06 1.669E-06 5.534E-07 2.952E-07 1.904E-07 8.963E-08 3.523E-08
1.856E-08 1.226E-08 9.024E-09
 SW  7.411E-06 1.735E-06 5.691E-07 2.994E-07 1.913E-07 8.857E-08 3.396E-08
1.756E-08 1.147E-08 8.374E-09
WSW  6.258E-06 1.454E-06 4.745E-07 2.495E-07 1.593E-07 7.377E-08 2.829E-08
1.464E-08 9.570E-09 6.987E-09
  W  6.221E-06 1.450E-06 4.744E-07 2.497E-07 1.596E-07 7.397E-08 2.841E-08
1.471E-08 9.614E-09 7.020E-09
WNW  5.545E-06 1.298E-06 4.254E-07 2.239E-07 1.431E-07 6.627E-08 2.542E-08
1.314E-08 8.586E-09 6.265E-09
 NW  5.540E-06 1.331E-06 4.317E-07 2.244E-07 1.420E-07 6.479E-08 2.423E-08
1.229E-08 7.928E-09 5.732E-09
NNW  6.080E-06 1.453E-06 4.714E-07 2.454E-07 1.555E-07 7.106E-08 2.666E-08
1.354E-08 8.750E-09 6.333E-09
  N  6.534E-06 1.548E-06 5.041E-07 2.637E-07 1.677E-07 7.712E-08 2.922E-08
1.496E-08 9.713E-09 7.055E-09
NNE  6.130E-06 1.460E-06 4.741E-07 2.471E-07 1.567E-07 7.174E-08 2.699E-08
1.374E-08 8.892E-09 6.443E-09
 NE  7.270E-06 1.711E-06 5.612E-07 2.952E-07 1.885E-07 8.726E-08 3.341E-08
1.725E-08 1.125E-08 8.206E-09
ENE  7.072E-06 1.658E-06 5.456E-07 2.877E-07 1.841E-07 8.543E-08 3.286E-08
1.703E-08 1.114E-08 8.134E-09
  E  5.759E-06 1.351E-06 4.427E-07 2.325E-07 1.483E-07 6.857E-08 2.623E-08
1.355E-08 8.847E-09 6.455E-09
ESE  5.943E-06 1.387E-06 4.584E-07 2.425E-07 1.555E-07 7.244E-08 2.803E-08
1.460E-08 9.574E-09 7.007E-09
 SE  6.484E-06 1.506E-06 4.988E-07 2.647E-07 1.701E-07 7.953E-08 3.094E-08
1.617E-08 1.063E-08 7.792E-09
SSE  4.966E-06 1.150E-06 3.807E-07 2.020E-07 1.298E-07 6.072E-08 2.363E-08
1.235E-08 8.122E-09 5.955E-09
  SAMPLE    2.260 DAY DECAY,  UNDEPLETED
  S  5.257E-06 1.209E-06 3.943E-07 2.067E-07 1.313E-07 5.981E-08 2.183E-08
1.057E-08 6.504E-09 4.492E-09
SSW  7.235E-06 1.636E-06 5.337E-07 2.802E-07 1.779E-07 8.038E-08 2.849E-08
1.324E-08 7.874E-09 5.298E-09
 SW  7.362E-06 1.712E-06 5.557E-07 2.894E-07 1.830E-07 8.260E-08 2.967E-08
1.417E-08 8.646E-09 5.937E-09
WSW  6.207E-06 1.432E-06 4.614E-07 2.396E-07 1.511E-07 6.775E-08 2.392E-08
1.119E-08 6.715E-09 4.555E-09
  W  6.179E-06 1.431E-06 4.633E-07 2.414E-07 1.527E-07 6.890E-08 2.470E-08
1.175E-08 7.137E-09 4.883E-09
WNW  5.507E-06 1.282E-06 4.155E-07 2.164E-07 1.369E-07 6.171E-08 2.208E-08
1.048E-08 6.363E-09 4.353E-09
 NW  5.520E-06 1.321E-06 4.261E-07 2.202E-07 1.387E-07 6.237E-08 2.248E-08
1.087E-08 6.701E-09 4.640E-09
NNW  6.047E-06 1.438E-06 4.627E-07 2.388E-07 1.502E-07 6.718E-08 2.385E-08
1.131E-08 6.869E-09 4.700E-09
  N  6.492E-06 1.529E-06 4.930E-07 2.553E-07 1.609E-07 7.211E-08 2.561E-08
1.212E-08 7.351E-09 5.034E-09
NNE  6.101E-06 1.448E-06 4.666E-07 2.415E-07 1.522E-07 6.842E-08 2.457E-08
1.181E-08 7.255E-09 5.017E-09
 NE  7.239E-06 1.698E-06 5.531E-07 2.891E-07 1.835E-07 8.355E-08 3.067E-08
1.502E-08 9.345E-09 6.522E-09
ENE  7.041E-06 1.644E-06 5.376E-07 2.816E-07 1.790E-07 8.173E-08 3.012E-08
1.479E-08 9.223E-09 6.446E-09
  E  5.742E-06 1.343E-06 4.382E-07 2.292E-07 1.456E-07 6.656E-08 2.472E-08
```

LISTING 2.2. (Contd)

```
1.229E-08 7.731E-09 5.440E-09
ESE  5.916E-06 1.375E-06 4.513E-07 2.372E-07 1.511E-07 6.918E-08 2.560E-08
1.260E-08 7.860E-09 5.493E-09
 SE  6.431E-06 1.483E-06 4.848E-07 2.541E-07 1.613E-07 7.304E-08 2.620E-08
1.241E-08 7.504E-09 5.119E-09
SSE  4.924E-06 1.131E-06 3.695E-07 1.936E-07 1.228E-07 5.556E-08 1.987E-08
9.374E-09 5.645E-09 3.833E-09
  SAMPLE    8.000 DAY DECAY,     DEPLETED
  S  4.737E-06 1.046E-06 3.254E-07 1.651E-07 1.022E-07 4.449E-08 1.494E-08
6.711E-09 3.916E-09 2.589E-09
SSW  6.542E-06 1.423E-06 4.452E-07 2.273E-07 1.413E-07 6.175E-08 2.073E-08
9.224E-09 5.312E-09 3.464E-09
 SW  6.636E-06 1.482E-06 4.595E-07 2.318E-07 1.429E-07 6.176E-08 2.049E-08
9.105E-09 5.274E-09 3.468E-09
WSW  5.601E-06 1.241E-06 3.827E-07 1.928E-07 1.188E-07 5.120E-08 1.688E-08
7.442E-09 4.275E-09 2.788E-09
  W  5.571E-06 1.238E-06 3.830E-07 1.933E-07 1.193E-07 5.156E-08 1.711E-08
7.596E-09 4.393E-09 2.882E-09
WNW  4.965E-06 1.109E-06 3.435E-07 1.733E-07 1.069E-07 4.618E-08 1.530E-08
6.782E-09 3.916E-09 2.567E-09
 NW  4.964E-06 1.138E-06 3.497E-07 1.745E-07 1.068E-07 4.563E-08 1.492E-08
6.586E-09 3.813E-09 2.512E-09
NNW  5.445E-06 1.242E-06 3.812E-07 1.903E-07 1.165E-07 4.977E-08 1.621E-08
7.108E-09 4.086E-09 2.672E-09
  N  5.850E-06 1.323E-06 4.072E-07 2.042E-07 1.254E-07 5.382E-08 1.764E-08
7.754E-09 4.457E-09 2.913E-09
NNE  5.491E-06 1.249E-06 3.837E-07 1.919E-07 1.176E-07 5.037E-08 1.650E-08
7.276E-09 4.204E-09 2.762E-09
 NE  6.514E-06 1.464E-06 4.543E-07 2.294E-07 1.416E-07 6.132E-08 2.047E-08
9.176E-09 5.359E-09 3.550E-09
ENE  6.337E-06 1.418E-06 4.417E-07 2.236E-07 1.382E-07 6.002E-08 2.012E-08
9.052E-09 5.297E-09 3.515E-09
  E  5.162E-06 1.156E-06 3.589E-07 1.810E-07 1.117E-07 4.839E-08 1.622E-08
7.320E-09 4.304E-09 2.870E-09
ESE  5.325E-06 1.186E-06 3.710E-07 1.883E-07 1.167E-07 5.086E-08 1.715E-08
7.743E-09 4.541E-09 3.017E-09
 SE  5.804E-06 1.286E-06 4.021E-07 2.045E-07 1.268E-07 5.518E-08 1.847E-08
8.231E-09 4.760E-09 3.120E-09
SSE  4.445E-06 9.814E-07 3.068E-07 1.560E-07 9.671E-08 4.209E-08 1.408E-08
6.272E-09 3.625E-09 2.375E-09
  SAMPLE              DEPOSITION
  S  1.911E-08 3.913E-09 1.022E-09 4.588E-10 2.596E-10 9.982E-11 2.888E-11
1.145E-11 6.112E-12 3.783E-12
SSW  2.284E-08 4.679E-09 1.222E-09 5.486E-10 3.104E-10 1.194E-10 3.453E-11
1.369E-11 7.308E-12 4.523E-12
 SW  2.888E-08 5.915E-09 1.544E-09 6.935E-10 3.923E-10 1.509E-10 4.365E-11
1.730E-11 9.238E-12 5.718E-12
WSW  2.482E-08 5.083E-09 1.327E-09 5.960E-10 3.372E-10 1.297E-10 3.751E-11
1.487E-11 7.939E-12 4.914E-12
  W  2.225E-08 4.558E-09 1.190E-09 5.345E-10 3.023E-10 1.163E-10 3.364E-11
1.333E-11 7.119E-12 4.406E-12
WNW  1.960E-08 4.014E-09 1.048E-09 4.707E-10 2.663E-10 1.024E-10 2.962E-11
1.174E-11 6.270E-12 3.881E-12
 NW  2.073E-08 4.247E-09 1.109E-09 4.980E-10 2.817E-10 1.083E-10 3.134E-11
1.242E-11 6.633E-12 4.106E-12
NNW  2.055E-08 4.209E-09 1.099E-09 4.935E-10 2.792E-10 1.074E-10 3.106E-11
1.231E-11 6.574E-12 4.069E-12
  N  2.384E-08 4.882E-09 1.275E-09 5.724E-10 3.238E-10 1.245E-10 3.603E-11
1.428E-11 7.625E-12 4.720E-12
NNE  2.468E-08 5.055E-09 1.320E-09 5.927E-10 3.353E-10 1.289E-10 3.730E-11
1.479E-11 7.896E-12 4.887E-12
 NE  2.842E-08 5.822E-09 1.520E-09 6.826E-10 3.862E-10 1.485E-10 4.296E-11
1.703E-11 9.093E-12 5.628E-12
ENE  3.050E-08 6.247E-09 1.631E-09 7.325E-10 4.144E-10 1.593E-10 4.610E-11
1.827E-11 9.757E-12 6.039E-12
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LISTING 2.2. (Contd)

```
 E  3.367E-08 6.896E-09 1.800E-09 8.085E-10 4.574E-10 1.759E-10 5.089E-11
2.017E-11 1.077E-11 6.666E-12
ESE  3.024E-08 6.195E-09 1.617E-09 7.263E-10 4.109E-10 1.580E-10 4.571E-11
1.812E-11 9.675E-12 5.988E-12
 SE  2.621E-08 5.370E-09 1.402E-09 6.296E-10 3.562E-10 1.370E-10 3.962E-11
1.570E-11 8.386E-12 5.191E-12
SSE  1.670E-08 3.421E-09 8.931E-10 4.011E-10 2.269E-10 8.727E-11 2.525E-11
1.001E-11 5.343E-12 3.307E-12
 A  SITE BNDRY     S 1820.0 2.016E-06 1.997E-06 1.745E-06 6.782E-09 111111
 A  SITE BNDRY   SSW 2030.0 2.138E-06 2.099E-06 1.831E-06 6.150E-09 111111
 A  SITE BNDRY     W 2120.0 1.694E-06 1.673E-06 1.448E-06 5.373E-09 111111
```

TABLE 2.17. Output Reports Prepared by GASPAR II

Report Type	General Description of Report Contents
1	Banner page.
2a	Transfer parameters.
2b	Physical parameters.
2c	Usage parameters.
3a	Ingestion dose factors - 4 tables (adult, teen, child, infant).
3b	Inhalation dose factors - 4 tables (adult, teen, child, infant).
3c	Ground exposure external dose factors.
3d	Noble gas dose factors.
3e	Radiological decay constants.
4a	Site data - population and milk production.
4b	Site data - meat and vegetable production and product summary.
5a	Job control/agricultural parameters and first source term.
5b	Additional source terms.
6a	Site meteorological data - $\bar{\chi}/Q'$ and $\bar{\chi}$ Q' decayed.
6b	Site meteorological data - χ/Q' decayed/depleted and D/Q.
7	Special location meteorological data.
8	Environmental activity summary.
9a	ALARA pathway summary.
9b	NEPA pathway summary.
10a	ALARA radionuclide totals.
10b	NEPA radionuclide totals.
11a	ALARA radionuclide plume detail.
11b	NEPA radionuclide plume detail.
12a	ALARA radionuclide ground-exposure detail.
12b	NEPA radionuclide ground-exposure detail.
13a	ALARA radionuclide inhalation detail.
13b	NEPA radionuclide inhalation detail.
14a	ALARA radionuclide vegetable-ingestion detail.
14b	NEPA radionuclide vegetable-ingestion detail.
15a	ALARA radionuclide cow-milk ingestion detail.
15b	NEPA radionuclide cow-milk ingestion detail.

TABLE 2.17. (Contd)

Report Type	General Description of Report Contents
16a	ALARA radionuclide meat-ingestion detail.
16b	NEPA radionuclide meat-ingestion detail.
17	Special location pathway summary.
18	Special location, radionuclide plume detail.
19	Special location, radionuclide ground-exposure detail.
20a	Special location, radionuclide vegetable-ingestion detail, adult.
20b	Special location, radionuclide vegetable-ingestion detail, teen.
20c	Special location, radionuclide vegetable-ingestion detail, child.
20d	Special location, radionuclide vegetable-ingestion detail, infant.
21a	Special location, radionuclide meat-ingestion detail, adult.
21b	Special location, radionuclide meat-ingestion detail, teen.
21c	Special location, radionuclide meat-ingestion detail, child.
21d	Special location, radionuclide meat-ingestion detail, infant.
22a	Special location, radionuclide cow-milk ingestion detail, adult.
22b	Special location, radionuclide cow-milk ingestion detail, teen.
22c	Special location, radionuclide cow-milk ingestion detail, child.
22d	Special location, radionuclide cow-milk ingestion detail, infant.
23a	Special location, radionuclide goat-milk ingestion detail, adult.
23b	Special location, radionuclide goat-milk ingestion detail, teen.
23c	Special location, radionuclide goat-milk ingestion detail, child.
23d	Special location, radionuclide goat-milk ingestion detail, infant.
24a	Special location, radionuclide inhalation detail, adult.
24b	Special location, radionuclide inhalation detail, teen.
24c	Special location, radionuclide inhalation detail, child.
24d	Special location, radionuclide inhalation detail, infant.
25	Cost-benefit report.
26	Normalized dose factors for 10 CFR 50 (one report for each combination of age group and organ).
27	Normalized dose factors for 10 CFR 20 (one report for each organ for infant age group).

LISTING 2.3. Sample Report Type 1: Banner Page

```
*********************************************************************************************
*                                                                                           *
*                                                                                           *
*                                                                                           *
*            GGGGGGGG      AA      SSSSSSSS  PPPPPPPP      AA      RRRRRRRR    IIIII IIIII  *
*            G      G      AA      S         PP     P      AA      RR     R      I     I    *
*            G            A  A     SSSSSSS   PP     P     A  A     RRRRRRRR      I     I    *
*            G   GGGGG  AAAAAA           S   PPPPPPPP   AAAAAA     RRRR          I     I    *
*            G      G  A      A          S   PP        A      A    RR RR         I     I    *
*            GGGGGGG  A        A  SSSSSSS    PP       A        A   RR   RR     IIIII IIIII  *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                 EVALUATION OF RADIATION DOSES FROM RELEASES OF RADIOACTIVITY              *
*                                                                                           *
*                          IN NUCLEAR POWER PLANTS AIRBORNE EFFLUENTS                       *
*                                                                                           *
*                            REVISION DATE:  PNL VAX - DECEMBER 1986      1                 *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*            SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS         2                      *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*                            RELIABILITY AND RISK ASSESSMENT BRANCH                         *
*                                                                                           *
*                            OFFICE OF NUCLEAR REACTOR REGULATION                           *
*                                                                                           *
*                            U.S. NUCLEAR REGULATORY COMMISSION                             *
*                                                                                           *
*                            WASHINGTON, D.C. 20555                                         *
*                                                                                           *
*                                DATE OF RUN:      1-DEC-86      3                          *
*                                                                                           *
*                                                                                           *
*                                                                                           *
*********************************************************************************************
```

2b), and USAGE (report type 2c). Report type 2a consists of two pages as illustrated in Listing 2.4 from Sample Problem 3. The information in report type 2a includes element transfer factors for vegetables, milk, and meat; goat-milk transfer factors for selected elements; transport times; and selected pathway parameters. Report type 2b is illustrated in Listing 2.5 from Sample Problem 3. The data in this report from common block PHYS include the area within each area element as a function of downwind distance and selected physical parameters used in dose calculations. Listing 2.6 is a sample report type 2c showing common block USAGE data values of food-product consumption rates, inhalation rates, and the fraction of people in each age group. Listing 2.6 is also from Sample Problem 3. Report types 2a, 2b, and 2c are printed <u>only</u>

LISTING 2.4. Report Type 2a: Transfer Parameters

PART I

CONSTANTS IN LABELED COMMON BLOCK TRANFR

STABLE ELEMENT TRANSFER DATA

ELEM	VEG/SOIL	MILK(D/L)	MEAT(D/KG)	ELEM	VEG/SOIL	MILK(D/L)	MEAT(D/KG)
--	-------	-------	-------	--	-------	-------	-------
H	4.8E+00	1.0E-02	1.2E-02	SB	1.1E-02	1.5E-03	4.0E-03
HE	5.0E-02	2.0E-02	2.0E-02	TE	1.3E+00	1.0E-03	7.7E-02
LI	8.3E-04	5.0E-02	1.0E-02	I	2.0E-02	6.0E-03	2.9E-03
BE	4.2E-04	1.0E-04	1.0E-03	XE	1.0E+01	2.0E-02	2.0E-02
B	1.2E-01	2.7E-03	8.0E-04	CS	1.0E-02	1.2E-02	4.0E-03
C	5.5E+00	1.2E-02	3.1E-02	BA	5.0E-03	4.0E-04	3.2E-03
N	7.5E+00	2.2E-02	7.7E-02	LA	2.5E-03	5.0E-06	2.0E-04
O	1.6E+00	2.0E-02	1.6E-02	CE	2.5E-03	1.0E-04	1.2E-03
F	6.5E-04	1.4E-02	1.5E-01	PR	2.5E-03	5.0E-06	4.7E-03
NE	1.4E-01	2.0E-02	2.0E-02	ND	2.4E-03	5.0E-06	3.3E-03
NA	5.2E-02	4.0E-02	3.0E-02	PM	2.5E-03	5.0E-06	4.8E-03
MG	1.3E-01	1.0E-02	5.0E-03	SM	2.5E-03	5.0E-06	5.0E-03
AL	1.8E-04	5.0E-04	1.5E-03	EU	2.5E-03	5.0E-06	4.8E-03
SI	1.5E-04	1.0E-04	4.0E-05	GD	2.6E-03	5.0E-06	3.6E-03
P	1.1E+00	2.5E-02	4.6E-02	TB	2.6E-03	5.0E-06	4.4E-03
S	5.9E-01	1.8E-02	1.0E-01	DY	2.5E-03	5.0E-06	5.3E-03
CL	5.0E+00	5.0E-02	8.0E-02	HO	2.6E-03	5.0E-06	4.4E-03
AR	6.0E-01	2.0E-02	2.0E-02	ER	2.5E-03	5.0E-06	4.0E-03
K	3.7E-01	1.0E-02	1.2E-02	TM	2.6E-03	5.0E-06	4.4E-03
CA	3.6E-02	8.0E-03	4.0E-03	YB	2.5E-03	5.0E-06	4.0E-03
SC	1.1E-03	5.0E-06	1.6E-02	LU	2.6E-03	5.0E-06	4.4E-03
TI	5.4E-05	5.0E-06	3.1E-02	HF	1.7E-04	5.0E-06	4.0E-01
V	1.3E-03	1.0E-03	2.3E-03	TA	6.3E-03	2.5E-02	1.6E+00
CR	2.5E-04	2.2E-03	2.4E-03	W	1.8E-02	5.0E-04	1.3E-03
MN	2.9E-02	2.5E-04	8.0E-04	RE	2.5E-01	2.5E-02	8.0E-03
FE	6.6E-04	1.2E-03	4.0E-02	OS	5.0E-02	5.0E-03	4.0E-01
CO	9.4E-03	1.0E-03	1.3E-02	IR	1.3E+01	5.0E-03	1.5E-03
NI	1.9E-02	6.7E-03	5.3E-03	PT	5.0E-01	5.0E-03	4.0E-03
CU	1.2E-01	1.4E-02	8.0E-03	AU	2.5E-03	5.0E-03	8.0E-03
ZN	4.0E-01	3.9E-02	3.0E-02	HG	3.8E-01	3.8E-02	2.6E-01
GA	2.5E-04	5.0E-05	1.3E+00	TL	2.5E-01	2.2E-02	4.0E-02
GE	1.0E-01	5.0E-04	2.0E+01	PB	6.8E-02	6.2E-04	2.9E-04
AS	1.0E-02	6.0E-03	2.0E-03	BI	1.5E-01	5.0E-04	1.3E-02
SE	1.3E+00	4.5E-02	1.5E-02	PO	1.5E-01	3.0E-04	1.2E-02
BR	7.6E-01	5.0E-02	2.6E-02	AT	2.5E-01	5.0E-02	8.0E+00
KR	3.0E+00	2.0E-02	2.0E-02	RN	3.5E+00	2.0E-02	2.0E-02
RB	1.3E-01	3.0E-02	3.1E-02	FR	1.0E-02	5.0E-02	2.0E-02
SR	1.7E-02	8.0E-04	6.0E-04	RA	3.1E-04	8.0E-03	3.4E-02
Y	2.6E-03	1.0E-05	4.6E-03	AC	2.5E-03	5.0E-06	6.0E-02
ZR	1.7E-04	5.0E-06	3.4E-02	TH	4.2E-03	5.0E-06	2.0E-04
NB	9.4E-03	2.5E-03	2.8E-01	PA	2.5E-03	5.0E-06	8.0E+02
MO	1.2E-01	7.5E-03	8.0E-03	U	2.5E-03	5.0E-04	3.4E-04
TC	2.5E-01	2.5E-02	4.0E-01	NP	2.5E-03	5.0E-06	2.0E-04
RU	5.0E-02	1.0E-06	4.0E-01	PU	2.5E-04	2.0E-06	1.4E-05
RH	1.3E+01	1.0E-02	1.5E-03	AM	2.5E-04	5.0E-06	2.0E-04
PD	5.0E+00	1.0E-02	4.0E-03	CM	2.5E-03	5.0E-06	2.0E-04
AG	1.5E-01	5.0E-02	1.7E-02	BK	2.5E-03	5.0E-06	2.0E-04
CD	3.0E-01	1.2E-04	5.3E-04	CF	2.5E-03	5.0E-06	2.0E-04
IN	2.5E-01	1.0E-04	8.0E-03	ES	2.5E-03	5.0E-06	2.0E-04
SN	2.5E-03	2.5E-03	8.0E-02	FM	2.5E-03	5.0E-06	2.0E-04

LISTING 2.4. (Contd)

PART II

GOAT MILK TRANSFER FACTORS

ELEMENT	FACTOR(D/L)
H	1.7E-01
B	1.2E-02
C	1.0E-01
MG	4.2E-02
P	2.5E-01
CL	5.0E-01
K	5.7E-02
CA	4.7E-01
FE	1.3E-03
CU	1.3E-02
SR	1.4E-02
I	6.0E-02
CS	3.0E-01
PO	1.8E-03

TRANSPORT TIME

INDEX,I	TIM(I)(SEC)	TIME(DAYS)
1	1.73E+06	20.0
2	3.46E+05	4.0
3	1.21E+06	14.0
4	5.18E+06	60.0
5	1.73E+05	2.0
6	8.64E+04	1.0
7	2.59E+06	30.0

PATHWAY PARAMETERS

PARAMETER		VALUE
BLDAY	VEGETABLE GROWING PERIOD (DAY)	6.00E+01
COWIN	MILK COW FEED INTAKE (KG/DAY)	5.00E+01
GOATIN	MILK GOAT FEED INTAKE (KG/DAY)	6.00E+00
PARTUP	PARTICULATE RETENTION ON VEG.	1.00E-01
REMVEG	WEATHERING CONSTANT (1/SEC)	5.73E-07
SD	SOIL SURFACE DENSITY (KG/M**2)	2.40E+02
VIORET	IODINE RETENTION ON VEG.	1.00E+00
YA1	PASTURE GRASS YIELD (KG/M**2)	7.00E-01
YA2	FEED CROP YIELD (KG/M**2)	2.00E+00
YV	GARDEN VEG. CROP YIELD (KG/M**2)	2.00E+00

when a parameter in one of the common blocks has been changed using block data change records; the example listings (e.g., Listing 2.4) contain some changed parameters, as given in the sample problems.

LISTING 2.5. Report Type 2b: Physical Parameters

CONSTANTS IN LABELED COMMON BLOCK PHYS

AREA OF ANNULAR SECTIONS

DISTANCE INTERVAL (MILES)	AREA(M**2)
0 - 1	5.08E+05
1 - 2	1.53E+06
2 - 3	2.54E+06
3 - 4	3.56E+06
4 - 5	4.58E+06
5 - 10	3.81E+07
10 - 20	1.53E+08
20 - 30	2.54E+08
30 - 40	3.56E+08
40 - 50	4.58E+08

ENVIRONMENTAL PARAMETERS

PARAMETER		VALUE
PLIFE	MIDPOINT OF REACTOR LIFETIME (SEC)	6.31E+08
SF	SHIELDING FACTOR - INDIVIDUALS	7.50E-01
SSF	SHIELDING FACTOR - POPULATION	5.00E-01
VHS	HYDROSPHERE WATER VOLUME (L)	2.70E+19
VNA	ATMOSPHERE VOLUME (M**3)	3.80E+18
FID	FRACTION OF IODINE DEPOSITING	5.00E-01

2.2.3 Report Type 3: Dose-Factor Library Data

A complete set of reports giving all parameter values in the dose-factor library is printed when parameter JC(5) is set greater than zero (see input record type 2.0). Five reports of type 3 can be generated, as indicated in Table 2.17.

The ingestion dose-factor reports (type 3a) are printed for each of four age groups (in order, adult, teen, child, infant), with four pages for each report. Listing 2.7 is a sample of report type 3a showing the first page of the adult ingestion dose factors. Where a dose factor is not available for a specific radionuclide-organ combination, the dose-factor library contains a zero (0.0E+00). Inhalation dose factors are printed in report type 3b, as illustrated in Listing 2.8 for the first page of the teen dose-factor report.

LISTING 2.6. Report Type 2c: Usage Parameters

CONSTANTS IN LABELED COMMON BLOCK USAGE

CONSUMPTION RATE FOR POPULATION DOSES

VARIABLE	UNITS/YR	INFANTS+CHILDREN	TEENAGERS	ADULTS
AVINH	M**3	3.70E+03	8.00E+03	8.00E+03
AVLVEG	KG	1.00E+01	2.00E+01	3.00E+01
AVMET	KG	3.70E+01	5.90E+01	9.50E+01
AVMLK	L	1.70E+02	2.00E+02	1.10E+02
AVVEG	KG	2.00E+02	2.40E+02	1.90E+02
POPF		1.80E-01	1.10E-01	7.10E-01

CONSUMPTION RATE FOR INDIVIDUAL DOSES

VARIABLE	UNITS/YR	INFANTS	CHILDREN	TEENAGERS	ADULTS
SLVEG	KG	2.00E+01	5.20E+02	4.20E+01	6.40E+01
SPINH	M**3	1.40E+03	3.70E+03	8.00E+03	8.00E+03
SPMET	KG	0.00E+00	4.10E+01	6.50E+01	1.10E+02
SPMLK	L	3.30E+02	3.30E+02	4.00E+02	3.10E+02
SPVEG	KG	0.00E+00	5.20E+02	6.30E+02	5.20E+02

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The inhalation dose factors are printed for four age groups with four pages per age group. External dose factors for exposure to contaminated ground are printed in report type 3c, as illustrated in Listing 2.9. Dose factors are given for skin and total-body dose for each radionuclide for use with all age groups. The report contains four pages. Report 3d is a one-page report giving noble gas dose-conversion factors as provided in the block data module of GASPAR II. Data in this table are for exposure to noble gas radionuclides in the plume. A sample report type 3d is shown in Listing 2.10. The final report of this type is report 3e, which gives the radiological decay constants for each radionuclide. Listing 2.11 is a sample report type 3e showing the

LISTING 2.7. Report Type 3a: Ingestion Dose Factors

INGESTION DOSE FACTORS FOR ADULT
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1H - 3	0.00E+00	5.99E-08	5.99E-08	5.99E-08	5.99E-08	5.99E-08	5.99E-08
4BE- 10	3.18E-06	4.91E-07	7.94E-08	0.00E+00	3.71E-07	0.00E+00	2.68E-05
6C - 14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
7N - 13	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09
9F - 18	6.24E-07	0.00E+00	6.92E-08	0.00E+00	0.00E+00	0.00E+00	1.85E-08
11NA- 22	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05
11NA- 24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
15P - 32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
20CA- 41	1.85E-04	0.00E+00	2.00E-05	0.00E+00	0.00E+00	0.00E+00	1.84E-07
21SC- 46	5.51E-09	1.07E-08	3.11E-09	0.00E+00	9.99E-09	0.00E+00	5.21E-05
24CR- 51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
25MN- 54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
25MN- 56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
26FE- 55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
26FE- 59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
27CO- 57	0.00E+00	1.75E-07	2.91E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
27CO- 58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
27CO- 60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
28NI- 59	9.76E-06	3.35E-06	1.63E-06	0.00E+00	0.00E+00	0.00E+00	6.90E-07
28NI- 63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
28NI- 65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
29CU- 64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
30ZN- 65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
30ZN- 69M	1.70E-07	4.08E-07	3.73E-08	0.00E+00	2.47E-07	0.00E+00	2.49E-05
30ZN- 69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
34SE- 79	0.00E+00	2.63E-06	4.39E-07	0.00E+00	4.55E-06	0.00E+00	5.38E-07
35BR- 82	0.00E+00	0.00E+00	2.26E-06	0.00E+00	0.00E+00	0.00E+00	2.59E-06
35BR- 83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
35BR- 84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
35BR- 85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
37RB- 86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
37RB- 87	0.00E+00	1.23E-05	4.28E-06	0.00E+00	0.00E+00	0.00E+00	5.76E-07
37RB- 88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
37RB- 89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
38SR- 89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
38SR- 90	8.71E-03	0.00E+00	1.75E-04	0.00E+00	0.00E+00	0.00E+00	2.19E-04
38SR- 91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
38SR- 92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
39Y - 90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
39Y - 91M	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
39Y - 91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-05
39Y - 92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
39Y - 93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
40ZR- 93	4.18E-08	2.34E-09	1.09E-09	0.00E+00	8.87E-09	0.00E+00	2.43E-06
40ZR- 95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05

first of five pages. Note that report type 3e contains data for all radionuclides in the data library, plus noble gas radionuclides from the block data module. Report types 3a, 3b, and 3c contain data for only the data library radionuclides because noble gases are not included in ingestion, inhalation, and ground-exposure pathway doses. All of the sample reports shown in Listings 2.6 through 2.11 are from Sample Problem 3.

LISTING 2.8. Report Type 3b: Inhalation Dose Factors

INHALATION DOSE FACTORS FOR TEENAGER
(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1H - 3	0.00E+00	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08
4BE- 10	2.78E-04	4.33E-05	7.09E-06	0.00E+00	0.00E+00	3.84E-04	1.77E-05
6C - 14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
7N - 13	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09
9F - 18	6.52E-07	0.00E+00	7.10E-08	0.00E+00	0.00E+00	0.00E+00	3.89E-08
11NA- 22	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05
11NA- 24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
15P - 32	2.36E-04	1.37E-05	8.95E-06	0.00E+00	0.00E+00	0.00E+00	1.16E-05
20CA- 41	4.05E-05	0.00E+00	4.38E-06	0.00E+00	0.00E+00	1.01E-01	3.03E-07
21SC- 46	7.24E-05	1.41E-04	4.18E-05	0.00E+00	1.35E-04	0.00E+00	2.98E-05
24CR- 51	0.00E+00	0.00E+00	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
25MN- 54	0.00E+00	6.39E-06	1.05E-06	0.00E+00	1.59E-06	2.48E-04	8.35E-06
25MN- 56	0.00E+00	2.12E-10	3.15E-11	0.00E+00	2.24E-10	1.90E-06	7.18E-06
26FE- 55	4.18E-06	2.98E-06	6.93E-07	0.00E+00	0.00E+00	1.55E-05	7.99E-07
26FE- 59	1.99E-06	4.62E-06	1.79E-06	0.00E+00	0.00E+00	1.91E-04	2.23E-05
27CO- 57	0.00E+00	1.18E-07	1.15E-07	0.00E+00	0.00E+00	7.33E-05	3.93E-06
27CO- 58	0.00E+00	2.59E-07	3.47E-07	0.00E+00	0.00E+00	1.68E-04	1.19E-05
27CO- 60	0.00E+00	1.89E-06	2.48E-06	0.00E+00	0.00E+00	1.09E-03	3.24E-05
28NI- 59	5.44E-06	2.02E-06	9.24E-07	0.00E+00	0.00E+00	1.41E-05	6.48E-07
28NI- 63	7.25E-05	5.43E-06	2.47E-06	0.00E+00	0.00E+00	3.84E-05	1.77E-06
28NI- 65	2.73E-10	3.66E-11	1.59E-11	0.00E+00	0.00E+00	1.17E-06	4.59E-06
29CU- 64	0.00E+00	2.54E-10	1.06E-10	0.00E+00	8.01E-10	1.39E-06	7.68E-06
30ZN- 65	4.82E-06	1.67E-05	7.80E-06	0.00E+00	1.08E-05	1.55E-04	5.83E-06
30ZN- 69M	1.44E-09	3.39E-09	3.11E-10	0.00E+00	2.06E-09	3.92E-06	2.14E-05
30ZN- 69	6.04E-12	1.15E-11	8.07E-13	0.00E+00	7.53E-12	1.98E-07	3.56E-08
34SE- 79	0.00E+00	5.43E-07	8.71E-08	0.00E+00	8.13E-07	7.71E-05	3.53E-06
35BR- 82	0.00E+00	0.00E+00	2.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35BR- 83	0.00E+00	0.00E+00	4.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35BR- 84	0.00E+00	0.00E+00	5.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35BR- 85	0.00E+00	0.00E+00	2.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
37RB- 86	0.00E+00	2.38E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	2.21E-06
37RB- 87	0.00E+00	1.40E-05	4.58E-06	0.00E+00	0.00E+00	0.00E+00	3.05E-07
37RB- 88	0.00E+00	6.82E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	3.65E-15
37RB- 89	0.00E+00	4.40E-08	2.91E-08	0.00E+00	0.00E+00	0.00E+00	4.22E-17
38SR- 89	5.43E-05	0.00E+00	1.56E-06	0.00E+00	0.00E+00	3.02E-04	4.64E-05
38SR- 90	4.14E-03	0.00E+00	8.33E-05	0.00E+00	0.00E+00	2.06E-03	9.56E-05
38SR- 91	1.10E-08	0.00E+00	4.39E-10	0.00E+00	0.00E+00	7.59E-06	3.24E-05
38SR- 92	1.19E-09	0.00E+00	5.08E-11	0.00E+00	0.00E+00	3.43E-06	1.49E-05
39Y - 90	3.73E-07	0.00E+00	1.00E-08	0.00E+00	0.00E+00	3.66E-05	6.99E-05
39Y - 91M	4.63E-11	0.00E+00	1.77E-12	0.00E+00	0.00E+00	4.00E-07	3.77E-09
39Y - 91	8.26E-05	0.00E+00	2.21E-06	0.00E+00	0.00E+00	3.67E-04	5.11E-05
39Y - 92	1.84E-09	0.00E+00	5.36E-11	0.00E+00	0.00E+00	3.35E-06	2.06E-05
39Y - 93	1.69E-08	0.00E+00	4.65E-10	0.00E+00	0.00E+00	1.04E-05	7.24E-05
40ZR- 93	6.83E-05	3.38E-06	1.84E-06	0.00E+00	1.16E-05	3.67E-05	1.60E-06
40ZR- 95	1.82E-05	5.73E-06	3.94E-06	0.00E+00	8.42E-06	3.36E-04	1.86E-05

2.2.4 Report Type 4: Site Data

Site data defined by distance and direction are printed in report type 4. Report type 4a contains data tables for distribution of the population and milk production for the site. Report type 4b contains data for meat and vegetable production. These reports are illustrated in Listings 2.12 and 2.13 for 4a and 4b, respectively, from Sample Problem 2. Both reports are printed when

LISTING 2.9. Report Type 3c: Ground-Exposure Dose Factors

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND
(MREM/HR PER PCI/M**2)

NUCLIDE	SKIN	TOTAL BODY
1H - 3	0.00E+00	0.00E+00
4BE- 10	0.00E+00	0.00E+00
6C - 14	0.00E+00	0.00E+00
7N - 13	7.60E-09	8.80E-09
9F - 18	6.80E-09	8.00E-09
11NA- 22	1.60E-08	1.80E-08
11NA- 24	2.50E-08	2.90E-08
15P - 32	0.00E+00	0.00E+00
20CA- 41	3.41E-09	4.01E-09
21SC- 46	1.30E-08	1.50E-08
24CR- 51	2.20E-10	2.60E-10
25MN- 54	5.80E-09	6.80E-09
25MN- 56	1.10E-08	1.30E-08
26FE- 55	0.00E+00	0.00E+00
26FE- 59	8.00E-09	9.40E-09
27CO- 57	9.10E-10	1.00E-09
27CO- 58	7.00E-09	8.20E-09
27CO- 60	1.70E-08	2.00E-08
28NI- 59	0.00E+00	0.00E+00
28NI- 63	0.00E+00	0.00E+00
28NI- 65	3.70E-09	4.30E-09
29CU- 64	1.50E-09	1.70E-09
30ZN- 65	4.00E-09	4.60E-09
30ZN- 69M	2.90E-09	3.40E-09
30ZN- 69	0.00E+00	0.00E+00
34SE- 79	0.00E+00	0.00E+00
35BR- 82	1.90E-08	2.20E-08
35BR- 83	6.40E-11	9.30E-11
35BR- 84	1.20E-08	1.40E-08
35BR- 85	0.00E+00	0.00E+00
37RB- 86	6.30E-10	7.20E-10
37RB- 87	0.00E+00	0.00E+00
37RB- 88	3.50E-09	4.00E-09
37RB- 89	1.50E-08	1.80E-08
38SR- 89	5.60E-13	6.50E-13
38SR- 90	0.00E+00	0.00E+00
38SR- 91	7.10E-09	8.30E-09
38SR- 92	9.00E-09	1.00E-08
39Y - 90	2.20E-12	2.60E-12
39Y - 91M	3.80E-09	4.40E-09
39Y - 91	2.40E-11	2.70E-11
39Y - 92	1.60E-09	1.90E-09
39Y - 93	5.70E-10	7.80E-10
40ZR- 93	0.00E+00	0.00E+00
40ZR- 95	5.00E-09	5.80E-09

population doses are to be calculated. Report type 4b also contains a summary (item 1 in Listing 2.13) of food production and usage for the site, including the amount of each food type available for export from the 50-mi region (for use in the NEPA evaluation).

2.2.5 Report Type 5: Job Control, Agriculture, and Source-Term Data

Report type 5 contains a summary of job control parameters given on record type 2.0, selected agricultural parameters from record type 3.0 and source-term information from record set 8. Two forms of report type 5 are

LISTING 2.10. Report Type 3d: Noble Gas Dose Factors

DOSE FACTORS FOR NOBLE GASES
MREM/YR PER PCI/M**3 AND MREM/PCI INHALED FOR LUNG

NUCLIDE	GAMMA-AIR	BETA-AIR	TOTAL BODY	BETA-SKIN	LUNG
18AR- 41	9.30E-03	3.28E-03	8.84E-03	2.69E-03	0.00E+00
36KR- 83M	1.93E-05	2.88E-04	7.56E-08	0.00E+00	2.91E-06
36KR- 85M	1.23E-03	1.97E-03	1.17E-03	1.46E-03	1.95E-05
36KR- 85	1.72E-05	1.95E-03	1.61E-05	1.34E-03	1.87E-05
36KR- 87	6.17E-03	1.03E-02	5.92E-03	9.73E-03	1.02E-04
36KR- 88	1.52E-02	2.93E-03	1.47E-02	2.37E-03	3.38E-05
36KR- 89	1.73E-02	1.06E-02	1.66E-02	1.01E-02	1.09E-04
54XE-131M	1.56E-04	1.11E-03	9.15E-05	4.76E-04	1.10E-05
54XE-133M	3.27E-04	1.48E-03	2.51E-04	9.94E-04	1.46E-05
54XE-133	3.53E-04	1.05E-03	2.94E-04	3.06E-04	1.05E-05
54XE-135M	3.36E-03	7.39E-04	3.12E-03	7.11E-04	8.79E-06
54XE-135	1.92E-03	2.46E-03	1.81E-03	1.86E-03	2.46E-05
54XE-137	1.51E-03	1.27E-02	1.42E-03	1.22E-02	1.23E-04
54XE-138	9.21E-03	4.75E-03	8.83E-03	4.13E-03	4.93E-05

used: 5a includes all data for this type, and 5b contains only source-term data. Type 5a is used for the first source term, and 5b is used for subsequent source terms. Listing 2.14 is a sample of record type 5a showing the job title (item 1), job control parameter values (item 2), agricultural parameters (item 3), and a source-term data set (item 4). Report type 5b is similar to 5a except that items 2 and 3 are omitted. Listing 2.14 is from Sample Problem 2.

The job control array (JC) is printed in report type 5a. This array contains 10 positions of which only seven are currently used in GASPAR II. However, all 10 values are printed in report type 5a to assist in identifying input errors. The last three values are not used and have no effect on the calculations.

2.2.6 Report Type 6: Site Meteorological Data

Two reports of type 6 are used to present site meteorological data for use in population dose calculations: report type 6a presents atmospheric dispersion factors ($\bar{\chi}/Q'$) for undecayed/undepleted dispersion and for decayed/undepleted dispersion, while report type 6b presents similar values for decayed/depleted dispersion and ground deposition (D/Q). All four types of dispersion factors are presented as a function of distance and direction from the site for the 50-mi region. Listings 2.15 and 2.16 show examples of

LISTING 2.11. Report Type 3e: Radiological Decay Constants

RADIOLOGICAL DECAY CONSTANTS
(1/SECOND)

NUCLIDE	DECAY CONSTANT
18AR- 41	1.05E-04
36KR- 83M	1.04E-04
36KR- 85M	4.38E-05
36KR- 85	2.05E-09
36KR- 87	1.51E-04
36KR- 88	6.78E-05
36KR- 89	3.61E-03
54XE-131M	6.80E-07
54XE-133M	3.55E-06
54XE-133	1.53E-06
54XE-135M	7.41E-04
54XE-135	2.12E-05
54XE-137	2.96E-03
54XE-138	8.15E-04
1H - 3	1.78E-09
4BE- 10	1.37E-14
6C - 14	3.84E-12
7N - 13	1.16E-03
9F - 18	1.05E-04
11NA- 22	8.44E-09
11NA- 24	1.28E-05
15P - 32	5.61E-07
20CA- 41	1.57E-13
21SC- 46	9.57E-08
24CR- 51	2.90E-07
25MN- 54	2.57E-08
25MN- 56	7.50E-05
26FE- 55	8.14E-09
26FE- 59	1.80E-07
27CO- 57	2.96E-08
27CO- 58	1.13E-07
27CO- 60	4.18E-09
28NI- 59	2.93E-13
28NI- 63	2.29E-10
28NI- 65	7.64E-05
29CU- 64	1.52E-05
30ZN- 65	3.29E-08
30ZN- 69M	1.40E-05
30ZN- 69	2.03E-04
34SE- 79	3.39E-13
35BR- 82	5.46E-06
35BR- 83	8.05E-05
35BR- 84	3.63E-04
35BR- 85	4.03E-03
37RB- 86	4.29E-07

report types 6a and 6b, respectively, as taken from Sample Problem 2. A pair of these reports is printed each time new meteorological data are read [for population dose calculation runs, JC(1)=0].

2.2.7 Report Type 7: Meteorological Data for Special Locations

Report type 7 presents data supplied on input record type 13.0 for up to five special locations for which individual doses are to be evaluated.

LISTING 2.12. Report Type 4a: Population and Milk Production

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE

SITE POPULATION DATA (PEOPLE)

	DOWNWIND DISTANCE(MILES)										
DIR	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	TOTAL
N	2.400E+01	4.090E+02	5.022E+03	2.090E+02	1.003E+04	3.908E+04	4.990E+03	3.288E+04	4.009E+04	1.003E+05	2.331E+05
NNE	0.000E+00	2.090E+02	8.320E+02	2.003E+03	2.988E+05	2.099E+04	5.492E+04	2.987E+03	1.223E+04	2.871E+05	6.800E+05
NE	3.300E+01	2.900E+01	2.990E+02	3.999E+04	2.334E+03	4.184E+04	3.949E+04	4.948E+04	3.848E+04	1.001E+05	3.121E+05
ENE	3.200E+01	2.090E+02	4.430E+02	1.229E+03	3.426E+04	2.346E+05	4.398E+04	3.451E+04	9.807E+03	1.400E+05	4.990E+05
E	1.400E+01	3.440E+02	2.190E+02	5.544E+03	3.005E+04	9.145E+03	2.235E+04	5.298E+03	9.872E+04	1.989E+04	1.916E+05
ESE	3.200E+01	4.600E+01	3.980E+02	2.987E+03	1.990E+03	3.100E+04	2.998E+04	3.990E+03	1.900E+05	3.210E+04	2.925E+05
SE	5.200E+01	3.090E+02	2.310E+02	3.009E+03	2.376E+03	1.291E+04	2.341E+04	3.483E+04	5.897E+04	9.875E+04	2.348E+05
SSE	1.900E+01	1.200E+02	4.980E+02	1.289E+03	3.492E+03	5.987E+04	3.143E+04	3.291E+04	9.043E+03	1.273E+05	2.660E+05
S	0.000E+00	1.100E+01	0.000E+00	3.980E+02	1.242E+04	3.487E+04	3.125E+04	1.099E+05	2.346E+04	3.453E+04	2.468E+05
SSW	0.000E+00	0.000E+00	2.900E+02	1.908E+03	1.544E+04	4.563E+04	3.291E+04	2.098E+03	3.255E+04	2.342E+04	1.542E+05
SW	0.000E+00	0.000E+00	3.980E+02	4.256E+03	8.293E+03	9.808E+04	1.099E+04	3.980E+03	4.987E+04	2.099E+05	3.857E+05
WSW	2.300E+01	2.350E+02	5.340E+02	1.098E+03	3.929E+04	3.245E+03	4.321E+04	2.347E+03	4.353E+04	4.239E+05	5.574E+05
W	3.400E+01	3.200E+01	4.350E+02	6.450E+02	1.298E+03	3.240E+02	4.567E+04	2.387E+03	3.426E+04	3.426E+04	1.193E+05
WNW	9.000E+00	1.900E+01	4.350E+02	2.387E+03	4.398E+04	2.319E+04	3.248E+04	3.898E+04	9.255E+03	7.865E+04	2.294E+05
NW	2.300E+01	5.400E+01	5.670E+02	2.347E+03	2.365E+03	6.578E+03	6.735E+04	1.891E+04	4.391E+04	1.091E+05	2.512E+05
NNW	5.400E+01	1.900E+02	3.210E+02	1.980E+03	2.354E+03	7.654E+03	4.871E+04	2.436E+04	8.796E+03	3.889E+04	1.333E+05
TOTAL	3.490E+02	2.216E+03	1.092E+04	7.128E+04	5.088E+05	6.690E+05	5.631E+05	3.998E+05	7.029E+05	1.858E+06	4.786E+06

AVERAGE SITE DENSITY(PEOPLE/M**2) = 2.39E-04

SITE ANNUAL MILK PRODUCTION (LITERS/YR)

	DOWNWIND DISTANCE(MILES)										
DIR	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	TOTAL
N	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
NNE	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
NE	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
ENE	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
E	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
ESE	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
SE	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
SSE	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
S	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
SSW	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
SW	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
WSW	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
W	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
WNW	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
NW	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
NNW	1.475E+05	4.425E+05	7.375E+05	1.033E+06	1.328E+06	1.106E+07	4.425E+07	7.375E+07	1.033E+08	1.328E+08	3.688E+08
TOTAL	2.360E+06	7.080E+06	1.180E+07	1.652E+07	2.124E+07	1.770E+08	7.080E+08	1.180E+09	1.652E+09	2.124E+09	5.900E+09

AVERAGE SITE DENSITY(LITERS/M**2) = 2.95E-01

Listing 2.17 gives a sample report type 7, as taken from Sample Problem 1. The report contains the run title (item 1), print-control flags for report types 18 through 25 (items 2 and 3), descriptive information for the locations (item 4), and four meteorological dispersion factors for the location (item 5). The four dispersion factors are labeled as follows:

X/Q - undecayed and undepleted dispersion factor

X/Q:DEC - decayed and undepleted dispersion factor

X/Q:DCDP - decayed and depleted dispersion factor

DEPOSITE - ground deposition factor.

LISTING 2.13. Report Type 4b: Meat and Vegetable Production

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE

SITE ANNUAL MEAT PRODUCTION (KG/YR)

DIR	DOWNWIND DISTANCE(MILES) 0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	TOTAL
N	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
NNE	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
NE	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
ENE	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
E	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
ESE	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
SE	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
SSE	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
S	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
SSW	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
SW	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
WSW	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
W	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
WNW	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
NW	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
NNW	4.250E+05	1.275E+06	2.125E+06	2.975E+06	3.825E+06	3.188E+07	1.275E+08	2.125E+08	2.975E+08	3.825E+08	1.063E+09
TOTAL	6.800E+06	2.040E+07	3.400E+07	4.760E+07	6.120E+07	5.100E+08	2.040E+09	3.400E+09	4.760E+09	6.120E+09	1.700E+10

AVERAGE SITE DENSITY(KG/M**2) = 8.50E-01

SITE ANNUAL VEGETATION PRODUCTION (KG/YR)

DIR	DOWNWIND DISTANCE(MILES) 0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	TOTAL
N	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
NNE	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
NE	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
ENE	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
E	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
ESE	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
SE	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
SSE	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
S	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
SSW	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
SW	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
WSW	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
W	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+08	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
WNW	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
NW	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
NNW	1.825E+05	5.475E+05	9.125E+05	1.278E+06	1.643E+06	1.369E+07	5.475E+07	9.125E+07	1.278E+08	1.643E+08	4.563E+08
TOTAL	2.920E+06	8.760E+06	1.460E+07	2.044E+07	2.628E+07	2.190E+08	8.760E+08	1.460E+09	2.044E+09	2.628E+09	7.300E+09

AVERAGE SITE DENSITY(KG/M**2) = 3.65E-01

AGRICULTURAL PRODUCTIVITY (1)

FOOD PRODUCT	ANNUAL USE UNITS/PERSON	TOTAL SITE PRODUCTION	EXPORT	TOTAL POPULATION SERVED
VEGETATION(KG)	1.97E+02	7.30E+09	6.36E+09	3.70E+07
MILK (L)	1.31E+02	5.90E+09	5.27E+09	4.51E+07
MEAT (KG)	8.06E+01	1.70E+10	1.66E+10	2.11E+08

LISTING 2.14. Report Type 5a: Job Control, Agriculture, and Source-Term Data

```
SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE   1

 JOB CONTROL PARAMETERS   2

     JC(1) =  0  :POPULATION/INDIVIDUAL DOSE SELECTION
     JC(2) =  2  :NUMBER OF SOURCE RELEASE POINTS
     JC(3) =  1  :PRINT CONTROL FOR DOSE ACCUMULATION
     JC(4) =  0  :READ CONTROL FOR BLOCK DATA CHANGE RECORDS
     JC(5) =  0  :PRINT CONTROL FOR DOSE FACTOR TABLE
     JC(6) =  0  :CALCULATION CONTROL FOR UNIT DOSE FACTORS
     JC(7) =  1  :READ CONTROL FOR DISPERSION DATA INPUT FILE
     JC(8) =  0
     JC(9) =  0
     JC(10)=  0

 EXPOSURE PATHWAY FRACTIONS   3

     PARAMETER DESCRIPTION(FRACTION)    VALUE
     ---------------------------------------
     FV   LEAFY VEGETABLE FROM GARDEN    0.58
     FG   OTHER EDIBLES FROM GARDEN      0.76
     FP   TIME MILK COWS ON PASTURE      1.00
     FB   TIME BEEF ON PASTURE           1.00
     FGT  TIME MILK GOATS ON PASTURE     1.00
     FPF  MILK COW INTAKE FROM PASTURE   0.50
     FBF  BEEF INTAKE FROM PASTURE       0.80
     FPG  MILK GOAT INTAKE FROM PASTURE  1.00

     HUMIDITY(G/M**3)  15.10
     DISTANCE TO EAST COAST (MILES):  1.26E+03

 SOURCE TERM RELEASE NUMBER  1    4

     RELEASE POINT        SAMPLE 2 - SOURCE TERM 1, RADWASTE BLDG VENT
     UML =  1.00E+00   SOURCE TERM MULTIPLICATION FACTOR
     JC1 =  0          NEW OR PREVIOUS MET DATA PARAMETER
     JC2 =  0          NEW OR PREVIOUS SOURCE TERM RELEASE DATA PARAMETER

       NUCLIDE    CI/YR           NUCLIDE    CI/YR
       -------    -----           -------    -----
       36KR 85M  1.00E+00         27CO 58   2.00E-03
       36KR 88   3.00E+00         27CO 60   2.50E-04
       54XE133M  1.00E+00         35BR 84   2.60E-04
       54XE133   7.00E+01         35BR 85   3.00E-05
       54XE135   4.00E+00         38SR 89   4.30E-05
        1H   3   2.30E+02         38SR 90   1.30E-06
       24CR 51   2.30E-04         38SR 91   6.50E-05
       25MN 54   3.90E-05         39Y  93   3.40E-06
       26FE 55   1.60E-04         40ZR 95   7.40E-06
       26FE 59   1.40E-04         52TE125M  2.90E-06
       53I 131   6.20E-02

              3.091E+02 TOTAL CURIES FOR  21 RADIONUCLIDES
```

LISTING 2.15. Report Type 6a: Site Meteorological Data - Undecayed/Undepleted, Decayed/Undepleted

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE

SITE ANNUAL X/Q DATA (SEC/M**3)

DIR	DOWNWIND DISTANCE(MILES) 0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	9.149E-06	2.005E-06	6.048E-07	3.056E-07	1.906E-07	8.559E-08	3.152E-08	1.590E-08	1.025E-08	7.412E-09
NNE	8.572E-06	1.871E-06	5.619E-07	2.832E-07	1.763E-07	7.890E-08	2.890E-08	1.451E-08	9.327E-09	6.731E-09
NE	1.026E-05	2.257E-06	6.840E-07	3.467E-07	2.168E-07	9.778E-08	3.630E-08	1.843E-08	1.193E-08	8.659E-09
ENE	9.999E-06	2.201E-06	6.688E-07	3.395E-07	2.126E-07	9.605E-08	3.579E-08	1.823E-08	1.183E-08	8.593E-09
E	8.072E-06	1.762E-06	5.336E-07	2.703E-07	1.690E-07	7.619E-08	2.830E-08	1.439E-08	9.326E-09	6.773E-09
ESE	8.410E-06	1.853E-06	5.648E-07	2.874E-07	1.802E-07	8.170E-08	3.060E-08	1.565E-08	1.018E-08	7.412E-09
SE	9.196E-06	2.035E-06	6.224E-07	3.172E-07	1.992E-07	9.049E-08	3.401E-08	1.744E-08	1.136E-08	8.284E-09
SSE	7.033E-06	1.557E-06	4.763E-07	2.427E-07	1.524E-07	6.923E-08	2.602E-08	1.334E-08	8.695E-09	6.339E-09
S	7.435E-06	1.643E-06	5.009E-07	2.548E-07	1.598E-07	7.241E-08	2.712E-08	1.387E-08	9.027E-09	6.575E-09
SSW	1.033E-05	2.303E-06	7.077E-07	3.618E-07	2.277E-07	1.038E-07	3.929E-08	2.027E-08	1.326E-08	9.691E-09
SW	1.043E-05	2.292E-06	6.947E-07	3.521E-07	2.202E-07	9.934E-08	3.691E-08	1.877E-08	1.217E-08	8.836E-09
WSW	8.717E-06	1.917E-06	5.814E-07	2.947E-07	1.843E-07	8.315E-08	3.091E-08	1.572E-08	1.020E-08	7.407E-09
W	8.705E-06	1.917E-06	5.820E-07	2.952E-07	1.847E-07	8.341E-08	3.103E-08	1.579E-08	1.024E-08	7.440E-09
WNW	7.796E-06	1.716E-06	5.206E-07	2.640E-07	1.651E-07	7.452E-08	2.770E-08	1.408E-08	9.126E-09	6.626E-09
NW	7.770E-06	1.688E-06	5.054E-07	2.542E-07	1.580E-07	7.052E-08	2.572E-08	1.287E-08	8.254E-09	5.946E-09
NNW	8.502E-06	1.853E-06	5.558E-07	2.799E-07	1.741E-07	7.783E-08	2.845E-08	1.426E-08	9.154E-09	6.600E-09

SITE ANNUAL DECAYED X/Q FOR XE-133M (SEC/M**3)

DIR	DOWNWIND DISTANCE(MILES) 0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	9.088E-06	1.979E-06	5.905E-07	2.953E-07	1.824E-07	7.978E-08	2.750E-08	1.279E-08	7.698E-09	5.245E-09
NNE	8.531E-06	1.854E-06	5.526E-07	2.765E-07	1.709E-07	7.510E-08	2.623E-08	1.242E-08	7.577E-09	5.216E-09
NE	1.021E-05	2.238E-06	6.736E-07	3.392E-07	2.108E-07	9.351E-08	3.326E-08	1.601E-08	9.881E-09	6.861E-09
ENE	9.955E-06	2.182E-06	6.584E-07	3.320E-07	2.065E-07	9.178E-08	3.274E-08	1.580E-08	9.766E-09	6.790E-09
E	8.048E-06	1.752E-06	5.281E-07	2.664E-07	1.659E-07	7.397E-08	2.668E-08	1.305E-08	8.147E-09	5.706E-09
ESE	8.372E-06	1.836E-06	5.557E-07	2.808E-07	1.749E-07	7.791E-08	2.788E-08	1.347E-08	8.327E-09	5.786E-09
SE	9.118E-06	2.001E-06	6.037E-07	3.037E-07	1.883E-07	8.281E-08	2.864E-08	1.328E-08	7.953E-09	5.392E-09
SSE	6.971E-06	1.531E-06	4.615E-07	2.321E-07	1.438E-07	6.318E-08	2.180E-08	1.007E-08	6.004E-09	4.052E-09
S	7.389E-06	1.623E-06	4.900E-07	2.470E-07	1.535E-07	6.795E-08	2.396E-08	1.138E-08	6.940E-09	4.765E-09
SSW	1.022E-05	2.254E-06	6.809E-07	3.423E-07	2.120E-07	9.274E-08	3.158E-08	1.434E-08	8.428E-09	5.630E-09
SW	1.036E-05	2.261E-06	6.779E-07	3.401E-07	2.106E-07	9.259E-08	3.223E-08	1.513E-08	9.157E-09	6.256E-09
WSW	8.644E-06	1.886E-06	5.639E-07	2.821E-07	1.742E-07	7.602E-08	2.596E-08	1.191E-08	7.077E-09	4.771E-09
W	8.645E-06	1.891E-06	5.675E-07	2.848E-07	1.763E-07	7.747E-08	2.687E-08	1.255E-08	7.552E-09	5.138E-09
WNW	7.742E-06	1.692E-06	5.075E-07	2.546E-07	1.575E-07	6.915E-08	2.394E-08	1.115E-08	6.709E-09	4.563E-09
NW	7.741E-06	1.676E-06	4.988E-07	2.495E-07	1.543E-07	6.791E-08	2.387E-08	1.138E-08	6.977E-09	4.813E-09
NNW	8.455E-06	1.833E-06	5.449E-07	2.720E-07	1.679E-07	7.344E-08	2.538E-08	1.186E-08	7.151E-09	4.872E-09

One report of type 7 is printed for each source-term set when individual doses are to be calculated.

2.2.8 Report Type 8: Environmental Activity Summary

Report type 8 contains calculated summary values of radionuclide activity accumulated in selected pathways to the midpoint of the plant lifetime (parameter PLIFE, default value is 20 yr). A sample report type 8 is shown in Listing 2.18 representing the first source term from Sample Problem 2. A report of this type is printed for each source-term set on population-dose

LISTING 2.16. Report Type 6b: Site Meteorological Data - Decayed/Depleted, Ground Deposition

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE

SITE ANNUAL DECAYED (FOR I-131) AND DEPLETED X/Q DATA (SEC/M**3)

DOWNWIND DISTANCE(MILES)

DIR	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	8.194E-06	1.714E-06	4.885E-07	2.366E-07	1.425E-07	5.971E-08	1.901E-08	8.223E-09	4.691E-09	3.050E-09
NNE	7.682E-06	1.601E-06	4.548E-07	2.199E-07	1.323E-07	5.540E-08	1.766E-08	7.673E-09	4.402E-09	2.880E-09
NE	9.194E-06	1.932E-06	5.538E-07	2.694E-07	1.628E-07	6.874E-08	2.224E-08	9.800E-09	5.676E-09	3.742E-09
ENE	8.962E-06	1.884E-06	5.414E-07	2.638E-07	1.596E-07	6.750E-08	2.192E-08	9.684E-09	5.619E-09	3.709E-09
E	7.238E-06	1.510E-06	4.326E-07	2.105E-07	1.273E-07	5.381E-08	1.750E-08	7.775E-09	4.537E-09	3.011E-09
ESE	7.537E-06	1.585E-06	4.572E-07	2.232E-07	1.353E-07	5.738E-08	1.871E-08	8.295E-09	4.822E-09	3.186E-09
SE	8.232E-06	1.738E-06	5.017E-07	2.449E-07	1.484E-07	6.277E-08	2.028E-08	8.859E-09	5.074E-09	3.306E-09
SSE	6.295E-06	1.330E-06	3.838E-07	1.873E-07	1.135E-07	4.799E-08	1.550E-08	6.765E-09	3.873E-09	2.521E-09
S	6.660E-06	1.405E-06	4.048E-07	1.974E-07	1.196E-07	5.061E-08	1.643E-08	7.239E-09	4.185E-09	2.751E-09
SSW	9.243E-06	1.964E-06	5.691E-07	2.784E-07	1.688E-07	7.150E-08	2.309E-08	1.005E-08	5.724E-09	3.706E-09
SW	9.343E-06	1.959E-06	5.609E-07	2.726E-07	1.646E-07	6.930E-08	2.228E-08	9.732E-09	5.592E-09	3.658E-09
WSW	7.803E-06	1.637E-06	4.686E-07	2.275E-07	1.373E-07	5.767E-08	1.842E-08	7.970E-09	4.537E-09	2.942E-09
W	7.796E-06	1.639E-06	4.699E-07	2.285E-07	1.380E-07	5.812E-08	1.868E-08	8.143E-09	4.668E-09	3.046E-09
WNW	6.982E-06	1.467E-06	4.203E-07	2.042E-07	1.233E-07	5.191E-08	1.666E-08	7.250E-09	4.150E-09	2.705E-09
NW	6.966E-06	1.446E-06	4.095E-07	1.977E-07	1.188E-07	4.970E-08	1.584E-08	6.899E-09	3.971E-09	2.606E-09
NNW	7.618E-06	1.585E-06	4.494E-07	2.171E-07	1.304E-07	5.451E-08	1.729E-08	7.473E-09	4.267E-09	2.779E-09

SITE ANNUAL DEPOSITION DATA (1/M**2)

DOWNWIND DISTANCE(MILES)

DIR	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	2.384E-08	4.882E-09	1.275E-09	5.724E-10	3.238E-10	1.245E-10	3.603E-11	1.428E-11	7.625E-12	4.720E-12
NNE	2.468E-08	5.055E-09	1.320E-09	5.927E-10	3.353E-10	1.289E-10	3.730E-11	1.479E-11	7.896E-12	4.887E-12
NE	2.842E-08	5.822E-09	1.520E-09	6.826E-10	3.862E-10	1.485E-10	4.296E-11	1.703E-11	9.093E-12	5.628E-12
ENE	3.050E-08	6.247E-09	1.631E-09	7.325E-10	4.144E-10	1.593E-10	4.610E-11	1.827E-11	9.757E-12	6.039E-12
E	3.367E-08	6.896E-09	1.800E-09	8.085E-10	4.574E-10	1.759E-10	5.089E-11	2.017E-11	1.077E-11	6.666E-12
ESE	3.024E-08	6.195E-09	1.617E-09	7.263E-10	4.109E-10	1.580E-10	4.571E-11	1.812E-11	9.675E-12	5.988E-12
SE	2.621E-08	5.370E-09	1.402E-09	6.296E-10	3.562E-10	1.370E-10	3.962E-11	1.570E-11	8.386E-12	5.191E-12
SSE	1.670E-08	3.421E-09	8.931E-10	4.011E-10	2.269E-10	8.727E-11	2.525E-11	1.001E-11	5.343E-12	3.307E-12
S	1.911E-08	3.913E-09	1.022E-09	4.588E-10	2.596E-10	9.982E-11	2.888E-11	1.145E-11	6.112E-12	3.783E-12
SSW	2.284E-08	4.679E-09	1.222E-09	5.486E-10	3.104E-10	1.194E-10	3.453E-11	1.369E-11	7.308E-12	4.523E-12
SW	2.888E-08	5.915E-09	1.544E-09	6.935E-10	3.923E-10	1.509E-10	4.365E-11	1.730E-11	9.238E-12	5.718E-12
WSW	2.482E-08	5.083E-09	1.327E-09	5.960E-10	3.372E-10	1.297E-10	3.751E-11	1.487E-11	7.939E-12	4.914E-12
W	2.225E-08	4.558E-09	1.190E-09	5.345E-10	3.023E-10	1.163E-10	3.364E-11	1.333E-11	7.119E-12	4.406E-12
WNW	1.960E-08	4.014E-09	1.048E-09	4.707E-10	2.663E-10	1.024E-10	2.962E-11	1.174E-11	6.270E-12	3.881E-12
NW	2.073E-08	4.247E-09	1.109E-09	4.980E-10	2.817E-10	1.083E-10	3.134E-11	1.242E-11	6.633E-12	4.106E-12
NNW	2.055E-08	4.209E-09	1.099E-09	4.935E-10	2.792E-10	1.074E-10	3.106E-11	1.231E-11	6.574E-12	4.069E-12

calculation runs. The "RELEASE" column (item 1) gives the annual release rate in Ci/yr as defined on input record type 8.1.n. The "ENVIRON" column (item 2) represents the total activity of the radionuclide in the environment at the midpoint of plant life (parameter PLIFE) assuming continuous release at the annual rate. The "GROUND" column (item 3) gives the total activity of each radionuclide on the ground after PLIFE yr of operation. These values are evaluated using the ground-deposition factors for the 50-mi

LISTING 2.17. Report Type 7: Meteorological Data for Special Locations

```
SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS              1

      4                                5                          3
2                                                          REPORT CONTROL FLAGS
JS SPECIAL LOCATION DIR MILES   X/Q      X/Q:DEC   X/Q:DCDP  DEPOSITE  PL GD VT MT CM GM IN
-- ---------------- --- -----  -------- --------  --------  --------  -- -- -- -- -- -- --
 1 A SITE BNDRY       S  1.13  9.19E-08 9.17E-08  8.78E-08  1.75E-09  0  0  0  0  0  0  0
 1 A SITE BNDRY     SSW  1.26  1.06E-07 1.05E-07  1.01E-07  1.73E-09  0  0  0  0  0  0  0
 1 A SITE BNDRY      SW  1.35  1.34E-07 1.34E-07  1.29E-07  1.87E-09  0  0  0  0  0  0  0

                                  REPORTS ARE NOT PRINTED IF JS=1 OR CONTROL FLAGS=1
                                                         FLAGS:  PL - PLUME
                                                                 GD - GROUND
                                                                 VT - VEGETABLE
                                                                 MT - MEAT
                                                                 CM - COW MILK
                                                                 GM - GOAT MILK
                                                                 IN - INHALATION
```

LISTING 2.18. Report Type 8: Environmental Activity Summary

```
SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE
  SAMPLE 2 - SOURCE TERM 1, RADWASTE BLD

RELEASE, ENVIRONS  INVENTORY, AND ANNUAL PATHWAY INVENTORIES-CI
             1         2         3                   4
 NUCLIDE RELEASE  ENVIRON   GROUND VEGETATION  MILK      MEAT
+-------- -------- -------- -------- -------- -------- ---------+
*  KR 85M 1.00E+00 7.24E-04 0.00E+00 0.00E+00 0.00E+00 0.00E+00 *
*  KR 88  3.00E+00 1.40E-03 0.00E+00 0.00E+00 0.00E+00 0.00E+00 *
*  XE133M 1.00E+00 8.93E-03 0.00E+00 0.00E+00 0.00E+00 0.00E+00 *
*  XE133  7.00E+01 1.45E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 *
*  XE135  4.00E+00 5.98E-03 0.00E+00 0.00E+00 0.00E+00 0.00E+00 *
*  H   3  2.30E+02 2.76E+03 0.00E+00 3.13E-02 1.27E-02 4.38E-02 *
*  CR 51  2.30E-04 2.51E-05 1.86E-05 4.93E-08 2.39E-08 7.81E-08 *
*  MN 54  3.90E-05 4.81E-05 3.58E-05 4.74E-08 8.50E-10 9.74E-09 *
*  FE 55  1.60E-04 6.19E-04 4.61E-04 2.13E-07 1.76E-08 2.09E-06 *
*  FE 59  1.40E-04 2.47E-05 1.83E-05 6.04E-08 9.61E-09 1.07E-06 *
*  CO 58  2.00E-03 5.61E-04 4.16E-04 1.33E-06 1.33E-07 6.07E-06 *
*  CO 60  2.50E-04 1.76E-03 1.31E-03 3.58E-07 2.39E-08 1.10E-06 *
*  BR 84  2.60E-04 2.27E-08 3.63E-09 0.00E+00 0.00E+00 0.00E+00 *
*  BR 85  3.00E-05 2.36E-10 2.62E-13 0.00E+00 0.00E+00 0.00E+00 *
*  SR 89  4.30E-05 8.57E-06 6.35E-06 2.13E-08 2.06E-09 5.26E-09 *
*  SR 90  1.30E-06 2.06E-05 1.53E-05 2.20E-09 1.10E-10 2.89E-10 *
*  SR 91  6.50E-05 1.02E-07 5.50E-08 0.00E+00 7.90E-14 1.72E-25 *
*  Y  93  3.40E-06 5.64E-09 3.10E-09 0.00E+00 8.41E-17 5.90E-25 *
*  ZR 95  7.40E-06 1.88E-06 1.39E-06 4.55E-09 2.38E-12 5.66E-08 *
*  TE125M 2.90E-06 6.66E-07 4.94E-07 2.11E-09 2.06E-10 5.42E-08 *
*  I 131  6.20E-02 1.97E-03 7.17E-04 4.65E-07 1.97E-05 1.10E-05 *
+---------------------------------------------------------------+
```

region (D/Q). The "GROUND" value for nondepositing radionuclides will be zero. The "VEGETATION," "MILK," and "MEAT" columns (item 4) give the total annual radioactivity for each pathway. These values will be zero for nondepositing radionuclides and for short-lived radionuclides that essentially decay away before consumption (see entries for ^{91}Sr and ^{93}Y, which have about 10-hr half-lives).

2.2.9 Report Type 9: Population-Dose Summary

Two reports of type 9 are printed giving total population doses by pathway and organ for ALARA evaluations (report type 9a) and NEPA evaluations (report type 9b). Listing 2.19 gives a sample report type 9a from Sample Problem 2. Report type 9b is similar to 9a except that "ALARA" is replaced with "NEPA," and dose values may be different. The reports also give the percentage of the organ dose contributed by each pathway.

The ALARA doses represent population exposures within 50 mi. The NEPA doses include the ALARA exposures, plus exposures beyond 50 mi. Therefore, the NEPA values should always be greater than or equal to the ALARA values. Contributions beyond 50 mi are always included for noble gases, ^{3}H, and ^{14}C when they are in the source term. Additional contributions may also result when there is excess food production available for export (as indicated in report type 4b).

2.2.10 Report Type 10: Population-Dose Pathway Totals

Report type 10 presents total population doses by radionuclide and organ summed over all exposure pathways for ALARA evaluations (report type 10a) and for NEPA evaluations (report type 10b), and also gives percent contribution to organ dose by radionuclide. Listing 2.20 is an example of report type 10a from Sample Problem 2. Note that the "TOTAL" values on this report should match the "TOTAL" values on the type 9 reports. This report format is similar to the six population-dose reports that follow for each pathway (report types 11 through 16). The reports are easily distinguishable by the key word printed for pathway type (see item 1 in Listings 2.20 and 2.21).

2.2.11 Report Types 11-16: Population-Dose Results by Pathway

The results of population-dose calculations are printed by pathway in reports of type 11 through 16, as indicated in Table 2.17. A representative

LISTING 2.19. Report Type 9a: ALARA Pathway Summary

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.68E-01	4.25E-01
	1.27%	1.27%	0.30%	1.27%	1.27%	0.66%	1.32%	3.28%
GROUND	6.30E-02	6.30E-02	6.30E-02	6.30E-02	6.30E-02	6.30E-02	6.30E-02	7.42E-02
	0.50%	0.50%	0.12%	0.50%	0.49%	0.26%	0.50%	0.57%
INHAL	1.21E+00	1.20E+00	1.21E-02	1.21E+00	1.23E+00	6.20E+00	1.22E+00	1.20E+00
	9.52%	9.48%	0.02%	9.56%	9.62%	25.33%	9.61%	9.26%
VEGET	5.85E+00	5.85E+00	2.78E+01	5.85E+00	5.85E+00	6.01E+00	5.85E+00	5.85E+00
	46.08%	46.13%	51.28%	46.03%	45.94%	24.55%	46.06%	45.17%
COW MILK	2.57E+00	2.56E+00	1.23E+01	2.57E+00	2.59E+00	8.63E+00	2.56E+00	2.56E+00
	20.21%	20.16%	22.67%	20.25%	20.31%	35.23%	20.12%	19.73%
MEAT	2.85E+00	2.85E+00	1.39E+01	2.85E+00	2.85E+00	3.42E+00	2.84E+00	2.84E+00
	22.42%	22.45%	25.62%	22.40%	22.36%	13.97%	22.40%	21.97%
TOTAL	1.27E+01	1.27E+01	5.43E+01	1.27E+01	1.27E+01	2.45E+01	1.27E+01	1.29E+01

report (type 14a) is shown in Listing 2.21 from Sample Problem 2. Each report type gives population doses for one pathway (item 1 in Listing 2.21) by organ and radionuclide. The reports are printed first for ALARA results and then for NEPA results. The only radionuclides included in a report are those for which there is at least one non-zero organ dose. If all values in a report are zero, then the entire report is not printed. The "TOTAL" doses for the pathway should agree with the pathway doses in the summary report (type 9).

2.2.12 Report Type 17: Special-Location Pathway Summary

Report type 17 gives pathway summary results for one of the special locations defined for individual-dose calculations. A sample report type 17 is shown in Listing 2.22 for the second location from Sample Problem 1. The report includes the location description (item 1), air-dose totals (item 2), and individual doses for each pathway and organ. Only non-zero doses are printed in the report. For example, in Listing 2.22, no results are printed for vegetable consumption by infants because the default ingestion rate of vegetables by infants was set at zero in Sample Problem 1.

LISTING 2.20. Report Type 10a: ALARA Radionuclide Totals

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = *TOTAL* 1

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
KR 85M	2.27E-03	2.27E-03	2.27E-03	2.27E-03	2.27E-03	2.27E-03	2.34E-03	8.31E-03
	0.02%	0.02%	0.00%	0.02%	0.02%	0.00%	0.02%	0.06%
KR 88	6.58E-02	6.58E-02	6.58E-02	6.58E-02	6.58E-02	6.58E-02	6.61E-02	9.67E-02
	0.52%	0.52%	0.12%	0.52%	0.52%	0.27%	0.52%	0.75%
XE133M	8.63E-04	8.63E-04	8.63E-04	8.63E-04	8.63E-04	8.63E-04	9.64E-04	8.09E-03
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%
XE133	7.37E-02	7.37E-02	7.37E-02	7.37E-02	7.37E-02	7.37E-02	7.90E-02	2.52E-01
	0.58%	0.58%	0.14%	0.58%	0.58%	0.30%	0.62%	1.94%
XE135	1.87E-02	1.87E-02	1.87E-02	1.87E-02	1.87E-02	1.87E-02	1.92E-02	6.04E-02
	0.15%	0.15%	0.03%	0.15%	0.15%	0.08%	0.15%	0.47%
H 3	1.65E+00	1.65E+00	0.00E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00
	12.97%	12.97%	0.00%	12.95%	12.93%	6.72%	12.96%	12.72%
CR 51	9.54E-06	1.95E-05	9.36E-06	9.36E-06	9.40E-06	9.46E-06	2.82E-05	1.11E-05
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	4.84E-04	5.71E-04	4.74E-04	5.20E-04	4.87E-04	4.74E-04	7.81E-04	5.56E-04
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	5.31E-05	8.94E-05	3.27E-04	2.08E-04	0.00E+00	0.00E+00	1.80E-04	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	5.12E-04	1.56E-03	5.38E-04	7.67E-04	3.34E-04	3.34E-04	1.27E-03	3.93E-04
	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
CO 58	7.43E-03	1.23E-02	6.67E-03	6.98E-03	6.67E-03	6.67E-03	1.72E-02	7.81E-03
	0.06%	0.10%	0.01%	0.05%	0.05%	0.03%	0.14%	0.06%
CO 60	5.14E-02	5.40E-02	5.09E-02	5.11E-02	5.09E-02	5.09E-02	5.94E-02	5.99E-02
	0.40%	0.43%	0.09%	0.40%	0.40%	0.21%	0.47%	0.46%
BR 84	5.18E-08	2.77E-08	2.77E-08	2.77E-08	2.77E-08	2.77E-08	2.77E-08	3.23E-08
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 85	1.81E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	4.76E-05	2.27E-04	1.66E-03	8.14E-09	8.14E-09	8.14E-09	3.72E-04	9.45E-09
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.71E-05	7.19E-05	3.84E-03	0.00E+00	0.00E+00	0.00E+00	7.73E-05	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	9.36E-07	5.00E-05	9.55E-07	9.35E-07	9.35E-07	9.35E-07	1.15E-05	1.09E-06
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	4.28E-09	5.78E-06	5.78E-09	4.24E-09	4.24E-09	4.24E-09	7.64E-07	5.80E-09
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.70E-05	7.80E-05	2.09E-05	1.74E-05	1.82E-05	1.59E-05	9.19E-05	1.85E-05
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

LISTING 2.20. (Contd)

TE125M	7.99E-07	1.75E-05	5.72E-06	1.94E-06	1.36E-05	1.70E-06	5.64E-06	5.42E-08
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
I 131	2.51E-02	1.06E-02	3.37E-02	4.08E-02	6.58E-02	1.18E+01	4.62E-03	5.61E-03
	0.20%	0.08%	0.06%	0.32%	0.52%	48.26%	0.04%	0.04%
C 14	1.08E+01	1.08E+01	5.40E+01	1.08E+01	1.08E+01	1.08E+01	1.08E+01	1.08E+01
	85.09%	85.13%	99.52%	84.99%	84.83%	44.12%	85.05%	83.43%
TOTAL	1.27E+01	1.27E+01	5.43E+01	1.27E+01	1.27E+01	2.45E+01	1.27E+01	1.29E+01

LISTING 2.21. Report Type 14a: ALARA Vegetable-Ingestion Details

SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)
PATHWAY = VEGET 1

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.85E-01	2.85E-01	0.00E+00	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01
	4.86%	4.86%	0.00%	4.86%	4.86%	4.73%	4.86%	4.86%
CR 51	2.50E-08	3.98E-06	0.00E+00	0.00E+00	4.80E-09	1.44E-08	3.03E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	7.80E-06	7.87E-05	0.00E+00	3.60E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	2.01E-05	3.04E-05	1.23E-04	7.62E-05	0.00E+00	0.00E+00	4.35E-05	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	4.54E-05	2.55E-04	5.29E-05	1.07E-04	0.00E+00	0.00E+00	3.08E-05	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	4.22E-04	2.42E-03	0.00E+00	1.67E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	3.21E-04	1.75E-03	0.00E+00	1.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	4.03E-05	1.38E-04	1.41E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	6.85E-05	6.33E-05	3.41E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	5.80E-09	1.77E-05	2.80E-08	7.69E-09	1.16E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.61E-07	2.96E-06	1.21E-06	3.86E-07	2.03E-06	3.49E-07	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
I 131	2.83E-04	9.44E-05	4.07E-04	5.00E-04	8.44E-04	1.62E-01	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.01%	2.70%	0.00%	0.00%
C 14	5.56E+00	5.56E+00	2.78E+01	5.56E+00	5.56E+00	5.56E+00	5.56E+00	5.56E+00
	95.12%	95.06%	99.98%	95.12%	95.12%	92.57%	95.13%	95.14%
TOTAL	5.85E+00	5.85E+00	2.78E+01	5.85E+00	5.85E+00	6.01E+00	5.85E+00	5.85E+00

LISTING 2.22. Report Type 17: Special-Location Pathway Summary

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
SPECIAL LOCATION NO. 2 A SITE BNDRY (1)
AT 1.17 MILES WSW

ANNUAL BETA AIR DOSE = 4.19E-02 MILLRADS (2)
ANNUAL GAMMA AIR DOSE = 2.32E-02 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.50E-02	3.50E-02
GROUND	1.98E-03	1.98E-03	1.98E-03	1.98E-03	1.98E-03	1.98E-03	1.98E-03	2.34E-03
VEGET								
ADULT	4.61E-02	4.61E-02	1.37E-01	4.72E-02	4.90E-02	9.04E-01	4.45E-02	4.45E-02
TEEN	6.77E-02	6.72E-02	2.28E-01	6.95E-02	7.22E-02	1.21E+00	6.54E-02	6.54E-02
CHILD	1.45E-01	1.42E-01	5.54E-01	1.48E-01	1.52E-01	2.33E+00	1.41E-01	1.41E-01
MEAT								
ADULT	1.34E-02	1.37E-02	5.33E-02	1.35E-02	1.35E-02	4.93E-02	1.33E-02	1.33E-02
TEEN	1.07E-02	1.08E-02	4.50E-02	1.07E-02	1.07E-02	3.66E-02	1.06E-02	1.06E-02
CHILD	1.89E-02	1.89E-02	8.47E-02	1.90E-02	1.90E-02	5.82E-02	1.88E-02	1.88E-02
COW MILK								
ADULT	1.90E-02	1.84E-02	5.94E-02	1.98E-02	2.11E-02	6.39E-01	1.79E-02	1.79E-02
TEEN	3.14E-02	3.03E-02	1.10E-01	3.30E-02	3.54E-02	1.01E+00	2.96E-02	2.96E-02
CHILD	6.89E-02	6.62E-02	2.69E-01	7.15E-02	7.52E-02	2.01E+00	6.56E-02	6.56E-02
INFANT	1.36E-01	1.30E-01	5.28E-01	1.44E-01	1.46E-01	4.84E+00	1.30E-01	1.30E-01
GOATMILK								
ADULT	2.70E-02	2.56E-02	6.13E-02	2.90E-02	3.22E-02	1.51E+00	2.44E-02	2.44E-02
TEEN	4.24E-02	3.97E-02	1.13E-01	4.62E-02	5.20E-02	2.40E+00	3.81E-02	3.81E-02
CHILD	8.71E-02	8.03E-02	2.78E-01	9.31E-02	1.02E-01	4.73E+00	7.90E-02	7.90E-02
INFANT	1.65E-01	1.51E-01	5.45E-01	1.85E-01	1.90E-01	1.15E+01	1.50E-01	1.50E-01
INHAL								
ADULT	1.95E-02	1.94E-02	1.54E-04	1.96E-02	1.97E-02	8.56E-02	1.97E-02	1.94E-02
TEEN	1.97E-02	1.96E-02	2.13E-04	1.98E-02	2.00E-02	1.01E-01	2.00E-02	1.95E-02
CHILD	1.74E-02	1.73E-02	2.82E-04	1.75E-02	1.77E-02	1.08E-01	1.76E-02	1.73E-02
INFANT	1.00E-02	9.93E-03	2.18E-04	1.02E-02	1.02E-02	9.26E-02	1.02E-02	9.92E-03

2.2.13 Report Types 18-24: Special-Location Pathway Details

Report types 18 through 24 present results of individual-dose calculations by radionuclide and organ, as shown in Listing 2.23 (from Sample Problem 1, under vegetable ingestion by adults). Each report gives results for one location (item 1), one pathway (item 2), and one age group (item 3). The ground and plume external-exposure reports are given for the adult age group only, as doses for other age groups are assumed to be about the same as adult doses. Reports are printed only if there is at least one non-zero dose value for the report. When control parameter JC(3) is set to zero, selected reports of type 18 through 24 are printed for each source term giving cumulative results. When JC(3) is greater than zero, results are printed after the final source term only. Printing of these reports is controlled by flags JS and JSS, as described for input record type 13.

2.2.14 Report Type 25: Cost-Benefit Report

The results of the cost-benefit analysis based on ALARA population doses are printed in report type 25. Two identical reports of this type are printed. An example report type 25 is shown in Listing 2.24 as taken from Sample Problem 2. The report gives the activity release rate for each source term (item 1) and the population dose for total-body and thyroid (item 2). A summary is also printed for each source term, giving the results by radionuclide type (item 3) and the totals for the source term (item 4). The number of reports of type 25 printed for each case depends on the number of source terms defined in the input file (record set 8). Results for three source terms are printed per page.

2.2.15 Report Type 26: Normalized Dose Factors for 10 CFR 50 Evaluations

Results of the PARTS calculations for normalized dose factors for 10 CFR 50 evaluations are printed in report type 26. A sample report is shown in Listing 2.25 from Sample Problem 3. The report includes normalized dose factors for one age group (item 1), one organ (item 2), and several exposure pathways. The factors are given for each radionuclide defined on the source-term input record (set 8). Reports are printed for four age groups (adult, teen, child, and infant) and seven organs (total-body, GI tract, bone, liver, kidney, thyroid, and lungs).

LISTING 2.23. Report Type 20a: Special Location - Vegetable-Ingestion Details

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY 1
PATHWAY = VEGET 2

AGE GROUP = ADULT 3

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.98E-02	1.98E-02	0.00E+00	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02
	42.26%	42.26%	0.00%	41.20%	39.59%	2.01%	43.89%	43.90%
C 14	2.54E-02	2.54E-02	1.27E-01	2.54E-02	2.54E-02	2.54E-02	2.54E-02	2.54E-02
	53.99%	54.00%	98.08%	52.64%	50.58%	2.57%	56.08%	56.10%
I 131	1.64E-03	7.57E-04	2.01E-03	2.87E-03	4.92E-03	9.40E-01	0.00E+00	0.00E+00
	3.50%	1.61%	1.55%	5.95%	9.81%	95.37%	0.00%	0.00%
I 133	9.53E-07	2.81E-06	1.80E-06	3.12E-06	5.45E-06	4.59E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.01%	0.05%	0.00%	0.00%
MN 54	3.66E-06	5.88E-05	0.00E+00	1.92E-05	5.71E-06	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.13%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%
FE 59	1.01E-05	8.77E-05	1.12E-05	2.63E-05	0.00E+00	0.00E+00	7.35E-06	0.00E+00
	0.02%	0.19%	0.00%	0.05%	0.00%	0.00%	0.02%	0.00%
CO 58	6.58E-05	5.95E-04	0.00E+00	2.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	1.27%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	1.52E-08	5.31E-08	5.78E-07	6.94E-08	6.47E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	6.18E-09	1.55E-06	0.00E+00	0.00E+00	1.36E-09	3.69E-09	8.20E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.40E-06	3.44E-06	8.67E-06	5.99E-06	0.00E+00	0.00E+00	3.34E-06	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	2.47E-05	2.10E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.45%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	3.79E-25	2.97E-30	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	5.18E-06	2.90E-05	1.81E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.06%	0.14%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	5.54E-06	6.93E-06	2.76E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.01%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.22E-10	1.44E-08	3.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.44E-15	2.80E-09	8.82E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	7.19E-10	3.37E-06	3.31E-09	1.06E-09	1.67E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.91E-08	5.70E-07	1.43E-07	5.17E-08	5.80E-07	4.29E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	4.70E-02	4.70E-02	1.29E-01	4.82E-02	5.01E-02	9.86E-01	4.52E-02	4.52E-02

LISTING 2.24. Report Type 25: Cost-Benefit Results

```
SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE
 COST BENEFIT TABLES (NUCLIDE RELEASE, T.BODY AND THYROID - PERSON-REM)

  SAMPLE 2 - SOURCE TERM 1, RADWASTE BLD   SAMPLE 2 - SOURCE TERM 2,  TURBINE BLD

NUCLIDE    CI/YR     T.BODY      THYROID    NUCLIDE    CI/YR     T.BODY      THYROID
-------+----------+----------+----------+  -------+----------+----------+----------+
KR 85M I 1.00E+00 I 2.27E-03 I 2.27E-03 I  C  14  I 1.40E+01 I 1.08E+01 I 1.08E+01 I
KR 88  I 3.00E+00 I 6.58E-02 I 6.58E-02 I  -------+----------+----------+----------+
XE133M I 1.00E+00 I 8.63E-04 I 8.63E-04 I
XE133  I 7.00E+01 I 7.37E-02 I 7.37E-02 I
XE135  I 4.00E+00 I 1.87E-02 I 1.87E-02 I
H   3  I 2.30E+02 I 1.65E+00 I 1.65E+00 I
CR 51  I 2.30E-04 I 9.54E-06 I 9.46E-06 I
MN 54  I 3.90E-05 I 4.84E-04 I 4.74E-04 I
FE 55  I 1.60E-04 I 5.31E-05 I 0.00E+00 I
FE 59  I 1.40E-04 I 5.12E-04 I 3.34E-04 I
CO 58  I 2.00E-03 I 7.43E-03 I 6.67E-03 I
CO 60  I 2.50E-04 I 5.14E-02 I 5.09E-02 I
BR 84  I 2.60E-04 I 5.18E-08 I 2.77E-08 I
BR 85  I 3.00E-05 I 1.81E-13 I 0.00E+00 I
SR 89  I 4.30E-05 I 4.76E-05 I 8.14E-09 I
SR 90  I 1.30E-06 I 7.71E-05 I 0.00E+00 I
SR 91  I 6.50E-05 I 9.36E-07 I 9.35E-07 I
Y  93  I 3.40E-06 I 4.28E-09 I 4.24E-09 I
ZR 95  I 7.40E-06 I 1.70E-05 I 1.59E-05 I
TE125M I 2.90E-06 I 7.99E-07 I 1.70E-06 I
I 131  I 6.20E-02 I 2.51E-02 I 1.18E+01 I
-------+----------+----------+----------+
```

```
SUBTOTALS  CI/YR     T.BODY      THYROID    SUBTOTALS  CI/YR     T.BOYD      THYROID
-------+----------+----------+----------+  -------+----------+----------+----------+
NOBLE  I 7.90E+01 I 1.61E-01 I 1.61E-01 I  NOBLE  I 0.00E+00 I 0.00E+00 I 0.00E+00 I
IODINE I 6.20E-02 I 2.51E-02 I 1.18E+01 I  IODINE I 0.00E+00 I 0.00E+00 I 0.00E+00 I
PART.  I 3.23E-03 I 6.00E-02 I 5.84E-02 I  PART.  I 0.00E+00 I 0.00E+00 I 0.00E+00 I
C-14   I 0.00E+00 I 0.00E+00 I 0.00E+00 I  C-14   I 1.40E+01 I 1.08E+01 I 1.08E+01 I
H-3    I 2.30E+02 I 1.65E+00 I 1.65E+00 I  H-3    I 0.00E+00 I 0.00E+00 I 0.00E+00 I
-------+----------+----------+----------+  -------+----------+----------+----------+
TOTAL  I 3.09E+02 I 1.89E+00 I 1.37E+01    TOTAL  I 1.40E+01 I 1.08E+01 I 1.08E+01 I
```

2.2.16 Report Type 27: Normalized Dose Factors for 10 CFR 20 Evaluations

Report type 27 presents results of the PARTS calculation of normalized dose factors for 10 CFR 20 evaluations. Listing 2.26 gives an example report from Sample Problem 3. Reports are printed for the infant age group only (item 1) for seven organs (item 2). Each report presents normalized dose

LISTING 2.25. Report Type 26: 10 CFR 50 Normalized Dose Factors

1 DOSE PARAMETERS FOR 10 CFR 50 EVALUATIONS
AGE GROUP: ADULT ORGAN OF REFERENCE: T. BODY 2
R(I), INDIVIDUAL PATHWAY DOSE PARAMETERS FOR RADIONUCLIDES OTHER THAN NOBLE GASES

RADIO-NUCLIDE	INHALATION (MREM/YR PER UCI/M3)	GROUND PLANE (M2.MREM/YR PER UCI/SEC)	COW-MILK (M2.MREM/YR PER UCI/SEC)	GOAT-MILK (M2.MREM/YR PER UCI/SEC)	ANIMAL-MEAT (M2.MREM/YR PER UCI/SEC)	VEGETABLES (M2.MREM/YR PER UCI/SEC)
H 3	2.3E+01	0.0E+00	7.4E+00	1.5E+01	3.1E+00	2.1E+01
C 14	0.0E+00	0.0E+00	2.3E+03	2.3E+03	2.1E+03	5.4E+03
CR 51	3.2E+00	1.6E+05	2.1E+02	4.9E+01	8.1E+01	1.5E+03
MN 54	2.0E+02	4.7E+07	1.4E+04	2.5E+03	2.0E+04	9.8E+05
FE 55	1.3E+02	0.0E+00	3.5E+04	6.5E+03	5.1E+05	4.9E+05
FE 59	3.3E+02	9.3E+06	2.0E+05	4.7E+04	2.7E+06	2.9E+06
CO 58	6.6E+01	1.3E+07	8.2E+04	1.7E+04	4.5E+05	1.4E+06
CO 60	4.7E+02	7.9E+08	3.3E+05	5.6E+04	1.9E+06	5.9E+06
SR 89	2.8E+02	7.3E+02	3.1E+05	1.2E+06	9.6E+04	6.8E+06
SR 90	1.8E+04	0.0E+00	1.2E+07	3.3E+07	3.8E+06	2.8E+08
SR 91	7.9E-02	7.3E+04	9.2E+00	3.9E+01	7.3E-14	1.1E+02
ZR 95	7.4E+02	8.3E+06	1.6E+00	3.3E-01	4.5E+03	5.5E+03
RU103	2.1E+01	3.7E+06	3.3E+00	7.3E-01	5.1E+05	5.6E+04
RU106	2.8E+02	1.4E+07	2.3E+01	4.1E+00	4.1E+06	4.2E+05
AG110M	1.9E+02	1.2E+08	3.0E+05	5.3E+04	4.4E+04	1.1E+05
TE125M	1.5E+01	5.3E+04	2.1E+04	4.3E+03	6.6E+05	4.6E+05
I 131	6.5E+02	2.9E+05	1.9E+06	4.5E+06	1.1E+05	2.6E+06
I 133	1.4E+02	4.2E+04	1.6E+04	3.9E+04	2.5E-03	1.0E+04
I 135	8.1E+01	4.3E+04	9.7E+01	2.3E+02	4.8E-19	3.4E+02
CS137	1.4E+04	4.4E+08	6.7E+07	2.7E+08	9.5E+06	1.0E+08
NP237	1.7E+07	1.8E+08	2.0E+04	3.3E+03	3.4E+05	6.8E+07
PU239	2.0E+07	1.0E+05	2.6E+03	4.4E+02	8.0E+03	2.2E+07
PU240	2.0E+07	1.7E+05	2.6E+03	4.4E+02	8.0E+03	2.2E+07
PU241	3.3E+05	3.9E+05	4.5E+01	7.6E+00	1.4E+02	3.8E+05
AM241	1.7E+07	2.3E+07	1.8E+04	3.1E+03	3.2E+05	6.2E+07

factors for inhalation (item 3), exposure to contaminated ground (item 4), ingestion of cow milk (item 5), and the sum of the ground-exposure and cow-milk ingestion pathways (item 6). Results are printed for each radionuclide defined in the source-term records (set 8).

2.3 SAMPLE CALCULATIONS

The three sample problems presented in this section illustrate the preparation of input records for GASPAR II. The general purpose of each sample problem is as follows:

Sample Problem 1 - calculation of individual doses for three special locations

Sample Problem 2 - use of the alternate meteorological data input file for population and individual dose calculations (two source terms and three special locations)

LISTING 2.26. Report Type 27: 10 CFR 20 Normalized Dose Factors

DOSE PARAMETERS FOR 10 CFR 20 EVALUATIONS
P(I), DOSE PARAMETERS FOR GASEOUS EFFLUENTS
AGE GROUP: INFANT 1 ORGAN OF REFERENCE: T. BODY 2

PATHWAYS

RADIO-NUCLIDE	3 INHALATION (MREM/YR PER UCI/M3)	4 GROUND (M2.MREM/YR PER UCI/SEC)	5 COW MILK (M2.MREM/YR PER UCI/SEC)	6 MILK AND GROUND (M2.MREM/YR PER UCI/SEC)
H 3	1.2E+01	0.0E+00	2.3E+01	2.3E+01
C 14	0.0E+00	0.0E+00	2.2E+04	2.2E+04
CR 51	2.8E+00	2.1E+05	1.2E+03	2.1E+05
MN 54	1.6E+02	3.5E+07	7.7E+04	3.5E+07
FE 55	1.1E+02	0.0E+00	2.0E+05	2.0E+05
FE 59	3.0E+02	1.2E+07	1.2E+06	1.3E+07
CO 58	5.8E+01	1.7E+07	4.7E+05	1.7E+07
CO 60	3.7E+02	1.4E+08	1.9E+06	1.4E+08
SR 89	3.6E+02	9.7E+02	2.7E+06	2.7E+06
SR 90	9.9E+03	0.0E+00	4.1E+07	4.1E+07
SR 91	1.1E-01	9.7E+04	7.7E+01	9.7E+04
ZR 95	6.4E+02	1.1E+07	9.0E+00	1.1E+07
RU103	2.2E+01	4.9E+06	2.2E+01	4.9E+06
RU106	3.4E+02	9.5E+06	2.1E+02	9.5E+06
AG110M	1.6E+02	9.9E+07	1.8E+06	1.0E+08
TE125M	2.1E+01	7.0E+04	2.0E+05	2.7E+05
I 131	6.2E+02	3.9E+05	1.1E+07	1.1E+07
I 133	1.8E+02	5.6E+04	1.2E+05	1.8E+05
I 135	8.8E+01	5.7E+04	6.4E+02	5.8E+04
CS137	1.4E+03	3.6E+07	4.3E+07	7.9E+07
NP237	5.6E+06	1.2E+07	4.0E+04	1.2E+07
PU239	5.9E+06	6.9E+03	5.1E+03	1.2E+04
PU240	5.9E+06	1.1E+04	5.1E+03	1.7E+04
PU241	1.4E+05	3.9E+04	1.3E+02	3.9E+04
AM241	5.8E+06	1.6E+06	3.9E+04	1.6E+06

Sample Problem 3 - calculation of special normalized dose factors and modification of block data parameters.

Preparation of input records is described for each of these sample problems in Sections 2.3.1 through 2.3.3. Output from the sample problems is discussed in Section 2.3.4.

Note: The sample input parameter values have no significance relative to any real analysis. The values are used for illustration purposes only. When preparing input for a specific site, evaluate each parameter; using the values given in these sample problems as default values is inappropriate.

2.3.1 Sample Problem 1

Sample Problem 1 represents a standard calculation for individual doses with all input records read from the standard input file. Three source terms are provided and doses are calculated at three special locations. Remember that a given special location defined for a source term represents the same physical location for all source terms for each special location. The distance to the given location may be different if the source terms are physically separated. Selected reports are requested of total doses over all source terms. Table 2.18 presents the input record images for Sample Problem 1. Each record in Table 2.18 is described by record line number, as listed below:

Line 1:	Title record for Sample Problem 1
Line 2:	Job control record indicating that only individual doses are to be calculated, three source terms will be provided, and only total doses will be printed
Line 3:	Site-specific information on location and agricultural practices
Line 4:	Title record for first source term
Line 5:	Source-term multiplier (2.0) and job control parameters to read new meteorological data and source data; release is continuous so PURGE=0.
Line 6-24:	Names and release rates (Ci/yr) for each radionuclide in the first source term
Line 25:	Blank record to end reading of the first source-term radionuclide records
Line 26:	Data for first special location for first source term
Line 27:	Data for second special location for first source term
Line 28:	Data for third special location for first source term
Line 29:	Blank record to end reading of special-location records for first source term
Line 30:	Title record for second source term
Line 31:	Source-term multiplier (2.0) and job control parameters to read new meteorological data and source data; release is a 700-hr purge

TABLE 2.18. Sample Problem 1 Input Record List

Line Number	Type	Input Record Image
1	1.0	SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
2	2.0	1 3 1 0 0 0
3	3.0	1260. 0.58 1.0 0.76 0.5 15.1 1.0 1.0 1.0 0.8
4	8.0	SOURCE TERM 1 - PLANT VENT, CONTINUOUS
5	8.1	2.0 0 0
6	8.1.1	H 3 8.2E+02
7	8.1.2	C 14 1.0E+00
8	8.1.3	AR41 2.5E+01
9	8.1.4	KR83M 3.0E+00
10	8.1.5	KR85M 3.3E+01
11	8.1.6	KR85 2.6E+02
12	8.1.7	KR87 8.0E+00
13	8.1.8	KR88 4.8E+01
14	8.1.9	XE131M 1.6E+01
15	8.1.10	XE133M 6.6E+01
16	8.1.11	XE133 3.5E+03
17	8.1.12	XE135 1.4E+02
18	8.1.13	XE138 2.0E+00
19	8.1.14	I 131 2.3E-02
20	8.1.15	I 133 2.7E-02
21	8.1.16	MN54 4.5E-04
22	8.1.17	FE59 1.5E-04
23	8.1.18	C058 1.5E-03
24	8.1.19	PU239 1.0E-07
25	8.1.20	
26	13.1	1A SITE BNDRY S 1820.0 9.195E-08 9.172E-08 8.778E-08 1.750E-09
27	13.2	1A SITE BNDRY SSW 2030.0 1.056E-07 1.053E-07 1.008E-07 1.732E-09
28	13.3	1A SITE BNDRY SW 2170.0 1.342E-07 1.338E-07 1.287E-07 1.872E-09
29	13.4	
30	8.0	SOURCE TERM 2 - PLANT VENT, PURGE
31	8.1	2.0 0 0 700.
32	8.1.1	C 14 7.0E+00
33	8.1.2	
34	13.1	1A SITE BNDRY S 1820.0 2.016E-06 1.997E-06 1.745E-06 6.782E-09
35	13.2	1A SITE BNDRY SSW 2030.0 2.138E-06 2.099E-06 1.831E-06 6.150E-09
36	13.3	1A SITE BNDRY W 2120.0 1.694E-06 1.673E-06 1.448E-06 5.373E-09
37	13.4	
38	8.0	SOURCE TERM 3 - RADWASTE BLDG VENT
39	8.1	1.0 0 0
40	8.1.1	KR85M 1.0
41	8.1.2	KR88 3.0
42	8.1.3	XE133M 1.0
43	8.1.4	XE133 70.0
44	8.1.5	XE135 4.0
45	8.1.6	H 3 2.3E+02
46	8.1.7	CR51 2.3E-04
47	8.1.8	MN54 3.9E-05
48	8.1.9	FE55 1.6E-04
49	8.1.10	FE59 1.4E-04
50	8.1.11	C058 2.0E-03
51	8.1.12	C060 2.5E-04
52	8.1.13	BR84 2.6E-04
53	8.1.14	BR85 3.0E-05
54	8.1.15	SR89 4.3E-05
55	8.1.16	SR90 1.3E-06
56	8.1.17	SR91 6.5E-05
57	8.1.18	Y 93 3.4E-06
58	8.1.19	ZR95 7.4E-06
59	8.1.20	TE125M 2.9E-06
60	8.1.21	I 131 6.2E-02
61	8.1.22	
62	13.1	A SITE BNDRY S 1640.0 3.538E-06 3.506E-06 3.085E-06 8.852E-091 1
63	13.2	A SITE BNDRY WSW 1890.0 2.944E-06 2.902E-06 2.538E-06 8.004E-0911 1
64	13.3	A SITE BNDRY W 2120.0 2.251E-06 2.221E-06 1.924E-06 5.373E-09 11111
65	13.4	

Line 32: Release of ^{14}C (Ci) during the purge

Line 33: Blank record to end reading of the second source-term radionuclide data

Line 34: Data for first special location for second source term

Line 35: Data for second special location for second source term

Line 36: Data for third special location for second source term

Line 37: Blank record to end reading of special-location records for second source term

Line 38: Title record for third source term

Line 39: Source-term multiplier (1.0) and job control parameters to read new meteorological data and source data; release is not a purge

Line 40-60: Names and release rates (Ci/yr) for each radionuclide in the third source term

Line 61: Blank record to end reading of the third source-term radionuclide data

Line 62: Data for first special location for third source term

Line 63: Data for second special location for third source term

Line 64: Data for third special location for third source term

Line 65: Blank record to end reading of special-location records for third source term.

Execution of this sample problem is terminated when end-of-file marker is encountered while trying to read a job control record for the next case. A complete list of the computer-generated output for this sample problem is presented in Appendix D and in the Appendix B microfiche located inside the back cover of this report. A list of output reports generated is given in Section 2.3.4.

2.3.2 Sample Problem 2

Sample Problem 2 illustrates the use of the alternate meteorological data input file as generated by the XOQDOQ computer program. The alternate file is described in Section 2.1.3. Population and individual doses are calculated for two source terms. Table 2.19 gives the input record images for the Sample Problem 2 input file. The alternate meteorological data file is shown in Listing 2.2 of Section 2.1.3. Each record in Table 2.19 is described by record line number, as listed below:

Line 1:	Title record for Sample Problem 1
Line 2:	Job control record indicating that population doses are included, two source terms will be provided, only total doses will be printed, and the alternate meteorological data file will be used
Line 3:	Site-specific information on location and agricultural practices
Line 4:	Title record for site population data
Line 5:	Population data control record - read data starting in north sector (7 values on 1st record, and 10 values per sector)
Line 6:	First record for north sector population data
Line 7:	Second record for north sector population data
Line 8-9:	Population data for north northeast sector
Line 10-37:	Population data for sectors northeast through north-northwest, in order (two records per direction)
Line 38:	Title record for site milk production data
Line 39:	Milk production data control record - read one value representing the total production within 50 mi
Line 40:	Total milk production (L/yr) within 50 mi
Line 41:	Title record for site meat production data
Line 42:	Meat production data control record - read one value representing the total production within 50 mi
Line 43:	Total meat production (kg/yr) within 50 mi
Line 44:	Title record for site vegetable production data
Line 45:	Vegetable production data control record - read one value representing the total production within 50 mi

TABLE 2.19. Sample Problem 2 Input Record List

Line Number	Type	Input Record Image
1	1.0	SAMPLE PROBLEM 2 INPUT FILE, USE OF ALTERNATE MET DATA FILE
2	2.0	0 2 1 0 0 0 1
3	3.0	1260. 0.58 1.0 0.76 0.5 15.1 1.0 1.0 1.0 0.8
4	4.0	POPULATION DATA FOR SAMPLE PROBLEM 2
5	4.1	0 7 10
6	4.1.1a	N 24. 409. 5022. 209. 10030. 39082. 4990.
7	4.1.1b	32876. 40092. 100330.
8	4.1.2a	NNE 0. 209. 832. 2003. 298800. 20988. 54920.
9	4.1.2b	2987. 12233. 287055.
10	4.1.3a	NE 33. 29. 299. 39987. 2334. 41837. 39485.
11	4.1.3b	49481. 38475. 100098.
12	4.1.4a	ENE 32. 209. 443. 1229. 34256. 234567. 43980.
13	4.1.4b	34510. 9807. 139987.
14	4.1.5a	E 14. 344. 219. 5544. 30049. 9145. 22345.
15	4.1.5b	5298. 98721. 19887.
16	4.1.6a	ESE 32. 46. 398. 2987. 1990. 30998. 29981.
17	4.1.6b	3990. 189976. 32099.
18	4.1.7a	SE 52. 309. 231. 3009. 2376. 12908. 23409.
19	4.1.7b	34829. 58972. 98754.
20	4.1.8a	SSE 19. 120. 498. 1289. 3492. 59870. 31425.
21	4.1.8b	32908. 9043. 127329.
22	4.1.9a	S 0. 11. 0. 398. 12423. 34872. 31245.
23	4.1.9b	109874. 23456. 34526.
24	4.1.10a	SSW 0. 0. 290. 1908. 15443. 45629. 32908.
25	4.1.10b	2098. 32546. 23416.
26	4.1.11a	SW 0. 0. 398. 4256. 8293. 98076. 10987.
27	4.1.11b	3980. 49870. 209875.
28	4.1.12a	WSW 23. 235. 534. 1098. 39287. 3245. 43209.
29	4.1.12b	2347. 43526. 423876.
30	4.1.13a	W 34. 32. 435. 645. 1298. 324. 45672.
31	4.1.13b	2387. 34256. 34256.
32	4.1.14a	WNW 9. 19. 435. 2387. 43980. 23187. 32478.
33	4.1.14b	38976. 9255. 78651.
34	4.1.15a	NW 23. 54. 567. 2347. 2365. 6578. 67345.
35	4.1.15b	18907. 43908. 109087.
36	4.1.16a	NNW 54. 190. 321. 1980. 2354. 7654. 48713.
37	4.1.16b	24356. 8796. 38890.
38	5.0	MILK PRODUCTION DATA, UNIFORM FOR SITE
39	5.1	0 0 0
40	5.2	5.9E+9
41	6.0	MEAT SITE DATA
42	6.1	0 0 0
43	6.2	1.7E+10
44	7.0	VEGETABLE SITE DATA
45	7.1	0 0 0
46	7.2	7.3E+9
47	8.0	SAMPLE 2 - SOURCE TERM 1, RADWASTE BLDG VENT
48	8.1	1.0 0 0
49	8.1.1	KR85M 1.0
50	8.1.2	KR88 3.0
51	8.1.3	XE133M 1.0
52	8.1.4	XE133 70.0
53	8.1.5	XE135 4.0
54	8.1.6	H 3 2.3E+02
55	8.1.7	CR51 2.3E-04
56	8.1.8	MN54 3.9E-05
57	8.1.9	FE55 1.6E-04
58	8.1.10	FE59 1.4E-04
59	8.1.11	CO58 2.0E-03
60	8.1.12	CO60 2.5E-04
61	8.1.13	BR84 2.6E-04
62	8.1.14	BR85 3.0E-05
63	8.1.15	SR89 4.3E-05
64	8.1.16	SR90 1.3E-06

TABLE 2.19. (Contd)

Line Number	Type	Input Record Image			
65	8.1.17	SR91	6.5E-05		
66	8.1.18	Y 93	3.4E-06		
67	8.1.19	ZR95	7.4E-06		
68	8.1.20	TE125M	2.9E-06		
69	8.1.21	I 131	6.2E-02		
70	8.1.22				
71	8.0	SAMPLE 2 - SOURCE TERM 2, TURBINE BLDG,. PURGE			
72	8.1	2.0	0	0	200.
73	8.1.1	C 14	7.0E+00		
74	8.1.2				

Line 46: Total vegetable production (kg/yr) within 50 mi

Line 47: Title record for first source term

Line 48: Source-term multiplier (1.0) and job control parameters to read new meteorologic and source-term data

Line 49-69: Names and release rates (Ci/yr) for each radionuclide in the first source term

Line 70: Blank record to end reading of the first source-term radionuclide records

Line 71: Title record for the second source term

Line 72: Source-term multipliers (2.0) and job control parameters to read new meteorologic and source-term data; release is a 200-hr purge

Line 73: Release of ^{14}C (Ci) during a 200-hr purge

Line 74: Blank record to end reading of radionuclide records for the second source term.

Sample Problem 2 terminates when an end-of-file marker is encountered while attempting to read a job control record (type 2.0) for the next case. The output listing generated by Sample Problem 2 is contained in the Appendix B microfiche inside the back cover of this report. A list of output reports generated is presented in Section 2.3.4.

2.3.3 Sample Problem 3

The third sample problem illustrates the use of GASPAR II to calculate normalized dose factors for 10 CFR 20 and 10 CFR 50 evaluations. Use of block data change control records to modify selected default parameter values is also demonstrated. Input records for Sample Problem 3 are listed in Table 2.20. Each record in Table 2.20 is described by line number, as listed below:

Line 1: Title record for Sample Problem 3

Line 2: Job control record indicating that only individual doses are considered, block data change records will be read, reports of dose factors in the data library will be printed, and that normalized dose factors will be calculated (PARTS calculation)

TABLE 2.20. Sample Problem 3 Input Record List

Line Number	Type	Input Record Image
1	1.0	SAMPLE PROBLEM 3 - DEMONSTRATION OF PARTS CALCULATION
2	2.0	1 1 1 1 1 1
3	2.1	P 3 0.75
4	2.1	T 5 0.10
5	2.1	U 12 1 2 20. 520.
6	2.1	
7	3.0	1260. 0.58 1.0 0.76 0.5 15.1 1.0 1.0 1.0 0.8
8	8.0	SOURCE RADIONUCLIDES
9	8.1	0.0 0 0
10	8.1.1	H 3
11	8.1.2	C 14
12	8.1.3	CR51
13	8.1.4	KR85
14	8.1.5	MN54
15	8.1.6	FE55
16	8.1.7	FE59
17	8.1.8	CO58
18	8.1.9	CO60
19	8.1.10	SR89
20	8.1.11	SR90
21	8.1.12	SR91
22	8.1.13	ZR95
23	8.1.14	RU103
24	8.1.15	RU106
25	8.1.16	AG110M
26	8.1.17	TE125M
27	8.1.18	I 131
28	8.1.19	I 133
29	8.1.20	I 135
30	8.1.21	CS137
31	8.1.22	NP237
32	8.1.23	PU239
33	8.1.24	PU240
34	8.1.25	PU241
35	8.1.26	AM241
36		

Line 3:	Change record - change the value of the third parameter in common block PHYS (parameter SF) to 0.75
Line 4:	Change record - change the value of the fifth parameter in common block TRANFR (parameter PARTUP) to 0.10
Line 5:	Change record - change the first and second values of the twelfth parameter array in common block USAGE (parameter SPVEG) to 20 and 520
Line 6:	Blank record to end reading of block data change records
Line 7:	Site-specific information on location and agricultural practices
Line 8:	Title record for source term
Line 9:	Source-term multiplier (0.0, unused) and job control parameters to read new source-term radionuclide names; release is not a purge
Line 10-35:	Names of radionuclides to be included in the calculations
Line 36:	Blank record to end reading of radionuclide names for the source term.

When normalized site dose factors are to be calculated, release rates and meteorological data need not be provided (lines 9-35). Sample Problem 3 is terminated when an end-of-file marker is encountered while attempting to read a job control record for the next case. A complete output listing generated by Sample Problem 3 is included in the Appendix B microfiche inside the back cover of this report. A list of output reports is given in Section 2.3.4.

2.3.4 Sample Problem Output

Reports generated by each sample problem are listed in Table 2.21. Complete listings of sample problem output are included in the Appendix B microfiche located inside the back cover of this report.

TABLE 2.21. Summary of Output Report[a] Order for Sample Problems

Sample Problem 1		Sample Problem 2		Sample Problem 3
Banner Page		Banner Page		Banner Page
5a	Source Term 1	4a		2a (2 pages)
7		4b		2b
5a	Source Term 2	5a		2c
7		6a	Source	3a (16 pages)
5a	Source Term 3	6b	Term 1	3b (16 pages)
7		7		3c (4 pages)
17	Location 1	8		3d
17	Location 2	5b		3e (4 pages)
17	Location 3	6a	Source	5a
19		6b	Term 2	27 (28 pages)
21a		7		28 (7 pages)
21b		8		
21c		9a		
22a		9b		
22b		10a		
22c		11a		
23a	Location 1	12a		
23b		13a		
23c		14a		
23d		15a		
24a		16a		
24b		10b		
24c		11b		
24d		12b		
21a		13b		
21b		14b		
21c		15b		
22a		16b		
22b		17	Location 1	
22c		17	Location 2	
23a	Location 2	17	Location 3	
23b		18	Location 1	
23c		18	Location 2	
23d		18	Location 3	
24a		26a		
24b		26b		
24c				
24d				
18				
25a				
25b	Location 3			
25c				
25d				

(a) For descriptions of output reports, see Table 2.17.

2.4 ERROR MESSAGES

Eighteen error messages are generated in the GASPAR II computer program. Table 2.22 lists each error message, the cause of the message, and the action taken by the program when the error condition is encountered.

TABLE 2.22. Error Messages Generated by GASPAR II

Message	Cause/Correction	Action	Module Printing
***IN SOURCE TERM "NN" YOU HAVE EXCEEDED THE GRAND TOTAL LIMITATION ON NUCLIDES; THE SOURCE TERM TITLE RECORD IS "TITLE"	Additional nuclides in source term NN (NN > 2) causes total number of different nuclides to exceed 33. Eliminate those nuclides of less importance or separate nuclides into two computer runs. Data record 8.1.n.	CONTINUE (Some nuclides eliminated)	SOURCE
***INDEX OF AREA ARRAY OUT OF DOMAIN I1 = "NN" I2 = "NN"	I1 < 0 or I1 > I2 or I2 > 10. Correct index.	CONTINUE (Data not changed)	BLKDAT
***INDEX OF IGOT ARRAY OUT OF DOMAIN I1 = "NN" I2 = "NN"	I1 < 0 or I1 > I2 or I2 > 14. Correct index.	CONTINUED (Data not changed)	BLKDAT
*** INDEX OF PARAMETER N ARRAY OUT OF DOMAIN I1 = "NN" I2 = "NN"	I1 < 0, or I1 > I2, or N < 6 and I2 > 3, or N > 8 and I2 > 4. Correct index.	CONTINUE (Data not changed)	BLKDAT
***INDEX OF SOIL ARRAY OUT OF DOMAIN I1 = "NNN" I2 = "NNN"	I1 < 0 or I1 > I2. I2 > 100. Correct index.	CONTINUE (Data not changed)	BLKDAT
***INDEX OF ZGMLK ARRAY OUT OF DOMAIN I1 = "NN" I2 = "NN"	I1 < 0 or I1 > I2 or I2 > 14. Correct index.	CONTINUE (Data not changed)	BLKDAT
***INDEX OF ZMET ARRAY OUT OF DOMAIN I1 = "NNN" I2 = "NNN"	I1 < 0 or I1 > I2 or I2 > 100. Correct index.	CONTINUE (Data not changed)	BLKDAT
***INDEX OF ZMLK ARRAY OUT OF DOMAIN I1 = "NNN" I2 = "NNN"	I1 < 0 or I1 > I2. I2 > 100. Correct index.	CONTINUE (Data not changed)	BLKDAT
*** NUCLIDE NOT FOUND IN LIBRARY "NUCLIDE DATA RECORD 8.1.n PRINTED"	Nuclide element number or name not in nuclide library. Check nuclides on data records 8.1.n.	CONTINUE (Nuclide not used in calculations)	SOURCE
***PARAMETER INDEX OF PHYS DATA OUT OF DOMAIN N = "NN"	N not between 1 and 7. Check data record 2.1, beginning with P.	CONTINUE (Data not changed)	BLKDAT
***PARAMETER INDEX OF TRANFR DATA OUT OF DOMAIN N = "NN"	N not between 1 and 16. Check data record 2.1, beginning with T.	CONTINUE (Data not changed)	BLKDAT
***PARAMETER INDEX OF USAGE DATA OUT OF DOMAIN N = "NN"	N not between 1 and 12. Check data record 2.1, beginning with U.	CONTINUE (Data not changed)	BLKDAT
***PROGRAM STOPPED SINCE MULTIPLIER APPLIED TO EACH NUCLIDE LESS THAN OR EQUAL ZERO. UML ON DATA RECORD 8.1	Provide positive value for UML on data record 8.1.	STOP	MAIN

TABLE 2.22. (Contd)

Message	Cause/Correction	Action	Module Printing
***PROGRAM TERMINATED DUE TO BLANK CONTROL RECORD OR NUMBER OF RELEASE POINTS JC(2) ZERO OR NEGATIVE	Normal termination, or provide positive number of release points on data record 2.0.	STOP	MAIN
***PROGRAM TERMINATED, DUE TO ZERO OR NEGATIVE DISTANCE FROM FACILITY TO NE CORNER OF U.S. CD ON DATA RECORD 3.0	Provide positive value for CD on data record 3.0.	STOP	MAIN
***PROGRAM TERMINATED, NO NUCLIDES RELEASED FROM SOURCE NUMBER "NN" CHECK DATA RECORD 8.1.N	Improper format for description of nuclide. Check data record 8.1.n.	STOP	MAIN
WARNING INCOMPLETE REPORT, JC(2) EXCEEDS 10	More than 10 source terms in input data. Separate sources into a maximum of 10 per computer run. Data record 8.1.	CONTINUE (Only first 10 sources used in calculations)	DOSIT
***YOU HAVE TOO MANY NUCLIDES IN THIS SOURCE TERM. THE FOLLOWING NUCLIDES HAVE BEEN ELIMINATED FROM ALL CALCULATIONS. "LIST OF NUCLIDES"	More than 33 nuclides provided on release data records 8.1.n. Eliminate those nuclides of less importance or separate nuclides into two computer runs.	CONTINUE (Some nuclides eliminated)	SOURCE

3.0 MATHEMATICAL MODELS

This section presents details of the mathematical models used in GASPAR II. The discussion is divided into three topics: 1) atmospheric dispersion; 2) exposure pathway models (external, inhalation, and terrestrial food); and 3) dosimetry models. Figure 3.1 illustrates the interrelationship between these models as they are applied to consequence analyses of light-water nuclear reactors. The annual radionuclide release rate from the reactor fuel to the atmosphere is the starting point in the analysis.

Atmospheric dispersion is described by user-supplied normalized dispersion factors represented as $\bar{\chi}/Q'$ (sec/m^3). Although no models are included in GASPAR II for evaluating $\bar{\chi}/Q'$ within the 50-mi region, values may be calculated using the NRC computer program XOQDOQ (Sagendorf et al. 1982) and supplied to GASPAR II on an alternate input file. Preparation of this alternate file is described in Section 2.1.3. The use of atmospheric dispersion factors in GASPAR II is discussed in Section 3.1.1. Evaluation of population doses for the NEPA analysis requires an estimate of the dose received from the first pass of the plume over the eastern United States and from worldwide dispersion. These contributions are included only for carbon, tritium, and noble gases. The simple models used for these analyses are described in Section 3.1.2.

The concentrations predicted by the source term and dispersion factors are used to estimate external exposures and uptake by individuals and the population from inhalation and from ingestion of farm products. External exposures are included for noble gases in the plume and for depositing radionuclides on the ground. All radionuclides (except ^{14}C) are assumed to contribute to inhalation exposure (although inhalation of noble gases is assumed to expose only the lung). Ingestion exposure is considered for the following farm products: leafy vegetables, other vegetables, cow milk, goat milk, and beef. (Leafy-vegetable and goat-milk ingestion are only included for individual dose calculations and not for population exposures.)

GASPAR II addresses dosimetry by using precalculated dose conversion factors provided in a data file. Factors are provided for external exposure to airborne material, external exposure to deposited material, inhalation, and ingestion.

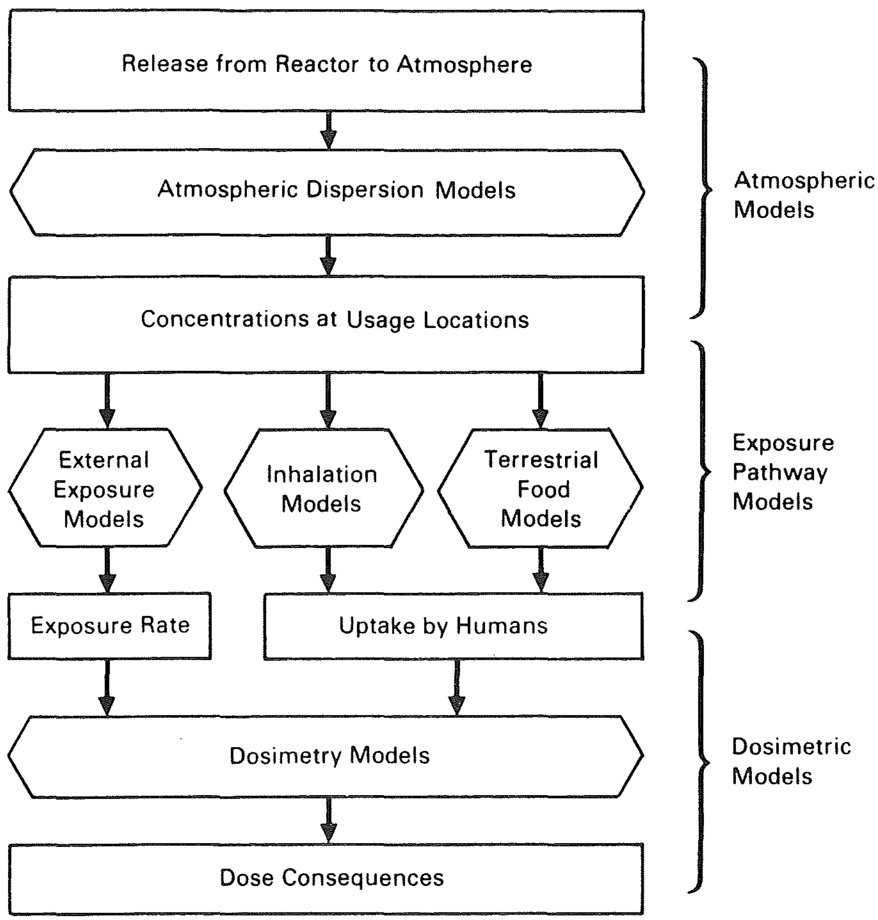


FIGURE 3.1. Flow Diagram of Mathematical Models Used in GASPAR II

3.1 ATMOSPHERIC DISPERSION MODELS

Transport of material from the release point to exposure locations within 50 mi is modeled in GASPAR II using precalculated, user-defined, atmospheric dispersion factors. Transport beyond 50 mi is described using simple models for exposures of the eastern United States and the total U.S. population (from worldwide dispersion). Use of the dispersion factors for the 50-mi region is described in Section 3.1.1, and transport beyond 50 mi is described in Section 3.1.2.

3.1.1 Atmospheric Dispersion Within 50 Mi

GASPAR II requires the user to supply normalized annual average air concentrations at each location for which exposures are to be evaluated. Four values must be supplied for each location (r) representing the following conditions:

1. $(\bar{\chi}/Q')_r$ with no radiological decay or plume depletion (sec/m^3)

2. $(\bar{\chi}/Q')_{dr}$ with radiological decay corresponding to a half-life of 2.26 days (^{133m}Xe) and no plume depletion (sec/m^3)

3. $(\bar{\chi}/Q')_{ddr}$ with radiological decay corresponding to a half-life of 8 days (^{131}I) and plume depletion (sec/m^3)

4. $(D/Q)_r$ with no radiological decay (m^{-2}/yr).

The first value is used for tritium, ^{14}C, and other long-lived radionuclides that are nondepositing. The second value is used for short-lived radioiodine for inhalation doses and for noble gases for external exposure to the plume (no deposition included). The third value is used for all radionuclides other than tritium, ^{14}C, and noble gases for evaluation of inhalation doses. The fourth value relates the released activity to the ground concentration at the locations of interest for 1 yr of release and is used for all radionuclides other than tritium, ^{14}C, and noble gases for ground exposure and ingestion pathways.

To use the decayed dispersion factors for radionuclides other than ^{133m}Xe and ^{131}I, a decay correction must be performed for the radionuclide of interest. The decay correction involves estimation of an effective transit time based on the ratio of the decaved to the undecayed $\bar{\chi}/Q'$ values as follows:

$$T = \frac{-\ln \left[(\bar{\chi}/Q')_{dr}/(\bar{\chi}/Q')_r\right]}{\lambda_{Xe}} \tag{3.1}$$

where T = effective transit time from the release point to the exposure location (sec)

$(\bar{\chi}/Q')_{dr}$ = atmospheric dispersion factor (corrected for decay for a 2.26 day half-life) at exposure location r (sec/m^3)

$(\bar{\chi}/Q')_r$ = undecayed and undepleted atmospheric dispersion factor at exposure location r (sec/m^3)

λ_{Xe} = radiological decay constant corresponding to a half-life of 2.26 days for ^{133m}Xe (sec^{-1}).

The decay correction is made using the effective transit time and the radiological decay constant for the radionuclide of interest as follows:

$$(\bar{\chi}/Q')_{dri} = (\bar{\chi}/Q')_r \exp(-\lambda_i T) \tag{3.2}$$

where $(\bar{\chi}/Q')_{dri}$ = decayed and undepleted atmospheric dispersion factor for radionuclide i at exposure location r (sec/m^3)

λ_i = radiological decay constant for radionuclide i (sec^{-1}).

The decay correction applied to the decayed and depleted values $(\bar{\chi}/Q')_{ddr}$ also includes a correction to account for the radioiodine correction that is present in the input values. This correction is made as follows:

$$(\bar{\chi}/Q')_{ddri} = (\bar{\chi}/Q')_{ddr} \exp(-\lambda_i T)/\exp(-\lambda_I T) \tag{3.3}$$

where $(\bar{\chi}/Q')_{ddri}$ = decayed and depleted atmospheric dispersion factor for radionuclide i at exposure location r (sec/m^3)

$(\bar{\chi}/Q')_{ddr}$ = decayed and depleted atmospheric dispersion factor for ^{131}I (8-day half-life) at exposure location r (sec/m^3)

λ_I = radiological decay constant for ^{131}I (8-day half-life) (sec^{-1}).

The deposition factors, $(D/Q)_r$, do not include radiological decay and must, therefore, be corrected for the radionuclide of interest. This correction is based on the effective transit time as calculated in Equation 3.1 for each exposure location:

$$(D/Q)_{ri} = (D/Q)_r \exp(-\lambda_i T) \tag{3.4}$$

where $(D/Q)_{ri}$ = decayed ground deposition factor for radionuclide i at exposure location r (m^{-2}/yr)

$(D/Q)_r$ = undecayed ground deposition factor at exposure location r (m^{-2}/yr).

The corrected dispersion factors are used to calculate the air and ground concentrations for each radionuclide at each exposure location as follows:

$$C_{ai} = 10^{12} (\bar{\chi}/Q')_{dri} Q'_i \quad (3.5)$$

$$C_{ai} = 10^{12} (\bar{\chi}/Q')_{ddri} Q'_i \quad (3.6)$$

$$C_{Si} = 10^{12} (D/Q)_{ri} Q_i \quad (3.7)$$

where C_{ai} = air concentration at the exposure location for radionuclide i (pCi/m^3)

C_{Si} = ground concentration for 1 yr of deposition at the exposure location for radionuclide i (pCi/m^2/yr)

10^{12} = unit conversion factor (pCi/Ci)

Q'_i = annual release rate for radionuclide i (Ci/sec)

Q_i = total annual release for radionuclide i (Ci).

These concentration values are used in the following sections where the exposure pathway models are described.

When population doses are to be calculated, the atmospheric dispersion factors are defined as a function of distance and direction from the site. The factors are provided for each area element defined by the 16 compass directions and 10 distance intervals to 50 mi. Four special parameters are evaluated to account for spatial variations of population, milk production, meat production, and vegetable production. These parameters are evaluated as follows:

$$P_{ci} = \sum_r P_r (\bar{\chi}/Q')_{dri} \quad (3.8)$$

$$P_{mi} = \sum_r P_{mr} (D/Q)_{ri} \tag{3.9}$$

$$P_{ti} = \sum_r P_{tr} (D/Q)_{ri} \tag{3.10}$$

$$P_{vi} = \sum_r P_{vi} (D/Q)_{ri} \tag{3.11}$$

where P_{ci} = concentration-weighted population dispersion factor for the site (person-sec/m^3)

P_{mi} = concentration-weighted milk production for the site (L/m^2/yr)

P_{ti} = concentration-weighted meat production for the site (kg/m^2/yr)

P_{vi} = concentration-weighted vegetable production for the site (kg/m^2/yr)

r = index on area element

P_r = population in area element r (persons)

P_{mr} = milk production in area element r (L/yr)

P_{tr} = meat production in area element r (kg/yr)

P_{vi} = vegetable production in area element r (kg/yr).

A similar term is generated for external exposure of the population to ground concentration, which includes accumulation of activity to the midpoint of plant life:

$$P_{ei} = \left[\frac{1 - \exp(-\lambda_i t)}{\lambda_i}\right] \sum_r P_r(D/Q)_{ri} \tag{3.12}$$

where P_{ei} = the population-weighted ground deposition factor at the midpoint of plant life (person-sec/m^2)

t = midpoint of plant life (sec).

3.1.2 Atmospheric Dispersion Beyond 50 Mi

The atmospheric dispersion models used to evaluate the population exposure from the first pass of the plume across the eastern United States and from worldwide dispersion are described in this section. These models are used only in the NEPA population dose evaluation.

Consider the release of a pollutant to the atmosphere being transported in the downwind direction. As the pollutant is transported, it disperses both laterally and vertically. The vertical dispersion is constrained by the presence of both the ground plane and the stable atmospheric layer aloft, the height of which determines the mixing depth. These constraints result in the material being uniformly distributed in the vertical direction after a travel time characteristic of the meteorology and geometry. The shape of such a plume geometry can be visualized as a right cylindrical wedge whose height is equal to the mixing depth. This model is obviously a simplification of far field atmospheric transport; however, dispersion conditions approaching the wedge characterization do occur at downwind distances, and such a geometry is often included in dispersion models (Slade 1968). For the moment, it is assumed that no material losses through deposition or radiological decay occur.

Using the conservation of mass principle and assuming uniform wind speed, the rate at which material passes through a surface A at the downwind distance r is calculated as follows:

$$Q' = \bar{\chi}\, w\, L\, \bar{u} \tag{3.13}$$

where Q' = the rate at which material passes the exposure location (Ci/sec)

$\bar{\chi}$ = the airborne concentration at the exposure location (Ci/m^3)

w = the lateral dimension of the plume at the exposure location (m)

L = the vertical mixing depth (m)

$\bar{u}$ = the uniform wind speed (m/sec).

The atmospheric dispersion factor $\bar{\chi}/Q'$ can be written as:

$$\frac{\bar{\chi}}{Q'} = \frac{1}{wL\bar{u}} \qquad (3.14)$$

which has units of sec/m^3.

For a conserving material (i.e., nondecaying-nondepositing), the rate of pollutant passing through surface A equals the release rate of the pollutant at its source Q'(o):

$$Q'(o) = Q' \qquad (3.15)$$

For the wedge dispersion geometry, $\bar{\chi}/Q'$ is thus inversely related to the width of the wedge, the height of the mixing depth, and the wind speed. For a decaying material, Equation 3.15 is modified by the factor $\exp(-\lambda_i\ r/\bar{u})$, where λ_i is the radiological decay constant for the radionuclide i (sec^{-1}), and r is the downwind distance of plume travel (m). A similar modification could be introduced for deposition; however, in GASPAR II, particulate matter is assumed to be deposited in the first dispersion regime (i.e., within 50 mi) and only nondepositing material is transported beyond 50 mi.

In evaluating the total exposure of the population in the wedge-shaped plume, it is necessary to estimate the spatial integral of the airborne concentration weighted by the population density:

$$E(R) = \frac{1}{Q'(o)} \int_0^R \bar{\chi} \exp(-\lambda_i\ r/\bar{u})\ \rho\ w dr \qquad (3.16)$$

where $E(R)$ = the population exposure factor (person-sec/m^3)

R = the radius of the cylindrical wedge containing the population (m)

ρ = the population density at the exposure location (persons/m^2) (assumed uniform).

Assuming that the population density ρ is uniform over the entire cylindrical wedge and using Equations 3.14 and 3.15, Equation 3.16 integrated over the plume path length R gives the following population exposure factor:

$$E(R) = \frac{\rho}{L\,\lambda_i}\,[1 - \exp(-\lambda_i\, R/\bar{u})] \qquad (3.17)$$

Note that the population exposure factor is dependent only on the depth of the mixing layer and not on the lateral plume dimension, w. This relationship results because the airborne concentrations are inversely proportional to w, while the number of individuals exposed is directly proportional to w. Equation 3.17 is used in GASPAR II to evaluate the population dose from noble gases, tritium, and ^{14}C during their first pass over the United States. The population dose is evaluated as the product of the population exposure factor, the amount of the radionuclide released, and an appropriate dose conversion factor for the exposure pathway (inhalation or external exposure to the plume). In GASPAR II, the following wedge parameter values are assigned:

Mixing Depth L:	1,000 m
Wind Speed $\bar{u}$:	2 m/sec
Population Density:	160 persons/mi^2

The plume path length R is required in the input stream of GASPAR (see Table 2.2, record type 3.0). In population dose calculations this parameter is typically taken to be an estimate of the distance from the facility to the northeast corner of the United States (i.e., Maine).

Worldwide dispersion is considered for noble gases, tritium, and ^{14}C. For tritium and noble gases, the doses are evaluated using the total amount of the radionuclide in the environment at the midpoint of plant life. This total amount is evaluated as follows:

$$A_i = \frac{Q_i'\,[1 - \exp(-\lambda_i t)]}{\lambda_i} \qquad (3.18)$$

where A_i = total activity of radionuclide i in the environment at the midpoint of plant life (Ci)

Q_i' = radionuclide release rate (Ci/sec)

λ_i = radiological decay constant for radionuclide i (sec^{-1})

t = midpoint of plant life (sec).

The concentration of noble gases is estimated based on dilution in an effective atmospheric volume of 3.8×10^{18} m^3. Tritium is assumed to be diluted in the hydrosphere represented by the top 75 m of the world's oceans (2.7×10^{19} L).

For ^{14}C, a specific activity model is used to evaluate doses from worldwide dispersion. This model (as presented by Veluri et al. 1976) predicts the ^{14}C activity per gram of environmental carbon from continuous release after a time period as follows:

$$S_pA = \frac{Q_i'}{0.16\ Va}\left[\frac{A_1}{\lambda_1}\left[1 - \exp(-\lambda_1 t)\right] + \frac{A_2}{\lambda_2}\left[1 - \exp(-\lambda_2 t)\right]\right] \qquad (3.19)$$

where S_pA = specific activity of ^{14}C at time t (Ci/g carbon)

Q_i' = release rate of ^{14}C (Ci/yr)

0.16 = the concentration of natural carbon in the atmosphere (g/m^3)

Va = volume of the atmosphere (m^3)

A_1, A_2 = constants in the Veluri model with values of 0.96 and 0.04, respectively (dimensionless)

λ_1, λ_2 = constants in the Veluri model with values of 0.0209 and 0.00125, respectively (yr^{-1})

t = time to midpoint of plant life (sec).

The evaluation of dose to the U.S. population from dispersion beyond 50 mi is described in Section 3.5.

3.2 EXPOSURE MODELS

This section describes the exposure pathway models used to evaluate external inhalation and ingestion doses. The mathematical models for exposures of individuals are presented first, with special considerations for population doses presented later, in Section 3.2.4.

3.2.1 External Exposure Models

External exposure models relate airborne concentrations to radiation dose from submersion in a plume of noble gases, and they relate ground concentrations of depositing radionuclides to radiation dose received by persons exposed to the contaminated ground. The plume exposure model provides the beta and gamma contributions to two doses - the air dose (mrad/yr) and the individual dose (mrem/yr). Dose calculations for populations outside of the 50-mi radius are discussed in Section 3.1. Derivation of the dose-rate factors used in the following equations is discussed in Section 3.3.

3.2.1.1 Noble Gases

Two types of doses are calculated for plume exposure to noble gases: 1) air dose from gamma and beta radiation, and 2) organ-tissue doses as described in the following sections.

Air Doses. The gamma- and beta-air doses are calculated for a uniform semi-infinite cloud of radionuclides using Equations 3.20 and 3.21, respectively.

$$D_a^{\gamma} = \sum_i C_{ai} D_{ai}^{\gamma} \tag{3.20}$$

where D_a^{γ} = the gamma-air dose rate at the exposure location (mrad/yr)

C_{ai} = the air concentration of radionuclide i at the exposure location as defined in Section 3.1 (pCi/m^3)

D_{ai}^{γ} = the gamma dose-rate factor for radionuclide i (mrad-m^3/pCi-yr).

$$D_a^{\beta} = \sum_i C_{ai} D_{ai}^{\beta} \tag{3.21}$$

where D_a^{β} = the beta-air dose rate at location r (mrad/yr)

D_{ai}^{β} = the beta dose-rate factor for radionuclide i (mrad-m^3/pCi-yr).

Total-Body and Skin Doses. The total-body dose from submersion in a plume of radioactive noble gases is determined from Equation 3.22:

$$D_a^T = \sum_i C_{ai} D_{ai}^T \tag{3.22}$$

where D_a^T = the total-body dose-rate from submersion in a semi-infinite cloud at the exposure location (mrem/yr)

D_{ai}^T = the total-body dose-rate factor for radionuclide i (mrem-m^3/pCi-yr).

The skin dose from submersion in a plume of noble gases is calculated as follows:

$$D_a^S = \sum_i C_{ai} D_{ai}^S \tag{3.23}$$

where D_a^S = the skin dose rate from submersion in a semi-infinite cloud at the exposure location (mrem-m^3/pCi-yr)

D_{ai}^S = the skin dose-rate factor for radionuclide i (mrem-m^3/pCi-yr).

The skin-dose conversion factor is the sum of dose factors for gamma and beta contributions:

$$D_{ai}^S = 1.11\ D_{ai}^{\gamma}\ SF + D_{\beta i}^S \tag{3.24}$$

where 1.11 = correction factor for tissue versus air absorption (mrem/mrad)

D_{ai}^{γ} = gamma dose-rate factor for radionuclide i in air (mrad-m^3/pCi-yr)

SF = the attenuation factor that accounts for the dose reduction from shielding provided by residential structures (dimensionless)

$D_{\beta i}^S$ = beta dose-rate factor for skin tissue for radionuclide i (mrem-m^3/pCi-yr).

The shielding factor (SF) is set to 0.7 for individual dose calculations and to 0.5 for population dose calculations.

3.2.1.2 Deposited Radionuclides

Radionuclides deposited on the ground from the atmosphere provide a rather uniform external source of radiation for individuals and populations. The total-body dose from deposited radionuclides is calculated from Equation 3.25.

$$D_g^T = 3.17 \times 10^{-8} \, SF \sum_i C_{Si} \frac{[1 - \exp(-\lambda_i t)]}{\lambda_i} D_{gi}^T \tag{3.25}$$

where D_g^T = the external dose from exposure to radionuclides deposited on the ground at the exposure location (mrem/yr)

3.17×10^{-8} = units conversion factor (yr/sec)

λ_i = the radiological decay constant of radionuclide i $(sec)^{-1}$

t = the total time for accumulation in soil, taken to be the midpoint of the facility operating life (sec)

D_{gi}^T = the dose-rate factor for radionuclide i deposited on the ground (mrem-m^2/pCi-yr at 1 m above the ground surface).

The external dose evaluations are performed only for the total body. Other internal organs are assumed to receive the same dose as the total body. A discussion of dose factors is presented in Section 3.3.

The equation for calculating skin dose from exposure to deposited radionuclides is similar to Equation 3.25, with the substitution of the skin dose-rate factor in place of the total-body dose-rate factor:

$$D_g^S = 3.17 \times 10^{-8} \, SF \sum_i C_{Si} \frac{1 - \exp(-\lambda_i t)}{\lambda_i} D_{gi}^S \tag{3.26}$$

where D_g^S = the skin dose from exposure to radionuclides on the ground at the exposure location (mrem/yr)

D_{gi}^S = the skin dose-rate factor for radionuclide i on the ground (mrem-m^2/pCi-yr).

3.2.2 Inhalation Models

The inhalation dosimetry methodology used in GASPAR II is based on the model given by the ICRP in Publication 2 (ICRP 1959), which describes behavior of inhaled material in the lung, transfer to the rest of the body from the lung, and calculation of internal doses. Doses from inhalation of noble gases, however, are calculated differently. They do not deposit in the lung and are poorly absorbed in the blood; hence, inhaled noble gases irradiate only the lung. The derivation of radiation dose rate factors for inhalation is discussed in Section 3.3.

3.2.2.1 Noble Gases

The radiation dose to the lung from inhaled noble gases is calculated from Equation 3.27:

$$D_a^L = \sum_i B\ C_{ai}\ D_{ai}^L \qquad (3.27)$$

where D_a^L = the noble gas inhalation dose rate to the lung at the exposure location (mrem/yr)

B = inhalation ventilation rate (m^3/yr)

D_{ai}^L = the inhalation lung dose-rate factor for radionuclide i (mrem/pCi inhaled).

Note: The noble gas lung dose reported by the code will be the sum of the inhalation dose from Equation 3.27 (D_a^L) and the air-submersion total-body dose from Equation 3.22 (D_a^T). The noble gas lung dose factors only include the contribution from beta radiation because the gamma contribution is inherently included in the air-submersion total-body dose.

3.2.2.2 Other Radionuclides

Inhalation doses from radionuclides other than noble gases are calculated for the total body and for several internal organs by Equation 3.28, which is identical to Equation 3.27 except for the substitution of an organ- and nuclide-specific dose factor for the noble gas lung dose factor.

$$D^I_{aj} = \sum_i B\, C_{ai}\, D^I_{aji} \quad (3.28)$$

where D^I_{aj} = the inhalation dose to organ j from radionuclide i at the exposure location (mrem/yr)

D^I_{aji} = the inhalation dose-rate factor for organ j and radionuclide i (mrem/pCi inhaled).

Default values for inhalation ventilation rates are indicated in Table 3.1.

TABLE 3.1. Default Inhalation Ventilation Rates (m^3/yr)

Dose	Adult	Teen	Child	Infant
Individual	8,000	8,000	3,700	1,400
Population	8,000	8,000	3,700	---

3.2.3 Terrestrial Food Models

The terrestrial models relate radionuclide concentrations in air to concentrations in various environmental media. GASPAR II considers several pathways and exposure groups. This section presents models and equations that estimate radiation dose to each of the exposed groups by each pathway. The models presented here are based largely on the models of Regulatory Guide 1.109 (NRC 1977) and Soldat et al. (1974), as originally developed for the HERMES program (Fletcher and Dotson 1971).

The fundamental equation for estimating radiation dose to an individual from a given pathway is:

$$R_{aipj} = C_{ip}\, U_{ap}\, D_{aipj} \quad (3.29)$$

where R_{aipj} = the dose to an organ j, of an individual of age group a, from radionuclide i, via pathway p (mrem/yr)

C_{ip} = the concentration of nuclide i in media of pathway p (pCi/L or pCi/kg)

U_{ap} = the pathway usage parameter representing intake associated with ingestion pathway p for age group a (L/yr or kg/yr as appropriate to the pathway)

D_{aipj} = the dose conversion factor specific to age group a, radionuclide i, pathway p, and organ j (for ingestion pathways, the dose factor converts from pCi ingested to mrem).

The concentration parameter, C_{ip}, is the primary consideration of the exposure pathway models. This parameter is calculated from the initial radionuclide release by using models and data specific to the site and pathway of interest.

The radiation doses calculated by GASPAR II from ingestion of terrestrial foods are 50-yr dose commitments from 1 yr of uptake. Details of the dose conversion factors are presented in Section 3.3.

GASPAR II considers four specific food products: vegetables, leafy vegetables, milk, and meat. Vegetation types can become contaminated by direct deposition onto plant surfaces and by uptake of contaminants from soil through roots to edible parts of the plant. Animal products become contaminated when animals consume contaminated pasture or feed. Details of these exposure pathways are described below.

3.2.3.1 Vegetation

The concentrations of radionuclides in vegetation are derived from air and ground concentrations as defined by Equations 3.6 and 3.7, respectively, which are general expressions for all exposure pathways. First, the concentration in the plant (for those consumed by humans and animals) is calculated for root uptake and direct deposition onto plant surfaces. For direct deposition on plant leaves, the plant concentration is calculated as:

$$C_{ipL} = \frac{3.17 \times 10^{-8}\, C_{Si}\, r}{Y_v\, \lambda_{ei}} \left[1 - \exp(-\lambda_{ei} T_e)\right] \exp(-\lambda_i T_h) \qquad (3.30)$$

where C_{ipL} = the concentration of radionuclide i in plants for pathway p from deposition onto leaves (pCi/kg)

3.17×10^{-8} = unit conversion (yr/sec)

C_{Si} = the ground concentration for radionuclide i (pCi/m^2/yr)

r = the fraction of deposited activity retained on leaves (dimensionless)

Y_v = the agricultural yield for the crop (kg wet weight/m^2)

λ_{ei} = the effective weathering half-time for radionuclide i (sec^{-1})

$$\lambda_{ei} = \lambda_w + \lambda_i$$

where λ_w is the weathering decay constant for removal from plant surfaces (sec^{-1})

T_e = the period that crops are exposed above ground during the year (sec)

λ_i = the radiological decay constant for radionuclide i (sec^{-1})

T_h = the holdup time between harvest and consumption (sec).

Default values for several of the parameters listed in Equation 3.30 are provided as follows: retention fraction (r) - 0.2 for particulates and 1.0 for radioiodine; crop growing period (T_e) - 60 days for vegetable crops and 30 days for animal products (NRC 1977); crop yield (Y_v) - 2.0 kg/m^2 for vegetable crops and 0.7 kg/m^2 for animal products; and weathering half-time (for λ_w) - 14 days. Table 3.2 presents default values for holdup times for individuals for all four food pathways.

TABLE 3.2. Default Holdup Times for Terrestrial Food Pathways (hr)

Holdup Times	Vegetables	Leafy Vegetables	Cow Milk	Meat
Average	1,440	48	96	480
Maximum	336	24	48	480

The plant concentration from the root uptake pathway is calculated as:

$$C_{ipr} = \frac{(3.17 \times 10^{-8}\ C_{Si})\ B_{iv}}{P\lambda_i} [1 - \exp(-\lambda_i T_b)] \exp(-\lambda_i T_h) \qquad (3.31)$$

where C_{ipr} = the concentration of radionuclide i in plants for pathway p from root uptake (pCi/kg)

P = the effective surface density for soil in the root zone (kg soil/m^2)

B_{iv} = the concentration factor for uptake of radionuclide i from soil by edible parts of plants (pCi/kg wet weight/pCi/kg soil)

T_b = the total time for accumulation in soil, taken to be the midpoint of facility operating life (sec).

and other terms are as previously defined. GASPAR II provides default values for concentration factors by element. Table 3.3 includes a list of these parameters. The values given in Table 3.3 are taken from Regulatory Guide 1.109 (NRC 1977) and from a compilation prepared for the Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors (NRC 1976). The default value for the effective soil surface density is 240 kg/m^2, which represents the soil weight in an assumed cultivating depth of 15 cm.

The total concentration in the plant is given as the sum of the root and leafy uptake:

$$C_{ip} = C_{ipL} + C_{ipr} \tag{3.32}$$

where C_{ip} is the total concentration of radionuclide i in crop p (pCi/kg), and other terms are as previously defined.

Equations 3.30 through 3.32 are used for all radionuclides except tritium and ^{14}C. It is assumed that tritium is uniformly distributed throughout the plant at one-half the tritium concentration found in atmospheric moisture water.

$$C_{tp} = C_{ta}(0.75)(0.5/H) \tag{3.33}$$

where C_{tp} = the tritium concentration in plants (pCi/kg)

TABLE 3.3. Terrestrial Bioaccumulation Factors

Element	Plants[a]	Meat[b]	Cow Milk[c]
H	4.8E+00[d]	1.2E-02	1.0E-02
He	5.0E-02	2.0E-02	2.0E-02
Li	8.3E-04	1.0E-02	5.0E-02
Be	4.2E-04	1.0E-03	1.0E-04
B	1.2E-01	8.0E-04	2.7E-03
C	5.5E+00	3.1E-02	1.2E-02
N	7.5E+00	7.7E-02	2.2E-02
O	1.6E+00	1.6E-02	2.0E-02
F	6.5E-04	1.5E-01	1.4E-02
Ne	1.4E-01	2.0E-02	2.0E-02
Na	5.2E-02	3.0E-02	4.0E-02
Mg	1.3E-01	5.0E-03	1.0E-02
Al	1.8E-04	1.5E-03	5.0E-04
Si	1.5E-04	4.0E-05	1.0E-04
P	1.1E+00	4.6E-02	2.5E-02
S	5.9E-01	1.0E-01	1.8E-02
Cl	5.0E+00	8.0E-02	5.0E-02
Ar	6.0E-01	2.0E-02	2.0E-02
K	3.7E-01	1.2E-02	1.0E-02
Ca	3.6E-02	4.0E-03	8.0E-03
Sc	1.1E-03	1.6E-02	5.0E-06
Ti	5.4E-05	3.1E-02	5.0E-06
V	1.3E-03	2.3E-03	1.0E-03
Cr	2.5E-04	2.4E-03	2.2E-03
Mn	2.9E-02	8.0E-04	2.5E-04
Fe	6.6E-04	4.0E-02	1.2E-03
Co	9.4E-03	1.3E-02	1.0E-03
Ni	1.9E-02	5.3E-03	6.7E-03
Cu	1.2E-01	8.0E-03	1.4E-02
Zn	4.0E-01	3.0E-02	3.9E-02
Ga	2.5E-04	1.3E+00	5.0E-05
Ge	1.0E-01	2.0E+01	5.0E-04
As	1.0E-02	2.0E-03	6.0E-03
Se	1.3E+00	1.5E-02	4.5E-02
Br	7.6E-01	2.6E-02	5.0E-02
Kr	3.0E+00	2.0E-02	2.0E-02
Rb	1.3E-01	3.1E-02	3.0E-02
Sr	1.7E-02	6.0E-04	8.0E-04
Y	2.6E-03	4.6E-03	1.0E-05
Zr	1.7E-04	3.4E-02	5.0E-06
Nb	9.4E-03	2.8E-01	2.5E-03
Mo	1.2E-01	8.0E-03	7.5E-03
Tc	2.5E-01	4.0E-01	2.5E-02
Ru	5.0E-02	4.0E-01	1.0E-06
Rh	1.3E+01	1.5E-03	1.0E-02
Pd	5.0E+00	4.0E-03	1.0E-02
Ag	1.5E-01	1.7E-02	5.0E-02
Cd	3.0E-01	5.3E-04	1.2E-04
In	2.5E-01	8.0E-03	1.0E-04
Sn	2.5E-03	8.0E-02	2.5E-03
Sb	1.1E-02	4.0E-03	1.5E-03
Te	1.3E+00	7.7E-02	1.0E-03
I	2.0E-02	2.9E-03	6.0E-03
Xe	1.0E+01	2.0E-02	2.0E-02
Cs	1.0E-02	4.0E-03	1.2E-02
Ba	5.0E-03	3.2E-03	4.0E-04
La	2.5E-03	2.0E-04	5.0E-06
Ce	2.5E-03	1.2E-03	1.0E-04
Pr	2.5E-03	4.7E-03	5.0E-06
Nd	2.4E-03	3.3E-03	5.0E-06
Pm	2.5E-03	4.8E-03	5.0E-06
Sm	2.5E-03	5.0E-03	5.0E-06
Eu	2.5E-03	4.8E-03	5.0E-06
Gd	2.6E-03	3.6E-03	5.0E-06

Table 3.3. (Contd)

Element	Plants(a)	Meat(b)	Cow Milk(c)
Tb	2.6E-03	4.4E-03	5.0E-06
Dy	2.5E-03	5.3E-03	5.0E-06
Ho	2.6E-03	4.4E-03	5.0E-06
Er	2.5E-03	4.0E-03	5.0E-06
Tm	2.6E-03	4.4E-03	5.0E-06
Yb	2.5E-03	4.0E-03	5.0E-06
Lu	2.6E-03	4.4E-03	5.0E-06
Hf	1.7E-04	4.0E-01	5.0E-06
Ta	6.3E-03	1.6E+00	2.5E-02
W	1.8E-02	1.3E-03	5.0E-04
Re	2.5E-01	8.0E-03	2.5E-02
Os	5.0E-02	4.0E-01	5.0E-03
Ir	1.3E+01	1.5E-03	5.0E-03
Pt	5.0E-01	4.0E-03	5.0E-03
Au	2.5E-03	8.0E-03	5.0E-03
Hg	3.8E-01	2.6E-01	3.8E-02
Tl	2.5E-01	4.0E-02	2.2E-02
Pb	6.8E-02	2.9E-04	6.2E-04
Bi	1.5E-01	1.3E-02	5.0E-04
Po	1.5E-01	1.2E-02	3.0E-04
At	2.5E-01	8.0E+00	5.0E-02
Rn	3.5E+00	2.0E-02	2.0E-02
Fr	1.0E-02	2.0E-02	5.0E-02
Ra	3.1E-04	3.4E-02	8.0E-03
Ac	2.5E-03	6.0E-02	5.0E-06
Th	4.2E-03	2.0E-04	5.0E-06
Pa	2.5E-03	8.0E+02	5.0E-06
U	2.5E-03	3.4E-04	5.0E-04
Np	2.5E-03	2.0E-04	5.0E-06
Pu	2.5E-04	1.4E-05	2.0E-06
Am	2.5E-04	2.0E-04	5.0E-06
Cm	2.5E-03	2.0E-04	5.0E-06
Bk	2.5E-03	2.0E-04	5.0E-06
Cf	2.5E-03	2.0E-04	5.0E-06
Es	2.5E-03	2.0E-04	5.0E-06
Fm	2.5E-03	2.0E-04	5.0E-06

(a) Units are pCi/g plant (wet) per pCi/g soil.
(b) Units are pCi/kg (animal product) per pCi/day intake.
(c) Units are pCi/L (milk) per pCi/day intake.
(d) 4.8E-00 = 4.8 x 10^{-0}.

C_{ta} = the tritium concentration in air (pCi/m^3)

0.75 = the fraction of total plant mass that is water

0.5 = the ratio of tritium concentration in plant water to the tritium concentration in atmospheric moisture

H = the absolute humidity in air (kg/m^3).

If the average absolute humidity, H, over the growing season is not available, H can be calculated by GASPAR II if the input includes both H as relative humidity (%) and the average temperature (°F).

The ^{14}C plant concentration is calculated using a model similar to the tritium model based on the assumption that ^{14}C is released in the oxide form (CO or CO_2). The ratio of the concentration of ^{14}C to natural carbon in plants is assumed to be the same as the concentration ratio in air. The ^{14}C plant concentration is estimated as follows:

$$C_{cp} = C_{ca}\ p\ (0.11)/1.6 \times 10^{-4} \tag{3.34}$$

where C_{cp} = the ^{14}C concentration in plants (pCi/kg)

C_{ca} = the ^{14}C concentration in air (pCi/m^3)

p = the fractional equilibrium ratio (dimensionless)

0.11 = the fraction of total plant mass that is carbon (dimensionless)

1.6×10^{-4} = the concentration of natural carbon in the atmosphere (kg/m^3).

The fractional equilibrium ratio, p, is used to account for the fractional equilibrium achieved between atmospheric and plant carbon concentrations for intermittent releases, such as purges of gaseous waste decay tanks. The equilibrium ratio is defined as the ratio of the total annual release time to the total annual time during which photosynthesis occurs (taken to be 4,380 hr). For continuous releases, p is set to unity.

3.2.3.2 Animal Products

The concentration of radionuclides in animal products is calculated from the plant concentration given by Equations 3.30 and 3.31. For animal product pathways, these equations are evaluated without the exponential term for decay from holdup during food processing and distributing. The animal-product concentration resulting from animals ingesting contaminated feed crops is calculated as:

$$C_{iaf} = F_{ia} Q_f \left\{ C^g_{ip}\ f_p\ f^g_p + C^s_{ip} \left[f_p (1 - f^g_p) + (1 - f_p) \right] \exp(-\lambda_i T_S) \right\} \exp(-\lambda_i T_h) \tag{3.35}$$

where C_{iaf} = the concentration of radionuclide i in animal product p from animal ingestion of contaminated feed (pCi/L or pCi/kg)

F_{ia} = transfer factor for radionuclide i from animal feed to animal product (day/kg or day/L)

Q_f = the consumption rate of feed by the animal (kg/day)

C^g_{ip} = the concentration of radionuclide i in pasture grass; C_{ip} evaluated for pasture parameters (pCi/kg)

f_p = fraction of time that animals are on the pasture (dimensionless)

f^g_p = fraction of animal intake from pasture while animals are on the pasture (dimensionless)

C^s_{ip} = the concentration of radionuclide i in stored feed; C_{ip} evaluated for stored feed (pCi/kg)

T_S = holdup time for stored feed prior to animal intake (sec)

and other terms are as previously defined. Evaluating the feed concentration, C_{ip}, from Equations 3.30 and 3.31 involves using parameters that are representative of animal feed production and which may differ from vegetable production for human consumption. For example, the growing period is set to 30 days to represent animal grazing habits. Also, the crop yield is less (0.7 kg/m^2) for animal feed production. Feed consumption by the animals is set to 50 kg/day for both milk and meat production. The holdup time for feed storage is set to 90 days.

The concentrations of tritium and ^{14}C in animal products are estimated using Equation 3.35 with plant concentrations defined by Equations 3.33 (C_{tp}) and 3.34 (C_{cp}), respectively. For tritium and ^{14}C, the animal feed is assumed to all be contaminated.

The dose received by an individual is calculated using the food product concentration (C_{iaf} or C_{ip}) for the pathway of interest determined in Equation 3.29. Table 3.4 provides default consumption rates (U_{ap}) used with food-product pathways. Individual doses are calculated using the "maximum" individual values for each age group. The average values are used to evaluate population exposures, as described in the next section.

TABLE 3.4. Default Consumption Rate Values for Food Pathways

Parameter	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Average adult	190	30	110	95
Average teen	240	20	200	59
Average child	200	10	170	37
Maximum adult	520	64	310	110
Maximum teen	630	42	400	65
Maximum child	520	26	330	41
Maximum infant	0	0	330	0

3.2.4 Population Dose Consideration

The models and parameters used in calculating individual doses are used with slight differences in parameter values to calculate population doses. The individual dose calculations are based on parameter values that maximize the dose for a given pathway and age group. However, population doses are estimated using parameters that represent average conditions. These differences are indicated in some of the parameter default values presented above (i.e., Tables 3.1, 3.2, and 3.4).

The expression for estimating population exposure is:

$$H_{ipj} = 0.001 \sum_{a=1}^{\text{age groups}} P_{ap} C_{ip} U_{ap} D_{aipj} \tag{3.36}$$

where H_{ipj} = the population dose to organ j, from radionuclide i, from pathway p, summed over age groups (person-rem)

0.001 = a units conversion factor (rem/mrem)

P_{ap} = the population of age group a, exposed to pathway p (persons)

U_{ap} = the average individual usage parameter for age group a, and pathway p (units as defined for Equation 3.29)

and other terms are as previously defined.

The total population dose within 50 mi is the sum of the population doses evaluated by Equation 3.36 over all area elements. The special products defined by Equations 3.8 through 3.12 are used to simplify the population dose calculations, as they represent the weighted sum of key parameters over all area elements. These special products are used in the evaluations of C_{ip} for food pathways and the product $P_{ap}\ C_{ip}$ for inhalation and external exposure to the plume.

The NEPA population-dose values include contributions from tritium, carbon, and noble gases dispersed beyond 50 mi and from excess food exported from the 50-mi region. The population dose for dispersed activity is evaluated using Equation 3.36 with the product:

$$P_{ap}\ C_{ip}$$

replaced with the term:

$$E(R)\ Q_i'$$

where E(R) is the population exposure factor (see Equation 3.17), and Q' is the radionuclide release rate expressed in pCi/sec. This representation is used for the dose from tritium and ^{14}C in farm products produced beyond 50 mi, contaminated by activity dispersed beyond 50 mi. The dose from tritium is apportioned across the food pathways as 48% from vegetables, 28% from milk, and 24% from meat. For ^{14}C, the dose is apportioned as 47% from vegetables, 16% from milk, and 37% from meat. The external exposure to noble gases dispersed beyond 50 mi is also calculated using the above population exposure factor. Other radionuclides are assumed to be completely deposited within 50 mi. When an area produces more food of a given type (i.e., vegetables, milk, or meat) than can be consumed by the local population, the excess is assumed to be exported. The population dose resulting from the consumption of the exported food is included in the NEPA population doses. The determination of the exportable amount is performed as follows:

1. The total population served is estimated:

$$P_{sp} = \frac{T_p}{\sum U_{ap} f_a} \tag{3.37}$$

where P_{sp} = total population served by food type p (persons)

T_p = total production of food type within 50 mi (kg/yr)

f_a = fraction of population in age group a (dimensionless).

If the population served is less than the 50-mi population, then no food is exported.

2. If the population served is greater than the 50-mi population, then the exported amount is estimated as follows:

$$T_{ep} = T_p - P_T \sum U_{ap} f_a \tag{3.38}$$

where T_{ep} = amount of food type p exported beyond 50 mi (kg/yr)

P_T = total population within 50 mi (persons).

3. The dose to the people beyond 50 mi is calculated from the dose within 50 mi as follows:

$$H^e_{ipj} = H_{ipj} \frac{P_{sp} - P_T}{P_T} \tag{3.39}$$

where H^e_{ipj} = the population dose to organ j, from radionuclide i, from pathway p, from food exported beyond 50 mi (person-rem)

H_{ipj} = the 50-mi population dose to organ j, from radionuclide i, from pathway p (person-rem).

The contribution to the U.S. population dose from worldwide dispersion of noble gases is evaluated based on the worldwide concentration of the noble gas radionuclides, the total U.S. population, and the noble gas dose models described in Sections 3.2.1.1 and 3.2.2.1.

The U.S. population dose from worldwide dispersion of tritium in the hydrosphere is calculated from the tritium concentration assuming an average individual daily intake of water in foods of 1 L. The dose is calculated as follows:

$$H_{tpj} = 3.65 \times 10^{11} F_p P_{us} A_H D_{aHpj}/V_H \tag{3.40}$$

where H_{tpj} = U.S. population dose from ingestion of tritium for pathway p and organ j (person-rem)

3.65×10^{11} = (10^{-3} rem/mrem) (10^{12} pCi/Ci) (365 days/yr) (1 L/day)

F_p = fraction of total hydrogen ingestion that is from foods from pathway p

P_{us} = total population of the U.S. (persons)

A_H = total activity of tritium in the hydrosphere as calculated by Equation 3.18 (Ci)

D_{aHpj} = ingestion-dose conversion factor for tritium for adults a, for food p, and organ j (mrem/pCi ingested)

V_H = volume of the hydrosphere (L).

The distribution of hydrogen intake and tritium dose is assumed to be 48% from vegetables, 28% from milk, and 24% from meat.

The population dose within the U.S. from worldwide dispersion of ^{14}C is calculated from the specific activity as follows:

$$D_c = 1.57 \times 10^8 P_{us} S_pA \tag{3.41}$$

where D_c = U.S. population dose from worldwide dispersion of ^{14}C (person-rem)

1.57×10^8 = dose conversion factor (rem-g carbon)/(Ci-yr)

S_pA = specific activity of ^{14}C from worldwide dispersion (Ci/g carbon).

The dose conversion factor is based on an ICRP estimate that a body burden of 400 μCi of ^{14}C results in an annual dose of 5 rem/yr. The specific activity is calculated using Equation 3.19.

External exposures are included in population dose estimates also. No consideration of age groups is made because external exposure is assumed to result in approximately the same dose to individuals of all age groups per unit time of exposure. The usage parameter for external exposure is set for the average member of the exposed population. The calculations are discussed in Section 3.3.

3.3 DOSIMETRY MODELS

This section describes the dosimetry models that are used to evaluate factors in the GASPAR II dose factor file. These dose factors are represented in Equation 3.36 by the parameter D_{aipj}, which converts exposure (hr/yr or pCi/yr ingested) to dose to an individual (mrem/yr). The dose-factor data file contains dose-factor values for external exposure to contaminated ground and for ingestion and inhalation of radionuclides. Dose factors for external exposure from immersion in air are included in data statements in GASPAR II. The external dose factors are defined only for adults and for total-body exposures because dose from exposure to external penetrating radiation is not very sensitive to differences in body size or organ depth. The ingestion and inhalation dose factors are defined for four age groups (adult, teen, child, and infant) and seven organs (bone, liver, total-body, thyroid, kidney, lung, and lower large intestine). A discussion of procedures for calculating external dose factors (from contaminated ground and from airborne noble gases) and internal dose factors (from ingestion and inhalation) follows.

3.3.1 External Exposure

This section describes the dose conversion factors used by GASPAR II to estimate external dose from exposure to contaminated ground, and external and lung doses from submersion in an airborne plume of noble gases.

3.3.1.1 Contaminated Ground

GASPAR II estimates external exposure from contaminated ground. The dose conversion factors are based on the exposure rate at 1 m above an infinite plane of uniform contamination. An exponential tissue-penetration factor is applied to the infinite plane exposure rate to estimate the total-body dose factor. A tissue depth of 5 cm is used for this calculation, as suggested by the National Council on Radiation Protection and Measurement (1975). Total-body dose factors estimate doses to all organs except the skin, which is based on corrections of the infinite plane values for penetration through the 0.007-cm-thick dead skin layer.

In reviewing external dose factors for ground during the preparation of the LADTAP II (NRC 1986) report, the following errors in the dose factor file were detected and corrected:

1. Several radionuclides were found to have skin and total-body dose factors reversed for ground exposure and no values given for immersion exposure. These radionuclides are ^{91m}Y, ^{95}Nb, ^{99}Mo, ^{103}Ru, ^{106}Ru, ^{132}I, ^{135}I, ^{140}La, ^{147}Nd, ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Pu.
2. No external dose factors were given for ^{93m}Nb.
3. No external dose factors were given for ^{143}Pr for total-body water immersion.
4. Radionuclide ^{210}Bi (half-life 5.01 days) was incorrectly represented as ^{210m}Bi in the adult portion of the library.

Corrections to all of these errors have been incorporated in the current dose-factor file.

3.3.1.2 Airborne Noble Gases

The contribution to individual and population doses from noble gases is evaluated assuming uniform distribution of activity in the plume. The models for these evaluations are described in Sections 3.2.1.1 and 3.2.2.1. Dose factors required for the calculation of air doses, total-body dose, skin dose, and lung dose (from noble gas inhalation) are presented in Table 3.5. The dose factors in this table correspond to symbols in equations as follows:

Gamma Air:	D^{γ}_{ai}	Equation 3.20
Beta Air:	D^{β}_{ai}	Equation 3.21
Gamma Total-Body:	D^{T}_{ai}	Equation 3.22
Beta Skin:	$D^{S}_{\beta i}$	Equation 3.24
Beta Lung:	D^{L}_{ai}	Equation 3.27

TABLE 3.5. Dose Factors for Noble Gases

Radio-Nuclide	Gamma Air(a)	Beta Air(a)	Gamma Total-Body(b)	Beta Skin(b)	Beta Lung(c)
^{41}Ar	9.30E-03(d)	3.28E-03	8.84E-03	2.69E-03	0.00E+00
^{83m}Kr	1.93E-05	2.88E-04	7.56E-08	0.00E+00	2.91E-06
^{85m}Kr	1.23E-03	1.97E-03	1.17E-03	1.46E-03	1.95E-05
^{85}Kr	1.72E-05	1.95E-03	1.61E-05	1.34E-03	1.87E-05
^{87}Kr	6.17E-03	1.03E-02	5.92E-03	9.73E-03	1.02E-04
^{88}Kr	1.52E-02	2.93E-03	1.47E-02	2.37E-03	3.38E-05
^{89}Kr	1.73E-02	1.06E-02	1.66E-02	1.01E-02	1.09E-04
^{131m}Xe	1.56E-04	1.11E-03	9.15E-05	4.76E-04	1.10E-05
^{133m}Xe	3.27E-04	1.48E-03	2.51E-04	9.94E-04	1.46E-05
^{133}Xe	3.53E-04	1.05E-03	2.94E-04	3.06E-04	1.05E-05
^{135m}Xe	3.36E-03	7.39E-04	3.12E-03	7.11E-04	8.79E-06
^{135}Xe	1.92E-03	2.46E-03	1.81E-03	1.86E-03	2.46E-05
^{137}Xe	1.51E-03	1.27E-02	1.42E-03	1.22E-02	1.23E-04
^{138}Xe	9.21E-03	4.75E-03	8.83E-03	4.13E-03	4.93E-05

(a) Units are mrad-m^3/pCi-yr.
(b) Units are mrem-m^3/pCi-yr.
(c) Units are mrem/pCi inhaled.
(d) 9.30E-03 = 9.30×10^{-3}.

3.3.2 Internal Dose Factors

The internal dose factors in the GASPAR II dose-factor file for ingestion and inhalation are based on values derived by Hoenes and Soldat (1977) with modifications that reflect current values for several internal dosimetry parameters (Boone and Palms 1983). The initial derivation formed the basis for the dose factors presented in Regulatory Guide 1.109 (NRC 1977). These factors were based primarily on the models in Publication 2 of the International Commission on Radiological Protection (ICRP 1959), as updated by Publications 6 (ICRP 1964) and 10 (ICRP 1968). The modification by Boone and Palms incorporated recommendations of ICRP Publication 19 (1972) regarding dosimetry for actinide elements. A summary of the dosimetry models of these publications follows.

3.3.2.1 Ingestion

Ingestion dosimetry models consider the gastrointestinal tract as the initial entry into the body. The model presented in ICRP Publication 2 describing the dosimetry of the gastrointestinal tract considers four distinct compartments: stomach, small intestine, upper large intestine, and lower large intestine. The ingested material enters through the stomach and travels sequentially through each compartment. Absorption of material into the blood is considered to occur only in the small intestine. The material entering the stomach is assumed to reside there for 1 hr and then move in a batch mode to the small intestine. Flow through the small intestine and large intestine is assumed to be continuous and linear. The intestinal wall is considered the critical tissue in the intestine. The dose is therefore calculated as one-half the dose to the mass of the contents. For alpha radiation, a factor of 0.01 is also applied to the effective energy to account for the ineffectiveness of alpha particles in reaching the sensitive cells of the stomach and intestine walls. The lower large intestine (GI-LLI) is the only portion of the gastrointestinal tract considered in GASPAR II because this portion has the highest dose factor for most radionuclides.

The material absorbed in the small intestine is assumed to be transferred via the blood to other organs. Elimination from the organs is described by a single exponential expression with a biological half-time defined for each organ. In the organ dosimetry model, the radionuclide is assumed to be located in the center of a spherical organ. All particle radiations emitted are absorbed within the organ; all photon radiations are partially absorbed depending on the organ radius and photon energy. The potential contribution to organ dose from photon radiation originating outside of that organ is ignored.

3.3.2.2 Inhalation

Inhalation dosimetry models consider the lung as the initial entry point to the body. Dose factors in the GASPAR II data library are based on lung dosimetry defined in ICRP Publication 2 (1959). In this model, the distribution of inhaled particulate material within the body is described for two classes of compounds: readily soluble compounds and insoluble compounds. For both classes of compounds, it is assumed that 25% of the inhaled material is quickly exhaled, 50% is deposited in upper respiratory passages (and subsequently swallowed), and the remaining 25% is deposited in the lungs. For insoluble compounds, half of the amount deposited in the lungs is assumed to be swallowed in the first 24 hr, and half is assumed to remain in the lungs with a 120-day half-time (except for plutonium and thorium, which have 1-yr and 4-yr half-lives, respectively). The total amount of insoluble material swallowed (i.e., that which reaches the GI tract) is then 62.5%. Material classed as "insoluble" is not absorbed from the small intestine, and only the GI tract receives a radiation dose.

For readily soluble compounds, 50% reaches the GI tract, while the 25% initially deposited in the lung is assumed to be taken up immediately into the body (via the blood). The total amount reaching an organ is then given by:

$$f_a = (0.25 + 0.5\ f_1)\ f_2' \qquad (3.42)$$

where f_a = the fraction of that taken into the body by inhalation that reaches the organ of interest

f_1 = the fraction of the radionuclide passing from the GI tract to the blood

f_2' = the fraction of the radionuclide passing from the blood to the organ.

3.3.2.3 Age-Specific Dose Factors

Age-dependence of dose factors is considered using the above models for ingestion and inhalation as extended by Hoenes and Soldat (1977). Because radiation doses may vary for people of differing ages, four age groups have been defined with dose factors calculated for each group. The age groups considered are "infant" (0 to 1 yr old), "child" (1 to 11 yr old), "teen" (11 to 17 yr old), and "adult" (17 yr and older). The "child" is represented by a typical 4-yr-old, the "teen" by a 14-yr-old, and the adult by the definition for Standard Man as described in ICRP Publication 2 (1959). The following text describes features of the dose-factor calculations as taken from Hoenes and Soldat (1977):

> Equations for calculating internal dose commitment factors were derived from those given by the ICRP [1959] for body burden and maximum permissible concentration (MPC). Effective absorbed energies for the radionuclides were calculated from the ICRP model. When necessary, these energies were corrected for the ingrowth of daughter radionuclides following ingestion or inhalation of the parent. . . . Quality factors, as listed in ICRP Publication 2 [1959], were applied to the effective energies, including the value of 1.7[a] for beta particles and electrons with energies equal to or less than 30 keV. Age-dependent parameters were applied when available, but, where data were lacking, metabolic parameters for the Standard Man were used for other age groups.
>
> Effective absorbed energies used to compute dose factors are controlled by the size of the organ. Thus, as an individual grows and the sizes of his body organs increase, the total amount of radiation absorbed in an organ will also increase but the amount of energy absorbed per unit mass will generally decrease. If an intake of radioactive material occurs before an individual matures, later increases in organ size and mass may affect the dose commitment. In calculating the dose commitment factors listed in Tables 1 through 8 [Hoenes and Soldat 1977, pp. 8-39], this change of organ size and mass was considered. To reduce the complexity of the equations, it was necessary to assume that an abrupt change in organ size and mass would occur at the division points between age groups. This assumption significantly simplifies the calculations without underestimating the dose commitment.
>
> The mass of the contents of the gastrointenstinal tract (GI tract) was taken to be proportional to total-body mass. The travel time to the lower large intestine (t') and the travel time through the lower large intestine (') were also assumed to be proportional to the mass of the total body. Radioactive decay of the radionuclide ingested was accounted for in calculating dose commitment factors for the GI tract.
>
> In certain instances, the energy of a daughter nuclide makes a significant contribution to the effective energy per disintegration of the parent nuclide at the entrance to the lower large intestine (LLI). This occurs when the ratio of daughter decays to parent decays is relatively large. Such a situation arises when the following conditions exist. The parent decays to a daughter nuclide which: 1) is less efficiently absorbed from the small intestine than the parent, 2) has a long enough half-life to persist through the upper large intestine, and 3) has a short enough half-life, compared to the parent, to present a relatively high disintegration rate in the lower large intestine. . . . Some radionuclides have daughter products

[a] For ^{3}H, the current value is 1.0.

which will be absorbed into the blood stream before reaching the lower large intestine. In these cases, the energy of the daughters was not included in the dose commitment factors for the GI tract even though it was included for other body organs.

Since specific biological half-lives are available as a function of age for hydrogen, iodine and cesium, that information was used when computing the dose commitments factors for the radionuclides of these elements. For other radionuclides contained in this report, the biological half-lives for Standard Man were used for all age groups. Dose commitment factors calculated without using age specific biological half-lives will generally overestimate the radiation dose for age groups other than adults. This overestimate occurs because biological half-lives for adults tend to be greater than those for younger individuals. Other biological parameters which were assumed to remain constant for all age groups are: fraction reaching organ of reference by ingestion (f_w) and by inhalation (f_a), fraction from GI tract to blood (f_1), and fraction from blood to organ of reference (f_2') [ICRP 1959, 1964, 1968].

The age-specific dose conversion factors calculated and presented by Hoenes and Soldat form the basis for dose factors used in GASPAR II. The values for ingestion in the GASPAR II dose-factor file were updated by Soldat for the LADTAP II report (NRC 1986) to reflect recent changes in metabolic data and corrections of numeric errors in the original report by Hoenes and Soldat. A summary of changes made to the ingestion dose factors is presented in the LADTAP II technical reference manual (NRC 1986). Changes made to the inhalation dose factors are summarized in Table 3.6, and the reasons for those changes are given in Table 3.7. A major change made to internal dose factors was to revise dose factors for actinide elements as recommended by ICRP (1972). For each age group, internal dose factors for actinides have been evaluated by Boone and Palms (1983). The current values in the GASPAR II dose-factor file agree with the values reported by Boone and Palms.

TABLE 3.6. Inhalation Dose Factors - Changes to Data File

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
Adult Age Group		
^{3}H	All except bone	8.98E-8
^{90}Sr	Bone	3.59E-3
	Total-Body	7.21E-5
^{133m}Te	GI-LLI	7.65E-9
^{210}Pb	GI-LLI	1.51E-6
^{229}Th	Bone	1.51E+1
	Liver	4.34E-1
	Total-Body	2.51E-1
	Kidney	2.13E+0
	Lung	3.62E+0
	GI-LLI	4.83E-5

Table 3.6. (Contd)

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
^{232}Th	Bone	2.56E+0
	Total-Body	9.04E-4
^{237}Np	Bone	1.56E+0
	Liver	1.00E+0
^{238}Np	Liver	7.20E-8
^{239}Np	Liver	2.54E-8
^{238}Pu	Bone	1.43E+0
	Liver	9.71E-1
^{239}Pu	Bone	1.66E+0
	Liver	1.07E+0
^{240}Pu	Bone	1.65E+0
	Liver	1.07E+0
^{241}Pu	Bone	3.42E-2
	Liver	8.69E-3
^{242}Pu	Bone	1.53E+0
	Liver	1.03E+0
^{244}Pu	Bone	1.79E+0
	Liver	1.18E+0
^{241}Am	Bone	1.68E+0
	Liver	1.13E+0
^{242m}Am	Bone	1.70E+0
	Liver	1.06E+0
^{243}Am	Bone	1.68E+0
	Liver	1.10E+0
^{242}Cm	Bone	2.22E-2
	Liver	1.77E-2
^{243}Cm	Bone	1.10E+0
	Liver	7.61E-1
^{244}Cm	Bone	8.37E-1
	Liver	5.88E-1
^{245}Cm	Bone	1.74E+0
	Liver	1.14E+0
^{246}Cm	Bone	1.73E+0
	Liver	1.14E+0
^{247}Cm	Bone	1.68E+0
	Liver	1.12E+0
^{248}Cm	Bone	1.40E+1
	Liver	9.26E+0
^{252}Cf	Bone	5.43E-1

Table 3.6. (Contd)

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
Teen Age Group		
^{3}H	All except bone	9.06E-8
^{90}Sr	Bone	4.14E-3
	Total-Body	8.33E-5
^{93}Zr	Liver	3.38E-6
	Total-Body	1.84E-6
	Kidney	1.16E-5
	Lung	3.67E-5
	GI-LLI	1.60E-6
^{210}Pb	GI-LLI	1.60E-6
^{229}Th	Bone	1.54E+1
	Liver	4.44E-1
	Total-Body	2.56E-1
	Kidney	2.18E+0
	Lung	5.24E+0
	GI-LLI	5.12E-5
^{232}Th	Bone	2.61E+0
	Total-Body	9.21E-4
^{237}Np	Bone	1.64E+0
	Liver	1.06E+0
^{238}Np	Liver	1.02E-7
^{239}Np	Liver	3.60E-8
^{238}Pu	Bone	1.50E+0
	Liver	1.03E+0
^{239}Pu	Bone	1.73E+0
	Liver	1.12E+0
^{240}Pu	Bone	1.72E+0
	Liver	1.12E+0
^{241}Pu	Bone	3.74E-2
	Liver	9.56E-3
^{242}Pu	Bone	1.60E+0
	Liver	1.08E+0
^{244}Pu	Bone	1.87E+0
	Liver	1.24E+0
^{241}Am	Bone	1.77E+0
	Liver	1.20E+0
^{242m}Am	Bone	1.79E+0
	Liver	1.13E+0
^{243}Am	Bone	1.77E+0
	Liver	1.17E+0

Table 3.6. (Contd)

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
^{242}Cm	Bone	3.17E-2
	Liver	2.51E-2
^{243}Cm	Bone	1.19E+0
	Liver	8.30E-1
^{244}Cm	Bone	9.19E-1
	Liver	6.53E-1
^{245}Cm	Bone	1.83E+0
	Liver	1.22E+0
^{246}Cm	Bone	1.81E+0
	Liver	1.22E+0
^{247}Cm	Bone	1.77E+0
	Liver	1.19E+0
^{248}Cm	Bone	1.47E+1
	Liver	9.83E+0
^{252}Cf	Bone	7.16E-1
Child Age Group		
^{3}H	All except bone	1.73E-7
^{90}Sr	Bone	1.04E-2
	Total-Body	2.07E-4
^{93}Zr	Liver	7.80E-6
	Total-Body	5.55E-6
	Kidney	3.00E-5
	Lung	7.10E-5
	GI-LLI	1.47E-6
^{210}Pb	GI-LLI	1.55E-6
^{229}Th	Bone	2.18E+1
	Liver	5.75E-1
	Total-Body	3.63E-1
	Kidney	2.83E+0
	Lung	1.08E+1
	GI-LLI	4.99E-5
^{232}Th	Bone	3.68E+0
	Total-Body	1.28E-3
^{237}Np	Bone	2.72E+0
	Liver	1.62E+0
^{238}Np	Liver	2.30E-7
^{239}Np	Liver	8.14E-8
^{238}Pu	Bone	2.55E+0
	Liver	1.60E+0
^{239}Pu	Bone	2.79E+0
	Liver	1.68E+0

Table 3.6. (Contd)

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
^{240}Pu	Bone	2.79E+0
	Liver	1.68E+0
^{241}Pu	Bone	7.94E-2
	Liver	1.75E-2
^{242}Pu	Bone	2.59E+0
	Liver	1.62E+0
^{244}Pu	Bone	3.02E+0
	Liver	1.85E+0
^{241}Am	Bone	2.97E+0
	Liver	1.84E+0
^{242m}Am	Bone	3.07E+0
	Liver	1.76E+0
^{243}Am	Bone	2.94E+0
	Liver	1.78E+0
^{242}Cm	Bone	9.48E-2
	Liver	5.68E-2
^{243}Cm	Bone	2.32E+0
	Liver	1.42E+0
^{244}Cm	Bone	1.94E+0
	Liver	1.18E+0
^{245}Cm	Bone	3.05E+0
	Liver	1.84E+0
^{246}Cm	Bone	3.02E+0
	Liver	1.84E+0
^{247}Cm	Bone	2.94E+0
	Liver	1.82E+0
^{248}Cm	Bone	2.45E+1
	Liver	1.50E+1
^{252}Cf	Bone	2.18E+0
Infant Age Group		
^{3}H	All except bone	2.63E-7
^{87}Rb	Liver	7.11E-5
	Total-Body	2.64E-5
	GI-LLI	2.99E-7
^{90}Sr	Bone	1.11E-2
	Total-Body	2.23E-4
^{93}Zr	Liver	9.51E-6
	Total-Body	6.18E-6
	Kidney	3.19E-5
	Lung	1.37E-4
	GI-LLI	1.48E-6

Table 3.6. (Contd)

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
^{210}Pb	GI-LLI	1.57E-6
^{229}Th	Bone	2.28E+1
	Liver	5.94E-1
	Total-Body	3.81E-1
	Kidney	9.32E-1
	Lung	1.27E+1
	GI-LLI	5.02E-5
^{232}Th	Bone	3.86E+0
	Total-Body	2.29E-3
^{237}Np	Bone	2.88E+0
	Liver	1.71E+0
^{238}Np	Liver	6.05E-7
^{239}Np	Liver	2.13E-7
^{238}Pu	Bone	2.69E+0
	Liver	1.68E+0
^{239}Pu	Bone	2.93E+0
	Liver	1.76E+0
^{240}Pu	Bone	2.93E+0
	Liver	1.75E+0
^{241}Pu	Bone	8.43E-2
	Liver	1.85E-2
^{242}Pu	Bone	2.72E+0
	Liver	1.69E+0
^{244}Pu	Bone	3.17E+0
	Liver	1.94E+0
^{241}Am	Bone	3.15E+0
	Liver	1.95E+0
^{242m}Am	Bone	3.25E+0
	Liver	1.86E+0
^{243}Am	Bone	3.10E+0
	Liver	1.88E+0
^{242}Cm	Bone	1.28E-1
	Liver	8.65E-2
^{243}Cm	Bone	2.47E+0
	Liver	1.52E+0
^{244}Cm	Bone	2.07E+0
	Liver	1.27E+0
^{245}Cm	Bone	3.22E+0
	Liver	1.96E+0
^{246}Cm	Bone	3.20E+0
	Liver	1.96E+0

Table 3.6. (Contd)

Radionuclide	Organ	Inhalation Dose Factor (mrem in 50 yr per pCi/yr)
^{247}Cm	Bone	3.11E+0
	Liver	1.93E+0
^{248}Cm	Bone	2.58E+1
	Liver	1.59E+1
^{252}Cf	Bone	2.37E+0

TABLE 3.7. Reasons for Differences in Inhalation Dose Factors

Radionuclide	Reason for Differences
^{3}H	The quality factor for tritium in all organs has decreased from 1.7 to 1.0.
^{90}Sr	Corrections to ^{90}Sr dose factors reflect changes in f_2' from 0.3 to 0.17 for bone and from 1.0 to 0.17 for total-body.
^{87}Rb	No explanation for differences in infant dose factors; values listed are those reported by Hoenes and Soldat (1977).
^{93}Zr	The original NUREG-0172 values (LADTAP II) for effective energy were a factor of 10 too high for all ages except adult and for all organs except bone.
^{133m}Te	The value of effective energy for adult GI-LLI was corrected from 11.62 to 1.62.
^{210}Pb	The effective energy for GI-LLI for all ages was corrected from 0.46 to 0.019.
^{229}Th	Values for effective energy were recalculated using correct decay scheme data. The changes in effective energy are as follows:

Organ	Old Value	New Value
Bone	940	1,600
Liver	49	160
Kidney	49	160
Thyroid	49	160
Total-Body	330	190
Lung	270	280
GI-LLI	4.0	0.61

Radionuclide	Reason for Differences
^{232}Th	The biological half-time for total-body is 5.7E+4 days, not 5.7E+6 days.
Actinides	The metabolic model for transuranic nuclides from ICRP Publication 19 should be used in place of that given in ICRP Publication 2 (which was used in NUREG-0172). This leads to several important changes for Np, Pu, Am, Cm, and Cf. These are: Biological half-time in bone is 100 years. Biological half-time in liver is 40 years. f_2' in bone is 0.45. f_2' in liver is 0.45.

4.0 DETAILED PROGRAM INFORMATION

This chapter presents technical information useful for modifying the GASPAR II computer program. The reader is assumed to be familiar with the models employed by GASPAR II and to have a working knowledge of standard FORTRAN 77. The chapter includes descriptions of program structure and logic, computer requirements, common block usage, modules, and data files.

4.1 PROGRAM STRUCTURE

This section provides the following information related to GASPAR II program structure: 1) module hierarchy, 2) data input location, 3) data output location, and 4) data transfer between modules. GASPAR II is composed of 23 modules, including the main program, block data, subroutines, and functions. Data transfer is performed mainly through 21 labeled common blocks. Supplemental transfer is performed through argument call lists. Details of common blocks are given in Section 4.3. Input of dose factors is performed in one subroutine (REDDF), while case-specific input records are read by several subroutines as data are needed in specific portions of the analysis. An optional input file may also be used for specification of meteorological data. Output reports of input data are generated by subroutines reading the data. The output reports for calculated results are prepared by subroutines OUTSPL (special location tables), OUTMAN (population dose tables), PRINTC (cost-benefit tables), and PARTS (special unit dose factors).

Figure 4.1 presents the subroutine calling sequence. This diagram indicates the general order in which subroutines are called and gives a summary of where specific tasks are performed. All modules are included in the figure except system functions. Details of each module are given in Section 4.4.

Data are supplied to GASPAR II by three input units: 1) standard input records (default logical unit 9), 2) optional meteorological data (logical unit 7), and 3) data library of dose factors (logical unit 20). The standard input records and meteorological records are described in Section 2.1, and the data library is described in Section 4.5.

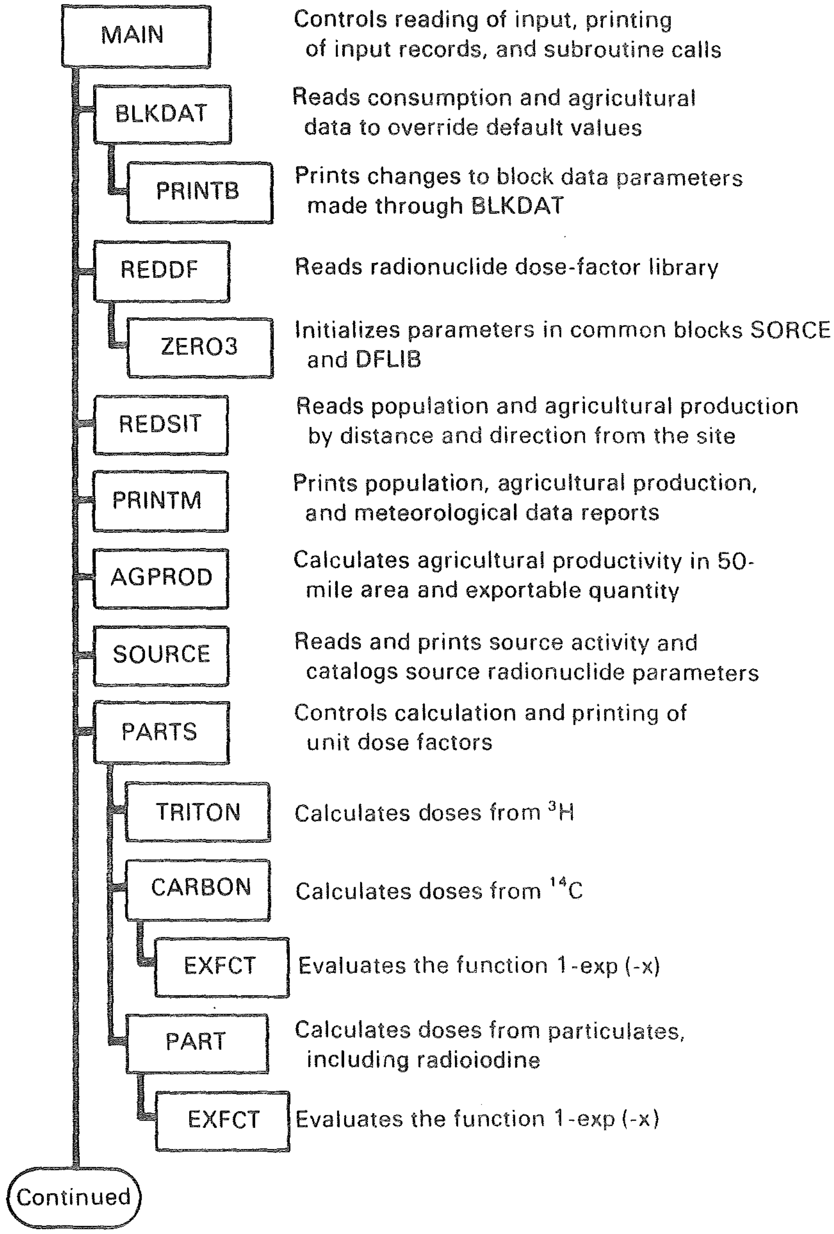
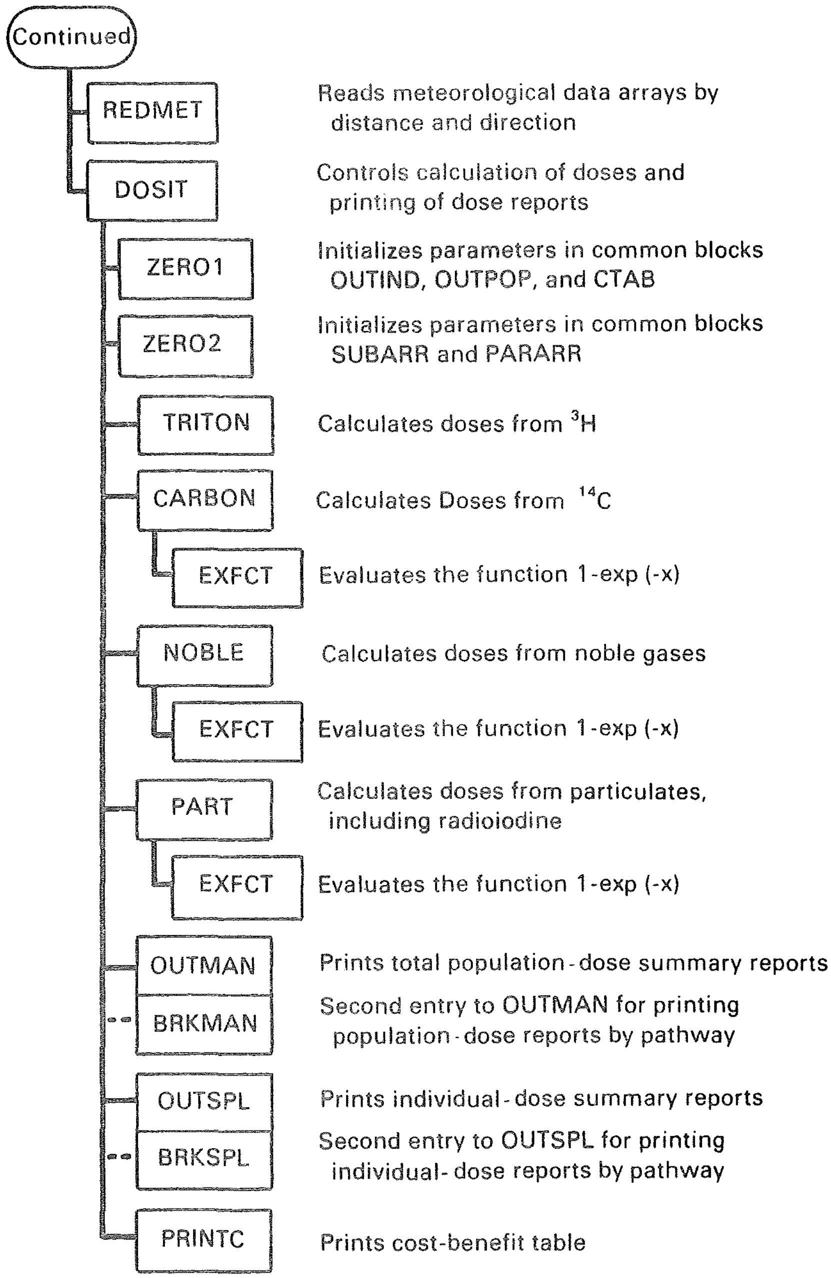


FIGURE 4.1. GASPAR II Subroutine Calling Sequence

Table 4.1 indicates the subroutines from which each record type is read. All records in this table are read from the default unit 9 except the dose-factor library, which is read from unit 20. The meteorological records are read either from unit 9 or 7. The user may change the standard input logical unit from 9 to another value through the common block DEVICE parameter IDEV.

FIGURE 4.1. (Contd)



This parameter is set to 9 in a data statement at the beginning of the main program. Changing the definition of IDEV will change the input logical unit for all input record reads. The optional meteorological records are read from unit JDEV, which is defined in the main program also. The logical unit may be changed by modifying the defining statement in the main program.

TABLE 4.1. Data Input Locations

Module Name	Record Type	Record Description
MAIN	1.0	Plant title
	2.0	Control parameters
	3.0	Site information
	13.n	Special-location data
BLKDAT	2.1	Block data changes
REDDF	---	Dose-factor data file
REDMET	9 (record set)	$\bar{\bar{X}}$/Q' data
	10 (record set)	$\bar{\bar{X}}$/Q' decayed
	11 (record set)	$\bar{\bar{X}}$/Q' decayed/depleted
	12 (record set)	D/Q deposition
REDSIT	4 (record set)	Population data
	5 (record set)	Milk production data
	6 (record set)	Meat production data
	7 (record set)	Vegetable production data
SOURCE	8 (record set)	Source-term data

Output reports generated by GASPAR II are described in Table 4.2. The table indicates the modules from which each report is printed. Many of the reports are optional depending on input data and input control integers. Reports selected by control integers are indicated in Table 4.3.

TABLE 4.2. Summary of Output Report Definitions

Report	Module	Description of Report
1	MAIN	Banner page
2a	PRINTB	Transfer parameters
2b	PRINTB	Physical parameters
2c	PRINTB	Usage parameters
3a	REDDF	Ingestion dose factors - 4 tables (adult, teen, child, infant)
3b	REDDF	Inhalation dose factors - 4 tables (adult, teen, child, infant)
3c	REDDF	Ground exposure external dose factors
3d	REDDF	Noble gas dose factors
3e	REDDF	Radiological decay constants
4a	MAIN/PRINTM	Site data - population and milk production

TABLE 4.2. (Contd)

Report	Module	Description of Report
4b	MAIN/PRINTM/AGPROD	Site data - meat and vegetable production and production summary
5a	MAIN/SOURCE	Job control/agricultural parameters and first source term
5b	MAIN/SOURCE	Additional source terms
6a	MAIN/PRINTM	Site meteorological data - $\bar{X}/Q'$ and $\bar{X}/Q'$ decayed
6b	MAIN/PRINTM	Site meteorological data - $\bar{X}/Q'$ decayed/depleted and D/Q
7	MAIN	Special-location meteorological data
8	DOSIT	Environmental activity summary
9a	OUTMAN	ALARA pathway summary
9b	OUTMAN	NEPA pathway summary
10a	OUTMAN	ALARA radionuclide totals
10b	OUTMAN	NEPA radionuclide totals
11a	OUTMAN	ALARA radionuclide plume detail
11b	OUTMAN	NEPA radionuclide plume detail
12a	OUTMAN	ALARA radionuclide ground-exposure detail
12b	OUTMAN	NEPA radionuclide ground-exposure detail
13a	OUTMAN	ALARA radionuclide inhalation detail
13b	OUTMAN	NEPA radionuclide inhalation detail
14a	OUTMAN	ALARA radionuclide vegetable-ingestion detail
14b	OUTMAN	NEPA radionulcide vegetable-ingestion detail
15a	OUTMAN	ALARA radionuclide cow-milk ingestion detail
15b	OUTMAN	NEPA radionuclide cow-milk ingestion detail
16a	OUTMAN	ALARA radionuclide meat-ingestion detail
16b	OUTMAN	NEPA radionuclide meat-ingestion detail
17	OUTSPL	Special location, pathway summary
18	OUTSPL	Special location, radionuclide plume detail
19	OUTSPL	Special location, radionuclide ground-exposure detail
20a	OUTSPL	Special location, radionuclide vegetable-ingestion detail (adult)
20b	OUTSPL	Special location, radionuclide vegetable-ingestion detail (teen)
20c	OUTSPL	Special location, radionuclide vegetable-ingestion detail (child)

TABLE 4.2. (Contd)

Report	Module	Description of Report
20d	OUTSPL	Special location, radionuclide vegetable-ingestion detail (infant)
21a	OUTSPL	Special location, radionuclide meat-ingestion detail (adult)
21b	OUTSPL	Special location, radionuclide meat-ingestion detail (teen)
21c	OUTSPL	Special location, radionuclide meat-ingestion detail (child)
21d	OUTSPL	Special location, radionuclide meat-ingestion detail (infant)
22a	OUTSPL	Special location, radionuclide cow-milk ingestion detail (adult)
22b	OUTSPL	Special location, radionuclide cow-milk ingestion detail (teen)
22c	OUTSPL	Special location, radionuclide - cow-milk ingestion detail (child)
22d	OUTSPL	Special location, radionuclide - cow-milk ingestion detail (infant)
23a	OUTSPL	Special location radionuclide goat-milk ingestion detail (adult)
23b	OUTSPL	Special location radionuclide goat-milk ingestion detail (teen)
23c	OUTSPL	Special location radionuclide goat-milk ingestion detail (child)
23d	OUTSPL	Special location radionuclide goat-milk ingestion detail (infant)
24a	OUTSPL	Special location radionuclide inhalation detail (adult)
24b	OUTSPL	Special location radionuclide inhalation detail (teen)
24c	OUTSPL	Special location radionuclide inhalation detail (child)
24d	OUTSPL	Special location radionuclide inhalation detail (infant)
25a	PRINTC	ALARA cost-benefit report
25b	PRINTC	NEPA cost-benefit report
26	PARTS	Normalized dose factors for 10 CFR 50 (one report for each combination of age group and organ)
27	PARTS	Normalized dose factors for 10 CFR 20 (one report for each organ for infant age group)

TABLE 4.3. Output Reports Selected by Control Integers

Control Integer	Record	Input Value	Report Response
JC(1)	2.0	0	Population and special-location individual doses may be calculated.
		1	Only special-location individual doses are calculated.
JC(3)	2.0	0	All dose reports are printed, limited by the value of JC(1). Note: If doses in a report are zero, then the report is not printed. Cumulative dose reports are printed for each source term.
		1	Same as above except print totals only after final source term.
JC(4)	2.0	0	No block data records are read and no type 2 reports are printed.
		>0	A report is printed for each common block changed - TRANFR (report 2a), PHYS (report 2b), and USAGE (report 2c).
JC(5)	2.0	0	No dose-factor library reports are printed.
		1	Reports 3a-3e are printed (dose factor library data).
JC(6)	2.0	0	No normalized dose-factor reports are printed.
		1	Reports 26 and 27 are printed (normalized dose factors).
JS(n)	13.n	0	Printing of individual dose reports (18-24) is controlled by integer JSS (see below).
		1	No details are printed by radionuclide for special location n.
JSS(n,i)	13.n	0	Reports of dose by radionuclide are printed for special location n and pathway i. Pathways are: 1 - plume, 2 - ground exposure, 3 - vegetable ingestion, 4 - meat ingestion, 5 - cow milk ingestion, 6 - goat milk ingestion, 7 - inhalation. Note: JSS has effect only when JS(n)=0.
		>0	Reports of dose by radionuclide are not printed for special location n and pathway i.

4.2 COMPUTER REQUIREMENTS

The version of GASPAR II presented in this report has been implemented on a VAX[a] 11/780 computer with the VAX FORTRAN 77 compiler. GASPAR II has also

(a) VAX is a registered trademark of Digital Equipment Corporation, Maynard, Massachusetts.

been implemented on a Data General MV8000[a] with a FORTRAN 77 compiler. Standard FORTRAN programming practices have been used in GASPAR II so that the program can easily be adapted to other computers with FORTRAN 77 compilers. The one known, nonstandard code line in GASPAR II is the call to the system date routine, DATE, called by the main program to provide the current date for the banner page. The call to DATE returns a character representation of the current date in the argument DATE. Also printed on the banner page is a title describing the current version. This title is set in MAIN in a format statement and should be changed to reflect the current application.

GASPAR II is a rapid-running program. Sample Problems 1, 2, and 3 of Section 2.2 are executed in 27, 23, and 13 sec of CPU (central processing unit) time, respectively.

4.3 COMMON BLOCKS

GASPAR II uses 21 common blocks to handle most data transfers between modules. A general description of each common block is provided below:

Common Block	Description
ACPOP	Population served by agricultural production
BLANK	Purge release time
CTAB	Cost-benefit table data
DEVICE	Logical input unit device
DFLIB	Dose conversion factors
ELEMEN	Element symbols
METDTA	Site meteorological data
NUKES	Current radionuclide parameters
OUTIND	Results of individual dose calculations
OUTPOP	Results of population dose calculations
PARARR	Intermediate dose results
PHYS	Miscellaneous physical parameters
POPLIN	Population distribution information
SITE	Site-specific agricultural information
SORCE	Radionuclide index information
SPECIL	Special-location atmospheric dispersion factors
SPIDEN	Distance and direction indicies of special locations
SPLOC	Titles for special locations
SUBARR	Intermediate air-submersion doses
TRANFR	General agricultural parameters
USAGE	General pathway usage parameters

(a) MV8000 is a registered trademark of the Data General Corporation, Southboro, Massachusetts.

Table 4.4 shows the modules that reference each common block. Modules EXFCT and PRINTM reference no common blocks and are not included in the table. Each of the common blocks used in GASPAR II is described in greater detail in the sections that follow. Information is provided on parameter order, array size, and parameter uses and definitions.

TABLE 4.4. Common Block Usage in GASPAR II

Module Name	AGPOP	BLANK	CTAB	DEVICE	DFLIB	ELEMEN	METDTA	NUKES	OUTIND	OUTPOP	PARARR
MAIN	---	---	---	used	---	---	used	---	---	---	---
AGPROD	used	---	---	---	---	---	---	---	---	---	---
BLKDAT	---	---	---	used	---	---	---	---	---	---	---
BLKDATA	---	---	---	---	used	used	---	---	---	---	---
CARBON	used	used	---	---	used	---	---	used	---	---	used
DOSIT	---	---	used	---	used	used	used	used	used	used	---
NOBLE	---	---	---	---	used	---	---	used	---	---	---
OUTMAN	---	---	---	---	---	used	---	---	---	used	---
OUTSPL	---	---	---	---	---	used	---	---	used	---	---
PART	used	---	---	---	used	---	---	used	---	---	used
PARTS	---	---	---	---	used	used	---	used	used	---	used
PRINTB	---	---	---	---	---	used	---	---	---	---	---
PRINTC	---	---	used	---	---	used	---	---	---	---	---
REDDF	---	---	---	---	used	used	---	---	---	---	---
REDMET	---	---	---	used	---	---	---	---	---	---	---
REDSIT	---	---	---	used	---	---	---	---	---	---	---
SOURCE	---	used	used	used	used	used	---	---	---	---	---
TRITON	used	---	---	---	used	---	---	used	---	---	used
ZERO1	---	---	used	---	---	---	---	---	used	used	---
ZERO2	---	---	---	---	---	---	---	---	---	---	used
ZERO3	---	---	---	---	used	---	---	---	---	---	---

Module Name	PHYS	POPLIN	SITE	SORCE	SPECIL	SPIDEN	SPLOC	SUBARR	TRANFR	USAGE
MAIN	---	used	used	---	used	used	used	---	---	---
AGPROD	---	---	---	---	---	---	---	---	---	used
BLKDAT	used	---	---	---	---	---	---	---	used	used
BLKDATA	used	---	---	used	---	---	---	---	used	used
CARBON	used	used	used	---	---	---	---	---	used	used
DOSIT	used	---	---	used	used	---	---	used	used	---
NOBLE	used	used	---	used	---	---	---	used	---	used
OUTMAN	---	---	---	used	---	---	---	---	---	---
OUTSPL	---	---	---	used	---	used	used	---	---	---
PART	used	used	used	used	---	---	---	---	used	used
PARTS	used	---	---	used	---	---	---	used	used	---
PRINTB	used	---	---	---	---	---	---	---	used	used
PRINTC	---	---	---	used	---	---	---	---	---	---
REDDF	---	---	---	used	---	---	---	---	---	---
REDMET	---	---	---	---	---	---	---	---	---	---
REDSIT	---	---	---	---	---	---	---	---	---	---
SOURCE	---	---	---	used	---	---	---	---	---	---
TRITON	used	used	used	---	---	---	---	---	used	used
ZERO1	---	---	---	---	---	---	---	---	---	---
ZERO2	---	---	---	---	---	---	---	used	---	---
ZERO3	---	---	---	used	---	---	---	---	---	---

4.3.1 Common Block AGPOP

Common block AGPOP contains three parameters giving the total population served by production within 50 mi for 1) vegetables, XVEG; 2) milk, XMLK; and 3) meat, XMET. The values are calculated in subroutine AGPROD from population fraction data and average per capita consumption of each food by individuals in each age group.

4.3.2 Common Block BLANK

The only parameter in common block BLANK is the total annual release time in hr (PURGE) for a purge source term. The parameter is only used in the calculation of individual doses from ^{14}C.

4.3.3 Common Block CTAB

Common block CTAB contains data and index information for the cost-benefit table printed by subroutine PRINTC. A description of these parameters is given in Table 4.5.

TABLE 4.5. Common Block CTAB

Parameter Name	Type	Description
LST(10,10)	Integer	Array for source-term titles - 10 titles of up to 10 words each. The array is read and printed using character formats.
MAP(33,10)	Integer	Location of data in library data arrays for each radionuclide (33) in each source term (10). The array is established in subroutine DOSIT.
COST(39,3,10)	Real	Array for calculated results of the cost-benefit table of population doses. The 39 positions of the first index have the following uses: 1-33, individual radionuclide data 34, subtotals for noble gases 35, subtotals for iodine 36, subtotals for particulates 37, subtotals for carbon-14 38, subtotals for tritium 39, totals for all radionuclides. The second index (3) is for: 1, Ci released 2, total-body dose 3, thyroid dose. The last index (10) is for each source term.

4.3.4 Common Block DEVICE

Common block DEVICE contains the logical unit used for input of standard input records (IDEV). IDEV is defined in the main program (the default value is 9).

4.3.5 Common Block DFLIB

Common block DFLIB contains dose conversion factors and radiological decay constants as provided in the dose-factor data file that is read in subroutine REDDF. Parameters included in this common block are described in Table 4.6.

4.3.6 Common Block ELEMEN

Common block ELEMEN includes the element symbol array IELEM(100). This array contains the two-character name for each element, left justified. Values for IELEM are defined in data statements in the block data module BLKDATA. The array type is integer*2.

TABLE 4.6. Common Block DFLIB

Parameter Name	Type	Description
DFL(750,7)	Real	50-yr dose commitment factors for 1 yr of uptake by ingestion (mrem/pCi ingested). Values are supplied for adults first (for each radionuclide), then for teens, children, and infants (a total of 750 radionuclide/age combinations is allowed). Data for 7 organs may be given. Current organ order is bone, liver, total-body, thyroid, kidney, lung, and GI-LLI.
DFA(750,7)	Real	50-yr dose commitment factors for 1 yr of uptake by inhalation. Usage is as for array DFL. Dose factors for noble gases are stored at the beginning of the adult portion of the DFA array. The noble gas data are defined in BLKDATA with usage as follows: 1. bone, gamma air-dose factor 2. liver, beta air-dose factor 3. total-body, total-body dose factor 4. thyroid, beta skin-dose factor 5. lung, lung-inhalation dose factor.
EXG(200,2)	Real	External dose conversion factor for exposure to contaminated ground (mrem/hr per pCi/m^2). Values are read from the "adult" portion of the data library for up to 200 radionuclides. The first position of the second array index is for skin dose, and the second position is for total-body dose.
TAU(200)	Real	Radiological decay constant for each radionuclide (hr^{-1}).

4.3.7 Common Block METDTA

Meteorological dispersion factors are stored in common block METDTA. The data are read by subroutine REDMET, with data arrays being passed through the argument list. Each array is of dimension 160, for 160 area elements defined by 16 compass directions and 10 downwind distances. Table 4.7 describes the four parameter arrays in common block METDTA.

4.3.8 Common Block NUKES

Common block NUKES contains parameters for the current radionuclide under consideration in subroutines DOSIT and PARTS. The number of special locations is also included. A description of the parameters in common block NUKES is given in Table 4.8.

4.3.9 Common Block OUTIND

Common block OUTIND is used to transfer results of individual dose calculations between DOSIT and PARTS (where values are set) and OUTSPL (where reports are printed). The parameters in OUTIND are initialized to zero in subroutine ZERO1. The large arrays in the common block have data stacked according to the following equivalent dimensions: (33,5,8,4), where 33 is the maximum number of radionuclides in the source term, 5 is the maximum number of special locations, 8 is the number of organs, and 4 is the number of age groups. The order of the organ data is bone, liver, total-body, thyroid, kidney, lung, gastrointestinal tract (lower large intestine), and skin. The age-group order is adult, teen, child, and infant. A description of parameter arrays in common block OUTIND is given in Table 4.9.

TABLE 4.7. Common Block METDTA

arameter Name	Type	Description
XQ(160)	Real	Normalized air concentration at each downwind area element for 16 compass directions and 10 distances (sec/m^3). Distance intervals are bounded by the following distances (mi): 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50.
XQD(160)	Real	Normalized air concentration with decay based on a half-life of 2.26 days.
XQDD(160)	Real	Normalized air concentration with decay (for 8-day half-life) and depletion of the plume included (sec/m^3).
DEP(160)	Real	Normalized ground-deposition factor (m^{-2}) at each area element.

TABLE 4.8. Common Block NUKES

Parameter Name	Type	Description
LOC(4)	Integer	Location of data for current radionuclide in library data arrays. The four values are for adult, teen, child, and infant age groups.
ENIV	Real	Concentration of the current radionuclide in the environment at the midpoint of plant life (Ci).
TGRD	Real	Total activity of the current radionuclide on the ground within 50 mi at the midpoint of plant life (Ci).
TVEG	Real	Total activity of the current radionuclide in crops produced within 50 mi at the midpoint of plant life (Ci)
TMLK	Real	Total activity of the current radionuclide in cow milk produced within 50 mi (Ci).
TMET	Real	Total activity of the current radionuclide in meat produced within 50 mi (Ci).
NSP	Integer	Number of special locations to be considered for individual dose calculations: $0 \leq NSP \leq 5$. This parameter is referred to as NSPL in some modules.

TABLE 4.9. Common Block OUTIND

Parameter Name	Type	Description
SPLSUB(33,5,8)	Real	External dose from air submersion for each radionuclide, special location, and organ (mrem).
SPLGRD(33,5,8)	Real	External dose from exposure to contaminated ground for each radionuclide, special location, and organ (mrem).
SPLVEG(5280)	Real	Dose from ingestion of vegetables for each radionuclide, special location, organ, and age group (mrem).
SPLMET(5280)	Real	Same as SPLVEG for ingestion of meat (mrem).
SPLMLK(5280)	Real	Same as SPLVEG for ingestion of cow milk (mrem).
SPLGMK(5280)	Real	Same as SPLVEG for ingestion of goat milk (mrem).
SPLINH(5280)	Real	Dose from inhalation pathway for each radionuclide, special location, organ, and age group (mrem).
AIRGAM(5)	Real	Total air dose from photon radiation at each special location (mrad).
AIRBET(5)	Real	Total beta air dose at each special location (mrad).

4.3.10 Common Block OUTPOP

Common block OUTPOP contains results of the population dose calculations. Each of the six arrays in this common block contains information for up to 33 radionuclides, 8 organs, and ALARA and NEPA doses. The arrays of common block OUTPOP are described in Table 4.10.

4.3.11 Common Block PARARR

Common block PARARR transfers intermediate dose results for a radionuclide for population and individual dose calculations. Parameters of common block PARARR are initialized by subroutine ZERO2. The parameters are described in Table 4.11.

4.3.12 Common Block PHYS

Common block PHYS contains several physical parameters used in the dose calculations, including shielding factors, plant life, and environmental volumes. The parameters are described in Table 4.12.

4.3.13 Common Block POPLIN

Common block POPLIN contains information on the population distribution near the site. The parameters are described in Table 4.13.

TABLE 4.10. Common Block OUTPOP

Parameter Name	Type	Description
POPSUB(33,8,2)	Real	Population external dose from air submersion for up to 33 radionuclides, 8 organs and 2 dose types (ALARA and NEPA) (person-rem).
POPGRD(33,8,2)	Real	Population external dose from exposure to contaminated ground for up to 33 radionuclides, 8 organs and 2 dose types (ALARA and NEPA) (person-rem).
POPINH(33,8,2)	Real	Population dose from inhalation for up to 33 radionuclides, 8 organs and 2 dose types (ALARA and NEPA) (person-rem).
POPVEG(33,8,2)	Real	Population dose from ingestion of vegetables for up to 33 radionuclides, 8 organs and 2 dose types (ALARA and NEPA) (person-rem).
POPMLK(33,8,2)	Real	Population dose from ingestion of cow milk for up to 33 radionuclides, 8 organs and 2 dose types (ALARA and NEPA) (person-rem).
POPMET(33,8,2)	Real	Population dose from ingestion of meat for up to 33 radionuclides, 8 organs and 2 dose types (ALARA and NEPA) (person-rem).

TABLE 4.11. Common Block PARARR

Parameter Name	Type	Description
AA2(8,2)	Real	Population dose from external exposure to contaminated ground for each organ (8) and for ALARA and NEPA analyses (person-rem).
AA3(8,2)	Real	Population dose from inhalation for each organ (8) and for ALARA and NEPA analyses (person-rem).
AA4(8,2)	Real	Population dose from vegetable ingestion for each organ (8) and for ALARA and NEPA analyses (person-rem).
AA5(8,2)	Real	Population dose from milk ingestion for each organ (8) and for ALARA and NEPA analyses (person-rem).
AA6(8,2)	Real	Population dose from meat ingestion for each organ (8) and for ALARA and NEPA analyses (person-rem).
A2(5,8)	Real	Individual external dose from ground exposure for each special location (5) and organ (8) (mrem).
A3(5,8,4)	Real	Individual dose from inhalation for each special location (5), organ (8) and age group (4) (mrem).
A4(5,8,4)	Real	Individual dose from vegetable ingestion for each special location (5), organ (8), and age group (4) (mrem).
A5(5,8,4)	Real	Individual dose from cow-milk ingestion for each special location (5), organ (8), and age group (4) (mrem).
A6(5,8,4)	Real	Individual dose from meat ingestion for each special location (5), organ (8), and age group (4) (mrem).
A7(5,8,4)	Real	Individual dose from goat-milk ingestion for each special location (5), organ (8), and age group (4) (mrem).

TABLE 4.12. Common Block PHYS

Parameter Name	Type	Description
AREA(10)	Real	Area within each element of a 22.5° sector (m^2).
PLIFE	Real	Midpoint of plant life (sec).
SF	Real	Shielding factor for individuals (dimensionless).
SSF	Real	Shielding factor for the population (dimensionless).
VHS	Real	Hydrosphere water volume for tritium dose calculation (L).
VNA	Real	Volume of the atmosphere for U.S. dose calculation (m^3).
FID	Real	Fraction of iodine that may deposit (dimensionless).

TABLE 4.13. Common Block POPLIN

Parameter Name	Type	Description
POP(160)	Real	Population data for the site for each area element beginning in the north sector (clockwise). The data are organized in a 16-by-10 array (16 directions, 10 distances).
PERSON	Real	Total population within 50 mi of the site.
PDEN	Real	Multiple uses: 1) average population density within 50 mi of the site; 2) PDEN is also used as the average population density of the eastern U.S. (persons/m^2).
CD	Real	The distance from the facility to the northeast corner of the U.S. (Maine) (mi).

TABLE 4.14. Common Block SITE

Parameter Name	Type	Description
ZMILK(160)	Real	Production of milk within each area element for 16 directions and 10 distances (L/yr).
ZMEAT(160)	Real	Production of meat within each area element for 16 directions and 10 distances (kg/yr).
ZVEGT(160)	Real	Production of vegetables within each area element for 16 directions and 10 distances (kg/yr).
ZMLKT	Real	Total milk production within 50 mi (L/yr).
ZMETT	Real	Total meat production within 50 mi (kg/yr).
ZVEGTT	Real	Total vegetable production within 50 mi (kg/yr).
DMLK	Real	Average milk production for the site (L/m^2/yr).
DMET	Real	Average meat production for the site (kg/m^2/yr).
DVEG	Real	Average vegetable production for the site (kg/m^2/yr).
FV	Real	Fraction of leafy vegetable intake for individuals that is grown in local gardens (dimensionless).
FP	Real	Fraction of a yr that cows are on pasture (dimensionless).
H	Real	Average absolute humidity for the growing season (g/m^3).
JC(10)	Integer	Main job control integer array. The first seven values are used as follows: JC(1), input deck type JC(2), number of releases JC(3), dose accumulation JC(4), block data changes JC(5), dose-factor reports JC(6), unit dose-factor calculation JC(7), meteorological data input.
FPF	Real	Fraction of cow feed derived from pasture while cows are on pasture (dimensionless).

TABLE 4.14. (Contd)

Parameter Name	Type	Description
FG	Real	Fraction of vegetable intake for individuals that is grown in the local gardens (dimensionless).
FGT	Real	Fraction of a yr that goats are on pasture (dimensionless).
FPG	Real	Fraction of goat feed derived from pasture while goats are on pasture (dimensionless).
FB	Real	Fraction of a yr that beef are on pasture (dimensionless).
FBF	Real	Fraction of beef feed derived from pasture while beef are on pasture (dimensionless).

4.3.14 Common Block SITE

Common block SITE contains site-specific parameters related to agricultural production, plus the main control integer array JC(10). The parameters are described in Table 4.14.

4.3.15 Common Block SORCE

Common block SORCE contains index information on data that are provided in the dose-factor data file. A description of the parameters in common block SORCE is given in Table 4.15. These parameters are defined or calculated in subroutine REDDF, except for NGASES, which is defined in BLKDATA.

4.3.16 Common Block SPECIL

Common block SPECIL contains atmospheric dispersion factors for each special location. The factors are read in the main program. A description of the parameters is given in Table 4.16.

4.3.17 Common Block SPIDEN

Common block SPIDEN contains the two integer arrays IDIR(5) and IDIST(5), which indicate the direction and distance of the area element to which each special location corresponds. The north direction corresponds to direction 1, and other directions are numbered clockwise. The near distance is numbered as 1.

TABLE 4.15. Common Block SORCE

Parameter Name	Type	Description
IZ(750)	Integer	Atomic number of each radionuclide in the dose-factor file for each age group. Four lists of radionuclides are defined by arrays IZ and IMASS. The length of each list is determined by NLIBA, NLIBT, NLIBC, and NLIBI. The lists are for age groups adult, teen, child, and infant.
IMASS(750)	Integer	Atomic mass of each radionuclide in the dose-factor file for each age group.
META(750)	Integer	Metastable state indicator for each radionuclide in the dose-factor file for each age group. META is read and printed as a character parameter.
NGASES	Integer	Number of noble gases for which data are given at the beginning of the adult portion of dose-factor arrays.
NLIBA	Integer	Number of radionuclides for which dose factors are provided for adults (includes noble gases).
NLIBT	Integer	Total number of radionuclides for which dose factors are provided for adults and teens.
NLIBC	Integer	Total number of radionuclides for which dose factors are provided for adults, teens, and children.
NLIBI	Integer	Total number of radionuclides for which dose factors are provided for adults, teens, children, and infants. Note: $0 \leq NGASES < NLIBA \leq NLIBT \leq NLIBC \leq NLIBI$.

TABLE 4.16. Common Block SPECIL

Parameter Name	Type	Description
XQ1(5)	Real	Normalized air concentration at each special location (sec/m^3).
XQD1(5)	Real	Normalized air concentration at each special location with decay correction in transit for a half-life of 2.26 days (sec/m^3).
XQDD1(5)	Real	Normalized air concentration at each special location corrected for decay (half-life of 8 days) and plume depletion in transit (sec/m^3).
DEP1(5)	Real	Normalized ground concentration at each special location (m^{-2}/yr).

4.3.18 Common Block SPLOC

A descriptive name for each special location is the only parameter in common block SPLOC. The character array NAME(5,2) contains two eight-character words to describe each of the five special locations. The names are read in MAIN on record type 13.n.

4.3.19 Common Block SUBARR

Common block SUBARR contains intermediate results of air-submersion dose calculations for the current radionuclide. The parameters are initialized by subroutine ZERO2. Table 4.17 indicates the usage of each parameter of common block SUBARR.

4.3.20 Common Block TRANFR

Common block TRANFR contains several food-crop pathway parameters. Default values for these parameters are set in block data BLKDATA and may be changed with block data change records read by subroutine BLKDAT. A description of parameters in common block TRANFR is given in Table 4.18.

4.3.21 Common Block USAGE

Common block USAGE contains general exposure pathway usage and consumption parameters. Default values for these parameters are set in BLKDATA and may be changed with block data change records read in subroutine BLKDAT. Parameters in common block USAGE are described in Table 4.19.

4.4 MODULE DESCRIPTIONS

Details of each of the 23 modules of the GASPAR II computer program are provided in this section. A list of the modules and a brief description of the purpose of each module is presented in Table 4.20. Information in the following sections describes all modules in detail. Listings of all subroutines are included in Appendix B (microfiche).

TABLE 4.17. Common Block SUBARR

Parameter Name	Type	Description
AA1(8,2)	Real	Population doses from external exposure to the plume for each organ (8) and for ALARA and NEPA analyses (person-rem).
A1(5,8)	Real	Individual doses from external exposure to the plume for each special location (5) and each organ (8) (mrem).
A(5)	Real	Total air dose from photon radiation at each special location (mrad).
B(5)	Real	Total air dose from beta radiation at each special location (mrad).

TABLE 4.18. Common Block TRANFR

Parameter Name	Type	Description
BLDAY	Real	Growing period of vegetables consumed by humans (days).
COWIN	Real	Rate of feed ingestion by milk cows (kg/day).
GOATIN	Real	Rate of feed ingestion by milk goats (kg/day).
IGOT(14)	Integer	Atomic numbers of elements for which goat-milk transfer factors are given in array ZGMLK.
PARTUP	Real	Retention factor on vegetables for particulates other than iodine.
REMVEG	Real	Vegetation weathering-removal constant corresponding to half-time of 14 days (sec^{-1}).
SD	Real	Effective surface density of soil (kg/m^2).
SOIL(100)	Real	Transfer factor from soil to plants for each element (Ci/kg plant per Ci/kg soil).
VIORET	Real	Retention fraction of iodine on vegetables (dimensionless).
YA1	Real	Pasture grass yield (kg/m^2).
YA2	Real	Feed-crop yield (kg/m^2).
YV	Real	Vegetable-crop yield from garden (kg/m^2).
ZGMLK(14)	Real	Feed-to-milk transfer factors for goats for elements identified in array IGOT (days/L).
ZMET(100)	Real	Feed-to-meat transfer factors for each element (days/kg).
ZMLK(100)	Real	Feed-to-milk transfer factors for cows for each element (days/L).
TIM(8)	Real	Holdup and transport times as follows (default values in parentheses): TIM(1), transport of meat to population and maximum individual (20 days) TIM(2), transport of milk to population (4 days) TIM(3), Vegetable harvest to consumption holdup time for populations (60 days) TIM(4), maximum individual vegetable holdup time (14 days) TIM(5), maximum individual milk holdup time (2 days) TIM(6), maximum individual leafy vegetable holdup time (1 day) TIM(7), pasture grazing period (30 days) TIM(8), animal feed storage time (90 days).

Information provided in the following sections describes the purpose of each module, interactions with other modules (control and data transfer), and details of structure and logic useful for modification of the program.

TABLE 4.19. Common Block USAGE

Parameter Name	Type	Description
AVINH(3)	Real	Average inhalation rates for three age groups: 1) infant and child, 2) teen, and 3) adult (m^3/yr).
AVLVEG(3)	Real	Average annual leafy vegetable intake rate for three age groups: 1) infant and child, 2) teen, and 3) adult (m^3/yr).
AVMET(3)	Real	Average annual meat intake per individual for three age groups: 1) infant and child, 2) teen, and 3) adult (kg/yr).
AVMLK(3)	Real	Average annual milk intake per individual for three age groups: 1) infant and child, 2) teen, and 3) adult (kg/yr).
AVVEG(3)	Real	Average annual vegetable intake per individual for three age groups: 1) infant and child, 2) teen, and 3) adult (kg/yr).
POPF(3)	Real	Fraction of population in each age group: 1) infant and child, 2) teen, and 3) adult
	USPOP	Real Estimated U.S. population for the year 2010.
SLVEG(4)	Real	Annual leafy vegetable intake for the maximally exposed individual for four age groups: 1) infant, 2) child, 3) teen, and 4) adult (kg/yr).
SPINH(4)	Real	Annual inhalation volume for the maximally exposed individual for four age groups: 1) infant, 2) child, 3) teen, and 4) adult (m^3/yr).
SPMET(4)	Real	Annual meat intake for the maximally exposed individual for four age groups: 1) infant, 2) child, 3) teen, and 4) adult (kg/yr).
SPMLK(4)	Real	Annual milk intake for the maximally exposed individual for four age groups: 1) infant, 2) child, 3) teen, and 4) adult (L/yr).
SPVEG(4)	Real	Annual vegetable intake for the maximally exposed individual for four age groups: 1) infant, 2) child, 3) teen, and 4) adult (kg/yr).

4.4.1 MAIN Program

The main program MAIN controls case iteration; input of record types 1.0, 2.0, 3.0, and 13.n; and calls subroutines to read the dose-factor library, modify block data parameter values, and calculate doses. Subroutines called by MAIN are AGPROD, BLKDAT, DOSIT, PARTS, PRINTM, REDDF, REDMET, and REDSIT. Common blocks referenced by MAIN are DEVICE, METDTA, POPLIN, SITE, SPECIL, SPIDEN, and SPLOC.

TABLE 4.20. Module Summary for GASPAR II

Module Name	Type	Description
MAIN	Main program	Controls case iteration.
ACPROD	Subroutine	Computes agricultural productivity consumed in and exported from the 50-mi region.
BLKDAT	Subroutine	Reads input records and changes parameter values in common blocks PHYS, TRANFR, and USAGE.
BLKDATA	Block Data	Sets default values for several parameters.
CARBON	Subroutine	Calculates doses from ^{14}C releases.
DOSIT	Subroutine	Controls dose calculations.
EXFCT	Function	Evaluates the expression $1-e^{-x}$.
NOBLE	Subroutine	Calculates doses from noble gases.
OUTMAN	Subroutine	Prints output reports of population doses.
OUTSPL	Subroutine	Prints output reports of individual doses.
PART	Subroutine	Calculates doses from particulates and iodine.
PARTS	Subroutine	Controls calculation of special, normalized dose factors.
PRINTB	Subroutine	Prints reports of data in common blocks PHYS, TRANFR, and USAGE.
PRINTC	Subroutine	Prints report of cost-benefit results.
PRINTM	Subroutine	Prints partial reports of site data by distance and direction.
REDDF	Subroutine	Reads dose conversion factors and prints reports.
REDMET	Subroutine	Reads meteorological data.
REDSIT	Subroutine	Reads site population and agricultural production data.
SOURCE	Subroutine	Reads and identifies radionuclide-release data.
TRITON	Subroutine	Calculates doses from tritium.
ZERO1	Subroutine	Initializes arrays in common blocks CTAB, OUTIND, and OUTPOP.
ZERO2	Subroutine	Initializes arrays in common blocks PARARR and SUBARR.
ZERO3	Subroutine	Initializes arrays in common blocks DFLIB and SORCE.

A summary of the structure and control logic for MAIN is given in Figure 4.2. The following actions and tests are performed in the main program:

1. The logical unit for reading input records is set to 9 (parameter IDEV of common block DEVICE). To change the input unit, it is only necessary to change this one statement.

2. When meteorological data input is to be read from an alternate file [as indicated by JC(7)], the logical unit for the alternate file is set to 7 in MAIN.

3. The run will be terminated by any of four tests in MAIN. If a value of JC(2) is zero or negative, the run will be stopped and an error message printed. A zero or negative value given for CD (distance to northeastern corner of the United States) will also cause printing of an error message,

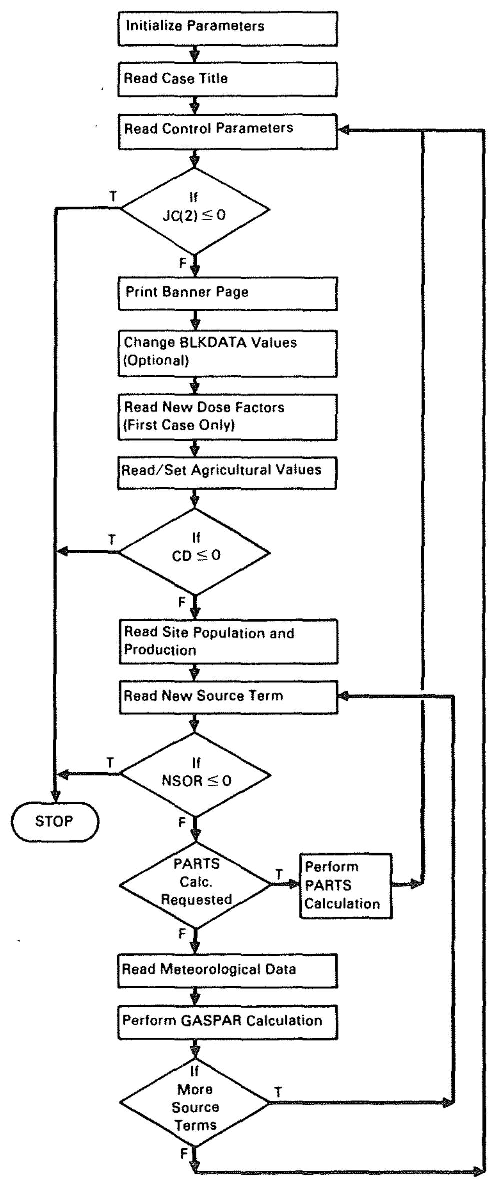


FIGURE 4.2. Main Program Structure and Control Logic

as will an error in a source-term specification that results in no identifiable radionuclides in a source inventory ($NSOR \leq 0$). The normal termination of a run is to reach an end-of-file marker at the control record input (first read at the start of additional input shown in Figure 4.2).

4. Site parameters are read (record type 3.0) and tested. If no value is given on the input record for a given parameter, a default value is used for the parameter. The one exception is for the parameter CD; a zero or negative value for CD will cause termination of the run.

5. If population doses have been requested [JC(1)=0], subroutine REDSIT is called four times to read on successive calls the site population, milk production, meat production, and vegetable production. Output reports are printed for each data set by calls to PRINTM. Titles for the output reports (types 4a and 4b) are printed in MAIN, and the bodies of the reports are printed in PRINTM.

6. Subroutine SOURCE is called to read the release inventory data (record set 8). The number of radionuclides in the current inventory is returned from SOURCE as parameter NSOR. A value of $NSOR < 1$ will cause termination of the run.

7. The parameter JC1, which is returned from the call to SOURCE, will cause input of new meteorological data to be skipped if $JC1 > 0$.

8. Meteorological data are read on four successive calls to subroutine REDMET. Information read on each call is as follows:

   (1) $\bar{\chi}/Q'$, undepleted and undecayed

   (2) $\bar{\chi}/Q'$, undepleted and decayed for a half-life of 2.26 days (^{133m}Xe)

   (3) $\bar{\chi}/Q'$, depleted and decayed for a half-life of 8 days (^{131}I)

   (4) D/Q, ground-deposition factors.

   Subroutine PRINTM is called after each call to REDMET to print the bodies of output reports 6a and 6b.

9. If special normalized dose factors are to be calculated [$JC(6) > 0$] then subroutine PARTS is called and control returns to the start of the next case.

10. Data for each special location are read (record set 13).
11. Subroutine DOSIT is called to control calculation and printing of doses for the current source term.
12. The parameter PDEN is first used to represent the average population density within 50 mi of the site. After this value has been printed, PDEN is reset to 6.18 x 10^{-5} (persons/m^2), representing the average population density in the eastern United States.

Internal parameters used in MAIN are described in Table 4.21.

TABLE 4.21. Internal Parameters for MAIN Program

Parameter Name	Type	Description
Area	Real	Total area within 50 mi (m^2).
I	Integer	Count index on special locations.
IDATE	Char*9	Date of run.
IPASS	Integer	Flag for counting the number of passes made in the current run.
ISOR	Integer	Count index on the number of source terms considered for the current pass.
ITITLE(78)	Char*1	Title describing the current calculations.
JC1	Integer	Control flag for meteorological data input: If JC1 and JC(1)=0, read data.
JDEV	Integer	Logical input unit for meteorological data (default is 7).
JS(5)	Integer	Control flag for printing reports for special locations: If JS(1)=1, no details printed If JS(1)≤0, printing controlled by flag array JSS.
JSS(5,7)	Integer	Control flag for special-location output reports for 5 locations and 7 exposure pathways. A zero value allows printing of details for the following pathways: 1) plume external dose, 2) ground external dose, 3) vegetable ingestion, 4) meat ingestion, 5) cow-milk ingestion, 6) goat-milk ingestion, and 7) inhalation.
LIST(33,4)	Integer	Location of data for input radionuclides (33) in master list for each age group (4).
LS(78)	Char*1	Title for site data read from REDSIT or REDMET.
NSDR	Integer	Number of radionuclides in the current source term.
NSPL	Integer	Number of special locations to be considered; $0 \le NSPL \le 5$.
NSR	Integer	Number of current source terms being considered for current case (incremented in SOURCE).
Q(33)	Real	Annual release of activity by radionuclide (Ci/yr).
T	Real	Average temperature over growing season (°F).
X	Real	Intermediate exponential argument in the evaluation of absolute humidity (H) from the average temperature (T).

4.4.2 Subroutine AGPROD

Subroutine AGPROD (called by MAIN) calculates the total production of agricultural products within 50 mi of the site and determines the amount (if any) available for export beyond the 50-mi region. The average individual consumption is estimated from the population fraction and consumption rates by age group. The population served is calculated by dividing the total production by the average individual consumption rate. If the population served is greater than the 50-mi population, the excess is exported. A subreport of output report 4b is printed giving a summary of productivity calculations performed by AGPROD. Common blocks AGPOP and USAGE are referenced by AGPROD. The argument parameters for subroutine AGPROD are described in Table 4.22, and the internal parameters are described in Table 4.23.

TABLE 4.22. Argument Parameters for Subroutine AGPROD

Parameter Name	Type	Description
PERSON	Real	Total population within the 50-mi region.
ZMETT	Real	Total annual production of meat within the 50-mi region (kg/yr).
ZMLKT	Real	Total annual production of milk within the 50-mi region (L/yr).
ZVEGTT	Real	Total annual production of vegetables within the 50-mi region (kg/yr).

TABLE 4.23. Internal Parameters for Subroutine AGPROD

Parameter Name	Type	Description
X1	Real	Annual amount of vegetable crops available for export from the 50-mi region (kg).
XV	Real	Average annual rate of vegetable consumption by the population (kg/person/yr).
Y1	Real	Annual amount of milk available for export from the 50-mi region (L).
YM	Real	Average annual rate of milk consumption by the population (L/person/yr).
Z1	Real	Annual amount of meat available for export from the 50-mi region (kg).
ZA	Real	Average annual rate of meat consumption by the population (kg/person/yr).

4.4.3 Subroutine BLKDAT

Subroutine BLKDAT is called by the main program to read block data change records (type 2.1) and change selected values of input parameters. Common blocks DEVICE, PHYS, TRANSFR, and USAGE are referenced in BLKDAT. Subroutine PRINTB is called to print reports for the common blocks for which parameters have been changed. The basic logic of BLKDAT is shown in Figure 4.3. Internal parameters used in BLKDAT are described in Table 4.24.

4.4.4 Block Data BLKDATA

Block data module BLKDATA establishes default values for all parameters in common blocks ELEMEN, PHYS, TRANSFR, and USAGE and for parameters related to noble gases in common blocks DFLIB and SORCE. Dose factors and radionuclide identification information are defined for noble gases. The noble gas data are set in the first positions of arrays, and data for other radionuclides are read from the data library and placed in the arrays following the noble gas data. The number of noble gas radionuclides currently considered is 14 (NGASES). BLKDATA is a block data definition module; it contains no executable statements and is not in the calling sequence.

4.4.5 Subroutine CARBON

Subroutine CARBON is called by DOSIT and PARTS to perform dose calculations for ^{14}C. CARBON uses function EXFCT and references common blocks AGPOP, DFLIB, NUKES, PARARR, PHYS, POPLIN, SITE, TRANFR, USAGE, and blank common.

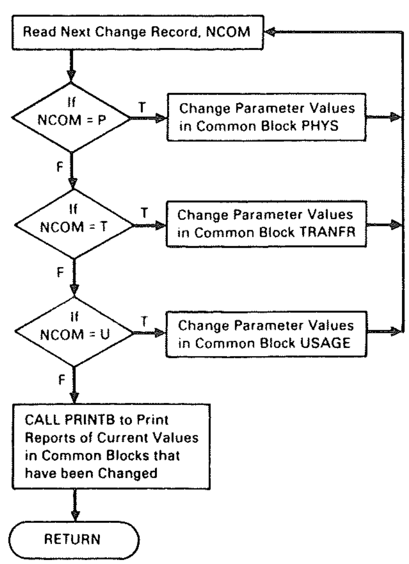


FIGURE 4.3. Module BLKDAT Logic Diagram

Special models are used in CARBON to calculate doses to the population and to individuals (see Chapter 3.0). The three real argument parameters for CARBON are: 1) Q, the release of ^{14}C in curies, 2) XB(160), the array of undepleted and undecayed, normalized dispersion factors for use in the 50-mi population dose (in sec/m^3); and 3) XQS(5), the undepleted and undecayed normalized dispersion factors for each special location (in sec/m^3). When CARBON is called from PARTS for the special dose-factor calculation, all input parameters have been set to 1.0.

Internal parameters used in CARBON are described in Table 4.25.

TABLE 4.24. Internal Parameters for Subroutine BLKDAT

Parameter Name	Type	Description
BLNK	Char*1	A blank character used for comparison with input characters.
DAT(100)	Real	Temporary storage array for input data values.
I1	Integer	Index for initial position in an array where data are provided on input record 2.1.
I2	Integer	Index for final position in an array where data are provided on input record 2.1.
IND	Integer	Calculated index for setting input data values into arrays.
N	Integer	Position index of a variable in the common block modified by input record 2.1.
NCOM	Char*1	Character indicating the labeled common block to be changed by input record 2.1: P=PHYS, T=TRANFR, U=USAGE.
NCRD	Integer	Number of additional input records read when more than 6 values of an array are being changed.
NDAT	Integer	Number of values to be changed in an array.
NF	Integer	Storage location (in array DAT) of first data value on input record 2.1 continuation records.
NFLAGP	Integer	Number of parameters changed in common block PHYS.
NFLAGT	Integer	Number of parameters changed in common block TRANFR.
NFLAGU	Integer	Number of parameters changed in common block USAGE.
NL	Integer	Location in array DAT for storage of the last data value on input record 2.1 continuation records.
P	Char*1	The letter "P" used for comparison with NCOM to identify modifications to common block PHYS.
T	Char*1	The letter "T" used for comparison with NCOM to identify modifications to common block TRANFR.
U	Char*1	The letter "U" used for comparison with NCOM to identify modifications to common block USAGE.

TABLE 4.25. Internal Parameters for Subroutine CARBON

Parameter Name	Type	Description
ARG1	Real	Intermediate argument in decay calculations.
ARG2	Real	Intermediate argument in decay calculations.
BOTB	Real	Bone-dose correction factor for carbon (dimensionless): BOTB=5, bone BOTB=1, other organs.
DCAR	Real	U.S. population dose from worldwide dispersion of carbon (person-rem).
W	Real	Concentration of ^{14}C in goat milk (pCi/L).
X	Real	Concentration of ^{14}C in vegetables (pCi/kg).
Y	Real	Concentration of ^{14}C in cow milk (pCi/L).
Z	Real	Concentration of ^{14}C in meat (pCi/kg).

4.4.6 Subroutine DOSIT

This module is called by the main program to control calculation of doses and printing of reports through calls to other subroutines. A general logic diagram for subroutine DOSIT is presented in Figure 4.4. DOSIT calls subroutines CARBON, NOBLE, OUTMAN, OUTSPL, PART, TRITON, ZERO1, and ZERO2, as indicated in Figure 4.4. Common blocks CTAB, DFLIB, ELEMEN, METDTA, NUKES, OUTIND, OUTPOP, PARARR, PHYS, SORCE, SPECIL, SUBARR, and TRANFR are referenced by DOSIT.

An inline function INDEX is defined in DOSIT to evaluate the position of data in arrays containing doses for special locations. The function is defined as follows:

$$\mathrm{INDEX}(I,J,K,L) = I + 33\{J - 1 + 5[K - 1 + 8(L - 1)]\}$$

where I = index for radionuclide
J = index for special location
K = index for organ
L = index for age group.

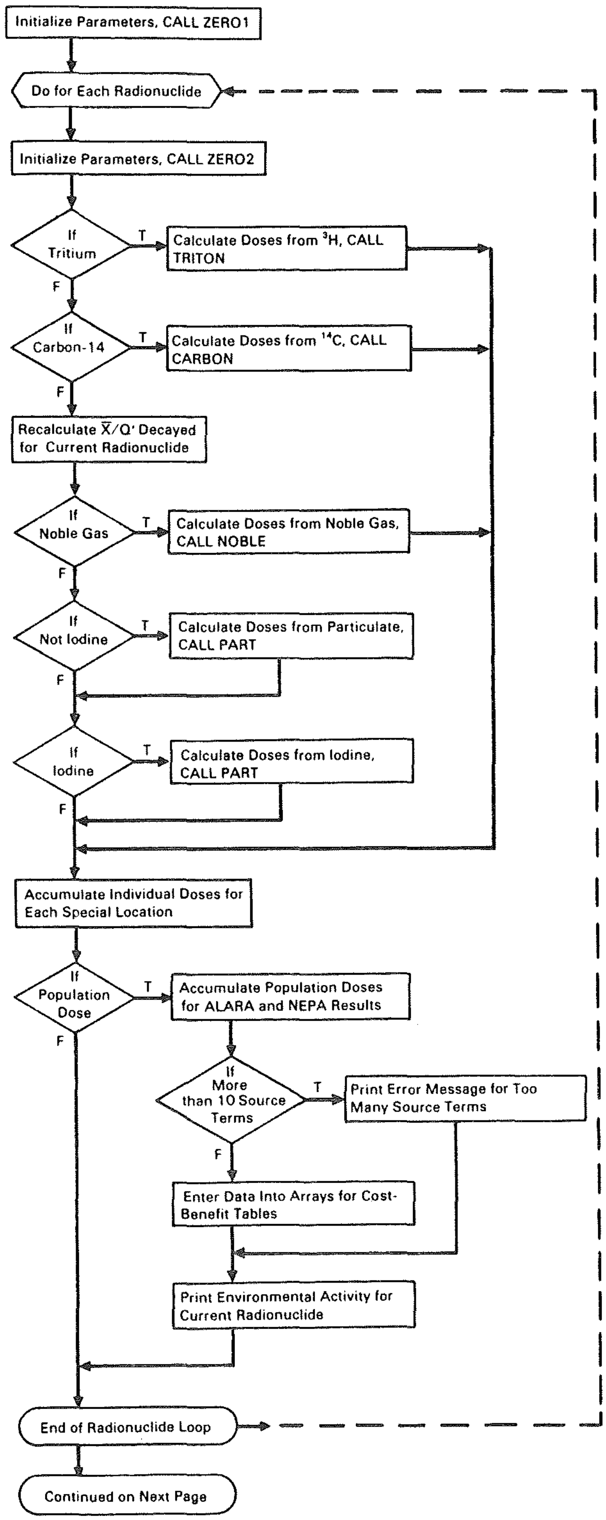
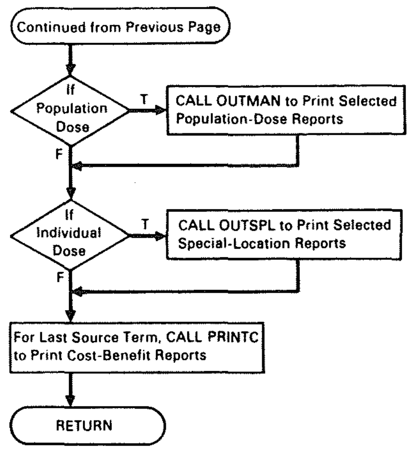


FIGURE 4.4. Module DOSIT Logic Diagram

FIGURE 4.4. (Contd)



The argument list parameters for DOSIT are described in Table 4.26 and internal parameters are described in Table 4.27.

4.4.7 Function EXFCT

Function EXFCT is used to evaluate the expression:

$$1-e^{-x}$$

where x is the dimensionless argument in the call list. The evaluation method depends on the value of the argument, x. If x is greater than or equal to 30, the function value is set to 1.0. If the argument is between 0.01 and 30, the above expression is evaluated with the system exponential function, EXP(-x). For argument values equal to or below 0.01, a numeric algorithm is used. This algorithm is defined as:

$$1 - e^{-x} = x + \frac{x^3}{6} - \frac{x^2}{2} - \frac{x^4}{24}$$

The only internal parameters are X2, X3, and X4, which represent x^2, x^3, and x^4, respectively. Function EXFCT is called by subroutines CARBON, NOBLE, and PART.

TABLE 4.26. Argument Parameters for Subroutine DOSIT

Parameter Name	Type	Description
ISOR	Integer	Index of current source term.
ITIT(78)	Integer	Title of current run.
JC(10)	Integer	Job control flags: JC(1), input deck type JC(2), number of releases JC(3), dose accumulation report selection JC(4), block data changes JC(5), dose-factor report selection JC(6), PARTS calculation JC(7), dispersion-factor input selection.
JS(5)	Integer	Control flag for printing of reports for special locations. If JS(i)=1, no details are printed If JS(i)≤0, printing is controlled by flag array JSS.
JSS(5,7)	Integer	Control flag for special-location output reports for 5 locations and 7 exposure pathways. A zero value allows printing of details for the specified pathway: (1) plume external, (2) ground external, (3) vegetable ingestion, (4) meat ingestion, (5) cow-milk ingestion, (6) goat-milk ingestion, (7) inhalation.
LIST(33,4)	Integer	Location index of data in the dose-factor arrays for each radionuclide in the source term (33) and each age group (4).
NSOR	Integer	Number of radionuclides in the current source term.
NSPL	Integer	Number of special locations to be considered.
Q(33)	Real	Release rate for each radionuclide in the source inventory (Ci/yr).

TABLE 4.27. Internal Parameters for Subroutine DOSIT

Parameter Name	Type	Description
ARG	Real	Exponential argument in radiological decay calculation (dimensionless).
DEPP(160)	Real	Normalized ground-deposition factor at each area element, corrected for decay for the current radionuclide (m^{-2}/yr).
DEPP1(5)	Real	Normalized ground concentration at each special location, corrected for decay for the current radionuclide (m^{-2}/yr).
IJKL	Integer	Calculated index for packing results into storage arrays for individual doses.
N	Integer	Count index on the number of radionuclides for which nonzero releases are given in the source term.
NSUB	Integer	Index of current radionuclide for storage of data into the result arrays for cost-benefit output reports (see COST).
NX	Integer	Maximum number of radionuclides allowed in the source term (33); used in the inline function INDEX.

TABLE 4.27. (Contd)

Parameter Name	Type	Description
NY	Integer	Maximum number of special locations (5); used in the inline function INDEX.
NZ	Integer	Maximum number of organs allowed (8); used in the inline function INDEX.
T	Real	Effective transit time to the current location through the atmosphere (hr).
TEST	Logical	Logical control flag indicating when the cost-benefit table is to be printed (set to .TRUE. when the report is to be printed).
TL	Real	Intermediate exponential term in the calculation of activity at the midpoint of plant life (hr).
VRET	Real	Retention fraction of current radionuclide on vegetables (dimensionless).
XEX	Real	Exponential argument for the calculation of decay correction in transit for atmospheric dispersion and deposition factors (dimensionless).
XMLT	Real	Correction factor for decay in transit for the current radionuclide in the calculation of atmospheric dispersion and deposition factors (dimensionless).
XQQ(160)	Real	Normalized air concentration at each area element with decay in transit for the current radionuclide (sec/m^3).
XQQ1(5)	Real	Normalized air concentration at each special location with decay in transit for the current radionuclide (sec/m^3).
XXQDD(160)	Real	Normalized air concentration at each area element with decay and deposition for the current radionuclide (sec/m^3).
XXQDD1(5)	Real	Normalized air concentration at each special location with decay and deposition for the current radionuclide (sec/m^3).

4.4.8 Subroutine NOBLE

Subroutine NOBLE is called by DOSIT to evaluate doses from noble gas radionuclides. NOBLE references common blocks DFLIB, NUKES, PHYS, POPLTN, SORCE, SUBARR, and USAGE. Doses are calculated from external exposure to airborne noble gases plus inhaled activity. Population doses (ALARA and NEPA) and individual doses at special locations are evaluated.

The four argument parameters of NOBLE are: 1) Q, activity of the current noble gas radionuclide released per yr (in Ci/yr); 2) XB(160), decayed but undepleted dispersion factor at each area element for use in the population dose calculation (in sec/m^3); 3) XQS(5), decayed but undepleted dispersion factor at each special location for use in individual dose calculations (in sec/m^3); and 4) JC, control integer array. Only the first position of the control integer array is used [JC(1)] to determine if a population dose calculation is to be performed [if $JC(1) \leq 0$, do population dose calculation]. Internal parameters of NOBLE are described in Table 4.28.

4.4.9 Subroutine OUTMAN

Subroutine OUTMAN is called by subroutine DOSIT to write reports of population doses for ALARA and NEPA evaluations. Two entry points are contained in OUTMAN. The first entry point (called as OUTMAN) is used to initialize parameters and to print population dose summary reports (type 9) for ALARA and NEPA results. The second entry point (called as BRKMAN) is used to print detailed reports of population doses. First, a total-dose report (type 10) is printed, followed by reports (types 11 through 16) for each pathway giving details by radionuclide and organ.

The internal array IO(8) is used to control the order in which organ data are printed. The values for IO are set in a data statement and relate the output order to the order in which data are stored in the dose arrays. The order in dose arrays and the current output order are given in Table 4.29.

The three parameters in the argument list of OUTMAN have the following use: 1) NSOR, number of radionuclides in the current source term; 2) LIST(33,4), location index of data in the dose-factor arrays for each radionuclide (33) and each organ (4); and 3) ITIT(78), title of the current run. The internal parameters for OUTMAN are described in Table 4.30.

Subroutine OUTMAN references common blocks ELEMEN, OUTPOP, and SORCE.

TABLE 4.28. Internal Parameters of Subroutine NOBLE

Parameter Name	Type	Description
ARG	Real	Exponential argument used in evaluating noble gas decay across the eastern part of the U.S.
TL	Real	Exponential term used in the decay calculation for transit of the plume across the eastern part of the U.S. (hr).
X	Real	Intermediate term in the population and individual dose calculations, including atmospheric dispersion and unit conversions (various units).
XP	Real	Population-weighted atmospheric dispersion factor for the site (person-sec/m^3).

TABLE 4.29. Organ Data Order: Internal and Output

Internal Position	Organ	IO	Output Order
1	Bone	3	Total-body
2	Liver	7	GI-LLI
3	Total-Body	1	Bone
4	Thyroid	2	Liver
5	Kidney	5	Kidney
6	Lung	4	Thyroid
7	GI-LLI	6	Lung
8	Skin	8	Skin

TABLE 4.30. Internal Parameters for Subroutine OUTMAN

Parameter Name	Type	Description
A(8)	Real	Total dose for the current radionuclide, pathway, and for each organ; used in evaluating the percent contribution to dose (person-rem).
AA(8)	Real	Total dose for 8 organs for the current pathway, summed over all radionuclides (person-rem).
ID(8)	Integer	Organ index selection array to control the order in which doses are printed (by organ).
LL	Integer	Position index of data for the current radionuclide in the master data arrays.
P(8)	Real	Percent contribution to population dose for the current radionuclide and pathway for each organ.
PATH(7)	Char*8	Character titles for each pathway used in the output reports.
TEST	Real	Sum of all doses for a radionuclide for the current pathway; used to skip printing of information for a radionuclide having zero dose.

4.4.10 Subroutine OUTSPL

Subroutine OUTSPL is called by subroutine DOSIT to print reports of individual doses at the special locations. Subroutine OUTSPL contains two entry points: OUTSPL and BRKSPL. The first entry point is called to print a pathway summary report (type 17) for each special location. The second entry point is called to print detailed reports for each pathway and age group (types 18 through 24). Each pathway report includes doses by radionuclide and organ for one age group. Common blocks ELEMEN, OUTIND, SORCE, SPIDEN, and SPLOC are referenced by OUTSPL.

The internal array IO(8) is used to control the order in which organ data are printed. See Section 4.4.9 for a description of usage for IO.

The array SPL(26400) is set equivalent to arrays SPLVEG(5280), SPLMET(5280), SPLMLK(5280), SPLGMK(5280), and SPLINH(5280), in that order. The inline function INDEX is used to select dose values from array SPL for printing. INDEX is defined as

$$\mathrm{INDEX}(I,J,K,L,M) = I + 33 \left\{J - 1 + 5 \left[K - 1 + 8 \left(L - 1 + 4(M-1)\right)\right]\right\}$$

where I = index on radionuclide

J = index on special location

K = index on organ

L = index on age group.

M = index on pathway (in order, vegetables, meat, cow milk, goat milk, and inhalation).

The argument list parameters for OUTSPL are described in Table 4.31, and the internal parameters are described in Table 4.32.

TABLE 4.31. Argument Parameters for Subroutine OUTSPL

Parameter Name	Type	Description
ITIT(78)	Integer	Title of the current run.
JS(5)	Integer	Control flags for printing reports for special locations: if JS(i)=1, no details are printed for location if JS(i)≤0, printing is controlled by array JSS.
JSS(5,7)	Integer	Control flag for report printing for 5 locations and 7 pathways. A zero value causes printing of reports for the corresponding location and pathway. Pathways are (in order): 1) plume external, 2) ground external, 3) vegetable ingestion, 4) meat ingestion, 5) cow-milk ingestion, 6) goat-milk ingestion, and 7) inhalation.
LIST(33,4)	Integer	Location of data for input radionuclides (33) in master arrays for each age group (4).
NSOR	Integer	Number of radionuclides in the current source term 1≤NSOR≤33.
NSPL	Integer	Number of special locations considered for the current case. 1≤NSPL≤5.

TABLE 4.32. Internal Parameters for Subroutine OUTSPL

Parameter Name	Type	Description
A(8)	Real	Total dose over all radionuclides for the current pathway (mrem).
IO(8)	Integer	Control integer for selection of printing order for organ doses.
LL	Integer	Position index of data for the current radionuclide in master data arrays.
MM	Integer	Position index of current pathway information in the dose arrays as defined by the equivalence relationship between SPL and the pathway dose arrays of common block OUTIND.
NAM(4)	Char*8	Age-group titles for output reports: "ADULT," "TEEN," "CHILD," and "INFANT."
NW	Integer	Number of age groups for which arrays are dimensioned (4); used in the inline function INDEX for unpacking doses.
NX	Integer	Number of radionuclides for array dimensions (33) used in the inline function INDEX for unpacking doses.
NY	Integer	Number of special locations for array dimensions (5) used in the inline function INDEX for unpacking doses.
NZ	Integer	Number of organs for array dimensions (8) used in the inline function INDEX for unpacking doses.
P(8)	Real	Percent contribution to individual dose for the current radionuclide, pathway, age group, and special location, for each organ (8).
PATH(7)	Char*8	Titles for pathway headings used on output reports.
SPL(26400)	Real	Equivalence array set up to access doses in pathway dose arrays of common block OUTIND.
SPRINT(8)	Real	Array containing doses for each organ; used to print the current output line.
T	Logical	Logical control parameter for printing the current pathway title.
TEST	Real	Sum of all doses for a report: If TEST$\leq$0, report is not printed.

4.4.11 Subroutine PART

Subroutine PART is called by subroutines DOSIT and PARTS to perform dose calculations for particulates and iodine. PART calls function EXFCT and references common blocks AGPOP, DFLIB, NUKES, PARARR, PHYS, POPLIN, SITE, SORCE, TRANFR, and USAGE. No reading or writing is performed by PART.

Doses to populations (ALARA and NEPA) are estimated first, followed by doses to individuals at each special location. Population doses are returned to the calling program through the AA arrays of common block PARARR, and individual doses are returned through the A arrays.

Argument-list parameters and internal parameters for subroutine PART are described in Tables 4.33 and 4.34, respectively.

TABLE 4.33. Argument Parameters for Subroutine PART

Parameter Name	Type	Description
BEP(160)	Real	Normalized ground-deposition factor for the current radionuclide for each area element (m^{-2}/yr).
BEP1(5)	Real	Normalized ground-deposition factor for each special location for the current radionuclide (m^{-2}/yr).
Q	Real	Annual release rate for current radionuclide (Ci/yr).
R	Real	Retention factor on vegetation for the current radionuclide (dimensionless).
XB(160)	Real	Normalized atmospheric dispersion factor for each area element for the current radionuclide; used in the population inhalation-dose calculation (sec/m^3).
XB1(160)	Real	Normalized atmospheric dispersion factor, corrected for decay and depletion, for each area element for the current radionuclide (sec/m^3).
XQM(5)	Real	Normalized atmospheric dispersion factor for each special location corrected for decay and depletion, for the current radionuclide (sec/m^3).
XQN(5)	Real	Normalized atmospheric dispersion factor for each special location for the current radionuclide; used with the individual inhalation dose calculation (sec/m^3).

4.4.12 Subroutine PARTS

Subroutine PARTS is called by the main program to control calculation and printing of the normalized dose factors. PARTS is very similar to DOSIT, except that radionuclide activity (Q) and dispersion and deposition factors

TABLE 4.34. Internal Parameters for Subroutine PART

Parameter Name	Type	Description
ARG	Real	Exponential argument in decay calculations (dimensionless).
BE	Real	Intermediate exponential parameter in the calculation of activity decay and buildup to the midpoint of plant life (hr).
BU	Real	Exponential factor in the calculation of activity buildup on pasture grass (hr).
BV	Real	Exponential factor in the calculation of activity buildup on vegetable crops (hr).
DEC(8)	Real	Decay correction factors calculated for various time periods as defined in the time array TIM (dimensionless).
PSA	Real	Number of people served by meat production within 50 mi (persons).
PSM	Real	Number of people served by cow-milk production within 50 mi (persons).
PSV	Real	Number of people served by vegetable production within 50 mi (persons).
SP	Real	Transfer factor from soil to plant for the current radionuclide (dimensionless).
TA	Real	Transfer factor from animal feed to meat for the current radionuclide (days/kg).
TG	Real	Transfer factor from animal feed to goat milk for the current radionuclide (days/L).
TM	Real	Transfer factor from animal feed to cow milk for the current radionuclide (days/L).
V	Real	Intermediate parameter in the calculation of inhalation doses.
W	Real	Intermediate parameter in the calculation of dose from external exposure to contaminated ground.
WW	Real	Intermediate parameter in the calculation of dose from external exposure to contaminated ground.
X	Real	Intermediate parameter in the calculation of dose from vegetable ingestion.
X1	Real	Intermediate concentration for the vegetable-ingestion pathway.
X2	Real	Intermediate concentration for the milk-ingestion pathway.
X3	Real	Intermediate concentration for the meat-ingestion pathway.
XOQ	Real	Normalized atmospheric dispersion factor for the current area element and radionuclide; used in the inhalation-dose calculation (sec/m^3).

TABLE 4.34. (Contd)

Parameter Name	Type	Description
XX	Real	Effective removal constant for the current radionuclide (sec^{-1}).
Y	Real	Intermediate parameter in the cow-milk ingestion dose pathway and in buildup on vegetation (various units).
YZ	Real	Intermediate parameter in the cow-milk ingestion dose calculation.
YZB	Real	Intermediate parameter in the meat-ingestion pathway.
Z	Real	Intermediate parameter in the meat-ingestion pathway.
Z1	Real	Intermediate parameter in the goat-milk ingestion pathway.

are set to unity. Common blocks DFLIB, ELEMEN, NUKES, OUTIND, OUTPOP, PARARR, PHYS, SORCE, SUBARR, and TRANFR are referenced by PARTS. Function EXFCT and subroutines CARBON, PART, and TRITON are called by PARTS.

A general logic diagram for PARTS is shown in Figure 4.5. Special dose factors may be calculated for all radionuclides except noble gases. For noble gases, the dose conversion factors are equivalent to the special dose factors.

The three argument list parameters for subroutine PARTS are: 1) NSOR, number of radionuclides to be considered; 2) ITIT(28), title of the current run; and 3) LIST(33,4), location index of data in master arrays for each radionuclide in the source term (33) and each age group (4). Internal parameters for PARTS are described in Table 4.35.

The inline function INDEX is used to determine the array position for doses in dose-result arrays. The use and definition of INDEX is identical to the same function defined in subroutine DOSIT (see Section 4.4.6).

4.4.13 Subroutine PRINTB

Subroutine PRINTB is called by subroutine BLKDAT to print report numbers 2a, 2b, and 2c, giving current values of parameters in common blocks TRANFR, PHYS, and USAGE, respectively. Those three common blocks plus ELEMEN are referenced by PRINTB. The argument-list parameters are flags used to control

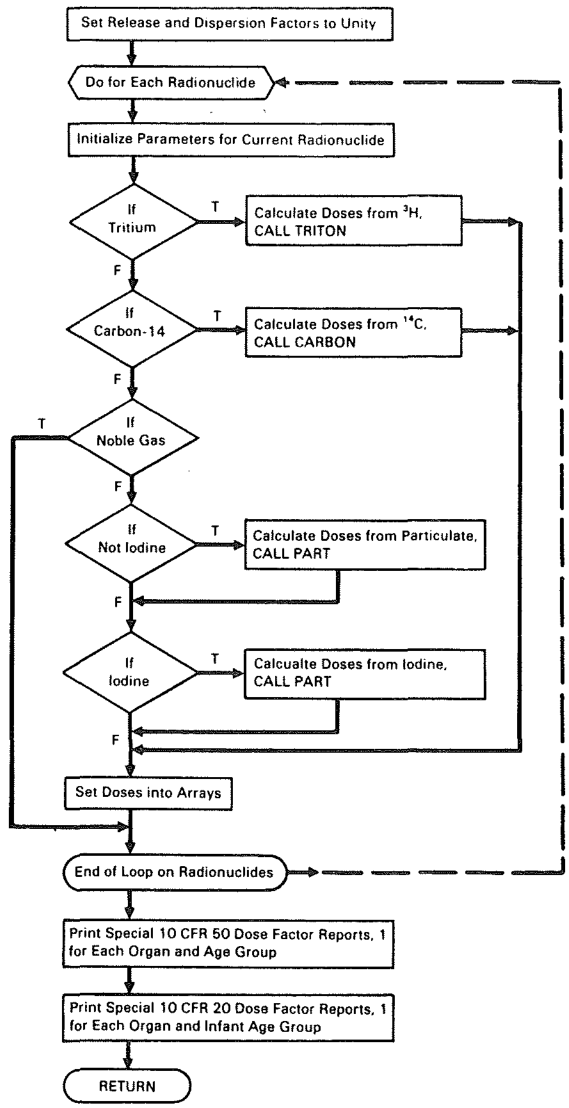


FIGURE 4.5. Module PARTS Logic Diagram

printing of each report: NFLAGP>0 to print a PHYS report; NFLAGT>0 to print a TRANFR report; and NFLAGU>0 to print a USAGE report. Internal parameters used by PRINTB are described in Table 4.36.

4.4.14 Subroutine PRINTC

Subroutine PRINTC is called by subroutine DOSIT to print two identical cost-benefit reports. Each report contains up to 10 subreports, one for each source term. The subreports are printed in rows, three abreast across the page with as many rows as are needed down the page. Common blocks CTAB, ELEMEN, and SORCE are referenced by PRINTC. The argument list for PRINTC

TABLE 4.35. Internal Parameters for Subroutine PARTS

Parameter Name	Type	Description
ARG	Real	Exponential argument in the decay and buildup calculation for the current radionuclide in the environment (dimensionless).
DEPP(160)	Real	Unused array needed for the argument list in the call to subroutine PART.
DEPP1(5)	Real	Array containing unit deposition factors; used in the call to subroutine PART.
IJKL	Integer	Index for positioning and retrieving doses in stacked arrays; calculated by inline function INDEX.
ISOR	Integer	Number of source terms (set to 1).
NSPL	Integer	Number of special locations to be considered (set to 1 for PARTS calculations).
NX	Integer	Number of radionuclides allowed in the source terms (33); used in the inline function INDEX.
NY	Integer	Number of special locations (5); used in the inline function INDEX.
NZ	Integer	Number of organs (8); used in the inline function INDEX.
Q	Real	Release rate of current radionuclide (set to 1.0 for the PARTS calculations).
TL	Real	Intermediate exponential terms used in the calculation of activity at the midpoint of plant life.
VRET	Real	Retention fraction of current radionuclide on vegetation (dimensionless).
XMLT	Real	Correction factor for decay in transit for the current radionuclide in the calculation of atmopheric dispersion and deposition factors (dimensionless).
XQQ(160)	Real	Array to transfer unit dispersion factors (undecayed and undepleted) to dose subroutines CARBON, PART, and TRITON for population dose calculations.
XQQ1(5)	Real	Array to transfer unit dispersion factors (undecayed and undepleted) to dose subroutines CARBON, PART, and TRITON for individual dose calculations.
XXQDD(160)	Real	Array to transfer unit dispersion factors (decayed and undepleted) to dose subroutines CARBON, PART, and TRITON for population dose calculations.
XXQDD1(5)	Real	Array to transfer unit dispersion factors (decayed and undepleted) to dose subroutines CARBON, PART, and TRITON for individual dose calculations.

TABLE 4.36. Internal Parameters for Subroutine PRINTB

Parameter Name	Type	Description
I	Integer	Do loop index on printing transfer factors by element in two columns of 50.
J	Integer	Index on element number for information printed in the second column.
P(12)	Real	Character titles of parameter names for output report headings.
Q(10)	Real	Character titles of parameter names for output report headings.

contains two parameters: ISOR is the number of source terms for which subtables will be printed, and ITIT(78) is the title for the current run. Internal parameters for subroutine PRINTC are described in Table 4.37.

TABLE 4.37. Internal Parameters for Subroutine PRINTC

Parameter Name	Type	Description
IND	Integer	Print control index for cost-benefit tables.
K	Integer	Do loop index on the number of cost-benefit tables to be printed across the present page of output.
KKK	Integer	Do loop index to cause two copies of cost-benefit reports to be printed.
NB	Integer	Beginning index of source term to be printed on current page of cost-benefit table.
NE	Integer	Ending index of source term to be printed on current page of cost-benefit table.
NI	Integer	Index of second table to be printed on current page of cost-benefit output report.
NPR	Integer	Number of tables to be printed on the current page of cost-benefit output.
NSTAT(3)	Integer	Index array to control printing of results in cost-benefit tables; one value for each column (table).
PSOR	Integer	Index on the number of source terms yet to be printed for cost-benefit tables.

4.4.15 Subroutine PRINTM

The main program calls PRINTM to print the body of reports of site parameters. Two types of reports are printed by PRINTM; site meteorological reports and site population and agricultural production reports. Titles for the reports are printed in the main program. Data are passed to PRINTM through the argument list in array A. The data are printed as a function of distance and direction from the site. Totals are also printed for population and agricultural production reports.

Argument-list parameters are described in Table 4.38, and internal parameters are described in Table 4.39.

TABLE 4.38. Argument Parameters for Subroutine PRINTM

Parameter Name	Type	Description
A(NT)	Real	Array of values to be printed.
IT	Integer	Control integer to cause column and row totals to be calculated and printed for the output table: If IT=0, print totals If IT≠0, print just the values without the totals.
M	Integer	Number of distance intervals to consider (set to 10 in call statements to PRINTM).
N	Integer	Number of sectors to be considered (set to 16 in call statements to PRINTM).
NT	Integer	Total number of area elements to be considered (set to 160 in call statements to PRINTM).
TOT	Real	The sum of the NT parameter values contained in array A.

TABLE 4.39. Internal Parameters for Subroutine PRINTM

Parameter Name	Type	Description
IRX	Integer	Index for extracting data from array A to be printed.
ISEC(16)	Integer	Titles for sector compass directions; used in output tables.
IX	Integer	Do loop index on the number of sectors.
JX	Integer	Do loop index on the number of distance intervals.
SC(10)	Real	Sum of parameter values for each distance interval.
SR(16)	Real	Sum of parameter values for each sector.

4.4.16 Subroutine REDDF

Subroutine REDDF is called by the main program to read the dose conversion factor data library and print optional reports of library data. Common blocks DFLIB, ELEMEN, and SORCE are referenced by REDDF. The argument parameter IPRNT causes reports of library data to be printed (if IPRINT=1). A description of the dose conversion factor library read by REDDF is given in Section 4.5. A general logic diagram of REDDF is shown in Figure 4.6, and internal parameters are described in Table 4.40.

As the dose factors are read, the total number of radionuclides for which data are provided is counted for each age group. Values are thus established for the parameters NLIBA, NLIBT, NLIBC, and NLIBI, which are used to indicate age-group breakpoints for the master arrays with dimension 750. These arrays are IZ, IMASS, META, DFA, and DFL. Data for noble gases are placed at the

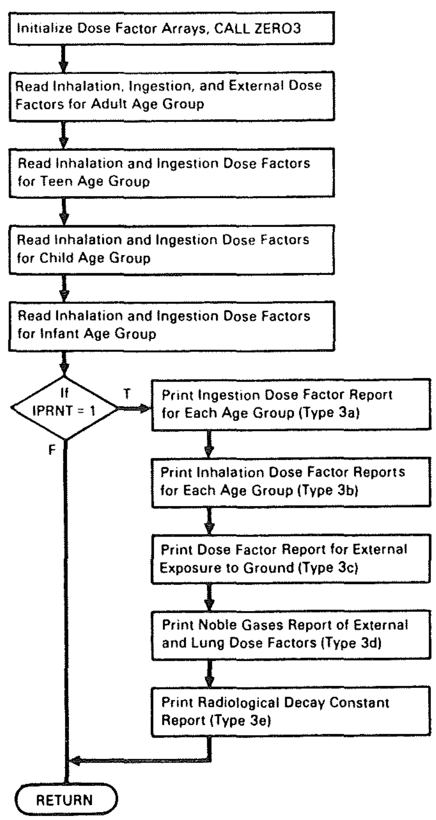


FIGURE 4.6. Module REDDF Logic Diagram

TABLE 4.40. Internal Parameters for Subroutine REDDF

Parameter Name	Type	Description
J	Integer	Implied do loop on several read and print statements.
K	Integer	Count index for input of radionuclide data.
K1	Integer	Temporary index for array location of first radionuclide for current age group.
KK	Integer	Temporary index to element name array for printing.
LS	Char*1	Dummy input parameter to read past unused titles in dose-factor library.
N	Integer	Control integer to limit printing of headings to one time.

beginning of these arrays in block data BLKDAT. The parameter NGASES gives the number of spaces (noble gas radionuclides) to be skipped at the front of the master arrays.

4.4.17 Subroutine REDMET

Subroutine REDMET reads one set of meteorological data each time it is called by the main program. The reading is from logical unit JDEV, which is either the standard input file IDEV(=9) or the alternate file (unit 7). Common block DEVICE is referenced to provide the value of IDEV.

Data are read for 16 compass directions, starting with either the north or south downwind sector and proceeding clockwise. If parameter IDAT is zero, then input is read starting in the north sector. The alternate meteorological input file always starts with data in the south sector (i.e., north wind direction) when the file has been prepared by the XOQDOQ program. When input is from the standard input file, a record of type 9.1, 10.1, 11.1, or 12.1 is read, giving control information for the order in which to read the data.

Argument list parameters for REDMET are described in Table 4.41, and internal parameters are described in Table 4.42.

4.4.18 Subroutine REDSIT

Subroutine REDSIT is called by the main program to read site population and agricultural production data. Common block DEVICE is referenced to provide the logical unit for reading input records (IDEV). Data can be read by three modes: 1) by direction starting with the north sector, 2) by direction

TABLE 4.41. Argument Parameters for Subroutine REDMET

Parameter Name	Type	Description
A(NA)	Real	Array of values to be read.
JDEV	Integer	Logical input device number for reading of data in REDMET.
LS(78)	Integer	Character title for the information to be read.
NA	Integer	Number of area elements in array A to be used (NA is only used as a variable dimension for A).

TABLE 4.42. Internal Parameters for Subroutine REDMET

Parameter Name	Type	Description
IDAT	Integer	Control integer for reading data by sector: If IDAT=0, start reading on the north sector If IDAT≠0, start on the south sector.
IDIR	Integer	Number of directions to be considered (16).
KC	Integer	Number of values to be read on the first record for the current sector.
KT	Integer	Number of distance intervals to be considered (10).
LC	Integer	Index for input of data values.

starting with the south sector, or 3) as a total value for the site. Selection of the method to read input is controlled by parameters IDAT and KT on record type 4.1, 5.1, 6.1, or 7.1. A zero value for KT will cause input to be read as the total for the site. This total value (i.e., population or production) is then distributed uniformly over the 50-mi region. Input is read starting with the north sector when IDAT is set to zero (and KT>0), and input starts with the south sector when IDAT is greater than zero (and KT>0).

Argument list parameters for subroutine REDSIT are described in Table 4.43, and internal parameters are described in Table 4.44.

4.4.19 Subroutine SOURCE

Subroutine SOURCE is called by the main program to read the next source term, identify the radionuclides submitted, and prepare arrays for the next calculation. Common blocks BLANK, CTAB, DEVICE, DFLIB, ELEMEN, and SORCE are referenced by SOURCE.

TABLE 4.43. Argument Parameters for Subroutine REDSIT

Parameter Name	Type	Description
A(NA)	Real	Array of values to be read for current data set (population or food production).
LS(78)	Integer	Character title for the current data set to be read.
NA	Integer	Total number of values in array A to be considered; used only as a variable dimension to array A.

TABLE 4.44. Internal Parameters for Subroutine REDSIT

Parameter Name	Type	Description
DEN	Real	Average density over the 50-mi area for the current data parameter (population or food production).
IDAT	Integer	Input control integer for compass sector to start data input: IDAT=0, north IDAT=1, south.
IDIR	Integer	Number of sectors to be considered (16).
KC	Integer	Number of distance entries on first sector record
KT	Integer	Total number of annular values to be read for each sector: KT=0 if the 50-mi total will be uniformly distributed over all sectors and distance intervals.
LC	Integer	Position index of the first value on the second record for the current sector.
NQ	Integer	Total number of area elements to be considered; used as the product of KT and IDIR to test for uniform distribution of the current parameter over the 50-mi area.
PI	Real	The numerical value of the constant π
RADI(10)	Real	Outer boundary of each distance interval (mi).
TOT	Real	Input value for the total (population or food production) to be distributed over the 50-mi area.
X	Real	Square of the outer boundary of the current distance interval; used in the distribution of population and food production over the 50-mi area.
XX	Real	Amount (population or food production) for the current distance interval in the distribution calculation over the 50-mi area.

A general logic diagram for SOURCE is given in Figure 4.7. Two records (types 8.0 and 8.1) are always read for each source term. However, if control parameter JC2 is greater than zero, then the previous source term is used.

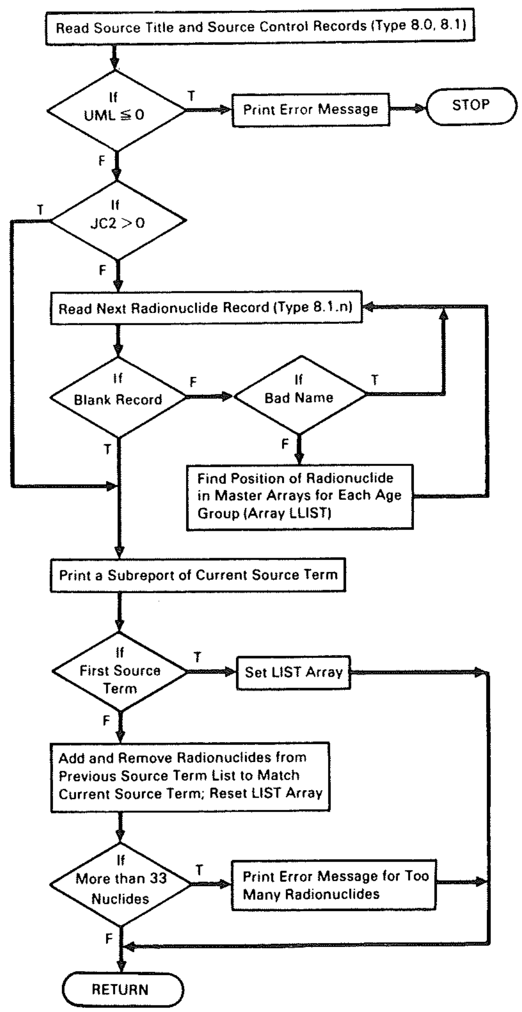


FIGURE 4.7. Module SOURCE Logic Diagram

A report is printed of the current source term as a subreport to report types 5a and 5b. The report is printed using up to three columns across the page, depending on the number of radionuclides in the source term.

Argument-list parameters for subroutine SOURCE are described in Table 4.45, and internal parameters are described in Table 4.46.

4.4.20 Subroutine TRITON

Subroutine TRITON is called by subroutines DOSIT and PARTS to calculate doses from tritium. Common blocks AGPOP, DFLIB, NUKES, PARARR, PHYS, POPLIN, SITE, TRANFR, and USAGE are referenced by TRITON.

TABLE 4.45. Argument Parameters for Subroutine SOURCE

Parameter Name	Type	Description
ISOR	Integer	Number of radionuclides in the current source term.
JC1	Integer	Control integer to indicate if new meteorology needed for the current source term: If JC1=0, read new data If JC1=1, use last data set.
JC6	Integer	Job control integer to indicate if a PARTS calculation is to be performed; used in SOURCE to allow zero values to be entered for the release quantity (see record type 8.1.n).
LIST(33,4)	Integer	Location of data for input radionuclides (33) in master arrays for each age group.
NSR	Integer	Number of source terms that have been processed, including the current source term.
Q(33)	Real	Release inventory for current source term for each radionuclide (Ci/yr).

TABLE 4.46. Internal Parameters for Subroutine SOURCE

Parameter Name	Type	Description
IA	Integer	Symbol of element name for the current radionuclide as read from input record 8.1.n.
ICNT	Integer	Control integer for printing of error message on too many radionuclides given in the source term.
IK	Integer	Index used in determining the atomic number of the current radionuclide being identified; also used as the atomic number of the radionuclide.
IM(5)	Integer	Input value for atomic mass number for the current radionuclide, including "M" for metastable, as appropriate.
JC2	Integer	Control integer to indicate if new release data are provided (JC2=0) or if previous set can be used (JC2=1).
JCNT	Integer	Control integer for printing of error message on too many radionuclides specified in the current source term.
JJ	Integer	Do loop index on the number of characters in the atomic mass symbol.
JS	Integer	Do loop index on the number of radionuclides in the previous source term; used when the source-term list is being updated for the current source term.
K	Integer	Index used in evaluating the numeric value of the atomic mass given on input.
K1	Integer	Position of first data entry in the master data arrays of data for the current age group.

TABLE 4.46. (Contd)

Parameter Name	Type	Description
KJ	Integer	Do loop index on the number of radionuclides in the current source term; used when the source-term list is being updated for the current source term.
KK(13)	Integer	Atomic number of each element that has only one character in its element symbol [i.e., KK(1) is for H].
L	Integer	Do loop index used in the identification of characters given in the atomic mass input symbol array IM.
LL	Integer	Do loop index and position index for data in the master data arrays (i.e., IMASS, IZ, and META).
LLIST(33,4)	Integer	Position index array by radionuclide and age group for data in the master data arrays (DFA, DFL, IMASS, META, and IZ) for the current source term (see also LIST).
LST2(10)	Integer	An additional word (four characters) for input and printing of the title for the current source term; read on input record type 8.0.
MASS	Integer	Atomic mass symbol for the current radionuclide as modified for comparison with master array IMASS.
MET	Integer	Temporary storage parameter for the metastable state indicator for the current radionuclide ("M" or blank).
N	Integer	Temporary position index for data in the master arrays, used when comparing the previous source term with the new source term.
NN	Integer	Number of the source term currently being processed; limited to a maximum value of 10.
NSOR	Integer	Number of radionuclides in the current source term being read.
NUM(14)	Integer	Single characters used in identifying the atomic mass number characters: (blank) 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, M, _ (underline), and - (dash).
QQ	Real	Release rate of current radionuclide (Ci/yr).
QT	Real	Total activity release rate in the current source term, summed over all radionuclides (Ci/yr).
QTEMP(33)	Real	Temporary storage array for the release activity of each radionuclide in the current inventory (Ci/yr).
UML	Real	Source-term multiplication factor applied to the input release activity for each radionuclide.

TRITON evaluates population doses (ALARA and NEPA) and individual doses from releases of tritium. Population doses are transferred to the calling program through the "AA" arrays of common block PARARR, and individual doses are transmitted through the "A" arrays.

The three argument list parameters are: 1) Q, activity of tritium released (Ci/yr); 2) XB(160), atmospheric dispersion factors for tritium at each area element (in sec/m^3); and 3) XQS(5), atmospheric dispersion factor for tritium at each special location (in sec/m^3). Internal parameters of subroutine TRITON are described in Table 4.47.

TABLE 4.47. Internal Parameters for Subroutine TRITON

Parameter Name	Type	Description
DATR	Real	Average tritium air concentration for the first pass across the eastern U.S.
DH3	Real	Tritium concentration in foods from the first pass across the eastern U.S., plus from the uniform distribution of tritium in the hydrosphere.
PSA	Real	Number of people served by meat production within 50 mi.
PSM	Real	Number of people served by cow-milk production within 50 mi.
PSV	Real	Number of people served by vegetable production within 50 mi.
W	Real	Tritium concentration in meat.
X	Real	Intermediate parameter in the tritium dose calculations with multiple uses: ALARA air concentration, and air concentration for individuals.
Y	Real	Intermediate parameter in tritium dose calculations with multiple uses: average air concentration used for population vegetable pathway, average concentration in milk, and air concentration for individual vegetable pathway.
Z	Real	Intermediate parameter in the tritium dose calculations with multiple uses: average concentration in cow milk for population dose calculations and individual dose calculations.
Z1	Real	Intermediate parameter in the tritium dose calculation for the goat-milk pathway for individuals.

4.4.21 Subroutine ZERO1

Subroutine ZERO1 is called by subroutines DOSIT and PARTS to initialize arrays in common blocks CTAB, OUTIND, and OUTPOP. The common block storage space of OUTIND and OUTPOP are represented in ZERO1 by one large array for each block. The entire common block is set to zero by setting each member of the large array to zero. The first 100 locations of common block CTAB (title array LST) are not initialized. The second 100 locations (integer array MAP) are set to integer zero, and the rest of the CTAB locations (real array COST) are set to real zero.

4.4.22 Subroutine ZERO2

Subroutine ZERO2 is called by subroutines DOSIT and PARTS to initialize dose storage arrays for the current radionuclide being evaluated. The initialization is performed by setting all of common blocks SUBARR and PARARR to real zero. The contents of common block SUBARR are represented by the single array A(66), and common block PARARR is represented by array B(920).

4.4.23 Subroutine ZERO3

Subroutine ZERO3 is called once during each run by subroutine REDDF to initialize master arrays used for radionuclide identification. Common blocks ELEMEN and SORCE are referenced by ZERO3. The first 14 locations (parameter NGASES) of arrays IZ, IMASS, META, and TAU are not initialized because these locations are used for noble gas radionuclide data in block data BLKDATA. Similarly, the first 14 locations of arrays DFA and DFL for each age group are not initialized. All positions of the external ground dose-factor (EXG) arrays are set to zero because this array is not used for noble gases. The age group position index parameters are also set to zero (NLIBA, NLIBT, NLIBC, and NLIBI).

4.5 DATA FILE DESCRIPTION

GASPAR II references one data file that provides dose-conversion factors which relate radionuclide concentrations in environmental media (ground, air, and foods) to dose received by individuals and population groups. This section describes the data contained in the file, the file structure, and the program parameters through which data transfers are made. A complete list of the dose-factor file is included on the Appendix B microfiche, which is located in the back cover pocket. The third sample problem output listing also contains the library data in a format that is easily read (Appendix B). This data file is the same file used by the LADTAP II computer program.

The dose-factor file is composed of four main sections, one section for each age group: adult, teen, child, and infant. Each of these sections begins with an age-group title record and ends with a blank record (blank or negative in the first four columns). Data for each radionuclide are provided in sets. The structure of the file is illustrated in Figure 4.8. The first few records of the file are shown in Listing 4.1.

Each radionuclide in the adult portion of the data file has four records of data. The first record gives radionuclide identification parameters and external dose factors for exposure to contaminated surfaces and immersion in contaminated water. Data on the first record are described in Table 4.48. The water-immersion dose factors, EXS1 and EXS2, are not used by GASPAR II.

The second record for each radionuclide provides ingestion-dose conversion factors for each organ. These dose factors have units of mrem in 50 yr (commitment period) per pCi of intake in the first yr. Values on each record are provided for seven organs in the following order: bone, liver, total-body, thyroid, kidney, lung, and GI-LLI (gastrointestinal tract, lower-large intestine). The record format is 7E8.0, and the values are read into array DFL.

The third record for each radionuclide contains inhalation dose conversion factors (for the same seven organs as for the ingestion dose-factor records). These factors are read into array DFA using format 10E8.0.

The adult portion of the data library contains a fourth record for each radionuclide which provides the effective energy by organ radius. Values on this record are not used by GASPAR II and are skipped.

Many entries in the dose-factor file are zero. The zero values represent organ-radionuclide combinations for which doses are not expected to be significant, relative to the doses to other organs. It is unlikely that any significant contributions to dose are omitted by use of "zero" dose factors.

Adult	Adult Dose-Factor Title Record First Radionuclide Identification and External Dose Factors First Radionuclide Adult Ingestion Dose Factors First Radionuclide Adult Inhalation Dose Factors First Radionuclide Effective Energy Data Second Radionuclide Identification and External Dose Factors Second Radionuclide Adult Ingestion Dose Factors Second Radionuclide Adult Inhalation Dose Factors Second Radionuclide Effective Energy Data . . . Blank Record
Teen	Teen Dose-Factor Title Record First Radionuclide Identification First Radionuclide Teen Ingestion Dose Factors First Radionuclide Teen Inhalation Dose Factors Second Radionuclide Identification Second Radionuclide Teen Ingestion Dose Factors Second Radionuclide Teen Inhalation Dose Factors . . . Blank Record
Child	Child Dose-Factor Title Record (Same organization as for teen) Blank Record
Infant	Infant Dose-Factor Title Record (Same organization as for teen) Blank Record

FIGURE 4.8. Dose-Factor Library Structure

LISTING 4.1. Sample Listing of Dose-Factor Library

```
 ADULT DOSE FACTORS
  1  3 1.78E-090.0      0.0      0.0      0.00E+00
0.0      5.99E-085.99E-085.99E-085.99E-085.99E-095.99E-08
0.0      8.98E-088.98E-088.98E-088.98E-088.98E-088.98E-08
 1.00E-031.00E-031.00E-031.00E-031.00E-031.00E-031.00E-031.00E-03
  4 10 1.37E-140.0      0.0      0.0      0.0
3.18E-064.91E-077.94E-080.0      3.71E-070.0      2.68E-05
1.98E-043.06E-054.96E-060.0      0.0      2.22E-041.67E-05
 0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
  6 14 3.84E-120.0      0.0      0.0      0.0
2.84E-065.68E-075.68E-075.68E-075.68E-075.68E-075.68E-07
2.27E-064.26E-074.26E-074.26E-074.26E-074.26E-074.26E-07
 5.00E-025.00E-025.00E-025.00E-025.00E-025.00E-025.00E-025.00E-02
  7 13 1.16E-037.60E-091.90E-068.80E-090.0
8.36E-098.36E-098.36E-098.36E-098.36E-098.36E-098.36E-09
6.27E-096.27E-096.27E-096.27E-096.27E-096.27E-096.27E-09
 5.38E-015.57E-015.87E-016.46E-017.01E-017.77E-019.83E-011.13E 00
  9 18 1.05E-046.80E-091.80E-068.00E-090.0
6.24E-070.0      6.92E-080.0      0.0      0.0      1.85E-08
4.71E-070.0      5.19E-080.0      0.0      0.0      9.24E-09
 2.85E-013.04E-013.34E-013.91E-014.44E-015.18E-017.17E-018.61E-01
 11 22 8.44E-091.60E-084.00E-061.80E-080.0
1.74E-051.74E-051.74E-051.74E-051.74E-051.74E-051.74E-05
1.30E-051.30E-051.30E-051.30E-051.30E-051.30E-051.30E-05
 2.86E-013.25E-013.87E-015.07E-016.19E-017.75E-011.20E 001.51E 00
 11 24 1.28E-052.50E-087.80E-062.90E-080.0
1.70E-061.70E-061.70E-061.70E-061.70E-061.70E-061.70E-06
1.28E-061.28E-061.28E-061.28E-061.28E-061.28E-061.28E-06
 7.12E-017.71E-018.68E-011.05E 001.23E 001.48E 002.19E 002.74E 00
 15 32 5.61E-070.0      6.40E-090.0      0.0
1.93E-041.20E-057.46E-060.0      0.0      0.0      2.17E-05
1.65E-049.64E-066.26E-060.0      0.0      0.0      1.08E-05
 6.95E-016.95E-016.95E-016.95E-016.95E-016.95E-016.95E-016.95E-01
 20 41 1.57E-133.41E-097.28E-074.01E-090.0
1.85E-040.0      2.00E-050.0      0.0      0.0      1.84E-07
3.83E-050.0      4.13E-060.0      0.0      3.83E-062.86E-07
 0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
 21 46 9.57E-081.30E-083.70E-061.50E-080.0
5.51E-091.07E-083.11E-090.0      9.99E-090.0      5.21E-05
5.51E-051.07E-043.11E-050.0      9.99E-050.0      3.23E-05
 1.97E-012.32E-012.90E-013.99E-015.01E-016.44E-011.03E 001.32E 00
 24 51 2.90E-072.20E-105.20E-082.60E-100.0
0.0      0.0      2.66E-091.59E-095.86E-103.53E-096.69E-07
0.0      0.0      1.25E-087.44E-092.85E-091.80E-064.15E-07
 2.00E-033.00E-034.00E-035.00E-037.00E-039.00E-031.50E-021.90E-02
 25 54 2.57E-085.80E-091.50E-066.80E-090.0
0.0      4.57E-068.72E-070.0      1.36E-060.0      1.40E-05
0.0      4.95E-067.87E-070.0      1.23E-061.75E-049.67E-06
 3.60E-025.10E-027.60E-021.22E-011.66E-012.27E-013.92E-015.12E-01
 25 56 7.50E-051.10E-083.20E-061.30E-080.0
0.0      1.15E-072.04E-080.0      1.46E-070.0      3.67E-06
0.0      1.55E-102.29E-110.0      1.63E-101.18E-062.53E-06
 8.75E-019.04E-019.51E-011.04E 001.13E 001.24E 001.57E 001.82E 00
 26 55 8.14E-090.0      6.40E-110.0      0.0
```

Data for teen, child, and infant age groups are similar to that for adults, with two exceptions. First, the identification record does not include the decay constant or external dose factors. Secondly, the effective energy record is not included; only three records are provided for each radionuclide. The data file is read from logical unit 20.

TABLE 4.48. Radionuclide Identification Record

Parameter Name	Format	Columns	Description
IZ(I)	IX,I3	2-4	Atomic number of radionuclide I.
IMASS(I)	I3	5-7	Atomic weight of radionuclide I.
META(I)	A1	8	Indicator for isomeric state of radionuclide I - blank for ground state and M for metastable.
TAU(I)	E8.0	9-16	Radiological decay constant for radionuclide I (per sec).
EXG(I,1)	E8.0	17-24	External total-body dose conversion factor for ground exposure for radionuclide I (mrem/hr per pCi/m^2).
EXS2	E8.0	25-32	External total-body dose conversion factor for water exposure for radionuclide I (mrem/hr per pCi/L).
EXG(I,2)	E8.0	33-40	External skin-dose conversion factor for ground exposure for radionuclide I (mrem/hr per pCi/m^2).
EXS1	E8.0	41-48	External skin-dose conversion factor for water immersion for radionuclide I (mrem/hr per pCi/L).

5.0 REFERENCES

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APPENDIX A

GLOBAL DICTIONARY

APPENDIX A

GLOBAL DICTIONARY

This appendix is a global dictionary of parameters used in GASPAR II. The dictionary includes all parameters that are 1) listed in common blocks, 2) supplied through input, 3) involved in control logic, and 4) used as major loop indexes. Minor parameters, such as implied loop indexes in PRINT statements, are not included. However, all parameters are included in the definitions contained in the module listing and module specifications (see Section 4.4). An entry is provided for each parameter for the modules in which the parameter is used.

The global dictionary is organized alphabetically by parameter name with array dimensions also noted. The "Type" column indicates if the parameter is used as an integer, or real variable, or a character parameter. Character parameter word size is indicated by an asterisk followed by the number of characters per word. The size of integer parameters used for character information is also indicated.

The "Module" column identifies the program module in which the parameter is used. (Secondary ordering within the global dictionary is by module name.) The "data interchange" column indicates the mode used for transferring parameters between modules. The three representations used are internal, argument, and common. Internal representation is used for parameters that are defined and used within a given module. Internal parameters may be passed through argument lists to subroutines where they will appear with an ARGUMENT data interchange. Argument representation is used for parameters passed into the module through an argument list. Common representation refers to parameters provided in common blocks. The "common" label name is also indicated under data interchange. Common block parameters are defined only for modules where they are set or used.

The "Usage" column indicates whether the parameter value is changed in the module (set, "S") or just referenced in an equation, if statement, call list, or print statement (used, "U").

The "Description" column gives detailed information on the use of the parameters. Special uses within a particular module, such as parameter input, are also noted.

APPENDIX A

GLOBAL DICTIONARY

Parameter Name	Type	Module	Data Interchange	Usage	Description
A(29050)	Real	ZERO1	Common OUTIND	S	Dummy array equivalent to the entire contents of common block OUTIND
A(5)	Real	DOSIT	Common SUBARR	U	Contribution to the air gamma dose from the current radionuclide (mrad)
A(5)	Real	NOBLE	Common SUBARR	S	Same as A in DOSIT
A(66)	Real	ZERO2	Common SUBARR	S	Dummy array equivalent to the entire common block SUBARR
A(8)	Real	OUTMAN	Internal	–	Total dose for the current radionuclide and pathway and for each organ, used in evaluating the percent contribution to dose (person-rem)
A(8)	Real	OUTSPL	Internal	–	Total dose over all radionuclides for current pathway (mrem)
A(NA)	Real	REDMET	Argument	S	Array of values to be read
A(NA)	Real	REDSIT	Argument	S	Array of values to be read for current data set (population, or food production)
A(NT)	Real	PRINTM	Argument	U	Array of values to be printed

Parameter Name	Type	Module	Data Interchange	Usage	Description
A1(5,8)	Real	DOSIT	Common SUBARR	U	Individual doses from external exposure to the plume for each of 5 special locations and 8 organs (mrem)
A1(5,8)	Real	NOBLE	Common SUBARR	S	Same as A1 in DOSIT
A1(5,8)	Real	PARTS	Common SUBARR	U	Same as A1 in DOSIT
A2(5,8)	Real	DOSIT	Common PARARR	U	Individual external dose from ground exposure for 5 locations and 8 organs (mrem)
A2(5,8)	Real	PART	Common PARARR	S/U	Same as A2 in DOSIT
A2(5,8)	Real	PARTS	Common PARARR	U	Same as A2 in DOSIT
A3(5,8,4)	Real	DOSIT	Common PARARR	U	Individual dose from inhalation for each of 5 special locations, 8 organs, and 4 age groups (mrem)
A3(5,8,4)	Real	PART	Common PARARR	S	Same as A3 in DOSIT
A3(5,8,4)	Real	PARTS	Common PARARR	U	Same as A3 in DOSIT
A3(5,8,4)	Real	TRITON	Common PARARR	S/U	Same as A3 in DOSIT
A4(5,8,4)	Real	CARBON	Common PARARR	S/U	Individual dose from vegetable ingestion for 5 special locations, 8 organs, and 4 age groups (mrem)
A4(5,8,4)	Real	DOSIT	Common PARARR	U	Same as A4 in CARBON
A4(5,8,4)	Real	PART	Common PARARR	S	Same as A4 in CARBON
A4(5,8,4)	Real	PARTS	Common PARARR	U	Same as A4 in CARBON
A4(5,8,4)	Real	TRITON	Common PARARR	S/U	Same as A4 in CARBON

Parameter Name	Type	Module	Data Interchange	Usage	Description
A5(5,8,4)	Real	CARBON	Common PARARR	S/U	Individual dose from cow-milk ingestion for 5 locations, 8 organs, and 4 age groups (mrem)
A5(5,8,4)	Real	DOSIT	Common PARARR	U	Same as A5 in CARBON
A5(5,8,4)	Real	PART	Common PARARR	S	Same as A5 in CARBON
A5(5,8,4)	Real	PARTS	Common PARARR	U	Same as A5 in CARBON
A5(5,8,4)	Real	TRITON	Common PARARR	S/U	Same as A5 in CARBON
A6(5,8,4)	Real	CARBON	Common PARARR	S/U	Individual dose from meat ingestion for 5 locations, 8 organs, and 4 age groups (mrem)
A6(5,8,4)	Real	DOSIT	Common PARARR	U	Same as A6 in CARBON
A6(5,8,4)	Real	PART	Common PARARR	S	Same as A6 in CARBON
A6(5,8,4)	Real	PARTS	Common PARARR	U	Same as A6 in CARBON
A6(5,8,4)	Real	TRITON	Common PARARR	S/U	Same as A6 in CARBON
A7(5,8,4)	Real	CARBON	Common PARARR	S/U	Individual dose from goat-milk ingestion for 5 locations, 8 organs, and 4 age groups (mrem)
A7(5,8,4)	Real	PARTS	Common PARARR	U	Same as A7 in CARBON
A7(5,8,4)	Real	DOSIT	Common PARARR	U	Same as A7 in CARBON
A7(5,8,4)	Real	PART	Common PARARR	S	Same as A7 in CARBON
A7(5,8,4)	Real	TRITON	Common PARARR	S/U	Same as A7 in CARBON

Parameter Name	Type	Module	Data Interchange	Usage	Description
AA(8)	Real	OUTMAN	Internal	–	Total dose for 8 organs for the current pathway, summed over all radionuclides (person-rem)
AA1(8,2)	Real	DOSIT	Common SUBARR	U	Population doses for external exposure to noble gases in the plume for 8 organs and for the 50-mi and U.S. populations (person-rem)
AA1(8,2)	Real	NOBLE	Common SUBARR	S/U	Same as AA1 in DOSIT
AA2(8,2)	Real	DOSIT	Common PARARR	U	Population dose from external exposure to contaminated ground for 8 organs and for the 50-mi and U.S populations (person-rem)
AA2(8,2)	Real	PART	Common PARARR	S/U	Same as AA2 in DOSIT
AA3(8,2)	Real	DOSIT	Common PARARR	U	Population dose from inhalation for 8 organs and for the 50-mi and U.S. populations (person-rem)
AA3(8,2)	Real	PART	Common PARARR	S/U	Same as AA3 in DOSIT
AA3(8,2)	Real	TRITON	Common PARARR	S/U	Same as AA3 in DOSIT
AA4(8,2)	Real	CARBON	Common PARARR	S/U	Population dose for vegetable ingestion for 8 organs and for the 50-mi and U.S. populations (person-rem)
AA4(8,2)	Real	DOSIT	Common PARARR	U	Same as AA4 in CARBON
AA4(8,2)	Real	PART	Common PARARR	S/U	Same as AA4 in CARBON
AA4(8,2)	Real	TRITON	Common PARARR	S/U	Same as AA4 in CARBON
AA5(8,2)	Real	CARBON	Common PARARR	S/U	Population dose for cow-milk ingestion for 8 organs and for the 50-mi and U.S. populations (person-rem)

Parameter Name	Type	Module	Data Interchange	Usage	Description
AA5(8,2)	Real	DOSIT	Common PARARR	U	Same as AA5 in CARBON
AA5(8,2)	Real	PART	Common PARARR	S/U	Same as AA5 in CARBON
AA5(8,2)	Real	TRITON	Common PARARR	S/U	Same as AA5 in CARBON
AA6(8,2)	Real	CARBON	Common PARARR	S/U	Population dose for meat ingestion for 8 organs, and for the 50-mi and U.S. populations (person-rem)
AA6(8,2)	Real	DOSIT	Common PARARR	U	Same as AA6 in CARBON
AA6(8,2)	Real	PART	Common PARARR	S/U	Same as AA6 in CARBON
AA6(8,2)	Real	TRITON	Common PARARR	S/U	Same as AA6 in CARBON
AA7(8,2)	Real	CARBON	Common PARARR	S/U	Population dose from vegetable ingestion for 8 organs and for the 50-mi and U.S. populations (person-rem)
AA7(8,2)	Real	DOSIT	Common PARARR	U	Same as AA7 in CARBON
AA7(8,2)	Real	PART	Common PARARR	S/U	Same as AA7 in CARBON
AA7(8,2)	Real	TRITON	Common PARARR	S/U	Same as AA7 in CARBON
AIRBET(5)	Real	DOSIT	Common OUTIND	S/U	Total individual beta air dose at each special location (mrad)
AIRBET(5)	Real	OUTSPL	Common OUTIND	U	Same as AIRBET in DOSIT
AIRGAM(5)	Real	DOSIT	Common OUTIND	S/U	Total individual air dose from photon radiation at each special location (mrad)
AIRGAM(5)	Real	OUTSPL	Common OUTIND	U	Same as AIRGAM in DOSIT
AREA	Real	MAIN	Internal	–	Total area within 50 miles (m^2)

Parameter Name	Type	Module	Data Interchange	Usage	Description
AREA(10)	Real	BLKDATA	Common PHYS	S	Area within a sector interval (22.5^o sectors) as a function of distance (m^2)
AREA(10)	Real	PART	Common PHYS	U	Same as AREA in BLKDATA
AREA(10)	Real	PRINTB	Common PHYS	U	Same as AREA in BLKDATA
ARG	Real	DOSIT	Internal	–	Exponential argument in radiological decay calculation (dimensionless)
ARG	Real	NOBLE	Internal	–	Exponential argument used in evaluating noble gas decay across the eastern U.S.
ARG	Real	PART	Internal	–	Exponential argument in decay calculations (dimensionless)
ARG	Real	PARTS	Internal	–	Exponential argument in the decay and buildup calculation for the current radionuclide in the environment (dimensionless)
ARG1	Real	CARBON	Internal	–	Intermediate argument in decay calculations
ARG2	Real	CARBON	Internal	–	Intermediate argument in decay calculations
AVINH(3)	Real	BLKDAT	Common USAGE	S	Average inhalation rates for 3 age groups: 1) infants and children, 2) teens, 3) adults (m^3/yr)
AVINH(3)	Real	BLKDATA	Common USAGE	S	Same as AVINH in BLKDAT
AVINH(3)	Real	PART	Common USAGE	U	Same as AVINH in BLKDAT
AVINH(3)	Real	PRINTB	Common USAGE	U	Same as AVINH in BLKDAT
AVINH(3)	Real	TRITON	Common USAGE	U	Same as AVINH in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
AVLVEG(3)	Real	BLKDAT	Common USAGE	S	Average annual leafy vegetable intake per individual for 3 age groups: 1) infants and children, 2) teens, 3) adults (kg/yr)
AVLVEG(3)	Real	BLKDATA	Common USAGE	S	Same as AVLVEG in BLKDAT
AVLVEG(3)	Real	PRINTB	Common USAGE	U	Same as AVLVEG in BLKDAT
AVMET(3)	Real	AGPROD	Common USAGE	U	Average annual meat intake per individual for 3 age groups: 1) infants and children, 2) teens, and 3) adults (kg/yr)
AVMET(3)	Real	BLKDAT	Common USAGE	S	Same as AVMET in AGPROD
AVMET(3)	Real	BLKDATA	Common USAGE	S	Same as AVMET in AGPROD
AVMET(3)	Real	CARBON	Common USAGE	U	Same as AVMET in AGPROD
AVMET(3)	Real	PART	Common USAGE	U	Same as AVMET in AGPROD
AVMET(3)	Real	PRINTB	Common USAGE	U	Same as AVMET in AGPROD
AVMET(3)	Real	TRITON	Common USAGE	U	Same as AVMET in AGPROD
AVMLK(3)	Real	AGPROD	Common USAGE	U	Average annual milk intake per individual for 3 age groups: 1) infants and children, 2) teens, and 3) adults (L/yr)
AVMLK(3)	Real	BLKDAT	Common USAGE	S	Same as AVMLK in AGPROD
AVMLK(3)	Real	BLKDATA	Common USAGE	S	Same as AVMLK in AGPROD
AVMLK(3)	Real	CARBON	Common USAGE	U	Same as AVMLK in AGPROD
AVMLK(3)	Real	PART	Common USAGE	U	Same as AVMLK in AGPROD
AVMLK(3)	Real	PRINTB	Common USAGE	U	Same as AVMLK in AGPROD

Parameter Name	Type	Module	Data Interchange	Usage	Description
AVMLK(3)	Real	TRITON	Common USAGE	U	Same as AVMLK in AGPROD
AVVEG(3)	Real	AGPROD	Common USAGE	U	Average annual vegetable intake per individual for 3 age groups: 1) children and infants, 2) teens, and 3) adults (kg/yr)
AVVEG(3)	Real	BLKDAT	Common USAGE	S	Same as AVVEG in AGPROD
AVVEG(3)	Real	BLKDATA	Common USAGE	S	Same as AVVEG in AGPROD
AVVEG(3)	Real	CARBON	Common USAGE	U	Same as AVVEG in AGPROD
AVVEG(3)	Real	PART	Common USAGE	U	Same as AVVEG in AGPROD
AVVEG(3)	Real	PRINTB	Common USAGE	U	Same as AVVEG in AGPROD
AVVEG(3)	Real	TRITON	Common USAGE	U	Same as AVVEG in AGPROD
B(3168)	Real	ZERO1	Common OUTPOP	S	Dummy array equivalent to the entire common block OUTPOP
B(5)	Real	DOSIT	Common SUBARR	U	Total air beta dose for the current radionuclide at 5 special locations (mrad)
B(5)	Real	NOBLE	Common SUBARR	S	Same as B in DOSIT
B(920)	Real	ZERO2	Common PARARR	S	Dummy array equivalent to the entire common block PARARR
BE	Real	PART	Internal	–	Intermediate exponential parameter in the decay and buildup calculation to the midpoint of plant life (sec)
BEP(160)	Real	PART	Argument	U	Normalized ground-deposition factor for the current radionuclide for each area element (m^{-2}/yr)

Parameter Name	Type	Module	Data Interchange	Usage	Description
BEP1(5)	Real	PART	Argument	U	Normalized ground-deposition factor for each special location for the current radionuclide (m^{-2}/yr)
BLDAY	Real	BLKDAT	Common TRANFR	S	Growing period of vegetation consumed by humans (days)
BLDAY	Real	BLKDATA	Common TRANFR	S	Same as BLDAY in BLKDAT
BLDAY	Real	PART	Common TRANFR	U	Same as BLDAY in BLKDAT
BLDAY	Real	PRINTB	Common TRANFR	U	Same as BLDAY in BLKDAT
BLELM(13)	Integer	SOURCE	Internal	–	Element name symbols for elements that have only 1 character in their name (i.e., H, B, C, N, etc.)
BLNK	Char*1	BLKDAT	Internal	–	A blank character used for comparison of input characters
BLNK	Integer	SOURCE	Internal	–	A blank character used in testing input characters for blanks
BOTB	Real	CARBON	Internal	–	Bone-dose correction factor for carbon: 5 for bone, 1 for other organs (dimensionless)
BU	Real	PART	Internal	–	Exponential factor in the calculation of activity buildup on pasture grass (sec)
BV	Real	PART	Internal	–	Exponential factor in the calculation of activity buildup on vegetable crops (sec)
C(1400)	Real	ZERO1	Common CTAB	S	Dummy array equivalent to array COST in common block CTAB

Parameter Name	Type	Module	Data Interchange	Usage	Description
CD	Real	CARBON	Common POPLTN	U	Distance from the facility to the NE corner of the U.S. (input in mi, recalculated to m)
CD	Real	MAIN	Common POPLIN	S	Same as CD in CARBON
CD	Real	NOBLE	Common POPLTN	S	Same as CD in CARBON
CD	Real	TRITON	Common POPLTN	U	Same as CD in CARBON
COST(39,3,10)	Real	DOSIT	Common CTAB	S/U	Result array for the cost-benefit table. The first index is for dose type: 1-33 by radionuclide; 34, noble gases; 35, iodine; 36, particulates; 37, carbon-14; 38, tritium; and 39, totals. The second index is for: 1, Ci; 2, total-body dose; and 3, thyroid dose. The third index is for source term.
COST(39,3,10)	Real	PRINTC	Common CTAB	U	Same as COST in DOSIT
COWIN	Real	BLKDAT	Common TRANFR	S	Rate of feed ingestion by milk cows (kg/day)
COWIN	Real	BLKDATA	Common TRANFR	S	Same as COWIN in BLKDAT
COWIN	Real	CARBON	Common TRANFR	U	Same as COWIN in BLKDAT
COWIN	Real	PART	Common TRANFR	U	Same as COWIN in BLKDAT
COWIN	Real	PRINTB	Common TRANFR	U	Same as COWIN in BLKDAT
COWIN	Real	TRITON	Common TRANFR	U	Same as COWIN in BLKDAT
DAT(100)	Real	BLKDAT	Internal	–	Temporary storage array for input data values

Parameter Name	Type	Module	Data Interchange	Usage	Description
DATR	Real	TRITON	Internal	–	Average tritium air concentration for the first pass across the eastern U.S.
DCAR	Real	CARBON	Internal	–	U.S. population carbon dose from worldwide dispersion (person-rem)
DEC(8)	Real	PART	Internal	–	Decay correction factors calculated for various time periods, as defined in the time array TIM (dimensionless)
DEN	Real	REDSIT	Internal	–	Average density of the current data parameter over the 50-mi area (population or food production)
DEP(160)	Real	DOSIT	Common METDTA	U	Normalized ground-deposition factor at each area element, as provided on input with decay corresponding to an 8-day half-life (m^{-2}/yr)
DEP(160)	Real	MAIN	Common METDTA	U	Same as DEP in DOSIT
DEP1(5)	Real	DOSIT	Common SPECIL	U	Normalized ground concentration at each special location, as provided on input with decay corresponding to an 8-day half-life (m^{-2}/yr)
DEP1(5)	Real	MAIN	Common SPECIL	S/U	Same as DEP1 in DOSIT
DEPP(160)	Real	DOSIT	Internal	–	Normalized ground-deposition factor at each area element, corrected for decay for the current radionuclide (m^{-2}/yr)
DEPP(160)	Real	PARTS	Internal	–	Unused array needed for the argument call list to PART
DEPP1(5)	Real	DOSIT	Internal	–	Normalized ground concentration at each special location, corrected for decay for the current radionuclide (m^{-2}/yr)

Parameter Name	Type	Module	Data Interchange	Usage	Description
DEPP1(5)	Real	PARTS	Internal	–	Array containing unit deposition factors, used in the call to subroutine PART
DFA(750,7)	Real	NOBLE	Common DFLIB	U	Inhalation dose conversion factors for 7 organs and up to 750 radionuclide/age-group combinations; noble gas external and lung dose factors are stored at the beginning of the adult portion of the array
DFA(750,7)	Real	PART	Common DFLIB	U	Same as DFA in NOBLE
DFA(750,7)	Real	REDDF	Common DFLIB	S/U	Same as DFA in NOBLE
DFA(750,7)	Real	TRITON	Common DFLIB	U	Same as DFA in NOBLE
DFA(750,7)	Real	ZERO3	Common DFLIB	S	Same as DFA in NOBLE
DFL(750,7)	Real	CARBON	Common DFLIB	U	Ingestion dose conversion factors for 7 organs and up to 750 radionuclide/age-group combinations
DFL(750,7)	Real	PART	Common DFLIB	U	Same as DFL in CARBON
DFL(750,7)	Real	REDDF	Common DFLIB	S/U	Same as DFL in CARBON
DFL(750,7)	Real	TRITON	Common DFLIB	U	Same as DFL in CARBON
DFL(750,7)	Real	ZERO3	Common DFLIB	S	Same as DFL in CARBON
DH3	Real	TRITON	Internal	–	Tritium concentration in foods from the first pass across the eastern U.S., plus from the uniform distribution of tritium in the hydrosphere
DIST(5)	Real	MAIN	Common SPIDEN	S/U	Distance from facility to special location (mi)

Parameter Name	Type	Module	Data Interchange	Usage	Description
DIST(5)	Real	OUTSPL	Common SPIDEN	U	Same as DIST in MAIN
DMET	Real	MAIN	Common SITE	S/U	Average meat production for the site ($kg/m^2/yr$)
DMLK	Real	MAIN	Common SITE	S/U	Average milk production for the site ($L/m^2/yr$)
DVEG	Real	MAIN	Common SITE	S/U	Average vegetable production for the site ($kg/m^2/yr$)
ENIV	Real	DOSIT	Common NUKE	S	Activity of the current radionuclide accumulated in the environment at the midpoint of plant life (Ci)
ENIV	Real	NOBLE	Common NUKES	U	Same as ENIV in DOSIT
ENIV	Real	PARTS	Common NUKES	S	Same as ENIV in DOSIT
ENIV	Real	TRITON	Common NUKES	U	Same as ENIV in DOSIT for tritium
EXFCT	Real	EXFCT	Argument	S	Value of the function EXFCT to be returned to the calling routine (dimensionless)
EXG(200,2)	Real	PART	Common DFLIB	U	External dose conversion factors for exposure to contaminated ground for each radionuclide (200) and for skin dose and total-body dose (mrem/hr per pCi/m^2)
EXG(200,2)	Real	REDDF	Common DFLIB	S/U	Same as EXG in PART
EXG(200,2)	Real	ZERO3	Common DFLIB	S	Same as EXG in PART
FB	Real	MAIN	Common SITE	S/U	Fraction of time that beef cattle are in pasture
FB	Real	PART	Common SITE	U	Same as FB in MAIN

Parameter Name	Type	Module	Data Interchange	Usage	Description
FBF	Real	MAIN	Common SITE	S/U	Fraction of beef-cattle feed intake from pasture while beef cattle are in pasture
FBF	Real	PART	Common SITE	U	Same as FBF in MAIN
FG	Real	CARBON	Common SITE	U	Fraction of maximally exposed individual's vegetable consumption derived from local gardens
FG	Real	MAIN	Common SITE	S/U	Same as FG in CARBON
FG	Real	PART	Common SITE	U	Same as FG in CARBON
FGF	Real	PART	Common SITE	U	Fraction of the goat-feed intake from pasture while goats are on pasture (same as FPG in MAIN)
FGT	Real	MAIN	Common SITE	S/U	Fraction of time that goats are in pasture
FGT	Real	PART	Common SITE	U	Same as FGT in MAIN
FID	Real	BLKDAT	Common PHYS	S	Fraction of iodine deposited from the air
FID	Real	BLKDATA	Common PHYS	S	Same as FID in BLKDAT
FID	Real	PART	Common PHYS	U	Same as FID in BLKDAT
FID	Real	PRINTB	Common PHYS	U	Same as FID in BLKDAT
FP	Real	MAIN	Common SITE	S/U	Fraction of time that milk cows are in pasture
FP	Real	PART	Common SITE	U	Same as FP in MAIN
FPF	Real	MAIN	Common SITE	S/U	Fraction of milk-cow feed intake from pasture while milk cows are in pasture

Parameter Name	Type	Module	Data Interchange	Usage	Description
FPF	Real	PART	Common SITE	U	Same as FPF in MAIN
FPG	Real	MAIN	Common SITE	S/U	Fraction of goat-feed intake from pasture while goats are in pasture (same as FGF in PART)
FV	Real	CARBON	Common SITE	U	Fraction of time leafy vegetables are grown (dimensionless)
FV	Real	MAIN	Common SITE	S/U	Same as FV in CARBON
FV	Real	PART	Common SITE	U	Same as FV in CARBON
FV	Real	TRITON	Common SITE	U	Same as FV in CARBON
GOATIN	Real	BLKDAT	Common TRANER	S	Rate of feed ingestion by milk goats (kg/day)
GOATIN	Real	BLKDATA	Common TRANFR	S	Same as GOATIN in BLKDAT
GOATIN	Real	CARBON	Common TRANFR	U	Same as GOATIN in BLKDAT
GOATIN	Real	PART	Common TRANFR	U	Same as GOATIN in BLKDAT
GOATIN	Real	TRITON	Common TRANFR	U	Same as GOATIN in BLKDAT
H	Real	MAIN	Common SITE	S/U	Average absolute humidity over the growing season (g/m^3)
H	Real	TRITON	Common SITE	U	Same as H in MAIN
I	Integer	DOSIT	Internal	–	Do loop index for the current radionuclide in the source inventory
I	Integer	MAIN	Internal	–	Count index on special locations

Parameter Name	Type	Module	Data Interchange	Usage	Description
I	Integer	NOBLE	Internal	–	Do loop index with multiple uses: number of organs, and number of special locations
I	Integer	OUTMAN	Internal	–	Do loop index on the number of radionuclides in the source inventory
I	Integer	OUTSPL	Internal	–	Do loop index on the number of radionuclides in the source inventory
I	Integer	PART	Internal	–	Do loop index used for several different loops
I	Integer	PRINTB	Internal	–	Do loop index on printing transfer factors by element in 2 columns of 50
I	Integer	PRINTC	Internal	–	Do loop index with several uses
I	Integer	REDMET	Internal	–	Do loop index on compass directions
I	Integer	SOURCE	Internal	–	Count index on the number of radionuclide records that have been read
I	Integer	TRITON	Internal	–	Do loop index over the number of area elements (160)
I1	Integer	BLKDAT	Internal	–	Index for initial position in an array where data are provided on input record 2.1
I2	Integer	BLKDAT	Internal	–	Index for final position in an array where data are provided on input record 2.1
IA	Integer	SOURCE	Internal	–	Symbol of element name for the current radionuclide as read from input record 8.1.n

Parameter Name	Type	Module	Data Interchange	Usage	Description
ICNT	Integer	SOURCE	Internal	–	Control integer for printing of error message on too many radionuclides given in the source term
IDAT	Integer	REDMET	Internal	–	Control integer for reading data by sector: if IDAT=1, start reading on south sector; otherwise start on north sector
IDAT	Integer	REDSIT	Internal	–	Input control integer for compass sector to start data input: IDAT=0 for north, IDAT=1 for south
IDATE	Char*9	MAIN	Internal	–	Date of run
IDEV	Integer	BLKDAT	Common DEVICE	U	Logical unit from which input records are read; default is 9
IDEV	Integer	MAIN	Common DEVICE	S/U	Same as IDEV in BLKDAT
IDEV	Integer	REDSIT	Common DEVICE	U	Same as IDEV in BLKDAT
IDEV	Integer	SOURCE	Common DEVICE	U	Same as IDEV in BLKDAT
IDIR	Integer	REDMET	Internal	–	Number of sectors to be considered (16)
IDIR	Integer	REDSIT	Internal	–	Same as IDIR in REDMET
IDIR(5)	CHAR*4	MAIN	Common SPIDEN	S/U	Direction from the site to each special location, given as an integer value to indicate 1 of the standard 16 compass directions (1=N, 2=NNE, etc.)
IDIR(5)	Integer	OUTSPL	Common SPIDEN	U	Same as IDIR in MAIN
IELEM(100)	Integer	BLKDATA	Common ELEMEN	S	Element name symbol for each element, by atomic number

Parameter Name	Type	Module	Data Interchange	Usage	Description
IELEM(100)	Integer	DOSIT	Common ELEMEN	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	OUTMAN	Common ELEMEN	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	OUTSPL	Common ELEMEN	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	PARTS	Common ELEMEN	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	PRINTB	Common ELEMEN	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	PRINTC	Common SORCE	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	REDDF	Common ELEMEN	U	Same as IELEM in BLKDATA
IELEM(100)	Integer	SOURCE	Common ELEMEN	U	Same as IELEM in BLKDATA
IGOT(14)	Integer	BLKDAT	Common TRANFR	S	Atomic numbers of elements where goat-milk transfer factors are given in array ZGMLK
IGOT(14)	Integer	BLKDATA	Common TRANFR	S	Same as IGOT in BLKDAT
IGOT(14)	Integer	PART	Common TRANFR	U	Same as IGOT in BLKDAT
IGOT(14)	Integer	PRINTB	Common TRANFR	U	Same as IGOT in BLKDAT
IJKL	Integer	DOSIT	Internal	–	Calculated index for packing results into storage arrays for individual doses
IJKL	Integer	PARTS	Internal	–	Index for positioning and retrieving doses in stacked arrays, calculated by inline function INDEX
IK	Integer	SOURCE	Internal	–	Index used in determining the atomic number of the current radionuclide being identified; also used as the atomic number of the radionuclide

Parameter Name	Type	Module	Data Interchange	Usage	Description
IM(5)	Integer	SOURCE	Internal	-	Input value for atomic mass number for the current radionuclide, including "M" for metastable, as appropriate
IMASS(750)	Integer	DOSIT	Common SORCE	U	Atomic mass of each radionuclide in the dose-factor file for each age group
IMASS(750)	Integer	OUTMAN	Common SORCE	U	Same as IMASS in DOSIT
IMASS(750)	Integer	OUTSPL	Common SORCE	U	Same as IMASS in DOSIT
IMASS(750)	Integer	PARTS	Common SORCE	U	Same as IMASS in DOSIT
IMASS(750)	Integer	PRINTC	Common SORCE	U	Same as IMASS in DOSIT
IMASS(750)	Integer	REDDF	Common SORCE	S/U	Same as IMASS in DOSIT
IMASS(750)	Integer	SOURCE	Common SORCE	U	Same as IMASS in DOSIT
IMASS(750)	Integer	ZERO3	Common SORCE	S	Same as IMASS in DOSIT
IND	Integer	BLKDAT	Internal	-	Calculated index for setting input data values into arrays
IND	Integer	PRINTC	Internal	-	Print control index for cost-benefit tables
IO(8)	Integer	OUTMAN	Internal	-	Organ index selection array to control the order in which doses are printed by organ
IO(8)	Integer	OUTSPL	Internal	-	Same as IO in OUTMAN
IPASS	Integer	MAIN	Internal		Flag for counting the number of passes made in the current run

Parameter Name	Type	Module	Data Interchange	Usage	Description
IPRNT	Integer	REDDF	Argument	U	Control integer to cause printing of dose-factor library reports: if IPRNT>0, print; IPRNT=JC(5)
IRX	Integer	PRINTM	Internal	–	Index for extracting data from the array (A) to be printed
ISEC(16)	Integer	PRINTM	Internal	–	Titles for sector compass directions, used in output tables
ISOR	Integer	DOSIT	Argument	U	Index of current source term
ISOR	Integer	MAIN	Internal	–	Count index on the number of source terms considered for the current pass
ISOR	Integer	PARTS	Internal	–	Number of source terms; set to 1
ISOR	Integer	PRINTC	Argument	U	Number of source terms for the current case
ISOR	Integer	SOURCE	Argument	S/U	Number of radionuclides in the current source term
IT	Integer	PRINTM	Argument	U	Control integer to cause column and row totals to be calculated and printed for the output table: IT=0 to print totals; IT≠0 to just print the values without the totals
ITIT(78)	Integer	DOSIT	Argument	U	Same as ITITLE in MAIN
ITIT(78)	Integer	OUTMAN	Argument	U	Same as ITITLE in MAIN
ITIT(78)	Integer	OUTSPL	Argument	U	Same as ITITLE in MAIN
ITIT(78)	Integer	PARTS	Argument	U	Same as ITITLE in MAIN
ITIT(78)	Integer	PRINTC	Argument	U	Same as ITITLE in MAIN

Parameter Name	Type	Module	Data Interchange	Usage	Description
ITITLE(78)	Char*1	MAIN	Internal	–	Title describing the current calculations
IX	Integer	PRINTM	Internal	–	Do loop index on the number of sectors
IZ(750)	Integer	DOSIT	Common SORCE	U	Atomic number of each radionuclide in the dose-factor file for each age group
IZ(750)	Integer	OUTMAN	Common SORCE	U	Same as IZ in DOSIT
IZ(750)	Integer	OUTSPL	Common SORCE	U	Same as IZ in DOSIT
IZ(750)	Integer	PART	Common SORCE	U	Same as IZ in DOSIT
IZ(750)	Integer	PARTS	Common SORCE	U	Same as IZ in DOSIT
IZ(750)	Integer	PRINTC	Common SORCE	U	Same as IZ in DOSIT
IZ(750)	Integer	REDDF	Common SORCE	S/U	Same as IZ in DOSIT
IZ(750)	Integer	SOURCE	Common SORCE	U	Same as IZ in DOSIT
IZ(750)	Integer	ZERO3	Common SORCE	S	Same as IZ in DOSIT
J	Integer	DOSIT	Internal	–	Do loop index on age groups
J	Integer	NOBLE	Internal	–	Do loop index on organs
J	Integer	OUTMAN	Internal	–	Do loop index on organs
J	Integer	OUTSPL	Internal	–	Do loop index on the number of special locations
J	Integer	PART	Internal	–	Do loop index for the number of organs (8); also used for the number of downwind distance intervals (10)

Parameter Name	Type	Module	Data Interchange	Usage	Description
J	Integer	PARTS	Internal	–	Do loop index on age groups; also set to 1 and used to indicate the first position on special locations
J	Integer	PRINTB	Internal	–	Index on element number for information printed in the second column
J	Integer	PRINTC	Internal	–	Do loop index on print statements
J	Integer	REDDF	Internal	–	Implied do loop on several read and print statements
J	Integer	TRITON	Internal	–	Do loop index with multiple uses: number of organs, and number of special locations
JC(10)	Integer	CARBON	Common SITE	U	Job control flags: JC(1) – input record type JC(2) – number of releases JC(3) – dose accumulation report selection JC(4) – block data changes JC(5) – dose-factor report selection JC(6) – PARTS calculation JC(7) – dispersion-factor input selection
JC(10)	Integer	DOSIT	Argument	S/U	Same as JC in CARBON
JC(10)	Integer	MAIN	Common SITE	S/U	Same as JC in CARBON
JC(10)	Integer	NOBLE	Argument	U	Same as JC in CARBON
JC(10)	Integer	TRITON	Interval SITE	U	Same as JC in CARBON

Parameter Name	Type	Module	Data Interchange	Usage	Description
JC1	Integer	MAIN	Internal	–	Control integer to indicate if new meteorology data are needed for the current source term: JC1=0 to read new data; JC1=1 to use last data set
JC1	Integer	SOURCE	Argument	S	Same as JC1 in MAIN
JC2	Integer	SOURCE	Internal	–	Control integer to indicate if new release data are provided (JC2=0) or if previous set can be used (JC2=1)
JC6	Integer	SOURCE	Argument	U	Job control integer to indicate if a PARTS calculation is to be performed; used in SOURCE to allow zero values to be entered for the release quantity (see record type 8.1.n)
JCNT	Integer	SOURCE	Internal	–	Control integer for printing of the error message on too many radionuclides specified in the current source term
JDEV	Integer	MAIN	Internal	–	Logical input unit for meteorological data
JDEV	Integer	REDMET	Argument	U	Same as JDEV in MAIN
JJ	Integer	DOSIT	Internal	–	Do loop index on the number of special locations
JJ	Integer	SOURCE	Internal	–	Do loop index on the number of characters in the atomic mass symbol
JS	Integer	SOURCE	Internal	–	Do loop index on the number of radionuclides in the previous source term; used when the source-term list is being updated for the current source term

Parameter Name	Type	Module	Data Interchange	Usage	Description
JS(5)	Integer	DOSIT	Argument	U	Control flag for printing reports for special locations: if JS(I)=1, no details printed; if JS(I)≤0, printing is controlled by flag array JSS
JS(5)	Integer	MAIN	Internal	–	Same as JS in DOSIT
JS(5)	Integer	OUTSPL	Argument	U	Same as JS in DOSIT
JSS(5,7)	Integer	DOSIT	Argument	U	Control flag for special-location output reports for 5 locations and 7 exposure pathways. A zero value allows printing of details for the following pathways: 1) plume external dose, 2) ground external dose, 3) vegetable ingestion, 4) meat ingestion, 5) cow-milk ingestion, 6) goat-milk ingestion, and 7) inhalation.
JSS(5,7)	Integer	MAIN	Internal	–	Same as JSS in DOSIT
JSS(5,7)	Integer	OUTSPL	Argument	U	Same as JSS in DOSIT
JX	Integer	PRINTM	Internal	–	Do loop index on the number of distance intervals
K	Integer	OUTMAN	Internal	–	Do loop index for the two population dose report types (ALARA and NEPA)
K	Integer	OUTSPL	Internal	–	Do loop index on the number of organs (8)
K	Integer	PRINTC	Internal	–	Do loop index on the number of cost-benefit tables to be printed across the present page of output
K	Integer	REDDF	Internal	–	Count index for input of radionuclide data

Parameter Name	Type	Module	Data Interchange	Usage	Description
K	Integer	SOURCE	Internal	–	Index used in evaluating the numeric value of the atomic mass given on input
K	Integer	TRITON	Interval	–	Do loop index with multiple uses: number of age groups, and number of organs
K1	Integer	REDDF	Internal	–	Temporary index for array location of first age group in master data arrays
K1	Integer	SOURCE	Internal	–	Position of first data entry in the master data arrays of data for the current age group
KC	Integer	REDMET	Internal	–	Number of values to be read on the first record for the current sector
KC	Integer	REDSIT	Internal	–	Number of distance entries on first sector record
KJ	Integer	SOURCE	Internal	–	Do loop index on the number of radionuclides in the current source term; used when the source-term list is being updated for the current source term
KK	Integer	REDDF	Internal	–	Temporary index to element name array for printing
KK(13)	Integer	SOURCE	Internal	–	Atomic number of each element that has only 1 character in its element symbol [i.e., KK(1) is for H]
KKK	Integer	PRINTC	Internal	–	Do loop index to cause 2 copies of cost-benefit reports to be printed
KT	Integer	REDMET	Internal	–	Number of distance intervals to be considered (10)

Parameter Name	Type	Module	Data Interchange	Usage	Description
KT	Integer	REDSIT	Internal	–	Total number of annular values to be read for each sector: 0 if the 50-mi total will be uniformly distributed over all sectors and distance intervals
L	Integer	DOSIT	Internal	–	Do loop index on the number of age groups
L	Integer	OUTSPL	Internal	–	Do loop index on age groups
L	Integer	PART	Internal	–	Do loop index on the number of age groups
L	Integer	PARTS	Internal	–	Do loop index on age groups
L	Integer	SOURCE	Internal	–	Do loop index used in the identification of characters given in the atomic mass input symbol array IM
L	Integer	TRITON	Internal	–	Do loop index on the number of age groups
L(100)	Integer	ZERO1	Common CTAB	U	Dummy array equivalent to array LST in common block CTAB
LC	Integer	REDMET	Internal	–	Index for input of data values
LC	Integer	REDSIT	Internal	–	Position index of the first value on the second record for the current sector
LIST(33,4)	Integer	DOSIT	Argument	U	Location index of data in the dose-factor arrays for each radionuclide in the source term (33) and each age group (4)
LIST(33,4)	Integer	MAIN	Internal	–	Same as LIST in DOSIT
LIST(33,4)	Integer	OUTMAN	Argument	U	Same as LIST in DOSIT
LIST(33,4)	Integer	OUTSPL	Argument	U	Same as LIST in DOSIT
LIST(33,4)	Integer	PARTS	Argument	U	Same as LIST in DOSIT

Parameter Name	Type	Module	Data Interchange	Usage	Description
LIST(33,4)	Integer	SOURCE	Argument	S/U	Same as LIST in DOSIT
LL	Integer	OUTMAN	Internal	–	Position index of data for the current radionuclide in the master data arrays
LL	Integer	OUTSPL	Internal	–	Same as LL in OUTMAN
LL	Integer	SOURCE	Internal	–	Do loop index and position index of data in the master data arrays (i.e., IMASS, IZ, and META)
LLIST(33,4)	Integer	SOURCE	Internal	–	Position index array by radionuclide and age group for data in the master data arrays (DFA, DFL, IMASS, META, and IZ) for the current source term (see also LIST)
LOC(4)	Integer	CARBON	Common NUKES	U	Index pointers for dose-factor arrays for each age group
LOC(4)	Integer	DOSIT	Common NUKES	S/U	Same as LOC in CARBON
LOC(4)	Integer	NOBLE	Common NUKES	U	Same as LOC in CARBON
LOC(4)	Integer	PART	Common NUKES	U	Same as LOC in CARBON
LOC(4)	Integer	PARTS	Common NUKES	S/U	Same as LOC in CARBON
LOC(4)	Integer	TRITON	Common NUKES	U	Same as LOC in CARBON
LS	Char	REDDF	Internal	–	Dummy input parameter to read past unused titles in dose-factor library
LS(78)	Char*1	MAIN	Internal	–	Title for site data read from REDSIT or REDMET
LS(78)	Integer	REDMET	Argument	S	Character title for the information to be read

Parameter Name	Type	Module	Data Interchange	Usage	Description
LS(78)	Integer	REDSIT	Argument	S	Character title for the current data set to be read
LST(10,10)	Integer	DOSIT	Common NUKES	U	Title array for each source term (10), with 10 words used for each title
LST(10,10)	Integer	PRINTC	Common CTAB	U	Same as LST in DOSIT
LST(10,10)	Integer	SOURCE	Common CTAB	S/U	Same as LST in DOSIT
LST2(10)	Integer	SOURCE	Internal	–	An additional word (4 characters) for input and printing of the title for the current source term; read on input record type 8.0
M	Integer	OUTMAN	Internal	–	Do loop index for the number of pathways to be considered
M	Integer	OUTSPL	Internal	–	Do loop index on pathway
M	Integer	PRINTM	Argument	U	Number of distance intervals to consider; set to 10 in call statements to PRINTM
M(330)	Integer	ZERO1	Common CTAB	S	Dummy array equivalent to array MAP in common block CTAB
MAP(33,10)	Integer	DOSIT	Common CTAB	S	Position index of data in cost-benefit result arrays corresponding to positions of data in master data arrays
MAP(33,10)	Integer	PRINTC	Common CTAB	U	Same as MAP in DOSIT
MASS	Integer	SOURCE	Internal	–	Atomic mass symbol for the current radionuclide, as modified for comparison with master array IMASS

Parameter Name	Type	Module	Data Interchange	Usage	Description
MET	Integer	SOURCE	Internal	-	Temporary storage parameter for the metastable state indicator for the current radionuclide ("M" or blank)
META(750)	Integer	BLKDATA	Common SOURCE	S	Metastable state indicator for each radionuclide in the dose-factor file for each age group
META(750)	Integer	DOSIT	Common SORCE	U	Same as META in BLKDATA
META(750)	Integer	OUTMAN	Common SORCE	U	Same as META in BLKDATA
META(750)	Integer	OUTSPL	Common SORCE	U	Same as META in BLKDATA
META(750)	Integer	PARTS	Common SORCE	U	Same as META in BLKDATA
META(750)	Integer	PRINTC	Common SORCE	U	Same as META in BLKDATA
META(750)	Integer	REDDF	Common SORCE	S/U	Same as META in BLKDATA
META(750)	Integer	SOURCE	Common SORCE	U	Same as META in BLKDATA
META(750)	Integer	ZERO3	Common SORCE	S	Same as META in BLKDATA
MM	Integer	OUTSPL	Internal	-	Position index of current pathway information in the dose arrays, as defined by the equivalence relationship between SPL and the pathway dose arrays of common block OUTIND
N	Integer	BLKDAT	Internal	-	Position index of a variable in the common block modified by input record 2.1
N	Integer	DOSIT	Internal	-	Count index on the number of radionuclides for which nonzero releases are given in the source term

Parameter Name	Type	Module	Data Interchange	Usage	Description
N	Integer	PRINTM	Argument	U	Number of sectors to be considered; set to 16 in call statements to PRINTM
N	Integer	REDDF	Internal	–	Control integer to limit printing of headings to 1 time
N	Integer	SOURCE	Internal	–	Temporary position index for data in the master arrays; used when comparing the previous source term with the new source term
N1	Integer	ZERO3	Internal	–	Starting position after noble gas data in the master arrays IZ, IMASS, META, DFA, DFL, and TAU
NA	Integer	REDMET	Argument	U	Number of area elements in array A to be used (NA is only used as a variable dimension for A)
NA	Integer	REDSIT	Argument	U	Total number of values in array A to be considered; used only as a variable dimension to array A
NAM(4)	Char*8	OUTSPL	Internal	–	Age group titles for output reports: "ADULT," "TEEN," "CHILD," and "INFANT"
NAME(5,2)	Char*8	MAIN	Common SPLOC	S/U	Name of each special location (5), with two 8-character words per location
NAME(5,2)	Char*8	OUTSPL	Common SPLOC	U	Same as NAME in MAIN
NB	Integer	PRINTC	Internal	–	Beginning index of source term to be printed on current page of cost-benefit table
NCOM	Char*1	BLKDAT	Internal	–	Letter indicating the labeled common block to be changed by input record 2.1: P=PHYS, T=TRANFR, U=USAGE

Parameter Name	Type	Module	Data Interchange	Usage	Description
NCRD	Integer	BLKDAT	Internal	–	Number of additional input records read when more than 6 values of an array are being changed
NDAT	Integer	BLKDAT	Internal	–	Number of values to be changed in an array
NE	Integer	PRINTC	Internal	–	Ending index of source term to be printed on current page of cost-benefit table
NF	Integer	BLKDAT	Internal	–	Storage location in array DAT of first data value on input record 2.1 continuation records
NFLAGP	Integer	BLKDAT	Internal	–	Number of parameters changed in common block PHYS
NFLAGP	Integer	PRINTB	Argument	U	Control flag for printing common block PHYS output reports; print if NFLAGP>0
NFLAGT	Integer	BLKDAT	Internal	–	Number of parameters changed in common block TRANFR
NFLAGT	Integer	PRINTB	Argument	U	Control flag for printing common block TRANFR output report; print if NFLAGT>0
NFLAGU	Integer	BLKDAT	Internal	–	Number of parameters changed in common block USAGE
NFLAGU	Integer	PRINTB	Argument	U	Control flag for printing common block USAGE output report; print if NFLAGU>0
NGASES	Integer	BLKDATA	Common SORCE	S	Number of noble gas radionuclides for which data are given
NGASES	Integer	REDDF	Common SORCE	U	Same as NGASES in BLKDATA
NGASES	Integer	ZERO3	Common SORCE	U	Same as NGASES in BLKDATA

Parameter Name	Type	Module	Data Interchange	Usage	Description
NI	Integer	PRINTC	Internal	–	Index of second table to be printed on current page of cost-benefit output report
NL	Integer	BLKDAT	Internal	–	Location in array DAT for storage of the last data value on input record 2.1 continuation records
NLIBA	Integer	REDDF	Common SORCE	S/U	Number of radionuclides for which adult dose factors are given
NLIBA	Integer	SOURCE	Common SORCE	U	Same as NLIBA in REDDF
NLIBA	Integer	ZERO3	Common SORCE	S	Same as NLIBA in REDDF
NLIBC	Integer	REDDF	Common SORCE	S/U	Number of radionuclides for which child dose factors are given
NLIBC	Integer	SOURCE	Common SORCE	U	Same as NLIBC in REDDF
NLIBC	Integer	ZERO3	Common SORCE	S	Same as NLIBC in REDDF
NLIBI	Integer	REDDF	Common SORCE	S/U	Number of radionuclides for which infant dose factors are given
NLIBI	Integer	SOURCE	Common SORCE	U	Same as NLIBI in REDDF
NLIBI	Integer	ZERO3	Common SORCE	S	Same as NLIBI in REDDF
NLIBT	Integer	REDDF	Common SORCE	S/U	Number of radionuclides for which teen dose factors are given
NLIBT	Integer	SOURCE	Common SORCE	U	Same as NLIBT in REDDF
NLIBT	Integer	ZERO3	Common SORCE	S	Same as NLIBT in REDDF

Parameter Name	Type	Module	Data Interchange	Usage	Description
NN	Integer	SOURCE	Internal	–	Number of the source term currently being processed; limited to a maximum value of 10
NPR	Integer	PRINTC	Internal	–	Number of tables to be printed on the current page of cost-benefit output
NQ	Integer	REDMET	Internal	–	Total number of area elements to be considered (160)
NQ	Integer	REDSIT	Internal	–	Total number of area elements to be considered; used as the product of KT and IDIR to test for uniform distribution of the current parameter over the 50-mi area
NSOR	Integer	DOSIT	Argument	U	Number of radionuclides in the current source term
NSOR	Integer	MAIN	Internal	–	Same as NSOR in DOSIT
NSOR	Integer	OUTMAN	Argument	U	Same as NSOR in DOSIT
NSOR	Integer	OUTSPL	Argument	U	Same as NSOR in DOSIT
NSOR	Integer	PARTS	Argument	U	Same as NSOR in DOSIT
NSOR	Integer	SOURCE	Internal	–	Number of radionuclides in the current source term being read
NSP	Integer	DOSIT	Common NUKES	S	Number of special locations to be considered
NSP	Integer	PARTS	Common NUKES	S/U	Number of special locations; set to 1 for the PARTS calculations
NSPL	Integer	CARBON	Common NUKES	U	Number of special locations to be considered (5 maximum)

Parameter Name	Type	Module	Data Interchange	Usage	Description
NSPL	Integer	DOSIT	Argument	U	Same as NSPL in CARBON
NSPL	Integer	MAIN	Internal	–	Same as NSPL in CARBON
NSPL	Integer	NOBLE	Common NUKES	U	Same as NSPL in CARBON
NSPL	Integer	OUTSPL	Argument	U	Same as NSPL in CARBON
NSPL	Integer	PART	Common NUKES	U	Same as NSPL in CARBON
NSPL	Integer	PARTS	Internal	–	Number of special locations to be considered; set to 1 for PARTS calculations
NSPL	Integer	TRITON	Common NUKES	U	Same as NSPL in CARBON
NSR	Integer	MAIN	Internal	–	Number of source terms being considered for current case (incremented in SOURCE)
NSR	Integer	SOURCE	Argument	S/U	Number of source terms that have been processed, including the current source term
NSTAT(3)	Integer	PRINTC	Internal	–	Index array to control printing of results in cost-benefit tables, 1 value for each column (table)
NSUB	Integer	DOSIT	Internal	–	Index on current radionuclide for storage of data into the result arrays for cost-benefit output reports (see COST)
NT	Integer	PRINTM	Argument	U	Total number of area elements to be considered; set to 160 in call statements to PRINTM

Parameter Name	Type	Module	Data Interchange	Usage	Description
NUM(14)	Integer	SOURCE	Internal	–	Single characters used in identifying the atomic mass number characters: blank, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, M, _ (underline), and - (dash)
NW	Integer	OUTSPL	Internal	–	Number of age groups for which arrays are dimensioned (4); used in the inline function INDEX for unpacking doses
NX	Integer	DOSIT	Internal	–	Number of radionuclides allowed in the source term (33); used in the inline function INDEX
NX	Integer	OUTSPL	Internal	–	Same as NX in DOSIT
NX	Integer	PARTS	Internal	–	Same as NX in DOSIT
NY	Integer	DOSIT	Internal	–	Number of special locations (5); used in the inline function INDEX
NY	Integer	OUTSPL	Internal	–	Same as NY in DOSIT
NY	Integer	PARTS	Internal	–	Same as NY in DOSIT
NZ	Integer	DOSIT	Internal	–	Number of organs considered (8); used in the inline function INDEX
NZ	Integer	OUTSPL	Internal	–	Same as NZ in DOSIT
NZ	Integer	PARTS	Internal	–	Same as NZ in DOSIT
P	Char*1	BLKDAT	Internal	–	The letter "P" used for comparison with NCOM to identify modifications to common block PHYS
P(12)	Real	PRINTB	Internal	–	Character titles for report headings of parameters

Parameter Name	Type	Module	Data Interchange	Usage	Description
P(8)	Real	OUTMAN	Internal	–	Percent contribution to population dose for the current radionuclide and pathway for each organ
P(8)	Real	OUTSPL	Internal	–	Same as P in OUTMAN
PARTUP	Real	BLKDAT	Common TRANFR	S	Retention factor on vegetables for particulates other than iodine
PARTUP	Real	BLKDATA	Common TRANFR	S	Same as PARTUP in BLKDAT
PARTUP	Real	DOSIT	Common TRANFR	U	Same as PARTUP in BLKDAT
PARTUP	Real	PARTS	Common TRANFR	U	Same as PARTUP in BLKDAT
PARTUP	Real	PRINTB	Common TRANFR	U	Same as PARTUP in BLKDAT
PATH(7)	Char*8	OUTMAN	Internal	–	Character titles for each pathway used in the output reports
PATH(7)	Char*8	OUTSPL	Internal	–	Same as PATH in OUTMAN
PDEN	Real	CARBON	Common POPLTN	U	Average population density for the eastern portion of the U.S. (persons/m^2)
PDEN	Real	MAIN	Common POPLIN	S/U	Average population density for: 1) the 50-mi region, and 2) the eastern portion of the U.S. (persons/m^2)
PDEN	Real	NOBLE	Common POPLTN	U	Same as PDEN in CARBON
PDEN	Real	TRITON	Common POPLTN	U	Same as PDEN in CARBON
PERSON	Real	AGPROD	Argument	U	Total population within the 50-mi region
PERSON	Real	CARBON	Common POPLTN	U	Same as PERSON in AGPROD
PERSON	Real	MAIN	Common POPLIN	U	Same as PERSON in AGPROD

Parameter Name	Type	Module	Data Interchange	Usage	Description
PERSON	Real	PART	Common POPLTN	U	Same as PERSON in AGPROD
PERSON	Real	TRITON	Common POPLTN	U	Same as PERSON in AGPROD
PI	Real	REDSIT	Internal	–	The numerical value of the constant pi
PLIFE	Real	BLKDAT	Common PHYS	S	Plant life midpoint (sec)
PLIFE	Real	BLKDATA	Common PHYS	S	Same as PLIFE in BLKDAT
PLIFE	Real	CARBON	Common PHYS	U	Same as PLIFE in BLKDAT
PLIFE	Real	DOSIT	Common PHYS	U	Same as PLIFE in BLKDAT
PLIFE	Real	PART	Common PHYS	U	Same as PLIFE in BLKDAT
PLIFE	Real	PARTS	Common PHYS	U	Same as PLIFE in BLKDAT
PLIFE	Real	PRINTB	Common TRANFR	U	Same as PLIFE in BLKDAT
POP(160)	Real	MAIN	Common POPLIN	U	Population within each area element about the site (persons)
POP(160)	Real	NOBLE	Common POPLTN	U	Same as POP in MAIN
POP(160)	Real	PART	Common POPLTN	U	Same as POP in MAIN
POP(160)	Real	TRITON	Common POPLTN	U	Same as POP in MAIN
POPF(3)	Real	AGPROD	Common USAGE	U	Fraction of population in each age group: 1) infants and children, 2) teens, 3) adults
POPF(3)	Real	BLKDAT	Common PHYS	S	Same as POPF in AGPROD
POPF(3)	Real	BLKDATA	Common USAGE	S	Same as POPF in AGPROD
POPF(3)	Real	CARBON	Common USAGE	U	Same as POPF in AGPROD

Parameter Name	Type	Module	Data Interchange	Usage	Description
POPF(3)	Real	PART	Common USAGE	U	Same as POPF in AGPROD
POPF(3)	Real	PRINTB	Common USAGE	U	Same as POPF in AGPROD
POPF(3)	Real	TRITON	Common POPLTN	U	Same as POPF in AGPROD
POPGRD(33,8,2)	Real	DOSIT	Common OUTPOP	S/U	Population external dose from exposure to contaminated ground for 33 radionuclides, 8 organs, and the 50-mi and U.S. populations (person-rem)
POPGRD(33,8,2)	Real	OUTMAN	Common OUTPOP	U	Same as POPGRD in DOSIT
POPINH(33,8,2)	Real	DOSIT	Common OUTPOP	S/U	Population dose from inhalation for 33 radionuclides, 8 organs, and the 50-mi and U.S. populations (person-rem)
POPINH(33,8,2)	Real	OUTMAN	Common OUTPOP	U	Same as POPINH in DOSIT
POPMET(33,8,2)	Real	DOSIT	Common OUTPOP	S/U	Population dose from ingestion of meat for 33 radionuclides, 8 organs, and the 50-mi and U.S. populations (person-rem)
POPMET(33,8,2)	Real	OUTMAN	Common OUTPOP	U	Same as POPMET in DOSIT
POPMLK(33,8,2)	Real	DOSIT	Common OUTPOP	S/U	Population dose from ingestion of cow milk for 33 radionuclides, 8 organs, and the 50-mi and U.S. population (person-rem)
POPMLK(33,8,2)	Real	OUTMAN	Common OUTPOP	U	Same as POPMLK in DOSIT
POPSUB(33,8,2)	Real	DOSIT	Common OUTPOP	S/U	Population external dose from air submersion for 33 radionuclides (noble gases only), 8 organs, and the 50-mi and U.S. populations (person-rem)
POPSUB(33,8,2)	Real	OUTMAN	Common OUTPOP	U	Same as POPSUB in DOSIT

Parameter Name	Type	Module	Data Interchange	Usage	Description
POPVEG(33,8,2)	Real	DOSIT	Common OUTPOP	S/U	Population dose from ingestion of vegetables for 33 radionuclides, 8 organs, and the 50-mi and U.S. populations (person-rem)
POPVEG(33,8,2)	Real	OUTMAN	Common OUTPOP	U	Same as POPVEG in DOSIT
PSA	Real	PART	Internal	–	Number of people served by meat production within 50 mi (persons)
PSA	Real	TRITON	Internal	–	Same as PSA in PART
PSM	Real	PART	Internal	–	Number of people served by cow-milk production within 50 mi (persons)
PSM	Real	TRITON	Internal	–	Same as PSM in PART
PSOR	Integer	PRINTC	Internal	–	Index on the number of source terms for which cost-benefit tables have yet to be printed
PSV	Real	PART	Internal	–	Number of people served by vegetable production within 50 mi (persons)
PSV	Real	TRITON	Internal	–	Same as PSV in PART
PURGE	Real	CARBON	Common BLANK	U	Total annual release time for the current source term (hr/yr)
PURGE	Real	SOURCE	Common BLANK	S/U	Same as PURGE in CARBON
Q	Real	CARBON	Argument	U	Total activity of carbon-14 released (Ci/yr)
Q	Real	NOBLE	Argument	U	Release activity of the current radionuclide (Ci/yr)
Q	Real	PART	Argument	U	Same as Q in NOBLE

Parameter Name	Type	Module	Data Interchange	Usage	Description
Q	Real	PARTS	Internal	–	Release rate of current radionuclide; set to 1.0 for the PARTS calculations
Q	Real	TRITON	Argument	U	Activity release rate for tritium (Ci/yr)
Q(10)	Real	PRINTB	Internal	–	Character titles of parameter names for output report headings
Q(33)	Real	DOSIT	Argument	U	Radionuclide release rate for each radionuclide in the source inventory (Ci/yr)
Q(33)	Real	MAIN	Internal	–	Same as Q in DOSIT
Q(33)	Real	SOURCE	Argument	S/U	Same as Q in DOSIT
QQ	Real	SOURCE	Internal	–	Release rate of current radionuclide (Ci/yr)
QT	Real	SOURCE	Internal	–	Total activity release rate in the current source term, summed over all radionuclides (Ci/yr)
QTEMP(33)	Real	SOURCE	Internal	–	Temporary storage array for the release activity of each radionuclide in the current inventory (Ci/yr)
R	Real	PART	Argument	U	Retention factor on vegetation for the current radionuclide (dimensionless)
RADI(10)	Real	REDSIT	Internal	–	Outer boundary of each distance interval (mi)
REMVEG	Real	BLKDAT	Common TRANFR	S	Vegetation weathering removal constant; default value corresponds to a half-time of 14 days (sec^{-1})
REMVEG	Real	BLKDATA	Common TRANFR	S	Same as REMVEG in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
REMVEG	Real	PART	Common TRANFR	U	Same as REMVEG in BLKDAT
REMVEG	Real	PRINTB	Common TRANFR	U	Same as REMVEG in BLKDAT
SC(10)	Real	PRINTM	Internal	–	Sum of parameter values for each distance interval
SD	Real	BLKDAT	Common TRANFR	S	Effective surface density of soil; default value 240 is based on a soil mixing depth of 15 cm (kg/m^2)
SD	Real	BLKDATA	Common TRANFR	S	Same as SD in BLKDAT
SD	Real	PART	Common TRANFR	U	Same as SD in BLKDAT
SD	Real	PRINTB	Common TRANFR	U	Same as SD in BLKDAT
SF	Real	BLKDAT	Common USAGE	S	External radiation shielding factor for individuals for plume and ground plane exposures (dimensionless)
SF	Real	BLKDATA	Common PHYS	S	Same as SF in BLKDAT
SF	Real	NOBLE	Common PHYS	U	Same as SF in BLKDAT
SF	Real	PART	Common PHYS	U	Same as SF in BLKDAT
SF	Real	PRINTB	Common PHYS	U	Same as SF in BLKDAT
SLVEG(4)	Real	BLKDAT	Common USAGE	S	Maximally exposed individual annual leafy vegetable intake for four age groups: 1) infants, 2) children 3) teens, 4) adults (kg/yr)
SLVEG(4)	Real	BLKDATA	Common USAGE	S	Same as SLVEG in BLKDAT
SLVEG(4)	Real	PART	Common USAGE	U	Same as SLVEG in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
SLVEG(4)	Real	PRINTB	Common USAGE	U	Same as SLVEG in BLKDAT
SLVEG(4)	Real	TRITON	Common USAGE	U	Same as SLVEG in BLKDAT
SOIL(100)	Real	BLKDAT	Common TRANFR	S	Transfer factors from soil to plants for each element
SOIL(100)	Real	BLKDATA	Common TRANFR	S	Same as SOIL in BLKDAT
SOIL(100)	Real	PART	Common TRANFR	U	Same as SOIL in BLKDAT
SOIL(100)	Real	PRINTB	Common TRANFR	U	Same as SOIL in BLKDAT
SP	Real	PART	Internal	–	Transfer factor from soil to plant for the current radionuclide (dimensionless)
SPINH(4)	Real	BLKDAT	Common USAGE	S	Maximally exposed individual annual inhalation volume for four age groups: 1) infants, 2) children, 3) teens, 4) adults (m^3/yr)
SPINH(4)	Real	BLKDATA	Common USAGE	S	Same as SPINH in BLKDAT
SPINH(4)	Real	PART	Common USAGE	U	Same as SPINH in BLKDAT
SPINH(4)	Real	PRINTB	Common USAGE	U	Same as SPINH in BLKDAT
SPINH(4)	Real	TRITON	Common USAGE	U	Same as SPINH in BLKDAT
SPL(26400)	Real	OUTSPL	Internal	–	Equivalence array set up to access doses in pathway dose arrays of common block OUTIND
SPLGMK(5280)	Real	DOSIT	Common OUTIND	S/U	Individual dose from ingestion of goat milk for 33 radionuclides, 5 special locations, 8 organs, and 4 age groups (mrem)

Parameter Name	Type	Module	Data Interchange	Usage	Description
SPLGMK(5280)	Real	PARTS	Common OUTIND	S/U	Same as SPLGMK in DOSIT
SPLGRD(33,5,8)	Real	DOSIT	Common OUTIND	S/U	Individual dose from external exposure to contaminated ground for 33 radionuclides, 5 special locations, and 8 organs (mrem)
SPLGRD(33,5,8)	Real	OUTSPL	Common OUTIND	U	Same as SPLGRD in DOSIT
SPLGRD(33,5,8)	Real	PARTS	Common OUTIND	S/U	Same as SPLGRD in DOSIT
SPLINH(5280)	Real	DOSIT	Common OUTIND	S/U	Individual dose from inhalation for 33 radionuclides, 5 special locations, 8 organs, and 4 age groups (mrem)
SPLINH(5280)	Real	PARTS	Common OUTIND	S/U	Same as SPLINH in DOSIT
SPLMET(5280)	Real	DOSIT	Common OUTIND	S/U	Individual dose from meat ingestion for 33 radionuclides, 5 special locations, 8 organs, and 4 age groups (mrem)
SPLMET(5280)	Real	PARTS	Common OUTIND	S/U	Same as SPLMET in DOSIT
SPLMLK(5280)	Real	DOSIT	Common OUTIND	S/U	Individual dose from ingestion of cow milk for 33 radionuclides, 5 special locations, 8 organs, and 4 groups (mrem)
SPLMLK(5280)	Real	PARTS	Common OUTIND	S/U	Same as SPLMLK in DOSIT
SPLSUB(33,5,8)	Real	DOSIT	Common OUTIND	S/U	Individual external dose from air submersion for 33 radionuclides, 5 special locations, and 8 organs (mrem)
SPLSUB(33,5,8)	Real	OUTSPL	Common OUTIND	U	Same as SPLSUB in DOSIT
SPLSUB(33,5,8)	Real	PARTS	Common OUTIND	S/U	Same as SPLSUB in DOSIT

Parameter Name	Type	Module	Data Interchange	Usage	Description
SPLVEG(5280)	Real	DOSIT	Common OUTIND	S/U	Individual dose from ingestion of vegetables for 33 radionuclides, 5 special locations, 8 organs, and 4 age groups (mrem)
SPLVEG(5280)	Real	PARTS	Common OUTIND	S/U	Same as SPLVEG in DOSIT
SPMET(4)	Real	BLKDAT	Common USAGE	S	Maximally exposed individual annual meat intake for 4 age groups: 1) infants, 2) children, 3) teens, 4) adults (kg/yr)
SPMET(4)	Real	BLKDATA	Common USAGE	S	Same as SPMET in BLKDAT
SPMET(4)	Real	CARBON	Common USAGE	U	Same as SPMET in BLKDAT
SPMET(4)	Real	PART	Common USAGE	U	Same as SPMET in BLKDAT
SPMET(4)	Real	PRINTB	Common USAGE	U	Same as SPMET in BLKDAT
SPMET(4)	Real	TRITON	Common USAGE	U	Same as SPMET in BLKDAT
SPMET(4)	Real	BLKDAT	Common USAGE	S	Same as SPMET in BLKDAT
SPMLK(4)	Real	BLKDAT	Common USAGE	S	Maximally exposed individual annual milk intake for 4 age groups: 1) infants, 2) children, 3) teens, 4) adults (L/yr)
SPMLK(4)	Real	BLKDATA	Common USAGE	S	Same as SPMLK in BLKDAT
SPMLK(4)	Real	CARBON	Common USAGE	U	Same as SPMLK in BLKDAT
SPMLK(4)	Real	PART	Common USAGE	U	Same as SPMLK in BLKDAT
SPMLK(4)	Real	PRINTB	Common USAGE	U	Same as SPMLK in BLKDAT
SPMLK(4)	Real	TRITON	Common USAGE	U	Same as SPMLK in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
SPRINT(8)	Real	OUTSPL	Common USAGE	–	Array containing doses for each organ; used to print the current output line
SPVEG(4)	Real	BLKDAT	Common USAGE	S	Maximally exposed individual annual vegetable intake for 4 age groups: 1) infants, 2) children, 3) teens, 4) adults (kg/yr)
SPVEG(4)	Real	BLKDATA	Common USAGE	S	Same as SPVEG in BLKDAT
SPVEG(4)	Real	CARBON	Common USAGE	U	Same as SPVEG in BLKDAT
SPVEG(4)	Real	PART	Common USAGE	U	Same as SPVEG in BLKDAT
SPVEG(4)	Real	PRINTB	Common USAGE	U	Same as SPVEG in BLKDAT
SPVEG(4)	Real	TRITON	Common USAGE	U	Same as SPVEG in BLKDAT
SR(16)	Real	PRINTM	Internal	–	Sum of parameter values for each sector
SSF	Real	BLKDAT	Common PHYS	S	External radiation shielding factor for populations for plume and ground plane exposures
SSF	Real	BLKDATA	Common PHYS	S	Same as SSF in BLKDAT
SSF	Real	NOBLE	Common PHYS	U	Same as SSF in BLKDAT
SSF	Real	PART	Common PHYS	U	Same as SSF in BLKDAT
SSF	Real	PRINTB	Common PHYS	U	Same as SSF in BLKDAT
T	Char*1	BLKDAT	Internal	–	The letter "T" used for comparison with NCOM to identify modifications to common block TRANFR
T	Real	DOSIT	Internal	–	Effective transit time to the current location through the atmosphere (hr)

Parameter Name	Type	Module	Data Interchange	Usage	Description
T	Real	MAIN	Internal	–	Average temperature over growing season; used to calculate absolute humidity (^{o}F)
T	Logical	OUTSPL	Internal	–	Logical control parameter for printing the current pathway title
TA	Real	PART	Internal	–	Transfer factor from animal feed to meat for the current radionuclide (day/kg)
TAU(200)	Real	DOSIT	Common DFLIB	U	Radiological decay constant for each radionuclide (sec^{-1})
TAU(200)	Real	NOBLE	Common DFLIB	U	Same as TAU in DOSIT
TAU(200)	Real	PART	Common DFLIB	U	Same as TAU in DOSIT
TAU(200)	Real	PARTS	Common DFLIB	U	Same as TAU in DOSIT
TAU(200)	Real	REDDF	Common DFLIB	S/U	Same as TAU in DOSIT
TAU(200)	Real	ZERO3	Common DFLIB	S	Same as TAU in DOSIT
TEST	Logical	DOSIT	Internal	–	Logical control flag indicating when the cost-benefit table is to be printed; set to .TRUE. when the report is to be printed
TEST	Real	OUTMAN	Internal	–	Sum of all doses for a radionuclide for the current pathway; used to skip printing of information for a radionuclide having zero dose
TEST	Real	OUTSPL	Internal	–	Same as TEST in OUTMAN
TG	Real	PART	Internal	–	Transfer factor from animal feed to goat milk for the current radionuclide (day/L)

Parameter Name	Type	Module	Data Interchange	Usage	Description
TGRD	Real	DOSIT	Common NUKES	S/U	Total activity of the current radionuclide on the ground within 50 mi at the midpoint of plant life (Ci)
TGRD	Real	PART	Common NUKES	S	Same as TGRD in DOSIT
TIM(8)	Real	BLKDAT	Common TRANFR	S	Holdup and transport times (days): 1) meat transport time to population and maximally exposed individual (20 days), 2) milk transport time to population (4 days), 3) vegetable holdup time from harvest to consumption for population (60 days), 4) vegetable holdup time to maximally exposed individual (14 days), 5) milk holdup time to maximally exposed individual (2 days), 6) leafy vegetable holdup time to maximally exposed individual (1 day), 7) pasture-grazing period (30 days), 8) animal-feed storage time (90 days)
TIM(8)	Real	BLKDATA	Common TRANFR	S	Same as TIM in BLKDAT
TIM(8)	Real	PART	Common TRANFR	U	Same as TIM in BLKDAT
TIM(8)	Real	PRINTB	Common TRANFR	U	Same as TIM in BLKDAT
TL	Real	DOSIT	Internal	–	Intermediate exponential term in the calcuation of activity at the midpoint of plant life (hr)
TL	Real	NOBLE	Internal	–	Exponential term used in the decay calculation for transit of the plume across the eastern part of the U.S. (hr)
TL	Real	PARTS	Internal	–	Same as TL in DOSIT

Parameter Name	Type	Module	Data Interchange	Usage	Description
TM	Real	PART	Internal	–	Transfer factor from animal feed to cow milk for the current radionuclide (day/L)
TMET	Real	CARBON	Common NUKES	S/U	Total activity of carbon-14 in meat produced within 50 mi (Ci)
TMET	Real	DOSIT	Common NUKES	S/U	Total activity of the current radionuclide in meat produced within 50 mi at the midpoint of plant life (Ci)
TMET	Real	PART	Common NUKES	S	Same as TMET in DOSIT
TMET	Real	PARTS	Common NUKES	S/U	Same as TMET in DOSIT
TMET	Real	TRITON	Common NUKES	S/U	Same as TMET in DOSIT for tritium
TMLK	Real	CARBON	Common NUKES	S/U	Total activity of carbon-14 in cow milk produced within 50 mi (Ci)
TMLK	Real	DOSIT	Common NUKES	S/U	Total activity of the current radionuclide in cow milk produced within 50 mi at the midpoint of plant life (Ci)
TMLK	Real	PART	Common NUKES	S	Same as TMLK in DOSIT
TMLK	Real	PARTS	Common NUKES	S/U	Same as TMLK in DOSIT
TMLK	Real	TRITON	Common NUKES	S/U	Same as TMLK in DOSIT for tritium
TOT	Real	PRINTM	Common NUKES	S/U	The sum of the NT parameter values contained in array A
TOT	Real	REDSIT	Internal	–	Input value for the total (population or food production) to be distributed over the 50-mi area
TVEG	Real	Carbon	Common NUKES	S/U	Total activity of carbon-14 in vegetables produced within 50 mi (Ci)

Parameter Name	Type	Module	Data Interchange	Usage	Description
TVEG	Real	DOSIT	Common NUKES	S/U	Total activity of the current radionuclide in crops produced within 50 mi at the midpoint of plant life (Ci)
TVEG	Real	PART	Common NUKES	S	Same as TVEG in DOSIT
TVEG	Real	PARTS	Common NUKES	S/U	Same as TVEG in DOSIT
TVEG	Real	TRITON	Common USAGE	S/U	Same as TVEG in DOSIT for tritium
U	Char*1	BLKDAT	Internal	-	The letter "U" used for comparison with NCOM to identify modifications to common block USAGE
UML	Real	SOURCE	Internal	-	Source-term multiplication factor applied to the input release activity for each radionuclide
USPOP	Real	BLKDAT	Common USAGE	S	Estimated U.S. population for the year 2010
USPOP	Real	BLKDATA	Common USAGE	S	Same as USPOP in BLKDAT
USPOP	Real	CARBON	Common USAGE	U	Same as USPOP in BLKDAT
USPOP	Real	NOBLE	Common USAGE	U	Same as USPOP in BLKDAT
USPOP	Real	PRINTB	Common USAGE	U	Same as USPOP in BLKDAT
V	Real	PART	Internal	-	Intermediate parameter in the calculation of inhalation doses
VHS	Real	BLKDAT	Common PHYS	S	Volume of water in the hydrosphere, in the top 75 m of water (L)
VHS	Real	BLKDATA	Common PHYS	S	Same as VHS in BLKDAT
VHS	Real	PRINTB	Common PHYS	U	Same as VHS in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
VHS	Real	TRITON	Common PHYS	U	Same as VHS in BLKDAT
VIORET	Real	BLKDAT	Common TRANFR	S	Retention fraction of iodine on vegetation
VIORET	Real	BLKDATA	Common TRANFR	S	Same as VIORET in BLKDAT
VIORET	Real	DOSIT	Common TRANFR	U	Same as VIORET in BLKDAT
VIORET	Real	PARTS	Common TRANFR	U	Same as VIORET in BLKDAT
VIORET	Real	PRINTB	Common TRANFR	U	Same as VIORET in BLKDAT
VNA	Real	BLKDAT	Common PHYS	S	Volume of the atmosphere (m^3)
VNA	Real	BLKDATA	Common PHYS	S	Same as VNA in BLKDAT
VNA	Real	NOBLE	Common PHYS	U	Same as VNA in BLKDAT
VNA	Real	PRINTB	Common PHYS	U	Same as VNA in BLKDAT
VRET	Real	DOSIT	Internal	–	Retention fraction of current radionuclide on vegetables (dimensionless)
VRET	Real	PARTS	Internal	–	Same as VRET in DOSIT
W	Real	CARBON	Internal	–	Concentration of carbon-14 in goat milk (pCi/L)
W	Real	PART	Internal	–	Intermediate parameter in the calculation of dose from external exposure to contaminated ground
W	Real	TRITON	Internal	–	Tritium concentration in meat

Parameter Name	Type	Module	Data Interchange	Usage	Description
WW	Real	PART	Internal	–	Intermediate parameter in the calculation of dose from external exposure to contaminated ground
X	Real	CARBON	Internal	–	Concentration of carbon-14 in vegetables (pCi/kg)
X	Real	EXFCT	Argument	U	Exponential argument for which the function EXFCT is to be evaluated
X	Real	MAIN	Internal	–	Intermediate exponential argument in the evaluation of absolute humidity (H) from the average temperature (T)
X	Real	NOBLE	Internal	–	Intermediate term in the population and individual dose calculations, including atmospheric dispersion and unit conversions (various units)
X	Real	PART	Internal	–	Intermediate parameter in the calculation dose from vegetable ingestion
X	Real	REDSIT	Internal	–	Square of the outer boundary of the current distance interval; used in the distribution of population and food production over the 50-mi area
X	Real	TRITON	Internal	–	Intermediate parameter in the tritium dose calculations with multiple uses: ALARA air concentration, average vegetable concentration, and air concentration for individuals
X1	Real	AGPROD	Internal	U	Annual amount of vegetable crops available for export from the 50-mi region (kg)

Parameter Name	Type	Module	Data Interchange	Usage	Description
X1	Real	PART	Internal	–	Intermediate concentration for the vegetable-ingestion pathway
X2	Real	PART	Internal	–	Intermediate concentration for the milk-ingestion pathway
X3	Real	PART	Internal	–	Intermediate concentration for the meat-ingestion pathway
XB(160)	Real	CARBON	Argument	U	Atmospheric dispersion factor for each area element (sec/m^3)
XB(160)	Real	NOBLE	Argument	U	Normalized air concentration for the current noble gas radionuclide with decay in transit to each area element (sec/m^3)
XB(160)	Real	PART	Argument	U	Normalized atmospheric dispersion factors for each area element for the current radionuclide, for use in the inhalation dose calculation (sec/m^3)
XB(160)	Real	TRITON	Argument	U	Atmospheric dispersion factor for tritium at each area element (sec/m^3)
XB1(160)	Real	PART	Argument	U	Normalized atmospheric dispersion factor corrected for decay and depletion for each area element for the current radionuclide (sec/m^3)
XEX	Real	DOSIT	Internal	–	Exponential argument for the calculation of decay-in-transit correction for atmospheric disperison and deposition factors (dimensionless)
XMET	Real	AGPROD	Common AGPOP	S/U	Total population served meat produced within the 50-mi region (persons)
XMET	Real	CARBON	Common AGPOP	U	Same as XMET in AGPROD

Parameter Name	Type	Module	Data Interchange	Usage	Description
XMET	Real	PART	Common AGPOP	U	Same as XMET in AGPROD
XMET	Real	TRITON	Common AGPOP	U	Same as XMET in AGPROD
XMLK	Real	AGPROD	Common AGPOP	U	Total population served milk produced within the 50-mi region (persons)
XMLK	Real	CARBON	Common AGPOP	U	Same as XMLK in AGPROD
XMLK	Real	PART	Common AGPOP	U	Same as XMLK in AGPROD
XMLK	Real	TRITON	Common AGPOP	U	Same as XMLK in AGPROD
XMLT	Real	DOSIT	Internal	–	Correction factor for decay in transit for the current radionuclide in the calculation of atmospheric dispersion and deposition factors (dimensionless)
XMLT	Real	PARTS	Internal	–	Same as XMLT in DOSIT
XOQ	Real	PART	Internal	–	Normalized atmospheric dispersion factor for the current area element and radionuclide for use in the inhalation dose calculation (sec/m^3)
XP	Real	NOBLE	Internal	–	Population-weighted atmospheric dispersion factor for the site (person-sec/m^3)
XQ(160)	Real	DOSIT	Common METDTA	U	Normalized air concentration at each downwind area element for 16 compass directions and 10 distances (sec/m^3)
XQ(160)	Real	MAIN	Common METDTA	U	Same as XQ in DOSIT
XQ1(5)	Real	DOSIT	Common SPECIL	U	Normalized air concentration at each special location (sec/m^3)

Parameter Name	Type	Module	Data Interchange	Usage	Description
XQ1(5)	Real	MAIN	Common SPECIL	S/U	Same as XQ1 in DOSIT
XQD(160)	Real	DOSIT	Common METDTA	U	Normalized air concentration with decay based on a half-life of 2.26 days (sec/m^3)
XQD(160)	Real	MAIN	Common METDTA	U	Same as XQD in DOSIT
XQD1(5)	Real	DOSIT	Common SPECIL	U	Normalized air concentration at each special location with decay correction in transit for a half-life of 2.26 days (sec/m^3)
XQD1(5)	Real	MAIN	Common SPECIL	S/U	Same as XQD1 in DOSIT
XQDD(160)	Real	DOSIT	Common METDTA	U	Normalized air concentration with decay correction for an 8-day half-life and depletion in transit (sec/m^3)
XQDD(160)	Real	MAIN	Common METDTA	U	Same as XQDD in DOSIT
XQDD1(5)	Real	DOSIT	Common SPECIL	U	Normalized air concentration at each special location, corrected for decay (for an 8-day half-life) and depletion in transit (sec/m^3)
XQDD1(5)	Real	MAIN	Common SPECIL	S/U	Same as XQDD1 in DOSIT
XQM(5)	Real	PART	Argument	–	Normalized atmospheric dispersion factor for each special location, corrected for decay and depletion for the current radionuclide (sec/m^3)
XQN(5)	Real	PART	Argument	–	Normalized atmospheric dispersion factor for each special location for the current radionuclide; used with the inhalation dose calculation (sec/m^3)

Parameter Name	Type	Module	Data Interchange	Usage	Description
XQQ(160)	Real	DOSIT	Internal	–	Normalized air concentration at each area element with decay in transit for the current radionuclide (sec/m^3)
XQQ(160)	Real	PARTS	Internal	–	Array to transfer unit dispersion factors to dose subroutines CARBON, PART, and TRITON
XQQ1(5)	Real	DOSIT	Internal	–	Normalized air concentration at each special location with decay in transit for the current radionuclide (sec/m^3)
XQQ1(5)	Real	PARTS	Internal	–	Array to transfer unit dispersion factors to dose subroutines CARBON, PART, and TRITON
XQS(5)	Real	CARBON	Argument	U	Atmospheric dispersion factor for each special location for individual dose (sec/m^3)
XQS(5)	Real	NOBLE	Argument	U	Normalized air concentration for the current noble gas radionuclide, with decay in transit to each special location (sec/m^3)
XQS(5)	Real	TRITON	Argument	U	Atmospheric dispersion factor for tritium at each special location (sec/m^3)
XV	Real	AGPROD	Internal	S/U	Average annual rate of vegetable consumption by the population (kg/person/yr)
XVEG	Real	AGPROD	Common AGPOP	S/U	Total population served vegetables produced within the 50-mi region (persons)
XVEG	Real	CARBON	Common AGPOP	U	Same as XVEG in AGPROD

Parameter Name	Type	Module	Data Interchange	Usage	Description
XVEG	Real	PART	Common AGPOP	U	Same as XVEG in AGPROD
XVEG	Real	TRITON	Common AGPOP	U	Same as XVEG in AGPROD
XX	Real	PART	Internal	–	Effective removal constant for the current radionuclide on vegetation (sec^{-1})
XX	Real	REDSIT	Internal	–	Amount (population or food production) for the current distance interval in the distribution calculation over the 50-mi area
XXQDD(160)	Real	DOSIT	Internal	–	Normalized air concentration at each area element with decay and deposition for the current radionuclide (sec/m^3)
XXQDD(160)	Real	PARTS	Internal	–	Array to transfer unit dispersion factors to dose subroutines CARBON, PART, and TRITON
XXQDD1(5)	Real	DOSIT	Internal	–	Normalized air concentration at each special location with decay and deposition for the current radionuclide (sec/m^3)
XXQDD1(5)	Real	PARTS	Internal	–	Array to transfer unit dispersion factors to dose subroutines CARBON, PART, and TRITON
Y	Real	CARBON	Internal	–	Concentration of carbon-14 in cow milk (pCi/L)
Y	Real	PART	Internal	–	Intermediate parameter in the cow-milk ingestion dose pathway

Parameter Name	Type	Module	Data Interchange	Usage	Description
Y	Real	TRITON	Internal	-	Intermediate parameter in tritium dose calculations with multiple uses: average air concentration used for population vegetable pathway, average concentration in milk, and air concentration for individual vegetable pathway
Y1	Real	AGPROD	Internal	-	Annual amount of milk available for export from the 50-mi region (L)
YA1	Real	BLKDAT	Common TRANFR	S	Pasture grass yield (kg/m^2)
YA1	Real	BLKDATA	Common TRANFR	S	Same as YA1 in BLKDAT
YA1	Real	PART	Common TRANFR	U	Same as YA1 in BLKDAT
YA1	Real	PRINTB	Common TRANFR	U	Same as YA1 in BLKDAT
YA2	Real	BLKDAT	Common TRANFR	S	Feed crop yield (kg/m^2)
YA2	Real	BLKDATA	Common TRANFR	S	Same as YA2 in BLKDAT
YA2	Real	PART	Common TRANFR	U	Same as YA2 in BLKDAT
YA2	Real	PRINTB	Common TRANFR	U	Same as YA2 in BLKDAT
YM	Real	AGPROD	Internal	-	Average annual rate of milk consumption by the population (L/person/yr)
YV	Real	BLKDAT	Common TRANFR	S	Garden vegetable crop yield (kg/m^2)
YV	Real	BLKDATA	Common TRANFR	S	Same as YV in BLKDAT
YV	Real	PART	Common TRANFR	U	Same as YV in BLKDAT
YV	Real	PRINTB	Common TRANFR	U	Same as YV in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
YZ	Real	PART	Internal	–	Intermediate parameter in the cow-milk ingestion dose calculation
YZB	Real	PART	Internal	–	Intermediate parameter in the meat-ingestion pathway
Z	Real	CARBON	Internal	–	Concentration of carbon-14 in meat (pCi/kg)
Z	Real	PART	Internal	–	Intermediate parameter in the meat-ingestion pathway
Z	Real	TRITON	Internal	–	Intermediate parameter in the tritium dose calculations with multiple uses: average concentration in cow milk for population dose calculations and individual dose calculations
Z1	Real	AGPROD	Internal	–	Annual amount of meat available for export from the 50-mi region (kg)
Z1	Real	PART	Internal	–	Intermediate parameter in the goat milk-ingestion pathway
Z1	Real	TRITON	Internal	–	Intermediate parameter in the tritium dose calculation for the goat-milk pathway for individuals
ZA	Real	AGPROD	Internal	–	Average annual rate of meat consumption by the population (kg/person/yr)
ZGMLK(14)	Real	BLKDAT	Common TRANFR	S	Feed-to-milk transfer factors for elements identified in array IGOT (days/L)
ZGMLK(14)	Real	BLKDATA	Common TRANFR	S	Same as ZGMLK in BLKDAT
ZGMLK(14)	Real	CARBON	Common TRANFR	U	Same as ZGMLK in BLKDAT

Parameter Name	Type	Module	Data Interchange	Usage	Description
ZGMLK(14)	Real	PART	Common TRANFR	U	Same as ZGMLK in BLKDAT
ZGMLK(14)	Real	PRINTB	Common TRANFR	U	Same as ZGMLK in BLKDAT
ZGMLK(14)	Real	TRITON	Common TRANFR	U	Same as ZGMLK in BLKDAT
ZMEAT(160)	Real	CARBON	Common SITE	U	Annual meat production within each distance and direction interval; set in REDSIT (kg/yr)
ZMEAT(160)	Real	MAIN	Common SITE	U	Same as ZMEAT in CARBON
ZMEAT(160)	Real	PART	Common SITE	U	Same as ZMEAT in CARBON
ZMEAT(160)	Real	TRITON	Common SITE	U	Same as ZMEAT in CARBON
ZMET(100)	Real	BLKDAT	Common TRANFR	S	Feed-to-meat transfer factors for each element (days/kg)
ZMET(100)	Real	BLKDATA	Common TRANFR	S	Same as ZMET in BLKDAT
ZMET(100)	Real	CARBON	Common TRANFR	U	Same as ZMET in BLKDAT
ZMET(100)	Real	PART	Common TRANFR	U	Same as ZMET in BLKDAT
ZMET(100)	Real	PRINTB	Common TRANFR	U	Same as ZMET in BLKDAT
ZMET(100)	Real	TRITON	Common TRANFR	U	Same as ZMET in BLKDAT
ZMETT	Real	AGPROD	Argument	–	Average annual meat production within the 50-mi region (kg/yr)
ZMETT	Real	CARBON	Common SITE	U	Same as ZMETT in AGPROD
ZMETT	Real	PART	Common SITE	U	Same as ZMETT in AGPROD
ZMETT	Real	TRITON	Common SITE	U	Same as ZMETT in AGPROD

Parameter Name	Type	Module	Data Interchange	Usage	Description
ZMILK(160)	Real	CARBON	Common SITE	U	Annual milk production within each distance and direction interval; set in REDSIT (L/yr)
ZMILK(160)	Real	MAIN	Common SITE	U	Same as ZMILK in CARBON
ZMILK(160)	Real	PART	Common SITE	U	Same as ZMILK in CARBON
ZMILK(160)	Real	TRITON	Common SITE	U	Same as ZMILK in CARBON
ZMLK(100)	Real	BLKDAT	Common TRANFR	S	Feed-to-milk transfer factors for each element (days/L)
ZMLK(100)	Real	BLKDATA	Common TRANFR	S	Same as ZMLK in BLKDAT
ZMLK(100)	Real	CARBON	Common TRANFR	U	Same as ZMLK in BLKDAT
ZMLK(100)	Real	PART	Common TRANFR	U	Same as ZMLK in BLKDAT
ZMLK(100)	Real	PRINTB	Common TRANFR	U	Same as ZMLK in BLKDAT
ZMLK(100)	Real	TRITON	Common TRANFR	U	Same as ZMLK in BLKDAT
ZMLKT	Real	AGPROD	Argument	U	Total annual milk production within the 50-mi region (L/yr)
ZMLKT	Real	MAIN	Common SITE	U	Same as ZMLKT in AGPROD
ZMLKT	Real	PART	Common SITE	U	Same as ZMLKT in AGPROD
ZMLKT	Real	TRITON	Common SITE	U	Same as ZMLKT in AGPROD
ZVEGT(160)	Real	CARBON	Common SITE	U	Annual vegetable production within each distance and direction interval; set in REDSIT (kg/yr)
ZVEGT(160)	Real	MAIN	Common SITE	U	Same as ZVEGT in CARBON

Parameter Name	Type	Module	Data Interchange	Usage	Description
ZVEGT(160)	Real	PART	Common SITE	U	Same as ZVEGT in CARBON
ZVEGT(160)	Real	TRITON	Common SITE	U	Same as ZVEGT in CARBON
ZVEGTT	Real	AGPROD	Argument	U	Total annual vegetable production within the 50-mi region (kg/yr)
ZVEGTT	Real	CARBON	Common SITE	U	Same as ZVEGTT in AGPROD
ZVEGTT	Real	MAIN	Common SITE	U	Same as ZVEGTT in AGPROD
ZVEGTT	Real	PART	Common SITE	U	Same as ZVEGTT in AGPROD
ZVEGTT	Real	TRITON	Common SITE	U	Same as ZVEGTT in AGPROD

APPENDIX B

PROGRAM, DATA FILE, AND SAMPLE PROBLEM LISTING

APPENDIX B

PROGRAM, DATA FILE, AND SAMPLE PROBLEM LISTING

This appendix provides a listing of each module in the current version of GASPAR II, a listing of the radionuclide dose-factor library, and complete computer-generated output listings for the three sample problems described in Section 2.3. These listings are contained on microfiche in the back cover of this report. The order of information presented is as follows:

APPENDIX C

CHANGES TO GASPAR

APPENDIX C

CHANGES TO GASPAR

Several changes were made to the previous version of GASPAR (Eckerman et al. 1980). These changes can be categorized as cosmetic or functional. Cosmetic changes relate to added comment lines (for better understanding of the program listings) and to modifications of output reports for correct representation of calculated results. Functional changes are modifications that affect calculated values or parameter usage.

Table C.1 provides a detailed summary of functional changes and a general summary of cosmetic, output-report changes to GASPAR II, with reference to the modules and lines affected. Details of cosmetic, comment-line changes are not provided here, as they are apparent in reviewing program listings.

Module PARTS is entirely new to GASPAR II.

A major change made in preparation of GASPAR II was to remove dose conversion factors (except for noble gases) from the block data module BLKDATA. A new version of subroutine REDDF has been prepared that reads dose conversion factors from a standard data file. This data file is the same data file used by the LADTAP II computer program, and contains data for 169 radionuclides (instead of just 33 as were available with the original GASPAR program).

Most of the changes have no effect on the calculated results. Changes in dose factors will result in proportionate changes in doses. The effects of other changes are indicated in Table C.1.

TABLE C.1. Summary of Changes to GASPAR II

Module(s)	Line(s)	Description of Change
MAIN	113, 129, 130, 223-225, 235-237, 295-301	Use of system date routine and parameter IDATE modified for VAX requirements
MAIN	144-146, 149, 150, 152-155, 158-161, 171-227	Report formats modified
MAIN	164-170	Error messages modified
MAIN	243, 425-430, 434, 442, 448, 456, 465, 488, 520	Parameter JDEV added for input of meteorological data from an alternate file
MAIN	241, 244	Read statements moved to eliminate printing of banner page at end of a run
MAIN	313	Subroutine REDDF is called on the first pass for every run
MAIN	319, 323	Parameter CD used instead of PDEN to minimize multiple uses of PDEN
MAIN	402-405	New logic structure for report of site parameters
MAIN	410-413	Logic added to allow PARTS calculation
MAIN	397	Parameter JC(6) added to argument list of call to SOURCE
AGPROD	96-102	Report formats changed
BLKDAT	153, 164, 210, 237, 263, 294, 305, 316, 327, 342, 356, 409, 455-476	Error messages modified or added
BLKDATA	-	Unnecessary dimension and equivalence statements eliminated
BLKDATA	-	Dose factor data statements eliminated
BLKDATA	155	U.S. population redefined to 2.8 x 10^8 for the year 2010.
BLKDATA	190-216	Noble gas dose factor data statements redefined
DOSIT	386	Print statement moved to avoid unnecessary heading printout
DOSIT	444-450, 469-475	Evaluation of deposition factor modified to eliminate decay correction for ^{131}I; this may result in a slight decrease in estimated doses that are based on the deposition factors
EXFCT	27-41	Logic modified to return a value of 1.0 for arguments greater than 30

TABLE C.1. (Contd)

Module(s)	Line(s)	Description of Change
BLKDATA	85	Parameter IELEM defined as integer*2
DOSIT	323	
OUTMAN	67	
OUTSPL	94	
PARTS	117	
PRINTB	96	
PRINTC	71	
REDDF	64	
SOURCE	161	
PART	346	DEC(3) changed to DEC(4) to use a 60-day holdup time for vegetables for population doses; this may result in a slight decrease in population doses from vegetable ingestion for short-lived radionuclides
PART	441	DEC(4) changed to DEC(3) to use a 14-day holdup time for vegetables for individual doses; this may result in a slight increase in individual doses from vegetable ingestion for short-lived radionuclides
PRINTB	109, 117, 118, 202, 213-218, 221, 225	Parameters U and MDIS added for use in print statements
PRINTB	122-173	Format statements modified or added to improve reports
PRINTM	63-72	Formats changed slightly to improve readability
REDMET	2, 74, 75, 81, 92, 93, 99, 100, 102, 103	Parameter JDEV added to argument list for definition of input unit for meteorological data file
REDSIT	91-93, 111, 113	Error message improved; KCI defined for use with error message
SOURCE	2, 234, 451	Parameter JC6 added to allow input of zero activity when a PARTS calculation is to be performed
SOURCE	186-218	Formats revised for improved error messages and reports
SOURCE	369-420	Source inventory report modified to allow up to 3 columns across the page
ZERO1	35, 54-56	Array M added to common block to allow array MAP to be initialized to integer zero
ZERO3	52-54	Common blocks SORCE and DFLIB redefined with standard parameter names
ZERO3	65-87	Array initialization rewritten to use standard parameter names and to by-pass initialization of data locations used for noble gases
ZERO3	92-95	Initialization of radionuclide count indexes added

APPENDIX D

SAMPLE PROBLEM 1 OUTPUT LISTING

APPENDIX D

SAMPLE PROBLEM 1 OUTPUT LISTING

This appendix presents a complete listing of the output reports generated by GASPAR II for the first sample problem of Chapter 2.0. Complete listings for all three sample problems are included on the Appendix B microfiche.

```
*****************************************************************************************************
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*             GGGGGGGG     AA      SSSSSSSS  PPPPPPPP     AA      RRRRRRRR    IIIII IIIII           *
*             G      G     AA      S         PP     P     AA      RR     R      I     I             *
*             G           A  A     SSSSSSS   PP     P    A  A     RRRRRRRR      I     I             *
*             G   GGGGG  AAAAAA          S   PPPPPPPP   AAAAAA    RRRR          I     I             *
*             G      G  A      A         S   PP        A      A   RR RR         I     I             *
*             GGGGGGG  A        A SSSSSSS    PP       A        A  RR    RR    IIIII IIIII           *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                    EVALUATION OF RADIATION DOSES FROM RELEASES OF RADIOACTIVITY                   *
*                                                                                                   *
*                             IN NUCLEAR POWER PLANTS AIRBORNE EFFLUENTS                            *
*                                                                                                   *
*                               REVISION DATE:  PNL VAX - DECEMBER 1986                             *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*             SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS                                       *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*                               RELIABILITY AND RISK ASSESSMENT BRANCH                              *
*                                                                                                   *
*                               OFFICE OF NUCLEAR REACTOR REGULATION                                *
*                                                                                                   *
*                               U.S. NUCLEAR REGULATORY COMMISSION                                  *
*                                                                                                   *
*                               WASHINGTON, D.C. 20555                                              *
*                                                                                                   *
*                                   DATE OF RUN:      1-DEC-86                                      *
*                                                                                                   *
*                                                                                                   *
*                                                                                                   *
*****************************************************************************************************
```

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS

JOB CONTROL PARAMETERS

JC(1) =	1	:POPULATION/INDIVIDUAL DOSE SELECTION
JC(2) =	3	:NUMBER OF SOURCE RELEASE POINTS
JC(3) =	1	:PRINT CONTROL FOR DOSE ACCUMULATION
JC(4) =	0	:READ CONTROL FOR BLOCK DATA CHANGE RECORDS
JC(5) =	0	:PRINT CONTROL FOR DOSE FACTOR TABLE
JC(6) =	0	:CALCULATION CONTROL FOR UNIT DOSE FACTORS
JC(7) =	0	:READ CONTROL FOR DISPERSION DATA INPUT FILE
JC(8) =	0	
JC(9) =	0	
JC(10)=	0	

EXPOSURE PATHWAY FRACTIONS

PARAMETER	DESCRIPTION(FRACTION)	VALUE
FV	LEAFY VEGETABLE FROM GARDEN	0.58
FG	OTHER EDIBLES FROM GARDEN	0.76
FP	TIME MILK COWS ON PASTURE	1.00
FB	TIME BEEF ON PASTURE	1.00
FGT	TIME MILK GOATS ON PASTURE	1.00
FPF	MILK COW INTAKE FROM PASTURE	0.50
FBF	BEEF INTAKE FROM PASTURE	0.80
FPG	MILK GOAT INTAKE FROM PASTURE	1.00

HUMIDITY(G/M**3) 15.10

SOURCE TERM RELEASE NUMBER 1

RELEASE POINT		SOURCE TERM 1 - PLANT VENT, CONTINUOUS
UML =	2.00E+00	SOURCE TERM MULTIPLICATION FACTOR
JC1 =	0	NEW OR PREVIOUS MET DATA PARAMETER
JC2 =	0	NEW OR PREVIOUS SOURCE TERM RELEASE DATA PARAMETER

NUCLIDE	CI/YR	NUCLIDE	CI/YR
1H 3	1.64E+03	54XE133M	1.32E+02
6C 14	2.00E+00	54XE133	7.00E+03
18AR 41	5.00E+01	54XE135	2.80E+02
36KR 83M	6.00E+00	54XE138	4.00E+00
36KR 85M	6.60E+01	53I 131	4.60E-02
36KR 85	5.20E+02	53I 133	5.40E-02
36KR 87	1.60E+01	25MN 54	9.00E-04
36KR 88	9.60E+01	26FE 59	3.00E-04
54XE131M	3.20E+01	27CO 58	3.00E-03
94PU239	2.00E-07		

9.844E+03 TOTAL CURIES FOR 19 RADIONUCLIDES

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS

								REPORT CONTROL FLAGS						
JS	SPECIAL LOCATION	DIR	MILES	X/Q	X/Q:DEC	X/Q:DCDP	DEPOSITE	PL	GD	VT	MT	CM	GM	IN
1	A SITE BNDRY	S	1.13	9.19E-08	9.17E-08	8.78E-08	1.75E-09	0	0	0	0	0	0	0
1	A SITE BNDRY	SSW	1.26	1.06E-07	1.05E-07	1.01E-07	1.73E-09	0	0	0	0	0	0	0
1	A SITE BNDRY	SW	1.35	1.34E-07	1.34E-07	1.29E-07	1.87E-09	0	0	0	0	0	0	0

REPORTS ARE NOT PRINTED IF JS=1 OR CONTROL FLAGS=1

FLAGS:
- PL - PLUME
- GD - GROUND
- VT - VEGETABLE
- MT - MEAT
- CM - COW MILK
- GM - GOAT MILK
- IN - INHALATION

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS

```
SOURCE TERM RELEASE NUMBER  2

     RELEASE POINT       SOURCE TERM 2 - PLANT VENT, PURGE
     UML =  2.00E+00   SOURCE TERM MULTIPLICATION FACTOR
     JC1 =  0          NEW OR PREVIOUS MET DATA PARAMETER
     JC2 =  0          NEW OR PREVIOUS SOURCE TERM RELEASE DATA PARAMETER
     PURGE =    700. HOURS

       NUCLIDE      CI/YR
       -------      -----
        6C  14    1.40E+01

                1.400E+01 TOTAL CURIES FOR   1 RADIONUCLIDES
```

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS

								REPORT CONTROL FLAGS						
JS	SPECIAL LOCATION	DIR	MILES	X/Q	X/Q:DEC	X/Q:DCDP	DEPOSITE	PL	GD	VT	MT	CM	GM	IN
1	A SITE BNDRY	S	1.13	2.02E-06	2.00E-06	1.74E-06	6.78E-09	0	0	0	0	0	0	0
1	A SITE BNDRY	SSW	1.26	2.14E-06	2.10E-06	1.83E-06	6.15E-09	0	0	0	0	0	0	0
1	A SITE BNDRY	W	1.32	1.69E-06	1.67E-06	1.46E-06	5.37E-09	0	0	0	0	0	0	0

REPORTS ARE NOT PRINTED IF JS=1 OR CONTROL FLAGS=1

FLAGS:
PL - PLUME
GD - GROUND
VT - VEGETABLE
MT - MEAT
CM - COW MILK
GM - GOAT MILK
IN - INHALATION

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS

SOURCE TERM RELEASE NUMBER 3

```
RELEASE POINT        SOURCE TERM 3 - RADWASTE BLDG VENT
UML =  1.00E+00   SOURCE TERM MULTIPLICATION FACTOR
JC1 =  0          NEW OR PREVIOUS MET DATA PARAMETER
JC2 =  0          NEW OR PREVIOUS SOURCE TERM RELEASE DATA PARAMETER
```

NUCLIDE	CI/YR	NUCLIDE	CI/YR
36KR 85M	1.00E+00	27CO 58	2.00E-03
36KR 88	3.00E+00	27CO 60	2.50E-04
54XE133M	1.00E+00	35BR 84	2.60E-04
54XE133	7.00E+01	35BR 85	3.00E-05
54XE135	4.00E+00	38SR 89	4.30E-05
1H 3	2.30E+02	38SR 90	1.30E-06
24CR 51	2.30E-04	38SR 91	6.50E-05
25MN 54	3.90E-05	39Y 93	3.40E-06
26FE 55	1.60E-04	40ZR 95	7.40E-06
26FE 59	1.40E-04	52TE125M	2.90E-06
53I 131	6.20E-02		

3.091E+02 TOTAL CURIES FOR 21 RADIONUCLIDES

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS

								REPORT CONTROL FLAGS						
JS	SPECIAL LOCATION	DIR	MILES	X/Q	X/Q:DEC	X/Q:DCDP	DEPOSITE	PL	GD	VT	MT	CM	GM	IN
0	A SITE BNDRY	S	1.02	3.54E-06	3.51E-06	3.08E-06	8.85E-09	1	0	0	0	0	0	1
0	A SITE BNDRY	WSW	1.17	2.94E-06	2.90E-06	2.54E-06	8.00E-09	1	1	0	0	0	0	1
0	A SITE BNDRY	W	1.32	2.25E-06	2.22E-06	1.92E-06	5.37E-09	0	1	1	1	1	1	0

REPORTS ARE NOT PRINTED IF JS=1 OR CONTROL FLAGS=1

FLAGS: PL - PLUME
GD - GROUND
VT - VEGETABLE
MT - MEAT
CM - COW MILK
GM - GOAT MILK
IN - INHALATION

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
SPECIAL LOCATION NO. 1 A SITE BNDRY
AT 1.02 MILES S

ANNUAL BETA AIR DOSE = 3.95E-02 MILLRADS
ANNUAL GAMMA AIR DOSE = 2.28E-02 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.44E-02	1.44E-02	1.44E-02	1.44E-02	1.44E-02	1.44E-02	1.48E-02	3.37E-02
GROUND	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.56E-03
VEGET								
ADULT	4.70E-02	4.70E-02	1.29E-01	4.82E-02	5.01E-02	9.86E-01	4.52E-02	4.52E-02
TEEN	6.80E-02	6.74E-02	2.15E-01	6.99E-02	7.29E-02	1.32E+00	6.55E-02	6.55E-02
CHILD	1.44E-01	1.40E-01	5.21E-01	1.46E-01	1.51E-01	2.53E+00	1.39E-01	1.39E-01
MEAT								
ADULT	1.31E-02	1.34E-02	5.01E-02	1.32E-02	1.32E-02	5.24E-02	1.30E-02	1.30E-02
TEEN	1.03E-02	1.05E-02	4.23E-02	1.04E-02	1.04E-02	3.88E-02	1.03E-02	1.03E-02
CHILD	1.82E-02	1.82E-02	7.96E-02	1.82E-02	1.83E-02	6.11E-02	1.81E-02	1.81E-02
COW MILK								
ADULT	1.92E-02	1.86E-02	5.60E-02	2.01E-02	2.16E-02	6.98E-01	1.80E-02	1.80E-02
TEEN	3.14E-02	3.02E-02	1.03E-01	3.31E-02	3.57E-02	1.10E+00	2.94E-02	2.94E-02
CHILD	6.78E-02	6.48E-02	2.54E-01	7.06E-02	7.47E-02	2.19E+00	6.42E-02	6.42E-02
INFANT	1.33E-01	1.26E-01	4.98E-01	1.41E-01	1.44E-01	5.28E+00	1.26E-01	1.26E-01
GOATMILK								
ADULT	2.83E-02	2.68E-02	5.81E-02	3.04E-02	3.40E-02	1.66E+00	2.54E-02	2.54E-02
TEEN	4.38E-02	4.08E-02	1.07E-01	4.79E-02	5.43E-02	2.62E+00	3.90E-02	3.90E-02
CHILD	8.82E-02	8.08E-02	2.63E-01	9.48E-02	1.05E-01	5.17E+00	7.94E-02	7.94E-02
INFANT	1.65E-01	1.50E-01	5.17E-01	1.87E-01	1.93E-01	1.25E+01	1.49E-01	1.49E-01
INHAL								
ADULT	2.21E-02	2.20E-02	1.81E-04	2.22E-02	2.24E-02	1.01E-01	2.23E-02	2.20E-02
TEEN	2.23E-02	2.22E-02	2.51E-04	2.25E-02	2.27E-02	1.20E-01	2.27E-02	2.22E-02
CHILD	1.98E-02	1.96E-02	3.36E-04	1.99E-02	2.01E-02	1.28E-01	2.00E-02	1.96E-02
INFANT	1.14E-02	1.13E-02	2.60E-04	1.16E-02	1.16E-02	1.10E-01	1.16E-02	1.13E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
SPECIAL LOCATION NO. 2 A SITE BNDRY
AT 1.17 MILES WSW

ANNUAL BETA AIR DOSE = 4.19E-02 MILLRADS
ANNUAL GAMMA AIR DOSE = 2.32E-02 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.50E-02	3.50E-02
GROUND	1.98E-03	1.98E-03	1.98E-03	1.98E-03	1.98E-03	1.98E-03	1.98E-03	2.34E-03
VEGET								
ADULT	4.61E-02	4.61E-02	1.37E-01	4.72E-02	4.90E-02	9.04E-01	4.45E-02	4.45E-02
TEEN	6.77E-02	6.72E-02	2.28E-01	6.95E-02	7.22E-02	1.21E+00	6.54E-02	6.54E-02
CHILD	1.45E-01	1.42E-01	5.54E-01	1.48E-01	1.52E-01	2.33E+00	1.41E-01	1.41E-01
MEAT								
ADULT	1.34E-02	1.37E-02	5.33E-02	1.35E-02	1.35E-02	4.93E-02	1.33E-02	1.33E-02
TEEN	1.07E-02	1.08E-02	4.50E-02	1.07E-02	1.07E-02	3.66E-02	1.06E-02	1.06E-02
CHILD	1.89E-02	1.89E-02	8.47E-02	1.90E-02	1.90E-02	5.82E-02	1.88E-02	1.88E-02
COW MILK								
ADULT	1.90E-02	1.84E-02	5.94E-02	1.98E-02	2.11E-02	6.39E-01	1.79E-02	1.79E-02
TEEN	3.14E-02	3.03E-02	1.10E-01	3.30E-02	3.54E-02	1.01E+00	2.98E-02	2.98E-02
CHILD	6.89E-02	6.62E-02	2.69E-01	7.15E-02	7.52E-02	2.01E+00	6.56E-02	6.56E-02
INFANT	1.36E-01	1.30E-01	5.28E-01	1.44E-01	1.46E-01	4.84E+00	1.30E-01	1.30E-01
GOATMILK								
ADULT	2.70E-02	2.56E-02	6.13E-02	2.90E-02	3.22E-02	1.51E+00	2.44E-02	2.44E-02
TEEN	4.24E-02	3.97E-02	1.13E-01	4.62E-02	5.20E-02	2.40E+00	3.81E-02	3.81E-02
CHILD	8.71E-02	8.03E-02	2.78E-01	9.31E-02	1.02E-01	4.73E+00	7.90E-02	7.90E-02
INFANT	1.65E-01	1.51E-01	5.45E-01	1.85E-01	1.90E-01	1.15E+01	1.50E-01	1.50E-01
INHAL								
ADULT	1.95E-02	1.94E-02	1.54E-04	1.96E-02	1.97E-02	8.56E-02	1.97E-02	1.94E-02
TEEN	1.97E-02	1.96E-02	2.13E-04	1.98E-02	2.00E-02	1.01E-01	2.00E-02	1.95E-02
CHILD	1.74E-02	1.73E-02	2.82E-04	1.75E-02	1.77E-02	1.08E-01	1.76E-02	1.73E-02
INFANT	1.00E-02	9.93E-03	2.18E-04	1.02E-02	1.02E-02	9.26E-02	1.02E-02	9.92E-03

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
SPECIAL LOCATION NO. 3 A SITE BNDRY
AT 1.32 MILES W

ANNUAL BETA AIR DOSE = 4.89E-02 MILLRADS
ANNUAL GAMMA AIR DOSE = 2.63E-02 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.66E-02	1.66E-02	1.66E-02	1.66E-02	1.66E-02	1.66E-02	1.70E-02	4.03E-02
GROUND	1.40E-03	1.40E-03	1.40E-03	1.40E-03	1.40E-03	1.40E-03	1.40E-03	1.65E-03
VEGET								
ADULT	3.83E-02	3.83E-02	1.11E-01	3.91E-02	4.04E-02	6.63E-01	3.71E-02	3.71E-02
TEEN	5.60E-02	5.56E-02	1.85E-01	5.73E-02	5.92E-02	8.88E-01	5.43E-02	5.43E-02
CHILD	1.20E-01	1.17E-01	4.49E-01	1.22E-01	1.24E-01	1.71E+00	1.17E-01	1.17E-01
MEAT								
ADULT	1.10E-02	1.12E-02	4.33E-02	1.11E-02	1.11E-02	3.72E-02	1.10E-02	1.10E-02
TEEN	8.74E-03	8.83E-03	3.66E-02	8.78E-03	8.80E-03	2.77E-02	8.69E-03	8.69E-03
CHILD	1.55E-02	1.55E-02	6.88E-02	1.55E-02	1.55E-02	4.41E-02	1.54E-02	1.54E-02
COW MILK								
ADULT	1.57E-02	1.53E-02	4.81E-02	1.63E-02	1.73E-02	4.67E-01	1.49E-02	1.49E-02
TEEN	2.58E-02	2.50E-02	8.88E-02	2.69E-02	2.87E-02	7.40E-01	2.45E-02	2.45E-02
CHILD	5.65E-02	5.44E-02	2.18E-01	5.83E-02	6.10E-02	1.47E+00	5.40E-02	5.40E-02
INFANT	1.11E-01	1.07E-01	4.28E-01	1.17E-01	1.19E-01	3.54E+00	1.06E-01	1.06E-01
GOATMILK								
ADULT	2.24E-02	2.14E-02	4.95E-02	2.39E-02	2.62E-02	1.11E+00	2.05E-02	2.05E-02
TEEN	3.50E-02	3.30E-02	9.13E-02	3.78E-02	4.20E-02	1.75E+00	3.19E-02	3.19E-02
CHILD	7.15E-02	6.66E-02	2.24E-01	7.60E-02	8.26E-02	3.46E+00	6.57E-02	6.57E-02
INFANT	1.35E-01	1.25E-01	4.41E-01	1.49E-01	1.54E-01	8.37E+00	1.24E-01	1.24E-01
INHAL								
ADULT	1.69E-02	1.69E-02	1.24E-04	1.70E-02	1.71E-02	6.84E-02	1.70E-02	1.68E-02
TEEN	1.71E-02	1.70E-02	1.70E-04	1.72E-02	1.73E-02	8.04E-02	1.73E-02	1.70E-02
CHILD	1.51E-02	1.50E-02	2.24E-04	1.52E-02	1.53E-02	8.54E-02	1.53E-02	1.50E-02
INFANT	8.70E-03	8.62E-03	1.72E-04	8.81E-03	8.84E-03	7.30E-02	8.81E-03	8.61E-03

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = GROUND

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
I 131	1.71E-04	1.71E-04	1.71E-04	1.71E-04	1.71E-04	1.71E-04	1.71E-04	2.08E-04
	7.87%	7.87%	7.87%	7.87%	7.87%	7.87%	7.87%	8.11%
I 133	3.65E-06	3.65E-06	3.65E-06	3.65E-06	3.65E-06	3.65E-06	3.65E-06	4.44E-06
	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%
MN 54	8.42E-05	8.42E-05	8.42E-05	8.42E-05	8.42E-05	8.42E-05	8.42E-05	9.88E-05
	3.87%	3.87%	3.87%	3.87%	3.87%	3.87%	3.87%	3.85%
FE 59	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.79E-05
	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%
CO 58	2.76E-04	2.76E-04	2.76E-04	2.76E-04	2.76E-04	2.76E-04	2.76E-04	3.24E-04
	12.70%	12.70%	12.70%	12.70%	12.70%	12.70%	12.70%	12.62%
PU239	3.39E-11	3.39E-11	3.39E-11	3.39E-11	3.39E-11	3.39E-11	3.39E-11	3.30E-10
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	3.00E-07	3.00E-07	3.00E-07	3.00E-07	3.00E-07	3.00E-07	3.00E-07	3.55E-07
	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
CO 60	1.62E-03	1.62E-03	1.62E-03	1.62E-03	1.62E-03	1.62E-03	1.62E-03	1.91E-03
	74.65%	74.65%	74.65%	74.65%	74.65%	74.65%	74.65%	74.51%
BR 84	5.84E-09	5.84E-09	5.84E-09	5.84E-09	5.84E-09	5.84E-09	5.84E-09	6.81E-09
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	2.60E-10	2.60E-10	2.60E-10	2.60E-10	2.60E-10	2.60E-10	2.60E-10	3.02E-10
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	3.71E-08	3.71E-08	3.71E-08	3.71E-08	3.71E-08	3.71E-08	3.71E-08	4.34E-08
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.66E-10	1.66E-10	1.66E-10	1.66E-10	1.66E-10	1.66E-10	1.66E-10	2.28E-10
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	5.09E-07	5.09E-07	5.09E-07	5.09E-07	5.09E-07	5.09E-07	5.09E-07	5.91E-07
	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
TE125M	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.74E-09
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.18E-03	2.56E-03

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = VEGET

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.98E-02	1.98E-02	0.00E+00	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02
	42.26%	42.26%	0.00%	41.20%	39.59%	2.01%	43.89%	43.90%
C 14	2.54E-02	2.54E-02	1.27E-01	2.54E-02	2.54E-02	2.54E-02	2.54E-02	2.54E-02
	53.99%	54.00%	98.08%	52.64%	50.58%	2.57%	56.08%	56.10%
I 131	1.64E-03	7.57E-04	2.01E-03	2.87E-03	4.92E-03	9.40E-01	0.00E+00	0.00E+00
	3.50%	1.61%	1.55%	5.95%	9.81%	95.37%	0.00%	0.00%
I 133	9.53E-07	2.81E-06	1.80E-06	3.12E-06	5.45E-06	4.59E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.01%	0.05%	0.00%	0.00%
MN 54	3.66E-06	5.88E-05	0.00E+00	1.92E-05	5.71E-06	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.13%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%
FE 59	1.01E-05	8.77E-05	1.12E-05	2.63E-05	0.00E+00	0.00E+00	7.35E-06	0.00E+00
	0.02%	0.19%	0.00%	0.05%	0.00%	0.00%	0.02%	0.00%
CO 58	6.58E-05	5.95E-04	0.00E+00	2.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	1.27%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	1.52E-08	5.31E-08	5.78E-07	6.94E-08	6.47E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	6.18E-09	1.55E-06	0.00E+00	0.00E+00	1.36E-09	3.69E-09	8.20E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.40E-06	3.44E-06	8.67E-06	5.99E-06	0.00E+00	0.00E+00	3.34E-06	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	2.47E-05	2.10E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.45%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	3.79E-25	2.97E-30	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	5.18E-06	2.90E-05	1.81E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.06%	0.14%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	5.54E-06	6.93E-06	2.76E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.01%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.22E-10	1.44E-08	3.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.44E-15	2.80E-09	8.82E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	7.19E-10	3.37E-06	3.31E-09	1.06E-09	1.67E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.91E-08	5.70E-07	1.43E-07	5.17E-08	5.80E-07	4.29E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	4.70E-02	4.70E-02	1.29E-01	4.82E-02	5.01E-02	9.86E-01	4.52E-02	4.52E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = VEGET

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.33E-02	2.33E-02	0.00E+00	2.33E-02	2.33E-02	2.33E-02	2.33E-02	2.33E-02
	34.27%	34.57%	0.00%	33.31%	31.96%	1.77%	35.56%	35.57%
C 14	4.22E-02	4.22E-02	2.11E-01	4.22E-02	4.22E-02	4.22E-02	4.22E-02	4.22E-02
	62.07%	62.62%	98.24%	60.34%	57.89%	3.20%	64.41%	64.43%
I 131	2.31E-03	8.49E-04	3.07E-03	4.29E-03	7.39E-03	1.25E+00	0.00E+00	0.00E+00
	3.39%	1.26%	1.43%	6.14%	10.14%	95.00%	0.00%	0.00%
I 133	8.64E-07	2.14E-06	1.67E-06	2.83E-06	4.97E-06	3.95E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
MN 54	5.71E-06	5.91E-05	0.00E+00	2.88E-05	8.59E-06	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.09%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%
FE 59	1.57E-05	9.64E-05	1.75E-05	4.08E-05	0.00E+00	0.00E+00	1.29E-05	0.00E+00
	0.02%	0.14%	0.00%	0.06%	0.00%	0.00%	0.02%	0.00%
CO 58	1.02E-04	6.11E-04	0.00E+00	4.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.15%	0.91%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	1.87E-08	6.55E-08	7.10E-07	8.62E-08	7.95E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	9.60E-09	1.61E-06	0.00E+00	0.00E+00	2.10E-09	5.33E-09	1.37E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	2.29E-06	4.26E-06	1.39E-05	9.83E-06	0.00E+00	0.00E+00	6.24E-06	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	3.85E-05	2.23E-04	0.00E+00	1.71E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.06%	0.33%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	3.44E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	8.53E-06	3.55E-05	2.98E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.05%	0.14%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.51E-06	8.58E-06	3.76E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.01%	0.17%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.12E-10	1.28E-08	2.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.27E-15	2.53E-09	8.27E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.13E-09	3.78E-06	5.20E-09	1.64E-09	2.41E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	3.15E-08	6.96E-07	2.36E-07	8.50E-08	0.00E+00	6.59E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	6.80E-02	6.74E-02	2.15E-01	6.99E-02	7.29E-02	1.32E+00	6.55E-02	6.55E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = VEGET

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	3.65E-02	3.65E-02	0.00E+00	3.65E-02	3.65E-02	3.65E-02	3.65E-02	3.65E-02
	25.42%	25.99%	0.00%	24.90%	24.17%	1.44%	26.23%	26.24%
C 14	1.03E-01	1.03E-01	5.13E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01
	71.46%	73.06%	98.32%	70.01%	67.95%	4.05%	73.74%	73.76%
I 131	4.11E-03	6.44E-04	7.19E-03	7.23E-03	1.19E-02	2.39E+00	0.00E+00	0.00E+00
	2.86%	0.46%	1.38%	4.94%	7.87%	94.48%	0.00%	0.00%
I 133	1.42E-06	1.52E-06	3.04E-06	3.76E-06	6.27E-06	6.99E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
MN 54	1.13E-05	3.57E-05	0.00E+00	4.26E-05	1.19E-05	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.03%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%
FE 59	3.22E-05	6.73E-05	3.99E-05	6.46E-05	0.00E+00	0.00E+00	1.87E-05	0.00E+00
	0.02%	0.05%	0.00%	0.04%	0.00%	0.00%	0.01%	0.00%
CO 58	2.05E-04	3.90E-04	0.00E+00	6.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	0.28%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%
PU239	2.50E-08	5.18E-08	9.76E-07	1.04E-07	9.23E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.93E-08	1.02E-06	0.00E+00	0.00E+00	2.92E-09	1.07E-08	1.95E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	5.65E-06	3.38E-06	3.44E-05	1.82E-05	0.00E+00	0.00E+00	1.03E-05	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	7.74E-05	1.45E-04	0.00E+00	2.63E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.10%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	5.84E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	2.08E-05	2.82E-05	7.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.02%	0.14%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	1.55E-05	6.88E-06	7.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.96E-10	1.15E-08	5.20E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	4.19E-15	2.27E-09	1.52E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	2.33E-09	2.73E-06	1.19E-08	2.62E-09	3.75E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	7.62E-08	5.51E-07	5.71E-07	1.55E-07	0.00E+00	1.60E-07	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.44E-01	1.40E-01	5.21E-01	1.46E-01	1.51E-01	2.53E+00	1.39E-01	1.39E-01

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = MEAT

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	3.03E-03	3.03E-03	0.00E+00	3.03E-03	3.03E-03	3.03E-03	3.03E-03	3.03E-03
	23.06%	22.60%	0.00%	22.96%	22.89%	5.78%	23.23%	23.25%
C 14	1.00E-02	1.00E-02	5.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
	76.11%	74.58%	99.78%	75.79%	75.55%	19.08%	76.69%	76.75%
I 131	6.89E-05	3.17E-05	8.40E-05	1.20E-04	2.06E-04	3.94E-02	0.00E+00	0.00E+00
	0.52%	0.24%	0.17%	0.91%	1.56%	75.13%	0.00%	0.00%
I 133	2.33E-13	6.88E-13	4.40E-13	7.66E-13	1.34E-12	1.13E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	7.40E-08	1.19E-06	0.00E+00	3.88E-07	1.15E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	9.40E-06	8.17E-05	1.04E-05	2.45E-05	0.00E+00	0.00E+00	6.85E-06	0.00E+00
	0.07%	0.61%	0.02%	0.19%	0.00%	0.00%	0.05%	0.00%
CO 58	2.06E-05	1.87E-04	0.00E+00	9.21E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.16%	1.39%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%
PU239	5.58E-12	1.95E-11	2.12E-10	2.55E-11	2.37E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	3.28E-10	8.24E-08	0.00E+00	0.00E+00	7.22E-11	1.96E-10	4.35E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.45E-06	3.58E-06	9.03E-06	6.24E-06	0.00E+00	0.00E+00	3.48E-06	0.00E+00
	0.01%	0.03%	0.02%	0.05%	0.00%	0.00%	0.03%	0.00%
CO 60	8.17E-06	6.96E-05	0.00E+00	3.71E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.06%	0.52%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%
SR 89	7.31E-08	4.08E-07	2.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.92E-08	9.91E-08	3.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	8.02E-26	9.46E-24	1.99E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	8.82E-29	1.01E-22	3.19E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	5.87E-10	2.75E-06	2.70E-09	8.67E-10	1.36E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	3.06E-08	9.12E-07	2.28E-07	8.27E-08	9.29E-07	6.87E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.31E-02	1.34E-02	5.01E-02	1.32E-02	1.32E-02	5.24E-02	1.30E-02	1.30E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = MEAT

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.81E-03	1.81E-03	0.00E+00	1.81E-03	1.81E-03	1.81E-03	1.81E-03	1.81E-03
	17.46%	17.26%	0.00%	17.38%	17.32%	4.66%	17.59%	17.61%
C 14	8.45E-03	8.45E-03	4.22E-02	8.45E-03	8.45E-03	8.45E-03	8.45E-03	8.45E-03
	81.72%	80.77%	99.79%	81.34%	81.06%	21.79%	82.32%	82.39%
I 131	5.25E-05	1.93E-05	6.98E-05	9.77E-05	1.68E-04	2.85E-02	0.00E+00	0.00E+00
	0.51%	0.18%	0.16%	0.94%	1.61%	73.55%	0.00%	0.00%
I 133	1.91E-13	4.73E-13	3.68E-13	6.25E-13	1.10E-12	8.72E-11	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	5.87E-08	6.07E-07	0.00E+00	2.96E-07	8.83E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	7.51E-06	4.60E-05	8.34E-06	1.95E-05	0.00E+00	0.00E+00	6.14E-06	0.00E+00
	0.07%	0.44%	0.02%	0.19%	0.00%	0.00%	0.06%	0.00%
CO 58	1.64E-05	9.79E-05	0.00E+00	7.10E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.16%	0.94%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%
PU239	3.47E-12	1.22E-11	1.32E-10	1.61E-11	1.48E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	2.62E-10	4.40E-08	0.00E+00	0.00E+00	5.74E-11	1.46E-10	3.74E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.21E-06	2.25E-06	7.33E-06	5.20E-06	0.00E+00	0.00E+00	3.30E-06	0.00E+00
	0.01%	0.02%	0.02%	0.05%	0.00%	0.00%	0.03%	0.00%
CO 60	6.48E-06	3.74E-05	0.00E+00	2.87E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.06%	0.36%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%
SR 89	6.16E-08	2.56E-07	2.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	5.46E-08	6.23E-08	2.73E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	6.65E-26	7.58E-24	1.67E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	7.40E-29	8.24E-23	2.70E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	4.70E-10	1.58E-06	2.16E-09	6.83E-10	1.00E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	2.58E-08	5.69E-07	1.93E-07	6.95E-08	0.00E+00	5.39E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.03E-02	1.05E-02	4.23E-02	1.04E-02	1.04E-02	3.88E-02	1.03E-02	1.03E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = MEAT

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.19E-03	2.19E-03	0.00E+00	2.19E-03	2.19E-03	2.19E-03	2.19E-03	2.19E-03
	12.02%	12.03%	0.00%	11.99%	11.96%	3.58%	12.10%	12.10%
C 14	1.59E-02	1.59E-02	7.94E-02	1.59E-02	1.59E-02	1.59E-02	1.59E-02	1.59E-02
	87.30%	87.36%	99.79%	87.06%	86.87%	25.99%	87.84%	87.90%
I 131	7.40E-05	1.16E-05	1.29E-04	1.30E-04	2.14E-04	4.31E-02	0.00E+00	0.00E+00
	0.41%	0.06%	0.16%	0.71%	1.17%	70.44%	0.00%	0.00%
I 133	3.20E-13	3.41E-13	6.84E-13	6.46E-13	1.41E-12	1.57E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	9.02E-08	2.84E-07	0.00E+00	3.39E-07	9.49E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	1.19E-05	2.49E-05	1.48E-05	2.39E-05	0.00E+00	0.00E+00	6.93E-06	0.00E+00
	0.07%	0.14%	0.02%	0.13%	0.00%	0.00%	0.04%	0.00%
CO 58	2.54E-05	4.84E-05	0.00E+00	8.29E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	0.27%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%
PU239	3.61E-12	7.46E-12	1.41E-10	1.50E-11	1.33E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	4.09E-10	2.17E-08	0.00E+00	0.00E+00	6.20E-11	2.27E-10	4.14E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	2.31E-06	1.38E-06	1.41E-05	7.46E-06	0.00E+00	0.00E+00	4.22E-06	0.00E+00
	0.01%	0.00%	0.02%	0.04%	0.00%	0.00%	0.02%	0.00%
CO 60	1.01E-05	1.89E-05	0.00E+00	3.41E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.06%	0.10%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
SR 89	1.16E-07	1.57E-07	4.07E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	8.69E-08	3.86E-08	4.32E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.18E-25	6.92E-24	3.13E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.39E-26	7.55E-23	5.06E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	7.52E-10	8.81E-07	3.84E-09	8.45E-10	1.21E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	4.83E-08	3.49E-07	3.62E-07	9.81E-08	0.00E+00	1.02E-07	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.82E-02	1.82E-02	7.96E-02	1.82E-02	1.83E-02	6.11E-02	1.81E-02	1.81E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	7.12E-03	7.12E-03	0.00E+00	7.12E-03	7.12E-03	7.12E-03	7.12E-03	7.12E-03
	37.02%	38.19%	0.00%	35.39%	32.97%	1.02%	39.47%	39.48%
C 14	1.09E-02	1.09E-02	5.46E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02
	56.76%	58.56%	97.37%	54.26%	50.54%	1.56%	60.52%	60.52%
I 131	1.19E-03	5.47E-04	1.45E-03	2.07E-03	3.55E-03	6.79E-01	0.00E+00	0.00E+00
	6.18%	2.93%	2.58%	10.30%	16.45%	97.31%	0.00%	0.00%
I 133	1.53E-06	4.51E-06	2.88E-06	5.02E-06	8.76E-06	7.37E-04	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.02%	0.04%	0.11%	0.00%	0.00%
MN 54	5.27E-08	8.47E-07	0.00E+00	2.76E-07	8.23E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	7.05E-07	6.13E-06	7.82E-07	1.84E-06	0.00E+00	0.00E+00	5.14E-07	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	3.74E-06	3.38E-05	0.00E+00	1.67E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.18%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	1.81E-12	6.33E-12	6.89E-11	8.28E-12	7.71E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	8.56E-10	2.15E-07	0.00E+00	0.00E+00	1.89E-10	5.12E-10	1.14E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	9.91E-08	2.44E-07	6.15E-07	4.25E-07	0.00E+00	0.00E+00	2.37E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	1.44E-06	1.22E-05	0.00E+00	6.52E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	2.39E-07	1.33E-06	8.31E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	2.45E-07	3.07E-07	1.22E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.00E-11	1.18E-09	2.49E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.78E-18	3.19E-12	1.01E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	2.05E-13	9.61E-10	9.45E-13	3.03E-13	4.76E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	9.67E-10	2.88E-08	7.22E-09	2.62E-09	2.94E-08	2.17E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.92E-02	1.86E-02	5.60E-02	2.01E-02	2.16E-02	6.98E-01	1.80E-02	1.80E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	9.26E-03	9.26E-03	0.00E+00	9.26E-03	9.26E-03	9.26E-03	9.26E-03	9.26E-03
	29.51%	30.66%	0.00%	27.99%	25.91%	0.84%	31.51%	31.51%
C 14	2.01E-02	2.01E-02	1.01E-01	2.01E-02	2.01E-02	2.01E-02	2.01E-02	2.01E-02
	64.15%	66.68%	97.42%	60.84%	56.32%	1.82%	68.49%	68.49%
I 131	1.98E-03	7.28E-04	2.63E-03	3.68E-03	6.33E-03	1.07E+00	0.00E+00	0.00E+00
	6.30%	2.41%	2.54%	11.12%	17.72%	97.23%	0.00%	0.00%
I 133	2.73E-06	6.76E-06	5.27E-06	8.94E-06	1.57E-05	1.25E-03	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.03%	0.04%	0.11%	0.00%	0.00%
MN 54	9.13E-08	9.44E-07	0.00E+00	4.60E-07	1.37E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	1.23E-06	7.53E-06	1.36E-06	3.19E-06	0.00E+00	0.00E+00	1.00E-06	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	6.48E-06	3.87E-05	0.00E+00	2.81E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	2.46E-12	8.66E-12	9.38E-11	1.14E-11	1.05E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.49E-09	2.51E-07	0.00E+00	0.00E+00	3.28E-10	8.30E-10	2.13E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.80E-07	3.35E-07	1.09E-06	7.74E-07	0.00E+00	0.00E+00	4.91E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	2.49E-06	1.44E-05	0.00E+00	1.10E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	4.39E-07	1.83E-06	1.53E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	3.69E-07	4.22E-07	1.85E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.82E-11	2.07E-09	4.57E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	5.09E-18	5.67E-12	1.86E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	3.59E-13	1.20E-09	1.65E-12	5.21E-13	7.66E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.78E-09	3.93E-08	1.33E-08	4.80E-09	0.00E+00	3.72E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	3.14E-02	3.02E-02	1.03E-01	3.31E-02	3.57E-02	1.10E+00	2.94E-02	2.94E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.47E-02	1.47E-02	0.00E+00	1.47E-02	1.47E-02	1.47E-02	1.47E-02	1.47E-02
	21.63%	22.65%	0.00%	20.78%	19.64%	0.67%	22.87%	22.87%
C 14	4.95E-02	4.95E-02	2.47E-01	4.95E-02	4.95E-02	4.95E-02	4.95E-02	4.95E-02
	72.96%	76.40%	97.45%	70.10%	66.24%	2.26%	77.13%	77.13%
I 131	3.64E-03	5.71E-04	6.37E-03	6.41E-03	1.05E-02	2.12E+00	0.00E+00	0.00E+00
	5.37%	0.88%	2.51%	9.08%	14.09%	96.93%	0.00%	0.00%
I 133	5.99E-06	6.38E-06	1.28E-05	1.58E-05	2.64E-05	2.94E-03	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.02%	0.04%	0.13%	0.00%	0.00%
MN 54	1.84E-07	5.78E-07	0.00E+00	6.89E-07	1.93E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	2.55E-06	5.33E-06	3.17E-06	5.12E-06	0.00E+00	0.00E+00	1.48E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	1.31E-05	2.50E-05	0.00E+00	4.29E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	3.35E-12	6.93E-12	1.30E-10	1.40E-11	1.23E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	3.05E-09	1.62E-07	0.00E+00	0.00E+00	4.62E-10	1.69E-09	3.09E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	4.50E-07	2.69E-07	2.74E-06	1.45E-06	0.00E+00	0.00E+00	8.22E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	5.06E-06	9.50E-06	0.00E+00	1.71E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 84	9.97E-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	1.08E-06	1.47E-06	3.79E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.69E-07	3.42E-07	3.82E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	4.23E-11	2.47E-09	1.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.25E-17	6.80E-12	4.56E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	7.51E-13	8.80E-10	3.84E-12	8.44E-13	1.21E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	4.36E-09	3.15E-08	3.27E-08	8.86E-09	0.00E+00	9.18E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	6.78E-02	6.48E-02	2.54E-01	7.06E-02	7.47E-02	2.19E+00	6.42E-02	6.42E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = INFANT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.23E-02	2.23E-02	0.00E+00	2.23E-02	2.23E-02	2.23E-02	2.23E-02	2.23E-02
	16.78%	17.62%	0.00%	15.73%	15.45%	0.42%	17.70%	17.70%
C 14	1.03E-01	1.03E-01	4.85E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01
	77.99%	81.90%	97.30%	73.14%	71.81%	1.96%	82.29%	82.30%
I 131	6.89E-03	5.60E-04	1.33E-02	1.57E-02	1.83E-02	5.15E+00	0.00E+00	0.00E+00
	5.19%	0.44%	2.67%	11.08%	12.70%	97.48%	0.00%	0.00%
I 133	1.15E-05	6.66E-06	2.70E-05	3.94E-05	4.63E-05	7.16E-03	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.03%	0.03%	0.14%	0.00%	0.00%
MN 54	2.90E-07	4.71E-07	0.00E+00	1.28E-06	2.84E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	4.07E-06	4.93E-06	5.91E-06	1.03E-05	0.00E+00	0.00E+00	3.05E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	2.14E-05	2.14E-05	0.00E+00	8.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	3.58E-12	6.99E-12	1.40E-10	1.57E-11	1.29E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	4.83E-09	1.41E-07	0.00E+00	0.00E+00	6.88E-10	3.15E-09	6.13E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	5.72E-07	2.72E-07	3.31E-06	2.14E-06	0.00E+00	0.00E+00	1.05E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	8.26E-06	8.33E-06	0.00E+00	3.50E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 84	1.92E-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	2.07E-06	1.48E-06	7.21E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	8.57E-07	3.45E-07	4.23E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	8.45E-11	2.76E-09	2.33E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.65E-17	7.68E-12	9.72E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.18E-12	8.27E-10	6.82E-12	1.66E-12	1.79E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	9.03E-09	3.18E-08	6.68E-08	2.23E-08	0.00E+00	2.25E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.33E-01	1.26E-01	4.98E-01	1.41E-01	1.44E-01	5.28E+00	1.26E-01	1.26E-01

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.45E-02	1.45E-02	0.00E+00	1.45E-02	1.45E-02	1.45E-02	1.45E-02	1.45E-02
	51.33%	54.24%	0.00%	47.74%	42.74%	0.88%	57.09%	57.09%
C 14	1.09E-02	1.09E-02	5.46E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02
	38.58%	40.76%	93.89%	35.88%	32.12%	0.66%	42.91%	42.91%
I 131	2.85E-03	1.31E-03	3.47E-03	4.97E-03	8.52E-03	1.63E+00	0.00E+00	0.00E+00
	10.07%	4.90%	5.98%	16.34%	25.08%	98.36%	0.00%	0.00%
I 133	3.67E-06	1.08E-05	6.92E-06	1.20E-05	2.10E-05	1.77E-03	0.00E+00	0.00E+00
	0.01%	0.04%	0.01%	0.04%	0.06%	0.11%	0.00%	0.00%
MN 54	9.35E-09	1.50E-07	0.00E+00	4.90E-08	1.46E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	1.67E-07	1.45E-06	1.85E-07	4.35E-07	0.00E+00	0.00E+00	1.22E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	7.68E-07	6.94E-06	0.00E+00	3.42E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	3.04E-13	1.06E-12	1.16E-11	1.39E-12	1.29E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.97E-10	4.96E-08	0.00E+00	0.00E+00	4.35E-11	1.18E-10	2.62E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.84E-08	4.52E-08	1.14E-07	7.89E-08	0.00E+00	0.00E+00	4.40E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	2.42E-07	2.06E-06	0.00E+00	1.10E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	8.97E-07	5.01E-06	3.13E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	6.99E-07	8.75E-07	3.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	4.22E-11	4.97E-09	1.04E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	6.67E-19	7.66E-13	2.42E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	4.27E-14	2.00E-10	1.97E-13	6.30E-14	9.89E-14	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	2.00E-10	5.97E-09	1.49E-09	5.41E-10	6.08E-09	4.49E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	2.83E-02	2.68E-02	5.81E-02	3.04E-02	3.40E-02	1.66E+00	2.54E-02	2.54E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.89E-02	1.89E-02	0.00E+00	1.89E-02	1.89E-02	1.89E-02	1.89E-02	1.89E-02
	43.16%	46.30%	0.00%	39.46%	34.82%	0.72%	48.41%	48.41%
C 14	2.01E-02	2.01E-02	1.01E-01	2.01E-02	2.01E-02	2.01E-02	2.01E-02	2.01E-02
	45.98%	49.33%	94.00%	42.05%	37.10%	0.77%	51.59%	51.59%
I 131	4.74E-03	1.75E-03	6.31E-03	8.83E-03	1.52E-02	2.58E+00	0.00E+00	0.00E+00
	10.83%	4.28%	5.89%	18.44%	28.01%	98.40%	0.00%	0.00%
I 133	6.54E-06	1.62E-05	1.26E-05	2.15E-05	3.76E-05	2.99E-03	0.00E+00	0.00E+00
	0.01%	0.04%	0.01%	0.04%	0.07%	0.11%	0.00%	0.00%
MN 54	1.62E-08	1.67E-07	0.00E+00	8.17E-08	2.44E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	2.91E-07	1.76E-06	3.23E-07	7.54E-07	0.00E+00	0.00E+00	2.38E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	1.33E-06	7.95E-06	0.00E+00	5.76E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	4.13E-13	1.45E-12	1.57E-11	1.91E-12	1.76E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	3.45E-10	5.79E-08	0.00E+00	0.00E+00	7.55E-11	1.92E-10	4.92E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	3.35E-08	6.21E-08	2.02E-07	1.44E-07	0.00E+00	0.00E+00	9.10E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	4.18E-07	2.42E-06	0.00E+00	1.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	1.65E-06	6.86E-06	5.76E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	1.05E-06	1.20E-06	5.26E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	7.63E-11	8.70E-09	1.92E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.22E-18	1.36E-12	4.45E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	7.46E-14	2.50E-10	3.44E-13	1.08E-13	1.59E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	3.68E-10	8.13E-09	2.76E-09	9.93E-10	0.00E+00	7.76E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	4.38E-02	4.08E-02	1.07E-01	4.79E-02	5.43E-02	2.62E+00	3.90E-02	3.90E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.99E-02	2.99E-02	0.00E+00	2.99E-02	2.99E-02	2.99E-02	2.99E-02	2.99E-02
	33.94%	37.03%	0.00%	31.56%	28.58%	0.58%	37.69%	37.69%
C 14	4.95E-02	4.95E-02	2.47E-01	4.95E-02	4.95E-02	4.95E-02	4.95E-02	4.95E-02
	56.12%	61.23%	94.08%	52.18%	47.25%	0.96%	62.31%	62.31%
I 131	8.74E-03	1.37E-03	1.53E-02	1.54E-02	2.53E-02	5.09E+00	0.00E+00	0.00E+00
	9.91%	1.69%	5.82%	16.22%	24.11%	98.33%	0.00%	0.00%
I 133	1.44E-05	1.53E-05	3.07E-05	3.80E-05	6.33E-05	7.06E-03	0.00E+00	0.00E+00
	0.02%	0.02%	0.01%	0.04%	0.06%	0.14%	0.00%	0.00%
MN 54	3.25E-08	1.03E-07	0.00E+00	1.22E-07	3.43E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	6.04E-07	1.26E-06	7.49E-07	1.21E-06	0.00E+00	0.00E+00	3.51E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	2.70E-06	5.14E-06	0.00E+00	8.81E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	5.62E-13	1.16E-12	2.19E-11	2.34E-12	2.07E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	7.03E-10	3.73E-08	0.00E+00	0.00E+00	1.07E-10	3.90E-10	7.13E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	8.35E-08	4.99E-08	5.08E-07	2.70E-07	0.00E+00	0.00E+00	1.52E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	8.50E-07	1.60E-06	0.00E+00	2.88E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	4.07E-06	5.52E-06	1.43E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	2.19E-06	9.74E-07	1.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.78E-10	1.04E-08	4.71E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	3.00E-18	1.63E-12	1.09E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.56E-13	1.83E-10	7.98E-13	1.75E-13	2.51E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	9.02E-10	6.53E-09	6.77E-09	1.83E-09	0.00E+00	1.90E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	8.82E-02	8.08E-02	2.63E-01	9.48E-02	1.05E-01	5.17E+00	7.94E-02	7.94E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 1 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = INFANT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	4.54E-02	4.54E-02	0.00E+00	4.54E-02	4.54E-02	4.54E-02	4.54E-02	4.54E-02
	27.44%	30.22%	0.00%	24.34%	23.54%	0.36%	30.50%	30.50%
C 14	1.03E-01	1.03E-01	4.85E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01
	62.53%	68.87%	93.74%	55.45%	53.64%	0.83%	69.50%	69.50%
I 131	1.65E-02	1.34E-03	3.19E-02	3.76E-02	4.39E-02	1.24E+01	0.00E+00	0.00E+00
	10.00%	0.89%	6.17%	20.16%	22.77%	98.67%	0.00%	0.00%
I 133	2.77E-05	1.60E-05	6.49E-05	9.45E-05	1.11E-04	1.72E-02	0.00E+00	0.00E+00
	0.02%	0.01%	0.01%	0.05%	0.06%	0.14%	0.00%	0.00%
MN 54	5.15E-08	8.35E-08	0.00E+00	2.27E-07	5.04E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	9.63E-07	1.17E-06	1.40E-06	2.44E-06	0.00E+00	0.00E+00	7.22E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	4.39E-06	4.39E-06	0.00E+00	1.76E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	6.01E-13	1.17E-12	2.34E-11	2.63E-12	2.17E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.11E-09	3.25E-08	0.00E+00	0.00E+00	1.59E-10	7.27E-10	1.41E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.06E-07	5.04E-08	6.14E-07	3.97E-07	0.00E+00	0.00E+00	1.94E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	1.39E-06	1.40E-06	0.00E+00	5.89E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	7.78E-06	5.57E-06	2.71E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	2.44E-08	9.83E-07	1.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	3.55E-10	1.16E-08	9.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	6.35E-18	1.84E-12	2.33E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	2.45E-13	1.72E-10	1.42E-12	3.45E-13	3.72E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.87E-09	6.59E-09	1.38E-08	4.62E-09	0.00E+00	4.65E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.65E-01	1.50E-01	5.17E-01	1.87E-01	1.93E-01	1.25E+01	1.49E-01	1.49E-01

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = VEGET

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.75E-02	1.75E-02	0.00E+00	1.75E-02	1.75E-02	1.75E-02	1.75E-02	1.75E-02
	37.96%	37.96%	0.00%	37.08%	35.72%	1.94%	39.33%	39.34%
C 14	2.70E-02	2.70E-02	1.35E-01	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02
	58.54%	58.54%	98.35%	57.18%	55.08%	2.98%	60.65%	60.66%
I 131	1.50E-03	6.92E-04	1.83E-03	2.62E-03	4.49E-03	8.59E-01	0.00E+00	0.00E+00
	3.26%	1.50%	1.34%	5.55%	9.17%	95.03%	0.00%	0.00%
I 133	9.42E-07	2.78E-08	1.78E-06	3.09E-08	5.39E-06	4.54E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.01%	0.05%	0.00%	0.00%
MN 54	3.57E-06	5.73E-05	0.00E+00	1.87E-05	5.57E-06	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.12%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%
FE 59	9.37E-06	8.15E-05	1.04E-05	2.44E-05	0.00E+00	0.00E+00	6.83E-06	0.00E+00
	0.02%	0.18%	0.00%	0.05%	0.00%	0.00%	0.02%	0.00%
CO 58	6.08E-05	5.49E-04	0.00E+00	2.71E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.13%	1.19%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	1.51E-08	5.26E-08	5.72E-07	6.87E-08	6.40E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	5.59E-09	1.40E-06	0.00E+00	0.00E+00	1.23E-09	3.34E-09	7.41E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.26E-06	3.11E-06	7.84E-06	5.42E-06	0.00E+00	0.00E+00	3.02E-06	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	2.23E-05	1.90E-04	0.00E+00	1.01E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.41%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	1.99E-25	1.57E-30	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	4.68E-06	2.62E-05	1.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.06%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	5.01E-06	6.26E-06	2.49E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.01%	0.18%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.07E-10	1.26E-08	2.65E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.14E-15	2.46E-09	7.75E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	6.50E-10	3.04E-06	2.99E-09	9.60E-10	1.51E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.73E-08	5.15E-07	1.29E-07	4.67E-08	5.25E-07	3.88E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	4.61E-02	4.61E-02	1.37E-01	4.72E-02	4.90E-02	9.04E-01	4.45E-02	4.45E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = VEGET

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.05E-02	2.05E-02	0.00E+00	2.05E-02	2.05E-02	2.05E-02	2.05E-02	2.05E-02
	30.33%	30.57%	0.00%	29.55%	28.44%	1.70%	31.36%	31.39%
C 14	4.49E-02	4.49E-02	2.24E-01	4.49E-02	4.49E-02	4.49E-02	4.49E-02	4.49E-02
	66.31%	66.84%	98.49%	64.61%	62.18%	3.71%	68.60%	68.61%
I 131	2.11E-03	7.76E-04	2.80E-03	3.92E-03	6.75E-03	1.14E+00	0.00E+00	0.00E+00
	3.11%	1.16%	1.23%	5.65%	9.35%	94.56%	0.00%	0.00%
I 133	8.54E-07	2.12E-06	1.65E-06	2.80E-06	4.91E-06	3.91E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
MN 54	5.57E-06	5.76E-05	0.00E+00	2.81E-05	8.37E-06	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.09%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%
FE 59	1.46E-05	8.96E-05	1.62E-05	3.79E-05	0.00E+00	0.00E+00	1.20E-05	0.00E+00
	0.02%	0.13%	0.00%	0.05%	0.00%	0.00%	0.02%	0.00%
CO 58	9.44E-05	5.65E-04	0.00E+00	4.10E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	0.84%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	1.85E-08	6.48E-08	7.03E-07	8.53E-08	7.87E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	8.67E-09	1.46E-06	0.00E+00	0.00E+00	1.90E-09	4.82E-09	1.24E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	2.07E-06	3.85E-06	1.25E-05	8.89E-06	0.00E+00	0.00E+00	5.64E-06	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	3.48E-05	2.01E-04	0.00E+00	1.55E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.30%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	1.81E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	7.71E-06	3.21E-05	2.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.05%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	6.79E-06	7.76E-06	3.40E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.01%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	9.86E-11	1.12E-08	2.48E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.99E-15	2.22E-09	7.27E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.02E-09	3.42E-06	4.70E-09	1.48E-09	2.18E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	2.85E-08	6.29E-07	2.13E-07	7.68E-08	0.00E+00	5.96E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	6.77E-02	6.72E-02	2.28E-01	6.95E-02	7.22E-02	1.21E+00	6.54E-02	6.54E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = VEGET

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	3.22E-02	3.22E-02	0.00E+00	3.22E-02	3.22E-02	3.22E-02	3.22E-02	3.22E-02
	22.12%	22.57%	0.00%	21.72%	21.14%	1.38%	22.76%	22.77%
C 14	1.09E-01	1.09E-01	5.46E-01	1.09E-01	1.09E-01	1.09E-01	1.09E-01	1.09E-01
	75.06%	76.57%	98.56%	73.68%	71.72%	4.69%	77.22%	77.23%
I 131	3.76E-03	5.88E-04	6.57E-03	6.61E-03	1.08E-02	2.19E+00	0.00E+00	0.00E+00
	2.58%	0.41%	1.19%	4.46%	7.13%	93.90%	0.00%	0.00%
I 133	1.41E-06	1.50E-06	3.01E-06	3.72E-06	6.20E-06	6.91E-04	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
MN 54	1.11E-05	3.48E-05	0.00E+00	4.15E-05	1.16E-05	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%
FE 59	2.99E-05	6.25E-05	3.71E-05	6.01E-05	0.00E+00	0.00E+00	1.74E-05	0.00E+00
	0.02%	0.04%	0.00%	0.04%	0.00%	0.00%	0.01%	0.00%
CO 58	1.89E-04	3.60E-04	0.00E+00	6.17E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.13%	0.25%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%
PU239	2.48E-08	5.13E-08	9.66E-07	1.03E-07	9.14E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.74E-08	9.23E-07	0.00E+00	0.00E+00	2.64E-09	9.66E-09	1.76E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	5.11E-06	3.06E-06	3.11E-05	1.65E-05	0.00E+00	0.00E+00	9.33E-06	0.00E+00
	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CO 60	7.00E-05	1.31E-04	0.00E+00	2.37E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.09%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
BR 84	3.08E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	1.88E-05	2.54E-05	6.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.02%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	1.40E-05	6.22E-06	6.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.72E-10	1.01E-08	4.56E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	3.68E-15	2.00E-09	1.34E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	2.11E-09	2.47E-06	1.08E-08	2.37E-09	3.39E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	6.89E-08	4.98E-07	5.17E-07	1.40E-07	0.00E+00	1.45E-07	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.45E-01	1.42E-01	5.54E-01	1.48E-01	1.52E-01	2.33E+00	1.41E-01	1.41E-01

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = MEAT

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.67E-03	2.67E-03	0.00E+00	2.67E-03	2.67E-03	2.67E-03	2.67E-03	2.67E-03
	19.92%	19.55%	0.00%	19.84%	19.78%	5.42%	20.05%	20.07%
C 14	1.06E-02	1.06E-02	5.32E-02	1.06E-02	1.06E-02	1.06E-02	1.06E-02	1.06E-02
	79.34%	77.90%	99.81%	79.04%	78.81%	21.58%	79.86%	79.93%
I 131	6.29E-05	2.90E-05	7.68E-05	1.10E-04	1.88E-04	3.60E-02	0.00E+00	0.00E+00
	0.47%	0.21%	0.14%	0.82%	1.39%	73.00%	0.00%	0.00%
I 133	2.31E-13	6.81E-13	4.35E-13	7.57E-13	1.32E-12	1.11E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	7.21E-08	1.16E-06	0.00E+00	3.78E-07	1.13E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	8.73E-06	7.60E-05	9.70E-06	2.28E-05	0.00E+00	0.00E+00	6.37E-06	0.00E+00
	0.07%	0.56%	0.02%	0.17%	0.00%	0.00%	0.05%	0.00%
CO 58	1.91E-05	1.72E-04	0.00E+00	8.50E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	1.26%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	5.53E-12	1.93E-11	2.10E-10	2.52E-11	2.35E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	2.96E-10	7.45E-08	0.00E+00	0.00E+00	6.52E-11	1.77E-10	3.93E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.31E-06	3.24E-06	8.16E-06	5.64E-06	0.00E+00	0.00E+00	3.15E-06	0.00E+00
	0.00%	0.02%	0.02%	0.04%	0.00%	0.00%	0.02%	0.00%
CO 60	7.39E-06	6.29E-05	0.00E+00	3.35E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.06%	0.46%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
SR 89	6.61E-08	3.69E-07	2.30E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.16E-08	8.96E-08	3.56E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	7.04E-26	8.30E-24	1.74E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	7.75E-29	8.90E-23	2.81E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	5.30E-10	2.48E-06	2.44E-09	7.84E-10	1.23E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	2.76E-08	8.24E-07	2.06E-07	7.48E-08	8.39E-07	6.21E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.34E-02	1.37E-02	5.33E-02	1.35E-02	1.35E-02	4.93E-02	1.33E-02	1.33E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = MEAT

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.59E-03	1.59E-03	0.00E+00	1.59E-03	1.59E-03	1.59E-03	1.59E-03	1.59E-03
	14.93%	14.78%	0.00%	14.87%	14.83%	4.34%	15.03%	15.04%
C 14	8.99E-03	8.99E-03	4.49E-02	8.99E-03	8.99E-03	8.99E-03	8.99E-03	8.99E-03
	84.34%	83.46%	99.82%	83.99%	83.74%	24.53%	84.89%	84.96%
I 131	4.80E-05	1.77E-05	6.38E-05	8.93E-05	1.54E-04	2.61E-02	0.00E+00	0.00E+00
	0.45%	0.16%	0.14%	0.83%	1.43%	71.13%	0.00%	0.00%
I 133	1.88E-13	4.67E-13	3.64E-13	6.18E-13	1.08E-12	8.62E-11	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	5.72E-08	5.92E-07	0.00E+00	2.88E-07	8.60E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	6.98E-06	4.28E-05	7.75E-06	1.81E-05	0.00E+00	0.00E+00	5.70E-06	0.00E+00
	0.07%	0.40%	0.02%	0.17%	0.00%	0.00%	0.05%	0.00%
CO 58	1.51E-05	9.04E-05	0.00E+00	6.56E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.14%	0.84%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
PU239	3.44E-12	1.21E-11	1.31E-10	1.59E-11	1.47E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	2.37E-10	3.98E-08	0.00E+00	0.00E+00	5.19E-11	1.32E-10	3.38E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.10E-06	2.03E-06	6.63E-06	4.70E-06	0.00E+00	0.00E+00	2.98E-06	0.00E+00
	0.01%	0.02%	0.01%	0.04%	0.00%	0.00%	0.03%	0.00%
CO 60	5.86E-06	3.39E-05	0.00E+00	2.60E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.31%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
SR 89	5.56E-08	2.31E-07	1.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	4.93E-08	5.63E-08	2.47E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	5.83E-26	6.65E-24	1.47E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	6.50E-29	7.24E-23	2.37E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	4.25E-10	1.42E-06	1.96E-09	6.17E-10	9.07E-10	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	2.33E-08	5.14E-07	1.74E-07	6.28E-08	0.00E+00	4.87E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.07E-02	1.08E-02	4.50E-02	1.07E-02	1.07E-02	3.66E-02	1.06E-02	1.06E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = MEAT

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.93E-03	1.93E-03	0.00E+00	1.93E-03	1.93E-03	1.93E-03	1.93E-03	1.93E-03
	10.18%	10.19%	0.00%	10.16%	10.14%	3.31%	10.24%	10.24%
C 14	1.69E-02	1.69E-02	8.45E-02	1.69E-02	1.69E-02	1.69E-02	1.69E-02	1.69E-02
	89.22%	89.29%	99.82%	89.01%	88.84%	29.05%	89.71%	89.76%
I 131	6.76E-05	1.06E-05	1.18E-04	1.19E-04	1.95E-04	3.93E-02	0.00E+00	0.00E+00
	0.36%	0.06%	0.14%	0.63%	1.03%	67.64%	0.00%	0.00%
I 133	3.16E-13	3.37E-13	6.76E-13	8.36E-13	1.39E-12	1.55E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MN 54	8.79E-08	2.77E-07	0.00E+00	3.30E-07	9.25E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	1.11E-05	2.31E-05	1.37E-05	2.22E-05	0.00E+00	0.00E+00	6.44E-06	0.00E+00
	0.06%	0.12%	0.02%	0.12%	0.00%	0.00%	0.03%	0.00%
CO 58	2.34E-05	4.47E-05	0.00E+00	7.66E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.12%	0.24%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%
PU239	3.57E-12	7.39E-12	1.39E-10	1.49E-11	1.32E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	3.69E-10	1.96E-08	0.00E+00	0.00E+00	5.60E-11	2.05E-10	3.74E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	2.09E-06	1.25E-06	1.27E-05	6.75E-06	0.00E+00	0.00E+00	3.82E-06	0.00E+00
	0.01%	0.00%	0.02%	0.04%	0.00%	0.00%	0.02%	0.00%
CO 60	9.10E-06	1.71E-05	0.00E+00	3.09E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.05%	0.09%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
SR 89	1.05E-07	1.42E-07	3.68E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.86E-08	3.49E-08	3.90E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.04E-25	6.07E-24	2.75E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.22E-28	6.64E-23	4.45E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	6.80E-10	7.97E-07	3.47E-09	7.64E-10	1.09E-09	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	4.36E-08	3.16E-07	3.27E-07	8.87E-08	0.00E+00	9.19E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.89E-02	1.89E-02	8.47E-02	1.90E-02	1.90E-02	5.82E-02	1.88E-02	1.88E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	6.27E-03	6.27E-03	0.00E+00	6.27E-03	6.27E-03	6.27E-03	6.27E-03	6.27E-03
	33.06%	34.03%	0.00%	31.71%	29.68%	0.98%	35.08%	35.08%
C 14	1.16E-02	1.16E-02	5.80E-02	1.16E-02	1.16E-02	1.16E-02	1.16E-02	1.16E-02
	61.18%	62.96%	97.73%	58.68%	54.92%	1.82%	64.91%	64.92%
I 131	1.08E-03	5.00E-04	1.32E-03	1.89E-03	3.25E-03	6.20E-01	0.00E+00	0.00E+00
	5.72%	2.71%	2.23%	9.57%	15.35%	97.09%	0.00%	0.00%
I 133	1.51E-06	4.46E-06	2.85E-06	4.96E-06	8.66E-06	7.29E-04	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.03%	0.04%	0.11%	0.00%	0.00%
MN 54	5.14E-08	8.25E-07	0.00E+00	2.69E-07	8.02E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	6.55E-07	5.70E-06	7.27E-07	1.71E-06	0.00E+00	0.00E+00	4.77E-07	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	3.46E-06	3.13E-05	0.00E+00	1.54E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	1.80E-12	6.26E-12	6.82E-11	8.19E-12	7.63E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	7.74E-10	1.95E-07	0.00E+00	0.00E+00	1.70E-10	4.62E-10	1.03E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	8.96E-08	2.21E-07	5.56E-07	3.84E-07	0.00E+00	0.00E+00	2.14E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	1.30E-06	1.11E-05	0.00E+00	5.89E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	2.16E-07	1.21E-06	7.52E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	2.22E-07	2.78E-07	1.10E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	8.81E-12	1.04E-09	2.18E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.44E-18	2.81E-12	8.85E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.85E-13	8.68E-10	8.54E-13	2.74E-13	4.30E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	8.74E-10	2.61E-08	6.53E-09	2.36E-09	2.65E-08	1.96E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.90E-02	1.84E-02	5.94E-02	1.98E-02	2.11E-02	6.39E-01	1.79E-02	1.79E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	8.16E-03	8.16E-03	0.00E+00	8.16E-03	8.16E-03	8.16E-03	8.16E-03	8.16E-03
	26.00%	26.93%	0.00%	24.77%	23.07%	0.81%	27.60%	27.60%
C 14	2.14E-02	2.14E-02	1.07E-01	2.14E-02	2.14E-02	2.14E-02	2.14E-02	2.14E-02
	68.21%	70.66%	97.77%	64.98%	60.52%	2.12%	72.40%	72.40%
I 131	1.81E-03	6.65E-04	2.40E-03	3.36E-03	5.79E-03	9.81E-01	0.00E+00	0.00E+00
	5.75%	2.19%	2.19%	10.20%	16.36%	96.96%	0.00%	0.00%
I 133	2.70E-06	6.69E-06	5.21E-06	8.84E-06	1.55E-05	1.23E-03	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.03%	0.04%	0.12%	0.00%	0.00%
MN 54	8.90E-08	9.20E-07	0.00E+00	4.49E-07	1.34E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	1.14E-06	7.00E-06	1.27E-06	2.96E-06	0.00E+00	0.00E+00	9.34E-07	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	5.98E-06	3.58E-05	0.00E+00	2.60E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	2.44E-12	8.57E-12	9.28E-11	1.13E-11	1.04E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.35E-09	2.27E-07	0.00E+00	0.00E+00	2.98E-10	7.50E-10	1.93E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.63E-07	3.03E-07	9.87E-07	7.00E-07	0.00E+00	0.00E+00	4.44E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	2.25E-06	1.30E-05	0.00E+00	9.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	3.97E-07	1.65E-06	1.39E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	3.34E-07	3.81E-07	1.67E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.59E-11	1.82E-09	4.01E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	4.47E-18	4.98E-12	1.63E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	3.24E-13	1.09E-09	1.49E-12	4.71E-13	6.93E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.61E-09	3.55E-08	1.20E-08	4.34E-09	0.00E+00	3.36E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	3.14E-02	3.03E-02	1.10E-01	3.30E-02	3.54E-02	1.01E+00	2.96E-02	2.96E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.29E-02	1.29E-02	0.00E+00	1.29E-02	1.29E-02	1.29E-02	1.29E-02	1.29E-02
	18.76%	19.55%	0.00%	18.10%	17.19%	0.64%	19.72%	19.72%
C 14	5.27E-02	5.27E-02	2.63E-01	5.27E-02	5.27E-02	5.27E-02	5.27E-02	5.27E-02
	76.37%	79.59%	97.80%	73.67%	69.99%	2.63%	80.28%	80.28%
I 131	3.33E-03	5.22E-04	5.83E-03	5.86E-03	9.62E-03	1.94E+00	0.00E+00	0.00E+00
	4.83%	0.79%	2.16%	8.20%	12.79%	96.59%	0.00%	0.00%
I 133	5.92E-06	6.31E-06	1.27E-05	1.57E-05	2.61E-05	2.91E-03	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.02%	0.03%	0.14%	0.00%	0.00%
MN 54	1.79E-07	5.63E-07	0.00E+00	6.71E-07	1.88E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	2.37E-06	4.96E-06	2.94E-06	4.76E-06	0.00E+00	0.00E+00	1.38E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	1.21E-05	2.31E-05	0.00E+00	3.97E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.02%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	3.31E-12	6.86E-12	1.29E-10	1.38E-11	1.22E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	2.76E-09	1.46E-07	0.00E+00	0.00E+00	4.18E-10	1.53E-09	2.79E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	4.07E-07	2.43E-07	2.48E-06	1.31E-06	0.00E+00	0.00E+00	7.43E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	4.57E-06	8.59E-06	0.00E+00	1.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	9.79E-07	1.33E-06	3.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	6.95E-07	3.09E-07	3.46E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	3.71E-11	2.17E-09	9.83E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.10E-17	5.97E-12	4.01E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	6.79E-13	7.96E-10	3.47E-12	7.63E-13	1.09E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	3.94E-09	2.85E-08	2.96E-08	8.01E-09	0.00E+00	8.30E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	6.89E-02	6.62E-02	2.69E-01	7.15E-02	7.52E-02	2.01E+00	6.56E-02	6.56E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = COW MILK

AGE GROUP = INFANT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.96E-02	1.96E-02	0.00E+00	1.96E-02	1.96E-02	1.96E-02	1.96E-02	1.96E-02
	14.42%	15.06%	0.00%	13.62%	13.40%	0.41%	15.13%	15.13%
C 14	1.10E-01	1.10E-01	5.16E-01	1.10E-01	1.10E-01	1.10E-01	1.10E-01	1.10E-01
	80.91%	84.51%	97.67%	76.40%	75.15%	2.27%	84.87%	84.87%
I 131	6.30E-03	5.11E-04	1.22E-02	1.43E-02	1.67E-02	4.71E+00	0.00E+00	0.00E+00
	4.63%	0.39%	2.30%	9.94%	11.42%	97.18%	0.00%	0.00%
I 133	1.14E-05	6.59E-06	2.67E-05	3.89E-05	4.58E-05	7.08E-03	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.03%	0.03%	0.15%	0.00%	0.00%
MN 54	2.83E-07	4.59E-07	0.00E+00	1.25E-06	2.77E-07	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	3.78E-06	4.58E-06	5.49E-06	9.59E-06	0.00E+00	0.00E+00	2.84E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	1.98E-05	1.98E-05	0.00E+00	7.93E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	3.54E-12	6.92E-12	1.38E-10	1.55E-11	1.28E-11	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	4.36E-09	1.27E-07	0.00E+00	0.00E+00	6.22E-10	2.85E-09	5.54E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	5.17E-07	2.46E-07	2.99E-06	1.93E-06	0.00E+00	0.00E+00	9.46E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	7.47E-06	7.53E-06	0.00E+00	3.16E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 84	1.01E-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	1.87E-06	1.34E-06	6.52E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	7.75E-07	3.12E-07	3.82E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	7.41E-11	2.43E-09	2.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.33E-17	6.75E-12	8.54E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.07E-12	7.48E-10	6.16E-12	1.50E-12	1.62E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	8.17E-09	2.88E-08	6.04E-08	2.02E-08	0.00E+00	2.03E-08	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.36E-01	1.30E-01	5.28E-01	1.44E-01	1.46E-01	4.84E+00	1.30E-01	1.30E-01

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.28E-02	1.28E-02	0.00E+00	1.28E-02	1.28E-02	1.28E-02	1.28E-02	1.28E-02
	47.37%	49.93%	0.00%	44.19%	39.73%	0.84%	52.44%	52.44%
C 14	1.16E-02	1.16E-02	5.80E-02	1.16E-02	1.16E-02	1.16E-02	1.16E-02	1.16E-02
	42.97%	45.29%	94.71%	40.08%	36.04%	0.77%	47.56%	47.56%
I 131	2.60E-03	1.20E-03	3.18E-03	4.54E-03	7.79E-03	1.49E+00	0.00E+00	0.00E+00
	9.64%	4.68%	5.18%	15.68%	24.17%	98.27%	0.00%	0.00%
I 133	3.63E-06	1.07E-05	6.85E-06	1.19E-05	2.08E-05	1.75E-03	0.00E+00	0.00E+00
	0.01%	0.04%	0.01%	0.04%	0.06%	0.12%	0.00%	0.00%
MN 54	9.11E-09	1.46E-07	0.00E+00	4.78E-08	1.42E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	1.55E-07	1.35E-06	1.72E-07	4.04E-07	0.00E+00	0.00E+00	1.13E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	7.09E-07	6.41E-06	0.00E+00	3.16E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	3.01E-13	1.05E-12	1.14E-11	1.37E-12	1.28E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.78E-10	4.49E-08	0.00E+00	0.00E+00	3.93E-11	1.07E-10	2.37E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	1.66E-08	4.09E-08	1.03E-07	7.13E-08	0.00E+00	0.00E+00	3.98E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	2.19E-07	1.86E-06	0.00E+00	9.91E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	8.11E-07	4.53E-06	2.83E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	6.32E-07	7.91E-07	3.15E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	3.70E-11	4.36E-09	9.16E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	5.86E-19	6.73E-13	2.12E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	3.86E-14	1.81E-10	1.78E-13	5.70E-14	8.94E-14	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.81E-10	5.39E-09	1.35E-09	4.89E-10	5.49E-09	4.06E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	2.70E-02	2.56E-02	6.13E-02	2.90E-02	3.22E-02	1.51E+00	2.44E-02	2.44E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.67E-02	1.67E-02	0.00E+00	1.67E-02	1.67E-02	1.67E-02	1.67E-02	1.67E-02
	39.26%	41.95%	0.00%	36.08%	32.03%	0.70%	43.74%	43.74%
C 14	2.14E-02	2.14E-02	1.07E-01	2.14E-02	2.14E-02	2.14E-02	2.14E-02	2.14E-02
	50.49%	53.94%	94.80%	46.39%	41.19%	0.89%	56.25%	56.26%
I 131	4.33E-03	1.60E-03	5.76E-03	8.07E-03	1.39E-02	2.35E+00	0.00E+00	0.00E+00
	10.22%	4.02%	5.10%	17.48%	26.71%	98.29%	0.00%	0.00%
I 133	6.47E-06	1.60E-05	1.25E-05	2.12E-05	3.72E-05	2.96E-03	0.00E+00	0.00E+00
	0.02%	0.04%	0.01%	0.05%	0.07%	0.12%	0.00%	0.00%
MN 54	1.58E-08	1.63E-07	0.00E+00	7.96E-08	2.37E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	2.71E-07	1.66E-06	3.00E-07	7.01E-07	0.00E+00	0.00E+00	2.21E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	1.23E-06	7.34E-06	0.00E+00	5.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	4.09E-13	1.44E-12	1.56E-11	1.89E-12	1.74E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	3.12E-10	5.24E-08	0.00E+00	0.00E+00	6.83E-11	1.73E-10	4.45E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	3.03E-08	5.62E-08	1.83E-07	1.30E-07	0.00E+00	0.00E+00	8.23E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	3.78E-07	2.19E-06	0.00E+00	1.68E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	1.49E-06	6.20E-06	5.21E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.02%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	9.51E-07	1.09E-06	4.75E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	6.69E-11	7.63E-09	1.68E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	1.07E-18	1.20E-12	3.91E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	6.74E-14	2.26E-10	3.11E-13	9.80E-14	1.44E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	3.33E-10	7.35E-09	2.49E-09	8.97E-10	0.00E+00	6.96E-10	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	4.24E-02	3.97E-02	1.13E-01	4.62E-02	5.20E-02	2.40E+00	3.81E-02	3.81E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	2.64E-02	2.64E-02	0.00E+00	2.64E-02	2.64E-02	2.64E-02	2.64E-02	2.64E-02
	30.31%	32.85%	0.00%	28.33%	25.82%	0.56%	33.38%	33.38%
C 14	5.27E-02	5.27E-02	2.63E-01	5.27E-02	5.27E-02	5.27E-02	5.27E-02	5.27E-02
	60.49%	65.56%	94.87%	56.53%	51.53%	1.11%	66.62%	66.62%
I 131	7.99E-03	1.25E-03	1.40E-02	1.41E-02	2.31E-02	4.65E+00	0.00E+00	0.00E+00
	9.18%	1.56%	5.04%	15.10%	22.59%	98.18%	0.00%	0.00%
I 133	1.42E-05	1.51E-05	3.04E-05	3.76E-05	6.26E-05	6.98E-03	0.00E+00	0.00E+00
	0.02%	0.02%	0.01%	0.04%	0.06%	0.15%	0.00%	0.00%
MN 54	3.17E-08	9.99E-08	0.00E+00	1.19E-07	3.34E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	5.61E-07	1.17E-06	6.96E-07	1.13E-06	0.00E+00	0.00E+00	3.27E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	2.49E-06	4.74E-06	0.00E+00	8.13E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	5.56E-13	1.15E-12	2.17E-11	2.32E-12	2.05E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	6.35E-10	3.37E-08	0.00E+00	0.00E+00	9.64E-11	3.53E-10	6.44E-10	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	7.55E-08	4.51E-08	4.59E-07	2.44E-07	0.00E+00	0.00E+00	1.38E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	7.69E-07	1.44E-06	0.00E+00	2.61E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	3.68E-06	4.99E-06	1.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	1.98E-06	8.81E-07	9.85E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.56E-10	9.12E-09	4.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	2.64E-18	1.43E-12	9.61E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.41E-13	1.65E-10	7.22E-13	1.59E-13	2.27E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	8.16E-10	5.90E-09	6.12E-09	1.66E-09	0.00E+00	1.72E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	8.71E-02	8.03E-02	2.78E-01	9.31E-02	1.02E-01	4.73E+00	7.90E-02	7.90E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 2 A SITE BNDRY
PATHWAY = GOATMILK

AGE GROUP = INFANT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	4.00E-02	4.00E-02	0.00E+00	4.00E-02	4.00E-02	4.00E-02	4.00E-02	4.00E-02
	24.22%	26.44%	0.00%	21.69%	21.03%	0.35%	26.67%	26.67%
C 14	1.10E-01	1.10E-01	5.16E-01	1.10E-01	1.10E-01	1.10E-01	1.10E-01	1.10E-01
	66.61%	72.73%	94.57%	59.64%	57.83%	0.96%	73.33%	73.33%
I 131	1.51E-02	1.23E-03	2.92E-02	3.44E-02	4.01E-02	1.13E+01	0.00E+00	0.00E+00
	9.15%	0.81%	5.35%	18.62%	21.09%	98.54%	0.00%	0.00%
I 133	2.74E-05	1.58E-05	6.41E-05	9.34E-05	1.10E-04	1.70E-02	0.00E+00	0.00E+00
	0.02%	0.01%	0.01%	0.05%	0.06%	0.15%	0.00%	0.00%
MN 54	5.02E-08	8.13E-08	0.00E+00	2.21E-07	4.91E-08	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 59	8.95E-07	1.08E-06	1.30E-06	2.27E-06	0.00E+00	0.00E+00	6.71E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 58	4.06E-06	4.05E-06	0.00E+00	1.63E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PU239	5.95E-13	1.16E-12	2.32E-11	2.60E-12	2.15E-12	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CR 51	1.01E-09	2.93E-08	0.00E+00	0.00E+00	1.44E-10	6.57E-10	1.28E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	9.59E-08	4.55E-08	5.55E-07	3.59E-07	0.00E+00	0.00E+00	1.75E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	1.26E-08	1.27E-06	0.00E+00	5.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	7.03E-06	5.04E-06	2.45E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 90	2.21E-06	8.88E-07	1.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	3.11E-10	1.02E-08	8.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	5.58E-18	1.62E-12	2.05E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	2.21E-13	1.56E-10	1.28E-12	3.12E-13	3.37E-13	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.69E-09	5.98E-09	1.25E-08	4.18E-09	0.00E+00	4.21E-09	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.65E-01	1.51E-01	5.45E-01	1.85E-01	1.90E-01	1.15E+01	1.50E-01	1.50E-01

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 3 A SITE BNDRY
PATHWAY = PLUME

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
AR 41	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.20E-03	1.93E-03
	7.28%	7.28%	7.28%	7.28%	7.28%	7.28%	7.07%	4.79%
KR 83M	1.24E-09	1.24E-09	1.24E-09	1.24E-09	1.24E-09	1.24E-09	6.93E-08	3.51E-07
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
KR 85M	2.71E-04	2.71E-04	2.71E-04	2.71E-04	2.71E-04	2.71E-04	2.78E-04	8.00E-04
	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.63%	1.98%
KR 85	2.49E-05	2.49E-05	2.49E-05	2.49E-05	2.49E-05	2.49E-05	6.63E-05	2.99E-03
	0.15%	0.15%	0.15%	0.15%	0.15%	0.15%	0.39%	7.42%
KR 87	2.48E-04	2.48E-04	2.48E-04	2.48E-04	2.48E-04	2.48E-04	2.55E-04	8.71E-04
	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.49%	2.16%
KR 88	5.67E-03	5.67E-03	5.67E-03	5.67E-03	5.67E-03	5.67E-03	5.69E-03	7.82E-03
	34.28%	34.28%	34.28%	34.28%	34.28%	34.28%	33.41%	19.39%
XE131M	8.71E-06	8.71E-06	8.71E-06	8.71E-06	8.71E-06	8.71E-06	1.02E-05	8.13E-05
	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.06%	0.20%
XE133M	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.20E-04	7.87E-04
	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.70%	1.95%
XE133	7.14E-03	7.14E-03	7.14E-03	7.14E-03	7.14E-03	7.14E-03	7.51E-03	2.01E-02
	43.14%	43.14%	43.14%	43.14%	43.14%	43.14%	44.06%	49.94%
XE135	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.85E-03	4.81E-03
	10.97%	10.97%	10.97%	10.97%	10.97%	10.97%	10.87%	11.92%
XE138	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.34E-05	9.68E-05
	0.32%	0.32%	0.32%	0.32%	0.32%	0.32%	0.31%	0.24%
TOTAL	1.66E-02	1.66E-02	1.66E-02	1.66E-02	1.66E-02	1.66E-02	1.70E-02	4.03E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 3 A SITE BNDRY
PATHWAY = INHAL

AGE GROUP = ADULT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.68E-02	1.68E-02	0.00E+00	1.68E-02	1.68E-02	1.68E-02	1.68E-02	1.68E-02
	99.47%	99.69%	0.00%	99.03%	98.41%	24.57%	98.58%	100.00%
I 131	8.78E-05	2.69E-05	1.08E-04	1.53E-04	2.63E-04	5.11E-02	0.00E+00	0.00E+00
	0.52%	0.16%	86.91%	0.90%	1.54%	74.72%	0.00%	0.00%
I 133	1.01E-06	1.98E-06	1.93E-06	3.31E-06	5.77E-06	4.81E-04	0.00E+00	0.00E+00
	0.00%	0.01%	1.55%	0.02%	0.03%	0.70%	0.00%	0.00%
MN 54	3.82E-08	4.69E-07	0.00E+00	2.40E-07	5.97E-08	0.00E+00	8.49E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%
FE 59	1.03E-07	1.84E-06	1.15E-07	2.72E-07	0.00E+00	0.00E+00	9.95E-06	0.00E+00
	0.00%	0.01%	0.09%	0.00%	0.00%	0.00%	0.06%	0.00%
CO 58	2.79E-07	1.43E-05	0.00E+00	2.13E-07	0.00E+00	0.00E+00	1.25E-04	0.00E+00
	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.73%	0.00%
PU239	5.06E-07	2.70E-10	1.08E-05	6.99E-06	2.16E-06	0.00E+00	1.12E-06	0.00E+00
	0.00%	0.00%	8.73%	0.04%	0.01%	0.00%	0.00%	0.00%
CR 51	1.41E-09	4.67E-08	0.00E+00	0.00E+00	3.21E-10	8.37E-10	2.03E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	3.86E-08	5.91E-08	2.41E-07	1.66E-07	0.00E+00	0.00E+00	7.06E-07	0.00E+00
	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	2.27E-07	4.36E-06	0.00E+00	1.76E-07	0.00E+00	0.00E+00	9.13E-05	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.54%	0.00%
BR 84	1.26E-09	6.62E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 85	5.70E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	2.29E-08	9.26E-07	8.00E-07	0.00E+00	0.00E+00	0.00E+00	3.68E-06	0.00E+00
	0.00%	0.00%	0.64%	0.00%	0.00%	0.00%	0.02%	0.00%
SR 90	4.59E-08	5.74E-08	2.29E-06	0.00E+00	0.00E+00	0.00E+00	7.64E-07	0.00E+00
	0.00%	0.00%	1.84%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	9.23E-12	7.05E-07	2.28E-10	0.00E+00	0.00E+00	0.00E+00	1.34E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	5.05E-13	8.16E-08	1.83E-11	0.00E+00	0.00E+00	0.00E+00	9.39E-09	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.05E-08	6.81E-06	4.85E-08	1.56E-08	2.45E-08	0.00E+00	8.01E-07	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	8.29E-11	1.25E-08	6.06E-10	2.81E-10	2.20E-09	1.86E-10	5.56E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.69E-02	1.69E-02	1.24E-04	1.70E-02	1.71E-02	6.84E-02	1.70E-02	1.68E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 3 A SITE BNDRY
PATHWAY = INHAL

AGE GROUP = TEEN

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.70E-02	1.70E-02	0.00E+00	1.70E-02	1.70E-02	1.70E-02	1.70E-02	1.70E-02
	99.32%	99.70%	0.00%	98.70%	97.86%	21.10%	97.95%	100.00%
I 131	1.13E-04	2.78E-05	1.52E-04	2.11E-04	3.60E-04	6.27E-02	0.00E+00	0.00E+00
	0.66%	0.16%	89.22%	1.23%	2.08%	78.09%	0.00%	0.00%
I 133	1.39E-06	2.31E-06	2.72E-06	4.57E-06	8.02E-06	6.52E-04	0.00E+00	0.00E+00
	0.00%	0.01%	1.60%	0.03%	0.05%	0.81%	0.00%	0.00%
MN 54	5.09E-08	4.05E-07	0.00E+00	3.10E-07	7.71E-08	0.00E+00	1.20E-05	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%
FE 59	1.40E-07	1.75E-06	1.56E-07	3.62E-07	0.00E+00	0.00E+00	1.50E-05	0.00E+00
	0.00%	0.01%	0.09%	0.00%	0.00%	0.00%	0.09%	0.00%
CO 58	3.74E-07	1.28E-05	0.00E+00	2.79E-07	0.00E+00	0.00E+00	1.81E-04	0.00E+00
	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	1.05%	0.00%
PU239	5.26E-07	2.85E-10	1.13E-05	7.32E-06	2.25E-06	0.00E+00	1.91E-06	0.00E+00
	0.00%	0.00%	6.64%	0.04%	0.01%	0.00%	0.01%	0.00%
CR 51	1.90E-09	4.22E-08	0.00E+00	0.00E+00	4.32E-10	1.05E-09	2.95E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	5.43E-08	6.26E-08	3.28E-07	2.34E-07	0.00E+00	0.00E+00	1.21E-06	0.00E+00
	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	3.04E-07	3.97E-06	0.00E+00	2.31E-07	0.00E+00	0.00E+00	1.33E-04	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.77%	0.00%
BR 84	1.75E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 85	8.16E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	3.28E-08	9.77E-07	1.14E-06	0.00E+00	0.00E+00	0.00E+00	6.36E-06	0.00E+00
	0.00%	0.00%	0.67%	0.00%	0.00%	0.00%	0.04%	0.00%
SR 90	5.30E-08	6.09E-08	2.64E-06	0.00E+00	0.00E+00	0.00E+00	1.31E-06	0.00E+00
	0.00%	0.00%	1.55%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.29E-11	9.55E-07	3.24E-10	0.00E+00	0.00E+00	0.00E+00	2.24E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	7.20E-13	1.12E-07	2.62E-11	0.00E+00	0.00E+00	0.00E+00	1.61E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.43E-08	6.74E-08	6.59E-08	2.08E-08	3.05E-08	0.00E+00	1.22E-06	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.18E-10	1.33E-08	8.66E-10	3.97E-10	0.00E+00	2.48E-10	9.51E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.71E-02	1.70E-02	1.70E-04	1.72E-02	1.73E-02	8.04E-02	1.73E-02	1.70E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 3 A SITE BNDRY
PATHWAY = INHAL

AGE GROUP = CHILD

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	1.50E-02	1.50E-02	0.00E+00	1.50E-02	1.50E-02	1.50E-02	1.50E-02	1.50E-02
	99.20%	99.86%	0.00%	98.57%	97.74%	17.52%	98.10%	100.00%
I 131	1.17E-04	1.22E-05	2.06E-04	2.06E-04	3.38E-04	6.96E-02	0.00E+00	0.00E+00
	0.77%	0.08%	92.16%	1.36%	2.21%	81.47%	0.00%	0.00%
I 133	1.72E-06	1.22E-06	3.70E-06	4.54E-06	7.55E-06	8.60E-04	0.00E+00	0.00E+00
	0.01%	0.00%	1.66%	0.03%	0.05%	1.01%	0.00%	0.00%
MN 54	5.76E-08	1.39E-07	0.00E+00	2.60E-07	6.08E-08	0.00E+00	9.56E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%
FE 59	1.63E-07	6.92E-07	2.02E-07	3.27E-07	0.00E+00	0.00E+00	1.24E-05	0.00E+00
	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%	0.08%	0.00%
CO 58	4.26E-07	4.63E-06	0.00E+00	2.39E-07	0.00E+00	0.00E+00	1.49E-04	0.00E+00
	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.98%	0.00%
PU239	3.87E-07	1.28E-10	8.43E-06	5.08E-06	1.44E-06	0.00E+00	1.73E-06	0.00E+00
	0.00%	0.00%	3.77%	0.03%	0.00%	0.00%	0.01%	0.00%
CR 51	2.17E-09	1.52E-08	0.00E+00	0.00E+00	3.42E-10	1.20E-09	2.39E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	7.61E-08	2.81E-08	4.64E-07	2.46E-07	0.00E+00	0.00E+00	1.09E-06	0.00E+00
	0.00%	0.00%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	3.47E-07	1.47E-06	0.00E+00	2.01E-07	0.00E+00	0.00E+00	1.08E-04	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.71%	0.00%
BR 84	2.21E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 85	1.13E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	4.54E-08	4.40E-07	1.58E-06	0.00E+00	0.00E+00	0.00E+00	5.68E-06	0.00E+00
	0.00%	0.00%	0.71%	0.00%	0.00%	0.00%	0.04%	0.00%
SR 90	6.10E-08	2.73E-08	3.06E-06	0.00E+00	0.00E+00	0.00E+00	1.17E-06	0.00E+00
	0.00%	0.00%	1.37%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 91	1.69E-11	6.41E-07	4.47E-10	0.00E+00	0.00E+00	0.00E+00	1.96E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	9.89E-13	7.52E-08	3.61E-11	0.00E+00	0.00E+00	0.00E+00	1.44E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	1.68E-08	2.76E-08	8.60E-08	1.89E-08	2.70E-08	0.00E+00	1.01E-06	0.00E+00
	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.62E-10	5.99E-09	1.19E-09	4.13E-10	0.00E+00	3.41E-10	8.47E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	1.51E-02	1.50E-02	2.24E-04	1.52E-02	1.53E-02	8.54E-02	1.53E-02	1.50E-02

SAMPLE PROBLEM 1 - INDIVIDUAL DOSE CALCULATIONS
ANNUAL INDIVIDUAL DOSE (MREM) SUMMARY BY PATHWAY AND NUCLIDE
SPECIAL LOCATION NO. 3 A SITE BNDRY
PATHWAY = INHAL

AGE GROUP = INFANT

NUCLIDE	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H 3	8.61E-03	8.61E-03	0.00E+00	8.61E-03	8.61E-03	8.61E-03	8.61E-03	8.61E-03
	99.01%	99.91%	0.00%	97.76%	97.42%	11.80%	97.74%	100.00%
I 131	8.40E-05	4.54E-06	1.63E-04	1.90E-04	2.22E-04	6.36E-02	0.00E+00	0.00E+00
	0.97%	0.05%	94.77%	2.16%	2.51%	87.12%	0.00%	0.00%
I 133	1.25E-06	4.82E-07	2.96E-06	4.28E-06	5.00E-06	7.94E-04	0.00E+00	0.00E+00
	0.01%	0.00%	1.72%	0.05%	0.06%	1.09%	0.00%	0.00%
MN 54	3.02E-08	4.28E-08	0.00E+00	1.54E-07	3.02E-08	0.00E+00	6.06E-06	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%
FE 59	9.28E-08	2.43E-07	1.33E-07	2.30E-07	0.00E+00	0.00E+00	9.94E-06	0.00E+00
	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.11%	0.00%
CO 58	2.45E-07	1.50E-06	0.00E+00	1.64E-07	0.00E+00	0.00E+00	1.05E-04	0.00E+00
	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	1.19%	0.00%
PU239	1.53E-07	4.89E-11	3.35E-06	2.01E-06	5.66E-07	0.00E+00	9.68E-07	0.00E+00
	0.00%	0.00%	1.95%	0.02%	0.00%	0.00%	0.01%	0.00%
CR 51	1.26E-09	5.02E-09	0.00E+00	0.00E+00	1.86E-10	8.09E-10	1.81E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
FE 55	3.26E-08	1.07E-08	1.93E-07	1.15E-07	0.00E+00	0.00E+00	8.52E-07	0.00E+00
	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%
CO 60	1.80E-07	4.89E-07	0.00E+00	1.23E-07	0.00E+00	0.00E+00	6.90E-05	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.78%	0.00%
BR 84	1.62E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BR 85	9.11E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SR 89	3.00E-08	1.68E-07	1.05E-06	0.00E+00	0.00E+00	0.00E+00	5.34E-06	0.00E+00
	0.00%	0.00%	0.61%	0.00%	0.00%	0.00%	0.06%	0.00%
SR 90	2.48E-08	1.04E-08	1.24E-06	0.00E+00	0.00E+00	0.00E+00	8.95E-07	0.00E+00
	0.00%	0.00%	0.72%	0.00%	0.00%	0.00%	0.01%	0.00%
SR 91	1.27E-11	2.70E-07	3.52E-10	0.00E+00	0.00E+00	0.00E+00	1.94E-07	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Y 93	7.89E-13	3.23E-08	2.90E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ZR 95	9.19E-09	9.83E-09	5.22E-08	1.26E-08	1.41E-08	0.00E+00	7.92E-07	0.00E+00
	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%
TE125M	1.17E-10	2.29E-09	8.45E-10	3.53E-10	0.00E+00	2.88E-10	7.93E-08	0.00E+00
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	8.70E-03	8.62E-03	1.72E-04	8.81E-03	8.84E-03	7.30E-02	8.81E-03	8.61E-03

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13. ABSTRACT (200 words or less)

The Nuclear Regulatory Commission's GASPAR II computer program performs environmental dose analyses for releases of radioactive effluents from nuclear power plants into the atmosphere. The analyses estimate radiation dose to individuals and population groups from inhalation, ingestion, and external exposure pathways. The estimated doses provide information for National Environmental Policy Act evaluations and for determining compliance with Appendix I of 10 CFR 50. This report describes the mathematical models used in the GASPAR II computer program, instructs the user in preparing input to the program, and supplies detailed information on program structure and parameters used to modify the program.

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