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PRESTO-II: A LOW-LEVEL WASTE ENVIRONMENTAL TRANSPORT AND RISK ASSESSMENT CODE

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ABSTRACT

PRESTO-II (Prediction of Radiation Effects from Shallow Trench Operations) is a computer code designed for the evaluation of possible health effects from shallow-land and, waste-disposal trenches. The model is intended to serve as a non-site-specific screening model for assessing radionuclide transport, ensuing exposure, and health impacts to a static local population for a 1000-year period following the end of disposal operations. Human exposure scenarios considered include normal releases (including leaching and operational spillage), human intrusion, and limited site farming or reclamation. Pathways and processes of transit from the trench to an individual or population include ground-water transport, overland flow, erosion, surface water dilution, suspension, atmospheric transport, deposition, inhalation, external exposure, and ingestion of contaminated beef, milk, crops, and water. Both population doses and individual doses, as well as doses to the intruder and farmer, may be calculated. Cumulative health effects in terms of cancer deaths are calculated for the population over the 1000-year period using a life-table approach. Data are included for three example sites: Barnwell, South Carolina; Beatty, Nevada; and West Valley, New York. A code listing and example input for each of the three sites are included in the appendices to this report.

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) is responsible for developing a generally-applicable environmental standard for the disposal of low-level radioactive waste (LLW). A methodology was developed to assist in assessing the potential human health impacts from such operations. This methodology was called PRESTO (Prediction of Radiation Effects from Shallow Trench Operations) (Little et al., 1981). To assist in application of the PRESTO methodology, at least two different computer codes have been developed to estimate radionuclide transport and health risk. Documentation for Version 1.2 of the PRESTO-EPA model was delivered to EPA in April, 1983, and the EPA is continuing to develop and document versions of the PRESTO-EPA code (Bandroski and Hung, 1985).

This report documents the second code, PRESTO-II. PRESTO-II has been applied to simulate radionuclide transport at several DOE low-level radionuclide disposal sites, and for the NRC in support of a de minimis classification for waste (Fields and Emerson, 1984).

PRESTO-II differs from the EPA code in the following respects:

- PRESTO-II contains a different approach for computing infiltration through the trench cap. The input data-intensive calculation of trench-cap infiltration used in subroutine INFIL of PRESTO-EPA has been replaced by a simpler and perhaps more defensible approach that computes this important variable from experimentally determined permeability and hourly precipitation values. Still other approaches to infiltration have been added as options: (1) use of yearly precipitation values; (2) user-specification of infiltration; and (3) estimation of trench cap infiltration as a fraction of calculated watershed infiltration. All of these methods provide values for infiltration through an intact trench cap - infiltration through failed portions of the cap is computed in a separate calculation.
- Watershed infiltration, an important variable for determining radionuclide weathering from the surface soils, is determined in PRESTO-II using a parametric evapotranspiration equation devised by Morton (1976, 1978). This model requires input values for the following site variables: annual precipitation, mean sea level pressure, latitude, monthly dew point, monthly ambient air temperatures, and the observed fraction of maximum monthly sunshine.

According to Morton, this evapotranspiration model has been verified over a wide range of climates and reasonable estimates of water balance have been obtained for 122 river basins on three continents. Wallace (1978) reports the Morton model to be superior to both the Thornwaite-Mather (1955) and Penman (1948) approaches to modeling evapotranspiration in certain environments.

- The computation of trench water balance (including water level, water overflow, and water percolation through the trench bottom), is made using a finite element approach in the PRESTO-II code. In comparison, a finite difference approach with a one-year time step is used in the PRESTO-EPA

code. The advantages of the finite element approach are that unrealistic predictions of trench overflow are avoided in wet years, and that the time-averaged vertical extent of the saturated zone within the trench is available for use in other calculations (such as those determining radionuclide leaching and contaminated water release from the trench).

- A streamlined algorithm for describing radionuclide transport through subsurface pathways is used in the PRESTO-II code. The calculation of a correction factor for the combined effects of dispersion and radioactive decay used in the PRESTO-EPA code was not used in PRESTO-II. This correction factor differed from unity only in some scenarios in which the magnitude of human exposure was small.
- Additional user options for routing of contaminated water have been implemented in PRESTO-II. For example, contaminated aquifer water that is not pumped from the aquifer at the well may be routed to surface streams.
- The PRESTO-II code has profited from the discovery of several errors in version 2.3 of the PRESTO-EPA model. These errors have been found and corrected in many cases through joint efforts by the authors of this report and by EPA researchers.

PRESTO-II is a computer code developed to estimate possible health effects from low-level radioactive waste buried in shallow trenches. The code can be used to make estimates for up to 1000 years following the end of LLW disposal operations. The code is intended to be as generic as possible. Most of the transport methodology is derived from previously published work; e.g., USNRC, (1977). Different transport mechanisms may be considered, but there has been no intent to tailor the code to a particular site. Nevertheless, the assumption in the PRESTO methodology of saturated hydrologic transport results in the prediction of more rapid radionuclide transport than would actually occur at some arid sites. Thus, in most cases, the model results are conservative for such sites. The DARTAB model (Begovich et al., 1981) is used in modified form as an important module of PRESTO-II to generate human health-risk estimates from radionuclide concentration and intake values. Cancer risks are calculated for individuals or populations over the assessment period using a life-table approach developed by EPA (Dunning et al., 1980).

The PRESTO-II code construction is modular to allow alternate submodels or subroutines to be substituted if necessary. Many of the submodels included in PRESTO-II were developed for other types of assessments and have been adapted for use in estimating health effects from shallow land disposal of LLW.

The PRESTO-II model is most appropriately used as a screening model, and site specific codes should be considered in cases where PRESTO-II numerical results fall close to reference values used for decision making. The model may be used to estimate doses to populations as an aid to the ALARA process. It may also be used to estimate doses to maximally exposed individual members of the public by specification in the input data that the location of the individual and of the well used for obtaining water for drinking, crop irrigation, and livestock watering, is at the site boundary. The code contains algorithms to track both radionuclide amounts and radionuclide concentrations in well water. Radionuclides are first withdrawn from the well

for human ingestion in an amount appropriate for the number of exposed persons specified, and remaining radionuclides may be withdrawn to be used for irrigating crops and watering livestock. A second reason to account for both amount and concentration of radionuclides at the well is to insure that the amount withdrawn at the well (based on the calculated concentration at the well) does not exceed the amount available. As a result of this calculation, the dose and risk calculated for a single individual may exceed the dose and risk calculated for individual members of a large population taking water from a well.

Use of PRESTO-II to calculate population doses for considerations of ALARA, or to calculate maximally exposed onsite or offsite individual doses for consideration of compliance with maximum exposure regulations, is determined by the user's choice of population size, well location, and other input option values and parameters.

PRESTO-II is designed to consider the LLW shallow burial situation discussed below. The LLW disposal site consists of several disposal trenches. The PRESTO-II code treats all trenches at the site as one combined trench (Fields et al., 1982). Waste materials may be buried in many types of containers ranging from plastic bags or cardboard boxes to steel drums. The trench may be backfilled to eliminate voids and decrease subsidence, thus minimizing possible trench cap cracking. When completely filled, the trench may be assumed covered with a cap of soil or clay mounded above grade to facilitate runoff and decrease infiltration of precipitation.

Water, principally from precipitation, is often a primary transport medium for radioactivity from LLW stored in shallow trenches. Precipitation falling on the trench may either infiltrate the soil or trench cap, run off the surface, or evaporate, and radionuclides may be transported from a LLW disposal trench by groundwater or by precipitation runoff. Runoff also causes erosion of the soil surface and erode the trench cap. Water percolating downward through the trench to the subtrench soil zone may ultimately enter an aquifer. Radionuclides that finally reach the aquifer will generally be transported more slowly than the characteristic flow velocity of water in the aquifer because the radionuclides interact with the solid materials in the aquifer. Some of the radionuclides which enter the aquifer may eventually reach irrigation or drinking wells or surface streams.

Contaminated water from the trench may overflow onto the surface soil. Once overflow has occurred, radionuclides may be transported by runoff water to nearby streams and become available for human consumption via irrigation or drinking.

Humans may also be exposed to radionuclides transported from LLW sites by atmospheric processes. Radionuclides left on the soil surface by trench overflow, by spillage during disposal operations, or by complete removal of the trench cap may be suspended in the atmosphere and transported downwind where they may be inhaled or deposited on vegetation and soil. In the case of deposition, the radioactivity may produce external exposure to humans or may enter into the food chain and result in radioactivity in crops, meat, and milk.

The code allows the user to select human exposure scenarios including: migration of radioactivity from the trench in hydrologic and atmospheric environmental pathways to food and drinking water, the presence of a resident intruder on the site, and farming of the site. Processes considered in calculating individual or population exposure include: groundwater transport, precipitation runoff, trench water overflow and seepage, chemical exchange,

trench cap erosion, stream dilution, and resuspension and atmospheric dispersion of contaminated soil followed by inhalation or deposition on crops and land.

The termination of LLW disposal operations (as associated with final trench closure) is the starting time for the total assessment period considered by the code. The user specifies the total length of the assessment period, from 1 to 1000 years. The health effects for a user-specified length of time within this assessment period are calculated. The averaging time for health effects can be as short as any single year of the assessment period or as long as the entire assessment period. The maximum concentration of each radionuclide and the year of this maximum for each of the four major exposure pathways for each nuclide is calculated. The initiation time and period for mechanical suspension of the surface soil by farming is specified by the user. The user can also specify the time at which the trench cap begins to fail and the temporal profile of this failure, which results in exposure of the trench contents. The code time step is fixed at one year.

The resident intruder scenario assumes that an intruder digs into the disposal trench while building a residence. The individual will receive external exposure to the buried radionuclides due to time spent in the basement of the residence, which is assumed to have walls made of trench material. The user-specified length of residency, time in the assessment period when the residence is first occupied, and the composition of the initial trench inventory will all contribute to the dose from external exposure.

Farming the site after loss of institutional control is treated as a separate intrusion scenario. By farming the site a farmer will be affected by most of the hydrologic and atmospheric transport processes described above. In contrast to an off-site population, however, a larger portion of the farmer's food may consist of crops grown in the contaminated zone near the trench. The water used by the farmer for irrigation, drinking, and livestock may be taken from directly beneath the trench or from a nearby stream and thus contain a much higher concentration of radioactivity than water used by the off-site population. The farming process may also mechanically suspend contaminated soil in the atmosphere. Such mechanical suspension may impact both the farmer and a downwind population.

Annual-average concentrations of each radionuclide in environmental media (such as well water or the atmosphere) over the assessment period are used to calculate radionuclide concentrations in foodstuffs. Foodstuff information and human ingestion and breathing rates are utilized to calculate the annual average radionuclide intake per individual in the population by ingestion and inhalation. These intake data are used by the exposure and risk submodels to estimate dose rate and health risk.

The health risk estimation methodology assumes that each member of the population is a member of a cohort that is exposed to constant, annual-averaged radionuclide concentration levels. For atmospheric transport calculations, the total population is assumed to reside within the same 22.5-degree sector. User-specified parameters give the fraction of the year that the wind blows into that sector. A user option allows the results of the atmospheric dispersion calculation in the code to be replaced by an externally calculated dispersion coefficient which considers several population centers. Each member of the population is assumed to eat the same quantities of food (vegetables, beef, and milk). These foods are assumed produced on the same fields and spray irrigated with contaminated water. Contaminated water is

assumed drunk by beef and dairy cattle. The code user may independently specify the fractions of water taken from wells or streams and used for human consumption, for irrigation, or for livestock consumption.

PRESTO-II considers only one scenario per computer run. The scenario to be simulated may be structured by the user by changing values of user-specified parameters such as population size and location, distance to well, percent cap failure, resuspension rate, etc.

Input data have been compiled for each of three example locations: Barnwell, South Carolina; Beatty, Nevada; and West Valley, New York. These data must be regarded as example values designed to verify operation of the code, rather than as unanimously agreed upon numerical specifications of these sites. The sources of our data are provided for use by readers interested in preparing data sets that allow simulation of other exposure scenarios that would be considered in performing complete assessments of radionuclide transport and health risk for these example sites. Our data are documented in Chapter 3 and in Appendices C, D, and E. The code may be suitable for use at many other locations if input data are available. Results from each of the three sites suggest that there may be low health risk to nearby populations from shallow land disposal of LLW. A summary of results for one scenario at the Barnwell site is presented in Table I.

To assist the PRESTO-II user in compiling radionuclide data, a radionuclide Daughter Inventory Generator (DIG) computer code has been written (Fields and Sharp, in press). This code facilitates the construction of the LLW disposal site inventory radionuclide data set for the PRESTO-II code. The DIG code accepts a table of radionuclide names and amounts initially present in a waste stream and produces a tabulation of radionuclide names and amounts present after a user-specified elapsed time. This resultant radionuclide inventory characterizes wastes that have undergone radioactive decay and daughter ingrowth before leaching and transport, thus identifying daughter radionuclides that should be considered for inclusion in the pollutant source term. The output of the DIG code also includes radionuclide decay constants, which are required in the PRESTO-II code input data set.

A second code has also been written to assist the user in preparing PRESTO-II data sets. This second code is PRESTO-PREP (Bell, Emerson, and Fields, 1984). The PRESTO-PREP code accesses radionuclide data bases to prepare a radionuclide data set in the proper format for reading by PRESTO-II.

PRESTO-II, like any complex computer code, may be misapplied. Misapplication may consist of trying to apply the code to examine a site where one or more modeling assumptions are invalid, or of choosing values of input parameters that do not accurately reflect variables such as radionuclide inventory, site meteorology, surface and subsurface hydrology and geology, and future population demographics. One serious misapplication of the PRESTO-II methodology would be use of carelessly chosen k_d values to determine hydrologic transport. Element-specific values of k_d vary widely as sites, chemical forms, and other waste components are changed.

Some release and transport scenarios, such as those necessary to consider major meteorological changes, mining of the trench contents, in-situ combustion of trench wastes, and intrusion and radionuclide transport by burrowing animals or plant roots, are not considered in the PRESTO-II model and code. The user must make significant changes to the code and the input data in order to consider those scenarios. If such mechanisms are added to a version of the PRESTO-II model, the authors of this report would appreciate being informed, and will consider adding these capabilities to their version of the code.

**Table I. Results of example problem based on Barnwell, SC data.
Estimated health risks to surrounding population
for 1000 years following trench closure**

Site	Barnwell, S.C.
Population	7033
Deaths/year	5.5E-4
Annual risk per person	7.2E-8

Contributions to net annual death rate by pathway or mode

INTERNAL	5.5E-4
INGESTION	5.5E-4
INHALATION	1.8E-14
EXTERNAL	9.1E-13
AIR IMMERSION	2.3E-17
GROUND SURFACE	9.1E-13

**Contributions to net annual death rate by radionuclide
(20 selected radionuclides):**

H-3	2.6E-14
C-14	2.5E-5
Mn-54	2.1E-16
Fe-55	3.6E-16
Co-60	3.6E-13
Zn-65	3.8E-16
Sr-90	7.9E-16
Tc-99	5.3E-4
Cs-134	3.2E-14
Cs-137	2.3E-13
Ba-137	5.8E-13
Ce-144	2.2E-20
Pb-210	4.1E-17
Ra-226	4.8E-19
Th-232	7.4E-18
U-234	1.1E-17
U-235	1.6E-17
U-238	1.1E-14
Pu-238	1.6E-18
Pu-239	2.9E-18

1. INTRODUCTION

PRESTO-II is a computer code developed to estimate possible health effects from low-level radioactive waste buried in shallow trenches. The code can be used to make estimates for up to 1000 years following the end of low-level waste (LLW) disposal operations. The code is intended to be as generic as possible, in that different transport mechanisms may be considered, but there has been no intent to tailor the code to a particular site. Nevertheless, the assumption in the PRESTO-II methodology of saturated hydrologic transport results in the prediction of more rapid radionuclide transport than would actually occur at some arid sites. In most cases, the model results are conservative for such sites.

The PRESTO-II model is most appropriately used as a screening model, and site-specific codes should be considered in cases where PRESTO-II numerical results fall close to reference values used for decision making. Furthermore, PRESTO-II, like any complex computer code, may be misapplied. Misapplication may consist of trying to apply the code to examine a site where one or more modeling assumptions are invalid, or of choosing values of input parameters that do not accurately reflect variables such as radionuclide inventory, site meteorology, surface and subsurface hydrology and geology, and future population demographics. Some release and transport scenarios, such as those necessary to consider major meteorological changes or mining of the trench contents, are not considered in the PRESTO-II model and code. The user must make significant changes to the code and the input data in order to consider those scenarios.

The DARTAB model (Begovich et al., 1981) is used in modified form as an important module of PRESTO-II to generate human health risk estimates from radionuclide environmental concentrations and intake values.

1.1 DESCRIPTION OF A LOW-LEVEL WASTE DISPOSAL SITE

The description of the life cycle of a shallow land-disposal site may help to explain the modeling approach. Following site selection and procurement, trenches are dug on the site. The PRESTO-II code treats all trenches at the site as one combined trench (Fields et al., 1982). Waste materials in various types of containers ranging from plastic bags or cardboard boxes to steel drums are added to the trench; there is currently no standard container for LLW disposal. Once a trench is filled, or at various stages of filling, the trench may be backfilled to eliminate voids and decrease the potential for subsidence and cracking of the trench cap. Following backfilling, the trench is covered with a cap of soil or clay mounded above grade to facilitate runoff of precipitation and decrease infiltration. To minimize erosion in non-arid climates the cap is seeded with some shallow-rooted species and is maintained for a number of years. Although not all burial operations are identical, most

current and past LLW facilities have included some of the practices described above.

At humid sites, hydrologic transport is the principal process by which the general public may become exposed to radioactivity from LLW stored in shallow trenches. Figure 1.1 is a schematic representation of the subsurface zone at a LLW disposal site. Figure 1.2 is a similar representation of the surface zone. Precipitation at a site may infiltrate the soil or trench cap, run off the surface, or evaporate. Depending on the ground cover, length and steepness of slope, etc., runoff may cause erosion of soil from the surface.

Hydrologic transport of radionuclides from an LLW burial trench may be by the ground water or via surface runoff. Groundwater or precipitation entering the trench may mix with the waste material and become contaminated. This contaminated water may either overflow the top of the trench or percolate downward through the bottom of the trench to the subtrench soil zone and ultimately enter an aquifer. Transport velocities are calculated assuming saturated flow. The calculated velocity may therefore be too high for arid sites, where unsaturated transport would be expected to occur. The use of a saturated flow transport velocity results in predictions that are, for the most part, conservative. The water in the aquifer will have a characteristic flow velocity from a few meters per year to hundreds of meters per year. Radionuclides that finally reach the aquifer generally will be transported at velocities lower than the characteristic flow velocity of the water in the aquifer. This retardation is due to the interaction of the radionuclides with the solid materials in the aquifer. Some of the radionuclides in the aquifer may eventually appear at wells used as sources of irrigation or drinking water, or at the point where the aquifer communicates with surface streams.

A trench dug in material of low permeability may eventually overflow if rainfall is high enough and if methods are not used to remove trench water. Once overflow has occurred, the radionuclides may be transported by runoff to nearby streams and become available for human consumption via irrigation or drinking by animals or humans. An additional contribution to the surface radionuclide inventory arises from the possibility of radionuclide spillage during trench filling operations. Humans residing away from the burial site may be exposed to contaminated stream or aquifer water if this water is used for irrigation of food crops or drinking.

Humans may also be exposed to radionuclides transported from LLW sites by atmospheric processes. Radionuclides left on the soil surface by trench overflow, by spillage during trench filling operations, or by complete erosion of the trench cap may be suspended in the atmosphere by wind or mechanical disturbances. These radionuclides may then be transported downwind where they may be inhaled or deposited on the ground and vegetation. Deposited radioactivity may enter the food chain and result in radioactive contamination in crops, meat, and milk. Deposition on the soil surface may also result in external exposure of humans to the radioactivity.

Subsurface Radionuclide Inventory and Associated Transport Processes.

Figure 1.1. Schematic representation of the sub-surface environment of a low-level waste disposal site and selected transport pathways.

Surface Radionuclide Inventory and Associated Transport Processes.

Fig. 1.2. Schematic representation of the surface environment of a low-level waste disposal site and selected transport pathways.

Besides the transport pathways represented in Fig. 1.1, there are several other methods by which humans may be exposed to radioactivity from a LLW disposal site, and which are considered in the PRESTO-II model. If the trench cap erodes away, the trench contents will be more accessible to environmental transport processes. After the end of institutional control of the site, an intruder could reside on the site or farm the site. In any case, the intruder will likely receive an external exposure to the buried radionuclides if he digs into the trench. Factors such as the length of residency in a house with a basement, length of time after burial, and initial radionuclide inventory will all influence the dose and subsequent risk.

Farming the site may also result in off-site exposures to radioactivity by mechanically suspending contaminated soil in the atmosphere. In contrast to an off-site population, however, a farmer may ingest crops grown near the trench and irrigated from a well much closer to the trench. Depending on when farming has started, the on-site irrigation water may contain a higher concentration of radioactivity than off-site irrigation water. Root uptake of radionuclides from near-trench soils is considered in the model; however, uptake directly from the trench contents is not simulated.

The PRESTO-II model may be used to calculate doses and risks to an individual or population averaged over a user-specified time interval. The model is relatively simple so that input data requirements and computer costs are reasonably small.

1.2 BASIC MODEL ASSUMPTIONS

A variety of model assumptions have been made in developing the PRESTO-II methodology. The motivating factors for these assumptions included economy of submodels, both in number and in computer time required for their use; defensibility of assumptions; data requirements of calculational methods; availability of previously documented algorithms; and flexibility of the resulting model. Several of the submodels included in PRESTO-II were developed for other types of assessments and have been adapted for use in estimating health effects from shallow land disposal of LLW.

Although the code user may modify the code to change the length of the assessment period, the model was designed to estimate releases and subsequent health effects to local populations over a period of 1000 years following closure of a LLW disposal site. The code time step is one year and input data are assumed to be annual average values.

The model also assumes that the radionuclide inventory entered as input data is the amount of activity found in the trenches at the end of the disposal operation. Waste materials in the trench are assumed to be

an uncanistered homogeneous mixture of radionuclides and other waste materials.

The in-growth of daughter products of radiological decay is not calculated by the model to maintain model simplicity and to avoid the extensive calculations required to deal with the the ingrowth of daughter products. In cases where the major dose contribution is from external exposure to a short-lived progeny in equilibrium with a parent radionuclide present in the trench inventory, the user may wish to include the daughters in the trench inventory as described at the end of Sect. 2.2.3. To assist the PRESTO-II user in compiling radionuclide data, a radionuclide Daughter Inventory Generator (DIG) computer code has been written (Fields and Sharp, in press). This code facilitates the construction of the LLW disposal site inventory radionuclide data set for the PRESTO-II code. The DIG code accepts a table of radionuclide names and amounts initially present in a waste stream and produces a tabulation of radionuclide names and amounts, including daughters, present after a user-specified elapsed time. The output of the DIG code also includes radionuclide decay constants, which are required in the PRESTO-II code input data set.

A second code has also been written to assist the user in preparing PRESTO-II data sets. This second code is PRESTO-PREP (Bell, Emerson, and Fields, 1984). The PRESTO-PREP code queries the PRESTO user and accesses radionuclide data bases to prepare a radionuclide data set in the proper format for reading by PRESTO-II.

The detailed description of the physicochemical interaction between the radionuclide and the solid geologic media has been grouped into a single factor, the distribution coefficient, k_d . Different values of k_d can be used for soil, the mixture of soil and waste material in the trench, sub trench soil, and the aquifer.

Below the trench, saturated conditions are assumed to exist. Transport of radionuclides is vertical from the trench bottom to the aquifer and then horizontal through the aquifer. Each element is transported horizontally with a velocity estimated from user-supplied values of velocity in the aquifer, aquifer porosity, k_d , and aquifer density. A similar calculation is made for vertical transport below the trench, but, for vertical transport, the water velocity may be either specified or calculated. The radionuclide inventory as corrected for radioactive decay is conserved throughout the model.

Three types of submodels are used in the code: unit response submodels, bookkeeping submodels, and scheduled event submodels. The unit response submodels calculate the annual response of a given process. For example, EVAPO is a unit response submodel that calculates the annual infiltration through an intact trench cap. Other unit response models calculate an annual average source term for atmospheric transport and an annual average erosion from the trench cap.

Bookkeeping submodels keep track of the results of unit response submodels and user-supplied control options. For example, one bookkeeping submodel (TRENCH) maintains a water balance in the trench by

calculating an annual average value for the level of standing water in the trench and the annual volumes of water leaving the trench via trench overflow and by deep percolation.

Annual-average concentrations over the user-specified assessment period of each radionuclide in environmental media, such as well water or the atmosphere, are used to calculate radionuclide concentrations in foodstuffs. Foodstuff information and human ingestion and breathing rates are used in calculating the annual average radionuclide intake per individual in the population by ingestion and inhalation. These intake data are then used to estimate dose rate and health risk using DARTAB and its associated subroutines.

The health-risk estimation methodology assumes that each member of the population is an adult. The atmospheric transport calculations made by the code assume that the total population resides within the same 22.5-degree sector at the same distance from the source of radionuclide. User-specified parameters give the fraction of year that the plume blows in that sector. Therefore, each member of the population, breathing at the same rate, inhales the same quantity of each radionuclide. A control option allows the atmospheric dispersion calculation in the code to be replaced by externally calculated dispersion coefficients, which may be calculated for several population centers.

Each member of the population is assumed to eat the same quantity of food, grown on the same fields. This assumption simplifies the calculations and is appropriate because of the large uncertainties in predicting individual mobility, population demography, agricultural practices, and geologic and hydrologic changes that might occur during the simulation period.

Several scenarios of human exposure to radiation from the buried waste may be considered by changing input parameters; these include normal disposal site operation, spillage of wastes during disposal operations, presence of a resident intruder on the site, farming of the site, and erosion of the trench cap with subsequent atmospheric contamination via suspension of mixed waste material and soil. By changing the site description parameters, the user may design other scenarios of interest. The PRESTO-II code makes calculations for various combinations of exposure pathways. The exposure pathways for each of four scenarios are listed in Table 1.1. Other combinations of pathways may be specified by changing the input control parameters.

All members of the population use the same sources of drinking and irrigation water. The population age distribution and size is held constant over the assessment period. The user can specify the fraction of the drinking and irrigation water that is supplied by a contaminated well or stream. Doses and risks to populations are calculated by characterizing the population centers for each site with a single geographic centroid location and the total population. Individual dose calculations for atmospheric releases under the normal scenario may be calculated for a person at the site boundary in the prevailing downwind

direction. Individual doses due to waterborne effluents may also be calculated at the site boundary.

For the intrusion scenario, individual calculations may assume that the intruder (1) receives an internal dose from drinking water from a well drilled into the trench, and (2) receives an external dose from residing in a basement on the trench location. The time of onset and duration of exposure and scenario are user-specified.

The farming or reclamation scenario has many options, in that the on-site farmer may grow and eat his own vegetables, beef, and milk produced on land irrigated by trench water, but drink off-site water equal in concentration to the normal scenario population intake. The farmer also may inhale suspended contaminated soil from the residual operational spillage. Population dose and risk calculations under the farming scenario may assume that the food products grown on-site are ingested by the general population rather than the farmer alone.

The eroded trench release scenario becomes important if the trench cap has become completely removed by either erosion or other means. Thereafter, human exposure may ensue from resuspension and atmospheric transport of trench contents and resulting inhalation by an individual or the specified population. Populations may receive an external dose from immersion in the suspended plume.

The code is structured to consider only one scenario per computer run. The scenario to be simulated is specified by the user by changing input values of such parameters as population size and location, distance to well, percent cap failure, resuspension rate, etc. Subsequent chapters describe the environmental transport pathways and the equations used to simulate those processes, and the operation of the code, including the input data requirements and format.

1.3 EXAMPLE DATA SETS FOR MODEL VERIFICATION

The PRESTO-II model has been run using many combinations of input data to verify that the methodology was coded as intended. These runs were also intended to serve as partial validation that the model predictions were in essential agreement with the behavior of actual LLW disposal sites. The sites chosen were selected based partially on the need to consider a variety of hydrologic and climatic situations, and partially on the availability of data. The sites selected were located at Barnwell, South Carolina; Beatty, Nevada; and West Valley, New York. Data published in this report are regarded as consisting of example values designed to verify operation of the code, rather than as unanimously agreed upon numerical specifications of these sites. The sources of our data are provided for use by readers interested in preparing data sets that allow simulation of other exposure scenarios that would be considered in performing complete assessments of radionuclide transport and health risk for these example sites. Our data are documented in Chapter 3 and Appendices C, D, and E. The code may be

suitable for use at many other locations if input data are available. Results from each of the three sites suggest that there is, for the simulation period considered here, likely to be low health risk (in comparison to risks associated with natural background radiation exposure) to nearby populations from the considered local shallow land disposal of LLW.

Table 1.1 Radiological exposure pathways for various scenarios

Scenario	For population	For individual
Normal	Ingests off-site water Ingests off-site foods Inhales downwind air	Ingests site-boundary water Ingests site-boundary foods Inhales site-boundary air
Intrusion	None	Ingests trench well water Direct exposure from residency
Farming	Ingests on-site foods Ingests off-site water	Ingests on-site foods Ingests on-site water Inhales suspended soil
Eroded trench	Inhales suspended material at centroid Direct exposure from plume	Inhales suspended material at boundary Direct exposure to exposed trench

2. DISCUSSION OF METHODOLOGY

2.1 ENVIRONMENTAL TRANSPORT PATHWAYS

Pathways of environmental transport of radionuclides considered by the model are shown in Figs. 2.1 and 2.2. Pathways of environmental transport of radionuclides that involve water (see Fig. 2.1) include both surface water and ground water. Water may leave the trench as seepage through the bottom or by overflowing at the ground surface. The user may choose to consider the soil surface to be contaminated initially by operational spillage. Radionuclides in water near the soil surface may be transported to a surface water body or may reenter the trench by seepage. Contaminated water may ultimately reach human receptors by use of water from either a well or a surface water body.

Atmospheric pathways of radionuclide transport are illustrated in Fig. 2.2. Material may reach the atmosphere from the following two sources: the contaminated soil surface, which became contaminated from overflow or from operational spillage, or the exposed trench contents following possible erosion of the total cap sometime in the future. Humans may ultimately be impacted by inhalation of or immersion in suspended materials downwind; by ingestion of crops, meat, or milk contaminated as a result of animal ingestion or deposition on soil or crops; by ingestion of contaminated water; or by direct irradiation following deposition on ground surfaces.

The approach to calculating radionuclide concentrations in the pertinent environmental media will be described in more detail in the following sections.

2.1.1 Transport Pathways Involving Water

At many sites, water is the most important medium for transport of radionuclides away from the trench. Whether the transport pathway is predominantly via the aquifer or via overland flow of water, an important quantity is the amount of water entering the trench via infiltration through the intact and failed portions of the cap.

Computation of Infiltration Through Failed Trench Cap

On the intact portions of the cap, the normal trench cap infiltration rate, to be discussed later, occurs. On the failed portion of the cap, the infiltration is the sum of rainfall plus irrigation. Therefore, the volume of water entering the trench annually calculated by the following equation:

$$W_T = A_T [f_c (P_a + I_a) + (1 - f_c) W_a] , \quad (2.1)$$

Figure 2.1. Hydrologic environmental transport pathways.

Figure 2.2. Atmospheric environmental transport pathways.

where

- W_T = volume of water entering trench (m^3/y),
 A_T = area of trench (m^2),
 f_c = fraction of trench cap that has failed (unitless),
 P_a = annual precipitation (m/y),
 I_a = annual irrigation (m/y),
 W_a = annual infiltration for intact portion of cap (m/y).

In PRESTO-EPA, W_a was computed using subroutine INFIL and the value of W_T was added to standing water from the previous year to calculate the maximum depth of standing water in the current year. In PRESTO-II, Morton's model (subroutine EVAPO) may be used to compute W_a and the average depth of water in the trench is determined as described in the discussion associated with Eq. (2.4).

Trench Cap Modifications

The trench cap may fail by two methods: erosion or mechanical disturbance. In the former case, the thickness of material removed annually from the trench cap by sheet erosion is calculated using an adaption of the universal soil loss equation (USLE) (Wischmeier and Smith, 1965).

The annual amount of erosion is subtracted from the cap thickness for the current year of simulation. If the remaining thickness is less than 1 cm, the cap is considered to be completely failed and f_c is set to 1.0. The USLE may be written as follows:

$$I_L = f_R f_K f_L f_S f_C f_P f_D, \quad (2.2)$$

where

- I_L = annual sediment loss from surface erosion (mass/y),
 f_R = rainfall factor (see text),
 f_K = soil - erodibility factor (mass/unit area),
 f_L = slope - length factor (unitless),
 f_S = slope - steepness factor (unitless),
 f_C = cover factor (unitless),
 f_P = erosion control practice factor (unitless),
 f_D = sediment delivery factor (unitless).

We used the parameterization scheme of McElroy et al. (1976) to specify site-specific values of the factors in Eq. (2.2). The rainfall factor, f_R , expresses the erosion potential of average annual rainfall in the locality. This factor is defined by McElroy as a summation of the individual storm products of the kinetic energy of rainfall, in hundreds of foot-tons per acre, and the maximum 30-minute rainfall intensity, in inches per hour, for all significant storms, on an annual average basis. The soil erodibility factor, f_K , is tabulated by McElroy et al. (1976) as a function of five soil characteristics: percent silt plus very fine sand; percent sand greater than 0.1 mm in diameter; organic matter content; soil structure; and permeability. The factors, f_L and f_S for slope-length and steepness account for the fact that soil loss is affected by both length and degree of slope. The code usage of the USLE combines both factors into a single factor that may be evaluated using charts in McElroy et al. (1976). The factor f_C represents the ratio of the amounts of soil eroded from land that is treated under a specified condition to that eroded from clean-tilled fallow ground under the same slope and rainfall conditions. The erosion control practice factor, f_P , allows for reduced erosion potential by the effect of practices that alter drainage patterns and lower runoff rate and intensity. The sediment delivery ratio, f_D , is defined by McElroy et al. (1976) as the fraction of the gross erosion that is delivered to a stream. Units of I_L (tons/yr) are converted to those desired (m/yr) within the code. See Chap. 3 for a description of input units.

The second method of trench cap failure accounts for the possibility of mechanical disturbance due to human intrusion or some other means which might completely destroy portions of the cap. This phenomenon might be termed partial cap failure, but in the PRESTO-II methodology it corresponds to total failure of some part of the cap. The code user may specify some rate of cap failure as shown in Fig. 2.3. By specifying appropriate values for the (x,y) pairs in Fig. 2.3, the user may parameterize selective removal of the cap from a portion of the trench area. Mathematically this function is represented by

$$f_c = 0 \text{ if } t < N_1 ,$$

$$f_c = \frac{(P_2 - P_1)(t - N_1)}{(N_2 - N_1)} + P_1 \text{ if } N_1 \leq t \leq N_2 , \quad (2.3)$$

$$f_c = P_2 \text{ if } t > N_2$$

Figure 2.3. Trench cap removal function.

Even though P_2 might be specified less than 1.0 in year N_2 , the cap might ultimately fail completely by virtue of erosion. As f_c changes, the amount of water added to the trench annually also changes.

Computation of Annual Infiltration through Intact Trench Cap

Three options are provided in the PRESTO-II control options for specifying annual infiltration through intact portions of the trench cap. The first to be discussed is the use of a finite element computation that generates an average annual value. The second approach is taken by the code when input parameter FN, the ratio of infiltration through the intact portion of the trench cap to average watershed infiltration is zero and input parameter XINFL, the infiltration per unit area through the intact portion of the trench cap, is non-zero, and makes the infiltration through the intact portion of the cap equal to parameter XINFL times the area of the intact portion of the trench. The third approach is taken by the code when FN is non-zero and XINFL is zero, and makes the infiltration per unit area through the intact portion of the cap equal to FN times the infiltration value calculated for the watershed (to be discussed in a later section) times the intact area of the cap.

We will first develop a finite element approach to estimate infiltration through an intact trench cap. This approach replaces the finite difference approach used in earlier implementations of the PRESTO methodology, including PRESTO-EPA. The finite difference approach was replaced due to its tendency to overpredict trench overflow within a one-year time step.

The annual-average depth of water in the trench may be calculated by first rearranging terms in a time-averaged (steady-state) expression of Darcy's law to compute a test depth D :

$$D = L \left(\frac{W_T}{r_T A_T} - 1 \right) \quad (2.4)$$

where

D = test depth of water in trench during current year (m),

L = length of saturated zone below trench (m),

W_T = volume of water annually entering trench (m^3/yr),

r_T = permeability of material below the trench (m/yr),

A_T = trench cross-sectional area (m^2),

The average annual water depth in the trench (D_W), the volume of water leaving the bottom of the trench (V_B), and the volume of water overflowing the trench (V_O) are given by:

for $D < 0$, $D_W = 0$, and $V_B = W_T$, $V_O = 0$,

for $0 < D < D_T$, $D_W = D$, $V_B = W_T$, $V_O = 0$, (2.5)

for $D > D_T$, $D_W = D_T$, $V_B = \frac{r_T A_T (D + 1)}{L}$, $V_O = W_T - V_B$.

The second method of evaluating infiltration through the cap is described in the first paragraph of this section.

The third method of evaluating infiltration through the intact portion of the trench cap will now be briefly discussed. If water infiltration for local watershed non-trench areas is known, one may chose to estimate infiltration for intact portions of the trench cap based on this value. To make this estimate, one must consider construction of a trench cap of a material with a different

permeability from that characteristic of the site. A simple model of infiltration for the intact trench cap is used. This simple model states that the ratio of cap to site infiltration is the ratio of cap to site permeability, and relies on two assumptions. The first assumption is that when infiltration occurs, the depth of water over the cap is equal to that over the remainder of the site. This assumption seems reasonable, although conservative, since the cap might be sloped to enhance surface runoff. A second assumption is that the thickness of the saturated zone of the trench cap is approximately the depth of the surface saturated one for non-trench areas. This assumption is not strictly true (saturated zone thickness is a complex function of time) but the error it introduces should not be large. We have therefore chosen in PRESTO-II to require the model user to specify a value FN, the ratio of (intact) cap infiltration to site infiltration. As explained above, this value may be approximated by the ratio of cap material permeability to average watershed permeability.

Radionuclide Leaching by Trench Water

Water in the trench may be contaminated by contact with the waste material. The user chooses one of five methods (see Table 2.1) to calculate the amount of each radionuclide that leaves the trench in water via the bottom or overflow.

Options 1-4 are combinations of two factors: the amount of waste material contacted by water and the method of partitioning contamination between waste and water. In options 1 and 3, total contact options, we assume that the total volume of the trench is wetted each year as water trickles from top to bottom in the trench. Immersed fraction options 2 and 4 calculate the wetted fraction as the ratio of maximum water depth to trench depth. Leaching options 1 and 2 utilize a distribution coefficient, k_d , to estimate the radionuclide concentration in trench water whereas options 3 and 4 employ a solubility approach:

$$C_W^T = \frac{I_T^f W}{A_T(D_{\max} \theta_T + D_T^f W k_d \rho_C)} \quad (\text{Chemical Exchange Option}) ,$$

$$C_W^T = \frac{\lambda S N_A}{M} N_Y N_C N_V \quad (\text{Solubility Option}) , \quad (2.6)$$

where

- C_W^T = concentration of radionuclide i in trench water (Ci/m^3),
 I_T = amount of nuclide i in trench (Ci),
 f_W = fraction of total waste contacted by water
 (1 for LEOPT = 1 or 3; ≤ 1 for LEOPT = 2 or 4),
 A_T = trench area (m^2),
 D_{max} = maximum depth of standing water (m),
 θ_T = porosity within trench (unitless),
 D_T = trench depth (m),
 k_{d2} = distribution coefficient within waste for radionuclide i (mL/g),
 ρ_C = density of waste material (g/cm^3),
 S = elemental solubility (g/mL),
 λ = radionuclide decay coefficient (yr^{-1}),
 M = mass of radionuclide ($g/mole$),
 N_A = Avagadro's number,
 N_Y = ratio (yr/s),
 N_c = ratio ($C_i(dis/s)^{-1}$),
 N_v = ratio (mL/m^3).

Leaching options 3 and 4 use a solubility factor to estimate the maximum concentrations of radionuclides in the trench water: Leaching option 5 allows the user to input an average annual fractional release of the total radionuclide inventory. This fraction is applied to each radionuclide and does not consider either k_d or solubility. Solubility may be used where information on k_d is not available.

Transport Below Trench

Once material has been leached in the trench and migrated through the surrounding trench walls, it is assumed transported vertically to the aquifer and then horizontally through the aquifer to a well. The velocity of radionuclide transport is retarded relative to water by vertical and horizontal retardation factors, R_V and R_H , calculated by

$$R_V = 1 + \frac{\rho_S k_{d3}}{\theta_V}, \quad R_H = 1 + \frac{\rho_S k_{d4}}{\theta_V}, \quad (2.7)$$

where

ρ_S = bulk density of soil (g/cm^3),

k_{d3} = distribution coefficient of subtrench zone (mL/g),

k_{d4} = distribution coefficient of aquifer (mL/g),

θ_V = subsurface porosity (unitless).

The expected total transit time from trench to well in years is called the breakthrough time, t_t . The breakthrough time is calculated by summing the vertical and horizontal transit times, t_V and t_H , which are respectively calculated by:

$$t_V = \frac{D_V R_V}{V_V}, \quad t_H = \frac{D_H R_H}{V_H}, \quad (2.8)$$

where

D_V = distance from trench to aquifer (m),

D_H = length of aquifer flow to well (m),

V_V = vertical water velocity (m/yr),

V_H = water velocity in aquifer (m/yr),

and retardation factors are as defined above.

For most radionuclides, a maximum well-water concentration level usually occurs just following breakthrough, i.e., the arrival of the leading edge of the contaminated aquifer water at the well. Since the concentration of radionuclide in the surface soil of the disposal area is influenced by trench leachate overflow and leaching by precipitation, and since the stream concentration is influenced by initial inputs and by inputs of leachate from the soil surface, the year of maximum stream concentration may also be difficult to anticipate. Similarly, atmospheric concentrations are determined by initial conditions and by mechanisms effecting surface soil concentrations and these values, too, may peak at unexpected times. Breakthrough time, year of maximum concentration, and concentration values are printed in the code output (see Sect. 4.7).

The amount of each radionuclide released from the trench annually is decayed the appropriate amount as determined by t_V and t_H . The equation used here is:

$$I_{W,n+t} = I_{B,n} \exp(-\lambda t), \quad (2.9)$$

where

$I_{W,n+t}$ = activity of each radionuclide released from trench bottom in year n and in transit t years (Ci),

$I_{B,n}$ = activity of each radionuclide released in year n from trench bottom (Ci),

n = current year of simulation,

λ = radiological decay constant (yr^{-1}).

This amount of each radionuclide is divided by a volume of water available at the well annually, V_A , to calculate a maximum radionuclide concentration in well water later used for irrigation or drinking. If, based on the water volume that is calculated to be required from the well, this calculated maximum concentration leads to more radionuclide being removed from the well than is available, the concentration is recomputed, subject to the constraint that the quantity of radionuclide removed at the well is equal to the quantity that is available.

The volume of contaminated water available for pumping from the well is dependent on several parameters. Our approach assumes that a previously uncontaminated aquifer with a flow velocity S_A provides water to a well. A bolus of contaminated water from a LLW trench is diluted each year by the volume of aquifer water that flows beneath the trench in one year, plus the volume of additional water into which the bolus diffuses. If the volume of the bolus is small in comparison to the volume of aquifer water involved, then these assumptions lead to the equation:

$$V_A = S_A \theta_A D_A [\sqrt{A_T} + 2 \tan(\alpha/2) D_H] , \quad (2.10)$$

where

V_A = total volume of contaminated water available for removal from well annually (m^3/y),

S_A = ground-water velocity (m/yr),

θ_A = aquifer porosity,

D_A = thickness of the aquifer (m),

α = constant angle of spread of the contaminant plume in the aquifer (radians),

A_T = trench area (m^2),

D_H = trench to well distance (m).

Alpha is the dispersion angle of a contaminated plume in the water of an aquifer. This dispersion angle must be estimated or empirically determined (e.g., by chemical analysis, conductivity measurements, or radioactivity measurements at boreholes). The use of a dispersion angle is consistent with published characterizations of the horizontally projected profile of a chemical contamination front as it moves through an aquifer (Sykes, Soyupak, and Farquhar, 1982).

Mass balance of each radionuclide in well water is achieved by testing the product of total well-water volume removed times radionuclide concentration against the total available radionuclide mass I_{n+t} as calculated in Eq. (2.9). Total well water used, V_W , is calculated by

$$V_W = [3.9 \times 10^7 W_I L_L + U_W L_H + 1.5 \times 10^4 L_A] N_P, \quad (2.11)$$

where

V_W = annual well water used (L/y),

$3.9 \times 10^7 \sim 4492 \text{ m}^2$ irrigated per person per year $\times 8760 \text{ h/yr}$,

W_I = irrigation rate ($L/m^2 \cdot h$),

L_L = fraction of irrigation from well (input variable WATL),

U_W = individual annual water consumption ($m^3/\text{yr} \cdot \text{person}$),

L_H = fraction of human water use from well (input variable WATH),

1.5×10^4 = water fed to cattle consumed by humans ($L/\text{person} \cdot \text{yr}$),

L_A = fraction of animal water use from well (input variable WATA),

N_P = size of the population (number of persons).

Units of V_w are converted to m^3 within the code. If the mass balance for each radionuclide will be violated, the concentration of radionuclide in water is recalculated using the amount of water actually available, rather than V_w .

Radionuclides not removed at the well may eventually reach the stream. If code parameter IAQSTR (input card 4) is greater than 0.0, radionuclides reaching the well, but not being extracted from the aquifer at the well, will be added to the stream. This addition will be simulated in the year that the radionuclides "miss" the well.

The calculated concentrations of radionuclides in well water are averaged over the length of the simulation and used by the foodchain and human exposure parts of the code.

Computation of Annual Infiltration for Watershed

Quantification of the water budget of the LLW watershed and nearby croplands is necessary to evaluate radionuclide fate in these regions. In addition, if parameter FN (on input card 13) is non-zero, the watershed water budget will be used to calculate infiltration through intact areas of the trench cap. Water inputs to the watershed consist of precipitation and irrigation. Losses of water may include runoff, evapotranspiration, and deep seepage. To summarize these hydrologic sources and sinks on an annual basis, we utilize the following mass balance equation:

$$P_a + I_a = W_a + E_a + R_a, \quad (2.12)$$

where

- P_a = annual precipitation (m/y),
- I_a = annual irrigation (m/y),
- W_a = annual deep seepage or infiltration (m/y),
- E_a = annual total evapotranspiration, including surface evaporation and plant transpiration (m/y),
- R_a = annual runoff (m/y).

We define a constant runoff fraction as

$$f_r = R_a / P_a. \quad (2.13)$$

Runoff fraction is a well formulated macroscopic concept, and estimates for most watersheds are available from local sources or from measurements of annual precipitation and runoff at nearby watersheds. Substituting for R_a into Eq. (2.12) and solving for W_a we find that

$$W_a = (1 - f_r)P_a + I_a - E_a \quad (2.14)$$

Equation (2.14) is used to calculate the linear amount (depth) of water available to enter the waste trench or surrounding soil in a given year.

Site specific values of P_a , I_a , and f_r must be known for the site of interest. Such data have been compiled for watersheds and regions in many parts of the U.S. (Geraghty et al., 1973; Baes et al., 1982).

The average annual total evapotranspiration, E_a , may be calculated by a model devised by Morton (1976, 1978) and input into Eq. (2.14). An adaptation of Morton's model is included in PRESTO-II as a subroutine. Data requirements for Morton's model, discussed in Sect. 3.3.3, are annual precipitation, mean sea-level atmospheric pressure, and monthly values of dew point, ambient air temperature, and observed fraction of maximum sunshine.

Morton's evapotranspiration model has been well documented. According to Morton, it has been verified over a wide range of climates and reasonably estimates evapotranspiration at 122 river basins on three continents. According to Wallace (1978), the Morton model is superior to both the Thornwaite-Mather (1955) and Penman (1948) approaches to modeling evapotranspiration in arid environments. Furthermore, Morton's model has been applied to generate evapotranspiration for each of the 0.5 by 0.5 degree latitude/longitude cells considered in the extensive data base for the CRRIS system of transport codes (Baes and Miller, 1981) that has been developed for the Environmental Protection Agency. Morton warns against using the model near sharp environmental discontinuities such as coastlines or mountain ranges.

Trench overflow transport and stream contamination

As mentioned above, water may overflow the trench onto the soil surface if the maximum depth of standing water becomes greater than the trench depth. If this occurs, radionuclides in the overflow will be added to the surface inventory of radionuclides specified for initial operational spillage. The surface will then have a component of contaminated soil with concentration C_S^S Ci/m³ and a component of contaminated water in the surface soil of C_W^S Ci/m³. The material comprising C_S^S is considered relatively insoluble and becomes a source term for resuspension and atmospheric transport (this process is discussed in Sect. 2.1.2). The contaminated water in the surface soil is considered to be well mixed with the soil and interstitial water.

Water and associated radionuclides on the surface may either enter the stream or re-enter the trench. The amount of each radionuclide added to the stream is represented by the product of C_W^S , the radionuclide concentration in the surface soil water, and the annual volume of runoff from the contaminated soil surface, WSTREM. The value of C_W^S for each radionuclide is calculated by:

$$C_W^S = \frac{10^3 I_S}{k_{d1} M_S + M_W} , \quad (2.15)$$

where

$$\begin{aligned} C_W^S &= \text{radionuclide concentration in surface soil water (Ci/m}^3\text{)}, \\ I_S &= \text{amount of radionuclide on surface (Ci)}, \\ k_{d1} &= \text{distribution coefficient for surface soil region (mL/g)}, \\ M_S &= \text{mass of soil in contaminated region (kg)}, \\ M_W &= \text{mass of water in contaminated soil region (kg)}, \\ 10^3 &= \text{m}^3 \text{ kg/m}^3 = \text{mL/L}. \end{aligned}$$

Equation (2.15) is used to compute the concentration of radionuclide in the surface soil interstitial water (units of Ci/m³). The equation is numerically correct. The equation appears dimensionally incorrect, due to the presence of numerous conversion factors, but is written as above (corresponding more closely to the expression used in the computer code) for the convenience of the code user.

The radionuclide concentration in the contaminated surface soil region, C_S^S , is calculated using:

$$C_S^S = 10^{-3} C_W^S k_{d1} , \quad (2.16)$$

where

$$\begin{aligned} C_S^S &= \text{radionuclide concentration in soil Ci/kg}, \\ 10^{-3} &= \text{m}^3 \cdot \text{g/mL} \cdot \text{kg}. \end{aligned}$$

The contaminated region of surface soil is defined by the user in terms of length, S_L (m), width, S_W (m), and depth, S_D (m). These parameters allow the calculation of soil (M_S) and water mass (M_W) in the contaminated soil region by:

$$M_S = 10^3 \rho_S S_W S_L S_D , \quad M_W = 10^3 \theta_S S_W S_L S_D , \quad (2.17)$$

where

$$\begin{aligned} \rho_S &= \text{soil bulk density (g/cm}^3\text{)}, \\ \theta_S &= \text{soil porosity (unitless)}, \\ 10^3 &= (\text{cm}^3 \cdot \text{kg/m}^3 \cdot \text{g}) \text{ for soil and } (\text{kg/m}^3) \text{ for water,} \\ M_S \text{ and } M_W &\text{ are expressed in units of kg.} \end{aligned}$$

Water falling on the contaminated soil region may either evaporate, runoff, or infiltrate. Of the liquid a certain fraction of the total precipitation, f_r , will enter the stream annually.

The amount of contaminated water that enters the stream from runoff from the contaminated region is

$$W_S = f_r P S_a S_L . \quad (2.18)$$

An additional amount of contaminated water may enter the stream from the aquifer itself. If code parameter IAQSTR (input card 4) is greater than 0.0, radionuclides reaching the well, but not being extracted from the aquifer at the well, will be added to the stream. This addition will be simulated in the year that the radionuclides miss the well.

The amount of contaminated surface-soil water that seeps vertically downward and is assumed to enter the trench from the LLW site surface soil is given by

$$W_D = (1 - f_r) P S_a S_L . \quad (2.19)$$

The annual contribution of radionuclides from the contaminated surface-soil region to the stream, R_S , is then the product of W_S and the radionuclide concentration in the surface soil water, C_W^S (Eq. 2.15). The amount of each radionuclide annually added back into the trench from the contaminated surface soil region is the product of W_D and C_W^R . The concentration of radionuclides in the stream is the quotient of R_S and the annual flow rate of the stream.

Another input of radionuclides to the stream may be specified by the code user by entering a non-zero value of variable STAM(I), for radionuclide I, on input card 27. This value is assumed present in the stream at time $t = 0$.

In a calculation similar to that used for computing the amount of radionuclides removed from the well, the amount of each radionuclide removed from the stream is conserved by first computing a value based on the predicted amount of water extracted from the stream:

$$I_r = V_S C_W^R , \quad (2.20)$$

where

I_r = annual amount of nuclide removed from stream (Ci/y),

C_W^R = radionuclide concentration in stream (Ci/m³),

and V_S is as defined in a manner analogous to Eq. (2.11). For the calculation of V_S , the fractional water uses by humans and animals, and for irrigation, as specified by input variables SATH, SATA, and SATL on input card 5, are used in place of the corresponding variables WATH, WATA, and WATL defined for well water use in Eq. (2.11). If I_r as computed above is larger than the annual input of that nuclide to the stream, R_S , then the radionuclide concentration in the stream is recalculated to ensure conservation of mass:

$$C_W^R = \frac{R_S}{V_S} \quad (2.21)$$

Time-averaged concentrations of each radionuclide in well water and stream water are calculated for the appropriate number of simulation years by dividing the sum of the annual radionuclide concentrations in the well water and the stream water by the length of the simulation. The time-averaged values are summarized in the PRESTO-II output tables and are provided to the DARTAB subroutines for use in the subsequent dose and risk calculations.

2.1.2 Atmospheric Transport Sources and Pathways

External Calculation of E/Q Ratio

The DWNWND model (Fields and Miller, 1980) as modified for use in PRESTO-II is a compact algorithm suitable for quantifying atmospheric transport at sites where the population is concentrated into a single, small community. For cases in which this distribution is not appropriate for use, we have made provision for the code user to enter an externally computed population average value for the air concentration, E , to source strength, Q , ratio. An externally computed E/Q ratio should be used for complex population distributions. This value is entered as variable CHIQ on input card 17. One code which the user might use for determining E/Q in such cases is AIRDOS-EPA (Moore et al., 1979). A second code that may prove useful, if the population resides in a small number of communities, is DWNWND (Fields and Miller, 1980).

In many cases, uncertainties in the computed atmospheric source strength for contaminated areas are larger than differences between the internally computed and externally determined E/Q ratios.

Internal Atmospheric Transport Model Capability and Formulation

The atmospheric transport portion of the PRESTO-II code will be discussed in two parts: (a) a description of source strength computation and (b) a discussion of the calculation of atmospheric concentration at the residence site of the specified at-risk population. For most applications, PRESTO-II is expected to be applied to a site of known population distribution, and the user must input geographical and meteorological parameters characterizing the population site and its relationship to the low-level waste disposal area. The formulation of atmospheric transport discussed herein is not intended to automatically identify regions of high risk; rather, it is formulated to calculate risk-related parameters for a particular, identified site.

Where population risk is to be determined, the geometric population centroid specified by the user is the point for which a 22.5-degree sector-average, ground-level air concentration is needed. Where the population distribution subtends from the waste disposal area an angle significantly greater than 22.5 degrees, the user should run the code separately for each subpopulation. A mean yearly sector-average atmospheric concentration is computed by PRESTO-II and is input to DARTAB for use in computing external exposures.

The most commonly used approach for estimating the atmospheric concentration and deposition of material downwind from its point of release is the Gaussian-plume atmospheric transport model (Slade, 1968). This approach is versatile and well documented, and we have chosen to implement, in subroutine form, a version of a Gaussian-plume transport code called DWNWIND (Fields and Miller, 1980) as a module in the PRESTO-II code.

User inputs for the atmospheric transport simulation allow specification of a surface radionuclide concentration at the waste disposal site. Parameters used here include the initial surface radionuclide inventory, the chemical exchange coefficient for surface soils, and a parameter describing soil leaching of radionuclides. The portion of a radionuclide that is sorbed onto soil particles is considered available for transport. A source strength is computed based either on a time-dependent (monotonically decreasing) resuspension factor or a process-dependent mechanical suspension variable. The given LLW site is described by meteorological variables including:

F_w = fraction of the year wind blows toward at-risk individuals,

H = source height (m),

H_L = lid height (m),

S = stability class,

T_d = type of dispersion formulation,

H_r = Hosker roughness parameter (m); about $0.01 \times$ physical roughness,

U = wind velocity (m/s),
 V_d = velocity, deposition (m/s),
 V_g = velocity, gravitational fall (m/s),
 x = gauge distance from source base (m).

Source Term Characterization

The release rate for atmospheric transport is termed the source strength. In PRESTO-II, source strength is directly dependent on the surface soil-sorbed radionuclide concentrations, C_G . The source strength is the arithmetic sum of two parts, that parameterized by a time-dependent resuspension factor R_e (Anspaugh et al., 1975) and that parameterized by a resuspension rate R_r (Healy, 1980).

We first describe the wind-driven suspension component. If, following Anspaugh, we write

$$R_e = R_{e1} \exp(R_{e2} \sqrt{T}) + R_{e3} \quad (2.22)$$

where T is elapsed time (days) and R_{e2} has units of inverse meters, then the radionuclide concentration C_A in the atmosphere above but close to the source is given by

$$C_A = R_e C_G \quad (2.23)$$

Using Anspaugh's values of 1×10^{-4} , -0.15 , and 1×10^{-9} for R_{e1} , R_{e2} , and R_{e3} , respectively, the value of R_e calculated as above is probably conservative for more humid sites. As data from sites other than Nevada become available, model users will probably wish to update the parameters used for computing R_e .

The value of elapsed time appearing in Eq. (2.22) is computed from the start of the simulation. It is, therefore, correct for the initial surface inventory, but not for incremental additions thereto, which may occur at later times. However, when later additions result from trench overflow, they will consist of dissolved material and would likely act as surface depositions of mobile particulates sorbed onto weathered particulates. It is, therefore, assumed that a steady-state asymptotic value of R_e is for most sites appropriate for later additions to the surface inventory.

The user wishing to specify a time-independent windblown resuspension factor may do so by setting the values of R_{e1} and R_{e2} to zero. When this is done, determination of windblown suspension of all contributions to the surface inventory will be treated identically, regardless of the time that the contribution is made.

It is possible (Fields, 1982) to develop atmospheric source terms from known soil-surface radionuclide concentration and extent, wind speed, and mechanical disturbance parameters. In Eq. (2.23), C_A is the atmospheric concentration of radionuclide immediately above the site at a height of about 1 m (Shinn et al., 1976), for a site of large upwind extent. Large upwind extent may be interpreted as exceeding the atmospheric build-up length, given by UH_D/V_g , where U is wind velocity, H_D is the mixing height (1 m), and V_g is the gravitational fall velocity. The representative site extent used in the PRESTO-II code is the square root of the site area, A , and a tentative correction fraction, F , is computed using the equation:

$$F = \frac{V_g \sqrt{A}}{UH_D} . \quad (2.24)$$

With the stipulation that the value used for F may not exceed unity, the source term component for windblown suspension is given by

$$Q_r = C_A H_D U F \sqrt{A} . \quad (2.25)$$

A second source component results from mechanical disturbance of site surface soil. Mechanical disturbance occurs during a user-specified interval. Within this interval, the fraction of time per year that the disturbance occurs is F_{mech} . The source term component for mechanical disturbance is parameterized by the resuspension rate, R_r , having units of inverse seconds, to wit

$$Q_{\text{mech}} = C_G A R_r F_{\text{mech}} . \quad (2.26)$$

The net source strength for the site is the sum of these components:

$$Q = Q_r + Q_{\text{mech}} . \quad (2.27)$$

Transport formulation

The PRESTO-II code uses a Gaussian-plume atmospheric transport model, which is an extension of an equation of the form (Slade, 1968):

$$E = \frac{Q}{2\pi U \sigma_y \sigma_z} \left[\exp - \left[\frac{y^2}{2\sigma_y^2} \right] \right] \left[\exp - \frac{1}{2} \left[\frac{z - H}{\sigma_z} \right]^2 + \exp - \frac{1}{2} \left[\frac{z + H}{\sigma_z} \right]^2 \right] . \quad (2.28)$$

This equation describes a distribution of bell-shaped (Gaussian) profile, where E represents the downwind, ground-level, sector-centerline radionuclide concentration, Q the source strength, and H the corrected source release height (to be discussed later). Dispersion parameters, σ_y and σ_z , are the standard deviations of the plume concentration in the horizontal and vertical directions, respectively. The aerosol is assumed transported at a height-independent wind speed U to a sampling position located at surface elevation z and horizontal distance y from the plume center. Mass conservation within the plume is insured by assuming perfect reflection at the ground surface. This is accomplished by the use of an image source at an elevation $-H$, which leads to the presence of two terms within the braces, and to the factor $1/2$. A correction for plume depletion will be discussed later. Eq. (2.28) may be obtained from any of several reasonable conceptual transport/dispersion models.

Atmospheric transport at several sites of possible interest to individuals evaluating consequences of low-level waste transport have also been considered elsewhere. These include Hanford, Washington (Fields, Miller, and Cotter, 1981; Miller and Cotter, 1981), Savannah River, South Carolina (Fields, Miller, and Cotter, 1980), and Brookhaven, New York (Singer and Smith, 1966).

Implicit in Eq. (2.28) is the assumption that the plume centerline height is that of the release height, H . In practice, the plume may be considered to originate at some height, H , with respect to the population at risk. Some situations, such as presence of a ridge between the disposal site and the population centroid, may dictate use of an effective height greater than H (e.g., the ridge height). The plume thus has an effective height, H_{eff} , at which the plume may be considered to originate. This effective value should be used instead of a stack height as the starting point for Gaussian plume calculations. If the particulates in the effluent have an average gravitational fall velocity, V_g , then the plume centerline will tilt downward with an angle from the horizontal, the tangent of which is V_g/U . The elevation of the plume centerline a distance x downwind is then

$$H = H_{\text{eff}} - xV_g/U , \quad H \geq 0 , \quad (2.29)$$

and it is this corrected value that is used to compute the aerosol concentration at a distant point.

Consideration of the Effects on Transport of a Stable Air Layer

The Gaussian-plume formulation has been modified for use in PRESTO-II to account for the presence of a stable air layer at high altitudes. Upward dispersion of the plume subsequent to release is eventually restricted when the plume encounters an elevated stable air layer or lid at some height H_L . Pasquill (1976) has summarized some reasonable approximations to the modified vertical concentration profile for various ranges downwind, and his remarks have influenced our approach. We compute a limiting value of σ_z defined as

$$\sigma_z(\text{limit}) = 2(H_L - \frac{H}{2})/2.15 . \quad (2.30)$$

This equation follows from setting the ground-level contribution to the plume from an image source located above the stable air layer to 0.1 of the plume concentration. It is assumed that the limiting value of σ_z calculated in this manner is correct for distances beyond the distance for which the value of σ_z for no lid present becomes greater than $\sigma_z(\text{limit})$. For shorter downwind distances where the vertical dispersion coefficient is less than $\sigma_z(\text{limit})$, the Pasquill-Gifford value of σ_z is used. For greater downwind distances, where $\sigma_z > \sigma_z(\text{limit})$, the value of $\sigma_z(\text{limit})$ given in Eq. (2.30) is used instead. The lid height is a user-specified value, H_L , in the PRESTO-II code. For LLW applications, the source height will usually be sufficiently low that the influence of H_L will be small. For some sites, however, the influence of an intervening ridge may necessitate a larger effective source height.

Correction for the Effects of Plume Depletion

The plume is depleted at ground level during travel as the particulates are deposited. Both fallout and electrochemical deposition may be important considerations, and ground cover characteristics are of major importance. (Under certain obvious conditions, washout is also of great importance, but those conditions have not been included within this model.) Fallout is partially quantified in the V_g term defined earlier. Near ground level the deposition process is often characterized by a deposition velocity V_d (Gifford and Pack, 1962; Murphy 1976a,b). The deposition rate W is defined by

$$W = V_d E . \quad (2.31)$$

We may compute the magnitude of plume depletion dQ/dx as a function of downwind distance x out to a final distance X within the downwind sector by integrating across the plume. Using Eq. (2.28) and setting $z = 0$, we have

The most often used dispersion parameterization scheme for the Gaussian plume is the Pasquill-Gifford approach; this is the approach we find most appropriate for long-term LLW assessment calculations.

Pasquill (1961, 1974) considered ground level-emission tracer studies and wind-direction fluctuation data to arrive at a dispersion parameterization for six atmospheric stability classes ranging from A, most unstable, through F, most stable (see Table 2.2). Unless site-specific meteorology dictates otherwise, we suggest that the D stability category, denoting a neutral atmosphere, be used. Pasquill's values are approximate for ground-level emissions of low surface roughness (Vogt, 1977). These values were devised for small source distances (<1 km). The so-called Pasquill-Gifford form of this parameterization (Hilsmeier and Gifford, 1962) has been tabulated by Culkowski and Patterson (1976), and we have used their values in our model.

2.1.3 Foodchain Calculations

Mean concentrations both on an annual basis and over the assessment period of radionuclides in air, stream water, and well water are calculated by the equations listed in Sects. 2.1.1 and 2.1.2. This section describes how radionuclides in those and other environmental media are used to calculate human intake/exposure and potential health risk.

Radionuclides in water may impact humans by internal doses from use of drinking water or irrigation water used for crops. Radionuclides in air may impact humans by either external or internal radiological doses. External doses may result from immersion in a plume of contaminated air and from exposure to trench contents or by exposure to soil surfaces contaminated by deposition from the plume. Internal doses may result from inhalation of contaminated air or ingestion of food products contaminated by deposition from the plume. Air dose and risk calculations are made by the DARTAB program (Begovich et al., 1981) which is utilized as a subroutine in PRESTO-II. DARTAB will be discussed in some detail later. Radionuclide inputs to DARTAB consist of average collective concentration in air (person-Ci/m³), average collective concentration on the ground surface (person-Ci/m²), the average collective ingestion rate (person-pCi/yr) and the average collective inhalation rate (person-pCi/yr). Calculation of each of these by PRESTO-II will be discussed in the next few pages.

Concentrations of radionuclides in air usable by the population or individual under consideration are calculated as described in Sect. 2.1.2. The mean concentrations in air are constant during the total period of the assessment (between and including years IAVG1, and IAVG2 on input card 3), as required for input to DARTAB.

The concentration of each radionuclide on the ground surface for year i , $Q(i)_g$ (Ci/m²), is updated on a yearly basis using

$$\frac{dQ}{dx} = \int_{-\infty}^{\infty} V_d E dy = \int_{-\infty}^{\infty} \frac{V_d}{U} \frac{Q}{\pi \sigma_y \sigma_z} \exp \left[-\frac{y^2}{2\sigma_y^2} - \frac{H^2}{2\sigma_z^2} \right] dy. \quad (2.32)$$

By performing the indicated quadrature across the plume and further integrating along the longitudinal direction to express the loss of release agent as a multiplicative factor, it can be shown (Miller, Hoffman, and Shaeffer, 1978) that the ratio of the air concentration considering deposition processes, E_d , to the air concentration without regarding deposition, E , is

$$\frac{E_d}{E} = \exp \left\{ -\sqrt{\frac{2}{\pi}} \frac{V_d}{u} \int_0^x \frac{\exp \left(-\frac{H^2}{2\sigma_z^2} \right) dx}{\sigma_z} \right\}. \quad (2.33)$$

Since σ_z is a complicated empirical function of the downwind distance x , Eq. (2.33) must be evaluated numerically.

In the PRESTO-II applications, the average value of E across a 22.5-degree downwind sector is the desired quantity. In this case, the trans-sector integration leads to the value 2.032 in place of the $1/\sigma_y$ factor in Eq. (2.32).

In conclusion, assuming that the radionuclide distribution is that of a Gaussian plume, we may compute the mean exposure E at ground level for the 22.5-degree downwind sector uncorrected for deposition by

$$E = \frac{2.032 F_d F_w Q}{U x \sigma_z} \exp \left(-\frac{H^2}{2\sigma_z^2} \right). \quad (2.34)$$

This value is corrected for deposition by multiplying by the F_d as calculated in Eq. (2.33).

The value of H in Eq. (2.34) must be an effective source height. This value is corrected in PRESTO-II for plume tilt as in Eq. (2.29) and the accompanying discussion. For use in the PRESTO-II code, H is on the order of 1 m for reasonably flat sites, but in many cases other values should be used to account for local site characteristics, e.g., for the presence of updrafts.

It has been noted that the choice of plume dispersion parameterization is a user option in the PRESTO-II code. The choice of appropriate parameterization depends on site meteorology, topography, and release conditions. The DWNWIND code (Fields and Miller, 1980) which has been included in part of PRESTO-II includes a choice of eight parameterization schemes for plume dispersion and a choice of six stability classifications.

$$D(i)_S = \frac{\bar{C}_A V_d}{\lambda_S} , \quad (2.35)$$

and

$$Q(i)_S = [Q(i-1)_S + D(i)_S] \exp - (\lambda_S + \lambda) , \quad (2.36)$$

where

$\bar{C}_A$ = mean ground level radionuclide concentration at population of interest (Ci/m³),

V_d = deposition velocity (m/s),

$D(i)_S$ = amount of radionuclide deposited in year i (Ci),

λ_S = soil loss constant (y⁻¹), and

λ = radiological decay constant (y⁻¹).

In PRESTO-II, separate contributions to the radionuclide surface soil inventory are computed for atmospheric deposition and for irrigation deposition. These inputs are summed to yield the total ground-surface radionuclide concentration.

Appropriate unit conversions are made within the code. The collective inhalation rate is calculated by multiplying the population size by the generic individual inhalation rate of radionuclides. Q_{inh} , calculated by

$$Q_{inh} = U_a \cdot \bar{C}_A , \quad (2.37)$$

where

U_a = inhalation rate (m³/yr).

The units of Q_{inh} are converted to pCi/yr for input to the health risk portion of the code.

The collective ingestion rate is the input to DARTAB that requires the most calculations by PRESTO-II. Ingestion includes intake of drinking water, beef, milk, and crops. Except for drinking water, all of these media may be contaminated by either atmospheric processes or by irrigation. For the most part, we use the equations from AIRDOS-EPA (Moore et al., 1979) to calculate radionuclide concentrations in beef, milk, and crops consumed by humans.

The atmospheric deposition rate onto food surfaces or soil that is used in subsequent calculation of radionuclide content in the food chain is

$$d = C_A V_d \cdot 3.6 \times 10^{15} \quad (2.38)$$

where

C_A = mean ground level radionuclide concentration at point of interest (Ci/m^3),

V_d = mean rate of radionuclide deposition onto ground or plant surfaces ($\text{pCi}/\text{m}^2 \cdot \text{h}$),

$$3.6 \times 10^{15} = \text{sec}/\text{h} \cdot \text{pCi}/\text{Ci}.$$

The following equation estimates the concentration $\bar{C}_v$ of a given nuclide in and on vegetation at the deposited location (except for ^3H and ^{14}C):

$$\bar{C}_v = \left[d \frac{R[1 - \exp(-\lambda_e t_e)]}{Y_v \lambda_e} + \frac{B \times \text{CSP}}{p} \right] \exp(-\lambda t_h) \quad (2.39)$$

where $\bar{C}_v$ is measured in pCi/kg , d is defined above, and

R = the fraction of deposited activity retained on crops (unitless),

λ_e = the effective removal rate constant for the radionuclide from crops (h^{-1}), where $\lambda_e = \lambda + \lambda_w$, λ is the radioactive decay constant, and λ_w is the removal rate constant for physical loss by weathering,

t_e = the time period that crops are exposed to contamination during the growing season (h),

Y_v = the agricultural productivity (yield) [$\text{kg}(\text{dry weight})/\text{m}^2$],

B = the radionuclide concentration factor for uptake from soil by edible parts of crops, [pCi/kg (wet weight) per pCi/kg dry soil]; B values are read as dry weight basis values, and converted by the code to wet weight basis values.

CSP = soil radionuclide concentration, updated yearly
(pCi/m²),

P = the effective "surface density" for soil
[kg(dry soil)/m²], and

t_h = time interval between harvest and consumption of
the food (h).

Vegetation concentrations of radionuclides ³H and ¹⁴C are developed as discussed in Eqs. (2.52) and (2.53).

The rate constant for contaminant removal from the soil, λ_s (h⁻¹), is estimated using

$$\lambda_s = \frac{r_s}{0.15 \cdot 8760 \cdot \left[\frac{1 + \rho_s k_d}{\theta_s} \right]} \quad (2.40)$$

where

r_s = soil permeability (m/yr),

ρ_s = soil bulk density (g/cm³),

k_d = distribution coefficient of the radionuclide (mL/g),

θ_s = surface soil porosity (unitless),

0.15 = depth of soil layer (m),

8760 = h/yr.

Eq. (2.39) is used to estimate radionuclide concentrations in produce and leafy vegetables consumed by humans and in forage (pasture grass or stored feed) consumed by dairy cows, beef cattle, or goats.

The concentration of each radionuclide in animal forage is calculated by use of the equation

$$C_f = f_p f_s C_p + (1 - f_p f_s) C_s \quad (2.41)$$

where

C_s = the radionuclide concentration in stored feeds
[calculated using Eq. (2.39) with t_h = 2160 h (90 d)]
(pCi/kg),

- f_p = the fraction of the year that animals graze on pasture (unitless),
- f_s = the fraction of daily feed that is pasture grass when the animals graze on pasture (unitless).

The concentration of each radionuclide in milk is estimated as

$$C_m = F_m C_f Q_f \exp(-\lambda t_f) , \quad (2.42)$$

where

- C_m = the radionuclide concentration in milk (pCi/L),
- C_f = the radionuclide concentration in the animal's feed (pCi/kg),
- F_m = the average fraction of the animal's daily intake of a given radionuclide which appears in each liter of milk (d/L),
- Q_f = the amount of feed consumed by the animal per day (kg (wet weight)/d),
- t_f = the average transport time of the activity from the feed into the milk and to the receptor (h),
- λ = the radiological decay constant (h^{-1}).

The radionuclide concentration in meat from atmospheric deposition depends, as with milk, on the amount of feed consumed and its level of contamination. The radionuclide concentration in meat is estimated using

$$C_F = F_f C_f Q_f \exp(-\lambda t_s) , \quad (2.43)$$

where

- C_F = the nuclide concentration in animal flesh (pCi/kg),
- F_f = the fraction of the animal's daily intake of a given radionuclide which appears in each kilogram of flesh (d/kg),
- C_f = the concentration of radionuclide in the animal's feed (pCi/kg),
- Q_f = the amount of feed consumed by the animal per day (kg/d),
- t_s = the average time from slaughter to consumption (h).

Concentrations of radionuclides in foodstuffs that result from spray irrigation with contaminated water are estimated using essentially the same equations as for atmospheric deposition; the differences are as follows: the concentration in vegetation, C_v , is estimated using Eq. (2.39), but a different value of the retention fraction, R , is used. For irrigation, the second term of Eq. (2.39) is modified by a factor of f_I , the fraction of the year during which irrigation occurs. The t_e in the exponent becomes t_w , equivalent to f_I in hours. For irrigation calculations, the deposition rate, d , in Eq. (2.40), becomes I_r , expressed as

$$I_r = C_w \cdot W_I, \quad (2.44)$$

where

I_r = radionuclide application rate ($\text{pCi}/\text{m}^2 \cdot \text{h}$),

C_w = radionuclide concentration in irrigation water (pCi/L),

W_I = irrigation rate ($\text{L}/\text{m}^2 \cdot \text{h}$).

The concentration in water, C_w , is an average of well and stream water weighted by the respective amounts of each that are used as specified by input parameter WATL and SATL on input card 5. For irrigation calculations, the radionuclide concentration in milk and meat is calculated by adding a term to Eqs. (2.42) and (2.43) to account for the animal's ingestion of food contaminated during irrigation.

$$C_m = F_m(C_f \cdot Q_f + C_w \cdot Q_w) \exp(-\lambda t_f) \quad (2.45)$$

$$C_f = F_f(C_f \cdot Q_f + C_w \cdot Q_w) \exp(-\lambda t_s), \quad (2.46)$$

where

Q_w = the amount of water consumed by the animal (L/d).

Once radionuclide concentrations in all the foodstuffs are calculated, the annual ingestion rate for each radionuclide is estimated by

$$Q_{\text{ing}} = Q_v + Q_{\text{milk}} + Q_{\text{meat}} + Q_w, \quad (2.47)$$

where the variables represent individual annual intakes of a given radionuclide via total ingestion, and ingestion of vegetation, milk, meat, and drinking water, respectively, in pCi/yr. The annual intakes via each type of food, Q_v for instance, are calculated as

$$Q_v = (C_I^v + C_A^v) \cdot U_v, \quad (2.48)$$

where

Q_v = annual radionuclide intake from vegetation (pCi/yr),

C_I^v = radionuclide concentration in vegetation from irrigation (pCi/kg),

C_A^v = radionuclide concentration in vegetation from atmospheric deposition (pCi/kg),

U_v = individual annual intake of vegetation (kg/yr).

To satisfy the input requirements for DARTAB, the annual individual intakes are multiplied by the size of the population to calculate the collective annual ingestion values.

As mentioned earlier, Eqs. (2.38)–(2.46) do not apply directly to calculations of concentrations of ^3H or ^{14}C in foodstuffs. For application of tritium in irrigation water, we assume that the concentration in all vegetation, C_v , is the same as the tritium concentration in drinking water; therefore,

$$C_v = C_w, \quad (2.49)$$

where C_v and C_w are in pCi/kg and pCi/L, respectively. The concentration of ^3H in animal's feed, C_f , is therefore also equal to C_w . Then, from Eqs. (2.45) and (2.46), the concentration of tritium in animal's milk and flesh can be written as

$$C_m = F_m \cdot C_w (Q_f + Q_w), \quad (2.50)$$

$$C_f = F_f \cdot C_w (Q_f + Q_w), \quad (2.51)$$

where

- C_m = concentration of tritium in milk (pCi/L),
 F_m = fraction of the animal's daily intake of ^3H that appears in each liter of milk (1/L) times conversion/factor (L/kg),
 C_w = ^3H concentration in animal's drinking water (pCi/L),
 Q_f = animal's daily intake of forage (kg/d),
 Q_w = cow's daily intake of water (kg/d),
 C_F = concentration of tritium in animal's flesh (pCi/kg),
 F_f = fraction of the animal's daily intake of ^3H that appears in each kg of flesh (1/kg).

The exponential decay term is neglected due to the relatively long half-life of tritium.

For vegetation contaminated by atmospheric deposition of tritium, ^3H concentrations are calculated by

$$C_v = \frac{C_A}{h} \cdot (0.75)(0.5)(1 \times 10^{15}) , \quad (2.52)$$

where

- C_v = tritium concentration in vegetation (pCi/kg),
 C_A = concentration of ^3H in air (Ci/m³),
 h = absolute humidity of the atmosphere (g/m³),
 0.75 = fraction of the plant mass that is water,
 0.5 = ratio of tritium concentration in plant water to that in atmospheric water,
 1×10^{15} = $(1 \times 10^{12} \text{ pCi/Ci}) \times (10^3 \text{ g/kg})$.

The mean ground level air concentration of ^3H , C_A , is calculated using equations in Sect. 2.1.2. For ^{14}C , the concentration in vegetation is calculated assuming that the ratio of ^{14}C to the natural carbon in vegetation is the same as that ratio in the surrounding atmosphere. The concentration of ^{14}C is given by

$$C_v = C_A \cdot r \cdot \left(\frac{0.11}{0.16}\right) \cdot (1 \times 10^{15}) , \quad (2.53)$$

where

C_v = ^{14}C concentration in vegetation (pCi/kg),

C_A = mean ground-level concentration of ^{14}C in air (Ci/m³), also calculated from equations given in Sect. 2.1.2,

r = ratio of the total release time of ^{14}C to the total annual time during which photosynthesis occurs, $p \leq 1$,

0.11 = fraction of the plant mass that is natural carbon,

0.16 = concentration of natural carbon in the atmosphere (g/m³).

2.2 DOSE AND RISK CALCULATIONS

2.2.1 DARTAB Calculations

In Eqs. (2.40-2.50) we showed how calculations are made of radionuclide concentrations in the air and on the ground, and of annual ingestion and inhalation rates. These concentrations and rates are utilized by the DARTAB portion of PRESTO-II to generate tables of radiological dose and resulting health risk. The remainder of this section describes the mathematical calculations made within DARTAB. For the most part, the equations and text have been taken from Sect. 2.3 of the DARTAB documentation report (Begovich et al., 1981), entitled "General Equations."

Radiological dose quantities

The annual dose committed to an average individual or to a population at location k for the l th organ, i th nuclide, and j th exposure pathway is given by

$$D_{ijl}(k) = \frac{K_j E_{ij}(k) \cdot DF_{ijl}}{P(k)}, \quad (2.54)$$

where K_j contains any numerical factors introduced by the units of $E_{ij}(k)$, the exposure to the i th radionuclide in the j th pathway, DF_{ijl} is the dose-rate factor for the i th radionuclide, the j th pathway and the l th organ, and $P(k)$ is the exposed population at location k . All E_{ij} and DF_{ijl} for various nuclides (index i) and organs (index l) have consistent units.

DARTAB performs three calculations and tabulations of dose rate and dose: (1) dose rate to an individual at a selected location, (2) dose rate to a mean or average individual, and (3) collective population dose rate. As a component of PRESTO-II, calculations (1) and (2) are equivalent, as is

calculation (3) for a population of 1. Table 2.3 lists units of DF_{ij1} and E_{ij} for each of the four pathways for selected individual dose calculations. Dose rates, D_{ij1} , are in mrad/yr.

Mean individual dose rates are calculated using

$$D_{ij1} = \frac{\sum_k P(k) \times D_{ij1}(k)}{\sum_k P(k)} . \quad (2.55)$$

Note that in PRESTO-II the impacted population is considered to reside at only one location ($k = 1$). Hence, calculations of mean individual dose rate are numerically equivalent to the sum of pathway doses for the selected individual dose rate.

The collective dose rate for the exposed population is the product of D_{ij1} and the number of persons exposed. Units of the collective dose rate are person-rad/yr.

The above dose rates may be expressed in a number of different combinations. The doses can be summed directly over pathways:

$$D_{i1}(k) = \sum_j D_{ij1}(k) , \quad (2.56)$$

or nuclides:

$$D_{j1}(k) = \sum_i D_{ij1}(k) . \quad (2.57)$$

The total dose to the 1th organ at location k , $D_1(k)$, is then

$$D_1(k) = \sum_j \sum_i D_{ij1}(k) . \quad (2.58)$$

The dose equivalent (mrem), H_1 , for the 1th organ is given as

$$\begin{aligned} H_1(k) = & QF(\text{low-LET}) \times D_1(k, \text{low-LET}) \\ & + QF(\text{high-LET}) \times D_1(k, \text{high-LET}) , \end{aligned} \quad (2.59)$$

where QF denotes the quality factor. The factor is defined as 1 (low-LET radiations) or 20 (high-LET radiations).

To combine dose rates to different organs, a weighted sum is used:

$$D_{ij} = \sum_1 W_1 D_{ij1}(k) , \quad (2.60)$$

where W_1 are stochastic-risk-based weighting factors for the various organ doses supplied by the user where

$$\sum_1 W_1 = 1.0 . \quad (2.61)$$

Weighting factors for the various organs were supplied by the EPA for input into DARTAB. The International Commission on Radiological Protection (ICRP, 1977) has proposed a similar approach to adding organ doses.

Health effects estimates

The health risk and risk equivalent are computed in a manner similar to the dose calculations. The health risk or individual risk of premature death to an individual at location k for the lth cancer, ith radionuclide, and jth exposure pathway is given by:

$$R_{ijl}(k) = 10^{-5} \cdot K_j E_{ij}(k) RF_{ijl}/P(k) , \quad (2.62)$$

where

$E_{ij}(k)$ = is the exposure to or intake rate of the ith radionuclide through the jth exposure or intake mode at location k in the environment, and

RF_{ijl} = the mortality risk factor per unit exposure or intake rate of the ith radionuclide in the jth exposure or intake mode for the lth cancer site.

and where K_j again serves to reconcile the units of $E_{ij}(k)$ and RF_{ijl} . The total individual risk represented by the exposures and intakes of all radionuclides through all pathways is given as:

$$R(k) = 10^{-5} \sum_j K_j \sum_i E_{ij}(k) \sum_l RF_{ijl}/P(k) , \quad (2.63)$$

and the health risk can be summed over pathways, radionuclides, or cancers. The mean or average individual risk is estimated in a similar way.

The collective risk is expressed as the fatal health effects rate. For example, the total equilibrium fatal cancer rate in exposed population is:

$$HE = \frac{10^{-5}}{T_e} \sum_j K_j \cdot \sum_i E_{ij}(k) \sum_l RF_{ijl}, \quad (2.64)$$

where T_e is the mean individual lifetime (70.7 yr).

In DARTAB, life loss (years) per premature death is calculated by

$$Y_1(k) = \sum_j K_j \sum_i E_{ij}(k) YL_{ijl} \sum_j K_j \sum_i E_{ij}(k) RF_{ijl}. \quad (2.65)$$

where

$Y_1(k)$ = average life lost (years) per premature death from cancer 1 at location k, and

YL_{ijl} = total life lost (years) for unit exposure to nuclide i, pathway j, and cancer 1.

The factor K_j converts any pathway-specific units to the required units. Note then that the numerator is just the total years of life lost by those experiencing a cancer of the 1th site, while the denominator is the total number of deaths due to radiation induced cancers of the 1th site.

DARTAB performs two calculations and tabulations of life loss per premature death: (1) life loss per premature death for an individual at a selected location and (2) life loss per premature death for a mean or average individual. As a component of PRESTO-II, these two calculations are identical. Table 2.4 lists units of the exposure, loss of life and risk mortality factors.

Mean individual life loss/premature death estimates, $Y_e(k)$, is merely the sum over all locations, k, of $Y_1(k)$ calculated using Eq. (2.65). As with the dose calculations, it should be noted that PRESTO-II assumes that the total population resides at one location, $k = 1$. Therefore, mean individual premature death values are equivalent to those for the selected individual.

Readers desiring a complete discussion of the development of the dose, risk, or risk equivalent factors utilized by DARTAB should consult the DARTAB documentation report, Begovich et al. (1981), pages 5-10, or the

report by Dunning, Leggett, and Yalcintas (1980). The latter describes the theory and development of the RADRISK code that generates the risk factors utilized by DARTAB.

2.2.2 Estimation of Basement Dose to Resident Intruder

The DARTAB subroutine of the PRESTO-II model contains algorithms to compute the dose rate per unit radionuclide surface concentration to an individual standing on a contaminated, infinite plane. This section of this report describes the calculation of a factor which is used to convert the input to this infinite-plane computation so that the calculation computes a value appropriate for an individual spending part of his time in a basement. We assume in this calculation that the basement actually extends into and is surrounded by the trench contents. Furthermore, we assume that most of the individual's time is spent at the center of the basement, that the basement radius is three meters, and that the radiation attenuation coefficient of the trench may be approximated by that of earth, with attenuation coefficients taken from literature published by the British Standards Institute (1966). The elapsed time between closure of the waste disposal area and construction of the basement is an input parameter for the model.

We define a conversion factor F which will be used to convert the radionuclide concentration in the trench surrounding the basement to a value appropriate for an input parameter to the infinite-plane calculation. Provided the basement is continuously occupied, this conversion factor is defined by the equation

$$F = \frac{D_b/\rho}{D_p/\sigma} \quad (2.66)$$

where

D_b/ρ = dose rate in basement per unit of radionuclide concentration in trench $[(\text{mrad/yr})/(\text{pCi/m}^3)]$,

D_p/σ = infinite-plane dose rate per unit of surface concentration on ground $[(\text{mrad/yr})/(\text{pCi/m}^2)]$.

In Eq. (2.66), σ represents the radionuclide concentration per unit surface area on the infinite plane and ρ represents the radionuclide concentration per unit volume in the trench material. If we know the value of the factor F , we may compute the radionuclide dose rate to an individual within the basement by using a modified form of the above equation,

$$D_b = \frac{D_p}{\sigma} F \rho \quad (\text{mrad/yr}) \quad (2.67)$$

We may compute the basement whole-body gamma dose rate per unit of radionuclide concentration at a distance one meter above the basement floor by integrating the radiation flux from each volume element of the trench material over the trench volume v . For uniform radionuclide concentration and for a single photon energy, this equation is

$$\frac{D_b}{\rho C} = \int_v \frac{B(\mu_T r_T)}{r^2} e^{-(\mu_a r_a + \mu_T r_T)} dv, \quad (2.68)$$

where

C = units transformation constant $[(\text{mrad/yr})/(\text{pCi/m}^2)]$,

$B(\mu_T r_T)$ = build up factor, calculated using formulas by Eisenhauer and Simmons (1975) for energies up to 200 keV and Taylor's formula for energies above 200 keV. Coefficients for the Eisenhauer and Simmons equation were taken from Eisenhauer and Simmons (1975) and for Taylor's formula were taken from Morgan and Turner (1967),

r = distance from point of interest to element of volume of the trench dv (m),

μ_a = linear attenuation coefficient of air (m^{-1}),

μ_T = linear attenuation coefficient of trench (m^{-1}),

r_a = distance in air from point of interest to element of volume dv (m),

r_T = distance in trench from point of interest to element of volume dv (m).

We also consider the basement to be circular, so that Eq. (2.68) becomes

$$\begin{aligned} \frac{D_b}{\rho C} &= \int_{v(\text{beyond floor})} \frac{B(\mu_T r_T)}{r^2} e^{-(\mu_a r_a + \mu_T r_T)} dv \\ &+ \int_{v(\text{beyond wall})} \frac{B(\mu_T r_T)}{r^2} e^{-(\mu_a r_a + \mu_T r_T)} dv, \\ &= 2\pi \left[\int_0^{R+d} \int_z^{z+d} \frac{B(\mu_T r_T)}{r^2} e^{-(\mu_a r_a + \mu_T r_T)} dz dy \right] \\ &\quad \left[+ \int_R^{R+d} \int_{-r}^R \frac{B(\mu_T r_T)}{r^2} e^{-(\mu_a r_a + \mu_T r_T)} dz dy \right], \end{aligned} \quad (2.69)$$

where

R = basement radius (m),

z = distance of point of interest from floor (1 m),

H = basement height (m),

d = cut-off thickness of trench, chosen to be 10 mean free paths (or $10/\mu_a$).

The first integrand refers to the section of the trench immediately below the basement floor, while the second integrand refers to the trench material outside the walls of the basement. For this calculation, the basement is assumed circular, and we have used a two-dimensional Simpson's rule method (McCormick and Salvadori, 1964) to numerically evaluate the integrals.

Eq. (2.69) has been evaluated to determine values of the ratio $D_b/\rho C$, and we have found that as the assumed basement radius varies from 3-6 m, the computed value of $D_b/\rho C$ changes by only 30% (being greater for the smaller basement radius) for radiation energies ranging from 20 keV through 10 MeV. We have used tabulated values of the linear attenuation coefficient for air (Kocher, 1979) and for earth (British Standards Inst., 1966).

The dose rate at a height of one m per unit surface concentration from an infinite plane is given by the equation

$$\frac{D}{\sigma C} = \int_S \frac{1}{r^2} e^{-\mu_a r} dS = 2\pi \int_1^\infty \frac{1}{r} e^{-\mu_a r} dr = 2\pi I, \quad (2.70)$$

where

C = units transformations constant $\{(\text{mrad/yr})/(\text{pCi/m}^2)\}$,

$I = \int_1^\infty (1/r) \exp(-\mu_a r) dr$ (dimensionless),

μ_a = linear attenuation coefficient of air (m^{-1}),

1 = height of point of interest (m).

In this transformation, the incremental area element dS is $2\pi X dX$, where X is the radius projection onto the plane; and since $r^2 = X^2 + 1$, we have $X dX = R dR$. I, the value of the integral in this equation, may be computed numerically using a polynomial approximation (Gautschi and Cahill, 1964) for values of μ_a corresponding to different values of γ energies. The results of these calculations are summarized in Table 2.5.

The value of the ratio F as defined by Eq. (2.66) may be obtained for a given energy by dividing the results of the basement calculation by the results of the infinite plane calculation. Values of this ratio for energies between 10 keV and 10 MeV are given for a basement radius of 3.0 m in Table 2.5. We see that a conservative average value of F may be chosen to be 0.1 m.

If we assume that the basement is occupied one-third of each day, we must multiply either the calculated dose rate or radionuclide concentration within the trench by one-third. We may, therefore, include the estimated basement exposure dose rate in the infinite plane dose-rate calculation of the DARTAB subroutine by multiplying the average radionuclide volume concentration within the trench during the basement occupancy period by 0.1 m (the volume to the surface correction term F) and by one-third (the fraction of time the basement is assumed to be occupied). Thus, the true value of σ is augmented by the quantity 0.033p to yield a value that corresponds to the plane dose plus the basement dose. In the PRESTO-II computer code, the time at which the basement is constructed is a user input parameter, and the average volume radionuclide concentration for that period between basement construction until the end of the simulation period is computed by the code. This incremental concentration is added to the computed average surface concentration if the code user has elected to include the basement exposure mode by appropriately selecting the value for IBSMT on input card 3.

2.2.3 Handling of Daughter Products

The PRESTO-II code does not make calculations to account for ingrowth of daughters of radioactive decay of materials during storage in the trench or during environmental transport following release from the trench. The RADRISK data files accessed by DARTAB do, however, include dose and risk factors that account for such ingrowth and subsequent exposure after materials have entered the human body. In cases where the daughter is short-lived relative to the parent, the radionuclide concentrations calculated for environmental media may be in error because of this ingrowth.

For example, when ^{137}Cs ($T_{1/2} = 30$ yr) is included in trench inventory, one can reasonably expect that $^{137\text{m}}\text{Ba}$ ($T_{1/2} = 2.55$ min) would be in secular equilibrium with the parent nuclide. If $^{137\text{m}}\text{Ba}$ is not listed as part of the trench inventory, then no environmental concentrations of $^{137\text{m}}\text{Ba}$ will be calculated; therefore, external exposures will be underestimated because of the absence of the 0.662 MeV Ba x-rays. The internal exposures will include the exposure to Ba x-rays as noted above.

In situations where external exposures may be important, and where as in the above example, the daughter is present, the user should include the daughter product in the initial trench inventory. In such cases, the daughter should be entered with the same activity, decay coefficient, and environmental transport parameters as the parent. By so entering the daughter, the effect of secular equilibrium will be achieved throughout transport in the environment. The fact the Cs and Ba probably do not have identical chemical and environmental behavior will be relatively unimportant because of the short progeny half-life. Entering the daughter in the source term in such a manner will not grossly overestimate internal exposures as might seem the case because the dynamics of the daughter alone inside a human body tend to result in low doses. In particular, this is true because the DARTAB calculation will not be affected by the decay rate of the daughter as indicated in the environmental transport portion of the PRESTO-II input data set.

Table 2.1 Leaching options specified by LEAOPT

Option	Leach calculation method
1	Total contact, distribution coefficient
2	Immersed fraction, distribution coefficient
3	Total contact, solubility
4	Immersed fraction, solubility
5	Release fraction

Table 2.2. Definition of the Pasquill atmospheric stability categories (Pasquill, 1961)

Surface wind speed (at 10 m), m/sec ⁻¹	Day			Night	
	Incoming solar radiation			Thinly overcast or ≥4/8 low cloud	≤3/8 cloud
	Strong	Moderate	Slight		
<2	A	A-B			
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

Table 2.3 Units of exposure factor, E_{ij} , and dose rate factor, DF_{ij1} , for selected individual dose rate calculations by DARTAB. Table 2.4 lists similar factors for risk

Pathway	Units of factor	
	E_{ij}	DF_{ij1}
Ingestion	(person-pCi)/yr	(mrad/yr)/(pCi/yr)
Inhalation	(person-pCi)/yr	(mrad/yr)/(pCi/yr)
Air immersion	(person-Ci)/m ²	(mrad/yr)/(Ci/cm ²)
Ground surface-exposure	(person-Ci)/m ²	(mrad/yr)/(Ci/m ²)

Table 2.4 Units of years lost factor, YL_{ijl} , and mortality risk factor, RF_{ijl} , for health risk calculations by DARTAB, corresponding to exposure factors listed in Table 2.3

Pathway	Units of factor	
	YL_{ijl}^a	RF_{ijl}
Ingestion	yr life loss/(pCi/yr)	(deaths/ 10^5 person)/(pCi/yr)
Inhalation	yr life loss/(pCi/yr)	(deaths/ 10^5 person)/(pCi/yr)
Air immersion	yr life loss/(pCi/cm ³)	(deaths/ 10^5 person)/(pCi/cm ³)
Ground surface-exposure	yr life loss/(pCi/cm ²)	(deaths/ 10^5 person)/(pCi/cm ²)

^aYears of life lost is total years lost per cohort of 10^5 people.

Table 2.5. Results of basement and infinite plane unit dose rate computations

γ energy MeV	F (m)
0.05	0.015
0.10	0.045
0.20	0.061
0.50	0.087
1.0	0.087
2.0	0.088
4.0	0.092
6.0	0.098
8.0	0.099
10.0	0.101

3. CODE DESCRIPTION

3.1 SUBROUTINE STRUCTURE, INFORMATION FLOW, AND INPUT PARAMETERS

The PRESTO-II code is structured in a modular form to permit simple upgrading or replacement of given submodels without rewriting the entire code. The code is written in the FORTRAN IV language to be operated in batch mode on an IBM 3033 computer system. The code requires 850K bytes of memory to execute. Most runs will require less than 30 s of central processing unit time on an IBM 3033. This includes about 10 s in the GO step. The program requires one magnetic tape for temporary storage and an input file (see Sect. 3.3.3). The program should be easily transportable to other IBM installations. Non-IBM users will probably have to modify the NAMELIST inputs (see Sect. 3.3.2) and perhaps other program segments where character manipulations are used.

The code is designed to process up to 40 nuclides for a maximum of 1000 years. Different submodels are invoked or called in changed order for scenarios other than the normal scenario. Three classes of submodels are used in PRESTO-II: unit response submodels, scheduled event submodels, and bookkeeping submodels. Unit response submodels simulate processes such as rainwater infiltration through the intact portion of the trench cap, erosion of soil overburden from the trench cover, and atmospheric transport. Such submodels are likely accessed only once during a model run and generate parameters and rates used elsewhere in the simulation. Scheduled event submodels are those that estimate such occurrences as the time of trench cap failure, while bookkeeping submodels include those simulating water balance in the trench, and radionuclide concentration in the trench and aquifer outflow. Such submodels are iterated annually for the simulation period. Risk evaluation bookkeeping submodels accept exposure and ingestion values from the transport portion of the code and generate doses and population risks, based on a life-table approach. The subroutine structure of the code is shown in Fig. 3.1.

3.2 SUBROUTINE DESCRIPTION

Table 3.1 lists the primary subroutines used in PRESTO-II and their calling subprogram, along with their input and output data. Subroutine functions are described in the following text.

MAIN

The main calling program of PRESTO-II defines the most commonly used variables of the code, specifies dimension and common areas, and initializes variables and input control parameters. The input and output subroutines, SOURCE and OUT, are called directly by MAIN (Fig. 3.1), as are the unit response model subroutines AIRTRM, and ERORF. MAIN also calculates the vertical water velocity, retardation factors,

SUBROUTINES CALLED

Figure 3.1. PRESTO-II subroutine structure.

and vertical and horizontal and total transit times in ground water (the transfers from trench to vertical soil column to aquifer in Fig. 2.1) and the basement exposure correction factor (Sect. 2.2.2).

MAIN calls bookkeeping subroutines to calculate quantities associated with trench water balance, trench cap status, changes in land use and basement occupancy. Other subroutines called by MAIN compute amount of leaching from trench, transport of soluble surface components, atmospheric concentrations, and well concentrations. In addition aquifer volume, hypothetical radionuclide withdrawal from well, and material balance are calculated in MAIN.

Risk evaluation submodels called from MAIN account for radionuclide concentrations in food due to atmospheric deposition and water irrigation, radionuclide intake by man. These subroutines are IRRIG, FOOD, HUMEX, CV, COV, IRRIGA, FOODA, HUMEXA, CVA, and COVA. Finally DARTAB, which creates tables of predicted health effects from radioactive effluents, is called.

The annual simulation loop and the radionuclide loop are executed a selected number of times. During a model run, MAIN may access any or all of the subroutines or functions which are discussed below in alphabetical order.

Average concentration values printed in the concentration tables are computed in the MAIN Subroutine using a summation calculation within the MAXYR loop (the main yearly iteration loop). After this loop is completed, the summed concentration values are divided by the number of years considered in the simulation and the results are printed. Maximum concentration values are identified by comparing stored concentration values to the values determined in each iteration of the same yearly simulation loop. If the new value is greater, then it, and the corresponding year number, are stored for printing in the concentration tables.

AIRTRM

This subroutine is the main calling program for the atmospheric transport submodel. AIRTRM calculates (22.5 degree) sector-averaged atmospheric exposures normalized to source strength and wind speed. AIRTRM and all its accompanying subroutines are adaptations of an interactive Gaussian plume atmospheric model, DWNWND (Fields and Miller, 1980). AIRTRM also calculates the deposition rate onto surfaces per unit source strength, DEPO. To make these calculations, AIRTRM accesses four other subroutines,

SIGMAZ, DPLT, YLAG, and SIMPUN, and utilizes a number of user-input parameters including source height, H; lid height, HLID; stability class, IS; type of suitability class formulation, IT; Hosker roughness parameter, ROUGH; wind velocity, U; deposition velocity, VD; gravitational fall velocity, VG; and source to receptor distance, XG. The normalized atmospheric exposures are returned to the main program and are used in later dose and risk calculations.

CAP

This function calculates, and returns to both MAIN and TRENCH the fraction of the trench cap that has failed. Cap failure may be either partial or total. Total failure may be caused by erosion of all overburden as calculated by ERORF. Partial failure indicates that a portion of the cap has been completely removed; the remainder of the cap is still subject to erosion. Partial failure may be caused by user input of the end points of a linear function to selectively remove all overburden from a fraction of the trench.

Variables used in CAP include the simulation year, NYEAR; the first, NYR1, and last, NYR2, years of user-specified failure; the corresponding user-specified percentages of cap failure for those years, PCT1 and PCT2; the thickness of the trench cap, OVER; and the rate of erosion, SOILOS, from subroutine ERORF. CAP calculates a linear function of cap loss at the user-specified rates between the times NYR1 and NYR2. CAP also tests the current thickness of overburden, OVER. If OVER is less than a small number, total cap failure due to erosion is assumed to have occurred. If the cap either has been completely eroded or the user-specified value of PCT2 is 100%, then CAP returns a value of 1.0 signifying total cap failure. Otherwise, CAP returns a function-specified fraction between 0 and 1.0. Rates of infiltration are subsequently altered in MAIN and TRENCH.

COV, COVA

These functions are called respectively by subroutine IRRIG and IRRIGA to calculate radionuclide concentrations in vegetables, milk, and meat consumed by humans that may be contaminated by irrigation of agricultural crops with contaminated water. For each nuclide, COV uses the agricultural productivity of vegetation, the period of irrigation annually, the storage delay period between harvest and use for pasture grass, feed, leafy vegetables and produce, and the radionuclide decay constant.

- CV,CVA** These functions are utilized by subroutines FOOD and FOODA to calculate radionuclide concentrations in pasture grass and stored feed consumed by animals, and in leafy vegetables and produce consumed by humans. CV is essentially the same as function COV, except that CV is for atmospherically deposited radionuclides and COV accounts for radionuclides deposited during spray irrigation. For each radionuclide, input data include agricultural productivity, fraction of the year vegetation is exposed to depositing radionuclides, and the delay time between harvest and consumption for stored feed, pasture grass, leafy vegetables, and produce.
- DARTAB** In the original form, DARTAB is a stand-alone program which combines radionuclide environmental exposure data with dosimetric and health effects data to create tables of predicted impacts of radioactive effluents. This program has eleven subroutines and contains over 3000 FORTRAN source statements. DARTAB subroutines are RDSTOR, FACOUT, CHLOC, PREPDR, PREPRF, PREPHR, MULT, DRTAB, ORGFAC, SUMMRY, and SUMM22; these are not discussed specifically in this report. Readers interested in these methodologies should consult the document describing the code (Begovich et al., 1981). DARTAB has been modified slightly so that its original main program is treated as a subroutine. Environmental exposure data are now passed in COMMON from MAIN to DARTAB's subroutines.
- DARTAB makes use of dosimetric and health effects data from the methodologies of RADRISK (Dunning, Leggett, and Yalcintas, 1980). RADRISK is a life-table approach to calculating the human health risk to a cohort of 10^5 people from a constant input of 1 pCi/year (0.037 Bq/year) via ingestion and inhalation for a lifetime (70.7 years).
- These intake conditions are approximated in PRESTO-II by calculating an average intake over the span of the assessment for each type of intake. RADRISK data files are accessed directly by DARTAB.
- DPLT** Subroutine DPLT, called by AIRTRM, computes a correction factor for plume depletion. To make this calculation, DPLT calls both subroutines SIGMAZ and SIMPUN.
- ERORF** This subroutine uses the universal soil loss equation, USLE, developed by the U.S. Department of Agriculture (USDA, 1961) to determine sediment loading for rain-driven surface erosion. Estimation methods and tabulations for factors used in USLE have been published by McElroy et al. (1976).

The code user inputs all six of these factor values. The calculated erosion rate is returned to MAIN where it is converted to an annual erosion rate in meters. This erosion rate is utilized by MAIN to determine the thickness of the cap.

EVAP0

This subroutine calculates the areal evapotranspiration at watershed (nontrench) area of a site. As originally written by Morton (1976; 1978) the code considered only five-year averages of evapotranspiration and did not calculate infiltration. Morton's code has been adapted to calculate watershed infiltration on an annual basis and to consider water added via irrigation. As presently coded, watershed infiltration is calculated using fractional runoff values input by the code user.

User input parameters for subroutine EVAP0 are site latitude, annual precipitation, average monthly ratio of observed to maximum possible sunshine duration, average monthly dewpoint and ambient air temperatures, annual irrigation rate, and fractional runoff. These data may be obtained from National Climatological Summary tables (NOAA, 1979) and other sources (Geraghty et al., 1973; Olson, Emerson, and Nungesser, 1980). The calculated annual infiltration is used by subroutine TRENCH to maintain a water balance in the trench.

FOOD,FOODA

Subroutine FOOD is called only once per simulation and calculates the average concentration of each radionuclide in foods contaminated by atmospheric deposition and root uptake. The deposition input to FOOD is calculated in subroutine AIRTRM. The equations and internal parameters used by FOOD are those in AIRDOS-EPA (Moore et al., 1979). Output from FOOD is used by the subroutine HUMEX to calculate the human exposure via ingestion of these contaminated foodstuffs. Subroutine FOODA is called from MAIN each simulation year.

HUMEX,HUMEXA

Subroutine HUMEX accepts user supplied foodchain parameter and receives averaged data from subroutines AIRTRM, FOOD, IRRIG, and VERHOR to calculate the average annual human intakes via ingestion and inhalation. Output from HUMEX supplies the input to the DARTAB subroutines for calculations of risk and dose and tabulation of health results. Subroutine HUMEXA is called from MAIN each simulation year.

- IRRIG,IRRIGA** Foods may be irrigated with contaminated water from either surface or ground-water sources. Input to IRRIG, which is called only once per simulation, includes the time-averaged radionuclide concentrations in well or surface water calculated by VERHOR or subroutine SURSOL, respectively. IRRIG calls function COV and uses the equations taken from AIRDOS-EPA (Moore et al., 1979) to calculate the time-averaged concentration of each radionuclide from direct deposition by irrigation and subsequent root uptake in foodcrops. Subroutine IRRIGA is called from MAIN each simulation year.
- LEACH** Subroutine LEACH calculates the amount of each radionuclide from the homogeneous trench contents that leaves the trench each year. Losses may be via transport through the trench bottom or by overflow of the trench. There are five independent user-selected methods that may be used to calculate these amounts: the option is chosen by specifying a value from 1-5 for parameter LEAOPT. Table 2.2 lists the calculational methods corresponding to values of LEAOPT. The total-contact options, 1 and 3, assume that all of the trench contents have been contacted by water during the previous year. The immersed-fraction options, 2 and 4, assume that the wetted fraction of the waste equals the ratio of maximum water level to the trench depth. The distribution coefficient options, 1 and 2, utilize a k_d approach to calculate radionuclide concentration in the water, while options 3 and 4 use a solubility estimate rather than k_d . If the user specifies LEAOPT = 5, then a user-provided fraction of the total waste is lost through the trench bottom annually.
- Output from LEACH is the activity leaving the trench annually for each radionuclide through the bottom of the trench and by overflowing.
- OUT** This subroutine outputs an annual summary of the trench cap status, trench water balance, amount of water leaving trench, and radionuclide content in trench water, trench overflow water, aquifer, well water, and on the ground surface. The user may choose to print this summary for every year or less frequently by specifying the appropriate values of IPRT1, IPRT2, and IDELT in the input data deck.
- SIGMAZ** This subroutine is called by both AIRTRM and DFLT to compute the vertical dispersion parameter, SIGZ. Depending on the choice of value given to parameter IT in the input data set, SIGMAZ will calculate SIGZ by one of eight schemes, shown in

Table 3.1. Necessary input data include the downwind distance, XG, stability class, IS, Hosker roughness parameter, ROUGH, and lid height, HLID. Other data necessary for Lagrangian interpolations (by function YLAG) are contained internally in SIGMAZ and need not be input by the user.

SIMPUN	This subroutine, originally written by Barish (1970), uses Simpson's rule to integrate along the ground level center-line of the atmospheric plume to compute the depletion fraction. All input to SIMPUN is supplied by DPLT, the subroutine that calls SIMPUN and to which the results are returned.
SOURCE	Subroutine SOURCE performs most of the necessary inputs of information to initialize and quantify transport parameters, except that required for Subroutine INFIL. Data concerning program control, climatic description, trench description aquifer description, atmospheric description, site-surface description, and radionuclide description are read in by SOURCE from unit 5, stored on unit 26 and reread. SOURCE also prints out these data before any calculated results are output.
SURSOL	Subroutine SURSOL computes the amount of soluble radionuclide that enters the stream annually. Input variables to SURSOL include the average depth of active exchange in the soil, ADEPTH; the average downslope distance to the stream, PD; the cross slope extent of the spillage, EXTENT; the average annual infiltration, XINFL; the bulk density of soil, BDENS; the wet density of soil, DWET; and amount of spillage, SOAM; and the surface soil distribution coefficient, XKD. Variables output from SURSOL include SSTREM, SDEEP, and CW, the amounts of radionuclide going to the stream and the trench, and the radionuclide concentration in water, respectively.
SUSPND	This subroutine calculates the above trench atmospheric source term from the ground surface by two methods, a time-dependent resuspension factor and a resuspension rate due to mechanical disturbances. Input variables include the current year of simulation and radionuclide,

the spatial area of the contaminated surface, SAREA; the radionuclide concentration on the ground surface, GNDCON; the beginning and ending years of mechanical disturbances, IRRES1 and IRRES2; the resuspension rate, RR; and the wind velocity, U. SUSPND assumes that all radionuclides to be resuspended were deposited on the soil surface at simulation time zero. Material may be added to the atmospheric source term through two methods: resuspension by wind from surface soil, YSO1, and resuspension by mechanical disturbance, YSO2. The resuspension factor calculated uses the empirical equation of Anspaugh et al. (1975).

The atmospheric source term, YSO (referred to previously as algebraic variable Q), is returned to MAIN and is used along with E/Q to calculate the air concentration of each radionuclide available for deposition onto foodstuffs and for inhalation by the general population. The value of E/Q is calculated by AIRTRM.

TRENCH

Subroutine TRENCH determines the trench water balance. Input variables include trench dimensions, porosity and permeability of trench contents, trench water volume from the previous year, length of the saturated zone, annual precipitation and infiltration, and the current year of the simulation. Output from TRENCH includes the maximum depth of water in the trench, the volume of water in the trench, volume of water overflowing the trench, and water volume lost from the bottom of the trench.

The overflowing amount of water, VOLO, is calculated by comparing the maximum water depth to the trench depth and overflowing any amount greater than trench volume. The variables VOLO, VOLB, OLDWAT, and DMAX that quantify overflow, bottom loss, water level during the previous year, and maximum water depth in trench, respectively, are used by the subroutine LEACH, discussed previously.

VERHOR

This subroutine calculates and decays the amount of each radionuclide, AQAM, that reaches the irrigation/drinking water well in a given year. Variables evaluated elsewhere in the code and input to VERHOR include the current year of the simulation, NYEAR; transit time from the trench to the well, ITIME; the volume of water leaving the trench bottom, VOLB; the amount of each radionuclide leaving the bottom of the trench, POLB; and the radioactive decay constant, DECAI.

YLAG This function performs a Lagrangian interpolation of the SIGZ block data and is called by subroutine SIGMAZ. The original program was written by Brooks and Long (1970) and adapted for use here. All input data are supplied by SIGMAZ.

3.3 USER INPUT TO PRESTO-II

There are basically three types of data that are needed to execute PRESTO-II. They are: (1) site-specific and radionuclide data used in transport section of the code for calculating concentrations, (2) data used specifically by DARTAB and submitted for creating tabular output, and (3) dosimetric and health effects data (created by RADRISK) also used by the DARTAB submodel. Preparation of data will be explained in the following sections.

3.3.1 Site Specific Data

Site specific environmental and nuclide data have been compiled for each of three sites (Barnwell, Beatty, and West Valley). An appendix is included in this report for each of the three sites, to support the data in this section.

Some of the data for each site were readily available, and others were estimated from other sites. Easily available data include site location (latitude and longitude), precipitation amount, monthly mean temperatures, soil porosity, soil bulk density, depth of aquifer, trench dimensions, depth of overburden, location and flow of surface water bodies and wells, topography, average meteorology, location of population centers, etc. Data about which considerable uncertainty still exists include ground-water flow velocity both vertically and horizontally, element-specific retardation as a function of the distribution coefficients (k_d) and the activity inventory by nuclide of each site. Estimates of the aquifer flow velocity are available from USGS investigations or other sources such as site operators (Chem-Nuclear Systems, Inc., 1980; Giardina et al., 1977; Clebsch, 1968). The effects of these and other uncertainties may be evaluated at a later date.

A recent survey of k_d values for agricultural soils (Baes and Sharp, 1983) was the primary source of distribution coefficient data. The activity inventory of the sites may be the least accessible of any of the necessary data. For the Barnwell facility, incoming radionuclide activity has been listed on a computerized data base. These data are probably the most reliable of the three sites, but are also proprietary until published in the open literature. The West Valley facility radionuclide inventory was described by EPA in 1977 (Giardina et al., 1977). However, the inventory was described without reference to specific radionuclides in most cases. Virtually no data on activity inventory exist for the Beatty site; inventory input for that site were estimated by merging the inventories from other facilities.

The necessary data for the food chain, human exposure, dose, and risk portions of PRESTO-II are generally generic in nature. Transfer coefficients for crops, meat, and milk, and human ingestion and inhalation rates are taken from AIRDOS-EPA (Moore et al, 1979) or other assessment literature (Baes et al., 1982). Site-specific food chain data include the productivity of pasture grass and produce, the irrigation rates, and the amount of land irrigated.

Table 3.2 is a description of the site specific input data format. Values of the listed variables for the Barnwell, Beatty, and West Valley sites, respectively, in the described format are included in the input listing in Appendices C-E. The site specific data is read from logical unit numbers four and five (see Appendix B). The site-specific input data are described in Tables 3.3, 3.4, 3.5, and 3.6.

3.3.2 Input for DARTAB Subroutine

This input provides the user options for processing the exposure data, dosimetric data, and tabulations of output. The first data card is a title card. The remaining data are read using the IBM FORTRAN NAMELIST format. The data must be in a special form in order to be read with NAMELIST. The data is grouped in NAMELIST groups. (The first character in each data record to be read must be a blank and the first record of each group must have an @ as its second character followed by the NAMELIST group name.) The name cannot contain embedded blanks and must be followed by a comma. The data items follow, separated by commas. The data items are of the form:

variable name = constant or

array name = constant, separated by commas.

The order of data items in a NAMELIST group is not important, but arrays that refer to nuclides should have the constants in the same order as data for Sect. 3.3.1. The end of a NAMELIST group is designated by @END. An example of this type of input can be seen in Appendix C. Table 3.7 lists the NAMELIST group names and the variables in each group.

The data described in this section are read from logical unit number 5 and must follow directly after the data of Sect. 3.3.1.

The remainder of this section will describe pertinent values of the variables utilized by DARTAB, as listed in Table 3.7 and 3.8. The rationale for each value and alternative values may be discussed briefly.

Namelist INPUT: ILOC, JLOC. These are the direction indices of the exposure array that is used to locate an individual for which a dose or risk table is printed. AIRDOS-EPA, the code for which DARTAB was originally written, supplied a two-dimensional exposure array to DARTAB. PRESTO-II, however, supplies only a mean exposure value for each of

air concentration, ground surface concentration, collective inhalation rate and collective ingestion rate, for only one location. These values are the first entry of the array; hence, both indices should be specified as 1.

PLOC. This variable is an indirect indicator of location. Because PRESTO-II does not provide a two-dimensional exposure array to DARTAB, PLOC should be set to 100 or omitted.

AGEX. Current mean life expectancy, weighted for sex ratio is 70.7. Later census data may change this value.

ILET. For LLW disposal site simulations with a mixture of nuclides, ILET should be set to 1,1 meaning a combined LET table for both dose and risk tables. For the intrusion scenario, where external exposures are of greater importance, the user may wish to set ILET to 2,2.

DTABLE, RTABLE, FTABLE. These variables, each dimensioned by seven, indicate which type of detailed dose, risk and risk equivalent table, respectively, will be printed. The type of table printed for each position in the variable array is shown in Table 3.9. A zero entered for a given array position indicates that no table of that type will be printed. A value of one will lead to a table for the "selected individual." A value of two will yield tables for the mean individual. Specifying three will create tables for the collective population, while a four will give tables for the "selected individual," the mean individual and the population. Individual and Tabulation options are summarized in Table 3.9.

Because PRESTO-II considers each individual in the population to be a mean individual, the tables of selected individual and mean individual will be identical. Users wishing to consider only population impacts should specify 3 rather than 4 for each desired table type.

OUTPUT. If specified .TRUE., then NONCLD pages, one per radionuclide will be output to list the dose rate factors. These are probably not desired for every run.

GSCFAC. Except where extenuating situations exist in given site-specific applications, we suggest using a value of 1.0.

Namelist ORGAN: NORGN, ORGN. Table 3.8 lists a value of 18 to correspond to the names shown there. In all likelihood, users may not wish to see all of these dose rates and therefore should reduce both NORGN and ORGN.

TIME. We have chosen a 70-year dose commitment for each organ dose. If NORGN is changed, the number of values specified by TIME must also be changed.

Namelist QFACTOR: HLET, LLET. We suggest using the default values of 20 and 1 for high and low linear energy transfer (LET) relative biological effectiveness factors, respectively. Each of these variables is an array NORGN values long.

Namelist CANCER: NCANC, CANC. Table 3.8 lists the 18 cancers we recommend for inclusion.

RELABS. We suggest using the absolute risk model and therefore specify RELABS = 1 for each cancer.

Namelist GENTIC: GENEFF. Genetic effects will be output if GENEFF = .TRUE. and will not be output if .FALSE.

NGEN, GEN. In Table 3.8 we suggest three organs to be considered for genetic effects. These include testes, ovaries, and the average of the two.

GRFAC. As specified by Begovich et al. (1981), we suggest a low-LET risk conversion factor of 200 and a high-LET risk conversion factor of 20,000.

REPPER. We use the DARTAB default population replacement rate of 0.014133 yr^{-1} .

GLLET, GHLET. The low- and high-LET relative biological effect factors for genetic doses; set the same as LLET and HLET, 1 and 20, respectively.

Namelist RNUCLD: NONCLD. This number must be equivalent to the same variable in transport portion of code, Card 3, but always less than or equal to 40.

NUCLID. Alphanumeric names of the NONCLD radionuclides. Must be written without imbedded blanks as shown in Table 3.5 of 3.10. Must be listed here in same order as in transport section of input, cards 26+.

PSIZE. As used by Begovich et al. (1981), we suggest using 1.0 μm for each radionuclide except gases. This will ensure deposition in the lung.

RESP. A respiratory clearance class, either day ('D'), week ('W'), year ('Y'), gas ('*'), or not used (' ') must be entered for each nuclide in the form expected in the trench. Values for most likely nuclides may be found in Table 3.10. More extensive lists are given in Sullivan et al. (1981) and Eckerman, Ford, and Watson (1981).

GIABS. The absorption factor for each of the four segments of the GI tract for each nuclide must be entered. The DARTAB code expects to read a value for each segment (stomach, small intestine, upper large intestine and lower large intestine). However, most existing metabolic models assume that only in the small intestine are materials absorbed (Sullivan et al., 1981; Eckerman, Ford, and Watson, 1981); therefore, the input zero values for all GD sections except the small intestine (Table 3.10).

Namelist LOCTAB: NTLOC. Since PRESTO-II does not provide a location array of environmental concentrations to DARTAB, NTLOC must be set to zero.

RNLOC. We suggest setting this value to SUM rather than printing numerous radionuclide tables. Certain applications may require output on individual nuclides.

OGLOC. Again, we suggest printing the summation of all cancers. Note that this will have a greater effect if the number of cancers is larger than if listed as whole body only.

PTLOC. This variable specifies the pathway to use in printing the location table. Values of 1-7 will result in ingestion, inhalation, air immersion, ground surface exposures, internal exposures (sum of ingestion and inhalation), external exposures (sum of air immersion and ground surface exposures), and total, respectively.

FALOC. Similar to variable ILET. A combined table will be printed if 2 is specified.

HLLOC. Should be set equivalent to FALOC.

LTABLE. For the data set listed in Table 3.8, we suggest printing values for the collective group. Calculations under certain scenarios (i.e., intrusion, farming) may dictate setting LTABLE = 1.

Namelist ORGANE: The International Commission on Radiological Protection has recently suggested use of the risk equivalent which is a stochastic weighting of radiosensitivity of various organs in the body from exposure to whole body radiation. This namelist includes these organ dose weighting factors for 18 organs (NORGB = 18). Names and weighting factors of the organs are listed in Table 3.10. We suggest specifying IPATH = 5 for all 18 organs. Further, we suggest above that FTABLE, the detailed results of risk equivalent calculations, not be printed.

3.3.3 Input for EVAPO Subroutine

Input data required for subroutine EVAPO consists of average yearly site precipitation, average barometric pressure, average irrigation rate, site latitude, and monthly values of mean ambient temperature, mean dewpoint temperature, and mean ratio of observed to maximum solar input.

If, and only if, input parameters IVAP input card 4 has a value of 4, the code user must include hourly precipitation data for days when precipitation occurred. Data are listed in units of 0.1 mm/h, one day per card. If no measurable precipitation fell on a given date, it is not included in the data list. (The first day of each month is listed whether or not it rained then.) Values in Tables C.8, D.5, and E.5 are 1978 values for Augusta, Georgia; Beatty, Nevada; and Salamanca, New York, respectively, as supplied by the National Climatic Data Center, Asheville, North Carolina, sites relatively nearby the three considered LLW disposal areas.

These data are as described in Tables 3.2 and 3.3, while parameter values are given in Tables 3.4 and 3.12 and in Appendices D, E, and F.

3.3.4 Dosimetric and Health Effects Data

This data set is read in an unformatted form from logical unit number 25 (see job control language, Appendix B). This data file is on a magnetic tape which contains information about many radionuclides. This data was created by executing RADRISK (Dunning, Leggett, and Yalcintas, 1980). This data file should be sufficient to meet most users' needs. For a further description see the DARTAB user's guide (Begovich et al., 1981) and the RADRISK documentation.

Table 3.1. Interactions between major PRESTO-II subroutines

Subroutine name	Called by	Input	Output
AIRTRM	MAIN	Atmospheric parameters	Deposition rate; atmospheric dispersion coefficient
DARTAB	MAIN	Air concentrations, human intake by inhalation and ingestion, population size	Health risks, radiological doses
DPLT	AIRTRM	Atmospheric parameters; vertical dispersion coefficient	Plume depletion coefficient
ERORF	MAIN	Erosion parameters	Erosion rate
FOOD FOODA	MAIN	Food chain parameters, atmospheric concentration	Concentrations in meat, milk, and produce
EVAPO	MAIN	Site environmental data	Watershed infiltration
HUMEX HUMEXA	MAIN	Concentrations in meat, milk, water, produce, and air	Human intake by inhalation and ingestion
IRRIG IRRIGA	MAIN	Food chain parameters, concentrations in water	Concentrations in meat, milk, and produce
LEACH	MAIN	Trench and waste characteristics; water overflowing or percolating	Activity overflowing, activity percolating
OUT	MAIN		Prints annual summaries

Table 3.1 (continued)

Subroutine name	Called by	Input	Output
SIGMAZ	AIRTRM DPLT	Dispersion scheme choice; other atmospheric parameters	Vertical dispersion coefficient
SIMPUN	DPLT	Control parameters	Simpson's rule integral
SOURCE	MAIN	Reads site data	Returns site data to rest of code
SURSOL	MAIN	Surface characteristics, distributions coefficient	Concentrations in stream, surface soil, added to aquifer
SUSPND	MAIN	Trench characteristics, surface characteristics, suspension factors	Atmospheric source term, air concentration above trench
TRENCH	MAIN	Trench dimension, characteristics, annual infiltration	Water depth in trench, volume overflowing and leaving bottom
VERHOR	MAIN	Aquifer characteristics, dispersion correction integral	Activity in well

Table 3.2. PRESTO-II environmental and nuclide input data format

Card number	Format	Variables	
		Name	Meaning
1	20A4	TITLE	
2	20A4	LOCATE	Burial site information
		<u>Code Control Data 1</u>	
3	15I5		
	I5	MAXYR	Length of simulation (yr)
	I5	NONCLD	Number of radionuclides
	I5	LEAOPT	Leaching option
	I5	NYR1	First year of cap failure function
	I5	NYR2	Last year of cap failure function
	I5	IOPVWV	Vertical water velocity option
	I5	IOPSAT	Saturation option
	I5	IPRT1	Yearly print out beginning (yr)
	I5	IPRT2	Yearly print out ending (yr)
	I5	IDELT	Print annual summary each IDELT years
	I5	IRRES1	Mechanical suspension beginning year
	I5	IPRES2	Mechanical suspension ending year
	I5	LIND	Population indicator
	I5	IAVG1	First year of averaging window
	I5	IAVG2	Last year of averaging window
		<u>Code Control Data 2</u>	
4	3I5		
	I5	IVAP	Trench cap infiltration switch
	I5	IBSMT	Basement calculation beginning year
	I5	IAQSTR	Aquifer to stream switch
		<u>Cap Integrity and Water Use Data</u>	
5	8F10.0		
	F10.0	PCT1	Fraction of cap failure at year NYR1
	F10.0	PCT2	Fraction of cap failure at year NYR2
	F10.0	WATL	Fractional well water use for land (1.0 if all land water comes from well, 0.0 if none)
	F10.0	WATA	Fractional well water use for animals (1.0 if all water comes from well, 0.0 if none)
	F10.0	WATH	Fractional well water used by humans (1.0 if all human water used from well, 0.0 if none)
	F10.0	SATL	Fractional surface water use for land (1.0 if all land water comes from surface, 0.0 if none)
	F10.0	SATA	Fractional surface water use for animals (1.0 if all animal water comes from surface, 0.0 if none)
	F10.0	SATH	Fractional surface water use by humans (1.0 if all human water used comes from surface, 0.0 if none)

Table 3.2. (continued)

Card number	Format	Variables	
		Name	Meaning
<u>Evapotranspiration Data</u>			
6	4F10.0		
	F10.0	PPN	Average precipitation (m/yr)
	F10.0	P	Average barometric pressure (mbar)
	F10.0	XIRR	Irrigation (m/yr)
	F10.0	PHID	Site Latitude (degrees)
7-8	12F10.0	S(I)	Ratio of observed to maximum sunshine twelve monthly values (Jan.-Dec.)
9-10	12F10.0	T(I)	Average ambient temperature (°C) twelve monthly values (Jan.-Dec.)
11-12	12F10.0	TD(I)	Average dewpoint temperature (°C) twelve monthly values (Jan.-Dec.)
<u>Trench Data</u>			
13	8F10.0		
	F10.0	TAREA	Trench area (m ²)
	F10.0	TDEPTH	Trench depth (m)
	F10.0	OVER	Cap thickness (m)
	F10.0	PORT	Trench porosity
	F10.0	DENCON	Density of waste materials (g/cm ³)
	F10.0	REL FAC	Annual activity release fraction
	F10.0	FN	Ratio of trench cap to watershed infiltration
	F10.0	XINFL	Non-trench annual infiltration rate (m/yr)
14	F10.0	PERMC	Trench permeability (m/yr)
<u>Aquifer Data</u>			
15	8F10.0		
	F10.0	DTRAQ	Trench to aquifer depth (m)
	F10.0	DWELL	Trench to well distance (m)
	F10.0	GWV	Groundwater velocity (m/yr)
	F10.0	AQTHK	Aquifer thickness (m)
	F10.0	AQDISP	Aquifer dispersion angle (radians)
	F10.0	PORA	Aquifer porosity
	F10.0	PORV	Subtrench porosity
	F10.0	PERMV	Subtrench permeability (m/yr)
<u>Atmospheric Data 1</u>			
16	7F10.0		
	F10.0	H	Atmospheric source height (m)
	F10.0	VG	Gravitational fall velocity (m/s)
	F10.0	U	Mean wind speed (m/s)
	F10.0	VD	Deposition velocity (m/s)
	F10.0	XG	Source-to-receptor distance (m)
	F10.0	HLID	Atmospheric lid height (m)
	F10.0	ROUGH	Hosker roughness factor (m)

Table 3.2. (continued)

Card number	Format	Variables	
		Name	Meaning

<u>Atmospheric Data 2</u>			
17	7F10.0		
	F10.0	FTWIND	Fraction of time wind blows toward population
	F10.0	CHIQ	User-specified E/Q for impacted population
	F10.0	RE1	Beginning coefficient in resuspension equation
	F10.0	RE2	Decay factor in resuspension equation
	F10.0	RE3	Final coefficient in resuspension equation. Values of RE1, RE2, and RE3 must include both the algebraic sign and the magnitude.
	F10.0	RR	Resuspension rate (s^{-1})
	F10.0	FTMECH	Fraction of year mechanical disturbance occurs
<u>Atmospheric Data 3</u>			
18	2I5		
	I5	IT	Type of stability class formulation
	I5	IS	Stability class
<u>Universal Soil Loss Equation Factors</u>			
19	6F10.0		
	F10.0	RAINF	Rainfall factor
	F10.0	ERODF	Erodability factor
	F10.0	STPLNG	Slope steepness-length factor
	F10.0	COVER	Cover factor
	F10.0	CONTRL	Erosion control factor
	F10.0	SEDELR	Sediment delivery factor
<u>Surface Soil Data 1</u>			
20	5F10.0		
	F10.0	PORS	Soil porosity (unitless)
	F10.0	BDENS	Soil bulk density (gm/cm^3)
	F10.0	STFLOW	Stream flow rate (m^3/yr)
	F10.0	EXTENT	Cross slope extent of spillage (m)
	F10.0	ADEPTH	Depth of soil active region for soluble contamination (m)
<u>Surface Soil Data 2</u>			
21	2F10.0		
	F10.0	PD	Average downslope distance (m)
	F10.0	RUNOFF	Fraction of precipitation runs off

Table 3.2. (continued)

Card number	Format	Variables	
		Name	Meaning

<u>Air-Foodchain Data 1</u>			
22	6F10.0		
	F10.0	Y1	Productivity for grass ($\text{kg}/\text{m}^2 \text{ yr}$)
	F10.0	Y2	Productivity for vegetation ($\text{kg}/\text{m}^2 \text{ yr}$)
	F10.0	PP	Surface density for soil (kg/m^2)
	F10.0	XAMBWE	Weathering decay constant (h^{-1})
	F10.0	TE1	Period pasture grass exposed during growing season (h)
	F10.0	TE2	Period crops/veg. exposed during growing season (h)

<u>Air-Foodchain Data 2</u>			
23	8F10.0		
	F10.0	TH1	Period between harvest of pasture and ingestion by animal (h)
	F10.0	TH2	Period between storage of feed and ingestion by animal (h)
	F10.0	TH3	Period between harvest of leafy vegetation and ingestion by man (h)
	F10.0	TH4	Period between harvest of produce and ingestion by man (h)
	F10.0	TH5	Period between harvest of leafy vegetables and ingestion by man for general population exposure (h)
	F10.0	TH6	Period between harvest of produce and ingestion by man for general population exposure (h)
	F10.0	FP	Fraction of year that animals graze on pasture
	F10.0	FS	Fraction of daily feed that is fresh grass, while animals are on pasture

<u>Air-Foodchain Data 3</u>			
24	7F10.0		
	F10.0	QFC	Amount of feed consumed daily by cattle (kg)
	F10.0	QFG	Amount of feed consumed daily by goats (kg)
	F10.0	TF1	Transport time feed-mill-receptor for maximum individual exposure (h)
	F10.0	TF2	Transport time feed-mill-receptor for general population exposure (h)
	F10.0	TS	Time from slaughter of meat to consumption (h)
	F10.0	ABSH	Absolute humidity of the atmosphere (g/m^3)
	F10.0	P14	Fractional equilibrium ratio for C-14

Table 3.2. (continued)

Card number	Format	Variables	
		Name	Meaning
<u>Water-Foodchain Data</u>			
25	5F10.0		
	F10.0	FI	Fraction of year crops are irrigated
	F10.0	WIRATE	Irrigation rate (L/m ² -h)
	F10.0	QCW	Amount of water consumed by cows (L/d)
	F10.0	QGW	Amount of water consumed by goats (L/d)
	F10.0	QBW	Amount of water consumed by beef cattle (L/d)
<u>Human Intake Data</u>			
26	8F10.0		
	F10.0	ULEAFY	Leafy vegetation (kg/yr)
	F10.0	UPROD	Produce (kg/yr)
	F10.0	UCMILK	Cow milk (L/yr)
	F10.0	UGMILK	Goat milk (L/yr)
	F10.0	UMEAT	Meat (kg/yr)
	F10.0	UWAT	Drinking water (L/yr)
	F10.0	UAIR	Inhalation rate (m ³ /yr)
	F10.0	POP	Population
<u>Radionuclide Inventory Data</u>			
27	A8,2X, 6F10.0		
	A8,2X	NUCLID(I)	Radionuclide name
	F10.0	TRAM(I)	Amount of NUCLID(I) in trench at t = 0 (Ci)
	F10.0	SOAM(I)	Amount of spillage on surface at t = 0 (Ci)
	F10.0	STAM(I)	Amount of radionuclide in stream at t = 0 (Ci)
	F10.0	ATAM(I)	Amount of radionuclide in air above trench at t = 0 (Ci)
	F10.0	DECAY(I)	Decay constant (yr ⁻¹)
	F10.0	SOL(I)	Solubility (g/mL)

Table 3.2. (continued)

Card number	Format	Variables	
		Name	Meaning
<u>Chemical Exchange (k_d) Data</u>			
28	A8,2X, 4F10.0		
	A8,2X	NUCLID(I)	Radionuclide name
	F10.0	XKD(1,I)	Surface k_d (mL/g)
	F10.0	XKD(2,I)	Trench k_d (mL/g)
	F10.0	XKD(3,I)	Subtrench vertical zone k_d (mL/g)
	F10.0	XKD(4,I)	Aquifer k_d (mL/g)
<u>Radionuclide-Specific Foodchain Data</u>			
29	A8,2X, 9F10.0		
	A8,2X	NUCLID(I)	Radionuclide name
	F10.0	RA(I)	Retention fraction for air
	F10.0	RW(I)	Retention fraction for irrigation
	F10.0	BV(1)	Soil-to-plant uptake factor for vegetative parts
	F10.0	BR(I)	Soil-to-plant uptake factor for reproductive parts (grain)
	F10.0	FMC(I)	Forage-to-milk transfer factor for cows
	F10.0	FMG(I)	Forage-to-milk transfer factor for goats
	F10.0	FF(I)	Forage-to-beef transfer factor
30,33+		- same as card 27 for subsequent radionuclides -	
31,34+		- same as card 28 for subsequent radionuclides -	
32,35+		- same as card 29 for subsequent radionuclides -	
<u>Optional Hourly Precipitation Data</u>			
--	2(I2,1X), 24F3.0)		
	I2	MO	Month of rainfall event
	I2	IDA	Day of rainfall event
	24F3.0	HP	Hourly precipitation values for MO and IDA (tenths of mm) (one data card for each day having measurable precipitation) (last card must have "99" in first two columns)

Table 3.3. Description of site-specific input data

CARD 1	TITLE. Identifies the run; may be up to 80 characters in length.
CARD 2	LOCATE. Lists the location of the disposal site; up to 80 characters in length.
CARD 3	<p>Code Control Data 1.</p> <p>MAXYR. The number of years for which the simulation will run.</p> <p>NONCLD. The number of radionuclides which are used in the simulation; must be 40 or less.</p> <p>LEAOPT. The leaching option. Radionuclides will be removed from trench in different manners depending on the value of LEOPT. Must be 1-5.</p> <p>NYR1, NYR2. Beginning and ending years of cap failure function (see description of function CAP in Sect. 3.2). Both values must be less than or equal to MAXYR. NYR2 must be greater than or equal to NYR1.</p> <p>IOPVWV. Option for calculation of the vertical water velocity (VWV) below the trench. If IOPVWV = 1 then VWV equals infiltration rate divided by soil porosity. If IOPVWV $\neq$ 1 then VWV equals the permeability.</p> <p>IOPSAT. Option to control length of saturated flow (XLSAT) below trench. If IOPSAT = 1 then XLSAT equals quotient of infiltration and porosity. If IOPSAT $\neq$ 1 then the saturated length is set to the vertical distance from trench bottom to aquifer.</p> <p>IPRT1, IPRT2, IDELT. Variables to control beginning year of annual summary, ending year, and the time step between printing, respectively. An annual summary will be printed for each year between years IPRT1 and IPRT2 into which IDELT divides evenly.</p> <p>IRRES1, IRRES2. Beginning and ending year of mechanical suspension of contaminated soil into atmosphere. Used for farming scenario.</p> <p>LIND. If LIND = 0, then PRESTO-II computes concentrations and rates for maximally exposed individuals. If LIND = 1, then general population concentrations are computed. This value is used solely by DARTAB, and a value of 1 is suggested.</p> <p>IAVG1, IAVG2. Beginning and ending years of averaging of concentration values.</p>

Table 3.3. (continued)

CARD 4

Code Control Information 2.

IVAP. Switch for calculating trench cap infiltration. If IVAP = 1, cap infiltration is calculated as a fraction of non-trench infiltration. If IVAP = 2 or 0, the value input as XINFL on card 13 is used. If IVAP = 3, cap infiltration is calculated as the minimum value of annual precipitation (m/yr) and trench cap permeability (m/yr). If IVAP = 4, cap infiltration is calculated as the sum of, on an hourly basis, the minimum values of the hourly precipitation rate (m/yr) and the trench cap permeability (m/yr).

IBSMT. The beginning year for application of the basement correction factor for surface gamma exposure calculations made by DARTAB. If IBSMT $\neq$ 0, the correction factor is calculated beginning in that year. If IBSMT = 0, then no correction is calculated.

IAQSTR. If IAQSTR is greater than 0, water and radionuclide not removed from the aquifer at the well is added to the stream.

CARD 5

Cap Integrity and Water Use Data 1.

PCT1, PCT2. The fraction of the cap that is assumed failed by some artificial means in years NYR1 and NYR2, respectively. Failure of the cap constitutes total removal of all cap, of OVER thickness, for PCT1 of the trench area in NYR1 and for PCT2 of the trench area in NYR2. Between NYR1 and NYR2 a linear interpolation is performed between pairs (NYR1, PCT1 and NYR2, PCT2) to calculate the amount of the trench area that is totally bare. Even if PCT1 and PCT2 are set at zero, the trench cap may ultimately fail through erosion; see description of function CAP and subroutine ERORF.

WATL. Fraction of well water use for irrigation (1.0 if water comes from well, 0.0 if none). The sum of WATL and SATL should be 1.0, and mass should be similarly conserved for WATA and SATA and for WATH and SATH.

WATA. Fraction of well water use for animals (1.0 if water comes from well, 0.0 if none).

WATH. Fraction of well water used by humans (1.0 if watered used from well, 0.0 if none).

SATL. Fraction of surface water used for irrigation (1.0 if water comes from surface, 0.0 if none).

Table 3.3. (continued)

	SATA. Fraction of surface water used for animals (1.0 if all water comes from surface, 0.0 if none).
	SATH. Fraction of surface water used by humans (1.0 if all water used comes from surface, 0.0 if none).
CARD 6	PPN. Average precipitation in the site county. Values in Table 3.2 were taken from the geoecology data base (Olson, Emerson, and Nungesser, 1980). Units are meters per year.
	P. Average barometric pressure in millibars. Values in Table 3.2 for each site county were taken from Olson, Emerson, and Nungesser (1980).
	XIRR. Average irrigation rate of the county (m/yr). Used in EVAPO calculations of infiltration.
	PHID. This is the latitude in decimal degrees, e.g., 33.269°, not 33° 16' 8.4''. For a site in the southern hemisphere, PHID is negative.
CARDS 7-8	S(I). Twelve monthly mean values of ratio of observed to maximum sunshine for county of site. Must be entered in order from January through December. Values in Tables 3.3 and 3.11 taken from Olson, Emerson, and Nungesser (1980) must be entered in order from January-December. Must be entered in order from January-December. Tables 3.3 and 3.11 values from Olson, Emerson, and Nungesser (1980).
CARDS 9-10	T(I). Twelve monthly mean values of ambient temperature (°C). Must be entered in order from January-December. See Table 3.3.
CARDS 11-12	TD(I). Twelve monthly mean values of dewpoint temperature (°C). Must be entered in order from January-December. Table 3.3 values from Olsen, Emerson, and Nungesser (1980).
CARD 13	Trench Data.
	TAREA. The total combined trench horizontal cross-sectional area for the hypothetical trench being simulated. The effects of only one trench are calculated. Values listed in Table 3.3 are characteristic of single trench at each site. Must be ≥ 0 .
	TDEPTH. Nominal depth (m) of operating trench, ground surface to bottom.

Table 3.3. (continued)

	OVER. Thickness of trench overburden in m.
	PORT. Porosity of material within trench. Values in Table 3.3 are set equal to estimated soil porosity for site, PORS. Must be ≥ 0 .
	DENCON. Mean density of the waste materials in the trench (g/cm^3).
	RELFAC. The annual fraction of the total trench inventory of each radionuclide that is released if LEAOPT is chosen 5 (see CARD 3).
	FN. Ratio of trench cap infiltration to watershed (non-cap) infiltration. Used for IVAP = 1.
	XINFL. Annual infiltration rate for trench cap (m/yr). Used for IVAP = 2.
CARD 14	PERMC. Trench cap permeability (m/yr). Used for IVAP = 3 or IVAP = 4.
CARD 15	Aquifer Information.
	DTRAQ. The distance from the bottom of the trench to the nominal depth of the aquifer (m). $\text{DTRAQ} + \text{TDEPTH} + \text{OVER}$ should equal the aquifer depth below surface.
	DWELL. Distance from the trench to the well used for irrigation and drinking (m). For Barnwell, the number represents the distance to the nearest spring. For Beatty, the value in Table 3.3 is the distance to the nearest stream bed. For West Valley, the listed value of DWELL is assumed. Must be ≥ 0 .
	GWV. Velocity of the groundwater in the aquifer (m/y). Flow rates for Barnwell and Beatty were taken from Chem-Nuclear Systems, Inc. (1980) and Clebsch (1968), respectively. Values for West Valley were estimated from Giardina et al. (1977) and Prudic (1981). Must be entered ≥ 0 .
	AQTHK. Thickness of the aquifer at the location of the well (m). This is used to calculate the volume of water in which the available radionuclides are diluted. Values in Table 3.3 are from references cited for GWV but are uncertain. Must be ≥ 0 .
	AQDISP. Dispersion angle of the pollutant plume in the aquifer (radians). Used with AQTHK to calculate dilution volume. Values in Table 3.3 are arbitrary. Must be entered $\leq \pi$ radians.

Table 3.3. (continued)

PORA. Aquifer porosity.
 PORV. Subtrench porosity.
 PERMV. Subtrench permeability (m/yr).

CARD 16

Atmospheric Data 1.

H. Atmospheric source height (m). One meter chosen because most resuspension rate measurements are expressed of that height.

VG. Fall velocity of contaminated soil particles due to gravity (m/s). Values in Table 3.3 chosen after reviewing soil type classifications for counties of interest from Olson, Emerson, and Nungesser (1980). More precise values could be ascertained from measurements of surface particle distribution at each site and application of Stokes's Law.

U. Annual average wind speed (m/s) in the direction of interest. For population calculations, the wind speed towards the population centroid. Site specific data is generally not available, but data from the nearest STAR data site may be used. Must be entered ≥ 0 .

VD. Deposition velocity (m/s). Values in Table 3.3 are set equal to VG based on the suggestion by Sehmel (1980) that for large particles V_d approaches V_g . Nominal generic value is 0.01 m/s.

XG. Distance (m) from source (trench) to population or individual of interest. Values in Table 3.3 estimated from site description reports and maps of area.

HLID. Height of the inversion layer or lid (m). Data taken from averaged STAR data for the nearest meteorology station of interest.

ROUGH. Hosker's roughness parameter (m) (Hosker, 1974). Value used is considered generic.

CARD 17

Atmospheric Data 2.

FTWIND. Fractions of the time wind blows towards the population or individual of interest. Site-specific values taken from mean wind rose of nearest STAR data meteorology site.

Table 3.3. (continued)

CHIQ. The user-specified dispersion coefficient for the population of interest may be calculated by an external atmospheric dispersion code such as Moore et al. (1979). If ≥ 0 , will override any calculation of atmospheric dispersion within code.

RE1, RE2, RE3. Factors (including algebraic signs) in the resuspension rate equation $RE = RE1 \exp(RE2 \sqrt{t}) + RE3$.

RR. During the period between years IRRES1 and IRRES2, the resuspension rate RR (sec^{-1}) will be included as a source term to subroutine AIRTR. See description of subroutine SUSPND, Sect. 3.2.

FTMECH. The rate of resuspension, RR , will be modified by this fraction, which has a value between zero and unity.

CARD 18

Atmospheric Data 3.

IT. Indicator variable for type of stability class formulation. Suggested formulation is Pasquill-Gifford, $IT = 1$.

IS. Stability category indicator. Values of 1-6 correspond to stability categories of A-F. Single value represents most common stability category from nearest meteorology station to site of interest.

CARD 19

Factors for the Universal Soil Loss Equation (USLE). The parameterization scheme of McElroy et al. (1976) was used to generate each of the six factors on this card.

RAINF. The rainfall factor. Values in Table 3.3 were taken from Fig. 3.2, p. 44 of McElroy et al. (1976).

ERODF. The soil-erodibility factor has units of tons/ac-R where $R = \text{RAINF}$ above. Soil characteristics that influence or determine $ERODF$ for each site are shown in Table 3.5. These data were taken from site description reports or from a description of chemical characteristics of great soil groups by county in Olson, Emerson, and Nungesser (1980). Data for Beatty are less certain than the other sites and should be viewed circumspectly.

Table 3.3. (continued)

STPLNG. The slope steepness-length factor. For each site, the slope steepness and length of slope were estimated using schematic diagrams and aerial photographs of the site. Assuming a regular slope, these estimates were applied to ascertain values of topographic factor, LS, from Fig. 3.8 of McElroy et al. (1976). STPLNG was equated to LS.

COVER. The crop management factor. We assume that the trench has been successfully reseeded into some grassy species. According to McElroy et al. (1976) Table 3.3, the value of the cover factor ranges from 10^{-4} –0.45 for permanent vegetation, including pasture, from 0.004–0.3 for established meadows and from 0.07–0.5 for small grains. Wishing to conservatively estimate erosion, we chose a value of 0.3 for all sites.

CONTRL. The erosion control practices factor. Assuming reasonable soil conservation practices if farming of site occurs, we chose a value of 0.5 from Table 3.7 of McElroy et al. (1976). All three sites exhibit a slope in the range of 2–7%.

SEDELR. The sediment delivery ratio. This ratio is intended to apply to the fouling of waterways from construction activity. Because the trench is supposedly revegetated, we assumed a value of 1.0 for this factor in all cases.

CARD 20

Surface Soil Data 1.

PORS. Porosity of the surface soil. Values taken from site description reports referenced earlier. Must be ≥ 0 .

BDENS. Bulk density of the soil (g/cm^3). Values in Table 3.3 are roughly the national average. Must be entered ≥ 0 .

STFLOW. Annual flow rate of the nearest stream (m^3/yr). Estimated from site descriptions. Must be ≥ 0 .

EXTENT. The cross slope extent of the surface region contaminated by operational spillage in m. Value in Table 3.3 is equal to the length of the trench as referenced. Must be nonzero.

ADEPTH. The active depth of soil in the surface contaminated region (m). Used for calculation of radionuclide concentration in both surface soil and surface water. Arbitrarily chosen to be 0.1 cm; must be nonzero.

Table 3.3. (continued)

CARD 21 **Surface Soil Data 2.**

PD. Horizontal distance from trench to nearest stream (m). Estimated from site description reports. Must be ≥ 0 .

RUNOFF. Fraction of the annual precipitation that runs off annually. Values in Table 3.3 are estimated from precipitation run off estimates from U.S. Geological Survey (Robertson, personal communication, USGS, Reston, Virginia, 1981; CNSI, 1980; and Geraghty et al., 1973).

CARDS 22-26 **Foodchain Data.**

Most of the data on these cards pertain to transfer to materials through the foodchain. Since we utilize equations analogous to those of AIRDOS-EPA (Moore et al., 1979), these data are, for the most part, the generic values suggested in that guide.

CARD 22 **Y1, Y2. Agricultural productivity for pasture grass and other consumed vegetation, respectively (kg/m^2). Table 3.3 values are county-specific as reported by Baes et al. (1982).**

PP. Surface density of soil (kg/m^2). Assumes a 15 cm plow depth. For farming scenario, this value should be in agreement with the value of BDENS, CARD 20. Must be entered ≥ 0 .

XAMBWE. The weathering removal decay constant for atmospheric deposition onto foodcrops (h^{-1}). Values in Table 3.3 are generic.

TE1, TE2. Period of time that pasture grass or crops/leafy vegetables, respectively, are exposed to contaminated air during each growing season (h). Table 3.3 values are generic.

CARD 23 **TH1-TH6. These six variables represent the delay time between harvest and consumption by animal or man of pasture grass, stored feed, leafy vegetables for maximum individual, produce for maximum individual, and leafy vegetables and produce for the general population, respectively (h). Values listed are generic.**

FP. Fraction of each year that animals graze on pasture grass. Generic value listed in Table 3.3.

FS. This variable is the fraction of an animal's daily feed that is fresh grass for the period of time animals are in pasture. Value listed is generic.

Table 3.3. (continued)

CARD 24	<p>QFC. The amount of feed consumed daily by cattle (kg). Generic value listed in Table 3.3.</p> <p>QFG. The amount of feed consumed daily by dairy goats (kg). Generic value listed in Table 3.3.</p> <p>TF1, TF2. The transport time (h) from animal feed into milk and into the receptor human for the maximum individual and the general population exposures, respectively. Values listed are generic.</p> <p>TS. Length of time between slaughter of animal and human consumption of the resultant meat (h). Generic value is 20 d.</p> <p>ABSH. The absolute humidity of the atmosphere (g/m^3). Used in specific activity foodchain calculations for tritium concentrations in foodstuffs. Site-specific values in Table 3.3 taken from Etnier (1980).</p> <p>P14. The fractional equilibrium ratio for ^{14}C. Due to the nominal long-length of the simulation, we assumed for Table 3.3 that ^{14}C will be in equilibrium with the concentration of ^{14}C naturally occurring in the atmosphere thus $P14 = 1.0$. For shorter simulations ($\text{MAXYR} \leq 1000 \text{ yr}$) the user may wish to lessen P14.</p>
CARD 25	<p>FI. Fraction of the year that crops are irrigated.</p> <p>WIRATE. Irrigation rate ($\text{L/m}^2\text{-h}$). Calculated from information in the 1974 Census of Agriculture (U.S. Department of Commerce, 1977) and Olson, Emerson and Nungesser (1980) which provided total irrigation water and area of application for each LLW site on a county basis. Application time was set equivalent to number of frost free days for county taken from Shor, Baes, and Sharp (1982).</p> <p>QCW, QGW, QBW. Generic values for the amount of water (L/d) consumed by milk cows, milk goats, and beef cattle, respectively.</p>
CARD 26	<p>Human intake rates and population. All the variables on this card as listed with units in Table 3.1 are generic rates of ingestion and inhalation as suggested for AIRDOS-EPA. The exception is POP, the population under consideration. POP was estimated from maps and computerized 1980 census data of each area.</p>

Table 3.3. (continued)

Radionuclide cards (Nos. 27-29, etc.)

This group of cards includes three cards for each radionuclide in the trench inventory. As many as 40 radionuclides, and hence 120 cards, may be handled in this block of data. The first card for each radionuclide will be designated in this description as card 27+, the second card for each radionuclide as 28+ and the last card for each radionuclide as 29+.

CARD 27+

For each radionuclide these cards contain the information listed in Table 3.1 for CARD 27.

NUCLID. The name of the radionuclide as used in the code. Must be written left justified and with no imbedded blanks and with a hyphen separating the alphameric and numeric. The names used must agree with the conventions used in RADRISK and DARTAB and as shown in Tables 3.4 and 3.10. Also found on CARDS 28+ and 29+ and in the namelist input for DARTAB which follows.

TRAM. The amount (Ci) of each radionuclide found in the trench at the beginning of the simulation. Values of TRAM in Table 3.4 are specific to Barnwell and were estimated from receiving invoices over the life of the facility (also see Appendix C). TRAM values for West Valley were estimated from Giardina et al. (1977) and are shown in Appendix E. Beatty inventory data are nonexistent and as listed in Appendix D are a blend of the other two facilities.

SOAM. The amount (Ci) of spillage onto the surface that exists at the beginning of the simulation. As exhibited in Appendices C-E, SOAM is a constant 10^{-6} of TRAM. The user may wish to allow more or less spillage for a given radionuclide if such specific information exists.

STAM. The amount (Ci) of radioactivity placed into the stream nearest the site at the beginning of the simulation.

ATAM. The amount of radioactivity of each radionuclide (Ci) placed into the air directly above the trench at the beginning of the simulation.

DECAY. The radiological decay constant (λ^{-1}). As input is equal to $\ln 2$ divided by the radiological half-life. Half-life values were taken from Kocher (1981).

Table 3.3. (continued)

SOL. The solubility of the radionuclide stored in the trench (g/mL); The most uncertain pieces of data in the present data base. Values in Table 3.4 and Appendices C-E were estimated from solubilities of the oxide form of the element published in the Handbook of Chemistry and Physics, 57th Edition (Weast, 1976). Since the solubility approach is in general less accurate than the chemical exchange approach, only a few solubility values are included for model testing purposes. If well compacted, the environment within the trench may be chemically reducing. Better solubility estimates would arise from knowing the chemical state of the buried radionuclide and possible reactions in the reducing environment. The solubility data listed here should be viewed with great suspicion and updated if the user has any information about radionuclide compounds existing in the trench. SOL is used only if LEAOPT = 5 (see CARD 3).

- CARD 28+** Besides the nuclide name, this card contains only distribution coefficient, K_d , for each of four regions as specified in Table 3.1. For the sample runs in Appendices C-E, the four K_d values for each radionuclide are set equal. Some users may have access to detailed K_d data for their site of interest. If so, the values should be changed to reflect site-specific conditions. It should be noted that these K_d values are medians of numerous values reported for agricultural soils with pH in the range of 4.5-7 (Baes and Sharp, 1983). Any departure from these conditions may increase the already large range of reported K_d values and influence radionuclide concentrations and transport rates accordingly.
- CARD 29+** Except for the nuclide name, these data are element-specific values used in AIRDOS-EPA and listed in Table 3.4. For the sample runs in Appendices C-E, RA and RW were set to 0.2 and 0.25, respectively, for all nuclides.
- CARD 27N+** Where 27N is $(27 + 3 \cdot \text{NONCLD})$, being the number of radionuclides considered. This card and subsequent cards contains one year of hourly precipitation data for the site, formatted as specified in Table 3.1. Day with no precipitation need not be included. The hourly precipitation data are read if and only if parameter IVAP on input Card 4 is set equal to 4.
-

Table 3.4. Input data for three LLW disposal sites; refer to Table 3.1 for formats and definition of variables

Card number	Variable	Suggested values		
		Barnwell, SC	Beatty, NV	West Valley, NY
1	TITLE			
2	LOCATE	Barnwell SC	Beatty SC	West Valley NY
3	MAXYR	1000 ^a	1000 ^a	1000 ^a
	NONCLD	≤40 ^a	≤40 ^a	≤40 ^a
	LEAOPT	2 ^a	2 ^a	2 ^a
	NYR1	100 ^c	100 ^c	100 ^c
	NYR2	200 ^c	200 ^c	200 ^c
	IOPVWV	1 ^a	1 ^a	1 ^a
	IOPSAT	1 ^a	1 ^a	1 ^a
	IPRT1	0 ^a	0 ^a	0 ^a
	IPRT2	1000 ^a	1000 ^a	1000 ^a
	IDELT	100 ^a	100 ^a	100 ^c
	IRRES1	0 ^a	0 ^a	0 ^a
	IRRES2	0 ^a	0 ^a	0 ^a
	LIND	1	1	1
	Iavg1	1 ^a	1 ^a	1 ^a
	Iavg2	1000 ^a	1000 ^a	1000 ^a
4	IVAP	4 ^a	4 ^a	4 ^a
	IBSMT	0 ^a	0 ^a	0 ^a
	IAQSTR	0 ^a	0 ^a	0 ^a
5	PCT1	0.01 ^c	0.01 ^c	0.1 ^a
	PCT2	0.1 ^c	0.1 ^c	0.2 ^a
	WATL	1.0 ^a	1.0 ^a	1.0 ^a
	WATA	1.0 ^a	1.0 ^a	1.0 ^a
	WATH	1.0 ^a	1.0 ^a	1.0 ^a
	SATL	0.0 ^a	0.0 ^a	0.0 ^a
	SATA	0.0 ^a	0.0 ^a	0.0 ^a
	SATH	0.0 ^a	0.0 ^a	0.0 ^a
6	PPN	1.13	0.171	1.178
	P	1002.3	898.8	966.9
	XIRR	0.0	0.646	0.152
	PHID	33.2	36.83	42.25
7-8	S		See Table 3.11	
9-10	T		See Table 3.11	
11-12	TD		See Table 3.11	

Table 3.4. (continued)

Card number	Variable	Suggested values		
		Barnwell, SC	Reatty, WV	West Valley, NY
13	TAREA	9150	1.8E4	41500 ^c
	TDEPTH	6.7	6.7	6.7
	OVER	1.5	1.2	2.4
	PORT	0.4	0.2	0.25
	DENCON	2.0 ^a	2.0 ^a	2.0 ^a
	REL PAC	0 ^a	0 ^a	0 ^a
	FN	1 ^a	0.5 ^a	0.1 ^a
	XINFL	0.09	0.41	0.05
14	PERMC	43.3	154	1.488
15	DTRAQ	2.4	84	31 ^c
	DWELL	914	6700	6500 ^a
	GWV	2.15	182 ^c	3.0E-2
	AQTHK	25 ^a	4.3 ^a	6.4 ^a
	AQDISP	0.3 ^a	0.3 ^a	0.3 ^a
	PORA	0.4	0.2	0.25
	POKV	0.4	0.2	0.25
	PERM _V	43.3	154	0.019 ^c
16	H	1.0	1.0	1.0
	VG	0.01	0.027	0.01
	U	0.4	4.48	4.2
	VD	0.1	0.027	0.01
	XG	8000	16800	6500
	EL ID	300	300	300
	ROUGH	0.01	0.01	0.01
	FTWIND	0.49	0.056	0.0486
17	CHIQ	7.7E-9 ^b	7.0E-9 ^b	7.9E-9 ^b
	RE1	1.0E-6	1.0E-4	1.0E-6
	RE2	-0.15	-0.15	-0.15
	RE3	1.0E-11	1.0E-9	1.0E-10
	RR	0 ^a	0 ^a	0 ^a
	FTMECH	0	0	0
18	IT	1	1	1
	IS	2	4	4

Table 3.4. (continued)

Card number	Variable	Suggested values		
		Barnwell, SC	Beatty, NV	West Valley, NY
19	RAINF	250	20	100
	ERODF	0.23	0.5	0.19
	STPLNG	0.27	0.26	0.42
	COVER	0.30	0.30	0.30
	CONTRL	0.30	0.40	0.50
	SEDELR	1.0	1.0	1.0
20	PORS	0.4	0.1	0.25
	BDENS	1.6	1.6	1.6
	STFLOW	5300	2000 ^a	4.0E7
	EXTENT	305 ^a	180 ^a	244 ^a
	ADEPTH	0.01 ^a	0.01 ^a	0.1 ^a
21	PD	914	3000	380 ^a
	RUNOFF	0.05	0.05	0.53
22	Y1	0.19	0.04	0.14
	Y2	0.53	0.76	0.56
	PP	240	240	240
	XAMBWE	0.0021	0.0021	0.0021
	TE1	720	720	720
	TE2	1440	1440	1440
23	TH1	0	0	0
	TH2	2160	2160	2160
	TH3	24	24	24
	TH4	1440	1440	1440
	TH5	336	336	336
	TH6	336	336	336
	FP	0.77	0.47	0.49
	FS	0.94	1.0	0.31
24	QFC	50	50	50
	QFG	6	6	6
	TF1	48	48	48
	TF2	96	96	96
	TS	480	480	480
	ABSH	9.9	4.4	6.4
	P14	1.0	1.0	1.0

Table 3.4. (continued)

Card number	Variable	Suggested values		
		Barnwell, SC	Beatty, NV	West Valley, NY
25	FI	0.73	0.65	0.47
	WIRATE	.015	.114	.042
	QCW	60	60	60
	QGW	8	8	8
	QBW	50	50	50
	26			
26	ULEAFY	190	190	190
	UPROD	190	190	190
	UCMILK	110	110	110
	UGMILK	0	0	0
	UMEAT	95	95	95
	UWAT	370	370	370
	UAIR	8000	8000	8000
	POP	7033	2000	10000
27,28+		See Table 3.4		

^aDesignates either a control variable or listed value very uncertain for the site.

^bCHIQ calculated external to PRESTO-II using atmospheric dispersion model (AIRDOS-EPA) and known population distribution.

^cPersonal Communication, C. Y. Hung to Jon Broadway, March 18, 1983 routed to D. E. Fields.

Table 3.5. Radionuclide-specific data used to prepare data bases for example sites.

Nuclide	TRAM ^a	Decay	SOL ^b	BR ^c	BV ^c	FMC ^c	FMG ^c	FF ^c	ED ^c
H-3	34,499	5.64E-2	0	4.8E-0	4.8E-0	1.0E-2	1.7E-1	1.2E-2	0.0
C-14	9.5	1.21E-4	0	5.5E-0	5.5E-0	1.2E-2	1.0E-1	3.1E-2	0.0
Mn-54	9,737	8.09E-1	1.5E+2	5.0E-2	2.5E-1	3.5E-4	2.5E-4	4.0E-4	6.5E1
Fe-55	65,672	2.57E-1	5.5E+1	1.0E-3	4.0E-3	2.5E-4	1.3E-4	2.0E-2	2.5E1
Ni-59	0	8.66E-6	150	6.0E-2	6.0E-2	1.0E-3	6.7E-3	6.0E-3	1.5E2
Co-60	432,755	1.32E-1	5.5E+1	7.0E-3	2.0E-2	2.0E-3	1.0E-3	2.0E-2	4.5E1
Ni-63	11,029	6.29E-3	1.5E+2	6.0E-2	6.0E-2	1.0E-3	6.7E-3	6.0E-3	1.5E2
Zn-65	7,613	1.04E-0	1.6E+1	9.0E-1	1.5E-0	1.8E-3	3.9E-2	1.0E-1	4.0E1
Kr-85	1,682	6.47E-2	0	0	0	2.0E-2	2.0E-2	2.0E-2	0.0
Sr-90	2,617	2.42E-2	2.7E+2	2.5E-1	2.5E+0	1.5E-3	1.4E-2	3.0E-4	3.5E1
Y-94	0	3.47E-5	350	5.0E-3	2.0E-2	2.0E-2	2.5E-3	2.5E-1	3.5E2
Tc-99	61	3.25E-6	3.3E-2	1.5E+0	9.5E+0	1.0E-2	2.5E-2	8.5E-3	1.5E0
Ru-106	0	6.89E-1	2.2E+2	2.0E-2	7.5E-2	6.0E-7	1.3E-4	2.0E-3	3.5E2
Cd-109	16	5.45E-1	6.7E-0	1.5E-1	5.5E-1	1.0E-3	1.5E-3	5.5E-4	6.5E0
Sb-125	2.7	2.50E-1	4.5E+1	3.0E-2	2.0E-1	1.0E-4	1.5E-3	1.0E-3	4.5E1
I-125	0	4.22E-0	1.0E-2	1.0E+0	1.0E+0	1.0E-2	6.0E-2	7.0E-3	1.0E1
I-129	0	4.08E-8	0.01	1.0E+0	1.0E+0	1.0E-2	3.0E-1	7.0E-3	1.0E1
Cs-134	37,069	3.36E-1	1.1E+3	3.0E-2	8.0E-2	7.0E-3	3.0E-1	2.0E-2	1.0E3
Cs-137	289,403	2.30E-2	1.1E+3	3.0E-2	8.0E-2	7.0E-3	3.0E-1	2.0E-2	1.0E3
Co-141	547	7.78E-0	1.1E+3	4.0E-3	1.0E-2	2.0E-5	1.0E-4	7.5E-4	8.5E2
Co-144	2,160	8.90E-0	1.1E+3	4.0E-3	1.0E-2	2.0E-5	1.0E-4	7.5E-4	8.5E2
Pm-147	179	2.64E-1	6.1E+1	4.0E-3	1.0E-2	2.0E-5	5.0E-4	5.5E-3	6.5E2
Re-187	1.5	1.47E-11	7.5E-0	3.5E-1	1.5E+0	1.5E-3	2.5E-2	8.0E-3	7.5E0
Pb-210	22	3.11E-2	9.9E+1	9.0E-3	4.5E-2	2.5E-4	6.2E-4	3.0E-4	9.0E2
Ra-226	0.6	4.33E-4	2.2E+2	1.5E-3	1.5E-4	4.5E-4	1.5E-2	2.5E-4	4.5E2
Th-232	1.3	4.93E-11	6.0E+4	8.5E-5	8.5E-4	5.0E-6	5.0E-4	6.0E-4	1.5E3
U-233	0	4.28E-6	4.5E+1	4.0E-3	8.5E-3	6.0E-4	5.0E-4	2.0E-4	4.5E2
U-234	3.0	2.83E-6	4.5E+1	4.0E-3	8.5E-3	6.0E-4	5.0E-4	2.0E-4	4.5E2
U-235	3.5	9.85E-10	4.5E+1	4.0E-3	8.5E-3	6.0E-4	5.0E-4	2.0E-4	4.5E2
U-236	0.5	2.96E-8	4.5E+1	4.0E-3	8.5E-3	6.0E-4	5.0E-4	2.0E-4	4.5E2
U-238	3063	1.55E-10	4.5E+1	4.0E-3	8.5E-3	6.0E-4	5.0E-4	2.0E-4	4.5E2
Pu-238	0.2	7.90E-3	1.8E+3	4.5E-5	4.5E-4	1.0E-7	1.5E-6	5.0E-7	4.5E3
Pu-239	0.1	2.87E-5	1.8E+3	4.5E-5	4.5E-4	1.0E-7	1.5E-6	5.0E-7	4.5E3
Pu-241	0	5.25E-2	1800	4.5E-5	4.5E-4	1.0E-7	2.5E-6	5.0E-7	4.5E3
Pu-242	0	1.83E-6	1800	4.5E-5	4.5E-4	1.0E-7	1.5E-6	5.0E-7	4.5E3
Am-241	0	1.51E-3	8.1E+2	2.5E-4	5.5E-3	4.0E-7		3.5E-6	7.0E2
Am-243	0	8.72E-5	810	2.5E-4	5.5E-3	4.0E-7		3.5E-6	7.0E2
Cm-243	0	2.17E-2	3300	1.5E-5	8.5E-4	2.0E-5		3.5E-6	2.0E3
Cm-244	0	3.94E-4	3300	1.5E-5	8.5E-4	2.0E-5		3.5E-6	2.0E3

^aValues of TRAM are specific to Barnwell. Other variables may not change between sites.^bSolubility option not used for example runs.^cValues are taken from Baes et al. (1982). Values for BR and BV are based on dry plant weight.

Table 3.6. Soil characteristics influencing erodibility factor, $ERCDF$ (or f_k), at each site

Site	<u>Grain size distribution, %</u>			Organic matter, %	Permeability, cm/h
	Clay	Silt and fine sand	Sand		
Barnwell	8.3	45	40	2.1	0.51
Beatty	2	90	8	2	1.3-2.8
West Valley	50	38	7.7	7.5	<0.15

Table 3.7. Namelist input for subroutine DARTAB.

Namelist group	Variable	Description
INPUT	ILOC	Direction index of the exposure array to use for individual tables.
	JLOC	Distance index of the exposure array to use for individual tables.
	PLOC	Percentile of total risk to use in choosing location for the exposure array for individual tables.
	AGEX	Average life expectancy (y) (Default - 70.7565).
	ILET	Array dimensioned to 2. ILET(7) = 0 indicates separate high and low LET (linear energy transfer) tables. 1 indicates combined table. 2 indicates both sets of tables will be output. ILET(1) refers to dose rate tables. ILET(2) refers to health risk tables.
	DTABLE	All indicate which tables are to be output for dose rates, health risks, and risk equivalents. Each is dimensioned by 7 corresponding to table types (Table 3.9). TABLE(7) 0 = no tables of this type 1 = table for selected individual 2 = table for mean individual 3 = table for collective group 4 = all three of the above.
	RTABLE	
	FTABLE	
	OUTPUT	
	GSCFAC	
ORGAN	NORGN	Number of organs.
	ORGN	Alphanumeric double precision names of organs.
	TIME	Time associated with dose commitment (y) (NORGN values).
QFACTOR	HLET	Relative biological effect factor to use for high-LET dose rates to convert absorbed dose to dose equivalent (rem), NORGN values.
	LLET	Same as HLET but for low-LET dose rates, NORGN values.
CANCER	NCANC	Number of cancers to be output.
	CANC	Alphanumeric double precision cancer names.
	RELABS	Absolute (=1) or relative (=2) risk model for each cancer.

Table 3.7. (continued)

Namelist group	Variable	Description
GENTIC	GENEFF	Logical variable indicates output of gentic effects
	GEN	Alphanumeric double precision names of the organs to be considered for genetic effects.
	NGEN	Number of organs.
	GRFAC	Risk conversion factors (genetic effects per rad/million births) GRFAC(1) corresponds to low-LET doses. GRFAC(2) corresponds to high-LET doses.
	REPPER	Replacement rate for the population.
	GLLET	Relative biological effect factor to use for low-LET genetic doses to convert absorbed dose to dose equivalent (rem). One value for each organ.
	GHLET	Same as GLLET but for high-LET.
RNUCLD	NONCLD	Number of radionuclides.
	NUCLID	Alphanumeric double precision radionuclide names.
	PSIZE	Activity median aerodynamic diameter associated with each radionuclide (μm).
	RESP	Respiratory clearance class associated with each radionuclide.
	GIABS	GI absorption factors.
LOCTAB	NTLOC	Number of location tables to be output.
	RNLOC	Radionuclide to use for table. SUM results in the sum of all nuclides, WORKLEVL results in working level calculations, WLSUM results in total risk for all nuclides.
	OGLOC	Organ or cancer to use for table. SUM results in sum of all cancers.
	PTLOC	Pathway to use.
	FALOC	Factor to be printed =0 both high- and low-LET =1 only combined LET table =2 all three tables.
	HLLOC	Factor to be printed =0 both high- and low-LET =1 only combined LET table =2 all three tables

Table 3.7. (continued)

Name list group	Variable	Description
	LTABLE	Indicates selected individual (LTABLE=1), mean individual (LTABLE=2), or collective group (LTABLE=3).
ORGANF	NORGB	Number of organ dose weights to use to combine dose rates.
	ORGB	The organs to be used.
	ORGDAT	Organ dose weighting factors.
	IPATH	Exposure pathway affected (1 = ingestion; 2 = inhalation; 3 = air immersion; 4 = ground surface; 5 = all pathways).

Table 3.8. Values of namelist input commonly used in PRESTO-II

Namelist group	Variable	Suggested value
INPUT	ILOC ^a	1
	JLOC ^a	1
	PLOC ^a	100 or omit
	AGEX ^a	70.7565 or omit
	ILET ^a	1, 1
	DTABLE	0, 0, 0, 0, 0, 3, 3
	RTABLE	0, 0, 0, 0, 0, 3, 3
	FTABLE	omit
	OUTPUT	.FALSE.
	GSCFAC	1.0
ORGAN	NORGN	18
	ORGN ^b	'R-MAR ', 'ENDOST ', '*PUL ', 'LIVER ', 'S-WALL ', 'LLI-WALL', 'KIDNEYS-', 'SPLEEN', 'THYROID ', 'MUSCLE ', 'THYMUS ', 'PANCREAS ', 'SI-WALL ', 'ULI-WALL', 'OVARIES ', 'BL WALL ', 'TESTES ', 'UTERUS '
	TIME	70 for each ORGN
QFACTOR	HLET	20 for each ORGN
	LLET	1 for each ORGN
CANCER	NCANC	18
	CANCER ^b	'R MARROW', 'ENDOST ', 'PULMONARY', 'BREAST ', 'LIVER ', 'ST WALL ', 'PANCREAS', 'LLI WALL', 'KIDNEYS ', 'BL WALL ', 'ULI WALL', 'SI WALL ', 'OVARIES ', 'TESTES ', 'SPLEEN ', 'UTERUS ', 'THYMUS ', 'THYROID '
	RELABS	1 for each CANCER
GENTIC	GENEFF	.FALSE.
	NGEN	3
	GEN ^b	'TESTES--', 'OVARIES-', 'AVERAGE-'
	GRFAC	200, 20000
	REPPER	.014133 or omit
	GLLET	1 for each GEN
	GHLET	20 for each GEN
RNUCLD	NONCLD	Same as NONCLD, Card 3, Table 3.3. See Table 3.5 for names. Must be written without imbedded blanks, in same order as listed in transport section of input, Cards 26+. Each name must be set in apostrophes.
	PSIZE	1.0 for each NUCLID, except 0 for gases
	RESP	One value per NUCLID see Table 3.10
	GIABS	Four values per NUCLID see Table 3.11

Table 3.8. (continued)

Namelist group	Variable	Suggested value
LOCTAB	NTLOC ^a	0
	RNLOC ^b	'SUM-----'
	OGLOC ^b	'SUM-----'
	PTLOC	7
	FALOC	1
	HLLOC	1
	LTABLE	3
ORGANF	NORGB	18
	ORGB ^b	see Table 3.9
	ORGDAT	see Table 3.9
	IPATH	5 for each ORGB

^aIndicated variables must be entered with the indicated value or the code will not operate properly. Remaining variable values are merely suggestions and may be changed if the user desires or the scenario dictates.

^bNames must be eight characters wide including blanks. Hyphen indicates a blank and should not be typed in data set.

Table 3.9. Possible types of detail tables output by DARTAB specified by DTABLE (dose tables), RTABLE (risk tables), and FTABLE (risk equivalent tables).

Array position	Table type	Label		Table label
		Column	Row	
1	a	Organs or cancers	Radionuclides	Individual pathways
2	b	Organs or cancers	Radionuclides	External and internal
3	c	Organs or cancers	Radionuclides	All pathways
4	d	Radionuclides	Pathways	Organs or cancers
5	e	Organs or cancers	Pathways	Radionuclides
6	f	Radionuclides	Pathways	Summed over organs or cancers
7	g	Organs or cancers	Pathways nuclides	Summed over

Table 3.10. Organ names and organ dose weighting factors for DARTAB as used in PRESTO-II

Organ	ORGB	ORGDAT
Bladder wall	'BL-WALL-'	.0166
Endosteal tissue	'ENDOST--'	.0147
Kidneys	'KIDNEYS-'	.0166
Liver	'LIVER--'	.0746
Lower large intestine wall	'LLI-WALL'	.0332
Muscle	'MUSCLE--'	.1908
Ovaries	'OVARIES-'	.0083
Pancreas	'PANCREAS'	.0581
Pulmonary tissue	'*PUL*--'	.2908
Red marrow	'R-MAR--'	.1559
Small intestine wall	'SI-WALL-'	.0083
Spleen	'SPLEEN--'	.0083
Stomach wall	'S-WALL--'	.0415
Testes	'TESTES--'	.0083
Thymus	'THYMUS--'	.0083
Thyroid	'THYROID-'	.0405
Upper large intestine wall	'ULI-WALL'	.0166
Uterus	'UTERUS--'	.0083

Table 3.11. Radionuclide-specific DARTAB data for use in
namelist section of PRESTO-II

Nuclide	PSIZE	RESP	Absorption factors for ^a small intestine: GIABS(2)
H-3	0		9.5E-1
C-14	0		9.5E-1
MN-54	1.0	W, D	1.0E-1
FE-55	1.0	W, D	1.0E-1
NI-59	1.0	W, D	5.0E-2
CO-60	1.0	Y, W	5.0E-2
NI-63	1.0	W, D	5.0E-2
ZN-65	1.0	Y, W, D	5.0E-1
KR-85	0	*	0
SR-90	1.0	Y	1.0E-2
	1.0	D	3.0E-1
NB-94	1.0	Y, W	1.0E-2
TC-99	1.0	W, D	8.0E-1
RU-106	1.0	Y, D, W	5.0E-2
CD-109	no data available		
SB-125	1.0	W, D	2.0E-1
I-125	1.0	D	9.5E-1
I-129	1.0	D	9.5E-1
CS-134	1.0	D	9.5E-1
CS-137	1.0	D	9.5E-1
CE-141	1.0	Y, W	3.0E-4
CE-144	1.0	Y, W	3.0E-4
PM-147	1.0	Y, W	3.0E-4
RE-187	no data available		
PB-210	1.0	W, D	2.0E-1
PO-210	1.0	W, D	1.0E-1
RA-226	1.0	W	2.0E-1
TH-232	1.0	Y, W	2.0E-1
U-233	1.0	Y	2.0E-1
	1.0	W, D	2.0E-1
U-234	1.0	Y	2.0E-3
	1.0	W, D	2.0E-1

Table 3.11. (continued)

Nuclide	PSIZE	RESP	Absorption factors for ^a small intestine GIABS(2)
U-235	1.0	Y	2.0E-3
	1.0	W, D	2.0E-1
U-236	1.0	Y	2.0E-3
	1.0	W, D	2.0E-1
U-238	1.0	Y	2.0E-3
	1.0	W, D	2.0E-1
PU-238	1.0	Y, W	1.0E-4
PU-239	1.0	Y	1.0E-4
	1.0	W	1.0E-3
PU-241	1.0	Y, W	1.0E-4
AM-241	1.0	Y, W	1.0E-3
AM-243	1.0	Y, W	1.0E-3
CM-243	1.0	Y, W	1.0E-3
CM-244	1.0	Y, W	1.0E-3

^aFour values of GIABS must be entered for each nuclide; however, the first, third, and fourth values are zero.

Table 3.12. Input data for subroutine EVAPO as used in the PRESTO-II code.
 Values given here are from Olsen, Emerson, and Nungesser, 1980.
 (See Table 3.1 for a description of variables)

Month	Barnwell			Beatty			West Valley		
	S(I)	T(I)	TD(I)	S(I)	T(I)	TD(I)	S(I)	T(I)	TD(I)
January	0.56	8.0	3.1	0.68	-0.6	-8.9	0.35	-4.4	-6.8
February	0.60	9.3	3.3	0.70	2.1	-6.9	0.40	-4.0	-6.9
March	0.64	12.9	5.8	0.72	5.2	-7.6	0.47	0.3	-3.6
April	0.70	18.0	10.3	0.73	10.1	-4.6	0.53	7.3	1.8
May	0.68	22.3	15.5	0.78	15.2	-3.2	0.58	13.0	7.4
June	0.65	25.9	19.2	0.85	19.9	-1.7	0.66	18.7	12.9
July	0.65	27.1	21.2	0.81	24.7	2.7	0.68	21.2	15.2
August	0.65	26.7	21.2	0.84	23.5	3.3	0.65	20.2	15.2
September	0.61	23.7	18.5	0.86	18.9	-1.4	0.59	16.5	11.6
October	0.66	18.2	12.5	0.79	12.3	-3.4	0.51	11.0	6.3
November	0.64	12.4	6.7	0.70	5.1	-5.7	0.30	4.5	0.7
December	0.69	8.4	2.6	0.70	0.6	-7.2	0.28	-2.0	-4.8

4. DESCRIPTION OF OUTPUT OF THE PRESTO-II CODE

The output of the PRESTO-II code is designed to be self-documenting, and contains descriptive comments, definitions, and intermediate tabulations. It is assumed that users of the code may be unfamiliar with the code structure and that the code may be implemented on a computer other than the IBM 3033 for which it was written. For these users many of the tables and comments will be most valuable.

The output will be described in eleven sections, corresponding to the eleven sections in the printout for each run. Table 4.1 consists of example output of the PRESTO-II code. This output corresponds to the Barnwell data set discussed in Appendix C.

4.1 INPUT DATA

The first section of the output of the PRESTO-II code simply prints the input data as it is read. PRESTO-II input data is read and then written on a temporary storage device and on the output device. Thus, a record of the input data set is printed out for positive identification of the run. Input data is subsequently read from the temporary storage device for use by the code.

4.2 DEFINITION, ORGANIZATION, AND PRELIMINARY ANALYSIS OF INPUT DATA

In the second section of the output of the PRESTO-II code, the input data are organized and summarized according to data type, transport subsystem or pathway, and printed out. As a result, the code user should be able easily to review the input data for each run. A more detailed description of the input data can be found in Sect. 3.3.

The first part of this output section consists of the computer run identification (time/date code) and the user-supplied identification from input card 1.

The output labeled "control information" identifies the site and interprets the run control data entered by the user. These control data include radionuclide leaching options, trench cap failure data, and water use parameters.

The output labeled "trench information" describes the trench area and depth, the porosity of the trench contents, and the annual infiltration for the watershed.

The output labeled "aquifer information" describes the groundwater velocity, the trench to aquifer distance, the trench to well distance, the aquifer thickness and contamination plume dispersion angle, the porosities of the sub trench area and the aquifer, and the sub trench permeability.

The output labeled "atmospheric information" describes the effective source height for the wind-blown or mechanically mobilized contamination plume from the site, the gravitational fall velocity of suspended soil particles, the site-to-population distance, the lid height, the Hosker surface roughness factor, the atmospheric stability class and dispersion formulation, the fraction of the time wind blows toward the population, and the parameters specifying resuspension factor and resuspension rate.

The output labeled "surface information" consists of the universal soil loss equation parameters, the surface soil porosity and bulk density, the runoff fraction for rainfall, the stream or river flow rate, the cross-slope extent of spillage, the active soil depth, and the average distance from the trench to the stream.

The output labeled "air-food-chain information" describes productivity data for grass and vegetation, timing data for computation of radioactive decay for the ingestion exposure pathway, and nuclide weathering (from the surface soil) and C-14 equilibrium data.

The output labeled "water-food-chain information" describes data which characterize water use by milk cattle, goats, and beef cattle and water use for crop irrigation.

The output labeled "human ingestion and inhalation rate information" describes the annual ingestion and inhalation parameters, and the number of persons at risk.

4.3 RADIONUCLIDE SUMMARY TABLES

A set of three tables under the heading, "nuclide information," summarize radionuclide data used for the transport calculations. First, an inventory table labeled "information on individual nuclides" specifies the initial inventory in the trench, on the soil surface, in the stream, and in the air. Also included in this table are the decay constant and the user-supplied solubility constant.

The second radionuclide table labeled "distribution coefficients mL/g" summarizes the chemical distribution coefficients for the surface soil, the trench contents, the vertical soil column, and the aquifer.

The third radionuclide table summarizes seven radionuclide-specific foodchain parameters used by the FOOD, IRRIG, HUMEX, CV, and COV subroutines. These parameters are also used by the FOODA, IRRIGA, HUMEXA, CVA, and COVA subroutines.

Also, radionuclide atomic mass numbers are extracted from the radionuclide names and used in the calculations. Results from the mass extraction algorithm are printed in a table labeled "initial calculations" as a convenience for the user who may be using the PRESTO-II code on other than the IBM 3033 computer, and who may be using other alphanumeric string manipulation functions.

4.4 INITIAL UNIT RESPONSE CALCULATIONS

This output section includes results of nuclide-specific annual transport calculations which will be used by the bookkeeping submodels for each simulation year. They also include soil loss calculation results and the calculated (or input) value for the ratio of atmospheric radionuclide concentration per unit release rate at the radionuclide disposal site.

4.5 ANNUAL SUMMARY TABLES FOR SPECIFIED YEARS

Control variables determine the years for which results will be printed. For these years, a number of hydrologic and transport variables are output. Included are trench cap status, maximum possible water depth in the trench, water loss by overflow and drainage from the trench, and trench inventory. Radionuclide concentration values and flux values are presented for a number of key pathways and regions of interest.

4.6 RADIONUCLIDE CONCENTRATION TABLES

The radionuclide concentration tables present, by nuclide, the average concentration over the entire assessment period, the year of maximum concentration, and the level of the maximum (population mean) concentration for the atmosphere, for the well water, and for the stream water. The year and level of maximum concentration is of interest since it is related to the year at which population exposures are most significant. Human exposures may peak, or even commence, many years after closure of a disposal site.

Separate average radionuclide concentration tables for the user-specified averaging window (which may be a fraction of the total assessment period) are included. These tables present the radionuclide concentration in five types of foods due to atmospheric deposition, and due to irrigation.

4.7 RADIONUCLIDE EXPOSURE TABLES

Annual population intakes of radionuclides by ingestion and by inhalation are next printed. The fraction of ingestion input due to drinking water is given.

Next, the radionuclide exposure tables list, by nuclide, the year of maximum exposure and the corresponding level of the maximum (population mean) exposure for the atmosphere, for the ground surface (including the resident intruder exposure term which also leads to external exposure, as described in Sect. 2.2.2), for ingestion, and for inhalation. The maximum exposures for the atmosphere and the ground

surface are listed in units of Ci/m and Ci/m, respectively. The exposure rates for ingestion and inhalation are presented in units of pCi/y. Although the exposure terms are dependent on the concentrations summarized in the concentration tables, the times of maximum exposures will in general differ from the times of maximum concentrations. This difference occurs for several reasons, including the dependence of exposure on soil concentration (a function of the values printed in the concentration tables) and the nuclide-specific uptake and concentration mechanisms of the food chain which are considered in computing exposures from ingestion.

4.8 DARTAB CONTROL INFORMATION

DARTAB control information includes: run identification data, summaries of output table control information, lists of organs and cancers to be considered in the run, dose equivalent factors for low- and high-LET (linear energy transfer) radiation, radionuclide uptake and clearance data, and, if such exist, lists of nuclides and organ dose or cancer risk factors not found in the RADRISK data sets which were accessed by DARTAB. The location of the population at risk, the lifetime fatal cancer risk at that location, and the organ dose weighting factors are also printed.

4.9 DARTAB DOSE TABLES

DARTAB dose tables produced in the output of Table 4.1 present individual and collective dose summary rates by low- and high-LET radiation and organ (including weighted sums of organs), by low- and high-LET radiation and exposure pathway, and by low- and high-LET radiation and radionuclide. Both absolute dose and percentage of total dose are included in these tables. The tables printed are dependent on the DARTAB control data.

4.10 DARTAB FATAL CANCER RISK TABLES

DARTAB fatal cancer risk tables produced in the output of Table 4.1 present individual and collective fatal cancer risk, loss of life by premature death, and lifetime fatal cancer risk exposure equivalent. Genetic risks are also summarized. Values presented are summarized by low- and high-LET radiation and organ and by low- and high-LET radiation and pathway. The tables printed are dependent on the DARTAB control data.

Table 4.1. Example of PRESTO-II code output

** INPUT DATA AS READ IN **

BARNWELL -- 40 NUCLIDES

BARNWELL SC

1000	40	1	100	200	1	1	0	1000	100	0	0	1	1	1000
4	000	0												
	.01		.1		1.0		1.0		1.0		0.0		0.0	0.0
	1.130		1002.3		0		33.2							
	.56		.60		.64		.70		.68		.65		.65	.65
	.61		.66		.64		.69							
	8.0		9.3		12.9		18.0		22.3		25.9		27.1	26.7
	23.7		18.2		12.4		8.4							
	3.1		3.3		5.8		10.3		15.5		19.2		21.2	21.2
	18.5		12.5		6.7		2.6							
	9150.		6.7		1.5		0.4		2.		0		1.0	.09
	43.3													
	2.4		914.		2.15		25		0.3		0.4		0.4	43.3
	1.		.01		.4		.01		8000.		300.		.01	
	.49		7.7E-5		1.0E-6		-.15		1.0E-11		0.0		0.0	
1	2													
	250.		.23		0.27		.30		.30		1.0			
	.4		1.6		5300		305.0		0.01					
	914.		.05											
	.15		.53		240.		.0021		720.		1440.			
	0		2160.		24.		1440.		336.		336.		.77	.94
	50.		6.		48.		96.		480.		9.9		1.	
	.73		.015		60.		8.		50.					
	190.		190.		110.		0.		95.		370.		8000.	7033.
H-3			3.499.		3.4E-4		0		0		5.64E-2			
H-3			0.01		0.01		0.01		0.01					
H-3			0.20		0.25		4.5E-0		4.8E-0		1.0E-2		1.7E-1	1.2E-2
C-14			9.5		9.5E-8						1.21E-4			
C-14			0.01		0.01		0.01		0.01					
C-14			0.20		0.25		5.5E-0		5.5E-0		1.2E-2		1.0E-1	3.1E-2
MN-54			9737.		9.7E-5		0		0		8.09E-1		1.5E+2	

MN-54	150	150	150	150	150	2.5E-4	2.5E-4	8.0E-4
MN-54	0.20	0.25	2.5E-1	5.0E-2	2.5E-4	2.57E-1		
FE-55	65672.	6.3E-4	55.	55.				
FE-55	55.	55.	55.	55.	1.2E-3	1.3E-4	4.0E-2	
FE-55	0.20	0.25	4.0E-3	1.0E-3	8.66E-6			
NI-59	0.0							
NI-59	150	150	150	150				
NI-59	0.20	0.25	6.0E-2	6.0E-2	6.7E-3	6.7E-3	5.3E-2	
CO-60	432755.	4.3E-3	0.	0.	1.32E-1	100.		
CO-60	55.	55.	55.	55.				
CO-60	0.20	0.25	9.4E-3	9.4E-3	1.0E-3	1.0E-3	1.3E-2	
NI-63	11029.	1.1E-4			6.29E-3			
NI-63	150.	150.	150.	150.				
NI-63	0.20	0.25	6.0E-2	6.0E-2	6.7E-3	6.7E-3	5.3E-2	
ZN-65	7613.	7.6E-5	16.	16.	1.04E-0			
ZN-65	16.	16.	16.	16.	3.9E-2	3.9E-2	3.0E-2	
ZN-65	0.20	0.25	1.5E+0	9.0E-1	6.47E-2			
KR-85	1682.	1.7E-5	0.	0.				
KR-85	0.	0.	0.	0.	2.0E-2	2.0E-2	2.0E-2	
KR-85	0.20	0.25	0.	0.	2.42E-2			
SR-90	2617.	2.6E-5	27.	27.	8.0E-4	1.4E-2	6.0E-4	
SR-90	27.	27.	27.	27.	2.42E-2			
SR-90	0.20	0.25	2.5E+0	2.5E-1				
Y-90	2617.	2.6E-5	27.	27.	8.0E-4	1.4E-2	6.0E-4	
Y-90	27.	27.	27.	27.	2.42E-2			
Y-90	0.20	0.25	2.5E+0	2.5E-1				
NB-94	0.0							
NB-94	350.	350.	350.	350.	2.5E-3	2.5E-3	2.5E-3	
NB-94	0.20	0.25	2.0E-2	5.0E-3	3.25E-6			
TC-99	61.	6.1E-7	0.033	0.033	2.5E-2	2.5E-2	4.0E-1	
TC-99	0.033	0.033	9.5E-0	1.5E+0	6.89E-1			
TC-99	0.20	0.25						
RU-106	0.0							
RU-106	220.	220.	220.	220.	1.0E-6	1.0E-6	1.0E-6	
RU-106	0.20	0.25	7.5E-2	2.0E-2				
CD-109	16.	1.6E-7			5.45E-1			

RA-226	220.	220.	220.				
RA-226	0.20	0.25	1.5E-2	1.5E-3	1.5E-2	1.5E-2	3.4E-2
TH-232	1.3	1.3E-2					
TH-232	6.0E4	6.0E4	6.0E4	6.0E4	4.93E-11		
TH-232	0.20	0.25	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-233	0.0				4.28E-6		
U-233	45.	45.	45.	45.			
U-233	0.20	0.25	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-234	3.0	3.0E-8			2.83E-6		
U-234	45.	45.	45.	45.			
U-234	0.20	0.25	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-235	3.5	3.5E-8			9.85E-10		
U-235	45.	45.	45.	45.			
U-235	0.20	0.25	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-236	0.5	5.0E-5			2.94E-8		
U-236	45.	45.	45.	45.			
U-236	0.20	0.25	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-238	3063.	3.1E-5			1.55E-10		
U-238	45.	45.	45.	45.			
U-238	0.20	0.25	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
PU-238	0.2	2.0E-9			7.90E-3		
PU-238	1800.	1800.	1800.	1800.			
PU-238	0.20	0.25	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
PU-239	0.1	1.0E-5			2.87E-5		
PU-239	1800.	1800.	1800.	1800.			
PU-239	0.20	0.25	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
PU-241	0.0				5.25E-2		
PU-241	1800.	1800.	1800.	1800.			
PU-241	0.20	0.25	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
AM-241	0.0				1.51E-3		
AM-241	810.	810.	810.	810.			
AM-241	0.20	0.25	5.5E-3	2.5E-4	0.	0.	
PU-242	0.0				1.83E-6		
PU-242	1800.	1800.	1800.	1800.			
PU-242	0.20	0.25	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
AM-243	0.0				8.72E-5		

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PRESTO-11: A MODEL FOR PREDICTING THE MIGRATION OF RADIOACTIVE WASTES
FROM SHALLOW TRENCH BURIAL SITES

THIS RUN WAS MADE AT 22.09H ON 05/08/85

BARNWELL -- 40 NUCLIDES

*** CONTROL INFORMATION ***

THE BURIAL SITE IS LOCATED AT BARNWELL SC
THE SIMULATION WILL RUN FOR 1000 YEARS AND WILL INCLUDE 40 NUCLIDES
LEACHING OPTION NUMBER 1 WILL BE USED
IN YEAR 100 .0001 OF THE CAP WILL BE ASSUMED TO FAIL
THIS WILL CONTINUE UNTIL 0.10 HAS FAILED IN YEAR 200
CAP MAY ALSO FAIL BY SURFACE EROSION
VERTICAL WATER VELOCITY WILL BE CALCULATED USING INFILTRATION AND POROSITY
LENGTH OF VERTICAL SATURATED ZONE WILL BE CALCULATED USING INFILTRATION AND POROSITY
POPULATION INDICATOR IS 1
GENERAL POPULATION EXPOSURE WILL BE USED TO CALCULATE HEALTH EFFECTS
1.000 OF IRRIGATION WATER WILL BE GOTTEN FROM WELL
1.000 OF DRINKING WATER FOR ANIMALS WILL BE GOTTEN FROM WELL
1.000 OF DRINKING WATER FOR HUMANS WILL BE GOTTEN FROM WELL
0.0 OF IRRIGATION WATER WILL BE GOTTEN FROM STREAM
0.0 OF DRINKING WATER FOR ANIMALS WILL BE GOTTEN FROM STREAM
0.0 OF DRINKING WATER FOR HUMANS WILL BE GOTTEN FROM STREAM
TRENCH CAP INFILTRATION WILL BE CALCULATED FROM HOURLY PRECIPITATION

*** CLIMATIC INFORMATION ***

THE AVERAGE ANNUAL PRECIPITATION IS 1.130 METERS
THE AVERAGE ATMOSPHERIC PRESSURE IS 1002.30 MBAR
THE LATITUDE OF THE SITE IS 33.20

MONTH	FRACTION OF SUNSHINE	AVERAGE TEMP C	AVG DEW POINT TEMP C
JAN	.56	8.00	3.10
FEB	.60	9.30	3.30
MAR	.64	12.90	5.80
APR	.70	18.00	10.30
MAY	.68	22.30	15.50
JUN	.63	25.90	19.20
JUL	.65	27.10	21.20
AUG	.65	26.70	21.20
SEP	.61	23.70	18.50
OCT	.66	18.20	12.50
NOV	.64	12.40	6.70
DEC	.69	8.40	2.60

*** TRENCH INFORMATION ***

THE TRENCH HAS AN AREA OF 0.9150E 04 SQUARE METERS AND A DEPTH OF 0.6700E 01 METERS
TRENCH POROSITY IS 0.40
TRENCH CAP PERMEABILITY IS 43.300 METERS PER YEAR

*** AQUIFER INFORMATION ***

THE GROUND WATER HAS A VELOCITY OF 2.150 METERS PER YEAR
TRENCH TO AQUIFER DISTANCE IS 2.4 METERS
TRENCH TO WELL DISTANCE IS 914.00 METERS
THE AQUIFER THICKNESS IS 25.00 METERS
THE AQUIFER DISPERSION ANGLE IS 0.3000 RADIANS
POROSITY OF THE AQUIFER REGION IS 0.40000
POROSITY BENEATH THE TRENCH IS 0.40000
PERMEABILITY BENEATH THE TRENCH IS 43.300 METERS/YEAR

*** ATMOSPHERIC INFORMATION ***

SOURCE HEIGHT IS 1.0 METERS
 VELOCITY OF GRAVITATION FALL IS 0.01 METERS/SECOND
 WIND VELOCITY IS 0.40 METERS/SECOND
 DEPOSITION VELOCITY IS 0.01 METERS/SECOND
 GAUGE DISTANCE FROM SOURCE IS 8000.00 METERS
 LID HEIGHT IS 300.00 METERS
 MOSKOW ROUGHNESS FACTOR IS 0.01
 TYPE OF STABILITY FORMULATION IS 1
 STABILITY CLASS IS 2
 FRACTION OF TIME WIND BLOWS TOWARD POPULATION IS 0.490000
 NORMALIZED DOWN WIND ATMOSPHERIC EXPOSURE IS $7.7000E-09$ CI/M**3 PER CI/SEC
 RESUSPENSION FACTOR PARAMETERS $0.1000E-05$ $-0.1500E-00$ $0.1000E-10$
 FROM YEAR 0 TO YEAR 0 THE RESUSPENSION RATE DUE TO MECHANICAL DISTURBANCES WILL BE 0.0
 THIS WILL OCCUR DURING 0.0 OF EACH YEAR

*** SURFACE INFORMATION ***

PARAMETERS FOR UNIVERSAL LOSS EQUATION

RAINFALL 250.00
 ERODIBILITY 0.23
 STEEPNESS-SLOPE 0.27
 COVER 0.30
 EROSION CONTROL 0.30
 DELIVERY RATIO 1.00
 SOIL POROSITY IS 0.40000
 SOIL BULK DENSITY IS 1.60000 G/CC
 RUNOFF FRACTION IS 0.05000

STREAM FLOW RATE IS $5.3000E-03$ CUBIC METERS PER YEAR
 CROSS SLOPE EXTENT OF SPILLAGE IS 305.00 METERS
 ACTIVE SOIL DEPTH IS 0.01 METERS
 AVERAGE DOWN SLOPE DISTANCE TO STREAM IS 914.00 METERS

*** AIR-FOODCHAIN INFORMATION ***

AGRICULTURAL PRODUCTIVITY FOR GRASS 0.19 KG/M**2
 AGRICULTURAL PRODUCTIVITY FOR VEGETATION 0.53 KG/M**2
 SURFACE DENSITY FOR SCIL 240.00 KG/M**2
 WEATHER DECAY CONSTANT 0.00 1/HOURS
 PERIOD PASTURE GRASS EXPOSURE GROWING SEASON 720.00 HOURS
 PERIOD CRCP/VEGETATION EXPOSURE GROWING SEASON 1440.00 HOURS
 PERIOD BETWEEN HARVEST PASTURE GRASS AND INGESTION BY ANIMAL 0.0 HOURS
 PERIOD BETWEEN STORED FEED AND INGESTION BY ANIMAL 2160.00 HOURS
 PERIOD BETWEEN HARVEST LEAFY VEGETABLES AND INGESTION BY MAN(M.I.E.) 24.00 HOURS
 PERIOD BETWEEN HARVEST PRODUCE AND INGESTION BY MAN(M.I.E.) 1440.00 HOURS
 PERIOD BETWEEN HARVEST LEAFY VEG AND INGESTION BY MAN(G.P.E.) 336.00 HOURS
 PERIOD BETWEEN HARVEST PRODUCE AND INGESTION BY MAN(G.P.E.) 336.00 HOURS
 FRACTION OF YEAR ANIMALS GRAZE ON PASTURE 0.77
 FRACTION OF DAILY FEED THAT IS FRESH GRASS 0.94
 AMOUNT OF FEED CONSUMED BY CATTLE 50.00 KG
 AMOUNT OF FEED CONSUMED BY GOATS 6.00 KG
 TRANSPORT TIME FEED-MILL-RECEPTOR FOR M.I.E. 48.00 HOURS
 TRANSPORT TIME FEED-MILL-RECEPTOR FOR G.P.E. 96.00 HOURS
 TIME FROM SLAUGHTER OF MEAT TO CONSUMPTION 480.00 HOURS
 ABSOLUTE HUMIDITY OF THE ATMOSPHERE 9.90 G/M**3
 FRACTIONAL EQUILIBRIUM RATIO FOR C-14 1.00

*** WATER-FOODCHAIN INFORMATION ***

FRACTION OF YEAR CROPS ARE IRRIGATED 0.73
IRRIGATION RATE 0.01 L/(M**2-H)
AMOUNT OF WATER CONSUMED BY COWS 60.00 L/D
AMOUNT OF WATER CONSUMED BY GOATS 8.00 L/D
AMOUNT OF WATER CONSUMED BY BEEF CATTLE 50.00 L/D

*** HUMAN INGESTION AND INHALATION RATE INFORMATION ***

ANNUAL INTAKE OF LEAFY VEG 190.00 KILOGRAMS PER YEAR
ANNUAL INTAKE OF PRODUCE 190.00 KILOGRAMS PER YEAR
ANNUAL INTAKE OF COW'S MILK 110.00 LITERS PER YEAR
ANNUAL INTAKE OF GOAT'S MILK 0.0 LITERS PER YEAR
ANNUAL INTAKE OF MEAT 95.00 KILOGRAMS PER YEAR
ANNUAL INTAKE OF DRINKING WATER 370.00 LITERS PER YEAR
ANNUAL INHALATION RATE OF AIR 8000.00 CUBIC METERS PER YEAR
A POPULATION OF 7033. WILL BE CONSIDERED

*** NUCLIDE INFORMATION ***

INFORMATION ON INDIVIDUAL NUCLIDES

NUCLIDE	AMT IN TRENCH CI	SPLILLAGE CI	STREAM AMT CI	AMT IN AIR CI	DECAY CONST 1/Y	SOLUBILITY CONST G/ML
H-3	3.4499E 04	3.4000E-04	0.0	0.0	5.6400E-02	0.0
C-14	9.5000E 00	9.5000E-08	0.0	0.0	1.2100E-04	0.0
MN-54	9.7370E 03	9.7000E-05	0.0	0.0	8.0900E-01	1.5000E 02
FE-55	6.5672E 04	6.6000E-04	0.0	0.0	2.5700E-01	0.0
NI-59	0.0	0.0	0.0	0.0	8.6600E-06	0.0
CO-60	4.3276E 05	4.3000E-03	0.0	0.0	1.3200E-01	1.0000E 02
NI-63	1.1029E 04	1.1000E-04	0.0	0.0	6.2900E-03	0.0
ZN-65	7.6130E 03	7.6000E-05	0.0	0.0	1.0400E 00	0.0
KR-85	1.6820E 03	1.7000E-05	0.0	0.0	6.4700E-02	0.0
SR-90	2.6170E 03	2.6000E-05	0.0	0.0	2.4200E-02	0.0
Y-90	2.6170E 03	2.6000E-05	0.0	0.0	2.4200E-02	0.0
NB-94	0.0	0.0	0.0	0.0	3.4700E-05	0.0
TC-99	6.1000E 01	6.1000E-07	0.0	0.0	3.2500E-06	0.0
RU-106	0.0	0.0	0.0	0.0	6.8900E-01	0.0
CD-109	1.6000E 01	1.6000E-07	0.0	0.0	5.4500E-01	0.0
SB-125	2.7000E 00	2.7000E-08	0.0	0.0	2.5000E-01	0.0
I-125	0.0	0.0	0.0	0.0	4.2200E 00	0.0
I-129	0.0	0.0	0.0	0.0	4.0800E-08	0.0
CS-134	3.7069E 04	3.7000E-04	0.0	0.0	3.3600E-01	3.0000E 02
CS-137	2.8940E 05	2.9000E-03	0.0	0.0	2.3100E-02	3.0000E 02
BA-137M	2.8940E 05	2.9000E-03	0.0	0.0	2.3100E-02	3.0000E 02
CE-141	5.4700E 02	5.5000E-06	0.0	0.0	7.7800E 00	0.0
CE-144	2.1600E 03	2.2000E-05	0.0	0.0	8.0000E 00	1.0000E 09
PM-147	1.7900E 02	1.8000E-06	0.0	0.0	2.6400E-01	0.0
RE-187	1.5000E 00	1.5000E-08	0.0	0.0	1.4700E-11	0.0
PB-210	2.2000E 01	2.2000E-07	0.0	0.0	3.1100E-02	0.0
RA-226	6.0000E-01	6.0000E-09	0.0	0.0	4.3400E-04	0.0
TH-232	1.3000E 00	1.3000E-08	0.0	0.0	4.9300E-11	0.0
U-233	0.0	0.0	0.0	0.0	4.2800E-06	0.0
U-234	3.0000E 00	3.0000E-08	0.0	0.0	2.8300E-06	0.0

U-235	3.5000E 00	3.5000E-08	0.0	0.0	9.8500E-10	0.0
U-236	5.0000E-01	5.0000E-09	0.0	0.0	2.9600E-08	0.0
U-238	3.0630E 03	3.1000E-05	0.0	0.0	1.5500E-10	0.0
PU-238	2.0000E-01	2.0000E-09	0.0	0.0	7.9000E-03	0.0
PU-239	1.0000E-01	1.0000E-09	0.0	0.0	2.8700E-05	0.0
PU-241	0.0	0.0	0.0	0.0	5.2500E-02	0.0
AM-241	0.0	0.0	0.0	0.0	1.5100E-03	0.0
PU-242	0.0	0.0	0.0	0.0	1.8300E-06	0.0
AM-243	0.0	0.0	0.0	0.0	8.7200E-05	0.0
CM-243	0.0	0.0	0.0	0.0	2.7000E-02	0.0

DISTRIBUTION COEFFICIENTS ML/G

NUCLIDE	SURFACE	TRENCH	VERTICAL	AQUIFER
H-3	1.00E-02	1.00E-02	1.00E-02	1.00E-02
C-14	1.00E-02	1.00E-02	1.00E-02	1.00E-02
AN-54	1.50E 02	1.50E 02	1.50E 02	1.50E 02
FE-55	5.50E 01	5.50E 01	5.50E 01	5.50E 01
NI-59	1.50E 02	1.50E 02	1.50E 02	1.50E 02
CO-60	5.50E 01	5.50E 01	5.50E 01	5.50E 01
NI-63	1.50E 02	1.50E 02	1.50E 02	1.50E 02
ZN-65	1.60E 01	1.60E 01	1.60E 01	1.60E 01
KR-85	0.0	0.0	0.0	0.0
SR-90	2.70E 01	2.70E 01	2.70E 01	2.70E 01
Y-90	2.70E 01	2.70E 01	2.70E 01	2.70E 01
NB-94	3.50E 02	3.50E 02	3.50E 02	3.50E 02
TC-99	3.30E-02	3.30E-02	3.30E-02	3.30E-02
RU-106	2.20E 02	2.20E 02	2.20E 02	2.20E 02
CD-109	6.70E 00	6.70E 00	6.70E 00	6.70E 00
SB-125	4.50E 01	4.50E 01	4.50E 01	4.50E 01
I-125	1.00E-02	1.00E-02	1.00E-02	1.00E-02
I-129	1.00E-02	1.00E-02	1.00E-02	1.00E-02

CS-134	1.10E 03	1.10E 03	1.10E 03	1.10E 03
CS-137	1.10E 03	1.10E 03	1.10E 03	1.10E 03
BA-137M	1.10E 03	1.10E 03	1.10E 03	1.10E 03
CE-141	1.10E 03	1.10E 03	1.10E 03	1.10E 03
CE-144	1.10E 03	1.10E 03	1.10E 03	1.10E 03
PM-147	6.10E 01	6.10E 01	6.10E 01	6.10E 01
RE-187	7.50E 00	7.50E 00	7.50E 00	7.50E 00
PB-210	5.40E 02	5.40E 02	5.40E 02	5.40E 02
RA-226	2.20E 02	2.20E 02	2.20E 02	2.20E 02
TH-232	6.00E 04	6.00E 04	6.00E 04	6.00E 04
U-233	4.50E 01	4.50E 01	4.50E 01	4.50E 01
U-234	4.50E 01	4.50E 01	4.50E 01	4.50E 01
U-235	4.50E 01	4.50E 01	4.50E 01	4.50E 01
U-236	4.50E 01	4.50E 01	4.50E 01	4.50E 01
U-238	4.50E 01	4.50E 01	4.50E 01	4.50E 01
PU-238	1.80E 03	1.80E 03	1.80E 03	1.80E 03
PU-239	1.80E 03	1.80E 03	1.80E 03	1.80E 03
PU-241	1.80E 03	1.80E 03	1.80E 03	1.80E 03
AM-241	8.10E 02	8.10E 02	8.10E 02	8.10E 02
PU-242	1.80E 03	1.80E 03	1.80E 03	1.80E 03
AM-243	8.10E 02	8.10E 02	8.10E 02	8.10E 02
CM-243	3.30E 03	3.30E 03	3.30E 03	3.30E 03

NUCLIDE	RETENTION IN AIR	RETENTION IN WATER	TRANS COEFF SOIL-V CROP D/KG	TRANS COEFF SOIL-R CROP D/KG	TRANS COEFF VEG-COW MILK D/KG	TRANS COEFF VEG-GOAT MILK D/KG	TRANS COEFF VEG-MEAT D/KG
H-3	2.00E-01	2.50E-01	4.80E 00	4.80E 00	1.00E-02	1.70E-01	1.20E-02
C-14	2.00E-01	2.50E-01	5.50E 00	5.50E 00	1.20E-02	1.00E-01	3.10E-02
MN-54	2.00E-01	2.50E-01	2.50E-01	5.00E-02	2.50E-04	2.50E-04	8.00E-04
FE-55	2.00E-01	2.50E-01	4.00E-03	1.00E-03	1.20E-03	1.30E-04	4.00E-02
NI-59	2.00E-01	2.50E-01	6.00E-02	6.00E-02	6.70E-03	6.70E-03	5.30E-02
CO-60	2.00E-01	2.50E-01	9.40E-03	9.40E-03	1.00E-03	1.00E-03	1.30E-02
NI-63	2.00E-01	2.50E-01	6.00E-02	6.00E-02	6.70E-03	6.70E-03	5.30E-02
ZN-65	2.00E-01	2.50E-01	1.50E 00	9.00E-01	3.90E-02	3.90E-02	3.00E-02
KR-85	2.00E-01	2.50E-01	0.0	0.0	2.00E-02	2.00E-02	2.00E-02
SR-90	2.00E-01	2.50E-01	2.50E 00	2.50E-01	8.00E-04	1.40E-02	6.00E-04
Y-90	2.00E-01	2.50E-01	2.50E 00	2.50E-01	8.00E-04	1.40E-02	6.00E-04
NB-94	2.00E-01	2.50E-01	2.50E-02	5.00E-03	2.50E-03	2.50E-03	2.50E-03
TC-99	2.00E-01	2.50E-01	9.50E 00	1.50E 00	2.50E-02	2.50E-02	4.00E-01
RU-106	2.00E-01	2.50E-01	7.50E-02	2.00E-02	1.00E-06	1.00E-06	1.00E-06
CD-109	2.00E-01	2.50E-01	5.50E-01	1.50E-01	1.30E-04	1.30E-04	5.30E-04
SB-125	2.00E-01	2.50E-01	2.00E-01	3.00E-02	1.50E-03	1.50E-03	4.00E-03
I-125	2.00E-01	2.50E-01	1.00E 00	1.00E 00	6.00E-03	6.00E-02	6.00E-02
I-129	2.00E-01	2.50E-01	1.00E 00	1.00E 00	6.00E-03	6.00E-02	6.00E-02
CS-134	2.00E-01	2.50E-01	1.00E-02	1.00E-02	1.20E-02	3.00E-01	4.00E-03
CS-137	2.00E-01	2.50E-01	1.00E-02	1.00E-02	1.20E-02	3.00E-01	4.00E-03
BA-137M	2.00E-01	2.50E-01	1.00E-02	1.00E-02	1.20E-02	3.00E-01	4.00E-03
CE-141	2.00E-01	2.50E-01	1.00E-02	4.00E-03	1.00E-04	1.00E-04	1.20E-03
CE-144	2.00E-01	2.50E-01	1.00E-02	4.00E-03	1.00E-04	1.00E-04	1.20E-03
PN-147	2.00E-01	2.50E-01	1.00E-02	4.00E-03	5.00E-06	5.00E-06	4.80E-03
RE-187	2.00E-01	2.50E-01	1.50E 00	3.50E-01	2.50E-02	2.50E-02	8.00E-03
PB-210	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
RA-226	2.00E-01	2.50E-01	1.50E-02	1.50E-03	1.50E-02	1.50E-02	3.40E-02
TH-232	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
U-233	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
U-234	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
U-235	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
U-236	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
U-238	2.00E-01	2.50E-01	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05

INITIAL CALCULATIONS

NUCLIDE	MASS
H-3	3.
C-14	14.
MN-54	54.
FE-55	55.
NI-59	59.
CO-60	60.
NI-63	63.
ZN-65	65.
KR-85	85.
SR-90	90.
Y-90	90.
NB-94	94.
TC-99	99.
RU-106	106.
CD-109	109.
SB-125	125.
I-125	125.
I-129	129.
CS-134	134.
CS-137	137.
BA-137M	137.
CE-141	141.
CE-144	144.
PM-147	147.
RE-187	187.
PB-210	210.
RA-226	226.
TH-232	232.
U-233	233.

U-234
 U-235
 U-236
 U-238
 PU-238
 PU-239
 PU-241
 AM-241
 PU-242
 AM-243
 CM-243
 234.
 235.
 236.
 238.
 238.
 239.
 241.
 241.
 242.
 243.
 243.

INITIAL CALCULATIONS

NUCLIDE	VERTICAL RETARDATION	VERTICAL TIME Y	HORIZCNTAL RETARDATION	HORIZONTAL TIME Y	BREAK THRU TIME Y
H-3	1.0400E 00	1.4010E 00	1.0400E 00	4.4212E 02	4.4352E 02
C-14	1.0400E 00	1.4010E 00	1.0400E 00	4.4212E 02	4.4352E 02
MN-54	6.0100E 02	8.0960E 02	6.0100E 02	2.5549E 05	2.5630E 05
FE-55	2.2100E 02	2.9771E 02	2.2100E 02	9.3951E 04	9.4248E 04
NI-59	6.0100E 02	8.0960E 02	6.0100E 02	2.5549E 05	2.5630E 05
CO-60	2.2100E 02	2.9771E 02	2.2100E 02	9.3951E 04	9.4248E 04
NI-63	6.0100E 02	8.0960E 02	6.0100E 02	2.5549E 05	2.5630E 05
ZN-65	6.5000E 01	8.7560E 01	6.5000E 01	2.7633E 04	2.7720E 04
KR-85	1.0000E 00	1.3471E 00	1.0000E 00	4.2512E 02	4.2641E 02
SR-90	1.0900E 02	1.4683E 02	1.0900E 02	4.6338E 04	4.6484E 04
Y-90	1.0900E 02	1.4683E 02	1.0900E 02	4.6338E 04	4.6484E 04
NB-94	1.4010E 03	1.8873E 03	1.4010E 03	5.9559E 05	5.9747E 05
TC-99	1.1320E 00	1.5249E 00	1.1320E 00	4.8123E 02	4.8276E 02
RU-106	8.8100E 02	1.1868E 03	8.8100E 02	3.7453E 05	3.7571E 05
CD-109	2.7800E 01	3.7449E 01	2.7800E 01	1.1818E 04	1.1856E 04
SB-125	1.8100E 02	2.4382E 02	1.8100E 02	7.6946E 04	7.7190E 04
I-125	1.0400E 00	1.4010E 00	1.0400E 00	4.4212E 02	4.4352E 02
I-129	1.0400E 00	1.4010E 00	1.0400E 00	4.4212E 02	4.4352E 02

CS-134	4.4010E 03	5.5285E 03	4.4010E 03	1.8709E 06	1.8769E 06
CS-137	4.4010E 03	5.5285E 03	4.4010E 03	1.8709E 06	1.8769E 06
BA-137M	4.4010E 03	5.5285E 03	4.4010E 03	1.8709E 06	1.8769E 06
CE-141	4.4010E 03	5.5285E 03	4.4010E 03	1.8709E 06	1.8769E 06
CE-144	4.4010E 03	5.5285E 03	4.4010E 03	1.8709E 06	1.8769E 06
PM-147	2.4500E 02	3.3003E 02	2.4500E 02	1.0415E 05	1.0448E 05
RE-187	3.1000E 01	4.1760E 01	3.1000E 01	1.3179E 04	1.3220E 04
PB-210	2.1610E 03	2.9110E 03	2.1610E 03	9.1868E 05	9.2159E 05
RA-226	8.8100E 02	1.1868E 03	8.8100E 02	3.7453E 05	3.7571E 05
TH-232	2.4000E 05	3.2330E 05	2.4000E 05	1.0203E 08	1.0235E 08
U-233	1.8100E 02	2.4382E 02	1.8100E 02	7.6946E 04	7.7190E 04
U-234	1.8100E 02	2.4382E 02	1.8100E 02	7.6946E 04	7.7190E 04
U-235	1.8100E 02	2.4382E 02	1.8100E 02	7.6946E 04	7.7190E 04
U-236	1.8100E 02	2.4382E 02	1.8100E 02	7.6946E 04	7.7190E 04
U-238	1.8100E 02	2.4382E 02	1.8100E 02	7.6946E 04	7.7190E 04
PU-238	7.2010E 03	9.7003E 03	7.2010E 03	3.0613E 06	3.0710E 06
PU-239	7.2010E 03	9.7003E 03	7.2010E 03	3.0613E 06	3.0710E 06
PU-241	7.2010E 03	9.7003E 03	7.2010E 03	3.0613E 06	3.0710E 06
AM-241	3.2410E 03	4.3659E 03	3.2410E 03	1.3778E 06	1.3822E 06
PU-242	7.2010E 03	9.7003E 03	7.2010E 03	3.0613E 06	3.0710E 06
AM-243	3.2410E 03	4.3659E 03	3.2410E 03	1.3778E 06	1.3822E 06
CM-243	1.3201E 04	1.7783E 04	1.3201E 04	5.6120E 06	5.6297E 06

ANNUAL SOIL LCSS IS 3.1315E-01 KILOGRAMS PER SQUARE METER
 OR 1.9572E-04 METERS IS REMOVED FROM THE SURFACE
 ANNUAL INFILTRATION INTO TRENCH IS 0.7127 METERS
 VERTICAL WATER VELOCITY IS 1.7816 METERS PER YEAR
 NORMALIZED DOWN WIND ATMOSPHERIC EXPOSURE PER UNIT SOURCE RELEASE IS 0.7700E-08
 CI/M**3 PER CI/SEC

WATER OUTFLOW FROM TRENCH BOTTOM IS APPROACHING DILUTION VOLUME IN AQUIFER FOR YEAR 1

ANNUAL SUMMARY FOR YEAR 1 OF THE SIMULATION

THE TRENCH CAP HAS HAD 0.0 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.5208E C3 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	5.1607E 03	0.0	2.7446E 04	0.0
C-14	1.5034E 00	0.0	7.9955E 00	0.0
MN-54	4.3344E 03	0.0	1.5368E 00	0.0
FE-55	5.0740E 04	0.0	4.9063E 01	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	3.7887E 05	0.0	3.6636E 02	0.0
NI-63	1.0956E 04	0.0	3.8845E 00	0.0
ZN-65	2.6819E 03	0.0	8.9146E 00	0.0
KR-85	0.0	0.0	1.5766E 03	0.0
SR-90	2.5494E 03	0.0	5.0217E 00	0.0
Y-90	2.5494E 03	0.0	5.0217E 00	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	2.3357E 01	0.0	3.7643E 01	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	9.2044E 00	0.0	7.3062E-02	0.0
SB-125	2.1003E 00	0.0	2.4822E-03	0.0
I-125	0.0	0.0	0.0	0.0

I-129	0.0	0.0	0.0	0.0
CS-134	2.6489E 04	0.0	1.2807E 00	0.0
CS-137	2.8278E 05	0.0	1.3672E 01	0.0
BA-137M	2.8278E 05	0.0	1.3672E 01	0.0
CE-141	2.2864E-01	0.0	1.1054E-05	0.0
CE-144	2.9459E-01	0.0	1.4243E-05	0.0
PM-147	1.3735E 02	0.0	1.1975E-01	0.0
RE-187	1.4894E 00	0.0	1.0562E-02	0.0
PB-210	2.1324E 01	0.0	2.1002E-03	0.0
RA-226	5.9955E-01	0.0	1.4495E-04	0.0
TH-232	1.3000E 00	0.0	1.1523E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	2.9964E 00	0.0	3.5413E-03	0.0
U-235	3.4959E 00	0.0	4.1316E-03	0.0
U-236	4.9941E-01	0.0	5.9022E-04	0.0
U-238	3.0594E 03	0.0	3.6157E 00	0.0
PU-238	1.9842E-01	0.0	5.8625E-06	0.0
PU-239	9.9994E-02	0.0	2.9544E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC C1/M**3	SURFACE WATER CONC C1/M**3	SOLUBLE TO STREAM C1	SOLUBLE TO TRENCH C1	ATMOSPHERE AT SPILLAGE C1/M**3	ATMOSPHERE DOWN WIND C1/M**3	WELL WATER CONC C1/M**3
H-3	4.5653E-14	0.0	7.2004E-05	2.4405E-04	8.7976E-18	3.3193E-26	0.0
C-14	1.3495E-17	0.0	2.1284E-08	7.2138E-08	2.6005E-21	9.8115E-30	0.0
MN-54	8.7520E-12	0.0	9.2024E-07	3.1190E-06	1.6866E-15	6.3634E-24	0.0
FE-55	8.8840E-11	0.0	2.5476E-05	8.6348E-05	1.7120E-14	6.4593E-23	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	6.5587E-10	0.0	1.8808E-04	6.3747E-04	1.2639E-13	4.7687E-22	0.0
NI-63	2.2148E-11	0.0	2.3288E-06	7.8932E-06	4.2681E-15	1.6103E-23	0.0
ZN-65	3.0309E-12	0.0	2.9877E-06	1.0126E-05	5.8406E-16	2.2037E-24	0.0
KR-85	0.0	0.0	3.5727E-06	1.2109E-05	0.0	0.0	0.0
SR-90	3.5887E-12	0.0	2.0963E-06	7.1052E-06	6.9155E-16	2.6092E-24	0.0
Y-90	3.5887E-12	0.0	2.0963E-06	7.1052E-06	6.9155E-16	2.6092E-24	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	2.8556E-16	0.0	1.3648E-07	4.6258E-07	5.5029E-20	2.0762E-28	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-109	6.1991E-15	0.0	1.4593E-08	4.9461E-08	1.1946E-18	4.5072E-27	0.0
SB-125	3.4874E-15	0.0	1.2223E-09	4.1428E-09	6.7203E-19	2.5356E-27	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	5.8364E-11	0.0	8.3683E-07	2.8363E-06	1.1247E-14	4.2435E-23	0.0
CS-137	6.2551E-10	0.0	8.9687E-06	3.0398E-05	1.2054E-13	4.5479E-22	0.0
BA-137M	6.2551E-10	0.0	8.9687E-06	3.0398E-05	1.2054E-13	4.5479E-22	0.0
CE-141	5.0748E-16	0.0	7.2763E-12	2.4662E-11	9.7794E-20	3.6898E-28	0.0
CE-144	6.6232E-16	0.0	9.4965E-12	3.2187E-11	1.2763E-19	4.8156E-28	0.0
PM-147	2.4599E-13	0.0	6.3602E-08	2.1557E-07	4.7403E-17	1.7885E-25	0.0
RE-187	1.0834E-15	0.0	2.2782E-09	7.7218E-09	2.0877E-19	7.8768E-28	0.0
PB-210	4.6395E-14	0.0	1.3551E-09	4.5929E-09	8.9406E-18	3.3733E-26	0.0
RA-226	1.2531E-15	0.0	8.9834E-11	3.0448E-10	2.4147E-19	9.1108E-28	0.0
TH-232	2.9099E-15	0.0	7.6490E-13	2.5925E-12	5.6074E-19	2.1157E-27	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	4.9754E-15	0.0	1.7438E-09	5.9105E-09	9.5878E-19	3.6175E-27	0.0
U-235	5.8047E-15	0.0	2.0345E-09	6.8955E-09	1.1186E-18	4.2204E-27	0.0
U-236	8.2924E-16	0.0	2.9064E-10	9.8508E-10	1.5980E-19	6.0292E-28	0.0
U-238	5.1413E-12	0.0	1.8020E-06	6.1075E-06	9.9075E-16	3.7381E-24	0.0

PU-238	4.4041E-16	0.0	3.8590E-12	1.3079E-11	8.4849E-20	3.2021E-28	0.0
PU-239	2.2195E-16	0.0	1.9447E-12	6.5914E-12	4.2770E-20	1.6137E-28	0.0
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CN-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 100 OF THE SIMULATION

THE TRENCH CAP HAS HAD 1.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.4731E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	1.7017E-75	0.0	0.0	0.0
C-14	8.2334E-76	0.0	0.0	0.0
MN-54	6.8959E-32	0.0	2.4271E-35	0.0
FE-55	4.1118E-07	0.0	3.9468E-10	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	7.2707E-01	0.0	6.9790E-04	0.0
NI-63	5.6748E 03	0.0	1.9973E 00	0.0
ZN-65	3.7223E-42	0.0	1.2282E-44	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	1.9114E 02	0.0	3.7373E-01	0.0
Y-90	1.9114E 02	0.0	3.7373E-01	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	1.2577E-40	0.0	1.9886E-40	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	1.5549E-23	0.0	1.2252E-25	0.0
SB-125	3.3319E-11	0.0	3.9090E-14	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	9.4320E-11	0.0	4.5265E-15	0.0
CS-137	2.8587E 04	0.0	1.3720E 00	0.0
BA-137M	2.8587E 04	0.0	1.3720E 00	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	5.6185E-10	0.0	4.8627E-13	0.0
RE-187	7.4000E-01	0.0	5.2687E-03	0.0
PB-210	9.7158E-01	0.0	9.4988E-05	0.0
RA-226	5.6079E-01	0.0	1.3457E-04	0.0
TH-232	1.2598E 00	0.0	1.1437E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	2.6650E 00	0.0	3.1265E-03	0.0
U-235	3.1101E 00	0.0	3.6487E-03	0.0
U-236	4.4430E-01	0.0	5.2125E-04	0.0
U-238	2.7218E 03	0.0	3.1932E 00	0.0
PU-238	9.0497E-02	0.0	2.6543E-06	0.0
PU-239	9.9414E-02	0.0	2.9158E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CCNC CI/M**3	SURFACE WATER CCNC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	7.3420E-51	0.0	7.7094E-46	2.6130E-45	2.4810E-58	9.3606E-67	0.0
FE-55	1.1790E-32	0.0	3.3763E-27	1.1444E-26	3.9840E-40	1.5032E-48	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	2.0612E-26	0.0	5.9027E-21	2.0007E-20	6.9651E-34	2.6279E-42	0.0
NI-63	6.0491E-16	0.0	6.3517E-11	2.1528E-10	2.0441E-23	7.7122E-32	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	5.7078E-33	0.0	3.3296E-27	1.1285E-26	1.9287E-40	7.2771E-49	0.0
Y-90	5.7078E-33	0.0	3.3296E-27	1.1285E-26	1.9287E-40	7.2771E-49	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	7.7687E-39	0.0	2.7191E-33	9.2161E-33	2.6251E-46	9.9046E-55	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	5.1073E-26	0.0	7.3129E-22	2.4786E-21	1.7258E-33	6.5115E-42	0.0
CS-137	1.5540E-11	0.0	2.2251E-07	7.5418E-07	5.2512E-19	1.9813E-27	0.0
BA-137M	1.5540E-11	0.0	2.2251E-07	7.5418E-07	5.2512E-19	1.9813E-27	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	1.4614E-34	0.0	3.7735E-29	1.2790E-28	4.9383E-42	1.8632E-50	0.0
RE-187	2.4530E-64	0.0	5.1515E-58	1.7460E-57	8.2891E-72	0.0	0.0
PB-210	1.2384E-16	0.0	3.6121E-12	1.2243E-11	4.1847E-24	1.5789E-32	0.0
RA-226	1.2767E-18	0.0	0.01E-14	3.0979E-13	4.3140E-26	1.6277E-34	0.0
TH-232	2.8329E-15	0.0	7.4367E-13	2.5206E-12	9.5728E-23	3.6118E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	6.2136E-28	0.0	2.1748E-22	7.3713E-22	2.0996E-35	7.9220E-44	0.0
U-235	7.2514E-28	0.0	2.5381E-22	8.6024E-22	2.4503E-35	9.2450E-44	0.0

ANNUAL SUMMARY FOR YEAR 200 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	6.0460E-78	0.0	0.0	0.0
C-14	8.1344E-76	0.0	0.0	0.0
MN-54	4.8909E-67	0.0	1.6072E-70	0.0
FE-55	2.5845E-18	0.0	2.3162E-21	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	1.2263E-06	0.0	1.0990E-09	0.0
NI-63	2.9241E 03	0.0	9.6091E-01	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	1.4072E 01	0.0	2.5687E-02	0.0
Y-90	1.4072E 01	0.0	2.5687E-02	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8866E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	1.5605E-47	0.0	1.1474E-49	0.0
SB-125	4.1315E-22	0.0	4.5253E-25	0.0
I-125	0.0	0.0	0.0	0.0

1-129	0.0	0.0	0.0	0.0
CS-134	2.4004E-25	0.0	1.0757E-29	0.0
CS-137	2.8243E 03	0.0	1.2657E-01	0.0
BA-137M	2.8243E 03	0.0	1.2657E-01	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	1.7698E-21	0.0	1.4301E-24	0.0
RE-187	3.7570E-01	0.0	2.4680E-03	0.0
PB-210	4.2925E-02	0.0	3.9183E-06	0.0
RA-226	5.2466E-01	0.0	1.1755E-04	0.0
TH-232	1.2996E 00	0.0	1.0677E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	2.3787E 00	0.0	2.6054E-03	0.0
U-235	2.7768E 00	0.0	3.0415E-03	0.0
U-236	3.9670E-01	0.0	4.3451E-04	0.0
U-238	2.4302E 03	0.0	2.6618E 00	0.0
PU-238	4.0954E-02	0.0	1.1215E-06	0.0
PU-239	9.8844E-02	0.0	2.7069E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	9.4140E-55	0.0	2.6955E-49	9.1374E-49	3.1811E-62	1.2002E-70	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	4.4163E-43	0.0	1.2647E-37	4.2866E-37	1.4923E-50	5.6305E-59	0.0
NI-63	1.4869E-20	0.0	1.5612E-15	5.2916E-15	5.0243E-28	1.8957E-36	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	5.6007E-54	0.0	3.2672E-48	1.1074E-47	1.8925E-61	7.1405E-70	0.0
Y-90	5.6007E-54	0.0	3.2672E-48	1.1074E-47	1.8925E-61	7.1405E-70	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	9.9911E-63	0.0	3.4970E-57	1.1853E-56	3.3761E-70	1.2738E-78	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	3.1511E-41	0.0	4.5120E-37	1.5293E-36	1.0648E-48	4.0175E-57	0.0
CS-137	3.7222E-13	0.0	5.3297E-09	1.8064E-08	1.2578E-20	4.7456E-29	0.0
BA-137M	3.7222E-13	0.0	5.3297E-09	1.8064E-08	1.2578E-20	4.7456E-29	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	5.3035E-56	0.0	1.3694E-50	4.6413E-50	1.7921E-63	6.7616E-72	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	3.1159E-19	0.0	9.0885E-15	3.0804E-14	1.0529E-26	3.9726E-35	0.0
RA-226	1.2142E-21	0.0	8.6927E-17	2.9463E-16	4.1029E-29	1.5480E-37	0.0
TH-232	2.7594E-15	0.0	7.2436E-13	2.4551E-12	9.3243E-23	3.5181E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	5.7524E-41	0.0	2.0134E-35	6.8242E-35	1.9438E-48	7.3340E-57	0.0
U-235	6.7151E-41	0.0	2.3504E-35	7.9662E-35	2.2691E-48	8.5614E-57	0.0
U-236	9.5930E-42	0.0	3.3577E-36	1.1380E-35	3.2416E-49	1.2231E-57	0.0

U-238	5.9477E-38	0.0	2.0817E-32	7.0558E-32	2.0098E-45	7.5829E-54	0.0
PU-238	1.6135E-17	0.0	1.4119E-13	4.7851E-13	5.4523E-25	2.0571E-33	0.0
PU-239	3.8946E-17	0.0	3.4079E-13	1.1551E-12	1.3160E-24	4.9654E-33	0.0
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 300 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	0.0
C-14	8.0365E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	1.6297E-29	0.0	1.4605E-32	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	2.0749E-12	0.0	1.8595E-15	0.0
NI-63	1.5085E 03	0.0	4.9572E-01	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	1.0426E 00	0.0	1.9033E-03	0.0
Y-90	1.0426E 00	0.0	1.9033E-03	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8853E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	1.6070E-71	0.0	1.1817E-73	0.0
SB-125	5.1427E-33	0.0	5.6329E-36	0.0
I-125	0.0	0.0	0.0	0.0

I-129	0.0	0.0	0.0	0.0
CS-134	6.1095E-40	0.0	2.7380E-44	0.0
CS-137	2.7909E 02	0.0	1.2506E-02	0.0
BA-137M	2.7909E 02	0.0	1.2506E-02	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	5.5906E-33	0.0	4.5174E-36	0.0
RE-187	1.9520E-01	0.0	1.2823E-03	0.0
PB-210	1.8970E-03	0.0	1.7317E-07	0.0
RA-226	4.9124E-01	0.0	1.1007E-04	0.0
TH-232	1.2994E 00	0.0	1.0676E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	2.1314E 00	0.0	2.3345E-03	0.0
U-235	2.4888E 00	0.0	2.7261E-03	0.0
U-236	3.5556E-01	0.0	3.8945E-04	0.0
U-238	2.1782E C3	0.0	2.3858E 00	0.0
PU-238	1.8536E-02	0.0	5.0760E-07	0.0
PU-239	9.8284E-02	0.0	2.6915E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	7.5168E-77	0.0	2.1526E-71	7.2960E-71	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	9.4623E-60	0.0	2.7097E-54	9.1843E-54	3.1974E-67	1.2064E-75	0.0
NI-63	3.6547E-25	0.0	3.8375E-20	1.3007E-19	1.2350E-32	4.6595E-41	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	5.4957E-75	0.0	3.2059E-69	1.0866E-68	0.0	0.0	0.0
Y-90	5.4957E-75	0.0	3.2059E-69	1.0866E-68	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	1.9442E-56	0.0	2.7838E-52	9.4353E-52	6.5696E-64	2.4787E-72	0.0
CS-137	8.9156E-15	0.0	1.2766E-10	4.3268E-10	3.0127E-22	1.1367E-30	0.0
BA-137M	8.9156E-15	0.0	1.2766E-10	4.3268E-10	3.0127E-22	1.1367E-30	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	1.9246E-77	0.0	4.9695E-72	1.6844E-71	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	7.8400E-22	0.0	2.2867E-17	7.7506E-17	2.6492E-29	9.9955E-38	0.0

ANNUAL SUMMARY FOR YEAR 400 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	0.0
C-14	7.9397E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	1.0276E-40	0.0	9.2090E-44	0.0
NI-59	0.0	0.0	0.0	0.0
CD-60	3.5108E-18	0.0	3.1463E-21	0.0
NI-63	7.7822E 02	0.0	2.5574E-01	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	7.7255E-02	0.0	1.4102E-04	0.0
Y-90	7.7255E-02	0.0	1.4102E-04	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8840E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	6.4013E-44	0.0	7.0115E-47	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	1.5552E-54	0.0	6.9691E-59	0.0
CS-137	2.7578E 01	0.0	1.2358E-03	0.0
BA-137M	2.7578E 01	0.0	1.2358E-03	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	1.7660E-44	0.0	1.4270E-47	0.0
RE-187	1.0142E-01	0.0	6.6621E-04	0.0
PB-210	8.3838E-05	0.0	7.6531E-09	0.0
RA-226	4.5995E-01	0.0	1.0306E-04	0.0
TH-232	1.2992E 00	0.0	1.0674E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	1.9098E 00	0.0	2.0918E-03	0.0
U-235	2.2307E 00	0.0	2.4434E-03	0.0
U-236	3.1869E-01	0.0	3.4906E-04	0.0
U-238	1.9523E 03	0.0	2.1384E 00	0.0
PU-233	8.3890E-03	0.0	2.2974E-07	0.0
PU-235	9.7727E-02	0.0	2.6763E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CCNC CI/M**3	SURFACE WATER CCNC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	2.0274E-76	0.0	5.8059E-71	1.9678E-70	0.0	0.0	0.0
NI-63	8.9832E-30	0.0	9.4326E-25	3.1971E-24	3.0355E-37	1.1453E-45	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	1.1995E-71	0.0	1.7176E-67	5.8215E-67	0.0	0.0	0.0
CS-137	2.1354E-16	0.0	3.0577E-12	1.0364E-11	7.2159E-24	2.7226E-32	0.0
BA-137M	2.1354E-16	0.0	3.0577E-12	1.0364E-11	7.2159E-24	2.7226E-32	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	1.9726E-24	0.0	5.7536E-20	1.9501E-19	6.6657E-32	2.5150E-40	0.0
RA-226	1.0983E-27	0.0	7.8628E-23	2.6650E-22	3.7111E-35	1.4002E-43	0.0
TH-232	2.6180E-15	0.0	6.8724E-13	2.3293E-12	8.8465E-23	3.3378E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	4.9302E-67	0.0	1.7256E-61	5.8488E-61	1.6660E-74	0.0	0.0
U-235	5.7587E-67	0.0	2.0156E-61	6.8316E-61	1.9459E-74	0.0	0.0
U-236	8.2267E-68	0.0	2.8794E-62	9.7595E-62	2.7799E-75	0.0	0.0
U-238	5.1006E-64	0.0	1.7853E-58	6.0509E-58	1.7235E-71	0.0	0.0

PU-238	5.8185E-19	0.0	5.0913E-15	1.7256E-14	1.9661E-26	7.4182E-35	0.0
PU-239	6.7774E-18	0.0	5.9322E-14	2.0106E-13	2.2908E-25	8.6433E-34	0.0
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 500 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	2.4118E-53
C-14	7.8442E-76	0.0	0.0	1.1043E-44
MN-54	0.0	0.0	0.0	0.0
FE-55	6.4793E-52	0.0	5.8067E-55	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	5.9402E-24	0.0	5.3235E-27	0.0
NI-63	4.0146E 02	0.0	1.3193E-01	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	5.7243E-03	0.0	1.0449E-05	0.0
Y-90	5.7243E-03	0.0	1.0449E-05	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8828E-75	0.0	0.0	3.0729E-06
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	7.9680E-55	0.0	8.7276E-58	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	3.9585E-69	0.0	1.7739E-73	0.0
CS-137	2.7251E 00	0.0	1.2212E-04	0.0
BA-137M	2.7251E 00	0.0	1.2212E-04	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	5.5786E-56	0.0	4.5077E-59	0.0
RE-187	5.2691E-02	0.0	3.4613E-04	0.0
PB-210	3.7052E-06	0.0	3.3823E-10	0.0
RA-226	4.3065E-01	0.0	9.6491E-05	0.0
TH-232	1.2990E 00	0.0	1.0672E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	1.7111E 00	0.0	1.8743E-03	0.0
U-235	1.9594E 00	0.0	2.1900E-03	0.0
U-236	2.8564E-01	0.0	3.1287E-04	0.0
U-238	1.7498E 03	0.0	1.9166E 00	0.0
PU-238	3.7967E-03	0.0	1.0397E-07	0.0
PU-239	9.7179E-02	0.0	2.6613E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	7.6847E-60
C-14	0.0	0.0	0.0	0.0	0.0	0.0	3.5185E-51
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-63	2.2081E-34	0.0	2.3185E-29	7.8584E-29	7.4613E-42	2.8151E-50	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	9.7911E-13
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-137	5.1149E-18	0.0	7.3239E-14	2.4823E-13	1.7284E-25	6.5212E-34	0.0
BA-137M	5.1149E-18	0.0	7.3239E-14	2.4823E-13	1.7284E-25	6.5212E-34	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	4.9632E-27	0.0	1.4477E-22	4.9066E-22	1.6771E-34	6.5278E-43	0.0
RA-226	1.0445E-30	0.0	7.4780E-26	2.5346E-25	3.5295E-38	1.3317E-46	0.0
TH-232	2.5500E-15	0.0	6.6940E-13	2.2689E-12	8.6168E-23	3.2511E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-238	4.7235E-77	0.0	1.6533E-71	5.6036E-71	0.0	0.0	0.0

PU-238	1.1049E-19	0.0	9.6683E-16	3.2770E-15	3.7336E-27	1.4087E-35	0.0
PU-239	2.8285E-18	0.0	2.4750E-14	8.3888E-14	9.5579E-26	3.6062E-34	0.0
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 600 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	0.0
C-14	7.7498E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	4.0855E-63	0.0	3.6614E-66	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	1.0051E-29	0.0	9.0073E-33	0.0
NI-63	2.0710E 02	0.0	6.8057E-02	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	4.2414E-04	0.0	7.7424E-07	0.0
Y-90	4.2414E-04	0.0	7.7424E-07	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8815E-75	0.0	0.0	8.8946E-48
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	9.9182E-66	0.0	1.0864E-68	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0
CS-137	2.6928E-01	0.0	1.2067E-05	0.0
BA-137M	2.6928E-01	0.0	1.2067E-05	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	1.7622E-67	0.0	1.4239E-70	0.0
RE-187	2.7376E-02	0.0	1.7984E-04	0.0
PB-210	1.6375E-07	0.0	1.4548E-11	0.0
RA-226	4.0322E-01	0.0	9.0345E-05	0.0
TH-232	1.2985E 00	0.0	1.0671E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	1.5332E 00	0.0	1.6794E-03	0.0
U-235	1.7920E 00	0.0	1.9628E-03	0.0
U-236	2.5602E-01	0.0	2.8042E-04	0.0
U-238	1.5684E 03	0.0	1.7179E 00	0.0
PU-238	1.7184E-03	0.0	4.7058E-08	0.0
PU-235	9.6630E-02	0.0	2.6463E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-63	5.4274E-39	0.0	5.6989E-34	1.9316E-33	1.8340E-46	6.9196E-55	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	2.8340E-54
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-137	1.2251E-19	0.0	1.7542E-15	5.9457E-15	4.1399E-27	1.5620E-35	0.0
BA-137M	1.2251E-19	0.0	1.7542E-15	5.9457E-15	4.1399E-27	1.5620E-35	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	1.2488E-29	0.0	3.6424E-25	1.2345E-24	4.2198E-37	1.5921E-45	0.0
RA-226	9.9339E-34	0.0	7.1120E-29	2.4105E-28	3.3568E-41	1.2665E-49	0.0
TH-232	2.4838E-15	0.0	6.5202E-13	2.2099E-12	8.3931E-23	3.1667E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-238	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PU-238	2.0982E-20	0.0	1.8360E-16	6.2229E-16	7.0901E-28	2.6751E-36	0.0
PU-239	1.1801E-18	0.0	1.0326E-14	3.4999E-14	3.9877E-26	1.5045E-34	0.0
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 700 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E C3 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH C1	TRENCH OVERFLOW C1	TRENCH DRAINAGE C1	AMOUNT AT WELL C1
H-3	0.0	0.0	0.0	0.0
C-14	7.6565E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	2.6227E-74	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	1.7006E-35	0.0	1.5240E-38	0.0
NI-63	1.0684E 02	0.0	3.5110E-02	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	3.1427E-05	0.0	5.7368E-08	0.0
Y-90	3.1427E-05	0.0	5.7368E-08	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8802E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	1.2912E-76	0.0	0.0	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0
CS-137	2.6608E-02	0.0	1.1924E-06	0.0
BA-137M	2.6608E-02	0.0	1.1924E-06	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	5.8431E-79	0.0	0.0	0.0
RE-187	1.4224E-02	0.0	9.3437E-05	0.0
PB-210	7.2368E-09	0.0	5.6061E-13	0.0
RA-226	3.7753E-01	0.0	8.4590E-05	0.0
TH-232	1.2587E 00	0.0	1.0669E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	1.3737E 00	0.0	1.5047E-03	0.0
U-235	1.6062E 00	0.0	1.7593E-03	0.0
U-236	2.2947E-01	0.0	2.5134E-04	0.0
U-238	1.4057E 03	0.0	1.5397E 00	0.0
PU-238	7.7773E-04	0.0	2.1298E-08	0.0
PU-239	9.6082E-02	0.0	2.6312E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-63	1.3341E-43	0.0	1.4008E-38	4.7478E-38	4.5079E-51	1.7008E-59	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-137	2.9344E-21	0.0	4.2017E-17	1.4241E-16	9.9158E-29	3.7412E-37	0.0
BA-137M	2.9344E-21	0.0	4.2017E-17	1.4241E-16	9.9158E-29	3.7412E-37	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	3.1420E-32	0.0	9.1645E-28	3.1062E-27	1.0617E-39	4.0059E-48	0.0
RA-226	9.4478E-37	0.0	6.7640E-32	2.2926E-31	3.1925E-44	1.2045E-52	0.0
TH-232	2.4193E-15	0.0	6.3509E-13	2.1526E-12	8.1752E-23	3.0845E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-238	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 800 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E C3 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	0.0
C-14	7.5643E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	2.8774E-41	0.0	2.5787E-44	0.0
NI-63	5.5118E 01	0.0	1.8113E-02	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	2.3286E-C6	0.0	4.2507E-09	0.0
Y-90	2.3286E-C6	0.0	4.2507E-09	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8790E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0
CS-137	2.6293E-03	0.0	1.1782E-07	0.0
BA-137M	2.6293E-03	0.0	1.1782E-07	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0
RE-187	7.3901E-03	0.0	4.8546E-05	0.0
PB-210	3.1983E-10	0.0	2.9195E-14	0.0
RA-226	3.5349E-01	0.0	7.9201E-05	0.0
TH-232	1.2585E-00	0.0	1.0668E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	1.2309E-00	0.0	1.3482E-03	0.0
U-235	1.4396E-00	0.0	1.5768E-03	0.0
U-236	2.0567E-01	0.0	2.2528E-04	0.0
U-238	1.2600E-03	0.0	1.3801E-00	0.0
PU-238	3.5199E-04	0.0	9.6392E-09	0.0
PU-239	9.5535E-02	0.0	2.6164E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-63	3.2791E-48	0.0	3.4432E-43	1.1670E-42	1.1080E-55	4.1806E-64	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-137	7.0287E-23	0.0	1.0064E-18	3.4111E-18	2.3751E-30	8.9611E-39	0.0
BA-137M	7.0287E-23	0.0	1.0064E-18	3.4111E-18	2.3751E-30	8.9611E-39	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	7.9056E-35	0.0	2.3059E-30	7.8154E-30	2.6714E-42	1.0079E-50	0.0
RA-226	8.9854E-40	0.0	6.4330E-35	2.1804E-34	3.0363E-47	1.1456E-55	0.0
TH-232	2.3565E-15	0.0	6.1860E-13	2.0967E-12	7.9629E-23	3.0044E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-238	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PU-238	7.5663E-22	0.0	6.6207E-18	2.2440E-17	2.5567E-29	9.6465E-38	0.0
PU-239	2.0542E-19	0.0	1.7975E-15	6.0924E-15	6.9415E-27	2.6190E-35	0.0
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CN-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 900 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	0.0
C-14	7.4733E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	4.8685E-47	0.0	4.3631E-50	0.0
NI-63	2.8434E 01	0.0	9.3439E-03	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	1.7254E-07	0.0	3.1495E-10	0.0
Y-90	1.7254E-07	0.0	3.1495E-10	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8777E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0
CS-137	2.5981E-04	0.0	1.1643E-08	0.0
BA-137M	2.5981E-04	0.0	1.1643E-08	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0
RE-187	3.8395E-03	0.0	2.5222E-05	0.0
PB-210	1.4134E-11	0.0	1.2903E-15	0.0
RA-226	3.3097E-01	0.0	7.4156E-05	0.0
TH-232	1.2983E 00	0.0	1.0666E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	1.1029E 00	0.0	1.2080E-03	0.0
U-235	1.2903E 00	0.0	1.4133E-03	0.0
U-236	1.8434E-01	0.0	2.0191E-04	0.0
U-238	1.1293E 03	0.0	1.2370E 00	0.0
PU-238	1.5930E-04	0.0	4.3626E-09	0.0
PU-235	9.5002E-02	0.0	2.6017E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CONC CI/M**3	SURFACE WATER CONC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-63	8.0600E-53	0.0	8.4633E-48	2.8685E-47	2.7236E-60	1.0276E-68	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-137	1.6835E-24	0.0	2.4106E-20	8.1703E-20	5.6888E-32	2.1464E-40	0.0
BA-137M	1.6835E-24	0.0	2.4106E-20	8.1703E-20	5.6888E-32	2.1464E-40	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	1.9891E-37	0.0	5.8018E-33	1.9664E-32	6.7214E-45	2.5360E-51	0.0
RA-226	8.5457E-43	0.0	6.1181E-38	2.0737E-37	2.8877E-50	1.0895E-57	0.0
TH-232	2.2953E-15	0.0	6.0254E-13	2.0422E-12	7.7561E-23	2.926E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-238	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANNUAL SUMMARY FOR YEAR 1000 OF THE SIMULATION

THE TRENCH CAP HAS HAD 10.00 PER CENT FAILURE
 THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH DURING THE YEAR IS 0.0 METERS
 6.0439E 03 CUBIC METERS OF WATER LEFT BOTTOM OF TRENCH
 0.0 CUBIC METERS OF WATER OVERFLOWED TRENCH

NUCLIDE TRANSPORT INFORMATION

NUCLIDE	AMOUNT IN TRENCH CI	TRENCH OVERFLOW CI	TRENCH DRAINAGE CI	AMOUNT AT WELL CI
H-3	0.0	0.0	0.0	0.0
C-14	7.3833E-76	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0
CO-60	8.2374E-53	0.0	7.3823E-56	0.0
NI-63	1.4668E 01	0.0	4.8202E-03	0.0
ZN-65	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0
SR-90	1.2784E-C8	0.0	2.3337E-11	0.0
Y-90	1.2784E-C8	0.0	2.3337E-11	0.0
NB-94	0.0	0.0	0.0	0.0
TC-99	3.8765E-75	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0

I-125	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0
CS-137	2.5673E-05	0.0	1.1505E-09	0.0
BA-137M	2.5673E-05	0.0	1.1505E-09	0.0
CE-141	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0
RE-187	1.9949E-03	0.0	1.3105E-05	0.0
PB-210	6.2467E-13	0.0	5.7022E-17	0.0
RA-226	3.0988E-01	0.0	6.9432E-05	0.0
TH-232	1.2581E 00	0.0	1.0665E-06	0.0
U-233	0.0	0.0	0.0	0.0
U-234	9.8813E-01	0.0	1.0823E-03	0.0
U-235	1.1564E 00	0.0	1.2667E-03	0.0
U-236	1.6522E-01	0.0	1.8097E-04	0.0
U-238	1.0122E 03	0.0	1.1087E 00	0.0
PU-238	7.2101E-05	0.0	1.9745E-09	0.0
PU-239	9.4466E-02	0.0	2.5870E-06	0.0
PU-241	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0
AM-243	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0

NUCLIDE	SURFACE SOIL CCNC CI/M**3	SURFACE WATER CCNC CI/M**3	SOLUBLE TO STREAM CI	SOLUBLE TO TRENCH CI	ATMOSPHERE AT SPILLAGE CI/M**3	ATMOSPHERE DOWN WIND CI/M**3	WELL WATER CONC CI/M**3
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI-63	1.9811E-57	0.0	2.0803E-52	7.0508E-52	6.6945E-65	2.5258E-73	0.0
ZN-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KR-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-137	4.0323E-26	0.0	5.7738E-22	1.9569E-21	1.3626E-33	5.1410E-42	0.0
BA-137M	4.0323E-26	0.0	5.7738E-22	1.9569E-21	1.3626E-33	5.1410E-42	0.0
CE-141	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE-144	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM-147	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE-187	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB-210	5.0048E-40	0.0	1.4598E-35	4.9477E-35	1.6912E-47	6.3808E-56	0.0
KA-226	8.1275E-46	0.0	5.8187E-41	1.9722E-40	2.7464E-53	1.0362E-61	0.0
TH-232	2.2357E-15	0.0	5.8689E-13	1.9892E-12	7.5547E-23	2.8504E-31	0.0
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-234	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-238	0.0	0.0	0.0	0.0	0.0	0.0	0.0

AVERAGE CONCENTRATIONS OVER THE YEARS 1 TO 1000 OF THE SIMULATION
MAXIMUM ANNUAL CONCENTRATIONS

NUCL ID:	ATMOSPHERE DOWNWIND			IN WELL			IN STREAM		
	AVERAGE CI/M ³	MAXIMUM CI/M ³	YEAR	AVERAGE CI/M ³	MAXIMUM CI/M ³	YEAR	AVERAGE CI/M ³	MAXIMUM CI/M ³	YEAR
H-3	3.3199E-25	3.3193E-26	1	1.4495E-16	1.2726E-13	444	94E-11	1.3586E-08	1
C-14	9.8104E-33	6.8115E-30	1	2.8995E-09	2.4140E-06	444	83E-15	4.0158E-12	1
4N-54	7.3018E-27	6.3634E-24	1	0.0	0.0	0	2.9065E-13	1.7363E-10	1
FE-55	8.0464E-26	6.4593E-23	1	0.0	0.0	0	1.2041E-11	4.8008E-09	1
41-59	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
CO-60	6.1648E-25	4.7687E-22	1	0.0	0.0	0	1.1120E-10	3.5407E-08	1
NI-63	2.3423E-26	1.6103E-23	1	0.0	0.0	0	4.3556E-12	4.3940E-10	1
ZN-65	2.3327E-27	2.2037E-24	1	0.0	0.0	0	6.8570E-13	5.6371E-10	1
KR-85	0.0	0.0	0	5.3816E-19	5.3816E-16	427	6.7410E-13	6.7410E-10	1
SR-90	3.2728E-27	2.6092E-24	1	0.0	0.0	0	1.0302E-12	3.9553E-10	1
Y-90	3.2728E-27	2.6092E-24	1	0.0	0.0	0	1.0302E-12	3.9553E-10	1
NB-94	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
TC-99	2.0776E-31	2.0762E-28	1	1.5405E-08	1.1975E-05	483	2.5805E-14	2.5751E-11	1
RU-106	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
CD-109	4.7630E-30	4.5972E-27	1	0.0	0.0	0	3.3287E-15	2.7534E-12	1
SB-125	3.1248E-20	2.5356E-27	1	0.0	0.0	0	5.4453E-16	2.3062E-13	1
1-135	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
1-129	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
C5-134	5.5482E-26	4.2435E-23	1	0.0	0.0	0	5.3372E-13	1.5789E-10	1
CS-137	6.9040E-25	4.5479E-22	1	0.0	0.0	0	4.6105E-11	1.6922E-09	1
BA-137M	6.9040E-25	4.5479E-22	1	0.0	0.0	0	4.6105E-11	1.6922E-09	1
CE-141	3.6902E-31	3.6858E-28	1	0.0	0.0	0	1.3735E-16	1.3729E-15	1
CE-144	4.8158E-31	4.8156E-28	1	0.0	0.0	0	1.7920E-16	1.7918E-15	1
PM-147	2.2372E-28	1.7885E-25	1	0.0	0.0	0	3.0768E-14	1.2000E-11	1
RE-187	8.7700E-31	7.8768E-28	1	0.0	0.0	0	6.3424E-16	4.2985E-13	1
PE-210	5.0436E-29	3.3733E-26	1	0.0	0.0	0	4.3925E-15	2.5568E-13	1
RA-226	1.3539E-30	9.1108E-28	1	0.0	0.0	0	2.5170E-16	1.6920E-14	1
71-232	3.6071E-36	2.1157E-27	1	0.0	0.0	0	1.2663E-16	1.4432E-14	1
U-233	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
U-234	4.8101E-30	3.6175E-27	1	0.0	0.0	0	1.2674E-15	3.2902E-13	1
U-235	5.6168E-30	4.2204E-27	1	0.0	0.0	0	1.4780E-15	3.6386E-13	1
U-236	8.0268E-31	6.0252E-28	1	0.0	0.0	0	2.1123E-16	5.4837E-14	1
U-238	4.9767E-27	3.7381E-24	1	0.0	0.0	0	1.3096E-12	3.3999E-10	1
PU-238	4.9460E-31	3.2021E-28	1	0.0	0.0	0	4.4101E-17	7.2811E-16	1
PU-235	2.5207E-31	1.6137E-28	1	0.0	0.0	0	4.2065E-17	3.6693E-16	1
PU-241	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
AY-241	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
PU-242	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
AM-243	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
CM-243	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0

RADIONUCLIDE CONCENTRATION IN FOODS DUE TO IRRIGATION
PICO CURIES PER KILOGRAM

NUCLIDE	LEAFY VEG M.I.E.	PRODUCE M.I.E.	LEAFY VEG G.P.E.	PRODUCE G.P.E.	COW'S MILK M.I.E.	COW'S MILK G.P.E.	GOAT'S MILK M.I.E.	GOAT'S MILK G.P.E.	BEEF MEAT
H-3	1.4495E-07	1.4495E-07	1.4495E-07	1.4495E-07	1.5944E-07	1.5944E-07	3.4497E-07	3.4497E-07	1.9133E-07
C-14	6.7124E 00	6.7123E 00	6.7124E 00	6.7124E 00	1.1270E 01	1.1270E 01	1.1500E 01	1.1500E 01	2.8225E 01
IN-54	4.7850E-13	2.3969E-14	4.6491E-13	9.2981E-14	5.6699E-15	5.6448E-15	6.8039E-15	5.7738E-16	1.7434E-14
FE-55	3.5156E-13	8.4312E-14	3.4835E-13	8.7088E-14	2.0721E-14	2.0692E-14	2.6937E-16	2.6899E-16	6.8200E-13
NI-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO-60	1.2884E-11	1.2610E-11	1.2822E-11	1.2822E-11	6.3817E-13	6.3771E-13	7.6581E-14	7.6525E-14	8.2424E-12
NI-63	5.4617E-11	5.4562E-11	5.4605E-11	5.4605E-11	1.8289E-11	1.8288E-11	2.1946E-12	2.1946E-12	1.4463E-10
ZN-65	6.0793E-13	3.0832E-13	5.8582E-13	3.5149E-13	1.1082E-12	1.1019E-12	1.3299E-13	1.3223E-13	8.0987E-13
KR-85	1.2553E-09	1.2423E-09	1.2525E-09	1.2525E-09	3.5044E-09	3.5032E-09	4.2914E-10	4.2899E-10	3.3860E-09
BR-90	7.3494E-11	7.3207E-12	7.3431E-11	7.3431E-12	2.9347E-12	2.9344E-12	6.1630E-12	6.1622E-12	2.1984E-12
Y-90	7.3494E-11	7.3207E-12	7.3431E-11	7.3431E-12	2.9347E-12	2.9344E-12	6.1630E-12	6.1622E-12	2.1984E-12
NR-94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC-99	4.5409E 01	4.5409E 01	4.5409E 01	4.5409E 01	1.5884E 02	1.5884E 02	1.9449E 01	1.9449E 01	2.4638E 03
RJ-106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD-109	1.0605E-15	2.6635E-16	1.0460E-15	2.8528E-16	6.6818E-18	6.6619E-18	8.0182E-19	7.9943E-19	2.6519E-17
SD-125	6.9992E-16	1.0083E-16	6.9371E-16	1.0406E-16	5.1592E-17	5.1521E-17	6.1910E-18	6.1825E-18	1.3589E-16
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS-134	4.5552E-13	4.3144E-13	4.5010E-13	4.5010E-13	2.6706E-13	2.6657E-13	8.0119E-13	7.9971E-13	8.7558E-14
CS-137	9.5318E-11	9.5461E-11	9.5739E-11	9.5739E-11	5.7397E-11	5.7390E-11	1.7219E-10	1.7217E-10	1.9111E-11
BA-137M	9.5818E-11	9.5461E-11	9.5739E-11	9.5739E-11	5.7397E-11	5.7390E-11	1.7219E-10	1.7217E-10	1.9111E-11
CE-137	4.9611E-22	5.6425E-23	3.7504E-22	1.5042E-22	1.8560E-24	1.7786E-24	2.2272E-25	2.1343E-25	1.5175E-23
TE-134	2.1054E-22	1.9980E-23	1.5334E-22	6.1337E-23	7.7519E-25	7.3629E-25	9.3022E-26	8.8595E-26	5.9975E-24
PM-147	2.3771E-15	9.1113E-16	2.3549E-15	9.4195E-16	5.8353E-19	5.8267E-19	7.0022E-20	6.9921E-20	5.5293E-16
RE-137	1.0278E-14	2.3982E-15	1.0278E-14	2.3982E-15	1.2847E-14	1.2847E-14	1.5417E-15	1.5417E-15	4.1111E-15
RB-210	5.1450E-18	5.1192E-18	5.1393E-18	5.1393E-18	2.5669E-21	2.5664E-21	3.0802E-22	3.0797E-22	2.5629E-21
RA-226	2.9997E-15	2.9995E-16	2.9996E-15	2.9996E-16	2.2497E-15	2.2497E-15	2.6996E-16	2.6996E-16	5.0992E-15
TH-232	1.1304E-17	1.1304E-17	1.1304E-17	1.1304E-17	5.6519E-21	5.6519E-21	6.7823E-22	6.7823E-22	5.6519E-21
U-233	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U-235	2.2320E-18	2.2319E-18	2.2320E-18	2.2320E-18	1.1160E-21	1.1160E-21	1.3392E-22	1.3392E-22	1.1160E-21
U-235	2.6050E-18	2.6050E-18	2.6050E-18	2.6050E-18	1.3025E-21	1.3025E-21	1.5630E-22	1.5630E-22	1.3025E-21
U-236	3.7217E-19	3.7217E-19	3.7217E-19	3.7217E-19	1.8609E-22	1.8609E-22	2.2330E-23	2.2330E-23	1.8609E-22
U-238	2.3075E-15	2.3075E-15	2.3075E-15	2.3075E-15	1.1537E-18	1.1537E-18	1.3845E-19	1.3845E-19	1.1537E-18
PU-238	9.0121E-18	9.0006E-19	9.0096E-18	9.0096E-19	6.7553E-22	6.7550E-22	8.1063E-23	8.1060E-23	3.6014E-18
PU-239	3.3609E-17	3.3609E-18	3.3609E-17	3.3609E-18	2.5207E-21	2.5207E-21	3.0248E-22	3.0248E-22	1.3443E-17
PU-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-241	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PU-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AM-242	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CM-243	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOTE: G.P.E. - GENERAL POPULATION EXPOSURE
M.I.E. - MAXIMUM INDIVIDUAL EXPOSURE

G.P.E. WILL BE USED TO CALCULATE HEALTH EFFECTS

NUCLIDE	ANNUAL INTAKE BY INGESTION PCI/Y	ANNUAL INTAKE BY INHALATION FCI/Y
H-3	1.4442E-04	2.6560E-13
C-14	7.5332E 03	7.8507E-17
MN-54	1.6113E-08	5.8415E-11
FE-55	3.9644E-07	6.4371E-10
NI-59	0.0	0.0
CO-60	2.0006E-06	4.9318E-09
NI-63	2.2273E-07	1.8739E-10
ZN-65	1.5899E-08	1.8661E-11
KR-85	1.3808E-06	0.0
SR-90	3.9736E-08	2.6182E-11
Y-90	3.9736E-08	2.6182E-11
NB-94	0.0	0.0
TC-99	2.7557E 05	1.6620E-15
RU-106	0.0	0.0
CD-109	1.1106E-11	3.8104E-14
SB-125	8.5757E-12	2.4998E-14
I-125	0.0	0.0
I-129	0.0	0.0
CS-134	1.8856E-07	4.4386E-10
CS-137	2.5221E-06	5.5232E-09
BA-137M	2.5221E-06	5.5232E-09
CE-141	4.0677E-13	2.9522E-15
CE-144	4.9215E-13	3.8526E-15
PM-147	5.7612E-10	1.7897E-12
RE-187	1.2641E-11	7.0160E-15
PB-210	1.1756E-10	4.0348E-13
RA-226	1.0530E-11	1.0831E-14
TH-232	8.4458E-12	2.8857E-14
U-233	0.0	0.0
U-234	1.1272E-11	3.8528E-14
U-235	1.3151E-11	4.4950E-14
U-236	1.8767E-12	6.4215E-15
U-238	1.1648E-08	3.9813E-11

PU-238	1.4241E-12	3.9568E-15
PU-239	7.4050E-13	2.0166E-15
PU-241	0.0	0.0
AM-241	0.0	0.0
PU-242	0.0	0.0
AM-243	0.0	0.0
CM-243	0.0	0.0

FRACTION OF INGESTION DUE TO WATER

NUCLIDE	FRACTION
H-3	0.3713
C-14	0.1409
MN-54	0.0
FE-55	0.0
NI-59	0.0
CO-60	0.0
NI-63	0.0
ZN-65	0.0
KR-85	0.1442
SR-90	0.0
Y-90	0.0
NB-94	0.0
TC-99	0.0260
RU-106	0.0
CD-109	0.0
SB-125	0.0
I-125	0.0
I-129	0.0
CS-134	0.0
CS-137	0.0
BA-137M	0.0
CE-141	0.0
CE-144	0.0
PM-147	0.0
RE-187	0.0
PB-210	0.0
RA-226	0.0
TH-232	0.0
U-233	0.0
U-234	0.0
U-235	0.0
U-236	0.0
U-238	0.0

0.0
0.0
0.0
0.0
0.0
0.0
0.0

PU-238
PU-239
PU-241
AM-241
PU-242
AM-243
CM-243

NUCLIDE	AIR CONCENTRATION CI/M*#3	YEAR	SURFACE CONCENTRATION CI/M*#2	MAXIMUM ANNUAL EXPOSURE			YEAR	INHALATION RATE PERSON.PCI/Y	YEAR	INHALATION RATE PERSON.PCI/Y	YEAR
				YEAR	INGESTION RATE PERSON.PCI/Y	YEAR					
H-3	3.3193E-26	1	0.0	0	8.6380E-02	444	1	1.8676E-06	1	1.8676E-06	1
C-14	9.8115E-30	1	6.7856E-06	444	4.6219E-10	444	1	5.5204E-10	1	5.5204E-10	1
MN-54	6.3630E-24	1	8.9171E-19	1	9.7793E-02	1	1	3.5803E-04	1	3.5803E-04	1
FE-55	6.4593E-23	1	1.5663E-17	1	2.2367E-00	1	1	3.6343E-03	1	3.6343E-03	1
NI-59	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
CO-60	4.7687E-22	1	1.4138E-16	2	1.0820E-01	1	1	2.6831E-02	1	2.6831E-02	1
NI-63	1.6103E-23	1	7.0092E-18	5	7.2549E-01	1	1	9.0604E-04	1	9.0604E-04	1
ZN-65	2.5037E-24	1	2.4085E-19	1	1.0229E-01	1	1	1.2399E-04	1	1.2399E-04	1
KR-85	0.0	0	1.3498E-17	427	9.7114E-00	427	0	0.0	0	0.0	0
SR-90	2.6032E-24	1	9.1972E-19	3	4.7792E-02	1	1	1.4681E-04	1	1.4681E-04	1
Y-90	2.6032E-24	1	9.1972E-19	3	4.7792E-02	1	1	1.4681E-04	1	1.4681E-04	1
NB-94	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
TC-99	2.6762E-28	1	3.7188E-07	483	1.2562E-12	483	1	1.1682E-08	1	1.1682E-08	1
RU-106	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
CD-109	4.5072E-27	1	7.8719E-22	1	7.1263E-03	1	1	2.5359E-07	1	2.5359E-07	1
SB-125	2.5356E-27	1	6.1837E-22	1	4.7213E-05	1	1	1.4266E-07	1	1.4266E-07	1
I-125	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
I-129	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
CS-134	4.2435E-23	1	9.5606E-18	1	1.0124E-00	1	1	2.3876E-03	1	2.3876E-03	1
CS-137	4.5475E-22	1	1.9260E-16	4	1.1277E-01	1	1	2.5588E-02	1	2.5588E-02	1
BA-137M	4.5479E-22	1	1.9260E-16	4	1.1277E-01	1	1	2.5588E-02	1	2.5588E-02	1
CE-141	3.6596E-28	1	4.8628E-26	1	2.8745E-06	1	1	2.0760E-08	1	2.0760E-08	1
CE-144	4.8156E-28	1	2.0707E-26	1	3.4611E-06	1	1	2.7094E-08	1	2.7094E-08	1
PM-147	1.7885E-25	1	4.3091E-20	1	3.2326E-03	1	1	1.0063E-05	1	1.0063E-05	1
RE-187	7.4766E-28	1	2.5220E-22	2	2.7706E-05	1	1	4.4318E-08	1	4.4318E-08	1
PB-210	3.2733E-26	1	1.3726E-20	4	5.5296E-04	1	1	1.8979E-06	1	1.8979E-06	1
RA-226	9.1108E-28	1	4.1928E-22	8	3.6990E-05	1	1	5.1261E-08	1	5.1261E-08	1
TM-232	2.1157E-27	1	1.1320E-21	1000	3.4821E-05	1	1	1.1904E-07	1	1.1904E-07	1
U-233	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
U-234	3.6175E-27	1	1.4632E-21	4	5.9538E-05	1	1	2.0353E-07	1	2.0353E-07	1
U-235	4.2204E-27	1	1.7071E-21	4	6.9462E-05	1	1	2.3746E-07	1	2.3746E-07	1
U-236	6.0292E-28	1	2.4387E-22	4	9.9231E-06	1	1	3.5923E-08	1	3.5923E-08	1
U-238	3.7381E-24	1	1.5180E-18	4	6.1523E-02	1	1	2.1032E-04	1	2.1032E-04	1
PU-238	3.2021E-28	1	1.4639E-22	6	6.4642E-06	1	1	1.8016E-08	1	1.8016E-08	1
PU-239	1.6137E-28	1	7.8358E-23	15	3.2611E-06	1	1	9.0794E-09	1	9.0794E-09	1
PU-241	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
AM-241	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
PU-242	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
AM-243	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0
CM-243	0.0	0	0.0	0	0.0	0	0	0.0	0	0.0	0

BARNELL SIMULATION. WILL AT 514 4. XEROX 2. SCAM-E-8

TABLES FOR THE SELECTED INDIVIDUAL WILL BE DONE FOR THE LOCATION HAVING 100.00 % OF THE HIGHEST TOTAL RISK.

DOSE RATE TABLES COMBINING LOW AND HIGH LET WILL BE PRINTED.

HEALTH RISK TABLES COMBINING LOW AND HIGH LET WILL BE PRINTED.

0 INDICATES THE TABLE WILL NOT BE PRINTED

1 INDICATES INDIVIDUAL VALUES WILL BE PRINTED

2 INDICATES MEAN INDIVIDUAL VALUES WILL BE PRINTED

3 INDICATES COLLECTIVE VALUES WILL BE PRINTED

4 INDICATES ALL OF THE ABOVE WILL BE PRINTED

QUANTITY	TABLE NO.	1	2	3	4	5	6	7
1. DOSE RATES		0	0	0	0	0	3	3
2. HEALTH RISKS		0	0	0	0	0	3	3
3. RISK EQUIVALENT FACTOR		0	0	0	0	0	0	0

THE GROUND SURFACE CORRECTION FACTOR IS 0.50

THERE ARE 18 ORGANS TO BE OUTPUT. THEY ARE:

ORGAN	TIME	ORGAN	TIME	ORGAN	TIME
R MAR	70.	ENDOST	70.	*PUL*	70.
MUSCLE	70.	LIVER	70.	S WALL	70.
PANCREAS	70.	LLI WALL	70.	KIDNEYS	70.
BL WALL	70.	ULI WALL	70.	SI WALL	70.
OVARIES	70.	TESTES	70.	SPLEEN	70.
UTERUS	70.	THYMUS	70.	THYROID	70.

ORGAN	DOSE EQUIVALENT FACTORS	
	LOW LET	HIGH LET
R MAR	1.00000	20.0000
ENDOST	1.00000	20.0000
PUL	1.00000	20.0000
MUSCLE	1.00000	20.0000
LIVER	1.00000	20.0000
S WALL	1.00000	20.0000
PANCREAS	1.00000	20.0000
LLI WALL	1.00000	20.0000
KIDNEYS	1.00000	20.0000
BL WALL	1.00000	20.0000
ULI WALL	1.00000	20.0000
SI WALL	1.00000	20.0000
OVARIES	1.00000	20.0000
TESTES	1.00000	20.0000
SPLEEN	1.00000	20.0000
UTERUS	1.00000	20.0000
THYMUS	1.00000	20.0000
THYROID	1.00000	20.0000

THERE ARE 10 CANCERS TO BE OUTPUT.

A 1 INDICATES ABSOLUTE RISK; A 2 IS RELATIVE RISK.

CANCER CANCER CANCER
R MAMMARY 1. ENDOST 1. PULMONARY 1. BREAST 1.
S1 WALL 1. PANCREAS 1. LLI WALL 1. KIDNEYS 1.
UL WALL 1. ULI WALL 1. SI WALL 1. OVARIES 1.
TESTES 1. SPLEEN 1. UTERUS 1. THYMUS 1.
THYROID 1. LIVER 1.

GENETIC DOSES ARE PRINTED FOR TESTES OVARIES AVERAGE

THE RISK FACTOR (PER HAZARD/MILLION BIRTHS) FOR GENETIC DOSE ARE :

200.00000 FOR LOW LET. AND

20000.000 FOR HIGH LET.

AND THE REPLACEMENT RATE FOR THE POPULATION IS :

.14133E-01 YEAR-1

THERE ARE 40 RADIONUCLIDES TO BE OUTPUT.

NUCLIDE PARTICLE SIZE CLEARANCE CLASS

H-3	0.0		STOMACH	SI	G.I. ABSORPTION FRACTION	ULI	LLI
C-14	0.0		0.0	0.95000	0.0	0.0	0.0
MN-54	1.00000		0.0	0.95000	0.0	0.0	0.0
FE-55	1.00000	W	0.0	0.10000	0.0	0.0	0.0
NI-56	1.00000	W	0.0	0.10000	0.0	0.0	0.0
CO-60	1.00000	Y	0.0	0.05000	0.0	0.0	0.0
NI-63	1.00000	W	0.0	0.05000	0.0	0.0	0.0
ZN-65	1.00000	Y	0.0	0.50000	0.0	0.0	0.0
KR-85	0.0	Y	0.0	0.0	0.0	0.0	0.0
SR-90	1.00000	Y	0.0	0.01000	0.0	0.0	0.0
Y-90	1.00000	Y	0.0	0.01000	0.0	0.0	0.0
NB-94	1.00000	Y	0.0	0.01000	0.0	0.0	0.0
TC-99	1.00000	W	0.0	0.80000	0.0	0.0	0.0
RU-106	1.00000	Y	0.0	0.05000	0.0	0.0	0.0
CD-105	1.00000		0.0	0.0	0.0	0.0	0.0
SB-125	1.00000	W	0.0	0.20000	0.0	0.0	0.0
I-125	1.00000	D	0.0	0.95000	0.0	0.0	0.0
I-129	1.00000	D	0.0	0.95000	0.0	0.0	0.0
CS-134	1.00000	D	0.0	0.95000	0.0	0.0	0.0
CS-137	1.00000	D	0.0	0.95000	0.0	0.0	0.0
BA-137M	1.00000	D	0.0	0.95000	0.0	0.0	0.0
CS-141	1.00000	Y	0.0	0.00030	0.0	0.0	0.0
CE-144	1.00000	Y	0.0	0.00030	0.0	0.0	0.0
PM-147	1.00000	Y	0.0	0.0	0.0	0.0	0.0
RE-187	1.00000	W	0.0	0.20000	0.0	0.0	0.0
PB-210	1.00000	W	0.0	0.10000	0.0	0.0	0.0
RA-226	1.00000	W	0.0	0.20000	0.0	0.0	0.0
TH-232	1.00000	W	0.0	0.20000	0.0	0.0	0.0
U-233	1.00000	Y	0.0	0.20000	0.0	0.0	0.0

U-234	1.00000	Y	0.0	0.00200	0.0	0.0
U-235	1.00000	Y	0.0	0.00100	0.0	0.0
U-236	1.00000	Y	0.0	0.00200	0.0	0.0
U-238	1.00000	Y	0.0	0.00200	0.0	0.0
PU-238	1.00000	Y	0.0	0.00200	0.0	0.0
PU-239	1.00000	Y	0.0	0.00100	0.0	0.0
PU-241	1.00000	Y	0.0	0.00010	0.0	0.0
AM-241	1.00000	Y	0.0	0.00100	0.0	0.0
PU-242	1.00000	Y	0.0	0.00100	0.0	0.0
AM-243	1.00000	Y	0.0	0.00100	0.0	0.0
CM-243	1.00000	Y	0.0	0.00100	0.0	0.0

THE FOLLOWING NUCLIDES AND ORGAN DOSE FACTORS WERE NOT FOUND IN THE INPUT DATA SETS:
ORGAN NUCLIDE

R MAR CD-109
ENDOST CD-109
SPUL* CD-109
MUSCLE CD-109
LIVER CD-109
S WALL CD-109
PANCREAS CD-109
LLI WALL CD-109
KIDNEY CD-109
UL WALL CD-109
ULI WALL CD-109
SI WALL CD-109
OVARIES CD-109
TESTES CD-109
SPLEEN CD-109
THYMUS CD-109
TYPHOID CD-109

THE FOLLOWING NUCLIDES AND CANCER RISK FACTORS WERE NOT FOUND IN THE INPUT DATA SETS:
CANCER NUCLIDE

R MARFON CD-109
ENDOST CD-109
PULMONARY CD-109
BREAST CD-109
ST WALL CD-109
PANCREAS CD-109
LLI WALL CD-109
KIDNEYS CD-109
BL WALL CD-109
ULI WALL CD-109
SI WALL CD-109

OVARIES CD-109
 TESTES CD-109
 SPLEEN CD-109
 UTERUS CD-109
 THYMUS CD-109
 THYROID CD-109
 LIVER CD-109
 R MARROW FM-147
 ENDOST FM-147
 PULMONARY FM-147
 BREAST FM-147
 ST WALL FM-147
 PANCREAS FM-147
 LLJ WALL FM-147
 KIDNEYS FM-147
 BL WALL FM-147
 ULJ WALL FM-147
 SI WALL FM-147
 OVARIES FM-147
 TESTES FM-147
 SPLEEN FM-147
 UTERUS FM-147
 THYMUS FM-147
 THYROID FM-147
 LIVER FM-147
 R MARROW RE-187
 ENDOST RE-187
 PULMONARY RE-187
 BREAST RE-187
 SI WALL RE-187
 PANCREAS RE-187
 LLJ WALL RE-187
 KIDNEYS RE-187
 BL WALL RE-187
 ULJ WALL RE-187
 SI WALL RE-187
 OVARIES RE-187
 TESTES RE-187
 SPLEEN RE-187
 UTERUS RE-187
 THYMUS RE-187
 THYROID RE-187
 LIVER RE-187

THE FOLLOWING NUCLIDES AND GENETIC DOSE FACTORS WERE NOT FOUND IN THE INPUT DATA SETS:
 GEN-DOSE NUCLIDE
 TESTES CD-109
 OVARIES CD-109

AVERAGE	CD-109
TESTES	FM-147
OVARIES	FM-147
AVERAGE	PM-147
TESTES	RE-187
OVARIES	RE-187
AVERAGE	RF-187

THE LOCATION USED FOR THE SELECTED INDIVIDUAL EXPOSURE IS 0000 METERS R FROM THE SOURCE.
 THE FATAL CANCER RISK AT THAT LOCATION IS 0.001E-01

ORGAN DOSE WEIGHTING FACTORS

ORGAN	FACTORS	PATHWAYS
R MAR	0.15590	1 2 3 4
ENDOST	0.01470	1 2 3 4
PUL	0.29080	1 2 3 4
MUSCLE	0.19080	1 2 3 4
LIVER	0.07460	1 2 3 4
S *ALL	0.04150	1 2 3 4
PANCREAS	0.05810	1 2 3 4
LLI WALL	0.03320	1 2 3 4
KIDNEYS	0.01660	1 2 3 4
BL WALL	0.01660	1 2 3 4
ULI WALL	0.01660	1 2 3 4
SI WALL	0.00630	1 2 3 4
OVARIES	0.00830	1 2 3 4
TESTES	0.00830	1 2 3 4
SPLEEN	0.00830	1 2 3 4
UTERUS	0.00830	1 2 3 4
THYMUS	0.00830	1 2 3 4
THYROID	0.04050	1 2 3 4

BARNWELL SIMULATION, FELL AT 914 M, XG-8000 M, SCAMF-8
 ORGAN DOSE/EXPOSURE SUMMARY

*** SELECTED INDIVIDUAL ***

DOSE RATES:

ORGANS:	R MAR	ENDOST	*PUL*	MUSCLE	LIVER	S WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL
	ULI WALL	SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	WT.SUM	
LOW LET (MRAD/Y)	0.114	0.133	6.735E-03	0.102	0.183	0.109	9.625E-02	0.894	0.134	5.066E-02
	0.304	5.728E-02	9.358E-02	9.348E-02	9.515E-02	9.520E-02	9.540E-02	3.90	0.265	
HIGH LET (MRAD/Y)	8.442E-15	1.265E-13	1.649E-12	8.401E-16	1.384E-14	2.123E-15	8.401E-16	9.287E-14	4.295E-14	4.355E-16
	3.090E-14	5.247E-15	8.790E-16	8.805E-16	8.489E-16	8.401E-16	8.400E-16	8.400E-16	4.885E-13	
DOSE EQUIVALENT (MREM/Y)	0.114	0.133	6.735E-03	0.102	0.183	0.109	9.625E-02	0.894	0.134	5.066E-02
	0.304	5.728E-02	9.358E-02	9.348E-02	9.515E-02	9.520E-02	9.540E-02	3.90	0.265	

GONADAL DOSES:

GONADS:	TESTES	OVARIES	AVERAGE
LOW LET (MRAD)	2.80	2.81	2.81
HIGH LET (MRAD)	1.878E-14	1.875E-14	1.877E-14
DOSE EQUIVALENT (MREM)	2.80	2.81	2.81

*** MEAN INDIVIDUAL ***

DOSE RATE:

ORGANS:	R MAR	ENDOST	*PUL*	MUSCLE	LIVER	S WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL
	ULI WALL	SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	WT.SUM	
LOW LET (MRAD/Y)	0.114	0.133	6.735E-03	0.102	0.183	0.109	9.625E-02	0.894	0.134	5.066E-02
	0.304	5.728E-02	9.358E-02	9.348E-02	9.515E-02	9.520E-02	9.540E-02	3.90	0.265	
HIGH LET (MRAD/Y)	8.442E-15	1.265E-13	1.649E-12	8.401E-16	1.384E-14	2.123E-15	8.401E-16	9.287E-14	4.295E-14	4.355E-16
	3.090E-14	5.247E-15	8.790E-16	8.805E-16	8.489E-16	8.401E-16	8.400E-16	8.400E-16	4.885E-13	
DOSE EQUIVALENT (MREM/Y)	0.114	0.133	6.735E-03	0.102	0.183	0.109	9.625E-02	0.894	0.134	5.066E-02
	0.304	5.728E-02	9.358E-02	9.348E-02	9.515E-02	9.520E-02	9.540E-02	3.90	0.265	

GONADAL DOSES:

GONADS:	TESTES	OVARIES	AVERAGE
LOW LET (MRAD)	2.80	2.81	2.81
HIGH LET (MRAD)	1.878E-14	1.875E-14	1.877E-14
DOSE EQUIVALENT (MREM)	2.80	2.81	2.81

*** COLLECTIVE POPULATION ***

DOSE RATE:

	ORGANS:	R MAR	ENDOST	*PUL*	MUSCLE	LIVER	S WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL
		ULI WALL	SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	WT. SUM	
LOW LET (PERSON RAD/Y)	0.804	0.938	4.736E-02	0.721	1.29	0.765	0.677	6.29	0.945	0.356	
	2.14	0.403	0.658	0.657	0.669	0.670	0.671	27.4	1.86		
HIGH LET (PERSON RAD/Y)	5.937E-14	8.899E-13	1.160E-11	5.908E-15	9.735E-14	1.493E-14	5.908E-15	6.532E-13	3.021E-13	3.063E-15	
	2.173E-13	3.690E-14	6.182E-15	6.192E-15	5.971E-15	5.908E-15	5.908E-15	5.908E-15	3.435E-12		
DOSE EQ. (PERSON REM/Y)	0.804	0.938	4.736E-02	0.721	1.29	0.765	0.677	6.29	0.945	0.356	
	2.14	0.403	0.658	0.657	0.669	0.670	0.671	27.4	1.86		

GONADAL DOSES:

	GONADS:	TESTES	OVARIES	AVERAGE
LOW LET (PERSON RAD)	19.7	19.7	19.7	
HIGH LET (PERSON RAD)	1.321E-13	1.318E-13	1.320E-13	
DOSE EQ. (PERSON REM)	19.7	19.7	19.7	

BARNWELL SIMULATION, WELL AT 914 M, XG=8000 M, SCAM=E-8
PATHWAY DOSE/EXPOSURE SUMMARY

*** SELECTED INDIVIDUAL ***

DOSE RATES:

WEIGHTED SUMS OF ORGAN DOSE RATES

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET (MRAD/Y)	0.265	4.487E-12	1.093E-14	4.374E-10	0.265	4.374E-10	0.265	
HIGH LET (MRAD/Y)	8.280E-15	4.802E-13	0.0	0.0	4.885E-13	0.0	4.885E-13	
DOSE EQUIVALENT (MREM/Y)	0.265	1.409E-11	1.093E-14	4.374E-10	0.265	4.374E-10	0.265	

AVERAGE GONADAL DOSES:

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET (MRAD)	2.81	8.811E-12	2.738E-13	1.069E-08	2.81	1.069E-08	2.81	
HIGH LET (MRAD)	1.788E-14	8.848E-16	0.0	0.0	1.877E-14	0.0	1.877E-14	
DOSE EQUIVALENT (MREM)	2.81	8.829E-12	2.738E-13	1.069E-08	2.81	1.069E-08	2.81	

*** MEAN INDIVIDUAL ***

DOSE RATES:

WEIGHTED SUMS OF ORGAN DOSE RATES

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET (MRAD/Y)	0.265	4.487E-12	1.093E-14	4.374E-10	0.265	4.374E-10	0.265	
HIGH LET (MRAD/Y)	8.280E-15	4.802E-13	0.0	0.0	4.885E-13	0.0	4.885E-13	
DOSE EQUIVALENT (MREM/Y)	0.265	1.409E-11	1.093E-14	4.374E-10	0.265	4.374E-10	0.265	

AVERAGE GONADAL DOSES:

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET (MRAD)	2.81	8.811E-12	2.738E-13	1.069E-08	2.81	1.069E-08	2.81	
HIGH LET (MRAD)	1.788E-14	8.848E-16	0.0	0.0	1.877E-14	0.0	1.877E-14	
DOSE EQUIVALENT (MREM)	2.81	8.829E-12	2.738E-13	1.069E-08	2.81	1.069E-08	2.81	

*** COLLECTIVE POPULATION ***

DOSE RATES:

WEIGHTED SUMS OF ORGAN DOSE RATES

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET (PERSON RAD/Y)	1.86	3.156E-11	7.686E-14	3.076E-09	1.86	3.076E-09	1.86	
HIGH LET (PERSON RAD/Y)	5.823E-14	3.377E-12	0.0	0.0	3.435E-12	0.0	3.435E-12	
DOSE EQ. (PERSON REM/Y)	1.86	9.910E-11	7.686E-14	3.076E-09	1.86	3.076E-09	1.86	

AVERAGE GENADAL DESES:

	PATHWAYS:	INGESTION	INHALATION	AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
				IMMERSION	SURFACE			
LOW LET (PERSON RAD)	19.7	6.197E-11	1.926E-12	7.520E-08	19.7	7.520E-08	19.7	
HIGH LET (PERSON RAD)	1.258E-13	6.223E-15	0.0	0.0	1.320E-13	0.0	1.320E-13	
DOSE EQ. (PERSON REM)	19.7	6.209E-11	1.926E-12	7.520E-08	19.7	7.520E-08	19.7	

BARNWELL SIMULATION, WELL AT 914 M. XG=8000 M. SOAM=E-8
NUCLIDE DOSE/EXPOSURE SUMMARY

*** SELECTED INDIVIDUAL ***

DOSE RATES:

WEIGHTED SUMS OF ORGAN DOSE RATES

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (MRAD/Y)	1.244E-11	1.193E-02	1.022E-13	1.835E-13	0.0	1.723E-10	7.141E-14	1.855E-13	2.159E-15	4.407E-13
	4.840E-16	0.0	0.253	0.0	0.0	9.257E-17	0.0	0.0	1.564E-11	1.106E-10
	2.772E-10	6.408E-19	1.070E-17	4.729E-20	0.0	1.823E-15	7.465E-17	1.520E-17	0.0	6.855E-18
	2.264E-15	8.804E-19	7.340E-13	4.461E-19	6.629E-19	0.0	0.0	0.0	0.0	0.0
	0.265									
HIGH LET (MRAD/Y)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	2.178E-15	1.561E-17	4.165E-16	0.0	5.335E-16
	5.594E-16	8.388E-17	4.844E-13	9.563E-17	2.185E-16	0.0	0.0	0.0	0.0	0.0
	4.885E-13									
DOSE EQUIVALENT (MREM/Y)	1.244E-11	1.193E-02	1.022E-13	1.835E-13	0.0	1.723E-10	7.141E-14	1.855E-13	2.159E-15	4.407E-13
	4.840E-16	0.0	0.253	0.0	0.0	9.257E-17	0.0	0.0	1.564E-11	1.106E-10
	2.772E-10	6.408E-19	1.070E-17	4.729E-20	0.0	4.539E-14	3.868E-16	8.345E-15	0.0	1.068E-14
	1.345E-14	1.678E-15	1.042E-11	1.913E-15	4.370E-15	0.0	0.0	0.0	0.0	0.0
	0.265									

AVERAGE GENADAL DOSES:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (MRAD)	3.595E-10	0.165	2.842E-12	6.975E-12	0.0	4.450E-09	8.721E-13	6.805E-12	5.171E-14	3.440E-13
	2.018E-17	0.0	2.64	0.0	0.0	2.292E-15	0.0	0.0	5.066E-10	4.470E-09
	6.630E-09	2.632E-18	2.528E-18	1.120E-18	0.0	4.990E-15	2.118E-15	4.961E-16	0.0	1.070E-16
	6.189E-14	1.367E-17	7.772E-14	9.021E-18	1.743E-17	0.0	0.0	0.0	0.0	0.0
	2.81									
HIGH LET (MRAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	9.230E-15	9.279E-18	9.350E-17	0.0	1.035E-17
	1.038E-17	1.627E-18	8.588E-15	6.387E-17	3.585E-16	0.0	0.0	0.0	0.0	0.0
	1.877E-14									
DOSE EQUIVALENT (MREM)	3.595E-10	0.165	2.842E-12	6.975E-12	0.0	4.450E-09	8.721E-13	6.805E-12	5.171E-14	3.440E-13
	2.018E-17	0.0	2.64	0.0	0.0	2.292E-15	0.0	0.0	5.066E-10	4.470E-09
	6.630E-09	2.632E-18	2.528E-18	1.120E-18	0.0	1.896E-13	2.304E-15	2.366E-15	0.0	3.140E-16
	6.210E-14	4.621E-17	2.575E-13	1.286E-15	7.188E-15	0.0	0.0	0.0	0.0	0.0
	2.81									

*** MEAN INDIVIDUAL ***

DOSE RATES:

WEIGHTED SUMS OF ORGAN DOSE RATES

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (MRAD/Y)	1.244E-11	1.193E-02	1.022E-13	1.835E-13	0.0	1.723E-10	7.141E-14	1.855E-13	2.159E-15	4.407E-13
	4.840E-16	0.0	0.253	0.0	0.0	9.257E-17	0.0	0.0	1.564E-11	1.106E-10

	2.772E-10	6.403E-10	1.070E-17	4.729E-20	0.0	1.623E-15	7.465E-17	1.520E-17	0.0	6.855E-18
	2.264E-15	8.804E-16	7.340E-13	4.461E-19	6.629E-19	0.0	0.0	0.0	0.0	0.0
	0.265									
HIGH LET (MRAD/Y)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	2.178E-15	1.561E-17	4.165E-16	0.0	5.335E-16
	5.594E-16	2.388E-17	4.844E-13	9.563E-17	2.185E-16	0.0	0.0	0.0	0.0	0.0
	4.885E-13									
DOSE EQUIVALENT (MREM/Y)	1.244E-11	1.193E-02	1.022E-13	1.835E-13	0.0	1.723E-10	7.141E-14	1.855E-13	2.189E-15	4.407E-13
	4.840E-16	0.0	0.253	0.0	0.0	9.257E-17	0.0	0.0	1.564E-11	1.106E-10
	2.772E-10	6.408E-19	1.070E-17	4.729E-20	0.0	4.539E-14	3.868E-16	8.345E-15	0.0	1.068E-14
	1.345E-14	1.678E-15	1.042E-11	1.913E-15	4.370E-15	0.0	0.0	0.0	0.0	0.0
	0.265									

AVERAGE GONADAL DOSES:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CO-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (MRAD)	3.595E-10	0.165	2.842E-12	6.975E-12	0.0	4.450E-09	8.721E-13	6.805E-12	5.171E-14	3.440E-13
	2.018E-17	0.0	2.64	0.0	0.0	2.292E-15	0.0	0.0	5.066E-10	4.470E-09
	6.630E-09	2.632E-18	2.528E-18	1.120E-18	0.0	4.990E-15	2.118E-15	4.961E-16	0.0	1.070E-16
	6.189E-14	1.367E-17	7.772E-14	9.021E-18	1.744E-17	0.0	0.0	0.0	0.0	0.0
	2.81									
HIGH LET (MRAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	9.230E-15	9.279E-18	9.350E-17	0.0	1.035E-17
	1.038E-17	1.627E-18	8.688E-15	6.387E-17	3.585E-16	0.0	0.0	0.0	0.0	0.0
	1.877E-14									
DOSE EQUIVALENT (MREM)	3.595E-10	0.165	2.842E-12	6.975E-12	0.0	4.450E-09	8.721E-13	6.805E-12	5.171E-14	3.440E-13
	2.018E-17	0.0	2.64	0.0	0.0	2.292E-15	0.0	0.0	5.066E-10	4.470E-09
	6.630E-09	2.632E-18	2.528E-18	1.120E-18	0.0	1.896E-13	2.304E-15	2.366E-15	0.0	3.140E-16
	6.210E-14	1.621E-17	2.575E-13	1.286E-15	7.188E-15	0.0	0.0	0.0	0.0	0.0
	2.81									

*** COLLECTIVE POPULATION ***

DOSE RATES:

WEIGHTED SUMS OF ORGAN DOSE RATES

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CO-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (PERSON RAD/Y)	8.749E-11	8.389E-02	7.190E-13	1.291E-12	0.0	1.212E-09	5.022E-13	1.304E-12	1.518E-14	3.099E-12
	3.404E-15	0.0	1.78	0.0	0.0	6.511E-16	0.0	0.0	1.100E-10	7.775E-10
	1.950E-09	4.507E-18	7.524E-17	3.326E-19	0.0	1.282E-14	5.250E-16	1.069E-16	0.0	4.821E-17
	1.593E-14	6.192E-18	5.162E-12	3.138E-18	4.662E-18	0.0	0.0	0.0	0.0	0.0
	1.86									
HIGH LET (PERSON RAD/Y)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	1.532E-14	1.098E-16	2.929E-15	0.0	3.752E-15
	3.934E-15	5.899E-16	3.407E-12	6.726E-16	1.537E-15	0.0	0.0	0.0	0.0	0.0
	3.435E-12									
DOSE EQ. (PERSON REM/Y)	8.749E-11	8.389E-02	7.190E-13	1.291E-12	0.0	1.212E-09	5.022E-13	1.304E-12	1.518E-14	3.099E-12
	3.404E-15	0.0	1.78	0.0	0.0	6.511E-16	0.0	0.0	1.100E-10	7.775E-10
	1.950E-09	4.507E-18	7.524E-17	3.326E-19	0.0	3.192E-13	2.721E-15	5.869E-14	0.0	7.509E-14
	9.461E-14	1.180E-14	7.329E-11	1.345E-14	3.074E-14	0.0	0.0	0.0	0.0	0.0
	1.86									

AVERAGE GONADAL DOSES:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CF-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (PERSON RAD)	2.528E-09	1.16	1.999E-11	4.905E-11	0.0	3.130E-08	6.134E-12	4.786E-11	3.637E-13	2.419E-12
	1.419E-16	0.0	18.6	0.0	0.0	1.612E-14	0.0	0.0	3.563E-09	3.144E-08
	4.663E-08	1.851E-17	1.778E-17	7.879E-18	0.0	3.509E-14	1.490E-14	3.489E-15	0.0	7.528E-16
	4.353E-13	9.613E-17	5.466E-13	6.344E-17	1.226E-16	0.0	0.0	0.0	0.0	0.0
	19.7									
HIGH LET (PERSON RAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	6.492E-14	6.546E-17	6.576E-16	0.0	7.278E-17
	7.297E-17	1.144E-17	6.321E-14	4.492E-16	2.521E-15	0.0	0.0	0.0	0.0	0.0
	1.320E-13									
DOSE EQ. (PERSON REM)	2.528E-09	1.16	1.999E-11	4.905E-11	0.0	3.130E-08	6.134E-12	4.786E-11	3.637E-13	2.419E-12
	1.419E-16	0.0	18.6	0.0	0.0	1.612E-14	0.0	0.0	3.563E-09	3.144E-08
	4.663E-08	1.851E-17	1.778E-17	7.879E-18	0.0	1.333E-12	1.620E-14	1.664E-14	0.0	2.209E-15
	4.368E-13	3.250E-16	1.211E-12	9.047E-15	5.055E-14	0.0	0.0	0.0	0.0	0.0
	19.7									

BARNWELL SIMULATION, WELL AT 614 M, XG=8000 M, SCAM=E-8
RISK/RISK EQUIVALENT SUMMARY

*** SELECTED INDIVIDUAL ***

LIFETIME FATAL CANCER RISK:

	CANCERS:	R MARROW	ENDOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
LOW LET		3.726E-07	4.104E-08	4.018E-08	4.082E-07	9.429E-08	1.170E-07	6.203E-07	4.665E-08	1.761E-08	1.050E-07
		9.956E-09	1.625E-08	1.623E-08	1.652E-08	1.653E-08	1.657E-08	3.317E-06	2.852E-07	5.858E-06	
HIGH LET		3.930E-19	2.636E-19	9.492E-17	2.651E-21	1.841E-20	8.069E-21	6.445E-19	1.311E-19	1.206E-21	1.072E-19
		9.104E-21	1.155E-21	1.157E-21	1.179E-21	1.153E-21	1.153E-21	5.973E-22	1.496E-19	9.665E-17	
TOTAL		3.726E-07	4.104E-08	4.098E-08	4.082E-07	9.429E-08	1.170E-07	6.203E-07	4.665E-08	1.761E-08	1.050E-07
		9.956E-09	1.625E-08	1.623E-08	1.652E-08	1.653E-08	1.657E-08	3.317E-06	2.852E-07	5.858E-06	

AVERAGE LIFE LOSS PER PREMATURE DEATH:

	CANCERS:	R MARROW	ENDOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
LOW LET (YR)		31.5	29.3	23.0	21.6	21.5	21.4	21.5	21.4	21.4	21.5
		21.0	21.3	21.3	21.3	21.3	21.3	28.2	21.4	26.2	
HIGH LET (YR)		26.5	24.2	22.5	20.2	21.5	20.2	21.5	20.6	20.0	21.5
		21.5	20.0	20.0	20.1	20.0	20.0	26.1	19.6	22.5	
COMBINED (YR)		31.5	29.3	23.0	21.6	21.5	21.4	21.5	21.4	21.4	21.5
		21.0	21.3	21.3	21.3	21.3	21.3	28.2	21.4	26.2	

FATAL CANCER RISK EQUIVALENT:

	CANCERS:	R MARROW	ENDOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
(MREM/YR)		0.114	0.133	6.742E-03	0.102	0.109	9.652E-02	0.894	0.134	5.066E-02	0.304
		5.728E-02	9.329E-02	9.319E-02	9.486E-02	9.490E-02	9.510E-02	3.90	0.183	0.266	

WHOLE BODY FATAL CANCER RISK EQ(MREM/YR)

0.266

GENETIC RISKS:

LOW LET (EFFECTS/BIRTH) 5.612E-07
HIGH LET (EFFECTS/BIRTH) 3.753E-19
COMBINED (EFFECTS/BIRTH) 5.612E-07

GENETIC RISK EQUIVALENT:

(MREM/YR) 9.353E-02

BARNELL SIMULATION, WELL AT 514 M, XG=8000 M, SCAM=E-8
RISK/RISK EQUIVALENT SUMMARY

*** MEAN INDIVIDUAL ***

LIFETIME FATAL CANCER RISK:

	CANCERS:	R MARROW	ENDOOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
LOW LET		3.726E-07	4.104E-08	4.058E-08	4.082E-07	9.429E-08	1.170E-07	6.203E-07	4.666E-08	1.761E-08	1.050E-07
		9.956E-09	1.625E-08	1.623E-08	1.652E-08	1.653E-08	1.657E-08	3.317E-06	2.852E-07	5.858E-06	
HIGH LET		3.930E-19	2.636E-19	9.492E-17	2.651E-21	1.841E-20	8.069E-21	6.445E-19	1.311E-19	1.206E-21	1.072E-19
		9.104E-21	1.155E-21	1.157E-21	1.179E-21	1.153E-21	1.153E-21	8.973E-22	1.496E-19	9.665E-17	
TOTAL		3.726E-07	4.104E-08	4.058E-08	4.082E-07	9.429E-08	1.170E-07	6.203E-07	4.666E-08	1.761E-08	1.050E-07
		9.956E-09	1.625E-08	1.623E-08	1.652E-08	1.653E-08	1.657E-08	3.317E-06	2.852E-07	5.858E-06	

AVERAGE LIFE LOSS PER PREMATURE DEATH:

	CANCERS:	R MARROW	ENDOOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
LOW LET (YR)		31.5	29.3	23.0	21.6	21.5	21.4	21.5	21.4	21.4	21.5
		21.0	21.3	21.3	21.3	21.3	21.3	28.2	21.4	26.2	
HIGH LET (YR)		26.5	24.2	22.5	20.2	21.5	20.2	21.5	20.6	20.0	21.5
		21.5	20.0	20.0	20.1	20.0	20.0	26.1	19.6	22.5	
COMBINED (YR)		31.5	29.3	23.0	21.6	21.5	21.4	21.5	21.4	21.4	21.5
		21.0	21.3	21.3	21.3	21.3	21.3	28.2	21.4	26.2	

FATAL CANCER RISK EQUIVALENT:

	CANCERS:	R MARROW	ENDOOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
(MREM/YR)		0.114	0.133	6.742E-03	0.102	0.119	9.652E-02	0.894	0.134	5.066E-02	0.304
		5.728E-02	9.329E-02	9.319E-02	9.486E-02	9.490E-02	9.510E-02	3.90	0.183	0.266	

WHOLE BODY FATAL CANCER RISK EQ(MREM/YR)

0.236

GENETIC RISKS:

LOW LET (EFFECTS/BIRTH) 5.612E-07
HIGH LET (EFFECTS/BIRTH) 3.753E-19
COMBINED (EFFECTS/BIRTH) 5.612E-07

GENETIC RISK EQUIVALENT:

(MREM/YR) 9.353E-02

JARNHLL SIMULATION. WELL AT 914 M. XG=8000 M. SCAN=E-8
RISK/RISK EQUIVALENT SUMMARY

*** COLLECTIVE POPULATION ***

COLLECTIVE FATAL CANCER RISK:

	CANCERS:	R MARROW	ENDOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	CVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
LOW LET(DEATHS/YR)		3.704E-05	4.079E-06	4.073E-06	4.057E-05	9.372E-06	1.163E-05	6.165E-05	4.637E-06	1.751E-06	1.044E-05
		9.896E-07	1.614E-06	1.613E-06	1.642E-06	1.643E-06	1.647E-06	3.297E-04	2.835E-05	5.525E-04	
HIGH LET(DEATHS/YR)		3.906E-17	2.620E-17	9.435E-15	2.635E-19	1.830E-18	8.020E-19	6.406E-17	1.303E-17	1.196E-19	1.066E-17
		9.049E-19	1.148E-19	1.150E-19	1.172E-19	1.146E-19	1.146E-19	5.937E-20	1.487E-17	9.607E-15	
TOTAL (DEATHS/YR)		3.704E-05	4.079E-06	4.073E-06	4.057E-05	9.372E-06	1.163E-05	6.165E-05	4.637E-06	1.751E-06	1.044E-05
		9.896E-07	1.614E-06	1.613E-06	1.642E-06	1.643E-06	1.647E-06	3.297E-04	2.835E-05	5.525E-04	

FATAL CANCER RISK EQUIVALENT:

	CANCERS:	R MARROW	ENDOST	PULMINARY	BREAST	ST WALL	PANCREAS	LLI WALL	KIDNEYS	BL WALL	ULI WALL
		SI WALL	OVARIES	TESTES	SPLEEN	UTERUS	THYMUS	THYROID	LIVER	TOTAL	
(PERSON REM/YR)		0.802	0.938	4.742E-02	0.721	0.765	0.679	6.29	0.945	0.350	2.14
		0.403	0.656	0.655	0.667	0.667	0.669	27.4	1.29	1.87	

WHOLE BODY FATAL CANCER RISK EQ(PERSON REM/YR)

1.87

GENETIC RISKS:

LOW LET(EFFECTS/YR)	5.578E-05
HIGH LET(EFFECTS/YR)	3.730E-17
COMBINED(EFFECTS/YR)	5.578E-05

GENETIC RISK EQUIVALENT:

(PERSON REM/YR)	0.658
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BARNWELL SIMULATION, WELL AT 914 M, XG=8000 M, SCAM=E-8
PATHWAY RISK/RISK EQUIVALENT SUMMARY

*** SELECTED INDIVIDUAL ***

LIFETIME FATAL CANCER RISK:

	PATHWAYS:		INGESTION	INHALATION	AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
					IMMERSION	SURFACE			
LOW LET	5.558E-06	8.576E-17	2.285E-19	9.149E-15	5.558E-06	9.150E-15	5.558E-06		
HIGH LET	1.623E-18	9.503E-17	0.0	0.0	9.665E-17	0.0	9.665E-17		
TOTAL	5.558E-06	1.808E-16	2.285E-19	9.149E-15	5.558E-06	9.150E-15	5.558E-06		

FATAL CANCER RISK EQUIVALENT:

	PATHWAYS:		INGESTION	INHALATION	AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
					IMMERSION	SURFACE			
(MREM/YR)	0.266	8.650E-12	1.093E-14	4.378E-10	0.266	4.378E-10	0.266		

GENETIC RISKS:

	PATHWAYS:		INGESTION	INHALATION	AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
					IMMERSION	SURFACE			
LOW LET (EFFECTS/BIRTH)	5.612E-07	1.762E-18	5.477E-20	2.138E-15	5.612E-07	2.138E-15	5.612E-07		
HIGH LET (EFFECTS/BIRTH)	3.574E-19	1.770E-20	0.0	0.0	3.753E-19	0.0	3.753E-19		
COMBINED (EFFECTS/BIRTH)	5.612E-07	1.780E-18	5.477E-20	2.138E-15	5.612E-07	2.138E-15	5.612E-07		

GENETIC RISK EQUIVALENT:

(MREM/YR)	9.353E-02	2.967E-13	9.128E-15	3.564E-10	9.353E-02	3.564E-10	9.353E-02		
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BARNWELL SIMULATION, WELL AT 914 M, XG=8000 M, SCAM=E-8
PATHWAY RISK/RISK EQUIVALENT SUMMARY

***MEAN INDIVIDUAL ***

LIFETIME FATAL CANCER RISK:

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET		5.558E-06	8.576E-17	2.285E-19	9.149E-15	5.558E-06	9.150E-15	5.558E-06
HIGH LET		1.623E-18	9.503E-17	0.0	0.0	9.665E-17	0.0	9.665E-17
TOTAL		5.558E-06	1.008E-16	2.285E-19	9.149E-15	5.558E-06	9.150E-15	5.558E-06

FATAL CANCER RISK EQUIVALENT:

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
(MREM/YR)		0.266	8.650E-12	1.093E-14	4.378E-10	0.266	4.378E-10	0.266

GENETIC RISKS:

	PATHWAYS:	INGESTION	INHALATION	AIR IMMERSION	GROUND SURFACE	INTERNAL	EXTERNAL	TOTAL
LOW LET (EFFECTS/BIRTH)		5.612E-07	1.762E-18	5.477E-20	2.138E-15	5.612E-07	2.138E-15	5.612E-07
HIGH LET (EFFECTS/BIRTH)		3.576E-19	1.770E-20	0.0	0.0	3.753E-19	0.0	3.753E-19
COMBINED (EFFECTS/BIRTH)		5.612E-07	1.780E-18	5.477E-20	2.138E-15	5.612E-07	2.138E-15	5.612E-07

GENETIC RISK EQUIVALENT:

(MREM/YR)		9.353E-02	2.667E-13	9.128E-15	3.564E-10	9.353E-02	3.564E-10	9.353E-02
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JARNWELL SIMULATION, WELL AT 914 M, XG=8000 M, SCAM=E-8
PATHWAY RISK/RISK EQUIVALENT SUMMARY

*** COLLECTIVE POPULATION ***

COLLECTIVE FATAL CANCER RISK:

	PATHWAYS: INGESTION INHALATION		AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
			IMMERSION	SURFACE			
LOW LET(DEATHS/YR)	5.525E-04	8.924E-15	2.272E-17	9.094E-13	5.525E-04	9.095E-13	5.525E-04
HIGH LET(DEATHS/YR)	1.614E-16	9.446E-15	0.0	0.0	9.607E-15	0.0	9.607E-15
TOTAL (DEATHS/YR)	5.525E-04	1.797E-14	2.272E-17	9.094E-13	5.525E-04	9.095E-13	5.525E-04

FATAL CANCER RISK EQUIVALENT:

	PATHWAYS: INGESTION INHALATION		AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
			IMMERSION	SURFACE			
(PERSON REM/YR)	1.87	6.084E-11	7.690E-14	3.079E-09	1.87	3.079E-09	1.87
WHOLE BODY RISK EQ (PERSON REM/YR) FROM ALL EXPOSURES					1.87		

GENETIC RISKS(PERSON REM/YR):

	PATHWAYS: INGESTION INHALATION		AIR	GROUND	INTERNAL	EXTERNAL	TOTAL
			IMMERSION	SURFACE			
LOW LET(EFFECTS/YR)	5.578E-05	1.752E-16	5.444E-18	2.126E-13	5.578E-05	2.126E-13	5.578E-05
HIGH LET(EFFECTS/YR)	3.555E-17	1.759E-18	0.0	0.0	3.730E-17	0.0	3.730E-17
COMBINED(EFFECTS/YR)	5.578E-05	1.769E-14	5.444E-18	2.126E-13	5.578E-05	2.126E-13	5.578E-05

GENETIC RISK EQUIVALENT:

(PERSON REM/YR)	0.658	2.086E-12	6.420E-14	2.507E-09	0.658	2.507E-09	0.658
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BARNWELL SIMULATION, WELL AT 914 M, XG=8000 M, SCAPTE-8
NUCLIDE RISK/RISK EQUIVALENT SUMMARY

*** SELECTED INDIVIDUAL ***

LIFETIME FATAL CANCER RISK:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-167	PS-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PJ-242	AM-243	CM-243
TOTAL										
LOW LET	2.602E-16	2.492E-07	2.137E-18	3.598E-18	0.0	3.592E-15	1.092E-18	3.833E-18	4.522E-20	7.898E-18
	1.014E-20	0.0	5.309E-06	0.0	0.0	1.937E-21	0.0	0.0	3.260E-16	2.300E-15
	5.799E-15	1.341E-23	2.211E-22	0.0	0.0	2.855E-20	1.560E-21	3.135E-22	0.0	1.235E-22
	4.699E-20	1.561E-23	1.313E-17	7.823E-24	1.241E-23	0.0	0.0	0.0	0.0	0.0
	5.558E-06									
HIGH LET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	3.823E-19	3.258E-21	7.458E-20	0.0	1.057E-19
	1.108E-19	1.661E-20	9.592E-17	1.639E-20	2.926E-20	0.0	0.0	0.0	0.0	0.0
	9.665E-17									
TOTAL	2.602E-16	2.492E-07	2.137E-18	3.598E-18	0.0	3.592E-15	1.092E-18	3.833E-18	4.522E-20	7.898E-18
	1.014E-20	0.0	5.309E-06	0.0	0.0	1.937E-21	0.0	0.0	3.260E-16	2.300E-15
	5.799E-15	1.341E-23	2.211E-22	0.0	0.0	4.108E-19	4.818E-21	7.489E-20	0.0	1.058E-19
	1.578E-19	1.663E-20	1.090E-16	1.640E-20	2.928E-20	0.0	0.0	0.0	0.0	0.0
	5.558E-06									

FATAL CANCER RISK EQUIVALENT:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-167	PS-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
TOTAL										
(MREM/YR)	1.245E-11	1.193E-02	1.022E-13	1.722E-13	0.0	1.719E-10	5.225E-14	1.834E-13	2.163E-15	3.779E-13
	4.852E-16	0.0	0.254	0.0	0.0	9.266E-17	0.0	0.0	1.860E-11	1.101E-10
	2.775E-10	6.416E-19	1.058E-17	0.0	0.0	1.966E-14	2.305E-16	3.584E-15	0.0	5.061E-15
	7.549E-15	7.955E-16	5.218E-12	7.846E-16	1.401E-15	0.0	0.0	0.0	0.0	0.0
	0.266									

GENETIC RISKS:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-167	PS-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
TOTAL										
LOW LET (EFFECTS/BIRTH)	7.189E-17	3.300E-08	5.684E-19	1.395E-18	0.0	8.900E-16	1.744E-19	1.361E-18	1.034E-20	6.880E-20
	4.036E-24	0.0	5.282E-07	0.0	0.0	4.584E-22	0.0	0.0	1.013E-16	8.941E-16
	1.326E-15	5.263E-25	5.057E-25	2.241E-25	0.0	9.980E-22	4.237E-22	9.923E-23	0.0	2.141E-23
	1.238E-20	2.734E-24	1.554E-20	1.804E-24	3.487E-24	0.0	0.0	0.0	0.0	0.0
	5.612E-07									
HIGH LET (EFFECTS/BIRTH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	1.846E-19	1.856E-22	1.870E-21	0.0	2.070E-22
	2.075E-22	3.254E-23	1.798E-19	1.277E-21	7.170E-21	0.0	0.0	0.0	0.0	0.0
	3.783E-19									
COMBINED (EFFECTS/BIRTH)	7.189E-17	3.300E-08	5.684E-19	1.395E-18	0.0	8.900E-16	1.744E-19	1.361E-18	1.034E-20	6.880E-20
	4.036E-24	0.0	5.282E-07	0.0	0.0	4.584E-22	0.0	0.0	1.013E-16	8.941E-16
	1.326E-15	5.263E-25	5.057E-25	2.241E-25	0.0	1.856E-19	6.093E-22	1.969E-21	0.0	2.284E-22
	1.289E-20	3.528E-23	1.953E-19	1.279E-21	7.174E-21	0.0	0.0	0.0	0.0	0.0
	5.412E-07									

GENETIC RISK EQUIVALENT:

(MREM/YR)

1.198E-11	5.499E-03	9.473E-14	2.325E-13	0.0	1.483E-10	2.907E-14	2.268E-13	1.724E-11	1.147E-14
6.726E-19	0.0	8.803E-02	0.0	0.0	7.640E-17	0.0	0.0	1.689E-11	1.490E-10
2.210E-10	8.772E-20	8.428E-20	3.734E-20	0.0	3.093E-14	1.015E-16	3.282E-16	0.0	3.806E-17
2.098E-15	5.880E-18	3.255E-14	2.132E-16	1.196E-15	0.0	0.0	0.0	0.0	0.0
9.353E-02									

BARNWELL SIMULATION, WELL AT 914 M, XJ=8000 M, SCAM=E-8
NUCLIDE RISK/RISK EQUIVALENT SUMMARY

*** MEAN INDIVIDUAL ***

LIFETIME FATAL CANCER RISK:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET	2.602E-16	2.492E-07	2.137E-18	3.598E-18	0.0	3.592E-15	1.092E-18	3.833E-18	4.522E-20	7.898E-18
	1.014E-20	0.0	5.309E-06	0.0	0.0	1.937E-21	0.0	0.0	3.260E-16	2.300E-15
	5.799E-15	1.341E-23	2.211E-22	0.0	0.0	2.855E-20	1.560E-21	3.135E-22	0.0	1.235E-22
	4.699E-20	1.561E-23	1.313E-17	7.823E-24	1.241E-23	0.0	0.0	0.0	0.0	0.0
	5.558E-06									
HIGH LET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	3.823E-19	3.258E-21	7.458E-20	0.0	1.057E-19
	1.108E-19	1.661E-20	9.592E-17	1.639E-20	2.926E-20	0.0	0.0	0.0	0.0	0.0
	9.665E-17									
TOTAL	2.602E-16	2.492E-07	2.137E-18	3.598E-18	0.0	3.592E-15	1.092E-18	3.833E-18	4.522E-20	7.898E-18
	1.014E-20	0.0	5.309E-06	0.0	0.0	1.937E-21	0.0	0.0	3.260E-16	2.300E-15
	5.799E-15	1.341E-23	2.211E-22	0.0	0.0	4.108E-19	4.818E-21	7.489E-20	0.0	1.058E-19
	1.578E-19	1.663E-20	1.090E-16	1.640E-20	2.928E-20	0.0	0.0	0.0	0.0	0.0
	5.558E-06									

FATAL CANCER RISK EQUIVALENT:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
(MREM/YR)	1.243E-11	1.193E-02	1.022E-13	1.722E-13	0.0	1.719E-10	5.225E-14	1.834E-13	2.163E-15	3.779E-13
	4.852E-16	0.0	0.254	0.0	0.0	9.266E-17	0.0	0.0	1.560E-11	1.101E-10
	2.775E-10	6.416E-19	1.058E-17	0.0	0.0	1.966E-14	2.305E-16	3.684E-15	0.0	5.061E-15
	7.549E-15	7.955E-16	5.218E-12	7.846E-16	1.401E-15	0.0	0.0	0.0	0.0	0.0
	0.266									

GENETIC RISKS:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
LOW LET (EFFECTS/BIRTH)	7.189E-17	3.300E-08	5.684E-19	1.395E-18	0.0	8.900E-16	1.744E-19	1.361E-18	1.034E-20	6.880E-20
	4.036E-24	0.0	5.282E-07	0.0	0.0	4.584E-22	0.0	0.0	1.013E-16	8.941E-16
	1.326E-15	5.263E-25	5.657E-25	2.241E-25	0.0	9.980E-22	4.237E-22	9.923E-23	0.0	2.141E-23
	1.238E-20	2.734E-24	1.554E-20	1.804E-24	3.487E-24	0.0	0.0	0.0	0.0	0.0
	5.612E-07									
HIGH LET (EFFECTS/BIRTH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	1.846E-19	1.856E-22	1.870E-21	0.0	2.070E-22
	2.075E-22	3.254E-23	1.798E-19	1.277E-21	7.170E-21	0.0	0.0	0.0	0.0	0.0
	3.753E-19									
COMBINED (EFFECTS/BIRTH)	7.189E-17	3.300E-08	5.684E-19	1.395E-18	0.0	8.900E-16	1.744E-19	1.361E-18	1.034E-20	6.880E-20
	4.036E-24	0.0	5.282E-07	0.0	0.0	4.584E-22	0.0	0.0	1.013E-16	8.941E-16
	1.326E-15	5.263E-25	5.657E-25	2.241E-25	0.0	1.856E-19	4.093E-22	1.969E-21	0.0	2.284E-22
	1.238E-20	3.528E-23	1.553E-19	1.279E-21	7.174E-21	0.0	0.0	0.0	0.0	0.0
	5.612E-07									

GENETIC RISK EQUIVALENT:

MR EN/YR)

1.198E-11	5.499E-03	9.473E-14	2.325E-13	0.0	1.483E-10	2.907E-14	2.268E-13	1.724E-15	1.147E-14
6.726E-19	0.0	8.803E-02	0.0	0.0	7.640E-17	0.0	0.0	1.689E-11	1.490E-10
2.210E-10	8.772E-20	8.428E-20	3.734E-20	0.0	3.093E-14	1.015E-16	3.282E-16	0.0	3.806E-17
2.098E-15	5.880E-18	3.255E-14	2.132E-16	1.196E-15	0.0	0.0	0.0	0.0	0.0
9.353E-02									

BARRELL SIMULATION. WELL AT 914 M, XG=8000 M, SOAM=E-8
 NUCLIDE RISK/RISK EQUIVALENT SUMMARY

*** COLLECTIVE POPULATION ***

COLLECTIVE FATAL CANCER RISK:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	AB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-235	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
TOTAL										
LOW LET(DEATHS/YR)	2.586E-14	2.477E-05	2.124E-16	3.577E-16	0.0	3.570E-13	1.085E-16	3.810E-16	4.494E-18	7.850E-16
	1.008E-16	0.0	5.277E-04	0.0	0.0	1.925E-19	0.0	0.0	3.240E-14	2.287E-13
	5.764E-13	1.333E-21	2.197E-20	0.0	0.0	2.837E-18	1.551E-19	3.116E-20	0.0	1.228E-20
	4.670E-18	1.551E-21	1.305E-15	7.775E-22	1.234E-21	0.0	0.0	0.0	0.0	0.0
	5.525E-04									
HIGH LET(DEATHS/YR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	3.800E-17	3.239E-19	7.413E-18	0.0	1.050E-17
	1.101E-17	1.651E-18	9.534E-15	1.629E-18	2.909E-18	0.0	0.0	0.0	0.0	0.0
	9.607E-15									
TOTAL (DEATHS/YR)	2.586E-14	2.477E-05	2.124E-16	3.577E-16	0.0	3.570E-13	1.085E-16	3.810E-16	4.494E-18	7.850E-16
	1.008E-16	0.0	5.277E-04	0.0	0.0	1.925E-19	0.0	0.0	3.240E-14	2.287E-13
	5.764E-13	1.333E-21	2.197E-20	0.0	0.0	4.084E-17	4.789E-19	7.444E-18	0.0	1.051E-17
	1.568E-17	1.653E-18	1.084E-14	1.630E-18	2.910E-18	0.0	0.0	0.0	0.0	0.0
	5.525E-04									
TOTAL FATAL CANCER RISK FROM ALL EXPOSURES				5.525E-04						

FATAL CANCER RISK EQUIVALENT:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	AB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-235	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
TOTAL										
(PERSON REM/YR)	8.754E-11	8.387E-02	7.190E-13	1.211E-12	0.0	1.209E-09	3.674E-13	1.290E-12	1.522E-14	2.658E-12
	3.412E-15	0.0	1.79	0.0	0.0	6.517E-15	0.0	0.0	1.097E-10	7.741E-10
	1.951E-09	4.512E-18	7.439E-17	0.0	0.0	1.382E-13	1.621E-15	2.820E-14	0.0	3.560E-14
	5.309E-14	5.595E-15	3.669E-11	5.518E-15	9.852E-15	0.0	0.0	0.0	0.0	0.0
	1.67									

GENETIC RISKS:

NUCLIDES:	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	AB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-235	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
TOTAL										
LOW LET(EFFECTS/YR)	7.146E-15	3.280E-06	5.650E-17	1.387E-16	0.0	8.846E-14	1.734E-17	1.353E-16	1.028E-18	6.838E-18
	4.012E-22	0.0	5.250E-05	0.0	0.0	4.556E-20	0.0	0.0	1.007E-14	8.887E-14
	1.318E-13	5.232E-23	5.026E-23	2.227E-23	0.0	9.920E-20	4.211E-20	9.863E-21	0.0	2.128E-21
	1.230E-18	2.717E-22	1.545E-18	1.793E-22	3.466E-22	0.0	0.0	0.0	0.0	0.0
	5.578E-05									
HIGH LET(EFFECTS/YR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	1.835E-17	1.845E-20	1.859E-19	0.0	2.057E-20
	2.063E-20	3.235E-21	1.787E-17	1.270E-19	7.127E-19	0.0	0.0	0.0	0.0	0.0
	3.730E-17									
COMBINED(EFFECTS/YR)	7.146E-15	3.280E-06	5.650E-17	1.387E-16	0.0	8.846E-14	1.734E-17	1.353E-16	1.028E-18	6.838E-18
	4.012E-22	0.0	5.250E-05	0.0	0.0	4.556E-20	0.0	0.0	1.007E-14	8.887E-14
	1.318E-13	5.232E-23	5.026E-23	2.227E-23	0.0	1.845E-17	6.056E-20	1.957E-19	0.0	2.270E-20
	1.251E-18	3.507E-21	1.941E-17	1.871E-19	7.130E-19	0.0	0.0	0.0	0.0	0.0
	5.578E-05									

GENETIC RISK EQUIVALENT:
(PERSON REM/YR)

8.427E-11	3.868E-02	6.663E-13	1.635E-12	0.0	1.043E-09	2.045E-13	1.595E-12	1.212E-14	8.064E-14
4.731E-18	0.0	0.619	0.0	0.0	5.373E-16	0.0	0.0	1.188E-10	1.048E-09
1.534E-09	6.170E-19	5.927E-19	2.626E-19	0.0	2.176E-13	7.142E-16	2.308E-15	0.0	2.677E-16
1.475E-14	4.135E-17	2.289E-13	1.494E-15	8.409E-15	0.0	0.0	0.0	0.0	0.0
0.658									

BARNWELL SIMULATION, WELL AT 914 M, XG=8000 M, SOAM=E-8
COLLECTIVE DOSE EC. (PERSON REM /YEAR)

***SUMMED OVER ALL ORGAN
NUCLIDES

	M-3	C-14	MN-54	FE-55	NI-59	CO-60	I-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
INGESTION	8.749E-11	8.389E-02	1.876E-13	1.279E-12	0.0	8.589E-11	4.944E-13	1.228E-12	0.0	2.205E-12
	0.0	0.0	1.78	0.0	0.0	1.176E-16	0.0	0.0	8.590E-11	7.763E-10
	0.0	3.841E-18	3.486E-17	0.0	0.0	3.086E-13	0.0	0.0	0.0	9.690E-16
	1.081E-15	1.493E-16	8.875E-13	0.0	2.350E-14	0.0	0.0	0.0	0.0	0.0
	1.86									
% OF INTERNAL	100.	100.	96.8	99.2	0.0	78.0	98.5	99.9	0.0	71.1
	0.0	0.0	100.	0.0	0.0	94.3	0.0	0.0	99.8	99.8
	0.0	85.3	46.3	0.0	0.0	96.8	0.0	0.0	0.0	1.29
	1.37	1.27	1.21	0.0	76.5	0.0	0.0	0.0	0.0	0.0
	100.									
% OF ALL PATHWAYS	100.	100.	26.1	99.1	0.0	7.09	98.5	94.1	0.0	71.1
	0.0	0.0	100.	0.0	0.0	18.1	0.0	0.0	78.1	99.8
	0.0	85.2	46.3	0.0	0.0	96.7	0.0	0.0	0.0	1.29
	1.14	1.26	1.21	0.0	76.4	0.0	0.0	0.0	0.0	0.0
	100.									
INHALATION	0.0	0.0	6.202E-15	1.056E-14	0.0	2.421E-11	7.781E-15	1.259E-15	0.0	8.946E-13
	3.401E-15	0.0	3.122E-19	0.0	0.0	7.169E-18	0.0	0.0	1.383E-13	1.183E-12
	6.828E-17	6.632E-19	4.043E-17	0.0	0.0	1.031E-14	1.96E-15	5.859E-14	0.0	7.410E-14
	7.813E-14	1.165E-14	7.239E-11	1.345E-14	7.236E-15	0.0	0.0	0.0	0.0	0.0
	9.910E-11									
% OF INTERNAL	0.0	0.0	3.20	0.818	0.0	22.0	1.55	0.102	0.0	28.9
	100.	0.0	1.753E-17	0.0	0.0	5.74	0.0	0.0	0.161	0.152
	100.	14.7	53.7	0.0	0.0	3.23	100.	100.	0.0	98.7
	98.6	98.7	98.8	100.	23.5	0.0	0.0	0.0	0.0	0.0
	5.315E-09									
% OF ALL PATHWAYS	0.0	0.0	0.863	0.818	0.0	2.00	1.55	9.654E-02	0.0	28.9
	99.9	0.0	1.753E-17	0.0	0.0	1.10	0.0	0.0	0.126	0.152
	3.502E-06	14.7	53.7	0.0	0.0	3.23	80.7	99.8	0.0	98.7
	82.6	98.7	98.8	100.	23.5	0.0	0.0	0.0	0.0	0.0
	5.315E-09									
AIR IMMERSION	0.0	0.0	2.161E-16	5.685E-21	0.0	5.885E-14	0.0	4.985E-17	0.0	0.0
	4.114E-24	0.0	0.0	0.0	0.0	4.715E-20	0.0	0.0	3.085E-15	0.0
	1.466E-14	1.000E-21	3.212E-22	2.910E-23	0.0	2.144E-21	3.352E-22	1.965E-23	0.0	1.868E-23
	3.134E-20	1.130E-24	5.889E-21	6.142E-25	5.601E-25	0.0	0.0	0.0	0.0	0.0
	7.666E-14									
% OF EXTERNAL	0.0	0.0	4.115E-02	1.009E-03	0.0	5.341E-03	0.0	6.600E-02	0.0	0.0
	1.345E-04	0.0	0.0	0.0	0.0	8.959E-03	0.0	0.0	1.286E-02	0.0
	7.518E-04	40.1	66.2	8.750E-03	0.0	6.002E-04	6.392E-05	1.912E-05	0.0	9.563E-05
	2.034E-04	5.291E-05	5.112E-05	4.317E-05	1.658E-05	0.0	0.0	0.0	0.0	0.0
	2.495E-03									
% OF ALL PATHWAYS	0.0	0.0	3.006E-02	4.405E-07	0.0	4.856E-03	0.0	3.822E-03	0.0	0.0
	1.205E-07	0.0	0.0	0.0	0.0	7.241E-03	0.0	0.0	2.804E-03	0.0
	7.518E-04	2.219E-02	4.266E-04	8.750E-03	0.0	6.716E-07	1.232E-05	3.348E-08	0.0	2.888E-08
	3.313E-05	5.576E-09	8.036E-09	4.565E-09	1.822E-09	0.0	0.0	0.0	0.0	0.0
	4.122E-12									
GROUND SURFACE	0.0	0.0	5.249E-13	5.632E-16	0.0	1.102E-09	0.0	7.548E-14	1.518E-14	0.0
	3.055E-18	0.0	0.0	0.0	0.0	5.262E-16	0.0	0.0	2.398E-11	0.0
	1.950E-09	1.496E-21	1.641E-22	3.325E-19	0.0	3.572E-16	5.244E-16	1.028E-16	0.0	1.953E-17
	1.541E-14	2.136E-18	1.152E-14	1.423E-18	3.378E-18	0.0	0.0	0.0	0.0	0.0
	3.076E-09									

% OF EXTERNAL	0.0	0.0	100.	100.	0.0	100.	0.0	99.9	100.	0.0
	100.	0.0	0.0	0.0	0.0	100.	0.0	0.0	100.	0.0
	100.	59.9	33.8	100.	0.0	100.	100.	100.	0.0	100.
	100.	100.	100.	100.	100.	0.0	0.0	0.0	0.0	0.0
% OF ALL PATHWAYS	0.0	0.0	73.0	4.364E-02	0.0	90.9	0.0	5.79	100.	0.0
	8.985E-02	0.0	0.0	0.0	0.0	80.8	0.0	0.0	21.8	0.0
	100.	3.319E-02	2.179E-04	100.	0.0	0.112	19.3	0.175	0.0	2.601E-02
	16.3	1.810E-02	1.572E-02	1.058E-02	1.099E-02	0.0	0.0	0.0	0.0	0.0
	1.650E-07									
INTERNAL	8.749E-11	8.389E-02	1.938E-13	1.290E-12	0.0	1.101E-10	5.022E-13	1.229E-12	0.0	3.099E-12
	3.401E-15	0.0	1.78	0.0	0.0	1.248E-16	0.0	0.0	8.604E-11	7.775E-10
	6.828E-17	4.504E-18	7.528E-17	0.0	0.0	3.189E-13	2.196E-15	5.859E-14	0.0	7.507E-14
	7.921E-14	1.180E-14	7.328E-11	1.345E-14	3.073E-14	0.0	0.0	0.0	0.0	0.0
	1.86									
% OF ALL PATHWAYS	100.	100.	27.0	100.	0.0	9.09	1	94.2	0.0	100.
	99.9	0.0	100.	0.0	0.0	19.2	0.1	0.0	78.2	100.
	3.502E-06	99.9	100.	0.0	0.0	99.9	80.7	99.8	0.0	100.
	83.7	100.	100.	100.	100.	0.0	0.0	0.0	0.0	0.0
EXTERNAL	0.0	0.0	5.251E-13	5.632E-16	0.0	1.102E-09	0.0	7.553E-14	1.518E-14	0.0
	3.055E-18	0.0	0.0	0.0	0.0	5.263E-16	0.0	0.0	2.398E-11	0.0
	1.950E-09	2.496E-21	4.852E-22	3.326E-19	0.0	3.572E-16	5.244E-16	1.028E-16	0.0	1.953E-17
	1.541E-14	2.136E-18	1.152E-14	1.423E-18	3.378E-18	0.0	0.0	0.0	0.0	0.0
	3.076E-09									
% OF ALL PATHWAYS	0.0	0.0	73.0	4.364E-02	0.0	90.9	0.0	5.79	100.	0.0
	8.985E-02	0.0	0.0	0.0	0.0	80.8	0.0	0.0	21.8	0.0
	100.	5.538E-02	6.445E-04	100.	0.0	0.112	19.3	0.175	0.0	2.601E-02
	16.3	1.810E-02	1.572E-02	1.058E-02	1.099E-02	0.0	0.0	0.0	0.0	0.0
TOTAL OVER ALL PATHWAYS	8.749E-11	8.389E-02	7.190E-13	1.291E-12	0.0	1.212E-09	5.022E-13	1.304E-12	1.518E-14	3.099E-12
	3.401E-15	0.0	1.78	0.0	0.0	6.511E-16	0.0	0.0	1.100E-10	7.775E-10
	1.950E-09	4.507E-18	7.528E-17	3.326E-19	0.0	3.192E-13	2.721E-15	5.869E-14	0.0	7.509E-14
	9.461E-14	1.180E-14	7.329E-11	1.345E-14	3.074E-14	0.0	0.0	0.0	0.0	0.0
	1.86									
% OF TOTAL	4.693E-09	4.50	3.856E-11	6.922E-11	0.0	6.500E-08	2.694E-11	6.996E-11	8.143E-13	1.662E-10
	1.826E-13	0.0	90.5	0.0	0.0	3.492E-14	0.0	0.0	5.901E-09	4.170E-08
	1.046E-07	2.417E-16	4.038E-15	1.784E-17	0.0	1.712E-11	1.459E-13	3.148E-12	0.0	4.027E-12
	5.075E-12	6.331E-13	3.931E-09	7.216E-13	1.649E-12	0.0	0.0	0.0	0.0	0.0

BARNWELL SIMULATION, WELL AT 914 M. XG=8000 M. SOAM=E-8
COLLECTIVE GENETIC DOSE EC. (PERSON REM)

***SUMMED OVER ALL GONAD

NUCLIDES	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
INGESTION	2.528E-09	1.16	7.332E-12	4.887E-11	0.0	3.307E-09	6.119E-12	4.596E-11	0.0	2.412E-12
	0.0	0.0	18.6	0.0	0.0	3.130E-15	0.0	0.0	2.984E-09	3.140E-08
	0.0	1.837E-17	1.672E-17	0.0	0.0	1.313E-12	0.0	0.0	0.0	1.363E-15
	2.651E-15	2.142E-16	1.200E-12	0.0	4.579E-14	0.0	0.0	0.0	0.0	0.0
	19.7									
% OF INTERNAL	100.	100.	99.7	99.7	0.0	99.6	99.8	99.9	0.0	99.7
	0.0	0.0	100.	0.0	0.0	99.7	0.0	0.0	99.8	99.9
	0.0	99.6	94.7	0.0	0.0	99.3	0.0	0.0	0.0	93.2
	96.0	93.2	92.8	0.0	90.8	0.0	0.0	0.0	0.0	0.0
	100.									
% OF ALL PATHWAYS	100.	100.	36.7	99.6	0.0	10.6	99.8	96.0	0.0	99.7
	0.0	0.0	100.	0.0	0.0	19.4	0.0	0.0	83.7	99.9
	0.0	99.3	94.0	0.0	0.0	98.5	0.0	0.0	0.0	61.7
	0.607	65.9	66.3	0.0	90.6	0.0	0.0	0.0	0.0	0.0
	100.									
INHALATION	0.0	0.0	2.284E-14	1.337E-13	0.0	1.165E-11	1.502E-14	3.045E-14	0.0	7.439E-15
	1.399E-17	0.0	7.469E-20	0.0	0.0	7.912E-18	0.0	0.0	4.651E-12	4.545E-11
	3.760E-17	7.371E-20	1.051E-18	0.0	0.0	9.716E-15	1.308E-15	1.316E-14	0.0	9.972E-17
	1.108E-16	1.568E-17	9.363E-14	8.984E-15	4.646E-15	0.0	0.0	0.0	0.0	0.0
	6.209E-11									
% OF INTERNAL	0.0	0.0	0.311	0.273	0.0	0.351	0.245	6.621E-02	0.0	0.308
	100.	0.0	4.021E-19	0.0	0.0	0.252	0.0	0.0	0.156	0.145
	100.	0.400	5.92	0.0	0.0	0.734	100.	100.	0.0	6.82
	4.01	6.82	7.23	100.	9.21	0.0	0.0	0.0	0.0	0.0
	3.146E-10									
% OF ALL PATHWAYS	0.0	0.0	0.114	0.273	0.0	3.724E-02	0.245	6.363E-02	0.0	0.308
	9.86	0.0	4.021E-19	0.0	0.0	4.902E-02	0.0	0.0	0.13	0.145
	8.064E-08	0.398	5.91	0.0	0.0	0.729	8.07	79.1	0.0	4.52
	2.530E-02	4.82	5.17	99.3	9.19	0.0	0.0	0.0	0.0	0.0
	3.146E-10									
AIR IMMERSION	0.0	0.0	5.207E-15	5.021E-19	0.0	1.496E-12	0.0	1.233E-15	0.0	0.0
	1.739E-22	0.0	0.0	0.0	0.0	1.180E-18	0.0	0.0	7.410E-14	0.0
	3.496E-13	2.597E-20	8.042E-21	6.868E-22	0.0	5.688E-20	9.541E-21	4.981E-22	0.0	4.984E-22
	8.802E-19	3.557E-23	1.880E-19	2.085E-23	1.404E-23	0.0	0.0	0.0	0.0	0.0
	1.926E-12									
% OF EXTERNAL	0.0	0.0	4.122E-02	1.013E-03	0.0	5.346E-03	0.0	6.593E-02	0.0	0.0
	1.359E-04	0.0	0.0	0.0	0.0	5.918E-03	0.0	0.0	1.289E-02	0.0
	7.497E-04	40.0	65.9	8.717E-03	0.0	5.541E-04	6.405E-05	1.431E-05	0.0	6.682E-05
	2.028E-04	3.739E-05	3.638E-05	3.326E-05	1.173E-05	0.0	0.0	0.0	0.0	0.0
	2.561E-03									
% OF ALL PATHWAYS	0.0	0.0	2.605E-02	1.024E-06	0.0	4.780E-03	0.0	2.576E-03	0.0	0.0
	1.225E-04	0.0	0.0	0.0	0.0	7.182E-03	0.0	0.0	2.080E-03	0.0
	7.497E-04	0.140	4.523E-02	8.717E-03	0.0	4.266E-06	8.888E-05	2.993E-06	0.0	2.257E-05
	2.012E-04	1.094E-05	1.038E-05	2.304E-07	2.778E-08	0.0	0.0	0.0	0.0	0.0
	9.759E-12									
GROUND SURFACE	0.0	0.0	1.263E-11	4.958E-14	0.0	2.798E-08	0.0	1.869E-12	3.637E-13	0.0
	1.279E-16	0.0	0.0	0.0	0.0	1.298E-14	0.0	0.0	5.746E-10	0.0
	4.663E-08	3.893E-20	4.162E-21	7.878E-18	0.0	1.027E-14	1.490E-14	1.480E-12	0.0	7.459E-16
	4.340E-13	9.511E-17	5.167E-13	1.67E-17	1.197E-16	0.0	0.0	0.0	0.0	0.0
	7.520E-08									

% OF EXTERNAL	0.0	0.0	100.	100.	0.0	100.	0.0	99.9	100.	0.0
	100.	0.0	0.0	0.0	0.0	100.	0.0	0.0	100.	0.0
	100.	60.0	34.1	100.	0.0	100.	100.	100.	0.0	100.
	100.	100.	100.	100.	100.	0.0	0.0	0.0	0.0	0.0
% OF ALL PATHWAYS	0.0	0.0	63.2	0.101	0.0	89.4	0.0	3.90	100.	0.0
	90.1	0.0	0.0	0.0	0.0	80.5	0.0	0.0	16.1	0.0
	100.	0.210	2.341E-02	100.	0.0	0.770	91.9	20.9	0.0	33.8
	99.4	29.3	28.5	0.693	0.237	0.0	0.0	0.0	0.0	0.0
	3.810E-07									
INTERNAL	2.528E-09	1.16	7.355E-12	4.900E-11	0.0	3.318E-09	6.134E-12	4.599E-11	0.0	2.419E-12
	1.399E-17	0.0	18.6	0.0	0.0	3.138E-15	0.0	0.0	2.988E-09	3.144E-08
	3.760E-17	1.844E-17	1.777E-17	0.0	0.0	1.323E-12	1.308E-15	1.316E-14	0.0	1.463E-15
	2.762E-15	2.299E-16	1.294E-12	8.984E-15	5.043E-14	0.0	0.0	0.0	0.0	0.0
	19.7									
% OF ALL PATHWAYS	100.	100.	36.8	99.9	0.0	10.6	100.	96.1	0.0	100.
	9.86	0.0	100.	0.0	0.0	19.5	0.0	0.0	83.9	100.
	8.064E-08	99.6	99.9	0.0	0.0	99.2	8.07	79.1	0.0	66.2
	0.632	70.7	71.5	99.3	99.8	0.0	0.0	0.0	0.0	0.0
EXTERNAL	0.0	0.0	1.263E-11	4.958E-14	0.0	2.792E-08	0.0	1.870E-12	3.637E-13	0.0
	1.279E-16	0.0	0.0	0.0	0.0	1.298E-14	0.0	0.0	5.747E-10	0.0
	4.663E-08	6.490E-20	1.220E-20	7.879E-18	0.0	1.027E-14	1.490E-14	3.480E-15	0.0	7.459E-16
	4.340E-13	9.511E-17	5.167E-13	6.267E-17	1.197E-16	0.0	0.0	0.0	0.0	0.0
	7.520E-08									
% OF ALL PATHWAYS	0.0	0.0	63.2	0.101	0.0	89.4	0.0	3.91	100.	0.0
	90.1	0.0	0.0	0.0	0.0	80.5	0.0	0.0	16.1	0.0
	100.	0.351	6.864E-02	100.	0.0	0.770	91.9	20.9	0.0	33.8
	99.4	29.3	28.5	0.693	0.237	0.0	0.0	0.0	0.0	0.0
TOTAL OVER ALL PATHWAYS	2.528E-09	1.16	1.999E-11	4.905E-11	0.0	3.130E-08	6.134E-12	4.786E-11	3.637E-13	2.419E-12
	1.419E-16	0.0	18.6	0.0	0.0	1.612E-14	0.0	0.0	3.563E-09	3.144E-08
	4.663E-08	1.851E-17	1.778E-17	7.879E-18	0.0	1.333E-12	1.620E-14	1.664E-14	0.0	2.209E-15
	4.368E-13	3.250E-16	1.811E-12	9.047E-15	5.055E-14	0.0	0.0	0.0	0.0	0.0
	19.7									
% OF TOTAL	1.281E-08	5.88	1.013E-10	2.486E-10	0.0	1.586E-07	3.104E-11	2.425E-10	1.843E-12	1.226E-11
	7.191E-16	0.0	94.1	0.0	0.0	8.168E-14	0.0	0.0	1.806E-08	1.593E-07
	2.363E-07	9.379E-17	9.010E-17	3.992E-17	0.0	6.757E-12	8.211E-14	8.432E-14	0.0	1.119E-14
	2.213E-12	1.647E-15	9.176E-12	4.584E-14	2.562E-13	0.0	0.0	0.0	0.0	0.0

BARNWELL SIMULATION, WELL AT 914 M, XG=7000 M, S0AM=E-8
FATAL CANCER RATE (DEATH/YR)
COMB.LET

***SUMMED OVER ALL CANCER
NUCLIDES

	H-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PI-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
INGESTION	2.586E-14	2.477E-05	5.542E-17	3.548E-16	0.0	2.461E-14	1.063E-16	3.583E-16	0.0	5.786E-16
	0.0	0.0	5.277E-04	0.0	0.0	3.474E-20	0.0	0.0	2.527E-14	2.283E-13
	0.0	1.136E-21	1.026E-20	0.0	0.0	3.920E-17	0.0	0.0	0.0	1.427E-19
	1.727E-19	2.190E-20	1.344E-16	0.0	2.079E-18	0.0	0.0	0.0	0.0	0.0
	3.529E-04									
% OF INTERNAL	100.	100.	96.8	99.1	0.0	78.8	98.0	99.9	0.0	73.3
	0.0	0.0	100.	0.0	0.0	94.2	0.0	0.0	99.8	99.8
	0.0	85.3	46.7	0.0	0.0	96.2	0.0	0.0	0.0	1.36
	1.55	1.33	1.24	0.0	71.5	0.0	0.0	0.0	0.0	0.0
	100.									
% OF ALL PATHWAYS	100.	100.	26.1	99.1	0.0	6.89	98.0	94.0	0.0	73.3
	0.0	0.0	100.	0.0	0.0	18.0	0.0	0.0	78.0	99.8
	0.0	85.2	46.7	0.0	0.0	96.0	0.0	0.0	0.0	1.36
	1.10	1.33	1.24	0.0	71.4	0.0	0.0	0.0	0.0	0.0
	100.									
INHALATION	0.0	0.0	1.834E-18	3.052E-18	0.0	6.627E-18	2.199E-18	3.672E-19	0.0	2.094E-16
	1.007E-18	0.0	9.229E-23	0.0	0.0	2.122E-21	0.0	0.0	4.073E-17	3.484E-16
	2.017E-20	1.961E-22	1.172E-20	0.0	0.0	1.532E-18	3.240E-19	7.414E-19	0.0	1.037E-17
	1.095E-17	1.630E-18	1.070E-14	1.629E-18	8.301E-19	0.0	0.0	0.0	0.0	0.0
	1.797E-14									
% OF INTERNAL	0.0	0.0	3.20	0.854	0.0	21.2	2.03	0.102	0.0	26.7
	100.	0.0	1.748E-17	0.0	0.0	5.76	0.0	0.0	0.161	0.182
	100.	14.7	53.3	0.0	0.0	3.76	100.	100.	0.0	98.6
	98.4	98.7	98.6	100.	28.5	0.0	0.0	0.0	0.0	0.0
	3.253E-09									
% OF ALL PATHWAYS	0.0	0.0	0.864	0.853	0.0	1.86	2.03	9.638E-02	0.0	26.7
	99.9	0.0	1.748E-17	0.0	0.0	1.10	0.0	0.0	0.126	0.182
	3.499E-06	14.7	53.3	0.0	0.0	3.75	67.7	99.6	0.0	98.6
	69.8	98.6	98.7	100.	28.5	0.0	0.0	0.0	0.0	0.0
	3.253E-09									
AIR IMMERSION	0.0	0.0	6.388E-20	1.680E-24	0.0	1.740E-17	0.0	1.474E-20	0.0	0.0
	1.216E-27	0.0	0.0	0.0	0.0	1.393E-23	0.0	0.0	9.114E-19	0.0
	4.329E-18	2.953E-25	9.490E-26	0.0	0.0	6.334E-25	9.901E-26	5.809E-27	0.0	5.519E-27
	9.252E-24	3.340E-28	1.739E-24	1.818E-28	1.655E-28	0.0	0.0	0.0	0.0	0.0
	2.272E-17									
% OF EXTERNAL	0.0	0.0	4.118E-02	1.009E-03	0.0	5.340E-03	0.0	6.004E-02	0.0	0.0
	1.345E-04	0.0	0.0	0.0	0.0	8.952E-03	0.0	0.0	1.286E-02	0.0
	7.510E-04	40.0	66.2	0.0	0.0	6.005E-04	6.391E-05	1.915E-05	0.0	9.561E-05
	2.030E-04	5.286E-05	5.114E-05	4.325E-05	1.658E-05	0.0	0.0	0.0	0.0	0.0
	2.498E-03									
% OF ALL PATHWAYS	0.0	0.0	3.008E-02	4.697E-07	0.0	4.873E-03	0.0	3.869E-03	0.0	0.0
	1.206E-07	0.0	0.0	0.0	0.0	7.238E-03	0.0	0.0	2.813E-03	0.0
	7.510E-04	2.215E-02	4.319E-04	0.0	0.0	1.851E-06	2.067E-05	7.804E-08	0.0	5.249E-08
	5.900E-05	2.021E-08	1.605E-08	1.115E-08	5.687E-09	0.0	0.0	0.0	0.0	0.0
	4.112E-12									
GROUND SURFACE	0.0	0.0	1.551E-16	1.664E-19	0.0	3.257E-13	0.0	2.230E-17	4.494E-15	0.0
	9.038E-22	0.0	0.0	0.0	0.0	1.856E-19	0.0	0.0	7.085E-15	0.0
	5.764E-13	4.420E-25	4.851E-26	0.0	0.0	1.055E-19	1.549E-19	3.033E-20	0.0	5.772E-21
	4.557E-18	6.318E-22	3.301E-22	4.203E-22	5.562E-21	0.0	0.0	0.0	0.0	0.0
	9.094E-13									

INTERNAL									
2.586E-14	2.477E-05	5.725E-17	3.575E-16	0.0	3.124E-14	1.085E-16	3.586E-16	0.0	7.850E-16
1.007E-18	0.0	5.277E-04	0.0	0.0	3.686E-20	0.0	0.0	2.531E-14	2.287E-13
2.017E-20	1.333E-21	2.197E-20	0.0	0.0	4.073E-17	3.240E-19	7.414E-18	0.0	1.051E-17
1.112E-17	1.652E-18	1.084E-14	1.629E-18	2.909E-18	0.0	0.0	0.0	0.0	0.0
5.525E-04	100.	100.	27.0	100.	8.75	100.	94.1	0.0	100.
99.9	0.0	100.	0.0	0.0	19.1	0.0	0.0	78.1	100.
3.495E-06	99.9	100.	0.0	0.0	99.7	0.0	99.6	0.0	99.9
70.9	100.	100.	100.	100.	0.0	0.0	0.0	0.0	0.0
0.0	0.0	1.551E-16	1.664E-19	0.0	3.258E-13	0.0	2.232E-17	4.494E-18	0.0
9.038E-22	0.0	0.0	0.0	0.0	1.556E-19	0.0	7.066E-15	0.0	0.0
5.764E-13	7.373E-25	1.434E-25	0.0	0.0	1.055E-19	0.0	0.0	0.0	5.772E-21
4.557E-18	6.318E-22	3.401E-18	4.203E-22	9.982E-22	0.0	0.0	0.0	0.0	0.0
9.095E-13	0.0	73.0	4.654E-02	0.0	91.3	0.0	5.86	100.	0.0
8.967E-02	0.0	0.0	0.0	0.0	80.9	0.0	0.0	21.9	0.0
5.532E-02	6.527E-04	0.0	0.0	0.0	0.258	32.3	0.407	0.0	5.489E-02
100.	3.823E-02	3.138E-02	2.579E-02	3.430E-02	0.0	0.0	0.0	0.0	0.0
29.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.586E-14	2.477E-05	2.124E-16	3.577E-16	0.0	3.570E-13	1.085E-16	3.810E-16	4.494E-18	7.850E-16
1.008E-18	0.0	5.277E-04	0.0	0.0	1.925E-19	0.0	0.0	0.0	2.287E-13
5.764E-13	1.333E-21	2.197E-20	0.0	0.0	4.084E-17	4.789E-19	7.444E-18	0.0	1.051E-17
1.568E-17	1.653E-18	1.084E-14	1.630E-18	2.910E-18	0.0	0.0	0.0	0.0	0.0
5.525E-04	4.48	3.844E-11	6.474E-11	0.0	6.462E-08	1.965E-11	6.896E-11	8.135E-13	1.421E-10
4.680E-09	0.0	95.9	0.0	0.0	3.484E-14	0.0	0.0	5.865E-09	4.139E-08
1.824E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.043E-07	3.977E-15	0.0	0.0	0.0	7.391E-12	8.669E-14	1.347E-12	0.0	1.903E-12
2.833E-12	2.991E-13	1.962E-09	2.950E-13	5.267E-13	0.0	0.0	0.0	0.0	0.0
TOTAL OVER ALL PATHWAYS									
X OF TOTAL									

X OF ALL PATHWAYS

EXTERNAL

X OF ALL PATHWAYS

INTERNAL

X OF ALL PATHWAYS

X OF EXTERNAL

BARNWELL SIMULATION, WELL AT 914 M. XU=8000 M. SDAM=E-8
COLLECTIVE GENETIC EFFECT(EFFECTIVE/YR)
COMB.LET

***SUMMED OVER ALL GENAD
NUCLIDES

	M-3	C-14	MN-54	FE-55	NI-59	CO-60	NI-63	ZN-65	KR-85	SR-90
	Y-90	NB-94	TC-99	RU-106	CD-109	SB-125	I-125	I-129	CS-134	CS-137
	BA-137M	CE-141	CE-144	PM-147	RE-187	PB-210	RA-226	TH-232	U-233	U-234
	U-235	U-236	U-238	PU-238	PU-239	PU-241	AM-241	PU-242	AM-243	CM-243
	TOTAL									
INGESTION	7.146E-15	3.280E-06	2.072E-17	1.381E-16	0.0	9.346E-15	1.729E-17	1.299E-16	0.0	6.817E-18
	0.0	0.0	5.250E-05	0.0	0.0	8.843E-21	0.0	0.0	8.434E-15	8.874E-14
	0.0	5.193E-23	4.725E-23	0.0	0.0	1.823E-17	0.0	0.0	0.0	1.918E-20
	2.286E-20	3.016E-21	1.671E-17	0.0	6.471E-19	0.0	0.0	0.0	0.0	0.0
	5.578E-05									
% OF INTERNAL	100.	100.	99.7	99.7	0.0	99.6	99.8	99.9	0.0	99.7
	0.0	0.0	100.	0.0	0.0	99.7	0.0	0.0	99.8	99.9
	0.0	99.6	94.1	0.0	0.0	99.3	0.0	0.0	0.0	93.2
	94.1	93.2	93.1	0.0	90.8	0.0	0.0	0.0	0.0	0.0
	100.									
% OF ALL PATHWAYS	100.	100.	36.7	99.6	0.0	10.6	99.8	96.0	0.0	99.7
	0.0	0.0	100.	0.0	0.0	19.4	0.0	0.0	83.7	99.9
	0.0	99.3	94.0	0.0	0.0	99.1	0.0	0.0	0.0	84.5
	1.83	86.0	86.1	0.0	90.7	0.0	0.0	0.0	0.0	0.0
	100.									
INHALATION	0.0	0.0	6.457E-20	3.779E-19	0.0	3.294E-17	4.246E-20	8.607E-20	0.0	2.103E-20
	3.956E-23	0.0	2.111E-25	0.0	0.0	2.236E-23	0.0	0.0	1.318E-17	1.288E-16
	1.063E-22	2.083E-25	2.972E-24	0.0	0.0	1.362E-19	1.845E-20	1.889E-19	0.0	1.409E-21
	1.443E-21	2.216E-22	1.243E-18	1.270E-19	6.565E-20	0.0	0.0	0.0	0.0	0.0
	1.769E-16									
% OF INTERNAL	0.0	0.0	0.311	0.273	0.0	0.351	0.245	6.621E-02	0.0	0.308
	100.	0.0	4.021E-19	0.0	0.0	0.252	0.0	0.0	0.156	0.145
	100.	0.400	5.92	0.0	0.0	0.740	100.	100.	0.0	6.84
	5.94	6.84	6.93	100.	9.21	0.0	0.0	0.0	0.0	0.0
	3.172E-10									
% OF ALL PATHWAYS	0.0	0.0	0.114	0.273	0.0	3.724E-02	0.245	6.263E-02	0.0	0.308
	9.86	0.0	4.021E-19	0.0	0.0	4.908E-02	0.0	0.0	0.131	0.145
	8.064E-08	0.398	5.91	0.0	0.0	0.738	30.8	98.0	0.0	6.21
	0.115	6.32	6.40	99.9	9.21	0.0	0.0	0.0	0.0	0.0
	3.172E-10									
AIR IMMERSION	0.0	0.0	1.472E-20	1.419E-24	0.0	4.228E-18	0.0	3.485E-21	0.0	0.0
	4.916E-28	0.0	0.0	0.0	0.0	3.272E-24	0.0	0.0	2.095E-19	0.0
	9.882E-19	7.340E-26	2.273E-26	1.941E-27	0.0	1.608E-25	2.697E-26	1.408E-27	0.0	1.409E-27
	2.488E-24	1.005E-28	5.313E-28	5.892E-29	3.969E-29	0.0	0.0	0.0	0.0	0.0
	5.444E-18									
% OF EXTERNAL	0.0	0.0	4.122E-02	1.013E-03	0.0	5.346E-03	0.0	6.593E-02	0.0	0.0
	1.355E-04	0.0	0.0	0.0	0.0	8.918E-03	0.0	0.0	1.289E-02	0.0
	7.497E-04	40.0	65.9	8.717E-03	0.0	8.541E-04	8.408E-05	1.431E-05	0.0	6.682E-05
	2.028E-04	3.739E-05	3.638E-08	3.326E-05	1.173E-05	0.0	0.0	0.0	0.0	0.0
	2.561E-03									
% OF ALL PATHWAYS	0.0	0.0	2.605E-02	1.024E-06	0.0	4.780E-03	0.0	2.576E-03	0.0	0.0
	1.225E-04	0.0	0.0	0.0	0.0	7.182E-03	0.0	0.0	2.080E-03	0.0
	7.497E-04	0.140	4.523E-02	8.717E-03	0.0	8.718E-07	4.453E-05	7.194E-07	0.0	6.206E-06
	1.989E-04	2.867E-06	2.737E-06	4.634E-08	8.866E-09	0.0	0.0	0.0	0.0	0.0
	9.759E-12									
GROUND SURFACE	0.0	0.0	3.569E-17	1.401E-19	0.0	7.908E-14	0.0	5.282E-18	1.028E-18	0.0
	3.616E-22	0.0	0.0	0.0	0.0	3.669E-20	0.0	0.0	1.624E-15	0.0
	1.318E-13	1.100E-25	1.176E-26	2.227E-23	0.0	2.902E-20	4.211E-20	9.837E-21	0.0	2.108E-21
	1.227E-18	2.689E-22	1.460E-18	1.772E-22	3.384E-22	0.0	0.0	0.0	0.0	0.0
	2.126E-13									

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APPENDIX A

LISTING OF PRESTO-II CODE

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C*****
C*****
C***** PRESTO-II *****
C*****
C*****
C***
C*** A CODE FOR PREDICTING THE MIGRATION OF RADIOACTIVE WASTE FROM
C*** SHALLOW LAND BURIAL SITES AND THE HEALTH EFFECTS THAT RESULT
C*** FROM THESE LOW LEVEL RADIOACTIVE WASTES.
C***
C***
C*** THE MAIN PROGRAM ACTS AS A SUPERVISOR FOR THE REST OF THE
C*** CODE. MOST OF THE BOOKEEPING, INCLUDING MATERIAL BALANCE,
C*** IS DONE HERE. THE FOLLOWING SUBROUTINES ARE CALLED:
C*** SOURCE, AIRTRM, EVAPO, ERORF, TRENCH, LEACH, VERHOR, SURSOL,
C*** SUSPND, OUT, FOOD, IRRIG, HUMEX, AND DARTAB.
C***
C***
C***
C***
C***
C
C
C
C
C*** GLOBAL VARIABLES
C
C
C ADEPTH = AQUIFER DEPTH M
C AQDISP = AQUIFER DISPERSION ANGLE RADIANS
C AQTHK = AQUIFER THICKNESS M
C AQVOL = AQUIFER DILUTION FACTOR M**3
C AQAM = AMOUNT OF NUCLIDE AT WELL SITE CI/M**3
C AQAVG = AVERAGE NUCLIDE CONCENTRATION AT WELL SITE CI/M**3
C AQCON = NUCLIDE CONCENTRATION AT WELL SITE CI/M**3
C ATAVG = AVERAGE NUCLIDE CONCENTRATION IN ATMOSPHERE CI/M**3
C ATCON = NUCLIDE CONCENTRATION IN ATMOSPHERE DOWNWIND CI/M**3
C ATMASS = NUCLIDE MASS NUMBER
C BDENS = BULK DENSITY OF SOIL G/CC
C CPL1 = NUCLIDE CONCENTRATION IN LEAFY VEGETABLES FOR
C M.I.E. BY ATMOSPHERIC DEPOSITION PCI/KG
C CPL2 = NUCLIDE CONCENTRATION IN PRODUCE FOR M.I.E.
C BY ATMOSPHERIC DEPOSITION PCI/KG
C CPL3 = NUCLIDE CONCENTRATION IN LEAFY VEGETABLES AND
C PRODUCE FOR G.P.E. BY ATMOSPHERIC DEPOSITION PCI/KG
C CS = CONCENTRATION IN SURFACE SOIL CI/KG
C CW = CONCENTRATION IN SURFACE WATER CI/M**3
C CWAT = NUCLIDE CONCENTRATION IN WATER
C CCM11 = NUCLIDE CONCENTRATION IN COW'S MILK FOR M.I.E.
C BY ATMOSPHERIC DEPOSITION PCI/L

```

C	CCMI2	= NUCLIDE CONCENTRATION IN COW'S MILK FOR G.P.E.	
C		BY ATMOSPHERIC DEPOSITION	PCI/L
C	CGMI1	= NUCLIDE CONCENTRATION IN GOAT'S MILK FOR	
C		M.I.E. BY ATMOSPHERIC DEPOSITION	PCI/L
C	CGMI2	= NUCLIDE CONCENTRATION IN GOAT'S MILK FOR	
C		G.P.E. BY ATMOSPHERIC DEPOSITION	PCI/L
C	COPL1	= NUCLIDE CONCENTRATION IN LEAFY VEGETABLES FOR	
C		M.I.E. BY IRRIGATION	PCI/KG
C	COPL2	= NUCLIDE CONCENTRATION IN PRODUCE FOR M.I.E. BY	
C		IRRIGATION	PCI/KG
C	COPL3	= NUCLIDE CONCENTRATION IN LEAFY VEGETABLES AND	
C		PRODUCE FOR G.P.E. BY IRRIGATION	PCI/KG
C	CGMEAT	= NUCLIDE CONCENTRATION IN BEEF MEAT BY	
C		ATMOSPHERIC DEPOSITION	PCI/KG
C	COCMI1	= NUCLIDE CONCENTRATION IN COW'S MILK FOR M.I.E.	
C		BY IRRIGATION	PCI/L
C	COCMI2	= NUCLIDE CONCENTRATION IN COW' MILK FOR G.P.E.	
C		BY IRRIGATION	PCI/L
C	COGMI1	= NUCLIDE CONCENTRATION IN GOAT'S MILK FOR	
C		M.I.E. BY IRRIGATION	PCI/L
C	COGMI2	= NUCLIDE CONCENTRATION IN GOAT'S MILK FOR	
C		M.I.E. BY IRRIGATION	PCI/L
C	COMEAT	= NUCLIDE CONC IN BEEF MEAT BY IRRIGATION	PCI/KG
C	DECAY	= RADIOACTIVE DECAY CONSTANT	1/Y
C	DOVER	= ANNUAL THICKNESS OF TRENCH OVER BURDEN ERODED	M
C	DTRAQ	= DISTANCE FROM TRENCH TO AQUIFER	M
C	DWELL	= DISTANCE FROM TRENCH TO WELL	M
C	DERATE	= ATMOSPHERIC DEPOSITION RATE	
C	EXPOS	= NORMALIZED DOWN WIND ATMOSPHERIC EXPOSURE PER	
C		UNIT SOURCE RELEASE	
C	EXTENT	= CROSS SLOPE EXTENT OF SPILLAGE	M
C	ERREST	=	
C	FTWIND	= FRACTION OF TIME WIND BLOWS TOWARD POPULATION	
C	FI	= FRACTION OF YEAR CROPS ARE IRRIGATED	
C	GWV	= GROUND WATER VELOCITY	M/Y
C	GNDCON	= INSOLUBLE SURFACE SPILLAGE GROUND CONCENTRATION	
C	HTIME	= HORIZONTAL OR AQUIFER TRANSPORT TIME	Y
C	IDELT	= INCREMENTAL YEAR FOR PRINTING ANNUAL SUMMARIES	
C	IPRT1	= INITIAL YEAR FOR PRINTING ANNUAL SUMMARIES	
C	IPRT2	= FINAL YEAR FOR PRINTING ANNUAL SUMMARIES	
C	ITIME	= TOTAL TRANSPORT TIME FROM TRENCH TO WELL	Y
C	IOPSAT	= OPTION INDICATOR FOR CALCULATING LENGTH OF	
C		SATURATED ZONE	
C	IOPVWV	= OPTION IDICATOR FOR CALCULATING VERTICAL WATER	
C		VELOCITY	
C	LU2	= LOGICAL UNIT FOR OUTPUT	
C	MAXYR	= NUMBER OF YEARS IN SIMULATION	
C	NYEAR	= CURRENT YEAR OF SIMULATION	
C	NONCLD	= NUMBER OF NUCLIDES IN SIMULATION	
C	NUCLID	= NUCLIDE NAMES	
C	OVER	= TRENCH OVER BURDEN THICKNESS	M
C	PC	= FRACTION OF TRENCH CAP THAT HAS FAILED	

C	PCON1	= AIR CONCENTRATION	CI/M**3
C	PCON2	= GROUND SURFACE CONCENTRATION	CI/M**2
C	PCON3	= COLLECTIVE INGESTION RATE	PCI.PERSON/Y
C	PCON4	= COLLECTIVE INHALATION	PCI.PERSON/Y
C	PD	= DOWNSLOPE DISTANCE TO STREAM	M
C	POLB	= AMOUNT OF NUCLIDE LEAVING BOTTOM OF TRENCH	CI
C	POLO	= AMOUNT OF NUCLIDE OVERFLOWING TRENCH	CI
C	POP	= POPULATION	
C	PORS	= POSOSITY OF SOIL	
C	PORT	= POROSITY OF TRENCH CONTENTS	
C	PERMS	= PERMEABILITY OF SOIL	M/Y
C	QING	= ANNUAL INTAKE OF RADIONUCLIDE BY INGESTION	
C		OF CONTAMINATED FOOD CONSIDERING ATMOSPHERIC	
C		AND AQUATIC PATHWAYS	PCI/Y
C	QINH	= ANNUAL INTAKE OF NUCLIDE BY INHALATION	PCI/Y
C	QFRAC	= FRACTION OF INGESTION DUE TO WATER	
C	RETARH	= HORIZONTAL RETARDATION FACTOR	
C	RETARV	= VERTICAL RETARDATION FACTOR	
C	SOAM	= AMOUNT OF SURFACE SPILLAGE	CI
C	SAREA	= AREA OF SPILLAGE	M**2
C	SDEEP	= AMOUNT OF SOLUBLE SURFACE COMPONENT GOING TO	
C		TRENCH	CI
C	STAVG	= AVERAGE NUCLIDE CONCENTRATION IN STREAM	CI/M**3
C	STCON	= NUCLIDE CONCENTRATION IN STREAM	CI/M**3
C	SOILOS	= ANNUAL SOIL LOSS DUE TO EROSION	
C	SSTREM	= AMOUNT SURFACE COMPONENT GOING TO STREAM	CI
C	STFLOW	= STREAM FLOW RATE	M**3/Y
C	TRAM	= AMOUNT OF NUCLIDE IN TRENCH	CI
C	VD	= ATMOSPHERIC DEPOSITION VELOCITY	M/S
C	VOLB	= VOLUME OF WATER LEAVING TRENCH BOTTOM	M**3
C	VOLO	= VOLUME OF WATER OVERFLOWING TRENCH	M**3
C	VOLUSD	= HYPOTHETICAL VOLUME OF WATER USED FROM WELL	M**3
C	VTIME	= VERTICAL TRANSPORT TIME	Y
C	VWV	= VERTICAL WATER VELOCITY (TRENCH TO AQUIFER)	M/Y
C	WIRATE	= IRRIGATION RATE	L/M**2-H
C	XINFL	= ANNUAL INFILTRATION RATE	M
C	XKD	= CHEMICAL EXCHANGE COEFFICIENT	ML/G
C	XLSAT	= LENGTH OF SATURATED ZONE	M
C	YSO	= ATMOSPHERIC SOURCE AMOUNT AT SPILLAGE	CI

C-----OTHER VARIABLES ARE DEFINED IN SUBROUTINES WHERE THEY
C-----ARE USED MOST FREQUENTLY.

C-----

DOUBLE PRECISION NUCLID,PNUC

C

COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,

1 PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,

2 IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,

3 WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,

4 IAQSTR

C

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COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
COMMON/TRCH/TAREA,TDEPTH,OVER,FORT,RELFAC,DENCON,OLDWAT,FN,PERMC
C
COMMON/WATER/DTRAQ,DWELL,GWV,XLSAT,STFLOW,AQTHK,AQDISP,
1      PORA,PORV,PERMV
C
COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
1      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
2      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
3      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
4      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
5      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CHAT(40)
C
COMMON/LAND/RAIN,ERODF,STPLNG,COVER,CONTRL,SEDEL,SOILOS,
1      PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
2      INSITE
C
COMMON/AIR/H,VG,U,IT,IS,VD,XG,HLID,ROUGH,FTWIND,CHIQ,RE1,RE2,RE3
C
COMMON/IRRFOO/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
1      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
2      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
3      CCM1(40),CCM2(40),CGM1(40),CGM2(40),
4      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
5      COCM1(40),COCM2(40),COGM1(40),COGM2(40),
6      COMEAT(40),QING(40),QINH(40),POP,
7      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
1      QCW,QGW,QBW,ABSH,P14
C
COMMON/PASS/PNUC(40),PCON1(40),PCON2(40),PCON3(40),
1      PCON4(40),PPOP,LLIND,LDIST
C
COMMON/PCV/SOCON(40)
C
C-----
DIMENSION ITIME(40)
DIMENSION NUCL(40,8),NUMBER(11),IDIG(3),BSMT(40)
DIMENSION AQMAX(40),STMAX(40),ATMAX(40),MXAQ(40),MXST(40),MXAT(40)
DIMENSION PC1(40),PC2(40),PC3(40),PC4(40),NPC1(40),
1      NPC2(40),NPC3(40),NPC4(40),BSMTA(40),AQSTR(40)
DATA LU2/6/
DATA ISW/0/
DATA MINUS/'-'/
DATA NUMBER/'1','2','3','4','5','6','7','8','9','0',' '
IBK=0
DO 10 I=1,40
  AQAVG(I)=0.
  STAVG(I)=0.
  ATAVG(I)=0.
  SOAVG(I)=0.
  BSMT(I)=0.0

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```

    AQMAX(I)=0.0
    STMAX(I)=0.0
    ATMAX(I)=0.0
    MXAQ(I)=0
    MXST(I)=0
    MXAT(I)=0
    PC1(I)=0.
    PC2(I)=0.
    PC3(I)=0.
    PC4(I)=0.
    NPC1(I)=0
    NPC2(I)=0
    NPC3(I)=0
    NPC4(I)=0
    DO 10 NN=1,1000
    AQAM(I,NN)=0.
10 CONTINUE
    OLDWAT=0.
C----- INITIALIZE VARIABLES AND INPUT CONTROL PARAMETER.
C----- PRINT OUT INITIAL CONDITIONS.
C-----
    CALL SOURCE(NUCL)
C-----
C----- THE FOLLOWING EXTRACTS THE ATOMIC MASS FROM THE NUCLIDE
C----- NAME. THE NUCLIDE NAME MUST CONSIST OF ONE OR TWO LETTERS,
C----- A MINUS SIGN, AND ONE TO THREE DIGITS. NO IMBEDDED
C----- BLANKS ARE ALLOWED. THE NAME MUST BE LEFT JUSTIFIED.
C-----
C
    WRITE(LU2,7100)
    DO 70 I=1,NONCLD
    NDASH=2
    IF(NUCL(I,NDASH) .EQ. MINUS) GO TO 20
    NDASH=3
20 NNUM=NDASH+1
    DO 50 K=1,3
    ICHAR=NUCL(I,NNUM+K-1)
    DO 30 L=1,11
    IF(ICHAR .EQ. NUMBER(L)) GO TO 40
30 CONTINUE
40 IDIG(K)=L
    IF(IDIG(K) .EQ. 10) IDIG(K)=0
50 CONTINUE
    NDIG=3
    IF(IDIG(3) .EQ. 11) NDIG=2
    IF(IDIG(2) .EQ. 11) NDIG=1
    INUCN=0
    DO 60 L=1,NDIG
    INUCN=INUCN+IDIG(L)*10**(NDIG-L)
60 CONTINUE
    ATMASS(I)=FLOAT(INUCN)
    WRITE(6,7110)NUCLID(I),ATMASS(I)
70 CONTINUE

```

```

C-----
C----- DETERMINE IF FARMING IS ONSITE
C-----
      INSITE=0
      IF(XG .GT. PD)GO TO 80
      WRITE(LU2,7120)
      INSITE=1
      FARMGD=EXTENT*PD
      PEOPLE=FARMGD/4492.
      IF(PEOPLE .LT. POP) GO TO 80
      POP=PEOPLE
      WRITE(LU2,7130)POP
      80 CONTINUE
C-----
C----- DETERMINE NORMALIZED ATMOSPHERIC EXPOSURE AND
C----- DEPOSITION.
C-----
      EXPOS=CHIQ
      IF(CHIQ .LE. 0.0)CALL AILTRM(EXPOS,DEPO)
C-----
C----- DETERMINE ANNUAL INFILTRATION RATE USING MORTON'S MODEL
C-----
      CALL EVAPO
      IF(IVAP .EQ. 2)XINFL=FN*SINFL
      IF(IVAP .EQ. 3)XINFL=AMIN1(PERMV,PPN)
C-----
C----- DETERMINE VERTICAL WATER VELOCITY, RETARDATION FACTOR,
C----- VERTICAL TRANSIT TIME, HORIZONTAL TRANSIT TIME, AND
C----- TOTAL TRANSIT TIME.
C-----
      VWV=PERMV
      IF(10PVWV .EQ. 1 .AND. XINFL .GT. 0.)VWV=XINFL/PORV
      XLSAT=DTRAQ
      IF(10PSAT .EQ. 1)XLSAT=XINFL/PORV
      TT=SINFL/PORV
      IF(XLSAT .LE. 0.)XLSAT=AMIN1(TT,DTRAQ)
      WRITE(LU2,7000)
      DO 90 I=1,NONCLD
      RETARV=1.+(BDENS*XKD(3,I))/PORV
      VTIME=DTRAQ*RETARV/VWV
      RETARH=1.+(BDENS*XKD(4,I))/PORA
      HTIME=DWELL*RETARH/GWV
      TEMP=VTIME+HTIME
      IF(TEMP .GT. FLOAT(MAXYR) .AND. TEMP .LT. 1.1*FLOAT(MAXYR))IBK=1
      ITIME(I)=INT(TEMP)
      WRITE(LU2,7010)NUCLID(I),RETARV,VTIME,RETARH,HTIME,TEMP
      90 CONTINUE
      IF(1BK .EQ. 1)WRITE(LU2,7030)
C-----
C----- DETERMINE ANNUAL SOIL LOSS DUE TO EROSION OF INSOLUBLE
C----- MATERIALS (UNIVERSAL SOIL LOSS EQUATION).
C-----

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CALL ERORF
SOILOS=SOILOS*.22412
DOVER=SOILOS/(1000.*BDENS)
WRITE(LU2,7040)SOILOS,DOVER
WRITE(LU2,7050)XINFL
WRITE(LU2,7060)VWV
WRITE(LU2,7070)EXPOS
100 CONTINUE
C-----
C----- CALCULATE AQUIFER VOLUME
AQVOL=GWV*PORA*AQTHK*(SQRT(TAREA)+2.*TAN(AQDISP/2.)*DWELL)
C-----
C----- COMPUTE HYPOTHETICAL RADIONUCLIDE WITHDRAWAL FROM WELL AND
C----- STREAM PER YEAR.
C-----
VOLUSW=(WIRATE*4492.*FI*8760.*WWATL +
1      UWAT*WWATH + 15000.*WWATA)*POP*1.0E-3
VOLUSS=(WIRATE*4492.*FI*8760.*SWATL +
1      UWAT*SWATH + 15000.*SWATA)*POP*1.0E-3
C
C
C-----
C----- THE FOLLOWING LOOP WILL BE PROCESSED FOR EACH YEAR IN
C----- THE SIMULATION.
C-----
DO 230 N=1,MAXYR
NYEAR=N
TRLS=0.
IF(DOVER .GT. OVER)TRLS=DOVER-OVER
TDEPTH=TDEPTH-TRLS
OVER=OVER-DOVER
IF(OVER .LT. 0.)OVER=0.
C-----
C----- CALCULATE TRENCH WATER BALANCE.
C-----
CALL TRENCH(NYEAR,VOLB,VOLO,DMAX,PC)
IF(VOLB .LE. .1*AQVOL .OR. ISW .GT. 0)GO TO 110
ISW=ISW+1
WRITE(LU2,7080)NYEAR
110 CONTINUE
C-----
C----- THE FOLLOWING LOOP IS EXECUTED FOR EACH NUCLIDE.
C-----
DO 170 I=1,NONCLD
II=I
DECN=EXP(-DECAY(II))
TRAM(II)=TRAM(II)*DECN
CS(II)=CS(II)*DECN
CW(II)=CW(II)*DECN
C-----
C----- CALCULATE THE AMOUNT OF LEACHING.
C-----
CALL LEACH(II,NYEAR,VOLB,VOLO,DMAX)
C-----
C----- CALCULATE ADDITIONS TO AQUIFER.

```

```

C-----
      CALL VERNOR(II,NYEAR,ITIME)
      AQCON(II)=AQAM(II,NYEAR)/AQVOL
      AMT=VOLUSW*AQCON(II)
      IF(AMT .LE. AQAM(II,NYEAR) .OR. AMT .EQ. 0.) GO TO 120
C-----
C----- UPDATE WELL CONCENTRATION TO CONSERVE RADIONUCLIDE MASS
C-----
      AQCON(II)=AQAM(II,NYEAR)/(VOLUSW)
      120 IF(N .GE. IAVG1 .AND. N .LE. IAVG2)AQAVG(II)=AQAVG(II)+AQCON(II)
C-----
C----- CALCULATE EXCESS RADIONUCLIDE IN WELL GOING TO STREAM
C-----
      AQSTR(II)=0.
      IF(IAQSTR .GT. 0)AQSTR(II)=AQAM(II,NYEAR)-AMT
      IF(AQSTR(II) .LT. 0.)AQSTR(II)=0.
C-----
C----- FIND YEAR OF MAXIMUM CONCENTRATION IN WELL.
C-----
      IF(AQCON(II) .LE. AQMAX(II)) GO TO 130
      AQMAX(II)=AQCON(II)
      MXAQ(II)=N
      130 CONTINUE
C-----
C----- CALCULATE TRANSPORT OF SOLUBLE SURFACE COMPONENT
C-----
      CALL SURSOL(II,NYEAR)
      IF(NYEAR .EQ. 1)SSTREM(II)=STAM(II)+SSTREM(II)
      SSTREM(II)=SSTREM(II)+AQSTR(II)
      STCON(II)=SSTREM(II)/STFLOW
      AMT=VOLUSS*STCON(II)
      IF(AMT .LE. SSTREM(II) .OR. AMT .EQ. 0.)GO TO 140
      STCON(II)=SSTREM(II)/(VOLUSS)
      140 IF(N .GE. IAVG1 .AND. N .LE. IAVG2)STAVG(II)=STAVG(II)+STCON(II)
      IF(STCON(II) .LE. STMAX(II))GO TO 150
      STMAX(II)=STCON(II)
      MXST(II)=N
      150 CONTINUE
C
C-----
C----- CALCULATE ATMOSPHERIC CONCENTRATION AND AMOUNT
C----- ABOVE SPILLAGE AREA
C-----
C
      GNDCON=CS(II)*BDENS*ADEPTH*1.0E3
      CALL SUSPND(NYEAR,II,GNDCON)
      IF(NYEAR .EQ. 1)YSO(II)=YSO(II)+ATAM(II)
      ATCON(II)=YSO(II)*EXPOS*FTWIND
      IF(N .GE. IAVG1 .AND. N .LE. IAVG2)ATAVG(II)=ATAVG(II)+ATCON(II)
      IF(ATCON(II) .LE. ATMAX(II)) GO TO 160
      ATMAX(II)=ATCON(II)
      MXAT(II)=N
      160 CONTINUE
      BSMTA(II)=0.
      IF(IBSMT .GT. 0 .AND. NYEAR .GE. IBSMT)BSMT(II)=BSMT(II)+TRAM(II)
      IF(IBSMT .GT. 0 .AND. NYEAR .GE. IBSMT)BSMTA(II)=+TRAM(II)

```

```

C
C-----
C----- MATERIAL BALANCE
C-----
C
  TRAM(II)=TRAM(II)*(1.0-TRLS/TDEPTH)-POLB(II)-POLO(II)
  IF (TRAM(II) .LT. 0.) TRAM(II)=0.
C----- 3.1536E7 IS THE NUMBER OF SECONDS IN A YEAR
  CS(II)=CS(II)+((TRLS/TDEPTH*TRAM(II)-YSO(II)*3.1536E7)/
1  (EXTENT*PD*ADEPTH))*1.0E-3/BDENS
  CW(II)=CW(II)+((POLO(II)-SSTREM(II)-SDEEP(II))/
1  (EXTENT*PD*ADEPTH*PORS))
  IF (CW(II) .LT. 0.) CW(II)=0.
  IF (CS(II) .LT. 0.) CS(II)=0.
C ---
C----- COMPUTE SOIL CONCENTRATION
C-----
  SOCON(II)=ADEPTH*1.0D12*(CW(II)*PORS+1000.*CS(II)*BDENS)
  IF (N .GE. IAVG1 .AND. N .LE. IAVG2) SOAVG(II)=SOAVG(II)+SOCON(II)
C
170 CONTINUE
  DO 220 I=1,NONCLD
    II=I
    DERATE(II)=ATCON(II)*VD*3.6E15
    CALL FOODA(II)
    IF (N .GE. IAVG1 .AND. N .LE. IAVG2) CSPT(II)=CSPT(II)+CSP(II)
    CALL IRRIGA(II)
    IF (N .GE. IAVG1 .AND. N .LE. IAVG2) CSPOT(II)=CSPOT(II)+CSPO(II)
    CALL HUMEXA(II)
    BSMTA(II)=BSMTA(II)*.03333333/(TDEPTH*TAREA)
C-----
C----- CSP AND CSPO ARE CURRENT CONCENTRATIONS
C-----
    QSUR=(CSP(II)+CSPO(II))*1.E-12
    TEMP=ATCON(II)
    IF (PC1(II) .GE. TEMP) GO TO 180
    PC1(II)=TEMP
    NPC1(II)=NYEAR
180 CONTINUE
    TEMP=QSUR+BSMTA(II)
    IF (PC2(II) .GE. TEMP) GO TO 190
    PC2(II)=TEMP
    NPC2(II)=NYEAR
190 CONTINUE
    TEMP=QING(II)*POP
    IF (PC3(II) .GE. TEMP) GO TO 200
    PC3(II)=TEMP
    NPC3(II)=NYEAR
200 CONTINUE
    TEMP=QINH(II)*POP
    IF (PC4(II) .GE. TEMP) GO TO 210
    PC4(II)=TEMP
    NPC4(II)=NYEAR

```

```

210 CONTINUE
220 CONTINUE
    WD=DMAX
    IF(WD .GT. TDEPTH)WD=TDEPTH
    IF(MOD(NYEAR-IPRT1,IDEFT) .EQ. 0 .OR. NYEAR .EQ. 1)
1 CALL OUT(NYEAR,PC,WD,VOLO,VOLB)
230 CONTINUE
    NEXYR=IAVG2-IAVG1+1
    WRITE(LU2,7090)IAVG1,IAVG2
    DO 240 II=1,NONCLD
    AQAVG(II)=AQAVG(II)/FLOAT(NEXYR)
    STAVG(II)=STAVG(II)/FLOAT(NEXYR)
    ATAVG(II)=ATAVG(II)/FLOAT(NEXYR)
    SOAVG(II)=SOAVG(II)/FLOAT(NEXYR)
    WRITE(LU2,7020)NUCLID(II),ATAVG(II),ATMAX(II),MXAT(II),AQAVG(II),
1      AQMAX(II),MXAQ(II),STAVG(II),STMAX(II),MXST(II)
240 CONTINUE
C
C-----
C----- CALCULATE RADIONUCLIDE CONCENTRATIONS IN FOOD DUE TO
C----- ATMOSPHERIC DEPOSITION.
C-----
C
    WRITE(LU2,7140)
    WRITE(LU2,7150)
    DO 250 I=1,NONCLD
    II=I
    DERATE(II)=ATAVG(II)*VD*3.6E15
    CALL FOOD(II)
    WRITE(LU2,7010)NUCLID(II),CL1(II),CP1(II),CL2(II),CP2(II),
1      CCM1(II),CCM12(II),CGM1(II),CGM12(II),CMEAT(II)
250 CONTINUE
C
C-----
C----- CALCULATE RADIONUCLIDE CONCENTRATIONS IN FOOD DUE TO
C----- WATER IRRIGATION. ALSO CALCULATE ANNUAL RADIONUCLIDE
C----- INTAKE BY MAN.
C-----
C
    WRITE(LU2,7160)
    WRITE(LU2,7150)
    DO 260 I=1,NONCLD
    II=I
    CALL IRRIG(II)
    WRITE(LU2,7010)NUCLID(II),COL1(II),COP1(II),COL2(II),COP2(II),
1      COCM1(II),COCM12(II),COGM1(II),COGM12(II),COMEAT(II)
    CALL HUMEX(II)
260 CONTINUE
    WRITE(LU2,7170)
    IF(LIND .EQ. 0)WRITE(LU2,7180)
    IF(LIND .NE. 0)WRITE(LU2,7190)
    WRITE(LU2,7200)
    DO 270 I=1,NONCLD
    WRITE(LU2,7210)NUCLID(I),QING(I),QINH(I)
270 CONTINUE
    WRITE(LU2,7230)

```

```

C
C-----
C----- CALCULATE VARIABLES NECESSARY TO PASS TO DARTAB.
C----- DARTAB COMBINES RADIONUCLIDE ENVIRONMENTAL EXPOSURE
C----- DATA WITH DOSIMETRIC AND HEALTH EFFECTS DATA TO GENERATE
C----- TABULATIONS OF PREDICTED IMPACTS.
C-----
C
      PPOP=POP
      LDISI=XG
      LLIND=LIND
C-----
C----- CSP AND CSPO ARE AVERAGE CONCENTRATIONS
C-----
      DO 290 I=1,NONCLD
      QSUR=(CSP(I)+CSPO(I))*1.0D-12
      QFRAC=0.
      BSMT(I)=BSMT(I)/FLOAT(MAXYR-IBSMT+1)*.03333333/(TDEPTH*TAREA)
      IF(QING(I) .EQ. 0.0) GO TO 280
      CWATH=(WWATH*AQAVG(I)+SWATH*STAVG(I))*1.0E9
      QFRAC=CWATH*UWAT/QING(I)
280  WRITE(LU2,7220)NUCLID(I),QFRAC
      INUC(I)=NUCLID(I)
      PCON1(I)=ATAVG(I)*POP
      PCON2(I)=(QSUR+BSMT(I))*POP
      PCON3(I)=QING(I)*POP
      PCON4(I)=QINH(I)*POP
290  CONTINUE
      WRITE(LU2,7240)
      DO 300 I=1,NONCLD
      WRITE(LU2,7250)NUCLID(I),PC1(I),NPC1(I),PC2(I),NPC2(I),
1          PC3(I),NPC3(I),PC4(I),NPC4(I)
300  CONTINUE
      CALL DARTAB
      STOP
7000  FORMAT('1',51X,'INITIAL CALCULATIONS',
1      //' ',2X,'NUCLIDE',4X,'VERTICAL',5X,'VERTICAL',
2      4X,'HORIZONTAL',3X,'HORIZONTAL',
3      3X,'BREAK THRU',
4      /' ',11X,'RETARDATION',5X,'TIME Y',4X,
5      'RETARDATION',4X,'TIME Y',8X,'TIME Y')
7010  FORMAT(' ',A8,3X,9(1PE11.4,2X))
7020  FORMAT(' ',A8,3X,3(2(1PE11.4,2X),0PI4,5X))
7030  FORMAT(/' ',5X,'RADIONUCLIDE BREAKTHROUGH TIME IS ONLY SLIGHTLY',
1      ' GREATER THAN SIMULATION TIME AND LEADING EDGE OF PULSE',
2      ' MAY BE MISSED')
7040  FORMAT(/' ',10X,'ANNUAL SOIL LOSS IS ',1PE11.4,' KILOGRAMS PER',
1      ' SQUARE METER',/' ',20X,'OR ',E11.4,
2      ' METERS IS REMOVED FROM THE SURFACE')
7050  FORMAT(' ',10X,'ANNUAL INFILTRATION INTO TRENCH IS ',
1      F8.4,' METERS')
7060  FORMAT(' ',10X,'VERTICAL WATER VELOCITY IS ',F8.4,' METERS',
1      ' PER YEAR')

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7070 FORMAT(' ',10X,'NORMALIZED DOWN WIND ATMOSPHERIC EXPOSURE',
1 ' PER UNIT SOURCE RELEASE IS ',E11.4,' CI/M**3 PER CI/SEC')
7080 FORMAT(// ' ',5X,'WATER OUTFLOW FROM TRENCH BOTTOM IS APPROACHING',
1 ' DILUTION VOLUME IN AQUIFER FOR YEAR ',I4)
7090 FORMAT('1',35X,'AVERAGE CONCENTRATIONS OVER THE YEARS ',I3,
1 ' TO ',I4,' OF THE SIMULATION',
2 '/ ' ',50X,'MAXIMUM ANNUAL CONCENTRATIONS',
3 '///' ',1X,'NUCLIDE',8X,'ATMOSPHERE DOWNWIND',
4 24X,'IN WELL',26X,'IN STREAM',
5 '/ ' ',7X,3(6X,'AVERAGE',6X,'MAXIMUM',4X,'YEAR',1X),
6 '/ ' ',7X,3(2(6X,'CI/M**3'),9X))
7100 FORMAT('1',51X,'INITIAL CALCULATIONS',// ' ',50X,'NUCLIDE',
1 10X,'MASS',//)
7110 FORMAT(' ',51X,A6,8X,F5.0)
7120 FORMAT(' ',5X,'THE POPULATION RESIDES ONSITE')
7130 FORMAT(' ',5X,'POPULATION RESET TO ',F10.0,' FOR ONSITE FARM')
7140 FORMAT('1',30X,'RADIONUCLIDE CONCENTRATION IN FOODS DUE TO',
1 ' ATMOSPHERIC DEPOSITION',/ ' ',55X,'PICO CURIES PER KILOGRAM')
7150 FORMAT(// ' ',1X,'NUCLIDE',4X,'LEAFY VEG',6X,'PRODUCE',5X,
1 'LEAFY VEG',6X,'PRODUCE',4X,'COW'S MILK',3X,'COW'S MILK',
2 3X,'GOAT'S MILK',2X,'GOAT'S MILK',3X,'BEEF MEAT',
3 '/ ' ',14X,'M.I.E.',7X,'M.I.E.',7X,2('G.P.E.',7X),'M.I.E.',
4 7X,'G.P.E.',7X,'M.I.E.',7X,'G.P.E.')
7160 FORMAT(//// ' ',35X,'RADIONUCLIDE CONCENTRATION IN FOODS DUE TO',
1 ' IRRIGATION',/ ' ',55X,'PICO CURIES PER KILOGRAM')
7170 FORMAT(// ' ',5X,'NOTE: G.P.E. - GENERAL POPULATION',
1 ' EXPOSURE',/ ' ',11X,'M.I.E. - MAXIMUM INDIVIDUAL',
2 ' EXPOSURE')
7180 FORMAT('0',11X,'M.I.E. WILL BE USED TO CALCULATE',
1 ' HEALTH EFFECTS')
7190 FORMAT('0',11X,'G.P.E. WILL BE USED TO CALCULATE',
1 ' HEALTH EFFECTS')
7200 FORMAT('1',1X,'NUCLIDE',10X,'ANNUAL INTAKE',10X,
1 'ANNUAL INTAKE',/ ' ',18X,'BY INGESTION',11X,'BY INHALATION',
2 / ' ',20X,2('PCI/Y',18X))
7210 FORMAT(' ',1X,A8,9X,1PE11.4,12X,1PE11.4)
7220 FORMAT(' ',50X,A8,8X,F8.4)
7230 FORMAT('1',50X,'FRACTION OF INGESTION DUE TO WATER',
1 // ' ',50X,'NUCLIDE',10X,'FRACTION')
7240 FORMAT('1',55X,'MAXIMUM ANNUAL EXPOSURE',
1 ///,2X,'NUCLIDE',12X,'AIR',8X,'YEAR',8X,
2 'SURFACE',6X,'YEAR',7X,'INGESTION',5X,'YEAR',6X,
3 'INHALATION',5X,'YEAR',
4 / ' ',15X,2('CONCENTRATION',12X),5X,
5 2('RATE',19X),
6 / ' ',18X,'CI/M**3',18X,'CI/M**2',
7 16X,2('PERSON.PCI/Y',12X)/)
7250 FORMAT(' ',A8,8X,4(1PE11.4,4X,0PI4,6X))
END

```

C
C
C

SUBROUTINE AIRTRM(EXPOS,DEPO)

```
C
C
C
C
C
C
D.E. FIELDS, 2/81
COMPUTES ATMOSPHERIC EXPOSURE VALUES AT POINTS DOWNWIND FROM
RELEASE SITE FOR 22.5 DEG. SECTOR
RECEPTOR ASSUMED AT GROUND LEVEL

C
C
DEPO      =DEPOSITION RATE PER UNIT SOURCE STRENGTH
EXPN       =NORMALIZED EXPOSURE = EU/Q. S/M**2.
EXPOS      =EXPOSURE PER SOURCE STRENGTH NORMALIZED TO
            WIND VELOCITY
H          =SOURCE HGT. M
HLID       =LID HEIGHT
IPLU       =1 IMPLIES TRANSVERSE PLUME CALCULATION REQUIRED
ISEC       =1 IMPLIES SECTOR AVERAGE REQUIRED
IS         =STABILITY CLASS
IT         =TYPE OF STABILITY FORMULATION,
            =1 FOR PG
            =2 FOR BRIGGS-SMITH
ROUGH      =HOSKER ROUGHNESS PARAMETER, M, ABOUT
            .01*PHYSICAL ROUGHNESS
U          =VELOCITY, WIND, M/S
VD         =VELOCITY, DEPOSITION, M/S
VG         =VELOCITY, GRAVITATIONAL FALL, M/S
XG         =GAUGE DISTANCE FROM SOURCE BASE, M
COMMON/AIR/H,VG,U,IT,IS,VD,XG,HLID,ROUGH,FTWIND,CHIQ,RE1,RE2,RE3

C
C TEST FOR INVALID COMBINATIONS OF IS AND IT:
36 IF(IS.LT.1.OR.IS.GT.6)WRITE(6,38)IT,IS
   IF(IT.EQ.5.AND.(IS.EQ.1.OR.IS.EQ.5))WRITE(6,38)IT,IS
   IF(IT.EQ.6.AND.(IS.EQ.1.OR.IS.EQ.6))WRITE(6,38)IT,IS
38 FORMAT(2X,'INVALID COMBINATION OF IT=',I2,'AND IS=',I2)
C INITIALIZE PARAMETERS
PI=3.141593
IF(HLID.EQ.0.)HLID=12000.
LID=HLID
IXG=XG
ACCOUNT FOR PLUME TILT
HH=H-VG*XG/U
IF(HH.LT.0.)HH=0.0
C COMPUTE PLUME WIDTH FACTORS AT DISTANCE XG
CALL SIGMAZ(XG,IT,IS,ROUGH,SIGZ,IKPM,HLID,VG,U,HH)
C RESTRICT HLID TO TROPOPAUSE IF INPUT SPEC. =0.0
C COMPUTE CORRECTION FACTOR FOR PLUME DEPLETION
COR=1.
IF(VG.EQ.0..AND.VD.EQ.0.)GOTO45
CALL DPLT(PI,HH,VD,U,IT,IS,XG,ROUGH,HLID,COR,VG,H)
```

```

C
C      IF(COR.LT..999)WRITE(6,40) COR
40      FORMAT(2X,'DEPLETION CORRECTION FACTOR =',F8.4)
45      EXPO=EXP(-HH*HH/2./SIGZ/SIGZ)
C      COMPUTE SECTOR AVERAGE VALUES
      EXPN=COR*2.032*EXPO/SIGZ/XG
      EXPOS=EXPN/U
      DEPO=EXPOS*VD
80      CONTINUE
1000     CONTINUE
      RETURN
      END

C
C
      BLOCK DATA
C      D.E. FIELDS, 2/81
      COMMON/C/BY(6),BZ1(6),BZ2(6),BZ3(6),A1(6),A2(6),B1(6),B2(6),
& B3(6),PY(6,5),PZ(6,5),QY(6,5),QZ(6,5),XM(50)
C      FOR BRIGGS
      DATA BY/.22,.16,.11,.08,.06,.04/,
& BZ1/.2,.12,.08,.06,.03,.016/,
& BZ2/0.,0.,.0002,.0015,.0003,.0003/,
& BZ3/1.,1.,-.5,-.5,-1.,-1./
C      FOR PG
      DATA A1/-.0234,-.0147,-.0117,-.0059,-.0059,-.0029/,
& A2/.35,.248,.175,.108,.088,.054/,
& B1/.88,-.985,-1.186,-1.35,-2.88,-3.8/,
& B2/-.152,.82,.85,.793,1.255,1.419/,
& B3/.1475,.0168,.0045,.0022,-.042,-.055/
C      FOR KLUG, ET. AL. TYPES OF DISPERSION...
      DATA PY/.469,.306,.23,.219,.237,.273,0...4,.36,.32,.0,.31,
& .0,1.7,1.44,.91,1.02,.0,.66,.66,.63,.53,.41,7.56,
& .34,.37,.40,.43,.46,7.56/
      DATA QY/.903,.885,.855,.764,.691,.594,0...91,.86,.78,.0,.71,
& 0...717,.71,.729,.648,.0,.83,.83,.80,.80,.87,.52,
& 1.00,.94,.88,.82,.76,.52/
      DATA PZ/.017,.072,.076,.14,.217,.262,.0,.411,.326,.223,.0,
& .062,.0,.079,.131,.91,1.93,.0,.14,.14,.21,.26,.13,.56,
& .037,.076,.16,.32,.66,1.37/
      DATA QZ/1.38,1.021,.879,.727,.61,.5,.0,.907,.859,.776,.0,.709,
& .0,1.2,1.046,.702,.465,.0,1.09,1.09,.98,.89,.83,.55,1.28,
& 1.12,.96,.88,.63,.47/
      DATA XM/
& 1.000E+00,2.000E+00,3.000E+00,4.000E+00,5.000E+00,
& 1.000E+01,1.500E+01,2.000E+01,2.500E+01,3.000E+01,
& 3.500E+01,4.000E+01,4.500E+01,5.000E+01,1.500E+02,
& 2.000E+02,3.000E+02,4.000E+02,5.000E+02,6.000E+02,
& 7.000E+02,8.000E+02,9.000E+02,1.000E+03,1.100E+03,
& 1.200E+03,1.300E+03,1.400E+03,1.600E+03,1.800E+03,
& 2.000E+03,2.500E+03,3.000E+03,3.500E+03,4.000E+03,
& 4.500E+03,5.000E+03,6.000E+03,7.000E+03,8.000E+03,
& 1.000E+04,1.500E+04,2.000E+04,3.000E+04,4.000E+04,
& 5.000E+04,6.000E+04,7.000E+04,8.000E+04,1.000E+05/
      END

```

```

C
C
C
      FUNCTION CAP(NYEAR)
C
C
C***
C***
C*** THIS FUNCTION CALCULATES AND RETURNS THE FRACTION OF THE TRENCH
C*** CAP THAT HAS FAILED. FAILURE CAN BE CAUSED BY EROSION AS
C*** DETERMINED FROM THE UNIVERSAL SOIL LOSS EQUATION OR BY USER
C*** INPUTS. CAP=1 INDICATES TOTAL CAP FAILURE. THIS FUNCTION
C*** IS CALLED BY TRENCH.
C***
C***
C***
C***
C***
C***
C
C  INPUT VARIABLES
C
C    NYEAR = CURRENT YEAR OF SIMULATION
C    NYR1  = FIRST YEAR OF FAILURE
C    NYR2  = LAST YEAR OF FAILURE
C    PCT1  = PER CENT FAILURE IN NYR1
C    PCT2  = PER CENT FAILURE IN NYR2
C    OVER  = THICKNESS OF TRENCH CAP
C
C  OUTPUT VARIABLE
C
C    CAP   = FRACTION OF CAP THAT HAS FAILED
C
C
C    DOUBLE PRECISION NUCLID
C
C    COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR
C
C    COMMON/TRCH/TAREA,TDEPTH,OVER,PORT,RELFAC,DENWST,OLDWAT,FN,PERMC
C
C    CAP=0.0
C    IF(OVER .GT. 1.E-5) GO TO 20
C    CAP=1.0
C    RETURN
20 IF(NYEAR .LT. NYR1 .OR. NYR1 .GE. NYR2) RETURN
   CAP=((PCT2-PCT1)/(NYR2-NYR1))*(NYEAR-NYR1)+PCT1
   IF(NYEAR .GT. NYR2) CAP=PCT2
   RETURN
   END

```

```

C
C
C
FUNCTION COV(I,Y,TE,TH,B)
C
C
C***  CALCULATION OF RADIONUCLIDE CONCENTRATION IN FORAGE, PRODUCE AND
C      LEAFY VEGETABLES.  CALLED BY IRRIG.
C
C
C
C
C
C
C
DOUBLE PRECISION NUCLID
C
COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&    AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&    SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&    AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&    ATAVG(40),FMC(40),FMC(40),DECAY(40),XKD(4,40),SOL(40),
&    FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
COMMON/LAND/RAIN,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
&    PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
&    INSITE
C
COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&    ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&    QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&    CCM1(40),CCM2(40),CGM1(40),CGM2(40),
&    CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&    COCM1(40),COCM2(40),COGM1(40),COGM2(40),
&    COMEAT(40),QING(40),QINH(40),POP,
&    CSP(40),CSPT(40),CSP0(40),CSPOT(40)
C
COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&    QCW,QGW,QBW,ABSH,P14
C
COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&    PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&    IRRES1,IRRES2,LIND,IAGV1,IAGV2,RR,FTMECH,
&    WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&    IAQSTR
C
CWATL=(WWATL*AQAVG(I)+SWATL*STAVG(I))*1.0E9
NEXYR=IAGV2-IAGV1+1
DECA=DECAY(I)/8760.
DECSL=SINFL/(.15*(1.+BDENS/PORS*XKD(1,I)))/8760.
XAMBEF=DECA+XAMBWE

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```

TERM1=WIRATE*FI*CWATL*RW(I)*(1.0-EXP(-XAMBEF*TE))/(Y*XAMBEF)
CSPO(I)=CSPOT(I)/FLOAT(NEXYR)
IF(INSITE .EQ. 1)CSP(I)=SOAVG(I)
TERM2=CSP(I)*B/PP
COV=(TERM1+TERM2)*EXP(-DECA*TH)
RETURN
END

```

C
C
C

```

FUNCTION COVA(I,Y,TE,TH,B,IFLAG)

```

C
C

```

C***  CALCULATION OF RADIONUCLIDE CONCENTRATION IN FORAGE, PRODUCE AND
      LEAFY VEGETABLES.  CALLED BY IRRIG.

```

C
C
C
C
C
C
C

```

      DOUBLE PRECISION NUCLID

```

C

```

      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)

```

C

```

      COMMON/LAND/RAINP,ERODF,STPLNG,COVER,CONTRL,SEDEL,SOILOS,
&      PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
&      INSITE

```

C

```

      COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM11(40),CCMI2(40),CGMI1(40),CGMI2(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM11(40),COCM12(40),COGMI1(40),COGMI2(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)

```

C

```

      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14

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C

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      COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL

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C

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COMMON/PCV/SOCON(40)
COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PCT1,PCT2,LEAOPT,IOPVVV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR
C
  CWATL=(WWATL*AQCON(I)+SWATL*STCON(I))*1.0E9
  DECA=DECAY(I)/8760.
  DECSL=SINFL/(.15*(1.+BDENS/PORS*XKD(1,I)))/8760.
  XAMBEF=DECA+XAMBWE
  TERM1=WIRATE*FI*CWATL*RW(I)*(1.0-EXP(-XAMBEF*TE))/(Y*XAMBEF)
  IF(IFLAG .EQ. 0)CSPO(I)=
& (CSPO(I)+CWATL*WIRATE*8760.*FI)*EXP(-(DECA+DECSL)*8760.)
  IF(INSITE .EQ. 1)CSPO(I)=SOCON(I)
  TERM2=CSPO(I)*B/PP
  COVA=(TERM1+TERM2)*EXP(-DECA*TH)
  RETURN
  END
C
C
  FUNCTION CV(I,Y,TE,TH,B)
C
C
C***  CALCULATION OF RADIONUCLIDE CONCENTRATION IN FORAGE, PRODUCE AND
C      LEAFY VEGETABLES  CALLED BY FOOD
C
C
C
C
  DOUBLE PRECISION NUCLID
C
  COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
  COMMON/LAND/RAINP,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
&      PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
&      INSITE
C
  COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM1(40),CCM2(40),CGM1(40),CGM2(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM1(40),COCM2(40),COGM1(40),COGM2(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
  COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14

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C
COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
& PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1-IPRT2,IDELT,
& IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
& WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
& LAQSTR
C
NEXYR=IAVG2-IAVG1+1
DECA=DECAY(1)/8760.
XAMBEF=DECA+XAMBWE
TERM1=DERATE(1)*RA(1)*(1.0-EXP(-XAMBEF*TE))/(Y*XAMBEF)
CSP(1)=CSPT(1)/FLOAT(NEXYR)
IF(INSITE.EQ.1)CSP(1)=SOAVG(1)
TERM2=CSP(1)*B/PP
CV=(TERM1+TERM2)*EXP(-DECA*TH)
RETURN
END
C
C
FUNCTION CVA(I,Y,TE,TH,B,IFLAG)
C
C
C*** CALCULATION OF RADIONUCLIDE CONCENTRATION IN FORAGE, PRODUCE AND
C LEAFY VEGETABLES CALLED BY FOOD
C
C
C
C
C
DOUBLE PRECISION NUCLID
C
COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
& AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
& SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
& AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
& ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
& FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
& PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
& INSITE
C
COMMON/IRRFOO/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
& ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
& QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
& CCM11(40),CCM12(40),CGM11(40),CGM12(40),
& CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
& CCCM11(40),COCM12(40),COGM11(40),COGM12(40),
& COMEAT(40),QING(40),QINH(40),POP,
& CSP(40),CSPT(40),CSP0(40),CSPOT(40)

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C      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14
C
C      COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
C      COMMON/PCV/SOCON(40)
C
      DECA=DECAY(I)/8760.
      DECSL=SINFL/(.15*(1.0+BDENS/PORS*XKD(1,I)))/8760.
      XAMBEF=DECA+XAMBWE
      TERM1=DERATE(I)*RA(I)*(1.0-EXP(-XAMBEF*TE))/(Y*XAMBEF)
      IF(IFLAG .EQ. 0)
&CSP(I)=(CSP(I)+8760.*DERATE(I))*EXP(-(DECA+DECSL)*8760.)
      IF(INSITE .EQ. 1)CSP(I)=SOCON(I)
      TERM2=CSP(I)*B/PP
      CVA=(TERM1+TERM2)*EXP(-DECA*TH)
      RETURN
      END
C
C
      SUBROUTINE DPLT(PI,HH,VD,U,IT,IS,XG,ROUGH,HLID,COR,VG,H)
      COMPUTES PLUME DEPLETION CORRECTION
      DIMENSION XX(50),FX(50),AX(50)
      COMMON/C/BY(6),BZ1(6),BZ2(6),BZ3(6),A1(6),A2(6),B1(6),B2(6),
& B3(6),PY(6,5),PZ(6,5),QY(6,5),QZ(6,5),XM(50)
      IF(IS.GT.6)IS=6
      IKPM=1
      IDUM=1
      CALL SIGMAZ(XG,IT,IS,ROUGH,SIGZ,IKPM,HLID,VG,U,HH)
C      IKPM HAS BEEN RECOMPUTED
      IKP=IKPM+1
      SQRTPI=.79785
      FX(IKP)=EXP(-.5*(HH/SIGZ)**2)/SIGZ
      XX(IKP)=XG
      DO 20 I=1,IKPM
      XX(I)=XM(I)
      CALL SIGMAZ(XX(I),IT,IS,ROUGH,SIGZ,IDUM,HLID,VG,U,HH)
      FX(I)=EXP(-.5*(HH/SIGZ)**2)/SIGZ
20      CONTINUE
      L=1
      CALL SIMPUN(XX,FX,IKP,L,AX)
      COR=EXP(-SQRTPI*VD/U*AX(IKP))
      RETURN
      END
C
C
C
C
C

```


SUBROUTINE ERORF

```

C
C DETERMINES SEDIMENT LOADING FOR RAIN DRIVEN SURFACE
C EROSION. AVERAGE ANNUAL SOIL LOSS IN TONS PER ACRE
C IS CALCULATED USING THE UNIVERSAL SOIL LOSS EQUATION.
C
C
C
C
C
C
C
C
C
C ***** VARIABLES FOR UNIVERSAL SOIL LOSS EQUATION *****
C
C RAINF=RAINFALL FACTOR
C ERODF=ERODIBILITY FACTOR
C STPLNG=SLOPE-STEEPNESS AND SLOPE LENGTH FACTOR
C COVER=COVER FACTOR
C CONTRL=EROSION CONTROL PRACTICE FACTOR
C SEDELR=SEDIMENT DELIVERY RATIO
C
C
C
C
C      COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
C      &      PORS,PERMS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
C      &      INSITE
C
C      SOILOS = RAINF * ERODF * STPLNG * COVER * CONTRL * SEDELR
C
C
C
C      RETURN
C      END
C
C      SUBROUTINE EVAPO
C
C      THIS PROGRAM PROVIDES AN ESTIMATE OF EVAPOTRANSPIRATION FROM
C      ROUTINE CLIMATOLOGICAL OBSERVATIONS.
C      INPUT PARAMETERS INCLUDE-
C      FOR EACH STATION-LATITUDE,AVERAGE ATMOSPHERIC PRESSURE,AVERAGE
C      ANNUAL PRECIPITATION
C      FOR EACH TIME PERIOD- AIR TEMPERATURE,DEW POINT TEMPERATURE,
C      RATIO OF OBSERVED TO MAXIMUM POSSIBLE SUNSHINE DURATION
C      THE ORIGINAL PROGRAM WAS MODIFIED BY RD SHARP FOR 1 YEAR
C      CALCULATIONS INSTEAD OF 5-YEAR AVERAGE CALCULATIONS

```

C
 C
 C****
 C****
 C
 C***** LIST OF TERMS *****
 C PHID = LATITUDE - NEGATIVE IN SOUTHERN HEMISPHERE DEG
 C P = AVERAGE ATMOSPHERIC PRESSURE MB
 C PPN = AVERAGE ANNUAL PRECIPITATION MM
 C S(1) = RATIO OF OBSERVED TO MAX POSSIBLE SUNSHINE DURATION
 C MONNUM = MONTH NO STARTING WITH 1 FOR JANUARY
 C N = NUMBER OF DAYS IN MONTH DAYS
 C TD = DEW POINT TEMPERATURE DEG C
 C T = AIR TEMPERATURE DEG C
 C ALPHA(J) = CONSTANT IN COMPUTATION OF VAPOUR PRESSURE
 C BETA(J) = CONSTANT IN COMPUTATION OF VAPOUR PRESSURE 1/DEG C
 C GAMMA(J) = SENSIBLE HEAT TRANSFER COEFFICIENT MB/DEG
 C FAZ(J) = VAPOUR TRANSFER COEFFICIENT * STABILITY FACTOR W/M/M/MB
 C L(J) = LATENT HEAT
 C ADEL(J) = DIFFERENCE BETWEEN MAXIMUM AND MINIMUM ALBEDOS
 C (J) = 1 WHEN T IS GREATER THAN OR EQUAL TO ZERO
 C (J) = 2 WHEN T IS LESS THAN ZERO
 C V = SATURATION VAPOUR PRESSURE AT T MB
 C VD = SATURATION VAPOUR PRESSURE AT TD MB
 C DELTA = SLOPE OF SATURATION VAPOUR PRESSURE CURVE AT T MB/DEG
 C PHI = LATITUDE RADIANS
 C THETA = DECLINATION OF SUN RADIANS
 C OMEGA = HALF THE ANGLE BETWEEN SUNRISE AND SUNSET RADIANS
 C COSZ = COSINE OF THE SOLAR ZENITH ANGLE
 C NETA = RADIUS VECTOR OF SUN
 C GE = EXTRA-ATMOSPHERIC GLOBAL RADIATION W/M*M
 C AZ = ALBEDO WHEN SUN IS AT ZENITH
 C AL = MINIMUM ALBEDO
 C AU = MAXIMUM ALBEDO
 C DUST = TURBIDITY COEFFICIENT
 C W = PRECIPITABLE WATER VAPOUR MM
 C TAUT = TRANSMISSIVITY FOR DIRECT BEAM SOLAR RADIATION
 C TAU = PARTIAL TRANSMISSIVITY DUE TO ABSORPTION ALONE
 C GO = CLEAR SKY GLOBAL RADIATION W/(M*M)
 C G = INCIDENT GLOBAL RADIATION W/(M*M)
 C B = NET LONG WAVE RADIATION W/(M*M)
 C RAU = NET RADIATION AT MINIMUM ALBEDO W/(M*M)
 C RAL = NET RADIATION AT MAXIMUM ALBEDO W/(M*M)
 C ZETA = STABILITY FACTOR
 C FA = VAPOUR PRESSURE COEFFICIENT W/M/M/MB
 C LAMDA = HEAT TRANSFER COEFFICIENT MB/DEG
 C D = PENMAN WEIGHTING FACTOR
 C KSI = IMPROVEMENT TO PRIESTLY-TAYLOR WEIGHTING FACTOR
 C M = ADVECTION ENERGY TERM W/(M*M)
 C E = EVAPORATION FROM MOIST SURFACE AT AIR TEMPERATURE W/(M*M)
 C RA = NET RADIATION W/(M*M)
 C EP = POTENTIAL EVAPORATION W/(M*M)
 C EA = AREAL EVAPORATION W/(M*M)
 C RAM = NET RADIATION MM

```

C      EPM = POTENTIAL EVAPORATION                      MM
C      EAM = AREAL EVAPORATION                          MM
C      XIRR = ANNUAL IRRIGATION
C      XINFL = ANNUAL INFILTRATION
C*****
C***** SPECIFICATION STATEMENTS *****
C
C      COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
C      COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
&      PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
&      INSITE
C
C      INTEGER CONS(12)
C      REAL N
C      REAL KSI,LAMDA,M,MU,NETA,LNQ,LNX,LNY,LNZ
C      REAL LNZZ
C      REAL ADEL(2),ALPHA(2),BETA(2),GAMMA(2),FAZ(2),L(2)
C      DIMENSION TEAM(12),TEPM(12),TRAM(12)
C      DIMENSION N(12)
C      DATA N/31.,28.25,31.,30.,31.,30.,31.,31.,30.,31.,30.,31/
C*****
C***** CONSTANTS *****
C
C      PPN=(XIRR+PPN)*1000.
C      DATA ALPHA/17.27,21.88/
C      DATA BETA/237.3,265.5/
C      DATA FAZ/22.,25.30/
C      DATA L/28.5,32.78/
C      DATA ADEL/.05,.50/
C      DATA PI/3.141592654/
C      GAMMA(1)=0.66*P/1013.
C      GAMMA(2)=0.66*P/(1013.*1.15)
C      PHI=PHID*PI/180.
C      LNQ=-(PPN/(920.*(1013./P-SIN(ABS(PHI)))))**5
C      IF(LNQ.LT.-675.)LNQ=-675.
C      AZ=.11+.06*EXP(LNQ)
C      LNZ=-(PHID/38.)**8.
C      IF(LNZ.LT.-675.)LNZ=-675.
C      LNZZ=-(PHID/6.)**8
C      IF(LNZZ.LT.-675.)LNZZ=-675.
C      DO 25 I=1,12
C      TEAM(I)=0.0
C      TEMPM(I)=0.0
C      TRAM(I)=0.0
25  CONTINUE
C      DO 30 I=1,12
C      IF(T(I).GE. 0.0) CONS(I) =1
C      IF(T(I).LT. 0.0) CONS(I) =2
30  CONTINUE
C*****
C***** CALCULATIONS *****
C

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```

DO 60 I=1,12
MONNUM=I
J=CONS(I)
V = 6.11*EXP(ALPHA(J) * T(I)/(T(I)+BETA(J)))
DELTA = ALPHA(J)*BETA(J)*V/(T(I)+BETA(J))**2.0
VD=6.11*EXP(17.27*TD(I)/(TD(I)+237.3))
THETA=23.2*PI/180.*SIN((29.5*MONNUM-94.)*PI/180.)
IF(THETA.LT.PHI-89.999*PI/180.) THETA=PHI-89.999*PI/180.
IF(THETA.GT.PHI+89.999*PI/180.) THETA=PHI+89.999*PI/180.
C
ACOM=-TAN(PHI)*TAN(THETA)
ACOM=-(SIN(PHI)/COS(PHI))*SIN(THETA)/COS(THETA)
IF(ACOM.LT.-1.)ACOM=-1.
C
THE NEXT 6 LINES RETURN THE ARC COSINE OF ACOM
IF(ACOM) 100,101,102
100 OMEGA=PI-ATAN(SQRT((1.-ACOM**2)/ACOM**2))
GO TO 103
101 OMEGA=PI/2.
GO TO 103
102 OMEGA=ATAN(SQRT((1.-ACOM**2)/ACOM**2))
103 COSZ=SIN(PHI)*SIN(THETA)+COS(PHI)*COS(THETA)*SIN(OMEGA)/OMEGA
NETA=1.+SIN((29.5*MONNUM-106.)*PI/180.)/60.
GE=1354.*COSZ*OMEGA/(PI*NETA*NETA)
ZENA=ABS(PHI-THETA)
AL=AZ*(EXP(.855)-EXP((ZENA)*1.71/PI))*(COS(ZENA)*1.71/
*PI+SIN(ZENA)))/(1.296*(1.-SIN(ZENA)))
AU=AL+ADEL(J)
DUST=(.47+(COS(PHI-THETA))**2)*EXP((P-1013.)*( .17-AZ)*84.2/1013.)
W=VD/(.49+T(I)/129.)
LNK=((-.089*(P/(COSZ*1013.))**.75)-(.083*(DUST/COSZ)**.9)
*-(.0288*(W/COSZ)**.6))
IF(LNX.LT.-675.)LNX=-675.
IF(LNX.GT.700.)LNX=700.
TAUT=EXP(LNX)
LNY=(-.05-.01*(DUST/COSZ)**1.8-.00288**.5*(W/COSZ)**.3)
IF(.00288**.5*(W/COSZ)**.3.GT..0288*(W/COSZ)**.6) LNY=(-.05-.01*(D
UST/COSZ)**1.8-.0288*(W/COSZ)**.6)
IF(LNY.LT.LNX)LNY=LNX
TAUA=EXP(LNY)
GO=GE*(TAUT+TAUT*(1.-TAUT/TAUA)*(1+AL*TAUT))
G=G0*((.28+.1*EXP(LNZ)-.04*EXP(LNZZ))*
*(1.-S(I))+S(I))
CC=1.-(G/GE-.18)/.55
IF(CC.LT.0.)CC=0.
IF(CC.GT.1.)CC=1.
C=CC**.75
WFC= .25-.005*(V-VD)
IF(WFC.LT.0.)WFC=0.
B=5.22*((273.+T(I))**.4*(1.-(.707+VD/158.)*(1.+WFC*C*C)))/10.**8.
RAU=(1.-AL)*G-B
RAL=(1.-AU)*G-B
ZETA=(ABS(V-VD)/6.11)**.12
FA=FAZ(J)/ZETA

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```

LAMDA=GAMMA(J)+20.88*(T(I)+273.)*3./ (FA*10.**8.)
D=1./(1.+LAMDA/DELTA)
KSI=.26+1./(1.+(LAMDA*(LAMDA+.5*DELTA*(1.+VD/V)))/(DELTA*(LAMDA+
*DELTA*VD/V)))
MU=KSI-D
M=.66*B-.44*RAU
IF(M.LT.0.)M=0.
E=FA*(V-VD)
IF(E.LT. (.7*KSI*M+MU*RAL)/(1.-D))E=(.7*KSI*M+MU*RAL)/(1.-D)
IF(M.GT. ((1.-D)*E-MU*RAL)/KSI)M=((1.-D)*E-MU*RAL)/
*KSI
RA=RAU
IF(RA.GT. ((1.-D)*E-KSI*M)/MU)
*RA=((1.-D)*E-KSI*M)/MU
EP=D*RA+(1.-D)*E
EA=2.*KSI*(RA+M)-EP
EAM=N(MONNUM)*EA/L(J)
EPM=N(MONNUM)*EP/L(J)
RAM=N(MONNUM)*RA/L(J)
N(2)=28
EAM=FLOAT(IFIX(EAM+.5))
EPM=FLOAT(IFIX(EPM+.5))
RAM=FLOAT(IFIX(RAM+.5))
TEAM(MONNUM) = TEAM(MONNUM) + EAM
TEPM(MONNUM) = TEMPM(MONNUM) + EPM
TRAM(MONNUM) = TRAM(MONNUM) + RAM
IF(MONNUM .EQ. 12) YEAR = YEAR + 1
60 CONTINUE
C*****
EAM1YR=0.0
RAM1YR=0.0
EPM1YR=0.0
DO 70 I=1,12
EAM1YR = EAM1YR + TEAM(I)
EPM1YR = EPM1YR + TEMPM(I)
RAM1YR = RAM1YR + TRAM(I)
70 CONTINUE
PPN=PPN-XIRR*1000.
SINFL=(1.-RUNOFF)*PPN+XIRR*1000.-EAM1YR
PPN=PPN/1000.
SINFL=SINFL/1000.
IF(SINFL .LT. 0)WRITE(6,6000)
6000 FORMAT('0','*** CALCULATED SITE INFILTRATION LESS THAN',
& ' ZERO, INFILTRATION SET TO 1.0E-12 ')
IF(SINFL .LT. 0.)SINFL=1.0E-5
RETURN
END
C
C
DOUBLE PRECISION FUNCTION FCN(T)

```

```

C
C
C
C FCN DETERMINES FUNCTIONAL EVALUATIONS OF
C THE INTEGRAND OF THE GROUNDWATER TRANSPORT MODEL.
C FCN IS CALLED BY QUANC8.
C
C
C
C
C IMPLICIT REAL*8(A-H,O-Z)
C
C COMMON/DOUBLE/V,XL,D,R,AL
C
C DATA PI/3.14159265D0/
C P=V*XL/D
C DN=AL*XL/V
C TH=T*V/XL
C F1=(R/TH-1.D0)
C F2=P*TH/4.0D0/R
C F3=DN*TH
C F4=(R*P/PI/TH**3)**.5
C FCN=.5D0*V/XL*F4*DEXP(-F3-F2*F1*F1)
C RETURN
C END
C
C
C
C SUBROUTINE FOOD(IN)
C
C
C
C C***** CALCULATION OF RADIONUCLIDE CONCENTRATION IN VEGETABLES, MILK AND
C MEAT CONSUMED BY MAN RESULTING FROM ATMOSPHERIC DEPOSITION
C CALLED BY MAIN.
C
C
C
C
C
C
C
C
C INPUT VARIABLES
C
C NN = NUCLIDE NUMBER
C DECAY = RADIOACTIVE DECAY CONSTANT 1/Y
C XAMBWE = WEATHER DECAY CONSTANCE 1/H
C AIRBORNE MATERIAL
C PP = SURFACE DENSITY FOR SOIL KG/M**2
C RA = RETENTION FRACTION
C BV = CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE
C FROM SOIL BY VEGETATIVE PARTS OF CROPS

```

BR	= CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE FROM SOIL BY REPRODUCTIVE PARTS OF CROPS	
DERATE	= RADIONUCLIDE DEPOSITION RATE	PCI/M**2-H
IOPT	= OPTIONS FOR SPECIALS RADIONUCLIDES H-3 AND C-14	
	IOPT = 1 IF H-3 AND C-14 IS NOT INCLUDED IN THIS RUN	
	IOPT = 2 IF ONLY H-3 IS INCLUDED	
	IOPT = 3 IF ONLY C-14 IS INCLUDED	
	IOPT = 4 IF BOTH ARE INCLUDED	
Y1	= AG PRODUCTIVITY FOR GRASS CONSUMED BY ANIMALS	KG/M**2
Y2	= AG PRODUCTIVITY FOR VEGETATION CONSUMED BY MAN	KG/M**2
TE1	= TIME PASTURE GRASS EXPOSED DURING GROWING SEASON	H
TE2	= TIME CROP/VEG EXPOSED DURING GROWING SEASON	H
TH1	= PERIOD DELAY BETWEEN HARVEST OF PASTURE GRASS AND INGESTION BY ANIMALS	H
TH2	= PERIOD DELAY BETWEEN HARVEST OF STORED FEED AND INGESTION BY ANIMAL	H
TH3	= PERIOD DELAY BETWEEN HARVEST OF LEAFY VEG AND INGESTION BY MAN FOR MAXIMUM INDIVIDUAL EXPOSURE	H
TH4	= PERIOD DELAY BETWEEN HARVEST OF PRODUCE AND INGESTION BY MAN FOR MAXIMUM INDIVIDUAL EXPOSURE	H
TH5	= TIME DELAY BETWEEN HARVEST LEAFY VEG AND INGESTION BY MAN FOR GENERAL POPULATION EXPOSURE	H
TH6	= TIME DELAY BETWEEN HARVEST OF PRODUCE AND INGESTION BY MAN FOR GENERAL POPULATION EXP^SURE	H
FP	= FRACTION OF YEAR THAT ANIMAL GRAZE ON PASTURE	
FS	= FRACTION OF DAILY FEED THAT IS FRESH GRASS WHEN ANIMALS GRAZE ON PASTURE	
FMC	= FRACTION OF THE COW'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH LITER OF MILK	D/L
FMG	= FRACTION OF THE GOAT'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH LITER OF MILK	D/L
QFC	= AMOUNT OF FEED CONSUMED BY CATTLE	KG/D
QFG	= AMOUNT OF FEED CONSUMED BY GOATS	KG/D
TF1	= TRANSPORT TIME OF RADIONUCLIDE FROM FEED-MILK-RECEPTOR FOR M.I.E.	H
TF2	= TRANSPORT TIME OF RADIONUCLIDE FROM FEED-MILK-RECEPTOR FOR G.P.E.	H
FF	= FRACTION OF THE ANIMAL'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH KG OF FLESH	D/KG
TS	= TIME FROM SLAUGHTER OF MEAT TO CONSUMPTION	H
ABSH	= ABSOLUTE HUMIDITY OF THE ATMOSPHERE	G/M**3
PI4	= FRACTIONAL EQUILIBRIUM RATIO FOR C-14	
INTERMEDIATE VARIABLES		
XAMBEF	= EFFECTIVE DECAY CONSTANT	
CPAST	= NUCLIDE CONC IN PASTURE GRASS CONSUMED BY ANIMALS	
CSTO	= NUCLIDE CONC IN STOKED FEED CONSUMED BY ANIMALS	
CFEED	= RADIONUCLIDE CONCENTRATION IN ANIMALS'S FEED	
OUTPUT VARIABLES		

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C      CL1  = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN
C          FOR M.I.E.                                PCI/KG
C      CL2  = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN
C          FOR G.P.E.                                PCI/KG
C      CP1  = RADIONUCLIDE CONC IN PRODUCE CONSUMED BY MAN
C          FOR M.I.E.                                PCI/KG
C      CP2  = RADIONUCLIDE CONC IN PRODUCE CONSUMED BY MAN
C          FOR G.P.E.                                PCI/KG
C      CCM11 = RADIONUCLIDE CONC IN COW'S MILK FOR M.I.E.    PCI/L
C      CCM12 = RADIONUCLIDE CONC IN COW'S MILK FOR G.P.E.    PCI/L
C      CGM11 = RADIONUCLIDE CONC IN GOAT'S MILK FOR M.I.E.    PCI/L
C      CGM12 = RADIONUCLIDE CONC IN GOAT'S MILK FOR G.P.E.    PCI/L
C      CMEAT = RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT        PCI/KG
C
C
C      DOUBLE PRECISION NUCLID,H3,C14
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),PMC(40),PMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM11(40),CCM12(40),CGM11(40),CGM12(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM11(40),COCM12(40),COGM11(40),COGM12(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
C      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14
C
C      DATA H3/8HH-3      /,C14/8HC-14      /
C      DECA=DECAY(NN)/8760.
C      IF(NUCLID(NN) .EQ. H3) GO TO 200
C      IF(NUCLID(NN) .EQ. C14) GO TO 300
C      CALCULATION OF CPAST= RADIONUCLIDE CONCENTRATION IN PASTURE GRASS
C                          CONSUMED BY ANIMALS
C
100 B=BV(NN)
C      CPAST=CV(NN,Y1,TE1,TH1,B)
C      CALCULATION OF CSTO = RADIONUCLIDE CONCENTRATION IN STORED FEED
C                          CONSUMED BY ANIMALS
C      CSTO=CV(NN,Y1,TE1,TH2,B)
C      CALCULATION OF CFEE = RADIONUCLIDE CONC IN ANIMAL'S FEED
C      CFEE=FP*FS*CPAST+(1.0-FP*FS)*CSTO
C

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C*** CALCULATION OF CLX = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED
C      BY MAN
C*** 1. FOR MAXIMUM INDIVIDUAL EXPOSURE
      CL1(NN)=CV(NN,Y2,TE2,TH3,B)
C
C*** 2. FOR GENERAL POPULATION
      CL2(NN)=CV(NN,Y2,TE2,TH5,B)
C
C*** CALCULATION OF CPX = RADIONUCLIDE CONC IN PRODUCE
C      CONSUMED BY MAN
C*** 1. FOR MAXIMUM INDIVIDUAL EXPOSURE
      B=BR(NN)
      CP1(NN)=CV(NN,Y2,TE2,TH4,B)
C
C*** 2. FOR GENERAL POPULATION
      CP2(NN)=CV(NN,Y2,TE2,TH6,B)
C
C*** CALCULATION OF CCMIX = RADIONUCLIDE CONCENTRATION IN COW'S MILK
C*** 1 FOR MAXIMUM INDIVIDUAL EXPOSURE
      CCM11(NN)=FMC(NN)*CFEED*QFC*EXP(-DECA*TF1)
C
C*** 2 FOR GENERAL POPULATION
      CCM12(NN)=FMC(NN)*CFEED*QFC*EXP(-DECA*TF2)
C
C*** CALCULATION OF CGMIX = RADIONUCLIDE CONCENTRATION IN GOAT'S MILK
C 1 FOR MAXIMUM INDIVIDUAL EXPOSURE
      CGM11(NN)=FMG(NN)*CFEED*QFG*EXP(-DECA*TF1)
C
C*** 2 FOR GENERAL POPULATION
      CGM12(NN)=FMG(NN)*CFEED*QFG*EXP(-DECA*TF2)
C
C*** CALCULATION OF CMEAT = RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT
      CMEAT(NN)=FF(NN)*CFEED*QFC*EXP(-DECA*TS)
      RETURN
C
C*** CALCULATION FOR SPECIAL RADIONUCLIDE: TRITIUM
C
C*** CALCULATION OF CV3 = TRITIUM CONCENTRATION IN ALL VEGETATION
200 CV3=3.75E14*ATAVG(NN)/ABSH
C*** CALCULATION OF CONCENTRATION OF TRITIUM IN VEGETATION, MILK
C      AND MEAT CONSUMED BY MAN
      CL1(NN)=CV3
      CL2(NN)=CV3
      CP1(NN)=CV3
      CP2(NN)=CV3
      CCM11(NN)=FMC(NN)*CV3*QFC
      CCM12(NN)=CCM11(NN)
      CGM11(NN)=FMG(NN)*CV3*QFG
      CGM12(NN)=CGM11(NN)
      CMEAT(NN)=FF(NN)*CV3*QFC
      RETURN

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C
C***  CALCULATION FOR SPECIAL RADIONUCLIDE: CARBON-14
C
C***  CALCULATION OF CV14 = C-14 CONCENTRATION IN ALL VEGETATION
300 CV14=6.875E14*ATAVG(NN)*P14
C***  CALCULATION OF C-14 CONCENTRATION IN VEGETATION, MILK AND MEAT
C      CONSUMED BY MAN
      CL1(NN)=CV14
      CL2(NN)=CV14
      CP1(NN)=CV14
      CP2(NN)=CV14
      CCM11(NN)=FMC(NN)*CV14*QFC
      CCM12(NN)=CCM11(NN)
      CGM11(NN)=FMG(NN)*CV14*QFG
      CGM12(NN)=CGM11(NN)
      CMLAT(NN)=FF(NN)*CV14*QFC
      RETURN
      END
C
C
C
      SUBROUTINE FOODA(NN)
C
C
C
C*****  CALCULATION OF RADIONUCLIDE CONCENTRATION IN VEGETABLES, MILK AND
C      MEAT CONSUMED BY MAN RESULTING FROM ATMOSPHERIC DEPOSITION
C      CALLED BY MAIN.
C
C
C
C
C
C
C
C
C
C      INPUT VARIABLES
C
C      NN      = NUCLIDE NUMBER
C      DECAY   = RADIOACTIVE DECAY CONSTANT                      1/Y
C      XAMBWE  = WEATHER DECAY CONSTANCE                          1/H
C               AIRBORNE MATERIAL
C      PP      = SURFACE DENSITY FOR SOIL                        KG/M**2
C      RA      = RETENTION FRACTION
C      BV      = CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE
C               FROM SOIL BY VEGETATIVE PARTS OF CROPS
C      BR      = CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE
C               FROM SOIL BY REPRODUCTIVE PARTS OF CROPS
C      DERATE  = RADIONUCLIDE DEPOSITION RATE                    PCI/M**2-H
C      IOPT    = OPTIONS FOR SPECIALS RADIONUCLIDES H-3 AND C-14
C               IOPT = 1 IF H-3 AND C-14 IS NOT INCLUDED IN THIS RUN
C               IOPT = 2 IF ONLY H-3 IS INCLUDED
C               IOPT = 3 IF ONLY C-14 IS INCLUDED
C               IOPT = 4 IF BOTH ARE INCLUDED

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C	Y1	= AG PRODUCTIVITY FOR GRASS CONSUMED BY ANIMALS	KG/M**2
C	Y2	= AG PRODUCTIVITY FOR VEGETATION CONSUMED BY MAN	KG/M**2
C	TE1	= TIME PASTURE GRASS EXPOSED DURING GROWING SEASON	H
C	TE2	= TIME CROP/VEG EXPOSED DURING GROWING SEASON	H
C	TH1	= PERIOD DELAY BETWEEN HARVEST OF PASTURE GRASS AND INGESTION BY ANIMALS	H
C	TH2	= PERIOD DELAY BETWEEN HARVEST OF STORED FEED AND INGESTION BY ANIMAL	H
C	TH3	= PERIOD DELAY BETWEEN HARVEST OF LEAFY VEG AND INGESTION BY MAN FOR MAXIMUM INDIVIDUAL EXPOSURE	H
C	TH4	= PERIOD DELAY BETWEEN HARVEST OF PRODUCE AND INGESTION BY MAN FOR MAXIMUM INDIVIDUAL EXPOSURE	H
C	TH5	= TIME DELAY BETWEEN HARVEST LEAFY VEG AND INGESTION BY MAN FOR GENERAL POPULATION EXPOSURE	H
C	TH6	= TIME DELAY BETWEEN HARVEST OF PRODUCE AND INGESTION BY MAN FOR GENERAL POPULATION EXPOSURE	H
C	FP	= FRACTION OF YEAR THAT ANIMAL GRAZE ON PASTURE	
C	FS	= FRACTION OF DAILY FEED THAT IS FRESH GRASS WHEN ANIMALS GRAZE ON PASTURE	
C	FMC	= FRACTION OF THE COW'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH LITER OF MILK	D/L
C	FMG	= FRACTION OF THE GOAT'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH LITER OF MILK	D/L
C	QFC	= AMOUNT OF FEED CONSUMED BY CATTLE	KG/D
C	QFG	= AMOUNT OF FEED CONSUMED BY GOATS	KG/D
C	TF1	= TRANSPORT TIME OF RADIONUCLIDE FROM FEED-MILK-RECEPTOR FOR M.I.E.	H
C	TF2	= TRANSPORT TIME OF RADIONUCLIDE FROM FEED-MILK-RECEPTOR FOR G.P.E.	H
C	FF	= FRACTION OF THE ANIMAL'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH KG OF FLESH	D/KG
C	TS	= TIME FROM SLAUGHTER OF MEAT TO CONSUMPTION	H
C	ABSH	= ABSOLUTE HUMIDITY OF THE ATMOSPHERE	G/M**3
C	P14	= FRACTIONAL EQUILIBRIUM RATIO FOR C-14	
C	INTERMEDIATE VARIABLES		
C	XAMBEF	= EFFECTIVE DECAY CONSTANT	
C	CPAST	= NUCLIDE CONC IN PASTURE GRASS CONSUMED BY ANIMALS	
C	CSTO	= NUCLIDE CONC IN STORED FEED CONSUMED BY ANIMALS	
C	CFEED	= RADIONUCLIDE CONCENTRATION IN ANIMALS'S FEED	
C			
C	OUTPUT VARIABLES		
C	CL1	= RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN FOR M.I.E.	PCI/KG
C	CL2	= RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN FOR G.P.E.	PCI/KG
C	CP1	= RADIONUCLIDE CONC IN PRODUCE CONSUMED BY MAN FOR M.I.E.	PCI/KG
C	CP2	= RADIONUCLIDE CONC IN PRODUCE CONSUMED BY MAN FOR G.P.E.	PCI/KG

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C      CCM11 = RADIONUCLIDE CONC IN COW'S MILK FOR M.I.E.      PCI/L
C      CCM12 = RADIONUCLIDE CONC IN COW'S MILK FOR G.P.E.      PCI/L
C      CGM11 = RADIONUCLIDE CONC IN GOAT'S MILK FOR M.I.E.      PCI/L
C      CGM12 = RADIONUCLIDE CONC IN GOAT'S MILK FOR G.P.E.      PCI/L
C      CMEAT = RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT          PCI/KG
C
C
C      DOUBLE PRECISION NUCLID,H3,C14
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),PMC(40),PMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM11(40),CCM12(40),CGM11(40),CGM12(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM11(40),COCM12(40),COGM11(40),COGM12(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
C      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14
C
C      DATA H3/8HH-3      /,C14/8HC-14      /
C      IFLAG=0
C      DECA=DECAY(NN)/8760.
C      IF(NUCLID(NN) .EQ. H3) GO TO 200
C      IF(NUCLID(NN) .EQ. C14) GO TO 300
C      CALCULATION OF CPAST= RADIONUCLIDE CONCENTRATION IN PASTURE GRASS
C      CONSUMED BY ANIMALS
C      100 B=BV(NN)
C      CPAST=CVA(NN,Y1,TE1,TH1,B,IFLAG)
C      CALCULATION OF CSTO = RADIONUCLIDE CONCENTRATION IN STORED FEED
C      CONSUMED BY ANIMALS
C      IFLAG=1
C      CSTO=CVA(NN,Y1,TE1,TH2,B,IFLAG)
C      CALCULATION OF CFEEED = RADIONUCLIDE CONCENTRATION IN ANIMAL'S FEE
C      CFEEED=FP*FS*CPAST+(1.0-FP*FS)*CSTO
C
C      C*** CALCULATION OF CLX = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED
C      BY MAN
C      C*** 1. FOR MAXIMUM INDIVIDUAL EXPOSURE
C      IFLAG=1
C      CL1(NN)=CVA(NN,Y2,TE2,TH3,B,IFLAG)
C
C      C*** 2. FOR GENERAL POPULATION

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      IFLAG=1
      CL2(NN)=CVA(NN,Y2,TE2,TH5,B,IFLAG)
C
C*** CALCULATION OF CPX = RADIONUCLIDE CONC IN PRODUCE
C      CONSUMED BY MAN
C*** 1. FOR MAXIMUM INDIVIDUAL EXPOSURE
      B=BR(NN)
      IFLAG=1
      CP1(NN)=CVA(NN,Y2,TE2,TH4,B,IFLAG)
C
C*** 2. FOR GENERAL POPULATION
      IFLAG=1
      CP2(NN)=CVA(NN,Y2,TE2,TH6,B,IFLAG)
C
C*** CALCULATION OF CCMIX = RADIONUCLIDE CONCENTRATION IN COW'S MILK
C*** 1 FOR MAXIMUM INDIVIDUAL EXPOSURE
      CCM11(NN)=FMC(NN)*CFEED*QFC*EXP(-DECA*TF1)
C
C*** 2 FOR GENERAL POPULATION
      CCM12(NN)=FMC(NN)*CFEED*QFC*EXP(-DECA*TF2)
C
C*** CALCULATION OF CGMIX = RADIONUCLIDE CONCENTRATION IN GOAT'S MILK
C*** 1 FOR MAXIMUM INDIVIDUAL EXPOSURE
      CGM11(NN)=FMG(NN)*CFEED*QFC*EXP(-DECA*TF1)
C
C*** 2 FOR GENERAL POPULATION
      CGM12(NN)=FMG(NN)*CFEED*QFC*EXP(-DECA*TF2)
C
C*** CALCULATION OF CMEAT = RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT
      CMEAT(NN)=FF(NN)*CFEED*QFC*EXP(-DECA*TS)
      RETURN
C
C*** CALCULATION FOR SPECIAL RADIONUCLIDE: TRITIUM
C
C*** CALCULATION OF CV3 = TRITIUM CONCENTRATION IN ALL VEGETATION
200 CV3=3.75E14*ATCON(NN)/ABSH
C*** CALCULATION OF CONCENTRATION OF TRITIUM IN VEGETATION, MILK
C      AND MEAT CONSUMED BY MAN
      CL1(NN)=CV3
      CL2(NN)=CV3
      CP1(NN)=CV3
      CP2(NN)=CV3
      CCM11(NN)=FMC(NN)*CV3*QFC
      CCM12(NN)=CCM11(NN)
      CGM11(NN)=FMG(NN)*CV3*QFC
      CGM12(NN)=CGM11(NN)
      CMEAT(NN)=FF(NN)*CV3*QFC
      RETURN
C
C*** CALCULATION FOR SPECIAL RADIONUCLIDE: CARBON-14
C
C*** CALCULATION OF CV14 = C-14 CONCENTRATION IN ALL VEGETATION

```

**C
C
C**

**C
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**C
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C**

**C
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C

C

COMMON/IRRF00/Y1.Y2.TE1.TE2.TH1.TH2.TH3.TH4.TH5.TH6.FP.FS.

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&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM11(40),CCM12(40),CGM11(40),CGM12(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM11(40),COCM12(40),COGM11(40),COGM12(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
COMMON/PASS/PNUC(40),PCON1(40),PCON2(40),PCON3(40),
&      PCON4(40),PPOP,LLIND,LDIST
C
C
C**** CALCULATION OF RADIONUCLIDE INTAKE BY CONSUMPTION OF VEGETATION,
C      MILK, MEAT AND DRINKING WATER
C
      CWATH=(WWATH*AQAVG(NN)+SWATH*STAVG(NN))*1.0E9
      IF(LLIND.EQ. 0) GO TO 100
      QVEG=(CL2(NN)+COL2(NN))*ULEAFY+(CP2(NN)+COP2(NN))*UPROD
      QMILK=(CCM12(NN)+COCM12(NN))*UCMILK+(CGM12(NN)+COGM12(NN))*UGMILK
      GO TO 200
100  QVEG=(CL1(NN)+COL1(NN))*ULEAFY+(CP1(NN)+COP1(NN))*UPROD
      QMILK=(CCM11(NN)+COCM11(NN))*UCMILK+(CGM11(NN)+COGM11(NN))*UGMILK
200  QMEAT=(CMEAT(NN)+COMEAT(NN))*UMEAT
      QWAT=CWATH*UWAT
      QING(NN)=QVEG+QMILK+QMEAT+QWAT
C
C**** CALCULATION OF RADIONUCLIDE INTAKE BY INHALATION
C
      COAIR=ATAVG(NN)*1.0E12
      QINH(NN)=COAIR*UAIR
      RETURN
      END
C
C
C
      SUBROUTINE HUMEXA(NN)
C
C
C      CALCULATION OF ANNUAL RADIONUCLIDE INTAKE BY MAN.  CALLED BY MAIN
C
C
C
C
C

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C
C      INPUT VARIABLES
C      NN      = RADIONUCLIDE NUMBER
C      ULEAFY = ANNUAL INTAKE OF LEAFY VEGETABLES (KG/Y)
C      UPROD  = ANNUAL INTAKE OF PRODUCE (KG/Y)
C      UCMILK = ANNUAL INTAKE OF COW'S MILK(L/Y)
C      UGMILK = ANNUAL INTAKE OF GOAT'S MILK(L/Y)
C      UMEAT  = ANNUAL INTAKE OF BEEF CATTLE'S MEAT(KG/Y)
C      UWAT   = ANNUAL INTAKE OF DRINKING WATER(L/Y)
C      UAIR   = ANNUAL INHALATION RATE OF AIR(M3/Y)
C
C      OUTPUT VARIABLES
C      QING    = ANNUAL INTAKE OF RADIONUCLIDE BY INGESTION OF CONTAMINATED
C                FOOD CONSIDERING ATMOSPHERIC AND AQUATIC PATHWAYS(PCI/Y)
C      QINH    = ANNUAL INTAKE OF RADIONUCLIDE BY INHALATION(PCI/Y)
C
C      DOUBLE PRECISION NUCLID,PNUC
C
C      COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR
C
C      COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM11(40),CCM12(40),CGM11(40),CGM12(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM11(40),COCM12(40),COGM11(40),COGM12(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMC(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      COMMON/PASS/PNUC(40),PCON1(40),PCON2(40),PCON3(40),
&      PCON4(40),PPOP,LLIND,LDIST
C
C
C      C**** CALCULATION OF RADIONUCLIDE INTAKE BY CONSUMPTION OF VEGETATION,
C                MILK, MEAT AND DRINKING WATER
C
C      CWATH=(WWATH*AQCON(NN)+SWATH*STCON(NN))*1.0E9
C      IF(LLIND .EQ. 0) GO TO 100
C      QVEG=(CL2(NN)+COL2(NN))*ULEAFY+(CP2(NN)+COP2(NN))*UPROD
C      QMILK=(CCM12(NN)+COCM12(NN))*UCMILK+(CGM12(NN)+COGM12(NN))*UGMILK

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      GO TO 200
100  QVEG=(CL1(NN)+COL1(NN))*ULEAFY+(CP1(NN)+COP1(NN))*UPROD
      QMILK=(CCM11(NN)+COCM11(NN))*UCMILK+(CGM11(NN)+COGM11(NN))*UGMILK
200  QMEAT=(CMEAT(NN)+COMEAT(NN))*UMEAT
      QWAT=CWATH*UWAT
      QINC(NN)=QVEG+QMILK+QMEAT+QWAT
C
C**** CALCULATION OF RADIONUCLIDE INTAKE BY INHALATION
C
      COAIR=ATCON(NN)*1.0E12
      QINH(NN)=COAIR*UAIR
      RETURN
      END
C
C
C
      SUBROUTINE IRRIG(NN)
C
C
C
C***** CALCULATION OF RADIONUCLIDE CONCENTRATION IN VEGETABLE, MILK
C      AND MEAT CONSUMED BY MAN RESULTING FROM WATER IRRIGATION.
C      CALLED BY MAIN.
C
C
C
C
C
C      INPUT VARIABLES
C
C      NN      = NUCLEIDE NUMBER
C      DECAY   = RADIOACTIVE DECAY CONSTATNE                      1/Y
C      XAMBWE  = WEATHER DECAY CONSTATNE                          1/H
C      PP      = SURFACE DENSITY FOR SOIL                        KG/M**2
C      RW      = RETENTION FRACTION
C      BV      = CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE
C                FROM SOIL BY VEGETATIVE PARTS OF CROPS
C      BR      = CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE
C                FROM SOIL BY REPRODUCTIVE PARTS OF CROPS
C      FI      =FRACTION OF THE YEAR CROPS ARE IRRIGATED
C      WIRATE= IRRIGATION RATE                                    L/M**2-H
C      CWAT    = RADIONUCLIDE CONCENTRATION IN WATER              PCI/L
C      IOPT    = OPTIONS FOR SPECIAL RADIONUCLIDE H-3
C                IOPT = 1 IF H-3 IS NOT INCLUDED IN THIS RUN
C                IOPT = 2 IF H-3 IS INCLUDED
C      Y1      = AG PRODUCTIVITY FOR GRASS CONSUMED BY ANIMALS    KG/M**2
C      Y2      = AG PRODUCTIVITY FOR VEGETATION CONSUMED BY MAN   KG/M**2
C      TE1     = TIME PASTURE GRASS EXPOSED DURING GROWING SEASON  H
C      TE2     = TIME CROP/VEG EXPOSED DURING GROWING SEASON     H
C      TH1     = PERIOD DELAY BETWEEN HARVEST OF PASTURE GRASS
C                AND INGESTION BY ANIMALS                        H

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C TH2 = PERIOD DELAY BETWEEN HARVEST OF STORED FEED
 C AND INGESTION BY ANIMAL H
 C TH3 = PERIOD DELAY BETWEEN HARVEST OF LEAFY VEGETABLE
 C AND INGESTION BY MAN FOR M.I.E. H
 C TH4 = PERIOD DELAY BETWEEN HARVEST OF PRODUCE AND
 C INGESTION BY MAN FOR M.I.E. H
 C TH5 = PERIOD DELAY BETWEEN HARVEST OF LEAFY VEG
 C AND INGESTION BY MAN FOR G.P.E. H
 C TH6 = PERIOD DELAY BETWEEN HARVEST OF PRODUCE
 C TH5 = PERIOD DELAY BETWEEN HARVEST OF LEAFY VEG
 C FP = FRACTION OF YEAR THAT ANIMAL GRAZE ON PASTURE
 C FS = FRACTION OF DAILY FEED THAT IS FRESH GRASS WHEN
 C ANIMALS GRAZE ON PASTURE
 C FMC = FRACTION OF THE COW'S DAILY INTAKE OF
 C RADIONUCLIDE WHICH APPEARS IN EACH L OF MILK D/L
 C FMG = FRACTION OF THE GOAT'S DAILY INTAKE OF
 C RADIONUCLIDE WHICH APPEARS IN EACH L OF MILK D/L
 C QFC = AMOUNT OF FEED CONSUMED BY CATTLE KG/D
 C QFG = AMOUNT OF FEED CONSUMED BY GOATS KG/D
 C TF1 = TRANSPORT TIME OF RADIONUCLIDE FROM
 C FEED-MILK-RECEPTOR FOR M.I.E. H
 C TF2 = TRANSPORT TIME OF RADIONUCLIDE FROM
 C FEED-MILK-RECEPTOR FOR G.P.E. H
 C FF = FRACTION OF THE ANIMAL'S DAILY INTAKE OF
 C RADIONUCLIDE WHICH APPEARS IN EACH KG OF FLESH D/KG
 C TS = TIME FROM SLAUGHTER OF MEAT TO CONSUPTION H
 C QCW = AMOUNT OF WATER CONSUMED BY COW L/D
 C QGW = AMOUNT OF WATER CONSUMED BY GOAT L/D
 C QBW = AMOUNT OF WATER CONSUMED BY BEEF CATTLE L/D
 C
 C INTERMEDIATE VARIABLES
 C
 C XAMBEF= EFFECTIVE DECAY CONSTANT
 C COPAST= RADIONUCLIDE CONC IN PASTURE GRASS CONSUMED BY ANIMALS
 C COPAST= RADIONUCLIDE CONC IN STORED FEED CONSUMED BY ANIMALS
 C COFEED= RADIONUCLIDE CONC IN ANIMALS'S FEED
 C
 C OUTPUT VARIABLES
 C
 C COL1 = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN
 C FOR M.I.E. PCI/KG
 C COL2 = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN
 C FOR G.P.E. PCI/KG
 C COP1 = RADIONUCLIDE CONC IN PROCUCE CONSUMED BY MAN
 C FOR M.I.E. PCI/KG
 C COP2 = RADIONUCLIDE CONC IN PRODUCE CONSUMED BY MAN
 C FOR G.P.E. PCI/KG
 C COCM11= RADIONUCLIDE CONC IN COW'S MILK FOR M.I.E. PCI/L
 C COCM12= RADIONUCLIDE CONC IN COW'S MILK FOR G.P.E. PCI/L
 C COGM11= RADIONUCLIDE CONC IN GOAT'S MILK FOR M.I.E. PCI/L
 C COGM12= RADIONUCLIDE CONC IN GOAT'S MILK FOR G.P.E. PCI/L
 C COMEAT= RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT PCI/KG
 C
 C DOUBLE PRECISION NUCLID,H3,C14

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C      COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR

C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLE(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)

C      COMMON/IRRF00/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM1(40),CCM2(40),CGM1(40),CGM2(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM1(40),COCM2(40),COGM1(40),COGM2(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSP0(40),CSPOT(40)

C      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14

C      DATA R3/8HH-3 /
DECA=DECAY(NN)/8760.
CWATA=(WWATA*AQAVG(NN)+SWATA*STAVG(NN))*1.0E9
CWATL=(WWATL*AQAVG(NN)+SWATL*STAVG(NN))*1.0E9

C      IF(NUCLID(NN).EQ.H3)GO TO 200
C      CALCULATION OF COPAST=RADIONUCLIDE CONCENTRATION IN PASTURE GRASS
C      CONSUMED BY ANIMALS
B=BV(NN)
COPAST=COV(NN,Y1,TE1,TH1,B)
C      CALCULATION OF COSTO = RADIONUCLIDE CONC IN STORED FEED CONSUMED
C      BY ANIMALS
COSTO=COV(NN,Y1,TE1,TH2,B)
C      CALCULATION OF COFEED = RADIONUCLIDE CONC IN ANIMAL'S FEED
COFEED=FP*FS*COPAST+(1.0-FP*FS)*COSTO
C
C***  CALCULATION OF COPLX = RADIONUCLIDE CONCENTRATION IN LEAFY
C      VEGETABLE CONSUMED BY MAN
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
COL1(NN)=COV(NN,Y2,TE2,TH3,B)
C
C***  2. FOR GENERAL POPULATION EXPOSURE
COL2(NN)=COV(NN,Y2,TE2,TH5,B)
C
C***  CALCULATION OF COPX = RADIONUCLIDE CONC IN PRODUCE CONSUMED
C      BY MAN
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE

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      B=BR(NN)
      COP1(NN)=COV(NN,Y2,TE2,TH4,B)
C
C
C*** 2. FOR GENERAL POPULATION
      COP2(NN)=COV(NN,Y2,TE2,TH6,B)
C***  CALCULATION OF COCMIX = RADIONUCLIDE CONCENTRATION IN COW'S MILK
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
      COCM1(NN)=FMC(NN)*(COFEED*QFC+CWATA*QCW)*EXP(-DECA*TF1)
C
C***  2. FOR GENERAL POPULATION
      COCM2(NN)=FMC(NN)*(COFEED*QFC+CWATA*QCW)*EXP(-DECA*TF2)
C
C***  CALCULATION OF COGMIX = RADIONUCLIDE CONCENTRATION IN GOAT'S MILK
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
      COGM1(NN)=FMC(NN)*(COFEED*QFG+CWATA*QGW)*EXP(-DECA*TF1)
C
C***  2. FOR GENERAL POPULATION
      COGM2(NN)=FMC(NN)*(COFEED*QFG+CWATA*QGW)*EXP(-DECA*TF2)
C
C***  CALCULATION OF COMEAT = RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT
      COMEAT(NN)=FF(NN)*(COFEED*QFC+CWATA*QBW)*EXP(-DECA*TS)
      RETURN
C
C***  CALCULATION FOR SPECIAL RADIONUCLIDE: TRITIUM
C      TRITIUM CONC IN VEGETATION = TRITIUM CONCENTRATION IN ANIMAL'S
C      FEED = TRITIUM CONCENTRATION IN WATER = CWATL
C***  CALCULATION OF H-3 CONCENTRATION IN VEGETATION, MILK AND MEAT CON
C      BY MAN
      200 COL1(NN)=CWATL
      COL2(NN)=CWATL
      COP1(NN)=CWATL
      COP2(NN)=CWATL
      COCM1(NN)=FMC(NN)*(CWATL*QFC+CWATA*QCW)
      COCM2(NN)=COCM1(NN)
      COGM1(NN)=FMC(NN)*(CWATL*QFG+CWATA*QGW)
      COGM2(NN)=COGM1(NN)
      COMEAT(NN)=FF(NN)*(CWATL*QFC+CWATA*QCW)
      RETURN
      END
C
C
C
C      SUBROUTINE IRRIGA(NN)
C
C
C
C*****  CALCULATION OF RADIONUCLIDE CONC IN VEGETABLE, MILK AND MEAT
C          CONSUMED BY MAN RESULTING FROM WATER IRRIGATION.
C          CALLED BY MAIN.
C
C
C

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INPUT VARIABLES

NN	= NUCLIDE NUMBER	
DECAY	= RADIOACTIVE DECAY CONSTANCE	1/Y
XAMBWE	= WEATHER DECAY CONSTANCE	1/H
PP	= SURFACE DENSITY FOR SOIL	KG/M**2
RF	= RETENTION FRACTION	
BV	= CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE FROM SOIL BY VEGETATIVE PARTS OF CROPS	
BR	= CONCENTRATION FRACTION FOR UPTAKE OF RADIONUCLIDE FROM SOIL BY REPRODUCTIVE PARTS OF CROPS	
FI	= FRACTION OF THE YEAR CROPS ARE IRRIGATED	
WIRATE	= IRRIGATION RATE	L/M**2-H
CWAT	= RADIONUCLIDE CONCENTRATION IN WATER	PCI/L
IOPT	= OPTIONS FOR SPECIAL RADIONUCLIDE H-3	
	IOPT = 1 IF H-3 IS NOT INCLUDED IN THIS RUN	
	IOPT = 2 IF H-3 IS INCLUDED	
Y1	= AG PRODUCTIVITY FOR GRASS CONSUMED BY ANIMALS	KG/M**2
Y2	= AG PRODUCTIVITY FOR VEGETATION CONSUMED BY MAN	KG/M**2
TE1	= TIME PASTURE GRASS EXPOSED DURING GROWING SEASON	H
TE2	= TIME CROP/VEG EXPOSED DURING GROWING SEASON	H
TH1	= PERIOD DELAY BETWEEN HARVEST OF PASTURE GRASS AND INGESTION BY ANIMALS	H
TH2	= PERIOD DELAY BETWEEN HARVEST OF STORED FEED AND INGESTION BY ANIMAL	H
TH3	= PERIOD DELAY BETWEEN HARVEST OF LEAFY VEGETABLE AND INGESTION BY MAN FOR M.I.E.	H
TH4	= PERIOD DELAY BETWEEN HARVEST OF PRODUCE AND INGESTION BY MAN FOR M.I.E.	H
TH5	= PERIOD DELAY BETWEEN HARVEST OF LEAFY VEG AND INGESTION BY MAN FOR G.P.E.	H
TH6	= PERIOD DELAY BETWEEN HARVEST OF PRODUCE	
TH5	= PERIOD DELAY BETWEEN HARVEST OF LEAFY VEG	
FP	= FRACTION OF YEAR THAT ANIMAL GRAZE ON PASTURE	
FS	= FRACTION OF DAILY FEED THAT IS FRESH GRASS WHEN ANIMALS GRAZE ON PASTURE	
FMC	= FRACTION OF THE COW'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH L OF MILK	D/L
FMG	= FRACTION OF THE GOAT'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH L OF MILK	D/L
QFC	= AMOUNT OF FEED CONSUMED BY CATTLE	KG/D
QFG	= AMOUNT OF FEED CONSUMED BY GOATS	KG/D
TF1	= TRANSPORT TIME OF RADIONUCLIDE FROM FEED-MILK-RECEPTOR FOR M.I.E.	H
TF2	= TRANSPORT TIME OF RADIONUCLIDE FROM FEED-MILK-RECEPTOR FOR G.P.E.	H
FF	= FRACTION OF THE ANIMAL'S DAILY INTAKE OF RADIONUCLIDE WHICH APPEARS IN EACH KG OF FLESH	D/KG

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C      TS      = TIME FROM SLAUGHTER OF MEAT TO CONSUMPTION      H
C      QCW      = AMOUNT OF WATER CONSUMED BY COW                L/D
C      QGW      = AMOUNT OF WATER CONSUMED BY GOAT              L/D
C      QBW      = AMOUNT OF WATER CONSUMED BY BEEF CATTLE       L/D
C
C      INTERMEDIATE VARIABLES
C
C      XAMBEF= EFFECTIVE DECAY CONSTANT
C      COPAST= RADIONUCLIDE CONC IN PASTURE GRASS CONSUMED BY ANIMALS
C      COPAST= RADIONUCLIDE CONC IN STORED FEED CONSUMED BY ANIMALS
C      COFEED= RADIONUCLIDE CONC IN ANIMALS'S FEED
C
C      OUTPUT VARIABLES
C
C      COL1      = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN
C                  FOR M.I.E.                                     PCI/KG
C      COL2      = RADIONUCLIDE CONC IN LEAFY VEG CONSUMED BY MAN
C                  FOR G.P.E.                                     PCI/KG
C      COP1      = RADIONUCLIDE CONC IN PROCUCE CONSUMED BY MAN
C                  FOR M.I.E.                                     PCI/KG
C      COP2      = RADIONUCLIDE CONC IN PRODUCE CONSUMED BY MAN
C                  FOR G.P.E.                                     PCI/KG
C      COCM1= RADIONUCLIDE CONC IN COW'S MILK FOR M.I.E.         PCI/L
C      COCM2= RADIONUCLIDE CONC IN COW'S MILK FOR G.P.E.         PCI/L
C      COGM1= RADIONUCLIDE CONC IN GOAT'S MILK FOR M.I.E.        PCI/L
C      COGM2= RADIONUCLIDE CONC IN GOAT'S MILK FOR G.P.E.        PCI/L
C      COMEAT= RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT          PCI/KG
C
C
C      DOUBLE PRECISION NUCLID,H3,C14
C
C      COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
&      PF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      COMMON/IRRFOO/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
&      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
&      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
&      CCM1(40),CCM2(40),CGM1(40),CGM2(40),
&      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
&      COCM1(40),COCM2(40),COGM1(40),COGM2(40),
&      COMEAT(40),QING(40),QINH(40),POP,
&      CSP(40),CSPT(40),CSPO(40),CSPOT(40)

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C      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
&      QCW,QGW,QBW,ABSH,P14
C
C      DATA H3/8HH-3      /
C      IFLAG=0
C      DECA=DECAY(NN)/8760.
C      CWATA=(WWATA*AQCON(NN)+SWATA*STCON(NN))*1.0E9
C      CWATL=(WWATL*AQCON(NN)+SWATL*STCON(NN))*1.0E9
C
C      IF(NUCLID(NN) .EQ. H3)GO TO 200
C      CALCULATION OF COPAST=RADIONUCLIDE CONC IN PASTURE GRASS
C      CONSUMED BY ANIMALS
C      B=BV(NN)
C      COPAST=COVA(NN,Y1,TE1,TH1,B,IFLAG)
C      CALCULATION OF COSTO = RADIONUCLIDE CONC IN STORED FEED CONSUMED
C      BY ANIMALS
C      IFLAG=1
C      COSTO=COVA(NN,Y1,TE1,TH2,B,IFLAG)
C      CALCULATION OF COFEED = RADIONUCLIDE CONC IN ANIMAL'S FEED
C      COFEED=FP*FS*COPAST+(1.0-FP*FS)*COSTO
C
C***  CALCULATION OF COPLX = RADIONUCLIDE CONCENTRATION IN LEAFY
C      VEGETABLE CONSUMED BY MAN
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
C      IFLAG=1
C      COL1(NN)=COVA(NN,Y2,TE2,TH3,B,IFLAG)
C
C***  2. FOR GENERAL POPULATION EXPOSURE
C      IFLAG=1
C      COL2(NN)=COVA(NN,Y2,TE2,TH5,B,IFLAG)
C
C***  CALCULATION OF COPX = RADIONUCLIDE CONC IN PRODUCE CONSUMED
C      BY MAN
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
C      B=BR(NN)
C      IFLAG=1
C      COPI(NN)=COVA(NN,Y2,TE2,TH4,B,IFLAG)
C
C
C***  2. FOR GENERAL POPULATION
C      IFLAG=1
C      COP2(NN)=COVA(NN,Y2,TE2,TH6,B,IFLAG)
C***  CALCULATION OF COCMIX = RADIONUCLIDE CONCENTRATION IN COW'S MILK
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
C      COCM1(NN)=FMC(NN)*(COFEED*QFC+CWATA*QCW)*EXP(-DECA*TF1)
C
C***  2. FOR GENERAL POPULATION
C      COCM2(NN)=FMC(NN)*(COFEED*QFC+CWATA*QCW)*EXP(-DECA*TF2)
C
C***  CALCULATION OF COGMIX = RADIONUCLIDE CONCENTRATION IN GOAT'S MILK
C***  1. FOR MAXIMUM INDIVIDUAL EXPOSURE
C      COGM1(NN)=FMG(NN)*(COFEED*QFG+CWATA*QGW)*EXP(-DECA*TF1)

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C
C***  2. FOR GENERAL POPULATION
      COGMI2(NN)=FMC(NN)*(COFEED*QFG+CWATA*QGW)*EXP(-DECA*TF2)
C
C***  CALCULATION OF COMEAT = RADIONUCLIDE CONC IN BEEF CATTLE'S MEAT
      COMEAT(NN)=FF(NN)*(COFEED*QFC+CWATA*QBW)*EXP(-DECA*TS)
      RETURN
C
C***  CALCULATION FOR SPECIAL RADIONUCLIDE: TRITIUM
C      TRITIUM CONC IN VEGETATION = TRITIUM CONCENTRATION IN ANIMAL'S
C      FEED = TRITIUM CONCENTRATION IN WATER = CWATL
C***  CALCULATION OF H-3 CONC IN VEGETATION, MILK AND MEAT CONSUMED
C      BY MAN
      200 COL1(NN)=CWATL
          COL2(NN)=CWATL
          COP1(NN)=CWATL
          COP2(NN)=CWATL
          COCM11(NN)=FMC(NN)*(CWATL*QFC+CWATA*QGW)
          COCM12(NN)=COCM11(NN)
          COGMI1(NN)=FMC(NN)*(CWATL*QFG+CWATA*QGW)
          COGMI2(NN)=COGMI1(NN)
          COMEAT(NN)=FF(NN)*(CWATL*QFC+CWATA*QGW)
          RETURN
      END
C
C
C
      SUBROUTINE LEACH(NN,NYEAR,VOLB,VOLO,DMAX)
C
C
C***
C***
C***
C***
C***
C*** THIS SUBROUTINE CALCULATES THE AMOUNT OF EACH RADIONUCLIDE
C*** THAT LEAVES FROM THE BOTTOM OF THE TRENCH TO THE AQUIFER
C*** AND THE AMOUNT THAT LEAVES AS A RESULT OF WATER OVERFLOWING THE
C*** TRENCH. THIS SUBROUTINE IS CALLED BY MAIN.
C***
C*** THERE ARE FIVE METHODS THAT MAY BE USED TO CALCULATE THESE
C*** AMOUNTS. THEY ARE GIVEN BY THE FOLLOWING VALUES OF
C*** LEAOPT:
C***      1 TOTAL CONTACT,CHEMICAL EXCHANGE
C***      2 IMMERSED FRACTION, CHEMICAL EXCHANGE
C***      3 TOTAL CONTACT, CHEMICAL SOLUBILITY
C***      4 IMMERSED FRACTION, CHEMICAL SOLUBILITY
C***      5 RELEASE FACTOR
C***
C
C      INPUT VARIABLES
C

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C      NN      = NUCLIDE NUMBER
C      NYEAR   = CURRENT YEAR OF SIMULATION
C      TAREA   = AREA OF TRENCH
C      TDEPTH  = DEPTH OF TRENCH
C      PORT    = POROSITY OF TRENCH MATERIAL
C      RELFAC  = RELEASE FACTOR
C      LEAOPT  = LEACHING OPTION
C      SOL     = SOLUBILITY OF RADIONUCLIDE IN TRENCH
C      DENCON  = DENSITY OF WASTE
C      VOLO    = VOLUME OF WATER OVERFLOWING TRENCH
C      VOLB    = VOLUME OF WATER LEAVING BOTTOM OF TRENCH
C      NONCLD  = NUMBER OF NUCLIDES
C      TRAM    = AMOUNT OF NUCLIDE IN TRENCH
C      OLDWAT  = AMOUNT OF WATER IN TRENCH
C      DILFAC  = DILUTION FACTOR
C      DMAX    = MAXIMUM WATER DEPTH IN TRENCH
C      XKD     = CHEMICAL EXCHANGE COEFFICIENT
C
C  OUTPUT VARIABLES
C
C      POLB    = AMOUNT OF EACH NUCLIDE LEAVING BOTTOM OF TRENCH
C      POLO    = AMOUNT OF EACH NUCLIDE OVERFLOWING TRENCH
C
C  INTERMEDIATE VARIABLES
C
C      CCWAT   = CONCENTRATION OF NUCLIDE IN WATER
C      FWET    = WETTED OR IMMersed FRACTION
C      POLOUT  = TOTAL AMOUNT OF NUCLIDE LEAVING TRENCH
C
C  DOUBLE PRECISION NUCIID
C
C      COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTPSCH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR
C
C      COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
C      COMMON/TRCH/TAREA,TDEPTH,OVER,PORT,RELFAC,DENCON,OLDWAT,FN,PERMC
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),Y30(40),SOAVG(40),
&      AQCON(40),STCON(40),AIRCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMC(40),DECAY(40),XKD(4,40),SOL(40),
&      PF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      DATA LU6/6/
C      DW=DMAX+XINFL/PORT
C      TEMP=5.163E11*SOL(NN)*DECAY(NN)/ATMASS(NN)
C

```

```

C--- 5.163E11=6.02E23/3.7E10/8 50./3600E6
      IF(DW .LE. 0.)CCWAT=0.
      IF(DW .LE. 0.)GO TO 600
C---
C--- FOR OPTIONS 1 AND 3 ASSUME WETTED FRACTION
C--- TO BE TOTAL CONTACT AREA.
C---
      FWET=1.
      GO TO (200,100,400,300,500),LEAOPT
      WRITE(LU6,6000)
6000  FORMAT(' ','*** ERROR *** - INVALID LEACHING PARAMETER')
      RETURN
C
C--- FOR OPTION 2 USE IMMERSED FRACTION TO COMPUTE WETTED FRACTION.
C---
      100 FWET=DMAX/TDEPTH
      IF(FWET .GT. 1.0)FWET=1.0
C---
C--- FOR OPTIONS 1 AND 2 COMPUTE CONCENTRATIONS USING
C--- CHEMICAL EXCHANGE.
C---
      200 CCWAT=TRAM(NN)*FWET/(TAREA*(DW*PORT+TDEPTH*FWET*XKD(2,NN)
      & *DENCON))
      IF(SOL(NN) .NE. 0.0 .AND. CCWAT .GT. TEMP)CCWAT=TEMP
      GO TO 600
C---
C--- FOR OPTION 4 WETTED FRACTION IS THE IMMERSED FRACTION.
C---
      300 FWET=DMAX/TDEPTH
      IF(FWET .GT. 1.0)FWET=1.0
C---
C--- FOR OPTIONS 3 AND 4 USE CHEMICAL SOLUBILITY.
C---
      400 CCWAT=TRAM(NN)*FWET/(DW*TAREA*PORT)
      IF(CCWAT .GT. TEMP) CCWAT=TEMP
      GO TO 600
C---
C--- FOR OPTION 5 USE RELEASE FACTOR.
C---
      500 POLOUT=RELFAC*TRAM(NN)
      GO TO 610
      600 POLOUT=(VOLB+VOLO)*CCWAT
C---
C--- DISTRIBUTE RADIONUCLIDE OUTPUT BETWEEN OVERFLOW AND SEEPAGE
C---
      610 VOLS=VOLB+VOLO
      IF(VOLS .NE. 0.) GO TO 620
      POLB(NN)=0.0
      POLO(NN)=0.0
      RETURN
      620 POLB(NN)=POLOUT*VOLB/VOLS
      POLO(NN)=POLOUT*VOLO/VOLS
      RETURN
      END

```

```

C
      SUBROUTINE OUT(NYEAR,PC,WDEPTH,VOLO,VOLB)
C
C
C
C*** THIS ROUTINE OUTPUTS AN ANNUAL SUMMARY FOR YEARS
C*** REQUESTED BY USER INPUT. OUT IS CALLED BY MAIN.
C***
C***
C***
C
C
C
C      INPUT VARIABLES
C
C      NYEAR = CURRENT YEAR OF SUMULATION
C      PC    = FRACTION OF TRENCH CAP THAT HAS FAILED
C      WDEPTH = MAXIMUM DEPTH OF WATER IN TRENCH
C
C      DOUBLE PRECISION NUCLID
C
C      COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&      PC11,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&      IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&      WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&      IAQSTR
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&      AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&      SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&      AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&      ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
&      FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      DATA LU6/6/
C      WRITE(LU6,6000)NYEAR
C      PER=100.*PC
C      WRITE(LU6,6005)PER
C      WRITE(LU6,6010)WDEPTH
C      WRITE(LU6,6015)VOLB,VOLO
C      WRITE(LU6,6020)
C      DO 10 I=1,NONCLD
C      WRITE(LU6,6025)NUCLID(I),TRAM(I),POLO(I),POLB(I),
&      AQAM(I,NYEAR)
10 CONTINUE
C      WRITE(LU6,6030)
C      DO 20 I=1,NONCLD
C      WRITE(LU6,6025)NUCLID(I),CS(I),CW(I),SSTREM(I),
&      SDEEP(I),YSO(I),ATCON(I),AQCON(I)
20 CONTINUE
C      RETURN

```

```

6000 FORMAT('1',20X,'ANNUAL SUMMARY FOR YEAR ',I5,' OF THE ',
& 'SIMULATION')
6005 FORMAT(///' ',10X,'THE TRENCH CAP HAS HAD ',F6.2,
& ' PER CENT FAILURE')
6010 FORMAT(' ',10X,'THE MAXIMUM CALCULATED WATER DEPTH IN TRENCH ',
& 'DURING THE YEAR IS ',F6.2,' METERS')
6015 FORMAT(' ',10X,1PE11.4,' CUBIC METERS OF WATER LEFT BOTTOM',
& ' OF TRENCH',/' ',10X,1PE11.4,' CUBIC METERS OF WATER',
& ' OVERFLOWED TRENCH')
6020 FORMAT(///// ' ',51X,'NUCLIDE TRANSPORT INFORMATION',
& ///' ',2X,'NUCLIDE',3X,'AMOUNT IN',6X,'TRENCH',
& 7X,'TRENCH',5X,'AMOUNT AT',/' ',14X,'TRENCH',6X,
& 'OVERFLOW',4X,' DRAINAGE ',5X,'WELL',
& /' ',16X,4('CI',11X))
6025 FORMAT(' ',A8,3X,9(1PE11.4,2X))
6030 FORMAT(///// ' ',2X,'NUCLIDE',5X,'SURFACE',5X,'SURFACE',
& 4X,'SOLUBLE TO',3X,'SOLUBLE TO',3X,'ATMOSPHERE',
& 3X,'ATMOSPHERE',3X,'WELL WATER',
& /' ',13X,'SOIL CONC',3X,'WATER CONC',4X,'STREAM',7X,
& 'TRENCH',4X,'AT SPILLAGE',3X,'DOWN WIND',6X,'CONC',
& /' ',7X,2(6X,'CI/M**3'),9X,'CI',11X,'CI',3X,3(5X,'CI/M**3'))
END

```

C
C
C

```

      SUBROUTINE SIGMA2(XG,IT,IS,ROUGH,SIGZ,IKPM,HLID,VG,U,HH)
      COMPUTES VERTICAL DISPERSION COEFFICIENT
C      D.E. FIELDS, 2/81
      COMMON/C/BY(6),BZ1(6),BZ2(6),BZ3(6),A1(6),A2(6),B1(6),B2(6),
& B3(6),PY(6,5),PZ(6,5),QY(6,5),QZ(6,5),XM(50)
      DIMENSION AONE(6),BONE(6),ATWO(6),BTWO(6),CONE(6),DONE(6),
& CTWO(6),DTWO(6),RGH(6)
      DATA AONE/0.112,0.130,0.112,0.098,0.0609,0.0638/
      DATA BONE/1.06,0.950,0.920,0.889,0.895,0.783/
      DATA ATWO/5.38E-4,6.52E-4,9.05E-4,1.35E-3,1.96E-3,1.36E-3/
      DATA BTWO/0.815,0.750,0.718,0.688,0.684,0.672/
      DATA CONE/1.56,2.02,2.72,5.16,7.37,11.7/
      DATA DONE/0.0480,0.0269,0.,-0.060,-0.0957,-0.128/
      DATA CTWO/6.25E-4,7.76E-4,0.,186.,4.29E+3,4.59E+4/
      DATA DTWO/0.45,0.37,0.,-0.225,-0.60,-0.78/
      DATA RGH/0.01,0.04,0.10,0.40,1.0,4.0/
      P=0.0
      DO 8 I=1,50
      IKP=I
      IF(XM(I).GE.XG)GOTO9
8      CONTINUE
9      IF(IKP.LT.2)IKP=2
      IKPM=IKP-1
      CHOOSE TYPE OF COMPUTATION
      IPOINT=IT
      IF(IT.GT.3)IPOINT=4
      GOTO(10,20,30,40),IPOINT

```

```

C      PASQUILL-GIFFORD DISPERSION VALUES, FROM VOGT
10     ALX=ALOG(XG)
      SIGZ=(EXP(B1(IS)+(B2(IS)+B3(IS)*ALX)*ALX))/2.15
      GOTO99
C      HOSKER'S FORM. OF BRIGGS-SMITH DISPERSION VALUES, FROM ATM
20     ABS=ROUGH
      C1 =YLAG(ABS,RGH,CONE,0,3,6,0)
      D1 =YLAG(ABS,RGH,DONE,0,2,6,0)
      C2 =YLAG(ABS,RGH,CTWO,0,3,6,0)
      D2 =YLAG(ABS,RGH,DTWO,0,2,6,0)
      G=AONE(IS)*XG**BONE(IS)/(1.0+ATWO(IS)*XG**BTWO(IS))
      F=C1*(XG**D1)
      F=ALOG(F)
      IF(ROUGH.LE.0.10) GO TO 26
      F=F+ALOG(1.+1./(C2*XG**D2))
      GO TO 27
26     F=F-ALOG(1.+C2*XG**D2)
27     SIGZ=G*F
      IF(SIGZ.LT.1.0) SIGZ=1.0
      GOTO99
C      BRIGGS DISPERSION VALUES, FROM AIRDOS II
30     SIGZ=BZ1(IS)*XG*(1+BZ2(IS)*XG)**BZ3(IS)
      GOTO99
C      DISPERSION VALUES AFTER KLUG, AND OTHERS
40     J=IT-3
C      =1 FOR KLUG
C      =2 FOR BROOKHAVEN
C      =3 FOR ST. LOUIS
C      =4 FOR JULICH(50M)
C      =5 FOR JULICH(100M)
      SIGZ=PZ(1S,J)*XG**QZ(IS,J)
99     SIGCAL=2.*(HLID-HH*.5)/2.15
      IF(SIGZ.LT.SIGCAL) GO TO 1000
      SIGZ=SIGCAL
1000    RETURN
      END
C
C
C
C
      SUBROUTINE SIMPUN(XX,FX,NX,I,AX)
C      PROGRAM AUTHOR      J. BARISH,
C      COMPUTING TECHNOLOGY CENTER, UNION CARBIDE CORP., NUCLEAR DIV.,
C      OAK RIDGE, TENN.
C
      DIMENSION XX(2),FX(2),AX(2)
      IF (I.LT.0) GO TO 30
      AX(1)=0.0
      DO 10 IX=2,NX,2
        D1=XX(IX)-XX(IX-1)
        AX(IX)=AX(IX-1)+D1/2.0*(FX(IX)+FX(IX-1))
        IF (NX.EQ.IX) GO TO 20

```

```

      D2=XX(IX+1)-XX(IX-1)
      D3=D2/D1
      A2=D3/6.0*D2**2/(XX(IX+1)-XX(IX))
      A3=D2/2.0-A2/D3
10    AX(IX+1)=AX(IX-1)+(D2-A2-A3)*FX(IX-1)+A2*FX(IX)+A3* FX(IX+1)
20    RETURN
30    AX(NX)=0.0
      DO 40 IX=2,NX,2
          IC=NX+1-IX
          D1=XX(IC+1)-XX(IC)
          AX(IC)=AX(IC+1)+D1/2.0*(FX(IC+1)+FX(IC))
          IF (NX.EQ.IX) GO TO 20
          D2=XX(IC+1)-XX(IC-1)
          D3=D2/(XX(IC)-XX(IC-1))
          A2=D3/6.0*D2**2/D1
          A3=D2/2.0-A2/D3
40    AX(IC-1)=AX(IC+1)+(D2-A2-A3)*FX(IC-1)+A2*FX(IC)+ A3*FX(IC+1)
      RETURN
      END

```

C

C

SUBROUTINE SOURCE(NUCL)

C

C*****

C***

C*** THIS SUBROUTINE PERFORMS THE NECESSARY INPUTS TO INITIALIZE

C*** PARAMETERS AND VARIABLES. SOURCE IS CALLED FROM MAIN.

C***

C***

C***

C***

DOUBLE PRECISION NUCLID,NU,NC,DATE

C

COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,

1 PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,

2 IRRES1,IRRES2,LIND,Iavg1,Iavg2,RR,FTMECH,

3 WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,

4 LAQSTR

C

COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL

C

COMMON/TRCH/TAREA,TDEPTH,OVER,PORT,RELFAC,DENCON,OLDWAT,FN,PERMC

C

COMMON/WATER/DTRAQ,DWELL,GWV,XLSAT,STFLOW,AQTHK,AQDISP,

1 PORA,PORV,PERMV

C

COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40) ATAM(40),

1 AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),

2 SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),

3 AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),

4 ATAVG(40),FMC(40),FMG(40),DEC_{ai}(40),XKD(4,40),SOL(40),

5 FF(40),R₁(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)

```

C      COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
1      PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
2      INSITE
C
C      COMMON/AIR/H,VG,U,IT,IS,VD,XG,HLID,ROUGH,FTWIND,CHIQ,PE1,RE2,RE3
C
C      COMMON/IRRFOO/Y1,Y2,TE1,TE2,TH1,TH2,TH3,TH4,TH5,TH6,FP,FS,
1      ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,
2      QFC,QFG,TF1,TF2,TS,CL1(40),CL2(40),CP1(40),CP2(40),
3      CCM1(40),CCM2(40),CGMI1(40),CGMI2(40),
4      CMEAT(40),COL1(40),COL2(40),COP1(40),COP2(40),
5      COCM1(40),COCM2(40),COGMI1(40),COGMI2(40),
6      COMEAT(40),QING(40),QINH(40),POP,
7      CSP(40),CSPT(40),CSPO(40),CSPOT(40)
C
C      COMMON/FUNC/XAMBWE,FI,PP,WIRATE,
1      QCW,QGW,QBW,ABSH,P14
C
C      DIMENSION MONTH(12),DAT(20),NUCL(40.8),HP(12.31,24)
C      DATA LU5/5/,LU6/6/,LU26/26/
C      DATA IAMP/99/
C      DATA HP/8928*0.0/
C      DATA MONTH/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG',
1      'SEP','OCT','NOV','DEC'/
C      WRITE(LU6,7030)
10 READ(LU5,7040,END=20)DAT
C      WRITE(LU26,7040)DAT
C      WRITE(LU6,7020)DAT
C      GO TO 10
20 REWIND LU26
C-----
C----- CONTROL INFORMATION.
C-----
C      READ(LU26,7040)TITLE
C      READ(LU26,7040)LOCATE
C      READ(LU26,7060)MAXYR,NONCLD,LEAOPT,NYR1,NYR2,IOPVWV,IOPSAT,
1      IPRT1,IPRT2,IDELT,IRRES1,IRRES2,LIND,IAVG1,IAVG2
C      READ(LU26,7060)IVAP,IBSMT,IAQSTR
C      READ(LU26,7050)PCT1,PCT2,WWATL,WWATA,WWATH,SWATL,SWATA,SWATH
C      IF(IAVG1 .LE. 0)IAVG1=1
C      IF(IAVG2 .GT. MAXYR)IAVG2=MAXYR
C      IF(IAVG1 .GT. IAVG2)IAVG1=1
C      IF(IAVG1 .GT. IAVG2)IAVG2=MAXYR
C-----
C      WRITE(LU6,7090)
C----- ITIME IS PART OF THE SYSTEM LIBRARY. IT RETURNS THE CURRENT
C----- WALL TIME, ELAPSED TIME, AND DATE.
C-----
C      CALL ITIME(ICLOCK,IDIFF,DATE,IDAT)
C      CLOCK=FLOAT(ICLOCK)/360000.

```

```

WRITE(LU6,7100)CLOCK,DATE
WRITE(LU6,7110)TITLE
WRITE(LU6,7120)
WRITE(LU6,7130)LOCATE
IF(NONCLD .GE. 1 .AND. NONCLD .LE. 40) GO TO 30
WRITE(LU6,7140)
STOP
30 CONTINUE
WRITE(LU6,7150)MAXYR,NONCLD
WRITE(LU6,7160)LEAOPT
IF(NYR1 .LT. NYR2)WRITE(LU6,7170)NYR1,PCT1,PCT2,NYR2
IF(IOPVWV .EQ. 1)WRITE(LU6,7180)
IF(IOPVWV .EQ. 0)WRITE(LU6,7190)
IF(IOPSAT .EQ. 1)WRITE(LU6,7200)
IF(IOPSAT .EQ. 0)WRITE(LU6,7210)
WRITE(LU6,7230)LIND
IF(LIND .EQ. 0)WRITE(LU6,7240)
IF(LIND .NE. 0)WRITE(LU6,7250)
WRITE(LU6,7270)WWATL,WWATA,WWATH
WRITE(LU6,7280)SWATL,SWATA,SWATH
IF(IBSMT .GT. 0)WRITE(LU6,7300)IBSMT
IF(IAQSTR .GT. 0)WRITE(LU6,7310)
IF(IVAP .EQ. 1)WRITE(LU6,7320)
IF(IVAP .EQ. 2 .OR. IVAP .EQ. 0)WRITE(LU6,7330)
IF(IVAP .EQ. 3)WRITE(LU6,7340)
IF(IVAP .EQ. 4)WRITE(LU6,7350)
C-----
C----- CLIMATIC INFORMATION
C-----
      READ(LU26,7050)PPN,P,XIRR,PHID
      READ(LU26,7050)S
      READ(LU26,7050)T
      READ(LU26,7050)TD
C-----
      WRITE(LU6,7360)
      WRITE(LU6,7370)PPN
      WRITE(LU6,7380)P
      WRITE(LU6,7390)PHID
      WRITE(LU6,7400)
      DO 40 I=1,12
      WRITE(LU6,7410)MONTH(I),S(I),T(I),TD(I)
40 CONTINUE
C-----
C----- TRENCH INFORMATION
C-----
      READ(LU26,7050)TAREA,TDEPTH,OVER,POL,T,DENCON,RELFAC,FN,XINFL
      READ(LU26,7050)PERMC
      WRITE(LU6,7420)
      WRITE(LU6,7430)TAREA,TDEPTH
      WRITE(LU6,7440)PORT
      IF(IVAP .EQ. 1)WRITE(LU6,7450)FN

```



```

WRITE(LU6,7290)PERMC
C-----
C----- AQUIFER INFORMATION
C-----
READ(LU26,7050)DTRAQ,DWELL,GWV,AQTHK,AQDISP,PORA,PORV,PERMV
WRITE(LU6,7460)
WRITE(LU6,7470)GWV
WRITE(LU6,7480)DTRAQ
WRITE(LU6,7490)DWELL
WRITE(LU6,7500)AQTHK,AQDISP
WRITE(LU6,7510)PORA,PORV,PERMV
C-----
C----- ATMOSPHERIC INFORMATION
C-----
READ(LU26,7050)H,VG,U,VD,XG,HLID,ROUGH
READ(LU26,7050)FTWIND,CHIQ,RE1,RE2,RE3,RR,FTMECH
READ(LU26,7060)IT,IS
C-----
WRITE(LU6,7520)
WRITE(LU6,7530)H
WRITE(LU6,7540)VG
WRITE(LU6,7570)U
WRITE(LU6,7560)VD
WRITE(LU6,7550)XG
WRITE(LU6,7580)HLID
WRITE(LU6,7590)ROUGH
WRITE(LU6,7600)IT,IS
WRITE(LU6,7610)FTWIND
IF(CHIQ.LT. 0.0)WRITE(LU6,7630)
IF(CHIQ.GE. 1.0E-10)WRITE(LU6,7620)CHIQ
WRITE(LU6,7640)RE1,RE2,RE3
WRITE(LU6,7220)IRRES1,IRRES2,RR,FTMECH
C-----
C----- SURFACE INFORMATION
C-----
READ(LU26,7050)RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR
READ(LU26,7050)PORS,BDENS,STFLOW,EXTENT,ADEPTH
READ(LU26,7050)PD,RUNOFF
C-----
WRITE(LU6,7650)
WRITE(LU6,7660)RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR
WRITE(LU6,7670)PORS,BDENS
WRITE(LU6,7680)RUNOFF
WRITE(LU6,7690)STFLOW,EXTENT,ADEPTH,PD
C-----
C----- AIR-FOODCHAIN INFORMATION
C-----
WRITE(LU6,7700)
READ(LU26,7050)Y1,Y2,PP,XAMBWE,TE1,TE2
READ(LU26,7050)TH1,TH2,TH3,TH4,TH5,TH6,FP,FS
READ(LU26,7050)QFC,QFG,TF1,TF2,TS,ABSH,P14

```

```

WRITE(LU6,7710)Y1,Y2,PP,XAMBWE,TF1,TE2
WRITE(LU6,7720)TH1,TH2,TH3,TH4,TE5,TH6,FP,FS,QFC
WRITE(LU6,7730)QFG,TF1,TF2,TS,ABSH,P14
C-----
C----- WATER-FOODCHAIN INFORMATION
C-----
      WRITE(LU6,7740)
      READ(LU26,7050)FI,WIRATE,QCW,QGW,QBW
      WRITE(LU6,7750)FI,WIRATE,QCW,QGW,QBW
C-----
C----- HUMAN INGESTION AND INHALATION INFORMATION
C-----
      READ(LU26,7050)ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,POP
      WRITE(LU6,7760)
      WRITE(LU6,7770)ULEAFY,UPROD,UCMILK,UGMILK,UMEAT,UWAT,UAIR,POP
C-----
C----- NUCLIDE INFORMATION
C-----
      WRITE(LU6,7790)
      SMASS=1000.*BDENS*EXTENT*PD*ADEPTH
      WMASS=1000.*PORS*EXTENT*PD*ADEPTH
      DO 50 I=1,NONCLD
      READ(LU26,7070)NUCLID(I),(NUCL(I,K),K=1,8),TRAM(I),
1          SOAM(I),STAM(I),ATAM(I),DECAY(I),SOL(I)
      READ(LU26,7080)NU,(XKD(K,I),K=1,4)
      READ(LU26,7080)NC,RA(I),RW(I),BV(I),BR(I),FMC(I),FMG(I),FF(I)
      CW(I)=1000.*SOAM(I)/(XKD(1,I)*SMASS+WMASS)
      CS(I)=CW(I)*XKD(1,I)*1.0E-3
      WRITE(LU6,7780)NUCLID(I),TRAM(I),SOAM(I),STAM(I),ATAM(I),
1          DECAY(I),SOL(I)
50 CONTINUE
      WRITE(LU6,7800)
      DO 60 I=1,NONCLD
      WRITE(LU6,7810)NUCLID(I),(XKD(K,I),K=1,4)
60 CONTINUE
      WRITE(LU6,7820)
      DO 70 I=1,NONCLD
      WRITE(LU6,7810)NUCLID(I),RA(I),RW(I),BV(I),BR(I),FMC(I),
1          FMG(I),FF(I)
C
C**** CONVERT DRY WEIGHT BR AND BV TO WET WEIGHT BR AND BV
C
      BV(I)=.25*BV(I)
      BF(I)=.25*BR(I)
70 CONTINUE
      IF(IVAP.NE.4)GO TO 100
80 READ(LU26,7010)MO,IDA,(HP(MO,IDA,IH),IH=1,24)
      IF(IAMP.NE.MO)GO TO 80
      XINFL=0.
      PERMCY=PERMC/8760.*10000.

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DO 90 I=1,12
DO 90 J=1,31
DO 90 K=1,24
RAIN=AMIN1(PERMCY,RP(I,J,K))
XINFL=XINFL+RAIN/10000.
90 CONTINUE
100 CONTINUE
RETURN
7010 FORMAT(2(I2,1X),24(F3.0),2X)
7020 FORMAT(' ',20A4)
7030 FORMAT('1',5X,'** INPUT DATA AS READ IN **',//)
7040 FORMAT(20A4)
7050 FORMAT(8F10.0)
7060 FORMAT(16I5)
7070 FORMAT(A8,T1,8A1,2X,7F10.0)
7080 FORMAT(A8,2X,7F10.0)
7090 FORMAT('1',29X,'PKESTO-II: A MODEL FOR PREDICTING THE',
1      ' MIGRATION OF RADIOACTIVE WASTES',
2      '/' ' ',48X,'FROM SHALLOW TRENCH BURIAL SITES')
7100 FORMAT('0',40X,'THIS RUN WAS MADE AT ',F6.3,' ON ',A8)
7110 FORMAT('0',2('/ ' ',20X,20A4))
7120 FORMAT(///' ',5X,'*** CONTROL INFORMATION ***')
7130 FORMAT('0',10X,'THE BURIAL SITE IS LOCATED AT ',I2A4)
7140 FORMAT('0','*** ERROR :*** INVALID NUMBER OF NUCLIDES')
7150 FORMAT(' ',10X,'THE SIMULATION WILL RUN FOR',I5,' YEARS AND',
1      ' WILL INCLUDE',I3,' NUCLIDES')
7160 FORMAT(' ',10X,'LEACHING OPTION NUMBER',I2,' WILL BE USED')
7170 FORMAT(' ',10X,'IN YEAR',I4,' ',F4.2,' OF THE CAP WILL BE',
1      ' ASSUMED TO FAIL',/' ',15X,'THIS WILL CONTINUE',
2      ' UNTIL ',F4.2,' HAS FAILED IN YEAR ',I4,
3      '/' ' ',10X,'CAP MAY ALSO FAIL BY SURFACE EROSION')
7180 FORMAT(' ',10X,'VERTICAL WATER VELOCITY WILL BE CALCULATED',
1      ' USING INFILTRATION AND POROSITY')
7190 FORMAT(' ',10X,'PERMEABILITY WILL BE USED FOR MINIMUM',
1      ' VERTICAL WATER VELOCITY')
7200 FORMAT(' ',10X,'LENGTH OF VERTICAL SATURATED ZONE WILL BE',
1      ' CALCULATED USING INFILTRATION AND POROSITY')
7210 FORMAT(' ',10X,'LENGTH OF VERTICAL SATURATED ZONE WILL BE',
1      ' SET TO THE TRENCH TO AQUIFER DISTANCE')
7220 FORMAT(' ',10X,'FROM YEAR ',I4,' TO YEAR ',I4,
1      ' THE RESUSPENSION RATE DUE TO MECHANICAL DISTURBANCES',
2      ' WILL BE ',1PE11.4,/' ',15X,'THIS WILL OCCUR DURING ',
3      'F5.2,' OF EACH YEAR')
7230 FORMAT(' ',10X,'POPULATION INDICATOR IS ',I2)
7240 FORMAT(' ',15X,'MAXIMUM INDIVIDUAL EXPOSURE WILL BE USED',
1      ' TO CALCULATE HEALTH EFFECTS')
7250 FORMAT(' ',15X,'GENERAL POPULATION EXPOSURE WILL BE USED',
1      ' TO CALCULATE HEALTH EFFECTS')
7260 FORMAT(' ',10X,'THE POPULATION WILL BE EXPOSED TO CONTAMINATED ',
1      ' MATERIALS FROM YEAR ',I3,' TO ',I4)
7270 FORMAT(' ',10X,F6.3,' OF IRRIGATION WATER WILL BE GOTTEN FROM '

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1          'WELL',
2      /' ',10X,F6.3,' OF DRINKING WATER FOR ANIMALS WILL BE',
3          ' GOTTEN FROM WELL',
4      /' ',10X,F6.3,' OF DRINKING WATER FOR HUMANS WILL',
5          ' BE GOTTEN FROM WELL')
7280 FORMAT(' ',10X,F6.3,' OF IRRIGATION WATER WILL BE COTTEN FROM ',
1          'STREAM',
2      /' ',10X,F6.3,' OF DRINKING WATER FOR ANIMALS WILL BE ',
3          'GOTTEN FROM STREAM',
4      /' ',10X,F6.3,' OF DRINKING WATER FOR HUMANS WILL',
5          ' BE GOTTEN FROM STREAM')
7290 FORMAT(' ',10X,'TRENCH CAP PERMEABILITY IS ',F8.3,
1          ' METERS PER YEAR')
7300 FORMAT(' ',10X,'BEGINNING IN YEAR ',I4,' PEOPLE WILL LIVE ',
1          'IN THE BASEMENT')
7310 FORMAT(' ',10X,'UNUSED WATER AT WELL WILL GO TO SURFACE STREAM')
7320 FORMAT(' ',10X,'TRENCH CAP INFILTRATION WILL BE CALCULATED ',
1          'AS A FRACTION OF WATERSHED INFILTRATION')
7330 FORMAT(' ',10X,'INPUT VALUE WILL BE USED FOR TRENCH ',
1          'CAP INFILTRATION')
7340 FORMAT(' ',10X,'TRENCH CAP INFILTRATION WILL BE CALCULATED ',
1          'FROM ANNUAL PRECIPITATION')
7350 FORMAT(' ',10X,'TRENCH CAP INFILTRATION WILL BE CALCULATED ',
1          'FROM HOURLY PRECIPITATION')
7360 FORMAT(////' ',5X,'*** CLIMATIC INFORMATION ***')
7370 FORMAT(//' ',10X,'THE AVERAGE ANNUAL PRECIPITATION IS ',
1          F5.3,' METERS')
7380 FORMAT(' ',10X,'THE AVERAGE ATMOSPHERIC PRESSURE IS ',
1          F7.2,' MBAR')
7390 FORMAT(' ',10X,'THE LATITUDE OF THE SITE IS ',F8.2)
7400 FORMAT(//' ',10X,'MONTH',I5X,'FRACTION OF SUNSHINE',I5X,
1          'AVERAGE TEMP C',I8X,'AVG DEW POINT TEMP C')
7410 FORMAT(' ',I1X,A4.24X,F3.2,27X,F6.2,30X,F6.2)
7420 FORMAT(' ',5X,'*** TRENCH INFORMATION ***')
7430 FORMAT(//' ',10X,'THE TRENCH HAS AN AREA OF ',
1          E11.4,' SQUARE METERS AND A DEPTH OF ',
2          E11.4,' METERS')
7440 FORMAT(' ',10X,'TRENCH POROSITY IS ',F8.2)
7450 FORMAT(' ',10X,'RATIO OF CAP PERMEABILITY TO WATERSHED SOIL',
1          ' PERMEABILITY IS ',F8.2)
7460 FORMAT(//' ',5X,'*** AQUIFER INFORMATION ***')
7470 FORMAT(//' ',10X,'THE GROUND WATER HAS A VELOCITY OF ',F10.3,
1          ' METERS PER YEAR')
7480 FORMAT(' ',10X,'TRENCH TO AQUIFER DISTANCE IS ',F6.1,' METERS')
7490 FORMAT(' ',10X,'TRENCH TO WELL DISTANCE IS ',F8.2,' METERS')
7500 FORMAT(' ',10X,'THE AQUIFER THICKNESS IS ',F8.2,' METERS',
1          /' ',10X,'THE AQUIFER DISPERSION ANGLE IS ',F8.4,' RADIANS')
7510 FORMAT(' ',10X,'POROSITY OF THE AQUIFER REGION IS ',F8.5,
1          /' ',10X,'POROSITY BENEATH THE TRENCH IS ',F8.5,
2          /' ',10X,'PERMEABILITY BENEATH THE TRENCH IS ',F8.3,
3          ' METERS/YEAR')

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7520 FORMAT(// '1',5X,'*** ATMOSPHERIC INFORMATION ***')
7530 FORMAT(// ' ',10X,'SOURCE HEIGHT IS ',F6.1,' METERS')
7540 FORMAT(' ',10X,'VELOCITY OF GRAVITATION FALL IS ',
1      F6.2,' METERS/SECOND')
7550 FORMAT(' ',10X,'GAUGE DISTANCE FROM SOURCE IS ',F8.2,' METERS')
7560 FORMAT(' ',10X,'DEPOSITION VELOCITY IS ',F6.2,' METERS/SECOND')
7570 FORMAT(' ',10X,'WIND VELOCITY IS ',F6.2,' METERS/SECOND')
7580 FORMAT(' ',10X,'LID HEIGHT IS ',F8.2,' METERS')
7590 FORMAT(' ',10X,'HOSKE: SHNESS FACTOR IS ',F6.2)
7600 FORMAT(' ',10X,'TYPE OF STABILITY FORMULATION IS ',I2,
1      '/' ' ',10X,'STABILITY CLASS IS ',I2)
7610 FORMAT(' ',10X,'FRACTION OF TIME WIND BLOWS TOWARD POPULATION IS ',
1      F10.6)
7620 FORMAT(' ',10X,'NORMALIZED DOWN WIND ATMOSPHERIC EXPOSURE ',
1      'IF ',1PE11.4,' CI/M**3 PER CI/SEC')
7630 FORMAT(' ',10X,'NORMALIZED DOWN WIND ATMOSPHERIC EXPOSURE PER ',
1      'UNIT SOURCE AREA WILL BE CALCULATED INTERNALLY')
7640 FORMAT(' ',10X,'RESUSPENSION FACTOR PARAMETERS ',3(5X,E11.4))
7650 FORMAT(// ' ',5X,'*** SURFACE INFORMATION ***')
7660 FORMAT(// ' ',10X,'PARAMETERS FOR UNIVERSAL LOSS EQUATION',
1      '/' ' ',15X,'RAINFALL ',F8.2,
2      '/' ' ',15X,'ERODIBILITY ',F8.2,
3      '/' ' ',15X,'STEEPNESS-SLOPE',F8.2,
4      '/' ' ',15X,'COVER ',F8.2,
5      '/' ' ',15X,'EROSION CONTROL',F8.2,
6      '/' ' ',15X,'DELIVERY RATIO ',F8.2)
7670 FORMAT(' ',10X,'SOIL POROSITY IS ',F8.5,
1      '/' ' ',10X,'SOIL BULK DENSITY IS ',F8.5,' G/CC')
7680 FORMAT(' ',10X,'RUNOFF FRACTION IS ',F8.5)
7690 FORMAT(// ' ',10X,
1      10X,'STREAM FLOW RATE IS ',1PE11.4,' CUBIC METERS PER YEAR',
2      '/' ' ',10X,'CROSS SLOPE EXTENT OF SPILLAGE IS ',0PF8.2,' METERS'
3      '/' ' ',10X,'ACTIVE SOIL DEPTH IS ',F8.2,' METERS',
4      '/' ' ',10X,'AVERAGE DOWN SLOPE DISTANCE TO STREAM IS ',F8.2,
5      ' METERS')
7700 FORMAT('1',5X,'*** AIR-FOODCHAIN INFORMATION ***')
7710 FORMAT(// ' ',10X,'AGRICULTURAL PRODUCTIVITY FOR GRASS',F10.2,
1      ' KG/M**2',
2      '/' ' ',10X,'AGRICULTURAL PRODUCTIVITY FOR VEGETATION',
3      F10.2,' KG/M**2',
4      '/' ' ',10X,'SURFACE DENSITY FOR SOIL ',F10.2,' KG/M**2',
5      '/' ' ',10X,'WEATHER DECAY CONSTANT',F10.2,' 1/HOURS',
6      '/' ' ',10X,'PERIOD PASTURE GRASS EXPOSURE GROWING SEASON',
7      F10.2,' HOURS',
8      '/' ' ',10X,'PERIOD CROP/VEGETATION EXPOSURE GROWING SEASON',
9      F10.2,' HOURS')
7720 FORMAT(' ',10X,'PERIOD BETWEEN HARVEST PASTURE GRASS AND',
1      ' INGESTION BY ANIMAL',F10.2,' HOURS',
2      '/' ' ',10X,'PERIOD BETWEEN STORED FEED AND INGESTION',
3      ' BY ANIMAL',F10.2,' HOURS',
4      '/' ' ',10X,'PERIOD BETWEEN HARVEST LEAFY VEGETABLES AND',

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5      ' INGESTION BY MAN(M.I.E.)',F10.2,' HOURS',
6      /' ',.10X,'PERIOD BETWEEN HARVEST PRODUCE AND INGESTION BY',
7      ' MAN(M.I.E.)',F10.2,' HOURS',
8      /' ',.10X,'PERIOD BETWEEN HARVEST LEAFY VEG ',
9      ' AND INGESTION BY MAN(G.P.E.)',F10.2,' HOURS',
9      /' ',.10X,'PERIOD BETWEEN HARVEST PRODUCE',
9      ' AND INGESTION BY MAN(G.P.E.)',F10.2,' HOURS',
9      /' ',.10X,'FRACTION OF YEAR ANIMALS GRAZE ON PASTURE',F10.2
9      /' ',.10X,'FRACTION OF DAILY FEED THAT IS FRESH GRASS',F10.2.
9      /' ',.10X,'AMOUNT OF FEED CONSUMED BY CATTLE',F10.2,' KG')
7730 FORMAT(' ',.10X,'AMOUNT OF FEED CONSUMED BY GOATS',F10.2,' KG',
1      /' ',.10X,'TRANSPORT TIME FEED-MILL-RECEPTOR FOR M.I.E.',
2      F10.2,' HOURS',
3      /' ',.10X,'TRANSPORT TIME FEED-MILL-RECEPTOR FOR G.P.E.',
4      F10.2,' HOURS',
5      /' ',.10X,'TIME FROM SLAUGHTER OF MEAT TO CONSUMPTION',F10.2.
6      ' HOURS',
7      /' ',.10X,'ABSOLUTE HUMIDITY OF THE ATMOSPHERE',F10.2,
8      ' G/M**3',
9      /' ',.10X,'FRACTIONAL EQUILIBRIUM RATIO FOR C-14',F10.2)
7740 FORMAT('1',5X,'*** WATER-FOODCHAIN INFORMATION ***')
7750 FORMAT(///,' ',.10X,'FRACTION OF YEAR CROPS ARE IRRIGATED',F10.2.
1      /' ',.10X,'IRRIGATION RATE ',F10.2,' L/(M**2-H)',
2      /' ',.10X,'AMOUNT OF WATER CONSUMED BY COWS ',F10.2,' L/D',
3      /' ',.10X,'AMOUNT OF WATER CONSUMED BY GOATS ',F10.2,' L/D',
4      /' ',.10X,'AMOUNT OF WATER CONSUMED BY BEEF CATTLE ',F10.2.
5      ' L/D')
7760 FORMAT(///,' ',5X,'*** HUMAN INGESTION AND INHALATION RATE',
1      ' INFORMATION ***')
7770 FORMAT(/' ',.10X,'ANNUAL INTAKE OF LEAFY VEG ',F8.2,
1      ' KILOGRAMS PER YEAR',
2      /' ',.10X,'ANNUAL INTAKE OF PRODUCE ',F8.2,
3      ' KILOGRAMS PER YEAR',
4      /' ',.10X,'ANNUAL INTAKE OF COW'S MILK ',F8.2,
5      ' LITERS PER YEAR',
6      /' ',.10X,'ANNUAL INTAKE OF GOAT'S MILK',F8.2,
7      ' LITERS PER YEAR',
8      /' ',.10X,'ANNUAL INTAKE OF MEAT ',F8.2,' KILOGRAMS PER YEAR'
9      /' ',.10X,'ANNUAL INTAKE OF DRINKING WATER',F8.2,
9      ' LITERS PER YEAR',
9      /' ',.10X,'ANNUAL INHALATION RATE OF AIR ',F8.2,
9      ' CUBIC METERS PER YEAR',/' ',.10X,'A POPULATION OF ',
9      F10.0,' WILL BE CONSIDERED')
7780 FORMAT(' ',A8,3X,9(1PE11.4,2X))
7790 FORMAT('1',5X,'*** NUCLIDE INFORMATION ***',
1      /' ',.50X,'INFORMATION ON INDIVIDUAL NUCLIDES',
2      /' ',.NUCLIDE',3X,'AMT IN TRENCH',3X,'SPILLAGE',4X,
3      'STREAM AMT ',2X,'AMT IN AIR',2X,'DECAY CONST',
4      2X,'SOLUBILITY CONST',
5      /' ',.3X,4(12X,'CI'),8X,'1/Y',.11X,'G/ML')

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7800 FORMAT(////' ',.25X,'DISTRIBUTION COEFFICIENTS  ML/G',
1  //' ', 'NUCLIDE',.6X,'SURFACE',.6X,'TRENCH',.6X,'VERTICAL',
2  5X,'AQUIFER'//)
7810 FORMAT(' ',A8,1X,9(1PE11.2,2X))
7820 FORMAT(////' ', 'NUCLIDE',.4X,'RETENTION',.4X,'RETENTION',
1      4X,5('TRANS COEFF',2X),/' ',.12X,'IN AIR',.6X,'IN WATER',
2      5X,'SOIL-V CROP',.2X,'SOIL-R CROP',.2X,'VEG-COW MILK',
3      2X,'VEG-GOAT MILK',.2X,'VEG-MEAT',/' ',.40X,5('D/KG',9X))
END

```

C
C
C

SUBROUTINE SURSOL(II,NYEAR)

C
C

C----- CALCULATES THE AMOUNT OF SOLUBLE SURFACE CONTAMINANT THAT
C----- ENTERS THE STREAM AND TRENCH ANNUALLY.
C----- SURSOL IS CALLED BY MAIN.

C

C

C

C

C

C

C

C

INPUT VARIABLES

C

C

C

C

C

C

C

C

C

C

C

C

INTERMEDIATE VARIABLES

C

C

C

C

C

C

OUTPUT VARIABLES

C

C

C

C

C

C

C

C

C

C

C

C

C

C

ADEPTH = SOIL DEPTH OF ACTIVE EXCHANGE
XINFL = AVERAGE ANNUAL INFILTRATION
RUKOFF = FRACTION OF NET INPUT GOING TO STREAM
PD = DOWNSLOPE DISTANCE TO STREAM
BDENS = BULK DENSITY OF SOIL
EXTENT = CROSS SLOPE EXTENT OF SPILLAGE
SOAM = AMOUNT OF SPILLAGE
XKD = CHEMICAL EXCHANGE COEFFICIENT

SMASS = SOIL MASS
WMASS = WATER MASS

SSTREM = AMOUNT OF NUCLIDE GOING TO STREAM
SDEEP = AMOUNT OF NUCLIDE GOING TO TRENCH
CW = NUCLIDE CONCENTRATION IN WATER
CS = NUCLIDE CONCENTRATION IN SURFACE SOIL

DOUBLE PRECISION NUCLID

```

C
COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&    AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&    SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&    AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&    ATAVG(40),FMC(40),FMC(40),DECAY(40),XKD(4,40),SOL(40),
&    FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
&    PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
&    INSITE
C
C
C
C
WSTREM=RUNOFF*PPN*EXTENT*PD
WDEEP=SINFL*EXTENT*PD
SMASS=1000.*BDENS*EXTENT*PD*ADEPTH
WMASS=1000.*PORS*EXTENT*PD*ADEPTH
SUAM=CS(II)*SMASS+CW(II)*WMASS/1.0E3
WMASS=1000.*(PORS*EXTENT*PD*ADEPTH+WDEEP+WSTREM)
C-----
C----- COMPUTE NUCLIDE CONCENTRATION PER CUBIC METER OF WATER
C-----
CW(II)=1000.*SUAM/(XKD(1,II)*SMASS+WMASS)
C-----
C----- COMPUTE NUCLIDE CONCENTRATION PER KG OF SOIL
C-----
CS(II)=CW(II)*XKD(1,II)*1.0E-3
SSTREM(II)=WSTREM*CW(II)
SDEEP(II)=WDEEP*CW(II)
RETURN
END
C
C
C
SUBROUTINE SUSPND(IYR,II,GNDCON)
C
C
C*** COMPUTES AIR CONCENTRATION AND ATMOSPHERIC SOURCE TERM
C*** AT SPILLAGE AREA. CALLED ANNUALLY BY MAIN.
C***
C***
C***
C
C
C
C INPUT VARIABLES
C

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```

C      IYR   = CURRENT YEAR OF SIMULATION
C      II    = CURRENT NUCLIDE
C      SAREA = AREA COVERED BY SPILLAGE
C      GNDCON= GROUND CONCENTRATION
C      IRRES1= FIRST YEAR OF RESUSPENSION RATE
C      IRRES2= LAST YEAR OF RESUSPENSION RATE
C      RR     = RESUSPENSION RATE
C      FTMECH=FRACTION OF YEAR FOR MECHANICAL DISTURBANCE
C      U      = WIND VELOCITY
C
C
C
C
C      INTERMEDIATE VARIABLES
C
C      RE     = RESUSPENSION FACTOR
C      YSO1   = NORMAL CONTRIBUTION TO ATMOSPHERIC SOURCE
C      YSO2   = CONTRIBUTION TO ATMOSPHERIC SOURCE FROM MECHANICAL
C              DISTURBANCE
C
C
C      OUTPUT VARIABLES
C
C      AIRCON= AIR CONCENTRATION AT SPILLAGE AREA
C      YSO    = ATMOSPHERIC SOURCE AMOUNT AT SPILLAGE AREA
C
C
C-----
C----- ASSUME ALL RADIONUCLIDES DEPOSITED ON SOIL SURFACE AT
C----- TIME ZERO.
C-----
C
C      DOUBLE PRECISION NUCLID
C
C      COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
&          PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
&          IRRES1,IRRES2,LIND,IAVG1,IAVG2,RR,FTMECH,
&          WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
&          IAQSTR
C
C      COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
&          AQAM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
&          SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
&          AQCON(40),STCON(40),ATCON(40),AQAVG(40),STAVG(40),
&          ATAVG(40),FMC(40),FMC(40),DECAY(40),XKD(4,40),SOL(40),
&          FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C      COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
&          PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
&          INSITE
C
C      COMMON/AIR/H,VG,U,IT,IS,VD,XG,HLID,ROUGH,FTWIND,CHIQ,RE1,RE2,RE3

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```

C
      T=FLOAT(IYR)*365.
C-----
C----- RESUSPENSION FACTOR BY ANSPAUGH ET AL
C-----
      RE=RE1*EXP(RE2*SQRT(T))+RE3
      AIRCON(II)=RE*GNDCON
      HD=1.0
      F=SQRT(PD*EXTENT)*VG/U/HD
      IF(F .GT. 1.) F=1.0
      YS01=AIRCON(II)*HD*U*SQRT(PD*EXTENT)*F
C-----
C----- THE FOLLOWING IS FOR RESUSPENSION DUE TO MECHANICAL
C----- DISTURBANCES
C-----
      YS02=0.
      IF((IYR .GE. IRRES1) .AND. (IYR .LE. IRRES2))
&      YS02=PD*EXTENT*GNDCON*RR*FTMECH
C-----
      YS0(II)=(YS01+YS02)
C      IF(YS0(II) .GT. ONAM(II))YS0(II)=ONAM(II)
      RETURN
      END

C
C
C
C
      SUBROUTINE TRENCH(NYEAR,VOLB,VOL0,DMAX,PC)
C
C
C***
C***
C*** THIS SUBROUTINE MAINTAINS A TRENCH WATER BALANCE.  WATER
C*** ENTERS THE TRENCH IN THE FORM OF PRECIPITATION AND EXITS
C*** FROM THE BOTTOM IF POSSIBLE.  IF MORE WATER ENTERS THE
C*** TRENCH THAN CAN EXIT FROM THE BOTTOM THE TRENCH MAY
C*** OVERFLOW.
C***
C***
C***
C***
C***
C***
C
C  INPUT VARIABLES
C      TDEPTH = TRENCH DEPTH
C      TAREA  = TRENCH AREA
C      PORT   = POROSITY OF TRENCH MATERIAL
C      OLDWAT = VOLUME OF WATER IN TRENCH FROM PREVIOUS YR
C      XLSAT  = LENGTH OF SATURATED ZONE
C      PPN    = ANNUAL PRECIPITATION
C      XINFL  = ANNUAL INFILTRATION

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```

C      NYEAR = CURRENT YEAR OF SIMULATION
C
C      OUTPUT VARIABLES
C
C      DMAX = MAXIMUM DEPTH OF WATER IN TRENCH
C      OLDWAT = VOLUME OF WATER IN TRENCH AT END OF YEAR
C      VOLO = VOLUME OF WATER OVERFLOWING TRENCH
C      VOLB = VOLUME OF WATER GOING OUT BOTTOM OF TRENCH
C
C      INTERMEDIATE VARIABLES
C
C      NEWWAT = VOLUME OF WATER ENTERING TRENCH
C      PC = FRACTION OF TRENCH CAP THAT HAS FAILED
C
C
C      REAL NEWWAT
C
C      COMMON/EVAP/PPN,PHID,P,XIRR,S(12),T(12),TD(12),XINFL,SINFL
C
C      COMMON/TRCH/TAREA,TDEPTH,OVER,PORT,RELFAC,DENCON,OLDWAT,FN,PERMC
C
C      COMMON/WATER/DTRAQ,DWELL,GWV,XLSAT,STFLOW,AQTHK,AQDISP,
C      &      PORA,PORV,PERMV
C
C      COMMON/LAND/RAINF,ERODF,STPLNG,COVER,CONTRL,SEDELR,SOILOS,
C      &      PORS,BDENS,DWET,EXTENT,ADEPTH,PD,RUNOFF,
C      &      INSITE
C
C      PC=CAP(NYEAR)
C      NEWWAT=TAREA*(PC*SINFL+(1.-PC)*XINFL)
C      HTEST=DTRAQ*(NEWWAT/(PERMV*TAREA)-1.)
C      VOLO=0.
C      IF(TDEPTH-HTEST)200,100,100
100 VOLB=NEWWAT
C      DMAX=HTEST
C      IF(DMAX .LT. 0.)DMAX=0.
C      RETURN
200 VOLB=PERMV*TAREA*(TDEPTH+DTRAQ)/DTRAQ
C      VOLO=NEWWAT-VOLB
C      DMAX=TDEPTH
C      RETURN
C      END
C
C
C
C
C      SUBROUTINE VERHOR(II,NYEAR,ITIME)
C
C
C

```

```

C***
C*** THIS ROUTINE CALCULATES AND DECAYS THE AMOUNT OF RADIO
C*** ACTIVE MATERIAL THAT WILL REACH THE WELL IN A GIVEN YEAR.
C*** THIS SUBROUTINE IS CALLED FROM MAIN.
C***
C***
C***
C***
C***
C***
C
C
C INPUT VARIBALES
C
C II = NUCLIDE NUMBER
C NYEAR = CURRENT YEAR OF SIMULATION
C ITIME = TRANSIT TIME FROM TRENCH TO WELL
C VOLB = VOLUME OF WATER LEAVING TRENCH
C POLB = AMOUNT OF NUCLIDE LEAVING BOTTOM OF TRENCH
C DECAY = RADIOACTIVE DECAY CONSTANT
C
C
C
C
C OUTPUT VARIABLES
C
C AQAM = AMOUNT OF NUCLIDE AT WELL SITE
C
C DOUBLE PRECISION NUCLID
C
C COMMON/CNTRL/NONCLD,MAXYR,TITLE(20),LOCATE(12),NYR1,NYR2,
& PCT1,PCT2,LEAOPT,IOPVWV,IOPSAT,IPRT1,IPRT2,IDELT,
& IRRES1,IRRES2,LIND,IAVG1,IAVG2,RE,FTMECH,
& WWATL,WWATA,WWATH,SWATL,SWATA,SWATH,IVAP,IBSMT,
& IAQSTR
C
C COMMON/NUC/NUCLID(40),ATMASS(40),TRAM(40),SOAM(40),ATAM(40),
& A)AM(40,1000),STAM(40),POLO(40),POLB(40),CS(40),CW(40),
& SSTREM(40),SDEEP(40),AIRCON(40),YSO(40),SOAVG(40),
& AQCON(40),ETCON(40),ATCON(40),AQAVG(40),STAVG(40),
& ATAVG(40),FMC(40),FMG(40),DECAY(40),XKD(4,40),SOL(40),
& FF(40),RA(40),RW(40),BV(40),BR(40),DERATE(40),CWAT(40)
C
C DIMENSION ITIME(40)
C-----
C----- CALCULATE CORRECT POSITION IN ARRAY AND DECAY THE MATERIAL
C----- FOR THE PERIOD OF TIME MATERIAL IS IN TRANSIT FROM TRENCH
C----- TO WELL.
C-----
C ITMP=ITIME(II)
C IF((NYEAR+ITMP) .GT. (MAXYR) .OR. ITMP .LT. 0) GO TO 10
C AQAM(II,NYEAR+ITIME(II))=EXP(-DECAY(II)*ITIME(II))*(POLB(II)+
& SDEEP(II))

```

10 CONTINUE

RETURN

END

C

C

FUNCTION YLAG(XI,X,Y,IND1,N1,IMAX, IEX)

C PROGRAM AUTHORS A. A. BROOKS AND E.C. LONG,

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C

C

LAGRANGIAN INTERPOLATION

C

XI IS INTERPOLATED ENTRY INTO X-ARRAY

C

N IS THE ORDER OF LAGRANGIAN INTERPOLATION

C

Y IS ARRAY FROM WHICH YLAG IS OBTAINED BY INTERPOLATION

C

IND IS THE MIN-I FOR X(I).GT.XI

C

IF IND=0,X-ARRAY WILL BE SEARCHED

C

IMAX IS MAX INDEX OF X-AND Y-ARRAYS

C

EXTRAPOLATION CAN OCCUR,IEX=-1 OR +1

C

C

DIMENSION X(1),Y(1)

IND=IND1

N=N1

IEX=0

IF (N.LE.IMAX) GO TO 10

N=IMAX

IEX=N

10 IF (IND.GT.0) GO TO 40

DO 20 J = 1,IMAX

IF (XI-X(J)) 30,130,20

20 CONTINUE

IEX=1

GO TO 70

30 IND=J

40 IF (IND.GT.1) GO TO 50

IEX=-1

50 INL=IND-(N+1)/2

IF (INL.GT.0) GO TO 60

INL=1

60 INU=INL+N-1

IF (INU.LE.IMAX) GO TO 80

70 INL=IMAX-N+1

INU=IMAX

80 S=0.

P=1.

DO 110 J=INL,INU

P=P*(XI-X(J))

D=1.

DO 100 I=INL,INU

IF (I.NE.J) GO TO 90

XD=XI

GO TO 100

```
90      XD=X(J)
100     D=D*(XD-X(I))
110     S=S+Y(J)/D
        YLAG=S*P
120 RETURN
130 YLAG=Y(J)
        GO TO 120
        END
```

```

SUBROUTINE DARTAB
  REAL*8 NUCLID, ORGN, CANC, TOTBOD, RNLOC, OGLOC, GEN, OREP, CREP, RREP,
  A PO218, PB214, BI214, PO214, PULMO, LUNGS, NDP, TDP, PUL, RREPS
    DATA PO218/8HPO-218 /, PB214/8HPB-214 /, BI214/8HBI-214 /,
  A PO214/8HPO-214 /, PULMO/8HPULMONARY/, LUNGS/8HLUNGS /,
  B NDP/8H*N-P* /, TDP/8H*T-B* /, PUL/8H*PUL* /
    LOGICAL GENEFF, OUTPUT
  REAL LLET
  INTEGER RTABLE, DTABLE, TABLE(7), FTABLE, PTLOC, HLLOC, FALOC

C
  DATA TOTBOD/8HTOT BODY /
  DIMENSION TITLE(20), CONC(4), ILET(2), RREPS(4)
  NAMELIST /INPUT/ILOC, JLOC, PLOC, AGE, ILET, DTABLE, RTABLE, FTABLE,
  A OUTPUT, GSCFAC
  NAMELIST /ORGAN/ORGN, NORGN, TIME
  NAMELIST /QFACTOR/HLET, LLET
  NAMELIST /CANCER/CANC, NCANC, RELABS
  NAMELIST /RNUCLD/NUCLID, NONCLD, PSIZE, RESP, GIABS
  NAMELIST /LOCTBL/NTLOC, RNLOC, OGLOC, PTLOC, FALOC, HLLOC, LTABLE
  NAMELIST /GENETIC/GENEFF, GEN, NGEN, GRFAC, REPPER, GLLET, GHLET
  COMMON/COMEX/EXPP(20,20,40,4), POP(20,20), POFFAC, TOTFAC, NOL, NOU,
  > NRL, NRU, IDIST(20), ILOC, JLOC
  COMMON/COMOR/ORGN(20), NORGN, TIME(20), DOSE(20,40,4,2), DTABLE(7)
  COMMON/LETFAC/HLET(20), LLET(20)
  COMMON/COMCA/CANC(20), NCANC, RELABS(20), RISK(20,40,4,2), RTABLE(7),
  > AGE, YRLL(20,40,4,2)
  COMMON/COMRF/REF(20,40,4), FTABLE(7)
  COMMON/COMNU/NUCLID(40), NONCLD, PSIZE(40), RESP(40), GIABS(4,40),
  > INDPop
    COMMON/COMLOC/RNLOC(10), OGLOC(10), PTLOC(10), FALOC(10),
  > HLLOC(10), LTABLE(10), NTLOC
    COMMON/COMGEN/GEN(3), NGEN, GDOSE(3,40,4,2), GRISK(3,40,4,2),
  > GENEFF, GRFAC(2), REPPER, GLLET(3), GHLET(3), GREF(3,40,4)
    COMMON/COMRN/OREP(20), RREP(20), CREP(20), WLRN(20,20),
  A RRISK, RREF(2), YRLL, NOREP, NRREP, NCREP
    COMMON/COMUS/ARRAY(2200)
C***  SET DEFAULT VALUES.
      OUTPUT=.TRUE.
      ILOC=0
      JLOC=0
      PLOC=100.
      AGE=70.7565
      REPPER=1.41330E-2
      GSCFAC=.5
      NORGN=0
      NCANC=1
      CANC(1)=TOTBOD
      ILET(1)=0
      ILET(2)=2
      DO 10 J=1,7
      DTABLE(J)=0
      RTABLE(J)=0
      FTABLE(J)=0

```

```

10 CONTINUE
  RTABLE(6)=4
  ILET(1)=1
  ILET(2)=1
  DO 20 J=1,20
    TIME(J)=70.
    HLET(J)=20.
    LLET(J)=1.
    RELABS(J)=1.
20 CONTINUE
  NGEN=0
  NOREP=4
  NCREP=1
  NRREP=0
  RREPS(1)=PO218
  RREPS(2)=PB214
  RREPS(3)=BI214
  RREPS(4)=PO214
  CREP(1)=PULMO
  OREP(1)=LUNGS
  OREP(2)=NDP
  OREP(3)=TDP
  OREP(4)=PUL
  READ(26,11700) TITLE
  WRITE(6,10000) TITLE
  READ(26,INPUT)
  IF (PLOC.NE.0) WRITE(6,10100)PLOC
  IF (ILET(1).EQ.0.OR.ILET(1).EQ.2) WRITE(6,10200)
  IF (ILET(1).EQ.1.OR.ILET(1).EQ.2) WRITE(6,10300)
  IF (ILET(2).EQ.0.OR.ILET(2).EQ.2) WRITE(6,10400)
  IF (ILET(2).EQ.1.OR.ILET(2).EQ.2) WRITE(6,10500)
  WRITE(6,10600) DTABLE,RTABLE,FTABLE
  WRITE(6,11900) GSCFAC
C***  READ IN ORGAN PARAMETERS
40 READ(26,ORGAN)
  WRITE(6,10700) NORGN
  WRITE(6,10800) (ORGN(I),TIME(I),I=1,NORGN)
  IF (ILET(1).GT.0) READ(26,QFACTR)
  IF (ILET(1).GT.0) WRITE(6,10900) (ORGN(I),LLET(I),HLET(I), I=1,
> NORGN)
C***  READ IN CANCER PARAMETERS
50 READ(26,CANCER)
  WRITE(6,11000) NCANC
  WRITE(6,11100) (CANC(I),RELABS(I),I=1,NCANC)
C***  READ IN GENETIC PARAMETERS
  READ(26,GENETIC)
  IF(GENEFF) WRITE(6,11800) (GEN(I),I=1,NGEN)
  IF(GENEFF) WRITE(6,11850) GRFAC,REPPER
11800  FORMAT('OGENETIC DOSES ARE PRINTED FOR '
< 3(1X,A8))
11850  FORMAT(' THE RISK FACTOR (PER RAD/MILLION BIRTHS)',
< ' FOR GENETIC DOSE ARE :'/
< G15.8 , ' FOR LOW LET, AND'/
< G15.8, ' FOR HIGH LET, '/
< ' AND THE REPLACEMENT RATE FOR THE POPULATION IS :'/
< 1X,G10.5, ' YEAR-1')

```



```

C***   CONVERT TO /MRAD/BIRTHS
        GRFAC(1)=GRFAC(1)*1.E-9
        GRFAC(2)=GRFAC(2)*1.E-9
C***   READ IN RADIONUCLIDE PARAMETERS
        READ(26,RNUCLD)
        WRITE(6,11200) NONCLD
        WRITE(6,11300)(NUCLID(I),PSIZE(I),RESP(I), (GIABS(J,I),J=1,4),I=1,
> NONCLD)
        DO 30 I=1,NONCLD
        DO 25 K=1,4
        IF(NUCLID(I).EQ.RREPS(K)) GO TO 27
25      CONTINUE
        GO TO 30
27      NRREP=NRREP+1
        RREP(NRREP)=RREPS(K)
30      CONTINUE
        NTLOC=0
        READ(26,LOCTBL)
        IF(NTLOC.EQ.0) GO TO 55
        WRITE(6,11305) NTLOC
        WRITE(6,11310) (RNLOC(I) OGLOC(I),PTLOC(I),FALOC(I),HLLOC(I),
> I=1,NTLOC)
55      CONTINUE
11305   FORMAT('0',I2,' LOCATION TABLES ARE TO BE OUTPUT FOR: '//
> ' NUCLIDE ORGAN PATHWAY QUANTITY LET'//
> ' OR CANCER'//)
11310   FORMAT(1X,A8,1X,A8,4X,I2,7X,I2,7X,I2)
C***   READ IN DOSE RATES AND HEALTH RISKS
        CALL RDSTOR(OUTPUT)
C***   CHOOSE LOCATION AND FIND EXPOSURES
        CALL CHLOC(PLOC,CONC,GSCFAC)
        IF(NORGN.NE.0) CALL RMORGF
        CALL SUMMRY(TITLE,GSCFAC)
        IF (NORGN.LE.0) GO TO 70
C***   DECIDE IF LOW AND HIGH LET ARE TO BE SEPARATE TABLES
C***   AND THEN OUTPUT TABLES
        IDO=0
        DO 60 J=1,7
        IF (DTABLE(J).NE.0) IDO=1
        TABLE(J)=DTABLE(J)
60      CONTINUE
        IF(NTLOC.EQ.0 .OR. IDO.EQ.1) GO TO 67
        DO 65 J=1,NTLOC
        IF(FALOC(J).EQ.1) IDO=1
65      CONTINUE
67      CONTINUE
C***   ILET = 0 MEANS ONLY TABLES FOR LOW AND HIGH LET SEPARATELY
C***   ILET = 1 MEANS ONLY A TABLE FOR LOW AND HIGH LET COMBINED
C***   ILET = 2 MEANS BOTH SETS OF TABLES
        IF (IDO.EQ.1) CALL PREPDR(TABLE,ILET(1),TITLE,GSCFAC)
70      IDO=0
        DO 80 J=1,7
        IF (FTABLE(J).NE.0) IDO=1
80      TABLE(J)=FTABLE(J)
        IF(NTLOC.EQ.0 .OR. IDO.EQ.1) GO TO 87
        DO 85 J=1,NTLOC
        IF(FALOC(J).EQ.3) IDO=1

```



```

C***  THIS SUBROUTINE READS AND STORES DOSE RATES
C***  AND HEALTH RISKS FOR ORGANS AND CANCERS
      REAL*8 NUC,NUCLID,ORGN,CANC,O,C,OG,GEN,OREP,CREP,RREP
      LOGICAL GENEFF,OUTPUT
      COMMON/COMOR/ORGN(20),NORGN,TIME(20),DOSE(20,40,4,2),DTABLE(7)
      COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLRN(20,20),
A  RRISK,RRF(2),RYLL,NOREP,NRREP,NCREP

      COMMON/COMCA/CANC(20),NCANC,RELABS(20),RISK(20,40,4,2),RTABLE(7),
>  AGEK,YRLL(20,40,4,2)
      COMMON/COMRF/REF(20,40,4),FTABLE(7)
      COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS(4,40),
>  INDPOP
      COMMON/COMUS/C(40),O(40),D(2,40),R(2,40),RF(40),YLL(2,40),
>  G(2,3),OG(3),DCHK(20,40),RCHK(20,40),GCHK(3,40)
      COMMON/COMGEN/GEN(3),NGEN,GDOSE(3,40,4,2),GRISK(3,40,4,2),
>  GENEFF,GRFAC(2),REPPER,GLLET(3),GHLET(3),GREF(3,40,4)
      DIMENSION GIIN(4)
      LOGICAL*1 FAL,TRU,DCHK,RCHK,GCHK,IW
      DATA TRU/.TRUE./,FAL/.FALSE./
C***  ZERO OUT ALL ARRAYS
      NDO=NORGN+1
      DO 35 N=1,2
      DO 30 J=1,4
      DO 30 K=1,NONCLD
      DO 10 L=1,NDO
      DOSE(L,K,J,N)=0.0
        IF(L.GT.NOPN) GO TO 10
      GDOSE(L,K,J,N)=0.0
10  CONTINUE
      NDO=NCANC+1
      DO 20 L=1,NDO
      RISK(L,K,J,N)=0.0
        YRLL(L,K,J,N)=0.0
      REF(L,K,J)=0.0
        IF(L.GT.NGEN) GO TO 20
      GRISK(L,K,J,N)=0.0
      GREF(L,K,J)=0.0
20  CONTINUE
30  CONTINUE
35  CONTINUE
      DO 38 L=1,40
      DO 37 K=1,20
      DCHK(K,L)=TRU
      RCHK(K,L)=TRU
37  CONTINUE
      DO 39 K=1,3
      GCHK(K,L)=TRU
39  CONTINUE
38  CONTINUE
C***  READ FIRST RECORD
41  READ(25,END=180) NUC,SIZEIN,RESPIN,GIIN,TIMIN,IND
      IFIND=0
C***  CHECK TO SEE IF THE RADIONUCLIDE IS IN OUTPUT LIST
      DO 50 K=1,NONCLD
      IF (NUC.EQ.NUCLID(K)) GO TO 60

```

```

40     CONTINUE
50 CONTINUE
   IF(IFIND.EQ.0)GO TO 125
   GO TO 41
C***   FIND OUT WHAT TYPE OF RECORD FOLLOWS
60 IRA=IND/10
   IF(IRA.JT.2) GO TO 401
   ICHOS=IND-IRA*10
   IF (ICHOS.NE.2) GO TO 75
   DO 70 L=1,4
   IF (ABS(GIIN(L)-GIABS(L,K)).GT.1.E-6) GO TO 40
70 CONTINUE
75 IF (ICHOS.NE.3) GO TO 80
   IF (ABS(SIZEIN-PSIZE(K)).GT.1.E-6) GO TO 40
   IF (RESPIN.NE.RESP(K)) GO TO 40
80 IF (IND.LE.5) GO TO 130
C***   THE NEXT TWO RECORDS CONTAIN CANCERS AND RISKS
   IF(IFIND.NE.0) GO TO 81
   READ(25) NC,ILET,(C(I),I=1,NC)
   READ(25) ((R(L,I),L=1,ILET),I=1,NC)
   READ(25) ((YLL(L,I),L=1,ILET),I=1,NC)
   READ(25)(RF(I),I=1,NC),TRF
81     IFIND=1
   REF(NCANC+1,K,ICHOS-1)=TRF+REF(NCANC+1,K,ICHOS-1)
C***   CHECK TO SEE IF THE CANCER IS IN OUTPUT LIST
   DO 110 I=1,NC
   DO 90 J=1,NCANC
   IF (C(I).EQ.CANC(J)) GO TO 100
90 CONTINUE
   GO TO 110
C***   THE CANCER NAMES MATCH, NOW DO WE HAVE RELATIVE OR ABS RISK
100 IF (RFLABS(J).NE.IRA) GO TO 110
C***   A MATCH, STORE THE RISK
   RCHK(J,K)=FAL
   RISK(J,K,ICHOS-1,1)=R(1,I)
   YRLL(J,K,ICHOS-1,1)=YLL(1,I)
   IF (ILET.LE.1) GO TO 105
   RISK(J,K,ICHOS-1,2)=R(2,I)
   YRLL(J,K,ICHOS-1,2)=YLL(2,I)
105   REF(J,K,ICHOS-1)=RF(I)
   IF(IND.NE.3)GO TO 110
   DO 106 L=1,NRREP
   IF(NUCLID(K).EQ.RREP(L)) GO TO 107
106 CONTINUE
   GO TO 110
107 DO 108 L=1,NCREP
   IF(C(I).EQ.CREP(L)) GO TO 109
108 CONTINUE
   GO TO 110
109 RISK(J,K,2,2)=0.0
   YRLL(J,K,2,2)=0.0
110 CONTINUE
C***   THE RISKS HAVE BEEN STORED OR SKIPPED, GO TO NEXT RECORD
   GO TO 40

```

```

C***   SKIP THE RECORDS
125 READ(25,END=180) DUM
    READ(25,END=180) DUM
        IF(IND.LE.5 .OR. IND.GT.90) GO TO 41
        READ(25,END=180) DUM
        READ(25,END=180) DUM
    GO TO 41
C***   THE NEXT TWO RECORDS CONTAIN ORGANS AND DOSE RATES
130 IF(IFIND.NE.0) GO TO 131
    READ(25) NO,ILET,(O(I),I=1,NO)
    READ(25) ((D(L,I),L=1,ILET),I=1,NO)
131 IFIND=1
C***   FOR INTERNAL DOSES, ALSO CHECK OTHER NUCLIDE PARAMETERS
C***   CHECK TO SEE IF THE ORGANS ARE ON OUTPUT LIST
140 DO 170 I=1,NO
    DO 150 J=1,NORGN
        IF (O(I).EQ.ORGJ(J)) GO TO 160
150 CONTINUE
    GO TO 170
C***   A MATCH SO STORE THE DOSE
160 IF(IND.GT.3) GO TO 159
    IF(ABS(TIMIN-TIME(J)).GT.1.E-6) GO TO 40
159 DOSE(J,K,IND-1,1)=D(1,I)
    IF (ILET.GT.1) DOSE(J,K,IND-1,2)=D(2,I)
    DCHK(J,K)=FAL
    IF(IND.NE.3) GO TO 170
    DO 162 L=1,NRREP
        IF(NUCLID(K).EQ.RREP(L)) GO TO 163
162 CONTINUE
    GO TO 170
163 DO 165 L=1,NOREP
    IF(ORGJ(J).EQ.OREP(L)) GO TO 167
165 CONTINUE
    GO TO 170
167 DOSE(J,K,2,2)=0.0
170 CONTINUE
    IF(IND.LT.4) GO TO 40
    DO 172 I=1,NO
    DO 152 J=1,NGEN
        IF(O(I).EQ.GEN(J)) GO TO 161
152 CONTINUE
    GO TO 172
161 GDOSE(J,K,IND-1,1)=D(1,I)*30.
    IF(ILET.GT.1)GDOSE(J,K,IND-1,2)=D(2,I)*30.
172 CONTINUE
    GO TO 40
C***   DOSES HAVE BEEN SKIPPED OR STORED, GO TO NEXT RECORD
180 CONTINUE
    IW=TRU
    DO 200 K=1,NONCLD
    DO 200 J=1,NORGN
        IF(.NOT.DCHK(J,K)) GO TO 200
    IF(IW) WRITE(6,900)
    WRITE(6,901) ORGN(J),NUCLID(K)
    IW=FAL

```

```

200    CONTINUE
900    FORMAT('0 THE FOLLOWING NUCLIDES AND ',
<    ' ORGAN DOSE FACTORS WERE NOT FOUND',
>    ' IN THE INPUT DATA SETS: '//
>    ' ORGAN NUCLIDE'//)
901    FORMAT(1X,A8,1X,A8)
        IW=TRU
        DO 300 K=1,NONCLD
        DO 300 J=1,NCANC
        IF(.NOT.RCHK(J,K)) GO TO 300
        IF(IW) WRITE(6,902)
        IW=FAL
902    FORMAT('0THE FOLLOWING NUCLIDES AND ',
<    ' CANCER RISK FACTORS WERE NOT FOUND',
>    ' IN THE INPUT DATA SETS: '//
>    ' CANCER NUCLIDE'//)
        WRITE(6,901) CANC(J),NUCLID(K)
300    CONTINUE
        IF(.NOT.GENEFF) RETURN
        IW=TRU
        DO 400 K=1,NONCLD
        DO 400 J=1,NGEN
        IF(.NOT.GCHK(J,K)) GO TO 400
        IF(IW) WRITE(6,903)
        IW=FAL
903    FORMAT('0THE FOLLOWING NUCLIDES AND ',
<    ' GENETIC DOSE FACTORS WERE NOT',
>    ' FOUND IN THE INPUT DATA SETS: '//
>    ' GEN.DOSE NUCLIDE')
        WRITE(6,901) GEN(J),NUCLID(K)
400    CONTINUE
        DO 625 J=1,NONCLD
        DO 625 K=3,4
        NGN=NGEN-1
        AVG=0.0
        DO 600 I=1,NGN
        AVG=AVG+GDOSE(I,J,K,1)
600    CONTINUE
        GDOSE(NGEN,J,K,1)=AVG/FLOAT(NGN)
625    CONTINUE
        DO 700 L=1,2
        DO 700 I=1,4
        DO 700 K=1,NONCLD
        GRISK(1,K,I,L)=GDOSE(3,K,I,L)*GRFAC(L)
700    CONTINUE
        DO 705 I=1,4
        DO 705 K=1,NONCLD
        GREF(1,K,I)=(GRISK(1,K,I,1)+GRISK(1,K,I,2))/(30.*GRFAC(1))
705    CONTINUE
        IF(OUTPUT) CALL FACOUT
        RETURN
401    IF(IRA.NE.9) GO TO 800
        ICHOS=0
        IF(IND.EQ.98) ICHOS=3
        IF(IND.EQ.99) ICHOS=2

```

```

      IF(ICHOS.EQ.0) GO TO 125
      IF(.NOT.GENEFF) GO TO 125
      IF(ICHOS.NE.2)GO TO 507
      DO 505 L=1,4
505    IF (ABS(GIIN(L)-GIABS(L,K)).GT.1.E-6) GO TO 40
507    IF(ICHOS.NE.3)GO TO 510
      IF (ABS(SIZEIN-PSIZE(K)).GT.1.E-6) GO TO 40
      IF(RESPIN.NE.RESP(K)) GO TO 40
510    IF(IFIND.NE.0) GO TO 511
      READ(25) NG,LET,(OG(I),I=1,NG)
      READ(25) ((G(L,I),L=1,LET),I=1,NG)
511    IFIND=1
520    DO 530 I=1,NG
      DO 525 J=1,NGEN
      IF(OG(I).EQ.GEN(J)) GO TO 540
525    CONTINUE
      GO TO 530
540    GDOSE(J,K,ICHOS-1,1)=G(1,I)
      IF(LET.GT.1) GDOSE(J,K,ICHOS-1,2)=G(2,I)
      GCHK(J,K)=FAL
530    CONTINUE
      GO TO 40
800    IF(IND.NE.33) GO TO 125
      READ(25) NC,ILET,(C(I),I=1,NC)
      READ(25) ((R(L,I),L=1,ILET),I=1,NC)
      READ(25) ((YLL(L,I),L=1,ILET),I=1,NC)
      READ(25) (RF(I),I=1,NC),TRF
      IFIND=1
      CREP(1)=C(1)
      NCREP=NC
      RRISK=R(1,1)
      RYLL=YLL(1,1)
      RREF(1)=RF(1)
      RREF(2)=TRF
      GO TO 40
END
      SUBROUTINE FACOUT
      REAL*8 NUCLID,ORGN,CANC,OG,GEN,OREP,CREP,RREP,RN222,WBODY
      DATA RN222/8HRN-222 /,WBODY/'W BODY '/
      LOGICAL GENEFF
      COMMON/COMOR/ORGN(20),NORGN,TIME(20),DOSE(20,40,4,2),DTABLE(7)
      COMMON/COMN/OREP(20),RREP(20),CREP(20),WLRN(20,20),
A   RRISK,RREF(2),RYLL,NOREP,NRREP,NCREP
      COMMON/COMCA/CANC(20),NCANC,RELABS(20),RISK(20,40,4,2),
A   RTABLE(7),AGEX,YRLL(20,40,4,2)
      COMMON/COMRF/REF(20,40,4),FTABLE(7)
      COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS(4,40),
A   INDPOP
      COMMON/COMGEN/GEN(3),NGEN,GDOSE(3,40,4,2),GRISK(3,40,4,2),
A   GENEFF,GRFAC(2),REPPER,GLLET(3),GHLET(3),GREF(3,40,4)
      DO 1000 K=1,NONCLD
      WRITE(6,10000) NUCLID(K)
      WRITE(6,10100)
10000  FORMAT('1FOR NUCLIDE : ',A8//)
10100  FORMAT(' DOSE RATE CONVERSION FACTORS'//)

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A 1X,'ORGAN',11X,'INGESTION',10X,'INHALATION',
A 9X,'AIR',5X,'GROUND'/
B 12X,'LOW LET',3X,'HIGH LET',2X,'LOW LET',
B 3X,'HIGH LET',2X,'IMMERSION',1X,'SURFACE')
WRITE(6,10200) (ORGN(I),((DOSE(I,K,J,N),N=1,2),J=1,2),
A (DOSE(I,K,J,1),J=3,4),I=1,NORGN)
10200 FORMAT((1X,A8,1X,6(1PG10.3)))
IF(.NOT.GENEFF) GO TO 100
WRITE(6,10300)
WRITE(6,10200) (GEN(I),((GDOSE(I,K,J,N),N=1,2),J=1,2),
A (GDOSE(I,K,J,1),J=3,4),I=1,NGEN)
10300 FORMAT(' GENETIC EFFECT DOSE RATE CONVERSION FACTORS')
100 CONTINUE
WRITE(6,10175)
10175 FORMAT('0',28X,'RISK CONVERSION FACTORS',35X,
A 'YEARS OF LIFE LOST FACTORS'/
A 1X,'CANCEP',10X,'INGESTION',10X,'INHALATION',
A 9X,'AIR',5X,'GROUND',9X,'INGESTION',10X,'INHALATION',
A 7X,'AIR',5X,'GROUND'/
B 12X,'LOW LET',3X,'HIGH LET',2X,'LOW LET',
B 3X,'HIGH LET',2X,'IMMERSION',1X,'SURFACE',3X,
B 'LOW LET',3X,'HIGH LET',2X,'LOW LET',
B 3X,'HIGH LET',2X,'IMMERSION',1X,'SURFACE')
WRITE(6,10250) (CANC(I),((RISK(I,K,J,N),N=1,2),J=1,2),
A (RISK(I,K,J,1),J=3,4),((YELL(I,K,J,N),N=1,2),J=1,2),
B (YELL(I,K,J,1),J=3,4),I=1,NCANC)
10250 FORMAT((1X,A8,1X,12(1PG10.3)))
IF(.NOT.GENEFF) GO TO 200
WRITE(6,10400)
10400 FORMAT(' GENETIC EFFECT RISK CONVERSION FACTORS')
WRITE(6,10200) GEN(3),((GRISK(1,K,J,N),N=1,2),J=1,2),
A (GRISK(1,K,J,1),J=3,4)
200 CONTINUE
WRITE(6,10190)
10190 FORMAT('ORISK EQUIVALENT CONVERSION FACTORS'/
A 1X,'CANCER',3X,'INGESTION',1X,'INHALATION',
B 4X,'AIR',4X,'GROUND'/31X,'IMMERSION',2X,'SURFACE')
NALL=NCANC+1
CANC(NALL)=WBODY
WRITE(6,10275) (CANC(I), (REF(I,K,J),J=1,4),I=1,NALL)
10275 FORMAT((1X,A8,1X,4(1PG10.3)))
IF(.NOT.GENEFF) GO TO 300
WRITE(6,10600)
10600 FORMAT(' GENETIC EFFECT RISK EQ. CONVERSION FACTOR')
WRITE(6,10275) GEI(3), (GREF(1,K,I),I=1,4)
300 CONTINUE
1000 CONTINUE
DO 400 I=1,NONCLD
IF(NUCLID(I).EQ.RN222) GO TO 450
400 CONTINUE
RETURN
450 WRITE(6,10700) RRISK,RYELL,RREF
10700 FORMAT('1FOR RN-222 WORKING LEVEL CALCULATIONS: '/

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A ' RISK CONVERSION FACTOR = ',1PG10.3/
B ' YEARS OF LIFE LOST FACTOR = ',1PG10.3/
C ' RISK EQ. CONVERSION FACTOR (PULMINARY) = ',1PG10.3/
D ' RISK EQ. CONVERSION FACTOR (W BODY ) = ',1PG10.3)
  RETURN
  END
  SUBROUTINE PREPDR(TABLE,ILET,TITLE,GSCFAC)
C***  THIS ROUTINE PREPARES DOSE RATES TO BE OUTPUT.
  REAL*4 ORGN,NUCLID,RNLOC,OGLOC,ORC,ORG, LAST,GEN,OREP,RREP,CREP,
A  GON
  COMMON/HEAD/ORC
  COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLEN(20,20),
A  RRISK,RREF(2),RYELL,NOREP,NRREP,NCREP
  COMMON/COMWOR/FACO(20,4)
  COMMON/COMGEN/GEN(3),NGEN,GDOSE(3,40,4,2),GRISK(3,40,4,2),
>  GENEFF,GRFAC(2),RLPER,GLLET(3),GHLET(3),GREP(3,40,4)
  DATA ORG/8H ORGAN /,LAST/8HWT. SUM /,GON/8H GONAD /
  COMMON/COMLOC/RNLOC(10),OGLOC(10),PTLOC(10),FALOC(10),
>  HLLOC(10),LTABLE(10),NTLOC
  REAL LLET
  INTEGER TABLE,FALOC,HLLOC,PTLOC
  DIMENSION TABLE(1),TITLE(1),TITLA(10,3), FACD(4,3),TLET(2,3),
>  TITL2(2),ITAB(7),TITLB(10,3),TITLGA(10,3),TITLGB(10,3),
>  FACG(4,3),NOTE(20),NOT2(20),OFAC(20,20),NUN(8,3)
  DATA NUN/4H(WOR,4H KING,4H LEV,4H EL) ,4*4H ,4H(WOR,
>  4H KING,4H LEV,4H EL) ,4*4H ,4H(PER,4H SON ,4H WORK,
>  4H ING ,4H LEVE,4H L) ,2*4H /
  DATA NOTE/4H RADO,4H N DA,4H UGHT,4H ER E,4H XPOS,4H URE:,
>  14*4H /,NOT2/20*4H /
  LOGICAL IDO,GENEFF
  DATA TITLA/4HINDI,4HVIDU,4HAL D,4HOSE ,4H RATE,4H (MR, 4HAD/Y,
>  4HEAR),4H ,4H ,4HMEAN,4H IND,4HIVID,4HUAL , 4HDOSE,4H RAT,
>  4HE (M,4H RAD/,4HYEAR,4H) ,4H COLL,4HECTI, 4HVE D,4H CSE ,4H RATE,
>  4H (PE,4H RSON,4H RAD,4H /YE,4H AR) /
  DATA TITLB/4HINDI,4HVIDU,4HAL D,4HOSE ,4HEQ. ,4H RATE,4H(MRE,
>  4HM/YE,4H AR) ,4H ,4HMEAN,4H IND,4HIVID,4HUAL , 4HDOSE,4H EQ.,
>  4H RAT,4HE (M,4H REM/,4HYR) ,4H COLL,4HECTI 4HVE D,4HOSE ,4HEQ. ,
>  4H (PE,4H RSON,4H REM,4H /YE,4H AR) /
  DATA TITLGA/4HINDI,4HVIDU,4HAL G,4HENET,4HIC D,4HOSE ,
<  4H(MRA,4HD) ,4H ,4H ,
>  4HMEAN,4H IND,4HIVID,4HUAL ,4HGENE,4HTIC ,4HDOSE,4H (MR,
>  4HAD) ,4H ,
>  4H COLL,4HECTI,4HVE G,4HENET,4HIC D,4HOSE ,4H( PE,4H RSON,
>  4H RAD,4H) /
  DATA TITLGB/4HINDI,4HVIDU,4HAL G,4HENET,4HIC D,4H P SE ,
>  4HEQ. ,4H(MRE,4HM) ,4H ,
>  4HMEAN,4H IND,4HIVID,4HUAL ,4HGENE,4HTIC ,4HDOSE,4H EQ.,
>  4H (MR,4HM) ,
>  4H COLL,4HECTI,4HVE G,4HENET,4HIC D,4HOSE ,4HEQ. ,4H(PER,
<  4H SON ,4H REM)/
  DATA TLET/4HLOW ,4HLET ,4HHIGH,4H LET,4H ,4H ,
  COMMON/COMOR/ORGN(20),NORGN,TIME(20),DOSE(20,40,4,2)
  COMMON/LETFAC/HLET(20),LLET(20)
  COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS (4,40),

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> INDPOP
  DATA FACD/1.,1.,1.,100.,1.,1.,1.,100.,.001,.001,.001,.1/
  DATA FACG/1.,1.,1.,100.,1.,1.,1.,100.,.001,.001,.001,.1/
C*****777777777
C~**  MULTIPLY DOSES BY EXPOSURES
C***  PREPARE TABLE FOR HIGH AND LOW LET SEPARATELY
      DO 5 J=1,3
      FACD(4,J)=FACD(4,J)*GSCFAC
      FACG(4,J)=FACG(4,J)*GSCFAC
5      CONTINUE
      DO 50 L=1,2
10     DO 20 K=1,2
20     TTIL2(K)=TLET(K,L)
      DO 40 IT=1,3
      DO 42 J=1,NOREP
      DO 42 K=1,1
      OFAC(J,K)=1.
42     CONTINUE
      IDO=.FALSE.
      IF(ILET.EQ.1) GO TO 35
      DO 30 K=1,7
      ITAB(K)=0
      IF (TABLE(K).NE.IT.AND.TABLE(K).NE.4) GO TO 30
      ITAB(K)=1
      IDO=.TRUE.
30     CONTINUE
35     CONTINUE
      IF (ITAB(6).NE.0) ITAB(6)=0
      ORC=ORG
      IF (IDO) CALL MULT(IT,FACD(1,IT),DOSE(1,1,1,L),NORGN,ORGN,TITLE,
>  TITLA(1,IT),ITAB,TITL2,NOTE,NUN(1,IT),OFAC,OREP,NOREP,20)
      ORC=GON
      IF(IDO.AND.GENEFF) CALL MULT(IT,FACG(1,IT),GDOSE(1,1,1,L),NGEN,
>  GEN,TITLE,TITLGA(1,IT),ITAB,TITL2,NOT2,NOT2.0.,0.,0,3)
      IF(IT.EQ.2) GO TO 38
      IF(NTLOC.EQ.0) GO TO 38
      DO 45 LL=1,NTLOC
      IF(FALOC(LL).NE.1) GO TO 45
      IF(HLLOC(LL).EQ.1) GO TO 45
      IF(LTABLE(LL).NE.IT.AND.LTABLE(LL).NE.4) GO TO 45
      CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),FACD(1,IT),
A  DOSE(1,1,1,L),TITLE,TITLA(1,IT),TITL.,ORGN,NORGN,20,1)
      IF(GENEFF) CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),
<  FACG(1,IT),GDOSE(1,1,1,L),TITLE,TITLGA(1,IT),TITL2,GEN,NGEN,
<  3,1)
45     CONTINUE
38     CONTINUE
      IF (INDPOP.NE.1) GO TO 50
40     CONTINUE
50     CONTINUE
C***  COMBINE HIGH AND LOW LET USING INPUT QUALITY FACTORS
      DO 70 K=1,2
      TTIL2(K)=TLET(K,3)
70     CONTINUE

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DO 80 I=1,4
DO 80 J=1,NONCLD
DO 80 K=1,NORGN
DOSE(K,J,I,1)=(DOSE(K,J,I,1)*LLET(K)+ DOSE(K,J,I,2)*HLET(K))
DOSE(NORGN+1,J,I,1)=DOSE(NORGN+1,J,I,1)+DOSE(K,J,I,1)*FACO(K,I)
IF (K.GT.NGEN) GO TO 80
GDOSE(K,J,I,1)=(GDOSE(K,J,I,1)*GLLET(K)+GDOSE(K,J,I,2)*GHLET(K))
80 CONTINUE
DO 100 IT=1,3
IDO=.FALSE.
IF(ILET.EQ.0) GO TO 95
DO 90 I=1,6
ITAB(K, I)
IF (ITAB(K).NE.IT.AND.TABLE(K).NE.4) GO TO 90
ITAB(K)=1
IDO=.TRUE.
90 CONTINUE
95 CONTINUE
ORGN(NORGN+1)=LAST
ORC=ORG
IF (IDO) CALL MULT(IT,FACD(1,IT),DOSE,NORGN+1,ORGN,TITLE,
< TITLB(1,IT),ITAB,TITL2,NOTE,NUN(1,IT),OFAC,OREP,NOREP,20)
ORC=GON
IF(IDO.AND.GENEFF) CALL MULT(IT,FACG(1,IT),GDOSE,NGEN,GEN,
< TITLE,TITLGB(1,IT),ITAB,TITL2,NOT2,NOT2,0.,0.,0,3)
IF(IT.EQ.2) GO TO 138
IF(NTLOC.EQ.0) GO TO 138
DO 135 LL=1,NTLOC
IF(FALOC(LL).NE.1) GO TO 135
IF(HLLOC(LL).EQ.0) GO TO 135
IF(LTABLE(LL).NE.IT.AND.LTABLE(LL).NE.4) GO TO 135
CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),FACD(1,IT),
> DOSE,TITLE,TITLB(1,IT),TITL2,ORGN,NORGN,20,1)
IF(GENEFF) CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),
> FACG(1,IT),GDOSE,TITLE,TITLGB(1,IT),TITL2,GEN,NGEN,3,1)
135 CONTINUE
138 CONTINUE
IF (INDPOP.NE.1) RETURN
100 CONTINUE
RETURN
END
SUBROUTINE PREPHR(TABLE,ILET,TITLE,GSCFAC)
C*** PREPARE HEALTH RISKS TO BE OUTPUT
REAL*8 CANC,NUCLID,RNLOC,OGLOC,ORG,CAN, LAST, GEN, RREP, OREP, CREP,
A BL,GON
COMMON/HEAD/ORG
COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLRN(20,20),
A RRISK,RREF(2),RYRL,NOREP,NRREP,NCREP
DATA CAN/8H CANCER /,LAST/8HTOTAL /,BL/8H /,
A GON/8H GONAD /
INTEGER TABLE,FALOC,HLLOC,PTLOC
LOGICAL IDO,GENEFF
COMMON/COMLOC/RNLOC(10),OGLOC(10),PTLOC(10),FALOC(10),
> HLLOC(10),LTABLE(10),NTLOC
COMMON/COMGEN/GEN(3).NGEN.GDOSE(3,40,4,2),GRISK(3,40,4,2),

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> GENEFF,GRFAC(2),REPPER,GLLET(3),GHLET(3),GREF(3,40,4)
  DIMENSION TABLE(1),TITLE(1),TITLA(10,3), TLET(2,3),TITL2(2),
> FACD(4,3),ITAB(7),TITLG(10,3),FACG(4,3),NOTE(20),NOT2(20)
> ,NUN(8,3),DRISK(2)
  DATA NOTF/4HRADO,4HN DA,4HAGHT,4HER E,4HXPOS,4HURE ,4HRISK,
> 4H: ,12*4H /,NOT2/20*4H /
  DATA NUN/16*4H ,4H(DRA,4HTH/Y,4HR) ,5*4H /
  DATA TITLA/4HINDI,4HVIDU,4HAL L,4HIFET,4HIME ,4HRISK, 4H (DE,
> 4HATHS,4H) ,4H ,4HMEAN,4H IND,4HIVID,4HUAL , 4HLIFE,4HTIME,
> 4H RIS,4HK (D,4HEATH,4HS) ,4HFATA,4HL CA,4HNCR,4H RAT,
> 4HE (D,4HEATH,4H/YR),3*4H /
  DATA TITLG/4HINDI,4HVIDU,4HAL G,4HENET,4HIC E,4HFFEC,4HTS P,
< 4HER B,4HIRTH,4H ,
< 4HMEAN,4H IND,4HIVID,4HUAL ,4HGENE,4HTIC ,4HEFFE,4HCTS ,
< 4H/BIE,4HTH ,
< 4HCOLL,4HECTI,4HVE G,4HBLT,4HIC E,4HFFEC,4HT(EF,4HEFECT,
< 4HIVE/,4HYR) /
  DATA FACD/2*1.E-5,10.,1000.,2*1.E-5,10.,1000.,4*0./
  DATA FACG/1.,1.,1.,100.,1.,1.,1.,100.,.001,.001,.001,.1/
C*****???????
  DATA TLET/4HLOW ,4HLET ,4HHIGH,4H LET,4HCOMB,4H.LET/
  COMMON/COMCA/CANC(20),NCANC,RELABS(20),RISK(20,40,4,2),RTABLE(7),
> AGEX,YELL(20,40,4,2)
  COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS (4,40),
> INDPop
C*** MULTIPLY RISKS BY EXPOSURES
C*** PREPARE HIGH AND LOW LET SEPARATELY
  DO 2 J=1,3
    FACD(4,J)=GSCFAC*FACD(4,J)
    FACG(4,J)=GSCFAC*FACG(4,J)
2    CONTINUE
  DO 5 J=1,4
    FACG(J,3)=FACG(J,2)*REPPER
5    FACD(J,3)=FACD(J,2)/AGEX
  DO 50 L=1,2
10 DO 20 K=1,2
20 TITL2(K)=TLET(K,L)
  DO 25 I=1,4
  DO 25 J=1,NONCLD
  DO 25 K=1,NCANC
    RISK(NCANC+1,J,I,L)=RISK(K,J,I,L)+RISK(NCANC+1,J,I,L)
25 CONTINUE
  DO 40 IT=1,3
  ILO=.FALSE.
  IF(ILET.EQ.1) GO TO 35
  DO 30 K=1,7
  ITAB(K)=0
  IF (TABLE(K).NE.IT.AND.TABLE(K).NE.4) GO TO 30
  IDO=.TRUE.
  ITAB(K)=1
30 CONTINUE

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35    CONTINUE
      ORG=CAN
      DRISK(1)=RRISK
      IF(IT.EQ.3) DRISK(1)=RRISK/AGEX
      DRISK(2)=DRISK(1)
      IF (IDO) CALL MULT(IT,FACD(1,IT),RISK(1,1,1,L),NCANC+1,CANC,TITLE,
> TITLA(1,IT),ITAB,TITL2,NOTE,NUN(1,IT),DRISK,CREP,NCREP,20)
      ORG=GON
      IF(IDO.AND. GENEFF) CALL MULT(IT,FACG(1,IT),GRISK(1,1,1,L),
> 1,GEN(3),TITLE,TITLG(1,IT),ITAB,TITL2,NOT2,NOT2,0.,0.,0,3)
      IF(IT.EQ.2) GO TO 38
      IF(NTLOC.EQ.0) GO TO 38
      DO 45 LL=1,NTLOC
      IF(FALOC(LL).NE.2) GO TO 45
      IF(HLLOC(LL).EQ.1) GO TO 45
      IF(LTABLE(LL).NE.IT .AND. LTABLE(LL).NE.4) GO TO 45
      CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),FACD(1,IT),
> RISK(1,1,1,L),TITLE,TITLA(1,IT),TITL2,CANC,NCANC,20,3)
      IF(GENEFF) CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),
< FACG(1,IT),GRISK(1,1,1,L),TITLE,TITLG(1,IT),TITL2,
/ GEN(3),1,3,3)
45    CONTINUE
38    CONTINUE
      IF (INDPOP.NE.1) GO TO 50
40    CONTINUE
50    CONTINUE
C***    COMBINE HIGH AND LOW LET USING INPUT QUALITY FACTORS
      DO 70 I=1,4
      DO 70 J=1,NONCLD
      RISK(NCANC+1,J,I,1)=0.0
      DO 70 K=1,NCANC
      RISK(K,J,I,1)=RISK(K,J,I,1)+RISK(K,J,I,2)
      RISK(NCANC+1,J,I,1)=RISK(NCANC+1,J,I,1)+RISK(K,J,I,1)
      IF(K.GT.1) GO TO 70
      GRISK(K,J,I,1)=GRISK(K,J,I,1)+GRISK(K,J,I,2)
70    CONTINUE
      CANC(NCANC+1)=LAST
      DO 80 K=1,2
      TITL2(K)=TLET(K,3)
80    CONTINUE
      DO 100 IT=1,3
      IDO=.FALSE.
      IF(ILET.EQ.0) GO TO 95
      DO 90 K=1,6
      ITAB(K)=0
      IF (TABLE(K).NE.JT.AND.TABLE(K).NE.4) GO TO 90
      IDO=.TRUE.
      ITAB(K)=1
90    CONTINUE

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95      CONTINUE
      DRISK(1)=RRISK
      IF(IT.EQ.3) DRISK(1)=RRISK/AGEX
      DRISK(2)=DRISK(1)
      ORG=CAN
      IF (IDO) CALL MULT(IT,FACD(1,IT),RISK,NCANC+1,CANC,TITLE, TITLA(
> IT),ITAB,TITL2,NOTE,NUN(1,IT),DRISK,CREP,NCREP,20)
      ORG=GON
      IF(IDO.AND.GENEFF) CALL MULT(IT,FACG(1,IT),GRISK,1,GEN(3),
> TITLE,TITLG(1,IT),ITAB,TITL2,NOT2,NOT2,0.,0.,0,3)
      IF(IT.EQ.2) GO TO 138
      IF(NILOC.EQ.0) GO TO 138
      DO 135 LL=1,NILOC
      IF(FALOC(LL).NE.2) GO TO 135
      IF(HILOC(LL).EQ.0) GO TO 135
      IF(LTABLE(LL).NE.IT .AND. LTABLE(LL).NE.4) GO TO 135
      CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),FACD(1,IT),
> RISK,TITLE,TITLA(1,IT),TITL2,CANC,NCANC,20,3)
      IF(GENEFF) CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),
> FACG(1,IT),GRISK,TITLE,TITLG(1,IT),TITL2,GEN(3),1,3,3)
135     CONTINUE
138     CONTINUE
      IF (INDPOP.NE.1) RETURN
100 CONTINUE
      RETURN
      END
      SUBROUTINE PREPRF(TABLE,TITLE,GSCFAC)
C***    PREPARE HEALTH EQUIVALENT FACTORS TO BE OUTPUT.
      REAL*8 CANC,NUCLID,TOTAL,RNLOC,OGLOC,ORC,CAN,GEN,OREP,RREP,CREP,
> GON
      COMMON/COMN/OREP(20),RREP(20),CREP(20),WLRN(20,20),
A  RISK,RREF(2),RYRLN,NOREP,NRREP,NCREP
      LOGICAL GENEFF
      COMMON/HEAD/ORC
      DATA CAN/8H CANCER /,GON/8H GONAD /
      DATA TOTAL/8HW. BODY /
      INTEGER TABLE,FALOC,HILOC,PTLOC
      LOGICAL IDO
      COMMON/COMLOC/RNLOC(10),OGLOC(10),PTLOC(10),FALOC(10),
> HILOC(10),LTABLE(10),NTLOC
      COMMON/COMGEN/GEN(3),NGEN,GDOSE(3,40,4,2),GRISK(3,40,4,2),
> GENEFF,GRFAC(2),REPPER,GILET(3),GHLET(3),GREF(3,40,4)
      DIMENSION TABLE(1),TITLE(1),TITLA(10,3), TITL2(2),FACD(4,3),
> ITAB(7),NOTE(20),TITLG(10,3),FACG(4,3),NOTA(20),DREF(2),NUN(8,3)
      DATA NUN/4H(MRE,4HM/YR,4H) ,5*4H ,4H(MRE,
> 4HM/YR,4H) ,5*4H ,4H(PER,4HSON ,4HREM/,4HYR) ,
> 4*4H /
      DATA NOTE/4HRADO,4HN DA,4HUGHT,4HER E, 4HXPOS,4HURE ,
> 4HRISK,4H EQU,4HIVAL,4HENT:,10*4H /,NOTA/20*4H /
      DATA FACD/1.,1.,1.E6,1.E8,1.,1.,1.E6,1.E8,.001,
A  .001,1.E3,1.E5/
      DATA FACG/1.,1.,1.,100.,1.,1.,1.,100.,.001,.001,.001,.1/
      DATA TITLA/4HINDI,4HVIDU,4HAL R,4HISK ,4HEQ. ,4HRATE, 4H (MR,

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> 4HEM/Y,4HEAR),4H      ,4HMEAN,4H IND,4HIVID,4HUAL , 4HRISK,4H EQ.,
> 4H RAT,4HE(MR,4HEM/Y,4HEAR),4HCOLL,4HECTI, 4HVE R,4HISK ,4HEQ R.
> 4HATE(,4HPERS,4HON R,4HEM/Y,4HEAR)/
  DATA TITLG/4HINDI,4HVIDU,4HAL G,4HENEI,4HIC R,4HISK ,
A  4HEQ. ,4H(MRE,4HM/YE,4HAR) ,
A4HMEAN,4H IND,4HIVID,4HUAL ,4HGENE,4HTIC ,4HRISK,
A4H EQ.,4H(MRE,4HM/Y),
A4HCOLL,4H. GE,4HNETI,4HCR I,4HISK E,4HEQ. (,4HPERS,
A4HON R,4HEM/Y,4HEAR)/
  DATA TITL2/4H      ,4H      /
  COMMON/COMCA/CANC(20),NCANC,RELABS(20),RISK(20,40,4,2)
  COMMON/COMRF/REF(20,40,4),FTABLE(7)
  COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS (4,40),
> INDPop
  NCANR=NCANC+1
  CANC(NCANR)=TOTAL
  CREP(NCREP+1)=TOTAL
  DO 5 J=1,3
  FACD(4,J)=FACD(4,J)*GSCFAC
  FACG(4,J)=FACG(4,J)*GSCFAC
5  CONTINUE
  DO 20 IT=1,3
  IDO=.FALSE.
  DO 10 K=1,7
  ITAB(K)=0
  IF (TABLE(K).NE.IT.AND.TABLE(K).NE.4) GO TO 10
  ITAB(K)=1
  IDO=.TRUE.
10 CONTINUE
  NCRR=NCREP+1
  IF(NCREP.EQ.0) NCRR=0
  ORC=CAN
  FAC=1.
  IF(IT.EQ.3)FAC=.001
  DO 12 J=1,NCRR
12  DREF(J)=RREF(J)*FAC
  IF (IDO) CALL MULT(IT,FACD(1,IT),REF,NCANR,CANC,TITLE, TITLA(1,IT)
> ,ITAB,TITL2,NOTE,NUN(1,IT),DREF,CREP,NCRR,20)
  ORC=GON
  IF(IDO.AND.GENEFF) CALL MULT(IT,FACG(1,IT),GREF,1,GEN(3),
> TITLE,TITLG(1,IT),ITAB,TITL2,NOTA,NOTA,0.,0.,0,3)
  IF(IT.EQ.2) GO TO 38
  IF(NTLOC.EQ.0) GO TO 38
  DO 35 LL=1,NTLOC
  IF(FALOC(LL).NE.3) GO TO 35
  IF(LTABLE(LL).NE.IT .AND. LTABLE(LL).NE.4) GO TO 35
  CALL LOCTAB(IT,RNLOC(LL),PTLOC(LL),OGLOC(LL),FACD(1,IT),
A  REF,TITLE,TITLA(1,IT),TITL2,CANC,NCANR,20,2)
  IF(GENEFF) CALL LOCTAB (T,RNLOC(LL),PTLOC(LL),OGLOC(LL),
A  FACG(1,IT),GREF,TITLE,TITLG(1,IT),TITL2,GEN(3),1,3,2)
35  CONTINUE
38  CONTINUE
  IF (INDPOP.NE.1) RETURN
20 CONTINUE
  RETURN
  END

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SUBROUTINE DETAB(ARRAY,NORGN,ORGN,TITLE,TITL1,DTABLE,TITLA,NOTE,
A  NUN,RFAC,CREP,NCREP)
C***  THIS ROUTINE OUTPUT THE APPROPRIATE TABLES.
      REAL*8 ORGN,NUCLID,ORC,SUM,CREP,OREP,RREP,CFAK,RADON
      DATA RADON/8HEN-222 /
      COMMON/COMEN/OREP(20),RREP(20),CFAK(20),WLEN(20,20),
A  RRISK,RREF(2),RYELL,NOREP,NRREP,NRFREP
      COMMON/HEAD/ORC
      INTEGER DTABLE
      DIMENSION ARRAY(20,40,4),ORGN(1),TITLE(20),TITLA(2),PATH(4,7),
> DTABLE(1),TITL1(10),NOTE(20),CREP(1),WLSUM(4),RFAC(NCREP),NUN(8)
      DATA PATH/4HINGE,4HSTIO,4HN ,4H ,4HINHA,4HLATI,4EON ,
> 4H ,4HAIR ,4HIMME,4HRSIO,4HN ,4HGROU,4HND S, 4HURFA,4HCE ,
> 4HINTE,4HERNAL,4H ,4H ,4HEXTE,4HERNAL,4H ,4H ,
> 4H ,4H ,4H ,4H /
      DATA SUM/8HTOTAL /
      COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GLABS (4,40),
> INDPOP
      COMMON/COMUS/SUMX(40,7),SUMY(40,3),PERX(40),PERY(40),TVAL(40),
> FACO(20,4)
C***  SUM OVER ALL NUCLIDES FOR EACH ORGAN AND PATHWAY
C***  PATHWAY 5 IS INTERNAL, 6 IS EXTERNAL, AND 7 IS ALL PATHWAYS
      DO 10 I=1,7
      DO 10 K=1,NORGN
10  SUMX(K,I)=0.0
      DO 30 I=1,4
      DO 20 K=1,NORGN
      DO 20 J=1,NONCLD
      SUMX(K,I)=SUMX(K,I)+ARRAY(K,J,I)
      IF (I.LE.2) SUMX(K,5)=SUMX(K,5)+ARRAY(K,J,I)
      IF (I.GE.3) SUMX(K,6)=SUMX(K,6)+ARRAY(K,J,I)
      SUMX(K,7)=SUMX(K,7)+ARRAY(K,J,I)
20  CONTINUE
30  CONTINUE
C***  TABLE 1
      IF (DTABLE(1).EQ.0) GO TO 80
      DO 70 I=1,4
      WRITE(6,10000) TITLE,TITL1,TITLA
      WRITE(6,10200) (PATH(N,I),N=1,4)
      WRITE(6,10300) ORC,(ORGN(K),K=1,NORGN)
      WRITE(6,10400)
      DO 60 J=1,NONCLD
      DO 40 K=1,NORGN
      PERX(K)=0.0
40  IF (SUMX(K,I).NE.0.0) PERX(K)=ARRAY(K,J,I)/SUMX(K,I)*100.
      WRITE(6,10500) NUCLID(J),(ARRAY(K,J,I),K=1,NORGN)
      WRITE(6,10600) (PATH(N,I),N=1,4),(PERX(K),K=1,NORGN)
      DO 50 K=1,NORGN
      II=5
      IF (I.GT.2) II=6
      PERX(K)=0.0
      IF (SUMX(K,II).NE.0.0) PERX(K)=ARRAY(K,J,I)/SUMX(K,II)*100.
      PERY(K)=0.0

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50 IF (SUMX(K,7).NE.0.0) PERY(K)=ARRAY(K,J,I)/SUMX(K,7)*100.
WRITE(6,10600) (PATH(N,II),N=1,4),(PERX(K),K=1,NORGN)
WRITE(6,10700) (PERY(K),K=1,NORGN)
WRITE(6,10100)
60 CONTINUE
WRITE(6,11000) (SUMX(K,I),K=1,NORGN)
IF(I.NE.2) GO TO 70
DO 75 J=1,NONCLD
IF(NUCLID(J).NE.RADON) GO TO 75
WRITE(6,20100) NOTE
IF(RFAC(1).EQ.0.0) GO TO 75
WRITE(6,10300) ORC, (CREP(JJ),JJ=1,NCREP)
WRITE(6,20400) NUN, (RFAC(JJ),JJ=1,NCREP)
75 CONTINUE
70 CONTINUE
C*** TABLE 2
80 IF (DTABLE(2).EQ.0) GO TO 120
DO 110 I=1,2
WRITE(6,10000) TITLE,TITL1,TITLA
II=J+4
WRITE(6,10200) (PATH(N,II),N=1,4)
WRITE(6,10300) ORC, (ORGN(K),K=1,NORGN)
WRITE(6,10400)
DO 100 J=1,NONCLD
DO 90 K=1,NORGN
L=1
IF (I.EQ.2) L=3
TVAL(K)=ARRAY(K,J,L)+ARRAY(K,J,L+1)
PERY(K)=0.0
IF (SUMX(K,II).NE.0.0) PERY(K)=TVAL(K)/SUMX(K,II)*100.
PERX(K)=0.0
90 IF (SUMX(K,7).NE.0.0) PERX(K)=TVAL(K)/SUMX(K,7)*100.
WRITE(6,10500) NUCLID(J),(TVAL(K),K=1,NORGN)
WRITE(6,10600) (PATH(N,II),N=1,4),(PERY(K),K=1,NORGN)
WRITE(6,10700) (PERX(K),K=1,NORGN)
100 CONTINUE
WRITE(6,11000) (SUMX(K,II),K=1,NORGN)
WRITE(6,10100)
IF(I.NE.1) GO TO 110
DO 115 J=1,NONCLD
IF(NUCLID(J).NE.RADON) GO TO 115
WRITE(6,20100) NOTE
IF(RFAC(1).EQ.0.0) GO TO 115
WRITE(6,10300) ORC, (CREP(JJ),JJ=1,NCREP)
WRITE(6,20400) NUN, (RFAC(JJ),JJ=1,NCREP)
115 CONTINUE
110 CONTINUE
C*** TABLE 3
120 IF (DTABLE(3).EQ.0) GO TO 170
WRITE(6,10000) TITLE,TITL1,TITLA
WRITE(6,10900)
WRITE(6,10300) ORC, (ORGN(K),K=1,NORGN)
WRITE(6,10400)
DO 160 J=1,NONCLD
DO 130 K=1,NORGN

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130 TVAL(K)=0.0
    DO 150 K=1,NORGN
    DO 140 I=1,4
    TVAL(K)=ARRAY(K,J,I)+TVAL(K)
140 CONTINUE
    PERX(K)=0.0
    IF (SUMX(K,7).NE.0.0) PERX(K)=TVAL(K)/SUMX(K,7)*100.

150 CONTINUE
    WRITE(6,10500) NUCLID(J),(TVAL(K),K=1,NORGN)
    WRITE(6,10700) (PERX(K),K=1,NORGN)
    WRITE(6,10100)
160 CONTINUE
    WRITE(6,11000) (SUMX(K,7),K=1,NORGN)
    DO 165 J=1,NONCLD
    IF(NUCLID(J).NE.RADON) GO TO 165
    WRITE(6,20100) NOTE
    IF(RFAC(1).EQ.0.0) GO TO 165
    WRITE(6,10300)ORC, (CREP(K),K=1,NCREP)
    WRITE(6,20400)NUN, (RFAC(JJ),JJ=1,NCREP)
165 CONTINUE
C*** TABLE 4
170 IF (DTABLE(4).EQ.0) GO TO 260
    DO 250 K=1,NORGN
    WRITE(6,10000) TITLE,TITL1,TITLA
    WRITE(6,11100) ORC,ORGN(K)
    WRITE(6,11200) (NUCLID(J),J=1,NONCLD),SUM
    WRITE(6,11300)
    DO 180 I=1,3
    DO 180 J=1,NONCLD
180 SUMY(J,I)=0.0
    DO 200 I=1,4
    DO 190 J=1,NONCLD
    IF (I.LE.2) SUMY(J,1)=SUMY(J,1)+ARRAY(K,J,I)
    IF (I.GE.3) SUMY(J,2)=SUMY(J,2)+ARRAY(K,J,I)
    SUMY(J,3)=SUMY(J,3)+ARRAY(K,J,I)
190 CONTINUE
200 CONTINUE
    DO 220 I=1,4
    WRITE(6,11400) (PATH(N,I),N=1,4),(ARRAY(K,J,I),J=1,NONCLD),
    > SUMX(K,I)
    DO 210 J=1,NONCLD
    II=1
    IF (I.GT.2) II=2
    PERX(J)=0.0
    IF (SUMY(J,II).NE.0.0) PERX(J)=ARRAY(K,J,I)/SUMY(J,II)*100.
    PERY(J)=0.0
    IF (SUMY(J,3).NE.0.0) PERY(J)=ARRAY(K,J,I)/SUMY(J,3)*100.
210 CONTINUE
    WPP=0.0
    IF (SUMX(K,4+II).NE.0.0) WPP=SUMX(K,I)/SUMX(K,4+II)*100.
    WP=0.0

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      IF (SUMX(K,7).NE.0.0) WP=SUMX(K,I)/SUMX(K,7)*100.
      WRITE(6,11500) (PATH(N,4+II),N=1,4),(PERX(J),J=1,NONCLD),WPP
      WRITE(6,11600) (PERY(J),J=1,NONCLD),WP
      WRITE(6,10100)
220  CONTINUE
      DO 240 I=1,2
      WRITE(6,11400) (PATH(N,I+4),N=1,4),(SUMY(J,I),J=1,NONCLD), SUMX(K,
> 4+I)
      DO 230 J=1,NONCLD
      PERX(J)=0.0
230  IF (SUMY(J,3).NE.0.0) PERX(J)=SUMY(J,I)/SUMY(J,3)*100.
      WP=0.0
      IF (SUMX(K,7).NE.0.0) WP=SUMX(K,4+I)/SUMX(K,7)*100.
      WRITE(6,11600) (PERX(J),J=1,NONCLD),WP
      WRITE(6,10100)
240  CONTINUE
      WRITE(6,11700) (SUMY(J,3),J=1,NONCLD),SUMX(K,7)
      DO 245 J=1,NONCLD
      IF(NUCLID(J).NE.RADON) GO TO 245
      JJ=NCREP
      IF(ORGN(K).EQ.SUM) GO TO 256
      DO 255 JJ=1,NCREP
      IF(ORGN(K).NE.CREP(JJ)) GO TO 255
256  WRITE(6,20100) NOTE
      IF(RFAC(1).EQ.0.0) GO TO 250
      WRITE(6,20400)NUN, RFAC(JJ)
255  CONTINUE
245  CONTINUE
250  CONTINUE
C***  TABLE 5
260  IF (DTABLE(5).EQ.0) GO TO 350
      DO 340 J=1,NONCLD
      WRITE(6,10000) TITLE,TITL1,TITLA
      WRITE(6,11800) NUCLID(J)
      DO 270 I=1,3
      DO 270 K=1,NORGN
270  SUMY(K,I)=0.0
      DO 280 I=1,4
      DO 280 K=1,NORGN
      IF (I.LE.2) SUMY(K,1)=SUMY(K,1)+ARRAY(K,J,I)
      IF (I.GE.3) SUMY(K,2)=SUMY(K,2)+ARRAY(K,J,I)
      SUMY(K,3)=SUMY(K,3)+ARRAY(K,J,I)
280  CONTINUE
      WRITE(6,11900) ORC,(ORGN(K),K=1,NORGN)

      WRITE(6,11300)
      DO 300 I=1,4
      WRITE(6,11400) (PATH(N,I),N=1,4),(ARRAY(K,J,I),K=1,NORGN)

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      II=1
      IF (I.GE.3) II=2
      DO 290 K=1,NORGN
      PERX(K)=0.0
      IF (SUMY(K,II).NE.0.0) PERX(K)=ARRAY(K,J,I)/SUMY(K,II)*100.
      PERY(K)=0.0
      IF (SUMY(K,3).NE.0.0) PERY(K)=ARRAY(K,J,I)/SUMY(K,3)*100.
290  CONTINUE
      WRITE(6,11500) (PATH(N,II+4),N=1,4), (PERX(K),K=1,NORGN)
      WRITE(6,11600) (PERY(K),K=1,NORGN)
      WRITE(6,10100)
300  CONTINUE
      DO 320 I=1,2
      WRITE(6,11400) (PATH(N,I+4),N=1,4), (SUMY(K,I),K=1,NORGN)
      DO 310 K=1,NORGN
      PERX(K)=0.0
      IF (SUMY(K,3).NE.0.0) PERX(K)=SUMY(K,I)/SUMY(K,3)*100.
310  CONTINUE
      WRITE(6,11600) (PERX(K),K=1,NORGN)
      WRITE(6,10100)
320  CONTINUE

      WRITE(6,11700) (SUMY(K,3),K=1,NORGN)
      DO 330 K=1,NORGN
      PERX(K)=0.0
330  IF (SUMX(K,7).NE.0.0) PERX(K)=SUMY(K,3)/SUMX(K,7)*100.
      WRITE(6,10700) (PERX(K),K=1,NORGN)
      L=1
      WRITE(6,20100) NOTE
      IF(RFAC(1).EQ.0.0) GO TO 340
      WRITE(6,10300)ORC, (CREP(K),K=1,NCREP)
      WRITE(6,20400)NUN, (RFAC(K),K=1,NCREP)
335  CONTINUE
340  CONTINUE
C***  TABLE 6
350  IF (DTABLE(6).EQ.0) GO TO 500
      DO 360 I=1,7

      TVAL(I)=0.0
      DO 360 J=1,NONCLD
      SUMX(J,I)=0.0
360  CONTINUE
390  DO 400 I=1,4
      DO 400 J=1,NONCLD
      SUMX(J,I)=ARRAY(NORGN,J,I)
      IF(I.GE.3) GO TO 401
      SUMX(J,5)=SUMX(J,5)+ARRAY(NORGN,J,I)
      TVAL(5)=TVAL(5)+ARRAY(NORGN,J,I)
      GO TO 402
401  SUMX(J,6)=SUMX(J,6)+ARRAY(NORGN,J,I)
      TVAL(6)=TVAL(6)+ARRAY(NORGN,J,I)
402  SUMX(J,7)=SUMX(J,7)+ARRAY(NORGN,J,I)
      TVAL(I)=TVAL(I)+ARRAY(NORGN,J,I)

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      TVAL(7)=TVAL(7)+ARRAY(NORGN,J,I)

400 CONTINUE

410 CONTINUE
      WRITE(6,10000) TITLE,TITL1,TITLA

      WRITE(6,12100) ORC
      WRITE(6,11200) (NUCLID(J),J=1,NONCLD),SUM

      DO 430 I=1,4
      WRITE(6,11400) (PATH(N,I),N=1,4),(SUMX(J,I),J=1,NONCLD),TVAL(I)
      II=5
      IF (I.GE.3) II=6
      DO 420 J=1,NONCLD
      PERX(J)=0.0
      IF (SUMX(J,II).NE.0.0) PERX(J)=SUMX(J,I)/SUMX(J,II)*100.

      PERY(J)=0.0
      IF (SUMX(J,7).NE.0.0) PERY(J)=SUMX(J,I)/SUMX(J,7)*100.

420 CONTINUE
      WP=0.0
      IF (TVAL(II).NE.0.0) WP=TVAL(I)/TVAL(II)*100.
      WPP=0.0
      IF (TVAL(7).NE.0.0) WPP=TVAL(I)/TVAL(7)*100.
      WRITE(6,11500) (PATH(N,II),N=1,4), (PERX(J),J=1,NONCLD),WP
      WRITE(6,11600) (PERY(J),J=1,NONCLD),WPP
      WRITE(6,10100)

430 CONTINUE
      DO 450 I=5,6
      WRITE(6,11400) (PATH(N,I),N=1,4),(SUMX(J,I),J=1,NONCLD),TVAL(I)
      DO 440 J=1,NONCLD
      PERX(J)=0.0
      IF (SUMX(J,7).NE.0.0) PERX(J)=SUMX(J,I)/SUMX(J,7)*100.

440 CONTINUE
      WRITE(6,11600) (PERX(J),J=1,NONCLD)
      WRITE(6,10100)

450 CONTINUE
      WRITE(6,11700) (SUMX(J,7),J=1,NONCLD),TVAL(7)
      DO 460 J=1,NONCLD
      PERX(J)=0.0
      IF (TVAL(7).NE.0.0) PERX(J)=SUMX(J,7)/TVAL(7)*100.

460 CONTINUE
      WRITE(6,12000) (PERX(J),J=1,NONCLD)

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DO 465 J=1,NONCLD
IF(NUCLID(J).NE.RADON) GO TO 465
WRITE(6,20100) NOTE
IF(RFAC(1).EQ.0.0) GO TO 470
WRITE(6,20400)NUN, RFAC
470  CONTINUE
465  CONTINUE
C***  TABLE 7
500  IF(DTABLE(7).EQ.0) RETURN
DO 510 I=1,7
DO 510 J=1,NORGN
SUMX(J,I)=0.0
510  CONTINUE
DO 550 I=1,4
DO 550 J=1,NORGN
DO 550 K=1,NONCLD
SUMX(J,I)=SUMX(J,I)+ARRAY(J,K,I)
IF(I.GE.3) GO TO 501
SUMX(J,5)=SUMX(J,5)+ARRAY(J,K,I)
GO TO 502
501  SUMX(J,6)=SUMX(J,6)+ARRAY(J,K,I)
502  SUMX(J,7)=SUMX(J,7)+ARRAY(J,K,I)
550  CONTINUE
WRITE(6,10000) TITLE,TITL1,TITLA
WRITE(6,12200)
WRITE(6,10300) ORC,(ORGN(K),K=1,NORGN)
WRITE(6,11300)
DO 575 I=1,4
WRITE(6,11400) (PATH(N,I),N=1,4),(SUMX(J,I),J=1,NORGN)
II=5
IF(I.GE.3) II=6
DO 560 J=1,NORGN
PERX(J)=0.0
IF(SUMX(J,II).NE.0.0) PERX(J)=SUMX(J,I)/SUMX(J,II)*100.
PERY(J)=0.0
IF(SUMX(J,7).NE.0.0) PERY(J)=SUMX(J,I)/SUMX(J,7)*100.
560  CONTINUE
WRITE(6,11500) (PATH(N,II),N=1,4),(PERX(J),J=1,NORGN)
WRITE(6,11600) (PERY(J),J=1,NORGN)
WRITE(6,10100)
575  CONTINUE
DO 590 I=5,6
WRITE(6,11400) (PATH(N,I),N=1,4),(SUMX(J,I),J=1,NORGN)
DO 580 J=1,NORGN
PERX(J)=0.0
IF(SUMX(J,7).NE.0.0) PERX(J)=SUMX(J,I)/SUMX(J,7)*100.
580  CONTINUE
WRITE(6,11600) (PERX(J),J=1,NORGN)
WRITE(6,10100)

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590    CONTINUE
      WRITE(6,11700) (SUMX(J,7),J=1,NORGN)
      DO 600 J=1,NONCLD
        IF(NUCLID(J).NE.RADON) GO TO 600
        WRITE(6,20100) NOTE
        IF(RFAC(1).EQ.0.0) GO TO 600
        DO 610 L=1,NCREP
910      WLSUM(L)=0.0
        DO 612 JJ=1,1
        DO 612 L=1,NCREP
          WLSUM(L)=WLSUM(L)+RFAC(L)
912      CONTINUE
        WRITE(6,10300)ORC, (CREP(L),L=1,NCREP)
        WRITE(6,20400)NUN, (WLSUM(L),L=1,NCREP)
600    CONTINUE
      RETURN
10000  FORMAT(1E1,20X,20A4/21X,10A4/21X,2A4)
10100  FORMAT(1X)
10200  FORMAT('0*** FOR PATHWAY:',4A4//)
10300  FORMAT(1H0,A8,1H:,22X,10(2X,A8)/(33X,10(2X,A8)))
10400  FORMAT(9H0NUCLIDES/)
10500  FORMAT(1X,A8,23X,1P10G10.3/(33X,1P10G10.3))
10600  FORMAT(11H % OF TOTAL,1X,4A4,4X, 1P10G10.3/(33X,1P10G10.3))
10700  FORMAT(11H % OF TOTAL,21X,1P10G10.3/ (33X,1P10G10.3))
10800  FORMAT('0TOTAL      ',21X,1P10G10.3/(33X,1P10G10.3))
10900  FORMAT('0*** FOR ALL PATHWAYS:'//)
11000  FORMAT(' TOTAL',26X,1P10G10.3/(33X,1P10G10.3))
11100  FORMAT('0***FOR',A8,':',A8//)
11200  FORMAT(' NUCLIDES',23X,10(2X,A8)/(33X,10(2X,A8)))
11300  FORMAT(' PATHWAYS'//)
11400  FORMAT(1X,4A4,15X,1P10G10.3/(33X,1P10G10.3))
11500  FORMAT(6H % OF ,1X,4A4,9X,1P10G10.3/ (33X,1P10G10.3))
11600  FORMAT(18H % OF ALL PATHWAYS,14X,1P10G10.3/ (33X,1P10G10.3))
11700  FORMAT(24H TOTAL OVER ALL PATHWAYS,8X,1P10G10.3/(33X,1P10G10.3))
11800  FORMAT('0FOR NUCLIDE:',A8)
11900  FORMAT(1X,A8,23X,10(2X,A8)/(33X,10(2X,A8)))
12000  FORMAT(11H % OF TOTAL,21X,1P10G10.3/(33X,1P10G10.3))
12100  FORMAT('0***SUMMED OVER ALL',A8)
12200  FORMAT('0***SUMMED OVER ALL NUCLIDES')
20100  FORMAT('0'////10X,20A4)
20400  FORMAT(1X,8A4,1P10G10.3)
END
SUBROUTINE CHLOC(PLOC,CONC,GSCFAC)
REAL*8 CANC,NUC,NUCLID,RADON,OREP,CREP,RREP,PNUC
DIMENSION CONC(4),FAC(4),IOR(4)
  DATA FAC/2*1.E-5,10.,1000./
  DATA BRTHRT/.83E6/
  DATA RADON/8HRN-222 /
  DATA IOR/3,4,1,2/
  COMMON/COMEX/EXPP(20,20,40,4),POP(20,20),POPFAC,TOTFAC, NOL,NOU,
>  NRL,NRU,IDIST(20),ILOC,JLOC
  COMMON/COMCA/CANC(20),NCANC,RELABS(20),RISK(20,40,4,2), RTABLE(7),

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> AGEX,YRLL(20,40,4,2)
COMMON/COMRF/REF(20,40,4),FTABLE(7)
COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS(4,40),IND
COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLEN(20,20)
A ,RRISK,RREF(2),RYRLL,NOREP,NRREP,NCREP
COMMON/COMUS/TRISK(20,20),IO(400)
COMMON/PASS/PNUC(40),PCON1(40),PCON2(40),PCON3(40),
B PCON4(40),PPOP,LIND,LDIST
DIMENSION SRISK(400),ANGLE(16)
DATA ANGLE/4HN ,4HNE ,4HNE ,4HNE ,4HE ,
A 4HESE ,4ESE ,4ESSE ,4HS ,4HSSW ,4HSW ,4HWSW ,
B 4HW ,4HWNW ,4HNW ,4HNNW /
EQUIVALENCE(TRISK(1,1),SRISK(1))
FAC(4)=FAC(4)*GSCFAC
NOP=JLOC+(ILOC-1)*20
DO 2 K=1,20
DO 2 L=1,20
POP(L,K)=1.0
WLEN(L,K)=0.0
TRISK(L,K)=0.0
2 CONTINUE
DO 10 K=1,40
DO 10 J=1,20
DO 5 I=1,4
DO 5 L=1,20
5 EXPP(L,J,K,I)=0.0
10 CONTINUE
NOL=1
NOU=1
NRL=1
NRU=1
DO 90 II=1,NONCLD
IDIST(1)=LDIST
IND=LIND
NUC=PNUC(II)
CONC(1)=PCON1(II)
CONC(2)=PCON2(II)
CONC(3)=PCON3(II)
CONC(4)=PCON4(II)
DO 30 J=1,NONCLD
IF (NUC.EQ.NUCLID(J)) GO TO 40
30 CONTINUE
GO TO 90
40 CONTINUE
IF (NUC.EQ.RADON) GO TO 160
DO 70 ILO=NOL,NOU
DO 70 JLO=NRL,NRU
DO 50 NC=1,NCANC
DO 50 L=1,4
DO 50 N=1,2
TRISK(JLO,ILO)=TRISK(JLO,ILO)+RISK(NC,J,IOR(L),N)*
A CONC(L)*FAC(IOR(L))

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```

50 CONTINUE
  DO 60 J=1,4
    EXPP(JLO,ILO,J,IOR(I))=CONC(I)
60 CONTINUE
70 CONTINUE
  POP(1,1)=PPOP
  GO TO 90
160 CONTINUE
C***   SPECIAL SECTION FOR RADON-222
  DO 190 ILO=NOL,NOU
    DO 190 JLO=NRL,NRU
C      READ(26) WFRAC,WLEVEL
170 EXPP(JLO,ILO,J,3)=WLEVEL*1.E-6/(10.*WFRAC)
      EXPP(JLO,ILO,J,2)=WLEVEL*BRTHRT*8760./(10.*WFRAC)
      EXPP(JLO,ILO,J,1)=0.0
      EXPP(JLO,ILO,J,4)=0.0
      DO 180 N=1,2
        DO 180 K=1,4
          DO 180 NC=1,NCANC
            TRISK(JLO,ILO)=TRISK(JLO,ILO)+RISK(NC,J,K,N)*EXPP(JLO,ILO,J,K)*
A      FAC(K)
180    CONTINUE
      WLEN(JLO,ILO)=WLEVEL
      TRISK(JLO,ILO)=TRISK(JLO,ILO)+WLEVEL*RRISK
190 CONTINUE
      WRITE(6,20100)
20100  FORMAT(' THERE ARE NO GROUND SURFACE CONCENTRATION',
>  ' OR INGESTION RATE EXPOSURES FOR RN-222.')
90 CONTINUE
110 IF (ILOC.NE.0.AND.JLOC.NE.0) GO TO 130
  LENO=NOU-NOL+1
  LENR=NRU-NRL+1
  NLOC=LENO*LENR
  J=0
  DO 120 ILO=NOL,NOU
    DO 120 JLO=NRL,NRU
      IF(IND.EQ.1 .AND. POP(ILO,JLO).NE.0.0) TRISK(JLO,ILO)=
< TRISK(JLO,ILO)/POP(ILO,JLO)
      J=J+1
      SRISK(J)=TRISK(JLO,ILO)
      IO(J)=J
120 CONTINUE
  CALL VSORTP(SRISK,NLOC,IO)
  NOP=NLOC*PLOC*.01+.5
  IF (NOP.GE.NLOC) NOP=NLCC
  IF (NOP.LE.1) NOP=
  LOC=IO(NOP)
  ILOC=(LOC-1)/LENR+1
  JLOC=LCC-(ILOC-1)*LENR
  IF (JLCC.EQ.0) JLOC=NRU
  ILOC=1LOC+NOL-1
  JLOC=JLCC+NRL-1

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130 POPFAC=1.
    TOTFAC=1.
    IF (IND.NE.1) GO TO 150
    IF (POP(ILOC,JLOC).NE.0.0) POPFAC=1./POP(ILOC,JLOC)
    TOTPOP=0.0
    DO 140 K1=NRL,NEU
    DO 140 K2=NOL,NOU
140 TOTPOP=TOTPOP+POP(K2,K1)
    TOTFAC=1./TOTPOP
150    ANG=ANGLE(MOD(17-ILOC,16)+1)
    WRITE(6,10000) IDIST(JLOC),ANG,SRISK(NOP)
    RETURN
10000  FORMAT('1THE LOCATION USED FOR THE SELECTED INDIVIDUAL',
> ' EXPOSURE IS ',I7,' METERS ',A4,'FROM THE SOURCE.'/
> ' THE FATAL CANCER RISK AT THAT LOCATION IS ',G10.3)
    END
    SUBROUTINE VSORTP (A,LA,IR)
C
    DIMENSION A(1),IU(21),IL(21),IR(1)
C
    M=1
    I=1
    J=LA
    R=.375
10 IF (I.EQ.J) GO TO 100
20 IF (R.GT..5898437) GO TO 30
    R=R+3.90625E-2
    GO TO 40
30 R=R-.21875
40 K=I
C
C      SELECT A CENTRAL ELEMENT OF THE
      ARRAY AND SAVE IT IN LOCATION T
    IJ=I+(J-I)*R
    T=A(IJ)
    IT=IR(IJ)
C
C      IF FIRST ELEMENT OF ARRAY IS GREATER
      THAN T, INTERCHANGE WITH T
    IF (A(I).LE.T) GO TO 50
    A(IJ)=A(I)
    A(I)=T
    T=A(IJ)
    IR(IJ)=IR(I)
    IR(I)=IT
    IT=IR(IJ)
50 L=J
C
C      IF LAST ELEMENT OF ARRAY IS LESS THAN
      T, INTERCHANGE WITH T
    IF (A(J).GE.T) GO TO 70
    A(IJ)=A(J)
    A(J)=T
    T=A(IJ)
    IR(IJ)=IR(J)
    IR(J)=IT
    IT=IR(IJ)

```

C		IF FIRST ELEMENT OF ARRAY IS GREATER
C		THAN T, INTERCHANGE WITH T
	IF (A(I).LE.T) GO TO 70	
	A(IJ)=A(I)	
	A(I)=T	
	T=A(IJ)	
	IR(IJ)=IR(I)	
	IR(I)=IT	
	IT=IR(IJ)	
	GO TO 70	
60	TT=A(L)	
	A(L)=A(K)	
	A(K)=TT	
	ITT=IR(L)	
	IR(L)=IR(K)	
	IR(K)=ITT	
C		FIND AN ELEMENT IN THE SECOND HALF OF
C		THE ARRAY WHICH IS SMALLER THAN T
	70 L=L-1	
	IF (A(L).GT.T) GO TO 70	
C		FIND AN ELEMENT IN THE FIRST HALF OF
C		THE ARRAY WHICH IS GREATER THAN T
	80 K=K+1	
	IF (A(K).LT.T) GO TO 80	
C		INTERCHANGE THESE ELEMENTS
	IF (K.LE.L) GO TO 60	
C		SAVE UPPER AND LOWER SUBSCRIPTS OF
C		THE ARRAY YET TO BE SORTED
	IF (L-I.LE.J-K) GO TO 90	
	IL(M)=I	
	IU(M)=L	
	I=K	
	M=M+1	
	GO TO 110	
90	IL(M)=K	
	IU(M)=J	
	J=L	
	M=M+1	
	GO TO 110	
C		BEGIN AGAIN ON ANOTHER PORTION OF
C		THE UNSORTED ARRAY
100	M=M-1	
	IF (M.EQ.0) RETURN	
	I=IL(M)	
	J=IU(M)	
110	IF (M.GT.21) WRITE(6,10000)M	
	IF (J-I.GE.1) GO TO 40	
	IF (I.EQ.1) GO TO 10	
	I=I-1	
120	I=I+1	

```

      IF (I.EQ.J) GO TO 100
      T=A(I+1)
      IT=IR(I+1)
      IF (A(I).LE.T) GO TO 120
      K=I
130  A(K+1)=A(K)
      IR(K+1)=IR(K)
      K=K-1
      IF (T.LT.A(K)) GO TO 130
      A(K+1)=T
      IR(K+1)=IT
      GO TO 120

C
10000 FORMAT(' IN VSORTP, M=',I3)
      END
      SUBROUTINE MULT(IM,CONFAC,ARRAYI,NOC,NAMNOC,TITLE,TITL1, TABLE,
> TITL2,NOTE,NUN,RFACI,CREP,NCREP,NDIM)
      INTEGER TABLE
      REAL*8 NUCLID,NAMNOC,CREP,OREP,RREP,FREP,PUL,TBEQ
      COMMON/COMN/OREP(20),RREP(20),FREP(20),
A  WLEN(20,20),RRISK,RREF(2),RYELL,NOREP,NRREP,NFREP
      COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS(4,40),
> INDPop
      COMMON/COMEX/EXPP(20,20,40,4),POP(20,20),POPFAC,TOTFAC, NOL,NOU,
> NRL,NRU,IDIST(20),ILOC,JLOC
      DIMENSION ARRAYI(NDIM,40,4),ARRAYO(20,40,4),CONFAC(4),TITLE(1),
> TITL1(1),TITL2(1),NAMNOC(1),TABLE(1),NOTE(1),CREP(20),RFACI(20),
> RFACO(20),NUN(1)
      GO TO (10,30,50),IM
10  DO 20 I=1,4
      DO 20 J=1,NONCLD
      DO 20 K=1,NOC
      ARRAYO(K,J,I)=ARRAYI(K,J,I)*EXPP(JLOC,ILOC,J,I)*CONFAC(I)*POPFAC
20  CONTINUE
      RFACO(1)=0.0
      IF(NCREP.EQ.0) GO TO 80
      DO 25 I=1,NCREP
25  RFACO(I)=RFACI(I)*WLEN(JLOC,ILOC)*POPFAC
      GO TO 80
30  DO 40 I=1,4
      DO 40 J=1,NONCLD
      DO 40 K=1,NOC
      ARRAYO(K,J,I)=0.0D0
      DO 40 II=NOL,NOU
      DO 40 JJ=NRL,NRU
      ARRAYO(K,J,I)=ARRAYO(K,J,I)+ARRAYI(K,J,I)*EXPP(JJ,II,J,I)*
> CONFAC(I)*TOTFAC
40  CONTINUE
      RFACO(1)=0.0
      RFACO(2)=0.0
      IF(NCREP.EQ.0) GO TO 80
      DO 45 I=1,NCREP
      DO 45 II=NOL,NOU
      DO 45 JJ=NRL,NRU
      RFACO(I)=RFACI(I)*WLEN(JJ,II)*TOTFAC+RFACO(I)

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45      CONTINUE
      GO TO 80
50 DO 70 I=1,4
      DO 70 J=1,NONCLD
      TEXPP=0.0
      DO 60 II=NOL,NOU
      DO 60 JJ=NRL,NRU
      TEXPP=TEXPP+EXPP(JJ,II,J,I)
60 CONTINUE
      DO 70 K=1,NOC
      ARRAYO(K,J,I)=ARRAYI(K,J,I)*TEXPP*CONFAC(I)
70 CONTINUE
      RFACO(1)=0.0
      IF(NCREP.EQ.0) GO TO 80
      TWLRN=0.0
      DO 65 II=NOL,NOU
      DO 65 JJ=NRL,NRU
      TWLRN=TWLRN+WLRN(JJ,II)
65 CONTINUE
      DO 75 I=1,NCREP
      RFACO(I)=RFACI(I)*TWLRN
75 CONTINUE
80 CALL DRTAB(ARRAYO,NOC,NAMNOC,TITLE,TITL1,TABLE,TITL2,NOTE,
  A  NUN,RFACO,CREP,NCREP)

      RETURN
      END
      SUBROUTINE RDORGF
      REAL*8 ORGN,ORGB
      COMMON/COMWOR/FACO(20,4)
      DIMENSION ORGB(20),ORGDAT(20),IPATH(20)
      COMMON/COMOR/'ORGN(20),NORGN,TIME(20),DOSE(20,40,4,2)

      NAMLIST/ ORGANF/NORGB,ORGB,ORGDAT,IPATH
      READ(26,ORGANF)
      WRITE(6,10000)
      DO 10 J=1,NORGB
      WRITE(6,10100) ORGB(J),ORGDAT(J)
      IF (IPATH(J).NE.5) WRITE(6,10200) IPATH(J)
10 IF (IPATH(J).EQ.5) WRITE(6,10300)
      DO 80 K=1,NORGN
      DO 30 I=1,4
30 FACO(K,I)=0.0
      DO 40 J=1,NORGB
      IF (ORGN(I).EQ.ORG2(J)) GO TO 50
40 CONTINUE
      GO TO 80
50 IF (IPATH(J).EQ.5) GO TO 60
      FACO(K,IPATH(J))=ORGDAT(J)
      GO TO 80

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60 DO 70 I=1,4
   FACO(K,I)=ORGDAT(J)
70 CONTINUE
80 CONTINUE
   RETURN
10000 FORMAT('00ORGAN DOSE WEIGHTING FACTORS'//
  A ' ORGAN FACTORS PATHWAYS'/)
10100 FORMAT(1X,A8,1X,F8.5)
10200 FORMAT('+',19X,I2)
10300 FORMAT('+',19X,' 1 2 3 4')
   END
   SUBROUTINE LOCTAB(IT,RN,PT,OG,FACD,ARRAY,TITLE,TITL1,TITLA,
  < ORGN,NORGN,NDIM,NJ)
   REAL*8 RN,OG,SUM,NUCLID,ORGN,WLOPT(2),OREP,RREP,CREP,PUL,
  A TBEQ
   COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLEN(20,20),ERISK,
  A RREF(2),RYELL,NOREP,NRREP,NCREP
   COMMON/COMCA/DUM(6468),AGEX
   INTEGER PT
   DIMENSION TITLE(20),TITLA(2),TITL1(10),ARRAY(NDIM,40,4),
  < ORGN(1),FACD(1),TPATH(4,7),IDIR(16)
   COMMON/COMUS/OUTPUT(40,40),HOLDC(40),HOLDR(40)
   DATA IDIR/1,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2/
   DATA TPATH/4HINGE,4HSTIO,4HN ,4H ,4HINHA,4HLATI,4HON ,
  > 4H ,4HAIR ,4HINNE,4HRSIO,4HN ,4HGROU,4HND S, 4HURFA,4HCE ,
  > 4HINTE,4HRNAL,4H ,4H ,4HEXTE,4HRNAL,4H ,4H ,
  > 4HALL ,4H ,4H /
   DATA SUM/8HSUM /,WLOPT/8HWORKLEVL,8HWLSUM /,
  A PUL/8HPULMNARY/,TBEQ/8HBODY EQ./
   COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS (4,40),
  > INDPOP
   COMMON/COMEX/EXPP(20,20,40,4),POP(20,20),POPFAC,TOTFAC, NOL,NOU,
  > NRL,NRU,IDIST(20),ILOC,JLOC
   COMMON/COMWOR/WT(20,4)
10000 FORMAT(1H1,20X,20A4/21X,10A4/21X,2A4)
   DO 10 K=1,40
   HOLDR(K)=0.0
   HOLDC(K)=0.0
   DO 10 L=1,40
10 OUTPUT(L,K)=0.0
   TSUM=0.0
   DO 12 J=1,2
   IF(RN.EQ.WLOPT(J)) GO TO 1000
12 CONTINUE
14 CONTINUE
   IF(RN.EQ.SUM) GO TO 75
   IF(RN.EQ.WLOPT(2)) GO TO 75
   DO 50 J=1,NONCLD
   IF(RN.EQ.NUCLID(J)) GO TO 70
50 CONTINUE

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WRITE(6,10500) RN
10500 FORMAT(' RADIONUCLIDE ',A8,
A ' IS NOT IN LIST. TABLE WILL BE SKIPPED.')
RETURN
70 INE=J
GO TO 80
75 INB=1
INE=NONCLD
80 CONTINUE
IF(OG.EQ.SUM) GO TO 175
DO 150 J=1,NORGN
IF(OG.EQ.ORGJ(J)) GO TO 170
150 CONTINUE
WRITE(6,10600) OG
10600 FORMAT(' ORGAN ',A8,' IS NOT IN LIST.',
A ' TABLE WILL BE SKIPPED.')
RETURN
170 IOB=J
IOE=J
GO TO 180
175 IOB=1
IOE=NORGN
IF(IT.EQ.3) GO TO 180
IF(IT.EQ.1) GO TO 185
IOB=NORGN
IOE=NORGN
GO TO 180
185 CONTINUE
GO TO 195
180 DO 190 I=1,4
DO 190 K=IOB,IOE
WT(K,I)=1.
190 CONTINUE
195 CONTINUE
IPT=PT
IPB=IPT
IPE=IPT
IF(IPT.LE.4) GO TO 184
177 CONTINUE
IPT=IPT-4
GO TO (181,182,183),IPT
181 IPB=1
IPE=2
GO TO 184
182 IPB=3
IPE=4
GO TO 184
183 IPB=1
IPE=4

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184      CONTINUE
        DO 300 IPT=IPB,IPE
        DO 300 IN=INB,INE
        DO 300 IO=IOB,IOE
        DO 300 II=NOL,NOU
        DO 300 JJ=NRL,NRU
        OUTPUT(JJ,II)=OUTPUT(JJ,II)+ARRAY(IO,IN,IPT)*FACD(IPT)*
>      EXPP(JJ,II,IN,IPT)
300      CONTINUE
305      IF(IT.EQ.3) GO TO 500
        DO 400 II=NOL,NOU
        DO 400 JJ=NRL,NRU
        IF(POP(II,JJ).EQ.0.0) GO TO 375
        OUTPUT(JJ,II)=OUTPUT(JJ,II)/POP(II,JJ)
        GO TO 400
375      OUTPUT(JJ,II)=0.0
400      CONTINUE
        WRITE(6,10000) TITLE,TITL1,TITLA
        WRITE(6,10100) RN,OG,(TPATH(K,PT),K=1,4)
        DO 600 JJ=NRL,NRU
        WRITE(6,10200) IDIST(JJ),(OUTPUT(JJ,IDIR(II)),II=1,8)
600      CONTINUE
        WRITE(6,10125)
        DO 605 JJ=NRL,NRU
        WRITE(6,10200) IDIST(JJ),(OUTPUT(JJ,IDIR(II)),II=9,16)
605      CONTINUE
        RETURN
500      WRITE(6,10000) TITLE,TITL1,TITLA
        DO 680 II=1,16
        DO 680 JJ=NRL,NRU
        HOLDC(II)=OUTPUT(JJ,II)+HOLDC(II)
        HOLDR(JJ)=OUTPUT(JJ,II)+HOLDR(JJ)
680      TSUM=OUTPUT(JJ,II)+TSUM
        WRITE(6,10100)RN,OG,(TPATH(K,PT),K=1,4)
        DO 700 JJ=NRL,NRU
        WRITE(6,10200)IDIST(JJ),(OUTPUT(JJ,IDIR(II)),II=1,8)
        WRITE(6,10250)(HOLDC(IDIR(II)),II=1,8)
        WRITE(6,10175)
        DO 710 JJ=NRL,NRU
        WRITE(6,10205)IDIST(JJ),(OUTPUT(JJ,IDIR(II)),II=9,16),HOLDR(JJ)
        WRITE(6,10250)(HOLDC(IDIR(II)),II=9,16),TSUM
        RETURN
1000     IF(NDIM.NE.20) RETURN
        IF(OG.EQ.SUM) GO TO 1001
        IF(OG.EQ.PUL) GO TO 1001
        IF(OG.EQ.TBEQ) GO TO 1001
        IF(J.EQ.1) GO TO 305
        GO TO 14

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1001  CONTINUE
      IF(NO.NE.1) GO TO 1200
1100  DO 1150 II=NOL,NOU
      DO 1150 JJ=NEL,NRU
      OUTPUT(JJ,II)=WLRN(JJ,II)
1150  CONTINUE
      OG=SUM
      PT=7
      GO TO 305
1200  IF(NO.NE.3) GO TO 1300
      FAC=1.
      IF(IT.EQ.3) FAC=1./AGEX
      DO 1250 II=NOL,NOU
      DO 1250 JJ=NEL,NRU
      OUTPUT(JJ,II)=RRISK*WLRN(JJ,II)*FAC
1250  CONTINUE
      IF(J.EQ.1) GO TO 305
      GO TO 14
1300  IF(OG.NE.PUL) GO TO 1400
      FAC=1.
      IF(IT.EQ.3) FAC=.001
      DO 1350 II=NOL,NOU
      DO 1350 JJ=NEL,NRU
      OUTPUT(JJ,II)=RREF(1)*WLRN(JJ,II)*FAC
1350  CONTINUE
      IF(J.EQ.1) GO TO 500
      GO TO 14
1400  IF(OG.NE.TBEQ) RETURN
      FAC=1.
      IF(IT.EQ.3) FAC=.001
      DO 1450 II=NOL,NOU
      DO 1450 JJ=NEL,NRU
      OUTPUT(JJ,II)=RREF(2)*WLRN(JJ,II)*FAC
1450  CONTINUE
      IF(J.EQ.1) GO TO 305
      GO TO 14
10100 FORMAT(' FOR RADIONUCLIDE : ',A8/
> ' AND ORGAN/CANCER : ',A8/
> ' AND PATHWAY : ',4A4/
> ' DIRECTIONS:',3X,'N',12X,'NNE',10X,'NE',11X,
> 'ENE',10X,'E',12X,'ESE',10X,'SE',11X,'SSE'/
> ' DISTANCE'/' (METERS):'/)
10125 FORMAT(////15X,'S',12X,'SSW',10X,'SW',11X,'WSW',10X,'W'
> ,12X,'WNW',10X,'NW',11X,'NNW'/' DISTANCE'/' (METERS):')
10175 FORMAT(////15X,'S',12X,'SSW',10X,'SW',11X,'WSW',10X,'W'
> ,12X,'WNW',10X,'NW',11X,'NNW',10X,'SUM'/' DISTANCE'/'
> ' (METERS):')
10200 FORMAT(I10,1P8G13.3)
10205 FORMAT(I10,1P9G13.3)
10250 FORMAT('0SUM',6X,1P9G13.3)
      END

```

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      SUBROUTINE SUMMARY(TITLE,GSCFAC)
      REAL*8 NUCLID,ORGN,CANC,TOTBOD,RNLOC,OGLOC,GEN,TOTAL,WTSUM,
A   OREP,RREP,CREP,RN222
      LOGICAL GENEFF,RNWR
      REAL LLET
C
      COMMON/COMEX/EXPP(20,20,40,4),POP(20,20),POPFAC,TOTFAC, NOL,NOU,
>   NRL,NRU,IDIST(20),ILOC,JLOC
      COMMON/COMOR/ORGN(20),NORGN,TIME(20),DOSE(20,40,4,2), DTABLE(7)
      COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLRN(20,20),
A   RRISK,RREF(2),RYELL,NOREP,NRREP,NCREP
      COMMON/LETFAC/HLET(20),LLET(20)
      COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS (4,40),
>   INDPOP
      COMMON/COMGEN/GEN(3),NGEN,GDOSE(3,40,4,2),GRISK(3,40,4,2),
>   GENEFF,GRFAC(2),REPPER,GHLET(3),GHLET(3),GREP(3,40,4)
      COMMON/COMUS/STLOW(40),STHIG(40),STCOM(40),STGLO(40),
A   STGHI(40),STGCO(40)
      DIMENSION DOSFAC(4),GENFAC(4),TITLE(20)
      DATA RN222/8HRN-222 /
      DATA DOSFAC/1.,1.,1.,100./,
<   GENFAC/1.,1.,1.,100./,TOTAL/8HTOTAL /,WTSUM/8HWT.SUM /
      COMMON/COMWOR/DFAC(20,4)
      DOSFAC(4)=GSCFAC*DOSFAC(4)
      GENFAC(4)=GSCFAC*GENFAC(4)
      RNWR=.FALSE.
      DO 5 J=1,NONCLD
      IF(NUCLID(J).EQ.RN222) RNWR=.TRUE.
5   CONTINUE
      WLC=0.0
      DO 10 II=NOL,NOU
      DO 10 JJ=NRL,NRU
      WLC=WLC+WLRN(JJ,II)
10  CONTINUE
      WLE=WLC*TOTFAC
C**** DOSE RATES BY ORGAN
      DO 50 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0
50  CONTINUE
      SUML=0.0
      SUMH=0.0
      SUMC=0.0
      DO 100 L=1,NORGN
      DO 100 K=1.4

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FACNEW=POPFAC*DOSFAC(K)
FACNE2=POPFAC*GENFAC(K)
DO 100 J=1,NONCLD
  STHIG(L)=STHIG(L)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
  SUMH=SUMH+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)*DFAC(L,K)
  STLOW(L)=STLOW(L)+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
  SUML=SUML+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)*DFAC(L,K)
  STCOM(L)=STCOM(L)+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
  < *LLET(L)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)*HLET(L)
  SUMC=SUMC+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)*
  < LLET(L)*DFAC(L,K)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)*
  < HLET(L)*DFAC(L,K)
  IF(L.GT.NGEN) GO TO 100
  STGHI(L)=STGHI(L)+GDOSE(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)
  STGLO(L)=STGLO(L)+GDOSE(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
  STGCO(L)=STGCO(L)+GDOSE(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
  < *GLLET(L)+GDOSE(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)*GHLET(L)
100  CONTINUE
  WRITE(6,10100) TITLE,(ORGN(L),L=1,NORGN),WTSUM
  WRITE(6,10205) (STLOW(L),L=1,NORGN),SUML
  WRITE(6,10210) (STHIG(L),L=1,NORGN),SUMH
  WRITE(6,10215) (STCOM(L),L=1,NORGN),SUMC
  WLI=WLRN(JLOC,ILOC)*POPFAC
  IF(RNR)WRITE(6,20216) WLI
20216  FORMAT('ORADON DAUGHTER EXPOSURE: '/
  A  ' (WORKING LEVEL)',9X,1PG10.3)
  WRITE(6,10290) (GEN(L),L=1,NGEN)
  WRITE(6,10220) (STGLO(L),L=1,NGEN)
  WRITE(6,10225) (STGHI(L),L=1,NGEN)
  WRITE(6,10230) (STGCO(L),L=1,NGEN)
10100  FORMAT('1',20A4/30X,'ORGAN DOSE/EXPOSURE SUMMARY'//
  A  '0*** SELECTED INDIVIDUAL ***'/
  B  'ODOSE RATES: '/
  > 17X,' ORGANS: ',10(2X,A8)/(26X,10(2X,A8)))
10205  FORMAT(' LOW LET (MRAD/Y)',8X,1P10G10.3/
  A  (26X,1P10G10.3))
10206  FORMAT(' LOW LET (PERSON RAD/Y)',1X,1P10G10.3/
  A  (26X,1P10G10.3))
10210  FORMAT(' HIGH LET (MRAD/Y)',7X,1P10G10.3/
  A  (26X,1P10G10.3))
10211  FORMAT(' HIGH LET (PERSON RAD/Y)',1P10G10.3/
  A  (26X,1P10G10.3))
10215  FORMAT(' DOSE EQUIVALENT (MREM/Y)',1P10G10.3/
  A  (26X,1P10G10.3))
10216  FORMAT(' DOSE EQ. (PERSON REM/Y)',1P10G10.3/
  A  (26X,1P10G10.3))
10290  FORMAT('GONADAL DOSES: '/
  > 17X,' GONADS: ',10(2X,A8))
10220  FORMAT(' LOW LET (MRAD)',10X,1P10G10.3/
  A  (26X,1P10G10.3))

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10221  FORMAT(' LOW LET (PERSON RAD)',4X,1P10G10.3/
      A  (26X,1P10G10.3))
10225  FORMAT(' HIGH LET (MRAD)',9X,1P10G10.3/
      A  (26X,1P10G10.3))
10226  FORMAT(' HIGH LET (PERSON RAD)',3X,1P10G10.3/
      A  (26X,1P10G10.3))
10230  FORMAT(' DOSE EQUIVALENT (MREM)',2X,1P10G10.3/
      A  (26X,1P10G10.3))
10231  FORMAT(' DOSE EQ. (PERSON REM)',3X,1P10G10.3/
      A  (26X,1P10G10.3))
      IF(INDPOP.NE.1) GO TO 1000
      DO 150 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STGHI(J)=0.0
      STGLO(J)=0.0
      STGCO(J)=0.0
150    CONTINUE
      SUML=0.0
      SUMH=0.0
      SUMC=0.0
      DO 200 L=1,NORGN
      DO 200 K=1,4
      FACNEW=TOTFAC*DOSFAC(K)
      FACNE2=TOTFAC*GENFAC(K)
      DO 200 J=1,NONCLD
      DO 200 II=NOL,NOU
      DO 200 JJ=NRL,NEU
      STHIG(L)=STHIG(L)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      SUMH=SUMH+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW*DFAC(L,K)
      STLOW(L)=STLOW(L)+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      SUML=SUML+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW*DFAC(L,K)
      STCOM(L)=STCOM(L)+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      >  *LLET(L)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW*HLET(L)
      SUMC=SUMC+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW*
      >  LLET(L)*DFAC(L,K)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW*
      >  HLET(L)*DFAC(L,K)
      IF(L.GT.NGEN) GO TO 200
      STGHI(L)=STGHI(L)+GDOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
      STGLO(L)=STGLO(L)+GDOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
      STGCO(L)=STGCO(L)+GDOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
      >  *GLLET(L)+GDOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2*GHLET(L)
200    CONTINUE
      WRITE(6,10400) (ORGN(L),L=1,NORGN),WTSUM
10400  FORMAT('/'0*** MEAN INDIVIDUAL ***'/
      A  'ODOSE RATE: '/
      +  17X,' ORGANS:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10205) (STLOW(L),L=1,NORGN),SUML
      WRITE(6,10210) (STHIG(L),L=1,NORGN),SUMH
      WRITE(6,10215) (STCOM(L),L=1,NORGN),SUMC
      IF(RNWR)WRITE(6,20216) WLE
      WRITE(6,10590) (GEN(L),L=1,NGEN)

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10590  FORMAT('OGONADAL DOSES: '/
> 17X,' GONADS:',10(2X,A8))
WRITE(6,10220) (STGLO(L),L=1,NGEN)
WRITE(6,10225) (STGHI(L),L=1,NGEN)
WRITE(6,10230) (STGCO(L),L=1,NGEN)
DO 350 K=1,40
STLOW(K)=0.0
STHIG(K)=0.0
STCOM(K)=0.0
IF(K.GT.NGEN) GO TO 350
STGLO(K)=0.0
STGHI(K)=0.0
STGCO(K)=0.0
50  CONTINUE
SUML=0.0
SUMH=0.0
SUMC=0.0
DO 400 K=1,4
DO 400 J=1,NONCLD
TEXPP=0.0
DO 403 II=NOL,NOU
DO 403 JJ=NRL,NRU
TEXPP=TEXPP+EXPP(JJ,II,J,K)
403  CONTINUE
TEXPP=TEXPP*.001
DO 400 L=1,NORGN
STLOW(L)=STLOW(L)+DOSE(L,J,K,1)*TEXPP*DOSFAC(K)
SUML=SUML+DOSE(L,J,K,1)*TEXPP*DOSFAC(K)*DFAC(L,K)
STHIG(L)=STHIG(L)+DOSE(L,J,K,2)*TEXPP*DOSFAC(K)
SUMH=SUMH+DOSE(L,J,K,2)*TEXPP*DOSFAC(K)*DFAC(L,K)
STCOM(L)=STCOM(L)+DOSE(L,J,K,1)*TEXPP*DOSFAC(K)*LLET(L)+
> DOSE(L,J,K,2)*TEXPP*DOSFAC(K)*HLET(L)
SUMC=SUMC+DOSE(L,J,K,1)*TEXPP*DOSFAC(K)*LLET(L)*DFAC(L,K)+
> DOSE(L,J,K,2)*TEXPP*DOSFAC(K)*HLET(L)*DFAC(L,K)
IF(L.GT.NGEN) GO TO 400
STGLO(L)=STGLO(L)+GDOSE(L,J,K,1)*TEXPP*GENFAC(K)
STGHI(L)=STGHI(L)+GDOSE(L,J,K,2)*TEXPP*GENFAC(K)
STGCO(L)=STGCO(L)+GDOSE(L,J,K,1)*TEXPP*GENFAC(K)*GLLET(L)+
> GDOSE(L,J,K,2)*TEXPP*GENFAC(K)*GHLET(L)
400  CONTINUE
WRITE(6,10700) (ORGN(L),L=1,NORGN),WTSUM
10700  FORMAT(/'0*** COLLECTIVE POPULATION ***'/
A 'ODOSE RATE: '/
> 17X,' ORGANS:',10(2X,A8)/(26X,10(2X,A8)))
WRITE(6,10206) (STLOW(L),L=1,NORGN),SUML
WRITE(6,10211) (STHIG(L),L=1,NORGN),SUMH
WRITE(6,10216) (STCOM(L),L=1,NORGN),SUMC
IF(RNWR)WRITE(6,20416) WLC
20416  FORMAT('ORADON DAUGHTER EXPOSURE: '/
A ' (PERSON WORKING LEVEL)',2X,1PG10.3)
WRITE(6,10790) (GEN(L),L=1,NGEN)

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10790  FORMAT('OGONADAL DOSES: '/
>      17X,' GONADS:',10(2X,A8))
      WRITE(6,10221) (STGLO(L),L=1,NGEN)
      WRITE(6,10226) (STGHI(L),L=1,NGEN)
      WRITE(6,10231) (STGCO(L),L=1,NGEN)
C****
DOSE RATES BY PATHWAY
1000   DO 1050 J=1,40
        STHIG(J)=0.0
        STLOW(J)=0.0
        STCOM(J)=0.0
        STGHI(J)=0.0
        STGLO(J)=0.0
        STGCO(J)=0.0
1050   CONTINUE
        DO 1199 K=1,4
        DO 1100 L=1,NORGN
        FACNEW=POPFAC*DOSFAC(K)*DFAC(L,K)
        FACNE2=POPFAC*GENFAC(K)
        DO 1100 J=1,NONCLD
        STHIG(K)=STHIG(K)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
        STLOW(K)=STLOW(K)+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
        STCOM(K)=STCOM(K)+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
<      *LLET(L)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)*HLET(L)
        IF(L.NE.NGEN) GO TO 1100
        STGHI(K)=STGHI(K)+GDOSE(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)
        STGLO(K)=STGLO(K)+GDOSE(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
        STGCO(K)=STGCO(K)+GDOSE(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
<      *GILET(L)+GDOSE(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)*GHLET(L)
1100   CONTINUE
        IF(K.GT.2) GO TO 1101
        STHIG(5)=STHIG(5)+STHIG(K)
        STLOW(5)=STLOW(5)+STLOW(K)
        STCOM(5)=STCOM(5)+STCOM(K)
        STGHI(5)=STGHI(5)+STGHI(K)
        STGLO(5)=STGLO(5)+STGLO(K)
        STGCO(5)=STGCO(5)+STGCO(K)
1101   IF(K.LT.3)GO TO 1102
        STHIG(6)=STHIG(6)+STHIG(K)
        STLOW(6)=STLOW(6)+STLOW(K)
        STCOM(6)=STCOM(6)+STCOM(K)
        STGHI(6)=STGHI(6)+STGHI(K)
        STGLO(6)=STGLO(6)+STGLO(K)
        STGCO(6)=STGCO(6)+STGCO(K)
1102   STHIG(7)=STHIG(7)+STHIG(K)
        STLOW(7)=STLOW(7)+STLOW(K)
        STCOM(7)=STCOM(7)+STCOM(K)
        STGHI(7)=STGHI(7)+STGHI(K)
        STGLO(7)=STGLO(7)+STGLO(K)
        STGCO(7)=STGCO(7)+STGCO(K)
1199   CONTINUE
        WRITE(6,11100) TITLE

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11100  FORMAT('1',20A4/30X,' PATHWAY DOSE/EXPOSURE SUMMARY'/
A      '0*** SELECTED INDIVIDUAL ***'/
B      'ODOSE RATES: '/
<      ' WEIGHTED SUMS OF ORGAN DOSE RATES'/
<      '          PATHWAYS: INGESTION ',
<      'INHALATION AIR      GROUND',
<      '          INTERNAL EXTERNAL TOTAL'/
<      45X,' IMMERSION SURFACE')
WRITE(6,10205) (STLOW(L),L=1,7)
WRITE(6,10210) (STHIG(L),L=1,7)
WRITE(6,10215) (STCOM(L),L=1,7)
IF(RNWR)WRITE(6,20216) WLI
WRITE(6,11290)
11290  FORMAT('O AVERAGE GONADAL DOSES: '/
<      '          PATHWAYS: INGESTION ',
<      'INHALATION AIR      GROUND',
<      '          INTERNAL EXTERNAL TOTAL'/
<      45X,' IMMERSION SURFACE')
WRITE(6,10220) (STGLO(L),L=1,7)
WRITE(6,10225) (STGHI(L),L=1,7)
WRITE(6,10230) (STGCO(L),L=1,7)
IF(INDPOP.NE.1) GO TO 11000
DO 1150 J=1,40
STHIG(J)=0.0
STLOW(J)=0.0
STCOM(J)=0.0
STGHI(J)=0.0
STGLO(J)=0.0
STGCO(J)=0.0
1150  CONTINUE
DO 1299 K=1,4
FACNE2=TOTFAC*GENFAC(K)
DO 1200 L=1,NORGN
FACNEW=TOTFAC*DOSFAC(K)*DFAC(L,K)
DO 1200 J=1,NONCLD
DO 1200 II=NOL,NOU
DO 1200 JJ=NRL,NRU
STHIG(K)=STHIG(K)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
STLOW(K)=STLOW(K)+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
STCOM(K)=STCOM(K)+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
> *LLET(L)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW*LLET(L)
IF(L.NE.NGEN) GO TO 1200
STGHI(K)=STGHI(K)+GDOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
STGLO(K)=STGLO(K)+GDOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
STGCO(K)=STGCO(K)+GDOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2*
A      GLLET(L)+GDOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2*GHLET(L)
1200  CONTINUE
1203  IF(K.GT.2) GO TO 1201
STHIG(5)=STHIG(5)+STHIG(K)
STLOW(5)=STLOW(5)+STLOW(K)
STCOM(5)=STCOM(5)+STCOM(K)
STGHI(5)=STGHI(5)+STGHI(K)

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      STGLO(5)=STGLO(5)+STGLO(K)
      STGCO(5)=STGCO(5)+STGCO(K)
1201  IF(K.LT.3) GO TO 1202
      STHIG(6)=STHIG(6)+STHIG(K)
      STLOW(6)=STLOW(6)+STLOW(K)
      STCOM(6)=STCOM(6)+STCOM(K)
      STGHI(6)=STGHI(6)+STGHI(K)
      STGLO(6)=STGLO(6)+STGLO(K)
      STGCO(6)=STGCO(6)+STGCO(K)
1202  STHIG(7)=STHIG(7)+STHIG(K)
      STLOW(7)=STLOW(7)+STLOW(K)
      STCOM(7)=STCOM(7)+STCOM(K)
      STGHI(7)=STGHI(7)+STGHI(K)
      STGLO(7)=STGLO(7)+STGLO(K)
      STGCO(7)=STGCO(7)+STGCO(K)
1299  CONTINUE
      WRITE(6,11400)
11400  FORMAT(/'0*** MEAN INDIVIDUAL ***'/
A      'ODOSE RATES: '/
      < ' WEIGHTED SUMS OF ORGAN DOSE RATES'/
      < ' PATHWAYS: INGESTION ',
      < ' INHALATION AIR GROUND',
      < ' INTERNAL EXTERNAL TOTAL'/
      < 45X,' IMMERSION SURFACE')
      WRITE(6,10205) (STLOW(L),L=1,7)
      WRITE(6,10210) (STHIG(L),L=1,7)
      WRITE(6,10215) (STCOM(L),L=1,7)
      IF(RNWR)WRITE(6,20216) WLE
      WRITE(6,11590)
11590  FORMAT('O AVERAGE GONADAL DOSES: '/
      < ' PATHWAYS: INGESTION ',
      < ' INHALATION AIR GROUND',
      < ' INTERNAL EXTERNAL TOTAL'/
      < 45X,' IMMERSION SURFACE')
      WRITE(6,10220) (STGLO(L),L=1,7)
      WRITE(6,10225) (STGHI(L),L=1,7)
      WRITE(6,10230) (STGCO(L),L=1,7)
      DO 1350 K=1,40
      STLOW(K)=0.0
      STHIG(K)=0.0
      STCOM(K)=0.0
      STGLO(K)=0.0
      STGHI(K)=0.0
      STGCO(K)=0.0
1350  CONTINUE
      DO 1499 K=1,4
      DO 1400 J=1,NONCLD
      TEXPP=0.0
      DO 1404 II=NOL,NOU
      DO 1404 JJ=NRL,NEU
      TEXPP=TEXPP+EXPP(JJ,II,J,K)

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1404  CONTINUE
      TEXPP=TEXPP*.001
      DO 1400 L=1,NORGN
      STLOW(K)=STLOW(K)+DOSE(L,J,K,1)*TEXPP*DOSFAC(K)*DFAC(L,K)
      STHIG(K)=STHIG(K)+DOSE(L,J,K,2)*TEXPP*DOSFAC(K)*DFAC(L,K)
      STCOM(K)=STCOM(K)+DOSE(L,J,K,1)*TEXPP*DOSFAC(K)*LLET(L)*
> DFAC(L,K)+DOSE(L,J,K,2)*TEXPP*DOSFAC(K)*HLET(L)*DFAC(L,K)
      IF(L.NE.NGEN) GO TO 1400
      STGLO(K)=STGLO(K)+GDOSE(L,J,K,1)*TEXPP*GENFAC(K)
      STGHI(K)=STGHI(K)+GDOSE(L,J,K,2)*TEXPP*GENFAC(K)
      STGCO(K)=STGCO(K)+GDOSE(L,J,K,2)*TEXPP*GENFAC(K)*GHLET(L)+
A  GDOSE(L,J,K,1)*TEXPP*GENFAC(K)*GLLET(L)
1400  CONTINUE
1403  IF(K.GT.2) GO TO 1401
      STLOW(5)=STLOW(5)+STLOW(K)
      STHIG(5)=STHIG(5)+STHIG(K)
      STCOM(5)=STCOM(5)+STCOM(K)
      STGLO(5)=STGLO(5)+STGLO(K)
      STGHI(5)=STGHI(5)+STGHI(K)
      STGCO(5)=STGCO(5)+STGCO(K)
      GO TO 1402
1401  STLOW(6)=STLOW(6)+STLOW(K)
      STHIG(6)=STHIG(6)+STHIG(K)
      STCOM(6)=STCOM(6)+STCOM(K)
      STGLO(6)=STGLO(6)+STGLO(K)
      STGHI(6)=STGHI(6)+STGHI(K)
      STGCO(6)=STGCO(6)+STGCO(K)
1402  STLOW(7)=STLOW(7)+STLOW(K)
      STHIG(7)=STHIG(7)+STHIG(K)
      STCOM(7)=STCOM(7)+STCOM(K)
      STGLO(7)=STGLO(7)+STGLO(K)
      STGHI(7)=STGHI(7)+STGHI(K)
      STGCO(7)=STGCO(7)+STGCO(K)
1499  CONTINUE
11700 FORMAT('/0*** COLLECTIVE POPULATION ***'/
A  'ODOSE RATES: '/
<  ' WEIGHTED SUMS OF ORGAN DOSE RATES'/
<  ' PATHWAYS: INGESTION ',
<  'INHALATION AIR GROUND',
<  ' INTERNAL EXTERNAL TOTAL'/
<  45X,' IMMERSION SURFACE')
      WRITE(6,11700)
      WRITE(6,10206) (STLOW(L),L=1,7)
      WRITE(6,10211) (STHIG(L),L=1,7)
      WRITE(6,10216) (STCOM(L),L=1,7)
      IF(RNWR)WRITE(6,20416) WLC
      WRITE(6,11790)
11790 FORMAT('O AVERAGE GONADAL DOSES: '/
<  ' PATHWAYS: INGESTION ',
<  'INHALATION AIR GROUND',
<  ' INTERNAL EXTERNAL TOTAL'/
<  45X,' IMMERSION SURFACE')

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WRITE(6,10221) (STGLO(L),L=1,7)
WRITE(6,10226) (STGHI(L),L=1,7)
WRITE(6,10231) (STGCO(L),L=1,7)
C**** DOSE RATES BY NUCLIDE
11000 DO 2050 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0
2050  CONTINUE
      SUML=0.0
      SUMH=0.0
      SUMC=0.0
      SUMGL=0.0
      SUMGH=0.0
      SUMGC=0.0
      DO 2109 J=1,NONCLD
        DO 2100 K=1,4
          FACNE2=POPFAC*GENFAC(K)
          DO 2100 L=1,NORGN
            FACNEW=POPFAC*DOSFAC(K)*DFAC(L,K)
            STHIG(J)=STHIG(J)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
            STLOW(J)=STLOW(J)+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
            STCOM(J)=STCOM(J)+DOSE(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
            < *LLET(L)+DOSE(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)*HLET(L)
            IF(L.NE.NGEN) GO TO 2100
            STGHI(J)=STGHI(J)+GDOSE(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)
            STGLO(J)=STGLO(J)+GDOSE(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
            STGCO(J)=STGCO(J)+GDOSE(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)*
            A GLET(L)+GDOSE(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)*GHLET(L)
2100  CONTINUE
      SUML=SUML+STLOW(J)
      SUMH=SUMH+STHIG(J)
      SUMC=SUMC+STCOM(J)
      SUMGL=SUMGL+STGLO(J)
      SUMGH=SUMGH+STGHI(J)
      SUMGC=SUMGC+STGCO(J)
2109  CONTINUE
      WRITE(6,12100) TITLE,(NUCLID(L),L=1,NONCLD),TOTAL
12100 FORMAT('1',20A4/30X,'NUCLIDE DOSE/EXPOSURE SUMMARY'//
      A '0*** SELECTED INDIVIDUAL ***'/
      A 'ODOSE RATES:'//
      A ' WEIGHTED SUMS OF ORGAN DOSE RATES'//
      A 15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10205) (STLOW(L),L=1,NONCLD),SUML
      WRITE(6,10210) (STHIG(L),L=1,NONCLD),SUMH
      WRITE(6,10215) (STCOM(L),L=1,NONCLD),SUMC
      IF(RNWR)WRITE(6,20216) WLI
      WRITE(6,12290) (NUCLID(L),L=1,NONCLD),TOTAL

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12290  FORMAT('O AVERAGE GONADAL DOSES: '/
A 15X, ' NUCLIDES: ',10(2X,A8)/(26X,10(2X,A8)))
WRITE(6,10220) (STGLO(L),L=1,NONCLD),SUMGL
WRITE(6,10225) (STGHI(L),L=1,NONCLD),SUMGH
WRITE(6,10230) (STGCO(L),L=1,NONCLD),SUMGC
IF(INDPOP.NE.1) GO TO 21000
DO 2150 J=1,40
STHIG(J)=0.0
STLOW(J)=0.0
STCOM(J)=0.0
STGLO(J)=0.0
STGHI(J)=0.0
STGCO(J)=0.0
2150  CONTINUE
SUML=0.0
SUMH=0.0
SUMC=0.0
SUMGL=0.0
SUMGH=0.0
SUMGC=0.0
DO 2209 J=1,NONCLD
DO 2200 K=1,4
FACNE2=TOTFAC*GENFAC(K)
DO 2200 L=1,NORGN
FACNEW=TOTFAC*DOSFAC(K)*DFAC(L,K)
DO 2200 II=NOL,NOU
DO 2200 JJ=NRL,NRU
STHIG(J)=STHIG(J)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
STLOW(J)=STLOW(J)+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
STCOM(J)=STCOM(J)+DOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
> *LLET(L)+DOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW*HLET(L)
IF(L.NE.NGEN) GO TO 2200
STGLO(J)=STGLO(J)+GDOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
STGHI(J)=STGHI(J)+GDOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
STGCO(J)=STGCO(J)+GDOSE(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2*
A GLET(L)+GDOSE(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2*GHLET(L)
2200  CONTINUE
SUML=SUML+STLOW(J)
SUMH=SUMH+STHIG(J)
SUMC=SUMC+STCOM(J)
SUMGL=SUMGL+STGLO(J)
SUMGH=SUMGH+STGHI(J)
SUMGC=SUMGC+STGCO(J)
2209  CONTINUE
WRITE(6,12400) (NUCLID(L),L=1,NONCLD),TOTAL
12400  FORMAT('/'0*** MEAN INDIVIDUAL ***'/
A 'ODOSE RATES: '/
A ' WEIGHTED SUMS OF ORGAN DOSE RATES'/
> 15X, ' NUCLIDES: ',10(2X,A8)/(26X,10(2X,A8)))
WRITE(6,10205) (STLOW(L),L=1,NONCLD),SUML
WRITE(6,10210) (STHIG(L),L=1,NONCLD),SUMH
WRITE(6,10215) (STCOM(L),L=1,NONCLD),SUMC
IF(RNWR)WRITE(6,20216) WLE
WRITE(6,12590) (NUCLID(L),L=1,NONCLD),TOTAL

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12590  FORMAT('O AVERAGE GONADAL DOSES: '/
> 15X, ' NUCLIDES: ', 10(2X, A8) / (26X, 10(2X, A8)))
WRITE(6, 10220) (STGLO(L), L=1, NONCLD), SUMGL
WRITE(6, 10225) (STGHI(L), L=1, NONCLD), SUMGH
WRITE(6, 10230) (STGCO(L), L=1, NONCLD), SUMGC
DO 2350 K=1, 40
STLOW(K)=0.0
STHIG(K)=0.0
STCOM(K)=0.0
STGLO(K)=0.0
STGHI(K)=0.0
STGCO(K)=0.0
2350  CONTINUE
SUML=0.0
SUMH=0.0
SUMC=0.0
SUMGL=0.0
SUMGH=0.0
SUMGC=0.0
DO 2409 J=1, NONCLD
DO 2400 K=1, 4
TEXPP=0.0
DO 2403 II=NOL, NOU
DO 2403 JJ=NEL, NEU
TEXPP=TEXPP+EXPP(JJ, II, J, K)
2403  CONTINUE
TEXPP=TEXPP*.001
DO 2400 L=1, NORG
STLOW(J)=STLOW(J)+DOSE(L, J, K, 1)*TEXPP*DOSFAC(K)*DFAC(L, K)
STHIG(J)=STHIG(J)+DOSE(L, J, K, 2)*TEXPP*DOSFAC(K)*DFAC(L, K)
STCOM(J)=STCOM(J)+DOSE(L, J, K, 1)*TEXPP*DOSFAC(K)*LLET(L)*
> DFAC(L, K)+DOSE(L, J, K, 2)*TEXPP*DOSFAC(K)*HLET(L)*DFAC(L, K)
IF(L.NE.NGEN) GO TO 2400
STGLO(J)=STGLO(J)+GDOSE(L, J, K, 1)*TEXPP*GENFAC(K)
STGHI(J)=STGHI(J)+GDOSE(L, J, K, 2)*TEXPP*GENFAC(K)
STGCO(J)=STGCO(J)+GDOSE(L, J, K, 1)*TEXPP*GENFAC(K)*GLLET(L)+
A GDOSE(L, J, K, 2)*TEXPP*GENFAC(K)*GHLET(L)
2400  CONTINUE
SUML=SUML+STLOW(J)
SUMH=SUMH+STHIG(J)
SUMC=SUMC+STCOM(J)
SUMGL=SUMGL+STGLO(J)
SUMGH=SUMGH+STGHI(J)
SUMGC=SUMGC+STGCO(J)
2409  CONTINUE
WRITE(6, 12700) (NUCLID(L), L=1, NONCLD), TOTAL
12700  FORMAT('/ 'O *** COLLECTIVE POPULATION *** '/
A ' ODOSE RATES: '/
A ' WEIGHTED SUMS OF ORGAN DOSE RATES' /
> 15X, ' NUCLIDES: ', 10(2X, A8) / (26X, 10(2X, A8)))
WRITE(6, 10206) (STLOW(L), L=1, NONCLD), SUML

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WRITE(6,10211) (STHIG(L),L=1,NONCLD),SUMH
WRITE(6,10216) (STCOM(L),L=1,NONCLD),SUMC
IF(RNWR)WRITE(6,20416) WLC
WRITE(6,12790) (NUCLID(L),L=1,NONCLD),TOTAL
12790  FORMAT('O AVERAGE GONADAL DOSES: '/
> 15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
WRITE(6,10221) (STGLO(L),L=1,NONCLD),SUMGL
WRITE(6,10226) (STGHI(L),L=1,NONCLD),SUMGH
WRITE(6,10231) (STGCO(L),L=1,NONCLD),SUMGC
21000  CALL SUMMR2(TITLE,RNWR,GSCFAC)
RETURN
END

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SUBROUTINE SUMMR2(TITLE,RNWR,GSCFAC)
REAL*8 NUCLID,ORGN,CANC,TOTBOD,RNLOC,OGLOC,GEN,TOTAL,
A CREP,RREP,CREP,PUL
DATA PUL/8HPULMINARY/
LOGICAL GENEFF,RNWR
REAL LLET
C
COMMON/COMEX/EXPP(20,20,40,4),POP(20,20),POPFAC,TOTFAC,NOL,NOU,
> NRL,NRU,IDIST(20),ILOC,JLOC
COMMON/COMRN/OREP(20),RREP(20),CREP(20),WLRN(20,20),
A RRISK,RREF(2),RYRL,NOREP,NRREP,NCREP
COMMON/COMCA/CANC(20),NCANC,RELABS(20),RISK(20,40,4,2),RTABLE(7),
> AGEX,YRL(20,40,4,2)
COMMON/COMRF/REF(20,40,4),FTABLE(7)
COMMON/COMNU/NUCLID(40),NONCLD,PSIZE(40),RESP(40),GIABS(4,40),
> INDPOP
COMMON/COMGEN/GEN(3),NGEN,GDOSE(3,40,4,2),GRISK(3,40,4,2),
> GENEFF,GRFAC(2),REPPER,GLLET(3),GLET(3),GREF(3,40,4)
COMMON/COMUS/STLOW(40),STHIG(40),STCOM(40),STREQ(40),
A STGLO(40),STGHI(40),STGCO(40),STLL(40),STHLL(40),STCLL(40),
B STGRQ(40)
DIMENSION RISFAC(4),REQFAC(4),GENFAC(4),TITLE(20)
DATA RISFAC/2*1.E-5,10.,1000./,
< REQFAC/1.,1.,1.E6,1.E8/,
< GENFAC/1.,1.,1.,100./,TOTAL/8HTOTAL /
C**** RISK RATES BY CANCER
RISFAC(4)=RISFAC(4)*GSCFAC
REQFAC(4)=REQFAC(4)*GSCFAC
GENFAC(4)=GENFAC(4)*GSCFAC
LP=1
DO 25 K=1,NCANC
IF(CANC(K).EQ.PUL)LP=K

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25      CONTINUE
      DO 50 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0
      STREQ(J)=0.0
      STGRQ(J)=0.0
      STLLL(J)=0.0
      STHLL(J)=0.0
      STCLL(J)=0.0
50      CONTINUE
      SUML=0.0
      SUMH=0.0
      SUMC=0.0
      SUMLLL=0.0
      SUMHLL=0.0
      SUMCLL=0.0
      TBEQ=0.0
      RLL=0.0
      YRP=RYELL*WLEN(JLOC,ILOC)*POPFAC
      RR=RRISK*WLEN(JLOC,ILOC)*POPFAC
      IF (WLEN(JLOC,ILOC).NE.0.0) RLL=RYELL/RRISK
      RP=RR
      DO 109 L=1,NCANC
      DO 100 K=1,4
      FACNEW=POPFAC*RISFAC(K)
      FACNE2=POPFAC*GENFAC(K)
      DO 100 J=1,NONCLD
      STHIG(L)=STHIG(L)+RISK(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STHLL(L)=STHLL(L)+YRLL(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STLOW(L)=STLOW(L)+RISK(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STLLL(L)=STLLL(L)+YRLL(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STCOM(L)=STCOM(L)+RISK(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      < +RISK(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STCLL(L)=STCLL(L)+YRLL(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      < +YRLL(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STREQ(L)=STREQ(L)+REF(L,J,K)*POPFAC*REQFAC(K)*EXPP(JLOC,
      < ILOC,J,K)
      IF(L.GT.1) GO TO 100
      TBEQ=TBEQ+REF(NCANC+1,J,K)*POPFAC*REQFAC(K)*EXPP(JLOC,
      < ILOC,J,K)
      STGRQ(L)=STGRQ(L)+GREF(L,J,K)*FACNE2*EXPP(JLOC,ILOC,J,K)
      STGLO(L)=STGLO(L)+GRISK(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
      STGHI(L)=STGHI(L)+GRISK(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)
      STGCO(L)=STGCO(L)+GRISK(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)+
      A GRISK(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)

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100  CONTINUE
      SUML=SUML+STLOW(L)
      SUMH=SUMH+STHIG(L)
      SUMLLL=SUMLLL+STLLL(L)
      SUMHLL=SUMHLL+STHLL(L)
      SUMCLL=SUMCLL+STCLL(L)
      SUMC=SUMC+STCOM(L)
      IF(L.EQ.LP) STCPH=STCLL(L)
      IF(L.EQ.LP) STCCH=STCOM(L)
      IF(STLOW(L).NE.0.0)STLLL(L)=STLLL(L)/STLOW(L)
      IF(STHIG(L).NE.0.0)STHLL(L)=STHLL(L)/STHIG(L)
      IF(STCOM(L).NE.0.0)STCLL(L)=STCLL(L)/STCOM(L)
109  CONTINUE
      IF(SUML.NE.0.0)SUMLLL=SUMLLL/SUML
      IF(SUMH.NE.0.0)SUMHLL=SUMHLL/SUMH
      IF(SUMC.NE.0.0) YRT=(RYELL*WLRN(JLOC,ILOC)*POPFAC+SUMCLL)/
A   (SUMC+RRISK*POPFAC*WLRN(JLOC,ILOC))
      IF(SUMC.NE.0.0)SUMCLL=SUMCLL/SUMC
      YRP=STCPH+YRP
      RP=RP+STCCH
      IF(RP.NE.0.0) YRP=YRP/RP
      WRITE(6,10100) TITLE
      WRITE(6,10102)(CANC(L),L=1,NCANC),TOTAL
10100 FORMAT('1',20A4/30X,'RISK/RISK EQUIVALENT SUMMARY'//
A   '0*** SELECTED INDIVIDUAL ***'/
B   '0LIFETIME FATAL CANCER RISK: '//)
10102 FORMAT(16X,' CANCERS:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10205) (STLOW(L),L=1,NCANC),SUML
      WRITE(6,10210) (STHIG(L),L=1,NCANC),SUMH
      WRITE(6,10215) (STCOM(L),L=1,NCANC),SUMC
      IF(RNWR)WRITE(6,20216) RR
      TT=SUMC+RR
20216 FORMAT('0LUNG CANCER RISK FROM RADON DAUGHTER EXPOSURE ',
A   8X,1PG10.3)
      IF(RNWR)WRITE(6,20217) TT
20217 FORMAT(' TOTAL FATAL CANCER RISK FROM ALL EXPOSURES',
A   12X,1PG10.3)
10205 FORMAT(' LOW LET ',16X,1P10G10.3/(26X,1P10G10.3))
10210 FORMAT(' HIGH LET',16X,1P10G10.3/(26X,1P10G10.3))
10215 FORMAT(' TOTAL',18X,1P10G10.3/(26X,1P10G10.3))
      WRITE(6,30100)
30100 FORMAT('0AVERAGE LIFE LOSS PER PREMATURE DEATH:')
      WRITE(6,10102) (CANC(L),L=1,NCANC),TOTAL
      WRITE(6,10250) (STLLL(L),L=1,NCANC),SUMLLL
      WRITE(6,10255) (STHLL(L),L=1,NCANC),SUMHLL
      WRITE(6,10260) (STCLL(L),L=1,NCANC),SUMCLL
      IF(RNWR)WRITE(6,20218) RLL
20218 FORMAT('0AVG LIFE LOSS FROM RADON DAUGHTER EXPOSURE ',
A   'FOR LUNG',3X,1PG10.3)
      IF(RNWR)WRITE(6,20219)YRP
20219 FORMAT(' AVG LIFE LOSS FROM ALL EXPOSURES FOR LUNG',
A   13X,1PG10.3)
      IF(RNWR)WRITE(6,20220) YRT

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20220  FORMAT(' AVG LIFE LOSS FROM ALL EXPOSURES (TOTAL) ',
A 12X,1PG10.3)
10250  FORMAT(' LOW LET (YR)',12X,1P10G10.3/(26X,1P10G10.3))
10255  FORMAT(' HIGH LET (YR)',11X,1P10G10.3/(26X,1P10G10.3))
10260  FORMAT(' COMBINED (YR)',11X,1P10G10.3/(26X,1P10G10.3))
      WRITE(6,30200)
30200  FORMAT('OFATAL CANCER RISK EQUIVALENT:')
      WRITE(6,10102) (CANC(I),L=1,NCANC),TOTAL
      WRITE(6,10220) (STRBQ(L),L=1,NCANC),TBEQ
      WRITE(6,10221) TBEQ
10220  FORMAT(' (MREM/YR)',15X,1P10G10.3/(26X,1P10G10.3))
10221  FORMAT('OWHOLE BODY FATAL CANCER RISK EQ(MREM/YR)',
> 24X,1PG10.3)
      RQ=RREF(1)*WLRN(JLOC,ILOC)*POPFAC
      RT=RREF(2)*WLRN(JLOC,ILOC)*POPFAC
      TTP=RQ+STRBQ(LP)
      TTQ=RT+TBEQ
      IF(RNWR)WRITE(6,20221) RQ
      IF(RNWR)WRITE(6,20222) RT
      IF(RNWR)WRITE(6,20224) TTP
      IF(RNWR)WRITE(6,20223) TTQ
20221  FORMAT(' LUNG RISK EQUIVALENT(MREM/YR) FROM RADON ',
A 'DAUGHTER EXPOSURE ',4X,1PG10.3)
20321  FORMAT(' LUNG RISK EQ. (PERSON REM/YR) FROM RADON ',
A 'DAUGHTER EXPOSURE',6X,1PG10.3)
20222  FORMAT(' WHOLE BODY RISK EQ (MREM/YR) FROM RADON ',
A 'DAUGHTER EXPOSURE ',6X,1PG10.3)
20322  FORMAT(' WHOLE BODY RISK EQ (PERSON REM/YR) FROM RADON ',
A 'DAUGHTER EXPOSURE',1X,1PG10.3)
20223  FORMAT(' WHOLE BODY RISK EQ (MREM/YR) FROM ALL EXPOSURES',
A17X,1PG10.3)
20224  FORMAT(' PULMINARY RISK EQ (MREM/YR) FOR ALL EXPOSURES',
A 20X,1PG10.3)
20323  FORMAT(' WHOLE BODY RISK EQ (PERSON REM/YR) FROM ALL EXPOSURES',
A11X,1PG10.3)
20324  FORMAT(' PULMINARY RISK EQ (PERSON REM/YR) FOR ALL EXPOSURES',
A 14X,1PG10.3)
      WRITE(6,10190)
10190  FORMAT('OGENETIC RISKS:')
      WRITE(6,10225) STGLO(1)
10225  FORMAT(' LOW LET (EFFECTS/BIRTH)',1X,1P10G10.3/
> (26X,1P10G10.3))
      WRITE(6,10230) STGHI(1)
10230  FORMAT(' HIGH LET (EFFECTS/BIRTH)',1P10G10.3/
> (26X,1P10C10.3))
      WRITE(6,10235) STGCO(1)
10235  FORMAT(' COMBINED (EFFECTS/BIRTH)',1P10G10.3/
> (26X,1P10G10.3))
      WRITE(6,30300) STGRQ(1)

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30300  FORMAT('0GENETIC RISK EQUIVALENT: '/
A      ' (MREM/YR)',15X,1P10G10.3/(26X,1P10G10.3))
      IF(INDPOP.NE.1) GO TO 1000
      DO 150 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0
      STREQ(J)=0.0
      STLLL(J)=0.0
      STHLL(J)=0.0
      STCLL(J)=0.0
      STGRQ(J)=0.0
150    CONTINUE
      TBEQ=0.0
      SUMI=0.0
      SUMH=0.0
      SUMC=0.0
      SUMLLL=0.0
      SUMHLL=0.0
      SUMCLL=0.0
      RRM=0.0
      RLL=0.0
      RQM=0.0
      RTM=0.0
      YRP=0.0
      DO 206 II=NOL,NOU
      DO 206 JJ=NRL,NRU
      RQM=RQM+RREF(1)*WLRN(JJ,II)*TOTFAC
      RTM=RTM+RREF(2)*WLRN(JJ,II)*TOTFAC
      RRM=RRISK*WLRN(JJ,II)*TOTFAC+RRM
      YRP=YRLL*WLRN(JJ,II)*TOTFAC+YRP
206    CONTINUE
      IF(RRM.NE.0.0)RLL=YRP/RRM
      RP=YRP
      DO 209 L=1,NCANC
      DO 200 K=1,4
      FACNEW=TOTFAC*RISFAC(K)
      FACNE2=TOTFAC*GENFAC(K)
      DO 200 J=1,NONCLD
      DO 200 II=NOL,NOU
      DO 200 JJ=NRL,NRU
      STHIG(L)=STHIG(L)+RISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      STHLL(L)=STHLL(L)+YRLL(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      STLOW(L)=STLOW(L)+RISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      STLLL(L)=STLLL(L)+YRLL(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      STCOM(L)=STCOM(L)+RISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      > +RISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW

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      STCLL(L)=STCLL(L)+YRL(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
    > +YRL(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      STREQ(L)=STREQ(L)+REF(L,J,K)*EXPP(JJ,II,J,K)*TOTFAC
    > *REQFAC(K)
      IF(L.NE.1) GO TO 200
      TREQ=TREQ+REF(NCANC+1,J,K)*EXPP(JJ,II,J,K)*TOTFAC*REQFAC(K)
      STGRQ(L)=STGRQ(L)+GREF(L,J,K)*EXPP(JJ,II,J,K)*TOTFAC*GENFAC(K)
      STGLO(L)=STGLO(L)+GRISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
      STGHI(L)=STGHI(L)+GRISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
      STGCO(L)=STGCO(L)+GRISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2+

A   GRISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
200  CONTINUE
      SUML=SUML+STLOW(L)
      SUMH=SUMH+STHIG(L)
      SUMC=SUMC+STCOM(L)
      SUMLLL=SUMLLL+STLLL(L)
      SUMHLL=SUMHLL+STHLL(L)
      SUMCLL=SUMCLL+STCLL(L)
      IF(L.EQ.LP) STCPH=STCLL(LP)
      IF(L.EQ.LP) STCCH=STCOM(LP)
      IF(STLOW(L).NE.0.0)STLLL(L)=STLLL(L)/STLOW(L)
      IF(STHIG(L).NE.0.0)STHLL(L)=STHLL(L)/STHIG(L)
      IF(STCOM(L).NE.0.0)STCLL(L)=STCLL(L)/STCOM(L)
209  CONTINUE
      IF(SUML.NE.0.0)SUMLLL=SUMLLL/SUML
      IF(SUMH.NE.0.0)SUMHLL=SUMHLL/SUMH
      IF(SUMC.NE.0.0) YRT=(YRP+SUMCLL)/(RRM+SUMC)
      YRP=STCPH+YRP
      RP=RRM+STCCH
      IF(RP.NE.0.0)YRP=YRP/RP
      IF(SUMC.NE.0.0)SUMCLL=SUMCLL/SUMC
      WRITE(6,10400) TITLE
      WRITE(6,10402) (CANC(L),L=1,NCANC),TOTAL
10400  FORMAT('1',20A4/30X,'RISK/RISK EQUIVALENT SUMMARY'//
A   '0*** MEAN INDIVIDUAL ***'/
B   'OLIFETIME FATAL CANCER RISK: '/')
10402  FORMAT(16X,' CANCERS:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10205) (STLOW(L),L=1,NCANC),SUML
      WRITE(6,10210) (STHIG(L),L=1,NCANC),SUMH
      WRITE(6,10215) (STCOM(L),L=1,NCANC),SUMC
      IF(RNWR)WRITE(6,20216) RRM
      TTM=SUMC+RRM
      IF(RNWR)WRITE(6,20217)TTM
      WRITE(6,30100)
      WRITE(6,10102) (CANC(L),L=1,NCANC),TOTAL
      WRITE(6,10250) (STLLL(L),L=1,NCANC),SUMLLL
      WRITE(6,10255) (STHLL(L),L=1,NCANC),SUMHLL
      WRITE(6,10260) (STCLL(L),L=1,NCANC),SUMCLL

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IF(RNWR)WRITE(6,20218) RLL
IF(RNWR)WRITE(6,20219) YRP
IF(RNWR)WRITE(6,20220) YRT
WRITE(6,30200)
WRITE(6,10102) (CANC(L),L=1,NCANC),TOTAL
WRITE(6,10220) (STREQ(L),L=1,NCANC),TBEQ
WRITE(6,10221) TBEQ
IF(RNWR)WRITE(6,20221) RQM
IF(RNWR)WRITE(6,20222) RTM
TTP=RQM+STREQ(LP)
IF(RNWR)WRITE(6,20224) TTP
TTQM=RTM+TBEQ
IF(RNWR)WRITE(6,20223) TTQM

WRITE(6,10590)
10590 FORMAT('OGENETIC RISKS: '/')
WRITE(6,10225) STGLO(1)
WRITE(6,10230) STGHI(1)
WRITE(6,10235) STGCO(1)

WRITE(6,30300) STGRQ(1)

DO 350 K=1,40
STLOW(K)=0.0
STHIG(K)=0.0
STCOM(K)=0.0
STGLO(K)=0.0
STGHI(K)=0.0
STGCO(K)=0.0
STREQ(K)=0.0
STLLL(K)=0.0
STHLL(K)=0.0
STCLL(K)=0.0
STGRQ(K)=0.0
350 CONTINUE
SUML=0.0

TBEQ=0.0
SUMH=0.0
SUMC=0.0
SUMLLL=0.0
SUMHLL=0.0
SUMCLL=0.0
WLT=0.0
DO 401 II=NOL,NOU
DO 401 JJ=NRL,NRU
WLT=WLT+WLRN(JJ,II)

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401  CONTINUE
      RRC=RRISK*WLT/AGEX
      RQC=RREF(1)*WLT*.001
      RTC=RREF(2)*WLT*.001
      DO 400 K=1,4
      DO 400 J=1,NCNCLD
      TEXPP=0.0
      DO 403 II=NOL,NOU
      DO 403 JJ=NRL,NEU
      TEXPP=TEXPP+EXPP(JJ,II,J,K)
403  CONTINUE
      DO 400 L=1,NCANC
      STLOW(L)=STLOW(L)+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX
      STILL(L)=STILL(L)+YRL(L,J,K,1)*TEXPP*RISFAC(K)/AGEX
      SUML=SUML+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX
      SUMLL=SUMLL+YRL(L,J,K,1)*TEXPP*RISFAC(K)/AGEX
      STHIG(L)=STHIG(L)+RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      STHLL(L)=STHLL(L)+YRL(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      SUMH=SUMH+RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      SUMHL=SUMHL+YRL(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      STCOM(L)=STCOM(L)+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX+
      > RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      STCLL(L)=STCLL(L)+YRL(L,J,K,1)*TEXPP*
      > RISFAC(K)/AGEX+
      > YRL(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      SUMC=SUMC+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX+
      A RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      SUMCLL=SUMCLL+YRL(L,J,K,1)*TEXPP*RISFAC(K)/AGEX+
      A YRL(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      STREQ(L)=STREQ(L)+REF(L,J,K)*TEXPP*REQFAC(K)*.001
      IF(L.NE.1) GO TO 400
      TBEQ=TBEQ+REF(NCANC+1,J,K)*TEXPP*REQFAC(K)*.001
      STGRQ(L)=STGRQ(L)+GREF(L,J,K)*TEXPP*GENFAC(K)*.001
      STGLO(L)=STGLO(L)+GRISK(L,J,K,1)*TEXPP*GENFAC(K)*REPPER
      STGHI(L)=STGHI(L)+GRISK(L,J,K,2)*TEXPP*GENFAC(K)*REPPER
      STGCO(L)=STGCO(L)+GRISK(L,J,K,1)*TEXPP*GENFAC(K)*REPPER+
      A GRISK(L,J,K,2)*TEXPP*GENFAC(K)*REPPER
400  CONTINUE
      WRITE(6,10700)TITLE, (CANC(L),L=1,NCANC),TOTAL
10700  FORMAT('1',20A4/29X,'RISK/RISK EQUIVALENT SUMMARY'/
      1  /'0*** COLLECTIVE POPULATION ***'/
      A  '0COLLECTIVE FATAL CANCER RISK: '/
      A  16X,' CANCERS:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10705) (STLOW(L),L=1,NCANC),SUML
10705  FORMAT(' LOW LET(DEATHS/YR)',6X,1P10G10.3/
      A  (26X,1P10G10.3))
      WRITE(6,10710) (STHIG(L),L=1,NCANC),SUMH
10710  FORMAT(' HIGH LET(DEATHS/YR)',5X,1P10G10.3/
      A  (26X,1P10G10.3))
      WRITE(6,10715) (STCOM(L),L=1,NCANC),SUMC
      IF(RNWR)WRITE(6,20316) RRC
      TTC=SUMC+RRC
      IF(RNWR)WRITE(6,20317) TTC

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20316  FORMAT('OLUNG CANCER RISK(DEATHS/YR) FROM RADON DAUGHTER',
> ' EXPOSURE',8X,1PG10.3)
20317  FORMAT(' TOTAL FATAL CANCER RISK(DEATHS/YR) FROM ALL',
> ' EXPOSURE',12X,1PG10.3)
CWRITE(6,10750) (STLL(L),L=1,NCANC),SUMLL
CWRITE(6,10755) (STELL(L),L=1,NCANC),SUMHLL
CWRITE(6,10760) (STCLL(L),L=1,NCANC),SUMCLL
10750  FORMAT(' LOST LOW LET',12X,1P10G10.3/(26X,1P10G10.3))
10755  FORMAT(' LIFE LOST HIGH LET',6X,1P10G10.3/(26X,1P10G10.3))
10760  FORMAT(' LIFE LOST COMBINED',6X,1P10G10.3/(26X,1P10G10.3))
10715  FORMAT(' TOTAL (DEATHS/YR)',6X,1P10G10.3/
A (26X,1P10G10.3))
WRITE(6,30200)
WRITE(6,10102) (CANC(L),L=1,NCANC),TOTAL
WRITE(6,10719) (STREQ(L),L=1,NCANC),TBEQ
10719  FORMAT(' (PERSON REM/YR)',9X,1P10G10.3/(26X,1P10G10.3))
WRITE(6,10321) TBEQ
10321  FORMAT('OWHOLE BODY FATAL CANCER RISK EQ(PERSON REM/YR)',
1 18X,1PG10.3)
IF(RNWR)WRITE(6,20321) RQC
IF(RNWR)WRITE(6,20322) RTC
TTQC=RQC+STREQ(LP)
IF(RNWR)WRITE(6,20324) TTQC
TTQC=RTC+TBEQ
IF(RNWR)WRITE(6,20323) TTQC
10720  FORMAT('OGENETIC RISK EQUIVALENT: '/
1 ' (PERSON REM/YR)',9X,1P10G10.3/
A (26X,1P10G10.3))
WRITE(6,10790)
10790  FORMAT('OGENETIC RISKS:')
WRITE(6,10725) STGLO(1)
10725  FORMAT(' LOW LET(EFFECTS/YR)',5X,1P10G10.3/
> (26X,1P10G10.3))
WRITE(6,10730) STGHI(1)
10730  FORMAT(' HIGH LET(EFFECTS/YR)',4X,1P10G10.3/
> (26X,1P10G10.3))
WRITE(6,10735) STGCO(1)
10735  FORMAT(' COMBINED(EFFECTS/YR)',4X,1P10G10.3/
> (26X,1P10G10.3))
WRITE(6,10720) STGRQ(1)
C****  RISK RATES BY PATHWAY
1000  DO 1050 J=1,40
      ETHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STREQ(J)=0.0

      STGRQ(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0

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1050  CONTINUE
      DO 1199 K=1,4
      DO 1100 L=1,NCANC
      FACNEW=POPFAC*RISFAC(K)
      FACNE2=POPFAC*GENFAC(K)
      DO 1100 J=1,NONCLD
      STHIG(K)=STHIG(K)+RISK(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STLOW(K)=STLOW(K)+RISK(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STCOM(K)=STCOM(K)+RISK(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      < +RISK(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      IF(L.NE.1) GO TO 1100
      STREQ(K)=STREQ(K)+REF(NCANC+1,J,K)*POPFAC*REQFAC(K)*
      < EXPP(JLOC,ILOC,J,K)
      STGRQ(K)=STGRQ(K)+GREF(L,J,K)*POPFAC*GENFAC(K)*
      < EXPP(JLOC,ILOC,J,K)
      STGHI(K)=STGHI(K)+GRISK(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)
      STGLO(K)=STGLO(K)+GRISK(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)
      STGCO(K)=STGCO(K)+GRISK(L,J,K,1)*FACNE2*EXPP(JLOC,ILOC,J,K)+
      A GRISK(L,J,K,2)*FACNE2*EXPP(JLOC,ILOC,J,K)
1100  CONTINUE
1103  IF(K.GT.2) GO TO 1101
      STHIG(5)=STHIG(5)+STHIG(K)
      STLOW(5)=STLOW(5)+STLOW(K)
      STCOM(5)=STCOM(5)+STCOM(K)
      STGHI(5)=STGHI(5)+STGHI(K)
      STGLO(5)=STGLO(5)+STGLO(K)
      STGCO(5)=STGCO(5)+STGCO(K)
      STGRQ(5)=STGRQ(5)+STGRQ(K)
      STREQ(5)=STREQ(5)+STREQ(K)
1101  IF(K.LT.3) GO TO 1102
      STHIG(6)=STHIG(6)+STHIG(K)
      STLOW(6)=STLOW(6)+STLOW(K)
      STCOM(6)=STCOM(6)+STCOM(K)
      STGRQ(6)=STGRQ(6)+STGRQ(K)
      STREQ(6)=STREQ(6)+STREQ(K)
      STGHI(6)=STGHI(6)+STGHI(K)
      STGLO(6)=STGLO(6)+STGLO(K)
      STGCO(6)=STGCO(6)+STGCO(K)
1102  STHIG(7)=STHIG(7)+STHIG(K)
      STLOW(7)=STLOW(7)+STLOW(K)
      STCOM(7)=STCOM(7)+STCOM(K)
      STGRQ(7)=STGRQ(7)+STGRQ(K)
      STREQ(7)=STREQ(7)+STREQ(K)
      STGHI(7)=STGHI(7)+STGHI(K)
      STGLO(7)=STGLO(7)+STGLO(K)
      STGCO(7)=STGCO(7)+STGCO(K)
1199  CONTINUE
      WRITE(6,11100) TITLE
      WRITE(6,11102)

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11100  FORMAT('1',20A4/30X,'PATHWAY RISK/RISK EQUIVALENT SUMMARY'
A      //'0*** SELECTED INDIVIDUAL ***'/
A      'OLIFETIME FATAL CANCER RISK: '/')
11102  FORMAT('          PATHWAYS:  INGESTION ',
<      'INHALATION    AIR    GROUND',
<      '          INTERNAL  EXTERNAL  TOTAL'/
<      45X,' IMMERSION  SURFACE')
      WRITE(6,10205) (STLOW(L),L=1,7)
      WRITE(6,10210) (STHIG(L),L=1,7)
      WRITE(6,10215) (STCOM(L),L=1,7)
      IF(RNWR)WRITE(6,20216) RR
      IF(RNWR)WRITE(6,20217) TT
      WRITE(6,30200)
      WRITE(6,11102)
      WRITE(6,10220) (STREQ(L),L=1,7)
      IF(RNWR)WRITE(6,20422) RT
20422  FORMAT('OWHOLE BODY RISK EQ(MREM/YR) FROM RADON',
>      ' DAUGHTER  EXPOSURE',7X,1PG10.3)
      IF(RNWR)WRITE(6,20223) TTQ
      WRITE(6,10290)
      WRITE(6,11102)

10290  FORMAT('OGENETIC RISKS:')

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      WRITE(6,10225) (STGLO(L),L=1,7)
      WRITE(6,10230) (STGHI(L),L=1,7)
      WRITE(6,10235) (STGCO(L),L=1,7)
      WRITE(6,10300) (STGRQ(L),L=1,7)
      IF(INDPOP.NE.1) GO TO 11000
      DO 1150 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STREQ(J)=0.0

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      STGRQ(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0

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1150  CONTINUE
      TBBQ=0.0
      DO 1299 K=1,4
      FACNEW=TOTFAC*RISFAC(K)
      FACNE2=TOTFAC*GENFAC(K)
      DO 1200 L=1,NCANC
      DO 1200 J=1,NONCLD
      DO 1200 II=NOL,NOU

      DO 1200 JJ=NRL,NRU
      STHIG(K)=STHIG(K)+RISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      STLOW(K)=STLOW(K)+RISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      STCOM(K)=STCOM(K)+RISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
    > +RISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      IF(L.GT.1) GO TO 1200
      STREQ(K)=STREQ(K)+REF(NCANC+1,J,K)*EXPP(JJ,II,J,K)*
    > TOTFAC*REQFAC(K)
      STGRQ(K)=STGRQ(K)+GREF(L,J,K)*EXPP(JJ,II,J,K)*
    > TOTFAC*GENFAC(K)
      STGHI(K)=STGHI(K)+GRISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
      STGLO(K)=STGLO(K)+GRISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
      STGCO(K)=STGCO(K)+GRISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2+
    A GRISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
1200  CONTINUE
1203  IF(K.GT.2) GO TO 1201
      STHIG(5)=STHIG(5)+STHIG(K)
      STLOW(5)=STLOW(5)+STLOW(K)
      STCOM(5)=STCOM(5)+STCOM(K)
      STGRQ(5)=STGRQ(5)+STGRQ(K)
      STREQ(5)=STREQ(5)+STREQ(K)
      STGLO(5)=STGLO(5)+STGLO(K)
      STGHI(5)=STGHI(5)+STGHI(K)
      STGCO(5)=STGCO(5)+STGCO(K)

1201  IF(K.LT.3) GO TO 1202
      STHIG(6)=STHIG(6)+STHIG(K)
      STLOW(6)=STLOW(6)+STLOW(K)
      STCOM(6)=STCOM(6)+STCOM(K)
      STGRQ(6)=STGRQ(6)+STGRQ(K)
      STREQ(6)=STREQ(6)+STREQ(K)
      STGLO(6)=STGLO(6)+STGLO(K)
      STGHI(6)=STGHI(6)+STGHI(K)
      STGCO(6)=STGCO(6)+STGCO(K)
1202  STHIG(7)=STHIG(7)+STHIG(K)
      STLOW(7)=STLOW(7)+STLOW(K)

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      STCOM(7)=STCOM(7)+STCOM(K)
      STGRQ(7)=STGRQ(7)+STGRQ(K)
      STREQ(7)=STREQ(7)+STREQ(K)

      STGLO(7)=STGLO(7)+STGLO(K)
      STGHI(7)=STGHI(7)+STGHI(K)
      STGCO(7)=STGCO(7)+STGCO(K)
1299  CONTINUE
      WRITE(6,11400)TITLE
      WRITE(6,11102)
11400  FORMAT(/'1',20A4/
> 29X,'PATHWAY RISK/RISK EQUIVALENT SUMMARY'//
A '0***MEAN INDIVIDUAL ***'/
B '0LIFETIME FATAL CANCER RISK: '/')
      WRITE(6,10205) (STLOW(L),L=1,7)
      WRITE(6,10210) (STHIG(L),L=1,7)
      WRITE(6,10215) (STCOM(L),L=1,7)
      IF(RNWR)WRITE(6,20216) RRN
      IF(RNWR)WRITE(6,20217) TTM
      WRITE(6,30200)
      WRITE(6,11102)
      WRITE(6,10220) (STREQ(L),L=1,7)
      IF(RNWR)WRITE(6,20422) RTM
      IF(RNWR)WRITE(6,20223) TTQM
      WRITE(6,11590)
      WRITE(6,11102)
11590  FORMAT('0GENETIC RISKS: '/')
      WRITE(6,10225) (STGLO(L),L=1,7)
      WRITE(6,10230) (STGHI(L),L=1,7)
      WRITE(6,10235) (STGCO(L),L=1,7)
      WRITE(6,30300) (STGRQ(L),L=1,7)
      DO 1350 K=1,40
      STLOW(K)=0.0
      STHIG(K)=0.0
      STCOM(K)=0.0
      STGLO(K)=0.0
      STGHI(K)=0.0
      STGCO(K)=0.0
      STREQ(K)=0.0
      STGRQ(K)=0.0
1350  CONTINUE
      DO 1499 K=1,4
      DO 1400 J=1,NONCLD
      TEXPP=0.0
      DO 1404 II=NOL,NOU
      DO 1404 JJ=NRL,NRU
      TEXPP=TEXPP+EXPP(JJ,II,J,K)

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1404  CONTINUE
      DO 1400 L=1,NCANC
      STLOW(K)=STLOW(K)+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX
      STHIG(K)=STHIG(K)+RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      STCOM(K)=STCOM(K)+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX+
>    RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
      IF(L.GT.1) GO TO 1400
      STREQ(K)=STREQ(K)+REF(NCANC+1,J,K)*TEXPP*REQFAC(K)*.001
      STGRQ(K)=STGRQ(K)+GREF(L,J,K)*TEXPP*GENFAC(K)*.001
      STGLO(K)=STGLO(K)+GRISK(L,J,K,1)*TEXPP*GENFAC(K)*REPPER
      STGHI(K)=STGHI(K)+GRISK(L,J,K,2)*TEXPP*GENFAC(K)*REPPER
      STGCO(K)=STGCO(K)+GRISK(L,J,K,1)*TEXPP*GENFAC(K)*REPPER+
A    GRISK(L,J,K,2)*TEXPP*GENFAC(K)*REPPER
1400  CONTINUE
1403  IF(K.GT.2) GO TO 1401
      STLOW(5)=STLOW(5)+STLOW(K)
      STHIG(5)=STHIG(5)+STHIG(K)
      STCOM(5)=STCOM(5)+STCOM(K)
      STGLO(5)=STGLO(5)+STGLO(K)
      STGHI(5)=STGHI(5)+STGHI(K)
      STGCO(5)=STGCO(5)+STGCO(K)
      STGRQ(5)=STGRQ(5)+STGRQ(K)
      STREQ(5)=STREQ(5)+STREQ(K)
      GO TO 1402
1401  STLOW(6)=STLOW(6)+STLOW(K)
      STHIG(6)=STHIG(6)+STHIG(K)
      STCOM(6)=STCOM(6)+STCOM(K)
      STGLO(6)=STGLO(6)+STGLO(K)
      STGHI(6)=STGHI(6)+STGHI(K)
      STGCO(6)=STGCO(6)+STGCO(K)
      STGRQ(6)=STGRQ(6)+STGRQ(K)
      STREQ(6)=STREQ(6)+STREQ(K)
1402  STLOW(7)=STLOW(7)+STLOW(K)
      STHIG(7)=STHIG(7)+STHIG(K)
      STCOM(7)=STCOM(7)+STCOM(K)
      STGRQ(7)=STGRQ(7)+STGRQ(K)
      STREQ(7)=STREQ(7)+STREQ(K)
      STGLO(7)=STGLO(7)+STGLO(K)
      STGHI(7)=STGHI(7)+STGHI(K)
      STGCO(7)=STGCO(7)+STGCO(K)
1499  CONTINUE
      WRITE(6,11700)TITLE
      WRITE(6,11102)
11700  FORMAT('/'1',20A4/
>    29X,'PATHWAY RISK/RISK EQUIVALENT SUMMARY'//
A    '0*** COLLECTIVE POPULATION ***'/
B    '0COLLECTIVE FATAL CANCER RISK:'//)
      WRITE(6,10705) (STLOW(L),L=1,7)
      WRITE(6,10710) (STHIG(L),L=1,7)
      WRITE(6,10715) (STCOM(L),L=1,7)
      IF(RNWR)WRITE(6,20316) RRC
      IF(RNWR)WRITE(6,20317) TTC

```

```

WRITE(6,30200)
WRITE(6,11102)
WRITE(6,10719) (STREQ(L),L=1,7)
IF(RNWR)WRITE(6,20522) RTC
20522  FORMAT('OWHOLE BODY RISK EQ(PERSON REM/YR) FROM RADON ',
>  'DAUGHTER EXPOSURE',2X,1PG10.3)
WRITE(6,20323) TTQC
WRITE(6,11790)
WRITE(6,11102)
11790  FORMAT('OGENETIC RISKS(PERSON REM/YR): '/')
WRITE(6,10725) (STGLO(L),L=1,7)
WRITE(6,10730) (STGHI(L),L=1,7)
WRITE(6,10735) (STGCO(L),L=1,7)
WRITE(6,10720) (STGRQ(L),L=1,7)
C****  RISK RATES BY NUCLIDE
11000  DO 2050 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0
      STREQ(J)=0.0
      STGRQ(J)=0.0
2050   CONTINUE
      SUML=0.0
      SUMH=0.0
      SUMC=0.0
      SUMGL=0.0
      SUMGH=0.0
      SUMGC=0.0
      SUMRQ=0.0
      SUMGQ=0.0
      DO 2109 J=1,NONCLD
      DO 2100 K=1,4
      FACNEW=POPFAC*RISFAC(K)
      FACNE2=POPFAC*GENFAC(K)
      DO 2100 L=1,NCANC
      STHIG(J)=STHIG(J)+RISK(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STLOW(J)=STLOW(J)+RISK(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
      STCOM(J)=STCOM(J)+RISK(L,J,K,1)*FACNEW*EXPP(JLOC,ILOC,J,K)
<    +RISK(L,J,K,2)*FACNEW*EXPP(JLOC,ILOC,J,K)
      IF(L.GT.1) GO TO 2100
      STREQ(J)=STREQ(J)+REF(NCANC+1,J,K)*POPFAC*REQFAC(K)*
<    EXPP(JLOC,ILOC,J,K)
      SUMRQ=SUMRQ+REF(NCANC+1,J,K)*POPFAC*REQFAC(K)*
<    EXPP(JLOC,ILOC,J,K)
      STGRQ(J)=STGRQ(J)+GREF(L,J,K)*POPFAC*GENFAC(K)*
<    EXPP(JLOC,ILOC,J,K)
      SUMGQ=SUMGQ+GREF(L,J,K)*POPFAC*GENFAC(K)*

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```

      < EXPP(JLOC,ILOC,J,K)
      STGHI(J)=STGHI(J)+GRISK(L,J,K,2)*EXPP(JLOC,ILOC,J,K)*FACNE2
      STGLO(J)=STGLO(J)+GRISK(L,J,K,1)*EXPP(JLOC,ILOC,J,K)*FACNE2
      STGCO(J)=STGCO(J)+GRISK(L,J,K,1)*EXPP(JLOC,ILOC,J,K)*FACNE2+
A     GRISK(L,J,K,2)*EXPP(JLOC,ILOC,J,K)*FACNE2
2100  CONTINUE
      SUML=SUML+STLOW(J)
      SUMH=SUMH+STHIG(J)
      SUMC=SUMC+STCOM(J)
      SUMGL=SUMGL+STGLO(J)
      SUMGH=SUMGH+STGHI(J)
      SUMGC=SUMGC+STGCO(J)
2109  CONTINUE
      WRITE(6,12100) TITLE
      WRITE(6,12102)(NUCLID(L),L=1,NONCLD),TOTAL
12100  FORMAT('1',20A4/30X,'NUCLIDE RISK/RISK EQUIVALENT SUMMARY'/
      1  /'0*** SELECTED INDIVIDUAL ***'/
      A  'OLIFETIME FATAL CANCER RISK:')
12102  FORMAT(15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10205) (STLOW(L),L=1,NONCLD),SUML
      WRITE(6,10210) (STHIG(L),L=1,NONCLD),SUMH
      WRITE(6,10215) (STCOM(L),L=1,NONCLD),SUMC
      IF(RNWR)WRITE(6,20216) RR
      IF(RNWR)WRITE(6,20217) TT
      WRITE(6,30200)
      WRITE(6,12102) (NUCLID(L),L=1,NONCLD),TOTAL
      WRITE(6,10220) (STREQ(L),L=1,NONCLD),SUMRQ
      IF(RNWR)WRITE(6,20422) RT
      IF(RNWR)WRITE(6,20223) TTQ
      WRITE(6,12290)(NUCLID(L),L=1,NONCLD),TOTAL
12290  FORMAT('OGENETIC RISKS: '/
      A  15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10225) (STGLO(L),L=1,NONCLD),SUMGL
      WRITE(6,10230) (STGHI(L),L=1,NONCLD),SUMGH
      WRITE(6,10235) (STGCO(L),L=1,NONCLD),SUMGC
      WRITE(6,30300) (STGRQ(L),L=1,NONCLD),SUMGQ
      IF(INDPOP.NE.1) GO TO 21000
      DO 2150 J=1,40
      STHIG(J)=0.0
      STLOW(J)=0.0
      STCOM(J)=0.0
      STREQ(J)=0.0
      STGRQ(J)=0.0
      STGLO(J)=0.0
      STGHI(J)=0.0
      STGCO(J)=0.0

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```

2150  CONTINUE
      SUML=0.0
      SUMH=0.0
      SUMC=0.0
      SUMGL=0.0
      SUMGH=0.0
      SUMGC=0.0
      SUMRQ=0.0
      SUMGQ=0.0
      DO 2209 J=1,NONCLD
      DO 2200 L=1,NCANC
      DO 2200 K=1,4
      FACNEW=TOTFAC*RISFAC(K)
      FACNE2=TOTFAC*GENFAC(K)
      DO 2200 II=NOL,NOU
      DO 2200 JJ=NEL,NEU
      STHIG(J)=STHIG(J)+RISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      STLOW(J)=STLOW(J)+RISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
      STCOM(J)=STCOM(J)+RISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNEW
    > +RISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNEW
      IF(L.GT.1) GO TO 2200
      STREQ(J)=STREQ(J)+REF(NCANC+1,J,K)*EXPP(JJ,II,J,K)*TOTFAC*
    > REQFAC(K)
      SUMRQ=SUMRQ+REF(NCANC+1,J,K)*EXPP(JJ,II,J,K)*TOTFAC*
    > REQFAC(K)
      STGRQ(J)=STGRQ(J)+GREF(L,J,K)*EXPP(JJ,II,J,K)*TOTFAC*
    > CENFAC(K)
      SUMGQ=SUMGQ+GREF(L,J,K)*EXPP(JJ,II,J,K)*TOTFAC*
    > GENFAC(K)
      STGHI(J)=STGHI(J)+GRISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2
      STGLO(J)=STGLO(J)+GRISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
      STGCO(J)=STGCO(J)+GRISK(L,J,K,2)*EXPP(JJ,II,J,K)*FACNE2+
    + GRISK(L,J,K,1)*EXPP(JJ,II,J,K)*FACNE2
2200  CONTINUE
      SUML=SUML+STLOW(J)
      SUMH=SUMH+STHIG(J)
      SUMC=SUMC+STCOM(J)
      SUMGL=SUMGL+STGLO(J)
      SUMGH=SUMGH+STGHI(J)
      SUMGC=SUMGC+STGCO(J)
2209  CONTINUE
      WRITE(6,12400)TITLE, (NUCLID(L),L=1,NONCLD),TOTAL
12400  FORMAT('1',20A4/
    > 30X,'NUCLIDE RISK/RISK EQUIVALENT SUMMARY'//
    A '0*** MEAN INDIVIDUAL ***'/
    B '0LIFETIME FATAL CANCER RISK:'//
    A 15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
      WRITE(6,10205) (STLOW(L),L=1,NONCLD),SUML
      WRITE(6,10210) (STHIG(L),L=1,NONCLD),SUMH
      WRITE(6,10215) (STCOM(L),L=1,NONCLD),SUMC
      IF(RNWR)WRITE(6,20216) RRM

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IF(RNWR)WRITE(6,20217) TTM
WRITE(6,30200)
WRITE(6,12102) (NUCLID(L),L=1,NONCLD),TOTAL
WRITE(6,10220) (STREQ(L),L=1,NONCLD),SUMRQ
IF(RNWR)WRITE(6,20422) RTM
IF(RNWR)WRITE(6,20223) TTQM
WRITE(6,12590) (NUCLID(L),L=1,NONCLD),TOTAL
12590 FORMAT('OGENETIC RISKS: '/
A 15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
WRITE(6,10225) (STLO(L),L=1,NONCLD),SUMGL
WRITE(6,10230) (STGHI(L),L=1,NONCLD),SUMGH
WRITE(6,10235) (STGCO(L),L=1,NONCLD),SUMGC
WRITE(6,30300) (STGRQ(L),L=1,NONCLD),SUMGQ
DO 2350 K=1,40
STLOW(K)=0.0
STHIG(K)=0.0
STCOM(K)=0.0
STGLO(K)=0.0
STGHI(K)=0.0
STGCO(K)=0.0
STREQ(K)=0.0
STGRQ(K)=0.0
2350 CONTINUE
SUML=0.0
SUMH=0.0
SUMC=0.0
SUMGL=0.0
SUMGH=0.0
SUMGC=0.0
SUMRQ=0.0
SUMGQ=0.0
DO 2409 J=1,NONCLD
DO 2400 K=1,4
TEXPP=0.0
DO 2403 II=NOL,NOU
DO 2403 JJ=NRL,NRU
TEXPP=TEXPP+EXPP(JJ,II,J,K)
2403 CONTINUE
DO 2400 L=1,NCANC
STLOW(J)=STLOW(J)+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX
STHIG(J)=STHIG(J)+RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
STCOM(J)=STCOM(J)+RISK(L,J,K,1)*TEXPP*RISFAC(K)/AGEX+
> RISK(L,J,K,2)*TEXPP*RISFAC(K)/AGEX
IF(L.GT.1) GO TO 2400
STREQ(J)=STREQ(J)+REF(NCANC+1,J,K)*TEXPP*REQFAC(K)*.001
SUMRQ=SUMRQ+REF(NCANC+1,J,K)*TEXPP*REQFAC(K)*.001
STGRQ(J)=STGRQ(J)+GREF(L,J,K)*TEXPP*GENFAC(K)*.001
SUMGQ=SUMGQ+GREF(L,J,K)*TEXPP*GENFAC(K)*.001
STGLO(J)=STGLO(J)+GRISK(L,J,K,1)*TEXPP*GENFAC(K)*REPPER
STGHI(J)=STGHI(J)+GRISK(L,J,K,2)*TEXPP*GENFAC(K)*REPPER
STGCO(J)=STGCO(J)+GRISK(L,J,K,1)*TEXPP*GENFAC(K)*REPPER
A +GRISK(L,J,K,2)*TEXPP*GENFAC(K)*REPPER

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2400    CONTINUE
        SUML=SUML+SILOW(J)
        SUMH=SUMH+STHIG(J)
        SUMC=SUMC+STCOM(J)
        SUMGL=SUMGL+STGLO(J)
        SUMGH=SUMGH+STGHI(J)
        SUMGC=SUMGC+STGCO(J)
2409    CONTINUE
        WRITE(6,12700)TITLE, (NUCLID(L),L=1,NONCLD),TOTAL
12700    FORMAT('1',20A4/
> 29X,'NUCLIDE RISK/RISK EQUIVALENT SUMMARY'//
A '0*** COLLECTIVE POPULATION ***'/
A '0COLLECTIVE FATAL CANCER RISK: '/
A 15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
        WRITE(6,10705) (SILOW(L),L=1,NONCLD),SUML
        WRITE(6,10710) (STHIG(L),L=1,NONCLD),SUMH
        WRITE(6,10715) (STCOM(L),L=1,NONCLD),SUMC
        IF(RNWR)WRITE(6,20216) RRC
        WRITE(6,20217) TTC
        WRITE(6,30200)
        WRITE(6,12102) (NUCLID(L),L=1,NONCLD),TOTAL
        WRITE(6,10719) (STREQ(L),L=1,NONCLD),SUMRQ
        IF(RNWR)WRITE(6,20522) RTC
        IF(RNWR)WRITE(6,20323) TTQC
        WRITE(6,12790) (NUCLID(L),L=1,NONCLD),TOTAL
12790    FORMAT('0GENETIC RISKS: '/
A 15X,' NUCLIDES:',10(2X,A8)/(26X,10(2X,A8)))
        WRITE(6,10725) (STGLO(L),L=1,NONCLD),SUMGL
        WRITE(6,10730) (STGHI(L),L=1,NONCLD),SUMGE
        WRITE(6,10735) (STGCO(L),L=1,NONCLD),SUMGC
        WRITE(6,10720) (STGRQ(L),L=1,NONCLD),SUMGQ
21000    RETURN
        END

```

APPENDIX B

IBM JOB CONTROL LANGUAGE

IBM JOB CONTROL LANGUAGE

Job control language (JCL) to execute PRESTO-II on an IBM 3033 specifies two input units, and one output unit, and one intermediate (temporary) data storage unit. Nuclide information and DARTAB NAMELIST information are read as card images from logical unit five. The RADRISK data are read from a magnetic tape (unit 25). Output is to the lineprinter (unit 6). The JCL also specifies 900k bytes of memory for the GO step and approximately 30 seconds of central processing unit time. The CPU time required for this 1000 y simulation of the Barnwell, S.C. site, for 40 radionuclides, was 62.6 s and the job cost was \$5.99. The cost for this simulation during "prime CPU time" would have been about \$12.00.

J E S 2 J O B L O G -- S Y S T E M X 1 0 A -- N O D E N X 1 0 A

22.02.37 JOB 8550 &IEF677I WARNING MESSAGE(S) FCR JOB CJEBARN ISSUED
22.02.37 JOB 8550 \$HASP373 CJEBARN STARTED - INIT 4 - CLASS E - SYS X10B
22.02.37 JOB 8550 &IEF403I CJEBARN - STARTED - TIME=22.02.37
22.05.51 JOB 8550 IEF234E R SC8,P-1543,PVT,CJEBARN,GO
22.05.51 JOB 8550 *IEF233A M SC8,X23765.,CJEBARN,GO,S.SYD17603.NALL
22.08.52 JOB 8550 IEF234E K SC8,X23765,PVT,CJEBARN
22.08.52 JOB 8550 &IEF404I CJEBARN - ENDED - TIME=22.08.52
22.08 52 JOB 8550 \$HASP395 CJEBARN ENDED -----CLASS=E

----- JES2 JOB STATISTICS -----

08 MAY 85 JOB EXECUTION DATE

7,096 CARDS READ

3,770 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

286,150 SYSOUT SPOOL BYTES

6.26 MINUTES WALL-CLOCK TIME

1	//CJEBARN JOB (24636,TAPE,I5),'XCSD EMERSON B228',TIME=(3,20),	JOB .550
	// PASSWORD=	
	***JOBPARM LINES=30,CCPIES=002,FORMS=4101	
	***ROUTE XEQ STANDBY	
	***ROUTE XEQ WHENEVER	
2	// EXEC FCRTDCLG,REGION.FORT=540K,PARM.FORT='XREF',	
	// PARM.GO='DUMP=H,EU=-1',REGION.GO=900K	
3	XXFORTDCLG PROC CLSIZE=384K,LKSIZE=270K,PLOT=DISH,LIB=LAB,	00000010
	XX GOSIZE=100K,GOTIME=,OUT='*'	00000020
4	XXFORT EXEC PGM=IEKAA00,REGION=&CLSIZE	00000030
5	XXFT55F001 DD DSN=&&DUMPT2,DISP=(MOD,PASS),UNIT=SYSDA,	00000040
	XX DCB=(RECFM=FB,LRECL=20,BLKSIZE=320),	C00000050
	XX SPACE=(320,(400,2560),RLSE)	00000060
6	XXFTSYNAD DD SYSOUT=&OUT,DCB=(RECFM=FA,BLKSIZE=133)	00000070
7	XXSTEPLIB DD DSN=SYS2.PALIB,DISP=SHR	00000080
8	XXSYSLIN DD DSN=&&LOADSET,UNIT=SYSDA,SPACE=(80,(400,20),RLSE),	C00000090
	XX DISP=(MOD,PASS),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)	00000100
9	//FORT.SYSPRINT DD DUMMY	
	X/SYSPRINT DD SYSOUT=&OUT,DCB=BLKSIZE=1100	00000110
10	XXSYSPUNCH DD SYSOUT=B	00000120
11	XXSYSLT2 DD UNIT=SYSDA,SPACE=(1024,(30,10))	00000130
12	//FORT.SYSIN DD *	
13	XXLKED EXEC PGM=IEWL,PARM='LIST,MAP',REGION=&LKSIZE,	C00000140
	XX COND=(5,LT,FCRT)	C0000150
14	XXSYSLIB DD DSN=SYS1.&LIB.LIB,DISP=SHR	00000160
15	XX DD DSN=SYS1.LOGLIB,DISP=SHR	00000170
16	XX DD DSN=GRAPHICS.&PLOT..LIB,DISP=SHR	00000180
17	XXSYSLIN DD DSN=&&LOADSET,DISP=(OLD,DELETE)	00000190
18	XX DD DDNAME=SYSIN	00000200
19	XXSYSLMOD DD DSN=&&FJOBLIB(NAMEX),UNIT=SYSDA,DISP=(NEW,PASS),	C00000210
	XX SPACE=(3072,(50,10,1))	00000220
20	XXSYSPRINT DD SYSOUT=&OUT,DCB=BLKSIZE=605	00000230
21	XXSYSUT1 DD UNIT=(SYSDA,SEP=(SYSLIN,SYSLMOD)),SPACE=(3072,(50,10))	00000240
22	XXGO EXEC PGM=*.LKED.SYSLMOD,COND=((5,LT,FORT),(5,LT,LKED)),	C00000250
	XX REGION=&GOSIZE,TIME=&GOTIME	00000260
23	XXDUMP DD SYSOUT=&OUT,DCB=(RECFM=FA,BLKSIZE=133)	00000270

24	XXFT06F001 DD SYSOUT=&OUT,CCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)	00000280
25	XXFT53F001 DD DSN=&&FJOB LIB(NAMEX),DISP=(OLD,DELETE),	00000290
	XX DCB=(RECFM=U,BLKSIZE=256),LABEL=(,,,IN)	00000300
26	XXFT55F001 DD DSN=&&DUMPT2,DISP=(OLD,DELETE)	00000310
27	//GO.FT05F001 DD *	
28	//GO.FT25F001 DD UNIT=TAPE62,DISP=(OLD,PASS),	
	// VOL=SER=X23765,LABEL=(1,SL,,,IN),DSN=S.SY017603.NALL,	
	// DCB=(RECFM=VBS,LRECL=240,BLKSIZE=2440,DEN=4)	
29	//GO.FT26F001 DD UNIT=SYSDA,DSN=&&DATA,DISP=(NEW,DELETE),	
	// SPACE=(TRK,(10.5),RLSE),CCB=(RECFM=FB,LRECL=80,BLKSIZE=4000)	
30	//GO.FT30F001 DD UNIT=SYSDA,DSN=&&TMPCM0,DISP=(NEW,PASS),	
	// SPACE=(TRK,(10.5)),DCB=(RECFM=VS,LRECL=240,BLKSIZE=3124)	
	//	

CTMT NO. MESSAGE

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4 IEF653I SUBSTITUTION JCL - PGM=IEKAA00,REGION=384K
6 IEF653I SUBSTITUTION JCL - SYSOUT=*,DCE=(RECFM=FA,BLKSIZE=133)
9 IEF653I SUBSTITUTION JCL - SYSOUT=*,DCE=BLKSIZE=1100
13 IEF653I SUBSTITUTION JCL - PGM=IEWL,PARM=LIST,MAP*,REGION=270K,
14 IEF653I SUBSTITUTION JCL - DSN=SYS1.LABLIB,DISP=SHR
16 IEF653I SUBSTITUTION JCL - DSN=GRAPHICS.DISH.LIB,DISP=SHR
20 IEF653I SUBSTITUTION JCL - SYSOUT=*,DCE=BLKSIZE=605
22 IEF653I SUBSTITUTION JCL - REGION=100K,TIME=
23 IEF653I SUBSTITUTION JCL - SYSOUT=*,DCE=(RECFM=FA,BLKSIZE=133)
24 IEF653I SUBSTITUTION JCL - SYSOUT=*,DCE=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
22 IEF686I DCNAME REFERRED TO CN DDNAME KEYWORD IN PRIOR STEP WAS NOT RESOLVED
IEF236I ALLOC. FOR CJEEARN FORT
IEF237I 181 ALLOCATED TO FT5SF001
IEF237I JES2 ALLOCATED TO FT5YNAD
IEF237I 288 ALLOCATED TO STEPLIB
IEF237I 180 ALLOCATED TO SYSLIN
IEF237I DMY ALLOCATED TO SYSPRINT
IEF237I JES2 ALLOCATED TO SYSPUNCH
IEF237I 48A ALLOCATED TO SYSUT2
IEF237I JES2 ALLOCATED TO SYSIN
IEF142I CJEBARN FORT - STEP WAS EXECUTED - COND CODE 0004 PASSED
IEF285I SYS85128.T220237.RA000.CJEBARN.DUMPT2
IEF285I VOL SER NCS= X3B1C1.
IEF285I JES2.J080555C.S00103
IEF285I SYS2.PALIE
IEF285I VOL SER NCS= MVSLNK.
IEF285I SYS85128.T220237.RA000.CJEBARN.LOADSET
IEF285I VOL SER NCS= X3B1C0.
IEF285I JES2.J080555C.S00104
IEF285I SYS85128.T220237.RA000.CJEBARN.R00000001
IEF285I VOL SER NCS= MVSDA1.
IEF285I JES2.J080555C.S10101
IEF373I STEP /FORT / START 85128.2202
IEF374I STEP /FORT / STOP 85128.2205 CPU OMIN 14.27SEC SRB OMIN 00.62SEC VIRT 604K SYS 384K

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*-----*
*KXY0001 DDNAME CUU CSNAME EXCP'S(IO) BLOCK SIZE*
*KXY0002 FT55F001 181 SYS85128.T220237.RA000.CJEBARN.DUMPT2 141 320 *
*KXY0002 STEPLIB 288 SYS2.PALIB 387 13030 *
*KXY0002 SYSLIN 180 SYS85128.T220237.RA000.CJEBARN.LOADSET 571 800 *
*KXY0002 SYSUT2 48A SYS85128.T220237.RA000.CJEBARN.R0000001 141 4096 *
*KXY0003 VIRTUAL STORAGE USED 604K TCTAL EXCP COUNT FOR STEP 1,240 *
*KXY0004 08 MAY 85.128 22.05.05.25 CPU TIME FOR STEP 0000 MIN 14.89 SEC *
*-----*

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IEF236I ALLOC. FOR CJEBARN LKED
IEF237I 41D ALLOCATED TO SYSLIB
IEF237I 41D ALLOCATED TO
IEF237I 408 ALLOCATED TO
IEF237I 28C ALLOCATED TO SYS00959
IEF237I 180 ALLOCATED TO SYSLIN
IEF237I DMY ALLOCATED TO
IEF237I 48A ALLOCATED TO SYSLMOD
IEF237I JES2 ALLOCATED TO SYSPRINT
IEF237I 181 ALLOCATED TO SYSUT1

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IEF142I CJEBARN LKED - STEP WAS EXECUTED - COND CODE 0000

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IEF285I SYS1.LABLIB KEPT
IEF285I VOL SER NCS= #VT918.
IEF285I SYS1.LOGLIB KEPT
IEF285I VOL SER NCS= #VT918.
IEF285I GRAPHICS.DISH.LIB KEPT
IEF285I VOL SER NCS= #VT21F.
IEF285I SYSCTLG.VSYSPK1 KEPT
IEF285I VOL SER NCS= SYSPK1.
IEF285I SYS85128.T220237.RA000.CJEBARN.LOADSET DELETED
IEF285I VOL SER NCS= X3B1C0.
IEF285I SYS85128.T220237.RA000.CJEBARN.FJCBLIB PASSED
IEF285I VOL SER NCS= #VSDA1.
IEF285I JES2.JOB0855C.S00105 SYSOUT
IEF285I SYS85128.T220237.RA000.CJEBARN.R0000002 DELETED
IEF285I VOL SER NCS= X3B1C1.

```

```

IEF373I STEP /LKED / START 85128.2205
IEF374I STEP /LKED / STOP 85128.2205 CPU 0MIN 01.21SEC SRB 0MIN 00.37SEC VIRT 264K SYS 384K

```

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*-----*
*KXY0001 DDNAME CUU DSNAME EXCP'S(10) BLOCK SIZE*
*KXY0002 SYSLIB 41D SYS1.LABLIB 226 7294 *
*KXY0002 41D SYS1.LCGLIB *
*KXY0002 408 GRAPHICS.DISH.LIB *
*KXY0002 SYS00959 28C SYSCTLG.VSYSPK1 *
*KXY0002 SYSLIN 180 SYS85128.T220237.RA000.CJEEARN.LOADSET 571 800 *
*KXY0002 SYSLMOD 48A SYS85128.T220237.RA000.CJEBARN.FJOBLIB 185 19069 *
*KXY0002 SYSUT1 181 SYS85128.T220237.RA000.CJEBARN.R0000002 216 19064 *
*KXY0003 VIRTUAL STORAGE USED 264K TCTAL EXCP COUNT FOR STEP 1,198 *
*KXY0004 08 MAY 85.128 22.05.51.16 CPU TIME FOR STEP 0000 MIN 01.58 SEC *
*-----*

```

```

IEF236I ALLOC. FOR CJEEARN GO
IEF237I 48A ALLOCATED TO PGM=*.DD
IEF237I JES2 ALLOCATED TO DUMP
IEF237I JES2 ALLOCATED TO FT06F001
IEF237I 48A ALLOCATED TO FT53F001
IEF237I 181 ALLOCATED TO FT55F001
IEF237I JES2 ALLOCATED TO FT05F001
IEF237I 5C8 ALLOCATED TO FT25F001
IEF237I 180 ALLOCATED TO FT26F001
IEF237I 48A ALLOCATED TO FT30F001

```

```

IEF142I CJEBARN GO - STEP WAS EXECUTED - COND CODE 0000
IEF285I SYS85128.T220237.RA000.CJEBARN.FJCBLIB KEPT
IEF285I VOL SER NCS= MVSDA1.
IEF285I JES2.JOB08550.S00106 SYSOUT
IEF285I JES2.JOB08550.S00107 SYSOUT
IEF285I SYS85128.T220237.RA000.CJEBARN.FJCBLIB DELETED
IEF285I VOL SER NCS= MVSDA1.
IEF285I SYS85128.T220237.RA000.CJEBARN.DUMPT2 DELETED
IEF285I VOL SER NCS= X3B1C1.
IEF285I JES2.JOB08550.S10102 SYSIN
IEF285I S.SY017603.NALL PASSED
IEF285I VOL SER NCS= X23765.
IEF285I SYS85128.T220237.RA000.CJEBARN.DATA DELETED
IEF285I VOL SER NCS= X3B1C0.
IEF285I SYS85128.T220237.RA000.CJEBARN.TMFCM0 PASSED
IEF285I VOL SER NCS= MVSDA1.

```

```

IEF373I STEP /GO / START 85128.2205
IEF374I STEP /GO / STOP 85128.2208 CPL 0MIN 45.27SEC SRB 0MIN 00.81SEC VIRT 840K SYS 404K

```

```

*-----*
*KXY0001 DDNAME CUU DSNAME EXCP'S(10) BLOCKSIZE*
*KXY0002 PGM=*.DD 48A SYS85128.T220237.RA000.CJEBARN.FJOBLIB 3 19069 *
*KXY0002 FT53F001 48A SYS85128.T220237.RA000.CJEBARN.FJOBLIB 256 *
*KXY0002 FT55F001 181 SYS85128.T220237.RA000.CJEBARN.DUMPT2 *
*KXY0002 FT25F001 5C8 S.SYC17603.NALL 1,335 2440 *
*KXY0002 FT26F001 180 SYS85128.T220237.RA000.CJEBARN.DATA 15 4000 *
*KXY0002 FT30F001 48A SYS85128.T220237.RA000.CJEBARN.TMPCMO 3124 *
*KXY0003 VIRTUAL STORAGE USED 840K TOTAL EXCP COUNT FOR STEP 1,353 *
*KXY0004 08 MAY 85.128 22.08.47.94 CPU TIME FOR STEP 0000 MIN 46.08 SEC *
*-----*
IEF285I S.SYC17603.NALL KEPT
IEF285I VOL SER NCS= X23765.
IEF237I 48A ALLOCATED TO SYS00001
IEF285I SYS85128.T220237.RA000.CJEBARN.R0000001 KEPT
IEF285I VOL SER NCS= MVSDA1.
IEF285I SYS85128.T220237.RA000.CJEBARN.TMPCMO DELETED
IEF285I VOL SER NCS= MVSDA1.
IEF375I JOB /CJEBARN / START 85128.2202
IEF376I JOB /CJEBARN / STOP 85128.2208 CPU 1MIN 00.75SEC SRB 0MIN 01.80SEC
*-----*
*KXY0003 TOTAL EXCP COUNT FOR JOB 3,791 *
*KXY0004 08 MAY 85.128 22.08.52.59 CPU TIME FOR JOB 0001 MIN 02.55 SEC *
*-----*
*KXY0005 **APPROXIMATE JOB COST* $ 5.99 (STANDBY) *
*-----*

```


APPENDIX C

INPUT DATA, SUPPORTING INFORMATION FOR EXAMPLE PROBLEM

Barnwell, South Carolina

APPENDIX C

INPUT DATA, SUPPORTING INFORMATION FOR EXAMPLE PROBLEM

C.1 GENERAL DESCRIPTION OF THE SITE*

C.1.1 Location and climate

The Barnwell low-level radioactive waste disposal facility is located 8 km west of the town of Barnwell, South Carolina, in Barnwell County. The 38 ha site is leased from the state of South Carolina by Chem-Nuclear Systems, Inc. (CNSI), which operates the facility. The site is adjacent to the Allied General Nuclear Services Barnwell Fuel Facility on the west and is only 0.3 km from the eastern boundary of the Savannah River Plant.

The Barnwell site is in a largely rural setting, with much of the land in the region used for farming or growing timber. Primary farm products are soybeans, corn, cotton, and dairy products. The population of the county in 1970 was slightly above 17,000.

The climate near Barnwell is relatively mild. The monthly mean temperatures range from 8 to 27°C for January and July, respectively. Precipitation occurs mostly in the summer with a mean annual total of 1.13 m. For the twenty year period before 1972, the mean precipitation ranged from 0.73 m (1954) to 1.87 m (1964). Snowfall occurs only rarely in Barnwell County, as do damaging winds or ice storms. The relatively long growing season ranges from about 230-270 days.

The atmosphere around the site would be considered relatively stable. The mean wind speed at the Savannah River Plant is only 0.4 m per second and inversion or neutral conditions occur more than 75% of the time.

C.1.2 Geology and soils

The Barnwell site is located on the Atlantic Coast Plain physiographic province near the eastern edge of the Aiken Plateau portion of that province. The topography of the site is gently rolling with grade elevation averaging 74-80 m above mean sea level. The area is underlain by about 300 m of "flat-lying, loose to poorly consolidated sediments of upper cretaceous, tertiary, and quaternary ages." Surface-quaternary soils include loose to medium dense fine sand and silty sand to depths of 0.6-2.1 m below grade. Below the surface soils is found 4.3-9.1 m of the embedded sandy clay and clayey fine sand of the Miocene Hawthorn formation. The Hawthorn is underlain by 11.5-18 m of the Barnwell formation

*Unless otherwise stated, information in this appendix was found in Chem-Nuclear Systems, Inc. (1980).

(late Eocene) and 14.6–35 m of the McBean formation (early Eocene). The Ellenton and Tuscaloosa formations, include sand and gravel with some clay and cretaceous sediments underlying tertiary sands and clays.

Topsoil of the region is generally fuquay loamy sand of the family loamy siliceous thermic. According to Olson, Emerson, and Nungesser (1980), Barnwell county encompasses the following soil orders and suborders: Order Ultisols, suborders Paleudults and Hapludults (gently sloping), suborders Ochraqults, Palendults, Hapludults, and Quartzipsamments (gently sloping) and order Entisols, suborder Quartzipsamments (gently sloping). Suborders Paleudults and Hapludults comprise about 70% of the county soil:

Portion of the soil layer just below the topsoil to a depth of about 2.1 m are very firm, tan and purple, and slightly micaceous. This soil layer is generally slightly clayey fine to coarse sand. Organic components of the soils of Barnwell county are listed in the main body of the report in Table 3.5. Information were taken from Olson, Emerson, and Nungesser (1980) and Chem-Nuclear Systems, Inc. (1980).

C.1.3 Hydrology

The Barnwell site is located between the Savannah River on the west and the Salkehatchie River on the east. The Salkehatchie is the nearest river at some 4.1 km, but the surface drainage of the site is to Lower Three Runs Creek a tributary of the Savannah River. There are no flowing streams on the site and Mary's Creek is a tributary of Lower Three Runs Creek. Flow rates in Lower Three Runs Creek varied from 0.14–14 m³/s during the 11-year period from July 1958 – August 1969, at Patterson's Hill Bridge.

Surface water from precipitation is collected for evaporation by Chem-Nuclear. In event of a heavy rainfall, water above a predetermined level in the collection pond is pumped to another pond for further evaporation. This system was devised to prevent recharge of the ground water near the trenches and thereby reduce the likelihood of contamination of surface water. More details on surface water flows are to be found on pages 93–95 of CNSI (1980).

The Hawthorn formation contains the highest water table on the site and extends within 9.1 m of the surface. The Barnwell formation underlie the Hawthorn with a thickness of about 12 m. The Barnwell is slightly more permeable than the Hawthorn and has been used for a few small wells in the area.

The McBean and Congaree formations underlie the Barnwell formation to some 90 m below the surface. The Congaree is fairly permeable and the municipal wells for the town of Barnwell, the nearest municipal user, yield about 1400 liters per minute. Beneath the McBean/Congaree formations are the Ellenton and Tuscaloosa formations. Although geologically differentiable, groundwater is free to move between them and they are

considered a single aquifer. The Tuscaloosa is the principal aquifer for the site and extends to more than 300 m below the surface.

Water table depth at the site gradually decreases as it nears the Savannah River. Fluctuations in the water table depth are a function of the locally varying permeabilities and the inclination of the piezometric surface. It is, therefore, not unusual to find significant differences in fluctuation patterns within relative small areas. The water table at the site generally occurs at depths of 9.1-18 m with a mean of about 12.2 m. Normal fluctuations between the high in late spring or summer and the low in fall or winter is about 2 m.

The groundwater moves under the site to the west and south toward Mary's Creek, 914 m away. The velocity is estimated to be 5.0×10^{-3} m/d as shown by CNSI (1980). More detail about groundwater movement and composition at the site can be found in CNSI (1980) pages 10-14, 89-91, and 95-98.

C.2 INPUT VARIABLES FOR PRESTO-II

C.2.1 Options or Control Variables

Most of the input variables on the first four cards are for code control or option selection (see Table C.1). The operation and logic of each of these variables is discussed in the data section of the report, Sect. 3.3. All code variables are defined in Table 3.1.

C.2.2 Site-description variables that are well-known

Some of the input data describing the site are very well known and not likely to change drastically. The previous statement assumes that none of the following variables will be arbitrarily varied for the purposes of a sensitivity analysis to determine the effect of a given parameter on code predictions.

Noncontrol variables which are considered well known include the following (refers to Table C.1): TDEPTH (trench depth), OVER (overburden), DWELL (distance to nearest well), all variables on cards 16 and 17, BDENS (soil bulk density), STFLOW (stream flow), PD (site boundary to nearest stream), SAREA (area of contaminated surface soil), and the radiological decay rate. References or notes on calculation are given for each of these in Table C.1.

C.2.3 Radionuclide-independent variables that are poorly known

A number of the input variables listed in Table 3.1 and C.1 are poorly known; that is to say, there may be a large amount of variation associated with the value listed in Table C.1. This is in spite of the fact that the

values listed have been taken from referencable sources. This section will briefly describe the variation or source of variation expected in each of these variables as listed in Table C.1.

WATL. Fraction of total irrigation water taken from well. The referenced value is a state average of groundwater use as a fraction of total water use for 1970. Value may vary over time and across state. The national range of value is from 0.01 (West Virginia) to 0.83 (Kansas). Most common U.S. range 0.10-0.25.

PORA, PORT, PORS. Porosity of aquifer, trench, and surface region. In Table C.1, these values are equal to the reference surface porosity. This is likely incorrect for PORA, the porosity used within the trench. If the trench were tightly compacted, the value could be much lower. The more likely situation is that trench contents are variably porous due to heterogeneous materials and voids. Value used for PORS is probably within 20% for surface soil users.

PERMV. Permeability of trench bottom. Referenced value is probably reasonable for surface region, but the permeability inside trench is probably extremely heterogeneous.

DENCON. Density of the trench contents. This number listed is strictly an assumption. For waste materials such as cardboard, clothing, gloves and soil, assuming few voids, the number may be reasonable. However, given or large masses of highly dense materials, the value listed is probably too small.

RELFAC. User-option annual release fraction for activity leaching from trench. This value has been estimated (Dole and Fields, 1981) for three sites: Savannah River Plant (10^{-8}), Oak Ridge National Laboratory (10^{-6}), and West Valley (2.5×10^{-4}).

GWV. Groundwater velocity. Referenced value from CNSI (1980).

AQTHK. Thickness of the aquifer. Used for dilution calculations. For Barnwell, depends on the aquifer and the location at which thickness is measured. The value in Table C.1 based on the Barnwell formation.

AQDI3P. Angle of pollutant dispersion in the aquifers plume. The value in Table C.1 is an assumption. Obviously a function of rate of flow, porosity, and permeability.

Card 19. Factors for use in the Universal Soil Loss Equation. Values listed in Table C.1 were calculated as prescribed by McElroy et al. (1976). However, the methods of McElroy et al. are generalized for large sections of the country. More detailed methods might yield more precise value. Except for RAINF, all factors vary only from 0-1. RAINF ranges from 20 to 350, nationwide. Range in the area of central Georgia-South Carolina appears to be about 200-270. The sediment delivery ratio (SEDEL) was conservatively set 1.0.

ADEPTH. The active depth of the surface soil. Used to calculate soil and water radionuclide concentrations as a result of overflow. Value in table assumed. No reference for depth of subsurface runoff, etc., to substantiate ADEPTH. Could reasonably be set to plow depth, nominally 15 cm. Unlikely that ADEPTH would approach 1 m.

RUNOFF. Fraction of annual precipitation that runs off. Value of 0.05 taken from CNSI (1980). Jack Robertson of USGS (personal communication) estimates a range of 4-7%.

C.2.4 Radionuclide-specific parameters that are poorly known

TRAM. Initial inventory of each radionuclide. Values in Table C.2 for Barnwell are probably the best available inventory data. Nevertheless, these inventory data are probably incorrect because they are based on shipping invoices and not actual measurements of materials received.

KD. Distribution coefficient, k_d . Code allows a separate k_d value for each radionuclide and for each of four regions at the site: The soil surface, the trench, the subtrench region, and the aquifer. Table C.2 lists only one value of k_d for each nuclide. The listed values are median values of a range of k_d measurements compiled by Baes and Sharp (1982) for agricultural soils of pH 4.5 to 9.0. Even for that limited sample of media, the range of reported k_d values is extreme. For example, the minimum k_d range of any element in Table C.2 was over an order of magnitude for Cd (1.26-26.8). The maximum reported range of k_d compiled by Baes and Sharp (1982) was for Mn (0.2 to 10^4). The k_d of most of the elements in Table C.2 range over three or more orders of magnitude. One might expect that variation of k_d in agricultural soils of pH 4.5-9.0 to be comparable to the variation of k_d in other media such as addressed by the code.

SOAM. The initial amount of spillage onto the surface. Listed in Table 3.4 as a constant 10^{-6} fraction of the initial inventory. Not likely that many data exist to support that or any number. One would presume that SOAM (1) varies between radionuclides and (2) is a small number at a well operated disposal facility.

SOL. The solubility of the stored radionuclide. With inventory at other sites, the data about which we have the least information. Not only does solubility vary greatly depending on initial chemical form and conditions within the trench, there are likely to be several appropriate values for each radionuclide depending on the source of the wastes. Orders of magnitude variation may occur. Most reasonable approach to estimating SOL would be to assume some form for each radionuclide based on the likely generator of that type of material. The solubility option is not selected for runs for this site.

BR, EV. Plant uptake factors for grain or fruits (reproductive) and grass (vegetative). The values listed in Table C.3 were derived by Baes et al. (1982). The BV, BR values embody a certain amount of uncertainty. However, relative to the magnitude of uncertainty in many of the other parameters, these data are fairly well known.

FMC, FMG. Forage-to-milk transfer factors for cows and goats. Most of the listed values are taken from AIRDOS-EPA (Moore et al., 1979). In a few cases, values were calculated from Ng et al. (1968). Variation likely to be small compared to other parameters; also difficult to improve upon due to expense of determination.

FF. Forage-to-beef transfer factors. Most of the listed values are from AIRDOS-EPA (Moore et al., 1979); but some were calculated from data in Ng et al. (1968). Variation probably small compared to other parameters.

C.3 ADDITIONAL SUPPORTING INFORMATION FOR INPUT DATA SET

Table C.4 lists the mean annual wind direction frequencies and true-averaged wind speeds for the Savannah River Plant, South Carolina. These, or similar data, should be used to calculate CHIQ for input.

Table C.5 lists population determined by the 1980 census for a polar grid surrounding the Barnwell site.

Table C.6 lists 1978 hourly precipitation for the weather station at Augusta, Georgia.

C.4 INPUT DATA SET

Table C.7 lists the Barnwell input data set.

This Appendix has described an example simulation performed using data believed representative of Barnwell, SC; however, many site parameters vary significantly within the site itself. Soil parameters, hydrologic parameters, and local radionuclide waste composition may vary greatly, yet transport and exposure scenarios are based on regional data and assumptions representative of a large area. Radionuclide inventories are primarily based on estimated waste composition, rather than measured values. These considerations, together with the caveats offered in the Executive Summary and in Chapter 1, suggest that the results presented here must be interpreted as estimates containing significant uncertainties.

Table C.1. Input data for Barnwell, SC; refer to Table 3.1
for formats and definitions of variables

Card number	Variable	Value	Reference or note
1	TITLE		User option
2	LOCATE	Barnwell SC	User option
3	MAXYR	1000	User option
	NONCLD	40	Must be 40 or less
	LEAOPT	2	User option
	NYR1	100	Personal Communication, C. Y. Hung to J. Broadway, March 18, 1983
	NYR2	200	Personal Communication, C. Y. Hung to J. Broadway, March 18, 1983
	IOPVWV	1	User option
	IOPSAT	1	User option
	IPRT1	0	User option
	IPRT2	1000	User option
	IDELT	100	User option
	IRRES1	0	User option
	IRRES2	0	User option
	LIND	1	User option
	IAVG1	1	User option
	IAVG2	1000	User option
4	IVAP	0	User option
	IBSMT	0	User option
	IAQSTR	0	User option
5	PCT1	0.01	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	PCT2	0.1	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	WATL	1.0	User option
	WATA	1.0	User option
	WATH	1.0	User option
	SATL	0.0	User option
	SATA	0.0	User option
	SATH	0.0	User option
6	PPN	1.130	
	P	1002.3	
	XIRR	0.0	
	PHID	33.2	
7	S	0.56	
		0.60	
		0.64	
		0.70	

Table C.1. (continued)

Card number	Variable	Value	Reference or note
		0.68	
		0.65	
		0.65	
		0.65	
8		0.61	
		0.66	
		0.64	
		0.69	
9	T	8.0	
		9.3	
		12.9	
		18.0	
		22.3	
		25.9	
		27.1	
		26.7	
10		23.7	
		18.2	
		12.4	
		8.4	
11	TD	3.1	
		3.3	
		5.8	
		10.3	
		15.5	
		19.2	
		21.2	
		21.2	
12		18.5	
		12.5	
		6.7	
		2.6	
13	TAREA	9150	CNSI (1980), p. 48
	TDEPTH	6.7	CNSI (1980), p. 48
	OVER	1.5	CNSI (1980), p. 47
	PORT	0.4	Sediment porosity; CNSI(1980), p. 90
	DENCON	2.0	Assumed
	RELFAC	0	User option
	FN	1.0	
	XINFI	0.09	Calculated
14	PERMC	43.3	
15	DTRAQ	2.4	Lowest water table depth less TDEPTH, CNSI, p. 88

Table C.1. (continued)

Card number	Variable	Value	Reference or note
16	DWELL	914	Site boundary to nearest spring; CNSI, p. 91
	GWV	21.5	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	AQTHK	25	Inferred from discussion CNSI(1980), pp. 80-90
	AQDISP	0.3	Assumed
	PORA	0.4	CNSI (1980), p. 90
	PORV	0.4	CNSI (1980), p. 90
	PERMV	43.3	CNSI, (1980)
	H	1.0	Assumed
	VG	0.01	Calculated from particle sizes
	U	0.4	Savannah River Lab. meteor.; National Climatic Center
	VD	0.01	Generic value
	IG	8000	Distance to town of Barnwell, SC
	HLID	300	C. F. Baes III (personal communication)
17	ROUGH	0.01	Generic value
	FTWIND	0.49	Savannah River meteorology
	CHIQ	7.7E-9	Computed using AIRDOS-EPA, Moore et al. (1979)
	RE1	1.0E-6	Assumed lower than Nevada, Anspaugh et al. (1975)
	RE2	-0.15	Same as Anspaugh et al. (1975)
18	RE3	1.0E-11	Assumed lower than Nevada, Anspaugh et al. (1975)
	RR	0	User option
	FTMECH	0	User option
	IT	1	User option
	IS	2	Savannah River meteorology
	RAINF	250	McElroy et al. (1976) pg 44, Fig. 3.2
	ERODF	0.23	McElroy et al. (1976) p. 46; see Table 3.5
	STPLNG	0.27	McElroy et al. (1976); Fig. 3.8
	COVER	0.30	McElroy et al. (1976); Table 3.3
	CONTEL	0.30	McElroy et al. (1976); Table 3.7

Table C.1. (continued)

Card number	Variable	Value	Reference or note
20	SEDELR	1.0	Assumed; see McElroy et al. (1976), p. 60-68
	PORS	0.4	Set equal to sediment porosity; CNSI (1980), p. 90
	BDENS	1.6	CNSI (1980), p. 87
	STFLOW	5300	CNSI (1980), p. 9.2
21	EXTENT	305	User option; this value = trench length, CNSI, p. 48
	ADEPTH	0.01	Assumed
	PD	914	Site boundary to nearest stream, CNSI p.91
	RUNOFF	0.29	Calculated from Geraghty et al. (1973)
22	Y1	0.19	Shor, Baes, and Sharp (1982); Appendix C
	Y2	0.53	Shor, Baes, and Sharp (1982); Appendix B
	PP	240	Assumes 15 cm plow depth
	XAMBWE	0.0021	Moore et al., 1979
23	TE1	720	Generic; Moore et al., 1979 Table E-15
	TE2	1440	Generic; Moore et al., 1979 Table E-15
	TH1	0	Generic; Moore et al., 1979, Table E-15
	TH2	2160	Generic; Moore et al., 1979, Table E-15
	TH3	24	Generic; Moore et al., 1979, Table E-15
	TH4	1440	Generic; Moore et al., 1979, Table E-15
	TH5	336	Generic; Moore et al., 1979, Table E-15
	TH6	336	Generic; Moore et al., 1979, Table E-15
24	FP	0.77	Shor, Baes, and Sharp (1982)
	FS	0.94	Shor, Baes, and Sharp (1982)
	QFC	50	Generic; Moore et al., 1979, Table E-15
	QFG	6	Generic; Moore et al., 1979, Table E-15
	TF1	48	Generic; Moore et al., 1979, Table E-15
	TF2	96	Generic; Moore et al., 1979, Table E-15

Table C.1. (continued)

Card number	Variable	Value	Reference or note
25	TS	480	Generic; Moore et al., 1979 Table E-15
	ABSH	9.9	State average; Etnier (1980)
	P14	1.0	Assumed
	FI	0.73	Growing season length/8760
	WIRATE	0.015	Calculated from Olson, Emerson and Nungesser (1980)
26	QCW	60	Generic; Moore et al., 1979
	QGW	8	Generic; Moore et al., 1979
	QBW	50	Generic; Moore et al., 1979
	ULRAFY	190	Generic; Moore et al., 1979
	UPROD	190	Generic; Moore et al., 1979
	UCMILK	110	Generic; Moore et al., 1979
	UGMILK	0	Generic; Moore et al., 1979
	UMEAT	95	Generic; Moore et al., 1979
	UWAT	370	Generic; Moore et al., 1979
	UAIR	8000	Generic; Moore et al., 1979
27+	POP	7033	1980 Census; Durfee (personal communication)
	see Tables C.2 and C.3		

Table C.2. Estimated radionuclide inventories for the Barnwell, South Carolina, Beatty, Nevada, and West Valley, New York low-level waste facilities.

Nuclide	Activity stored, Ci		
	Barnwell, SC ^a	Beatty, NV ^b	West Valley, NY ^c
H-3	34,499	106,696	106,696
C-14	9.5	442	442
Mn-54	9,737	9,737	0
Fe-55	65,672	65,672	0
Ni-59	0	0	0
Co-60	432,755	432,755	76,710
Ni-63	11,029	11,029	0
Zn-65	7,613	7,613	0
Kr-85	1,682	1,682	
Sr-90	2,617	10,420	10,420
Y-90	2617	10420	10420
Nb-94	0	0	0
Tc-99	61	61	0
Ru-106	0	10,420	10,420
Cd-109	16	16	0
Sb-125	2.7	2.7	0
I-125	0	444	444
I-129	0	0	
Cs-134	37,069	37,069	0
Cs-137	289,403	289,403	19.1
Ba-137M	289,403	289,403	19.1
Ce-141	547	547	
Ce-144	2,160	2,160	0
Pm-147	179	179	0
Re-187	1.5	1.5	1.5
Pb-210	22	22	0
Ra-226	0.6	1629	1629
Th-232	1.3	1.3	0.75
U-233	0	2.42	2.42
U-234	3.0	3.0	0

Table C.2. (continued)

Nuclide	Activity stored, Ci		
	Barnwell, SC ^a	Beatty, NV ^b	West Valley, NY ^c
U-235	3.5	3.5	0.1
U-236	0.5	0.5	0
U-238	3,063	3,063	112
Pu-238	0.2	38,481	38,481
Pu-239	0.1	91.6	91.6
Pu-241	0	0	0
Am-241	0	17.5	17.5
Pu-242	0	0	0
Am-243	0	0	0
Cm-243	0	0	0

^aTaken from receiving invoices at Chem-Nuclear Systems, Inc. (J. E. Till, personal communication).

^bNo citable information available. These data represent merger of Barnwell, SC and West Valley, NY columns, higher inventory of the two was listed for Beatty, NV.

^cData inferred from volume and mixed activity information listed in Giardina et al. (1977) and Kelleher and Michael (1973).

Table C.3. Element-specific data listed by radionuclide.^a
Refer to Table 3.1 for definition of variables

Nuclide	Plant uptake factor ^c					
	K_d^b	B_v	B_r	FMC^d	FMG^e	FP^f
H-3	.01	4.8E-0	4.8E-0	1.0E-2	1.7E-1	1.2E-2
C-14	.01	5.5E-0	5.5E-0	1.2E-2	1.0E-1	3.1E-2
Mn-54	150	2.5E-1	5.0E-2	2.5E-4	2.5E-4	8.0E-4
Fe-55	55	4.0E-3	1.0E-3	1.2E-3	1.3E-4	4.0E-2
Ni-59	150	6.0E-2	6.0E-2	6.7E-3	6.7E-3	5.3E-2
Co-60	55	9.4E-3	9.4E-3	1.0E-3	1.0E-3	1.3E-2
Ni-63	150	6.0E-2	6.0E-2	6.7E-3	6.7E-3	5.3E-3
Zn-65	16	1.5E-0	9.0E-1	3.9E-2	3.9E-2	3.0E-2
Kr-85	0	0	0	2.0E-2	2.0E-2	2.0E-2
Y-90	27.	2.5E-0	2.5E-1	8.0E-4	1.4E-2	6.0E-4
Sr-90	27	2.5E-0	2.5E-1	8.0E-4	1.4E-2	6.0E-9
Nb-94	350	2.0E-2	5.0E-3	2.5E-3	2.5E-3	2.5E-3
Tc-99	0.033	9.5E-0	1.5E+0	2.5E-2	2.5E-2	4.0E-1
Ru-106	220	7.5E-2	2.0E-2	1.0E-6	1.0E-6	1.0E-6
Cd-109	6.7	5.5E-1	1.5E-1	1.3E-4	1.3E-4	5.3E-4
Sb-125	45	2.0E-1	3.0E-2	1.5E-3	1.5E-3	4.0E-3
I-125	0.01	1.0E-0	1.0E-0	6.0E-3	6.0E-2	6.0E-2
I-129	0.01	1.0E-0	1.0E-0	6.0E-3	6.0E-2	6.0E-2
Cs-134	1100	1.0E-2	1.0E-2	1.2E-2	3.0E-1	4.0E-3
Cs-137	1100	1.0E-2	1.0E-2	1.2E-2	3.0E-1	4.0E-3
Ba-137M	1100.	1.0E-2	1.0E-2	1.2E-2	3.0E-1	4.0E-3
Ce-141	1100	1.0E-2	4.0E-3	1.0E-4	1.0E-4	1.2E-3
Ce-144	1100	1.0E-2	4.0E-3	1.0E-4	1.0E-4	1.2E-3
Pm-147	61	1.0E-2	4.0E-3	5.0E-6	5.0E-6	4.8E-3
Re-187	7.5	1.5E-0	3.5E-1	2.5E-2	2.5E-2	8.0E-3
Pb-210	540	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
Ra-226	220	1.5E-2	1.5E-3	1.5E-2	1.5E-2	3.4E-2
Th-232	60,000	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5

Table C.3. (continued)

Nuclide	Plant uptake factor ^c					
	K_d^b	B_v	B_r	FMC^d	FMG^e	FF^f
U-233	45	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-234	45	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-235	45	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-236	45	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
U-238	45	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
Pu-238	1800	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
Pu-239	1800	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
Pu-241	1800	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
Pu-242	1800	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
Am-241	810	5.5E-3	2.5E-4	0		0
Am-243	810	5.5E-3	2.5E-4	0		0
Cm-243	3300	8.5E-4	1.5E-5	0		0

^aTheoretically, the retention fractions RA and RW may be element-specific. However, we have chosen constant values of 0.20 and 0.25, respectively.

^bIn units of ml/g. Taken from Baes and Sharp (1983).

^c B_v is for uptake into vegetative portions of plant (used for pasture grass, silage). B_r is for uptake into reproductive parts of plant (used for grain, fruit, produce except leafy vegetables). Units in (activity/g dry plant)/(activity/g dry soil). Taken from Baes et al. (1982).

^dData taken from Moore et al., 1979 or calculated from data in Ng et al. (1968).

^eData taken from Moore et al., 1979 or calculated from Ng et al. (1968). If no value for goat's milk is available, a value for cow's milk is used.

^fData taken from Moore et al., 1979 or calculated from Ng et al. (1968).

Table C.4. Mean annual wind direction frequencies and true-average wind speeds (SML/Barnwell)

Wind toward	Frequency	Wind speed for each stability class (m/s)						
		A	B	C	D	E	F	G
N	0.085	3.88	3.54	3.42	3.75	4.22	4.01	4.32
NNW	0.067	3.97	3.32	3.61	3.88	4.46	4.43	3.68
NW	0.043	3.25	3.36	3.25	3.39	4.30	3.91	4.04
WNW	0.044	3.87	3.77	3.36	3.63	3.88	4.08	3.49
W	0.056	4.27	4.02	4.73	3.67	4.00	4.70	4.55
WSW	0.057	4.94	4.46	4.56	3.47	4.21	4.07	3.81
SW	0.063	4.47	4.23	4.33	3.54	3.77	4.28	4.02
SSW	0.034	3.02	3.66	4.31	2.72	3.98	4.37	4.11
S	0.026	3.61	3.31	3.67	2.59	3.01	3.88	4.52
SSE	0.036	3.87	3.11	2.74	2.92	3.46	4.04	4.85
SE	0.060	2.98	3.30	3.78	3.17	3.58	3.92	4.12
ESE	0.089	3.1	4.02	3.17	4.24	4.24	4.24	4.00
E	0.085	3.87	3.44	3.82	3.93	4.50	4.27	3.59
ENE	0.081	3.62	4.07	3.65	3.59	3.70	4.01	2.81
NE	0.080	3.70	3.69	4.09	3.75	3.88	3.56	3.65
NNE	0.091	3.68	3.54	3.71	3.34	4.12	4.01	3.60

Table C.5. Population distribution by distance and direction for Barnwell, SC

DIR	Distance from site trench (km)									
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
N	91	523	1177	1090	1398	1639	3214	11443	11275	5836
NNE	114	931	2611	1637	2292	3143	3809	7526	21875	147549
NE	254	1086	2158	2215	2922	3742	5508	5267	4975	6388
ENE	666	2536	2085	4668	4276	3816	25374	11991	5566	5193
E	290	1953	1689	2019	2586	2210	2883	4241	9745	7217
ESE	360	609	1266	921	1500	1752	2557	5303	12599	3710
SE	105	346	3090	3792	2392	5700	1765	2342	2278	4934
SSE	124	259	542	727	918	2924	1577	1479	3048	5326
S	72	153	468	555	1121	2599	1733	1840	3458	5410
SSW	52	185	475	727	2757	2602	1683	2997	17106	10269
SW	41	182	428	1258	1297	2484	3864	1842	2365	4159
WSW	47	142	351	1140	3519	2975	1408	1986	5635	4380
W	47	147	369	1006	2528	2792	1610	2549	5313	2916
WNW	37	59	627	3562	7106	107579	43485	12906	9371	12892
NW	66	112	1605	3846	14793	52072	9811	3164	2244	2905
NNW	73	631	2030	4109	25104	4335	3863	7271	4911	5404
TOTAL	2439	9854	20971	33272	86509	202364	114144	84147	121764	234188

Table C.6. Hourly precipitation data for Augusta, GA (site 90495) *

Rainfall during indicated hours of day (hundredths of inches)																												
YR	MO	DA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOT	
78	01	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
78	01	06	0	0	0	0	0	0	0	3	1	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	9
78	01	07	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
78	01	08	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6	5	10	17	8	0	0	0	0	0	54	
78	01	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	10	10	21	8	12	13	80		
78	01	13	7	4	1	0	5	2	5	14	8	1	4	10	3	14	15	2	0	0	0	0	0	0	0	0	95	
78	01	17	0	0	0	1	0	0	0	0	1	19	11	4	0	0	0	0	0	0	0	0	0	0	0	0	36	
78	01	19	0	0	0	0	0	0	0	2	35	35	36	12	2	2	2	2	1	2	3	3	7	7	9	2	195	
78	01	20	1	4	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
78	01	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	4	4	7	22	
78	01	25	6	9	12	17	17	14	46	19	2	2	6	2	5	5	5	5	28	28	1	9	32	6	0	2	278	
78	02	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	6	4	14		
78	02	02	6	4	2	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	
78	01	09	0	2	2	2	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	
78	02	13	0	0	0	0	0	0	0	0	3	9	12	0	0	0	0	0	0	0	0	0	0	0	0	0	24	
78	02	16	0	0	0	0	0	0	0	0	0	0	0	2	2	1	4	2	3	1	0	0	0	0	0	0	15	
78	02	18	0	0	2	12	5	14	0	0	0	2	4	1	1	2	1	1	1	0	0	0	0	0	0	0	46	
78	02	28	0	0	0	0	0	0	0	3	1	2	2	1	1	0	1	2	3	3	1	1	1	0	0	0	22	
78	03	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
78	03	03	0	7	17	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	
78	03	07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	3	3	1	1	13	
78	03	08	1	0	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
78	03	09	0	0	0	0	0	0	0	0	0	0	0	0	1	1	12	18	31	20	11	3	2	2	0	0	101	
78	03	10	0	1	1	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
78	03	12	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
78	03	14	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
78	03	25	0	0	14	1	4	20	1	0	3	1	0	0	0	0	1	2	4	45	49	23	6	0	0	0	174	
78	03	26	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
78	04	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
78	04	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	8	0	1	1	2	24	
78	04	12	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
78	04	13	1	0	0	3	30	56	46	22	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	157	

Table C.6. Hourly precipitation data for Augusta, GA (cont.)

[illegible]

Table C.6. Hourly precipitation data for Augusta, GA (cont.)

Rainfall during indicated hours of day (hundredths of inches)																											
YR	MO	DA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOT
78	08	04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	1	0	1	0	0	0	0	0	0	27
78	08	05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	16
78	08	06	0	0	0	0	0	0	0	0	1	2	0	0	0	6	0	0	0	0	0	0	0	0	0	0	9
78	08	07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	0	0	0	0	0	0	0	7
78	08	09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	4
78	08	14	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	4
78	08	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	2	0	0	0	0	0	0	52
78	08	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	6
78	08	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	4
78	08	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	47	0	0	0	0	0	0	0	87
78	08	31	0	0	0	0	0	0	0	0	0	0	0	0	0	120	10	0	13	1	0	86	32	0	0	0	262
78	09	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
78	09	03	0	10	13	0	77	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123
78	09	23	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
78	09	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
78	09	30	0	0	0	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
78	10	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	10	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92	12	1	0	4	0	0	0	0	2	111
78	10	14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
78	11	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	11	07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	13	1	2	3	2	3	27
78	11	08	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
78	11	17	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
78	11	27	0	0	0	0	0	0	0	4	15	13	6	1	0	0	0	3	6	0	0	1	1	3	1	1	55
78	11	29	0	0	1	0	0	0	0	0	1	2	13	22	24	17	9	2	16	12	11	11	3	5	3	1	153
78	11	30	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	4	0	3	0	1	0	1	0	11	
78	12	01	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
78	12	04	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
78	12	05	0	0	1	2	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
78	12	09	0	0	0	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	0	0	0	10
78	12	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
78	12	21	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78	12	24	0	0	0	0	0	18	25	21	7	6	5	8	2	0	1	0	0	0	0	0	0	0	0	0	93

Unlisted days had zero rainfall

Table C.7. Barnwell input data set

** INPUT DATA AS READ IN **

BARNWELL -- 40 NUCLIDES

BARNWELL SC

1000	40	1	100	200	1	1	0	1000	100	0	0	1	1	1000
4	000	0												
	.01		.1		1.0		1.0		1.0		0.0		0.0	0.0
	1.130		1002.3		0		33.2							
	.56		.60		.64		.70		.68		.65		.65	.65
	.61		.66		.64		.69							
	8.0		9.3		12.9		18.0		22.3		25.9		27.1	26.7
	23.7		18.2		12.4		8.4							
	3.1		3.3		5.8		10.3		15.5		19.2		21.2	21.2
	18.5		12.5		6.7		2.6							
	9150.		6.7		1.5		0.4		2.		0		1.0	.09
	43.3													
	2.4		914.		2.15		25		0.3		0.4		0.4	43.3
	1.		.01		.4		.01		8000.		300.		.01	
	.49		7.7E-5		1.0E-6		-.15		1.0E-11		0.0		0.0	
1	2													
	250.		.23		0.27		.30		.30		1.0			
	.4		1.6		5300		305.0		0.01					
	914.		.05											
	.19		.53		240.		.0021		720.		1440.			
	0		2160.		24.		1440.		336.		336.		.77	.94
	50.		6.		48.		96.		480.		9.9		1.	
	.73		.015		60.		8.		50.					
	190.		190.		110.		0.		95.		370.		8000.	7033.
H-3			34499.		3.4E-4		0		0		5.64E-2			
H-3			0.01		0.01		0.01		0.01					
H-3			0.20		0.25		4.8E-0		4.8E-0		1.0E-2		1.7E-1	1.2E-2
C-14			9.5		9.5E-8						1.21E-4			
C-14			0.01		0.01		0.01		0.01					
C-14			0.20		0.25		5.5E-0		5.5E-0		1.2E-2		1.0E-1	3.1E-2
MN-54			9737.		9.7E-5		0		0		8.09E-1		1.5E+2	
MN-54			150		150		150		150					
MN-54			0.20		0.25		2.5E-1		5.0E-2		2.5E-4		2.5E-4	8.0E-4

FE-55	65672.	6.6E-4	55.	55.	2.57E-1		
FE-55	55.	55.	4.0E-3	1.0E-3	1.3E-4	4.0E-2	
FE-55	0.20	0.25					
NI-59	0.0						
NI-59	150	150	6.0E-2	6.0E-2	6.7E-3	5.3E-2	
NI-59	0.20	0.25	0.	0.	1.00.		
CO-60	432755.	4.3E-3	55.	55.	1.0E-3	1.3E-2	
CO-60	55.	55.	9.4E-3	9.4E-3	6.29E-3		
CO-60	0.20	0.25	150.	150.	6.7E-3	5.3E-2	
NI-63	11029.	1.1E-4	150.	150.	1.04E-0		
NI-63	150.	150.	6.0E-2	6.0E-2	3.9E-2	3.0E-2	
NI-63	0.20	0.25	16.	16.	2.0E-2	2.0E-2	
ZN-65	7613.	7.6E-5	1.5E+0	9.0E-1	6.47E-2		
ZN-65	16.	16.	0.	0.	2.0E-2	2.0E-2	
ZN-65	0.20	0.25	0.	0.	2.42E-2		
KR-85	1682.	1.7E-5	27.	27.	8.0E-4	6.0E-4	
KR-85	0.	0.	2.5E+0	2.5E-1	2.42E-2		
KR-85	.20	.25	27.	27.	1.4E-2		
SR-90	2617.	2.6E-5	27.	27.	1.4E-2	6.0E-4	
SR-90	.20	.25	27.	27.	2.5E-3	2.5E-3	
Y-90	2617.	2.6E-5	350.	350.	2.5E-2	4.0E-1	
Y-90	27.	27.	0.033	0.033	2.5E-2		
Y-90	.20	.25	9.5E-0	1.5E+0	6.89E-1		
NB-94	0.0		220.	220.	1.0E-6	1.0E-6	
NB-94	350.	350.	7.5E-2	2.0E-2	5.45E-1		
NB-94	0.20	0.25	6.7	6.7	1.3E-4	5.3E-4	
TC-99	61.	6.1E-7	5.5E-1	1.5E-1	2.50E-1		
TC-99	0.033	0.033	45.	45.	1.5E-3	4.0E-3	
TC-99	0.20	0.25	2.0E-1	3.0E-2			
RU-106	0.0		2.0E-1	3.0E-2			
RU-106	220.	220.	2.0E-2	2.0E-2			
RU-106	0.20	0.25	7.5E-2	2.0E-2			
CD-109	16.	1.6E-7	6.7	6.7			
CD-109	6.7	6.7	5.5E-1	1.5E-1			
CD-109	0.20	0.25	45.	45.			
SB-125	2.7	2.7E-8	0.25	0.25			
SB-125	45.	45.	0.25	0.25			
SB-125	0.20	0.25	0.25	0.25			

U-233	0.0	45.	45.	45.	4.28E-6		
U-233	45.	0.25	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-233	0.20	3.0E-8	45.	45.	2.83E-6		
U-234	45.	0.25	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-234	0.20	3.5E-8	45.	45.	9.85E-10		
U-235	45.	0.25	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-235	0.20	5.0E-9	45.	45.	2.96E-8		
U-236	0.5	45.	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-236	45.	0.25	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-236	0.20	3.1E-5	45.	45.	1.55E-10		
U-238	3063.	45.	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-238	45.	0.25	1.0E-5	45.	1.0E-5	1.0E-5	1.0E-5
U-238	0.20	2.0E-9	1800.	1800.	1.5E-6	1.5E-6	8.0E-3
PU-238	0.2	0.25	4.5E-4	4.5E-5	2.87E-5		
PU-238	1800.	0.25	1800.	1800.	1.5E-6	1.5E-6	8.0E-3
PU-238	0.20	1.0E-9	1800.	1800.	1.5E-6	1.5E-6	8.0E-3
PU-239	0.1	0.25	4.5E-4	4.5E-5	5.25E-2		
PU-239	1800.	0.25	1800.	1800.	1.5E-6	1.5E-6	8.0E-3
PU-239	0.20	4.5E-4	4.5E-5	4.5E-5	1.5E-6	1.5E-6	8.0E-3
PU-241	0.0	1800.	1800.	1800.	1.5E-6	1.5E-6	8.0E-3
PU-241	1800.	0.25	4.5E-4	4.5E-5	1.5E-6	1.5E-6	8.0E-3
PU-241	0.20	0.0	0.0	0.0	1.5E-6	1.5E-6	8.0E-3
AM-241	0.0	810.	810.	810.	0.	0.	
AM-241	810.	0.25	5.5E-3	2.5E-4	1.83E-6		
AM-241	0.20	1800.	1800.	1800.	1.5E-6	1.5E-6	8.0E-3
PU-242	1800.	0.25	4.5E-4	4.5E-5	8.72E-5		
PU-242	0.20	0.0	0.0	0.0	0.	0.	
AM-243	810.	810.	810.	810.	0.	0.	
AM-243	0.20	0.25	5.5E-3	2.5E-4	2.7E-2		
AM-243	0.0	3300.	3300.	3300.			
CN-243	3300.	0.25	8.5E-4	1.5E-5			
CN-243	0.20						

[illegible]

BARNWELL SIMULATION. WELL AT 914 M. XG=8000 M, SCAM=E-8

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&INPUT ILOC=1,JLOC=1,ILET=1,DTABLE=0,0,0,0,0,3,3,
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RTABLE=0,0,0,0,0,3,3,OUTPUT=.FALSE.,&END
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•MUSCLE ••LIVER ••S WALL ••PANCREAS••LLI WALL••

•KIDNEYS •,•BL WALL •,•ULI WALL•,•SI WALL •,•OVARIES •,

•TESTES ••SPLEEN ••UTERUS ••THYMUS ••THYROID ••

[illegible]

EQFACTOR HLET=20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,

[illegible]

ENDOST ., PULMONARY ., BREAST ., .

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APPENDIX D

INPUT DATA, SUPPORTING INFORMATION FOR EXAMPLE PROBLEM

Beatty, Nevada

D.1 GENERAL DESCRIPTION OF THE SITE*

D.1.1 Location and climate

The Beatty low-level waste site is located 16 km south-southeast of Beatty, Nevada, and 29 km northwest of Lathrop Wells, Nevada. The site is in the Amargosa Desert and lies in the Basin and Range physiographic province which is characterized by broad, open, relatively flat-floored valleys separated by rugged mountain ranges. At the site the valley tends northwesterly.

The area surrounding the disposal site gently slopes towards the south or southeast. Regional slope is about 6-8 m/km. Precipitation in the area is very small, averaging about 17 cm per year. Most of the annual precipitation comes in relatively high-intensity short summer thunderstorms. The rainfall profile is very erratic with little or no sustained rainfalls in the region. The relatively high temperatures and low rainfall "suggests that virtually all precipitation is susceptible to a rapid return to atmosphere as water vapor."

The area nearby the site is virtually uninhabited. The villages of Beatty and Lathrop Wells are the nearest populations. Las Vegas, 140 km, southeast of the site is the nearest metropolitan area.

D.1.2 Geology and soils

Unconsolidated deposits of gravel, sand, silt, and clay form the valley floor in the Amargosa Desert. The thickness of this material has been tested by drilling only at a few places, but the maximum thickness is at least 175 m. A definite statement regarding the thickness of the valley fill cannot be made, but based on drilling at the Nevada Test Site the relief on the bedrock surface may be rugged, and consequently abrupt changes in the depth to bedrock could be expected. Other types of bedrock beneath the fill of the Amargosa Desert probably include sandstone, siltstone, conglomerate, dolomite, limestone, shale, phyllite, schist, and marble. The rocks have been classified as the Nupah Formation, Stirling Quartzite, and Bonanza King Formation. Thin dikes of brown or reddish brown rhyolite porphyry and dacite or rhyodacite porphyry also may occur beneath the valley fill, but probably to a lesser degree.

The most significant feature of the bedrock units is that although they are dense, hard, and inherently impermeable, they do contain limestone, dolomite, and marble strata which may develop permeability by

*Unless otherwise noted, information in this appendix was found in Clebsch (1968).

solution. These rock also have been fractured and faulted during recent intensive tectonic activity. Test drilling on the Nevada Test Site has shown that similar bedrock units transmit substantial quantities of water through fractures and possibly solution channels, and there is no reason to believe that the bedrock beneath the Amargosa Desert does not also transmit water. However, water in the bedrock beneath the Beatty site is at great depth and greatly confined.

The valley fill has been derived from the weathering of adjacent hills and mountain ranges. Its lithologic composition, grain size, and other physical characteristics are highly variable. Available information on the alluvial fill at the site indicates that the sediments are in general poorly sorted mixtures of fine and coarse grained materials such as clay and boulders or clay and gravel. Most of the material is thus interpreted to be a conglomerate, similar to the material exposed on the surface. Two interesting intervals, however, are primarily clay or fresh-water limestone altered to clay, indicating deposition in still water, such as a lake. The clay layer from 81 to 99 m has considerable hydrologic significance.

D.1.3 Hydrology

There are very few wells around the Beatty site and, therefore, groundwater occurrence and behavior is poorly known. Prior to opening of the site only two wells into the saturated zone were known within 13 km of the site. Nevertheless, information derived while surveying and operating the site indicate the average direction of flow to be southeast from the site for about 16 km. Following that, the flows are more southerly. The two nearest producing wells down-gradient from the proposed site are reported to be approximately 22 and 27 km east-southeast and south-southeast of the site. The nearer well is near the site of Leeland, Nevada, and enters an aquifer about 45 m below the surface. The well 27 km from the site is 170 m deep and is used for irrigation.

There are no perennial streams or rivers within 16 km of the Beatty site. The Amargosa River channel, although dry, is the principal drainage channel. This river bed passes to within 3.5 km of the disposal site.

D.2 INPUT VARIABLES FOR PRE3TO-II

D.2.1 Options or control variables

Most input variables on the first four data cards are for code control or option selection (see Table D.1). The operation and logic of each of these variables is discussed in the data section of the report, Sect. 3.3. All code variables are defined in Table 3.1.

D.2.2 Site-description variables that are well-known

As with the Barnwell data set, Appendix C, some input data describing Beatty are well known and not likely to change greatly.

Noncontrol variables which are considered well known include the following (refer to Table D.1): TARREA (trench area), TDEPTH (trench depth), OVER (overburden), DTRAQ (trench to aquifer depth), all variables on cards 15 and 17, EDENS (soil bulk density), SAREA (area of contaminated surface soil), and the radiological decay rate. References or notes on calculation are given for each of these in Table D.1.

D.2.3 Radionuclide-independent variables that are poorly known

A number of the input variables listed in Tables 3.1 and D.1 are poorly known or taken from limited data; that is to say, there may be a large amount of variation associated with the value listed in Table D.1. This is in spite of the fact that the values listed have been taken from referencable sources. This section will briefly describe the variation or sources of variation expected in each of these variables as listed in Table D.1.

WATL. Fraction of total irrigation water taken from well. The referenced value is a state average of groundwater use as a fraction of total water use for 1970. Value may vary over time and across state. The range in the United States is from 0.01 (West Virginia) to 0.83 (Kansas). The most common United States range is 0.10-0.25.

PORA, PORT, PORS. Porosity of aquifer, trench, and surface region. In Table D.1, these values are equal to each other. This is likely incorrect for PORT, the porosity used both within the trench. If total trench were tightly compacted, the value could be much lower. More likely situation is that trench contents are variably porous due to heterogeneous materials and voids. Clebsch (1968) seems somewhat uncertain about the porosity. He states that "the porosity of 20% is a reasonable value for material of this type, but it might be as low as 10%..." Nevertheless, it seems clear that the aquifer porosity should be relatively low.

PERMV. Permeability of trench bottom, permeability of surface region. The referenced value is probably reasonable for surface region, but as with porosity, the permeability inside trench is probably extremely heterogeneous.

DENCON. Density of the trench contents. The listed value is an assumption. For waste materials such as cardboard, clothing, gloves, and soil, assuming few voids, the number may be reasonable. However, given sizeable voids or large masses of highly dense materials, the value listed is probably too small. Could range as high as 10.

RELFAC. User-option annual release fraction for activity leaching from trench. Has been estimated (Dole and Fields, 1981) for at least three sites: Savannah River Plant (10^{-8}), Oak Ridge National Laboratory (10^{-6}), and West Valley (2.5×10^{-4}). Probably not constant from element to element.

DTRAQ, DWELL. Depth from trench bottom to aquifer, distance from trench to well. Clebsch (1968) describes the locations of the two nearest producing wells. The nearer well is 22 km distant and draws water from an aquifer 240 m below surface. The farther well is 27 km away and pumps from a depth of 912 m. The listed value of DTRAQ is set conservatively from these and other information in Clebsch (1968) as is the value of DWELL.

GWV. Groundwater velocity. Referenced value from C. Y. Hung, Personal Communication to Jon Broadway, March 18, 1983.

AQTHK. Thickness of the aquifer, used for advection calculations. For Beatty depends on the aquifer and the location at which thickness is measured. The value in Table D.1 is based on the discussion by Clebsch (1968) which seems to indicate that aquifer thickness may vary from 4.3 to 10.4 m.

AQDISP. Angle of pollutant dispersion in the aquifer plume. The value in Table D.1 is an assumption. AQDISP is obviously a function of rate of flow, porosity, and permeability.

Card 19. Factors for use in the Universal Soil Loss Equation. Values listed in Table D.1 were calculated as prescribed by McElroy et al. (1976). However, the methods of McElroy et al. are generalized for large sections of the country. More detailed methods might yield more precise value. Except for RAINF, all factors vary only from 0-1. RAINF ranges from 20 to 350, nationwide. Range in the area of southern Nevada appears to be about 15-20. The sediment delivery ratio (SEDELR) was set 1.0 because it is intended for use around construction sites, an assumption not justified after the trench has been closed and reseeded.

ADEPTH. The active depth of the surface soil, used to calculate soil and water radionuclide concentration as a result of overflow. Values in the table are assumed. We found no reference for depth of subsurface runoff, etc., to substantiate ADEPTH, but it can reasonably be set to a low depth, nominally 15 cm. It is unlikely that ADEPTH would approach 1 m.

RUNOFF. Fraction of annual precipitation that runs off. The referenced value is probably too large. Jack Robertson of USGS (personal communication) estimates no runoff on the average. Listed value is set at 0.05.

D.2.4 Radionuclide-specific parameters that are poorly known

TRAM. Initial inventory of each radionuclide. The values in Table D.3 for Beatty are simply the merger of the indicated values for Barnwell and West Valley. If both Barnwell and West Valley had an inventory of a given radionuclide, the larger of the two were used for Beatty. We know of no referenceable radionuclide inventories for Beatty.

KD. See discussion in Appendix C.2.

SOAM. See discussion in Appendix C.2.

SOL. See discussion in Appendix C.2.

BR, BV. See discussion in Appendix C.2.

FMC, FMG. See discussion in Appendix C.2.

FF. See discussion in Appendix C.2.

D.3 ADDITIONAL SUPPORTING INFORMATION FOR INPUT DATA SET

Table D.2 lists the mean annual wind direction frequencies and true-averaged wind speeds Jackass Flats, Nevada. These or similar data should be used to calculate CHIQ for input.

Table D.3 lists population determined by the 1980 Census for a polar grid surrounding the Beatty site.

Table D.4 lists 1978 hourly precipitation for the Beatty, Nevada, Site 260718.

D.4 INPUT DATA SET

Table D.5 lists the Beatty input data set.

This Appendix has described an example simulation performed using data believed representative of Beatty, Nevada; however, many site parameters vary significantly within the site itself. Soil parameters, hydrologic parameters, and local radionuclide waste composition may vary greatly, yet transport and exposure scenarios are based on regional data and assumptions representative of a large area. Radionuclide inventories are primarily based on estimates of waste composition for different sites, and are used solely to construct an example data set. These considerations, together with the caveats offered in the Executive Summary and in Chapter 1, suggest that the results presented here must be interpreted as estimates of transport at the site, and that these estimates contain significant uncertainties.

Table D.1. Input data for Beatty, Nevada; refer to Table 3.1 for formats and definitions of variables

Card number	Variable	Value	Reference or note
1	TITLE		User option
2	LOCATE	Beatty NV	User option
3	MAXYR	1000	User option
	NONCLD	40	Must be 40 or less
	LEAOPT	2	User option
	NYR1	100	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	NYR2	200	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	IOPVWV	1	User option
	IOPSAT	1	User option
	IPRT1	0	User option
	IPRT2	1000	User option
	IDELT	100	User option
	IRRES1	0	User option
	IRRES2	0	User option
	LIND	1	User option
	IAVG1	1	User option
	IAVG2	1000	User option
4	IVAP	4	User option
	IBSMT	0	User option
	IAQSTR	0	User option
5	PCT1	0.01	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	PCT2	0.1	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	WATL	1.0	User option
	WATA	1.0	User option
	WATH	1.0	User option
	SATL	0.0	User option
	SATA	0.0	User option
	SATH	0.0	User option
6	PPN	0.171	
	P	898.83	
	XIRR	.646	
	PHID	36.83	
7	S	.68	
		0.70	
		0.72	
		0.73	
		0.78	
		0.85	
		0.81	
		0.84	

Table D.1. (continued)

Card number	Variable	Value	Reference or note
8		0.86	
		0.79	
		0.70	
		0.70	
9	T	-0.6	
		2.1	
		5.2	
		10.1	
		15.2	
		19.9	
		24.7	
		23.6	
10		18.9	
		12.3	
		5.1	
		0.6	
11	TD	-8.9	
		-6.9	
		-7.6	
		-4.6	
		-3.2	
		-1.7	
		2.7	
		3.3	
12		-1.4	
		-3.4	
		-5.7	
		-7.2	
13	TAREA	1.8E4	Morton (1968)
	TDEPTH	6.7	Morton (1968)
	OVER	1.2	Morton (1968)
	PORT	0.2	Clebsch (1968), p. 91; set same as soil
	DENCON	2.0	Assumed
	RELFAC	0	User option
	FN	0.5	
	XINFL	0.41	Calculated

Table D.1. (continued)

Card number	Variable	Value	Reference or note
14	PERMC	154	
15	DTRAQ	84	Clebsch (1968), p. 87
	DWELL	6700	Clebsch (1968), p. 88
	GWV	182	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	AQTHK	4.3	Clebsch (1968), p. 88
	AQDISP	0.3	Assumed
	PORA	0.2	Clebsch (1968)
	POKV	0.2	Clebsch (1968)
	PERMV	154	Clebsch (1968)
16	H	1.0	Assumed
	VG	0.027	Calculated from particle sizes
	U	4.48	Jackass Flats meteorology; National Climatic Center
	VD	0.027	Equal to VG
	XG	16,800	Clebsch (1968)
	HLID	300	Assumed
	ROUGH	0.01	Generic value
17	FTWIND	0.056	Jackass Flats meteorology; National Climatic Center
	CHIQ	7.0E-9	Computed with external code, AIRDOS-EPA, Moore et al. (1979)
	RE1	1.0E-4	Anspaugh et. al. (1975)
	RE2	-0.15	Anspaugh et. al. (1975)
	RE3	1.0E-9	Anspaugh et. al. (1975)
	RR	0	User option (>0 when farming)
	FTMECH	0	User option (>0 when farming)
18	IT	1	User option
	IS	4	Jackass Flats meteorology; National Climatic Center
19	RAINF	20	McElroy et al. (1976), p. 44, Fig. 3.2
	ERODF	0.5	McElroy et al. (1976), p. 46, Table C.2
	STPLNG	0.26	McElroy et al. (1976), Fig 3.8
	COVER	0.30	McElroy et al. (1976), Table 3.3
	CONTRL	0.40	McElroy et al. (1976), Table 3.7
	SEDELR	1.0	Assumed; see McElroy et al. (1976), p. 60-68
20	PORS	0.1	Clebsch (1968), p. 90
	BDENS	1.6	Assumed
	STFLOW	2000	Clebsch (1968), p. 73
	EXTENT	180	User option; set to trench length x 10
	ADEPTH	0.01	Assumed - user option

Table D.1. (continued)

Card number	Variable	Value	Reference or note
21	PD	3000	Clebach (1968), p. 73
	RUNOFF	0.05	Jack Robertson, USGS (personal communication)
22	Y1	0.04	Shor, Baes, and Sharp, Appendix C (1982)
	Y2	0.76	Shor, Baes, and Sharp, Appendix B (1982)
	PP	240	Assumed 15 cm plow depth
	XAMBWE	0.0021	USNRC (1977)
	TE1	720	Generic, USNRC (1977), Table E-15
	TE2	1440	Generic, USNRC (1977), Table E-15
23	TH1	0	Generic, USNRC (1977), Table E-15
	TH2	2160	Generic, USNRC (1977), Table E-15
	TH3	24	Generic, USNRC (1977), Table E-15
	TH4	1440	Generic, USNRC (1977), Table E-15
	TH5	336	Generic, USNRC (1977), Table E-15
	TH6	336	Generic, USNRC (1977), Table E-15
	FP	0.47	Shor, Baes, and Sharp (1982)
	FS	1.0	Shor, Baes, and Sharp (1982)
24	QFC	50	Generic, USNRC (1977), Table E-15
	QFG	6	Generic, USNRC (1977), Table E-15
	TF1	48	Generic, USNRC (1977), Table E-15
	TF2	96	Generic, USNRC (1977), Table E-15
	TS	480	Generic, USNRC (1977), Table E-15
	ABSH	4.4	State average; Etnier (1980)
	P14	1.0	Assumed

Table D.1. (continued)

Card number	Variable	Value	Reference or note
25	FI	0.65	Growing season length/8760
	WIRATE	0.114	Estimated from Baes et. al. (1982) and TW
	QCW	60	Generic, USNRC (1977)
	QGV	8	Generic, USNRC (1977)
	QBW	50	Generic, USNRC (1977)
26	ULEAFY	190	Generic, USNRC (1977)
	UPROD	190	Generic, USNRC (1977)
	UCMILK	110	Generic, USNRC (1977)
	UGMILK	0	Generic, USNRC (1977)
	UMEAT	95	Generic, USNRC (1977)
	UWAT	370	Generic, USNRC (1977)
	UAIR	8000	Generic, USNRC (1977)
	POP	2000	1980 Census; Durfee (personal communication)
			see Tables C.3 and C.4
27+			

Table D.2. Mean annual wind direction frequencies and true-average wind speeds (Jackass Flats, NV)

Wind toward	Frequency	Wind speed for each stability class (m/s)						
		A	B	C	D	E	F	G
N	0.124	2.95	3.85	4.58	4.47	2.94	1.72	1.23
NNW	0.056	2.95	3.85	4.58	4.48	2.89	1.72	1.23
NN'	0.020	2.89	3.77	4.58	4.38	2.95	1.71	1.23
WNV	0.013	2.88	3.75	4.49	4.59	2.81	1.73	1.24
N	0.036	2.92	3.75	4.57	4.43	2.90	1.78	1.21
WSW	0.065	2.97	3.86	4.55	4.50	2.94	1.81	1.22
SW	0.113	2.93	3.88	4.52	4.49	2.93	1.84	1.22
SSW	0.131	2.96	3.82	4.59	4.49	2.91	1.85	1.22
S	0.112	2.92	3.77	4.55	4.48	2.91	1.84	1.22
SSE	0.065	2.94	3.88	4.55	4.48	2.92	1.83	1.22
SE	0.033	2.72	4.04	4.58	4.46	2.92	1.77	1.21
ESE	0.012	2.78	3.78	4.49	4.54	2.81	1.73	1.24
E	0.013	2.78	5.55	4.51	4.42	2.84	1.59	1.25
ENE	0.036	2.93	3.85	4.63	4.49	2.81	1.66	1.20
NE	0.069	2.94	3.85	4.59	4.52	2.95	1.64	1.27
NNE	0.099	2.94	3.83	4.60	4.47	2.88	1.71	1.23

Table D.3. Population distribution by distance and direction for Beatty, NV

DIR	Distance from site trench (km)									
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
N	9	14	16	19	5	0	1	2	6	10
NNE	9	17	16	19	6	1	2	4	7	7
NE	10	21	21	26	28	17	19	20	20	22
ENE	8	25	31	32	38	44	33	41	50	55
E	10	30	30	50	62	55	54	49	67	69
ESE	8	26	40	52	74	92	174	231	252	500
SE	10	25	41	55	69	106	148	204	247	267
SSE	10	27	37	50	61	87	105	86	69	62
S	10	25	44	50	56	78	66	50	23	68
SSW	10	25	39	38	44	55	52	24	8	103
SW	8	28	25	33	41	49	45	32	23	62
WSW	8	17	24	31	44	51	46	40	43	49
W	11	16	11	15	22	33	24	16	24	21
WNW	7	12	5	3	8	3	11	10	7	16
NW	7	13	8	2	1	2	5	8	11	18
NNW	9	14	15	15	2	1	6	9	11	18
Total	144	335	412	290	561	674	791	826	868	1347

[illegible]

[illegible]

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APPENDIX E

INPUT DATA, SUPPORTING INFORMATION FOR EXAMPLE PROBLEM

West Valley, New York

E.1 GENERAL DESCRIPTION OF THE SITE*

E.1.1 Location and climate

The West Valley disposal ground is in Western New York approximately 55 km south-southeast of Buffalo, New York, in Cattaraugus County. The nearest village is Springville, about 2.5 km north of the northern site boundary. The low-level waste disposal ground is part of a larger site known as the Western New York Nuclear Service Center (WNYNSC).

The WNYNSC is located on a relatively level plateau just south of Cattaraugus Creek. Hills bound the site on all sides but the north. Buttermilk Creek, a tributary of Cattaraugus Creek, has cut a valley through the center of the plateau to a depth of about 30 m on the eastern boundary of the plant site. The valley walls of Buttermilk Creek and its tributaries are steep and badly eroded in places. The WNYNSC encompasses 1350 ha of which the low-level waste disposal site includes 10 ha.

The region surrounding West Valley is humid and greatly influenced by the presence of Lakes Erie and Ontario within 80 km. Precipitation (over 1.0 m per year) is evenly divided throughout the year, with heavy snowfall associated with cold air passage over Lake Erie. Winds at the site are generally from west and south, and relatively strong (speeds of 4-8 m/s occur 59% of the time). The mean annual temperature of the site is 7.2°C with July being the warmest month (21.2°C) and January the coldest (-4.4°C).

The area around the disposal site has a low population density. The 1976 estimated population of Cattaraugus County was 86,000.

E.1.2 Geology and soils

The West Valley site is in the Glaciated Allegheny portions of the Appalachian Plateau physiographic province. The region is overlain by variable thicknesses of glacial deposits above Paleozoic sedimentation rocks. These strata dip slightly to the south (4-8 m/km). The combination of a tending northward erosion slope and southward dip has exposed several different formations in contiguous, irregular east-west bands.

The bedrock of the region is generally overlain by unconsolidated glacial and glacially related deposits consisting of till, sand, gravel, silts, and clays. Till consists of ground rock fragments containing cobbles and pebbles. At the WNYNSC, these deposits range in depth to 170 m. The mineralogy of the tills resemble that of the Paleozoic

*Unless otherwise noted, information in this section is from USDOE (1978) or Giardina et al. (1977).

rocks that were once exposed to glacial action in the region. The clay and silt fractions are dominated by quartz, mica, and chlorite; lesser amounts of calcite and dolomite are detectable in the silt fraction. Soils of the area may be described by three general descriptions: fill, jointed-fractured weathered till, and unweathered till. Fill is silty, moist, gray and brown mottled, with firm to soft consistency. The jointed-fractured weathered fill is tough, homogeneous brown with scattered gravel bits, having joints and fractures throughout. Unweathered till is gray in color, plastic clay, with scattered gravel, occasional buff-colored spots and some pebbles. Sand lenses may be encountered variously in places throughout the till.

Both USDOE (1978) and Giardina et al. (1977) have much more detailed and scholarly descriptions of the geology and soils of the West Valley region and site.

E.1.3 Hydrology

The West Valley site is underlain by three, or possibly four, aquifers. The top aquifer ranges from 0-6 m thick and consists of granular fluvial materials which are found on the surface of much of the site. This aquifer is "probably charged by surface infiltration that is prevented from further downward migration by the underlying, impermeable, silty till" (USDOE, 1978). The aquifer crops out in marshy areas and at the edges of erosion gullies from streams within the site boundaries. Therefore, groundwater from the top aquifer is discharged as surface drainage within the site boundary.

The second aquifer is a thin sand layer about 5 m below grade. It is confined above and below by impermeable fill; water level is 1.5 to 5 m above the level of the aquifer. The third aquifer is confined in a range of 31.4 to 37.8 m depth and consists of pebbly to silty sand. The last aquifer occurs in a weathered and fractured zone at the top of the shale bedrock. This aquifer may produce usable quantities of water even though it has relatively low permeability. The depth of this aquifer varies greatly because of the buried bedrock valley that underlies the site area.

The site is drained of surface water by Cattaraugus Creek and Buttermilk Creek, its tributary. Cattaraugus Creek flows generally westerly and empties into Lake Erie about 65 km downstream. Buttermilk Creek is the major surface drainage system of the West Valley site. Although it originates south of the WNYNSC, the lower portions of Buttermilk Creek, including its confluence with Cattaraugus Creek, are completely within the site boundary. The mean annual flow of the Cattaraugus Creek part of the site is about $3.1 \times 10^8 \text{ m}^3/\text{yr}$ of which Buttermilk Creek contributes about $4.1 \times 10^7 \text{ m}^3/\text{yr}$.

A more detailed description of the groundwater and surface hydrology is given by both USDOE (1978) and Giardina et al. (1977).

E.2 INPUT VARIABLES FOR PRESTO-II

E.2.1 Options or control variables

Most of the input variables on the first five data cards are for code control or option selection (see Table E.1). The operation and logic of each of these variables is discussed in the data section of the report, Sect. 3.3. All code variables are defined in Table 3.1.

E.2.2 Site-description variables that are well known

As with the Barnwell and Beatty site data bases discussed earlier, some of the input data describing the site are very well known and will neither change greatly nor largely affect predictions.

Noncontrol variables which are considered well-known include the following (refer to Table E.1): TAREA (trench area), TDEPTH (trench depth), OVER (overburden), all variables on cards 16 and 18, BDENS (soil bulk density), STFLOW (stream flow), SAREA (area of contaminated surface soil), and the radiological decay rate. References or notes on calculation are given for each of these in Table E.1.

E.2.3 Radionuclide-independent variables that are poorly known

A number of the input variables listed in Tables 3.1 and E.1 may have a large uncertainty associated with the value listed in Table E.1. This section will briefly describe the variation or source of variation expected in each of these variables as listed in Table E.1.

WATL. Fraction of total irrigation water taken from well. The referenced value is a state average of groundwater use as a fraction of total water use for 1970. Value may vary over time and across state. The mixture and poor quality of aquifers existing near the West Valley site would seem to make this parameter value even more uncertain. The U.S. range is from 0.01 (West Virginia) to 0.83 (Kansas). The most common U.S. range is 0.10-0.25.

PORA, PORT, PORS. Porosity of aquifer, trench, and surface region.

PERMV. Permeability of trench bottom. The listed value in Table E.1 is from C. Y. Hung, Personal Communication to Jon Broadway, March 18, 1983.

DENCON. Density of the trench contents. As with other sites the value listed is strictly an assumption. For waste materials such as cardboard, clothing, gloves, and soil, assuming few voids, the number may be reasonable. However, given sizeable voids or large masses of highly dense materials, the value listed is probably too small and could range as high as 10.

RELFAC. User-option annual release fraction for activity leaching from trench has been estimated (Dole and Fields, 1981) for at least three sites: Savannah River Plant (10^{-8}), Oak Ridge National Laboratory

(10^{-6}), and West Valley (2.5×10^{-4}). These values are probably not constant between elements.

DTRAQ. Trench bottom to aquifer depth. The listed value in Table E.1 is from C. Y. Hung, Personal Communication to Jon Broadway, March 18, 1983.

GWV. Groundwater velocity. The referenced value is from a series of computer simulations of the West Valley site. For this site, the value used for GWV is likely not very important due to the impermeable strata that minimize infiltration.

AQTHK. Thickness of the aquifer, used for dilution calculations. For West Valley, depends on the aquifer chosen for transport and the location at which thickness is measured. The value in Table E.1 is based on the second aquifer described by USDOE (1978).

AQDISP. Angle of pollutant dispersion in the aquifer plume. The value in Table E.1 is strictly an assumption, since AQDISP is very much a function of flow rate, porosity, and permeability. Because of slow flow rates, the value is probably larger for West Valley than for other sites.

Card 19. Factors for use in the Universal Soil Loss Equation. Values listed in Table E.1 were calculated as prescribed by McElroy et al. (1976). However, the methods of McElroy et al. are generalized for large sections of the country. More detailed methods might yield more precise values. Except for RAINF, all factors vary only from 0-1. RAINF ranges from 20-350, nationwide. The value of RAINF in western New York is roughly 90-100. The sediment delivery ratio (SEDEL) was set to 1.0 because it is intended to be used around large construction sites, an assumption that is not justified after the trench has been closed and reseeded.

ADEPTH. The active depth of the surface soil used to calculate soil and water radionuclide concentrations as a result of overflow from trench. Value in table is assumed. The value of ADEPTH could reasonably be set to plow depth, nominally 15 cm. It is unlikely that ADEPTH would approach 1 m. At West Valley, the impermeable soils may result in a much smaller active region except for the shallow water table aquifer which leads to surface discharge.

E.2.4 Radionuclide-specific parameters that are poorly known

TRAM. Initial inventory of each radionuclide. Values in Table C.3 for West Valley are more accurate than values for Beatty, i.e., better records were kept for the West Valley site. Nevertheless, the West Valley inventory data are probably incorrect because they are based on broadly classed groups of radionuclides and not actual measurements of materials received. By examining the shippers/generators of the waste materials, in detail, the West Valley inventory estimate could be improved but not perfected.

KD. See discussion in Appendix C.2.
SOAM. See discussion in Appendix C.2.
SOL. See discussion in Appendix C.2.
BR, BV. See discussion in Appendix C.2.
FMC, FMG. See discussion in Appendix C.2.
FF. See discussion in Appendix C.2.

E.3 ADDITIONAL SUPPORTING INFORMATION FOR INPUT DATA SET

Table E.2 lists the mean annual wind direction frequencies and true-averaged wind speeds for the metropolitan Buffalo, New York, airport. These or similar data should be used to calculate CHIQ for input.

Table E.3 lists population determined by the 1980 census for a polar grid surrounding the West Valley site.

Table E.4 lists 1978 hourly precipitation for the weather station at Salamanca, New York.

E.4 INPUT DATA SET

Table E.5 lists the West Valley input data set.

This Appendix has described an example simulation performed using data believed representative of West Valley, New York; however, many site parameters vary significantly within the site itself. Soil parameters, hydrologic parameters, and local radionuclide waste composition may vary greatly, yet transport and exposure scenarios are based on regional data and assumptions representative of a large area. Radionuclide inventories are primarily based on estimated waste composition, rather than measured values. These considerations, together with the caveats offered in the Executive Summary and in Chapter 1, suggest that the results presented here must be interpreted as estimates containing significant uncertainties.

Table E.1. Input data for West Valley, New York, refer to Table 3.1 for formats and definitions of variables

Card number	Variable	Value	Reference or note
1	TITLE		User option
2	LOCATE	West Valley, NY	User option
3	MAXYR	1000	User option
	NONCLD	40	Must be 40 or less
	LEAOPT	2	User option
	NYR1	100	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	NYR2	200	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	IOPVWV	1	User option
	IOPSAT	1	User option
	IPRT1	0	User option
	IPRT2	1000	User option
	IDELT	100	User option
	IRRES1	0	User option
	IRRES2	0	User option
	LIND	1	User option
	IAVG1	1	User option
	IAVG2	1000	User option
4	IVAP	4	User option
	IBSMT	0	User option
	IAQSTR	0	User option
5	PCT1	0.1	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	PCT2	0.2	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	WATL	1.0	User option
	WATA	1.0	User option
	WATH	1.0	User option
	SATL	0.0	User option
	SATA	0.0	User option
	SATH	0.0	User option

Table E.1. (continued)

Card number	Variable	Value	Reference or note
6	PPN	1.178	
	P	966.93	
	XIRR	0.152	
	PHID	42.25	
7	S	0.35	
		0.40	
		0.47	
		0.53	
		0.58	
		0.66	
		0.68	
		0.65	
		0.59	
		0.51	
8		0.30	
		0.28	
		-4.4	
		-4.0	
		0.3	
		7.3	
		13.0	
		18.7	
		21.2	
		20.1	
10		16.5	
		11.0	
		4.5	
		-2.0	
11	TD	-6.8	
		-6.9	
		-3.6	
		1.8	
		7.4	
		12.9	
		15.2	
		15.2	
12		11.6	
		6.3	
		0.7	
		-4.8	

Table E.1. (continued)

Card number	Variable	Value	Reference or note
13	TAREA	41500	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	TDEPTH	6.7	Morton (1968)
	OVER	2.4	Morton (1968)
	PORT	0.25	Clebsch (1968), p. 91μ set same as soil
	DENCON	2.0	Assumed
	RELFAC	0	User option
	FN	0.1	User option
	XINFIL	0.05	Calculated
14	PERMC	1.488	Assumed
15	DTRAQ	31	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
	DWELL	6500	Assumed
	GWV	0.03	Prudic (1981)
	AQTHK	6.4	USDOE (1978), p. 2-10
	AQDISP	0.3	Assumed
	PORA	0.25	Giardina et al. (1977), p. 100
	POKV	0.25	Giardina et al. (1977), p. 100
	PERM	0.019	Personal Communication, C. Y. Hung to J. Broadway to D. E. Fields, March 18, 1983
16	H	1.0	Assumed
	VG	0.01	Calculated from particle sizesμ Giardina et. at (1977), p. 103
	U	4.2	Buffalo, NY meteorology
	VD	0.01	Equal to VG
	IG	6500	Clebsch (1968)
	HLID	300	Assumed
	ROUGH	0.01	Generic value
17	FTWIND	0.049	Buffalo, NY meteorology
	CHIQ	7.9E-9	Computed with external code, AIRDOS-EPA Moore, et. al. (1979)

Table E.1. (continued)

Card number	Variable	Value	Reference or note
	RE1	1.0E-6	Anspaugh et. al. (1975)
	RE2	-0.15	Assumed lower than Anspaugh et. al. (1975)
	RE3	1.0E-10	Assumed lower than Anspaugh et. al. (1975)
	RR	0	User option >0 when farming)
	FTMECH	0	User option >0 when farming)
18	IT	1	User option
	IS	4	Buffalo, NY meteorology
19	RAINF	100	McElroy et al. (1976), p. 44, Fig. 3.2
	ERODF	0.19	McElroy et al. (1976), p. 46, Table C.2
	STPLNG	0.42	McElroy et al. (1976), Fig 3.8
	COVER	0.30	McElroy et al. (1976), Table 3.3
	CONTRL	0.50	McElroy et al. (1976), Table 3.7
	SEDELK	1.0	Assumed, see McElroy et al. (1976), p. 60-68
20	PORS	0.25	Giardina et al. (1977), p. 100
	BDENS	1.6	Assumed
	STFLOW	4.0E7	USDOE (1978), p. 2-10
	EXTENT	244	Set to maximum trench length
	ADEPTH	0.1	Assumed
21	PD	380	Calculated from map in USDOE (1978)
	RUNOFF	0.53	Geraghty et. al. (1973), p. 21
22	Y1	0.14	Shor, Baes, and Sharp, Appendix C (1982)
	Y2	0.56	Shor, Baes, and Sharp, Appendix B (1982)
	PP	240	Assumed 15 cm plow depth
	XAMBWE	0.0021	USNRC (1977)

Table E.1. (continued)

Card number	Variable	Value	Reference or note
23	TE1	720	Generic, USNRC (1977), Table E-15
	TE2	1440	Generic, USNRC (1977), Table E-15
	TH1	0	Generic, USNRC (1977), Table E-15
	TH2	2160	Generic, USNRC (1977), Table E-15
	TH3	24	Generic, USNRC (1977), Table E-15
	TH4	1440	Generic, USNRC (1977), Table E-15
	TH5	336	Generic, USNRC (1977), Table E-15
	TH6	336	Generic, USNRC (1977), Table E-15
	FP	0.49	Shor, Baes, and Sharp (1982)
	FS	0.31	Shor, Baes, and Sharp (1982)
24	QFC	50	Generic, USNRC (1977), Table E-15
	QFG	6	Generic, USNRC (1977), Table E-15
	TF1	48	Generic, USNRC (1977), Table E-15
	TF2	96	Generic, USNRC (1977), Table E-15
	TS	480	Generic, USNRC (1977), Table E-15
	ABSH	6.4	State average; Etnier (1980)
25	P14	1.0	Assumed
	FI	0.47	Growing season length/8760
	WIRATE	0.042	Estimated from Baes et. al. (1982) and TW
	QCW	60	Generic, USNRC (1977)
	QGW	8	Generic, USNRC (1977)
	QBW	50	Generic, USNRC (1977)

Table E.1. (continued)

Card number	Variable	Value	Reference or note
26	ULEAFY	190	Generic, USNRC (1977)
	UPROD	190	Generic, USNRC (1977)
	UCMILK	110	Generic, USNRC (1977)
	UGMILK	0	Generic, USNRC (1977)
	UMEAT	95	Generic, USNRC (1977)
	UWAT	370	Generic, USNRC (1977)
	UAIR	8000	Generic, USNRC (1977)
	POP	10,000	1980 Census; Durfee (personal communication)
27+	see Tables C.3 and C.4		

Table E.2. Mean annual wind direction frequencies and true-average wind speeds (Buffalo, NY),

Wind toward	Frequency	Wind speed for each stability class (m/s)						
		A	B	C	D	E	F	G
N	0.124	2.95	3.85	4.58	4.47	2.94	1.72	1.23
NNW	0.056	2.95	3.85	4.58	4.48	2.89	1.72	1.23
NW	0.020	2.89	3.77	4.58	4.38	2.95	1.71	1.23
WNW	0.013	2.88	3.75	4.49	4.59	2.81	1.73	1.24
W	0.036	2.92	3.75	4.57	4.43	2.90	1.78	1.21
WSW	0.065	2.97	3.86	4.55	4.50	2.94	1.81	1.22
SW	0.113	2.93	3.88	4.52	4.49	2.93	1.84	1.22
SSW	0.131	2.96	3.82	4.59	4.49	2.91	1.85	1.22
S	0.112	2.92	3.77	4.55	4.48	2.91	1.84	1.22
SSE	0.065	2.94	3.88	4.55	4.48	2.92	1.83	1.22
SE	0.033	2.72	4.04	4.58	4.46	2.92	1.77	1.21
ESE	0.012	2.78	3.78	4.49	4.54	2.81	1.73	1.24
E	0.013	2.78	5.55	4.51	4.42	2.84	1.59	1.25
ENE	0.036	2.93	3.85	4.63	4.49	2.81	1.66	1.20
NE	0.069	2.94	3.85	4.59	4.52	2.95	1.64	1.27
NNE	0.099	2.94	3.83	4.60	4.47	2.88	1.71	1.23

Table E.3. Population distribution by distance and direction for West Valley, NY

DIR	Distance from site trench (km)									
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
N	1140	1468	4478	15369	49854	98103	38223	15792	17995	11910
NNE	907	986	2388	4425	4486	9277	10934	18828	11468	15577
NE	172	1716	1725	1611	2867	8373	7573	11394	12639	17255
ENE	137	1974	1849	1370	2598	5252	8480	12486	9477	10783
E	208	971	1239	1805	3108	1352	1928	7930	18973	5386
ESE	290	1080	1133	1387	2412	3728	8981	8028	4566	2956
SE	255	016	1058	2202	4099	4045	4291	2703	2808	3318
SSE	300	501	862	4173	26793	5114	3933	4956	2904	1679
S	230	779	2735	7824	3306	19375	3639	2335	4470	3672
SSW	270	612	1999	1932	604	553	1754	15380	7303	2330
SW	271	789	1448	2053	3920	16083	34964	9944	6065	7008
WSW	245	774	1235	1754	2102	3529	7733	6406	4426	8087
W	385	988	5653	2773	4434	31615	4554	3691	431	0
WNW	442	1377	3031	5610	6193	0	0	0	0	0
NW	562	875	5089	10694	1684	0	0	0	0	0
NNW	1557	1437	5501	35164	140551	659588	165353	79291	30752	2881
TOTAL	7371	17243	41423	100146	259010	865986	302340	209164	134277	92842

Table E.4. Hourly precipitation data for Salamanca, NY (site 307398)*

[illegible]

Table E.4. (continued)

Rainfall during indicated hours of day (hundredths of inches)																											
YR	MO	DA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOT
78	05	05	10	20	40	20	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	110
78	05	08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	20	10	40
78	05	09	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	20
78	05	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10
78	05	13	0	0	0	0	0	0	0	0	0	0	10	0	20	10	0	10	0	10	0	0	0	0	0	0	60
78	05	14	0	0	0	0	0	0	0	10	0	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	30
78	05	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	10	30
78	05	17	10	0	20	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
78	05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	10	0	40
78	06	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	06	02	0	0	0	0	0	0	0	0	0	0	0	0	0	30	10	0	0	0	0	0	0	10	0	0	50
78	06	07	0	0	0	0	0	0	0	0	0	0	0	0	20	10	0	0	0	0	0	0	0	0	0	0	30
78	06	08	0	0	0	0	0	0	0	0	0	10	40	10	0	0	0	0	0	0	0	0	0	0	0	0	60
78	06	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	10	0	10	0	0	50
78	06	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	10	0	0	0	80
78	06	19	0	0	10	40	10	10	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80
78	06	21	0	0	0	0	0	0	0	0	20	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	30
78	06	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	20
78	07	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	07	08	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	50	20	0	0	0	0	0	80
78	07	21	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	60	10	0	0	10	0	0	0	0	110
78	07	27	0	0	30	10	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
78	07	29	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10	30	20	0	0	0	0	70
78	07	31	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78	08	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	08	03	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
78	08	06	0	0	10	0	0	0	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
78	08	07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10
78	08	09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	10
78	08	10	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
78	08	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	20
78	08	19	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	20	20	30	10	0	0	90
78	08	28	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	10	40
78	08	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	10
78	09	01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	09	03	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78	09	08	0	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
78	09	10	0	0	0	0	0	0	0	0	0	0	0	0	40	10	0	0	0	0	0	0	0	0	0	0	50
78	09	12	0	0	0	0	0	0	60	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
78	09	15	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78	09	16	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20

Table E.4. (continued)

Rainfall during indicated hours of day (hundredths of inches)																									
YR MO DA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOT
78 09 17	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0	0	0	0	0	10	0	30
78 09 18	0	0	0	0	10	0	10	0	0	0	0	0	0	0	0	10	0	0	0	30	0	10	0	0	70
78 09 30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	20
78 10 01	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78 10 04	0	10	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
78 10 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10
78 10 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	0	10	0	30
78 10 07	10	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	10	0	0	0	30
78 10 08	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	30
78 10 12	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	30
78 10 13	10	10	10	0	0	0	20	10	10	10	0	0	0	0	0	0	0	10	0	0	0	0	0	10	100
78 10 14	0	10	10	10	0	10	20	30	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
78 10 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	10
78 10 16	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
78 10 20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78 10 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10
78 10 26	0	0	10	10	0	0	0	0	0	20	10	10	20	20	0	0	0	0	10	0	0	0	0	0	110
78 11 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78 11 07	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10	0	0	0	0	0	20
78 11 14	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	10
78 11 17	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10	10	10	0	0	0	40
78 11 21	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78 11 23	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	10	0	0	0	0	0	0	0	20
78 11 24	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0	10	0	30
78 11 25	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	10
78 11 27	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	10	0	10	0	0	0	0	0	0	30
78 12 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78 12 03	0	0	0	0	0	0	0	0	10	0	10	0	10	0	0	10	0	0	0	0	0	0	0	0	40
78 12 04	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78 12 08	0	0	10	0	0	0	10	0	0	0	0	0	0	0	0	10	0	10	0	10	0	10	0	0	60
78 12 09	10	10	0	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	50
78 12 12	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78 12 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10
78 12 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	20
78 12 17	10	0	0	0	0	0	0	0	10	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	30
78 12 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10
78 12 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	10	10	10	10	60
78 12 21	10	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	30
78 12 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	20	50
78 12 25	10	20	20	10	0	10	0	0	0	0	10	0	0	0	0	10	0	0	0	0	0	0	0	0	90
78 12 27	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
78 12 31	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	10	10	0	50

* Unlisted days had no rainfall

[illegible]

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WEST VALLEY SAMPLE SIMULATION , WELL AT 100M, POPN AT 8000M
&INPUT ILOC=1,JLOC=1,ILET=1,1,DTABLE=0,0,0,0,0,3,3,
RTABLE=0,0,0,0,0,3,3,OUTPUT=.FALSE.,&END
&ORGAN NORGN=18,ORGN=R MAR ,,,ENDOST,,,PUL*,
,MUSCLE,,,LIVER,,,S WALL,,,PANCREAS,,,LLI WALL,,
,KIDNEYS,,,BL WALL,,,ULI WALL,,,SI WALL,,,OVARIES,,
,TESTES,,,SPLEEN,,,UTERUS,,,THYMUS,,,THYROID,,
TIME=70,70,70,70,70,70,70,70,70,70,70,70,70,70,70,70,&END
&QFACR HLET=20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,
LLET=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,&END
&CANCER NCANC=18,CANC=R MARROW,,,ENDOST,,,PULMNARY,,,BREAST,,
,,,ST WALL,,,PANCREAS,,,LLI WALL,,,KIDNEYS,,
,,,BL WALL,,,ULI WALL,,,SI WALL,,,OVARIES,,
,,,TESTES,,,SPLEEN,,,UTERUS,,
,,,THYMUS,,,THYROID,,,LIVER,,
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REFERENCES FOR APPENDIX E

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APPENDIX F

VARIABLES USED IN PRESTO-II

Variables Used in PRESTO-II

Name	Definition	Units
ABSH	Absolute Humidity of the Atmosphere	g/m^3
ADEPTH	Aquifer Depth	m
AIRCON	Atmospheric Concentration	Ci/m^3
AQAM	Amount of Nuclide at Well Site Initially	Ci
AQAVG	Average Nuclide Concentration at Well Site	Ci/m^3
AQCON	Nuclide Concentration at Well Site	Ci/m^3
AQDISP	Aquifer Dispersion Angle	radians
AQTHK	Aquifer Thickness	m
AQVOL	Aquifer Dilution Factor	m^3
ATAM	Amount of Nuclide Initially in Atmosphere	Ci
ATAVG	Average Nuclide Concentration in Atmosphere	Ci/m^3
ATCON	Nuclide Concentration in Atmosphere Downwind	Ci/m^3
ATMASS	Nuclide Mass Number	
BDENS	Bulk Density of Soil	g/cc
BR	Concentration Fraction for Uptake of Radionuclide from Soil by Reproductive Parts of Crops	-
BV	Concentration Fraction for Uptake of Radionuclide from Soil By Vegetative Parts of Crops	-
CCMI1	Nuclide Concentration in Cow's Milk for M.I.E. by Atmospheric Deposition	pCi/L
CCMI2	Nuclide Concentration in Cow's Milk for G.P.E. by Atmospheric Deposition	pCi/L
CFEED	Radionuclide Concentration in Animal's Feed	
CGMI1	Nuclide Concentration in Goat's Milk for M.I.E. by Atmospheric Deposition	pCi/L
CGMI2	Nuclide Concentration in Goat's Milk for G.P.E. by Atmospheric Deposition	pCi/L
CHIQ	User Specific CHI/Q for Atmospheric Exposures	s/m^3
CL1	Radionuclide Concentration in Leafy Vegetable for M.I.E. by Atmospheric Deposition	pCi/kg
CL2	Radionuclide Concentration in Leafy Vegetable for G.P.E. by Atmospheric Deposition	pCi/kg
CMEAT	Nuclide Concentration in Beef Meat by Atmospheric Deposition	pCi/kg
COCMI1	Nuclide Concentration in Cow's Milk for M.I.E. by Irrigation	pCi/L

Name	Definition	Units
COCM12	Nuclide Concentration in Cow's Milk for G.P.E. by Irrigation	pCi/L
COGM11	Nuclide Concentration in Goat's Milk for M.I.E. by Irrigation	pCi/L
COGM12	Nuclide Concentration in Goat's Milk for G.P.E. by Irrigation	pCi/L
COL1	Nuclide Concentration in Leafy Vegetable for M.I.E. by Irrigation	pCi/kg
COL2	Nuclide Concentration in Leafy Vegetable for G.P.E. by Irrigation	pCi/kg
COMEAT	Nuclide Concentration in Beef Meat by Irrigation	pCi/kg
CONTRL	Erosion Control Practice Factor	
COP1	Nuclide Concentration in Produce for M.I.E. by Irrigation	pCi/kg
COP2	Nuclide Concentration in Produce for G.P.E. by Irrigation	pCi/kg
COVER	Cover Factor	-
CPAST	Nuclide Concentration in Pasture Grass Consumed by Animals	pCi/kg
CP1	Nuclide Concentration in Produce for M.I.E. by Atmospheric Deposition	pCi/kg
CP2	Nuclide Concentration in Produce for G.P.E. by Atmospheric Deposition	pCi/kg
CS	Concentration in Surface Soil	Ci/kg
CSP	Soil Radionuclide Concentration Due to Atmospheric Deposition	pCi/m ²
CSP0	Soil Radionuclide Concentration Due to Irrigation Deposition	pCi/m ²
CSPT	Soil Radionuclide Concentration Running Total	pCi/m ²
CSPOT	Soil Radionuclide Concentration Running Total	pCi/m ²
CSTO	Nuclide Concentration in Stored Feed Consumed by Animals	pCi/kg
CW	Concentration in Surface Water	Ci/m ³
CWAT	Nuclide Concentration in Irrigation Water	pCi/m ³

Name	Definition	Units
DECAY	Radioactive Decay Constant	yr ⁻¹
DECN	Decay Correction Factor	-
DENCON	Density of Trench Contents	g/cm ³
DEPO	Deposition rate per unit source strength	m ⁻²
DERATE	Atmospheric Deposition Rate	pCi/m ² /h
DERATG	Atmospheric Radionuclide Deposition Rate	pCi/yr
DOVER	Annual Thickness of Trench over Burden Eroded	m
DTRAO	Distance from Trench to Aquifer	m
DWELL	Distance from Trench to Well	m
ERODF	Erodibility Factor	-
ERREST	Estimate of Error in Integrations	-
EXPN	Normalized Exposure, EU/Q	s/m ²
EXPOS	Normalized Down Wind Atmospheric Exposure per Unit Source Release	s/m ³
EXTENT	Cross Slope of Extent of Spillage	m
FF	Animal's Nuclide Daily Intake to Flesh Factor	-
FI	Fraction of Year Crops are Irrigated	-
FMC	Cow's Nuclide Daily Intake to Milk Factor	d ⁻¹
FMG	Goat's Nuclide Daily Intake to Milk Factor	d ⁻¹
FP	Fraction of the Year Animals Graze on Pasture	-
FS	Fraction of the Daily Feed that is Fresh Grass	-
FTMECH	Fraction of Year Mechanical Suspension Occurs	-
FTWIND	Fraction of Time Wind Blows Toward Population	-
GWV	Ground Water Velocity	m/yr
H	Source Height	m
HLID	Lid Height	m
HTIME	Horizontal or Aquifer Transport Time	yr
IAVG1	First Year of Averaging Calculation for Results	yr
IAVG2	Last Year of Averaging Calculation for Results	yr
IBSMT	Control Variable; Year of Basement Construction	yr
IDELT	Incremental Year for Printing Annual Summaries	yr
II	Nuclide Number	-
INSITE	Control Variable; Value 1 Implies On-Site Calculation	-

Name	Definition	Units
IOPSAT	Option Indicator for Calculating Length of Saturated Zone	-
IOPT	Options for Special Radionuclides H-3 and C-14; IOPT=1 if H-3 and C-14 are not included in this run; IOPT=2 if only H-3 is included; IOPT=3 if only C-14 is included; IOPT=4 if both are included	-
IOPVV	Option Indicator for Calculating Vertical Water Velocity	-
IPLU	1 Implies Transverse Plume Calculation Required	-
IPKT1	Initial Year for Printing Annual Summaries	yr
IPKT2	Final Year for Printing Annual Summaries	yr
IRRES1	First Year of Mechanical Suspension	yr
IRRES2	Final Year of Mechanical Suspension	yr
IS	Stability Class	-
ISEC	1 Implies Sector Average Required	-
IT	Type of Stability Formulation (1 for PG, 2 for Briggs-Smith)	-
ITIME	Total Transport Time from Trench to Well	yr
LDIST	Distance From Release Point to Receptor	m
LEAOPT	Leaching Option for Trench Material	-
LIND	Population Indicator	-
LLIND	Population Indicator Passed to DARTAB	-
LOCATE	Site Location	-
LU2	Logical Unit for Output	-
MAXYR	Number of Years in Simulation	-
NN	Nuclide Number	-
NONCLD	Number of Nuclides in Simulation	-
NUCLID	Nuclide Names	-
NYEAR	Current Year of Simulation	yr
NYR1	First Year of Programmed Cap Failure	yr
NYR2	Second Year of Programmed Cap Failure	yr
OLDWAT	Water in Trench at Start of Year	m ³
OVER	Trench over Burden Thickness	m
P14	Fractional Equilibrium Ratio for C-14	-
PC	Fraction of Trench Cap that has Failed	-
PCON1	Air Concentration	Ci/m ³

Name	Definition	Units
PCON2	Ground Surface Concentration	Ci/m ²
PCON3	Collective Ingestion Rate	pCi/
PCON4	Collective Inhalation	pCi/
PCT1	Fraction of Intact Cap in NYR1	-
PCT2	Fraction of Intact Cap in NYR2	-
PD	Downslope Distance to Stream	m
PERMS	Permeability of Soil	m/yr
PERMV	Permeability Beneath Trench	-
PNUC	Nuclide Names	-
POLB	Amount of Nuclide Leaving Bottom of Trench	Ci
POLO	Amount of Nuclide Overflowing Trench	Ci
POP	Population	-
PORA	Aquifer Porosity	-
PORS	Porosity of Soil	-
PORT	Porosity of Trench Contents	-
PORV	Porosity of Subtrench Region	-
PP	Surface Density for Soil	kg/m ²
PPOP	Population	-
QBW	Rate of Water Consumption by Beef Cattle	L/d
QCW	Rate of Water Consumption by Milk Cows	L/d
QFC	Rate of Feed Consumption by Cattle	kg/d
QFG	Rate of Feed Consumption by Goats	kg/d
QFRAC	Fraction of Ingestion due to Water	-
QGW	Amount of Water Consumed by Goats	L/d
QING	Annual Intake of Radionuclide by Ingestion of Contaminated Food Considering Atmospheric and Aquatic Pathways	pCi/yr
QINH	Annual Intake of Radionuclide by Inhalation	pCi/yr
RA	Retention Fraction of Atmospheric Deposition	-
RAINF	Rainfall Factor	-
RE1	First Anspaugh Resuspension Factor	m ⁻¹
RE2	Second Anspaugh Resuspension Factor	d ^{-1/2}
RE3	Third Anspaugh Resuspension Factor	m ⁻¹
RELFAC	Release Factor for Trench Leaching	-

Name	Definition	Units
RETARH	Horizontal Retardation Factor	-
RETARV	Vertical Retardation Factor	-
ROUGH	Hosker Roughness Parameter	m^{-1}
RR	Resuspension Rate	s
RUNOFF	Fraction of Precipitation that Runs Off	-
RW	Retention Fraction by Irrigation	-
SAREA	Area of Spillage	m^2
SDEEP	Amount of Soluble Surface Component Going to Trench	Ci
SEDELR	Sediment Delivery Ratio	-
SINFL	Watershed Yearly Infiltration	m
SOAM	Amount of Surface Spillage	Ci
SOAVG	Average Surface Concentration	Ci/m^2
SOCON	Surface Concentration	Ci/m^2
SOILOS	Annual Soil Loss Rate Due to Erosion	kg/m^3 yr
SOL	Solubility Constant	g/mL
SSTREM	Amount Surface Component Going to Stream	Ci
STAM	Amount of Nuclides in Stream	Ci/m^3
STCON	Nuclide Concentration in Stream	Ci/m^3
STFLOW	Stream Flow Rate	m^3/yr
STPLNG	Slope Steepness and Slope Length Factor	-
STAVG	Average Nuclide Concentration in Stream	Ci/m^3
SWATA	Fraction of Animals Drinking Water From Stream	-
SWATH	Fraction of Humans Drinking Water From Stream	-
SWATL	Fraction of Irrigation Water From Stream	-
TAREA	Trench Area	m^2
TDEPTH	Trench Depth	m
TE1	Period Pasture Grass Exposed During Growing Season	h
TE2	Period Crop/Vegetation Exposed During Growing Season	h
TF1	Transport Time Feed-Milk Receptor for M.I.E.	h
TF2	Transport Time Feed-Milk Receptor for G.P.E.	h
TH1	Period Delay Between Harvest of Pasture and Ingestion by Animal	h
TH2	Period Delay Between Stored Feed and Ingestion by Animal	h

Name	Definition	Units
TH3	Period Between Harvest of Leafy Vegetation and Ingestion by Man for M.I.E.	h
TH4	Period Between Harvest of Produce and Ingestion by Man for M.I.E.	h
TH5	Period Between Harvest of Leafy Vegetation and Ingestion by Man for G.P.E.	h
TH6	Period Between Harvest of Produce and Ingestion by Man for G.P.E.	h
TITLE	Title of Data Set	-
TRAM	Amount of Nuclide in Trench	Ci
TS	Time from Slaughter of Meat to Consumption	h
U	Velocity, Wind	m/s
UAIR	Annual Inhalation Rate of Air	m ³ /yr
UCMILK	Annual Intake of Cow's Milk	L/yr
UGMILK	Annual Intake of Goat's Milk	L/yr
ULEAFY	Annual Intake of Leafy Vegetation	kg/yr
UMEAT	Annual Intake of Beef Cattle's Meat	kg/yr
UPROD	Annual Intake of Produce	kg/yr
UWAT	Annual Intake of Drinking Water	L/yr
VD	Atmospheric Deposition Velocity	m/s
VG	Velocity, Gravitational Fall	m/s
VOLB	Volume of Water Leaving Trench Bottom	m ³
VOLO	Volume of Water Overflowing Trench	m ³
VOLUSD	Volume of Water Used from Well	m ³
VTIME	Vertical Transport Time	yr
VWV	Vertical Water Velocity (Trench to Aquifer)	m/yr
WIRATE	Irrigation Rate	L/m ²
WATA	Fraction of Animal's Drinking Water from Stream	-
WATH	Fraction of Human's Drinking Water from Stream	-
WWATL	Fraction of Irrigation Water from Stream	-
XAMBEF	Effective Decay Constant	h ⁻¹
XAMBWE	Weather Decay Constant	h ⁻¹
IG	Gauge Distance from Source Base	m
XINFL	Annual Infiltration Rate	m ³
IKD	Chemical Exchange Coefficient	mL/g
XLSAT	Length of Saturated Zone	m
Y1	Ag Productivity for Grass Consumed by Animals	kg/m ²
Y2	Ag Productivity for Vegetation Consumed by Man	kg/m ²
Y80	Atmospheric Source Amount at Spillage	Ci

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