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A Self-Teaching Curriculum for the NRC/SNL Low-Level Waste Performance Assessment Methodology

Prepared by
M. S. Y. Chu, M. W. Kozak, J. E. Campbell, B. M. Thompson

Sandia National Laboratories
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ABSTRACT

A performance assessment methodology has been developed for use by the U.S. Nuclear Regulatory Commission in evaluating license applications for low-level waste disposal facilities. This report provides detailed guidance on input and output procedures for the computer codes recommended for use in the methodology. Seven sample problems are provided for various aspects of a performance assessment analysis of a simple hypothetical conceptual model. When combined, these sample problems demonstrate how the methodology is used to produce a dose history for the site under normal conditions, and to demonstrate an analysis of an intruder scenario.

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1.0 INTRODUCTION

The U. S. Nuclear Regulatory Commission (NRC) and the Agreement States have the responsibility to license disposal facilities for commercial low-level radioactive wastes. License applicants are required by the NRC to demonstrate compliance with the performance objectives in Subpart C of 10 CFR Part 61. The NRC has the responsibility to evaluate license applications by reviewing and verifying assertions submitted by the applicant.

A low-level radioactive waste performance assessment methodology has been developed at Sandia National Laboratories (SNL) for the NRC to use in assessing the performance of low-level waste disposal facilities for license application evaluation. The methodology is designed to provide the NRC with a tool for performing analyses of postclosure performance of low-level waste facilities in support of license reviews relating to the postclosure performance objectives in 10 CFR Parts 61.41 and 61.42.

Background information leading to the development of the methodology is documented in detail in a five-volume series of reports [Shipers, 1989; Shipers and Harlan, 1989; Kozak et al., 1989a; Kozak et al., 1989b; Kozak et al., 1990a]. The important environmental pathways by which radionuclides can reach humans from a low-level waste facility are identified in the first two volumes of these reports. Models and codes that are appropriate for a low-level waste performance assessment analysis are identified and selected in Volumes 3 and 4. The actual implementation and the assessment of the selected models and computer codes are documented in Volume 5 in the series. Based on these five volumes, a low-level waste performance assessment methodology has been developed and is documented in Kozak et al. [1990b].

This performance assessment methodology allows the analyst to perform systematic quantitative analyses of the radionuclide releases from a low-level waste disposal facility, the transport of radionuclides through the environment and biosphere, and the doses to man from various exposure pathways. These analyses are used to demonstrate with reasonable assurance whether human exposures to radionuclides exceed regulatory performance objectives. For this reason, a simple and conservative approach is implemented in this performance assessment methodology.

The purpose of this document is to demonstrate the use of the methodology in analyzing the performance of a hypothetical low-level waste disposal facility. Examples are given to demonstrate the use of the individual types of analyses used in the methodology, and to illustrate how the results can be used to assess compliance with the postclosure requirements in 10 CFR Part 61. This report provides detailed guidance on the structure of the methodology, and on the use of computer codes in the methodology.

To facilitate input file preparation, a user-friendly input file preparation program was adapted for use with some of the methodology codes. This program also can be used to perform parametric analyses, and contains a post-processor that can provide various tabular and graphical output as requested by the user.

The structure of the performance assessment methodology and the capabilities and assumptions of the various models in the methodology are described in Chapter 2. A detailed user's guide for implementing the methodology is contained in Chapter 3. Chapter 4 includes six sample problems to demonstrate the use of the methodology. Finally, issues relating to the quality assurance of the computer codes in the methodology are discussed briefly in Chapter 5.

2.0 DESCRIPTION OF THE METHODOLOGY

A summary of the modeling approaches and assumptions used in the methodology is presented in this chapter. These approaches were documented in a series of reports on the development of the methodology. Shipers [1989] documented the identification of pathways and scenarios for low-level waste disposal. Shipers and Harlan [1989] screened those pathways and scenarios to identify the most important ones for a generic site and disposal facility. Kozak et al. [1989a] identified and recommended models for use in the methodology, and Kozak et al. [1989b] recommended codes to implement those models. These recommendations were modified somewhat by Kozak et al. [1990a], and this report also documented the implementation and assessment of computer codes for the methodology. It is in this implementation and assessment report that explicit details are given of the models used in the methodology, together with their major assumptions and limitations. These details were summarized by Kozak et al. [1990b]; this last report provided a discussion of the overall methodology, together with uncertainties and assumptions that are implicit in the modeling approaches. This overall discussion of the methodology is reiterated briefly in this chapter.

2.1 Overview of the Methodology

The performance assessment methodology was developed to provide the NRC with a tool for performing confirmatory analyses in support of license reviews on issues related to the postclosure performance objectives in 10 CFR 61, which are

- The general population must be protected from the releases of radioactivity to the general environment in ground water, surface water, air, soil, plants, or animals in such a way that the resulting annual dose to the maximally exposed person should not exceed 25 millirem to the whole body, 75 millirem to the thyroid, or 25 millirem to any other organ; and

- Individuals who inadvertently intrude into the disposal facility and occupy the site or contact the waste any time after institutional control period must be protected.

The methodology allows analyses of doses to individuals from off-site releases under normal conditions as well as on-site doses to inadvertent intruders. In many cases intruder-dose analyses need not be performed [Kozak et al., 1990b]. A demonstration of intruder protection may consist of a demonstration that the waste classification and segregation requirements of 10 CFR Part 61 have been met, and that adequate barriers to inadvertent intrusion have been provided for. However, dose analyses may be required in special cases when an applicant requests an exemption from the 10 CFR Part 61 waste classification scheme.

Shipers and Harlan [1989] have identified the important pathways for the releases of radionuclides from a low-level waste disposal facility. The primary pathways considered in the analysis of off-site releases from the facility under undisturbed conditions are (1) radionuclide releases to ground water, with subsequent human exposure to contaminated well water, and (2) radionuclide releases to ground water, then to surface water and the eventual exposure of humans to surface water. Other pathways, such as air transport or contamination of surface soil, may be found to be important at specific sites. Pathways considered in the analysis of an intruder-disturbed facility may include the ground-water pathways in addition to human exposure through air pathways, surface-water pathways, and direct radiation exposure pathways.

The methodology has been designed to be modular in structure, which allows the NRC to confirm or verify parts of, or all of the assertions made by a licensee. The modular structure permits the use of very simple models, with more complicated models substituted when required by site-specific characteristics [Starmer, 1988]. In addition, the modular structure allows updating of the methodology as better models are developed. This prevents the components of the methodology from becoming obsolete.

The procedure for applying the performance assessment methodology to the ground-water pathway is depicted in Figure 2-1. There are five main modules in the methodology for analyzing off-site releases: ground-water flow, source term, ground-water transport, surface-water transport, and pathways and dosimetry. The source-term module models the release of radionuclides from a low-level waste facility, the ground-water transport module models the transport of radionuclides in ground water, surface-water transport describe the transport of radionuclides in river, and the pathway and dosimetry module models the dose resulting from various exposure pathways. The capabilities and assumptions embodied in the models for each of these pathways are summarized below. Since the purpose of this documentation is to illustrate the execution of the computer codes in the methodology, the justifications for the selection of the codes are not addressed here. Kozak et al. [1990a, 1990b] discussed the assumptions, limitations and uncertainties that are associated with the modeling approaches in the methodology.

<u>Ground-Water Flow</u>

An estimate of flow into and around the disposal units is necessary both for source-term modeling, and for ground-water transport analysis. Flow through and around the engineered cover is generally a multidimensional process. Engineered covers typically are designed to have low vertical permeability, but with a large capacity for horizontal flow that allows excess water to be channeled away from the facility. These capabilities are often provided by using multiple layers of soils of greatly different hydrological properties. The most straightforward way to model such systems is to model the cover as a multidimensional flow system. Indeed, even one-dimensional analyses of cover systems need to account for lateral flow, making them pseudo-two-dimensional flow analyses.

For the current methodology the ground-water infiltration is assumed to have been estimated from water-balance modeling or field measurements.

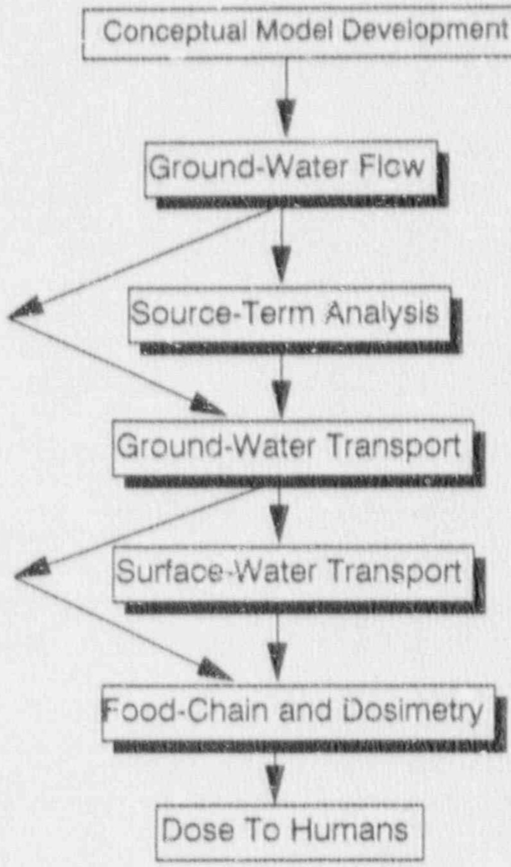


Figure 2-1. Performance Assessment Methodology Procedure for Ground-Water Pathway

In practice, such estimations generally have large uncertainties associated with them, and several techniques should be used to estimate infiltration so that their results can be compared [Foster, 1988; Johansson, 1988]. Specifying infiltration provides a boundary condition at the upper boundary of the domain for use in a ground-water flow code.

Hydrological processes will usually be assumed to be temporally steady in analyses with this methodology. Nevertheless, transient flow analyses may sometimes be necessary, and the capability for such analyses has been retained in the methodology.

For this methodology, flow into the facility is estimated using VAM2D [Huyakorn et al., 1989]. Kozak et al. [1990a] found VAM2D to be flexible enough to simulate a cover system with greatly contrasting soil layers. The numerical approaches, assumptions, and limitations of this code are discussed in the code documentation.

Source Term

Releases of radionuclides from a low-level waste facility are modeled in a simple and conservative manner. The major assumptions are listed below:

- Radionuclide chains are not explicitly accounted for in the source-term analysis. However, since the chains of importance for low-level wastes are non-branching and short, it is possible to analyze the transport of the parent radionuclide and correct the daughter concentrations at the end of the analysis [Kozak et al., 1990a].

- The amount and rate of water percolating into the waste-containing region is assumed to be known and temporally constant. Implicit in this assumption is that the hydrology can be modeled as steady state. The water flux into the facility can be estimated from VAM2D simulations.

- Engineered barriers are assumed to fail completely at some fixed time. There is no predictive capability in the methodology for demonstrating the expected lifetime of engineered barriers. After failure, no credit is given for inhibition of radionuclide release by the barrier.

- For unstabilized Class A waste, it is assumed that the radionuclides dissolve completely upon contact with water. The contaminants are assumed to reside at the surface of the waste, and are simply washed off by passing water.

- For stabilized waste, in which the leach rate is limited by the diffusion rate through the waste form, a constant release rate is assumed. This model can also be used for leach rates limited by solubility in the waste container if the isotope is long lived. Either diffusion limitations or solubility limitations of the release rate should be demonstrated by the licensee using adequate site-specific data. If such demonstrations and data are unavailable, the analyst should use the surface-wash model.

- Transport of radionuclides within the facility is assumed to be downward vertically and the facility is modeled as a series of N equal-sized well-mixed cells (Figure 2-2). The total volume of the N cells is equal to the total volume of the waste-containing trenches in the facility. The concentration of a radionuclide exiting cell n (C_n) is mixed with the radionuclide in the next cell and exits cell n+1 with concentration C_{n+1}. This model incorporates the effect of dispersion during transport within the facility in a simplified way, yet spans the full range of dispersive behavior possible in the disposal unit.

- If the sorption coefficient (K_d) of a radionuclide has been satisfactorily estimated using site-specific data, the effect of sorption onto the backfill material can be incorporated into the source term as a retarded velocity in the disposal unit.

<u>Ground-Water Transport</u>

In the current methodology, a simple approach is adopted for analyzing the transport of radionuclides in ground water. Use of more complicated methods should be undertaken if additional detail is justified. The major assumptions for this module are summarized below. These assumptions are embodied in the computer codes DISPERSE and SURFACE [Kozak et al., 1990a]. This code implements an analytical solution to the convective-dispersion equation. Since the publication of Kozak et al. [1990a], DISPERSE and SURFACE have been combined in a single software package called PAGAN (<u>P</u>erformance <u>A</u>ssessment <u>G</u>round-water <u>A</u>nalysis of low-level <u>N</u>uclear waste), which allows for menu-driven input and output functions for the two codes. PAGAN is discussed in greater detail in Chapter 3.

- Once the radionuclides exit the facility, transport through the unsaturated zone between the facility and the water table is assumed to be one-dimensional, vertically downward. Dispersion and sorption are ignored. The calculated unsaturated-zone travel time is used as an effective delay time for the onset of release in the source-term calculation.

- The aquifer is assumed to be homogeneous with a constant thickness. The aquifer flow is assumed to be one-dimensional with constant, known Darcy velocity.

- A time-dependent source of radionuclides is released into the aquifer at the water table in the shape of a rectangular area. This area is the same as the plan-view area of the disposal unit. Contaminant transport is modeled using the convective-dispersion equation with different dispersion coefficients in the transverse and longitudinal directions. The concentration of radionuclides

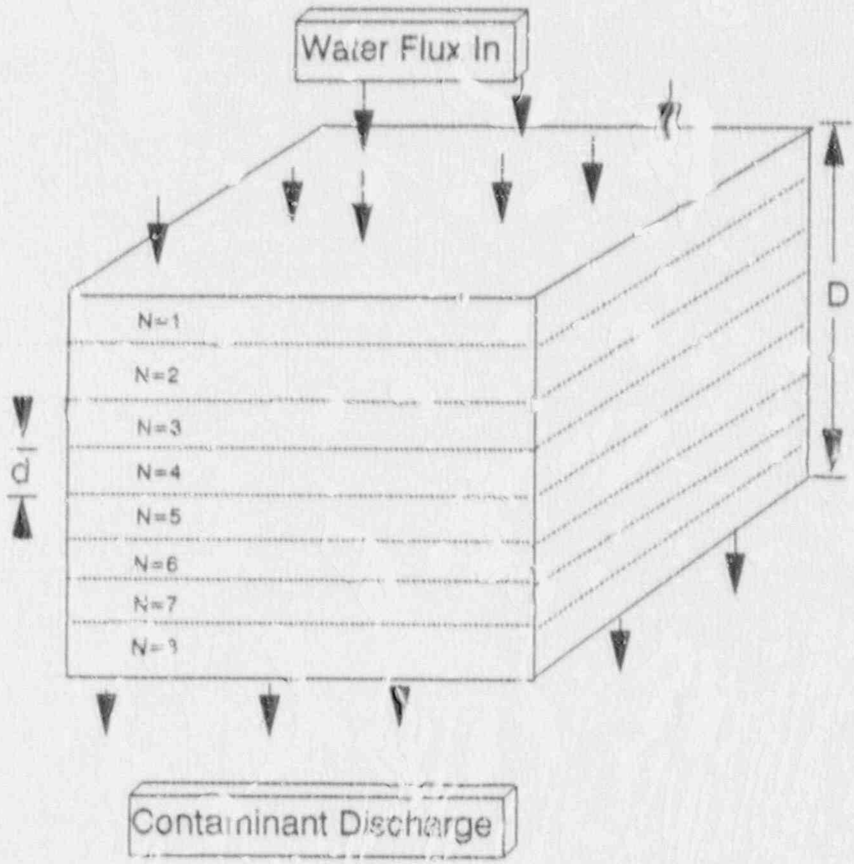


Figure 2-2. Mixing Cell Cascade Model For Near-field Transport [Kozak et al., 1990a]

at a water well in the aquifer is modeled as the center-line concentration at the water table, which is the maximum concentration in the aquifer at that distance.

- All of the radionuclides passing through a plane in the aquifer that intersects the surface-water body are assumed to enter the surface water. This is a conservative assumption, since usually not all radionuclides in an aquifer will enter the surface water.

Surface-Water Transport

Surface-water transport analyses are required when a contaminated aquifer discharges to a surface-water body. The purpose of surface-water transport analysis is to estimate the dispersion of the radionuclide in the surface water between the release point and the receptor point. The assumptions are described below.

- The analyst has two options in analyzing surface-water transport. A simple dilution-factor model is included in SURFACE that is appropriate for small streams. For lakes, or for larger rivers, the surface-water transport in GENII [Napier et al., 1988] should be used. These models are identical to the models in the LADTAP II computer code [Strenge et al., 1986], which are based on the work described in Codell et al. [1982]. The primary limiting assumptions of the GENII surface-water transport model are (1) constant flow depth, (2) constant downstream or longshore velocity, (3) straight river channel, (4) constant lateral dispersion coefficient, (5) continuous point discharge release of effluents, and (6) constant river width [Napier et al., 1988].

- Radionuclide interactions with sediment in the river are ignored in analyses in this methodology.

Pathways and Dosimetry

The computer code GENII, developed at Pacific Northwest Laboratory [Napier et al., 1988], has been selected for pathways and dosimetry analyses in the methodology. In GENII, doses to humans from releases of radionuclides into air, ground water, surface water, and soil are evaluated. The output from the ground-water transport module is used as input for GENII.

Exposure pathways considered in GENII include direct exposure to contaminated air and soil, inhalation of contaminated air, and ingestion of contaminated water and food products. GENII also has the capability to model air transport, dispersion and dilution in surface waters, and food chain transport.

Doses from both acute exposure and chronic releases can be calculated in GENII. The various exposure pathways available in GENII are illustrated in Figure 2-3. Here, data regarding the radioactive release or radioactive contamination levels may be input to the calculations at various points in the calculation. These points are represented as hexagonal boxes in Figure 2-3.

2.2 Interaction of Codes in the Methodology

The codes in the methodology are structured in such a way that the source-term analysis is performed by both of the ground-water transport codes. Table 2-1 summarizes the physical phenomena modeled by the codes in the methodology. The only source of contamination of the surface water is from discharge of a contaminated aquifer. Source-term and contaminant transport analyses are performed using PAGAN, which contains the codes DISPERSE and SURFACE. DISPERSE estimates source-term releases and radionuclide transport to a water well in the aquifer; SURFACE performs the same source-term calculation, but analyzes the transport of radionuclides to a surface-water body. In addition, SURFACE contains a very simple surface-water transport model in which a dilution factor is used to estimate the concentration of a radionuclide in the surface water.

The output from PAGAN includes a time- and location-dependent radionuclide concentration at a well in the aquifer, or a time- and location-dependent radionuclide flux into a surface-water body. These results are used by GENII for the calculation of surface-water transport, and calculation of dose through various user-selected exposure pathways. Figure 2-4 shows the interaction between the computer codes in the methodology.

Table 2-1. Computer Codes in the Methodology

Code	Ground-water Flow	Source-term Evaluation	Ground-water Transport	Surface-water Transport	Pathways & Dosimetry
VAM2D	x	x	x		
PAGAN	x	x	x	x	
GENII				x	x

The computer codes PAGAN and GENII are software packages that can be operated on a personal computer (PC). Analyses using the finite-element code VAM2D can be performed on a PC, but many of the analyses requiring VAM2D are sufficiently complicated to require more computational power than is usually available on a PC. For this reason, VAM2D has not been included in the PC package; instead, VAM2D should be used on larger computers.

2.3 Data Requirements for the Methodology

In this section the data required in each module in the performance assessment methodology are explicitly presented. These data must, in general, be collected as part of the site characterization performed by

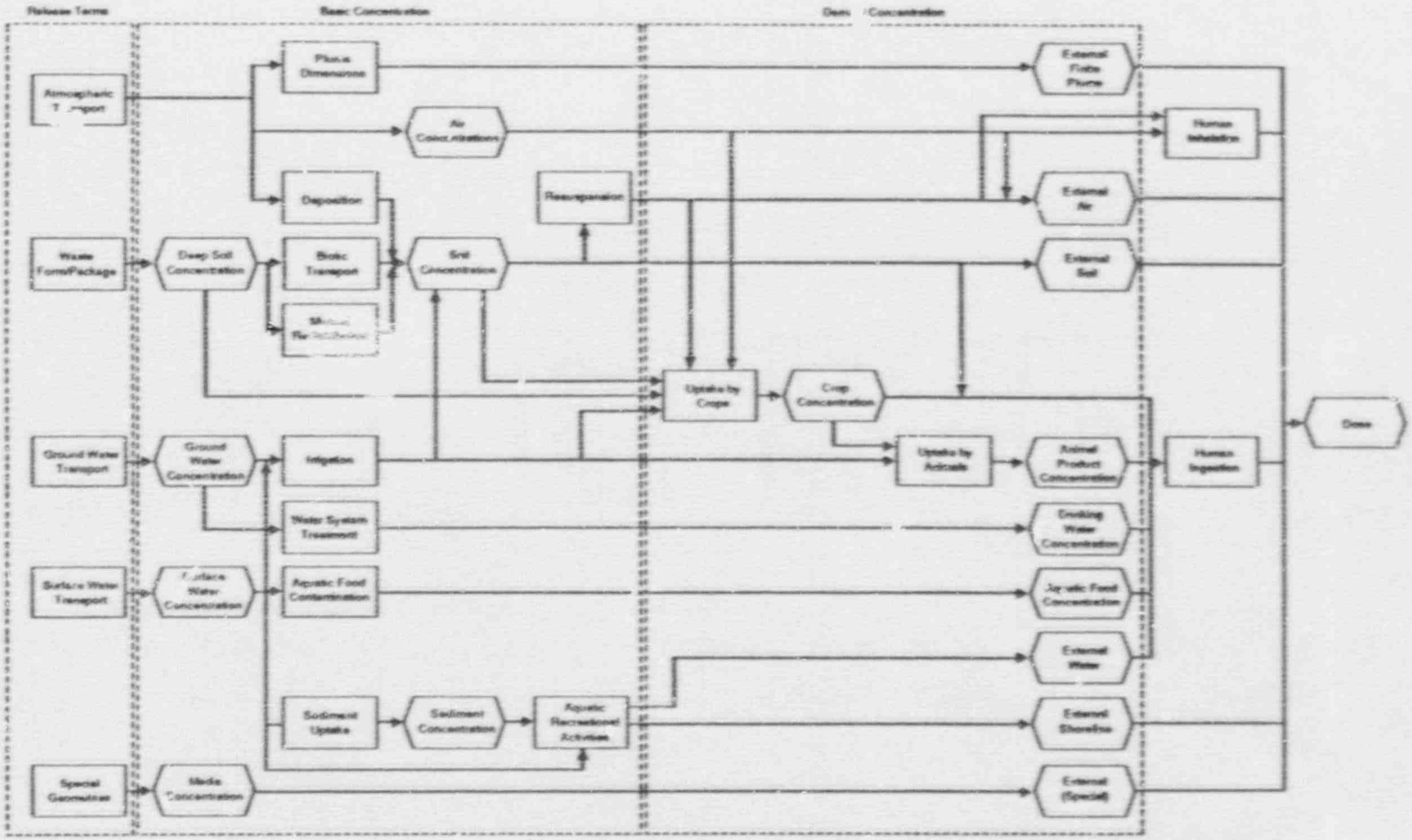


Figure 2-3. Exposure Pathways in GENII [Napier, et al., 1988]

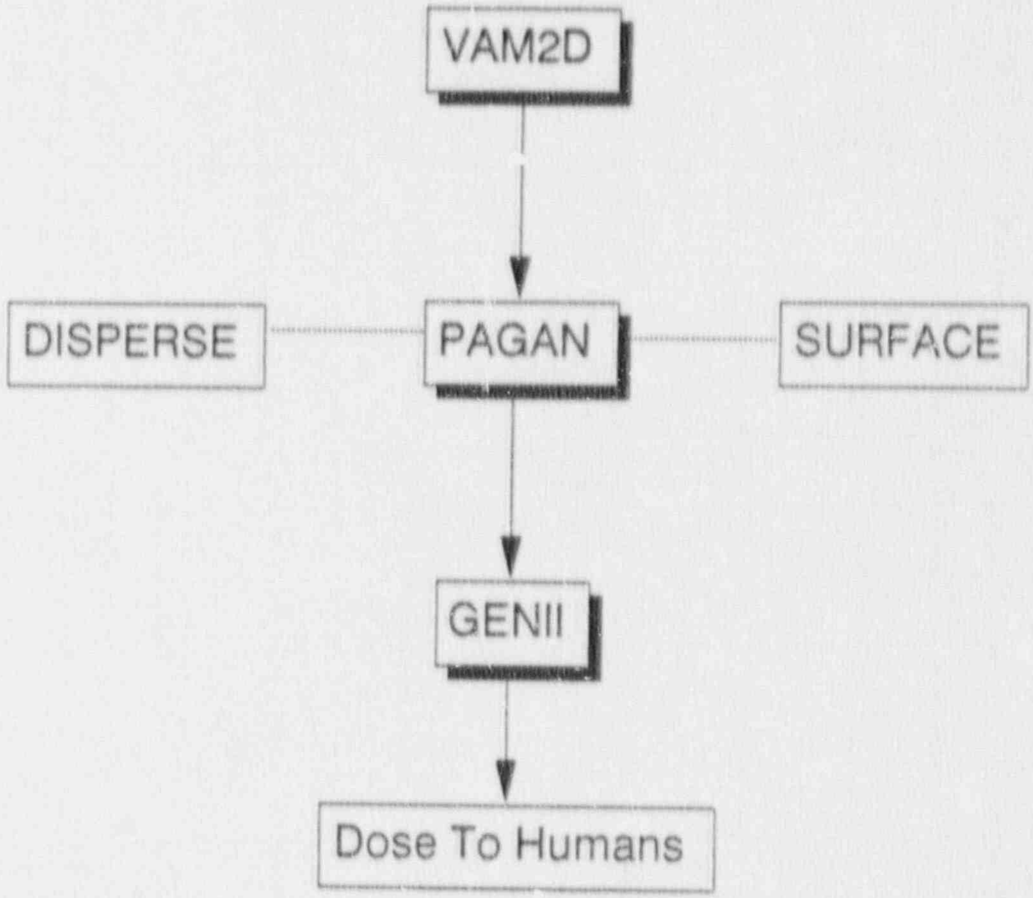


Figure 2-4. The Computer Codes in the Methodology

the licensee. However, the data used for performance assessment are usually a subset of the site characterization data.

The modules in the performance assessment methodology for off-site releases from the facility are (1) ground-water flow, (2) source term, (3) ground-water transport, (4) surface-water transport, and (5) pathways and dosimetry. Data requirements for the methodology models for each of these modules are shown below. The data requirements are given as the explicit requirements for the computer codes listed in Table 2-1. The data requirements for ground-water and surface-water flow modeling, and pathways and dosimetry analysis are for steady-state analyses. By contrast, data requirements for source-term, ground-water transport, and surface-water transport analyses are for transient analyses. The data requirements listed here do not include information calculated from one module for use in the next module. For instance, moisture content and Darcy flow in the facility are needed for source-term analysis, but these are provided from the ground-water flow analysis, hence are not listed as source-term data requirements.

Data Requirements for Ground-Water Flow Modeling

- An infiltration boundary condition is needed for estimation of water flow into the facility. Infiltration must be determined from one of a number of analysis and measurement methods. Determination of an appropriate method for estimating infiltration is a site-specific issue. In general, infiltration represents the difference between site-specific rainfall and evaporation, transpiration, and runoff. The uncertainty associated with this data is usually very large.

- Physical dimensions of the flow domain are needed: depth to water table, dimensions of the engineered cover, etc.

- Generic soil properties for each soil of interest in the natural surroundings, and in the engineered cover. These properties are porosity, saturated hydraulic conductivity, and soil bulk density.

- Unsaturated-zone soil properties for each soil of interest in the natural surroundings, and in the engineered cover. These properties are the characteristic curves (θ-Ψ curves) and the conductivity curves (K-Ψ or K-θ curves), which include information on residual moisture content and saturated moisture content. In VAM2D the characteristic curves and conductivity curves can be specified as parameters of the van Genuchten equation or the Brooks-Corey equation, which are both empirical equations.

- Aquifer pressure gradient, generally determined from field measurements in observation wells.

Data Requirements for Source-Term Modeling

- Inventory by radionuclide either at the time of closure or at the time at which releases begin. It must also be specified whether the waste is stabilized or unstabilized, and whether the types of waste are physically separated, as in separate trenches for Class A waste and Class B/C waste.

- It may be possible in some cases to specify data that indicate limitations on radionuclide releases. These data may include solubility limitations, sorption capabilities (K_d) in the disposal unit, or diffusion limitations (specify diffusion coefficient in the waste form and container dimensions) for stabilized waste. It must always be emphasized that any assumption about release limitations must be strongly justified by the licensee using site-specific conditions. Release limitations can have a dramatic effect on the performance of the facility, yet there is generally a large amount of uncertainty in the values of parameters that characterize them. Conservatism should always be the guide in making assumptions about release limitations.

Data Requirements for Ground-Water Transport Modeling

- Soil properties used in ground-water flow modeling are also required here.

- Longitudinal and transverse dispersivities must be specified for the soil below the water table. Dispersion is neglected in the unsaturated zone. Uncertainties associated with the dispersivities are usually large.

- The soil is assumed isotropic and spatially homogeneous in PAGAN, and data are needed to determine the adequacy of this assumption.

- Retardation in the aquifer can be included, but conservatively small values should be used, and then only if justified on a site-specific basis.

Data Requirements for Surface-Water Modeling

- The surface hydrology must be characterized using field measurements, including river flow rate, exchange flow rates between the surface water and ground water, or between surface-water bodies.

- Transport parameters required in the GENII surface-water transport model are average depth and width of the surface-water body, average water flow rate in the surface water, rate of water flow from the aquifer (effluent discharge), distance from the release point to the receptor (which must be assumed for a given scenario), transit time to irrigation withdrawal, and offshore distance to water intake.

Data Requirements for Pathways and Dosimetry

- A number of parameters must be specified in GENII for food-chain analyses: consumption rates and holdup times for meat, poultry, milk, eggs, leafy vegetables, other vegetables, fruit, and cereals. In addition, the irrigation rate and source of irrigation are required.

- Parameters in GENII for recreational exposures are hours of exposure from swimming, boating, and shoreline activities, and surface-water transit time from release point to recreational site. These must generally be assumed for a particular location.

3.0 USER'S GUIDES FOR THE METHODOLOGY

The software in the methodology consists of three separate packages. The first package consists of the computer code VAM2D. VAM2D is a two-dimensional finite-element code for simulating water flow and solute transport in variably saturated porous media. In the methodology, VAM2D is used to simulate the flow field in and near the disposal facility.

The second software package is called PAGAN (Performance Assessment Ground-water Analysis of low-level Nuclear waste), which incorporates analyses for source-term releases and ground-water transport. Input and output functions for PAGAN is controlled by a menu-driven shell called SUNS. In PAGAN, radionuclide releases from the facility are calculated using either a rinse-release or a leach-limited source-term model, and a mixing-cell cascade model for analysis of transport within the facility. This release term is used as an area source into the aquifer at the water table, and radionuclide concentrations at various locations and times can be calculated. If the contaminated aquifer also discharges into a surface-water body, the flux of radionuclides into the surface water can be calculated in a separate run of PAGAN. If the surface-water body is a small flowing river, the radionuclide concentration in the river may be calculated using a simple dilution factor in PAGAN.

The third software package contains GENII [Napier et al., 1988]. This software package uses radionuclide concentrations in the aquifer and the radionuclide flux into the surface water calculated using PAGAN, and calculates the radiation doses received by humans from various exposure pathways.

The second and the third packages are recommended for use on a personal computer (PC). Both packages have user-friendly, menu-driven programs that are designed to help the user to prepare input data files, to manage input and output files, and to automate the execution of the programs. Such a system is unavailable for VAM2D. The recommended procedure for implementing the methodology is to first execute VAM2D on a main-frame computer. The output from VAM2D is then used as input for subsequent calculations using the two software packages on a PC.

3.1 VAM2D

VAM2D was selected for use in the methodology to analyze the flow field around the facility in the unsaturated zone. The user's guide for Version 5.0 of VAM2D was published by Huyakorn et al. [1989]. This user's guide provides an extensive discussion of the theory and practice of using VAM2D, hence such details are not repeated in this report. An updated version of the data input guide (Version 5.1) has recently become available. Version 5.1 of VAM2D provides for more input and output options, and some clarifications and corrections have been made to the original input guide. The updated code and input guide are available from HydroGeoLogic, Inc. of Herndon, Virginia.

3.2 PAGAN, Version 1.0

The second package is called PAGAN (Performance Assessment Ground-water Analysis of low-level Nuclear waste). This package contains the transport codes DISPERSE and SURFACE [Kozak et al., 1990a], which operate under the SUNS system. SUNS (Sensitivity and UNcertainty Analysis Shell) is a software system developed at SNL for use in studies involving data uncertainties.

3.2.1 SUNS System

SUNS is composed of several different computer codes, each of which is controlled by an EXECUTIVE ROUTINE as shown in Figure 3-1. The primary function of the EXECUTIVE ROUTINE is to direct program execution to the appropriate module, based on the current status of input and output files and menu options selected by the user. In addition, it performs all major file management functions, and provides several utilities, such as data file printing and screen color selection.

The INPUT EDITOR provides a menu-driven facility for input file creation and editing. Input prompts and other information presented on the screen substantially reduce the need for the user to refer to a written software manual. In addition to the interactive prompts, a context-sensitive help system is included. This system provides a detailed help screen for each data item needed in the input file. The INPUT EDITOR also provides cut, copy, and paste functions to simplify repetitive data preparation.

The STATISTICS DRIVER serves as the driver routine for the user's code: in this case either DISPERSE or SURFACE. The STATISTICS DRIVER also performs statistical sampling, Monte Carlo analysis (using either simple random sampling or Latin Hypercube Sampling), together with any parametric analysis requested by the user. At the present time the options for performing statistical sampling and Monte Carlo analysis are disabled in this version of PAGAN.

The POST PROCESSOR provides graphical and tabular output from the user's code. Statistical output includes maximum and minimum values, means, variances and percentiles. On-screen graphical output includes x - y plots, scatter plots, histograms, and cumulative and complementary cumulative distribution functions. Also available are simple and partial correlation coefficients on both raw and rank data. The user can also directly examine any of the output data blocks created by the STATISTICS DRIVER and the user's code. Provision is made for additional hardcopy output to be placed on an auxiliary data output file that can be printed at the user's convenience.

In developing SUNS, the objective was to design a software shell that could accommodate virtually any computer code or analytical model. Particular design attention was focussed on the data input and output interfaces between SUNS and the model incorporated into the shell. In developing an input file, a simple line editor could obviously have been

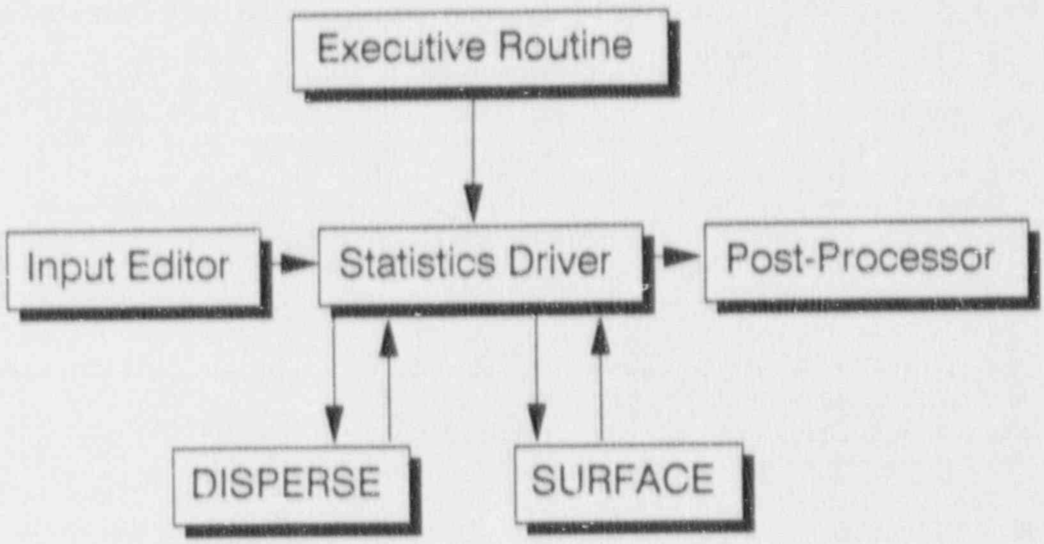


Figure 3-1. Structure of PAGAN

used for any application. However, the desire was to design an input editor that uses menus, help screens, and on-screen prompts, that simplifies input file creation, reduces input errors, and reduces or eliminates the need to refer to written manuals. To meet this objective, the input editor divides model input into three categories: (1) fixed data, (2) array data, and (3) variable data. Fixed data groups are useful for fixed physical properties, run controls, print controls, and other single-valued inputs. Array data groups (one- or two-dimensional) can be used to enter tables of data. In the present application they are used to provide a table of isotope data and two tables of information used to control the type and amount of output. Variable data groups are used for those model inputs that contain uncertainty; therefore these data are assigned probability distributions rather than fixed values. As noted above, the ability to assign probability distributions to variables is not available in PAGAN Version 1.0.

SUNS does not directly support graphics printers and plotters to make paper copies of the SUNS on-screen graphics. To produce hardcopy of the SUNS graphics, the user can use commercially available print enhancement. Graphics output of better quality can be produced by writing output data blocks to an ASCII file, which can then be used with any commercially available graphics software.

3.2.2 User's Guide for PAGAN

There are seven input screens in PAGAN. Four screens are for fixed-data parameters, and three are for array-data parameters. Four fixed-data groups and three array-data groups are contained in PAGAN. The fixed-data groups contain information on (1) run and output options, (2) numerical solution parameters, (3) physical properties of the system, and (4) controls for parametric study. The array-data groups include an array of information that are isotope-specific, an array that are distance-specific, and one that is time-specific. Each of these input screens is described in detail below. Similar descriptions are available in on-screen help windows in PAGAN; to call the help windows throughout PAGAN use the <F1> key.

<u>Fixed Data Group 1 (Figure 3-2)</u>

This data group prescribes the run and output options.

- Transport to well/river (1/2): A value of 1 is used for transport to a well in an aquifer. A value of 2 is used for transport through an aquifer into a surface-water body.

- Output source rate (0/1): A value of 1 is used if the release rate of the contaminant from the disposal unit is desired as an output. Otherwise a value of 0 is used.

- Output type options (1/2/3): A value of 1 is used when concentration-vs.-time values at a fixed location are the desired output. A value of 2 is used when concentration-vs.-distance values at a fixed time are the desired output. A value of 3 is used when a parameter is varied for sensitivity analysis.

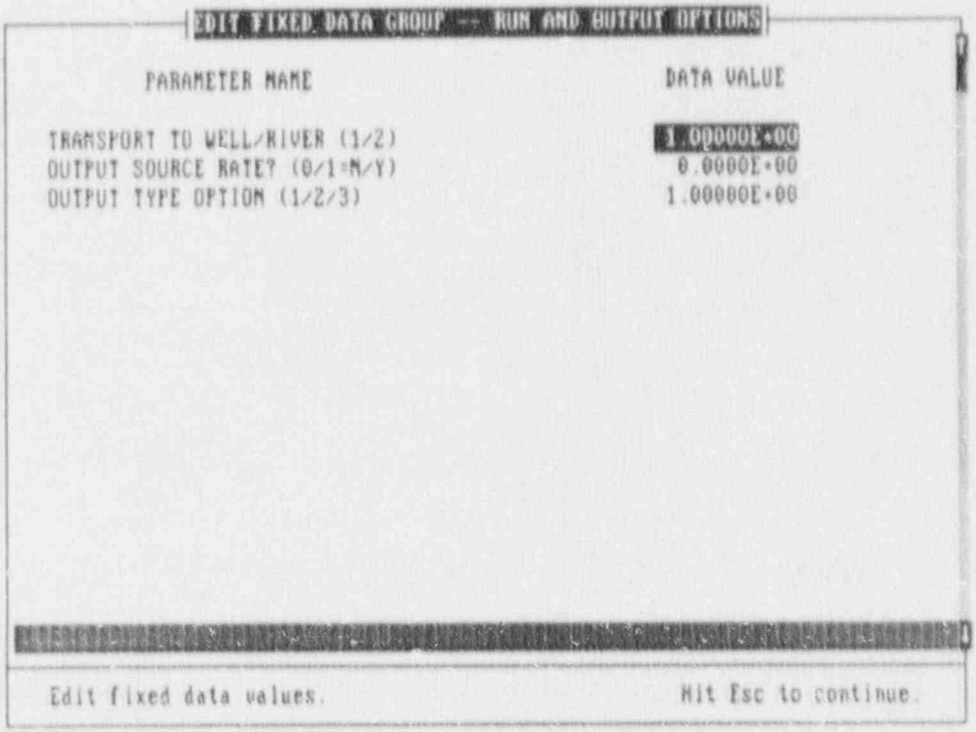


Figure 3-2. Fixed Data Group 1

Fixed Data Group 2 (Figure 3-3)

Fixed Data Group 2 contains parameters that are related to the numerical solutions in PAGAN.

- Maximum time of interest: Enter the time in years that the calculation ends.

- Number of intermediate times: Enter the desired number of times (an integer) that output concentrations are computed. For best results, this number should be less than or equal to T where T is the vertical travel time in the disposal unit (see Fixed Data Group 3).

- Integer discretization: An integer used in the numerical integration of discharge rate into the river. Should be a multiple of 4 for best results. Values between 200 and 400 are recommended, but smaller values can be used to reduce computational time.

- Distance to well/river: This is used in conjunction with output-type option 1 (concentration vs. time) in Fixed Data Group 1. The distance is in meters.

- Number of intermediate distances: This is used in conjunction with output-type option 2 (concentration vs. distance) in Fixed Data Group 1. This should be an integer.

- Number of source mixing cells: This is a measure of dispersion in the facility. A value of 1 means complete mixing, i.e. large dispersion. The maximum N is 80, which corresponds to negligible dispersion in the facility. In practice, it has been found that results are not significantly different for N > 50. This value is an integer.

- Source leach option (0/1): A value of 0 is used when the surface-wash leach model is used. In this model, a radionuclide is assumed to dissolve instantaneously upon contact with water. When a value of 1 is used, a constant leach model is assumed. The constant leach model is usually used for the diffusive release of a radionuclide from stabilized waste forms.

- Nuclide flux/river concentration (1/2): This option is used only for surface water transport. A value of 1 is used when the concentrations of radionuclides in the surface water is needed. A value of 2 is used when the radionuclide discharge rates (in Ci/yr) from the aquifer into the surface water is needed.

EDIT FIXED DATA GROUP --- NUMERICAL SOLUTION PARAMETERS

PARAMETER NAME	DATA VALUE
MAXIMUM TIME OF INTEREST (Y)	2.00000E+02
NUMBER OF INTERMEDIATE TIMES	2.00000E+01
INTEGRAL DISCRETIZATION (MOD4)	2.00000E+02
DISTANCE TO WELL/RIVER (M)	1.50000E+02
NUMBER OF INTERMEDIATE DISTS	1.00000E+00
NO. SOURCE MIXING CELLS	8.00000E+01
SOURCE LEACH OPTION (0/1)	0.0000E+00
RIVER CONC./NUCLIDE FLUX (1/2)	1.00000E+00

Edit fixed data values. Hit Esc to continue.

Figure 3-3. Fixed Data Group 2

<u>Fixed Data Group 3 (Figure 3-4)</u>

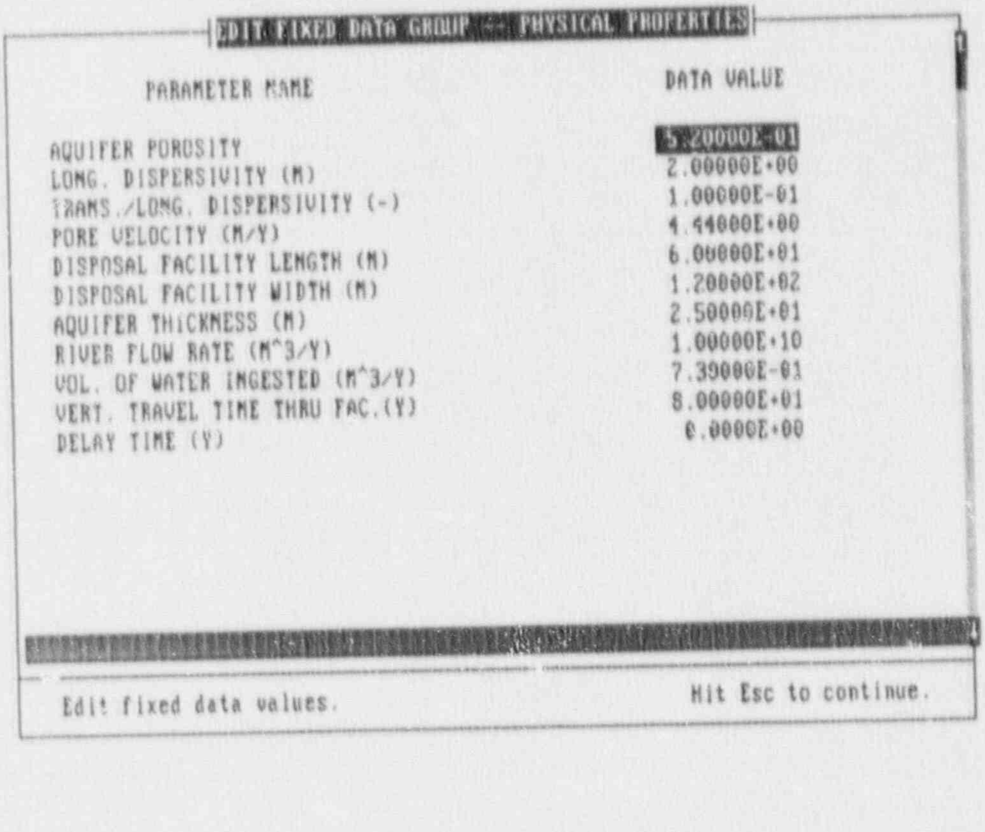
This data group contains input data used to describe physical properties of the facility, the aquifer, and the river.

- Aquifer Porosity: This is the effective porosity for transport.
- Longitudinal dispersivity in aquifer: Input in units of meters.
- Transverse/longitudinal dispersivity in aquifer: The ratio of transverse dispersivity to longitudinal dispersivity
- Pore Velocity: Calculated from aquifer Darcy velocity divided by effective porosity (m/yr).
- Disposal facility length: The length in meters in the direction of aquifer flow.
- Disposal facility width: The width in meters in the direction perpendicular to the aquifer flow
- Aquifer Thickness: Assumed constant; input in meters.
- River Flow Rate: Used only for simple dilution-factor surface-water model (m^3/yr).

- Volume of Water Ingested: The standard water consumption rate of 0.73 m^3/yr should usually be used here, but this option allows the analyst to use other values. This parameter is used to estimate the dose resulting from drinking contaminated water, which can be used as a scoping tool in the performance assessment analysis.

- Vertical travel time of water through disposal unit: This travel time is defined as $D\theta/V_y$, where D is the thickness of the disposal unit, θ the moisture content in the unit, and V_y the Darcy velocity in the unit. This value is used in the computation of the source constant and the source pre-exponential input.

- Delay Time: The delay time includes (1) the time of failure of containers and engineered barriers, and (2) the travel time between the bottom of the facility and the aquifer. PAGAN decays the initial radionuclide inventory to this delay time before the release starts if a non-zero value is entered here.


EDIT FIXED DATA GROUP -- PHYSICAL PROPERTIES

PARAMETER NAME	DATA VALUE
AQUIFER POROSITY	5.20000E-01
LONG. DISPERSIVITY (M)	2.00000E+00
TRANS./LONG. DISPERSIVITY (-)	1.00000E-01
PORE VELOCITY (M/Y)	4.44000E+00
DISPOSAL FACILITY LENGTH (M)	6.00000E+01
DISPOSAL FACILITY WIDTH (M)	1.20000E+02
AQUIFER THICKNESS (M)	2.50000E+01
RIVER FLOW RATE (M^3/Y)	1.00000E+10
VOL. OF WATER INGESTED (M^3/Y)	7.30000E-01
VERT. TRAVEL TIME THRU FAC.(Y)	8.00000E+01
DELAY TIME (Y)	0.0000E+00

Edit fixed data values. Hit Esc to continue.

Figure 3-4. Fixed Data Group 3

Fixed Data Group 4 (Figure 3-5)

This data group is used in conjunction with output type option 3 in the Fixed Data Group 1, where the sensitivity of the output to variation of a parameter is desired.

- Index of parameter to vary: Presently 8 parameters can be varied. Only one parameter is allowed to vary per execution.

Parameter	Index
Retardation factor in aquifer	1
Long. dispersivity in aquifer	2
Pore velocity of aquifer	3
Number of source mixing cells	4
Source constant	5
Source preexponential	6
Delay time	7
River flow rate	8

- Number of Parameter Values: Number of different parameter values that will be assigned; the maximum number is 5.

- Use given time/distance: A value of 1 is used when concentration-versus-distance output for a given time (prescribed in Fixed Data Group 2) is desired. A value of 2 is used when concentration-versus-time output at a given distance (prescribed in Fixed Data Group 2) is desired.

- Include dose: Use a value of 1 when dose from ingestion of water is desired. This option is intended as a scoping tool, since it does not include all environmental pathways. Doses are calculated using standard ICRP 30 ingestion dose conversion factors.

- Graphics output: A value of 1 is used when graphical output is desired.

- Hardcopy output: A value of 1 is used when a hardcopy of output is desired in addition to graphical output.

- Parameter value: A maximum of 5 values for any of the parameters specified by the indices listed above can be entered in a single execution to study the sensitivity of the output on this input parameter.

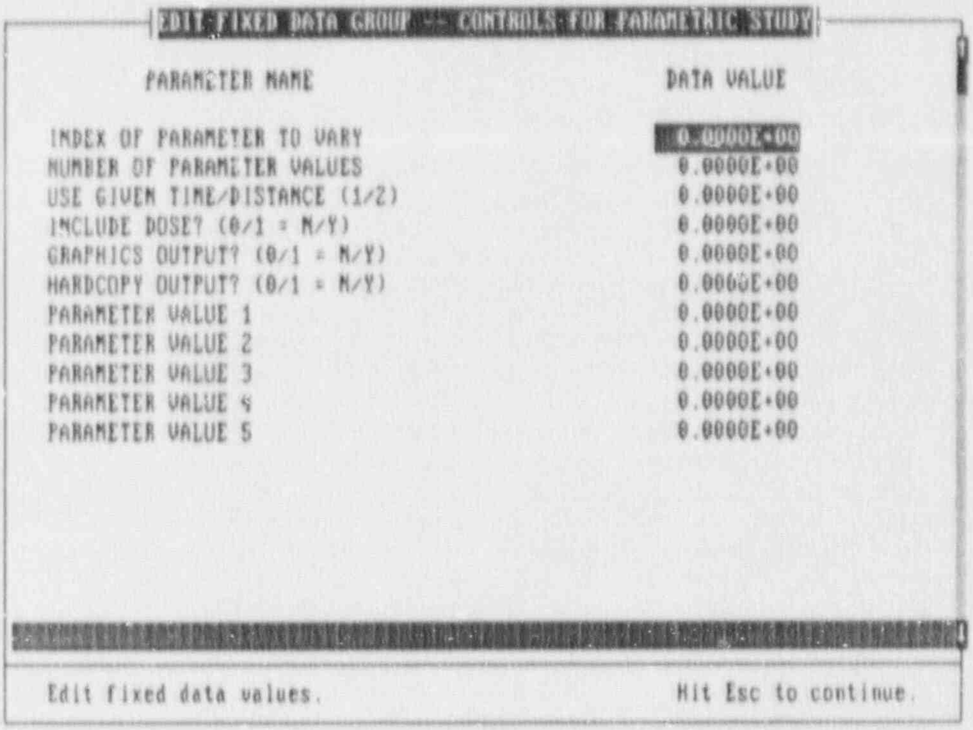


Figure 3-5. Fixed Data Group 4

<u>Array Data Group 1 (Figure 3-6)</u>

All the isotope-specific parameters are listed in this array. There are presently 100 isotopes included in the array. The half-lives and ingestion dose conversion factors of the isotopes are included in the data base of PAGAN. For those isotopes in the facility for which release and transport calculations are desired, the amounts of inventory for these isotopes should be entered and the transport flags should be turned on (Transport=1).

- Inventory: Enter inventory in Ci. If no entry is made, no calculations will be made for the isotope, regardless of the value of the transport flag.

- Retardation Factor: If the retardation factor is the same in both the disposal unit and the aquifer, the retardation factor entered here is used for calculation of the vertical travel time of the isotope through the disposal unit in addition to being used as the aquifer retardation factor. If the two values of retardation factor are different, the retardation factor in the Array Data Group is used for the aquifer retardation factor, and the source-term constant and source-term pre-exponential must be entered explicitly in Array Data Group 1.

- Source constant, or "leach rate" (yr^{-1}): If zero is entered here, this term is calculated in the code as $(RT)^{-1}$, where R is the retardation factor in the disposal unit, and T is the vertical travel time through the unit (specified in Fixed Data

EDIT ARRAY ISOTOPE PROPERTIES

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
H-3	1.00000E+03	1.00000E+00	0.00000E+00	0.00000E+00	1
C-14	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
NA-22	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
P-32	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
P-33	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
S-35	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
CL-36	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
CA-45	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
SC-46	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
CR-51	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
MN-54	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
FE-55	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
FE-59	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
CO-57	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
CO-58	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
CO-60	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0
NI-59	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0

Hit Esc to continue.

EDIT ARRAY ISOTOPE PROPERTIES

	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
H-3	0.00000E+00	0.00000E+00	1	1	1
C-14	0.00000E+00	0.00000E+00	0	1	1
NA-22	0.00000E+00	0.00000E+00	0	1	1
P-32	0.00000E+00	0.00000E+00	0	1	1
P-33	0.00000E+00	0.00000E+00	0	1	1
S-35	0.00000E+00	0.00000E+00	0	1	1
CL-36	0.00000E+00	0.00000E+00	0	1	1
CA-45	0.00000E+00	0.00000E+00	0	1	1
SC-46	0.00000E+00	0.00000E+00	0	1	1
CR-51	0.00000E+00	0.00000E+00	0	1	1
MN-54	0.00000E+00	0.00000E+00	0	1	1
FE-55	0.00000E+00	0.00000E+00	0	1	1
FE-59	0.00000E+00	0.00000E+00	0	1	1
CO-57	0.00000E+00	0.00000E+00	0	1	1
CO-58	0.00000E+00	0.00000E+00	0	1	1
CO-60	0.00000E+00	0.00000E+00	0	1	1
NI-59	0.00000E+00	0.00000E+00	0	1	1

Hit Esc to continue.

Figure 3-6. Array Data Group 1

Group 3). If a non-zero value is entered here, the calculated value will be over-written by the entered value.

- Source-term preexponential (Ci/yr): For the surface-wash leach model, a value of 0 is used, and this term is calculated in the code from the equation, $Q_0 = m/(RT)$ where m is the total activity (Ci) of the isotope in the facility, and T is the vertical travel time through the facility. If a non-zero value is entered, the calculated value will be over-written by the entered value. For the constant leach model, this term may be calculated from $Q_0 = 4D_e(H+a)m/a^2H$ where m is the total activity of the isotope, D_e the effective diffusion coefficient of the radionuclide in the waste form, and H and a the height and the radius of the container, respectively. This equation is derived from the solution to the diffusion equation for diffusion-limited releases from cylindrical waste containers.

- Transport Flag: Use a value of 1 if the isotope is to be included in the analysis.

- Graphics Flag. Use a value of 1 if on-screen graphics output is desired for the isotope.

- Hardcopy Flag: Use a value of 1 if hardcopy output is desired for the isotope.

<u>Array Data Group 2 (Figure 3-7)</u>

This array is used in conjunction with output option 1 (concentration vs. distance) in Fixed Data Group 1. A maximum of 7 distances can be entered.

<u>Array Data Group 3 (Figure 3-8)</u>

This array is used in conjunction with output option 2 (concentration vs. time) in the Fixed Data Group 1. A maximum of 7 times can be entered.

3.2.3 SUNS Postprocessor

Following execution of PAGAN, SUNS returns the user to the MAIN MENU. At this time the option EXAMINE OUTPUT is made available to the user. Choosing this option calls up the MAIN OUTPUT MENU, which gives options for graphical results, statistical results, or "other output". Since PAGAN currently is not set up to perform uncertainty analysis, the statistical results will not typically be meaningful. The "other output" option menu allows the user to examine tabular output data blocks, to examine the main output file, or to write the output data to an ASCII file for subsequent manipulation in spreadsheet or graphics programs. Choosing the option for graphical results in the MAIN OUTPUT MENU calls up the GRAPHICS MENU.

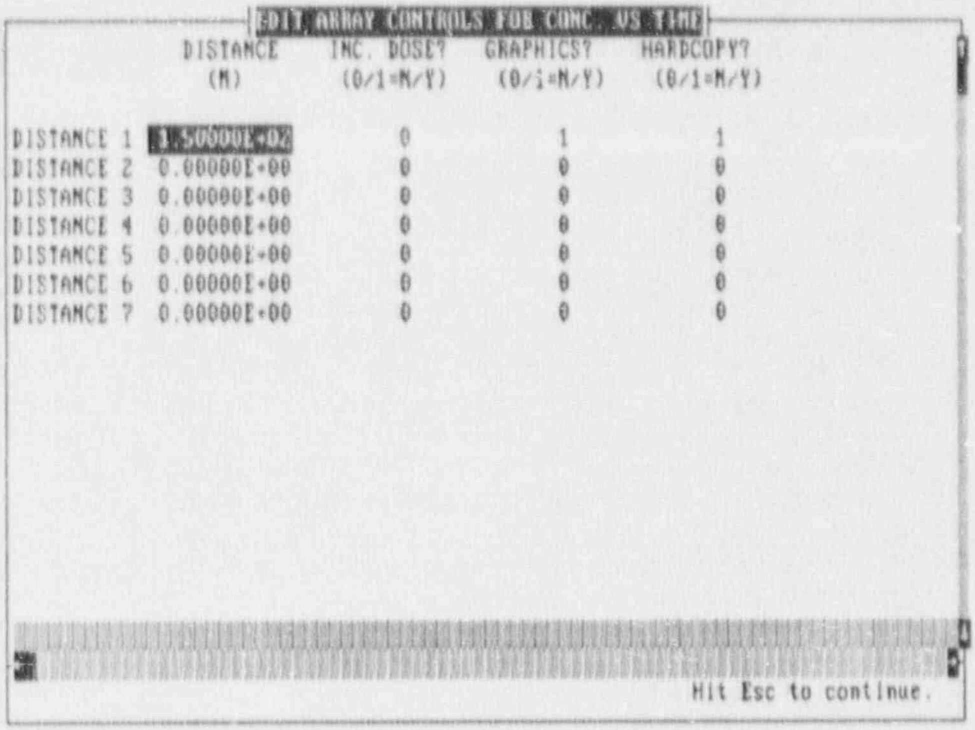


Figure 3-7. Array Data Group 2

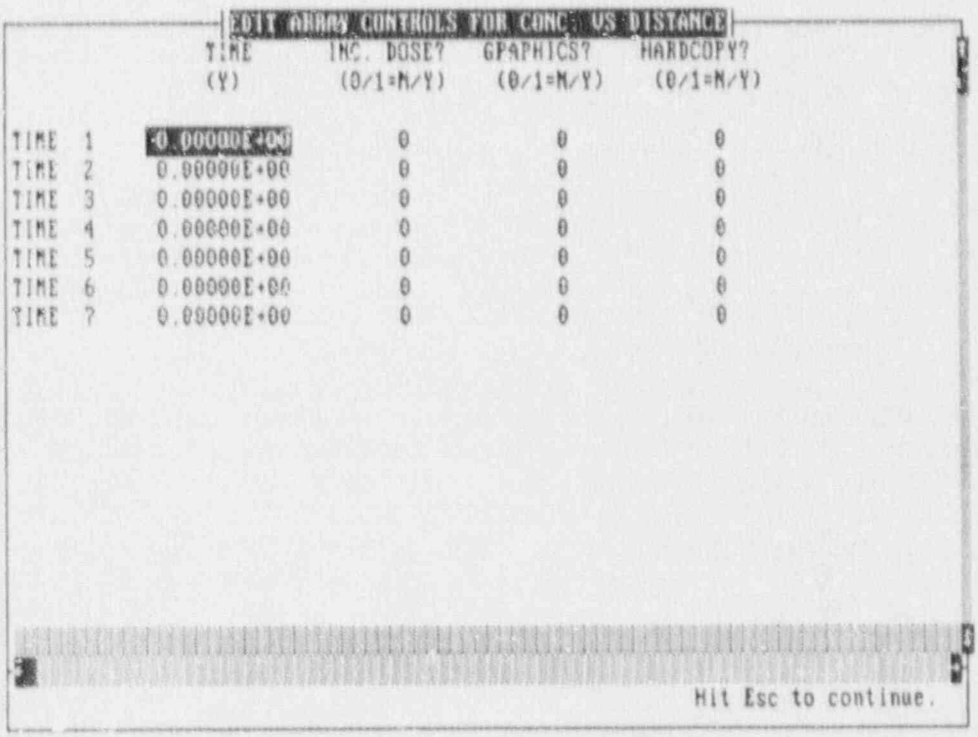


Figure 3-8. Array Data Group 3

The GRAPHICS MENU provides the user with five graphical output options: cumulative distribution function, complementary cumulative distribution function, histogram, scatter plot, or X-Y plot. The first three of these functions are related to the uncertainty analysis portion of SUNS, and will not provide meaningful results at the present time. The latter two options, scatter plot and X-Y plot, can be used to generate on-screen graphs of concentration, dose, or source-term release rate versus time, or concentration or dose versus distance.

The method is identical for generating any of these types of graph. Upon choosing, say X-Y plot, the user is confronted with a list of available variables to plot. First choose the independent variable (x-axis) by striking <ENTER> then <ESC>. Next move the cursor to the desired dependent variable (y-axis), and select the variable by <ENTER> then <ESC>. When one variable pair is chosen, the SCATTER AND X-Y PLOTS MENU is called. The user then chooses to draw the graph, add a variable pair, or modify plot parameters or colors. Default values for the graph axes provides a linear-linear plot, and the upper and lower bounds are automatically set as the maximum and minimum values of the data sets. Either or both axes can be altered to logarithmic scale, and the bounds can be altered by modifying plot parameters. Choose a logarithmic scale by typing "LOG" in the appropriate location, or return to linear scale by typing "LIN". Additional variable pairs (up to 10 maximum) can be plotted on the same graph for comparison.

These graphs are primarily on-screen graphics, and are not meant to provide hardcopy output. Consequently, the graphs are not saved, and must be reproduced each time the user enters the X-Y plot screen. To produce hardcopies of the graphs produced in the SUNS postprocessor, one must use a print enhancement package, of which several are commercially available. A better option is to export the desired output to an ASCII file, as discussed above, and produce better-quality graphs using commercially available graphics or spreadsheet software.

3.3 GENII

GENII is documented in detail in Napier et al [1988]. An interactive menu-driven program, APPRENTICE, is used to handle all file management and data input necessary for most applications. Since GENII is documented in detail elsewhere, only the major features are outlined here. In APPRENTICE, the user has the following options:

- Scenario options - near field, far field, acute releases, chronic releases, individual or population doses.
- Transport options - transport of radionuclides by air, surface water, and between soil layers by plants and animals.
- Exposure pathways options - drinking water ingestion, inhalation, aquatic food ingestion, terrestrial foods ingestion, animal product ingestion, and direct-radiation exposure.

Default values can be used for many data in analyzing the exposure pathways in GENII. These include water-consumption rate, aquatic-food ingestion rate, and terrestrial-food ingestion rate.

Two dose-factor files are included in GENII, an external-dose-factor file and an internal-dose-factor file. The dose conversion factors in these files are based on the ICRP 30 dosimetry standards [ICRP 30, 1982]. In addition, data on radionuclide half-lives, decay chains, and various fractional branching ratios within chains are listed in a standard library in GENII.

3.4 System Requirements

The VAM2D computer code is intended to be used on a mainframe computer. The code is written in standard FORTRAN 77, and can be implemented on any mainframe operating system.

PAGAN runs on an IBM compatible PC with a color monitor running DOS 3.31 or later. PAGAN requires 640K of RAM, and a math coprocessor and hard disk are recommended.

GENII will run on an IBM-AT or equivalent computer, configured with an 80287 math coprocessor, 640K of RAM, a minimum of 5 megabytes on-line disk storage, and operating under DOS 3.1 or later [Napier et al., 1988].

4.0 DEMONSTRATION OF THE METHODOLOGY

In this chapter examples are given to demonstrate the use of the methodology in assessing compliance with 10 CFR 61 performance objectives for a low-level waste disposal facility. The demonstration is based on the calculations of releases of radionuclides from a hypothetical low-level waste site, and the analysis of transport and eventual exposure to humans.

4.1 Description of Site and Facility

The low-level waste disposal facility and its surrounding site used in this methodology demonstration is depicted in Figure 4-1. The site chosen is hypothetical, yet its geologic and hydrologic properties are representative of a semi-humid region in the United States.

The disposal facility sits on a local topographic high point and is located 1 km from a river. The water table is located about 24 meters below the land surface, and the aquifer discharges into the river. The aquifer is 25 meters thick and is confined from below by an impermeable bedrock. A farm family is assumed to reside 100 meters from the edge of the disposal facility. The farmer raises cows, chickens, and crops, and uses the well water for drinking and irrigation. A small community is assumed to be located near the river. The residents of the community use the river water for drinking and recreation (e.g. swimming, boating), and also eat fish from the river. This conceptual model allows one to contrast doses due to drinking water from the river to those due to drinking well water. In this way, the analyst can determine which person is maximally exposed.

The low-level waste disposal facility consists of two 8-meter deep trenches, one for Class A waste and the other for Class B/C waste. The Class A trench is 60 meters wide, 120 meters long; and the Class B/C trench is 8 meters wide and 120 meters long. A three-layered cover system is placed over the top of the trenches to impede infiltration. The bottom layer is a low-permeability clay, the middle layer a silt loam, and the top layer is the original undisturbed soil. The trenches are assumed to be backfilled with the undisturbed soil.

The radionuclide inventory in the disposal facility is assumed to consists of 20 Curies of I-129 and 1800 Curies of H-3. I-129 wastes are solidified in concrete and are buried in the Class B/C trench, and H-3 wastes are unsolidified trash, disposed of in the Class A trench. The Class A wastes are contained in 55-gallon drums, and the Class B/C wastes are contained in high-integrity containers.

Table 4-1 lists the parameters used to the characterize the natural site. Parameters used to characterize the disposal facility are shown in Table 4-2.

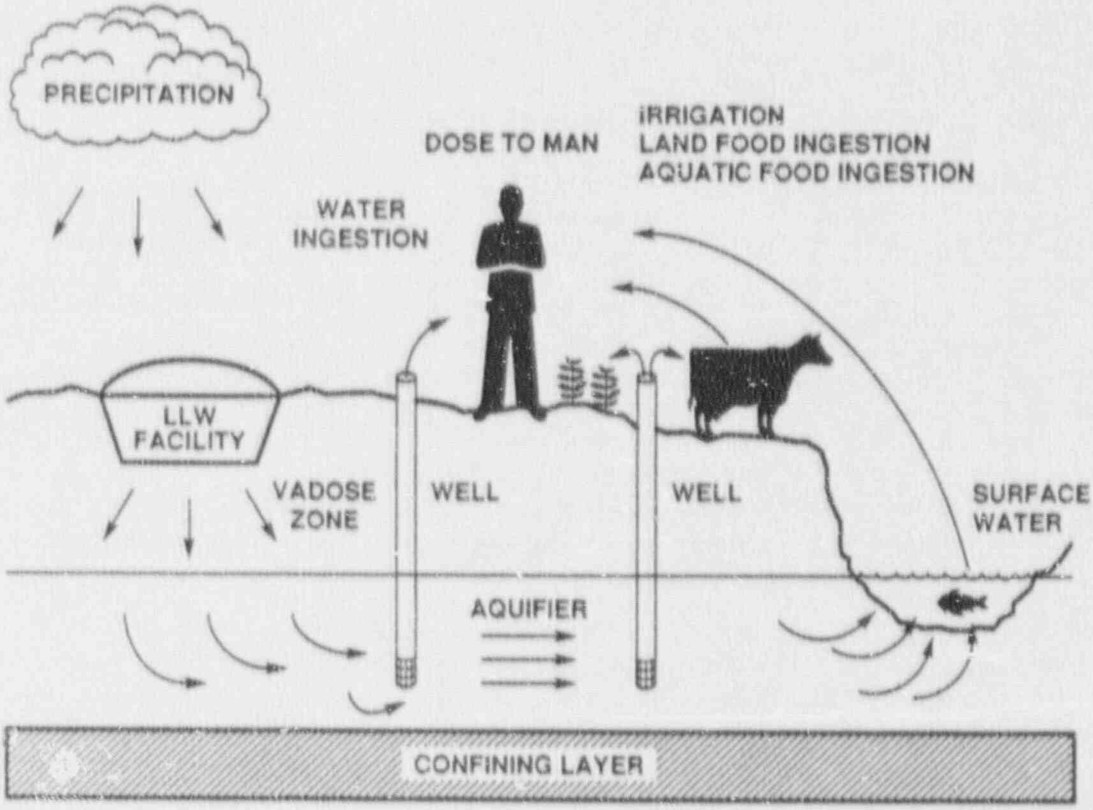


Figure 4-1. Conceptual Model Used in the Demonstration of the Methodology

Table 4-1: Natural Site Parameters

Average Annual Infiltration	25 cm/y
Thickness of Unsaturated Zone	24 m
Saturated Hydraulic Conductivity of Unsaturated Zone	115.3 m/y
Porosity of Unsaturated Zone	0.52
Thickness of Aquifer	25 m
Hydraulic Conductivity of Aquifer	115.3 m/y
Hydraulic Gradient of Aquifer	0.02
Porosity of Aquifer	0.52
Average Pore Velocity of Aquifer	4.44 m/y
Longitudinal Dispersivity of Aquifer	2 m
Transverse Dispersivity of Aquifer	0.2 m
River Flow Rate	10^{10} m^3/y

Table 4-2: Disposal Facility Parameters

Dimension of Class A Trench	60 m x 8 m x 120 m
Dimension of Class B/C Trench	8 m x 8 m x 120 m
Class A Inventory	1800 Ci H-3
Class C Inventory	20 Ci I-129
Cover System Thickness	
Top Layer (undisturbed soil)	50 cm
Middle Layer (silt loam)	60 cm
Bottom Layer (clay)	90 cm

4.2 Release Scenarios Analyzed for Demonstration

The performance objectives of 10 CFR 61 require technical analyses of the radiological impacts resulting from normal releases as well as intrusion-induced releases from a low-level waste facility. Consequently, two release modes have been selected for the demonstration of the methodology.

Normal Release

In this release mode the natural site is assumed to behave unperturbed by the presence of the disposal facility. This assumption allows the analyst to estimate infiltration from present-day site data. The precipitation at the site will cause percolation of water through the cover system of the facility into the disposal units. The water in the disposal unit corrodes waste containers and carries the radionuclides out of the trenches. The released radionuclides then travel downward into the aquifer below the facility, are transported by the aquifer, and finally discharge into the river nearby.

The sequence of calculations from release to dose for this analysis is shown in Figure 2-2. The rate of water flow into the disposal units is calculated using a two-dimensional simulation with VAM2D. The results of this flow calculation provides an estimate of the amount and rate of water percolating through the cover system into the disposal unit. They also provide an estimate of the travel time between the bottom of the disposal unit and the water table. This information is used in the source-term and near-field transport calculations in PAGAN. PAGAN is used to calculate radionuclide concentrations in the aquifer, and is also used to estimate radionuclide discharge rates into the river. Finally, GENII uses the output from PAGAN to calculate the doses to humans from selected exposure pathways. This sequence of calculations is illustrated in Sample Problems 1 through 5.

Intruder-Induced Release

A demonstration of intruder protection may consist of a demonstration that the waste classification and segregation requirements of 10 CFR Part 61 have been met, and that adequate barriers to inadvertent intrusion have been provided for. Thus in many cases intruder-dose analyses need not be performed. However, dose analyses may be required in special cases when an applicant requests an exemption from the 10 CFR Part 61 waste classification scheme.

In this scenario it is assumed that after termination of the institutional-control period (100 years after site closure), an individual excavates the disposal facility area and builds a house directly on the site.

The calculation of the doses received by this individual is demonstrated in Sample Problem 5. Only GENII is used to simulate this example problem.

4.3 Sample Problem 1 - Flow Into the Disposal Unit

In this sample problem, steady-state percolation of water through the cover system of the low-level waste facility is calculated using a two-dimensional simulation with the finite-element code VAM2D.

The conceptual model for the flow analysis is depicted in Figure 4-2. A flow simulation is performed for a two-dimensional cross-section from the land surface to the water table. Two-dimensional simulations are generally appropriate for situations where the third dimension is much larger than the two dimensions modeled. In this case, it is assumed that the third dimension of the trench is large enough that end effects can be ignored.

The characteristic curves describing the relationship between pressure head and water saturation are given by the expression derived by van Genuchten [1980], which is

$$\theta = \theta_{wr} + \frac{\theta_w - \theta_{wr}}{[1 + (\alpha|\Psi|)^{\beta}]^{m}}, \qquad (4\text{-}1)$$

where θ is the moisture content, θ_{wr} is the residual moisture content, θ_w is the saturated moisture content, Ψ is the pressure head, and α, β, and $m = (1-1/\beta)$ are empirical parameters. The parameters that characterize the soils in the conceptual model are listed in Table 4-3; in this table K_s is saturated hydraulic conductivity. The values for these properties are from typical soil properties listed in the literature [Sullivan and Suen, 1989; Carsel and Parrish, 1988].

Table 4-3.

Soil Properties Used In The Conceptual Model

Soil type	θ_w	θ_{wr}	K_s (cm/day)	α (1/cm)	β
Undisturbed soil-(Material #1)	0.52	0.218	31.6	0.0115	2.03
Cover Layer-Clay (Material #2)	0.446	0.00	0.0082	0.00152	1.17
Cover Layer-Silt Loam (Material #3)	0.469	0.190	303.0	0.0050	7.09
Undisturbed soil-(Material #4)	0.52	0.218	31.6	0.0115	2.03

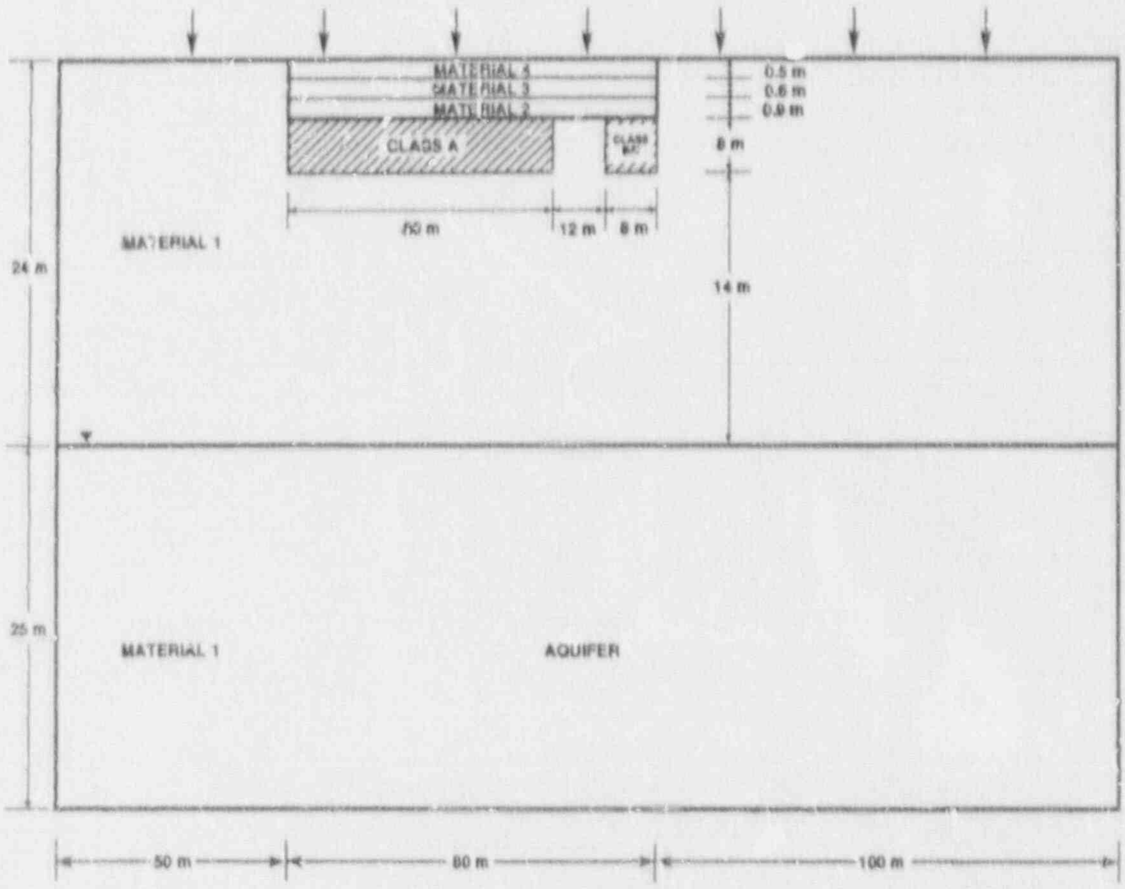


Figure 4-2. Conceptual Model for the Flow Analysis

Unsaturated-zone hydraulic conductivity, as calculated with the van Genuchten relationship, is expressed as a function of saturated conductivity and effective saturation, which is

$$K_u = K_s S_e^{1/2} \left[1-(1-S_e^{1/m})^m\right]^2 , \qquad (4\text{-}2)$$

where $S_e = (\theta - \theta_{wr})/(1-\theta_{wr})$ is the effective saturation [van Genuchten, 1980].

The finite-element grid used for this simulation is shown in Figure 4-3. The domain is divided into 480 rectangular elements with 533 associated nodes. The elements and nodes are numbered from bottom to top and from left to right. The origin of the x-z coordinate system is located at the lower left corner of the simulation domain.

A constant-flux (of 25 cm/yr) boundary condition is specified at the top 41 nodes that represent the ground surface. At the 41 nodes at the bottom of the domain, a zero-head boundary condition is imposed. This represents a phreatic surface (water table) at the bottom of the domain.

The input file for this analysis and the output file for the VAM2D analysis of unsaturated-zone flow is attached to this report as Appendix A.

Pressure-head and moisture-content contours from the VAM2D simulation are shown in Figures 4-4 and 4-5, respectively. Total-head contours for this analysis are shown in Figure 4-6. Darcy velocities in the uncovered region of the domain are close to the infiltration rate at the land surface, i.e. 25 cm/yr, while the vertical Darcy velocities in the trenches are about 2.8 cm/yr. The cover system has therefore caused almost a ten-fold decrease in flow into the disposal units.

Kozak et al. [1990a] have shown that for this conceptual model, the flow beneath the cover is at unit-gradient conditions. Furthermore, it was shown that large changes in infiltration led to small changes in flow into the disposal units for this cover system. These results show that a constant flow rate and moisture content are appropriate to use in the source-term analysis. The Darcy velocity was found to be 2.8 cm/yr and the moisture content was 0.[illegible]8 in the trenches; these values are used as an input for the next sample problem.

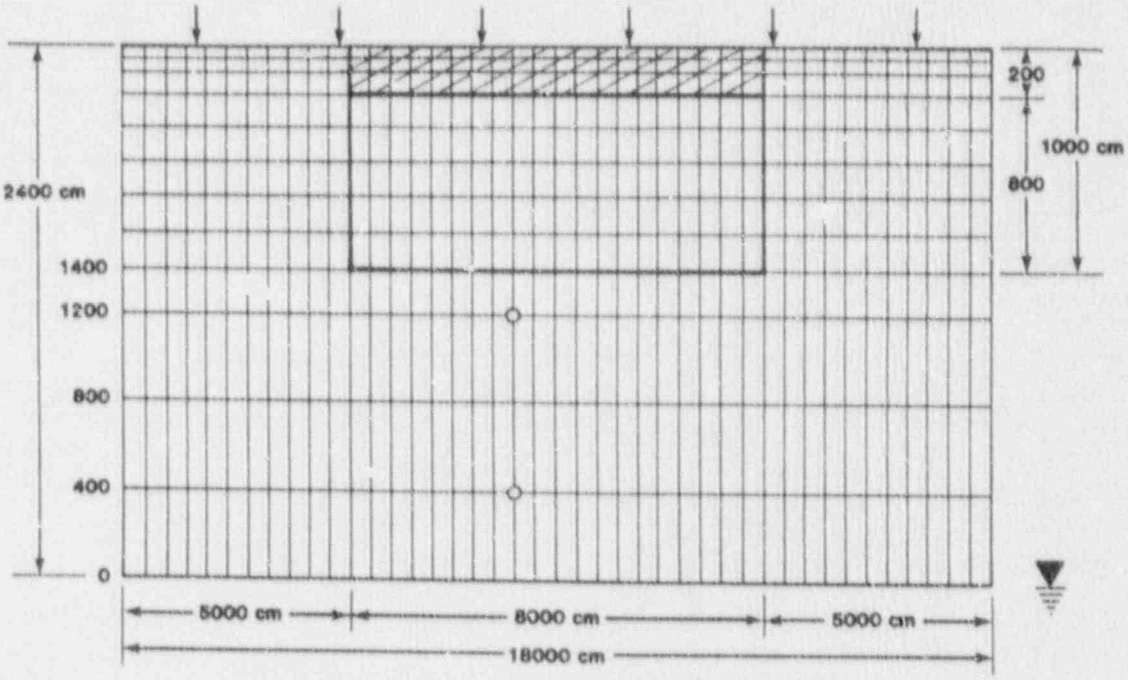


Figure 4-3. Unsaturated Zone Finite-Element Grid

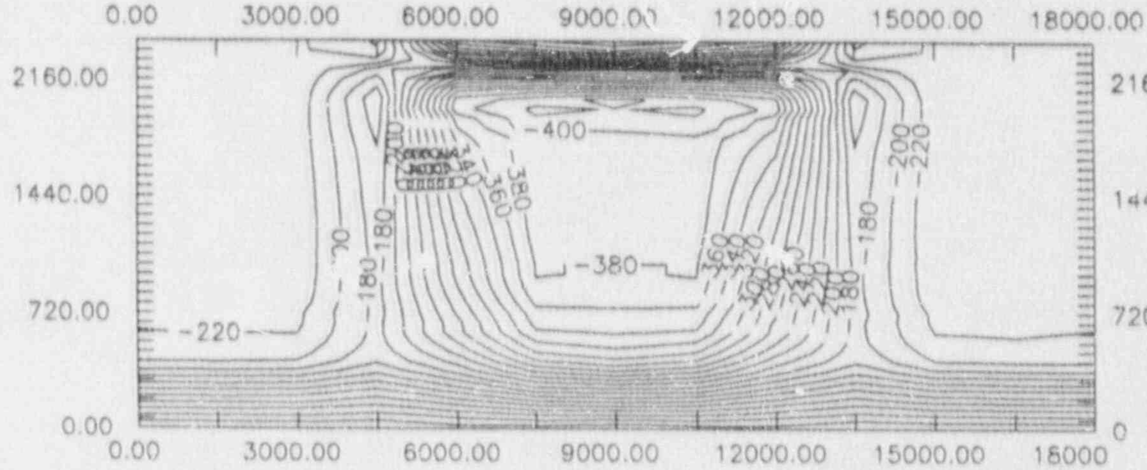


Figure 4-4. VAM2D Pressure-Head Contours

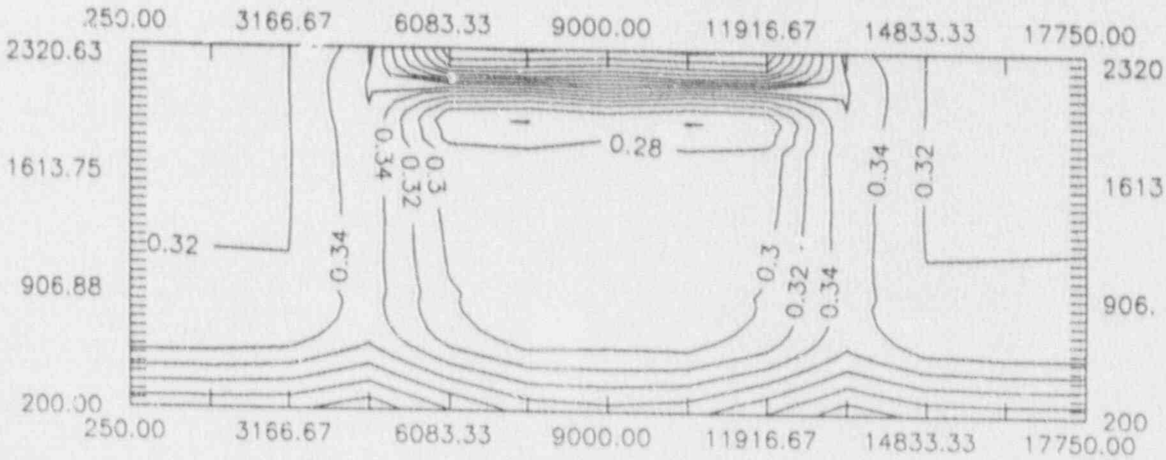


Figure 4-5. VAM2D Moisture-Content Contours

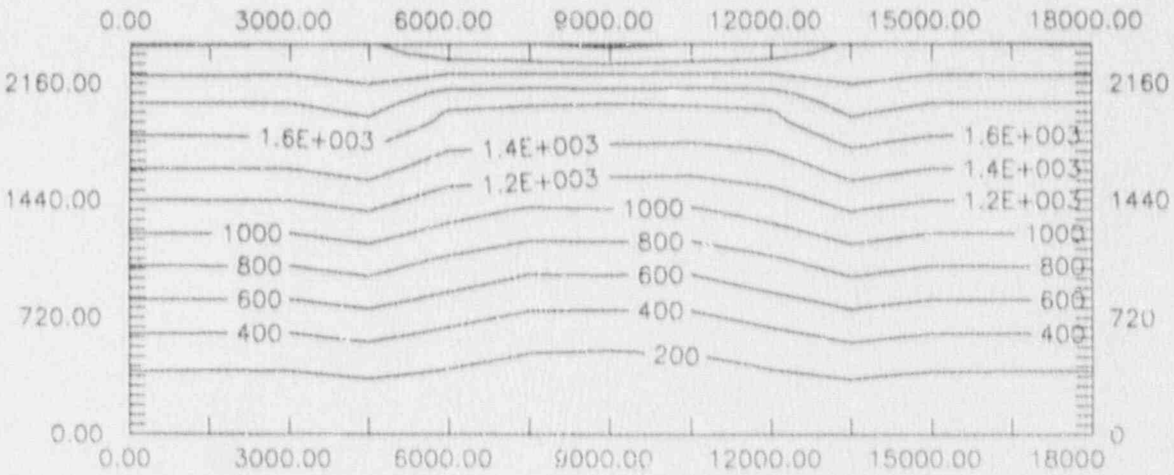


Figure 4-6. VAM2D Total-Head Contours

4.4 Sample Problem 2 - Concentrations in the Aquifer

In this sample problem, PAGAN is used to estimate both release rates of radionuclides from the disposal trenches and transport to a well in the aquifer. The disposal facility and the site are shown in Figure 4-2 and the parameters are listed in Tables 4-1 and 4-2. The concentrations of radionuclides at the well location (150 meters from the center of the Class A trench and 104 meters from the center of the Class B/C trench) are calculated at various times after the closure of the facility.

The following assumptions are used in the analysis:

- The Class A trench initially contains 1800 Ci of H-3. The waste containers degrade completely when the facility is closed, and all the H-3 is immediately available to be swept out of the disposal unit by water.
- The Class B/C trench initially contains 20 Ci of I-129. The wastes are contained in high-integrity containers that degrade completely 50 years after closure of the facility. After that, the radionuclides leach out of the solidified waste form at a constant rate.
- The average pore velocity in the aquifer is calculated from the equation $u_p = ki/\phi$, where k is the hydraulic conductivity, i is the hydraulic gradient, and ϕ is the aquifer porosity. These values, together with the average pore velocity, are given in Table 4-1.
- An flow rate of 0.028 m/yr into the disposal unit and a moisture content of 0.28 calculated by VAM2D in Sample Problem 1 are used to calculate the vertical travel time through the unit, the source constant, and the pre-exponential term.
- Dispersivity in the disposal unit is unknown, and a conservative approach is used. Dispersion in the trench is considered to be negligible; therefore a value of 100 is used for the number of mixing cells in the source-term analysis.
- Unsaturated-zone travel time between the facility and the water table is neglected.

Since H-3 and I-129 have different release mechanisms and different distances to the well location, two separate runs are required.

Calculation of H-3 - Sample Problem 2A

The vertical travel time for water in the facility is defined by

$$T = \frac{D \theta}{V_y} \qquad (4-3)$$

where D is the vertical dimension of the disposal unit, θ is the moisture content in the disposal unit, and V_y is the vertical Darcy velocity through the disposal unit. For this sample problem D = 8 m, θ = 0.28, R_d = 1.0, and V_y = 0.028 m/yr, and T is calculated to be 80 years. It is assumed the retardation factor for tritium in 1.0 in both the disposal unit and the aquifer.

The source constant used for the release of H-3 is determined in the computer code from the travel time for water and the retardation factor:

$$\alpha = (RT)^{-1} \qquad (4-4)$$

With T = 80 years, α is calculated to be equal to 0.0125 yr^{-1}.

The source-term pre-exponential term used for the release of H-3 is determined in the code from the relation between total inventory, travel time, and pre-exponential for the surface-wash model:

$$Q_0 = \frac{m}{R\ T} \qquad (4-5)$$

where, since m = 1,800 Ci, Qo equals 22.5 Ci/yr.

The values of m, R, and T are entered into Array Data Group 1 and Fixed Data Group 3 as discussed in Chapter 3. A flag of 1 is used for H-3 to turn on the transport calculations. The input file is shown in Appendix B. An alternate way to enter the source-term constants α and Q_0 would be to enter them explicitly in Array Data Group 1.

The analysis is carried out to 200 years at the well location with 20 intermediate times. A table of output that shows the concentration-versus-time values at the well location is requested (Output type option = 1 in Fixed Data Group 1, see Section 3.2.1). Also, the source rate into the aquifer can be output as an intermediate result by setting the flag to 1 in the same data group.

The calculated concentration history of H-3 at the well location is shown graphically in Figure 4-7. This graph is a standard output from PAGAN. Note that PAGAN does not directly support graphics printers and plotters to make paper copies of the PAGAN on-screen graphics. The hardcopy graphics presented in this report were produced using a commercial print enhancement package called PIZAZZ Plus (Application Techniques, Inc.). For better resolution graphics, the user can write output data blocks to an ASCII file, which can then be used with any commercially available graphics software.

Calculation of I-129 - Sample Problem 2B

The analysis of the release and transport of I-129 is the same as that of H-3, except for the following:

- The well is located 104 meters from the center of the B/C trench.

- A constant release rate of 2.0E-4 Ci/yr from the waste form is used as the source constant. This is estimated by using a diffusive leach rate that is equal to $4m(H+a)D_e/a^2H$ [Kozak et al., 1990a]. Here, m = 20 Ci, H = 1 m, a = 1 m, and D = 1×10^{-6} m^2/yr.

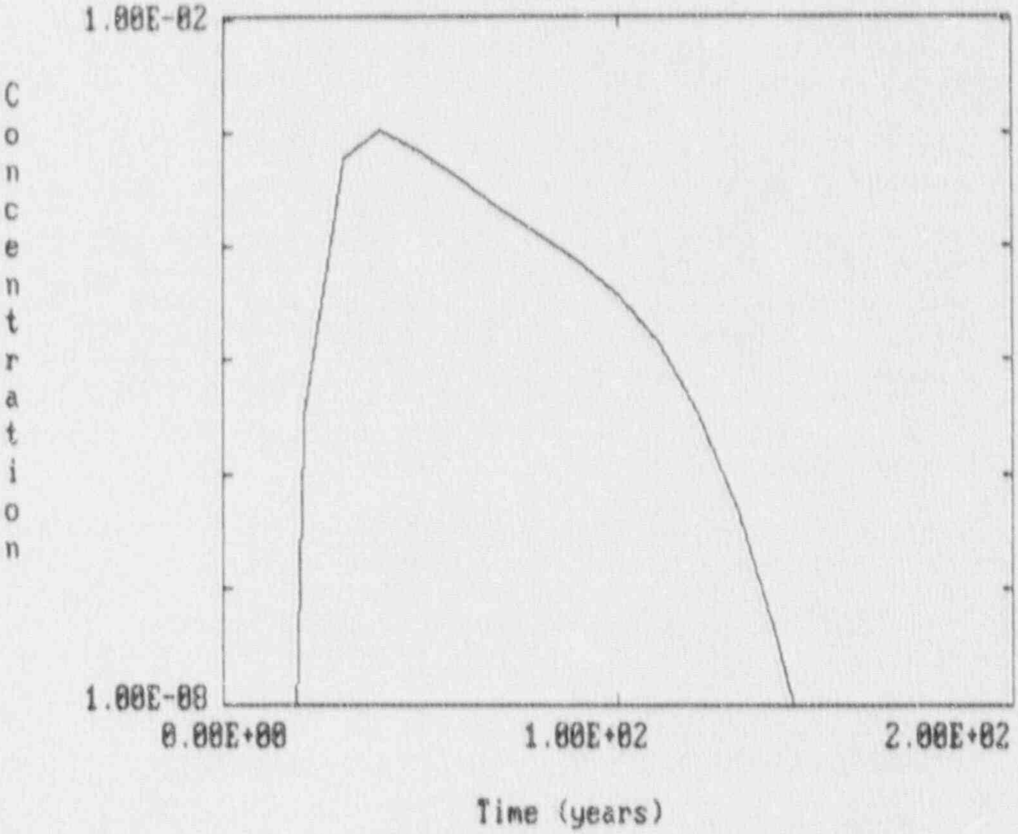
- A delay time of 50 years is used to represent the container failure time.

The analysis is performed out to 200 years after site closure. The input file for this run is shown in Appendix C, and the graphical output of concentration history from PAGAN is shown in Figure 4-8. With a constant leach rate from the waste form, the concentration of I-129 reaches an asymptotic value in the aquifer after 160 years.

4.5 Sample Problem 3 - Concentration of H-3 in Aquifer, Parametric Variation of Dispersivity

In this sample problem, a parametric analysis is performed using PAGAN to show the impact of data uncertainty on the output. The conceptual model and assumptions used here are the same as those described in Sample Problem 2. For the purpose of demonstration, it is assumed that the longitudinal dispersivity of the aquifer has five possible values: 0.5, 2.0, 10.0, 20.0, and 100.0 meters. The concentrations of H-3 at the well location are calculated for these four dispersivity values.

The input file is shown in Appendix D. The array-data group input is the same as in Sample Problem 2. A value of 3 is used for the output type option in the fixed data group 1 to indicate that parametric analysis is desired. In fixed data group 4, a parameter index 2 is entered to signify that longitudinal dispersivity is to be varied. The graphical output from PAGAN for this analysis is shown in Figure 4-9.



EXAMPLE 2A FOR STC
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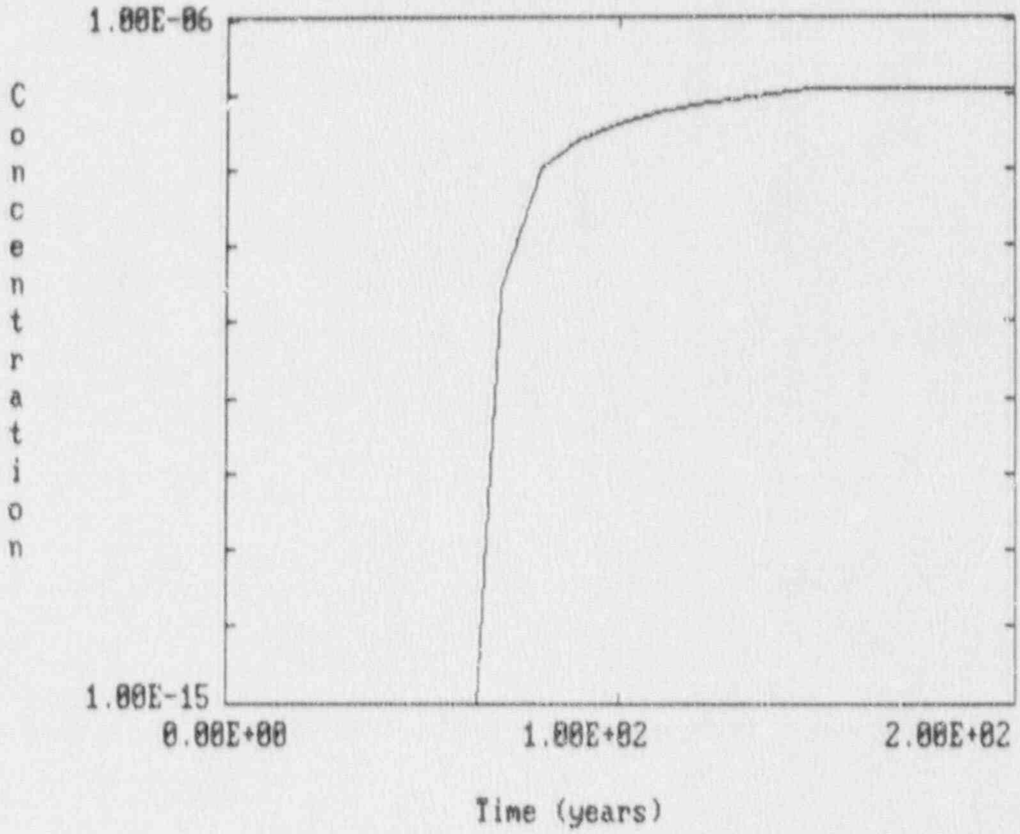
Figure 4-7. Concentration History of H-3 in Well Water



EXAMPLE 2B FOR STC
EX2B.INP Created 15:25:05 on 05-04-1990. Run 15:25:09 on 05/04/1990.

Figure 4-8. Concentration of I-129 in Well Water

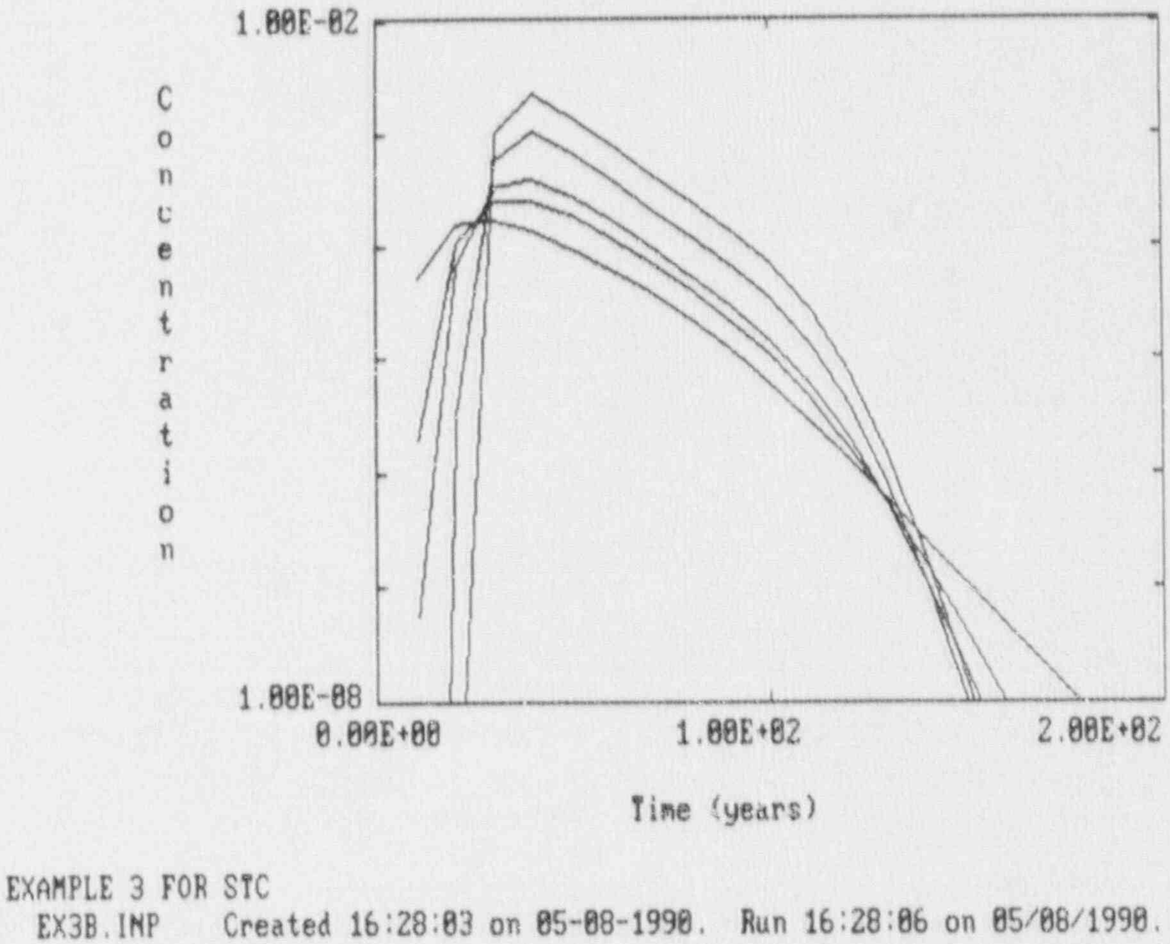


Figure 4-9. Concentration History of H-3 in Well Water For Several Dispersivities

4.6 Sample Problem 4 - Discharge Rates Into the River

In this sample problem, the contaminated aquifer analyzed in Sample Problem 2 is assumed to discharge into the river, and the discharge rates of H-3 and I-129 into the river are calculated using PAGAN.

All the radionuclides that pass through a plane in the aquifer that intersects the river are assumed to enter the river. The radionuclide discharge rates into the river are calculated using the SURFACE component of PAGAN. These discharge rates will be used as an input to GENII in the analysis of surface-water concentrations. If desired, a simple dilution factor can also be used in PAGAN to calculate the radionuclide concentrations in the river.

The source-term analysis in this sample problem is identical to the source-term analysis in Sample Problem 2. Since different release options are used by H-3 and I-129, two separate runs of PAGAN are required. The input file for this analysis is shown in Appendix E. The time-dependent discharge rates of radionuclides into the river are calculated for 400 years, and the results are shown graphically in standard PAGAN form in Figure 4-10 for H-3, and in Figure 4-11 for I-129.

4.7 Sample Problem 5 - Calculation of Doses from Exposure Pathways

In this sample problem, doses resulting from the potential exposures from the contaminated aquifer and the river are estimated using GENII. The farmer who lives at the boundary of the disposal facility is assumed to drink the well water, to irrigate crops and feed animals with the contaminated well water, and the farmer also consumes the contaminated crop and animals. Furthermore, the farmer also consumes fish from the contaminated river and makes recreational use of the river. In addition, an individual living near the river is assumed to drink contaminated river water, to consume fish from the river, and to make recreational use of the river

The concentrations of radionuclides in the well water and the river calculated by Sample Problems 2 and 4 are used as input to GENII. Because the dose calculations in GENII are for a fixed time only, many separate runs are needed to calculate the time-dependent doses resulting from the time-dependent concentrations in the well/river water. For this sample problem, the doses from contaminated well water and contaminated surface water are calculated at several times. The input and output files for GENII are identical at different times except for the input concentrations and output doses of H-3 and I-129 in well water and river.

Appendix F shows the input file generated by APPRENTICE in GENII to calculate the doses received by the farmer at 60 years resulting from the usage of the contaminated well water. Default values for water consumption rate and various food-consumption rates in GENII are used in this sample problem. The resulting output file is shown in Appendix G. The annual effective dose equivalent is shown in Figure 4-12 as a function of

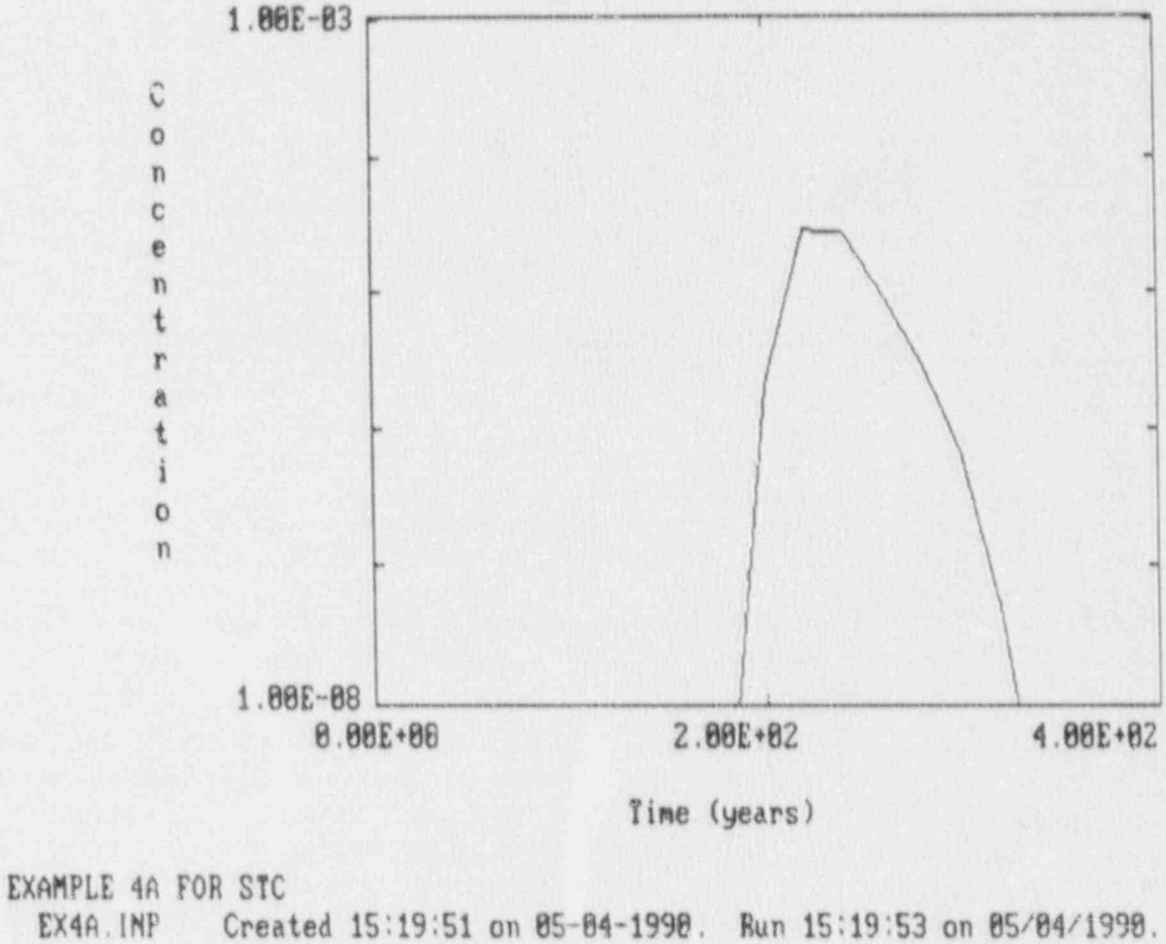
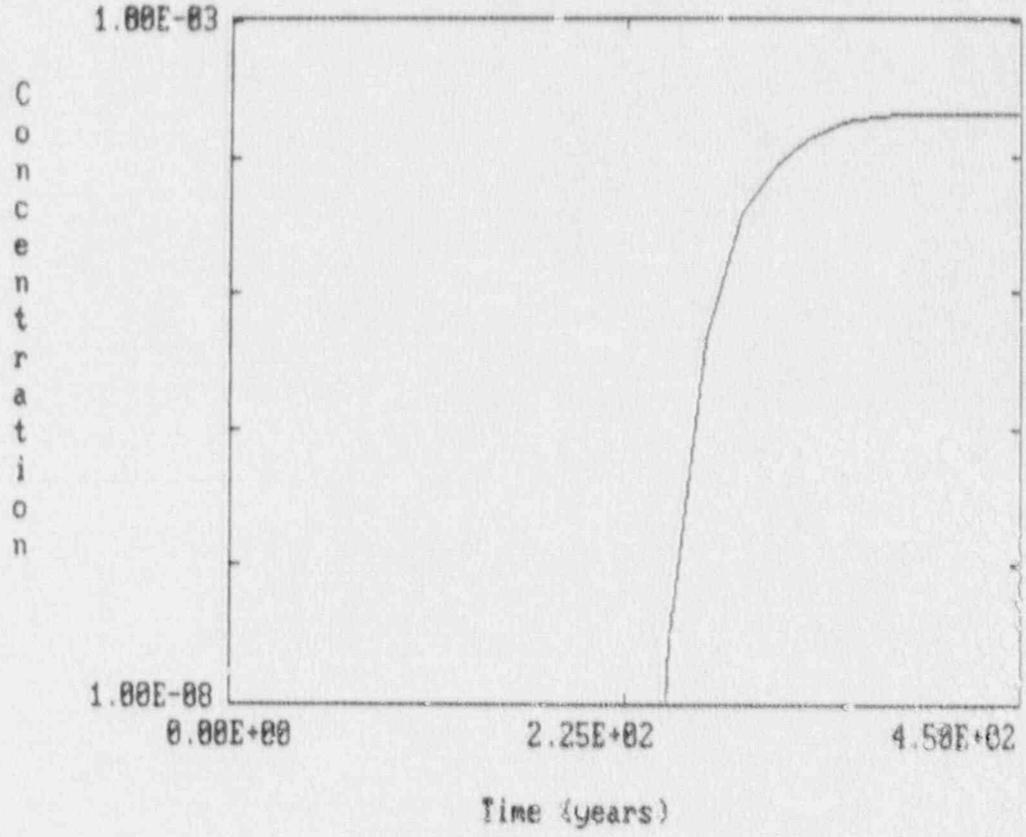


Figure 4-10. Concentration History of H-3 in the River



EXAMPLE 4B FOR STC
EX4B.INP   Created 15:22:55 on 05-04-1990. Run 15:22:58 on 05/04/1990.

Figure 4-11. Concentration History of I-129 in the River

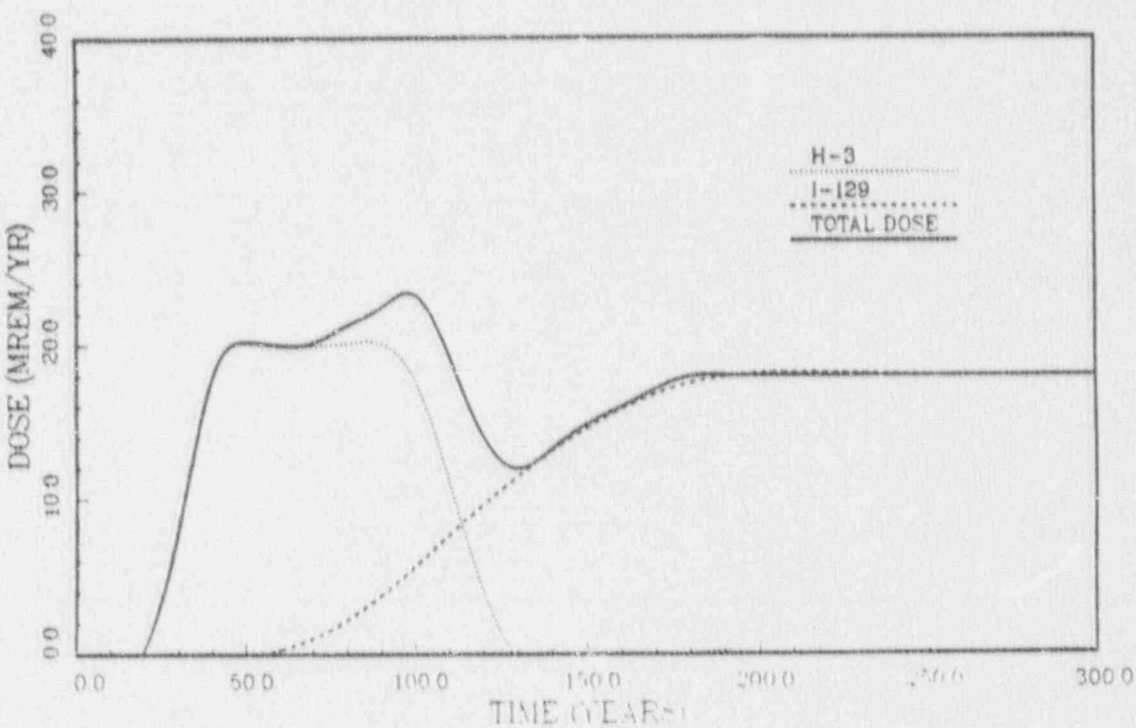


Figure 4-12. Annual Effective Dose Equivalent From Well-Water Exposures

time. The annual effective dose equivalent peaks at 100 years with a value of 24 mrem/yr. The major contribution to the peak dose comes from ingesting H-3 from the contaminated well water, but I-129 contributes to the dose as well. After about 140 years, I-129 becomes the sole contributor to the dose.

The discharge rates of I-129 and H-3 into the river calculated using PAGAN (Sample Problem 2) at several times are used as input for GENII to calculate the doses. The dose history thus generated is shown in Figure 4-13. Appendices H and I show the input and output files for the calculation at 400 years. The exposure pathways include drinking the river water, consuming food resulting from irrigation, and recreational use of the river. The resulting doses calculated by GENII from these exposures are extremely low. The annual effective dose equivalent resulting from exposures to river water are shown in Figure 4-12.

Figures 4-12 and 4-13 represent the results from the performance assessment methodology that can be compared to the performance objectives in 10 CFR Part 61. Doses to the town dwellers that drink water from the river are much less than the dose to the farmer, who drinks water from the well. The maximum annual effective dose equivalent for the farmer is about 24 millirem, which is very close to the statutory limit.

4.8 Sample Problem 6 - Doses from Air Transport

In this sample problem, a simple analysis of an air-transport pathway using GENII [Napier et al., 1988] is presented. The primary purpose of this sample problem is to demonstrate the use of the virtual source method [Turner, 1970] for modeling an area source using a point source Gaussian-plume model. A virtual source is an imaginary point source upwind from the source of the airborne contaminant. The virtual source is chosen such that some characteristic dimension of the plume, say two times the lateral eddy diffusion coefficient, is equal to the lateral dimension of the source. The eddy diffusion coefficient is mathematically identical to the standard deviation in a normal distribution, so this definition equates the source area with the 95% bound of the dispersion plume. Since the eddy diffusion coefficient is a function only of distance and stability class the distance to the virtual source can be uniquely defined for each stability class. This distance is then added to the distance from source to receptor, and the analysis is performed using a point source located at the virtual point.

A simple option for analyzing air transport in GENII requires the user to enter a value for the atmospheric dispersion factor, χ/Q, and the release rates of radionuclides into the air, along with appropriate food chain parameters and environmental pathways for exposure calculations. Alternatively, the concentration of radionuclide in surface soil can be specified, along with a mass resuspension factor, to calculate doses from entrained particulates. This alternate source specification is more applicable to analysis of intruder scenarios than to the analysis of the undisturbed site.

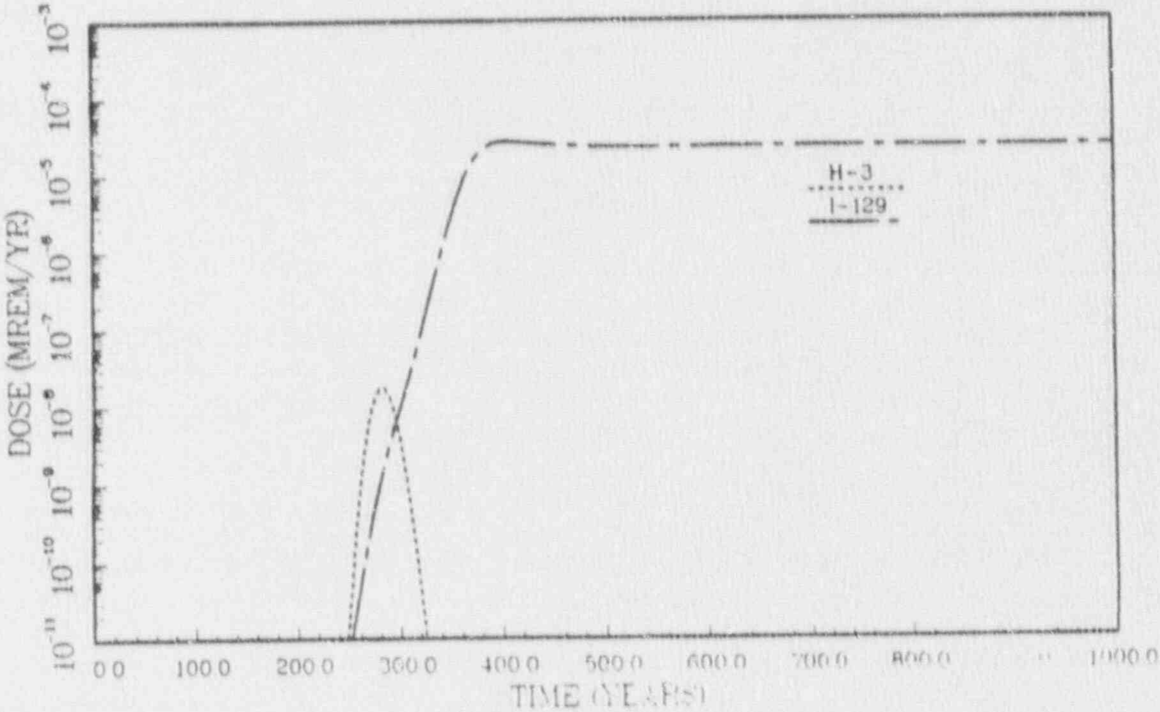


Figure 4-13. Annual Effective Dose Equivalent From River Exposures

For this sample problem it is assumed that the releases are gaseous, and that the rate of production of gaseous radionuclides is known. We assume 70 Ci/yr of H-3 and 2 Ci/yr of C-14 are released into the air. These release rates are quite large; the large values were deliberately chosen to provide relatively large doses for this sample problem. It is conservatively assumed that the Pasquill atmospheric stability class is Class F at all times, and that the wind consistently blows from the facility to the receptor. The receptor is assumed to be 100 m from the center of the disposal units, as shown in Figure 4-14. An average wind velocity of 1.0 m/s is assumed for this sample problem.

The first step in analyzing this air transport problem is to determine the location of the virtual source. The lateral dimension of the disposal unit is equated to twice the lateral dispersion coefficient, σ_y.

There are a number of equations that have been proposed to describe the functional dependence $\sigma_y(x)$ and $\sigma_z(x)$, but Vogt [1977] has recommended the following equations, which are empirical equations determined from the Pasquill-Gifford curves:

$$\sigma_y(x) = x[a_1 \ln(x) + a_2], \qquad (4\text{-}6)$$

$$\sigma_z(x) = \frac{1}{2.15} \exp[b_1 + b_2 \ln(x) + b_3 \ln^2(x)] , \qquad (4\text{-}7)$$

where the coefficients a_i and b_i are constants that depend on the Pasquill-Gifford stability class. Equating $2\sigma_y$ with 200 m, the dimension of the disposal unit, leads to a nonlinear algebraic equation that can be solved iteratively for x (the distance from the disposal unit to the virtual source) in straightforward fashion. For Class F stability, this distance is 3275.85 meters.

The next step in the analysis is to determine the atmospheric dispersion at the receptor point. The total distance from the virtual source to the receptor is used to calculate σ_y and σ_z, which is then used in to calculate χ/Q from the equation

$$\frac{\chi}{Q} = \frac{1}{\pi u \sigma_y \sigma_z}, \qquad (4\text{-}8)$$

where χ is the concentration in air (Ci/m^3), Q is the release rate of radionuclide (Ci/s), u is the wind speed (m/s), σ_y is the horizontal standard deviation of the plume (m), and σ_z is the vertical standard deviation of the plume (m). Using the parameters given above, this analysis leads to $\chi/Q = 1.1\text{x}10^{-4}$ s/m^3, which is used as an input to GENII.

The input and output files for this sample problem are attached as Appendix J to this report. The parameters used in this sample problem lead to a dose estimate of 18.6 mrem/yr, of which 17 mrem/yr is due to the C-14 release.

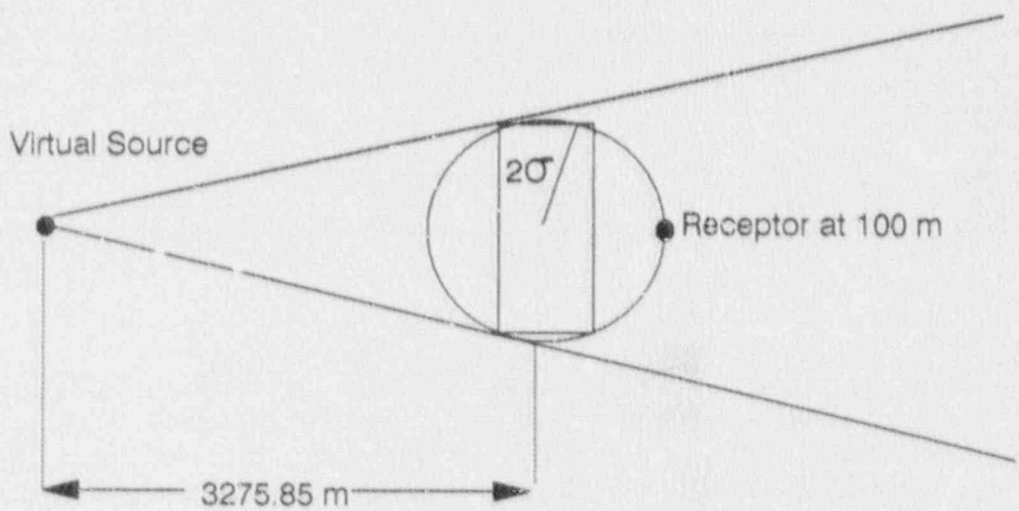


Figure 4-14. Virtual Source Method for Modeling Area Sources

4.9 Sample Problem 7 - Intruder-Construction Scenario

In this example, an individual is assumed to construct a house directly above the disposal facility at 100 years after the closure of the facility. During construction, some of the waste is assumed to be excavated and dispersed into the air. This individual receives radiation doses through inhalation of the contaminated dust and direct gamma radiation from standing on the contaminated soil and being immersed in the contaminated dust.

The following assumptions are used in calculating the dose the individual receives:

- Both Class A and Class B/C trenches have been excavated. The inventories are assumed to be initially uniformly distributed throughout their respective trenches. This assumption results in a H-3 concentration of 3.13E-2 Ci/m^3 (1,800 Ci/(120 m x 8 m x 60 m)) in the Class A trench, and an I-129 concentration of 2.6E-3 Ci/m^3 (20Ci/(120 m x 8 m x 8 m)) in the Class B/C trench. These concentrations are assumed to be retained during the redistribution that occurs during intrusion.

- The contaminated soil in the trench is assumed to be excavated by the construction worker and distributed onto the ground surface. Because GENII models the surface soil as a slab 15 cm thick, a value of 0.15 for the manual redistribution factor is used in the input to indicate that 0.15 m^3 of deep soil is required to provide a 15-cm-thick layer over an area of 1.0 m^2.

- The mass-loading resuspension model in GENII is used to calculate the concentration of H-3 in the air. The GENII default value of the mass-loading factor (10^{-4} kg/m^3) is considered conservative [Kozak et al., 1989a].

- Only inhalation of the contaminated air and external exposure from the contaminated ground surface are considered in the dose calculations.

- The construction worker is assumed to inhale the contaminated air and stand on the contaminated ground surface continuously for 80 hours.

The input and output files generated by the GENII analysis are shown in Appendices K and L, respectively. The dose received by the construction worker with the above assumptions is 0.15 millirem.

5.0 QUALITY ASSURANCE ISSUES

The methodology software package was developed in a framework that is consistent with SNL quality assurance requirements. A Quality Assurance Plan specific to the low-level waste project has been designed. The Quality Assurance Plan meets the general intent and the spirit of the Sandia Quality Plan and the Organization 6000 Quality Assurance Policy internal to Sandia National Laboratories. The following list briefly summarizes the QA requirements for computer codes:

1. Configuration Management

For all codes acquired, developed, or modified, the source code and listings along with all existing documentation are placed under suitable administrative control. All modifications are controlled and documented, and new interim version numbers assigned.

2. Testing and Code Verification

All codes acquired are tested with the sample problems provided by the originator. All modified codes are verified using test cases. All testing cases are planned, approved, reviewed, and documented.

The codes DISPERSE and SURFACE have been verified for self-consistency, against hand calculations, and for a variety of test cases as they were developed. Each subroutine in the programs was tested for self-consistency and accuracy of results prior to insertion into the program. Each code was checked against hand calculations for coarse integral discretizations, for which hand calculations were tractable. Furthermore, the area-source Green's function was shown to recover results from the point-source Green's function for small areas. In addition, the Green's functions in the codes recovered results from the analytical Green's functions for sources of infinitesimal duration published by Codell et al. [1982] in the appropriate limiting cases.

Another set of verification analyses were performed on DISPERSE by comparing predicted well concentrations from DISPERSE to predictions from both VAM2D [Huyakorn et al., 1989] and FEMWATER/BLT [Sullivan and Suen, 1989]. In all comparisons made between these codes, the behavior of DISPERSE was shown to be qualitatively similar to the more complicated approaches, and DISPERSE was shown to predict higher (more conservative) well concentrations than either VAM2D or FEMWATER/BLT [Kozak et al., 1990a]. These analyses demonstrated that DISPERSE provides a reasonable approximation to the more complicated solutions for a simple conceptual model, and that the solution method captures the appropriate physical processes that can be expected to occur.

PACAN has been extensively compared with the standard versions of DISPERSE and SURFACE to verify that the codes were properly implemented in the SUNS shell.

The SUNS shell has been used and tested with a number of codes. It was used with the computer code NEFTRAN to assess compliance with the high-level waste standard 40 CFR 191 for the EPA. It was also used in conjunction with the code IMPACTS BRC for dose calculations for Below-Regulatory-Concern wastes [Campbell and O'Neal, 1990]. In addition, the SUNS shell has been used for RICS (Reliability of Integrated Circuits) analyses at SNL. The SUNS system was extensively tested with these codes and found to be reliable and error-free.

PAGAN automatically provides the date and the time for every input files being created. The output files also provide the time and date that the run is generated and the input file used for that run. This features assures the traceability of the results of analyses.

The software package GENII adopts QA procedures and requirements required a PNL, which are similar to the SNL requirements. Quality assurance issues for GENII are documented in Napier et al. [1988].

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Appendix A: SAMPLE PROBLEM 1 INPUT AND OUTPUT

```
   1
TEST PROBLEM 5.5 FLOW-NEW SOILS-25 CM/YR
   1    0    0    0    0    1    1    1  533  480    0    0    4    0    0    0
   1    1   40    0    1         3.        1.0    1    0    0
   0    0    0    0    0    1    1    1    1    0    0    0
     0.0       0.05       1.3        50.
   -100.0
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    2    3    4    1    1    1    1    1    1    1    1    1    2    3    4
   1    1    1    1    1    1    1    1    1    2    3    4    1    1    1    1
   1    1    1    1    1    2    3    4    1    1    1    1    1    1    1    1
   1    2    3    4    1    1    1    1    1    1    1    1    1    2    3    4
   1    1    1    1    1    1    1    1    1    2    3    4    1    1    1    1
   1    1    1    1    1    2    3    4    1    1    1    1    1    1    1    1
   1    2    3    4    1    1    1    1    1    1    1    1    1    2    3    4
   1    1    1    1    1    1    1    1    1    2    3    4    1    1    1    1
   1    1    1    1    1    2    3    4    1    1    1    1    1    1    1    1
   1    2    3    4    1    1    1    1    1    1    1    1    1    2    3    4
   1    1    1    1    1    1    1    1    1    2    3    4    1    1    1    1
   1    1    1    1    1    2    3    4    1    1    1    1    1    1    1    1
   1    2    3    4    1    1    1    1    1    1    1    1    1    2    3    4
   1    1    1    1    1    1    1    1    1    2    3    4    1    1    1    1
   1    1    1    1    1    2    3    4    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
     31.60      31.60  0.000E00  0.000E00  0.520E00  0.000E00
     .0082      .0082  0.000E00  0.000E00  0.446E00  0.000E00
     303.0      303.0  0.000E00  0.000E00  0.469E00  0.000E00
     31.60      31.60  0.000E00  0.000E00  0.520E00  0.000E00
    0.4190       -1.0   0.01150       2.03
    0.0000       -1.0   0.00152       1.17
    0.4050       -1.0   0.00500       7.09
    0.4190       -1.0   0.01150       2.03
   13   41     500.00      400.    1
       0.0      500.0     1000.     1500.     2000.     2500.     3000.     3500.
```

```
  4000.    4500.    5000.    5400.    5800.    6290.    6600.    7000.
  7400.    7800.    8200.    8600.    9000.    9400.    9800.   10200.
 10600.   11000.   11400.   11800.   12200.   12600.   13000.   13500.
 14000.   14500.   15000.   15500.   16000.   16500.   17000.   17500.
 18000.
    0.0     400.     800.    1200.    1400.    1560.    1720.    1880.
  2040.    2200.    2290.    2350.    2400.
 41   41    0    0    2
  1    1      0.00
 14    1      0.00
 27    1      0.00
 40    1      0.00
 53    1      0.00
 66    1      0.00
 79    1      0.00
 92    1      0.00
105    1      0.00
118    1      0.00
131    1      0.00
144    1      0.00
157    1      0.00
170    1      0.00
183    1      0.00
196    1      0.00
209    1      0.00
222    1      0.00
235    .      0.00
248    1      0.00
261    1      0.00
274    1      0.00
287    1      0.00
300    1      0.00
313    1      0.00
326    1      0.00
339    1      0.00
352    1      0.00
365    1      0.00
378    1      0.00
391    1      0.00
404    1      0.00
417    1      0.00
430    1      0.00
443    1      0.00
456    1      0.00
469    1      0.00
482    1      0.00
495    1      0.00
508    1      0.00
```

521	1	0.00
13	1	1.71E1
26	1	3.43E1
39	1	3.43E1
52	1	3.43E1
65	1	3.43E1
78	1	3.43E1
91	1	3.43E1
104	1	3.43E1
117	1	3.43E1
130	1	3.43E1
143	1	3.08E1
156	1	2.75E1
169	1	2.75E1
182	1	2.75E1
195	1	2.75E1
208	1	2.75E1
221	1	2.75E1
234	1	2.75E1
247	1	2.75E1
260	1	2.75E1
273	1	2.75E1
286	1	2.75E1
299	1	2.75E1
312	1	2.75E1
325	1	2.75E1
338	1	2.75E1
351	1	2.75E1
364	1	2.75E1
377	1	2.75E1
390	1	2.75E1
403	1	3.08E1
416	1	3.43E1
429	1	3.43E1
442	1	3.43E1
455	1	3.43E1
468	1	3.43E1
481	1	3.43E1
494	1	3.43E1
507	1	3.43E1
520	1	3.43E1
533	1	1.71E1

10 162 175 188 201 214 227 240 253 266 279

```
********************************************************************************

                    THIS OUTPUT GENERATED BY VAM2D v. 5.0
                    INPUT FILE NAME = vamuns.dat;18

********************************************************************************


NUMBER OF PROBLEMS TO BE SOLVED =  1


PROBLEM NUMBER:  1

PROBLEM TITLE
--------------------------------------------------------------------------------

 TEST PROBLEM S.S FLOW-NEW SOILS-25 CM/YR

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



PROBLEM SPECIFICATION PARAMETERS
--------------------------------
MODEL OPTION PARAMETER ......................(IMODL) =     1
  NOTE:   IMODL = 0 FOR SOLUTE TRANSPORT ONLY
                = 1 FOR WATER FLOW ONLY
                = 2 FOR COUPLED FLOW AND TRANSPORT
HYSTERETIC SOIL MOISTURE (1=YES, 0=NO)....(IHYST) =    0
ANISOTROPIC REL. COND.(1=YES, 0=NO)........(IANI) =    0
CONVERT INITIAL HEAD VALUES(1=YES, 0=NO).(INTSPC) =    0
CHAIN-DECAY REACTIONS(1=YES, 0=NO).......(ICHAIN) =    0
STEADY STATE SIMULATION(1=YES, 0=NO)......(ISSTA) =    1
TIME STEP GENERATION INDEX (1=YES, 0=NO) .(ITSGN) =    1
NUMBER OF TIME STEPS ........................(NTS) =    1
TOTAL NUMBER OF NODES ........................(NP) =    0
TOTAL NUMBER OF ELEMENTS .....................(NE) =    0
SEQUENTIAL NUMBERING INDEX (0=Y, 1=X-DIR) (ISWAP) =    0
AXISYMMETRIC SIMULATION(1=YES, 0=NO).....(IAXSYM) =    4
NUMBER OF POROUS MATRIX MATERIALS ..........(NMAT) =    0
INITIAL CONDITION NON-UNIFORMITY INDEX.....(NONU) =    0
NUMBER OF INFIL./EVAP. ELEMENTS .........(NEIEVP) =    0
```

```
NUMBER PLANT SPECIES .....................(NPLANT) =

TIME STEPPING AND ITERATION CONTROL PARAMETERS
----------------------------------------------
TIME STEPPING INDEX (0=CNTRL, 1=BCKWD) ...(IKALL) =    1
TYPE OF ITERATION SCHEME (1=NEWT,0=PICARD)(INEWT) =    1
MAXIMUM NON-LINEAR ITERATIONS ...........(NITMAX) =   40
MAXIMUM NUMBER OF TIME STEP REFINEMENTS .(IRESOL) =    0
LUMPING OF ELEMENT MATRIX (1=YES, 0=NO) ..(ILUMP) =    1
ITERATION TOLERANCE FOR HEAD..............(HTOL) = 0.30000E+01
UNDER RELAXATION FACTOR FOR HEAD..........(HWWT) = 0.10000E+01
REL. PERMEABILITY UPSTREAM INDEX ........(IUPSTR) =    1
NONLINEAR ITERATION SELECTION ...........(ISELSC) =    0
N-R STORAGE COMPUTATION OPTION ..........(INSTOC) =

INPUT / OUTPUT CONTROL PARAMETERS
---------------------------------
VELOCITY/SATURATION INPUT................(NVREAD) =    0
BOUNDARY NODE DATA READ (1=YES, 0=NO)....(IOUTLT) =    0
NUMBER OF NODES FOR WHICH I.C. ARE READ....(NPIN) =    0
OUTPUT REQUIREMENT INDICATOR:
 (0=ALL DATA, 1=NO ELEMENT DATA,
  2=NO DATA, 3=NO MESH AND I.C. DATA.......(IPRD) =    0
UNIT 9 OUTPUT OF VEL / SAT (1=YES, 0=NO).(NVWRIT) =    0
VELOCITY PRINTOUT CONTROL INDEX............(NVPR) =    1
UNIT 10 OUTPUT HEAD/CONC. (0=NONE, N=NTI:).(NPLOT) =    1
NODAL VALUE PRINTOUT CONTROL INDEX........(NSTEP) =    1
OBSERVATION NODE INDEX...................(IOBSND) =    1
MASS BALANCE TO BE PERFORMED (1=YES,0=NO).(IMBAL) =    0
UNIT 8 OUTPUT OF HEAD/CONC (1=YES, 0=NO).(NOWRIT) =    0
PRINT CHECK OPTION INDEX.................(IPRCHK) =    0

TEMPORAL DISCRETIZATION DATA
----------------------------
INITIAL TIME VALUE ......................... (TIMA) =  0.0000E+00
VALUE OF FIRST TIME STEP ................... (TIN) =  0.5000E-01
TIME STEP MULTIPLIER ....................... (TFAC) =  0.1300E+01
MAXIMUM TIME STEP SIZE ..................... (TMAX) =  0.5000E+02

*** LIST OF GENERATED TIME VALUES ***
-------------------------------------

0.5000E-01
```

DEFAULT INITIAL VALUE OF PRESSURE HEAD

-0.1000E+03

ELEMENT PROPERTY NUMBERS

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	[illegible]	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	[illegible]	[illegible]	1	1	1	1	1
1	1	1	1	1	1	1	1	1	[illegible]	[illegible]	1	1	1	1	1
1	1	1	1	1	1	1	1	1	[illegible]	[illegible]	1	1	1	1	1
1	2	3	4	1	1	1	1	1	[illegible]	1	1	1	2	3	4
1	1	1	1	1	1	1	1	1	2	3	4	1	1	1	1
1	1	1	1	1	2	3	4	1	1	1	1	1	1	1	1
1	2	3	4	1	1	1	1	1	1	1	1	1	2	3	4
1	1	1	1	1	1	1	1	1	2	3	4	1	1	1	1
1	1	1	1	1	2	3	4	1	1	1	1	1	1	1	1
1	2	3	4	1	1	1	1	1	1	1	1	1	2	3	4
1	1	1	1	1	1	1	1	1	2	3	4	1	1	1	1
1	1	1	1	1	2	3	4	1	1	1	1	1	1	1	1
1	2	3	4	1	1	1	1	1	1	1	1	1	2	3	4
1	1	1	1	1	1	1	1	1	2	3	4	1	1	1	1
1	1	1	1	1	2	3	4	1	1	1	1	1	1	1	1
1	2	3	4	1	1	1	1	1	1	1	1	1	2	3	4
1	1	1	1	1	1	1	1	1	2	3	4	1	1	1	1
1	1	1	1	1	2	3	4	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

HYDRAULIC PROPERTIES OF POROUS MEDIA

MATERIAL NUMBER: 1 (I)

```
X-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,1)) =  0.3160E+02
Y-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,2)) =  0.3160E+02
XY-DIRECTION HYDRAULIC CONDUCTIVITY .. (PROP(I,3)) =  0.0000E+00
SPECIFIC STORAGE ..................... (PROP(I,4)) =  0.0000E+00
SATURATED WATER CONTENT............... (PROP(I,5)) =  0.5200E+00
AIR-ENTRY PRESSURE HEAD VALUE ........ (PROP(I,6)) =  0.0000E+00

MATERIAL NUMBER:    2  (I)

X-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,1)) =  0.8200E-02
Y-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,2)) =  0.8200E-02
XY-DIRECTION HYDRAULIC CONDUCTIVITY .. (PROP(I,3)) =  0.0000E+00
SPECIFIC STORAGE ..................... (PROP(I,4)) =  0.0000E+00
SATURATED WATER CONTENT............... (PROP(I,5)) =  0.4460E+00
AIR-ENTRY PRESSURE HEAD VALUE ........ (PROP(I,6)) =  0.0000E+00

MATERIAL NUMBER:    3  (I)

X-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,1)) =  0.3030E+03
Y-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,2)) =  0.3030E+03
XY-DIRECTION HYDRAULIC CONDUCTIVITY .. (PROP(I,3)) =  0.0000E+00
SPECIFIC STORAGE ..................... (PROP(I,4)) =  0.0000E+00
SATURATED WATER CONTENT............... (PROP(I,5)) =  0.4690E+00
AIR-ENTRY PRESSURE HEAD VALUE ........ (PROP(I,6)) =  0.0000E+00

MATERIAL NUMBER:    4  (I)

X-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,1)) =  0.3160E+02
Y-DIRECTION HYDRAULIC CONDUCTIVITY ... (PROP(I,2)) =  0.3160E+02
XY-DIRECTION HYDRAULIC CONDUCTIVITY .. (PROP(I,3)) =  0.0000E+00
SPECIFIC STORAGE ..................... (PROP(I,4)) =  0.0000E+00
SATURATED WATER CONTENT............... (PROP(I,5)) =  0.5200E+00
AIR-ENTRY PRESSURE HEAD VALUE ........ (PROP(I,6)) =  0.0000E+00

MATERIAL NUMBER:    1  (I)

RESIDUAL WATER SATURATION ............ (PROP(I,7)) =  0.4190E+00
POWER INDEX (N) OF K(REL) VS SAT...... (PROP(I,8)) = -0.1000E+01
 (SET N=-1 IF VAN GENUCHTEN REL. REQUIRED)
COEFF (ALPHA) OF SAT. VS CAPIL. HEAD.. (PROP(I,9)) =  0.1150E-01
POWER INDEX (BETA)     ..       ..     (PROP(I,10))=  0.283[illegible]E+01
POWER INDEX (GAMMA)    ..       ..     (PROP(I,11))=  0.5074E+00

MATERIAL NUMBER:    2  (I)

RESIDUAL WATER SATURATION ............ (PROP(I,7)) =  0.0000E+00
POWER INDEX (N) OF K(REL) VS SAT...... (PROP(I,8)) = -0.1000E+01
```

```
 (SET N=-1 IF VAN GENUCHTEN REL. REQUIRED)
COEFF (ALPHA) OF SAT. VS CAPIL. HEAD..  (PROP(I,9)) =  0.1520E-02
POWER INDEX (BETA)      ..      ..      (PROP(I,10))=  0.1170E+01
POWER INDEX (GAMMA)     ..      ..      (PROP(I,11))=  0.1453E+00

MATERIAL NUMBER:    3  (I)

RESIDUAL WATER SATURATION ............. (PROP(I,7)) =  0.4050E+00
POWER INDEX (N) OF K(REL) VS SAT....... (PROP(I,8)) = -0.1000E+01
 (SET N=-1 IF VAN GENUCHTEN REL. REQUIRED)
COEFF (ALPHA) OF SAT. VS CAPIL. HEAD..  (PROP(I,9)) =  0.5000E-02
POWER INDEX (BETA)      ..      ..      (PROP(I,10))=  0.7090E+01
POWER INDEX (GAMMA)     ..      ..      (PROP(I,11))=  0.8590E+00

MATERIAL NUMBER:    4  (I)

RESIDUAL WATER SATURATION ............. (PROP(I,7)) =  0.4190E+00
POWER INDEX (N) OF K(REL) VS SAT....... (PROP(I,8)) = -0.1000E+01
 (SET N=-1 IF VAN GENUCHTEN REL. REQUIRED)
COEFF (ALPHA) OF SAT. VS CAPIL. HEAD..  (PROP(I,9)) =  0.1150E-01
POWER INDEX (BETA)      ..      ..      (PROP(I,10))=  0.2030E+01
POWER INDEX (GAMMA)     ..      ..      (PROP(I,11))=  0.5074E+00
```

X-COORDINATES OF GRID LINES

0.00	500.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00
4000.00	4500.00	5000.00	5400.00	5800.00	6200.00	6600.00	7000.00
7400.00	7800.00	8200.00	8600.00	9000.00	9400.00	9800.00	10200.00
10600.00	11000.00	11400.00	11800.00	12200.00	12600.00	13000.00	13500.00
14000.00	14500.00	15000.00	15500.00	16000.00	16500.00	17000.00	17500.00
18000.00							

Y-COORDINATES OF GRID LINES

0.00	400.00	800.00	1200.00	1400.00	1560.00	1720.00	1880.00
2040.00	2200.00	2290.00	2350.00	2400.00			

*** FINITE-ELEMENT MESH CONNECTIONS ***

(NUMBERING IS COUNTER-CLOCKWISE)

ELEMENT	NODE NUMBERING				ELEMENT	NODE NUMBERING				ELEMENT	NODE NUMBERING			
1	1	14	15	2	2	2	15	16	3	3	3	16	17	4
4	4	17	18	5	5	5	18	19	6	6	6	19	20	7
7	7	20	21	8	8	8	21	22	9	9	9	22	23	10
10	10	23	24	11	11	11	24	25	12	12	12	25	26	13
13	14	27	28	15	14	15	28	29	16	15	16	29	30	17
16	17	30	31	18	17	18	31	32	19	18	19	32	33	20
19	20	33	34	21	20	21	34	35	22	21	22	35	36	23
22	23	36	37	24	23	24	37	38	25	24	25	38	39	26
25	27	40	41	28	26	28	41	42	29	27	29	42	43	30
28	30	43	44	31	29	31	44	45	32	30	32	45	46	33
31	33	46	47	34	32	34	47	48	35	33	35	48	49	36
34	36	49	50	37	35	37	50	51	38	36	38	51	52	39
37	40	53	54	41	38	41	54	55	42	39	42	55	56	43
40	43	56	57	44	41	44	57	58	45	42	45	58	59	46
43	46	59	60	47	44	47	60	61	48	45	48	61	62	49
46	49	62	63	[illegible]	47	50	63	64	51	48	51	64	65	52
49	53	66	67	54	50	54	67	68	55	51	55	68	69	56
52	56	69	70	57	53	57	70	71	58	54	58	71	72	59
55	59	72	73	[illegible]	56	60	73	74	61	57	61	74	75	62
58	62	75	76	[illegible]	59	63	76	77	64	60	64	77	78	65
61	66	79	80	67	62	67	80	81	68	63	68	81	82	69
64	69	82	83	70	65	70	83	84	71	66	71	84	85	72
67	72	85	86	73	68	73	86	87	74	69	74	87	88	75
70	75	88	89	76	71	76	89	90	77	72	77	90	91	78
73	79	92	93	80	74	80	93	94	81	75	81	94	95	82
76	82	95	96	83	77	83	96	97	84	78	84	97	98	85
79	85	98	99	86	80	86	99	100	87	81	87	100	101	88
82	88	101	102	89	83	89	102	103	90	84	90	103	104	91
85	92	105	106	93	86	93	106	107	94	87	94	107	108	95
88	95	108	109	96	89	96	109	110	97	90	97	110	111	98
91	98	111	112	99	92	99	112	113	100	93	100	113	114	101
94	101	114	115	102	95	102	115	116	103	96	103	116	117	104
97	105	118	119	106	98	106	119	120	107	99	107	120	121	108
100	108	121	122	109	101	109	122	123	110	102	110	123	124	111
103	111	124	125	112	104	112	125	126	113	105	113	126	127	114
106	114	127	128	115	107	115	128	129	116	108	116	129	130	117
109	118	131	132	119	110	119	132	133	120	111	120	133	134	121
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373	404	417	418	405	374	405	418	419	406	375	406	419	420	407
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385	417	430	431	418	386	418	431	432	419	387	419	432	433	420
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394	426	439	440	427	395	427	440	441	428	396	428	441	442	429
397	430	443	444	431	398	431	444	445	432	399	432	445	446	433
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409	443	456	457	444	410	444	457	458	445	411	445	458	459	446
412	446	459	460	447	413	447	460	461	448	414	448	461	462	449
415	449	462	463	450	416	450	463	464	451	417	451	464	465	452
418	452	465	466	453	419	453	466	467	454	420	454	467	468	455
421	456	469	470	457	422	457	470	471	458	423	458	471	472	459
424	459	472	473	460	425	460	473	474	461	426	461	474	475	462
427	462	475	476	463	428	463	476	477	464	429	464	477	478	465
430	465	478	479	466	431	466	479	480	467	432	467	480	481	468
433	469	482	483	470	434	470	483	484	471	435	471	484	485	472
436	472	485	486	473	437	473	486	487	474	438	474	487	488	475
439	475	408	489	476	440	476	489	490	477	441	477	490	491	478
442	478	491	492	479	443	479	492	493	480	444	480	493	494	481
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457	495	508	509	496	458	496	509	510	497	459	497	510	511	498
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463	501	514	515	502	464	502	515	516	503	465	503	516	517	504
466	504	517	518	505	467	505	518	519	506	468	506	519	520	507
469	508	521	522	509	470	509	522	523	510	471	510	523	524	511
472	511	524	525	512	473	512	525	526	513	474	513	526	527	514
475	514	527	528	515	476	515	528	529	516	477	516	529	530	517
478	517	530	531	518	479	518	531	532	519	480	519	532	533	520

*** NODAL COORDINATES ***

NODE	X-COOR.	Y-COOR.	NODE	X-COOR.	Y-COOR.	NODE	X-COOR.	Y-COOR.
1	0.00	0.00	2	0.00	400.00	3	0.00	800.00
4	0.00	1200.00	5	0.00	1400.00	6	0.00	1560.00
7	0.00	1720.00	8	0.00	1880.00	9	0.00	2040.00
10	0.00	2200.00	11	0.00	2290.00	12	0.00	2350.00
13	0.00	2400.00	14	500.00	0.00	15	500.00	400.00
16	500.00	800.00	17	500.00	1200.00	18	500.00	1400.00
19	500.00	1560.00	20	500.00	1720.00	21	500.00	1880.00
22	500.00	2040.00	23	500.00	2200.00	24	500.00	2290.00
25	500.00	2350.00	26	500.00	2400.00	27	1000.00	0.00
28	1000.00	400.00	29	1000.00	800.00	30	1000.00	1200.00
31	1000.00	1400.00	32	1000.00	1560.00	33	1000.00	1720.00
34	1000.00	1880.00	35	1000.00	2040.00	36	1000.00	2200.00

37	1000.00	2290.00	38	1000.00	2350.00	39	1000.00	2400.00
40	1500.00	0.00	41	1500.00	400.00	42	1500.00	800.00
43	1500.00	1200.00	44	1500.00	1400.00	45	1500.00	1560.00
46	1500.00	1720.00	47	1500.00	1880.00	48	1500.00	2040.00
49	1500.00	2200.00	50	1500.00	2290.00	51	1500.00	2350.00
52	[illegible]	2400.00	53	2000.00	0.00	54	2000.00	400.00
55	[illegible]	800.00	56	2000.00	1200.00	57	2000.00	1400.00
58	2000.00	1560.00	59	2000.00	1720.00	60	2000.00	1880.00
61	2000.00	2040.00	62	2000.00	2200.00	63	2000.00	2290.00
64	2000.00	2350.00	65	2000.00	2400.00	66	2500.00	0.00
67	2500.00	400.00	68	2500.00	800.00	69	2500.00	1200.00
70	2500.00	1400.00	71	2500.00	1560.00	72	2500.00	1720.00
73	2500.00	1880.00	74	2500.00	2040.00	75	2500.00	2200.00
76	2500.00	2290.00	77	2500.00	2350.00	78	2500.00	2400.00
79	3000.00	0.00	80	3000.00	400.00	81	3000.00	800.00
82	3000.00	1200.00	83	3000.00	1400.00	84	3000.00	1560.00
85	3000.00	1720.00	86	3000.00	1880.00	87	3000.00	2040.00
88	3000.00	2200.00	89	3000.00	2290.00	90	3000.00	2350.00
91	3000.00	2400.00	92	3500.00	0.00	93	3500.00	400.00
94	3500.00	800.00	95	3500.00	1200.00	96	3500.00	1400.00
97	3500.00	1560.00	98	3500.00	1720.00	99	3500.00	1880.00
100	3500.00	2040.00	101	3500.00	2200.00	102	3500.00	2290.00
103	3500.00	2350.00	104	3500.00	2400.00	105	4000.00	0.00
106	4000.00	400.00	107	4000.00	800.00	108	4000.00	1200.00
109	4000.00	1400.00	110	4000.00	1560.00	111	4000.00	1720.00
112	4000.00	1880.00	113	4000.00	2040.00	114	4000.00	2200.00
115	4000.00	2290.00	116	4000.00	2350.00	117	4000.00	2400.00
118	4500.00	0.00	119	4500.00	400.00	120	4500.00	800.00
121	4500.00	1200.00	122	4500.00	1400.00	123	4500.00	1560.00
124	4500.00	1720.00	125	4500.00	1880.00	126	4500.00	2040.00
127	4500.00	2200.00	128	4500.00	2290.00	129	4500.00	2350.00
130	4500.00	2400.00	131	5000.00	0.00	132	5000.00	400.00
133	5000.00	800.00	134	5000.00	1200.00	135	5000.00	1400.00
136	5000.00	1560.00	137	5000.00	1720.00	138	5000.00	1880.00
139	5000.00	2040.00	140	5000.00	2200.00	141	5000.00	2290.00
142	5000.00	2350.00	143	5000.00	2400.00	144	5400.00	0.00
145	5400.00	400.00	146	5400.00	800.00	147	5400.00	1200.00
148	5400.00	1400.00	149	5400.00	1560.00	150	5400.00	1720.00
151	5400.00	1880.00	152	5400.00	2040.00	153	5400.00	2200.00
154	5400.00	2290.00	155	5400.00	2350.00	156	5400.00	2400.00
157	5800.00	0.00	158	5800.00	400.00	159	5800.00	800.00
160	5800.00	1200.00	161	5800.00	1400.00	162	5800.00	1560.00
163	5800.00	1720.00	164	5800.00	1880.00	165	5800.00	2040.00
166	5800.00	2200.00	167	5800.00	2290.00	168	5800.00	2350.00
169	5800.00	2400.00	170	6200.00	0.00	171	6200.00	400.00
172	6200.00	800.00	173	6200.00	1200.00	174	6200.00	1400.00
175	6200.00	1560.00	176	6200.00	1720.00	177	6200.00	1880.00

178	6200.00	2040.00	179	6200.00	2200.00	180	6200.00	2290.00
181	6200.00	2350.00	182	6200.00	2400.00	183	6600.00	0.00
184	6600.00	400.00	185	6600.00	800.00	186	6600.00	1200.00
187	6600.00	1400.00	188	6600.00	1560.00	189	6600.00	1720.00
190	6600.00	1880.00	191	6600.00	2040.00	192	6600.00	2200.00
193	6600.00	2290.00	194	6600.00	2350.00	195	6600.00	2400.00
196	7000.00	0.00	197	7000.00	400.00	198	7000.00	800.00
199	7000.00	1200.00	200	7000.00	1400.00	201	7000.00	1560.00
202	7000.00	1720.00	203	7000.00	1880.00	204	7000.00	2040.00
205	7000.00	2200.00	206	7000.00	2290.00	207	7000.00	2350.00
208	7000.00	2400.00	209	7400.00	0.00	210	7400.00	400.00
211	7400.00	800.00	212	7400.00	1200.00	213	7400.00	1400.00
214	7400.00	1560.00	215	7400.00	1720.00	216	7400.00	1880.00
217	7400.00	2040.00	218	7400.00	2200.00	219	7400.00	2290.00
220	7400.00	2350.00	221	7400.00	2400.00	222	7800.00	0.00
223	7800.00	400.00	224	7800.00	800.00	225	7800.00	1200.00
226	7800.00	1400.00	227	7800.00	1560.00	228	7800.00	1720.00
229	7800.00	1880.00	230	7800.00	2040.00	231	7800.00	2200.00
232	7800.00	2290.00	233	7800.00	2350.00	234	7800.00	2400.00
235	8200.00	0.00	236	8200.00	400.00	237	8200.00	800.00
238	8200.00	1200.00	239	8200.00	1400.00	240	8200.00	1560.00
241	8200.00	1720.00	242	8200.00	1880.00	243	8200.00	2040.00
244	8200.00	2200.00	245	8200.00	2290.00	246	8200.00	2350.00
247	8200.00	2400.00	248	8600.00	0.00	249	8600.00	400.00
250	8600.00	800.00	251	8600.00	1200.00	252	8600.00	1400.00
253	8600.00	1560.00	254	8600.00	1720.00	255	8600.00	1880.00
256	8600.00	2040.00	[illegible]	8600.00	2200.00	258	8600.00	2290.00
259	8600.00	2350.00	260	8600.00	2400.00	261	9000.00	0.00
262	9000.00	400.00	263	9000.00	800.00	264	9000.00	1200.00
265	9000.00	1400.00	266	9000.00	1560.00	267	9000.00	1720.00
268	9000.00	1880.00	269	9000.00	2040.00	270	9000.00	2200.00
271	9000.00	2290.00	272	9000.00	2350.00	273	9000.00	2400.00
274	9400.00	0.00	275	9400.00	400.00	276	9400.00	800.00
277	9400.00	1200.00	278	9400.00	1400.00	279	9400.00	1560.00
280	9400.00	1720.00	281	9400.00	1880.00	282	9400.00	2040.00
283	9400.00	2200.00	284	9400.00	2290.00	285	9400.00	2350.00
286	9400.00	2400.00	287	9800.00	0.00	288	9800.00	400.00
289	9800.00	800.00	290	9800.00	1200.00	291	9800.00	1400.00
292	9800.00	1560.00	293	9800.00	1720.00	294	9800.00	1880.00
295	9800.00	2040.00	296	9800.00	2200.00	297	9800.00	2290.00
298	9800.00	2350.00	299	9800.00	2400.00	300	10200.00	0.00
301	10200.00	400.00	302	10200.00	800.00	303	10200.00	1200.00
304	10200.00	1400.00	305	10200.00	1560.00	306	10200.00	1720.00
307	10200.00	1880.00	308	10200.00	2040.00	309	10200.00	2200.00
310	10200.00	2290.00	311	10200.00	2350.00	312	10200.00	2400.00
313	10600.00	0.00	314	10600.00	400.00	315	10600.00	800.00
316	10600.00	1200.00	317	10600.00	1400.00	318	10600.00	1560.00

319	10600.00	1720.00	320	10600.00	[illegible]	321	10600.00	2040.00
322	10600.00	2200.00	323	10600.00	2290.00	324	10600.00	2350.00
325	10600.00	2400.00	326	11000.00	0.00	327	11000.00	400.00
328	11000.00	800.00	329	11000.00	1200.00	330	11000.00	1400.00
331	11000.00	1560.00	332	11000.00	1720.00	333	11000.00	1880.00
334	11000.00	2040.00	335	11000.00	2200.00	336	11000.00	2290.00
337	11000.00	2350.00	338	11000.00	2400.00	339	11400.00	0.00
340	11400.00	400.00	341	11400.00	800.00	342	11400.00	1200.00
343	11400.00	1400.00	344	11400.00	1560.00	345	11400.00	1720.00
346	11400.00	1880.00	347	11400.00	2040.00	348	11400.00	2200.00
349	11400.00	2290.00	350	11400.00	2350.00	351	11400.00	2400.00
352	11800.00	0.00	353	11800.00	400.00	354	11800.00	800.00
355	11800.00	1200.00	356	11800.00	1400.00	357	11800.00	1560.00
358	11800.00	1720.00	359	11800.00	1880.00	360	11800.00	2040.00
361	11800.00	2200.00	362	11800.00	2290.00	363	11800.00	2350.00
364	11800.00	2400.00	365	12200.00	0.00	366	12200.00	400.00
367	12200.00	800.00	368	12200.00	1200.00	369	12200.00	1400.00
370	12200.00	1560.00	371	12200.00	1720.00	372	12200.00	1880.00
373	12200.00	2040.00	374	12200.00	2200.00	375	12200.00	2290.00
376	12200.00	2350.00	377	12200.00	2400.00	378	12600.00	0.00
379	12600.00	400.00	380	12600.00	800.00	381	12600.00	1200.00
382	12600.00	1400.00	383	12600.00	1560.00	384	12600.00	1720.00
385	12600.00	1880.00	386	12600.00	2040.00	387	12600.00	2200.00
388	12600.00	2290.00	389	12600.00	2350.00	390	12600.00	2400.00
391	13000.00	0.00	392	13000.00	400.00	393	13000.00	800.00
394	13000.00	1200.00	395	13000.00	1400.00	396	13000.00	1560.00
397	13000.00	1720.00	398	13000.00	1880.00	399	13000.00	2040.00
400	13000.00	2200.00	401	13000.00	2290.00	402	13000.00	2350.00
403	13000.00	2400.20	404	13500.00	0.00	405	13500.00	400.00
406	13500.00	800.00	407	13500.00	1200.00	408	13500.00	1400.00
409	13500.00	1560.00	410	13500.00	1720.00	411	13500.00	1880.00
412	13500.00	2040.00	413	13500.00	[illegible]200.00	414	13500.00	2290.00
415	13500.00	2350.00	416	13500.00	2400.00	417	14000.00	0.00
418	14000.00	400.00	419	14000.00	800.00	420	14000.00	1200.00
421	14000.00	1400.00	422	14000.00	1560.00	423	14000.00	1720.00
424	14000.30	1880.00	425	14000.00	2040.00	426	14000.00	2200.00
427	14000.00	2290.00	428	14000.00	2350.00	429	14000.00	2400.00
430	14500.00	0.00	431	14500.00	400.00	432	14500.00	800.00
433	14500.00	1200.00	434	14500.00	1400.00	435	14500.00	1560.00
436	14500.00	1720.00	437	14500.00	1880.00	438	14500.00	2040.[illegible]
439	14500.00	2200.00	440	14500.00	2290.00	441	14500.00	2350 .0
442	14500.00	2400.00	443	15000.00	0.00	444	15000.[illegible]	400.00
445	15000.00	800.00	446	15000.00	120[illegible].00	447	15000.[illegible]	1400.00
448	15000.00	1560.00	449	15000.00	1720.00	450	15000[illegible]	[illegible]880.00
451	15000.00	2040.00	452	15000.00	2200.00	453	15000.[illegible]	[illegible]290.00
454	15000.00	2350.00	455	15000.00	2400.00	456	15500.00	0.00
457	15500.00	400.00	458	15500.00	800.00	459	15500.00	200.00

460	15500.00	1400.00	461	15500.00	1560.00	462	15500.00	1720.00
463	15500.00	1880.00	464	15500.00	2040.00	465	15500.00	2200.00
466	15500.00	2290.00	467	15500.00	2350.00	468	15500.00	2400.00
469	16000.00	0.00	470	16000.00	400.00	471	16000.00	800.00
472	16000.00	1200.00	473	16000.00	1400.00	474	16000.00	1560.00
475	16000.00	1720.00	476	16000.00	1880.00	477	16000.00	2040.00
478	16000.00	2200.00	479	16000.00	2290.00	480	16000.00	2350.00
481	16000.00	2400.00	482	16500.00	0.00	483	16500.00	400.00
484	16500.00	800.00	485	16500.00	1200.00	486	16500.00	1400.00
487	16500.00	1560.00	488	16500.00	1720.00	489	16500.00	1880.00
490	16500.00	2040.00	491	16500.00	2200.00	492	16500.00	2290.00
493	16500.00	2350.00	494	16500.00	2400.00	495	17000.00	0.00
496	17000.00	400.00	497	17000.00	800.00	498	17000.00	1200.00
499	17000.00	1400.00	500	17000.00	1560.00	501	17000.00	1720.00
502	17000.00	1880.00	503	17000.00	2040.00	504	17000.00	2200.00
505	17000.00	2290.00	506	17000.00	2350.00	507	17000.00	2400.00
508	17500.00	0.00	509	17500.00	400.00	510	17500.00	800.00
511	17500.00	1200.00	512	17500.00	1400.00	513	17500.00	1560.00
514	17500.00	1720.00	515	17500.00	1880.00	516	17500.00	2040.00
517	17500.00	2200.00	518	17500.00	2290.00	519	17500.00	2350.00
520	17500.00	2400.00	521	18000.00	0.00	522	18000.00	400.00
523	18000.00	800.00	524	18000.00	1200.00	525	18000.00	1400.00
526	18000.00	1560.00	527	18000.00	1720.00	528	18000.00	1880.00
529	18000.00	2040.00	530	18000.00	2200.00	531	18000.00	2290.00
532	18000.00	2350.00	533	18000.00	2400.00			

BOUNDARY CONDITION DATA

NUMBER OF STEADY DIRICHLET BOUNDARIES . . . ... (NBTO) = 41
NUMBER OF STEADY FLUX BOUNDARIES .... (NDFLUX) = 41
NUMBER OF TRANSIENT DIRICHLET BOUNDARIES. .. (NBHVAR) = 0
NUMBER OF TRANSIENT FLUX BOUNDARIES........ (NBFVAR) = 0

DIRICHLET BOUNDARY CONDITION DATA

INDEX	NODE NUMBER	DEP. VAR. #	PRESCRIBED VALUE
1	1	1	0.0000E+00
2	14	1	0.0000E+00
3	27	1	0.0000E+00
4	40	1	0.0000E+00
5	53	1	0.0000E+00

6	66	1	0.0000E+00
7	79	1	0.0000E+00
8	92	1	0.0000E+00
9	105	1	0.0000E+00
10	118	1	0.0000E+00
11	131	1	0.0000E+00
12	144	1	0.0000E+00
13	157	1	0.0000E+00
14	170	1	0.0000E+00
15	183	1	0.0000E+00
16	196	1	0.0000E+00
17	209	1	0.0000E+00
18	222	1	0.0000E+00
19	235	1	0.0000E+00
20	248	1	0.0000E+00
21	261	1	0.0000E+00
22	274	1	0.0000E+00
23	287	1	0.0000E+00
24	300	1	0.0000E+00
25	313	1	0.0000E+00
26	326	1	0.0000E+00
27	339	1	0.0000E+00
28	352	1	0.0000E+00
29	365	1	0.0000E+00
30	378	1	0.0000E+00
31	391	1	0.0000E+00
32	404	1	0.0000E+00
33	417	1	0.0000E+00
34	430	1	0.0000E+00
35	443	1	0.0000E+00
36	456	1	0.0000E+00
37	469	1	0.0000E+00
38	482	1	0.0000E+00
39	495	1	0.0000E+00
40	508	1	0.0000E+00
41	521	1	0.0000E+00

FLUX BOUNDARY CONDITION DATA

NODE #	D.O.F. #	B.C. CODE	FLUID FLUX	DUMMY ARRAY
13	1	0	17.10	0.0000E+00
26	1	0	34.30	0.0000E+00

39	1	0	34.30	0.0000E+00
52	1	0	34.30	0.0000E+00
65	1	0	34.30	0.0000E+00
78	1	0	34.30	0.0000E+00
91	1	0	34.30	0.0000E+00
104	1	0	34.30	0.0000E+00
117	1	0	34.30	0.0000E+00
130	1	0	34.30	0.0000E+00
143	1	0	30.80	0.0000E+00
156	1	0	27.50	0.0000E+00
169	1	0	27.50	0.0000E+00
182	1	0	27.50	0.0000E+00
195	1	0	27.50	0.0000E+00
208	1	0	27.50	0.0000E+00
221	1	0	27.50	0.0000E+00
234	1	0	27.50	0.0000E+00
247	1	0	27.50	0.0000E+00
260	1	0	27.50	0.0000E+00
273	1	0	27.50	0.0000E+00
286	1	0	27.50	0.0000E+00
299	1	0	27.50	0.0000E+00
312	1	0	27.50	0.0000E+00
325	1	0	27.50	0.0000E+00
338	1	0	27.50	0.0000E+00
351	1	0	27.50	0.0000E+00
364	1	0	27.50	0.0000E+00
377	1	0	27.50	0.0000E+00
390	1	0	27.50	0.0000E+00
403	1	0	30.80	0.0000E+00
416	1	0	34.30	0.0000E+00
429	1	0	34.30	0.0000E+00
442	1	0	34.30	0.0000E+00
455	1	0	34.30	0.0000E+00
468	1	0	34.30	0.0000E+00
481	1	0	34.30	0.0000E+00
494	1	0	34.30	0.0000E+00
507	1	0	34.30	0.0000E+00
520	1	0	34.30	0.0000E+00
533	1	0	17.10	0.0000E+00

——— ACTUAL HALF BAND WIDTH = 14 FULL BANDWIDTH = 29 ———

*** ELEMENT CENTROIDAL COORDINATES ***

ELEMENT	X-COOR.	Y-COOR.	ELEMENT	X-COOR.	Y-COOR.	ELEMENT	X-COOR.	Y-COOR.
1	250.00	200.00	2	250.00	600.00	3	256.00	1000.00
4	250.00	1300.90	5	250.00	1480.00	6	250.06	1640.00
7	25[illegible].00	1800.00	8	250.00	1960.00	9	250.00	2120.00
10	250.00	2245.00	11	250.00	2320.00	12	250.00	2375.00
13	750.00	200.00	14	750.00	600.00	15	750.00	1000.00
16	750.00	1300.00	17	750.00	1480.00	18	750.00	1640.00
19	750.00	1800.00	20	750.00	1960.00	21	750.00	2120.00
22	750.00	2245.00	23	750.00	2320.00	24	750.00	2375.00
25	1250.00	200.00	26	1250.00	600.00	27	1250.00	1000.00
28	1250.00	1300.00	29	1250.00	1480.00	30	1250.00	1640.00
31	1250.00	1800.00	32	1250.00	1960.00	33	1250.00	2120.00
34	1250.00	2245.00	35	1250.00	2320.00	36	1250.00	2375.00
37	1750.00	200.00	38	1750.00	600.00	39	1750.00	1000.00
40	1750.00	1300.00	41	1750.00	1480.00	42	1750.00	1640.00
43	1750.00	1800.00	44	1750.00	1960.00	45	1750.00	2120.00
46	1750.00	2245.00	47	1750.00	2320.00	48	1750.00	2375.00
49	2256.00	200.00	50	2250.00	600.00	51	2250.00	1000.00
52	2250.00	1300.00	53	2250.00	1480.00	54	2250.00	1640.00
55	2250.00	1800.00	56	2250.00	1960.00	57	2250.00	2120.00
58	2250.00	2245.00	59	2250.00	2320.00	60	2250.00	2375.00
61	2750.00	200.00	62	2750.00	600.00	63	2750.00	1000.00
64	2750.00	1300.00	65	2750.00	1480.00	66	2750.00	1640.00
67	2750.00	1800.00	68	2750.00	1960.00	69	2750.00	2120.00
70	2750.00	2245.00	71	2750.00	2320.00	72	2750.00	2375.00
73	3250.00	200.00	74	3250.00	600.00	75	3250.00	1000.00
76	3250.00	1300.00	77	3250.00	1480.00	78	3250.00	1640.00
79	3250.00	1800.00	80	3250.00	1960.00	81	3250.00	2120.00
82	3250.00	2245.00	83	3250.00	2320.00	84	3250.00	2375.00
85	3750.00	200.00	86	3750.00	600.00	87	3750.00	1000.00
88	3750.00	1300.00	89	3750.00	1480.00	90	3750.00	1640.00
91	3750.00	1800.00	92	3750.00	1960.00	93	3750.00	2120.00
94	3750.00	2245.00	95	3750.00	2320.00	96	3750.00	2375.00
97	4250.00	200.00	98	4259.00	600.00	99	4250.00	1000.00
100	4250.00	1300.00	101	4250.00	1480.00	102	4250.00	1640.00
103	4250.00	1800.00	104	4250.00	1960.00	105	4250.00	2120.00
106	4250.00	2245.00	107	4250.00	2320.00	108	4250.00	2375.00
109	4750.00	200.00	110	4750.00	800.00	111	4750.00	1000.00
112	4750.00	1300.00	113	4750.00	1480.00	114	4750.00	1640.00
115	4750.00	1800.00	116	4750.00	1960.00	117	4750.00	2120.00
118	4750.00	2245.00	119	4750.00	2320.00	120	4750.00	2375.00
121	5209.00	200.00	122	5200.00	600.00	123	5200.00	1000.00

124	5200.00	1300.00	125	5200.00	1480.00	126	5200.00	1640.00
127	5200.00	1800.00	128	5200.00	1960.00	129	5200.00	2120.00
130	5200.00	2245.00	131	5200.00	2320.00	132	5200.00	2375.00
133	5600.00	200.00	134	5600.00	600.00	135	5600.00	1000.00
136	5600.00	1300.00	137	5600.00	1480.00	138	5600.00	1640.00
139	5600.00	1800.00	140	5600.00	1960.00	141	5600.00	2120.00
142	5600.00	2245.00	143	5600.00	2320.00	144	5600.00	2375.00
145	6000.00	200.00	146	6000.00	600.00	147	6000.00	1000.00
148	6000.00	1300.00	149	6000.00	1480.00	150	6000.00	1640.00
151	6000.00	1800.00	152	6000.00	1960.00	153	6000.00	2120.00
154	6000.00	2245.00	155	6000.00	2320.00	156	6000.00	2375.00
157	6400.00	200.00	158	6400.00	600.00	159	6400.00	1000.00
160	6400.00	1300.00	161	6400.00	1480.00	162	6400.00	1640.00
163	6400.00	1800.00	164	6400.00	1960.00	165	6400.00	2120.00
166	6400.00	2245.00	167	6400.00	2320.00	168	6400.00	2375.00
169	6800.00	200.00	170	6800.00	600.00	171	6800.00	1000.00
172	6800.00	1300.00	173	6800.00	1480.00	174	6800.00	1640.00
175	6800.00	1800.00	176	6800.00	1960.00	177	6800.00	2120.00
178	6800.00	2245.00	179	6800.00	2320.00	180	6800.00	2375.00
181	7200.00	200.00	182	7200.00	600.00	183	7200.00	1000.00
184	7200.00	1300.00	185	7200.00	1480.00	186	7200.00	1640.00
187	7200.00	1800.00	188	7200.00	1960.00	189	7200.00	2120.00
190	7200.00	2245.00	191	7200.00	2320.00	192	7200.00	2375.00
193	7600.00	200.00	194	7600.00	600.00	195	7600.00	1000.00
196	7600.00	1300.00	197	7600.00	1480.00	198	7600.00	1640.00
199	7600.00	1800.00	200	7600.00	1960.00	201	7600.00	2120.00
202	7600.00	2245.00	203	7600.00	2320.00	204	7600.00	2375.00
205	8000.00	200.00	206	8000.00	600.00	207	8000.00	1000.00
208	8000.00	1300.00	209	8000.00	1480.00	210	8000.00	1640.00
211	8000.00	1800.00	212	8000.00	1960.00	213	8000.00	2120.00
214	8000.00	2245.00	215	8000.00	2320.00	216	8000.00	2375.00
217	8400.00	200.00	218	8400.00	600.00	219	8400.00	1000.00
220	8400.00	1300.00	221	8400.00	1480.00	222	8400.00	1640.00
223	8400.00	1800.00	224	8400.00	1960.00	225	8400.00	2120.00
226	8400.00	2245.00	227	8400.00	2320.00	228	8400.00	2375.00
229	8800.00	200.00	230	8800.00	600.00	231	8800.00	1000.00
232	8800.00	1300.00	233	8800.00	1480.00	234	8800.00	1640.00
235	8800.00	1800.00	236	8800.00	1960.00	237	8800.00	2120.00
238	8800.00	2245.00	239	8800.00	2320.00	240	8800.00	2375.00
241	9200.00	200.00	242	9200.00	600.00	243	9200.00	1000.00
244	9200.00	1300.00	245	9200.00	1480.00	246	9200.00	1640.00
247	9200.00	1800.00	248	9200.00	1960.00	249	9200.00	2120.00
250	9200.00	2245.00	251	9200.00	2320.00	252	9200.00	2375.00
253	9600.00	200.00	254	9600.00	600.00	255	9600.00	1000.00
256	9600.00	1300.00	257	9600.00	1480.00	258	9600.00	1640.00
259	9600.00	1800.00	260	9600.00	1960.00	261	9600.00	2120.00
262	9600.00	2245.00	263	9600.00	2320.00	264	9600.00	2375.00

265	10000.00	200.00	266	10000.00	600.00	267	10000.00	1000.00
268	10000.00	1300.00	269	10000.00	1480.00	270	10000.00	1640.00
271	10000.00	1800.00	272	10000.00	1960.00	273	10000.00	2120.00
274	10000.00	2245.00	275	10000.00	2320.00	276	10000.00	2375.00
277	10400.00	200.00	278	10400.00	600.00	279	10400.00	1000.00
280	10400.00	1300.00	281	10400.00	1480.00	282	10400.00	1640.00
283	10400.00	1800.00	284	10400.00	1960.00	285	10400.00	2120.00
286	10400.00	2245.00	287	10400.00	2320.00	288	10400.00	2375.00
289	10800.00	200.00	290	10800.00	600.00	291	10800.00	1000.00
292	10800.00	1300.00	293	10800.00	1480.00	294	10800.00	1640.00
295	10800.00	1800.00	296	10800.00	1960.00	297	10800.00	2120.00
298	10800.00	2245.00	299	10800.00	2320.00	300	10800.00	2375.00
301	11200.00	200.00	302	11200.00	600.00	303	11200.00	1000.00
304	11200.00	1300.00	305	11200.00	1480.00	306	11200.00	1640.00
307	11200.00	1800.00	308	11200.00	1960.00	309	11200.00	2120.00
310	11200.00	2245.00	311	11200.00	2320.00	312	11200.00	2375.00
313	11600.00	200.00	314	11600.00	600.00	315	11600.00	1000.00
316	11600.00	1300.00	317	11600.00	1480.00	318	11600.00	1640.00
319	11600.00	1800.00	320	11600.00	1960.00	321	11600.00	2120.00
322	11600.00	2245.00	323	11600.00	2320.00	324	11600.00	2375.00
325	12000.00	200.00	326	12000.00	600.00	327	12000.00	1000.00
328	12000.00	1300.00	329	12000.00	1480.00	330	12000.00	1640.00
331	12000.00	1800.00	332	12000.00	1960.00	333	12000.00	2120.00
334	12000.00	2245.00	335	12000.00	2320.00	336	12000.00	2375.00
337	12400.00	200.00	338	12400.00	600.00	339	12400.00	1000.00
340	12400.00	1300.00	341	12400.00	1480.00	342	12400.00	1640.00
343	12400.00	1800.00	344	12400.00	1960.00	345	12400.00	2120.00
346	12400.00	2245.00	347	12400.00	2320.00	348	12400.00	2375.00
349	12800.00	200.00	350	12800.00	600.00	351	12800.00	1000.00
352	12800.00	1300.00	353	12800.00	1480.00	354	12800.00	1640.00
355	12800.00	1800.00	356	12800.00	1960.00	357	12800.00	2120.00
358	12800.00	2245.00	359	12800.00	2320.00	360	12800.00	2375.00
361	13250.00	200.00	362	13250.00	600.00	363	13250.00	1000.00
364	13250.00	1300.00	365	13250.00	1480.00	366	13250.00	1640.00
367	13250.00	1800.00	368	13250.00	1960.00	369	13250.00	2120.00
370	13250.00	2245.00	[illegible]	13250.00	2320.00	372	13250.00	2375.00
373	13750.00	200.00	[illegible]	13750.00	600.00	375	13750.00	1000.00
376	13750.00	1300.00	[illegible]	13750.00	1480.00	378	13750.00	1640.00
379	13750.00	1800.00	[illegible]	13750.00	1960.00	381	13750.00	2120.00
382	13750.00	2245.00	[illegible]	13750.00	2320.00	384	13750.00	2375.00
385	14250.00	200.00	386	14250.00	600.00	387	14250.00	1000.00
388	14250.00	1300.00	389	14250.00	1480.00	390	14250.00	1640.00
391	14250.00	1800.00	392	14250.00	1960.00	393	14250.00	2120.00
394	14250.00	2245.00	395	14250.00	2320.00	396	14250.00	2375.00
397	14750.00	200.00	398	14750.00	600.00	399	14750.00	1000.00
400	14750.00	1300.00	401	14750.00	1480.00	402	14750.00	1640.00
403	14750.00	1800.00	404	14750.00	1960.00	405	14750.00	2120.00

406	14750.00	2245.00	407	14750.00	2320.00	408	14750.00	2375.00
409	15250.00	200.00	410	15250.00	600.00	411	15250.00	1000.00
412	15250.00	1300.00	413	15250.00	1480.00	414	15250.00	1640.00
415	15250.00	1800.00	416	15250.00	1960.00	417	15250.00	2120.00
418	15250.00	2245.00	419	15250.00	2320.00	420	15250.00	2375.00
421	15750.00	200.00	422	15750.00	600.00	423	15750.00	1000.00
424	15750.00	1300.00	425	15750.00	1480.00	426	15750.00	1640.00
427	15750.00	1800.00	428	15750.00	1960.00	429	15750.00	2120.00
430	15750.00	2245.00	431	15750.00	2320.00	432	15750.00	2375.00
433	16250.00	200.00	434	16250.00	600.00	435	16250.00	1000.00
436	16250.00	1300.00	437	16250.00	1480.00	438	16250.00	1640.00
439	16250.00	1800.00	440	16250.00	1960.00	441	16250.00	2120.00
442	16250.00	2245.00	443	16250.00	2320.00	444	16250.00	2375.00
445	16750.00	200.00	446	16750.00	600.00	447	16750.00	1000.00
448	16750.00	1300.00	449	16750.00	1480.00	450	16750.00	1640.00
451	16750.00	1800.00	452	16750.00	1960.00	453	16750.00	2120.00
454	16750.00	2245.00	455	16750.00	2320.00	456	16750.00	2375.00
457	17250.00	200.00	458	17250.00	600.00	459	17250.00	1000.00
460	17250.00	1300.00	461	17250.00	1480.00	462	17250.00	1640.00
463	17250.00	1800.00	464	17250.00	1960.00	465	17250.00	2120.00
466	17250.00	2245.00	467	17250.00	2320.00	468	17250.00	2375.00
469	17750.00	200.00	470	17750.00	600.00	471	17750.00	1000.00
472	17750.00	1300.00	473	17750.00	1480.00	474	17750.00	1640.00
475	17750.00	1800.00	476	17750.00	1960.00	477	17750.00	2120.00
478	17750.00	2245.00	479	17750.00	2320.00	480	17750.00	2375.00

LIST OF OBSERVATION NODES

162 175 188 201 214 227 240 253 266 279

+++++++++ BEGIN TRANSIENT CALCULATIONS ++++++++

**** ELAPSED SIMULATION TIME : 5.0000E-02 TIME STEP NUMBER : 1 TIME STEP SIZE: 0.500E-01 ****

NUMBER OF

ITERATION	NON-CONVERGENT NODES	MAXIMUM ERROR	NODE NUMBER	RELAXATION FACTOR
1	522	100.0	521	1.00
2	492	-52.94	415	0.700
3	485	-49.40	153	1.00
4	425	-54.95	373	1.00
5	373	-64.65	374	1.00
6	149	-57.73	374	1.00
7	129	-36.40	360	1.00
8	91	-10.18	361	1.00
9	0	-0.4827	179	1.00

*** NODAL HEAD VALUES ***

NODE	HEAD VALUE	NODE	HEAD VALUE	NODE	HEAD VALUE	NODE	HEAD VALUE	NODE	HEAD VALUE
1	0.0000E+00	2	-198.9	3	-230.8	4	-234.9	5	-235.3
6	-235.5	7	-235.5	8	-235.5	9	-235.5	10	-235.6
11	-235.7	12	-235.8	13	-235.9	14	0.0000E+00	15	-198.9
16	-230.8	17	-234.9	18	-235.3	19	-235.4	20	-235.4
21	-235.4	22	-235.4	23	-235.3	24	-235.3	25	-235.2
26	-235.1	27	0.0000E+00	28	-198.9	29	-230.7	30	-234.8
31	-235.3	32	-235.4	33	-235.4	34	-235.3	35	-235.3
36	-235.4	37	-235.4	38	-235.5	39	-235.5	40	0.0000E+00
41	-198.9	42	-230.8	43	-234.8	44	-235.1	45	-235.2
46	-235.3	47	-235.5	48	-235.6	49	-235.3	50	-235.3
51	-235.3	52	-235.3	53	0.0000E+00	54	-198.7	55	-230.6
56	-235.0	57	-235.6	58	-235.7	59	-235.4	60	-235.0
61	-234.9	62	-235.6	63	-235.4	64	-235.5	65	-235.5
66	0.0000E+00	67	-198.4	68	-230.3	69	-234.1	70	-234.5
71	-235.0	72	-235.7	73	-236.4	74	-236.2	75	-234.7
76	-235.2	77	-235.0	78	-235.1	79	0.0000E+00	80	-195.9
81	-231.9	82	-236.4	83	-236.0	84	-234.8	85	-233.5
86	-232.8	87	-234.1	88	-237.5	89	-235.8	90	-236.2
91	-235.9	92	0.0000E+00	93	-186.9	94	-223.8	95	-233.2
96	-237.8	97	-240.6	98	-242.2	99	-241.7	100	-236.3
101	-229.4	102	-234.6	103	-233.7	104	-234.7	105	0.0000E+00
106	-172.1	107	-196.7	108	-202.0	109	-205.5	110	-209.3
111	-215.0	112	-224.1	113	-240.0	114	-252.2	115	-236.3
116	-238.8	117	-235.8	118	0.0000E+00	119	-180.4	120	-17[illegible]
121	-170.8	122	-168.1	123	-165.6	124	-162.7	125	-158.9

126	-153.6	127	-167.5	128	-228.4	129	-225.5	130	-235.6
131	0.0000E+00	132	-163.9	133	-175.9	134	-173.3	135	-169.9
136	-166.8	137	-163.5	138	-159.5	139	-154.5	140	-124.5
141	-49.27	142	-109.1	143	-150.9	144	0.0000E+00	145	-179.9
146	-204.2	147	-208.4	148	-210.9	149	-213.7	150	-218.0
151	-225.1	152	-238.1	153	-307.6	154	-43.98	155	-104.0
156	-146.1	157	0.0000E+00	158	-203.1	159	-249.4	160	-265.4
161	-277.4	162	-289.1	163	-304.1	164	-326.2	165	-363.4
166	-394.4	167	-39.40	168	-99.38	169	-142.4	170	0.0000E+00
171	-227.9	172	-301.3	173	-330.4	174	-349.7	175	-365.7
176	-382.0	177	-397.2	178	-403.9	179	-405.6	180	-35.34
181	-95.34	182	-138.9	183	0.0000E+00	184	-250.3	185	-344.7
186	-378.1	187	-391.8	188	-398.7	189	-401.6	190	-401.4
191	-401.4	192	-401.6	193	-31.84	194	-91.84	195	-135.9
196	0.0000E+00	197	-267.3	198	-366.5	199	-391.5	200	-396.1
201	-397.1	202	-397.3	203	-397.7	204	-397.9	205	-397.8
206	-28.89	207	-88.88	208	-133.3	209	0.0000E+00	210	-278.1
211	-370.9	212	-390.1	213	-393.1	214	-394.0	215	-394.4
216	-394.5	217	-394.4	218	-394.4	219	-26.48	220	-86.47
221	-131.2	222	0.0000E+00	223	-284.0	224	-370.6	225	-388.0
226	-390.8	227	-391.5	228	-391.7	229	-391.7	230	-391.7
231	-391.6	232	-24.61	233	-84.60	234	-129.6	235	0.0000E+00
236	-286.8	237	-369.9	238	-386.3	239	-388.8	240	-389.5
241	-389.7	242	-389.7	243	-389.7	244	-389.6	245	-23.27
246	-83.27	247	-128.4	248	0.0000E+00	249	-287.9	250	-369.3
251	-385.3	252	-387.6	253	-388.3	254	-388.5	255	-388.5
256	-388.4	257	-388.4	258	-22.47	259	-82.47	260	-127.7
261	0.0000E+00	262	-288.2	263	-369.1	264	-384.9	265	-387.3
266	-387.9	267	-388.0	268	-388.1	269	-388.0	270	-387.9
271	-22.21	272	-82.20	273	-127.4	274	0.0000E+00	275	-287.9
276	-369.3	277	-385.3	278	-387.6	279	-388.3	280	-388.5
281	-388.5	282	-388.4	283	-388.4	284	-22.47	285	-82.47
286	-127.7	287	0.0000E+00	288	-286.8	289	-369.9	290	-386.3
291	-388.8	292	-389.5	293	-389.7	294	-389.7	295	-389.7
296	-389.6	297	-23.27	298	-83.27	299	-128.4	300	0.0000E+00
301	-284.0	302	-370.6	303	-388.0	304	-390.8	305	-391.5
306	-391.7	307	-391.7	308	-391.7	309	-391.6	310	-24.61
311	-84.60	312	-129.6	313	0.0000E+00	314	-278.1	315	-370.9
316	-390.1	317	-393.1	318	-394.0	319	-394.4	320	-394.5
321	-394.4	322	-394.4	323	-26.48	324	-86.47	325	-131.2
326	0.0000E+00	327	-267.3	328	-366.5	329	-391.5	330	-396.1
331	-397.1	332	-397.3	333	-397.7	334	-397.9	335	-397.8
336	-28.89	337	-88.88	338	-133.3	339	0.0000E+00	340	-250.3
341	-344.7	342	-378.1	343	-391.8	344	-398.7	345	-401.6
346	-401.4	347	-401.4	348	-401.6	349	-31.84	350	-91.84
351	-135.9	352	0.0000E+00	353	-227.9	354	-301.3	355	-330.4
356	-349.7	357	-365.7	358	-382.0	359	-397.2	360	-403.9

361	-405.6	362	-35.34	363	-95.34	364	-138.9	365	0.0000E+00
366	-203.1	367	-249.4	368	-265.4	369	-277.4	370	-289.1
371	-304.1	372	-326.2	373	-363.4	374	-394.4	375	-39.40
376	-99.38	377	-142.4	378	0.0000E+00	379	-179.9	380	-204.2
381	-208.4	382	-210.9	383	-213.7	384	-218.0	385	-225.1
386	-238.1	387	-307.6	388	-43.98	389	-104.0	390	-14[illegible].1
391	0.0000E+00	392	-163.9	393	-175.9	394	-173.3	395	-159.9
396	-166.8	397	-163.5	398	-159.5	399	-154.6	400	-124.5
401	-49.27	402	-109.1	403	-150.9	404	0.0000E+00	405	-160.4
406	-172.8	407	-170.8	408	-168.1	409	-165.6	410	-162.7
411	-150.9	412	-153.6	413	-167.5	414	-220.4	415	-225.5
416	-235.6	417	0.0000E+00	418	-172.1	419	-196.7	420	-202.0
421	-205.5	422	-209.3	423	-215.0	424	-224.1	425	-240.0
426	-252.2	427	-236.3	428	-238.8	429	-235.8	430	0.0000E+00
431	-186.9	432	-223.8	433	-233.2	434	-237.8	435	-240.6
436	-242.2	437	-241.7	438	-236.3	439	-229.4	440	-234.6
441	-233.7	442	-234.7	443	0.0000E+00	444	-195.9	445	-231.9
446	-236.4	447	-236.0	448	-234.8	449	-233.5	450	-232.6
451	-234.1	452	-237.5	453	-235.8	454	-236.2	455	-235.9
456	0.0000E+00	457	-198.4	458	-230.3	459	-234.1	460	-234.5
461	-235.0	462	-235.7	463	-236.4	464	-236.2	465	-234.7
466	-235.2	467	-235.0	468	-235.1	469	0.0000E+00	470	-198.7
471	-230.6	472	-235.0	473	-235.6	474	-235.7	475	-235.4
476	-235.0	477	-234.9	478	-235.6	479	-235.4	480	-235.5
481	-235.5	482	0.0000E+00	483	-198.9	484	-230.8	485	-234.8
486	-235.1	487	-235.2	488	-235.3	489	-235.5	490	-235.6
491	-235.3	492	-235.3	493	-235.3	494	-235.3	495	0.0000E+00
496	-198.9	497	-230.7	498	-234.8	499	-235.3	500	-235.4
501	-235.4	502	-235.3	503	-235.3	504	-235.4	505	-235.4
506	-235.5	507	-235.5	508	0.0000E+00	509	-198.9	510	-230.8
511	-234.9	512	-235.3	513	-235.4	514	-235.4	515	-235.4
516	-235.4	517	-235.3	518	-235.3	519	-235.2	520	-235.1
521	0.0000E+00	522	-198.9	523	-230.8	524	-234.9	525	-235.3
526	-235.5	527	-235.5	528	-235.5	529	-235.5	530	-235.6
531	-235.7	532	-235.8	533	-235.9				

*** LIST OF PARTIALLY SATURATED ELEMENTS ***

ELEM.	SAT. VALUE	ELEM.	SAT. VALUE	ELEM.	SAT. VALUE	ELEM.	SAT. VALUE	ELEM.	SAT. VALUE
1	0.7986	2	0.6313	3	0.6165	4	0.6148	5	0.6146
6	0.6145	7	0.6145	8	0.6145	9	0.6145	10	0.6145
11	0.6145	12	0.6145	13	0.7986	14	0.6313	15	0.6166

16	0.6148	17	0.6146	18	0.6146	19	0.6146	20	0.6146
21	0.6146	22	0.6146	23	0.6145	24	0.6146	25	0.7987
26	0.6313	27	0.6166	28	0.6149	29	0.6147	30	0.6146
31	0.6146	32	0.6146	33	0.6146	34	0.6146	35	0.6146
36	0.6146	37	0.7987	38	0.6314	39	0.6166	40	0.6148
41	0.6146	42	0.6146	43	0.6146	44	0.6147	45	0.6146
46	0.6145	47	0.6146	48	0.6146	49	0.7990	50	0.6315
51	0.6168	52	0.6150	53	0.6147	54	0.6145	55	0.6144
56	0.6144	57	0.6146	58	0.6147	59	0.6146	60	0.6146
61	0.8006	62	0.6319	63	0.6162	64	0.6147	65	0.6148
66	0.6151	67	0.6152	68	0.6150	69	0.6144	70	0.6143
71	0.6145	72	0.6145	73	0.8071	74	0.6360	75	0.6177
76	0.6142	77	0.6131	78	0.6128	79	0.6130	80	0.6140
81	0.6154	82	0.6154	83	0.6148	84	0.6148	85	0.8210
86	0.6502	87	0.6321	88	0.6272	89	0.6241	90	0.6213
91	0.6181	92	0.6145	93	0.6115	94	0.6125	95	0.6142
96	0.6143	97	0.8371	98	0.6717	99	0.6601	100	0.6590
101	0.6584	102	0.6573	103	0.6552	104	0.6510	105	0.6419
106	0.6259	107	0.6170	108	0.6157	109	0.8422	110	0.6806
111	0.6744	112	0.6778	113	0.6815	114	0.6853	115	0.6899
116	0.6961	117	0.7056	118	0.7172	119	0.7011	120	0.6661
121	0.8302	122	0.6653	123	0.6548	124	0.6547	125	0.6550
126	0.6548	127	0.6537	128	0.6508	129	0.6392	130	0.9797
131	0.9994	132	0.7422	133	0.8070	134	0.6364	135	0.6173
136	0.6107	137	0.6056	138	0.5995	139	0.5923	140	0.5811
141	0.5631	142	0.9689	143	0.9996	144	0.7506	145	0.7807
146	0.6073	147	0.5819	148	0.5722	149	0.5654	150	0.5592
151	0.5526	152	0.5455	153	0.5394	154	0.9652	155	0.9998
156	0.7581	157	0.7570	158	0.5849	159	0.5578	160	0.5409
161	0.5442	162	0.5409	163	0.5383	164	0.5367	165	0.5361
166	0.9653	157	0.9998	168	0.7649	169	0.7390	170	0.5715
171	0.5463	172	0.5401	173	0.5382	174	0.5374	175	0.5371
176	0.5371	177	0.5371	178	0.9656	179	0.9999	180	0.7709
181	0.7270	182	0.5653	183	0.5432	184	0.5391	185	0.5384
186	0.5382	187	0.5382	188	0.5381	189	0.5381	190	0.9663
192	0.7761	193	0.7202	194	0.5631	195	0.5431	196	0.5398
197	0.5392	198	0.5391	199	0.5390	200	0.5390	201	0.5390
202	0.9668	204	0.7802	205	0.7168	206	0.5623	207	0.5435
208	0.5404	209	0.5399	210	0.5398	211	0.5397	212	0.5397
213	0.5398	214	0.9671	216	0.7834	217	0.7153	218	0.5620
219	0.5438	220	0.5409	221	0.5404	222	0.5403	223	0.5402
224	0.5402	225	0.5403	226	0.9673	228	0.7855	229	0.7147
230	0.5619	231	0.5440	232	0.5411	233	0.5406	234	0.5405
235	0.5405	236	0.5405	237	0.5405	238	0.9674	240	0.7866
241	0.7147	242	0.5619	243	0.5440	244	0.5411	245	0.5406
246	0.5405	247	0.5405	248	0.5405	249	0.5405	250	0.9674
252	0.7866	253	0.7153	254	0.5620	255	0.5438	256	0.5409

257	0.5404	258	0.5403	259	0.5402	260	0.5402	261	0.5403
262	0.9673	264	0.7855	265	0.7168	266	0.5623	267	0.5435
268	0.5404	269	0.5399	270	0.5398	271	0.5397	272	0.5397
273	0.5398	274	0.9671	275	0.7834	277	0.7202	278	0.5631
279	0.5431	280	0.5398	281	0.5392	282	0.5391	283	0.5390
284	0.5390	285	0.5390	286	0.9668	288	0.7802	289	0.7270
290	0.5653	291	0.5432	292	0.5391	293	0.5384	294	0.5382
295	0.5382	296	0.5381	297	0.5381	298	0.9663	300	0.7761
301	0.7390	302	0.5715	303	0.5463	304	0.5401	305	0.5382
306	0.5374	307	0.5371	308	0.5371	309	0.5371	310	0.9658
311	0.9999	312	0.7709	[illegible]	0.7570	314	0.5849	315	0.5578
316	0.5489	317	0.5442	318	0.5409	319	0.5383	320	0.5367
321	0.5361	322	0.9653	323	0.9998	324	0.7649	325	0.7807
326	0.6073	327	0.5819	328	0.5722	329	0.5654	330	0.5592
331	0.5526	332	0.5455	333	0.5394	334	0.9652	335	0.9998
336	0.7581	337	0.8076	338	0.6364	339	0.6173	340	0.6107
341	0.6056	342	0.5999	343	0.5923	344	0.5811	345	0.5631
346	0.9689	347	0.9996	[illegible]	0.7506	349	0.8302	350	0.6653
351	0.6548	352	0.6547	353	0.6550	354	0.6548	355	0.6537
356	0.6508	357	0.6392	358	0.9797	359	0.9994	360	0.7422
361	0.8422	362	0.6806	363	0.6744	364	0.6778	365	0.6815
366	0.6853	367	0.6899	368	0.6961	369	0.7056	370	0.7172
371	0.7011	372	0.6661	373	0.8371	374	0.6717	375	0.6601
376	0.6590	377	0.6584	378	[illegible]	379	0.6552	380	0.6510
381	0.6419	382	0.6259	383	0.6170	384	0.6157	385	0.8210
386	0.6502	387	0.6321	388	0.6272	389	0.6241	390	0.6213
391	0.6181	392	0.6145	393	0.6115	394	0.6125	395	0.6142
396	0.6143	397	0.8071	398	0.6360	399	0.6177	400	0.6142
401	0.6131	402	0.6128	403	0.6130	404	0.6140	405	0.6154
406	0.6154	407	0.6148	408	0.6148	409	0.8006	410	0.6319
411	0.6162	412	0.6147	413	0.6148	414	0.6151	415	0.6152
416	0.6150	417	0.6144	418	0.6143	419	0.6145	420	0.6145
421	0.7990	422	0.6316	423	0.6166	424	0.6150	425	0.6147
426	0.6145	427	0.6144	428	0.6144	429	0.6146	430	0.6147
431	0.6146	432	0.6146	433	0.7987	434	0.6314	435	0.6166
436	0.6148	437	0.6146	438	0.6146	439	0.6145	440	0.6147
441	0.6146	442	0.6145	443	0.6146	444	[illegible]	445	0.7987
446	0.6313	447	0.6166	448	0.6149	449	0.6147	450	0.6146
451	0.6146	452	0.6146	453	0.6146	454	0.6146	455	0.6146
456	0.6146	457	0.7986	458	0.6313	459	0.6166	460	0.6148
461	0.6146	462	0.6146	463	0.6146	464	0.6146	465	0.6146
466	0.6146	467	0.6146	468	0.6146	469	0.7986	470	0.6313
471	0.6165	472	0.6148	473	0.6146	474	0.6145	475	0.6145
476	0.6145	477	0.6145	478	0.6145	479	0.6145	480	0.6145

*** ELEMENTAL FLUID VELOCITY ***

ELEMENT	X-VELOCITY	Y-VELOCITY	ELEMENT	X-VELOCITY	Y-VELOCITY	ELEMENT	X-VELOCITY	Y-VELOCITY
1	-2.101E-05	-0.800	2	-3.105E-06	-9.192E-02	3	-1.950E-06	-7.105E-02
4	-3.075E-06	-6.879E-02	5	-8.903E-06	-6.857E-02	6	-1.727E-05	-6.852E-02
7	-2.108E-05	-6.850E-02	8	-1.828E-05	-6.848E-02	9	-2.858E-05	-6.848E-02
10	-4.957E-05	-6.846E-02	11	-6.761E-05	-6.846E-02	12	-8.792E-05	-6.845E-02
13	-2.706E-05	-0.800	14	-9.923E-06	-9.199E-02	15	-1.248E-05	-7.111E-02
16	-9.467E-06	-6.884E-02	17	-1.692E-06	-6.862E-02	18	5.020E-06	-6.859E-02
19	5.803E-07	-6.861E-02	20	-1.326E-05	-6.864E-02	21	-6.118E-06	-6.862E-02
22	1.316E-05	-6.865E-02	23	2.591E-05	-6.866E-02	24	4.237E-05	-6.867E-02
25	-4.859E-05	-0.801	26	6.555E-06	-9.199E-02	27	8.047E-06	-7.114E-02
28	-6.772E-06	-6.893E-02	29	-2.181E-05	-6.873E-02	30	-2.459E-05	-6.865E-02
31	-2.109E-06	-6.858E-02	32	3.036E-05	-6.854E-02	33	1.729E-05	-6.861E-02
34	-8.508E-06	-6.859E-02	35	-1.430E-05	-6.860E-02	36	-2.807E-05	-6.858E-02
37	-1.951E-04	-0.802	38	-2.791E-05	-9.207E-02	39	2.[illegible]E-06	-7.107E-02
40	4.314E-05	-6.[illegible]75E-02	41	6.291E-05	-6.855E-02	42	4.572[illegible]	-6.861E-02
43	-1.714E-05	-6.874E-02	44	-7.458E-05	-6.874E-02	45	-2.597[illegible]	-6.854E-02
46	2.522E-05	-6.858E-02	47	2.305E-05	-6.855E-02	48	3.594E[illegible]	-6.857E-02
49	-5.446E-04	-0.806	50	-6.199E-05	-9.246E-02	51	-8.460E-[illegible]	-7.146E-02
52	-1.353E-04	-6.913E-02	53	-1.207E-04	-6.872E-02	54	-3.299E-05	-6.842E-02
55	1.110E-04	-6.820E-02	56	1.830E-04	-6.833E-02	57	2.454E-05	-6.882E-02
58	-8.148E-05	-6.865E-02	59	-5.412E-05	-6.874E-02	60	-6.820E-05	-6.865E-02
61	-4.108E-03	-0.829	62	-9.413E-05	-9.262E-02	63	2.806E-04	-7.057E-02
64	2.621E-04	-6.875E-02	65	9.194E-05	-6.911E-02	66	-1.610E-04	-6.952E-02
67	-4.215E-04	-6.965E-02	68	-4.150E-04	-6.899E-02	69	4.692E-05	-6.791E-02
70	2.363E-04	-6.854E-02	71	1.242E-04	-6.828E-02	72	1.355E-04	-6.856E-02
73	-1.597E-02	-0.929	74	-1.885E-03	-0.100	75	-8.329E-04	-7.240E-02
76	-9.245E-05	-6.731E-02	77	5.052E-04	-6.585E-02	78	9.577E-04	-6.569E-02
79	1.181E-03	-6.640E-02	80	7.631E-04	-6.850E-02	81	-4.111E-04	-7.064E-02
82	-6.504E-04	-6.852E-02	83	-2.[illegible]69E-04	-6.928E-02	84	-2.538E-04	-6.844E-02
85	-3.179E-02	-1.18	86	-6.206E-03	-0.137	87	-5.977E-03	-9.975E-02
88	-5.807E-03	-8.945E-02	89	-5.423E-03	-8.347E-02	90	-4.681E-03	-7.816E-02
91	-3.336E-03	-7.248E-02	92	-9.479E-04	-6.621E-02	93	1.692E-03	-6.277E-02
94	1.600E-03	-6.928E-02	95	4.610E-04	-6.712E-02	96	4.238E-04	-6.951E-02
97	-3.063E-02	-1.54	98	-7.957E-03	-0.213	99	-9.898E-03	-0.179
100	-1.206E-02	-0.176	101	-1.413E-02	-0.173	102	-1.636E-02	-0.169
103	-1.918E-02	-0.160	104	-2.280E-02	-0.145	105	-2.139E-02	-0.115
106	-8.223E-03	-6.660E-02	107	-1.529E-03	-7.274E-02	108	-9.444E-04	-6.533E-02
109	9.729E-03	-1.67	110	1.740E-03	-0.255	111	1.331E-03	-0.236
112	1.084E-03	-0.253	113	8.283E-04	-0.271	114	5.945E-04	-0.291
115	4.372E-04	-0.317	116	5.698E-04	-0.355	117	-1.695E-02	-0.424
118	-0.108	-0.526	119	-0.111	-0.197	120	-4.045E-02	-9.662E-02
121	4.826E-02	-1.37	122	1.099E-02	-0.189	123	1.284E-02	-0.162

124	1.537E-02	-0.162	125	1.786E-02	-0.163	126	2.053E-02	-0.162
127	2.382E-02	-0.157	128	2.791E-02	-0.146	129	3.934E-02	-0.104
130	1.174E-04	-1.522E-03	131	-3.91	-0.324	132	-8.886E-03	-0.115
133	5.148E-02	-0.928	134	9.511E-03	-0.102	135	9.323E-03	-7.114E-02
136	9.680E-03	-6.041E-02	137	9.827E-03	-5.286E-02	138	9.714E-03	-4.520E-02
139	9.259E-03	-3.595E-02	140	8.259E-03	-2.461E-02	141	4.554E-03	-1.177E-02
142	3.702E-05	-1.596E-03	143	-3.48	3.553E-02	144	-8.528E-03	-0.121
145	3.877E-02	-0.575	146	5.528E-03	-4.900E-02	147	4.362E-03	-2.817E-02
148	3.881E-03	-2.086E-02	149	3.434E-03	-1.686E-02	150	2.931E-03	-1.370E-02
151	2.272E-03	-1.079E-02	152	1.331E-03	-8.242E-03	153	4.942E-04	-6.872E-03
154	2.844E-06	-1.614E-03	155	-3.06	-5.762E-02	156	-8.545E-03	-0.122
157	2.492E-02	-0.359	158	2.671E-03	-2.567E-02	159	1.654E-03	-1.339E-02
160	1.210E-03	-9.893E-03	161	8.573E-04	-6.476E-03	162	5.317E-04	-7.602E-03
163	2.191E-04	-7.002E-03	164	1.496E-05	-6.773E-03	165	-5.437E-05	-6.711E-03
166	-2.388E-06	-1.641E-03	167	-2.65	-3.333E-02	168	-8.139E-03	-0.124
169	1.454E-02	-0.241	170	1.074E-03	-1.680E-02	171	4.317E-04	-9.112E-03
172	1.738E-04	-7.510E-03	173	[illegible].455E-05	-7.132E-03	174	-5.269E-05	-7.024E-03
175	-7.018E-05	-7.023E-03	176	-6.261E-05	-7.019E-03	177	-6.401E-05	-7.009E-03
178	-2.765E-06	-1.668E-03	179	-2.23	-3.976E-02	180	-7.518E-03	-0.126
181	7.731E-03	-0.181	182	3.512E-04	-1.399E-02	183	3.251E-05	-8.305E-03
184	-4.245E-05	-7.438E-03	185	-5.618E-05	-7.337E-03	186	-5.398E-05	-7.316E-03
187	-5.580E-05	-7.298E-03	188	-6.140E-05	-7.294E-03	189	-6.292E-05	-7.298E-03
190	-2.429E-06	-1.691E-03	191	-1.82	-3.812E-02	192	-6.611E-03	-0.127
193	3.745E-03	-0.152	194	1.191E-04	-1.331E-02	195	-2.540E-05	-8.373E-03
196	-4.222E-05	-7.662E-03	197	-4.662E-05	-7.573E-03	198	-5.070E-05	-7.551E-03
199	-5.226E-05	-7.549E-03	200	-5.159E-05	-7.552E-03	201	-5.163E-05	-7.555E-03
202	-1.941E-06	-1.710E-03	203	-1.42	-3.860E-02	204	-5.453E-03	-0.128
205	1.679E-03	-0.139	206	4.378E-05	-1.318E-02	207	-2.645E-05	-8.518E-03
208	-3.611E-05	-7.848E-03	209	-3.830E-05	-7.771E-03	210	-3.843E-05	-7.756E-03
211	-3.849E-05	-7.754E-03	212	-3.904E-05	-7.756E-03	213	-3.933E-05	-7.761E-03
214	-1.430E-06	-1.725E-03	215	-1.01	-3.853E-02	216	-4.070E-03	-0.129
217	6.802E-04	-0.133	218	1.166E-05	-1.317E-02	219	-1.884E-05	-8.636E-03
220	-2.278E-05	-7.987E-03	221	-2.349E-05	-7.913E-03	222	-2.400E-05	-7.898E-03
223	-2.434E-05	-7.897E-03	224	-2.441E-05	-7.901E-03	225	-2.451E-05	-7.906E-03
226	-8.742E-07	-1.735E-03	227	-0.606	-3.860E-02	228	-2.515E-03	-0.129
229	1.786E-04	-0.131	230	1.748E-06	-1.319E-02	231	-6.639E-06	-8.701E-03
232	-7.802E-06	-8.058E-03	233	-8.153E-06	-7.985E-03	234	-8.230E-06	-7.972E-03
235	-8.238E-06	-7.971E-03	236	-8.313E-06	-7.975E-03	237	-8.366E-06	-7.981E-03
238	-2.949E-07	-1.740E-03	239	-0.202	-3.861E-02	240	-8.511E-04	-0.130
241	-1.786E-04	-0.131	242	-1.748E-06	-1.319E-02	243	6.639E-06	-8.701E-03
244	7.802E-06	-8.058E-03	245	8.153E-06	-7.986E-03	246	8.230E-06	-7.972E-03
247	8.238E-06	-7.971E-03	248	8.313E-06	-7.975E-03	249	8.366E-06	-7.981E-03
250	2.949E-07	-1.740E-03	251	0.202	-3.861E-02	252	8.511E-04	-0.130
253	-6.802E-04	-0.133	254	-1.166E-05	-1.317E-02	255	1.884E-05	-8.636E-03
256	2.278E-05	-7.987E-03	257	2.349E-05	-7.913E-03	258	2.400E-05	-7.898E-03
259	2.434E-05	-7.897E-03	260	2.441E-05	-7.901E-03	261	2.451E-05	-7.906E-03
262	8.742E-07	-1.735E-03	263	0.606	-3.860E-02	264	2.515E-03	-0.129

265	-1.679E-03	-0.139	266	-4.378E-05	-1.318E-02	267	2.645E-05	-8.518E-03
268	3.611E-05	-7.848E-03	269	3.830E-05	-7.771E-03	270	3.843E-05	-7.756E-33
271	3.849E-05	-7.754E-03	272	3.904E-05	-7.756E-03	273	3.933E-05	-7.761E-03
274	1.430E-06	-1.725E-03	275	1.01	-3.853E-02	276	4.070E-03	-0.129
277	-3.745E-03	-0.152	278	-1.191E-04	-1.331E-02	279	2.540E-05	-8.373E-03
280	4.222E-05	-7.662E-03	281	4.662E-05	-7.573E-03	282	5.070E-05	-7.551E-03
283	5.226E-05	-7.549E-03	284	5.159E-05	-7.552E-03	285	5.163E-05	-7.555E-03
286	1.941E-06	-1.710E-03	287	1.42	-3.860E-02	288	5.453E-03	-0.128
289	-7.731E-03	-0.181	290	-3.512E-04	-1.399E-02	291	-3.251E-05	-8.305E-03
292	4.245E-05	-7.438E-03	293	5.618E-05	-7.337E-03	294	5.398E-05	-7.316E-03
295	5.580E-05	-7.298E-03	296	6.140E-05	-7.294E-03	297	6.292E-05	-7.298E-03
298	2.429E-06	-1.691E-03	299	1.82	-3.812E-02	300	6.611E-03	-0.127
301	-1.454E-02	-0.241	302	-1.074E-03	-1.680E-02	303	-4.317E-04	-9.112E-03
304	-1.738E-04	-7.510E-03	305	-2.455E-05	-7.132E-03	306	5.269E-05	-7.024E-03
307	7.018E-05	-7.023E-03	308	6.261E-05	-7.019E-03	309	6.401E-05	-7.009E-03
310	2.765E-06	-1.668E-03	311	2.23	-3.976E-02	312	7.518E-03	-0.126
313	-2.492E-02	-0.359	314	-2.671E-03	-2.567E-02	315	-1.654E-03	-1.339E-02
316	-1.210E-03	-9.893E-03	317	-8.573E-04	-8.476E-03	318	-5.317E-04	-7.602E-03
319	-2.191E-04	-7.002E-03	320	-1.496E-05	-6.773E-03	321	5.437E-05	-6.711E-03
322	2.988E-06	-1.641E-03	323	2.65	-3.339E-02	324	8.139E-03	-0.124
325	-3.877E-02	-0.575	326	-5.528E-03	-4.900E-02	327	-4.362E-03	-2.817E-02
328	-3.881E-03	-2.086E-02	329	-3.434E-03	-1.686E-02	330	-2.931E-03	-1.370E-02
331	-2.272E-03	-1.079E-02	332	-1.331E-03	-8.242E-03	333	-4.942E-04	-6.872E-03
334	-2.844E-06	-1.614E-03	335	3.06	-5.762E-02	336	8.545E-03	-0.122
337	-5.148E-02	-0.928	338	-9.511E-03	-0.102	339	-9.323E-03	-7.114E-02
340	-9.680E-03	-6.041E-02	341	-9.827E-03	-5.286E-02	342	-9.714E-03	-4.520E-02
343	-9.259E-03	-3.595E-02	344	-8.259E-03	-2.461E-02	345	-4.554E-03	-1.177E-02
346	-3.702E-05	-1.596E-03	347	3.48	3.553E-02	348	8.528E-03	-0.121
349	-4.826E-02	-1.37	350	-1.099E-02	-0.189	351	-1.284E-02	-0.162
352	-1.537E-02	-0.162	353	-1.786E-02	-0.163	354	-2.053E-02	-0.162
355	-2.382E-02	-0.157	356	-2.791E-02	-0.146	357	-3.934E-02	-0.104
358	-1.174E-04	-1.522E-03	359	3.91	-0.324	360	8.886E-03	-0.115
361	-9.729E-03	-1.67	362	-1.740E-03	-0.255	363	-1.331E-03	-0.236
364	-1.084E-03	-0.253	365	-8.283E-04	-0.271	366	-5.945E-04	-0.291
367	-4.372E-04	-0.317	368	-5.698E-04	-0.355	369	1.695E-02	-0.424
370	0.108	-0.526	371	0.111	-0.197	372	4.045E-02	-9.662E-02
373	3.063E-02	-1.54	374	7.957E-03	-0.213	375	9.898E-03	-0.179
376	1.206E-02	-0.176	377	1.413E-02	-0.173	378	1.636E-02	-0.169
379	1.918E-02	-0.160	380	2.200E-02	-0.145	381	2.139E-02	-0.115
382	8.223E-03	-6.660E-02	383	1.529E-03	-7.274E-02	384	9.444E-04	-6.533E-02
385	3.179E-02	-1.18	386	6.206E-03	-0.137	387	5.927E-03	-9.975E-02
388	5.807E-03	-8.945E-02	389	5.423E-03	-8.347E-02	390	4.601E-03	-7.816E-02
391	3.336E-03	-7.248E-02	392	9.479E-04	-6.621E-02	393	-1.992E-03	-6.277E-02
394	-1.600E-03	-6.928E-02	395	-4.610E-04	-6.712E-02	396	-4.238E-04	-6.351E-02
397	1.597E-02	-0.929	398	1.885E-03	-0.100	399	8.329E-04	-7.240E-02
400	9.245E-05	-6.731E-02	401	-5.052E-04	-6.595E-02	402	-9.577E-04	-6.569E-02
403	-1.181E-03	-6.640E-02	404	-7.631E-04	-6.850E-02	405	4.111E-04	-7.064E-02

406	6.504E-04	-6.852E-02	407	2.569E-04	-6.928E-02	408	2.538E-04	-6.844E-02
409	4.108E-03	-0.829	410	9.413E-05	-9.262E-02	411	-2.806E-04	-7.057E-02
412	-2.621E-04	-6.875E-02	413	-9.194E-05	-6.911E-02	414	1.610E-04	-6.952E-02
415	4.215E-04	-6.965E-02	416	4.150E-04	-6.899E-02	417	-4.692E-05	-6.791E-02
418	-7.363E-04	-6.854E-02	419	-1.242E-04	-6.828E-02	420	-1.355E-04	-6.856E-02
421	5.446E-04	-0.866	422	6.199E-05	-9.246E-02	423	8.460E-05	-7.146E-02
424	1.353E-04	-6.913E-02	425	1.207E-04	-6.872E-02	426	3.299E-05	-6.842E-02
427	-1.110E-04	-6.820E-02	428	-1.830E-04	-6.833E-02	429	-2.454E-05	-6.882E-02
430	8.148E-05	-6.865E-02	431	5.[illegible]12E-05	-6.874E-02	432	6.820E-05	-6.865E-02
433	1.951E-04	-0.802	434	2.791E-05	-9.287E-02	435	-2.125E-06	-7.107E-02
436	-4.314E-05	-6.875E-02	437	-6.291E-05	-6.855E-02	438	-4.572E-05	-6.861E-02
439	1.714E-05	-6.874E-02	440	7.458E-05	-6.874E-02	441	2.597E-05	-6.854E-02
442	-2.522E-05	-6.858E-02	443	-2.305E-05	-6.855E-02	444	-3.594E-05	-6.857E-02
445	4.859E-05	-0.801	446	-6.555E-06	-9.199E-02	447	-8.047E-06	-7.114E-02
448	6.772E-06	-6.893E-02	449	2.161E-05	-6.873E-02	450	2.459E[illegible]	-6.885E-02
451	2.109E-06	-6.858E-02	452	-3.036E-05	-6.834E-02	453	-1.729E-[illegible]	-6.861E-02
454	8.508E-06	-6.859E-02	455	1.490E-05	-6.860E-02	456	2.807E-05	-6.858E-02
457	2.706E-05	-0.800	458	9.923E-06	-9.199E-02	[illegible]	1.248E-05	-7.111E-02
460	9.467E-06	-6.884E-02	461	1.692E-06	-6.862E-02	462	-5.020E-06	-6.859E-02
463	-5.803E-07	-6.861E-02	464	1.326E-05	-6.864E-02	465	6.1[illegible]8E-06	-6.862E-02
466	-1.[illegible]6E-05	-6.865E-02	467	-2.591E-05	-6.866E-02	468	-4.237E-05	-6.867E-02
469	2.101E-05	-0.800	470	3.105E-06	-9.192E-02	471	1.950E-06	-7.105E-02
472	3.975E-06	-6.879E-02	473	8.903E-06	-6.837E-02	474	1.727E-05	-6.852E-02
475	2.108E-05	-6.850E-02	476	1.828E-05	-6.848E-02	477	2.858E-05	-6.848E-02
478	4.957E-05	-6.846E-02	479	6.761E-05	-6.846E-02	480	8.792E-05	-6.845E-02

SOLUTION IS NOW COMPLETE FOR TARGET TIME STEP NO. 1 NUMBER OF COMPUTATIONAL TIME STEPS PERFORMED = 1

*** OBSERVATION NODE INFORMATION ***

NODAL VALUES OF DEPENDENT VARIABLE OVER TIME

OBSERVED NODE NUMBER: 162

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.2891E+03						

OBSERVED NODE NUMBER: 175

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE

0.5000E-01 -0.3657E+03

OBSERVED NODE NUMBER: 188

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3987E+03						

OBSERVED NODE NUMBER: 201

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3971E+03						

OBSERVED NODE NUMBER: 214

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3940E+03						

OBSERVED NODE NUMBER: 227

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3915E+03						

OBSERVED NODE NUMBER: 240

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3895E+03						

OBSERVED NODE NUMBER: 253

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3883E+03						

OBSERVED NODE NUMBER: 266

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE

0.5000E-01	-0.3579E+03						

OBSERVED NODE NUMBER: 279

TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE	TIME	HEAD VALUE
0.5000E-01	-0.3883E+03						

***** VAM2D HAS FULLY EXECUTED *****

Appendix B: SAMPLE PROBLEM 2A INPUT

EX2A.INP

FILE DATE 05-04-1990   TIME 15:42:39

DISPERSE AND SURFACE
EXAMPLE 2A FOR STC

SAMPLING METHOD = 1   LATIN HYPERCUBE SAMPLING

NUMBER OF TRIALS = 0

RANDOM SEED   = .222

Selecting Main Menu Option GENERATE OUTPUT BLOCK HEADERS
Will Run FIXUP.EXE

FIXED DATA GROUP 1 RUN AND OUTPUT OPTIONS

PROMPT	VALUE
TRANSPORT TO WELL/RIVER (1/2)	1
OUTPUT SOURCE RATE? (0/1=N/Y)	0
OUTPUT TYPE OPTION (1/2/3)	1

FIXED DATA GROUP 2 NUMERICAL SOLUTION PARAMETERS

PROMPT	VALUE
MAXIMUM TIME OF INTEREST (Y)	200
NUMBER OF INTERMEDIATE TIMES	20
INTEGRAL DISCRETIZATION (MOD4)	200
DISTANCE TO WELL/RIVER (M)	150
NUMBER OF INTERMEDIATE DISTS	1
NO. SOURCE MIXING CELLS	80
SOURCE LEACH OPTION (0/1)	0
RIVER CONC./NUCLIDE FLUX (1/2)	1

FIXED DATA GROUP 3 PHYSICAL PROPERTIES

PROMPT	VALUE
AQUIFER POROSITY	.52
LONG. DISPERSIVITY (M)	2
TRANS./LONG. DISPERSIVITY (-)	.1
PORE VELOCITY (M/Y)	4.44
DISPOSAL FACILITY LENGTH (M)	60
DISPOSAL FACILITY WIDTH (M)	120
AQUIFER THICKNESS (M)	25
RIVER FLOW RATE (M^3/Y)	1E+10
VOL. OF WATER INGESTED (M^3/Y)	.73
VERT. TRAVEL TIME THRU FAC.(Y)	80
DELAY TIME (Y)	0

FIXED DATA GROUP 4 CONTROLS FOR PARAMETRIC STUDY

PROMPT	VALUE
INDEX OF PARAMETER TO VARY	0
NUMBER OF PARAMETER VALUES	0
USE GIVEN TIME/DISTANCE (1/2)	0
INCLUDE DOSE? (0/1 = N/Y)	0
GRAPHICS OUTPUT? (0/1 = N/Y)	0
HARDCOPY OUTPUT? (0/1 = N/Y)	0
PARAMETER VALUE 1	0
PARAMETER VALUE 2	0
PARAMETER VALUE 3	0
PARAMETER VALUE 4	0
PARAMETER VALUE 5	0

ARRAY NUMBER 1 ISOTOPE PROPERTIES

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
H-3	1.8000E+03	1.0000E+00	0.0000E+00	0.0000E+00	1
C-14	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NA-22	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-32	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-33	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
S-35	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CL-36	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CA-45	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SC-46	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CR-51	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MN-54	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-55	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-57	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-58	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-60	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-63	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZN-65	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SE-75	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RB-86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-85	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZR-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MO-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99m	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-103	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-106	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-108	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-110	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CD-109	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-113	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-126	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-124	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-129	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-131	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-134	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-135	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-136	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-137	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
BA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
LA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-141	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-144	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
EU-152	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
EU-154	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
YB-169	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PB-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PO-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RN-222	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-226	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AC-227	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-229	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-230	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PA-231	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-233	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-234	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-235	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NP-237	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-239	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-240	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-248	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CF-252	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
87	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
88	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
91	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
92	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
93	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
96	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
97	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
98	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
100	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

ARRAY NUMBER 1 CONTINUED

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
H-3	1	1
C-14	1	1
NA-22	1	1
P-32	1	1
P-33	1	1
S-35	1	1
CL-36	1	1
CA-45	1	1
SC-46	1	1
CR-51	1	1
MN-54	1	1
FE-55	1	1
FE-59	1	1
CO-57	1	1
CO-58	1	1
CO-60	1	1
NI-59	1	1
NI-63	1	1
ZN-65	1	1
SE-75	1	1
RB-86	1	1
SR-85	1	1
SR-89	1	1
SR-90	1	1
ZR-95	1	1
NB-94	1	1
NB-95	1	1
MO-99	1	1
TC-99	1	1
TC-99m	1	1
RU-103	1	1
RU-106	1	1
AG-108	1	1
AG-110	1	1
CD-109	1	1
SN-113	1	1
SN-126	1	1
SB-124	1	1
SB-125	1	1
I-125	1	1
I-129	1	1
I-131	1	1
CS-134	1	1
CS-135	1	1
CS-136	1	1
CS-137	1	1
BA-140	1	1
LA-140	1	1
CE-141	1	1
CE-144	1	1

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
EU-152	1	1
EU-154	1	1
YB-169	1	1
PB-210	1	1
PO-210	1	1
RN-222	1	1
RA-226	1	1
RA-228	1	1
AC-227	1	1
TH-228	1	1
TH-229	1	1
TH-230	1	1
TH-232	1	1
PA-231	1	1
U-232	1	1
U-233	1	1
U-234	1	1
U-235	1	1
U-236	1	1
U-238	1	1
NP-237	1	1
PU-236	1	1
PU-238	1	1
PU-239	1	1
PU-240	1	1
PU-241	1	1
PU-242	1	1
PU-244	1	1
AM-241	1	1
AM-243	1	1
CM-242	1	1
CM-243	1	1
CM-244	1	1
CM-248	1	1
CF-252	1	1
86	1	1
87	1	1
88	1	1
89	1	1
90	1	1
91	1	1
92	1	1
93	1	1
94	1	1
95	1	1
96	1	1
97	1	1
98	1	1
99	1	1
100	1	1

ARRAY NUMBER 2 CONTROLS FOR CONC. VS TIME

	DISTANCE (M)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
DISTANCE 1	1.5000E+02	0	1	1
DISTANCE 2	0.0000E+00	0	0	0
DISTANCE 3	0.0000E+00	0	0	0
DISTANCE 4	0.0000E+00	0	0	0
DISTANCE 5	0.0000E+00	0	0	0
DISTANCE 6	0.0000E+00	0	0	0
DISTANCE 7	0.0000E+00	0	0	0

ARRAY NUMBER 3 CONTROLS FOR CONC. VS DISTANCE

	TIME (Y)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
TIME 1	0.0000E+00	0	0	0
TIME 2	0.0000E+00	0	0	0
TIME 3	0.0000E+00	0	0	0
TIME 4	0.0000E+00	0	0	0
TIME 5	0.0000E+00	0	0	0
TIME 6	0.0000E+00	0	0	0
TIME 7	0.0000E+00	0	0	0

OUTPUT DATA BLOCKS

DATA BLOCK 1 Nuclide Concentration vs. Time at 150 m
NON-STATISTICAL OUTPUT

COLUMN NUMBER	COLUMN HEADING		TYPE REAL(R), INTEGER(I)
1	Time	(yr)	R
2	H-3	(Ci/m^3)	R

Appendix C: SAMPLE PROBLEM 2B INPUT

EX2B.INP

FILE DATE 05-04-1990   TIME 15:25:05

DISPERSE AND SURFACE
EXAMPLE 2B FOR STC

SAMPLING METHOD = 1   LATIN HYPERCUBE SAMPLING

NUMBER OF TRIALS = 0

RANDOM SEED   = .222

Selecting Main Menu Option GENERATE OUTPUT BLOCK HEADERS
Will Run FIXUP.EXE

FIXED DATA GROUP 1 RUN AND OUTPUT OPTIONS

PROMPT	VALUE
TRANSPORT TO WELL/RIVER (1/2)	1
OUTPUT SOURCE RATE? (0/1=N/Y)	0
OUTPUT TYPE OPTION (1/2/3)	1

FIXED DATA GROUP 2 NUMERICAL SOLUTION PARAMETERS

PROMPT	VALUE
MAXIMUM TIME OF INTEREST (Y)	200
NUMBER OF INTERMEDIATE TIMES	20
INTEGRAL DISCRETIZATION (MOD4)	200
DISTANCE TO WELL/RIVER (M)	104
NUMBER OF INTERMEDIATE DISTS	1
NO. SOURCE MIXING CELLS	80
SOURCE LEACH OPTION (0/1)	1
RIVER CONC./NUCLIDE FLUX (1/2)	1

FIXED DATA GROUP 3 PHYSICAL PROPERTIES

PROMPT	VALUE
AQUIFER POROSITY	.52
LONG. DISPERSIVITY (M)	2
TRANS./LONG. DISPERSIVITY (-)	.1
PORE VELOCITY (M/Y)	4.44
DISPOSAL FACILITY LENGTH (M)	8
DISPOSAL FACILITY WIDTH (M)	120
AQUIFER THICKNESS (M)	25
RIVER FLOW RATE (M^3/Y)	1E+10
VOL. OF WATER INGESTED (M^3/Y)	.73
VERT. TRAVEL TIME THRU FAC.(Y)	80
DELAY TIME (Y)	50

FIXED DATA GROUP 4 CONTROLS FOR PARAMETRIC STUDY

PROMPT	VALUE
INDEX OF PARAMETER TO VARY	0
NUMBER OF PARAMETER VALUES	0
USE GIVEN TIME/DISTANCE (1/2)	0
INCLUDE DOSE? (0/1 = N/Y)	0
GRAPHICS OUTPUT? (0/1 = N/Y)	0
HARDCOPY OUTPUT? (0/1 = N/Y)	0
PARAMETER VALUE 1	0
PARAMETER VALUE 2	0
PARAMETER VALUE 3	0
PARAMETER VALUE 4	0
PARAMETER VALUE 5	0

ARRAY NUMBER 1 ISOTOPE PROPERTIES

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
H-3	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
C-14	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NA-22	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-32	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-33	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
S-35	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CL-36	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CA-45	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SC-46	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CR-51	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MN-54	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-55	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-57	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-58	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-60	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-63	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZN-65	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SE-75	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RB-86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-85	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZR-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MO-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99m	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-103	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-106	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-108	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-110	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CD-109	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-113	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-126	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-124	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-129	2.0000E+01	1.0000E+00	1.2500E-02	2.0000E-04	1
I-131	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-134	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-135	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-136	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-137	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
BA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
LA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-141	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-144	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
EU-152	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
EU-154	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
YB-169	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PB-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PO-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RN-222	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-226	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AC-227	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-229	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-230	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PA-231	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-233	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-234	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-235	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NP-237	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-239	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-240	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-248	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CF-252	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
87	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
88	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
91	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
92	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
93	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
95	0.0000E+00	1.00[illegible]+00	0.0000E+00	0.0000E+00	0
96	0.0000E+00	1.0[illegible]E+00	0.0000E+00	0.0000E+00	0
97	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
98	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
100	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

ARRAY NUMBER 1 CONTINUED

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
H-3	1	1
C-14	1	1
NA-22	1	1
P-32	1	1
P-33	1	1
S-35	1	1
CL-36	1	1
CA-45	1	1
SC-46	1	1
CR-51	1	1
MN-54	1	1
FE-55	1	1
FE-59	1	1
CO-57	1	1
CO-58	1	1
CO-60	1	1
NI-59	1	1
NI-63	1	1
ZN-65	1	1
SE-75	1	1
RB-86	1	1
SR-85	1	1
SR-89	1	1
SR-90	1	1
ZR-95	1	1
NB-94	1	1
NB-95	1	1
MO-99	1	1
TC-99	1	1
TC-99m	1	1
RU-103	1	1
RU-106	1	1
AG-108	1	1
AG-110	1	1
CD-109	1	1
SN-113	1	1
SN-126	1	1
SB-124	1	1
SB-125	1	1
I-125	1	1
I-129	1	1
I-131	1	1
CS-134	1	1
CS-135	1	1
CS-136	1	1
CS-137	1	1
BA-140	1	1
LA-140	1	1
CE-141	1	1
CE-144	1	1

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
EU-152	1	1
EU-154	1	1
YB-169	1	1
PB-210	1	1
PO-210	1	1
RN-222	1	1
RA-226	1	1
RA-228	1	1
AC-227	1	1
TH-228	1	1
TH-229	1	1
TH-230	1	1
TH-232	1	1
PA-231	1	1
U-232	1	1
U-233	1	1
U-234	1	1
U-235	1	1
U-236	1	1
U-238	1	1
NP-237	1	1
PU-236	1	1
PU-238	1	1
PU-239	1	1
PU-240	1	1
PU-241	1	1
PU-242	1	1
PU-244	1	1
AM-241	1	1
AM-243	1	1
CM-242	1	1
CM-243	1	1
CM-244	1	1
CM-248	1	1
CF-252	1	1
86	1	1
87	1	1
88	1	1
89	1	1
90	1	1
91	1	1
92	1	1
93	1	1
94	1	1
95	1	1
96	1	1
97	1	1
98	1	1
99	1	1
100	1	1

ARRAY NUMBER 2 CONTROLS FOR CONC. VS TIME

	DISTANCE (M)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
DISTANCE 1	1.0400E+02	0	1	1
DISTANCE 2	0.0000E+00	0	0	0
DISTANCE 3	0.0000E+00	0	0	0
DISTANCE 4	0.0000E+00	0	0	0
DISTANCE 5	0.0000E+00	0	0	0
DISTANCE 6	0.0000E+00	0	0	0
DISTANCE 7	0.0000E+00	0	0	0

ARRAY NUMBER 3 CONTROLS FOR CONC. VS DISTANCE

	TIME (Y)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
TIME 1	0.0000E+00	0	0	0
TIME 2	0.0000E+00	0	0	0
TIME 3	0.0000E+00	0	0	0
TIME 4	0.0000E+00	0	0	0
TIME 5	0.0000E+00	0	0	0
TIME 6	0.0000E+00	0	0	0
TIME 7	0.0000E+00	0	0	0

OUTPUT DATA BLOCKS

DATA BLOCK 1   Nuclide Concentration vs. Time at 104 m
NON-STATISTICAL OUTPUT

COLUMN NUMBER	COLUMN HEADING		TYPE REAL(R), INTEGER(I)
1	Time	(yr)	R
2	I-129	(Ci/m^3)	R

Appendix D: SAMPLE PROBLEM 3 INPUT

EX3B.INP

FILE DATE 05-08-1990 TIME 16:28:03

DISPERSE AND SURFACE
EXAMPLE 3 FOR STC

SAMPLING METHOD = 1 LATIN HYPERCUBE SAMPLING

NUMBER OF TRIALS = 0

RANDOM SEED = .222

Selecting Main Menu Option GENERATE OUTPUT BLOCK HEADERS
Will Run FIXUP.EXE

FIXED DATA GROUP 1 RUN AND OUTPUT OPTIONS

PROMPT	VALUE
TRANSPORT TO WELL/RIVER (1/2)	1
OUTPUT SOURCE RATE? (0/1=N/Y)	0
OUTPUT TYPE OPTION (1/2/3)	3

FIXED DATA GROUP 2 NUMERICAL SOLUTION PARAMETERS

PROMPT	VALUE
MAXIMUM TIME OF INTEREST (Y)	200
NUMBER OF INTERMEDIATE TIMES	20
INTEGRAL DISCRETIZATION (MOD4)	200
DISTANCE TO WELL/RIVER (M)	150
NUMBER OF INTERMEDIATE DISTS	1
NO. SOURCE MIXING CELLS	50
SOURCE LEACH OPTION (0/1)	0
NUCLIDE FLUX/RIVER CONCS.(1/2)	1

FIXED DATA GROUP 3 PHYSICAL PROPERTIES

PROMPT	VALUE
AQUIFER POROSITY	.52
LONG. DISPERSIVITY (M)	2
TRANS./LONG. DISPERSIVITY (-)	.1
PORE VELOCITY (M/Y)	4.44
DISPOSAL FACILITY LENGTH (M)	60
DISPOSAL FACILITY WIDTH (M)	120
AQUIFER THICKNESS (M)	25
RIVER FLOW RATE (M^3/Y)	0
VOL. OF WATER INGESTED (M^3/Y)	.73
VERT. TRAVEL TIME THRU FAC.(Y)	80
DELAY TIME (Y)	0

FIXED DATA GROUP 4 CONTROLS FOR PARAMETRIC STUDY

PROMPT	VALUE
INDEX OF PARAMETER TO VARY	2
NUMBER OF PARAMETER VALUES	5
USE GIVEN TIME/DISTANCE (1/2)	2
INCLUDE DOSE? (0/1 = N/Y)	0
GRAPHICS OUTPUT? (0/1 = N/Y)	1
HARDCOPY OUTPUT? (0/1 = N/Y)	1
PARAMETER VALUE 1	.5
PARAMETER VALUE 2	2
PARAMETER VALUE 3	10
PARAMETER VALUE 4	20
PARAMETER VALUE 5	100

ARRAY NUMBER 1 ISOTOPE PROPERTIES

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
H-3	1.8000E+03	1.0000E+00	0.0000E+00	0.0000E+00	1
C-14	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NA-22	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-32	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-33	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
S-35	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CL-36	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CA-45	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SC-46	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CR-51	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MN-54	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-55	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-57	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-58	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-60	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-63	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZN-65	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SE-75	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RB-86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-85	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZR-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MO-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99m	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-103	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-106	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-108	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-110	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CD-109	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-113	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-126	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-124	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-129	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-131	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-134	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-135	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-136	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-137	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
BA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
LA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-141	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-144	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
EU-152	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
EU-154	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
YB-169	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PB-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PO-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RN-222	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-226	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AC-227	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-229	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-230	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PA-231	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-233	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-234	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-235	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NP-237	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-239	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-240	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-244	[illegible]	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-248	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CF-252	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
87	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
88	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
91	[illegible]	1.0000E+00	0.0000E+00	0.0000E+00	0
92	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
93	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
96	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
97	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
98	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
100	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

ARRAY NUMBER 1 CONTINUED

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
H-3	1	1
C-14	1	1
NA-22	1	1
P-32	1	1
P-33	1	1
S-35	1	1
CL-36	1	1
CA-45	1	1
SC-46	1	1
CR-51	1	1
MN-54	1	1
FE-55	1	1
FE-59	1	1
CO-57	1	1
CO-58	1	1
CO-60	1	1
NI-59	1	1
NI-63	1	1
ZN-65	1	1
SE-75	1	1
RB-86	1	1
SR-85	1	1
SR-89	1	1
SR-90	1	1
ZR-95	1	1
NB-94	1	1
NB-95	1	1
MO-99	1	1
TC-99	1	1
TC-99m	1	1
RU-103	1	1
RU-106	1	1
AG-108	1	1
AG-110	1	1
CD-109	1	1
SN-113	1	1
SN-126	1	1
SB-124	1	1
SB-125	1	1
I-125	1	1
I-129	1	1
I-131	1	1
CS-134	1	1
CS-135	1	1
CS-136	1	1
CS-137	1	1
BA-140	1	1
LA-140	1	1
CE-141	1	1
CE-144	1	1

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
EU-152	1	1
EU-154	1	1
YB-169	1	1
PB-210	1	1
PO-210	1	1
RN-222	1	1
RA-226	1	1
RA-228	1	1
AC-227	1	1
TH-228	1	1
TH-229	1	1
TH-230	1	1
TH-232	1	1
PA-231	1	1
U-232	1	[illegible]
U-233	1	1
U-234	1	1
U-235	1	1
U-236	1	1
U-238	1	1
NP-237	1	1
PU-236	1	1
PU-238	1	1
PU-239	1	1
PU-240	1	1
PU-241	1	1
PU-242	1	1
PU-244	1	1
AM-241	1	1
AM-243	1	1
CM-242	1	1
CM-243	1	1
CM-244	1	1
CM-248	1	1
CF-252	1	1
86	1	1
87	1	1
88	1	1
89	1	1
90	1	1
91	1	1
92	1	1
93	[illegible]	1
94		1
95		1
96		1
97	[illegible]	1
98	1	1
99	1	1
100	1	1

ARRAY NUMBER 2 CONTROLS FOR CONC. VS TIME

	DISTANCE (M)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
DISTANCE 1	1.5000E+02	0	1	1
DISTANCE 2	0.0000E+00	0	0	0
DISTANCE 3	0.0000E+00	0	0	0
DISTANCE 4	0.0000E+00	0	0	0
DISTANCE 5	0.0000E+00	0	0	0
DISTANCE 6	0.0000E+00	0	0	0
DISTANCE 7	0.0000E+00	0	0	0

ARRAY NUMBER 3 CONTROLS FOR CONC. VS DISTANCE

	TIME (Y)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
TIME 1	0.0000E+00	0	0	0
TIME 2	0.0000E+00	0	0	0
TIME 3	0.0000E+00	0	0	0
TIME 4	0.0000E+00	0	0	0
TIME 5	0.0000E+00	0	0	0
TIME 6	0.0000E+00	0	0	0
TIME 7	0.0000E+00	0	0	0

OUTPUT DATA BLOCKS

DATA BLOCK 1 Conc. vs. Time at 150 m - Parameter is Long. Dispersivity
NON-STATISTICAL OUTPUT

COLUMN NUMBER	COLUMN HEADING	TYPE REAL(R), INTEGER(I)
1	Time (yr)	R
2	H-3 PV1 (Ci/m^3)	R
3	H-3 PV2 (Ci/m^3)	R
4	H-3 PV3 (Ci/m^3)	R
5	H-3 PV4 (Ci/m^3)	R
6	H-3 PV5 (Ci/m^3)	[illegible]

Appendix E: SAMPLE PROBLEM 4 INPUT

EX4A.INP

FILE DATE 05-04-1990 TIME 15:19:51

```
DISPERSE AND SURFACE
EXAMPLE 4A FOR STC

SAMPLING METHOD  = 1     LATIN HYPERCUBE SAMPLING

NU.BER OF TRIALS =  0

RANDOM SEED      =  .222

Selecting Main Menu Option GENERATE OUTPUT BLOCK HEADERS
Will Run FIXUP.EXE
```

FIXED DATA GROUP 1 RUN AND OUTPUT OPTIONS

PROMPT	VALUE
TRANSPORT TO WELL/RIVER (1/2)	2
OUTPUT SOURCE RATE? (0/1=N/Y)	0
OUTPUT TYPE OPTION (1/2/3)	1

FIXED DATA GROUP 2 NUMERICAL SOLUTION PARAMETERS

PROMPT	VALUE
MAXIMUM TIME OF INTEREST (Y)	400
NUMBER OF INTERMEDIATE TIMES	20
INTEGRAL DISCRETIZATION (MOD4)	200
DISTANCE TO WELL/RIVER (M)	1000
NUMBER OF INTERMEDIATE DISTS	1
NO. SOURCE MIXING CELLS	80
SOURCE LEACH OPTION (0/1)	0
RIVER CONC./NUCLIDE FLUX (1/2)	2

FIXED DATA GROUP 3 PHYSICAL PROPERTIES

PROMPT	VALUE
AQUIFER POROSITY	.52
LONG. DISPERSIVITY (M)	2
TRANS./LONG. DISPERSIVITY (-)	.1
PORE VELOCITY (M/Y)	4.44
DISPOSAL FACILITY LENGTH (M)	60
DISPOSAL FACILITY WIDTH (M)	120
AQUIFER THICKNESS (M)	25
RIVER FLOW RATE (M^3/Y)	1E+10
VOL OF WATER INGESTED (M^3/Y)	.73
VERT. TRAVEL TIME THRU FAC.(Y)	80
DELAY TIME (Y)	0

FIXED DATA GROUP 4 CONTROLS FOR PARAMETRIC STUDY

PROMPT	VALUE
INDEX OF PARAMETER TO VARY	0
NUMBER OF PARAMETER VALUES	0
USE GIVEN TIME/DISTANCE (1/2)	0
INCLUDE DOSE? (0/1 = N/Y)	0
GRAPHICS OUTPUT? (0/1 = N/Y)	0
HARDCOPY OUTPUT? (0/1 = N/Y)	0
PARAMETER VALUE 1	0
PARAMETER VALUE 2	0
PARAMETER VALUE 3	0
PARAMETER VALUE 4	0
PARAMETER VALUE 5	0

ARRAY NUMBER 1 ISOTOPE PROPERTIES

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
H-3	1.8000E+03	1.0000E+00	0.0000E+00	0.0000E+00	1
C-14	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NA-22	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-32	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-33	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
S-35	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CL-36	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CA-45	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SC-46	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CR-51	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MN-54	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-55	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-57	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-58	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-60	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-63	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZN-65	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SE-75	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RB-86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-85	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZR-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MO-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99m	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-103	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-106	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-108	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-110	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CD-109	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-113	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-126	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-124	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-129	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-131	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-134	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-135	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-136	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-137	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
BA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
LA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-141	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-144	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
EU-152	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
EU-154	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
YB-169	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PB-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PO-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RN-222	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-226	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AC-227	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-229	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-230	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PA-231	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-233	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-234	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-235	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NP-237	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-239	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-240	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-248	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CF-252	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
87	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
88	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
91	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
92	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
93	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
96	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
97	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
98	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
100	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

ARRAY NUMBER 1 CONTINUED

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
H-3	1	1
C-14	1	1
NA-22	1	1
P-32	1	1
P-33	1	1
S-35	1	1
CL-36	1	1
CA-45	1	1
SC-46	1	1
CR-51	1	1
MN-54	1	1
FE-55	1	1
FE-59	1	1
CO-57	1	1
CO-58	1	1
CO-60	1	1
NI-59	1	1
NI-63	1	1
ZN-65	1	1
SE-75	1	1
RB-86	1	1
SR-85	1	1
SR-89	1	1
SR-90	1	1
ZR-95	1	1
NB-94	1	1
NB-95	1	1
MO-99	1	1
TC-99	1	1
TC-99m	1	1
RU-103	1	1
RU-106	1	1
AG-108	1	1
AG-110	1	1
CD-109	1	1
SN-113	1	1
SN-126	1	1
SB-124	1	1
SB-125	1	1
I-125	1	1
I-129	1	1
I-131	1	1
CS-134	1	1
CS-135	1	1
CS-136	1	1
CS-137	1	1
BA-140	1	1
LA-140	1	1
CE-141	1	1
CE-144	1	1

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
EU-152	1	1
EU-154	1	1
YB-169	1	1
PB-210	1	1
PO-210	1	1
RN-222	1	1
RA-226	1	1
RA-228	1	1
AC-227	1	1
TH-228	1	1
TH-229	1	1
TH-230	1	1
TH-232	1	1
PA-231	1	1
U-232	1	1
U-233	1	1
U-234	1	1
U-235	1	1
U-236	1	1
U-238	1	1
NP-237	1	1
PU-236	1	1
PU-238	1	1
PU-239	1	1
PU-240	1	1
PU-241	1	[illegible]
PU-242	1	1
PU-244	1	1
AM-241	1	1
AM-243	1	1
CM-242	[illegible]	1
CM-243	1	1
CM-244	1	1
CM-248	1	1
CF-252	1	1
86	1	1
87	1	1
88	1	1
89	1	1
90	1	1
91	1	1
92	1	1
93	1	1
94	1	1
95	1	1
96	1	1
97	1	1
98	1	1
99	1	1
100	1	1

ARRAY NUMBER 2 CONTROLS FOR CONC. VS TIME

	DISTANCE (M)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
DISTANCE 1	1.0000E+03	0	1	1
DISTANCE 2	0.0000E+00	0	0	0
DISTANCE 3	0.0000E+00	0	0	0
DISTANCE 4	0.0000E+00	0	0	0
DISTANCE 5	0.0000E+00	0	0	0
DISTANCE 6	0.0000E+00	0	0	0
DISTANCE 7	0.0000E+00	0	0	0

ARRAY NUMBER 3 CONTROLS FOR CONC. VS DISTANCE

	TIME (Y)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
TIME 1	0.0000E+00	0	0	0
TIME 2	0.0000E+00	0	0	0
TIME 3	0.0000E+00	0	0	0
TIME 4	0.0000E+00	0	0	0
TIME 5	0.0000E+00	0	0	0
TIME 6	0.0000E+00	0	0	0
TIME 7	0.0000E+00	0	0	0

OUTPUT DATA BLOCKS

DATA BLOCK 1 Nuclide Flux vs. Time at 1000 m
NON-STATISTICAL OUTPUT

COLUMN NUMBER	COLUMN HEADING	TYPE REAL(R), INTEGER(I)
1	Time (yr)	R
2	H-3 (Ci/yr)	R

EX4B.INP

FILE DATE 05-04-1990 TIME 15:22:55

DISPERSE AND SURFACE
EXAMPLE 4B FOR STC

SAMPLING METHOD = 1 LATIN HYPERCUBE SAMPLING

NUMBER OF TRIALS = 0

RANDOM SEED = .222

Selecting Main Menu Option GENERATE OUTPUT BLOCK HEADERS
Will Run FIXUP.EXE

FIXED DATA GROUP 1 RUN AND OUTPUT OPTIONS

PROMPT	VALUE
TRANSPORT TO WELL/RIVER (1/2)	2
OUTPUT SOURCE RATE? (0/1=N/Y)	0
OUTPUT TYPE OPTION (1/2/3)	1

FIXED DATA GROUP 2 NUMERICAL SOLUTION PARAMETERS

PROMPT	VALUE
MAXIMUM TIME OF INTEREST (Y)	400
NUMBER OF INTERMEDIATE TIMES	20
INTEGRAL DISCRETIZATION (MOD4)	200
DISTANCE TO WELL/RIVER (M)	1000
NUMBER OF INTERMEDIATE DISTS	1
NO. SOURCE MIXING CELLS	80
SOURCE LEACH OPTION (0/1)	1
RIVER CONC./NUCLIDE FLUX (1/2)	2

FIXED DATA GROUP 3 PHYSICAL PROPERTIES

PROMPT	VALUE
AQUIFER POROSITY	.52
LONG. DISPERSIVITY (M)	2
TRANS./LONG. DISPERSIVITY (-)	.1
PORE VELOCITY (M/Y)	4.44
DISPOSAL FACILITY LENGTH (M)	8
DISPOSAL FACILITY WIDTH (M)	120
AQUIFER THICKNESS (M)	25
RIVER FLOW RATE (M^3/Y)	1E+10
VOL. OF WATER INGESTED (M^3/Y)	.73
VERT. TRAVEL TIME THRU FAC.(Y)	80
DELAY TIME (Y)	50

FIXED DATA GROUP 4 CONTROLS FOR PARAMETRIC STUDY

PROMPT	VALUE
INDEX OF PARAMETER TO VARY	0
NUMBER OF PARAMETER VALUES	0
USE GIVEN TIME/DISTANCE (1/2)	0
INCLUDE DOSE? (0/1 = N/Y)	0
GRAPHICS OUTPUT? (0/1 = N/Y)	0
HARDCOPY OUTPUT? (0/1 = N/Y)	0
PARAMETER VALUE 1	0
PARAMETER VALUE 2	0
PARAMETER VALUE 3	0
PARAMETER VALUE 4	0
PARAMETER VALUE 5	0

ARRAY NUMBER 1 ISOTOPE PROPERTIES

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
H-3	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
C-14	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NA-22	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-32	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
P-33	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
S-35	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CL-36	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CA-45	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SC-46	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CR-51	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MN-54	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-55	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
FE-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-57	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-58	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CO-60	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-59	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NI-63	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZN-65	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SE-75	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RB-86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-85	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SR-90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
ZR-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NB-95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
MO-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TC-99m	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-103	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RU-106	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-108	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AG-110	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CD-109	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-113	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SN-126	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-124	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
SB-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-125	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
I-129	2.0000E+01	1.0000E+00	1.2500E-02	2.0000E-04	1
I-131	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-134	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-135	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-136	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CS-137	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
BA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
LA-140	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-141	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CE-144	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

	INVENTORY (Ci)	RETARDAT'N FACTOR	SOURCE CONSTANT	SOURCE PRE-EXP	TRANSPORT (0/1=N/Y)
EU-152	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
EU-154	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
YB-169	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PB-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PO-210	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RN-222	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-226	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
RA-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AC-227	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-228	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-229	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-230	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
TH-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PA-231	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-232	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-233	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-234	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-235	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
U-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
NP-237	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-236	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-238	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-239	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-240	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
PU-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-241	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
AM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-242	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-243	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-244	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CM-248	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
CF-252	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
86	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
87	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
88	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
89	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
90	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
91	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
92	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
93	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
94	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
95	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
96	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
97	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
98	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
99	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0
100	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0

ARRAY NUMBER 1 CONTINUED

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
H-3	1	1
C-14	1	1
NA-22	1	1
P-32	1	1
P-33	1	1
S-35	1	1
CL-36	1	1
CA-45	1	1
SC-46	1	1
CR-51	1	1
MN-54	1	1
FE-55	1	1
FE-59	1	1
CO-57	1	1
CO-58	1	1
CO-60	1	1
NI-59	1	1
NI-63	1	1
ZN-65	1	1
SE-75	1	1
RB-86	1	1
SR-85	1	1
SR-89	1	1
SR-90	1	1
ZR-95	1	1
NB-94	1	1
NB-95	1	1
MO-99	1	1
TC-99	1	1
TC-99m	1	1
RU-103	1	1
RU-106	1	1
AG-108	1	1
AG-110	1	1
CD-109	1	1
SN-113	1	1
SN-126	1	1
SB-124	1	1
SB-125	1	1
I-125	1	1
I-129	1	1
I-131	1	1
CS-134	1	1
CS-135	1	1
CS-136	1	1
CS-137	1	1
BA-140	1	1
LA-140	1	1
CE-141	1	1
CE-144	1	1

	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
EU-152	1	1
EU-154	1	1
YB-169	1	1
PB-210	1	1
PO-210	1	1
RN-222	1	1
RA-226	1	1
RA-228	1	1
AC-227	1	1
TH-228	1	1
TH-229	1	1
TH-230	1	1
TH-232	1	1
PA-231	1	1
U-232	1	1
U-233	1	1
U-234	1	1
U-235	1	1
U-236	1	1
U-238	1	1
NP-237	1	1
PU-236	1	1
PU-238	1	1
PU-239	1	1
PU-240	1	1
PU-241	1	1
PU-242	1	1
PU-244	1	1
AM-241	1	1
AM-243	1	1
CM-242	1	1
CM-243	1	1
CM-244	1	1
CM-248	1	1
CF-252	1	1
86	1	1
87	1	1
88	1	1
89	1	1
90	1	1
91	1	1
92	1	1
93	1	1
94	1	1
95	1	1
96	1	1
97	1	1
98	1	1
99	1	1
100	1	1

ARRAY NUMBER 2 CONTROLS FOR CONC. VS TIME

	DISTANCE (M)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
DISTANCE 1	1.0000E+03	0	1	1
DISTANCE 2	0.0000E+00	0	0	0
DISTANCE 3	0.0000E+00	0	0	0
DISTANCE 4	0.0000E+00	0	0	0
DISTANCE 5	0.0000E+00	0	0	0
DISTANCE 6	0.0000E+00	0	0	0
DISTANCE 7	0.0000E+00	0	0	0

ARRAY NUMBER 3 CONTROLS FOR CONC. VS DISTANCE

	TIME (Y)	INC. DOSE? (0/1=N/Y)	GRAPHICS? (0/1=N/Y)	HARDCOPY? (0/1=N/Y)
TIME 1	0.0000E+00	0	0	0
TIME 2	0.0000E+00	0	0	0
TIME 3	0.0000E+00	0	0	0
TIME 4	0.0000E+00	0	0	0
TIME 5	0.0000E+00	0	0	0
TIME 6	0.0000E+00	0	0	0
TIME 7	0.0000E+00	0	0	0

OUTPUT DATA BLOCKS

DATA BLOCK 1 Nuclide Flux vs. Time at 1000 m
NON-STATISTICAL OUTPUT

COLUMN NUMBER	COLUMN HEADING		TYPE REAL(R), INTEGER(I)
1	Time	(yr)	R
2	I-129	(Ci/yr)	R

Appendix F: DOSE CALCULATION AT 60 YEARS FROM WELL WATER
SAMPLE PROBLEM 5 INPUT

```
########################## Program GENII Input File ############  8 Jul 88 ####
Title: Sample Problem 5 - Doses at 60 years from well water
     \GENFILE\samp5a.in                          Created on 05-11-1990 at 11:01
OPTIONS========================== Default =====================================
T    Near-field scenario?        (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?           (Individual)                release, single site
F    Acute release?                (Chronic)    FAR-FIELD:  wide scale release,
     Maximum Individual data set used                       multiple sites
                                 Complete                               Complete
TRANSPORT OPTIONS============= Section   EXPOSURE PATHWAY OPTIONS====== Section
F  Air Transport                   1      F  Finite plume, external       5
F  Surface Water Transport         2      F  Infinite plume, external     5
F  Biotic Transport (near-field)  3,4     F  Ground, external             5
F  Waste Form Degradation (near)  3,4     F  Recreation, external         5
                                          F  Inhalation uptake            5,6
REPORT OPTIONS========================    T  Drinking water ingestion     7,8
T  Report AEDE only                       F  Aquatic foods ingestion      7,8
T  Report by radionuclide                 T  Terrestrial foods ingestion  7,9
T  Report by exposure pathway             T  Animal product ingestion     7,10
F  Debug report on screen                 F  Inadvertent soil ingestion

INVENTORY ####################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|-----------Basic Concentrations----------|
     Use when| transport selected    |  near-field scenario, optionally        |
     --------|-----------------------|-----------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface |
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water   |
     nuclide |/yr     /yr     /m3    |/m3     /unit   /m3     /L      /L      |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     H 3                                                       2.2E-07
     I 129                                                     1.8E-23

     --------|----Derived Concentrations-----|
     Use when|   measured values are known   |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|

TIME #########################################################################

1     Intake ends after (yr)
50    Dose calc. ends after (yr)
0     Release ends after (yr)
0     No. of years of air deposition prior to the intake period
0     No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####################################

0            Definition option: 1-Use population grid in file POP.IN
0                               2-Use total entered on this line

NEAR-FIELD SCENARIOS #########################################################

             Prior to the beginning of the intake period: (yr)
0              When was the inventory disposed?  (Package degradation starts)
0              When was LOIC?  (Biotic transport starts)
1.0          Fraction of roots in upper soil (top 15 cm)
0            Fraction of roots in deep soil
0.0          Manual redistribution: deep soil/surface soil dilution factor
```

```
1250        Source area for external dose modification factor (m2)
TRANSPORT ####################################################################
            ====AIR TRANSPORT=====================================SECTION 1=====
                    0-Calculate PM              |0          Release type (0-3)
 1          Option: 1-Use chi/Q or PM value     |F          Stack release (T/F)
                    2-Select MI dis. & dir      |0          Stack height (m)
                    3-Specify MI dist & dir     |0          Stack flow (m3/sec)
0           Chi/Q or PM value                   |0          Stack radius (m)
0           MI sector index (1=S)               |0          Effluent temp. (C)
0           MI distance from release point (m)  |0          Building x-section (m2)
T           Use jf data, (T/F) else chi/Q grid  |0          Building height (m)

            ====SURFACE WATER TRANSPORT===========================SECTION 2=====
0           Mixing ratio model: 0-use value, 1-river, 2-lake
0           Mixing ratio, dimensionless
0           Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0           Transit time to irrigation withdrawl location (hr)
            If mixing ratio model > 0:
0             Rate of effluent discharge to receiving water body (m3/s)
0             Longshore distance from release point to usage location (m)
0             Offshore distance to the water intake (m)
0             Average water depth in surface water body (m)
0             Average river width (m), MIXFLG=1 only
0             Depth of effluent discharge point to surface water (m), lake only

            ====WASTE FORM AVAILABILITY===========================SECTION 3=====
0           Waste form/package half life, (yr)
0           Waste thickness, (m)
0           Depth of soil overburden, m

            ====BIOTIC TRANSPORT OF BURIED SOURCE=================SECTION 4=====
T           Consider during inventory decay/buildup period (T/F)?
T           Consider during intake period (T/F)?   | 1-Arid non agricultural
0           Pre-Intake site condition..............| 2-Humid non agricultural
                                                   | 3-Agricultural

EXPOSURE #####################################################################

            ====EXTERNAL EXPOSURE=================================SECTION 5=====
            Exposure time:                   |   Residential irrigation:
0             Plume (hr)                     | T        Consider: (T/F)
0             Soil contamination (hr)        | 0        Source: 1-ground water
0             Swimming (hr)                  |                  2-surface water
0             Boating (hr)                   | 0        Application rate (in/yr)
0             Shoreline activities (hr)      | 0        Duration (mo/yr)
0           Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0           Transit time for release to reach aquatic recreation (hr)
0           Average fraction of time submersed in acute cloud (hr/person hr)

            ====INHALATION========================================SECTION 6=====
0           Hours of exposure to contamination per year
0           0-No resus-  1-Use Mass Loading              2-Use Anspaugh model
0             pension       Mass loading factor (g/m3)     Top soil available (cm)

            ====INGESTION POPULATION==============================SECTION 7=====
0           Atmospheric production definition (select option):
0             0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
              1-Use population-weighted chi/Q
              2-Use uniform production
              3-Use chi/Q and production grids (PRODUCTION will be overridden)
0           Population ingesting aquatic foods, 0 defaults to total (person)
0           Population ingesting drinking water, 0 defaults to total (person)
F           Consider dose from food exported out of region (default=F)

            Note below: S* or source: 0-none, 1-ground water, 2-surface water
                                      3-Derived concentration entered above
```

**** AQUATIC FOODS / DRINKING WATER INGESTION**********SECTION 8****

F Salt water? (default is fresh)

USE ? T/F	FOOD TYPE	TRAN-SIT hr	PROD-UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr
F	FISH	0.00	0.0E+00	0.00	0.0
F	MOLLUS	0.00	0.0E+00	0.00	0.0
F	CRUSTA	0.00	0.0E+00	0.00	0.0
F	PLANTS	0.00	0.0E+00	0.00	0.0

DRINKING WATER	
1	Source (see above)
F	Treatment? T/F
1.0	Holdup/transit(da)
730.0	Consumption (L/yr)

****TERRESTRIAL FOOD INGESTION**********************SECTION 9*****

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
T	LEAF V	90.00	1	35.0	6.0	1.5	0.0E+00	1.0	30.0
T	ROOT V	90.00	1	4[illegible].0	6.0	4.0	0.0E+00	5.0	220.0
T	FRUIT	90.00	1	35.0	6.0	2.0	0.0E+00	5.[illegible]	330.0
F	GRAIN	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0

****ANIMAL PRODUCTION CONSUMPTION*********************SECTION 10****

USE ? T/F	FOOD TYPE	---HUMAN--- CONSUMPTION RATE kg/yr	HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	----STORED FEED---- DIET FRAC-TION	GROW TIME da	-IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE da
T	BEEF	80.0	15.0	0.00	1.00	0.25	90.0	1	35.0	6.00	0.80	180.0
T	POULTR	18.0	1.0	0.00	1.00	1.00	90.0	1	0.0	0.00	0.80	180.0
T	MILK	270.0	1.0	0.00	1.00	0.25	45.0	1	47.0	6.00	2.00	100.0
T	EGG	30.0	1.0	0.00	1.00	1.00	90.0	1	0.0	0.00	0.80	180.0
						----FRESH FORAGE----						
	BEEF					0.75	45.0	1	47.0	6.00	2.00	100.0
	MILK					0.75	30.0	1	47.0	6.00	1.50	0.0

Appendix G: DOSE CALCULATION AT 60 YEARS FROM WELL WATER
SAMPLE PROBLEM 5 OUTPUT

```
-------------------------------------------------------------------------------
                     GENII  Dose Calculation Program
                      (Version 1.436 29-Jan-90)

Case title:    Sample Problem 5 - Doses at 60 years from well water

Executed on:  05/11/90 at 11:01:22                                   Page A.  1
-------------------------------------------------------------------------------

          This is a near field (narrowly-focused, single site) scenario.
          Release is chronic
          Individual dose

          THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
               Drinking water ingestion
               Terrestrial foods ingestion
               Animal product ingestion

          THE FOLLOWING TIMES ARE USED:
               Intake ends after (yr):                   1.0
               Dose calculations ends after (yr):       50.0

========== FILENAMES AND TITLES OF FILES/LIBRARIES USED =======================

 Input file name: \GENFILE\samp5a.in                                  5-11-90
 METABOLIC PARAMETERS-------------------------------------------      8-12-88
 RMDLIB - Radionuclide Master Library  (29-Aug-88 RAP)                8-29-88
 Food Transfer Factor Library - (RAP  29-Aug-88) (UPDATED LEACHING FA 8-29-88
 Bioaccumulation Factor Library - (30-Aug-88) RAP                     8-30-88
 External Dose Factors for GENII in person Sv/yr per Bq/n (28-Aug-88  8-29-88
 Internal Yearly Dose Increments  (Sv/Bq)  29-Aug-88  RAP             8-29-88

===============================================================================
  1        Surface soil input unit: (1-m2, 2-m3, 3-kg)

           -------- ----------Basic Concentrations----------
           Release          Surface Deep    Ground  Surface
           Radio-   Air     Soil    Soil    Water   Water
           nuclide   Ci/L    Ci/m2   Ci/m3   Ci/L    Ci/L
           -------- ------- ------- ------- ------- -------
           H 3      0.0E+00 0.0E+00 0.0E+00 2.2E-07 0.0E+00
           I 129    0.0E+00 0.0E+00 0.0E+00 1.8E-23 0.0E+00

========== NEAR-FIELD PARAMETERS ==============================================
     0.0   Inventory disposed n years prior to beginning of intake period
       0   LOIC occurred n years prior to beginning of intake period
 1.0E+00   Fraction of roots in upper soil (top 15 cm)
 0.0E+00   Fraction of roots in deep soil
 0.0E+00   Manual redistribution: deep soil/surface soil dilution factor

========== DRINKING WATER SOURCE/IRRIGATION ===================================
 7.3E+02   Drinking water consumption rate (l/yr)
       1   Drinking water source: 1-ground, 2-surface,  3-system
       F   Drinking water treatment: T/F
     1.0   Drinking water transit/holdup time (d)

========== TERRESTRIAL FOOD INGESTION =========================================

            GROW    --IRRIGATION--                PROD-    --CONSUMPTION--
 FOOD       TIME   S RATE     TIME     YIELD     UCTION   HOLDUP     RATE
 TYPE       d      # in/yr    mo/yr    kg/m2     kg/yr    d          kg/yr
 --------  -----   - -----    -----    -----    -------   ------    ------
 Leaf Veg   90.0   1  35.0      6.0      1.5                 1.0   3.0E+01
 Oth. Veg   90.0   1  40.0      6.0      4.0                 5.0   2.2E+02
 Fruit      90.0   1  35.0      6.0      2.0                 5.0   3.3E+02
```

********** ANIMAL FOOD INGESTION **********

FOOD TYPE	HUMAN CONSUMPTION RATE kg/yr	HUMAN CONSUMPTION HOLDUP d	TOTAL PRODUCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRACTION	GROW TIME d	S *	IRRIGATION RATE in/yr	IRRIGATION TIME mo/yr	YIELD kg/m3	STORAGE d
					STORED FEED						
Meat	8.0E+01	15.0		1.00	0.3	90.00	1	35.0	6.0	0.80	180.0
Poultry	1.8E+01	1.0		1.00	1.0	90.00	1	0.0	0.0	0.80	180.0
Cow Milk	2.7E+02	1.0		1.00	0.3	45.00	1	47.0	6.0	2.00	100.0
Eggs	3.0E+01	1.0		1.00	1.0	90.00	1	0.0	0.0	0.80	180.0
					FRESH FORAGE						
Meat					0.75	45.0	1	47.0	6.0	2.00	100.0
Cow Milk					0.75	30.0	1	47.0	6.0	1.50	0.0

Input prepared by: ______________________ Date: ____________

Input checked by: ______________________ Date: ____________

GENII Dose Calculation Program
(Version 1.436 29-Jan-90)

Case title: Sample Problem 5 - Doses at 60 years from well water

Executed on: 05/11/90 at 11:01:38 Page C. 1

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	2.2E-02	2.5E-01	5.4E-03
Breast	2.2E-02	1.5E-01	3.2E-03
R Marrow	2.2E-02	1.2E-01	2.6E-03
Lung	[illegible]	1.2E-01	2.6E-03
Thyroid	2.2E-02	3.0E-02	6.5E-04
Bone Sur	1.1E-02	3.0E-02	3.3E-04
S Int.	2.3E-02	6.0E-02	1.4E-03
UL Int.	2.3E-02	6.0E-02	1.4E-03
LL Int.	2.3E-02	6.0E-02	1.4E-03
Stomach	1.2E-02	6.0E-02	7.[illegible]E-04
Bladder	[illegible]	6.0E-02	7.0E-18
Internal Effective Dose Equivalent			2.0E-02
External Dose			0.0E+00
Annual Effective Dose Equivalent			2.0E-02

Controlling Organ:	S Int.
Controlling Pathway:	Ing
Controlling Radionuclide:	H 3
Total Inhalation EDE:	0.0E+00
Total Ingestion EDE:	2.0E-02

```
-----------------------------------------------------------------------------------
                         GENII  Dose Calculation Program
                          (Version 1.436 29-Jan-90)
Case title:    Sample Problem 5 - Doses at 60 years from well water

Executed on:   05/11/90 at 11:01:38                                      Page C.
-----------------------------------------------------------------------------------
Uptake/exposure period:                                                  1.0
Dose commitment period:                                                 50.0
Dose units:                                                       Rem


              Dose Commitment Year
                     1          2          3       ...
Internal    : ____________________________________
Intake      :|
Year:       3|                         0.0E+00     ...
             |                            +
            2|              0.0E+00    0.0E+00     ...                 Internal
             |                 +          +                            Effective
            1|   2.0E-0  +  2.1E-15 +  2.3E-16  +  ...   =  2.0E-02    Dose
                                                                       Equivalent
                   ||          ||         ||
Internal                                                               Cumulative
Annual          2.0E-02  +  2.1E-15 +  2.3E-16  +  ...   =  2.0E-02    Internal
Dose                                                                   Dose
                   +           +          +                    +
External
Annual          0.0E+00     0.0E+00    0.0E+00     ...      0.0E+00
  .
                   ||          ||         ||                  ||
Annual                                                                 Cumulative
Dose            2.0E-02  +  2.1E-15 +  2.3E-16  +  ...   =  2.0E-02    Dose

                                                                       Maximum
                                                            2.0E-02    Annual
                                                                       Dose Occurred
                                                                       In Year  1
______________________________________________________________________________
```

GENII Dose Calculation Program
(Version 1.436 29-Jan-90)

Case title: Sample Problem 5 - Doses at 60 years from well water

Executed on: 05/11/90 at 11:01:38 Page C. 3

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Exposure Pathway

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Leaf Veg	2.6E-04	1.5E-04	2.7E-04	2.7E-04	2.7E-04	1.3E-04	2.6E-04	2.6E-04
Oth. Veg	1 [illegible] 03	1.1E-03	2.0E-03	2.0E-03	2.0E-03	9.2E-04	1.9E-03	1.9E-03
Fruit	4.2E-03	2.4E-03	4.4E-03	4.4E-03	4.4E-03	2.0E-03	4.2E-03	4.2E-03
Meat	1.0E-03	5.8E-04	1.1E-03	1.1E-03	1.1E-0[illegible]	4.9E-04	1.0E-03	1.0E-03
Poultry	1.9E-04	1.1E-04	2.0E-04	2.0E-04	2.0E-04	9.2E-05	1.9E-04	1.9E-04
Cow Milk	3.6E-03	2.1E-03	3.9E-03	3.9E-03	3.9E-03	1.8E-03	3.6E-03	3.6E-03
Eggs	3.2E-04	1.8E-04	3.4E-04	3.4E-04	3.4E-04	1.6E-04	3.2E-04	3.2E-04
Water	1.0E-02	5.8E-03	1.1E-02	1.1E-02	1.1E-02	4.9E-03	1.0E-02	1.0E-02
Total	2.2E-02	1.2E-02	2.3E-02	2.3E-02	2.3E-02	1.1E-02	2.2E-02	2.2E-02

Pathway	Ovaries	Muscle	Thyroid	Bladder
Leaf Veg	2.6E-04	2.6E-04	2.6E-04	9.0E-18
Oth. Veg	1.9E-03	1.9E-03	1.9E-03	9.2E-18
Fruit	4.2E-03	4.2E-03	4.2E-03	8.2E-18
Meat	1.0E-03	1.0E-03	1.0E-03	6.4E-18
Poultry	1.9E-04	1.9E-04	1.9E-04	2.3E-21
Cow Milk	3.6E-03	3.6E-03	3.6E-03	6.6E-17
Eggs	3.2E-04	3.2E-04	3.2E-04	6.2E-19
Water	1.0E-02	1.0E-02	1.0E-02	1.8E-17
Total	2.2E-02	2.2E-02	2.2E-02	1.2E-16

External Dose by Exposure Pathway

Pathway	
Total	0.0E+00

GENII Dose Calculation Program
(Version 1.436 29-Jan-90)

Case title: Sample Problem 5 - Doses at 60 years from well water

Executed on: 05/11/90 at 11:01:38 Page C. 4

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Radionuclide

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
H 3	2.2E-02	1.2E-02	2.3E-02	2.3E-02	2.3E-02	1.1E-02	2.2E-02	2.2E-02
I 129	4.4E-17	5.1E-17	4.1E-17	3.8E-17	4.1E-17	3.5E-16	1.8E-16	3.5E-17
Total	2.2E-02	1.2E-02	2.3E-02	2.3E-02	2.3E-02	1.1E-02	2.2E-02	2.2E-02

Radionuclide	Ovaries	Muscle	Thyroid	Bladder
H 3	2.2E-02	2.2E-02	2.2E-02	0.0E+00
I 129	3.8E-17	8.9E-17	7.1E-13	1.2E-16
Total	2.2E-02	2.2E-[illegible]	2.2E-02	1.2E-16

GENII Dose Calculation Program
(Version 1.436 29-Jan-90)

Case title: Sample Problem 5 - Doses at 60 years from well water

Executed on: 05/11/90 at 11:01:38 Page C. 5

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Radio-nuclide	Inhalation Effective Dose Equivalent	Ingestion Effective Dose Equivalent	External Dose	Internal Effective Dose Equivalent	Annual Effective Dose Equivalent
H 3	0.0E+00	2.0E-02	0.0E+00	2.0E-02	2.0E-02
I 129	0.0E+00	2.1E-14	0.0E+00	2.1E-14	2.1E-14

Appendix H: DOSE CALCULATION AT 400 YEARS FROM RIVER WATER SAMPLE PROBLEM 5 INPUT

```
############################ Program GENII Input File ############  8 Jul 88 ####
Title: Sample Problem 5 - doses from river at 400 years
       \GENFILE\SAMP5RV.in                        Created on 05-11-1990 at 11:15
OPTIONS=========================== Default ======================================
F    Near-field scenario?       (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?          (Individual)                release, single site
F    Acute release?               (Chronic)     FAR-FIELD: wide-scale release,
     Maximum Individual data set used                      multiple sites
                               Complete                                   Complete
TRANSPORT OPTIONS============ Section   EXPOSURE PATHWAY OPTIONS===== Section
F  Air Transport                  1        F  Finite plume, external        5
T  Surface Water Transport        2        F  Infinite plume, external      5
F  Biotic Transport (near-field)  3,4      F  Ground, external              5
F  Waste Form Degradation (near)  3,4      T  Recreation, external          5
                                           F  Inhalation uptake             5,6
REPORT OPTIONS========================     T  Drinking water ingestion      7,8
T  Report AEDE only                        F  Aquatic foods ingestion       7,8
T  Report by radionuclide                  T  Terrestrial foods ingestion   7,9
T  Report by exposure pathway              T  Animal product ingestion      7,10
F  Debug report on screen                  F  Inadvertent soil ingestion

INVENTORY ######################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations----------
     Use when|  transport selected   |  near-field scenario, optionally
     --------|-----------------------|----------------------------------------
     Release                Surface Buried          Surface Deep    Ground  Surface
     Radio-   Air           Water   Waste   Air     Soil    Soil    Water   Water
     nuclide  /yr           /yr     /m3     /m3     /unit   /m3     /L      /L
     -------- -------- ------- ------- ------- ------- ------- ------- -------
     H 3                    4.4E-16
     I 129                  2.0E-04

     --------|----Derived Concentrations-----
     Use when|  measured values are known
     --------|-------------------------------
     Release  Terres. Animal  Drink   Aquatic
     Radio-   Plant   Product Water   Food
     nuclide  /kg     /kg     /L      /kg
     -------- ------- ------- ------- -------

TIME ###########################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
1    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #######################################

0          Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line

NEAR-FIELD SCENARIOS ###########################################################

           Prior to the beginning of the intake period: (yr)
0            When was the inventory disposed?  (Package degradation starts)
0            When was LOIC?  (Biotic transport starts)
0          Fraction of roots in upper soil (top 15 cm)
0          Fraction of roots in deep soil
0          Manual redistribution: deep soil/surface soil dilution factor
```

```
0         Source area for external dose modification factor (m2)
TRANSPORT ##################################################################
          ====AIR TRANSPORT=====================================SECTION 1=====
                 0-Calculate PM              | 0        Release type (0-3)
 1        Option: 1-Use chi/Q or PM value    | F        Stack release (T/F)
                 2-Select MI dist & dir      | 0        Stack height (m)
                 3-Specify MI dist & dir     | 0        Stack flow (m3/sec)
0         Chi/Q or PM value                  | 0        Stack radius (m)
0         MI sector index (1=S)              | 0        Effluent temp. (C)
0         MI distance from release point (m) | 0        Building x-section (m2)
T         Use jf data, (T/F) else chi/Q grid | 0        Building height (m)

          ====SURFACE WATER TRANSPORT===========================SECTION 2====
 1        Mixing ratio model: 0-use value, 1-river, 2-lake
0         Mixing ratio, dimensionless
3.2       Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
20.0      Transit time to irrigation withdrawl location (hr)
          If mixing ratio model > 0:
1.3E-5      Rate of effluent discharge to receiving water body (m3/s)
100.0       Longshore distance from release point to usage location (m)
0.0         Offshore distance to the water intake (m)
10.0        Average water depth in surface water body (m)
10.0        Average river width (m), MIXFLG=1 only
0           Depth of effluent discharge point to surface [illegible] (m), lake on.

          ====WASTE FORM AVAILABILITY===========================SECTION 3=====
0         Waste form/package half life. (yr)
0         Waste thickness, (m)
0         Depth of soil overburden, m

          ====BIOTIC TRANSPORT OF BURIED SOURCE=================SECTION 4=====
T         Consider during inventory decay/buildup period (T/F)?
T         Consider during intake period (T/F)?    | 1-Arid non agricultural
0         Pre-Intake site condition..............| 2-Humid non agricultural
                                                  | 3-Agricultural

EXPOSURE ###################################################################

          ====EXTERNAL EXPOSURE=================================SECTION 5=====
          Exposure time:                    |   Residential irrigation:
0           Plume (hr)                      | T       Consider: (T/F)
0           Soil contamination (hr)         | 0       Source: 1-ground water
100.0       Swimming (hr)                   |                 2-surface water
100.0       Boating (hr)                    | 0       Application rate (in/yr)
500.0       Shoreline activities (hr)       | 0       Duration (mo/yr)
1         Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
8.0       Transit time for release to reach aquatic recreation (hr)
0         Average fraction of time submersed in acute cloud (hr/person hr)

          ====INHALATION========================================SECTION 6=====
0         Hours of exposure to contamination per year
0         0-No resus-  1-Use Mass Loading           2-Use Anspaugh model
0           pension      Mass loading factor (g/m3)   Top soil available (cm)

          ====INGESTION POPULATION==============================SECTION 7=====
0         Atmospheric production definition (select option):
0           0-Use food-weighted chi/Q, ([illegible]sec/m3), enter value on this line
            1-Use population-weighted chi/Q
            2-Use uniform production
            3-Use chi/Q and production grids (PRODUCTION will be overridden)
0         Population ingesting aquatic foods, 0 defaults to total (person)
0         Population ingesting drinking water, 0 defaults to total (person)
F         Consider dose from food exported out of region (default=F)

          Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                    3-Derived concentration entered above
```

==== AQUATIC FOODS / DRINKING WATER INGESTION==========SECTION 8====

Salt water? (default is fresh)

USE ? T/F	FOOD TYPE	TRAN-SIT hr	PROD-UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr
F	FISH	0.00	0.0E+00	0.00	0.0
F	MOLLUS	0.00	0.0E+00	0.00	0.0
F	CRUSTA	0.00	0.0E+00	0.00	0.0
F	PLANTS	0.00	0.0E+00	0.00	0.0

DRINKING WATER	
2	Source (see above)
F	Treatment? T/F
1.0	Holdup/transit(da)
730.0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION==========================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
T	LEAF V	90.00	2	35.0	6.0	1.5	0.0E+00	1.0	30.0
T	ROOT V	90.00	2	40.0	6.0	4.0	0.0E+00	5.0	220.0
T	FRUIT	90.00	2	35.0	6.0	2.0	0.0E+00	5.0	330.0
F	GRAIN	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0

====ANIMAL PRODUCTION CONSUMPTION======================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	--------STORED FEED-------- DIET FRAC-TION	GROW TIME da	-IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE da
T	BEEF	80.0	15.0	0.00	1.00	0.25	90.0	2	35.0	6.00	0.80	180.0
T	POULTR	18.0	1.0	0.00	1.00	1.00	90.0	2	0.0	0.00	0.80	180.0
T	MILK	270.0	1.0	0.00	1.00	0.25	45.0	2	47.0	6.00	2.00	100.0
T	EGG	30.0	1.0	0.00	1.00	1.00	90.0	2	0.0	0.00	0.80	180.0
						--------FRESH FORAGE--------						
	BEEF					0.75	45.0	2	47.0	6.00	2.00	100.0
	MILK					0.75	30.0	2	47.0	6.00	1.50	0.0

##

Appendix I: DOSE CALCULATION AT 400 YEARS FROM RIVER WATER
SAMPLE PROBLEM 5 OUTPUT

```
-----------------------------------------------------------------------------
                      GENII  Dose Calculation Program
                       (Version 1.436 29-Jan-90)

Case title:    Sample Problem 5 - doses from river at 400 years

Executed on:   05/11/90 at 11:16:08                              Page A.  1
-----------------------------------------------------------------------------

          This is a far-field (wide-scale release, multiple site  scenario.
          Release is chronic
          Individual dose

          THE FOLLOWING TRANSPORT MODES ARE CONSIDERED
               Surface Water

          THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
               Recreation, external
               Drinking water ingestion
               Terrestrial foods ingestion
               Animal product ingestion

          THE FOLLOWING TIMES ARE USED:
               Intake ends after (yr):                    1.0
               Dose calculations ends after (yr):        50.0
               Release ends after (yr):                   1.0

========== FILENAMES AND TITLES OF FILES/LIBRARIES USED =====================

Input file name: \GENFILE\SAMP5RV.in                                 5-11-90
METABOLIC PARAMETERS-----------------------------------------------  8-12-88
RMDLIB - Radionuclide Master Library  (29-Aug-88 RAP)                8-29-88
Food Transfer Factor Library - (RAP  29-Aug-88) (UPDATED LEACHING FA 8-29-88
Bioaccumulation Factor Library - (30-Aug-88) RAP                     8-30-88
External Dose Factors for GENII in person Sv/yr per Bq/m (28-Aug-88  8-29-88
Internal Yearly Dose Increments  (Sv/Bq)  29-Aug-88  RAP             8-29-88

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

          -------- ----Release Terms------
          Release          Surface Buried
          Radio-   Air     Water   Source
          nuclide  Ci/yr   Ci/yr   Ci/m3
          -------- ------- ------- -------
          H 3      0.0E+00 4.4E-16 0.0E+00
          I 129    0.0E+00 2.0E-04 0.0E+00

========== SURFACE WATER TRANSPORT ==========================================
        1  Mixing ratio model:  0-use value, 1-river, 2-lake, 3-river flow
  2.0E+01  Transit time to irrigation withdrawl location (h)
  3.2E+00  Average water flow rate for: MIXFLG=1,2 (m/s), MIXFLG=0,3 (m3/s)
  0.1E-04  Rate of effluent discharge to receiving water body (m3/s)
  0.1E+03  Longshore distance from release point to usage location (m)
  0.0E+00  Offshore distance to the water intake (m)
  0.1E+02  Average water depth in surface water body (m)
  0.1E+02  Average river width (m)

========== EXTERNAL EXPOSURE ================================================
  1.0E+02  Hours of exposure from swimming
  1.0E+02  Hours of exposure from boating
  5.0E+02  Hours of exposure from shoreline activities
        1  Shoreline type: 1-river, 2-lake, 3-ocean, 4-tidal basin
  8.0E+00  Surface water transit time to recreational site (h)

========== DRINKING WATER SOURCE/IRRIGATION =================================
```

7.3E+02	Drinking water consumption rate (l/yr)
2	Drinking water source: 1-ground, 2-surface, 3-system
F	Drinking water treatment: T/F
1.0	Drinking water transit/holdup time (d)

TERRESTRIAL FOOD INGESTION

FOOD TYPE	GROW TIME d	IRRIGATION S *	IRRIGATION RATE in/yr	IRRIGATION TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	CONSUMPTION HOLDUP d	CONSUMPTION RATE kg/yr
Leaf Veg	90.0	2	35.0	6.0	1.5		1.0	3.0E+01
Oth. Veg	90.0	2	40.0	6.0	4.0		5.0	2.2E+02
Fruit	90.0	2	35.0	6.0	2.0		5.0	3.3E+02

ANIMAL FOOD INGESTION

FOOD TYPE	HUMAN CONSUMPTION RATE kg/yr	HUMAN CONSUMPTION HOLDUP d	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRACTION	GROW TIME d	IRRIGATION S *	IRRIGATION RATE in/yr	IRRIGATION TIME mo/yr	YIELD kg/m3	STOR-AGE d
					STORED FEED						
Meat	8.0E+01	15.0		1.00	0.3	90.00	2	35.0	6.0	0.80	180.0
Poultry	1.8E+01	1.0		1.00	1.0	90.00	2	0.0	0.0	0.80	180.0
Cow Milk	2.7E+02	1.0		1.00	0.3	45.00	2	47.0	6.0	2.00	100.0
Eggs	3.0E+01	1.0		1.00	1.0	90.00	2	0.0	0.0	0.80	180.0
					FRESH FORAGE						
Meat					0.75	45.0	2	47.0	6.0	2.00	100.0
Cow Milk					0.75	30.0	2	47.0	6.0	1.50	0.0

Input prepared by: ____________________ Date: ______

Input checked by: ____________________ Date: ______

GENII Dose Calculation Program
(Version 1.436 29-Jan-90)

Case title: Sample Problem 5 - doses from river at 400 years

Executed on: 05/11/90 at 11:16:24 Page C. 1

Release period:	1.0
Uptake/exposure period:	1.0
Dose commitment period:	50.0
Dose units:	Rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	4.2E-11	2.5E-01	1.1E-11
Breast	9.9E-11	1.5E-01	1.5E-11
R Marrow	2.0E-10	1.2E-01	2.4E-11
Lung	4.9E-1[illegible]	1.2E-01	5.9E-12
Thyroid	7.9E-0[illegible]	3.0E-02	2.4E-08
Bone Sur	3.9E-1[illegible]	3.0E-02	1.2E-11
Bladder	1.3E-1[illegible]	6.0E-02	7.8E-12
Stomach	5.6E-1[illegible]	6.0E-02	3.4E-12
S Int.	4.6E-11	6.0E-02	2.7E-12
LL Int.	4.6E-11	6.0E-02	2.7E-12
UL Int.	4.2E-11	6.0E-02	2.5E-12
Internal Effective Dose Equivalent			2.4E-08
External Dose			2.9E-13
Annual Effective Dose Equivalent			2.4E-08

Controlling Organ:	Thyroid
Controlling Pathway:	Ing
Controlling Radionuclide:	I 129
Total Inhalation EDE:	0.0E+00
Total Ingestion EDE:	2.4E-08

```
Release period:                                                1.0
Uptake/exposure period:                                        1.0
Dose commitment period:                                       50.0
Dose units:                                                Rem


              Dose Commitment Year
                    1          2          3      ...
Internal  :  ____________________________________
Intake    :  |
Year:     3  |                         0.0E+00   ...
             |                            +
          2  |              0.0E+00    0.0E+00   ...                Internal
             |                 +          +                         Effective
          1  |   2.1E-08 + 2.3E-09 + 2.5E-10 + ...   =   2.4E-08    Dose
                                                                    Equivalent
                    ||         ||         ||
Internal
Annual           2.1E-08 + 2.3E-09 + 2.5E-10 + ...   =   2.4E-08    Cumulative
Dose                                                                Internal
                                                                    Dose
                    +          +          +                 +
External
Annual           2.9E-13    0.0E+00    0.0E+00   ...     2.9E-13
Dose
                    ||         ||         ||                ||
Annual
Dose             2.1E-08 + 2.3E-09 + 2.3E-10 + ...   =   2.4E-08    Cumulative
                                                                    Dose

                                                         2.1E-08    Maximum
                                                                    Annual
                                                                    Dose Occurred
                                                                    In Year  1
---------------------------------------------------------------------------------
```

GENII Dose Calculation Program
(Version 1.436 29-Jan-90)

Case title: Sample Problem 5 - doses from river at 400 years

Executed on: 05/11/90 at 11:16:24 Page C. 3

Release period: 1.0
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Exposure Pathway

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Leaf Veg	3.8E-12	4.3E-12	3.5E-12	3.2E-12	3.5E-12	3.0E-11	1.5E-11	3.0E-12
Oth. Veg	3.9E-12	4.4E-12	3.6E-12	3.3E-12	3.6E-12	3.1E-11	1.6E-11	3.1E-12
Fruit	3.4E-12	3.9E-12	3.2E-12	2.9E-12	3.2E-12	2.7E-11	1.4E-11	2.7E-12
Meat	2.7E-12	3.1E-12	2.5E-12	2.3E-12	2.5E-12	2.1E-11	1.1E-11	2.1E-12
Poultry	9.8E-16	1.1E-15	9.1E-16	8.4E-16	9.1E-16	7.7E-15	4.0E-15	7.7E-16
Cow Milk	2.7E-11	3.1E-11	2.5E-11	2.4E-11	2.5E-11	2.2E-10	1.1E-10	2.2E-11
Eggs	2.6E-13	3.0E-13	2.4E-13	2.2E-13	2.4E-13	2.0E-12	1.1E-12	2.0E-13
Swim Ing	2.1E-14	2.4E-14	1.9E-14	1.8E-14	1.9E-14	1.6E-13	8.4E-14	1.6E-14
Water	7.8E-12	8.9E-12	7.2E-12	6.7E-12	7.2E-12	6.1E-11	3.2E-11	6.1E-12
Total	4.9E-11	5.6E-11	4.6E-11	4.2E-11	4.6E-11	3.9E-10	[illegible].0E-10	3.9E-11

Pathway	Ovaries	Muscle	Thyroid	Bladder
Leaf Veg	3.2E-12	7.6E-12	6.1E-08	1.0E-11
Oth. Veg	3.3E-12	7.8E-12	6.2E-08	1.0E-11
Fruit	2.9E-12	6.8E-12	5.5E-08	9.0E-12
Meat	2.3E-12	5.4E-12	4.3E-08	7.1E-12
Poultry	8.4E-16	2.0E-15	1.6E-11	2.6E-15
Cow Milk	2.4E-11	5.5E-11	4.4E-07	7.3E-11
Eggs	2.2E-13	5.2E-13	4.2E-09	6.8E-13
Swim Ing	1.8E-14	4.1E-14	3.3E-10	5.5E-14
Water	6.7E-12	1.6E-11	1.2E-07	2.1E-11
Total	4.2E-11	9.9E-11	7.9E-07	1.3E-10

External Dose by Exposure Pathway

Pathway	

Swim Ext	3.8E-14
Boating	1.9E-14
Shore	2.3E-13
---------------	-------
Total	2.9E-13

```
------------------------------------------------------------------------------
                       GENII  Dose Calculation Program
                        (Version 1.436 29-Jan-90)

Case title:    Sample Problem 5 - doses from river at 400 years

Executed on:   05/11/90 at 11:16:24                                Page C.  4
------------------------------------------------------------------------------

Release period:                                                1.0
Uptake/exposure period:                                        1.0
Dose commitment period:                                       50.0
Dose units:                                               Rem
```

Committed Dose Equivalent by Radionuclide

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
H 3	4.3E-24	2.5E-24	4.5E-24	4.5E-24	4.5E-24	2.1E-24	4.3E-24	4.3E-24
I 129	4.9E-11	5.6E-11	4.6E-11	4.2E-11	4.6E-11	3.9E-10	2.0E-10	3.9E-11
Total	4.9E-11	5.6E-11	4.6E-11	4.2E-11	4.6E-11	3.9E-10	2.0E-10	3.9E-11

Radionuclide	Ovaries	Muscle	Thyroid	Bladder
H 3	4.3E-24	4.3E-24	4.3E-24	0.0E+00
I 129	4.2E-11	9.9E-11	7.9E-07	1.3E-10
Total	4.2E-11	9.9E-11	7.9E-07	1.3E-10

Release period: 1.0
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Radio-nuclide	Inhalation Effective Dose Equivalent	Ingestion Effective Dose Equivalent	External Dose	Internal Effective Dose Equivalent	Annual Effective Dose Equivalent
H 3	0.0E+00	3.9E-24	4.7E-33	3.9E-24	3.9E-24
I 129	0.0E+00	2.4E-08	2.9E-13	2.4E-08	2.4E-08

Appendix J: SAMPLE PROBLEM 6 INPUT

```
##########################Program GENII Input File ############  8 Jul 88 ####
Title: INTRUSION CONSTRUCTION SCENARIO

       \GENFILE\SURFSOIL.in                        Created on 02-19-1990 at 13:05
OPTIONS====================== Default ======================================
T    Near-field scenario?       (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?          (Individual)                release, single site
F    Acute release?               (Chronic)    FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                      multiple sites
                                  Complete                               Complete
TRANSPORT OPTIONS============     Section   EXPOSURE PATHWAY OPTIONS=====  Section
F  Air Transport                    1       F  Finite plume, external        5
F  Surface Water Transport          2       T  Infinite plume, external      5
F  Biotic Transport (near-field)   3,4      T  Ground, external              5
F  Waste Form Degradation (near)   3,4      F  Recreation, external          5
                                            T  Inhalation uptake             5,6
REPORT OPTIONS======================        F  Drinking water ingestion      7,8
T  Report AEDE only                         F  Aquatic foods ingestion       7,8
T  Report by radionuclide                   F  Terrestrial foods ingestion   7,9
T  Report by exposure pathway               F  Animal product ingestion      7,10
F  Debug report on screen                   F  Inadvertent soil ingestion

INVENTORY ###################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|-----------Basic Concentrations---------|
     Use when|  transport selected   |  near-field scenario, optionally       |
     --------|-----------------------|----------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface |
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water   |
     nuclide |/yr    /yr     /m3    |/m3    /unit   /m3     /L      /L      |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     H 3                                                3.[illegible]E-02
     I 129                                              2.6E-03
     --------|----Derived Concentrations-----|
     Use when|   measured values are known   |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|

TIME ########################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
0    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) ####################################

0            Definition option: 1-Use population grid in file POP.IN
0                               2-Use total entered on this line

NEAR-FIELD SCENARIOS ########################################################

             Prior to the beginning of the intake period: (yr)
0              When was the inventory disposed?  (Package degradation starts)
0              When was LOIC?  (Biotic transport starts)
0            Fraction of roots in upper soil (top 15 cm)
0            Fraction of roots in deep soil
0.15           Manual redistribution: deep soil/surface soil dilution factor
```

```
1250        Source area for external dose modification factor (m2)
TRANSPORT ###########################################################################
            ====AIR TRANSPORT=====================================SECTION 1=====
                   0-Calculate PM                 | 0        Release type (0-3)
 1          Option: 1-Use chi/Q or PM value       | F        Stack release (T/F)
                   2-Select MI dist & dir         | 0        Stack height (m)
                   3-Specify MI dist & dir        | 0        Stack flow (m3/sec)
0           Chi/Q or PM value                     | 0        Stack radius (m)
0           MI sector index (1=S)                 | 0        Effluent temp. (C)
0           MI distance from release point (m)    | 0        Building x-section (m2)
T           Use jf data, (T/F) else chi/Q grid    | 0        Building height (m)

            ====SURFACE WATER TRANSPORT===========================SECTION 2=====
0           Mixing ratio model: 0-use value, 1-river, 2-lake
0           Mixing ratio, dimensionless
0           Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0           Transit time to irrigation withdrawl location (hr)
            If mixing ratio model > 0:
0             Rate of effluent discharge to receiving water body (m3/s)
0             Longshore distance from release point to usage location (m)
0             Offshore distance to the water intake (m)
0             Average water depth in surface water body (m)
0             Average river width (m), MIXFLG=1 only
0             Depth of effluent discharge point to surface water (m), lake only

            ====WASTE FORM AVAILABILITY===========================SECTION 3=====
0           Waste form/package half life, (yr)
0           Waste thickness, (m)
1.          Depth of soil overburden, m

            ====BIOTIC TRANSPORT OF BURIED SOURCE=================SECTION 4=====
T           Consider during inventory decay/buildup period (T/F)?
T           Consider during intake period (T/F)?   | 1-Arid non agricultural
0           Pre-Intake site condition..............| 2-Humid non agricultural
                                                   | 3-Agricultural
EXPOSURE ############################################################################

            ====EXTERNAL EXPOSURE=================================SECTION 5=====
            Exposure time:                     |    Residential irrigation:
80.00         Plume (hr)                       | T          Consider: (T/F)
80.0          Soil contamination (hr)          | 0          Source: 1-ground water
0             Swimming (hr)                    |                    2-surface water
0             Boating (hr)                     | 0          Application rate (in/yr)
0             Shoreline activities (hr)        | 0          Duration (mo/yr)
0           Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0           Transit time for release to reach aquatic recreation (hr)
0           Average fraction of time submersed in acute cloud (hr/person hr)

            ====INHALATION========================================SECTION 6=====
80.0        Hours of exposure to contamination per year
1           0-No resus-  1-Use Mass Loading            2-Use Anspaugh model
.0001         pension     Mass loading factor (g/m3)   Top soil available (cm)

            ====INGESTION POPULATION==============================SECTION 7=====
0           Atmospheric production definition (select option):
0             0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
              1-Use population-weighted chi/Q
              2-Use uniform production
              3-Use chi/Q and production grids (PRODUCTION will be overridden)
0           Population ingesting aquatic foods, 0 defaults to total (person)
0           Population ingesting drinking water, 0 defaults to total (person)
F           Consider dose from food exported out of region (default=F)

            Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                      3-Derived concentration entered above
```

==== AQUATIC FOODS / DRINKING WATER INGESTION========SECTION 8====

F Salt water? (default is fresh)

USE ? T/F	FOOD TYPE	TRANSIT hr	PRODUCTION kg/yr	-CONSUMPTION- HOLDUP da	-CONSUMPTION- RATE kg/yr
F	FISH	0.00	0.0E+00	0.00	0.0
F	MOLLUS	0.00	0.0E+00	0.00	0.0
F	CRUSTA	0.00	0.0E+00	0.00	0.0
F	PLANTS	0.00	0.0E+00	0.00	0.0

DRINKING WATER	
0	Source (see above)
T	Treatment? T/F
0	Holdup/transit(da)
0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION====================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	--IRRIGATION-- RATE in/yr	--IRRIGATION-- TIME mo/yr	YIELD kg/m2	PRODUCTION kg/yr	--CONSUMPTION-- HOLDUP da	--CONSUMPTION-- RATE kg/yr
F	LEAF V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F	ROOT V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F	FRUIT	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F	GRAIN	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0

====ANIMAL PRODUCTION CONSUMPTION===================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN CONSUMPTION--- RATE kg/yr	---HUMAN CONSUMPTION--- HOLDUP da	TOTAL PRODUCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRACTION	GROW TIME da	-IRRIGATION-- S *	-IRRIGATION-- RATE in/yr	-IRRIGATION-- TIME mo/yr	YIELD kg/m3	STORAGE da
						STORED FEED						
F	BEEF	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F	POULTR	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F	MILK	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F	EGG	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
						FRESH FORAGE						
	BEEF					0.00	0.0	0	0.0	0.00	0.00	0.0
	MILK					0.00	0.0	0	0.0	0.00	0.00	0.0

##

Appendix K: SAMPLE PROBLEM 6 OUTPUT

```
----------------------------------------------------------------------------
                     GENII  Dose Calculation Program
                      (Version 1.395 23-Jan-89)

Case title:    INTRUSION CONSTRUCTION SCENARIO

Executed on:   02/23/90 at 16:44:43                                Page A.  1
----------------------------------------------------------------------------

          This is a near field (narrowly-focused, single site) scenario.
          Release is chronic
          Individual dose

          THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
               Infinite plume, external
               Ground, external
               Inhalation uptake

          THE FOLLOWING TIMES ARE USED:
               Intake ends after (yr):                      1.0
               Dose calculations ends after (yr):          50.0

========== FILENAMES AND TITLES OF FILES/LIBRARIES USED ====================

Input file name: \GENFILE\SURFSOIL.in                                2-23-90
METABOLIC PARAMETERS---------------------------------------------    8-12-88
RMDLIB - Radionuclide Master Library  (29-Aug-88 RAP)                8-29-88
External Dose Factors for GENII in person Sv/yr per bq/n (2[illegible]-Aug-88   8-29-88
Internal Yearly Dose Increments  (Sv/Bq)  29-Aug-88  RAP             8-29-88

============================================================================
  1        Surface soil input unit: (1-m2, 2-m3, 3-kg)

          -------- ----------Basic Concentrations---------
          Release          Surface Deep    Ground  Surface
          Radio-   Air     Soil    Soil    Water   Water
          nuclide  Ci/L    Ci/m2   Ci/m3   Ci/L    Ci/L
          -------- ------- ------- ------- ------- -------
          H 3      0.0E+00 0.0E+00 3.1E-02 0.0E+00 0.0E+00
          I 129    0.0E+00 0.0E+00 2.6E-03 0.0E+00 0.0E+00

========== NEAR-FIELD PARAMETERS ===========================================
    0.0    Inventory disposed n years prior to beginning of intake period
      0    LOIC occurred n years prior to beginning of intake period
0.0E+00    Fraction of roots in upper soil (top 15 cm)
C ^F+00    Fraction of roots in deep soil
1   -01    Manual redistribution: deep soil/surface soil dilution factor
 .  3.0    Source area for external dose modification factor (m2)

========== WASTE FORM AVAILABILITY =========================================
0.0E+00    Waste form/package half life, yr
0.0E+00    Thickness of buried waste, m
1.0E+00    Depth of soil overburden, m

========== EXTERNAL EXPOSURE ===============================================
 8.0E-01   Hours of exposure to plume
 [illegible].0E+01   Hours of exposure to ground contamination

========== INHALATION ======================================================
 8.0E+01   Hours of inhalation exposure per year
       1   Resuspension model:  1-Mass Loading, 2-Anspaugh
 1.0E-04   Mass loading factor (g/m3)

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

2

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

PHOTOGRAPHIC SCIENCES CORPORATION
770 BASKET ROAD
P.O. BOX 338
WEBSTER, NEW YORK 14580
(716) 265-1600

Input prepared by: ______________________________ Date: ____________

Input checked by: ______________________________ Date: ____________

==

GENII Dose Calculation Program
(Version 1.393 20-Jan-89)

Case title: INTRUSION CONSTRUCTION SCENARIO

Executed on: 02/23/90 at 16:45:01 Page C. 1

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	1.9E-08	2.5E-01	4.7E-09
Breast	2.4E-08	1.5E-01	3.6E-09
R Marrow	3.3E-08	1.2E-01	4.0E-09
Lung	2.7E-08	1.2E-01	3.3E-09
Thyroid	7.0E-05	3.0E-02	2.1E-06
Bone Sur	4.4E-08	3.0E-02	1.3E-09
LL Int.	2.0E-08	6.0E-02	1.2E-09
S Int.	2.0E-08	6.0E-02	1.2E-09
UL Int.	2.0E-08	6.0E-02	1.2E-09
Stomach	1.2E-08	6.0E-02	7.3E-10
Bladder	1.2E-08	6.0E-02	7.1E-10

Internal Effective Dose Equivalent 2.1E-06
External Dose 1.5E-04

Annual Effective Dose Equivalent 1.5E-04

Controlling Organ: Thyroid
Controlling Pathway: Ext
Controlling Radionuclide: I 129

Total Inhalation EDE: 2.1E-06
Total Ingestion EDE: 0.0E+00

```
--------------------------------------------------------------------------------
                     GENII  Dose Calculation Program
                      (Version 1.395 23-Jan-89)

Case title:    INTRUSION CONSTRUCTION SCENARIO

Executed on:  02/23/90 at 16:45:01                                   Page C.  2
--------------------------------------------------------------------------------

Uptake/exposure period:                                         1.0
Dose commitment period:                                        50.0
Dose units:                                                 Rem


             Dose Commitment Year
                   1         2         3       ...
Internal   :  --------------------------------
Intake     : |
Year:      3 |                     0.0E+00    ...
             |                        +
           2 |          0.0E+00    0.0E+00    ...               Internal
             |             +          +                         Effective
           1 | 1.9E-06 + 2.2E-07 + 2.3E-08 + ...  =  2.1E-06   Dose
                                                                Equivalent
                  ||        ||        ||
Internal                                                        Cumulative
Annual         1.9E-06 + 2.2E-07 + 2.3E-08 + ...  =  2.1E-06   Internal
Dose                                                            Dose
                  +         +         +                 +
External
Annual         1.5E-04   0.0E+00   0.0E+00    ...     1.5E-04
Dose
                  ||        ||        ||                ||
Annual                                                          Cumulative
Dose           1.5E-04 + 2.2E-07 + 2.3E-08 + ...  =  1.5E-04   Dose

                                                                Maximum
                                                     1.5E-04   Annual
                                                                Dose Occurred
                                                                In Year  1
--------------------------------------------------------------------------------
```

GENII Dose Calculation Program
(Version 1.395 23-Jan-89)

Case title: INTRUSION CONSTRUCTION SCENARIO

Executed on: 02/23/90 at 16:45:01 Page C. 3

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Exposure Pathway

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhale	2.7E-08	1.2E-08	2.0E-08	2.0E-08	2.0E-08	4.4E-08	3.3E-08	1.8E-08
Total	2.7E-08	1.2E-08	2.0E-08	2.0E-08	2.0E-08	4.4E-08	3.3E-08	1.8E-08

Pathway	Ovarios	Muscle	Thyroid	Bladder
Inhale	1.9E-08	2.4E-08	7.0E-05	1.2E-08
Total	1.9E-08	2.4E-08	7.0E-05	1.2E-08

External Dose by Exposure Pathway

Pathway	
Plume	0.0E+00
Sur Soil	1.5E-04
Dep Soil	1.3E-23
Total	1.5E-04

GENII Dose Calculation Program
(Version 1.395 23-Jan-89)

Case title: INTRUSION CONSTRUCTION SCENARIO

Executed on: 02/23/90 at 16:45:01

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Radionuclide

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
H 3	1.5E-08	8.9E-09	1.6E-08	1.6E-08	1.6E-08	7.7E-09	1.5E-08	1.5E-08
I 129	1.2E-08	3.2E-09	4.2E-09	4.1E-09	4.4E-09	3.6E-08	1.9E-08	[illegible].5E-09
Total	2.7E-08	1.2E-08	2.0E-08	2.0E-08	2.0E-08	4.4E-08	3.3E-08	1.8E-08

Radionuclide	Ovaries	Muscle	Thyroid	Bladder
H 3	1.5E-08	1.5E-08	1.5E-08	0.0E+00
I 129	4.1E-09	9.3E-09	7.0E-05	1.2E-08
Total	1.9E-08	2.4E-08	7.0E-05	1.2E-08

GENII Dose Calculation Program
(Version 1.395 23-Jan-89)

Case title: INTRUSION CONSTRUCTION SCENARIO

Executed on: 02/23/90 at 16:45:01 Page C. 5

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Radio-nuclide	Inhalation Effective Dose Equivalent	Ingestion Effective Dose Equivalent	External Dose	Internal Effective Dose Equivalent	Annual Effective Dose Equivalent
H 3	1.4E-08	0.0E+00	1.1E-11	1.4E-08	1.4E-08
I 129	2.1E-06	0.0E+00	1.5E-04	2.1E-06	1.5E-04

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A performance assessment methodology has been developed for use by the U.S. Nuclear Regulatory Commission in evaluating license applications for low-level waste disposal facilities. This report provides detailed guidance on input and output procedures for the computer codes recommended for use in the methodology. Seven sample problems are provided for various aspects of a performance assessment analysis of a simple hypothetical conceptual model. When combined, these sample problems demonstrate how the methodology is used to produce a dose history for the site under normal conditions, and to demonstrate an analysis of an intruder scenario.

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