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Development and Application of a Risk Assessment Method for Radioactive Waste Management

Volume III: Economic Analysis; Description and Implementation of AMRAW-B Model

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DEVELOPMENT AND APPLICATION OF A RISK ASSESSMENT METHOD FOR RADIOACTIVE WASTE MANAGEMENT

Final Contract Report

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Volume IV: AMRAW Computer Code Users' Manual

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FOREWORD

The EPA Office of Radiation Programs carries out a national program to evaluate human exposures to radioactivity, and to promote the development of controls to protect the environment and public health from such radioactivity. An important part of this program consists of the development of environmental protection criteria and standards for radioactive waste management and disposal.

To sustain this effort, studies have been supported by EPA to develop methods to evaluate the environmental adequacy of proposed waste management alternatives, and this report describes one of the first attempts to develop a comprehensive assessment model. It has been funded at a very modest level. Much interest has been expressed in this work, and through publication, EPA is making it available to those involved with the development and use of models as decision-making tools.

In order for models to be useful as tools for decision-making concerning radioactive waste management alternatives, their capabilities and limitations must be fully understood. It should be noted that assessment models in themselves will not identify optimum waste management choices. However, they can be used to compare well defined alternatives. One of the necessary steps in any model development and validation process is the comparison of results with results obtained from the application of alternate models to test cases. It is hoped that as other comprehensive assessment models become available, comparison studies can be performed.

The methodology described herein has been applied, for model illustration purposes, to a reference repository in a bedded salt formation located in the southwestern United States. Any results published in this report should not be interpreted as implying conclusions concerning the suitability of the reference site or any site-specific method/repository combination for the preparation and disposal of radioactive waste.

Comments on this analysis as well as any new information would be welcomed; they may be sent to the Director, Technology Assessment Division (AW-459) Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460.

W. D. Rowe, Ph.D.
Deputy Assistant Administrator
for Radiation Programs (AW-459)

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ABSTRACT

A Radioactive Waste Management Systems Model, developed and implemented by The University of New Mexico under contract with the U. S. Environmental Protection Agency, is presented. The systems model and associated computer code called AMRAW (Assessment Method for Radioactive Waste), has two parts. The first part, AMRAW-A, consists of the Source Term (radioactive inventory versus time), the Release Model, and the Environmental Model. The Release Model considers various geologic and man-caused events which are potential mechanisms for release of radioactive material beyond the immediate environs of a repository or other location; the risk analysis mode uses events distributed probabilistically over time, and the consequence analysis mode uses discrete events occurring at specified times. The Environmental Model includes: 1) the transport to and accumulations at various receptors in the biosphere, 2) pathways from these environmental concentrations, and 3) resulting radiation dose to man.

The second part of the systems model, AMRAW-B, is the Economic Model which calculates health effects corresponding to the various organ dose rates from AMRAW-A, collects these health effects in terms of economic costs and attributes these costs to radionuclides, decay groups, and elements initially in the waste inventory. Implementation, with calculated results, of AMRAW for Terminal Storage in a Bedded Salt Reference Repository are presented. Preliminary demonstrations for the repository operations phase of waste management and terminal storage in a shale formation are described; possible applications to other radioactive and nonradioactive hazardous materials are discussed. AMRAW uniquely links all steps together in a continuous calculation sequence.

ACKNOWLEDGEMENTS

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Persons at the EPA, other federal agencies, national laboratories, federal contractors, and foreign correspondents have provided helpful suggestions during progress of the work or through review of draft reports. These contributions are greatly appreciated though space does not permit acknowledgement of each individual contribution.

Assistance in planning the AMRAW users' guide was by K. E. Patterson and C. C. Herrmann. AMRAW-B information used for preparation of the guide was furnished by S. Ben-David and D. S. Brookshire; auxiliary program material was prepared by H. S. Ng. Others at UNM who participated in the project, including AMRAW programming, and other persons making direct contributions are named in the Acknowledgements section of Volume I.

DEVELOPMENT AND APPLICATION OF A RISK ASSESSMENT METHOD FOR RADIOACTIVE WASTE MANAGEMENT

VOLUME LISTING

VOLUME I	GENERIC DESCRIPTION OF AMRAW-A MODEL
VOLUME II	IMPLEMENTATION FOR TERMINAL STORAGE IN REFERENCE REPOSITORY AND OTHER APPLICATIONS
VOLUME III	ECONOMIC ANALYSIS; DESCRIPTION AND IMPLEMENTAT OF AMRAW-B MODEL
VOLUME IV	AMRAW COMPUTER CODE USERS' MANUAL

VOLUME IV

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

VOLUME IV

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (CONTINUED)

VOLUME IV

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PART 1

A

AA1(JF, J)	Fraction of inventory transferred to receptor JF if a release via cutset J (i.e., JJ) occurs
ADJ	Fraction of inventory transferred from one environmental receptor pool to another pool per unit time; obtained from ADJ1 and ADJ2
ADJ1(JF,JFA,IZ)	Maximum fraction of a quantity dispersed to receptor JFA in Zone IZ which can be transferred to receptor JF in the same zone; paired with ADJ2 for inter-receptor adjustments over time following an initial dispersion.
ADJ2(JF,JFA,IZ)	Transfer rate constant associated with ADJ1, y^{-1}
AL	Axial dispersivity coefficient, m
AMRAW	(Assessment Method for Radioactive Waste) Assessment Model and associated computer code
AMRAW-A	That portion of AMRAW which includes Source Terms, Release Model, and Environmental Model
AMRAW-B	The economic part of AMRAW
AREAW (IZ)	Surface area of water by zone, cm^2
AREAG	Zone land surface area, cm^2, over which nuclide is deposited
AT	Transverse dispersivity coefficient, m
A1	Transfer coefficient giving fraction of inventory transferred from inventory to receptor JF and due to release mechanism under consideration; obtained from subroutine FAULT and is equal to AA1(JF,J) except for leaching
A2	Time transfer coefficient accounting for radioactive and environmental decay occurring between release and population dose times; calculated within subroutine TRINP with help of function CRATIO for ground water transport calculations

A2MIN	Truncation value (to 0.0) for A2 (accounts for decay and transport processes)

B

BIOFAC (K, JF, I)	Concentration or integrated concentration in food or drink per unit receptor concentration, by subpath I, up to NS = NSP(JF); units are (μCi-y/g)/(μCi/cm^2) for terrestrial food, (μCi/g)/(μCi/cm^3) for aquatic food, and dimensionless for drinking water
BULKD	Bulk solid density of aquifer, g/cm^3

C

C	Transfer coefficient which transforms environmental concentration in a receptor to corresponding dose commitment rate to a specified organ; calculated in subroutine TRMAN
CINV	Total number of canisters in inventory
CFAI	Number of canisters exposed to leach incident
CHECK	Flag for errors in data field; alphanumeric identification of checkpoint number (ICHEK)
COMPRESS	An auxiliary program for preparing an AMRAW-B input file from AMRAW-A output
CP(JF,J,K)	Function parameter: size of step function, slope of ramp function, exponential constant or set = 1.0 for delta function; K is component factor
CRATIO	Subroutine in AMRAW-A for ground water transport calculations
CRMIN	Cutoff value for CRATIO (ground water concentration)

D

DC1(K)	Effective diffusivity for nuclide K leaching, cm^2/d
DELTE	Time interval over which environmental decay constant is applied; also, time increment for which inter-receptor transfer is calculated
DELTL	Time increment during release to environment period

DECFAC	Effective radioactive decay factor between two times
DEP	Deposition concentration for water and ground surface (Ci/cm^2) due to air deposition
DEPGND	Total deposition on land surface of zone
DEPWTR	Total deposition on water surface of zone
DFMIN	Cutoff value for DECFAC (decay factor)
DISPN (JF, IZ)	Area or volume over which, or in which, a release is dispersed in each receptor JF in each zone IZ, cm^2 or cm^3
DOSFAC(K,JF,MODE,IH)	Dose commitment conversion factor for each organ IH of NIHT total; each card has conversion factors for specified nuclide and receptor/exposure mode combination, $(mrem/y)/(\mu Ci/cm^3)$, $(mrem)/(\mu Ci/cm^2)$ or $mrem/\mu Ci$, as appropriate
DRC (K)	Dissolution rate constant for nuclide K leaching, d^{-1}

E

EDC(K, I, IZ)	Environmental decay constants for nuclides K, receptor JF (represented here by I) and Zones IZ; data sequence on cards is EDC by zone to MZ zones for first nuclide, repeated in turn for each subsequent nuclide to NK nuclides; if ISECT = 4, this group of cards is repeated in turn for JF = 2 and JF = 3
ELEM (ID)	Symbol for each of ND chemical elements

F

FS	Exposed area of solidified waste specimen (canister as fractured), cm^2
FAULT	Subroutine in AMRAW-A which handles the Release Model and provides transfer coefficients used to accumulate releases to four preliminary input receptors
FUNCTION CRATIO	Determines concentration ratio in ground water at discharge point compared to release point; this ground water transport function is called by SUBROUTINE TRINP
FUNCTION RLEACH	Calculates amount of nuclide leached into the ground water preliminary environmental input receptor; the function is called by SUBROUTINE FAULT when a leach incident is involved

G

GNDDIS	Ground dispersion, related to ground water velocity and aquifer dimensions
GNDEP	Non-accumulating matrix which retains integrated deposition for current time increment for use in calculating transfer to terrestrial food products

H

HT	Height of aquifer, m

I

ICHCK	Flag for errors in data file--gives check point number
IFDIVW	Ground water time increment control; IFDIVW = 0 avoids subdivision of time increments and IFDIVW > 0 causes sub-division branch in subroutine TRINP to be executed
IFLAGE(JF,MODE,I)	Flag used in Environment-to-Man Pathways model designating whether output is accumulated as "local dose" (IFLAGE = 1) or "nonspecific dose" (IFLAGE = 2).
IFLAG(JF,J,K)	Probability function designation: 0 Constant 1 Step function 2 Ramp function 3 Exponential function 4 Delta function K is component factor of cutset J releasing to receptor JF
IE	Output medium for error and data check point messages
IN	Input medium, normally card reader
IP	Output medium (line printer or tape)
ISTART	Starting zone number
ISTOP	Ending zone number
ISECT	Control flag for EDC data; ISECT = 1: internal EDC default values used for JF = 2 & 3 (= 2.30×10^{-5}), type 36 cards ommited; ISECT = 2: EDC default values used for JF = 3, type 36 cards read for JF = 2;

	ISECT = 3: EDC default values used for JF = 2, type 36 cards read for JF = 3; ISECT = 4: type 36 cards read for JF = 2, followed by cards for JF = 3
ITE	TIME subscript used for designation of time increment, Δt, within environmental time period of interest
ITR	TIME subscript used for designation of time increments, Δt, within radionuclide release time period
ITRS	TIME subscript for release start time; appears for end of time increment when release calculations start
ITRE	TIME subscript for release end time; appears for end of time increment when release calculations cease (end)
ITSUMY	TIME subscript for first table in Section 6 of output
ITSUMJ	Increment on time subscript for successive tables
IW	Model branch or waste management phase (IW = 1 is residuals treatment; = 2 is transportation; = 3 is repository operations, and = 4 is terminal storage)
IZ	Subscript--geographic zone designation
IZONE(I)	Identification number for each zone to be tabulated up to IZONM zones; note, IZONE(10) designates non-specific dose category
IZONM	Number of zones to be tabulated

J

JF	Subscript--Environmental Receptor designation (JF = 1 is air; = 2 is land surface; = 3 is surface water; = 4 is ground water)
JFA	Environmental Receptor from which interreceptor transfer is made to receptor JF
JJ(JF, I)	Cutset sequential identification number for cutset I, up to NJ

K

K	Subscript--radionuclide designation, or in probability calculations K designates component factor of cutset J releasing to receptor JF

KSUB	The nuclide K level for subtotal line in tables (as for subtotal of fission products followed by actinides)

L

LPRINT	Counter

M

MAN1L(ITE,IH)	Average annual local dose to individual by nuclide, organ, and zone, mrem/y
MAN1N(ITE,IH)	Average annual nonspecific dose to population by nuclide and organ, man-rems/y
MAN2L(ITE,IH,IZ)	Average annual local dose to individual, total all nuclides, total all receptors, by organ and zone, mrem/y
MAN2LF(ITE,IH,IZ,JF)	Average annual local dose to individual, total all nuclides, by receptor, organ, and zones, mrem/y
MAN2N(ITE,IH)	Average annual nonspecific dose to individual, total all nuclides, total all receptors, by organ, man-rem/y
MAN2NF(ITE,IH,JF)	Average annual nonspecific dose to individual, total all nuclides, for receptor JF = 1 to 4, by organ, man-rem/y
MC	Number of columns in output tables (FOR POLYEPA)
MODE	A major grouping of environmental pathways under a receptor; in general, MODE = 1 is external exposure and MODE = 2 is internal
MS	Number of time intervals corresponding to the repository operations phase (for POLYEPA)
MT	Number of time reporting points (each "time increment" is between adjacent time reporting points)
MTADJ	Number of interpolated output time points (for POLYEPA)
MW	Maximum number of operation modes
MZ	Number of geographic zones calculated
M1	Counter
M10	Counter

N

NCASE	Identification number of case or cases submitted
ND	Number of chemical elements in inventory
NIHT	Number of body organs being calculated
NJ (JF)	Number of cutsets (release scenarios) for each receptor JF
NJJ(JF, I)	Number of component factors for cutset I
NK	Number of isotopes in inventory
NPRINT	Output table specification
NSP (JF)	Number of subpaths for each receptor JF; the value of NSP for each JF applies to both modes 1 and 2 for each receptor
NUCNAM (K)	Symbol name for nuclide K, double precision, up to 8 characters each

O

ORGNAM (I)	Names of organs (body sites) for which dose rates are calculated, up to I = NIHT, double precision, up to 8 characters each

P

POLYDATA	Data file for assembling POLYEPA input data
POLYEPA	An auxiliary program for preparing nuclide inventory data matrix by curve-fitting source data to prescribed times specified in AMRAW input
POLYDD	POLYEPA output data storage file
PORE	Aquifer porosity (as decimal)
PROBB(JF,J,K)	Initial probability of occurrence of component factor, y^{-1}; K is component factor

R

RELOUT	Release fraction by each cut set for each nuclide, to each Environmental Input Receptor

REMOV(JFA,IZ)	Used in accounting nuclide reduction in receptor JFA due to interreceptor transfer to receptor JF
RKD(K)	Distribution coefficient K_d, by nuclide K, cm^3/g
RKDMAX	Cutoff value for RKD (distribution coefficient K_d) above which ground water transport calculations may be bypassed
RLEACH	Subprogram in FAULT which handles leaching into ground water
R1J(JF, ITR)	Release increment to each Preliminary Environment Input Receptor from all release events by nuclide, for different times, Curies
R1JMIN	Truncation value (to 0.0) for R1J (Curies released to a given receptor)
R2(JF,ITE,IZ)	Adjusted concentration per release increment by receptor
R2CON	Intermediate unit conversion value of R2 used in accumulating R2TOT
R2MIN	Truncation value (to 0.0) for R2 (component of environmental concentration R2TOT)
R2TOT	Accumulated net total concentration in μCi per cm^2 or cm^3 by zone and Environment Input Receptor, for different times

S

SENDY	An auxiliary program for comparing results in tables from AMRAW run with corresponding tables from another run
SPACT (K)	Specific activity of nuclide K, Ci/g
SUBROUTINE FAULT	Determines release probability transfer coefficient; also, by use of time dependent component factors, the subroutine can modify the nuclide inventory at risk
SUBROUTINE TRINP	Determines transport-to-environment transfer coefficient, accounting for decay and other processes such as delay in ground water transport
SUBROUTINE TRMAN	Determines environment-to-man transfer coefficient for dose to man via all pathways from environmental concentrations

T

TFUEL	Total inventory in repository, metric tons
TIME (I)	The time in years at each of MT time reporting points
TIMEAD(I)	Time in years at each of MTADJ output time points (for POLYEPA)
TITLE	Title of run or case (1-10)
TP(JF,J,K)	Time at which functional change in probability commences, y; K is component factor

V

VOLINT(JF,MODE,I,IZ)	Consumption, exposure or food production rate, as appropriate, y/y, cm^3/y, or g/y
VS	Volume of solidified waste specimen (canister), cm^3
VX	Ground water seepage velocity, m/d

X

X(K, IT)	Mass of nuclide K at TIME (IT), grams
XL(I)	Distances from repository to average discharge point in each zone for I = 1 to MZ zones; XL = 0.0 indicates to code that contaminated plume does not discharge in zone
XX (ID)	Total inventory of each element at end of repository operations, grams

Y

YW(I)	Effective width of plume (width for concentration 0.1% of center line value) in each zone (distance XL) where discharge occurs, for I = 1 to MZ zones, m; input as 0.0 for each zone where no discharge occurs (not used except in output display)
YY(I)	Distance from plume centerline where concentration equals average across effective width YW, in each zone (distance XL) where discharge occurs, for I = 1 to MZ zones; input as 0.0 for each zone where no discharge occurs (not used except in output display)

Z

ZAVG	Average quantity of nuclide in Curies during release time increment
ZONALO(JF,IZ)	Dispersion allocation factors by zone IZ for transport-to-environment receptor JF, Ci-y/cm^3-Ci for JF = 1, Ci/Ci for JF = 2, 3; for JF = 4, ZONALO = 1.0 designates effected ground water in zone; 0.0 designates none
ZONDEP (IZ)	Surface deposition factor by zone IZ, Ci/cm^2-Ci

PART 2

AMB	One of three AMRAW-B input files; provides economic model control and conversion data
AMRAW	(Assessment Method for Radioactive Waste) Assessment Model and associated computer code
AMRAW-A	That portion of AMRAW which includes Source Term, Release Model, and Environmental Model
AMRAW-B	The economic part of AMRAW
AM1E	One of three AMRAW-B input files; provides time values, nuclide names and masses at each time
COMPRESS	An auxiliary program for preparing an AMRAW-B input file from AMRAW-A input
DAMAGE	An intermediate calculated value, damage per person (or nonspecific category), $/y, during a given time increment, for a given zone and nuclide, summed for dose to all organs
DDP	Implied value of dose, $/man-rem
DLD	An output parameter for Table 4, denoting deaths per time interval
DPY	Incidence rate for health effects, cases per 10^6 man-rem (dose to organs)
DT	An output parameter for Table 1, denoting DTZ summed over all zones
DT9	An output parameter for Table 1, denoting DTZ summed over all zones and the nonspecific category

DTZ	An output parameter for Tables 1 and 2, denoting damage rate (given nuclide and time) by zone for Table 1, $/y, and various summations for Table 2. For the latter, subscripts 1 through 5 represent, respectively: local damage summed over zones for high population, local damage summed over zones for low population, nonspecific damage, total of local and nonspecific damage for high population, and total for low population
DYRH	An output parameter for Table 5, denoting discounted damages per time interval, $, for high population projection
DYRL	Same as DYRH except for low population projection
ECONxx	One of three AMRAW-B input files; provides restructured output matrix MAN1 of dose rates from AMRAW-A (xx is case no.)
IH	Organ identifier subscript
IKK	Subscript identity of each of K nuclides in group
IN	Number which specifies computer input medium
IP	Number which specifies computer output medium
IS	Number which specifies an input medium with large storage used for file ECONxx
IT	Time subscript used in matrices
ITB3	Number which specifies printing option for Table 2 (1 - requests printing; 0 - suppresses printing)
IZ	Subscript used for zone identification
K	Number of nuclides in group
MAN1	Refers to large dose rate output matrix from AMRAW-A
MAN1L	Average annual local dose to individual by nuclide, organ, and zone, mrem/y, comprising part of MAN1
MAN1N	Average annual nonspecific dose to population by nuclide and organ, man-rem/y, comprising part of MAN1
MZ	Number of geographic zones
NG	Number of nuclide decay groups
NIHT	Number of organs (body sites)
NK	Number of nuclides

NT	Number of times
NUCNAM, NUC2	Abbreviated nuclide name, e.g., AM 242M
POPH	Input high population projection by zone
POPL	Input low population projection by zone
PV2	An output parameter for Table 3, denoting disconnected present value of damages from a given nuclide over the full time range
REG	Name of zone
RATE	Discount rate expressed as decimal; input in file AMB
SPV	An output parameter for SS for all decay groups
SS	An output parameter for Table 3, denoting sum of PV2 for all nuclides in a given decay group, $; also, used for marginal damages for a given decay group, $/gm
TIME (I)	Time in years for each subscripted value of TIME
TTD	An output parameter for Table 4, denoting sum of DLD over all time increments
TUDH	An output parameter for Table 5, denoting sum of DYRH over all time increments
TUDL	An output parameter for Table 5, denoting sum of DYRL over all time increments
VOL	Cost of increased levels of risk; input in file AMB
X	Quantity of given nuclide in inventory at given time, gm

CHAPTER 1

INTRODUCTION

The Radioactive Waste Management Systems Model (Fig. 1-1) has several parallel paths, each representing a phase in the waste management sequence: residuals treatment (interim surface storage and solidification at a reprocessing plant site), waste transport, repository operations, and terminal storage. If other phases become applicable, such as interim surface storage away from a reprocessing plant site, interim storage as spent fuel, reprocessing of waste form, and other transportation steps, each of these simply becomes an additional parallel path in the model. One branch (parallel path) of the systems model is shown in greater detail in Fig. 1-2.

Implementation of the model is by the AMRAW computer code (Assessment Method for Radioactive Waste Management). The code runs calculations separately for each branch of the model. AMRAW is divided into two parts which are run separately: 1) AMRAW-A (see Figs. 1-1 and 1-2), described in Vols. I and II, begins with the inventory at risk and calculates population dose rates, and 2) AMRAW-B, described in Vol. III, uses the calculated population dose rates, applies incidence rates of health effects associated with radiation dose and calculates the economic costs of health effects in the population.

The model provides for technology assessment of radioactive waste management in two categories: 1) risk analysis, which considers the probabilities of occurrence of various radiation release scenarios and the consequence of such releases, and 2) consequence analysis, which considers only the consequences of the various low-probability potential release events assuming they do occur. The methodology permits evaluation of the various long-term waste disposal methods and management options, for protection of public health and safety and protection of resources.

A user's guide for AMRAW-A is presented in Part 1 and for AMRAW-B in Part 2 of this volume.

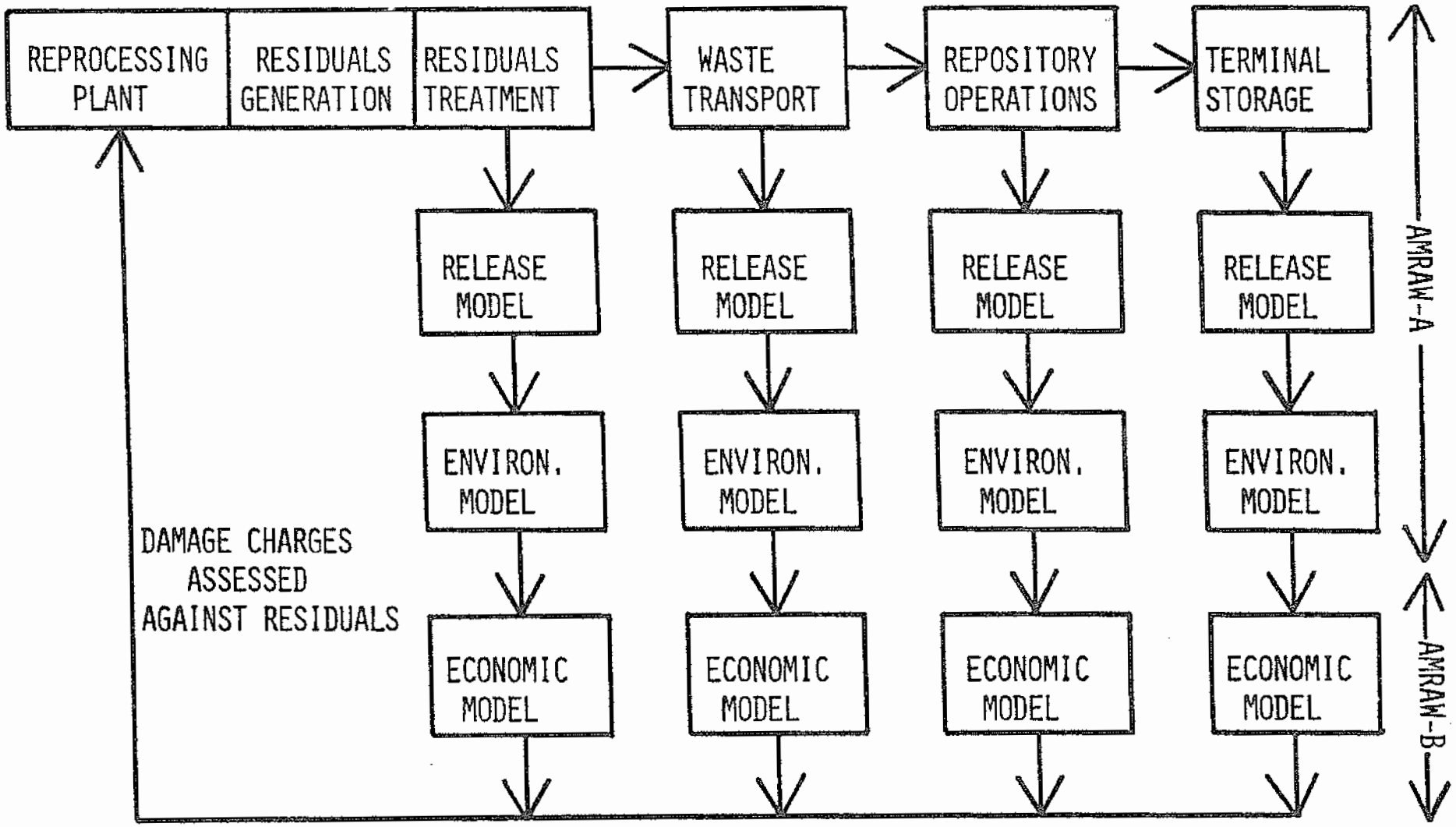

Figure 1-1. Radioactive waste management systems model.

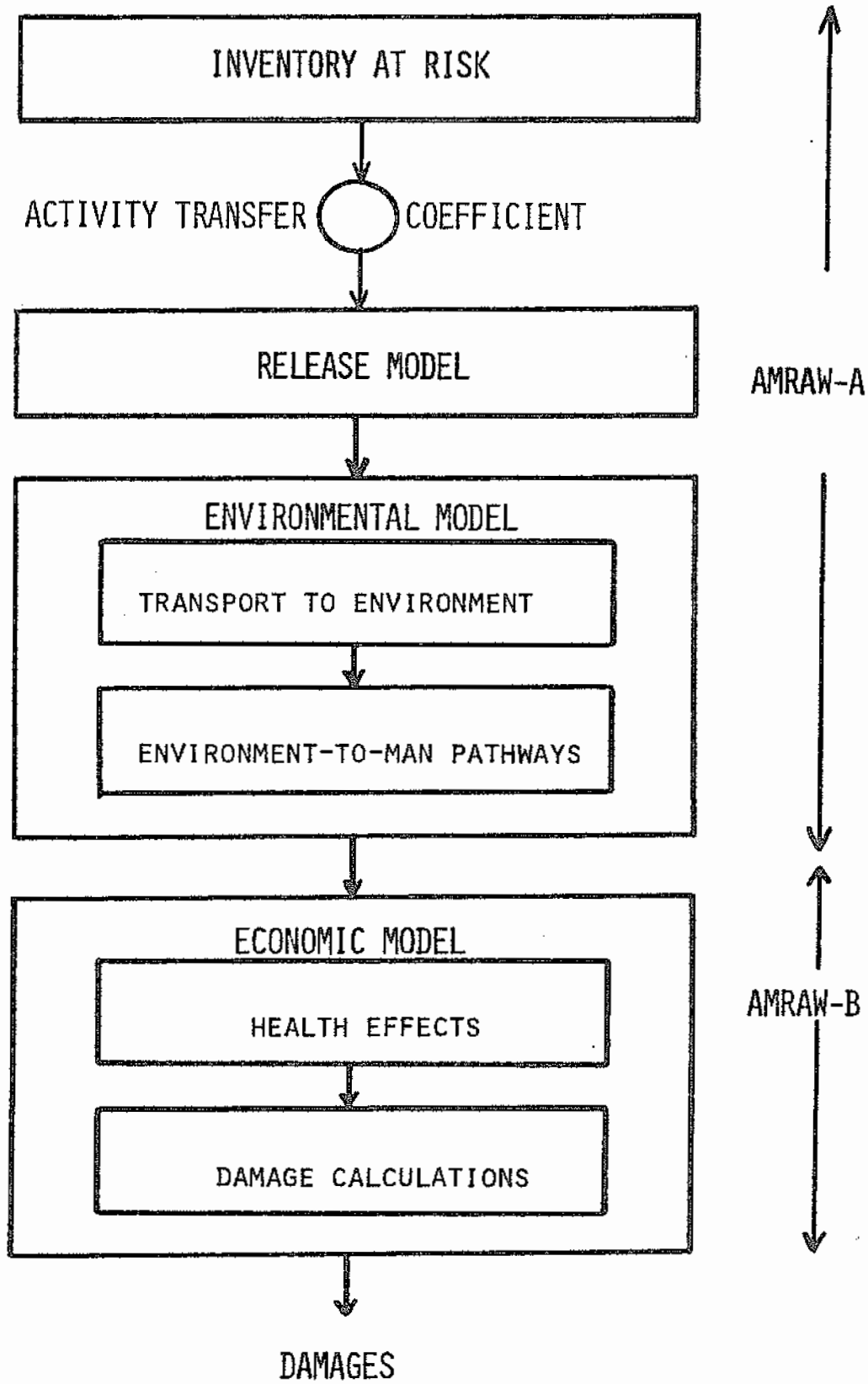

Figure 1-2. One branch of systems model.

PART 1

AMRAW-A USERS' GUIDE

CHAPTER 2

SUMMARY

A. PROGRAM SUMMARY

Title: AMRAW-A; Assessment Method for Radioactive Waste (First Part).

Abstract: AMRAW performs a sequence of calculations for an inventory of radioactive wastes, evaluating release quantities, dispersion to the environment, and pathways for dose to man.

Effective Date: January, 1978.

Programmer: S. E. Logan

Computer: IBM 360/67

Language: Fortran IV

Core Memory Requirement: 256 k bytes

Execution Time (CP sec): < 1,300

Auxiliary Hardware Requirements: Disk, Tape, Line Printer

B. PURPOSE

AMRAW-A, the first part of the Radioactive Waste Management Systems Model, calculates population dose rates from postulated releases of radioactive material. Population dose rates are divided into local dose rates for populations within each of several geographic zones and nonspecific dose rates which are associated with largely exported agricultural products. Sub-models consider in series (see Fig. 1-2): the inventory at risk (Source Term), postulated release scenarios in the Release Model, dispersion from the locale of release to environmental receptors in each geographic zone (Transport to Environment) and the pathway analysis (Environment-to-Man Pathways).

C. METHOD

The AMRAW code is written in Fortran IV language. The AMRAW-A part of the AMRAW computer code may be run for one or more branches of the model, depending upon the number of sets of input data provided. The discussion which follows is based upon the terminal storage branch, in that the frame of reference refers to the inventory emplaced in a repository. However, the calculation flow of the model and code also applies to the other branches.

The code is structured with sequences of "receptors" separated by transfer coefficients. The receptors represent the progress of releases, environmental concentrations, concentrations in food and drink, radiation doses, health effects and associated economic damages. The transfer coefficients are evaluated in subroutines using externally-determined input data. The subroutines can be modified or replaced, providing a modular arrangement. Factors for dispersion, biological accumulation, dose, etc., used in the transfer coefficients, are evaluated externally by various existing transport and dose codes.

Each branch of the model (Fig. 1-2) is entered with the mass of each significant radionuclide in the inventory at risk. This is converted to Curies in the inventory by an activity transfer coefficient (specific activity). The Release Model evaluates the probability for release by each of numerous potential release mechanisms, and the fraction of the inventory released by each such occurrence, during each increment of time. AMRAW may be run for any of several release scenarios: 1) probabilistic distribution of events over time, 2) discrete event at specified time, 3) several events each at mean time of first occurrence, 4) dynamic repository simulation, or 5) combinations of these. Subroutine FAULT handles the Release Model and provides the transfer coefficients used to accumulate releases to four preliminary input receptors from all release events considered. This subroutine uses function RLEACH when an event involves leaching into ground water.

Releases as determined by the Release Model are not necessarily directly to the environment. This is particularly true for deep releases to ground water. The first portion of the Environmental Model is therefore the "Transport to Environment" section. This adjusts each release

increment, obtaining the contribution-to-concentrations in environmental input receptors at various times following release. These receptors are: air, ground surface, surface water, and ground water. The adjustment provides for dispersion into each of the several geographical zones comprising the study region, and then accounts for dispersion areas or volumes in each zone. The adjustment also accounts for decay from the time of release to the time being evaluated, transfer between receptors (such as deposition from air onto ground), retardation in ground water flow, and other environmental removal or fixation processes. Subroutine TRINP handles transport from the preliminary input receptors, providing transfer coefficients which account for physical and environmental decay and ground water transport delays. This subroutine uses function CRATIO for the ground water transport calculations. Use of the transfer coefficients from TRINP by the main program leads to net environmental concentrations for input to pathway analysis.

The last portion of the Environmental Model covers the pathways from environmental input concentrations to radiation dose to the population, with dose rate calculations for several organs of concern. Subroutine TRMAN handles evaluation of transfer coefficients between environmental concentrations and population dose rates for the various pathways. Pathways include immersion in air, inhalation, ingestion of ground water and contaminated food and drink (from contaminated ground surface and surface water), submersion in water, and direct surface exposure.

The present dimensioning of AMRAW-A is as follows:

1) Radionuclides: 25.

2) Environmental receptors: 4, designated by programming as Air, Land Surface, Surface Water, and Ground Water.

3) Release Model events: 9 events or event combinations under each of the 4 environmental receptors. Each may be input with up to 9 component factors. Each of these factors may be flagged for type of function (constant, step, ramp, exponential, or delta) and specified by three appropriate function parameters.

4) Environmental pathways: 2 main pathways (modes) are programmed

for each environmental receptor. Dimensioning provides for up to 6 subpaths for each receptor (each mode under a given receptor is divided into the same number of subpaths).

5) Geographic zones: 8.

6) Human organs: 8. Typically, one of these is total body, but there is no restriction.

7) Time increments: 50.

With this dimensioning, the code runs with 256 k bytes of core storage, 10 cylinders (1459 k bytes) of disc storage, and requires 21 minutes of CPU time in the UNM IBM 360/67 computer. The range of subscripts for variables is specified by input data and may be any value within the above dimensioning with the exception of environmental receptors which are fixed within the code at four. Dimensioning may be increased if necessary, limited only by available core storage or other system requirements.

Large output matrices for local and nonspecific dose rates are written onto disc to conserve core space. Complete output is then written onto magnetic tape for retention but output may be diverted directly to printer by job control statements if preferred. Printed output is subsequently obtained from the tape as needed. If AMRAW-B is to be coupled to AMRAW-A for a combined run, AMRAW-B may access the disc for dose rate input data. The operation demonstrated at UNM is separate running of AMRAW-B. For this purpose, the dose rate portion of the AMRAW-A output is obtained from tape.

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CHAPTER 3

INPUT/OUTPUT DESCRIPTION

Input for AMRAW-A is by an 80 column card data deck. There are 40 card types. As implemented at UNM, the input deck is read from two files in disk storage (file division made between card types 19 and 20), instead of from a card reader. No additional inputs are required. Card input is described in the following section.

Output is described in Section 3.B.

A. CARD INPUT SPECIFICATIONS

1. Data Deck Setup. Descriptions and number required of each card type are given in section 2 which follows. The sequence of the data deck, beginning with the first or front card is listed below:

Card Type	Item	
1	NCASE	
2	TITLE	
3	ND, NK, MT, IW, ITRS, ITRE, MZ, NIHT, NPRINT, IFDIVW	
4	R1JMIN, A2MIN, R2MIN, RKDMAX, CRMIN, DFMIN	
5	TIME	
6	ELEM	
7	TFUEL	
8	XX	
9	NUCNAM, X	
10	CHECK, ICHCK	
11	SPACT	
12	DC1	
13	DRC	
14	ADJ1, ADJ2	
15	DISPN	
16	ZONALO	
17	ZONDEP	
18	AREAW	
19	RKD	
20	CHECK, ICHCK	
21	NSP	
22	VOLINT	
23	BIOFAC	
24	CHECK, ICHCK	
25	ORGNAM	
26	DOSFAC	
27	CHECK, ICHCK	
28	NJ	(There are 4 sets of card types 28 - 31)
29	JJ, NJJ	

Card Type	Item
30	AA1
31	PROBB, IFLAG, TP, CP
32	IFLAGE
33	VX, PORE, AL, AT, HT, BULKD, FS, VS, XL, YW, YY, CINV, CFAI
34	CHECK, ICHCK
35	ISECT
36	EDC (omitted if ISECT = 1)
37	CHECK, ICHCK
38	IZONM
39	IZONE
40	ITSUMY, ITSUMJ, KSUB

2. Description of Card Input. There are 3 subscripts prominently involved with input data: K, JF, and IZ. Subscript K designates the radionuclide, presently dimensioned to handle up to 25 nuclides. Subscript JF designates the 4 environmental receptor (shortened to "receptor" in descriptions which follow): JF = 1 is air, JF = 2 is land surface, JF = 3 is surface water, and JF = 4 is ground water. Subscript IZ designates geographic zones in the study region, presently dimensioned to handle up to 8 zones. Other subscripts are identified below as they occur.

The largest matrices of data are for X (card type 9), BIOFAC (card type 23), and DOSFAC (card type 26). The Release Model input (card types 28 to 31) can be as large as 400 cards if the full dimensioned capability is used. If EDC (card type 36) is read in instead of using internal default values, it is also a large input matrix. Because of the large amount of input data required, there are 6 check points provided; if any check point test is not satisfied, an error statement is output which identifies the block of data in which there are extra or omitted cards, and the run is terminated.

A list of each card type in input sequence, the necessary card format in each instance, the number of each card type required (one card unless stated otherwise), the data items and their descriptions, plus other explanatory notes are presented below.

Card Type	Format and Item	Description
1.	FORMAT (I5)	
	NCASE	Number of cases submitted.
2.	FORMAT (10A8)	3 cards
	TITLE	Title of case, double precision, up to 80 characters per card.
3.	FORMAT (16I5)	
	ND	Number of chemical elements in inventory.
	NK	Number of isotopes in inventory.
	MT	Number of time reporting points (each "time increment" is between adjacent time reporting points).
	IW	Model branch or waste management phase (IW = 1 is residuals treatment; IW = 2 is transportation; IW = 3 is repository

Card Type	Format and Item	Description
		operations and IW = 4 is terminal storage).
	ITRS	TIME subscript for end of time increment when release calculations start.
	ITRE	TIME subscript for end of time increment when release calculations cease (end).
	MZ	Number of geographic zones calculated.
	NIHT	Number of body organs calculated.
	NPRINT	Output table specification (see Chap. 3).
	IFDIVW	Ground water time increment control; IFDIVW = 0 avoids subdivision of time increments and IFDIVW > 0 causes subdivision branch in subroutine TRINP to be executed.
4.	FORMAT (8E10.2)	This card specifies truncation or cutoff values to avoid overflow, underflow, or nonproductive calculations.
	R1JMIN	Truncation value (to 0.0) for R1J (Curies released to a given receptor).
	A2MIN	Truncation value (to 0.0) for A2 (accounts for decay and transport processes).
	R2MIN	Truncation value (to 0.0) for R2 (component of environmental concentration R2TOT).
	RKDMAX	Cutoff value for RKD (distribution coefficient K_d) above which ground water transport calculations may be bypassed.
	CRMIN	Cutoff value for CRATIO (ground water concentration).
	DFMIN	Cutoff value for DECFAC (decay factor).
5.	FORMAT (8E10.2)	1 card for each 8 time points.
	TIME (I)	The time in years at each of MT time reporting points.
6.	FORMAT (20A4)	1 card if ND $\leq$ 20.
	ELEM (ID)	Symbol for each of ND chemical elements.
7.	FORMAT (8E10.2)	
	TFUEL	Total inventory in repository, metric tons.
8.	FORMAT (8E10.2)	1 card for each 8 elements.
	XX (ID)	Total inventory of each element at end of repository operations, grams.
9.	FORMAT (A8, 2X, 7E10.2)	Minimum of 1 card for each of NK nuclides; add one card for each nuclide for each 7 time points beyond the first 7 points.

Card Type	Format and Item	Description
	NUCNAM (K)	Symbol name for nuclide K, double precision, up to 8 characters each.
	X(K, IT)	Mass of nuclide K at TIME (IT), grams.
	FORMAT (10X, 7E10.2)	Used for all cards after the first for each nuclide (bypasses rereading NUCNAM).
10.	FORMAT (19A4, I2)	This card provides a check field to provide error statement and terminate runs if incorrect number of cards read to this stage.
	CHECK	Alphanumeric identification of checkpoint no. 1, up to 76 columns.
	ICHCK	01 in columns 77 and 78.
11.	FORMAT (8E10.2)	1 card for each 8 nuclides.
	SPACT (K)	Specific activity of nuclide K, ci/g.
12.	FORMAT (8E10.2)	1 card for each 8 nuclides.
	DC1(K)	Effective diffusivity for nuclide K leaching, cm^2/d.
13.	FORMAT (8E10.2)	1 card for each 8 nuclides.
	DRC (K)	Dissolution rate constant for nuclide K leaching, d^{-1}.
14.	FORMAT (8E10.2)	4 cards for each zone (1 card for each of 4 receptors in each zone). These cards provide pairs of adjustment parameters for inter-receptor adjustments over time following an initial dispersion.
	ADJ1(JF,JFA,IZ)	Maximum fraction of a quantity dispersed to receptor JFA in zone IZ which can be transferred to receptor JF in the same zone.
	ADJ2(JF,JFA,IZ)	Transfer rate constant associated with ADJ1, y^{-1}.
	Read as: $\left(\left(\left(ADJ1(JF,JFA,IZ),\ ADJ2(JF,JFA,IZ),\ JFA = 1,\ 4\right),\ JF = 1,\ 4\right),\ IZ = 1,\ MZ\right)$	
15.	FORMAT (8E10.2)	4 cards (1 for each receptor)
	DISPN (JF, IZ)	Area or volume over which, or in which, a release is dispersed in each receptor JF in each zone IZ, cm^2 or cm^3.
	Read as: $\left(\left(DISPN(JF,IZ),\ IZ = 1,\ MZ\right),\ JF = 1,\ 4\right)$	
16.	FORMAT (8E10.2)	4 cards (1 for each environmental receptor).

Card Type	Format and Item	Description
	ZONALO (JF, IZ)	Dispersion allocation factors by zone IZ for transport-to-environment receptor JF, Ci^{-y}/cm^3-Ci for JF = 1, Ci/Ci for JF = 2, 3. For JF = 4, ZONALO = 1.0 designates effected ground water in zone; 0.0 designates none.
	Read as: $\left(\left(\text{ZONALO(JF,IZ)}, \text{IZ} = 1, \text{MZ}\right), \text{JF} = 1, 4\right)$	
17.	FORMAT (8E10.2)	
	ZONDEP (IZ)	Surface deposition factor by zone IZ, Ci/cm^2-Ci.
18.	FORMAT (8E10.2)	
	AREAW (IZ)	Surface area of water by zone, cm^2.
	Note: Corresponding AREAG, land surface by zone, is set within code = DISPN (2, IZ).	
19.	FORMAT (8E10.2)	1 card for each 8 of NK nuclides.
	RKD(K)	Distribution coefficient K_d, by nuclide K, cm^3/g.
20.	FORMAT (19A4, I2)	This card provides the second data check point.
	CHECK	Alphanumeric identification of check point no. 2, up to 76 columns.
	ICHCK	02 in columns 77 and 78.

The following card types 21 to 23, and 25 and 26 provide data for the Environment-to-Man Pathways model (see Table 3-3 in Vol. I).

21.	FORMAT (16I5)	
	NSP (JF)	Number of subpaths for each receptor JF. The value of NSP for each JF applies to both modes 1 and 2 for each receptor.
22.	FORMAT (8E10.2)	4 cards (1 for each receptor) for each zone.
	VOLINT(JF,MODE,I,IZ)	Consumption, exposure or food production rate, as appropriate, y/y, cm^3/y, or g/y.
	Read as: $\left(\left(\text{VOLINT(JF,MODE,I,IZ)}, \text{I} = 1, \text{NS}\right), \text{MODE} = 1, 2\right)$, where I is subpath under JF, up to NS = NSP(JF).	
23.	FORMAT (8E10.2)	3 cards (1 each for receptors JF = 2, 3, 4) for each of NK nuclides.

Card Type	Format and Item	Description
	BIOFAC (K, JF, I)	Concentration or integrated concentration in food or drink per unit receptor concentration, by subpath I, up to NS = NSP(JF). Units are (μCi-y/g)/(μCi/cm^2) for terrestrial food, (μCi/g)/(μCi/cm^3) for aquatic food, and dimensionless for drinking water.
	Note: BIOFAC for JF = 1 (air) is set = 1.0 in code.	
24.	FORMAT (19A4, I2)	This card provides the third data check point.
	CHECK	Alphanumeric identification of check point point no. 3, up to 76 characters.
	ICHCK	03 in columns 77 and 78.
25.	FORMAT (10A8)	
	ORGNAM (I)	Names of organs (body sites) for which dose rates are calculated, up to I = NIHT, double precision, up to 8 characters each.
26.	FORMAT (8E10.2)	8 cards for each of NK nuclides (2 for each of 4 receptors JF; first of each pair for MODE 1 and second for MODE 2).
	DOSFAC(K,JF,MODE,IH)	Dose commitment conversion factor for each organ IH of NIHT total. Each card has conversion factors for specified nuclide and receptor/exposure mode combination, (mrem/y)/(μCi/cm^3), (mrem/(μCi/cm^2), or mrem/μCi, as appropriate.
27.	FORMAT (19A4, I2)	This card provides the fourth data check point.
	CHECK	Alphanumeric identification of check point no. 4, up to 76 characters.
	ICHCK	04 in columns 77 and 78.

The following card types 28 to 31 provide data for the Release Model scenarios (see Table 6-4, Vol. II) calculated by subroutine FAULT. As presently dimensioned, each of 4 receptors JF may have up to 9 cutsets (release scenarios) NJ, and each cutset may have up to 9 component factors NJJ. This portion of the data deck can have from 4 cards (trivial case with zero release scenarios for each receptor) to 400 cards, as follows:

4 sets of cards, 1 set for each receptor JF:
Card type 28 1 card (if NJ = 0, subsequent cards for this JF are omitted).
1 set of cards for each of NJ cutsets (9 maximum):

Card Type	Formula and Item	Description
	Card type 29 1 card Card type 30 1 card Card type 31 1 card for each of NJJ component factor (9 maximum).	
28.	FORMAT (16I5) NJ(JF)	4 cards, sequenced as stated above. Number of cutsets (release scenarios) for each receptor JF.
29.	FORMAT (16I5) JJ(JF, I) NJJ(JF, I)	Number of cards as stated above. Cutset sequential identification number for cutset I, up to NJ. Number of component factors for cutset I.
30.	FORMAT (8E10.2) AA1(JF, J)	Number of cards as stated above. Fraction of inventory tranferred to receptor JF if a release via cutset J (i.e., JJ) occurs.
31.	FORMAT (E10.2, I10, 2E10.2) Number of cards as stated above. Subscripts on this card are: K designates component factor (not to be confused with nuclide K used elsewhere) of cutset J (i.e. JJ) releasing to receptor JF. PROBB(JF,J,K) IFLAG(JF,J,K) TP(JF,J,K) CP(JF,J,K)	 Initial probability of occurrence of component factor, y^{-1}. Probability function designation: 0 Constant 1 Step function 2 Ramp function 3 Exponential function 4 Delta function. Time at which functional change in probability commences, y. Function parameter: size of step function, slope of ramp function, exponential constant, or set = 1.0 for delta function.
	Note: For the constant function, TP and CP may have any value (not used) but 0.0 is suggested to avoid confusion in output display.	
32.	FORMAT (16I5) IFLAGE(JF,MODE,I)	4 cards (1 for each receptor) Flag used in Environment-to-Man Pathways model designating whether output is accumulated as "local dose" (IFLAGE = 1) or "nonspecific dose" (IFLAGE = 2), (see Table 6-14, Vol. II). Values are sequenced on card for each of NSP subpaths under MODE = 1, followed by each of NSP subpaths under MODE = 2.

Card Type	Format and Item	Description

The following series of 2 to 5 cards of type 33 provide data for the leach subprogram RLEACH and the ground water transport subprogram CRATIO.

33.	FORMAT (8E10.2)	2 cards for 1 or 2 zones, 3 cards for 3 or 4 zones, 4 cards for 5 or 7 zones, and 5 cards for 8 zones.
	VX	Ground water seepage velocity, m/d.
	PORE	Aquifer porosity (as decimal).
	AL	Axial dispersivity coefficient, m.
	AT	Transverse dispersivity coefficient, m.
	HT	Height of aquifer, m.
	BULKD	Bulk solid density of aquifer, g/cm^3.
	FS	Exposed area of solidified waste specimen (canister as fractured), cm^2.
	VS	Volume of solidified waste specimen (canister), cm^3.
	XL(I)	Distances from repository to average discharge point in each zone for I = 1 to MZ zones. XL = 0.0 indicates to code that contaminated plume does not discharge in zone.
	YW(I)	Effective width of plume (width for concentration 0.1% of center line value) in each zone (distance XL) where discharge occurs, for I = 1 to MZ zones, m. Input as 0.0 for each zone where no discharge occurs (not used except in output display).
	YY(I)	Distance from plume centerline where concentration equals average across effective width YW, in each zone (distance XL) where discharge occurs, for I = 1 to MZ zones. Input as 0.0 for each zone where no discharge occurs (not used except in output display).
	CINV	Total number of canisters in inventory.
	CFAI	Number of canisters exposed to leach incident.
34.	FORMAT (19A4, I2)	This card provides the fifth data check point.
	CHECK	Alphanumeric identification of check point no. 5, up to 76 characters.
	ICHCK	05 in columns 77 and 78.

The following type 35 card controls data for the environmental decay constant EDC(K,JF,IZ), y^{-1}, where subscripts denote nuclide, receptor, and zone, respectively. EDC for JF = 1 & 4 is set by statements in the code: EDC(K, 1, IZ) = 50, providing for rapid deposition

Card Type	Format and Item	Description

from air after dispersion, and EDC (K, 4, IZ) = 0.0, as EDC has no present application to ground water calculations.

35.	FORMAT (16I5)	
	ISECT	Control flag for EDC data. ISECT = 1: internal EDC default values used for JF = 2 & 3 (= 2.30 x 10^{-5}). Type 36 cards omitted. ISECT = 2: EDC default values used for JF = 3; type 36 cards read for JF = 2. ISECT = 3: EDC default values used for JF = 2; type 36 cards read for JF = 3. ISECT = 4: type 36 cards read for JF = 2, followed by cards for JF = 3.
36.	FORMAT (8E10.2)	0 cards if ISECT = 1; MZ x NK/8 cards if ISECT = 2 or 3; 2(MZ x NK)/8 cards if ISECT = 4.
	EDC(K, I, IZ)	Environmental decay constants for nuclides K, receptor JF (represented here by I) and zones IZ. Data sequence on cards is EDC by zone to MZ zones for first nuclide, repeated in turn for each subsequent nuclide to NK nuclides. If ISECT = 4, this group of cards is repeated in turn for JF = 2 and JF = 3.
37.	FORMAT (19A4, IZ)	This card provides the sixth (and last) data check point.
	CHECK	Alphanumeric identification of check point no. 6, up to 76 characters.
	ICHCK	06 in columns 77 and 78.

The following card types 38 to 40 control selection of output for dose summary tables in Section 6 of output. Each such table is for a specified time.

38.	FORMAT (16I5)	
	IZONM	Number of zones to be tabulated.
39.	FORMAT (16I5)	
	IZONE(I)	Identification number for each zone to be tabulated, up to IZONM zones. Note: IZONE(10) designates nonspecific dose category.
40.	FORMAT (16I5)	
	ITSUMY	Time subscript for first table.
	ITSUMJ	Increment on time subscript for successive tables.

Card Type	Format and Item	Description
	KSUB	The nuclide K level for subtotal line in tables (as for subtotal of fission products followed by actinides).

A sample coding form for 1 nuclide, 1 zone, and 1 organ is given in Appendix C. More complete sample input is given in Appendix F.

B. OUTPUT DESCRIPTION

AMRAW-A requires three output mediums: disk, tape file, and line printer.

1. Disk. Intermediate temporary storage of calculated values for each nuclide is on disk. The disk storage capacity required is up to 1459 k bytes of information. Information stored on disk is transferred to tape (or directly to line printer) at the end of each case.

2. Tape File. The tape file is used to store selected run output transferred from disk into several tabular configurations. The output stored on tape may subsequently be used in part as input to AMRAW-B (Economic Model), used as input to auxiliary codes for further analysis, or may be directed to a line printer for one or multiple printed copies. If preferred, and if further computer processing of output is not planned, output can be routed directly to the line printer instead of to tape.

3. Line Printer. The line printer must be capable of 132 characters per line. The preferred mode of operation is to direct output stored on the tape file to the line printer instead of routing output directly to line printer. In addition to the major output, error statements and data check point confirmations are output. Error and check point statements are routed to the output medium specified by the variable IE (see Chapter 4) and should always be set to the line printer.

4. Output Tables. Extensive output tabulations are produced by AMRAW-A, as directed by the output control parameter (see card type 3, and Chapter 4). These tables are divided into 6 sections, each set off by a divider page for clarity. Table 3-1 is a directory of output tables. The number of tables listed of each type is based upon 25 nuclides, 8 zones, and 8 organs, resulting in a total of 627 tables if all are requested by NPRINT. The number of tables is reduced appropriately for fewer nuclides, zones, or organs. Sample output is given in Appendix F.

Table 3-1. Directory of AMRAW-A Output Tables

Description	[a]Number of Table Combinations				Total
	Nuclides	Zones	Organs	Environ. Receptors	
SECTION 1. Data Input					
1. Output listing of AMRAW input.	(20	pages)			
SECTION 2. Release to Environment					
1. Release Fractions by Each Cutset, RELOUT	25				25
2. Release Increments to Preliminary Environmental Input Receptors, R1J, from All Release Events, Ci	25			(4 in each table)	25
3. Concentrations at Environment Input Receptor, R2TOT. Units: JF = 1 μCi-y/cm^3, JF = 2 μCi/cm^2, JF = 3 and 4 μCi/cm^3.	25	8			200
SECTION 3. Local Dose to Individual					
1. Average Annual Local Dose to Individual, MAN1L, mrem/y.	25	8	(8 in each table)		200
SECTION 4. Nonspecific Dose to Population					
1. Average Annual Nonspecific Dose to Population, MAN1N, manrem/y.	25		(8 in each table)		25

Table 3-1. Directory of AMRAW Output Tables (continued)

	Nuclides	Zones	Organs	Environ. Receptors	Total
SECTION 5. Total Dose by Receptors					
1. Average Annual Local Dose to Individual, MAN2LF for JF = 1 to 4, MAN2L for Total, mrem/y, Total for All Nuclides.		8	8	(4 in each table)	64
2. Average Annual Nonspecific Dose to Population, MAN2NF for JF = 1 to 4, MAN2N for Total, manrem/y, Total for All Nuclides.			8	(4 in each table)	8
SECTION 6. Dose Summary Tables					
1. Average Annual Local Dose to Individual, MAN1L, in Zone, mrem/y.	(25 in each table)	[b] up to 8	(8 in each table)	[c] 5	40
2. Average Annual Nonspecific Dose to Population, MAN1N, manrem/y.	(25 in each table)	[b] up to 8	(8 in each table)	[c] 5	40
Total Number of Tables					627

Note:

a. All output tables, except Section 6 are for 50 time steps, 0 to 10^6 years.

b. Individual zones may be specified.

c. Section 6 may call for a table for each of all times beginning with 100 y or skip some times; 5 tables result if call for every ninth time.

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CHAPTER 4

PROGRAM OPTIONS

The first class of program options is concerned with design of the application. The number of nuclides, zones, organs, times, release scenarios, and environmental pathways may be varied within the range of dimensioning. The reader is referred to Vol. I for full discussion of these and other general input data options.

The input/output mediums are specified in statements in the main program which assign values for the variables IN, IE, and IP appropriate to the system being used (at UNM the values are 5, 6, and 2, respectively).

IN specifies the input medium, normally the card reader

IE specifies the output medium for error and data check point messages; this should always be set to the line printer

IP specifies the output medium for the code; this is normally tape file but it may be set to the line printer if preferred.

Calculation and output options are controlled by NPRINT (see card type 3, Chapter 3). This control variable has 3 digits, described in Table 3-1. The complete calculation and output capability is executed if NPRINT = 500. Options range down to setting the first digit to zero (such as NPRINT = 000 or simply = 0) resulting in reading in and outputting all data (in the Section 1 explanatory tabular arrangement) but performing no calculations. The latter is useful during setting up and checking a large data file.

EDC (environmental decay constant) values are internally set for the JF = 1 and 4 receptors. An option is provided for the values for JF = 2 and 3 receptors, controlled by ISECT (see card type 35 in Chapter 3). If ISECT = 1, internal EDC default values are used for both receptors. If EDC data is available for specific nuclides, receptors and zones, this may be read in by setting ISECT = 2 to 4. If ISECT = 2, EDC is read in for JF = 2; if ISECT = 3, EDC is read in for JF = 3; if ISECT = 4, EDC is read in for JF = 2 and 3.

Table 4-1. Calculation and Output Options Controlled by NPRINT

NPRINT = XYZ

Z controls organs calculated.

if Z = 0, all organs in input are calculated.

if $0 < Z \leq NIHT$, only 1 organ, the Zth organ, is calculated.

$Z > NIHT$ is error.

Y controls zones calculated.

if Y = 0, all zones in input are calculated.

if $0 < Y \leq MZ$, only 1 zone, the Yth zone, is calculated.

$Y > MZ$ is error.

X controls output as follows where an "X" denotes output:

Description[a] X =	0[b]	1	2	3	4	5	6	7-9
SECTION 1. Data Input								
1. Release Model data	X	X	X	X	X	X	X	X
Other input data	X					X		
SECTION 2. Release to Environment								
1. RELOUT						X		
2. R1J		X		X	X	X		X
3. R2TOT			X	X	X	X		
Section 3. Local Dose to Individual								
1. MAN1L					X	X	X	X
Section 4. Nonspecific Dose to Population								
1. MAN1N					X	X	X	X
Section 5. Total Dose by Receptors								
1. MAN2LF, MAN2L; 2. MAN2NF, MAN2N					X	X	X	X
Section 6. Dose Summary Tables								
1. MAN1L; 2. MAN1N					X	X	X	X

[a]See Table 2-1 for further description.

[b]For X = 0, reads in and then outputs all data; no calculations are made.

Section 6 of the output consists of dose summary tables. Each table is a summary for a specific zone (or nonspecific dose) at a specific time. The option controlling the number of zones and times output in this section is controlled by card types 38 to 40 (see Chapter 3). IZONM specifies the number of zones to be tabulated, IZONE identifies the zone number of each zone to be tabulated, ITSUMY specifies the time subscript for the first table and ITSUMJ specifies a time subscript increment for successive tables.

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CHAPTER 5

ERROR MESSAGES

There are several error message provisions in AMRAW-A. Each message, its meaning, and corrective action required, is listed below.

Error Message:	"ERROR NEAR CHECK POINT (x)(y)"
Meaning:	Data which follows error before check point x is not in correct order.
Corrective Action:	Check for extra or missing cards and make sure data is in correct order; sort as necessary.
Error Message:	"ERROR: ATTEMPTED REPOSITORY OPERATION WITHOUT SUBSEQUENT ENVIRONMENT TIME INCREMENT"
Meaning:	Continued operating repository until end of time being studied with no subsequent time in the environment left to study.
Corrective Action:	Make ITRE < MT.
Error Message:	"ERROR: VALUE OF ZONE (x) OUTSIDE OF RANGE OF MAXIMUM ZONE (y)"
Meaning:	Attempted use of nonexistent zone.
Corrective Action:	Modify value of 2nd (middle) digit of control parameter NPRINT such that it is $\leq$ MZ.
Error Message:	"ERROR: INVALID ORGAN NUMBER = (x) MAXIMUM NUMBER OF ORGANS = (y)"
Meaning:	Attempted to study nonexistent organ.
Corrective Action:	Modify right most digit of control parameter NPRINT such that it is $\leq$ NIHT.

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APPENDIX A

BACKGROUND MATERIAL

The basic structure of the AMRAW model and computer code was developed at UNM between 1972 and 1974 as part of the S. Logan Ph.D. dissertation: "A Technology Assessment Methodology Applied to High-Level Radioactive Waste Management," The University of New Mexico, 1974. Additional development proceeded with support from the Sandia Laboratories University Research Program and from the Energy Resources Board of the State of New Mexico. Completion of the model and code was done under EPA Contract No. 68-01-3256 beginning in August, 1975.

APPENDIX B

SAMPLE RUN REQUEST

AMRAW-A RUN REQUEST

Requested By: _____

Phone: _____ Date: _____

Number of Seconds: _____ No. of Ouput Lines: _____

Number of Copies Requested: _____

Special Form? _____ If so, form no. _____

Input Data On: Disk _____ Disk Name: _____

DSN: _____

Card _____ Tape _____ Tape Name: _____

Label: _____ DSN: _____

- -

O F F I C E U S E O N L Y

Date Received: _____

Date Submitted: _____

Date Returned: _____

Initials: _____

APPENDIX C

SAMPLE CODING FORM

Table C-1 presents a sample coding form for AMRAW-A input data illustrating proper formats for the following conditions.

1 nuclide:	C-14
1 zone:	Zone 1
1 organ:	Total Body
Model Branch:	IW = 4, Terminal Storage (beginning at 30 y reference time)
50 Times:	Range from 0 to 10^6 y.

Card types, described in Section 2.A.2., are indicated.

This example is for Zone 1 for the base case described in Part 1 of Vol. II in which it is assumed there is no surface water and no discharge of ground water. If the example were for Zone 2, the value on card type 18 (AREAW) would change from 0.0 to 5.06E+11 and the first 3 values of the second card of type 33 (XL, YW, and YY) would change from 0.0 to 1.00E+04, 2.58E+03, and 5.20E+02, respectively.

The Release Model data (card types 28 to 31) represent 10 cutsets: 3 for each of the first 3 environmental receptors, and 1 for the fourth receptor.

It is assumed that EDC (Environmental Decay Constant) uses internal default values. Hence card type 35 has a value of 1 and card type 36 is omitted.

Table C-1. Sample Coding Form for One Nuclide, One Zone, and One Organ

Card Type	Card Number (1–5)	Column 7–10	11–20	21–30	31–40	41–50	51–60	61–70	Identification Sequence (73–80)
1	1								
2	RUN FOR ONE NUCLIDE, ONE ZONE, ONE ORGAN								
2	TITLE MUST HAVE 3 LINES								
2	ALWAYS USE 3 EVEN IF 2 ARE BLANK								
3	1	1	50	4	8	50	1	1	500	1			
4	1.00E-22	1.00E-50	1.00E-35	5.00E+01	1.00E-50	1.00E-10		
5	0.00E+00	5.00E+00	1.00E+01	1.50E+01	2.00E+01	2.50E+01	3.00E+01	4.00E+01
5	5.00E+01	6.00E+01	7.00E+01	8.00E+01	9.00E+01	1.00E+02	2.00E+02	3.00E+02
5	4.00E+02	5.00E+02	6.00E+02	7.00E+02	8.00E+02	9.00E+02	1.00E+03	2.00E+03
5	3.00E+03	4.00E+03	5.00E+03	6.00E+03	7.00E+03	8.00E+03	9.00E+03	1.00E+04
5	2.00E+04	3.00E+04	4.00E+04	5.00E+04	6.00E+04	7.00E+04	8.00E+04	9.00E+04
5	1.00E+05	2.00E+05	3.00E+05	4.00E+05	5.00E+05	6.00E+05	7.00E+05	8.00E+05
5	9.00E+05	1.00E+06						
6	C							
7	1.87E+05							
8	4.04E+04							
9	C-14 1	0.0	6.14D+01	1.25D+03	4.07D+03	9.99D+03	2.17D+04	4.04D+04
9	C-14 2	4.04D+04	4.04D+04	4.03D+04	4.02D+04	4.02D+04	4.01D+04	4.01D+04
9	C-14 3	3.96D+04	3.91D+04	3.87D+04	3.82D+04	3.77D+04	3.73D+04	3.68D+04
9	C-14 4	3.64D+04	3.59D+04	3.19D+04	2.82D+04	2.50D+04	2.21D+04	1.95D+04
9	C-14 5	1.73D+04	1.54D+04	1.36D+04	1.21D+04	3.75D+03	1.07D+03	3.03D+02
9	C-14 6	8.62D+01	2.49D+01	7.38D+00	2.24D+00	7.02D-01	2.26D-01	2.28D-06
9	C-14 7	7.03D-12	1.50D-17	3.72D-23	0.0	0.0	0.0	0.0
9	C-14 8	0.0						

Table C-1. (continued)

	STATEMENT NUMBER		FORTRAN STATEMENT	IDENTIFICATION SEQUENCE
10	****	*****	CHECKPOINT NUMBER ONE (1) **********	****01
11	4.45E+00			
12	9.55E-10			
13	4.96E-03			
14	0.0	0.0	1.00E-09 2.00E+01 0.0 0.0 0.0	0.0
14	0.0	0.0	0.0 0.0 0.0 0.0 0.0	0.0
14	0.0	0.0	0.0 0.0 0.0 0.0 0.0	0.0
14	0.0	0.0	0.0 0.0 0.0 0.0 0.0	0.0
15	1.00E+00			
15	7.90E+11			
15	0.0			
15	1.00E+00			
16	1.26E-20			
16	1.29E-01			
16	0.0			
16	0.0			
17	4.04E-13			
18	0.0			
19	1.40E+00			
20	*****	*****	CHECKPOINT NUMBER TWO (2) **********	****02
21	1 4	4 1		
22	1.00E+00	7.30E+09		
22	4.00E-01	0.0	0.0 0.0 0.0 6.30E+07 0.0	0.0
22	0.0	0.0	0.0 0.0 0.0 0.0	0.0

Table C-1. (continued)

```
22    0.0             0.0             0.0             0.0             0.0             0.0             0.0
23    2.22E-03        5.29E-04        5.33E-04        1.29E-03
23    1.00E+00        1.24E+01        7.68E+00        0.0
23    1.24E+01
24 ************************************* CHECK POINT NUMBER THREE (3) ***********************************03
25 TOT BODY
26    0.0
26    4.24E-01
26    0.0
26    5.69E-01
26    0.0
26    5.69E-01
26    5.69E-01
26    5.69E-01
27 ************************************* CHECK POINT NUMBER FOUR (4) ************************************04
28       3
29       1       1
30    5.00E-02
31    1.00E-13                0       0.0             0.0
29       2       1
30    7.50E-02
31    2.40E-12                0       0.0             0.0
29       3       1
30    6.00E-03
```

Table C-1. (continued)

	STATEMENT NUMBER	CONT	FORTRAN STATEMENT	IDENTIFICATION SEQUENCE
31	2.40E-12		0 0.0 0.0	
28	3			
29	1 3			
30	3.30E-05			
31	1.00E+00		0 0.0 0.0	
31	1.00E+00		0 0.0 0.0	
31	0.0		2 1.60E+06 1.56E-07	
29	2 2			
30	5.00E-02			
31	1.00E+00		0 0.0 0.0	
31	1.00E-13		0 0.0 0.0	
29	3 2			
30	7.50E-02			
31	1.00E+00		0 0.0 0.0	
31	8.10E-12		0 0.0 0.0	
28	3			
29	1 3			
30	3.30E-05			
31	1.00E+00		0 0.0 0.0	
31	1.00E+00		0 0.0 0.0	
31	0.0		2 1.60E+06 1.56E-07	
29	2 2			
30	5.00E-02			
31	1.00E+00		0 0.0 0.0	

Table C-1. (concluded)

	STATEMENT NUMBER (1–5)	CONT. (6)	FORTRAN STATEMENT (7–72)	IDENTIFICATION SEQUENCE (73–80)
31	1.00E-13		0 0.0 0.0	
29	3	2		
30	7.50E-02			
31	1.00E+00		0 0.0 0.0	
31	8.10E-12		0 0.0 0.0	
28	1			
29	1	4		
30	0.0			
31	1.00E+00		0 0.0 0.0	
31	1.00E+00		0 0.0 0.0	
31	1.00E+00		0 0.0 0.0	
31	1.40E-07		0 0.0 0.0	
32	1	1		
32	1	1	1 1 2 2 2 2	
32	1	1	1 1 2 2 2	
32	1	2		
33	4.00E-03		1.50E-01 5.00E+01 6.00E+00 5.00E+01 2.30E+00 4.38E+04	2.22E+05
33	0.0		0.0 0.0 6.25E+04 2.50E+02	
34	**********		CHECK POINT NUMBER FIVE (5) **********	05
35	1			
37	**********		CHECK POINT NUMBER SIX (6) **********	06
38	1			
39	1			
40	14	9	1	
//				
/*				

APPENDIX D

JOB PROCESSING INSTRUCTIONS

1. Prepare jobcard for run using run request as follows:
   Job name - 8 characters alphanumeric serial number.
   Time parameter - number of seconds estimated.
   Lines parameter - number of lines (in thousands) estimated.
   Forms parameter - form number from request.
   Copies parameter - number of copies requested.

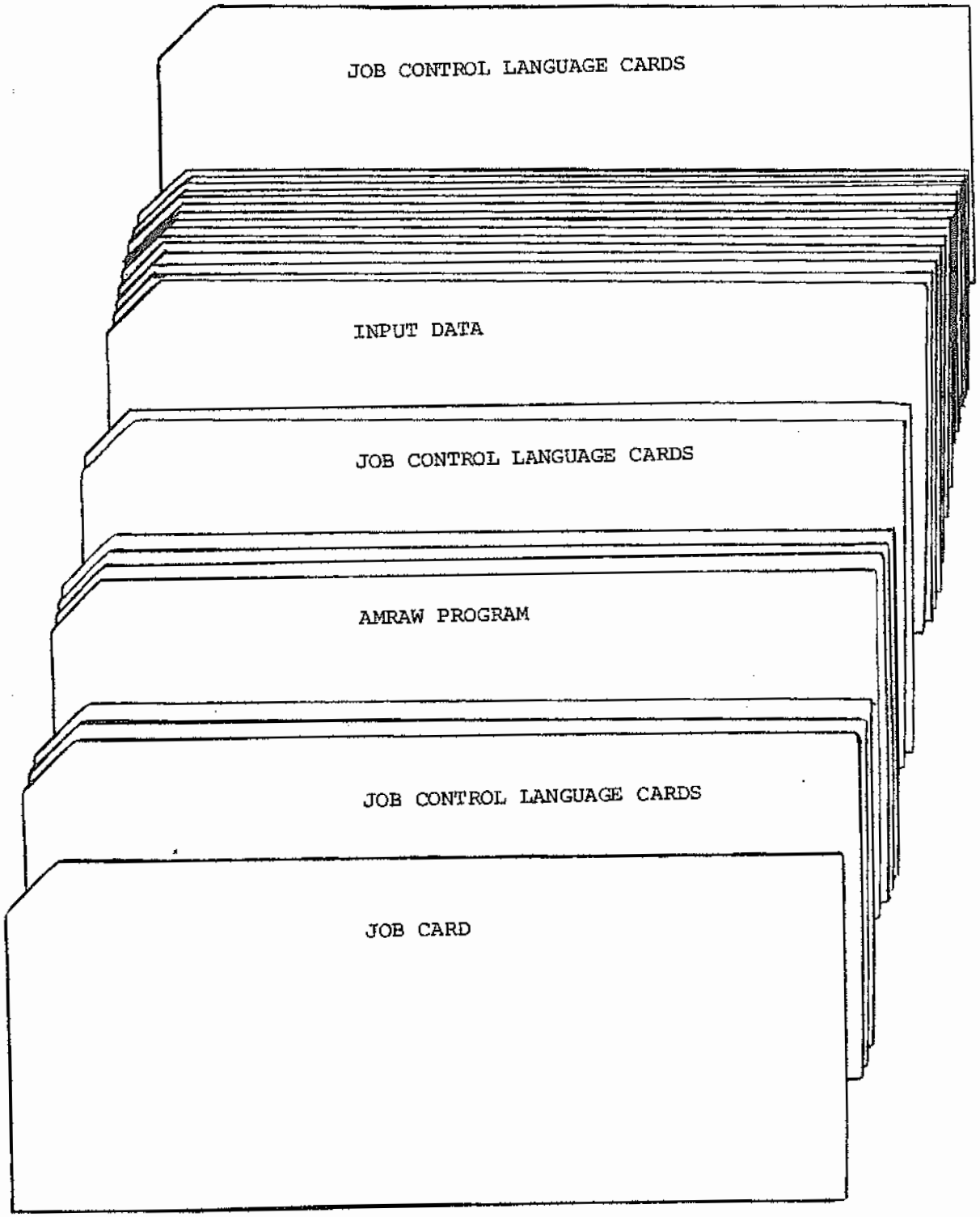
2. Input medium:
   Card - keypunch as necessary and place in appropriate section of deck.
   Disk - modify GO.SYSIN DD card to reflect parameters required by system.
   Tape - modify GO.SYSIN DD card to reflect parameters required by system.

3. Submit job and note date submitted.

4. Return job to requester and note date returned.

APPENDIX E

OPERATING DECK SETUP



APPENDIX F

SAMPLE INPUT AND OUTPUT

Sample input and output is presented for a "short run" using only 3 radionuclides: Sr-90, I-129, and Pb-210. Other parameters are as in a typical "fuel run": 4 environmental receptors, 10 release scenarios (cutsets), 14 environmental pathways, 8 geographic zones, 8 human organs, and 50 time increments.

1. Input Data. Input data is listed according to card input specifications in Section 3.A. and the sample coding forms in Appendix C.

2. Output. Output is separated by partition pages into 6 sections:

(a) *Section 1 - Data Input.* This section, presented in full, is a descriptive output of input data, in the following sequence:

Definition of Environmental Inputs/Definition of Probability Inputs/Probability and Related Data.

Selected Residual Elements in Waste/Selected Radionuclides in Waste.

Ground Water Parameters

EDC

DISPN/ZONALO/ZONDEP

AREAW/ADJ1/ADJ2

VOLINT

BIOFAC

DOSFAC

(b) *Section 2 - Release to Environment.* Sample output is presented for one nuclide (I-129):

Release Fractions by Each Cutset

Release Increments to Preliminary Environment Input Receptors

Concentrations at Environment Input Receptors (Zones 1 and 2 of 8 zones shown)

(c) Section 3 - Local Dose to Individual. Sample output is presented for one nuclide (I-129) and one zone (Zone 1) of 8:

Average Annual Local Dose to Individual

(d) Section 4 - Nonspecific Dose to Population. Sample output is presented for one nuclide (I-129):

Average Annual Nonspecific Dose to Population

(e) Section 5 - Total Dose by Receptors. This section presents totals for all nuclides:

Average Annual Local Dose to Individual. Sample output is presented for 1 organ (Total Body) of 8 and 2 zones (1 and 2) of 8.

Average Annual Nonspecific Dose to Population. Sample output is presented for 1 organ (Total Body).

(f) Section 6 - Dose Summary Tables. These tables summarize dose rates by nuclide to each organ. Sample output is presented for 1 time (1000 y) and 1 zone:

Average Annual Local Dose to Individual, Zone 1
Average Annual Nonspecific Dose to Population

APPENDIX F 1. Input Data

```
                    SHORT RUN BASE CASE FOR TERMINAL STORAGE PHASE
                              ALL PROBABILISTIC RELEASES
                     APR.,6, 1978 DATA FILE USED:  ANS1              NPRINT=500
 03   03   50    4    8   50    8    8  500    1
1.00E-22  1.00E-50  1.00E-35  5.00E+01  1.00E-50  1.00E-10
0.00E+00  5.00E+00  1.00E+01  1.50E+01  2.00E+01  2.50E+01  3.00E+01  4.00E+01
5.00E+01  6.00E+01  7.00E+01  8.00E+01  9.00E+01  1.00E+02  2.00E+02  3.00E+02
4.00E+02  5.00E+02  6.00E+02  7.00E+02  8.00E+02  9.00E+02  1.00E+03  2.00E+03
3.00E+03  4.00E+03  5.00E+03  6.00E+03  7.00E+03  8.00E+03  9.00E+03  1.00E+04
2.00E+04  3.00E+04  4.00E+04  5.00E+04  6.00E+04  7.00E+04  8.00E+04  9.00E+04
1.00E+05  2.00E+05  3.00E+05  4.00E+05  5.00E+05  6.00E+05  7.00E+05  8.00E+05
9.00E+05  1.00E+06
SR   I  PB
1.87E+05
1.26E+08  1.84E+05  9.08E+02
 SR-90 1  5.30D+05  3.89D+06  1.06D+07  2.24D+07  4.22D+07  7.11D+07  6.28D+07
 SR-90 2  4.91D+07  3.90D+07  3.09D+07  2.43D+07  1.91D+07  1.48D+07  1.15D+07
 SR-90 3  8.87D+05  7.72D+04  7.82D+03  7.85D+02  7.21D+01  6.10D+00  4.83D-01
 SR-90 4  3.65D-02  2.68D-03  1.62D-14  8.95D-25  0.0       0.0       0.0
 SR-90 5  0.0       0.0       0.0       0.0       0.0       0.0       0.0
 SR-90 6  0.0       0.0       0.0       0.0       0.0       0.0       0.0
 SR-90 7  0.0       0.0       0.0       0.0       0.0       0.0       0.0
 SR-90 8  0.0
 I-129 1  3.48D+02  2.66D+03  7.96D+03  1.77D+04  3.40D+04  5.84D+04  5.84D+04
 I-129 2  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04
 I-129 3  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04
 I-129 4  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.84D+04
 I-129 5  5.84D+04  5.84D+04  5.84D+04  5.84D+04  5.83D+04  5.83D+04  5.83D+04
 I-129 6  5.83D+04  5.83D+04  5.82D+04  5.82D+04  5.82D+04  5.82D+04  5.80D+04
 I-129 7  5.77D+04  5.74D+04  5.72D+04  5.69D+04  5.67D+04  5.65D+04  5.63D+04
 I-129 8  5.61D+04
PB-210 1  2.12D-07  2.12D-06  9.10D-06  3.90D-05  1.32D-04  3.25D-04  4.51D-04
PB-210 2  7.00D-04  9.66D-04  1.26D-03  1.58D-03  1.94D-03  2.35D-03  2.82D-03
PB-210 3  1.28D-02  3.68D-02  7.85D-02  1.39D-01  2.20D-01  3.20D-01  4.39D-01
PB-210 4  5.75D-01  7.29D-01  2.96D+00  6.06D+00  9.69D+00  1.37D+01  1.79D+01
PB-210 5  2.23D+01  2.69D+01  3.15D+01  3.63D+01  8.40D+01  1.27D+02  1.63D+02
PB-210 6  1.93D+02  2.19D+02  2.40D+02  2.59D+02  2.74D+02  2.88D+02  3.40D+02
PB-210 7  3.08D+02  2.53D+02  1.99D+02  1.55D+02  1.19D+02  9.16D+01  7.07D+01
PB-210 8  5.47D+01
****************** CHECK POINT NUMBER ONE (1)     ****************************01
1.42E+02  1.63E-04  8.12E+01
1.64E-08  9.62E-10  9.39E-10
2.90E-02  4.95E-03  2.75E-03
0.0       0.0       1.00E-09  2.00E+01  0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
0.0       0.0       1.00E-09  2.00E+01  0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       2.00E-01  2.00E+01
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
0.0       0.0       1.00E-09  2.00E+01  0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
```

```
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00002800
0.0         0.0         1.00E-09    2.00E+01    0.0         0.0         0.0         0.0                 00002850
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00002900
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00002950
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003000
0.0         0.0         1.00E-09    2.00E+01    0.0         0.0         0.0         0.0                 00003050
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003100
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003150
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003200
0.0         0.0         1.00E-09    2.00E+01    0.0         0.0         0.0         0.0                 00003250
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003300
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003350
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003400
0.0         0.0         1.00E-09    2.00E+01    0.0         0.0         0.0         0.0                 00003450
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003500
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003550
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003600
0.0         0.0         1.00E-09    2.00E+01    0.0         0.0         0.0         0.0                 00003650
0.0         0.0         0.0         0.0         5.00E-01    2.00E+01    0.0         0.0                 00003700
0.0         0.0         0.0         0.0         0.0         0.0         8.00E-01    2.00E+01            00003750
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00003800
1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00            00003850
7.99E+11    1.01E+14    2.27E+14    4.77E+13    1.22E+14    1.14E+14    1.57E+14    5.46E+12            00003900
0.0         5.06E+13    1.14E+14    1.12E+13    3.06E+13    2.85E+13    7.88E+13    2.60E+14            00003950
1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00    1.00E+00            00004000
1.26E-20    5.31E-23    5.09E-24    2.12E-24    3.83E-24    3.03E-23    3.18E-24    3.12E-23            00004050
1.29E-01    4.41E-01    9.15E-02    8.68E-03    3.59E-02    2.42E-01    4.18E-02    1.46E-02            00004100
0.0         2.17E-03    4.60E-04    2.18E-05    9.00E-05    6.00E-04    2.10E-04    1.44E-03            00004150
0.0         1.00E+00    0.0         0.0         0.0         0.0         0.0         1.00E+00            00004200
4.04E-13    1.93E-15    1.94E-16    1.05E-16    1.79E-16    1.17E-15    1.50E-16    1.25E-15            00004250
0.0         5.06E+11    1.14E+12    1.12E+11    3.06E+11    2.85E+11    7.88E+11    5.40E+11            00004300
2.00E+01    0.0         4.00E+03                                                                        00004350
******************* CHECK POINT NUMBER TWO (2)     ***************************02                         00004400
  1    4    4    1                                                                                      00004450
1.00E+00    7.30E+09                                                                                    00004500
4.00E-01    0.0         0.0         0.0         0.0         6.30E+07    0.0         0.0                 00004550
0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0                 00004600
0.0         0.0                                                                                         00004650
1.00E+00    7.30E+09                                                                                    00004700
4.00E-01    0.0         0.0         0.0         0.0         1.18E+10    0.0         0.0                 00004750
1.00E-03    0.0         0.0         0.0         4.00E+05    5.90E+09    0.0         0.0                 00004800
4.80E+03    7.08E+07                                                                                    00004850
1.00E+00    7.30E+09                                                                                    00004900
4.00E-01    0.0         0.0         0.0         1.11E+10    1.81E+10    4.67E+08    4.05E+09            00004950
1.00E-03    0.0         0.0         0.0         2.00E+05    4.60E+09    4.05E+09    0.0                 00005000
0.0         0.0                                                                                         00005050
1.00E+00    7.30E+09                                                                                    00005100
4.00E-01    0.0         0.0         0.0         3.95E+09    7.60E+09    8.32E+08    3.21E+09            00005150
1.00E-03    0.0         0.0         0.0         0.0         0.0         3.21E+09    0.0                 00005200
0.0         0.0                                                                                         00005250
1.00E+00    7.30E+09                                                                                    00005300
4.00E-01    0.0         0.0         0.0         2.52E+11    1.02E+10    5.43E+09    1.58E+10            00005350
1.00E-03    0.0         0.0         0.0         0.0         0.0         1.58E+10    0.0                 00005400
0.0         0.0                                                                                         00005450
1.00E+00    7.30E+09                                                                                    00005500
```

```
  4.00E-01  0.0       0.0       0.0       1.97E+10  1.38E+10  1.92E+09  1.50E+10   00005550
  1.00E-03  0.0       0.0       0.0       0.0       0.0       1.50E+10  0.0        00005600
  0.0       0.0                                                                    00005650
  1.00E+00  7.30E+09                                                               00005700
  4.00E-01  0.0       0.0       0.0       5.82E+09  3.27E+10  7.88E+09  6.31E+10   00005750
  1.00E-03  0.0       0.0       0.0       4.00E+05  1.67E+10  6.31E+10  0.0        00005800
  0.0       0.0                                                                    00005850
  1.00E+00  7.30E+09                                                               00005900
  4.00E-01  0.0       0.0       0.0       2.84E+09  0.0       6.23E+09  3.46E+10   00005950
  1.00E-03  0.0       0.0       0.0       4.00E+05  9.60E+08  3.46E+10  0.0        00006000
  2.00E+04  4.80E+07                                                               00006050
  5.26E-01  5.23E-03  3.56E-03  1.84E-02                                           00006100
  1.00E+00  2.40E-01  5.12E-01  0.00                                               00006150
  2.40E-01                                                                         00006200
  5.26E-01  9.48E-01  2.59E-01  9.86E-02                                           00006250
  1.00E+00  1.16E+00  3.84E+00  0.00                                               00006300
  1.16E+00                                                                         00006350
  5.26E-01  2.32E-03  1.71E-03  5.62E-03                                           00006400
  1.00E+00  1.16E-01  3.97E-01  0.00                                               00006450
  1.16E-01                                                                         00006500
****************** CHECK POINT NUMBER THREE (3)   ****************************03  00006550
TOT BODYGI TRACT GONADS   LIVER   LUNGS  MARROW   BONE  THYROID                    00006600
  0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0        00006650
  1.78E+03  3.56E+01  1.78E+03  0.0       9.71E+03  2.67E+04  2.67E+04  0.0        00006700
  0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0        00006750
  1.69E+02  4.85E+01  1.69E+02  0.0       0.0       8.43E+03  8.43E+03  0.0        00006800
  0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0        00006850
  1.69E+02  4.85E+01  1.69E+02  0.0       0.0       8.43E+03  8.43E+03  0.0        00006900
  1.69E+02  4.85E+01  1.69E+02  0.0       0.0       8.43E+03  8.43E+03  0.0        00006950
  1.69E+02  4.85E+01  1.69E+02  0.0       0.0       8.43E+03  8.43E+03  0.0        00007000
  9.55E+07  1.98E+07  1.31E+08  3.60E+07  4.85E+07  1.56E+08  1.45E+08  1.01E+08   00007050
  4.19E+00  5.34E+00  4.19E+00  2.11E+00  4.45E+02  2.48E+00  2.48E+00  5.55E+03   00007100
  5.73E+04  1.19E+04  7.88E+04  2.16E+04  2.91E+04  9.38E+04  8.72E+04  6.04E+04   00007150
  7.22E+00  9.70E+00  7.22E+00  2.81E+00  0.0       3.27E+00  3.27E+00  5.17E+03   00007200
  2.01E+03  4.18E+02  2.74E+03  7.57E+02  1.02E+03  3.29E+03  3.06E+03  2.12E+03   00007250
  7.22E+00  9.70E+00  7.22E+00  2.81E+00  0.0       3.27E+00  3.27E+00  5.17E+03   00007300
  7.22E+00  9.70E+00  7.22E+00  2.81E+00  0.0       3.27E+00  3.27E+00  5.17E+03   00007350
  7.22E+00  9.70E+00  7.22E+00  2.81E+00  0.0       3.27E+00  3.27E+00  5.17E+03   00007400
  1.43E+07  5.75E+06  1.21E+07  7.27E+06  9.02E+06  2.65E+07  2.45E+07  1.20E+07   00007450
  3.40E+03  7.12E+00  3.40E+03  3.10E+04  6.40E+05  3.30E+05  3.30E+05  0.0        00007500
  2.27E+04  5.15E+03  1.92E+04  1.16E+04  1.44E+04  4.23E+04  3.90E+04  1.91E+04   00007550
  5.10E+02  9.70E+00  5.10E+02  4.70E+03  0.0       5.00E+04  5.00E+04  0.0        00007600
  3.00E+02  1.21E+02  2.54E+02  1.53E+02  1.50E+02  5.59E+02  5.15E+02  2.53E+02   00007650
  5.10E+02  9.70E+00  5.10E+02  4.70E+03  0.0       5.00E+04  5.00E+04  0.0        00007700
  5.10E+02  9.70E+00  5.10E+02  4.70E+03  0.0       5.00E+04  5.00E+04  0.0        00007750
  5.10E+02  9.70E+00  5.10E+02  4.70E+03  0.0       5.00E+04  5.00E+04  0.0        00007800
****************** CHECK POINT NUMBER FOUR (4)    ****************************04  00007850
    3                                                                              00007900
    1    1                                                                         00007950
  5.00E-02                                                                         00008000
  1.00E-13          0  0.0       0.0                                               00008050
    2    1                                                                         00008100
  7.50E-02                                                                         00008150
  2.40E-12          0  0.0       0.0                                               00008200
    3    1                                                                         00008250
```

```
  6.00E-03                                                                                                  00008300
  2.40E-12          0  0.0        0.0                                                                      00008350
    3                                                                                                       00008400
    1    2                                                                                                  00008450
  3.33E-05                                                                                                  00008500
  1.00E+00          0  0.0        0.0                                                                      00008550
  0.0               2  1.60E+06   1.56E-07                                                                 00008600
    2    1                                                                                                  00008650
  5.00E-02                                                                                                  00008700
  1.00E-13          0  0.0        0.0                                                                      00008750
    3    1                                                                                                  00008800
  7.50E-02                                                                                                  00008850
  8.10E-12          0  0.0        0.0                                                                      00008900
    3                                                                                                       00008950
    1    3                                                                                                  00009000
  3.33E-05                                                                                                  00009050
  1.00E+00          0  0.0        0.0                                                                      00009100
  1.00E+00          0  0.0        0.0                                                                      00009150
  0.0               2  1.60E+06   1.56E-07                                                                 00009200
    2    2                                                                                                  00009250
  5.00E-02                                                                                                  00009300
  1.00E+00          0  0.0        0.0                                                                      00009350
  1.00E-13          0  0.0        0.0                                                                      00009400
    3    2                                                                                                  00009450
  7.50E-02                                                                                                  00009500
  1.00E+00          0  0.0        0.0                                                                      00009550
  8.10E-12          0  0.0        0.0                                                                      00009600
    1                                                                                                       00009650
    1    4                                                                                                  00009700
  0.0                                                                                                       00009750
  1.00E+00          0  0.0        0.0                                                                      00009800
  1.00E+00          0  0.0        0.0                                                                      00009850
  1.00E+00          0  0.0        0.0                                                                      00009900
  1.40E-07          0  0.0        0.0                                                                      00009950
    1    1                                                                                                  00010000
    1    1    1    1    2    2    2    2                                                                   00010050
    1    1    1    1    1    2    2    2                                                                   00010100
    1    2                                                                                                  00010150
  4.00E-03  1.50E-01  5.00E+01  6.00E+00  5.00E+01  2.30E+00  4.38E+04  2.22E+05                          00010200
  0.0       1.00E+04  0.0       0.0       0.0       0.0       0.0       2.00E+04                          00010250
  0.0       2.58E+03  0.0       0.0       0.0       0.0       0.0       3.64E+03                          00010300
  0.0       5.20E+02  0.0       0.0       0.0       0.0       0.0       7.30E+02                          00010350
  6.25E+04  2.50E+02                                                                                        00010400
****************** CHECK POINT NUMBER FIVE (5)    ****************************05                             00010450
    1                                                                                                       00010500
****************** CHECK POINT NUMBER SIX  (6)    ****************************06                             00010550
    3                                                                                                       00010600
    1    8   10                                                                                             00010650
   14    9    2                                                                                             00010700
```

APPENDIX F 2. Output (a)

** DEFINITION OF ENVIRONMENTAL INPUTS

JF	DEFINITION
1	AIR
2	GROUND SURFACE
3	SURFACE WATER
4	GROUND WATER

** DEFINITION OF PROBABILITY INPUTS

IFLAG	DEFINITION
0	PROBABILITY (PROB) CONSTANT
1	STEP FUNCTION AT TIME TP CHANGES PROB BY AMOUNT CP
2	RAMP FUNCTION AT TP CHANGES PROB BY SLOPE CP
3	EXPONENTIAL FUNCTION AT TP CHANGES PROB BY TIME CONSTANT CP
4	DELTA FUNCTION, AT TIME TP RELEASE TO ENVIRONMENT IS AA1

** PROBABILITY AND RELATED DATA

JF	NJF	J	NJJ	AA1	PROB	IFLAG	TP	CP
1	3	1	1	5.00E-02	1.00E-13	0	0.0	0.0
1	3	2	1	7.50E-02	2.40E-12	0	0.0	0.0
1	3	3	1	6.00E-03	2.40E-12	0	0.0	0.0
2	3	1	2	3.33E-05	1.00E 00	0	0.0	0.0
					0.0	2	1.60000E 05	1.56000E-07
2	3	2	1	5.00E-02	1.00E-13	0	0.0	0.0
2	3	3	1	7.50E-02	8.10E-12	0	0.0	0.0
3	3	1	3	3.33E-05	1.00E 00	0	0.0	0.0
					1.00E 00	0	0.0	0.0
					0.0	2	1.60000E 05	1.56000E-07
3	3	2	2	5.00E-02	1.00E 00	0	0.0	0.0
					1.00E-13	0	0.0	0.0
3	3	3	2	7.50E-02	1.00E 00	0	0.0	0.0
					8.10E-12	0	0.0	0.0
4	1	1	4	0.0	1.00E 00	0	0.0	0.0
					1.00E 00	0	0.0	0.0
					1.00E 00	0	0.0	0.0
					1.40E-07	0	0.0	0.0

********** CHECK POINT NUMBER FIVE (5) ********** 5
********** CHECK POINT NUMBER SIX (6) ********** 6

** SELECTED RESIDUAL ELEMENTS IN WASTE
GRAMS AT START OF TERMINAL STORAGE
FOR TOTAL FUEL = 187000.METRIC TONS

SR	1.26E 08
I	1.84E 05
PB	9.08E 02

** SELECTED RADIONUCLIDES IN WASTE
GRAMS IN WASTE VERSUS TIME IN YEARS

TIME	SR-90	I-129	PB-210
0.	5.30E 05	3.48E 02	2.12E-07
5.	3.89E 06	2.66E 03	2.12E-06
10.	1.06E 07	7.96E 03	9.10E-06
15.	2.24E 07	1.77E 04	3.90E-05
20.	4.22E 07	3.40E 04	1.32E-04
25.	7.11E 07	5.84E 04	3.25E-04
30.	6.28E 07	5.84E 04	4.51E-04
40.	4.91E 07	5.84E 04	7.00E-04
50.	3.90E 07	5.84E 04	9.66E-04
60.	3.09E 07	5.84E 04	1.26E-03
70.	2.43E 07	5.84E 04	1.58E-03
80.	1.91E 07	5.84E 04	1.94E-03
90.	1.48E 07	5.84E 04	2.36E-03
100.	1.15E 07	5.84E 04	2.82E-03
200.	6.87E 05	5.84E 04	1.28E-02
300.	7.72E 04	5.84E 04	3.68E-02
400.	7.82E 03	5.84E 04	7.85E-02
500.	7.85E 02	5.84E 04	1.39E-01
600.	7.21E 01	5.84E 04	2.20E-01
700.	6.10E 00	5.84E 04	3.20E-01
800.	4.83E-01	5.84E 04	4.39E-01
900.	3.65E-02	5.84E 04	5.75E-01
1000.	2.68E-03	5.84E 04	7.29E-01
2000.	1.62E-14	5.84E 04	2.96E 00
3000.	8.95E-25	5.84E 04	6.06E 00
4000.	0.0	5.84E 04	9.69E 00
5000.	0.0	5.84E 04	1.37E 01
6000.	0.0	5.84E 04	1.79E 01
7000.	0.0	5.84E 04	2.23E 01
8000.	0.0	5.84E 04	2.69E 01
9000.	0.0	5.84E 04	3.15E 01
10000.	0.0	5.84E 04	3.63E 01
20000.	0.0	5.83E 04	8.40E 01
30000.	0.0	5.83E 04	1.27E 02
40000.	0.0	5.83E 04	1.63E 02
50000.	0.0	5.83E 04	1.93E 02
60000.	0.0	5.83E 04	2.19E 02
70000.	0.0	5.82E 04	2.40E 02
80000.	0.0	5.82E 04	2.59E 02
90000.	0.0	5.82E 04	2.76E 02
100000.	0.0	5.82E 04	2.88E 02
200000.	0.0	5.80E 04	3.40E 02
300000.	0.0	5.77E 04	3.08E 02
400000.	0.0	5.74E 04	2.53E 02
500000.	0.0	5.72E 04	1.99E 02
600000.	0.0	5.69E 04	1.55E 02
700000.	0.0	5.67E 04	1.19E 02
800000.	0.0	5.65E 04	9.16E 01
900000.	0.0	5.63E 04	7.07E 01
1000000.	0.0	5.61E 04	5.47E 01
SPECIFIC ACTIVITY CI/G	1.42E 02	1.63E-04	8.12E 01

RADIONUCLIDE	CCI DATA	DRC DATA	RKD DATA
SR-90	1.64E-08	2.90E-02	2.00E 01
I-129	9.52E-10	4.95E-03	0.0
PB-210	9.39E-10	2.75E-03	4.00E 03

** GROUND WATER PARAMETERS

GROUND WATER SEEPAGE VELOCITY, VX, IN METERS/DAY = 4.00E-03
POROSITY OF SOLID MEDIUM, PORE = 1.50E-01
BULK SOLID DENSITY, BULKD, IN GRAMS/CUBIC CM = 2.30E 00
DISPERSIVITY COEFFICIENTS, IN METERS: AXIAL, AL = 5.00E 01 TRANSVERSE, AT = 6.00E 00

AQUIFER VALUES, IN METERS: HEIGHT, HT= 5.00E 01
DISTANCE FROM SOURCE TO EMERGENCE, XL(IZ) EFFECTIVE WIDTH, YW(IZ)
CONCENTRATION AT YY = AVERAGE CONCENTRATION IN YW

ZONE	IZ= 1	IZ= 2	IZ= 3	IZ= 4	IZ= 5	IZ= 6	IZ= 7	IZ= 8
XL(IZ)	0.0	1.00E 04	0.0	0.0	0.0	0.0	0.0	2.00E 04
YW(IZ)	0.0	2.58E 03	0.0	0.0	0.0	0.0	0.0	3.64E 03
YY(IZ)	0.0	5.20E 02	0.0	0.0	0.0	0.0	0.0	7.30E 02

EXPOSED AREA OF SOLIDIFIED WASTE SPECIMEN, FS, IN SQUARE CM = 4.38E 04
VOLUME OF SOLIDIFIED WASTE SPECIMEN, VS, IN CUBIC CM = 2.22E 05
TOTAL CANISTER INVENTORY, CINV = 6.25E 04
ASSUMED NUMBER OF CANISTER FAILURES, CFAI = 2.50E 02

** EDC(K,JF,IZ) DATA, (JF=1,2,3,4), DEFAULT VALUES USED, EXCEPTING NONE READ IN

IZ= 1

SR-90	5.00E 01	2.30E-05	2.30E-05	0.0
I-129	5.00E 01	2.30E-05	2.30E-05	0.0
PB-210	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 2

	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 3

SR-90	5.00E 01	2.30E-05	2.30E-05	0.0
I-129	5.00E 01	2.30E-05	2.30E-05	0.0
PB-210	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 4

	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 5

SR-90	5.00E 01	2.30E-05	2.30E-05	0.0
I-129	5.00E 01	2.30E-05	2.30E-05	0.0
PB-210	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 6

	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 7

SR-90	5.00E 01	2.30E-05	2.30E-05	0.0
I-129	5.00E 01	2.30E-05	2.30E-05	0.0
PB-210	5.00E 01	2.30E-05	2.30E-05	0.0

IZ= 8

	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0
	5.00E 01	2.30E-05	2.30E-05	0.0

```
** DISPN(JF,IZ) DATA, (JF=1,2,3,4)

  IZ= 1                                          IZ= 2
   1.00E 00  7.90E 11  0.0       1.00E 00      1.00E 00  1.01E 14  5.06E 13  1.00E 00

  IZ= 3                                          IZ= 4
   1.00E 00  2.27E 14  1.14E 14  1.00E 00      1.00E 00  4.77E 13  1.12E 13  1.00E 00

  IZ= 5                                          IZ= 6
   1.00E 00  1.22E 14  3.06E 13  1.00E 00      1.00E 00  1.14E 14  2.85E 13  1.00E 00

  IZ= 7                                          IZ= 8
   1.00E 00  1.57E 14  7.88E 13  1.00E 00      1.00E 00  5.46E 12  2.60E 14  1.00E 00


** ZONALO(JF,IZ) DATA, (JF=1,2,3,4)

  IZ= 1                                          IZ= 2
   1.26E-20  1.29E-01  0.0       0.0           5.31E-23  4.41E-01  2.17E-03  1.00E 00

  IZ= 3                                          IZ= 4
   5.09E-24  9.15E-02  4.60E-04  0.0           2.12E-24  8.68E-03  2.18E-05  0.0

  IZ= 5                                          IZ= 6
   3.83E-24  3.59E-02  9.00E-05  0.0           3.03E-23  2.42E-01  6.08E-04  0.0

  IZ= 7                                          IZ= 8
   3.18E-24  4.18E-02  2.10E-04  0.0           3.12E-23  1.46E-02  1.44E-03  1.00E 00


** ZONDEP(IZ) DATA

   IZ= 1     IZ= 2     IZ= 3     IZ= 4     IZ= 5     IZ= 6     IZ= 7     IZ= 8
   4.04E-13  1.93E-15  1.94E-16  1.05E-16  1.79E-16  1.17E-15  1.50E-16  1.25E-15
```

** AREAW(IZ) DATA

IZ= 1	IZ= 2	IZ= 3	IZ= 4	IZ= 5	IZ= 6	IZ= 7	IZ= 8
0.0	5.06E 11	1.14E 12	1.12E 11	3.06E 11	2.85E 11	7.88E 11	5.40E 11

** ADJ1(JF,JFA,IZ),ADJ2(JF,JFA,IZ) DATA, (JFA=1,2,3,4)

IZ= 1								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 2								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	2.00E-01	2.00E 01
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 3								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 4								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 5								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 6								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 7								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IZ= 8								
JF= 1	0.0	0.0	1.00E-09	2.00E 01	0.0	0.0	0.0	0.0
JF= 2	0.0	0.0	0.0	0.0	5.00E-01	2.00E 01	0.0	0.0
JF= 3	0.0	0.0	0.0	0.0	0.0	0.0	8.00E-01	2.00E 01
JF= 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** VOLINT(JF,MODE,NSP) DATA

IZ= 1

JF	MODE	NSP=1 THRU	VOLINT			
1	1	1	1.00E 00			
1	2	1	7.30E 09			
2	1	4	4.00E-01	0.0	0.0	0.0
2	2	4	0.0	6.30E 07	0.0	0.0
3	1	4	0.0	0.0	0.0	0.0
3	2	4	0.0	0.0	0.0	0.0
4	1	1	0.0			
4	2	1	0.0			

IZ= 2

JF	MODE	NSP=1 THRU	VOLINT			
1	1	1	1.00E 00			
1	2	1	7.30E 09			
2	1	4	4.00E-01	0.0	0.0	0.0
2	2	4	0.0	1.18E 10	0.0	0.0
3	1	4	1.00E-03	0.0	0.0	0.0
3	2	4	4.00E 05	5.90E 09	0.0	0.0
4	1	1	4.80E 03			
4	2	1	7.08E 07			

IZ= 3

JF	MODE	NSP=1 THRU	VOLINT			
1	1	1	1.00E 00			
1	2	1	7.30E 09			
2	1	4	4.00E-01	0.0	0.0	0.0
2	2	4	1.11E 10	1.81E 10	4.67E 08	4.05E 09
3	1	4	1.00E-03	0.0	0.0	0.0
3	2	4	2.00E 05	4.60E 09	4.05E 09	0.0
4	1	1	0.0			
4	2	1	0.0			

IZ= 4

JF	MODE	NSP=1 THRU	VOLINT			
1	1	1	1.00E 00			
1	2	1	7.30E 09			
2	1	4	4.00E-01	0.0	0.0	0.0
2	2	4	3.95E 09	7.60E 09	6.32E 08	3.21E 09
3	1	4	1.00E-03	0.0	0.0	0.0
3	2	4	0.0	0.0	3.21E 09	0.0
4	1	1	0.0			
4	2	1	0.0			

```
IZ= 5
   JF      MODE      NSP=1 THRU          VOLINT
    1        1              1      1.00E 00
    1        2              1      7.30E 09
    2        1              4      4.00E-01      0.0           0.0           0.0
    2        2              4      2.52E 11      1.02E 10      5.43E 09      1.58E 10
    3        1              4      1.00E-03      0.0           0.0           0.0
    3        2              4      0.0           0.0           1.58E 10      0.0
    4        1              1      0.0
    4        2              1      0.0
IZ= 6
   JF      MODE      NSP=1 THRU          VOLINT
    1        1              1      1.00E 00
    1        2              1      7.30E 09
    2        1              4      4.00E-01      0.0           0.0           0.0
    2        2              4      1.97E 10      1.38E 10      1.92E 09      1.50E 10
    3        1              4      1.00E-03      0.0           0.0           0.0
    3        2              4      0.0           0.0           1.50E 10      0.0
    4        1              1      0.0
    4        2              1      0.0
IZ= 7
   JF      MODE      NSP=1 THRU          VOLINT
    1        1              1      1.00E 00
    1        2              1      7.30E 09
    2        1              4      4.00E-01      0.0           0.0           0.0
    2        2              4      5.82E 09      3.27E 10      7.88E 09      6.31E 10
    3        1              4      1.00E-03      0.0           0.0           0.0
    3        2              4      4.00E 05      1.67E 10      6.31E 10      0.0
    4        1              1      0.0
    4        2              1      0.0
IZ= 8
   JF      MODE      NSP=1 THRU          VOLINT
    1        1              1      1.00E 00
    1        2              1      7.30E 09
    2        1              4      4.00E-01      0.0           0.0           0.0
    2        2              4      2.84E 09      0.0           6.23E 09      3.46E 10
    3        1              4      1.00E-03      0.0           0.0           0.0
    3        2              4      4.00E 05      9.60E 08      3.46E 10      0.0
    4        1              1      2.00E 04
    4        2              1      4.80E 07
```

```
** BIOFAC(K,JF,NSP) DATA

RADIONUCLIDE=   SR-90
    JF      NSP=1 THRU          BIOFAC
     1              1      1.00E 00
     2              4      5.26E-01      5.23E-03      3.56E-03      1.84E-02
     3              4      1.00E 00      2.40E-01      5.12E-01      0.0
     4              1      2.40E-01
RADIONUCLIDE=   I-129
    JF      NSP=1 THRU          BIOFAC
     1              1      1.00E 00
     2              4      5.26E-01      9.48E-01      2.59E-01      9.86E-02
     3              4      1.00E 00      1.16E 00      3.84E 00      0.0
     4              1      1.16E 00
RADIONUCLIDE=  PB-210
    JF      NSP=1 THRU          BIOFAC
     1              1      1.00E 00
     2              4      5.26E-01      2.32E-03      1.71E-03      5.62E-03
     3              4      1.00E 00      1.16E-01      3.97E-01      0.0
     4              1      1.16E-01
```

** DOSFAC(K,JF,MODE,IH) DATA

ORGAN = TOT BODY

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	1.78E 03	0.0	1.69E 02	0.0	1.69E 02	1.69E 02	1.69E 02
I-129	9.55E 07	4.19E 00	5.73E 04	7.22E 00	2.01E 03	7.22E 00	7.22E 00	7.22E 00
PB-210	1.43E 07	3.40E 03	2.27E 04	5.10E 02	3.00E 02	5.10E 02	5.10E 02	5.10E 02

ORGAN = GI TRACT

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	3.56E 01	0.0	4.85E 01	0.0	4.85E 01	4.85E 01	4.85E 01
I-129	1.98E 07	5.34E 00	1.19E 04	9.70E 00	4.18E 02	9.70E 00	9.70E 00	9.70E 00
PB-210	5.75E 06	7.12E 00	9.15E 03	9.70E 00	1.21E 02	9.70E 00	9.70E 00	9.70E 00

ORGAN = GONADS

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	1.78E 03	0.0	1.69E 02	0.0	1.69E 02	1.69E 02	1.69E 02
I-129	1.31E 08	4.19E 00	7.88E 04	7.22E 00	2.74E 03	7.22E 00	7.22E 00	7.22E 00
PB-210	1.21E 07	3.40E 03	1.92E 04	5.10E 02	2.54E 02	5.10E 02	5.10E 02	5.10E 02

ORGAN = LIVER

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	3.60E 07	2.11E 00	2.16E 04	2.81E 00	7.57E 02	2.81E 00	2.81E 00	2.81E 00
PB-210	7.27E 06	3.10E 04	1.16E 04	4.70E 03	1.53E 02	4.70E 03	4.70E 03	4.70E 03

ORGAN = LUNGS

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	9.71E 03	0.0	0.0	0.0	0.0	0.0	0.0
I-129	4.85E 07	4.45E 02	2.91E 04	0.0	1.02E 03	0.0	0.0	0.0
PB-210	9.02E 06	6.40E 05	1.44E 04	0.0	1.90E 02	0.0	0.0	0.0

ORGAN = MARROW

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	2.67E 04	0.0	8.43E 03	0.0	8.43E 03	8.43E 03	8.43E 03
I-129	1.56E 08	2.48E 00	9.38E 04	3.27E 00	3.29E 03	3.27E 00	3.27E 00	3.27E 00
PB-210	2.65E 07	3.30E 05	4.23E 04	5.00E 04	5.59E 02	5.00E 04	5.00E 04	5.00E 04

ORGAN = BONE

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	2.67E 04	0.0	8.43E 03	0.0	8.43E 03	8.43E 03	8.43E 03
I-129	1.45E 08	2.48E 00	8.72E 04	3.27E 00	3.06E 03	3.27E 00	3.27E 00	3.27E 00
PB-210	2.45E 07	3.30E 05	3.90E 04	5.00E 04	5.15E 02	5.00E 04	5.00E 04	5.00E 04

ORGAN = THYROID

	JF=1		JF=2		JF=3		JF=4	
	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2	MODE=1	MODE=2
SR-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-129	1.01E 08	5.55E 03	6.04E 04	5.17E 03	2.12E 03	5.17E 03	5.17E 03	5.17E 03
PB-210	1.20E 07	0.0	1.91E 04	0.0	2.53E 02	0.0	0.0	0.0

RADIONUCLIDE: I-129 (K = 2)

RELEASE FRACTIONS BY EACH CUTSET, RELOUT

TIME	JF	INITIAL RELEASE FRACTIONS		
40.	1	5.00E-14	1.80E-12	1.44E-13
40.	2	0.0	5.00E-14	6.07E-12
40.	3	0.0	5.00E-14	6.07E-12
40.	4	9.97E-12		
50.	1	5.00E-14	1.80E-12	1.44E-13
50.	2	0.0	5.00E-14	6.07E-12
50.	3	0.0	5.00E-14	6.07E-12
50.	4	9.97E-12		
60.	1	5.00E-14	1.80E-12	1.44E-13
60.	2	0.0	5.00E-14	6.07E-12
60.	3	0.0	5.00E-14	6.07E-12
60.	4	9.97E-12		
70.	1	5.00E-14	1.80E-12	1.44E-13
70.	2	0.0	5.00E-14	6.07E-12
70.	3	0.0	5.00E-14	6.07E-12
70.	4	9.97E-12		
80.	1	5.00E-14	1.80E-12	1.44E-13
80.	2	0.0	5.00E-14	6.07E-12
80.	3	0.0	5.00E-14	6.07E-12
80.	4	9.97E-12		
90.	1	5.00E-14	1.80E-12	1.44E-13
90.	2	0.0	5.00E-14	6.07E-12
90.	3	0.0	5.00E-14	6.07E-12
90.	4	9.97E-12		
100.	1	5.00E-14	1.80E-12	1.44E-13
100.	2	0.0	5.00E-14	6.07E-12
100.	3	0.0	5.00E-14	6.07E-12
100.	4	9.97E-12		
200.	1	5.00E-13	1.80E-11	1.44E-12
200.	2	0.0	5.00E-13	6.07E-11
200.	3	0.0	5.00E-13	6.07E-11
200.	4	9.00E-10		
300.	1	5.00E-13	1.80E-11	1.44E-12
300.	2	0.0	5.00E-13	6.07E-11
300.	3	0.0	5.00E-13	6.07E-11
300.	4	9.00E-10		
400.	1	5.00E-13	1.80E-11	1.44E-12
400.	2	0.0	5.00E-13	6.07E-11
400.	3	0.0	5.00E-13	6.07E-11
400.	4	9.00E-10		
500.	1	5.00E-13	1.80E-11	1.44E-12
500.	2	0.0	5.00E-13	6.07E-11
500.	3	0.0	5.00E-13	6.07E-11
500.	4	9.00E-10		
600.	1	5.00E-13	1.80E-11	1.44E-12
600.	2	0.0	5.00E-13	6.07E-11
600.	3	0.0	5.00E-13	6.07E-11
600.	4	9.00E-10		
700.	1	5.00E-13	1.80E-11	1.44E-12
700.	2	0.0	5.00E-13	6.07E-11
700.	3	0.0	5.00E-13	6.07E-11
700.	4	9.00E-10		
800.	1	5.00E-13	1.80E-11	1.44E-12
800.	2	0.0	5.00E-13	6.07E-11
800.	3	0.0	5.00E-13	6.07E-11
800.	4	9.00E-10		

This table continues through 1,000,000 years.

RADIONUCLIDE: I-129 (K= 2)

RELEASE INCREMENTS TO PRELIMINARY ENVIRONMENT INPUT
RECEPTORS, R1J, FROM ALL RELEASE EVENTS, IN CURIES

TIME	JF=1 AIR	JF=2 GROUND SURFACE	JF=3 SURFACE WATER	JF=4 GROUND WATER
0.	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0
40.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
50.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
60.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
70.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
80.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
90.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
100.	1.90E-11	5.83E-11	5.83E-11	9.49E-11
200.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
300.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
400.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
500.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
600.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
700.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
800.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
900.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
1000.	1.90E-10	5.83E-10	5.83E-10	8.56E-09
2000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
3000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
4000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
5000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
6000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
7000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
8000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
9000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
10000.	1.90E-09	5.83E-09	5.83E-09	8.36E-07
20000.	1.90E-08	5.83E-08	5.83E-08	8.33E-05
30000.	1.89E-08	5.82E-08	5.82E-08	8.32E-05
40000.	1.89E-08	5.82E-08	5.82E-08	8.32E-05
50000.	1.89E-08	5.82E-08	5.82E-08	8.32E-05
60000.	1.89E-08	5.82E-08	5.82E-08	8.32E-05
70000.	1.89E-08	5.82E-08	5.82E-08	8.31E-05
80000.	1.89E-08	5.81E-08	5.81E-08	8.31E-05
90000.	1.89E-08	5.81E-08	5.81E-08	8.31E-05
100000.	1.89E-08	5.81E-08	5.81E-08	8.31E-05
200000.	1.89E-07	5.80E-07	5.80E-07	8.29E-03
300000.	1.88E-07	5.78E-07	5.78E-07	8.26E-03
400000.	1.87E-07	5.75E-07	5.75E-07	8.21E-03
500000.	1.86E-07	5.72E-07	5.72E-07	8.18E-03
600000.	1.85E-07	5.70E-07	5.70E-07	8.14E-03
700000.	1.85E-07	5.67E-07	5.67E-07	8.11E-03
800000.	1.84E-07	5.65E-07	5.65E-07	8.08E-03
900000.	1.83E-07	5.63E-07	5.63E-07	8.05E-03
1000000.	1.83E-07	5.61E-07	5.61E-07	8.02E-03

RADIONUCLIDE: I-129 (K= 2)

CONCENTRATIONS AT ENVIRONMENT INPUT RECEPTOR, R2TOT UNITS: JF=1 MICROCURIE*YEARS/CUBIC CM
JF=2 MICROCURIES/SQUARE CM, JF=3 AND 4 MICROCURIES/CUBIC CM

ZONE= 1

TIME	JF=1 AIR	JF=2 GROUND SURFACE	JF=3 SURFACE WATER	JF=4 GROUND WATER
0.	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0
40.	4.11E-25	1.72E-17	0.0	0.0
50.	5.83E-25	3.44E-17	0.0	0.0
60.	7.55E-25	5.16E-17	0.0	0.0
70.	9.26E-25	6.87E-17	0.0	0.0
80.	1.10E-24	8.59E-17	0.0	0.0
90.	1.27E-24	1.03E-16	0.0	0.0
100.	1.44E-24	1.20E-16	0.0	0.0
200.	3.16E-23	2.92E-16	0.0	0.0
300.	4.87E-23	4.63E-16	0.0	0.0
400.	6.58E-23	6.34E-16	0.0	0.0
500.	8.28E-23	8.04E-16	0.0	0.0
600.	9.98E-23	9.75E-16	0.0	0.0
700.	1.17E-22	1.14E-15	0.0	0.0
800.	1.34E-22	1.31E-15	0.0	0.0
900.	1.51E-22	1.48E-15	0.0	0.0
1000.	1.67E-22	1.65E-15	0.0	0.0
2000.	3.37E-21	3.35E-15	0.0	0.0
3000.	5.02E-21	4.99E-15	0.0	0.0
4000.	6.62E-21	6.60E-15	0.0	0.0
5000.	8.19E-21	8.17E-15	0.0	0.0
6000.	9.72E-21	9.70E-15	0.0	0.0
7000.	1.12E-20	1.12E-14	0.0	0.0
8000.	1.27E-20	1.27E-14	0.0	0.0
9000.	1.41E-20	1.41E-14	0.0	0.0
10000.	1.55E-20	1.55E-14	0.0	0.0
20000.	3.08E-19	3.08E-14	0.0	0.0
30000.	4.16E-19	4.16E-14	0.0	0.0
40000.	5.03E-19	5.02E-14	0.0	0.0
50000.	5.71E-19	5.71E-14	0.0	0.0
60000.	6.25E-19	6.25E-14	0.0	0.0
70000.	6.68E-19	6.68E-14	0.0	0.0
80000.	7.02E-19	7.01E-14	0.0	0.0
90000.	7.29E-19	7.29E-14	0.0	0.0
100000.	7.50E-19	7.50E-14	0.0	0.0
200000.	1.92E-17	1.92E-13	0.0	0.0
300000.	1.89E-17	1.89E-13	0.0	0.0
400000.	1.88E-17	1.88E-13	0.0	0.0
500000.	1.87E-17	1.87E-13	0.0	0.0
600000.	1.87E-17	1.87E-13	0.0	0.0
700000.	1.86E-17	1.86E-13	0.0	0.0
800000.	1.85E-17	1.85E-13	0.0	0.0
900000.	1.85E-17	1.85E-13	0.0	0.0
1000000.	1.84E-17	1.84E-13	0.0	0.0

ZONE= 2

TIME	JF=1 AIR	JF=2 GROUND SURFACE	JF=3 SURFACE WATER	JF=4 GROUND WATER
0.	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0
40.	3.92E-27	2.91E-19	2.87E-21	0.0
50.	6.83E-27	5.82E-19	5.73E-21	0.0
60.	9.74E-27	8.73E-19	8.60E-21	0.0
70.	1.27E-26	1.16E-18	1.15E-20	0.0
80.	1.56E-26	1.46E-18	1.43E-20	0.0
90.	1.85E-26	1.75E-18	1.72E-20	0.0
100.	2.14E-26	2.04E-18	2.01E-20	0.0
200.	5.05E-25	4.95E-18	4.87E-20	0.0
300.	7.95E-25	7.85E-18	7.73E-20	0.0
400.	1.08E-24	1.07E-17	1.06E-19	0.0
500.	1.37E-24	1.36E-17	1.34E-19	0.0
600.	1.66E-24	1.65E-17	1.63E-19	0.0
700.	1.95E-24	1.94E-17	1.91E-19	0.0
800.	2.24E-24	2.23E-17	2.19E-19	0.0
900.	2.52E-24	2.51E-17	2.47E-19	0.0
1000.	2.81E-24	2.80E-17	2.75E-19	0.0
2000.	5.68E-23	5.67E-17	5.59E-19	0.0
3000.	8.47E-23	8.46E-17	8.33E-19	1.67E-35
4000.	1.12E-22	1.12E-16	1.10E-18	3.00E-25
5000.	1.38E-22	1.38E-16	1.37E-18	3.70E-20
6000.	1.64E-22	1.64E-16	2.74E-18	9.97E-18
7000.	1.90E-22	1.90E-16	1.46E-17	1.05E-16
8000.	2.15E-22	2.15E-16	9.16E-17	6.90E-16
9000.	2.39E-22	2.39E-16	3.51E-16	2.34E-15
10000.	2.63E-22	2.62E-16	7.74E-16	3.85E-15
20000.	5.22E-21	5.22E-16	1.03E-15	3.08E-16
30000.	7.05E-21	7.05E-16	5.14E-15	3.87E-15
40000.	8.51E-21	8.51E-16	8.40E-15	3.86E-15
50000.	9.67E-21	9.67E-16	1.10E-14	3.86E-15
60000.	1.06E-20	1.06E-15	1.31E-14	3.86E-15
70000.	1.13E-20	1.13E-15	1.47E-14	3.86E-15
80000.	1.19E-20	1.19E-15	1.60E-14	3.86E-15
90000.	1.23E-20	1.23E-15	1.70E-14	3.86E-15
100000.	1.27E-20	1.27E-15	1.78E-14	3.86E-15
200000.	3.26E-19	3.26E-15	5.52E-15	6.20E-17
300000.	3.21E-19	3.21E-15	4.74E-14	4.19E-15
400000.	3.19E-19	3.19E-15	5.13E-14	4.17E-15
500000.	3.18E-19	3.18E-15	5.15E-14	4.15E-15
600000.	3.16E-19	3.16E-15	5.13E-14	4.13E-15
700000.	3.15E-19	3.15E-15	5.11E-14	4.12E-15
800000.	3.14E-19	3.14E-15	5.09E-14	4.10E-15
900000.	3.13E-19	3.13E-15	5.07E-14	4.08E-15
1000000.	3.11E-19	3.11E-15	5.05E-14	4.07E-15

APPENDIX F 2. Output (c)

** AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MANIL, IN MILLIREMS/YEAR

ZONE= 1... NUCLIDE= I-129 K= 2

TIME	TOT BODY	GI TRACT	GONADS	LIVER	LUNGS	MARROW	BONE	THYROID
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	3.95E-13	8.34E-14	5.43E-13	1.49E-13	3.34E-13	6.46E-13	6.00E-13	2.08E-12
50.	7.90E-13	1.66E-13	1.09E-12	2.98E-13	5.89E-13	1.29E-12	1.20E-12	3.19E-12
60.	1.18E-12	2.48E-13	1.63E-12	4.47E-13	8.45E-13	1.94E-12	1.80E-12	4.30E-12
70.	1.58E-12	3.31E-13	2.17E-12	5.95E-13	1.10E-12	2.58E-12	2.40E-12	5.41E-12
80.	1.97E-12	4.13E-13	2.71E-12	7.44E-13	1.36E-12	3.23E-12	3.00E-12	6.52E-12
90.	2.37E-12	4.96E-13	3.25E-12	8.93E-13	1.61E-12	3.87E-12	3.60E-12	7.64E-12
100.	2.76E-12	5.78E-13	3.79E-12	1.04E-12	1.87E-12	4.51E-12	4.20E-12	8.75E-12
200.	6.70E-12	1.40E-12	9.21E-12	2.53E-12	4.42E-12	1.10E-11	1.02E-11	1.99E-11
300.	1.06E-11	2.22E-12	1.46E-11	4.01E-12	6.97E-12	1.74E-11	1.62E-11	3.09E-11
400.	1.46E-11	3.04E-12	2.00E-11	5.49E-12	9.52E-12	2.38E-11	2.21E-11	4.20E-11
500.	1.85E-11	3.86E-12	2.54E-11	6.96E-12	1.21E-11	3.02E-11	2.81E-11	5.30E-11
600.	2.24E-11	4.68E-12	3.07E-11	8.44E-12	1.46E-11	3.66E-11	3.40E-11	6.40E-11
700.	2.63E-11	5.49E-12	3.61E-11	9.90E-12	1.71E-11	4.30E-11	3.99E-11	7.50E-11
800.	3.01E-11	6.30E-12	4.14E-11	1.14E-11	1.96E-11	4.93E-11	4.58E-11	8.59E-11
900.	3.40E-11	7.11E-12	4.68E-11	1.29E-11	2.21E-11	5.56E-11	5.17E-11	9.68E-11
1000.	3.79E-11	7.92E-12	5.21E-11	1.43E-11	2.47E-11	6.20E-11	5.76E-11	1.08E-10
2000.	7.69E-11	1.61E-11	1.06E-10	2.90E-11	4.99E-11	1.26E-10	1.17E-10	2.18E-10
3000.	1.15E-10	2.40E-11	1.57E-10	4.32E-11	7.44E-11	1.87E-10	1.74E-10	3.24E-10
4000.	1.51E-10	3.17E-11	2.08E-10	5.71E-11	9.83E-11	2.48E-10	2.30E-10	4.28E-10
5000.	1.87E-10	3.92E-11	2.58E-10	7.07E-11	1.22E-10	3.07E-10	2.85E-10	5.29E-10
6000.	2.23E-10	4.65E-11	3.06E-10	8.40E-11	1.44E-10	3.64E-10	3.38E-10	6.28E-10
7000.	2.57E-10	5.37E-11	3.53E-10	9.69E-11	1.67E-10	4.20E-10	3.91E-10	7.25E-10
8000.	2.91E-10	6.08E-11	3.99E-10	1.10E-10	1.89E-10	4.75E-10	4.42E-10	8.20E-10
9000.	3.23E-10	6.76E-11	4.45E-10	1.22E-10	2.10E-10	5.29E-10	4.92E-10	9.12E-10
10000.	3.56E-10	7.43E-11	4.89E-10	1.34E-10	2.31E-10	5.82E-10	5.41E-10	1.00E-09
20000.	7.07E-10	1.48E-10	9.72E-10	2.67E-10	4.59E-10	1.16E-09	1.08E-09	1.99E-09
30000.	9.55E-10	2.00E-10	1.31E-09	3.60E-10	6.20E-10	1.56E-09	1.45E-09	2.69E-09
40000.	1.15E-09	2.41E-10	1.58E-09	4.35E-10	7.48E-10	1.89E-09	1.75E-09	3.25E-09
50000.	1.31E-09	2.74E-10	1.80E-09	4.94E-10	8.50E-10	2.14E-09	1.99E-09	3.69E-09
60000.	1.43E-09	3.00E-10	1.97E-09	5.41E-10	9.31E-10	2.35E-09	2.18E-09	4.04E-09
70000.	1.53E-09	3.20E-10	2.11E-09	5.78E-10	9.94E-10	2.51E-09	2.33E-09	4.32E-09
80000.	1.61E-09	3.37E-10	2.21E-09	6.07E-10	1.04E-09	2.63E-09	2.45E-09	4.54E-09
90000.	1.67E-09	3.50E-10	2.30E-09	6.31E-10	1.08E-09	2.73E-09	2.54E-09	4.71E-09
100000.	1.72E-09	3.60E-10	2.37E-09	6.49E-10	1.12E-09	2.82E-09	2.62E-09	4.85E-09
200000.	4.41E-09	9.22E-10	6.06E-09	1.66E-09	2.86E-09	7.21E-09	6.71E-09	1.24E-08
300000.	4.35E-09	9.09E-10	5.98E-09	1.64E-09	2.82E-09	7.11E-09	6.61E-09	1.23E-08
400000.	4.32E-09	9.04E-10	5.94E-09	1.63E-09	2.80E-09	7.07E-09	6.57E-09	1.22E-08
500000.	4.30E-09	9.00E-10	5.91E-09	1.62E-09	2.79E-09	7.04E-09	6.54E-09	1.21E-08
600000.	4.28E-09	8.96E-10	5.89E-09	1.62E-09	2.78E-09	7.01E-09	6.51E-09	1.21E-08
700000.	4.26E-09	8.92E-10	5.86E-09	1.61E-09	2.77E-09	6.98E-09	6.48E-09	1.20E-08
800000.	4.25E-09	8.89E-10	5.84E-09	1.60E-09	2.76E-09	6.95E-09	6.46E-09	1.20E-08
900000.	4.23E-09	8.85E-10	5.82E-09	1.60E-09	2.75E-09	6.93E-09	6.44E-09	1.19E-08
1000000.	4.22E-09	8.82E-10	5.80E-09	1.59E-09	2.74E-09	6.90E-09	6.42E-09	1.19E-08

** AVERAGE ANNUAL NONSPECIFIC DOSE TO POPULATION, MANIN, IN MANREMS/YEAR

NONSPECIFIC ... NUCLIDE= I-129 K= 2

TIME	TOT BODY	GI TRACT	GONADS	LIVER	LUNGS	MARROW	BONE	THYROID
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	1.15E-11	1.55E-11	1.15E-11	4.49E-12	0.0	5.22E-12	5.22E-12	8.25E-09
50.	1.29E-11	1.74E-11	1.29E-11	5.04E-12	0.0	5.86E-12	5.86E-12	9.27E-09
60.	1.43E-11	1.92E-11	1.43E-11	5.56E-12	0.0	6.47E-12	6.47E-12	1.02E-08
70.	1.56E-11	2.09E-11	1.56E-11	6.06E-12	0.0	7.05E-12	7.05E-12	1.11E-08
80.	1.68E-11	2.26E-11	1.68E-11	6.55E-12	0.0	7.62E-12	7.62E-12	1.21E-08
90.	1.81E-11	2.43E-11	1.81E-11	7.04E-12	0.0	8.19E-12	8.19E-12	1.29E-08
100.	1.93E-11	2.60E-11	1.93E-11	7.52E-12	0.0	8.75E-12	8.75E-12	1.38E-08
200.	3.50E-11	4.70E-11	3.50E-11	1.36E-11	0.0	1.58E-11	1.58E-11	2.50E-08
300.	4.90E-11	6.58E-11	4.90E-11	1.91E-11	0.0	2.22E-11	2.22E-11	3.51E-08
400.	6.21E-11	8.34E-11	6.21E-11	2.42E-11	0.0	2.81E-11	2.81E-11	4.45E-08
500.	7.48E-11	1.01E-10	7.48E-11	2.91E-11	0.0	3.39E-11	3.39E-11	5.36E-08
600.	8.73E-11	1.17E-10	8.73E-11	3.40E-11	0.0	3.95E-11	3.95E-11	6.25E-08
700.	9.97E-11	1.34E-10	9.97E-11	3.88E-11	0.0	4.51E-11	4.51E-11	7.14E-08
800.	1.12E-10	1.50E-10	1.12E-10	4.36E-11	0.0	5.07E-11	5.07E-11	8.01E-08
900.	1.24E-10	1.67E-10	1.24E-10	4.83E-11	0.0	5.62E-11	5.62E-11	8.89E-08
1000.	1.36E-10	1.83E-10	1.36E-10	5.31E-11	0.0	6.17E-11	6.17E-11	9.76E-08
2000.	2.91E-10	3.91E-10	2.91E-10	1.13E-10	0.0	1.32E-10	1.32E-10	2.09E-07
3000.	4.26E-10	5.72E-10	4.26E-10	1.66E-10	0.0	1.93E-10	1.93E-10	3.05E-07
4000.	5.49E-10	7.38E-10	5.49E-10	2.14E-10	0.0	2.49E-10	2.49E-10	3.93E-07
5000.	6.67E-10	8.96E-10	6.67E-10	2.60E-10	0.0	3.02E-10	3.02E-10	4.77E-07
6000.	8.40E-10	1.13E-09	8.40E-10	3.27E-10	0.0	3.81E-10	3.81E-10	6.02E-07
7000.	1.58E-09	2.12E-09	1.58E-09	6.15E-10	0.0	7.16E-10	7.16E-10	1.13E-06
8000.	5.83E-09	7.83E-09	5.83E-09	2.27E-09	0.0	2.64E-09	2.64E-09	4.17E-06
9000.	1.97E-08	2.65E-08	1.97E-08	7.68E-09	0.0	8.93E-09	8.93E-09	1.41E-05
10000.	4.16E-08	5.59E-08	4.16E-08	1.62E-08	0.0	1.88E-08	1.88E-08	2.98E-05
20000.	2.28E-07	3.06E-07	2.28E-07	8.88E-08	0.0	1.03E-07	1.03E-07	1.63E-04
30000.	5.57E-07	7.48E-07	5.57E-07	2.17E-07	0.0	2.52E-07	2.52E-07	3.99E-04
40000.	3.90E-06	5.25E-06	3.90E-06	1.52E-06	0.0	1.77E-06	1.77E-06	2.80E-03
50000.	6.54E-06	8.79E-06	6.54E-06	2.55E-06	0.0	2.96E-06	2.96E-06	4.69E-03
60000.	7.64E-06	1.03E-05	7.64E-06	2.97E-06	0.0	3.46E-06	3.46E-06	5.47E-03
70000.	8.11E-06	1.09E-05	8.11E-06	3.16E-06	0.0	3.67E-06	3.67E-06	5.81E-03
80000.	8.32E-06	1.12E-05	8.32E-06	3.24E-06	0.0	3.77E-06	3.77E-06	5.96E-03
90000.	8.44E-06	1.13E-05	8.44E-06	3.29E-06	0.0	3.82E-06	3.82E-06	6.04E-03
100000.	8.51E-06	1.14E-05	8.51E-06	3.31E-06	0.0	3.85E-06	3.85E-06	6.09E-03
200000.	2.54E-06	3.41E-06	2.54E-06	9.89E-07	0.0	1.15E-06	1.15E-06	1.82E-03
300000.	3.81E-05	5.12E-05	3.81E-05	1.48E-05	0.0	1.73E-05	1.73E-05	2.73E-02
400000.	4.16E-05	5.58E-05	4.16E-05	1.62E-05	0.0	1.88E-05	1.88E-05	2.98E-02
500000.	4.16E-05	5.59E-05	4.16E-05	1.62E-05	0.0	1.88E-05	1.88E-05	2.98E-02
600000.	4.14E-05	5.56E-05	4.14E-05	1.61E-05	0.0	1.87E-05	1.87E-05	2.96E-02
700000.	4.12E-05	5.54E-05	4.12E-05	1.61E-05	0.0	1.87E-05	1.87E-05	2.95E-02
800000.	4.11E-05	5.52E-05	4.11E-05	1.60E-05	0.0	1.86E-05	1.86E-05	2.94E-02
900000.	4.09E-05	5.50E-05	4.09E-05	1.59E-05	0.0	1.85E-05	1.85E-05	2.93E-02
1000000.	4.08E-05	5.48E-05	4.08E-05	1.59E-05	0.0	1.85E-05	1.85E-05	2.92E-02

** AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MAN2LF FOR JF=1 TO 4, MAN2L FOR TOTAL, IN MILLIREMS/YEAR

TOTAL FOR ALL NUCLIDES TOT BODY

ZONE= 1

TIME	JF=1 AIR	JF=2 GROUND SURFACE	JF=3 SURFACE WATER	JF=4 GROUND WATER	TOTAL
0.	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0
40.	4.46E-04	3.95E-13	0.0	0.0	4.46E-04
50.	4.98E-04	7.90E-13	0.0	0.0	4.98E-04
60.	5.11E-04	1.19E-12	0.0	0.0	5.11E-04
70.	4.96E-04	1.58E-12	0.0	0.0	4.96E-04
80.	4.62E-04	1.98E-12	0.0	0.0	4.62E-04
90.	4.17E-04	2.38E-12	0.0	0.0	4.17E-04
100.	3.67E-04	2.78E-12	0.0	0.0	3.67E-04
200.	3.79E-04	6.87E-12	0.0	0.0	3.79E-04
300.	4.55E-05	1.15E-11	0.0	0.0	4.55E-05
400.	5.42E-06	1.74E-11	0.0	0.0	5.42E-06
500.	6.91E-07	2.52E-11	0.0	0.0	6.91E-07
600.	8.30E-08	3.59E-11	0.0	0.0	8.30E-08
700.	8.92E-09	5.02E-11	0.0	0.0	8.97E-09
800.	9.61E-10	6.87E-11	0.0	0.0	1.03E-09
900.	2.38E-10	9.22E-11	0.0	0.0	3.30E-10
1000.	2.38E-10	1.21E-10	0.0	0.0	3.59E-10
2000.	1.22E-09	5.55E-10	0.0	0.0	1.87E-09
3000.	4.79E-09	1.86E-09	0.0	0.0	6.65E-09
4000.	1.10E-08	4.18E-09	0.0	0.0	1.52E-08
5000.	2.03E-08	7.58E-09	0.0	0.0	2.79E-08
6000.	3.25E-08	1.21E-08	0.0	0.0	4.46E-08
7000.	4.76E-08	1.77E-08	0.0	0.0	6.54E-08
8000.	6.61E-08	2.44E-08	0.0	0.0	9.05E-08
9000.	8.73E-08	3.22E-08	0.0	0.0	1.19E-07
10000.	1.11E-07	4.10E-08	0.0	0.0	1.52E-07
20000.	3.93E-07	1.44E-07	0.0	0.0	5.37E-07
30000.	9.32E-07	3.42E-07	0.0	0.0	1.27E-06
40000.	1.55E-06	5.66E-07	0.0	0.0	2.11E-06
50000.	2.16E-06	7.89E-07	0.0	0.0	2.94E-06
60000.	2.73E-06	1.00E-06	0.0	0.0	3.73E-06
70000.	3.25E-06	1.19E-06	0.0	0.0	4.44E-06
80000.	3.72E-06	1.36E-06	0.0	0.0	5.08E-06
90000.	4.13E-06	1.51E-06	0.0	0.0	5.64E-06
100000.	4.48E-06	1.64E-06	0.0	0.0	6.12E-06
200000.	1.28E-05	4.70E-06	0.0	0.0	1.75E-05
300000.	1.31E-05	4.80E-06	0.0	0.0	1.79E-05
400000.	1.13E-05	4.16E-06	0.0	0.0	1.55E-05
500000.	9.14E-06	3.35E-06	0.0	0.0	1.25E-05
600000.	7.16E-06	2.62E-06	0.0	0.0	9.78E-06
700000.	5.54E-06	2.03E-06	0.0	0.0	7.57E-06
800000.	4.26E-06	1.56E-06	0.0	0.0	5.82E-06
900000.	3.28E-06	1.21E-06	0.0	0.0	4.49E-06
1000000.	2.54E-06	9.32E-07	0.0	0.0	3.47E-06

ZONE= 2

TIME	JF=1 AIR	JF=2 GROUND SURFACE	JF=3 SURFACE WATER	JF=4 GROUND WATER	TOTAL
0.	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0
40.	4.25E-06	6.69E-15	1.62E-04	0.0	1.66E-04
50.	5.83E-06	1.34E-14	2.55E-04	0.0	2.60E-04
60.	6.60E-06	2.01E-14	3.03E-04	0.0	3.10E-04
70.	6.77E-06	2.68E-14	3.19E-04	0.0	3.26E-04
80.	6.55E-06	3.38E-14	3.14E-04	0.0	3.20E-04
90.	6.07E-06	4.03E-14	2.94E-04	0.0	3.00E-04
100.	5.45E-06	4.71E-14	2.66E-04	0.0	2.71E-04
200.	6.06E-06	1.16E-13	3.04E-04	0.0	3.10E-04
300.	7.43E-07	1.95E-13	3.76E-05	0.0	3.83E-05
400.	8.93E-08	2.94E-13	4.53E-06	0.0	4.62E-06
500.	1.15E-08	4.27E-13	5.82E-07	0.0	5.94E-07
600.	1.38E-09	6.08E-13	7.03E-08	0.0	7.17E-08
700.	1.49E-10	8.50E-13	7.61E-09	0.0	7.76E-09
800.	1.61E-11	1.16E-12	8.72E-10	0.0	8.90E-10
900.	3.98E-12	1.56E-12	2.84E-10	0.0	2.89E-10
1000.	3.98E-12	2.05E-12	3.19E-10	0.0	3.25E-10
2000.	2.22E-11	9.41E-12	1.80E-09	0.0	1.83E-09
3000.	8.08E-11	3.15E-11	6.54E-09	5.80E-31	6.65E-09
4000.	1.87E-10	7.07E-11	1.51E-08	1.04E-20	1.53E-08
5000.	3.43E-10	1.28E-10	2.77E-08	1.28E-15	2.82E-08
6000.	5.50E-10	2.05E-10	4.45E-08	3.46E-13	4.52E-08
7000.	8.08E-10	3.00E-10	6.54E-08	3.62E-12	6.65E-08
8000.	1.12E-09	4.14E-10	9.07E-08	2.39E-11	9.22E-08
9000.	1.48E-09	5.46E-10	1.20E-07	8.11E-11	1.23E-07
10000.	1.88E-09	6.95E-10	1.55E-07	1.33E-10	1.57E-07
20000.	6.65E-09	2.45E-09	5.41E-07	1.07E-11	5.50E-07
30000.	1.58E-08	5.79E-09	1.29E-06	1.34E-10	1.31E-06
40000.	2.62E-08	9.59E-09	2.14E-06	1.34E-10	2.18E-06
50000.	3.65E-08	1.34E-08	2.98E-05	1.34E-10	3.03E-06
60000.	4.63E-08	1.69E-08	3.78E-06	1.34E-10	3.84E-06
70000.	5.51E-08	2.02E-08	4.50E-06	1.34E-10	4.58E-06
80000.	6.30E-08	2.31E-08	5.14E-06	1.34E-10	5.23E-06
90000.	6.99E-08	2.56E-08	5.70E-06	1.34E-10	5.80E-06
100000.	7.59E-08	2.70E-08	6.19E-06	1.34E-10	6.29E-06
200000.	2.18E-07	7.97E-08	1.76E-05	1.46E-12	1.79E-05
300000.	2.22E-07	8.14E-08	1.81E-05	1.45E-10	1.84E-05
400000.	1.92E-07	7.04E-08	1.57E-05	1.45E-10	1.60E-05
500000.	1.55E-07	5.67E-08	1.27E-05	1.44E-10	1.29E-05
600000.	1.21E-07	4.44E-08	9.96E-06	1.43E-10	1.01E-05
700000.	9.39E-08	3.44E-08	7.74E-06	1.43E-10	7.87E-06
800000.	7.22E-08	2.65E-08	5.99E-06	1.42E-10	6.08E-06
900000.	5.56E-08	2.04E-08	4.65E-06	1.41E-10	4.72E-06
1000000.	4.30E-08	1.58E-08	3.62E-06	1.41E-10	3.68E-06

AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MANIL, IN ZONE 1, IN MILLIREMS/YEAR

1000. YEARS#

K	NUCLIDE	TOT BODY	GI TRACT	GONADS	LIVER	LUNGS	MARROW	BONE	THYROID
1	SR-90	6.36E-12	1.27E-13	6.36E-12	0.0	3.47E-11	9.54E-11	9.54E-11	0.0
2	I-129	3.79E-11	7.92E-12	5.21E-11	1.43E-11	2.47E-11	6.20E-11	5.76E-11	1.08E-10
	SUB TOTAL	4.42E-11	8.05E-12	5.84E-11	1.43E-11	5.93E-11	1.57E-10	1.53E-10	1.08E-10
3	PB-210	3.15E-10	3.41E-11	3.02E-10	2.15E-09	4.36E-08	2.26E-08	2.26E-08	7.01E-11
	SUB TOTAL	3.15E-10	3.41E-11	3.02E-10	2.15E-09	4.36E-08	2.26E-08	2.26E-08	7.01E-11
	TOTAL	3.59E-10	4.21E-11	3.60E-10	2.16E-09	4.36E-08	2.28E-08	2.27E-08	1.78E-10

#TIME SINCE START OF REPOSITORY OPERATIONS.

AVERAGE ANNUAL NONSPECIFIC DOSE TO POPULATION, MANIN, IN MANREMS/YEAR

1000. YEARS#

K	NUCLIDE	TOT BODY	GI TRACT	GONADS	LIVER	LUNGS	MARROW	BONE	THYROID
1	SR-90	5.74E-11	1.65E-11	5.74E-11	0.0	0.0	2.87E-09	2.87E-09	0.0
2	I-129	1.36E-10	1.83E-10	1.36E-10	5.31E-11	0.0	6.17E-11	6.17E-11	9.76E-08
	SUB TOTAL	1.94E-10	2.00E-10	1.94E-10	5.31E-11	0.0	2.93E-09	2.93E-09	9.76E-08
3	PB-210	6.48E-09	1.23E-10	6.48E-09	5.98E-08	0.0	6.36E-07	6.36E-07	0.0
	SUB TOTAL	6.48E-09	1.23E-10	6.48E-09	5.98E-08	0.0	6.36E-07	6.36E-07	0.0
	TOTAL	6.68E-09	3.23E-10	6.68E-09	5.98E-08	0.0	6.39E-07	6.39E-07	9.76E-08

#TIME SINCE START OF REPOSITORY OPERATIONS.

APPENDIX G

PROGRAMMER'S NOTES

Variables

The variables used and their definitions are presented in the list of nomenclature in the front pages of this volume.

"Index" File Structure

"Index" is an unformatted temporary file allocated to logical unit 1. Index holds a maximum of 260 records, each 400 bytes in length. Index is calculated for each nuclide and zone.

Subprogram Usage

SUBROUTINE FAULT - determines release probability transfer coefficient. Also, by use of time dependent component factors, the subroutine can modify the nuclide inventory at risk.

FUNCTION RLEACH - calculates amount of nuclide leached into the ground water preliminary environmental input receptor. The function is called by SUBROUTINE FAULT when a leach incident is involved.

SUBROUTINE TRINP - determines transport-to-environment transfer coefficient, accounting for decay and other processes such as delay in ground water transport.

FUNCTION CRATIO - determines concentration ratio in ground water at discharge point compared to release point. This ground water transport function is called by SUBROUTINE TRINP.

SUBROUTINE TRMAN - determines environment-to-man transfer coefficient for dose to man via all pathways from environmental concentrations.

Dimensioning

Some exchanges of dimensioning can be used for special cases without increasing storage requirements. For example, 9 Release Model events, each with 9 component factors represent 81 storage combinations

(= 9 x 9). If release is described by an involved function representing dynamic repository simulation, AMRAW can be dimensioned by other combinations such as one release event with up to 81 component factors if needed. The number of geographic zones, presently dimensioned at 8 is limited to 9 because of programming for the variable "NPRINT" which controls output options.

Multiple Cases

AMRAW-A has provisions for running more than one case, per submission. This can be: 1) more than one set of conditions for a waste management phase such as terminal storage, or 2) more than one phase, such as repository operations and terminal storage. A full set of input data is read in for each case.

Modification for Running on CDC System

AMRAW, written in FORTRAN IV, was developed with implementation on an IBM 360 system. Some changes are necessary for operation on a CDC system. The following programming features in AMRAW-A, used successfully on the IBM system, produce problems on a CDC 6400:

1. Three quadruply dimensioned arrays are used: DOSFAC, MAN2LF, and VOLINT. ANSI Fortran permits up to 3 subscripts.

2. DO loop control indices are passed through common, e.g., IZ in /BTRINP/, JF and IH in /BTRMAN/, etc.

3. "Computed GOTO" drops to the next statement when out of range in FORTRAN G on the IBM, but causes a fatal error on the CDC.

4. Integers are declared as INTEGERS*2 and INTEGER*4 variables, not necessary on the CDC. The use of INTEGER*4 in AMRAW is for storing 8 characters per variable; the CDC will store 10 characters when declared as INTEGER.

5. "Direct access" read and write, used in AMRAW do not exist directly on the CDC.

EPA personnel at the Las Vegas, Neveda facility identified the above problems, incorporated changes to respond to the problems, and have run the modified version on a CDC 6400 computer. The changes, listed in

correspondence with the problems, are as follows:

1. Change the 3 quadruply dimensioned arrays into triply dimensioned arrays through the addition of new variables.

2. Change the way the control indices are passed through common.

3. Introduce an extra IF test before the computed GOTO to achieve the same effect as in FORTRAN G.

4. Change INTERGER*2 and INTEGER*4 to INTEGER.

5. Replace the IBM direct access file writes and reads by calls to subroutines which manage ACTUAL KEY files.

Also, to reduce the large memory requirements, put the arrays resulting from MAN2LF into blank common. The way blank common is allocated on the available CDC 6400 system allows the LOADER to use the region which will become blank common during the loading process.

APPENDIX H

AMRAW-A LISTING

1. Main Program

   MAIN

2. Sub-programs

   FAULT - Release Model

   RLEACH - Leach rate calculations

   TRINP - Transport-to-Environment part of Environmental Model

   CRATIO - Ground water transport calculations

   TRMAN - Environment-to-Man part of Environmental Model

Discussion of changes needed for running on a CDC 6400 computer instead of IBM is presented in Appendix G (Programmer's Notes).

APPENDIX H Main Program

```
FORTRAN IV G LEVEL  21                    MAIN                DATE = 78096          22/35/04

          C     AMRAW: ASSESSMENT METHOD FOR RADIOACTIVE WASTE.
          C     A CODE DEVELOPED BY UNIVERSITY OF NEW MEXICO UNDER EPA CONTRACT #68-01-3256
          C     THIS LISTING IS AMRAW-A, CALCULATION THROUGH DOSE RATE.
          C     PRINCIPLE INVESTIGATOR: S.E.LOGAN, DECEMBER,1977.
0001            IMPLICIT INTEGER*2 (I-N)
0002            DOUBLE PRECISION NUCNAM(25),ORGNAM(8),TITLE(10,3),
               *HEAD(4,6),HEAD1(4),AIZ
0003            REAL AA1(4,9),ADJ1(4,4,8),ADJ2(4,4,8),BIOFAC(25,4,6),CP(4,9,4)
0004            REAL DC1,DISPN(4,8),DRC,DOSFAC(25,4,2,8),EDC(25,4,8)
0005            REAL MAN2LF(50,8,8,4),MAN2L(50,8,8),MAN2NF(50,8,4),MAN2N(50,8)
0006            REAL ELEM(15),MAN1L(50,8),MAN1N(50,8),PROBB(4,9,4),R1J(4,50)
0007            REAL R2(4,50,8),R2TOT(4,50,8),REMOV(4,8),RKD(25)
0008            REAL SPACT,TIME(50),TP(4,9,4),VOLINT(4,2,6,8),X,XX(15)
0009            REAL ZONALO(4,8),RELOUT(9),XL(8),YW(8),YY(8)
0010            REAL ZONDEP(8),GNDEP(50,8),AREAW(8)
0011            INTEGER*2 IFLAG(4,9,4),IFLAGE(4,2,6)
0012            INTEGER*2 JJ(4,9),NJ(4),NJJ(4,9),NSP(6),IZONE(10)
0013            INTEGER*4 NPRINT,CHECK(19),JN(9),VAR(5),IN,IP,IE
0014            DATA VAR/'(F10','.0,I','5,1P','9E1','2.2)'/
0015            DATA HEAD1/' NONE',' JF= 2',' JF= 3',' JF= 263'/
0016            DATA AIZ/'IZ='/
0017            DATA JN/'1E1','2E1','3E1','4E1','5E1','6E1','7E1','8E1','9E1'/
0018            DATA HEAD/'        ','   DATA ','INPUT   ','        ',
               2'     REL','EASE TO ','ENVIRONM','ENT     ',
               3'    LOCA','L DOSE T','O INDIVI','DUAL    ',
               4' NONSPEC','IFIC DOS','E TO POP','ULATION ',
               5'    TOTA','L DOSE B','Y RECEPT','ORS     ',
               6'      DO','SE SUMMA','RY TABLE','S       '/
0019            COMMON/BFAULT/ PROBB,AA1,TP,CP,IFLAG
0020            COMMON/BLEACH/ DC1(25),DRC(25),X(25,50),FS,VS,SPACT(25),CINV
0021            COMMON/FDLEA/ CFAI,XR,DELTIM,I1
0022            COMMON/BTRINP/ Y2,Y3,IZ,IFDIVW
0023            COMMON/CTRINP/ CRMIN,DFMIN
0024            COMMON/BTRMAN/ BIOFAC,VOLINT,DOSFAC,NSP,IFLAGE,JF,IH,DELTE
0025            COMMON/BCRATO/ RKD,CONCI,TIME,VX,PORE,AL,AT,HT,BULKD,YW,ITR,MT,
               1ITE,K,GNDDIS,YY
0026            COMMON/FCRATO/DELTL
0027            DEFINE FILE 1(260,400,U,INDEX)
0028            IN=5
0029            IE=6
0030            IP=4
0031            READ(IN,801)NCASE
0032            DO 9999 KASE=1,NCASE
0033            WRITE(IP,802)KASE
          C*************************************** READ IN DATA AND INITIALIZE CASE **
          C************************** THE TITLE MUST HAVE THREE LINES ****************
0034            READ(IN,803)TITLE
0035            IF(IP.NE.IE)WRITE(IE,836)TITLE,NCASE,(HEAD(I,1),I=1,4)
0036            READ(IN,801)ND,NK,MT,IW,ITRS,ITRE,MZ,NIHT,NPRINT,IFDIVW
0037            IF(IW.EQ.3.AND.ITRE.GE.MT)GO TO 9995
          C************************** SET ORGAN, ZONE, AND NPRINT VALUES **********
0038            IORGS=IABS(MOD(NPRINT,10))
0039            IORGE=IORGS-1
```

```
      IF(IORGS.EQ.0)IORGE=NIHT
      IF(IORGS.EQ.0)IORGS=1
      IF(IORGS.GT.NIHT)GO TO 9997
      NPRINT=NPRINT/10
      ISTART=IABS(MOD(NPRINT,10))
      ISTOP=ISTART-1
      IF(ISTART.EQ.0)ISTOP=MZ
      IF(ISTART.EQ.0)ISTART=1
      IF(ISTART.GT.MZ)GO TO 9996
      NPRINT=NPRINT/10
      IF(KASE.GT.1)GO TO 5
C*********************** READ IN CUTOFF VALUES ***********************
      READ(IN,806)R1JMIN,A2MIN,R2MIN,RKDMAX,CRMIN,DFMIN
      READ(IN,806)(TIME(I),I=1,MT)
      READ(IN,807)(ELEM(ID),ID=1,ND)
      READ(IN,806)TFUEL
      READ(IN,806)(XX(ID),ID=1,ND)
      DO 20 K=1,NK
      READ(IN,808)NUCNAM(K),(X(K,IT),IT=1,7)
      IF(MT.GE.8)READ(IN,809)(X(K,IT),IT=8,MT)
   20 CONTINUE
      READ(IN,845,ERR=9998,END=9998)CHECK,ICHCK
      IF(ICHCK.NE.1)GO TO 9998
      WRITE(IE,848)CHECK,ICHCK
      READ(IN,806)(SPACT(K),K=1,NK)
      READ(IN,806)(DC1(K),K=1,NK)
      READ(IN,806)(DRC(K),K=1,NK)
      READ(IN,806)(((ADJ1(JF,JFA,IZ),ADJ2(JF,JFA,IZ),JFA=1,4),JF=1,4),
     *IZ=1,MZ)
      READ(IN,806)((DISPN(JF,IZ),IZ=1,MZ),JF=1,4)
      READ(IN,806)((ZONALD(JF,IZ),IZ=1,MZ),JF=1,4)
      READ(IN,806)(ZONDEP(IZ),IZ=1,MZ)
      READ(IN,806)(AREAW(IZ),IZ=1,MZ)
      READ(IN,806)(RKD(K),K=1,NK)
      READ(IN,845,ERR=9998,END=9998)CHECK,ICHCK
      IF(ICHCK.NE.2)GO TO 9998
      WRITE(IE,848)CHECK,ICHCK
      READ(IN,801)(NSP(JF),JF=1,4)
      DO 30 IZ=1,MZ
      DO 30 JF=1,4
      NS=NSP(JF)
   30 READ(IN,806)((VOLINT(JF,MODE,I,IZ),I=1,NS),MODE=1,2)
      DO 40 K=1,NK
      DO 40 NS=1,6
   40 BIOFAC(K,1,NS)=1.
      DO 50 K=1,NK
      DO 50 JF=2,4
      NS=NSP(JF)
   50 READ(IN,806)(BIOFAC(K,JF,I),I=1,NS)
      READ(IN,845,ERR=9998,END=9998)CHECK,ICHCK
      IF(ICHCK.NE.3)GO TO 9998
      WRITE(IE,848)CHECK,ICHCK
      READ(IN,803)(ORGNAM(I),I=1,NIHT)
```

```
FORTRAN IV G LEVEL  21                    MAIN                DATE = 78096          22/35/04

0091                READ(IN,806)((((DOSFAC(K,JF,MODE,IH),IH=1,NIHT),MODE=1,2),JF=1,4),
                   *K=1,NK)
0092              5 CONTINUE
0093                READ(IN,845,ERR=9998,END=9998)CHECK,ICHCK
0094                IF(ICHCK.NE.4)GO TO 9998
0095                WRITE(IE,848)CHECK,ICHCK
            C************** JJ(JF,I) SPECIFIES A PARTICULAR RELEASE EVENT CUTSET. **
            C******************* NJ(JF) =# OF RELEASE CUTSETS ASSOCIATED WITH JF. **
            C********* NJJ(JF,I) =# OF PROBABILITIES ASSOCIATED WITH EACH CUTSET. **
0096         1000 ISECT=1
0097                WRITE(IP,836)TITLE,ISECT,(HEAD(I,ISECT),I=1,4)
0098                WRITE(IP,805)
0099                DO 1030 JF=1,4
0100                READ(IN,801)NJ(JF)
0101                NJF=NJ(JF)
0102                IF(NJF.EQ.0)GO TO 1030
0103                DO 1020 I=1,NJF
0104                READ(IN,801)JJ(JF,I),NJJ(JF,I)
0105                J=JJ(JF,I)
0106                NJJJ=NJJ(JF,I)
0107                READ(IN,806)AA1(JF,J)
0108                DO 1020 K=1,NJJJ
0109                READ(IN,810)PROBB(JF,J,K),IFLAG(JF,J,K),TP(JF,J,K),CP(JF,J,K)
0110                IF(K.EQ.1)WRITE(IP,811)JF,NJF,J,NJJJ,AA1(JF,J),PROBB(JF,J,1),
                   *IFLAG(JF,J,1),TP(JF,J,1),CP(JF,J,1)
0111                IF(K.GT.1)WRITE(IP,812)PROBB(JF,J,K),IFLAG(JF,J,K),TP(JF,J,K),
                   *CP(JF,J,K)
0112         1020 CONTINUE
0113         1030 CONTINUE
0114                IF(KASE.GT.1)GO TO 6
0115                DO 1060 JF=1,4
0116                J=NSP(JF)
0117         1060 READ(IN,801)((IFLAGE(JF,MODE,I),I=1,J),MODE=1,2)
0118                READ(IN,806)VX,PORE,AL,AT,HT,BULKD,FS,VS,(XL(I),I=1,MZ),
                   1(YW(I),I=1,MZ),(YY(I),I=1,MZ),
                   2CINV,CFAI
0119                READ(IN,845,ERR=9998,END=9998)CHECK,ICHCK
0120                IF(ICHCK.NE.5) GO TO 9998
0121                WRITE(IE,848)CHECK,ICHCK
            C******** READ EDC FLAG 1=DEFAULT,2=JF READ,3=JF READ,4=READ JF=2&3 ****
0122                READ(IN,801)ISECT
0123                I=ISECT
0124                DO 1130 K=1,NK
0125                DO 1130 IZ=1,MZ
0126                EDC(K,1,IZ)=50.0
0127                EDC(K,4,IZ)=0.0
0128                GO TO(1110,1120,1110,1130),I
0129         1110 EDC(K,2,IZ)=2.30*10.0**(-5)
0130                GO TO(1120,1130,1130,1130),I
0131         1120 EDC(K,3,IZ)=2.30*10.0**(-5)
0132         1130 CONTINUE
0133                GO TO(1210,1160,1160,1140),I
0134         1140 DO 1150 I=2,3
```

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FORTRAN IV G LEVEL  21                MAIN                DATE = 78096          22/35/04

0135          1150 READ(IN,806)((EDC(K,I,IZ),IZ=1,MZ),K=1,NK)
0136               GO TO 1210
0137          1160 READ(IN,806)((EDC(K,I,IZ),IZ=1,MZ),K=1,NK)
0138          1210 READ(IN,845,ERR=9998,END=9998)CHECK,ICHCK
0139               IF(ICHCK.NE.6) GO TO 9998
0140               WRITE(IE,848)CHECK,ICHCK
            C************************* READ SECTION 6 INPUT TO STMT 1310 *********
            C*************************************** IZONM = # OF TABLES WANTED **
0141               READ(IN,801)IZONM
0142               IF(IZONM.EQ.0)GO TO 1310
            C******* IZONE = ZONES TO DO, IZONE = 10 MEANS NONSPECIFIC *******
0143               READ(IN,801)(IZONE(I),I=1,IZONM)
            C*** ITSUMY=INITIAL TIME, ITSUMJ=TIME CHANGE, KSUB=K FOR SUBTOTAL **
0144               READ(IN,801)ITSUMY,ITSUMJ,KSUB
0145          1310 LPRINT=NK/10+1
0146               IF(NK.EQ.NK/10*10)LPRINT=LPRINT-1
0147             6 CONTINUE
0148               IF(NPRINT.EQ.0.OR.NPRINT.EQ.5)GO TO 1500
0149               GO TO 2000
            C*************************************** OUTPUT SELECTED INPUT DATA **
0150          1500 WRITE(IP,813)TFUEL
0151               WRITE(IP,814)(ELEM(ID),XX(ID),ID=1,ND)
0152               M1=1
0153               M10=10
0154               WRITE(IP,815)
0155               DO 1550 I=1,LPRINT
0156               IF(M10.GT.NK)M10=NK
0157               WRITE(IP,816)(NUCNAM(K),K=M1,M10)
0158               DO 1540 IT=1,MT
0159          1540 WRITE(IP,817)TIME(IT),(X(K,IT),K=M1,M10)
0160               WRITE(IP,818)(SPACT(K),K=M1,M10)
0161               M1=M10+1
0162               M10=M10+10
0163          1550 CONTINUE
0164               WRITE(IP,819)
0165               DO 1580 K=1,NK
0166          1580 WRITE(IP,820)NUCNAM(K),DC1(K),DRC(K),RKD(K)
0167               WRITE(IP,859) VX,PORE,BULKD,AL,AT,HT,(AIZ,I,I=1,MZ)
0168               WRITE(IP,870) (XL(I),I=1,MZ)
0169               WRITE(IP,871) (YW(I),I=1,MZ)
0170               WRITE(IP,872) (YY(I),I=1,MZ)
0171               WRITE(IP,873) FS,VS,CINV,CFAI
0172               WRITE(IP,821)HEAD1(ISECT)
0173               DO 1620 IZ=1,MZ,2
0174               IZP1=IZ+1
0175               IF (IZ.EQ.5)WRITE(IP,844)
0176               WRITE(IP,822)IZ,IZP1
0177               DO 1620 K=1,NK
0178          1620 WRITE(IP,823)NUCNAM(K),((EDC(K,JF,I),JF=1,4),I=IZ,IZP1)
0179               WRITE(IP,824)
0180               DO 1660 IZ=1,MZ,2
0181               IZP1=IZ+1
0182          1660 WRITE(IP,822)IZ,IZP1,((DISPN(JF,I),JF=1,4),I=IZ,IZP1)
```

```
0183              WRITE(IP,849)
0184              DO 1700 IZ=1,MZ,2
0185              IZP1=IZ+1
0186         1700 WRITE(IP,822)IZ,IZP1,((ZONALO(JF,I),JF=1,4),I=IZ,IZP1)
0187              WRITE(IP,850) (AIZ,I,I=1,MZ)
0188              WRITE(IP,880) (ZONDEP(I),I=1,MZ)
0189              WRITE(IP,851) (AIZ,I,I=1,MZ)
0190              WRITE(IP,880) (AREAW(I),I=1,MZ)
0191              WRITE(IP,825)
0192              DO 1740 IZ=1,MZ
0193              WRITE(IP,826)IZ
0194              DO 1740 JF=1,4
0195              WRITE(IP,827)JF,(ADJ1(JF,JFA,IZ),ADJ2(JF,JFA,IZ),JFA=1,4)
0196         1740 CONTINUE
0197              WRITE(IP,828)
0198              DO 1780 IZ=1,MZ
0199              IF((IZ/5)*5.EQ.IZ)WRITE(IP,844)
0200              WRITE(IP,829)IZ
0201              DO 1780 JF=1,4
0202              NS=NSP(JF)
0203              DO 1780 MODE=1,2
0204         1780 WRITE(IP,830)JF,MODE,NS,(VOLINT(JF,MODE,I,IZ),I=1,NS)
0205              WRITE(IP,831)
0206              DO 1830 K=1,NK
0207              WRITE(IP,832)NUCNAM(K)
0208              DO 1820 JF=1,4
0209              NS=NSP(JF)
0210         1820 WRITE(IP,843)JF,NS,(BIOFAC(K,JF,I),I=1,NS)
0211              IF((K/9)*9.EQ.K)WRITE(IP,844)
0212         1830 CONTINUE
0213              WRITE(IP,833)
0214              DO 1870 IH=IORGS,IORGE
0215              WRITE(IP,834)ORGNAM(IH)
0216              DO 1860 K=1,NK
0217         1860 WRITE(IP,835)NUCNAM(K),((DOSFAC(K,JF,MODE,IH),MODE=1,2),
                 1JF=1,4)
0218              IF((IH/2)*2.EQ.IH)WRITE(IP,844)
0219         1870 CONTINUE
0220              IF(NPRINT.EQ.0)GO TO 9999
            C*************************TO STMT 2999 CONSIDER EACH BRANCH SEPARATELY **
0221         2000 ISECT=2
0222              WRITE(IP,836)TITLE,ISECT,(HEAD(I,ISECT),I=1,4)
0223              IF(IW.EQ.3)DTIME=TIME(ITRE+1)-TIME(ITRE)
0224              DO 2020 IT=1,MT
0225              DO 2020 IH=1,NIHT
0226              MAN2N(IT,IH)=0.0
0227              DO 2020 JF=1,4
0228              MAN2NF(IT,IH,JF)=0.0
0229              DO 2020 IZ=ISTART,ISTOP
0230              MAN2LF(IT,IH,IZ,JF)=0.0
0231         2020 MAN2L(IT,IH,IZ)=0.0
0232              GNDDIS=1.0
            C*********************TO STMT 2999 CONSIDER EACH RADIONUCLIDE *******
```

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FORTRAN IV G LEVEL  21                MAIN              DATE = 78096          22/35/04

0233              DO 2999 K=1,NK
0234              IF(IW.EQ.3)DFAC=(1.0-(X(K,ITRE+1)/X(K,ITRE)))/DTIME
0235              CTR1=0.
0236              LINEP=4
0237              DO 2050 IT=1,MT
0238              DO 2040 IH=1,NIHT
0239         2040 MAN1N(IT,IH)=0.0
0240              DO 2050 JF=1,4
0241              R1J(JF,IT)=0.
0242              DO 2050 IZ=ISTART,ISTOP
0243              R2(JF,IT,IZ)=0.
0244              R2TOT(JF,IT,IZ)=0.
0245         2050 GNDEP(IT,IZ)=0.0
            C************** TO STMT 2500 CALCULATE ENVIRONMENTAL CONCENTRATIONS **
            C*********** CALCULATE RELEASE DURING EACH TIME INTERVAL ****************
            C************** TO PRELIMINARY ENVIRONMENT INPUT RECEPTORS TO STMT 2140 **
0246              IF(NPRINT.EQ.5)WRITE(IP,847)NUCNAM(K),K
0247              DO 2500 ITR=ITRS,ITRE
0248              DELTL=TIME(ITR)-TIME(ITR-1)
0249              XR=X(K,ITR)
0250              ZAVG=((XR+X(K,ITR-1))*SPACT(K))/2.0
0251              DO 2120 I=1,9
0252         2120 RELOUT(I)=0.0
0253              DO 2160 JF=1,4
0254              NJF=NJ(JF)
0255              IF(NJF.EQ.0)GO TO 2160
0256              DO 2140 I=1,NJF
0257              J=JJ(JF,I)
0258              NJJJ=NJJ(JF,I)
0259              IF(CTR1.GE.1.)GO TO 2140
            C********************** DETERMINE RELEASE FAULT PROB AND TRANSFER COEFF **
0260              CALL FAULT(TIME,PROB,A1,JF,J,NJJJ,ITR,K,CONCI)
0261              PRBDEL=PROB*DELTL
0262              IF(PRBDEL.GT.1.0) PRBDEL=1.0
0263              REL=PRBDEL*A1
0264              REL=ABS(REL)
0265              CTR1=CTR1+REL
0266              IF(REL.GT.1.)REL=1.
0267              RELOUT(I)=REL
0268              R1J(JF,ITR)=R1J(JF,ITR)+ZAVG*REL
0269         2140 CONTINUE
            C******************* TO STMT 2160 OUTPUT RELEASE FRACTIONS BY CUTSET ***
0270              VAR(4)=JN(NJF)
0271              LINEP= LINEP+1
0272              IF(LINEP.GT.60.AND.NPRINT.EQ.5)WRITE(IP,852)
0273              IF(LINEP.GT.60)LINEP=1
0274              IF(NPRINT.EQ.5)WRITE(IP,VAR)TIME(ITR),JF,(RELOUT(I),I=1,NJF)
0275         2160 CONTINUE
            C******TO STMT 2499 FOLLOW EACH RELEASE INCREMENT THROUGH ENVIRONMENT **
            C*********************************** DURING SUBSEQUENT TIME INTERVALS **
0276              DO 2499 ITE=ITR,MT
0277              DELT2=TIME(ITE-1)-TIME(ITR)
0278              DELT3=TIME(ITE)-TIME(ITR)
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0279              DO 2210 IZ=ISTART,ISTOP
0280              DO 2210 JF=1,4
0281         2210 REMOV(JF,IZ)=0.
            C********** TO STMT 2220 DETERMINE TRANSFER COEFF TO ENVIRONMENT INPUT **
0282              XEM1=X(K,ITE-1)
0283              XE=X(K,ITE)
0284              DO 2390 IZ=ISTART,ISTOP
0285              DO 2280 JF=1,4
            C*************************** SET TEMPORARY VALUES FOR DELT4 AND XEM2. **
0286              DELT4=0.
0287              XEM2=XEM1
0288              TRL=EOC(K,JF,IZ)
0289              IF(JF.EQ.4.OR.ITE.EQ.ITR)GO TO 2220
0290              XEM2=X(K,ITE-2)
0291              DELT4=(TIME(ITE)-TIME(ITE-2))/2.
0292         2220 CALL TRINP(DELT2,DELT3,DELT4,XR,XE,XEM1,XEM2,TRL,DECFAC,A2,
                 *XL(IZ),X(K,ITRE),DFAC,
                 *ITE,ITRE,IW,JF,RKD,RKDMAX,K)
0293              IF(R1J(JF,ITR).LE.R1JMIN)R1J(JF,ITR)=0.0
0294              IF(A2.LE.A2MIN)A2=0.0
0295              IF(JF.EQ.4)GO TO 2260
0296              IF(ITE.NE.ITR)GO TO 2270
0297              GO TO (2230,2240,2250),JF
0298         2230 R2(JF,ITE,IZ)=R1J(JF,ITR)*A2*ZONALO(JF,IZ)
0299              DEP=R1J(JF,ITR)*A2*ZONDEP(IZ)
0300              AREAG=DISPN(2,IZ)
0301              DEPGND=DEP*AREAG
0302              DEPWTR=DEP*AREAW(IZ)
0303              GO TO 2280
0304         2240 R2(JF,ITE,IZ)=R1J(JF,ITR)*A2*ZONALO(JF,IZ)+DEPGND
0305              GO TO 2280
0306         2250 R2(JF,ITE,IZ)=R1J(JF,ITR)*A2*ZONALO(JF,IZ)+DEPWTR
0307              GO TO 2280
0308         2260 R2(JF,ITE,IZ)=R1J(JF,ITR)*A2*ZONALO(JF,IZ)
0309              GO TO 2280
0310         2270 R2(JF,ITE,IZ)=R2(JF,ITE-1,IZ)*A2
0311         2280 IF(R2(JF,ITE,IZ).LE.R2MIN)R2(JF,ITE,IZ)=0.0
            C**** TO STMT 2499 ADJUST ENVIRON RECEPTOR; TRANSFER FROM OTHER RECEPTORS **
0312              DO 2330 JF=1,4
0313              DO 2330 JFA=1,4
0314              IF(JFA.EQ.JF.OR.ADJ1(JF,JFA,IZ).EQ.0.)GO TO 2330
0315              DELTE=TIME(ITE)-TIME(ITE-1)
0316              AMD=ADJ2(JF,JFA,IZ)*0.5*DELTE
0317              IF(AMD.GT.15.)GO TO 2300
0318              ADJ=ADJ1(JF,JFA,IZ)*(1.-EXP(-AMD))
0319              GO TO 2310
0320         2300 ADJ=ADJ1(JF,JFA,IZ)
0321              IF(JF.NE.1)GO TO 2310
            C******* FOLLOWING STATEMENT IS INTEGRATED CONCENTRATION FOR RESUSPENSION **
0322              ADJR2=ADJ*R2(JFA,ITE,IZ)*(DELTE/DISPN(JFA,IZ))
0323              GO TO 2320
0324         2310 ADJR2=ADJ*R2(JFA,ITE,IZ)
0325         2320 R2(JF,ITE,IZ)=R2(JF,ITE,IZ)+ADJR2
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FORTRAN IV G LEVEL  21                MAIN              DATE = 78096          22/35/04

0326              IF(JF.EQ.1)GO TO 2330
0327              REMOV(JFA,IZ)=REMOV(JFA,IZ)+ADJR2
0328        2330  CONTINUE
0329              DO 2390 JF=1,4
0330              IF(DISPN(JF,IZ).EQ.0.)GO TO 2390
0331              GO TO (2340,2350,2360,2370),JF
0332        2340  R2CON=10.**6*R2(JF,ITE,IZ)
0333              GO TO 2380
0334        2350  R2CON=10.**6*R2(JF,ITE,IZ)/DISPN(JF,IZ)
0335              IF(ITE.NE.ITR)GO TO 2380
0336              GNDEP(ITE,IZ)=R2CON
0337              GO TO 2380
0338        2360  R2CON=10.**6*R2(JF,ITE,IZ)/DISPN(JF,IZ)
0339              GO TO 2380
0340        2370  DISPN(JF,IZ)=GNDDIS
0341              IF(GNDDIS.EQ.0.)R2CON=0.
0342              IF(GNDDIS.EQ.0.)GO TO 2380
0343              R2CON=R2(JF,ITE,IZ)/DISPN(JF,IZ)
0344        2380  R2TOT(JF,ITE,IZ)=R2TOT(JF,ITE,IZ)+R2CON
0345        2390  CONTINUE
0346              DO 2499 JF=1,4
0347              DO 2499 IZ=ISTART,ISTOP
0348              R2(JF,ITE,IZ)=R2(JF,ITE,IZ)-REMOV(JF,IZ)
0349        2499  IF(R2(JF,ITE,IZ).LT.0.)R2(JF,ITE,IZ)=0.
0350        2500  CONTINUE
          C********************* TO STMT 2730 CALCULATE EACH CATAGORY OF MAN DOSE **
0351              DO 2780 IZ=ISTART,ISTOP
0352              DO 2700 IH=1,NIHT
0353              DO 2700 ITE=1,MT
0354        2700  MAN1L(ITE,IH)=0.0
0355              DO 2730 ITE=ITRS,MT
0356              DELTE=TIME(ITE)-TIME(ITE-1)
0357              DO 2720 IH=IORGS,IORGE
0358              DO 2720 JF=1,4
          C*************************** TRMAN, DETERMINE TRANSFER COEFF TO MAN DOSE **
0359              NSS=1
0360              CALL TRMAN(K,ITE,IZ,NSS,C)
0361              MAN1L(ITE,IH)=MAN1L(ITE,IH)+C*R2TOT(JF,ITE,IZ)
0362              MAN2LF(ITE,IH,IZ,JF)=MAN2LF(ITE,IH,IZ,JF)+C*R2TOT(JF,ITE,IZ)
0363              MAN2L(ITE,IH,IZ)=MAN2L(ITE,IH,IZ)+C*R2TOT(JF,ITE,IZ)
0364              NSS=2
0365              CALL TRMAN(K,ITE,IZ,NSS,C)
          C*****APPLYING .001 FACTOR TO STMTS 2720: CONVERTS MILLIMANREM TO MANREM********
0366              IF(JF.NE.2)GO TO 2710
0367              MAN2NF(ITE,IH,JF)=MAN2NF(ITE,IH,JF)+C*GNDEP(ITE,IZ)*0.001
0368              MAN2N(ITE,IH)=MAN2N(ITE,IH)+C*GNDEP(ITE,IZ)*0.001
0369              MAN1N(ITE,IH)=MAN1N(ITE,IH)+C*GNDEP(ITE,IZ)*0.001
0370              GO TO 2720
0371        2710  MAN2NF(ITE,IH,JF)=MAN2NF(ITE,IH,JF)+C*R2TOT(JF,ITE,IZ)*0.001
0372              MAN2N(ITE,IH)=MAN2N(ITE,IH)+C*R2TOT(JF,ITE,IZ)*0.001
0373              MAN1N(ITE,IH)=MAN1N(ITE,IH)+C*R2TOT(JF,ITE,IZ)*0.001
0374        2720  CONTINUE
0375        2730  CONTINUE
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FORTRAN IV G LEVEL  21                    MAIN                DATE = 78096          22/35/04

0376                INDEX=10*(K-1)+IZ
0377          2780  WRITE(1'INDEX)((MAN1L(ITE,IH),ITE=1,MT),IH=IORGS,IORGE)
0378                INDEX=10*(K-1)+10
0379                WRITE(1'INDEX)((MAN1N(ITE,IH),ITE=1,MT),IH=IORGS,IORGE)
             C*************** TO STMT 2870 OUTPUT ENVIRONMENT INPUT CONCENTRATIONS **
0380                IF(NPRINT.EQ.6)GO TO 2999
0381                IF(NPRINT.EQ.2)GO TO 2840
0382                WRITE(IP,839)NUCNAM(K),K
0383                DO 2820 IT=1,MT
0384          2820  WRITE(IP,838)TIME(IT),(R1J(JF,IT),JF=1,4)
0385          2840  IF(NPRINT.EQ.1.OR.NPRINT.GT.5)GO TO 2999
0386                DO 2870 IZ=ISTART,ISTOP,2
0387                IF(ISTOP.LE.ISTART)GO TO 2850
0388                IZP1=IZ+1
0389                WRITE(IP,837)NUCNAM(K),K,IZ,IZP1
0390                WRITE(IP,838)(TIME(IT),(R2TOT(JF,IT,IZ),JF=1,4),TIME(IT),
                   1(R2TOT(JF,IT,IZP1),JF=1,4),IT=1,MT)
0391                GO TO 2870
0392          2850  WRITE(IP,862)NUCNAM(K),K,IZ
0393                DO 2860 IT=1,MT
0394          2860  WRITE(IP,838)TIME(IT),(R2TOT(JF,IT,IZ),JF=1,4)
0395          2870  CONTINUE
0396          2999  CONTINUE
             C*************************************** OUTPUT DOSE RATE RESULTS **
             C************************** FOR LOCAL DOSE STMTS 3000 TO 3100 ****
             C*********************** FOR NONSPECIFIC DOSE STMTS 4000 TO 4100 ***
             C******************** FOR TOTAL ALL NUCLIDES STMTS 5000 TO 5400 ***
0397                IF(NPRINT.LT.4)GO TO 9999
0398          3000  ISECT=3
0399                WRITE(IP,836)TITLE,ISECT,(HEAD(I,ISECT),I=1,4)
0400                DO 3100 IZ=ISTART,ISTOP
0401                DO 3100 K=1,NK
0402                WRITE(IP,840)IZ,NUCNAM(K),K
0403                INDEX=10*(K-1)+IZ
0404                READ(1'INDEX)((MAN1L(ITE,IH),ITE=1,MT),IH=IORGS,IORGE)
0405                WRITE(IP,816)(ORGNAM(N),N=IORGS,IORGE)
0406                DO 3100 IT=1,MT
0407          3100  WRITE(IP,817)TIME(IT),(MAN1L(IT,IH),IH=IORGS,IORGE)
0408          4000  ISECT=4
0409                WRITE(IP,836)TITLE,ISECT,(HEAD(I,ISECT),I=1,4)
0410                DO 4100 K=1,NK
0411                WRITE(IP,841)NUCNAM(K),K
0412                INDEX=10*(K-1)+10
0413                READ(1'INDEX)((MAN1N(IT,IH),IT=1,MT),IH=IORGS,IORGE)
0414                WRITE(IP,816)(ORGNAM(N),N=IORGS,IORGE)
0415                DO 4100 IT=1,MT
0416          4100  WRITE(IP,817)TIME(IT),(MAN1N(IT,IH),IH=IORGS,IORGE)
0417          5000  ISECT=5
0418                WRITE(IP,836)TITLE,ISECT,(HEAD(I,ISECT),I=1,4)
0419                DO 5200 IH=IORGS,IORGE
0420                DO 5200 IZ=ISTART,ISTOP,2
0421                IF(ISTOP.LE.ISTART) GO TO 5110
0422                IZP1=IZ+1
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FORTRAN IV G LEVEL  21                    MAIN                DATE = 78096          22/35/0

 0423                WRITE(IP,900)ORGNAM(IH),IZ,IZP1
 0424                DO 5100 IT=1,MT
 0425                WRITE(IP,901)TIME(IT),(MAN2LF(IT,IH,IZ,JF),JF=1,4),
                    1MAN2L(IT,IH,IZ),
                    2TIME(IT),(MAN2LF(IT,IH,IZP1,JF),JF=1,4),MAN2L(IT,IH,IZP1)
 0426           5100 CONTINUE
 0427                GO TO 5200
 0428           5110 WRITE(IP,902) ORGNAM(IH),IZ
 0429                DO 5120 IT=1,MT
 0430                WRITE(IP,901)TIME(IT),(MAN2LF(IT,IH,IZ,JF),JF=1,4),
                    1MAN2L(IT,IH,IZ)
 0431           5120 CONTINUE
 0432           5200 CONTINUE
 0433                DO 5400 IH=IORGS,IORGE
 0434                WRITE(IP,950)ORGNAM(IH)
 0435                DO 5300 IT=1,MT
 0436                WRITE(IP,951)TIME(IT),(MAN2NF(IT,IH,JF),JF=1,4),MAN2N(IT,IH)
 0437           5300 CONTINUE
 0438           5400 CONTINUE
               C************ TO STMT 6500 OUTPUT DOSE SUMMARY TABLES ***************
 0439           6000 ISECT=6
 0440                IF(IZONM.EQ.0)GO TO 9999
 0441                WRITE(IP,836)TITLE,ISECT,(HEAD(I,ISECT),I=1,4)
               C************************************ SET ZONE FOR TABLE *************
 0442                DO 6500 IZP1=1,IZONM
 0443                IZ=IZONE(IZP1)
               C*********************** IZ=10 MEANS NONSPECIFIC DOSE RATES ******
               C************************************** SET TIME FOR TABLE ********
 0444                DO 6500 ITR=ITSUMY,MT,ITSUMJ
 0445                IF(IZ.NE.10)WRITE(IP,853)IZ
 0446                IF(IZ.EQ.10)WRITE(IP,854)
 0447                WRITE(IP,855)TIME(ITR),(ORGNAM(N),N=IORGS,IORGE)
               C***************************** INITIALIZE SUBTOTAL SETTING *******
 0448                M1=1
 0449                M10=KSUB
               C***************************** ZERO REMOV=SUBTOTAL ***************
 0450           6100 DO 6200 I=IORGS,IORGE
 0451           6200 REMOV(1,I)=0.0
 0452                DO 6300 K=M1,M10
 0453                INDEX=10*(K-1)+IZ
 0454                READ(1'INDEX)((MAN1L(ITE,IH),ITE=1,MT),IH=IORGS,IORGE)
               C************************************** WRITE TABLE ***************
 0455                WRITE(IP,856)K,NUCNAM(K),(MAN1L(ITR,IH),IH=IORGS,IORGE)
 0456                DO 6300 I=IORGS,IORGE
 0457           6300 REMOV(1,I)=REMOV(1,I)+MAN1L(ITR,I)
               C************************************** WRITE SUBTOTAL ***************
 0458                WRITE(IP,857) (REMOV(1,I),I=IORGS,IORGE)
 0459                IF(M10.EQ.NK)GO TO 6400
 0460                M1=KSUB+1
 0461                M10=NK
 0462                GO TO 6100
               C********** WRITE TOTAL IF IZ= 10 MAN2N OR ELSE MAN2L *********
 0463           6400 IF(IZ.NE.10)WRITE(IP,858)(MAN2L(ITR,I,IZ),I=IORGS,IORGE)
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0464        6500 IF(IZ.EQ.10)WRITE(IP,858)(MAN2N(ITR,I),I=IORGS,IORGE)
0465             GO TO 9999
0466        9995 WRITE(IE,861)
0467             GO TO 9999
0468        9996 WRITE(IE,842)ISTART,MZ
0469             GO TO 9999
0470        9997 WRITE(IE,860)IORGS,NIHT
0471             GO TO 9999
0472        9998 WRITE(IE,846)ICHCK,CHECK
0473        9999 CONTINUE
0474         801 FORMAT(16I5)
0475         802 FORMAT('1CASE NUMBER ',I3)
0476         803 FORMAT(10A8)
0477         805 FORMAT('1** DEFINITION OF ENVIRONMENTAL INPUTS',T60,'** DEFINITION
                1 OF PROBABILITY INPUTS'//8X,'JF    DEFINITION',T63,'IFLAG   DEFINI
                2TION'/8X,'--    ----------',T63,'-----   ----------'/9X,'1     AIR'
                3,T65,'0     PROBABILITY (PROB) CONSTANT'/9X,'2    GROUND SURFACE',
                4T65,'1     STEP FUNCTION AT TIME TP CHANGES PROB BY AMOUNT CP',
                */,9X,'3    SURFACE WATER',T65,
                1'2     RAMP FUNCTION AT TP CHANGES PROB BY SLOPE CP'/9X,
                2'4    GROUND WATER',T65,'3     EXPONENTIAL FUNCTION AT TP CHANGES
                3PROB BY TIME CONSTANT CP'/,T65,'4     DELTA FUNCTION,',
                4' AT TIME TP RELEASE TO ENVIRONMENT IS AA1'///,
                *' ** PROBABILITY AND RELATED DATA'/3X,'JF      NJF    J       ',
                1  'NJJ       AA1',10X,'PROB',11X,'IFLAG',11X,'TP',16X,'CP'/3X,'--'
                2,6X,'---    -',7X,'---',7X,'---',10X,'----',11X,'-----',11X,'--',
                316X,'--'/)
0478         806 FORMAT(8E10.2)
0479         807 FORMAT(20A4)
0480         808 FORMAT(A8,2X,7E10.2)
0481         809 FORMAT(10X,7E10.2)
0482         810 FORMAT(E10.2,I10,2E10.2)
0483         811 FORMAT(3X,I2,5X,I3,4X,I2,5X,I3,2(5X,1PE9.2),9X,I3,2(8X,1PE12.5))
0484         812 FORMAT(46X,1PE9.2,9X,I3,2(8X,1PE12.5))
0485         813 FORMAT('1** SELECTED RESIDUAL ELEMENTS IN WASTE'/T8,'GRAMS AT STAR
                1T OF TERMINAL STORAGE'/' FOR TOTAL FUEL = ',F10.0,'METRIC TONS'/)
0486         814 FORMAT(5X,A4,5X,1PE10.2)
0487         815 FORMAT('1** SELECTED RADIONUCLIDES IN WASTE'/15X,'GRAMS IN WASTE
                1 VERSUS TIME IN YEARS')
0488         816 FORMAT(/6X,'TIME',3X,10(A8,2X)/)
0489         817 FORMAT(F11.0,1P10E10.2)
0490         818 FORMAT(/' SPECIFIC ACTIVITY'/7X,'CI/G',1P10E10.2/'1')
0491         819 FORMAT('1RADIONUCLIDE',8X,'DC1 DATA',7X,'DRC DATA',7X,'RKD DATA'/)
0492         820 FORMAT(3X,A8,8X,3(1PE10.2,5X))
0493         821 FORMAT('1** EDC(K,JF,IZ) DATA, (JF=1,2,3,4)',
                1', DEFAULT VALUES USED, EXCEPTING',A8,'READ IN',/)
0494         822 FORMAT(//'    IZ=',I2,45X,'IZ=',I2/2X,2(1P4E10.2,4X))
0495         823 FORMAT(2X,A8,2(1P4E12.2,4X))
0496         824 FORMAT(///'1** DISPN(JF,IZ) DATA, (JF=1,2,3,4)'/)
0497         825 FORMAT(///' ** ADJ1(JF,JFA,IZ),ADJ2(JF,JFA,IZ) DATA, (JFA=1,2,3,4)
                1'/)
0498         826 FORMAT(2X,'IZ=',I2)
0499         827 FORMAT(3X,'JF=',I2,7X,4(1PE10.2,2X,1PE10.2,4X))
```

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FORTRAN IV G LEVEL  21                    MAIN                    DATE = 78096          22/35/04

0500          828 FORMAT('1** VOLINT(JF,MODE,NSP) DATA'/)
0501          829 FORMAT('  IZ=',I2/5X,'JF      MODE      NSP=1 THRU',10X,'VOLINT')
0502          830 FORMAT(5X,I2,6X,I2,12X,I2,6(3X,1PE10.2))
0503          831 FORMAT('1** BIOFAC(K,JF,NSP) DATA'/)
0504          832 FORMAT(' RADIONUCLIDE=',A8/5X,'JF      NSP=1 THRU',10X,'BIOFAC')
0505          833 FORMAT('1** DOSFAC(K,JF,MODE,IH) DATA'/)
0506          834 FORMAT(/' ORGAN = ',A6/T25,'JF=1',T61,'JF=2',T77,'JF=3',
                 1T103,'JF=4'/16X,4('MODE=1',7X,'MODE=2',7X))
0507          835 FORMAT(3X,A8,8(3X,1PE10.2))
            C*** TO HAVE N LINES IN TITLE MUST CHANGE 3(T27,10A8/) IN 1 BELOW ***
            C********** TO N(T27,10A8/) AND REMOVE CORRESPONDING # OF / ********
0508          836 FORMAT(/,'1'/9(1X,132('#')/),10(/),T37,'AMRAW: ASSESSMENT METHOD',
                 1' FOR RADIOACTIVE WASTE MANAGEMENT',4(/),3(T27,10A8/),///,T61,
                 2'SECTION',I3/,5(/),T51,4A8,15(/),9(1X,132('#')/))
0509          837 FORMAT('1RADIONUCLIDE: ',A8,' (K=',I2,')'/1X,29('-')/' CONCENTRATI
                 1ONS AT ENVIRONMENT INPUT RECEPTOR, R2TOT      UNITS: JF=1 MICROCURI
                 2E*YEARS/CUBIC CM'/' JF=2 MICROCURIES/SQUARE CM, JF=3 AND 4 MICROCU
                 3RIES/CUBIC CM'//' ZONE=',I2,T71,'ZONE=',I2,//
                 42(14X,'JF=1       JF=2       JF=3       JF=4',18X)/
                 52(6X,'TIME      AIR       GROUND     SURFACE    GROUND',17X)/
                 62(23X,'SURFACE    WATER      WATER',18X))
0510          838 FORMAT(0PF10.0,1P4E10.2,18X,0PF8.0,1P4E10.2)
0511          839 FORMAT('1RADIONUCLIDE: ',A8,' (K=',I2,')'/1X,29('-')/' RELEASE INC
                 1REMENTS TO PRELIMINARY ENVIRONMENT INPUT'/' RECEPTORS, R1J, FROM A
                 2LL RELEASE EVENTS, IN CURIES'//14X,'JF=1       JF=2       JF=3
                 3JF=4'/5X,'TIME      AIR       GROUND     SURFACE    GROUND'/23X,'SURFA
                 4CE    WATER      WATER')
0512          840 FORMAT('1** AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MANIL, IN MIL
                 1LIREMS/YEAR'//' ZONE=',I2,'... NUCLIDE=',A8,'  K=',I3/)
0513          841 FORMAT('1** AVERAGE ANNUAL NONSPECIFIC DOSE TO POPULATION, MANIN,
                 2IN MANREMS/YEAR'//' NONSPECIFIC ... NUCLIDE=',A8,'  K=',I3/)
0514          842 FORMAT(1X,132('*')/' ERROR:  VALUE OF ZONE',I5/'  OUTSIDE OF RANGE
                 1 OF MAXIMUM ZONE (',I2,')'/1X,132('*')//)
0515          843 FORMAT(5X,I2,12X,I2,6(3X,1PE10.2))
0516          844 FORMAT('1')
0517          845 FORMAT(19A4,I2)
0518          846 FORMAT(9(1X,132('*')/)//T54,'ERROR NEAR CHECK POINT ',
                 *I2//1X,19A4//9(1X,132('*')/))
0519          847 FORMAT('1RADIONUCLIDE: ',A8,' (K = ',I2,')'/1X,31('-')//' RELEASE
                 *FRACTIONS BY EACH CUTSET, RELOUT'//' TIME',T14,'JF',T20,
                 *'INITIAL RELEASE FRACTIONS')
0520          848 FORMAT(1X,19A4,I2)
0521          849 FORMAT(/////' ** ZONALO(JF,IZ) DATA, (JF=1,2,3,4)'/)
0522          850 FORMAT(/////' ** ZONDEP(IZ) DATA'////,4X,9(A3,I2,5X))
0523          851 FORMAT('1** AREAW(IZ) DATA'////,4X,9(A3,I2,5X))
0524          880 FORMAT(2X,9(1PE10.2))
0525          852 FORMAT('1TIME',T14,'JF',T20,33HINITIAL RELEASE FRACTIONS, CONT'D)
0526          853 FORMAT('1',T15,'  AVERAGE ANNUAL LOCAL DOSE TO INDIVIDU',
                 1'AL, MANIL, IN ZONE',I2,', IN MILLIREMS/YEAR',//)
0527          854 FORMAT('1',T15,'  AVERAGE ANNUAL NONSPECIFIC DOSE TO PO',
                 1'PULATION, MANIN, IN MANREMS/YEAR',//)
0528          855 FORMAT(T38,0PF9.0,' YEARS#',/,1X,94('-'),/,'   K  NUCLIDE',1X,
                 18(2X,A8),/,1X,94('-'))
```

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FORTRAN IV G LEVEL  21                    MAIN                DATE = 78096          22/35/04

0529          856 FORMAT(2X,I2,2X,A8,8(1PE10.2))
0530          857 FORMAT(1X,94('-'),/,5X,'SUB TOTAL',8(1PE10.2),/,1X,94('-'))
0531          858 FORMAT(7X,'TOTAL',2X,8(1PE10.2),/,1X,94('-'),
                 1/,'  #TIME SINCE START OF REPOSITORY OPERATIONS.')
0532          859 FORMAT(/////,' ** GROUND WATER PARAMETERS',///,3X,
                 1'GROUND WATER SEEPAGE VELOCITY, VX, IN METERS/DAY =',1PE10.2,/,
                 23X,'POROSITY OF SOLID MEDIUM, PORE =',1PE10.2,/,3X,
                 3'BULK SOLID DENSITY, BULKD, IN GRAMS/CUBIC CM =',1PE10.2,/,3X,
                 4'DISPERSIVITY COEFFICIENTS, IN METERS: AXIAL, AL =',1PE10.2,
                 *2X,'TRANSVERSE, AT =',1PE10.2,//,3X,
                 5'AQUIFER VALUES, IN METERS: HEIGHT, HT=',1PE10.2,
                 */,3X,'DISTANCE FROM SOURCE TO EMERGENCE, XL(IZ)',
                 *' EFFECTIVE WIDTH, YW(IZ)',/,3X,
                 *'CONCENTRATION AT YY = AVERAGE CONCENTRATION IN YW',//,
                 *4X,'ZONE',5X,9(A3,I2,5X))
0533          870 FORMAT(3X,'XL(IZ)',2X,9(1PE10.2))
0534          871 FORMAT(3X,'YW(IZ)',2X,9(1PE10.2))
0535          872 FORMAT(3X,'YY(IZ)',2X,9(1PE10.2))
0536          873 FORMAT(/,3X,
                 6'EXPOSED AREA OF SOLIDIFIED WASTE SPECIMEN, FS, IN SQUARE CM =',
                 *1PE10.2,/,3X,
                 7'VOLUME OF SOLIDIFIED WASTE SPECIMEN, VS, IN CUBIC CM =',1PE10.2,/
                 8,3X,'TOTAL CANISTER INVENTORY, CINV =',1PE10.2,/,3X,
                 9'ASSUMED NUMBER OF CANISTER FAILURES, CFAI =',1PE10.2)
0537          860 FORMAT(1X,132('*')/' ERROR:  INVALID ORGAN NUMBER =',I5,5X,
                 1'MAXIMUM NUMBER OF ORGANS =',I2,/,1X,132('*'))
0538          861 FORMAT(1X,132('*')/' ERROR:  ATTEMPTED REPOSITORY OPERATION ',
                 1'WITHOUT SUBSEQUENT ENVIRONMENT TIME INCREMENT',/,1X,132('*'))
0539          862 FORMAT('1RADIONUCLIDE: ',A8,' (K=',I2,')'/1X,29('-')/' CONCENTRATI
                 1ONS AT ENVIRONMENT INPUT RECEPTOR, R2TOT      UNITS: JF=1 MICROCURI
                 2E*YEARS/CUBIC CM'/' JF=2 MICROCURIES/SQUARE CM, JF=3 AND 4 MICROCU
                 3RIES/CUBIC CM'//' ZONE=',I2,//
                 41(14X,'JF=1        JF=2        JF=3        JF=4',18X)/
                 51(5X,'TIME      AIR        GROUND     SURFACE    GROUND',17X)/
                 61(23X,'SURFACE    WATER      WATER',18X))
0540          900 FORMAT('1** AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MAN2LF FOR JF
                 1=1 TO 4, MAN2L FOR TOTAL, IN MILLIREMS/YEAR',//,4X,
                 2'TOTAL FOR ALL NUCLIDES',T63,A8,//,
                 3'  ZONE=',I2,T71,'ZONE=',I2,//,2(13X,'JF=1        JF=2        JF=3
                 4  JF=4',13X),/,2(4X,'TIME      AIR        GROUND     SURFACE    GROUND
                 5   TOTAL',3X),/,2(22X,'SURFACE    WATER      WATER',13X))
0541          901 FORMAT(F9.0,1P5E10.2,1X,0P1F9.0,1P5E10.2)
0542          902 FORMAT('1** AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MAN2LF FOR JF
                 1=1 TO 4, MAN2L FOR TOTAL, IN MILLIREMS/YEAR',//,4X,
                 2'TOTAL FOR ALL NUCLIDES',T63,A8,//,
                 3'  ZONE=',I2,//,1(13X,'JF=1        JF=2        JF=3        JF=4',
                 4  13X),/,1(4X,'TIME      AIR        GROUND     SURFACE    GROUND     ',
                 5  'TOTAL',3X),/,1(22X,'SURFACE    WATER      WATER',13X))
0543          950 FORMAT('1** AVERAGE ANNUAL NONSPECIFIC DOSE TO POPULATION, MAN2NF
                 1FOR JF=1 TO 4, MAN2N FOR TOTAL, IN MANREMS/YEAR',//,4X,
                 2'TOTAL FOR ALL NUCLIDES',T63,A8,//,16X,'JF=1        JF=2        JF=3',
                 3'        JF=4'/,7X,'TIME      AIR        GROUND     SURFACE    GROUND',
                 4'     TOTAL',/,25X,'SURFACE    WATER      WATER')
0544          951 FORMAT(F12.0,1P5E10.2)
0545              STOP
0546              END
```

APPENDIX H Subprograms

```
FORTRAN IV G LEVEL  21                FAULT              DATE = 78096          22/35/04

 0001              SUBROUTINE FAULT(TIME,PROB,A1,JF,J,NJJJ,ITR,K,CONCI)
 0002              IMPLICIT INTEGER*2 (I-N)
 0003              COMMON/BFAULT/ PROBB,AA1,TP,CP,IFLAG
 0004              COMMON/FDLEA/ CFAI,XR,DELTIM,I1
 0005              COMMON/FCRATO/DELTL
 0006              DIMENSION PROBB(4,9,4),AA1(4,9),TIME(50),TP(4,9,4),CP(4,9,4)
 0007              INTEGER*2 IFLAG(4,9,4)
 0008              PROB=1.
            C************************* NJJJ=# OF PROB ASSOCIATED WITH EACH CUTSET. **
 0009              DO 100 I=1,NJJJ
 0010              CPROB=PROBB(JF,J,I)
 0011              IF(TIME(ITR).LT.TP(JF,J,I))GO TO 50
 0012              DELTIM=TIME(ITR)-TP(JF,J,I)
 0013              I1=IFLAG(JF,J,I)+1
 0014              GO TO(50,40,30,20),I1
            C************************************** PROB IS DELTA FUNCTION **
 0015              IF(DELTIM.EQ.0.)GO TO 10
 0016              GO TO 50
 0017           10 CPROB=1./DELTL
 0018              GO TO 50
            C***************************************** PROB CHANGES EXPONENTIALLY **
 0019           20 CPROB=CPROB+EXP(CP(JF,J,I)*DELTIM)
 0020              GO TO 50
            C************************************** PROB CHANGES BY RAMP FUNCTION. **
 0021           30 CPROB=CPROB + CP(JF,J,I)*DELTIM
 0022              GO TO 50
            C************************************** PROB CHANGES BY STEP FUNCTION. **
 0023           40 CPROB=CPROB+CP(JF,J,I)
            C****************************************** PROB IS CONSTANT *******
 0024           50 PROB=PROB*CPROB
 0025          100 CONTINUE
 0026              A1=AA1(JF,J)
 0027              IF(PROB.EQ.0.0)GO TO 155
 0028              IF(JF.EQ.4)GO TO 156
 0029              RETURN
 0030          155 CONCI=0.0
 0031              RETURN
 0032          156 A1=RLEACH(K,ITR,CONCI,X2)*CFAI*X2*365.
 0033              IF(XR.EQ.0.0)A1=0.0
 0034              IF(XR.EQ.0.0)RETURN
 0035              A1=A1/XR
 0036              RETURN
 0037              END
```

APPENDIX H Sub-programs

```
FORTRAN IV G LEVEL  21                    RLEACH              DATE = 78096          22/35/04

0001                FUNCTION RLEACH(K,ITR,CONCI,X2)
0002                IMPLICIT INTEGER*2 (I-N)
0003                COMMON/BLEACH/ DC1(25),DRC(25),X(25,50),FS,VS,SPACT(25),CINV
0004                COMMON/FDLEA/ CFAI,XR,DELTIM,I1
0005                COMMON/FCRATO/DELTL
0006                JM=5
0007                DTIME=DELTL
0008                IF(I1.EQ.2) DTIME=DELTIM
0009                IF(DTIME.GE.100.) JM=10
0010                AJM=JM
0011                DELTLD=DTIME*365./AJM
0012                CONCI=0.
0013                CONC2=0.
0014                STER=SQRT(DC1(K)/3.1416)
0015                CC1=(2.*FS*X(K,ITR)*CFAI)/(VS*CINV)
0016                TERM=STER*SQRT(DELTLD)
0017                DO 85 I=1,JM
0018                IF(DTIME.GE.10.)GO TO 65
0019                CC2=1.+.5*DRC(K)*DELTLD
0020                CONC2=CONC2+CC1*CC2*TERM
0021                CONCI=CONCI+CC1*CC2*TERM*SPACT(K)
0022                GO TO 75
0023             65 CC3=CC1/2.
0024                CC4=SQRT(DC1(K)*DRC(K))
0025                CC5=DELTLD+.5/DRC(K)
0026                CONC2=CONC2+CC3*CC4*CC5
0027                CONCI=CONCI+CC3*CC4*CC5*SPACT(K)
0028             75 RLEACH=CONC2
0029                IF(RLEACH .GT. 3.2E+07)RLEACH=3.2E+07
0030             85 CONTINUE
0031                RLEACH=RLEACH/(CFAI*FS*DTIME*365.)
0032                X2=FS*DELTL
0033                RETURN
0034                END
```

```
FORTRAN IV G LEVEL  21                    TRINP              DATE = 78096          22/35/04

 0001                SUBROUTINE TRINP(DELT2,DELT3,DELT4,XR,XE,XEM1,XEM2,TRL,
                    1DECFAC,A2,XL,XE3,DFAC,ITE,ITRE,IW,JF,RKD,RKDMAX,K)
 0002                IMPLICIT INTEGER*2 (I-N)
 0003                DIMENSION RKD(25)
 0004                COMMON/BTRINP/ Y2,Y3,IZ,IFDIVW
 0005                COMMON/CTRINP/ CRMIN,DFMIN
 0006                DECFAC=1.
 0007                GO TO(1,1,1,30),JF
 0008              1 IF(DELT4.EQ.0.)GO TO 5
 0009                Y=1.
 0010                GO TO 62
 0011              5 A2=1.
 0012                GO TO 70
 0013             30 IF(XL.LT.1.0) GO TO 68
 0014                IF(RKD(K).GT.RKDMAX) GO TO 68
 0015                DELTIM=DELT2*365.
 0016                DELTA=DELT3-DELT2
 0017                IIN=2
 0018                IF(IFDIVW.EQ.0)GO TO 50
 0019                IF(DELTA.GE.5000..AND.RKD(K).LT.1.)IIN=11
 0020                IF(DELTA.GE.50000.)IIN=6
 0021                IF(DELTA.GE.50000..AND.RKD(K).LT.1.)IIN=101
 0022             50 RIN=IIN
 0023                DELINC=DELTA*365./(RIN-1.)
 0024                XINC=(XE-XEM1)/(RIN-1.)
 0025                A2=0.0
 0026                DO 400 I=1,IIN
 0027                Y=CRATIO(DELTIM,XL,DELTA,DELINC,IZ)
 0028                IF(Y.LE.1.) GO TO 100
 0029                Y=1.
 0030            100 IF(XR.LE.1.0E-40)GO TO 300
 0031                IF(IW.EQ.3) GO TO 200
 0032                DECFAC=XEM1/XR
 0033                GO TO 250
 0034            200 IF(ITE.LE.ITRE) DECFAC=1.0
 0035                IF(ITE.GT.ITRE) DECFAC=XEM1/XE3
 0036            250 IF(Y.LT.CRMIN.OR.DECFAC.EQ.0.) GO TO 300
 0037                IF(DECFAC.LT.DFMIN) DECFAC=DFMIN
 0038                A2=A2+Y*DECFAC
 0039            300 DELTIM=DELTIM+DELINC
 0040                XEM1=XEM1+XINC
 0041            400 CONTINUE
 0042                A2=A2/RIN
 0043                GO TO 70
 0044             62 IF((XEM1+XEM2).LE.10.E-40.OR.ABS(TRL*DELT4).GE.50.)GO TO 68
 0045                IF(IW.EQ.3.AND.ITE.LE.ITRE)GO TO  64
 0046                DECFAC=(XE+XEM1)/(XEM1+XEM2)
 0047                GO TO  66
 0048             64 DECFAC=1.0-((DELT3-DELT2)*DFAC)
 0049             66 TRR1=TRL*DELT4
 0050                IF(TRR1.GT.180.) GO TO 68
 0051                A2=DECFAC*Y*EXP(-TRR1)
 0052                GO TO 70
 0053             68 A2=0.
 0054             70 RETURN
 0055                END
```

```
FORTRAN IV G LEVEL  21                    CRATIO              DATE = 78096          22/35/04

0001                FUNCTION CRATIO(DELTIM,XL,DELTA,DELINC,IZ)
0002                IMPLICIT INTEGER*2 (I-N)
0003                DIMENSION RKD(25),TIME(50),YY(8),YW(8)
0004                COMMON/BCRATO/ RKD,CONCI,TIME,VX,PORE,AL,AT,HT,BULKD,YW,ITR,MT,
                   1ITE,K,GNDDIS,YY
0005                COMMON/FCRATO/DELTL
0006                IF(CONCI.EQ.0..OR.CONCI.LE.1.E-60)CRATIO=0.
0007                IF(CONCI.EQ.0..OR.CONCI.LE.1.E-60)RETURN
0008                VPORE=VX
0009                DXX=AL*VPORE
0010                DYY=AT*VPORE
0011                IF(CONCI.LE.1.E-70)CONCI=0.
0012                SSAM=CONCI/HT
0013                DR1=BULKD*RKD(K)/PORE
0014                RD=1. + DR1
0015                EX=DXX/RD
0016                EY=DYY/RD
0017                EE=(EX*EY)**0.5
0018                U=VPORE/RD
0019                IF(DELTIM.LE.0.)CRATIO=0.
0020                IF(DELTIM.LE.0.)RETURN
0021              6 TEE=EE*DELTIM
0022                TEX=4.*3.14159*TEE
0023                IF(SSAM.GT.1.E+30.OR.TEX.LT.1.E-45)TER=1./(HT*TEX)
0024                IF(SSAM.GT.1.E+30.OR.TEX.LT.1.E-45)GO TO 31
0025                TER=SSAM/TEX
0026             31 TT1=ABS(XL-U*DELTIM)**2/(4.*EX*DELTIM)
0027                TT3=(YY(IZ)**2)/(4.*EY*DELTIM)
0028                TT4=ABS(TT1+TT3)
0029                IF(TT4.GE.90.)GO TO 10
0030                TT4=EXP(-TT4)
0031                GO TO 34
0032             10 TT4=0.
0033             34 IF(SSAM.GT.1.E+30.OR.TEX.LT.1.E-45)GO TO 33
0034                TER=TER/CONCI
0035             33 CONC=TER*TT4
0036                GNDDIS=YW(IZ)*HT*VPORE*PORE*DELTA*365.
0037                GNDINC=YW(IZ)*HT*VPORE*PORE*DELINC
0038                CONC=CONC*GNDINC
0039                CRATIO=CONC
0040                IF(CRATIO.GT.1.)CRATIO=1.
0041                RETURN
0042                END
```

```
FORTRAN IV G LEVEL  21                    TRMAN              DATE = 78096          22/35/04

0001                SUBROUTINE TRMAN(K,ITE,IZ,NSS,C)
0002                IMPLICIT INTEGER*2 (I-N)
0003                DIMENSION BIOFAC(25,4,6),VOLINT(4,2,6,8),DOSFAC(25,4,2,8)
0004                COMMON/BTRMAN/ BIOFAC,VOLINT,DOSFAC,NSP,IFLAGE,JF,IH,DELTE
0005                INTEGER*2 NSP(6),IFLAGE(4,2,6)
0006                NS=NSP(JF)
0007                C=0.
0008                DO 20 MODE=1,2
0009                CSUM=0.
0010                IF(DOSFAC(K,JF,MODE,IH).EQ.0.)GO TO 20
            C*********************************** SUM ALL SUBPATHWAYS TO DOSE TO MAN. **
0011                DO 10 I=1,NS
0012                IF(IFLAGE(JF,MODE,I).NE.NSS)GO TO 10
0013                FACT=BIOFAC(K,JF,I)
0014                IF(MODE.EQ.1)FACT=1.
0015                GO TO(4,2,6,6),JF
0016              2 IF(MODE.EQ.1)GO TO 6
0017              4 CSUM=CSUM+FACT*VOLINT(JF,MODE,I,IZ)/DELTE
0018                GO TO 10
0019              6 CSUM=CSUM+FACT*VOLINT(JF,MODE,1,IZ)
0020             10 CONTINUE
            C******************** DETERMINE TRANSFER COEFFICIENT FOR DOSE TO MAN. **
0021                C=C+CSUM*DOSFAC(K,JF,MODE,IH)
0022             20 CONTINUE
0023                RETURN
0024                END
```

APPENDIX I

FLOWCHART

Figure I-1 shows a simplified flowchart for AMRAW-A. The chart represents flow through the code for a specified waste management phase, such as repository operations or terminal storage. The reader is referred to Vol. I, Generic Description of AMRAW-A, for detailed description of each step through the model.

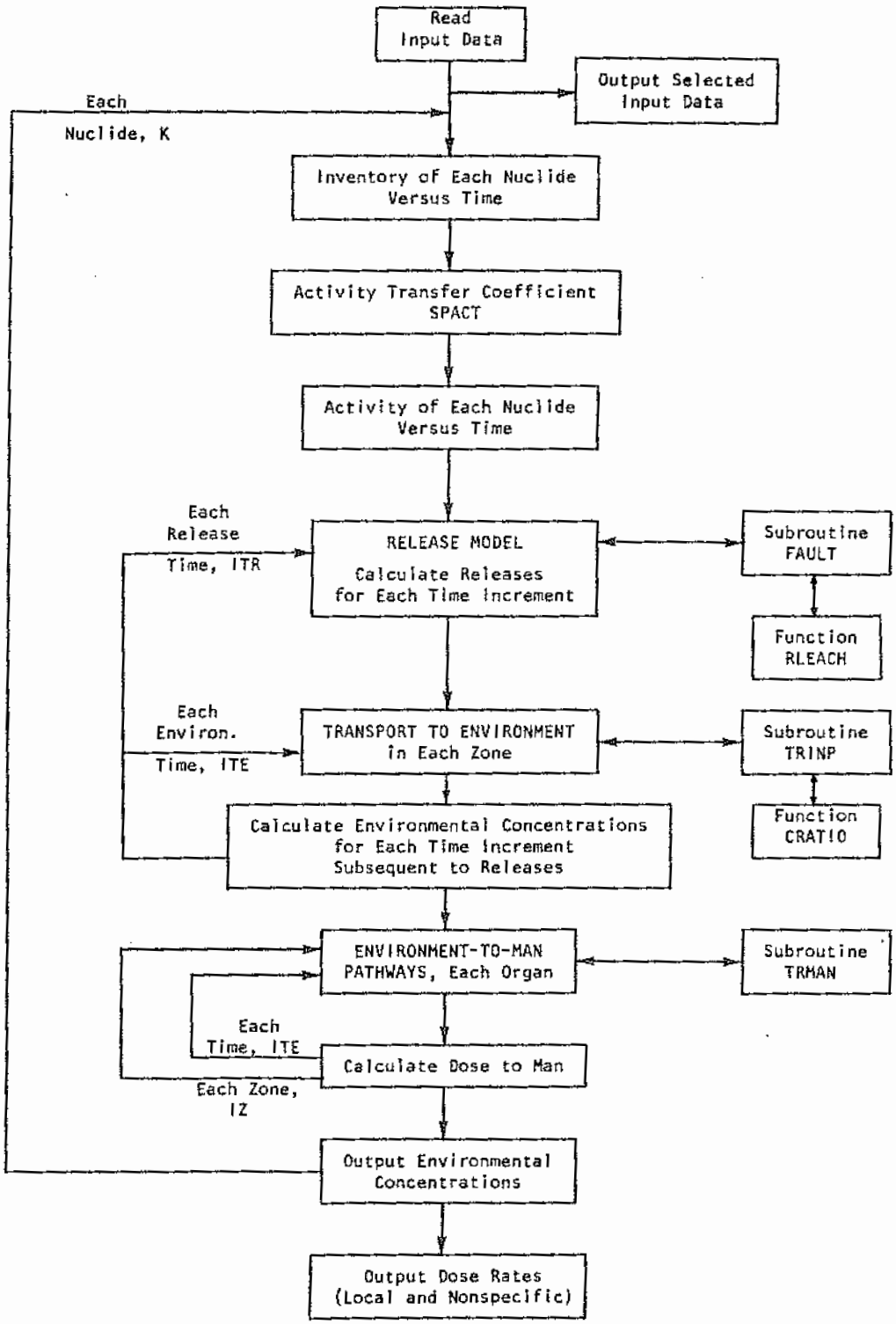

Figure I-1. AMRAW-A simplified flowchart.

APPENDIX J

AUXILIARY PROGRAMS

Auxiliary programs for use with AMRAW are described in this appendix.

1) COMPRESS - a program for preparing an AMRAW-B input file from AMRAW-A output.

2) POLYEPA - a program for preparing inventory data matrix by curve fitting source data to prescribed time specified in AMRAW input.

3) SENDY - a program for comparing results in tables from AMRAW run with corresponding tables from another run.

1. COMPRESS. All of the AMRAW-A output tables in Section 3 (Local Dose to Individual) and Section 4 (Nonspecific Dose to Population) comprise the major input to AMRAW-B (Economic Model). COMPRESS is an auxiliary program, written in PL-1 and Fortran IV language, which finds these tables in the full output stored on tape, strips off the headings and left hand column of time, and outputs a continuous "compressed" file in a form ready to be read by AMRAW-B. The program may be used separately to produce AMRAW-B input files from AMRAW-A output, or it may be joined to AMRAW-B to process data directly. Appendix T in Part 2 describes and presents a listing of COMPRESS, including JCL, as run on the IBM 360/67 computer at UNM.

2. POLYEPA. The repository inventory matrix input to AMRAW consists of quantities of each radionuclide at each time specified for calculation, over the total time range considered. However, source data are generally available listed for time which do not match the intended calculation times and also are usually not subdivided into sufficiently short time increments. POLYEPA is a program written in CALL-OS FORTRAN which uses a cubic spline curve-fitting technique for interpolation to adjust quantities to the required times and furnish the required intermediate values. POLYEPA reads in the name of NK isotopes K together with inventories X(I, K) at various time points I. For each isotope, there are a total of MT input time points for use in interpolating MTADJ output

data points. The output results can be written either on the terminal or stored in a data file "POLYDD" in the user's CALL-OS user library, for subsequent use as a portion of the AMRAW input data file. Before running POLYEPA, its input is assembled in a data file named "POLYDATA," stored in the user's CALL-OS user library.

Description of Card Input. One card of each type is required except as noted for card types 4 and 5.

Card Type	Format and Item	Description
1	Free format	
	MT	Number of input data time
	MS	Number of time intervals corresponding to the repository operations phase.
	MTADJ	Number of interpolated output time points.
	NK	Number of radioisotopes.
	MC	Number of columns in output tables.
2	Free format	
	TIME (I)	Time in years at each of MT input time points.
3	Free format	
	TIMEAD (I)	Time in years at each of MTADJ output time points.
	NK sets of card types 4 and 5 are required:	
4	FORMAT (A8)	
	NUCNAM (K)	Name of radioisotope (e.g., Sr-90, NB-93m, or PU-239).
5	Free format	
	X (I, K)	MT values of masses of isotope K at time points I.

Listing. Table J-1 is a listing of POLYEPA.

Table J-1.

```
      REAL*8 TIME(17),TIMLG(17),TIMEAD(55),XS(50),U,SEVAL,%
      X(17,25),XLG(17,25),B(17,25),C(17,25),D(17,25),NUCNAM(25)
      INTEGER MTSAV(26),MTA,MK,ISAV,MT,M1,M7,M10,MTADJ
      WRITE(6,500)
      CALL OPEN(1,'DATAPOLY','INPUT')
      CALL OPEN(9,'DDPOLY','OUTPUT')
      READ(1,*)MT,MS,MTADJ,MK,MC
      READ(1,*)(TIME(I),I=1,MT)
      READ(1,*)(TIMEAD(I),I=1,MTADJ)
      MSM1=MS-1
      MP=MTADJ+MSM1
         DO 10 I=MS,MT
         IMM=I-MSM1
10       TIMLG(IMM)=DLOG10(TIME(I))
      DO 50 K=1,MK
      READ(1,910)NUCNAM(K)
      READ(1,*)(X(I,K),I=1,MT)
         DO 20 I=MS,MT
         IMM=I-MSM1
         IF(X(I,K).GT.0.0D0)GO TO 20
         ISAV=I-1-MSM1
         GO TO 40
20       XLG(IMM,K)=DLOG10(X(I,K))
      ISAV=MT-MSM1
40    MTSAV(K)=ISAV
50    CONTINUE
         DO 60 K=1,MK
         MTA=MTSAV(K)
60       CALL SPLINE(MTA,MK,K,TIMLG,XLG,B,C,D)
 1    WRITE(6,501)
      READ(5,*)IANS
      IF(IANS.EQ.1)GO TO 3
      IF(IANS.GT.3)GO TO 1
      PAUSE 'ROLL PAPER TO BEGINNING OF CLEAN SHEET AND HIT RETURN'
 3    GO TO(2,2,4),IANS
 2    DO 90 I1=1,MK
      DO 61 I=1,MSM1
61    XS(I)=X(I,I1)
      MTA=MTSAV(I1)
      L=1
      M1=1
      M7=7
      DO 80 I=1,MTADJ,7
         DO 70 K=1,7
         IF(I+K-1.GT.MTADJ)GOTO70
         U=DLOG10(TIMEAD(I+K-1))
         XS(I+K+5)=SEVAL(MTA,MK,I1,U,TIMLG,XLG,B,C,D)
         XS(I+K+5)=10.0D0**XS(I+K+5)
70       CONTINUE
80    CONTINUE
      DO 81 I=1,MP,7
      IF(IANS.EQ.1)WRITE(9,930)NUCNAM(I1),L,(XS(K),K=M1,M7)
      IF(IANS.EQ.2)WRITE(6,930)NUCNAM(I1),L,(XS(K),K=M1,M7)
      L=L+1
      IF(M7.GE.MP)GO TO 90
```

Table J-1. (continued)

```
      M1=M7+1
      M7=M7+7
      IF(M7.GT.MP)M7=MP
   81 CONTINUE
   90 CONTINUE
      GO TO 1
    4 WRITE(6,900)
      M1=1
      M10=MC
   51 WRITE(6,925)(NUCNAM(K),K=M1,M10)
      DO 53 I=1,MT
   53 WRITE(6,940)TIME(I),(X(I,K),K=M1,M10)
      IF(M10.GE.MK)GO TO 55
      M1=M10+1
      M10=M10+MC
      IF(M10.GT.MK)M10=MK
      GO TO 51
   55 WRITE(6,920)
      M1=1
      M10=MC
   65 WRITE(6,925)(NUCNAM(K),K=M1,M10)
      DO 67 I=1,M5M1
   67 WRITE(6,940)TIME(I),(X(I,K),K=M1,M10)
      DO 82 I=1,MTADJ
      U=DLOG10(TIMEAD(I))
         DO 71 K=M1,M10
         MTA=MTSAV(K)
         XS(K)=SEVAL(MTA,MK,K,U,TIMLG,XLG,B,C,D)
   71    XS(K)=10.0D0**XS(K)
         IF(XS(K).LT.1.0E-25)XS(K)=0.00
   82 WRITE(6,940)TIMEAD(I),(XS(K),K=M1,M10)
      IF(M10.GE.MK)GO TO 999
      M1=M10+1
      M10=M10+MC
      IF(M10.GT.MK)M10=MK
      GO TO 65
      GO TO 1
  999 STOP
  500 FORMAT(' 1=WRITE TO DATA FILE'/%
            ' 2=WRITE DATA FILE FORMATTED OUTPUT ON TERMINAL'/%
            ' 3=WRITE FORMATTED FOR EPA REPORT')
  501 FORMAT(' ENTER REQUEST')
  900 FORMAT(///'  ** INPUT DATA'//4X,'PROPERTIES OF ACCUMULATED 10 YEAR%
 OLD WASTE AS A FUNCTION OF AGE.'//T51,'CONCENTRATION, GRAMS'/)
  910 FORMAT(A8)
  920 FORMAT(///'  *** OUTPUT RESULTS'//T51,%
'CONCENTRATIONS, GRAMS')
  925 FORMAT('0TIME(YRS)',10(2X,A8))
  930 FORMAT(A8,I2,7(1PE10.2))
  940 FORMAT(F10.0,10(1PE10.2))
      END
      SUBROUTINE SPLINE(N,MK,K,X,Y,B,C,D)
      INTEGER N,MK,K
      REAL*8 X(17),Y(17,25),B(17,25),C(17,25),D(17,25),T
       INTEGER NM1,IB,I
```

Table J-1. (concluded)

```
      NM1 = N-1
      IF ( N .LT. 3 ) GO TO 50
      D(1,K) = X(2) - X(1)
      C(2,K) = (Y(2,K) - Y(1,K))/D(1,K)
      DO 10 I = 2, NM1
         D(I,K) = X(I+1) - X(I)
         B(I,K) = 2.*(D(I-1,K) + D(I,K))
         C(I+1,K) = (Y(I+1,K) - Y(I,K))/D(I,K)
         C(I,K) = C(I+1,K) - C(I,K)
   10 CONTINUE
      B(1,K) = -D(1,K)
      B(N,K) = -D(N-1,K)
      C(1,K) = 0.
      C(N,K) = 0.
      IF ( N .EQ. 3 ) GO TO 15
      C(1,K) = C(3,K)/(X(4)-X(2)) - C(2,K)/(X(3)-X(1))
      C(N,K) = C(N-1,K)/(X(N)-X(N-2)) - C(N-2,K)/(X(N-1)-X(N-3))
      C(1,K) = C(1,K)*D(1,K)**2/(X(4)-X(1))
      C(N,K) = -C(N,K)*D(N-1,K)**2/(X(N)-X(N-3))
   15 DO 20 I = 2, N
         T = D(I-1,K)/B(I-1,K)
         B(I,K) = B(I,K) - T*D(I-1,K)
         C(I,K) = C(I,K) - T*C(I-1,K)
   20 CONTINUE
      C(N,K) = C(N,K)/B(N,K)
      DO 30 IB = 1, NM1
         I = N-IB
         C(I,K) = (C(I,K) - D(I,K)*C(I+1,K))/B(I,K)
   30 CONTINUE
      B(N,K) = (Y(N,K) - Y(NM1,K))/D(NM1,K) + D(NM1,K)*(C(NM1,K) + 2.*C(N,K))
      DO 40 I = 1, NM1
         B(I,K) = (Y(I+1,K) - Y(I,K))/D(I,K) - D(I,K)*(C(I+1,K) + 2.*C(I,K))
         D(I,K) = (C(I+1,K) - C(I,K))/D(I,K)
         C(I,K) = 3.*C(I,K)
   40 CONTINUE
      C(N,K) = 3.*C(N,K)
      D(N,K) = D(N-1,K)
      RETURN
   50 IF ( N .LT. 2 ) RETURN
      B(1,K) = (Y(2,K)-Y(1,K))/(X(2)-X(1))
      C(1,K) = 0.
      D(1,K) = 0.
      RETURN
      END
      REAL FUNCTION SEVAL*8 (N,MK,KK,U,X,Y,B,C,D)
      INTEGER N,MK,KK
      REAL*8 U,X(17),Y(17,25),B(17,25),C(17,25),D(17,25),DX
      INTEGER I, J, K
      DATA I/1/
      IF ( I.GE.N ) I = 1
      IF ( U .LT. X(I) ) GO TO 10
      IF ( U .LE. X(I+1) ) GO TO 30
   10 I = 1
      J = N + 1
   20 K = (I+J)/2


      IF ( U .LT. X(K) ) J = K
      IF ( U .GE. X(K) ) I = K
      IF ( J .GT. I+1 ) GO TO 20
   30 DX = U - X(I)
      SEVAL = Y(I,KK) + DX*(B(I,KK) + DX*(C(I,KK) + DX*D(I,KK)))
      RETURN
      END
```

3. SENDY. This is an auxiliary program developed to help compare results from different computer runs of AMRAW-A. It handles two cases at a time. AMRAW-A stores output results on magnetic tape; SENDY reads corresponding matrices of two different cases from the tape. It can compare results from two cases by finding the ratio of elements of the two matrices, or calculate the normalized values in each matrix (e.g., metric tons of initial waste stored). There are provisions in SENDY for users to modify the program to perform other mathematical manipulations on the two matrices.

SENDY indentifies the particular matrix by the unique headings of the matrix. It compares the matrix heading it reads on the tape with that of the input heading read from a card. Once the matrix heading on the tape matches that on the card, it reads and stores the entire matrix in the core. Input to SENDY consists of identification of magnetic tape volumes which store the two cases to be compared, headings identifying the matrix in each of the cases to be compared, and commands the comparison or normalizing operation to be performed.

AMRAW-A points out 9 variables in its output: 3 in section 2, one in sections 3 and 4, and 4 in section 5. In order to simplify the modification of SENDY to suit different users, the program is partitioned into 7 parts; namely, JCLSENDY, SENDYGEN, SENDY3A, SENDY4A, SENDY5A, SENDY5B and DDSENDY. A complete SENDY run consists of these 7 parts, plus input cards with commands and headings (see Figures J-1 and J-2).

SENDY first reads in commands (compare case n_1 with case n_2) and headings. Then it searches through the tape and locates the matrix whose headings match the one desired. After reading from tape, storing and printing out the matrix from each of the two cases, the arithmetical calculation on the two matrices is performed. After these calculations, the whole loop is repeated if requested (see Figure J-1).

DDSENDY is an integral part of SENDY consisting of the data set definition statements and the statements STOP/END. The data set reference number in the DD statement is made to be identical with the case number which was stored on the tape volume as addressed in the DD statement.

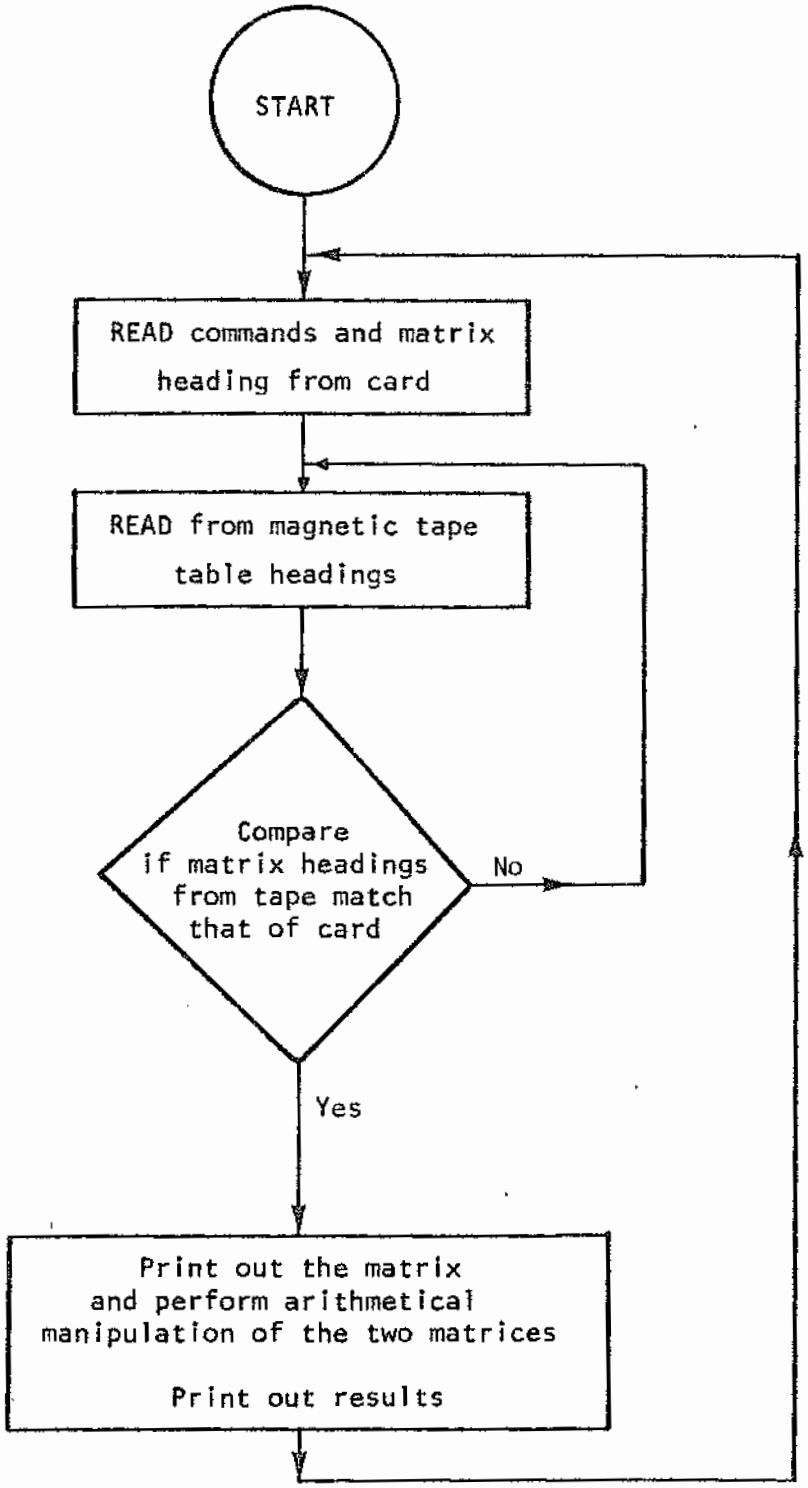

Figure J-1. SENDY simplified flowchart.

*

Heading

Command

Zone

Heading

Command

Heading

Command (e.g., compare case n_1 with n_2) 7

DDSENDY (JCL)

SENDY5B

SENDY5A

SENDY4A

SENDY3A

SENDYGEN

JCLSENDY

Sensitivity Study

Figure J-2. SENDY operating deck setup.

Description of Card Input. One card of each type is required.

Card Type	Format and Item	Description
1	FORMAT (10A4, I2, 2A4, A3, I2, T79, I2) Commands	
	EXPLAN(I)	Compare case n_1 with n_2.
	IP1	In column 41; first case number to compare (n_1).
	IP2	In column 54; second case number to compare (n_2).
	IMATH	Column 80, flags that control calculations options: IMATH Operation: 1 Normalized for case n_1. 2 Normalized for case n_2. 3 Normalized for case n_1 and n_2. 4 Dummy (for modification). 5 Dummy (for modification). 6 Dummy (for modification). 7 Ratio: first case, n_1, divided by second case, n_2.
2	FORMAT (17A4, A2, T77, A2, I1, A1) Heading	
	TITLE(I)	Store the heading of the desired matrix from card; column 1 to column 70.
	ISECT(3)	Section of output; column 77, 78.
	ISECT3	A code to aid in locating the matrix on tape: column 79, for ISECT3 (integer 3, 4, or 5 for AMRAW-A output section).
	CODE	Flag A or B in column 80. ISECT(3), ISECT3, and CODE appear on card as follows:

Section	AMRAW-A Item	
3	Local Dose, MAN1L	$_b$33A
4	Nonspecific Dose, MAN1N	$_b$44A
5	Local Dose, MAN2L	$_b$55A
5	Nonspecific Dose, MAN2NF	$_b$55B

3	FORMAT (T6, IZ)	Zone heading
	IZ	Additional table identifier where needed. Zone number as appeared on the left hand side of output pages: 1, 3, 5, or 7. Card required only for MAN2L from AMRAW-A with present output format.

Modification of SENDY. Calculation options may be added. Replace a CONTINUE statement by the mathematical routine desired. The matrix of the first case read in is stored in the variable that begins with an X in front of the original variable name. The second case is stored as the original variable name. The original variable with a Y in front can be used to store intermediate results. For example, SENDY4A deals with the variable MAN1N. The matrix from the first case is stored in XMAN1N, and from the second case as MAN1N. Variable YMAN1N is used to store intermediate results.

Statement numbers in each section of SENDY containing dummy "CONTINUE" statements and the corresponding IMATH flag are as follows:

	SENDY SECTION			
IMATH	3A	4A	5A	5B
4	2431	2535	2632	2732
5	2441	2545	2642	2742
6	2451	2555	2652	2752

Listing. Table J-2 presents the SENDY listing.

Sample Input. Sample input for a simple application of SENDY for comparison of nonspecific dose rates (AMRAW-A Section 3) from C-14. is presented. The comparison requested is to divide each value in the table from Case 55 by the corresponding value in the table from Case 48 (IMATH = 7) and output the resulting table of quotients. The input required is as follows:

Column 80

```
** SENSITIVITY ANALYSIS : COMPARE CASE 55 WITH CASE 48.      7
NONSPECIFIC ... NUCLIDE=    C-14   K=  1                     44A
```

Table J-2 (a). File SENDYGEN

```
      REAL X(3,4,50),XR1J(4,50),XR2TOT(4,50,8)
      REAL Y(3,4,50),YR1J(4,50),YR2TOT(4,50,8)
      REAL R(3,4,50),R1J(4,50),R2TOT(4,50,8)
      REAL XMAN1L(50,8),YMAN1L(50,8),MAN1L(50,8)
      REAL TIME(50)
      REAL XMAN1N(50,8),XAN2LF(50,8,4),XMAN2L(50,8),XAN2NF(50,4),
     CXMAN2N(50)
      REAL YMAN1N(50,8),YAN2LF(50,8,4),YMAN2L(50,8),YAN2NF(50,4),
     CYMAN2N(50)
      REAL MAN1N(50,8),MAN2LF(50,8,4),MAN2L(50,8),MAN2NF(50,4),MAN2N(50)
      EQUIVALENCE (X(1),XR1J(1),XR2TOT(1),XMAN1L(1),XMAN1N(1),XAN2LF(1),
     CXAN2NF(1)),(XMAN2L(1),XMAN2N(1))
      EQUIVALENCE (Y(1),YR1J(1),YR2TOT(1),YMAN1L(1),YMAN1N(1),YAN2LF(1),
     CYAN2NF(1)),(YMAN2L(1),YMAN2N(1))
      EQUIVALENCE (R(1),R1J(1),R2TOT(1),MAN1L(1),MAN1N(1),MAN2LF(1),MAN2
     CNF(1)),(MAN2L(1),MAN2N(1))
      INTEGER*4 JN(9),VAR(5),TITLE(17),CHECK(33),SECT(3),EXPLAN(15),IY,
     CIP1,IP2,IP1F,MT,IP,IN,NJ(4)
      DATA VAR/'9F10','.0,I','5,1P','9E1','2,2'/
      DATA JN/'1E1','2E1','3E1','4E1','5E1','6E1','7E1','8E1','9E1'/
      DATA NJ/3,3,3,1/
      DATA A,B,C/'A','B','C'/
      DATA SECT(1),SECT(2)/'SECT','ION '/
      IN=5
      IP=6
      MT=50
      MJF=4
      MIH=8
      TWASTE=187000.00
C     UNM COMPUTER SYSTUM ASSIGN DATA SET REFERENCE NUIMBER:
C     5 FOR CARD READER,6 FOR PRINTER.
C*****READ INPUT COMMAND : DETERMINE CASES TO COMPARE WITH. ******************
    1 READ(IN,1100,ERR=9990,END=9990)(EXPLAN(I),I=1,10),IP1,(EXPLAN(I),I
     C=11,13),IP2,IMATH
      IP1F=IP1
      WRITE(IP,1101)(EXPLAN(I),I=1,10),IP1,(EXPLAN(I),I=11,13),IP2
      IY=0
      READ(IN,1102)(TITLE(I),I=1,18),SECT(3),ISECT3,CODE
    2 IY=IY+1
      IF(IY.EQ.2) IP1=IP2
      GO TO (20,20,30,40,50),ISECT3
   20 READ(IP1,1103)
   80 DO 11 J=1,900
      READ(IP1,1104)(CHECK(I),I=16,18)
      WRITE(IP,1104)(CHECK(I),I=16,18)
      IF(CHECK(16).EQ.SECT(1).AND.CHECK(17).EQ.SECT(2).AND.CHECK(18).EQ.
     CSECT(3)) GO TO 2050
   11 CONTINUE
      WRITE(IP,1105)(TITLE(I),I=1,18)
      IF(ISECT3.EQ.2.AND.CODE.EQ.C) READ(IN,1100) DUMMY
      IF(ISECT3.EQ.5.AND.CODE.EQ.A) READ(IN,1100) DUMMY

      GO TO 1
   30 READ(IP1,1106)
      GO TO 80
   40 READ(IP1,1107)
      GO TO 80
   50 READ(IP1,1113)
      GO TO 80
 2050 READ(IP1,1108)
      IF(ISECT3.EQ.2.AND.CODE.EQ.A) GO TO 2100
      IF(ISECT3.EQ.2.AND.CODE.EQ.B) GO TO 2200
      IF(ISECT3.EQ.2.AND.CODE.EQ.C) GO TO 2300
      IF(ISECT3.EQ.3.AND.CODE.EQ.A) GO TO 2400
      IF(ISECT3.EQ.4.AND.CODE.EQ.A) GO TO 2500
      IF(ISECT3.EQ.5.AND.CODE.EQ.A) GO TO 2600
      IF(ISECT3.EQ.5.AND.CODE.EQ.B) GO TO 2700
 1100 FORMAT(10A4,I2,2A4,A3,I2,T79,I2)
 1101 FORMAT(1H1,10A4,I2,2A4,A3,I2)
 1102 FORMAT(17A4,A2,T77,A2,I1,A1)
 1103 FORMAT(4(255(/)),27(/))
 1104 FORMAT(1X,T61,2A4,A2)
 1105 FORMAT(1H1,'** OUTPUT MATRIX OF :',18A4,' CANNOT BE FOUND.'//' CHE
     CCK STATEMENT NUMBER 10,20 OR 30.'/)
 1106 FORMAT(51(255(/)),54(/))
 1107 FORMAT(95(255(/)),95(/))
 1108 FORMAT(29(/))
 1109 FORMAT(1H1,'RATIO OF TWO OUTPUT MATRIXES',/' CASE',I4,' DIVIDED BY
     C CASE',I4/1X,'**IN THIS MATRIX, THE ELEMENTS ARE RATIO OF CORRE',
     C'SPONDING ELEMENTS IN THE PRECEEDING TWO MATRIXES'/' -1.00 STANDS
     CFOR ZERO DIVIDED BY ZERO. -X STANDS FOR X DIVIDED BY ZERO',
     C/2H0(,17A4,A2,1H))
 1110 FORMAT(1X,33A4)
 1111 FORMAT(33A4)
 1112 FORMAT(1H1,'INITIAL TOTAL INVENTORY OF WASTE=',F12.2,' METRIC TON'
     C/1X,17A4,A2,4X,'CASE',I4,/' NORMALIZED DOSE .'///)
 1113 FORMAT(101(255(/)),28(/))
```

Table J-2 (b). File SENDY3A

```
C*************************************3A*************************************
C     READ MATRIX HEADINGS FROM TAPE.
 2400 DO 2406 K=1,2
      READ(IP1,1111)(CHECK(I),I=1,33)
 2406 WRITE(IP,1111)(CHECK(I),I=1,33)
 2410 READ(IP1,1110)(CHECK(I),I=1,7)
      DO 2420 I=1,7
      IF(CHECK(I).NE.TITLE(I)) GO TO 2430
 2420 CONTINUE
      WRITE(IP,1241)(TITLE(I),I=1,7),IP1
      DO 2407 K=1,3
      READ(IP1,1110)(CHECK(I),I=1,33)
 2407 WRITE(IP,1110)(CHECK(I),I=1,33)
      IF(IY.EQ.2) GO TO 2440
C     OUTPUT THE MATRIX FROM FIRST CASE FOR COMPARISON.
      DO 2450 IT=1,MT
 2450 READ(IP1,1242) TIME(IT),(XMAN1L(IT,IH),IH=1,MIH)
      REWIND IP1
      DO 2460 IT=1,MT
 2460 WRITE(IP,1242)TIME(IT),(XMAN1L(IT,IH),IH=1,MIH)
      GO TO 2
C     OUTPUT MATRIX FROM SECOND CASE FOR COMPARISON.
 2440 DO 2470 IT=1,MT
      READ(IP1,1242)TIME(IT),(MAN1L(IT,IH),IH=1,MIH)
 2470 WRITE(IP,1242)TIME(IT),(MAN1L(IT,IH),IH=1,MIH)
      REWIND IP1
      GO TO (2411,2421,2411,2431,2441,2451,2461),IMATH
 2411 IF(IMATH.NE.1.AND.IMATH.NE.3) GO TO 2421
      WRITE(IP,1112) TWASTE,(TITLE(I),I=1,17),IP1F
      DO 2412 IT=1,MT
      DO 2413 IH=1,MIH
 2413 YMAN1L(IT,IH)=XMAN1L(IT,IH)/TWASTE
 2412 WRITE(IP,1242) TIME(IT),(YMAN1L(IT,IH),IH=1,MIH)
 2421 IF(IMATH.NE.2.AND.IMATH.NE.3) GO TO 2431
      WRITE(IP,1112) TWASTE,(TITLE(I),I=1,17),IP2
      DO 2422 IT=1,MT
      DO 2423 IH=1,MIH
 2423 YMAN1L(IT,IH)=MAN1L(IT,IH)/TWASTE
 2422 WRITE(IP,1242) TIME(IT),(YMAN1L(IT,IH),IH=1,MIH)
 2431 CONTINUE
 2441 CONTINUE
 2451 CONTINUE
C     CALCULATE THE RATIO OF TWO MATRIXES.
 2461 DO 2480 IT=1,MT
      DO 2490 IH=1,MIH
      IF(MAN1L(IT,IH).NE.0.0) GO TO 2490
      IF(XMAN1L(IT,IH).NE.0.0) XMAN1L(IT,IH)=1.0
      MAN1L(IT,IH)=-1.0
 2490 MAN1L(IT,IH)=XMAN1L(IT,IH)/MAN1L(IT,IH)
 2480 CONTINUE
C     PRINT THE RATIO MATRIX.
      WRITE(IP,1109) IP1F,IP2,(TITLE(I),I=1,17)
      DO 2491 IT=1,MT
 2491 WRITE(IP,1242) TIME(IT),(MAN1L(IT,IH),IH=1,MIH)
      GO TO 1
 2430 READ(IP1,1243)
      GO TO 2410
 1241 FORMAT(1X,7A4,T62,'CASE',I4)
 1242 FORMAT(0PF11.0,1P10E10.2)
 1243 FORMAT(54(/))
```

Table J-2 (c). File SENDY4A

```
C*****************************************4A*************************************
C       READ MATRIX HEADINGS FROM TAPE.
 2500 DO 2506 K=1,2
      READ(IP1,1111)(CHECK(I),I=1,33)
 2506 WRITE(IP,1111)(CHECK(I),I=1,33)
 2530 READ(IP1,1110)(CHECK(I),I=1,33)
      DO 2510 I=1,10
      IF(CHECK(I).NE.TITLE(I)) GO TO 2520
 2510 CONTINUE
C       PRINT OUT HEADINGS
      WRITE(IP,1250)(CHECK(I),I=1,10),IP1
      DO 2521 J=1,3
      READ(IP1,1110)(CHECK(I),I=1,33)
 2521 WRITE(IP,1110)(CHECK(I),I=1,33)
      IF(IY.EQ.2) GO TO 2540
C       OUTPUT THE MATRIX FROM FIRST CASE FOR COMPARISON.
      DO 2550 IT=1,MT
 2550 READ(IP1,1251) TIME(IT),(XMAN1N(IT,IH),IH=1,MIH)
      REWIND IP1
      DO 2551 IT=1,MT
 2551 WRITE(IP,1251) TIME(IT),(XMAN1N(IT,IH),IH=1,MIH)
      GO TO 2
C       OUTPUT THE MATRIX FROM SECOND CASE FOR COMPARISON.
 2540 DO 2560 IT=1,MT
      READ(IP1,1251) TIME(IT),(MAN1N(IT,IH),IH=1,MIH)
 2560 WRITE(IP,1251) TIME(IT),(MAN1N(IT,IH),IH=1,MIH)
      REWIND IP1
      GO TO (2515,2525,2515,2535,2545,2555,2565),IMATH
 2515 IF(IMATH.NE.1.AND.IMATH.NE.3) GO TO 2525
      WRITE(IP,1112) TWASTE,(TITLE(I),I=1,18),IP1F
      DO 2516 IT=1,MT
      DO 2517 IH=1,MIH
 2517 YMAN1N(IT,IH)=XMAN1N(IT,IH)/TWASTE
 2516 WRITE(IP,1251) TIME(IT),(YMAN1N(IT,IH),IH=1,MIH)
 2525 IF(IMATH.NE.2.AND.IMATH.NE.3) GO TO 2535
      WRITE(IP,1112) TWASTE,(TITLE(I),I=1,18),IP2
      DO 2526 IT=1,MT
      DO 2527 IH=1,MIH
 2527 YMAN1N(IT,IH)=MAN1N(IT,IH)/TWASTE
 2526 WRITE(IP,1251) TIME(IT),(YMAN1N(IT,IH),IH=1,MIH)
 2535 CONTINUE
 2545 CONTINUE
 2555 CONTINUE
C       CALCULATE THE RATIO OF TWO MATRIXES.
 2565 DO 2570 IT=1,MT
      DO 2580 IH=1,MIH
      IF(MAN1N(IT,IH).NE.0.0) GO TO 2580
      IF(XMAN1N(IT,IH).EQ.0.0) XMAN1N(IT,IH)=1.0
      MAN1N(IT,IH)=-1.0
 2580 MAN1N(IT,IH)=XMAN1N(IT,IH)/MAN1N(IT,IH)
 2570 CONTINUE

C       PRINT THE RATIUO MATRIX.
      WRITE(IP,1109) IP1F,IP2,(TITLE(I),I=1,18)
      DO 2590 IT=1,MT
 2590 WRITE(IP,1251) TIME(IT),(MAN1N(IT,IH),IH=1,MIH)
      GO TO 1
 2520 READ(IP1,1252)
      GO TO 2530
 1250 FORMAT(1X,10A4,T62,'CASE',I4)
 1251 FORMAT(F11.0,1P10E10.2)
 1252 FORMAT(54(/))
```

Table J-2 (d). File SENDY5A

```
1000 C*********************************5A*****************************************
1030  2600 IF(IY.EQ.1) READ(IN,1261) IZA,IZB
1032       DO 2625 J=1,2
1034       READ(IP1,1111)(CHECK(I),I=1,33)
1036  2625 WRITE(IP,1111)(CHECK(I),I=1,33)
1040  2630 READ(IP1,1110)(CHECK(I),I=1,33)
1050  2610 DO 2620 I=1,17
1060       IF(CHECK(I).NE.TITLE(I)) GO TO 2640
1070  2620 CONTINUE
1080       WRITE(IP,1263)(CHECK(I),I=1,18),IP1
1100       READ(IP1,1110)(CHECK(I),I=1,33)
1110       WRITE(IP,1110)(CHECK(I),I=1,33)
1120  2631 READ(IP1,1262) IZ,IZP1
1130       IF(IZ.NE.IZA) GO TO 2650
1140       WRITE(IP,1264) IZ,IZP1
1150 C     PRINT HEADINGS.
1160       DO 2660 J=1,4
1170       READ(IP1,1110)(CHECK(I),I=1,33)
1180  2660 WRITE(IP,1110)(CHECK(I),I=1,33)
1190       IF(IY.EQ.2) GO TO 2690
1200 C     OUTPUT THE MATRIX FROM FIRST CASE FOR COMPARISON.
1210       DO 2670 IT=1,MT
1220  2670 READ(IP1,1265) TIME(IT),(XAN2LF(IT,IZ,JF),JF=1,MJF),XMAN2L(IT,IZ),
1230      CTIME(IT),(XAN2LF(IT,IZP1,JF),JF=1,MJF),XMAN2L(IT,IZP1)
1240       REWIND IP1
1250       DO 2680 IT=1,MT
1260  2680 WRITE(IP,1265) TIME(IT),(XAN2LF(IT,IZ,JF),JF=1,MJF),XMAN2L(IT,IZ),
1270      CTIME(IT),(XAN2LF(IT,IZP1,JF),JF=1,MJF),XMAN2L(IT,IZP1)
1280       GO TO 2
1290 C     OUTPUT THE MATRIX FROM SECOND CASE FOR COMPARISON.
1300  2690 DO 2691 IT=1,MT
1310  2691 READ(IP1,1265) TIME(IT),(MAN2LF(IT,IZ,JF),JF=1,MJF),MAN2L(IT,IZ),
1320      CTIME(IT),(MAN2LF(IT,IZP1,JF),JF=1,MJF),MAN2L(IT,IZP1)
1330       WRITE(IP,1265)(TIME(IT),(MAN2LF(IT,IZ,JF),JF=1,MJF),MAN2L(IT,IZ),
1340      CTIME(IT),(MAN2LF(IT,IZP1,JF),JF=1,MJF),MAN2L(IT,IZP1),IT=1,MT)
1350       REWIND IP1
1360       GO TO (2612,2622,2612,2632,2642,2652,2662),IMATH
1370  2612 IF(IMATH.NE.1.AND.IMATH.NE.3) GO TO 2622
1380       WRITE(IP,1112) TWASTE,(TITLE(I),I=1,18),IP1F
1390       DO 2613 IT=1,MT
1400       DO 2614 JF=1,MJF
1410       YAN2LF(IT,IZ,JF)=XAN2LF(IT,IZ,JF)/TWASTE
1420  2614 YAN2LF(IT,IZP1,JF)=XAN2LF(IT,IZP1,JF)/TWASTE
1430       YMAN2L(IT,IZ)=XMAN2L(IT,IZ)/TWASTE
1440       YMAN2L(IT,IZP1)=XMAN2L(IT,IZP1)/TWASTE
1450  2613 WRITE(IP,1265) TIME(IT),(YAN2LF(IT,IZ,JF),JF=1,MJF),YMAN2L(IT,IZ),
1460      CTIME(IT),(YAN2LF(IT,IZP1,JF),JF=1,MJF),YMAN2L(IT,IZP1)
1470  2622 IF(IMATH.NE.2.AND.IMATH.NE.3) GO TO 2632
1480       WRITE(IP,1112) TWASTE,(TITLE(I),I=1,18),IP2
1490       DO 2623 IT=1,MT
1500       DO 2624 JF=1,MJF
1510       YAN2LF(IT,IZ,JF)=MAN2LF(IT,IZ,JF)/TWASTE
1520  2624 YAN2LF(IT,IZP1,JF)=MAN2LF(IT,IZP1,JF)/TWASTE
1530       YMAN2L(IT,IZ)=MAN2L(IT,IZ)/TWASTE
1540       YMAN2L(IT,IZP1)=MAN2L(IT,IZP1)/TWASTE
1550  2623 WRITE(IP,1265) TIME(IT),(YAN2LF(IT,IZ,JF),JF=1,MJF),YMAN2L(IT,IZ),
1560      CTIME(IT),(YAN2LF(IT,IZP1,JF),JF=1,MJF),YMAN2L(IT,IZP1)
1570  2632 CONTINUE
1580  2642 CONTINUE
1590  2652 CONTINUE
1600 C     CALCULATE THE RATIO OF TWO MATRIXES.
1610  2662 DO 2695 IT=1,MT
1620       DO 2697 JF=1,MJF
1630       IF(MAN2LF(IT,IZ,JF).NE.0.0) GO TO 269
1640       IF(XAN2LF(IT,IZ,JF).EQ.0.0) XAN2LF(IT,IZ,JF)=1.0
1650       MAN2LF(IT,IZ,JF)=-1.0
1660   269 MAN2LF(IT,IZ,JF)=XAN2LF(IT,IZ,JF)/MAN2LF(IT,IZ,JF)
1670       IF(MAN2LF(IT,IZP1,JF).NE.0.0) GO TO 2696
1680       IF(XAN2LF(IT,IZP1,JF).EQ.0.0) XAN2LF(IT,IZP1,JF)=1.0
1690       MAN2LF(IT,IZP1,JF)=-1.0
1700  2696 MAN2LF(IT,IZP1,JF)=XAN2LF(IT,IZP1,JF)/MAN2LF(IT,IZP1,JF)
1710  2697 CONTINUE
1720       IF(MAN2L(IT,IZ).NE.0.0) GO TO 270
1730       IF(XMAN2L(IT,IZ).EQ.0.0) XMAN2L(IT,IZ)=1.0
1740       MAN2L(IT,IZ)=-1.0
1750   270 MAN2L(IT,IZ)=XMAN2L(IT,IZ)/MAN2L(IT,IZ)
1760       IF(MAN2L(IT,IZP1).NE.0.0) GO TO 271
1770       IF(MAN2L(IT,IZP1).EQ.0.0) XMAN2L(IT,IZP1)=1.0
1780       MAN2L(IT,IZP1)=-1.0
1790   271 MAN2L(IT,IZP1)=XMAN2L(IT,IZP1)/MAN2L(IT,IZP1)
1800  2695 CONTINUE
1810 C     PRINT THE RATIO MATRIX
1820       WRITE(IP,1109) IP1F,IP2,(TITLE(I),I=1,18)
1830       DO 2698 IT=1,MT
1840  2698 WRITE(IP,1265) TIME(IT),(MAN2LF(IT,IZ,JF),JF=1,MJF),MAN2L(IT,IZ),
1850      CTIME(IT),(MAN2LF(IT,IZP1,JF),JF=1,MJF),MAN2L(IT,IZP1)
1860       GO TO 1
1870  2640 READ(IP1,1266)
1880       GO TO 2630
1890  2650 READ(IP1,1267)
1900       GO TO 2631
1920  1261 FORMAT(T6,I2,T79,I2)
1930  1262 FORMAT(T8,I2,T76,I2)
1940  1263 FORMAT(1X,18A4,T76,'CASE',I4)
1950  1264 FORMAT(2X,'ZONE=',I2,T71,'ZONE=',I2)
1960  1265 FORMAT(0PF9.0,1P5E10.2,1X,0PF9.0,1P5E10.2)
1970  1266 FORMAT(234(/))
1980  1267 FORMAT(57(/))
```

Table J-2 (e). File SENDY5B

```
1000 C*****************************************5B*************************************
1010 C      SKIP 1887 RECORDS AND READ HEADINGS OF MATRIX FROM TAPE.
1020  2700 READ(IP1,1270)
1022       DO 2729 J=1,2
1024       READ(IP1,1111)(CHECK(I),I=1,33)
1026  2729 WRITE(IP,1111)(CHECK(I),I=1,33)
1030  2730 READ(IP1,1110)(CHECK(I),I=1,33)
1040       DO 2710 I=1,17
1050       IF (CHECK(I).NE.TITLE(I)) GO TO 2720
1060  2710 CONTINUE
1070 C      PRINT HEADINGS.
1080       WRITE(IP,1271)(CHECK(I),I=1,18),IP1
1090       DO 2711 K=1,4
1100       READ(IP1,1110)(CHECK(I),I=1,33)
1110  2711 WRITE(IP,1110)(CHECK(I),I=1,33)
1120       IF(IY.EQ.2) GO TO 2740
1130 C      OUTPUT THE MATRIX FROM FIRST CASE FOR COMPARISON.
1140       DO 2750 IT=1,MT
1150  2750 READ(IP1,1272) TIME(IT),(XAN2NF(IT,JF),JF=1,MJF),XMAN2N(IT)
1160       REWIND IP1
1170       DO 2760 IT=1,MT
1180  2760 WRITE(IP,1272) TIME(IT),(XAN2NF(IT,JF),JF=1,MJF),XMAN2N(IT)
1190       GO TO 2
1200 C      OUTPUT THE MATRIX FROM SECOND CASE FOR COMPARISON.
1210  2740 DO 2770 IT=1,MT
1220       READ(IP1,1272) TIME(IT),(MAN2NF(IT,JF),JF=1,MJF),MAN2N(IT)
1230  2770 WRITE(IP,1272) TIME(IT),(MAN2NF(IT,JF),JF=1,MJF),MAN2N(IT)
1240       REWIND IP1
1250       GO TO (2712,2722,2712,2732,2742,2752,2762),IMATH
1260  2712 IF(IMATH.NE.1.AND.IMATH.NE.3) GO TO 2722
1270       WRITE(IP,1112) TWASTE,(TITLE(I),I=1,18),IP1F
1280       DO 2713 IT=1,MT
1290       DO 2714 JF=1,MJF
1300  2714 YAN2NF(IT,JF)=XAN2NF(IT,JF)/TWASTE
1310       YMAN2N(IT)=XMAN2N(IT)/TWASTE
1320  2713 WRITE(IP,1272) TIME(IT),(YAN2NF(IT,JF),JF=1,MJF),YMAN2N(IT)
1330  2722 IF(IMATH.NE.2.AND.IMATH.NE.3) GO TO 2732
1340       WRITE(IP,1112)TWASTE,(TITLE(I),I=1,18),IP2
1350       DO 2723 IT=1,MT
1360       DO 2724 JF=1,MJF
1370  2724 YAN2NF(IT,JF)=MAN2NF(IT,JF)/TWASTE
1380       YMAN2N(IT)=MAN2N(IT)/TWASTE
1390  2723 WRITE(IP,1272) TIME(IT),(YAN2NF(IT,JF),JF=1,MJF),YMAN2N(IT)
1400  2732 CONTINUE
1410  2742 CONTINUE
1420  2752 CONTINUE
1430 C      CALCULATE THE RATIO OF TWO MATRIXES.
1440  2762 DO 2780 IT=1,MT
1450       DO 2790 JF=1,MJF
1460       IF(MAN2NF(IT,JF).NE.0.0) GO TO 2790
1470       IF(XAN2NF(IT,JF).EQ.0.0) XAN2NF(IT,JF)=1.0

1480       MAN2NF(IT,JF)=-1.0
1490  2790 MAN2NF(IT,JF)=XAN2NF(IT,JF)/MAN2NF(IT,JF)
1500       IF(MAN2N(IT).NE.0.0) GO TO 279
1510       IF(XMAN2N(IT).EQ.0.0) XMAN2N(IT)=1.0
1520       MAN2N(IT)=-1.0
1530   279 MAN2N(IT)=XMAN2N(IT)/MAN2N(IT)
1540  2780 CONTINUE
1550 C      PRINT OUT THE RATIO MATRIX.
1560       WRITE(IP,1109) IP1F,IP2,(TITLE(I),I=1,18)
1570       DO 2791 IT=1,MT
1580  2791 WRITE(IP,1272) TIME(IT),(MAN2NF(IT,JF),JF=1,MJF),MAN2N(IT)
1590       GO TO 1
1600  2720 READ(IP1,1273)
1610       GO TO 2730
1620  1270 FORMAT(7(255(/)),102(/))
1630  1271 FORMAT(1X,18A4,T76,'CASE',I4)
1640  1272 FORMAT(F12.0,1P5E10.2)
1650  1273 FORMAT(55(/))
```

Table J-2 (f). File DDSENDY (i.e., JCL)

```
1000  9990 STOP
1010       END
1020 //GO.FT48F001 DD UNIT=TAPE9,DSN=EPAJOB,VOL=SER=PE1737,
1030 // LABEL=(1,SL),DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1330),
1040 // DISP=(OLD,PASS)
1080 //GO.FT55F001 DD UNIT=TAPE9,DSN=EPAJOB,VOL=SER=PE1737,
1090 // LABEL=(3,SL),DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1330),
1100 // DISP=(OLD,PASS)
1110 //GO.SYSIN DD *
```

PART 2

AMRAW-B USERS' GUIDE

CHAPTER 6. SUMMARY

CHAPTER 7. INPUT/OUTPUT DESCRIPTION

CHAPTER 8. PROGRAM OPTIONS

CHAPTER 9. ERROR MESSAGES

APPENDICES: K THROUGH T

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CHAPTER 6

SUMMARY

A. PROGRAM SUMMARY

Title: AMRAW-B; Assessment Method for Radioactive Waste (Second Part).

Abstract: AMRAW-B performs a sequence of calculations for an inventory of radioactive wastes, evaluating health effects and economic costs resulting from dose to man calculated by AMRAW-A.

Effective Date: May, 1978.

Programmer: The University of New Mexico staff.

Computer: IBM 360/67.

Language: Fortran IV.

Core Memory Requirement: 124 k bytes.

Execution Time (CP sec): 270.

Auxiliary Hardware Requirements: Disk, Tape, Line Printer.

B. PURPOSE

AMRAW-B, the second part of the Radioactive Waste Management Systems Model, picks up the population dose rates calculated in AMRAW-A and calculates corresponding estimates of health effects and economic costs of these health effects (see Fig. 1-2). These calculations consider the populations in each geographic zone, incidence rates of health effects per unit of radiation dose to a given body organ, and costs based upon the value of small changes in risk.

C. METHOD

The AMRAW Code is written in Fortran IV language. The two parts of the code are: 1) AMRAW-A which contains the Source Term, the Release Model, and the Environmental Model, and 2) AMRAW-B which contains the Economics Model. They are being run separately but may be joined if desired. There is an advantage to running the first part independently to determine sensitivity of environmental concentrations and dose rates to variations in input. Similarly, there is an advantage to running the economic model independently to study the response to varied economic parameters.

The flow of AMRAW-B calculations is best described first using the sequence indicated by Fig. 1-2: 1) determine rate of occurrence of health effects, and 2) perform corresponding damage calculations in economic units. An altered sequence of the actual calculations within AMRAW-B is then described. The matrix of local dose rates from AMRAW-A, to individuals in each zone from each radionuclide to each body site (organ) during each time increment, multiplied by the population of each zone and then multiplied by the set of health effect incidence rates for each body site, obtains the health effect incidence rates in each zone. Similarly, nonspecific dose rates from AMRAW-A (dose to a nonspecific population) multiplied by health effect incidence rates obtains health effect incidence rates corresponding to nonspecific dose. As actually calculated within AMRAW-B, the input incidence rates of health effects, deaths/10^6 man-rem, are first converted to \$/man-rem by multiplying by \$260,000/10^6 (the value \$260,000 is the present input for cost of increased level of risk, VOL). Damage rates, \$/y, in each zone (and the nonspecific category), are calculated by multiplying together: dose rates, populations, and \$/man-rem. The damage rates, \$/y, are accumulated over nuclides and organs in each zone (and nonspecific) versus time. Total damage rates are also accumulated over zones, organs, and times for each nuclide. Damages during each time increment, \$, are then obtained by multiplying rates by the length of each time increment and accumulated over the total time range. Finally, the number of deaths (health effects) during each time increment are obtained by dividing the damages in dollars by \$260,000. Results are obtained for both high

and low population projections.

The present dimensioning of AMRAW-B is as follows:

1) Radionuclides: 25.

2) Geographic Zones: 8 (the nonspecific category is treated as a ninth zone in calculations).

3) Human Organs: 8; typically, one of these is total body.

4) Time Increments: 50.

AMRAW-B runs with 124 k bytes of core storage, 125 tracks (900 k bytes) of disk storage for input data, 10 cylinders (200 tracks or 1440 bytes) of disk storage for intermediate storage, and requires 270 seconds of CPU time in the UNM IBM 360/67 computer. Input data from the major data matrices can be furnished from tape instead of from disk if preferred.

CHAPTER 7

INPUT/OUTPUT DESCRIPTION

Input for AMRAW-B is by an 80 column card data deck. There are 15 card types. As implemented at UNM, the input deck is read from 3 files in disk and/or tape storage. No additional inputs are required. The 3 input data files are as follows:

1) AMB. This file provides economic model control and conversion data, including discount rate (zero presently used), cost assigned to a death, the numbers of times, zones, radionuclides, and organs involved, incidence rates of health effects by body site or organ, high and low population projections by zone, and designation of nuclide decay group.

2) AM1E. This file provides values of time at the end of each time increment, names of each radionuclide, and the mass of each radionuclide (in grams) in the repository inventory at each time.

3) ECONxx (xx is case number). This is the large output matrix, MAN1, of dose rates from AMRAW-A, restructured for AMRAW-B input.

Radionuclide mass versus time is used within AMRAW-B at this time only for calculation of marginal damages ($/gram) by decay group, based upon the accumulated inventory at the time repository operations cease. The full nuclide matrix provides for possible additions to AMRAW-B for allocation of damages to elements in the waste. The dose rate matrix, MAN1, from AMRAW-A is arranged as shown in Table 7-1. With the present dimensioning used, the dose rates are presented in 225 separate tables (9 zones x 25 nuclides). For input to AMRAW-B, this is processed through an auxiliary program, COMPRESS, to strip away headings and the time column, producing a data file with 11,250 lines (from 225 tables x 50 lines each). Each line has dose rate values for 8 organs resulting in 90,000 data items.

Card input is described in the following section. Output is described in Section 7.B.

Table 7-1. Arrangement of AMRAW-A Dose Rate Output: Local Dose Rate by Zone and Nonspecific Dose Rate

---

Zone 1[a]

Nuclide 1

Time Increment 1: Organ 1, Organ 2, ... Organ 8.[b]
2: Organ 1, Organ 2, ... Organ 8.
(repeat for other time increments)
⋮
50: Organ 1, Organ 2, ... Organ 8.

Nuclide 2
(repeat for other nuclides)
⋮
Nuclide 25

Zone 2

(repeat for other zones)
⋮
Zone 8

Nonspecific (handled as Zone 9).[c]

---

[a]Local dose rates are mrem/y.

[b]Organ refers to each body site for which dose rate is calculated.

[c]Nonspecific dose rates are man-rem/y.

A. CARD INPUT SPECIFICATIONS

1. Data Deck Setup. Descriptions and number required of each card type are given in section 2 which follows. The sequence of the data deck, beginning with the first or front card is listed below:

File	Card Type	Items
AMB	1	TITLE
	2	RATE
	3	VOL
	4	NT
	5	MZ
	6	NK
	7	NIHT
	8	SITE, DPY
	9	REG, POPH, POPL
	10	NG
	11	K, IKK
AM1E	12	TIME
	13	NUCNAM, X
	14	X
ECONxx	15	MAN1

2. Description of Card Input. Input data is grouped into 3 sequentially read data files: AMB, AM1E, and ECONxx (where xx denotes the case number from which this file is extracted).

The largest matrix of data is for MAN1 (card type 12). This is the dose rate output from AMRAW-A as selected and restructured by auxiliary program COMPRESS for use as AMRAW-B input. As presently dimensioned, this file can consist of as many as 11,250 cards. Because of its size, this file is handled via tape and/or disk storage.

A list of each card type in input sequence, the necessary card format in each instance, the number of each card type required (one card unless stated otherwise), the data items and their descriptions, plus

other explanatory notes are presented below.

Card Type	Format and Items	Description

The following card types 1 through 11 comprise data file AMB, economic model control and conversion data.

1.	FORMAT (10A4)	
	TITLE	Title of case, up to 40 characters.
2.	FORMAT (15X, F10.0)	
	RATE	Discount rate, expressed as decimal.
3.	FORMAT (15X, F10.0)	
	VOL	Cost of increased level of risk.
4.	FORMAT (20X, I5)	
	NT	Number of times.
5.	FORMAT (20X, I5)	
	MZ	Number of geographic zones.
6.	FORMAT (20X, I5)	
	NK	Number of nuclides.
7.	FORMAT (20X, I5)	
	NIHT	Number of organs (body sites).
8.	FORMAT (5A4, F5.0)	1 card for each of NIHT organs.
	SITE	Name of organ (body site), up to 20 characters.
	DPY	Health effect incidence rate, cases per 10^6 man-rem.
9.	FORMAT (A4, 1X, 2F10.0)	1 card for each of MZ zones.
	REG	Name of zone up to 4 characters
	POPH	High population projection.
	POPL	Low population projection.
10.	FORMAT (3X, 25I3)	
	NG	Number of nuclide decay groups.
11.	FORMAT (3X, 25I3)	1 card for each of NG groups.
	K	Number of nuclides in group.
	IKK(J)	Subscript identity of each of K nuclides in group.

The following card types 12 through 14 comprise data file AM1E which furnishes values of time to be calculated and the nuclide inventory versus time.

Card Type	Format and Items	Description
12.	FORMAT (1P8E10.2) TIME(I)	1 card for each 8 times of NT total. Time in years for each subscripted value of TIME.

One set of the following card types 10 and 11 is required for nuclide K of NK total (e.g., for 25 nuclides and 50 time, 25 x 8 = 200 cards, are required).

13.	FORMAT (A8, 2X, 7E10.2) NUCNAM (K) X(K, IT)	1 card in each nuclide set. Abbreviated name of nuclide (e.g., SR 90 or AM 241M). Inventory quantities for first 7 times IT.
14.	FORMAT (10X, 7E10.2) X(K, IT)	1 card for each 7 times, 8 through NT, in each nuclide group. Inventory quantities for times 8 through NT. This card bypasses rereading NUCNAM, which may be placed on each card along with card sequence number in the 10X field.

The following card type 15 comprises data file ECONxx (xx represents the case number from which the file is extracted). This file is the large matrix which is a portion of AMRAW-A output, providing calculated dose rates.

15.	FORMAT (1P8E10.2) MAN1 (IT, IH)	One set of cards for each Zone IZ of MZ + 1 total (the last "zone" is reserved for "nonspecific dose") (maximum MZ + 1 is 9) within each set is a subset of cards for each nuclide K of NK total (25 maximum), one card for each time 1 of NT total (50 maximum), (e.g., for 9 zones, including the nonspecific category, 25 nuclides, and 50 times, 9 x 25 x 50 = 11,250 cards, are required). Dose rate to each organ IH of NIHT total (8 maximum), at time IT (in Zone IZ via nuclide K).

A sample coding form illustrating the first card of each type is given in Appendix M. More complete sample input is given in Appendix P.

B. OUTPUT DESCRIPTION

AMRAW-B requires two output mediums: disk and line printer.

1. Disk. Intermediate temporary storage of calculated values for each nuclide is on disk. Output can be to disk and/or line printer.

2. Line Printer. The line printer must be capable of 132 characters per line.

3. Output Tables. Output from AMRAW-B is the series of tables listed in the directory in Table 7-2. Table 1 as numbered by AMRAW-B provides average damage rates in each zone, for nonspecific, and the total, versus time. Subtables are for high and low population projections, respectively. Table 2 is a series of tables, one for each time increment giving average damage rates: total for zones, nonspecific, and total by nuclide, for high and low population. Table 3 presents the total discounted present value of damages over the entire time range for each nuclide, subtotals for each decay group and the overall total, for high and low populations. This table also includes marginal damages, by decay group and total, based upon masses in repository inventory at the beginning of the terminal storage phase. Table 4 presents total expected deaths per time interval in each zone, for nonspecific, and the total, versus time. Similarly, Table 5 presents total damages in dollars per time interval. Subtables of Tables 4 and 5 are for high and low populations. Sample output is given in Appendix P.

Table 7-2. Directory of AMRAW-B Output Tables

Table No.	Title or Description	Nuclides	Units				Components				Population	
			$/y	$/Δt[a]	$/10^6 y	Deaths/Δt[a]	Each Zone	Total of zones	Non-specific	Total	High	Low
	Output listing of selected AMRAW-B input											
1-1	Zonal and Total Damages for High Population Projection, $/y.	Total	X				X	X	X	X	X	
1-2	Zonal and Total Damages for Low Population Projection, $/y.	Total	X				X	X	X	X		X
2	One table for each time interval calculated: damages by nuclide, $/y.	25 (1 table for each time interval-43)	X					X	X	X	X	X
3	Discounted Present Values, $, and $/g.	25			X					X	X	X
4-1	High Population Scenario: Number of Deaths Per Time Interval.	Total				X	X	X	X	X	X	
4-2	Low Population Scenario: Number of Deaths Per Time Interval.	Total				X	X	X	X	X		X
5-1	Total Undiscounted Damages for Each Zone for Each Time Interval-High Population, $.	Total		X			X	X	X	X	X	
5-2	Total Undiscounted Damages for Each Zone for Each Time Interval-Low Population, $.	Total		X			X	X	X	X		X

[a]Δt represents the length of time interval calculated.

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CHAPTER 8

PROGRAM OPTIONS

The major class of options is concerned with design of the application. The number of nuclides, geographic zones, times, release scenarios, and environmental pathways may be varied in AMRAW-A within the range of dimensioning and carry over into the AMRAW-B calculations.

There are no options built into AMRAW-B for alternate calculation sequences. There is an option to print or suppress printing of output Table 2. This table consists of 1 page for each time calculated (see Table 2-2 for description). Setting ITB3 = 1 requests printing of output Table 2; setting ITB3 = 0 suppresses printing. Write statements are provided (before and after Format statement 3806) for outputting the large MAN1 input matrix from file ECONxx. The write statements are suppressed by labeling as comment statements. Removal of the "C" from the two lines results in output.

The input/output mediums are specified in statements in the main program which assign values for the variables IN, IP, and IS appropriate to the system being used:

IN specifies an input medium, normally the card reader (at UNM, this is 5).

IP specifies the output medium for the code; this is normally the line printer but it may be set to disk or tape file if preferred, along with appropriate JCL (at UNM, line printer is 6).

IS specifies an input medium with large storage, used for file ECONxx. This can be disk or tape files; the value of IS can be any allowable and free integer as supported by appropriate JCL (at UNM, this may be 1, 3, or 4; 2 is used in AMRAW-B for system disk storage of intermediate calculations).

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CHAPTER 9

ERROR MESSAGES

AMRAW-B in the present version does not generate error messages. No such addition is planned at this point in time. If the computer code fails in a run, it is suggested that the input data formats be checked. Extensive comment statements have been placed in the program for assisting the user to isolate any problems.

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APPENDIX K

BACKGROUND MATERIAL

The basic structure of the AMRAW model and computer code was developed at UNM between 1972 and 1974 as part of the S. Logan Ph.D. dissertation: "A Technology Assessment Methodology Applied to High-Level Radioactive Waste Management," The University of New Mexico, 1974. Additional development proceeded with support from the Sandia Laboratories University Research Program and from the Energy Resources Board of the State of New Mexico. Completion of the model and code was done under EPA Contract No. 68-01-3256 beginning in August, 1975.

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APPENDIX L

SAMPLE RUN REQUEST

AMRAW-B RUN REQUEST

Requested By: _____

Phone: _____ Date: _____

Number of Seconds: _____ No. of Ouput Lines: _____

Number of Copies Requested: _____

Special Form? _____ If so, form no. _____

Input Data On: Disk _____ Disk Name: _____

DSN: _____

Card _____ Tape _____ Tape Name: _____

Label: _____ DSN: _____

- -

O F F I C E U S E O N L Y

Date Received: _____

Date Submitted: _____

Date Returned: _____

Initials: _____

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APPENDIX M

SAMPLE CODING FORM

Table M-1 presents a sample coding form for AMRAW-B input data illustrating proper formats for each of the 15 card types. The data shown is from the base case for terminal storage, reported elsewhere. Only the first card of each card type is illustrated. Card types 1 through 11 comprise data file AMB, card types 12 through 14 comprise data file AM1E and card type 15 represents the large dose rate output file from AMRAW-A: ECONxx. For 9 zones, including one "zone" allocated to non-specific dose rates, 25 nuclides, and 50 times, 11,250 cards of card type 15 are required. Because of the large size of the last file, it is obtained from AMRAW-A and placed on tape or disk by machine processing. File AM1E is obtained from an AMRAW-A input data file via machine processing. Normally, only file AMB requires key punching or typing on a terminal.

Table M-1. Sample Coding Form with First Cards of Each Type Illustrated[a]

Card Type	Card	Column 10 20 30 40 50 60 70 (FORTRAN STATEMENT)	IDENTIFICATION SEQUENCE 80
1	ECON48	- 50 PERIODS - NEW BODY COEFF.	
2	RATE[b]	0.0	
3	VOL	260000.0	
4	NT	50	
5	MZ	8	
6	NK	25	
7	NIHT	8	
8	TOTAL	BODY (REMAIN.) 85	
9	REPO	101 101	
10	NG 11		
11	G01 2	19 25	
12		0.00E+00 5.00E+00 1.00E+01 1.50E+01 2.00E+01 2.50E+01 3.00E+01	4.00E+01
13		C-14 1 0.0 6.14E+01 1.28E+03 4.07E+03 9.99E+03 2.17E+04	4.04E+04
14		C-14 2 4.04E+04 4.04E+04 4.03E+04 4.02E+04 4.02E+04 4.01E+04	4.01E+04
15		0.0 0.0 0.0 0.0 0.0 0.0	0.0

[a] One card each of types 1 - 7 and 10 is required; more than 1 card is generally required for each of the other types.

[b] The variable name on card types 2 - 7 is not read.

APPENDIX N

JOB PROCESSING INSTRUCTIONS

1. Prepare jobcard for computer run using run request as follows:

   Job name - 8 alphanumeric characters.

   Time parameter - number of seconds estimated.

   Lines parameter - number of lines (in thousands) estimated.

   Forms parameter - form number from request.

   Copies parameter - number of copies requested.

2. Input medium:

   Card - keypunch as necessary and place in appropriate section of deck.

   Disk - modify the data definition statement GO.FT01F001 DD card to reflect parameters required by the system.

   Tape - modify the data definition statement GO.FT02F001 DD card to reflect parameters required by the system.

3. Submit job and note date submitted.

4. Return job to requester and note date returned.

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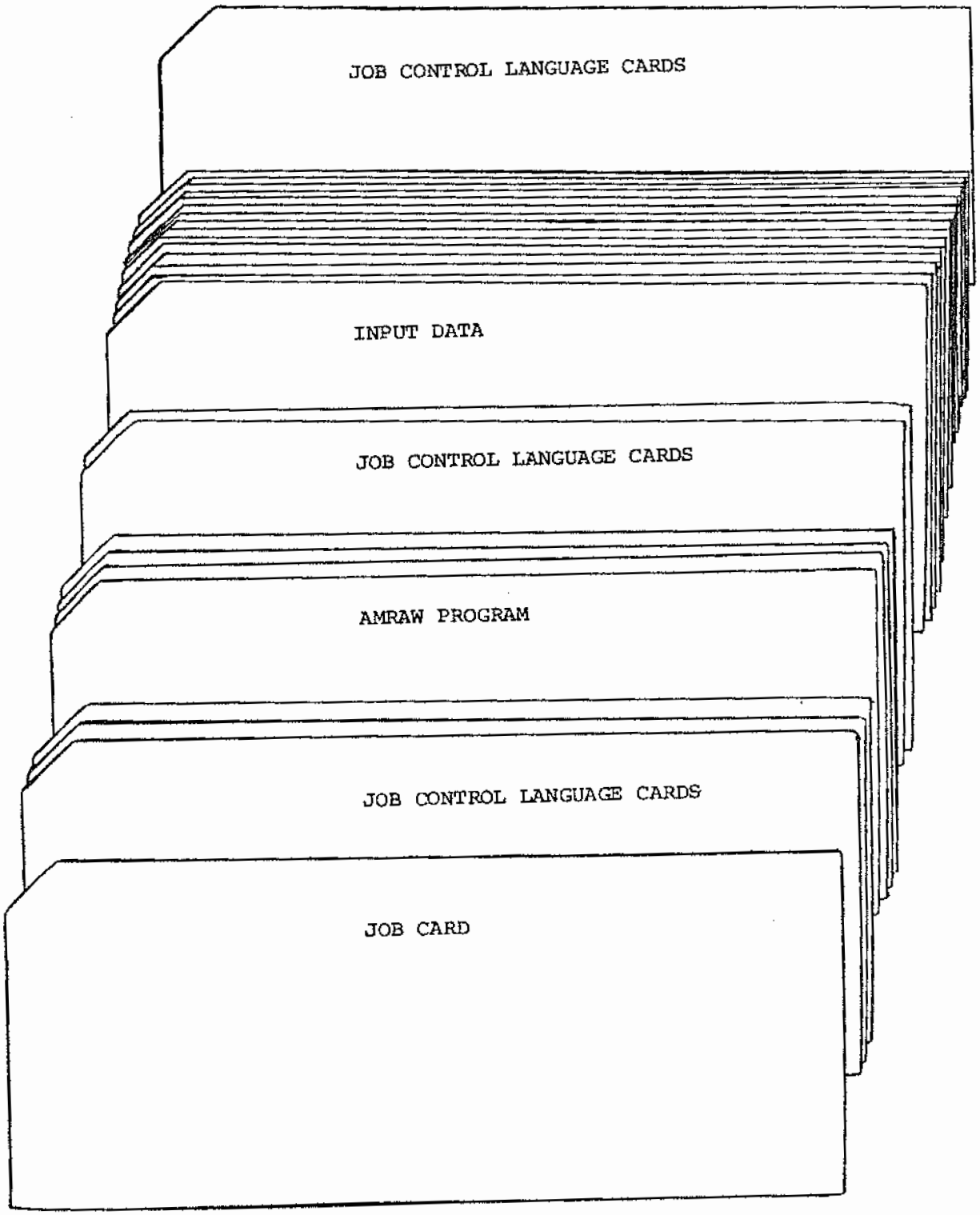
APPENDIX O

OPERATING DECK SETUP



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APPENDIX P

SAMPLE INPUT AND OUTPUT

AMRAW-B Sample Input

Sample input data for the base case for terminal storage phase, Case No. 48, are presented.

1. Table P-1. Data file AMB.[a]

2. Table P-2. Data file AM1E.[a]
   The full file for 50 times and 25 nuclides is 207 lines long; the beginning and end of the file is shown here.

3. Table P-3. Data file ECON48.
   This is the file with designation of form ECONxx for Case No. 48. The full file for 50 times, 25 nuclides, and 8 zones is 11,250 lines long; the beginning and end of the file is shown here, as obtained by processing AMRAW-A output through the auxiliary program, COMPRESS.

4. Tables P-4 and P-5. Sample of AMRAW-A output.
   These tables are a sample of AMRAW-A output prior to processing by COMPRESS to obtain the AMRAW-B input file illustrated in Table P-3.

   Table P-4. Average Annual Local Dose to Individual in Zone 1, from Ra-226, in Millirems/Year.

   Table P-5. Average Annual Nonspecific Dose to Population from Ra-226, in Man-rems/Year.

---

[a]The left hand line number column in these tables is computer-furnished for these listings and is not part of the data files.

Table P-1. Data File AMB

```
      12345678901234567890123456789012345678 90

3980 ECON48 - 50 PERIODS - NEW BODY COEFF.
3990 RATE                          0.0
4000 VOL                      260000.0
4010 NT                             50
4020 MZ                              8
4030 NK                             25
4040 NIHT                            8
4050 TOTAL BODY (REMAIN.)           85
4060 GI TRACT                       34
4070 GONAD(GENETIC)                200
4080 LIVER                           0
4090 LUNG                           44
4100 MARROW(LUKEMIA)                32
4110 BONE                            7
4120 THYROID                         0
4130 REPO          101             101
4140 EDDY        17200            6100
4150 REDB       213000           53600
4160 MIDO       784000          224000
4170 WTEX       217000           57900
4180 LEA        245000           74000
4190 CHAV       253000           67800
4200 REGB       155000           54900
4210 NG  11
4220 G01  2 19 25
4230 G02  5 11 13 15 20 21
4240 G03  6 10 12 14 17 22 24
4250 G04  3 16 18 23
4260 G05  1  1
4270 G06  2  2  3
4280 G07  2  4  5
4290 G08  1  6
4300 G09  1  7
4310 G10  1  8
4320 G11  1  9
```

Table P-2. Data File AM1E

1050	0.00E+00	5.00E+00	1.00E+01	1.50E+01	2.00E+01	2.50E+01	3.00E+01	4.00E+01
1060	5.00E+01	6.00E+01	7.00E+01	8.00E+01	9.00E+01	1.00E+02	2.00E+02	3.00E+02
1070	4.00E+02	5.00E+02	6.00E+02	7.00E+02	8.00E+02	9.00E+02	1.00E+03	2.00E+03
1080	3.00E+03	4.00E+03	5.00E+03	6.00E+03	7.00E+03	8.00E+03	9.00E+03	1.00E+04
1090	2.00E+04	3.00E+04	4.00E+04	5.00E+04	6.00E+04	7.00E+04	8.00E+04	9.00E+04
1100	1.00E+05	2.00E+05	3.00E+05	4.00E+05	5.00E+05	6.00E+05	7.00E+05	8.00E+05
1110	9.00E+05	1.00E+06						
1170	C-14 1	0.0	6.14D+01	1.28D+03	4.07D+03	9.99D+03	2.17D+04	4.04D+04
1180	C-14 2	4.04D+04	4.04D+04	4.03D+04	4.02D+04	4.02D+04	4.01D+04	4.01D+04
1190	C-14 3	3.96D+04	3.91D+04	3.87D+04	3.82D+04	3.77D+04	3.73D+04	3.68D+04
1200	C-14 4	3.64D+04	3.59D+04	3.19D+04	2.82D+04	2.50D+04	2.21D+04	1.95D+04
1210	C-14 5	1.73D+04	1.54D+04	1.36D+04	1.21D+04	3.75D+03	1.07D+03	3.03D+02
1220	C-14 6	8.62D+01	2.49D+01	7.38D+00	2.24D+00	7.02D-01	2.26D-01	2.28D-06
1230	C-14 7	7.03D-12	1.50D-17	3.72D-23	0.0	0.0	0.0	0.0
1240	C-14 8	0.0						
1250	SR-90 1	5.30D+05	3.89D+06	1.06D+07	2.24D+07	4.22D+07	7.11D+07	6.28D+07
1260	SR-90 2	4.91D+07	3.90D+07	3.09D+07	2.43D+07	1.91D+07	1.48D+07	1.15D+07
1270	SR-90 3	8.87D+05	7.72D+04	7.82D+03	7.85D+02	7.21D+01	6.10D+00	4.83D-01
1280	SR-90 4	3.65D-02	2.68D-03	1.62D-14	8.95D-25	0.0	0.0	0.0
1290	SR-90 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1300	SR-90 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1310	SR-90 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1320	SR-90 8	0.0						
1330	Y-90 1	1.38D+02	1.01D+03	2.75D+03	5.82D+03	1.10D+04	1.85D+04	1.63D+04
1340	Y-90 2	1.28D+04	1.02D+04	8.06D+03	6.34D+03	4.95D+03	3.86D+03	2.99D+03
1350	Y-90 3	2.30D+02	2.00D+01	2.03D+00	2.04D-01	1.87D-02	1.58D-03	1.25D-04
1360	Y-90 4	9.48D-06	6.96D-07	4.20D-18	0.0	0.0	0.0	0.0
1370	Y-90 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1380	Y-90 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1390	Y-90 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1400	Y-90 8	0.0						
1410	ZR-93 1	8.44D+05	6.38D+06	1.82D+07	4.00D+07	7.72D+07	1.33D+08	1.33D+08
1420	ZR-93 2	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08
1430	ZR-93 3	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08
1440	ZR-93 4	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.33D+08	1.32D+08
1450	ZR-93 5	1.32D+08	1.32D+08	1.32D+08	1.32D+08	1.31D+08	1.31D+08	1.30D+08
1460	ZR-93 6	1.30D+08	1.29D+08	1.29D+08	1.28D+08	1.28D+08	1.27D+08	1.22D+08
2870	AM-242M 3	5.95D+05	5.69D+05	5.43D+05	5.19D+05	4.95D+05	4.73D+05	4.52D+05
2880	AM-242M 4	2.90D+05	1.83D+05	1.14D+05	7.10D+04	4.44D+04	2.80D+04	1.78D+04
2890	AM-242M 5	1.14D+04	7.40D+03	9.66D+01	8.24D-01	6.08D-03	4.71D-05	4.14D-07
2900	AM-242M 6	4.22D-09	5.02D-11	6.92D-13	1.10D-14	0.0	0.0	0.0
2910	AM-242M 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2920	AM-242M 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2930	AM-243 1	1.08D+05	1.17D+06	9.45D+06	2.55D+07	4.98D+07	7.25D+07	7.25D+07
2940	AM-243 2	7.24D+07	7.23D+07	7.23D+07	7.22D+07	7.21D+07	7.21D+07	7.20D+07
2950	AM-243 3	7.14D+07	7.07D+07	7.00D+07	6.94D+07	6.87D+07	6.81D+07	6.75D+07
2960	AM-243 4	6.69D+07	6.64D+07	6.10D+07	5.54D+07	5.01D+07	4.54D+07	4.13D+07
2970	AM-243 5	3.77D+07	3.45D+07	3.18D+07	2.94D+07	1.29D+07	4.80D+06	1.66D+06
2980	AM-243 6	5.92D+05	2.25D+05	9.11D+04	3.93D+04	1.79D+04	8.56D+03	4.87D+01
2990	AM-243 7	3.75D+00	1.08D+00	6.45D-01	5.98D-01	7.39D-01	1.11D+00	1.91D+00
3000	AM-243 8	3.64D+00						
3010	CM-242 1	3.05D+00	3.09D+01	2.16D+02	5.61D+02	1.07D+03	1.58D+03	1.50D+03
3020	CM-242 2	1.43D+03	1.37D+03	1.31D+03	1.25D+03	1.19D+03	1.14D+03	1.09D+03
3030	CM-242 3	6.98D+02	4.40D+02	2.74D+02	1.71D+02	1.07D+02	6.73D+01	4.28D+01
3040	CM-242 4	2.75D+01	1.78D+01	2.33D-01	1.99D-03	1.47D-05	1.14D-07	1.00D-09
3050	CM-242 5	1.02D-11	1.21D-13	1.67D-15	2.66D-17	1.16D-32	0.0	0.0
3060	CM-242 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3070	CM-242 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3080	CM-242 8	0.0						
3090	CM-244 1	2.66D+04	3.76D+05	3.92D+06	1.03D+07	1.91D+07	2.47D+07	2.04D+07
3100	CM-244 2	1.39D+07	9.73D+06	6.79D+06	4.69D+06	3.21D+06	2.18D+06	1.47D+06
3110	CM-244 3	2.75D+04	6.19D+02	1.76D+01	4.97D-01	1.22D-02	2.63D-04	5.14D-06
3120	CM-244 4	9.33D-08	1.62D-09	0.0	0.0	0.0	0.0	0.0
3130	CM-244 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3140	CM-244 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3150	CM-244 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3160	CM-244 8	0.0						

Table P-3. Data File ECON48

```
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
2.40E-12      3.03E-11      8.05E-13      0.0           3.37E-10      1.28E-11      1.28E-11      0.0
3.41E-12      4.29E-11      1.14E-12      0.0           4.77E-10      1.82E-11      1.82E-11      0.0
4.41E-12      5.55E-11      1.48E-12      0.0           6.17E-10      2.35E-11      2.35E-11      0.0
5.40E-12      6.80E-11      1.81E-12      0.0           7.56E-10      2.88E-11      2.88E-11      0.0
6.39E-12      8.05E-11      2.14E-12      0.0           8.95E-10      3.40E-11      3.40E-11      0.0
7.38E-12      9.29E-11      2.47E-12      0.0           1.03E-09      3.93E-11      3.93E-11      0.0
8.36E-12      1.05E-10      2.80E-12      0.0           1.17E-09      4.46E-11      4.46E-11      0.0
1.82E-11      2.29E-10      6.10E-12      0.0           2.55E-09      9.71E-11      9.71E-11      0.0
2.77E-11      3.49E-10      9.29E-12      0.0           3.89E-09      1.48E-10      1.48E-10      0.0
3.70E-11      4.66E-10      1.24E-11      0.0           5.19E-09      1.97E-10      1.97E-10      0.0
4.61E-11      5.80E-10      1.54E-11      0.0           6.46E-09      2.46E-10      2.46E-10      0.0
5.48E-11      6.90E-10      1.84E-11      0.0           7.68E-09      2.92E-10      2.92E-10      0.0
6.34E-11      7.98E-10      2.12E-11      0.0           8.88E-09      3.38E-10      3.38E-10      0.0
7.17E-11      9.03E-10      2.40E-11      0.0           1.00E-08      3.82E-10      3.82E-10      0.0
7.98E-11      1.00E-09      2.67E-11      0.0           1.12E-08      4.25E-10      4.25E-10      0.0
8.76E-11      1.10E-09      2.93E-11      0.0           1.23E-08      4.67E-10      4.67E-10      0.0
1.65E-10      2.08E-09      5.54E-11      0.0           2.32E-08      8.82E-10      8.82E-10      0.0
2.18E-10      2.75E-09      7.30E-11      0.0           3.06E-08      1.16E-09      1.16E-09      0.0
2.55E-10      3.21E-09      8.53E-11      0.0           3.57E-08      1.36E-09      1.36E-09      0.0
2.79E-10      3.51E-09      9.35E-11      0.0           3.91E-08      1.49E-09      1.49E-09      0.0
2.93E-10      3.69E-09      9.80E-11      0.0           4.10E-08      1.56E-09      1.56E-09      0.0
2.99E-10      3.76E-09      1.00E-10      0.0           4.19E-08      1.59E-09      1.59E-09      0.0
3.00E-10      3.78E-09      1.01E-10      0.0           4.20E-08      1.60E-09      1.60E-09      0.0
2.96E-10      3.73E-09      9.92E-11      0.0           4.15E-08      1.58E-09      1.58E-09      0.0
2.88E-10      3.63E-09      9.66E-11      0.0           4.04E-08      1.54E-09      1.54E-09      0.0
3.54E-10      4.46E-09      1.19E-10      0.0           4.96E-08      1.89E-09      1.89E-09      0.0
1.45E-10      1.83E-09      4.87E-11      0.0           2.04E-08      7.75E-10      7.75E-10      0.0
5.00E-11      6.30E-10      1.67E-11      0.0           7.01E-09      2.67E-10      2.67E-10      0.0
1.61E-11      2.03E-10      5.39E-12      0.0           2.26E-09      8.58E-11      8.58E-11      0.0
5.03E-12      6.34E-11      1.69E-12      0.0           7.05E-10      2.68E-11      2.68E-11      0.0
1.56E-12      1.97E-11      5.24E-13      0.0           2.19E-10      8.33E-12      8.33E-12      0.0
4.90E-13      6.17E-12      1.64E-13      0.0           6.86E-11      2.61E-12      2.61E-12      0.0
1.56E-13      1.96E-12      5.21E-14      0.0           2.18E-11      8.30E-13      8.30E-13      0.0
5.06E-14      6.37E-13      1.69E-14      0.0           7.08E-12      2.69E-13      2.69E-13      0.0
3.16E-14      3.98E-13      1.06E-14      0.0           4.42E-12      1.68E-13      1.68E-13      0.0
3.16E-19      3.97E-18      1.06E-19      0.0           4.42E-17      1.68E-18      1.68E-18      0.0
9.72E-25      1.22E-23      3.25E-25      0.0           1.36E-22      5.18E-24      5.18E-24      0.0
2.08E-31      2.62E-30      6.96E-32      0.0           2.91E-29      1.11E-30      1.11E-30      0.0
5.16E-38      6.50E-37      1.73E-38      0.0           7.23E-36      2.75E-37      2.75E-37      0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0

0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
2.15E-02      4.52E-03      1.75E-02      3.35E-01      0.0           7.27E-01      7.27E-01      0.0
1.49E-02      3.13E-03      1.21E-02      2.32E-01      0.0           5.03E-01      5.03E-01      0.0
1.04E-02      2.19E-03      8.48E-03      1.63E-01      0.0           3.53E-01      3.53E-01      0.0
7.29E-03      1.53E-03      5.91E-03      1.14E-01      0.0           2.46E-01      2.46E-01      0.0
5.03E-03      1.06E-03      4.08E-03      7.84E-02      0.0           1.70E-01      1.70E-01      0.0
3.45E-03      7.24E-04      2.80E-03      5.37E-02      0.0           1.16E-01      1.16E-01      0.0
2.34E-03      4.92E-04      1.90E-03      3.65E-02      0.0           7.91E-02      7.91E-02      0.0
9.58E-04      2.10E-04      8.10E-04      1.56E-02      0.0           3.37E-02      3.37E-02      0.0
1.94E-05      4.08E-06      1.58E-05      3.03E-04      0.0           6.56E-04      6.56E-04      0.0
4.55E-07      9.55E-08      3.69E-07      7.09E-06      0.0           1.54E-05      1.54E-05      0.0
1.34E-08      2.81E-09      1.08E-08      2.08E-07      0.0           4.51E-07      4.51E-07      0.0
3.88E-10      8.15E-11      3.15E-10      6.05E-09      0.0           1.31E-08      1.31E-08      0.0
9.79E-12      2.06E-12      7.94E-12      1.53E-10      0.0           3.31E-10      3.31E-10      0.0
2.17E-13      4.56E-14      1.76E-13      3.38E-12      0.0           7.32E-12      7.32E-12      0.0
4.36E-15      9.15E-16      3.54E-15      6.79E-14      0.0           1.47E-13      1.47E-13      0.0
8.12E-17      1.71E-17      6.59E-17      1.27E-15      0.0           2.74E-15      2.74E-15      0.0
1.78E-18      3.74E-19      1.45E-18      2.78E-17      0.0           6.01E-17      6.01E-17      0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
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Table P-4. Sample of AMRAW-A Output

** AVERAGE ANNUAL LOCAL DOSE TO INDIVIDUAL, MANIL, IN MILLIREMS/YEAR

ZONE= 1... NUCLIDE= RA-226 K= 12

TIME	TOT BODY	GI TRACT	GONADS	LIVER	LUNGS	MARROW	BONE	THYROID
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	1.42E-13	6.24E-16	1.42E-13	5.72E-16	4.13E-13	1.68E-12	1.68E-12	7.25E-16
50.	2.43E-13	1.42E-15	2.44E-13	1.37E-15	7.05E-13	2.87E-12	2.87E-12	1.75E-15
60.	3.82E-13	2.53E-15	3.83E-13	2.49E-15	1.11E-12	4.51E-12	4.51E-12	3.17E-15
70.	5.68E-13	4.04E-15	5.69E-13	4.02E-15	1.65E-12	6.69E-12	6.69E-12	5.12E-15
80.	8.12E-13	6.04E-15	8.14E-13	6.05E-15	2.35E-12	9.56E-12	9.56E-12	7.71E-15
90.	1.12E-12	8.63E-15	1.13E-12	8.67E-15	3.25E-12	1.32E-11	1.32E-11	1.11E-14
100.	1.52E-12	1.19E-14	1.52E-12	1.20E-14	4.39E-12	1.78E-11	1.78E-11	1.53E-14
200.	9.15E-12	7.89E-14	9.18E-12	8.03E-14	2.65E-11	1.08E-10	1.08E-10	1.03E-13
300.	4.10E-11	3.63E-13	4.12E-11	3.70E-13	1.19E-10	4.82E-10	4.82E-10	4.73E-13
400.	1.20E-10	1.07E-12	1.20E-10	1.10E-12	3.46E-10	1.41E-09	1.41E-09	1.40E-12
500.	2.69E-10	2.43E-12	2.70E-10	2.48E-12	7.78E-10	3.16E-09	3.16E-09	3.17E-12
600.	5.14E-10	4.65E-12	5.15E-10	4.76E-12	1.49E-09	6.04E-09	6.04E-09	6.08E-12
700.	8.76E-10	7.97E-12	8.79E-10	8.15E-12	2.53E-09	1.03E-08	1.03E-08	1.04E-11
800.	1.38E-09	1.25E-11	1.38E-09	1.28E-11	3.98E-09	1.62E-08	1.62E-08	1.64E-11
900.	2.03E-09	1.86E-11	2.04E-09	1.90E-11	5.88E-09	2.39E-08	2.39E-08	2.43E-11
1000.	2.87E-09	2.63E-11	2.88E-09	2.69E-11	8.31E-09	3.38E-08	3.38E-08	3.43E-11
2000.	1.61E-08	1.48E-10	1.62E-08	1.52E-10	4.66E-08	1.89E-07	1.89E-07	1.94E-10
3000.	5.88E-08	5.42E-10	5.90E-08	5.55E-10	1.70E-07	6.91E-07	6.91E-07	7.09E-10
4000.	1.37E-07	1.26E-09	1.37E-07	1.29E-09	3.95E-07	1.60E-06	1.60E-06	1.65E-09
5000.	2.52E-07	2.32E-09	2.52E-07	2.38E-09	7.27E-07	2.96E-06	2.96E-06	3.04E-09
6000.	4.04E-07	3.74E-09	4.06E-07	3.83E-09	1.17E-06	4.75E-06	4.75E-06	4.89E-09
7000.	5.94E-07	5.49E-09	5.96E-07	5.62E-09	1.72E-06	6.98E-06	6.98E-06	7.18E-09
8000.	8.19E-07	7.57E-09	8.21E-07	7.75E-09	2.37E-06	9.62E-06	9.62E-06	9.90E-09
9000.	1.08E-06	9.98E-09	1.08E-06	1.02E-08	3.12E-06	1.27E-05	1.27E-05	1.31E-08
10000.	1.38E-06	1.27E-08	1.38E-06	1.30E-08	3.98E-06	1.62E-05	1.62E-05	1.67E-08
20000.	4.85E-06	4.49E-08	4.87E-06	4.60E-08	1.40E-05	5.70E-05	5.70E-05	5.87E-08
30000.	1.15E-05	1.06E-07	1.15E-05	1.09E-07	3.32E-05	1.35E-04	1.35E-04	1.39E-07
40000.	1.91E-05	1.77E-07	1.92E-05	1.81E-07	5.52E-05	2.24E-04	2.24E-04	2.31E-07
50000.	2.66E-05	2.46E-07	2.67E-05	2.52E-07	7.69E-05	3.13E-04	3.13E-04	3.22E-07
60000.	3.36E-05	3.11E-07	3.37E-05	3.19E-07	9.72E-05	3.95E-04	3.95E-04	4.07E-07
70000.	4.01E-05	3.71E-07	4.03E-05	3.80E-07	1.16E-04	4.71E-04	4.71E-04	4.86E-07
80000.	4.59E-05	4.25E-07	4.60E-05	4.35E-07	1.33E-04	5.39E-04	5.39E-04	5.56E-07
90000.	5.09E-05	4.71E-07	5.11E-05	4.83E-07	1.47E-04	5.98E-04	5.98E-04	6.17E-07
100000.	5.53E-05	5.12E-07	5.55E-05	5.24E-07	1.60E-04	6.50E-04	6.50E-04	6.70E-07
200000.	1.59E-04	1.47E-06	1.59E-04	1.50E-06	4.58E-04	1.86E-03	1.86E-03	1.92E-06
300000.	1.62E-04	1.50E-06	1.62E-04	1.53E-06	4.68E-04	1.90E-03	1.90E-03	1.96E-06
400000.	1.40E-04	1.29E-06	1.40E-04	1.33E-06	4.04E-04	1.64E-03	1.64E-03	1.69E-06
500000.	1.13E-04	1.04E-06	1.13E-04	1.07E-06	3.26E-04	1.32E-03	1.32E-03	1.36E-06
600000.	8.80E-05	8.15E-07	8.83E-05	8.34E-07	2.54E-04	1.03E-03	1.03E-03	1.07E-06
700000.	6.80E-05	6.30E-07	6.82E-05	6.45E-07	1.97E-04	7.99E-04	7.99E-04	8.24E-07
800000.	5.25E-05	4.86E-07	5.27E-05	4.98E-07	1.52E-04	6.17E-04	6.17E-04	6.36E-07
900000.	4.05E-05	3.75E-07	4.06E-05	3.84E-07	1.17E-04	4.75E-04	4.75E-04	4.90E-07
1000000.	3.13E-05	2.89E-07	3.14E-05	2.97E-07	9.04E-05	3.67E-04	3.67E-04	3.79E-07

Table P-5. Sample of AMRAW-A Output

** AVERAGE ANNUAL NONSPECIFIC DOSE TO POPULATION, MAMIN, IN MANREMS/YEAR

NONSPECIFIC *** NUCLIDE= RA-226 K= 12

TIME	TOT BODY	GI TRACT	GONADS	LIVER	LUNGS	MARROW	BONE	THYROID
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	6.48E-10	1.35E-12	6.48E-10	1.20E-13	0.0	7.71E-09	7.71E-09	0.0
50.	1.00E-09	2.08E-12	1.00E-09	1.85E-13	0.0	1.19E-08	1.19E-08	0.0
60.	1.47E-09	3.07E-12	1.47E-09	2.73E-13	0.0	1.75E-08	1.75E-08	0.0
70.	2.09E-09	4.35E-12	2.09E-09	3.87E-13	0.0	2.49E-08	2.49E-08	0.0
80.	2.89E-09	6.01E-12	2.89E-09	5.34E-13	0.0	3.43E-08	3.43E-08	0.0
90.	3.89E-09	8.09E-12	3.89E-09	7.19E-13	0.0	4.63E-08	4.63E-08	0.0
100.	5.14E-09	1.07E-11	5.14E-09	9.51E-13	0.0	6.12E-08	6.12E-08	0.0
200.	3.03E-08	6.30E-11	3.03E-08	5.60E-12	0.0	3.60E-07	3.60E-07	0.0
300.	1.32E-07	2.75E-10	1.32E-07	2.44E-11	0.0	1.57E-06	1.57E-06	0.0
400.	3.77E-07	7.85E-10	3.77E-07	6.98E-11	0.0	4.49E-06	4.49E-06	0.0
500.	8.35E-07	1.74E-09	8.35E-07	1.54E-10	0.0	9.93E-06	9.93E-06	0.0
600.	1.57E-06	3.27E-09	1.57E-06	2.91E-10	0.0	1.87E-05	1.87E-05	0.0
700.	2.66E-06	5.54E-09	2.66E-06	4.92E-10	0.0	3.17E-05	3.17E-05	0.0
800.	4.15E-06	8.63E-09	4.15E-06	7.67E-10	0.0	4.94E-05	4.94E-05	0.0
900.	6.10E-06	1.27E-08	6.10E-06	1.13E-09	0.0	7.26E-05	7.26E-05	0.0
1000.	8.58E-06	1.78E-08	8.58E-06	1.59E-09	0.0	1.02E-04	1.02E-04	0.0
2000.	5.02E-05	1.04E-07	5.02E-05	9.28E-09	0.0	5.97E-04	5.97E-04	0.0
3000.	1.82E-04	3.79E-07	1.82E-04	3.37E-08	0.0	2.17E-03	2.17E-03	0.0
4000.	4.18E-04	8.69E-07	4.18E-04	7.73E-08	0.0	4.97E-03	4.97E-03	0.0
5000.	7.63E-04	1.59E-06	7.63E-04	1.41E-07	0.0	9.08E-03	9.08E-03	0.0
6000.	1.22E-03	2.53E-06	1.22E-03	2.25E-07	0.0	1.45E-02	1.45E-02	0.0
7000.	1.78E-03	3.69E-06	1.78E-03	3.28E-07	0.0	2.11E-02	2.11E-02	0.0
8000.	2.44E-03	5.07E-06	2.44E-03	4.51E-07	0.0	2.90E-02	2.90E-02	0.0
9000.	3.20E-03	6.66E-06	3.20E-03	5.92E-07	0.0	3.81E-02	3.81E-02	0.0
10000.	4.07E-03	8.47E-06	4.07E-03	7.53E-07	0.0	4.84E-02	4.84E-02	0.0
20000.	1.51E-02	3.14E-05	1.51E-02	2.79E-06	0.0	1.80E-01	1.80E-01	0.0
30000.	2.57E-02	7.43E-05	3.57E-02	6.60E-06	0.0	4.25E-01	4.25E-01	0.0
40000.	5.89E-02	1.23E-04	5.89E-02	1.09E-05	0.0	7.01E-01	7.01E-01	0.0
50000.	8.16E-02	1.70E-04	8.16E-02	1.51E-05	0.0	9.71E-01	9.71E-01	0.0
60000.	1.03E-01	2.14E-04	1.03E-01	1.90E-05	0.0	1.22E 00	1.22E 00	0.0
70000.	1.22E-01	2.54E-04	1.22E-01	2.26E-05	0.0	1.45E 00	1.45E 00	0.0
80000.	1.39E-01	2.89E-04	1.39E-01	2.57E-05	0.0	1.65E 00	1.65E 00	0.0
90000.	1.54E-01	3.21E-04	1.54E-01	2.85E-05	0.0	1.83E 00	1.83E 00	0.0
100000.	1.67E-01	3.48E-04	1.67E-01	3.09E-05	0.0	1.99E 00	1.99E 00	0.0
200000.	5.14E-01	1.07E-03	5.14E-01	9.50E-05	0.0	6.12E 00	6.12E 00	0.0
300000.	5.27E-01	1.10E-03	5.27E-01	9.75E-05	0.0	6.27E 00	6.27E 00	0.0
400000.	4.55E-01	9.47E-04	4.55E-01	8.42E-05	0.0	5.42E 00	5.42E 00	0.0
500000.	3.67E-01	7.64E-04	3.67E-01	6.79E-05	0.0	4.37E 00	4.37E 00	0.0
600000.	2.87E-01	5.96E-04	2.87E-01	5.30E-05	0.0	3.41E 00	3.41E 00	0.0
700000.	2.22E-01	4.61E-04	2.22E-01	4.10E-05	0.0	2.64E 00	2.64E 00	0.0
800000.	1.71E-01	3.56E-04	1.71E-01	3.16E-05	0.0	2.03E 00	2.03E 00	0.0
900000.	1.32E-01	2.74E-04	1.32E-01	2.44E-05	0.0	1.57E 00	1.57E 00	0.0
1000000.	1.02E-01	2.12E-04	1.02E-01	1.88E-05	0.0	1.21E 00	1.21E 00	0.0

AMRAW-B Sample Output

This section of Appendix P contains output for the full run base case for terminal storage phase, Case No. 48, and is based on the total of cancers and genetic effects.

1. Output Summary of Selected Input: Table P-6.

2. Annual Damage Rates, by Zone, Nonspecific and Total

   a. Table P-7 (Output Table 1-1). Zonal and Total Damages for High Population Projection ($/y).

   b. Table P-8 (Output Table 1-2). Zonal and Total Damages for Low Population Projection ($/y).

3. Annual Damage Rates, by Nuclide, Total All Zones, and Nonspecific

   Table P-9. (Output Tables 2-9 (50 y), 2-14 (100 y)).
   The full output of this type is a table for all times calculated after 30 y.

4. Discounted Present Values of Damage Costs by Nuclide, and Total, Integrated Over 10^6 Years

   Table P-10 (Output Table F-10). Discounted Present Values ($), Discount Rate = 0.00%.

5. Number of Deaths per Time Interval

   a. Table P-11 (Output Table 4-1). High Population Scenario: Number of Deaths per Time Interval (#/Δy).

   b. Table P-12 (Output Table 4-2). Low Population Scenario: Number of Deaths per Time Interval (#/Δy).

6. Total Undiscounted Damages per Time Interval, by Zone

   a. Table P-13 (Output Table 5-1). Total Undiscounted Damages for Each Zone for Each Time Interval - High Population ($/Δy).

   b. Table P-14 (Output Table 5-2). Total Undiscounted Damages for Each Zone for Each Time Interval - Low Population ($/Δy).

Table P-6. Output Summary of Selected Input

ECON48 - 50 PERIODS - NEW BODY COEFF.

DISCOUNT RATE = 0.00 %
COST OF INCREASED LEVEL OF RISK OF DEATH = $ 260000.

SITE OR TYPE	COST OF EXCESS RISK OF DEATH DEATH /MIL. MAN-REM	$/MAN-REM
TOTAL BODY (REMAIN.)	85.0	22.1
GI TRACT	34.0	8.8
GONAD(GENETIC)	200.0	52.0
LIVER	0.0	0.0
LUNG	44.0	11.4
MARROW(LUKEMIA)	32.0	8.3
BONE	7.0	1.8
THYROID	0.0	0.0

POPULATION PROJECTIONS

ZONE	HIGH	LOW
1 REPO	101.	101.
2 EDDY	17200.	6100.
3 RED8	213000.	53600.
4 MIDJ	784000.	224000.
5 WTEX	217000.	57900.
6 LEA	245000.	74000.
7 CHAV	253000.	67800.
8 REG8	155000.	54900.

Appendix P

Table P-7. AMRAW-B Output Table 1-1

TABLE 1 - 1 : ZONAL AND TOTAL DAMAGES FOR HIGH POP. PROJECTION (S/YR)

TIME	REPO	EDDY	REDB	MIDD	WTEX	LCA	CHAV	REGB	TOT.ZONE	NON-SPEC	TTOTAL
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	1.61E-01	2.42E 00	1.58E 00	5.06E-01	2.34E-01	1.93E 00	2.28E 00	3.97E 00	1.31E 01	6.00E 01	7.30E 01
50.	1.70E-01	3.70E 00	2.32E 00	6.62E-01	3.03E-01	2.47E 00	3.41E 00	4.82E 00	1.79E 01	5.02E 01	6.80E 01
60.	1.69E-01	4.33E 00	2.65E 00	7.25E-01	3.31E-01	2.68E 00	3.91E 00	4.76E 00	1.96E 01	4.22E 01	6.17E 01
70.	1.62E-01	4.52E 00	2.71E 00	7.34E-01	3.34E-01	2.70E 00	4.00E 00	4.37E 00	1.95E 01	3.51E 01	5.46E 01
80.	1.52E-01	4.43E 00	2.60E 00	7.15E-01	3.25E-01	2.63E 00	3.83E 00	3.91E 00	1.86E 01	2.91E 01	4.77E 01
90.	1.43E-01	4.18E 00	2.40E 00	6.86E-01	3.12E-01	2.51E 00	3.53E 00	3.47E 00	1.72E 01	2.40E 01	4.12E 01
100.	1.35E-01	3.84E 00	2.17E 00	6.59E-01	2.99E-01	2.42E 00	3.17E 00	3.10E 00	1.58E 01	1.96E 01	3.54E 01
200.	1.98E-01	4.89E 00	2.43E 00	1.04E 00	4.71E-01	3.78E 00	3.41E 00	6.11E 00	2.23E 01	1.45E 01	3.68E 01
300.	1.74E-01	1.95E 00	1.28E 00	9.46E-01	4.28E-01	3.43E 00	1.61E 00	3.57E 00	1.35E 01	2.40E 00	1.59E 01
400.	1.89E-01	1.84E 00	1.36E 00	1.04E 00	4.71E-01	3.78E 00	1.70E 00	3.81E 00	1.42E 01	1.11E 00	1.53E 01
500.	2.04E-01	2.02E 00	1.51E 00	1.14E 00	5.14E-01	4.12E 00	1.89E 00	4.07E 00	1.55E 01	9.03E-01	1.64E 01
600.	2.19E-01	2.18E 00	1.63E 00	1.22E 00	5.52E-01	4.43E 00	2.05E 00	4.29E 00	1.66E 01	8.25E-01	1.74E 01
700.	2.31E-01	2.31E 00	1.73E 00	1.29E 00	5.84E-01	4.68E 00	2.16E 00	4.46E 00	1.74E 01	7.64E-01	1.82E 01
800.	2.40E-01	2.38E 00	1.79E 00	1.34E 00	6.07E-01	4.87E 00	2.23E 00	4.59E 00	1.81E 01	7.06E-01	1.88E 01
900.	2.46E-01	2.42E 00	1.82E 00	1.38E 00	6.25E-01	5.01E 00	2.27E 00	4.66E 00	1.84E 01	6.54E-01	1.91E 01
1000.	2.51E-01	2.44E 00	1.84E 00	1.41E 00	6.38E-01	5.12E 00	2.29E 00	4.71E 00	1.87E 01	6.07E-01	1.93E 01
2000.	3.95E-01	3.67E 00	2.80E 00	2.24E 00	1.01E 00	8.09E 00	3.44E 00	8.25E 00	2.99E 01	5.86E-01	3.05E 01
3000.	4.22E-01	3.60E 00	2.80E 00	2.40E 00	1.08E 00	8.66E 00	3.37E 00	8.53E 00	3.08E 01	4.89E-01	3.13E 01
4000.	4.91E-01	4.05E 00	3.18E 00	2.78E 00	1.26E 00	1.01E 01	3.80E 00	9.68E 00	3.53E 01	5.39E-01	3.59E 01
5000.	5.54E-01	4.51E 00	3.55E 00	3.15E 00	1.42E 00	1.14E 01	4.23E 00	1.07E 01	3.95E 01	6.23E-01	4.02E 01
6000.	6.07E-01	4.86E 00	3.86E 00	3.45E 00	1.56E 00	1.25E 01	4.57E 00	1.16E 01	4.30E 01	7.65E-01	4.37E 01
7000.	6.50E-01	5.17E 00	4.10E 00	3.69E 00	1.67E 00	1.34E 01	4.85E 00	1.23E 01	4.58E 01	1.25E 00	4.70E 01
8000.	6.85E-01	5.40E 00	4.29E 00	3.89E 00	1.76E 00	1.41E 01	5.05E 00	1.28E 01	4.80E 01	3.78E 00	5.18E 01
9000.	7.13E-01	5.62E 00	4.43E 00	4.05E 00	1.83E 00	1.47E 01	5.19E 00	1.33E 01	4.98E 01	1.18E 01	6.16E 01
10000.	7.36E-01	5.84E 00	4.55E 00	4.18E 00	1.89E 00	1.52E 01	5.31E 00	1.36E 01	5.13E 01	2.44E 01	7.57E 01
20000.	1.11E 00	8.41E 00	6.62E 00	6.27E 00	2.83E 00	2.27E 01	7.67E 00	2.22E 01	7.78E 01	3.61E 01	1.14E 02
30000.	8.54E-01	6.68E 00	4.71E 00	4.84E 00	2.19E 00	1.75E 01	5.29E 00	1.69E 01	5.90E 01	1.54E 02	2.13E 02
40000.	6.54E-01	5.44E 00	3.32E 00	3.71E 00	1.67E 00	1.34E 01	3.58E 00	1.85E 01	5.03E 01	3.03E 02	3.54E 02
50000.	5.34E-01	5.02E 00	2.63E 00	3.03E 00	1.37E 00	1.10E 01	2.80E 00	2.02E 01	4.66E 01	4.13E 02	4.60E 02
60000.	4.50E-01	4.98E 00	2.29E 00	2.55E 00	1.15E 00	9.25E 00	2.47E 00	2.01E 01	4.32E 01	4.74E 02	5.18E 02
70000.	3.78E-01	5.04E 00	2.08E 00	2.15E 00	9.71E-01	7.79E 00	2.33E 00	1.91E 01	3.99E 01	5.10E 02	5.50E 02
80000.	3.18E-01	5.10E 00	1.94E 00	1.80E 00	8.14E-01	6.53E 00	2.26E 00	1.80E 01	3.67E 01	5.30E 02	5.67E 02
90000.	2.66E-01	5.14E 00	1.83E 00	1.51E 00	6.84E-01	5.48E 00	2.22E 00	1.69E 01	3.40E 01	5.41E 02	5.75E 02
100000.	2.27E-01	5.18E 00	1.76E 00	1.29E 00	5.83E-01	4.67E 00	2.21E 00	1.59E 01	3.19E 01	5.47E 02	5.78E 02
200000.	4.47E-01	6.84E 00	4.32E 00	2.54E 00	1.15E 00	9.20E 00	5.73E 00	1.50E 01	4.52E 01	2.38E 02	2.83E 02
300000.	3.80E-01	1.23E 01	4.18E 00	2.16E 00	9.78E-01	7.82E 00	5.70E 00	4.33E 01	7.68E 01	1.32E 03	1.39E 03
400000.	4.14E-01	1.05E 01	4.01E 00	2.36E 00	1.06E 00	8.53E 00	5.34E 00	3.63E 01	6.86E 01	1.04E 03	1.11E 03
500000.	4.30E-01	8.55E 00	3.69E 00	2.45E 00	1.10E 00	8.87E 00	4.77E 00	2.88E 01	5.86E 01	7.57E 02	8.16E 02
600000.	4.34E-01	6.93E 00	3.35E 00	2.46E 00	1.11E 00	8.92E 00	4.21E 00	2.31E 01	5.05E 01	5.43E 02	5.93E 02
700000.	4.29E-01	5.72E 00	3.03E 00	2.44E 00	1.10E 00	8.84E 00	3.72E 00	1.89E 01	4.42E 01	3.92E 02	4.37E 02
800000.	4.20E-01	1.06E 01	2.76E 00	2.39E 00	1.08E 00	8.63E 00	3.32E 00	1.59E 01	4.50E 01	2.87E 02	3.32E 02
900000.	4.07E-01	3.94E 02	2.53E 00	2.31E 00	1.05E 00	8.38E 00	2.97E 00	1.35E 01	4.25E 02	2.39E 02	6.64E 02
1000000.	3.92E-01	5.95E 03	2.33E 00	2.23E 00	1.01E 00	8.09E 00	2.70E 00	1.18E 01	5.98E 03	5.66E 02	6.55E 03

Appendix P. Table P-8. AMRAW-B Output Table 1-2

TABLE 1 - 2 : ZONAL AND TOTAL DAMAGES FOR LOW POP. PROJECTION ($/YR)

TIME	REPO	EDDY	REDB	MIDO	WTEX	LEA	CHAV	REGS	TOT.ZONE	NON-SPEC	TTOTAL
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	1.61E-01	8.59E-01	3.97E-01	1.44E-01	6.25E-02	5.84E-01	6.10E-01	1.41E 00	4.23E 00	6.00E 01	6.42E 01
50.	1.70E-01	1.31E 00	5.84E-01	1.89E-01	8.09E-02	7.47E-01	9.14E-01	1.71E 00	5.71E 00	5.02E 01	5.59E 01
60.	1.69E-01	1.54E 00	6.68E-01	2.07E-01	8.82E-02	8.11E-01	1.05E 00	1.69E 00	6.21E 00	4.22E 01	4.84E 01
70.	1.62E-01	1.60E 00	6.81E-01	2.10E-01	8.91E-02	8.16E-01	1.07E 00	1.55E 00	6.18E 00	3.51E 01	4.13E 01
80.	1.52E-01	1.57E 00	6.54E-01	2.04E-01	8.66E-02	7.93E-01	1.03E 00	1.38E 00	5.87E 00	2.91E 01	3.50E 01
90.	1.43E-01	1.48E 00	6.04E-01	1.96E-01	8.32E-02	7.60E-01	9.45E-01	1.23E 00	5.44E 00	2.40E 01	2.94E 01
100.	1.35E-01	1.36E 00	5.46E-01	1.83E-01	7.98E-02	7.30E-01	8.50E-01	1.10E 00	4.99E 00	1.96E 01	2.46E 01
200.	1.98E-01	1.74E 00	6.11E-01	2.57E-01	1.26E-01	1.14E 00	9.13E-01	2.16E 00	7.19E 00	1.45E 01	2.17E 01
300.	1.74E-01	6.91E-01	3.22E-01	2.70E-01	1.14E-01	1.04E 00	4.31E-01	1.30E 00	4.34E 00	2.40E 00	6.74E 00
400.	1.89E-01	6.53E-01	3.43E-01	2.98E-01	1.26E-01	1.14E 00	4.55E-01	1.35E 00	4.56E 00	1.11E 00	5.66E 00
500.	2.04E-01	7.16E-01	3.80E-01	3.25E-01	1.37E-01	1.25E 00	5.06E-01	1.44E 00	4.96E 00	9.03E-01	5.86E 00
600.	2.19E-01	7.75E-01	4.11E-01	3.49E-01	1.47E-01	1.34E 00	5.49E-01	1.52E 00	5.31E 00	8.25E-01	6.13E 00
700.	2.31E-01	8.18E-01	4.34E-01	3.69E-01	1.56E-01	1.41E 00	5.80E-01	1.58E 00	5.58E 00	7.64E-01	6.35E 00
800.	2.40E-01	8.44E-01	4.50E-01	3.84E-01	1.62E-01	1.47E 00	5.99E-01	1.62E 00	5.77E 00	7.06E-01	6.48E 00
900.	2.46E-01	8.58E-01	4.58E-01	3.95E-01	1.67E-01	1.51E 00	6.09E-01	1.65E 00	5.90E 00	6.54E-01	6.55E 00
1000.	2.51E-01	8.64E-01	4.63E-01	4.04E-01	1.70E-01	1.55E 00	6.13E-01	1.67E 00	5.98E 00	6.07E-01	6.59E 00
2000.	3.95E-01	1.30E 00	7.05E-01	6.39E-01	2.70E-01	2.44E 00	9.23E-01	2.92E 00	9.60E 00	5.86E-01	1.02E 01
3000.	4.22E-01	1.28E 00	7.05E-01	6.84E-01	2.88E-01	2.61E 00	9.02E-01	3.02E 00	9.91E 00	4.89E-01	1.04E 01
4000.	4.91E-01	1.44E 00	8.01E-01	7.94E-01	3.36E-01	3.04E 00	1.02E 00	3.43E 00	1.13E 01	5.39E-01	1.19E 01
5000.	5.54E-01	1.60E 00	8.94E-01	9.00E-01	3.79E-01	3.44E 00	1.13E 00	3.80E 00	1.27E 01	6.23E-01	1.33E 01
6000.	6.07E-01	1.72E 00	9.70E-01	9.86E-01	4.15E-01	3.77E 00	1.23E 00	4.10E 00	1.38E 01	7.65E-01	1.46E 01
7000.	6.50E-01	1.83E 00	1.03E 00	1.05E 00	4.45E-01	4.04E 00	1.30E 00	4.34E 00	1.47E 01	1.25E 00	1.59E 01
8000.	6.85E-01	1.92E 00	1.08E 00	1.11E 00	4.69E-01	4.25E 00	1.35E 00	4.54E 00	1.54E 01	3.78E 00	1.92E 01
9000.	7.13E-01	1.99E 00	1.11E 00	1.16E 00	4.88E-01	4.43E 00	1.39E 00	4.69E 00	1.60E 01	1.18E 01	2.78E 01
10000.	7.36E-01	2.07E 00	1.14E 00	1.20E 00	5.04E-01	4.58E 00	1.42E 00	4.81E 00	1.65E 01	2.44E 01	4.09E 01
20000.	1.11E 00	2.98E 00	1.67E 00	1.79E 00	7.54E-01	6.85E 00	2.06E 00	7.88E 00	2.51E 01	3.61E 01	6.12E 01
30000.	8.54E-01	2.37E 00	1.19E 00	1.38E 00	5.83E-01	5.29E 00	1.42E 00	6.00E 00	1.91E 01	1.54E 02	1.73E 02
40000.	6.54E-01	1.93E 00	8.35E-01	1.06E 00	4.46E-01	4.05E 00	9.59E-01	6.54E 00	1.65E 01	3.03E 02	3.20E 02
50000.	5.34E-01	1.78E 00	6.62E-01	8.66E-01	3.65E-01	3.32E 00	7.49E-01	7.16E 00	1.54E 01	4.13E 02	4.28E 02
60000.	4.50E-01	1.77E 00	5.75E-01	7.30E-01	3.08E-01	2.79E 00	6.63E-01	7.11E 00	1.44E 01	4.74E 02	4.89E 02
70000.	3.78E-01	1.79E 00	5.24E-01	6.14E-01	2.59E-01	2.35E 00	6.25E-01	6.78E 00	1.33E 01	5.10E 02	5.23E 02
80000.	3.18E-01	1.81E 00	4.87E-01	5.15E-01	2.17E-01	1.97E 00	6.05E-01	6.37E 00	1.23E 01	5.30E 02	5.43E 02
90000.	2.66E-01	1.82E 00	4.60E-01	4.33E-01	1.83E-01	1.65E 00	5.95E-01	5.97E 00	1.14E 01	5.41E 02	5.52E 02
100000.	2.27E-01	1.84E 00	4.42E-01	3.69E-01	1.55E-01	1.41E 00	5.93E-01	5.65E 00	1.07E 01	5.47E 02	5.57E 02
200000.	4.47E-01	2.43E 00	1.09E 00	7.27E-01	3.06E-01	2.78E 00	1.54E 00	5.31E 00	1.46E 01	2.38E 02	2.53E 02
300000.	3.80E-01	4.35E 00	1.05E 00	6.18E-01	2.61E-01	2.36E 00	1.53E 00	1.53E 01	2.59E 01	1.32E 03	1.34E 03
400000.	4.14E-01	3.74E 00	1.01E 00	6.74E-01	2.84E-01	2.58E 00	1.43E 00	1.29E 01	2.30E 01	1.04E 03	1.07E 03
500000.	4.30E-01	3.03E 00	9.29E-01	6.99E-01	2.95E-01	2.68E 00	1.28E 00	1.02E 01	1.95E 01	7.57E 02	7.77E 02
600000.	4.34E-01	2.46E 00	8.42E-01	7.03E-01	2.97E-01	2.69E 00	1.13E 00	8.19E 00	1.67E 01	5.43E 02	5.60E 02
700000.	4.29E-01	2.03E 00	7.64E-01	6.98E-01	2.94E-01	2.67E 00	9.98E-01	6.71E 00	1.46E 01	3.92E 02	4.07E 02
800000.	4.20E-01	3.74E 00	6.96E-01	6.83E-01	2.88E-01	2.61E 00	8.90E-01	5.62E 00	1.49E 01	2.87E 02	3.02E 02
900000.	4.07E-01	1.40E 02	6.37E-01	6.61E-01	2.79E-01	2.53E 00	7.97E-01	4.79E 00	1.50E 02	2.38E 02	3.88E 02
1000000.	3.92E-01	2.11E 03	5.87E-01	6.33E-01	2.69E-01	2.44E 00	7.23E-01	4.17E 00	2.12E 03	5.66E 02	2.69E 03

Table P-9. Output Tables 2-9 and 2-14: AMRAW-B Annual Damage Rates by Nuclide

TABLE 2 - 9 : TIME PERIOD= 50.

NUCLIDE	HIGH POP	LOW POP	NON-SPEC	TOT-HIGH	TOT-LOW
C-14	3.88E-07	1.22E-07	3.46E-06	3.85E-06	3.58E-06
SR-90	9.09E 00	2.86E 00	3.61E 01	4.52E 01	3.89E 01
Y-90	7.76E-02	2.43E-02	9.02E-02	1.68E-01	1.14E-01
ZR-93	1.59E-07	5.06E-08	1.38E-06	1.53E-06	1.43E-06
NB-93M	2.13E-07	6.74E-08	9.28E-06	9.49E-06	9.35E-06
TC-99	3.92E-06	1.24E-06	2.30E-04	2.34E-04	2.31E-04
I-129	6.19E-10	2.00E-10	1.17E-09	1.79E-09	1.37E-09
CS-135	7.71E-07	2.41E-07	8.55E-06	9.32E-06	8.79E-06
CS-137	6.92E-01	2.18E-01	6.64E 00	7.33E 00	6.86E 00
PB-210	6.32E-10	2.00E-10	2.04E-09	2.67E-09	2.24E-09
RA-225	3.70E-08	1.16E-08	3.76E-07	4.13E-07	3.88E-07
RA-226	1.13E-08	3.54E-09	1.95E-07	2.06E-07	1.98E-07
TH-229	9.73E-07	3.20E-07	1.80E-07	1.15E-06	5.00E-07
TH-230	9.50E-08	3.13E-08	9.85E-09	1.05E-07	4.11E-08
NP-237	6.89E-04	2.24E-04	8.05E-04	1.49E-03	1.03E-03
NP-239	3.26E-03	1.06E-03	1.88E-05	3.28E-03	1.08E-03
PU-238	6.59E-01	2.17E-01	3.43E-02	6.93E-01	2.52E-01
PU-239	3.76E-03	1.24E-03	2.05E-04	3.97E-03	1.45E-03
PU-240	5.92E-02	1.95E-02	3.23E-03	6.24E-02	2.28E-02
PU-241	4.59E-03	1.51E-03	3.35E-04	4.92E-03	1.85E-03
AM-241	8.27E-01	2.68E-01	9.58E-01	1.78E 00	1.23E 00
AM-242M	6.34E-02	2.05E-02	8.09E-02	1.44E-01	1.01E-01
AM-243	1.75E-01	5.67E-02	2.04E-01	3.79E-01	2.61E-01
CM-242	3.33E-03	1.09E-03	1.33E-03	4.67E-03	2.43E-03
CM-244	6.20E 00	2.02E 00	6.09E 00	1.23E 01	8.10E 00

TABLE 2 - 14 : TIME PERIOD= 100.

NUCLIDE	HIGH POP	LOW POP	NON-SPEC	TOT-HIGH	TOT-LOW
C-14	1.14E-06	3.48E-07	1.11E-05	1.22E-05	1.14E-05
SR-90	7.28E 00	2.26E 00	1.27E 01	2.00E 01	1.50E 01
Y-90	6.80E-02	2.08E-02	5.99E-02	1.28E-01	8.07E-02
ZR-93	4.77E-07	1.49E-07	2.52E-06	2.99E-06	2.66E-06
NB-93M	7.58E-07	2.35E-07	2.95E-05	3.03E-05	2.98E-05
TC-99	1.16E-05	3.58E-06	7.34E-04	7.45E-04	7.37E-04
I-129	2.12E-09	6.86E-10	1.75E-09	3.87E-09	2.43E-09
CS-135	2.27E-06	6.91E-07	1.81E-05	2.04E-05	1.88E-05
CS-137	6.61E-01	2.03E-01	4.64E 00	5.30E 00	4.85E 00
PB-210	6.00E-09	1.86E-09	7.42E-09	1.34E-08	9.28E-09
RA-225	2.65E-07	8.09E-08	2.52E-06	2.78E-06	2.60E-06
RA-226	8.38E-08	2.56E-08	1.00E-06	1.09E-06	1.03E-06
TH-229	7.39E-06	2.41E-06	4.44E-07	7.84E-06	2.85E-06
TH-230	7.07E-07	2.31E-07	2.38E-08	7.30E-07	2.54E-07
NP-237	2.16E-03	6.92E-04	8.35E-04	3.00E-03	1.53E-03
NP-239	1.14E-02	3.71E-03	2.10E-05	1.14E-02	3.73E-03
PU-238	1.43E 00	4.67E-01	2.37E-02	1.45E 00	4.90E-01
PU-239	1.24E-02	4.03E-03	2.15E-04	1.26E-02	4.25E-03
PU-240	2.42E-01	7.90E-02	4.21E-03	2.46E-01	8.32E-02
PU-241	1.25E-03	4.07E-04	2.90E-05	1.27E-03	4.36E-04
AM-241	2.41E 00	7.72E-01	9.26E-01	3.34E 00	1.70E 00
AM-242M	1.55E-01	4.94E-02	6.55E-02	2.20E-01	1.15E-01
AM-243	5.36E-01	1.72E-01	2.07E-01	7.44E-01	3.79E-01
CM-242	8.28E-03	2.69E-03	1.08E-03	9.37E-03	3.77E-03
CM-244	2.96E 00	9.51E-01	9.57E-01	3.92E 00	1.91E 00

Table P-10. AMRAW-B Output Table 3

TABLE 3 : DISCOUNTED PRESENT VALUES ($)
DISCOUNT RATE = 0.00 %

NUCLIDE	HIGH POPULATION DISCOUNTED	HIGH POPULATION PV $/GM	LOW POPULATION DISCOUNTED	LOW POPULATION PV $/GM
PU-240	0.37E 06		0.12E 06	
CM-244	0.96E 03		0.52E 03	
SUB TOT	3.72E 05	8.51E-03	1.21E 05	2.77E-03
RA-225	0.72E 07		0.66E 07	
TH-229	0.18E 08		0.57E 07	
NP-237	0.68E 09		0.27E 09	
PU-241	0.58E 03		0.19E 03	
AM-241	0.90E 05		0.30E 05	
SUB TOT	7.06E 08	6.82E 00	2.82E 08	2.72E 00
PB-210	0.99E 06		0.45E 06	
RA-226	0.63E 08		0.58E 08	
TH-230	0.11E 07		0.37E 06	
PU-238	0.88E 03		0.29E 03	
AM-242M	0.22E 03		0.84E 02	
CM-242	0.11E 02		0.36E 01	
SUB TOT	6.52E 07	1.00E 01	5.89E 07	9.06E 00
NP-239	0.15E 05		0.51E 04	
PU-239	0.25E 07		0.80E 06	
AM-243	0.10E 07		0.34E 06	
SUB TOT	3.51E 06	4.41E-02	1.15E 06	1.44E-02
C-14	0.32E 02		0.30E 02	
SUB TOT	3.16E 01	7.83E-04	2.98E 01	7.37E-04
SR-90	0.42E 04		0.31E 04	
Y-90	0.28E 02		0.17E 02	
SUB TOT	4.21E 03	6.70E-05	3.16E 03	5.03E-05
ZR-93	0.25E 04		0.21E 04	
NB-93M	0.32E 05		0.31E 05	
SUB TOT	3.46E 04	2.60E-04	3.35E 04	2.52E-04
TC-99	0.48E 09		0.47E 09	
SUB TOT	4.82E 08	3.13E 00	4.73E 08	3.07E 00
I-129	0.46E 04		0.36E 04	
SUB TOT	4.58E 03	7.85E-02	3.58E 03	6.13E-02
CS-135	0.26E 05		0.23E 05	
SUB TOT	2.56E 04	3.76E-04	2.30E 04	3.38E-04
CS-137	0.12E 04		0.11E 04	
SUB TOT	1.17E 03	7.69E-06	1.07E 03	7.01E-06
TOTAL	1.26E 09	1.57E 00	8.15E 08	1.01E 00

Appendix P

Table P-11 AMRAW-B Output Table 4-1

TABLE 4 - 1 : HIGH POPULATION SCENARIO
NUMBER OF DEATHS PER TIME INTERVAL.(*260000.)

TIME	REPO	EDDY	REBD	MIDQ	WYC	LEA	CHAV	REGB	TOT.ZONE	NON-SPEC	TTOTAL
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	6.19E-06	9.32E-05	6.06E-05	1.94E-05	9.01E-06	7.44E-05	8.76E-05	1.53E-04	5.03E-04	2.31E-03	2.81E-03
50.	6.55E-06	1.42E-04	8.93E-05	2.55E-05	1.17E-05	9.51E-05	1.31E-04	1.85E-04	6.87E-04	1.93E-03	2.62E-03
60.	6.51E-06	1.67E-04	1.02E-04	2.79E-05	1.27E-05	1.03E-04	1.50E-04	1.83E-04	7.53E-04	1.62E-03	2.37E-03
70.	6.23E-06	1.74E-04	1.04E-04	2.82E-05	1.28E-05	1.04E-04	1.54E-04	1.69E-04	7.51E-04	1.35E-03	2.10E-03
80.	5.85E-06	1.70E-04	1.00E-04	2.75E-05	1.25E-05	1.01E-04	1.47E-04	1.50E-04	7.15E-04	1.12E-03	1.83E-03
90.	5.49E-06	1.61E-04	9.24E-05	2.64E-05	1.20E-05	9.67E-05	1.36E-04	1.33E-04	6.63E-04	9.22E-04	1.58E-03
100.	5.17E-06	1.48E-04	8.35E-05	2.54E-05	1.15E-05	9.29E-05	1.22E-04	1.19E-04	6.07E-04	7.55E-04	1.36E-03
200.	7.63E-05	1.88E-03	9.34E-04	4.00E-04	1.81E-04	1.45E-03	1.31E-03	2.35E-03	8.59E-03	5.58E-03	1.42E-02
300.	6.67E-05	7.49E-04	4.92E-04	3.64E-04	1.64E-04	1.32E-03	6.18E-04	1.41E-03	5.19E-03	9.23E-04	6.11E-03
400.	7.25E-05	7.08E-04	5.24E-04	4.01E-04	1.81E-04	1.45E-03	6.52E-04	1.47E-03	5.46E-03	4.26E-04	5.89E-03
500.	7.86E-05	7.76E-04	5.80E-04	4.37E-04	1.98E-04	1.59E-03	7.27E-04	1.57E-03	5.95E-03	3.47E-04	6.30E-03
600.	8.41E-05	8.40E-04	6.29E-04	4.70E-04	2.12E-04	1.70E-03	7.89E-04	1.65E-03	6.38E-03	3.17E-04	6.70E-03
700.	8.87E-05	8.87E-04	6.64E-04	4.97E-04	2.24E-04	1.80E-03	8.33E-04	1.72E-03	6.71E-03	2.94E-04	7.00E-03
800.	9.22E-05	9.16E-04	6.87E-04	5.17E-04	2.34E-04	1.87E-03	8.59E-04	1.76E-03	6.94E-03	2.72E-04	7.21E-03
900.	9.46E-05	9.31E-04	7.00E-04	5.32E-04	2.40E-04	1.93E-03	8.74E-04	1.79E-03	7.09E-03	2.52E-04	7.34E-03
1000.	9.65E-05	9.38E-04	7.07E-04	5.43E-04	2.45E-04	1.97E-03	8.80E-04	1.81E-03	7.19E-03	2.34E-04	7.42E-03
2000.	1.52E-03	1.41E-02	1.08E-02	8.60E-03	3.89E-03	3.11E-02	1.32E-02	3.17E-02	1.15E-01	2.25E-03	1.17E-01
3000.	1.62E-03	1.38E-02	1.08E-02	9.21E-03	4.15E-03	3.33E-02	1.30E-02	3.28E-02	1.19E-01	1.88E-03	1.21E-01
4000.	1.89E-03	1.56E-02	1.22E-02	1.07E-02	4.84E-03	3.87E-02	1.46E-02	3.72E-02	1.36E-01	2.07E-03	1.38E-01
5000.	2.13E-03	1.73E-02	1.37E-02	1.21E-02	5.46E-03	4.38E-02	1.63E-02	4.12E-02	1.52E-01	2.40E-03	1.54E-01
6000.	2.34E-03	1.87E-02	1.48E-02	1.33E-02	5.99E-03	4.80E-02	1.76E-02	4.46E-02	1.65E-01	2.94E-03	1.68E-01
7000.	2.50E-03	1.99E-02	1.58E-02	1.42E-02	6.41E-03	5.15E-02	1.86E-02	4.72E-02	1.76E-01	4.81E-03	1.81E-01
8000.	2.63E-03	2.08E-02	1.65E-02	1.50E-02	6.76E-03	5.42E-02	1.94E-02	4.93E-02	1.85E-01	1.45E-02	1.99E-01
9000.	2.74E-03	2.16E-02	1.70E-02	1.56E-02	7.04E-03	5.64E-02	2.00E-02	5.10E-02	1.91E-01	4.56E-02	2.37E-01
10000.	2.83E-03	2.25E-02	1.75E-02	1.61E-02	7.27E-03	5.83E-02	2.04E-02	5.23E-02	1.97E-01	9.38E-02	2.91E-01
20000.	4.25E-02	3.23E-01	2.55E-01	2.41E-01	1.09E-01	8.72E-01	2.95E-01	8.56E-01	2.99E 00	1.39E 00	4.38E 00
30000.	3.29E-02	2.57E-01	1.81E-01	1.86E-01	8.41E-02	6.73E-01	2.03E-01	6.51E-01	2.27E 00	5.91E 00	8.18E 00
40000.	2.52E-02	2.09E-01	1.28E-01	1.43E-01	6.43E-02	5.16E-01	1.38E-01	7.10E-01	1.93E 00	1.17E 01	1.36E 01
50000.	2.06E-02	1.93E-01	1.01E-01	1.17E-01	5.27E-02	4.22E-01	1.08E-01	7.77E-01	1.79E 00	1.59E 01	1.77E 01
60000.	1.73E-02	1.91E-01	8.79E-02	9.82E-02	4.44E-02	3.56E-01	9.51E-02	7.72E-01	1.66E 00	1.82E 01	1.99E 01
70000.	1.46E-02	1.94E-01	8.01E-02	8.27E-02	3.74E-02	3.00E-01	8.96E-02	7.37E-01	1.53E 00	1.96E 01	2.12E 01
80000.	1.22E-02	1.96E-01	7.45E-02	6.93E-02	3.13E-02	2.51E-01	8.69E-02	6.92E-01	1.41E 00	2.04E 01	2.18E 01
90000.	1.02E-02	1.98E-01	7.03E-02	5.83E-02	2.63E-02	2.11E-01	8.54E-02	6.48E-01	1.31E 00	2.08E 01	2.21E 01
100000.	8.72E-03	1.99E-01	6.76E-02	4.96E-02	2.24E-02	1.80E-01	8.51E-02	6.13E-01	1.23E 00	2.10E 01	2.22E 01
200000.	1.72E-01	2.63E 00	1.66E 00	9.79E-01	4.41E-01	3.54E 00	2.21E 00	5.77E 00	1.74E 01	9.16E 01	1.09E 02
300000.	1.46E-01	4.71E 00	1.61E 00	8.31E-01	3.76E-01	3.01E 00	2.19E 00	1.66E 01	2.95E 01	5.07E 02	5.37E 02
400000.	1.59E-01	4.06E 00	1.54E 00	9.07E-01	4.09E-01	3.28E 00	2.05E 00	1.40E 01	2.64E 01	4.01E 02	4.27E 02
500000.	1.66E-01	3.29E 00	1.42E 00	9.41E-01	4.25E-01	3.41E 00	1.84E 00	1.11E 01	2.26E 01	2.91E 02	3.14E 02
600000.	1.67E-01	2.67E 00	1.29E 00	9.47E-01	4.28E-01	3.43E 00	1.62E 00	8.89E 00	1.94E 01	2.09E 02	2.28E 02
700000.	1.65E-01	2.20E 00	1.17E 00	9.39E-01	4.24E-01	3.40E 00	1.43E 00	7.28E 00	1.70E 01	1.51E 02	1.68E 02
800000.	1.62E-01	4.06E 00	1.06E 00	9.19E-01	4.15E-01	3.32E 00	1.28E 00	6.10E 00	1.73E 01	1.10E 02	1.28E 02
900000.	1.56E-01	1.52E 02	9.74E-01	8.90E-01	4.02E-01	3.22E 00	1.14E 00	5.20E 00	1.34E 02	9.16E 01	2.55E 02
1000000.	1.51E-01	2.29E 03	8.98E-01	8.59E-01	3.88E-01	3.11E 00	1.04E 00	4.53E 00	2.30E 03	2.18E 02	2.52E 03
TOTAL	1.65E 00	2.47E 03	1.28E 01	9.38E 00	4.23E 00	3.39E 01	1.61E 01	8.63E 01	2.63E 03	2.21E 03	4.84E 03

Table P-12. AMRAW-B Output Table 4-2

TABLE 4 - 2 : LOW POPULATION SCENARIO
NUMBER OF DEATHS PER TIME INTERVAL.($260000.)

TIME	REPO	EDDY	REBD	MIDO	WTE	LEA	CHAV	REGB	TOT.ZONE	NON-SPEC	TTOTAL
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	6.19E-06	3.30E-05	1.53E-05	5.56E-06	2.41E-06	2.25E-05	2.35E-05	5.41E-05	1.63E-04	2.31E-03	2.47E-03
50.	6.55E-06	5.05E-05	2.25E-05	7.27E-06	3.11E-06	2.87E-05	3.51E-05	6.57E-05	2.19E-04	1.93E-03	2.15E-03
60.	6.51E-06	5.91E-05	2.57E-05	7.96E-06	3.39E-06	3.12E-05	4.03E-05	6.49E-05	2.39E-04	1.62E-03	1.86E-03
70.	6.23E-06	6.17E-05	2.62E-05	8.07E-06	3.43E-06	3.14E-05	4.12E-05	5.96E-05	2.38E-04	1.35E-03	1.59E-03
80.	5.85E-06	6.05E-05	2.52E-05	7.86E-06	3.33E-06	3.05E-05	3.95E-05	5.32E-05	2.26E-04	1.12E-03	1.34E-03
90.	5.49E-06	5.70E-05	2.32E-05	7.54E-06	3.20E-06	2.92E-05	3.64E-05	4.72E-05	2.09E-04	9.22E-04	1.13E-03
100.	5.17E-06	5.23E-05	2.10E-05	7.25E-06	3.07E-06	2.81E-05	3.27E-05	4.22E-05	1.92E-04	7.55E-04	9.46E-04
200.	7.63E-05	6.67E-04	2.35E-04	1.14E-04	4.83E-05	4.39E-04	3.51E-04	8.32E-04	2.76E-03	5.58E-03	8.34E-03
300.	6.67E-05	2.66E-04	1.24E-04	1.04E-04	4.39E-05	3.99E-04	1.66E-04	5.01E-04	1.67E-03	9.23E-04	2.59E-03
400.	7.25E-05	2.51E-04	1.32E-04	1.15E-04	4.84E-05	4.39E-04	1.75E-04	5.20E-04	1.75E-03	4.26E-04	2.18E-03
500.	7.86E-05	2.75E-04	1.46E-04	1.25E-04	5.27E-05	4.79E-04	1.95E-04	5.55E-04	1.91E-03	3.47E-04	2.25E-03
600.	8.41E-05	2.98E-04	1.58E-04	1.34E-04	5.67E-05	5.15E-04	2.11E-04	5.84E-04	2.04E-03	3.17E-04	2.36E-03
700.	8.87E-05	3.15E-04	1.67E-04	1.42E-04	5.99E-05	5.44E-04	2.23E-04	6.08E-04	2.15E-03	2.94E-04	2.44E-03
800.	9.22E-05	3.25E-04	1.73E-04	1.48E-04	6.23E-05	5.66E-04	2.30E-04	6.25E-04	2.22E-03	2.72E-04	2.49E-03
900.	9.46E-05	3.30E-04	1.76E-04	1.52E-04	6.41E-05	5.82E-04	2.34E-04	6.35E-04	2.27E-03	2.52E-04	2.52E-03
1000.	9.65E-05	3.32E-04	1.78E-04	1.55E-04	6.55E-05	5.95E-04	2.36E-04	6.41E-04	2.30E-03	2.34E-04	2.53E-03
2000.	1.52E-03	5.01E-03	2.71E-03	2.46E-03	1.04E-03	9.40E-03	3.55E-03	1.12E-02	3.69E-02	2.25E-03	3.92E-02
3000.	1.62E-03	4.90E-03	2.71E-03	2.63E-03	1.11E-03	1.01E-02	3.47E-03	1.16E-02	3.81E-02	1.88E-03	4.00E-02
4000.	1.89E-03	5.53E-03	3.08E-03	3.05E-03	1.29E-03	1.17E-02	3.92E-03	1.32E-02	4.36E-02	2.07E-03	4.57E-02
5000.	2.13E-03	6.15E-03	3.44E-03	3.46E-03	1.46E-03	1.32E-02	4.36E-03	1.46E-02	4.88E-02	2.40E-03	5.12E-02
6000.	2.34E-03	6.63E-03	3.73E-03	3.79E-03	1.60E-03	1.45E-02	4.71E-03	1.58E-02	5.31E-02	2.94E-03	5.60E-02
7000.	2.50E-03	7.05E-03	3.96E-03	4.05E-03	1.71E-03	1.55E-02	5.00E-03	1.67E-02	5.65E-02	4.81E-03	6.13E-02
8000.	2.63E-03	7.37E-03	4.15E-03	4.28E-03	1.80E-03	1.64E-02	5.21E-03	1.75E-02	5.93E-02	1.45E-02	7.38E-02
9000.	2.74E-03	7.67E-03	4.29E-03	4.45E-03	1.88E-03	1.70E-02	5.35E-03	1.81E-02	6.15E-02	4.56E-02	1.07E-01
10000.	2.83E-03	7.97E-03	4.40E-03	4.60E-03	1.94E-03	1.76E-02	5.48E-03	1.85E-02	6.33E-02	9.38E-02	1.57E-01
20000.	4.25E-02	1.15E-01	6.41E-02	6.89E-02	2.90E-02	2.63E-01	7.91E-02	3.03E-01	9.65E-01	1.39E 00	2.35E 00
30000.	3.29E-02	9.12E-02	4.56E-02	5.31E-02	2.24E-02	2.03E-01	5.45E-02	2.31E-01	7.34E-01	5.91E 00	6.65E 00
40000.	2.52E-02	7.42E-02	3.21E-02	4.08E-02	1.72E-02	1.56E-01	3.69E-02	2.52E-01	6.34E-01	1.17E 01	1.23E 01
50000.	2.06E-02	6.85E-02	2.55E-02	3.33E-02	1.41E-02	1.28E-01	2.88E-02	2.75E-01	5.94E-01	1.59E 01	1.65E 01
60000.	1.73E-02	6.79E-02	2.21E-02	2.81E-02	1.18E-02	1.07E-01	2.55E-02	2.74E-01	5.54E-01	1.82E 01	1.88E 01
70000.	1.46E-02	6.87E-02	2.02E-02	2.36E-02	9.97E-03	9.05E-02	2.40E-02	2.61E-01	5.12E-01	1.96E 01	2.01E 01
80000.	1.22E-02	6.96E-02	1.87E-02	1.98E-02	8.35E-03	7.58E-02	2.33E-02	2.45E-01	4.73E-01	2.04E 01	2.09E 01
90000.	1.02E-02	7.01E-02	1.77E-02	1.66E-02	7.02E-03	6.36E-02	2.29E-02	2.30E-01	4.38E-01	2.08E 01	2.12E 01
100000.	8.72E-03	7.06E-02	1.70E-02	1.42E-02	5.98E-03	5.43E-02	2.28E-02	2.17E-01	4.11E-01	2.10E 01	2.14E 01
200000.	1.72E-01	9.33E-01	4.18E-01	2.80E-01	1.18E-01	1.07E 00	5.91E-01	2.04E 00	5.62E 00	9.16E 01	9.72E 01
300000.	1.46E-01	1.67E 00	4.05E-01	2.38E-01	1.00E-01	9.09E-01	5.87E-01	5.90E 00	9.95E 00	5.07E 02	5.17E 02
400000.	1.59E-01	1.44E 00	3.88E-01	2.59E-01	1.09E-01	9.91E-01	5.50E-01	4.95E 00	8.85E 00	4.01E 02	4.10E 02
500000.	1.66E-01	1.17E 00	3.57E-01	2.69E-01	1.13E-01	1.03E 00	4.92E-01	3.92E 00	7.51E 00	2.91E 02	2.99E 02
600000.	1.67E-01	9.46E-01	3.24E-01	2.71E-01	1.14E-01	1.04E 00	4.34E-01	3.15E 00	6.44E 00	2.09E 02	2.15E 02
700000.	1.65E-01	7.80E-01	2.94E-01	2.68E-01	1.13E-01	1.03E 00	3.84E-01	2.58E 00	5.61E 00	1.51E 02	1.57E 02
800000.	1.62E-01	1.44E 00	2.68E-01	2.63E-01	1.11E-01	1.00E 00	3.42E-01	2.16E 00	5.75E 00	1.10E 02	1.16E 02
900000.	1.56E-01	5.38E 01	2.45E-01	2.54E-01	1.07E-01	9.74E-01	3.07E-01	1.84E 00	5.77E 01	9.16E 01	1.49E 02
1000000.	1.51E-01	8.12E 02	2.26E-01	2.45E-01	1.03E-01	9.39E-01	2.78E-01	1.60E 00	8.15E 02	2.18E 02	1.03E 03
TOTAL	1.65E 00	8.75E 02	3.22E 00	2.68E 00	1.13E 00	1.03E 01	4.33E 00	3.06E 01	9.29E 02	2.21E 03	3.13E 03

Appendix P.

Table P-13. AMRAW-B Output Table 5-1

TABLE 5 - 1 : TOTAL UNDISCOUNTED DAMAGES FOR EACH ZONE FOR EACH TIME INTERVAL - HIGH POPULATION

TIME	REPO	EDDY	REDO	MIDO	WTE	LIA	CHAV	RIGB	TOT.ZONE	NON-SPEC	TTOTAL
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	1.61E 00	2.42E 01	1.58E 01	5.06E 00	2.34E 00	1.93E 01	2.28E 01	3.97E 01	1.31E 02	6.00E 02	7.30E 02
50.	1.70E 00	3.70E 01	2.32E 01	6.62E 00	3.03E 00	2.47E 01	3.41E 01	4.82E 01	1.79E 02	5.02E 02	6.80E 02
60.	1.69E 00	4.33E 01	2.65E 01	7.25E 00	3.31E 00	2.68E 01	3.91E 01	4.76E 01	1.96E 02	4.22E 02	6.17E 02
70.	1.62E 00	4.52E 01	2.71E 01	7.34E 00	3.34E 00	2.70E 01	4.00E 01	4.37E 01	1.95E 02	3.51E 02	5.46E 02
80.	1.52E 00	4.43E 01	2.60E 01	7.15E 00	3.25E 00	2.63E 01	3.83E 01	3.91E 01	1.86E 02	2.91E 02	4.77E 02
90.	1.43E 00	4.18E 01	2.40E 01	6.86E 00	3.12E 00	2.51E 01	3.53E 01	3.47E 01	1.72E 02	2.40E 02	4.12E 02
100.	1.35E 00	3.84E 01	2.17E 01	6.59E 00	2.99E 00	2.42E 01	3.17E 01	3.10E 01	1.58E 02	1.96E 02	3.54E 02
200.	1.98E 01	4.89E 02	2.43E 02	1.04E 02	4.71E 01	3.78E 02	3.41E 02	6.11E 02	2.23E 03	1.45E 03	3.68E 03
300.	1.74E 01	1.95E 02	1.28E 02	9.46E 01	4.28E 01	3.43E 02	1.61E 02	3.67E 02	1.35E 03	2.40E 02	1.59E 03
400.	1.89E 01	1.84E 02	1.36E 02	1.04E 02	4.71E 01	3.78E 02	1.70E 02	3.81E 02	1.42E 03	1.11E 02	1.53E 03
500.	2.04E 01	2.02E 02	1.51E 02	1.14E 02	5.14E 01	4.12E 02	1.89E 02	4.07E 02	1.55E 03	9.03E 01	1.64E 03
600.	2.19E 01	2.18E 02	1.63E 02	1.22E 02	5.52E 01	4.43E 02	2.05E 02	4.29E 02	1.66E 03	8.25E 01	1.74E 03
700.	2.31E 01	2.31E 02	1.73E 02	1.29E 02	5.84E 01	4.68E 02	2.16E 02	4.46E 02	1.74E 03	7.64E 01	1.82E 03
800.	2.40E 01	2.38E 02	1.79E 02	1.34E 02	6.07E 01	4.87E 02	2.23E 02	4.59E 02	1.81E 03	7.06E 01	1.88E 03
900.	2.46E 01	2.42E 02	1.82E 02	1.38E 02	6.25E 01	5.01E 02	2.27E 02	4.66E 02	1.84E 03	6.54E 01	1.91E 03
1000.	2.51E 01	2.44E 02	1.84E 02	1.41E 02	6.38E 01	5.12E 02	2.29E 02	4.71E 02	1.87E 03	6.07E 01	1.93E 03
2000.	3.95E 02	3.67E 03	2.80E 03	2.24E 03	1.01E 03	8.09E 03	3.44E 03	8.25E 03	2.99E 04	5.86E 02	3.05E 04
3000.	4.22E 02	3.60E 03	2.80E 03	2.40E 03	1.08E 03	8.66E 03	3.37E 03	8.53E 03	3.08E 04	4.89E 02	3.13E 04
4000.	4.91E 02	4.05E 03	3.18E 03	2.78E 03	1.26E 03	1.01E 04	3.80E 03	9.63E 03	3.53E 04	5.39E 02	3.59E 04
5000.	5.54E 02	4.51E 03	3.55E 03	3.15E 03	1.42E 03	1.14E 04	4.23E 03	1.07E 04	3.95E 04	6.23E 02	4.02E 04
6000.	6.07E 02	4.86E 03	3.86E 03	3.45E 03	1.56E 03	1.25E 04	4.57E 03	1.16E 04	4.30E 04	7.65E 02	4.37E 04
7000.	6.50E 02	5.17E 03	4.10E 03	3.69E 03	1.67E 03	1.34E 04	4.85E 03	1.23E 04	4.58E 04	1.25E 03	4.70E 04
8000.	6.85E 02	5.40E 03	4.29E 03	3.89E 03	1.76E 03	1.41E 04	5.05E 03	1.28E 04	4.80E 04	3.78E 03	5.18E 04
9000.	7.13E 02	5.62E 03	4.43E 03	4.05E 03	1.83E 03	1.47E 04	5.19E 03	1.33E 04	4.98E 04	1.18E 04	6.16E 04
10000.	7.36E 02	5.84E 03	4.55E 03	4.18E 03	1.89E 03	1.52E 04	5.31E 03	1.36E 04	5.13E 04	2.44E 04	7.57E 04
20000.	1.11E 04	8.41E 04	6.62E 04	6.27E 04	2.83E 04	2.27E 05	7.67E 04	2.22E 05	7.78E 05	3.61E 05	1.14E 06
30000.	8.54E 03	6.68E 04	4.71E 04	4.84E 04	2.19E 04	1.75E 05	5.29E 04	1.69E 05	5.90E 05	1.54E 06	2.13E 06
40000.	6.54E 03	5.44E 04	3.32E 04	3.71E 04	1.67E 04	1.34E 05	3.58E 04	1.85E 05	5.03E 05	3.03E 06	3.54E 06
50000.	5.34E 03	5.02E 04	2.63E 04	3.03E 04	1.37E 04	1.10E 05	2.80E 04	2.02E 05	4.66E 05	4.13E 06	4.60E 06
60000.	4.50E 03	4.98E 04	2.29E 04	2.55E 04	1.15E 04	9.25E 04	2.47E 04	2.01E 05	4.32E 05	4.74E 06	5.18E 06
70000.	3.78E 03	5.04E 04	2.08E 04	2.15E 04	9.71E 03	7.79E 04	2.33E 04	1.91E 05	3.99E 05	5.10E 06	5.50E 06
80000.	3.18E 03	5.10E 04	1.94E 04	1.80E 04	8.14E 03	6.53E 04	2.26E 04	1.80E 05	3.67E 05	5.30E 06	5.67E 06
90000.	2.66E 03	5.14E 04	1.83E 04	1.51E 04	6.84E 03	5.48E 04	2.22E 04	1.69E 05	3.40E 05	5.41E 06	5.75E 06
100000.	2.27E 03	5.18E 04	1.76E 04	1.29E 04	5.83E 03	4.67E 04	2.21E 04	1.59E 05	3.19E 05	5.47E 06	5.78E 06
200000.	4.47E 04	6.84E 05	4.32E 05	2.54E 05	1.15E 05	9.20E 05	5.73E 05	1.50E 06	4.52E 06	2.38E 07	2.83E 07
300000.	3.80E 04	1.23E 06	4.18E 05	2.16E 05	9.78E 04	7.82E 05	5.70E 05	4.33E 06	7.68E 06	1.32E 08	1.39E 08
400000.	4.14E 04	1.05E 06	4.01E 05	2.36E 05	1.06E 05	8.53E 05	5.34E 05	3.63E 06	6.86E 06	1.04E 08	1.11E 08
500000.	4.30E 04	8.55E 05	3.69E 05	2.45E 05	1.10E 05	8.87E 05	4.77E 05	2.89E 06	5.86E 06	7.57E 07	8.16E 07
600000.	4.34E 04	6.93E 05	3.35E 05	2.46E 05	1.11E 05	8.92E 05	4.21E 05	2.31E 06	5.05E 06	5.43E 07	5.93E 07
700000.	4.29E 04	5.72E 05	3.03E 05	2.44E 05	1.10E 05	8.84E 05	3.72E 05	1.89E 06	4.42E 06	3.92E 07	4.37E 07
800000.	4.20E 04	1.06E 06	2.76E 05	2.39E 05	1.08E 05	8.63E 05	3.32E 05	1.59E 06	4.50E 06	2.87E 07	3.32E 07
900000.	4.07E 04	3.94E 07	2.53E 05	2.31E 05	1.05E 05	8.38E 05	2.97E 05	1.35E 06	4.25E 07	2.38E 07	6.64E 07
1000000.	3.92E 04	5.95E 08	2.33E 05	2.23E 05	1.01E 05	8.09E 05	2.70E 05	1.18E 06	5.98E 08	5.66E 07	6.55E 08
TOTAL	4.29E 05	6.41E 08	3.33E 06	2.44E 06	1.10E 06	8.82E 06	4.20E 06	2.24E 07	6.84E 08	5.73E 08	1.26E 09

Appendix P.

Table P-14. AMRAW-B Output Table 5-2

TABLE 5 - 2 : TOTAL UNDISCOUNTED DAMAGES FOR EACH ZONE FOR EACH TIME INTERVAL - LOW POPULATION

TIME	REPO	EDDY	REBD	NIDO	WTE	LEA	CHAV	REGS	TOT.ZONE	NON-SPEC	TTOTAL
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.	1.61E 00	8.59E 00	3.97E 00	1.44E 00	6.25E-01	5.84E 00	6.10E 00	1.41E 01	4.23E 01	6.00E 02	6.42E 02
50.	1.70E 00	1.31E 01	5.84E 00	1.89E 00	8.09E-01	7.47E 00	9.14E 00	1.71E 01	5.71E 01	5.02E 02	5.59E 02
60.	1.69E 00	1.54E 01	6.68E 00	2.07E 00	8.82E-01	8.11E 00	1.05E 01	1.69E 01	6.21E 01	4.22E 02	4.84E 02
70.	1.62E 00	1.60E 01	6.81E 00	2.10E 00	8.91E-01	8.16E 00	1.07E 01	1.55E 01	6.18E 01	3.51E 02	4.13E 02
80.	1.52E 00	1.57E 01	6.54E 00	2.04E 00	8.66E-01	7.93E 00	1.03E 01	1.38E 01	5.87E 01	2.91E 02	3.50E 02
90.	1.43E 00	1.48E 01	6.04E 00	1.96E 00	8.32E-01	7.60E 00	9.45E 00	1.23E 01	5.44E 01	2.40E 02	2.94E 02
100.	1.35E 00	1.36E 01	5.46E 00	1.88E 00	7.98E-01	7.30E 00	8.50E 00	1.10E 01	4.99E 01	1.96E 02	2.46E 02
200.	1.98E 01	1.74E 02	6.11E 01	2.97E 01	1.26E 01	1.14E 02	9.13E 01	2.16E 02	7.19E 02	1.45E 03	2.17E 03
300.	1.74E 01	6.91E 01	3.22E 01	2.70E 01	1.14E 01	1.04E 02	4.31E 01	1.30E 02	4.34E 02	2.40E 02	6.74E 02
400.	1.89E 01	6.53E 01	3.43E 01	2.98E 01	1.26E 01	1.14E 02	4.55E 01	1.35E 02	4.56E 02	1.11E 02	5.66E 02
500.	2.04E 01	7.16E 01	3.80E 01	3.25E 01	1.37E 01	1.25E 02	5.06E 01	1.44E 02	4.96E 02	9.03E 01	5.86E 02
600.	2.19E 01	7.75E 01	4.11E 01	3.49E 01	1.47E 01	1.34E 02	5.49E 01	1.52E 02	5.31E 02	8.25E 01	6.13E 02
700.	2.31E 01	8.18E 01	4.34E 01	3.69E 01	1.56E 01	1.41E 02	5.80E 01	1.58E 02	5.58E 02	7.64E 01	6.35E 02
800.	2.40E 01	8.44E 01	4.50E 01	3.84E 01	1.62E 01	1.47E 02	5.99E 01	1.62E 02	5.77E 02	7.06E 01	6.48E 02
900.	2.46E 01	8.58E 01	4.58E 01	3.95E 01	1.67E 01	1.51E 02	6.09E 01	1.65E 02	5.90E 02	6.54E 01	6.55E 02
1000.	2.51E 01	8.64E 01	4.63E 01	4.04E 01	1.70E 01	1.55E 02	6.13E 01	1.67E 02	5.98E 02	6.07E 01	6.59E 02
2000.	3.95E 02	1.30E 03	7.05E 02	6.39E 02	2.70E 02	2.44E 03	9.23E 02	2.92E 03	9.60E 03	5.86E 02	1.02E 04
3000.	4.22E 02	1.28E 03	7.05E 02	6.84E 02	2.88E 02	2.61E 03	9.02E 02	3.02E 03	9.91E 03	4.89E 02	1.04E 04
4000.	4.91E 02	1.44E 03	8.01E 02	7.94E 02	3.36E 02	3.04E 03	1.02E 03	3.43E 03	1.13E 04	5.39E 02	1.19E 04
5000.	5.54E 02	1.60E 03	8.94E 02	9.00E 02	3.79E 02	3.44E 03	1.13E 03	3.80E 03	1.27E 04	6.23E 02	1.33E 04
6000.	6.07E 02	1.72E 03	9.70E 02	9.86E 02	4.15E 02	3.77E 03	1.23E 03	4.10E 03	1.38E 04	7.65E 02	1.46E 04
7000.	6.50E 02	1.83E 03	1.03E 03	1.05E 03	4.45E 02	4.04E 03	1.30E 03	4.34E 03	1.47E 04	1.25E 03	1.59E 04
8000.	6.85E 02	1.92E 03	1.08E 03	1.11E 03	4.69E 02	4.25E 03	1.35E 03	4.54E 03	1.54E 04	3.78E 03	1.92E 04
9000.	7.13E 02	1.99E 03	1.11E 03	1.16E 03	4.88E 02	4.43E 03	1.39E 03	4.69E 03	1.60E 04	1.18E 04	2.78E 04
10000.	7.36E 02	2.07E 03	1.14E 03	1.20E 03	5.04E 02	4.58E 03	1.42E 03	4.81E 03	1.65E 04	2.44E 04	4.09E 04
20000.	1.11E 04	2.98E 04	1.67E 04	1.79E 04	7.54E 03	6.85E 04	2.06E 04	7.88E 04	2.51E 05	3.61E 05	6.12E 05
30000.	8.54E 03	2.37E 04	1.19E 04	1.38E 04	5.83E 03	5.29E 04	1.42E 04	6.00E 04	1.91E 05	1.54E 05	1.73E 06
40000.	6.54E 03	1.93E 04	8.35E 03	1.06E 04	4.46E 03	4.05E 04	9.59E 03	6.54E 04	1.65E 05	3.03E 06	3.20E 06
50000.	5.34E 03	1.78E 04	6.62E 03	8.66E 03	3.65E 03	3.32E 04	7.49E 03	7.16E 04	1.54E 05	4.13E 06	4.28E 06
60000.	4.50E 03	1.77E 04	5.75E 03	7.30E 03	3.08E 03	2.79E 04	6.63E 03	7.11E 04	1.44E 05	4.74E 06	4.89E 06
70000.	3.78E 03	1.79E 04	5.24E 03	6.14E 03	2.59E 03	2.35E 04	6.25E 03	6.75E 04	1.33E 05	5.10E 06	5.23E 06
80000.	3.18E 03	1.81E 04	4.87E 03	5.15E 03	2.17E 03	1.97E 04	6.05E 03	6.37E 04	1.23E 05	5.30E 06	5.43E 06
90000.	2.66E 03	1.82E 04	4.60E 03	4.33E 03	1.83E 03	1.65E 04	5.95E 03	5.97E 04	1.14E 05	5.41E 06	5.52E 06
100000.	2.27E 03	1.84E 04	4.42E 03	3.69E 03	1.55E 03	1.41E 04	5.93E 03	5.65E 04	1.07E 05	5.47E 06	5.57E 06
200000.	4.47E 04	2.43E 05	1.09E 05	7.27E 04	3.06E 04	2.78E 05	1.54E 05	5.31E 05	1.46E 06	2.38E 07	2.53E 07
300000.	3.80E 04	4.35E 05	1.05E 05	6.18E 04	2.61E 04	2.36E 05	1.53E 05	1.53E 06	2.59E 06	1.32E 08	1.34E 08
400000.	4.14E 04	3.74E 05	1.01E 05	6.74E 04	2.84E 04	2.58E 05	1.43E 05	1.29E 06	2.30E 06	1.04E 08	1.07E 08
500000.	4.30E 04	3.03E 05	9.29E 04	6.99E 04	2.95E 04	2.68E 05	1.28E 05	1.02E 06	1.95E 06	7.57E 07	7.77E 07
600000.	4.34E 04	2.46E 05	8.42E 04	7.03E 04	2.97E 04	2.69E 05	1.13E 05	8.19E 05	1.67E 06	5.43E 07	5.60E 07
700000.	4.29E 04	2.03E 05	7.64E 04	6.98E 04	2.94E 04	2.67E 05	9.98E 04	6.71E 05	1.46E 06	3.92E 07	4.07E 07
800000.	4.20E 04	3.74E 05	6.96E 04	6.83E 04	2.88E 04	2.61E 05	8.90E 04	5.62E 05	1.49E 06	2.87E 07	3.02E 07
900000.	4.07E 04	1.40E 07	6.37E 04	6.61E 04	2.79E 04	2.53E 05	7.97E 04	4.79E 05	1.50E 07	2.38E 07	3.88E 07
1000000.	3.92E 04	2.11E 08	5.87E 04	6.38E 04	2.69E 04	2.44E 05	7.23E 04	4.17E 05	2.12E 08	5.66E 07	2.69E 08
TOTAL	4.29E 05	2.27E 08	8.38E 05	6.97E 05	2.94E 05	2.67E 06	1.12E 06	7.95E 06	2.41E 08	5.73E 08	8.15E 08

APPENDIX Q

PROGRAMMER'S NOTES

Variables

The variables used and their definitions are presented in the list of nomenclature in the front pages of this volume.

"Index" File Structure

"Index" is an unformatted temporary file allocated to logical unit 2. Index holds a maximum of 260 records, each 400 bytes in length. Index is calculated for each nuclide and zone.

Number of Zones

The number of geographic zones, designated by the variable MZ, in the initial demonstration is 8. Nonspecific doses and corresponding damages are treated in the calculations as though they are for an additional zone (MZP1 = MZ + 1, or 9 for the demonstration). While input provides for a number of zones other than 8, and the ranges of calculation loops correspond, there are some program changes required for MZ $\neq$ 8, to provide consistent table formats. For example, in FORMATS 850, 918, and 957, the multiplier of the repeated group (A4, 6X) must be changed from 8 to a new and different value of MZ. Follow-on work can make modifications to automatically accommodate a range of MZ values, but the user is cautioned that these improvements have not yet been made.

Output of Table 2

Table 2 is output (providing the flag ITB3 is set to 1) for all values of time after an initial sequence of times which are bypassed. "IF" statements in lines 1820 and 1900 (numbered on the right side in Appendix R listing) bypass calculations and output for time subscripts through 7 (i.e., through 30 y or subscript 6 in the demonstration). If a different bypass control is desired, the 2 "IF" statements must be modified. It may be desirable in the future to use an input variable

for this purpose. This could be the variable NRO suggested in the next paragraph.

Basis for Table 3

Table 3 includes columns of marginal present value costs for decay groups. The values are obtained by dividing the sum of present values of damage for each nuclide in a decay group, $, by the total mass of nuclides, g, comprising the decay group at a specified time. Presently, the specified time for which mass values, X, are obtained (see input data file AM1E) in the beginning of the terminal storage phase, or a reference time of 30 y (time subscript 7). In a new application, the "7" in lines 2630 and 2670 should be replaced by the integer corresponding to the appropriate time subscript. Line 2290 also uses this time, designated NYRO (number of years of repository operations); this is set equal to 30 in line 402. It may be desirable in the future to use an input variable (e.g., NRO) for the time subscript representing the end of repository operations. This subscript variable could then be used instead of 7 in lines 2630 and 2670, and line 402 could be changed to NYRO = TIME(NRO).

Discount Rate

The discount rate, RATE, is read in as a decimal number in F format. When a zero discount value, 0.0, is read in, it is changed to RATE = .00001 (line 720) for use as a routing flag which bypasses discounting calculations. For output as a percentage, PRATE = RATE x 100 (line 722) is used. When a write statement outputs PRATE, F5.2 format is used which ignores the 1 for the converted zero discount and writes it as 0.00. If a non-zero discount value is used, RATE remains as read in (as low as 0.01%, or RATE = .0001), the discounting calculations are executed, and the proper percentage rate is output as PRATE.

Dose Rate Multiplier

Calculations within AMRAW-B are done in terms of man-rem of dose. AMRAW-A output is in units of milli-rem for local dose and man-rem for nonspecific dose. A multiplier, THO, is used as a conversion factor and is assigned values of .001 and 1.0 for local dose and nonspecific dose, respectively (see lines 1000 and 1020).

Population

Population projections (high and low) are used for local dose calculations in each zone. Nonspecific dose is based upon a total agricultural production implying a nonspecific population. Calculation of damage for nonspecific dose in line 1980 provides for adjustment by including POPH(9) and POPL(9), high and low "populations" for the nonspecific category as designated by subscript 9. These are set equal to 1.0 (see lines 730 and 740) at present.

Input File Containing MAN1

MAN1L and MAN1N from AMRAW-A are processed to MAN1 in file ECONxx for input to AMRAW-B. This can be via disk or tape file. The user is cautioned that JCL for use of COMPRESS must specify disk or tape to be consistent with the input device specification provided for by the user in AMRAW-B.

Modification for Running on Other Systems

AMRAW, written in FORTRAN IV, was developed with implementation on an IBM 360 system. Some changes may be necessary for operation of AMRAW-B on a CDC or other system. However, some of the conditions which require changes in AMRAW-A such as quadruply dimensioned arrays (see Appendix G in Part 1) do not exist in AMRAW-B, which should simplify conversion.

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APPENDIX R

AMRAW-B LISTING

The AMRAW-B code consists of a main program only; there are no subprograms. The code has 394 lines including comment statements.

Appendix R. AMRAW-B Program Listing

```
C***
C***  AMRAW:  ASSESSMENT METHOD FOR RADIOACTIVE WASTE.
C***  A CODE DEVELOPED BY UNIVERSITY OF NEW MEXICO
C***  UNDER EPA CONTRACT #68-01-3256
C***  THIS LISTING IS AMRAW-B, THE ECONOMIC MODEL,MAY 1978.
C***
      IMPLICIT INTEGER*2 (I-N)
      DOUBLE PRECISION NUCNAM(25),HEAD
      DOUBLE PRECISION NUC2(25)
      DATA HEAD/'PVS/GM.'/
      REAL MAN1(50,8),DDP(8),DPY(8),TIME(50),LAMBDA(8)
      REAL POPL(9),POPH(9),DAMAGE(50),PVN(7,25),TDTKH(25)
      REAL TDTKL(25),X(25,50),DTZ(9),SPV(7),TTO(11),THD(50,11)
      REAL DTH(50,25),DTL(50,25),DYRL(50,11),DYRH(50,11),DLD(11)
      DIMENSION IK(25),IG(11),PV2(7,25),SS(7,11),TUDH(11),TUDL(11)
      DIMENSION IFLAGH(8),TITLE(10),SITE(8,5),REG(8),IKK(25)
      DATA LAMBDA/8*0./
      DATA IFLAGH/1,2,3,4,5,6,7,8/
      INTEGER*4 INDEX,POS(2),IN,IP,IS
      DATA POS/'HIGH','LOW'/
      DEFINE FILE 2(260,400,U,INDEX)
      CALL FSPIE
      IN=5
      IP=6
      IS=1
      NYRO=30
C***
C***    READ # OF TIME PERIODS,DISCOUNT RATE, RISK OF DEATH($),   ***
C***    DOSE BY BODY SITE, POPULATION PROJECTION(LOW&HIGH) FROM AMB
C***    PRINT INPUT DATA
C***
      READ(IN,651)TITLE
  651 FORMAT(10A4)
      READ(IN,1806)RATE
      READ(IN,1806)VOL
      READ(IN,856)NT,MZ,NK,NIHT
      DO 1640 I=1,NIHT
 1640 READ(IN,1651)(SITE(I,J),J=1,5),DPY(I)
      DO 1650 I=1,MZ
 1650 READ(IN,1652)REG(I),POPH(I),POPL(I)
 1651 FORMAT(5A4,F5.0)
 1652 FORMAT(A4,1X,2F10.0)
  652 FORMAT(///5X,10A4)
      WRITE(IP,652)TITLE
      LL=0
      READ(IN,653)NG
      DO 660 I=1,NG
      READ(IN,653)K,(IKK(J),J=1,K)
      IG(I)=K
      DO 665 J=1,K
      L=LL+J
  665 IK(L)=IKK(J)
  660 LL=L
```

```
  653 FORMAT(3X,25I3)                                                   00000680
      MZP1=MZ+1                                                         00000690
      DO 2807 I=1,NIHT                                                  00000700
 2807 DDP(I)=DPY(I)*.26                                                 00000710
      IF(RATE.EQ.0.)RATE=0.00001                                        00000720
      PRATE=RATE*100.                                                   00000722
      POPH(9)=1.                                                        00000730
      POPL(9)=1.                                                        00000740
      WRITE(IP,2806)PRATE,VOL                                           00000750
 2806 FORMAT(/5X,'DISCOUNT RATE =',F5.2,' %'/5X,'COST OF INCREASED '    00000760
     *,'LEVEL OF RISK OF DEATH = $',F8.0//33X,                          00000770
     *'COST OF EXCESS RISK OF DEATH'/7X,'SITE OR TYPE',8X,              00000780
     * 'DEATH /MIL. MAN-REM',4X,'$/MAN-REM'/)                           00000790
       DO 2601 I=1,NIHT                                                 00000800
 2601  WRITE(IP,2607)(SITE(I,J),J=1,5),DPY(I),DDP(I)                    00000810
 2607  FORMAT(5X,5A4,1X,2F16.1)                                         00000820
       WRITE(IP,2608)                                                   00000830
 2608 FORMAT(//7X,'POPULATION PROJECTIONS'/5X,' ZONE ',5X,              00000840
     *'HIGH',6X,'LOW'/)                                                 00000850
      DO 2602 I=1,MZ                                                    00000860
 2602 WRITE(IP,2609)I,REG(I),POPH(I),POPL(I)                            00000870
 2609 FORMAT(5X,I1,1X,A4,2F10.0)                                        00000880
C***                                                                    00000890
C***    READ TIME INTERVALS AND NUCLIDE INVENTORY FROM AMIE  ***        00000900
C***                                                                    00000910
      READ(5,806)(TIME(I),I=1,NT)                                       00000920
      DO 650 K=1,NK                                                     00000930
      READ(5,808)NUCNAM(K),(X(K,IT),IT=1,7)                             00000940
  650 READ(5,809)(X(K,IT),IT=8,NT)                                      00000950
C***                                                                    00000960
C***    READ MAN1 (AMRAW-A OUTPUT) FROM ECONXX   ***                    00000970
C***    CALCULATE DAMAGES AND STORE ON DISK   ***                       00000980
C***                                                                    00000990
      THC=.001                                                          00001000
      DO 900 IZ=1,MZP1                                                  00001010
      IF(IZ.EQ.9)THO=1.0                                                00001020
      DO 900 K=1,NK                                                     00001030
C     WRITE(IP,3806)IZ,K                                                00001040
 3806 FORMAT('1','IZ=',I1,'   K=',I2//)                                 00001050
      DO 901 IT=1,NT                                                    00001060
      DAMAGE(IT)=0.0                                                    00001070
      READ(IS,806)(MAN1(IT,IH),IH=1,NIHT)                               00001080
C     WRITE(IP,806)(MAN1(IT,IH),IH=1,NIHT)                              00001090
  901 CONTINUE                                                          00001100
      DO 902 IT=1,NT                                                    00001110
      DO 902 IH=1,NIHT                                                  00001120
      IHT=IH                                                            00001130
C***                                                                    00001140
C***    CHECK IF TOTAL BODY DOSE RATE IS TO BE USED  ***                00001150
C***                                                                    00001160
      IF(IFLAGH(IH).NE.IH)IHT=1                                         00001170
  902 DAMAGE(IT)=DAMAGE(IT)+MAN1(IT,IHT)*DDP(IH)*                       00001180
     1EXP(-LAMBDA(IHT)*TIME(IT))*THO                                    00001190
```

```
      INDEX=10*(K-1)+IZ
  900 WRITE(2'INDEX)(DAMAGE(IT),IT=1,NT)
C***
C***    CALCULATE AND PRINT TABLES ON ZONAL AND TOTAL DAMAGES  ***
C***    (HIGH & LOW POPULATION PROJECTION -- $/YEAR )          ***
C***    TABLE - 1
C***
      WRITE(IP,860)
      NTABLE=1
      WRITE(IP,850)NTABLE,POS(1),(REG(J),J=1,MZ)
      DO 921 IT=1,NT
      DO 921 IR=1,11
      DYRL(IT,IR)=0
  921 DYRH(IT,IR)=0
      DO 906 NTABLE=1,2
      DO 903 IT=1,NT
      DT=0.0
      DT9=0.0
      DO 905 IZ=1,MZP1
  905 DTZ(IZ)=0.0
      DO 904 IZ=1,MZP1
      IF(IT.LE.7)GO TO 903
      DO 904 K=1,NK
      INDEX=10*(K-1)+IZ
      READ(2'INDEX)(DAMAGE(ITE),ITE=1,NT)
      IF(NTABLE.EQ.1)POP=POPH(IZ)
      IF(NTABLE.EQ.2)POP=POPL(IZ)
      DTZ(IZ)=DTZ(IZ)+DAMAGE(IT)*POP
  904 CONTINUE
      DT=DTZ(1)+DTZ(2)+DTZ(3)+DTZ(4)+DTZ(5)+DTZ(6)+DTZ(7)+DTZ(8)
      DT9=DT+DTZ(9)
      IF(NTABLE.EQ.2)GO TO 917
      DO 1501 IZ=1,MZ
      DYRH(IT,IZ)=DTZ(IZ)
 1501 CONTINUE
      DYRH(IT,9)=DT
      DYRH(IT,10)=DTZ(9)
      DYRH(IT,11)=DT9
  917 CONTINUE
      IF(NTABLE.EQ.1)GO TO 903
      DO 1502 IZ=1,MZ
      DYRL(IT,IZ)=DTZ(IZ)
 1502 CONTINUE
      DYRL(IT,9)=DT
      DYRL(IT,10)=DTZ(9)
      DYRL(IT,11)=DT9
  903 WRITE(IP,851)TIME(IT),(DTZ(IZ),IZ=1,MZ),DT,DTZ(9),DT9
      IF(NTABLE.LT.2)WRITE(IP,860)
      NT2=NTABLE+1
      IF(NTABLE.LT.2)WRITE(IP,850)NT2,POS(2),(REG(J),J=1,MZ)
  906 CONTINUE
C***
C***    $ DAMAGES BY NUCLIDE AND BY TIME PERIOD    ***
```

```
C***      SET ITB3 TO 1 TO PRINT,TO 0 TO SUPPRESS PRINT. ***
C***      TABLE - 2
C***
      ITB3=0
      DC 920 IT=1,NT
      DO 920 K=1,NK
      DTL(IT,K)=0
  920 DTH(IT,K)=0
      DC 907 IT=1,NT
      IF(IT.LE.7)GO TO 916
      IF(ITB3.EQ.1)WRITE(IP,860)
      IF(ITB3.EQ.1)WRITE(IP,861)IT,TIME(IT)
      IF(ITB3.EQ.1)WRITE(IP,853)
  916 CCNTINUE
      DO 915 K=1,NK
      DO 908 I=1,9
  908 DTZ(I)=0.0
      IF(IT.LE.7)GO TO 907
      DO 909 IZ=1,MZ
      INDEX=10*(K-1)+IZ
      READ(2'INDEX)(DAMAGE(ITE),ITE=1,NT)
      DTZ(1)=DTZ(1)+DAMAGE(IT)*POPH(IZ)
  909 DTZ(2)=DTZ(2)+DAMAGE(IT)*POPL(IZ)
      INDEX=10*(K-1)+9
      READ(2'INDEX)(DAMAGE(ITE),ITE=1,NT)
      DTZ(3)=DTZ(3)+DAMAGE(IT)*(POPL(9)+POPH(9))/2.
      DTZ(4)=DTZ(1)+DTZ(3)
      DTZ(5)=DTZ(2)+DTZ(3)
      DTH(IT,K)=DTZ(4)
      DTL(IT,K)=DTZ(5)
      IF(ITB3.EQ.1)WRITE(IP,854)NUCNAM(K),(DTZ(I),I=1,5)
  915 CCNTINUE
  907 CCNTINUE
C***
C***     DISCOUNTED PRESENT VALUE FOR HIGH & LOW POPULATION BY NUCLIDE *
C***     TABLE - 3
C***
      WRITE(IP,2222)PRATE
 2222 FCRMAT('1',5X,'TABLE 3 : DISCOUNTED PRESENT VALUES ( $ )'/
     * 16X,'DISCOUNT RATE =',F5.2,' %'//
     *14X,'HIGH POPULATION',9X,'LOW POPULATION'/
     *1X,'NUCLIDE ',2(3X,'DISCOUNTED',4X,'PV $/GM')/)
      M1=2
      DO 912 II=1,2
      DC 911 K=1,NK
  911 PVN(1,K)=0.0
      DO 913 K=1,NK
      DC 913 IT=2,NT
      IF(II.EQ.1)TD=DTH(IT,K)
      IF(II.EQ.2)TD=DTL(IT,K)
      Z1=TIME(IT-1)
      Z2=TIME(IT)
      IF(RATE.EQ.0.00001)GO TO 914
```

```
      IF(RATE*Z1.GT.15.)GO TO 913                                       00002260
      IF(RATE*Z2.GT.15.)GO TO 913                                       00002270
      PVN(1,K)=PVN(1,K)+TD*((1/RATE)*(EXP(RATE                          00002280
     **NYRO))*((EXP(-RATE*Z1))-(EXP(-RATE*Z2))))                        00002290
      IF(RATE.NE.0.00001)GO TO 913                                      00002300
  914 PVN(1,K)=PVN(1,K)+TD*(Z2-Z1)                                      00002310
  913 CONTINUE                                                          00002320
      DO 10 K=1,NK                                                      00002330
      ID=IK(K)                                                          00002340
      NUC2(K)=NUCNAM(ID)                                                00002350
   10 PV2(1,K)=PVN(1,ID)                                                00002360
      L2=0                                                              00002370
      DO 20 J=1,NG                                                      00002380
      ID=IG(J)                                                          00002390
      L1=L2+1                                                           00002400
      L2=L2+ID                                                          00002410
      SS(1,J)=0                                                         00002420
      DO 20 K=L1,L2                                                     00002430
   20 SS(1,J)=SS(1,J)+PV2(1,K)                                          00002440
      L2=0                                                              00002450
      DO 1001 J=1,NG                                                    00002460
      ID=IG(J)                                                          00002470
      L1=L2+1                                                           00002480
      L2=L2+ID                                                          00002490
      DO 1002 K=L1,L2                                                   00002500
 1002 PV2(M1,K)=PV2(1,K)                                                00002510
 1001 SS(M1,J)=SS(1,J)                                                  00002520
      SPV(1)=0                                                          00002530
      DO 935 K=1,NK                                                     00002540
  935 SPV(1)=SPV(1)+PVN(1,K)                                            00002550
      SPV(M1)=SPV(1)                                                    00002560
      M1=M1+1                                                           00002570
C***                                                                    00002580
C***    DISCOUNTED PRESENT VALUE PER GRAM OF INITIAL WASTE MIX    ***   00002590
C***    FOR HIGH & LOW POPULATION                                 ***   00002600
C***                                                                    00002610
      DO 910 K=1,NK                                                     00002620
  910 PVN(1,K)=PVN(1,K)/X(K,7)                                          00002630
      DO 30 K=1,NK                                                      00002640
      ID=IK(K)                                                          00002650
      NUC2(K)=NUCNAM(ID)                                                00002660
      PVN(2,K)=X(ID,7)                                                  00002670
   30 PV2(1,K)=PVN(1,ID)                                                00002680
      L2=0                                                              00002690
      DO 40 J=1,NG                                                      00002700
      ID=IG(J)                                                          00002710
      L1=L2+1                                                           00002720
      L2=L2+ID                                                          00002730
      SS(1,J)=0                                                         00002740
      DO 40 K=L1,L2                                                     00002750
   40 SS(1,J)=SS(1,J)+PVN(2,K)                                          00002760
      M11=M1-1                                                          00002770
      L2=0                                                              00002780
```

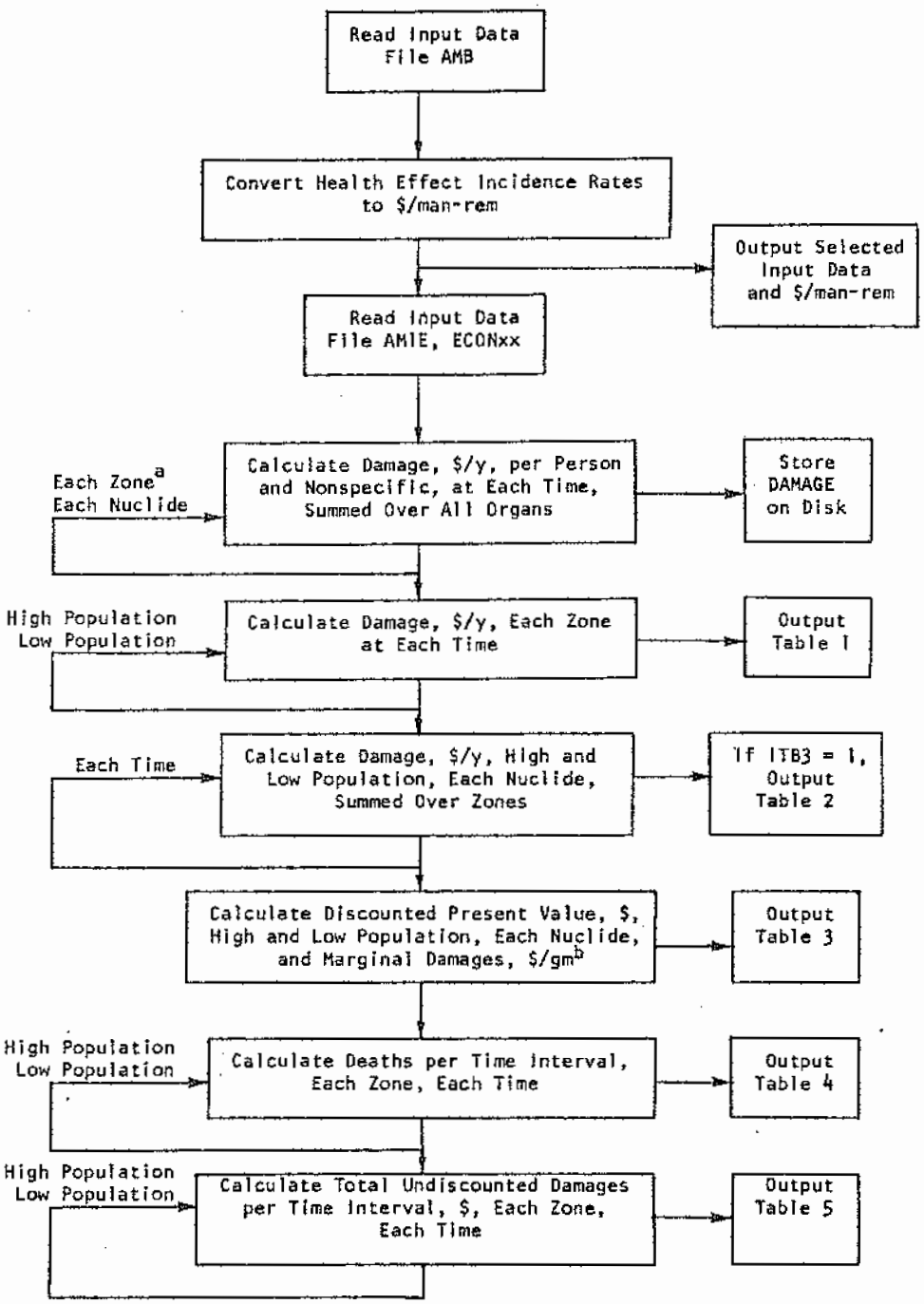
```
      DC 1003 J=1,NG                                                    00002790
      ID=IG(J)                                                          00002800
      L1=L2+1                                                           00002810
      L2=L2+ID                                                          00002820
      DO 1004 K=L1,L2                                                   00002830
 1004 PV2(M1,K)=PV2(1,K)                                                00002840
 1003 SS(M1,J)=SS(M11,J)/SS(1,J)                                        00002850
      SPV(1)=0                                                          00002860
      DC 2935 K=1,NK                                                    00002870
 2935 SPV(1)=SPV(1)+PVN(2,K)                                            00002880
      SPV(M1)=SPV(M11)/SPV(1)                                           00002890
       M1=M1+1                                                          00002900
  912 CCNTINUE                                                          00002910
      L2=0                                                              00002920
      DO 1014 J=1,NG                                                    00002930
      ID=IG(J)                                                          00002940
      L1=L2+1                                                           00002950
      L2=L2+ID                                                          00002960
      DO 1013 K=L1,L2                                                   00002970
 1013 WRITE(IP,2855)NUC2(K),PV2(2,K),PV2(4,K)                           00002980
 2855 FORMAT((1X,A8,1X,1PE12.2,12X,1PE12.2))                            00002990
 1014 WRITE(IP,1967)(SS(L,J),L=2,5)                                     00003000
 1015 WRITE(IP,967)(SPV(L),L=2,5)                                       00003010
C***                                                                    00003020
C***    # OF DEATHS PER TIME INTERVAL FOR HIGH & LOW POPULATION   ***   00003030
C***    TABLE - 4                                                       00003040
C***                                                                    00003050
      DC 933 I=1,2                                                      00003060
      PL=0                                                              00003070
      IF(I.EQ.1)WRITE(IP,919)I,POS(1)                                   00003080
      IF(I.EQ.2)WRITE(IP,919)I,POS(2)                                   00003090
      WRITE(IP,918)VOL,(REG(J),J=1,MZ)                                  00003100
      DO 969 IR=1,11                                                    00003110
      DLD(IR)=0                                                         00003120
  969 TTD(IR)=0                                                         00003130
      DC 970 IT=1,NT                                                    00003140
      DC 970 IR=1,11                                                    00003150
  970 THD(IT,IR)=0                                                      00003160
      DC 932 IT=1,NT                                                    00003170
      DO 931 IR=1,11                                                    00003180
      IF(I.EQ.1)DY=DYRH(IT,IR)                                          00003190
      IF(I.EQ.2)DY=DYRL(IT,IR)                                          00003200
      IF(IT.EQ.1.)GO TO 989                                             00003210
      PL=TIME(IT)-TIME(IT-1)                                            00003220
  989 CCNTINUE                                                          00003230
      DLD(IR)=(DY/VOL)*(PL)                                             00003240
  931 THD(IT,IR)=DLD(IR)                                                00003250
  932 WRITE(IP,851)TIME(IT),(DLD(IR),IR=1,11)                           00003260
      DO 955 IR=1,11                                                    00003270
      TTD(IR)=0                                                         00003280
      DO 955 IT=1,NT                                                    00003290
  955 TTD(IR)=TTD(IR)+THD(IT,IR)                                        00003300
  934 WRITE(IP,968)(TTD(IR),IR=1,11)                                    00003310
```

```
  933 CCNTINUE                                                          00003320
C***                                                                    00003330
C***     TOTAL UNDISCOUNTED DAMAGES FOR EACH ZONE & FOR EACH TIME  ***  00003340
C***     INTERVAL  --  FOR HIGH & LOW POPULATION                   ***  00003350
C***     TABLE - 5                                                     00003360
C***                                                                    00003370
      PL=0                                                              00003380
      DC 1600 IR=1,11                                                   00003390
      TLDH(IR)=0.                                                       00003400
      TUDL(IR)=0.                                                       00003410
      DC 1600 IT=2,NT                                                   00003420
      PL=TIME(IT)-TIME(IT-1)                                            00003430
      DYRH(IT,IR)=DYRH(IT,IR)*PL                                        00003440
      TLDH(IR)=TUDH(IR)+DYRH(IT,IR)                                     00003450
      DYRL(IT,IR)=DYRL(IT,IR)*PL                                        00003460
 1600 TLDL(IR)=TUDL(IR)+DYRL(IT,IR)                                     00003470
      K1=1                                                              00003480
      K2=2                                                              00003490
      WRITE(IP,957)K1,POS(1),(REG(J),J=1,MZ)                            00003500
      DO 1601 IT=1,NT                                                   00003510
 1601 WRITE(IP,851)TIME(IT),(DYRH(IT,IR),IR=1,11)                       00003520
      WRITE(IP,968)(TUDH(IR),IR=1,11)                                   00003530
      WRITE(IP,957)K2,POS(2),(REG(J),J=1,MZ)                            00003540
      DO 1602 IT=1,NT                                                   00003550
 1602 WRITE(IP,851)TIME(IT),(DYRL(IT,IR),IR=1,11)                       00003560
      WRITE(IP,968)(TUDL(IR),IR=1,11)                                   00003570
      STOP                                                              00003580
  806 FCRMAT(1P8E10.2)                                                  00003590
 1806 FCRMAT(15X,F10.0)                                                 00003600
 1807 FCRMAT(8F5.0)                                                     00003610
  808 FCRMAT(A8,2X,7E10.2)                                              00003620
  809 FCRMAT(10X,7E10.2)                                                00003630
  850 FCRMAT(T6,20X,'TABLE I - ',I1,' : ',                              00003640
     *'ZCNAL AND TOTAL DAMAGES FOR ',A4,' POP. PROJECTION ($/YR)'       00003650
     *//,6X,' TIME',2X,8(A4,6X),'TOT.ZONE',2X,'NON-SPEC',               00003660
     *2X,'TTOTAL')                                                      00003670
  851 FCRMAT(F11.0,1P11E10.2)                                           00003680
  853 FCRMAT(2X,'NUCLIDE',5X,'HIGH POP',4X,'LOW POP',5X,'NON-SPEC'      00003690
     *,4X,'TOT-HIGH',4X,'TOT-LOW')                                      00003700
  854 FCRMAT(1X,A8,1X,1P5E12.2)                                         00003710
  857 FCRMAT('1',A8,' POPULATION SCENARIO - DISCOUNTED PRESENT ',       00003720
     *'VALUE ($)'//'  NUCLIDE  INTEREST RATES-',F6.3/)                  00003730
  855 FCRMAT((1X,A8,1X,1P7E12.2))                                       00003740
  856 FCRMAT(20X,I5)                                                    00003750
  860 FCRMAT('1')                                                       00003760
  861 FCRMAT(10X,'TABLE 2 - ',I2,' : ','TIME PERIOD=',F11.0//)          00003770
  918 FCRMAT(33X,'NUMBER OF DEATHS PER TIME INTERVAL,($',F7.0,')'       00003780
     *//,6X,' TIME',2X,8(A4,6X),'TOT.ZONE',2X,'NON-SPEC',               00003790
     *2X,'TTOTAL'/)                                                     00003800
  950 FCRMAT(18X,'0%',10X,'1%',10X,'2%',10X,'3%',10X,'4%',10X,          00003810
     *'5%',10X,'6%'/)                                                   00003820
  919 FCRMAT('1',T37,'TABLE 4 - ',I1,' : ',A4,' POPULATION SCENARIO')   00003830
  967 FCRMAT(1X,'TOTAL    ',1X,1P7E12.2)                                00003840
 1967 FCRMAT(1X,' SUB TOT',1X,1P7E12.2)                                 00003850
  968 FCRMAT(1X,'TOTAL',5X,1P11E10.2)                                   00003860
  957 FCRMAT('1',6X,'TABLE 5 - ',I1,' : ','TOTAL UNDISCOUNTED DAMAGES ' 00003870
     *,'FOR EACH ZONE',1X,'FCR EACH TIME INTERVAL -'                    00003880
     *,1X,A4,1X,'POPULATION'//,6X,' TIME',2X,                           00003890
     *8(A4,6X),'TOT.ZONE',2X,'NON-SPEC',                                00003900
     *2X,'TTOTAL'/)                                                     00003910
      END                                                               00003920
```

APPENDIX S

FLOWCHART

Figure S-1 shows a simplified flowchart for AMRAW-B. The chart represents flow through the code for a specified waste management phase, such as repository operations or terminal storage. The reader is referred to Volume III, which describes AMRAW-B, for detailed descriptions of each step.



[a]The term "Each Zone" also indicates the sums of all zones, nonspecific, and total of zones and nonspecific.

[b]Marginal damages are based upon inventory of each decay chain at beginning of e.g. terminal storage.

Figure S-1. AMRAW-B simplified flowchart.

APPENDIX T

AUXILIARY PROGRAM

An auxiliary program COMPRESS, is used to process dose rate output from AMRAW-A for use as input to AMRAW-B via the file ECONxx. All of the AMRAW-A output tables in Section 3 (Local Dose to Individual) and Section 4 (Nonspecific Dose to Population) comprise the major input to AMRAW-B (Economic Model). COMPRESS, written in PL-1 and Fortran IV language, finds these tables in the full output stored on tape, strips off the headings and left hand column of time, and outputs a continuous "compressed" file in a form ready to be read by AMRAW-B. Appendix P includes samples of AMRAW-A output and the COMPRESS output file.

The COMPRESS output file consists of the calculated value of dose rates (each line is for sequence of organs calculated for a specific time), for each nuclide in the first geographic zone, followed by the same sequence in each of the other zones in turn and finally, by the nonspecific category. The program may be used separately to produce AMRAW-B input files ECONxx from AMRAW-A output (xx identifies the case number), or it may be joined to AMRAW-B to process data directly. Table T-1 is a listing of COMPRESS, including JCL, as run on the IBM360/67 computer at UNM. The first execution step employs PL-1 and the second step employs Fortran IV. It is necessary to specify, in the JCL cards, the name of the tape and label number storing the AMRAW-A output (see line 390), and the name and label for the output file tape or the DSN for the output disk if used instead of tape (see lines 125 and 690).

Table T-1. Listing of COMPRESS

```
100 //A          JOB (BAB411,LGK,500,20),'HENRY NG'
110 // REGION=256K
120 /*SETUP         9NLHN1619,BD5  2314
121 //DELETE    EXEC PGM=IEHPROGM
122 //SYSPRINT    DD SYSOUT=A
123 //SCT         DD UNIT=2314,VOL=SER=BD5,DISP=SHR
124 //SYSIN       DD *
125        SCRATCH DSNAME=ECON35,VOL=2314=BD5
126 /*
130 //SQUEEZ EXEC LPL1FCG,CPARM='ST,NEST,NOL',P2=DUMMY
140 //PL1.SYSIN DD *
150  /*   FIND EXTRANEOUS MATERIAL AND DELETE IT */
160  EXCESS: PROC OPTIONS(MAIN);
170  DCL CRUNCH FILE RECORD OUTPUT;
180  DCL EXTRA FILE RECORD INPUT;
190  DCL DATA CHAR(133) VARYING;
200  DCL SUBSTR BUILTIN;
210  ON ENDFILE (EXTRA) GO TO FINISH;
220              OPEN FILE(CRUNCH);
230              OPEN FILE(EXTRA);
240  /* FIND 'SECTION  3' IN OUTPUT */
250      AGAIN: READ FILE(EXTRA) INTO (DATA);
260              IF SUBSTR(DATA,61,10)¬='SECTION  3' THEN GO TO AGAIN;
270  PUT SKIP LIST(DATA);
280  /* FIND 'TIME' IN OUTPUT */
290      TIMER: READ FILE(EXTRA) INTO (DATA);
300              IF SUBSTR(DATA,7,4)¬='TIME' THEN GO TO TIMER;
310              DO IN=1 TO 50;
320                 READ FILE(EXTRA) INTO (DATA);
330                 WRITE FILE(CRUNCH) FROM (DATA);
340              END;
350              GO TO TIMER;
360     FINISH: CLOSE FILE(CRUNCH);
370              CLOSE FILE(EXTRA);
380  END EXCESS;
390 //GO.EXTRA DD UNIT=TAPE9,VOL=SER=HN1619,DSN=EPAJOB,LABEL=(5,SL),
400 // DISP=(OLD,PASS)
410 //GO.CRUNCH DD UNIT=SYSW,DSN=&&SQUEEZE,DISP=(NEW,PASS),
420 // DCB=(RECFM=FB,LRECL=133,BLKSIZE=6650),SPACE=(CYL,(1,1),RLSE)
430 //REVAMP EXEC LFORTGCG,LPARM='SIZE=225K'
440 //FORT.SYSIN DD *
450       DIMENSION RDATA(50,8)
460       DO 10 IZ=1,9
470       DO 10 NUC=1,25
480       DO 10 IT=1,50
490       READ(1,100)(RDATA(IT,IORGN),IORGN=1,8)
495       WRITE(2,200)(RDATA(IT,IORGN),IORGN=1,8)
497    10 CONTINUE
500   100 FORMAT(11X,1P8E10.2)
510   200 FORMAT(1P8E10.2)
650       ENDFILE 2
651       REWIND 2
660       STOP
670       END
680 //GO.FT01F001 DD UNIT=SYSW,DSN=&&SQUEEZE,DISP=(OLD,DELETE)
690 //GO.FT02F001 DD UNIT=2314,VOL=SER=BD5,DSN=ECON35,DISP=(NEW,KEEP),
700 // DCB=(RECFM=FB,LRECL=80,BLKSIZE=7200),SPACE=(CYL,(5,2),RLSE)
710 //
720 /*
```