NUREG/CR-5264
ORNL/TDMC-3

Guide for Licensing Evaluations Using CRAC2

NUREG/CR--5264

TI89 006288

A Computer Program for Calculating Reactor Accident Consequences

Manuscript Completed: July 1986
Date Published: December 1988

Prepared by
J.E. White, R.W. Roussin, H. Gilpin*

Oak Ridge National Laboratory
Oak Ridge, TN 37831

*NRC Summer Student

Prepared for
Division of Information Support Services
Office of Administration and Resources Management
U.S. Nuclear Regulatory Commission
Washington, DC 20555
NRC FIN A9096

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ABSTRACT

A version of the CRAC2 computer code applicable for use in analyses of consequences and risks of reactor accidents in case work for environmental statements has been implemented for use on the Nuclear Regulatory Commission Data General MV/8000 computer system. Input preparation is facilitated through the use of an interactive computer program which operates on an IBM personal computer. The resulting CRAC2 input deck is transmitted to the MV/8000 by using an error-free file transfer mechanism. To facilitate the use of CRAC2 at NRC, relevant background material on input requirements and model descriptions has been extracted from four reports - "Calculations of Reactor Accident Consequences," Version 2, NUREG/CR-2326 (SAND81-1994) and "CRAC2 Model Descriptions," NUREG/CR-2552 (SAND82-0342), "CRAC Calculations for Accident Sections of Environmental Statements," NUREG/CR-2901 (SAND82-1693), and "Sensitivity and Uncertainty Studies of the CRAC2 Computer Code," NUREG/CR-4038 (ORNL-6114). When this background information is combined with instructions on the input processor, this report provides a self-contained guide for preparing CRAC2 input data with a specific orientation toward applications on the MV/8000.

CONTENTS

I. CODE IMPROVEMENTS AND ENHANCEMENTS FOR LICENSING EVALUATIONS
A. Introduction

B. Description of CRAC2 Modifications for Licensing Evaluations

1. Sheltering/Relocation Region Modifications
2. Participating Population Fractions Modifications
3. New EVACUATE Subgroup
4. New Output Results
5. Modified Rain Bin Sampling
6. Reduction of Washout Coefficient
7. Correction to Properly Combine CCDFs of Accident Consequences for Different Fractions of the Population
8. Reduction in the Exposure Time for Ground Dose to Marrow

C. Executing CRAC2 on the NRC MV/8000

1. The CRAC2 Directory
2. Running the River Bend Sample Problem
3. Procedure for Executing a New Case

D. Input Preparation Using the CRACIN Pre-processor Module

1. General Description of CRACIN
2. Hardware and Software Requirements Including Program and Data Files
3. Executing CRACIN on an IBM PC
4. Illustration on the Use of CRACIN to Prepare Input Data for Sample Problem #1 in Section V. . . . . .

II. INPUT DATA DESCRIPTION 2-1

A. Introduction 2-1

B. Input Data Organization 2-2

C. Input Data Deck 2-6

D. Title Card 2-6

E. Subgroup Header Card 2-7

F. Subgroup Data Cards 2-8

1. Subgroup SPATIAL 2-11
2. Subgroup SITE 2-14
3. Subgroup ECONOMIC 2-22
4. Subgroup POPULATION 2-26

5. Subgroup TOPOGRAPHY 2-33
6. Subgroup ISOTOPE 2-37
7. Subgroup LEAKAGE 2-41
8. Subgroup DISPERSION 2-45
9. Subgroup EVACUATE 2-47
10. Subgroup ACUTE 2-53
11. Subgroup LATENT 2-57
12. Subgroup CHRONIC 2-62
13. Subgroup SCALE 2-72
14. Subgroup RESULTS 2-74
15. Subgroup OPTIONS 2-83

G. End Card 2-87

III. OUTPUT DESCRIPTION 3-1

A. Input Data Print 3-1

B. Detailed Print Options 3-1

1. Interdiction, Decontamination, Chronic Dose Commitment and Evacuation - NPL . . . 3-2
2. Dispersion Data - NPD 3-4
3. Health Effects - NPH 3-5
4. Final Result Values - NPP 3-6
5. Isotope Activity - NPA 3-8
6. Site Data File and Economic Effects - NRE . . . 3-8

C. Meteorological Data Summary 3-18

D. Final Results 3-18

IV. FILE DESCRIPTIONS 4-1

1. Standard Input File 4-1
2. Standard Output File 4-1
3. Chronic Subgroup Reference File 4-1
4. Reference Subgroup Change File 4-1
5. Concentration File 4-2
6. Site Data File 4-2
7. Dose Conversion File 4-3
8. Meteorological Data File 4-6
9. Final Summary Files 4-8
10. Temporary Work Files 4-8
11. Summary Results 4-9

V. SAMPLE PROBLEMS 5-1

A. Sample Problem 1 5-1

B. Sample Problem 2 5-2

C. Sample Problem 3 5-3

D. Sample Problem 4 5-4

E. Sample Problem 5 5-5

F. Sample Problem Output 5-5

Appendices

A. The CRAC2 Computer Code A-1

A.1 Concept of Operation A-2
A.2 Program Flow A-5
A.2.1 Program MAIN, THE CRAC2 Code Controller . . . A-5
A.2.2 Subroutine INPUT, the Input Controller . . . A-5
A.2.3 Subroutine SITE, the Accident Site Data Processor A-6
A.2.4 Subroutine BINMET, the Meteorological Data Sorter A-6
A.2.5 Subroutine RANBIN, the Latin•Hypercube Initializer A-8
A.2.6 Subroutine SPADAT, the Routine to Set Spatial Meteorology A-8
A.2.7 Subroutine TIMES, the Generator of Stratified Random Times A-8
A.2.8 Subroutine RANDU, the Random Number Generator A-8
A.2.9 Subroutine TIMES2, the Generator of Random Times A-8
A.2.10 Subroutine EXTRCT, the Meteorological Data Extractor A-8
A.2.11 Subroutine INCTIM, the Time Incrementing Routine A-9
A.2.12 Subroutine DISP, the CRAC2 Dispersion Model A-9
A.2.13 Subroutine ACTIVE, the CRAC2 Activity Model A-9
A.2.14 Health Effects and Property Damage Routines A-10
A.2.15 Subroutine STORE, the Routine to Process Standard Results A-16
A.2.16 Subroutine STOROPT, the Routine to Process Special Results A-16

LIST OF TABLES

I-1 Functional Files in the CRAC2 Directory 1-2

I-2 River Bend Data Files in the CRAC2 Directory and Logical Unit Assignments in a CRAC2 Run 1-2

I-3 Temporary Files Used by CRAC2 1-3

I-4 Files Produced by CRAC2 1-3

I-5 Programs and Modules Used for CRAC2 Input Preparation 1-5

I-6 Reference Case Data Files Used for CRAC2 Input Preparation 1-6

II-1 Input Subgroup Description 2-8

II-2 List of Valid Isotopes 2-38

II-3 List of Organ Names 2-55

II-4 List of Result Names 2-79

A-1 Description of Input Subroutines A-7

LIST OF FIGURES

II-1	Representation of the CRAC2 Geometry	2-12
II-2	Dose Effectiveness Model	2-55
III-1	Detailed Contamination Output Sample	3-11
III-2	Detailed Dispersion Output Sample	3-12
III-3	Detailed Health Effects Output Sample	3-13
III-4	Sample Contribution to Final Results From Each Meteorological Trial	3-15
III-5	Sample Output of Activity Option Print	3-15
III-6	Sample Point of Economic Cost Output	3-17
III-7	Meteorological Data Summary	3-21
III-8	Final Results Sample Output	3-23
III-9	Frequency Distribution Table Sample Output	3-24
A-1	Spatial Interval Representation	A-2
A-2	Flow of MAIN, the CRAC2 Control Program	A-17
A-3	Flow of DISP, the Dispersion Model	A-18
A-4	Flow of ACTIVE, the Activity Model	A-19
A-5	Flow of DAMAGE, the Damage Model	A-20
A-6	Flow of EARLY, the Early Effects Model	A-21
A-7	Graphic View of the Uniform Dose Interval Model	A-22
A-8	Flow of the CHRONX, the Chronic Effects Model	A-23
A-9	Flow of PROPDAM, the Property Damage Model	A-24

PREFACE

The CRAC2 computer program is a revised version of the CRAC code developed for the Reactor Safety Study and reported in WASH-1400 (1975), Reactor Safety Study, Appendix VI: Calculation of Reactor Accident Consequences, NUREG 75/014, USNRC. CRAC2 was developed at Sandia National Laboratories in order to incorporate more realistic consequence estimation techniques for site evaluation, emergency planning and response, and risk assessment. The work is documented in NUREG/CR-2326 (SAND 81-1994), Calculation of Reactor Accident Consequences, Version 2, CRAC2, Computer Code User's Guide, by L. T. Ritchie, J. D. Johnson, and R. M. Blond (1983), in NUREG/CR-2552 (SAND 82-0342), CRAC2 Model Descriptions, by L. T. Ritchie, J. Alpert, R. P. Burke, J. D. Johnson, R. M. Ostmeyer, D. C. Aldrich, and R. M. Blond (1984). Additional changes were made to CRAC2 at Sandia National Laboratories to make it more applicable to analyses of consequences and risks of reactor accidents in casework for environmental statements and plant specific probabilistic risk assessment reviews. These changes are described in NUREG/CR-2901 (SAND82-1693), CRAC Calculations for Accident Sections of Environmental Statements, by J. D. Johnson and L. T. Ritchie (1983). Finally, an independent sensitivity analysis, described in NUREG/CR-4038 (ORNL-6114), Sensitivity and Uncertainty Studies of the CRAC2 Computer Code, by D. C. Kocher, R. C. Ward, G. G. Killough, D. E. Dunning, Jr., B. B. Hicks, R. P. Hooker, Jr., J.-Y. Ku, and K. S. Rao, led to changes that were incorporated into the NRC staff version of CRAC2.

The Technical Data Management Center (TDMC), a part of the Engineering Physics Information Centers (EPIC) at Oak Ridge National Laboratory, has the task of updating, maintaining, documenting the NRC staff version of CRAC2 and installing an operational version on the NRC MV/8000 computer. The purpose of this document is to provide a user's guide to the preparation of input for this version of CRAC2 and to make available in one document all essential information needed for its understanding and use. For that reason, relevant portions of NUREG/CR-2326, NUREG/CR-2552, and NUREG/CR-2901 have been incorporated essentially intact with the permission of the Technical Information and Document Control Division (TIDC), Office of Administration, U.S. Nuclear Regulatory Commission.

We acknowledge the direction of Larry W. Bell (NRR/NRC) and the encouragement and advice of the contract monitor, Myrna Steele (TIDC/ADM/NRC) during the course of this project. We acknowledge with gratitude the support of Betty F. Maskewitz, the Director of EPIC. We especially thank Andrea Sjoreen for guidance and numerous discussions about the use of CRAC2. Ron D. Sharp provided the IBM version from which we started and Richard Ward provided an update which included a modified rain bin-sampling procedure. All three are members of the Computing and Telecommunications Division working for the Health and Safety Research Division, ORNL. Daniel Alpert of Sandia contributed modifications to properly summarize consequences from multiple population groups.

I. CODE IMPROVEMENTS AND ENHANCEMENTS FOR LICENSING EVALUATIONS

A. Introduction

The CRAC2 computer code has been installed for use on the Nuclear Regulatory Commission Data General MV/8000 super minicomputer. Based on the CRAC (Calculation of Reactor Accident Consequences) computer code developed in support of the Reactor Safety Study,[1] CRAC2 was developed at Sandia National Laboratories (SNL)[2,3] to incorporate more realistic consequence estimation techniques for site evaluation, emergency planning and response, and risk assessment. The availability of CRAC2 on the MV/8000 represents the first completed effort in implementing a large scale nuclear code on the in-house minicomputer for staff use. The purpose of this report is to compile in a single volume all relevant information for the effective use of the CRAC2 computer code by NRC staff and to serve as a reference for the MV/8000 implementation which gives the regulatory staff access to a time and cost-effective licensing tool.

Since its initial release, CRAC2 has been extended at SNL[4] to include casework analysis requirements for Draft/Final Environmental Statements (DES/FES). During the course of making CRAC2 a more efficient and effective licensing tool, several modifications in the emergency response assumptions were made by SNL. Additionally, Oak Ridge National Laboratory (ORNL) performed an independent sensitivity study of selected models and input parameters used in the CRAC2 code. Recommendations[5] of the ORNL study group were incorporated in the NRC staff version in support of calculations required to evaluate the impact of new source terms. The reduction of the washout coefficient

in the wet-deposition model and the use of an improved meteorological bin-sampling procedure were the two code improvements resulting from the ORNL study. Because the information needed by the staff to execute the code on the MV/8000 was scattered among several reports, letters and memorandum, we were asked to prepare this comprehensive report.

Section I.B, which is based primarily on the introductory material from Ref. 4, describes the modifications that were made to CRAC2 to enhance the code's capabilities for DES/FES casework analysis. The important new feature is the refinement in the relocation emergency response model. In addition, Section I.B summarizes all other code modifications which document the NRC staff version of CRAC2. Section I.C provides instructions for executing the staff version of CRAC2 on the MV/8000. Cases can be submitted to the MV/8000 with the output results optionally routed to the analyst terminal screen. Section I.D describes how to prepare input data via an interactive session on a PC. The resulting input deck is uploaded to the MV/8000 or an IBM computer for batch execution. Sections II, III, IV, and V are from Ref. 2 and provide Input, Output, Data File, and Sample Problem descriptions. Appendix A from Ref. 3 provides an overview of the CRAC2 computer code.

B. Description of CRAC2 Modifications for Licensing Evaluations

Several modifications[4] were required in the CRAC2 computer code for use in DES/FES casework analysis. The following four sections describe these modifications. All other changes to the staff version are summarized in Sections 5 through 8.

1. Sheltering/Relocation Region Modification

The evacuation or emergency response model in the staff version of the CRAC2 computer code includes a provision for a sheltering region outside the maximum evacuation distance. Persons within the sheltering region are assumed to be moved indoors where they will be exposed to only a fraction of the external radiation that they would receive if they remained outdoors. The sheltering region is defined as the region between the maximum evacuation distance and the maximum sheltering distance. The maximum sheltering distance must always be equal to or greater than the maximum evacuation distance. If the maximum sheltering distance is equal to the maximum evacuation distance, no sheltering region exists.

The sheltering region now has an associated relocation time. When the sheltering region exists, an exposure time specified for each evacuation scheme is used for computing external ground exposure dose, after which immediate relocation is assumed to take place. Beyond the sheltering region, the normal relocation time is used for all evacuation schemes.

2. Participating Population Fractions Modification

The participating population fractions modification is based on assigning different emergency response parameters to different population groups. The population as a whole has been divided into three groups. The classification of the population into these three groups is arbitrary. For example, the population can be divided into three components called normal, transient, and special:

Normal - persons remaining in the vicinity of their homes.

Transient - persons who are moving from location to location.

Special - hospitalized persons, penal institution inmates, mental institution inmates, etc.

These three groups could have significantly different emergency responses. Fractions are assigned to each of these groups dependent upon direction from the reactor site. The sum of the fractions for any given direction must equal unity. Emergency response is further differentiated into that occurring during normal and that occurring during adverse conditions. Each population group therefore has a different emergency response depending on these two conditions, bringing the total number of possible emergency responses to six. Results for the three population groups and normal and adverse conditions are combined into a summary, weighted by their respective probabilities.

3. New EVACUATE Subgroup

The EVACUATE subgroup in the input data file for CRAC2 has been modified to accomodate the sheltering region with the newly associated relocation time and the participating population fractions modification. The section describing the EVACUATE subgroup and its input is found starting on page 2-47 with appropriate descriptions of the two modifications.

4. New Output Results

Two results have been added to the list of possible results which may be obtained using the CRAC2 computer code. These two results are

defined as the number of persons receiving a whole body dose from early exposure exceeding 25 rem and the number of persons receiving a thyroid dose from early exposure exceeding 300 rem. Both results are calculated for each evacuation scheme and have associated complementary cumulative frequency distributions.

The consequence versus distance and direction tables have been modified through both addition of new consequences and replacement of some consequences. The consequence versus distance tables represent mean consequence values for which there are no associated complementary cumulative frequency distributions. One new consequence versus distance and direction table has been added -- latent cancer fatality risk. Three new consequences versus distance-only tables have also been added -- early whole body dose (evacuation average), early thyroid dose (evacuation average), and land decontamination factor. Four of the original consequence versus distance and direction tables have been replaced by new consequence tables. The consequences which have been replaced are the interdiction cost tables -- land interdiction cost, land decontamination cost, crop interdiction cost, and milk interdiction cost. The new consequence tables contain the number of persons receiving total bone marrow dose from early exposure exceeding 200 rem (evacuation average), the number of persons receiving whole body dose from early exposure exceeding 25 rem (evacuation average), the number of persons receiving thyroid dose from early exposure exceeding 300 rem (evacuation average), and whole body person-rem due to both early and chronic exposure (last evacuation). The table of latent cancer deaths originally reflected cancers due to early exposure only. This table has been modified to reflect cancers due to both early and chronic exposures.

5. Modified Rain Bin-Sampling

The meteorological bin-sampling procedure in CRAC2 involves sorting each of the 8760 hours of weather data in one year into one of 29 bins, 7 of which represent weather sequences with the first occurrence of rain at specified distances within 30 miles (48 km) of the release site. ORNL developed an alternative bin-sampling procedure[5] in which each of the 7 rain bins was divided into 4 bins that depend on rainfall rate, thus increasing the total number of weather bins to 50. The alternative procedure is potentially important if the CRAC2 wet-deposition model is used, since the scavenging rate depends on rainfall intensity. This bin-sampling procedure was added to the staff version at the request of NRR/DSI/AEB.[6]

6. Reduction in the Washout Coefficient

The wet-deposition model in CRAC2 uses a scavenging rate, Λ, of the form $\Lambda = CR$, where R is the precipitation rate in mm/h and the washout coefficient, C, is 10^{-3} $(mm\text{-}s/h)^{-1}$ for unstable and neutral atmospheric conditions and 10^{-4} $(mm\text{-}s/h)^{-1}$ for stable conditions. At the request of NRR/DSI/AEB,[7] the washout coefficient for unstable atmospheric conditions was changed to 10^{-4} $(mm\text{-}s/h)^{-}1$. This parameter is fixed in variable RAINLA(1) in subroutine ACTIVE.

7. Correction to Properly Combine CCDFs of Accident Consequences for Different Fractions of the Populations

The following corrections were contributed by SNL.[8] The code has been changed so that when PARMOD in subgroup EVAC equals "YS1," the results for the three population segments are combined into a single

value representing the total "societal" consequences. Since two emergency response conditions (referred to as "normal" and "adverse" in NUREG/CR-2901) are considered in the "staff" version, the corrected version of the code provides full sets of results (means and CCDFs) for the two conditions plus the "summary" (i.e., average) condition. The individual results for the six cases are no longer printed. These individual results may still be obtained by performing a second calculation with PARMOD equal to "NO," and scaling the results by the appropriate population fraction.

A couple of points should be made about the "staff" version of the code.

- When PARMOD equals "YS1," only the following early results are valid: Acute Fatalities, Acute Injuries, Pop w/BMR DS > 200, Pop w/BMR DS > 25, and Pop w/THY DS > 300. Both mean results and CCDFs have been corrected for these results. However, risks of early death, early injury and latent cancer death, fatal and injury radii, and acute doses (BMR and THY) are not defined for multiple population groups -- do not use these results. You could obtain these results for individual segments of the population by repeating the calculations with PARMOD equal to "NO."

- "Latent" results referred to as "RESULTS USING LAST EVACUATION SCHEME" are all valid except cancer risk. However, TOT LAT/INITIAL, and TOT WBODY MANREM are a function of emergency response and thus, it is recommended that you make the last

evacuation scheme (i.e., the sixth) your scheme that is most likely (see the enclosed EVAC subgroup input). This is usually a minor point since total cancers and population dose are dominated by the long-term exposure (except in the case of a release containing only noble gases).

- The large tables (34 intervals by 16 sectors) containing early fatalities, early injuries, risk of fatality, risk of injury, and cancer risk were not corrected because of insufficient time.

- Multiple runs are not allowed when PARMOD equals "YS1." That is, your input deck should contain a reference case followed by an END card and one modification case ending with an END card.

8. Reduction in the Exposure Time for Ground Dose to Marrow

At the request of NRR/DSI/AEB,[6] the exposure time before relocation in subroutine EARLY (if IEXPD = -1) was changed from 24 hours to 12 hours.

C. Executing CRAC2 on the MV/8000

The user must have some experience on the NRC MV/8000 in order to understand the instructions for executing CRAC2 on that computer. It is assumed that the user has an account on the MV/8000 system and is familiar with AOS directories and files, CLI commands and macros, and has some experience with editing files and submitting programs for batch execution.

1. The CRAC2 Directory

A directory has been established which contains all files necessary to allow the user to run CRAC2 for the River Bend sample problem. The user should submit the River Bend sample run in order to understand the steps that are involved. A description of the contents of the CRAC2 directory are given in a file contained therein, called CRAC2.INFO. This file also contains instructions on the steps to be taken to prepare and execute CRAC2.

The CRAC2 directory contains program and macro files as listed in Table I-1 and River Bend data files as listed in Table I-2. The logical unit assignments for the data files as they are used in a CRAC2 run are also indicated.

2. Running the River Bend Sample Problem

The following five steps should be taken to run the River Bend sample problem.

a. Read the descriptive material in the CRAC2.INFO file.

b. Copy the RIV macro to your own directory.

c. Invoke the RIV macro.

   This will copy the CRAC2 and CLEAN macros into your directory along with the data files listed in Table I-2. The data files will be renamed FT??, where ?? corresponds to the logical unit assignments indicated in Table I-2.

The RIV macro will print a message warning the user that CRAC2 will use a series of temporary files which will be created and then deleted. The user should take care that there are no files in his area that happen to have the same names. The names used for these files are shown in Table I-3. Table I-4 has a list of three output files generated by a CRAC2 run.

More detailed descriptions of the various CRAC2 data files are given in Section IV.

d. Invoke the CRAC2 macro (include argument for output file).

The command line (for example)

```
CRAC2 RIV.SAM.OUT
```

will submit CRAC2 to run in batch mode and write standard output (logical unit 6) to the file RIV.SAM.OUT.

e. After CRAC2 execution is finished, invoke the CLEAN macro.

This step will delete the temporary files which were generated and used during the CRAC2 run.

Table I-1. Functional Files in the CRAC2 Directory

Filename	Description
RIV.CLI	Macro for copying files needed to run the River Bend sample problem.
CRAC2.CLI	Macro for executing CRAC2.
CRAC2.PR	CRAC2 executable program file.
CLEAN.CLI	Macro for deleting temporary files created by CRAC2.

Table I-2. River Bend Data Files in the CRAC2 Directory and Logical Unit Assignments in a CRAC2 Run

Filename in CRAC2 Directory	Filename in User Directory	Logical Unit	Description
RIV.DATA	FT05	05	Input data for River Bend sample problem
RIV.SITE	FT20	20	Site date file for River Bend.
RIV.DOSE	FT21	21	Dose rate conversion factors.
RIV.MET	FT27	27	Meteorological data for River Bend.
FT51	FT51	51	Random number seed.

Table I-3. Temporary Files Used by CRAC2

Filename	Description
FT10	Chronic subgroup.
FT11	Reference case subgroups.
FT12	Concentration file.
FT31-FT49	Intermediate results for each leakage category.
FT22-24	Additional scratch units.
FT28-29	Additional scratch units.

Table I-4. Files Produced by CRAC2

Filename	Logical Unit	Description
User Specified	06	Standard output file.
FT30	30	Final summary file.
FT50	50	Summary results.

3. Procedure for Executing a New Case

To run a new case the user must first prepare appropriate data files in the user's directory. The input data file FT05 must be supplied as well as the FT21 dose rates conversion factors and the FT51 random number seed. The FT20 site data file and the FT27 meteorological data files are required for certain selected input options. Details of the input requirements are given in Section II.

When the appropriate files have been prepared and reside in the user's directory, the CRAC2 macro can then be used to submit the case for batch execution.

Input preparation can be facilitated through the use of a CRAC2 input processor which can be run on an IBM PC. The use of the input processor is described in Section I-D.

D. Input Preparation for CRAC2

A program called CRACIN, written in BASICA for the IBM PC using DOS 2.10, is available to assist in input preparation for CRAC2. A prospective user should have some experience in using a personal computer and should understand how to boot the DOS operating system from a diskette. A user should, of course, be familiar with the input requirements of CRAC2. The latter are given in detail in Section II.

1. General Description of CRACIN

The CRACIN program produces a file of data in the proper format to be read as a valid input deck for CRAC2. This file corresponds to the FT05 file discussed in Section I-C, which provides the site specific parameters, the characteristics of the postulated accidents, the emergency protective measures to be taken, the number and types of consequences to be studied, and the options controlling the output to be produced by the program.

The FT05 file has reference data. This data consists of a title card, the 15 subgroups with a standard set of data, and an "END" card terminator. To run the reference case without modifications, a second title card followed by an "END" card should be included. The user can modify the reference case by inputting a new title card describing the modification and specifying one or more of the subgroups. The modification case is also terminated with an "END" card.

At the conclusion of a session, the user can select from one of four types of cases to be considered in that particular run. The choices are 500 mile full results, 500 mile minimal medical results, 50 mile full results, and "quick" run.

2. Hardware and Software Requirements Including Program and Data Files

The CRACIN BASICA program can be run on an IBM PC (or compatible) with a monochrome monitor, single disk drive, and 128K of RAM memory, using DOS 2.10.

The user must have a double density program diskette containing files as indicated in Tables I-5 and I-6.

Table I-5. Programs and Modules Used for CRAC2 Input Preparation

Name	Function
ACUTE.BAS	Prepares ACUTDATA.TXT (ACUTE Subgroup)
AUTOEXEC.BAT	
BASICA.COM	Advanced BASIC Interpreter
CHRONIC.BAS	Prepares CHRODATA.TXT (CHRONIC Subgroup)
COMMAND.COM	DOS 2.10
DISPERSI.ON	Prepares DISPDATA.TXT (DISPERSION Subgroup)
ECONOMIC.BAS	Prepares ECONDATA.TXT (ECONOMIC Subgroup)
EVACUATE.BAS	Prepares EVACDATA.TXT (EVACUATION Subgroup)
ISOTOPE.BAS	Prepares ISOTDATA.TXT (ISOTOPE Subgroup)
LATENT.BAS	Prepares LATEDATA.TXT (LATENT Subgroup)
LEAKAGE.BAS	Prepares LEAKDATA.TXT (LEAKAGE Subgroup)
MAIN.BAS	Driver Program for CRACIN
MERGE.BAS	Combines reference data with CRACIN produced files containing the .TXT extension
OPTIONS.BAS	Prepares OPTIDATA.TXT (OPTIONS Subgroup)
POPULATI.ON	Prepares POPUDATA.TXT (POPULATION Subgroup)
RESULTS.BAS	Prepares RESUDATA.TXT (RESULTS Subgroup)
SCALE.BAS	Prepares SCALDATA.TXT (SCALE Subgroup)
SELECT.BAS	Selects Type of Case to be Run
SITE.BAS	Prepares SITEDATA.TXT (SITE Subgroup)
SPATIAL.BAS	Prepares SPATDATA.TXT (SPATIAL Subgroup)
TOPOGRAP.HY	Prepares TOPODATA.TXT (TOPOGRAPHY Subgroup)

Table I-6. Reference Case Data Files Used for CRAC2 Input Preparation

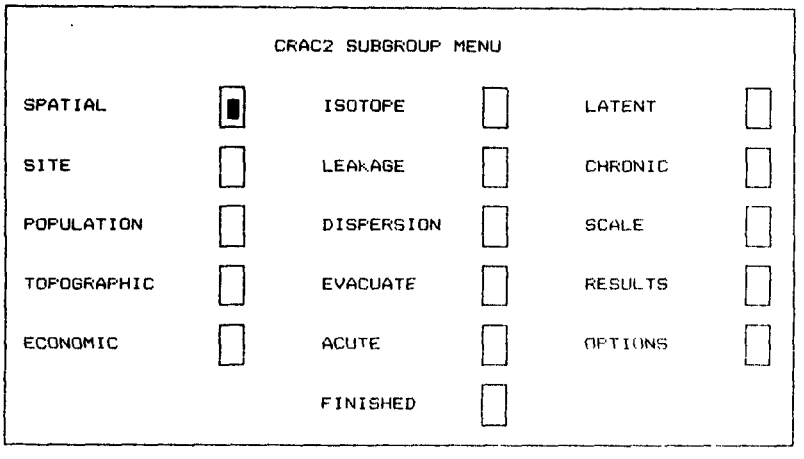
File	Input Subgroup
ACUTDATA.TXT	ACUTE
CHRODATA.TXT	CHRONIC
DISPDATA.TXT	DISPERSION
ECONDATA.TXT	ECONOMIC
EVACDATA.TXT	EVACUATION
ISOTDATA.TXT	ISOTOPE
LATEDATA.TXT	LATENT
LEAKDATA.TXT	LEAKAGE
OPTIDATA.TXT	OPTIONS
POPUDATA.TXT	POPULATION
RESUDATA.TXT	RESULTS
SCALDATA.TXT	SCALE
SITEDATA.TXT	SITE
SPATDATA.TXT	SPATIAL
TOPODATA.TXT	TOPOGRAPHY

The CRACIN input processor consists of 17 modules whose execution is controlled by the MAIN driver program. There is a module for each of the 15 input subgroups required by CRAC2. The names of these modules and the files they produce are listed in Table I-5. Detailed descriptions of the 15 input subgroups are found in Section II. The SELECT module allows the selection of a 500 mile full, 500 mile minimal medical, 50 mile full, or "quick" run result.

The user controls which input subgroups are to be modified for a run by a menu selection. When this is done, the corresponding module will prepare, under user direction, the appropriate subgroup data files (see Table I-5 for names). These are characterized by a filename extension ".TXT." The ".TXT" subgroup file will be inserted after the second title card and will thus override the corresponding reference case subgroup.

3. Running CRACIN on an IBM PC

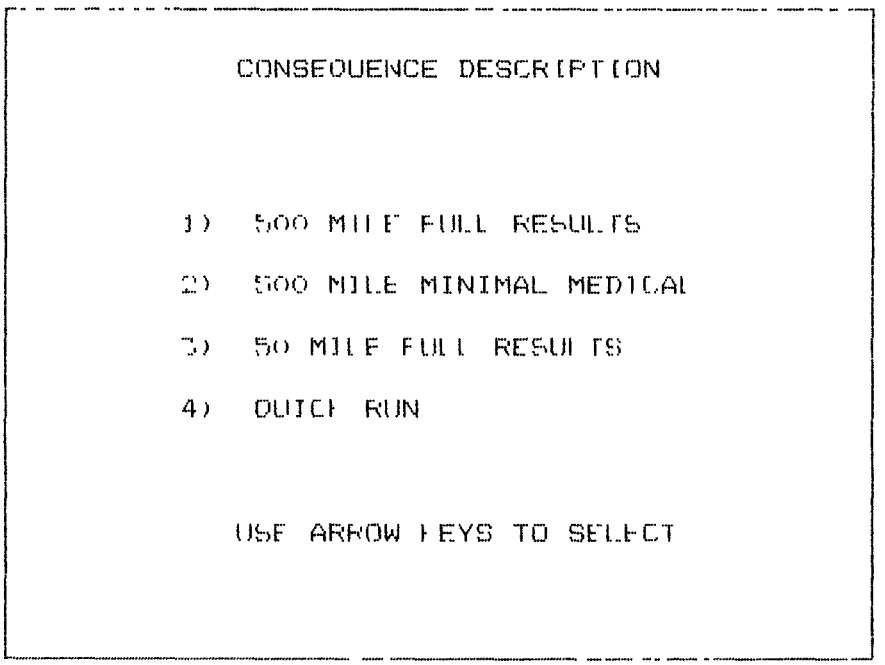
To begin running, insert the CRACIN program diskette into "Drive A." Turn on the power switch or do a system restart. After a normal delay for warm-up and self-testing, a CRAC2 SUBGROUP MENU screen appears.



The cursor control keys (up and down arrow) allow movement around the screen. When the cursor is positioned in the desired location, that option is chosen by pressing the "enter" key.

From this SUBGROUP MENU, the user can select any input subgroup he wishes to change. Pressing "enter" will call up appropriate messages and prompts on the screen to guide the user in providing the proper responses to build that particular input subgroup.

When all appropriate subgroups have been modified, the cursor should be positioned at the "FINISHED" box, and the "enter" key pressed. At this point a message from the SELECT module asks if other than full 500 mile full results are desired. If the response is "Y" (yes), the following screen will appear.



When the appropriate selection is made, the following messages appear,

SUBDECKS ARE NOW SET UP FOR A 500 MILE FULL RESULT RUN

- STRIKE RETURN AND SELECT 'FINISHED' ON THE NEXT MENU ->

which, when followed, will return to the prompt from the SELECT module. At this point, the response should be "N" (no).

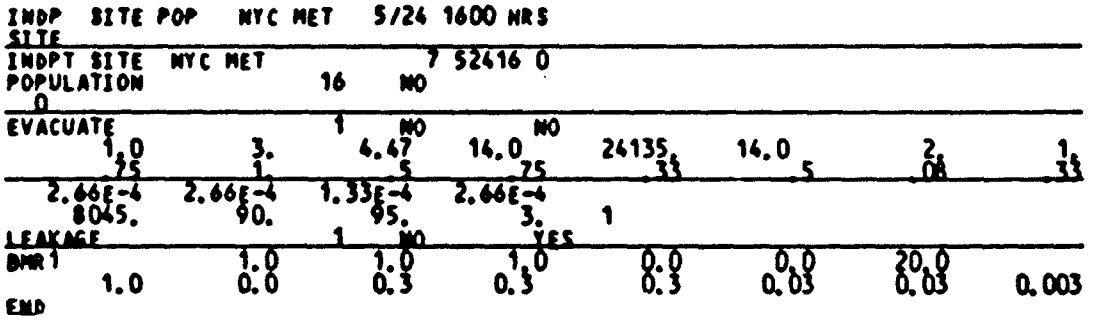
A message from the MAIN program will ask if the user desires to assemble all the subgroup input files (reference case plus any modified subgroups) into a single file (this corresponds to the FT05 data file described in Section I-A. If the response is yes, the user will be prompted to provide a filename for the CRAC2 input deck he is creating. Once the desired input deck is resident on the diskette, the user should leave BASICA by striking the "enter" key. The file specified by the user is now ready to be transferred to the MV/8000 for execution.

4. Illustration on the use of CRACIN to Prepare Input Data for Sample Problem #1 in Section V.

To assist the first-time user in an interactive CRACIN session, we are providing a complete set of the terminal screens and responses required to generate the input data for sample problem #1 on page 5-1. For convenience, a description of the problem is given below. Note that the request to make a permanent change to the reference case is ignored since practical staff applications of CRAC2 have been limited to one site per computer run.

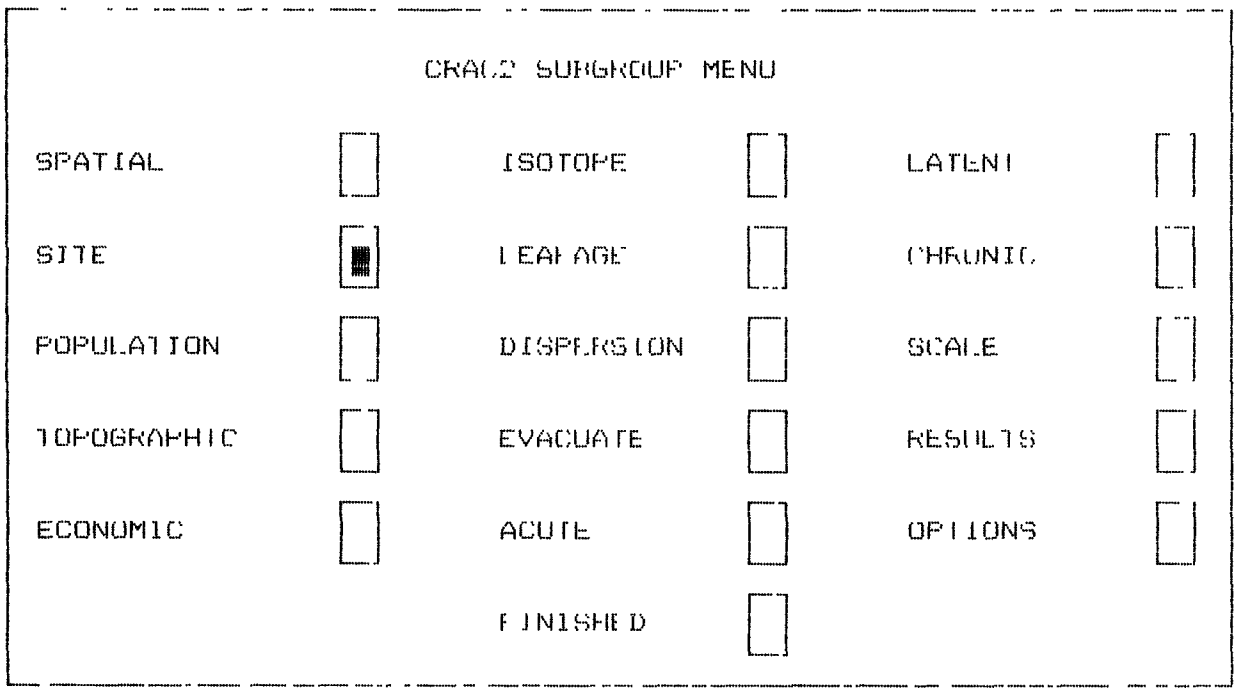
The problem consists of a single trial using start code 7. Meteorological data for the trial is supplied from the meteorological data file. The single trial begins at 1600 hours on May 24. The population and topographic data are to be read from the site data file. The POPULATION subgroup contains a request for all 16 wind directions to be processed. One evacuation strategy is to be applied

to the analysis. The LEAKAGE subgroup specifies one leakage category with the name BMR1 (Benchmark Release 1). The data file created by CRACIN should correspond to the following:



Input data for 4 subgroups (SITE, POPULATION, EVACUATE, and LEAKAGE) will be prepared in this demonstration case. For each subgroup, the terminal screens start with the CRAC2 SUBGROUP MENU where the cursor is positioned in the box selecting the subgroup of interest. After completing all parameter requirements for a given subgroup, the program returns to the CRAC2 SUBGROUP MENU where the user manipulates the cursor positioning arrows to select the box corresponding to the next subgroup to be modified. (**Note**: If pressing the cursor control keys elicits no response from the computer, depress and release the "NUM LOCK" key once and try again.) CRACIN will automatically set the keyboard to upper case. The "enter" key is used to terminate your selection of a parameter value. Once you press the "enter" key, you cannot further edit your parameter value.

The example begins by illustrating the CRAC2 SUBGROUP MENU after the cursor has been moved to the SITE subgroup. The screen will look as indicated below.

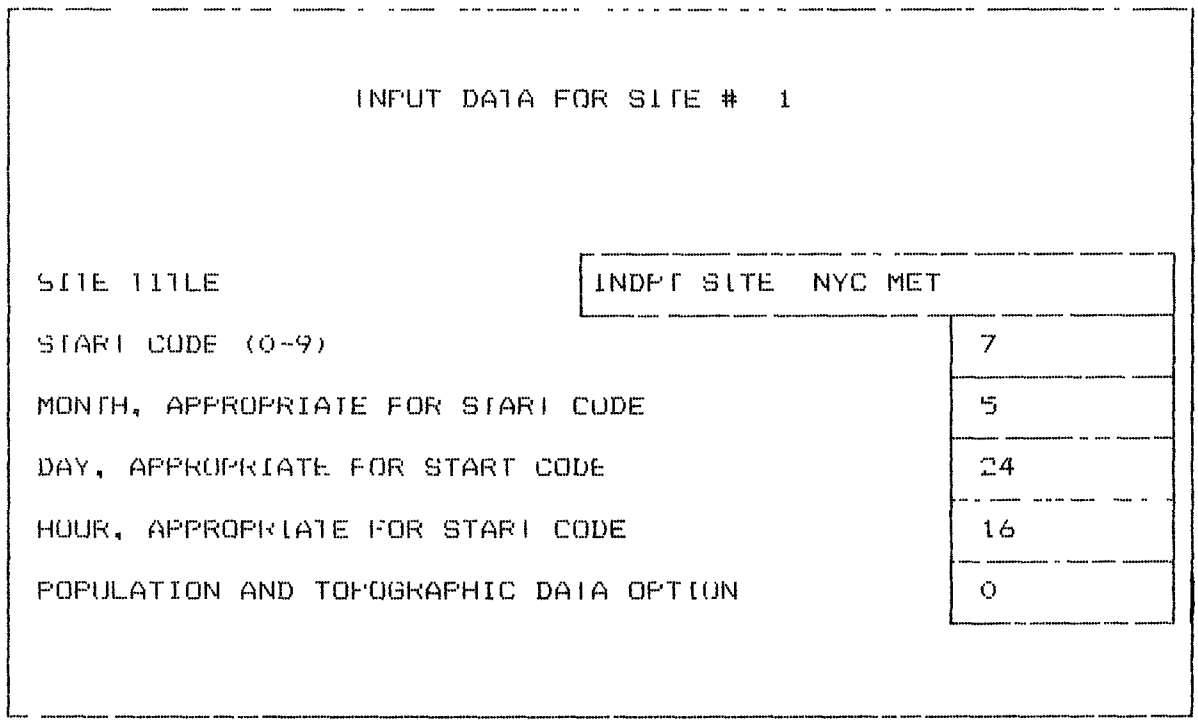


Press the ENTER key and the program displays:

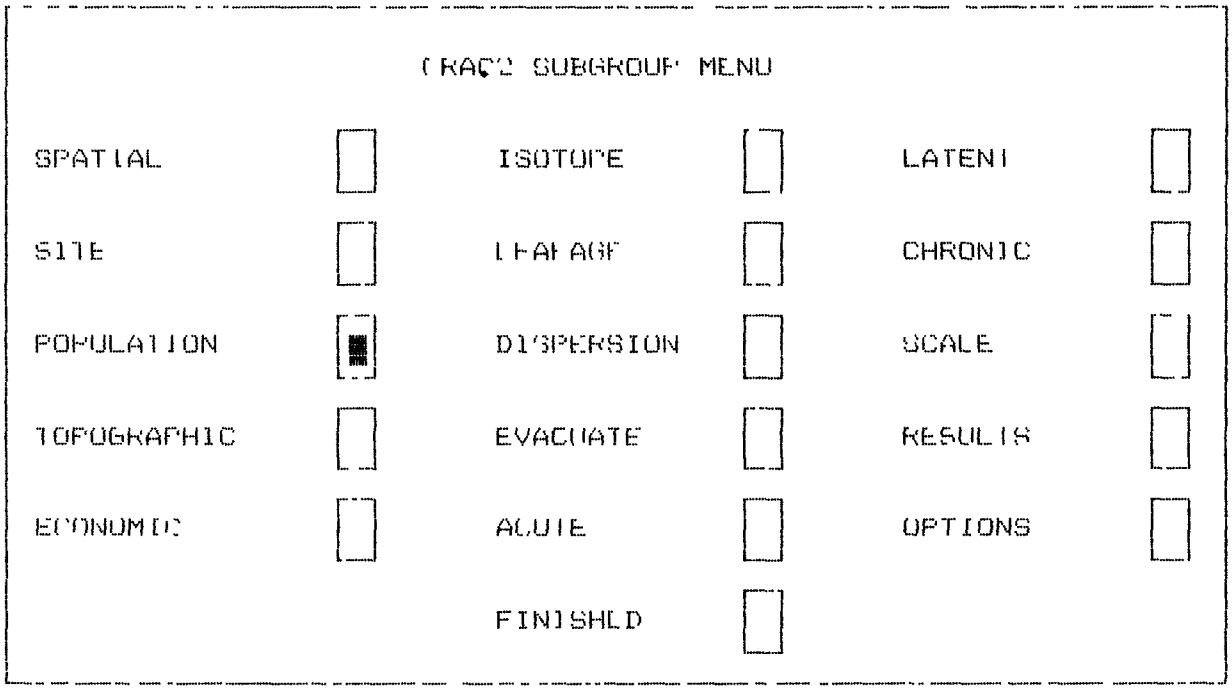
```
                    SUBGROUP SITE

ENTER THE TOTAL NUMBER OF SITES TO BE PROCESSED (1-8): 1
```

It is suggested that users only supply a 1 here since practical staff applications have been limited to one site per computer run.

Upon pressing the ENTER key, the screen will display a descriptive guide for entering SITE data into appropriate boxes. After the user has entered appropriate sample problem values the screen should appear as follows.



The above screen concludes parameter data for subgroup SITE. Pressing ENTER returns the CRAC2 SUBGROUP MENU and moving the cursor to the POPULATION box produces the next screen.



Pressing the ENTER key produces the following request which the user responds to by entering the appropriate value (i.e., 16).

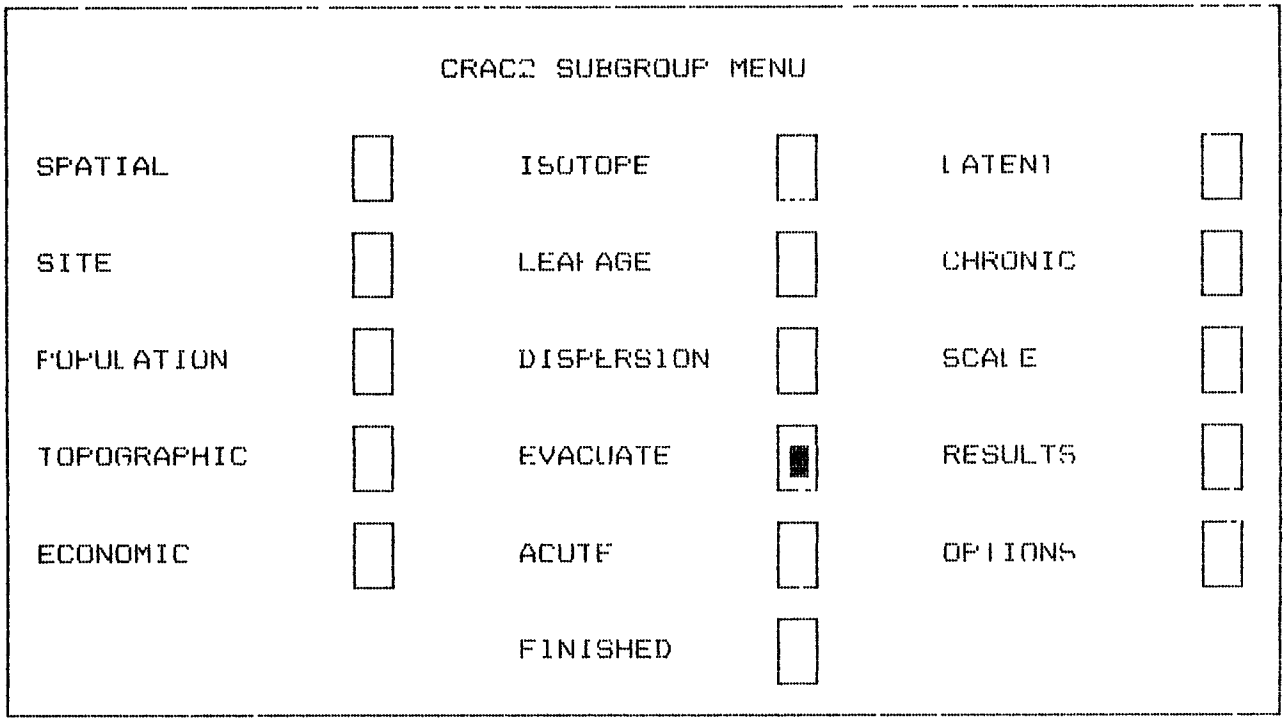
```
ENTER THE TOTAL NUMBER OF POPULATION SECTORS TO BE RUN FOR EACH SITE (1-16): 16
```

After requesting 16 sectors, we arrive at the next screen.

```
                    POPULATION OPTION INDICATOR

    0)  POPULATION DATA IS TO BE READ FROM SITE DATA FILE.
    1)  USE A UNIFORM POPULATION DENSITY.
    2)  INPUT POPULATION FOR EACH SECTOR FROM KEYBOARD.

                    SELECT AN OPTION: 0
```

The 0 option concludes data for POPULATION.

After striking ENTER and moving the cursor to the EVACUATE subgroup, the screen looks as follows.



Striking ENTER produces the following request.

ENTER NUMBER OF EVACUATION STRATEGIES (1--6): 1

After selecting 1 EVACUATION STRATEGY, pressing ENTER will display the next four screens needed to describe the EVACUATION parameters. (The screens are displayed in the image that exists after the user has entered all appropriate values.

EVACUATION PARAMETERS

FOR EVACUATION SCHEME # 1

PROBABILITY OF EVALUATION	1.0
TIME DELAY BEFORE EVACUATION (HOURS)	3.
EVACUATION SPEED (METERS/SECOND)	4.47
MAX EVAC DISTANCE DOWNWIND (INTERVALS)	14.
FINAL EVACUATION DISTANCE (METERS)	24135
MAX DOWNWIND SHELTERING DISTANCE (INTERVALS)	14.0
EVACUATION MODEL (1.0 OR 2.0)	2.
NON-EVAC EXPOSURE DURATION (DAYS)	1.

EVACUATION PARAMETERS

STATIONARY EVACUEE CLOUD SHIELDING	.75
MOVING EVACUEE CLOUD SHIELDING	1.
CLOUD SHIELDING W/ SHELTERING	.5
CLOUD SHIELDING W/OUT EMERGENCY ACTION	.75
STATIONARY EVACUEE GROUND SHIELDING	.33
MOVING EVACUEE GROUND SHIELDING	.5
GROUND SHIELDING W/ SHELTERING	.08
GROUND SHIELDING W/OUT EMERGENCY ACTION	.33

EVACUATION PARAMETERS

STATIONARY EVACUEE BREATHING RATE (M 3/S)	2.66E-4
MOVING EVACUEE BREATHING RATE (M 3/S)	2.66E-4
BREATHING RATE W/ SHELTERING (M 3/S)	1.33E-4
BREATHING RATE W/NO EMERGENCY ACTION (M 3/S)	2.66E-4

EVACUATION PARAMETERS

RADIUS OF EVACUATED AREA (METERS)	8045.
DOWNWIND EVACUATION ARC WIDTH (DEG)	90.
DIRECT EVACUATION COST ($/EVACUEE)	95.
PUFF MODEL MAX RELEASE DURATION (Hrs)	3.
EXPOSURE DURATION SWITCH (-1,0,1)	1

Next to be entered is the LEAKAGE subgroup. The following illustrations show the screen images after appropriate values have been entered.

CRAC2 SUBGROUP MENU

SPATIAL	[ ]	ISOTOPE	[ ]	LATENT	[ ]
SITE	[ ]	LEAKAGE	[■]	CHRONIC	[ ]
POPULATION	[ ]	DISPERSION	[ ]	SCALE	[ ]
TOPOGRAPHIC	[ ]	EVACUATE	[ ]	RESULTS	[ ]
ECONOMIC	[ ]	ACUTE	[ ]	OPTIONS	[ ]
		FINISHED	[ ]		

SUBGROUP LEAKAGE

ENTER THE NUMBER OF LEAKAGE CATEGORIES TO BE EVALUATED (1-15): 1

WOULD YOU LIKE TO SPECIFY PARAMETER MODIFICATION (YES/NO)? NO

INPUT DATA FOR RELEASE 1

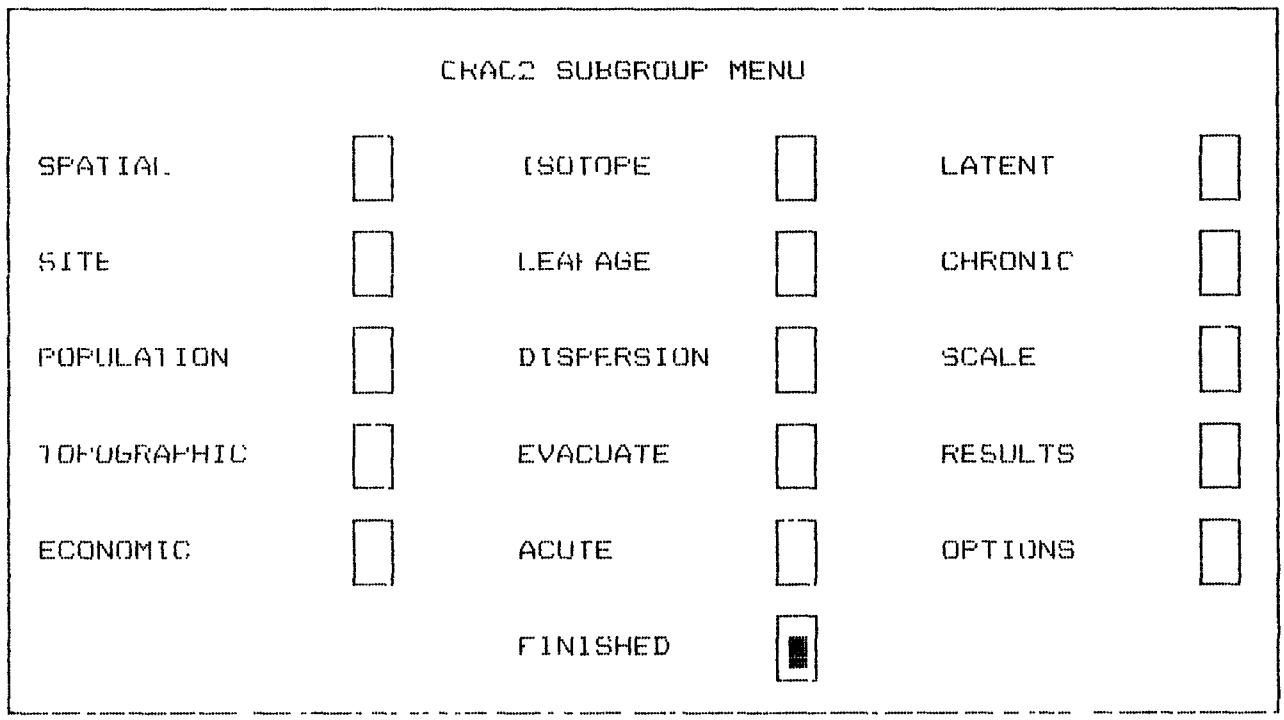
NAME OF ACCIDENT OR RELEASE CATEGORY	BMR1
PROBABILITY ASSOCIATED WITH ACCIDENT	1.0
TIME BETWEEN SHUTDOWN OR MELT AND RELEASE (HR)	1.0
DURATION OF RELEASE (HR)	1.0
WARNING TIME TO EVACUATED BEFORE RELEASE (HR)	0.
SENSIBLE HEAT RATE (CALORIES/SEC)	0.
RELEASE HEIGHT (METERS)	70.

FOR ACCIDENT BMR1

FRACTION OF EACH ISOTOPE GROUP RELEASED INTO ATMOSPHERE

NOBLES	1.0
ORG. IODINES	0.
INORG. IODINES	0.5
Cs-Rb	0.5
Te-Sb	0.5
Ba Sr	0.05
Ru	0.02
La	0.005

For this sample problem, no other subgroups need to be modified. The user should select the FINISHED box from the CRAC2 SUBGROUP MENU as indicated below,



which leads to the following sequence of requests and responses.

WOULD YOU LIKE TO SET UP THE DECKS FOR A DIFFERENT TYPE OF RUN (e.g. Minimal Medical, 50 Mile, etc.) Y/N ?N

WOULD YOU LIKE TO ASSEMBLE THE DECKS INTO ONE AT THIS TIME (Y/N)? Y

ENTER FILENAME FOR YOUR CRAC2 INPUT DECK ? SAMPLE1.DAT

INPUT FILE SAMPLE1.DAT NOW RESIDENT ON DISK

STRIKE THE RETURN KEY TO EXIT FROM CRACIN

At this point the user is in the DOS environment and the file created is ready to be transferred to a computer where the staff version of CRAC2 resides. For example, to execute CRAC2 on the MV/8000, the user is referred to section I.C of this report.

II. INPUT DATA DESCRIPTION

A. Introduction

The input data to the CRAC2 model consist of a title card, 15 data subgroups, and a terminator card. The subgroups describe the site specific parameters, the characteristics of the postulated accidents, the emergency protective measures to be taken, the number and types of consequences to be studied, and the options controlling the output to be produced by the program.

The model has a reference or base data case which is input at the beginning of each execution. This reference case consists of a title card, the 15 subgroups with a standard set of data, and an "END" card terminator. To use the reference case with no modifications, only a second title card followed by an "END" card is required. The user can modify the reference case by inputting a new title card describing the modification and respecifying one or more of the subgroups. Each modification case is also terminated with an "END" card, after which the program evaluates the modified data and computes the specified results. Upon completion of the computations, the program automatically reinstates the current reference case and checks for an additional title card with an associated set of modifications for the program to evaluate. The number of modification cases a user may implement for a single program execution is unlimited. Any or all subgroup modifications may be made permanent for all subsequent modification cases during a single execution.

The ability to change only a portion of the data without having to respecify the entire reference case simplifies the work of the user while allowing a considerable amount of flexibility in performing parametric studies. The output from the model provides a complete record of each study.

B. Input Data Organization

The input data to the consequence model consists of five major data divisions:

- Site Specification
- Accident Description
- Evacuation
- Health Effects and Property Damage
- Output Specification

All of the input data to the CRAC2 model are assigned to distinct sets or subgroups of data which describe a specific function and are a part of one of these five divisions.

1. Site Specification.* Five subgroups are used to describe and characterize the site.

   1) Spatial - This subgroup specifies the radial intervals around the site. These annuli are basic to the computational steps of CRAC2.

   2) Site - This subgroup indicates the site identification, the type of meteorological sampling to be performed, and the number of meteorological samples to be taken. In addition,

*See Chapters 5, 10, and 12 of Appendix VI, Reactor Safety Study.

the source of the population and land usage data for the site is specified.

3) Economic - This subgroup specifies cost data for computation of economic effects.

4) Population - This subgroup specifies the population sectors to be run and, optionally, the population distribution around the site.

5) Topography - This subgroup specifies the state location and land-fraction data for the spatial intervals within the 16 sectors around the site.

With these five subgroups of data, the model has the required information to perform a consequence calculation for a specific location. The specification of the Spatial subgroup must always precede the specification of the Site, Population, and Topography subgroups.

2. Accident Description.* Three subgroups are used to describe the potential reactor accidents.

1) Isotope - This subgroup specifies isotopes to be released at the time of the accident, the isotopic inventories, and the associated isotopic parameters.

2) Leakage - This subgroup describes the accident in terms of probability, time from shutdown

*See Chapters 2 and 3 of Appendix VI, Reactor Safety Study.

to release, release duration, heat release rate and isotope leakage group fractions.

3) Dispersion - This subgroup specifies the building wake dimensions and the special wake and rain depletion options.

The specification of the Isotope subgroup must always precede the specification of the Leakage subgroup.

3. Evacuation.* The evacuation model parameters are input by the subgroup Evacuate. Velocity and delay/shelter/movement models are available. The specification of the Spatial subgroup from the site specification division must always precede the specification of the Evacuate subgroup.

4. Health Effects and Property Damage.** Three subgroups are required for the processing of health effects and property damage.

1) Acute - This subgroup specifies the organs that are subject to acute effects from early exposure to the released radioactive material.

2) Latent - This subgroup specifies the latent effects and the organs to be processed for the cancer fatality calculations from the early and chronic exposure to the released radioactive material.

*See Chapter 11 of Appendix VI, Reactor Safety Study.
**See Chapters 8 and 9 of Appendix VI, Reactor Safety Study.

3) Chronic - This subgroup specifies the chronic exposure pathways data for computing the chronic doses and for determining the protective action measures appropriate to the level of chronic exposure.

The specification of both the Acute and Latent subgroups as well as the Isotope subgroup from the accident description division must always precede the specification of the Chronic subgroup.

5. Output. Three subgroups are associated with printed results.

1) Results - This subgroup identifies the type and names of the output results to be generated.

2) Scale - This subgroup specifies the scaling magnitude values for tabulating the complementary cumulative distributions of the output results.

3) Options - This subgroup specifies the print options in effect for detailed analyses.

With all of these subgroups properly specified, CRAC2 will generate the requested set of results and will present them in a manner which can be utilized in the risk assessment process.

CRAC2 has been developed to give the analyst a relatively easy method for performing parametric and sensitivity studies.

A reference data set containing all of the subgroups is specified at the beginning of every program execution. The analyst determines which subgroups are to be modified and includes the modified subgroups after the reference data set. If there are multiple occurrences of the same subgroup in the reference case data or in any modification case data, the last occurrence of the subgroup takes precedence. The program allows for many such modification cases while reinstating the reference data set after the completion of each modification case.

C. Input Data Deck

The CRAC2 input data deck defines the reference case to be used by the program. The accident to be analyzed by the model must be described by the reference case and any subsequent data modifications. To use the reference case without any alterations, append a modification containing only a title card and an "END" card. The input data deck is made up of title cards, subgroup header cards, subgroup data cards, and "END" cards. The format and use of these cards in the input data deck is described in the following sections. All names under the heading of mnemonics correspond to the FORTRAN variable names in the CRAC2 computer code.

D. Title Card

The reference case title card must be the first card in the reference case data and each modification case title card must be the first card in its respective modification case data. The title cards are alphanumeric. The reference and

modification case titles are punched in columns 1 through 72. Column 80 functions as a switch for printing the input data deck. When Column 80 is non-blank, the input data will not be printed.

Column	Mnemonic	Format	Description
1-72	ID(I)	18A4	Case title and identifying information. The information is read into the array ID as (ID(I), I = 1, 18).
80	ICD	A1	Print switch for input data. Blank - print input data. Non-blank - do not print input data.

E. Subgroup Header Card

The 15 subgroups are each introduced by a header card. The header card has the following format:

Column	Mnemonic	Format	Description
1-2	SUBGRP	A2	Subgroup name (the first two characters of the subgroup name identify the subgroup). Valid subgroup names are listed in Table II-1.
21-25	NUM	I5	Number of logical sets of data to be input for the subgroup (the data count).
26-27	IRG	I2	Flag to denote whether data items correspond to 18 intervals. If = 0, no effect. If # 0, data items for 18 intervals provided.
30-32	PARMOD	A3	Parameter modification switch. When the switch has the value "YES", parameters within the subgroup are to be algebraically modified. When the switch has any other value, no parameter modification is requested.

Column	Mnemonic	Format	Description
40-42	PERM*	A3	Permanent change switch. When the switch has the value "YES", a permanent change is requested, and this subgroup becomes part of the reference case. When the switch has any other value, a temporary change is requested, and this subgroup will not be used in any subsequent modification cases.

If parameters are to be algebraically modified within the subgroup, PARMOD = "YES", an additional card must follow the header card. This card specifies the parameter multipliers (see individual subgroups). The multiplier 1.0 must be supplied for parameters which are not to be modified. Blank fields are read as zeros. The reference case data should contain no permanent change requests, i.e., PERM="NO" or blank in each subgroup header card.

F. Subgroup Data Cards

Table II-1 gives the valid names and a brief description of the 15 subgroups including the subgroup data count.** Each subgroup is described in detail in the sections that follow.

Table II-1. Input Subgroup Description

Subgroup Name	Data Count Name	Data Count Max Value	Description
1. SPATIAL	NSI	34	Specifies the radii of annular spatial intervals around the accident site.

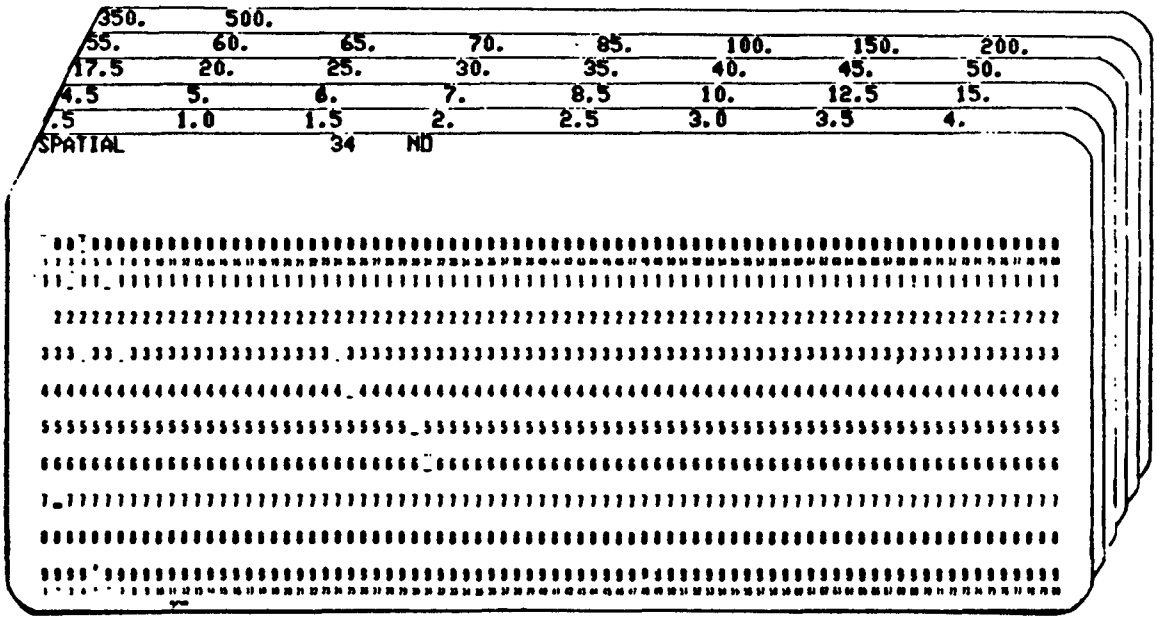
*This variable is not activated in the CRACIN preprocessor.
**Associated with most subgroups is a number of logical sets of data. The count of these sets is stored in the named variable. The data count comes from the NUM field of the corresponding subgroup header card.

Subgroup Name		Data Count Name	Max Value	Description
2.	SITE	--	--	Specifies the site identification information, the parameters that define the meteorological sampling method, the source of the meteorological data, and the number of meteorological trials to be sampled. The sources of the population and topographical data for the site are also defined.
3.	ECONOMIC	NST	54	Specifies cost data for computation of economic effects.
4.	POPULATION	NPB4	16	Specifies population option switch and the population sectors to be processed. Optionally, the population for each spatial interval within the 16 sectors around the site may be defined.
5.	TOPOGRAPHY	--	--	Specifies the state code and land fraction data for each spatial interval within the 16 sectors around the site.
6.	ISOTOPE	NIS	54	Specifies the inventory of isotopes and associated parameters.
7.	LEAKAGE	NPB2	15	Specifies the release identification, the associated release parameters, and the fraction of the total core inventory which is released for each isotope leakage group.
8.	DISPERSION	--	--	Specifies the reactor building dimensions and the special wake and rain depletion options.
9.	EVACUATE	NEVAC	6	Specifies the emergency protective action parameters.
10.	ACUTE	NEARLY	8	Specifies the acute effects due to early exposure to the radioactive cloud that are to be studied and the supporting dose-mortality and injury data for each organ.

Subgroup Name	Data Count Name	Max Value	Description
11. LATENT	NLA	8	Specifies the latent effects due to early exposure to the radioactive cloud and chronic exposure to the ground contamination and the supporting manrem conversion factors and the choice of latent effects model.
12. CHRONIC	NEXP	6	Specifies the data used in computing radiation doses from chronic exposure and the protective action measures appropriate to the level of chronic exposure.
13. SCALE	NCT	40	Specifies the consequence magnitude scaling values for tabulating the complementary cumulative distributions of the final results.
14. RESULTS	NRES	84	Specifies the final results for which mean, variance and complementary cumulative distributions are to be computed and printed.
15. OPTIONS	--	--	Specifies the print options for detailed output for each meteorological trial and the switches that control the latent and chronic calculations and leakage probability normalization.

1. Subgroup SPATIAL - specifies the radii of the annular spatial intervals around the accident site.

Sample input cards:



The NUM field, 34 in the sample header card above, specifies the number of spatial intervals, NSI, to be input. If the site data file is requested by the subgroup SITE, NSI must be set to 34 to correspond to the data on the site data file. If the site data file is not requested, NSI may be any positive integer between 1 and 34.

The CRAC2 model assumes a spatial grid around each site as shown in Figure II-1.

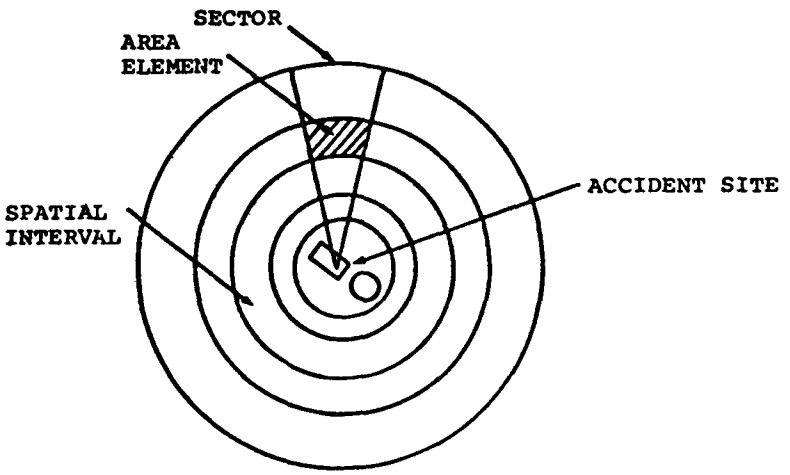


Figure II-1. Representation of the CRAC2 Geometry

The spatial grid consists of the annular grid divided into 16 sectors. Each sector is 22-1/2 degrees wide and is centered on a compass direction. Sector 1 is centered on due north and its left hand boundary is directed 11-1/4 degrees west of due north. The remaining sectors are numbered clockwise, 2 through 16. There are NSI*16 area elements, where NSI is the number of spatial intervals specified by this subgroup.

The data card format for this subgroup is described below.

Column	Mnemonic	Format	Description
1-80	R(I)	8E10.3	Outer radius in miles for each spatial interval or ring. If the site data file is going to be referenced, the 34 radii are required to have the following values: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 6.0, 7.0, 8.5, 10.0, 12.5, 15.0, 17.5, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 85.0, 100.0, 150.0, 200.0, 350.0, 500.0. The data are read into the array R as follows, (R(I), I = 1, NSI), eight items per card. Use as many cards as required to define the NSI radii.

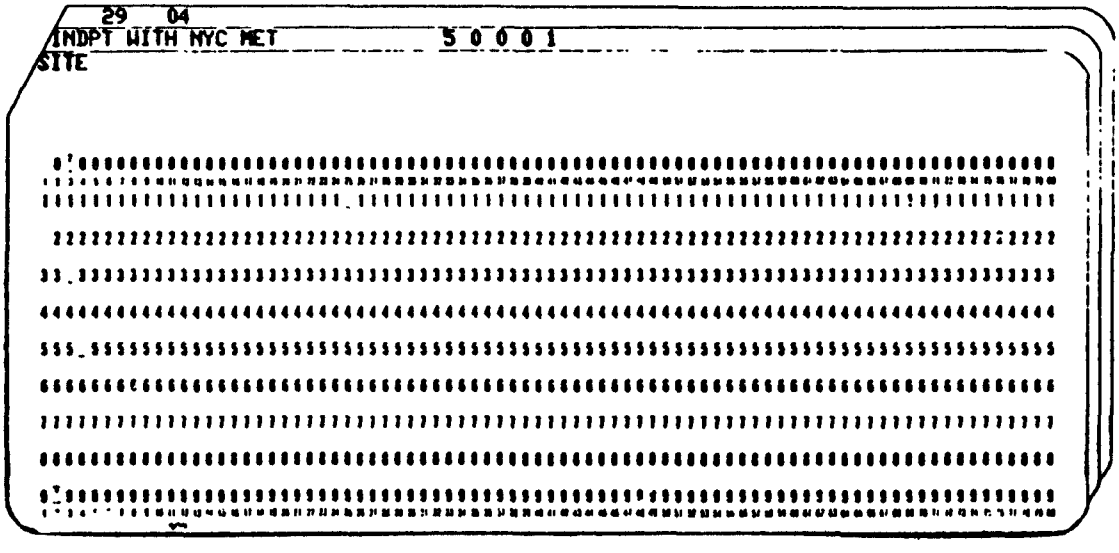
No parameter modification is permitted for this subgroup.

A representative listing of the SPATIAL subgroup sample input data is shown below.

```
 SUBGROUP SPATIAL
 PARAMETER  NSI SET TO   34

                    * * *  SPATIAL MESH DESCRIPTION  * * *

 REGION   OUTER RADIUS(M)   AVG. RADIUS(M)   AREA(M**2)   OUTER RADIUS(MI)   AVG. RADIUS(MI)   AREA(MI**2)

      1      8.05E+02         4.02E+02        1.27E+05       5.00E-01           2.50E-01          4.91E-02
      2      1.61E+03         1.21E+03        3.81E+05       1.00E+00           7.50E-01          1.47E-01
      3      2.41E+03         2.01E+03        6.36E+05       1.50E+00           1.25E+00          2.46E-01
      4      3.22E+03         2.82E+03        8.90E+05       2.00E+00           1.75E+00          3.44E-01
      5      4.02E+03         3.62E+03        1.14E+06       2.50E+00           2.25E+00          4.42E-01
      6      4.83E+03         4.43E+03        1.40E+06       3.00E+00           2.75E+00          5.40E-01
      7      5.63E+03         5.23E+03        1.65E+06       3.50E+00           3.25E+00          6.38E-01
      8      6.44E+03         6.04E+03        1.91E+06       4.00E+00           3.75E+00          7.37E-01
      9      7.24E+03         6.84E+03        2.16E+06       4.50E+00           4.25E+00          8.35E-01
     10      8.05E+03         7.64E+03        2.42E+06       5.00E+00           4.75E+00          9.33E-01
     11      9.66E+03         8.85E+03        2.59E+06       6.00E+00           5.50E+00          2.16E+00
     12      1.13E+04         1.05E+04        6.61E+06       7.00E+00           6.50E+00          2.55E+00
     13      1.37E+04         1.25E+04        1.18E+07       8.50E+00           7.75E+00          4.57E+00
     14      1.61E+04         1.49E+04        1.41E+07       1.00E+01           9.25E+00          5.45E+00
     15      2.01E+04         1.81E+04        2.86E+07       1.25E+01           1.13E+01          1.10E+01
     16      2.41E+04         2.21E+04        3.50E+07       1.50E+01           1.38E+01          1.35E+01
     17      2.82E+04         2.62E+04        4.13E+07       1.75E+01           1.63E+01          1.60E+01
     18      3.22E+04         3.02E+04        4.77E+07       2.00E+01           1.88E+01          1.84E+01
     19      4.02E+04         3.62E+04        1.14E+08       2.50E+01           2.25E+01          4.42E+01
     20      4.83E+04         4.43E+04        1.40E+08       3.00E+01           2.75E+01          5.40E+01
     21      5.63E+04         5.23E+04        1.65E+08       3.50E+01           3.25E+01          6.38E+01
     22      6.44E+04         6.04E+04        1.91E+08       4.00E+01           3.75E+01          7.37E+01
     23      7.24E+04         6.84E+04        2.16E+08       4.50E+01           4.25E+01          8.35E+01
     24      8.05E+04         7.64E+04        2.42E+08       5.00E+01           4.75E+01          9.33E+01
     25      8.85E+04         8.45E+04        2.67E+08       5.50E+01           5.25E+01          1.03E+02
     26      9.66E+04         9.25E+04        2.92E+08       6.00E+01           5.75E+01          1.13E+02
     27      1.05E+05         1.01E+05        3.18E+08       6.50E+01           6.25E+01          1.23E+02
     28      1.13E+05         1.09E+05        3.43E+08       7.00E+01           6.75E+01          1.33E+02
     29      1.37E+05         1.25E+05        1.18E+09       8.50E+01           7.75E+01          4.57E+02
     30      1.61E+05         1.49E+05        1.41E+09       1.00E+02           9.25E+01          5.45E+02
     31      2.41E+05         2.01E+05        6.36E+09       1.50E+02           1.25E+02          2.46E+03
     32      3.22E+05         2.82E+05        8.90E+09       2.00E+02           1.75E+02          3.44E+03
     33      5.63E+05         4.43E+05        4.20E+10       3.50E+02           2.75E+02          1.62E+04
     34      8.05E+05         6.84E+05        6.48E+10       5.00E+02           4.25E+02          2.50E+04
```

2. Subgroup SITE - specifies the site identification information, the parameters that define the meteorological sampling method, the source of the meteorological data, and the number of meteorological trials to be sampled. The source of the topographical data and the source of the population data for the reactor site are also defined. Meteorological data may be specified by this subgroup depending on the sampling option selected. This subgroup must be specified after the subgroup SPATIAL.

Sample input cards:



The NUM field is not used by the SITE subgroup. One site must be specified in the subgroup.

One card with the following format is required to identify the site, the site data, and the sampling option.

Column	Mnemonic	Format	Description
1-30	ISITE	5A4,10X	Site identification title.
31-32	ISTART	I2	Start code - determines the meteorological sampling method and the number of meteorological trials to be sampled.* 0 - User must input meteorological data for each spatial interval. The description of the additional input for start code 0 is shown below. Subgroups POPU and TOPO are required to supply the population and topographic data for the site. A single trial is processed. 1 - Meteorological data for the site is taken from the meteorological data file on TAPE 27. Population and topographical data may be taken from the site data file or from subgroups POPU and TOPO depending on the value of IPO (see cols. 39-40 below). N stratified random day and night trials are sampled, where N = MO*100 + IDA (see cols. 33-34, 35-36 below). N should be a multiple of 24 to get an equal number of day and night trials in each month. 2 - Same as start code 1, except that only day trials are sampled and N should be a multiple of 12. 3 - Same as start code 1, except that only night trials are sampled and N should be a multiple of 12. 4 - User must input 5 days of meteorological data. The description of additional input for start code 4 is shown below. Subgroups POPU and TOPO must be used to supply the population and topographical data for the site. A single trial is processed.

*In the discussion of the individual start codes, the subgroups POPULATION and TOPOGRAPHY are referred to as POPU and TOPO, respectively.

Column	Mnemonic	Format	Description
			5 - Meteorological, topographical, and population data are supplied as for start code 1. Meteorological sampling is performed using the meteorological bins. The sampling strategy is given by the additional input for start code 5. The description of this input is shown below. The number of meteorological trials processed is the sum of the samples from each bin. If the wind rose data from the meteorological bins is to be used, IDA must be nonzero.
			6 - Same as start code 1, except that N completely random trials are processed, i.e., the start time of the time of the accident is random.
			7 - Meteorological, topographical, and population data are supplied as for start code 1. User specifies a particular start time using the fields MO, IDA, and IHR as described below. One trial is processed using this start time.
			8 - Meteorological, topographical, and population data are supplied as for start code 1. User specifies sample interval for month, day, and hour using the fields MO, IDA, and IHR (see cols. 33-34, 35-36, 37-38 below). Trials are sampled over a one year period using the given intervals, i.e., if MO=1, IDA=4, and IHR=13, a trial will be sampled every 4 days on 13 hour intervals (1:00 PM, 2:00 AM, 3:00 PM, 4:00 AM AM, etc.) until the end of the current month. The month number is then incremented by MO and the process is repeated until the end of the month. This is continued until the month number exceeds 12.
			9 - One or more invariant meteorologies must be supplied with associated probabilities for each combination of stability, windspeed, and rain condition. Subgroups POPU and TOPO must be

Column	Mnemonic	Format	Description
			used to supply the population and topographical data for the site. The number of trials depends on the number of invariant meteorologies and the associated probabilities. The same meteorological conditions are used for each spatial interval for a given trial. See the description of additional input for start code 9 below.
33-34	MO	I2	For start codes 1, 2, 3 and 6, the number of trials is given by 100*MO+IDA. For start code 7, MO is the month in which the single trial occurs. For start code 8, MO is the sample interval for the month. For start codes 0, 4, 5 and 9, MO is not used.
35-36	IDA	I2	For start codes 1, 2, 3, and 6, the number of trials is given by 100*MO+IDA. For start code 5, IDA indicates the wind rose source. If IDA is nonzero, the wind rose data calculated from the meteorological bins is substituted for the annual or seasonal wind rose. For start code 7, IDA is the day on which the single trial occurs. For start code 8, IDA is the number of days between trials. For start codes 0, 4, and 9, IDA is not used.
37-38	IHR	I2	For start code 7, IHR is the hour in which the trial occurs. For start code 8, IHR is the number of hours between trials. For start codes 1-6 and 9, IHR is not used.
39-40	IPO	I2	Site population and topographical data option. Valid only for start codes 1, 2, 3, 5, 6, 7, and 8. 0 - Individual site population and topographical data are taken from the site data file. 1 - Site population and topographic data are supplied by the subgroups POPU and TOPO, respectively. No data is supplied from the site data file.

Column	Mnemonic	Format	Description
			2 - Topographical data is read from the site data file and subgroup POPU must supply the population data.

When the ISTART code 0, 4, 5 or 9 is specified, the additional data required for these cases must immediately follow this card.

Additional Card Input Required for Start Code Zero:

Mnemonic	Format	Description
ISTA(I)	16I5	Stability in each spatial interval (1=A, 2=B, 3=C, 4=D, 5=E, 6=F). NSI values must be input, where NSI is the number of spatial intervals specified in subgroup SPATIAL. The data are read into the array ISTA as follows, (ISTA(I), I=1, NSI). Use as many cards as required, 16 values per card.
VEL(I)	8E10.3	Wind speed at each spatial interval in meters per second. NSI values must be input, starting on a new card and using as many cards as required. The data are read into the array VEL as follows, (VEL(I), I=1, NSI).
IRAIN(I)	16I5	Rain indicator* for each spatial interval. NSI values must be input, starting on a new card and using as many cards as required. The data are read into the array IRAIN as follows, (IRAIN(I), I=1, NSI).
ZMAX(1) ZMAX(2)	E10.3 E10.3	Mixing heights** (meters) for unstable and stable weather conditions, respectively. These heights must start on a new card.

*The rain indicator represents the rain rate in hundredths of inches per hour when LIRAIN = 0. When LIRAIN = 2, a zero value for the rain indicator represents no rain, a value of one represents incident rain. See the DISPERSION subgroup description.

**Only the unstable mixing height is utilized in the CRAC2 dispersion model.

Additional Card Input Required for Start Code 4:

Mnemonic	Format	Description
METEOR (J,K)	12I5	Hourly weather data for 5 consecutive days. Use 10 cards with 12 entries per card. Each entry is a 5 digit integer: ijkkk where i is the rain indicator*, j is the stability class (1=A, 2=B, ..., 6=F), kkk is 10 times the windspeed (mi/hr). The data are read into the array METEOR as follows, ((METEOR(J,K), J=1,24), K=1,5).

Additional Card Input Required for Start Code 5:

Card	Columns	Mnemonic	Format	Description
1	1-5	NBIN	I5	Number of defined weather bins. There are 29 bins defined in CRAC2 and NBIN is always set to 29 by the CRAC2 code.
	6-10	NCON	I5	Number of trials to be selected from each bin. If NCON=0 the number of trials from each bin must be individually specified on the next set of cards.
2	1-60	IWGHT(I)	12I5	Individual number of trials to be selected from each bin. The data are read into the array IWGHT as follows, (IWGHT(I), I=1, NBIN). Use as many cards as required. No cards are required when NCON > 0.

Additional Card Input Required for Start Code 9:

Card	Column	Mnemonic	Format	Description
1	1-5	NSTAB	I5	Number of stability classes (max=6).
	6-10	NVEL	I5	Number of wind speeds (max=8).

*The rain indicator represents the rain rate in hundredths of inches per hour when LIRAIN = 0. When LIRAIN = 2, a zero value for the rain indicator represents no rain, a value of one represents incident rain. See the DISPERSION subgroup description.

Additional Card Input Required for Start Code 9: (Cont'd)

Card	Column	Mnemonic	Format	Description
	11-15	NRA	I5	If NRA = 2 rain is considered.* If NRA = 1 rain is not occurring.
2	1-30	ISTA1(I)	6I5	NSTAB stability classes (1=A, 2=B, ..., 6=F). The data are read into the array ISTA1 as follows, (ISTA1(I), I=1, NSTAB).
3	1-80	VEL1(I)	8E10.3	NVEL wind speeds (meters/sec). The data are read into the array VEL1 as follows, (VEL1(I), I=1, NVEL).
4	1-80	PMATRX (I,J,K)	8E10.3	Cards 4 through 4+ ((NSTAB* NVEL*NRA)/8) contain the probabilities for each combination of stability, windspeed, and rain/no rain. These values, some of which may be zero, must add up to one. They are read into array PMATRX as follows: (((PMATRX(I,J,K), K=1, NRA), J=1, NVEL), I=1, NSTAB). The number of trials processed will be equal to the number of non-zero values in array PMATRX. Use as many cards as required.
Last	1-10	ZMAX(1)	E10.3	Mixing heights** (meters) for
	11-20	ZMAX(2)	E10.3	unstable and stable weather conditions, respectively.

No parameter modification is allowed for this subgroup.

A representative listing of the SITE subgroup sample input data is shown below:

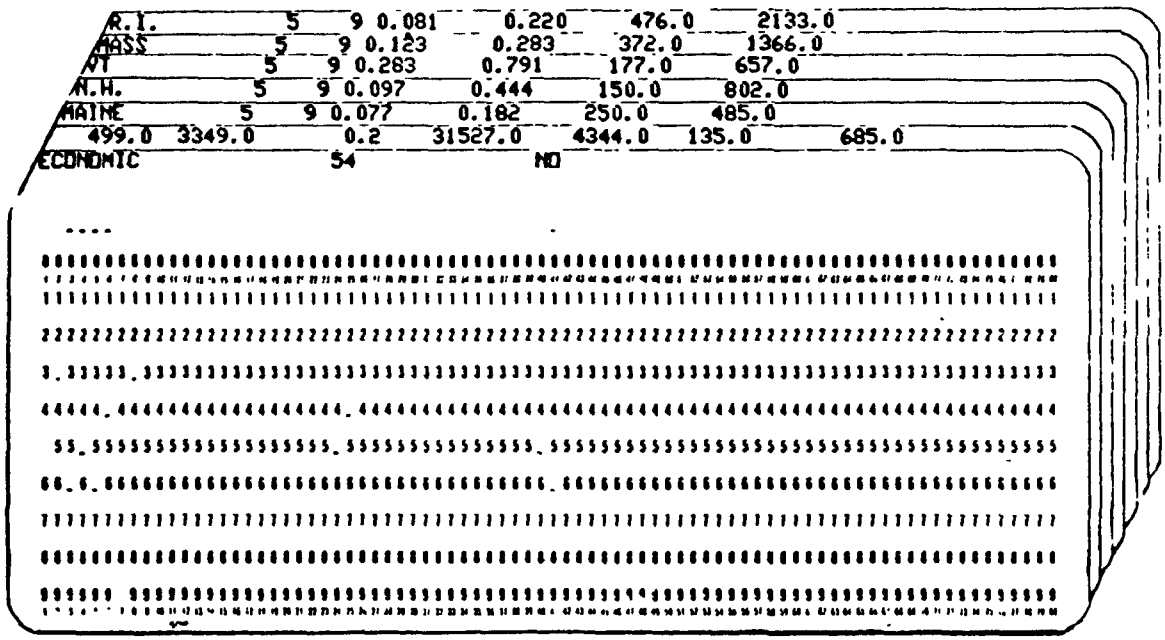
*For NRA = 2 and LIRAIN = 0, the rain rate in hundredths of inches per hour is represented by NRA-1 when rain is considered. For NRA = 2 and LIRAIN = 2, incident rain is occurring when rain is considered. See the DISPERSION subgroup description.

**Only the unstable mixing height is utilized in the CRAC2 dispersion model.

```
SUBGROUP SITE
PARAMETER NP83 SET TO ... 1

                    * * * INPUT SITE AND TRIAL DATA * * *

          SITE                    PROBABILITY    START CODE MO DA HR IPO
     INDPT WITH NYC MET             1.0000                 5  0  0  0  1

                  * * * * WEIGHTED IMPORTANCE SAMPLING * * * *

          29 METEOROLOGICAL BINS HAVE BEEN SPECIFIED.

          116 METEOROLOGICAL START TIMES WILL BE SAMPLED.

        THE FOLLOWING WEIGHTS WILL BE USED FOR EACH BIN
                    1    4
                    2    4
                    3    4
                    4    4
                    5    4
                    6    4
                    7    4
                    8    4
                    9    4
                   10    4
                   11    4
                   12    4
                   13    4
                   14    4
                   15    4
                   16    4
                   17    4
                   18    4
                   19    4
                   20    4
                   21    4
                   22    4
                   23    4
                   24    4
                   25    4
                   26    4
                   27    4
                   28    4
                   29    4
```

3. Subgroup ECONOMIC - specifies the cost data used in computing economic effects.

Sample input cards:



The NUM field, 54 in the sample header card above, specifies the number of geographic regions, NST, for which economic data are to be input. The indices of the arrays containing this economic data correspond to the order of the state and regional data in this subgroup. The state codes used in the subgroup TOPOGRAPHY must coincide with these indices. If the topography is read from the site data file, economic data must be supplied for 54 regions (the 48 continental states plus Nova Scotia, Quebec, Ontario, Baja California, Sonora, and Chihuahua), as given in the sample data. A maximum of 54 geographical regions may be input.

One card having the following format must be input after the header card.

Columns	Mnemonic	Format	Description
1-10	DCFLD	E10.2	Decontamination cost for farm areas ($/acre).
11-20	DCRBP	E10.2	Decontamination cost for residential, business, and public areas ($/person).
21-30	RATE	E10.2	Compensation rate per year for residential, business, and public areas (fraction of value).
31-34	VRBP	E10.2	Value of residential, business, and public areas ($/person).
41-50	CRELOC	E10.2	Relocation cost ($/person).
51-60	CONMLK	E10.2	Cost of milk consumption ($/person).
61-70	CONCRP	E10.2	Cost of non-dairy products consumed ($/person).

Following this card, one card must be input for each of the NST regions. The format of each of the region cards is described below.

Columns	Mnemonic	Format	Description
1-8	STATE(I)	A8	Name of state or region.
11-15	MONST(I)	I5	Seeding month for state.
16-20	MONEND(I)	I5	Harvesting month for state.
21-30	FARML(I)	E10.2	Fraction of land devoted to farming for state.
31-40	DPF(I)	E10.2	Fraction of farm sales resulting from dairy production for state.
41-50	ASFP(I)	E10.2	Annual average farm sales for state ($/acre).

Columns	Mnemonic	Format	Description
51-60	VFARM(I)	E10.2	Average f m land value for state ($/acre).

The index I corresponds to the order of the states and regions in this subgroup. This index becomes the state code for the TOPOGRAPHY subgroup.

No parameter modification is allowed for this subgroup.

A representative listing of the ECONOMIC subgroup sample input data is shown below.

SUBGROUP ECONOMIC
PARAMETER SET TO 54

DCFLD	DECONTAM. COST OF FARM FIELDS ($/ACRE)	4.998E+02
DCRBP	DECONTAM. COST OF RESID.,BUSI.,PUB. AREA	3.349E+03
RATE	COMPENSATION RATE	2.008E-01
VRBP	VALUE OF RESIDENTIAL,BUSINESS,AND PUBLIC AREA	3.153E+04
CRELOC	RELOCATION COST ($/PERSON)	4.344E+03
CONMLK	COST OF MILK CONSUMPTION ($/PERSON)	1.350E+02
CONCBP	COST OF NON-DAIRY PRODUCTS CONSUMED ($/PERSON)	6.850E+02

* * * AGRICULTURAL DATA * * *

	STATE	SEEDING MONTH	HARVESTING MONTH	FARM LAND FRACTION	DAIRY PROD. FRACTION	ANNUAL SALES	VALUE OF FARM
1	MAINE	5	9	.077	.182	250.0000	485.0000
2	N.H.	5	9	.097	.444	158.0000	882.0000
3	VT	5	9	.283	.791	177.0000	657.0000
4	MASS	5	9	.123	.283	372.0000	1366.0000
5	R.I.	5	9	.081	.220	476.0000	2133.0000
6	CONN	5	9	.140	.313	500.0000	2150.0000
7	N.Y.	5	9	.315	.579	188.0000	642.0000
8	N.J.	5	9	.197	.162	376.0000	2222.0000
9	PA	5	9	.387	.413	239.0000	669.0000
10	OHIO	5	9	.618	.153	183.0000	1516.0000
11	IND	5	9	.720	.067	206.0000	1498.0000
12	ILL	5	9	.795	.041	213.0000	1706.0000
13	MICH	5	9	.265	.238	197.0000	955.0000
14	WIS	5	9	.528	.598	194.0000	807.0000
15	MINN	5	9	.563	.185	160.0000	854.0000
16	IOWA	5	9	.944	.050	242.0000	1458.0000
17	MO	5	9	.724	.079	111.0000	674.0000
18	N.D.	5	9	.922	.047	45.0000	386.0000
19	S.D.	5	9	.922	.074	46.0000	257.0000
20	NEBR	5	9	.967	.027	99.0000	478.0000
21	KANS	5	9	.915	.034	92.0000	437.0000
22	DEL	4	10	.471	.046	500.0000	1725.0000
23	MD	4	10	.414	.227	273.0000	1799.0000
24	VA	4	10	.371	.171	126.0000	864.0000
25	W.VA	4	10	.278	.203	44.0000	472.0000
26	N.C.	4	10	.368	.056	261.0000	819.0000
27	S.C.	4	10	.327	.063	140.0000	635.0000
28	GA	4	10	.417	.058	164.0000	689.0000
29	FLA	4	10	.368	.077	233.0000	930.0000
30	KY	4	10	.557	.117	141.0000	792.0000
31	TENN	4	10	.587	.140	118.0000	669.0000
32	ALA	4	10	.408	.041	144.0000	515.0000
33	MISS	4	10	.475	.047	135.0000	520.0000
34	ARK	4	10	.494	.038	150.0000	691.0000
35	LA	4	10	.332	.087	137.0000	763.0000
36	OKLA	4	10	.782	.051	60.0000	442.0000
37	TEXAS	4	10	.811	.053	54.0000	354.0000
38	MONTANA	5	9	.658	.026	20.0000	186.0000
39	IDAHO	5	9	.294	.114	93.0000	485.0000
40	WYOMING	5	9	.568	.024	15.0000	119.0000

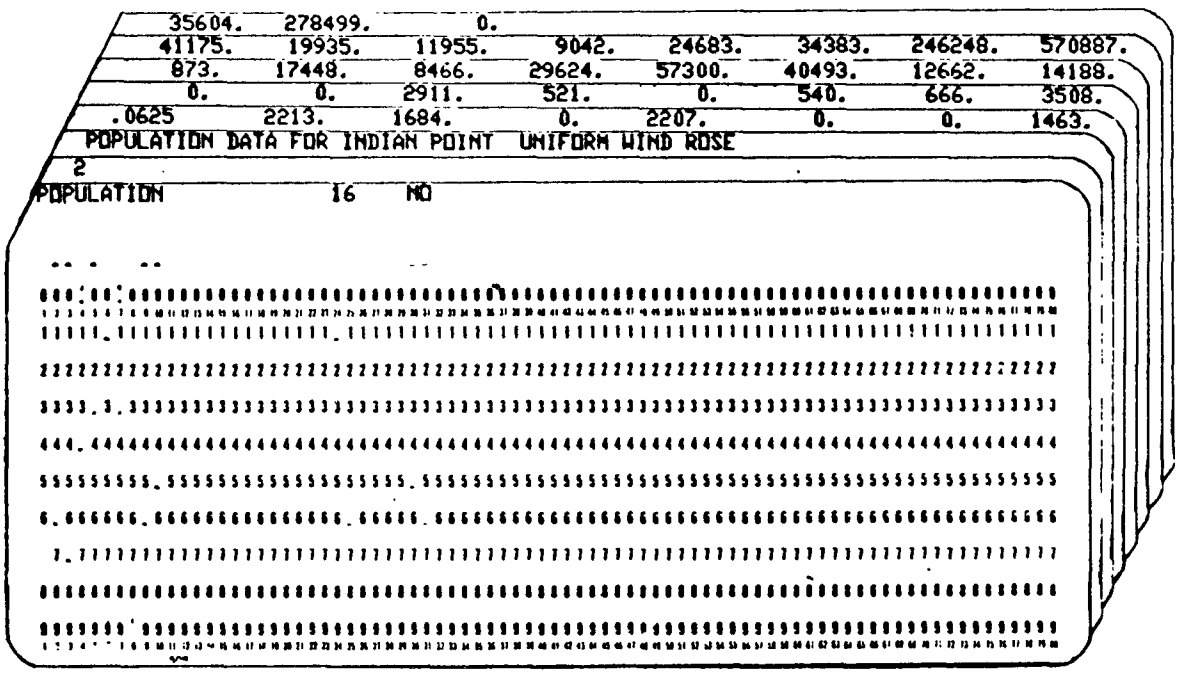
REPRODUCED FROM BEST AVAILABLE COPY

41	COLORADO	4	10	.578	.039	69.0000	332.0000
42	N.MEXICO	4	10	.600	.056	21.0000	100.0000
43	ARIZONA	4	10	.556	.069	36.0000	134.0000
44	UTAH	4	10	.236	.215	36.0000	265.0000
45	NEVADA	4	10	.127	.117	19.0000	184.0000
46	WASH	5	9	.369	.138	132.0000	586.0000
47	OREGON	5	9	.300	.093	68.0000	330.0000
48	CALIF	4	10	.318	.119	316.0000	936.0000
49	NOVA SCO	5	9	0.000	0.000	0.0000	0.0000
50	QUEBEC	5	9	0.000	0.000	0.0000	0.0000
51	ONTARIO	5	9	0.000	0.000	0.0000	0.0000
52	BAJA CAL	5	9	0.000	0.000	0.0000	0.0000
53	SONORA	5	9	0.000	0.000	0.0000	0.0000
54	CHIHUAHU	5	9	0.000	0.000	0.0000	0.0000

REPRODUCED FROM
BEST AVAILABLE COPY

4. Subgroup POPULATION - specifies the population option and the population sectors to be processed. Optionally, the population distribution around the site may be defined. This subgroup must be input after subgroup SPATIAL.

Sample input cards:



The NUM field, 16 in the sample header card above, specifies the total number of population sectors, NPB4, to be processed. Up to 16 sectors are allowed. The population values to be input are the number of people in each area element of the 16 sectors. Note that the population must be defined for all 16 sectors even if less than 16 sectors are to be processed. This is necessary because the radioactive cloud may overlap sectors adjacent to

the ones being processed. Specifying a sector to be processed is essentially the same as saying that the midpoint of the cloud will travel in the direction defined by the radius bisecting the specified sector.

After the header card, an options card with the following format must be supplied.

Column	Mnemonic	Format	Description
1-3	IPOPT	I3	Population option indicator*. IPOPT=0 specifies that the population data for 34 rings and 16 sectors are to be read in from the site data file. No further cards are required for this subgroup. IPOPT=1 specifies that a uniform population density is to be read in on the next card. The description of the additional input follows. NPB4 is automatically set to 1 for this option. IPOPT=2 specifies that for each sector, the sector probability and the population for each of the NSI rings are read from the cards that follow. The description of the additional input is given below. IPOPT=3 specifies that for each sector, the sector probability and the population for each of the NSI rings are read along with the seasonal wind roses from the cards that follow. See the description of the additional input below.

*The value of IPOPT should be nonzero when variable IPO in subgroup SITE is nonzero or no population data will be specified and all results involving population will be unpredictable. When the value of IPO is zero, the population data specified by the POPULATION subgroup will be replaced by the population data from the site data file.

Column	Mnemonic	Format	Description
4-51	ISECNO(I)	16I3	The sector numbers of the NPB4 sectors to be processed. If for example, NPB4=1 and ISECNO(1) = 8, only the 8th sector will be processed. The data are read into the array ISECNO as (ISECNO(I), I = 1, NPB4). If ISECNO is not specified, i.e., columns 4 through 51 are blank, or if the value of ISECNO(I) is not one of the sectors 1 through 16, ISECNO(I) is set to I for I = 1 to NPB4.

When IPOPT=1, the following additional card is required:

Column	Mnemonic	Format	Description
1-10	POPDEN	E10.3	Population density (people per square mile).
11-15	IEXINT	I5	Exclusion intervals; the number of spatial intervals from which the population is excluded, counting from the accident site.

When IPOPT=2, additional cards are required consisting of 16 sets of population values, one for each of the 16 sectors. A description of the data cards for each sector is presented below. The order of input of the 16 sets determines the sector number of the set. The first set, the set with index I = 1, corresponds to sector 1, the north-centered sector. The last set, the set with index I = 16, corresponds to sector 16.

Card	Column	Mnemonic	Format	Description
1	1-80	IDENT(J)	20A4	Identification of the population data. It is stored in the array IDENT as (IDENT(J), J = 1, 20).

Card	Column	Mnemonic	Format	Description
2	1-10	P(I,4)	E10.3	Probability associated with the wind blowing toward population sector I, i.e., the annual wind rose probability. The program automatically normalizes the probabilities of the sectors to be processed to one.
	11-80	POP(I,K)	7E10.3	Population values for the first seven of the NSI area elements in this sector starting with the element closest to the site.
3	1-80	POP(I,K)	8E10.3	The remaining population values for this sector. There are eight values per card. Use as many cards as necessary to supply the remaining population values. The population data are stored in the array POP as follows, (POP(I,K), K = 1, NSI), where I is the index of the sector.

Cards 2 and 3 are repeated for each of the 16 sectors, starting with a new card for each sector.

When IPOPT=3, additional cards are required for the sector population and seasonal wind rose data. The population data corresponds identically to that required for the IPOPT=2 option above. The wind rose data follow the population data and are required for each of the four seasons. One data card, which is described below, must be included for each seasonal wind rose. The wind rose data must appear in the order winter (Dec., Jan., Feb.), spring (Mar., Apr., May), summer, (June, July, Aug.), and fall (Sept., Oct., Nov.).

Column	Mnemonic	Format	Description
1-80	ROSE(K,I)	16F5.4	Wind rose probabilities for each sector for one season. Wind rose probabilities represent the wind blowing toward the sector. The data are read into the array ROSE as follows, (ROSE(K,I), K=1,16) where K is the sector index and I is the season index. One card must be present for each season in the order winter, spring, summer, fall.

No parameter modification is allowed for this subgroup.

A printed listing of the sample data for subgroup POPULATION is shown below.

SUBGROUP POP
PARAMETER NPB4 SET TO 16

* * * INPUT POPULATION DATA * * *

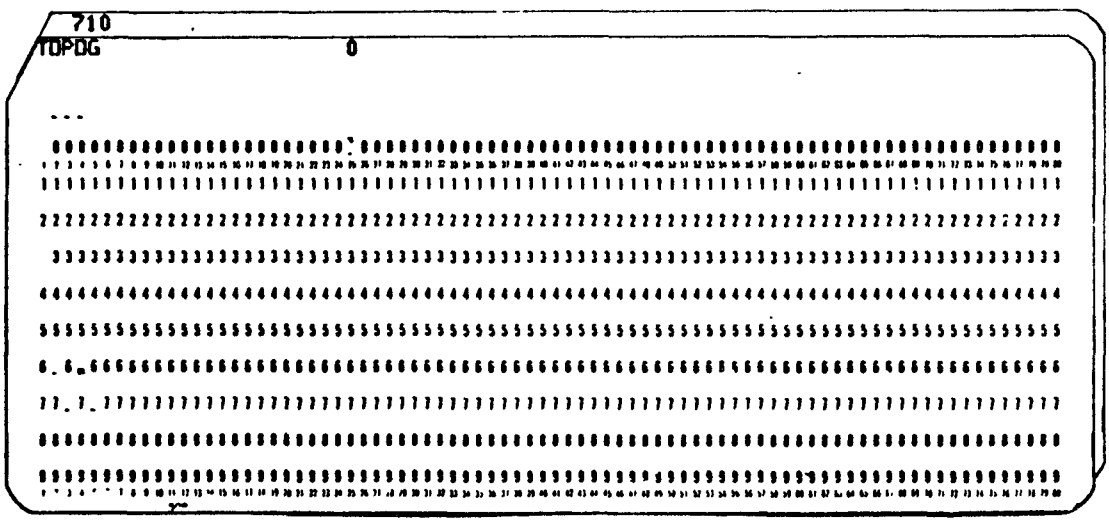
INDEX	SECTOR	PROBABILITY	POPULATION BY SPATIAL INTERVAL									
POPULATION DATA FOR INDIAN POINT UNIFORM WIND ROSE												
1	1	6.25E-02	2.21E+03	1.68E+03	0.	2.21E+03	0.	0.	1.46E+03	0.	0.	2.91E+03
			5.21E+02	0.	5.48E+02	6.66E+02	3.51E+03	8.73E+02	1.74E+04	8.47E+03	2.96E+04	5.73E+04
			4.05E+04	1.27E+04	1.42E+04	4.12E+04	1.93E+04	1.20E+04	9.84E+03	2.47E+04	3.44E+04	8.46E+05
			5.71E+05	3.56E+04	2.70E+05	0.						
2	2	6.25E-02	0.	0.	3.60E+03	1.12E+03	5.28E+03	0.	2.43E+03	0.	0.	0.
			9.32E+02	8.88E+02	6.18E+02	7.14E+02	0.	2.32E+03	4.12E+02	3.18E+03	1.83E+04	8.14E+03
			4.85E+03	1.12E+04	5.08E+03	4.44E+03	7.88E+03	3.20E+03	7.77E+03	9.21E+03	3.38E+04	8.65E+04
			1.95E+05	1.76E+05	2.07E+05	1.16E+03						
3	3	6.25E-02	0.	0.	0.	3.27E+03	0.	0.	0.	1.91E+03	0.	1.76E+03
			1.85E+03	2.85E+03	1.59E+03	3.33E+03	6.27E+03	4.98E+03	4.97E+03	6.09E+03	5.18E+03	9.66E+03
			1.76E+04	5.83E+03	6.77E+03	4.37E+03	1.36E+04	3.87E+04	2.16E+04	1.86E+04	9.81E+04	5.89E+05
			4.29E+05	8.48E+05	6.34E+05	3.16E+02						
4	4	6.25E-02	0.	0.	0.	0.	0.	0.	0.	2.51E+03	0.	1.66E+03
			0.	1.18E+03	2.78E+03	7.54E+03	1.05E+04	5.78E+03	9.93E+02	9.57E+03	1.13E+04	6.31E+04
			1.09E+04	1.24E+04	1.16E+04	9.44E+04	1.88E+05	1.12E+05	1.45E+05	1.72E+05	4.72E+05	1.87E+05
			1.69E+06	3.89E+06	6.23E+03	0.						
5	5	6.25E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
			0.	2.22E+03	4.87E+03	1.07E+03	9.64E+03	4.25E+03	6.98E+02	3.58E+03	2.87E+04	1.54E+04
			1.55E+04	1.98E+05	1.47E+05	9.20E+04	2.13E+05	6.48E+04	1.88E+04	1.45E+04	5.38E+04	1.56E+05
			2.46E+05	2.43E+05	1.63E+04	0.						
6	6	6.25E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
			0.	0.	2.27E+03	0.	1.15E+04	2.79E+03	3.89E+03	1.58E+03	5.37E+04	1.18E+05
			3.78E+04	3.31E+04	0.	3.02E+04	3.34E+04	2.57E+04	2.15E+04	2.18E+04	4.79E+04	1.42E+04
			0.	0.	0.	0.						
7	7	6.25E-02	0.	0.	0.	2.01E+03	0.	0.	0.	1.41E+03	2.11E+02	0.
			0.	0.	9.35E+03	2.12E+03	1.66E+04	1.08E+04	5.30E+03	5.26E+03	1.87E+05	5.15E+04
			2.18E+04	9.11E+04	2.82E+05	3.20E+05	2.24E+05	7.36E+04	1.24E+04	0.	0.	0.
			0.	0.	0.	0.						
8	8	6.25E-02	0.	0.	0.	0.	0.	0.	0.	0.	1.87E+03	1.86E+03
			3.88E+03	0.	9.43E+03	1.50E+04	4.72E+03	2.62E+04	2.73E+04	7.95E+04	2.85E+05	1.39E+05
			1.92E+05	4.98E+05	6.91E+05	4.36E+05	4.65E+03	0.	0.	0.	0.	1.91E+02
			0.	0.	0.	0.						
9	9	6.25E-02	0.	0.	0.	0.	1.63E+03	1.46E+03	0.	0.	0.	0.
			0.	0.	1.51E+03	6.55E+03	1.69E+04	9.83E+03	2.29E+04	3.87E+04	2.66E+05	1.17E+06
			1.73E+06	2.15E+06	1.98E+06	7.43E+05	1.28E+03	4.41E+04	6.46E+04	8.47E+04	2.88E+05	9.81E+04
			6.58E+04	0.	0.	0.						
10	10	6.25E-02	0.	0.	3.07E+03	0.	0.	0.	0.	4.63E+02	0.	1.54E+03
			8.28E+03	0.	4.72E+03	1.13E+04	3.98E+04	3.61E+04	3.43E+04	2.89E+04	1.92E+05	4.63E+05
			3.92E+05	6.87E+05	5.55E+05	4.12E+05	3.44E+05	2.37E+05	2.15E+05	6.67E+04	3.32E+05	4.25E+05
			1.81E+06	1.90E+05	1.49E+06	1.25E+06						
11	11	6.25E-02	0.	0.	0.	1.61E+03	0.	0.	0.	3.58E+03	0.	5.89E+03
			6.78E+03	6.72E+03	1.94E+03	4.76E+03	6.66E+03	9.99E+03	1.98E+04	1.91E+04	3.51E+04	9.47E+04
			3.11E+04	1.09E+05	1.31E+05	3.92E+04	3.86E+04	4.81E+04	5.65E+04	1.76E+04	8.04E+04	3.91E+05
			3.85E+06	1.79E+06	4.59E+06	2.58E+06						
12	12	6.25E-02	0.	0.	0.	0.	0.	0.	9.39E+02	0.	5.38E+02	0.
			2.82E+03	2.64E+02	1.99E+02	2.89E+02	0.	2.86E+03	3.28E+03	3.19E+03	9.29E+03	9.88E+03
			1.25E+04	1.32E+04	2.86E+04	3.19E+04	1.59E+04	1.45E+04	1.51E+04	4.02E+04	1.63E+05	3.62E+05
			6.78E+05	8.45E+05	2.84E+06	2.04E+06						
13	13	6.25E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
			0.	3.88E+00	0.	2.20E+01	8.58E+02	2.34E+03	4.25E+02	6.24E+03	8.89E+03	2.86E+03
			5.98E+03	8.33E+03	1.08E+04	2.79E+03	1.73E+03	5.25E+02	1.05E+03	3.89E+03	2.22E+04	2.75E+05
			3.59E+05	2.42E+05	3.27E+06	1.01E+07						

REPRODUCED FROM
BEST AVAILABLE COPY

14	14	6.25E-02	0.	0.	0.	0.	7.90E+01	0.	0.	3.28E+01	0.	0.
			3.88E+01	0.	0.	1.24E+03	3.64E+03	6.75E+03	2.69E+03	2.74E+03	8.39E+03	3.11E+04
			7.30E+03	4.68E+03	3.19E+03	4.58E+03	2.89E+03	2.91E+03	2.79E+03	7.78E+03	3.47E+04	2.75E+04
			3.24E+05	3.19E+05	2.81E+06	4.85E+05						
15	15	6.25E-02	0.	0.	0.	0.	9.88E+01	0.	0.	0.	0.	0.
			7.81E+02	0.	0.	0.	0.	1.38E+03	4.55E+03	1.19E+03	1.19E+04	4.37E+03
			5.36E+03	7.78E+03	4.81E+03	1.19E+04	5.93E+03	7.88E+03	4.81E+03	3.35E+03	8.62E+03	2.21E+04
			1.54E+05	7.34E+05	7.21E+05	0.						
16	16	6.25E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
			0.	2.71E+03	1.12E+04	0.	2.68E+03	1.14E+04	3.28E+04	1.83E+04	1.87E+04	5.98E+03
			1.34E+04	6.65E+03	7.71E+03	2.18E+03	3.79E+03	3.87E+03	2.59E+03	3.36E+03	8.54E+03	1.88E+04
			2.91E+05	1.12E+05	1.84E+05	0.						

5. Subgroup TOPOGRAPHY - specifies the state code and land fraction for each area element of the spatial grid. This subgroup must be specified after subgroup SPATIAL. This subgroup supplies the topographical data when no site data file is referenced or when no topographical data is requested from the site file.

Sample input cards:



The NUM field must either be 16 or zero for this subgroup. If it is 16, the state codes and land fractions are specified for each area element of the spatial grid (see subgroup SPATIAL). If it is zero, as in the example above, a single state code and land fraction is applied to the complete spatial grid.

If NUM=0, the following card is required:

Column	Mnemonic	Format	Description
1-3	LSTATE	I3	Two digit state code (number corresponding to order of states in subgroup ECONOMIC).

Column	Mnemonic	Format	Description
4-5	FRLAN	F2.1	Land area decimal fraction multiplied by 10 (10 = 100% land, 09 = 90% land, etc.)

If NUM=16, one set of cards for each of the 16 sectors, must be input according to the following format:

Column	Mnemonic	Format	Description
1-3	ISTATE(I,K)	I3	Two digit state code and land fraction for area elements in sector I.
4-5	FRLAND(I,K)	F2.1	
6-8			The data are read into the pair of arrays ISTATE and FRLAND as follows, (ISTATE(I,K), FRLAND (I,K), K=1, NSI), where NSI is the number of spatial intervals. Each card contains the data for 16 area elements. Use as many cards as required to specify NSI data pairs.
9-10			
.	.	.	
.	.	.	
.	.	.	
76-78			
79-80			

The above set of cards is repeated for each of the 16 sectors. Data for a new sector begins with a new card.

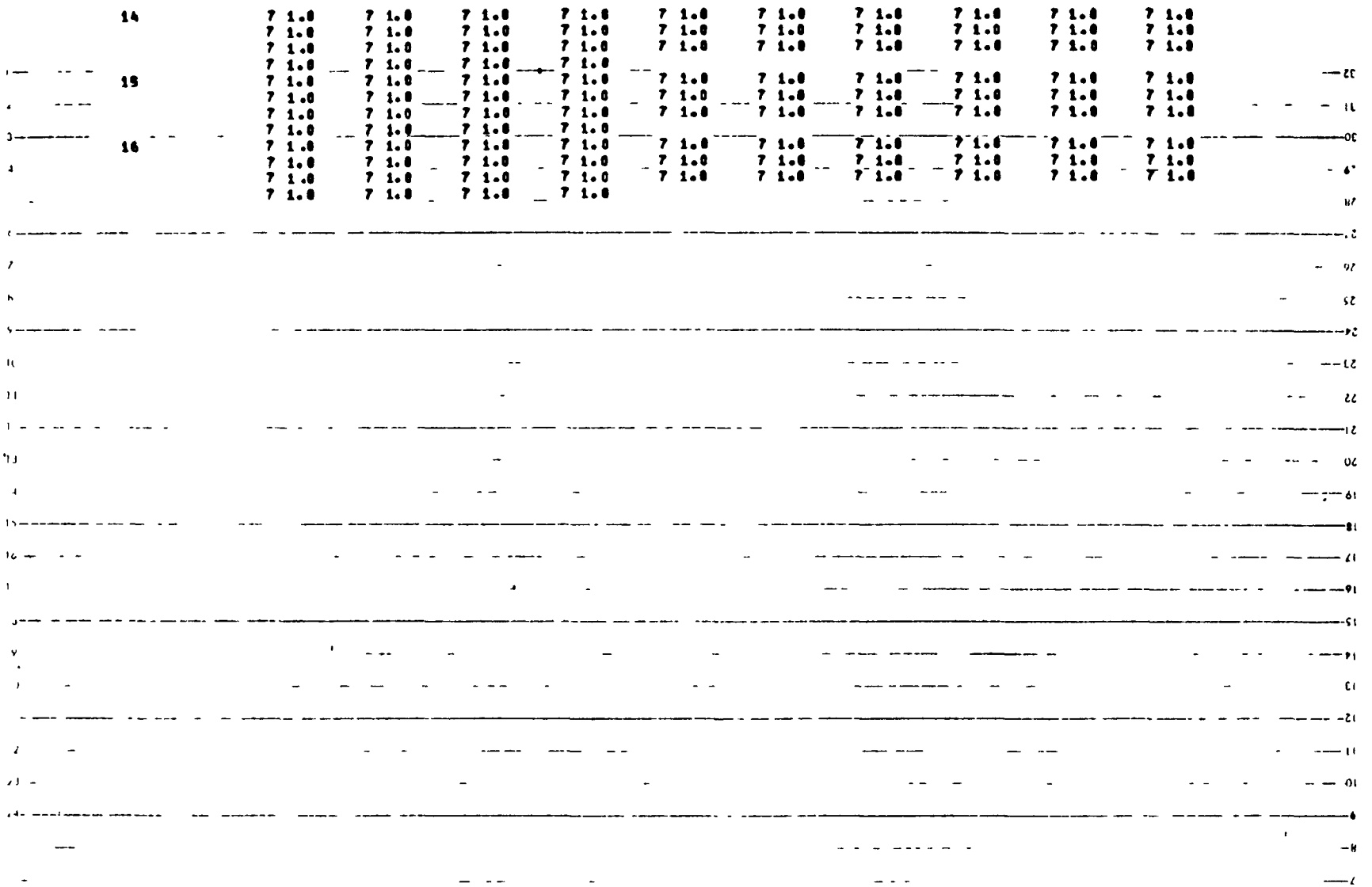
No parameter modification is allowed for this subgroup.

A representative listing of the TOPOGRAPHY subgroup sample input data is shown below.

SUBGROUP TOPOG
PARAMETER SET TO 0

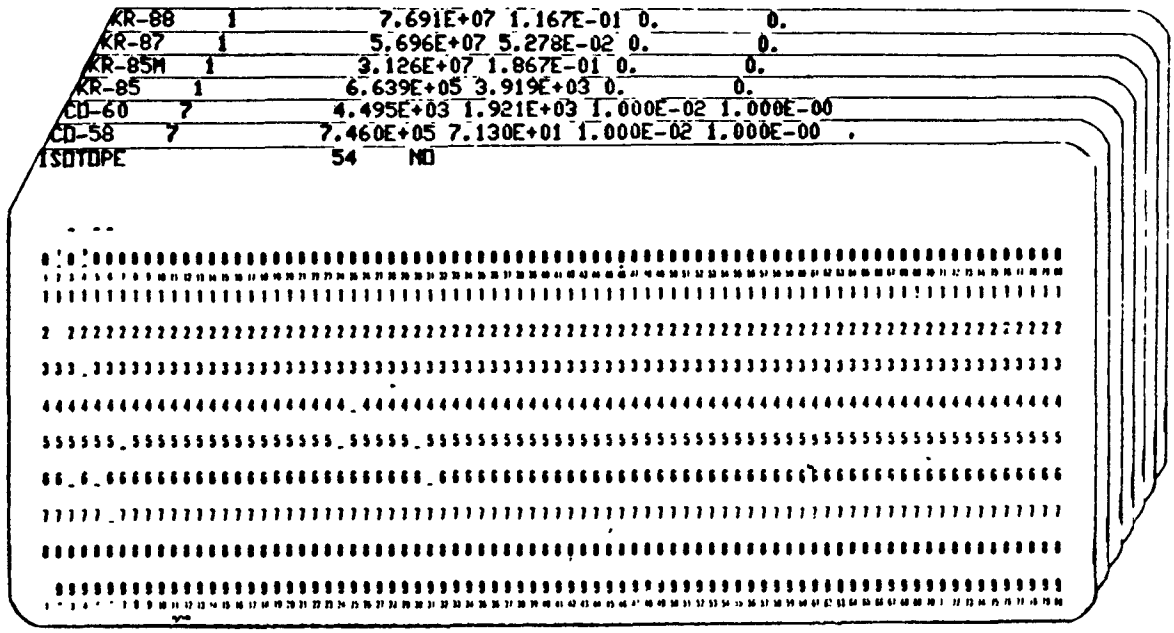
* * * STATE CODE AND HABITABLE LAND FRACTION FOR EACH AREA ELEMENT * * *

SECTOR	STATE AND LAND FRACTION									
1	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
2	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
3	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
4	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
5	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
6	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
7	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
8	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
9	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
10	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
11	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
12	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						
13	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0	7 1.0
	7 1.0	7 1.0	7 1.0	7 1.0						



6. Subgroup ISOTOPE - specifies the inventory of isotopes and associated isotopic parameters.

Sample input cards:



The NUM field, 54 in the sample header above, specifies the total number of isotopes, NIS, in the inventory. A maximum of 54 isotopes can be specified.

NIS cards, one for each isotope, must be input following the header card. One isotope and its associated parameters are defined on each card. The format for each isotope card is described below.

Columns	Mnemonic	Format	Description
1-8	NAME(I)	A8	Isotope name (left justified). This name must be one of the 54 isotopes listed in Table II-2.
10	IGRP(I)	I1	Index of the isotope leakage group for this isotope (see subgroup LEAKAGE).

Columns	Mnemonic	Format	Description
12-19	PARENT(I)	A8	Name of parent (left justified). The parent must be among the NIS isotopes in the inventory.
21-30	SACT(I)	E10.3	Isotope inventory in the core at the time of the accident (curies).
31-40	HALF(I)	E10.3	Half-life (days).
41-50	VD(I)	E10.3	Deposition velocity (m/sec).
51-60	RLAM(I)	E10.3	Rain depletion switch. The value of the rain coefficient C [sec^{-1} $(mm/hr)^{-1}$] in the washout coefficient $\lambda = CR$ of the rain depletion equation is determined by the value of RLAM(I).*

The index I corresponds to the order of the isotopes in the inventory list. The isotope and parent names must be spelled exactly as shown in Table II-2 below. Only the 54 isotopes given in this table may be used.

Table II-2. List of Valid Isotopes

1	CO-58	19	RU-105	37	CS-134
2	CO-60	20	RU-106	38	CS-136
3	KR-85	21	RH-105	39	CS-137
4	KR-85M	22	SB-127	40	BA-140
5	KR-87	23	SB-129	41	LA-140
6	KR-88	24	TE-127	42	CE-141
7	RB-86	25	TE-127M	43	CE-143
8	SR-89	26	TE-129	44	CE-144
9	SR-90	27	TE-129M	45	PR-143
10	SR-91	28	TE-131M	46	ND-147
11	Y-90	29	TE-132	47	NP-239
12	Y-91	30	I-131	48	PU-238
13	ZR-95	31	I-132	49	PU-239
14	ZR-97	32	I-133	50	PU-240
15	NB-95	33	I-134	51	PU-241
16	MO-99	34	I-135	52	AM-241
17	TC-99M	35	XE-133	53	CM-242
18	RU-103	36	XE-135	54	CM-244

*When the value of RLAM(I) is zero, CRAC2 uses for C the value 0. When the value of RLAM(I) is nonzero, CRAC2 uses for C the value 1.0E-4 for stable weather and 1.0E-3 for neutral and unstable weather.

If parameter modification (PARMOD = "YES") is specified in the header, the following card is required between the header and isotope cards.

Columns	Mnemonic	Format	Description
1-10	CSACT	E10.3	Multiplier for the NIS activity values in the array SACT.
11-20	CVD	E10.3	Multiplier for the NIS deposition velocity values in the array VD.
21-30	CRLAM	E10.3	Multiplier for the NIS rain depletion switch values in the array RLAM.

A representative listing of the ISOTOPE subgroup input data is shown below.

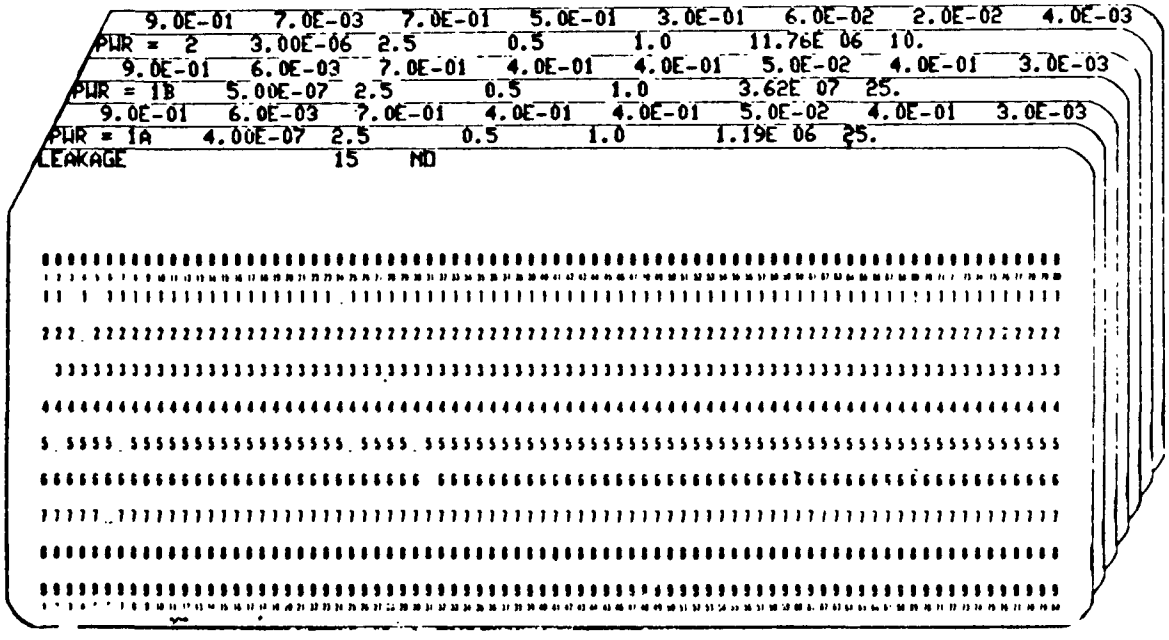
SUBGROUP ISOTOPE
PARAMETER NIS SET TO 54

• • • INPUT ISOTOPES • • •

NUMBER	NAME	GROUP	PARENT	INITIAL(CURIES)	HALF-LIFE(DAYS)	DEPOSITION VELOCITY(M/SEC)	RAIN DEPLETION
1	CO-58	7		7.460E+05	7.130E+01	1.000E-02	1.000E+00
2	CO-60	7		4.495E+03	1.921E+03	1.000E-02	1.000E+00
3	KR-85	1		6.639E+05	3.919E+03	0.	0.
4	KR-85M	1		3.126E+07	1.867E-01	0.	0.
5	KR-87	1		5.696E+07	5.278E-02	0.	0.
6	KR-88	1		7.891E+07	1.167E-01	0.	0.
7	RB-86	4		4.815E+04	1.865E+01	1.000E-02	1.000E+00
8	SR-89	6		9.588E+07	5.200E+01	1.000E-02	1.000E+00
9	SR-90	6		5.171E+06	1.026E+04	1.000E-02	1.000E+00
10	SR-91	6		1.238E+08	3.950E-01	1.000E-02	1.000E+00
11	Y-90	8	SR-90	5.546E+06	2.670E+00	1.000E-02	1.000E+00
12	Y-91	8	SR-91	1.169E+08	5.880E+01	1.000E-02	1.000E+00
13	ZR-95	8		1.489E+08	6.550E+01	1.000E-02	1.000E+00
14	ZR-97	8		1.561E+08	7.000E-01	1.000E-02	1.000E+00
15	NB-95	8	ZR-95	1.407E+08	3.510E+01	1.000E-02	1.000E+00
16	MO-99	7		1.655E+08	2.751E+00	1.000E-02	1.000E+00
17	TC-99M	7	MO-99	1.428E+08	2.508E-01	1.000E-02	1.000E+00
18	RU-103	7		1.244E+08	3.959E+01	1.000E-02	1.000E+00
19	RU-105	7		8.211E+07	1.850E-01	1.000E-02	1.000E+00
20	RU-106	7		2.892E+07	3.690E+02	1.000E-02	1.000E+00
21	RH-105	7	RU-105	5.574E+07	1.479E+00	1.000E-02	1.000E+00
22	SB-127	5		7.720E+06	3.800E+00	1.000E-02	1.000E+00
23	SB-129	5		2.714E+07	1.808E-01	1.000E-02	1.000E+00
24	TE-127	5	SB-127	7.452E+06	3.896E-01	1.000E-02	1.000E+00
25	TE-127M	5		9.839E+05	1.090E+02	1.000E-02	1.000E+00
26	TE-129	5	SB-129	2.547E+07	4.861E-02	1.000E-02	1.000E+00
27	TE-129M	5		6.698E+06	3.340E+01	1.000E-02	1.000E+00
28	TE-131M	5		1.281E+07	1.250E+00	1.000E-02	1.000E+00
29	TE-132	5		1.268E+08	3.250E+00	1.000E-02	1.000E+00
30	I-131	3	TE-131M	8.737E+07	8.040E+00	1.000E-02	1.000E+00
31	I-132	3	TE-132	1.286E+08	9.521E-02	1.000E-02	1.000E+00
32	I-133	3		1.840E+08	8.667E-01	1.000E-02	1.000E+00
33	I-134	3		2.017E+08	3.653E-02	1.000E-02	1.000E+00
34	I-135	3		1.734E+08	2.744E-01	1.000E-02	1.000E+00
35	XE-133	1	I-133	1.841E+08	5.290E+00	0.	0.
36	XE-135	1	I-135	3.800E+07	3.821E-01	0.	0.
37	CS-134	4		1.261E+07	7.524E+02	1.000E-02	1.000E+00
38	CS-136	4		3.910E+06	1.300E+01	1.000E-02	1.000E+00
39	CS-137	4		6.537E+06	1.099E+04	1.000E-02	1.000E+00
40	BA-140	6		1.681E+08	1.279E+01	1.000E-02	1.000E+00
41	LA-140	8	BA-140	1.717E+08	1.676E+00	1.000E-02	1.000E+00
42	CE-141	8		1.527E+08	3.253E+01	1.000E-02	1.000E+00
43	CE-143	8		1.485E+08	1.375E+00	1.000E-02	1.000E+00
44	CE-144	8		9.156E+07	2.844E+02	1.000E-02	1.000E+00
45	PR-143	8	CE-143	1.455E+08	1.358E+01	1.000E-02	1.000E+00
46	ND-147	8		6.529E+07	1.099E+01	1.000E-02	1.000E+00
47	NP-239	8		1.850E+09	2.350E+00	1.000E-02	1.000E+00
48	PU-238	8	CM-242	1.168E+05	3.251E+04	1.000E-02	1.000E+00
49	PU-239	8	NP-239	2.581E+04	8.912E+06	1.000E-02	1.000E+00
50	PU-240	8	CM-244	2.893E+04	2.469E+06	1.000E-02	1.000E+00
51	PU-241	8		5.421E+06	5.335E+03	1.000E-02	1.000E+00
52	AM-241	8	PU-241	3.624E+03	1.581E+05	1.000E-02	1.000E+00
53	CM-242	8		1.369E+06	1.630E+02	1.000E-02	1.000E+00
54	CM-244	8		8.406E+04	6.611E+03	1.000E-02	1.000E+00

7. Subgroup LEAKAGE - specifies the release identification, the associated release parameters, and the fraction of the total core inventory which is released for each isotope leakage group. This subgroup must be specified after subgroup ISOTOPE.

Sample input cards:



The NUM field, 15 in the sample header card above, indicates the total number of leakage categories, NPB2, to be evaluated. A maximum of 15 leakage categories can be specified.

The set of data cards for one leakage category is presented below. There are NPB2 sets of cards in the complete subgroup.

Card 1 in the set identifies the release and specifies the associated release parameters.

Column	Mnemonic	Format	Description
1-8	LNAME(J)	A8	Name of release category.
11-20	P(J,2)	E10.3	The probability associated with this release. The program will automatically normalize the sum of the probabilities over all release categories to one. This normalization can be suppressed by an option switch, NORM, in subgroup OPTIONS.
21-30	TL(J)	E10.3	Time between reactor shutdown and release into the atmosphere (hours). Used for isotope decay calculations.
31-40	DR(J)	E10.3	Duration of release (hours). This parameter is used to compute the cloud expansion factor, EF, where $EF(J) = (DR(J)/.05)^{Q}$, and Q is defined as .2 for $DR(J) \leq 1$ .25 for $DR(J) > 1$. DR(J) cannot exceed 10 hours.
41-50	TLL(J)	E10.3	Warning time (hours). The time from officially being warned to the beginning of the atmospheric release. Used in evacuation modeling.
51-60	FPR(J)	E10.3	Sensible heat rate (Calories, gm/sec) due to thermal heat content of the released gases. Used in plume rise calculation.
61-70	RH(J)	E10.3	Release height of plume (meters). If the release height is less than the building height, the plume is assumed to be entrained in the building wake and the release height is set to ground level.

The remaining cards in the set define the leakage fractions for each of the accident leakage groups. NGRP is the number of isotope leakage groups, where NGRP is the maximum value of IGRP for the isotopes specified by the ISOTOPE subgroup.

Column	Mnemonic	Format	Description
1-80	FLEAK(J,I)	8E10.3	Fraction of each isotope group to be released into atmosphere.* No more than 10 isotope leakage groups can be defined. The leakage fraction data are read into the array FLEAK as follows, (FLEAK(J,I), I=1, NGRP). Use as many cards as required to define the NGRP isotope leakage groups.

The above set of cards must be repeated for each leakage category. The index J corresponds to the order of the leakage categories in this subgroup.

If parameter modification (PARMOD = "YES") is specified, the following card is required after the header card:

Column	Mnemonic	Format	Description
1-10	CTL	E10.3	Multiplier for the NPB2 values in the array TL.
11-20	CEF	E10.3	Multiplier for the NPB2 values in the array EF.
21-30	CTLL	E10.3	Multiplier for the NPB2 values in array TLL.
31-40	CFPR	E10.3	Multiplier for the NPB2 values in array FPR.
41-50	CRH	E10.3	Multiplier for the NPB2 values in array RH.

A representative listing of the LEAKAGE subgroup sample input data is shown below.

*The sample input data shows eight isotope leakage groups as described in Chapter 2 of Appendix VI of the Reactor Safety Study. These groups are Xe-Kr, organic I, I, Cs-Rb, Te-Sb, Ba-Sr, Ru, and La. In the reference case data, all iodine isotopes are assigned to the iodine group, i.e. leakage group 3.

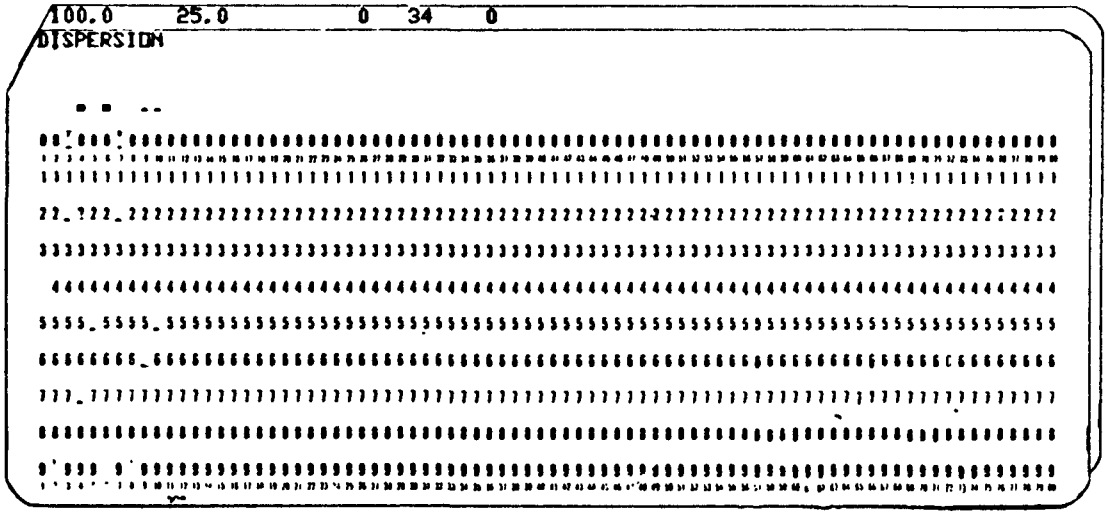
SUBGROUP LEAKAGE
PARAMETER NPB2 SET TO 15

* * * INPUT ISOTOPIC LEAKAGE FRACTIONS * * *

1 PWR = 1A	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	4.000E-07	2.500E+00	1.585E+00	1.000E+00	1.190E+06	2.500E+01
GROUP - LEAKAGE FRACTION	1-9.00E-01	2-6.00E-03	3-7.00E-01	4-4.00E-01	5-4.00E-01	6-5.00E-02	7-4.00E-01	8-3.00E-03
2 PWR = 1B	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	5.000E-07	2.500E+00	1.585E+00	1.000E+00	3.620E+07	2.500E+01
GROUP - LEAKAGE FRACTION	1-9.00E-01	2-6.00E-03	3-7.00E-01	4-4.00E-01	5-4.00E-01	6-5.00E-02	7-4.00E-01	8-3.00E-03
3 PWR = 2	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	3.000E-06	2.500E+00	1.585E+00	1.000E+00	1.176E+07	1.000E+01
GROUP - LEAKAGE FRACTION	1-9.00E-01	2-7.00E-03	3-7.00E-01	4-5.00E-01	5-3.00E-01	6-6.00E-02	7-2.00E-02	8-4.00E-03
4 PWR = 3	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	4.000E-06	5.000E+00	2.340E+00	2.000E+00	4.200E+05	1.000E+01
GROUP - LEAKAGE FRACTION	1-8.00E-01	2-6.00E-03	3-2.00E-01	4-2.00E-01	5-3.00E-01	6-2.00E-02	7-3.00E-02	8-3.00E-03
5 PWR = 4	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	5.000E-07	2.000E+00	2.783E+00	2.000E+00	7.000E+03	1.000E+01
GROUP - LEAKAGE FRACTION	1-6.00E-01	2-2.00E-03	3-9.00E-02	4-4.00E-02	5-3.00E-02	6-5.00E-03	7-3.00E-03	8-4.00E-04
6 PWR = 5	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	7.000E-07	2.000E+00	2.991E+00	1.000E+00	2.100E+04	1.000E+01
GROUP - LEAKAGE FRACTION	1-3.00E-01	2-2.00E-03	3-3.00E-02	4-9.00E-03	5-5.00E-03	6-1.00E-03	7-6.00E-04	8-7.00E-05
7 PWR = 6	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	6.000E-06	1.200E+01	3.761E+00	1.000E+00	0.	1.000E+01
GROUP - LEAKAGE FRACTION	1-3.00E-01	2-2.00E-03	3-8.00E-04	4-8.00E-04	5-1.00E-03	6-9.00E-05	7-7.00E-05	8-1.00E-05
8 PWR = 7	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	4.000E-05	1.000E+01	3.761E+00	1.000E+00	0.	1.000E+01
GROUP - LEAKAGE FRACTION	1-6.00E-03	2-2.00E-05	3-2.00E-05	4-1.00E-05	5-2.00E-05	6-1.00E-06	7-1.00E-06	8-2.00E-07
9 PWR = 8	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	4.000E-05	5.000E-01	1.585E+00	0.	0.	1.000E+01
GROUP - LEAKAGE FRACTION	1-2.00E-03	2-5.00E-06	3-1.00E-04	4-5.00E-04	5-1.00E-06	6-1.00E-08	7-0.	8-0.
10 PWR = 9	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	4.000E-04	5.000E-01	1.585E+00	0.	0.	1.000E+01
GROUP - LEAKAGE FRACTION	1-3.00E-06	2-7.00E-09	3-1.00E-07	4-6.00E-07	5-1.00E-09	6-1.00E-11	7-0.	8-0.
11 BWR = 1	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	1.000E-06	2.000E+00	1.585E+00	1.500E+00	8.400E+06	2.500E+01
GROUP - LEAKAGE FRACTION	1-1.00E+00	2-7.00E-03	3-4.00E-01	4-4.00E-01	5-7.00E-01	6-5.00E-02	7-5.00E-01	8-5.00E-03
12 BWR = 2	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	6.000E-06	3.000E+01	2.783E+00	2.000E+00	1.690E+06	1.000E+01
GROUP - LEAKAGE FRACTION	1-1.00E+00	2-7.00E-03	3-9.00E-01	4-5.00E-01	5-3.00E-01	6-1.00E-01	7-3.00E-02	8-4.00E-03
13 BWR = 3	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	2.000E-05	3.000E+01	2.783E+00	2.000E+00	1.400E+06	2.500E+01
GROUP - LEAKAGE FRACTION	1-1.00E+00	2-7.00E-03	3-1.00E-01	4-1.00E-01	5-3.00E-01	6-1.00E-02	7-2.00E-02	8-4.00E-03
14 BWR = 4	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	2.000E-06	5.000E+00	2.515E+00	2.000E+00	0.	2.500E+01
GROUP - LEAKAGE FRACTION	1-6.00E-01	2-7.00E-04	3-8.00E-04	4-5.00E-03	5-9.00E-03	6-6.00E-04	7-6.00E-04	8-1.00E-04
15 BWR = 5	PROB-P(J,2)	TIME TO RELEASE	EXPANSION FACTOR	WARNING TIME	SENSIBLE HEAT (CAL/SEC)	RELEASE HEIGHT
	1.000E-04	3.500E+00	3.162E+00	0.	0.	1.500E+02
GROUP - LEAKAGE FRACTION	1-5.00E-04	2-2.00E-09	3-6.00E-11	4-4.00E-09	5-8.00E-12	6-8.00E-14	7-0.	8-0.

8. Subgroup DISPERSION - specifies the reactor building dimensions and the special wake and rain depletion options.

Sample input cards:



The NUM field for this subgroup is ignored.

One card with the format described below must be input following the header card:

Column	Mnemonic	Format	Description
1-10	BUILDL	E10.3	Reactor building length (meters).
11-20	BUILDH	E10.3	Reactor building height (meters).
21-25	MWAKE	I5	Number of spatial intervals for special effects of a wake dominated plume. For a plume not dominated by wake effects, set MWAKE = 0.
26-30	IRDEPL	I5	Rain depletion switch. 0 - unaltered depletion model. 34 - The radius of spatial interval NSI is redefined to be 2000 miles. The average population density for the

Column	Mnemonic	Format	Description
			U.S. of 78 people per square mile is assumed for this area. The activity left in the cloud is depleted in this interval by incident rain (0.5 mm/hr).
31-35	LIRAIN	I5	Rain option switch. 0 - observed rain, i.e., the hourly rain data from the meteorological information. 1 - rainfall ignored, i.e., all rain information in the meteorological data is ignored. 2 - incident rain, i.e., a rainfall rate of 0.5 mm/hr is substituted for all occurrences of rainfall in the meteorological information.

No parameter modification is allowed for this subgroup.

A representative listing of the DISPERSION subgroup sample input data is shown below.

```
SUBGROUP DISPERSE
PARAMETER    SET TO     0

                    * * * INPUT BUILDING, WAKE, AND RAIN DATA * * *

 BUILDL     REACTOR BUILDING LENGTH (M)                    1.000E+02
 BUILDH     REACTOR BUILDING HEIGHT (M)                    2.500E+01
 MWAKE      = # OF INTERVALS FOR SPECIAL WAKE EFFECTS              0
 IRDEPL     = 34  TURNS ON RAIN FOR THE LAST INTERVAL             34
 LIRAIN     = 0, 1, OR 2  REQUESTS OBSERVED RAIN,                  0
              NO RAIN (RAINFALL IGNORED), OR
              INCIDENT RAIN, RESPECTIVELY
```

9. Subgroup EVACUATE - specifies the emergency action data, including the choice of evacuation model and the constants for sheltering, shielding, and evacuation. The NUM field in the header card specifies the number of evacuation strategies, NEVAC, to be defined. No more than six strategies are allowed. The weighted evacuation scenario is the weighted sum of the strategies. The impact of each evacuation strategy on early effects consequences is evaluated. In addition, the impact on early effects for the weighted (summary) evacuation scenario is evaluated. The impact of evacuation on the latent effects and evacuation costs is based only on the emergency action data defined in the last evacuation strategy.

Following the header card, one card corresponding to each evacuation strategy is required. The format of each strategy card is described below.

Column	Mnemonic	Format	Description
1-10	EVCONIN (1,J)	E10.3	Probability of evacuation with strategy J in the weighted evacuation scenario.
11-20	EVCONIN (2,J)	E10.3	Time delay between officially being warned and beginning evacuation (hours).
21-30	EVCONIN (3,J)	E10.3	Evacuation speed (meters/sec)

Column	Mnemonic	Format	Description
31-40	EDIST(J)	E10.3	Maximum evacuation distance for downwind sectors (intervals). Spatial intervals lying within this distance will be evacuated according to the evacuation scheme specified in EVCONIN (7,J). Exposure to air and ground contamination will depend on the scheme selected. Individuals living in spatial intervals beyond this distance will be exposed to ground contamination for either 1, EXPD(J), or 7 days. The exposure model is determined by the switch IEXPD and the exposure duration EXPD(J).
41-50	EVCONIN (5,J)	E10.3	End of evacuation distance for evacuees (meters). Distance from the reactor site at which evacuees complete their evacuation.
51-60	SDIST(J)	E10.3	Maximum sheltering distance for downwind sectors (intervals). Individuals living in sectors lying within this distance will be sheltered if they do not evacuate. The maximum sheltering distance cannot be less than the maximum evacuation distance. This region also has an associated relocation time RELOCT(J).
61-70	EVCONIN (7,J)	E10.3	Evacuation model option: 1.0 - constant velocity evacuation model (WASH-1400 model). 2.0 - detailed tracking of evacuees, allowing for delay, shelter, and movement of the evacuee.
71-75	EXPD(J)	F5.0	Exposure duration (days) for external groundshine in the non-evacuating intervals outside of maximum sheltering distance for the case when IEXPD has the value 1.

Column	Mnemonic	Format	Description
76-80	RELOCT(J)	F5.0	Exposure duration (days) for external groundshine in the sheltering/ relocation zone located between the maximum evacuation distance and the maximum sheltering distance.

This evacuation card corresponds to evacuation scheme J.

The shielding data, breathing rate data, evacuation cost data, and duration of exposure switch (outside maximum sheltering distance) do not change between evacuation strategies. These data are read from the three cards which follow the evacuation strategy cards. The format of these cards is described below.

Card	Column	Mnemonic	Format	Description
1	1-10	SHFAC(1,1)	E10.3	Cloud shielding for stationary evacuees (effectiveness factor between 0 and 1 where 1 means no shielding).
	11-20	SHFAC(2,1)	E10.3	Cloud shielding for moving evacuees (effectiveness factor between 0 and 1).
	21-30	SHFAC(3,1)	E10.3	Cloud shielding with sheltering (effectiveness factor between 0 and 1).
	31-40	SHFAC(4,1)	E10.3	Cloud shielding with no emergency action (effectivenss factor between 0 and 1).
	41-50	SHFAC(1,2)	E10.3	Ground shielding for stationary evacuees (effectiveness factor between 0 and 1).
	51-60	SHFAC(2,2)	E10.3	Ground shielding for moving evacuees (effectiveness factor between 0 and 1).
	61-70	SHFAC(3,2)	E10.3	Ground shielding with sheltering (effectiveness factor between 0 and 1).

Card	Column	Mnemonic	Format	Description
	71-80	SHFAC(4,2)	E10.3	Ground shielding with no emergency action (effectiveness factor between 0 and 1).
2	1-10	BRATE(1)	E10.3	Breathing rate for stationary evacuees (cubic meters/sec).
	11-20	BRATE(2)	E10.3	Breathing rate for moving evacuees (cubic meters/sec).
	21-30	BRATE(3)	E10.3	Breathing rate with sheltering (cubic meters/sec).
	31-40	BRATE(4)	E10.3	Breathing rate with no emergency action (cubic meters/sec).
3	1-10	EVCOST(1)	E10.3	Radius of circular evacuated area near the reactor (meters). Used for WASH-1400 evacuation cost model.
	11-20	EVCOST(2)	E10.3	Width of evacuation arc for downwind sectors (degrees). WASH-1400 evacuation cost model.
	21-30	EVCOST(3)	E10.3	Direct evacuation cost (dollars per evacuee). WASH-1400 evacuation cost model.
	31-40	EVCOST(4)	E10.3	Maximum release duration (hours) for which the WASH-1400 keyhole-shaped evacuation model is to be applied.
	41-45	IEXPD	I5	Duration of exposure switch: -1 - People in the non-evacuating intervals outside of the maximum sheltering distance will be relocated after 7 days. But if the 7-day total bone marrow external groundshine dose approaches lethal levels (200 rem), relocation occurs at 12 hours.

Card	Column	Mnemonic	Format	Description
				0 - People in the non-evacuating intervals outside of the maximum sheltering distance will be relocated after 24 hours.
				1 - People in the non-evacuating intervals outside of the maximum sheltering distance will be relocated after EXPD days.

Reductions in inhalation doses due to sheltering or respiratory protective measures can be included by reducing the assumed breathing rate.

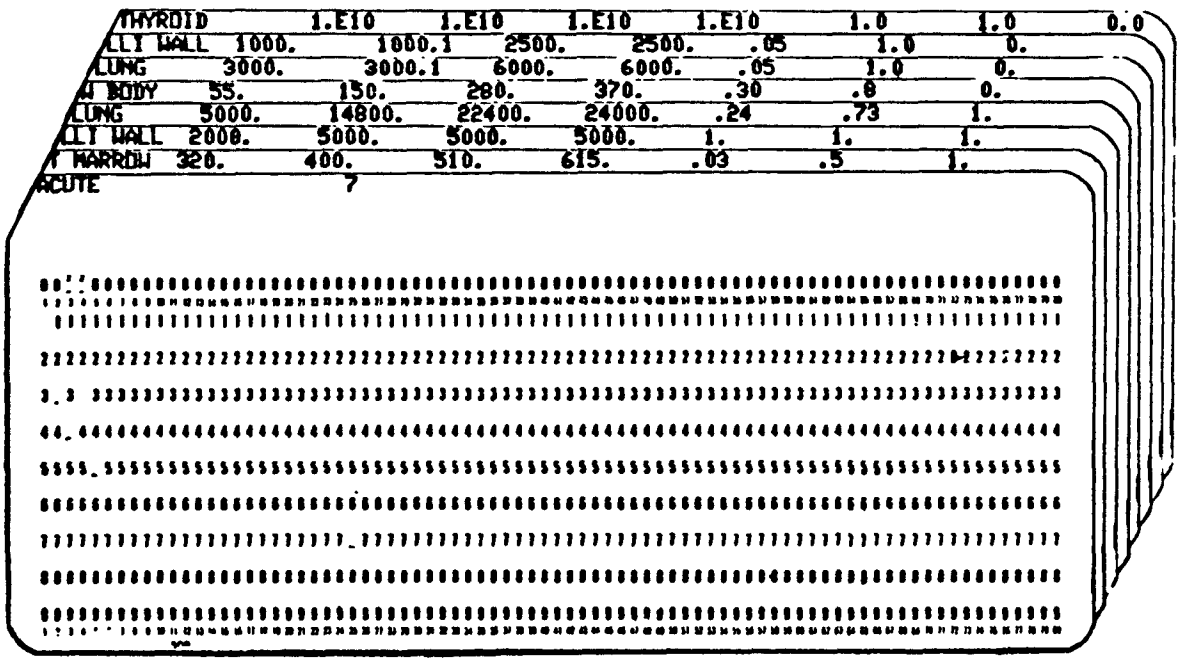
If PARMOD equals "YS1" (columns 30-32 of EVACUATE subgroup header card), six evacuation strategies must be specified. Evacuation strategies 1 through 3 represent normal evacuation conditions and evacuation strategies 4 through 6 represent adverse evacuation conditions. Population fractions are read from the next three cards (following card 3 above) corresponding to the three different population groups. Each card contains population fractions for 16 sectors or directions. The first card contains the population fractions for the first population group in each of the 16 sectors. The second and third cards contain the population fractions for the second and third population groups, respectively. The format of these cards is described in the following table.

Card	Column	Mnemonic	Format	Description
4	1-80	PFRAC(1,K)	16F5.0	Population fractions for group 1 for each of 16 directions.
5	1-80	PFRAC(2,K)	16F5.0	Population fractions for group 2 for each of 16 directions.
6	1-80	PFRAC(3,K)	16F5.0	Population fractions for group 3 for each of 16 directions.

The 3 population fractions for any given direction should sum to one. The population fractions for group 1 are applied to evacuation strategies 1 and 4. The population fractions for group 2 are applied to evacuation strategies 2 and 5. The population fractions for group 3 are applied to evacuation strategies 3 and 6. Probabilities assigned to these two conditions are used for each of the 3 respective evacuation strategies. For example, assigning a 0.90 probability to normal evacuation conditions and a 0.10 probability to adverse evacuation conditions will result in assigning a 0.90 probability to each of the strategies 1 through 3 and 0.10 probability to each of the strategies 4 through 6. Evacuation strategies 1 through 3 are essentially treated as a single evacuation strategy for normal evacuation conditions and evacuation strategies 4 through 6 are essentially treated as a single evacuation strategy for adverse evacuation conditions.

10. Subgroup ACUTE - specifies the acute effects due to early exposure to the radioactive cloud that are to be studied and the supporting dose-mortality and injury data for each organ.

Sample input cards:



The NUM field, 7 in the example header above, specifies the total number of acute health effects, NEARLY, to be studied. Up to 8 acute effects are permitted.

After the header card, one card with the following format must be input for each acute effect.

Columns	Mnemonic	Format	Description
1-8	ERLORG(I)	A8	Affected organ name. This name must be one of the 13 organs listed in Table II-3.

Columns	Mnemonic	Format	Description
11-50	DL(J,I)	4E10.3	Four dose threshold values (rems). The dose values for effect I are read into the array DL as (DL(J,I), J =1,4). DL(1,I) is the threshold below which the probability of the effect is zero. DL(4,I) is the dose value above which the probability of the effect is 1. DL(2,I) and DL(3,I) are intermediate values with corresponding probabilities given by PL(1,I) and PL(2,I) respectively. Arrays DL and PL together specify the probability of the given effect over the entire dose range. The early exposure model assumes that the points described by DL and PL are connected by straight lines. The model linearly interpolates in the table to determine the probability of the effect. See the Figure II-2.
51-70	PL(J,I)	2E10.3	Two probabilities corresponding to the intermediate dose limits in array DL. See the description of DL above. The data for effect I are read into the array PL as (PL(J,I), J=1,2).
71-80	FATFAC(I)	E10.3	Mortality factor: 0.0 means no fatalities, i.e., the health effect is a non-fatal illness or injury; 1.0 means everyone with this health effect dies; intermediate values mean that the given fraction of the people with this acute effect die and the rest survive.

No parameter modification is permitted for subgroup ACUTE.

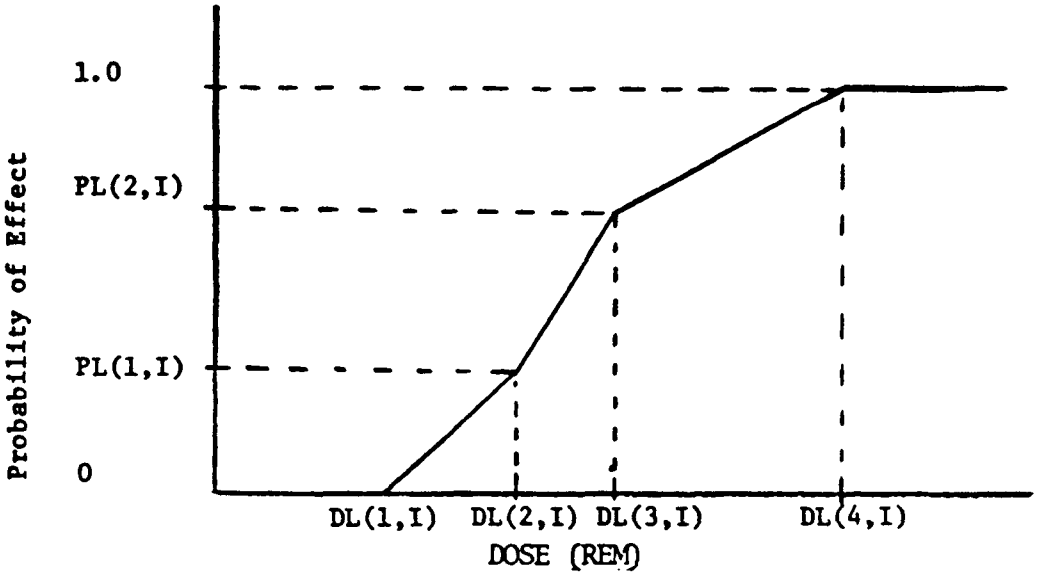


Figure II-2. Dose Effectiveness Model

Table II-3
List of Organ Names

Index	Organ Name	Definition
1.	LUNG	Lungs
2.	T MARROW	Total bone marrow
3.	SKELETON	Skeletal bone
4.	T E C L	Total endosteal cells (interior bone surface)
5.	ST WALL	Stomach wall
6.	SI+CONT	Small intestine and contents
7.	SUL WALL	Upper large intestine wall
8.	LLI WALL	Lower large intestine wall
9.	THYROID	Thyroid
10.	OTHER	Tissues other than lungs, bone marrow, walls of G.I. tract, and thyroid
11.	W BODY	Whole body
12.	TESTES	Testes
13.	OVARIES	Ovaries

A representative listing of the ACUTE subgroup sample input data is shown below.

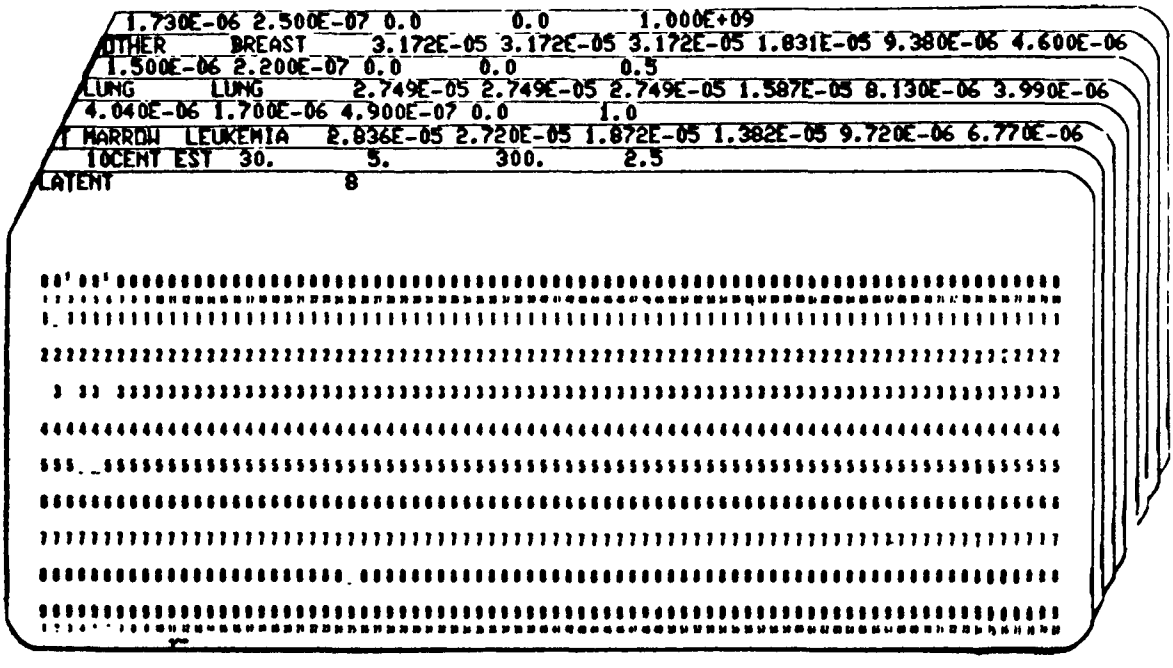
SUBGROUP ACUTE
PARAMETER NERL SET TO 7

* * * INPUT ACUTE HEALTH EFFECTS DATA * * *

ORGAN	DOSE BREAK-POINTS (RADS)				RESPECTIVE PROB. LIMITS		MORTALITY FACTOR
T MARROW	3.200E+02	4.000E+02	5.100E+02	6.150E+02	3.000E-02	5.000E-01	1.000E+00
LLI WALL	2.000E+03	5.000E+03	5.000E+03	5.000E+03	1.000E+00	1.000E+00	1.000E+00
LUNG	5.000E+03	1.400E+04	2.240E+04	2.480E+04	2.400E-01	7.300E-01	1.000E+00
W BODY	5.500E+01	1.500E+02	2.000E+02	3.700E+02	3.000E-01	8.000E-01	0.
LUNG	3.000E+03	3.000E+03	6.000E+03	6.000E+03	5.000E-02	1.000E+00	0.
LLI WALL	1.000E+03	1.000E+03	2.500E+03	2.500E+03	5.000E-02	1.000E+00	0.
THYROID	1.000E+10	1.000E+10	1.000E+10	1.000E+10	1.000E+00	1.000E+00	0.

11. Subgroup LATENT - specifies the latent effects due to both early and chronic exposures, the supporting manrem conversion factors, and the choice of latent effects model.

Sample input cards:



The NUM field, 8 in the sample header card above, specifies the number of latent effects from radiation exposure, NLA, to be studied. Up to 8 latent effects are permitted.

Following the header card, an options card is required with the format described below. The last four items of data on the card are required only when the Central Estimate option has been requested.

Column	Mnemonic	Format	Description
1-5	INTIME	I5	Number of time periods to be used for computing latent effects from radiation exposure, normally 10. If the latent/chronic calculation option switch in subgroup OPTIONS is set to 2, latent effects are computed for the acute time period only.
6-7	CENT	A2	Latent effects model switch. Blank - the linear hypothesis or BEIR method will be used for estimating latent health effects. CE - the "Central Estimate" method will be used for estimating latent health effects. The remaining data fields on this card apply only to the CE option.
16-25	THRESH(1)	E10.3	First threshold (rems) for Central Estimate.
26-35	FACT(1)	E10.3	Dose effectiveness factor applied to doses below THRESH(1) for Central Estimate.
36-45	THRESH(2)	E10.3	Second threshold (rems) for Central Estimate.
46-55	FACT(2)	E10.3	Dose effectivness factor applied to doses between THRESH(1) and THRESH(2) for Central Estimate.

Following the latent effects option card, two cards with the format described below must be input for each latent effect.

Card	Columns	Mnemonic	Format	Description
1	1-8	LAORG(I)	A8	Affected organ name. This name must be one of the 13 organs listed in Table II-3.
	11-18	LAEFF(I)	A8	Name of the latent effect, e.g., "CANCER," "LEUKEMIA," etc. This field is used to identify the latent effect.

Card	Columns	Mnemonic	Format	Description
	21-80	MRCON(I,K)	6E10.3	Manrem conversion factors for time periods 1 through 6. The manrem data from this card are read into the array MRCON as (MRCON (I,K), K=1,6).
2	1-40	MRCON(I,K)	4E10.3	The manrem conversion factors for time periods 7 through 10. The manrem data from this card are read into the array MRCON as (MRCON(I,K), K=7,10). The 10 time periods are < 1, 1-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80, and > 80 years. The program multiplies the number of manrem for organ I and time period K by MRCON (I,K) to get the number of latent effects for that organ and time period.* For time period K following the exposure, these conversion factors account for changes, with time, of the exposed population age distribution only.
	41-50	ORGFAC(I)	E10.3	Central Estimate organ compensation factor. Dose effectiveness factors are applied to the organ dose only if the organ compensation factor times the organ dose is less than the respective Central Estimate thresholds.

*The manrem conversion factors for cancers other than leukemia have been updated in CRAC2 to reflect a lifetime rather than a 30-year risk plateau. Except for leukemia, there is no evidence that the increased risk of cancer eventually declines after the 30-year risk plateau as was assumed for the WASH-1400 conversion factors that were used in CRAC.

No parameter modification is permitted for subgroup LATENT.

A representative listing of the LATENT subgroup sample input data is shown below.

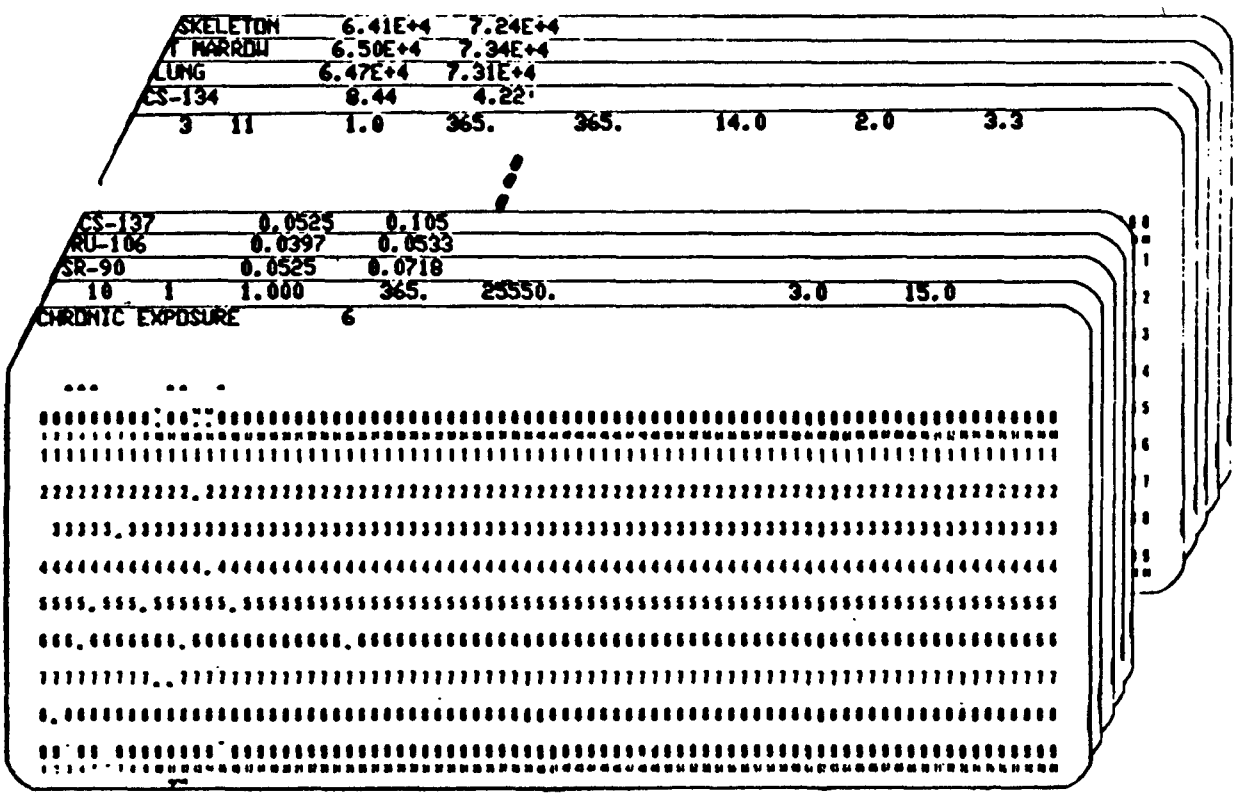
SUBGROUP LATENT
PARAMETER NLAT SET TO 8

• • • INPUT LATENT HEALTH EFFECTS DATA • • •

ORGAN	EFFECT	MAN-RAD CONVERSION TO LATENT EFFECT FOR PERIODS (YEARS) <1	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	>80	ORGFAC
• • • CENTRAL ESTIMATE • • •		3.000E+01	5.000E+00	3.000E+02	2.500E+00							
Y MARROW	LEUKEMIA	2.836E-05	2.720E-05	1.872E-05	1.382E-05	9.720E-06	6.770E-06	4.040E-06	1.700E-06	6.900E-07	0.	1.000E+00
LUNG	LUNG	2.749E-05	2.749E-05	2.749E-05	1.587E-05	8.130E-06	3.990E-06	1.500E-06	2.200E-07	0.	0.	5.000E-01
OTHER	BREAST	3.172E-05	3.172E-05	3.172E-05	1.831E-05	9.380E-06	4.600E-06	1.730E-06	2.500E-07	0.	0.	1.000E+09
SKELETON	BONE	1.107E-05	1.064E-05	6.990E-06	3.020E-06	1.670E-06	9.100E-07	4.200E-07	1.200E-07	1.000E-08	0.	1.000E+00
LLI WALL	GI TRK	1.688E-05	1.688E-05	1.688E-05	9.740E-06	4.990E-06	2.450E-06	9.200E-07	1.300E-07	0.	0.	1.000E+00
OTHER	OTHER	3.220E-05	3.050E-05	2.539E-05	1.446E-05	7.520E-06	3.690E-06	1.390E-06	2.000E-07	0.	0.	1.000E+00
W BODY	W BODY	1.579E-04	1.533E-04	1.274E-04	7.542E-05	4.141E-05	2.241E-05	1.000E-05	2.620E-06	5.000E-07	0.	1.000E+00
THYROID	THYROID	3.340E-06	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.000E+09

12. Subgroup CHRONIC - specifies the data used in computing radiation doses from chronic exposure and the protective action measures appropriate to the level of chronic exposure. This subgroup must be specified after the ISOTOPE, ACUTE, and LATENT subgroups.

Sample input cards:



The NUM field, 6 in the sample header card above, specifies the number of exposure groups, NEXP, to be considered when determining chronic dose levels.

Exactly six exposure groups must be defined. Each of the groups represents a specific chronic exposure mechanism These groups must appear in the order corresponding to:

1) Inhalation of resuspended radionuclides.

2) Ingestion of cesium via crops and milk contaminated by direct deposition on plants.

3) Ingestion of strontium via crops and milk contaminated by direct deposition on plants.

4) Ingestion of radioactive iodine via crops and milk contaminated by direct deposition on plants.

5) Ingestion of cesium and strontium via crops and milk contaminated by root uptake.

6) Exposure to groundshine from contaminated ground.

Following the header card, six sets of cards are required, one set for each group. In general, the data for the six exposure groups should be used as they appear in the reference case. The number of isotopes in each set and the values of the variables may be changed, but the general format including the number of sets and set ordering must not be altered. The format of the six sets is described below.

Card I for exposure group 1:

Columns	Mnemonic	Format	Description
1-5	NIE(I)	I5	Number of isotopes to be considered for the exposure group.
6-10	NCRIT(I)	I5	Organ index of the critical organ for this exposure group (see Table II-3).
11-20	PROFAC(I)	E10.3	Protection factor in the exposure mechanism, e.g., for external gamma radiation - shielding factor between 0.0 and 1.0 (1.0 means no shielding).
21-30	DAYS1(I)	E10.3	Integration time in days for computing the maximum allowable dose RDLIM(I,1).

Columns	Mnemonic	Format	Description
31-40	DAYS2(I)	E10.3	Integration time in days for computing the maximum allowable dose RDLIM(I,2).
41-50	TAGE(I)	E10.3	Weathering half-life in days for isotopes in this exposure group.
51-60	RDLIM(I,1)	E10.3	Radiation dose exposure limit in rem corresponding to DAYS1(I).*
61-70	RDLIM(I,2)	E10.3	Radiation dose exposure limit in rem corresponding to DAYS2(I).*

After card 1, enter NIE(I) sets of cards as described below. The index I represents the exposure group index. The index J represents the isotope index for exposure group I and takes the values 1 to NIE(I).

Card Type A:

Columns	Mnemonic	Format	Description
1-8	NUCLID(I,J)	A8	Isotope name (must be one of the isotopes entered in the ISOTOPE subgroup).
11-20	CF(I,J,1)	E10.3	Concentration factor for the time period from 0 to DAYS1(I) relating ground contamination level to total human intake of the isotope from crops (Ci/(Ci/m^2)).** Omit for exposure group 6.
21-30	CF(I,J,2)	E10.3	Concentration factor for the time period from 0 to DAYS2(I) relating ground contamination level to total human intake of the isotope from milk (Ci/(Ci/m^2)).** Omit for exposure group 6.

*For groups 2 through 5, RDLIM(I,1) is the radiation exposure limit for ingestion of contaminated crops and RDLIM(I,2) is the radiation exposure limit for ingestion of contaminated milk.

**For exposure group 1, this concentration factor is used to calculate the maximum permissible ground concentration for the group radionuclides.

For exposure groups 2-5 only, follow each card A with 13 cards, one for each organ in Table II-3 (the 13 cards must be in the order of the organs in Table II-3). Each card must have the following format:

Card Type B:

Columns	Mnemonic	Format	Description
1-8	--	A8	Organ name
11-70	CSING (group 2) or SRING (group 3) or RIING (group 4) or RTING (group 5)	6E10.3	Ingestion dose conversion factors for six time periods for the named organ and current isotope (rem/Ci). For exposure groups 2, 3, and 4, the first dose factor is used to determine the maximum acceptable ground contamination level. The remaining five dose factors correspond to the time periods of 0-10, 10-20, 20-30, 30-40, and 40-50 years following exposure. For exposure group 5, the six dose factors correspond to the time periods of 0-10, 10-20, 20-30, 30-40, 40-50, and >50 years and the dose factor for the time period 0-10 years is used to determine the maximum acceptable ground contamination level. The factors are stored in the arrays CSING, SRING, RIING, and RTING corresponding to cesium ingestion, strontium ingestion, radioactive iodine ingestion, and ingestion of radionuclides through root uptake. The data are read, for example, as (CSING (J,N,L), L=1,6) for cesium ingestion, where J is the isotope index, N is the organ index, and L is the time period index.

Repeat the set of cards consisting of one A card and thirteen B cards (omit the B cards for groups 1 and 6) for each isotope considered under the exposure group.

No parameter modification is permitted for subgroup CHRONIC.

A representative listing of the CHRONIC subgroup sample data is shown below.

SUBGROUP CHRONIC
PARAMETER NEXP SET TO 6

* * * INPUT CHRONIC EFFECTS DATA * * *

CO-58	1.830E+02	2.810E-01	5.900E+04	5.900E+04	2.000E+03	0.	0.	0.	0.	
CO-60	2.660E+02	5.670E-01	4.600E+05	4.600E+05	7.400E+05	0.	1.800E+05	0.	0.	
KR-85	2.300E-01	4.470E-04	1.800E-01	1.800E-01	0.	0.	0.	0.	0.	
KR-85M	9.220E+00	3.220E-02	2.100E-01	2.100E-01	0.	0.	0.	0.	0.	
KR-87	1.730E+01	1.720E-01	9.600E-01	9.600E-01	0.	0.	0.	0.	0.	
KR-88	1.110E+02	4.470E-01	2.000E+00	2.000E+00	0.	0.	0.	0.	0.	
RB-86	9.270E+00	1.940E-02	1.400E+04	1.400E+04	0.	0.	0.	0.	0.	
SR-89	0.	0.	7.800E+03	7.800E+03	0.	0.	0.	0.	0.	
SR-90	0.	0.	1.600E+04	1.600E+04	2.000E+03	0.	0.	0.	0.	
SR-91	8.250E+01	1.600E-01	4.300E+03	4.300E+03	0.	0.	0.	0.	0.	
Y-90	0.	0.	3.300E+04	3.300E+04	0.	0.	0.	0.	0.	
Y-91	2.810E-01	5.940E-04	2.000E+05	2.000E+05	0.	0.	0.	0.	0.	
ZR-95	7.720E+01	1.520E-01	1.300E+05	1.300E+05	0.	0.	0.	0.	0.	
ZR-97	1.310E+02	4.000E-02	1.500E+04	1.500E+04	0.	0.	0.	0.	0.	
NB-95	7.820E+01	1.560E-01	3.100E+04	3.100E+04	0.	0.	0.	0.	0.	
MO-99	2.180E+01	3.420E-02	1.600E+04	1.600E+04	0.	0.	0.	0.	0.	
TC-99M	8.120E+00	2.540E-02	8.900E+01	8.900E+01	0.	0.	0.	0.	0.	
RU-103	5.520E+01	1.050E-01	5.400E+04	5.400E+04	0.	0.	0.	0.	0.	
RU-105	4.850E+01	1.670E-01	2.200E+03	2.200E+03	0.	0.	0.	0.	0.	
RU-106	2.860E+01	4.060E-02	2.500E+06	2.500E+06	1.400E+06	0.	0.	0.	0.	
RH-105	7.530E+00	1.610E-02	3.600E+03	3.600E+03	0.	0.	0.	0.	0.	
SB-127	7.050E+01	1.430E-01	2.500E+04	2.500E+04	0.	0.	0.	0.	0.	
SB-129	6.990E+01	2.530E-01	3.200E+03	3.200E+03	0.	0.	0.	0.	0.	
TE-127	3.430E-01	8.780E-04	1.600E+03	1.600E+03	0.	0.	0.	0.	0.	
TE-127M	1.340E+00	5.610E-04	1.200E+05	1.200E+05	0.	0.	0.	0.	0.	
TE-129	1.810E+00	1.350E-02	5.600E+02	5.600E+02	0.	0.	0.	0.	0.	
TE-129M	1.020E+01	6.970E-03	1.500E+05	1.500E+05	0.	0.	0.	0.	0.	
TE-131M	1.390E+02	2.940E-01	1.100E+04	1.100E+04	0.	0.	0.	0.	0.	
TE-132	1.690E+02	4.190E-02	3.000E+04	3.000E+04	0.	0.	0.	0.	0.	
I-131	4.150E+01	8.220E-02	2.400E+03	2.400E+03	0.	0.	0.	0.	0.	
I-132	9.230E+01	4.830E-01	1.000E+03	1.000E+03	0.	0.	0.	0.	0.	
I-133	6.500E+01	1.460E-01	3.100E+03	3.100E+03	0.	0.	0.	0.	0.	
I-134	3.870E+01	5.000E-01	5.600E+02	5.600E+02	0.	0.	0.	0.	0.	
I-135	1.400E+02	4.000E-01	2.500E+03	2.500E+03	0.	0.	0.	0.	0.	
XE-133	5.750E+00	6.970E-03	4.100E-01	4.100E-01	0.	0.	0.	0.	0.	
XE-135	1.890E+01	5.060E-02	9.400E-01	9.400E-01	0.	0.	0.	0.	0.	
CS-134	1.660E+02	3.280E-01	4.500E+04	4.500E+04	6.800E+03	0.	0.	0.	0.	
CS-136	2.160E+02	4.440E-01	8.200E+03	8.200E+03	0.	0.	0.	0.	0.	
CS-137	5.840E+01	1.150E-01	3.400E+04	3.400E+04	6.800E+03	0.	0.	0.	0.	
BA-140	3.970E+01	4.140E-02	6.300E+03	6.300E+03	0.	0.	0.	0.	0.	
LA-140	2.330E+02	5.390E-01	1.600E+04	1.600E+04	0.	0.	0.	0.	0.	
CE-141	7.640E+00	1.500E-02	6.200E+04	6.200E+04	0.	0.	0.	0.	0.	
CE-143	3.140E+01	6.880E-02	1.300E+04	1.300E+04	0.	0.	0.	0.	0.	
CE-144	4.980E+00	3.440E-03	2.100E+06	2.100E+06	8.000E+05	0.	0.	0.	0.	
PR-143	0.	0.	4.900E+04	4.900E+04	0.	0.	0.	0.	0.	
ND-147	1.570E+01	2.780E-02	3.700E+04	3.700E+04	1.000E+03	0.	0.	0.	0.	
NP-239	1.870E+01	2.650E-02	9.200E+03	9.200E+03	1.000E+02	0.	0.	0.	0.	
PU-238	5.410E-02	9.580E-06	1.200E+08	1.200E+08	1.900E+08	0.	0.	0.	0.	
PU-239	2.960E-02	5.420E-06	1.200E+08	1.200E+08	1.700E+08	0.	0.	0.	0.	
PU-240	5.150E-02	9.170E-06	1.200E+08	1.200E+08	1.700E+08	1.000E+07	0.	0.	0.	
PU-241	3.530E-06	2.940E-10	6.400E+04	6.400E+04	4.660E+05	3.000E+04	1.000E+04	1.000E+04	1.000E+04	
AM-241	4.840E+00	3.220E-03	1.300E+08	1.300E+08	1.800E+08	0.	0.	0.	1.000E+07	
CM-242	4.370E-02	8.310E-06	7.600E+07	7.600E+07	1.100E+07	0.	0.	0.	0.	
CM-244	1.240E+00	1.070E-03	1.300E+08	1.300E+08	1.800E+08	0.	0.	0.	0.	

GROUP 1 10 ISOTOPES - CRIT.ORGAN - 1 - PROFAC 1.000 - DAYS1,2 365. 25550. AGING 0. ROLIM(1,2) .300E+01 .150E+02

ISO	I	NAME	TEFF	SDEE(1,2)		CF(1,2)		
1	9	SR-90	0.	.3175E-02	.1161E-01	.5250E-01	.7180E-01	
	1	1	1.800E+04	0.	0.	0.	0.	0.
	2	2	5.300E+05	1.300E+05	3.000E+04	3.000E+04	1.000E+04	0.
	3	3	1.600E+06	6.000E+05	2.000E+05	3.000E+05	1.000E+05	0.
	4	8	1.430E+04	0.	0.	0.	0.	0.
	5	9	8.800E+03	2.000E+02	0.	0.	0.	0.
	6	10	8.800E+03	2.000E+02	0.	0.	0.	0.
	7	11	1.400E+05	5.000E+04	2.000E+04	2.000E+04	1.000E+04	0.
2	28	RU-106	0.	.1938E-04	.7216E-04	.3970E-01	.5330E-01	
	1	1	3.900E+06	0.	0.	0.	0.	0.
	2	2	6.200E+03	0.	0.	0.	0.	0.
	3	3	5.900E+03	0.	0.	0.	0.	0.
	4	8	1.036E+05	0.	0.	0.	0.	0.
	5	9	6.300E+03	0.	0.	0.	0.	0.
	6	10	6.500E+03	0.	0.	0.	0.	0.
	7	11	6.200E+04	0.	0.	0.	0.	0.
3	39	CS-137	0.	.1429E-02	.3571E-02	.5250E-01	.1050E+00	
	1	1	4.800E+04	0.	0.	0.	0.	0.
	2	2	3.700E+04	0.	0.	0.	0.	0.
	3	3	3.600E+04	0.	0.	0.	0.	0.
	4	8	2.010E+04	0.	0.	0.	0.	0.
	5	9	3.600E+04	0.	0.	0.	0.	0.
	6	10	3.600E+04	0.	0.	0.	0.	0.
	7	11	3.600E+04	0.	0.	0.	0.	0.
4	48	PU-238	0.	.1829E-06	.4522E-06	.5298E-01	.1070E+00	
	1	1	3.100E+00	0.	0.	0.	0.	0.
	2	2	2.300E+05	3.400E+05	3.000E+05	2.300E+05	2.000E+05	0.
	3	3	1.304E+08	1.900E+08	1.700E+08	1.400E+08	1.300E+08	0.
	4	8	2.900E+04	3.400E+04	3.000E+04	2.700E+04	2.000E+04	0.
	5	9	2.299E+05	3.400E+05	2.900E+05	2.400E+05	2.000E+05	0.
	6	10	4.800E+06	4.100E+06	3.100E+06	3.000E+06	2.000E+06	0.
	7	11	1.000E+07	1.700E+07	1.500E+07	1.200E+07	1.100E+07	0.
5	49	PU-239	0.	.1952E-06	.4709E-06	.5300E-01	.1080E+00	
	1	1	2.900E+00	0.	0.	0.	0.	0.
	2	2	2.296E+05	3.500E+05	3.400E+05	2.800E+05	3.000E+05	0.
	3	3	1.301E+08	2.000E+08	1.900E+08	1.800E+08	1.700E+08	0.
	4	8	2.800E+04	3.500E+04	3.400E+04	3.300E+04	3.000E+04	0.
	5	9	2.296E+05	3.500E+05	3.400E+05	2.800E+05	3.000E+05	0.
	6	10	4.700E+06	4.300E+06	4.000E+06	3.800E+06	3.000E+06	0.
	7	11	1.700E+07	1.800E+07	1.700E+07	1.600E+07	1.400E+07	0.
6	50	PU-240	0.	.1952E-06	.4709E-06	.5300E-01	.1080E+00	
	1	1	2.900E+00	1.000E+07	0.	0.	0.	0.
	2	2	2.296E+05	3.500E+05	3.500E+05	2.700E+05	3.000E+05	0.
	3	3	1.302E+08	2.000E+08	1.900E+08	1.800E+08	1.700E+08	0.
	4	8	2.900E+04	3.500E+04	3.400E+04	3.200E+04	3.000E+04	0.
	5	9	2.296E+05	3.500E+05	3.400E+05	2.800E+05	3.000E+05	0.
	6	10	4.700E+06	4.400E+06	3.900E+06	3.000E+06	3.000E+06	0.
	7	11	1.800E+07	1.800E+07	1.600E+07	1.600E+07	1.500E+07	0.
7	51	PU-241	0.	.1889E-03	.2882E-03	.5288E-01	.1818E+00	
	1	1	5.300E+05	3.800E+04	1.000E+04	1.000E+04	1.000E+04	0.
	2	2	1.796E+03	5.700E+03	7.500E+03	8.000E+03	9.000E+03	0.
	3	3	9.797E+05	3.120E+06	4.200E+06	4.700E+06	4.000E+06	0.
	4	8	0.	0.	0.	0.	0.	0.
	5	9	1.695E+03	5.700E+03	7.600E+03	8.000E+03	8.000E+03	0.
	6	10	3.096E+04	6.300E+04	7.600E+04	7.000E+04	6.000E+04	0.
	7	11	1.000E+05	2.000E+05	3.700E+05	3.500E+05	4.000E+05	0.
8	52	AM-241	0.	.1826E-06	.4480E-06	.5300E-01	.1080E+00	
	1	1	3.100E+00	0.	0.	0.	1.000E+07	0.
	2	2	2.502E+05	3.000E+05	3.600E+05	3.100E+05	3.000E+05	0.
	3	3	1.396E+08	2.100E+08	2.000E+08	1.800E+08	1.700E+08	0.
	4	8	3.100E+04	3.700E+04	3.200E+04	4.000E+04	3.000E+04	0.
	5	9	2.495E+05	3.700E+05	3.500E+05	3.300E+05	3.000E+05	0.
	6	10	5.000E+06	4.600E+06	3.400E+06	4.000E+06	2.000E+06	0.
	7	11	1.900E+07	1.900E+07	1.700E+07	1.600E+07	1.500E+07	0.

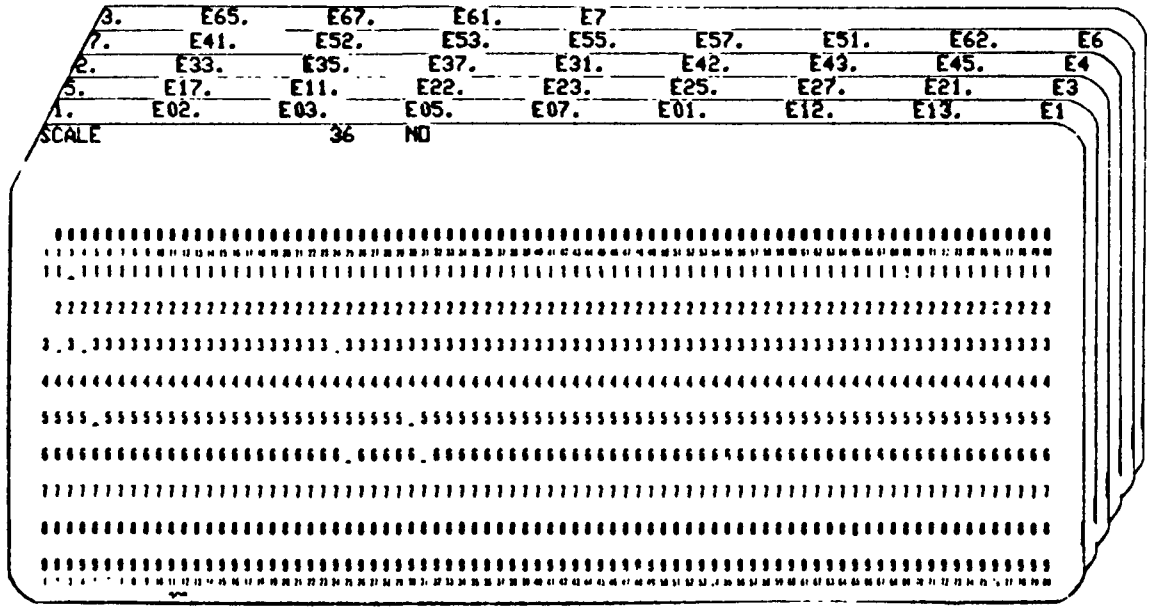
```
   9 53  CM-242       0.            .1181E-05     .5273E-05     .2920E-01     .3270E-01
      1    1 8.700E+07 0.         0.         0.         0.         0.
      2    2 6.100E+03 1.200E+03 1.200E+03 1.000E+03 5.000E+02 0.
      3    3 3.400E+06 7.800E+05 7.000E+05 6.000E+05 4.000E+05 0.
      4    8 6.400E+03 2.000E+02 1.000E+02 1.000E+02 1.000E+02 0.
      5    9 6.000E+03 1.300E+03 1.200E+03 1.000E+03 5.000E+02 0.
      6   10 1.700E+05 2.000E+04 1.800E+04 1.000E+04 1.000E+04 0.
      7   11 1.600E+06 1.000E+05 1.000E+05 0.        1.000E+05 0.
  10 54  CM-244       0.            .1054E-06     .4744E-06     .5220E-01     .1020E+00
      1    1 3.100E+08 0.         0.         0.         0.         0.
      2    2 2.096E+05 2.200E+05 1.500E+05 1.000E+05 6.000E+04 0.
      3    3 1.197E+08 1.300E+08 8.000E+07 5.000E+07 4.000E+07 0.
      4    8 2.700E+04 2.300E+04 1.500E+04 9.000E+03 6.000E+03 0.
      5    9 2.096E+05 2.200E+05 1.500E+05 1.000E+05 6.000E+04 0.
      6   10 4.400E+06 2.800E+06 1.600E+06 9.000E+05 3.000E+05 0.
      7   11 1.700E+07 1.100E+07 6.000E+06 4.000E+06 3.000E+06 0.

GROUP  2   3 ISOTOPES - CRIT.ORGAN -11 - PROFAC 1.000 - DAYS1,2   365.   365.  AGING   .140E+02 ROLIM(1,2)    .280E+01   .330E+01

 ISO I NAME  -   TEFF          -  SDEE(1,2)          -  CF(1,2)
  1 37  CS-134      .1374E+02     .3749E-05     .1237E-04     .8440E+01     .4220E+01
      1    1 6.470E+04 7.310E+04 0.         0.         0.         0.
      2    2 6.500E+04 7.340E+04 0.         0.         0.         0.
      3    3 6.410E+04 7.240E+04 0.         0.         0.         0.
      4    8 8.280E+04 9.330E+04 0.         0.         0.         0.
      5    9 6.490E+04 7.330E+04 0.         0.         0.         0.
      6   10 6.270E+04 7.080E+04 0.         0.         0.         0.
      7   11 6.320E+04 7.140E+04 0.         0.         0.         0.
  2 38  CS-136      .6741E+01     .7868E-04     .2594E-03     .2840E+01     .1420E+01
      1    1 8.828E+03 8.820E+03 0.         0.         0.         0.
      2    2 9.290E+03 9.290E+03 0.         0.         0.         0.
      3    3 9.100E+03 9.100E+03 0.         0.         0.         0.
      4    8 1.350E+04 1.350E+04 0.         0.         0.         0.
      5    9 9.230E+03 9.230E+03 0.         0.         0.         0.
      6   10 8.880E+03 8.880E+03 0.         0.         0.         0.
      7   11 8.960E+03 8.960E+03 0.         0.         0.         0.
  3 39  CS-137      .1398E+02     .5129E-05     .1693E-04     .8440E+01     .4220E+01
      1    1 4.710E+04 5.590E+04 0.         0.         0.         0.
      2    2 4.730E+04 5.610E+04 0.         0.         0.         0.
      3    3 4.680E+04 5.560E+04 0.         0.         0.         0.
      4    8 5.640E+04 6.640E+04 0.         0.         0.         0.
      5    9 4.680E+04 5.550E+04 0.         0.         0.         0.
      6   10 4.600E+04 5.450E+04 0.         0.         0.         0.
      7   11 4.620E+04 5.490E+04 0.         0.         0.         0.

GROUP  3   2 ISOTOPES - CRIT.ORGAN - 2 - PROFAC 1.000 - DAYS1,2   365.   365.  AGING   .140E+02 ROLIM(1,2)    .200E+01   .330E+01

 ISO I NAME  -   TEFF          -  SDEE(1,2)          -  CF(1,2)
  1  8  SR-89       .1103E+02     .1916E-03     .3121E-03     .3970E+00     .4020E+00
      1    1 2.910E+03 5.810E+02 0.         0.         0.         0.
      2    2 2.630E+04 5.260E+03 0.         0.         0.         0.
      3    3 5.950E+04 1.190E+04 0.         0.         0.         0.
      4    8 4.270E+05 8.530E+04 0.         0.         0.         0.
      5    9 2.910E+03 5.810E+02 0.         0.         0.         0.
      6   10 2.910E+03 5.810E+02 0.         0.         0.         0.
      7   11 9.550E+03 1.910E+03 0.         0.         0.         0.
  2  9  SR-90       .1398E+02     .3808E-05     .5396E-05     .5050E+00     .5080E+00
      1    1 1.590E+04 3.180E+03 5.500E+02 1.800E+01 0.         0.
      2    2 1.040E+06 2.080E+05 5.250E+04 1.290E+04 1.000E+04 3.100E+03
      3    3 3.080E+06 6.150E+05 2.570E+05 9.810E+04 1.090E+05 4.300E+04
      4    8 4.060E+05 8.120E+04 5.000E+01 0.         0.         0.
      5    9 1.590E+04 3.180E+03 5.500E+01 1.800E+01 0.         0.
      6   10 1.590E+04 3.180E+03 5.500E+01 1.300E+01 0.         0.
      7   11 2.760E+05 5.520E+04 2.030E+04 7.440E+03 8.080E+03 3.130E+03
```

```
 GROUP  4   2 ISOTOPES - CRIT.ORGAN - 9 - PROFAC 1.000 - DAYS1,2     0.   365.  AGING  .140E+02 RDLIM(1,2)   0.          .100E+02

  ISO I NAME  -   TEFF            -  SDEE(1,2)                -  CF(1,2)
   1 32  I-133        .8162E+00     0.            .1189E-02      .1000E-07      .4060E-02
         1    1 8.530E+02 1.580E+02 0.          0.          0.          0.
         2    2 7.990E+02 1.480E+02 0.          0.          0.          0.
         3    3 7.880E+02 1.460E+02 0.          0.          0.          0.
         4    8 9.870E+03 1.820E+03 0.          0.          0.          0.
         5    9 1.730E+06 3.210E+05 0.          0.          0.          0.
         6   10 9.070E+02 1.680E+02 0.          0.          0.          0.
         7   11 1.460E+03 2.700E+02 0.          0.          0.          0.
   2 38  I-131        .5187E+01     0.            .1593E-05      .1000E-07      .6920E+00
         1    1 1.920E+03 3.560E+02 0.          0.          0.          0.
         2    2 1.550E+03 2.870E+02 0.          0.          0.          0.
         3    3 1.670E+03 3.100E+02 0.          0.          0.          0.
         4    8 1.830E+04 1.910E+03 0.          0.          0.          0.
         5    9 9.870E+06 1.680E+06 0.          0.          0.          0.
         6   10 2.200E+03 4.070E+02 0.          0.          0.          0.
         7   11 4.750E+03 8.790E+02 0.          0.          0.          0.

 GROUP  5   4 ISOTOPES - CRIT.ORGAN - 2 - PROFAC 1.000 - DAYS1,2  3650.  3650.  AGING  .240E+04 RDLIM(1,2)   .500E+01   .500E+01

  ISO I NAME  -   TEFF            -  SDEE(1,2)                -  CF(1,2)
   1 37  CS-134       .5720E+03     .4154E-03     .1245E-02      .1640E+00      .5470E-01
         1    1 7.310E+04 0.        0.          0.          0.          0.
         2    2 7.340E+04 0.        0.          0.          0.          0.
         3    3 7.240E+04 0.        0.          0.          0.          0.
         4    8 9.330E+04 0.        0.          0.          0.          0.
         5    9 7.330E+04 0.        0.          0.          0.          0.
         6   10 7.080E+04 0.        0.          0.          0.          0.
         7   11 7.140E+04 0.        0.          0.          0.          0.
   2 39  CS-137       .1970E+04     .3565E-03     .1067E-02      .2500E+00      .8350E-01
         1    1 5.590E+04 0.        0.          0.          0.          0.
         2    2 5.610E+04 0.        0.          0.          0.          0.
         3    3 5.560E+04 0.        0.          0.          0.          0.
         4    8 6.640E+04 0.        0.          0.          0.          0.
         5    9 5.550E+04 0.        0.          0.          0.          0.
         6   10 5.450E+04 0.        0.          0.          0.          0.
         7   11 5.490E+04 0.        0.          0.          0.          0.
   3  8  SR-89        .5090E+02     .6989E-01     .1398E+00      .1360E-01      .6800E-02
         1    1 5.810E+02 0.        0.          0.          0.          0.
         2    2 5.260E+03 0.        0.          0.          0.          0.
         3    3 1.190E+04 0.        0.          0.          0.          0.
         4    8 8.530E+04 0.        0.          0.          0.          0.
         5    9 5.810E+02 0.        0.          0.          0.          0.
         6   10 5.810E+02 0.        0.          0.          0.          0.
         7   11 1.910E+03 0.        0.          0.          0.          0.
   4  9  SR-90        .1945E+04     .1794E-04     .3593E-04      .1340E+01      .6690E+00
         1    1 3.180E+03 5.500E+02 1.000E+01 0.          0.          0.
         2    2 2.080E+05 5.250E+04 1.290E+04 1.000E+04 3.180E+03 3.183E+03
         3    3 6.150E+05 2.570E+05 9.810E+04 1.090E+05 4.380E+04 4.380E+04
         4    8 8.120E+04 5.000E+01 0.          0.          0.          0.
         5    9 3.180E+03 5.500E+01 1.000E+01 0.          0.          0.
         6   10 3.180E+03 5.500E+01 1.300E+01 0.          0.          0.
         7   11 5.520E+04 2.030E+04 7.440E+03 8.000E+03 3.130E+03 3.130E+03

 GROUP  6  18 ISOTOPES - CRIT.ORGAN -11 - PROFAC  .333 - DAYS1,2   365. 10950.  AGING   .329E+04 RDLIM(1,2)   .500E+01   .250E+02

  ISO I NAME  -   TEFF            -  SDEE(1,2)                -  CF(1,2)
   1  1  CO-58        .6979E+02     .5336E-03     .2621E-02
         1    1 1.130E+05          2    2 1.350E+05          3    3 1.350E+05          4    8 7.970E+04
         5    9 9.640E+04          6   10 1.540E+05          7   11 1.200E+05
```

2	2	CO-60		.1212E+04		.6955E-04		.7847E-04															
		1	1	2.920E+05		2	2	3.250E+05		3	3	3.290E+05		4	8	2.370E+05							
		5	9	2.730E+05		6	10	3.630E+05		7	11	3.070E+05											
3	15	NB-95		.3473E+02		.1287E-02		.6434E-02															
		1	1	8.590E+04		2	2	1.810E+05		3	3	1.810E+05		4	8	5.920E+04							
		5	9	6.830E+04		6	10	1.190E+05		7	11	9.200E+04											
4	13	ZR-95		.6422E+02		.7603E-03		.3753E-02															
		1	1	8.440E+04		2	2	1.830E+05		3	3	1.840E+05		4	8	6.110E+04							
		5	9	7.880E+04		6	10	1.130E+05		7	11	9.020E+04											
5	10	RU-103		.3912E+02		.1646E-02		.8228E-02															
		1	1	6.850E+04		2	2	7.830E+04		3	3	7.810E+04		4	8	4.630E+04							
		5	9	6.710E+04		6	10	7.810E+04		7	11	6.450E+04											
6	28	RU-106		.3317E+03		.1127E-02		.3566E-02															
		1	1	2.250E+04		2	2	2.910E+04		3	3	2.900E+04		4	8	1.720E+04							
		5	9	2.480E+04		6	10	2.920E+04		7	11	2.390E+04											
7	30	I-131		.8020E+01		.9839E-02		.4919E-01															
		1	1	4.610E+04		2	2	6.860E+04		3	3	6.830E+04		4	8	3.490E+04							
		5	9	5.150E+04		6	10	5.970E+04		7	11	4.910E+04											
8	37	CS-134		.6122E+03		.1209E-03		.2503E-03															
		1	1	1.810E+05		2	2	2.230E+05		3	3	2.230E+05		4	8	1.330E+05							
		5	9	1.730E+05		6	10	2.420E+05		7	11	1.930E+05											
9	38	CS-136		.1295E+02		.1170E-02		.5090E-02															
		1	1	2.340E+05		2	2	2.930E+05		3	3	2.930E+05		4	8	1.690E+05							
		5	9	2.050E+05		6	10	3.220E+05		7	11	2.570E+05											
10	39	CS-137		.2529E+04		.2978E-03		.1486E-03															
		1	1	6.450E+04		2	2	8.340E+04		3	3	8.370E+04		4	8	4.920E+04							
		5	9	7.170E+04		6	10	8.390E+04		7	11	6.830E+04											

13. Subgroup SCALE - specifies the consequence magnitude value scale for tabulating the complementary cumulative distributions of the output results.

Sample input cards:



The NUM field, 36 in the sample header above, specifies the number of output result magnitudes, NCT, to be used. Up to 40 values are allowed. The values are input according to the following format:

Column	Mnemonic	Format	Description
1-80	AMAG(I)	8E10.3	Consequence magnitude values. The values are stored in the array AMAG as (AMAG(I), I=1, NCT). Each card contains eight values. Use as many cards as required.

The consequence magnitude values can be scaled, if desired, in the RESULTS subgroup.

If parameter modification (PARMOD = "YES") is specified, the following card is required after the header card.

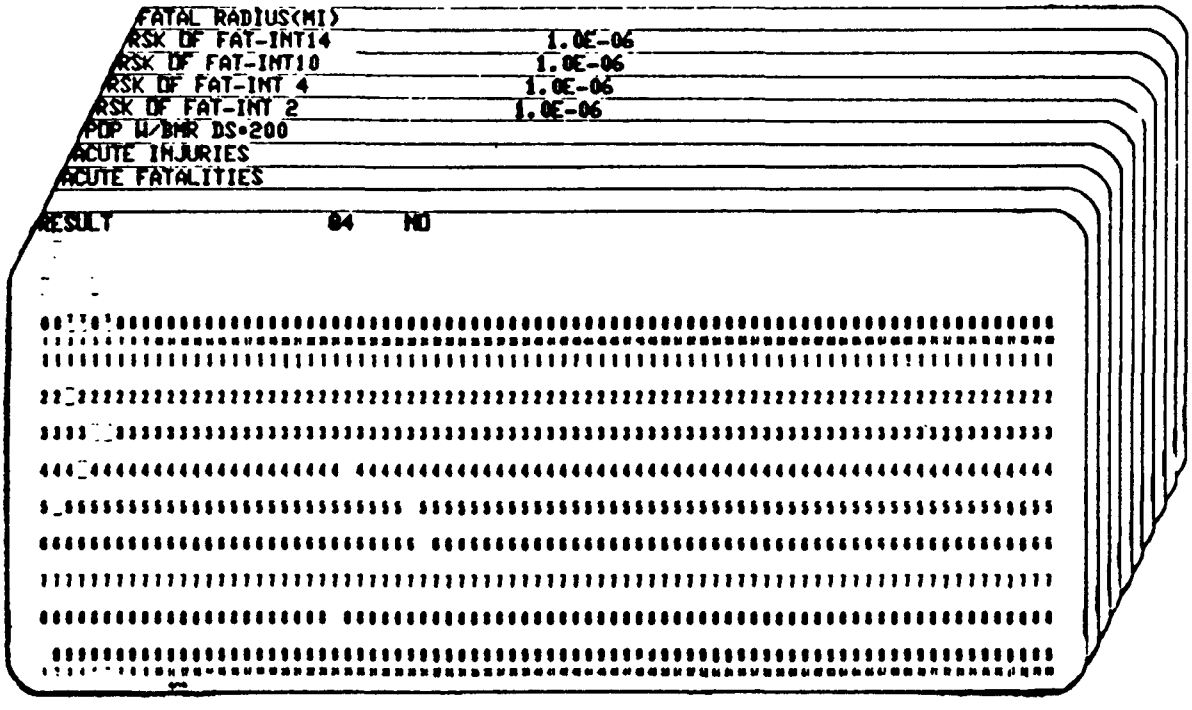
Column	Mnemonic	Format	Description
1-10	CAMAG	E10.3	Multiplier for the NCT consequence magnitude values in the array AMAG.

A representative listing of the SCALE subgroup sample input data is shown below.

```
SUBGROUP SCALE
PARAMETER NCT  SET TO   36

* * * INPUT SCALE FOR PLOTTING THE COMPLEMENTARY CUMULATIVE DISTRIBUTIONS OF THE CONSEQUENC

 NUMBER    MAGNITUDE

      1     1.00E+00
      2     2.00E+00
      3     3.00E+00
      4     5.00E+00
      5     7.00E+00
      6     1.00E+01
      7     2.00E+01
      8     3.00E+01
      9     5.00E+01
     10     7.00E+01
     11     1.00E+02
     12     2.00E+02
     13     3.00E+02
     14     5.00E+02
     15     7.00E+02
     16     1.00E+03
     17     2.00E+03
     18     3.00E+03
     19     5.00E+03
     20     7.00E+03
     21     1.00E+04
     22     2.00E+04
     23     3.00E+04
     24     5.00E+04
     25     7.00E+04
     26     1.00E+05
     27     2.00E+05
     28     3.00E+05
     29     5.00E+05
     30     7.00E+05
     31     1.00E+06
     32     2.00E+06
     33     3.00E+06
     34     5.00E+06
     35     7.00E+06
     36     1.00E+07
```

14. Subgroup RESULTS - specifies the output results for which the mean, variance, non-zero probability, peak value (maximum value of the trial results), peak value probability, peak value identification information, and complementary cumulative distributions are to be computed and printed.

Sample input cards:



The NUM field, 84 in the sample header above, ordinarily indicates the number of final results or consequences, NRES, to be included in the output when NROPT has the value 0. A maximum of 84 final results are allowed with this option. The NUM field is ignored for all other options defined by NROPT.

One options card having the following format must be input after the header card.

Column	Mnemonic	Format	Description
1-5	NROPT	I5	Final results option. For each option, distance is reported in miles and area in square miles. 0 - The number of final results to be computed and printed is given by NRES. The names of the final results must be supplied on subsequent cards as described below. 1 - Print acute fatalities vs. distance from the reactor and number of people vs. dose to the organ named in ORGNAM.* No additional cards are required. 2 - Print latent effects vs. distance from the reactor.* No additional cards are necessary. 3 - Print radioactive cloud area vs. distance from the reactor. No additional cards are necessary. 4 - Print decontamination factor vs. distance from the reactor and the size of the four interdiction areas. No additional cards are necessary. 5 - Print dose vs. distance from the reactor to the organ named in ORGNAM.* No additional cards are necessary.
6-13	ORGNAM	A8	Organ name for people vs. dose and dose vs. distance options. Used only when NROPT=1 or 5. The allowable organ names are listed

*The results for Options 1, 2, and 5 are for the last evacuation strategy.

Column	Mnemonic	Format	Description
			in Table II-3. The name must be left justified and spelled exactly as in the table. For NROPT=1, the default value is W BODY; for NROPT=5, the default value is T MARROW. If ORGNAM is specifically defined, the succeeding values on this card must also be specified.
16-20	IORGTM	I5	Index of the latest time period over which the dose to the organ named in ORGNAM is to be summed; where 1=acute time period, 2=1 yr, 3=1-10 yrs, 4=10-20 yrs, 5=20-30 yrs, 6=30-40 yrs, 7=40-50 yrs, 8=50-60 yrs, 9=60-70 yrs, 10=70-80 yrs, 11=>80 yrs. Used only when NROPT=1 or 5. For NROPT=1, the default value is 1, for NROPT=5, the default value is 11.
21-25	NSCALE	I5	Number of dose values in DSCALE ($\leq$9). Used only when NROPT=1. Default value = 8.
26-75	DSCALE	10F5.0	Up to 9 dose values in increasing order. When NROPT=1, the number of people receiving a dose to the organ named in ORGNAM in the ranges defined by the values in array DSCALE are reported in the final results. Default values are 0, 1, 10, 25, 100, 320, 400, and 615 rem.
76-80	SCALE	F5.0	Scaling multiplier for the consequence magnitude values (see subgroup SCALE). A blank or zero value is set to 1.0.

The additional data required for the case when NROPT = 0 must immediately follow this card.

Additional Card Input Required for NROPT = 0

When NROPT = 0, NRES defines the number of final results to be computed and printed. In this case, NRES cards with the

following format must be input. The index of the final result names is represented by K.

Column	Mnemonic	Format	Description
1-16	RESNAM(I,K), I=1,2	2A8	One of the 84 allowable 16 character final result names listed in Table II-4. Result names of the form "TOTAL latent effect" and "INITIAL latent effect" are valid only if the latent effect name is one of those input in subgroup LATENT. The names must be spelled exactly as in the subgroup.
21-30	RESFAC(K)	E10.3	Factor by which the named final result is to be multiplied. A blank or zero value is set to 1.0.
31-40	RSCALE(K)	E10.3	Scaling multiplier for the consequence magnitude values (see subgroup SCALE) for the named final result. A blank or zero value is set to 1.0.

No parameter modification is permitted for this subgroup.

A representative listing of the RESULTS subgroup sample input data is shown below.

```
SUBGROUP RESULTS
PARAMETER NMES SET TO   84

                    • • • INPUT NAMES OF FINAL RESULTS TO BE PRINTED • • •

NUMBER      NAME                FACTOR     SCALE

   1    ACUTE FATALITIES      1.000E+00 1.000E+00
   2    ACUTE INJURIES        1.000E+00 1.000E+00
   3    POP W/BMR DS>200      1.000E+00 1.000E+00
   4    RSK OF FAT-INT 2      1.000E+00 1.000E-06
   5    RSK OF FAT-INT 4      1.000E+00 1.000E-06
   6    RSK OF FAT-INT10      1.000E+00 1.000E-06
   7    RSK OF FAT-INT14      1.000E+00 1.000E-06
   8    FATAL RADIUS(MI)      1.000E+00 1.000E+00
   9    RSK OF INJ-INT 2      1.000E+00 1.000E-06
  10    RSK OF INJ-INT14      1.000E+00 1.000E-06
  11    RSK OF INJ-INT18      1.000E+00 1.000E-06
  12    RSK OF INJ-INT20      1.000E+00 1.000E-06
  13    RSK OF INJ-INT24      1.000E+00 1.000E-06
  14    INJUR RADIUS(MI)      1.000E+00 1.000E+00
  15    ACU BMR DS-INT 2      1.000E+00 1.000E-02
  16    ACU BMR DS-INT10      1.000E+00 1.000E-02
  17    ACU BMR DS-INT14      1.000E+00 1.000E-02
  18    ACU BMR DS-INT18      1.000E+00 1.000E-02
  19    ACU BMR DS-INT20      1.000E+00 1.000E-02
  20    ACU BMR DS-INT24      1.000E+00 1.000E-02
```

21	ACU THY DS-INT 2	1.000E+00	1.000E-02
22	ACU THY DS-INT10	1.000E+00	1.000E-02
23	ACU THY DS-INT14	1.000E+00	1.000E-02
24	ACU THY DS-INT18	1.000E+00	1.000E-02
25	ACU THY DS-INT20	1.000E+00	1.000E-02
26	ACU THY DS-INT24	1.000E+00	1.000E-02
27	ACU THY DS-INT30	1.000E+00	1.000E-02
28	TOT LAT/INITIAL	1.000E+00	1.000E+00
29	TOT LAT/TOTAL	1.000E+00	1.000E+00
30	TOT WBODY MAMREM	1.000E+00	1.000E+02
31	CANCER RSK-INT 2	1.000E+00	1.000E-06
32	CANCER RSK-INT14	1.000E+00	1.000E-06
33	CANCER RSK-INT18	1.000E+00	1.000E-06
34	CANCER RSK-INT20	1.000E+00	1.000E-06
35	CANCER RSK-INT24	1.000E+00	1.000E-06
36	CANCER RSK-INT30	1.000E+00	1.000E-06
37	INITIAL LEUKEMIA	1.000E+00	1.000E+00
38	INITIAL LUNG	1.000E+00	1.000E+00
39	INITIAL BREAST	1.000E+00	1.000E+00
40	INITIAL BONE	1.000E+00	1.000E+00
41	INITIAL GI TRK	1.000E+00	1.000E+00
42	INITIAL THYROID	1.000E+00	1.000E+00
43	INITIAL OTHER	1.000E+00	1.000E+00
44	INITIAL W BODY	1.000E+00	1.000E+00
45	TOTAL LEUKEMIA	1.000E+00	1.000E+00
46	TOTAL LUNG	1.000E+00	1.000E+00
47	TOTAL BREAST	1.000E+00	1.000E+00
48	TOTAL BONE	1.000E+00	1.000E+00
49	TOTAL GI TRK	1.000E+00	1.000E+00
50	TOTAL THYROID	1.000E+00	1.000E+00
51	TOTAL OTHER	1.000E+00	1.000E+00
52	TOTAL W BODY	1.000E+00	1.000E+00
53	INTERD POP	1.000E+00	1.000E+00
54	INTERD COST	1.000E+00	1.000E+06
55	INTERD AREA	1.000E+00	1.000E+00
56	INTERD DIST	1.000E+00	1.000E+00
57	INTERD RSK-INT14	1.000E+00	1.000E-06
58	INTERD RSK-INT20	1.000E+00	1.000E-06
59	INTERD RSK-INT24	1.000E+00	1.000E-06
60	DECON POP	1.000E+00	1.000E+00
61	DECON COST	1.000E+00	1.000E+06
62	DECON AREA	1.000E+00	1.000E+00
63	DECON DIST	1.000E+00	1.000E+00
64	DECON RISK-INT14	1.000E+00	1.000E-06
65	DECON RISK-INT24	1.000E+00	1.000E-06
66	DECON RISK-INT30	1.000E+00	1.000E-06
67	INT CROP COST	1.000E+00	1.000E+06
68	INT CROP AREA	1.000E+00	1.000E+00
69	INT CROP DIST	1.000E+00	1.000E+00
70	INT CRPRSK-INT14	1.000E+00	1.000E-06
71	INT CRPRSK-INT24	1.000E+00	1.000E-06
72	INT CRPRSK-INT30	1.000E+00	1.000E-06
73	INT CRPRSK-INT32	1.000E+00	1.000E-06
74	INT MILK COST	1.000E+00	1.000E+06
75	INT MILK AREA	1.000E+00	1.000E+00
76	INT MILK DIST	1.000E+00	1.000E+00
77	INT MLKRSK-INT14	1.000E+00	1.000E-06
78	INT MLKRSK-INT24	1.000E+00	1.000E-06
79	INT MLKRSK-INT30	1.000E+00	1.000E-06
80	INT MLKRSK-INT32	1.000E+00	1.000E-06
81	RELOCATION COST	1.000E+00	1.000E+06
82	EVACUATION COST	1.000E+00	1.000E+06
83	TOT COST W/O DEC	1.000E+00	1.000E+06
84	TOT COST W/DECON	1.000E+00	1.000E+06

Table II-4
List of Result Names

Result Name	Result Description
ACUTE FATALITIES	Number of acute fatalities occurring within one year due to initial exposure to the radioactive cloud, i.e., mortalities occurring due to damage to the organs input in subgroup ACUTE.
ACUTE INJURIES	Number of acute injuries or illnesses occurring within one year due to initial exposure to the radioactive cloud, i.e., morbidities occurring due to damage to the organs input in subgroup ACUTE.
POP W/BMR DS>200	Number of people with an acute bone marrow dose greater than 200 rems. Includes people counted as acute fatalities.
RSK OF FAT-INT 2 -INT 4 -INT10 -INT14	Risk of incurring a fatality within one year due to initial exposure to the radioactive cloud at the midpoint of the interval specified.
FATAL RADIUS(MI)	Greatest distance (miles) from the reactor at which acute fatalities occur.
RSK OF INJ-INT 2 -INT14 -INT18 -INT20 -INT24	Risk of incurring an injury or illness within one year due to initial exposure to the radioactive cloud at the midpoint of the interval specified.
INJUR RADIUS(MI)	Greatest distance (miles) from the reactor at which acute injuries occur.
ACU BMR DS-INT 2 -INT10 -INT14 -INT18 -INT20 -INT24	Acute bone marrow dose (rems) due to initial exposure to the radioactive cloud at the midpoint of the interval specified.
ACU THY DS-INT 2 -INT10 -INT14 -INT18 -INT20 -INT24 -INT30	Acute thyroid dose (rems) due to initial exposure to the radioactive cloud at the midpoint of the interval specified.

Table II-4 (Cont'd)

Result Name	Result Description
TOT LAT/INITIAL	Total latent effects occurring due to initial exposure to the radioactive cloud, i.e., sum of the effects from all organs input in subgroup LATENT except for thyroid and whole body.
TOT LAT/TOTAL	Total latent effects occurring due to both initial and chronic exposure, i.e., sum of the effects from all organs input in subgroup LATENT except for thyroid and whole body.
TOT WBODY MANREM	Whole body population dose, i.e., sum of (number of people exposed) times (whole body dose received) at each dose level. The number of people exposed does not include people counted as acute fatalities.
CANCER RSK-INT 2 -INT14 -INT18 -INT20 -INT24 -INT30	Risk of incurring cancer due to initial exposure to the radioactive cloud at the midpoint of the interval specified, i.e., sum of the risks from all organs input in subgroup LATENT except for whole body and thyroid.
INITIAL (latent effect)	Number of specified "latent effects" incurred due to initial exposure to the radioactive cloud. The latent effect must be specified in subgroup LATENT.
TOTAL (latent effect)	Number of specified "latent effects" incurred due to both initial and chronic exposure. The latent effect must be specified in subgroup LATENT.
INTERD POP	Number of people occupying the area which is interdicted.
INTERD COST	Cost (dollars) of land interdiction, i.e., sum of both the land interdiction cost with decontamination and the relocation cost with decontamination.
INTERD AREA	Total land area (square miles) from which people are interdicted.

Table II-4 (Cont'd)

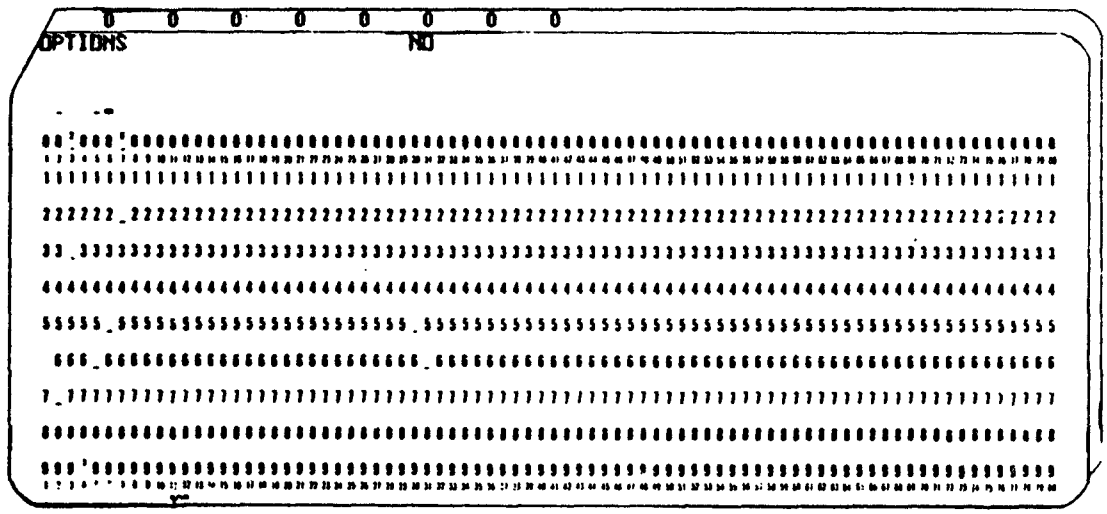
Result Name	Result Description
INTERD DIST	Maximum distance (miles) from the reactor at which land is interdicted.
INTERD RSK-INT14 -INT20 -INT24	Risk of interdicting land at the mid-point of the interval specified.
DECON POP	Number of people occupying land that is decontaminated.
DECON COST	Cost of of land decontamination (dollars).
DECON AREA	Total land area (square miles) that is decontaminated.
DECON DIST	Maximum distance (miles) from the reactor at which land is decontaminated.
DECON RISK-INT14 -INT24 -INT30	Risk of land decontamination at the midpoint of the interval specified.
INT CROP COST	Cost of disposal of contaminated crops (dollars).
INT CROP AREA	Total land area (square miles) in which only crops are interdicted.
INT CROP DIST	Maximum distance (miles) from the reactor at which crops are interdicted.
INT CRPRSK-INT14 -INT24 -INT30 -INT32	Risk of interdicting crops at the midpoint of the interval specified.
INT MILK COST	Cost of disposal of contaminated milk (dollars).
INT MILK AREA	Total land area (square miles) for the interdiction of milk only.
INT MILK DIST	Maximum distance (miles) from the reactor at which milk is interdicted.

Table II-4 (Cont'd)

Result Name	Result Description
INT MLKRSK-INT14 -INT24 -INT30 -INT32	Risk of interdicting milk at the mid-point of the interval specified.
RELOCATION COST	Cost of relocating people occupying the interdicted area (dollars).
EVACUATION COST	Cost of evacuating people according to the last evacuation scheme specified in subgroup EVACUATE (dollars).
TOT COST W/O DEC	Total cost without decontamination (dollars), i.e., sum of evacuation, agricultural, interdiction, and relocation costs assuming no decontamination procedures take place.
TOT COST W/DECON	Total cost with decontamination (dollars), i.e., sum of evacuation, agricultural, decontamination, interdiction, and relocation costs assuming that decontamination procedures take place.

15. Subgroup OPTIONS - specifies the print options for detailed output of each meteorological trial and options to bypass normalization of probabilities and to skip the latent and chronic calculations.

Sample input cards:



The NUM field is not used by this subgroup. One card having the format described below must be input after the header card.

Column	Mnemonic	Format	Description
1-5	NPL	I5	Output option switch to control the detailed printing of interdiction, decontamination, chronic dose commitment, and evacuation data. NPL $\leq$ 0 No detailed print. NPL $\geq$ 1 Print detailed evacuation, interdiction, and decontamination data by spatial interval. NPL $\geq$ 2 Print chronic dose commitment by spatial interval.

Column	Mnemonic	Format	Description
6-10	NPD	I5	Output option to control the detailed printing of dispersion data by spatial interval. NPD $\leq$ 0 No detailed print. 1 $\leq$ NPD $\leq$ 2 Print trial identification and dispersion data. NPD $\geq$ 3 Print trial identification and the sum of the released inventory.
11-15	NPH	I5	Output option to control the detailed printing of organ dose and health effects data by spatial interval. NPH $\leq$ 0 No detailed print. NPH $>$ 0 Print acute effects from early exposure. NPH > 1 Print latent effects from early exposure. NPH > 2 Print latent effects from chronic exposure.
16-20	NPP	I5	Output option to control the printing of the contribution to the final result values from each trial and to delete the printing of the frequency distributions of the final results. NPP < 0 Delete printing of the frequency distributions of the final results. NPP = 0 Frequency distributions of the final results are printed. NPP > 0 Print the contribution to the individual and societal results for each meteorological trial.
21-25	NPA	I5	Output option to control the detailed printing of isotope activity at the time of release and isotope air concentration in each spatial interval. NPA $\leq$ 0 No detailed print. NPA $>$ 0 Print the activity at the time of release for each isotope.

Column	Mnemonic	Format	Description
			NPA > 1 Print the air concentrations for each isotope within each spatial interval.
26-30	NRE	I5	Output option to control the printing of the data from the site data file and the cost and economic effects data by spatial interval. NRE = 0 No detailed print. NRE ≠ 0 Print the population and topographical data requested from the site data file. NRE ≥ 2 Print the cost and economic effects data for each spatial interval.
31-35	NORM	I5	Switch to normalize the release category probabilities. NORM = 0 Normalize probabilities. NORM ≠ 0 Do not normalize probabilities.
36-40	NLC	I5	Switch to bypass the latent and chronic calculations. NLC = 0 Perform latent and chronic exposure calculations. NLC = 1 Skip the chronic exposure calculation. NLC = 2 Skip the chronic exposure calculations. Latent effects are calculated for acute time period only.

A complete account of the options for the detailed output together with examples of the output is included in the output description of Section III.

No parameter modification is allowed for this subgroup.

A representative listing of the OPTIONS subgroup sample input data is shown below.

```
SUBGROUP OPTIONS
PARAMETER ... SET TO     0

                    * * * INPUT PRINT OPTIONS * * *

NPL=0 OR 1          PRINT OPTION FOR INTERDICT. & DECON.          0
NPD=0 OR 1          PRINT OPTION FOR DISPERSION                   0
NPH=0,1,2,OR 3      PRINT OPTION FOR HEALTH EFFECTS               0
NPP=0 OR 1          PRINT OPTION FOR TRIAL RESULTS                0
NPA=0,1, OR 2       PRINT OPTION FOR ACTIVITY & AIR CONC.         0
NRE=0,1, OR 2       PRINT OPTION FOR ECONOMIC COSTS               0
NORM=0,1            INPUT PROB. NORMAL. OPTION IN EFFECT          0
NLC=0,1, OR 2       OPTION TO SKIP LAT/CHRON CALCULATIONS         0
```

G. End Card

The end card is used to terminate the reference case and each subsequent modification case in the input data. The card is alphanumeric and contains the word "END" punched in columns 1 through 3.

Columns	Contents
1-3	END

An end card must appear as the last card of the reference case and each modification case.

III. OUTPUT DESCRIPTION

This section describes the printed output produced by the CRAC2 code.

A. Input Data Print

A printed representation of the subgroup data is generated for the input subgroups in the reference case and each modification case unless the listing is specifically suppressed by the applicable title card. Samples of these subgroup prints are included with the input data description in Section II of this user's guide.

B. Detailed Print Options

The OPTIONS subgroup controls the detailed printing from the CRAC2 program. The detailed printing is divided into six general areas. Within each of the six areas, alternative print options are available. Selection and use of the alternative print options from these six areas are described in the discussion of the OPTIONS subgroup in Section II. A brief description of the detailed print options that are provided in these six areas follows. The descriptions include samples of the detailed prints from each area together with explanations of the printed material. The user must understand that these detailed print options will generate the selected prints for each meteorological trial and that large quantities of printed output can be generated.

1. Interdiction, Decontamination, Chronic Dose Commitment, and Evacuation Data - NPL. This detailed print option provides for the printing of the interdiction and decontamination data, the chronic dose commitment data, and evacuation data by spatial interval. The value of the variable NPL determines the alternative print option selected. Figure III-1 is an example of this print option with NPL=2. The interdiction, decontamination, and chronic dose commitment data are shown for one spatial interval. The circled numbers in the figure reference the following legend:

   (1) The spatial interval number where the people were residing at the start of the accident.

   (2) The spatial interval where the people were caught by the radioactive cloud.

   (3) The number of sectors (22-1/2 degrees) that have been contaminated at the spatial interval where the radioactive cloud has caught the people.

   (4) The fraction of the sector covered by the cloud.

   (5) The time required to decay dose to acceptable levels with decontamination.

   (6) The time required to decay dose to acceptable levels without decontamination.

   (7) Interdiction severity level

      0 - no decontamination or interdiction required

      1 - milk interdiction required

      2 - crop interdiction required

3 - milk and crop interdiction required

4 - people must be relocated for less than ten years

5 - land must be totally interdicted and people permanently relocated

(8) The decontamination factor is defined as the ratio of current radioactivity levels to acceptable radioactivity levels.

(9) The total number of people affected by the decontamination for this spatial interval.

(10) The crop decontamination factor at the time of the accident.

(11) The crop decontamination factor after 60 days.

(12) The milk decontamination factor at the time of the accident.

(13) The milk decontamination factor after 90 days.

(14) Chronic dose exposure group

1 - Inhalation of resuspended radionuclides.

2 - Ingestion of cesium via crops and milk contaminated by direct deposition on plants.

3 - Ingestion of strontium via crops and milk contaminated by direct deposition on plants.

4 - Ingestion of radioactive iodine via crops and milk contaminated by direct deposition on plants.

5 - Ingestion of cesium and strontium via crops and milk contaminated by root uptake.

6 - Exposure to groundshine from contaminated ground.

(15) Within each exposure group the rows represent the six integration time periods for chronic dose (0-10, 10-20, 20-30, 30-40, 40-50, and 50-80 years).

(16) The columns represent the doses to the selected latent organs. The column order is the same as the order of the organs in the latent subgroup.

2. Dispersion Data - NPD. This detailed print option provides for the printing of the dispersion data by spatial interval and the sum of the released inventory. The value of the variable NPD determines the alternative print option selected. Figure III-2 is an example of this print option with NPD=1. The dispersion data and meteorological parameters by spatial interval are shown for one meteorological trial. The circled numbers in the figure reference the following legend:

(1) Spatial interval number.

(2) Spatial interval outer radius (meters).

(3) Elapsed time for cloud to reach midpoint of interval (hours).

(4A) The total number of hours during which rain occurs while the cloud is crossing the interval.

(4B) The rainfall rate in hundredths of inches/hour.

(5) The Pasquill-Gifford stability category for the interval (1-6 corresponds to A-F).

(6) The windspeed for the interval (meters/sec).

(7) The cloud height (meters).

(8) Sigma z, σ_z, is the vertical dispersion standard deviation at the midpo the spatial interval (meters).

(9) Lateral coverage is defined as total horizontal spread at the midpoint of interval not including the expansion factor (meters).

(10) Area coverage is the total cloud coverage for the spatial interval not including the expansion factor (meters^2).

(11) CHI/Q is the concentration per unit source term for the interval.

The numbers (12) - (14) are specific to the isotope Cs-137.

(12) The fraction left in the cloud once it has passed the interval.

(13) Integrated air concentration (Ci-sec/m^3).

(14) Ground concentration (Ci/m^2).

3. Health Effects - NPH. This detailed print option provides for the printing of doses and health effects by spatial interval. The value of the variable NPH determines the alternative print option selected. Figure III-3 is an example of this print option with NPH=3. The acute effects from early exposure, the latent effects from early exposure, and the latent effects from chronic exposure are shown for one spatial interval. The circled numbers in the figure reference the following legend:

The following numbers apply to early effects from early exposure:

(1) The spatial interval number.

(2) The name of the organ.

(3) The probability that the total dose to the organ will result in an early effect (fatality or injury).

(4) Total dose to the organ (rem).

(5) The external cloud gamma ray shine dose (rem).

(6) The integrated ground exposure dose (rem).

(7) The inhalation dose from exposure to the cloud (rem).

(8) The cumulative probability that there is an early fatality due to a critical dose to this organ and the previous organs.

(9) The cumulative probability that there is an early injury due to a critical dose to this organ and the previous organs.

The following numbers apply to latent effects from early exposure:

(10) The organ name and latent effect.

(11) The external cloud gamma ray shine dose (rem).

(12) The integrated ground exposure dose (rem).

(13) The inhalation dose for the ten time intervals of 0-1, 1-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80, and 80-infinity years.

(14) The number of effects in cases per person for the same ten time periods above.

(15) The total number of effects in cases per person.

The following numbers apply to latent effects from chronic exposure:

(16) The name of the latent health effect.

(17) The inhalation dose for the ten time periods given in (13).

(18) The ingestion dose for the same ten time periods.

(19) The ground dose for the same ten time periods.

(20) The total number of effects in cases for the same ten time periods.

4. Final Result Values - NPP. This detailed print option provides for the printing of the contribution to the final results from each meteorological trial. In addition, the option provides the user the choice of deleting the frequency distribution tables from the final results.

The value of the variable NPP determines the alternative print option selected. Figure III-4 is an example of this print option with NPP=1. The contribution to the set of final results are shown for one meteorological trial. The circled numbers in the figure reference the following legend:

(1) Month indicator for the accident start time.

(2) Day indicator for the accident start time.

(3) Hour indicator for the accident start time.

(4) Core inventory group number (always 1).

(5) Accident description leakage category number.

(6) Meteorological site number (always 1).

(7) Population sector number.

(8) Number of the meteorological trial.

(9) Probability of this set of consequences.

(10) The consequences for the meteorological trial. The consequences are divided between societal (direction-dependent) and individual (direction-independent) results and are in the order of the final results array, FRES.

5. Isotope Activity - NPA. This detailed print option provides for the printing of the activity of each isotope at the time of release and the air concentration for each isotope within each spatial interval. The value of the variable NPA determines the alternative print option selected. Figure III-5 is an example of this print option with NPA=2. The activity of each isotope at the time of release as well as the air concentration of each isotope are shown by spatial interval. The circled numbers in the figure reference the following legend:

   (1) Spatial interval.
   (2) Midpoint of the spatial interval (meters).

6. Site Data File and Economic Effects - NRE. This detailed print option provides for the printing of the economic effects data by spatial interval. In addition, where a site data file has been used, the option provides for the printing of the population and topographic data from the site data file. The value of the variable NPP determines the alternative print option selected. Figure III-6 is an example of this print option with NRE=2. The cost and economic effects data are shown by spatial interval. The circled numbers in the figure reference the following legend:

   (1) Contamination Severity Index.
   0 - No decontamination or interdiction

1 - Milk interdiction (disposal)

2 - Crop interdiction (disposal)

3 - Milk and crop interdiction

4 - Immediate decontamination only

5 - Interdiction followed by decontamination if it is possible to decontaminate

(2) Waiting period before decontamination.

(3) Time for dose to reach acceptable level without decontamination.

(4) Fraction of area covered by the cloud.

(5) The sector number of the grid element being processed.

(6) The state code for this grid element.

(7) Land fraction in this grid element.

(8) Population within this grid element.

(9) Farm area within this grid element (acres).

(10) Annual production of farm products ($/year).

(11) Annual production of milk products ($/year).

(12) Annual production of nondairy product ($/year).

(13) Potential cost of milk disposal.

(14) Potential cost of crop disposal.

(15) This row gives the costs for the six cost categories:

* Agricultural cost (disposal of harvest)

* Decontamination cost

* Land interdiction cost with decontamination

* Relocation cost with decontamination

* Land interdiction cost without decontamination

* Relocation cost without decontamination

(16) This row specifies the exposed population for each of the chronic effects groups.

* Population exposed to the plume

* Population exposed through non-dairy product consumption

* Population exposed through dairy product consumption

* * * INTERDICTION & DECONTAMINATION DATA * * *

① CURRENT RING	② RING WHERE HIT	③ SECTORS INVOLVED	④ FRACTION COVERED	⑤ AGING TIME W/DECON	⑥ AGING TIME W/O DECON	⑦ INTERDICT SEVERITY	⑧ DECONTAM FACTOR	⑨ POPULATION AFFECTED	⑩ DECONTAMINATION FACTORS CROP	⑪ CROP60	⑫ MILK	⑬ MILK90
1	1	3	5.61E-01	0.	0.	0	1.00E+00	1.04E+01	0.00	0.00	0.00	0.00

K	KDOSE	LASTIN	TGSTAT	FCSTAT
2	2	16	.240E+01	.100E+01

⑭ ⑯ * * * CHRONIC DOSE COMMITMENT * * *

⑮	ORGAN 1	ORGAN 2	ORGAN 3	ORGAN 4	ORGAN 5	ORGAN 6	ORGAN 7	ORGAN 8
EXPOSURE GROUP 1								
TIME 1	.676E+00	.594E+00	.594E+00	.353E+00	.673E+00	.631E+00	.507E+00	0.
TIME 2	.111E+01	.141E+01	.141E+01	.833E+00	.116E+01	.146E+01	.118E+01	0.
TIME 3	.273E+00	.354E+00	.355E+00	.209E+00	.304E+00	.356E+00	.290E+00	0.
TIME 4	.182E+00	.236E+00	.237E+00	.139E+00	.203E+00	.237E+00	.193E+00	0.
TIME 5	0.	0.	0.	0.	0.	0.	0.	0.
TIME 6	0.	0.	0.	0.	0.	0.	0.	0.
EXPOSURE GROUP 2	ORGAN 1	ORGAN 2	ORGAN 3	ORGAN 4	ORGAN 5	ORGAN 6	ORGAN 7	ORGAN 8
TIME 1	.511E+00	.366E-01	.104E+00	.205E-01	.174E-01	.185E-01	.322E-01	0.
TIME 2	.470E-03	.481E-02	.675E-01	.198E-04	.112E-03	.101E-02	.592E-02	0.
TIME 3	.923E-04	.118E-02	.520E-01	.904E-05	.860E-04	.845E-03	.672E-02	0.
TIME 4	.904E-04	.116E-02	.525E-01	.768E-05	.763E-04	.742E-03	.610E-02	0.
TIME 5	.200E-03	.441E-03	.407E-01	.607E-05	.698E-04	.561E-03	.374E-02	0.
TIME 6	.189E-01	.478E-03	.492E-01	.148E-04	.965E-04	.876E-03	.487E-02	0.
EXPOSURE GROUP 3	ORGAN 1	ORGAN 2	ORGAN 3	ORGAN 4	ORGAN 5	ORGAN 6	ORGAN 7	ORGAN 8
TIME 1	.111E+01	.113E+01	.114E+01	.163E+01	.225E+01	.107E+01	.109E+01	0.
TIME 2	.367E-04	.351E-02	.162E-01	.316E-05	.367E-05	.367E-05	.128E-02	0.
TIME 3	.114E-05	.814E-03	.619E-02	0.	.114E-05	.821E-06	.470E-03	0.
TIME 4	0.	.631E-03	.688E-02	0.	0.	0.	.510E-03	0.
TIME 5	0.	.196E-03	.271E-02	0.	0.	0.	.198E-03	0.
TIME 6	0.	.196E-03	.271E-02	0.	0.	0.	.198E-03	0.
EXPOSURE GROUP 4	ORGAN 1	ORGAN 2	ORGAN 3	ORGAN 4	ORGAN 5	ORGAN 6	ORGAN 7	ORGAN 8
TIME 1	0.	0.	0.	0.	0.	0.	0.	0.
TIME 2	0.	0.	0.	0.	0.	0.	0.	0.
TIME 3	0.	0.	0.	0.	0.	0.	0.	0.
TIME 4	0.	0.	0.	0.	0.	0.	0.	0.
TIME 5	0.	0.	0.	0.	0.	0.	0.	0.
TIME 6	0.	0.	0.	0.	0.	0.	0.	0.
EXPOSURE GROUP 5	ORGAN 1	ORGAN 2	ORGAN 3	ORGAN 4	ORGAN 5	ORGAN 6	ORGAN 7	ORGAN 8
TIME 1	.549E-01	.103E+00	.197E+00	.898E-01	.549E-01	.533E-01	.659E-01	0.
TIME 2	.127E-03	.122E-01	.595E-01	.116E-04	.127E-04	.127E-04	.470E-02	0.
TIME 3	.417E-05	.299E-02	.227E-01	0.	.417E-05	.301E-05	.172E-02	0.
TIME 4	0.	.231E-02	.252E-01	0.	0.	0.	.187E-02	0.
TIME 5	0.	.718E-03	.995E-02	0.	0.	0.	.725E-03	0.
TIME 6	0.	.718E-03	.995E-02	0.	0.	0.	.725E-03	0.
EXPOSURE GROUP 6	ORGAN 1	ORGAN 2	ORGAN 3	ORGAN 4	ORGAN 5	ORGAN 6	ORGAN 7	ORGAN 8
TIME 1	.164E+00	.240E+00	.447E+00	.247E+00	.164E+00	.159E+00	.185E+00	0.
TIME 2	.255E-03	.243E-01	.119E+00	.232E-04	.255E-04	.255E-04	.941E-02	0.
TIME 3	.835E-05	.598E-02	.455E-01	0.	.835E-05	.603E-05	.345E-02	0.
TIME 4	0.	.464E-02	.505E-01	0.	0.	0.	.375E-02	0.
TIME 5	0.	.144E-02	.199E-01	0.	0.	0.	.145E-02	0.
TIME 6	0.	.144E-02	.199E-01	0.	0.	0.	.145E-02	0.

Figure III-1. Detailed Contamination Output Sample

* * * DISPERSION DATA BY SPATIAL INTERVAL * * *

RING NUM	ENDPOINT RADIUS	ELAPSED TIME	**** WEATHER ***** RAIN INC (4A)	RAIN OBS (4B)	STB (5)	WNDSPD (6)	CLOUD HEIGHT (7)	SIGMAZ (8)	LATERAL COVERAGE (9)	TOT AREA COVERAGE (10)	CHI/Q (11)	*** EXAMPLE ISOTOPE CS-137 **** FRAC LEFT (12)	AIR CON. (13)	GRND CON. (14)
1	8.047E+02	6.574E-02	0	0	4	3.400	0.	2.914E+01	1.842E+02	1.482E+05	2.374E-05	9.363E-01	4.504E+01	4.431E-01
2	1.609E+03	1.315E-01	0	0	4	3.400	0.	5.233E+01	3.469E+02	2.792E+05	7.080E-06	9.028E-01	1.277E+01	1.265E-01
3	2.414E+03	1.972E-01	0	0	4	3.400	0.	6.977E+01	5.008E+02	4.030E+05	3.684E-06	8.785E-01	6.435E+00	6.391E-02
4	3.219E+03	2.630E-01	0	0	4	3.400	0.	8.439E+01	6.496E+02	5.227E+05	2.350E-06	8.590E-01	4.003E+00	3.981E-02
5	4.023E+03	3.287E-01	0	0	4	3.400	0.	9.725E+01	7.946E+02	6.394E+05	1.667E-06	8.424E-01	2.781E+00	2.768E-02
6	4.828E+03	3.944E-01	0	0	4	3.400	0.	1.089E+02	9.369E+02	7.539E+05	1.263E-06	8.278E-01	2.069E+00	2.060E-02
7	5.633E+03	4.602E-01	0	0	4	3.400	0.	1.196E+02	1.077E+03	8.665E+05	1.001E-06	8.148E-01	1.612E+00	1.606E-02
8	6.437E+03	5.259E-01	0	0	4	3.400	0.	1.295E+02	1.215E+03	9.776E+05	8.192E-07	8.029E-01	1.299E+00	1.295E-02
9	7.242E+03	5.917E-01	0	0	4	3.400	0.	1.389E+02	1.351E+03	1.087E+06	6.869E-07	7.921E-01	1.074E+00	1.071E-02
10	8.047E+03	6.574E-01	0	0	4	3.400	0.	1.477E+02	1.486E+03	1.196E+06	5.872E-07	7.820E-01	9.062E-01	9.033E-03
11	9.656E+03	7.889E-01	0	0	4	3.400	0.	1.602E+02	1.686E+03	2.713E+06	4.772E-07	7.636E-01	7.232E-01	7.189E-03
12	1.127E+04	9.204E-01	0	0	4	3.400	0.	1.757E+02	1.948E+03	3.135E+06	3.765E-07	7.473E-01	5.578E-01	5.548E-03
13	1.368E+04	1.098E+00	0	0	4	3.785	0.	1.935E+02	2.271E+03	5.482E+06	2.634E-07	7.278E-01	3.809E-01	3.784E-03
14	1.609E+04	1.261E+00	0	0	4	4.100	0.	2.132E+02	2.652E+03	6.403E+06	1.890E-07	7.118E-01	2.668E-01	2.653E-03
15	2.012E+04	1.534E+00	0	0	4	4.100	0.	2.372E+02	3.151E+03	1.268E+07	1.429E-07	6.885E-01	1.962E-01	1.946E-03
16	2.414E+04	1.806E+00	0	0	4	4.100	0.	2.645E+02	3.764E+03	1.514E+07	1.073E-07	6.683E-01	1.428E-01	1.417E-03
17	2.816E+04	2.073E+00	1	21	4	4.182	0.	2.895E+02	4.367E+03	1.757E+07	8.286E-08	3.846E-03	1.072E-01	4.019E-02
18	3.219E+04	2.327E+00	1	75	4	4.400	0.	3.128E+02	4.960E+03	1.996E+07	6.419E-08	1.023E-10	4.785E-04	2.051E-04
19	4.023E+04	2.835E+00	1	75	4	4.400	0.	3.450E+02	5.835E+03	4.695E+07	4.946E-08	7.259E-26	9.709E-12	2.295E-12
20	4.828E+04	3.315E+00	1	32	4	4.663	0.	3.841E+02	6.982E+03	5.618E+07	3.503E-08	7.259E-26	0.	0.
21	5.633E+04	3.781E+00	1	10	4	4.800	0.	4.200E+02	8.110E+03	6.526E+07	2.680E-08	7.259E-26	0.	0.
22	6.437E+04	4.232E+00	1	5	4	4.954	0.	4.533E+02	9.221E+03	7.420E+07	2.116E-08	7.259E-26	0.	0.
23	7.242E+04	4.670E+00	1	1	4	5.100	0.	4.845E+02	1.032E+04	8.302E+07	1.719E-08	7.259E-26	0.	0.
24	8.047E+04	5.104E+00	1	1	4	5.148	0.	5.140E+02	1.140E+04	9.175E+07	1.452E-08	7.259E-26	0.	0.
25	8.851E+04	5.526E+00	0	0	4	5.300	0.	5.420E+02	1.247E+04	1.004E+08	1.223E-08	7.259E-26	0.	0.
26	9.656E+04	5.948E+00	0	0	4	5.300	0.	5.727E+02	1.354E+04	1.089E+08	1.066E-08	7.259E-26	0.	0.
27	1.046E+05	6.356E+00	0	0	4	5.474	0.	6.089E+02	1.459E+04	1.174E+08	9.009E-09	7.259E-26	0.	0.
28	1.127E+05	6.762E+00	0	0	4	5.500	0.	6.450E+02	1.564E+04	1.258E+08	7.898E-09	7.259E-26	0.	0.
29	1.368E+05	7.947E+00	0	0	4	5.660	0.	7.173E+02	1.770E+04	4.274E+08	6.095E-09	7.259E-26	0.	0.
30	1.609E+05	9.327E+00	0	0	4	6.861	0.	8.257E+02	2.076E+04	5.012E+08	5.257E-09	7.259E-26	0.	0.
31	2.414E+05	1.614E+01	0	0	4	3.282	0.	9.600E+02	2.719E+04	2.188E+09	5.106E-09	7.259E-26	0.	0.
32	3.219E+05	2.232E+01	0	0	4	3.618	0.	9.600E+02	3.686E+04	2.966E+09	3.420E-09	7.259E-26	0.	0.
33	5.633E+05	3.373E+01	0	0	4	5.874	0.	9.600E+02	5.528E+04	1.335E+10	1.401E-09	7.259E-26	0.	0.
34	3.219E+06	2.008E+02	1	1	4	4.414	0.	9.600E+02	2.008E+05	5.331E+11	5.027E-10	7.259E-26	0.	0.

Figure III-2. Detailed Dispersion Output Sample

• • • • • HEALTH EFFECTS DETAILED OUTPUT - SPATIAL INTERVAL NUMBER ① 5 • • • • •

ACUTE EFFECTS FROM EARLY EXPOSURE, EVACUATION SCHEME 1

② ORGAN	③ PROB	④ TOTAL DS	⑤ CLOUD DS	⑥ GROUND DS	⑦ INHAL DS	⑧ CUM FATAL	⑨ CUM INJUR
T MARROW	1.000E+00	6.185E+02	1.411E+02	3.783E+02	9.906E+01	1.000E+00	0.
LLI WALL	0.	7.558E+02	9.327E+01	2.361E+02	4.264E+02	1.000E+00	0.
LUNG	2.013E-02	5.822E+03	1.180E+02	3.073E+02	5.397E+03	1.000E+00	0.
W BODY	1.000E+00	5.131E+02	1.251E+02	3.275E+02	6.049E+01	1.000E+00	1.000E+00
LUNG	9.437E-01	5.822E+03	1.180E+02	3.073E+02	5.397E+03	1.000E+00	1.000E+00
LLI WALL	0.	7.558E+02	9.327E+01	2.361E+02	4.264E+02	1.000E+00	1.000E+00
THYROID	0.	1.283E+04	1.162E+02	3.072E+02	1.240E+04	1.000E+00	1.000E+00

LATENT EFFECTS FROM EARLY EXPOSURE

⑩				⑪		⑫					⑮
ORGAN IS T MARROW	EFFECT IS LEUKEMIA		CLOUD DS = 1.411E+02		GROUND DS = 3.783E+02						
INHAL DS	3.386E+02	8.962E+01	1.837E+01	4.467E+00	4.430E+00	1.647E+00	1.647E+00	1.647E+00	1.647E+00	1.647E+00	
CASES/P	2.633E-02	2.638E-03	3.440E-04	6.174E-05	4.306E-05	1.115E-05	6.653E-06	2.800E-06	8.069E-07	0.	2.724E-02
ORGAN IS LUNG	EFFECT IS LUNG		CLOUD DS = 1.180E+02		GROUND DS = 3.073E+02						
INHAL DS	5.397E+03	1.492E+03	1.215E+00	1.578E-01	1.458E-01	2.432E-01	2.432E-01	2.432E-01	2.432E-01	2.432E-01	
CASES/P	1.600E-01	4.101E-02	3.340E-05	2.505E-06	1.185E-06	9.705E-07	3.648E-07	5.351E-08	0.	0.	2.011E-01
ORGAN IS OTHER	EFFECT IS BREAST		CLOUD DS = 1.526E+02		GROUND DS = 3.979E+02						
⑬ INHAL DS	2.759E+02	3.433E+01	3.631E+00	3.094E+00	2.688E+00	2.068E+00	2.068E+00	2.068E+00	2.068E+00	2.068E+00	
CASES/P	2.621E-02	1.089E-03	1.152E-04	5.665E-05	2.521E-05	9.514E-06	3.578E-06	5.171E-07	0.	0.	2.751E-02
ORGAN IS SKELETON	EFFECT IS BONE		CLOUD DS = 1.426E+02		GROUND DS = 3.796E+02						
INHAL DS	4.173E+02	3.234E+02	2.522E+02	1.932E+02	1.961E+02	1.504E+02	1.504E+02	1.504E+02	1.504E+02	1.504E+02	
⑭ CASES/P	1.040E-02	3.441E-03	1.763E-03	5.834E-04	3.275E-04	1.369E-04	6.318E-05	1.805E-05	1.504E-06	0.	1.673E-02
ORGAN IS LLI WALL	EFFECT IS GI TRK		CLOUD DS = 9.327E+01		GROUND DS = 2.361E+02						
INHAL DS	6.023E+02	3.056E+01	2.212E-02	1.850E-02	1.605E-02	1.271E-02	1.271E-02	1.271E-02	1.271E-02	1.271E-02	
CASES/P	1.573E-02	5.159E-04	3.735E-07	1.802E-07	8.010E-08	3.115E-08	1.170E-08	1.653E-09	0.	0.	1.624E-02
ORGAN IS OTHER	EFFECT IS OTHER		CLOUD DS = 1.526E+02		GROUND DS = 3.979E+02						
INHAL DS	2.759E+02	3.433E+01	3.631E+00	3.094E+00	2.688E+00	2.068E+00	2.068E+00	2.068E+00	2.068E+00	2.068E+00	
CASES/P	2.661E-02	1.047E-03	9.219E-05	4.536E-05	2.021E-05	7.632E-06	2.875E-06	4.137E-07	0.	0.	2.783E-02
ORGAN IS W BODY	EFFECT IS W BODY		CLOUD DS = 1.251E+02		GROUND DS = 3.275E+02						
INHAL DS	3.775E+02	8.061E+01	2.206E+01	1.770E+01	1.507E+01	1.401E+01	1.401E+01	1.401E+01	1.401E+01	1.401E+01	
CASES/P	1.311E-01	1.236E-02	2.811E-03	1.335E-03	6.239E-04	3.139E-04	1.401E-04	3.670E-05	7.003E-06	0.	1.487E-01
THYROID - NON-IODINE, IODINE NOT 131, I-131				3.819E+03	1.061E+04	2.575E+04					
ORGAN IS THYROID	EFFECT IS THYROID		CLOUD DS = 1.162E+02		GROUND DS = 3.072E+02						
INHAL DS	4.018E+04	0.	0.	0.	0.	0.	0.	0.	0.		
CASES/P	5.822E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Figure III-3. Detailed Health Effects Output Sample

LATENT EFFECTS FROM CHRONIC EXPOSURE

(16)

ORGAN IS T MARROW EFFECT IS LEUKEMIA INTERVAL 23 AND SECTOR 1

(17) INHAL DS	5.435E-02	6.890E-01	7.132E-02	1.750E-02	1.725E-02	6.561E-03	1.773E-03	1.773E-03	1.773E-03	1.773E-03
INGES DS M	1.352E-01	1.217E+00	1.758E-01	4.320E-02	3.349E-02	1.038E-02	2.595E-03	2.595E-03	2.595E-03	2.595E-03
(18) INGES DS C	3.360E-01	3.024E+00	3.521E-01	8.653E-02	6.707E-02	2.079E-02	5.198E-03	5.198E-03	5.198E-03	5.198E-03
GRND DS	8.817E+00	6.951E+00	6.951E+00	6.951E+00	1.767E+00	1.767E+00	1.767E+00	1.166E+00	1.166E+00	1.166E+00
(19) CASES	1.500E-01	1.656E-01	1.209E-01	1.155E-01	3.001E-02	2.904E-02	2.870E-02	1.919E-02	1.919E-02	1.919E-02

(20)

ORGAN IS LUNG EFFECT IS LUNG INTERVAL 23 AND SECTOR 1

INHAL DS	7.573E-01	6.816E+00	6.968E-03	1.368E-03	1.341E-03	2.973E-03	7.006E-02	7.006E-02	7.006E-02	7.006E-02
INGES DS M	6.639E-02	5.975E-01	1.842E-03	6.028E-05	0.	0.	0.	0.	0.	0.
INGES DS C	1.979E-01	1.781E+00	5.689E-03	1.207E-04	0.	0.	0.	0.	0.	0.
GRND DS	7.058E+00	5.478E+00	5.478E+00	5.478E+00	1.351E+00	1.351E+00	1.351E+00	9.019E-01	9.019E-01	9.019E-01
CASES	1.264E-01	2.169E-01	8.703E-02	8.688E-02	2.145E-02	2.147E-02	2.254E-02	1.541E-02	1.541E-02	1.541E-02

ORGAN IS OTHER EFFECT IS BREAST INTERVAL 23 AND SECTOR 1

INHAL DS	2.736E-02	2.462E-01	1.495E-02	1.252E-02	1.100E-02	8.324E-03	3.247E-03	3.247E-03	3.247E-03	3.247E-03
INGES DS M	6.452E-02	5.807E-01	1.842E-04	4.353E-05	0.	0.	0.	0.	0.	0.
INGES DS C	1.923E-01	1.730E+00	3.689E-04	8.720E-05	0.	0.	0.	0.	0.	0.
GRND DS	9.367E+00	7.204E+00	7.204E+00	7.204E+00	1.758E+00	1.758E+00	1.758E+00	1.173E+00	1.173E+00	1.173E+00
CASES	8.730E-01	8.048E-01	6.604E-01	6.602E-01	1.618E-01	1.616E-01	1.611E-01	1.076E-01	1.076E-01	1.076E-01

ORGAN IS SKELETON EFFECT IS BONE INTERVAL 23 AND SECTOR 1

INHAL DS	1.543E-01	1.389E+00	1.002E+00	7.710E-01	7.779E-01	6.038E-01	1.822E-01	1.822E-01	1.822E-01	1.822E-01
INGES DS M	2.708E-01	2.437E+00	8.606E-01	3.285E-01	3.650E-01	1.440E-01	3.600E-02	3.600E-02	3.600E-02	3.600E-02
INGES DS C	6.067E-01	5.461E+00	1.724E+00	6.580E-01	7.311E-01	2.884E-01	7.211E-02	7.211E-02	7.211E-02	7.211E-02
GRND DS	8.818E+00	6.966E+00	6.966E+00	6.966E+00	1.754E+00	1.754E+00	1.754E+00	1.170E+00	1.170E+00	1.170E+00
CASES	6.100E-02	8.676E-02	6.237E-02	5.379E-02	2.104E-02	1.698E-02	1.284E-02	9.117E-03	9.117E-03	9.117E-03

ORGAN IS LLI WALL EFFECT IS GI TRK INTERVAL 23 AND SECTOR 1

INHAL DS	3.034E-02	2.731E-01	2.939E-04	1.340E-04	1.138E-04	8.995E-05	5.472E-05	5.472E-05	5.472E-05	5.472E-05
INGES DS M	1.080E-01	9.719E-01	1.474E-04	0.	0.	0.	0.	0.	0.	0.
INGES DS C	2.965E-01	2.669E+00	3.354E-04	0.	0.	0.	0.	0.	0.	0.
GRND DS	5.231E+00	4.118E+00	4.118E+00	4.118E+00	1.031E+00	1.031E+00	1.031E+00	6.879E-01	6.879E-01	6.879E-01
CASES	5.361E-02	6.419E-02	6.010E-02	6.009E-02	1.004E-02	1.004E-02	1.004E-02	6.698E-03	6.698E-03	6.698E-03

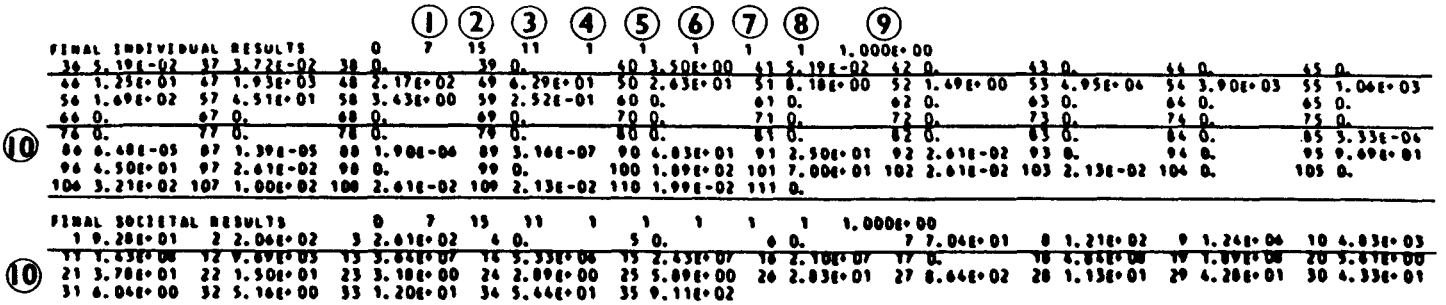
ORGAN IS OTHER EFFECT IS OTHER INTERVAL 23 AND SECTOR 1

INHAL DS	2.736E-02	2.462E-01	1.495E-02	1.252E-02	1.100E-02	8.324E-03	3.247E-03	3.247E-03	3.247E-03	3.247E-03
INGES DS M	6.452E-02	5.807E-01	1.842E-04	4.353E-05	0.	0.	0.	0.	0.	0.
INGES DS C	1.923E-01	1.730E+00	3.689E-04	8.720E-05	0.	0.	0.	0.	0.	0.
GRND DS	9.367E+00	7.204E+00	7.204E+00	7.204E+00	1.758E+00	1.758E+00	1.758E+00	1.173E+00	1.173E+00	1.173E+00
CASES	1.772E-01	1.634E-01	1.341E-01	1.340E-01	3.285E-02	3.280E-02	3.271E-02	2.185E-02	2.185E-02	2.185E-02

ORGAN IS M BODY EFFECT IS M BODY INTERVAL 23 AND SECTOR 1

INHAL DS	4.770E-02	4.293E-01	8.777E-02	7.004E-02	6.081E-02	5.547E-02	1.806E-02	1.806E-02	1.806E-02	1.806E-02
INGES DS M	8.245E-02	7.420E-01	6.798E-02	2.491E-02	2.706E-02	1.048E-02	2.620E-03	2.620E-03	2.620E-03	2.620E-03
INGES DS C	2.287E-01	2.058E+00	1.362E-01	4.990E-02	5.420E-02	2.099E-02	5.249E-03	5.249E-03	5.249E-03	5.249E-03
GRND DS	7.520E+00	5.817E+00	5.817E+00	5.817E+00	1.431E+00	1.431E+00	1.431E+00	9.550E-01	9.550E-01	9.550E-01
CASES	7.062E-01	7.224E-01	5.507E-01	5.409E-01	1.410E-01	1.374E-01	1.325E-01	8.912E-02	8.912E-02	8.912E-02

Figure III.-3. (Continued)



							①	②	③	④	⑤	⑥	⑦	⑧	⑨																		
FINAL INDIVIDUAL RESULTS					0	7	15	11	1	1	1	1	1	1.000E+00																		
36	5.19E-02	37	3.72E-02	38	0.		39	0.		40	3.50E+00	41	5.19E-02	42	0.		43	0.		44	0.		45	0.								
46	1.25E+01	47	1.93E+03	48	2.17E+02		49	6.29E+01		50	2.63E+01	51	8.18E+00	52	1.49E+00		53	4.95E+04		54	3.90E+03		55	1.04E+03								
56	1.69E+02	57	4.51E+01	58	3.43E+00		59	2.52E-01		60	0.	61	0.	62	0.		63	0.		64	0.		65	0.								
66	0.	67	0.	68	0.		69	0.		70	0.	71	0.	72	0.		73	0.		74	0.		75	0.								
76	0.	77	0.	78	0.		79	0.		80	0.	81	0.	82	0.		83	0.		84	0.		85	5.33E-04								
⑩ 86	6.48E-05	87	1.39E-05	88	1.90E-06		89	3.16E-07		90	4.83E+01	91	2.50E+01	92	2.61E-02		93	0.		94	0.		95	9.69E-01								
96	4.50E+01	97	2.61E-02	98	0.		99	0.		100	1.09E+02	101	7.00E+01	102	2.61E-02		103	2.13E-02		104	0.		105	0.								
106	3.21E+02	107	1.00E+02	108	2.61E-02		109	2.13E-02		110	1.99E-02	111	0.																			
FINAL SOCIETAL RESULTS					0	7	15	11	1	1	1	1	1	1.000E+00																		
1	9.28E+01	2	2.06E+02	3	2.61E+02		4	0.		5	0.	6	0.	7	7.06E+01		8	1.21E+02		9	1.24E+04		10	4.83E+03								
11	1.43E+06	12	9.89E+05	13	3.65E+07		14	5.33E+06		15	2.43E+07	16	2.10E+07	17	0.		18	4.85E+08		19	1.89E+08		20	5.67E+00								
⑩ 21	3.70E+01	22	1.50E+01	23	3.10E+00		24	2.89E+00		25	5.09E+00	26	2.83E+01	27	8.64E+02		28	1.13E+01		29	4.28E+01		30	4.33E+01								
31	6.04E+00	32	5.16E+00	33	1.20E+01		34	5.44E+01		35	9.11E+02																					

Figure III-4. Sample Contribution to Final Results From Each Meteorological Trial

NUM	ISOTOPE	ACTIVITY AT TIME OF RELEASE (CURIES)
1	CO-58	2.24E+04
2	CO-60	1.35E+02
3	KR-85	6.64E+05
4	KR-85M	2.68E+07
5	KR-87	5.30E+07
6	KR-88	6.01E+07
7	RB-86	1.44E+04
8	SR-89	2.87E+06
9	SR-90	1.55E+05
10	SR-91	3.45E+06
11	Y-90	1.66E+04
12	Y-91	3.51E+05
13	ZR-95	4.47E+05
14	ZR-97	4.49E+05
15	NB-95	4.22E+05
16	MO-99	4.91E+06
17	TC-99M	4.36E+06
18	RU-103	3.73E+06
19	RU-105	2.11E+06
20	RU-106	8.68E+05
21	RH-105	1.68E+06
22	SB-127	2.30E+06
23	SB-129	6.94E+06
24	TE-127	2.24E+06
25	TE-127M	2.95E+05
26	TE-129	7.56E+06
27	TE-129M	2.01E+06
28	TE-131M	3.76E+06
29	TE-132	3.77E+07
30	I-131	2.61E+07
31	I-132	3.84E+07
32	I-133	5.34E+07
33	I-134	2.74E+07
34	I-135	4.68E+07
35	XE-133	1.84E+08
36	XE-135	4.72E+07
37	CS-136	3.78E+06
38	CS-136	1.17E+06
39	CS-137	1.96E+06
40	BA-140	5.03E+06
41	LA-140	5.15E+05
42	CE-141	4.58E+05
43	CE-143	4.36E+05
44	CE-144	2.75E+05
45	PR-143	4.37E+05
46	ND-147	1.95E+05
47	NP-239	5.48E+06
48	PU-238	3.50E+02
49	PU-239	7.76E+01
50	PU-240	8.68E+01
51	PU-241	1.63E+04
52	AM-241	1.09E+01
53	CM-242	4.11E+03
54	CM-244	2.52E+02

Figure III-5 Sample Output of Activity Option Print

* * * AIR CONCENTRATION AT EACH SPATIAL INTERVAL (CURIE-SEC/M**3) * * *

NUM	ISOTOPE	① 1=4.0E+2	② 2=1.2E+3	3=2.0E+3	4=2.8E+3	5=3.6E+3	6=4.4E+3	7=5.2E+3	8=6.0E+3	9=6.8E+3
1	CO-58	5.14E-01	1.46E-01	7.34E-02	4.57E-02	3.17E-02	2.36E-02	1.84E-02	1.48E-02	1.23E-02
2	CO-60	3.10E-03	8.78E-04	4.42E-04	2.75E-04	1.91E-04	1.42E-04	1.11E-04	8.93E-05	7.39E-05
3	KR-85	1.58E+01	4.70E+00	2.45E+00	1.56E+00	1.11E+00	8.39E-01	6.65E-01	5.44E-01	4.56E-01
4	KR-85M	6.32E+02	1.87E+02	9.62E+01	6.07E+01	4.27E+01	3.20E+01	2.51E+01	2.03E+01	1.69E+01
5	KR-87	7.68E+02	2.21E+02	1.11E+02	6.83E+01	4.67E+01	3.42E+01	2.61E+01	2.06E+01	1.67E+01
6	KR-88	1.41E+03	4.15E+02	2.12E+02	1.33E+02	9.31E+01	6.94E+01	5.41E+01	4.35E+01	3.59E+01
7	RB-86	3.31E-01	9.39E-02	4.73E-02	2.94E-02	2.04E-02	1.52E-02	1.18E-02	9.55E-03	7.89E-03
8	SR-89	6.40E+01	1.87E+01	9.43E+00	5.87E+00	4.08E+00	3.03E+00	2.36E+00	1.90E+00	1.57E+00
9	SR-90	3.56E+00	1.01E+00	5.09E-01	3.17E-01	2.20E-01	1.64E-01	1.28E-01	1.03E-01	8.50E-02
10	SR-91	7.91E+01	2.23E+01	1.12E+01	6.93E+00	4.79E+00	3.55E+00	2.75E+00	2.21E+00	1.82E+00
11	Y-90	3.83E-01	1.09E-01	5.56E-02	3.46E-02	2.42E-02	1.81E-02	1.42E-02	1.15E-02	9.57E-03
12	Y-91	8.06E+00	2.28E+00	1.15E+00	7.17E-01	4.98E-01	3.71E-01	2.89E-01	2.33E-01	1.93E-01
13	ZR-95	1.03E+01	2.91E+00	1.46E+00	9.11E-01	6.33E-01	4.71E-01	3.67E-01	2.96E-01	2.45E-01
14	ZR-97	1.03E+01	2.91E+00	1.46E+00	9.09E-01	6.30E-01	4.67E-01	3.63E-01	2.92E-01	2.41E-01
15	NB-95	9.69E+00	2.75E+00	1.39E+00	8.62E-01	5.99E-01	4.45E-01	3.47E-01	2.80E-01	2.31E-01
16	MO-99	1.13E+02	3.19E+01	1.61E+01	1.00E+01	6.95E+00	5.16E+00	4.02E+00	3.24E+00	2.68E+00
17	TC-99M	1.00E+02	2.84E+01	1.43E+01	8.92E+00	6.20E+00	4.62E+00	3.60E+00	2.91E+00	2.40E+00
18	RU-103	8.56E+01	2.43E+01	1.22E+01	7.61E+00	5.29E+00	3.93E+00	3.06E+00	2.47E+00	2.04E+00
19	RU-105	4.82E+01	1.35E+01	6.74E+00	4.15E+00	2.85E+00	2.10E+00	1.62E+00	1.29E+00	1.06E+00
20	RU-106	1.99E+01	5.65E+00	2.85E+00	1.77E+00	1.23E+00	9.15E-01	7.13E-01	5.75E-01	4.75E-01
21	RH-105	3.87E+01	1.10E+01	5.53E+00	3.44E+00	2.39E+00	1.78E+00	1.39E+00	1.12E+00	9.24E-01
22	SB-127	5.28E+01	1.49E+01	7.53E+00	4.68E+00	3.25E+00	2.42E+00	1.88E+00	1.52E+00	1.25E+00
23	SB-129	1.59E+02	4.45E+01	2.22E+01	1.37E+01	9.39E+00	6.91E+00	5.33E+00	4.25E+00	3.48E+00
24	TE-127	5.15E+01	1.46E+01	7.35E+00	4.58E+00	3.18E+00	2.37E+00	1.84E+00	1.49E+00	1.23E+00
25	TE-127M	6.78E+00	1.92E+00	9.68E-01	6.02E-01	4.18E-01	3.11E-01	2.43E-01	1.95E-01	1.62E-01
26	TE-129	1.73E+02	4.90E+01	2.46E+01	1.52E+01	1.05E+01	7.81E+00	6.06E+00	4.86E+00	4.00E+00
27	TE-129M	4.61E+01	1.31E+01	6.59E+00	4.10E+00	2.85E+00	2.12E+00	1.65E+00	1.33E+00	1.10E+00
28	TE-131M	8.62E+01	2.44E+01	1.23E+01	7.62E+00	5.29E+00	3.93E+00	3.06E+00	2.46E+00	2.03E+00
29	TE-132	8.66E+02	2.45E+02	1.26E+02	7.68E+01	5.33E+01	3.96E+01	3.09E+01	2.49E+01	2.06E+01
30	I-131	6.00E+02	1.70E+02	8.57E+01	5.33E+01	3.70E+01	2.75E+01	2.15E+01	1.73E+01	1.43E+01
31	I-132	8.82E+02	2.50E+02	1.26E+02	7.83E+01	5.44E+01	4.04E+01	3.15E+01	2.54E+01	2.10E+01
32	I-133	1.22E+03	3.46E+02	1.76E+02	1.08E+02	7.50E+01	5.57E+01	4.33E+01	3.48E+01	2.87E+01
33	I-134	6.14E+02	1.65E+02	7.91E+01	4.67E+01	3.08E+01	2.18E+01	1.61E+01	1.23E+01	9.67E+00
34	I-135	1.07E+03	3.02E+02	1.51E+02	9.33E+01	6.44E+01	4.76E+01	3.68E+01	2.95E+01	2.42E+01
35	XE-133	4.37E+03	1.30E+03	6.78E+02	4.32E+02	3.07E+02	2.32E+02	1.86E+02	1.51E+02	1.26E+02
36	XE-135	1.12E+03	3.34E+02	1.74E+02	1.11E+02	7.87E+01	5.96E+01	4.72E+01	3.86E+01	3.24E+01
37	CS-134	8.69E+01	2.46E+01	1.24E+01	7.72E+00	5.36E+00	3.99E+00	3.11E+00	2.51E+00	2.07E+00
38	CS-136	2.69E+01	7.62E+00	3.86E+00	2.39E+00	1.66E+00	1.23E+00	9.61E-01	7.75E-01	6.40E-01
39	CS-137	4.50E+01	1.28E+01	6.43E+00	4.00E+00	2.78E+00	2.07E+00	1.61E+00	1.30E+00	1.07E+00
40	BA-140	1.16E+02	3.27E+01	1.65E+01	1.03E+01	7.13E+00	5.30E+00	4.13E+00	3.33E+00	2.75E+00
41	LA-140	1.19E+01	3.40E+00	1.73E+00	1.09E+00	7.63E-01	5.73E-01	4.51E-01	3.66E-01	3.06E-01
42	CE-141	1.05E+01	2.98E+00	1.50E+00	9.34E-01	6.49E-01	4.83E-01	3.76E-01	3.03E-01	2.51E-01
43	CE-143	1.00E+01	2.83E+00	1.43E+00	8.86E-01	6.15E-01	4.57E-01	3.55E-01	2.86E-01	2.36E-01
44	CE-144	6.31E+00	1.79E+00	9.01E-01	5.61E-01	3.90E-01	2.90E-01	2.26E-01	1.82E-01	1.50E-01
45	PR-143	1.00E+01	2.84E+00	1.43E+00	8.91E-01	6.19E-01	4.61E-01	3.59E-01	2.89E-01	2.39E-01
46	ND-147	4.49E+00	1.27E+00	6.41E-01	3.99E-01	2.77E-01	2.06E-01	1.60E-01	1.29E-01	1.07E-01
47	NP-239	1.26E+02	3.56E+01	1.80E+01	1.12E+01	7.75E+00	5.76E+00	4.48E+00	3.61E+00	2.98E+00
48	PU-238	8.05E-03	2.28E-03	1.15E-03	7.15E-04	4.97E-04	3.70E-04	2.88E-04	2.32E-04	1.92E-04
49	PU-239	1.78E-03	5.04E-04	2.54E-04	1.58E-04	1.10E-04	8.17E-05	6.37E-05	5.13E-05	4.24E-05
50	PU-240	1.99E-03	5.45E-04	2.85E-04	1.77E-04	1.23E-04	9.16E-05	7.14E-05	5.75E-05	4.75E-05
51	PU-241	3.74E-01	1.06E-01	5.34E-02	3.32E-02	2.31E-02	1.72E-02	1.34E-02	1.08E-02	8.91E-03
52	AM-241	2.50E-04	7.08E-05	3.57E-05	2.22E-05	1.54E-05	1.15E-05	8.94E-06	7.21E-06	5.96E-06
53	CM-242	9.43E-02	2.67E-02	1.35E-02	8.38E-03	5.82E-03	4.33E-03	3.38E-03	2.72E-03	2.25E-03
54	CM-244	5.79E-03	1.64E-03	8.27E-04	5.15E-04	3.58E-04	2.66E-04	2.07E-04	1.67E-04	1.38E-04

Figure III-5. **Activity Option Print** Continued

* * * * * ECONOMIC EFFECTS DETAILED OUTPUT - SPATIAL INTERVAL 4 * * * * *

ICOST = 5 (1) TIMEK = 2.475E+04 (2) TOTIME = 4.959E+04 (3) ANGREN = 3.462E-02 (4)

(5) SCTR	(6) STATE	(7) FRM FRAC	(8) POP	(9) FRM AREA	(10) ANN PROD	(11) ANN MLK	(12) ANN OTHR	MLK DSP (13)	CRP DSP (14)			
1	7	1.000E+00	2.207E+03	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						(15) COSTS	1.303E+04	0.	6.962E+07	9.587E+06	6.962E+07	9.587E+06
						(16) EXP POP	2.207E+03	8.007E+00	5.588E+01			
2	7	1.000E+00	1.118E+03	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	3.529E+07	4.857E+06	3.529E+07	4.857E+06
						EXP POP	1.118E+03	8.007E+00	5.588E+01			
3	7	1.000E+00	3.265E+03	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	1.030E+08	1.418E+07	1.030E+08	1.418E+07
						EXP POP	3.265E+03	8.007E+00	5.588E+01			
4	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
5	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
6	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
7	7	1.000E+00	2.007E+03	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	6.332E+07	8.718E+06	6.332E+07	8.718E+06
						EXP POP	2.007E+03	8.007E+00	5.588E+01			
8	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
9	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
10	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
11	7	1.000E+00	1.610E+03	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	5.080E+07	6.994E+06	5.080E+07	6.994E+06
						EXP POP	1.610E+03	8.007E+00	5.588E+01			
12	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
13	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
14	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
15	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			
16	7	1.000E+00	0.	6.930E+01	1.303E+04	7.544E+03	5.485E+03	5.116E+05	5.485E+03			
						COSTS	1.303E+04	0.	4.449E+04	0.	4.449E+04	0.
						EXP POP	0.	8.007E+00	5.588E+01			

Figure III-6. Sample Print of Economic Cost Output

C. Meteorological Data Summary

A summary of the meteorological data is always produced when the meteorological data file is referenced. The summary gives an accounting of the full year of meteorological data. When meteorological bin sampling has been selected, the summary includes two tables of the meteorological bin statistics derived form the data. A sample of the meteorological data summary is shown in Figure III-7 for the case where meteorological bin sampling has been selected.

D. Final Results

The final results prints are generated for all executions of the CRAC2 program. Six different final results options are available (see subgroup RESULTS). Figure III-8 is a sample print of the final results table for option NROPT=0. The circled numbers in the figure reference the following legend:

(1) Description of each final result.

(2) Mean value of each result processed.

(3) Variance for each result processed.

(4) Probability of nonzero results.

(5) The maximum result value from the set of meteorological trials.

(6) Probability of the maximum result.

(7) The date for the maximum value trial.

(8) The bin number of the maximum value trial.

(9) The population sector for the maximum value trial.

(10) The site group for the maximum value trial.

(11) The accident leakage group for the value trial.

(12) The core inventory group for the maximum value trial.

It is important to recall that for the option NROPT=0, the printing of final results is influenced by the number of evacuation strategies requested in the EVACUATION subgroup. Corresponding to each evacuation strategy, results are printed of the early effects consequences that result from that emergency action. When more than one evacuation strategy has been requested, summary effects are printed reflecting the weighted sum of the requested strategies. Finally, results are printed of the latent effects and accident costs based solely on the last evacuation strategy. When all of the 84 allowable final result names are requested in the RESULTS subgroup and six evacuation strategies have been requested in the EVACUATE subgroup, a total of 246 final results will be printed for each leakage category. These results consist of 27 results for each of the evacuation strategies, 27 results for the evacuation summary, and 57 results showing latent effects and accident costs based solely on the last evacuation strategy.

Figure III-9 shows an example of the frequency distribution of the final results for each consequence. The final results have been grouped within the magnitude bins represented in the far left column. The frequency distribution is a complementary cumulative distribution function (CCDF). These distributions can be used directly to produced CCDF curves. A value in the frequency distribution table is interpreted as being the probability that the given consequence will exceed the given magnitude value shown at the left. The magnitude column

takes on the appropriate units for the specific consequences. The value immediately below the column headings is a scaling factor for the consequence magnitudes. The RESULTS subgroup describes the different optional outputs which are available in CRAC2. The interpretation of the statistics is the same for all of the result options.

NEW YORK , NY.
METEOROLOGICAL DATA FILE CONTAINS 697 HOURS OF OBSERVED RAIN DATA.
ACCUMULATED RAIN MEASUREMENTS TOTALED 49.38 INCHES FOR THE YEAR.
HOLZWORTH AFTERNOON MIXING HEIGHT 1200 METERS.

* * * * METEOROLOGICAL BIN SUMMARY * * * *

BIN PRIORITIES
R - RAIN WITHIN INTERVALS
S - SLOWDOWNS WITHIN INTERVALS
C D E F - STABILITY CATEGORIES
1 (0-1), 2 (1-2), 3 (2-3), 4 (3-5), 5 (GT 5) - WIND SPEED INTERVALS (M/S)

	METBIN		WIND DIRECTION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	PER CENT
1	R	0	.037	.095	.105	.119	.093	.065	.019	.062	.110	.067	.040	.038	.034	.037	.037	.049	697	7.9566
2	R	5	0.000	.167	0.000	.083	.167	0.000	0.000	.083	.167	0.000	.083	0.000	0.000	.083	0.000	.167	12	.1370
3	R	10	0.000	.016	.129	.081	.048	.065	.065	.032	.129	.145	.081	.032	.048	.048	.032	.048	62	.7078
4	R	15	.029	.049	.059	.100	.078	.069	.020	.069	.098	.118	.078	.059	.039	.029	.039	.059	102	1.1644
5	R	20	.013	.067	.120	.120	.067	.053	.040	.067	.107	.080	.053	.080	0.000	.013	.080	.040	75	.8562
6	R	25	.075	.045	.060	.104	.045	.045	.045	.075	.075	.134	.104	.060	.030	.060	.030	.015	67	.7648
7	R	30	.049	.131	.033	.066	.033	.049	.082	.098	.131	.148	.049	0.000	.016	.033	.016	.066	61	.6963
8	S	10	.083	.042	.042	.042	.083	.042	0.000	.083	.167	.083	.125	0.000	0.000	.125	.042	.042	24	.2740
9	S	15	0.000	.125	0.000	.063	0.000	0.000	0.000	.125	.188	.063	.063	.063	0.000	0.000	.125	.188	16	.1826
10	S	20	0.000	.056	0.000	.056	.056	0.000	.111	.056	.278	.056	.056	0.000	.056	.056	0.000	.167	18	.2055
11	S	25	.357	0.000	0.000	0.000	0.000	.071	0.000	0.000	.143	.071	.071	0.000	.071	0.000	.071	.143	14	.1598
12	S	30	.222	.167	0.000	0.000	0.000	.056	0.000	.111	.167	0.000	.056	0.000	0.000	0.000	.056	.167	18	.2055
13	C	3	.077	.048	.083	.042	.048	.036	.060	.042	.077	.060	.149	.101	.036	.048	.048	.048	168	1.9178
14	C	4	.044	.031	.016	.015	.020	.024	.021	.034	.223	.124	.132	.100	.050	.062	.065	.039	892	10.1826
15	D	2	.016	0.000	.082	.148	.115	.164	.098	.049	.082	.066	0.000	.033	.033	.016	.049	.049	61	.6963
16	D	3	.018	.035	.080	.071	.066	.088	.050	.093	.119	.093	.075	.066	.053	.022	.013	.049	226	2.5799
17	D	4	.046	.091	.053	.048	.038	.038	.036	.063	.121	.080	.083	.099	.068	.052	.038	.061	948	10.8219
18	D	5	.039	.056	.027	.012	.012	.008	.018	.020	.140	.095	.058	.074	.074	.120	.163	.188	3325	37.9566
19	E	2	.037	.074	.111	0.000	0.000	.111	.037	.074	.222	.074	.037	.111	0.000	.111	0.000	0.000	27	.3082
20	E	3	0.000	.038	.156	.078	.024	.054	.042	.024	.114	.066	.150	.096	.042	.030	.036	.060	167	1.9064
21	E	4	.047	.118	.058	.023	.009	.013	.019	.019	.075	.106	.157	.107	.063	.056	.057	.089	682	7.7854
22	E	5	.078	.081	.026	.011	0.000	0.000	0.000	.007	.104	.078	.093	.104	.063	.093	.148	.122	278	3.0822
23	F	2	0.000	.086	.086	.103	.095	.026	.034	.043	.026	.121	.095	.060	.086	.043	.026	.069	116	1.3242
24	F	3	.039	.055	.087	.058	.055	.042	.023	.026	.074	.065	.123	.077	.068	.065	.058	.087	318	3.5388
25	F	4	.058	.092	.077	.032	.027	.002	.017	.007	.055	.087	.192	.119	.047	.085	.050	.060	402	4.5890
26	ALL		.042	.066	.049	.037	.030	.026	.021	.034	.127	.092	.086	.080	.059	.079	.094	.077	8760	

Figure III-7. Meteorological Data Summary

NEW YORK , NY.

* * * * METEOROLOGICAL BIN SUMMARY * * * *

BIN PRIORITIES
R - RAIN WITHIN INTERVALS
S - SLOWDOWNS WITHIN INTERVALS
C D E F - STABILITY CATEGORIES
1 (0-1), 2 (1-2), 3 (2-3), 4 (3-5), 5 (GT 5) - WIND SPEED INTERVALS (M/S)

			WIND DIRECTION																
METBIN			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	PER CENT
1	R	0	26	66	73	83	65	45	13	43	77	47	28	24	24	26	26	34	697	7.9566
2	R	5	0	2	0	1	2	0	0	1	2	0	1	0	0	1	0	2	12	.1370
3	R	10	0	1	0	5	3	4	4	2	0	9	5	2	3	3	2	3	62	.7078
4	R	15	3	5	6	11	0	7	2	7	10	12	0	6	4	3	4	6	102	1.1644
5	R	20	1	5	9	9	5	4	3	5	0	6	4	6	0	1	6	3	75	.8562
6	R	25	5	3	4	7	3	3	3	5	5	9	7	4	2	4	2	1	67	.7648
7	R	30	3	0	2	4	2	3	5	6	0	9	3	0	1	2	1	4	61	.6963
8	S	10	2	1	1	1	2	1	0	2	4	2	3	0	0	3	1	1	24	.2740
9	S	15	0	2	0	1	0	0	0	2	3	1	1	1	0	0	2	3	16	.1826
10	S	20	0	1	0	1	1	0	2	1	5	1	1	0	1	1	0	3	18	.2055
11	S	25	5	0	0	0	0	1	0	0	2	1	1	0	1	0	1	2	14	.1598
12	S	30	4	3	0	0	0	1	0	2	3	0	1	0	0	0	1	3	18	.2055
13	C	3	13	0	14	7	0	6	10	7	13	10	25	17	6	0	0	0	168	1.9178
14	C	4	39	28	14	13	10	21	19	30	199	111	110	89	45	55	58	35	892	10.1826
15	D	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000
16	D	2	1	0	5	9	7	10	6	3	5	4	0	2	2	1	3	3	61	.6963
17	D	3	4	0	10	16	15	20	13	21	27	21	17	15	12	5	3	11	226	2.5799
18	D	4	44	86	50	38	36	36	34	60	115	76	79	94	57	49	36	50	940	10.8219
19	D	5	131	107	91	40	39	25	32	67	464	316	165	247	246	399	543	333	3325	37.9566
20	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000
21	E	2	1	2	3	0	0	3	1	2	6	2	1	3	0	3	0	0	27	.3082
22	E	3	0	5	26	13	4	9	7	4	19	11	25	16	7	5	6	10	167	1.9064
23	E	4	32	75	34	16	6	9	13	13	51	72	107	73	43	38	39	61	682	7.7854
24	E	5	19	22	7	3	0	0	0	2	20	21	25	28	17	25	40	33	278	3.0822
25	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000
26	F	2	0	10	10	12	11	3	4	5	3	14	11	7	10	5	3	0	116	1.3242
27	F	3	12	17	27	10	17	13	7	0	23	20	30	24	21	20	10	27	310	3.5388
28	F	4	20	37	31	13	11	1	7	3	22	35	77	40	19	34	20	24	402	4.5890
29	F	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000

* * * * SUMMARIES * * * *

R	38	98	102	120	88	66	38	69	118	92	56	39	34	48	41	53	1076	12.2831
S	11	7	1	3	3	3	2	7	17	5	7	1	2	4	5	12	98	1.0274
C	52	36	28	28	26	27	29	37	212	121	143	106	51	63	66	43	1068	12.1005
D	180	281	164	103	97	91	85	151	611	417	261	350	317	454	585	405	4560	52.0548
E	52	104	78	32	18	21	21	21	104	106	158	120	67	71	85	104	1146	13.0822
F	32	64	68	43	39	17	10	16	40	69	126	79	50	59	41	59	828	9.4521
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000
2	6	15	22	23	23	10	15	12	20	22	15	17	13	12	10	13	256	2.9224
3	25	35	81	52	39	46	33	30	76	60	102	67	45	35	31	54	819	9.3493
4	124	220	124	70	67	59	71	94	263	253	339	269	153	151	143	169	2597	29.6461
5	161	215	103	45	43	33	34	41	596	370	232	310	274	449	593	375	3922	44.7717

Figure III-7. Meteorological Data Summary Continued

• • • • FINAL RESULTS • • • •

INDP UNIFORM POP NYC MET MET BIN
ACCIDENT SEQUENCE SUMMARY, EVACUATION SCHEME SUMMARY
PAGE 1

	① DESCRIPTION	② MEAN	③ VARIANCE	④ P(NOT 0)	⑤ PEAK	⑥ P(PEAK)	⑨⑩⑪⑫	⑦ TOTAL	⑧
1	ACUTE FATALITIES	3.38E+01	7.46E+02	1.00E+00	1.21E+02	1.03E-03	1010101	15823	12
2	ACUTE INJURIES	9.01E+01	5.13E+03	1.00E+00	6.97E+02	4.28E-03	1010101	29515	5
3	POP W/BNR DS 200	1.01E+02	5.45E+03	1.00E+00	5.99E+02	6.85E-04	1010101	31907	2
4	RSK OF FAT-INT 2	4.62E-02	6.70E-04	8.89E-01	1.10E-01	3.82E-03	1010101	36507	6
5	RSK OF FAT-INT 4	5.28E-03	1.80E-04	2.73E-01	6.68E-02	3.48E-03	1010101	17724	16
6	RSK OF FAT-INT10	0.	0.	0.	0.	0.	0	0	0
7	RSK OF FAT-INT14	0.	0.	0.	0.	0.	0	0	0
8	FATAL RADIUS(MI)	1.50E+00	8.68E-01	1.00E+00	4.00E+00	6.08E-02	1010101	34223	28
9	RSK OF INJ-INT 2	7.80E-02	1.25E-04	1.00E+00	1.10E-01	1.34E-02	1010101	36507	6
10	RSK OF INJ-INT14	4.88E-05	5.05E-08	6.46E-02	1.24E-03	2.29E-02	1010101	6204	28
11	RSK OF INJ-INT18	2.82E-05	1.84E-07	4.28E-03	6.58E-03	4.28E-03	1010101	29515	5
12	RSK OF INJ-INT20	0.	0.	0.	0.	0.	0	0	0
13	RSK OF INJ-INT24	0.	0.	0.	0.	0.	0	0	0
14	INJUR RADIUS(MI)	5.38E+00	1.21E+01	1.00E+00	2.00E+01	4.28E-03	1010101	29515	5
15	ACU BNR DS-INT 2	7.92E+02	4.20E+05	1.00E+00	4.47E+03	7.99E-04	1010101	1303	11
16	ACU BNR DS-INT10	7.45E+01	3.33E+03	1.00E+00	2.53E+02	1.77E-02	1010101	24324	27
17	ACU BNR DS-INT14	2.58E+01	3.55E+02	1.00E+00	8.68E+01	2.29E-02	1010101	6204	28
18	ACU BNR DS-INT18	1.31E+01	1.49E+02	1.00E+00	1.16E+02	4.28E-03	1010101	29515	5
19	ACU BNR DS-INT20	6.42E+00	3.54E+01	1.00E+00	3.97E+01	3.48E-03	1010101	27322	7
20	ACU BNR DS-INT24	1.56E+00	8.37E-01	1.00E+00	5.99E+00	9.13E-04	1010101	5318	9
21	ACU THY DS-INT 2	2.48E+04	6.01E+08	1.00E+00	1.67E+05	7.99E-04	1010101	1303	11
22	ACU THY DS-INT10	1.84E+03	3.40E+06	1.00E+00	7.83E+03	1.77E-02	1010101	24324	27
23	ACU THY DS-INT14	6.25E+02	3.60E+05	1.00E+00	2.64E+03	2.29E-02	1010101	6204	28
24	ACU THY DS-INT18	1.67E+02	2.04E+04	1.00E+00	6.48E+02	9.13E-04	1010101	5318	9
25	ACU THY DS-INT20	9.28E+01	7.28E+03	1.00E+00	6.22E+02	7.99E-04	1010101	36421	11
26	ACU THY DS-INT24	2.36E+01	2.26E+02	1.00E+00	9.31E+01	9.13E-04	1010101	5318	9
27	ACU THY DS-INT30	8.59E+00	3.06E+01	1.00E+00	2.24E+01	9.13E-04	1010101	29612	9

Figure III-8. Final Results Sample Output

* * * FREQUENCY DISTRIBUTIONS * * *

INDP UNIFORM POP MYC MET MET BIN
ACCIDENT SEQUENCE BMR1
PAGE 4

MAGNITUDE	1-ACUTE FATALITIES MAG.X1.00E+00	2-ACUTE INJURIES MAG.X1.00E+00	3-POP W/BMR DS>200 MAG.X1.00E+00	4-RSK OF FAT-INT 2 MAG.X1.00E-06	5-RSK OF FAT-INT 4 MAG.X1.00E-06	6-RSK OF FAT-INT10 MAG.X1.00E-06	7-RSK OF FAT-INT14 MAG.X1.00E-06	8-FATAL RADIUS(MI) MAG.X1.00E+00	9-RSK OF INJ-INT 2 MAG.X1.00E-06	10-RSK OF INJ-INT MAG.X1.00E-06
1.0E+00	1.00E+00	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	8.89E-01	1.00E+00	6.46E-02
2.0E+00	1.00E+00	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	2.73E-01	1.00E+00	6.46E-02
3.0E+00	1.00E+00	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	1.21E-01	1.00E+00	6.46E-02
5.0E+00	1.00E+00	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
7.0E+00	1.00E+00	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
1.0E+01	1.00E+00	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
2.0E+01	6.41E-01	1.00E+00	1.00E+00	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
3.0E+01	3.87E-01	8.98E-01	1.00E+00	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
5.0E+01	1.63E-01	8.71E-01	8.84E-01	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
7.0E+01	1.28E-01	3.71E-01	4.50E-01	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
1.0E+02	5.20E-02	3.26E-01	3.21E-01	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	6.46E-02
2.0E+02	0.	8.64E-02	1.14E-01	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	4.17E-02
3.0E+02	0.	4.28E-03	1.37E-03	8.89E-01	2.73E-01	0.	0.	0.	1.00E+00	4.17E-02
5.0E+02	0.	4.28E-03	0.	8.84E-01	2.73E-01	0.	0.	0.	1.00E+00	4.17E-02
7.0E+02	0.	0.	0.	8.84E-01	2.42E-01	0.	0.	0.	1.00E+00	4.06E-02
1.0E+03	0.	0.	0.	8.84E-01	2.22E-01	0.	0.	0.	1.00E+00	2.29E-02
2.0E+03	0.	0.	0.	8.84E-01	1.30E-01	0.	0.	0.	1.00E+00	0.
3.0E+03	0.	0.	0.	8.84E-01	1.30E-01	0.	0.	0.	1.00E+00	0.
5.0E+03	0.	0.	0.	8.84E-01	1.30E-01	0.	0.	0.	1.00E+00	0.
7.0E+03	0.	0.	0.	8.80E-01	1.30E-01	0.	0.	0.	1.00E+00	0.
1.0E+04	0.	0.	0.	8.77E-01	1.30E-01	0.	0.	0.	1.00E+00	0.
2.0E+04	0.	0.	0.	8.77E-01	1.29E-01	0.	0.	0.	1.00E+00	0.
3.0E+04	0.	0.	0.	6.41E-01	1.29E-01	0.	0.	0.	1.00E+00	0.
5.0E+04	0.	0.	0.	4.50E-01	3.48E-03	0.	0.	0.	1.00E+00	0.
7.0E+04	0.	0.	0.	2.10E-01	0.	0.	0.	0.	7.69E-01	0.
1.0E+05	0.	0.	0.	3.82E-03	0.	0.	0.	0.	2.30E-02	0.
2.0E+05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3.0E+05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5.0E+05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7.0E+05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.0E+06	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2.0E+06	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3.0E+06	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5.0E+06	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7.0E+06	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.0E+07	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Figure III-9. Frequency Distribution Table Sample Output

IV. FILE DESCRIPTION

The following data files are used in the CRAC2 code.

1. File 5 (TAPE5, program variable NIT) Standard Input File

   Standard input file supplied by the user, normally containing the input data deck. The input data deck consists of the input subgroups necessary to define the reference case and to specify one or more modification cases.

   File format: Card images, 80 characters per logical record.

   File contents: See previous sections for detailed description of the input data deck.

2. File 6 (TAPE6, program variable NOT) Standard Output File

   Standard output file, normally the printer.

   File format: 133 character logical records

   File contents: All output produced by the model except error messages which are written using the FORTRAN "PRINT" statement.

3. File 10 (TAPE10, program variable NITSV) Chronic Subgroup Reference File

   Temporary file used to store a copy of the most current chronic subgroup from the input data deck on File 5. It is used to initialize the chronic subgroup and health data.

   File format: Card images, 80 characters per logical record

   File contents: Copy of the card images of the most recently read chronic subgroup.

4. File 11 (TAPE11, program variable NAT) Reference Subgroup Change File

   Temporary file used to store reference case subgroups, so that they may be reinstituted in subsequent modification cases.

File format: Card images, 80 characters per logical record.

File contents: Copies of the card images of user-specified reference case subgroups.

4. File 12 (TAPE12) Concentration File

Temporary file used to save the isotope air and ground concentrations, effective cloud height, and plume rise data for each leakage category when the number of leakage categories (NLEAK) is greater than 1. The file is written in subroutine ACTIVE and read in subroutine DAMAGE.

File format: Unformatted sequential temporary data file. The number of records written on this file for each modification case is NLEAK, where NLEAK is the number of leakage categories. If NLEAK=1, no records are written.

File contents: Records containing the following data:

Variable Name	Type	Description
AC(54, 34)	Real	Integrated air concentration for each isotope at each spatial interval.
GC(54, 34)	Real	Ground concentration for each isotope at each spatial interval.
EFHGHT(34)	Real	Effective height of the cloud at each spatial interval.
HITE(34)	Real	Plume interline height at each spatial interval.

5. File 20 (TAPE 20) Site Data File

Permanent reference file containing the site identification, seasonal windroses, population, and land data for one

nuclear power plant site. The file is read by subroutine SITE.

File contents: Formatted sequential data file. The file has 135 card image records corresponding to one plant site.

File format: The file consists of the following data:

Data Array and Dimension	Data Format	Data Description
IDENT(20)	20A4	Site identification information. The data are read as (IDENT(I), I=1,20).
ROSE(16,4)	16F5.3	Windrose probability in each of 16 directions for each of 4 seasons. The data are read as ((ROSE(I,J), I=1,16), J=1,4).
POP1(16,34)	4(8F10.0,/), 2F10.0	Individual site population for each of 16 sectors and 34 predefined spatial intervals. The data are read as ((POP1(I,J), J=1,34), I=1,16).
FRLAN1(16,34)	16F5.2	Land fraction for each of 16 sectors and 34 spatial intervals. The data are read as ((FRLAN1(I,J), I=1,16), J=1,34).
INSTAT1(16,34)	34I2	State code for each of 16 sectors and 34 spatial intervals. The data are read as ((ISTAT1(I,J), J=1,34), I=1,16).

7. File 21 (TAPE21) Dose Conversion File

Permanent reference file used to store ground, cloud, and inhalation dose conversion factors for 13 organs and 54 isotopes. This data is used in the computation of the health effects. File 21 is read by subroutine CHRON.

File contents: Formatted sequential data file. The file has 1423 card image records.

File format: Records 1 through 6 contain the names of the 54 isotopes for which data is stored on the file. The order of the names corresponds to the order of the data in subsequent records. These six records have the format 10A8.

Records 7 through 1423 contain the organ names and dose conversion factors. There are 109 records for each of the 13 organs. Records 7 through 115 pertain to organ 1, records 116 through 224 to organ 2 and so forth. The set of records pertaining to organ I has the format described below:

The first record of the set contains the name of the organ in A8 format.

The second through 109th records of the set contain the dose conversions for organ I in the order ((INCON (I,J,K), J=1,7), (GRCON(I,J,K), J=1,3), CLCON(I,K), K=1,54). The format of these records is (7E10.4/4E10.3).

A description of the data follows:

Variable Name	Type	Description
GRCON(I,J,K)	Real	Array containing the dose conversion factors for exposure to contaminated ground in rem/Ci/m^2, where I is the organ number (between 1 and 13), J is the time index (1 to 3), K is the isotope index (1 to 54).

		GRCON(I,1,K) contains the dose conversion factor, which, when multiplied by the initial ground concentration of isotope K, gives the 8-hour integrated dose to organ I from isotope K. GRCON(I,2,K) contains the dose conversion factor, which, when multiplied by the ground concentration of isotope K, gives the 7 day integrated dose to organ I from isotope K. GRCON(I,3,K) contains the dose conversion factor, which when multiplied by the initial ground concentration of isotope K, gives the dose rate in rem-cm^2/Ci-yr to organ I from isotope K.
CLCON(I,K)	Real	Array containing the dose conversion factors for exposure to contaminated air in rem-m^3/Ci-sec, where I is the organ number (between 1 and 13), K is the isotope index (1 to 54). CLCON(I,K) contains the dose conversion factor, which when multiplied by the exposure (Ci-sec/m^3) gives the dose to organ I from isotope K.
INCON(I,J,K)	Real	Array containing the dose conversion factors for inhaled radionuclides (rem/Ci inhaled), where I is the organ number (between 1 and 13), J is the time period index, 1 to 7, representing the periods: 1 - time period for acute exposure (1 year for lung;

7 days for marrow, skeletal bone, endosteal cells, stomach wall, small intestine, upper large intestine, and lower large intestine; 2 days for thyroid, whole body, testes, ovaries, and other tissues),
2 - 0-1 year,
3 - 1-10 years,
4 - 10-20 years,
5 - 20-30 years,
6 - 30-40 years,
7 - 40-50 years),

K is the isotope index (1 to 54).

INCON(I,J,K) contains the dose conversion factor, which when multiplied by the number of curies of isotope K inhaled, gives the dose to organ I during time period J, from isotope K.

8. File 27 (TAPE27) Meteorological Data File

Permanent reference file used to store meteorological data for one nuclear power plant site. The file is read by the subroutine SITE or the subroutine BINMET.

File contents: Formatted sequential data file. The file has 8762 card image records corresponding to one site.

File format: Record 1 contains the reactor site identification information with format 5A4.

Records 2 through 8761 contain the hourly directional weather data for the site, one record per hour. Each record consists of two words identifying the day and hour of the day and two words of packed meteorological data for this hour.

The format of this record is (1X,I3,1X,I2,1X,I6,I3). The day and hour of the day are used as indices to store the meteorological data. The two words of meteorological data can be represented as DDWWWS and RRR, where two characters contain the wind direction (indicated by DD), three characters contain the wind velocity (indicated by WWW), one character contains the stability class (indicated by S), and three chracters contain the rain intensity (indicated by RRR). When the meteorological data are read, the first word of packed meteorological data is multiplied by 10 and the meteorological data are stored as follows:

Data Array Name and Dimension	Data Type	Data Description
IDTA(24,365)	Integer	Hourly directional weather data. The data is packed with wind direction stored in the 1000000's and 100000's digits, the windspeed in the 10000's, 1000's and 100's digits, the stability category in the 10's digit, and a 0 in the 1's digit. The data are stored as ((IDTA(I,J), I=1,24), J=1,365).
RAIN(24,365)	Integer	Hourly rain data. The data are packed with the hourly rainfall in the 100's, 10's and 1's digits. The data are stored as ((RAIN(I,J), I=1, 24), J=1,365).

The direction data is in sector numbers, 1 to 16. The wind speed is in tenths of meters per second. The stability data

is coded with the stability categories A, B, C, D, E, and F represented as 1, 2, 3, 4, 5, and 6, respectively. The rain intensity is recorded in hundredths of inches of rain per hour.

Record 8762 contains eight mixing heights representing the seasonal Holzworth mixing heights in hundreds of meters for stable (morning) and unstable (afternoon) conditions. The four stable heights appear first in the order winter, spring, summer, and fall; the four unstable heights follow in the same seasonal order. The format of the record is 8F10.2. Only the unstable mixing heights are utilized in the CRAC2 dispersion model.

9. File 30 (TAPE30, program variable NT30) Final Summary File

The unformatted file on which the final result summaries are stored. This file contains the site title, number of leakage groups including the summary, total number of results, number of scale magnitude values used in the distributions, number of sectors, number of spatial intervals, final result names, scaling factors, distribution scale magnitudes, and the distributions of the final results from each leakage.

10. Files 31, 32, ..., 45 Temporary Work Files

Temporary unformatted files used to store the intermediate results of each leakage group. File 31 corresponds to leakage group 1, File 32 corresponds to leakage group 2, ..., and File 45 corresponds to leakage group 15.

11. File 50 (TAPE50, program variable NET) Summary Results

Copy of the standard output file showing the summary results summed over all leakage categories but with no frequency distributions.

File Format: 133 character logical records.

File Contents: All output produced by the model of the summary results over all leakage categories.

V. Sample Problems

This section briefly describes five sample problems that have been chosen to illustrate the use of CRAC2. These five problems were designed as modification cases to the reference case defined by the sample input decks in the subgroup descriptions of Section II. A complete listing of the reference case together with the five modification cases that define these problems can be found on the microfiche included with this user's guide. The output from the CRAC2 code for each of the sample problems is also included on the microfiche.

The sample problems are intended to serve as a guide and primer for users of the CRAC2 code. These problems should provide meaningful examples that illustrate the preparation of input data, the selection of user options, and the output produced by the code.

A. Sample Problem 1.

Sample problem 1 is defined by the reference case and the modification case listed here.

```
INDP  SITE POP   NYC MET   5/24 1600 HRS
SITE
INDPT SITE  NYC MET              7 52416 0
POPULATION              16   NO
 0
EVACUATE                 1   NO      NO
      1.0        3.        4.47      14.0        24135.      14.0        2.        1.
      .25        1.        .5        .75         .33         .5          .08       .33
   2.66E-4    2.66E-4    1.33E-4    2.66E-4
     8045.        90.        95.        3.        1
LEAKAGE                  1   NO      YES
BMR 1
      1.0        1.0        1.0        1.0        0.0         0.0         20.0
      1.0        0.0        0.3        0.3        0.3         0.03        0.03      0.003
END
```

The problem consists of a single trial using start code 7. Meteorological data for the trial is supplied from the meteorological data file. The single trial begins at 1600 hours on May 24. The population and topographic data are to be read from the site data file. The POPULATION subgroup contains a request for all 16 wind directions to be processed. One evacuation strategy is to be applied to the analysis. The LEAKAGE subgroup specifies one leakage category with the name BMR1 (Benchmark Release 1) and requests that the subgroup be made a permanent change to the reference case.

B. Sample Problem 2

Sample problem 2 is defined by the reference case with the permanent modification from problem 1 and the modification case listed here.

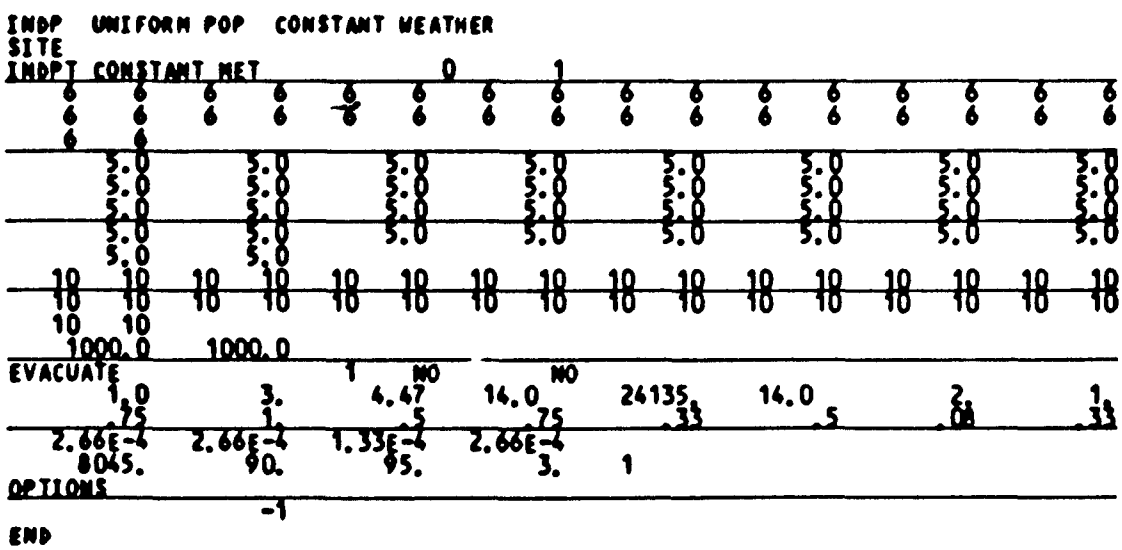
```
INDP  UNIFORM POP   NYC MET   5/24 1600 HRS   ACUTE FATALITIES BY DISTANCE
SITE
INDPT UNIFORM NYC MT          7 52416 1
POPULATION                    NO      YES
 1
100.0
EVACUATE                  1   NO      NO
      1.0       3.      4.47    14.0      24135.    14.0      2.      1.
      .75       1.       .5      .75       .33       .5       .08     .33
  2.66E-4   2.66E-4   1.33E-4   2.66E-4
    8045.      90.       95.       3.    1
RESULTS
 1
OPTIONS
 1   1   1   1   2   0
END
```

The problem consists of a single trial using start code 7. Meteorological data for the trial is supplied from the meteorological data file. The single trial begins at 1600 hours on

May 24. The population and topographic data are to be supplied by the POPULATION and TOPOGRAPHY subgroups. The POPULATION subgroup requests a uniform population of 100 people per square mile and requests that the subgroup be made a permanent change to the reference case. One evacuation strategy is to be applied to the analysis. The RESULTS subgroup requests the acute fatalities versus distance option. The special print options, NPL=1, NPD=1, NPH=1, NPP=1, NPA=2, and NRE=0, are requested in the OPTIONS subgroup.

C. Sample Problem 3

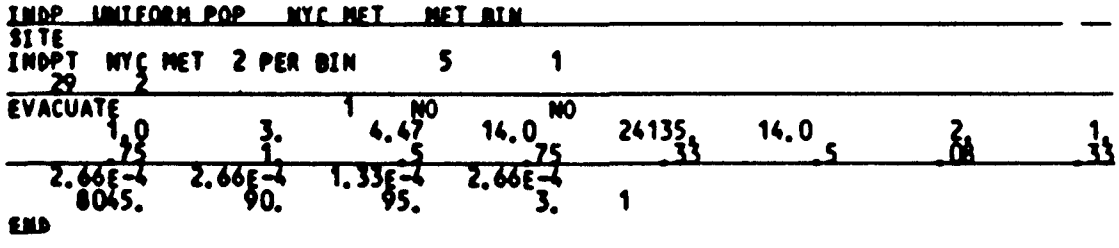
Sample problem 3 is defined by the reference case with the permanent modifications from problems 1 and 2 and the modification case listed here.



The problem consists of a single trial using start code 0. The meteorological data for each sector is supplied with the SITE subgroup. The population and topographic data are to be supplied by the POPULATION and TOPOGRAPHY subgroups in the modified reference case. The meteorological data in the SITE subgroup defines a constant weather with F stability, 5.0 m/s winds, 0.1 in/hr rain, and 1000 meter mixing heights. One evacuation strategy is to be applied to the analysis. The OPTIONS subgroup requests that the frequency distribution table not be printed.

D. Sample Problem 4

Sample problem 4 is defined by the reference case with the permanent modifications from problems 1 and 2 and the modification case listed here.



The problem consists of an analysis using start code 5, meteorological bin sampling. Meteorological trials will be sampled over a one-year period from the meteorological data file. Two meteorological trials will be selected from each meteorological

bin. The population and topographic data will be specified by the POPULATION and TOPOGRAPHY subgroups in the modified reference case. One evacuation strategy will be applied to the analysis.

E. Sample Problem 5

Sample problem 5 is defined by the reference case with the permanent modifications from problems 1 and 2 and the modification case listed here.

```
INDP  UNIFORM POP   NYC MET   STRATIFIED
SITE
INDPT STRATIFIED NYC MET      8 1 813 1
END
```

The problem requests an analysis using start code 8, stratified sampling. Meteorological trials will be sampled over a one-year period from the meteorological data file. The trials will occur every 8 days, offset by 13 hours. The population and topograhic data will be specified by the POPULATION and TOPOGRAPHY subgroups in the modified reference case. The six evacuation strategies of the reference case will be applied to the analysis.

F. Sample Problem Output

A microfiche listing of the CRAC2 output for each of these five sample problems has been included with this user's guide. The microfiche consists of four parts:

1) A listing of the reference case input data deck and the five modification cases that define the sample problems.

2) A listing of the CRAC2 code compiled on the CDC computing system at Sandia National Laboratories.

3) A listing of the results for each of the five sample problems.

4) A listing of the operating system day/file produced during the compilation and execution of the CRAC2 code as the five sample problems were processed.

APPENDIX A

The CRAC2 Computer Code

The purpose of this appendix is to describe the CRAC2 computer code that implements the models described in Section 3 of this report. Every attempt has been made to ensure an accurate rendition of these models with the goal of providing a consistent and reliable computer code.

The description of the computer code consists of two parts, an overview of the concept of operation of the code, and a description of the design and flow of the code elements.

This Appendix has been extracted in its entirety from NUREG/CR-2552 (SAND-0342), "CRAC2 Model Descriptions," by L. T. Ritchie, D. J. Alpert, R. P. Burke, J. D. Johnson, R. M. Ostmeyer, D. C. Aldrich, and R. M. Blond.

Because of its general usefulness, we have decided to leave this appendix essentially intact. Where necessary, portions of the text are flagged and footnotes are provided to help clarify differences between the original program and the modified staff version. The "flagging" consists of a vertical line with a footnote letter in the margin.

A.1 Concept of Operation

CRAC2 incorporates a progression of mathematical and statistical models which represent the radioactive material immediately after release from containment; the movement of the material as it disperses into the area around the power plant; the deposition of the material by wet and dry deposition processes and the effects of the material on man and his environment. The code approaches the calculation by dividing the area around a power plant into radial annuli which are called spatial intervals. The spatial interval is basic to these computational processes. Figure A-1 depicts a power plant and this spatial interval concept. The code allows for a maximum of 34 such spatial intervals.* The program computes the average concentration and total coverage of the radioactive cloud for each spatial interval. All other mathematical and statistical models are processed in terms of these spatial intervals.

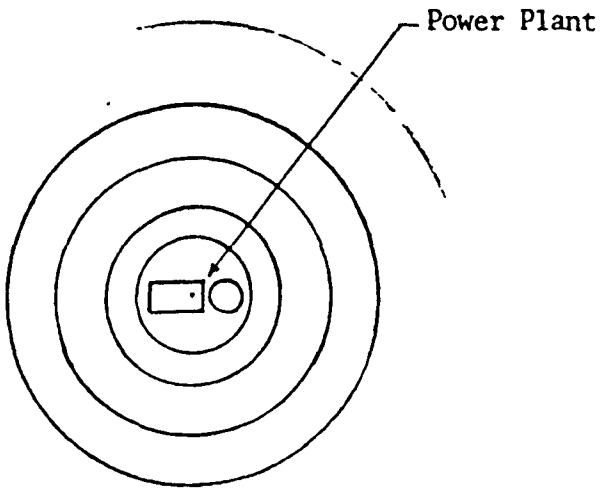


Figure A-1 Spatial Interval Representation

* See Table IV 4-1 in Appendix VI of the Reactor Safety Study.

The operation of the CRAC2 code functions can be outlined in terms of six logical steps. These steps divide the computational model into code segments that represent distinct models or recurrent processes.

Problem definition is the first step in the process. This step occurs once for each problem case specified by the user.

1. Problem Definition. The computational process is initialized by defining the problem to be solved. The INPUT control routine and fifteen input subroutines process the input data subgroups that define the user's problem.

The next two steps must be repeated for each new weather sequence, but are independent of the accident sequence.

2. Meteorological Conditions.* The second step in the computational process assigns the specific meteorological conditions to each spatial interval. This is done either in input subroutine SITE when user supplied meteorology is to be incorporated, or in subroutine SPADAT when time dependent meteorological data have been specified. A thermal stability, wind speed, and precipitation rate are assigned to each interval. This allows for changes to occur in the dispersion pattern of the cloud of radioactive material. A meteorological file containing representative hourly weather data can be automatically sampled and hourly meteorological data assigned if requested by the user.

3. Dispersion.** The next step incorporates the meteorological data into the Pasquill-Gifford model of Gaussian dispersion. This step involves the calculation of standard deviations of the horizontal and vertical dispersion values, σ_y and σ_z, and isotope dependent decay constants at the midpoint of each spatial interval. This computational step is performed in subroutine DISP.

For each weather sequence, the final three steps must be repeated for each accident sequence; up to this point the steps have been independent of the accident sequence.

---

* See Chapter 5 of Appendix VI of the Reactor Safety Study
** See Chapter 4 of Appendix VI of the Reactor Safety Study

4. Activity.* This step computes the air and ground concentrations of each radionuclide for each spatial interval. The accident parameters are utilized to compute plume rise and any initial isotope decay. The cloud is also depleted by wet and dry deposition mechanisms. All calculations are done at the midpoint of the spatial intervals. Air and ground concentrations are uniform over the entire interval area which has been contaminated by the cloud of radioactive material. Subroutine ACTIVE is responsible for this step.

5. Damage.** The damage step assesses the impact of the contamination upon man and his environment. The damage model determines how far the people in a specific spatial interval will evacuate before the cloud overtakes them. The dose to the organs of these people is computed from the immediate or early exposure. Fatalities and injuries are the resultant consequences. The latent dose is computed for the survivors and an assessment is made of the latent cancer fatalities. Chronic exposure doses are computed and a determination is made of the protective action for the contaminated land. Costs associated with this action are then computed. The population groups are factored into the results so that consequences represent each population sector. Subroutines DAMAGE, EARLY, CHRONX and PRPDAM are responsible for the damage calculations.

6. Results. Each set of consequences is stored and final statistics are computed for all desired results. Subroutines STORE and STOROPT provide these functions.

A.2 Program Flow

The CRAC2 code consists of a main program, a control routine for input processing and fifteen input subroutines, eleven meteorology and dispersion subroutines and nine damage and results subroutines. A description of each subroutine is given below. The code itself contains extensive comments to supply the user with sufficient information to read and work with the program.

---

* See Chapter 4 of Appendix VI of the Reactor Safety Study.

** See Chapters 8, 9, 11, and 12 of Appendix VI of the Reactor Safety Study.

[a]The relocation emergency response has a special case in the staff version. The evacuation/emergency response model includes a provision for a sheltering region outside the maximum evacuation distance.

A.2.1 Program MAIN, the CRAC2 Code Controller

The MAIN routine controls the execution of the CRAC2 code based upon the directions of the user. This routine calls subroutine INPUT to process the set of data that defines the problem to be solved. MAIN determines how many sets of results and/or meteorological sequences have been specified for this study and calls subroutine SITE to load the desired meteorological and site data. The control routine calls a sequence of routines for the computation of each meteorological sequence.

1. Subroutine SPADAT - Calculates the meteorological conditions for each spatial interval.

2. Subroutine DISP - Calculates the dispersion parameters at the midpoint of each spatial interval.

3. Subroutine ACTIVE - Calculates the air and ground concentration of the radionuclides at the midpoint of each spatial interval.

4. Subroutine DAMAGE - Calculates the health effects and property damage for all spatial intervals and population sectors.

When all of the meteorological sequences for a specific problem have been processed, the entry point FSUM in subroutine STORE or FSUMOPT in subroutine STOROPT is called to compute the final summaries. MAIN controls the entire sequence of computations until all problems defined by the user have been completed. The flow of the CRAC2 control program is given in Figure A-2.

A.2.2 Subroutine INPUT, the Input Controller

Subroutine INPUT controls the input processing for CRAC2. The routine reads and prints the title card and processes the subgroup header card. For each subgroup header card read, it then calls the appropriate subroutine to process the corresponding subgroup of data*. Table A-1 gives a brief description of the fifteen input subroutines that can be called by INPUT. INPUT also controls the files which maintain and reinitialize the reference data after each problem case. When a group of data is modified, the reference data being changed is stored on file NAT. With the completion of a problem case, the reference data on file NAT is reinitialized and another problem case can be performed. Subroutine INPUT functions in one of three modes: read in the reference case (IREST = -1); store the reference data and read in the modified data (IREST = 0); or restore the reference case data (IREST = 1). INPUT also

* See Chapter 2 of the CRAC2 Computer Code User's Guide, NUREG/CR-2326.

terminates the execution of the program when all of the problem cases for this execution of CRAC2 are complete. All of the input subroutines shown in Table A-1 follow essentially the following processing scheme. When the reference case is to be input, IREST = -1, and the routines read in the appropriate data. When a data subgroup is to be modified, IREST = 0, and the routines write out whatever data is found in the data arrays to the NAT file and then read in the modification data over the existing arrays. When the reference case is being reinitialized, IREST = 1, and the routines read whatever data as been written to the NAT file.

A.2.3 Subroutine SITE, the Accident Site Data Processor

b Subroutine SITE is responsible for reading the site characteristic weather data from the meteorological data file and the population and topographical data from the site data file. These data sources are read only as they are requested by the user in the input data from the input subgroups. If the user has requested the importance sampling technique (ISTART = 5 in the SITE subgroup data) to select the meteorological trials, subroutine SITE calls the BINMET subroutine which sorts the meteorological data into the 29 weather categories provided by the CRAC2 model.

A.2.4 Subroutine BINMET, the Meteorological Data Sorter

c Subroutine BINMET sorts the full year of meteorological data representing the site into 29 weather categories (also called bins) selected for the CRAC2 model. Each weather sequence is examined to determine (1) the first occurrence of rain within 30 miles of the site, (2) the first occurrence of a wind speed slow down within 30 miles of the site, or (3) the stability and wind speed at the start of the sequence. The first of these conditions that is satisfied by the sequence determines the weather category to which it is assigned. Tables are constructed of the weather category frequencies and the bin assignment of each weather sequence. This information is used by the importance sampling algorithm. A summary of the meteorological data, including two tables of the meteorological bin statistics derived from the data, are printed by BINMET.

---

[b]The importance sampling scheme (ISTART=5) has been revised for the staff version. The number of weather bins specified is now 50.

[c]Changed to incorporate four rainfall intensity bins for each of the rain bins in the meteorological bin sampling procedure (start code 5).

Table A-1. DESCRIPTION OF INPUT SUBROUTINES

Subroutine Name	Input Data Subgroup	Subroutine Function
1. SPAT	SPATIAL	Specifies the radii of annular spatial intervals around the accident site.
2. SIT	SITE	Specifies the site identification information, the parameters that define the meteorological sampling method, the source of the meteorological data, and the number of meteorological trials to be sampled. The sources of the population and topographical data for the site are also defined.
3. ECONOM	ECONOMIC	Specifies cost data for computation of economic effects.
4. POPU	POPULATION	Specifies population option switch and the population sectors to be processed. Optionally, the population for each spatial interval within the 16 sectors around the site may be defined.
5. TOPO	TOPOGRAPHY	Specifies the state code and land fraction data for each spatial interval within the 16 sectors around the site.
6. ISOTOP	ISOTOPE	Specifies the inventory of isotopes and associated parameters.
7. LEAKAG	LEAKAGE	Specifies the release identification, the associated release parameters, and the fraction of the total core inventory which is released for each isotope leakage group.
8. DISOPT	DISPERSION	Specifies the reactor building dimensions and the special wake and rain depletion options.
9. EVACU	EVACUATE	Specifies the emergency protective action parameters.
10. ACUTE	ACUTE	Specifies the acute effects due to early exposure to the radioactive cloud that are to be studied and the supporting dose-mortality and injury data for each organ.
11. LATE	LATENT	Specifies the latent effects due to early and chronic exposure that are to be studied and the supporting man-rem conversion factors and the choice of latent effects model.
12. CHRON	CHRONIC	Specifies the data used in computing radiation doses from chronic exposure and the protective action measures appropriate to the level of chronic exposure.
13. SCALE	SCALE	Specifies the consequence magnitude scaling values for tabulating the complementary cumulative distributions of the final results.
14. RESIN	RESULTS	Specifies the final results for which mean, variance and complementary cumulative distributions are to be computed and printed.
15. OPT	OPTIONS	Specifies the print options for detailed output for each meteorological trial and the switches that control the latent and chronic calculations and leakage probability normalization.

A.2.5 Subroutine RANBIN, the Latin Hypercube Initializer

The RANBIN subroutine selects the initial weather sequence sampled from each of the 29 weather categories. The selection is made using the Latin hypercube selection criteria. Latin hypercube sampling is used to assure random samples selected from evenly spaced sets within each bin.

A.2.6 Subroutine SPADAT, the Routine to Set Spatial Meteorology

Subroutine SPADAT takes the start time (month, day, and hour) of a given weather sequence and prepares the stability, wind speed and precipitation data based upon the initial and subsequent hourly meteorological conditions. The routine determines the season for this start time. It then stores the proper directional probabilities and the stable and unstable mixing heights for each season. SPADAT assigns a sequence of hourly meteorological data to the spatial intervals by calculating hourly travel distances based upon wind speed. The stability, wind speed and precipitation indicator are assigned to all of those intervals which are covered by the cloud for this hour. If the wind speed for this hour is not sufficient to fully traverse an interval, SPADAT determines the number of hours required for the wind speeds to cover the interval and averages the stability, wind speed and time of precipitation for all of the hours. It then assigns these averaged values to the interval. Months, days, and hours are incremented when necessary by subroutine INCTIM.

A.2.7 Subroutine TIMES, the Generator of Stratified Random Times

This subroutine calculates (24)·N stratified random start times. The stratification scheme selects N random day times and N random night times from each month.

A.2.8 Subroutine RANDU, the Random Number Generator

RANDU chooses a random number between 0 and 1 for use in computing random start times.

A.2.9 Subroutine TIMES2, the Generator of Random Times

This subroutine chooses a random start time for the year by selecting a random month, a random day, and a random hour.

A.2.10 Subroutine EXTRCT, the Meteorological Data Extractor

This subroutine extracts the rain, stability and windspeed data for one hour from the meteorological data supplied for the start code, ISTART = 4. It then computes the distance traveled by the cloud for the hour.

---

[d] Only used for start code 5 which now has 50 weather categories.

A.2.11 Subroutine INCTIM, the Time Incrementing Routine

This routine increments the hour, day and month counters whenever required.

A.2.12 Subroutine DISP, the CRAC2 Dispersion Model

The purpose of subroutine DISP is to compute the atmospheric dispersion of the released cloud of radioactive material using the Pasquill-Gifford parameterization of the Gaussian transport model. The routine is leakage independent and therefore is exercised only once for each set of meteorological conditions processed. DISP is called by the control program one time for each meteorological sequence. Figure A-3 shows the flow of the routine.

When it is desired to completely deposit the remnant of the radioactive cloud in the last interval, the option LIRAIN = 34 is used. The last spatial interval is then enlarged to cover an area out to 2000 miles and rain is forced to fall at the rate of .5 mm/hr over the entire interval.

Each spatial interval has a stability, wind speed and rain rate assigned to it in subroutine SPADAT. The stability and wind speed determine the meteorological forces that will act to disperse the cloud. The lateral diffusion is determined by computing a σ_y spread based upon the Martin and Tikvart power law relations of the Pasquill-Gifford curves. The vertical dispersion calculation of σ_z is based on a treatment by Turner.

An option is available to reset the values of σ_y and σ_z if the building wake is to dominate the plume. Once the values of σ_y and σ_z at the midpoint of an interval are known, an initial value of $1/\chi$ is calculated. Since the cloud timing to the interval midpoint is available, the exponential isotopic decay constant in the interval for each radionuclide is also computed.

A.2.13 Subroutine ACTIVE, the CRAC2 Activity Model

The principal functions of the subroutine ACTIVE are to compute the air concentration (Ci-sec/m^3) and ground concentration (Ci/m^2) for each radionuclide at every spatial interval. The control program calls ACTIVE one time for each meteorological sequence. Subroutine ACTIVE incorporates the accident dependent leakage parameters into the calculation for each of the leakage categories defined in the data input. Figure A-4 shows the flow of the routine.

Heat released at the time of the accident lifts the plume of radioactive material off the ground. This plume rise term

is incorporated into the model by computing a new centerline release height. Brigg's plume rise formulations are incorporated for this purpose. In addition, ACTIVE computes the initial radionuclide decay including daughter buildup from core shutdown to release to the environment.

The calculations performed by ACTIVE are done for each spatial interval. The centerline height, h, is computed at the midpoint of each spatial interval as a function of the release height and the plume rise. The exponential term in the Gaussian expression for ground level concentration, EXPON, is computed, as well as the effective cloud height, EFHGHT.

The value of χ over Q, CHIQ, is computed as the quotient of EXPON and the concentration value generated in the subroutine DISP, modified to reflect the expansion factor associated with the release duration.

The computation from CHIQ of the air and ground concentrations of each radionuclide in the interval considers the amount of radioactive material released into the atmosphere in the accident, the decay and daughter buildup of the radionuclides, and the depletion resulting from dry and wet deposition. These air and ground concentrations are computed at the midpoint of the spatial interval and apply uniformly to the entire area which was covered by the radioactive cloud in the spatial interval.

A.2.14 Health Effects and Property Damage Routines

The DAMAGE subroutine controls and performs the health effects and property damage calculations. The DAMAGE routine is called by the main program one time for each meteorological sequence. Figure A-5 shows the flow within the DAMAGE subroutine.

DAMAGE first assigns the dollar costs of evacuation for each of three evacuation cost models. In the first model no evacuation takes place. In the second model, all people in a circular area surrounding the site are evacuated. The radius of the circle corresponds to the maximum evacuation distance. In the third model, a circular area around the site is evacuated together with an arc that is centered on the prevailing wind direction that extends beyond the circular area. The user must specify the radius of the circle and of the arc as well as the arc width. Costs are calculated based on the number of people evacuated by the respective model.

The accident leakage categories are each processed in the order in which they are defined by the leakage subgroup data. The applicable evacuation cost for the leakage category is assigned as determined by the parameters of the leakage

category that is being processed. When the warning time is 0, the first model is used, when the duration of release is greater than EVCOST(4), the second cost model is used; for all other situations the keyhole evacuation cost model is utilized.

The spatial intervals are used as the basis for the health effects and property damage calculation. Subroutines DISP and ACTIVE have previously computed the air concentrations (Ci-sec/m^3) and ground concentrations (Ci/m^2) of radioactive material, the area covered by the material, and the cloud duration at each interval. To evaluate the consequences of an accident, DAMAGE processes each spatial interval through (1) an evacuation model; (2) an acute, latent and chronic dose and dose effects model; and (3) a property damage model. A complete set of consequences is computed for each spatial distance from the reactor.

Two options are provided to treat the evacuation of people to mitigate the early exposure of individuals to the radioactive materials released by the reactor accident. The first evacuation option was utilized in the Reactor Safety Study and is based on a constant effective evacuation velocity. For those intervals being evacuated; e.g., those intervals within the maximum evacuation distance, the routine calculates the distance required for the cloud to catch the people. The second evacuation option is also based on a constant evacuation velocity. Option two, however, incorporates a delay time before public movement, followed by evacuation radially away from the reactor at constant speed. In addition to the maximum evacuation distance, both the assumed delay time and evacuation speed are required as input to the model. Different shielding factors and breathing rates are used while persons are stationary (before evacuation) or in transit (during evacuation). All persons within the designated evacuation area move as a group with the same delay time and evacuation speed.

Both evacuation options provide for sheltering outside of the designated evacuation area. No emergency action occurs outside the sheltering radius. However, shielding factors and breathing rates are defined separately for people who are in the sheltering and no emergency action areas. The sheltering radius must be specified with the input date for the evacuation model.

For both of the evacuation options, the people within the non-evacuating intervals are assumed to remain at their respective locations for either 24 hours, 24(EXPD) hours or for seven days. In the seven day relocation option, if the seven day dose approaches lethal levels, i.e., a dose to the bone marrow exceeding 200 rem, it is assumed that immediate detection will be made and the people will be relocated after a 24-hour exposure. In the 24 hour or 24(EXPD) hour relocation options, the people will always be relocated after the specified 24 hour or 24(EXPD) hour exposure. An exponential interpolation between

[e]For the staff version, the 24-hour exposure was reduced to 12 hours.

the 8 hour dose and the 7-day dose is performed to calculate this 24 hour or 24(EXPD) hour dose.

The cloud gamma ray shine factor calculations are performed in routines SHINCF and POL2. This cloud gamma ray shine factor is calculated by a two variable interpolation of the cloud centerline height and vertical standard deviation, σ_z.

The dose and health effects from the early exposure to the cloud are computed next. Early exposure is defined as the exposure from the passing radioactive cloud and from the immediate ground contamination. The passing cloud exposure manifests itself as the dose from the inhalation of the radioactive material and from the cloud gamma ray shine. The immediate ground exposure is based upon an integrated exposure time either during the emergency evacuation or during the relocation phase of the damage calculation.

Subroutine EARLY is utilized to compute these early doses. Figure A-6 shows the flow within this routine. In addition, this subroutine calculates both the acute and latent effects from this early dose. Calculations are performed on the basis of individual spatial intervals.

Subroutine EARLY first calculates the acute effects from the early exposure. For every organ considered, the routine accumulates the dose from each radionuclide. The three exposure paths, cloud shine, inhalation, and ground exposure, are calculated separately and are summed together for the total dose to the organ. Figure A-7 shows a graphic presentation of the modeling of dose with distance from the accident. The dose is represented by a uniform trapezoidal volume for each spatial interval.

Acute dose effects are calculated utilizing a three segment linear interpolation of the dose response curves. Acute effects are the fatalities and injuries which manifest themselves in less than one year after exposure. The calculation of acute effects is performed on an individual organ basis so that the specific cause of the early effects can be determined. The routine generates a probability of acute effect which in turn is accumulated over all organs for this spatial interval. The accumulation process assumes that those people not fatally injured by a previous organ are available to be fatally injured by the next organ. Therefore, a person can only be a fatality one time, by one organ. Synergistic effects between organs are ignored.

The EARLY subroutine also evaluates the latent (long-term) effects from the early exposure when the LAT2 entry point is called. The calculation is again performed on an organ by organ basis. Organs subject to latent effects are not necessarily

REFERENCES

1. WASH-1400 (1975), Reactor Safety Study, Appendix VI: Calculation of Reactor Accident Consequences, NUREG 75/014, US Nuclear Regulatory Commission.

2. L. T. Ritchie, J. D. Johnson, and R. M. Blond, (1983), Calculations of Reactor Accident Consequences, Version 2, CRAC2, Computer Code User's Guide, NUREG/CR-2326 (SAND 81-1994), Sandia National Laboratories.

3. L. T. Ritchie, D. J. Alpert, R. P. Burke, J. D. Johnson, R. M. Ostmeyer, D. C. Aldrich, and R. M. Blond, "CRAC2 Model Descriptions," NUREG/CR-2552 (SAND 82-0342).

4. J. D. Johnson and L. T. Ritchie, "CRAC Calculations for Accident Sections of Environmental Statements," NUREG/CR-2901 (SAND82-1693).

5. D. C. Kocher, R. C. Ward, et al, Sensitivity and Uncertainty Studies of the CRAC2 Computer Code, NUREG/CR-4038 (ORNL-6114).

6. Private communications from Larry Bell to TDMC, June 18, 1985.

7. Letter from Larry Bell and Earl Markee, "Change in CRAC2 Wet Removal Coefficient," July 19, 1985.

8. Letter from Daniel Alpert (Sandia) to Larry Bell (NRC) dated July 25, 1985.