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CRAC Calculations for Accident Sections of Environmental Statements

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Sandia National Laboratories

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FOREWORD BY
DIVISION OF SYSTEMS INTEGRATION STAFF

Subsequent to the Nuclear Regulatory Commission's Statement of Interim Policy on Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969 (published in 45 Federal Register June 13, 1980, pp.40101 - 40103), the staff in the Division of Systems Integration, Office of Nuclear Reactor Regulation, has been providing analyses of impacts of reactor accidents in Environmental Statements. For analyses of relatively low probability accidents involving large atmospheric releases of radioactivity, a primary tool used by the staff has been the CRAC computer code (developed for the Reactor Safety Study - WASH-1400). The present CRAC code requires a large number of runs and a large amount of data handling outside of the code to aid the staff's analyses for a given plant/site combination.

The contractual effort described in this report provides modifications in the CRAC2 code (a revised version of CRAC) intended to make CRAC2 a more effective and efficient licensing tool applicable to analyses of consequences and risks of reactor accidents in casework for Environmental Statements and plant specific Probabilistic Risk Assessment reviews. It is known that the results calculated by use of CRAC and CRAC2 were reasonably close (within the expected range of uncertainty) for some specific benchmark problems used in the recent international benchmark exercise on reactor accident consequence calculations sponsored by Organization of Economic Cooperation and Development. However, the staff has not completed testing the modified CRAC2 code package provided by the contractor, nor conducted any benchmark comparisons for any particular plant/site combinations with the results that would be obtained from application of CRAC to the same plant/site. Therefore, pending completion of these staff actions, the numerical results presented in the report relating to any particular plant/site are regarded by the staff as only examples of application of the modified code-package. Upon completion of the benchmarking evaluation of the modified code-package, the staff intends to use it as the tool for future casework analyses for Environmental Statements.

ABSTRACT

The CRAC2 computer code has been adapted to the calculation requirements of Draft/Final Environmental Impact Statement (DES/FES) casework analysis for the Nuclear Regulatory Commission. CRAC2 is a revised version of the CRAC (Calculation of Reactor Accident Consequences) computer code developed in support of the Reactor Safety Study, WASH-1400. A graphical output package has been developed for displaying CRAC2 computed results. All phases of the casework analysis calculations from initial data formatting to plotting of calculated results are executed through the use of procedure files on the Idaho National Engineering Laboratory (INEL) computing system at Idaho Falls, Idaho. The INEL computing system operates under the Control Data Corporation (CDC) NOS/BE Operating System (Level 518) and Intercom Version 5.

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I. INTRODUCTION

The objective of this program was to make the CRAC2 computer code a more effective and efficient licensing tool. In particular, the CRAC2 code's applicability to consequence casework analysis of core-melt accidents for Draft/Final Environmental Statements (DES/FES) was to be enhanced. CRAC2 is a revised version of the CRAC (Calculation of Reactor Accident Consequences) computer code developed in support of the Reactor Safety Study, WASH-1400. This report assumes familiarity with existing CRAC2 documentation. The results of earlier work in developing the CRAC2 code and a graphical output package (TALK) to display CRAC2 results have been utilized.

Methods presented here were developed for creating CRAC2 data files from the meteorological, demographical, and topographical data supplied by the Nuclear Regulatory Commission (NRC) on the Idaho National Engineering Laboratory (INEL) computing system at Idaho Falls, Idaho. The INEL computing system operates under the NOS/BE Operating System (Level 518) and Intercom Version 5. The CRAC2 code has been adapted to the calculation requirements of DES/FES casework analysis through several modifications in emergency response assumptions and in calculated results. TALK, the graphical output package for displaying CRAC2 results, has also been modified for display of additional results. The modified graphical output package, TALK2, was developed and tested at INEL in the spring of 1982.

II. NARRATIVE DESCRIPTION OF CRAC2 MODIFICATIONS

Several modifications were required in the CRAC2 computer code for use in casework analysis for Draft and Final Environmental Statements. The following sections describe these modifications.

A. Sheltering/Relocation Region Modification

The evacuation or emergency response model in 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.

B. 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.

C. 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 in the CRAC2 User's Guide is reproduced here with appropriate descriptions of the two modifications.

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)
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

Column	Mnemonic	Format	Description
			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 FXPD(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.
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 on the following page.

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).
	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.

Card	Column	Mnemonic	Format	Description
3	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 24 hours.

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 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.

D. 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 with new 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.

III. PROCEDURE FILE USAGE IN PERFORMING DES/FES CASEWORK CALCULATIONS

Procedure files are used to simplify the handling of data in performing DES/FES casework calculations. One procedure file is used to manipulate site-specific input data into a CRAC2-compatible format. Another procedure file is used to initiate CRAC2 executions. A third procedure file is used to initiate the interactive plotting program which creates a device-independent plot file which can be processed using any one of three system post-processor procedures. Three additional procedure files are used for permanent file storage on magnetic tape. The procedure files retained on the INEL computing system are described in the sections following the description of the INEL login procedures. All typed commands are followed by a carriage return (hit the RETURN key on the terminal).

A. INEL Login Instructions

The following list of instructions describes the procedure for logging onto the INEL computing system at Idaho Falls, Idaho.

1. Turn on terminal and set-up for 1200 baud, half-duplex transmission.
2. Dial FTS 583-1920 (1200 baud line at INEL).
3. Listen for computer dial tone.
4. Connect modem and/or terminal.
5. Hit RETURN key until terminal responds with login command.
6. Type LOGIN,userid,password.
7. Terminal will respond with list of computer system bulletins and then the word "COMMAND-".
8. Type ATTACH,USERLIB
9. Type LIBRARY,USERLIB
10. Type ATTACH,FILESET,ID=SWA

The file FILESET contains all procedure files as described in this chapter.

B. METPOP: Calling Procedure For Reformatting Non-CRAC2 Input Data

The METPOP procedure is used for reformatting non-CRAC2 formatted meteorological data, demographical data, and topographical data provided by the NRC. The METPOP procedure file is retrieved from the set of files by entering:

```
GF,METPOP
```

The METPOP procedure is then initiated by entering:

```
METPOP,fname,sname,mname
```

where METPOP specifies the name of the procedure and the other

parameters are defined as follows:

fname is the name of the permanent file containing NRC-provided meteorological, demographical, and topographical data in non-CRAC2 format. fname is limited to a maximum of 20 characters.

sname is the site name to be associated with the CRAC2-formatted demographical and topographical data. sname is limited to a maximum of 10 characters.

mname is the station name to be associated with the CRAC2-formatted meteorological data file. mname is limited to a maximum of 10 characters. The meteorological data file is cataloged as MET[mname] with no spaces between characters.

The format of the NRC-supplied file "fname" is described in Appendix D.

C. CRAC2: Calling Procedure For Initiating CRAC2 Executions

The CRAC2 procedure is used for initiating CRAC2 computer code executions using a prescribed set of input parameters. The CRAC2 procedure file is retrieved from the set of files by entering:

```
GF,CRAC2
```

The CRAC2 procedure is then initiated by entering:

```
CRAC2,sitnam,mtr,nsi,rt,p1,p2,sc,evmd,quk
```

where CRAC2 specifies the name of the procedure and the other parameters are defined as follows:

sitnam is the site name associated with the CRAC2-formatted demographical and topographical data. sitnam is limited to a maximum of 10 characters.

mtr is the station name associated with the CRAC2-formatted meteorological data file. mtr is limited to a maximum of 10 characters.

nsi specifies either a 50 or 500-mile execution

YES = 50-mile execution

NO = 500-mile execution

rt is the reactor type.

BWR = Boiling Water Reactor

PWR = Pressurized Water Reactor

p1,p2 is the thermal power level factor for the reactor. The reference isotope inventory is multiplied by the thermal power level factor to correct for a power level different from the standard 3412 MWt PWR. p1 and p2 are assembled into one decimal number:

p1.p2

p1 can either be 0 or 1

p2 can be any integer from 000 to 999 (3 digits must be specified for p2)

For example, if a power level of 3412 MWt is desired, p1 would be set to 1 and p2 would be set to 000. The thermal power level factor would then be 1.000 for a 3412 MWt power level.

sc is the start code determining the meteorological sampling method.

5 = meteorological bin sampling (4 samples from each of 29 bins)

6 = single random meteorological sample

evmd specifies the EVACUATE and ACUTE subgroups to be used. The EVACUATE subgroup is taken from the file of EVACUATE subgroups (see Appendix E).

S = Standard emergency response (see Table E-1) and supportive medical treatment with respect to bone marrow irradiation

M = Minimum medical treatment emergency response (see Table E-2) and minimum medical treatment with respect to bone marrow irradiation

R = Early relocation emergency response (see Table E-3) and supportive medical treatment with respect to bone marrow irradiation

quk specifies either a "quick" execution or a full execution.

0 = full execution, no extended print options

1 = "quick" execution, extended print options, single random meteorological sample, single release category

Note: Specifying quk as 1 will override the start code specification, sc, and the reactor type, rt.

All parameters must be specified in the order given.

The result of executing this procedure with quk = 1 will be an output file which can be transferred to a line printer. The results of executing this procedure with quk = 0 will be an output file containing all calculated results, three microfiche copies of the output file, an unformatted catalogued file (TAPE30) containing all calculated results (used by plotting routine), and a formatted catalogued file (TAPE50) containing all calculated results for the summary leakage category, excluding risk tables and frequency distributions. TAPE30 is catalogued using procedure-specified variables as:

[sitnam][lmt][evmd]T30

TAPE50 is catalogued using procedure-specified variables in the same manner:

[sitnam][lmt][evmd]T50

The quantity lmt is either 50 or 500 depending on the value of the input variable nsi. TAPE30 and TAPE50 for the Catawba site using a 500-mile limit and minimum medical treatment would be catalogued as:

CATAWBA500MT30

and

CATAWBA500MT50

respectively.

The retention time on a TAPE30 file is 180 days. If a TAPE30 file has not been accessed for a period of 180 days it will be purged from the computing system disk files. The retention period on a TAPE50 file is 30 days after which it will be purged from the computing system disk files. These files can be backed up on magnetic tape as described in Section III.D.

D. PLOT: Calling Procedure For Plotting CRAC2 Results

The PLOT procedure is used for initiating the graphical output package for plotting previously calculated CRAC2 results. The PLOT procedure is retrieved from the set of files by entering:

GF,PLOT

The PLOT procedure is then initiated by entering:

PLOT

where PLOT specifies the name of the procedure. No other parameters

are required. The plotting procedure is interactive such that the user will be queried as to the type and form of plots desired. When all plots have been completed, a file of plot commands will have been constructed. Three post-processors are available for displaying prepared plots:

1) TEKPOP, Tektronix CRT display

2) VRSPOP, Versatec paper display

3) FR80POP, Microfiche or 35-mm microfilm display

The first post-processor (TEKPOP) can be used for preliminary examination of plots while the second post-processor (VRSPOP) can be used for report-quality hardcopies. The third post-processor (FR80POP) can be used for compact storage of plots from which report-quality hardcopies can be re-created.

To use the TEKPOP post-processor the user must enter:

```
ATTACH,TEKPOP
TEKPOP
```

from a Tektronix graphics terminal. The terminal responds with "ENTER DIRECTIVES" to which the user responds with a space followed by a carriage return. The first plot will be displayed on the Tektronix screen. To display the next plot, the user again enters a space followed by a carriage return. This process is repeated until all plots have been displayed. The terminal will respond with an error message after all plots have been displayed but this is normal.

To use the VRSPOP post-processor the user must enter:

```
BEGIN,VRSPOP
```

The terminal will respond with "ENTER DIRECTIVES" to which the user responds with a space followed by a carriage return. This will route copy of the plot file to a Versatec plotter at INEL.

To use the FR80POP post-processor the user must enter:

```
BEGIN,FR80POP,FICHE=film,TITLE1=$ CRAC2 PLOTS$,
    TITLE2=$ $$$, TITLE3=$ $$$
```

where:

film specifies the type of film to be used.

YES = microfiche

NO = 35mm microfilm

The terminal will respond with "ENTER DIRECTIVES" to which the user responds with a space followed by a carriage return. This will route a copy of the plot file to a DICOMED film processor at INEL.

E. DUMP: Calling Procedure For File Backup On Magnetic Tape

The DUMP procedure is used for catalogued file backup on a magnetic tape at INEL. The DUMP procedure file is retrieved from the set of files by entering:

```
GF,DUMP
```

The DUMP procedure is then initiated by entering:

```
DUMP,tpvsn
```

where DUMP specifies the name of the procedure and tpvsn specifies the 6-character volume serial number of the magnetic tape that is to receive catalogued files. A batch job is initiated for later execution. All names of catalogued files with ID=SWA are compared against the names of files already stored on the magnetic tape. Any file that has not been stored previously will be added to the files on magnetic tape. Magnetic tapes are retained for 365 days during which time they may be copied to a new magnetic tape as described in Section III.G.

F. LOAD: Calling Procedure For File Retrieval From Magnetic Tape

The LOAD procedure is used for retrieval of files from the magnetic tape backup described in Section III.E. The LOAD procedure file is retrieved from the set of files by entering:

```
GF,LOAD
```

Before initiating this procedure, a file must be created containing the names of the files to be retrieved and recatalogued so the user enters:

```
REQUEST,A,*PF
EDIT,A
ADD
```

to which the terminal will respond "ENTER TEXT". The names of the files to be retrieved are then entered in the following format, delimited by "%" symbols:

```
%PF=[file name 1],ID=SWA
PF=[file name 2],ID=SWA
PF=[file name 3],ID=SWA
                .
                .
                .
PF=[file name N],ID=SWA%
```

The terminal responds with "?" so the user enters:

```
END
```

The file of file names is then catalogued for access by the LOAD procedure by entering:

```
CATALOG,A,FILES,ID=SWA,RP=5
```

The LOAD procedure is initiated by entering:

```
LOAD,tpvsn
```

where LOAD specifies the name of the procedure and "tpvsn" specifies the 6-character volume serial number of the magnetic tape that contains the files with ID=SWA. A batch job is initiated for later execution. All files that are located from the list of file names will be recatalogued on a disk file for user access.

G. TRNSFR: Calling Procedure For Tape-to-Tape Transfer of Files (Expired Magnetic Tapes)

The TRNSFR procedure is used for transferring backup files from one magnetic tape to another before the first tape expiration occurs. The TRNSFR procedure file is retrieved from the set of files by entering:

```
GF,TRNSFR
```

The TRNSFR procedure is initiated by entering:

```
TRNSFR,tpvsn
```

where TRNSFR specifies the name of the procedure and "tpvsn" specifies the 6-character volume serial number of the magnetic tape from which files are to be transferred. A batch job is initiated for later execution. The files are first reloaded to disk and a new magnetic tape is requested. The disk files are then loaded to the new magnetic tape. The 6-character volume serial number of the new magnetic tape can be determined from the dayfile of the output job. This volume serial number should be recorded. This transfer of files from tape-to-tape should be performed in the months of June and December of each year to prevent the loss of the files due to expiration of magnetic tapes after the 365-day retention period.

H. Output File Retrieval

In retrieving output files from batch job executions, entering the command:

```
FILES
```

will list all files that are currently associated with the terminal.

Batch computer jobs are listed under the queues INPUT, EXECUTION, and OUTPUT. A job in the OUTPUT queue can be retrieved by entering the command:

```
BATCH,jobname,LOCAL
```

which will transfer the output file from the OUTPUT queue to the local user area. The output file can be examined using the text editor. The output file can then be transferred to a line printer by entering the command:

```
ROUTE,jobname,DC=PR,FID=*ACHAR,TID=EF,ST=MFA
```

This command will specifically route an output file to the NRC line printer at the Phillips Building in Bethesda, Maryland with the first five characters "ACHAR". To route the output file to another line printer, this command will have to be modified. An output file can remain in the output queue for two weeks after which it is automatically transferred to magnetic tape for a two-week retention period. INEL computing consultants would have to be contacted to determine the location of an output file after being deleted from the OUTPUT queue.

I. Catalogued File Audit

A list of the files currently catalogued under ID=SWA can be generated by entering:

```
PFCOST,ID=SWA,LF=AUD
```

When this command has been executed, the list of files generated can be displayed through the use of the text editor by entering:

```
EDIT,AUD
L*
```

After the list has been displayed, enter the command:

```
END
```

to exit from the text editor.

IV. DES/FES CASEWORK CALCULATIONS FOR CATAWBA

The following pages are examples of how the plotting procedure is used in performing the DES/FES casework analysis calculations for the proposed Catawba nuclear reactor site. The examples are copies of the displays from a Tektronix CRT terminal.

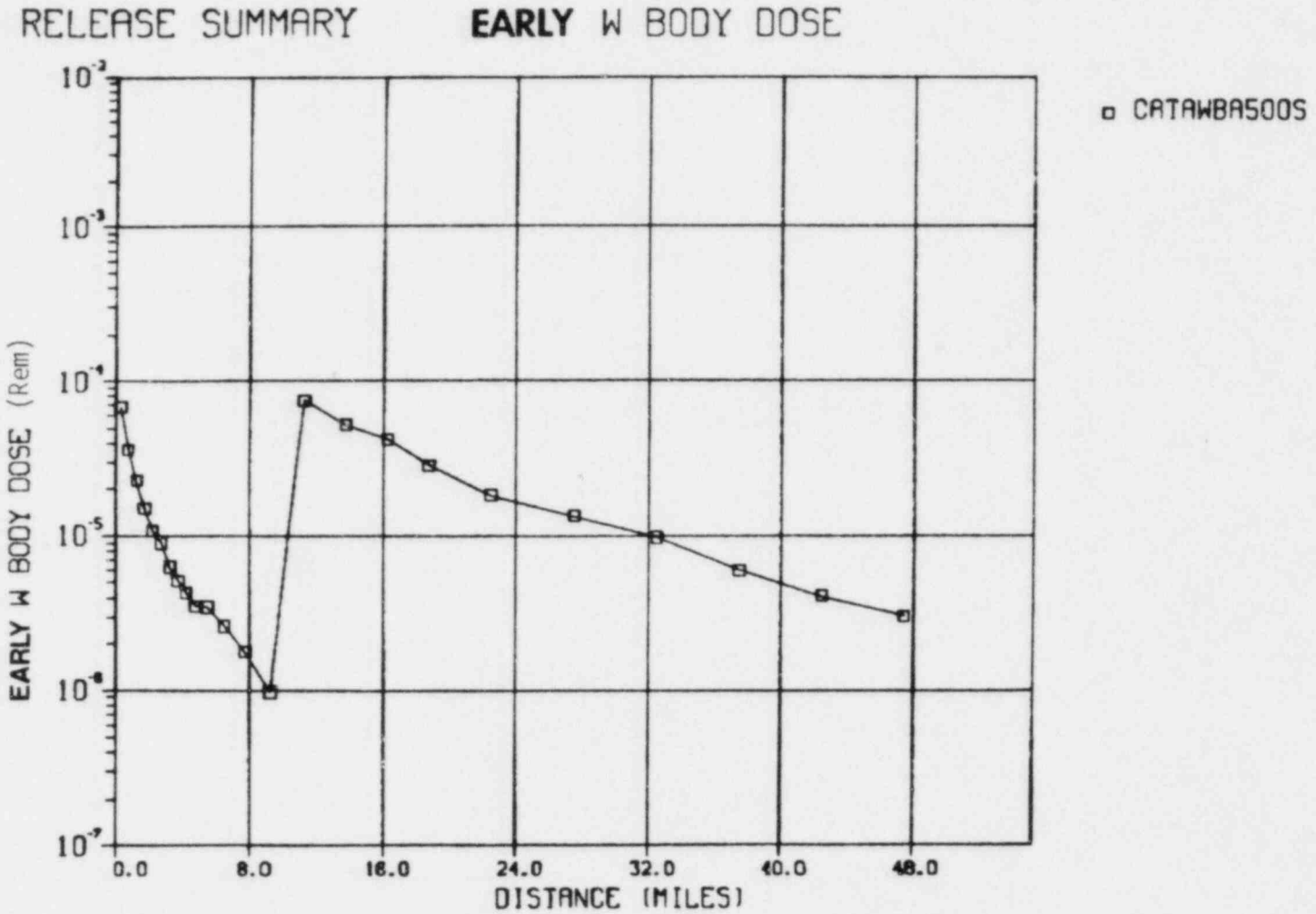

Figure IV-1: Catawba Site, 500-mile Execution, Standard, Early Whole Body Dose Versus Distance

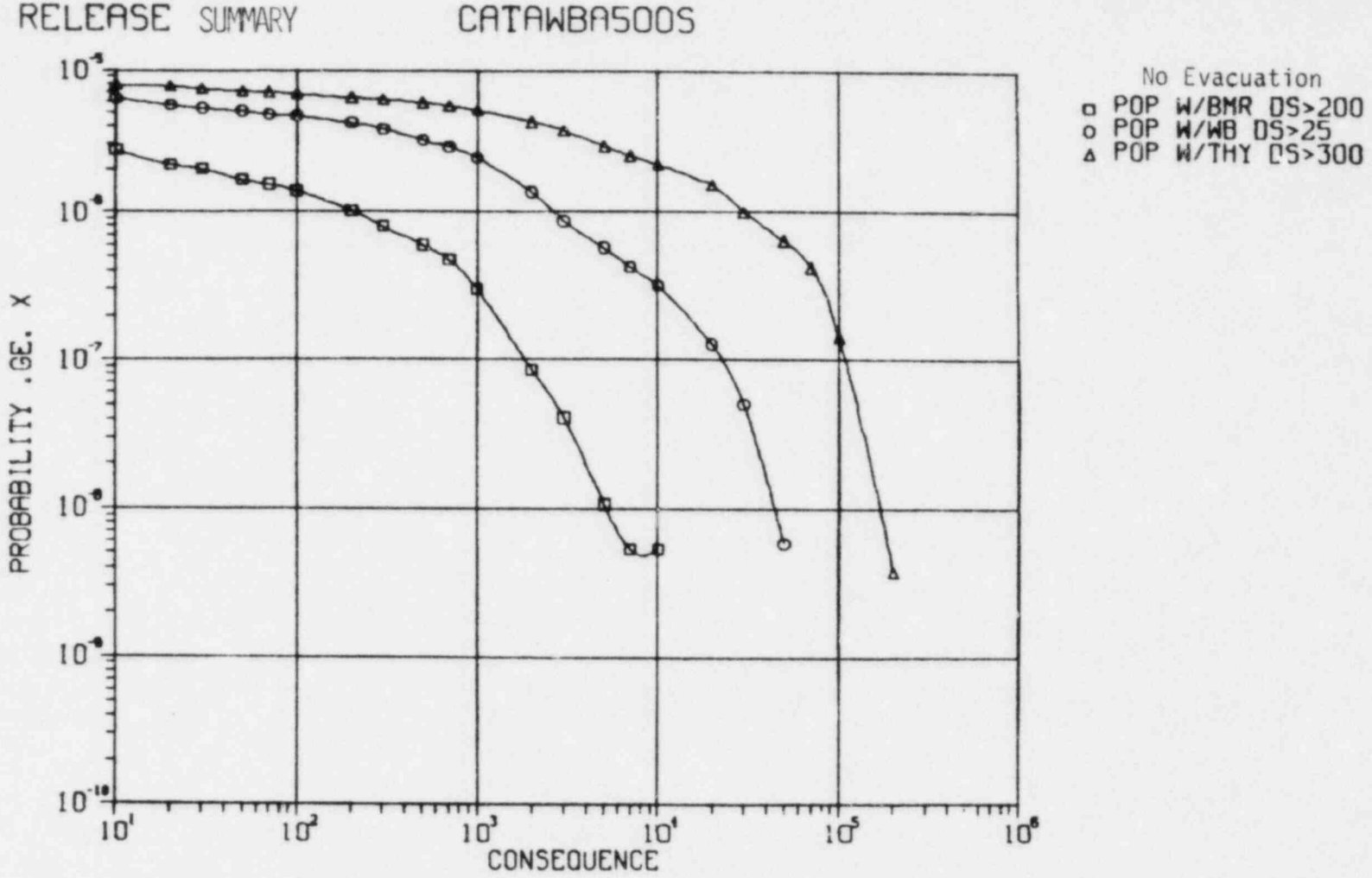

Figure IV-2: Catawba Site, 500-mile Execution, Standard, Population With Bone Marrow Dose Greater Than 200 Rem, Population With Whole Body Dose Greater Than 25 Rem, Population With Thyroid Dose Greater Than 300 Rem (All Early Doses)

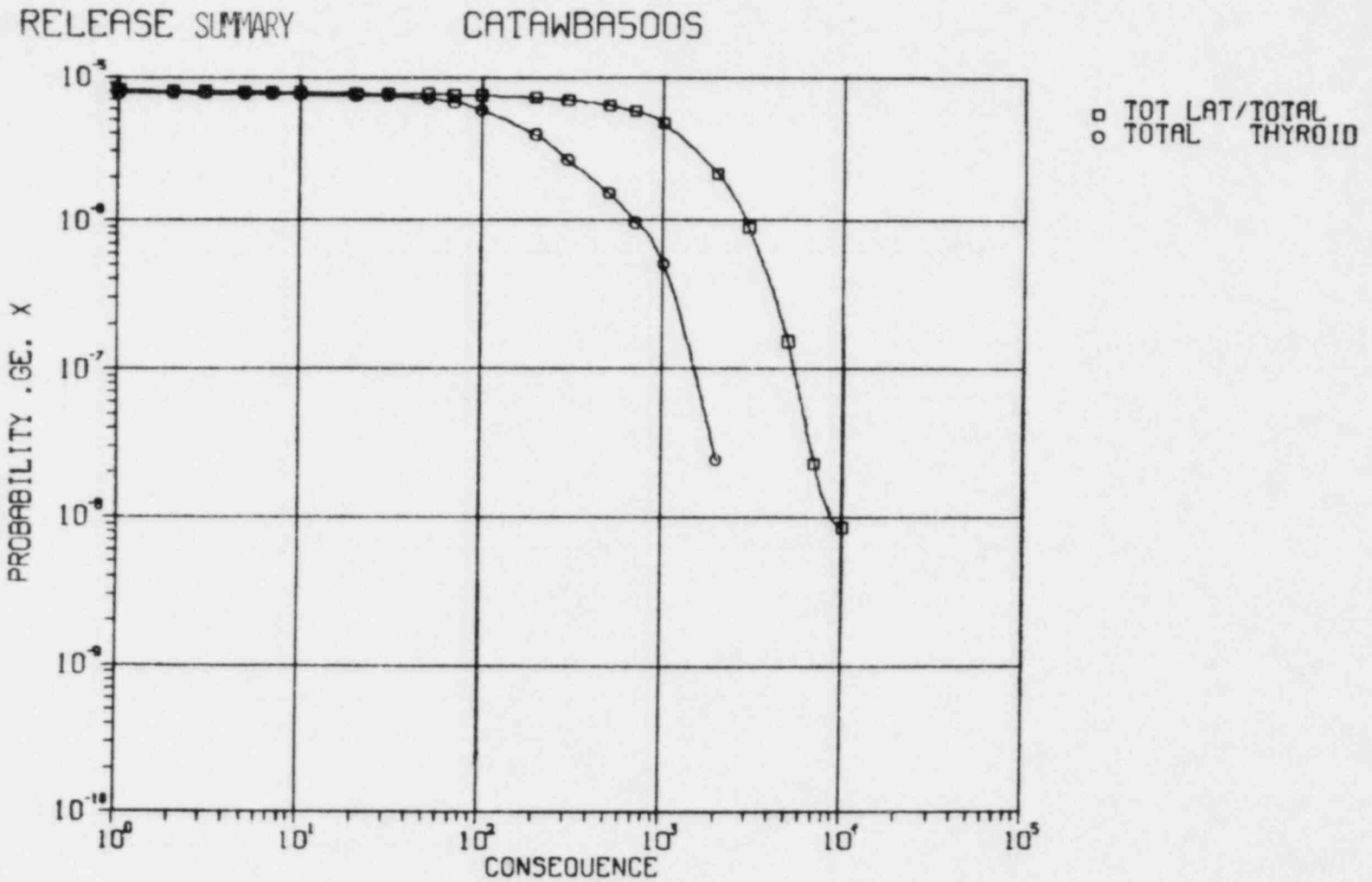

Figure IV-3: Catawba Site, 500-mile Execution, Standard, Total Latent Cancer Fatalities Excluding Thyroid Fatalities, Total Thyroid Fatalities (Includes Early and Chronic Exposures)

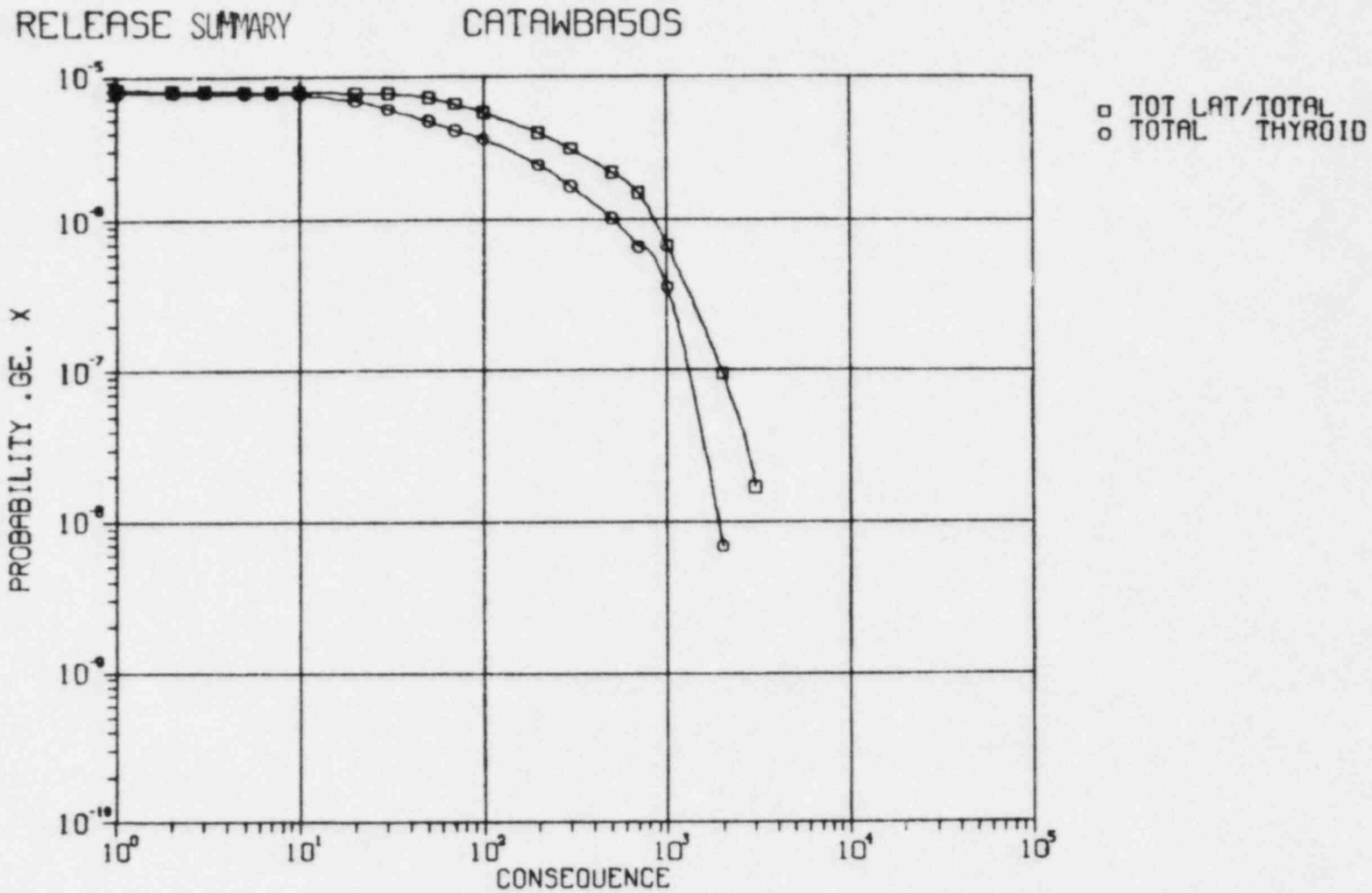

Figure IV-4: Catawba Site, 50-mile Execution, Standard, Total Latent Cancer Fatalities Excluding Thyroid Fatalities, Total Thyroid Fatalities (Includes Early and Chronic Exposures)

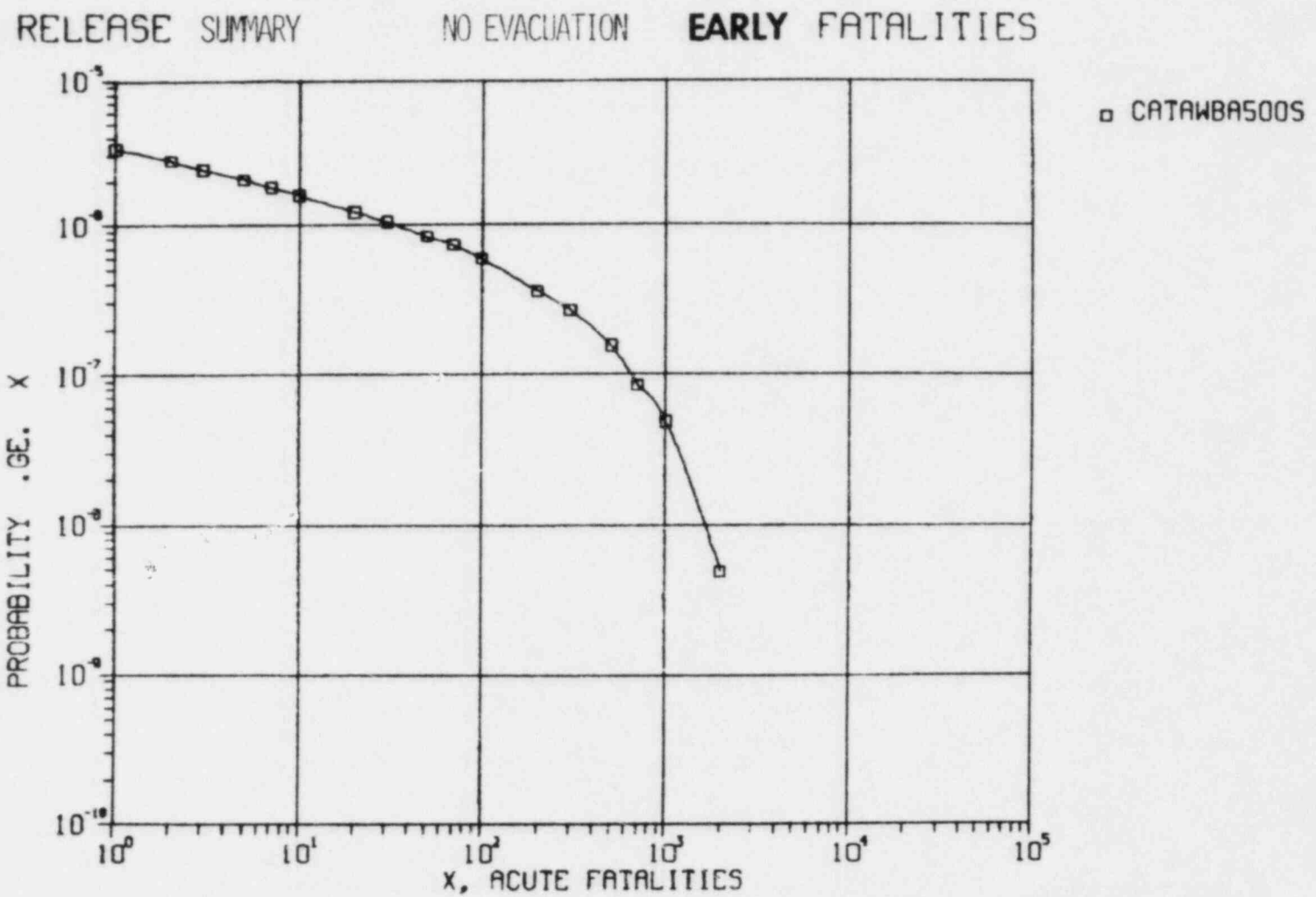

Figure IV-5: Catawba Site, 500-mile Execution, Standard, Early Fatalities (No Evacuation, No Shielding, 24-hour Relocation)

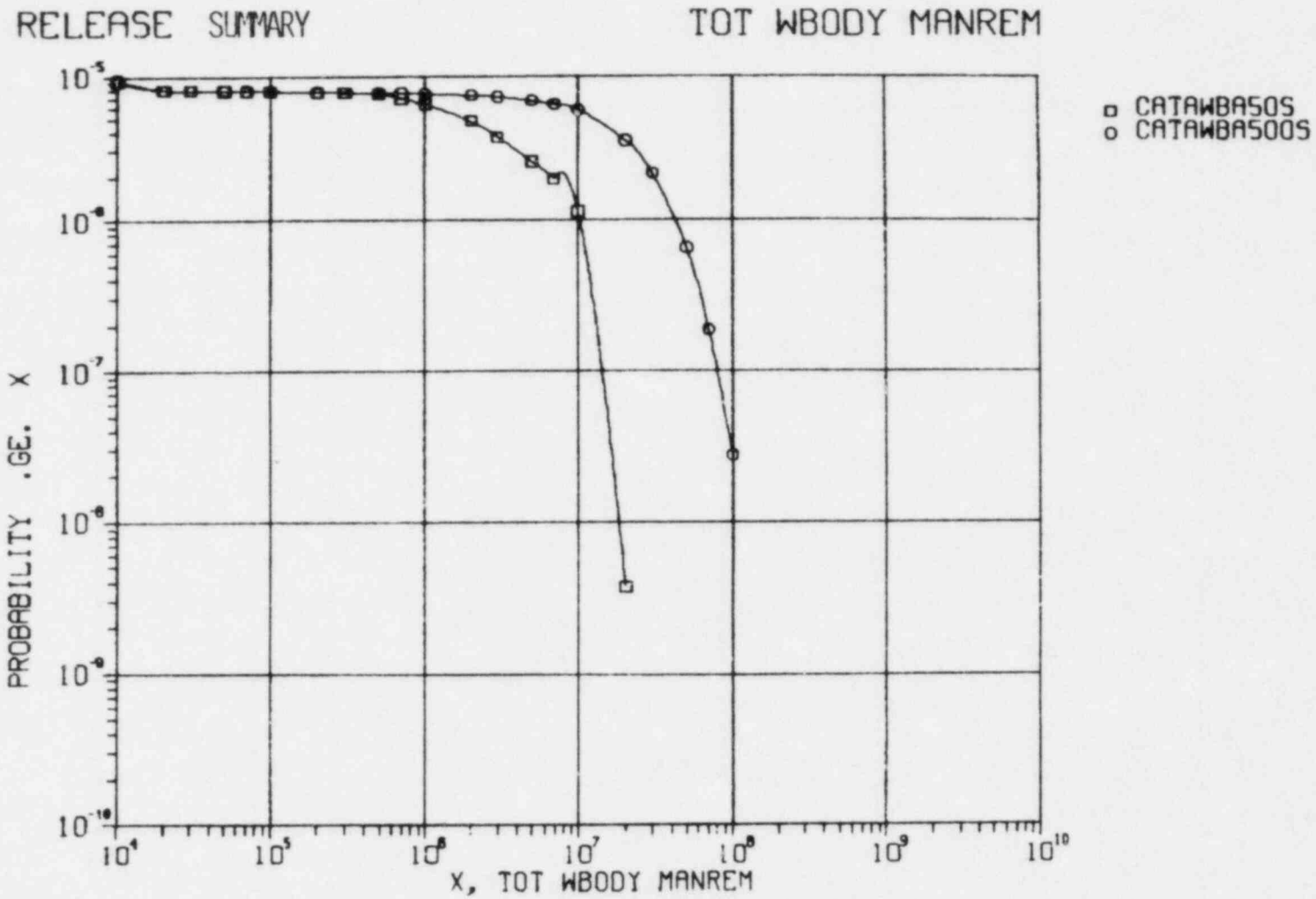

Figure IV-6: Catawba Site, 50-mile Execution, Standard, Catawba Site, 500-mile Execution, Standard, Total Whole Body Manrem

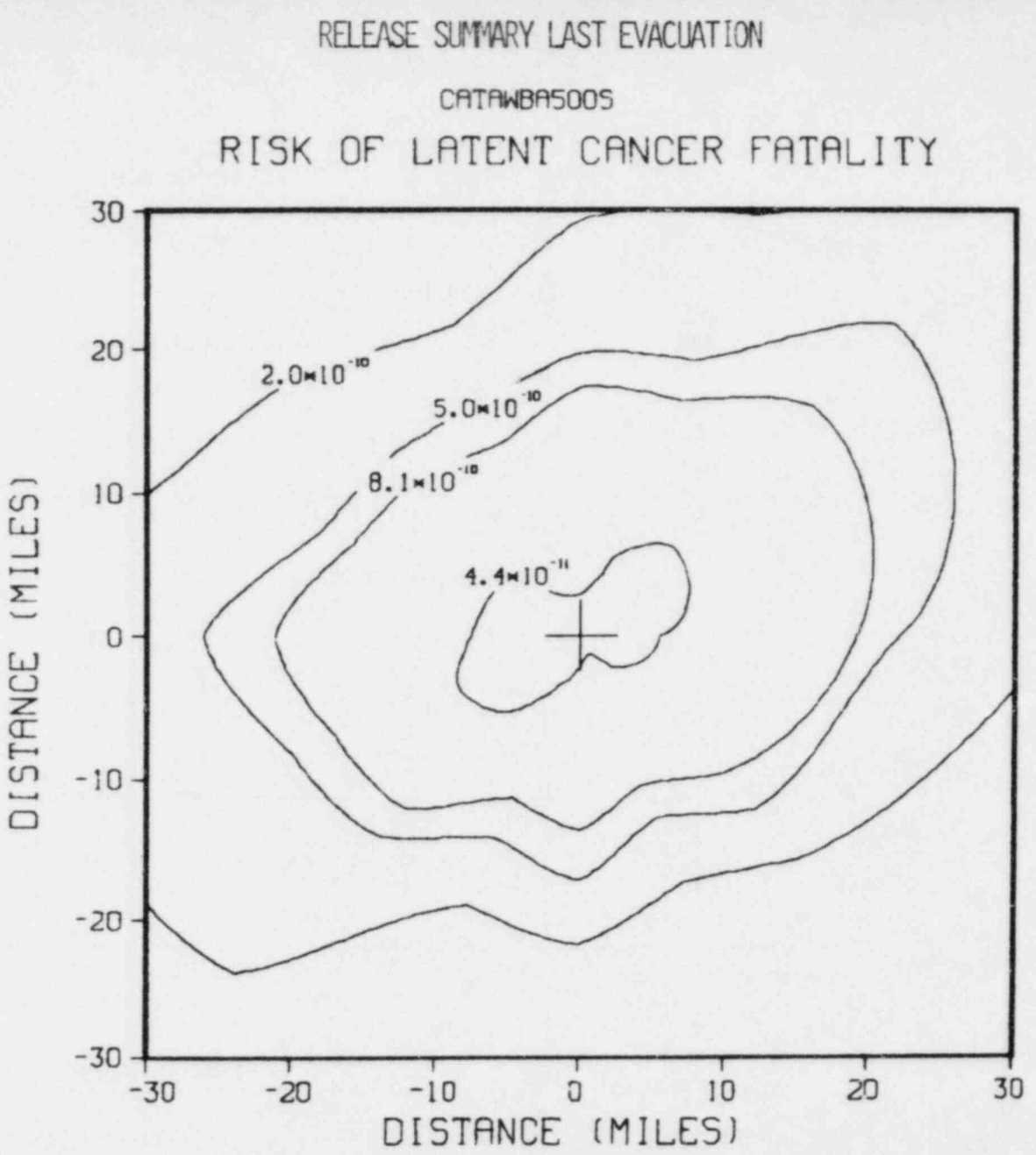

Figure IV-7: Catawba Site, 500-mile Execution, Standard, Risk of Latent Cancer Fatality (Early Exposure)

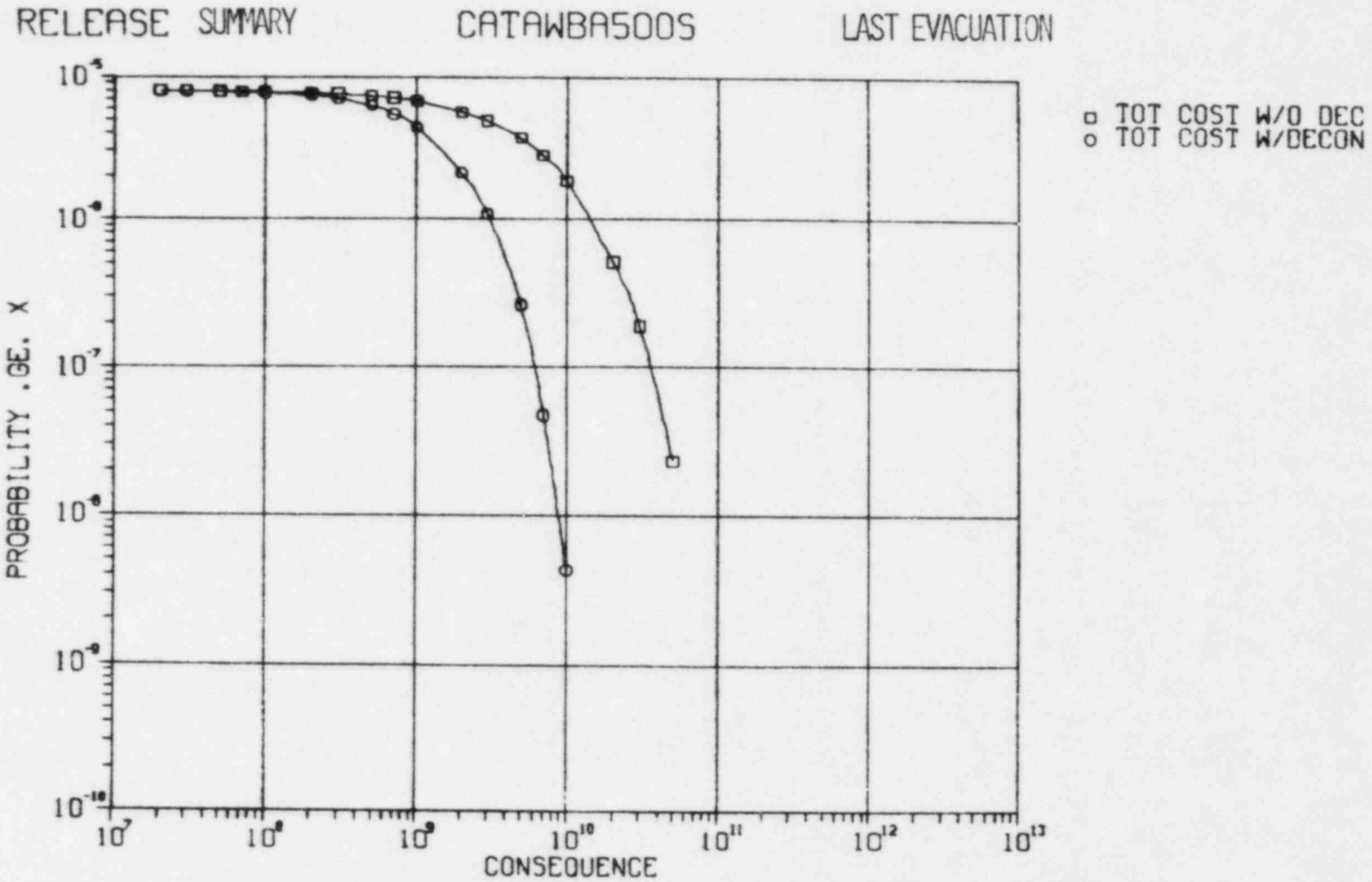

Figure IV-8: Catawba Site, 500-mile Execution, Standard, Total Cost Without Decontamination, Total Cost With Decontamination

V. References

1. Ritchie, L. T., J. D. Johnson and R. M. Blond, Calculations of Reactor Accident Consequences, Version 2, SAND81-1994, NUREG/CR-2326, Sandia National Laboratories, Albuquerque, NM, (to be published).

2. NOS/BE Version 1 Reference Manual, No. 60493800, Control Data Corporation, Minneapolis, MN.

3. NOS/BE Version 1 Batch User's Guide, No. 60494000, Control Data Corporation, Minneapolis, MN.

4. INTERCOM Version 5 Reference Manual, No. 60455010, Control Data Corporation, Minneapolis, MN.

5. INTERCOM Version 5 Remote Batch User's Guide, No. 60455890, Control Data Corporation, Minneapolis, MN.

6. INEL User's Guide, Idaho National Engineering Laboratory, Idaho Falls, ID.

7. FORTRAN Extended Version 4 Reference Manual, No. 60497800, Control Data Corporation, Minneapolis, MN.

8. DISSPLA User's Manual, Version 8.2, Integrated Software Systems Corporation, San Diego, CA.

VI. APPENDICES

APPENDIX A

Procedure File Listings

The following figures are listings of procedure files used in DES/FES casework analysis calculations. The usage of the files is described in Chapter III.

```
.PROC,METPOP,FNAME,SNAME,MNAME.
.*
.*  THIS PROCEDURE WAS WRITTEN BY JAY JOHNSON, SANDIA LABS, ORG 4415
.*  FOR SARBES ACHARYA -- MRR OF NRC.
.*              FNAME IS NRC METEOROLOGY/POPULATION/TOPOGRAPHY FILE NAME
.*              SNAME IS SITE NAME ASSOC. WITH THE POP/TOP GROUP
.*              MNAME IS METEOROLOGY STATION NAME
.*
REQUEST,TAPE11,*PF.
ATTACH,TAPE10,_FNAME,ID=SWA.
ATTACH,LGO,METLG,ID=SWA.
CONNECT,OUTPUT.
LGO.
.*  NEW METEOROLOGY FILE ON TAPE11 (CATALOGED LATER)
RETURN,LGO.
REWIND,TAPE6.
COPY,TAPE6,OUTPUT.
RETURN,TAPE6,OUTPUT.
REQUEST,TAPE4,*PF.
REWIND,TAPE10.
ATTACH,TAPE2,POPDATA,ID=SWA.
COPYBR,TAPE2,TEMP,999.
ATTACH,LGO,POPLG,ID=SWA.
CONNECT,OUTPUT.
LGO.
REWIND,TAPE12.
COPYBR,TAPE12,TEMP,1.
REWIND,TEMP.
COPYBR,TEMP,TAPE4,999.
.*  POPULATION/TOPOGRAPHY SUBGROUPS ON TAPE4 (CATALOGED LATER)
RETURN,TAPE10,TAPE12,TEMP,LGO.
REWIND,TAPE6.
COPY,TAPE6,OUTPUT.
RETURN,TAPE6,OUTPUT.
REQUEST,TAPE22,*PF.
ATTACH,LGO,SITELG,ID=SWA.
ATTACH,TAPE20,SITENAMES,ID=SWA.
COPYBR,TEMP1,TAPE21.
REWIND,TAPE21.
LGO.
.*  CATALOG FILE OF SITE NAMES ASSOC. WITH POP/TOP SUBGROUPS
CATALOG,TAPE22,SITENAMES,ID=SWA,RP=999.
.*  PURGE OLD FILE OF SITE NAMES (TAPE20)
PURGE,TAPE20.
.*  CATALOG NEW METEOROLOGY FILE (TAPE11)
CATALOG,TAPE11,MET_MNAME,ID=SWA,RP=999.
.*  CATALOG POPULATION/TOPOGRAPHY SUBGROUPS FILE (TAPE4)
CATALOG,TAPE4,POPDATA,ID=SWA,RP=999.
.*  PURGE OLD POPULATION/TOPOGRAPHY SUBGROUPS FILE (TAPE2)
PURGE,TAPE2.
RETURN,TAPE2,TAPE4,TAPE11.
RETURN,TAPE20,TAPE21,TAPE22,TEMP1,LGO.
EXIT.
RETURN,TAPE2,TAPE4,TAPE10,TAPE11,TEMP,LGO.
RETURN,TAPE20,TAPE21,TAPE22,TEMP1.
REWIND,TAPE6.
CONNECT,OUTPUT.
COPY,TAPE6,OUTPUT.
RETURN,TAPE6,OUTPUT.
EXIT.
.DATA,TEMP1.
SNAME
```

Figure A-1: METPOP Procedure File Listing

```
.PROC,CRAC2,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EUMD,QUK.
CONNECT,OUTPUT.
ATTACH,PROC1,PROC1,ID=SWA.
BEGIN,PROC1,PROC1,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EUMD,QUK.
RETURN,PROC1.
IFE,R1G.EQ.0,L1.
RETURN,JOB.
REWIND,DAT,DAT2,DAT3,DAT4.
IFE,SC.EQ.5,L2.
IFE,QUK.EQ.0,L2.
IFE,$NSI$.EQ.$YES$,L4.
COPYCF,DAT3,JOB.
ELSE,L4.
COPYCF,DAT4,JOB.
ENDIF,L4.
ELSE,L2.
IFE,$NSI$.EQ.$YES$,L5.
COPYCF,DAT,JOB.
ELSE,L5.
COPYCF,DAT2,JOB.
ENDIF,L5.
ENDIF,L2.
BATCH,JOB,INPUT,HERE.
ENDIF,L1.
RETURN,DAT,DAT2,DAT3,DAT4,OUTPUT.
RETURN,T1,T2,T3,T4,T5,T6,T7,T8,T9,T10.
RETURN,T11,T12,T13,T14,T15,T16,T17,T18.
REVERT.
EXIT.
RETURN,DAT,DAT2,DAT3,DAT4,OUTPUT.
RETURN,T1,T2,T3,T4,T5,T6,T7,T8,T9,T10.
RETURN,T11,T12,T13,T14,T15,T16,T17,T18.
REVERT.
.DATA,DAT.
SWA,T100,P1,EC500,STANY.
ACCNT,ID=SWA,PW=73QRMK,CHG=448161004.
ATTACH,PROC2,PROC2,ID=SWA.
BEGIN,PROC2,PROC2,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EUMD,QUK.
.DATA,DAT2.
SWA,T100,P1,EC500,STANY.
ACCNT,ID=SWA,PW=73QRMK,CHG=448161004.
ATTACH,PROC2,PROC2,ID=SWA.
BEGIN,PROC2,PROC2,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EUMD,QUK,LMT.
.DATA,DAT3.
SWA,T3000,P1,EC500,STANY.
ACCNT,ID=SWA,PW=73QRMK,CHG=448161004.
ATTACH,PROC2,PROC2,ID=SWA.
BEGIN,PROC2,PROC2,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EUMD,QUK.
.DATA,DAT4.
SWA,T3000,P1,EC500,STANY.
ACCNT,ID=SWA,PW=73QRMK,CHG=448161004.
ATTACH,PROC2,PROC2,ID=SWA.
BEGIN,PROC2,PROC2,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EUMD,QUK,LMT.
```

Figure A-2: CRAC2 Procedure File Listing

```
.PROC,PROC1,SITNAM,MTR,NSI,RT,PL1,PL2,SC,EVMD,QUK=1.
.*
.*     THIS PROCEDURE VALIDATES PARAMETERS USED IN
.*                CRAC2 PROCEDURE
.*
SET,R1G=0.
.*  VALIDATE 50/500 MILE OPTION -- NSI
.*         YES = 50-MILE OPTION
.*          NO = 500-MILE OPTION
IFE,$NSI$.EQ.$YES$,L1.
COPYBR,T1,OUTPUT,10.
ELSE,L1.
IFE,$NSI$.EQ.$NO$,L2.
COPYBR,T2,OUTPUT,10.
ELSE,L2.
COPYBR,T3,OUTPUT,10.
SET,R1G=1.
ENDIF,L1.
ENDIF,L2.
.*  VALIDATE BWR/PWR REACTOR TYPE -- RT
IFE,$RT$.EQ.$BWR$,L3.
COPYBR,T4,OUTPUT,10.
ELSE,L3.
IFE,$RT$.EQ.$PWR$,L4.
COPYBR,T4,OUTPUT,10.
ELSE,L4.
COPYBR,T5,OUTPUT,10.
SET,R1G=1.
ENDIF,L3.
ENDIF,L4.
.*  VALIDATE POWER LEVEL -- PL1.PL2
.*         PL1.PL2 = X.XXX
IFE,PL1.GE.0,L5.
IFE,PL1.LT.2,L5.
IFE,PL2.GE.0,L5.
IFE,PL2.LT.1000,L5.
COPYBR,T6,OUTPUT,10.
ELSE,L5.
COPYBR,T7,OUTPUT,10.
SET,R1G=1.
ENDIF,L5.
RETURN,T1,T2,T3,T4,T5,T6,T7.
.*  VALIDATE START CODE -- SC
.*         5 = METEOROLOGICAL BIN SAMPLING
.*         6 = SINGLE RANDOM METEOROLOGICAL TRIAL
IFE,SC.EQ.5,L9.
COPYBR,T8,OUTPUT,10.
ELSE,L9.
IFE,SC.EQ.6,L10.
COPYBR,T9,OUTPUT,10.
ELSE,L10.
COPYBR,T10,OUTPUT,10.
SET,R1G=1.
ENDIF,L9.
ENDIF,L10.
.*  VALIDATE EVACUATION-MEDICAL SWITCH -- EVMD
.*         S = STANDARD EVACUATION AND SUPPORTIVE MED.
.*         M = STANDARD EVACUATION AND MIN. MED.
.*         R = EARLY RELOCATION AND SUPPORTIVE MED.
.*         U = USER-SPECIFIED EVACUATION SUBGROUP
IFE,$EVMD$.NE.$MS$,L31.
COPYBR,T15,OUTPUT,1.
ELSE,L31.
IFE,$EVMD$.NE.$RS$,L32.
COPYBR,T15,OUTPUT,1.
ELSE,L32.
IFE,$EVMD$.NE.$SS$,L33.
COPYBR,T15,OUTPUT,1.
ELSE,L33.
IFE,$EVMD$.NE.$US$,L34.
COPYBR,T15,OUTPUT,1.
ELSE,L34.
COPYBR,T16,OUTPUT,1.
SET,R1G=1.
ENDIF,L31.
ENDIF,L32.
ENDIF,L33.
ENDIF,L34.
.*  VALIDATE QUICK RUN OPTION -- QUK
.*         0 = FULL RUN
.*        >0 = SINGLE TRIAL, EXTENDED PRINT OPTIONS IN EFFECT
IFE,QUK.EQ.0,L11.
COPYBR,T11,OUTPUT,10.
ELSE,L11.
COPYBR,T12,OUTPUT,10.
ENDIF,L11.
.*  VALIDATE SITE NAME
REWIND,TEMP.
RETURN,T8,T9,T10,T11,T12,T15,T16.
COPYBR,TEMP,TAPE1.
REWIND,TAPE1.
SET,R1=1.
ATTACH,TAPE2,SITENAMES,ID=SWA.
ATTACH,TAPE3,POPDATA,ID=SWA.
ATTACH,NAMELG,NAMELG,ID=SWA.
MAP,OFF.
NAMELG.
SET,R1=0.
REWIND,TAPE99.
COPYBR,TAPE99,OUTPUT,10.
RETURN,TEMP,TAPE1,TAPE2,TAPE3,TAPE99,NAMELG.
.*  VALIDATE METEOROLOGICAL FILE NAME
ATTACH,A,MET_MTR,ID=SWA.
COPYBR,T13,OUTPUT,10.
IFE,R1G.NE.0,L15.
COPYBR,T17,OUTPUT,10.
ELSE,L15.
COPYBR,T18,OUTPUT,10.
ENDIF,L15.
RETURN,A,T13,T14,T17,T18.
REVERT.
EXIT.
SET,R1G=1.
RETURN,TEMP,TAPE1,TAPE2,TAPE3,NAMELG.
IFE,R1.EQ.0,L12.
COPYBR,T14,OUTPUT,10.
ELSE,L12.
REWIND,TAPE99.
COPYBR,TAPE99,OUTPUT,10.
ATTACH,A,MET_MTR,ID=SWA.
COPYBR,T13,OUTPUT,10.
RETURN,A,T13,T14,T17,T18,TAPE99.
REVERT.
EXIT.
COPYBR,T14,OUTPUT,10.
ENDIF,L12.
RETURN,A,T13,T14,T17,T18,TAPE99.
```

Figure A-3: PROC1 Procedure File Listing (Called by CRAC2)

```
REVERT.
.DATA,TEMP.
_SITNAM
.DATA,T1.
          50-MILE EXECUTION

.DATA,T2.
          500-MILE EXECUTION

.DATA,T3.
       -- DISTANCE OPTION -NSI INVALID
       --       MUST BE YES OR NO

.DATA,T4.
          _RT SEQUENCES TO BE USED

.DATA,T5.
       -- REACTOR TYPE _RT INVALID
       --    MUST BE BWR OR PWR

.DATA,T6.
          POWER LEVEL IS PL1_-_PL2

.DATA,T7.
       -- POWER LEVEL PL1_-_PL2 INVALID
       --    MUST BE BETWEEN 0 AND 2

.DATA,T8.
          START CODE IS 5
          METEOROLOGICAL BIN SAMPLING

.DATA,T9.
          START CODE IS 6
          SINGLE RANDOM METEOROLOGICAL TRIAL

.DATA,T10.
       -- START CODE _SC INVALID
       --    MUST BE 5 OR 6

.DATA,T11.
          THIS IS A FULL EXECUTION
            (NOT QUICK TEST RUN)

.DATA,T12.
          THIS IS A QUICK TEST RUN

.DATA,T13.
          METEOROLOGICAL DATA FILE FOR _MTR FOUND

.DATA,T14.
       -- METEOROLOGICAL DATA FILE FOR _MTR NOT FOUND

.DATA,T15.
          EVACUATION/MEDICAL RESPONSE IS _EVMD

.DATA,T16.
       -- EVACUATION/MEDICAL RESPONSE _EVMD INVALID
       -- MUST BE S, R, OR M

.DATA,T17.
       --
       -- NO CRAC2 JOB SUBMITTED
       --

.DATA,T18.
          **************************
          *  CRAC2 JOB SUBMITTED   *
          **************************
```


Figure A-3: PROC1 Procedure File Listing (Cont.)

```
.PROC,PROC2,SITNAM,MTR,MSI,RT,PL1,PL2,SC,EVMD,QUK,LMT=50/500.
.*  THIS PROCEDURE WRITTEN BY J. D. JOHNSON, SANDIA LABS, ORG 4415
.*     THIS PROCEDURE IS CALLED BY THE PROCEDURE CRAC2
.*     THIS PROCEDURE COMPILES INPUT DATA AND INITIATES CRAC2 EXECUT.
.*
.*  INITIALLIZE MICROFICHE
BEGIN,FTITLE,,TITLE1=$S ACHARYA  $,
TITLE2=$  SITNAM  MET=_MTR$$$,
TITLE3=$ PL=_PL1_._PL2 RT  $,
TITLE4=$LMT_MI RUN  EVMED=_EVMD$,
LFN=TAPE6,DUP=$02$.
REQUEST,TAPE30,*PF.
REQUEST,TAPE50,*PF.
.*  UPDATE AND COMPILE CRAC2 FOR DES/FES CASEWORK ANALYSIS
ATTACH,UPD,FESUPDATE,ID=SWA.
ATTACH,OLDPL,CRAC2CU,ID=DXA.
UPDATE,F,W,C,I=UPD,L=0.
FTN,I=COMPILE,L=0,OPT=2.
RETURN,UPD,OLDPL,COMPILE.
.*
.*  COMPILE INPUT DATA SUBGROUPS ACCCORDING TO PROCEDURE-SPECIFIED
.*     PARAMETERS
.*
ATTACH,DATA,CRACDATAFES,ID=SWA.
.*  LOCATE POPULATION DECK (TAPE3) ACCORDING TO ORDER OF SITE NAMES
.*     (TAPE2)
COPYBR,TEMP1,TAPE1,1.
REWIND,TAPE1.
ATTACH,TAPE2,SITENAMES,ID=SWA.
ATTACH,TAPE3,POPDATA,ID=SWA.
ATTACH,NAMELG,NAMELG,ID=SWA.
MAP,OFF.
NAMELG.
RETURN,TAPE1,TAPE2,NAMELG,TEMP1.
COPYBR,TEMP1A,TEMP,1.
COPYBR,TEMP6,TEMP,1.
REWIND,TEMP.
COMBINE,TEMP,TAPE1,999.
RETURN,TEMP,TEMP1A,TEMP6.
.*  LOCATE EVACUATE SUBGROUP TO BE USED
ATTACH,TAPE4,EVACFIL,ID=SWA.
IFE,$EVMD$.EQ.$MS$,L2A.
COPYBR,TEMP11,TEMP,1.
COPYBR,DATA,TEMP,1.
COPYBR,TAPE4,DUM,2.
COPYBR,TAPE4,TEMP,1.
ELSE,L2A.
IFE,$EVMD$.EQ.$RS$,L3A.
COPYBR,TEMP4,TEMP,1.
COPYBR,DATA,TEMP,1.
COPYBR,TAPE4,DUM,3.
COPYBR,TAPE4,TEMP,1.
ELSE,L3A.
COPYBR,TEMP4,TEMP,1.
COPYBR,DATA,TEMP,1.
COPYBR,TAPE4,DUM,1.
COPYBR,TAPE4,TEMP,1.
ENDIF,L2A.
ENDIF,L3A.
COPYBR,TAPE3,TEMP,1.
.*  LOCATE LEAKAGE SUBGROUP ACCORDING TO REACTOR TYPE -- BWR OR PWR
IFE,$RT$.EQ.$BWR$,L2.
COPYBR,TEMP7,TEMP,1.
```

Figure A-4: PROC2 Procedure File Listing (Called by CRAC2)

```
ELSE,L2.
COPYBR,TEMP8,TEMP,1.
ENDIF,L2.
.*  SET START CODE -- 5 OR 6
IFE,SC.EQ.6,L1A.
COPYBR,TEMP10,TEMP,1.
ENDIF,L1A.
IFE,QUK.NE.0,L1.
COPYBR,TEMP5,TEMP,1.
ENDIF,L1.
COPYBR,TEMP3,TEMP,1.
COPYBR,TEMP2,TEMP,1.
REWIND,TEMP3.
COPYBR,TEMP3,TEMP,1.
RETURN,DATA,DUM,TAPE3,TAPE4,TEMP4.
REWIND,TEMP.
COMBINE,TEMP,DATA,999.
REWIND,DATA.
COPYSBF,DATA,OUTPUT.
REWIND,DATA.
.*  ATTACH HEALTH AND MET. DATA FILES
ATTACH,TAPE21,HEALTHDATA2,ID=DXA.
ATTACH,TAPE27,MET_MTR,ID=SWA.
LIBRARY,INELLIB.
.*  INITIALLIZE CORE, LOAD, AND EXECUTE
RFL,EC=500.
LDSET,PRESET=ZERO.
MAP,OFF.
LGO,DATA,PL=99999.
IFE,QUK.EQ.0,L2.
IFE,SC.EQ.5,L3.
.*  CATALOG TAPE30 AND TAPE50
CATALOG,TAPE30,SITNAM_LMT_EVMD_T30,ID=SWA,RP=999.
CATALOG,TAPE50,SITNAM_LMT_EVMD_T50,ID=SWA,RP=30.
RETURN,TAPE30,TAPE50,LGO.
REWIND,TAPE1.
.*  STORE SITE AND FILE NAMES FOR PLOTTING PROGRAM USAGE
ATTACH,TAPE2,SITFIL,ID=SWA.
ATTACH,SITE1LG,SITE1LG,ID=SWA.
REQUEST,TAPE3,*PF.
MAP,OFF.
SITE1LG.
CATALOG,TAPE3,SITFIL,ID=SWA,RP=999.
PURGE,TAPE2.
RETURN,SITE1LG,TAPE3.
REWIND,OUTPUT.
.*  COPY OUTPUT TO MICROFICHE FILE
COPYCF,OUTPUT,TAPE6,999.
ENDIF,L2.
ENDIF,L3.
REVERT.
EXIT.
REVERT.
.DATA,TEMP1.
SITNAM
.DATA,TEMP1A.
SITNAM_LMT_EVMD
.DATA,TEMP2.
SITNAM  MET=_MTR  LMT_=MILES  PUR LVL=_PL1_._PL2  REACTOR=_RT  EVMED=_EVMD
.DATA,TEMP3.
END
.DATA,TEMP4.
REFERENCE CASE                                                    1
SPATIAL                34    _NSI
```

Figure A-4: PROC2 Procedure File Listing (Cont.)

```
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.       12.5      15.
17.5      20.       25.       30.       35.       40.       45.       50.
55.       60.       65.       70.       85.       100.      150.      200.
350.      500.
ACUTE                    8
T MARROW  320.      400.      510.      615.      .03       .5        1.
LLI WALL  2000.     5000.     5000.     5000.     1.        1.        1.
LUNG      5000.     14800.    22400.    24000.    .24       .73       1.
T MARROW  55.       150.      200.      200.1     .015      .025      0.
LUNG      3000.     3000.1    6000.     6000.     .05       1.0       0.
LLI WALL  1000.     1000.1    2500.     2500.     .05       1.0       0.
THYROID         1.E10     1.E10     1.E10     1.E10     1.0       1.0       0.0
W BODY          1.E10     1.E10     1.E10     1.E10     1.0       1.0       0.0
ISOTOPE                  54    YES
PL1_._PL2          1.0       1.0
.DATA,TEMP5.
SITE
SINGLE RANDOM MET                6 0 1 0 1
OPTIONS
    1    2    3    4    1    2
LEAKAGE                  1
BUR G1       8.00E-06    1.5       2.0       1.0       1.0       25.0
1.0       0.1       0.07      0.14      0.12      0.015     0.01      0.002
POPULATION
  1
100.        1
.DATA,TEMP6.
SIGNAR_LMT_EVMD_T30
.DATA,TEMP7.
LEAKAGE                  6
BUR G1       8.00E-06    1.5       2.0       1.0       1.0       25.0
1.0       0.1       0.07      0.14      0.12      0.015     0.01      0.002
BUR G2       1.00E-05    50.0      2.0       40.0      1.0       25.0
1.0       0.1       0.003     0.11      0.083     0.011     0.007     0.001
BUR G3       1.00E-06    3.5       0.5       1.0       1.0       25.0
1.0       0.1       0.02      0.055     0.11      0.006     0.007     0.013
BUR G1P      2.00E-06    1.5       2.0       1.0       1.0    E0610.0
1.0       0.1       0.45      0.67      0.64      0.073     0.052     0.0083
BUR G2P      3.00E-06    50.0      2.0       40.0      1.0    E0610.0
1.0       0.1       0.098     0.27      0.41      0.025     0.028     0.005
BUR G3P      3.00E-07    2.0       0.5       1.0       1.50 E0710.0
1.0       0.1       0.095     0.30      0.36      0.034     0.027     0.005
.DATA,TEMP8.
LEAKAGE                  4
EVENT V      2.00E-06    1.0       1.0       1.0       4.20  E0510.0
1.0       0.01      0.64      0.82      0.41      0.10      0.04      0.006
TMLB'        3.00E-06    2.5       0.5       1.0       1.176 E0710.0
1.0       0.01      0.31      0.39      0.15      0.044     0.018     0.002
PWR 3        3.00E-06    5.0       1.5       2.0       4.20  E0510.0
0.8       0.01      0.2       0.2       0.3       0.02      0.03      0.003
PWR 7        4.00E-05    10.0      10.0      1.0       0.0       10.0
  6.00E-03  2.00E-05  2.00E-05  1.00E-05  2.00E-05  1.00E-06  1.00E-06  2.00E-07
.DATA,TEMP10.
SITE
SINGLE RANDOM MET                6 0 1 0 1
.DATA,TEMP11.                                                              1
REFERENCE CASE
SPATIAL                  34
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.       12.5      15.
17.5      20.       25.       30.       35.       40.       45.       50.
55.       60.       65.       70.       85.       100.      150.      200.
350.      500.
```

Figure A-4: PROC2 Procedure File Listing (Cont.)

```
ACUTE                          $
T MARROW    175.      235.      340.      460.      .025      .5        1.
LLI WALL    2000.     5000.     5000.     5000.     1.        1.        1.
LUNG        5000.     14800.    22400.    24000.    .24       .73       1.
T MARROW    55.       150.      200.      200.1     .015      .025      0.
LUNG        3000.     3000.1    6000.     6000.     .05       1.0       0.
LLI WALL    1000.     1000.1    2500.     2500.     .05       1.0       0.
W BODY            1.E10     1.E10     1.E10     1.E10     1.0       1.0       0.0
THYROID           1.E10     1.E10     1.E10     1.E10     1.0       1.0       0.0
ISOTOPE                  S4       YES
PL1..._PL2          1.0       1.0
```


Figure A-4: PROC2 Procedure File Listing (Cont.)

```
.PROC,DUMP,TPUSN.
.*
.*     THIS PROCEDURE IS USED TO BACKUP PERMANENT
.*   FILES ON A 9-TRACK, 6250 BPI MAGNETIC TAPE
.*   THROUGH A BATCH JOB.
.*
RETURN,JOB.
REWIND,DAT.
COPYCF,DAT,JOB.
BATCH,JOB,INPUT,HERE.
.DATA,DAT.
SWA,T200,STANY,GE1,P1.
ACCNT,ID=SWA,PW=730RMK,CHG=448161004.
USN,DUMTAPE=_TPUSN_.
REQUEST,DUMTAPE,GE,S,NORING,E.
DUMPF,CL,DP=C,ID=SWA,PW=ZYXQ1.
SAVETP,DUMTAPE,RP=180.
UNLOAD,DUMTAPE.
EXIT.
*EOR
*EOF
```

Figure A-5: DUMP Procedure File Listing

```
.PROC,LOAD,TPUSN.
.*
.*     THIS PROCEDURE IS USED TO RELOAD PERMANENT
.*   FILES FROM A 9-TRACK, 6250 BPI MAGNETIC TAPE
.*   TO DISK FILE THROUGH A BATCH JOB.
.*
RETURN,JOB.
REWIND,DAT.
COPYCF,DAT,JOB.
BATCH,JOB,INPUT,HERE.
.DATA,DAT.
SWA,T200,STANY,GE1,P1.
ACCNT,ID=SWA,PW=730RMK,CHG=448161004.
ATTACH,FILES,FILES,ID=SWA.
USN,DUMTAPE=_TPUSN_.
REQUEST,DUMTAPE,GE,S,NORING,E.
LOADPF,I=FILES,PW=ILOAD.
ATTACH,USERLIB,USERLIB.
LIBRARY,USERLIB.
KEEPF,ID=SWA.
UNLOAD,DUMTAPE.
EXIT.
*EOR
M
*EOR
*EOF
```

Figure A-6: LOAD Procedure File Listing


```
.PROC,TRNSFR,TPUSN.
.*
.*     THIS PROCEDURE IS USED TO TRANSFER PERMANENT
.*   FILES FROM A 9-TRACK, 6250 BPI MAGNETIC TAPE TO
.*   ANOTHER 9-TRACK, 6250 BPI MAGNETIC TAPE THROUGH A
.*   BATCH JOB WHEN THE FIRST TAPE IS ABOUT TO EXPIRE.
.*   TAPES ARE ONLY SAVED FOR 180 DAYS.
.*
RETURN,JOB.
REWIND,DAT.
COPYCF,DAT,JOB.
BATCH,JOB,INPUT,HERE.
.DATA,DAT.
SWA,T300,STANY,GE1,P1.
ACCNT,ID=SWA,PW=730RMK,CHG=448161004.
USN,DUMTAPE=_TPUSN_.
REQUEST,DUMTAPE,GE,S,NORING,E.
LOADPF,PW=ILOAD.
UNLOAD,DUMTAPE.
REQUEST,DUMTAPE,GE,S,NORING,M,USN=SCRATCH.
DUMPF,CL,ID=SWA,PW=ZYXQ1.
SAVETP,DUMTAPE,RP=180.
UNLOAD,DUMTAPE.
EXIT.
*EOR
*EOF
```

Figure A-7: TRNSFR Procedure File Listing

```
.PROC,PLOT.
RETURN,INPUT,OUTPUT.
RETURN,PLFILE.
ATTACH,LGO,PLOTLG,ID=SWA.
ATTACH,TAPE3,PLTUNTS,ID=SWA.
ATTACH,TAPE4,SITFIL,ID=SWA.
ATTACH,DISSPLA,DISSPLA.
LIBRARY,INELLIB,DISSPLA.
CONNECT,INPUT,OUTPUT.
RFL,EC=100.
LGO.
RETURN,DISSPLA,LGO,TAPE1,TAPE3,TAPE4.
DISCONT,INPUT,OUTPUT.
RETURN,INPUT,OUTPUT.
LIBRARY,USERLIB.
REVERT.
EXIT(U)
RETURN,DISSPLA.LGO,TAPE1,TAPE3,TAPE4.
DISCONT,INPUT,OUTPUT.
RETURN,INPUT,OUTPUT.
LIBRARY,USERLIB.
REVERT.
```

Figure A-8: PLOT Procedure File Listing

APPENDIX B

Description of TALK2 Plotting Program

TALK2 is a FORTRAN program that produces graphic plots of data generated by the CRAC2 (Calculation of Reactor Accident Consequences, Version 2) program. It is a revised version of the TALK plotting program developed by Science Applications, Inc. (SAI) for Sandia National Laboratories. TALK2 is initiated through the procedure PLOT described in Section III.D. The code was developed and tested at the Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho in the spring of 1982. TALK2 is written primarily in CDC FORTRAN IV Extended, an enhanced version of the ANSI FORTRAN 1966 Standard. In addition, TALK2 utilizes the International Software Systems Corporation (ISSCO) DISSPLA software in program library format plus 3 CDC COMPASS assembly language routines.

In order for TALK2 to function properly, the program must be executed at a facility supporting the DISSPLA library of device-independent plotting routines and device-dependent graphics drivers, e.g., TEKPOP, the driver for the Tektronix terminal.

TALK2 is too large (190K octal words) to be run interactively with the entire program in the CYBER 176 Central Memory (CM). Since array space is a significant fraction of the program size, disk-resident memory or ECM has been used to reduce the CM required by the program. Under NOS/BE, the arrays in labeled common that are to belong to ECM are denoted by the CDC FORTRAN IV statement 'LEVEL 2', followed by the array list. A complete description of ECM is given in the CDC FORTRAN manual.

Three routines written in CDC COMPASS assembly language are called by the FORTRAN routines of TALK2--ATTACH, ISTRIP, and RETURN. The COMPASS routine ATTACH allows a particular catalogued file to be associated with a logical unit. This routine is available through a reference to the catalogued file INELLIB. ATTACH is supported by neither CDC nor INEL CSC and therefore may not work at another CDC installation. The COMPASS routine ATTACH requires that the character data file name be passed in 'I' format (0-filled) whereas FORTRAN IV blank-fills Hollerith words that are not entirely filled with non-blank characters. ISTRIP replaces blanks by zeroes. ISTRIP only functions properly when the passed array is one word long. The COMPASS routine RETURN frees the referenced logical unit for re-assignment to another catalogued file. RETURN is supported by neither CDC nor INEL CSC and therefore may not work at another CDC installation.

TALK2 produces graphic plots, via calls to DISSPLA library routines, suitable for display on either a storage-tube cathode-ray terminal (CRT) such as a Tektronix graphics terminal or on a standard plotter. The data that is plotted is obtained by prior execution of the CRAC2 code. The measure values written to TAPE30 by CRAC2, when saved as catalogued files, can then be plotted by TALK2. TALK2 is designed for an interactive environment. The user chooses files and measures from a 'menu' for each. As TALK2 executes, the user is queried to determine which set of measures are to be plotted. TALK2 may also be executed in batch mode, as

long as all questions asked by TALK2 are anticipated and are properly answered. TALK2 accepts and validates user-input choices, reads site-specific measure data files created by CRAC2, reads the site name file, reads the plot limits file, and produces a device-independent plot file.

Prior to the execution of TALK2, three files must be prepared by the user:

1) Measure Data Files - CRAC2 calculated results for each reactor site save on unformatted disk file TAPE30.

2) Plot Limits File - list of result names and associated default X and Y axis plot limits.

3) Site Names File - list of all site names and the corresponding file name given to associated CRAC2 output file (TAPE30).

The Measure Data File (TAPE1 in TALK2) consists of calculated results in the form of frequency distributions and consequence versus distance from prior CRAC2 executions that are available for plotting. Figure B-1 is a listing of the measures with corresponding indices. The Plot Limits File (TAPE3 in TALK2) provides TALK2 with the default X and Y axis plot limits for each measure that can be plotted as a frequency distribution. Figure B-2 is a description of the file contents and Figure B-4 is a listing of the current Plot Limits File. The Site Names File (TAPE4 in TALK2) is a file which consists of n records ($n \leqslant 100$) of two fields each. The structure and content of the file provide a means of associating a particular reactor site name with the name of a catalogued file. Data for that site are created by a prior CRAC2 execution. The first field is 20 characters in length and should contain the reactor site name. The second field is also 20 characters in length and should contain the name given to the catalogued file containing CRAC2 measure data (TAPE30 written by a prior CRAC2 execution). Figure B-3 is a description of the file contents.

TALK2 is executed interactively on a NOS/BE system with INTERCOM using a CYBER Control Language Procedure File (see NOS/BE Reference Manual). The Procedure File attaches the necessary files and libraries and initiates execution of TALK2. TALK2 produces five different classes of plots as chosen by the user:

1) Same measure, different reactor sites, same release

2) Same measure, same reactor site, different releases

3) Different measures, same reactor site, same release

4) Contour risk plots

5) Measure versus distance plots.

The user may produce an arbitrary number of plots of any class or classes in a single terminal session.

Typical execution times for TALK2 (run interactively) to produce one plotfile with one curve are between 0.5 and 0.6 CPU seconds. Typical TEKPOP execution times to actually produce a single plot with one curve are between 0.5 and 0.6 CPU seconds. Wall-clock time to produce a plot interactively will vary with the computer system load. Under light system load conditions (i.e., off-peak hours as defined in the INEL User's Guide), the total time between initiation of TALK2 and the termination of a plot is between 1 and 2 minutes.

EVACUATION 1

1- ACUTE FATALITIES
2- ACUTE INJURIES
3- POP W/BMR DS>200
4- POP W/UB DS>25
5- POP W/THY DS>300
6- RSK OF FAT-INT 2
7- RSK OF FAT-INT 4
8- RSK OF FAT-INT10
9- RSK OF FAT-INT14
10- FATAL RADIUS(MI)
11- RSK OF INJ-INT 2
12- RSK OF INJ-INT14
13- RSK OF INJ-INT18
14- RSK OF INJ-INT20
15- RSK OF INJ-INT24
16- INJUR RADIUS(MI)
17- ACU BMR DS-INT 2
18- ACU BMR DS-INT10
19- ACU BMR DS-INT14
20- ACU BMR DS-INT18
21- ACU BMR DS-INT20
22- ACU BMR DS-INT24
23- ACU THY DS-INT 2
24- ACU THY DS-INT10
25- ACU THY DS-INT14
26- ACU THY DS-INT18
27- ACU THY DS-INT20
28- ACU THY DS-INT24
29- ACU THY DS-INT30

EVACUATION 2

30- ACUTE FATALITIES
31- ACUTE INJURIES
32- POP W/BMR DS>200
33- POP W/UB DS>25
34- POP W/THY DS>300
35- RSK OF FAT-INT 2
36- RSK OF FAT-INT 4
37- RSK OF FAT-INT10
38- RSK OF FAT-INT14
39- FATAL RADIUS(MI)
40- RSK OF INJ-INT 2
41- RSK OF INJ-INT14
42- RSK OF INJ-INT18
43- RSK OF INJ-INT20
44- RSK OF INJ-INT24
45- INJUR RADIUS(MI)
46- ACU BMR DS-INT 2
47- ACU BMR DS-INT10
48- ACU BMR DS-INT14
49- ACU BMR DS-INT18
50- ACU BMR DS-INT20
51- ACU BMR DS-INT24
52- ACU THY DS-INT 2
53- ACU THY DS-INT10
54- ACU THY DS-INT14
55- ACU THY DS-INT18
56- ACU THY DS-INT20
57- ACU THY DS-INT24
58- ACU THY DS-INT30

EVACUATION 3

59- ACUTE FATALITIES
60- ACUTE INJURIES
61- POP W/BMR DS>200
62- POP W/UB DS>25
63- POP W/THY DS>300
64- RSK OF FAT-INT 2
65- RSK OF FAT-INT 4
66- RSK OF FAT-INT10
67- RSK OF FAT-INT14
68- FATAL RADIUS(MI)
69- RSK OF INJ-INT 2
70- RSK OF INJ-INT14
71- RSK OF INJ-INT18
72- RSK OF INJ-INT20
73- RSK OF INJ-INT24
74- INJUR RADIUS(MI)
75- ACU BMR DS-INT 2
76- ACU BMR DS-INT10
77- ACU BMR DS-INT14
78- ACU BMR DS-INT18
79- ACU BMR DS-INT20
80- ACU BMR DS-INT24
81- ACU THY DS-INT 2
82- ACU THY DS-INT10
83- ACU THY DS-INT14
84- ACU THY DS-INT18
85- ACU THY DS-INT20
86- ACU THY DS-INT24
87- ACU THY DS-INT30

EVACUATION 4

88- ACUTE FATALITIES
89- ACUTE INJURIES
90- POP W/BMR DS>200
91- POP W/UB DS>25
92- POP W/THY DS>300
93- RSK OF FAT-INT 2
94- RSK OF FAT-INT 4
95- RSK OF FAT-INT10
96- RSK OF FAT-INT14
97- FATAL RADIUS(MI)
98- RSK OF INJ-INT 2
99- RSK OF INJ-INT14
100- RSK OF INJ-INT18
101- RSK OF INJ-INT20
102- RSK OF INJ-INT24
103- INJUR RADIUS(MI)
104- ACU BMR DS-INT 2
105- ACU BMR DS-INT10
106- ACU BMR DS-INT14
107- ACU BMR DS-INT18
108- ACU BMR DS-INT20
109- ACU BMR DS-INT24
110- ACU THY DS-INT 2
111- ACU THY DS-INT10
112- ACU THY DS-INT14
113- ACU THY DS-INT18
114- ACU THY DS-INT20
115- ACU THY DS-INT24
116- ACU THY DS-INT30

EVACUATION 5

117- ACUTE FATALITIES
118- ACUTE INJURIES
119- POP W/BMR DS>200
120- POP W/UB DS>25
121- POP W/THY DS>300
122- RSK OF FAT-INT 2
123- RSK OF FAT-INT 4
124- RSK OF FAT-INT10
125- RSK OF FAT-INT14
126- FATAL RADIUS(MI)
127- RSK OF INJ-INT 2
128- RSK OF INJ-INT14
129- RSK OF INJ-INT18
130- RSK OF INJ-INT20
131- RSK OF INJ-INT24
132- INJUR RADIUS(MI)
133- ACU BMR DS-INT 2
134- ACU BMR DS-INT10
135- ACU BMR DS-INT14
136- ACU BMR DS-INT18
137- ACU BMR DS-INT20
138- ACU BMR DS-INT24
139- ACU THY DS-INT 2
140- ACU THY DS-INT10
141- ACU THY DS-INT14
142- ACU THY DS-INT18
143- ACU THY DS-INT20
144- ACU THY DS-INT24
145- ACU THY DS-INT30

EVACUATION 6

146- ACUTE FATALITIES
147- ACUTE INJURIES
148- POP W/BMR DS>200
149- POP W/UB DS>25
150- POP W/THY DS>300
151- RSK OF FAT-INT 2
152- RSK OF FAT-INT 4
153- RSK OF FAT-INT10
154- RSK OF FAT-INT14
155- FATAL RADIUS(MI)
156- RSK OF INJ-INT 2
157- RSK OF INJ-INT14
158- RSK OF INJ-INT18
159- RSK OF INJ-INT20
160- RSK OF INJ-INT24
161- INJUR RADIUS(MI)
162- ACU BMR DS-INT 2
163- ACU BMR DS-INT10
164- ACU BMR DS-INT14
165- ACU BMR DS-INT18
166- ACU BMR DS-INT20
167- ACU BMR DS-INT24
168- ACU THY DS-INT 2
169- ACU THY DS-INT10
170- ACU THY DS-INT14
171- ACU THY DS-INT18
172- ACU THY DS-INT20
173- ACU THY DS-INT24
174- ACU THY DS-INT30

EVACUATION SUM

175- ACUTE FATALITIES
176- ACUTE INJURIES
177- POP W/BMR DS>200
178- POP W/UB DS>25
179- POP W/THY DS>300
180- RSK OF FAT-INT 2
181- RSK OF FAT-INT 4
182- RSK OF FAT-INT10
183- RSK OF FAT-INT14
184- FATAL RADIUS(MI)
185- RSK OF INJ-INT 2
186- RSK OF INJ-INT14
187- RSK OF INJ-INT18
188- RSK OF INJ-INT20
189- RSK OF INJ-INT24
190- INJUR RADIUS(MI)
191- ACU BMR DS-INT 2
192- ACU BMR DS-INT10
193- ACU BMR DS-INT14
194- ACU BMR DS-INT18
195- ACU BMR DS-INT20
196- ACU BMR DS-INT24
197- ACU THY DS-INT 2
198- ACU THY DS-INT10
199- ACU THY DS-INT14
200- ACU THY DS-INT18
201- ACU THY DS-INT20
202- ACU THY DS-INT24
203- ACU THY DS-INT30

EVACUATION 6 Cont.

233- CANCER RSK-INT 2
234- CANCER RSK-INT14
235- CANCER RSK-INT18
236- CANCER RSK-INT20
237- CANCER RSK-INT24
238- CANCER RSK-INT30
239- INTERD AREA
240- INTERD DIST
241- INTERD RSK-INT14
242- INTERD RSK-INT20
243- INTERD RSK-INT24
244- DECON AREA
245- DECON DIST
246- DECON RISK-INT14
247- DECON RISK-INT24
248- DECON RISK-INT30
249- INT CROP AREA
250- INT CROP DIST
251- INT CRPRSK-INT14
252- INT CRPRSK-INT24
253- INT CRPRSK-INT30
254- INT CRPRSK-INT32
255- INT MILK AREA
256- INT MILK DIST
257- INT MLKRSK-INT14
258- INT MLKRSK-INT24
259- INT MLKRSK-INT30
260- INT MLKRSK-INT32

EVACUATION 6 Cont.*

204- TOT LAT/INITIAL
205- TOT LAT/TOTAL
206- TOT WBODY MANREM
207- INTERD POP
208- INTERD COST
209- DECON POP
210- DECON COST
211- INT CROP COST
212- INT MILK COST
213- RELOCATION COST
214- EVACUATION COST
215- TOT COST W/O DEC
216- TOT COST W/DECOM
217- INITIAL LEUKEMIA
218- INITIAL LUNG
219- INITIAL BREAST
220- INITIAL BONE
221- INITIAL GI TRK
222- INITIAL OTHER
223- INITIAL W BODY
224- INITIAL THYROID
225- TOTAL LEUKEMIA
226- TOTAL LUNG
227- TOTAL BREAST
228- TOTAL BONE
229- TOTAL GI TRK
230- TOTAL OTHER
231- TOTAL W BODY
232- TOTAL THYROID

*Measures in the range 204 through 260, when dependent upon early exposure, are based on EVACUATION 6.

Figure B-1: CRAC2 Measures With Indices

RECORD	FIELD	COLUMNS	FORMAT	DATA CONTENT
1	1	1-20	2A10	RSNM - Measure name. Alphanumeric.
	2	21-30	E10.5	XMIN - Minimum X axis value for associated measure. Real.
	3	31-40	E10.5	XMAX - Maximum X axis value for associated measure. Real.
	4	41-50	E10.5	YMIN - Minimum Y axis value for associated measure. Real.
	5	51-60	E10.5	YMAX - Maximum Y axis value for associated measure. Real.

Figure B-2: Plot Limits File

RECORD	FIELD	COLUMNS	FORMAT	DATA CONTENT
1	1	1-20	2A10	NAMRS - Site name. Alphanumeric.
	2	21-40	2A10	DLG - Permanent file name. Alphanumeric.

Figure B-3: Site Names File

Measures	Min. X-axis	Max. X-axis	Min. Y-axis	Max. Y-axis
1- ACUTE FATALITIES	1.00E+00	1.00E+05	1.00E-10	1.00E-05
2- ACUTE INJURIES	1.00E+01	1.00E+06	1.00E-10	1.00E-05
3- POP W/BMR DS>200	1.00E+01	1.00E+06	1.00E-10	1.00E-05
4- POP W/WB DS>25	1.00E+01	1.00E+06	1.00E-10	1.00E-05
5- POP W/THY DS>300	1.00E+01	1.00E+06	1.00E-10	1.00E-05
6- RSK OF FAT-INT 2	1.00E-10	1.00E-05	1.00E-10	1.00E-05
7- RSK OF FAT-INT 4	1.00E-10	1.00E-05	1.00E-10	1.00E-05
8- RSK OF FAT-INT10	1.00E-10	1.00E-05	1.00E-10	1.00E-05
9- RSK OF FAT-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
10- FATAL RADIUS(MI)	1.00E+00	1.00E+02	1.00E-10	1.00E-05
11- RSK OF INJ-INT 2	1.00E-10	1.00E-05	1.00E-10	1.00E-05
12- RSK OF INJ-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
13- RSK OF INJ-INT18	1.00E-10	1.00E-05	1.00E-10	1.00E-05
14- RSK OF INJ-INT20	1.00E-10	1.00E-05	1.00E-10	1.00E-05
15- RSK OF INJ-INT24	1.00E-10	1.00E-05	1.00E-10	1.00E-05
16- INJUR RADIUS(MI)	1.00E+00	1.00E+02	1.00E-10	1.00E-05
17- ACU BMR DS-INT 2	1.00E+00	1.00E+06	1.00E-10	1.00E-05
18- ACU BMR DS-INT10	1.00E+00	1.00E+06	1.00E-10	1.00E-05
19- ACU BMR DS-INT14	1.00E+00	1.00E+06	1.00E-10	1.00E-05
20- ACU BMR DS-INT18	1.00E+00	1.00E+06	1.00E-10	1.00E-05
21- ACU BMR DS-INT20	1.00E+00	1.00E+06	1.00E-10	1.00E-05
22- ACU BMR DS-INT24	1.00E+00	1.00E+06	1.00E-10	1.00E-05
23- ACU THY DS-INT 2	1.00E+00	1.00E+06	1.00E-10	1.00E-05
24- ACU THY DS-INT10	1.00E+00	1.00E+06	1.00E-10	1.00E-05
25- ACU THY DS-INT14	1.00E+00	1.00E+06	1.00E-10	1.00E-05
26- ACU THY DS-INT18	1.00E+00	1.00E+06	1.00E-10	1.00E-05
27- ACU THY DS-INT20	1.00E+00	1.00E+06	1.00E-10	1.00E-05
28- ACU THY DS-INT24	1.00E+00	1.00E+06	1.00E-10	1.00E-05
29- ACU THY DS-INT30	1.00E+00	1.00E+06	1.00E-10	1.00E-05
204- TOT LAT/INITIAL	1.00E+00	1.00E+05	1.00E-10	1.00E-05
205- TOT LAT/TOTAL	1.00E+00	1.00E+05	1.00E-10	1.00E-05
206- TOT WBODY MANREM	1.00E+04	1.00E+10	1.00E-10	1.00E-05
207- INTERD POP	1.00E+03	1.00E+08	1.00E-10	1.00E-05
208- INTERD COST	1.00E+06	1.00E+12	1.00E-10	1.00E-05
209- DECON POP	1.00E+03	1.00E+08	1.00E-10	1.00E-05
210- DECON COST	1.00E+06	1.00E+12	1.00E-10	1.00E-05
211- INT CROP COST	1.00E+06	1.00E+12	1.00E-10	1.00E-05
212- INT MILK COST	1.00E+06	1.00E+12	1.00E-10	1.00E-05
213- RELOCATION COST	1.00E+07	1.00E+13	1.00E-10	1.00E-05
214- EVACUATION COST	1.00E+05	1.00E+10	1.00E-10	1.00E-05
215- TOT COST W/O DEC	1.00E+07	1.00E+13	1.00E-10	1.00E-05
216- TOT COST W/DECON	1.00E+07	1.00E+13	1.00E-10	1.00E-05
217- INITIAL LEUKEMIA	1.00E+00	1.00E+05	1.00E-10	1.00E-05
218- INITIAL LUNG	1.00E+00	1.00E+05	1.00E-10	1.00E-05
219- INITIAL BREAST	1.00E+00	1.00E+05	1.00E-10	1.00E-05
220- INITIAL BONE	1.00E+00	1.00E+05	1.00E-10	1.00E-05
221- INITIAL GI TRK	1.00E+00	1.00E+05	1.00E-10	1.00E-05
222- INITIAL OTHER	1.00E+00	1.00E+05	1.00E-10	1.00E-05
223- INITIAL W BODY	1.00E+00	1.00E+05	1.00E-10	1.00E-05
224- INITIAL THYROID	1.00E+00	1.00E+05	1.00E-10	1.00E-05
225- TOTAL LEUKEMIA	1.00E+00	1.00E+05	1.00E-10	1.00E-05
226- TOTAL LUNG	1.00E+00	1.00E+05	1.00E-10	1.00E-05
227- TOTAL BREAST	1.00E+00	1.00E+05	1.00E-10	1.00E-05
228- TOTAL BONE	1.00E+00	1.00E+05	1.00E-10	1.00E-05
229- TOTAL GI TRK	1.00E+00	1.00E+05	1.00E-10	1.00E-05
230- TOTAL OTHER	1.00E+00	1.00E+05	1.00E-10	1.00E-05
231- TOTAL W BODY	1.00E+00	1.00E+05	1.00E-10	1.00E-05
232- TOTAL THYROID	1.00E+00	1.00E+05	1.00E-10	1.00E-05
233- CANCER RSK-INT 2	1.00E-10	1.00E-05	1.00E-10	1.00E-05
234- CANCER RSK-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
235- CANCER RSK-INT18	1.00E-10	1.00E-05	1.00E-10	1.00E-05
236- CANCER RSK-INT20	1.00E-10	1.00E-05	1.00E-10	1.00E-05
237- CANCER RSK-INT24	1.00E-10	1.00E-05	1.00E-10	1.00E-05

Measures	Min. X-axis	Max. X-axis	Min. Y-axis	Max. Y-axis
238- CANCER RSK-INT30	1.00E-10	1.00E-05	1.00E-10	1.00E-05
239- INTERD AREA	1.00E+00	1.00E+03	1.00E-10	1.00E-05
240- INTERD DIST	1.00E+00	1.00E+02	1.00E-10	1.00E-05
241- INTERD RSK-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
242- INTERD RSK-INT20	1.00E-10	1.00E-05	1.00E-10	1.00E-05
243- INTERD RSK-INT24	1.00E-10	1.00E-05	1.00E-10	1.00E-05
244- DECON AREA	1.00E+00	1.00E+04	1.00E-10	1.00E-05
245- DECON DIST	1.00E+00	1.00E+03	1.00E-10	1.00E-05
246- DECON RISK-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
247- DECON RISK-INT24	1.00E-10	1.00E-05	1.00E-10	1.00E-05
248- DECON RISK-INT30	1.00E-10	1.00E-05	1.00E-10	1.00E-05
249- INT CROP AREA	1.00E+00	1.00E+05	1.00E-10	1.00E-05
250- INT CROP DIST	1.00E+00	1.00E+03	1.00E-10	1.00E-05
251- INT CRPRSK-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
252- INT CRPRSK-INT24	1.00E-10	1.00E-05	1.00E-10	1.00E-05
253- INT CRPRSK-INT30	1.00E-10	1.00E-05	1.00E-10	1.00E-05
254- INT CRPRSK-INT32	1.00E-10	1.00E-05	1.00E-10	1.00E-05
255- INT MILK AREA	1.00E+00	1.00E+05	1.00E-10	1.00E-05
256- INT MILK DIST	1.00E+00	1.00E+03	1.00E-10	1.00E-05
257- INT MLKRSK-INT14	1.00E-10	1.00E-05	1.00E-10	1.00E-05
258- INT MLKRSK-INT24	1.00E-10	1.00E-05	1.00E-10	1.00E-05
259- INT MLKRSK-INT30	1.00E-10	1.00E-05	1.00E-10	1.00E-05
260- INT MLKRSK-INT32	1.00E-10	1.00E-05	1.00E-10	1.00E-05

*Plot limits for measures 1 through 29 are used for measures from each evacuation strategy.

Figure B-4: Listing of Current Plot Limits File

APPENDIX C

Control Streams For CRAC2 Batch Execution

The following two sections list control streams for the batch execution of CRAC2 through use of a job deck on the INEL computing system at Idaho Falls, Idaho.

Batch Execution of CRAC2 Using a Job Deck

The following control stream can be used to make standard CRAC2 executions on the computing system at INEL:

```
SWA,T[time limit in octal seconds],P[job priority],STANY.
ACCNT,ID=[userid],PW=[password],CHG=[chargeno].
REQUEST,TAPE30,*PF.
REQUEST,TAPE50,*PF.
.*  ATTACH SUBGROUP DATA FILE, UPDATE, LIST ON OUTPUT FILE
ATTACH,OLDPL,CRACDATA2,ID=DXA.
UPDATE,F,D,C=DATA.
COPYSBF,DATA,OUTPUT.
REWIND,DATA.
RETURN,OLDPL.
.*  ATTACH CRAC2 PROGRAM, UPDATE, COMPILE
ATTACH,OLDPL,CRAC2CV,ID=DXA.
UPDATE,F,W,C.
FTN,I=COMPILE,OPT=2,L=0.
.*  ATTACH DATA FILES
ATTACH,TAPE20,[site data file name],ID=SWA.
ATTACH,TAPE21,HEALTHDATA2,ID=DXA.
ATTACH,TAPE27,[meteorological data file name],ID=SWA.
LIBRARY,INELLIB.
.*  INITIALLIZE CORE, LOAD, EXECUTE
RFL,EC=500.
LDSET,PRESET=ZERO.
LGO,DATA,PL=99999.
CATALOG,TAPE30,[catalogued file name],ID=SWA,RP=999. **
CATALOG,TAPE50,[catalogued file name],ID=SWA,RP=30. **
EXIT(U)
7/8/9
*IDENT,NUDATA
[update changes to input data file]
7/8/9
*IDENT,NUCRAC2
[update changes to CRAC2 program]
7/8/9
6/7/8/9
```

** Optional Card

Batch Execution of CRAC2 Using a Job Deck With DES/FES Modifications

The following control stream can be used to make CRAC2 executions using modifications designed for DES/FES casework analysis at INEL:

```
SWA,T[time limit in octal seconds],P[job priority],STANY.
ACCNT,ID=[userid],PW=[password],CHG=[chargeno].
REQUEST,TAPE30,*PF.
REQUEST,TAPE50,*PF.
.*  ATTACH SUBGROUP DATA FILE, UPDATE, LIST ON OUTPUT FILE
ATTACH,OLDPL,CRACDATA2,ID=DXA.
UPDATE,F,D,C=DATA.
COPYSBF,DATA,OUTPUT.
REWIND,DATA.
RETURN,OLDPL.
.*  ATTACH CRAC2 PROGRAM, UPDATE, COMPILE
ATTACH,UPD,FESUPDATE,ID=SWA.
ATTACH,OLDPL,CRAC2CV,ID=DXA.
UPDATE,F,W,N,I=UPD.
.*  UPDATE WITH CORRECTIONS IN DECK
UPDATE,F,P=NEWPL,W,C.
RETURN,OLDPL,UPD,NEWPL.
FTN,I=COMPILE,OPT=2,L=0.
.*  ATTACH DATA FILES
ATTACH,TAPE20,[site data file name],ID=SWA.
ATTACH,TAPE21,HEALTHDATA2,ID=DXA.
ATTACH,TAPE27,[meteorological data file name],ID=SWA.
LIBRARY,INELLIB.
.*  INITIALLIZE CORE,LOAD, EXECUTE
RFL,EC=500.
LDSET,PRESET=ZERO.
LGO,DATA,PL=99999.
CATALOG,TAPE30,[catalogued file name],ID=SWA,RP=999. **
CATALOG,TAPE50,[catalogued file name],ID=SWA,RP=30. **
EXIT(U)
7/8/9
*IDENT,NUDATA
[update changes to input data file]
7/8/9
*IDENT,NUCRAC2
[update changes to CRAC2 program]
7/8/9
6/7/8/9
```

** Optional Card

APPENDIX D

Description of NRC-Supplied Data File in Non-CRAC2 Format

The CRAC2 computer code requires three types of information which are site-specific in nature. This information includes hourly meteorological data recorded over a period of one year and demographical and topographical data for the area surrounding the site. A file containing this information in non-CRAC2 format is transformed into a CRAC2-formatted meteorological data file and CRAC2-formatted population and topography subgroups. This transformation takes place through the use of the procedure METPOP retained on the INEL computing system. A description of the use of METPOP is contained in Section IIIA.

The non-CRAC2-formatted data file contains the three sets of site-specific data in the order meteorological data, demographical data, and topographical data. The data is formatted using 80-column card images as illustrated in the following tables.

Table D-1: Meteorological Data Format

CARD	FIELD	COLUMNS	FORMAT	DATA CONTENT
1	1-5	1-20	5A4	Meteorological data title.
2	1	1- 6	I6	Rain rate in tenths of millimeters per hour for first hour.
	2	7	I1	Atmospheric stability category (1-6) for first hour.
	3	8-10	I3	Wind velocity in tenths of meters per second for first hour.
	4	11-12	I2	Sector wind direction (1-16) for first hour.
	5	13-18	I6	Rain rate for second hour.
	6	19	I1	Atmospheric stability category for second hour.
	7	20-22	I3	Wind velocity for second hour.

Table D-1 (Continued): Meteorological Data Format

CARD	FIELD	COLUMNS	FORMAT	DATA CONTENT
2	8	23-24	I2	Sector wind direction for second hour.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	21	61-66	I6	Rain rate for sixth hour.
	22	67	I1	Atmospheric stability category for sixth hour.
	23	68-70	I3	Wind velocity for sixth hour.
	24	71-72	I2	Sector wind direction for sixth hour.
3-1461	-	-	-	(Cards 3 through 1461 contain meteorological data in the same format as card 2, six hours of data per card. The data for one day or 24 hours is therefore contained in 4 cards. The full year of data or 8760 hours requires 1460 cards.)
1462	1-4	1-40	4E10.2	Holzworth seasonal mixing heights in hundreds of meters for stable atmospheric conditions (winter, spring, summer, fall).
	5-8	41-80	4E10.2	Holzworth seasonal mixing heights in hundreds of meters for unstable atmospheric conditions (winter, spring, summer, fall).

Table D-2: Demographical Data Format

RECORD	FIELD	COLUMNS	FORMAT	DATA CONTENT
1	1-20	1-80	20A4	Demographical data title.
2	1	1-10	E10.5	Probability associated with the wind blowing toward population sector 1.
	2- 8	11-80	7E10.0	Population values for the first seven downwind spatial intervals.
3	1- 8	1-80	8E10.0	Population values for the downwind spatial intervals 8 through 16.
4	1- 2	1-20	2E10.0	Population values for the downwind spatial intervals 17 and 18.
5-49	-	-	-	(For sectors 2 through 16, cards 2 through 4 are repeated for each sector.)
50	1-16	1-80	16F5.4	Probability associated with the wind blowing toward population sectors 1 through 16 during the winter.
51	1-16	1-80	16F5.4	Probability associated with the wind blowing toward population sectors 1 through 16 during the spring.
52	1-16	1-80	16F5.4	Probability associated with the wind blowing toward population sectors 1 through 16 during the summer.
53	1-16	1-80	16F5.4	Probability associated with the wind blowing toward population sectors 1 through 16 during the fall.

The sectors are numbered starting with the north-centered sector as sector 1 and numbering clockwise. The spatial intervals of the NRC-supplied data have outer radii of 1., 2., 3., 4., 5., 10., 20.,

30., 40., 50., 60., 70., 85., 100., 150., 200., 350., and 500. miles. These radii are transformed to correspond to the CRAC2 outer radii of 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., 25., 30., 35., 40., 45., 50., 55., 60., 65., 70., 85., 100., 150., 200., 350., and 500. miles.

Table D-3: Topographical Data Format

CARD	FIELD	COLUMNS	FORMAT	DATA CONTENT
1	1-20	1-80	20A4	Topographical data title.
2	1	1- 3	1X,I2	Two digit state code (number corresponding to order of states in subgroup ECONOMIC) for first spatial interval of sector 1.
	2	4- 5	I2	Land area decimal fraction multiplied by 10 (10 = 100% land, 09 = 90% land, etc.)
	3	6- 8	1X,I2	Two digit state code for second spatial interval of sector 1.
	4	9-10	I2	Land area decimal fraction multiplied by 10.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	31	76-78	1X,I2	Two digit state code for sixteenth area element of sector 1.
	32	79-80	I2	Land area decimal fraction multiplied by 10.
3-4	-	-	-	(The format of card 2 is repeated until all 34 area elements have been specified for sector 1.)
5-49	-	-	-	(For sectors 2 through 16, the process is repeated starting with a new card for each sector.)

APPENDIX E

Description of EVACUATE Subgroups

The three figures and three tables that follow describe the emergency response parameters that are used for the three general types of CRAC2 executions initiated through the procedure CRAC2. The three types of executions include standard emergency response, minimal medical treatment emergency response, and relocation emergency response. Figures E-1, E-2, and E-3 list the EVACUATE subgroups in the format described in Section II.C. Tables E-1, E-2, and E-3 describe the data from the EVACUATE subgroups in a more readable format. The standard emergency response can be modified through use of the text editor on the file of EVACUATE subgroups EVACFIL,ID=SWA. The standard emergency response EVACUATE subgroup is the first subgroup on the file. Extreme care must be exercised in making changes to this file.

```
EVACUATE                    6    NO          NO
        .3          1.          4.47        14.0        24135.      14.0          2.
        .4          3.          4.47        14.0        24135.      14.0          2.
        .3          5.          4.47        14.0        24135.      14.0          2.
        0.          0.            0.          0.          0.        14.0          2.          1.
        0.          0.            0.          0.          0.          0.          2.
        0.          5.          .447        14.0        24135.      14.0          2.
       .75          1.            .5         .75          .33          .5         .08         .33
  2.66E-4     2.66E-4     1.33E-4     2.66E-4
     8045.         90.         165.          3.          0
```

Figure E-1: Standard Evacuate Subgroup

```
EVACUATE                    6    NO          NO
        0.          1.          3.          16.         24135.      16.           2.         .333
        0.          1.          3.          18.         24135.      16.           2.         .333
        0.          2.          3.          16.         24135.      16.           2.         .333
        0.          3.          3.          19.         24135.      19.           2.         .333
        0.          0.          0.          0.            0.        0.            2.         .333
        1.          1.          3.          14.         24135.      14.           2.         .333
       .75          1.         .75         .75           .33         .5          .33         .33
  2.66E-4     2.66E-4     2.66E-4     2.66E-4
     8045.         90.         165.          3.         -1
```

Figure E-2: Minimum Medical Evacuate Subgroup

```
EVACUATE                    6    NO          NO
        0.          1.          3.          14.         24135.      19.           2.      1. .333
        0.          1.          3.          14.         24135.      22.           2.      1. .333
        0.          2.          3.          14.         24135.      19.           2.      1. .333
        0.          2.          3.          14.         24135.      22.           2.      1. .333
        0.          0.          0.          0.            0.        0.            2.      1. .333
        1.          0.          0.          0.            0.       19.           2.      1. .333
       .75          1.         .75         .75           .33         .5          .33         .33
  2.66E-4     2.66E-4     2.66E-4     2.66E-4
     8045.         90.         165.          3.          1
```

Figure E-3: Relocation Evacuate Subgroup

Table E-1: Standard Evacuate Subgroup Description

PROBABILITY	TIME DELAY(hrs)	EVACUATION SPEED(m/s)	EVACUATION RANGE(mi)	SHELTERING/ RELOCATION RANGE(mi)	RELOCATION TIME WITHIN SHELTERING RANGE(days)	RELOCATION TIME OUTSIDE SHELTERING RANGE(days)
0.3	1.0	4.47	0. - 10.	-----	-----	1.0
0.4	3.0	4.47	0. - 10.	-----	-----	1.0
0.3	5.0	4.47	0. - 10.	-----	-----	1.0
0.0	0.0	0.0	-----	0. - 10.	1.0	1.0
0.0	0.0	0.0	-----	-----	-----	1.0
0.0	5.0	0.447	0. - 10.	-----	-----	1.0

Table E-2: Minimum Medical Evacuate Subgroup Description

PROBABILITY	TIME DELAY(hrs)	EVACUATION SPEED(m/s)	EVACUATION RANGE(mi)	SHELTERING/ RELOCATION RANGE(mi)	RELOCATION TIME WITHIN SHELTERING RANGE(days)	RELOCATION TIME OUTSIDE SHELTERING RANGE(days)
0.0	1.0	3.0	0. - 15.	-----	-----	1. or 7.
0.0	1.0	3.0	0. - 20.	-----	-----	1. or 7.
0.0	2.0	3.0	0. - 15.	-----	-----	1. or 7.
0.0	3.0	3.0	0. - 25.	-----	-----	1. or 7.
0.0	0.0	0.0	-----	-----	-----	1. or 7.
1.0	1.0	3.0	0. - 10.	-----	-----	1. or 7.

Table E-3: Relocation Evacuate Subgroup Description

PROBABILITY	TIME DELAY(hrs)	EVACUATION SPEED(m/s)	EVACUATION RANGE(mi)	SHELTERING/ RELOCATION RANGE(mi)	RELOCATION TIME WITHIN SHELTERING RANGE(days)	RELOCATION TIME OUTSIDE SHELTERING RANGE(days)
0.0	1.0	3.0	0. - 10.	10. - 25.	0.333	1.0
0.0	1.0	3.0	0. - 10.	10. - 40.	0.333	1.0
0.0	2.0	3.0	0. - 10.	10. - 25.	0.333	1.0
0.0	2.0	3.0	0. - 10.	10. - 40.	0.333	1.0
0.0	0.0	0.0	-----	-----	-----	1.0
1.0	0.0	0.0	-----	0. - 25.	0.333	1.0

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The CRAC2 computer code has been adapted to the calculation requirements of Draft/Final Environmental Impact Statement (DES/FES) casework analysis for the Nuclear Regulatory Commission. CRAC2 is a revised version of the CRAC (Calculation of Reactor Accident Consequences) computer code developed in support of the Reactor Safety Study, WASH-1400. A graphical output package has been developed for displaying CRAC2 computed results. All phases of the casework analysis calculations from initial data formatting to plotting of calculated results are executed through the use of procedure files on the Idaho National Engineering Laboratory (INEL) computing system at Idaho Falls, Idaho. The INEL computing system operates under the Control Data Corporation (CDC) NOS/BE Operating System (Level 518) and Intercom Version 5.

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