AIRCOM: A MODULE FOR

ITERATIVE PERFORMANCE ASSESSMENT PHASE 2

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ABSTRACT

This user guide describes the AIRCOM module, its structures, and instructions for its use. AIRCOM is one of the modules executed under the Total-System Performance Assessment (TPA) Exec to simulate performance of the overall repository system.

Within the TPA system there is one code which calculates gaseous release and two which calculate direct release. A certain fraction of the direct release is assumed to be gaseous (respirable fraction). The three output files produced need to be combined into one file for use by the DITTY module. AIRCOM is a utility designed to perform this function. In this sense, it can be viewed as a pre-processor for the DITTY module. AIRCOM does not perform any physical modeling except for the introduction of respirable fractions for the direct release. The three input files contain release rate as a function of time and nuclide. The files contain radionuclide releases at discrete times. AIRCOM reads these releases; checks if releases are specified at the same discrete times; and, if not, interplots releases to common time and then adds these releases to provide total releases as functions of time.

The AIRCOM program can be run in two modes. It can be run either under the Total-System Performance Assessment (TPA) program or in a standalone mode. AIRCOM is written in ANSI Standard FORTRAN 77.

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FOREWORD

In accordance with the provisions of the Nuclear Waste Policy Act of 1982, the Nuclear Regulatory Commission (NRC) has the responsibility of evaluating and granting a license for the first and subsequent, if any, geological repositories for high-level nuclear waste (HLW). This act was amended in 1987 to designate one site in the unsaturated region of tuffaceous rocks of Yucca Mountain in southern Nevada for detailed characterization. The Center for Nuclear Waste Regulatory Analyses (CNWRA) at Southwest Research Institute (SwRI) is a Federally Funded Research and Development Center (FFRDC) created to support the NRC in its mission of evaluating and licensing the proposed HLW repository. To meet its licensing function, the NRC will review the application submitted by the U.S. Department of Energy (DOE). One critical section of the license application will deal with the assessment of the future performance of the repository system, which has to meet certain minimum standards established by regulations.

In order to develop capabilities to review the Performance Assessment (PA) in the DOE license application, the NRC and CNWRA are engaged in developing and applying PA methods and models to existing data. Later, at the time of license application review, these methods may be used to conduct independent PA, if the NRC elects to do so. Because of the large space and time scales involved in estimating repository performance, mathematical models encoded as computer codes are the chosen tools for PA. The repository system consists of designed (or engineered) barriers embedded in the natural geological setting. Estimating performance of the total system requires that the behavior of these components be projected under possible future conditions. This effort is obviously a complex task that requires a variety of calculations. The development of the AIRCOM program described in this report is a part of the TPA computer code that performs these calculations.

ACKNOWLEDGMENTS

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1 INTRODUCTION

1.1 REGULATORY AND TECHNICAL BACKGROUND

The Nuclear Regulatory Commission (NRC), in conjunction with the Center for Nuclear Waste Regulatory Analyses (CNWRA), is developing an independent performance assessment (PA) capability to:

- Aid in developing an independent understanding of the processes, conditions, and events important to predicting long-term repository performance and their relative significance in such predictions

- Provide an independent capability for reviewing U.S. Department of Energy (DOE) demonstrations of compliance with the overall system and subsystem performance objectives

- Aid in the detailed technical review of DOE iterative total-system and subsystem PAs

- Contribute to the development of guidance to DOE on the adequacy of site characterization data and repository design, with respect to demonstrating compliance with the regulations

This independent PA capability is designed to quantitatively calculate estimates of repository performance specified in the regulations. To make predictions of performance and comparisons with regulatory performance measures, the Total-System Performance Assessment (TPA) code has been developed to provide computational algorithms for estimating values of various performance measures [See Sagar and Janetzke (1993) for the description of the TPA code]. To estimate the performance measures, the TPA code contains a set of Consequence Modules (CMs) that are largely independent computational units.

The primary regulations applicable to the high-level waste (HLW) geological repository were promulgated by the NRC in 10 CFR Part 60—Disposal of High-Level Radioactive wastes in Geologic Repositories. Two sections of 10 CFR Part 60 pertain specifically to post-closure performance. These sections include Part 60.112—Overall System Performance Objective for the Geologic Repository after Permanent Closure; and Part 60.113—Performance of Particular Barriers after Permanent Closure. Part 60.112 makes reference to satisfying the generally applicable environmental standards for radioactivity established by the Environmental Protection Agency (EPA). These environmental standards referred to in Part 60.112 were promulgated by the EPA in 40 CFR Part 191 in 1985. However, on litigation, certain provisions of these standards were remanded by a federal court. Proposed revisions of 40 CFR Part 191 were under review in early 1993. In late 1992, the U.S. Congress enacted a new law known as the Energy Policy Act according to which the EPA will develop standards applicable specifically to Yucca Mountain (YM) that may be different from those in 40 CFR Part 191.

Three different performance measures are used in Part 191. These measures are: (i) release of radioactivity over the entire accessible environment boundary (integrated over areal space) cumulated over a 10,000-yr period (integrated over time) after closure must not exceed specific limits at specified levels (Part 191.13—Containment Requirements), where the preferred method of representing this performance measure is through a Complementary Cumulative (Probability) Distribution Function (CCDF); (ii) dose to humans in the first 1,000 yr after repository closure must not exceed specified limit (Part 191.15—Individual Protection Requirements), this requirement is deterministic; and

(iii) concentration of alpha-, beta-, and gamma-emitting radionuclides must not exceed specified limits (Part 191.16—Groundwater Protection Requirements), this requirement is deterministic. While the first performance measure is to consider all future credible scenarios, the other two apply only to undisturbed performance.

In addition, three other performance measures are used in 10 CFR Part 60.113 to define performance of individual barriers (in contrast to the total system). These performance measures are: (i) life of the waste package must exceed specified limits [Part 60.113(a)(ii)(A)—Substantially Complete Containment Requirement]; (ii) release from engineered barriers must be less than specified limits [Part 60.113(a)(1)(ii)(B)—Groundwater Release Requirement]; and (iii) Groundwater Travel Time (GWTT) must be greater than specified limits [Part 60.113(a)(2)—Groundwater Travel Time Requirement].

In all, there are six distinct performance measures. In general, a TPA code must allow for estimation of the three measures related to 40 CFR Part 191 and preferably, but not necessarily, for the other three related to 10 CFR 60.113. Figure 1-1 depicts the six performance measures and lists the steps for their assessment. The steps for the assessment of the six performance measures include model conceptualization of process, assembly of data suitable for input to the mathematical models, consequence analysis, sensitivity uncertainty analysis, and regulatory compliance assessment.

1.2 TPA BACKGROUND

To estimate the performance measures, the TPA code contains a set of CMs that are computationally independent units, with their execution controlled by an Executive Module (Exec) (Sagar and Janetzke, 1993). The Exec acts as the manager and assures that CMs are executed in the desired sequence and that appropriate values of the common parameters are passed to CMs. The Exec of the TPA directs data flow between different subprocesses and controls their execution. Figure 1-2 schematically shows the organization of Version 2.0 of the TPA code. The shaded parts of Figure 1-2 represent the Exec. A data flow diagram indicating intermodule communication interfaces is shown in Figure 1-3. This figure also shows all CMs of the TPA, including the AIRCOM module.

1.3 PURPOSE OF SOFTWARE

AIRCOM was designed to be a preprocessor for the DITTY module. DITTY requires its air release input file to be organized by nuclide. The release rate time history of each nuclide is expected to follow the nuclide name as a unique contiguous set of records. The TPA system has three modules which produce release rates (ci/yr) to be transferred to DITTY. These three files must first be merged into one with the proper format. This merging process is performed by AIRCOM. Later, a calculation of respirable fractions was added to AIRCOM. These fractions apply only to the direct release data of VOLCANO and DRILLO2 and not to the gaseous release data from C14H. The program can be run as part of the TPA system or iteractively in standalone mode. AIRCOM is written in ANSI standard FORTRAN 77.

1.4 REPORT CONTENT

Features of the software are described in Chapter 2. Chapter 3 contains the input instructions for the AIRCOM program, and Chapter 4 describes the outputs. The verification and validation status

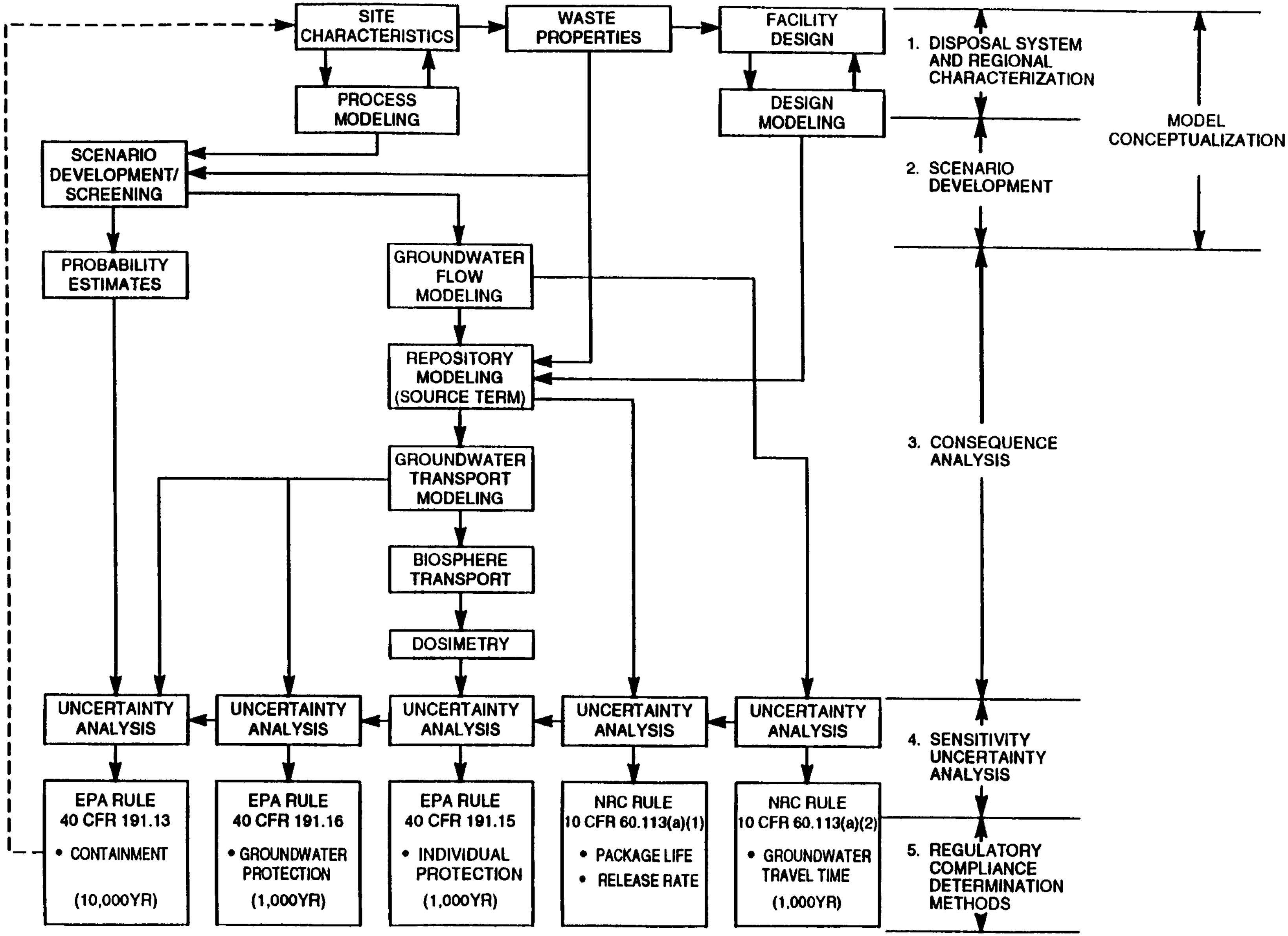

Figure 1-1. Regulatory performance measures

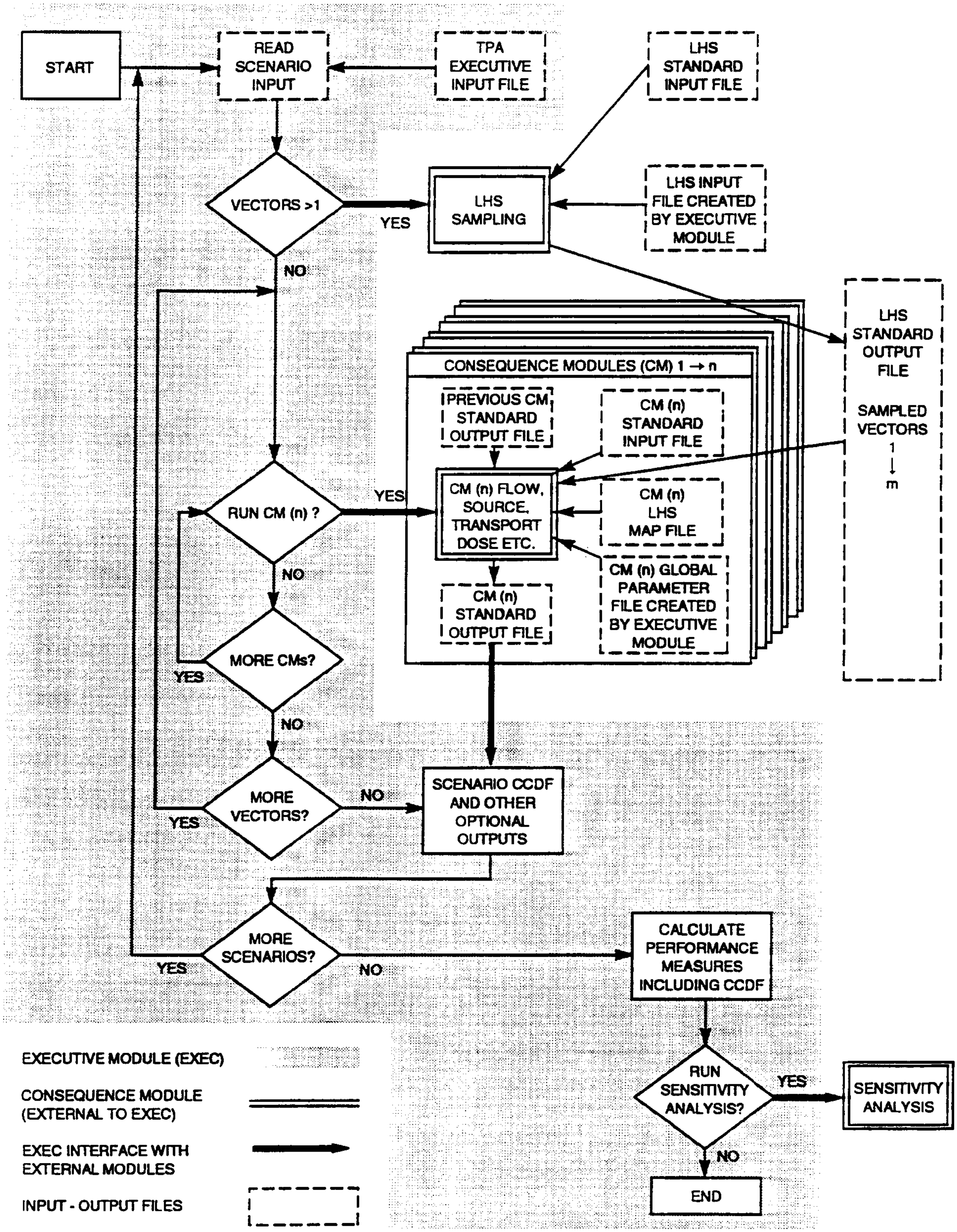

Figure 1-2. Organization of the TPA computer code

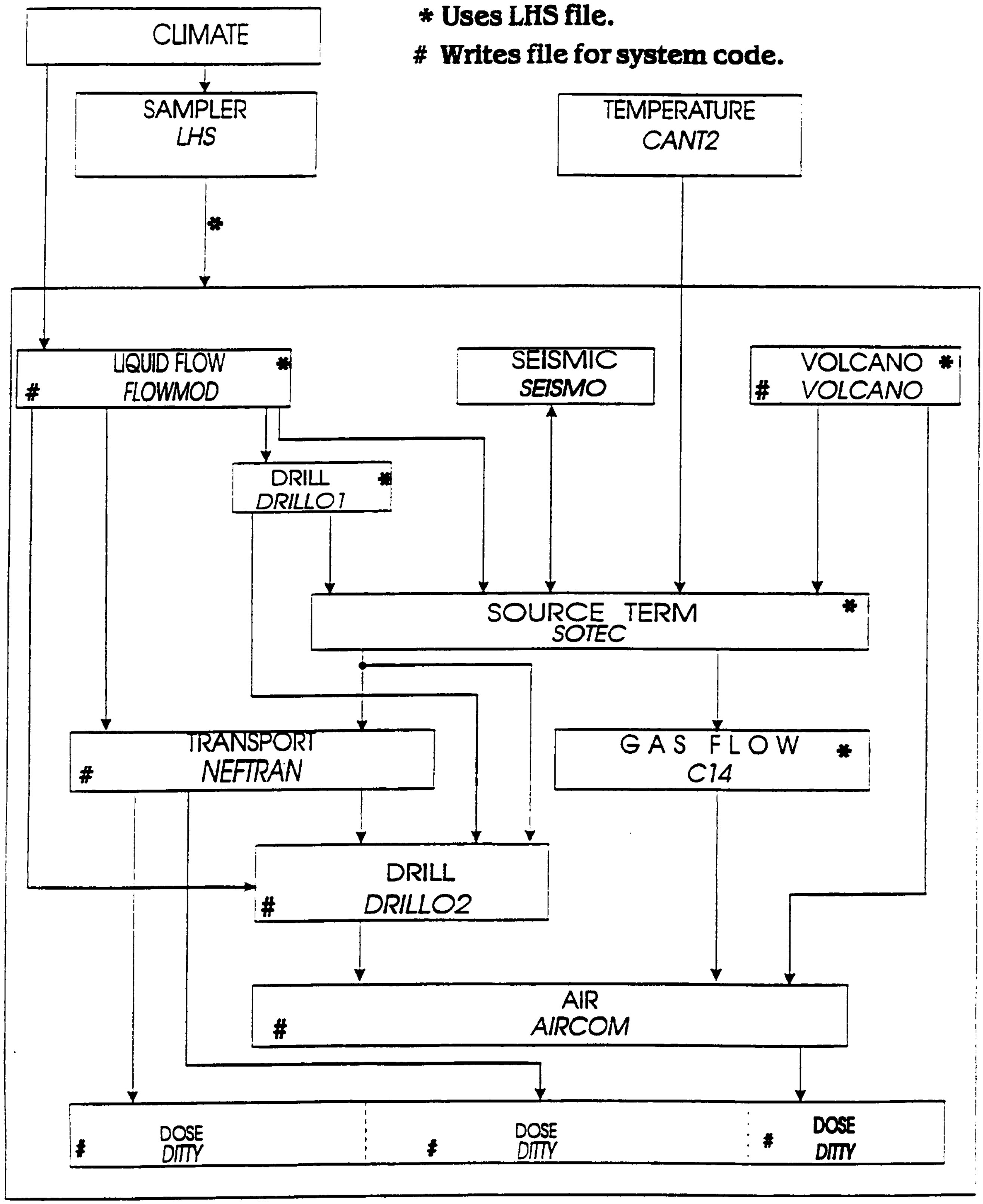

Figure 1-3. TPA system flow diagram

are discussed in Chapter 5. Chapter 6 contains the references used in this report. A complete list of error messages is contained in the Appendix.

2 AIRCOM SOFTWARE DESCRIPTION

This chapter describes the AIRCOM program, its inputs, and the output result. The airpath combination utility, or AIRCOM, was written to combine the airpath release rates computed in three CMs. The outputs of the CMs may contain different nuclides with possibly different time discretization which must be combined. The AIRCOM module was developed to combine the outputs of up to three CMs into a single file for input to the DITTY module. Figure 2-1 is a flow chart of the code.

2.1 SOFTWARE CAPABILITIES AND SALIENT FEATURES

The AIRCOM program reads the TPA_AIR.AGD file if it exists, otherwise it reads commands from the keyboard.

- Combines the output of up to three CMs
- Combines nuclide release rates of up to three files that contain nuclide release rates
- Interpolates nuclide release rates before combining if the times at which rates are reported in the individual files do not match

2.2 HARDWARE REQUIREMENTS AND INSTALLATION PROCEDURES

The AIRCOM program is run on a VAX 8700 at Southwest Research Institute (SwRI) and on a CRAY Y-MP at Idaho National Engineering Laboratory (INEL). A precompiler is used to ensure that the VAX version of the FORTRAN program is consistent with the CRAY compiler. The code is in single precision.

The execution procedures for running the AIRCOM program are described in this section. The AIRCOM program can use an input file or accept input from the keyboard. The AIRCOM program can also run in TPA mode if the file TPA_AIR.AGD exists in the directory where AIRCOM is to run. The following procedures should be followed to run the AIRCOM program.

(i) Check that the input files specified in the TPA command input file or the files entered by keyboard exist.

(ii) The AIRCOM program selects the processing mode via the INQUIRE statement. The statement detects the presence of the TPA_AIR.AGD file in the current working directory selecting the TPA mode or accepts interactive input if not present.

(iii) The files specified as input to AIRCOM should exist in the current working directory, otherwise the program will be aborted with error messages.

(iv) The consequences which will be combined will be determined by the scenario name in the seventh entry to the AIRCOM command input.

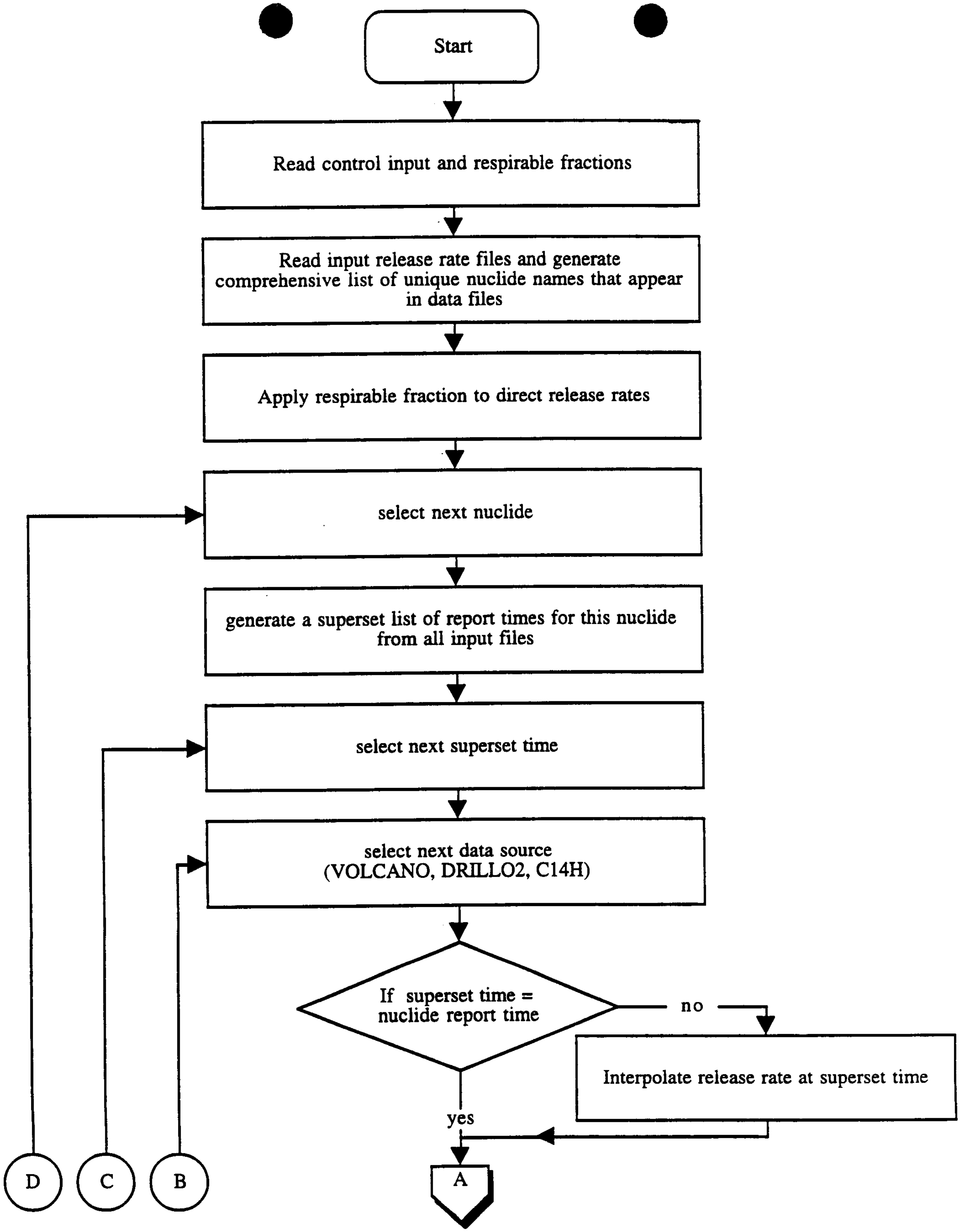

Figure 2-1. Flow chart of the AIRCOM program

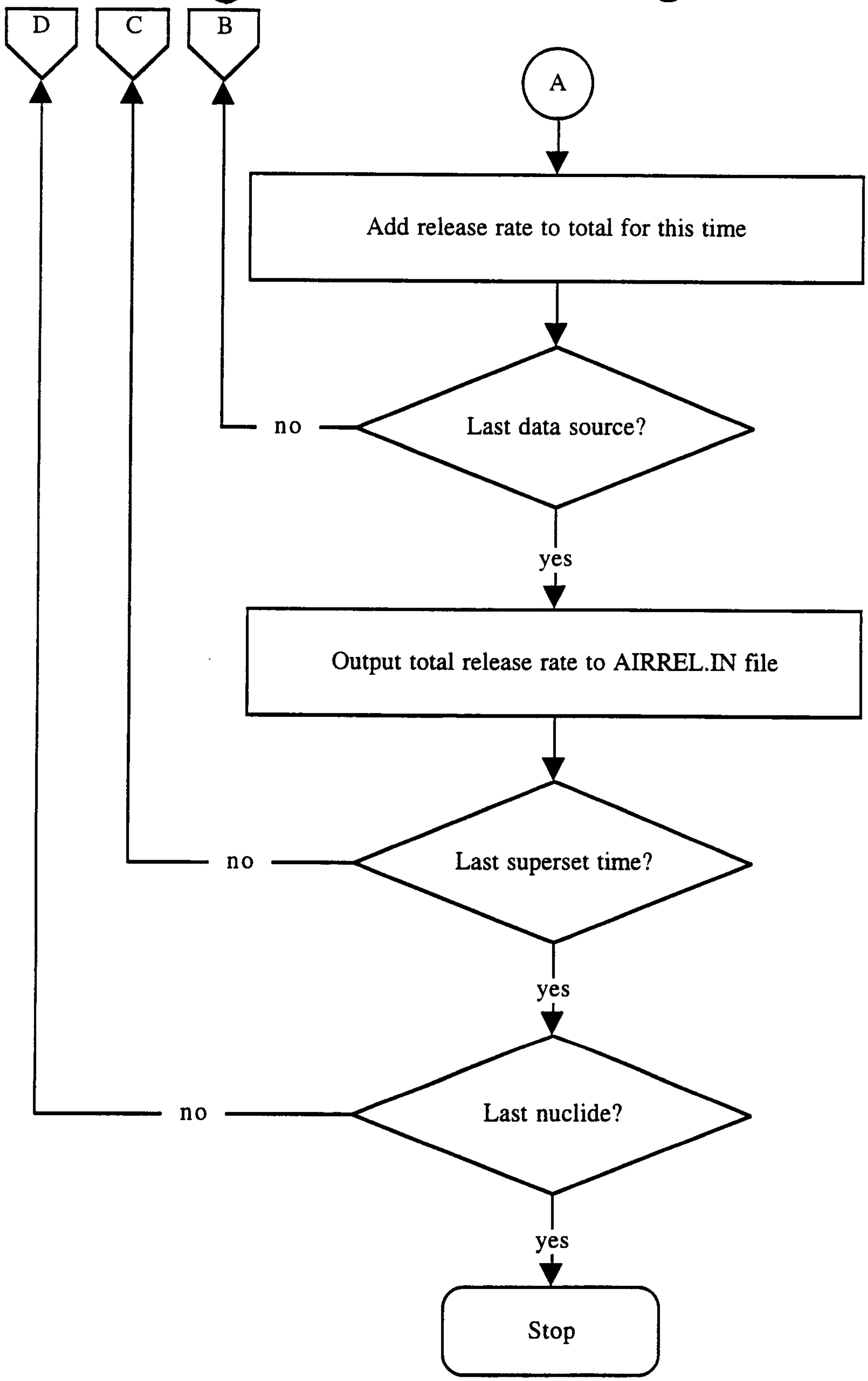

Figure 2-1 (Cont'd). Flow chart of the AIRCOM program

2.3 USER SUPPORT

For technical assistance contact:

R.W. Janetzke
Center for Nuclear Waste Regulatory Analyses
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210/522-3318

2.4 INSTRUCTIONS FOR CODE MAINTENANCE

See Tables 2-1 and 2-2 for a list of subroutines and functions in the AIRCOM main program.

Table 2-1. List of subroutines in the AIRCOM main program

Subroutine	Purpose
FACTOR	Generates a combined list of unique nuclide names from all of the release rate input files
OPNFIL	Opens files and generates errors for any problems encountered in opening files

Table 2-2. List of functions in the AIRCOM main program

Function	Purpose
CKNAME	Formats the nuclide name into a standard format regardless of input format
FNUC	Finds the nuclide in the current input nuclide file
VALNUC	Locates the current nuclide in the combined list of unique nuclide names

2.4.1 Source Code

The source code of AIRCOM is AIRCOM.PRE, which resides in the SwRI CTC VAX 8700 computer. Users need to convert AIRCOM.PRE into AIRCOM.FOR, which is the standard FORTRAN 77 code compatible with both the CRAY and VAX. To convert AIRCOM.PRE, users need to have a copy of PREFOR.EXE code in the VAX local directory. A description of the FORTRAN preprocessor program preFOR can be found in Janetzke and Sagar (1991). Running PREFOR.EXE will prompt the user to supply the input file name and output file name. An example of the job sequence is shown below:

```
$ run prefor
preFOR 2.0     26 October 1990     Ron Janetzke
CONVERT A preFOR FILE TO A FORTRAN COMPILE FILE

ENTER THE UPDATE/preFOR SOURCE FILE NAME
PATH NAMES UP TO 64 CHARACTERS ARE ALLOWED >>
aircom.pre
ENTER OUTPUT (COMPILE) FILE NAME
PATH NAMES UP TO 64 CHARACTERS ARE ALLOWED >>
aircom.for

   1 DECKS PROCESSED
  10 INSERT DECKS PROCESSED
   490 EXECUTABLE LINES IN THE COMPILE FILE
   451 COMMENT LINES IN THE COMPILE FILE
   941 TOTAL LINES IN THE COMPILE FILE
FORTRAN STOP
$
```

2.4.2 Compilation and Link

The FORTRAN file AIRCOM.FOR created by PREFOR can be compiled and linked in either VAX or CRAY using their standard commands.

Command for compilation on the VAX

$FORTRAN AIRCOM
Command for linking
$LINK AIRCOM

Code generation on CRAY

cd aircom
prefor <preair.inp
Cf77 AIRCOM.F

2.4.3 Common Block Variables

No common blocks are used in AIRCOM.

3 INSTRUCTIONS FOR DATA INPUT

The data input for AIRCOM depends on whether the code is run in the standalone mode or in the TPA. In total, the AIRCOM program has five input files. In standalone mode where AIRCOM is run independently, the input files to be used and the AIRCOM.INP must be present. The TPA_AIR.AGD will be used if present. If it is not, then the input file information must be entered interactively. Table 3-1 lists the AIRCOM input files and their basic properties. In the following sections, we describe these input files.

Table 3-1. List of AIRCOM input files

File Name	Unit Number	Stand-Alone Mode	TPA Mode	Description
TPA_AIR.AGD	12	No	Yes	TPA mode command file
AIRCOM.INP	11	Yes	Yes	Respirable fraction data
C14AIR.DAT	7 *	Yes	Yes	Gas release of C14H
DR2AIR.DAT	8 *	Yes	Yes	Direct release of DRILLO2
VOLAIR.DAT	9 *	Yes	Yes	Direct release of VOLCANO

* Unit numbers are assigned in order that the filenames appear in the TPA_AIR.AGD file

3.1 DESCRIPTION OF TPA_AIR.AGD

For the TPA mode, the TPA_AIR.AGD file contains the following information:

Comment line to tell users about the combined output file
File name of the first CM output file
file name of the second CM output file
File name of the third CM output file
File name of the output generated by AIRCOM
The number of the Monte Carlo realization that is being analyzed
The scenario name

EXAMPLE OF TPA_AIR.AGD

```
TITLE: Test file for aircom
c14air.dat
dr2air.dat
volair.dat
airrel.in
```

1
CSDV

3.2 DESCRIPTION OF AIRCOM.INP

The input file AIRCOM.INP is a file that provides the respirable fractions for the DRILLO2 and VOLCANO files.

Explanation of AIRCOM.INP

Comment line containing title and run information
Number of nuclides
"Nuclide name," drill fraction, volcano fraction; (repeated for each nuclide)

. . .
. . .
. . .

EXAMPLE OF AIRCOM.INP

```
TITLE: AIRCOM nuclide factor file (name drill volcano); rwj
04-23-93
30    - number of nuclides
'CM246' 0.04 0.30
'PU242' 0.04 0.30
'U 238' 0.04 0.30
'U 234' 0.04 0.30
'CM245' 0.04 0.30
'AM241' 0.04 0.30
'NP237' 0.04 0.30
'U 233' 0.04 0.30
'TH229' 0.04 0.30
'AM243' 0.04 0.30
'PU239' 0.04 0.30
'U 235' 0.04 0.30
'PU240' 0.04 0.30
'U 236' 0.04 0.30
'PU238' 0.04 0.30
'TC99 ' 0.04 0.30
'TH230' 0.04 0.30
'RA226' 0.04 0.30
'PB210' 0.04 0.30
'CS137' 0.04 0.30
'CS135' 0.04 0.30
'I 129' 0.04 0.30
'SN126' 0.04 0.30
'TC 99' 0.04 0.30
'ZR93 ' 0.04 0.30
'SR90 ' 0.04 0.30
'NI59 ' 0.04 0.30
'C 14 ' 1.0 1.0
```

```
'SE79 ' 0.04 0.30
'NB94 ' 0.04 0.30
```

3.3 DESCRIPTION OF CONSEQUENCE MODULE FILES PROCESSED BY AIRCOM

The following is a generic example to illustrate the AIRCOM release rate input file format.

Number of nuclides in the file
First nuclide name
Number of time-release data pairs for this nuclide
Time, release
. .
. .
. .

Second nuclide name
Time, release
. .
. .
. .

Third nuclide name
.
.
.

```
3         : 3 nuclides
C14       : nuclide name
2         : 2 events
250    0 : time, release
750    0 : time, release
CMw46
2
0      0
436.5  0
PU242
2
0      0
4386.5   0
```

3.4 DESCRIPTION OF C14AIR.DAT

The input of file C14AIR.DAT is the output file of the C14 program.

Explanation of C14AIR.DAT

Comment line to tell users information about the C14 run
Number of nuclides
Nuclide name

Number of entries for nuclide
Year, release (repeated for each entry)
. .
. .
. .

EXAMPLE OF C14AIR.DAT

```
TITLE: Release rates(Ci/yr) for times(yr) from C14.
           1
C14
20
   250.0000        0.0000000E+00
   750.0000        0.0000000E+00
   1250.000        0.0000000E+00
   1750.000        0.0000000E+00
   2250.000        0.0000000E+00
   2750.000         2.776313
   3250.000         3.578602
   3750.000         4.954784
   4250.000         2.784068
   4750.000         4.572435
   5250.000         2.784451
   5750.000         3.640053
   6250.000         3.141448
   6750.000         2.919950
   7250.000         3.480272
   7750.000         2.273502
   8250.000         3.790034
   8750.000         3.394502
   9250.000         2.440276
   9750.000         3.075111
```

3.5 DESCRIPTION OF DR2AIR.DAT

The input file DR2AIR.DAT is the output file of the DRILLO2 program.

Explanation of DR2AIR.DAT

Comment line to tell users information about the DRILLO2 run
Number of nuclides
Nuclide name
Number of entries for nuclide
Year, release
. .
. .
. .

EXAMPLE OF DR2AIR.DAT

```
 ACTIVITY RELEASE DATA FROM DRILLO2
   29
CM246
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.1
     4388.5          0.0
   10000.0          0.0
PU242
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.2
     4388.5          0.0
   10000.0          0.0
U238
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.3
     4388.5          0.0
   10000.0          0.0
U234
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.4
     4388.5          0.0
   10000.0          0.0
CM245
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.50
     4388.5          0.0
   10000.0          0.0
AM241
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.60
     4388.5          0.0
   10000.0          0.0
NP237
5
          0.0          0.0
     4386.5          0.0
     4387.5          0.70
```

```
    4388.5        0.0
   10000.0        0.0
U233
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.80
    4388.5        0.0
   10000.0        0.0
TH229
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.90
    4388.5        0.0
   10000.0        0.0
AM243
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.010
    4388.5        0.0
   10000.0        0.0
PU239
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.020
    4388.5        0.0
   10000.0        0.0
U235
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.030
    4388.5        0.0
   10000.0        0.0
PU240
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.040
    4388.5        0.0
   10000.0        0.0
U236
5
       0.0        0.0
    4386.5        0.0
    4387.5        0.050
    4388.5        0.0
   10000.0        0.0
```

```
PU238
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.060
     4388.5         0.0
    10000.0         0.0
TH230
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.070
     4388.5         0.0
    10000.0         0.0
RA226
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.080
     4388.5         0.0
    10000.0         0.0
PB210
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.090
     4388.5         0.0
    10000.0         0.0
CS137
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.0010
     4388.5         0.0
    10000.0         0.0
CS135
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.0020
     4388.5         0.0
    10000.0         0.0
I129
5
        0.0         0.0
     4386.5         0.0
     4387.5         0.0030
     4388.5         0.0
    10000.0         0.0
SN126
5
```

```
      0.0       0.0
   4386.5       0.0
   4387.5       0.0040
   4388.5       0.0
  10000.0       0.0
TC99
5
      0.0       0.0
   4386.5       0.0
   4387.5       0.0050
   4388.5       0.0
  10000.0       0.0
ZR93
5
      0.0       0.0
   4386.5       0.0
   4387.5       0.0060
   4388.5       0.0
  10000.0       0.0
SR90
5
      0.0       0.0
   4386.5       0.0
   4387.5       0.0070
   4388.5       0.0
  10000.0       0.0
NI59
5
      0.0       0.0
   4386.5       0.0
   4387.5       0.0080
   4388.5       0.0
  10000.0       0.0
C14
5
      0.0       0.0
   4386.5       0.0
   4387.5       0.0090
   4388.5       0.0
  10000.0       0.0
SE79
5
      0.0       0.0
   4386.5       0.0
   4387.5       0.00010
   4388.5       0.0
  10000.0       0.0
NB94
5
      0.0       0.0
   4386.5       0.0
```

```
    4387.5        0.00020
    4388.5        0.0
   10000.0        0.0
```

3.6 DESCRIPTION OF VOLAIR.DAT

The input file VOLAIR.DAT is the output file of the VOLCANO program.

Explanation of VOLAIR.DAT

Comment line to tell users information about the VOLCANO run
Number of nuclides
Nuclide name
Number of entries for this nuclide
Year, release

```
 .    .
 .    .
 .    .
```

EXAMPLE OF VOLAIR.DAT

```
ACTIVITY RELEASE DATA FROM VOLCANO
   30
CM246
5
        0.0       0.0
     7633.1       0.0
     7634.1       10.0
     7635.1       0.0
    10000.0       0.0
PU242
5
        0.0       0.0
     7633.1       0.0
     7634.1       20.0
     7635.1       0.0
    10000.0       0.0
U238
5
        0.0       0.0
     7633.1       0.0
     7634.1       30.0
     7635.1       0.0
    10000.0       0.0
U234
5
        0.0       0.0
     7633.1       0.0
     7634.1       40.0
     7635.1       0.0
```

```
   10000.0        0.0
CM245
5
       0.0        0.0
    7633.1        0.0
    7634.1        50.0
    7635.1        0.0
   10000.0        0.0
AM241
5
       0.0        0.0
    7633.1        0.0
    7634.1        60.0
    7635.1        0.0
   10000.0        0.0
NP237
5
       0.0        0.0
    7633.1        0.0
    7634.1        70.0
    7635.1        0.0
   10000.0        0.0
U233
5
       0.0        0.0
    7633.1        0.0
    7634.1        80.0
    7635.1        0.0
   10000.0        0.0
TH229
5
       0.0        0.0
    7633.1        0.0
    7634.1        90.0
    7635.1        0.0
   10000.0        0.0
AM243
5
       0.0        0.0
    7633.1        0.0
    7634.1        110.0
    7635.1        0.0
   10000.0        0.0
PU239
5
       0.0        0.0
    7633.1        0.0
    7634.1        120.0
    7635.1        0.0
   10000.0        0.0
U235
```

```
5
        0.0          0.0
     7633.1          0.0
     7634.1          130.0
     7635.1          0.0
    10000.0          0.0
PU240
5
        0.0          0.0
     7633.1          0.0
     7634.1          140.0
     7635.1          0.0
    10000.0          0.0
U236
5
        0.0          0.0
     7633.1          0.0
     7634.1          150.0
     7635.1          0.0
    10000.0          0.0
PU238
5
        0.0          0.0
     7633.1          0.0
     7634.1          160.0
     7635.1          0.0
    10000.0          0.0
U234
5
        0.0          0.0
     7633.1          0.0
     7634.1          170.0
     7635.1          0.0
    10000.0          0.0
TH230
5
        0.0          0.0
     7633.1          0.0
     7634.1          180.0
     7635.1          0.0
    10000.0          0.0
RA226
5
        0.0          0.0
     7633.1          0.0
     7634.1          190.0
     7635.1          0.0
    10000.0          0.0
PB210
5
        0.0          0.0
```

```
       7633.1          0.0
       7634.1          210.0
       7635.1          0.0
      10000.0          0.0
CS137
5
          0.0          0.0
       7633.1          0.0
       7634.1          220.0
       7635.1          0.0
      10000.0          0.0
CS135
5
          0.0          0.0
       7633.1          0.0
       7634.1          230.0
       7635.1          0.0
      10000.0          0.0
I129
5
          0.0          0.0
       7633.1          0.0
       7634.1          240.0
       7635.1          0.0
      10000.0          0.0
SN126
5
          0.0          0.0
       7633.1          0.0
       7634.1          250.0
       7635.1          0.0
      10000.0          0.0
TC99
5
          0.0          0.0
       7633.1          0.0
       7634.1          260.0
       7635.1          0.0
      10000.0          0.0
ZR93
5
          0.0          0.0
       7633.1          0.0
       7634.1          270.0
       7635.1          0.0
      10000.0          0.0
SR90
5
          0.0          0.0
       7633.1          0.0
       7634.1          280.0
```

```
    7635.1        0.0
   10000.0        0.0
NI59
5
       0.0        0.0
    7633.1        0.0
    7634.1        290.0
    7635.1        0.0
   10000.0        0.0
C14
5
       0.0        0.0
    7633.1        0.0
    7634.1        310.0
    7635.1        0.0
   10000.0        0.0
SE79
5
       0.0        0.0
    7633.1        0.0
    7634.1        320.0
    7635.1        0.0
   10000.0        0.0
NB94
5
       0.0        0.0
    7633.1        0.0
    7634.1        330.0
    7635.1        0.0
   10000.0        0.0
```

4 DESCRIPTION OF OUTPUTS

The AIRCOM program produces one output file that contains the combined release rates from up to three CMs. The combined results are used as an input to the DITTY program. The output file of AIRCOM is formatted for use by the DITTY module.

Table 4-1 lists the output file and its usage. The output file is described in detail in the following sections.

Table 4-1. AIRCOM output file

File Name	Unit No.	Stand-Alone Mode	TPA Mode	Description
AIRREL.IN	10	Yes	Yes	Combined release rates (ci/yr) from all input files

4.1 DESCRIPTION OF AIRREL.IN

The output file AIRREL.IN is the output file of the AIRCOM program (the suffix '.IN' is used in this name because this becomes the input file for DITTY).

Explanation of AIRREL.IN

Comment line from TPA_AIR.AGD or input from keyboard
Total number of nuclides
Nuclide name, number of entries
Year, release rate
.   .
.   .
.   .

EXAMPLE OF AIRREL.IN

```
 TITLE: AIRCOM to DITTY total release of combined files.
   29
C 14         28
 0.000E+00 0.000E+00
 0.250E+03 0.000E+00
 0.750E+03 0.000E+00
 0.125E+04 0.000E+00
 0.175E+04 0.000E+00
 0.225E+04 0.000E+00
 0.275E+04 0.278E+01
 0.325E+04 0.358E+01
 0.375E+04 0.495E+01
```

```
  0.425E+04 0.278E+01
  0.439E+04 0.327E+01
  0.439E+04 0.328E+01
  0.439E+04 0.328E+01
  0.475E+04 0.457E+01
  0.525E+04 0.278E+01
  0.575E+04 0.364E+01
  0.625E+04 0.314E+01
  0.675E+04 0.292E+01
  0.725E+04 0.348E+01
  0.763E+04 0.256E+01
  0.763E+04 0.313E+03
  0.764E+04 0.255E+01
  0.775E+04 0.227E+01
  0.825E+04 0.379E+01
  0.875E+04 0.339E+01
  0.925E+04 0.244E+01
  0.975E+04 0.308E+01
  0.100E+05 0.000E+00
CM246          8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.400E-02
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.300E+01
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
PU242          8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.800E-02
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.600E+01
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
U 238          8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.120E-01
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.900E+01
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
U 234          8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.160E-01
  0.439E+04 0.000E+00
```

```
 0.763E+04 0.000E+00
 0.763E+04 0.630E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
CM245         8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.200E-01
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.150E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
AM241         8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.240E-01
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.180E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
NP237         8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.280E-01
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.210E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
U 233         8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.320E-01
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.240E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
TH229         8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.360E-01
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.270E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
AM243         8
 0.000E+00 0.000E+00
```

```
 0.439E+04 0.000E+00
 0.439E+04 0.400E-03
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.330E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
PU239          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.800E-03
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.360E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
U 235          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.120E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.390E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
PU240          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.160E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.420E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
U 236          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.200E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.450E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
PU238          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.240E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.480E+02
 0.764E+04 0.000E+00
```

```
 0.100E+05 0.000E+00
TH230          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.280E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.540E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
RA226          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.320E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.570E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
PB210          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.360E-02
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.630E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
CS137          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.400E-04
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.660E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
CS135          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.800E-04
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.690E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
I 129          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.120E-03
 0.439E+04 0.000E+00
```

```
  0.763E+04 0.000E+00
  0.763E+04 0.720E+02
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
SN126          8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.160E-03
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.750E+02
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
TC99           8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.200E-03
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.780E+02
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
ZR93           8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.240E-03
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.810E+02
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
SR90           8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.280E-03
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.840E+02
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
NI59           8
  0.000E+00 0.000E+00
  0.439E+04 0.000E+00
  0.439E+04 0.320E-03
  0.439E+04 0.000E+00
  0.763E+04 0.000E+00
  0.763E+04 0.870E+02
  0.764E+04 0.000E+00
  0.100E+05 0.000E+00
SE79           8
  0.000E+00 0.000E+00
```

```
 0.439E+04 0.000E+00
 0.439E+04 0.400E-05
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.960E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
NB94          8
 0.000E+00 0.000E+00
 0.439E+04 0.000E+00
 0.439E+04 0.800E-05
 0.439E+04 0.000E+00
 0.763E+04 0.000E+00
 0.763E+04 0.990E+02
 0.764E+04 0.000E+00
 0.100E+05 0.000E+00
```

5 VERIFICATION AND VALIDATION STATUS

The AIRCOM program is able to run in standalone mode or as part of the TPA system. The debugger was used to check the global data values after the global data files were read in the AIRCOM program. The standalone version of AIRCOM is considered the benchmark version.

The AIRCOM program was developed on the VAX/VMS system. All changes to AIRCOM while integrating it with the TPA system were also kept on-line using the version extension feature. Additional information is provided in the change request forms which are maintained in the CNWRA.

The AIRCOM code, as a CM of the TPA code, is managed under procedures set out in CNWRA Technical Operating Procedure (TOP)-018. The production of this users manual is one of the requirements of TOP-018.

6 REFERENCES

Janetzke, R.W., and B. Sagar. 1991. *preFOR: A Pre-Processor for Fortran Files, Users Manual.* CNWRA 91-003. San Antonio, TX: Center for Nuclear Waste Regulatory Analyses.

Sagar, B., and R.W. Janetzke. 1993. *Total-System Performance Assessment (TPA) Computer Code: Description of Executive Module, Version 2.0.* CNWRA 93-017. San Antonio, TX: Center for Nuclear Waste Regulatory Analyses.

APPENDIX

ERROR MESSAGES

ERROR MESSAGES

('file not open error number',err,' aircom.inp')
('file not open error number ',err,' on file ',fname1)
('file not open error number ',err,' on file ',fname2)
('file not open error number ',err,' on file ',fname3)
('OPEN OPERATION INCOMPLETE. CHECK opnfil SOURCE CODE.')
('Unit is open. Use of OPNFIL requires a closed unit.')
('File is in use, probably on another unit or by another user.')
('OPNFIL successful.')
('Requested READ file was not found.')
('NEW file creation blocked by existing file.')
('File status request is not valid.')