DOSE ASSESSMENT USING CAP88

Purpose

This Meteorology and Air Quality Group (MAQ) procedure describes the process for developing input, modifying files, and running the Environmental Protection Agency's (EPA) CAP88 computer code for dose calculations.

Scope

This procedure applies to the use of the CAP88 code for determining dose for compliance with National Emission Standards for Hazardous Air Pollutants regarding radionuclides (Rad-NESHAP), and to certain other dose assessments requiring the use of gaussian plume atmospheric dispersion modeling.

In this procedure

Hazard Control Plan

The hazard evaluation associated with this work is documented in HCP-MAQ-Office Work.

Signatures

Prepared by: (Signed) Keith Jacobson, MAQ	Date: 8/21/03
Approved by: (Signed) Dave Fuehe, Rad-NESHAP Project Leader	Date: 8/22/03
Approved by: (Signed) Terry Morgan, QA Officer	Date: 8/25/03
Approved by: (Signed) Jean Dewart, MAQ Group Leader	Date: 8/25/03

05/26/04

General information about this procedure

Attachments

This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Guidance for CAP88 Modeling at LANL	3
2	"METDAT" Input File	2
3	"POPDAT" Input File	1
4	"PREPNPT" Input File	1
5	Review Checklist for CAP88 Output	1

History of revision

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	9/1/95	New document.
1	12/16/96	Changes to modeling methods added to guidance attachment.
2	9/2/98	Changes to address DR-138, changes to reflect enhanced quality assurance, changed definition of maximum dose receptor, information on climate variables added, review checklist attachment added, changes from lessons learned from J. Till audit, and guidance document revised.
3	9/13/99	Describe use of automated script files for loading and running program, describe test run, and enhance documentation and review steps.
4	5/9/01	Changes to reflect running the CAP88 package on a new ESH-17 UNIX operating system.
5	4/15/02	Quick-change revision to change 'sibyl' to 'wxmach' throughout, remove attachment for script files, and update guidance attachment.
6	8/26/03	Changes to reflect some of the upgrades and control scripts to running the CAP88 program and handling of files.

General information, continued

Who requires training to this procedure?

The following personnel require training before implementing this procedure:

- group health physicist ("**preparer**") assigned to perform dose assessments using CAP88

The following personnel **do not** require training to this procedure:

- **Technical or peer reviewer** chosen to perform the independent review of the assessment
- Rad-NESHAP **project leader** who approves the assessment

Training method

The training method for this procedure is **"self-study" (reading)** and is documented in accordance with the procedure for training (MAQ-024). Personnel performing CAP88 dose assessments should have a health physics background.

Definitions specific to this procedure

<u>CAP88</u>: Clean Air Package circa 1988, the EPA atmospheric dispersion, dose calculation, and risk assessment computer program (model, code) used to calculate dose from air-effluents that carry radionuclides. CAP88 consists of four separate codes: PREPAR, AIRDOS, PREDAR, and DARTAB.

<u>STAR data</u>: input to PREPAR and AIRDOS consisting of wind speed, direction, and frequency data arranged in a stability array in the file "metdat."

<u>metdat</u>: the STAR data input file read by AIRDOS.

<u>popdat</u>: the population array (distribution) input file read by AIRDOS.

<u>prepnpt</u>: the source term information input file read by PREPAR.

<u>predain</u>: the receptor location designation file (used for population runs).

<u>UNIX</u>: the operating environment on the MAQ machine "Wxmach."

<u>NANO</u>: a text editor that may be used to modify input files.

<u>MDL</u>: the Maximum Dose Location, the location of the individual dose calculation component of CAP88 specified in the 'predain' input file, also sometimes called the Critical Receptor Location. Previously was called the Maximum Exposed Individual (MEI), but this use is discouraged.

<u>script</u>: a set of UNIX commands in a file that performs file manipulations or operations.

General information, continued

References

The following documents are referenced in this procedure:

- RRES-MAQ-024, “Personnel Training”
- RRES-MAQ-037, “Software Management”
- RRES-MAQ-038, “Developing Group Software”
- RRES-MAQ-507, “Preparation of the Annual RAD-NESHAP Report”
- ESH-17:96-95, “Final Decision on MET File Use for LANSCE NESHAP Calculations,” February 23, 1996
- ESH-17:96-422, “Discontinued Dose Assessment Methods for the RAD-NESHAP Program,” October 7, 1996
- 40 CFR 61, Subpart H, “National Emission Standards for Emission of Radionuclides Other than Radon from Department of Energy Facilities”
- CAP88, Clean Air Act Assessment Package, RSICC CCC-542
- ICRP Reports #26 and #30
- Nuclear Regulatory Commission (NRC) Regulatory Guide #1.109
- UNIX Users Manual
- DOE/OSN, DOE Office of Nuclear Safety – Safety Notices Issue No. 95-02, September 1995
- U.S. Environmental Protection Agency, “User’s Guide for the Industrial Source Complex (ISC3) Dispersion Models Volume II – Description of Model Algorithms,” EPA-454/B-95-003b (1995)
- Brent M. Bowen, “Los Alamos Climatology,” Los Alamos National Laboratory report LA-11735-MS (1990)
- Jeffrey A. Baars, “Mixing Depth Estimation at Los Alamos: a Preliminary Investigation” Los Alamos National Laboratory Report LA-UR-97-366 (1996)
- George C. Holzworth, “Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States,” U.S. Environmental Protection Agency Office of Air Programs report (1972)
- George C. Holzworth, “Estimates of Mean Maximum Mixing Depths in the Contiguous United States,” Monthly Weather Review, Vol. 92, No. 5, pp 235-242 (May 1964)
- Keith W. Jacobson, “RRES-MAQ Software Development – CAP88 Tools”, July 2003, in RRES-MAQ records center.

Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

Applicability and use of the CAP88 code

Code background

This code was developed to demonstrate compliance with the Clean Air Act as applied to radionuclide emissions from DOE facilities (such as LANL) outlined in 40 CFR 61 Subpart H (Rad-NESHAP). The code consists of a gaussian plume type atmospheric transport model that calculates air concentrations. The code determines effective dose equivalent resulting from inhalation, immersion, ground deposition, and ingestion. Dispersion and environmental transport parameters are based on NRC Reg. Guide 1.109 methodology. Dose conversion factors and organ weighting values are based on ICRP 26/30 methodology. The version of CAP88 used by LANL was obtained from the Radiation Safety Information Computation Center (RSICC).

Further reading on CAP88 usage

Read the regulatory requirements in subpart H of 40 CFR 61 for background information on the use and applicability of CAP88, especially sections 61.91, 61.93, 61.94, and 61.95. Review the CAP88 manuals provided with the program. Follow the appropriate methodology when running the code. The procedures outlined by EPA for calculating dose cannot be changed without prior written approval from the regional EPA office (40 CFR 61, subpart H, section 61.93, par. a). Review the guidance provided as Attachment 1. A method for calculating the dose for radionuclides not included in the current CAP88 library is described in the attachment.

The current version of CAP88 used by the Air Quality Group resides on the ESH-17 HP workstation “wxmach.” The current operating environment is UNIX. Reference the UNIX users’ manual for further information. It is assumed the user has an active ‘wxmach’ account and a validated password.

There are a variety of text editors available on wxmach, though the NANO text editor is used in this procedure. Another editor may be used in place of NANO throughout this procedure (for example, VI).

CAP88 Tools

In addition to the CAP88 software package, there are a number of additional programs developed by the group that are used in conjunction with CAP88. These programs are documented and classified according to MAQ-037 and MAQ-038 and are provided in “RRES-MAQ Software Development – CAP88 Tools”. The user should have the latest version available, which was last updated in July 2003.

Setting up workspace and transferring files

Accessing the computer code

These instructions assume the operator is working from a desktop computer with PC/TCP terminal software and with remote connection capability (TELNET).

NOTE: UNIX entries are case sensitive; the default is lower case. All entries are enclosed in quotes, so do not type the quotes when making entries.

Steps to log on and set up work space

To log on and set up the workspace, perform the following steps:

Step	Action
1	Start the terminal program. Connect to the ‘wxmach’ computer. This is done from the Windows Program Manager. Click on the TNVT (Telnet) icon.
2	When the TNVT Window screen appears, click on the ‘wxmach’ menu option.
3	Enter your assigned user name and password at the login prompt.
4	Change to the CAP88 working directory (if needed).

Setting up workspace and transferring files, continued

Copy files to workspace

Before running the CAP88 codes, it is wise to set up a disk directory for performing the work, as an example, the CAP88 runs for the annual dose assessment might be performed in a disk directory called "~/CAP88/CY02". After the directory has been set up, begin copying over the necessary files as described in the steps below. For additional information, please refer to the "CAP88 Tools" document.

Steps to manually transfer working files via FTP

Backup copies of the CAP88 program and input files are stored permanently on the MAQ main server.

To transfer the needed working files into the working area on "wxmach" from the MAQ system via FTP, perform the following steps:

Step	Action
1	Use the FTP utility on the PC. The backup files are on the "Projects" drive in the folder "Rad-NESHAP/CAP88."
2	Copy the 9 needed files, using the FTP command "get": airdos92.out, prepar92.out, dartab92.out, prpdar92.out, makrpt92.out, allrad88, predain, rdrskbin, and scripts.tar.
3	Once the files have been "FTP'd" to the mainframe computer, you may have to use both uncompress <*filename*> and tar -xf <*filename*> to expand the files.

Setting up workspace and transferring files, continued

Quality assurance run

The test run of CAP88 is to verify the proper operation of the CAP88 program and all input data. A script file (QARUN.PL) performs this test run and uses the EPA test case data.

The original EPA test case files were obtained from the Radiation Safety Computation Center. The files were uploaded, without modification, to a permanent, secure directory. During the quality assurance run, the script file copies and uses these files as needed, in a read-only fashion. The secured file directory and the read-only access ensure these files remain unaltered.

Steps to perform QA run

To test the proper operation of the program, perform the following steps:

Step	Action
1	Type the command QARUN.PL at the command prompt. This will get and run the PREV.PL and VVRUN.SH scripts.
2	When the run is complete, record the name of the CAP88 output file and save it to the MAQ server. Print a copy of the QA_CHECK file to verify the EPA test case ran without errors.

Edit input data files

After transferring all the files as specified in this chapter, edit the input files as described in the following three chapters.

Stability Array Development, Input File 'metdat'

Met towers

See attachment 2 for an example of the "metdat" input file. There are four on-site meteorological towers for which STAR data can be obtained. To determine the appropriate tower/STAR data file for each LANL source, the following table should be used (the first-listed site is preferred).

TA*	Tower
2	TA-53 or TA-6
3	TA-6
5	TA-53
6	TA-6
8	TA-6
9	TA-6
11	TA-6
14	TA-6
15	TA-6 or TA-49
16	TA-6
18	TA-53 or TA-54
21	TA-6
22	TA-6
28	TA-6
33	TA-49 or TA-54
35	TA-6
36	TA-49 or TA-54
37	TA-6 or TA-49
39	TA-49

TA*	Tower
40	TA-6
41	TA-6 or TA-53
43	TA-6
46	TA-53
48	TA-6
49	TA-49
50	TA-6
51	TA-53
52	TA-6
53	TA-53
54	TA-54
55	TA-6
59	TA-6
60	TA-6
61	TA-6
63	TA-6
64	TA-6
69	TA-6

***Only those TAs with known or potential release points are listed**

Wind stability categories

The file 'metdat' is the STAR input file which contains a frequency array of wind speed and direction data for six atmospheric stability categories, A through F. Stability category, or sigma-phi, is determined from the value of the standard deviation of vertical wind speed fluctuations, which is equal to the standard deviation of the vertical wind speed divided by the horizontal wind speed. The values for sigma-phi are given below:

Stability Array Development, Input File 'metdat', continued

Stability Categories

Category	sigma-phi
A	13.9 to 90.0
B	12.0 to 13.9
C	9.4 to 12.0
D	6.0 to 9.4
E	2.9 to 6.0
F	0.0 to 2.9

Wind speed categories

The wind speed is divided into six possible categories and sixteen possible directions. The range of each wind speed category is given below:

Wind Speed Categories

Category	Wind Speed (m/s)
1	0.00 to 1.75
2	1.75 to 3.25
3	3.25 to 5.50
4	5.50 to 8.50
5	8.50 to 11.50
6	11.50 and greater

Wind averaging time

Calculations done to demonstrate compliance with the NESHAP dose limit use different averaging times for LANL, LANSCE, stack, and LANSCE diffuse emissions.

LANSCE dose assessments for gaseous mixed activation products are based on the actual meteorology for the month in which LANSCE stack emissions occurred. The sum of the monthly calculations will be reported as the annual dose from these emissions (for further information, see MAQ-RN).

LANSCE diffuse-emission dose calculations are based on the actual operating-cycle average meteorology for the cycle in which LANSCE diffuse emissions occurred.

Stack-emissions dose calculations for the rest of LANL (and LANSCE particulate and vapor emissions) use the actual annual-average meteorology for the year in which emissions occurred. For a further discussion of wind averaging time, see ESH-17:96-95.

Stability Array Development, Input File 'metdat', continued

Climate data

The CAP88 code allows input of user-supplied data for other dispersion modeling variables related to local climate; the values to use for LANL are listed in the tables below. Users of CAP88 should enter a "lid height." The users should use a value of 1600 m, which is the average of the annual mean morning and afternoon mixing depths from Holzworth (1972). Also provided in the second table are suggested mixing heights by month for modeling of LANSCE GMAP effluents by month.

LANL-Specific Climate variables for Input to CAP88

modeling variable	value	units	Reference
'D' vertical temperature gradient	0.020	K/m	EPA, 1995
'E' vertical temperature gradient	0.035	K/m	||
'F' vertical temperature gradient	0.035	K/m	||
annual average mixing depth	1600	m	LANL, 1997
annual mean rainfall	45	cm	Bowen, 1990
annual mean temperature	282	K	Bowen, 1990

Monthly Values of Mixing Depth[1] for LANSCE GMAP Assessments	Night/Morning[2] (minimum) (m)	Afternoon[3] (maximum) (m)	# hours night/ # hours day	weighted average (m)
January	300	710	1.40	460
February	300	1370	1.20	750
March	300	2380	1.01	1330
April	300	2700	0.83	1750
May	300	3650	0.71	2690
June	300	3520	0.65	2820
July	300	3400	0.67	2630
August	300	3100	0.78	2750
September	300	1920	0.94	1160
October	300	1330	1.12	760
November	300	1020	1.33	580
December	300	620	1.46	430

[1]Note: the average value should be used; the values for morning and afternoon are only included to point out the strong diurnal pattern for Los Alamos.
[2]Barrs, 1996
[3]Holzworth, 1964

Stability Array Development, Input File 'metdat', continued

Method to construct data file

The user is able to construct the data file using the STARFILE request form available on the Laboratory's WEATHER MACHINE home page on the Internet. This new method is described in the following set of steps.

Steps to edit the metdat files

To edit the metdat files on the Internet, perform the following steps:

Step	Action
1	Obtain the necessary meteorological file by going to the web site (http://weather.lanl.gov/cgi-bin/starfilerequest.pl) and following the instructions given on the web page to obtain a file for the period of interest.
2	After the file has been saved to the disk drive, it will need to be copied to "wxmach." The easiest way to save it is to use the FTP utility.
3	After saving, edit the comment lines out by invoking the FRED editor, type fred [metfilename]. Type dl 10 to delete comment at line #10. Then type dl 1,5 to delete comment lines 1 through 5.
4	Copy the file to the required input file name using the cp command. For example, cp [metfilename metdat].

Population Array Development, Input File 'popdat'

What the popdat file contains

See attachment 3 for an example of the "popdat" input file. The "popdat" input file contains a 16-sector array of population data at selected radial distances from the release point. The first line of the file prescribes the distance of each radial section. The next 48 lines provide the data. Population files can be derived for any release point. The following table provides a list of currently available population arrays for LANL.

Population Array Centers

Technical Area	Maximum Emitter Location	Comment
3	Building 29	CMR
9	Building 42	Anchor site east
11	TA-Center	K site
14	TA-Center	Q site
15	TA-Center	PHERMEX Site
16	Building 205	WETF
18	Building 127	Pajarito laboratory
21	Building 155	TSTA
22	TA-Center	Explosives Testing
33	Building 86	HP site
35	Building 34	Ten site
41	Building 4	W-Site
43	Building 1	HRL
48	Building 1	RC
49	TA-Center	Frijoles Mesa
50	Building 1	WM site
53	Building 3M	LANSCE
54	Building 1009	Area G
55	Building 4	PF-4
59	Building 1	OH-1

Population sectors

The distance and direction where the maximum individual dose calculation is located is specified in line two of the input file "predain" where "i" equals the sector number and "j" equals the section number. Sectors are numbered according to the format provided in the following table:

Population Array Development, Input File ‘popdat’, continued

Population Sector Numbers

Number	Direction	Degree Interval
1	N	348.75 to 11.25
2	NNW	326.25 to 348.75
3	NW	303.75 to 326.25
4	WNW	281.25 to 303.75
5	W	258.75 to 281.25
6	WSW	236.25 to 258.75
7	SW	213.75 to 236.25
8	SSW	191.25 to 213.75
9	S	168.75 to 191.25
10	SSE	146.25 to 168.75
11	SE	123.75 to 146.25
12	ESE	101.25 to 123.75
13	E	78.75 to 101.25
14	ENE	56.25 to 78.75
15	NE	33.75 to 56.25
16	NNE	11.25 to 33.75

Steps to edit the ‘popdat’ file

To edit the ‘popdat’ file, perform the following steps:

Step	Action
1	Refer to the tables for the correct population array and direction number given above and ensure the files are complete by reviewing them for the following: • the distance to cells for each of the 16 sectors has the appropriate values (line 2 of popdat file). • the correct population numbers are entered in the 16 sector array (lines 3 to 36 of popdat file).

Population Array Development, Input File ‘popdat’, continued

Step	Action
2	If the distance to a particular receptor needs to be changed, make the change on line 2 of popdat. Type “nano [POPFILENAME]” to start the editor (NANO). The distance in the dose run used will be an average of two adjacent numbers given on line 2. For example, if the distance to be used in the dose run is 800 meters, you could enter the values of ‘780, 820’ at the appropriate location on line 2. Use the NANO editor to exchange values in line 2. NANO prints the line, use the space bar to move to the correct spot in the line and type the replacement values (in overtype mode). Save and exit the NANO editor with the CNTRL-O then the CNTRL-X command.
3	After the distance and direction to the dose receptor have been determined for the dose run, in the popdat file, edit line 2 of the “predain” input file with the appropriate values. Set “jloc=*distance number*” where distance number is the appropriate value from the table above. Set “iloc=*direction number*” where direction number is the appropriate value determined in step 2 for the dose run.
4	Population files can contain population cell data for a range of distances from 10 to 20 radials. The radial distance of the nearest receptor for each of the 16 distances should be updated as needed (see MAQ-507.

Source Term Input Development, Input File 'prepnpt'

What the 'prepnpt' file contains

See attachment 4 for an example of the "prepnpt" input file. The user must supply information on the source such as stack height, effluent velocity (m/s), stack diameter (m), radionuclides released, amount in Ci, any progeny to be modeled, and any other user-supplied input for the release site needed by CAP88.

Steps to edit the 'prepnpt' file

The steps to manually edit the 'prepnpt' file are provided here. It is assumed that an old 'prepnpt' file exists for editing.

Beginning in 1998, a trial process to automate the CAP88 dose assessment process was used in some cases. This involved the electronic transfer of stack effluent data, automatic generation of input files, and auto-running of the CAP88 codes; please refer to ESH-17-98:307 to review the steps used. During 2002 – 2003, the processes involved were documented in the "CAP88 Tools" report.

To manually edit the source term or 'prepnpt' file, perform the following steps:

Step	Action
1	Use the NANO editor to open the input file by typing "nano prepnpt". Line 1 should be edited to show the name of the person authoring the file. Line 2 should provide the phone number of the person authoring the file.
2	Lines 3-6 should list the source term input file, STAR data file, population data file, and predain file to be used in the dose run, respectively. Also, as an aid, the line 6 could list the iloc and jloc information used in the predain file. **NOTE**: The EPA names the "predain" file "preda."
3	Line 7 should only contain an asterisk. This tells CAP88 to look for the state (nm) that the dose assessment is being run for on line 11. Lines 8-10 and 12-16 are comments fields; enter comments as deemed appropriate.
4	Edit lines 15-16 to provide a text title to the dose run.
5	Edit line 18 to select the desired run-options. Refer to the CAP88 user's manual to review run-options.
6	Edit line 20 to show the number of radial distances used in the popdat file.
7	Review that the correct climatological data is entered on line 24.
8	Enter the number of stacks or area sources to be modeled on line 26.

Source Term Input Development, Input File 'prepnpt', continued

Step	Action
9	Enter the physical description of the stack or area source on line 27; stack height (m), effluent velocity (m/s), and stack diameter (m) or area (m^2).
10	Enter on line 30 the number of radionuclides to be modeled.
11	Enter the type of radionuclide to be modeled and the amount (Ci) released on line 31 and on following lines for each radionuclide being modeled.
12	Entering the word 'comment' on the line can enter two additional comment lines after the radionuclide list that proceeds them.
13	Modifications to radionuclides are entered at the end of the file by entering the word 'modifications' on one line and radionuclide-specific modifications on following lines. Refer to the CAP88 manual to review modifications.

Running CAP88

Edit receptor location file

After performing the edits of the input files in the previous chapters, edit line #2 of the input file ‘predain’ (also called preda) to contain the receptor information provided on line 6 of the ‘prepnpt’ files. This is the location for which the maximum dose location (MDL) dose will be calculated.

Files needed

After all the files have been loaded into the local working directory and the input files have been edited with the appropriate information, you are ready to perform a dose run. Note that each CAP88 code generates intermediate output files that are used by the succeeding CAP88 program. The table below lists all the input and executable files:

Files Needed to Run CAP88

Input Files	Executable Files
prepnpt	prepar92.out
metdat	airdos92.out
popdat	prpdar92.out
predain	dartab92.out
allrad88	
rdrskbin	

How to execute a dose run

There are two basic processes described here: “manual” and “automatic.” The “automatic” method uses a script file to perform the commands. The manual method is described to document the steps and in the event the script file method needs modification.

To run the program manually, perform the steps in the blocks starting immediately below. To run the “automatic” program, skip to the block ‘Steps to perform an “automatic” CAP88 run’ on page 20.

Running CAP88, continued

Manually run the CAP88 program

Type the name of each executable file and the program will automatically search for and read in the input files and create a series of output files for use by the next executable. Run the program as follows:

“prepar92.out”
“airdos92.out”
“prpdar92.out”
“dartab92.out”

The last output file generated will be called ‘darsynop.’ This file contains all the dose information as well as the input information on the source term.

Append files, log and save the results

The ‘darsynop’ files should have the signature block header appended to the head of the file. All of the input files used in the dose run should be appended to the tail of the file, as well as a log of the commands and error messages (if any) from the dose run. Follow the steps below to perform these tasks after the output file has been created:

Step	Action
1	Generate a history file of the commands executed by typing the command: history > hist.txt
2	View the run time errors file to check to see if any errors occurred during the dose run; use the command cat preperrs. If errors occurred, the author will need to correct the problem(s) and rerun the dose program.
3	Append the ‘hist.txt’ file and the signature block file to the front or head of the ‘darsynop’ file by typing the following command: cat hist.txt sign.txt darsynop > cap88tmp
4	Append the input files to the end or tail of the ‘darsynop’ file by typing the following command: cat cap88tmp preperrs prepnpt metdat popdat predain > darsynop
5	Rename the file following the naming convention discussed below. Print a copy of the file on the network printer.

Running CAP88, continued

Steps to perform an "automatic" CAP88 run

Note, the steps and various programs to perform "automatic" runs of CAP88 are more thoroughly documented in the report "CAP88 Tools".
To use the script file to run the CAP88 program, perform the following steps:

Step	Action
1	Ensure that the input files to be used in the dose assessment have the correct data and have been copied to the standard CAP88 input file names (see block "Files needed" at beginning of this chapter).
2	Run the CAPRUN.PL script by typing it at the command prompt. The CAPRUN.PL script will invoke the DOESRUN.SH script. This script will perform the majority of the manual steps given above and also allows the user to supply a specific name to the output file and also appends all input files to the output file.

File naming and tracking conventions

All input and output files should follow the naming convention used by MAQ for identification of release points. Examples of input and output file names are given in the table below.

CAP88 File Naming Conventions

default name	Convention	Example
prepnpt	pre-TechArea-Building-Stack	Pre03002927
popdat	pop-TechArea-Building-Stack	Pop03002927
predain	reda-TechArea-Building-Stack	Preda03002927
cap88out	out-TechArea-Building-Stack	Out03002927
metdat	met-TechArea Tower-Year.format	Met0698.cap

Save and Copy the files to a CD

All of the files used in the annual dose assessment for the Rad-NESHAP report should be saved and stored on a CD-ROM, for distribution to the EPA.

Running CAP88, continued

Copy files to MAQ system

Store copies of all input files on the MAQ computer system on the drive PROJECTS in the folder Rad-NESHAPs/CAP88. Use the FTP utility to transfer copies from “wxmach” to the MAQ system.

Pick up output

Go to the network printer to pick up the output file.

Technical review and approval

Verification and approval of CAP88 assessments

This chapter describes the steps to review the 'cap88out' file for accuracy and completeness. As described in DOE/OSN safety notice No. 95-02, self-checking and independent verification provide the last defensive barrier to error. The purpose of self-checking is to reduce human error. The most important part of self-checking for CAP88 assessments is to check to see if the expected response (dose) occurred.

As an aid to reviewing and validating the dose assessment, the Review Checklist for CAP88 Output (attachment 5) has been developed for each of the three participants in the review process.

Review by preparer

The **preparer** utilizes historical knowledge and experience with the project, and exercises best professional judgment to compare the actual response to the expected response. The **preparer** initials the checklist (attachment 5) and signs the output file to indicate review of the file, and forwards the file and checklist to the technical or peer reviewer.

Review by technical or peer reviewer

"Independent verification is the practice of checking a given task for conformance to established criteria by a qualified person other than the one who performed the task." For CAP88 dose assessment, the independent verifier, also called the technical or peer reviewer, shall be a Health Physicist with experience in dose assessment.

The **technical reviewer** uses the checklist as a guide to review the input and output data for technical accuracy and completeness. The **technical reviewer** finalizes the verification by signing the output file, initials the checklist, and forwards the file to the Rad-NESHAP project leader.

Approval by project leader

Approval of the file records is the responsibility of the **Rad-NESHAP project leader**. The **project leader** reviews the output file and signs the appropriate signature block on the CAP88 output file to validate the author and technical reviews. The **project leader** sends a copy of the output file and checklist to the records coordinator for filing and storage.

Records resulting from this procedure

Records

The following records generated as a result of this procedure are to be submitted as records **within two weeks of the model run** to the records coordinator:

- ‘cap88out’ output file
- memo summarizing the results of the dose assessment (optional)
- Review Checklist for CAP88 Output (attachment 5)

Click here to record “self-study” training to this procedure.

GUIDANCE FOR CAP88 MODELING AT LANL

1) Introduction Most Air Quality modeled air-pathway calculations or dose assessments are performed using the mainframe version of CAP88, resident on wxmach. . The Meteorology and Air Quality Group (MAQ) utilizes other air pathway models such as GENII-S, Hotspot, ERAD, and ISC3 to assess doses from short-term or acute releases. The modules of CAP88 (PREPAR, AIRDOS, PRPDAR, and DARTAB) have been compiled to run under the current operating environment, UNIX. This guidance is given in regards to modeling various sources at LANL for compliance to the EPA regulations.

2) Source Term Development Beginning in 1995, radioisotopic analysis was conducted for stack filters. Previously, historical and process knowledge were used to determine the type of radionuclides released in addition to the gross alpha and beta measurements of the stack filter (ESH-17:96-422).

Americium and plutonium:

Estimates for Am-241 (and Pu-241) emissions will not be based on Pu-239 emissions since Am-241 is now directly measured.

Uranium:

If U-235 is measured as being released from a stack, Th-231 is assumed to be in secular equilibrium but will no longer be included in the source term as indicated (mandated) by NCRP 123.

If U-238 is measured in a stack sample, its progeny Th-234 and Pa-234m may be assumed to be in secular equilibrium and could be included in the source term.

U-234 will now only be included in the source term if it is actually measured in the stack sample.

Enriched Uranium

Documented analysis by MAQ shows that the most applicable source term for modeling enriched uranium at LANL is with 97% as U-234 and 3% as U-235.

Depleted Uranium

Documented analysis by MAQ has determined that depleted uranium should be modeled with 76% as U-238, 1% as U-235, and 23% as U-234.

3) Meteorological Stability Array Files (STAR Data) The meteorological files are constructed using data collected from the four meteorological towers operated by Air Quality. These ‘metdat’ files contain wind frequency and atmospheric stability arrays (STAR). The STAR data file can be constructed for any length of time. The STAR data sets are constructed for the actual height at which the data are collected.

4) Revised Point Source Modeling Beginning with the 1995 assessment year, each monitored stack will be modeled individually (versus grouped).

To model each stack, a revised set of stack parameters was completed which included the height of the stack above ground level. In 1998, the stack heights and diameters at 31 stacks were re-surveyed. The new set of stack parameters can be found in table 3 of the 1997 Air Emissions and Dose Report. Stack exit velocities are based on the actual flow rates recorded over the assessment year. This provides a more conservative approach to the modeling.

5) Revised Non-point Source Methodology Beginning with the 1995 annual air emissions report, results from Air Quality's AIRNET project will be added to the CAP88 results after conversion to dose. Results will be reported for the stations specified in the FFCA that will include the net dose at each station by radionuclide detected. Eventually, all dose estimates from non-point sources at LANL (excluding LANSCE gaseous and mixed activated air products emissions) will be made using environmental air sampling results. The FFCA network and AIRNET upgrades were completed in late 1995.

The laboratory has negotiated a Federal Facilities Compliance Agreement (FFCA) with the EPA to complete a schedule of compliance activities. The EPA agreed that LANL would use the AIRNET system to demonstrate compliance to NESHAP regulations for all potential non-point sources at LANL (excluding LANSCE gaseous and mixed activated air product emissions).

6) Dose Assessment for Other Radionuclides Not Included in CAP88 Some of the radionuclides released at LANL are not included in the CAP88 dose conversion factor database. Most are released in less than mCi amounts. These mCi amounts have historically not contributed more than 1% of the total dose. To calculate the dose for such radionuclides, a separate 'prepnpt' file is created for the non-CAP88 radionuclides. The radioactive decay constant (in days^{-1}) is inserted into the modification statement of the input file. The air concentration and surface deposition rate of the radionuclide of interest (by setting the appropriate options on line 18) are calculated by CAP88 at the appropriate receptor location.

If the radionuclide is listed in Appendix E (Table 2) of 40 CFR 61, the concentration calculated by CAP88 can be converted into an annual effective dose equivalent. The dose factors from Table 2 are conservative in nature and include gross assumptions about inhalation, ground shine and ingestion of the radionuclide listed (Parks, 1998).

If dose conversation factors are not available from 40 CFR 61, other sources, such as Federal Guidance Report No. 11 (EPA, 1988) could be used. Also the external dose factors (immersion and ground shine) for the radionuclide of interest can be calculated using the computer program DOSFACTOR II (Kocher, 1981). This program was used originally to derive part of the CAP88 radionuclide database. Accepted Health Physics methods should be used to derive additional internal dose factors (if needed).

References for Guidance attachment

EPA, 1989

U.S. Environmental Protection Agency, "National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities," Code of Federal Regulations, Title 40, Part 61.90, Subpart H (1989).

EPA, 1988

"Limiting Values of Radionuclide Intake and Air Concentration And Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, DC 1988

Kocher, David C., 1981

"Dose-Rate Conversion Factors for External Exposure to Photons and Electrons," U.S. Nuclear Regulatory Commission report NUREG/CR-1918 (August 1981)

Parks, Barry M., 1998

Training Course on CAP88-PC2 given at DOE/Los Alamos Area Office, March 2-4, 1998.

“METDAT” INPUT FILE

```
CAP88 file format.
Stability calculations made for data from ta53 between 01/01/1997 00:00  001
and 12/31/1997 23:45  365.
All data has been used in the analysis.
The sample population consists of 34845 data vectors.
<-- cut here to beginning of file for ICN runs -->
star
 $starnl ns=6,is=1,2,3,4,5,6,0,0, $end
default
<-- remove this for ICN runs -- cut here to beginning of file for PC runs -->
 1  1  0.001660.000340.000000.000000.000000.00000
 1  2  0.002900.000430.000030.000000.000000.00000
 1  3  0.005910.001640.000000.000000.000000.00000
 1  4  0.008670.004620.000000.000000.000000.00000
 1  5  0.007380.005680.000000.000000.000000.00000
 1  6  0.004940.004590.000000.000000.000000.00000
 1  7  0.005170.003390.000000.000000.000000.00000
 1  8  0.003270.002090.000000.000000.000000.00000
 1  9  0.001780.001660.000000.000000.000000.00000
 1 10  0.001180.001090.000000.000000.000000.00000
 1 11  0.000980.000660.000030.000000.000000.00000
 1 12  0.000550.000460.000000.000000.000000.00000
 1 13  0.000770.000460.000030.000000.000000.00000
 1 14  0.000720.000340.000060.000000.000000.00000
 1 15  0.000630.000320.000000.000000.000000.00000
 1 16  0.001000.000400.000000.000000.000000.00000
 2  1  0.000430.000340.000000.000000.000000.00000
 2  2  0.000570.000630.000090.000000.000000.00000
 2  3  0.001090.001640.000000.000000.000000.00000
 2  4  0.001410.003960.000030.000000.000000.00000
 2  5  0.001120.003870.000000.000000.000000.00000
 2  6  0.000800.002530.000000.000000.000000.00000
 2  7  0.000890.002470.000000.000000.000000.00000
 2  8  0.001150.002320.000000.000000.000000.00000
 2  9  0.000490.001810.000030.000000.000000.00000
 2 10  0.000230.001350.000000.000000.000000.00000
 2 11  0.000090.000400.000030.000000.000000.00000
 2 12  0.000200.000370.000060.000000.000000.00000
 2 13  0.000060.000550.000110.000000.000000.00000
 2 14  0.000090.000320.000290.000030.000000.00000
 2 15  0.000110.000520.000110.000000.000000.00000
 2 16  0.000230.000140.000000.000000.000000.00000
 3  1  0.000720.001150.000170.000000.000000.00000
 3  2  0.000860.002120.000370.000030.000000.00000
 3  3  0.001810.003620.000460.000000.000000.00000
 3  4  0.001870.005770.000370.000000.000000.00000
 3  5  0.001520.005970.000260.000000.000000.00000
 3  6  0.000600.003730.000090.000000.000000.00000
 3  7  0.000690.004080.000030.000000.000000.00000
 3  8  0.001260.006310.000320.000000.000000.00000
 3  9  0.000690.006460.001350.000000.000000.00000
 3 10  0.000460.002780.000890.000030.000000.00000
 3 11  0.000110.001550.000660.000000.000000.00000
 3 12  0.000260.001180.000800.000000.000000.00000
 3 13  0.000200.001430.002040.000090.000000.00000
 3 14  0.000170.001150.001840.000110.000000.00000
```

```
3 15  0.000400.000980.000630.000030.000000.00000
3 16  0.000460.000600.000290.000000.000000.00000
4  1  0.005650.008490.008840.004450.000490.00000
4  2  0.004190.009330.007810.003670.000370.00000
4  3  0.003620.007380.004330.000800.000000.00000
4  4  0.003040.004910.001430.000000.000000.00000
4  5  0.002090.003530.000600.000030.000000.00000
4  6  0.002180.002380.000550.000000.000000.00000
4  7  0.001690.003990.000920.000200.000320.00000
4  8  0.002300.009590.009070.001920.000630.00003
4  9  0.002380.017220.031710.008120.000570.00011
4 10  0.002090.014550.036560.010420.000490.00009
4 11  0.002470.014640.024450.005880.000230.00000
4 12  0.002270.006830.010790.004510.000660.00006
4 13  0.002470.007660.013890.004280.000030.00000
4 14  0.002700.006280.012110.004480.000400.00000
4 15  0.003850.003560.005420.002760.000370.00011
4 16  0.004910.005450.004760.002150.000290.00009
5  1  0.007610.010910.002960.000030.000000.00000
5  2  0.007520.010650.002980.000090.000000.00000
5  3  0.005540.005540.001260.000000.000000.00000
5  4  0.003420.002760.000260.000000.000000.00000
5  5  0.002840.001490.000000.000000.000000.00000
5  6  0.002300.001230.000090.000000.000000.00000
5  7  0.001980.001950.000230.000000.000000.00000
5  8  0.001890.003360.002320.000140.000000.00000
5  9  0.002610.009300.005140.000290.000000.00000
5 10  0.003440.021930.023650.000860.000000.00000
5 11  0.004250.023420.011970.000140.000000.00000
5 12  0.003440.020120.017740.000030.000000.00000
5 13  0.004330.021180.016820.000140.000000.00000
5 14  0.006000.016160.003560.000000.000000.00000
5 15  0.007260.009590.002730.000090.000000.00000
5 16  0.007860.010700.003730.000110.000000.00000
6  1  0.003870.001000.000030.000000.000000.00000
6  2  0.003040.001150.000090.000000.000000.00000
6  3  0.003360.000660.000000.000000.000000.00000
6  4  0.002870.000490.000000.000000.000000.00000
6  5  0.002730.000060.000000.000000.000000.00000
6  6  0.002120.000110.000000.000000.000000.00000
6  7  0.002500.000660.000000.000000.000000.00000
6  8  0.002840.001000.000000.000000.000000.00000
6  9  0.003560.002440.000200.000000.000000.00000
6 10  0.003670.004280.001000.000000.000000.00000
6 11  0.002900.001520.000090.000000.000000.00000
6 12  0.001980.003330.000550.000000.000000.00000
6 13  0.001520.004100.000430.000000.000000.00000
6 14  0.002300.003330.000030.000000.000000.00000
6 15  0.002350.001230.000000.000000.000000.00000
6 16  0.003130.001030.000030.000000.000000.00000
```

"POPDAT" INPUT FILE

```
default
0.500,  1.100, 2.000, 4.000, 8.000,15.000,20.000,30.00,40.00,60.00,80.00
     0     7    68   240   129     0    13    87   917   786
   566     0     0     0     0     0     0     0     0     0
     0     7    63   639   288     0     5    19   253   154
   284     0     0     0     0     0     0     0     0     0
     0     5    31   887  1407     0     2    23    47   418
   553     0     0     0     0     0     0     0     0     0
     0     2    15   969  6155     0     0    24    28    58
  2427     0     0     0     0     0     0     0     0     0
     0     0     3    83   216     0     6    61   267    57
    68     0     0     0     0     0     0     0     0     0
     0     1    16    29     0     7     0    26   355  2340
     4     0     0     0     0     0     0     0     0     0
     0     3    11     0     0     4     1     0     0  2037
   164     0     0     0     0     0     0     0     0     0
     0     3     3     0     0    31     1   711  1244  6463
 49597     0     0     0     0     0     0     0     0     0
     0     3     3     0     0    21     0    15   127   381
  2962     0     0     0     0     0     0     0     0     0
     0     2     3     0   604   354     0   289  5397  2444
   101     0     0     0     0     0     0     0     0     0
     0     0     1     0  4552   496     0   947 69214  7129
   640     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     7    11   652  7408   679
  2108     0     0     0     0     0     0     0     0     0
     0     0     0     0     1   313  1291  3852   362    21
   401     0     0     0     0     0     0     0     0     0
     0     0     0     0     0   540  1456  4282  3426  1369
  1493     0     0     0     0     0     0     0     0     0
     0     4     7     0     0     1  1185 14165  2436  2363
  3483     0     0     0     0     0     0     0     0     0
     0     7    61    83    16     2    10  2311   386   646
   296     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
```

"PREPNPT" INPUT FILE

```
Keith W. Jacobson
(505) 665-6080
prepnpt
metdat
popdat
preda-lanl
*
Los Alamos National Laboratory
ESH17 ms:J978
Los Alamos
nm
87545
DOE-stack
1999
Calculate annual EDE from monitored release points, May 2000.
Run by K.W.Jacobson w/LANL mainframe-wxmach version of CAP88.
option
 $opti option=0,1,0,1,0,0,0,1,1,lipo=1,nstb=2 $end
grid
 $grid nol=1,nou=16,nrl=1,nru=20,

  lat=35.55, lon=106.15, $end
meteorological data
 $mete lidai=1525,rr=45.3,ta=282.,tg=0.02,0.035,0.035 $end
physical source data
1
 $phys ph=13.10 dia=0.91 vel=10.0  $end
wind frequency data
radionuclide data
10
 $radi nuc='ar-41',  rel=  1.29E+01 $end
 $radi nuc='br-82',  rel=  6.27E-04 $end
 $radi nuc='c-10',   rel=  4.24E-02 $end
 $radi nuc='c-11',   rel=  2.62E+02 $end
 $radi nuc='co-60',  rel=  3.97E-06 $end
 $radi nuc='h-3',    rel=  4.46E-01 $end
 $radi nuc='n-13',   rel=  1.59E+00 $end
 $radi nuc='n-16',   rel=  1.50E-02 $end
 $radi nuc='o-14',   rel=  1.00E-01 $end
 $radi nuc='o-15',   rel=  1.89E+01 $end
population array
modifications
3
$modi nuc="c-10",   lamrr=3.12e+03,anlam=3.12e+03,lamsur=5.48e-05 $end
$modi nuc="n-16",   lamrr=8.43e+03,anlam=8.43e+03,lamsur=5.48e-05 $end
$modi nuc="o-14",   lamrr=8.36e+02,anlam=8.36e+02,lamsur=5.48e-05 $end
comment
  input created by mak88
  created on 05/03/2000 16:03:55
```

Meteorology and Air Quality Group

Review Checklist for CAP88 Output

This form is from MAQ-501

Case: Output name:

Preparer review checklist for CAP88 Output **Initials: _______**

Assessment Identified?	Y / N
VVRUN.log reviewed?	Y / N
V&V header attached?	Y / N
EPA Test Case data OK?	Y / N
Individual Location correct?	Y / N
Individual Dose	Y / N
Radionuclides correct?	Y / N
Number of Curies correct?	Y / N
Release site parameters correct?	Y / N
Population data correct?	Y / N
Meteorological data correct?	Y / N
Input files appended to output?	Y / N
Modifications OK?	Y / N

Forward this checklist and the output to the technical reviewer.

Technical reviewer checklist for CAP88 Output **Initials: _______**

Preparer Reviewed, Signed and Dated?	Y / N
Individual location correct/	Y / N
Individual dose correct?	Y / N
Radionuclides correct?	Y / N
Number of Curies correct?	Y / N
Release site parameters correct?	Y / N

Other reviews or notes:

Forward this checklist and output to the Rad-NESHAP Project leader.

Approver checklist for CAP88 Output **Initials: _______**

Technical Review signed and Date?	Y / N
Sign and Date Document?	Y / N
Document Ok to forward to Records?	Y / N

Other reviews or notes:

Forward this checklist and the output to the records coordinator.

Meteorology and Air Quality Group

Review Checklist for CAP88 Output

This form is from MAQ-501

Case: Output name:

Preparer review checklist for CAP88 Output **Initials: _______**

Assessment Identified?	Y / N
VVRUN.log reviewed?	Y / N
V&V header attached?	Y / N
EPA Test Case data OK?	Y / N
Individual Location correct?	Y / N
Individual Dose	Y / N
Radionuclides correct?	Y / N
Number of Curies correct?	Y / N
Release site parameters correct?	Y / N
Population data correct?	Y / N
Meteorological data correct?	Y / N
Input files appended to output?	Y / N
Modifications OK?	Y / N

Forward this checklist and the output to the technical reviewer.

Technical reviewer checklist for CAP88 Output **Initials: _______**

Preparer Reviewed, Signed and Dated?	Y / N
Individual location correct/	Y / N
Individual dose correct?	Y / N
Radionuclides correct?	Y / N
Number of Curies correct?	Y / N
Release site parameters correct?	Y / N

Other reviews or notes:

Forward this checklist and output to the Rad-NESHAP Project leader.

Approver checklist for CAP88 Output **Initials: _______**

Technical Review signed and Date?	Y / N
Sign and Date Document?	Y / N
Document Ok to forward to Records?	Y / N

Other reviews or notes:

Forward this checklist and the output to the records coordinator.