Appendix A

Cascade Impactor Data Reduction System - CIDRS
(Documentation for Computer Programs)

CONTENTS

Appendix A

General Overview of The Cascade Impactor Data Reduction System (CIDRS)

Although it is possible to reduce data obtained from cascade impactors by hand or with calculators, the number of calculations which must be done to treat the data from just one impactor run make hand calculations impractically laborious. When the treatment of data from multiple runs is considered it becomes obvious that a computer is required. In March 1978 a system of programs known by the acronym "CIDRS" (for Cascade Impactor Data Reduction System) was published for this purpose by the US EPA. CIDRS was written in Fortran for use on large "main-frame" computers and has been adapted since for use on some minicomputers. Denver Research Institute released an adaptation of CIDRS written in BASIC for the TRS-80 micro-computer in March 1980. The system described here, Apple CIDRS, is an updated and expanded adaptation of the TRS-80 CIDRS, written in BASIC for the Apple II micro-computer series. With some effort, the program could be adapted to any other micro-computer which is programmable in one of the variants of Microsoft BASIC.

The CIDRS package consists of a series of programs which together provide the capabilities to:

1) Calculate and store the values of needed ancillary data such as dry gas composition and moisture content of stack gases (Methods 3 and 4).

2) Reduce velocity (pitot) traverse data (Method 2) and aid in the selection of sampling flow rates and nozzle dimensions.

3) Generate files containing the hardware specifics on the impactor configurations used in sampling for later use in calculating stage D50's.

4) Reduce the data from individual impactor runs and generate size distribution information from that data at a set of standard conditions for a standardized array of particle sizes.

5) Combine and appropriately average the results from multiple sample runs obtained at a single source.

6) Calculate the fractional efficiencies of control devices from samples obtained at the control device inlets and outlets.

7) Plot the size distributions and fractional efficiencies obtained above.

In addition, programs are also provided to facilitate program selection, for carrying out disk file "housekeeping" chores, defining orifice constants for use in flow rate calculations, and for reducing Method 5 and Method 17 data.

Apple CIDRS is written to be used with a dual disk drive Apple II system operating under Apple DOS 3.3. In a dual drive system, Drive 1 is used for the program disk and Drive 2 for data file storage. It can be used with a single

disk drive system, but a great deal of disk swapping will be necessary to do so as the core programs for impactor data reduction alone completely fill a disk. Printed output of tabular material should be possible with any combination of printer and compatible interface. The interface is expected to be located in Slot 1 of the Apple. Graphics dump capability is included for dot matrix printers with graphics capability when used with a Prometheus Graffiti interface, an Orange-Micro Grappler, or similar "smart" interface card. Otherwise the user must supply his own screen dump routines if graphics hardcopy is desired.

CIDRS for the Apple II is supplied on three disks. One of these contains the impactor data reduction programs. The second is a data disk which has on it several necessary files and some sample data files. Also included are impactor configuration files for a number of commercially available impactors and some sample data files. The third disk contains the Method 5/17 programs and velocity traverse and run setup programs. The disks are all copyable and it is recommended that the originals be write protected and preserved as master copies and duplicates be used as working copies.

Briefly, the programs on the CIDRS disk relating to single impactor run data analysis are:

MPPROG - This is the main program of the system. It accepts and reduces the raw data from single impactor runs. The program calculates impactor stage D50's, particle concentrations for each stage, provides some information for quality control and data validation, calculates log-normal distribution parameters based on a least squares best fit to the measured size distribution, and generates size distribution information for a set of standardized particle sizes through a spline fit and interpolation/extrapolation procedure. Raw data may be saved on disk for subsequent reuse and the final results can also be saved for plotting or to be combined with data from other runs.

ORSAT - Accepts data from Orsat analyses, calculates excess air for combustion processes, and writes the gas composition data to disk for later use by MPPROG.

METH4 - Reduces data from Method 4 moisture content sampling and writes the results to a disk file for later use by MPPROG. The file value for moisture content becomes the default value used in reducing impactor data, but it can be altered in MPPROG.

DEF/IMP - This program builds files containing specific hardware information on the impactor configurations used in sampling. Information on the type of impactor (round or rectangular jets), number of stages, the number and sizes of the jets on each stage, calibration values of $\sqrt{\psi_{50}}$ for each stage, and jet to plate spacing for each stage must be entered. The information in these files is used by MPPROG for calculating the stage D50's.

DEF/ORI - MPPROG permits the impactor flow rate and gas volume sampled to be calculated from data obtained with dry gas meters or from orifice meters at the users option. This program generates files of orifice calibration information for use by MPPROG if the flow rate is to be calculated from orifice meter data. It also calculates values for $\Delta H@$ for use in setting flow rates during sampling.

Files on the impactor run analysis disk related to combining data from multiple runs are:

STATIS - A program for averaging data from multiple runs made under similar conditions. Simple averages of the differential forms of distributions are made with tests for and rejection of outliers being made at the user's option. The average differential distribution is then integrated to obtain the average distribution in the cumulative forms. Standard deviations and 90% confidence limits are calculated for all forms of the distribution. Provision is also made for correcting the data for errors arising from anisokinetic sampling if the user so desires. The results can be written to disk for later plotting and for use in calculating fractional efficiencies of control devices.

SYNTRAV - Similar to STATIS, but performs velocity weighted averaging for properly combining results obtained in ducts having skewed (or non-uniform) velocity distributions.

EFFICIENCY - Calculates the fractional efficiencies of control devices from control device inlet and outlet data sets. The inlet and outlet data can be from single runs or averaged results from STATIS or SYNTRAV. If both the inlet and outlet data sets are averaged results, confidence limits for the resulting efficiencies are also calculated.

Plotting - Only screen plotting capabilities are included in the system with provision for doing "screen dumps" to dot matrix printers that have graphics capability. The actual plotting is done via a commercial machine language program, Ampergraph. The programs on the impactor run analysis disk related to plotting are:

AMPERGRAPH - The machine language plotting routines. The copyright to this program is owned by Madwest Software, Madison, WI and license fees for its use here have been paid to Madwest. Distribution of additional copies will require payment of additional fees ($18.00 each copy on a single copy distribution basis).

DATAPLOT - Program for loading AMPERGRAPH and selecting whether the data to be plotted is from single run analyses (files from MPPROG), from combined runs (files from STATIS or SYNTRAV), or from EFFICIENCY.

PLOT3 - Plots data from single runs in three forms: differential, cumulative mass concentration, and cumulative percent by mass. In the cumulative forms both the original distribution generated directly from the data and the results from the spline fit are plotted.

STATPLOT - Plots the results of combining data from multiple runs by STATIS or SYNTRAV. The results are plotted in the same three forms as used in the single run plotting. Error bars representing 90% confidence limits are also shown.

EFF/PLOT - Plots fractional efficiency results from EFFICIENCY together with error bars representing 90% confidence limits,if available.

In addition to the primary data reduction and plotting programs described above, there are several utility programs on the impactor run analysis disk. These are:

MAIN MENU - Provides a way for linking the operation of the various programs described above. Menu selection of the programs can be made from MAIN MENU. All programs return to this one upon completion of use.

PURGE RUNFILE - If files of reduced run data are to be deleted, that should be done via this program as it also removes the deleted runs from an index file which is also maintained on the disk. It also provides a catalog of the reduced data files on the disk.

PURGE IMPACTOR FILE - An index file of impactor configurations is also kept on the data disk. This program is used to delete obsolete impactor configuration files. Any deletions of such files should be done via this program as it also deletes the configuration name from the impactor index file.

XPOINTS.DAT - A text file which contains the array of standardized particle diameters to be used in the data presentations.

DISK EXPANDER - Initiates (formats) DOS 3.3 disks with an extra track, thus providing increased program and data storage capability on a disk. Also initiates non-bootable (DOS-less) disks for use as data disks, providing two more tracks for data storage.

COPYA36 - When EXEC'ed, loads COPYA from the DOS 3.3 System Master, modifies it to copy an additional track, and runs it. This provides a way to copy disks which were initiated with an extra track by DISK EXPANDER. This program should be transferred for use to the DOS 3.3 System Master via FID (Apple's file utility program on the DOS 3.3 System Master).

The Field Setup disk includes programs for Orsat calculations, Methods 2, 4, 5 and 17 data reduction, calibration of orifice meters and dry gas meters using NBS traceable laminar flow devices, calibration of pitot tubes, and sampling setup programs for Methods 5 and 17 and cascade impactors. The programs on the disk are:

WATER% - Method 4 moisture sampling data analysis. This program is the same as that called METH4 on the impactor data reduction disk.

ORSAT - The same program found on the impactor data reduction disk.

MTOP - Method 5/17 setup program. This program aids in selecting the correct sampling nozzle to use for Method 5 or 17 sampling and provides an alternative to the standard sampling nonograph for generating metering orifice settings by generating a table of corresponding pitot and metering orifice settings. The latter can simplify field sampling, and permits the use of non-standard metering orifices, which can be advantageous at times.

MTDR - Data reduction program for Methods 5 and 17.

IMPOP - Program for reducing velocity traverse data, selecting impactor nozzle diameters and flow rates for isokinetic sampling, selecting metering orifices for impactor sampling, and generating orifice meter pressure drop settings for impactor sampling.

PCONST - Program to calculate calibration constants for pitot tubes from comparative velocity pressures at a common location.

CAL - A program for calibrating orifice and dry gas meters using NBS traceable laminar flow elements.

Most of the programs in CIDRS for the Apple use a commercial machine language program called "BUILD USING", which is appended to them, for formatting text output to the screen and printer. Apple Computer Inc. did not include any form of the common "Print Using" capability found on most microcomputers. "BUILD USING" adds this capability. For translations of the programs to other machines, the calls to "BUILD USING" are as follows:

Call BU, output string, format string, expression and/or variable list.

output string = formatted result for printing
format string = string expression of format to be used,
expression and/or variable list = list of values (separated by commas) to be printed.

The output string is then printed by a simple Print statement. The Copyright for this program is owned by Rod Stover and it is marketed by Sensible Software, Inc., West Bloomfield, MI. It is used in CIDRS, in an undocumented form, with the permission of Sensible Software, Inc.

The programs described above all use menu selection of all options, and provide interactive prompts for data input. More complete descriptions of each of the programs, lists of all variables used, and detailed operating instructions follow. In the variable lists, all variable names that end with "$" are strings, and all that end with a "(" are arrays. Samples of the results from each program follow the respective detailed descriptions. No commas or semicolons may be used in any inputs.

MAIN MENU

MAIN MENU is a program which provides simple selection of the programs on the CIDRS disk. It is run automatically when the disk is booted, and most of the programs in the system return to it upon their completion.

Program Operation

When run, the monitor screen will show MAIN MENU and lists both the primary program MPPROG and the auxilliary programs, as shown below:

```
                    MAIN MENU

  TO SELECT OPTION ENTER APPROPRIATE NUMBER

     1) ORSAT
     2) METHOD 4 (H20)
     3) "MPPROG"
     4) DEFINE IMPACTOR CONFIG.
     5) DATAPLOT
     6) STATIS (AVERAGE RUNS)
     7) EFFICIENCY CALC.
     8) DELETE RUNFILE
     9) DEFINE ORIFICE CONSTANTS
    10) SYNTRAV (VEL. WGTD AVG.)
    11) COMBO
     Q)UIT

    YOUR CHOICE
```

MAIN MENU

The user should type a selection of a number 1 through 10 or the letter Q and then press the Return button. This will bring up the selected program.

Program Options

The auxilliary programs listed on the "MAIN MENU" shown in Figure 1 are briefly defined below:

1) ORSAT writes the gas composition file needed by the MPPROG program.

2) METH 4 writes the percent water vapor in the stack gases file needed by the MPPROG program.

3) MPPROG is the primary program.

4) DEF/IMP write files on the cascade impactors jet diameters, number of jets per jet stage, calibration constants for the specific cascade impactor, etc. The program MPPROG uses this file information to set the number of jet stages for the particle sample weight input data page (page 3 of 3 of input data to MPPROG) and for calculation of the jet stage D50s.

5) DATAPLOT loads the binary plotting routines and allows selection of data from MPPROG, STATIS (or SYNTRAV), and EFFICIENCY for plotting on monitor screen. Plots of cumulative percent of particles by weight, cumulative mass concentration, and DM/dLogD are made. The x-axis is logarithmetic and spans the range from 0.1 to 100 microns particle diameter. Plots of the MPPROG output will show the actual original points (jet stage D50 on the x-axis and percent of particles less than stated diameter, etc. on the y-axis) and points at a set of standard diameters resulting from a mathematical spline fit. Plots of the output of STATIS will show mathematical averages of the spline fit values and 90% confidence limits. The graphical output is for the monitor screen only, with a provision for screen graphics "dump" to a dot matrix printer. A Prometheus "Graphitti", Orange Micro "Grappler", or other similar "smart" printer card with "screen dump" capabilities is required for the "dump" function to work.

6) STATIS averages the particle size data from two or more runs. It provides output on cumulative percent, cumulative concentration, and dM/dLogD bases with 90% confidence limits. Runs to average are selected by MPPROG test and run numbers. Mixing of "inlet" and "outlet" impactor runs is not permitted. The dM/dLogD values at each particle diameter are averaged and these averaged dM/dLogD values are integrated to provide averages of the cumulative mass concentration and of the cumulative percent less than size distributions. Hardcopy output of the calculated results and disk storage for access by "DATAPLOT" are available as options. Provision is also made for correcting for anisokinetic sampling errors.

7) EFFICIENCY calculates the particle collection efficiency (fractional) of control devices from the cascade impactor data taken at the inlet to and the outlet of a control device. The impactor data can come from single runs (MPPROG) or from averages of multiple runs (STATIS or SYNTRAV). EFF/PLOT will plot the curves of the fractional collection efficiency as a function of particle diameter.

8) DELETE RUNFILE this program deletes old impactor run files from the disk and an index catalog that is accessed by STATIS and MPPROG. You should delete all old impactor run results via this "PURGE RUNFILE" program in order that the "RUN/NAM" index file will match what is actually on the disk.

9) DEF/ORI writes files of the flowmeter orifice constants for use in MPPROG. Also DEF/ORI calculates the orifice flow constants ($\Delta H@$) needed for impactor run set up program (IMPOP) on the other disk (used to find sampling conditions for the field source test with a cascade impactor (i.e. gas sampling flow rate, etc.). The required input data for the DEF/ORI program are an orifice set identification code, nominal orifice diameter, temperature and pressure at calibration conditions, calibration flow rate (acfm), and gas pressure drop across the orifice (inches of water).

10) SYNTRAV is a modification of STATIS which calculates velocity weighted averages rather than simple averages as are done by STATIS. If samples are taken at locations having very different gas velocities, the weighted averages provided by SYNTRAV will more nearly represent the true emissions.

Q) Exit to BASIC.

If you plan to input cascade impactor data into the MPPROG program, you will first need to input data into ORSAT and METH4 (and DEF/IMP if you are not using an impactor for which the specifications are already stored).

With the MAIN MENU program (Figure 1) showing on the screen monitor, you will need to select the number that corresponds to program you wish to run and type it in.

Description of Variables

A - option selected
A$ - input dummy
D$ - DOS command flag

ORSAT

ORSAT is a program for generating a disk file of the dry gas composition to be used in MPPROG for calculating stage D50s. The program accepts data from conventional Orsat type analyses and provides output to a printer and/or disk at the user's option. Excess Air and Dry Molecular weight are also calculated per EPA Method 3.

Processing Orsat Data

To obtain the program "ORSAT" from the MAIN MENU program press "1" and then press the "Return" button. The monitor screen will show ORSAT V 1.0 as presented below:

```
                ORSAT V 1.0

TO ENTER/CHANGE AN ITEM PRESS NUMBER OF
ITEM THEN VALUE AND PRESS (RETURN)

 1) YES HARD COPY OPTION
 2) YES DISK FILE UPDATE
 3)  0.00 CARBON MONOXIDE %
 4)  0.00 CARBON DIOXIDE %
 5)  0.00 OXYGEN %
 6)  0.00 NITROGEN %

    00.000 DRY MOLECULAR WEIGHT
    00.000 EXCESS AIR %

SELECT S)AVE, OR ENTER NUMBER OF ITEM
TO BE CHANGED
```

Monitor Screen View of Program "ORSAT"

Note that the gas compositions shown above are all 0.00 whereas these will normally have values either from data you have entered or from old data from a prior test. The values currently on file are read into memory when the program is run.

To enter a new value for any of the 6 variables press the number of the item to be changed, then enter the new value. Note that these gas compositions are all in units of percent by gas volume on a dry (no water vapor) basis, as is provided by an Orsat Gas Analysis (EPA METH3).

After entering all the new Orsat data, press the letter "S" (for Save). The input data will be saved for use in MPPROG, which performs the particle size data reduction calculations, and control will be passed back to the MAIN MENU program.

Program Description

Initialization is done in lines 6 through 100 and a subroutine from lines 1000 through 1190. The current values of the ORSAT file (ORSAT.DAT) are read into memory in lines 1125 through 1180. The data entry takes place in a subroutine from line 2000 to 2250. The excess air calculation takes place in in lines 2110 and 2115. The dry molecular weight of the flue gas is calculated in line 2100. Printed output, if selected, takes place in a subroutine from line 3000 through 3150 and the disk update takes place in a subroutine from line 4000 through 4040. A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in an irrecoverable loss of the program. The subroutine is copyrighted and permission has been granted by the copyright owner for its use here.

Description of Variables

A - input selection dummy
A$ - input dummy
BU - print formatter address
CU - percent carbon dioxide
CM - percent carbon monoxide
D$ - DOS command flag
EX - percent excess air
F$(- print format statements
F1$ - hardcopy flag
F2$ - disk update flag
FM$ - print format
MW - molecular weight
MW$ - input error message
N2 - percent nitrogen
O2 - percent oxygen
R$ - input and print dummies
X - intermediate value in excess air calculation

ORSAT DATA

3)	0.00	CARBON MONOXIDE %
4)	12.00	CARBON DIOXIDE %
5)	8.60	OXYGEN %
6)	79.40	NITROGEN %
	30.264	DRY MOLECULAR WEIGHT
	69.570	EXCESS AIR %

METH4 is a program for generating a disk file of the flue gas moisture content to be used in MPPROG for calculating stage D50s. The program accepts data from conventional Method 4 sampling analyses and provides output to a printer and/or disk at the user's option.

Processing EPA METH4 Data (Moisture Content)

After pressing "2" on the MAIN MENU program, the METH4 Program will appear on the monitor screen, as is shown below: (NOTE: the values will be filled in with data from the current METH4 data file).

```
                METH4  V 1.0

TO ENTER/CHANGE AN ITEM PRESS NUMBER OF
ITEM THEN NEW VALUE AND PRESS (RETURN)

 1) YES HARD COPY OPTION
 2) YES DISK FILE UPDATE
 3)  0.000 GAS METER VOL. (CU FT)
 4)  0.00 ML WATER COLLECTED
 5) 0     GAS METER TEMP (DEG.F)
 6)  0.00 GAS M. DP (IN.H20)
 7)  0.00 P BAROM.  (IN.HG)
 8)  1.000 GAS METER CORR. FACTOR
     0.000 MOISTURE CONTENT (%)

SELECT S)AVE, OR ENTER NUMBER OF ITEM TO
BE CHANGED
```

METH4 Program as Seen on Monitor Screen

If you wish to enter data obtained from an EPA METH4 test, type in the appropriate item number and then the value of the variable in the proper units.

After you have completed entering your data, press the key S (for Save), then press the "Return" key.

When you have finished with the METH4 Program, you will be returned to the MAIN MENU.

Program Description

Initialization is done in lines 6 through 100 and a subroutine from lines 1000 through 1160. The current values of the METH4 file (METH4.DAT) are read into memory in lines 1120 through 1190. The data entry takes place in a subroutine from line 2000 to 2260. The moisture content is recalculated in lines 2100 through 2115 each time an entry is changed. Printed output, if selected, takes place in a subroutine from line 3000 through 3150 and the disk update takes place in a subroutine from line 4000 through 4040. A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in a irrecoverable loss of the program. The subroutine is copywrited and permission has been granted by the copywrite owner for its use here.

Description of Variables

A - menu selection dummy
A$ - input dummy
BU - print formatter address
BW - fraction moisture
D$ - DOS command flag
F$(- print format statements
F1$ - hardcopy flag
F2$ - disk update flag
FM$ - print format
MF - gas meter correction factor
PB - barometric pressure
PG - gas meter differential pressure to ambient
R$ - input and print dummies
TG - gas meter temperature
VG - gas meter volume
VH - volume of water vapor at normal conditions
VS - volume of dry gas at normal conditions
WA - volume of condensed water

METH4 DATA

3) 14.963 GAS METER VOL.(CU.FT)
4) 26.35 ML WATER COLLECTED
5) 80 GAS METER TEMP(DEG.F)
6) 0.00 GAS M. DP(IN.H20)
7) 30.05 P BAROM.(IN.HG)

7.802 MOISTURE CONTENT (%)

DEF/IMP

DEF/IMP is used to generate files to use in data reduction by MPPROG. These files contain the needed hardware information on the specific impactor configurations used in sampling. Because the same configuration tends to be used repeatedly, it is desirable to store the information in a permanent file which can be accessed simply whenever it is needed. The information to be input includes a unique impactor name to be used in identifying the file, whether the impactor is a round jet or slotted jet type, the number of stages which make up the impactor (including a precollector if one is used), and the number of jets, jet diameter (or length and width if slot type), calibration $\sqrt{\psi_{50}}$, and jet to plate spacing if it is a round jet type. The files can be called up for review by simply entering the name of the impactor. The disk files can be updated and printed copies of a configuration file can be obtained at the user's option. In addition, for cases such as the Pilat Mark V impactor, for which a subset of an array of jet stages must be selected, a file containing information on all available stages can be read into memory. The subset used can then be selected by stage number from the complete array, avoiding a great deal of repetitious data entry. A crude plot showing the relative spacings of the cuts (in log diameter) can be shown on the screen after all stages have been selected. The relative spacings will be accurate for stages that will produce large D50s; however, the plotted spacings will be too close for stages that will produce small D50s because of the increasing effect of the Cunningham correction, which is not included here. If two stages are found to be too closely spaced for the D50 method of data reduction to be valid, a warning will be given and a suggestion for skipping a stage in the MPPROG fits will be made. If the suggestion is accepted, the file will contain a flag to that affect for MPPROG.

Data Input

When run, the program will first give a prompt concerning whether or not a subset of stages from an existing file is to be used. If so, the name of the file from which the stages are to be selected must be entered. The selected file will be read into memory, and the information for each stage will appear on the screen. The parameters for each stage will be listed on a single line and identified by a sequence number. The selections are made by entering the numbers of the desired stages in the order in which they are to be used, inlet first through outlet last. No changes can be made to the parameters in this part of the program. After the desired stages have been selected, press "Q" and the program will proceed to the remaining options and data menus.

The remaining input takes place on two screen pages, the first of which is concerned primarily with general information, and the second for individual stage input and/or changes. The information needed on Page 1 is input by entering the selected menu item number, at which point a prompt for that item will be given. The Page 1 input display is shown on the next page. The items are:

1) Is hardcopy desired? Selecting this item will reverse the currently displayed answer.

2) Is a disk update of the file desired? Again selection of the item reverses the answer.

3) Impactor name: The file name to be used is the impactor name with /IMP added. The /IMP is added by the program and should not be entered by the user. When a file name is entered, the disk is checked for the existence of a current file with that name. If such a file exists, it is read into memory and the current information in the file will be displayed on the data entry screens. This read will not take place if stages have just been selected as a subset from an existing file.

4) Description: Enter a brief description of the configuration to help identify its properties for use in MPPROG. This description will be printed on the screen when the impactor is selected in MPPROG. Be brief to avoid space problems in the MPPROG display.

5) Select the type of jet geometry - Circular (round) or Slit. Selection of this option toggles between the two.

6) Enter the number of stages making up the impactor configuration. This will include a precollector if one is used, but does not include the backup filter. If stages have been selected as a subset from a file, this will already be filled in. The program is dimensioned for a maximum of 15 stages.

7) Discharge coefficient: Earlier versions of MPPROG used fixed values of discharge coefficients for computing stage pressure drops. The current version calculates them based on the stage Reynolds number so this entry is now obsolete.

```
   DEFIMP  V2.4-Page 1 of 2

1) HARD COPY OPTION:                    YES
2) DISK FILE UPDATE:                    YES
3) IMPACTOR NAME:
   FILE NAME:----------
4) DESCRIPTION:
5) SHAPE OF JETS (CIRC./SLIT):        CIRC.
6) NUMBER OF STAGES:                       0
7) DISCHARGE COEFFICIENT               0.610

P)AGE, Q)UIT, OR NUMBER OF ITEM
TO ENTER/CHANGE: ?
```

After completing the entries on Page 1, press "P" and "Return" to proceed to the second page of data entry which is illustrated below. This page is devoted entirely to the stage parameters. The program will set up one line for parameters for each stage, numbered sequentially from 1 to the total number of stages entered on the previous page. Entry of data is made by entering the stage number for which information is to be entered or changed. When a stage is selected, the cursor will be placed at the start of the leftmost entry in its line. Pressing "Return" will accept the current value of the entry and advance the cursor to the start of the next entry. Entering a number will change the current value to that number. When the cursor is advanced beyond the last field the program will revert to the stage select mode. If the impactor is a round jet type, columns will be provided for the number of jets on the stage, the calibration value of $\sqrt{\psi_{50}}$,the jet diameter in centimeters, and the separation between the jet outlet and the collection surface in centimeters. If the impactor uses slot type jets, columns will be provided for the number of slots at each stage, the calibration value of $\sqrt{\psi_{50}}$, the jet width in centimeters, and the jet length in centimeters.

DEFIMP V2.4-PAGE 2 of 2

STAGE NO.	NO. JETS	SQR PSI	JET DIA.	J TO P DIST.
1	0	0.000	0.0000	0.000
2	0	0.000	0.0000	0.000
3	0	0.000	0.0000	0.000
4	0	0.000	0.0000	0.000
5	0	0.000	0.0000	0.000
6	0	0.000	0.0000	0.000
7	0	0.000	0.0000	0.000

TO ENTER/CHANGE DATA FOR A STAGE ENTER STAGE NO. P)AGE

Upon completion of all data entry, press "Q" and "Return" to proceed. The value of a parameter proportional to the D50 of each stage will be computed and, at the user's option, plotted. This value will be used to check the relative spacings of the cuts that the impactor will produce. Any which are too close to one another will produce a warning to the user and a suggestion regarding the omission of one of the stages in the MPPROG distribution fitting procedures. After the relative spacings are checked, the information will be printed and/or saved to disk depending on the users selected options.

Description of Major Program Segments

Program initialization takes place in lines 6 through 100 and in a subroutine from line 1000 to line 1160. Loading of a pre-existing impactor stage set for stage selection takes place in a subroutine from lines 6000 through 6450. Stage selection is then made in a subroutine from line 7000 through 7120. Page 1 of the primary data entry menu takes place in lines 2000 through 2490, with pre-existing impactor files being checked and loaded in lines 2367 through 2450. Page 2 of the data entry is done in lines 2500 through 3350.

The check for the relative spacing of the stage cut diameters is done in lines 3500 through 3710. Plotting of the relative cuts is done in a subroutine in lines 3400 through 3499. Printing of the information is done by a subroutine from line 4000 through 4500 and the disk update is done in lines 5000 through 5920. A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in an irrecoverable loss of the program. The subroutine is copyrighted and permission has been granted by the copyright owner for its use here.

Identification of Variables

A - option selection dummy
A$ - input dummy
BU - address of print formatter
CP(- plot variable for relative cut spacing
CR - test value for closeness of cuts
CZ - index of number of stages selected in stage select routine
D$ - flag for DOS commands
DC - coefficient of discharge
EF - error flag
F$(- format statements for printing
F1$ - flag for hardcopy
F2$ - flag for disk update/save
HH - screen tab index
I - loop index
J - variable counter
JA(- jet area
JD(- jet diameter
JK(- parameter proportional to cut diameter
JL(- jet length for slotted jets
JN(- number of jets on stage
JS(- jet to plate distance
MR - number of stages to omit in MPPROG spline fit
MZ(- flag for which stage(s) to omit in MPPROG fitting
N$(- names of impactors on file
NI$ - impactor name
NM$ - impactor file name
NS - number of stages
NZ - number of stages in file from which stages are to be selected
OK - flag for pre-existing file
P - menu page number
PF - format selector
R$ - dummy for input and printing
RA - plot scale variable
RM$ - impactor description
SH - impactor type flag
SH$ - impactor type
TI - number of impactors on file
Y$ - input dummy
ZA(, ZD(, ZL(, ZS(, & ZZ(- equivalent to JA(, etc. for file from which stages are to be selected.

D E F I M P V2.4

2) DISK FILE UPDATE: YES
3) IMPACTOR NAME: UW V/III DEMO
   FILE NAME: UW V/III DEMO/IMP
4) DESCRIPTION: PC-3-4-5-7-9
5) SHAPE OF JETS(CIRC./SLIT): CIRC.
6) NUMBER OF STAGES: 6
7) DISCHARGE COEFFICIENT 0.610

STAGE NO.	NO. JETS	SQR PSI	JET DIA.	J TO P DIST.
1	1	0.240	1.2700	0.850
2	12	0.381	0.2438	0.318
3	90	0.365	0.0790	0.318
4	110	0.371	0.0508	0.318
5	110	0.383	0.0343	0.318
6	105	0.363	0.0262	0.318

MPPROG

This program is the heart of the entire system and is the longest and most complex program in CIDRS. The required inputs are impactor configurations from DEF/IMP, stage weights from the impactor run, blank corrections to be applied to the stage weights, sampling information regarding the gas volume sampled, the sample duration, pressures and temperatures at meter, flue gas, and impactor conditions, the particle density to be used if D50's are to be calculated on a Stokes diameter basis, the flue gas composition and moisture content, the diameter of the sampling nozzle, and the flue gas velocity.

Options availble to the user include:

1) Choice of the diameter basis to be used in the data presentation --Stokes (physical), Classical Aerodynamic, and Impaction Aerodynamic.

2) Choice of using fixed calibration values for the values of the impactor stage constants or values obtained from theory. The theoretical values include the effects of jet Reynolds number and the jet to plate spacing and are probably superior to the fixed calibration values in most cases. If the theoretical values are chosen, the user must also specify the type of substrate used as the use of fibrous substrates will reduce the effective stage constant.

3) Obtaining printed output of the input data and the results.

4) Saving either or both the input data and results to disk for later use.

PROGRAM OPERATION

The program operation proceeds through a number of subroutines which will be described in more detail later. These routines can be broken down into six fundamental operations. The first is related to program initialization and requires no user input or intervention. The second is data input, which takes place in three screen pages. The third deals with preliminary calculations of such items as gas flow rates, stage pressures, jet velocities, gas viscosity, and isokinetic ratio; this section requires little user intervention other than restarting at program halts for display of intermediate information. The fourth program block is the one in which the stage D50's are calculated. At this point the user must select whether fixed calibration stage constants are to be used or if theoretical values are to be calculated: and, if the latter option is selected, select the substrate type for which they are to be calculated. In the fifth block, the best log-normal fit is made and the spline fit and interpolation/extrapolation are performed to obtain results at a standard set of particle diameters. The final block provides screen and printed displays of the results and handles disk storage of the data and results as desired.

Data Input

To select the MPPROG Program from the Main Menu, press 3 and then the Return key. Then the MPPROG program will load and run.

Input to Page 1 of 3. First the user will be prompted as to whether an old data set is to be loaded. If so, respond "Y" and a prompt for the File Name for that data set will be given. After either choice, the program will proceed to the data input/change routines. These consist of three menu pages as follows:

```
Impactor Version 4.0 - Page 1 of 3

 1) Part. Diameter              Imp. Aero.
 2) Date of Test:
 3) Time of Test:
 4) Location of Test:
 5) Test Number
 6) Test Type
 7) Run Number:
 8) Run Remarks:
 9) Water Vapor                    0.00%
     CO2 00.00%            CO   0.00%
     02   0.00%            N2  00.00%
10) Impactor Type:
11) Particle Density      0.00 GRAMS/CC
12) Orifice ID (optional):
13) Substrate material:

ENTER: Q)UIT, P)AGE, OR NUMBER OF ITEM TO
 ENTER/CHANGE:
```

MPPROG, Page 1 of 3, as shown on screen

If you wish to enter the cascade impactor test data on page 1 of 3, press the item number of the variable and then type in the information (in the appropriate units).

The explanation, units, and choices for the variables on Page 1 of 3 of MPPROG are as follows:

1) Select one of three types of particle diameters. The diameters are: P (physical or Stokes), C (classical aerodynamic), or I (impaction aerodynamic).
2) Enter date (ALPHA NUMERIC), such as July 18 1984 or 7/18/84.
3) Enter test time (NUMERIC) on a 24 hour basis, such as 1430 for 2:30pm.
4) Enter test location (ALPHA NUMERIC).
5) Enter field test number (NUMERIC). The test number is expected to be keyed to major projects.
6) Select test type, either INLET or OUTLET. (Inlet to or outlet from control equipment such as an electrostatic precipitator).

7) Enter run designation (ALPHA NUMERIC).
The program will generate the FILE NAME from the test number, the run designation, and the test type. If that file name already exists in the run index file, the file name and run designation will be rejected.

8) Enter remarks and comments about the cascade impactor source test run (ALPHA NUMERIC). If lengthy comments are made, some of the menu items may be pushed off the screen display.

9) The percent water vapor and dry gas composition will be obtained from the METH4 and ORSAT program files. (These can be changed from the keyboard here. The percent water can also be calculated by entering a water volume on the next menu page if you wish).

10) Enter the name of the specific cascade impactor that was used in DEF/IMP for specifying the hardware configuration. Data on the number of jet stages, stage geometry, and stage calibration constants will be obtained from the impactor file which was generated by the program "DEF/IMP". You must run "DEF/IMP" before MPPROG to generate the impactor file unless you select a "generic" impactor configuration which is already on file. The generic impactors in the file include:

UW III GENERIC - UW Mark 3 Model, 7 stages
ANDERSEN GENERIC - Andersen Mark III, 8 stages
BRINK GENERIC - Brink Model, 7 stages
MRI 1502 GENERIC - MRI Model 1502
UW V ALL - UW (Pilat) Mark V, all 13 stages

Enter only the selected impactor name (such as UW III GENERIC). Do not include the /IMP portion of the file name.

11) Enter the particle density to be used in calculating the particle Stokes (physical) diameter. Be very careful in what particle density you use here. Note that with a particle density of 1.0 grams/cc results in calculating the particle aerodynamic diameter (i.e. diameter of sphere of unit density which has aerodynamic properties equal to the actual real particle). If you select aerodynamic dia. (item 1), the program sets particle density = 1.0 when the calculations are done.

12) Enter the gas metering orifice identification diameter. Enter the ID designation as 3 digits/period/alpha set name. The program gets the orifice constants from the file written by the program DEF/ORI. This orifice ID is not required unless the stack gas sampling flow rate is to be calculated from an orifice meter rather than a dry gas meter. It is useful to enter the orifice ID for completeness in run documentation in any case.

13) Enter type of substrate used to collect particle samples on the jet stages (examples are greased stainless steel foil, aluminum foil,

quartz fiber filter, Kapton, etc.). This entry is not required to run MPPROG, but it is useful to have a record of substrate material or coating (grease) used in the test.

Note that the numbers above correspond to the item numbers in Page 1 of 3 (Fig. 5). When the user has completed data entry into page 1 of 3, then press P and RETURN and page 2 of 3 will appear.

Input to Page 2 of 3 - page 2 of 3 will appear on the monitor screen as shown below:

```
 1) GAS METER VOL              .000 CUBIC FEET
 2) IMPACTOR DELTA P           .00  IN. HG.
 3) ORIFICE DELTA P            .00  INCHES H20
 4) STACK PRESSURE             .00  INCHES H20
 5) BAROMETRIC PRES            .00  INCHES HG
 6) STACK TEMP                 0    DEGREES F
 7) METER TEMP                 0    DEGREES F
 8) IMPACTOR TEMP              0    DEGREES F
 9) SAMPLE TIME                .00  MINUTES
10) AVG GAS VEL                .00  FEET/SEC
11) ORIFICE PRESS              .00  INCHES HG
12) NOZZLE DIA                 .000 INCHES
13) MAX PART DIA             60.00  MICRONS
14) VOL of CONDENSED WATER     .00  CC
15) METER CORR FACTOR         1.00

ENTER:  Q)UIT,  P)AGE, or NUMBER OF ITEM TO
ENTER/CHANGE:
```

MPPROG, Page 2 of 3 as shown on screen

Now if you wish to enter the impactor test data on page 2 of 3, press the item number of the variable you wish to enter or change and return. The explanation for the variables on page 2 of 3 of MPPROG are as follows:

1) Enter dry gas meter volume in cubic feet. Set equal to zero (0) if the gas flow is to be calculated from the orifice meter.

2) Enter the impactor gas pressure drop. If left at 0, the program will calculate the jet stage pressure drop for each stage using standard orifice equations and the impactor geometry, gas composition, temperature, pressure, and gas sampling flow rate. Normally it should be left at zero because the impactor pressure drop will not be measured during the run.

3) Enter the gas flow rate metering orifice pressure drop. If the orifice meter is downstream of dry gas meter and vacuum pump as in a standard EPA METH5 type sampling train the orifice meter pressure drop should be entered as a negative value.

4) Enter the static pressure of stack gas (negative if stack is below ambient atmospheric pressure). This stack pressure is the pressure difference (inches water gauge) between the stack gas and the atmospheric barometric pressure.

5) Enter the atmospheric barometric pressure (inches mercury absolute) at the elevation of the stack sampling location.

6) Enter the stack gas temperature (degrees F).

7) Enter the dry gas meter temperature (degrees F).

8) Enter the impactor temp. (degrees F). May differ from stack gas temperature.

9) Enter the total time of gas sampling through impactor (minutes).

10) Enter the stack gas velocity (ft/sec). This is optional but needed if the isokinetic ratio is to be calculated and if correction for non-isokinetic sampling is desired.

11) Enter the orifice meter differential pressure to ambient. This is negative if the orifice meter and dry gas meter were located upstream of the vacuum pump as is done on occasion. Leave the value as zero if the pump, orifice, and gas meter were in the standard Method 5 configuration.

12) Enter the sampling nozzle diameter (inches). Optional, but needed if the isokinetic ratio is to be calculated or correction for non-isokinetic sampling is desired.

13) Enter the maximum particle diameter (typically 60 microns for controlled sources, 1000 microns for uncontrolled).

14) Enter the volume of condensed water collected if a moisture content specific to this run is to be calculated. If left zero, the default or previous value will be used.

15) Enter the dry gas meter correction factor if different from 1.0.

When the entry of data into page 2 of MPPROG is complete, press P and Return and page 3 of 3 will appear.

Input to Page 3 of 3

The page 3 of 3 of MPPROG data entry is shown in below:

```
Impactor Version 2.5     Page 3 of 3

MASS GAIN OF STAGE 1          .00 MG
MASS GAIN OF STAGE 2          .00 MG
MASS GAIN OF STAGE 3          .00 MG
MASS GAIN OF STAGE 4          .00 MG
MASS GAIN OF STAGE 5          .00 MG
MASS GAIN ON FILTER 6         .00 MG


MASS GAIN OF 7 BLANK SUBST.  .00 MG
MASS GAIN OF 8 BLANK FILTER  .00 MG

ENTER: Q)UIT, P)AGE, or NUMBER OF
ITEM TO ENTER/CHANGE:
```

MPPROG, Page 3 of 3, as shown on screen

Note that the number of stages shown on the monitor screen is dependent upon the type of cascade impactor specified in item #10 on page 1 of 3 of MPPROG. For example the 7 stage UW Mark III Generic has 7 stage weights, 1 filter weight, 1 blank substrate weight, and 1 blank outlet filter weight (10 weights in total).

To enter the mass gains of the particles on the substrates under the jet stages, on the impactor outlet filter, and on the blanks, press the number of the stage or of the filter or blank you wish to enter or change and Return.

Note that the program will subtract the blank weights from the measured stage and outlet filter weights to correct for interferences. Negative or zero net stage weights are not allowed - they will cause fatal errors. Therefore, if a weight is zero, give it an infinitesimally small positive value. At this point data entry for the run is complete.

Check Filename

The user should now check page 1 of 3 (press P) for the file name (Item #7 on page 1 of 3). This is an alpha numeric filename (name composed of letters and numbers). This filename is generated by MPPROG from the impactor test number, the impactor run number, and the test type (inlet to control equipment or outlet from control equipment). An example of a filename is T1R2.OT (corresponds to test #1, run #2, outlet from control equipment).

Processing the Data

After completing the data entry, press "Q" and "Return" to begin processing. Several intermediate results will be shown on the screen, after which the program will pause with a prompt to the user to select the use of

fixed calibration stage constants from the DEF/IMP generated file or theoretical values for calculating D50's. If the theoretical option is selected, further prompts will be given regarding the use of theory for the first stage cut and the type of substrate that was used. The performance of the first stage of most (or all) impactors differs substantially from theory and a fixed calibration value is believed to be better than the value calculated from theory. Fortunately, for most impactors, the first stage normally operates at a relatively high Reynolds number and has a relatively small jet to plate spacing, so the calibration value is likely to be valid. NOTE: THE CALIBRATION VALUES OF THE STAGE CONSTANTS THAT WERE LOADED FROM DISK ARE OVERWRITTEN IF THE THEORETICAL CONSTANTS OPTION IS SELECTED. Therefore if new calculations using the calibration values of the constants are desired after once having used theoretical values, the impactor hardware information must be reloaded from disk. Theoretical constants are not available for slot type impactors and must be recalculated for each run for round jet impactors.

After the stage D50's are calculated, the reduced size distribution will be printed on the screen in cumulative percent by mass form and the log-normal and spline fits will be made. The user will then be given prompts regarding whether hardcopy of the results is desired and if the results or raw data are to be saved to disk. If a number of runs are to be reduced with many of the input variables remaining constant, it will probably be convenient to save the raw data to be used later, with changes being made as needed, for reducing other runs. This can save considerable time in data input. Finally the choice of returning to the main menu or continuing with the reduction of more runs in this program will be made.

Description of Major Subroutines in MPPROG

Initialization

Partial initialization takes place in lines 9 through 99 at which point a jump to a subroutine from lines 1000 through 1399 takes place. The bulk of the Format statements used in setting up the displays are found in these lines and values of a number of important constants and flags are set up there. The default moisture content and the dry gas analysis are read in by routines at lines 1270 and 1300. The array of standard particle diameters for which results are calculated is read in from disk by a subroutine at line 5700.

Menu Selection

A short subroutine at line 1400 is used to enter the users selection of menu choices and check the choice for validity.

Data Entry

Data entry takes place in a series of three major blocks (screen pages) of a subroutine beginning at line 2000. Lines 2000 to 2999 make up the first page of data entry, which is primarily devoted to general information on the run and the hardware used in making it. Lines 3000 to 3390 make up the second page of data entry in which information is entered regarding sample volumes, flows, pressures, temperatures, etc. Finally, catch weights are entered at the third screen page which runs from line 3500 to 3690.

In the first data entry page, a subroutine at line 2800 is used to check for the validity of disk files from which input is requested. Impactor configuration files are read from disk by a routine beginning at line 2350. File names for disk storage of raw data and results are formed when the run identification is entered by a subroutine at line 2420. The file name is constructed from the test number, run ID, and Inlet/Outlet designation. To insure that previous files are not overwritten, the file name is checked against an index file when it is formed. An existing file name cannot be used. If the flow is to be calculated from orifice meter data, the orifice meter calibration information is read in by a subroutine at line 2610. Entry of data on the remaining pages is straightforward and self-explanatory.

Calculation Sequence

Upon completion of data entry, the calculations take place in the following sequence:

1) The gas viscosity and wet and dry molecular weights are calculated in a subroutine at lines 4500 through 4810. The viscosity is calculated by a method in which the viscosity of a gas mixture is calculated from the viscosities of its constituents (Wilke, 1950). The individual component viscosities are calculated from polynomial curve fits to data contained in the CRC Handbook of Chemistry and Physics.

2) The impactor flow rate at standard conditions and at impactor conditions (which will usually be stack conditions) and the isokinetic ratio are calculated from either the gas meter or orifice meter data as selected by the user in a subroutine located in lines 4000 through 4050.

3) Stage pressure drops, jet velocities, and Reynolds numbers are calculated in a subroutine from line 4900 through 4998. The pressure drops of individual stages are calculated by treating the stages as orifice plates having approach ratios of 0.2. The latter figure is close to that for the stages of the Pilat impactors and for most other multi-jet impactors as well. The coefficient of discharge is estimated based on the Reynolds number from a fit to a curve given in Brown (1950). Gas compressibility is accounted for by a correction factor given by Considine (1957). Some pressure recovery takes place which lessens the permanent pressure loss from the jets from that calculated by the orifice equations. This recovery is accounted for by an empirical correction factor which has been optimized for the Pilat (UW) impactors. It is expected that the same correction should be suitable for most commercial multi-jet impactors.

Tests of the pressure drops predicted by the program against measured values for various combinations of stages of Pilat Mark III, V, and 10 impactors have been made. Impactor configurations with six to fourteen stages were used in these tests. The impactors were operated at flow rates which produced total pressure drops ranging from a fraction of an inch of mercury to nineteen inches of mercury. The average signed error in the predicted total pressure drop was -2.6 percent. The average unsigned error was 8.0 percent

and the maximum error was 28 percent. The inlet pressure to each stage is the important factor in calculating stage D50's. Because much of the total pressure drop, and the error in the calculated total pressure drop, occurs at the last stage, the accuracy of the pressure drop calculations is believed to be adequate for the purpose. If the actual overall pressure drop through the stages, exclusive of the backup filter is known, it can be entered and will be apportioned through the stages by scaling from the calculated pressure drops in lines 4965 through 4973.

4) Theoretical stage constants for D50 calculations are calculated, if desired, in a subroutine from lines 20000 to 20090. The stage constants are calculated from curve fits to theoretical values of $\sqrt{\psi_{50}}$, versus Re and S/W (Farthing, 1983). The basic fitting equations reproduce Farthing's theoretical values over the range of Reynolds number from 10 to 3000 and S/W from 2 to 11 with a maximum error of +/- 3.5% and an average error of -0.2%. The fitting equations have been adjusted to account for a systematic bias of +7% in the theoretical values as compared to laboratory calibrations. Corrections to the theoretical stage constants can be made for the shifts which result from using fibrous substrates. These corrections are based on comparisons of calibrations of a number of Brink and Pilat impactor stages which were done at SoRI with both glass fiber and greased substrates.

5) Stage D50's are calculated in an iterative loop from lines 5000 to 5160. In the loop an initial estimate of the value of the Cunningham correction factor, CU, is made and a value of the D50 is calculated using the estimate. A new value of CU is then calculated using the D50 and the process is repeated until successive estimates of CU differ by less than 0.02%, at which time the loop is terminated. The last pair of values of D50 and CU are retained as the final results.

6) The stage weights are used to form cumulative percentages smaller than consecutive D50s beginning at the final stage and proceeding toward the inlet in lines 5170 through 5350. Corrections for blank weight gains are made in the process. The total measured mass concentration in at dry normal conditions is calculated at line 5380.

7) Transformations to log-probability coordinates from linear diameters and cumulative percentages are made preparatory to the spline and best log-normal fits in lines 5500 through 5690 and 5775 through 5778. Any stages to be omitted in the fits are dropped in lines 5581 through 5583. The data to be fit are then reordered in lines 5780 to 5900 so that the stage index increases from the filter to the impactor inlet rather than the entry order from inlet to filter. If problems are encountered that would lead to a fatal error, an error flag is set and the program will return to the data input pages.

8) A least squares fit of the best log-normal approximation to the distribution is made by a subroutine from line 10000 to 10150.

9) A cubic spline is fit to the data for use in generating distribution parameters at a set standard diameters in lines 6000 through 6290 (Lawless, 1978). A modification of the cubic spline described by Lawless is used. The modification insures that no negative slopes will be generated. Interpolation along the spline curve is used to generate distribution values at the standard diameters which fall between the stage D50s and to extrapolate for those which fall below the smallest D50 or above the largest. The extrapolations are carried to diameters far removed from the range of the stage D50s for later use in averaging results from multiple runs. However, they should not be expected to be very good, quantitatively, much farther than a factor of two in diameter from the smallest and largest of the stage D50s. These interpolations and extrapolations are made between lines 6500 and 6848.

10) Printed output of the raw data and results are done, if desired, by a subroutine at lines 9000 through 9890.

11) If desired, results are saved to disk for later plotting and/or averaging by a subroutine from lines 7000 through 7700. The results are written to a text file and the text file name is added to an index file.

12) Raw data are saved, if desired, in two files by a subroutine in lines 30000,30090. All numeric information needed to reproduce the results are placed in data arrays, if they are not already array variables, and a binary save of the memory locations in which array variables are stored in the machine is made. This makes the numeric storage fast and compact. String variables are simply written to a standard text file. Reloading of raw data from a previously stored run is done through the following subroutine (lines 31000 through 31090).

13) A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in an irrecoverable loss of the program. The subroutine is copyrighted and permission has been granted by the copyright owner for its use here.

Description of Variables in MPPROG

AV - average flue gas velocity
B(- intermediate value storage for spline fit
BS - first stage for which theoretical stage constant is to be generated
BU - address of the print formatting routine
BW - flue gas fraction moisture
C - dummy used in spline fit
C0-C3 - constants used in normal transform
CC - previous value of Cunningham correction in iteration
CC(- final values of Cunningham corrections
CD - flue gas percent CO2
CM - flue gas percent CO
CP - metering orifice calibration pressure
CQ - metering orifice calibration flow rate
CT - metering orifice calibration temperature
CU - new value of Cunningham correction in iteration
CU(- cumulative mass fraction smaller than D50
D$ - DOS command prefix
D0-D3 - constants for inverse normal transformation
D5 - new stage D50 estimate in iteration
D5(- final stage D50s
D6(- stage D50s on impaction aerodynamic basis
DA - start of array storage address - used in raw data save
DA(- dummy array into which non-subscripted variables are placed
for data save
DC - discharge coefficient & square of same
DG(- dM/dLogD's
DI - metering orifice diameter
DJ(- jet diameters
DL - length of array space in memory - used in data save
DL(- estimate of slope in spline fit
DM - dry molecular weight of flue gas
DP - measured impactor stage total pressure drop
DP(- stage pressure drops
DQ - dummy used in spline interpolation
DQ(- dummy used in spline fit
DT$ - date
ET - convergence test value in spline fit
F$ - format strings
F$(- format strings
F(- gas composition fractions as array
Fl - flag for diameter basis on which spline fit is made
FA - used in fibrous substrate theoretical stage constant correction
FC - blank backup filter weight gain
FF - backup filter weight gain
FF$ - flag for substrate selection in theoretical stage constant calculation
FI - number of reduced data sets stored on disk
FI$ - file name for reduced data
FL - flag in normal and inverse normal transforms
FM - used in fibrous substrate correction

FR - constant used in transforming form deg. F to deg. Rankine
FS - impactor flowrate at dry normal conditions
GD - gas density
GX, GY, GZ - constants used in theoretical stage constant calculations
H(- 1st differences for spline fit
H1, H2 - scaling lengths for spline interpolations
H2(- 2nd differences for spline fit
HG - constant used in conversions from in. H20 to in. Hg
I - loop index
I$ - test type
IM$ - impactor type
IN$ - impactor comments
IS - percent isokinetic
J - loop index
JA(- jet areas
JN(- numbers of jets per stage
JS(- impactor stage constants
K - loop index & counter
L - mean free path
L$ - test location
L1-L9 - used in log-normal fit
LR - Log (Reynolds number) in base 10
LT - Ln(10)
LZ - used in log-normal fit
M(- stage weight gains
MA - molecular weight of standard air
MF - gas meter correction factor
MR - number of stages to omit in spline fit
MW - wet molecular weight
MW(- individual constituent molecular weights
MX - number of menu items per page
MZ(- flag to skip a stage in spline fit
N2 - percent nitrogen
ND - nozzle diameter
NM$ - file name for data storage
NN - number of orifices in orifice set
NP - number of entries in array of standard diameters
NZ - number of data points to be used in spline fit
O2 - percent oxygen in flue gas
OF - used in correcting for jet to plate spacing in theoretical stage constant calculations
OK - file validity flag
OM - relaxation parameter used in spline fit
OP - metering orifice pressure drop
P - menu selection variable
PB - barometric pressure
PC - pressure differential to ambient at metering orifice inlet (orifice upstream of pump)
PM - pressure conversion factor
PP - metering orifice calibration pressure
PR - used in spline interpolation
PS - stack pressure differential to ambient

QC - flow rate conversion factor cfm to cc/s
QI - impactor flow rate (acfm at impactor conditions)
QO - orifice flow rate
QS - impactor flow rate at dry standard conditions
R$ - dummy string for input and printing
RE(- stage Reynolds numbers
RH - particle density
RN$ - run designation
RO$ - orifice ID
RR$ - run remarks
S - number of stages in impactor (includes precollector but not backup filter)
S1 - used in spline interpolation
S2(, S3(- used in spline fit
SC - weight gain of blank stage
SH - impactor type flag
SI(- impactor stage constants
SM$ - substrate material
SP - standard barometric pressure
SU - used in viscosity calculation
T - gas temperature, deg. C
T$ - time at which run was made
TC - total mass concentration
TD - duration of sample
TH$ - flag for theoretical stage constants
TI - impactor temperature
TK - temperature, deg. K
TM - gas meter temperature
TN - test number
TN$ - test remarks
TS - stack temperature
TX, TY - dummies for sorting
U - gas viscosity
U(- single constituent viscosity
VJ(- stage jet velocities
VM - meter volume
VT - total pressure drop
W - goodness of fit estimater for spline fit
WA - volume of condensed water
WD, WN, WX, WY, WZ - constants in equation for theoretical stage constant
X - dummy for file input
X$ - input dummy
X(- array of log(D50)'s
XO - maximum particle diameter
X1-X3 - used in spline interpolation and as dummies
XM - sum of stage weight gains
XP(- array of standard diameters
XX$ - dummy for printing
XX(- LOGs of standard diameters
XY$, XZ$ - dummies for printing
Y - test number
Y(- normal transforms of cumulative percents
Y1(- slope of spline fit

Y2 - compression correction factor & square of same for stage
pressure drop calculation
Y2(- used in spline fit
YY$ - dummy for file checks
YY(- cumulative percents in probability space
ZP - constant in theoretical stage constant equation
ZY - error flag
ZZ$ - dummy for file input
ZZ$(- names of files in index file

```
**********IMPACTOR VERSION 4.1**********

********** INPUT DATA **********


 1)PART. DIAMETER    CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 4/20/84
 3)TIME OF TEST: 0900
 4)LOCATION OF TEST: STACK
 5)TEST NUMBER    0
 6)TEST TYPE          OUTLET
 7)RUN NUMBER: SAMPLECALC-FILE NAME:T0RSAMPLECALC.OT
 8)RUN REMARKS: DATA FROM SECTION 5 SAMPLE
10)IMPACTOR TYPE: UW III SAMPLE
UW III WITH GENERIC CAL.

 9)WATER VAPOR          4.91%
    CO2    .22%         CO    .03%
    O2   19.75%         N2  80.00%
12)  ORIFICE ID (OPTIONAL): .120S
13)  SUBSTRATE MATERIAL: APEIZON H


 1)GAS METER VOL     40.190 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P     .00 INCHES H2O
 4)STACK PRESSURE      .00 INCHES H2O
 5)BAROMETRIC PRES   29.60 INCHES HG
 6)STACK TEMP       300    DEGREES F
 7)METER TEMP        74    DEGREES F
 8)IMPACTOR TEMP    300    DEGREES F
 9)SAMPLE TIME      120.00 MINUTES
10)AVG GAS VEL       50.00 FEET/SEC
11)ORIFICE PRES        .00 INCHES HG
12)NOZZLE DIA          .188 INCHES
13)MAX PART DIA     100.0  MICRONS
14)WATER VOLUME      43.0  CC
15)METER FACTOR       1.0000


 MASS GAIN OF STAGE 1   21.57 MG
 MASS GAIN OF STAGE 2    3.11 MG
 MASS GAIN OF STAGE 3    4.84 MG
 MASS GAIN OF STAGE 4    1.60 MG
 MASS GAIN OF STAGE 5     .89 MG
 MASS GAIN OF STAGE 6     .09 MG
 MASS GAIN OF STAGE 7    -.13 MG
 MASS GAIN OF FILTER     1.36 MG

MASS GAIN OF BLANK SUBSTRATE     -.21
MASS GAIN OF BLANK FILTER          .08
```

********** RESULTS **********

TEST NUMBER: 0 RUN NUMBER: SAMPLECALC

ACTUAL FLOW RATE .501 CFM
FLOW RATE AT STANDARD CONDITIONS .328 CFM
PERCENT ISOKINETIC 87.141 %
VISCOSITY 229.8E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .72 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.020	12.604	12.728	37.270	835	23.5
2	1.019	13.116	13.240	27.707	305	19.6
3	1.043	5.764	5.887	13.162	363	24.3
4	1.092	2.711	2.833	7.9493	150	14.7
5	1.162	1.531	1.651	4.7811	190	16.3
6	1.303	.828	.945	3.9171	281	19.3
7	1.607	.432	.548	3.6866	464	22.5

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 3.12E+01 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 1.8515	3.21	9.99E-01	2.21E-01
.159	- 1.8317	3.35	1.04E+00	2.30E-01
.251	- 1.8120	3.50	1.09E+00	2.38E-01
.398	- 1.7922	3.66	1.14E+00	2.47E-01
.631	- 1.7734	3.81	1.19E+00	2.55E-01
1.000	- 1.7490	4.01	1.25E+00	5.15E-01
1.585	- 1.6543	4.90	1.53E+00	2.75E+00
2.512	- 1.4410	7.48	2.33E+00	4.52E+00
3.981	- 1.2851	9.94	3.10E+00	4.00E+00
6.310	- 1.0548	14.58	4.54E+00	1.26E+01
10.000	- .5984	27.48	8.57E+00	2.76E+01
15.850	.1641	56.52	1.76E+01	6.07E+01
25.120	1.2022	88.54	2.76E+01	3.39E+01
39.810	2.5469	99.46	3.10E+01	4.14E+00
63.100	5.4494	100.00	3.12E+01	1.18E-04
100.00	1000000	100.00	3.12E+01	0.00E+00
158.50	1000000	100.00	3.12E+01	0.00E+00
251.20	1000000	100.00	3.12E+01	0.00E+00
398.10	1000000	100.00	3.12E+01	0.00E+00
631.00	1000000	100.00	3.12E+01	0.00E+00

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: 1.25 MG/DNM3 (4.01 %)
CUM MASS LESS THAN 2.512 MICRON: 2.33 MG/DNM3 (7.48 %)
CUM MASS LESS THAN 10.000 MICRON: 8.57 MG/DNM3 (27.48 %)
CUM MASS LESS THAN 15.850 MICRON: 17.62 MG/DNM3 (56.52 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

**** RESULTS CONTINUED ****

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-1.67 + .96X
MASS MEDIAN DIAMETER: 54.943
GEOMETRIC STANDARD DEVIATION: 11.014
CORRELATION COEFFICIENT: .858

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**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********


 1)PART. DIAMETER     CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 9/10/84
 3)TIME OF TEST: 2043
 4)LOCATION OF TEST: POWER PLANT
 5)TEST NUMBER     1
 6)TEST TYPE           OUTLET
 7)RUN NUMBER: DEMO1-FILE NAME:T1RDEMO1.OT
 8)RUN REMARKS: RAW DATA STORED ON DISK
10)IMPACTOR TYPE: UW V/III DEMO
PC-3-4-5-7-9

 9)WATER VAPOR          7.80%
    CO2 12.00%         CO    .00%
    O2   8.60%         N2 79.40%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: APEIZON H ON SS


 1)GAS METER VOL      5.005 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P    -4.3 INCHES H2O
 4)STACK PRESSURE      .88 INCHES H2O
 5)BAROMETRIC PRES  30.05 INCHES HG
 6)STACK TEMP       280     DEGREES F
 7)METER TEMP        80     DEGREES F
 8)IMPACTOR TEMP    280     DEGREES F
 9)SAMPLE TIME       15.00 MINUTES
10)AVG GAS VEL       52.90 FEET/SEC
11)ORIFICE PRES        .00 INCHES HG
12)NOZZLE DIA          .188 INCHES
13)MAX PART DIA     500.0  MICRONS
14)WATER VOLUME        .0  CC
15)METER FACTOR      1.0000


 MASS GAIN OF STAGE 1   41.04 MG
 MASS GAIN OF STAGE 2   14.86 MG
 MASS GAIN OF STAGE 3    8.52 MG
 MASS GAIN OF STAGE 4    5.43 MG
 MASS GAIN OF STAGE 5    1.57 MG
 MASS GAIN OF STAGE 6     .39 MG
 MASS GAIN OF FILTER      .01 MG

MASS GAIN OF BLANK SUBSTRATE      .00
MASS GAIN OF BLANK FILTER         .00
```

********* RESULTS **********

TEST NUMBER: 1 RUN NUMBER: DEMO1

ACTUAL FLOW RATE .500 CFM
FLOW RATE AT STANDARD CONDITIONS .331 CFM
PERCENT ISOKINETIC 82.170 %
VISCOSITY 216.8E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .55 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.018	12.266	12.378	42.857	956	22.9
2	1.044	5.044	5.154	22.167	415	21.3
3	1.079	2.823	2.933	10.304	171	15.1
4	1.132	1.698	1.806	2.7430	217	18.0
5	1.249	.902	1.008	.5569	322	21.0
6	1.457	.506	.611	.0139	441	21.2

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 5.11E+02 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 8.1290	.00	0.00E+00	5.82E-12
.159	- 6.8520	.00	0.00E+00	8.30E-08
.251	- 5.5753	.00	6.48E-06	2.31E-04
.398	- 4.2987	.00	4.44E-03	1.26E-01
.631	- 3.1649	.08	3.98E-01	6.41E+00
1.000	- 2.4117	.79	4.06E+00	2.84E+01
1.585	- 1.9913	2.32	1.19E+01	6.32E+01
2.512	- 1.4117	7.90	4.03E+01	2.29E+02
3.981	- .9369	17.44	8.90E+01	2.36E+02
6.310	- .6148	26.94	1.38E+02	2.60E+02
10.000	- .3121	37.75	1.93E+02	2.90E+02
15.850	- .0298	48.81	2.49E+02	2.75E+02
25.120	.2444	59.66	3.05E+02	2.77E+02
39.810	.5369	70.43	3.60E+02	2.72E+02
63.100	.8726	80.86	4.13E+02	2.58E+02
100.00	1.3048	90.40	4.62E+02	2.23E+02
158.50	1.9733	97.58	4.98E+02	1.29E+02
251.20	3.3898	99.96	5.10E+02	7.50E+00
398.10	10.2046	100.00	5.11E+02	5.09E-19
631.00	1000000	100.00	5.11E+02	0.00E+00

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: 4.06 MG/DNM3 (.79 %)
CUM MASS LESS THAN 2.512 MICRON: 40.33 MG/DNM3 (7.90 %)
CUM MASS LESS THAN 10.000 MICRON: 192.72 MG/DNM3 (37.75 %)
CUM MASS LESS THAN 15.850 MICRON: 249.19 MG/DNM3 (48.81 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

**** RESULTS CONTINUED ****

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.59 + 2.45X
MASS MEDIAN DIAMETER: 11.392
GEOMETRIC STANDARD DEVIATION: 2.561
CORRELATION COEFFICIENT: .966

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**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********

 1)PART. DIAMETER     CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 9/10/84
 3)TIME OF TEST: 2043
 4)LOCATION OF TEST: POWER PLANT
 5)TEST NUMBER     1
 6)TEST TYPE           OUTLET
 7)RUN NUMBER: DEMO2-FILE NAME:T1RDEMO2.OT
 8)RUN REMARKS:
10)IMPACTOR TYPE: UW V/III DEMO
PC-3-4-5-7-9

 9)WATER VAPOR          7.80%
    CO2 12.00%         CO    .00%
    O2   8.60%         N2 79.40%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: APEIZON H ON SS


 1)GAS METER VOL      2.832 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P    -1.1 INCHES H2O
 4)STACK PRESSURE      .88 INCHES H2O
 5)BAROMETRIC PRES  30.05 INCHES HG
 6)STACK TEMP       280    DEGREES F
 7)METER TEMP        80    DEGREES F
 8)IMPACTOR TEMP    280    DEGREES F
 9)SAMPLE TIME       15.00 MINUTES
10)AVG GAS VEL       60.00 FEET/SEC
11)ORIFICE PRES        .00 INCHES HG
12)NOZZLE DIA          .124 INCHES
13)MAX PART DIA     500.0  MICRONS
14)WATER VOLUME        .0  CC
15)METER FACTOR       1.0000


 MASS GAIN OF STAGE 1   72.32 MG
 MASS GAIN OF STAGE 2    4.90 MG
 MASS GAIN OF STAGE 3    3.64 MG
 MASS GAIN OF STAGE 4    3.70 MG
 MASS GAIN OF STAGE 5    2.05 MG
 MASS GAIN OF STAGE 6     .41 MG
 MASS GAIN OF FILTER      .01 MG

MASS GAIN OF BLANK SUBSTRATE      .00
MASS GAIN OF BLANK FILTER          .00
```

********** RESULTS **********

TEST NUMBER: 1 RUN NUMBER: DEMO2

ACTUAL FLOW RATE .281 CFM
FLOW RATE AT STANDARD CONDITIONS .186 CFM
PERCENT ISOKINETIC 93.010 %
VISCOSITY 216.8E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .17 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.014	16.407	16.518	16.902	537	17.2
2	1.033	6.822	6.933	11.272	233	16.1
3	1.051	4.359	4.469	7.0895	96	13.1
4	1.081	2.760	2.869	2.8381	122	16.4
5	1.149	1.498	1.606	.4826	181	19.6
6	1.271	.832	.937	.0115	248	19.5

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 1.10E+03 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 9.1690	.00	0.00E+00	1.45E-15
.159	- 7.9764	.00	0.00E+00	4.01E-11
.251	- 6.7839	.00	0.00E+00	2.66E-07
.398	- 5.5916	.00	1.27E-05	4.26E-04
.631	- 4.3989	.00	6.07E-03	1.65E-01
1.000	- 3.3091	.05	5.18E-01	8.46E+00
1.585	- 2.5084	.61	6.69E+00	5.98E+01
2.512	- 1.9979	2.29	2.52E+01	1.34E+02
3.981	- 1.5459	6.11	6.73E+01	2.73E+02
6.310	- 1.2463	10.63	1.17E+02	2.12E+02
10.000	- 1.0801	14.00	1.54E+02	1.62E+02
15.850	- .9658	16.71	1.84E+02	1.44E+02
25.120	- .8330	20.24	2.23E+02	2.15E+02
39.810	- .6852	24.66	2.72E+02	2.80E+02
63.100	- .4994	30.88	3.40E+02	4.24E+02
100.00	- .2223	41.20	4.54E+02	7.63E+02
158.50	.2856	61.24	6.75E+02	1.53E+03
251.20	1.5362	93.78	1.03E+03	1.44E+03
398.10	8.1798	100.00	1.10E+03	1.32E-10
631.00	1000000	100.00	1.10E+03	0.00E+00

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: .52 MG/DNM3 (.05 %)
CUM MASS LESS THAN 2.512 MICRON: 25.20 MG/DNM3 (2.29 %)
CUM MASS LESS THAN 10.000 MICRON: 154.28 MG/DNM3 (14.00 %)
CUM MASS LESS THAN 15.850 MICRON: 184.06 MG/DNM3 (16.71 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

**** RESULTS CONTINUED ****

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-3.08 + 2.07X
MASS MEDIAN DIAMETER: 30.713
GEOMETRIC STANDARD DEVIATION: 3.036
CORRELATION COEFFICIENT: .897

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**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********


 1)PART. DIAMETER     CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 9/10/84
 3)TIME OF TEST: 2043
 4)LOCATION OF TEST: POWER PLANT
 5)TEST NUMBER     1
 6)TEST TYPE           OUTLET
 7)RUN NUMBER: DEMO3-FILE NAME:T1RDEMO3.OT
 8)RUN REMARKS:
10)IMPACTOR TYPE: UW V/III DEMO
PC-3-4-5-7-9

 9)WATER VAPOR          7.80%
    CO2 12.00%         CO    .00%
    O2   8.60%         N2 79.40%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: APEIZON H ON SS


 1)GAS METER VOL      3.597 CUBIC FEET
 2)IMPACTOR DELTA P     .00 IN. HG.
 3)ORIFICE DELTA P    -1.9 INCHES H2O
 4)STACK PRESSURE       .88 INCHES H2O
 5)BAROMETRIC PRES   30.05 INCHES HG
 6)STACK TEMP        284    DEGREES F
 7)METER TEMP         79    DEGREES F
 8)IMPACTOR TEMP     284    DEGREES F
 9)SAMPLE TIME        15.00 MINUTES
10)AVG GAS VEL        77.30 FEET/SEC
11)ORIFICE PRES         .00 INCHES HG
12)NOZZLE DIA           .125 INCHES
13)MAX PART DIA      500.0  MICRONS
14)WATER VOLUME         .0  CC
15)METER FACTOR       1.0000


 MASS GAIN OF STAGE 1   12.87 MG
 MASS GAIN OF STAGE 2    7.18 MG
 MASS GAIN OF STAGE 3    4.71 MG
 MASS GAIN OF STAGE 4    3.53 MG
 MASS GAIN OF STAGE 5    1.75 MG
 MASS GAIN OF STAGE 6     .29 MG
 MASS GAIN OF FILTER       .01 MG

MASS GAIN OF BLANK SUBSTRATE      .00
MASS GAIN OF BLANK FILTER         .00
```

********** RESULTS **********

TEST NUMBER: 1 RUN NUMBER: DEM03

ACTUAL FLOW RATE .360 CFM
FLOW RATE AT STANDARD CONDITIONS .237 CFM
PERCENT ISOKINETIC 91.064 %
VISCOSITY 217.7E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .28 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.015	14.507	14.619	57.581	682	19.5
2	1.037	5.998	6.110	33.916	296	18.2
3	1.062	3.603	3.714	18.392	122	13.9
4	1.101	2.235	2.345	6.7568	155	17.0
5	1.187	1.203	1.311	.9888	230	20.1
6	1.340	.671	.777	.0330	314	20.1

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 3.01E+02 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 7.8130	.00	0.00E+00	3.56E-11
.159	- 6.7466	.00	0.00E+00	8.37E-08
.251	- 5.6805	.00	2.07E-06	6.31E-05
.398	- 4.6144	.00	6.03E-04	1.52E-02
.631	- 3.5480	.02	5.89E-02	1.18E+00
1.000	- 2.6450	.41	1.23E+00	1.50E+01
1.585	- 1.9329	2.66	8.02E+00	5.69E+01
2.512	- 1.3449	8.93	2.69E+01	1.44E+02
3.981	- .7916	21.43	6.46E+01	2.13E+02
6.310	- .3738	35.43	1.07E+02	2.04E+02
10.000	- .0449	48.21	1.45E+02	1.81E+02
15.850	.2182	58.64	1.77E+02	8.35E+01
25.120	.3632	64.18	1.93E+02	8.43E+01
39.810	.5236	69.97	2.11E+02	9.16E+01
63.100	.7244	76.56	2.31E+02	1.09E+02
100.00	1.0190	84.59	2.55E+02	1.34E+02
158.50	1.5468	93.90	2.83E+02	1.36E+02
251.20	2.8199	99.76	3.01E+02	2.43E+01
398.10	9.4883	100.00	3.01E+02	3.44E-16
631.00	1000000	100.00	3.01E+02	0.00E+00

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: 1.23 MG/DNM3 (.41 %)
CUM MASS LESS THAN 2.512 MICRON: 26.91 MG/DNM3 (8.93 %)
CUM MASS LESS THAN 10.000 MICRON: 145.23 MG/DNM3 (48.21 %)
CUM MASS LESS THAN 15.850 MICRON: 176.65 MG/DNM3 (58.64 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

**** RESULTS CONTINUED ****

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.62 + 2.68X
MASS MEDIAN DIAMETER: 9.504
GEOMETRIC STANDARD DEVIATION: 2.359
CORRELATION COEFFICIENT: .965

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**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********


 1)PART. DIAMETER    CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 9/10/84
 3)TIME OF TEST: 2043
 4)LOCATION OF TEST: POWER PLANT
 5)TEST NUMBER    1
 6)TEST TYPE          INLET
 7)RUN NUMBER: DEMO1-FILE NAME:T1RDEMO1.IT
 8)RUN REMARKS:
10)IMPACTOR TYPE: UW V/III DEMO
PC-3-4-5-7-9

 9)WATER VAPOR          7.80%
    CO2 12.00%         CO    .00%
    O2   8.60%         N2 79.40%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: APEIZON H ON SS


 1)GAS METER VOL      1.001 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P    -4.3 INCHES H2O
 4)STACK PRESSURE      .88 INCHES H2O
 5)BAROMETRIC PRES  30.05 INCHES HG
 6)STACK TEMP       280    DEGREES F
 7)METER TEMP        80    DEGREES F
 8)IMPACTOR TEMP    280    DEGREES F
 9)SAMPLE TIME        3.00 MINUTES
10)AVG GAS VEL       52.90 FEET/SEC
11)ORIFICE PRES       .00 INCHES HG
12)NOZZLE DIA         .188 INCHES
13)MAX PART DIA    1000.0  MICRONS
14)WATER VOLUME       .0  CC
15)METER FACTOR      1.0000


 MASS GAIN OF STAGE 1   92.70 MG
 MASS GAIN OF STAGE 2   14.26 MG
 MASS GAIN OF STAGE 3    8.89 MG
 MASS GAIN OF STAGE 4    4.63 MG
 MASS GAIN OF STAGE 5    1.57 MG
 MASS GAIN OF STAGE 6     .39 MG
 MASS GAIN OF FILTER      .08 MG

MASS GAIN OF BLANK SUBSTRATE      .00
MASS GAIN OF BLANK FILTER         .00
```

********* RESULTS **********

TEST NUMBER: 1 RUN NUMBER: DEMO1

ACTUAL FLOW RATE .500 CFM
FLOW RATE AT STANDARD CONDITIONS .331 CFM
PERCENT ISOKINETIC 82.170 %
VISCOSITY 216.8E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .55 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.018	12.266	12.378	24.339	956	22.9
2	1.044	5.044	5.154	12.700	415	21.3
3	1.079	2.823	2.933	5.4440	171	15.1
4	1.132	1.698	1.806	1.6650	217	18.0
5	1.249	.902	1.008	.3836	322	21.0
6	1.457	.506	.611	.0653	441	21.2

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 4.35E+03 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 4.9050	.00	2.07E-03	2.49E-02
.159	- 4.4248	.00	2.13E-02	2.34E-01
.251	- 3.9447	.00	1.76E-01	1.74E+00
.398	- 3.4646	.03	1.16E+00	1.03E+01
.631	- 2.9972	.14	5.95E+00	4.36E+01
1.000	- 2.5793	.50	2.16E+01	1.19E+02
1.585	- 2.1933	1.42	6.16E+01	3.31E+02
2.512	- 1.7219	4.25	1.85E+02	9.45E+02
3.981	- 1.3061	9.57	4.17E+02	1.30E+03
6.310	- 1.0082	15.67	6.82E+02	1.32E+03
10.000	- .7842	21.65	9.43E+02	1.30E+03
15.850	- .6729	25.05	1.09E+03	2.80E+02
25.120	- .6304	26.42	1.15E+03	3.23E+02
39.810	- .5795	28.11	1.22E+03	4.25E+02
63.100	- .5104	30.49	1.33E+03	6.35E+02
100.00	- .4050	34.27	1.49E+03	1.06E+03
158.50	- .2278	40.99	1.78E+03	1.98E+03
251.20	.1046	54.17	2.36E+03	4.02E+03
398.10	.8421	80.01	3.48E+03	7.00E+03
631.00	3.2357	99.94	4.35E+03	2.26E+02

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: 21.60 MG/DNM3 (.50 %)
CUM MASS LESS THAN 2.512 MICRON: 185.25 MG/DNM3 (4.25 %)
CUM MASS LESS THAN 10.000 MICRON: 942.57 MG/DNM3 (21.65 %)
CUM MASS LESS THAN 15.850 MICRON: 1090.9 MG/DNM3 (25.05 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

**** RESULTS CONTINUED ****

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.57 + 1.87X
MASS MEDIAN DIAMETER: 23.827
GEOMETRIC STANDARD DEVIATION: 3.432
CORRELATION COEFFICIENT: .986

STATIS and SYNTRAV

STATIS and SYNTRAV are programs for combining data from multiple runs. STATIS provides results by forming simple averages of the data from the selected runs, while SYNTRAV provides velocity weighted averages. If the runs to be combined were taken at different locations in a duct in which the velocity distribution was badly skewed or non-uniform, the averaging should be done using SYNTRAV as the velocity weighted average will more nearly represent the true average emissions. SYNTRAV is intended to be used to combine results from several partial traverses of the duct to form one full traverse. Each partial traverse is expected to cover a defined portion of the duct with no overlap among them. Both programs will provide corrections for errors resulting from anisokinetic sampling to be made by particle size if the user so desires. A maximum of 20 runs can be averaged by the programs as they re currently dimensioned.

The programs actually average only the differential form of the distributions. The values of dM/dLogD for the standardized set of diameters generated and stored on disk by MPPROG are picked up from the data disk for averaging as the runs are selected. If three or more runs are being averaged, outliers can be identified and removed from the averaging process at the user's option. Average cumulative forms of the distribution are generated by integrating the average differential distribution. The average distribution in the cumulative concentration form is obtained directly by the integration. The average distribution in the cumulative percent by mass form is obtained by normalizing the average cumulative concentration form. By constructing the averaged cumulative forms of the distribution in this way the effect of errors in the original data for single stages can be removed from the results if outliers are removed without discarding data from other valid stages. If the cumulative distributions were averaged directly, an error at any one stage of a run would propagate forward through the remainder of the distribution if the erroneous data were not dropped. But if outlier analysis were used, it might then result in the loss of valid data from other stages. If three or more runs are averaged, the program also provides 90% confidence limits for the results.

Program Operation

At startup, the user is asked if correction for anisokinetic sampling is desired. If so, the values of dM/dLogD will be corrected for each selected run as it is read into memory.

The runs to be averaged are selected by specifying the test type (Inlet or Outlet), the test number, and the run designations. Mixing of test types is not permitted. It is anticipated that a single test number will be used to identify a major test program or series of tests, consequently all the runs to be averaged will probably share a common test number and only the run identifiers will be different. If this is the case, once the test number is entered and the type is specified, only the run identifier must be specified to read it into memory. Runs with different test numbers can be averaged however.

The data entry options and program operation are controlled by entering a number, 1, 2, or 3, the letter "C", or the letter "Q". These result in the following actions:

1) Toggle the test type between Inlet and Outlet

2) Selects entry of the Test Number

3) Select entry of the next run to be used by entry of the run identifier (the characters between the "R" and the ".IT" or ".0T" in the run file name).

C) Display the contents of the index file for the reduced runs stored on the disk.

Q) Quit the selection process and proceed with the averaging.

Each time a run is selected the Test Number, Run identifier, and Test Type are combined to form the run (result) file name. This name is checked against the index file and if the name is valid, the file is read. As the file is read, the diameters at which the spline interpolations were made in MPPROG are checked to be certain that they are consistent from run to run, and the diameter basis on which the fits were made are checked for consistency. If a run is selected for which either the diameters or diameter basis is not the same as that of the first run entered, it is rejected for inclusion in the average and a message to that effect is written on the screen. If corrections for anisokinetic sampling is desired, a run will be rejected for which the gas velocity and/or nozzle diameter was omitted in the MPPROG data entry. A message to this effect will be given in such a case. Once a run is read into memory and accepted, a counter for the sequence number of the next run to entered, if any, will be advanced and a new prompt line for input option "3" will be added.

If the sampling areas covered by the runs being combined in SYNTRAV were not equal, the user will be asked to enter appropriate value after the data for each run has been read from disk and validated. The value entered may be the actual area spanned by the run or the fraction of the total duct are represented by the run, but must be consistent for all runs in the set.

After all runs to be averaged have been selected and "Q" is entered, the user will be asked if outliers are to be dropped. Once this question is answered the calculations will proceed. Upon completion of the calculations the results will be displayed on the screen. A value of 3.0 E+33 is used for the confidence interval as a flag if insufficient runs were averaged for a meaningful confidence interval to be calculated. Following the screen display the user will be given prompts regarding whether printed copy and saving the results to disk are desired. If the results are to be saved to disk, a prompt for a file name will be given. No index file is maintained for these file names. If plots of the averaged results are desired or if they are to be used for calculating fractional efficiencies, they must be saved on the disk.

Program Description

Initialization is done in lines 6 through 35 and in a subroutine from line 1000 through 1399. The index file of the reduced data stored on the disk is read during this initialization.

Selection of the input options is made through a subroutine from line 1400 through 1450 from the major input routine 2000 through 2179. The index file is displayed by a subroutine from line 1460 through 1510. The run file name is constructed and checked in lines 2175 through 2180. Data files are read in lines 3000 through 3048. Checks for file consistency are done in lines 3049 through 3078.

The values of dM/dLogD are reconstructed from the file information and corrections for anisokinetic sampling are made in lines 3125 through 3150. The Corrections for anisokinetic sampling are made using an equation developed by Beleyev and Levin (19).

The actual averaging process takes place in a subroutine which begins at line 4000 and ends at line 4400. Values for Students t-table at the 90% confidence limit are set up for 2 through 9 samples in lines 4040 through 4110. These are used in the outlier tests and in calculating the 90% confidence limits for the results. The t-table value for an infinite number of samples is used if 10 or more runs are being averaged. The averaging takes place in lines 4130 through 4235. Outlier tests are performed in lines 4240 through 4275. The outlier tests are performed as described in Appendix F of EPA Publication 600/9-76-005 (Quality Assurance Handbook for Air Pollution Measurement Systems. Volume I - Principles). The integration for calculation of the average cumulative concentration is done in lines 4381 through 4388. The values of the cumulative concentrations smaller than the first standard particle diameter from the MPPROG data files are averaged and used as a constant of integration.

The screen display of the results is done by a subroutine from line 5000 through line 5110. Printed output is done in lines 6000 through 6400, and the disk save is done in lines 7000 through 7100.

A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in an irrecoverable loss of the program. The subroutine is copyrighted and permission has been granted by the copyright owner for its use here.

Description of Variables

A - menu selection dummy
AV - duct velocity for last run read from disk
B - intermediate value in anisokinetic correction
BA - constant in anisokinetic error correction
BB - constant in anisokinetic error correction
BU - print formatter address
C(- confidence intervals
C1-C3 - constants used in conversions from probabiliby scale
CI(- confidence intervals

CK - error flag
CP(- average cumulative percent
D$ - DOS command flag
DO - intermediate value used in probability scale conversion
DB$ - diameter basis for spline fit
DG(- dM/dLogD
DT$ - run date
F$(- print format statements
F0$-F3$ - print format statements
FA$ - print format statement
FB$ - print format statement
FL - flag used in probability scale conversion
FM$ - print format statement
FM$(- print format statements
FP$ - print format statement
I - loop index
I$ - input file type designation
IC$ - flag for anisokinetic correction
I0$ - run type
IS - percent isokinetic
J - loop index
K - loop index
KF - constant in anisokinetic correction
L$ - sampling location
M(- average dM/dLogD's
MX - index counter for run input
N - number of runs selected
ND - nozzle diameter
NI - index number of next run to be input
NM$ - run data file name
NN - Number of points retained in average
NP - number of particle diameters in standard set
NR - number of run data files on disk
OK - error flag
OL$ - do outlier flag
R - isokinetic ratio
R$ - dummy for printing
RH - particle density
RN$ - run designation
RR$ - run remarks
RT - intermediate value in anisokinetic correction
S - number of stages in impactor
S(- standard deviations
SS - sum of squares of deviations
SX - sum of dM/dLogD's
T$ - run time
TC - total concentration
TC(- t-table values at 90% confidence level
TN - test number
U - gas viscosity
VE(- flue gas velocity
VS - dummy used in averaging

X - input dummy
X(- standardized diameter array
X1-X3 - used in conversion from probability scale
XP(- particle diameters
Y(- particle concentrations
YY(- cumulative percent in probability units
Z - dummy for outlier test
ZZ - dummy for outlier test
ZZ$ - diameter basis

****** RESULTS OF STATIS(TICS) WITH ISOKINETIC CORRECTIONS ******

RESULTS OF AVERAGES FOR RUNS :

T1RDEM01.OT
T1RDEM02.OT
T1RDEM03.OT

CLASS. AERO DIA.

DIA. MICRON	DM/DLOGD MG/DNM3	STD DEV	90% CON INT	CUM LOAD. MG/DNM3	90% CON INT	CUM%
.10	1.38E-11	1.91E-11	3.22E-11	0.00E+00	0.00E+00	.00
.16	5.56E-08	4.81E-08	8.11E-08	7.41E-09	8.11E-09	.00
.25	9.82E-05	1.19E-04	2.01E-04	6.56E-06	2.01E-05	.00
.40	4.73E-02	6.87E-02	1.16E-01	6.32E-03	1.16E-02	.00
.63	2.58E+00	3.35E+00	5.64E+00	1.85E-01	5.64E-01	.03
1.00	1.72E+01	1.01E+01	1.71E+01	2.65E+00	1.89E+00	.44
1.59	5.94E+01	3.13E+00	5.27E+00	8.91E+00	2.60E+00	1.49
2.51	1.65E+02	5.01E+01	8.44E+01	3.49E+01	8.85E+00	5.83
3.98	2.31E+02	3.13E+01	5.27E+01	7.23E+01	1.33E+01	12.08
6.31	2.10E+02	2.31E+01	3.89E+01	1.16E+02	1.48E+01	19.33
10.00	1.91E+02	5.38E+01	9.06E+01	1.56E+02	1.78E+01	26.14
15.85	1.48E+02	7.87E+01	1.33E+02	1.89E+02	2.40E+01	31.56
25.12	1.69E+02	8.14E+01	1.37E+02	2.20E+02	3.07E+01	36.74
39.81	1.90E+02	9.36E+01	1.58E+02	2.57E+02	3.71E+01	42.85
63.10	2.35E+02	1.49E+02	2.51E+02	2.98E+02	4.75E+01	49.69
100.00	3.39E+02	3.23E+02	5.45E+02	3.58E+02	7.65E+01	59.85
158.50	5.51E+02	7.56E+02	1.27E+03	4.40E+02	1.58E+02	73.53
251.20	4.57E+02	7.66E+02	1.29E+03	5.38E+02	2.41E+02	89.83
398.10	4.09E-11	7.08E-11	1.19E-10	5.99E+02	2.73E+02	100.0
631.00	0.00E+00	0.00E+00	0.00E+00	5.99E+02	2.73E+02	100.0
FOR TOTAL MASS:						
9999.0	6.38E+02	4.15E+02	7.00E+02			

******* VELOCITY WEIGHTED AVERAGES *******

RESULTS OF AVERAGES FOR RUNS :

T1RDEM01.0T
T1RDEM02.0T
T1RDEM03.0T

CLASS. AERO DIA.

DIA. MICRON	DM/DLOGD MG/DNM3	STD DEV	90% CON INT	CUM LOAD. MG/DNM3	90% CON INT	CUM%
.10	1.61E-11	2.38E-11	4.01E-11	0.00E+00	0.00E+00	.00
.16	5.71E-08	5.21E-08	8.78E-08	7.62E-09	8.78E-09	.00
.25	9.00E-05	9.70E-05	1.64E-04	6.02E-06	1.64E-05	.00
.40	4.14E-02	5.61E-02	9.45E-02	5.54E-03	9.45E-03	.00
.63	2.31E+00	2.70E+00	4.55E+00	1.65E-01	4.55E-01	.03
1.00	1.66E+01	7.94E+00	1.34E+01	2.53E+00	1.48E+00	.44
1.59	5.90E+01	8.55E+00	1.44E+01	8.68E+00	2.46E+00	1.51
2.51	1.61E+02	3.17E+01	5.35E+01	3.41E+01	6.06E+00	5.93
3.98	2.29E+02	3.67E+01	6.19E+01	7.08E+01	1.02E+01	12.32
6.31	2.07E+02	2.26E+01	3.82E+01	1.14E+02	1.25E+01	19.79
10.00	1.87E+02	3.64E+01	6.14E+01	1.54E+02	1.45E+01	26.77
15.85	1.38E+02	5.11E+01	8.61E+01	1.85E+02	1.79E+01	32.14
25.12	1.59E+02	5.62E+01	9.47E+01	2.14E+02	2.20E+01	37.19
39.81	1.79E+02	7.28E+01	1.23E+02	2.48E+02	2.69E+01	43.18
63.10	2.24E+02	1.33E+02	2.24E+02	2.87E+02	3.71E+01	49.92
100.00	3.25E+02	3.01E+02	5.07E+02	3.45E+02	6.67E+01	60.05
158.50	5.29E+02	7.10E+02	1.20E+03	4.24E+02	1.46E+02	73.73
251.20	4.34E+02	7.24E+02	1.22E+03	5.17E+02	2.25E+02	89.93
398.10	3.87E-11	6.70E-11	1.13E-10	5.75E+02	2.56E+02	100.0
631.00	0.00E+00	0.00E+00	0.00E+00	5.75E+02	2.56E+02	100.0

FOR TOTAL MASS:

9999.0	6.12E+02	3.74E+02	6.31E+02			

SYNTRAV provides a means of combining data from several partial traverses of a duct to synthesize a complete traverse. However, if several of these synthesized traverses are to be averaged, neither STATIS nor SYNTRAV can do the job because they are set up to work from files produced by MPPROG. This program, COMBO, provides the capability of averaging synthetic traverses from SYNTRAV (or STATIS) in the same manner that STATIS provides for single runs. The program reads files produced by SYNTRAV, averages the values of dm/DLogD and integrates the averaged dM/dLogD's to provide the averaged cumulative forms of the distribution. Mixing of sets having different diameter bases is not allowed nor is mixing of inlet and outlet sets. Outliers can be removed at the user's discretion. The output is available in hardcopy and can be saved to disk for plotting by STATPLOT and use in calculating fractional efficiencies by EFFICIENCY. The user inputs are selection of set type (Inlet or Outlet) and the SYNTRAV file names for the sets to be averaged.

Program and Variable Descriptions

SYNTRAV is simply a modified version of STATIS which has been set up to obtain its input from files like those generated by STATIS rather than MPPROG. For detailed descriptions refer to the documentation for STATIS.

**** AVERAGES OF SYNTEHESIZED TRAVERSES ****

RESULTS OF AVERAGES FOR RUNS :

STATIS DEMO WITH ISO CORR
EMFACT DEMO WITH ISO CORR
STATIS DEMO WITH ISO CORR
EMFACT DEMO WITH ISO CORR

CLASS. AERO DIA.

DIA. MICRON	DM/DLOGD MG/DNM3	STD DEV	90% CON INT	CUM LOAD. MG/DNM3	90% CON INT	CUM%
.10	1.49E-11	1.32E-12	2.21E-12	0.00E+00	0.00E+00	.00
.16	5.63E-08	8.87E-10	1.49E-09	7.51E-09	1.49E-10	.00
.25	9.41E-05	4.71E-06	7.90E-06	6.29E-06	7.90E-07	.00
.40	4.44E-02	3.38E-03	5.67E-03	5.93E-03	5.67E-04	.00
.63	2.45E+00	1.56E-01	2.61E-01	1.75E-01	2.61E-02	.03
1.00	1.69E+01	3.60E-01	6.03E-01	2.59E+00	7.07E-02	.44
1.59	5.92E+01	2.32E-01	3.90E-01	8.79E+00	1.01E-01	1.50
2.51	1.63E+02	2.54E+00	4.25E+00	3.45E+01	4.39E-01	5.83
3.98	2.30E+02	1.24E+00	2.09E+00	7.16E+01	6.46E-01	12.20
6.31	2.09E+02	1.54E+00	2.57E+00	1.15E+02	7.26E-01	19.55
10.00	1.89E+02	2.55E+00	4.28E+00	1.55E+02	8.81E-01	26.45
15.85	1.43E+02	5.57E+00	9.33E+00	1.87E+02	1.35E+00	31.84
25.12	1.64E+02	6.17E+00	1.03E+01	2.17E+02	1.94E+00	36.96
39.81	1.84E+02	6.32E+00	1.06E+01	2.52E+02	2.44E+00	43.01
63.10	2.30E+02	6.68E+00	1.12E+01	2.92E+02	2.89E+00	49.81
100.00	3.32E+02	8.03E+00	1.35E+01	3.52E+02	3.38E+00	59.95
158.50	5.40E+02	1.29E+01	2.16E+01	4.32E+02	4.23E+00	73.63
251.20	4.45E+02	1.31E+01	2.20E+01	5.27E+02	5.23E+00	89.88
398.10	3.98E-11	1.27E-12	2.12E-12	5.87E+02	5.67E+00	100.0
631.00	0.00E+00	0.00E+00	0.00E+00	5.87E+02	5.67E+00	100.0

FOR TOTAL MASS: (UNCORRECTED)

9999.0	6.25E+02	1.49E+01	2.50E+01

EFFICIENCY

EFFICIENCY is a program for calculating the fractional efficiencies of control devices from cascade impactor data. The data from which the efficiencies are to be calculated may represent information from single impactor runs or from combined runs for either, or both, the inlet and outlet data sets. Efficiencies are calculated for each of the diameters in the standardized array used in MPPROG. If the inlet and outlet data sets represent averages, confidence intervals at the 90% level will be calculated as well. The results will be displayed on the screen and, at the user's option can be printed and/or saved to disk for plotting.

Program Operation

When run, the user will first be prompted for the source of the inlet data - a single run file from MPPROG or data for combined runs from STATIS (or SYNTRAV). If data from MPPROG is selected, a listing of the available MPPROG files will be printed on the screen and the user will be prompted to enter the test number and run designation of the desired file. The file name will be displayed for verification and, if accepted, the data will be read into memory. If data from STATIS or SYNTRAV is selected, a catalog of the data disk will be displayed after which the user will be prompted to enter the name of the correct file. Again the user will be asked to verify the file name, after which the data will be read into memory. After the inlet data has been gathered from disk, the same sequence of steps will be followed to load the desired outlet data.

After both sets of data have been loaded, a check will be made to verify that both files are on the same diameter basis. If so, the efficiencies will be calculated and displayed. The display will include the fractional efficiency for each diameter in the standardized set and the overall total efficiency based on the inlet and outlet total concentration. The user will then be given prompts regarding the desirability of printed output and saving the results to disk. Finally, a choice of doing another set of efficiencies or returning to the MAIN MENU will be offered.

Program Description

Program initialization is done in a subroutine from lines 1000 through 1999. Selection of the source of the data files is made in a subroutine from lines 10000 through 10050. MPPROG files are listed and read in a subroutine from line 2200 through 2500. STATIS/SYNTRAV files are read in a subroutine from line 3000 through 3100. The calculations are done in lines 4000 through 4035 and displayed on the screen in lines 4040 through 4999. Hardcopy is printed by a subroutine in lines 7000 through 7999 and saving the results to disk is done in a subroutine in lines 6000 through 6999.

A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in an irrecoverable loss of the program. The subroutine is copyrighted and permission has been granted by the copyright owner for its use here.

Description of Variables

BU - address of print formatter
CF - flag for calculating confidence limits
CI(- confidence intervals
CK - flag for reading index file
D$ - DOS command flag
DB$ - diameter basis
DI$ - name of file to be read
DT$ - run date
F$ - format statement
F$(- format statements
I - loop index
I$ - file source flag
IB$ - inlet diameter basis
ID$ - inlet file name
IN - inlet/outlet flag
L$ - run location
M(- dM/dLogD's
NM$ - results file name
NP - number of particle diameters
NR - number of runs in index file
OD$ - outlet file name
R$ - print dummy
RN$ - run designation
RN$ - names of files in run index
RR$ - run remarks
S - input dummy
T$ - type of data to select
TC(- total concentrations
TN - test number
TT$ - input dummy
XP(- particle diameter array

OUTLET DATA FROM EMFACT DEMO WITH ISO CORR
INLET DATA FROM T1RDEMO1.IT

OVERALL EFFICIENCY =8.6E+01

DIA.	%PENE.	CI(%P)	%EFF
.10	6.5E-08	0.0E+00	1.0E+02
.16	2.4E-05	0.0E+00	1.0E+02
.25	5.2E-03	0.0E+00	1.0E+02
.40	4.0E-01	0.0E+00	1.0E+02
.63	5.3E+00	0.0E+00	9.5E+01
1.00	1.4E+01	0.0E+00	8.6E+01
1.59	1.8E+01	0.0E+00	8.2E+01
2.51	1.7E+01	0.0E+00	8.3E+01
3.98	1.8E+01	0.0E+00	8.2E+01
6.31	1.6E+01	0.0E+00	8.4E+01
10.00	1.4E+01	0.0E+00	8.6E+01
15.85	4.9E+01	0.0E+00	5.1E+01
25.12	4.9E+01	0.0E+00	5.1E+01
39.81	4.2E+01	0.0E+00	5.8E+01
63.10	3.5E+01	0.0E+00	6.5E+01
100.0	3.1E+01	0.0E+00	6.9E+01
158.5	2.7E+01	0.0E+00	7.3E+01
251.2	1.1E+01	0.0E+00	8.9E+01
398.1	5.5E-13	0.0E+00	1.0E+02
631.0	0.0E+00	0.0E+00	1.0E+02

DATAPLOT

DATAPLOT performs two functions. First it loads the binary program "AMPERGRAPH" and then prompts the user to select the source of the information to be plotted. Upon selecting the source, the program loads the appropriate BASIC program to deal with the actual plotting. The selection of the source is made by entering one of the following:

R - plot data from MPPROG (single run data, run PLOT3)

S - plot combined run data from STATIS, SYNTRAV, OR COMBO (run STATPLOT)

E - plot data from EFFICIENCY (run EFF/PLOT)

There are no user modifiable variables in the program.

PLOT3 and STATPLOT

PLOT 3 and STATPLOT are programs for plotting size distribution results. PLOT3 plots single run data from files generated by MPPROG, while STATPLOT plots combined run results from STATIS, SYNTRAV or COMBO. The programs produce plots of the size distribution in three forms as follows:

1) Cumulative percentage - Done in a Log-Probability format with particle diameters on a logrithmic scale as the abcissa and cumulative percentage on a probability scale as the ordinate. The probability axis is marked with ticks at identified percentages. Both the original distribution and the results of the spline fit will be plotted if the files were generated by MPPROG.

2) Differential distribution - Done in a log-Log format with particle diameters as the abcissa and dM/dLogD as the ordinate. The range of the vertical axis is selectable by the user. Only the results of the spline fit are plotted if the data are from MPPROG. Error bars representing 90% confidence limits are added if the data are from STATIS or SYNTRAV.

3) Cumulative mass concentration - Done in a Log-Log format with particle diameter as the abcissa and cumulative mass concentration as the ordinate. The range of the vertical axis is selectable by the user. Both the original distribution and the results of the spline fit will be plotted if the data are from MPPROG. Error bars representing 90% confidence limits will be added if the data are from STATIS OR SYNTRAV.

The range of the particle size axis is fixed in the program as 0.1um to 100um but can be altered by editing the program ("0.1,100" in lines 100, 275, and 410 in PLOT3; lines 100, 275, and 405 in STATPLOT). The limits must be integral powers of ten. The actual plotting is done by "AMPERGRAPH", a set of machine language routines which must have been loaded before PLOT3 or STATPLOT is run. If these programs have been run from DATAPLOT, AMPERGRAPH will have been loaded.

Provision is made for obtaining hardcopies of the plots on compatible dot-matrix printers. The printer interface must be in Slot 1 of the Apple, and must be an Orange Micro "Grappler" card, a Prometheus "Grafitti" card, or a similar "smart" interface card that provides onboard graphics dump software and uses the same commands as do the "Grappler" and "Grafitti" cards. The program can also be modified by the user to make use of a user supplied graphics dump routine.

HIMEM is reset to protect the graphics display area and the AMPERGRAPH routines. When the user has completed all plotting HIMEM should be restored to its normal value or there may not be enough space for long programs or programs which require large variable space to run. Normally this is 38400 for Apple DOS 3.3, but it can be different if a variant of the standard DOS 3.3 is used. Entering "HIMEM:38400" from BASIC will do the reset. This is done by the program if it makes a normal exit, but must be done by the user if the program crashes or its operation is halted prematurely by the user. In the event of a crash due to an input error, etc. the program can be re-started by typing "TEXT", pressing Return, then typing "RUN" and pressing Return.

Program Operation

When run, the program first displays the contents of the reduced run index file on the screen if single run data is being plotted. A catalog of the disk will be displayed if the data is to come from STATPLOT or SYNTRAV files. The user is then prompted to enter the name of the file from which the data is to be plotted.

The following sequence is done if the data to be plotted are from MPPROG:

After the file is read, the Cumulative Percentage plot will be drawn and held on the screen for a short period of time after which the user will be asked if hardcopy is desired. If so, the screen dump will be done.

Next, the minimum and maximum values of dM/dLogD will be printed on the screen and the user will be asked to enter the desired minimum and maximum values for the vertical axis. THESE VALUES MUST BE INTEGRAL POWERS OF TEN. The differential distribution will then be plotted and again the user will be asked if hardcopy is desired.

Upon completion of the differential distribution, the minimum and maximum values of the cumulative concentrations will be displayed and the user will be asked to enter the desired minimum and maximum values to be plotted. AGAIN, THESE VALUES MUST BE INTEGRAL POWERS OF TEN. And once more, the data will be plotted and the user will be asked about hardcopy.

The order in which the plots are done changes to the sequence: Cumulative Concentration, dM/dLogD, and Cumulative Percentage, if combined run results are being plotted.

The program exits to BASIC when the cumulative concentration curve is completed. If more runs are to be plotted, simply type "RUN" and press Return. If another program in the system is to be run, type "RUN MAIN MENU" and press Return.

Program Descriptions

PLOT3

Initialization takes place in lines 5 through 16. The run index file is read in line 17 and the file names in the index are displayed in line 10. The file name to be read is entered in line 19, and the file is read into memory in lines 20 through 80. The plotting grid for the cumulative percent plot is drawn in lines 100 through 140 and the vertical axis is labeled in lines 141 through 151. The file name is printed in the upper left portion of the plotting grid in line 154. The spline fit results for the cumulative percentage curve are plotted in lines 159 through 170. The raw data for cumulative fractions of the total concentration are converted by a subroutine in lines 5580 through 5700 at line 171, and the original size distribution is plotted in lines 172 through 177. A FOR/NEXT loop is used in line 178 to set the duration for which the screen display is held. Hardcopy is taken care of in lines 179 through 190.

The minimum and maximum values of dM/dLogD are found in lines 210 through 240 and displayed in lines 250 and 260. The user enters the vertical plot limits in line 270. The differential distribution is plotted in lines 271 through 340. Hardcopy is provided for in lines 341 through 346.

The minimum and maximum cumulative concentrations are found in lines 370 and 380, and the user enters the selected values for the plot limits at line 390. The plotting grid is drawn and labeled in lines 400 through 480. The results of the spline fit are plotted in lines 510 through 540, and the original data are plotted in lines 550 through 570. Hardcopy is provided for in lines 590 through 630. Lines 8988 through 9950 provide transforms from probability units to linear percent.

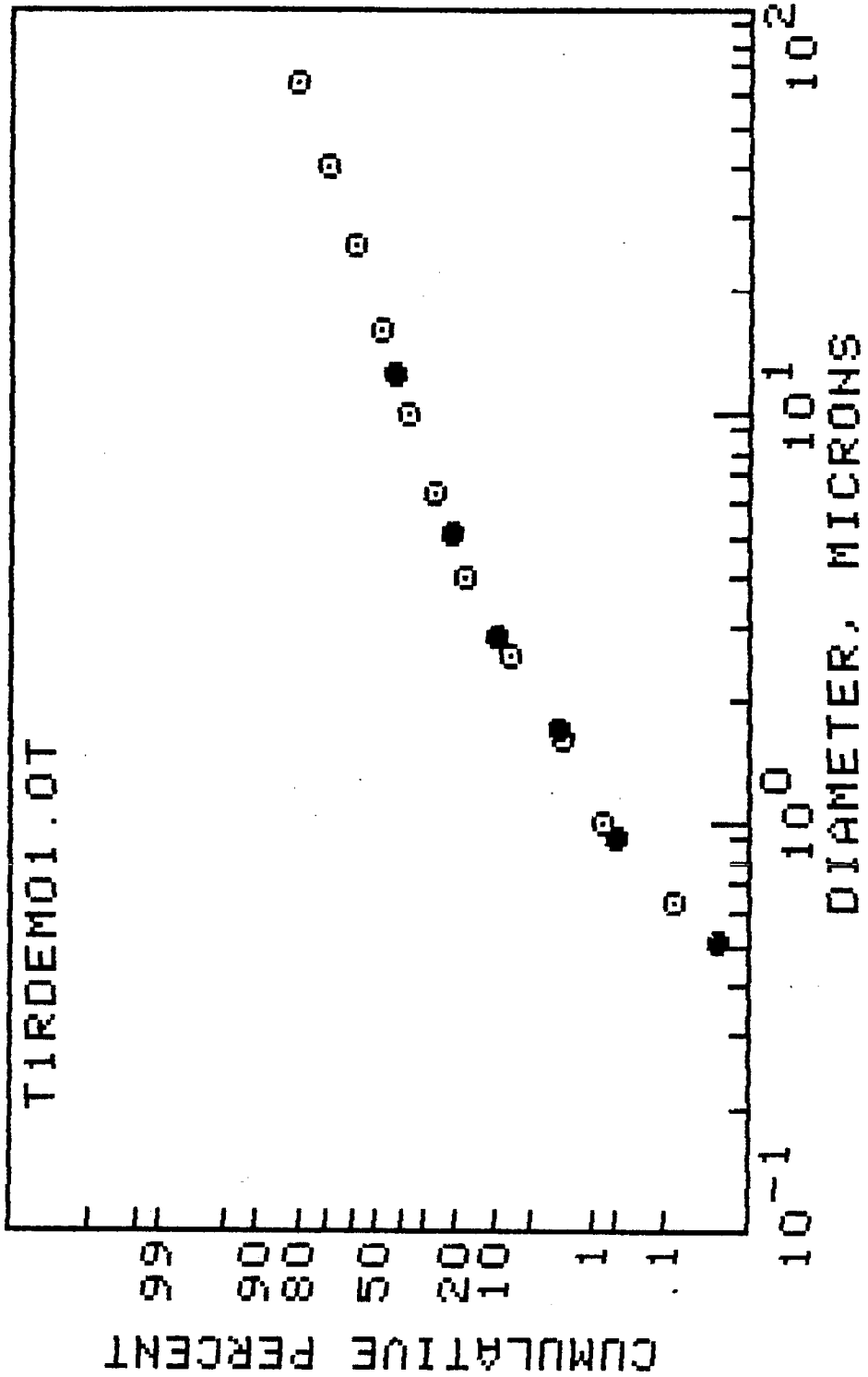
Description of Variables in PLOT3

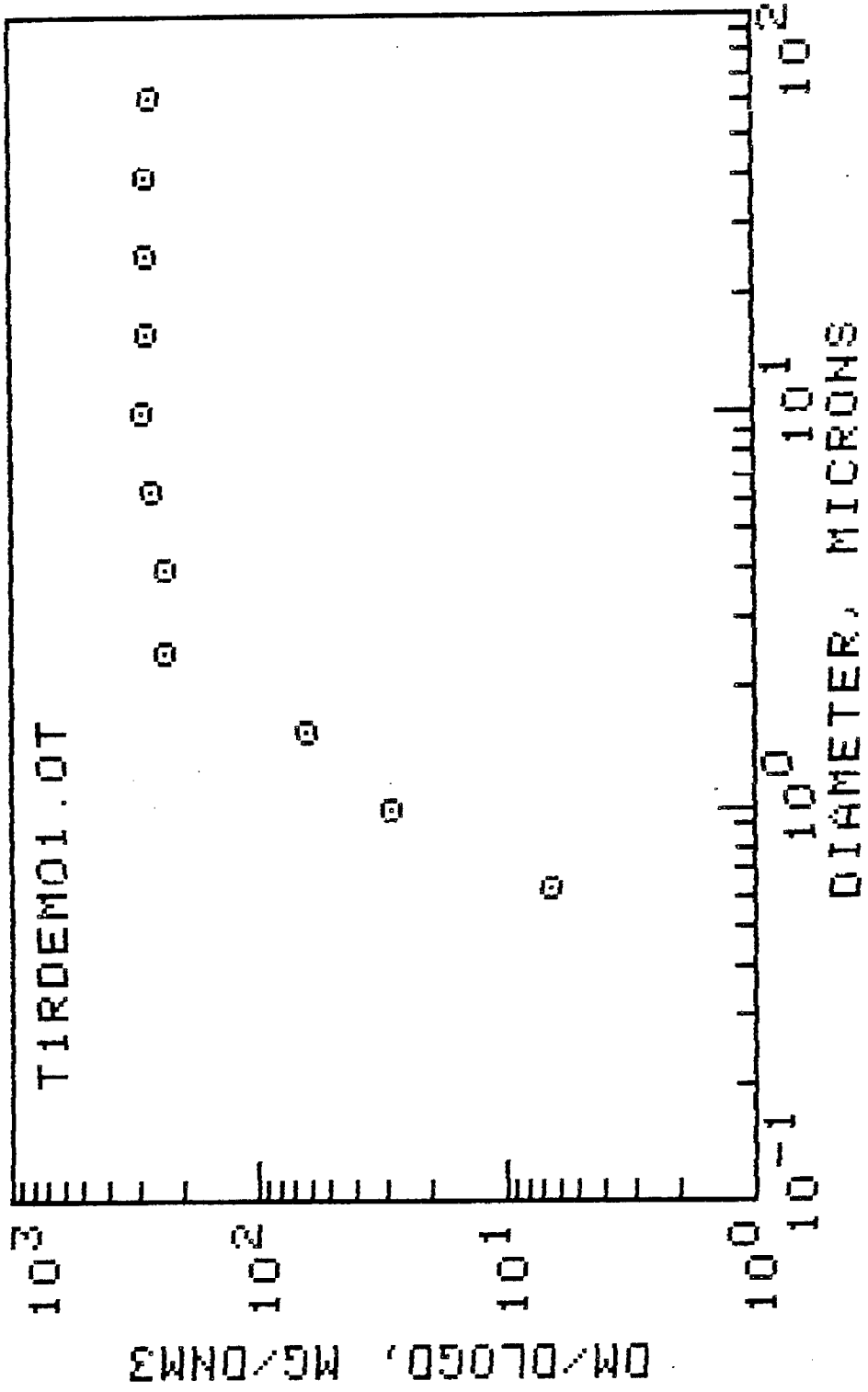
C0-C3 - constants used in normal transforms
CU - cumulative percent/100
CU(- cumulative percent/100 from raw data
D$ - DOS command flag
D0-D3 - used in normal transforms
D5(- stage D50s on selected diameter basis
D6(- stage D50s on Impaction Aerodynamic basis
DB - sorting dummy
DB$ - diameter basis
DG(- dM/dLogD
DL - sorting dummy
DT$ - date
FL - flag used in normal transforms
I - loop index
L$ - sampling location
LA$ - labels for tick marks
LX$ - label for X-axis
LY$ - label for Y-axis
NM$ - file name
NP - number of diameters in standardized diameter array
NR - number of runs in index file
P$ - screen dump command string
R$ - input dummy
RR$ - run remarks
S - number of impactor stages
T - intermediate value in normal transform
T$ - run time
TC - total concentration
X1 - dummy variable
X2 - dummy used in normal transform
X3 - linearized cumulative fraction
XP(- array of standard diameters
Y$ - contents of index file
Y(- cumulative fractions smaller than D50s in probability units
YL - maximum dM/dLogD
YM - minimum dM/dLogD
YY(- cumulative percents at standard diameters in probability units

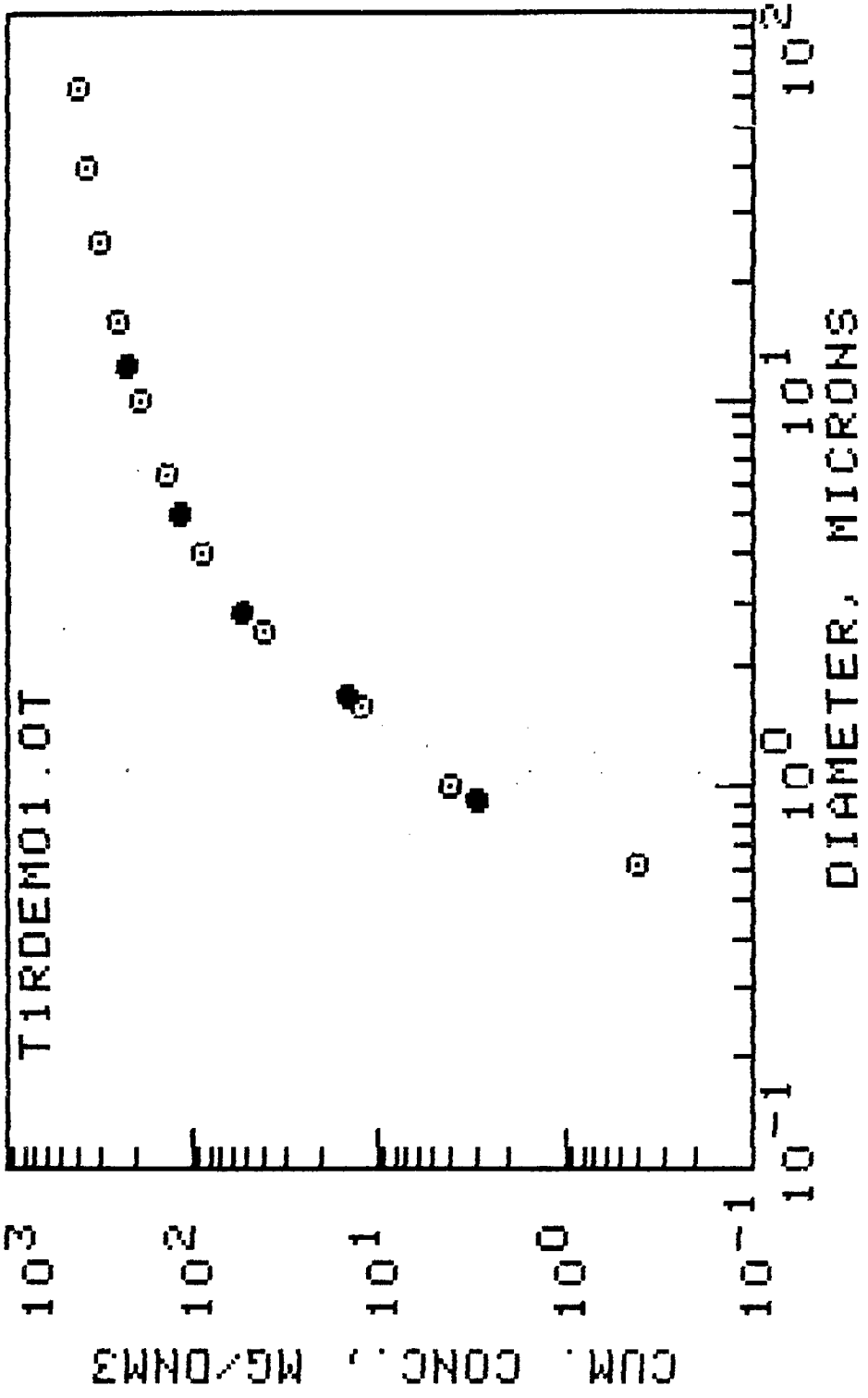
Description of Variables in STATPLOT

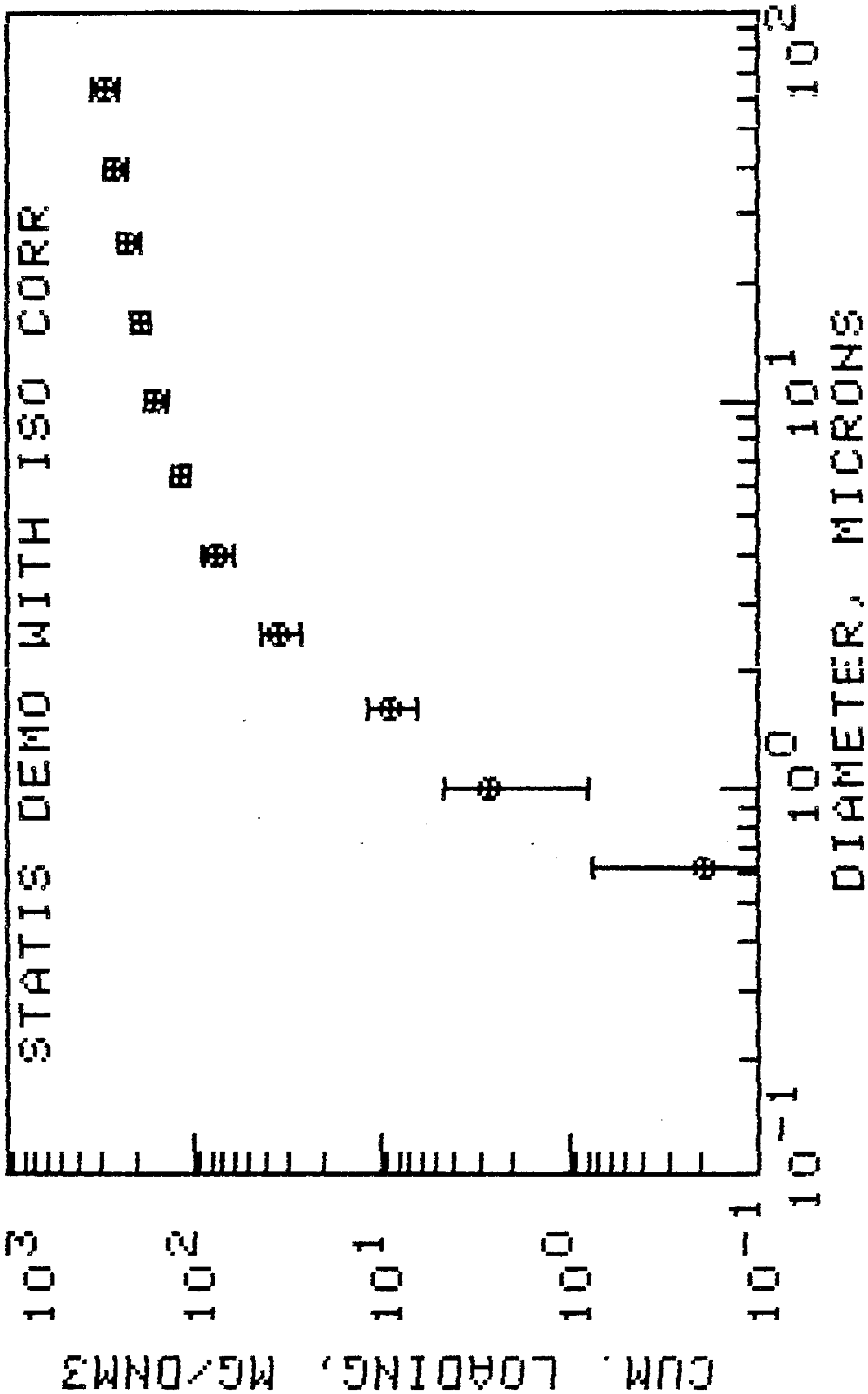
Most of the variables which appear in STATPLOT also appear in PLOT 3 and have the same meanings. The following are not shared with PLOT3:

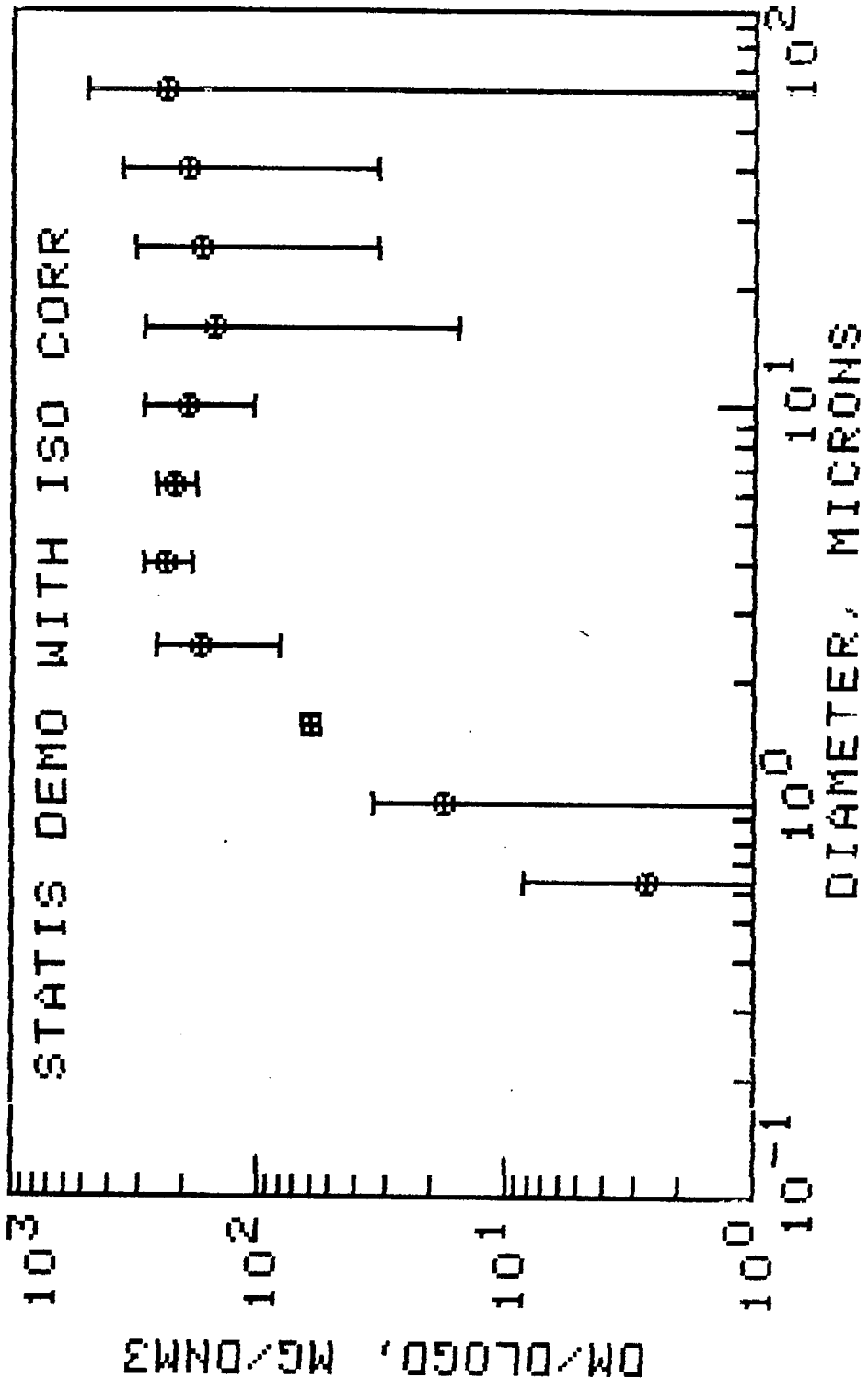
CY(- confidence intervals for cumulative loading
M(- dM/dLogD
S(- standard deviation (not used, but read from file)

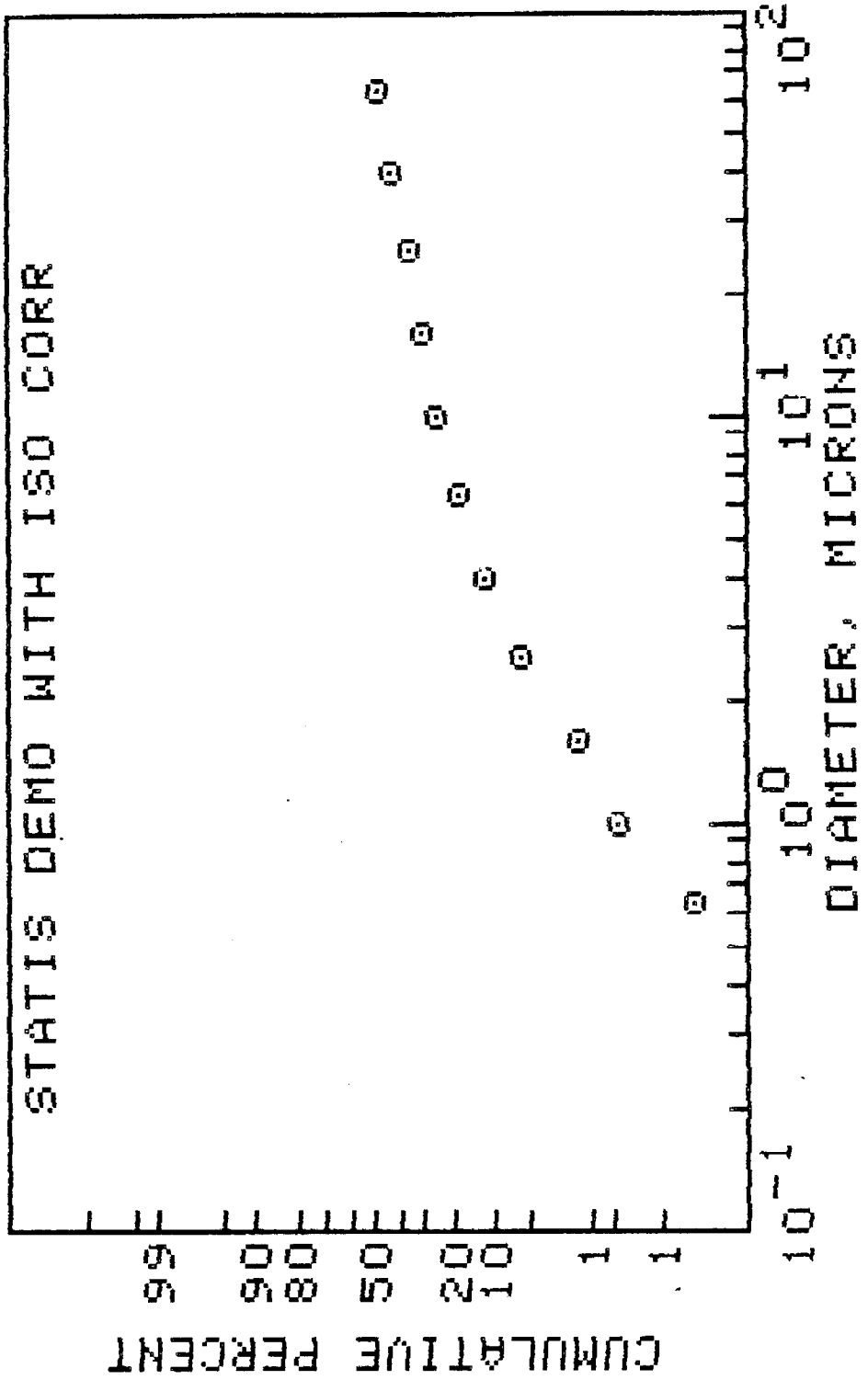

T1RDEM01.DT
CUMULATIVE PERCENT
0.5
0.8
2
5
10
20
1
1
10^{-1}
10^{0}
10^{1}
10^{2}
DIAMETER, MICRONS


T1RDEM01.OT
DM/DLOGD, MG/DNM3
DIAMETER, MICRONS
10^3
10^2
10^1
10^0
10^-1
10^2
10^1
10^0


T1R0EM01.0T
DIAMETER, MICRONS
CUM. CONC., MG/DNM3
10^2
10^1
10^0
10^-1
10^3
10^2
10^1
10^0
10^-1


STATIS DEMO WITH ISO CORR
CUM. LOADING, MG/DNM3
DIAMETER, MICRONS
10^3
10^2
10^1
10^0
10^-1
10^-1
10^0
10^1
10^2


STATIS DEMO WITH ISO CORR
DM/DLOGD, MG/DNM3
DIAMETER, MICRONS
10^3
10^2
10^1
10^0
10^-1
10^0
10^1
10^2


STATIS DEMO WITH ISO CORR
CUMULATIVE PERCENT
99.9
99.8
99.5
99
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
10^{-1}
10^{0}
10^{1}
10^{2}
DIAMETER, MICRONS

EFF/PLOT

EFF/PLOT is a program for plotting fractional penetration (1-efficiency) curves from results generated by EFFICIENCY. The results from EFFICIENCY must have been stored on disk by that program if EFF/PLOT is to be used. The program produces a Log-Log plot of penetration versus diameter over the size range from 0.1 to 100um. The range of penetrations to be spanned by the plot is selectible by the user. 90% confidence limits are shown for each penetration if they were calculated in EFFICIENCY.

Program Operation

NOTE: AMPERGRAPH must have been loaded prior to running this program. It will have been loaded beforehand if this program was run from DATAPLOT. When EFF/PLOT is run, a brief set of instructions will be displayed, after which a catalog of the data disk will be shown. A prompt is then given for the name of the data file to be entered.

After the file is read, the minimum and maximum penetrations are shown and the user is asked to enter the desired plot limits. THESE MUST BE INTEGRAL POWERS OF TEN. The penetrations will then be plotted and displayed for a short period of time, after which the user will be asked if hardcopy is desired. As in the other plotting programs, the graphics dump is set up for a Prometheus "Grafitti" or Orange Micro "Grappler" interface card coupled to a dot ;matrix printer having graphics capability. The program will require modification by the user if the interface/printer combination is not compatible with these.

After the screen dump, if one is requested, the program exits to BASIC. If further efficiency plots are desired, simply type "RUN" and press Return. If other programs in the system are to be run, type "RUN MAIN MENU" and press Return.

HIMEM is set to 16383 at the start of the program in order to protect the graphics display memory and the binary plotting routines (AMPERGRAPH). It is reset to 38400, the normal DOS 3.3 HIMEM, when the program terminates normally. However, if it terminates because of an input error or other such problems, or is interrupted by the user, HIMEM will not be reset and subsequent programs which require large amounts of memory may not run. If this problem occurs, normal operation can be restored by typing "HIMEM:38400" while in BASIC.

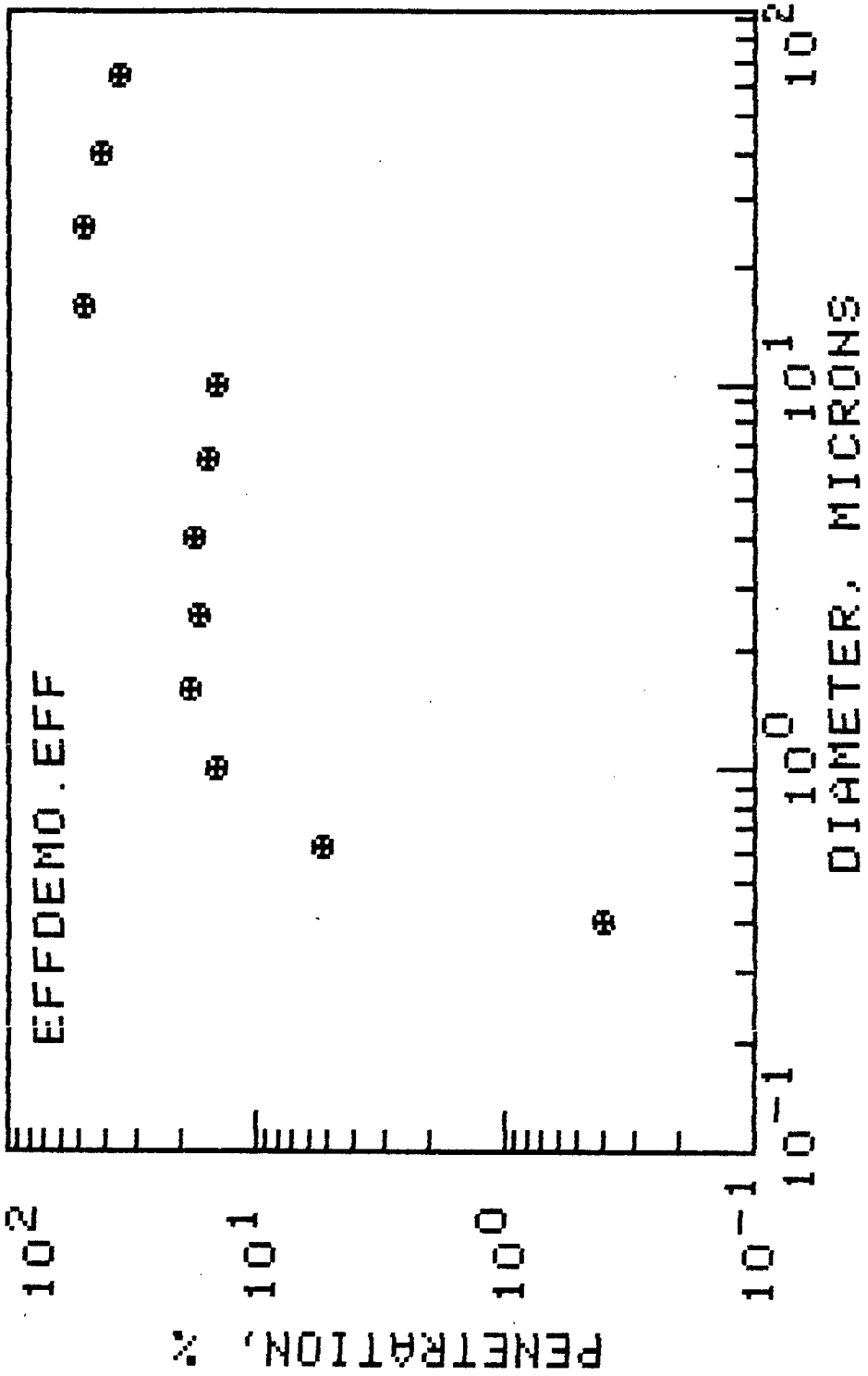
Program Description

Brief instructions to the user are given in lines 1 and 2, and program initialization takes place in lines 3 through 16. The disk catalog is read and displayed in line 17, the name of the file to be plotted is entered in line 19, and the file is read in lines 20 through 80.

The minimum and maximum penetrations are found in lines 200 through 240, and are displayed in lines 250 and 260. The user enters the selected plot limits in 270. The plotting is then done in lines 271 through 340. Printed output is handled in lines 341 through 346. Finally, HIMEM is reset in line 348 and the program terminates.

Description of Variables

CI(- confidence intervals
D$ - DDS command flag
DB - maximum penetration
DL - minimum penetration
I - loop index
LS$ - label
M(- penetrations
NM$ - file name
NP - number of particle diameters in standard array
P$ - screen dump command string
R$ - input dummy
XP(- standard particle diameters
XL - plot minimum
YM - plot maximum


EFFDEMO.EFF
DIAMETER, MICRONS
PENETRATION, %
10^{-1}
10^{0}
10^{1}
10^{2}

PURGE RUNFILE and PURGE IMPACTOR FILE

These programs are used for purging obsolete reduced run data files and impactor configuration files, respectively, from the data disk. If old files are to be deleted, the deletions should be done through these programs so that the names of the deleted files will be removed from the index files. The operation of the programs is quite similar, consequently they are described together here.

Program Operation

A catalog of the disk will be displayed and the user will be prompted for entry of the file to be deleted. In the case of deleting run files, the test number, run ID, and test type will be requested and the file name will be constructed from these. In the case of impactor files, the name of the impactor (the file name less the /IMP ending) is to be entered. NOTE: The verification of the name of the file to be deleted requires only the single key "Y" or "N" as a response; do not press return after pressing the proper key. After receiving verification of the file name, the program will delete the file from the disk and rewrite the appropriate index file with the entry dropped from it. The user will then be asked if more files are to be deleted, and if so, will repeat the sequence. If not, the program will terminate. To return to the system menu, type "RUN MAIN MENU" and press Return.

Program Descriptions

The disk catalog is displayed in line 15 and the file name is input or constructed in lines 20 through 40. Verification of the file name is requested in line 50. The file is deleted in lines 62 through 65. The index file is read in lines 75 through 150, and rewritten in lines 160 through 220. The prompt for deleting more runs is given in line 230.

Description of Variables

D$ - DOS command flag
I - loop index
I$ - inlet/outlet flag
K(- flag for index of run/impactor to be dropped
M - number of names left in index file after deletion
MM$ - name of impactor file to be deleted
NM$ - name of impactor or of runfile to be deleted
NR - number of entries in the index file
R$ - input dummy
RN$ - run ID
RO - flag to avoid attempt to redimension arrays
TN - test number of run file to be deleted
Y$(- contents of index file

DEF/ORI

DEF/ORI is used to generate files to be used in data reduction by MPPROG which contain the needed information on metering orifices for flow rate calculations. Because the same orifices tend to be used repetitively, it is desirable to store the information in a permanent file which can be accessed simply whenever it is needed. The information to be input includes a unique letter to be used in identifying a file which contains data on a set of orifices, a nominal hole diameter for each orifice, and calibration pressures, temperatures, and flowrates. The program also calculates values of ΔH@ for each orifice for use in setting flow rates when sampling. The files can be called up for review by simply entering the letter designation for the set to be reviewed. The disk files can be updated and printed copies can be obtained at the user's option.

Data Input

Input takes place on two screen pages, the first of which is concerned primarily with general information, and the second for individual orifice input and/or changes. The information needed on Page 1 is input by entering the selected menu item number, at which point a prompt for that item will be given. the Page 1 input display is shown below.

```
DEFORI V1.2 - PAGE 1 OF 2

1) HARD COPY OPTION: YES
2) DISK FILE UPDATE: YES
3) ORIFICE SET NAME:
   FILE NAME: _______
4) DESCRIPTION:
5) NUMBER IN SET:  0

P)AGE, Q)UIT, OR NUMBER OF ITEM
TO ENTER/CHANGE: ?
```

The items entered on page 1 are:

1) Is hardcopy desired?. Selecting this item will reverse the currently displayed answer.

2) Is a disk update of the file desired? Again selection of the item reverses the answer.

3) Orifice set designation: The file name used is the set designation with /ORI added. The /ORI is added by the program and should not be entered by the user. When a new set designation is entered, the disk is checked for the existence of a current file with that designation. If such a file exists, it is read into memory and the current information in the file will be displayed on the data entry screens.

4) Description: Enter a brief description of the configuration to help identify it later.

5) Enter the number of orifices in the set. If the set already existed, this will have been filled in when the file was read. It can be altered if additional orifices are to be added to the set.

After completing the entries on Page 1, press "P" and "Return" to proceed to the second page of data entry which is illustrated below.

```
                DEFORI V1.2 - PAGE 2 OF 2

ORI.    DIA.    QCAL      PCAL      TCAL      DPCAL
NO.     (IN)    (CFM)   (IN HG)   (DEG F)   (H2O)
 1      .000    .0000     .00         0         .00
 2      .000    .0000     .00         0         .00
 3      .000    .0000     .00         0         .00

TO ENTER/CHANGE DATA FOR AN ORI.
ENTER ORI. NO. OR Q)UIT OR P)AGE
```

This page is devoted entirely to orifice calibration information. The program will set up one line for parameters for each orifice in the set, numbered sequentially from 1 to the number entered on the previous page. Entry of data is made by entering the number for which information is to be entered or changed. When an orifice is selected, the cursor will be placed at the start of the leftmost entry in its line. Pressing "Return" will accept the current value and advance the cursor to the start of the next entry. Entering a value will replace the current entry. When the cursor is advances beyond the last field the program will revert to the orifice select mode. Single point calibrations are used here. The data required for each orifice are:

The nominal diameter of the orifice.

The flow rate, in acfm, at the orifice inlet conditions at which the orifice was calibrated.

The absolute pressure, in inches of mercury, at the orifice inlet during calibration.

The gas temperature, in degrees Fahrenheit during calibration.

The pressure differential across the orifice, in inches of water, at the calibration flow rate.

Upon completion of all data entry, press "Q" and "Return" to proceed. The information will be printed and/or saved to disk depending on the users selected options.

Description of Major Program Segments

Program initialization takes place in lines 6 through 100 and in a subroutine from line 1000 to line 1160. Page 1 of the primary data entry menu takes place in lines 2000 through 2475 with pre-existing files being checked and loaded in lines 2367 through 2460. Page 2 of the data entry is done in lines 2500 through 3350.

Printing of the information is done by a subroutine from line 4000 through 4500 and the disk update is done in lines 5000 through 5920. A machine language subroutine for print formatting is appended to the program as line 63999. THIS LINE MAY NOT BE EDITED - doing so will result in an irrecoverable loss of the program. The subroutine is copyrighted and permission has been granted by the copyright owner for its use here.

Identification of Variables

A - option selection dummy
A$ - input dummy
BU - address of print formatter
D$ - DOS command flag
EF - error flag
F$(- format statements for printing
F1$ - flag for hardcopy
F2$ - flag for disk update/save
HH - screen tab index
I - loop index
J - variable counter
JA(- pressure differential
JD(- pressure
JL(- temperature
JN(- orifice diameter
JS(- flow rate
N$(- designations of orifice sets on file
NI$ - set designation
NM$ - orifice file name
NS - number of orifices in set
OK - flag for pre-existing file
P - menu page number
PF - format selector
R$ - dummy for input and printing
RM$ - set description
TI - number of sets on file
Y$ - input dummy

D F F O R I V1.2

2) DISK FILE UPDATE: YES

3) ORIFICE SET NAME : S

FILE NAME: S/ORI

4) DESCRIPTION: SORI ORIFICE SET 'S' PLUS METH 5 ORIFICE

5) NUMBER IN SET: 8

ORI. NO.	DIA. (IN)	QCAL (CFM)	PCAL (IN HG)	TCAL (DEG F)	DPCAL (H2O)	KCAL	<>H@
1	.014	.0096	29.30	72	10.00	68006.9	62797.6
2	.021	.0218	29.30	72	10.00	13188.1	12177.9
3	.029	.0586	29.30	72	10.00	1825.16	1685.35
4	.042	.0938	29.30	72	10.00	712.34	657.78
5	.059	.2003	29.30	72	10.00	156.22	144.25
6	.082	.4120	29.30	72	10.00	36.92	34.10
7	.120	1.3870	29.30	72	10.00	3.26	3.01
8	.388	.7500	29.92	68	1.86	2.01	1.86

IMPOP

IMPOP is a program for reducing data from velocity traverses, selecting impactor nozzle diameters and flow rates for sampling, calculating orifice and gas meter settings to obtain the selected flow rates, and filling in pretest information on field data sheets for impactor runs. Printing of the pretest information is formatted for use with the preprinted field data form (run sheet) shown following the program description. The program is intended primarily to assist in sampling stationary sources using cascade impactors, but it can also be used in conjunction with the program MTOP for setting up to do Method 5 and Method 17 sampling. The results of a velocity traverse can also be saved to disk for later use in plotting a velocity contour map using the programs CONDOT.RECT STACK or CONDOT.ROUND STACK.

Program Operation

The program operates in a series of three major blocks. The first block is devoted to the reduction of data from a velocity traverse, the second to the selection of sampling nozzles and flowrates, and the third to the selection of metering orifices and the generation of meter parameters for obtaining the selected sampling rate. If velocities and temperatures are known, one can skip the velocity traverse portion of the program and move directly to nozzle and flow rate selection by responding "N" to a prompt which is given when the program begins. If the latter is done, the required velocity and temperature must be entered manually; prompts for this will be given. Printed output is available from the first (velocity) and third (metering parameters) blocks.

Velocity Traverse

Data input to the velocity traverse portion takes place on two or more screen pages. The first page is devoted to general information regarding the measurement location and the circumstances of measurement. The remaining pages are for the input of the temperatures and velocity pressures at each of the measurement points for a single port. The first page for data input is shown on the following page. When selecting items for data entry from a "menu" for which only a single character entry is possible, only the key which designates the item should be pressed. Do not press return after pressing the key for your selection. A prompt for the required input will then appear at the bottom of the screen.

```
        IMPACTOR OP & VELOCITY PROGRAM

1) TEST CODE (xxxxI)
2) NUMBER OF PORTS                  0
3) NUMBER OF POINTS PER PORT        0
4) DATE
5) % 02                           0.0
6) % CO2                          0.0
7) % H2O                          0.0
8) AMBIENT PRESSURE             30.00 in. Hg
9) DELTA P STACK                 0.00 in. H2O
A) AMBIENT TEMP                  0.   deg F
B) STACK TYPE                    RECT/
D) DUCT LENGTH                   0.00 feet
E) DUCT DEPTH                    0.00 feet

ENTER ITEM NO. TO CHANGE, C TO CONTINUE,
R TO RETURN TO MENU, OR V FOR NEW
VELOCITY TRAVERSE.
```

The information needed for page 1 is entered as follows:

1) Enter a five character code for the velocity traverse. A code based on the Test Number to be used as the major project designation in MPPROG followed by "I" or "O" for inlet or outlet is suggested. This code can consist of any alpha-numeric string without commas or semicolons.

2) Enter the number of ports used in making the traverse. If the stack was round and the traverse was made from two ports at 90 degrees to each other, this should be set as four (4), not two(2), if a contour plot is to be made. In the latter case, enter the data as though the traverse were made sequentially from four ports which were evenly spaced at 90 degrees.

3) Enter the number of points at which measurements were made along each traverse line.

4) Enter the date in a form which suits the user. (NO commas or semicolons).

5) Enter the oxygen content of the flue gas as a percentage on a dry basis.

6) Enter the CO2 content of the flue gas as a percentage on a dry basis.

7) Enter the flue gas moisture content as a percentage (wet basis).

8) Enter the barometric pressure at the sampling location in inches of mercury.

9) Enter the pressure differential between the stack and ambient in inches of water (negative if stack is at lower pressure than ambient).

A) Enter the expected gas/orifice meter temperature in "°F".

B) Toggles the stack type between rectangular and round. This will also toggle entry "D" between "DUCT LENGTH" and "DUCT DIAMETER". At the same time, entry "E" will appear or disappear as appropriate.

D) Enter the stack length (the dimension along the face in which the ports are installed) for a rectangular duct or the diameter if the duct is round.

E) Enter the depth of the port (dimension of the face parallel to a traverse line) if the duct is rectangular.

The duct dimensions are not necessary, but if given, the total volumetric gas flow will be calculated.

When the entry to this page is completed, press "C" to move on to the actual entry of the traverse measurements. Pressing "R" will permit the user to exit this program and return to the disk menu (all data will be lost). Pressing "V" simply restarts the program but preserves the data.

A sample screen for the remaining pages of velocity traverse data entry is shown below. The number of traverse points per port entered on page 1 sets the number of line entries for this page. This page will be repeated once for each of the number of ports entered on page 1. Entering "N" will advance to the page for the next port in the sequence. The program "wraps" back around to Port 1 if "N" is entered when on the page for the final port. Entering "K" enables entry of the pitot calibration constant. Entering "P" permits one to select a particular port number for data entry. Entering "V" restarts the program but preserves all current data. Entry of a point number results in successive prompts for the entry of the velocity pressure and flue gas temperature at that point. Pressing only "Return" for either entry retains the current value for that entry.

```
                VELOCITY TRAVERSE

P) PORT NO              1
K) PITOT CONSTANT       0.830

POINT #    Vp(H2O)   T(degF)   VEL(ft/s)
  1          0.000       0         0.00
  2          0.000       0         0.00
  3          0.000       0         0.00
AVG DUCT VELOCITY = 0.0 ft/sec
AVG DUCT TEMP     = 0   deg F
AVG SQRT DELTA P  = 0.000 in H2O

ENTER POINT NO. OR ITEM NO.,
N FOR NEXT PORT, C TO CONTINUE,
V TO RESTART
```

If the duct is round, the program will provide a line in the field for Port 1 for entry of data for the center of the duct. This information is not used for any of the calculations of average velocities or flow rates and entry is optional. It is needed if a contour map of the velocity field is to be plotted later. The entry sequence for a round stack is from the center outward.

After entering all the data for the complete traverse, enter "C" and the program will calculate and display the average velocity and temperature for the entire duct (and the total volumetric flow rate if the duct dimensions were entered). A printed copy of the raw and reduced data can be obtained at the user's option by pressing "P". Pressing "S" will save the data to disk under the file name "VEL DATA", with the Test Code appended (eg VEL DATA.221 if the Test Code were 221). Pressing "V" restarts the program with all data intact. Pressing "D" will advance to the next major program block-selection of nozzle size and flow rate.

Nozzle Size and Flow Rate

This portion of the program operates through three screen pages of entry and selection. The first page, shown below, repeats a large portion of Page 1 from the velocity traverse section but adds lines for entering a Run Number, Substrate Set Number, and Impactor ID information. The entries which duplicate those of the velocity traverse section will already be filled if the velocity section was not skipped. The Run Number can be any alpha-numeric sequence that contains no commas or semicolons. A suggested sequence is the Test Number designating a major test series, followed by I or O to designate that the sample was an inlet or outlet sample, followed by a number representing the inlet or outlet sample sequence number for that test. The Substrate Set identifier can only be numeric.

```
        IMPACTOR OP & VELOCITY PROGRAM

1) RUN NUMBER  (xxxxI-n)
2) SUBSTRATE SET NO.       0
3) IMP TYPE/SHELL NO/PLATE NO
4) DATE
5) % O2                    0.0
6) % CO2                   0.0
7) % H2O                   0.0
8) AMBIENT PRESSURE       30.00 in Hg
9) DELTA P STACK           0.00 in H20
A) AMBIENT TEMP            0.   deg F
B) STACK TYPE              RECT.
D) DUCT LENGTH             0.00 ft
E) DUCT DEPTH              0.00 ft

ENTER ITEM NO. TO CHANGE, C TO CONTINUE,
R TO RETURN TO MENU, OR V FOR NEW VELOCITY
```

When entry to Page 1 is complete, press "C" to continue. (Pressing "V" will restart the program with all data intact; pressing "R" will offer an opportunity to exit the program and return to the disk menu.) At this point the program will offer selection of doing the sampling calculations for the average velocity and temperature for a particular port from the velocity traverse, for the duct as a whole, or for a velocity and temperature which the user will enter directly. After "C" has been pressed, the values of velocity and temperature to be used in the remaining calculations will be displayed. These may be changed at the user's option. They must be entered if the velocity trverse section of the program was skipped. Pressing "C" once more results in the display of a menu for selecting the type of sampler to be used. Selecting one of the samplers shown will result in the program stepping through an array of nozzle sizes, calculating the flow rate required for isokinetic sampling for each size. Once the calculated flow drops below a maximum for the particular sampler, the program will display the nozzle diameter (in mm) and flow rate (in acfm) and ask if the combination is acceptable. If it is not, the program will continue stepping downward through the available nozzles until an acceptable combination is reached. The maximum flow rates for display are:

Andersen - 1.25 acfm - set in line 1700

Brink - .04 acfm for the 5 stage - set in line 1770
- .025 acfm for the 6 stage - set in line 1760

Pilat (UW) - 2.0 acfm - set in line 1710

Series Cyclone - 2.0 acfm - set in line 1729

These limits should not be taken as usable upper limits for the sampler flow rates; they are probably too high in most cases. They are used here merely to start the displayed combinations at the first set which approaches a usable value. When an acceptable combination is found, pressing "Y" will result in the program advancing to the next major block - selection of a metering orifice and calculation of metering parameters.

The nozzle sizes for the Andersen and Pilat impactors start at 5/8 inch and decrease in size by increments of 1/16 inch to a minimum of 1/8 inch. All of these sizes may not be available to the user. These sizes are set in lines 1650 through 1680. The Brink nozzles start at a size of 5mm and decrease in steps of .5mm to 2mm and then in steps of .1mm to 1mm. These sizes are set in lines 1750 through 1830. The series cyclone nozzles sizes are set in a twelve (12) element array at line 11497 with dimensions ranging from 3.5 to 12mm.

Metering Parameters

Once the sampling flow rate to be used has been found, meter rates and orifice meter settings must be calculated. Because impactors typically operate at much lower flow rates than used with conventional Method 5 sampling systems, smaller orifice meters are needed than are used with Method 5 systems. Method 5 nomographs cannot be used with the smaller orifices so the required settings are calculated here. The very wide range of possible flow rates that can be used with impactors make it impossible to standardize on one or even two

orifice meter configurations as done in Method 5, therefore the program requires entry of an orifice ID and calibration constant, ΔH@, for the selected orifice.

After the orifice constant is entered, the program will display a table of orifice meter settings and corresponding times, in seconds, per gas meter revolution. The gas meter is assumed to produce 1 revolution per 0.1cf. The settings are based on the absolute pressure at the orifice inlet being atmospheric less the value quoted as Psys. The absolute pressure in the gas meter is taken as being equal to the pressure at the orifice meter inlet less the orifice meter pressure differential. The system is set up as it is to enable sampling with the orifice and gas meter located upstream of the pump to avoid requiring a leakless pump. The latter are difficult to obtain for use at the low flow rates at which some impactors operate. The actual pressure at the orifice meter in this system configuration will depend on the impactor used, the flow rate, losses through the backup filter, probe, hoses and moisture traps. Thus the table is generated for wide range of possible orifice inlet pressures. It is desirable to use an orifice meter which produces a pressure differential in the range of two (2) to five (5) inches of water for good readability without undue flow restriction. If a Method 5 type pump and meter configuration is used, the orifice meter should be set to the value corresponding to the entries for Psys of 0 or -0.5.

Gas meter accuracy becomes problematical at the very low flow rates at which the Brink impactor is operated. However, it is not a good practice to rely solely on a single meter for setting the flow and calculating the total volume sampled; a cross check is desirable. One simple way to obtain a cross check is to employ two orifice meters in series. It is unlikely that both will have problems at any one time, thus the flow can be set witth one and verified with the other. Provision for such a douple orifice meter setup is made if the Brink impactor is selected.

After the orifice has been selected, an option to obtain a printed copy of the table and other information can be obtained by pressing "C". The printout is formatted to be done on a preprinted field sampling form. Examples of a blank form and one on which the information has been printed are provided at the end of the program description. The program then returns to the start of the velocity traverse section.

Program Description

Initialization is done in lines 110 through 140 and a subroutine from line 11000 through 11500.

Page 1 data input for both the velocity traverse and flow rate selection segments is handled in lines 165 through 580. Pressure and molecular weight calculations are done in lines 600 through 640. Flags are checked in lines 645 and 650 to jump to either the average velocity output, the flow rate selection segment, or to fall through to the velocity traverse data input as appropriate. Input of the velocity traverse data is done in lines 660 through 900. Velocities are calculated and the velocity pressures and temperatures are

summed for averaging in lines 910 through 990. The average velocity and temperature for each port is calculated in lines 1000 and 1010. The average square root of the velocity pressure for the port is calculated in line 1015. Grand averages for the duct as a whole are calculated in lines 1030 through 1115. The display of the grand averages is done in lines 1110 through 1190 and the options at that point are handled in lines 1190 through 1240. The disk save of the point velocities is done via a subroutine in lines 20000 through 20180. Printing of the velocity traverse data and results is done by a subroutine in lines 8000 through 8460.

Selection of the portion of the duct for which the sampling flow rate calculations are to be made takes place in lines 1300 through 1560. The impactor type to be used is selected in lines 1570 through 1640. The nozzle and flow rate calculations and selection are done in lines 1650 through 1995. Metering orifice selection is done in lines 2000 through 2580. Printing of the Run Sheet (orifice DP table) is done in lines 2600 through 2970.

Description of Variables

A - dummy for menu selections
A$ - dummy for menu selections
A2 - substrate set number
B1 - number of ports
B2 - number of traverse points per port
BU - print formatter address
C - pitot constant
CJ - number of points for averaging
CN(- cyclone nozzle diameters
D$ - DOS command flag
D1 - nozzle diameter in 16ths of an inch
D2 - duct area
D4 - nozzle diameter in mm
DB - duct depth
DL - duct length or diameter
F - gas meter temperature
F$(- format statements
F1 - internal flag for jumps
F9 - internal flag for jumps
F1$ - part of file name for velocity traverse save to disk
FK - temperature in deg. Rankine
FO$ - format statement
G - impactor type selector
G$ - date
G1 - % O2
G2 - % CO2
G4 - % N2
G5 - % H2O
H1 - orifice calibration constant (H)
H2 - orifice calibration constant (H)

I - loop index
I$ - impactor ID
11, 12, & 13 - indices for print formatting
J - loop index
J(- time per meter revolution
K - loop index
M - number of orifice meters
M1 - dry mol. weight
M2 - wet mol. weight
M3 - number of Brink stages
N - port number selected manually
N$ - run designation
O$ - flag for selected port(s) for traverse
O(- velocity pressures
O1 - orifice ID
O2 - orifice ID of second orifice
(A(- point velocity
P1 - local barometric pressure
P2 - stack pressure differential
P3 - absolute pressure of flue gas
Q$ - flag for new traverse
Q1 - sampling flow rate
Q2 - stack flow rate, acfm
Q3 - stack flow rate, dscfm
R - metering orifice inlet pressure differential to ambient
R$ - input and printing ;dummy
RR - same as R
S(- intermediate pressure calculation results
SP - flag for round duct velocity traverse
ST$ - duct type
T - temperature for orifice/gas meter calculations
T(- temperature at traverse point
V - velocity for flow rate calculations
V(- velocity at traverse point
X - orifice meter intermediate calculation results
X(- average temperature for port
Y(- average velocity for port
Z$ - input dummy
Z1 - average velocity in duct
Z2 - average temperature in duct
Z3 - average square root of velocity pressure for duct

DEMO1 1/2/86

% O2: 9.7 % N2: 81.3 AMB P: 30.00 Cp: .83 DUCT AREA: 144

%CO2: 9.0 %H20: 14.6 <>Pstk: -5.0 AMB T: 90

	PORT 1			PORT 2			PORT 3		
PT #	PV H20	T F	VEL ft/s	PV H20	T F	VEL ft/s	PV H20	T F	VEL ft/s
1	.30	300	37.1	.28	295	35.7	.29	301	36.5
2	.32	305	38.5	.31	303	37.8	.31	310	38.0
3	.33	310	39.2	.33	312	39.2	.33	320	39.4
AVG	.56	305	38.3	.55	303	37.6	.56	310	38.0

AVG DUCT VEL = 37.9 ft/s VOLUME FLOW = 327,884 acfm
AVG DUCT TEMP = 306 deg F = 191,825 scfm
AVG SQRT DELTA P = 0.558 IN. H20

DEMO I 1

IMP ID:	UW U Z	% O2:	9.7	AMB P:	30.00	PORT :	A
DATE:	1/2/86	% CO2:	9.0	AMB T:	90	GAS VEL:	37.90
SUB SET :	1	% N2:	81.3	<>Pstack:	-5.0	GAS TEMP:	306
		% H20:	14.60	Pstack:	29.63	IMP FLOW:	.436

NOZ DIA: .188

ORI ID: .082S
<>H@: 34.1
GAS METER #:

Psys "Hg	<>P H20	TIME sec
-1.0	4.1	16.7
-.5	4.1	16.4
.0	4.2	16.1
.5	4.3	15.9
1.0	4.3	15.6
1.5	4.4	15.3
2.0	4.5	15.0
2.5	4.6	14.8
3.0	4.7	14.5
3.5	4.7	14.2
4.0	4.8	13.9
4.5	4.9	13.7
5.0	5.0	13.4
5.5	5.1	13.1
6.0	5.2	12.8
6.5	5.3	12.6
7.0	5.5	12.3
7.5	5.6	12.0
8.0	5.7	11.7
8.5	5.8	11.5
9.0	6.0	11.2
9.5	6.1	10.9
10.0	6.3	10.6
10.5	6.4	10.3

REAL BLANK

DEMO I 1

IMP ID: UW V Z	% O2: 9.7	AMB P: 30.00	PORT : A
DATE: 1/2/86	% CO2: 9.0	AMB T: 90	GAS VEL: 37.90
SUB SET : 1	% N2: 81.3	<>Pstack: -5.0	GAS TEMP: 306
	% H20: 14.60	Pstack: 29.63	IMP FLOW: .775

START TIME	SAMPLING TIME (min.) / Traverse point	VOLUME COND. H_2O (ml)
END TIME	OPERATORS: 1) 2)	SAMPLING LOCATION
RUN EVALUATION		UNLOADED BY

	TIME (MIN)	Port No. / Traverse point	GAS METER VOLUME	GAS METER TEMP. (F)	PRESS. DROP (in. Hg)	METER ORIFICE ΔP_1 (in. H_2O)	ΔP_2 (in. H_2O) or Gas Meter S/Nbr	IMPACTOR TEMP. (F)	FLUE GAS TEMP. (F)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									

NOZ DIA: .250

ORI ID: .120S
<>H@: 3.01
GAS METER #:

Psys Hg	<>P H20	TIME sec
-1.0	1.1	9.5
-.5	1.1	9.3
.0	1.2	9.2
.5	1.2	9.0
1.0	1.2	8.8
1.5	1.2	8.7
2.0	1.3	8.5
2.5	1.3	8.4
3.0	1.3	8.2
3.5	1.3	8.1
4.0	1.3	7.9
4.5	1.4	7.8
5.0	1.4	7.6
5.5	1.4	7.5
6.0	1.5	7.3
6.5	1.5	7.2
7.0	1.5	7.0
7.5	1.6	6.8
8.0	1.6	6.7
8.5	1.6	6.5
9.0	1.7	6.4
9.5	1.7	6.2
10.0	1.8	6.1
10.5	1.8	5.9

SAMPLING NOTES

5598-38

REAL BLANK

START TIME	SAMPLING TIME (min.) / Traverse point	VOLUME COND. H_2O (ml)	
END TIME	OPERATORS: 1) 2)	SAMPLING LOCATION	
RUN EVALUATION			UNLOADED BY

	TIME (MIN)	Port No. / Traverse point	GAS METER VOLUME	GAS METER TEMP. (F)	PRESS. DROP (in. Hg)	METER ORIFICE ΔP_1 (in. H_2O)	ΔP_2 (in. H_2O) or Gas Meter S/Rev	IMPACTOR TEMP. (F)	FLUE GAS TEMP. (F)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									

SAMPLING NOTES

NOTES AND OBSERVATIONS	Note Your Observations on the APPEARANCE of EACH Stage, Substrate, or Cyclone Upon Disassembly
	PRECUTTER CYCLONE
	STAGE ZERO
	STAGE ONE
	STAGE TWO
	STAGE THREE
	STAGE FOUR
	STAGE FIVE
	STAGE SIX
	STAGE SEVEN
	STAGE EIGHT
	BACK UP FILTER(S)

```
1  REM     **** MAIN MENU ***
7 D$ =  CHR$ (4)
9  HOME : PRINT "        MAIN  MENU": PRINT : PRINT
10  PRINT "TO SELECT OPTION ENTER APPROPIATE NUMBER"
11  PRINT "  1)   ORSAT"
12  PRINT "  2)   METHOD 4 (H2O)"
13  PRINT "  3)   MPPROG (SINGLE RUN ANALYSIS)"
14  PRINT "  4)   DEFINE IMPACTOR CONFIGURATION"
15  PRINT "  5)   DATAPLOT"
16  PRINT "  6)   STATIS (SIMPLE AVERAGING OF RUNS)"
17  PRINT "  7)   FRACTIONAL EFFICIENCIES"
18  PRINT "  8)   DELETE RUNFILE"
19  PRINT "  9)   DEFINE ORIFICE CONSTANTS"
20  PRINT "10)   SYNTRAV (VELXAREA WGTD AVG.)"
21  PRINT "11)   COMBO (AVERAGE SYNTRAV RESULTS)"
80  PRINT "  Q)UIT"
90  PRINT : INPUT "YOUR CHOICE";A$
95  IF A$ = "Q" THEN  PRINT : HOME : END
97 A =  VAL (A$)
110   IF A = 1 THEN  PRINT D$;"RUN ORSAT"
120   IF A = 2 THEN  PRINT D$;"RUN METH4"
130   IF A = 3 THEN  PRINT D$;"RUN MPPROG"
140   IF A = 4 THEN  PRINT D$;"RUN DEF/IMP"
150   IF A = 5 THEN  PRINT D$;"RUN DATAPLOT"
160   IF A = 6 THEN  PRINT D$;"RUN STATIS"
170   IF A = 7 THEN  PRINT D$;"RUN EFFICIENCY"
180   IF A = 8 THEN  PRINT D$;"RUN  PURGE RUNFILE"
185   IF A = 9 THEN  PRINT D$;"RUN DEF/ORI"
186   IF A = 10 THEN  PRINT D$;"RUN SYNTRAV"
188   IF A = 11 THEN  PRINT D$;"RUN COMBO"
190   GOTO 9

]
```

```
1  REM     ** ORSAT PROGRAM V 1.0"
2  REM  **CREATES/UPDATES/LISTS ORSAT.DAT
3  REM  ***DRI VERS.26-NOV-79
4  REM  ** SRI VERS.2/1/83
5  REM
6  GOSUB 63999
7 D$ =  CHR$ (4)
10 F1$ = "YES":F2$ = "YES"
100  REM  ** MAIN PROGRAM **
110  GOSUB 1000
120  GOSUB 2000
130  IF F1$ = "YES" THEN  GOSUB 3000
140  IF F2$ = "YES" THEN  GOSUB 4000
145  PRINT
997  PRINT D$;"RUN MAIN MENU" + ",D1"
998  GOTO 110
999  END
1000  REM      ** FORMAT DEFINITION
1010  HOME
1020 P = 1
1030 F$(0) = "     ORSAT V 1.0"
1040 F$(1) = " 1) & HARD COPY OPTION  "
1050 F$(2) = " 2) & DISK FILE UPDATE  "
1060 F$(3) = " 3) #<0#.##  CARBON MONOXIDE %"
1070 F$(4) = " 4) #<0#.##  CARBON DIOXIDE %"
1080 F$(5) = " 5) #<0#.##  OXYGEN %"
1090 F$(6) = " 6) #<0#.##  NITROGEN %"
1100 F$(7) = "     #<0#.### DRY MOLECULAR WEIGHT"
1110 F$(8) = "     #<0#.### EXCESS AIR %"
1120  ONERR  GOTO 1170
1125  PRINT D$;"OPEN ORSAT.DAT" + ",D2"
1130  PRINT D$;"READ ORSAT.DAT"
1140  INPUT CM,CD,O2,N2,MW,EX
1150  PRINT D$;"CLOSE ORSAT.DAT"
1160  RETURN
1170  PRINT "ERROR; TO CONTINUE PRESS ANY KEY; ERROR CODE = "
; PEEK (222): INPUT A$: GOTO 120
1180  PRINT D$;"CLOSE"
1190  RETURN
1400  REM  ** MENU INSTRUCTIONS
2000  REM   ** MASTER MENU AND COMPUTATIONS
2005  HOME : PRINT F$(0): PRINT
2010  PRINT "TO ENTER/CHANGE AN ITEM PRESS NUMBER OF ITEM THE
N NEW VALUE AND PRESS <RETURN>"
2020  GOTO 2030
2030  VTAB 6: CALL BU,R$,F$(1),F1$: PRINT R$
2040  CALL BU,R$,F$(2),F2$: PRINT R$
2050  CALL BU,R$,F$(3),CM: PRINT R$
2060  CALL BU,R$,F$(4),CD: PRINT R$
2070  CALL BU,R$,F$(5),O2: PRINT R$
2080  CALL BU,R$,F$(6),N2: PRINT R$
2090  PRINT
```

```
2100 MW = .44 * CO + .32 * O2 + .28 * (CM + N2)
2110 X = .264 * N2 - (O2 - .5 * CM): IF X = 0 THEN EX = 0: GOTO
2120
2115 EX = (O2 - .5 * CM) * 100 / X
2120  CALL BU,R$,F$(7),MW: PRINT R$
2130  CALL BU,R$,F$(8),EX: PRINT R$: PRINT
2140 X = CM + CO + O2 + N2
2145 MW$ = "WARNING: TOTAL ADDS TO ##<0#.#%, NOT 100%"
2150  IF X <  > 100 THEN  CALL BU,R$,MW$,X: PRINT R$
2160  IF X < 2 AND N2 > 0 THEN  PRINT "WARNING: ENTER % RATHE
R THAN FRACTIONAL VALUES"
2165  PRINT "
      "
2170  VTAB 21: PRINT : PRINT "SELECT S)AVE, OR ENTER NUMBER O
F ITEM TO BE CHANGED"
2175  VTAB 23: HTAB 13: GET A$
2180  IF A$ = "S" THEN  RETURN
2190 A =  VAL (A$)
2195  IF A < 1 OR A > 6 GOTO 2170
2200  IF A = 1 THEN F1$ = "NO": PRINT : GOTO 2020
2210  IF A = 2 THEN F2$ = "NO": PRINT : GOTO 2020
2215  HTAB 15: PRINT "        ": VTAB 23: HTAB 15
2220  IF A = 3 THEN  INPUT "CM= ";CM: GOTO 2020
2230  IF A = 4 THEN  INPUT "CO= ";CO: GOTO 2020
2240  IF A = 5 THEN  INPUT "O2= ";O2: GOTO 2020
2250  IF A = 6 THEN  INPUT "N2= ";N2: GOTO 2020
3000  REM  ** HARDCOPY OPTION
3010  PRINT "PRINTED COPY OPTION NOW BEING EXECUTED-TURN PRIN
TER ON AND PRESS ANY KEY": GET A$
3012  PRINT
3015  PRINT D$;"PR#1"
3020  PRINT "         ORSAT DATA": PRINT
3050  CALL BU,R$,F$(3),CM: PRINT R$
3060  CALL BU,R$,F$(4),CO: PRINT R$
3070  CALL BU,R$,F$(5),O2: PRINT R$
3080  CALL BU,R$,F$(6),N2: PRINT R$
3120  CALL BU,R$,F$(7),MW: PRINT R$
3130  CALL BU,R$,F$(8),EX: PRINT R$
3140  PRINT D$;"PR#0"
3150  RETURN
4000  PRINT
4001  PRINT D$;"OPEN ORSAT.DAT";",D2": PRINT D$;"CLOSE ORSAT.
DAT": PRINT D$;"DELETE ORSAT.DAT"
4005 FM$ = "###.###^^^^"
4007  PRINT D$;"OPEN ORSAT.DAT" + ",D2"
4010  PRINT D$;"WRITE ORSAT.DAT"
4020  PRINT CM: PRINT CO: PRINT O2: PRINT N2: PRINT MW: PRINT
EX
4030  PRINT D$;"CLOSE ORSAT.DAT"
4040  RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.
```

```
65535  REM
  BUILDUSING (2.0)    APPENDED.

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 SENSIBLE SOFTWARE


==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM     ** METH4 PROGRAM V 1.0"
2  REM    **CREATES/UPDATES/LISTS METH4.DAT
3  REM    ***DRI VERS.26-NOV-79
4  REM    ** SRI VERS.2/2/83
5  REM
6  GOSUB 63999
7 D$ =  CHR$ (4)
10 F1$ = "YES":F2$ = "YES"
100  REM    ** MAIN PROGRAM **
110  GOSUB 1000
120  GOSUB 2000
130  IF F1$ = "YES" THEN  GOSUB 3000
140  IF F2$ = "YES" THEN  GOSUB 4000
145  PRINT
997  PRINT D$;"RUN MAIN MENU" + ",D1"
998  GOTO 110
999  END
1000  REM       ** FORMAT DEFINITION
1010  HOME
1020 P = 1
1030 F$(0) = "     METH4 V 1.0"
1040 F$(1) = " 1) & HARD COPY OPTION   "
1050 F$(2) = " 2) & DISK FILE UPDATE   "
1060 F$(3) = " 3) ##<0#.### GAS METER VOL.(CU.FT)"
1070 F$(4) = " 4) ###<0#.## ML WATER COLLECTED"
1080 F$(5) = " 5)  ###     GAS METER TEMP(DEG.F)"
1090 F$(6) = " 6)  ##<0#.## GAS M. DP(IN.H20)"
1100 F$(7) = " 7)   ##.## P BAROM.(IN.HG)"
1110 F$(8) = "     ##<0#.### MOISTURE CONTENT (%)"
1112 F$(9) = " 8)   #.### METER CORR. FACTOR"
1115 MF = 1
1120  ONERR  GOTO 1170
1125  PRINT D$;"OPEN METH4.DAT" + ",D2"
1130  PRINT D$;"READ METH4.DAT"
1140  INPUT VG,WA,TG,PG,PB,BW
1150  PRINT D$;"CLOSE METH4.DAT"
1160  RETURN
1170  PRINT "ERROR; TO CONTINUE PRESS ANY KEY; ERROR CODE = "
; PEEK (222): INPUT A$: GOTO 120
1180  PRINT D$;"CLOSE"
1190  RETURN
1400  REM  ** MENU INSTRUCTIONS
2000  REM       ** MASTER MENU AND COMPUTATIONS
2005  HOME : PRINT F$(0): PRINT
2010  PRINT "TO ENTER/CHANGE AN ITEM PRESS NUMBER OF ITEM THE
N NEW VALUE AND PRESS <RETURN>"
2020  GOTO 2030
2030  VTAB 6: CALL BU,R$,F$(1),F1$: PRINT R$
2040  CALL BU,R$,F$(2),F2$: PRINT R$
2050  CALL BU,R$,F$(3),VG: PRINT R$
2060  CALL BU,R$,F$(4),WA: PRINT R$
2070  CALL BU,R$,F$(5),TG: PRINT R$
```

```
2080  CALL BU,R$,F$(6),PG: PRINT R$
2085  CALL BU,R$,F$(7),PB: PRINT R$
2087  CALL BU,R$,F$(9),MF: PRINT R$
2090  PRINT
2100 VH = .0472 * WA
2105 VS = 17.65 * MF * VG * (PB - PG / 13.6) / (TG + 460)
2110  IF (VH + VS) = 0 THEN BW = 0: GOTO 2120
2115 BW = VH / (VH + VS)
2120  CALL BU,R$,F$(8),BW * 100: PRINT R$
2170  VTAB 21: PRINT : PRINT "SELECT S)AVE, OR ENTER NUMBER O
F ITEM TO BE CHANGED"
2175  VTAB 23: HTAB 13: GET A$
2180  IF A$ = "S" THEN  RETURN
2190 A =  VAL (A$)
2195  IF A < 1 OR A > 8 GOTO 2170
2200  IF A = 1 THEN F1$ = "NO": PRINT : GOTO 2020
2210  IF A = 2 THEN F2$ = "NO": PRINT : GOTO 2020
2215  HTAB 15: PRINT "              ": VTAB 23: HTAB 15
2220  IF A = 3 THEN  INPUT "VG= ";VG: GOTO 2020
2230  IF A = 4 THEN  INPUT "WA= ";WA: GOTO 2020
2240  IF A = 5 THEN  INPUT "TG= ";TG: GOTO 2020
2250  IF A = 6 THEN  INPUT "PG= ";PG: GOTO 2020
2260  IF A = 7 THEN  INPUT "PB= ";PB: GOTO 2020
2270  IF A = 8 THEN  INPUT "MCF= ";MF: GOTO 2020
3000  REM     ** HARDCOPY OPTION
3010  PRINT "PRINTED COPY OPTION NOW BEING EXECUTED-TURN PRIN
TER ON AND PRESS ANY KEY": GET A$
3012  PRINT
3015  PRINT D$;"PR#1"
3020  PRINT "         METH4 DATA": PRINT
3050  CALL BU,R$,F$(3),VG: PRINT R$
3060  CALL BU,R$,F$(4),WA: PRINT R$
3070  CALL BU,R$,F$(5),TG: PRINT R$
3080  CALL BU,R$,F$(6),PG: PRINT R$
3120  CALL BU,R$,F$(7),PB: PRINT R$
3125  PRINT " "
3130  CALL BU,R$,F$(8),BW * 100: PRINT R$
3140  PRINT D$;"PR#0"
3150  RETURN
4000  PRINT
4001  PRINT D$;"OPEN METH4.DAT" + ",D2": PRINT D$;"CLOSE METH
4.DAT": PRINT D$;"DELETE METH4.DAT"
4005 FM$ = "###.###^^^^"
4007  PRINT D$;"OPEN METH4.DAT" + ",D2"
4010  PRINT D$;"WRITE METH4.DAT"
4020  PRINT VG: PRINT WA: PRINT TG: PRINT PG: PRINT PB: PRINT
BW
4030  PRINT D$;"CLOSE METH4.DAT"
4040  RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM
```

==> DO NOT EDIT 63999.

```
65535  REM
  BUILDUSING (2.0)    APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM ××× DEFIMP PROGRAM V2.4 ×××
2  REM ×××CREATES/UPDATES/LISTS INFORMATION IN &&&.IMP FILE
3  REM  ×××DRI VERS. 8-MAY-80
4  REM  ×× SRI VERS.2/2/83
5  REM  ×× V2.1 5/18/83 V2.2 4/12/84 (ADD J TO P DIST. FOR TH
EO. SQR(PSI) IN MPPROG) V2.3 5/7/84 V2.4 12/6/85 ADD STAGE SE
LECT FROM PREVIOUS IMPACTOR
6  GOSUB 63999: REM  INITIALIZE PRINT FORMATTER
7 D$ =  CHR$ (4)
10 F1$ = "YES":F2$ = "YES"
13  DIM ZN(15),ZS(15),ZD(15),ZL(15),ZZ(15),ZK(15),ZA(15),CZ(1
5)
14  DIM JN(15),JS(15),JD(15),JL(15),MZ(15),JK(15),JA(15),CP(1
5)
20  DIM N$(50),F$(14)
30 NM$ = "-------":SH$ = "CIRC.":SH = 0:EF = 0
100  REM      ×× MAIN PROGRAM ××
110  GOSUB 1000: REM  INITIALIZE PROGRAM
115  HOME : INPUT "DO YOU WANT TO SELECT STAGES FROM AN EXIST
ING SET?";A$: IF A$ = "Y" THEN  GOSUB 6000
120  GOSUB 2000: REM  INPUT MENUS
121  IF R$ = "Q" THEN  GOTO 130
122  GOSUB 2500
123  IF R$ = "Q" THEN  GOTO 130
124  IF R$ = "P" GOTO 120
130  GOSUB 3500
135  IF F1$ = "YES" THEN  GOSUB 4000
140  IF F2$ = "YES" THEN  GOSUB 5000
145  PRINT "RUN MAIN MENU"
230  HOME : VTAB 5: PRINT "R)ETURN TO MAIN MENU OR"
240  INPUT "C)ONTINUE ENTERING IMPACTORS";R$
250  IF R$ = "R" GOTO 997
260  IF R$ <  > "C" THEN 230
270  GOTO 30
997  PRINT D$;"RUN MAIN MENU" + ",D1"
998  GOTO 110
999  END
1000  REM  ×× FORMAT DEFINITION ××
1010  HOME
1020 P = 1
1030 F$(0) = "        D E F I M P   V2.4"
1040 F$(1) = " 1)  HARD COPY OPTION: &"
1050 F$(2) = " 2)  DISK FILE UPDATE: &"
1055 F$(4) = "     FILE NAME: &"
1060 F$(3) = " 3)  IMPACTOR NAME: &"
1070 F$(5) = " 4)  DESCRIPTION: "
1080 F$(7) = " 6)  NUMBER OF STAGES: ##"
1090 F$(6) = " 5)  SHAPE OF JETS(CIRC./SLIT): &"
1100 F$(8) = "STAGE    NO.      SQR    JET    J TO P"
1110 F$(9) = " NO.    JETS      PSI    DIA.    DIST."
1120 F$(10) = " ## ;    ###;     <0#.###;  #<0#.####"
1130 F$(11) = "STAGE    NO.      SQR    SLOT    SLOT"
```

```
1140 F$(12) = " NO.    SLOTS      PSI    WIDTH  LENGTH"
1150 F$(13) = " ## ;    ###;      <0#.### ;  <0#.####;  #<0#.#
##"
1155 F$(14) = " 7)  DISCHARGE COEFFICIENT   <0#.###"
1156 DC = .61
1160  RETURN
1169  REM  ERROR HANDLER
1170  PRINT "ERROR; TO CONTINUE PRESS ANY KEY; ERROR CODE = "
; PEEK (222): INPUT R$: GOTO 120
1399  REM  MENU SELECT SUBROUTINE
1400  VTAB 22: PRINT "P)AGE, Q)UIT, OR NUMBER OF ITEM TO ENTE
R/CHANGE: ";
1410  INPUT R$
1420  IF R$ = "Q" THEN  RETURN
1430  IF R$ = "P" THEN P = P + 1: IF P > 2 THEN P = 1: RETURN

1435  IF R$ = "P" THEN  RETURN
1440 A =  VAL (R$): IF A < 1 OR A > 9 THEN  GOTO 1400
1450  RETURN
2000  REM  ** MAIN MENU **
2010 P = 1
2020  HOME : PRINT F$(0) + "-PAGE 1 OF 2"
2030  VTAB 3: CALL BU,R$,F$(1),F1$: PRINT R$
2040  CALL BU,R$,F$(2),F2$: PRINT R$
2050  CALL BU,R$,F$(3),NI$: PRINT R$
2055  CALL BU,R$,F$(4),NM$: PRINT R$
2060  PRINT F$(5) + RM$
2070  CALL BU,R$,F$(6),SH$: PRINT R$
2080  CALL BU,R$,F$(7),NS: PRINT R$
2085  CALL BU,R$,F$(14),DC: PRINT R$
2090  GOSUB 1400
2100  IF (R$ = "Q") OR (P = 2) THEN  RETURN
2110  IF A > 7 THEN  GOSUB 1400
2115  IF A = 0 GOTO 2000
2120  ON A GOSUB 2320,2340,2360,2460,2480,2470,2490
2130  GOTO 2020
2320 A = 0: IF F1$ = "YES" THEN F1$ = "NO": RETURN
2325 F1$ = "YES": RETURN
2340 A = 0: IF F2$ = "YES" THEN F2$ = "NO": RETURN
2345 F2$ = "YES": RETURN
2360 A = 0: HOME : PRINT F$(0) + " PAGE 1 OF 2"
2365  VTAB 3: INPUT "KEY IN IMPACTOR NAME: ";Y$
2366  IF Y$ = NI$ THEN  RETURN
2367 NI$ = Y$:NM$ = Y$ + "/IMP": ONERR  GOTO 2440
2368  PRINT Y$: PRINT D$;"OPEN IMP/NAM" + ",D2"
2370  PRINT D$;"READ IMP/NAM"
2371 OK = 0
2372  INPUT TI: IF TI = 0 THEN  PRINT D$;"CLOSE IMP/NAM": PRINT
"TI=0": FOR I = 1 TO 2000: NEXT I: RETURN
2374  FOR I = 1 TO TI
2376  INPUT N$(I)
2378  IF N$(I) = NI$ THEN OK = 1: REM  CHECK TO SEE IF FILE F
OR NAME DIM PAC TO RAL READ YEXISTS
2380  NEXT I
2381  PRINT D$;"CLOSE IMP/NAM"
```

```
2382  IF OK = 0 THEN  PRINT "OK=0 TI="TI: FOR I = 1 TO 1000: NEXT
I: RETURN
2384  REM  IF NAMED IMPACTOR ALREADY ON FILE, GET FILE CONTEN
TS
2385  PRINT "OK=1 TI=";TI
2386  IF RM$ = "SELECTED STAGES" THEN  RETURN
2388  PRINT D$;"OPEN" + NM$ + ",D2"
2389  PRINT D$;"READ" + NM$
2390  INPUT NS
2391  IF NS = 0 GOTO 2450
2395  FOR I = 1 TO NS
2400  INPUT JN(I),JD(I),JA(I),JS(I),JL(I),JK(I),MZ(I)
2420  NEXT I
2430  INPUT RM$,MR,SH,DC: IF SH = 1 THEN SH$ = "SLIT.": GOTO
2450
2435  IF SH = 0 THEN SH$ = "CIRC.": GOTO 2450
2440  PRINT "FILE ERROR "; PEEK (222):EF = 1: STOP
2450  PRINT D$;"CLOSE" + NM$: ONERR  GOTO 1170: RETURN
2460  IF A = 0 THEN  RETURN
2461 A = 0: HOME : PRINT F$(0)
2465  VTAB 3: INPUT "ENTER REMARKS/DESCRIPTION: ";RM$: RETURN

2470 A = 0: HOME
2475  VTAB 3: INPUT "ENTER NUMBER OF STAGES: ";NS: RETURN
2480 A = 0: IF SH$ = "CIRC." THEN SH$ = "RECT":SH = 1: RETURN

2485 SH$ = "CIRC.":SH = 0: RETURN
2490  HOME : VTAB 3: INPUT "ENTER DISCHARGE COEFFICIENT ";DC:
A = 0: RETURN
2500  REM   *** MENU PAGE 2 ***
3000  REM
3001 J = 0:HH = 10
3005 PF = 13
3010  POKE 216,0
3020  HOME : PRINT F$(0) + "-PAGE 2 OF 2"
3025  IF SH = 0 THEN  VTAB 3: PRINT F$(8): PRINT F$(9): GOTO
3050
3030  VTAB 3: PRINT F$(11): PRINT F$(12)
3050  FOR I = 1 TO NS
3070  CALL BU,R$,F$(13),I,JN(I),JS(I),JD(I),JL(I): PRINT R$
3080  NEXT I
3090  VTAB 21: HTAB 1: PRINT "TO ENTER/CHANGE DATA FOR A STAG
E ENTER  STAGE NO. OR Q)UIT OR P)AGE                ";: VTAB 22:
 HTAB 29: INPUT R$: IF R$ = "Q" OR R$ = "P" THEN  RETURN
3108 J = 0
3110 I =  VAL (R$): IF I < 1 OR I > NS GOTO 3090
3112  VTAB 21: PRINT "PRESS 'RETURN' TO ACCEPT CURRENT VALUE
 OR ENTER NEW VALUE.                "
3115  VTAB I + 4: CALL BU,R$,F$(PF),I,JN(I),JS(I),JD(I),JL(I)
: PRINT R$;: HTAB HH - 1: INPUT "";R$: IF R$ = "" GOTO 3300
3120 J = J + 1: ON J GOTO 3130,3140,3150,3160
3130 JN(I) =  VAL (R$):HH = HH + 8: GOTO 3115
3140 JS(I) =  VAL (R$):HH = HH + 8: GOTO 3115
3150 JD(I) =  VAL (R$):HH = HH + 9:JA(I) = 3.14159 * JD(I) *
JD(I) / 4
```

```
3155  IF SH = 1 THEN JA(I) = JL(I) * JD(I)
3157  GOTO 3115
3160  REM   IF SH = 0 THEN HH = 9:JA(I) = 3.14159 * JD(I) * J
D(I) / 4: GOTO 3000
3170 JL(I) =  VAL (R$):HH = 9
3175  IF SH = 1 THEN JA(I) = JL(I) * JD(I)
3177  GOTO 3000
3300 J = J + 1: ON J GOTO 3310,3320,3330,3340
3310 HH = HH + 8: GOTO 3115
3320 HH = HH + 8: GOTO 3115
3330  REM  IF SH = 0 THEN HH = 9: GOTO 3090
3335 HH = HH + 9: GOTO 3115
3340 HH = 9: GOTO 3000
3350 HH = 9: GOTO 3090
3399  REM  GRAPHIC DISPLAY OF RELATIVE SPACINGS OF STAGE D50'
S (IN TERMS OF LOG(D50))
3400 RANGE =  LOG (JK(1)) -  LOG (JK(NS))
3405  HGR2
3410  FOR I = 1 TO NS
3415 CP(I) = 240 * ( LOG (JK(1)) -  LOG (JK(I))) / RANGE
3420  HPLOT 250 - CP(I),130 TO 250 - CP(I),150
3421  HPLOT 250 - CP(I),50 + 4 * I
3425  NEXT I
3427  HPLOT 250 - CP(1),120 TO 250 - CP(1),125
3430  GET R$: TEXT : RETURN
3499  STOP
3500  REM  CHECK FOR OVERLAPPING STAGES. WARNINGS WILL BE GIV
EN IF CUTS ARE CLOSER THAN A FACTOR OF 1.5 FROM ONE ANOTHER.
3510 MR = 0:CRITERIA = 1.5: HOME
3520  FOR I = 1 TO NS
3525  IF SH = 0 THEN JK(I) = JS(I) *  SQR (.27 * (JD(I) ^ 3) *
JN(I) * 3.14159)
3526  IF SH = 1 THEN JK(I) = JS(I) *  SQR (1.08 * (JD(I) ^ 2)
 * JL(I) * JN(I))
3527  PRINT "CONSTANT FOR STAGE ";I;" = ";JK(I)
3528  NEXT I
3530  PRINT : PRINT "PRESS ANY KEY TO CONTINUE": GET R$: PRINT

3531  PRINT "PLOT OF RELATIVE CUT SPACINGS ? (Y/N)": GET R$: IF
R$ = "Y" THEN  GOSUB 3400
3532 MR = 0: FOR I = 1 TO NS:MZ(I) = 0: NEXT I
3535  FOR I = 1 TO NS - 1
3537  IF MZ(MR) = I GOTO 3700
3540  IF JK(I) > CRITERIA * JK(I + 1) THEN 3700
3570  HOME : PRINT "THE STAGE CONSTANT FOR STAGE ";I + 1;" IS
 TOO": PRINT "LARGE COMPARED TO THAT OF STAGE ";I;".": PRINT
"THIS WILL INTRODUCE AN IRREGULARITY IN  THE RECOVERED SIZE D
ISTRIBUTION."
3600  PRINT "THE FOLLOWING IS RECOMMENDED:"
3620  PRINT "THE MASSES ON STAGES ";I + 1;" AND ";I + 2;" WIL
L": PRINT "BE ASSIGNED TO STAGE ";I + 2;", AND STAGE ";I + 1:
 PRINT "WILL BE OMITTED IN SPLINE FITS."
3650  PRINT
3660  PRINT "DO YOU WANT TO TAKE THIS ACTION (Y/N)?": GET R$:
 PRINT
```

```
3680  IF R$ = "N" THEN 3696
3690  IF R$ <  > "Y" THEN 3660
3695 MR = MR + 1:MZ(MR) = I + 1: GOTO 3700
3696  PRINT "DO YOU WANT TO OMIT STAGE ";I;" INSTEAD? (Y/N)":
 GET R$: IF R$ = "N" THEN 3700
3697  IF R$ <  > "Y" THEN 3696
3698 MR = MR + 1:MZ(MR) = I
3700  NEXT I
3710  RETURN
4000  REM  ** HARDCOPY OPTION **
4010  PRINT "PRINTED COPY OPTION NOW BEING EXECUTED-TURN PRIN
TER ON AND PRESS ANY KEY": GET R$
4012  PRINT
4015  PRINT D$;"PR#1"
4020  PRINT F$(0)
4040  CALL BU,R$,F$(2),F2$: PRINT R$
4050  CALL BU,R$,F$(3),NI$: PRINT R$
4055  CALL BU,R$,F$(4),NM$: PRINT R$
4060  PRINT F$(5) + RM$
4070  CALL BU,R$,F$(6),SH$: PRINT R$
4080  CALL BU,R$,F$(7),NS: PRINT R$
4085  CALL BU,R$,F$(14),DC: PRINT R$
4090  PRINT : PRINT : PRINT
4100  IF SH = 0 THEN  PRINT F$(8): PRINT F$(9): GOTO 4120
4110  PRINT F$(11): PRINT F$(12)
4120  FOR I = 1 TO NS
4130  IF SH = 0 THEN  CALL BU,R$,F$(13),I,JN(I),JS(I),JD(I),J
L(I): PRINT R$
4140  IF SH = 1 THEN  CALL BU,R$,F$(13),I,JN(I),JS(I),JD(I),J
L(I): PRINT R$
4150  NEXT I
4160  IF MR = 0 THEN  PRINT D$;"PR#0": RETURN
4200  PRINT : PRINT : PRINT
4300  FOR I = 1 TO MR
4310  PRINT " THE MASS ON STAGE ";MZ(I);" AND ";MZ(I) + 1;" W
ILL BE ASSIGNED TO THE CUTPOINT OF STAGE ";MZ(I) + 1;" FOR TH
E SPLINE FITS, AND STAGE ";MZ(I);" WILL BE OMITTED IN SPLINE
FITS": PRINT
4320  NEXT I
4490  PRINT D$;"PR#0"
4500  RETURN
5000  REM  ** DISK UPDATE **
5001  PRINT "": PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"CLOS
E" + NM$: PRINT D$;"DELETE" + NM$
5007  PRINT D$;"OPEN" + NM$ + ",D2"
5010  PRINT D$;"WRITE" + NM$
5020  PRINT NS
5030  FOR I = 1 TO NS
5040  PRINT JN(I): PRINT JD(I): PRINT JA(I): PRINT JS(I): PRINT
JL(I): PRINT JK(I): PRINT MZ(I)
5045  NEXT I
5050  PRINT RM$: PRINT MR: PRINT SH: PRINT DC
5090  PRINT D$;"CLOSE" + NM$
5095  REM   PRINT "OK=";OK: INPUT "TO CONT.ENTER Y";R$
5100  IF OK = 1 THEN  RETURN
```

```
5499  REM  ADD NEW IMPACTOR NAME TO INDEX FILE
5500  PRINT D$;"OPEN IMP/NAM" + ",D2"
5510  PRINT D$;"READ IMP/NAM"
5520  INPUT TI
5522  FOR I = 1 TO TI
5524  INPUT N$(I)
5526  NEXT I
5530 TI = TI + 1
5540  PRINT D$;"CLOSE IMP/NAM"
5550  PRINT D$;"OPEN IMP/NAM" + ",D2"
5560  PRINT D$;"WRITE IMP/NAM"
5570  PRINT TI
5580  FOR I = 1 TO TI - 1
5590  PRINT N$(I)
5600  NEXT I
5610  PRINT NI$
5620  PRINT D$;"CLOSE IMP/NAM"
5630  RETURN
5900  PRINT "DISK ERROR: "; PEEK (222)
5910  PRINT "CHECK DRIVE, ETC. IF NEEDED PRESS 'CONTROL C' AN
D THEN RESTART DISK SAVE WITH 'RUN 5000'
5920  GOTO 5000
6000  HOME
6364  REM  GET IMPACTOR DATA FOR STAGE SELECTION FROM PREVIOU
SLY EXISTING FILE
6365  VTAB 3: INPUT "KEY IN IMPACTOR NAME: ";Y$
6366  IF Y$ = NI$ THEN  RETURN
6367 NI$ = Y$:NF = 1:NM$ = Y$ + "/IMP": ONERR  GOTO 2440
6368  PRINT Y$: PRINT D$;"OPEN IMP/NAM" + ",D2"
6370  PRINT D$;"READ IMP/NAM"
6371 OK = 0
6372  INPUT TI: IF TI = 0 THEN  PRINT D$;"CLOSE IMP/NAM": PRINT
"TI=0": FOR I = 1 TO 2000: NEXT I: RETURN
6374  FOR I = 1 TO TI
6376  INPUT N$(I)
6378  IF N$(I) = NI$ THEN OK = 1
6380  NEXT I
6381  PRINT D$;"CLOSE IMP/NAM"
6382  IF OK = 0 THEN  PRINT "OK=0 TI="TI: FOR I = 1 TO 1000: NEXT
I: RETURN
6385  PRINT "OK=1 TI=";TI
6386  REM       RETURN
6388  PRINT D$;"OPEN" + NM$ + ",D2"
6389  PRINT D$;"READ" + NM$
6390  INPUT NZ
6391  IF NZ = 0 GOTO 6450
6395  FOR I = 1 TO NZ
6400  INPUT ZN(I),ZD(I),ZA(I),ZS(I),ZL(I),ZK(I),ZZ(I)
6420  NEXT I
6430  INPUT RM$,MR,SH,DC: IF SH = 1 THEN SH$ = "SLIT.": GOTO
6450
6435  IF SH = 0 THEN SH$ = "CIRC.": GOTO 6450
6440 NF = 0: PRINT "FILE ERROR "; PEEK (222):EF = 1: STOP
6450  PRINT D$;"CLOSE" + NM$: ONERR  GOTO 1170:NM$ = "": RETURN
```

```
7000 CZ = 0
7001 J = 0:HH = 9
7005 PF = 13
7010 P = 2:P1 = 1:P2 = 9:P3 = 17:P4 = 25:P5 = 33
7020  HOME : PRINT F$(0) + "STAGE SELECT"
7025  IF SH = 0 THEN  VTAB 3: PRINT F$(8): PRINT F$(9): GOTO
7050
7030  VTAB 3: PRINT F$(11): PRINT F$(12)
7050  FOR I = 1 TO NZ
7070  CALL BU,R$,F$(13),I,ZN(I),ZS(I),ZD(I),ZL(I): PRINT R$
7080  NEXT I
7089  REM  MAKE SELECTIONS
7090  VTAB 21: HTAB 1: PRINT "TO SELECT A STAGE ENTER ITS STA
GE NO. OR Q)UIT WHEN DONE                ";: VTAB 22: HTAB 29: INPUT
R$: IF R$ = "Q" THEN NI$ = "":NM$ = "":RM$ = "SELECTED STAGES
": RETURN
7100 NC =  VAL (R$): IF NC < 1 OR NC > NZ THEN 7090
7108 J = 0
7110 CZ = CZ + 1: VTAB 23: PRINT "FOR STAGE ";CZ;" USING STAG
E ";NC;" ABOVE    ":JN(CZ) = ZN(NC):JS(CZ) = ZS(NC):JD(CZ) = Z
D(NC):JL(CZ) = ZL(NC):MZ(CZ) = ZZ(NC):JK(CZ) = JK(NC):JA(CZ) =
ZA(NC)
7120 NS = CZ: GOTO 7090
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)    APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM      *  *  *  * IMPACTOR PROGRAM VERSION 4.1 *  *  *
*
2  REM  ***** MAIN IMP. DATA REDUCTION
3  REM   **** BASED ON DRI TRS 80 IMP. PROG. IN TURN BASED ON
 SORI "CIDRS"
4  REM  **** APPLE VERSION BY J D MCCAIN       ****
5  REM   **** VERSION 1.0 CREATED 1/28/83 V1.2 3/16/83 V1.5 5
/2/83 V2.2 5/19/83 V2.3 10/20/83 V2.4 2/23/84 V2.5 4/12/84 (T
HEO. SQR PSI)
6  REM   7/20/84 ADD AV, ND, AND IS TO OUTPUT FILE ON DISK 12
/10/84 ADD RAW DATA SAVE&RETRIEVE
7  REM   V3.0 4/22/85 REVISE PRESSURE DROP ALLOCATION WHEN DP
 TOTAL IS ENTERED WITH DATA
8  REM      12/12/85 V3.1 ADD COMP. GAS CORRECTIONS TO STAGE D
P CALC'S,  DROP TEST FILE INFO READS, & CHANGE FROM V*D50 TO
V*D50*SQR(RHO) FOR BOUNCE TEST V4.0 12/16/85 ADD METER CORR &
 %H2O CALC, 2/13/86 ADD MANUAL GAS COMP. INPUT (V4.1)
9  GOSUB 63999: REM  INITIALIZE PRINT FORMATTER
15 D$ =  CHR$ (13) +  CHR$ (4)
16 WG = 0:RH = 2.5:DA = 0:DL = 0
19  REM ***** NOTE! DO NOT EDIT LINE #20 NOR PLACE ANY 'DIM'
STATEMENTS BEFORE IT OR DATA SAVE PART OF PROGRAM WILL NOT WO
RK
20  DIM M(23),JN(20),DJ(20),JA(20),SI(20),JS(20),MZ(20),DA(40
),RE(20),U(5),F(5),MW(5): REM   NOTE! DO NOT EDIT THIS LINE!!
!!
30 I$ = "INLET":FI$ = "XX"
50  DIM DI$(50)
60  DIM F$(35),ZZ$(100)
100  HOME : GOSUB 1000: REM  INITIALIZE PROGRAM
105  POKE 216,0: PRINT "DO YOU WANT TO RETRIEVE AN OLD": PRINT
"DATA SET? (Y/N)": GET R$: IF R$ = "Y" THEN  GOSUB 31000
110  POKE 216,0: GOSUB 2000
115 ZY = 0: IF NM$ = FI$ THEN  HOME : PRINT "THE NAME USED FO
R THIS RUN IS THE SAME  AS THAT OF THE OLD/LAST RUN.  THE
   PREVIOUS DATA WILL BE OVERWRITTEN IF THERESULTS ARE SAVED.
": PRINT "IS IT OK TO PROCEED (Y/N) ?": GET A$: IF A$ <  > "Y
" GOTO 110
116  IF NM$ = "" THEN  HOME : PRINT "NEED FILE NAME - WILL GO
 BACK TO PAGE 1 OF DATA ENTRY. PRESS ANY KEY TO CONT.": GET A
$: GOTO 110
120  HOME : PRINT "CALCULATIONS"
140  PRINT : PRINT "FLOW RATES": GOSUB 4000
155  PRINT "PRESSURE DROPS": GOSUB 4900: IF SH = 1 THEN 160
156  INPUT "C(ALIB. OR T)HEO. SQRT PSI ?";TH$: IF TH$ <  > "C
" AND TH$ <  > "T" THEN 156
157  IF TH$ = "T" THEN  GOSUB 20000
160  POKE 216,0: PRINT "CUTPOINTS": GOSUB 5000
170  HOME : PRINT "CALCULATIONS"
180  PRINT "FIT - INIT": GOSUB 5500
182  IF ZY = 1 THEN  GOTO 110
185  PRINT "LOG-NORMAL SIZE DISTRIBUTION": GOSUB 10000
```

```
190  PRINT "SPLINE FIT": GOSUB 6000
200  GOSUB 9000: PRINT D$;"PR#0": REM  HARDCOPY
220  GOSUB 7000: REM  DISK SAVE
225  PRINT "DO YOU WANT TO SAVE RAW DATA? (Y/N)": GET R$: IF
R$ = "Y" THEN  GOSUB 30000
240  HOME : VTAB 5: PRINT "R)ETURN TO MAIN MENU OR": INPUT "C
)ONTINUE WITH MORE RUNS";R$
250  IF R$ = "R" THEN 997
260  IF R$ <  > "C" THEN 240
270  GOTO 105
997  PRINT D$;"RUN MAIN MENU" + ",D1"
999  END
1000  REM     <<< *** INITIALIZATION ***>>>
1002  DIM XX(20),YY(20),Y1(20),Y2(20),DG(20),XP(20)
1004  DIM H(20),DL(20),H2(20),B(20),DQ(20),S2(20),C(20),S3(20
)
1005  DIM CU(20),CC(20),PS(20),DP(20),VJ(20),D5(20),D6(20),X(
20),Y(20)
1006 F$(29) = " 1)PART. DIAMETER     "
1008 F$(30) = "12) ORIFICE ID (OPTIONAL): &"
1009 F$(31) = "13) SUBSTRATE MATERIAL: "
1010 F$(32) = "14)WATER VOLUME    ####.#  CC"
1012 F$(33) = "15)METER FACTOR       #.#####"
1018 F$(0) = "IMPACTOR VERSION 4.1"
1020 F$(1) = " 2)DATE OF TEST: "
1030 F$(2) = " 3)TIME OF TEST: "
1040 F$(3) = " 4)LOCATION OF TEST: "
1050 F$(4) = " 5)TEST NUMBER ####"
1060 F$(5) = " 7)RUN NUMBER: "
1070 F$(6) = " 8)RUN REMARKS: "
1080 F$(7) = "10)IMPACTOR TYPE: "
1090 F$(8) = " 1)GAS METER VOL   ###.### CUBIC FEET"
1100 F$(9) = " 2)IMPACTOR DELTA P ##.## IN. HG."
1110 F$(10) = " 3)ORIFICE DELTA P   #.## INCHES H2O"
1120 F$(11) = " 4)STACK PRESSURE   ##.## INCHES H2O"
1130 F$(12) = " 5)BAROMETRIC PRES  ##.## INCHES HG"
1140 F$(13) = " 6)STACK TEMP      ####    DEGREES F"
1150 F$(14) = " 7)METER TEMP       ###    DEGREES F"
1160 F$(15) = " 8)IMPACTOR TEMP   ####    DEGREES F"
1170 F$(16) = " 9)SAMPLE TIME     ####.## MINUTES"
1180 F$(17) = "10)AVG GAS VEL      ###.## FEET/SEC"
1190 F$(18) = "11)ORIFICE PRES      ##.## INCHES HG"
1200 F$(19) = "12)NOZZLE DIA         #.### INCHES"
1205 F$(21) = "13)MAX PART DIA    ####.#  MICRONS"
1210 F$(20) = "     CO2 ##.##%;         CO ##.##%"
1220 F$(22) = "     O2  ##.##%;         N2 ##.##%"
1230 F$(24) = " 9)WATER VAPOR          ##.##%"
1240 F$(25) = "11) PARTICLE DENSITY ##.## GRAMS/CC"
1250 F$(26) = " MASS GAIN OF &; ###.## MG"
1260 F$(27) = " 6)TEST TYPE           "
1265 F$(28) = "CUM MASS LESS THAN ##.###; MICRON: ###.##; MG/
DNM3 (###.## %)"
1269  REM  GET FILE VALUE FOR MOISTURE CONTENT
1270  PRINT D$;"OPEN METH4.DAT" + ",D2": PRINT D$;"READ METH4
.DAT"
```

```
1280  INPUT X,X,X,X,X,BW
1290  PRINT D$;"CLOSE"
1299  REM  GET FILE VALUES FOR DRY GAS COMPOSITION
1300  PRINT D$;"OPEN ORSAT.DAT" + ",D2": PRINT D$;"READ ORSAT
.DAT"
1310  INPUT CM,CD,O2,N2
1320  PRINT D$;"CLOSE"
1330 TH$ = "C":MF = 1:GD = 1.293E - 03:PM = 1.4764E - 05:MA =
28.97:DC2 = .61 * .61:HG = 13.6:QC = 471.95:FR = 460:FS = 492
:SP = 29.92:X0 = 1000:F1 = 10: REM   DC2=SQUARE OF DISCHARGE
COEFF.
1335  GOSUB 5700
1340  RETURN
1400  REM          **** MENU INSTRUCTIONS
1410  VTAB 21: PRINT "ENTER: Q)UIT, P)AGE, OR NUMBER OF ITEM
TO ENTER/CHANGE: ""
1420  VTAB 22: HTAB 20: INPUT R$: IF R$ = "Q" THEN  RETURN
1430  IF R$ = "P" THEN  RETURN
1440 P =  VAL (R$): IF P < 1 OR P > MX THEN  GOTO 1410
1450  RETURN
2000  REM     ***<<< MENU, PAGE 1 >>>***
2010 MX = 13:ZY = 0
2020  HOME : PRINT F$(0);"  - PAGE 1 OF 3": PRINT
2025  PRINT F$(29);: IF F1 = 1 THEN  PRINT "PHYSICAL": GOTO 2
030
2026  IF F1 = 0 THEN  PRINT " IMP. AERO.": GOTO 2030
2027 F1 = 10: PRINT "CLASS. AERO."
2030  PRINT F$(1);DT$
2040  PRINT F$(2);T$
2050  PRINT F$(3);L$
2060  CALL BU,R$,F$(4),TN: PRINT R$
2070  PRINT F$(27);I$
2080  PRINT F$(5);RN$;" -FILE NAME: ";NM$
2090  PRINT F$(6);RR$
2100  CALL BU,R$,F$(24),BW * 100: PRINT R$
2104  CALL BU,R$,F$(20),CD,CM: PRINT R$
2106  CALL BU,R$,F$(22),O2,N2: PRINT R$: PRINT
2110  PRINT F$(7);IM$;"  ";IN$
2155  CALL BU,R$,F$(25),RH: PRINT R$
2157  CALL BU,R$,F$(30),RO$: PRINT R$
2158  PRINT F$(31) + SM$
2160  GOSUB 1400
2200  IF R$ = "Q" THEN  RETURN
2210  IF R$ = "P" THEN  GOTO 3000
2230  ON P GOSUB 2252,2260,2270,2280,2290,2390,2420,2520,2730
,2530,2240,2610,2850
2235  GOTO 2010
2240  VTAB 23: HTAB 15: INPUT " PART. DENS.= ";RH: RETURN
2252  VTAB 23: HTAB 15: PRINT "ENTER DIAM.BASIS I)MP.AERO, C)
LASS.AERO,OR P)HYSICAL": GET X$: IF X$ = "I" THEN F1 = 0: RETURN

2253  IF X$ = "C" THEN F1 = 10: RETURN
2254 F1 = 1: RETURN
2260  VTAB 23: HTAB 15: INPUT "ENTER TEST DATE ";DT$: RETURN
```

```
2270  VTAB 23: HTAB 15: INPUT "ENTER TEST TIME ";T$: RETURN
2280  VTAB 23: HTAB 15: INPUT "TEST LOCATION ";L$: RETURN
2290  VTAB 23: HTAB 15: INPUT "ENTER TEST NUMBER ";Y: IF TN =
Y THEN  RETURN
2295 TN = Y: GOTO 2430
2390  VTAB 23: HTAB 15: INPUT "ENTER I)NLET OR O)UTLET ";X$: IF
X$ = "I" THEN I$ = "INLET": RETURN
2400 X$ = "O":I$ = "OUTLET"
2410  IF RN$ = "" THEN  RETURN
2415  GOTO 2430
2420  VTAB 23: HTAB 15: INPUT "ENTER RUN NUMBER ";RN$
2429  REM  BUILD FILE NAME FOR SAVING RESULTS
2430 NM$ = "T" +  STR$ (TN) + "R" + RN$ + "." +  LEFT$ (I$,1)
 + "T"
2431 ZZ$ = "RUN":Y$ = NM$
2433  GOSUB 2800: REM  CHECK FOR PRIOR USE OF FILE NAME
2436  IF OK = 0 THEN  RETURN
2470  VTAB 24: PRINT "A FILE FOR THAT TEST/RUN ALREADY EXISTS
"
2480  FOR I = 1 TO 2000: NEXT I
2490 RN$ = "":NM$ = "": RETURN
2520  VTAB 23: HTAB 15: INPUT "ENTER RUN REMARKS ";RR$: RETURN

2530  VTAB 23: HTAB 15: INPUT "ENTER IMP. TYPE ";Y$
2535 IM$ = Y$
2536 ZZ$ = "IMP"
2537  GOSUB 2800: REM  CHECK FOR IMPACTOR FILE EXISTENCE
2538  IF OK = 0 THEN IM$ = IM$ + " NOT IN FILE": RETURN
2539  REM  GET IMPACTOR HARDWARE DATA
2540  PRINT D$;"OPEN" + IM$ + "/IMP" + ",D2": PRINT D$;"READ"
 + IM$ + "/IMP"
2550  INPUT S
2560  FOR I = 1 TO S
2570  INPUT JN(I),DJ(I),JA(I),SI(I),JS(I),MZ(I),MZ(I)
2580  NEXT I
2590  INPUT IN$,MR,SH,DC2
2600  PRINT D$;"CLOSE":DC2 = DC2 * DC2: RETURN
2610  VTAB 23: HTAB 5: INPUT "ENTER ORIFICE ID (.DDDL) ";RO$:
Y$ =  RIGHT$ (RO$,1):ZZ$ = "ORI": GOSUB 2800
2620  IF OK = 0 THEN RO$ = RO$ + " NOT IN FILE": RETURN
2629  REM  GET ORIFICE METER CONSTANTS
2630  PRINT D$;"OPEN" + Y$ + "/ORI" + ",D2": PRINT D$;"READ" +
Y$ + "/ORI"
2640  INPUT NN
2650  FOR I = 1 TO NN
2660  INPUT DI,CQ,CP,CT,PP
2670  IF DI =  VAL (RO$) THEN  PRINT D$;"CLOSE":I = NN: NEXT
I: RETURN
2680  NEXT I
2690 RO$ = RO$ + " NOT IN FILE": PRINT D$;"CLOSE": RETURN
2730  VTAB 23: HTAB 20: INPUT "% H20= ";R$: IF R$ = "" THEN  GOTO
2742
2735 BW =  VAL (R$):BW = BW / 100:WA = 0
2740 F$(24) =  LEFT$ (F$(24),28) + " (KEYBOARD)"
2742  VTAB 23: HTAB 20: PRINT "CHANGE OTHER GASES?";: GET R$:
```

```
 PRINT R$: IF R$ <  > "Y" THEN  RETURN
2744  VTAB 23: HTAB 20: PRINT "                          ": VTAB 23
: HTAB 20: INPUT "ENTER CO2: ";R$: IF R$ <  > "" THEN CD =  VAL
(R$)
2746  VTAB 23: HTAB 20: PRINT "                          ": VTAB 23
: HTAB 20: INPUT "ENTER CO : ";R$: IF R$ <  > "" THEN CM =  VAL
(R$)
2748  VTAB 23: HTAB 20: PRINT "                          ": VTAB 23
: HTAB 20: INPUT "ENTER  O2: ";R$: IF R$ <  > "" THEN O2 =  VAL
(R$)
2750 N2 = 100 - (O2 + CD + CM)
2760  RETURN
2800  PRINT D$;"OPEN" + ZZ$ + "/NAM" + ",D2": PRINT D$;"READ"
 + ZZ$ + "/NAM"
2802 OK = 0
2805  INPUT N9: IF N9 = 0 THEN  PRINT D$;"CLOSE": PRINT "FILE
 FOR ";ZZ$;"/NAM EMPTY": FOR I = 1 TO 3000: NEXT I: RETURN
2810  FOR I = 1 TO N9
2815  INPUT YY$: IF YY$ = Y$ THEN OK = 1
2820  NEXT I
2830  PRINT D$;"CLOSE": IF N9 = 100 THEN  HOME : FLASH : PRINT
"FILE FOR ";ZZ$;"/NAM FULL": NORMAL : PRINT "PURGE FILE BEFOR
E CONTINUING": FOR I = 1 TO 1000: NEXT I
2840  RETURN
2850  VTAB 23: INPUT "ENTER SUBTRATE MATERIAL: ";SM$: RETURN

3000  REM       <<<*** MENU, PAGE 2 ***>>>
3010 P = 1
3020  HOME : PRINT F$(0);" - PAGE 2 OF 3": PRINT
3030  CALL BU,R$,F$(8),VM: PRINT R$
3040  CALL BU,R$,F$(9),DP: PRINT R$
3050  CALL BU,R$,F$(10),OP: PRINT R$
3060  CALL BU,R$,F$(11),PS: PRINT R$
3070  CALL BU,R$,F$(12),PB: PRINT R$
3080  CALL BU,R$,F$(13),TS: PRINT R$
3090  CALL BU,R$,F$(14),TM: PRINT R$
3100  CALL BU,R$,F$(15),TI: PRINT R$
3110  CALL BU,R$,F$(16),TD: PRINT R$
3120  CALL BU,R$,F$(17),AV / 60: PRINT R$
3130  CALL BU,R$,F$(18),PC / 13.569: PRINT R$
3140  CALL BU,R$,F$(19),ND: PRINT R$
3150  CALL BU,R$,F$(21),X0: PRINT R$
3152  CALL BU,R$,F$(32),WA: PRINT R$
3154  CALL BU,R$,F$(33),MF: PRINT R$
3160 MX = 15: GOSUB 1400
3190  IF R$ = "Q" THEN  RETURN
3200  IF R$ = "P" THEN  GOTO 3500
3230  ON P GOSUB 3260,3270,3280,3290,3300,3310,3320,3330,3340
,3350,3360,3370,3380,3390,3400
3250  GOTO 3020
3260  VTAB 24: HTAB 5: INPUT "VM (0 FOR ORIFICE FLOW) = ";VM:
 RETURN
3270  VTAB 24: INPUT "IMPACTOR DP (FOR THEO.DP ENTER 0) DP= "
;DP: RETURN
3280  VTAB 24: HTAB 15: INPUT "ORIFICE DP= ";OP: RETURN
```

```
3290  VTAB 24: HTAB 5: INPUT "STACK DP TO AMBIENT = ";PS: RETURN

3300  VTAB 24: HTAB 15: INPUT "PB= ";PB: RETURN
3310  VTAB 24: HTAB 15: INPUT "TS= ";TS: RETURN
3320  VTAB 24: HTAB 15: INPUT "TM= ";TM: RETURN
3330  VTAB 24: HTAB 15: INPUT "TI= ";TI: RETURN
3340  VTAB 24: HTAB 15: INPUT "SAMPLE DURATION= ";TD: RETURN

3350  VTAB 24: HTAB 15: INPUT "AV= ";AV:AV = AV * 60: RETURN

3360  VTAB 24: HTAB 5: INPUT "ORIFICE DP TO AMBIENT = ";PC:PC
 = PC * 13.569: RETURN
3370  VTAB 24: HTAB 15: INPUT "ND= ";ND: RETURN
3380  VTAB 24: HTAB 15: INPUT "MAX DIA= ";X0: RETURN
3390  VTAB 24: HTAB 15: INPUT "WATER VOL.= ";WA: RETURN
3400  VTAB 24: HTAB 15: INPUT "METER FACTOR = ";MF: RETURN
3498  RETURN
3500  REM          <<< *** MENU, PAGE 3, IMPACTOR STAGE WEIGHT
S ***>>>
3510 P = 1:WG = 1
3520  HOME : PRINT F$(0);" - PAGE 3 OF 3"
3540 NZ = S - MR:MX = S + 3: FOR I = 1 TO S + 3
3550  IF I <  = S THEN X$ = "STAGE " +  STR$ (I)
3570  IF I = S + 1 THEN X$ = "FILTER " +  STR$ (I)
3575  IF I = S + 2 THEN  PRINT :X$ =  STR$ (I) + " BLANK SUBS
T."
3578  IF I = S + 3 THEN X$ =  STR$ (I) + " BLANK FILTER"
3580  CALL BU,R$,F$(26),X$,M(I): PRINT R$
3590  NEXT I
3600  GOSUB 1400
3640  IF R$ = "Q" THEN  RETURN
3650  IF R$ = "P" THEN  GOTO 2000
3670  VTAB 23: HTAB 10: PRINT "ENTER MASS ";P: VTAB 23: HTAB
23: INPUT ":";M(P)
3690 FF = M(S + 1):FC = M(S + 3):SC = M(S + 2): GOTO 3520
4000  REM   <<< *** SUBROUTINE FLOW ***>>>
4002  IF WA > 0 AND VM > 0 THEN VH = .0472 * WA:VS = 17.65 *
VM * MF * (PB - (OP - PC) / 13.6) / (TM + FR):BW = VH / (VH +
VS): REM  CALCULATE MOISTURE CONTENT IF CONDENSED WATER & GAS
 METER VOLUMES WERE ENTERED
4003  PRINT "VISCOSITY": GOSUB 4500
4005  IF VM = 0 THEN QO = CQ *  SQR (OP * CP * MA * (TM + FR)
 / PP / (CT + FR) / DM / (PB + PC / HG)):QS = QO * (PB + PC /
HG) * FS / SP / (TM + FR):QI = QS * (TI + FR) * SP / FS / (PB
 + PS / HG) / (1 - BW): REM  FLOW FROM ORIFICE METER
4020  IF VM <  > 0 THEN QI = MF * VM / TD * (PB - (OP - PC) /
HG) / (PB + PS / HG) * (TI + FR) / ((TM + FR) * (1 - BW)): REM
 FLOW FROM GAS METER
4030  IF VM <  > 0 THEN QS = MF * VM / TD * 17.65 * (PB - (OP
 - PC) / HG) / (TM + FR)
4040  IF AV <  > 0 AND ND <  > 0 THEN IS = 183.35 * QI / (ND *
ND * AV) * 100 * (TS + FR) / (TI + FR): REM  PERCENT ISOKINET
IC
4045  PRINT "QI = ";QI;" QS= ";QS;" IS= ";IS: IF WA > 0 THEN
 PRINT "% WATER = ";BW * 100
```

```
4050  RETURN
4500  REM   <<<*** SUBROUTINE VISCOSITY ***>>>
4509  REM    CALCULATE WET AND DRY MOLECULAR WEIGHTS
4510 MW(1) = 44.1
4520 MW(2) = 28.01
4530 MW(3) = 28.02
4540 MW(4) = 32
4550 MW(5) = 18.02
4560 F(1) = CD / 100
4570 F(2) = CM / 100
4580 F(3) = N2 / 100
4590 F(4) = O2 / 100
4600 F(5) = BW
4610 MW = 0: FOR I = 1 TO 4:MW = MW + F(I) * MW(I): NEXT I:DM
 = MW:MW = MW * (1 - BW) + BW * MW(5)
4619  REM   CALCULATE VISCOSITIES OF INDIVIDUAL GAS COMPONENT
S FROM CURVE FITS TO DATA IN CRC HANDBOOK OF CHEMISTRY AND PH
YSICS
4620 T = (TI - 32) * 5 / 9
4630 U(1) = 138.494 + T * (.499 + T * ( - .286E - 3 + T * .97
2E - 7))
4640 U(2) = 165.763 + T * (.442 + T * ( - .213E - 3))
4650 U(3) = 167.086 + T * (.417 + T * ( - .139E - 3))
4660 U(4) = 190.187 + T * (.558 + T * ( - .336E - 3 + T * .13
9E - 6))
4670 U(5) = 87.8 + T * (.374 + T * ( - .283E - 4))
4679  REM  CALCULATE VISCOSITY OF GAS MIXTURE BY METHOD GIVEN
 BY WILKE - J. CHEM. PHYSICS VOL 18
4680 U = 0
4690  FOR I = 1 TO 5
4700  IF F(I) = 0 GOTO 4790
4710 SU = 0
4720  FOR J = 1 TO 5
4730  IF F(I) = 0 GOTO 4770
4740  IF I = J GOTO 4770
4750 VT = 1 +  SQR (U(I) / U(J) *  SQR (MW(J) / MW(I)))
4760 SU = SU + VT * VT / (4 *  SQR ((1 + MW(I) / MW(J)) / 2))
 * F(J)
4770  NEXT J
4780 U = U + U(I) / (1 + SU / F(I))
4790  NEXT I
4795  PRINT "VIS = ";U;" UP"
4800 U = U * 1E - 6
4810  RETURN
4900  REM  ****"THEO. PRES. DROP CALC. FOR COMPRESSIBLE FLOW
****
4901  REM   BASED ON PRESURE DROP FOR SHARP EDGED ORIFICE
4902  PRINT "HARDCOPY OF STAGE DP CALC'S?": GET R$: IF R$ = "
Y" THEN  PRINT D$;"PR#1"
4910 DP(0) = 0:PS(0) = PB + PS / HG:Y2 = 1: REM "Y2=COMPRESSI
ON CORRECTION FACTOR
4920  FOR I = 1 TO S
4921  PRINT : PRINT "FOR STAGE=";I
4925 PS(I) = PS(I - 1) - DP(I - 1): REM "STAGE INLET PRES.
4927  PRINT "P IN.= ";PS(I)
```

```
4930 VJ(I) = QC * QI * PS(0) / (JA(I) * JN(I) * PS(I)): REM "
PLUG FLOW VELOCITY AT JET INLET
4931 RE(I) = GD * PS(I) * MW * FS * VJ(I) * DJ(I) / SP / (TI +
FR) / MA / U:LRE = .434 *  LOG (RE(I)): REM  CALCULATE REYNOL
DS NUMBER OF FLOW
4932  PRINT "RE=";RE(I)
4934  REM   "DISCHARGE COEFFICIENT FOR SHARP EDGED ORIFICE VS
 RE. NO. - APPROACH RATIO = 0.2 FROM PIECEWISE FIT TO CURVE I
N BROWN - "UNIT OPERATIONS"
4935 DC2 = (LRE < 1.55) * (.273 * LRE + .2173) + (LRE >  = 1.
55 AND LRE < 2) * (.089 * LRE + .5022) + (LRE >  = 2 AND LRE <
2.2) * (.05 * LRE + .58) + (LRE >  = 2.2 AND LRE < 3) * ( - .
05 * LRE + .8) + (LRE >  = 3 AND LRE < 4) * ( - .03 * LRE + .
74) + (LRE >  = 4) * .62:DC2 = DC2 * DC2
4936  PRINT "DC="; SQR (DC)
4940 DP(I) = PM * GD * PS(I) * MW * FS * VJ(I) * VJ(I) / SP /
(TI + FR) / MA / DC2 / Y2:DP(I) = DP(I) * .78: REM "PRESSURE
DROP ESTIMATE
4941 Y2 = 1 - DP(I) / PS(I) * .25:Y2 = Y2 * Y2: REM   "COMPRE
SSION CORRECTION FACTOR FROM FIT TO CURVE IN CONSIDINE - "PRO
CESS INSTRUMENTS AND CONTROLS HANDBOOK"
4942  PRINT "DP EST.=";DP(I)
4943  PRINT "Y="; SQR (Y2)
4950 DP(I) = PM * GD * PS(I) * MW * FS * VJ(I) * VJ(I) / SP /
(TI + FR) / MA / DC2 / Y2:DP(I) = DP(I) * 0.78: REM "CORRECTE
D PRESSURE DROP
4951  PRINT "DP=";DP(I): PRINT
4955  IF (DP(I) / PS(I)) > .47 THEN  PRINT "FLOW SONIC AT STA
GE ";I:DP(I) = 0.47 * PS(I): PRINT "REVISED DP=";DP(I): REM "
LIMIT TO SONIC DP
4960  NEXT I
4961  IF DP = 0 GOTO 4991
4965  REM "SCALE DP'S IF MEASURED PRESSURE DROP WAS INPUT
4971  FOR I = 1 TO S:DP(I) = DP(I) * DP / (PS(0) - PS(S) + DP
(S)): NEXT I
4972  FOR I = 1 TO S:PS(I) = PS(I - 1) - DP(I - 1): NEXT I
4973  FOR I = 1 TO S:VJ(I) = QC * QI * PS(0) / (JA(I) * JN(I)
 * PS(I)): NEXT I
4991  PRINT "STAGE  VJET,CM/S  RE. NO.   DP  P IN"
4992 F$ = "  ##;    ####.#;    #####;   ##.#;  ##.##"
4993  FOR I = 1 TO S
4994  CALL BU,R$,F$,I,VJ(I),RE(I),DP(I),PS(I): PRINT R$
4996  NEXT I
4997  PRINT "TOTAL DP= ";PS(0) - PS(S) + DP(S): PRINT D$;"PR#
0"
4998  RETURN
5000  REM   <<<*** SUBROUTINE CUT ***>>>
5005  IF F1 = 10 THEN RH = 1
5010 TK = 5 / 9 * (TI - 32) + 273
5020  FOR I = 1 TO S
5030 L = .337 * U *  SQR (TK / MW) / PS(I): REM  MEAN FREE PA
TH
5040 CU = 1.05
5050 X = 1
5059  REM  CALCULATE D50 ESTIMATE
```

```
5060 D5 =  SQR (18 * U * DJ(I) / (RH * VJ(I) * CU)) * SI(I)
5070 CC = CU
5080 CU = 1 + 2 * L / D5 * (1.23 + .41 *  EXP ( - .44 * D5 /
L)): REM  CALCULATE CUNNINGHAM SLIP CORRECTION FACTOR
5090 X = X + 1
5095  REM   **LIMIT TO NO. OF ITERATIONS SET IN LINE 5100**
5100  IF X > 30 THEN  PRINT "STAGE ";I;"FAILED TO CONVERGE": GOTO
5120
5105  REM   **CONVERGENCE CRITERIUM SET IN LINE 5110**
5110  IF  ABS (1 - CC / CU) > .0002 GOTO 5060: REM  CHECK FOR
 CONVERGENCE
5120 D5(I) = D5 * 10000: REM  CONVERT D50 FROM CM TO MICRONS
5130 CC(I) = CU
5140 D6(I) = D5(I) *  SQR (CC(I) * RH): REM  CALCULATE D50 ON
 IMPACTION AERODYNAMIC BASIS
5160  NEXT I
5169  REM  CALCULATE TOTAL MASS OF PARTICULATE SAMPLED
5170 XM = 0:M(S + 1) = FF
5180  FOR I = 1 TO S + 1
5190 XM = XM + M(I)
5200  NEXT I
5205 XM = XM - (S * SC) - FC: REM  CORRECT TOTAL MASS FOR BLA
NK WEIGHT CHANGES
5209  REM  CALCULATE CUMULATIVE MASS FRACTIONS (INCLUDING BLA
NK CORRECTIONS)
5210  FOR I = 1 TO S
5220 CU(I) = 0
5230  FOR J = I + 1 TO S + 1
5240 CU(I) = CU(I) + M(J)
5245  IF J < S + 1 THEN CU(I) = CU(I) - SC
5247  IF J = S + 1 THEN CU(I) = CU(I) - FC
5250  NEXT J
5260 CU(I) = CU(I) / XM
5270  NEXT I
5280  HOME
5289  REM  DISPLAY RAW RESULTS
5290  IF F1 <  > 10 THEN  PRINT "STAGE C.CORR   CUMFR  DP(PHY
) DP(I.AERO": GOTO 5297
5295  PRINT "STAGE C.CORR   CUMFR  DP(CL.A) DP(I.A)"
5297 F$ = "  ##; ###.###;  ##.###;  ##.###;  ##.###"
5300  FOR I = 1 TO S
5310  CALL BU,R$,F$,I,CC(I),(CU(I) * 100) * (CU(I) > .000005)
,D5(I),D6(I): PRINT R$
5320  NEXT I
5330  PRINT
5340  PRINT "PRESS ANY KEY TO CONTINUE": GET R$
5350  HOME : GOTO 5380
5380 TC = XM / (QS * TD * .02832): REM  CONCENTRATION, MASS P
ER DNM3
5390  RETURN
5500  REM   <<<*** SUBROUTINE FIT ***>>>
5510 C0 = 2.515517
5520 C1 = 0.802853
5530 C2 = 0.010328
5540 D1 = 1.432788
```

```
5550 D2 = 0.189269
5560 D3 = 0.001308
5570 LT =  LOG (10)
5578 K = 0
5579  REM  REVERSE ORDER OF DATA FOR SPLINE FIT
5580  FOR I = 1 TO S
5581  FOR J = 1 TO MR
5582  IF MZ(J) = I THEN I = I + 1: REM  CHECK FOR STAGES TO B
E SKIPPED IN SPLINE FIT
5583  NEXT J
5585 K = K + 1
5590  IF F1 > 0 THEN X(K) =  LOG (D5(I)) / LT: GOTO 5600
5591 X(K) =  LOG (D6(I)) / LT
5600 FL = 1
5610 CU = CU(I)
5620  IF CU <  = .5 GOTO 5650
5630 FL =  - 1
5640 CU = 1 - CU
5650  IF CU <  = 0 THEN  PRINT "**** !!!! PUNT !!!! ****": PRINT
" STAGE WEIGHTS PRODUCE NEGATIVE OR ZERO CUMULATIVE. RECHECK
WEIGHTS.": GET R$:ZY = 1: RETURN
5660 T =  SQR ( - 2 *  LOG (CU))
5670 Y(K) = ( - T + (C0 + C1 * T + C2 * T * T) / (1 + T * (D1
 + T * (D2 + T * D3)))) * FL
5680  NEXT I
5690  GOTO 5775
5699  REM  GET ARRAY OF STANDARD DIAMETERS FOR SPLINE OUTPUT
5700  PRINT D$;"OPEN XPOINTS.DAT" + ",D1"
5705  PRINT D$;"READ XPOINTS.DAT"
5710  INPUT NP
5730  FOR I = 1 TO NP
5740  INPUT XP(I)
5760  NEXT I
5770  PRINT D$;"CLOSE": RETURN
5775 S = S - MR: REM   NUMBER OF DATA POINTS FOR SPLINE FIT
5776  FOR I = 1 TO NP
5777 XX(I) =  LOG (XP(I)) / LT: REM  LOG TRANSFORM OF STANDAR
D DIAMETER ARRAY
5778  NEXT I
5780  FOR I = 1 TO S / 2
5790 TX = X(I):TY = Y(I)
5800 X(I) = X(S + 1 - I):Y(I) = Y(S + 1 - I)
5810 X(S + 1 - I) = TX:Y(S + 1 - I) = TY
5820  NEXT I
5830  FOR I = 1 TO S - 1
5840  FOR J = I + 1 TO S
5850  IF X(J) >  = X(I) GOTO 5890
5860 TX = X(I):TY = Y(I)
5870 X(I) = X(J):Y(I) = Y(J)
5880 X(J) = TX:Y(J) = TY
5890  NEXT J
5900  NEXT I
5910  IF F1 = 1 THEN XX(0) =  LOG (X0 /  SQR (RH)) / LT: GOTO
5920
5915 XX(0) =  LOG (X0) / LT
```

```
5920  RETURN
6000  REM    <<<*** SPLINE FIT ***>>>
6001  REM   USES METHOD OF LAWLESS - EPA 600/7-78-187
6005 YY(0) =  - 100
6010 OM = 1.0717968: REM   'RELAXATION PARAMETER'
6020 VT =  SQR (6.2832)
6030  REM   - FIRST DIFFERENCES
6040  FOR I = 1 TO S - 1
6050 H(I) = X(I + 1) - X(I)
6060 DL(I) = (Y(I + 1) - Y(I)) / H(I)
6070  NEXT I
6080  REM   - SECOND DIFF'S
6090  FOR I = 2 TO S - 1
6100 H2(I) = H(I - 1) + H(I)
6110 B(I) = .5 * H(I - 1) / H2(I)
6120 DQ(I) = (DL(I) - DL(I - 1)) / H2(I)
6130 S2(I) = 2 * DQ(I)
6140 C(I) = 3 * DQ(I)
6150  NEXT I
6160 S2(1) = 0
6170 S2(S) = 0
6180  REM    - SUCCESIVE OVER RELAXATION SOL'N
6190 ET = 0
6200  FOR I = 2 TO S - 1
6210 W = (C(I) - B(I) * S2(I - 1) - (.5 - B(I)) * S2(I + 1) -
S2(I)) * OM
6220  IF  ABS (W) > ET THEN ET =  ABS (W)
6230 S2(I) = S2(I) + W
6240  NEXT I
6250  IF ET > 1E - 5 GOTO 6190
6260  REM   - THIRD DIFF'S
6270  FOR I = 1 TO S - 1
6280 S3(I) = (S2(I + 1) - S2(I)) / H(I)
6290  NEXT I
6500  REM   *** NOW INTERPOLATE ***
6520  FOR J = 1 TO NP
6525  PRINT ".";
6530 I = 1
6540  IF XX(J) = X(1) GOTO 6750
6550  IF XX(J) < X(1) GOTO 6630
6560  IF XX(J) = X(S) GOTO 6730
6570  IF XX(J) > X(S) GOTO 6680
6580 I = I + 1
6590  IF XX(J) = X(I) GOTO 6750
6600  IF XX(J) > X(I) GOTO 6580
6610  GOTO 6740
6620  REM   EXTRAPOLATE BELOW X(1)
6630 S1 = DL(1) - H(1) / (H(1) + H(2)) * 2 * (DL(2) - DL(1))
6635  IF S1 < 0 THEN S1 = DL(1)
6640 YY(J) = Y(1) + (XX(J) - X(1)) * S1
6645  IF YY(J) < YY(J - 1) THEN S1 = DL(1):YY(J) = Y(1) + (XX
(J) - X(1)) * S1
6650 Y1(J) = S1
6660  GOTO 6820
6670  REM   - EXTRAPOLATE ABOVE X(S)
```

```
6680 S1 = DL(S - 1) + H(S - 1) * S2(S - 1)
6685  IF S1 < 0 THEN S1 = DL(S - 1)
6690 YY(J) = Y(S) + (XX(J) - X(S)) * S1
6694  IF XX(J) >  = XX(0) THEN YY(J) = 1E6:Y1(J) = 0: GOTO 67
10
6696 X3 = XX(J) - XX(0):X1 = X(S) - XX(0):X2 = XX(J) - X(S)
6698 YY(J) = YY(J) + ((X2 * X2 / X1 - X2) / X1 + 1) / X1 - 1 /
X3
6704 Y1(J) = S1 + (2 * X2 / X1 - 1) / X1 / X1 + 1 / X3 / X3
6710  GOTO 6820
6720  REM   -INTERPOLATE BETWEEN X(*)
6730 I = S
6740 I = I - 1
6750 H1 = XX(J) - X(I)
6760 H2 = XX(J) - X(I + 1)
6770 PR = H1 * H2
6780 Y2(J) = S2(I) + H1 * S3(I)
6790 DQ = (S2(I) + S2(I + 1) + Y2(J)) / 6
6800 YY(J) = Y(I) + H1 * DL(I) + PR * DQ
6805  IF YY(J) < Y(I) THEN YY(J) = Y(I) + H1 * DL(I)
6810 Y1(J) = DL(I) + (H1 + H2) * DQ + PR * S3(I) / 6
6815  IF Y1(J) < 0 THEN Y1(J) = DL(I)
6820 DG(J) =  EXP ( - YY(J) * YY(J) / 2) * Y1(J) * TC / VT
6830  NEXT J
6831  PRINT
6835 S = S + MR
6840  RETURN
7000  REM    <<<*** DISPLAY RESULTS ***>>>
7005 XZ$ = "PHYS DIA.":XY$ = "IMP. AERO DIA.":XX$ = "CLASS. A
ERO DIA."
7006 F$ = "  ##.##;   ###.##;   #.##^^^^;   #.##^^^^"
7007  IF F1 = 0 THEN ZZ$ = XY$
7008  IF F1 = 1 THEN ZZ$ = XZ$
7009  IF F1 = 10 THEN ZZ$ = XX$
7010  HOME : PRINT ZZ$ + " CUM%  CONC. DM/DLOGD"
7015 D0 = .47047 /  SQR (2):C1 = .34802:C2 =  - .0958798:C3 =
.7478556
7020  FOR I = 1 TO NP
7025 X1 = YY(I): GOSUB 9900
7030  CALL BU,R$,F$,XP(I),(X3 * 100) * (X3 > .00005),X3 * TC,
DG(I): PRINT R$
7040  NEXT I
7050  INPUT "DO YOU WANT TO SAVE THE RESULTS";Y$
7060  IF  LEFT$ (Y$,1) = "N" THEN  RETURN
7070  IF  LEFT$ (Y$,1) <  > "Y" THEN 7050
7079  REM  SAVE RESULTS TO DISK
7080  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"WRITE" + NM$
7090  PRINT DT$: PRINT T$
7110  PRINT L$: PRINT RR$: PRINT ZZ$
7120  PRINT TC
7130  FOR I = 1 TO NP
7140  PRINT XP(I): PRINT YY(I): PRINT DG(I)
7150  NEXT I
7151  PRINT S
7152  FOR I = 1 TO S
```

```
7153  PRINT D5(I): PRINT D6(I): PRINT CU(I): PRINT Y(I)
7154  NEXT I
7156  PRINT AV: PRINT ND: PRINT IS: PRINT U: PRINT RH
7160  PRINT D$;"CLOSE"
7165  IF FI$ = NM$ THEN  RETURN
7169  REM  ADD RESULTS FILE NAME TO INDEX FILE
7170  PRINT D$;"OPEN RUN/NAM" + ",D2": PRINT D$;"READ RUN/NAM
"
7180  INPUT FI: FOR I = 1 TO FI: INPUT ZZ$(I): NEXT I:FI = FI
 + 1: PRINT D$;"CLOSE"
7185 ZZ$(FI) = NM$
7190  PRINT D$;"OPEN RUN/NAM" + ",D2": PRINT D$;"WRITE RUN/NA
M"
7200  PRINT FI: FOR I = 1 TO FI: PRINT ZZ$(I): NEXT I: PRINT
D$;"CLOSE"
7220 FI$ = NM$
7240  RETURN
9000  REM     <<<***HARDCOPY***>>>
9010  HOME : INPUT "DO YOU WANT HARDCOPY (Y/N) ?";R$: IF R$ =
"N" THEN  RETURN
9015  IF R$ <  > "Y" THEN  GOTO 9010
9020  HOME : PRINT "TURN PRINTER ON"
9030 D$ =  CHR$ (4): PRINT D$;"PR#1": PRINT  CHR$ (9) + "80 N
" +  CHR$ (9) + "10L" +  CHR$ (24)
9040  PRINT "     **********************";F$(0);"**************
*****": PRINT
9050  PRINT "     ********** INPUT DATA **********": PRINT
: PRINT
9060  PRINT F$(29);: IF F1 = 1 THEN  PRINT "PHYSICAL"
9065  IF F1 = 0 THEN  PRINT "IMPACTION AERODYNAMIC"
9070  IF F1 = 10 THEN  PRINT "CLASSICAL AERODYNAMIC"
9080  PRINT F$(1);DT$
9090  PRINT F$(2);T$
9100  PRINT F$(3);L$
9110  CALL BU,R$,F$(4),TN: PRINT R$
9120  PRINT F$(27);I$
9130  PRINT F$(5);RN$;"-FILE NAME:";NM$
9140  PRINT F$(6);RR$
9180  PRINT F$(7);IM$
9185  PRINT IN$
9190  PRINT
9200  CALL BU,R$,F$(24),BW * 100: PRINT R$
9210  CALL BU,R$,F$(20),CD,CM: PRINT R$
9220  CALL BU,R$,F$(22),O2,N2: PRINT R$
9225  CALL BU,R$,F$(30),RO$: PRINT R$
9227  PRINT F$(31) + SM$
9230  PRINT : PRINT
9240  CALL BU,R$,F$(8),VM: PRINT R$
9250  CALL BU,R$,F$(9),DP: PRINT R$
9260  CALL BU,R$,F$(10),OP: PRINT R$
9270  CALL BU,R$,F$(11),PS: PRINT R$
9280  CALL BU,R$,F$(12),PB: PRINT R$
9285  CALL BU,R$,F$(13),TS: PRINT R$
9290  CALL BU,R$,F$(14),TM: PRINT R$
9300  CALL BU,R$,F$(15),TI: PRINT R$
```

```
9310  CALL BU,R$,F$(16),TD: PRINT R$
9320  CALL BU,R$,F$(17),AV / 60: PRINT R$
9330  CALL BU,R$,F$(18),PC / 13.569: PRINT R$
9340  CALL BU,R$,F$(19),ND: PRINT R$
9350  CALL BU,R$,F$(21),X0: PRINT R$
9352  CALL BU,R$,F$(32),WA: PRINT R$
9354  CALL BU,R$,F$(33),MF: PRINT R$
9360  PRINT : PRINT
9370  FOR I = 1 TO S + 1
9380 X$ = "STAGE " +  STR$ (I)
9390  IF I = S + 1 THEN X$ = "FILTER "
9400  CALL BU,R$,F$(26),X$,M(I): PRINT R$
9410  NEXT I
9412  PRINT :X$ = "MASS GAIN OF BLANK SUBSTRATE   ##.##": CALL
BU,R$,X$,SC: PRINT R$
9414 X$ = "MASS GAIN OF BLANK FILTER      ##.##": CALL BU,R$,
X$,FC: PRINT R$
9420  PRINT  CHR$ (12)
9500  PRINT "*********       RESULTS      **********"
9505  PRINT : PRINT "TEST NUMBER: ";TN;"  RUN NUMBER: ";RN$: PRINT

9510 F$ = "ACTUAL FLOW RATE         ##.### CFM": CALL BU,R$,F$
,QI: PRINT R$
9520 F$ = "FLOW RATE AT STANDARD CONDITIONS   ##.### CFM": CALL
BU,R$,F$,QS: PRINT R$
9530 F$ = "PERCENT ISOKINETIC        ###.### %": CALL BU,R$,F$
,IS: PRINT R$
9550 F$ = "VISCOSITY              ###.#^^^^GM/CM-SEC": CALL B
U,R$,F$,U: PRINT R$
9555  IF DP = 0 THEN F$ = "CALCULATED IMPACTOR DELTA P = ##.#
# IN. HG": CALL BU,R$,F$,PS(0) - PS(S) + DP(S): PRINT R$
9558  PRINT : PRINT
9560  IF F1 = 10 THEN XZ$ = "(CLAS AERO)"
9565  IF F1 <  > 10 THEN XZ$ = "(PHYSICAL) "
9570  PRINT "STAGE   CUNN.      DP        DP          CUM      R
E.     V%D50"
9575  PRINT "         CORR. ";XZ$;"(IMP AERO)   FREQ.     NO.
   UM-M/S"
9580 F$ = "  ##;     #.###;     ##.###;     ##.###;     #.####;
  ####;     ###.#"
9590  FOR I = 1 TO S
9600  CALL BU,R$,F$,I,CC(I),D5(I),D6(I),(CU(I) * 100) * (CU(I
) > .000005),RE(I),D5(I) * VJ(I) *  SQR (RH) / 100: PRINT R$
9610  NEXT I
9615  PRINT : PRINT "STAGE CUT DIAMETERS BASED ON ";: IF TH$ =
"C" THEN  PRINT "FILE VALUES OF STAGE CONSTANTS": PRINT
9616  IF TH$ = "T" THEN  PRINT "THEORETICAL VALUES OF STAGE C
ONSTANTS": PRINT
9620  IF MR = 0 GOTO 9650
9625  FOR I = 1 TO MR
9630  PRINT "NOTE: THE MASSES ON STAGES ";MZ(I);" AND ";MZ(I)
 + 1;" HAVE BEEN COMBINED FOR THE SPLINE FIT BECAUSE OF CUTS
BEING TOO CLOSE TOGETHER"
9635  PRINT
9650 F$ = "TOTAL MASS CONCENTRATION =  #.##^^^^ MG/DRY NORMAL
```

```
 CUBIC METER": CALL BU,R$,F$,TC: PRINT R$
9651  PRINT
9655  IF F1 = 1 THEN  PRINT "SPLINE FIT ON PHYSICAL DIAMETER
BASIS": PRINT
9660  IF F1 = 0 THEN  PRINT "SPLINE FIT ON IMPACTION AERODYNA
MIC DIAMETER BASIS": PRINT
9665  IF F1 = 10 THEN  PRINT "SPLINE FIT ON CLASSICAL AERODYN
AMIC DIAMETER BASIS": PRINT
9670  PRINT "PARTICLE DIA.  CUMFR  CUMFR   CUM.MASS   DM/DLOG
D"
9680  PRINT "  (MICRONS)  (STDDEV)(PERCENT)(MG/DRY N.CU.METER
) "
9690  PRINT :D0 = .47047 /  SQR (2):C1 = .34802:C2 =  - .0958
798:C3 = .7478556
9695 F$ = " ##.###;  -##.####;    ###.##;   #.##^^^^;   #.##^
^^^"
9700  FOR I = 1 TO NP
9706 X1 = YY(I): GOSUB 9900
9710  CALL BU,R$,F$,XP(I),YY(I),(X3 * 100) * (X3 > .00005),X3
 * TC,DG(I): PRINT R$
9720  NEXT I
9725  PRINT
9730  IF F1 <  > 10 THEN  GOTO 9790
9735  PRINT : PRINT
9740  PRINT "***  INHALABLE PARTICULATE MATTER ***"
9745  PRINT
9750 I = 6: GOSUB 9800
9760 I = 8: GOSUB 9800
9770 I = 11: GOSUB 9800
9780 I = 12: GOSUB 9800
9785  PRINT "NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER
 ARE": PRINT "ON CLASSICAL AERODYNAMIC BASIS."
9790  GOSUB 9840: RETURN
9800 X1 = YY(I): GOSUB 9900
9810  CALL BU,R$,F$(28),XP(I),X3 * TC,X3 * 100: PRINT R$
9820  RETURN
9840  REM    *** PRINT SIZE DIST. PARAMETERS
9842  IF MR > 1 OR F1 = 10 THEN  PRINT  CHR$ (12)
9843  IF MR > 1 OR F1 = 10 THEN  PRINT " ****  RESULTS CONTIN
UED ****"
9845  PRINT
9850  PRINT "LOG-NORMAL SIZE DISTRIBUTION PARAMETERS": PRINT

9855 F$ = "LEAST SQUARES LINE:  Y=##.##; + ##.##X"
9860  CALL BU,R$,F$,L6,L5: PRINT R$
9865 F$ = "MASS MEDIAN DIAMETER: ###.###": CALL BU,R$,F$,L7: PRINT
R$
9870 F$ = "GEOMETRIC STANDARD DEVIATION:  ###.###": CALL BU,R
$,F$,L8: PRINT R$
9880 F$ = "CORRELATION COEFFICIENT:  ###.###": CALL BU,R$,F$,
L9: PRINT R$
9890  PRINT  CHR$ (12): RETURN
9900  REM    *** CALC. N(X)-THE NORMAL FCN ***
9905  IF X1 >  = 0 THEN FL = 1
9910  IF X1 < 0 THEN X1 =  - X1:FL =  - 1
```

```
9920 X2 = 1 / (1 + D0 * X1)
9930 X3 = 1 - ((C3 * X2 + C2) * X2 + C1) * X2 *  EXP ( - X1 *
X1 / 2)
9940 X3 = (1 + FL * X3) / 2
9950  RETURN
9960  REM    ***INSERT COEFF'S.
9970 D0 = .47047 /  SQR (2)
9980 C1 = .34802:C2 =  - .0958798:C3 = .7478556
9990  RETURN
10000  REM    *** CALCULATE LOG-NORMAL LEAST SQUARES FIT TO D
ATA ***
10020 LZ = 0:L1 = 0:L2 = 0:L3 = 0:L4 = 0:L5 = 0:L6 = 0:L7 = 0
:L8 = 0:L9 = 0
10030  FOR I = 1 TO NZ
10040 LZ = LZ + X(I): REM   X(I) IS LOG OF STAGE D50
10050 L1 = L1 + Y(I): REM   Y(I) IS LOGNORM TRANSFORM OF CUM
FRACTION
10055 L2 = L2 + Y(I) * X(I)
10060 L3 = L3 + X(I) * X(I)
10070 L4 = L4 + Y(I) * Y(I)
10080  NEXT I
10090 L5 = (L2 - L1 * LZ / NZ) / (L3 - LZ * LZ / NZ)
10100 L6 = L1 / NZ - L5 * LZ / NZ
10110 L7 = 10 ^ ( - L6 / L5)
10120 L8 = 10 ^ (1 / L5)
10130 L9 = L5 *  SQR ((L3 - LZ * LZ / NZ) / (L4 - L1 * L1 / N
Z))
10140 L9 = L9 * L9
10145  PRINT "MMD= ";L7;" SIGG= ";L8;" R2= ";L9: PRINT : PRINT
"TO CONTINUE PRESS ANY KEY ": GET R$
10150  PRINT R$: RETURN
19999  REM  CALCULATE THEORETICAL SQUARE ROOTS OF PSI50
20000  INPUT "SUBSTRATE TYPE IS G)REASE (OR BARE) OR  F)ILTER
 ";FF$: IF FF$ <  > "G" AND FF$ <  > "F" THEN 20000
20010  INPUT "USE THEORY FOR STAGE 1 (Y/N) ";R$: IF R$ <  > "
Y" AND R$ <  > "N" THEN 20010
20020 BS = 2: IF R$ = "Y" THEN BS = 1
20021  IF R$ <  > "Y" THEN  GOTO 20025
20022  INPUT "IS STAGE 1 THE RIGHT ANGLE PRECOLLECTOR?";R$: IF
R$ = "Y" THEN BS = 2: REM  IF YES, CALCULATE RAPC SQRT PSI50
FROM FIT TO EMPIRICAL CALIBRATION DATA FOR VARIOUS NOZZLE TIP
 SIZES.
20023  IF R$ = "Y" THEN  IF ND >  = .25 THEN SI(1) = .245: GOTO
20025
20024  IF R$ = "Y" THEN  IF ND < .25 THEN SI(1) = .045 + .2 *
ND / .25
20025 WX =  - .01104:WY = .232:WZ =  - .215:WN = .4343:WD = .
7:GX = .93:GY = 1.26:GZ = .798 *  SQR (3.14159):FA = .98:FM =
.13 / 5000
20029  REM  ACTUAL CALC'S OF STAGE SQRT PSI50'S
20030  FOR I = BS TO S
20040 SW = JS(I) / DJ(I):OF = WX * SW * SW + WY * SW + WZ
20050 ZP = (WN *  LOG (RE(I)) - OF) / WD: IF ZP < 0 THEN ZP =
0
20060 SI(I) = GX * GY * ( EXP ( - ZP * ZP / 2)) / GZ + GX * .
```

```
52 /  SQR (2)
20070  IF FF$ = "F" THEN SI(I) = SI(I) * (FA - VJ(I) * FM): REM
 CORRECT FOR EFFECTS OF FIBROUS SUBSTRATES IF USED.
20075  PRINT I,SI(I)
20080  NEXT I
20090  RETURN
29999  REM   DATA SAVE - BINARY SAVE OF ALL REAL ARRAY VARIAB
LES IN PROGRAM AFTER FIRST PLACING NON-ARRAY VARIABLES INTO D
UMMY ARRAY
30000 DA(0) = F1:DA(1) = VM:DA(2) = DP:DA(3) = OP:DA(4) = PS:
DA(5) = PB:DA(6) = TS:DA(7) = TM:DA(8) = TI:DA(9) = TD:DA(10)
 = AV:DA(31) = WA:DA(32) = MF
30010 DA(11) = PC:DA(12) = ND:DA(13) = X0:DA(14) = TN:DA(15) =
RH:DA(16) = S:DA(17) = MR:DA(18) = DC2:DA(19) = NN:DA(20) = D
I:DA(21) = CQ:DA(22) = CP:DA(23) = CT:DA(24) = PP:DA(25) = BW
:DA(26) = N9
30020 DA(27) = CD:DA(28) = CM:DA(29) = O2:DA(30) = N2
30040 DA =  PEEK (107) + 256 *  PEEK (108):DL =  PEEK (109) +
256 *  PEEK (110) - DA: REM  START AND LENGTH OF ARRAY STORAG
E
30045 DL = 1000
30049  REM  SAVE STRING DATA
30050  PRINT : PRINT D$;"BSAVE" + NM$ + ".DATA" + ",A";DA;",L
";DL
30060  PRINT D$;"OPEN" + NM$ + ".TEXT"
30070  PRINT D$;"WRITE" + NM$ + ".TEXT"
30080  PRINT DT$: PRINT T$: PRINT L$: PRINT I$: PRINT RN$: PRINT
NM$: PRINT RR$: PRINT IM$: PRINT IN$: PRINT RO$: PRINT SM$
30090  PRINT D$;"CLOSE": RETURN
30999  REM  RELOAD OLD RUN DATA
31000  PRINT "ENTER FILE NAME OF RUN TO BE RETRIEVED:": INPUT
FI$
31010 DA =  PEEK (107) + 256 *  PEEK (108)
31020  PRINT D$;"BLOAD" + FI$ + ".DATA,A";DA;",D2": REM  REST
ORE REAL ARRAY VARIABLES FROM DISK
31029  REM  RESTORE NON-ARRAY VARIABLES FROM DUMMY ARRAY
31030 F1 = DA(0):VM = DA(1):DP = DA(2):OP = DA(3):PS = DA(4):
PB = DA(5):TS = DA(6):TM = DA(7):TI = DA(8):TD = DA(9):AV = D
A(10)
31040 PC = DA(11):ND = DA(12):X0 = DA(13):TN = DA(14):RH = DA
(15):S = DA(16):MR = DA(17):DC2 = DA(18):NN = DA(19):DI = DA(
20):CQ = DA(21):CP = DA(22):CT = DA(23):PP = DA(24):BW = DA(2
5):N9 = DA(26)
31050 CD = DA(27):CM = DA(28):O2 = DA(29):N2 = DA(30):WA = DA
(31):MF = DA(32)
31055 FF = M(S + 1):FC = M(S + 3):SC = M(S + 2)
31059  REM  GET STRING VARIABLE DATA
31060  PRINT D$;"OPEN" + FI$ + ".TEXT"
31070  PRINT D$;"READ" + FI$ + ".TEXT"
31080  INPUT DT$: INPUT T$: INPUT L$: INPUT I$: INPUT RN$: INPUT
NM$: INPUT RR$: INPUT IM$: INPUT IN$: INPUT RO$: INPUT SM$
31085 F$(24) = " 9)WATER VAPOR          ##.##%"
31090  PRINT D$;"CLOSE": RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM
```

```
==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)    APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM   STATIS  V 2.1 - AVERAGES DATA AFTER MAKING CORRECTIO
N FOR ISOKINETIC SAMPLING ERROR - USES BELAYEV & LEVIN ALGLRI
THM - 8/16/84
2  REM     COMPUTES AVERAGES AND CONFIDENCE INTERVALS FOR DM/
DLOGD AND CUM. LOADING. CUM. LOADING OBTAINED BY INTEGRATION
OF AVG DMDLOGD AFTER OUTLIER REMOVAL.
3  REM        ORG 2/25/83 JDM - V1.3 4/2/83 - V1.4 2/22/84 - V
2.0 8/17/84 - V2.1 4/17/86
6 D$ =  CHR$ (4):KF = 1800000000:BA = 2:BB = .617
10  HOME
20  DIM X(21),Y(21,60),XP(20),YY(20),DG(20),CP(20),RN$(100),F
$(20),FM$(10)
30  GOSUB 63999: REM  INITIALIZE PRINT FORMATTER
35  GOSUB 1000: REM  INIALIZE PROGRAM
40  HOME : PRINT F0$: PRINT : PRINT
50  PRINT "DO YOU WANT THE DATA CORRECTED FOR": INPUT "ISOKIN
ETIC SAMPLING ERRORS (Y/N)? ";IC$: IF IC$ <  > "Y" AND IC$ <
 > "N" THEN 40
100  HOME : PRINT "IMPACTOR DATA STATISTICS PROGRAM"
110  GOSUB 2000
115  IF OK = 0 GOTO 140
120  GOSUB 3000
130  GOTO 110
140  GOSUB 4000
150  GOSUB 5000
160  GOSUB 6000
170  GOSUB 7000
180  REM   PRINT D$;"RUN MAIN-MENU"
999  END
1000  REM   ** INITIALIZE"
1001 NP = 20
1005 C1 = .34802:C2 =  - .0958798:C3 = .7478556:D0 = .47047 /
 SQR (2)
1010 N = 0:IO$ = "INLET":I$ = ".IT"
1020 F0$ = " STAT. VER 2.1"
1030 F1$ = "##.#     "
1040 F2$ = "###.##; #.##^^^^;  #.##^^^^;  #.##^^^^"
1050 F3$ = "####.###"
1069  REM  GET INDEX FILE FOR REDUCED RUN DATA
1070  PRINT D$;"OPEN RUN/NAM" + ",D2"
1080  PRINT D$;"READ RUN/NAM"
1090  INPUT NR
1110  FOR I = 1 TO NR
1120  INPUT RN$(I)
1130  NEXT I
1140  PRINT D$;"CLOSE RUN/NAM"
1170 FM$(2) = "1) TEST TYPE &; 2) TEST NUMBER ###"
1180 FM$(3) = "3)RUN ## ; &"
1399  RETURN
1400  REM    MENU INSTRUCTIONS
1410  VTAB 23: PRINT "C)AT. OF RUNS, Q)UIT, OR NUMBER OF ITEM
 TO ENTER/CHANGE: ";
```

```
1420  INPUT R$
1425  IF R$ = "C" THEN  GOTO 1460
1430  IF R$ = "Q" THEN CK = 0: RETURN
1440 A =  VAL (R$): IF A < 1 OR A > 3 THEN  GOTO 1400
1450  RETURN
1459  REM  DISPLAY RUN INDEX FILE CONTENTS
1460  HOME : VTAB 3
1465  GOSUB 1070
1467  SPEED= 100
1470  FOR I = 1 TO NR
1480  PRINT RN$(I)
1490  NEXT I
1495  SPEED= 255
1500  VTAB 1: PRINT "THE AVAILABLE RUNS ARE :"
1510  VTAB 23: PRINT "TO CONTINUE PRESS SPACE BAR.": GET R$:A
 = 4: RETURN
2000  REM   MENU
2010 P = 1
2020  HOME : PRINT F0$;" - PAGE 1 OF 1"
2030  CALL BU,R$,FM$(2),IO$,TN: PRINT R$
2050  IF N = 60 THEN MX = 60
2060  IF N < 60 THEN MX = N + 1
2065  IF P > 12 THEN P = 12
2070  FOR I = 1 TO MX
2080  CALL BU,R$,FM$(3),I,F$(I): PRINT R$
2100  NEXT I
2105 NI = MX
2110  GOSUB 1400
2115  IF R$ = "Q" THEN OK = 0: RETURN
2120  ON A GOTO 2130,2150,2170,2020
2130  IF IO$ = "INLET" THEN IO$ = "OUTLET":I$ = ".OT": GOTO 2
020
2135 IO$ = "INLET":I$ = ".IT": GOTO 2020
2150  VTAB 24: HTAB 19: PRINT "                    ": VTAB 24: HTAB
19: INPUT "TN= ";TN: GOTO 2020
2170  VTAB 24: HTAB 19: PRINT "                  ": VTAB 24: HTAB
19: INPUT "RUN = ";RN$
2175 NM$ = "T" +  STR$ (TN) + "R" + RN$ + I$:OK = 0
2176  FOR I = 1 TO NR
2177  IF NM$ = RN$(I) THEN OK = 1
2178  NEXT I
2179  IF OK = 1 THEN  RETURN
2180  VTAB 24: INVERSE : PRINT " RUN NOT IN CATALOG - TRY AGA
IN ": NORMAL : FOR I = 1 TO 2000: NEXT I: GOTO 2020
3000  REM   READ RUN FILES
3010 CK = 0
3019  REM  GET RUN DATA
3020  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"READ" + NM$
3030  INPUT DT$: INPUT T$: INPUT L$: INPUT RR$: INPUT DB$: INPUT
TC
3040  FOR I = 1 TO NP: INPUT XP(I): INPUT YY(I): INPUT DG(I):
 NEXT I
3041  IF IC$ = "N" THEN 3048
3042  INPUT S
3044  FOR I = 1 TO S: INPUT X: INPUT X: INPUT X: INPUT X: NEXT
```

```
I
3046  INPUT AV: INPUT ND: INPUT IS: INPUT U: INPUT RH
3048  PRINT D$;"CLOSE": IF IC$ = "N" THEN 3050
3049  IF AV <  = 0 OR ND <  = 0 OR IS <  = 0 THEN  PRINT "NO
VELOCITY OR NOZZLE DIAMETER FOR RUN": PRINT "SPECIFIED - CANN
OT DO ISOKINETIC ERROR": PRINT "CORRECTION - RUN REJECTED": RETURN

3050  IF NI = 1 THEN ZZ$ = DB$: FOR I = 1 TO NP:X(I) = XP(I):
 NEXT I
3059  REM  CHECK FOR CONSISTENT DIAMETER BASE AND DIAMETERS
3060  FOR I = 1 TO NP: IF XP(I) <  > X(I) THEN CK = 1: NEXT I

3065  IF DB$ <  > ZZ$ THEN CK = 1
3070  IF CK = 1 THEN  VTAB 24: INVERSE : PRINT "LAST RUN WAS
INCOMPATIBLE IN DIAMETERS": NORMAL : FOR I = 1 TO 2000: NEXT
I: RETURN
3080 X1 = YY(1): IF X1 >  = 0 THEN FL = 1
3090  IF X1 < 0 THEN X1 =  - X1:FL =  - 1
3100 X2 = 1 / (1 + D0 * X1)
3110 X3 = 1 - ((C3 * X2 + C2) * X2 + C1) * X2 *  EXP ( - X1 *
X1 / 2)
3120 Y(0,NI) = TC * (1 + FL * X3) / 2:Y(NP + 1,NI) = TC
3125  IF IC$ = "Y" THEN R = 100 / IS:AV = AV * .508:ND = ND *
2.54: REM  SET UP FOR ISIKINETIC CORRECTION
3130  FOR I = 1 TO NP
3132  IF IC$ = "N" THEN Y(I,NI) = DG(I): GOTO 3150
3134  REM  MAKE CORRECTION FOR ISOKINETIC SAMPLING ERRORS
3135 RT = RH * XP(I) * XP(I) / (KF * U)
3140 B = (BA + BB / R) * RT * AV / ND
3145 Y(I,NI) = DG(I) / (1 + (R - 1) * B / (B + 1))
3150  NEXT I
3170  REM   HOME : PRINT NI,Y(0,NI),Y(1,NI),Y(20,NI),TC
3180  REM   FOR I = 1 TO 5000: NEXT I
3190 N = N + 1:CK = 1:F$(NI) = NM$: RETURN
4000  REM   *** NOW DO AVERAGES,STATS ETC.
4004  HOME : PRINT : PRINT "COMPUTING STATISTICS"
4020  DIM TC(10),CI(NP + 1)
4040 TC(2) = 6.314
4050 TC(3) = 2.920
4060 TC(4) = 3.353
4070 TC(5) = 2.132
4080 TC(6) = 2.015
4090 TC(7) = 1.943
4100 TC(8) = 1.895
4110 TC(9) = 1.86
4120  DIM M(NP + 1),S(NP + 1),C(NP + 1)
4125  INPUT "REMOVE OUTLIERS ? (Y/N)";OL$: IF OL$ <  > "Y" AND
OL$ <  > "N" THEN 4125
4130  FOR I = 0 TO NP + 1
4135  PRINT "C";
4140 SX = 0
4150 SS = 0
4160  FOR J = 1 TO N
4170 Z = Y(I,J)
4180 SX = SX + Z
```

```
4190 SS = SS + Z * Z
4200  NEXT J
4210 M(I) = SX / N
4215  IF N = 1 THEN 4230
4220 S(I) =  SQR ( ABS ((SS - SX * SX / N) / (N - 1)))
4230  IF N < 2 THEN C(I) = 3E33: GOTO 4380
4235  IF N = 2 THEN CI(I) = TC(2) * S(I) /  SQR (2): GOTO 438
0
4237  IF OL$ = "N" THEN NN = N: GOTO 4370
4240 SX = 0
4250 SS = 0
4260 NN = 0
4270  IF N < 3 THEN ZZ = 3E33
4274  IF N >  = 3 AND N < 10 THEN ZZ = S(I) * TC(N)
4276  IF N >  = 10 THEN ZZ = S(I) * 1.645
4280  FOR J = 1 TO N
4290 Z = Y(I,J)
4300  IF  ABS (Z - M(I)) > ZZ GOTO 4340
4310 SX = SX + Z
4320 SS = SS + Z * Z
4330 NN = NN + 1
4340  NEXT J
4350 M(I) = SX / NN
4355  IF NN <  = 1 THEN S(I) = 0:C(I) = 3E33
4360 S(I) =  SQR ( ABS ((SS - SX * SX / NN) / (NN - 1))): REM
 STANDARD DEVIATION
4369  REM  FIND 90 PERCENT CONFIDENCE INTERVAL
4370  IF NN >  = 2 AND NN < 10 THEN CI(I) = S(I) * TC(NN) /  SQR
(NN)
4375  IF NN > 10 THEN CI(I) = 1.645 * S(I) /  SQR (NN)
4380  NEXT I
4381  REM     INTEGRATE FOR AVERAGE CUM. USING MODIFIED SIMPS
ONS'S RULE - MOD. GIVES VALUES AT EVERY X RATHER THAN ONLY FO
R ALTERNATE X'S
4382 YY(1) = M(0):DG(1) = CI(0) * CI(0)
4384  FOR I = 2 TO NP
4386 YY(I) = YY(I - 1) + 0.2 * (((I -  INT (I / 2) * 2) = 0) *
(2 * M(I) + M(I - 1)) + ((I -  INT (I / 2) * 2) = 1) * (2 * M
(I - 1) + M(I))) / 3:DG(I) = DG(I - 1) + (CI(I) * CI(I) + CI(
I - 1) * CI(I - 1)) * .01
4388  NEXT I
4389  PRINT
4400  RETURN
5000  REM  *** DISPLAY RESULTS ***
5010  HOME
5012  PRINT ZZ$: PRINT
5015  PRINT "DIA.  MEAN   STD DEV    90%CON.INT."
5020  FOR I = 0 TO NP + 1
5030 K = I - 1
5040  IF K / 10 <  >  INT (K / 10) THEN 5060
5050  PRINT " DIA.   MEAN     STD DEV   90%CON.INT."
5060  REM  IF I <  = NP THEN  CALL BU,R$,F1$,X(I): PRINT R$;
5070  CALL BU,R$,F2$,X(I),M(I),S(I),CI(I): PRINT R$
5071  REM  FIX SO THAT NA IS PRINTED IF CI=3E33
5090  IF I <  > NP AND I / 10 =  INT (I / 10) THEN  PRINT "(P
```

```
RESS SPACE BAR FOR MORE>": GET R$
5100  NEXT I
5105  PRINT "<PRESS SPACE BAR TO CONTINUE>:GET R$
5110  RETURN
6000  REM  *** HARDCOPY ***
6005  PRINT
6010  PRINT "DO YOU WANT HARDCOPY ? (Y / N)": GET R$: IF R$ <
 > "Y" AND R$ <  > "N" THEN  GOTO 6010
6020  IF R$ = "N" THEN  RETURN
6030  PRINT : PRINT "TURN PRINTER ON"
6035  PRINT D$;"PR#1"
6040  PRINT  CHR$ (1) + "80N" +  CHR$ (24)
6045  PRINT  CHR$ (9) + "6L" +  CHR$ (24)
6050 FA$ = "  DIA.   DM/DLOGD  STD DEV   90% CON        CUM LO
AD.  90% CON  CUM%"
6055 FB$ = " MICRON   MG/DNM3              INT          MG/DN
M3     INT  "
6060 FM$ = " ###.##;  #.##^^^^;  #.##^^^^;  #.##^^^^;       #.
##^^^^;  #.##^^^^  ;##.##"
6065 FP$ = " ###.##;  #.##^^^^;  #.##^^^^;    NA           #.#
#^^^^;    NA       ;##.##"
6070  IF IC$ = "Y" THEN  PRINT "****** RESULTS OF STATIS(TICS
) WITH ISOKINETIC CORRECTIONS ******": GOTO 6075
6072  PRINT "******* RESULTS OF STATIS(TICS) *******"
6075  PRINT
6080  PRINT " RESULTS OF AVERAGES FOR RUNS :": PRINT
6090  FOR I = 1 TO N
6100  PRINT F$(I)
6110  NEXT I
6120  PRINT : PRINT ZZ$: PRINT : PRINT
6130  PRINT FA$: PRINT FB$: PRINT
6140  FOR I = 1 TO NP
6142 CP(I) = 100 * YY(I) / YY(NP): IF CP(I) <  = .005 THEN CP
(I) = 0
6145  IF CI(I) > 1E32 THEN  CALL BU,R$,FP$,X(I),M(I),S(I),YY(
I),CP(I): PRINT R$: GOTO 6160
6150  CALL BU,R$,FM$,X(I),M(I),S(I),CI(I),YY(I), SQR (DG(I)),
CP(I): PRINT R$
6160  NEXT I
6170  PRINT
6180  PRINT "FOR TOTAL MASS: (UNCORRECTED)"
6190  CALL BU,R$,FM$,9999,M(NP + 1),S(I),CI(NP + 1): PRINT R$

6200  PRINT  CHR$ (12)
6300  PRINT D$;"PR#0"
6400  RETURN
7000  REM  *** DISK SAVE ***
7010  HOME : INPUT " DO YOU WANT TO SAVE THE RESULTS ON DISK?
 (Y/N)";R$
7020  IF R$ = "N" THEN  RETURN
7030  IF R$ <  > "Y" GOTO 7010
7040  INPUT "ENTER A FILENAME FOR THE RESULTS :";NM$
7050  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"WRITE" + NM$
7055  PRINT ZZ$
7060  FOR I = 0 TO NP + 1
```

```
7065  IF I = NP + 1 THEN  PRINT X(I): PRINT M(I): PRINT S(I):
 PRINT CI(I): GOTO 7080
7070  PRINT X(I): PRINT M(I): PRINT S(I): PRINT CI(I): PRINT
YY(I): PRINT  SQR (DG(I))
7080  NEXT I
7085  PRINT IO$
7090  PRINT D$;"CLOSE"
7100  RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)   APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM  STAT(ISTICS) PROG. V1.4 REVISED 8/20/84 TO MAKE VEL.
WGTD AVERAGES - REV = SYNTRAV ** SYNTRAV IS INTENDED TO BE US
ED TO SYNTHESIZE A FULL TRAVERSE FROM SEVERAL PARTIAL TRAVERS
ES
2  REM  COMPUTES AVERAGES AND CONFIDENCE INTERVALS FOR DM/DLO
GD AND CUM. LOADING. CUM. LOADING OBTAINED BY INTEGRATION OF
AVG DMDLOGD AFTER OUTLIER REMOVAL.
3  REM  ORG 2/25/83 JDM - V1.3 4/2/83 - V1.4 2/22/84
4  REM  V2.0 ADD ISOKINETIC CORRECTION FROM STATIS 12/19/85
6 D$ =  CHR$ (4):KF = 1800000000:BA = 2:BB = .617
10  HOME
15  PRINT "THIS PROGRAM IS INTENDED TO BE USED TO  SYNTHESIZE
 A COMPLETE TRAVERSE FROM     SEVERAL PARTIAL TRAVERSES.  THE
 RUNS    BEING COMBINED SHOULD, TAKEN TOGETHER,  COVER THE EN
TIRE DUCT BUT THE AREAS     SHOULD NOT HAVE OVERLAPPED";:
16  PRINT " OR HAVE BEEN DUPLICATED.": PRINT "  THE AREAS (OR
 RELATIVE AREAS) COVERED BY EACH RUN WILL BE NEEDED AS INPUTS
    UNLESS THEY WERE EQUAL."
17  PRINT "  THE CONFIDENCE INTERVALS AND STANDARD DEVIATIONS
 PRODUCED BY THE PROGRAM MAY  NOT BE MEANINGFUL.": PRINT "  T
HE PROGRAM 'COMBO' CAN BE USED TO    AVERAGE SETS OF  RESULTS
 FROM THIS ONE."
18  VTAB 23: PRINT "PRESS ANY KEY TO CONTINUE": GET R$
20  DIM X(21),Y(21,20),XP(20),YY(20),DG(20),CP(20),VE(20),ARE
A(20)
30  GOSUB 63999
40  HOME : PRINT F0$: PRINT : PRINT
50  PRINT "DO YOU WANT THE DATA CORRECTED FOR": INPUT "ISOKIN
ETIC SAMPLING ERRORS (Y/N)? ";IC$: IF IC$ <  > "Y" AND IC$ <
 > "N" THEN 40
60  PRINT "WERE THE AREAS OF THE SAMPLING SUBZONES EQUAL? (Y/
N)": GET AR$: PRINT AR$: IF AR$ <  > "Y" AND AR$ <  > "N" THEN
60
90  GOSUB 1000
100  HOME : PRINT "IMPACTOR VELOCITY WEIGHTED AVERAGES"
110  GOSUB 2000
115  IF OK = 0 GOTO 140
120  GOSUB 3000
130  GOTO 110
140  GOSUB 4000
150  GOSUB 5000
160  GOSUB 6000
170  GOSUB 7000
180  REM   PRINT D$;"RUN MAIN-MENU"
999  END
1000  REM   ** INITIALIZE"
1001 NP = 20
1005 C1 = .34802:C2 =  - .0958798:C3 = .7478556:D0 = .47047 /
 SQR (2)
```

```
1010 N = 0:IO$ = "INLET":I$ = ".IT"
1020 F0$ = " SYNTRAV VERSION 2.0 "
1030 F1$ = "##.#     "
1040 F2$ = "###.##; #.##^^^^;  #.##^^^^;  #.##^^^^"
1050 F3$ = "####.###"
1069  REM  GET RUN INDEX FILE
1070  PRINT D$;"OPEN RUN/NAM" + ",D2"
1080  PRINT D$;"READ RUN/NAM"
1090  INPUT NR
1100  DIM RN$(NR)
1110  FOR I = 1 TO NR
1120  INPUT RN$(I)
1130  NEXT I
1140  PRINT D$;"CLOSE RUN/NAM"
1150  DIM F$(20),FM$(10)
1170 FM$(2) = "1) TEST TYPE &; 2) TEST NUMBER ###"
1180 FM$(3) = "3)RUN ## ; &"
1399  RETURN
1400  REM    MENU INSTRUCTIONS
1410  VTAB 23: PRINT "C)AT. OF RUNS, Q)UIT, OR NUMBER OF ITEM
 TO ENTER/CHANGE: ";
1420  INPUT R$
1425  IF R$ = "C" THEN  GOTO 1460
1430  IF R$ = "Q" THEN CK = 0: RETURN
1440 A =  VAL (R$): IF A < 1 OR A > 3 THEN  GOTO 1400
1450  RETURN
1459  REM  DISPLAY RUN INDEX FILE
1460  HOME : VTAB 3
1465  SPEED= 100
1470  FOR I = 1 TO NR
1480  PRINT RN$(I)
1490  NEXT I
1495  SPEED= 255
1500  VTAB 1: PRINT "THE AVAILABLE RUNS ARE :"
1510  VTAB 23: PRINT "TO CONTINUE PRESS SPACE BAR.": GET R$:A
 = 4: RETURN
2000  REM   MENU
2010 P = 1
2020  HOME : PRINT F0$;" - PAGE 1 OF 1"
2030  CALL BU,R$,FM$(2),IO$,TN: PRINT R$
2050  IF N = 20 THEN MX = 20
2060  IF N < 20 THEN MX = N + 1
2065  IF P > 12 THEN P = 12
2070  FOR I = 1 TO MX
2080  CALL BU,R$,FM$(3),I,F$(I): PRINT R$
2100  NEXT I
2105 NI = MX
2110  GOSUB 1400
2115  IF R$ = "Q" THEN OK = 0: RETURN
2120  ON A GOTO 2130,2150,2170,2020
2130  IF IO$ = "INLET" THEN IO$ = "OUTLET":I$ = ".OT": GOTO 2
020
2135 IO$ = "INLET":I$ = ".IT": GOTO 2020
2150  VTAB 24: HTAB 19: PRINT "                ": VTAB 24: HTAB
19: INPUT "TN= ";TN: GOTO 2020
```

```
2170  VTAB 24: HTAB 19: PRINT "                    ": VTAB 24: HTAB
19: INPUT "RUN = ";RN$
2175 NM$ = "T" +  STR$ (TN) + "R" + RN$ + I$:OK = 0
2176  FOR I = 1 TO NR
2177  IF NM$ = RN$(I) THEN OK = 1: REM  CHECK FOR VALIDITY OF
 FILE NAMED
2178  NEXT I
2179  IF OK = 1 THEN  RETURN
2180  VTAB 24: INVERSE : PRINT " RUN NOT IN CATALOG - TRY AGA
IN ": NORMAL : FOR I = 1 TO 2000: NEXT I: GOTO 2020
3000  REM   READ RUN FILES
3010 CK = 0
3020  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"READ" + NM$
3030  INPUT DT$: INPUT T$: INPUT L$: INPUT RR$: INPUT DB$: INPUT
TC
3040  FOR I = 1 TO NP: INPUT XP(I): INPUT YY(I): INPUT DG(I):
 NEXT I
3042  INPUT S
3044  FOR I = 1 TO S: INPUT X: INPUT X: INPUT X: INPUT X: NEXT
I
3046  INPUT AV: INPUT ND: INPUT IS: INPUT U: INPUT RH:VE(NI) =
AV
3048  PRINT D$;"CLOSE": IF IC$ = "N" THEN 3050
3049  IF AV <  = 0 OR ND <  = 0 OR IS <  = 0 THEN  PRINT "NO
VELOCITY OR NOZZLE DIAMETER FOR RUN": PRINT "SPECIFIED - CANN
OT DO ISOKINETIC ERROR": PRINT "CORRECTION - RUN REJECTED": RETURN

3050  IF NI = 1 THEN ZZ$ = DB$: FOR I = 1 TO NP:X(I) = XP(I):
 NEXT I
3059  REM  CHECK CONSISTENTCY OF DIAMETER BASE AND DIAMETERS
3060  FOR I = 1 TO NP: IF XP(I) <  > X(I) THEN CK = 1: NEXT I

3065  IF DB$ <  > ZZ$ THEN CK = 1
3070  IF CK = 1 THEN  VTAB 24: INVERSE : PRINT "LAST RUN WAS
INCOMPATIBLE IN DIAMETERS": NORMAL : FOR I = 1 TO 2000: NEXT
I: RETURN
3080 X1 = YY(1): IF X1 >  = 0 THEN FL = 1
3090  IF X1 < 0 THEN X1 =  - X1:FL =  - 1
3100 X2 = 1 / (1 + D0 * X1)
3110 X3 = 1 - ((C3 * X2 + C2) * X2 + C1) * X2 *  EXP ( - X1 *
X1 / 2)
3120 Y(0,NI) = TC * (1 + FL * X3) / 2:Y(NP + 1,NI) = TC
3125  IF IC$ = "Y" THEN R = 100 / IS:AV = AV * .508:ND = ND *
2.54: REM  SET UP FOR ISIKINETIC CORRECTIONS
3127 AR(NI) = 1: IF AR$ = "N" THEN  HOME : PRINT "ENTER AREA
OF SAMPLING ZONE FOR":: PRINT "RUN  ";NM$;": ";: INPUT AR(NI)
: REM  GET AREA FOR WEIGHTING
3130  FOR I = 1 TO NP
3132  IF IC$ = "N" THEN Y(I,NI) = DG(I): GOTO 3150
3134  REM  MAKE ISOINETIC CORRECTION
3135 RT = RH * XP(I) * XP(I) / (KF * U)
3140 B = (BA + BB / R) * RT * AV / ND
3145 Y(I,NI) = DG(I) / (1 + (R - 1) * B / (B + 1))
3150  NEXT I
3170  REM   HOME : PRINT NI,Y(0,NI),Y(1,NI),Y(20,NI),TC
```

```
3180  REM   FOR I = 1 TO 5000: NEXT I
3190 N = N + 1:CK = 1:F$(NI) = NM$: RETURN
4000  REM   *** NOW DO AVERAGES,STATS ETC.
4004  HOME : PRINT : PRINT "COMPUTING STATISTICS"
4005  PRINT "C";
4020  DIM TC(10),CI(NP + 1)
4040 TC(2) = 6.314
4050 TC(3) = 2.920
4060 TC(4) = 3.353
4070 TC(5) = 2.132
4080 TC(6) = 2.015
4090 TC(7) = 1.943
4100 TC(8) = 1.895
4110 TC(9) = 1.86
4120  DIM M(NP + 1),S(NP + 1),C(NP + 1)
4125  INPUT "REMOVE OUTLIERS ? (Y/N)";OL$: IF OL$ <  > "Y" AND
OL$ <  > "N" THEN 4125
4130  FOR I = 0 TO NP + 1
4135  PRINT "C";
4140 SX = 0
4145 VS = 0
4150 SS = 0
4160  FOR J = 1 TO N
4170 Z = Y(I,J) * VE(J) * AR(J)
4175 VS = VS + VE(J) * AR(J)
4180 SX = SX + Z
4190 SS = SS + Z * Z
4200  NEXT J
4210 M(I) = SX / VS
4220 S(I) =  SQR ( ABS ((SS - SX * SX / N) / (N - 1))) / (VS /
N)
4230  IF N < 2 THEN C(I) = 3E33: GOTO 4380
4235  IF N = 2 THEN CI(I) = TC(2) * S(I) /  SQR (2): GOTO 438
0
4237  IF OL$ = "N" THEN NN = N: GOTO 4370
4240 SX = 0
4250 SS = 0
4260 NN = 0
4270  IF N < 3 THEN ZZ = 3E33
4274  IF N >  = 3 AND N < 10 THEN ZZ = S(I) * TC(N)
4276  IF N >  = 10 THEN ZZ = S(I) * 1.645
4280  FOR J = 1 TO N
4290 Z = Y(I,J)
4300  IF  ABS (Z - M(I)) > ZZ GOTO 4340
4310 SX = SX + Z
4320 SS = SS + Z * Z
4330 NN = NN + 1
4340  NEXT J
4350 M(I) = SX / NN
4355  IF NN <  = 1 THEN S(I) = 0:C(I) = 3E33
4360 S(I) =  SQR ( ABS ((SS - SX * SX / NN) / (NN - 1))): REM
 STANDARD DEVIATION
4369  REM  CALCULATE 90 PERCENT CONFIDENCE INTERVALS
4370  IF NN >  = 2 AND NN < 10 THEN CI(I) = S(I) * TC(NN) /  SQR
(NN)
```

```
4375  IF NN > 10 THEN CI(I) = 1.645 * S(I) /  SQR (NN)
4380  NEXT I
4381  REM     INTEGRATE FOR AVERAGE CUM. USING MODIFIED SIMPS
ONS'S RULE - MOD. GIVES VALUES AT EVERY X RATHER THAN ONLY FO
R ALTERNATE X'S
4382 YY(1) = M(0):DG(1) = CI(0) * CI(0)
4384  FOR I = 2 TO NP
4386 YY(I) = YY(I - 1) + 0.2 * (((I -  INT (I / 2) * 2) = 0) *
(2 * M(I) + M(I - 1)) + ((I -  INT (I / 2) * 2) = 1) * (2 * M
(I - 1) + M(I))) / 3:DG(I) = DG(I - 1) + (CI(I) * CI(I) + CI(
I - 1) * CI(I - 1)) * .01
4388  NEXT I
4389  PRINT
4400  RETURN
5000  REM  *** DISPLAY RESULTS ***
5010  HOME
5012  PRINT ZZ$: PRINT
5015  PRINT "DIA.  MEAN   STD DEV    90%CON.INT."
5020  FOR I = 0 TO NP + 1
5030 K = I - 1
5040  IF K / 10 <  >  INT (K / 10) THEN 5060
5050  PRINT " DIA.   MEAN     STD DEV   90%CON.INT."
5060  REM  IF I <  = NP THEN  CALL BU,R$,F1$,X(I): PRINT R$;
5070  CALL BU,R$,F2$,X(I),M(I),S(I),CI(I): PRINT R$
5071  REM  FIX SO THAT NA IS PRINTED IF CI=3E33
5090  IF I <  > NP AND I / 10 =  INT (I / 10) THEN  PRINT "<P
RESS SPACE BAR FOR MORE>": GET R$
5100  NEXT I
5105  PRINT "<PRESS SPACE BAR TO CONTINUE>:GET R$
5110  RETURN
6000  REM  *** HARDCOPY ***
6005  PRINT
6010  PRINT "DO YOU WANT HARDCOPY ? (Y / N)": GET R$: IF R$ <
 > "Y" AND R$ <  > "N" THEN  GOTO 6010
6020  IF R$ = "N" THEN  RETURN
6030  PRINT : PRINT "TURN PRINTER ON"
6035  PRINT D$;"PR#1"
6040  PRINT  CHR$ (1) + "80N" +  CHR$ (24)
6045  PRINT  CHR$ (9) + "6L" +  CHR$ (24)
6050 FA$ = "  DIA.   DM/DLOGD  STD DEV   90% CON        CUM LO
AD.  90% CON  CUM%"
6055 FB$ = " MICRON   MG/DNM3              INT          MG/DN
M3     INT  "
6060 FM$ = " ###.##;  #.##^^^^;  #.##^^^^;  #.##^^^^;      #.
##^^^^;  #.##^^^^  ;##.##"
6065 FP$ = " ###.##;  #.##^^^^;  #.##^^^^;    NA           #.#
#^^^^;    NA       ;##.##"
6070  PRINT "******* VELOCITY WEIGHTED AVERAGES *******"
6075  PRINT
6080  PRINT " RESULTS OF AVERAGES FOR RUNS :": PRINT
6090  FOR I = 1 TO N
6100  PRINT F$(I)
6110  NEXT I
6120  PRINT : PRINT ZZ$: PRINT : PRINT
6130  PRINT FA$: PRINT FB$: PRINT
```

```
6140  FOR I = 1 TO NP
6142 CP(I) = 100 * YY(I) / YY(NP): IF CP(I) <  = .005 THEN CP
(I) = 0
6145  IF CI(I) > 1E32 THEN  CALL BU,R$,FP$,X(I),M(I),S(I),YY(
I),CP(I): PRINT R$: GOTO 6160
6150  CALL BU,R$,FM$,X(I),M(I),S(I),CI(I),YY(I), SQR (DG(I)),
CP(I): PRINT R$
6160  NEXT I
6170  PRINT
6180  PRINT "FOR TOTAL MASS: (UNCORRECTED)""
6190  CALL BU,R$,FM$,9999,M(NP + 1),S(I),CI(NP + 1): PRINT R$

6200  PRINT  CHR$ (1) + "40N" +  CHR$ (24)
6300  PRINT D$;"PR#0"
6400  RETURN
7000  REM  *** DISK SAVE ***
7010  HOME : INPUT " DO YOU WANT TO SAVE THE RESULTS ON DISK?
 (Y/N)";R$
7020  IF R$ = "N" THEN  RETURN
7030  IF R$ <  > "Y" GOTO 7010
7040  INPUT "ENTER A FILENAME FOR THE RESULTS :";NM$
7050  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"WRITE" + NM$
7055  PRINT ZZ$
7060  FOR I = 0 TO NP + 1
7065  IF I = NP + 1 THEN  PRINT X(I): PRINT M(I): PRINT S(I):
 PRINT CI(I): GOTO 7080
7070  PRINT X(I): PRINT M(I): PRINT S(I): PRINT CI(I): PRINT
YY(I): PRINT  SQR (DG(I))
7080  NEXT I
7085  PRINT IO$
7090  PRINT D$;"CLOSE"
7100  RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)   APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM   COMBO - AVERAGES SIZE DISTRIBUTION TRAVERSES, EACH S
YNTHESIZED BY SYNTRAV OR STATIS FROM SEVERAL PARTIAL TRAVERSE
S
2  REM   COMPUTES AVERAGES AND CONFIDENCE INTERVALS FOR DM/DL
OGD AND CUM. LOADING. CUM. LOADING OBTAINED BY INTEGRATION OF
 AVG DMDLOGD AFTER OUTLIER REMOVAL.
3  REM ORG 12/30/85 JDM
6 D$ =  CHR$ (4):KF = 1800000000:BA = 2:BB = .617
10  HOME
20  DIM X(21),Y(21,20),XP(21),YY(21),DG(21),CP(21),M(21),S(21
),C(21),CI(21)
30  GOSUB 63999
35  GOSUB 1000
100  HOME : PRINT "IMPACTOR DATA STATISTICS PROGRAM"
110  GOSUB 2000
115  IF OK = 0 GOTO 140
130  GOTO 100
140  GOSUB 4000
150  GOSUB 5000
160  GOSUB 6000
170  GOSUB 7000
180  REM   PRINT D$;"RUN MAIN-MENU"
999  END
1000  REM   ** INITIALIZE"
1001 NP = 20:OK = 1
1005 C1 = .34802:C2 =  - .0958798:C3 = .7478556:D0 = .47047./
 SQR (2)
1010 N = 0:IO$ = "INLET":I$ = ".IT"
1020 F0$ = " COMBO VER 1.0"
1030 F1$ = "##.#    "
1040 F2$ = "###.##; #.##^^^^;  #.##^^^^;  #.##^^^^"
1050 F3$ = "####.###"
1150  DIM F$(20),FM$(10)
1170 FM$(2) = "1) TEST TYPE &"
1180 FM$(3) = "2) FILE ## ; &"
1399  RETURN
1400  REM    MENU INSTRUCTIONS
1410  VTAB 23: PRINT "C)ATALOG, Q)UIT, OR ITEM TO ENTER: ";: GET
R$: PRINT R$
1425  IF R$ = "C" THEN  GOTO 1460
1430  IF R$ = "Q" THEN CK = 0: RETURN
1440 A =  VAL (R$): IF A < 1 OR A > 2 THEN  GOTO 1400
1450  RETURN
1460  HOME : PRINT D$;"CATALOG,D2"
1510  VTAB 23: PRINT "TO CONTINUE PRESS SPACE BAR.": GET R$:A
 = 3: RETURN
2000  REM   MENU
2010 P = 1
2020  HOME : PRINT F0$;" - PAGE 1 OF 1"
2030  CALL BU,R$,FM$(2),IO$: PRINT R$
2050  IF N = 20 THEN MX = 20
2060  IF N < 20 THEN MX = N + 1
```

```
2065  IF P > 12 THEN P = 12
2070  FOR I = 1 TO MX
2080  CALL BU,R$,FM$(3),I,F$(I): PRINT R$
2100  NEXT I
2105 NI = MX
2110  GOSUB 1400
2115  IF R$ = "Q" THEN OK = 0: RETURN
2120  ON A GOTO 2130,2150,2020
2130  IF IO$ = "INLET" THEN IO$ = "OUTLET": GOTO 2020
2135 IO$ = "INLET": GOTO 2020
2150  HOME : PRINT : PRINT "ENTER NAME OF FILE:": INPUT "";NM
$
2155  ONERR  GOTO 2180
2159  REM  CHECK FILE NAME AND IF VALID, LOAD DATA FROM FILE
2160  PRINT D$;"VERIFY" + NM$ + ",D2"
2170  PRINT "VERIFIED": POKE 216,0: GOTO 3000
2180  VTAB 24: INVERSE : PRINT " RUN DOES NOT VERIFY - TRY AG
AIN ": NORMAL : FOR I = 1 TO 2000: NEXT I: POKE 216,0: GOTO 1
10
3000  REM        READ FILES
3001  PRINT "ABOUT TO READ FILE"
3005  PRINT D$;"OPEN" + NM$: PRINT D$;"READ" + NM$
3010 CK = 0: ONERR  GOTO 2180
3020  INPUT DB$
3022  FOR I = 0 TO NP + 1
3024  IF I = NP + 1 THEN  INPUT XP(I): INPUT M(I): INPUT S(I)
: INPUT CI(I): GOTO 3028
3026  INPUT XP(I): INPUT M(I): INPUT S(I): INPUT CI(I): INPUT
YY(I): INPUT DG(I)
3028  NEXT I
3030  INPUT I$
3048  PRINT D$;"CLOSE"
3049  PRINT NI: PRINT DB$: PRINT I$: PRINT "READ FILE"
3050  POKE 216,0: IF NI = 1 THEN ZZ$ = DB$: FOR I = 1 TO NP:X
(I) = XP(I): NEXT I
3054  REM  CHECK FOR CONSISTENT DIAMETER BASE AND DIAMETERS
3055  IF I$ <  > IO$ THEN CK = 1
3060  FOR I = 1 TO NP: IF XP(I) <  > X(I) THEN CK = 1: NEXT I

3065  IF DB$ <  > ZZ$ THEN CK = 1
3070  IF CK = 1 THEN  VTAB 24: INVERSE : PRINT "LAST RUN WAS
INCOMPATIBLE IN DIAMETERS": NORMAL : FOR I = 1 TO 2000: NEXT
I:CK = 0: RETURN
3120 Y(0,NI) = YY(1):Y(NP + 1,NI) = M(NP + 1)
3130  FOR I = 1 TO NP
3132 Y(I,NI) = M(I)
3150  NEXT I
3190 N = N + 1:CK = 1:F$(NI) = NM$: RETURN
4000  REM   *** NOW DO AVERAGES,STATS ETC.
4004  HOME : PRINT : PRINT "COMPUTING STATISTICS"
4020  DIM TC(10)
4040 TC(2) = 6.314
4050 TC(3) = 2.920
4060 TC(4) = 3.353
4070 TC(5) = 2.132
```

```
4080 TC(6) = 2.015
4090 TC(7) = 1.943
4100 TC(8) = 1.895
4110 TC(9) = 1.86
4120  REM
4125  INPUT "REMOVE OUTLIERS ? (Y/N)";OL$: IF OL$ <  > "Y" AND
OL$ <  > "N" THEN 4125
4130  FOR I = 0 TO NP + 1
4135  PRINT "C";
4140 SX = 0
4150 SS = 0
4160  FOR J = 1 TO N
4170 Z = Y(I,J)
4180 SX = SX + Z
4190 SS = SS + Z * Z
4200  NEXT J
4210 M(I) = SX / N
4215  IF N = 1 THEN 4230
4220 S(I) =  SQR ( ABS ((SS - SX * SX / N) / (N - 1)))
4230  IF N < 2 THEN C(I) = 3E33: GOTO 4380
4235  IF N = 2 THEN CI(I) = TC(2) * S(I) /  SQR (2): GOTO 438
0
4237  IF OL$ = "N" THEN NN = N: GOTO 4370
4240 SX = 0
4250 SS = 0
4260 NN = 0
4270  IF N < 3 THEN ZZ = 3E33
4274  IF N >  = 3 AND N < 10 THEN ZZ = S(I) * TC(N)
4276  IF N >  = 10 THEN ZZ = S(I) * 1.645
4280  FOR J = 1 TO N
4290 Z = Y(I,J)
4300  IF  ABS (Z - M(I)) > ZZ GOTO 4340
4310 SX = SX + Z
4320 SS = SS + Z * Z
4330 NN = NN + 1
4340  NEXT J
4350 M(I) = SX / NN
4355  IF NN <  = 1 THEN S(I) = 0:C(I) = 3E33
4360 S(I) =  SQR ( ABS ((SS - SX * SX / NN) / (NN - 1)))
4370  IF NN >  = 2 AND NN < 10 THEN CI(I) = S(I) * TC(NN) /  SQR
(NN)
4375  IF NN > 10 THEN CI(I) = 1.645 * S(I) /  SQR (NN)
4380  NEXT I
4381  REM     INTEGRATE FOR AVERAGE CUM. USING MODIFIED SIMPS
ONS'S RULE - MOD. GIVES VALUES AT EVERY X RATHER THAN ONLY FO
R ALTERNATE X'S
4382 YY(1) = M(0):DG(1) = CI(0) * CI(0)
4384  FOR I = 2 TO NP
4386 YY(I) = YY(I - 1) + 0.2 * (((I -  INT (I / 2) * 2) = 0) *
(2 * M(I) + M(I - 1)) + ((I -  INT (I / 2) * 2) = 1) * (2 * M
(I - 1) + M(I))) / 3:DG(I) = DG(I - 1) + (CI(I) * CI(I) + CI(
I - 1) * CI(I - 1)) * .01
4388  NEXT I
4389  PRINT
4400  RETURN
```

```
5000  REM  *** DISPLAY RESULTS ***
5010  HOME
5012  PRINT ZZ$: PRINT
5015  PRINT "DIA.  MEAN   STD DEV    90%CON.INT."
5020  FOR I = 0 TO NP + 1
5030 K = I - 1
5040  IF K / 10 <  > INT (K / 10) THEN 5060
5050  PRINT " DIA.   MEAN      STD DEV   90%CON.INT."
5060  REM  IF I <  = NP THEN  CALL BU,R$,F1$,X(I): PRINT R$;
5070  CALL BU,R$,F2$,X(I),M(I),S(I),CI(I): PRINT R$
5071  REM  FIX SO THAT NA IS PRINTED IF CI=3E33
5090  IF I <  > NP AND I / 10 =  INT (I / 10) THEN  PRINT "<P
RESS SPACE BAR FOR MORE>": GET R$
5100  NEXT I
5105  PRINT "<PRESS SPACE BAR TO CONTINUE>:GET R$
5110  RETURN
6000  REM  *** HARDCOPY ***
6005  PRINT
6010  PRINT "DO YOU WANT HARDCOPY ? (Y / N)": GET R$: IF R$ <
 > "Y" AND R$ <  > "N" THEN  GOTO 6010
6020  IF R$ = "N" THEN  RETURN
6030  PRINT : PRINT "TURN PRINTER ON"
6035  PRINT D$;"PR#1"
6040  PRINT  CHR$ (1) + "80N" +  CHR$ (24)
6045  PRINT  CHR$ (9) + "6L" +  CHR$ (24)
6050 FA$ = "  DIA.   DM/DLOGD  STD DEV   90% CON        CUM LO
AD.  90% CON  CUM%"
6055 FB$ = " MICRON   MG/DNM3                INT          MG/DN
M3     INT  "
6060 FM$ = " ###.##;  #.##^^^^;  #.##^^^^;  #.##^^^^;       #.
##^^^^;  #.##^^^^  ;##.##"
6065 FP$ = " ###.##;  #.##^^^^;  #.##^^^^;    NA           #.#
#^^^^;    NA       ;##.##"
6070  PRINT "****  AVERAGES OF SYNTEHESIZED TRAVERSES ****"
6075  PRINT
6080  PRINT " RESULTS OF AVERAGES FOR RUNS :": PRINT
6090  FOR I = 1 TO N
6100  PRINT F$(I)
6110  NEXT I
6120  PRINT : PRINT ZZ$: PRINT : PRINT
6130  PRINT FA$: PRINT FB$: PRINT
6140  FOR I = 1 TO NP
6142 CP(I) = 100 * YY(I) / YY(NP)
6143  IF CP(I) <  = .005 THEN CP(I) = 0
6145  IF CI(I) > 1E32 THEN  CALL BU,R$,FP$,X(I),M(I),S(I),YY(
I),CP(I): PRINT R$: GOTO 6160
6150  CALL BU,R$,FM$,X(I),M(I),S(I),CI(I),YY(I), SQR (DG(I)),
CP(I): PRINT R$
6160  NEXT I
6170  PRINT
6180  PRINT "FOR TOTAL MASS: (UNCORRECTED)"
6190  CALL BU,R$,FM$,9999,M(NP + 1),S(I),CI(NP + 1): PRINT R$

6200  PRINT  CHR$ (12)
6300  PRINT D$;"PR#0"
```

```
6400  RETURN
7000  REM  *** DISK SAVE ***
7010  HOME : INPUT " DO YOU WANT TO SAVE THE RESULTS ON DISK?
 (Y/N)";R$
7020  IF R$ = "N" THEN  RETURN
7030  IF R$ <  > "Y" GOTO 7010
7040  INPUT "ENTER A FILENAME FOR THE RESULTS :";NM$
7050  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"WRITE" + NM$
7055  PRINT ZZ$
7060  FOR I = 0 TO NP + 1
7065  IF I = NP + 1 THEN  PRINT X(I): PRINT M(I): PRINT S(I):
 PRINT CI(I): GOTO 7080
7070  PRINT X(I): PRINT M(I): PRINT S(I): PRINT CI(I): PRINT
YY(I): PRINT  SQR (DG(I))
7080  NEXT I
7085  PRINT IO$
7090  PRINT D$;"CLOSE"
7100  RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)   APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
1  REM  EFFICIENCY V1.0
2  REM  CREATED 4/29/84
10  GOSUB 1000: REM  INITIALIZE
30 IN = 1:T$ = "INLET": GOSUB 10000: GOSUB 2000:ID$ = DI$:IB$
 = DB$: REM  GET IN LET  DATA
40 IN = 2:T$ = "OUTLET": GOSUB 10000: GOSUB 2000:OD$ = DI$: IF
DB$ <  > IB$ THEN  PRINT "FILES ARE NOT ON SAME DIAMETER BASI
S": PRINT "REDO SELECTIONS": STOP : GOTO 30: REM  GET OUTLET
DATA
50  GOSUB 4000: INPUT "SAVE TO DISK ? (Y/N)";R$: IF R$ = "Y" THEN
 GOSUB 6000
55  INPUT "HARDCOPY ? (Y/N)";R$: IF R$ = "Y" THEN  GOSUB 7000

60  INPUT "MORE SETS ? (Y/N)";R$: IF R$ = "Y" THEN CK = 0:CFL
AG = 1: GOTO 30
998  PRINT D$;"RUN MAIN MENU" + ",D1"
999  END
1000 CK = 0:NP = 20:CFLAG = 1:D$ =  CHR$ (4)
1010  DIM XP(21),M(2,21),CI(2,21),TC(2)
1020  GOSUB 63999: REM  INITIALIZE PRINT FORMATTER
1030 F$(1) = "   DIA.   %PENE.   CI(%P)  %EFF"
1040 F$(3) = "  ##.##;  #.#^^^^;   #.#^^^^;  #.#^^^^"
1999  RETURN
2000  IF  RIGHT$ (I$,1) = "M" THEN  GOSUB 2200: RETURN
2010  GOSUB 3000: RETURN
2200 CFLAG = 0
2205  IF CK > 0 THEN 2290
2209  REM  GET RUN INDEX FILE
2210  PRINT D$;"OPEN RUN/NAM" + ",D2"
2220  PRINT D$;"READ RUN/NAM"
2230  INPUT NR
2240  DIM RN$(NR)
2250  FOR I = 1 TO NR
2260  INPUT RN$(I)
2270  NEXT I
2280  PRINT D$;"CLOSE"
2285 CK = 10
2289  REM  DISPLAY RUN FILE INDEX
2290  HOME : VTAB 3: SPEED= 100
2300  PRINT "THE AVAILABLE RUNS ARE:"
2310  FOR I = 1 TO NR
2320  PRINT RN$(I)
2340  NEXT I
2350  SPEED= 255
2360  VTAB 23: PRINT "PRESS ANY KEY TO CONTINUE": GET R$
2370  PRINT "FOR ";T$;" ENTER TEST NUMBER": INPUT "AND RUN DE
SIGNATION (#,ALPHA)";TN,RN$
2372  PRINT "IS THIS THE CORRECT FILE ?": HTAB 5:DI$ = "T" +
 STR$ (TN) + "R" + RN$
2374  IF IN = 1 THEN DI$ = DI$ + ".IT": PRINT DI$;"   (Y/N)":
 GET R$: IF R$ <  > "Y" THEN 2370
2376  IF IN = 2 THEN DI$ = DI$ + ".OT": PRINT DI$;"   (Y/N)":
```

```
 GET R$: IF R$ <  > "Y" THEN 2370
2380  REM  READ RUN FILES
2400  PRINT D$;"OPEN" + DI$ + ",D2": PRINT D$;"READ" + DI$
2410  INPUT DT$: INPUT TT$: INPUT L$: INPUT RR$: INPUT DB$: INPUT
TC(IN)
2420  FOR I = 1 TO NP: INPUT XP(I): INPUT S: INPUT M(IN,I): NEXT
I: PRINT D$;"CLOSE"
2500  RETURN
2999  REM  GET DATA IF AVERAGE OF RUNS IS TO BE USED IN EFFIC
IENCY CALCULATIONS
3000  PRINT D$;"CATALOG" + ",D2"
3010  PRINT : INPUT "ENTER STATIS SAVE FILE NAME
 ";DI$
3012  PRINT "IS '";DI$;"' THE CORRECT FILE NAME (Y/N)?";: GET
R$: PRINT R$: IF R$ <  > "Y" THEN 3000
3020  PRINT D$;"OPEN" + DI$
3030  PRINT D$;"READ" + DI$
3040  INPUT DB$
3050  FOR I = 0 TO NP + 1
3060  IF I = NP + 1 THEN  INPUT XP(I): INPUT M(IN,I): INPUT S
: INPUT CI(IN,I): GOTO 3080
3070  INPUT XP(I): INPUT M(IN,I): INPUT S: INPUT CI(IN,I): INPUT
S: INPUT S
3080  NEXT I
3085 TC(IN) = M(IN,NP + 1)
3090  PRINT D$;"CLOSE"
3100  RETURN
3999  REM  CALCULATE PERCENT PENETRATIONS
4000  FOR I = 1 TO NP
4010  IF M(1,I) > 0 THEN M(0,I) = 100 * M(2,I) / M(1,I)
4020  IF CFLAG <  > 0 AND M(1,I) > 0 AND M(2,I) > 0 THEN CI(0
,I) = M(0,I) *  SQR (((CI(1,I) / M(1,I)) ^ 2) + ((CI(2,I) / M
(2,I)) ^ 2))
4030  NEXT I
4035 M(0,0) = 100 * TC(2) / TC(1): REM  TOTAL PENETRATION
4039  REM  DISPLAY RESULTS
4040  HOME : PRINT F$(1)
4050  FOR I = 1 TO NP
4060  CALL BU,R$,F$(3),XP(I),M(0,I),CI(0,I),100 - M(0,I): PRINT
R$
4070  NEXT I
4080  PRINT "TOTAL EFFICIENCY =";:
4085 F$ = "#.#^^^^"
4090  CALL BU,R$,F$,100 - M(0,0): PRINT R$
4100  PRINT "PRESS SPACE BAR TO CONTINUE"
4999  RETURN
6000  REM  DISK SAVE
6010  HOME : INPUT " DO YOU WANT TO SAVE THE RESULTS ON DISK?
 (Y/N)";R$
6020  IF R$ = "N" THEN  RETURN
6030  IF R$ <  > "Y" GOTO 6010
6040  INPUT "ENTER A FILENAME FOR THE RESULTS :";NM$:NM$ = NM
$ + ".EFF"
6050  PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"WRITE" + NM$
6060  PRINT NP
```

```
6070  FOR I = 0 TO NP + 1
6080  PRINT XP(I): PRINT M(0,I): PRINT CI(0,I)
6090  NEXT I
6100  PRINT D$;"CLOSE"
6999  RETURN
7000  PRINT "TURN PRINTER ON": REM  HARDCOPY
7010  PRINT D$;"PR#1"
7020  PRINT  CHR$ (9) + "80N" +  CHR$ (9) + "5L" +  CHR$ (24)

7030  PRINT "OUTLET DATA FROM ";OD$: PRINT "INLET DATA FROM "
;ID$: PRINT
7035  PRINT "OVERALL EFFICIENCY =";: CALL BU,R$,F$,100 - M(0,
0): PRINT R$: PRINT : PRINT
7040  PRINT F$(1)
7050  FOR I = 1 TO NP
7060  CALL BU,R$,F$(3),XP(I),M(0,I),CI(0,I),100 - M(0,I): PRINT
R$
7070  NEXT I
7999  PRINT D$;"PR#0": RETURN
10000  HOME : PRINT "SELECT ";T$: INPUT "FROM M)PPROG OR S)TA
TIS ";I$
10010  IF I$ = "M" AND IN = 1 THEN I$ = "IM": RETURN
10020  IF I$ = "M" AND IN = 2 THEN I$ = "OM": RETURN
10030  IF I$ <  > "S" THEN 10000
10040 I$ = "IS": IF IN = 2 THEN I$ = "OS"
10050  RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)   APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

```
0  REM  WRITTEN BY J.D.MCCAIN, SOUTHERN RESEARCH INSTITUTE -
REVISION 8/1/84
1  TEXT : HOME : PRINT : PRINT "A CATALOG OF RUNS ON FILE WIL
L BE LISTED NEXT. SELECTTHE RUN TO BE PLOTTED AND TYPE IN FIL
E NAME WHEN REQUESTED. NOTE AMPERGRAPH LOADER MUST HAVE BEEN
RUN PRIOR TO THIS PROGRAM."
2  PRINT " THE RUN WILL THEN BE PLOTTED FIRST AS CUM. % VS. D
IA., THEN AS DM/DLOGD VS DIA., AND FINALLY AS CUM. CONC. VS D
IA. TO PLOT ANOTHER RUN SIMPLY TYPE 'RUN' AFTER THE LAST HAS
BEEN COMPLETED. TO HALT CATALOG SCROLLING USE 'CTRL-S' "
3  PRINT "TO CONTINUE PRESS ANY KEY": GET R$: PRINT R$: PRINT

4  REM :PRINT : INPUT "ENTER FILE NAME OF RUN TO BE PLOTTED
   ";NM$
5  HIMEM: 16383
10 D$ =  CHR$ (4)
12  DIM XP(20),YY(20),DG(20)
16 NP = 20
17  PRINT D$;"OPEN RUN/NAM" + ",D2": PRINT D$;"READ RUN/NAM":
 INPUT NR: DIM Y$(NR): FOR I = 1 TO NR: INPUT Y$(I): NEXT I: PRINT
D$;"CLOSE": REM  GET INDEX FILE
18  FOR I = 2 TO NR: PRINT Y$(I): NEXT I: PRINT : REM  DISPLA
Y RUN FILE INDEX
19  PRINT : INPUT "ENTER FILE NAME OF RUN TO BE PLOTTED     "
;NM$
20  PRINT D$;"OPEN" + NM$ + ",D2"
30  PRINT D$;"READ" + NM$
40  INPUT DT$: INPUT T$: INPUT L$: INPUT RR$: INPUT DB$: INPUT
TC
50  FOR I = 1 TO NP
60  INPUT XP(I): INPUT YY(I): INPUT DG(I)
70  NEXT I
71  INPUT S
72  DIM D5(S),D6(S),CU(S),Y(S)
73  FOR I = 1 TO S
74  INPUT D5(I): INPUT D6(I): INPUT CU(I): INPUT Y(I)
75  NEXT I
80  PRINT D$;"CLOSE"
85 C0 = 2.515517:C1 = .802853:C2 = .010328
86 D1 = 1.432788:D2 = .189269:D3 = .001308
90  PRINT XP(1),XP(20)
95  HGR2
99  REM  DRAW AND LABEL GRID FOR CUMULATIVE PERCENT PLOT
100  & SCALE,.1,100, - 4,4
110  &  LOG X
120 LX$ = "DIAMETER, MICRONS"
130 LY$ = "CUMULATIVE PERCENT"
140  & LABELAXES,1,8
141 LABEL$ = ".1-": & LABEL,.068, - 3.22
142 LABEL$ = " 1-": & LABEL,.068, - 2.46
143 LABEL$ = "10-": & LABEL,.068, - 1.42
144 LABEL$ = "20-": & LABEL,.068, - .97
```

```
145 LABEL$ = "50-": & LABEL,.068, - .13
146 LABEL$ = "80-": & LABEL,.068,.71
147 LABEL$ = "90-": & LABEL,.068,1.16
148 LABEL$ = "99-": & LABEL,.068,2.2
149 LABEL$ = "  -": & LABEL,.068,2.96
150  & LABEL,.068, - 2.705: & LABEL,.068, - 1.775: & LABEL,.0
68, - .655: & LABEL,.068, - .385
151  & LABEL,.068,.125: & LABEL,.068,.395: & LABEL,.068,1.515
: & LABEL,.068,2.445
154 LABEL$ = NM$: & LABEL,.2,3.5
158  REM   PLOT SPLINE FIT IN LINES 159-170, PLOT RAW DATA IN
 LINES 172-177
159  FOR I = 1 TO NP
160  & OPENCIRCLE,XP(I),YY(I)
170  NEXT I
171  GOSUB 5580
172  FOR I = 1 TO S
173  IF DB$ <  > "PHYS DIA." AND DB$ <  > "CLASS. AERO DIA." THEN
 & CLOSEDCIRCLE,D6(I),Y(I): GOTO 177
174  & CLOSEDCIRCLE,D5(I),Y(I)
177  NEXT I
178  FOR I = 1 TO 5000: NEXT I
179  TEXT : HOME : INPUT "HARDCOPY? (REQUIRES GRAPHITTI CARD)
 Y/N ";R$: IF R$ <  > "Y" THEN 200
180  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 180
185  IF R$ = "S" THEN P$ = "G2R"
186  IF R$ = "L" THEN P$ = "G2RD"
187  PRINT D$;"PR#1"
190  PRINT  CHR$ (9) + P$: PRINT  CHR$ (12): PRINT D$;"PR#0"
199  REM  FIND RANGE OF DM/DLOGD
200 DB = 0:DL = 1.0E32
210  FOR I = 1 TO 15
215  IF DG(I) <  = 0 THEN DG(I) = 1.0E - 15: GOTO 240
220  IF DG(I) > DB THEN DB = DG(I)
230  IF DG(I) < DL THEN DL = DG(I)
240  NEXT I
249  REM  SELECT PLOT RANGE
250  TEXT : HOME : PRINT "MIN DM/DLOGD=";DL
260  PRINT : PRINT "MAX DM/DLOGD=";DB
270  PRINT : PRINT : INPUT "SELECT RANGE FOR DM/DLOGD PLOT -
MIN,MAX. MUST BE INTEGRAL POWERS OF TEN ";YL,YM
271  HGR2 : REM  CLEAR SCREEN AND DO DM/DLOGD PLOT
275  & SCALE,.1,100,YL,YM
280  &  LOG X: &  LOG Y
290 LY$ = "DM/DLOGD, MG/DNM3"
300  & LABELAXES,1,YL
310 LABEL$ = NM$: & LABEL,.2,.6 * YM
320  FOR I = 1 TO 15
325  IF DG(I) <  = 0 THEN  GOTO 340
330  & OPENCIRCLE,XP(I),DG(I)
340  NEXT I
341  FOR I = 1 TO 5000: NEXT I: TEXT : HOME : INPUT "HARDCOPY
? (REQUIRES GRAPHITTI CARD) Y/N";R$: IF R$ <  > "Y" THEN 350
342  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
```

```
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 342
343  IF R$ = "S" THEN P$ = "G2R"
344  IF R$ = "L" THEN P$ = "G2RD"
345  PRINT D$;"PR#1"
346  PRINT  CHR$ (9) + P$: PRINT  CHR$ (12): PRINT D$;"PR#0"
350  REM    CUM CONC PLOT
360 D0 = .47047 /  SQR (2):C1 = .34802:C2 =  - .0958798:C3 =
.7478556
369  REM  SHOW MIN AND MAX CUM. CONC.
370  TEXT : HOME : PRINT "MIN CONC.=";:X1 = YY(1): GOSUB 9900
: PRINT X3 * TC
380  PRINT : PRINT "MAX CONC.=";:X1 = YY(15): GOSUB 9900: PRINT
X3 * TC
390  PRINT : PRINT : INPUT "SELECT RANGE FOR CUM. CONC. PLOT
- MIN,MAX. MUST BE INTEGRAL POWERS OF TEN ";YL,YM
399  REM  DO CUM. CONC. PLOT
400  HGR2
410  & SCALE,.1,100,YL,YM
430  &  LOG X: &  LOG Y
440 LY$ = "CUM. CONC., MG/DNM3"
450  & LABELAXES,1,YL
480 LABEL$ = NM$: & LABEL,.2,.6 * YM
510  FOR I = 1 TO NP
520 X1 = YY(I): GOSUB 9900
525  IF X3 <  = 0 THEN 570
530  & OPENCIRCLE,XP(I),X3 * TC
540  NEXT I
550  FOR I = 1 TO S
555  IF DB$ <  > "PHYS DIA." AND DB$ <  > "CLASS. AERO DIA." THEN
 & CLOSEDCIRCLE,D6(I),CU(I): GOTO 570
560  & CLOSEDCIRCLE,D5(I),CU(I) * TC
570  NEXT I
580  FOR I = 1 TO 5000: NEXT I: TEXT : HOME : INPUT "HARDCOPY
? (REQUIRES GRAPHITTI CARD) Y/N";R$: IF R$ <  > "Y" THEN 700
590  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 590
600  IF R$ = "S" THEN P$ = "G2R"
610  IF R$ = "L" THEN P$ = "G2RD"
620  PRINT D$;"PR#1"
630  PRINT  CHR$ (9) + P$: PRINT  CHR$ (12): PRINT D$;"PR#0"
700  HIMEM: 38400
999  END
5579  REM  CUM % TO STD DEV TRANSFORM
5580  FOR I = 1 TO S
5600 FL = 1
5610 CU = CU(I)
5620  IF CU <  = .5 GOTO 5650
5630 FL =  - 1
5640 CU = 1 - CU
5650  REM
5660 T =  SQR ( - 2 *  LOG (CU))
5670 Y(I) = ( - T + (C0 + C1 * T + C2 * T * T) / (1 + T * (D1
 + T * (D2 + T * D3)))) * FL
5680  NEXT I
5700  RETURN
```

```
9899  REM  TRANSFORM FROM STD DEV TO LINEAR %
9900  IF X1 >  = 0 THEN FL = 1
9910  IF X1 < 0 THEN FL =  - 1:X1 =  - X1
9920 X2 = 1 / (1 + D0 * X1)
9930 X3 = 1 - ((C3 * X2 + C2) * X2 + C1) * X2 *  EXP ( - X1 *
X1 / 2)
9940 X3 = (1 + FL * X3) / 2
9950  RETURN
10000  END

]
```

```
0  REM  WRITTEN BY J.D.MCCAIN SO. RESEARCH INSTITUTE REVISION
 8/1/84
1  TEXT : HOME : PRINT : PRINT "A CATALOG WILL BE LISTED NEXT
. SELECT THE STATIS FILE TO BE PLOTTED AND TYPE IN FILE NAME
WHEN REQUESTED. NOTE AMPERGRAPH LOADER MUST HAVE BEEN RUN PRI
OR TO THIS PROGRAM."
2  PRINT " THE RUN WILL THEN BE PLOTTED FIRST AS CUM.LOADING
VS. DIA. AND THEN AS DM/DLOGD VS DIA. TO PLOT ANOTHER RUN SIM
PLY TYPE 'RUN' AFTER THE LAST HAS BEEN COMPLETED. TO HALT CAT
ALOG SCROLLING USE 'CTRL-S' "
3  PRINT "TO CONTINUE PRESS ANY KEY": GET R$: PRINT R$: PRINT

5  HIMEM: 16383: REM  PROTECT GRAPHICS SCREEN DISPLAY AREA
10 D$ =  CHR$ (4)
12  DIM XP(21),M(21),S(21),CI(21),YY(21),CY(21)
16 NP = 20
17  PRINT D$;"CATALOG" + ",D2": REM  SHOW CATALOG TO FACILITA
TE DATA FILE SELECTION
18  REM  GET FILE NAME TO BE PLOTTED
19  PRINT : INPUT "ENTER FILE NAME OF RUN TO BE PLOTTED     "
;NM$
20  PRINT D$;"OPEN" + NM$
30  PRINT D$;"READ" + NM$
40  INPUT DB$
50  FOR I = 0 TO NP + 1
55  IF I = NP + 1 THEN  INPUT XP(I): INPUT M(I): INPUT S(I): INPUT
CI(I): GOTO 70
60  INPUT XP(I): INPUT M(I): INPUT S(I): INPUT CI(I): INPUT Y
Y(I): INPUT CY(I)
70  NEXT I
80  PRINT D$;"CLOSE"
85 C0 = 2.515517:C1 = .802853:C2 = .010328
86 D1 = 1.432788:D2 = .189269:D3 = .001308
89  REM  DISPLAY MIN AND MAX CUM. CONC.S FOR SCALE SELECTION
90  PRINT "MIN CUM = ";YY(1);" MAX CUM = ";YY(15)
92  INPUT "ENTER YMIN,YMAX FOR CUM LOADING PLOT (MUST BE INTE
GRAL POWERS OF TEN) ";YL,YM
95  HGR2
99  REM  PLOT CUM. CONC. GRAPH
100  & SCALE,.1,100,YL,YM
110  &  LOG X: &  LOG Y
120 LX$ = "DIAMETER, MICRONS"
130 LY$ = "CUM. LOADING, MG/DNM3"
140  & LABELAXES,1,YL * 10
154 LABEL$ = NM$: & LABEL,.2,.6 * YM
159  FOR I = 1 TO NP
160  IF YY(I) <  = 0 THEN 170
163  & OPENCIRCLE,XP(I),YY(I): REM  PLOT POINT
165  & ERR OR BARS,0,CY(I): REM  PLOT ERROR (CONFIDENCE LIMIT
) BARS
170  NEXT I
176  FOR I = 1 TO 5000: NEXT I
```

```
179  TEXT : HOME : INPUT "HARDCOPY? (REQUIRES GRAPHITTI CARD)
 Y/N ";R$: IF R$ <  > "Y" THEN 200
180  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 180
185  IF R$ = "S" THEN P$ = "G2R"
186  IF R$ = "L" THEN P$ = "G2RD"
187  PRINT D$;"PR#1"
190  PRINT  CHR$ (9) + P$: PRINT  CHR$ (12): PRINT D$;"PR#0"
199  REM  FIND MIN. AND MAX. DM/DLOGD'S
200 DB = 0:DL = 1.0E32
210  FOR I = 1 TO 15
215  IF M(I) <  = 0 THEN M(I) = 1.0E - 15: GOTO 240
220  IF M(I) > DB THEN DB = M(I)
230  IF M(I) < DL THEN DL = M(I)
240  NEXT I
249  REM  DISPLAY LIMITS AND SELECT PLOT SCALE
250  TEXT : HOME : PRINT "MIN DM/DLOGD=";DL
260  PRINT : PRINT "MAX DM/DLOGD=";DB
270  PRINT : PRINT : INPUT "SELECT RANGE FOR DM/DLOGD PLOT -
MIN,MAX. MUST BE INTEGRAL POWERS OF TEN ";YL,YM
271  HGR2
274  REM  DO DM/DLOGD PLOT
275  & SCALE,.1,100,YL,YM
280  &  LOG X: &  LOG Y
290 LY$ = "DM/DLOGD, MG/DNM3"
299  & LABELAXES,1,YL * 10
310 LABEL$ = NM$: & LABEL,.2,.6 * YM
320  FOR I = 1 TO 20
325  IF M(I) <  = 0 THEN 340
330  & OPENCIRCLE,XP(I),M(I)
335  & ERR OR BARS,0,CI(I)
340  NEXT I
341  FOR I = 1 TO 5000: NEXT I: TEXT : HOME : INPUT "HARDCOPY
? (REQUIRES GRAPHITTI CARD) Y/N";R$: IF R$ <  > "Y" THEN 400
342  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 342
343  IF R$ = "S" THEN P$ = "G2R"
344  IF R$ = "L" THEN P$ = "G2RD"
345  PRINT D$;"PR#1"
346  PRINT  CHR$ (9) + P$: PRINT  CHR$ (12): PRINT D$;"PR#0"
400  HGR2
404  REM  SET UP GRID FOR CUM. PERCENT PLOT
405  & SCALE,.1,100, - 4,4
410  &  LOG X
420 LX$ = "DIAMETER, MICRONS"
430 LY$ = "CUMULATIVE PERCENT"
440  & LABELAXES,1,8
441 LABEL$ = ".1-": & LABEL,.068, - 3.22
442 LABEL$ = " 1-": & LABEL,.068, - 2.46
443 LABEL$ = "10-": & LABEL,.068, - 1.42
444 LABEL$ = "20-": & LABEL,.068, - .97
445 LABEL$ = "50-": & LABEL,.068, - .13
446 LABEL$ = "80-": & LABEL,.068,.71
447 LABEL$ = "90-": & LABEL,.068,1.16
448 LABEL$ = "99-": & LABEL,.068,2.2
```

```
449 LABEL$ = "  -": & LABEL,.068,2.96
450  & LABEL,.068, - 2.705: & LABEL,.068, - 1.775: & LABEL,.0
68, - .655: & LABEL,.068, - .385
451  & LABEL,.068,.125: & LABEL,.068,.395: & LABEL,.068,1.515
: & LABEL,.068,2.445
454 LABEL$ = NM$: & LABEL,.2,3.5
459  REM  DO CUM. PERCENT POINT PLOTTING
460  FOR I = 1 TO 19
470 FL = 1:CU = YY(I) / YY(20)
480  IF CU < .5 THEN 500
490 FL =  - 1:CU = 1 - CU
500  IF CU <  = 0 THEN 600
505 T =  SQR ( - 2 *  LOG (CU))
510 Y = ( - T + (C0 + C1 * T + C2 * T * T) / (1 + T * (D1 + T
 * (D2 + T * D3)))) * FL
520  & OPENCIRCLE,XP(I),Y
600  NEXT I
610  FOR I = 1 TO 5000: NEXT I
620  TEXT : HOME : INPUT "HARDCOPY? (REQUIRES GRAPHITTI CARD)
 Y/N ";R$: IF R$ <  > "Y" THEN 4998
630  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 630
640  IF R$ = "S" THEN P$ = "G2R"
650  IF R$ = "L" THEN P$ = "G2RD"
660  PRINT D$;"PR#1"
670  PRINT  CHR$ (9) + P$: PRINT  CHR$ (12): PRINT D$;"PR#0"
4998  HIMEM: 38400
4999  END
5579  REM  LINEAR PERCENT TO STD. DEV. TRANSFORM
5580  FOR I = 1 TO S
5600 FL = 1
5610 CU = CU(I)
5620  IF CU <  = .5 GOTO 5650
5630 FL =  - 1
5640 CU = 1 - CU
5650  REM
5660 T =  SQR ( - 2 *  LOG (CU))
5670 Y(I) = ( - T + (C0 + C1 * T + C2 * T * T) / (1 + T * (D1
 + T * (D2 + T * D3)))) * FL
5680  NEXT I
5700  RETURN
10000  END

]
```

```
1  TEXT : HOME : PRINT : PRINT "A CATALOG WILL BE LISTED NEXT
. SELECT THE .EFF FILE TO BE PLOTTED AND TYPE IN FILE NAME WH
EN REQUESTED. NOTE AMPERGRAPH LOADER MUST HAVE BEEN RUN PRIOR
 TO THIS PROGRAM."
2  PRINT " THE RUN WILL THEN BE PLOTTED. TO PLOT ANOTHER RUN
SIMPLY TYPE 'RUN' AFTER THE LAST HAS BEEN COMPLETED. TO HALT
CATALOG SCROLLING USE 'CTRL-S' "
3  PRINT "TO CONTINUE PRESS ANY KEY": GET R$: PRINT R$: PRINT

5  HIMEM: 16383
6  REM  **** PLOT SQUARE ****
10 D$ =  CHR$ (4)
12  DIM XP(21),M(21),CI(21)
16 NP = 20
17  PRINT D$;"CATALOG" + ",D2"
19  PRINT : INPUT "ENTER FILE NAME OF RUN TO BE PLOTTED     "
;NM$
20  PRINT D$;"OPEN" + NM$ + ",D2"
30  PRINT D$;"READ" + NM$
40  INPUT NP
50  FOR I = 0 TO NP + 1
60  INPUT XP(I): INPUT M(I): INPUT CI(I)
70  NEXT I
80  PRINT D$;"CLOSE"
200 DB = 0:DL = 1.0E32
210  FOR I = 1 TO 20
215  IF M(I) <  = 0 THEN M(I) = 1.0E - 15: GOTO 240
220  IF M(I) > DB THEN DB = M(I)
230  IF M(I) < DL THEN DL = M(I)
240  NEXT I
250  TEXT : HOME : PRINT "MIN PENE.=";DL
260  PRINT : PRINT "MAX PENE.=";DB
270  PRINT : PRINT : INPUT "SELECT RANGE FOR PENETRATION PLOT
 - MIN,MAX. MUST BE INTEGRAL POWERS OF TEN ";YL,YM
271  HGR2
275  & SCALE,.1,100,YL,YM
276  & LIMIT,.20,.7,0,1
280  &  LOG X: &  LOG Y
290 LY$ = "PENETRATION, %":LX$ = "DIAMETER, MICRONS"
300  & LABELAXES
310 LABEL$ = NM$: & LABEL,.2,.6 * YM
320  FOR I = 1 TO 20
325  IF M(I) <  = 0 THEN 340
330  & OPENCIRCLE,XP(I),M(I)
335  & ERR OR BARS,0,CI(I)
340  NEXT I
341  FOR I = 1 TO 5000: NEXT I: TEXT : HOME : INPUT "HARDCOPY
? (REQUIRES GRAPHITTI CARD) Y/N";R$: IF R$ <  > "Y" THEN 350
342  PRINT : PRINT : INPUT "S)MALL (3X4) OR L)ARGE (6X8) SIZE
 FOR PLOT ";R$: IF R$ <  > "S" AND R$ <  > "L" GOTO 342
343  IF R$ = "S" THEN P$ = "G2R"
344  IF R$ = "L" THEN P$ = "G2RD"
```

```
345  PRINT D$;"PR#1"
346  PRINT  CHR$ (9) + P$: PRINT D$;"PR#0"
348  HIMEM: 38400
350  END

]
```

PURGE RUNFILE

```
5 RO = 0
10 D$ =  CHR$ (4)
15  PRINT D$ + "CATALOG" + ",D2": FOR I = 1 TO 5000: NEXT I
20  HOME : PRINT : INPUT "ENTER TEST NUMBER OF RUN TO BE DELE
TED ";TN
30  PRINT : INPUT "ENTER RUN ID OF RUN TO BE DELETED ";RN$
35  PRINT : INPUT "ENTER I)NLET OR O)UTLET RUN? ";I$
40 NM$ = "T" +  STR$ (TN) + "R" + RN$ + "." + I$ + "T"
50  PRINT "CHECK FILE NAME AND VERIFY THAT": PRINT NM$: PRINT
"IS THE FILE TO BE DELETED -Y/N ": GET R$: PRINT R$: PRINT
60  IF R$ <  > "Y" THEN  HOME : GOTO 20
62  PRINT D$;"OPEN" + NM$: PRINT D$;"CLOSE" + NM$
65  PRINT D$ + "DELETE" + NM$
70 K = 0:M = 0
72 D$ =  CHR$ (4)
75  PRINT D$ + "OPEN RUN/NAM"
80  PRINT D$ + "READ RUN/NAM"
90  INPUT NR
100  IF RO = 0 THEN  DIM Y$(NR),K(NR)
110  FOR I = 1 TO NR
120  INPUT Y$(I)
130  IF NM$ = Y$(I) THEN M = M + 1:K(M) = I
140  NEXT I
150  PRINT D$ + "CLOSE"
155  IF M = 0 THEN  END
160  PRINT D$ + "OPEN RUN/NAM"
170  PRINT D$ + "WRITE RUN/NAM"
175  PRINT NR - M
180  FOR I = 1 TO NR
190  IF NM$ = Y$(I) THEN  GOTO 210
200  PRINT Y$(I)
210  NEXT I
220  PRINT D$ + "CLOSE"
230  INPUT "MORE TO DELETE? (Y/N) ";R$: IF R$ <  > "Y" THEN  END

240 RO = 1
250  GOTO 15

]
```

```
5 RO = 0
10 D$ =  CHR$ (4)
15  PRINT D$ + "CATALOG" + ",D2": FOR I = 1 TO 5000: NEXT I
20  HOME : PRINT : INPUT "ENTER IMPACTOR NAME TO BE DELETED "
;NM$
40 MM$ = NM$ + "/IMP"
50  PRINT "CHECK FILE NAME AND VERIFY THAT": PRINT MM$: PRINT
" IS THE FILE TO BE DELETED -Y/N ": GET R$: PRINT R$: PRINT
60  IF R$ <  > "Y" THEN  HOME : GOTO 20
62  PRINT D$;"OPEN" + MM$: PRINT D$;"CLOSE" + MM$
65  PRINT D$ + "DELETE" + MM$
70 K = 0:M = 0
72 D$ =  CHR$ (4)
75  PRINT D$ + "OPEN IMP/NAM"
80  PRINT D$ + "READ IMP/NAM"
90  INPUT NR
100  IF RO = 0 THEN  DIM Y$(NR),K(NR)
110  FOR I = 1 TO NR
120  INPUT Y$(I)
130  IF NM$ = Y$(I) THEN M = M + 1:K(M) = I
140  NEXT I
150  PRINT D$ + "CLOSE"
155  IF M = 0 THEN  END
160  PRINT D$ + "OPEN IMP/NAM"
170  PRINT D$ + "WRITE IMP/NAM"
175  PRINT NR - M
180  FOR I = 1 TO NR
190  IF NM$ = Y$(I) THEN  GOTO 210
200  PRINT Y$(I)
210  NEXT I
220  PRINT D$ + "CLOSE"
230  INPUT "MORE TO DELETE? (Y/N) ";R$: IF R$ <  > "Y" THEN  END

240 RO = 1
250  GOTO 15

]
```

```
1  REM  *** DEF/ORI PROGRAM V1.2 ***
2  REM  **CREATES/UPDATES/LISTS INFORMATION IN &.ORI FILE
4  REM   ** VERS 1.0 2/2/83
5  REM   REVISED 2/26/84
6  GOSUB 63999: REM  INITIALIZE PRINT FORMATTER
7 D$ =  CHR$ (4)
10 F1$ = "YES":F2$ = "YES"
13  DIM JN(15),JS(15),JD(15),JL(15),MZ(15),KC(15)
20  DIM F$(15),A$(30),N$(100),NI$(100)
30 NM$ = "--------":SH$ = "CIRC.":SH = 0:EF = 0
100  REM       ** MAIN PROGRAM **
110  GOSUB 1000
120  GOSUB 2000
121  IF R$ = "Q" THEN  GOTO 135
122  GOSUB 2500
123  IF R$ = "Q" THEN  GOTO 135
124  IF R$ = "P" GOTO 120
135  IF F1$ = "YES" THEN  GOSUB 4000
140  IF F2$ = "YES" THEN  GOSUB 5000
141  HOME : VTAB 5: PRINT "C)ONTINUE WITH MORE SETS, OR"
142  INPUT "R)ETURN MAIN MENU";R$: IF R$ = "C" THEN  GOTO 120

143  IF R$ <  > "R" GOTO 141
145  PRINT "RUN MAIN MENU"
997  REM   PRINT D$;"RUN MAIN MENU"+",D1"
998  REM  GOTO 110
999  END
1000  REM  ** FORMAT DEFINITION
1010  HOME
1020 P = 1
1030 F$(0) = "        D E F O R I   V1.2"
1040 F$(1) = " 1)  HARD COPY OPTION: &"
1050 F$(2) = " 2)  DISK FILE UPDATE: &"
1055 F$(4) = "     FILE NAME: &"
1060 F$(3) = " 3)  ORIFICE SET NAME : &"
1070 F$(5) = " 4)  DESCRIPTION: "
1080 F$(7) = " 5)  NUMBER IN SET: ##"
1100 F$(8) = "ORIFICE  DIA.(IN) QCAL   JET"
1130 F$(11) = "ORI. DIA.   QCAL   PCAL   TCAL    DPCAL"
1140 F$(12) = "NO.  (IN)   (CFM) (IN HG)(DEG F)  (H2O)"
1150 F$(13) = "## ; #.###;  #.####;  ##.##;  ###;    ##.##"
1151 F$(14) = "ORI. DIA.   QCAL   PCAL    TCAL   DPCAL     KC
AL   <>H@"
1152 F$(15) = "## ; #.###;  #.####;  ##.##;  ###;    ##.##;
 ####.##;   ####.##"
1155  REM        ONERR  GOTO 1170
1160  RETURN
1170  PRINT "ERROR; TO CONTINUE PRESS ANY KEY; ERROR CODE = "
; PEEK (222): INPUT R$: GOTO 120
1399  REM  MENU SELECTOR
1400  VTAB 22: PRINT "P)AGE, Q)UIT, OR NUMBER OF ITEM TO ENTE
R/CHANGE: ";
```

```
1410  INPUT R$
1420  IF R$ = "Q" THEN  RETURN
1430  IF R$ = "P" THEN P = P + 1: IF P > 2 THEN P = 1: RETURN

1435  IF R$ = "P" THEN  RETURN
1440 A =  VAL (R$): IF A < 1 OR A > 9 THEN  GOTO 1400
1450  RETURN
2000  REM       ** MAIN MENU
2010 P = 1
2020  HOME : PRINT F$(0) + "-PAGE 1 OF 2"
2030  VTAB 3: CALL BU,R$,F$(1),F1$: PRINT R$
2040  CALL BU,R$,F$(2),F2$: PRINT R$
2050  CALL BU,R$,F$(3),NI$: PRINT R$
2055  CALL BU,R$,F$(4),NM$: PRINT R$
2060  PRINT F$(5) + RM$
2080  CALL BU,R$,F$(7),NS: PRINT R$
2090  GOSUB 1400
2100  IF (R$ = "Q") OR (P = 2) THEN  RETURN
2110  IF A > 5 THEN  GOSUB 1400
2115  IF A = 0 GOTO 2000
2120  ON A GOSUB 2320,2340,2360,2460,2470
2130  GOTO 2020
2320 A = 0: IF F1$ = "YES" THEN F1$ = "NO": RETURN
2325 F1$ = "YES": RETURN
2340 A = 0: IF F2$ = "YES" THEN F2$ = "NO": RETURN
2345 F2$ = "YES": RETURN
2360 A = 0: HOME : PRINT F$(0) + " PAGE 1 OF 2"
2365  VTAB 3: INPUT "KEY IN ORIFICE SET LETTER DESIG: ";Y$
2366  IF Y$ = NI$ THEN  RETURN
2367 NI$ = Y$:NF = 1:NM$ = Y$ + "/ORI": ONERR  GOTO 2440
2368  PRINT Y$: PRINT D$;"OPEN ORI/NAM" + ",D2"
2370  PRINT D$;"READ ORI/NAM": REM  GET ORIFICE SET INDEX FIL
E
2371 OK = 0
2372  INPUT TI: IF TI = 0 THEN  PRINT D$;"CLOSE ORI/NAM": PRINT
"TI=0": FOR I = 1 TO 2000: NEXT I: RETURN
2374  FOR I = 1 TO TI
2376  INPUT N$(I)
2378  IF N$(I) = NI$ THEN OK = 1
2380  NEXT I
2381  PRINT D$;"CLOSE ORI/NAM"
2382  IF OK = 0 THEN  PRINT "OK=0 TI="TI: FOR I = 1 TO 2000: NEXT
I: RETURN
2385  PRINT "OK=1 TI=";TI: FOR I = 1 TO 2000: NEXT I
2386  REM  RETURN
2387  REM  IF SET ALREADY EXISTS, LOAD IT FROM DISK
2388  PRINT D$;"OPEN" + NM$ + ",D2"
2389  PRINT D$;"READ" + NM$
2390  INPUT NS
2391  IF NS = 0 GOTO 2450
2395  FOR I = 1 TO NS
2400  INPUT JN(I),JS(I),JD(I),JL(I),JA(I)
2420  NEXT I
2430  GOTO 2450
2440 NF = 0: PRINT "FILE ERROR "; PEEK (222):EF = 1: STOP
```

```
2450  PRINT D$;"CLOSE" + NM$: ONERR  GOTO 1170: RETURN
2460  IF A = 0 THEN  RETURN
2461 A = 0: HOME : PRINT F$(0)
2465  VTAB 3: INPUT "ENTER REMARKS/DESCRIPTION: ";RM$: RETURN

2470 A = 0: HOME : PRINT F%(0)
2475  VTAB 3: INPUT "ENTER NO. OF ORIFICES IN SET :";NS: RETURN

2500  REM      *** MENU PAGE 2
3000  REM
3001 J = 0:HH = 6:SH = 1
3020  HOME : PRINT F$(0) + "-PAGE 2 OF 2"
3030  VTAB 3: PRINT F$(11)
3040  PRINT F$(12)
3050  FOR I = 1 TO NS
3070  CALL BU,R$,F$(13),I,JN(I),JS(I),JD(I),JL(I),JA(I): PRINT
R$
3080  NEXT I
3090  VTAB 21: HTAB 1: PRINT "TO ENTER/CHANGE DATA FOR AN ORI
. ENTER ORI. NO. OR Q)UIT OR P)AGE                ";: VTAB 22: HTAB
29: INPUT R$: IF R$ = "Q" OR R$ = "P" THEN  RETURN
3108 J = 0
3110 I =  VAL (R$): IF I < 1 OR I > NS GOTO 3090
3112  VTAB 21: PRINT "PRESS 'RETURN' TO ACCEPT CURRENT VALUE
 OR ENTER NEW VALUE.                              "
3115  VTAB I + 4: CALL BU,R$,F$(13),I,JN(I),JS(I),JD(I),JL(I)
,JA(I): PRINT R$;: HTAB HH - 1: INPUT "";R$: IF R$ = "" GOTO
3300
3120 J = J + 1: ON J GOTO 3130,3140,3150,3160,3170
3130 JN(I) =  VAL (R$):HH = HH + 7: GOTO 3115
3140 JS(I) =  VAL (R$):HH = HH + 8: GOTO 3115
3150 JD(I) =  VAL (R$):HH = HH + 8: GOTO 3115
3160 JL(I) =  VAL (R$):HH = HH + 7: GOTO 3115
3170 JA(I) =  VAL (R$):HH = 6: GOTO 3000
3300 J = J + 1: ON J GOTO 3310,3320,3330,3340,3350
3310 HH = HH + 7: GOTO 3115
3320 HH = HH + 8: GOTO 3115
3330 HH = HH + 8: GOTO 3115
3340 HH = HH + 7: GOTO 3115
3350 HH = 6: GOTO 3000
3499  STOP
4000  REM      ** HARDCOPY OPTION
4010  PRINT "PRINTED COPY OPTION NOW BEING EXECUTED-TURN PRIN
TER ON AND PRESS ANY KEY": GET R$
4012  PRINT
4015  PRINT D$;"PR#1"
4020  PRINT F$(0)
4040  CALL BU,R$,F$(2),F2$: PRINT R$
4050  CALL BU,R$,F$(3),NI$: PRINT R$
4055  CALL BU,R$,F$(4),NM$: PRINT R$
4060  PRINT F$(5) + RM$
4080  CALL BU,R$,F$(7),NS: PRINT R$
4090  PRINT : PRINT : PRINT
4110  PRINT F$(14): PRINT F$(12)
4120  FOR I = 1 TO NS
```

```
4130 KC(I) = (460 + JL(I)) * JA(I) / (JS(I) * JS(I) * JD(I) *
28.97): REM  CALCULATE KCAL PER EPA 600/7-77-058
4135 HA = .9234 * KC(I): REM  CALCULATE DELTA H A (METH5 ORIF
ICE CALIBRATION CONSTANT)
4140  CALL BU,R$,F$(15),I,JN(I),JS(I),JD(I),JL(I),JA(I),KC(I)
,HA: PRINT R$
4150  NEXT I
4160  PRINT D$;"PR#0": RETURN
5000  REM           ** DISK UPDATE
5001  PRINT "": PRINT D$;"OPEN" + NM$ + ",D2": PRINT D$;"CLOS
E" + NM$: PRINT D$;"DELETE" + NM$
5005  REM       ONERR  GOTO 5900
5007  PRINT D$;"OPEN" + NM$ + ",D2"
5010  PRINT D$;"WRITE" + NM$
5020  PRINT NS
5030  FOR I = 1 TO NS
5040  PRINT JN(I): PRINT JS(I): PRINT JD(I): PRINT JL(I): PRINT
JA(I)
5045  NEXT I
5090  PRINT D$;"CLOSE" + NM$
5095  PRINT "OK=";OK: INPUT "TO CONT.ENTER Y";R$
5100  IF OK = 1 THEN  RETURN
5105  IF TI = 0 GOTO 5550
5499  REM  ADD SET NAME TO INDEX FILE
5500  PRINT D$;"OPEN ORI/NAM" + ",D2"
5510  PRINT D$;"READ ORI/NAM"
5520  INPUT TI
5530  FOR I = 1 TO TI: INPUT NI$(I): NEXT I
5540  PRINT D$;"CLOSE ORI/NAM"
5550 TI = TI + 1:NI$(TI) = NI$
5560  PRINT D$;"OPEN ORI/NAM" + ",D2": PRINT D$;"WRITE ORI/NA
M"
5570  PRINT TI
5580  FOR I = 1 TO TI: PRINT NI$(I): NEXT I
5590  PRINT D$;"CLOSE"
5630  RETURN
5900  PRINT "DISK ERROR: "; PEEK (222)
5910  PRINT "CHECK DRIVE, ETC. IF NEEDED PRESS 'CONTROL C' AN
D THEN RESTART DISK SAVE WITH 'RUN 5000'
5920  GOTO 5000
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM


==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)   APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP
```

```
1  REM   UPDATE TO SAVE VELOCITY TABLES 11/15/84 JDM
2  REM  CLEAN UP PROMPTS & CONVERT FROM KCAL TO <>H@ 12/27/85
 JDM
100  REM   ** IMP OP & VEL TRAV PROG **
110  DIM X(20),Y(20),C(20),T(20,20),V(20,20),O(20,20),S(52),J
(52),F$(60)
120  GOSUB 63999
130 D$ =  CHR$ (4)
140  GOSUB 11000
150  HOME : PRINT F$(0): PRINT
160  PRINT "NEW VELOCITY TRAVERSE (Y OR N)?  ";: GET Q$: PRINT
Q$: PRINT : IF Q$ = "N" THEN F1 = 1
161  GOTO 170
165  HOME : PRINT F$(0): PRINT
170  IF Q$ = "Y" THEN  HOME : GOTO 270
180  IF Q$ >  < "N" THEN 150
190  REM   ** START
200  HOME : PRINT F$(0): PRINT
210  CALL BU,R$,F$(1),N$: PRINT R$
220  REM  GOSUB RUN CODE CHECK
230  CALL BU,R$,F$(2),A2: PRINT R$
240  CALL BU,R$,F$(3),I$: PRINT R$
250  GOTO 330
270  REM   ** VEL START
280  CALL BU,R$,F$(4),M$: PRINT R$
290 F3 = 0
300  IF  RIGHT$ (M$,1) = "0" THEN F3 = 1
310  CALL BU,R$,F$(5),B1: PRINT R$
320  CALL BU,R$,F$(6),B2: PRINT R$
330  CALL BU,R$,F$(7),G$: PRINT R$
340  CALL BU,R$,F$(8),G1: PRINT R$
350  CALL BU,R$,F$(9),G2: PRINT R$
360  CALL BU,R$,F$(10),G5: PRINT R$
370  CALL BU,R$,F$(11),P1: PRINT R$
380  CALL BU,R$,F$(12),P2: PRINT R$
390  CALL BU,R$,F$(13),F: PRINT R$
395  PRINT "B)  STACK TYPE              ";ST$
396  IF ST$ = "ROUND" THEN  CALL BU,R$,F$(52),DL: PRINT R$
397  IF ST$ = "RECT." THEN  CALL BU,R$,F$(50),DL: PRINT R$: CALL
BU,R$,F$(51),DB: PRINT R$
400  VTAB 20: PRINT "PRESS ITEM NO. TO CHANGE, C TO CONTINUE,
R TO RETURN TO MENU, OR V FOR NEW       VELOCITY"
410  VTAB 22: HTAB 13: GET A$
420  IF A$ = "R" THEN  PRINT "ARE YOU SURE YOU WANT TO EXIT P
ROGRAM?";: GET R$: PRINT R$: PRINT : IF R$ = "Y" THEN  PRINT
D$;" RUN MENU"
425  IF A$ = "R" THEN  GOTO 165
430  IF A$ = "C" THEN 600
432  IF A$ = "V" THEN F9 = 0:F1 = 0:F4 = 0: GOTO 150
435  HTAB 15: PRINT "                          ": VTAB 22: HTAB 1
5
440  IF A$ = "A" THEN  INPUT "AMB TEMP = ";F: GOTO 165
```

```
445  IF A$ = "B" THEN  IF ST$ = "ROUND" THEN ST$ = "RECT.": GOTO
165
446  IF A$ = "B" THEN ST$ = "ROUND":B1 = 4: GOTO 165
447  IF A$ = "D" AND ST$ = "RECT." THEN  INPUT "ENTER DUCT LE
NGTH: ";DL:D2 = DL * DB: GOTO 165
448  IF A$ = "E" AND ST$ = "RECT." THEN  INPUT "ENTER DUCT DE
PTH : ";DB:D2 = DL * DB: GOTO 165
449  IF A$ = "D" AND ST$ = "ROUND" THEN  INPUT "ENTER DUCT DI
A. : ";DL:D2 = 3.14159 * (DL ^ 2) / 4: GOTO 165
450 A =  VAL (A$)
460  IF A = 1 AND Q$ = "N" THEN  INPUT "RUN NO. = ";N$: GOTO
165
470  IF A = 2 AND Q$ = "N" THEN  INPUT "SUBSTRATE SET = ";A2:
 GOTO 165
480  IF A = 3 AND Q$ = "N" THEN  INPUT "TYPE/SHELL/PLATE = ";
I$: GOTO 165
490  IF A = 1 AND Q$ = "Y" THEN  INPUT "TEST CODE = ";M$: GOTO
165
500  IF A = 2 AND Q$ = "Y" THEN  INPUT "NO. PORTS = ";B1: GOTO
165
510  IF A = 3 AND Q$ = "Y" THEN  INPUT "NO. POINTS/PORT = ";B
2: GOTO 165
520  IF A = 4 THEN  INPUT "DATE = ";G$: GOTO 165
530  IF A = 5 THEN  INPUT "% O2 = ";G1: GOTO 165
540  IF A = 6 THEN  INPUT "% CO2 = ";G2: GOTO 165
550  IF A = 7 THEN  INPUT "% H2O = ";G5: GOTO 165
560  IF A = 8 THEN  INPUT "AMB PRES = ";P1: GOTO 165
570  IF A = 9 THEN  INPUT "DEL P STACK = ";P2: GOTO 165
580  GOTO 165
600 G4 = 100 - G1 - G2
610 P3 = P1 + P2 / 13.6
620 M1 = .32 * G1 + .44 * G2 + .28 * G4
630 M2 = (100 - G5) * M1 / 100 + .18 * G5
640 FK = F + 460
645  IF F1 = 1 THEN 1110
650  IF F4 = 1 OR F9 = 1 THEN 1300 REM         GOTO PORT #
660  REM   **  VEL TRAVERSE
670 I = 0
680 I = I + 1
685  IF I > B1 THEN I = 1
690  HOME : PRINT "VELOCITY TRAVERSE": PRINT
700  CALL BU,R$,F$(14),I: PRINT R$
710  CALL BU,R$,F$(15),C: PRINT R$
720  PRINT : PRINT "POINT #   Vp(H2O)    T(degF)    VEL(ft/s)"
760 SP = 1: IF ST$ = "ROUND" AND I = 1 THEN SP = 0
765  FOR K = SP TO B2
770  CALL BU,R$,F$(16),K,O(I,K),T(I,K),V(I,K): PRINT R$
780  NEXT K
790  CALL BU,R$,F$(17),Y(I): PRINT R$
800  CALL BU,R$,F$(18),X(I): PRINT R$
805  CALL BU,R$,FO$,OA(I): PRINT R$
807  IF SP = 0 THEN  PRINT : PRINT "NOTE: POINT '0' IS CENTER
 (FOR CONTOURS"
810  VTAB 22: INPUT "ENTER POINT NO. OR ITEM NO., N FOR NEXT
PORT, C TO CONTINUE, V TO RESTART ";A$
```

```
815  IF A$ = "V" THEN 165
820  IF A$ = "N" THEN 680
830  IF A$ = "P" THEN  HTAB 13: INPUT "PORT NO.= ";I: GOTO 69
0
840  IF A$ = "K" THEN  HTAB 13: INPUT "PITOT CONST. = ";C: GOTO
910
850  IF A$ = "C" THEN 1030
860 A =  VAL (A$)
870  IF A < 0 OR A > B2 THEN 690
880  HTAB 13: PRINT "FOR POINT NO. ";A
890  HTAB 13: INPUT "Vp = ";R$: IF R$ <  > "" THEN O(I,A) =  VAL
(R$)
900  HTAB 13: INPUT "T  = ";R$: IF R$ <  > "" THEN T(I,A) =  VAL
(R$)
910 CJ = 0
915 X(I) = 0
916 Y(I) = 0
918  IF SP = 0 AND A = 0 THEN V(1,0) = 85.48 * C /  SQR (P3 *
M2) *  SQR (O(1,0) * (T(1,0) + 460))
920  FOR J = 1 TO B2
940 V(I,J) = 85.48 * C /  SQR (P3 * M2) *  SQR (O(I,J) * (T(I
,J) + 460))
950 X(I) = X(I) + T(I,J)
960 Y(I) = Y(I) + V(I,J)
970 CJ = CJ + 1
980  NEXT J
990  IF CJ = 0 THEN 1020
1000 X(I) = X(I) / CJ
1010 Y(I) = Y(I) / CJ
1015 OA(I) = Y(I) / (( SQR (X(I) + 460)) * 85.48 * C) *  SQR
(P3 * M2)
1020  GOTO 690
1030 Z1 = 0
1040 Z2 = 0
1045 Z3 = 0
1050  FOR I = 1 TO B1
1060 Z1 = Z1 + Y(I)
1070 Z2 = Z2 + X(I)
1075 Z3 = Z3 + OA(I)
1080  NEXT I
1090 Z1 = Z1 / B1
1100 Z2 = Z2 / B1
1105 Z3 = Z3 / B1
1110  HOME : PRINT "VELOCITY TRAVERSE": PRINT :F1 = 0
1120  CALL BU,R$,F$(48),Z1: PRINT R$
1130  CALL BU,R$,F$(49),Z2: PRINT R$
1135  CALL BU,R$,FO$,Z3: PRINT R$
1140  PRINT : CALL BU,R$,F$(19),D2: PRINT R$: PRINT
1150 Q2 = Z1 * D2 * 60
1160 Q3 = Q2 * 530 / (460 + Z2) * P3 / 29.92 * (100 - G5) / 1
00
1170  CALL BU,R$,F$(20),Q2: PRINT R$
1180  CALL BU,R$,F$(21),Q3: PRINT R$
1190  VTAB 20: PRINT "PRESS ITEM NO TO CHANGE,P TO PRINT DATA
,D FOR DELTA P PROGRAM,V FOR NEW VELOCITYPROGRAM, S FOR DISK
```

```
SAVE"
1192  VTAB 23: HTAB 13: GET A$
1193  IF A$ = "S" THEN  GOSUB 20000: REM   SAVE TRAVERSE TO D
ISK
1194  IF A$ = "3" THEN  INPUT "DUCT AREA = ";D2: GOTO 1110
1200  IF A$ = "P" THEN  GOSUB 8000: GOTO 1110 REM  VEL OUTPUT

1210  IF A$ = "V" THEN F9 = 0: GOTO 150
1220  IF A$ = "D" THEN Q$ = "N":F9 = 1: GOTO 190
1225  IF A$ = "1" THEN  INPUT "DUCT VEL = ";Z1: GOTO 1110
1230  IF A$ = "2" THEN  INPUT "DUCT TEMP = ";Z2: GOTO 1110
1240  GOTO 1110
1300  REM   ** PORT NO.
1310  PRINT : PRINT "SELECT:": INPUT "PORT NO., M(=MANUAL), O
R A(=ALL) ";O$
1320  IF O$ = "A" THEN 1400
1330  IF O$ = "M" THEN  INPUT "MANUAL CALCULATION ON PORT NO.
 ";O$: GOTO 1450
1340 N =  VAL (O$)
1350 V = Y(N)
1360 T = X(N)
1370  PRINT : CALL BU,R$,F$(24),V: PRINT R$
1380  CALL BU,R$,F$(25),T: PRINT R$
1390  GOTO 1570
1400 V = Z1
1410 T = Z2
1420  PRINT : CALL BU,R$,F$(17),V: PRINT R$
1430  CALL BU,R$,F$(18),T: PRINT R$
1440  GOTO 1570
1450  HOME : PRINT "MANUAL VELOCITY ": PRINT
1460  CALL BU,R$,F$(26),V: PRINT R$
1470  CALL BU,R$,F$(27),T: PRINT R$
1480  PRINT : PRINT "PRESS 1 OR 2 TO CHANGE,C TO CONTINUE,
V TO RESTART ";: GET A$: PRINT A$
1500  IF A$ = "V" THEN 190
1510  IF A$ = "C" THEN 1580
1520 A =  VAL (A$)
1530  VTAB 8: PRINT "                                ": VTAB 8: HTAB
13
1540  IF A = 1 THEN  INPUT "GAS VEL = ";V: GOTO 1450
1550  IF A = 2 THEN  INPUT "GAS TEMP = ";T: GOTO 1450
1560  GOTO 1450
1570  REM   ** IMP FLOW RATE
1575  PRINT : PRINT "C TO CONTINUE";: GET Z$: PRINT
1580  HOME : PRINT "IMPACTOR FLOW RATE CALCULATION": PRINT
1590  PRINT "IMPACTOR TYPE     1)  ANDERSEN"
1600  PRINT "                  2)  BRINK"
1610  PRINT "                  3)  PILAT"
1615  PRINT "                  4)  SERIES CYCLONE"
1620  PRINT "                  5)  MANUAL SEARCH"
1630  PRINT : INPUT "YOUR CHOICE ";G: PRINT
1635  IF G < 1 OR G > 5 THEN 1580
1640  ON G GOTO 1650,1740,1650,1725,1860
1650 D1 = 11:I = 0
1660 I = I + 1
```

```
1670 D1 = D1 - 1
1675  IF D1 = 0 THEN  PRINT "NO MORE!!! - WILL RESTART": GOTO
1650
1680 D4 = D1 / 16 * 25.4
1690 Q1 = 5.072E - 04 * V * D4 ^ 2
1700  IF G = 1 AND Q1 > 1.25 THEN 1660
1710  IF G = 3 AND Q1 > 2 THEN 1660
1715  PRINT : PRINT "NOZ.DIA. = ";D4;"MM   Q = ";Q1;" ACFM": PRINT
"ARE THESE OK? (Y/N)";: GET R$: PRINT R$: IF R$ = "N" THEN 16
60
1716  IF R$ <  > "Y" THEN 1715
1720 D1 = D1 / 16: GOTO 2000
1725 I = 13: REM   NO. OF CYC. NOZZLES+1
1726 I = I - 1: IF I <  = 0 THEN  PRINT "NO MORE - WILL RESTA
RT": GOTO 1725
1728 D1 = CN(I):Q1 = 5.072E - 4 * V * D1 ^ 2
1729  IF Q1 > 2 AND I > 1 THEN 1726
1730  PRINT : PRINT "NOZ.DIA. = ";D1;"MM    Q= ";Q1;" ACFM": PRINT
"ARE THESE OK? (Y/N)";: GET R$: PRINT R$: IF R$ = "N" THEN 17
26
1732  IF R$ <  > "Y" THEN 1730
1735  GOTO 2000
1740  PRINT : INPUT "5 OR 6 STAGE BRINK ";M3
1745  IF M3 < 5 OR M3 > 6 THEN 1740
1750 D1 = 5
1760 Q2 = .025
1770  IF M3 = 5 THEN Q2 = .04
1775 I = 0
1780 I = I + 1
1790 Q1 = 5.072E - 04 * V * D1 ^ 2
1800  IF Q1 < Q2 THEN 1940
1810  IF D1 = 1.4 THEN 1940
1820  IF D1 < 2.5 THEN D1 = D1 - .1: GOTO 1840
1830 D1 = D1 - .5
1840  IF I < 20 GOTO 1780
1850  GOTO 1940
1860  VTAB 10
1870  CALL BU,R$,F$(28),D1: PRINT R$
1880 Q1 = 5.072E - 04 * V * D1 ^ 2
1890  PRINT : CALL BU,R$,F$(29),Q1: PRINT R$
1900  PRINT : PRINT "IS THE FLOW RATE OK (Y OR N)? ";: GET A$
: PRINT A$: PRINT
1910  IF A$ = "N" THEN  INPUT "NOZ DIA = ";D1: VTAB 14: PRINT
: PRINT : PRINT : GOTO 1860
1920  IF A$ = "Y" THEN 2000
1930  GOTO 1860
1940  IF G = 2 THEN  PRINT : CALL BU,R$,F$(28),D1: PRINT R$: GOTO
1970
1950 D1 = D1 / 16
1960  CALL BU,R$,F$(30),D1: PRINT R$
1970  CALL BU,R$,F$(29),Q1: PRINT R$
1980  PRINT : PRINT "ARE THESE NUMBERS OK (Y OR N)?";: GET A$
: PRINT A$: PRINT
1990  IF A$ = "N" THEN 1820
1995  IF A$ <  > "Y" THEN 1980
```

```
2000 X = (Q1 * (100 - G5) / 100 * P3 / (T + 460)) ^ 2 * FK *
M1 / .9234
2010  REM   ** ORIFICE SELECTION
2020 M = 1: IF G = 2 OR G = 5 THEN  PRINT : PRINT "1 ORIFICE
OR 2?  ";: GET M: PRINT M: IF M < 1 OR M > 2 THEN 2020
2050  IF M = 2 THEN 2300
2060  HOME : PRINT "ONE ORIFICE": PRINT
2070  CALL BU,R$,F$(31),1,1,O1$: PRINT R$
2080  CALL BU,R$,F$(32),2,1,H1: PRINT R$
2090 R =  - 1.5
2100  FOR I = 1 TO 24
2110 R = R + .5
2120 S(I) = X * H1 / (P1 - R)
2130 J(I) = 6 * FK * (P1 - R - S(I) / 13.6) / (Q1 * FK * P3 *
(100 - G5) / 100)
2140  NEXT I
2150  PRINT : PRINT "Psys   <>P  Tsec    Psys   <>P  Tsec"
2160 R =  - 1.5
2170 RR = 0
2180  FOR I = 1 TO 12
2190 K = I + 12
2200 R = R + .5
2210 RR = R + 6
2220  CALL BU,R$,F$(33),R,S(I),J(I),RR,S(K),J(K): PRINT R$
2230  NEXT I
2240  PRINT : PRINT "PRESS C TO CONTINUE,1 TO CHANGE ORIFICE
ID,2 TO CHANGE <>H@,F TO REPEAT FLOW    RATE CALCULATION,S TO
 SKIP THIS CALC  ";: GET A$: PRINT A$
2250  IF A$ = "F" THEN 1570
2255  IF A$ = "S" THEN 190
2260  IF A$ = "1" THEN  VTAB 23: HTAB 13: INPUT "ORIFICE ID =
 ";O1$: GOTO 2060
2270  IF A$ = "2" THEN  VTAB 23: HTAB 13: INPUT "<>H@ = ";H1:
 GOTO 2060
2280  IF A$ = "C" THEN 2600
2290  GOTO 2060
2300  HOME : PRINT "2 ORIFICES": PRINT
2310  CALL BU,R$,F$(31),1,1,O1$: PRINT R$
2320  CALL BU,R$,F$(32),2,1,H1: PRINT R$
2330  CALL BU,R$,F$(31),3,2,O2$: PRINT R$
2340  CALL BU,R$,F$(32),4,2,H2: PRINT R$
2350 R =  - 1.5
2360  FOR I = 1 TO 24
2370 R = R + .5
2380 S(I) = X * H1 / (P1 - R)
2390 J(I) = X * H2 / (P1 - R - S(I))
2400  NEXT I
2410  PRINT : PRINT "Psys  <>P1  <>P2     Psys  <>P1  <>P2"
2420 R = 0
2430 RR = 0
2440  FOR I = 1 TO 12
2450 K = I + 12
2460 R = R + .5
2470 RR = R + 6
2480  CALL BU,R$,F$(33),R,S(I),J(I),RR,S(K),J(K): PRINT R$
```

```
2490  NEXT I
2500  PRINT : PRINT "C TO CONTINUE,1-4 TO CHANGE DATA,F FOR
NEW FLOW RATE CALC,R TO REPEAT ";: GET A$: PRINT A$
2510  IF A$ = "R" THEN 190
2515  IF A$ = "F" THEN 1570
2520  IF A$ = "C" THEN 2600
2530 A =  VAL (A$)
2540  IF A = 1 THEN  HTAB 13: INPUT "ORIFICE #1 ID = ";O1$: GOTO
2300
2550  IF A = 2 THEN  HTAB 13: INPUT "Kcal #1 = ";H1: GOTO 230
0
2560  IF A = 3 THEN  INPUT "ORIFICE #2 ID = ";O2$: GOTO 2300
2570  IF A = 4 THEN  INPUT "Kcal #2 = ";H2
2580  GOTO 2300
2600  REM   ¥¥  FULL OUTPUT
2610  PRINT : PRINT "INSERT RUN SHEET": PRINT "C TO CONTINUE,
 S TO SKIP ";: GET Z$: PRINT Z$
2612  IF Z$ <  > "C" AND Z$ <  > "S" THEN 2610
2615  IF Z$ = "S" THEN 190
2620  PRINT D$;"PR#1"
2630  PRINT "                                          ";N$
2640  PRINT : CALL BU,R$,F$(36),I$,G1,P1,O$: PRINT R$
2650  PRINT : CALL BU,R$,F$(37),G$,G2,F,V: PRINT R$
2660  PRINT : CALL BU,R$,F$(38),A2,G4,P2,T: PRINT R$
2670  PRINT : CALL BU,R$,F$(34),G5,P3,Q1: PRINT R$
2700  PRINT : PRINT : PRINT : PRINT : PRINT : PRINT : PRINT
2705  CALL BU,R$,F$(39),D1: PRINT R$: PRINT
2707  IF M = 2 THEN 2840
2710  PRINT "
  ORI ID: ";O1$
2720  PRINT "
  <>H@:   ";H1
2730  PRINT "
  GAS METER #:"
2740 R =  - 1.5: PRINT
2750  PRINT "
  Psys   <>P   TIME"
2760  PRINT "
   Hg    H2O    sec"
2770  PRINT "
  ----   ---   ----"
2780  FOR I = 1 TO 24
2790 R = R + .5
2800  CALL BU,R$,F$(35),R,S(I),J(I): PRINT R$
2810  NEXT I
2820  PRINT : PRINT D$;"PR#0"
2830  GOTO 190
2840  PRINT "
  ORI #1 ID: ";O1$
2850  PRINT "
  <>H@ #1  : ";H1
2860  PRINT "
  ORI #2 ID: ";O2$
2870  PRINT "
  <>H@ #2  : ";H2
```

```
2880 R = 0: PRINT
2890  PRINT "
  Psys    <>P      <>P"
2900  PRINT "
   Hg     H2O      H2O"
2910  PRINT "
  ----    ---      ---"
2920  FOR I = 1 TO 24
2930 R = R + .5
2940  CALL BU,R$,F$(35),R,S(I),J(I): PRINT R$
2950  NEXT I
2960  PRINT : PRINT D$;"PR#0"
2970  GOTO 190
8000  REM     ** VEL OUTPUT
8010  PRINT : PRINT "LOAD TRAVERSE FORM INTO PRINTER, C TO
CONTINUE ": GET Z$: PRINT Z$
8015  PRINT D$;"PR#1"
8020  CALL BU,R$,F$(40),M$,G$: PRINT R$: PRINT
8030  CALL BU,R$,F$(41),G1,G4,P1,C,D2: PRINT R$: PRINT
8040  CALL BU,R$,F$(42),G2,G5,P2,F: PRINT R$: PRINT : PRINT
8050 I = 1
8060 I1 = I + 1:I2 = I + 2:I3 = I + 3
8070  IF B1 < I3 THEN 8160
8080  CALL BU,R$,F$(43),I,I1,I2,I3: PRINT R$: PRINT
8090  PRINT "PT     PV    T    VEL     PV    T    VEL     PV    T    V
EL     PV    T    VEL"
8100  PRINT " #     H2O   F   ft/s     H2O   F   ft/s     H2O   F   ft
/s     H2O   F   ft/s": PRINT
8110  FOR K = 1 TO B2
8120  CALL BU,R$,F$(44),K,O(I,K),T(I,K),V(I,K),O(I1,K),T(I1,K
),V(I1,K),O(I2,K),T(I2,K),V(I2,K),O(I3,K),T(I3,K),V(I3,K): PRINT
R$
8130  NEXT K
8140  PRINT : CALL BU,R$,F$(45),OA(I),X(I),Y(I),OA(I1),X(I1),
Y(I1),OA(I2),X(I2),Y(I2),OA(I3),X(I3),Y(I3): PRINT R$: PRINT
: PRINT
8150  GOTO 8410
8160  IF B1 < I2 THEN 8250
8170  CALL BU,R$,F$(43),I,I1,I2: PRINT R$: PRINT
8180  PRINT "PT     PV    T    VEL     PV    T    VEL     PV    T    V
EL"
8190  PRINT " #     H2O   F   ft/s     H2O   F   ft/s     H2O   F   ft
/s": PRINT
8200  FOR K = 1 TO B2
8210  CALL BU,R$,F$(44),K,O(I,K),T(I,K),V(I,K),O(I1,K),T(I1,K
),V(I1,K),O(I2,K),T(I2,K),V(I2,K): PRINT R$
8220  NEXT K
8230  PRINT : CALL BU,R$,F$(45),OA(I),X(I),Y(I),OA(I1),X(I1),
Y(I1),OA(I2),X(I2),Y(I2): PRINT R$: PRINT : PRINT
8240  GOTO 8410
8250  IF B1 < I1 THEN 8340
8260  CALL BU,R$,F$(43),I,I1: PRINT R$: PRINT
8270  PRINT "PT     PV    T    VEL     PV    T    VEL"
8280  PRINT " #     H2O   F   ft/s     H2O   F   ft/s": PRINT
8290  FOR K = 1 TO B2
```

```
8300  CALL BU,R$,F$(44),K,O(I,K),T(I,K),V(I,K),O(I1,K),T(I1,K
),V(I1,K): PRINT R$
8310  NEXT K
8320  PRINT : CALL BU,R$,F$(45),OA(I),X(I),Y(I),OA(I1),X(I1),
Y(I1): PRINT R$: PRINT : PRINT
8330  GOTO 8410
8340  CALL BU,R$,F$(43),I: PRINT R$: PRINT
8350  PRINT "PT     PV    T    VEL"
8360  PRINT " #     H20   F   ft/s": PRINT
8370  FOR K = 1 TO B2
8380  CALL BU,R$,F$(44),K,O(I,K),T(I,K),V(I,K): PRINT R$
8390  NEXT K
8400  PRINT : CALL BU,R$,F$(45),OA(I),X(I),Y(I): PRINT R$: PRINT
: PRINT
8410 I = I + 4
8420  IF I <  = B1 THEN 8060
8430  CALL BU,R$,F$(46),Z1,Q2: PRINT R$
8440  CALL BU,R$,F$(47),Z2,Q3: PRINT R$
8445  CALL BU,R$,FO$,Z3: PRINT R$
8450  PRINT : PRINT D$;"PR#0"
8460  RETURN
11000  REM  ** FORMATS **
11005 C = .83:P1 = 30: DIM CN(12):ST$ = "RECT."
11010 F$(0) = "IMPACTOR OP & VELOCITY PROGRAM"
11020 F$(1) = "1)  RUN NUMBER  (xxxxI-n)    ########"
11030 F$(2) = "2)  SUBSTRATE SET            ########"
11040 F$(3) = "3)  IMP TYPE/SHELL NO/PLATE NO ########"
11050 F$(4) = "1)  TEST CODE  (xxxxI)       ######"
11060 F$(5) = "2)  NUMBER OF PORTS            ##<0#"
11070 F$(6) = "3)  NUMBER OF POINTS PER PORT ##<0#"
11080 F$(7) = "4)  DATE                     #########"
11090 F$(8) = "5)  % O2                      #<0#.#"
11100 F$(9) = "6)  % CO2                     #<0#.#"
11110 F$(10) = "7)  % H2O                     #<0#.#"
11120 F$(11) = "8)  AMBIENT PRESSURE      ##<0#.## in. Hg"
11130 F$(12) = "9)  DELTA P STACK        ###<0#.## in. H2O"
11140 F$(13) = "A)  AMBIENT TEMP         ###<0#.   deg F"
11150 F$(14) = "P)  PORT NO               ###"
11160 F$(15) = "K)  PITOT CONSTANT        ##<0#.###"
11170 F$(16) = "    ##;      #<0#.###     ;###<0#;        ##<0#
.##"
11180 F$(17) = "AVG DUCT VELOCITY = ##<0#.# ft/sec"
11190 F$(18) = "AVG DUCT TEMP     = ####  deg F"
11200 F$(19) = "3) DUCT AREA =      ##<0#.# ft2"
11210 F$(20) = "FLOW RATE    = ##,###,##<0#.# acfm"
11220 F$(21) = "             = ##,###,##<0#.# scfm"
11230 F$(22) = "    % N2           ###.#"
11240 F$(23) = "    STACK PRES     ###.## in. Hg"
11250 F$(24) = "AVG PORT VELOCITY = ###.# ft sec"
11260 F$(25) = "AVG PORT TEMP     = ####  deg F"
11270 F$(26) = "1)  GAS VELOCITY    ##<0#.# ft/sec"
11280 F$(27) = "2)  GAS TEMP       ###<0#   deg F"
11290 F$(28) = "NOZZLE DIAMETER = ###.##  mm"
11300 F$(29) = "FLOW RATE       = ###.### ACFM"
11310 F$(30) = "NOZZLE DIAMETER = ###.##  in."
```

```
11320 F$(31) = "#;) ORIFICE NO ##; ID  #####"
11330 F$(32) = "#;) ORIFICE NO ##; ?<?>H@ ###<0#.###"
11340 F$(33) = "##.#; ###.#; ###.#;    ##.#; ###.#; ###.#"
11350 F$(34) = "                          % H20: ##.##;    Pstack:
  ##.##;    IMP FLOW: #.###"
11360 F$(35) = "
     ##.#; ###.#;   ###.#"
11370 F$(36) = " IMP ID:   ######;    % O2:  ##.#;     AMB P:
 ##.##;      PORT #: ####"
11380 F$(37) = " DATE:   ########;    % CO2: ##.#;     AMB T:
 #####;      GAS VEL: ##.##"
11390 F$(38) = " SUB SET #: ####;    % N2:  ##.#;     ?<?>Ps
tack: ###.#;   GAS TEMP:  ####"
11400 F$(39) = "
     NOZ DIA: ##.###"
11410 F$(40) = "                 ########;                ######
##"
11420 F$(41) = "% O2: ##.#;     % N2: ###.#;     AMB P: ##.##
;     Cp: ####.##;     DUCT AREA: ###"
11430 F$(42) = "%CO2: ##.#;     %H20: ###.#;     ?<?>Pstk: ##
#.#;    AMB T: ###"
11440 F$(43) = "         PORT ##;          PORT ##;          POR
T ##;          PORT ##"
11450 F$(44) = "##;  #.## ;####; ##.#;  #.## ;####; ##.#;  #.
## ;####; ##.#;  #.## ;####; ##.#"
11460 F$(45) = "AVG #.##; ####; ##.#;  #.##; ####; ##.#;  #.#
#; ####; ##.#;  #.##; ####; ##.#"
11470 F$(46) = "       AVG DUCT VEL  = ###.# ft/s;          V
OLUME FLOW = ##,###,### acfm"
11480 F$(47) = "       AVG DUCT TEMP = ####  deg F;
         = ##,###,### scfm"
11490 F$(48) = "1) AVG DUCT VEL   = ##<0#.# ft/sec"
11491 F$(50) = "D)  DUCT LENGTH           #<0#.## FEET"
11492 F$(52) = "D)  DUCT DIAMETER         #<0#.## FEET"
11493 F$(51) = "E)  DUCT DEPTH            #<0#.## FEET"
11495 F$(49) = "2) AVG DUCT TEMP  = ####  deg F"
11496 FO$ = "AVG SQRT DELTA P  = #<0#.### IN. H2O"
11497 CN(1) = 3.5:CN(2) = 4:CN(3) = 4.5:CN(4) = 5:CN(5) = 5.4
:CN(6) = 6:CN(7) = 7:CN(8) = 8:CN(9) = 9:CN(10) = 10:CN(11) =
11:CN(12) = 12: REM    CYC NOZZLE SET
11500  RETURN
19999  REM  TRAVERSE SAVE
20000  PRINT :D$ =  CHR$ (4):FI$ = "VEL DATA." + M$
20100  PRINT D$;"OPEN" + FI$
20110  PRINT D$;"WRITE" + FI$
20120  PRINT ST$: PRINT B1: PRINT B2: PRINT DL: PRINT DB: PRINT
 INT (Z1 * 100 + .5) / 100: PRINT  INT (V(1,0) * 100 + .5) /
100
20130  FOR I = 1 TO B1
20140  FOR J = 1 TO B2
20150  PRINT  INT (V(I,J) * 100 + .5) / 100
20160  NEXT J
20170  NEXT I
20180  PRINT D$;"CLOSE": RETURN
63999 BU =  PEEK (121) + 256 *  PEEK (122) + 286: CALL BU:BU =
```

```
 PEEK (6) + 256 *  PEEK (7): CALL BU + 3: RETURN : REM

==> DO NOT EDIT 63999.

65535  REM
  BUILDUSING (2.0)    APPENDED.

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==> TO REMOVE 'APPENDAGE', ENTER:
]EXEC BU.STRIP

]
```

Appendix B

Commercially Available Hardware (Calibration Data, etc.)

APPENDIX B

COMMERCIALLY AVAILABLE HARDWARE

B.1 Calibration Data for Commercial Impactors

Southern Research Institute (SoRI) has published (Cushing et.at., 1976, 1979) calibration data for five different models of commercially available cascade impactors used for stack sampling. SoRI has subsequently calibrated multiple individual impactors for four of these five models. Table B-1 presents a summary tabulation of these calibration results. Since both the jet diameter (D_j) and the stage constant ($\sqrt{\psi_{50}}$) are used together in the data reduction calculations, the stage constants ($\sqrt{\psi_{50}}$) have been normalized to the manufacturer's nominal hole diameters. Where multiple impactors of the same model were calibrated, the values shown in Table B-1 represent averages of the normalized stage constants. Comparisons for like stages indicate that D_{50} values under identical operating conditions typically vary within a standard deviation from 5 to 10% of the mean stage value.

Those averages refect the calibration data from seven Andersen (fiberglass), four Brink (grease), eight Brink (fiberglass), eight UW Mark III (grease), seven UW Mark V (grease) and three MRI Model 1502 impactors.

The data for the Sierra Model 226 was obtained on a single impactor and the data on the Flow Sensor was obtained from the manufacturer since this impactor has not been calibrated at SoRI. The following paragraphs describe the calibrations of the different impactors.

Several stages of the Pollution Control Systems, University of Washington Mark III impactor are common to the Mark V impactor. One should, however, note that stages 6 and 7 of the Mark III are different from stages 6 and 7 of the Mark V. Stage constants for both impactors are presented together in Table B-1. Impactor parameters ($\sqrt{\psi_{50}}$) for stages 1-3 with greased substrates were obtained by calibration of a single impactor using monodisperse dye particles generated by a vibrating orifice aerosol generator (VOAG) as described by Cushing et.al. (1976). Stage constants for the lower stages are averages of calibrations for 8 Mark III and 7 Mark V impactors with greased metal substrates using the uniform latex spheres (PSL) technique as described by Cushing et.al. (1976). Consequently, the stage constants for stages 4, 5, and 7 of the Mark V represent normalized averages of calibrations on 15 different units. Standard deviations are typically under 8 percent of the mean, extending to 12 percent for stages 11, 12, and 13.

Table B-1 IMPACTOR PARAMETERS

I. Round Hole Impactors

Stage No	No. of Jets	Jet Diameter D_j, cm	Jet To Plate Distance S, cm	Calibration Data Lab Conditions Stage Constants ($\sqrt{\psi_{50}}$) Greased Metal	Fiber Mat
EPA/SoRI Design Right Angle Precollectors:					
N/A	1	1.2700	0.850	0.240	
Pollution Control Systems (U of W) Mark III/V Cascade Impactor:					
III	V				
1	1	1	1.8237	1.437	0.144	
2	2(old)	6	0.5791	0.520	0.331	
-	2(new)	6	0.4305	0.520	-	
3	3	12	0.2438	0.318	0.381	
4	4	90	0.0790	0.318	0.365	0.352
5	5	110	0.0508	0.318	0.371	0.352
-	6	110	0.0390	0.318	0.366	
6	7	110	0.0343	0.318	0.383	0.355
7	-	90	0.0254	0.318	0.386	0.347
-	8	105	0.0300	0.318	0.347	
-	9	105	0.0262	0.318	0.363	
-	10	78	0.0262	0.318	0.366	
-	11	56	0.0262	0.318	0.369	
-	12	40	0.0262	0.318	0.382	
-	13	36	0.0262	0.318	0.369	
Belfort (MRI) Model 1502 Cascade Impactor:					
	1	8	0.8700	0.767	0.12	
	2	12	0.4760	0.419	0.25	
	3	24	0.1984	0.191	0.34	
	4	24	0.1191	0.191	0.372	
	5	24	0.0838	0.191	0.367	
	6	24	0.0533	0.191	0.360	
	7	12	0.0533	0.191	0.351	

Stage No	No. of Jets	Jet Diameter D_j, cm	Jet To Plate Distance S, cm	Calibration Data Lab Conditions Stage Constants ($\sqrt{\psi_{50}}$) Greased Metal	Fiber Mat
		Andersen Mark III Cascade Impactor:			
1	264	0.1638	0.254		0.305
2	264	0.1253	0.254		0.430
3	264	0.0948	0.254		0.410
4	264	0.0759	0.254		0.385
5	264	0.0533	0.254		0.369
6	264	0.0343	0.254		0.360
7	264	0.0254	0.254		0.362
8	156	0.0254	0.254		0.274
		Brink Model C Cascade Impactor:			
Cyc	Cyclone	(Catch assigned to Jet No. 0)			
0	1	0.3607	1.016	0.321	0.380
1	1	0.2490	0.747	0.312	0.359
2	1	0.1775	0.533	0.364	0.342
3	1	0.1396	0.419	0.373	0.365
4	1	0.0946	0.282	0.334	0.308
5	1	0.0731	0.220	0.381	0.338
6	1	0.0559	0.178	0.375	0.358
		Flow Sensor Mark IV Cascade Impactor:			
1	72	0.1613	0.254		0.38
2	144	0.0991	0.272		0.36
3	144	0.0742	0.272		0.38
4	144	0.0610	0.272		0.37
5	144	0.0457	0.293		0.35
6	144	0.0343	0.293		0.38
7	72	0.0343	0.293		0.34

II. Radial Slot Type Impactors

Stage No			No. of Slits	Jet Slit Width W, cm	Jet Slit Length L, cm	Jet To Plate Distance S, cm	Greased Metal	Fiber Mat
			Sierra Model 226, 228, and 2210 Cascade Impactor:					
A	B	C						
1	1	1	4	0.3590	5.156	0.635		0.33
2	2	2	4	0.1988	5.152	0.318		0.48
3	3	3	4	0.1147	3.882	0.239		0.36
4	4	4	4	0.0627	3.844	0.239		0.40
5	5	5	4	0.0358	3.869	0.239		0.47
6	6	6	4	0.0288	2.301	0.239		0.47
-	7	7	4	DNA	DNA	DNA		DNA*
-	8	8	4	DNA	DNA	DNA		DNA*
-	-	9	4	DNA	DNA	DNA		DNA*
-	-	10	4	DNA	DNA	DNA		DNA*

A = Model 226, B = Model 228, C = Model 2210,
* Mfg. data
DNA = Data Not Available

Data for the first three stages of the MRI Model 1502 were taken from VOAG calibration of a single impactor. Lower stage data use a normalized average of calibrations on three impactors using the PSL technique. Standard deviations were less than 7 percent of the mean.

Data for the first four stages of the Anderson Mark III were taken from VOAG calibrations of a single impactor. Lower stage data use a normalized average calibrations on seven impactors using the PSL technique. Standard deviations were less than 5 percent of the mean.

Stages 0 and 1 of the Brink Model C were taken from VOAG calibrations of a single impactor, once with fiberglass substrates and onece with greased metal substrates. The remaining four stages are averages of PSL calibrations with 4 (for greased metal) or 8 (for glass fiber) impactors. Standard deviations were generally less than 7% of the mean values. It is significant to note that typically calibration constants for glass fiber substrates are smaller than the corresponding constants for greased metal substrates.

The Flow Sensor calibration data was taken from the equipment manual furnished by the manufacturer. Calibrations are for fiberglass substrates. SoRI has not calibrated this impactor.

The Sierra model 226 Source Sampler was calibrated by Cushing et.al. (1976, 1979), but no further calibrations were performed as was done for the other four impactors in their report. The results of Cushing et.al. for 7 L/min operation are presented in Table B-1 for fiberglass substrates. The Sierra uses a radial slot design rather than a round hole geometry.

B.2 Description of Commercially Available Impactors

Figure B-1 shows the six commercially available impactors discussed in Section B.1 and the EPA/SoRI designed Right Angle Precollector. The following paragraphs give detailed equipment descriptions for each of these impactors. Table B-2 gives a condensed summary of the different impactors.

B.2.1. Pollution Control Systems, University of Washington Impactor (Pilat) Mark III and Mark V Impactor

The Mark III and Mark V impactors are round-hole, multiple-jet cascade impactors. The Mark III impactor has seven stages and can be operated at high flow rates (0.5 cfm). The Mark V has 13 stages, of which 10 or 11 are used at any one time, permitting operation over a wide range of flow rates from 3 to 13 L/min (0.1 to 0.4 acfm). This low flow rate capability permits the Mark V to be used in high concentration sampling situations. Although not commonly used, when the aerosol is sticky and bounce is not a problem, sample flow rates of up to 50 L/min (2 acfm) are possible with the removal of certain stages. The jets and substrate stages are interchangeable between the two impactors. The impactors are similar except for the number of stages and range of flow rates. It is often useful to have use of a Mark III shell with six or seven Mark V plates permitting an impactor to be configured for optimum performance in specific sampling circumstances. The design of the impactor readily permits the use of either greased metal substrates or fiber mat substrates. The

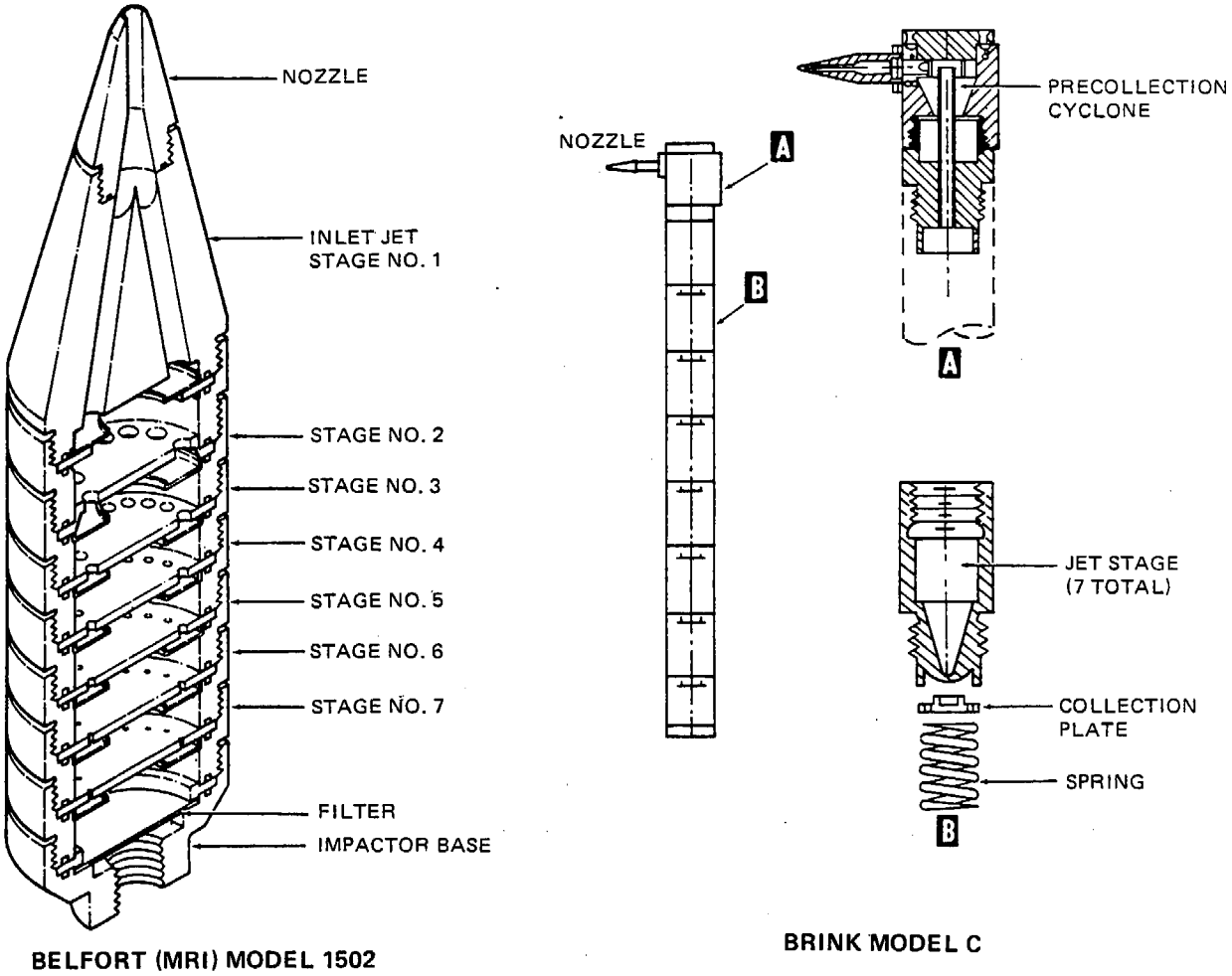

Figure B-1. Schematics of six commercial cascade impactors (Sheet 1 of 3).

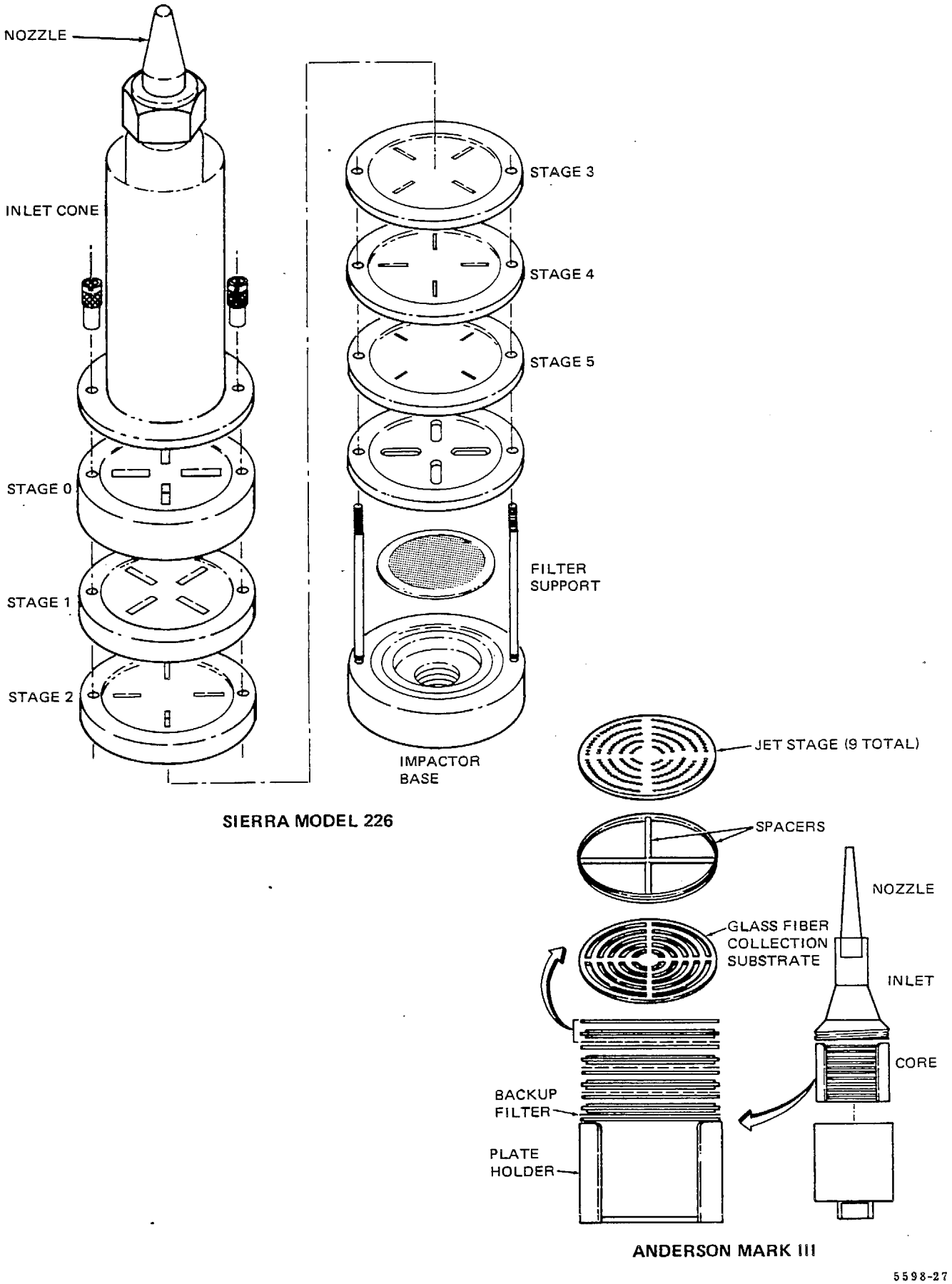

Figure B-1. Schematics of six commercial cascade impactors (Sheet 2 of 3).

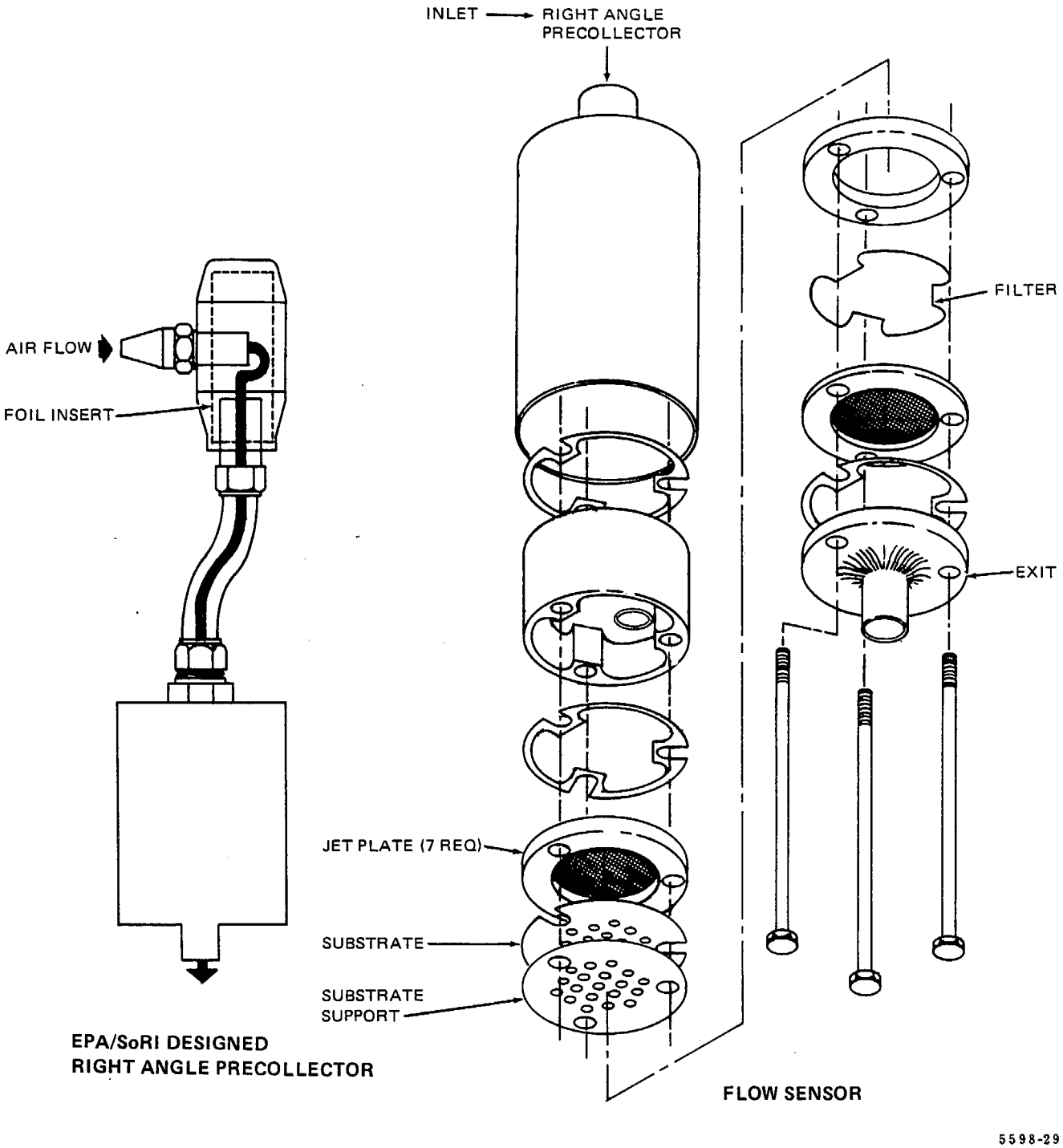

Figure B-1. Schematics of six commercial cascade impactors (Sheet 3 of 3).

Table B-2. Summary Characteristics of Commerical Instruments

Key No.	Manufacturer	Vender/Model No.	$ Quote X1000	DESCRIPTION/Comments	Key Parameters
GEN	EPA/SoRI design	Right Angle Pre.Co	1.6	Right Angle Impactor Precollector	1 Fr(11 at 0.5 SCFM), several grams
0310	Andersen Samp DAG	Mark III Impactor	4.2	Multi Jet Cascade Impactor,Iso. Stk Smp	9 Fr(F,.4 +10)
4120	Sierra Inst. DAG	Model 228	3.8	Multi Jet Cascade Impactor,Iso. Stk Smp	9 Fr(F,.3 +18)
1720	Flow Sensor DAG	Mark 4	5.8	Multi Jet Cascade Impactor,Iso. Stk Smp	8 Fr(F,.5 + 7)
2910	Belfort	Belfort 1502 (MRI)	2.1	Multi Jet Cascade Impactor,Iso. Stk Smp	8 Fr(F,.5 + 9)
3820	Pollution Control	Mark 5	3.9	Multi Jet Cascade Impactor,Iso. Stk Smp	12 Fr(F,.2 +20)
4910	Zoltec	Brink Model C	2.9	Low Flow M. Jet Cas. Imp., Iso. Stk Smp	8 Fr(F,.5 + 9)
GEN	EPA/SoRI design	6-Stage Cyclone	7.6	Cyclone Set w/SoRI 1,2,3,4,5,F	6 Fr(F,.3 +10),10 gm/stg. SoRI design

Key No.	Comments
GEN	Designed for Loadings > 1 gr/SCF, Right Angle, SoRI/EPA design.
0310	0.5 SCFM (F,.42, .78, 1.2, 2.2, 4.3, 5.9, 9.3, 9.9)Ref 18
4120	0.25SCFM (F, .3, .5, .9, 1.7, 2.7, 4.4, 11, 18)Mfg. Data
1720	0.5 SCFM (F,.52, .90, 1.3, 2.2, 3.0, 4.3, 6.8,)Ref 18, same as Mark 3, Right angle Preseparator, not built in Presep
2910	0.5 SCFM (F,.52, .69, 1.1, 2.2, 4.8, 9.0, 9.0,)Ref 18, sts 1&2 cut at 9 Metrology Res.Inc. was bought by Belfort
3820	0.5 SCFM (F,.21, .28, .36, .46, .62, .80, 1.05, 2.8, 5.6, 14)Mfg.,U of W, Stages interchangable with Mark 3
4910	.03 SCFM (F,.47, .78, 1.1, 2.3, 3.7, 5.4, 9.2)Ref 18, Low Flow for Inlets, High Loading collection stages available
GEN	1.0 ACFM (F,.40, .90, 2.0, 3.2, 8.3) Uses EPA/SoRI 5-Series Cyclone design

		Size Resolution						Concentration Information				Sampling Rate (SCFM)		Nominal Flow Rate	Nozzle Sizes(in.) Available		Min Port Req.	Max Oper. Temp.	
								Mass Basis (mg/M3)		Number Basis (#/cm3)									
Key No.	Manufacturer	#of Size Cuts	UF 0+.3	FINE .3+3	MED 3+10	COARSE >10	Dia. Basis A,P,O	min.	MAX.	min.	MAX.	min.	MAX.	(SCFM)	min	MAX	(in.)	Deg F	Weight (lb)
GEN	EPA/SoRI R. Angle Pre	1	0	0	0	1	A	N/A	High	N/A	N/A	.1	1.2	.5	3/16	1/2	4	820	1
0310	Andersen Samp DAG	8	0	4	3	1	A	N/A	DNA	N/A	N/A	.1	.75	.5	1/8	1/2	3	820	~10
4120	Sierra Inst DAG	8	0	5	1	2	A	N/A	DNA	N/A	N/A	.04	.35	.25	3/32	1/2	3	820	4.5
1720	Flow Sensor DAG	7	0	5	2	0	A	N/A	DNA	N/A	N/A	.1	.75	.5	1/8	1/2	3	850	5
2910	Belfort (MRI)	7	0	4	3	0	A	N/A	DNA	N/A	N/A	DNA	1.0	.5	1/8	1/2	3	450	3.5
3820	Pollution Control	11(13)	2	8	2	1	A	N/A	DNA	N/A	N/A	.02	1.0	.5	3/16	1/2	3	450	15
4910	Zoltec	8	0	4	3	0	A	N/A	DNA	N/A	N/A	.02	.05	.03	3/32	1/2	3	820	7
GEN	EPA/SoRI Des.5-Cyc.	5	0	3	2	0	A	N/A	High	N/A	N/A	.2	1.25	1.0	1/8	1/2	4	820	10

Mark III and Mark V were designed by Professor Mike Pilat of the University of Washington.

Pollution control also offers three other stack sampling impactors; Mark 8 and Mark 10, and Mark 20B. The Mark 8 is a high grain loading impactor. Literature was not available on the Mark 8 at the time of this writing but it is planned to collect bulk quantities in four to five size fractions (somewhat comparable to the EPA/SoRI 5-Series Cyclone Set). The Mark 10 has 27 stages, over the size range 0.05 to 20 μm and operates at 0.1 - 0.2 acfm. Six of the stages are low pressure stages. The upper stages are similar to the Mark V. The low flow of the Mark 10 makes it suitable for high concentration (high grain loading) flue gas. The Mark 20B is the companion impactor to the Mark 10. The Mark 20B has 14 stages, six of which are low pressure stages. It also covers the 0.05 to 20 μm size range but has a flow rate of 2 acfm, thus shorter run times are possible at the outlets of high efficiency pollution control equipment.

B.2.2 Belfort Instrument Co., Model 1502 (MRI) Impactor

The Belfort 1502 was designed by Metrology Research Institute and was originally marketed as the MRI Model 1502. Most of the data in the literature (Cushing, 1976) refers to this instrument as the MRI Model 1502. The Model 1502 is a round-hole, multiple jet high flow rate (0.5 cfm) cascade impactor. The impactor design readily permits the use of either greased metal substrates or fiber mat substrates. The design also permits the user to configure the impactor as desired for a particular sampling situation, although only seven stages are available to select from.

B.2.3 Andersen Impactor Division of Andersen Group, Mark III Impactor

The Andersen Mark III is a round-hole, multiple jet high flow rate (0.5 cfm) cascade impactor. The impactor design uses offset concentric jet stage hole patterns (odd and even). As shown in Figure B-1, this design uses an elaborately cut pattern fiber substrate (odd and even) which uses the subsequent stage for support. The odd type substrate is designed to be placed beneath an odd numbered jet stage so that the collection area is directly beneath the jets of the odd numbered stage but does not block the jets of the even numbered jet plate serving as a support. The concentric slots in the filter allow the gas to pass through the jets of the next stage.

The even type substrates is designed to be placed beneath an even numbered jet stage so that the collection area is directly beneath the jets of the even numbered stages but does not block the jets of the odd numbered jets plate serving as a support. This design procedures a compact sampler but one must be careful to use the correct type substrate for each of the two types of jet plates (odd and even). If a substrate is loaded in the wrong place the jets of the subsequent stage will be totally blocked. The normal procedures for loading an impactor already requires that a preweighed numbered substrate be loaded in a specific location (sequence number assignment), consequently the use of an odd/even design does not cause any additional complications. The disadvantage of this design is that if one desires to delete a given stage, he must delete a pair of stages (or substitute a stage of the appropriate parity

but much larger D_{50}). The second disadvantage is that such a design is not well suited to the use of greased substrates. Lightweight metal foil substrates are available from the manufacturer but the slotted design can permit the grease to flow from the substrate (carry over) onto the backside of the foil and the support plate (subsequent jet plate). Large weight changes for blank runs could indicate that such carry over is occurring but observation of the jet plates provides a positive test for grease carry over problems. When fiberglass substrates are used the spacer rings can cut the substrate if the top is tightened too much. Thin metal rings are available from the manufacturer for use as inserts to overcome these problems.

Andersen also offers the HCSS Impactor, High Concentration Stack Sampler. It offers three size fractions of 1.5, 5.8, and 11 μm at a flow rate of 0.5 cfm. As the name implies, it is designed to collect bulk quantities (several grams per stage) at high concentration sources (inlets). It is thus comparable to the EPA/SoRI 5-Series Cyclone Set.

B.2.4 Zoltec Corporation, Brink Model C Impactor

The Brink impactor was originally designed by J.A. Brink, Jr. (1958) of the Monsanto Chemical Company Research Department for measuring emissions from mist elimination equipment at phosphoric acid plants. By using single hole jets stages, the impactor operates at a very low flow rate and is thus well suited for sampling high concentration aerosols. The Brink Model C incorporates an integral cyclone which serves as a right angle precollector. Because of the low flow rate (0.03 acfm) normal Method 5 Sampling Train flow control units must be modified with smaller orifices (0.020 to 0.060 inch orifice plate) in order to obtain a measurable pressure drop at 0.03 acfm. In some cases, the dry gas meter may not function at these low flows. If it does function, it must be calibrated for this flow range. The design of the impactor easily permits the use of either greased metal foil inserts or fiber mat inserts (fiberglass or quartz). The cyclone is used to both remove large particles that could cause overloading and permit the impactor to be oriented at right angles to the direction of flow in the duct. The cyclone cut is nominally 15 to 20 μm but is not sufficiently calibrated to permit a D_{50} to be calculated for stack conditions. Consequently the cyclone catch and nozzle wash are assigned to the first calculated D_{50} (Stage 0).

B.2.5 Flow Sensor Division of Andersen Group, Mark III and Mark IV Impactor

Flow Sensor offers two impactors, the Mark III and Mark IV. Both are round-hole multiple jet high flow rate (0.5 cfm) cascade impactors. Both use the same jet stages. The difference is that the Mark IV uses an external right angle precollector but the Mark III has a built in, in-line precollector (not right angle). The design of the impactor does not readily permit the use of greased substrates. Fiber mat substrates are used which are punched with a hole pattern. These holes align with holes on the collection dish which permit the gas to pass to the next stage. If a metal insert was cut to match the hole pattern in the support dish, the same grease coating problems discussed with the Andersen would apply to the Flow Sensor.

B.2.6 Sierra Instruments Division of Andersen Group, Model 226, 228, and 2210

The Sierra Series 220 impactors use a radial slot design as shown in Figure B-1. The differences between the three models is the addition of extra stages. The Model 226 has six stages, the Model 228 has eight stages and Model 2210 has ten stages. Stages 1-6 are common to all three models, Stages 7 and 8 are common to the Model 228 and Model 2210. The flow range is from 0.035 to 0.35 cfm.

The Model 2210 covers the range 0.09 µm to 23 µm at 0.1 acfm (max flow for stage #10). At 0.25 acfm with the number 10 stage removed the range is 0.16 to 9.2 µm.

B.2.7 Other Impactors

Various other impactors have been developed to the prototype stage but are not currently available from vendors. Also, numerous impactors have been designed for ambient use. Discussion of these prototype and ambient impactors are beyond the scope of this document.

B.3 Manufacturer's Addresses

Andersen Samplers Div. of
Andersen Group
4215 Wendell Drive
Atlanta, GA 30336

Belfort Instrument Co.
Subsidiary of TransTechnology Corp.
727 South Wolfe Street
Baltimore, MD 21231

Flow Sensor Div. of
Andersen Group
4215 Wendell Drive
Atlanta, GA 30336

Pollution Control Systems Corp.
4530 Union Bay Place N.E.
Seattle, Washington 98105

Sierra Instruments Div. of
Andersen Group
4215 Wendell Drive
Atlanta, GA 30336

Zoltek Corporation
3101 McKelvey Road
St. Louis, MO 63044

Appendix C

Data Forms and Check Lists

Table C-1

PRELIMINARY SURVEY FOR PARTICULATE SIZING

PLANT DATA Date: _____

Company Name: _____

Address: _____ City: _____ State: _____

Name of Contacts: (Key) _____ Title: _____

_____ Title: _____

_____ Title: _____

Telephone Number: _____

Union Labor Craft Restrictions: _____

_____

Copies of Previous Compliance Testing: _____

PLANT OPERATIONS

Process Description: _____

_____

_____

(Operating Schedule): _____

_____

_____

(Batch or Continuous): _____

_____

_____

(Rates/Variability): _____

_____

_____

Table C-1 (Continued)
Page 2
Preliminary Survey for Particulate Sizing

AIR POLLUTION CONTROL EQUIPMENT

Description: _____

_____

(Operating Schedule): _____

_____

(Rate/Variability): _____

_____

SKETCH OF SAMPLING SITES (with approximate dimensions, port locations, upstream and downstream to equipment).

Table C-1 (Continued)
Page 3
Preliminary Survey for Particulate Sizing

CONDITIONS AT SAMPLING SITES INLET - OUTLET
(circle one)

Pressure

Temperature

Stake Gas Velocity

Duct Dimensions/Port Locations/Internal Obstructions to Traversing/Port Size/ Fitting Type
(see also sketch)

Gas Composition (Moisture, SO_2, etc.)

Particulate Loading

Pre-cutter Required?

Approx. Size Dist.

Substrate Type/Loss
by Filter Type Filter

Blank Weight Gain/Loss
by Substrates:
Filter:

Particulate Condition--
hard, sticky, wet, dry

(Use back of page for additional notes)

Table C-1 (Continued)
Page 4
Preliminary Survey for Particulate Sizing

OTHER ITEMS

1) Electricity Source

a. Amperage per circuit/number of circuits _____

b. Location of fuse box _____

c. Extension cord lengths _____ Quantity _____

d. Adapters Needed _____

e. Electrician _____

2) Safety Equipment Needed

a. Hard hats _____ d. Safety shoes _____

b. Safety glasses _____ e. Alarms _____

c. Goggles _____ f. Other _____

3) Ice

a. Vendor _____

b. Location _____

4) Solvents

a. Vendor _____

b. Location _____

5) Sampling Ports

a. Who will provide _____ Welder: _____

b. Size opening _____

6) Scaffolding

a. Height _____

b. Length _____

c. Vendor _____

Address _____

Telephone _____

Table C-1
Page 5
Preliminary Survey for Particulate Sizing

OTHER ITEMS (Cont.)

7) Distilled Water

a. Vendor _____

b. Location _____

8) Test Site Facilities

a. Parking _____

b. Restroom _____

c. Laboratory Facilities _____

d. Clean-up Area _____

9) Motels:

a. _____ Phone _____ Rate _____

b. _____ Phone _____ Rate _____

c. _____ Phone _____ Rate _____

10) Restaurants:

a. Near Plant _____

_____

b. Near Motel (late hours, carry out) _____

_____

11) Airport Convenient to Plant _____ Distance _____

12) Comments: _____

_____

_____

_____

_____

Survey By: _____

Table C-2

SAFETY CHECKLIST

Company _____ Date _____

Location _____

A. MEDICAL:

1) Plant first aid available (yes/no) _____.
If available give location of unit and telephone number

_____

B. TEST SITE CHECKLIST: Check if OK.

1) Ladders:

General conditions _____, rest stops _____, cage _____

Lighting _____

Comments: _____

_____

2) Scaffolds/Platforms:

General conditions _____, guardrails _____

toeboards _____, screening _____

Comments: _____

_____

3) Are Safety Warnings Below Sampling Platform Adequate:

Ropes _____, Flags _____

Signs (Danger Falling Objects, Men Working Overhead) _____

4) Are Plywood Inserts Needed to prevent hand tools from falling through open metal grating? _____

5) Are plant paging phones nearby? _____

6) Are Two-way Radios Required (Elevator, Stack)?_____

7) Are Fire Extinguishers and First Aid Kits Available at Sampling Site? _____

8) Is Non-flammable Thermal Protection Needed from Hot Metal Ductwork? _____

9) Is adequate lighting available if testing is to be performed after dark? _____

C. PERSONNEL PROTECTION EQUIPMENT: Check if needed.

1) Safety glasses _____, side shields _____
face shields _____, goggles _____, hard hat _____,
safety shoes _____ electrical hazard shoes _____,
life belt and safety block _____,
hearing protective devices _____, ladder climbing devices _____

2) Respiratory equipment:
Air purifying _____, air supplied _____,
self-contained _____,
Other _____
_____

3) Body protection:

Chemical protective garments _____

Heat protective garments _____

Chemical gloves _____

Heat resistant gloves _____

Leather gloves _____

Severe cold weather gear _____

Other _____

_____

D. SPECIAL OR UNUSUAL TEST PROCEDURES AND SAFETY PRECAUTIONS NECESSARY:

_____

_____

_____

_____

_____

_____

RUN SHEET FOR CARB SIZE DISTRIBUTION METHOD USING A CASCADE IMPACTOR SAMPLING TRAIN

REAL BLANK

RUN CODE	DATE	DIFFERENTIAL STACK PRESSURE (IN. H_2O)
CONTROL BOX ID	START TIME	AMBIENT PRESSURE (LAB BAROMETER) (IN. Hg)
GAS METER ID	END TIME	AMBIENT TEMPERATURE (F)
THE CALCULATED TARGET ΔH VALUES REQUIRES THE OPERATOR TO USE ORIFICE ID _____	SAMPLING DURATION (MIN.)	—60 SEC LEAK TEST— PRE HOT A. 15 IN. Hg W/SAMPLER FT^3
SAMPLING ASSIGNMENT INLET, OUTLET, OTHER:	GAS METER-START (FT^3)	B. 5 IN. Hg W/SAMPLER FT^3
	GAS METER-FINISH (FT^3)	C. 15 IN. Hg W/O SAMPLER FT^3 POST HOT
TARGET ΔH	TOTAL VOLUME BY GAS METER (ACF)	NOTE: RELEASE VACUUM AT NOZZLE TO AVOID RUPTURING FILTER. PASS ≤ 0.02 FT^3 FOR A OR B OR C VISUAL CHECK OF NOZZLE ☐

	RUN TIME (MIN)	PORT NO. TRAVERSE POINT	GAS METER READING	GAS METER TEMP. (F)	FLUE GAS TEMP. (F)		ORIFICE ΔH IN. (H_2O)	PUMP VACUUM (IN. Hg)	PROBE TEMP. (F)
	Pre								
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
	POST TEST CALCULATIONS:								
		TOTAL							
		AVG.							

—WATER—

CONDENSER ID NO.

CONDENSER H_2O CATCH (ml)

DRYING COLUMN WEIGHT CHANGE

ID NO. _____ INITIAL WT. _____ (gm)

FINAL WT. _____ (gm)

(1 gm = 1 ml) H_2O GAIN (ml)

TOTAL VOLUME H_2O (ml)

NOTES AND OBSERVATIONS

SAMPLING LOCATION

INLET OUTLET

IN THE SPACE BELOW GIVE THE UNIT, CHAMBER, DUCT PANTLEG, ETC. WHERE THE SAMPLER WAS RUN.

PORT NUMBER(S)

SAMPLER ORIENTATION (CIRCLE ONE)

HORIZONTAL
TOP ENTRY VERTICAL
W/ TURN AROUND
W/O TURN AROUND
BOTTOM ENTRY VERTICAL
OTHER

OPERATORS

(1) _____ (2) _____

5050-482A

LAB LOAD/UNLOAD SHEET FOR UNIVERSITY OF WASHINGTON IMPACTOR (SIX JET PLATES)

RUN CODE

SUBSTRATE SET IDENTIFICATION NO.

PERSON LOADING IMPACTOR AND DATE LOADED

- LOAD IMPACTOR
- MARK SHELL AND PRECOLLECTOR WITH RUN CODE
- LEAK TEST

UNIVERSITY OF WASHINGTON MARK V IMPACTOR

SHELL ID NO. _____

JET PLATE SET ID NO. _____

STAGE CONFIGURATION _____

PRECOLLECTOR ID NO. _____

NOZZLE ID NO. _____

NOZZLE DIAMETER _____ (INCHES)

LAB LEAK CHECK (60 SEC PRESSURE CHANGE)
CHECK UNDER VACUUM (~ 8 IN. Hg)

WITH PRECOLLECTOR:

INITIAL _____ (IN. Hg)

FINAL _____ (IN. Hg)

WITHOUT PRECOLLECTOR (ONLY IF LEAKS FOUND ABOVE)

INITIAL _____ (IN. Hg)

FINAL _____ (IN. Hg)

NOTES AND OBSERVATIONS

PERSON UNLOADING IMPACTOR AND DATE UNLOADED

NOTE YOUR OBSERVATIONS ON THE APPEARANCE OF EACH STAGE, SUBSTRATE, OR CYCLONE UPON DISASSEMBLY

PRECUTTER
I P

STAGE ZERO (DISK)
I D

STAGE ONE (FIRST PLATE, NO. _____)
I -1

STAGE TWO (SECOND PLATE, NO. _____)
I -2

STAGE THREE (THIRD PLATE, NO. _____)
I -3

STAGE FOUR (FOURTH PLATE, NO. _____)
I -4

STAGE FIVE (FIFTH PLATE, NO. _____)
I -5

STAGE SIX (SIXTH PLATE, NO. _____)
I -6

BLANK OR BEHIND DISK (CIRCLE ONE)
I -BX

BACK UP FILTER
I -F

5050-481A

WEIGHT SHEET

University of Washington Impactors (Pilot)
Mark V Stages in a Mark III Type Shell

SUBSTANCE SET NO. _____

☐ APIEZON H
☐ FIBERGLASS ☐ BARE
☐ HERC. POLY. ☐ OTHER

DATE OF INITIAL WEIGHING 1 _____
DATE OF INITAL WEIGHING 2 _____
DATE OF FINAL WEIGHING 1 _____
DATE OF FINAL WEIGHING 2 _____

WASH DOWN

SOLVENT ☐ ACETONE ☐ DISTILLED WATER

PRECOLLECTOR NOZZLE AND BODY:
EVAPORATOR DISH:
ID _____
INITIAL Wt (mg) _____
FINAL Wt (mg) _____

Δ (mg) _____
WASH VOLUME (mL) _____
RESIDUE, W_{aN} _____

CORRECTED WASH WEIGHT _____ mg

PRECOLLECTOR EXIT TUBE AND SOLID DISK:
EVAPORATOR DISH:
ID _____
INITIAL Wt (mg) _____
FINAL Wt (mg) _____

Δ (mg) _____
WASH VOLUME (mL) _____
RESIDUE, W_{aT} _____

CORRECTED WASH WEIGHT _____ mg

(ADD THESE WEIGHTS TO THE DRY WEIGHTS TO GET TOTAL WT GAIN)*

		INITIAL			FINAL			TOTAL
DESCRIPTION	ID NO.	TARE (mg)	1 (mg)	2 (mg)	TARE (mg)	1 (mg)	2 (mg)	WT. GAIN (mg)
PRECOLLECTOR								*
SOLID DISK								*
	ZERO							
DISK DONUT:								
CONTROL	CTRL							
S1								
S2								
S3								
S4								
S5								
S6								
BLANK								
FILTER 1								
FILTER 2								
	ZERO							

SEE ALSO: (1) LAB LOAD/UNLOAD SHEET
(2) OPERATOR'S RUN SHEET

RUN NO. _____
DATE _____

COMMENTS:

FILTER TYPE: ☐ 2500 QAS QUARTZ
☐ REEVE ANGEL 934AH FIBERGLASS ☐ ACID WASHED ONLY
☐ GEIAH TEFLON ☐ ACID WASHED AND STACK CONDITIONED
☐ OTHER ☐ STACK CONDITIONED ONLY

DESCRIPTION OF TARES USED:

_____
_____
_____
_____

5598-11

DRY GAS METER

CALIBRATION SHEET

Dry Gas Meter I.D._____ Wet Test Meter I.D. _____ Orifice I.D. _____

Barometric Pressure, P_B _____in. Hg

Run #	1	2	3	4	5	6	7
Orifice Setting, ΔH							
Final Reading (Test)							
Initial Reading (Test)							
Volume V_T, ft^3							
Temp T_T, °F							
Final Reading (DGM)							
Initial Reading (DGM)							
Volume V_{DGM}, ft^3							
Temp T_{DGM}, °F							
Elapsed Time Θ, min.							
DGM Flow Rate Q, acfm							
$(\frac{\Delta H T}{P\ MW_D})$							
$\Delta H@$							
γ							

$$\Delta H@ = \frac{(0.0317)\Delta H}{P_B (T_B + 460)} \left[\frac{(T_T + 460)}{V_T} \Theta\right]^2$$

$$\gamma = \frac{V_T (P_B)\ (T_B + 460)}{V_B (P_B + \frac{\Delta H}{13.6})\ (T_T + 460)}$$

CALIBRATION PERFORMED BY _____

Date _____

FIELD AUDIT OF GAS FLOW
for
SAMPLING SYSTEMS WITH LEAKLESS PUMPS
and
LEAK CHECK OF PITOT SYSTEM
(Dry Gas Meter Compared to ΔH Orifice)

Sampling Control System ID: _____

DGM ID: _____ with pretest γ = _____

ΔH Orifice ID: _____ with ΔH@ = _____

$Q_{DGM} = \gamma Q_{meter}$ (acfm)

$Q_{ori} = \sqrt{0.92\alpha/\Delta H@}$ (acfm)

where $\alpha = T_{DGM}\Delta H\left[\left(P_{bar} + \frac{\Delta H}{13.6}\right) 28.97\right]$

P_{bar} = _____ ("Hg)

1. Zero the ΔH gauge.
2. Leak check by plugging the inlet to the sampling system, adjusting the system pressure, P_{sys}, to -15"Hg, and measure the leak rate, _____(cfm). It must be less than 0.005.
3. Open the inlet to the sampling system and adjust ΔH to _____("WG). Measure the time to sample 2 ft^3 according to the DGM and record parameters:

DGM		ΔH Orifice		Run Time	
initial: _____(ft^3)	ΔH:		("WG)		(min:sec)
final: _____(ft^3)	T_{DGM}:		(°R)		

net = 2.000 (ft^3)

The run time must fall between _____ to _____(min:sec)
The run time range is obtained by:

$t = 2\gamma\sqrt{\Delta H@/0.92\alpha}$ = _____ min: 0.97t to 1.03t.

LEAK CHECK OF PITOT: ID No. _____ High side is ☐ A or ☐ B

1. Blow gently into high side so that pressure gautge registers 3"-6".
2. Seal the line and observe the gauge for loss of pressure. There should be no detectable leak. Note: With a manometer time is required for the fluid to drain from the walls before a stable reading occurs.

☐ No detectable change for 15 seconds.

Date: _____ Time of Day: _____ Operator: _____

Appendix D

Estimations of The Uncertainties Associated With Cascade Impactor Data and Measured Fractional Penetrations in Control Device

APPENDIX D

Estimations of The Uncertainties Associated With Cascade Impactor Data and Measured Fractional Penetrations in Control Device

The uncertainty (or confidence interval), CIP, in the measured penetration, P, can be estimated as:

$$CIP = P \left(\left(\frac{CI_o}{AO} \right)^2 + \left(\frac{CI_I}{AI} \right)^2 \right)^{1/2} \qquad (D\text{-}1)$$

where

CI_o = confidence interval of outlet average

CI_I = confidence interval of inlet average

AO = outlet average
AI = inlet average
P = AO/AI = penetration
CIP = confidence interval of the penetration.

The relative uncertainty in P is then given by:

$$CIP/P = \left(\left(\frac{CI_o}{AO} \right)^2 + \left(\frac{CI_I}{AI} \right)^2 \right)^{1/2} \qquad (D\text{-}2)$$

Confidence intervals for the inlet and outlet averages are given by:

$$CI = \frac{t_{n,L}\, S}{\sqrt{n}} \qquad (D\text{-}3)$$

where

$t_{n,L}$ = Students "t" factor for (n-1) degrees of freedom at the desired confidence level, L.
S = standard deviation of the data set.
n = number of elements in data set (no. of runs).

Representative values of $t_n / \sqrt{n}$ are tabulated below for confidence levels of 95, 90, 80, and 50%. The 50% confidence interval is commonly called the "probable error of the mean".

Table D-1

n	50%* $t_n/\sqrt{n}$	80% $t_n/\sqrt{n}$	90% $t_n/\sqrt{n}$	95% $t_n/\sqrt{n}$
2	.71	2.18	4.46	8.98
3	.47	1.09	1.69	2.48
4	.38	.82	1.18	1.59
8	.25	.50	.67	.84
15	.18	.35	.45	.55
20	.15	.30	.39	.47
n >20	$.67/\sqrt{n}$	$1.28/\sqrt{n}$	$1.64/\sqrt{n}$	$1.96/\sqrt{n}$

* Commonly called the "probable error of the mean".

For n greater than about 15 the values of t_n are very nearly constant and the relationship shown on the last line of the table is sufficiently accurate for our purposes.

For equal numbers of inlet and outlet samples, the relative uncertainty in the penetration is thus given by:

$$\frac{CIP_L}{P} = \left[\left(\frac{t_{n,L}}{\sqrt{n}}\right)^2 \left\{ \left(\frac{S_o}{AO}\right)^2 + \left(\frac{S_I}{AI}\right)^2 \right\} \right]^{1/2} \quad \text{(D-4)}$$

$$= \frac{t_{n,L}}{\sqrt{n}} \left(\left(\frac{S_o}{AO}\right)^2 + \left(\frac{S_I}{AI}\right)^2 \right)^{1/2} \quad \text{(D-5)}$$

$$= \frac{t_{n,L}}{\sqrt{n}} \sqrt{(CV_o)^2 + (CV_I)^2} \quad \text{(D-6)}$$

CV_I and CV_o, respectively, are the inlet and outlet coefficients of variation and L is level of confidence (e.g., 90%, 50%, etc.).

S = (Standard Deviation), can be broken down into components arising from several sources.

For the present purposes these can be taken to be

S_{BAL} = component due to weighing uncertainties,

S_{SUB} = component due to substrate blank run uncertainties, which includes errors from both handling and gas-phase reactions with the substrates,

S_{MEAS} = uncertainties due to sampling errors and process variations.

S_{MEAS} can be broken down into components due to:

1) temporal process variations
2) spatial variations (concentration stratification)
3) isokinetic sampling errors
4) errors in flow rate, temperatures, pressures, etc.

or $S^2_{MEAS} = (S^2_{PROC} + S^2_m)$, where S^2_{PROC} includes Items 1 and 2 while S^2_m includes Items 3 and 4. Strictly speaking Item 2 should not be considered as introducing an uncertainty but because of the way the data are taken, its effect cannot often be separated from that of Item 1.

Thus: $$S^2 = S^2_{BAL} + S^2_{SUB} + S^2_{MEAS} \qquad (D\text{-}7)$$

Data taken during one typical test of a precipitator on a coal-fired utility boiler resulted in the following values as determined from blanks and controls.

$S_{BAL} = .028$ mg

$\sqrt{S^2_{BAL} + S^2_{SUB}} = .077$ mg inlet stages

$\sqrt{S^2_{BAL} + S^2_{SUB}} = 0.099$ mg outlet stages

Errors from flow rates or gas volumes sampled were estimated by assuming that the error arose only from the differences in the actual volumes sampled. The estimates were made ignoring isokinetic effects and shifts in stage collection efficiencies, both of which are second order effects.

The errors in the masses collected on each stage from this cause are then estimated by,

$$S^2_m = M^2 \left(\frac{S_v}{V}\right)^2 \qquad (D\text{-}8)$$

where

S^2_m = contribution to variance in mass

M = sample mass

S^2_v = variance in sampled volume

V = sampled volume.

In the case of outlet data, for which positive displacement dry gas meters were used for volume measurements, the quantity $\left(\frac{S_v}{V}\right)^2$ is given by,

$$\left(\frac{S_v}{V}\right)^2 = \frac{S^2_R}{V^2} + \frac{S^2_p}{p^2} + \frac{S^2_T}{T^2} + \frac{S^2_{CAL}}{CAL^2} \qquad (D\text{-}9)$$

where

S_R^2 = variance in determinations of meter end points ≈ $(0.05\ ft^3)^2$

S_p^2 = variance in determinations of gas meter pressure ≈ $(0.1\ in\ Hg)^2$

S_T^2 = variance in determinations of gas meter temperatures ≈ $(5°R)^2$

V = volume sampled ≈ 30 ft^3

p = gas meter pressure ≈ 25" Hg

T = gas meter temperature ≈ 530°R

$\left(\frac{S_{CAL}}{CAL}\right)^2$ = contribution to variance due to uncertainty in the gas meter calibration ≈ $(0.02)^2$, i.e. 2% calibration error.

Thus for our outlet sample data set we have

$$\left(\frac{S_v}{V}\right)^2_{outlet} = \left(\frac{.05}{30}\right)^2 + \left(\frac{.1}{25}\right)^2 + \left(\frac{5}{530}\right)^2 + \left(.02\right)^2$$

$$= 5.08 \times 10^{-4}$$

$$= .(.0225)^2$$

In the case of inlet data, for which orifice meters and sampling times were used for sample volume measurements, the quantity $\left(\frac{S_v}{V}\right)^2$ is given by,

$$\left(\frac{S_v}{V}\right)^2 = \left(\frac{S_t}{t}\right)^2 + \left(\frac{S_{CAL}}{CAL}\right)^2 + \left\{\left(\frac{S_p}{p}\right)^2 + \left(\frac{S_T}{T}\right)^2 + \left(\frac{S_{\Delta p}}{\Delta p}\right)^2\right\}/4 \qquad \text{(D-10)}$$

where

S_t^2 = variance in duration of sample time ≈ $(30\ sec)^2$

t = duration of sample time ≈ 30 min = 1800 sec

$\left(\frac{S_{CAL}}{CAL}\right)^2$ = $(0.05)^2$, i.e. 5% uncertainty in orifice meter calibration

$\left(\frac{S_p}{p}\right)^2 = \left(\frac{.1}{25}\right)^2$

$\left(\frac{S_T}{T}\right)^2 = \left(\frac{10}{530}\right)^2$

$S^2_{\Delta p}$ = variance in reading and setting orifice pressure drop $\approx (0.2 \text{ in } H_2O)^2$

Δp = orifice meter pressure drop ≈ 6 in H_2O.

Thus for our inlet sample data set we have

$$\left(\frac{S_v}{\bar{V}}\right)^2_{\text{inlet}} = \left(\frac{30}{1800}\right)^2 + (.05)^2 + \left\{\left(\frac{.1}{25}\right)^2 + \left(\frac{10}{530}\right)^2 + \left(\frac{.2}{6}\right)^2\right\}/4$$

$$= 0.00315$$

$$= (0.0561)^2$$

The component of the standard deviation in the data arising from the process, S^2_{PROC}, can now be found from the expression:

$$S^2_{PROC} = S^2 - S^2_{BAL} - S^2_{SUB} - S^2_m \quad \text{(D-11)}$$

$$= S^2 - \left(S^2_{BAL} + S^2_{SUB}\right) - M^2\left(\frac{S_v}{\bar{V}}\right)^2 \quad \text{(D-12)}$$

where

$$\left(\frac{S_v}{\bar{V}}\right)^2_{\text{outlet}} \approx (0.023)^2$$

and

$$\left(\frac{S_v}{\bar{V}}\right)^2_{\text{inlet}} \approx (0.056)^2$$

Results of the data runs for the test used in this illustration are shown in Table D-2. Note that the relative uncertainty in the stage weights and hence the inlet and outlet concentrations for each size fraction were dominated by S_{PROC}.

Average values of 0.36 for CV_I and CV_O as found from Table D-2 were used to calculate the relative uncertainty in the penetration at the 50% confidence level for various numbers of paired inlet and outlet runs. The results are shown in Table D-3.

Table D-2

Relative Uncertainty in Typical Data Sets

	Average Raw Mass on Stage (mg)	Average Mass, M, on Stage (Corrected for blanks) (mg)	S	S_{PROC}	$S_{PROC/M}$
Inlet Stage					
0	3.20	3.22	1.19	1.17	.365
1	5.69	5.71	2.70	2.68	.469
2	6.34	6.36	2.66	2.64	.414
3	4.31	4.33	2.03	2.01	.465
4	2.69	2.71	0.95	.94	.345
5	0.98	1.00	0.37	.36	.358
6	0.37	0.39	0.12	.089	.229
Outlet Stages Set 1 (rap)					
1	6.40	6.23	2.27	2.26	.363
2	3.02	2.85	0.94	.93	.327
3	1.86	1.69	.66	.651	.385
4	1.50	1.33	.46	.448	.337
5	1.70	1.53	1.06	1.05	.689
6	3.83	3.66	.76	.749	.205
7	1.78	1.61	.70	.692	.430
8	.293	.124	.170	.138	1.114
Set 2 (no rap)					
1	2.32	2.14	1.13	1.12	.526
2	1.18	1.01	.39	.377	.373
3	.86	.69	.23	.207	.300
4	.59	.42	.13	.084	.199
5	1.52	1.35	.17	.135	.100
6	3.54	3.37	.80	.790	.234
7	1.93	1.76	.50	.488	.278
8	.74	.57	.31	.293	.515

Table D-3

The Relative Probable Error in the Penetration, CIP_{50}/P, Versus Number of Paired Runs

No. of paired runs, n	$\frac{CIP}{P}$
2	.36
3	.24
4	.19
5	.17
8	.13
15	.09
20	.08
50	.05

For $n > 20$ the relative uncertainty in P becomes inversely proportional to $\sqrt{n}$.

A plot of the relative probable error in the measured fractional penetrations, (CIP_{50}/P) is shown in Figure D-1, from which we find that about 12 paired inlet and outlet runs are required to obtain a "probable error" in P of 10%, about 50 paired runs for a 5% "probable error", and 1200 paired runs to obtain a "probable error" in P of 1%. These numbers are specific to the particular test series described in Table D-2, but they are believed to be typical for tests of a similar nature.

Table D-4 shows average values of CV_I and CV_O for a number of test sites and industries taken from data obtained by SoRI during a number of control device evaluation programs. The values generally are about 0.4 with the exception of two of the three metallurgical processes, for which the inlet values appear to be closer to unity. Thus more samples must be taken in a metallurgical sampling program than in sampling the other processes represented in the table in order to achieve the same probable error in the penetrations. Because of frequently occurring day to day variations in plant operating conditions, e.g. load, temperatures, coal composition and space, sampling port, and manpower limitations it is improbable in industrial sampling programs that more than about twelve (12) paired runs can be obtained under any one "operating condition". This limits the minimum probable error that can be achieved in the measured penetrations to about 10%. More often, only about four paired runs will be possible which results in a minimum probable error of about 20% in the measured penetrations.

Table D-4

Average Inlet and Outlet Coefficients of Variation for Several Sources

Source	Process & Control Device	CV_I	CV_O
A	Pulv. coal boiler Dry E.S.P.	.38	.39 .32
B	Pulv. coal boiler Dry E.S.P.	.36	.35
C	Pulb. coal boiler Dry E.S.P.	.36	.28
D	Open hearth steel furnace scrubber	.81	.30
E	Electric arc ferro-alloy furnace scrubber	1.19	.14
F	Kraft recovery boiler Dry E.S.P.	.45	.46
G	Aluminum potline Wet E.S.P.	.52	.21

Table D-5 provides the number of runs which would have been required to obtain probable errors (50% confidence limits) of less than 10 and 20 percent in the measured concentrations of particles within a given size band for the sources shown in Table D-4. The required numbers of runs were calculated separately for the control device inlets and outlets of each source. Note that inlets typically require a greater number of runs than do outlets to obtain a given degree of maximum uncertainty in the results. In the cases of the metallurgical processes this reflects to a great extent the difference in averaging times for inlet and outlet samples. The metallurgical processes were batch operations with highly variable emissions and produced particle concentrations which did not permit long sampling times at the control device inlets. Hence the run-to-run variations in concentrations and size distribution were very large as compared to those for the outlets for which single samples could span the entire process cycle.

Table D-6 gives the number of runs required for each of the sources to obtain 95% confidence that the true average concentration within a given size band is within 20% of the measured value. It is obvious that the required number to achieve this level of uncertainty is, in almost all cases, quite impractical. For those sources having coefficients of variation, CV, of about 0.35, seven (7) runs are needed to obtain 95% confidence that the true average is within 30% of the measured value. The latter number of runs is probably within the range of practicality in most situations.

Based on the previous discussions, it is recommended that a minimum of three runs (traverses) be made to determine the particle size distribution of emissions from industrial sources. This number will often be sufficient to provide 20% maximum probable errors in the final results. Seven to ten (or more) runs may be required in the case of measurements on a highly variable source or if lower probable errors or greater confidence levels are needed.

Table D-5

Numbers of samples required to obtain maximum probable errors of 10 and 20 percent in the measured concentrations of particles within a given size band for the sources listed in Table D4.

Source	Number of Runs for 10% Maximum probable error		Number of Runs for 20% Maximum probable error	
	Inlet	Outlet	Inlet	Outlet
A	7	8	3	3
B	7	7	3	3
C	7	5	3	2
D	>20	5	8	2
E	>20	2	18	2
F	10	10	3	4
G	15	3	4	2

Table D-6

The Number of Runs Required for 95% Confidence that the True Average Concentration Within a Size Band is Within 20% of the Measured Value for the Sources Listed in Table D4.

Source	Number of Runs	
	Inlet	Outlet
A	18	20
B	15	18
C	15	10
D	70	12
E	150	5
F	30	25
G	30	7

UNIT CONVERSION TABLE

English to Metric

1 in	=	25.40 mm = 2.540 cm
1 ft	=	0.3048 m
1 ft^3	=	0.02832 m^3 = 28.32 liters
1 lb	=	453.6 gm
1 grain	=	0.06480 gm
1 lb/ft^3	=	1.602 x 10^4 gm/m^3
1 gr/ft^3	=	2.288 gm/m^3

Metric to English

1 cm	=	0.3937 in.
1 m	=	3.281 ft
1 m^3	=	35.31 ft^3
1 gm	=	0.002205 lb
1 gm	=	15.43 grains
1 gm/m^3	=	6.243 x 10^{-5} lb/ft^3
1 gm/m^3	=	0.4370 gr/ft^3

Others

1 m^3	=	10^3 liters = $10^6 cm^3$
1 cm^3	=	1 cc = 10^{-3} liters
1 µm	=	10^{-6}m = 10^4Å
1 lb	=	7,000 grains
1 in. Hg	=	13.6 in. H_2O
R	=	0.08205 liter-atm/mole-K
1 gm/gm-mole	=	1 lb/lb-mole = 1 amu
°R	=	°F + 460
°K	=	°C + 273.2
°C	=	(5/9) (°F - 32)
°F	=	(9/5) °C + 32
1 ft/sec	=	0.6818 miles/hr

Nozzle Sizes

Fractional Inches		Decimal Inches		Decimal mm
1/8	=	.125	=	3.18
3/16	=	.1875	=	4.76
1/4	=	.250	=	6.35
5/16	=	.3125	=	7.94
3/8	=	.375	=	9.53
1/2	=	.500	=	12.70

Normal conditions are 20.0°C, 760 Torr, (68°F, 29.92 in. Hg) on a dry basis.
MMW of Standard Air, dry is 28.95 amu.
The Pitot/coefficient, C_p, for a isolated Type S Pitot Tube may be assigned a baseline value of 0.84 if the geometry of the Pitot meets the dimensional critera given in Method 2.
$\Delta H@$ is defined as the Method 5 orifice pressure differential (in. H_2O) that correlates to 0.75 cfm of dry air at 528°R and 29.92 in. Hg.
$V_A = (P_N/P_A)\ (T_A/T_N)\ V_N$, for absolute temperature.