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Project Summary

Particulate Data Reduction (PADRE) System Reference Manual

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The Particulate Data Reduction (PADRE) system is an interactive computer program that facilitates entry, reduction, and analysis of cascade impactor data for particle size distributions. PADRE was developed to ensure the quality of data included in the Fine Particle Emissions Information Systems (FPEIS), a component of the Environmental Assessment Data Systems (EADS). Users control the logical flow through the system in response to prompts from the program. PADRE can be used to store, review, edit, and analyze data and, through a variety of data checks, to identify invalid or suspect data. Impactor stage cut points are calculated, and cumulative and differential mass concentrations are determined and interpolated to standard diameters. This document describes how to access and use PADRE and summarizes its logic and capabilities. The program narrative describes all calculations and algorithms and all messages produced by the system. Specific user instructions are detailed in a separate PADRE User's Guide.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The purpose of the PADRE system is to facilitate entry of validated cascade impactor data from representative in-stack runs into the Fine Particle Emissions Information System (FPEIS). Reduction of observed data, to determine the effective stage cut diameters as well as the cumulative and differential mass concentrations, takes only a few seconds; this capability permits test plans or operating conditions to be modified to optimize data quality. Data entered through PADRE are not automatically included in FPEIS; the test contractor is expected to designate representative runs after he has validated the data.

Data Reduction is based on the Cascade Impactor Data Reduction System (CIDRS) computer programs developed by Southern Research Institute (SoRI) under contract to EPA. PADRE allows data reduction from a wider variety of impactor types and configurations than does CIDRS. Additionally, PADRE is interactive, which facilitates data entry and allows rapid analysis of impactor data by novice computer users.

FPEIS was developed in the mid-1970's and became fully operational in January 1977. EPA's Industrial Environmental Research Laboratory at Research Triangle Park (IERL-RTP) then develped a series of data bases (modeled on the FPEIS concept) that would be capable of reporting multimedia discharge information uniformly and consistently. This work resulted in EADS, which is both a resource for producing evaluated information and an environmental data repository (see Figure 1). Its structure permits full characterization of all data with minimum redundancy.

Overview

Basically, the system consists of data organization and data processing.

Data Organization

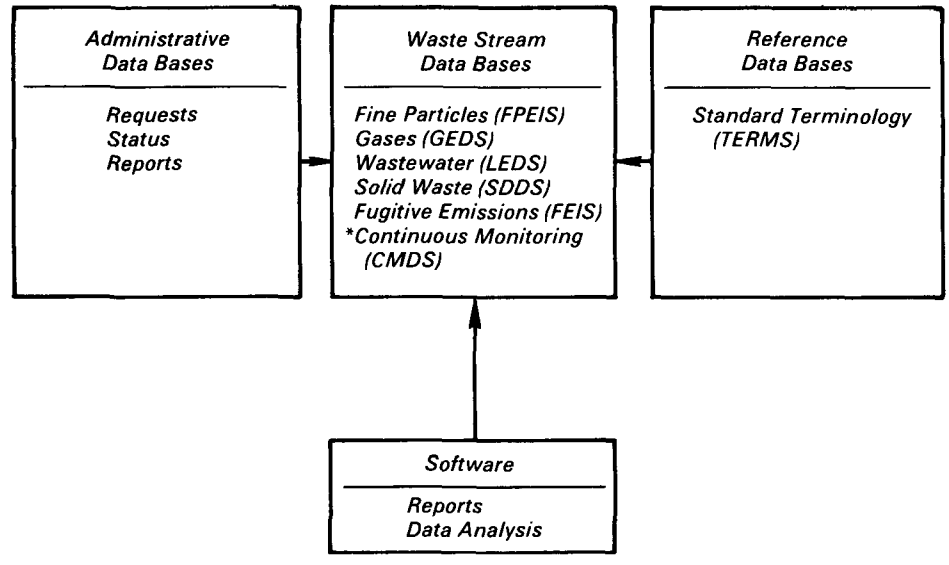
Data organization and terminology are as consistent with EADS/FPEIS as possible. Thus, for PADRE, several impactor runs (samples for EADS/FPEIS) are logically connected to one test, with specification of the stream and operating levels embedded in the run data records. In particular, all runs for a given test share a common site and particle density and begin on or after that test date. PADRE utilizes user-specified keys (described below) to access all stored data. Three data categories may be entered by PADRE users: weight data, test data, and run data. A fourth category, impactor data, must be supplied to the EPA Project Officer before data can be reduced.

- Weight data include a description of the substrates, pre-weights for each substrate, and post-weights for each substrate. Net weights are calculated from pre-weights and post-weights. Substrate pre-weights are entered into the system independently of run data. PADRE will assign a substrate's ID number when the pre-weights are first entered; users must specify this ID number when they enter run data.
- Test data are the same for all test runs. These include the test comments, (assumed) particle density, site code, and test date.
- Run data include run comments, operating conditions, identification of impactor used, and ID number of the set of substrates used in the impactor.
- Impactor data include brand name, model, serial number, calibration date, and number of stages. For each stage, the number of jets, average jet diameter, Stokes' number, and cumulative fractional pressure drop are required.

Data are entered and stored in units where they are commonly observed to facilitate data entry and correction.

Data Processing

PADRE involves four processes: data entry, data reduction, data comparison, and data designation for inclusion in FPEIS. In the *entry process*, observable data are read from an interactive computer terminal operated by the user. These data may then be reviewed and modified. In the *reduction process*, effective cut points (stage D_{50}'s) and mass concentrations for each impactor stage are computed under actual operating conditions. Mass concentrations are interpolated to standard intervals. In the *comparison process*, data from several user-specified runs are reduced and statistics at each standard diameter are computed. In the *designation process*, observable data from user-specified runs are printed in the format of EADS data input forms. The user may submit these forms to EPA to include data in the EADS.



*Planned or proposed EADS components.

Figure 1. *Environmental Assessment Data Systems (EADS) overview.*

Prerequisites

Prerequisites of using PADRE include EPA approval, data, and a terminal.

Approval of EPA

The PADRE system is operational at EPA's National Computation Center (NCC) on the UNIVAC 1100/83 computer. The system may be made available to all users of cascade impactors: EPA personnel, EPA contractors, State agencies, and commercial and consultant impactor users. EPA provides this resource tool to analyze cascade impactor data with the understanding that users will share validated data from representative runs by submitting them for inclusion in the EADS/FPEIS data base.

Data

While new users are encourged initially to practice with PADRE using artificial or sample data, it is assumed that most users will be using actual data from in-stack impactors. PADRE is no substitute for a careful record of all operating conditions and observed data. New users may wish to transcribe these data to PADRE data entry forms, as described in the PADRE User's Guide. This procedure will help users become familiar with the variable names and brief descriptions used in the prompts, prepare users for the order of the prompts, and ensure that all necessary data have been recorded.

Calibration constants for the user's impactor are required in order to calculate the D_{50}'s. These may be submitted to the EPA Project Officer before the PADRE system is used, so they will be available to the system when the impactor configuration is specified. Calibration information for a specific impactor is sought by the impactor type (e.g., Anderson and Brink), the impactor model (e.g., Mark III), and a unique number assigned to the set of plates used in the calibration run. If a user does not know the calibration constants for his impactor but wants to conduct preliminary analyses, he may specify the impactor type and model with plate set ID zero to access "generic" calibration constants. The validity of the D_{50}'s will, of course, depend on how closely his impactor corresponds to the mythical impactor the generic calibration constants describe.

Terminal

Access to PADRE requires an interactive computer terminal. All program printed lines contain less than 80 characters. Any terminal that can access that NCC in Research Triangle Park, NC, may be used, but one that produces a

```
--------------------------------------------------------------------------------
       --Introduction to the PArticulate Data REduction (PADRE) System--

An outline for logical flow of the program follows.
        Your comments and suggestions will be solicited as you exit from PADRE.

     "@ADD" PADRE
        |
    BULLETIN BOARD
        |
   INTRODUCTION TO PADRE?      <- You are here!!
        |
 .----)---+
 ^    1. ENTER DATA?
 ^         +--)--YES--)--)-.
 ^       NO      .--)--)---+
 ^         |     ^  ENTER/MODIFY WEIGHTS?    pre- & post-sampling weights
 ^         |     ^     |
 ^         |     ^  ENTER/MODIFY TEST DATA?    test keys & comments,
 ^         |     ^                                particle density
 ^         |     ^     |
 ^         |     ^  ENTER RUN DATA?      operating conditions, impactor id
 ^         |     ^     |
 ^         |     ^  ENTER MORE DATA?     repeat this section
 ^         |     ^-<-YES-<-+
 ^         +-<--<--<--NO-<-.
 ^         |
 ^    2. RETRIEVE A RUN?                    must provide RUN keys
 ^         +--)--YES--)--)-.                (SITE, test DATE, RUN NUMBER)
 ^       NO      .--)--)---+
 ^         |     ^     LIST DATA?        all data associated with RUN
 ^         |     ^     |
 ^         |     ^  MODIFY RUN DATA?     correct errors in RUN data
 ^         |     ^     |
 ^         |     ^  REDUCE RUN DATA?     calculate D50's, mass concentrations
 ^         |     ^     |
 ^         |     ^  DESIGNATE RUN FOR FPEIS?     print EADS forms 6 & 7a
 ^         |     ^     |
 ^         |     ^  RETRIEVE ANOTHER RUN      repeat this section
 ^         |     ^-<-YES-<-+
 ^         +-<--<--<-NO--<-.
 ^         |
 ^    3. RETRIEVE A TEST?                       must provide TEST keys
 ^         +--)--YES--)--)-.                      (SITE and DATE)
 ^       NO      .--)--)---+
 ^         |     ^  REVIEW ALL RUNS?     Summary with one line per run
 ^         |     ^     |
 ^         |     ^  COMPARE RUNS?        Calculate summary statistics
 ^         |     ^     |
 ^         |     ^  CALCULATE PENETRATION/EFFICIENCY?
 ^         |     ^     |
 ^         |     ^  RETRIEVE ANOTHER TEST?     repeat this section
 ^         |     ^-<-YES-<-+
 ^         +--<--<--<-NO-<-.
 ^         |
 ^    RETURN TO BEGINNING OF PADRE?
 ^-<-YES--+
        |
     ENTER COMMENTS?
        |
    TERMINATE SESSION
--------------------------------------------------------------------------------

You can follow several paths through this program.  You will be offered
a series of options at decision points.  At each decision point you
will be asked a question of the form "DO YOU WISH TO ...?  ENTER Y OR N."
You may choose either to accept the option (e.g. enter data for a new run)
or to continue to the next decision point, where you will be offered
another option.  Indicate your decision by entering Y or N; then depress
the return key on the terminal.  Any response other than Y or N will be
rejected and you will again be prompted to enter Y or N.

There are three basic sections or loops.  At the end of each section you
will have the option either to return to the beginning of that section or
to proceed to the next section.  After the last section, you will have the
option to return to the beginning of the first section.  There are no dead
ends in PADRE.  If you take a wrong path, you can always drop through to
the bottom of the section, or of the program, and return to the beginning.

When you indicate that you are ready to terminate the program, you will be asked
for comments about the program or its documentation.  Please enter your comments
while your experience with PADRE is still fresh in your mind.

NOTE: you can always abort & restart PADRE by:
     1)  @@x tio                    This brings EVERYTHING to a screeching halt!
     2)  @fin                       This closes all the data files properly.
     3)  @run 43xxx,63022....       This restarts PADRE from the beginning.
     4)  @add PADRE
         etc.
     Once you've done the "@@x tio," the data files are left in unpredictable
states of assignment in the system, so steps 2 & 3 are necessary to reinitialize
everything.
--------------------------------------------------------------------------------
```

Figure 2. *PADRE introduction.*

permanent "hard copy" to document the PADRE session is recommended. The basic requirement is that the terminal emulate a teletype at 30 or 120 characters per second and handle computer communications with even parity.

Use of PADRE

Use of PADRE includes user authorization, logical control, data entry and review, retrieving stored data, and sample sessions.

User Authorization

Users should check with the EPA Project Officer, Gary L. Johnson, (919/541-7612) to obtain the proper authorization to access the EPA/NCC.

PADRE is readily availble to users holding a valid NCC account number; however, special arrangements may be made for other users to access the NCC (and PADRE) on a case-by-case basis through the National Technical Information Service (NTIS). All users will be expected to bear the costs of the computer use.

PADRE Logical Control

Users can follow several paths through this program. For example, the user may wish only to enter pre-weights for several sets of substrates, or may wish either to update or to reduce previously entered data. The user will be offered a series of options at decision points. At each decision point, the user will be asked a question of the form "DO YOU WISH TO...? ENTER Y OR N." The user may choose either to accept the option (e.g., enter data for a new run) or to continue to the next decision point in the program, where another option will be offered. The user indicates a decision by entering Y or N and then depressing the return key on the terminal. Any response other than Y or N will be rejected, and the user will again be prompted to enter Y or N.

Figure 2 is a guide to the options this program offers. There are three basic sections or loops. At the end of each section, the user has the option either to return to the beginning of that section or to proceed to the next section. After the last section, the user has the option to return to the beginning of the first section.

No "dead ends" exist in PADRE. If the user takes a wrong path, he can drop through to the bottom of the section (or of the program) and return to the beginning.

Data Entry and Review

Eventually, the user will reach a point when he should enter observed data. The computer will prompt him with a brief description of and the name associated with the data item. The computer will then wait for the user to enter the data. After all items have been entered, there will be a review of the data, listing both the names and values. The user will then have an opportunity to mark which, if any, items he wishes to change. After the marked items have been changed, there will be another review and opportunity to make further changes. When the user has been through the entire list of variables and has made no changes, the system will proceed to the next decision point.

Retrieving Stored Data

PADRE manages all data storage and retrieval for the user, but certain user requirements are basically matters of good housekeeping. These requirements are also essential for retrieving stored data.

- Substrate weights are assigned an ID by PADRE.
- Run data are saved by PADRE using multiple keys.

To retrieve stored data, the user must specifiy these keys exactly as originally specified or assigned. Whenever PADRE stores data, it prints a message with the keys that must be used to retrieve those data (see Figure 3). These keys should be recorded for further reference.

If the user wants to recall data for an old (previously entered) run, he must specify the same site ID and test date as when the data was originally entered, as well as the run number assigned by PADRE. The user will be prompted for each of these items at the appropriate point in the session. If the user wants to recall data from an old test in order to modify the test data, he must specify the same site ID and test date as he did when the test data were entered. He can then change any of the test data; if any of the key items are changed, the system will alter them for all runs in that test.

Sample Sessions

Figures 3 through 5 show actual PADRE dialog for basic operations. A previously entered set of data is modified and reduced. Both the terminal and the expanded output are reproduced.

```
DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>N

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>Y
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
   IRUN    RCOMM    JDATE    ISTART    DUR     RTYPE
>     X        X                X         X
*** ANOTHER RUN WITH THIS ID ALREADY EXISTS
THE NEW RUN NO. IS            3
ENTER RUN COMMENTS
>This run propagated from #1
ENTER NEW VALUE FOR ISTART
>1200
ENTER NEW VALUE FOR DUR
>60
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
  PAMBNT    DPSTK   VSTACK   TSTACK    TIMP     DMAX     CYCL    DNOZZ    CUTNOZ   CMASS
>
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
    CO2       CO        N2        O2        H2O       NS     IDSUBS   ACUTPT
>
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
    BF     FLARGE   IMPNAM   IMPMOD   IPLATE    FLOW    METHOD
>
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
   IRUN    RCOMM    JDATE    ISTART    DUR     RTYPE
>
   *** MASS ON NOZZLE  IS LOW
DO YOU WISH TO MODIFY THE INVALID VALUES?  ENTER Y OR N
>N
DATA FOR RUN  3 BY RTI  AT RTP  ON  32183 HAS BEEN SAVED IN THE TRIAL DATA FILE
DATA FOR TEST BY CONTRACTOR RTI , AT SITE RTP , ON DATE  32183, RUN NO.   3
TEST COMMENTS      TCOMM= Demonstrate PADRE with sample Andersen data from CIDRS
 manual
PARTICLE DENSITY (GM/CC): RHO=    2.400

RUN COMMENTS:      RCOMM= This run propagated from #1
DATE OF RUN:       JDATE=  32383  AMBIENT PRESSURE (IN HG)          PAMBNT=  30.06
START TIME:       ISTART=   1200  STACK PRESS WRT AMBIENT (IN H2O):DPSTK=    .00
RUN DURATION (MIN):  DUR=   60.0  STACK GAS VELOCITY (FT/SEC):      VSTACK=   1.00
RUN TYPE:         RTYPE= 0        STACK TEMPERATURE (DEG F):       TSTACK=  280.0
% CARBON DIOXIDE:    CO2=   14.0  IMPACTOR TEMPERATURE (DEG F):      TIMP=  280.0
% CARBON MONOXIDE:    CO=     .0  MAX. PARTICLE DIAM. (MICRONS):     DMAX=   49.0
% NITROGEN:           N2=   80.0  CYCLONE CUT POINT (MICRONS):       CYCL=     .0
% OXYGEN:             O2=    6.0  NOZZLE DIAMETER (INCHES):         DNOZZ=  1.000
% WATER VAPOR:       H2O=    8.0  NOZZLE CUT POINT (MICRONS):      CUTNOZ=    .00
BACKUP FILTER USED?   BF= YES      LARGE PARTICLES ON FILTER?       FLARGE= NO
FLOW RATE DETERMINATION: METHOD=UNKNOWN
IMPACTOR TYPE:    IMPNAM=ANDERSEN IMPACTOR FLOW RATE (ACFM):          FLOW=   .358
IMPACTOR MODEL:   IMPMOD=UNKNOWN
IMP. PLATE SET ID:IPLATE=      3  SUBSTRATES ID:                    IDSUBS=     0
NO. IMP. STAGES USED  NS=      8  DESCR=GREASED FOIL
NO. JETS  DIAM.   CUMDP  CALIB          NOZZLE        .000 MG
  264    .1671  .0000   .3050          STAGE  1       .000
  264    .1281  .0000   .4300          STAGE  2       .290
  264    .0953  .0000   .4100          STAGE  3       .580
  264    .0780  .0000   .3850          STAGE  4       .180
  264    .0547  .0000   .3410          STAGE  5      1.530
  264    .0359  .1760   .3200          STAGE  6      4.390
  264    .0269  .2940   .3310          STAGE  7      1.900
  156    .0253 1.0000   .2740          STAGE  8       .390
IMPACTOR DP SCALING FACTOR     1.287  FILTER         .540 MG
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N
DO YOU WISH TO RETRIEVE A TEST?  ENTER Y OR N
>N
```

Figure 3. Modifying run data.

```
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N

DO YOU WISH TO TO REDUCE THE DATA? ENTER Y OR N
>Y

 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM     03/21/83          16:48:06
DATA FOR TEST BY CONTRACTOR RTI , AT SITE RTP , ON DATE  32183, RUN NO.  1
SAMPLING AT  109.4 % OF ISOKINETIC RATE
WANT TO SEE RESULTS USING CLASSICAL (STOKES) DEF. OF DIAM.?  ENTER Y OR N
>Y

Demonstrate PADRE's capability to accept free form comments
TOTAL MASS  7.9245-003  1.1979-002  1.8134+001  2.7412+001       DMAX=  49.0
              GR/ACF       GR/DNCF      MG/ACM      MG/DNCM            MICRONS

 STAGE       MASS       MASS    CUM. MASS      D50     GEO. MEAN DM/DLOGD  DN/DLOGD
             (MG)   (MG/DNCM) (MG/DNCM)  (MICRONS) (MICRONS) (MG/DNCM) (NO/DNCM)
NOZZLE        .01        .02      27.39     38.80      43.60  2.45-001  2.35+003
    1        1.22       3.03      24.36      9.16      18.85  4.84+000  5.74+005
    2         .29        .72      23.63      8.66       8.91  2.97+001  3.34+007
    3         .58       1.44      22.19      5.26       6.75  6.65+000  1.72+007
    4         .18        .45      21.75      3.62       4.36  2.77+000  2.65+007
    5        1.53       3.80      17.94      1.83       2.58  1.29+001  5.98+008
    6        4.39      10.91       7.03       .86       1.26  3.33+001  1.33+010
    7        1.90       4.72       2.31       .55        .69  2.37+001  5.84+010
    8         .39        .97       1.34       .27        .39  3.24+000  4.46+010
FILTER        .54       1.34                             .19  4.46+000  4.89+011
   *** CUT POINTS FOR STAGES -1  0 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  0 WITH D50=    38.80 OMITTED FROM INTERPOLATION
   *** CUT POINTS FOR STAGES  1  2 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  2 WITH D50=     8.66 OMITTED FROM INTERPOLATION
INTERPOLATED TO STD. INTERVALS: (VALUES AT DIAM. MARKED WITH * ARE EXTRAPOLATED)
                                  1.47       .30              .00
                                  3.56       .63          2.22+001
                                  9.72      1.00          3.99+001
                                 13.28      1.25          3.35+001
                                 20.15      2.50          1.34+001
                                 22.76      6.00          9.59+000
                                 24.69     10.00*         8.37+000
                                 25.95     15.00*         5.98+000
                                 26.59     20.00*         4.37+000
 WANT TO PLOT CUM. % MASS?  ENTER Y OR N
>Y
```

Figure 4. Reducing run data (sheet 1 of 2).

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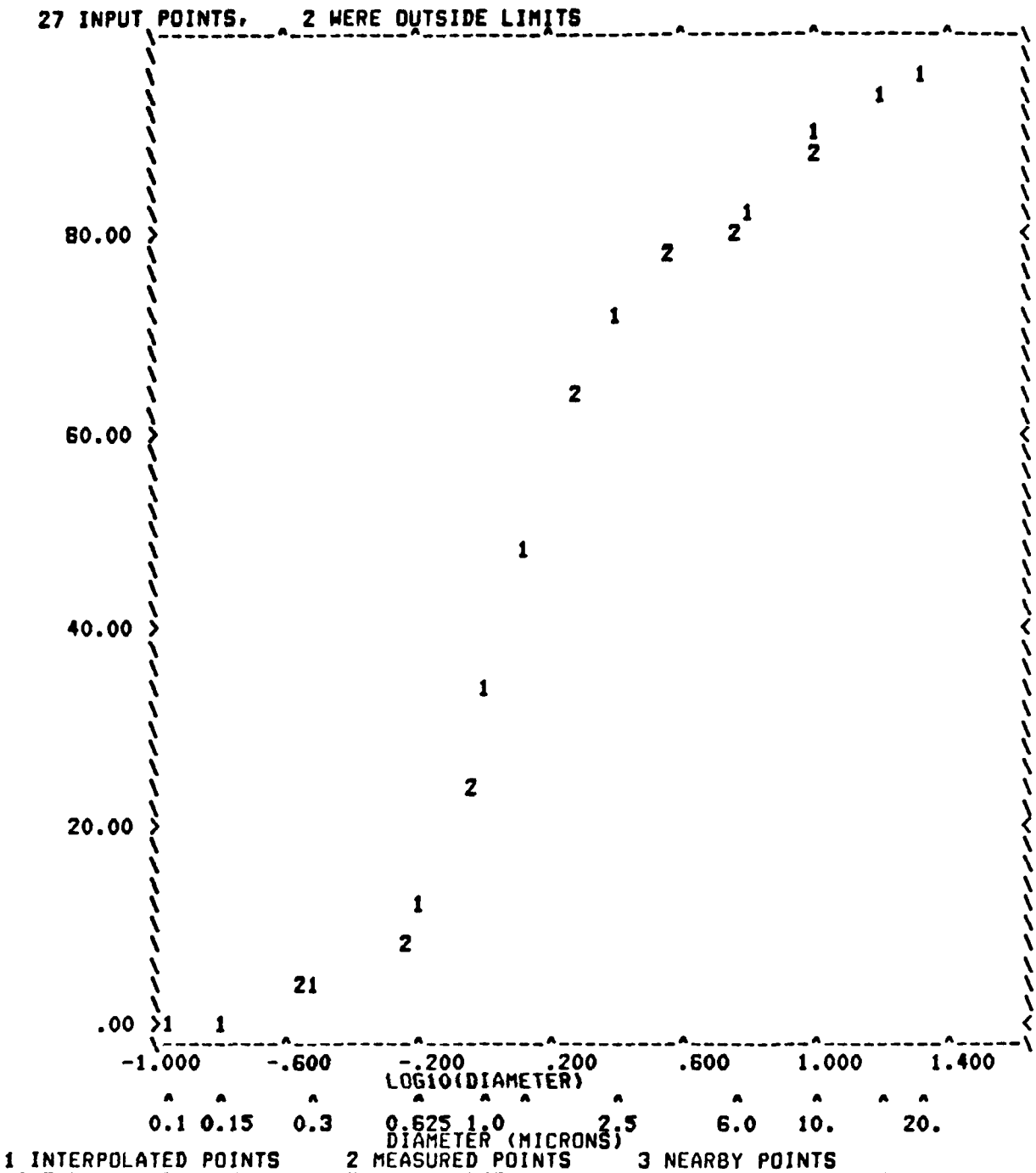
***Gary L. Johnson** is the EPA Project Officer (see below).*

The complete report, entitled "Particulate Data Reduction (PADRE) System Reference Model," (Order No. PB 84-206 929; Cost: $13.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Industrial Environmental Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711




```
1 INTERPOLATED POINTS     2 MEASURED POINTS     3 NEARBY POINTS
WANT TO SEE RESULTS USING THE TGLD DEF. OF AERO. DIAM.?  ENTER Y OR N
>N
WANT TO SEE RESULTS USING MERCERS DEF. OF AERO. DIAM.?  ENTER Y OR N
>N
DO YOU WANT EXPANDED OUTPUT MAILED TO YOU?  ENTER Y OR N.
>Y

DO YOU WISH TO PRINT FPEIS CODING FORMS?   ENTER Y OR N
>Y
PRINT DATA ON CODING FORMS FOR TEST BY RTI , AT RTP , ON  32183, RUN NO.   1
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
```

Figure 4. Reducing run data (sheet 2 of 2).

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```
 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM     03/21/83        16:48:06
DATA FOR TEST BY CONTRACTOR RTI , AT SITE RTP , ON DATE  32183, RUN NO.  1
TEST COMMENTS: DEMONSTRATE PADRE WITH SAMPLE ANDERSEN DATA FROM CIDRS MANUAL
RUN COMMENTS  DEMONSTRATE PADRE'S CAPABILITY TO ACCEPT FREE FORM COMMENTS


IMPACTOR DESCRIPTION AND CALIBRATION

TYPE: ANDERSEN  PLATE SET ID:     3
MODEL: (RANDOM   IMPACTOR OR SCALING FACTOR:      1.287
STAGE  NO.JETS  DIAM.  CUMOP   CALIB
   1     264   .1671   .0000   .3050
   2     264   .1281   .0000   .4300
   3     264   .0953   .0000   .4100
   4     264   .0700   .0000   .3050
   5     264   .0547   .0000   .3410
   6     264   .0359   .1760   .3200
   7     264   .0269   .2940   .3310
   8     156   .0253  1.0000   .2740

 IMPACTOR FLOWRATE =  .350 ACFM              IMPACTOR TEMPERATURE =  288.0 F (137.8 C)      SAMPLING DURATION =  60.00 MIN

 IMPACTOR PRESSURE DROP =  .190 IN. OF HG    STACK TEMPERATURE =  280.0 F (137.6 C)        STACK PRESSURE = 30.06 INCHES OF HG

 DRY GAS COMPOSITION (PERCENT)      CO2 = 14.00         CO =  .00          N2 = 80.00         O2 =  6.00          H2O =  0.00

 CALC. MASS LOADING = 7.9245-003 GR/ACF          1.1979-002 GR/DNCF          1.8134+001 MG/ACM          2.7412+001 MG/DNCM
SAMPLING AT  109.4 % OF ISOKINETIC RATE


 DIAMETERS ARE CALCULATED HERE ACCORDING TO THE CLASSICAL (STOKES) DEFINITION

 ASSUMED PARTICLE DENSITY = 2.400GM/CU.CM.      MAX. PARTICLE DIAMETER =  49.0 MICRONS

IMPACTOR STAGE                 NOZZLE     S1        S2        S3        S4        S5        S6        S7        S8        S9      FILTER
STAGE INDEX NO.                   1        2         3         4         5         6         7         8         9        10

DSO (MICRONS)                   38.00     9.16      6.66      5.26      3.62      1.83       .86       .55       .27       .27/2.0
MASS (MG)                         .01     1.21       .29       .30       .18      1.53      4.39      1.90       .39        .54
MG/DNCM/STAGE                 2.49-002  3.03+000  7.21-001  1.44+000  4.47-001  3.80+000  1.09+001  4.72+000  9.69-001  1.34+000
CUM. % OF MASS      < DSO       99.91     88.85     86.22     80.96     79.33     65.46     25.66      8.43      4.90
CUM. MASS (MG/ACM)  < DSO     1.81+001  1.61+001  1.56+001  1.47+001  1.44+001  1.19+001  4.65+000  1.53+000  8.88-001
CUM. MASS (MG/DNCM) < DSO     2.74+001  2.44+001  2.36+001  2.22+001  2.17+001  1.79+001  7.03+000  2.31+000  1.34+000
CUM. MASS (GR/ACF)  < DSO     7.92-003  7.04-003  6.83-003  6.42-003  6.29-003  5.19-003  2.03-003  6.68-004  3.88-004
CUM. MASS (GR/DNCF) < DSO     1.20-002  1.06-002  1.03-002  9.70-003  9.50-003  7.84-003  3.07-003  1.01-003  5.86-004
GEO. MEAN DIA.(MICRONS)       4.36+001  1.89+001  8.91+000  6.75+000  4.36+000  2.58+000  1.26+000  6.85-001  3.86-001  1.94-001
DM/DLOGD (MG/DNCM)            2.45-001  4.84+000  2.97+001  6.65+000  2.77+000  1.29+001  3.33+001  2.37+001  3.24+000  4.46+000
DM/DLOGD (NUMBER/DNCM)        2.35+003  5.74+005  3.34+007  1.72+007  2.65+007  5.98+008  1.33+010  5.84+010  4.46+010  4.89+011
   *** CUT POINTS FOR STAGES -1  0 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  0 WITH DSO=   38.00 OMITTED FROM INTERPOLATION
   *** CUT POINTS FOR STAGES  1  2 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  2 WITH DSO=    6.66 OMITTED FROM INTERPOLATION
INTERPOLATED VALUES (VALUES AT DIAMETERS MARKED WITH * ARE EXTRAPOLATED)
STD. DIA. (MICRONS)     .300      .625     1.000     1.250     2.500     6.000    10.000*   15.000*   20.000*
CUM. MASS (MG/DNCM)    1.471     3.561     9.722    13.270    20.153    22.759    24.606    25.950    26.595
DM/DLOGD (MG/DNCM)     .00    2.22+001  3.99+001  3.35+001  1.34+001  9.59+000  8.37+000  5.98+000  4.37+000

NORMAL (ENGINEERING STANDARD) CONDITIONS ARE 21 DEG C AND 760MM HG.1
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Figure 5. Expanded output: reduced data (at NCC).

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Information
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