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Project Summary

Particulate Data Reduction System (PADRE) User Guide

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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 System (FPEIS), a component of the Environmental Assessment Data Systems (EADS). (NOTE: EPA-600/8-80-007, NTIS No. PB 80-222433, is the FPEIS user guide.) 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 is a working reference for users at a computer terminal. The principal technical reference for PADRE is a separate Reference Manual.

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.

Overview

PADRE involves four processes: (1) data entry, (2) data reduction, (3) data comparison, and (4) 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.

Prerequisites

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, and State agencies, as well as 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 encouraged 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 Guide. This procedure will help users to become familiar with the variable names and brief descriptions used in the program, prepare users for the order of the computer prompts for user-supplied data, 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 prior to using PADRE system, 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., Andersen 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 the NCC in Research Triangle Park, North Carolina, may be used, but one that produces a 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

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 available to users holding a valid NCC account number; 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: "DO YOU WISH TO ...? ENTRY 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.

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. If the user enters Y after the first prompt: "Do you want an introduction to PADRE?", a 60 line flowchart, outlining the logical flow, will be printed on the terminal.

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 will 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 specify 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. These keys should be recorded for future 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 1 through 4 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 ENTER OR MODIFY ANY TEST DATA?  ENTER Y OR N.
>N

DO YOU WISH TO ENTER DATA FOR A RUN? ENTER Y OR N.
>Y

THE COMPLETE ID FOR THIS RUN IS CNTRTR=RTI  SITE=RTP  IDATE= 32183 IRUN= 1
*** RECORD THESE VALUES IN YOUR NOTEBOOK

ENTER RUN COMMENTS, RCOMM
>Demonstrate PADRE's capability to accept free form comments
ENTER DATE OF RUN, JDATE, AS MMDDYY
>32383
ENTER STARTING TIME OF RUN, ISTART, AS HHMM (24 HR CLOCK)
>1000
ENTER DURATION OF RUN, DUR, IN MINUTES
>60
ENTER RUN TYPE, RTYPE; I FOR INLET, O FOR OUTLET
>e
*** THE CHARACTER e IS NOT APPROVED FOR CODES.  RE-ENTER CODE e
>O
ENTER PERCENT H2O IN STACK GAS
>8
ENTER COMPOSITION OF DRY STACK GAS
ENTER PERCENT CO2
>14
ENTER PERCENT CO
>0
ENTER PERCENT N2
>80
ENTER PERCENT O2
>6
ENTER AMBIENT PRESSURE, PAMBNT (INCHES HG)
>30.06
ENTER STACK PRESSURE RELATIVE TO AMBIENT, DPSTK (INCHES H2O)
>0
ENTER STACK TEMPERATURE, TSTACK (DEG F)
>280
ENTER STACK GAS VELOCITY, VSTACK (FT/SEC)
>1.0
ENTER IMPACTOR TEMPERATURE, TIMP (DEG F)
>280-
WAS EPA METHOD 5 USED TO DETERMINE THE FLOW RATE? ENTER Y OR N
>N
ENTER NAME (<21 CHAR) OF METHOD USED
>UNKNOWN
ENTER IMPACTOR FLOW RATE, FLOW (ACFM, STACK COND.)
>0.358
ENTER PHYSICAL DIAMETER OF LARGEST PARTICLE COLLECTED, DMAX (MICRONS)
>49
ENTER NOZZLE DIAMETER, DNOZZ (INCHES)
>1.0
ENTER CUTPOINT OF NOZZLE, CUTNOZ (MICRONS) OR 0 (ZERO) FOR PADRE TO CALCULATE IT
>0
ENTER CUTPOINT OF CYCLONE, CYCL (MICRONS) OR 0 (ZERO) IF NONE USED
>0
ENTER NOZZLE/CYCLONE MASS, CMASS (MG)
>0
WAS BACKUP FILTER USED?  ENTER Y OR N.
>Y
DID BACKUP FILTER COLLECT LARGE PARTICLES?  ENTER Y OR N
>NO
DO YOU WANT TO INTERPOLATE MASS CONCENTRATIONS TO NON-STD. DIAM.?  ENTER Y OR N
>NO
ENTER IMPACTOR TYPE, IMPNAM
>ANDERSEN
ENTER IMPACTOR MODEL, IMPMOD
>UNKNOWN
ENTER PLATE SET ID, IPLATE, OR ZERO FOR GENERIC CALIBRATION
>3
ENTER NUMBER OF STAGES USED IN IMPACTOR, NS
>8
ENTER ID OF WEIGHT RECORD
>21
   *** MASS ON NOZZLE  IS LOW
DATA FOR RUN  1 BY RTI  AT RTP  ON  32183 HAS BEEN SAVED IN THE TRIAL DATA FILE

DO YOU WANT TO ENTER DATA OR TO MODIFY WEIGHT OR TEST DATA?  ENTER Y OR N
>N
```

Figure 1. *Entering run data.*

```
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 2. 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 carability 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                                   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 3. *Reducing run data.*

```
DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>1
THE PHYSICAL (STOKES) DIAMETER WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>2
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>IN

   *** MASS ON STAGE             7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              1
```

Repetitive output omitted

```
   *** MASS ON NOZZLE  IS LOW
*** WEIGHT RECORD              66 IS DELETED
   *** MASS ON NOZZLE  IS LOW
    ***** NET WEIGHTS HAVE NOT BEEN CALCULATED
*** DATA FOR RUN RTI   COL     11376   11 IS INCOMPLETE AND CANNOT BE USED

TEST SITE     COL       COL       COL       COL       COL       COL
TEST DATE    11376     11376     11376     11376     11376     11376
RUN NUMBER       1         2         3         4         5         6
RUN DATE     11376     11376     11376     11476     11476     11576
START TIME    1450      1715      1822      1520      1600      1135
TOTAL MASS 6.739E+03 7.480E+03 4.203E+03 1.495E+03 3.077E+03 7.075E+03

STD. DIAM.  CUM. % MASS < D50
 3    .30       .48       .90       .22      1.32       .99       .55
 4    .63       .99      1.51      1.21      3.20      1.51       .78
 5   1.00      1.89      2.39      2.41      5.34      2.35      1.27
 6   1.25      2.75      3.09      3.44      6.35      2.84      1.88
 7   2.50      7.10      6.73      8.80     14.96      7.15      5.55
 8   6.00     14.07     13.55     19.04     24.66     13.74     12.10
 9  10.00     24.81     16.94     23.83     30.53     17.68     15.53
10  15.00     35.17     22.66     30.05     35.52     23.62     21.69
11  20.00     44.28     30.71     37.78     39.64     31.67     30.10

DATA COMPARISON FOR    6 INLET  RUNS BY RTI
STD. DIAM.   NO.  DM/DLOGD  CUMULATIVE          CUM. % MASS < D50
(MICRONS)   RUNS (MG/DNCM)  MASS < D50   AVG.     STD. DEV.   MIN.      MAX.
 3    .30     6  7.99E+01  3.30E+01      .74        .40        .22      1.32
 4    .63     6  1.03E+02  6.33E+01     1.53        .87        .78      3.20
 5   1.00     6  3.39E+02  1.08E+02     2.61       1.41       1.27      5.34
 6   1.25     6  4.41E+02  1.46E+02     3.39       1.54       1.88      6.35
 7   2.50     6  1.12E+03  3.65E+02     8.38       3.39       5.55     14.96
 8   6.00     6  1.01E+03  7.35E+02    16.19       4.78      12.10     24.66
 9  10.00     6  1.51E+03  1.01E+03    21.55       5.81      15.53     30.53
10  15.00     6  2.76E+03  1.35E+03    28.12       6.32      21.69     35.52
11  20.00     6  3.70E+03  1.76E+03    35.70       5.76      30.10     44.28
DO YOU WANT TO PLOT CUM % MASS?  ENTER Y OR N
>Y
```

Figure 4. *Comparing several runs (part 1 of 2).*

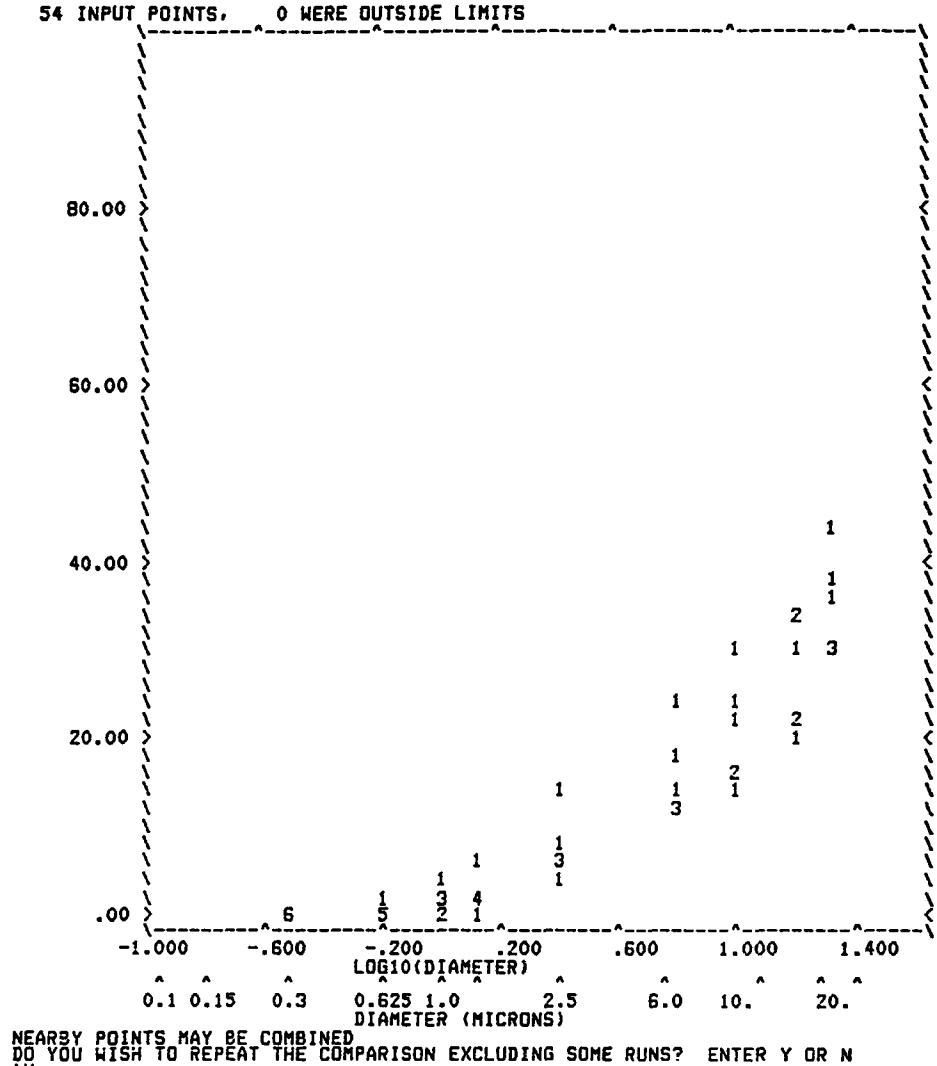

Figure 4. Comparing several runs (part 2 of 2).

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***Gary L. Johnson** is the EPA Project Officer (see below).*
The complete report, entitled "Particulate Data Reduction System (PADRE) User Guide," (Order No. PB 84-178 417; Cost: $8.50, subject to change) will be available only from:
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