Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

Background Report Reference

AP-42 Section Number: 9.9.1

Background Report Section: 4

Reference Number: 51

Title: A Computer-Based Cascade Impactor Data Reduction System

Southern Research Institute
March 1978

EPA-600/7-78-042
March 1978

AP-42 Section 9.9.1
Reference
Report Sect. 4
Reference 51

A COMPUTER-BASED CASCADE IMPACTOR DATA REDUCTION SYSTEM

Library Region IV
US Environmental Protection Agency
345 Courtland Street
Atlanta, Georgia 30365

by

J. W. Johnson, G. I. Clinard,
L. G. Felix, and J. D. McCain

Southern Research Institute
2000 Ninth Avenue, South
Birmingham, Alabama 35205

Contract No. 68-02-2131
T. D. 10101
Program Element No. EHE624

EPA Project Officer: D. Bruce Harris

Industrial Environmental Research Laboratory
Office of Energy, Minerals and Industry
Research Triangle Park, N.C. 27711

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

ABSTRACT

This document describes a cascade impactor data reduction system written in the FORTRAN IV language. The overall system incorporates six programs: MPPROG, SPLIN1, GRAPH, STATIS, PENTRA, and PENLOG. Impactor design, particulate catch information, and sampling conditions from single impactor runs are used to calculate particle size distributions. MPPROG and SPLIN1 perform data analyses and make curve fits, while GRAPH is totally devoted to various forms of graphical presentation of the calculated distributions. The particle size distributions can be output in several forms. STATIS averages data from multiple impactor runs under a common condition and PENTRA or PENLOG calculate the control device penetration and/or efficiency. The plotting routines have been written for a PDP15/76 computer and are not compatible with other computing systems without modification.

SECTION 1

INTRODUCTION

Cascade impactors have gained wide acceptance as a practical means of making particle size distribution measurements. These devices are regularly used in a wide variety of environments, ranging from ambient conditions to flue gas streams at 400°C (752°F). Specially fabricated impactors can be used for more extreme conditions.

Because of their usefulness, the U.S. Environmental Protection Agency has funded research which has explored the theoretical and practical aspects of impactor operation. As part of this research, an effort has been made to design a comprehensive data reduction system which will make full use of cascade impactor measurements.

This publication describes a cascade impactor data reduction system designed to automatically reduce data taken with any one of four commercially available round jet cascade impactors: The Andersen Mark III Stack Sampler, the Brink Model BMS-11 (as supplied and with extra stages), the University of Washington Mark III Source Test Cascade Impactor, and the Meteorology Research Incorporated Model 1502 Inertial Cascade Impactor. Provision is not made in this system for reducing data taken with slotted jet impactors. With modification the computer programs can accomodate any round jet impactor with an arbitrary number of stages and with more extensive revision data can be reduced for slotted jet impactors.

The computer programs which comprise this data reduction system are written in the FORTRAN IV language. The plotting subroutines used were written specifically for the Digital Equipment Corporation (DEC) PDP-15/76 computer and these programs are not compatible with other plotting systems. However, these programs can be used as a guide when revision is made for use with another operating system.

The data reduction system is made up of six major (mainline) programs and 34 subroutines. Section 2 contains a broad outline of the functioning of each mainline program along with an explanation of the rationale for their design. The mainline programs and subroutines are discussed in detail in Section 3. Section 4 is a user's guide for each of the mainline programs. Detailed instructions for the input to each of the mainline programs is given in this section. Section 5 is a set of example calculations which are meant to be used in program checkout. An example of each kind of output that can be produced by this system is provided. Section 6 contains a complete program listing along with simplified flowcharts for the mainline programs. In an Appendix, a description is given of the plotter software used with the DEC PDP-15/76 computer system.

CONTENTS

	Page
Abstract	ii
Figures	vii
Tables	viii
Acknowledgments	x
1. Introduction	1
2. General Program Outline	3
Individual Run Data Analysis	3
MPPROG	5
SPLIN1	18
Generation of Interpolated Points	19
GRAPH	30
Analysis of Grouped Data	31
STATIS	31
Programs PENTRA/PENLOG	34
3. Programming Details	36
Program MPPROG	36
Breakdown of Program MPPROG	37
Functions of the Called Subprograms	59
Subroutine VIS	60
Subroutine MEAN	61
Subroutine CUT	62
Subroutine CUM	68
Subroutine DMDNGD	70
Block Data Subprogram COMBK1	74
Block Data Subprogram COMBK2	74
Input to Program MPPROG	77
Card Input	77
File Input	86
Output from Program MPPROG	87
Graph Output	91
File Output	91
Program SPLIN1	95
Breakdown of Program SPLIN1	95
Subroutines Called by Program SPLIN1	107
Input to Program SPLIN1	107
File Input	108
Output from Program SPLIN1	108
File Input	109
Program GRAPH	110
Breakdown of Program GRAPH	110
Functions of the Called Subroutines	120
Subroutine CUMPCT	136
Subroutine WALLY2	142

CONTENTS (Continued)

Page

Subroutine WALLY3. 152
Subroutine JOE2. 163
Input and Output for the Mainline Program GRAPH. . . . 170
Card Input and Resulting Output. 170
File Input and Output. 179
Program STATIS 183
Breakdown of Program STATIS. 184
Functions of the Called Subroutines. 206
Subroutine STPLOT. 213
Subroutine STATPT. 224
Input for Mainline Program 228
Card Input 228
File Input 230
Output for Mainline Program STATIS 231
Graph Output 236
Program PENTRA 240
Functions of the Called Subroutines 254
Input to Mainline Program PENTRA 254
Card Input 254
File Input 255
Output from Mainline Program PENTRA. 258
Line Printer Output. 258
Graph Output 258
File Output. 258
Program PENLOG 259
General Subroutines and Functions. 261
Subroutine SYMBOL. 261
Breakdown of Subroutine SYMBOL 261
Function SLIM. 278
Breakdown of Function SLIM 278
Function XVAL. 282
Breakdown of Function XVAL 282
Function YVAL. 283
Subroutine CPPLOT. 283
Breakdown of Subroutine CPPLOT 283
Subroutine YPROB 288
4. User Instructions. 291
Mainline Program MPPROG. 291
Requirements for Program Execution 291
Card Format. 292
Sample Job Stream. 292
Mainline Program SPLIN1. 294
Requirements for Program Execution 294
Card Format. 294
Sample Job Streams 296
Mainline Program Graph 297
Requirements for Program Execution 297

CONTENTS (Continued)

		Page
	Card Format	297
	Sample Job Stream	299
	Mainline Program STATIS	300
	Requirements for Program Execution	300
	Card Format	300
	Sample Job Streams	302
	Mainline Program PENTRA	303
	Requirements for Program Execution	303
	Card Format	303
	Sample Job Streams	303
	File Reference Information	306
	Program and Subprogram Calling List	308
5.	Example Calculations	310
	Data Deck for Program MPPROG-Hypothetical Andersen	312
	Data Deck for Program MPPROG-Hypothetical Brink	316
	Data Deck for Program MPPROG-Hypothetical University of Washington	354
	Data Deck for Program MPPROG-Hypothetical Meteorology Research, Inc.	358
	Data Deck for Program MPPROG-Brink	362
	Data Deck for Program SPLIN1	370
	Data Deck for Program GRAPH	371
	Data Deck for Program STATIS	384
	Data Deck for Program MPPROG-Andersen	396
	Data Deck for Program SPLIN1	402
	Data Deck for Program GRAPH	403
	Data Deck for Program STATIS	416
	Data Deck for Program PENTRA	428
	Data Deck for Program PENLOG	431
6.	Program Listings	434
	Flow Chart of Program GRAPH	435
	Listing of Main Program GRAPH	441
	Flow Chart of Program MPPROG	447
	Listing of Main Program MPPROG	448
	Flow Chart of Program PENTRA	463
	Listing of Main Program PENTRA	470
	Listing of Main Program PENLOG	477
	Flow Chart of Program SPLIN1	484
	Listing of Main Program SPLIN1	486
	Flow Chart of Program STATIS	491
	Listing of Main Program STATIS	496
	Listing of Subroutine AVCON	508
	Listing of Block Data Subprogram COMBK1	511
	Listing of Block Data Subprogram COMBK2	512
	Listing of Subroutine CPPLOT	514
	Listing of Subroutine CUM	516
	Listing of Subroutine CUMPCT	517
	Listing of Subroutine CUT	521

CONTENTS (Continued)

	Page
Listing of Subroutine DMDNGD	524
Listing of Subroutine FPLOT	527
Listing of Subroutine JOE1	529
Listing of Subroutine JOE2	531
Listing of Subroutine LABEL	534
Listing of Subroutine LGLBL	535
Listing of Subroutine MEAN	536
Listing of Subroutine NDTRI	537
Listing of Subroutine PIONT	538
Listing of Subroutine SIMQ	540
Listing of Function SLIM	542
Listing of Subroutine STAGE	543
Listing of Subroutine STATPT	544
Listing of Subroutine STPLOT	547
Listing of Subroutine SYMBOL	551
Listing of Subroutine VIS	554
Listing of Subroutine WALLY1	555
Listing of Subroutine WALLY2	560
Listing of Subroutine WALLY3	563
Listing of Subroutine XLOG	566
Listing of Subroutine XSLBL	567
Listing of Subroutine XVAL	568
Listing of Subroutine YLOG	569
Listing of Subroutine YPROB	570
Listing of Subroutine YVAL	573
References	574
Appendix	575