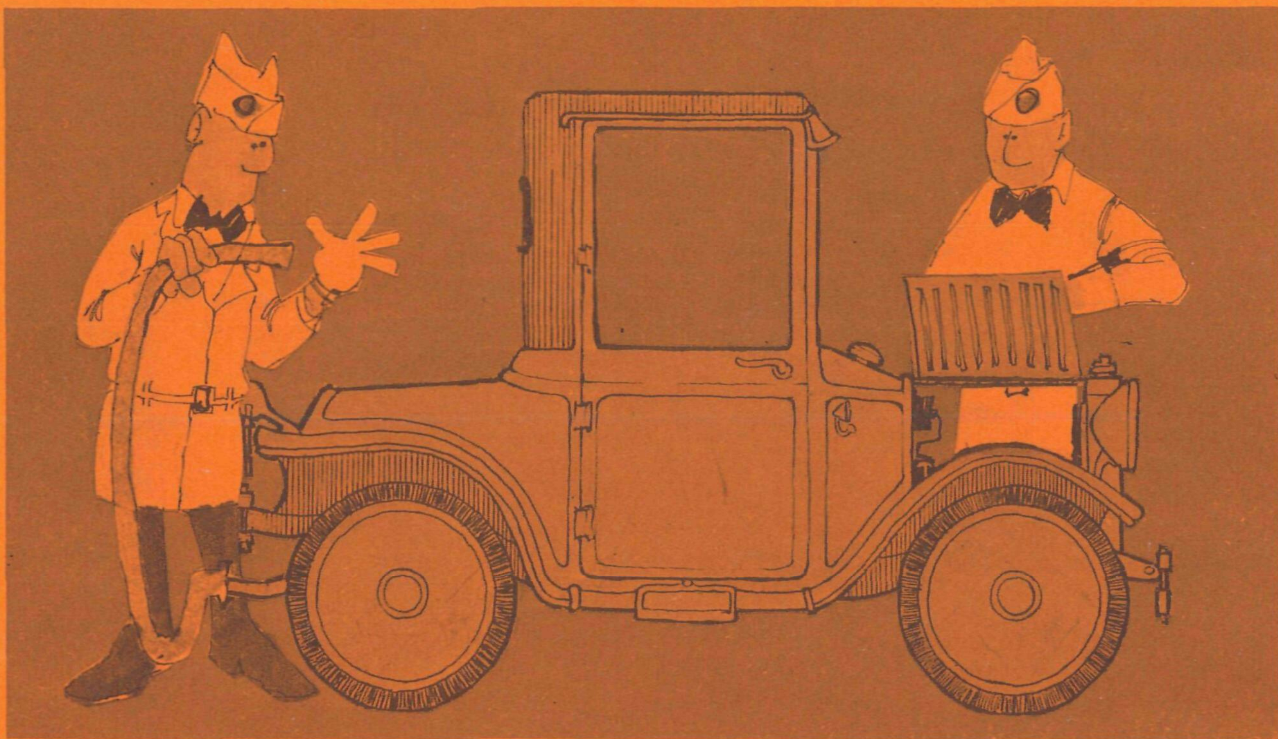
EPA 460/3-74-010g

A Study of Mandatory Engine Maintenance for Reducing Vehicle Exhaust Emissions

Volume VII. A User's Manual and Guide to the Economic Effectiveness Computer Program



FINAL REPORT

July 1973

In Support of:
APRAC Project Number CAPE-13-68

for

Coordinating Research Council, Inc.
Thirty Rockefeller Plaza
New York, New York 10020

and

Environmental Protection Agency
Air Pollution Control Office
5600 Fishers Lane
Rockville, Maryland 20852

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ONE SPACE PARK • REDONDO BEACH CALIFORNIA 90278

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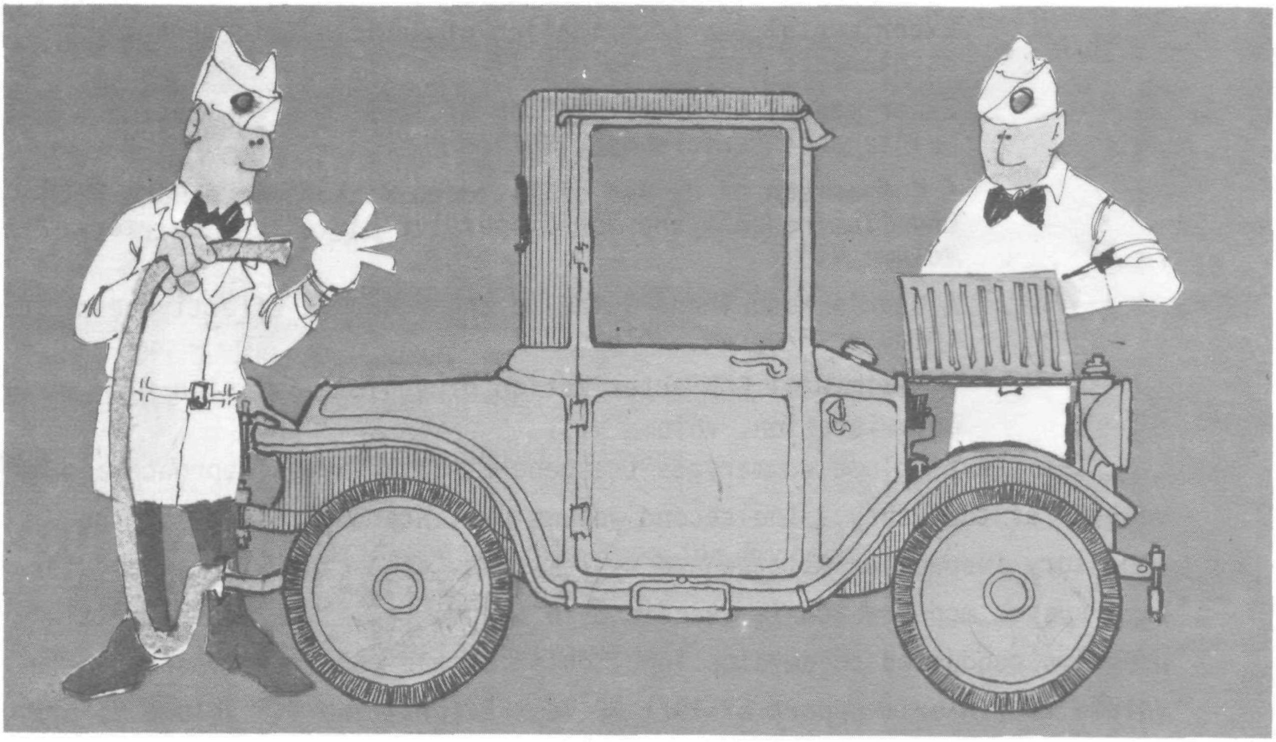

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PREFACE

This report, "A Study of Mandatory Engine Maintenance for Reducing Vehicle Exhaust Emissions," consists of eight volumes. The following are the subtitles given for each volume:

- Executive Summary, Volume I
- Mandatory Inspection/Maintenance Systems Study, Volume II
- A Documentation Handbook for the Economic Effectiveness Model, Volume III
- Experimental Characterization of Vehicle Emissions and Maintenance States, Volume IV
- Experimental Characterization of Service Organization Maintenance Performance, Volume V
- A Comparison of Oxides of Nitrogen Measurements Made With Chemiluminescent and Non-Dispersive Radiation Analyzers, Volume VI
- A User's Manual and Guide to the Economic Effectiveness Computer Program, Volume VII
- Experimental Characterization of Vehicle Emission Deterioration, Volume VIII

The first volume summarizes the general objectives, approach and results of the study. The second volume presents the results of the mandatory inspection/maintenance system study conducted with a computerized system model which is described in Volume III. The experimental programs conducted to develop input data for the model are described in Volume IV (Interim Report of 1971-72 Test Effort) and V. Volume VI presents comparative measurements of NO and NO_x using chemiluminescence and NDIR/NDUV instruments and differences in these measurements are examined. A detailed description of the Economic Effectiveness Computer Program along with a user's guide is presented in Volume VII. Volume VIII contains a characterization of vehicle emission and engine parameter deterioration rates.

The work presented herein is the product of a joint effort by TRW Transportation and Environmental Operations and its subcontractor, Scott Research Laboratories. TRW, as the prime contractor, was responsible for overall program management, experimental design, data management and analysis, and the economic effectiveness study. Scott acquired and tested all of the study vehicles. Scott also provided technical assistance in selecting emission test procedures and in evaluating the test results.

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1.0 INTRODUCTION

The General Economic Effectiveness Program (GEEP) is a computer model which simulates the dynamic behavior of alternative vehicle inspection/maintenance systems. It is completely general in design and can be used to assess a wide range of inspection/maintenance strategies. GEEP has been coded in Fortran IV and is presently operating on a CDC 6500 System.

The greatest potential uses of GEEP are: 1) Assessing the overall feasibility of vehicle inspection/maintenance, 2) measuring the impact of regional effects on program performance, 3) designing the optimal system configuration, and 4) contrasting the cost-effectiveness of a mandatory program with other control concepts.

GEEP was developed primarily for assessing the feasibility, both performance wise and economically, of a mandatory program of vehicle inspection/maintenance. Since its inception (circa 1969) it has been expanded to include other basic strategies; e.g. mandatory maintenance, voluntary maintenance, and to account for the influx of new vehicles with differing emission levels. These added features have greatly enhanced the program in terms of its effectiveness as a research tool.

The program has been constructed on a hierarchal input-output concept. Simplicity and flexibility are the salient characteristics of the input language. As such, the input system greatly reduces the time required to set up and execute a computer run. The program also provides several levels of output depending on user needs. For standard cases, it outputs computer generated plots of emission time histories, program figures of merit, estimated emission reductions and numerous cost accounting data. For more detailed information, a debug option is available which prints the basic calculations from each of the major subroutines.

This manual describes for the programmer/user the operating instructions and input formats for the program. It is composed of five sections and two appendices. The present section summarizes the purpose and general uses of the program. Section 2.0 presents a brief discussion on the mathematical framework used in developing the basic model and provides a concise overview of the program's structure. Section 3.0 outlines the input requirements and formats for undertaking a computer simulation run. Included are tables of the available input and output options. Detailed information on the deck setup, computer resource requirements and program debugging options are given in Section 4.0. Finally, in Section 5.0 a complete set of flow schematics and listings is presented for each of the 55 subroutines contained in GEEP.

2.0 MATHEMATICAL MODEL FRAMEWORK AND PROGRAM OVERVIEW

2.1 MODEL FRAMEWORK

The primary purpose of the Economic Effectiveness Model is to serve as a research and design tool for assessing the various implications of a mandatory program of vehicle inspection/maintenance. As such, it has been constructed with the capability of investigating a wide range of possible procedure and design alternatives. The model has been constructed to analyze the regional feasibility of vehicle inspection/maintenance as well as specify an optimal system design. Input data for several regional areas have been incorporated directly into the model.

The model by its design is procedure oriented. That is, it is best used for evaluating the attractiveness of alternative procedures, e.g., engine inspection or emission inspection, which govern and control the operation of an inspection/maintenance system. Actually, there exists a hierarchy of decision variables within the structure of the model. The model analyzes these decision variables by simulating the behavior of the inspection/maintenance process over time. Here, the economic-effectiveness of various strategies can be measured in terms of emission reductions and program costs. A statistical analysis of these forecasted emission reductions is performed to determine their actual significance. This analysis includes an estimate of the overall variance for each emission species (i.e., HC, CO, NO_x).

In addition to these functions, the model can also be used to analyze the sensitivity of system performance to various assumptions and basic data inputs. Used in this way the model provides a mechanism for identifying areas requiring further analytical and empirical definition. Finally, the model generates a description of the designed system including: total number of inspection lanes required, equipment specification and facilities configuration.

The methodological approach adopted for constructing the Economic Effectiveness Model involved a blending of theoretical and empirical relationships. The theory provided the conceptual framework for describing the inspection/maintenance process whereas the experimental data yielded the specific transformations needed to define and interconnect the various model elements.

The development of the model required a detailed specification of the various relationships characterizing the Inspection/Maintenance Process. Three main components -- engineering design, economic analysis and regional characterization -- form the core or nucleus of the model. Each of these components describes or delineates one fundamental aspect of the total process. How these interact must be clearly understood so that system design factors are selected in combinations to yield optimal cost and performance.

Attempting to describe a physical process with an abstract mathematical model raises a number of technical problems. One important issue involves the level of aggregation used in the model to characterize the actual process. Use of a simulation model yields an effective vehicle for coping with many of these questions. Here, basic study grounds and model assumptions, e.g., level of aggregation, can be isolated and examined in detail. As such, a simulation model strikes a good balance between a strictly theoretical model and an empirical model. The simulation model used in describing the inspection/maintenance process provides a powerful tool not only for assessing the feasibility of this control approach but also in developing an optimal system design specification. One phase of such a feasibility assessment involves the evaluation of potential procedure strategies, e.g. engine inspection. Within this context, the simulation model can be used to measure the performance of these strategies over time and under varying system constraints. The resultant model design provides a great deal of flexibility yet contains sufficient depth to describe the process in intimate detail.

A detailed description of the basic model structure and flow processes is contained in Volume 3 of this series entitled, A Documentation Handbook for the Economic Effectiveness Model. Descriptions contained in this volume are designed for use by the user and/or the computer programmer engaged in exercising the GEEP computer program.

2.2 PROGRAM OVERVIEW

The General Economic Effectiveness Program embodies a set of mathematical algorithms and techniques which have been developed to simulate a mandatory program of vehicle inspection and maintenance (I/M). The program contains the necessary data and logic to evaluate a variety of inspection/maintenance alternatives. Figure 2-1 presents a schematic overview of the program's structure.

The program is nominally under the control of an executive system (GX) which checks for input errors and controls output. GX also initiates the computational process by calling subroutines INITIAL and REGION. INITIAL moves starting valves into each storage array, expands, normalizes and determines mean valves and variances for all engine parameters and mode emission distributions. Subroutine REGION calls one of five existing regional sets which contain pass/fail criteria, regional emission weighting factors, initial emission levels, and vehicle population data (e.g., engine parameter distributions). Next, GX calls subroutine ATTRITION which estimates the change in the vehicle population due to the introduction of new cars on the attrition of older ones. This data is inputted directly into both MICRO and BLINE.

Subroutine MICRO embodies the actual Inspection/Maintenance Model. Here, the effects of deterioration, testing and maintenance are measured based on the specific procedure under investigation. Simultaneously, the same effects based on a voluntary program are computed in subroutine BLINE. The estimated emission reduced potential from the mandatory program is then contrasted with the results developed vis-a-vis the figure of merit.

Subroutine COSTS determines the costs of the mandatory program and develops the appropriate figures of merit. Cost of equipment, facilities and training are also estimated. Finally, subroutine OUT produces a concise summary of the calculated results.

Table 2-1 presents an overview of the subroutine hierarchy within GEEP. As can be seen, there exists six functional levels. The discussion thus far, has only covered the first two levels. A complete description of the remaining subroutines are found in Section 5.0.

The circled letters (A-G) shown in Figure 2-1 refer to access points associated with the second level hierarchy. A more detailed flow schematic for these subroutines is presented in Figures 2-2 through 2.8, respectively.

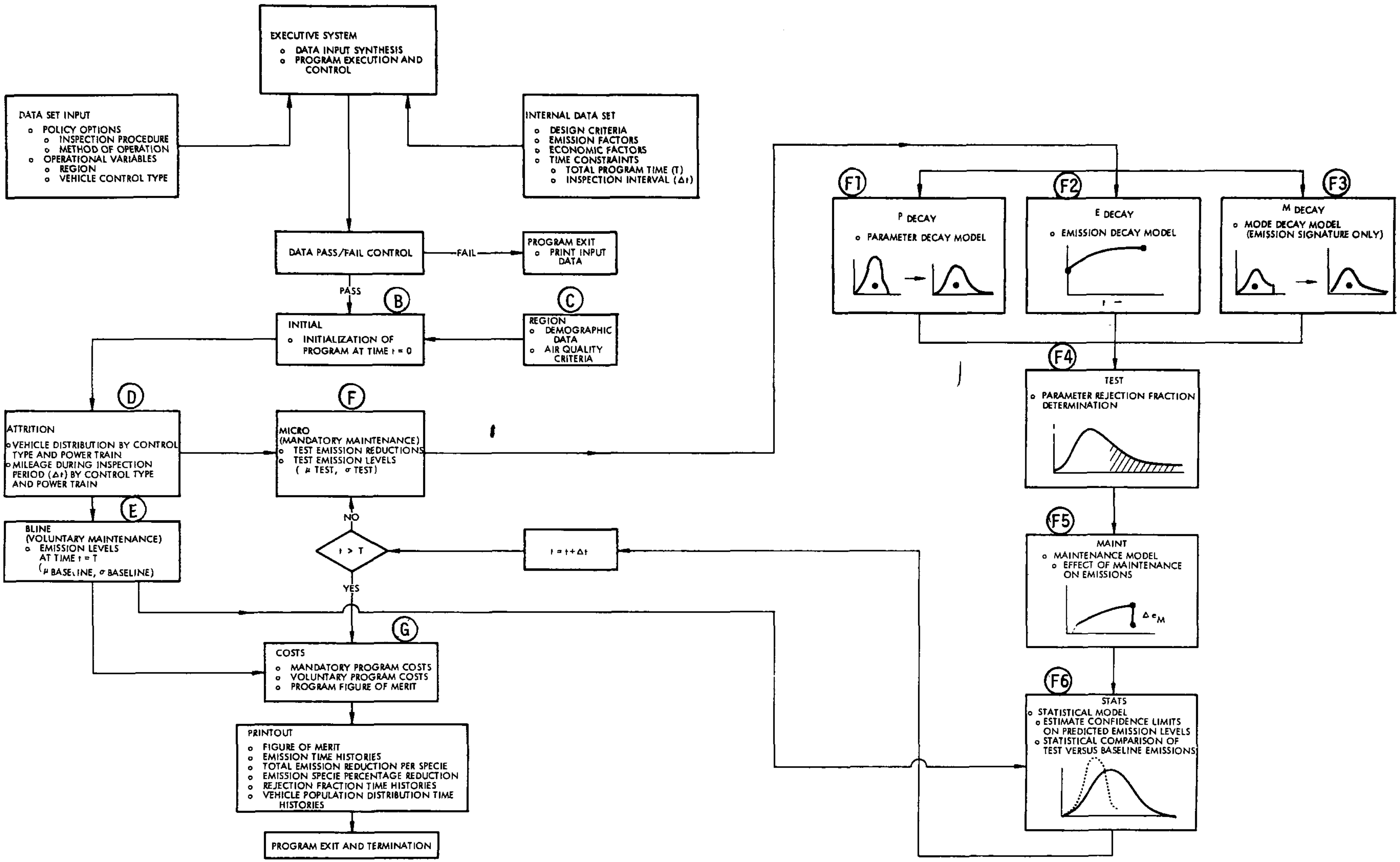


Figure 2-1 Schematic Flowchart for the General Economic Effectiveness Program

Table 2-1 SUBROUTINE HIERARCHY

1	2	3	4	5	6
		REGION 1 4			
	REGION	2 5			
		3 6			
	INITIAL	PRINT (1)(2)(3)			
		PRINT (4)(5)(S)			
		PRINT 2			
	BLINE	FIT			
		FUN 1			
GEEP		PDECAY	FUN 1		
		MDECAY	STD 2	NORM	
		EDECAY			
			AREA	NORM	
		TEST	FUN 1	FUN 1	
			UNION		
			TABLE	NORM	
	MICRO		DISTPR	SWITCH	
			CONVOL	RESIZE	NORM
		STATS		STD 2	NORM
			NORM	NORM	
			STD 2		
			FUN 1	FUN 1	
			XPT	NORM	
		PLOT	PLOTXY		
	COSTS	QUEUE	IFACT		
		FIT			
	OUT				

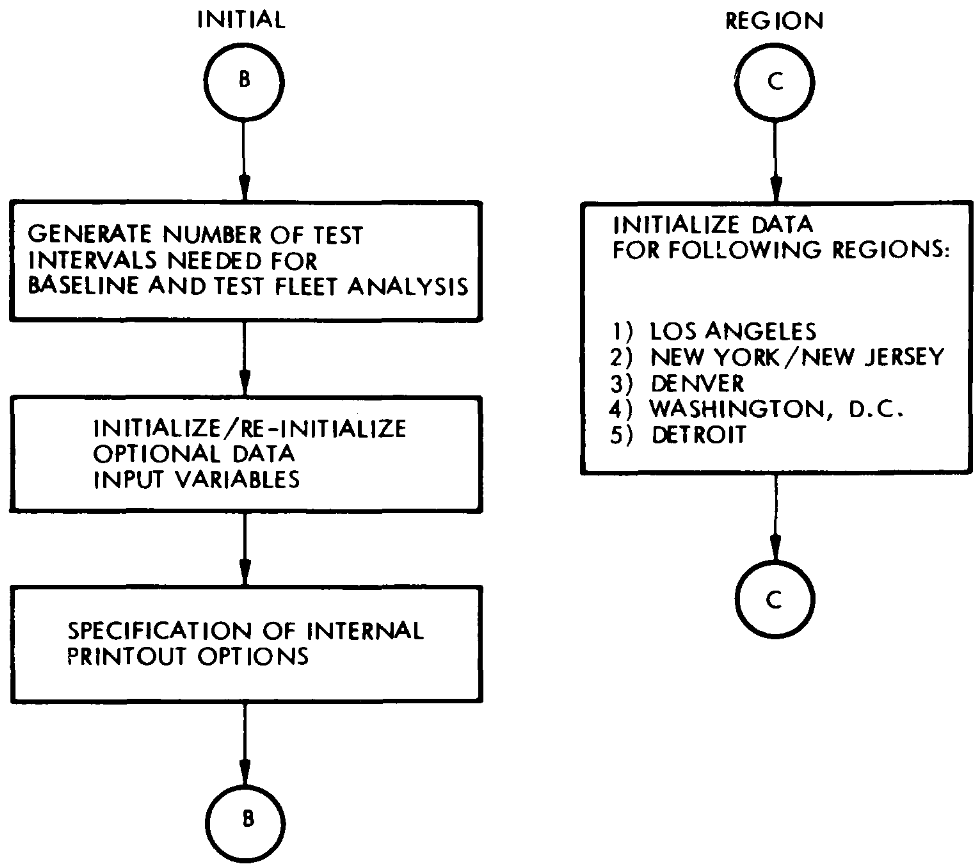


Figure 2-2 Flowcharts for Subroutines INITIAL and REGION

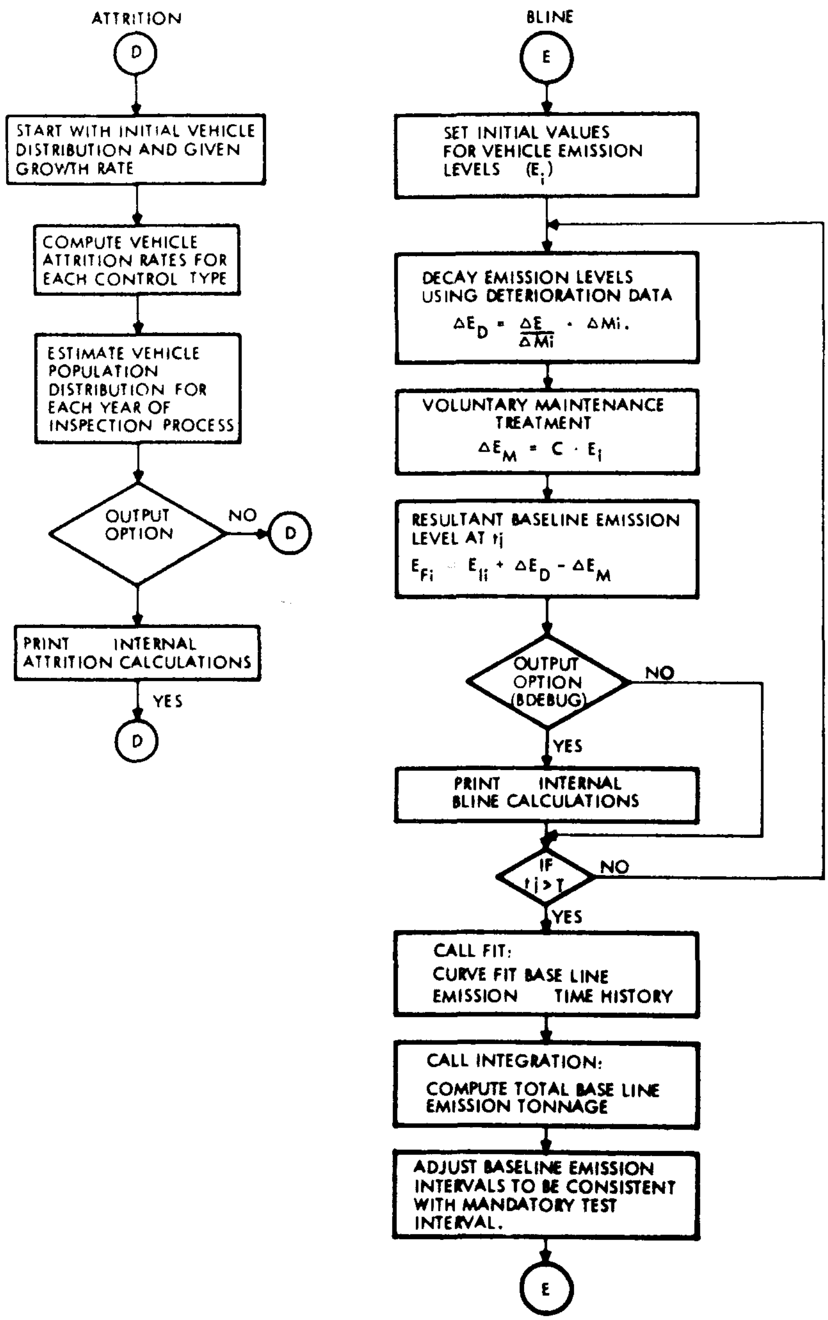


Figure 2-3 Flowcharts for Subroutines ATTRITION and BLINE

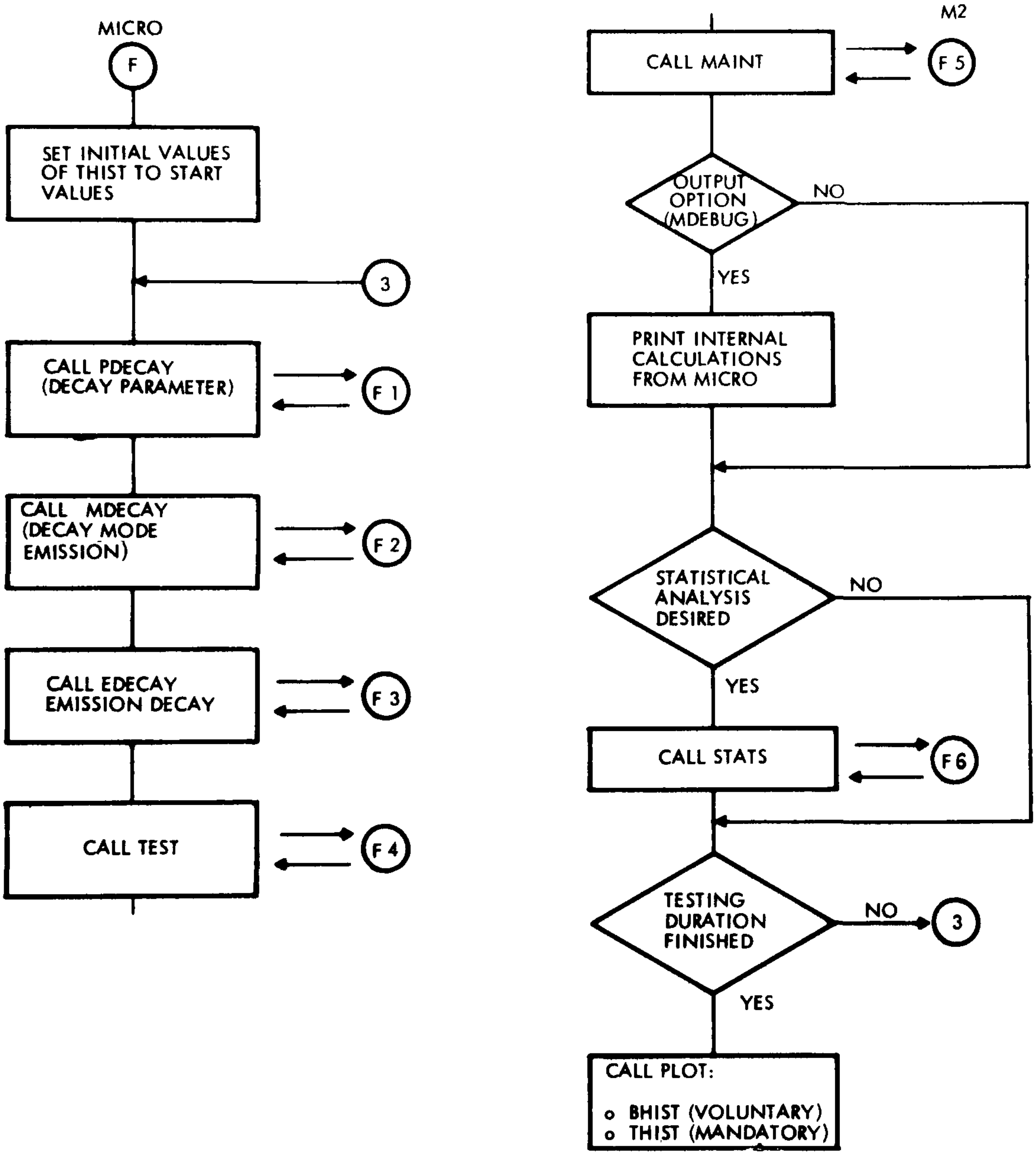


Figure 2-4 Flowchart for Subroutine MICRO

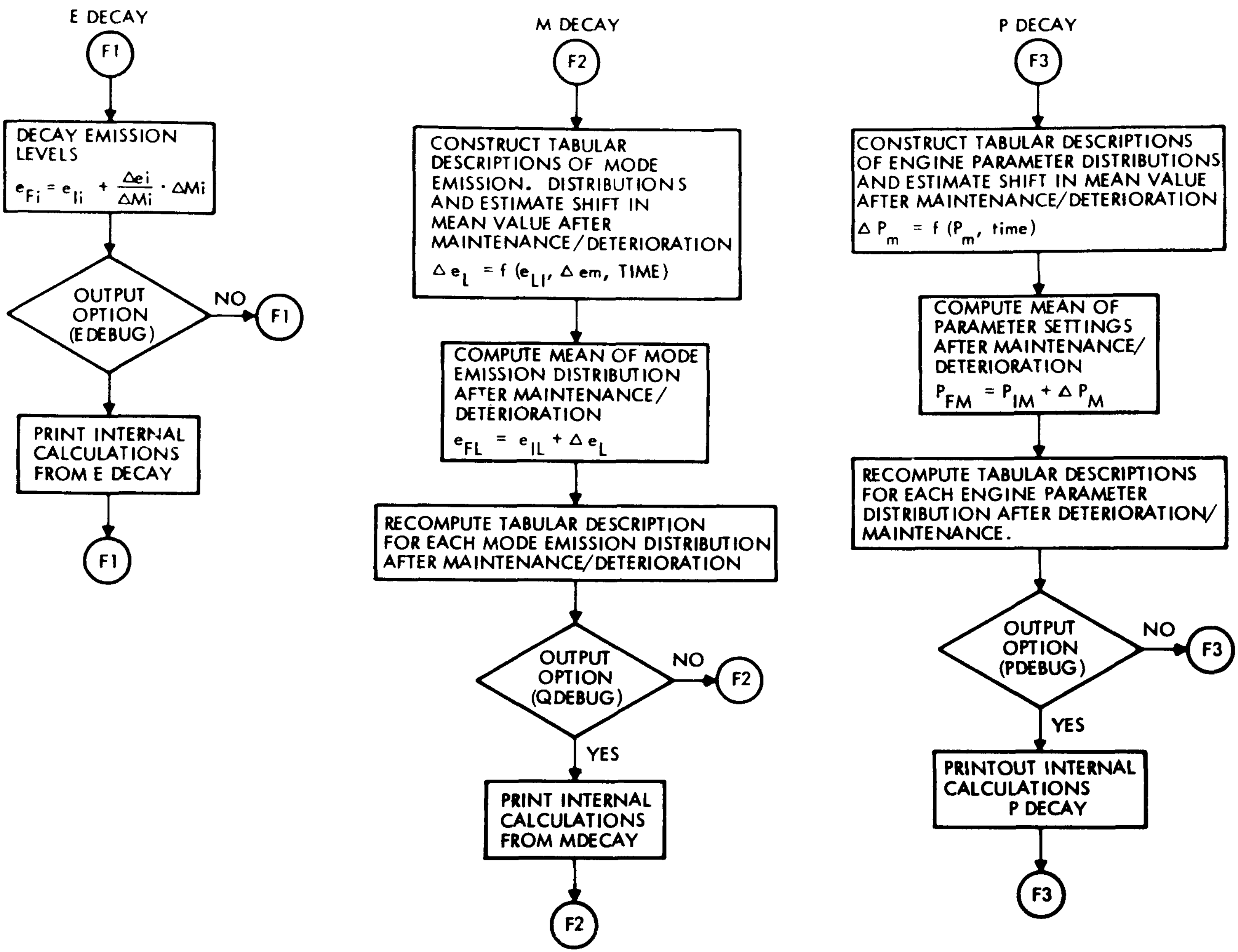
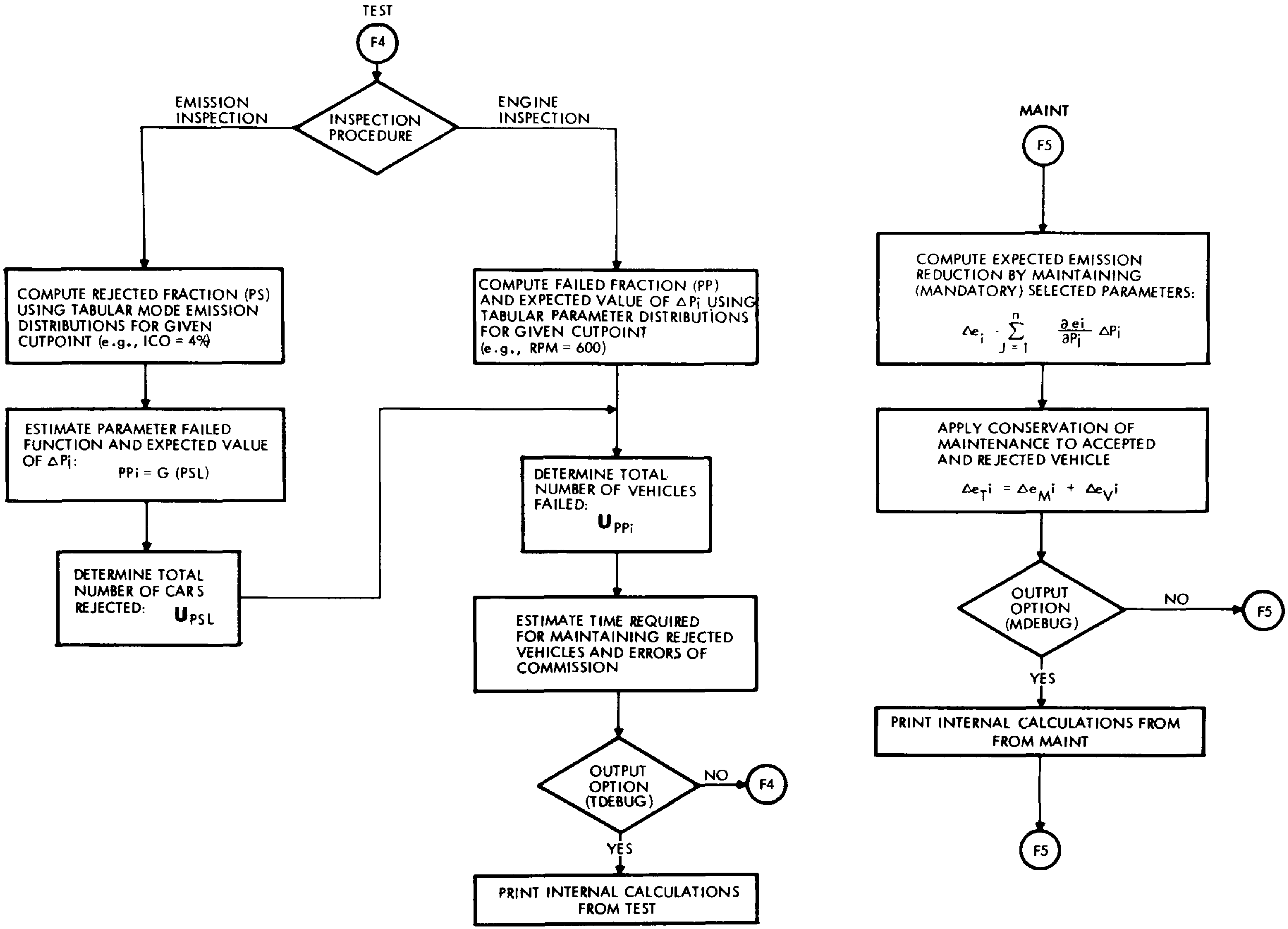


Figure 2-5 Flowcharts for Subroutines EDECAY, MDECAY and PDECAY



2-6 Flowcharts for Subroutines TEST and MAINT

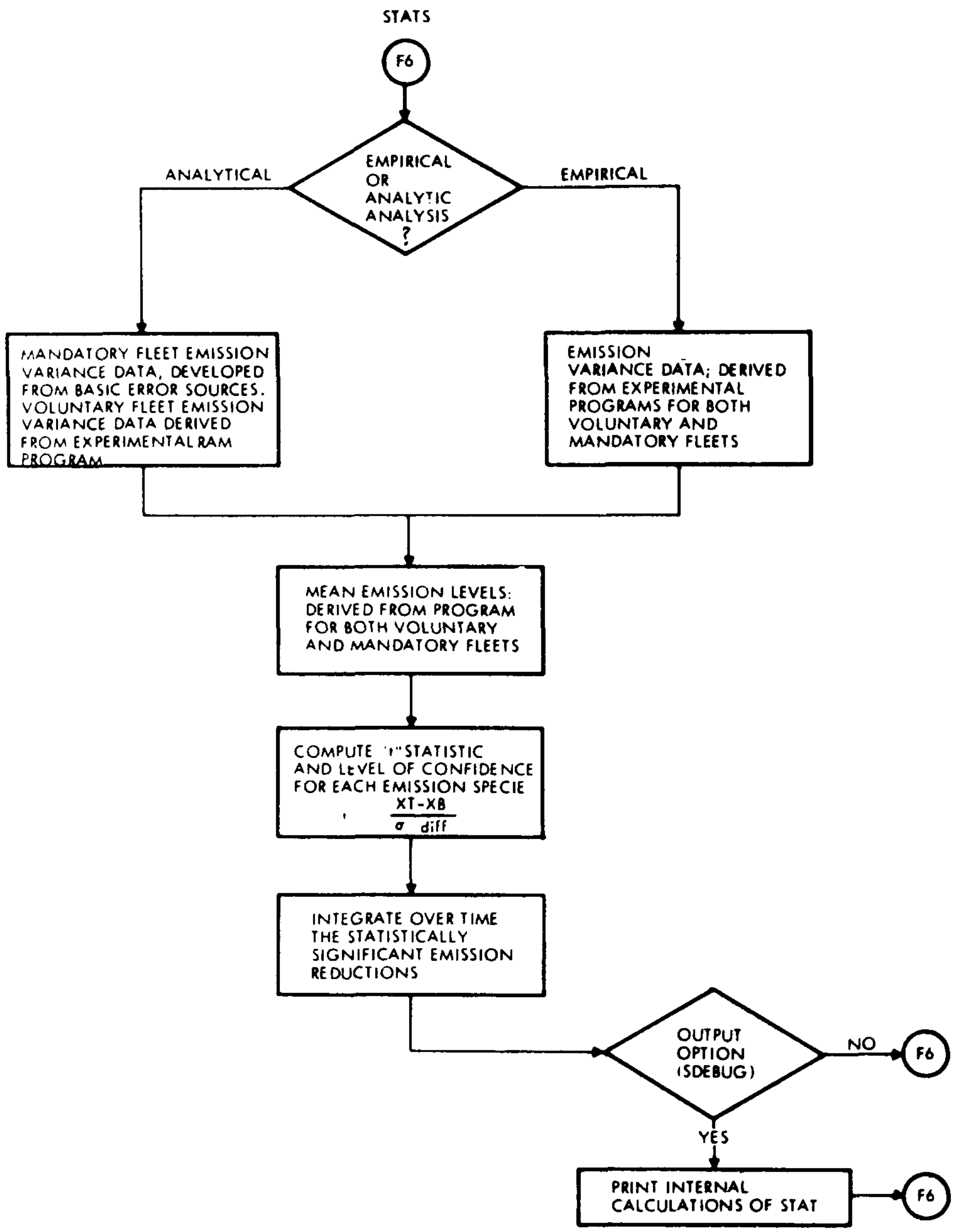


Figure 2-7 Flowchart for Subroutine STATS

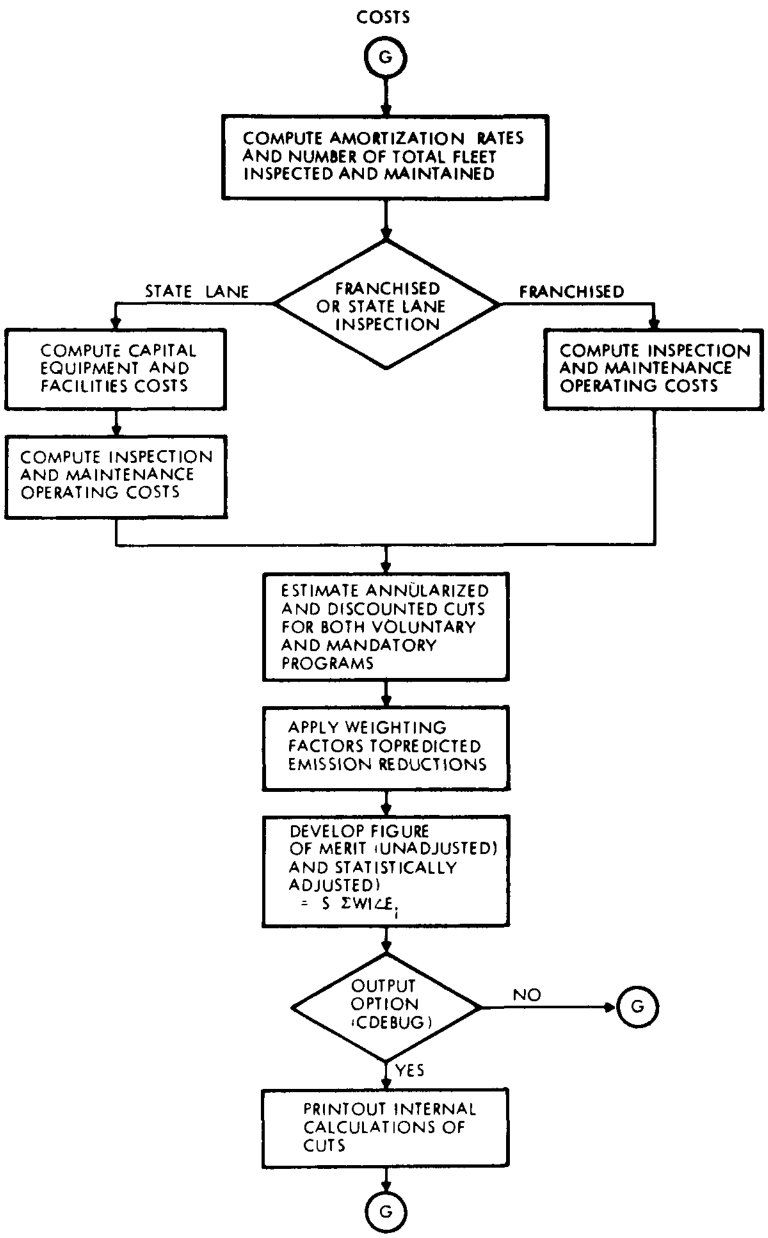


Figure 2-8 Flowchart for Subroutine COSTS

3.0 BASIC INPUT REQUIREMENTS AND CALCULATED OUTPUT

3.1 INPUT OPTIONS

Presented herein is a description of the salient input/output features of the program. The program's input/output system has been designed to accommodate a wide range of inspection/maintenance options. Basically, the input options can be separated as follows -- inspection procedure, maintenance treatment and regional area.

The inspection procedure refers to the type of diagnostic evaluation used in identifying engine maladjustments and malfunctions. There are two basic types of inspection strategies:

(1) Engine Parameter Inspection

(2) Exhaust Emission Inspection

Within each of these two approaches lies a number of different alternatives (e.g., idle). Based on a specific inspection strategy, the model determines the optimum pass/fail criteria for the various engine parameters and/or exhaust mode emissions.

The model partitions the engine block into three major subsystems -- idle, ignition and induction -- each of which can be maintained either singularly or in combination. The three maintenance treatments currently available are:

(1) Idle Adjustment

(2) Idle Adjustment with an Ignition Tuneup (Extensive A)

(3) Idle Adjustment with an Ignition and Induction Tuneup (Extensive B)

Thus the model is capable of examining a total of six different and unique inspection/maintenance alternatives. Furthermore, the user can elect to examine the impact of maintenance _only_ strategies by merely rejecting the total vehicle population.

In addition to the various procedural options, the model requires descriptive information on the demographic and air quality characteristics of the candidate regional area. The essential regional data includes: (1) vehicle population distributions, (2) vehicle emission levels and engine state, and (3) a quantitative estimate of existing air quality. The last item is used in formulating an emission species weighting function. This function integrates the three exhaust emissions (HC, CO and NO_x) into a composite figure which can be used directly in contrasting various alternatives. To date, vehicular demographic and emissions data has been collected for the following regions:

- Los Angeles Basin
- Detroit Metropolitan Area
- Denver Metropolitan Area
- New York/New Jersey Metropolitan Area
- District of Columbia Metropolitan Area

Selection of one of these regions for analysis is made by merely specifying its key word name in the input file.

3.1.1 Keyword Data Input

The Keyword input consists of a series of input cards each containing a "keyword" from the list of valid entries (The ØPTS array). Each keyword activates an appropriate portion of GEEP code. Table 3-1 presents a list of all valid keywords with a description of the variables affected. For a detailed description of the consequences of a particular input, consult the flowcharts and listing in Section 5.1 (Main program).

Table 3-1 AVAILABLE KEYWORD INPUT

KEYWORD	CODE NUMBER	DESCRIPTION	VARIABLES AFFECTED
PARAMETER	2	Parameter inspection in franchised garages (unloaded)	RTYPE = PMØDEL, LIDLE=1, SLANE="GARAGE"
SIGNATURE	3	Mode emission signature inspection in state facilities (unloaded)	RTYPE = SMØDEL, LIDLE=1, SLANE="STATE"
UNCONTROL	5	Include uncontrolled vehicles (pre 1968) in fleet being modeled. (K=1)	KSTART=1, KSTØP=at least 1. Model uses control types KSTART through KSTØP
CONTROL	6	Include controlled vehicles (1968 - 1970) in fleet being modeled. (K=2)	KSTART=at most 2, KSTØP=at least 2
POST 70	7	Include post 70 vehicles (post 1970) in fleet being modeled. (K=3)	KSTART=at most 3, KSTØP=3
IDLE	8	Include Idle parameters in those being tested.	MSTART=1, MSTØP=at least 3. Model uses parameters MSTART through MSTØP. (See Table 4.1.1.2)
IGNITION	9	Include Ignition parameters in those being tested.	MSTART=at most 4, MSTØP=at least 5 OPTI=at least 2
INDUCTION	10	Include Induction parameters in those being tested	MSTART=at most 6, MSTØP=10 OPTI=at least 3
LOADED	25	Flag indicating test run in loaded condition.	LIDLE=2
HYBRID	27	Flag indicating hybrid test. Part run loaded, part unloaded.	LIDLE=3

Table 3-1 AVAILABLE KEYWORD INPUT (con't.)

KEYWORD	CODE NUMBER	DESCRIPTION	VARIABLES AFFECTED
DEBUG	1	OLD debug flag	None
BLINE	11	BLINE debug flag.	Turns on Bline debug output. BDEBUG=YES
MICRO	12	MICRO debug flag.	Turns on MICRO debug output. MDEBUG=YES
TEST	13	TEST debug flag.	Turns on TEST debug output. TDEBUG=YES
COSTS	14	COSTS debug flag.	Turns on COSTS debug output. CDEBUG=YES
AREA	15	AREA debug flag.	Turns on AREA debug output. ADEBUG=YES
CUTPTS	16	CUTPTS debug flag.	Turns on CUTPTS debug output. LDEBUG=YES
PDECAY	17	PDECAY debug flag.	Turns on PDECAY debug output. PDEBUG=YES
DATA	18	DATA debug flag.	Turns on DATA debug output. DDEBUG=YES
MDECAY	19	MDECAY debug flag.	Turns on MDECAY debug output. QDEBUG=YES
STATS	20	STATS debug flag.	Turns on STATS debug output. SDEBUG=YES
STOP	4	Indicates last case in a job.	RSTØP = YES

Table 3-1 AVAILABLE KEYWORD INPUT (con't)

KEYWORD	CODE NUMBER	DESCRIPTION	VARIABLES AFFECTED
LA	21	Los Angeles regional data flag.	RNAME=1
NY	22	New York regional data flag.	RNAME=2
WASH	23	Washington, D.C. regional data flag.	RNAME=3
DENVER	24	Denver regional data flag.	RNAME=4
DETROIT	35	Detroit regional data flag.	RNAME=5
IHC	31	Include IHC in mode emissions being tested.	LSTART=at most 1, LSTØP=at least 1. Model uses mode emission LSTART through LSTØP. See Table 4.1.1.3.
ICØ	30	Include ICØ in mode emissions being tested.	LSTART=at most 2, LSTØP=at least 2.
INØ	36	Include INØ in mode emissions being tested.	LSTART=at most 3, LSTØP=at least 3.
HC45	32	Include HC 45 in mode emissions being tested.	LSTART=at most 4, LSTØP=at least 4.
CØ45	33	Include CØ 45 in mode emissions being tested.	LSTART=at most 5, LSTØP=at least 5.
NØ45	37	Include NØ 45 in mode emissions being tested.	LSTART=at most 6, LSTØP=at least 6.

Table 3-1 AVAILABLE KEYWORD INPUT (con't.)

KEYWORD	CODE NUMBER	DESCRIPTION	VARIABLES AFFECTED
STATE	28	Flag indicating maintenance in State owned facilities.	SLANE="STATE"
GARAGE	29	Flag indicating franchised garage maintenance.	SLANE="GARAGE"
MISFIRE	34	Use misfire in simulation. (Misfire is normally not used.)	MISFIRE=YES

Figure 3-1 shows the sequential order for the Keyword card setup.

3.1.2 Namelist Data Input

Many inputs to the General Economic Effectiveness Program have numeric values and therefore do not lend themselves to a simple keyword input scheme. These parameters are specified in a namelist input data section. Table 3-2 contains a complete list of all valid namelist variables along with a description of their role in the Inspection/Maintenance model. Figure 3-2 illustrates the card order setup for the Namelist input. Section 3.2 describes the exact card formats and deck setup required for a namelist input record.

The bulk of the input data is normally invariant (e.g., influence coefficients) and accordingly resides within the program. This approach greatly simplifies the task of executing multiple computer runs and minimizes potential sources of error. A complete listing of all initial data is available through the use of the DATA option. Tables 3-3 and 3-4 have been prepared to assist the user in relating code internal numbers with input descriptions for engine parameters and mode emissions, respectively. These tables should be of specific value when attempting to introduce additional parameters and/or mode emissions.

3.2 INPUT FORMAT

Input to the General Economic Effectiveness Program is given by case. Each case, consisting of two sections, constitutes a complete inspection/maintenance program description. Keyword data input, the first section of each case, defines the inspection procedures, the inspection parameters or mode emissions, the region to be modeled and the debug options (See Table 3-1 for a complete list of keyword options). Namelist input data,

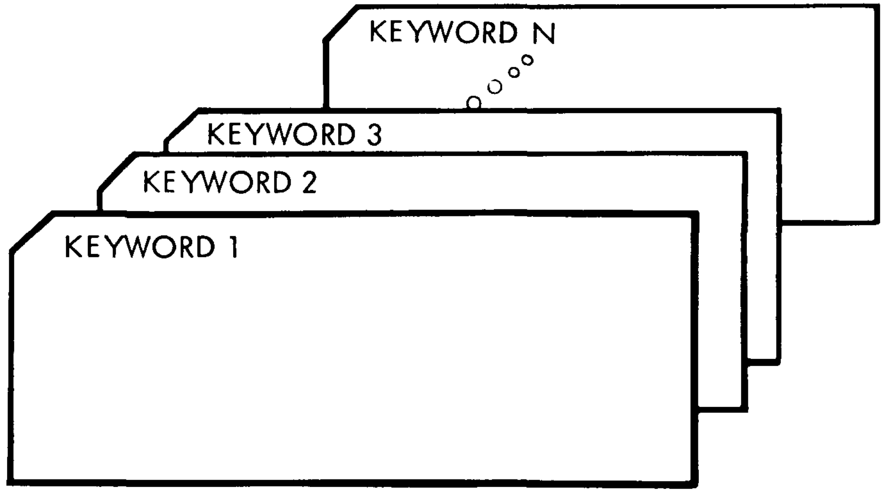


Figure 3-1   Keyword Card Order

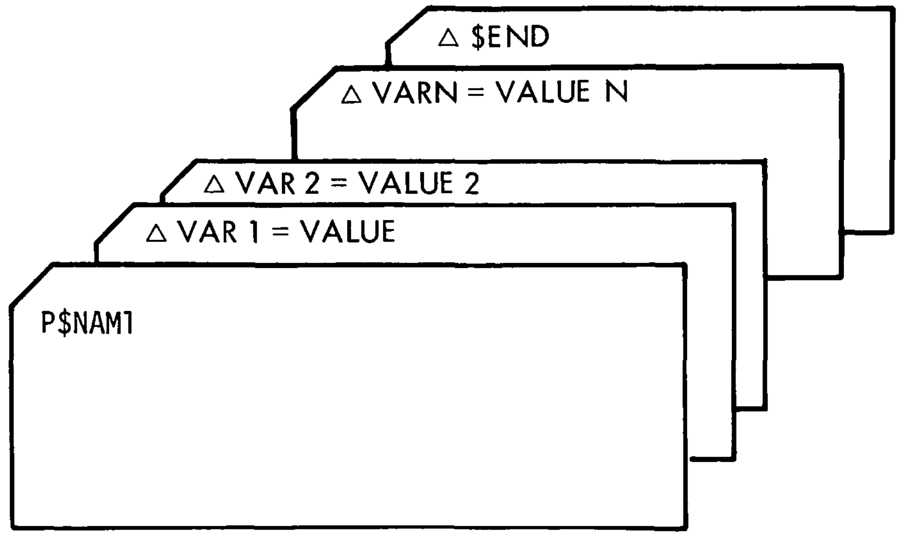


Figure 3-2 Namelist Input Card Order

Table 3-2 VALID GEEP NAMELIST VARIABLES

VARIABLE	DIMENSION	DESCRIPTION
COEFBP	10 × 15	Parameter decay rates. May be altered for sensitivity analysis.
EFF	10	Parameter maintenance efficiency for ΔE calculation.
EMW	3	Emission weighting function. Expresses relative importance of emission reductions by species.
FPERC	10 × 3	Voluntary maintenance by parameter and control type. May be altered for sensitivity analysis.
HORZN	scalar	Time horizon of I/M program in months.
LPICK	10	Array of time periods for linear programming cutpoint optimization
NPICK	10	Array of time periods for statistical analysis of results of the current time interval.
PARM	3 × 3	Emission decay rate not attributable to parameter deterioration.
PCONF	scalar	Confidence level for statistical analysis.
PI	15 × 10	Successful inspection percentage for each parameter and control-power train type.
PPICK	10	Array of time periods for plot generation under various debug options.
PSTAR	scalar	Constant rejection rate.
SCALEBM	3	Miscellaneous fudge factor input. Currently does nothing.
START	15 × 3	Initial emission rates for each species, control type and power train type. Initialized in REGION.

Table 3-2 VALID GEEP NAMELIST VARIABLES (Con't)

VARIABLE	DIMENSION	DESCRIPTION
STAT	scalar	Number of inspection stations.
SXCUT	6 × 3	Mode emission cutpoints.
TDIST	10 × 3	Parameter usage vector. Used for deleting certain parameters from consideration.
TINT	scalar	Time interval for mandatory inspection.
XCUT	10 × 3	Parameter cutpoints.
XLANE	scalar	Number of inspection lanes per station.
Z2	scalar	Mechanics hourly rate.
Z9	scalar	User inconvenience rate.
Z16	scalar	Attendant hourly rate.

Table 3-3. ENGINE PARAMETER CODE NUMBERS

Parameter Number	Subsystem	Parameter
1	Idle	Idle CØ
2	Idle	RPM
3	Idle	Timing
4	Ignition	Misfire
5	Ignition	$NØ_x$ Control
6	Induction	Air Pump
7	Induction	PCV
8	Induction	Air Cleaner
9	Induction	Vacuum Choke Kick
10	Induction	Choke Heat Riser

Table 3-4 MODE EMISSION CODE NUMBERS

MODE EMISSION NUMBER	MODE EMISSION	DESCRIPTION
1	IHC	Idle HC
2	ICØ	Idle CØ
3	INØ	Idle NO_x
4	HC 45	Cruise 45 HC
5	CØ 45	Cruise 45 CØ
6	NØ 45	Cruise 45 $NØ_x$

the second section of each case, includes specification of all numeric data for a GEEP simulation. These data include the inspection time interval, emission weighting factors, cutpoints for parameter and mode emission inspections, and miscellaneous cost data.

Keyword data is specified by listing one keyword per card starting in card column 1. Only the first ten characters of the data card are read, and therefore columns 11 through 80 are available for comments or case descriptions. The order of the keyword cards is insignificant as the model treats each entry separately, setting the appropriate parameters depending on the keyword. An invalid entry, that is, one which does not apppear in the OPTS array, is flagged and printed out along with a non-fatal error message. At the end of each case the keyword "THAT'S ALL" signals an end of section one data for the case being processed. A "STOP" keyword input, anywhere in a case, signals that the case being processed is the last one in the data deck.

Namelist input data, Section 2, is more strictly formatted than the keyword input, The card following the "THAT'S ALL" end of keyword data flag, must be a P$NAM1 card starting in column 1. Following this card are the actual input data starting in card column 2. Possible variable input formats are described in Table 3-5. Each variable name must be a valid namelist NAM1 variable and must not start in column 1. The end of all namelist parameters is indicated by a $END card in card column 2. Following the $END card would be the first keyword input of the next case or a $\begin{pmatrix}7\\8\\9\end{pmatrix}$ EOR (END OF RECORD) card if this was the last case.

Table 3-5. POSSIBLE NAMELIST VARIABLE FORMATS

- SCALAR INPUT

$\begin{pmatrix} c \\ c \\ 2 \end{pmatrix}$ $\qquad\qquad$ $\begin{pmatrix} c \\ c \\ 2 \end{pmatrix}$ = card column 2

VARNAME = value

- ARRAY INPUT - SINGLE CELL

$\begin{pmatrix} c \\ c \\ 2 \end{pmatrix}$

VARNAME (index) = value

- ARRAY INPUT - MULTICELL STARTING AT BEGINNING OF ARRAY

VARNAME = value, value, value, value, ..., value

- ARRAY INPUT - MULTICELL STARTING AT ARBITRARY CELL

VARNAME (index) = value, value, value, value, ..., value

NOTE

Matrix input is by columns.

Example:

If A is dimensioned 3 × 2, then the order of input should be

$A = A_{11}, A_{21}, A_{31}, A_{12}, A_{22}, A_{32}$

Appendix B contains several complete sample cases, including listings of the input setup as well as produced output. Section 4.0 describes the operating procedures for running GEEP including all control cards required in the control card deck.

3.3 OUTPUT SPECIFICATIONS AND OPTIONS

GEEP has been designed to provide a wealth of information on the calculated emission reductions and associated costs of each inspection/maintenance program. Table 3-6 summarizes the basic output options.

The program also generates the following ancillary information:

1) Mass emission time histories.
   - Aggregated
   - Control type
   - Power train
2) Vehicle population distributions and attrition rates over time.
3) Summary of input data.
4) Engine parameter and mode emission distribution plots and statistics.
5) Pass/fail criteria and vehicle rejection probabilities by year.
6) Engine parameter rejection rates and average parameter adjustments.
7) Summary of regional and operational design results.
8) Statistical confidence limits on predicted emission reductions.

A debug option has been incorporated into each major system routine to assist in interpreting program output and in checking out new policy alternatives. This option yields a complete diagnostic analysis on all fundamental calculations within the model.

Printed and plotted output from GEEP are designed to display to the user a maximum amount of information. Output from the program consists of three types: standard output, debug output and plots. The standard output includes emission rates, reduction percentages, figures of merit, and cost data. The debug printout is generally in the form of tables presenting the values of intermediate variables in the model's calculations. Plotted output consists of parameter frequency plots and emission time history plots.

Table 3-7 exhibits a printout summary of typical results. This printout features estimates for several figures of merit, computed emission reductions, and a variety of accounting costs. Additional examples of GEEP output are found in Appendix B.

Table 3-6 SUMMARY OUTPUT OPTIONS

OPTION	INPUTS	RESULTING OUTPUT
• BASIC	None	• Summary Results
		• Emission Time History Plots
		• Vehicle Population Characteristics
		• Regional Data Summary
		• STATS Results (if executed)
		• CUTPOINT Data
		• Emission Rate and Failure Rate Tables
• PPICK	PPICK	• Engine Parameter Distribution Plots
• DEBUG	BLINE	• Debug information for Subroutine BLINE
	MICRO	• Debug information for Subroutine MICRO
	TEST	• Debug information for Subroutine TEST
	COSTS	• Debug information for Subroutine COSTS
	AREA	• Debug information for Function AREA
	CUTPTS	• Debug information for Subroutine CUTPTS
	PDECAY	• Debug information for Subroutine PDECAY
	DATA	• Debug information for DATA BLOCK
	STATS	• Debug information for Subroutine STATS

Table 3-7 SUMMARY OUTPUT RESULTS

```
*********************************
*    TRW INSPECTION/MAINTENANCE  *
*          SYSTEM MODEL          *
*********************************
```

SUMMARY INFORMATION

ENGINE PARAMETER STRATEGY EXTENSIVE B
INSPECTION PERIOD IS 12.0 MONTHS

PAYOFF FUNCTION UNADJUSTED (DOLLARS/WEIGHTED EMISSION)	5736.21
PAYOFF FUNCTION STATISTICALLY ADJUSTED (DOLLARS/WEIGHTED EMISSION)	4412.06
PAYOFF FUNCTION AT END OF LAST YEAR (DOLLARS/WEIGHTED EMISSION)	2736.02
HC EMISSION REDUCTION (PERCENT)	4.73
CO EMISSION REDUCTION (PERCENT)	4.08
NO EMISSION REDUCTION (PERCENT)	1.50
HC AVERAGE EMISSIONS (TONS/DAY)	1052.04
CO AVERAGE EMISSIONS (TONS/DAY)	13126.92
NO AVERAGE EMISSIONS (TONS/DAY)	728.26
TOTAL COSTS FOR MANDATORY PROGRAM (DOLLARS/YEAR)	187961701.45
TOTAL COSTS FOR VOLUNTARY PROGRAM (DOLLARS/YEAR)	237764666.67
RATIO OF MANDATORY TO VOLUNTARY COSTS (PERCENT)	79.05
INSPECTION CAPITAL COSTS (DOLLARS/STATION)	0.00
AVERAGE INSPECTION OPERATING COSTS (DOLLARS/YEAR)	76700284.45
MAINTENANCE CAPITAL COSTS (DOLLARS)	0.00
AVERAGE MAINTENANCE OPERATING COSTS (DOLLARS/YEAR)	111261417.00
USER COSTS (DOLLARS/CAR)	1.93
COST PER INSPECTION	31.46
COST PER VEHICLE MAINTAINED	34.25
AVERAGE NUMBER OF CARS INSPECTED/YEAR	5974450.00
AVERAGE NUMBER OF CARS REJECTED/YEAR	5196615.51
AVERAGE NUMBER OF CARS MAINTAINED/YEAR	5196615.51
AVERAGE FAILURE PERCENTAGE	.87
TOTAL PROGRAM DURATION (YEARS)	5.00

4.0 OPERATING PROCEDURES

4.1 THE PROGRAMMING SYSTEM

The General Economic Effectiveness Program is a Fortran IV program operational on the Control Data (CDC) 6000 series computers. The CDC machines are third generation multiprogrammable computers capable of processing approximately 1,000,000 instructions per second with up to 19 different jobs concurrently running in central memory. The TRW Time Sharing System (TRW/TSS) uses a CDC 6400-6500 combination with intercommunication between user disk files and the three CPU's with Batch and Remote Batch capabilities. The combined storage space on the two machines is in excess of $660{,}000_8$ words (60 bit) central memory and 800 million words on disk.

The GEEP source and object decks reside on the permanent file storage disk of the TRW/TSS. As a file on this disk they are accessible in either Remote or Remote Batch mode. Since the control cards and deck setup are essentially identical, a Remote mode submittion will be assumed in the following discussions.

4.2 CONTROL CARD SPECIFICATION

The TRW/TSS CDC machines run under the KRONOS operating system, the control cards of which are simple and self explanatory. Table 4-1 details the job control cards and contains a short explanation of each card. This control card setup assumes an object deck run.

4.3 DECK SETUP

The input deck setup required for the execution of the program consists of the job control cards (JCC), the program deck and the data

Table 4-1 REQUIRED JOB CONTROL CARDS

CARD	DESCRIPTION
$ SEQUENCE, E284.	Operator supplied sequence card
$ ACCOUNT, RB56415, ROBE564.	Program account and password
$ NAME, 142001, 56415, BADDORF, R.	User Name card
$ PROBLEM, 289010.	Charge number
$ PRIORITY, N.	Nominal Priority
$ FLENGTH, 150000.	150_8K Field length request
$ MAXTIM, 300.	5 minute max/time request
GET, GEEP.	Retrieve object deck
GEEP (TAPE 5=INPUT)	Execute Program (Data Follows)
$\begin{pmatrix}7\\8\\9\end{pmatrix}$ EØR	End of Record card.

cards set. Figure 4-1 illustrates the deck setup for a standard run. This example demonstrates the card setup for executing several cases during the same run.

4.4 DIAGNOSTIC AND TROUBLESHOOTING PROCEDURES

Basically, three types of errors can occur during a GEEP run: program detected errors, system detected error, and the elusive computer error. The last is a very rare, non-recoverable problem which can be solved by resubmitting either the entire run or just those cases not yet executed. Program detected errors are those inconsistancies which trigger an error branch in the GEEP code. These include input errors detected by the check routine in the main program. The diagnostics are self explanatory, and the problems are generally not fatal to the execution of a case. The linear programming package for cutpoint optimization is the second routine containing program data error flags. The diagnostic messages possible are listed in Table 4-2 with a description of the problem and the solution.

The other common diagnostic message results from a system detected error. These errors include dividing by zero, square roots of negative numbers, and raising negative numbers to non-integer powers. These occur most often in the routines which interpolate or manipulate distributions and are usually the result of bad input. A description of the various possible diagnostic messages can be found in Appendix K of the CDC Fortran Manual. The load map can be used with the help of a GEEP listing to pinpoint the location and exact nature of the data discrepancy. But probably the most likely system detected error will be associated with the NAMELIST input data.

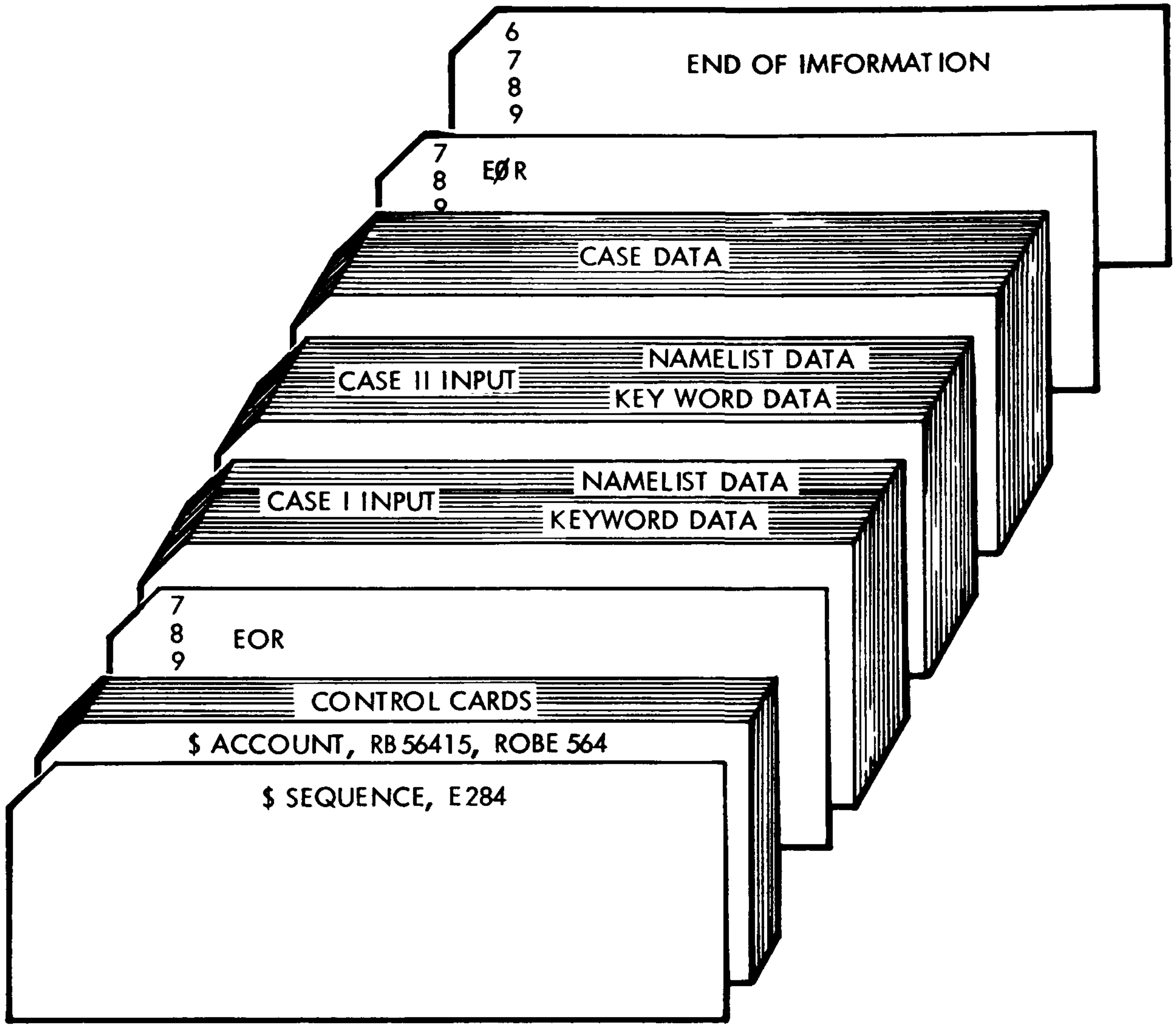


Figure 4-1 Example Card Configuration for Object Deck Run

Table 4-2 DIAGNOSTIC MESSAGES

DIAGNOSTIC MESSAGE	MEANING AND SOLUTION
A MATCH WAS NOT FOUND FOR XXXXXXX	The key word input XXXXXXX is either misspelled or not a valid GEEP option. The program ignores that card.
TOO MANY ITERATIONS IN LINPRO	The iteration loop to match cutpoints with rejected fractions is not converging. Change the emission reduction constraints a few percent to move the problem away from the unstable point. Fatal error.
NO FEASIBLE SOLUTION LOWERING CONSTRAINTS	The linear program has no feasible solution The constraints are being lowered automatically by 10%. Program will continue until the constraints have been reduced by 70% at which point the case aborts.
SOLUTION UNBOUNDED - RUN TERMINATED	LPRO error message. Treated as no feasible solution.
TOO MANY ITERATIONS - RUN TERMINATED	LPRO error message. Treated as no feasible solution.
PROBLEM INFEASIBLE - RUN TERMINATED	LPRO error message. Treated as no feasible solution.
INSUFFICIENT DIMENSTION IN XPT CALLED STATS	More than 50 points required to characterize a distribution. Contact programmer. Fatal error.
INSUFFICIENT DIMENSTION SIZE IN RESIZE CALLED FROM CONVOL	More than 50 points required to characterize a distribution. Contact programmer. Fatal error.

In attempting to understand any problem with the processor, the debug flags for the affected routines should be activated (See Table 3-1).

4.5 LIBRARY ROUTINES REQUIRED

The GEEP computer program uses several standard Fortran functions from the CDC system library. These routines, with a brief description of each are tabulated in Table 4-3. If an error should occur within one of the library programs the system back-track printout will locate the calling subroutine for debugging purposes.

4.6 GENERAL COMPUTER REQUIREMENTS

Although GEEP was designed for the use on the CDC 6500 system it can be made to operate on other computing systems. Listed below are minimum requirements, both Hardware and Software, for possible conversion to an alternative system.

- Software support of Fortran IV (Fortran G).
- Computing Hardware equivalent to a CDC 6400 with at least 200,000 words of core storage (2 million bytes).
- A full operating system capable of supporting the above hardware system.
- A card reader/punch and high-speed line printer.

4.7 EXECUTION/PRINT ESTIMATES

The execution time, required field length, and number of pages printed by GEEP depend entirely on the number of cases and debug options chosen. Estimates for these figures appear in Table 4-4. It should be noted that, for a standard run, no compilation time or print-out is necessary. These values are all estimates and vary according to desired option.

Table 4-3 SYSTEM LIBRARY FUNCTIONS CALLED BY GEEP

FUNCTION	DESCRIPTION
SQRT (X)	Square root of X
MINO (I,J)	Minimum of I and J
MAXO (I,J)	Maximum of I and J
EXP (X)	e^X
ALØG (X)	lnx
AMIN1 (X,Y)	Minimum of X and Y
AMAX1 (X,Y)	Maximum of X and Y
ABS (X)	Absolute value of X
IABS (I)	Absolute value of I
INT (X)	Largest integer less than X

Table 4-4 EXECUTION/PRINT ESTIMATES

Compilation of GEEP processor:	200 seconds CPU time 110000_8 Words Storage 250 Pages (10000 lines) output
One Case - No debug output:	30 seconds CPU time 171000_8 Words Storage 20 Pages (600 lines) output
One Case - PDECAY debug:	30 seconds CPU time 171000_8 Words Storage 150 Pages (5000 lines) output
One Case - Full debug:	35 seconds CPU time 171000_8 Words Storage 250 Pages (10000 lines) output

4.8 PROGRAM LIMITATIONS

The program is basically limited in terms of the programmed inspection/maintenance alternatives. The most important of these is the input inspection type and control fleet specification limitation. The GEEP computer program expects as input a series of inspection specifications such as idle, ignition and induction which are consecutive in the parameters affected. For instance, acceptable inspection type specifications include IDLE-IGNITION, IGNITION-INDUCTION, IDLE, IDLE-IGNITION-INDUCTION. The only non-permissible combination is IDLE-INDUCTION which would involve the inspection of parameters one through three and six through ten, a non-connected set. The same principle applies to the control subfleet specification limitation which states that any combination of control fleets except the UNCONTROLED-POST 70 combination is acceptable.

The only other program limitations on the program are obvious constraints on the input data such as $0 \leq P^* \leq 1$. There are no limits on the number of cases. The amount of printed output is currently limited to 200,000 lines.

5.0 DETAILED FLOW SCHEMATICS

Presented in the following sections are descriptions, detailed flowcharts and computer listings of each of the fifty-five subroutines in GEEP. Each contains a description of the input variables and output results. Also included are brief summaries of the main equations and techniques for the routine.

This section has been prepared primarily for use by FORTRAN programmers in adopting or modifying the program's structure. Therefore, heavy emphasis is placed on the flowcharts and listings with only cursory descriptions of analytical techniques or data values, details of which are available in Volume III. The user is refered to Table 5.0 which provides a descriptive overview of the program's subroutines.

5.1 MAIN PROGRAM

The main routine of the General Economic Effectiveness Program contains the overall logic for evaluating a mandatory vehicle inspection/maintenance program. The basic input is read and decoded in the main routine, which then intiates the flow through the major routines of GEEP. The following sections contain complete descriptions of each GEEP routine which explain both the input and output as well as the execution flow paths.

Table 5-1 contains a listing of the main routine and Figure 5-1 a flowchart.

5.2 SUBROUTINE INITIAL

Subroutine INITIAL of the General Economic Effectiveness Program initializes various parameters and averages several large input matrices

Table 5-0 SUMMARY LEVEL SUBROUTINE DESCRIPTIONS

LEVEL 1

Name	Description
GEEP	The executive program; provides main linkage for major component subroutines.

LEVEL 2

Subroutine Name	Description
REGION	Supplies region data (location, size, population, emission levels, etc.) for a specific demographic region.
INITIAL	Initializes program variables. Certain variables change throughout the program execution but must be re-initialized at the start of each run. Also pertinent arrays are filled or "zeroed out."
BLINE	The emission study for the baseline fleet is performed at this time. Strictly voluntary maintenance.
MICRO	The emission study for the test fleet is controlled here. Mandatory inspections and maintenances.
COSTS	The program costs are calculated for parts, labor, land, etc.
OUT	The output of the entire program summaries (emission histories, rejection histories, percentage emission reductions, etc.).

Table 5-0 SUMMARY LEVEL SUBROUTINE DESCRIPTIONS (cont.)

LEVEL 3

Subroutine Name	Description
PRINT 1	Output of the argument variable with the dimension size of (10, 15, 3).
PRINT 2	Output of the argument variable with the dimension size of (15, 3).
PRINT 3	Output of the argument variable with the dimension size of (10, 15).
PRINT 4	Output of the argument variable with the dimension size of (10, 15, 4).
PRINT 5	Output of the argument variable with the dimension size of (4, 15).
FIT	Each emission history must be represented in terms of a polynomial for integration purposes. This subroutine is a 2nd order curve fit.
FUN 1	A single table linear interpolation, with extrapolation beyond end points.
PDECAY	Particular parameter distributions must undergo specific decay processes between inspection periods.
MDECAY	Similar to PDECAY, particular mode distributions undergo decay.
EDECAY	Similar to PDECAY, emission levels are decayed.
TEST	This subroutine controls the estimations of that portion of a specific parameter or mode distribution that is rejected; i.e., that portion of the distribution which exceeds the allowable emission standards.
MAINT	Emission levels must be corrected for maintenance due to both the baseline and the test programs.
STATS	At the conclusion of any test interval, a statistical analysis may be performed on the baseline vs test program reductions.

Table 5-0 SUMMARY LEVEL SUBROUTINE DESCRIPTIONS (cont.)

Subroutine Name	Description
PLOT	Provides a graphical plot of the emission histories.
QUEUE	Provides a queue model for user inconvenience estimations.

LEVEL 4

Name		Description
STD 2		Using a frequency distribution, calculates the corresponding mean and sigma.
AREA	(XOPT = 0)	Estimates the normalized area of a parameter distribution, nominally from the end point to the cutpoint.
	(XOPT = 1)	Returns the expected value of the rejected portion of the distribution. $\int xf(x)dx$ = expected value
UNION		Provides the union of n number of probabilities; namely, the rejection fractions.
TABLE		Generates a frequency distribution (table) from a representative mean and sigma. Generates: (1) Normal (2) Lognormal (3) Hyperbolic
CONVOL		Generates the convolution of two distributions: $C = \int_{\infty}^{\infty} f(t)\ g\ (x-t)\ dt$ e.g., for two standard normal distributions; $\mu_1 = \mu_2 = 0.\quad \sigma_1 = \sigma_2 = 1.\quad \mu_c = \mu_1 + \mu_2$ $\sigma_c = \sqrt{\sigma_1^2 + \sigma_2^2}$

Table 5-0 SUMMARY LEVEL SUBROUTINE DESCRIPTIONS (cont.)

Subroutine Name	Description
DISTPR	Used in conjunction with CONVOL. Outputs the two input distributions along with the resultant distribution with their respective means and sigmas.
NORM	Normalizes a distribution so that $\int f(x)\,dx = 1$
XPT	Given a distribution and an area, integrates until the input area is achieved and outputs the respective X-axis coordinate.
PLOTXY	Supports subroutine plot by outputting the actual grid pattern.
IFACT	Calculates N factorial for integer N.

LEVEL 5

Name	Description
SWITCH	For most purposes, a representative distribution's X-axis must be monotonically increasing. If not, the order of the X-axis values along with their respective Y values are reordered.
RESIZE	Given a distribution and a cell width, ΔX, a new array, is generated to represent the input distribution as a function of the new ΔX.

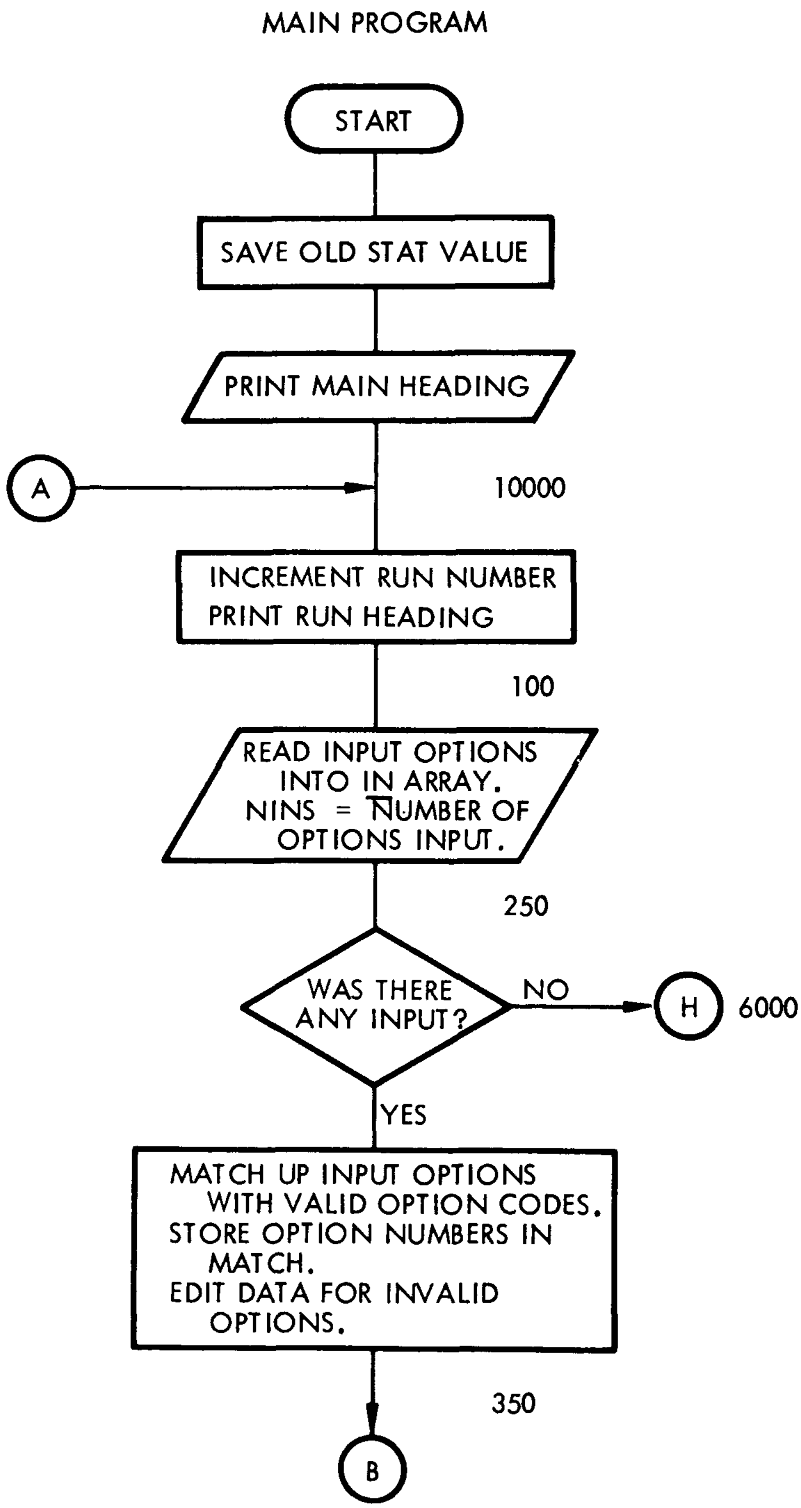


Figure 5-1 Main Program Flowchart

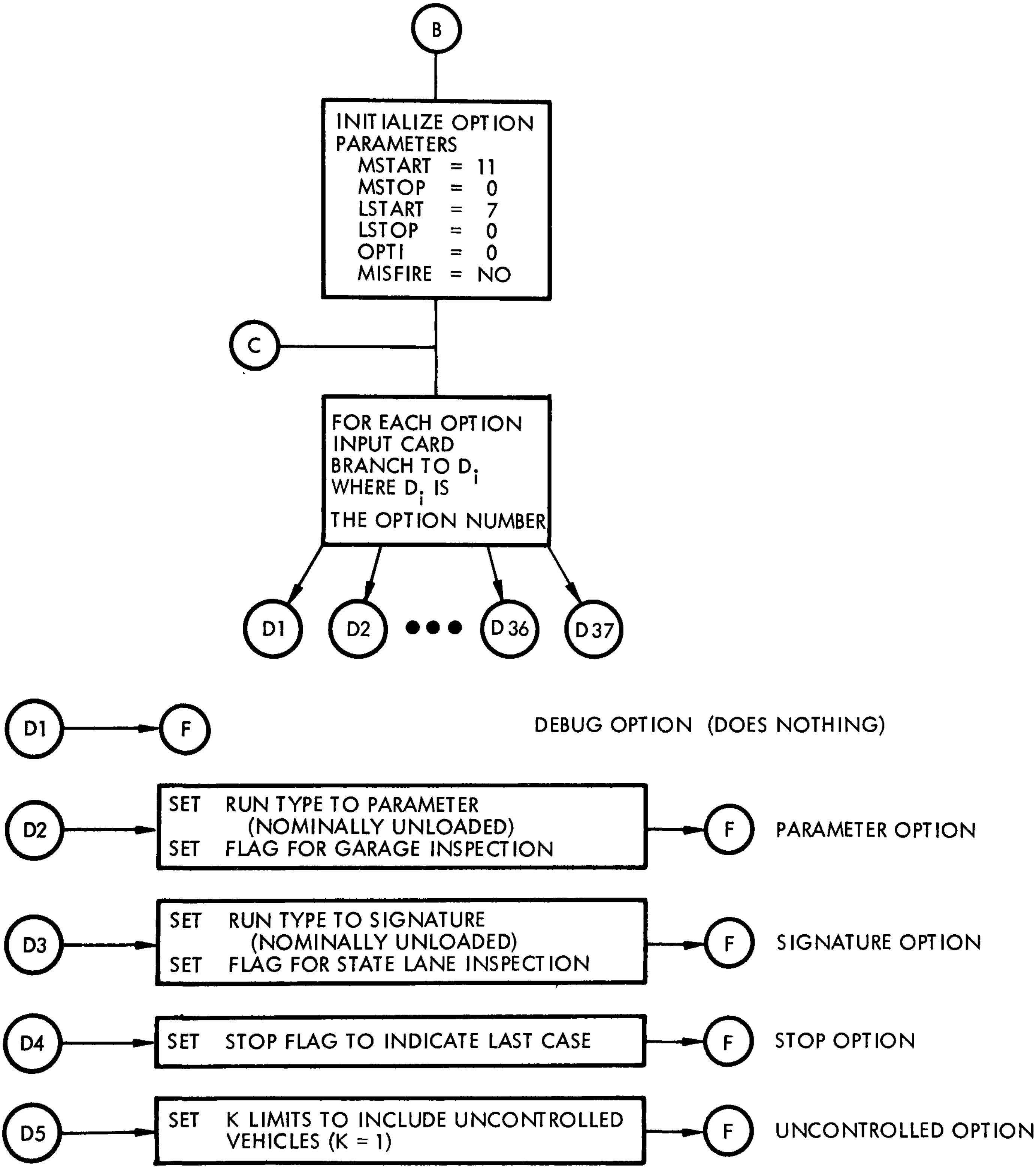


Figure 5-1 Main Program Flowchart (cont.)

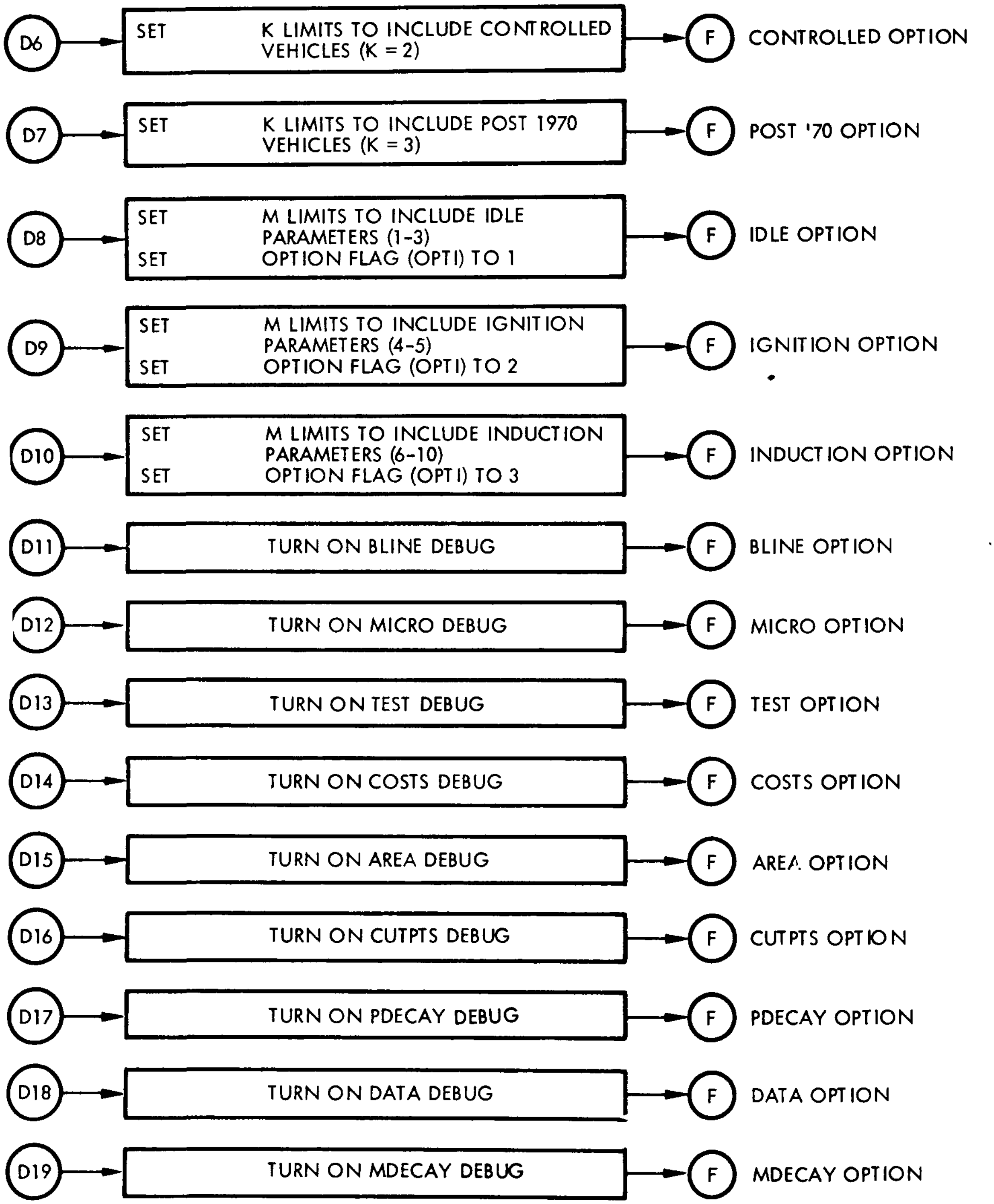


Figure 5-1 Main Program Flowchart (cont.)

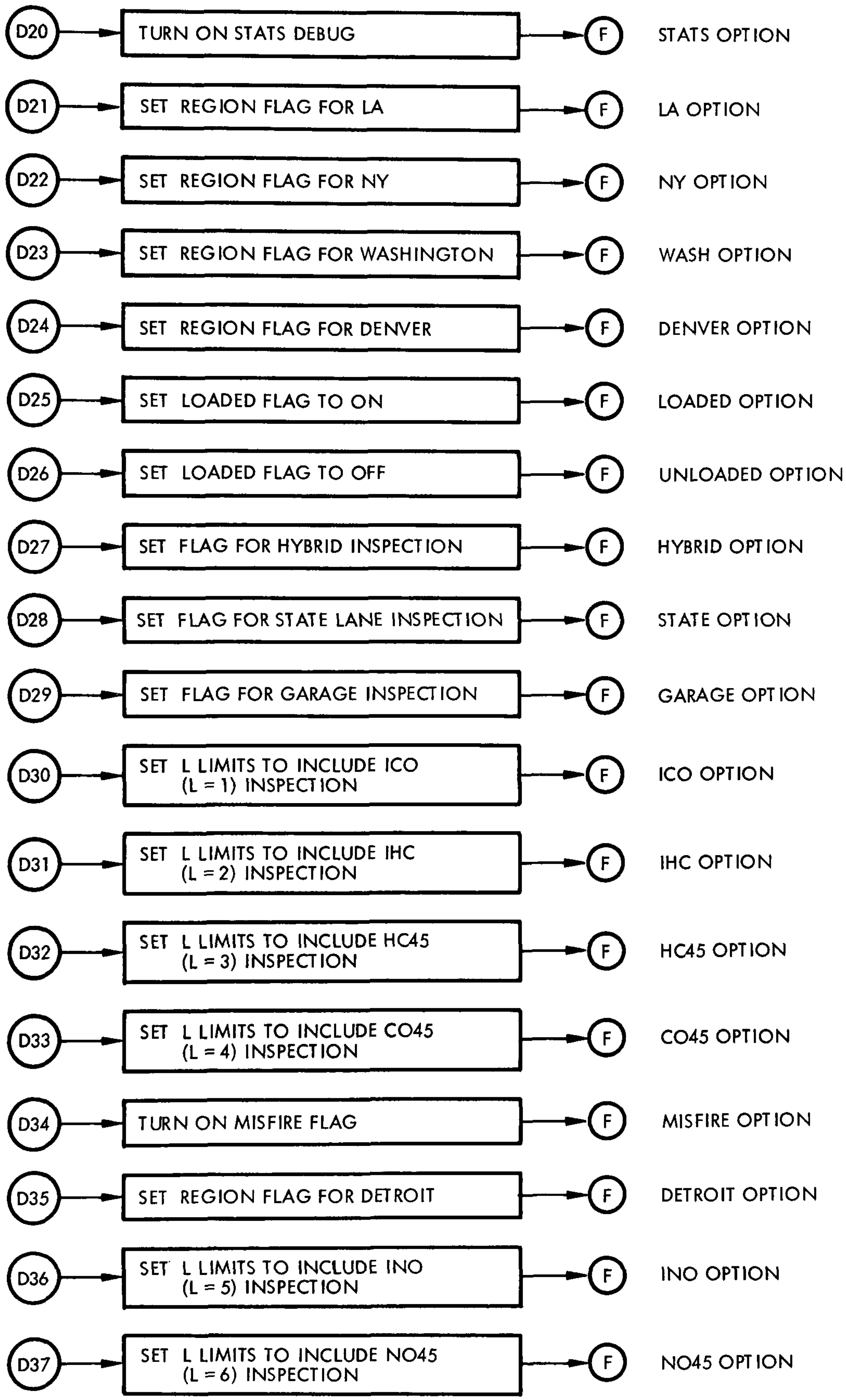


Figure 5-1 Main Program Flowchart (cont.)

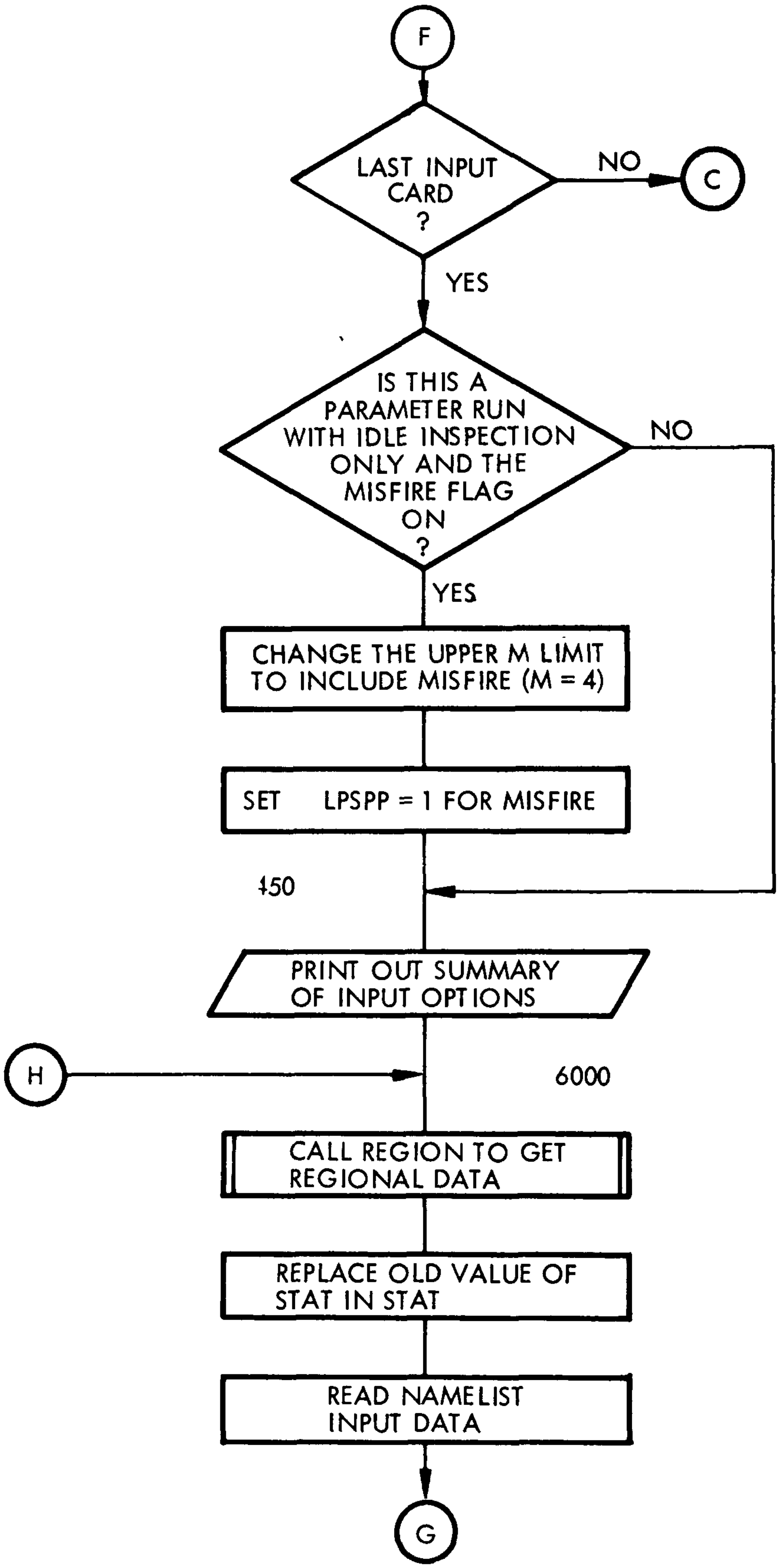


Figure 5-1 Main Program Flowchart (cont.)

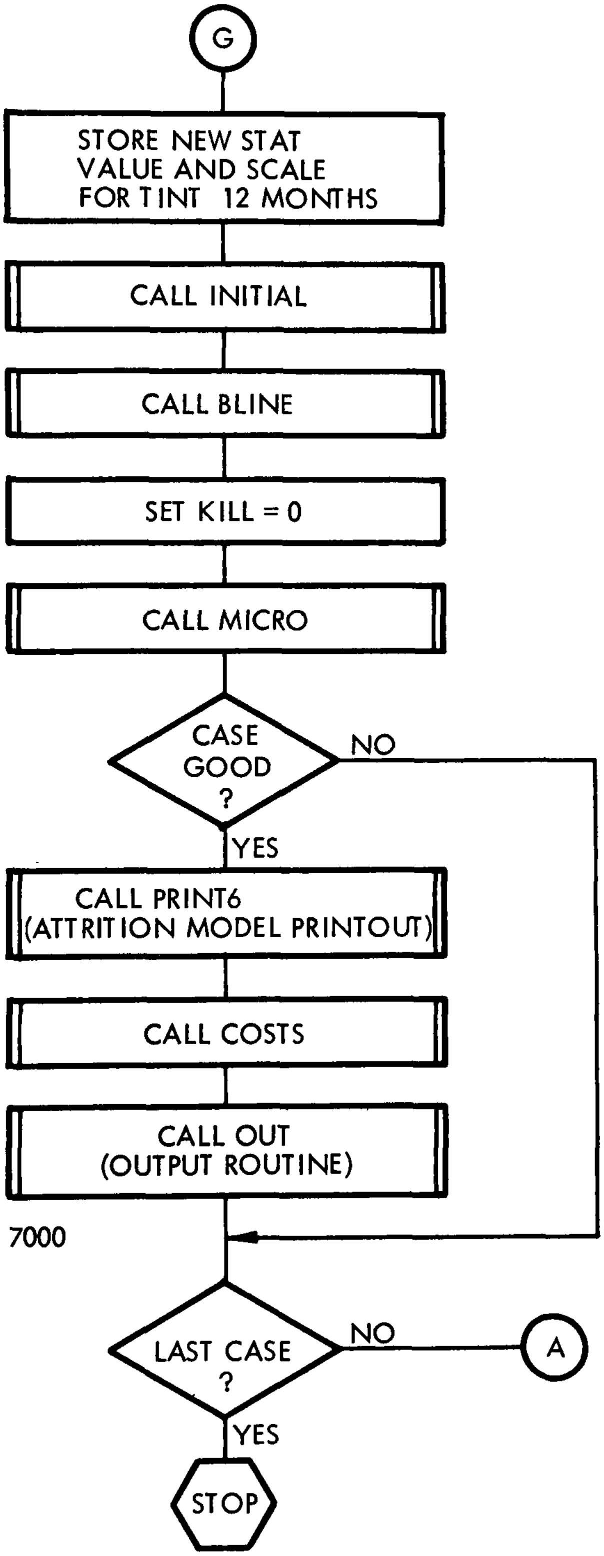


Figure 5-1 Main Program Flowchart (cont.)

Table 5-1 MAIN PROGRAM LISTING

```
      PROGRAM GX(INPUT,OUTPUT,TAPE5,TAPE6=OUTPUT)
C     ECONOMIC/EFFECTIVENESS PROCESSOR
      DIMENSION IN(50),MATCH(50)
       COMMON /COM01/ AMB(3),ALAB,     AVV,  BINT,
     +    BAREA(3), BLD1,      BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/          CARA,     CARIY,    CARMY,    CARPOP(16),
     +    CARSY,    CBSUM,     CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +    CINCON,   CPCB,  CPI,     CPVPY,    CSUM,      CARAY,
     +    CN(15,3,16),         COEFB(15,3),        COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
       COMMON /COM03/          DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),      EP(10,15),EFF(10),  DELIT(3),
     +    FREQA,    FREQB,     FPERC(10,3),
     +    HORZN,    HORZNY,
     +    HPC(15,16),          HPCS(15,16),        HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),          HPTOT(16),
     +    HPTOTS(16)
CC ADD3
       COMMON /COM04/          ITE,      ITL,      ITP,      ITIME(16),
     +    KSTART,   KSTOP,     LOPT, LPICK(10),LLPICK,
     +    LIDLE,    LINT(16),  LPSPP(10),LSTART,   LSTOP,
     +    MBASE,    MPH,       MSPEC(10),MSTART,   MSTOP,
     +    MU(10,3),   MMS(10,15),          MVPR(10,15)
CC ADD4
       COMMON /COM05/          NAME(50), NCNTR,    NEMIS,    NEMP,
     +    NINTR,    NINTRB,    NMODE,    NO,       NOPTS,    NPAR,
     +    NPTRN,    NPTS,      NSTEPS,   NTR,      NTRB,     NPICK(16),
     +    OCIY,     OCMY,      OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/          PARM(3,3),PART,   PAYNEW,   PAYOFF(3),
     +    PC(15),   PCS(15),   PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15),  PT(5),    PTOT,     PTS(5),  PAYADJ,
     +    PAR(10,15,3),        PAR1(10,3,3),       PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),  PTA(5),    PCONF,    PARINT(10,10,9)
     + ,PAYFIN
       COMMON /COM07/          REINSP,   RNAME,    RSIZE,    RSTOP,
     +    RTYPE,
```

Table 5-1 MAIN PROGRAM LISTING (cont.)

```
                 +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
                 +    SMODEL,   START(15,3), STAT,     STIME(3), SUMBM(3),
                 +    SCALEBM(3),         SM(6,15),           SPAR(10,15,6),
                 +    SXCUT(6,3),         SIG(10,3),            SIGCE(3),
                 +    SIGME(10),          SIGMNE(10),         SIGP(10,15),
                 +    SIGRATE,  SIST,      SIGS(6,15),          SIGSDE(3),
                 +    STABLEX(33,6,15),    STABLEY(33,6,15)
                 COMMON /COM10/           TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
                 +    TINT,     TObE(3),  TONX,     TOTE(3),  TPDB(3),  TPDT(3),
                 +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
                 +    THIST(5,3,16),      THISTT(3,16),       TIMEC(10,15),
                 +    TIMEM(10,15),       TABLEX(33,10,15),    TABLEY(33,10,15)
          CC ADD10
                 COMMON /COM11/           WF(10),
                 +    X1BP(3,3,6), XINT,     XINTB,    XLANE,    XSUM, XCUT(10,3),
                 +    XTM(16),  XBASE(9,3),YBASE(9,3)
          CC ADD11
                 COMMON /COM12/           Y1BP(3,3,10),       Y2BP(3,3,10),
                 +    YES,      YSUM,     YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
                 +    Z1,       Z2,       Z3,       Z4,       Z5,       Z6,
                 +    Z7,       Z8,       Z9,       Z10,      Z11,      Z12,
                 +    Z13,      Z14,      Z15,      Z16,      Z17,
                 +    ZCARI,    ZCARM,    ZIC,      ZSUM,
                 +    ZZ(3,3)
          CC ADD12
                 COMMON /DEBUG/           ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
                 +    LDEBUG,   MDEBUG,   PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
          CC ADDD
                 REAL           ITE,      ITL,      ITP,      ITIME,
                 +    MMS,      MPH,      MSPEC,    MU,       MVPR,
                 +    NAME,     NO,       LDEBUG,   MDEBUG,
                 +    IN,       MISFIRE
                 INTEGER        RNAME,    SITEI,    SITEM,    STAT,
                 +    TDIST,    XLANE,    OPTI,     PPICK,    PPPICK
                NAMELIST /NAM1/ XCUT,COEFBP,EMW,TINT,BMMI,START,HORZN,
                + SCALEBM,MMS,SXCUT,Z2,Z9,Z16,STAT,XLANE,NPICK,PCONF,EFF,FPERC,
                + PARM,TDIST ,LPICK,PPICK,PI,PSTAR
                DATA KSTART,KSTOP/4,0/
                STATSV=STAT
                  NRUN=0
                CALL GEEPER
          10000 CONTINUE
```

```
          NRUN=NRUN+1
          WRITE (6,190) NRUN
      190 FORMAT(1H1,5(/),25X,*GENERALIZED ECONOMIC EFFECTIVENESS*,
         + * PROGRAM*,////
         1 40X,*R U N  N O .*I3/)
CC        INPUT OF PROGRAM OPTIONS
          NINS=1
      100 READ (5,200) IN(NINS)
      200 FORMAT(A10)
          IF(IN(NINS).EQ.10HTHAT S ALL) GO TO 250
          NINS=NINS+1
          GO TO 100
      250 CONTINUE
          NINS=NINS-1
          IF(NINS.EQ.0) GO TO 6000
          DO 350 I=1,NINS
          MATCH(I)=1
          DO 300 J=1,NOPTS
          IF(IN(I).NE.OPTS(J)) GO TO 300
          MATCH(I)=J
          GO TO 350
      300 CONTINUE
          IF(I.EQ.NINS) GO TO 350
          WRITE (6,310) IN(I)
      310 FORMAT(5X,5(1H*),* A MATCH WAS NOT FOUND FOR*,
         + * THE INPUT *,A10/)
      350 CONTINUE
          MSTART=11
          MSTOP=0
          LSTART=7
          LSTOP=0
          OPTI=0
          MISFIRE=NO
CC        DATA INITIALIZATION FOR PROGRAM OPTIONS
          DO 400 I=1,NINS
          IGO=MATCH(I)
          GO TO (400,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,
         + 20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37),IGO
        2 RTYPE=PMODEL
          LIDLE=1
          SLANE=10HGARAGE
          GO TO 400
```

Table 5-1 MAIN PROGRAM LISTING (cont.)

```
    3 RTYPE=SMODEL
      LIDLE=1
      SLANE=10HSTATE
      GO TO 400
    4 RSTOP=YES
      GO TO 400
    5 KSTART=1
      KSTOP=MAX0(KSTOP,1)
      GO TO 400
    6 KSTART=MIN0(KSTART,2)
      KSTOP=MAX0(KSTOP,2)
      GO TO 400
    7 KSTART=MIN0(KSTART,3)
      KSTOP=3
      GO TO 400
    8 MSTART=1
      MSTOP=MAX0(MSTOP,3)
      OPTI=MAX0(1,OPTI)
      GO TO 400
    9 MSTART=MIN0(MSTART,4)
      MSTOP=MAX0(MSTOP,5)
      OPTI=MAX0(2,OPTI)
      GO TO 400
   10 MSTART=MIN0(MSTART,6)
       MSTOP=10
      OPTI=MAX0(3,OPTI)
      GO TO 400
   11 BDEBUG=YES
      GO TO 400
   12 MDEBUG=YES
      GO TO 400
   13 TDEBUG=YES
      GO TO 400
   14 CDEBUG=YES
      GO TO 400
   15 ADEBUG=YES
      GO TO 400
   16 LDEBUG=YES
      GO TO 400
   17 PDEBUG=YES
      GO TO 400
   18 DDEBUG=YES
```

Table 5-1 MAIN PROGRAM LISTING (cont.)

```
   GO TO 400
19 QDEBUG=YES
   GO TO 400
20 SDEBUG=YES
   GO TO 400
21 RNAME=1
   GO TO 400
22 RNAME=2
   GO TO 400
23 RNAME=3
   GO TO 400
24 RNAME=4
   GO TO 400
25 LIDLE=2
   GO TO 400
26 LIDLE=1
   GO TO 400
27 LIDLE=3
   GO TO 400
28 SLANE=10HSTATE
   GO TO 400
29 SLANE=10HGARAGE
   GO TO 400
30 LSTART=1
   LSTOP=MAX0(1,LSTOP)
   GO TO 8
31 LSTART=MIN0(2,LSTART)
   LSTOP=MAX0(2,LSTOP)
   GO TO 8
32 LSTART=MIN0(3,LSTART)
   LSTOP=MAX0(3,LSTOP)
   GO TO 9
33 LSTART=MIN0(LSTART,4)
   LSTOP=MAX0(LSTOP,4)
   GO TO 10
34 MISFIRE=YES
   GO TO 400
35 RNAME=5
   GO TO 400
36 LSTART=MIN0(LSTART,5)
   LSTOP=MAX0(LSTOP,5)
   GOTO 400
```

Table 5-1 MAIN PROGRAM LISTING (cont.)

```
   37   LSTART=MINO(LSTART,6)
        LSTOP=6
        GOTO 400
  400   CONTINUE
        IF(RTYPE.EQ.PMODEL) GO TO 450
        IF(MSTOP.NE.3) GO TO  450
        IF(MISFIRE.EQ.NO) GO TO 450
        MSTOP=4
        LPSPP(4)=1
  450   CONTINUE
        WRITE (6,500) (IN(I),I=1,NINS)
  500   FORMAT(5(/),20X,*INPUTS ARE:*//30(21X,A10/))
        NN=2*RNAME-1
        WRITE (6,1000) RTYPE,NAME(NN+20),NAME(NN+21),
      + (NAME(K+3),K=KSTART,KSTOP)
 1000   FORMAT(1H1,//,5X,*RUN TYPE -- *,T50,A10,* MODEL*,/
      + 5X,*AREA CONSIDERED -- *,T50,2A10/
      + 5X,*CAR POPULATION TYPE -- *,3(T49,A8/))
        WRITE (6,1100) (M,NAME(M+30),M=MSTART,MSTOP)
 1100   FORMAT(/5X,*PARAMETERS CONSIDERED -- *,10(T49,I2,5X,A10/))
        IF(RTYPE.EQ.SMODEL) WRITE (6,1150) (L,NAME(L+40),L=
      + LSTART,LSTOP)
 1150   FORMAT(/,5X,*SIGNATURE MODES CONSIDERED -- *,
      + 6(T49,I2,5X,A10/))
        IF(MISFIRE.EQ.YES)
      +WRITE (6,1200) OPTS(LIDLE+24),SLANE
 1200   FORMAT(/20X,*MISFIRE UNDER *A10,* CONDITIONS*/
      + 20X,A10,* INSPECTION STATIONS*/)
        WRITE (6,1300) BDEBUG,MDEBUG,TDEBUG,CDEBUG,ADEBUG,
      + LDEBUG,PDEBUG,DDEBUG,SDEBUG
 1300   FORMAT(//,20X,*DEBUG OPTIONS FOR THE FOLLOWING*,
      + * SUBROUTINES:*//
      + 10X,*BLINE*,T50,A10/10X,*MICRO*,T50,A10/
      + 10X,*TEST*,T50,A10/10X,*COSTS*,T50,A10/
      + 10X,*AREA*,T50,A10/10X,*LINPRO*,T50,A10/
      + 10X,*PDECAY*,T50,A10/10X,*DATA*,T50,A10/,
      + 10X,*STATS*,T50,A10/)
 6000   CONTINUE
        CALL REGION(RNAME)
        STAT=STATSV
        READ (5,NAM1)
        STATSV=STAT
```

Table 5-1 MAIN PROGRAM LISTING (cont.)

```
      STAT=STAT*12./TINT
      CALL INITIAL
      CALL BLINE
      KILL=0
      CALL MICRO(KILL)
      IF(KILL.EQ.1) GOTO 7000
      CALL PRINT6(CN,TPER,TMIL,NTR,CARPOP)
      CALL COSTS
      CALL OUT
 7000 IF(RSTOP.EQ.YES) STOP
      GO TO 10000
  999 FORMAT(1H1)
      END
```

for later use in the model. INITIAL computes the inspection time intervals for the test and base (mandatory and voluntary) cases and estimates the vehicle population size over the time horizon using an input linear regression. The Vehicle Population Model is called from INITIAL to evaluate the dynamic character of the age percentage and vehicle miles travelled distributions for the various subpopulations being modeled. Average partial derivatives and deterioration coefficients are computed along with certain average cost information. The parameter and mode emission distributions are expanded and their means and standard deviations computed. These means and sigmas are averaged and stored for later printout. Figure 5-2 contains a flowchart of INITIAL and Table 5-2 a computer listing

5.3 SUBROUTINE REGION - DEMOGRAPHIC DATA

Subroutine REGION contains the control logic for the regional data initialization routines. It shifts control to one of the regional data routines based on the value of RNAME.

RNAME	SUBROUTINE CALLED	REGION
1	REGION1	Los Angeles
2	REGION2	New York City
3	REGION3	Washington, D. C.
4	REGION4	Denver
5	REGION5	Detroit

Input to REGION consists solely of RNAME, the region flag. The output from REGION travels through the common blocks found in the REGION subroutines and the MAIN program from which REGION is called. Figure 5-3 presents a flowchart for subroutine REGION while Table 5-3 lists the code.

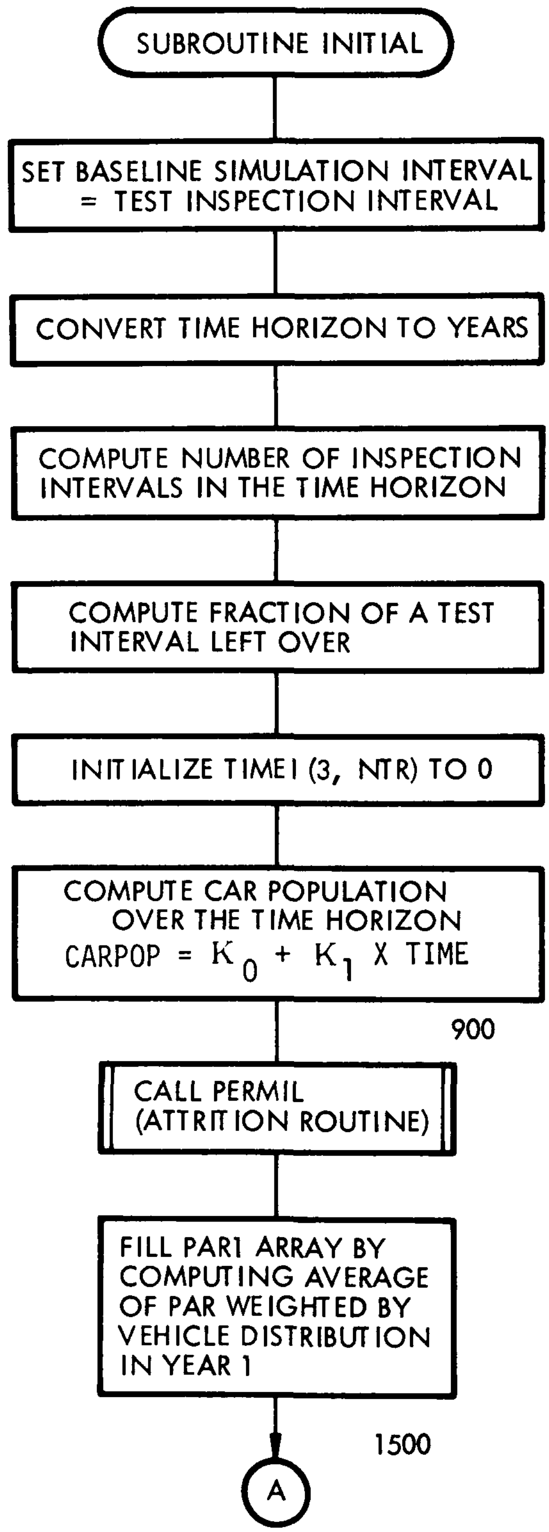


Figure 5-2 Subroutine INITIAL Flowchart

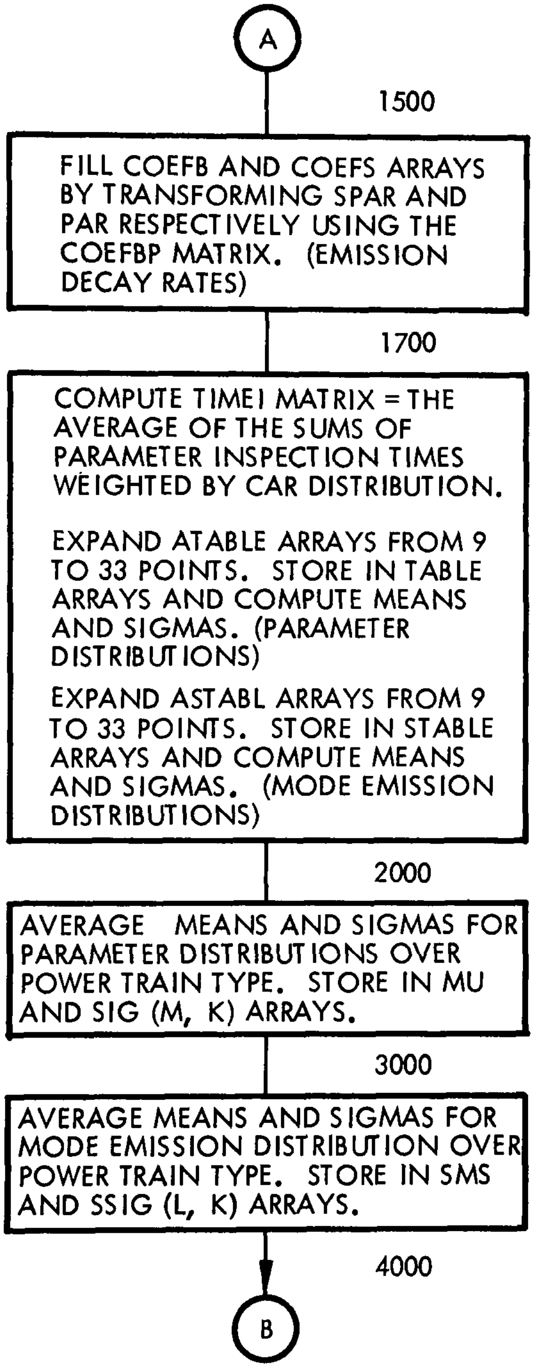


Figure 5-2 Subroutine INITIAL Flowchart (cont.)

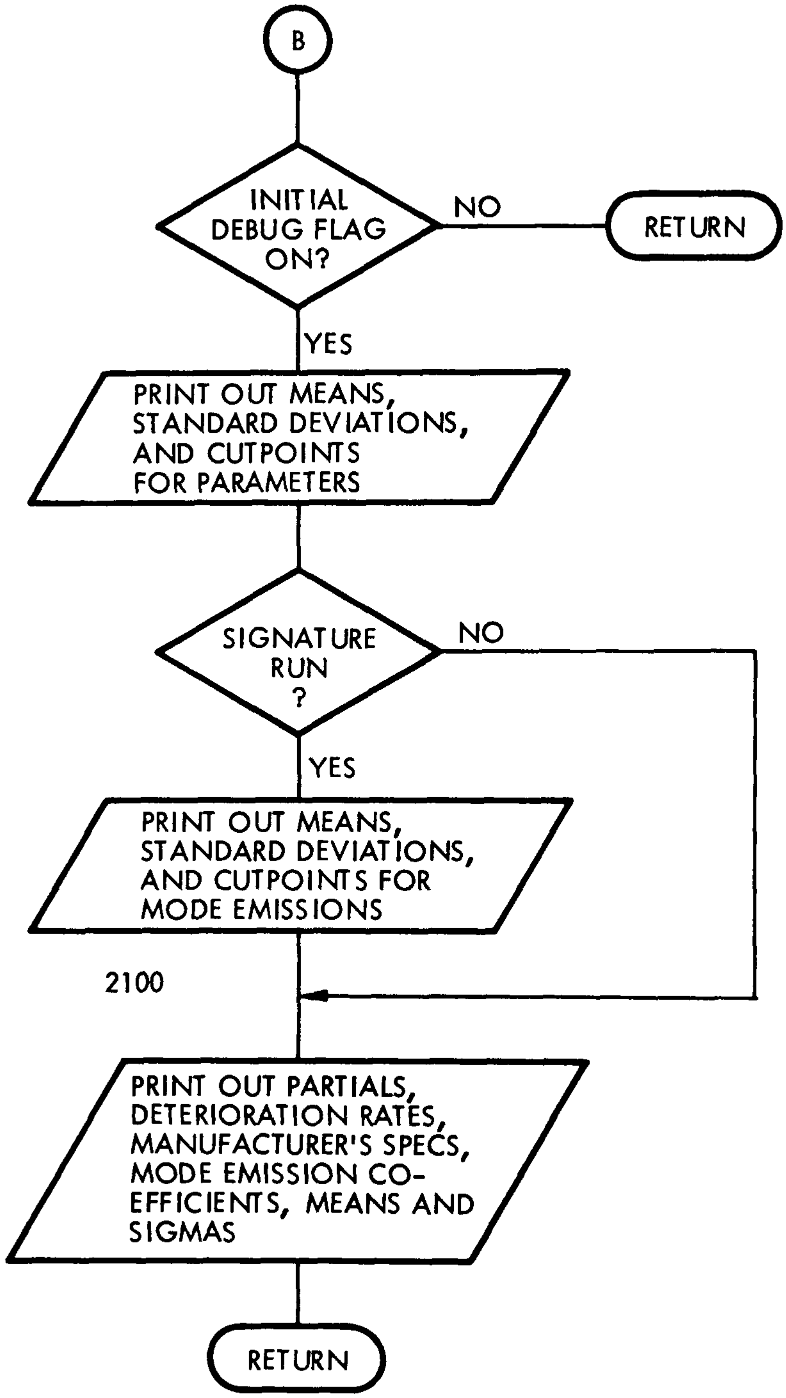


Figure 5-2 Subroutine INITIAL Flowchart (cont.)

Table 5-2 SUBROUTINE INITIAL LISTING

```
      SUBROUTINE INITIAL
      DIMENSICN SMS(6,3),SSIG(6,3)
      DIMENSION XBP(9),YBP(9)
      DIMENSICN DUMX(33),DUMY(33)
       COMMON /COM01/ AMB(3),ALAB,     AVV,  BINT,
     +    BAREA(3), BLD1,      BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/          CARA,     CARIY,    CARMY,    CARPOP(16),
     +    CARSY,    CBSUM,     CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +    CINCON,   CPCB,  CPI,       CPVPY,    CSUM,     CARAY,
     +    CN(15,3,16),         COEFB(15,3),        COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
       COMMON /COM03/          DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),      EP(10,15),EFF(10),  DELIT(3),
     +    FREQA,    FREQB,     FPERC(10,3),
     +    HORZN,    HORZNY,
     +    HPC(15,16),          HPCS(15,16),        HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),          HPTOT(16),
     +    HPTOTS(16)
CC ADD3
       COMMON /COM04/          ITE,      ITL,      ITP,      ITIME(16),
     +    KSTART,   KSTOP,     LOPT, LPICK(10),LLPICK,
     +    LIDLE,    LINT(16),  LPSPP(10),LSTART,   LSTOP,
     +    MBASE,    MPH,       MSPEC(10),MSTART,   MSTOP,
     +    MU(10,3),   MMS(10,15),        MVPR(10,15)
CC ADD4
       COMMON /COM05/          NAME(50), NCNTR,    NEMIS,    NEMP,
     +    NINTR,    NINTRB,    NMODE,    NO,       NOPTS,    NPAR,
     +    NPTRN,    NPTS,      NSTEPS,   NTR,      NTRB,     NPICK(16),
     +    OCIY,     OCMY,      OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/PARM(3,3),  PART,     PAYNEW,   PAYOFF(3),
     +    PC(15),   PCS(15),   PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15),  PT(5),    PTOT,     PTS(5),  PAYADJ,
     +    PAR(10,15,3),        PAR1(10,3,3),       PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),  PTA(5),    PCONF,    PARINT(10,10,9)
     + ,PAYFIN
       COMMON /COM07/          REINSP,   RNAME,    RSIZE,    RSTOP,
```

Table 5-2 SUBROUTINE INITIAL LISTING (cont.)

```
     +    RTYPE,
     +    SALE,      SALL,      SALP,      SITEI,     SITEM,     SLANE,
     +    SMODEL,    START(15,3), STAT,      STIME(3), SUMBM(3),
     +    SCALEBM(3),           SM(6,15),             SPAR(10,15,6),
     +    SXCUT(6,3),           SIG(10,3),             SIGCE(3),
     +    SIGME(10),            SIGMNE(10),           SIGP(10,15),
     +    SIGRATE,   SIST,       SIGS(6,15),           SIGSDE(3),
     +    STABLEX(33,6,15),      STABLEY(33,6,15)
      COMMON /COM10/            TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,      TOBF(3),   TONX,      TOTE(3),  TPOB(3),   TPOT(3),
     +    TXTRA,     TSIZE,      TSIG(3),   TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),        THISTT(3,16),         TIMEC(10,15),
     +    TIMEM(10,15),         TABLEX(33,10,15),      TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/            WF(10),
     +    X1BP(3,3,6), XINT,       XINTB,     XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),   XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/            Y1BP(3,3,10),         Y2BP(3,3,10),
     +    YES,       YSUM,      YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,        Z2,        Z3,        Z4,        Z5,        Z6,
     +    Z7,        Z8,        Z9,        Z10,       Z11,       Z12,
     +    Z13,       Z14,       Z15,       Z16,       Z17,
     +    ZCARI,     ZCARM,     ZIC,       ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/            ADEBUG,    BDEBUG,    CDEBUG,    DDEBUG,
     +    LDEBUG,    MDEBUG,    PDEBUG,    QDEBUG,    SDEBUG,    TDEBUG
CC ADDD
      REAL            ITE,       ITL,       ITP,       ITIME,
     +    MMS,       MPH,       MSPEC,     MU,        MVPR,
     +    NAME,      NO,        LDEBUG,    MDEBUG,
     +    IN,        MISFIRE
      INTEGER         RNAME,     SITEI,     SITEM,     STAT,
     +    TDIST,     XLANE,     OPTI,      PPICK,     PPPICK
CC
CC   ANY DATA APPEARING IN THIS SUBROUTINE IS FOR
CC   RE-INTIALIZATION PURPOSES FOR MULTIPLE RUNS
     BINT=TINT
     HORZNY=HORZN/12
     XINT=HORZN/TINT+1.E-10
     INT=XINT
```

Table 5-2 SUBROUTINE INITIAL LISTING (cont.)

```
      NINTR=XINT+.99
      NTR=NINTR+1
      MID=NTR
      TXTRA=XINT-INT
      XINTB=HORZN/BINT+1.E-10
      INTB=XINTB
      NINTRB=XINTB+.99
      NTRB=NINTRB+1
      BXTRA=XINTB-INTB
      SIGRATE=1.
      CARAV=CARPOP(1)
      TIMEI(1,1)=TIMEI(2,1)=TIMEI(3,1)=0.
      DO 900 N=2,NTR
      TIMEI(1,N)=TIMEI(2,N)=TIMEI(3,N)=0.
         N1=N-1
         CARPOP(N)=CARPOP(N1)*(1.00+0.03*TINT/12.)
  900    CARAV=CARAV+CARPOP(N)
      CARPOP(16)=CARAV/NTR
      CALL PERMIL(TPER,TMIL,TINT,KSTART,KSTOP,NPTRN)
      SUMBM(1)=SUMBM(2)=SUMBM(3)=0.
      DO 1500 M=1,NPAR
      DO 1500 K=1,NCNTR
      WW1=PAR1(M,K,1)=PAR1(M,K,2)=PAR1(M,K,3)=0.
       MU(M,K)=SIG(M,K)=0.
      DO 1400 JJ=1,NPTRN
      J=JJ+5*(K-1)
      PLUS(M,J)=0.
      WW1=WW1+TPER(1,J)
      DO 1400 I=1,NEMIS
      PAR1(M,K,I)=PAR1(M,K,I)+PAR(M,J,I)*TPER(1,J)
 1400 CONTINUE
      DO 1500 I=1,NEMIS
      IF(WW1.GT.1.E-10)PAR1(M,K,I)=PAR1(M,K,I)/WW1
      IF(WW1.LT.1.E-10) PAR1(M,K,I)=0.
 1500 CONTINUE
      DO 1700 I=1,NEMIS
      DO 1700 JJ=1,NPTRN
      DO 1700 K=1,NCNTR
      J=JJ+5*(K-1)
      DO 1650 L=1,NMODE
      SUM=0
      DO 1600 M=1,NPAR
```

```
 1600 SUM=SUM+PAR(M,J,I)*COEFBP(M,J)
      COEFB(J,I)=SUM+PARM(K,I)
 1650 CONTINUE
 1700 CONTINUE
      DO 2000 JJ=1,NPTRN
      DO 2000 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      DO 1900 M=MSTART,MSTOP
      DO 1750 N=1,15
 1750 TIMEI(OPTI,N)=TIMEI(OPTI,N)+TIMEC(M,J)*TDIST(M,K)*TPER(N,J)
      IF(M.EQ.5.OR.M.EQ.6) GO TO 1900
      IF(M.EQ.4.OR.M.EQ.10) GO TO 1900
      DO 1850 L=1,NPTS
      XBP(L)=ATABLEX(L,M,K)
      YBP(L)=ATABLEY(L,M,K)
 1850 CONTINUE
      NN=NSTEPS+1
      DELX=(XBP(NPTS)-XBP(1))/NSTEPS
      DO 1875 L=1,NN
            DUMX(L)=XBP(1)+(L-1)*DELX
            DUMY(L)=FUN1(       DUMX(L),XBP,YBP,NPTS)
 1875 CONTINUE
      CALL PACKD(DUMX,DUMY,NN)
      CALL STD2(DUMX,DUMY,NN,PM(M,J),SIGP(M,J))
      DO 1880 L=1,NN
      TABLEX(L,M,J)=DUMX(L)
      TABLEY(L,M,J)=DUMY(L)
 1880  CONTINUE
 1900 CONTINUE
      DO 1975 LL=1,NMODE
      DO 1925 L=1,NPTS
      XBP(L)=ASTABLX(L,LL,K)
      YBP(L)=ASTABLY(L,LL,K)
 1925 CONTINUE
      DELX=(XBP(NPTS)-XBP(1))/NSTEPS
      DO 1950 L=1,NN
              DUMX(L)=XBP(1)+(L-1)*DELX
              DUMY(L)=FUN1(          DUMX(L),XBP,YBP,NPTS)
 1950 CONTINUE
      CALL PACKD(DUMX,DUMY,NN)
      CALL STD2(DUMX,DUMY,NN,SM(LL,J),SIGS(LL,J))
      DO 1960 L=1,NN
```

```
      STABLEX(L,LL,J)=DUMX(L)
      STABLEY(L,LL,J)=DUMY(L)
 1960  CONTINUE
      L=LL
 1975 CONTINUE
 2000 CONTINUE
       DO 3000 M=MSTART,MSTOP
       DO 3000 K=KSTART,KSTOP
       TT=0.
      DO 2500 JJ=1,NPTRN
       J=JJ+5*(K-1)
       MU(M,K)=MU(M,K)+PM(M,J)*TPER(N,J)
       SIG(M,K)=SIG(M,K)+SIGP(M,J)*TPER(N,J)
       TT=TT+TPER(N,J)
 2500 CONTINUE
       IF(TT.LT.1.E-10) GO TO 3000
       MU(M,K)=MU(M,K)/TT
       SIG(M,K)=SIG(M,K)/TT
 3000 CONTINUE
       DO 4000 L=LSTART,LSTOP
       DO 4000 K=KSTART,KSTOP
       TT=0.
       DO 3500 JJ=1,NPTRN
       J=JJ+5*(K-1)
       SMS(L,K)=SMS(L,K)+SM(L,J)*TPER(N,J)
       SSIG(L,K)=SSIG(L,K)+SIGS(L,J)*TPER(N,J)
       TT=TT+TPER(N,J)
 3500 CONTINUE
       IF(TT.LT.1.E-10) GO TO 4000
       SMS(L,K)=SMS(L,K)/TT
       SSIG(L,K)=SSIG(L,K)/TT
 4000 CONTINUF
      IF(DDEBUG.EQ.NO) RETURN
      DO 2100 K=KSTART,KSTOP
      WRITE (6,2005) K,NAME(K+3)
 2005 FORMAT(1H1,//,30X,*DISCRIPTIVE DATA FOR E/E STUDIES*
     + ,* -- CONTROL TYPE *,I3,*  --  *,A8//)
      WRITE (6,2010)
 2010 FORMAT(70X,*WEIGHTED PARTIALS*/,* PARAMETER*,5X,*TYPE*,
     + 4X,*XCUT*,6X,*MU*,8X,*SIG*,8X,5X,9X,*HC*,
     + 11X,*CO*,10X,*NO*//)
      DO 2025 M=MSTART,MSTOP
```

```
      WRITE (6,2020) NAME(M+30),          XCUT(M,K),MU(M,K),SIG(M,K),
     + (PAR1(M,K,I),I=1,NEMIS)
 2020 FORMAT(1X,A10,3X,3X,2X,3E10.2, 15X,3E13.4/)
 2025 CONTINUE
      IF(RTYPE.EQ.PMODEL) GO TO 2100
      WRITE (6,2030)
 2030 FORMAT(4(/),*  MODE *//)
      J=1+5*(K-1)
      DO 2050 L=LSTART,LSTOP
      LL=L+10
      WRITE (6,2040) NAME(L+40)          ,SXCUT(L,K),SMS(L,K),SSIG(L,K)
 2040 FORMAT(1X,A10,3X,3X,2X,3E10.2/)
 2050 CONTINUE
 2100 CONTINUE
      WRITE (6,999)
      CALL PRINT1(
     + PAR,50HPAR   -   PARTIALS   -   DE/DP
     +,PAR,50HPAR   -   PARTIALS   -   DE/DP
     + )
      IF(RTYPE.EQ.SMODEL) WRITE (6,999)
      IF (RTYPE.EQ.SMODEL) CALL PRINT4(
     + SPAR,50HSPAR - SIGNATURE PARTIALS
     + , SPAR,50H
     + )
      WRITE (6,999)
      CALL PRINT2(
     + COEFB,50HEMISSION DETERIORATION RATES
     + ,COEFB,50H
     + ,COEFB,50H
     + )
      CALL PRINT3(
     + COEFBP,50HCOEFBP  --  PARAMETER DECAY COEFFICIENTS
     + ,MMS,50HMMS   -   MANUFACTURER SPECIFICATIONS
     + )
      IF (RTYPE.EQ.SMODEL) CALL PRINT5(
     +  SM,50HSM  -- INITIAL SIGNATURE MEAN VALUES
     + , SIGS,50HSIGS  --  INITIAL SIGNATURE SIGMAS
     + )
  999 FORMAT(1H1)
      RETURN
      END
```

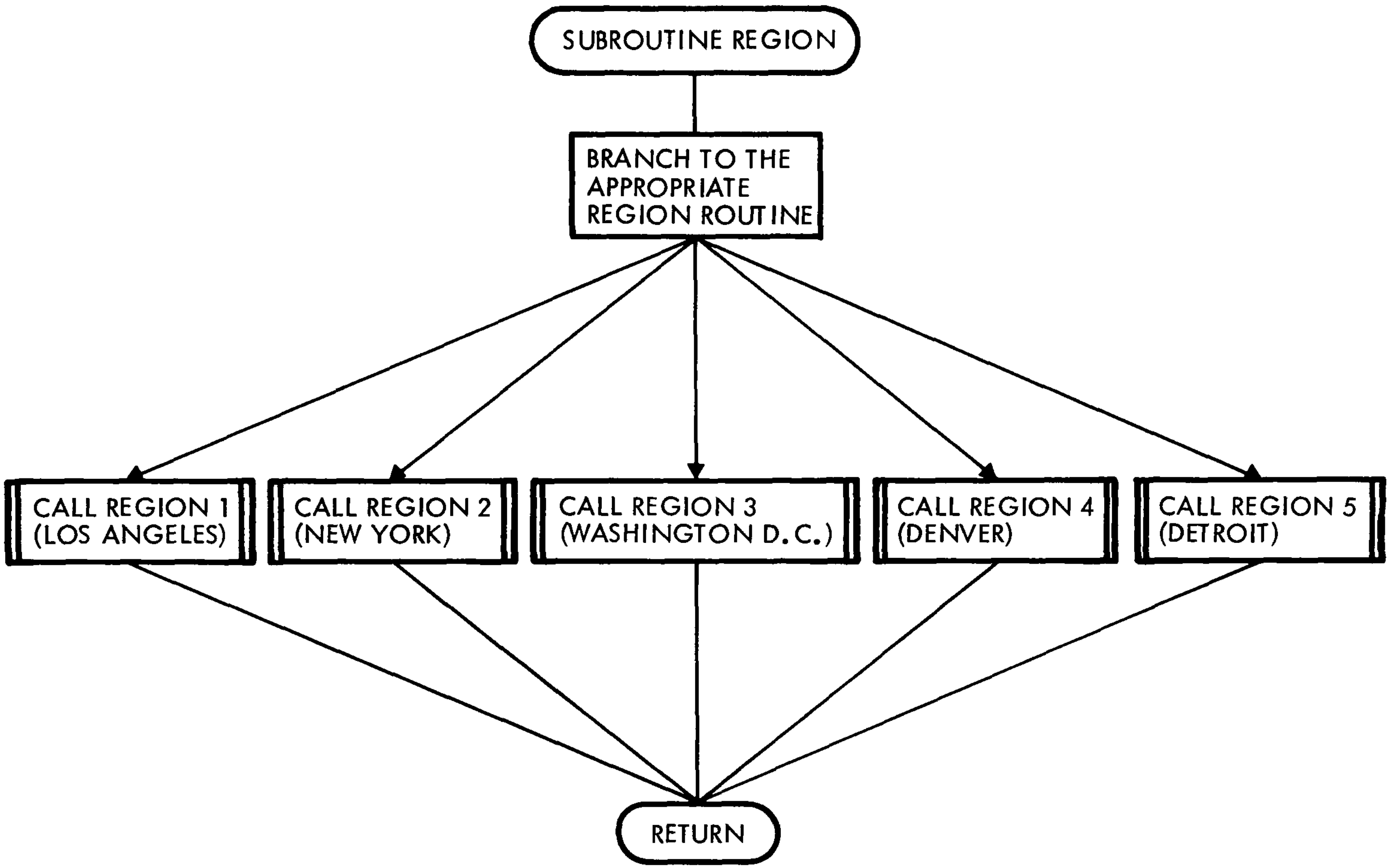


Figure 5-3 Subroutine REGION Flowchart

Table 5-3 SUBROUTINE REGION LISTING

```
      SUBROUTINE REGION(RNAME)
      INTEGER RNAME
      GOTO (10,20,30,40,50), RNAME
10    CALL REGION1
      RETURN
20    CALL REGION2
      RETURN
30    CALL REGION3
      RETURN
40    CALL REGION4
      RETURN
50    CALL REGION5
      RETURN
      END
```

5.3.1 Subroutine REGION1

Subroutine REGION1 contains the data for the Los Angeles Basin. The data is stored in internal arrays and matrices and is moved into the main storage during the initialization phase.

There is no input to REGION1. It is called from REGION only when the LA data card has been included in the keyword input. Figure 5-4 shows the flowchart for this subroutine and Table 5-4 a listing. The data requirements for the other modeled regions is similar to that of REGION1.

5.3.2 Subroutine REGION2

(See 5.3.1)

5.3.3 Subroutine REGION3

(See 5.3.1)

5.3.4 Subroutine REGION4

(See 5.3.1)

5.3.5 Subroutine REGION5

(See 5.3.1)

5.4 SUBROUTINE BLINE

Subroutine BLINE contains the algorithms for simulating the impact of a voluntary maintenance program. The emission deterioration data, voluntary maintenance data and starting emission levels are all identical to those used in the mandatory model, and enter BLINE through the common blocks. Other than the common blocks there is no input to BLINE. Output consists of the baseline emission time history stored in BHIST and

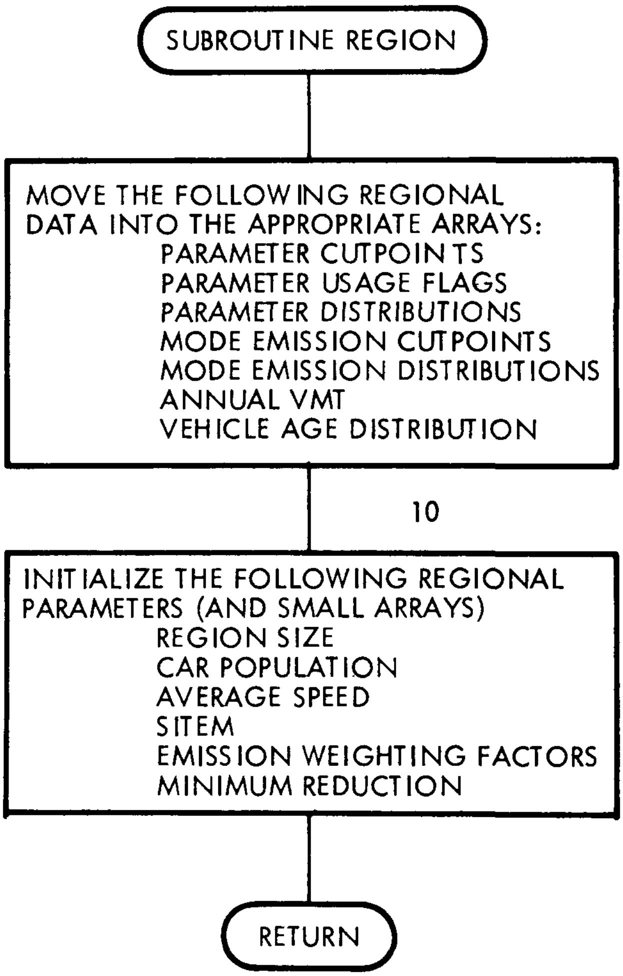


Figure 5-4 Subroutine REGION1 Flowchart

Table 5-4 SUBROUTINE REGION1 LISTING

```
      SUBROUTINE REGION1
      DIMENSION XCUTI(10,3),SXCUTI(6,3),ATABX(9,10,3),ATABY(9,10,3)
       DIMENSION ASTABX(9,6,3),ASTABY(9,6,3)
      DIMENSICN TDST(10,3)
      INTEGER TDST
CC    DISTRIBUTION CUTPOINTS
      DATA XCUTI/1.0,- 50., 2.,0.,0.,0.,-1.0,30.,-0.05,0.,
     + 1.0,-5.,1.0,0.,0.,0.,-1.0,25.,-0.05,0.,
     + 1.0,-500., 2.,0.,0.,0.,-1.0,10.,-0.05,0./
      DATA SXCUTI/3000.,6.,4000.,450.,3.5,4000.,250.,4.0,5000.,250.,1.5,
     + 5000.,2000.,3.0,4000.,200.,1.0,4000./
      DATA (ATABX  (I),I=1,180)/
     + -7.,-3.75,-2.25,-1.25,0.25,1.25,2.25,5.25,8.,
     + -200.,-90.,-70.,-30.,10.,70.,110.,130.,380.,
     + -10.,-3.75,-2.75,0.25,2.25,4.25,6.25,7.25,10.,
     + 27*0.,
     + -4.0,-2.75,-1.25,-0.75,0.25,0.75,1.25,2.25,6.,
     + - 70.,-55.,-25.,5.,25.,50.,75.,120.,180.,
     + -0.22,-0.1,-0.03,-0.01,0.01,0.03,0.07,0.12,0.26,
     + 9*0.,
     + -8.,-4.75,-3.25,-1.25,.25,.75,2.25,4.75,8.,
     + -250.,-190.,-130.,-50.,10.,30.,50.,110.,340.,
     + -10.,-7.75,-4.75,-3.0,-1.75,0.25,2.25,4.25,10.,
     + 27*0.,
     + -2.75,-1.75,-1.25,-0.75,0.25,0.75,1.25,2.25,4.0,
     + - 70.,-55.,-25.,5.,25.,90.,115.,135.,170.,
     + -0.14,-0.11,-0.07,-0.05,-0.01,0.01,0.03,0.05,0.21,
     + 9*0./
      DATA (ATABX  (I),I=181,270)/
     + -8.,-4.5,-2.,-1.25,-.25,.75,1.75,5.25,7.5,
     + -350.,-190.,-140.,-70.,-50.,30.,70.,150.,440.,
     + -10.,-5.75,-1.75,0.25,2.25,4.25,5.25,8.25,10.,
     + 27*0.,
     + -2.75,-2.25,-1.25,-0.75,0.25,0.75,1.25,3.,3.5,
     + -30.,-10.,5.,20.,35.,45.,105.,130.,170.,
     + -0.21,-0.1,-0.07,-0.03,-0.01,0.01,0.03,0.1,0.28,
     + 9*0./
      DATA (ATABY  (I),I=1,180)/
     + .0203,.0405,.0541,.0743,.0878,0.0743,.0405,.0270,.0067,
     + 0.006,0.026,0.04,0.06,0.141,0.107,0.081,0.045,0.007,
     + 0.02,0.034,0.06,0.228,0.087,0.08,0.02,0.013,0.007,
```

Table 5-4 SUBROUTINE REGION1 LISTING (cont.)

```
     + 27*0.,
     + 0.0079,0.0314,0.102,0.15,0.291,0.133,0.071,0.016,0.008,
     + .0075,.0149,.0299,.2463,.0896,.0597,.0373,.0299,.0075,
     + 0.0175,0.035,0.088,0.298,0.175,0.105,0.07,0.018,0.0175,
     + 9*0.,
     + .0067,.0133,.0267,.0733,.0933,.1200,.0667,.0333,.0067,
     + 0.0133,0.0267,0.066,0.133,0.126,0.093,0.086,0.04,0.007,
     + 0.013,0.027,0.036,0.047,0.053,0.247,0.06,0.046,0.007,
     + 27*0.,
     + 0.014,0.043,0.065,0.159,.3450, .137,0.036,0.021,0.007,
     6 .0074,.0148,.0296,.3630,.0963,.0370,.0222,.0148,.0074,
     + 0.009,0.025,0.05,0.108,0.358,0.192,0.075,0.033,0.017,
     + 9*0./
      DATA (ATABY  (I),I=181,270)/
     + .0067,.0134,.0336,.1007,.1409,.1208,.0872,.0268,.0067,
     + 0.007,0.02,0.04,0.093,0.153,0.12,0.067,0.033,0.006,
     + 0.0135,0.027,0.108,0.378,0.101,0.067,0.02,0.0135,0.013,
     + 27*0.,
     + 0.015,0.022,0.044,0.125,0.529,0.096,0.044,0.008,0.007,
     + .0155,.0233,.5659,.0698,.0465,.0310,.0155,.0078,.0077,
     + 0.008,0.016,0.032,0.142,0.444,0.206,0.047,0.008,0.007,
     + 9*0./
      DATA (ASTABX (I),I=1,162)/
     *50.,150.,350.,450.,550.,750.,850.,1650.,1800.,
     * 1.,2.25,2.75,3.75,5.25,6.75,7.75,8.25,10.25,
     *10.,70.,90.,110.,130.,170.,190.,270.,400.,
     *50.,125.,175.,225.,275.,325.,375.,875.,1000.,
     * .5,.75,1.25,1.75,2.75,3.75,4.25,8.25,9.25,
     *90.,700.,1100.,1500.,1900.,2100.,2300.,2800.,3000.,
     *50.,75.,125.,175.,275.,325.,375.,675.,775.,
     * .5,1.25,2.25,2.75,3.25,4.75,5.75,7.25,10.,
     *10.,30.,50.,70.,90.,110.,130.,150.,290.,
     *10.,75.,125.,175.,225.,275.,325.,425.,775.,
     * .5,.75,1.25,1.75,2.25,3.25,3.75,4.25,6.75,
     * 400.,700.,1500.,2100.,2500.,2700.,2900.,3500.,4000.,
     *10.,50.,90.,110.,130.,170.,210.,330.,390.,
     * .5,1.5,3.5,5.5,6.5,8.5,9.5,10.5,12.,
     *10.,50.,70.,90.,150.,190.,210.,290.,390.,
     *10.,30.,50.,70.,90.,110.,130.,190.,300.,
     * .1,0.3,0.5,.7,.9,1.3,2.1,2.3,3.0,
     * 600.,1300.,1700.,2100.,2700.,2900.,3100.,3300.,3600./
      DATA ASTABY /
```

```
     * .0140,.0280,.1189,.1399,.1119,.0769,.0490,.0280,.0810,
     * .0208,.0347,.0486,.0556,.0625,.0833,.0625,.0486,.0347,
     * .0069,.2083,.2986,.1597,.0625,.0486,.0347,.0139,.0409,
     * .0000,.0417,.0903,.1806,.2083,.1736,.1042,.0139,.04,
     * .0278,.0764,.0833,.1319,.1111,.0903,.0486,.0108,.0469,
     * .0417,.0625,.0764,.1181,.0972,.0764,.0625,.0486,.0100,
     * .0000,.0270,.0946,.1959,.1622,.0946,.0608,.0275,.1000,
     * .0336,.0671,.0805,.1275,.0604,.0470,.0403,.0268,.0200,
     * .0000,.0067,.0940,.1544,.1946,.1678,.1409,.0805,.0400,
     * .0000,.0473,.2297,.3514,.2365,.0743,.0135,.0068,.0167,
     * .3557,.1879,.1800,.1745,.0470,.0268,.0267,.0070,.0160,
     * .0134,.0268,.0537,.0738,.0805,.1141,.1275,.0604,.1203,
     * .0000,.0144,.0288,.0647,.1079,.1151,.0719,.0504,.1088,
     * .2300,.2370,.1220,.0650,.0580,.0250,.0080,.0075,.0070,
     * .0000,.0144,.0935,.1799,.1511,.0719,.0432,.0216,.0272,
     * .0000,.0072,.0360,.1151,.1511,.1655,.1223,.0791,.0144,
     * .1799,.2158,.1439,.1079,.0863,.0360,.0216,.0144,.0302,
     * .0216,.0432,.0576,.0863,.1655,.1079,.0863,.0504,.0360/
      DATA TDST/1,1,1,1,0,0,1,1,1,1,1,1,1,1,0,1,1,1,1,1,1,0,1,1,1,0,1,
     + 1,1,0/
      COMMON /BADDOR/ X(15),ANNUAL(15)
      DIMENSION X1(15),ANNUA1(15),START1(15,3)
      DATA X1/10.8,10.5,10.2,9.8,9.3,8.8,8.1,7.2,6.2,5.1,
     + 4.1,3.0,2.0,0.9,4.0/
      DATA ANNUA1/15000.,13000.,11000.,9600.,8400.,7000.,5300.,
     + 5000.,4400.,4200.,4000.,3800.,3700.,3550.,3000./
      DATA START1/5*11.94,5*7.26,5*4.43,5*129.8,5*86.6,5*63.4,
     + 5*3.97,5*6.34,5*6.0/
        COMMON /COM01/ AMB(3),ALAB,      AVV,   BINT,
     +     BAREA(3), BLD1,      BLD2,     BSIG(3),  BXTRA,     BSIZE,
     +     BHIST(3,16),         BMMI(10,15,3),
     +     ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
        COMMON /COM02/           CARA,      CARIY,     CARMY,     CARPOP(16),
     +     CARSY,     CBSUM,     CCOEF(10),CCOSTI,    CCUSTM,    CGTT,
     +     CINCON,    CPCB,  CPI,        CPVPY,     CSUM,      CARAY,
     +     CN(15,3,16),         COEFB(15,3),          COEFBP(10,15),
     +     CPART(10,15)
CC ADD2
        COMMON /COM03/           DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),   DELIT(3),
     +     FREQA,     FREQB,     FPERC(10,3),
     +     HORZN,     HORZNY,
```

Table 5-4 SUBROUTINE REGION1 LISTING (cont.)

```
     +    HPC(15,16),                HPCS(15,16),               HPP(10,15,16),
     +    HPS(5,15,16),              HPT(5,16),                 HPTOT(16),
     +    HPTOTS(16)
CC ADD3
      COMMON /COM04/                 ITE,       ITL,            ITP,        ITIME(16),
     +    KSTART,     KSTOP,         LOPT, LPICK(10),LLPICK,
     +    LIDLE,      LINT(16),      LPSPP(10),LSTART,          LSTOP,
     +    MBASE,      MPH,           MSPEC(10),MSTART,          MSTOP,
     +    MU(10,3),     MMS(10,15),                 MVPR(10,15)
CC ADD4
      COMMON /COM05/                 NAME(50),  NCNTR,          NEMIS,      NEMP,
     +    NINTR,      NINTRB,        NMODE,     NO,             NOPTS,      NPAR,
     +    NPTRN,      NPTS,          NSTEPS,    NTR,            NTRB,       NPICK(16),
     +    OCIY,       OCMY,          OPTI,      OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
      COMMON /COM06/PARM(3,3),  PART,        PAYNEW,   PAYOFF(3),
     +    PC(15),     PCS(15),       PHI(14),   PLU(14),        PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15),        PT(5),     PTOT,           PTS(5),     PAYADJ,
     +    PAR(10,15,3),              PAR1(10,3,3),              PLUS(10,15),
     +    PM(10,15),                 PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),    PTA(5),        PCONF,     PARINT(10,10,9)
     + ,PAYFIN
      COMMON /COM07/                 REINSP,    RNAME,          RSIZE,      RSTOP,
     +    RTYPE,
     +    SALE,       SALL,          SALP,      SITEI,          SITEM,      SLANE,
     +    SMODEL,     START(15,3),  STAT,          STIME(3),  SUMBM(3),
     +    SCALEBM(3),                SM(6,15),                  SPAR(10,15,6),
     +    SXCUT(6,3),                SIG(10,3),                  SIGCE(3),
     +    SIGME(10),                 SIGMNE(10),                SIGP(10,15),
     +    SIGRATE,    SIST,           SIGS(6,15),                SIGSDE(3),
     +    STABLEX(33,6,15),           STABLEY(33,6,15)
      COMMON /COM10/                 TAREA(3),  TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,       TOBE(3),       TONX,      TOTE(3),        TPDB(3),    TPDT(3),
     +    TXTRA,      TSIZE,          TSIG(3),  TPER(16,15),    TMIL(16,15),
     +    THIST(5,3,16),             THISTT(3,16),              TIMEC(10,15),
     +    TIMEM(10,15),              TABLEX(33,10,15),           TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/                 WF(10),
     +    XIBP(3,3,6), XINT,          XINTB,       XLANE,          XSUM, XCUT(10,3),
     +    XTM(16),    XBASE(9,3),YBASE(9,3)
CC ADD11
```

Table 5-4 SUBROUTINE REGION1 LISTING (cont.)

```
          COMMON /COM12/         Y1BP(3,3,10),         Y2BP(3,3,10),
     +     YES,        YSUM,     YTM(15),    Y1DBP(4,4,10),Y2DBP(4,4,10),
     +     Z1,         Z2,       Z3,         Z4,         Z5,         Z6,
     +     Z7,         Z8,       Z9,         Z10,        Z11,        Z12,
     +     Z13,        Z14,      Z15,        Z16,        Z17,
     +     ZCARI,      ZCARM,    ZIC,        ZSUM,
     +     ZZ(3,3)
CC ADD12
          COMMON /DEBUG/         ADEBUG,     BDEBUG,     CDEBUG,     DDEBUG,
     +     LDEBUG,     MDEBUG,   PDEBUG,     QDEBUG,     SDEBUG,     TDEBUG
CC ADDD
          REAL         ITE,      ITL,        ITP,        ITIME,
     +     MMS,        MPH,      MSPEC,      MU,         MVPR,
     +     NAME,       NO,       LDEBUG,     MDEBUG,
     +     IN,         MISFIRE
          INTEGER      RNAME,    SITEI,      SITEM,      STAT,
     +     TDIST,      XLANE,    OPTI,       PPICK,      PPPICK
CC     DATA INITIALIZATION FOR LOS ANGELES
       DO 1 K=1,3
       DO 1 M=1,10
       XCUT(M,K)=XCUTI(M,K)
       TDIST(M,K)=TDST(M,K)
       DO 1 L=1,9
       ATABLEX(L,M,K)=ATABX(L,M,K)
 1     ATABLEY(L,M,K)=ATABY(L,M,K)
       DO 2 M=1,6
       DO 2 K=1,3
       SXCUT(M,K)=SXCUTI(M,K)
       DO 2 L=1,9
        ASTABLX(L,M,K)=ASTABX(L,M,K)
 2      ASTABLY(L,M,K)=ASTABY(L,M,K)
       DO 3 I=1,15
       X(I)=X1(I)
       ANNUAL(I)=ANNUA1(I)
       DO 3 J=1,3
       START(I,J)=START1(I,J)
 3     CONTINUE
CC     L. A. BASIN
       RSIZE=1250.
       MPH=30.
       CARPOP(1)=4.E6
       SITEM=1000
```

Table 5-4 SUBROUTINE REGION1 LISTING (cont.)

```
      EMW(1)=.6
      EMW(2)=.1
      EMW(3)=.3
      AMB(1)=0.01
      AMB(2)=3.4
      AMB(3)=0.4
      RETURN
      END
```

the total integrated yearly emission located in BAREA and TOBE .

All emission rates are stored in A, B and C matrices as differences from the starting values, START. Therefore, the A matrix is initialized to zero, representing the emission delta at the start of the first simulation time period. Emission rates are weighted by the vehicle population percentages generated in the attrition routines to obtain the total emission rates by species.

The major equations of BLINE are:

(1) $B = A + \frac{dE}{dM} \times \frac{dM}{dt} \times \Delta t$ M is mileage, t is time.

Where: Emission rate at the end of the simulation period (B) equals that at the beginning (A) plus the deterioration rates times Δt.

(2) $C = B - \Delta P_B \times \frac{\partial E}{\partial t} \times \Delta t$

Where: The post maintenance emission rate (C) equals B minus the effects of voluntary maintenance ΔE. ΔE is computed by summarizing the change in the parameter setting (ΔP_B) due to voluntary maintenance times the appropriate influence coefficient. Figure 5-5 presents the flowchart for subroutine BLINE and Table 5-5 the listing.

5.5 SUBROUTINE MICRO

Subroutine MICRO contains the logic for the inspection/maintenance model. MICRO contains the calling sequence to the supporting subroutines and generates a set of time histories and integrated averages for each emission species. MICRO sets up in the CN array the starting emission values and initializes the THIST and the THISTT arrays in which the emission time histories are eventually stored. The A matrix is initialized

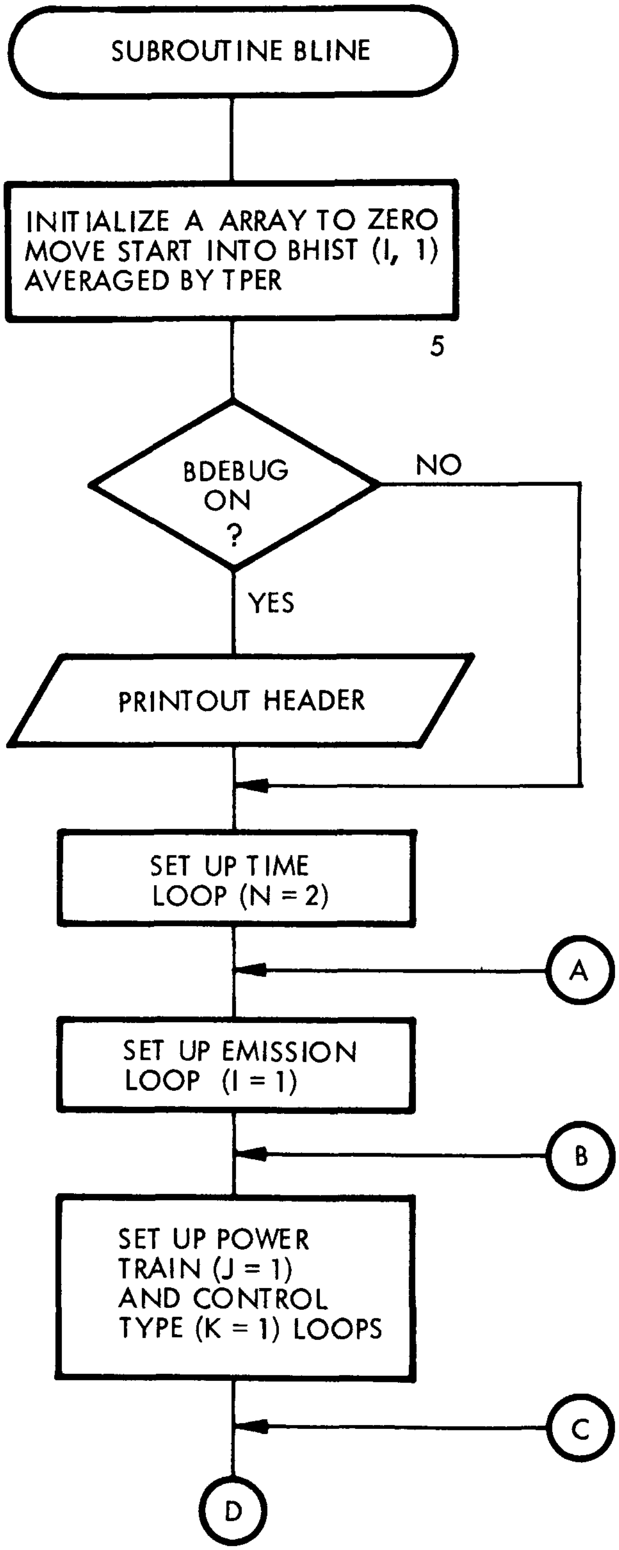


Figure 5-5 Subroutine BLINE Flowchart

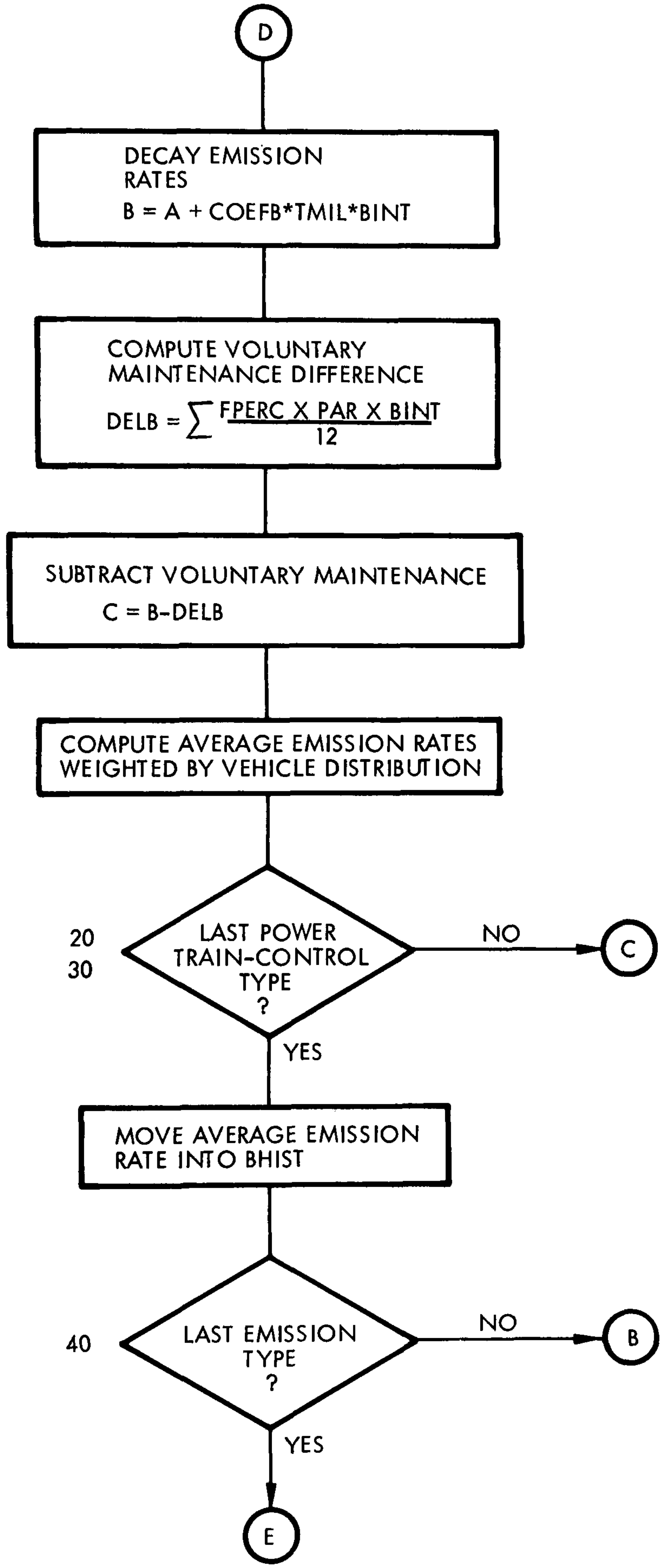


Figure 5-5 Subroutine BLINE Flowchart (cont.)

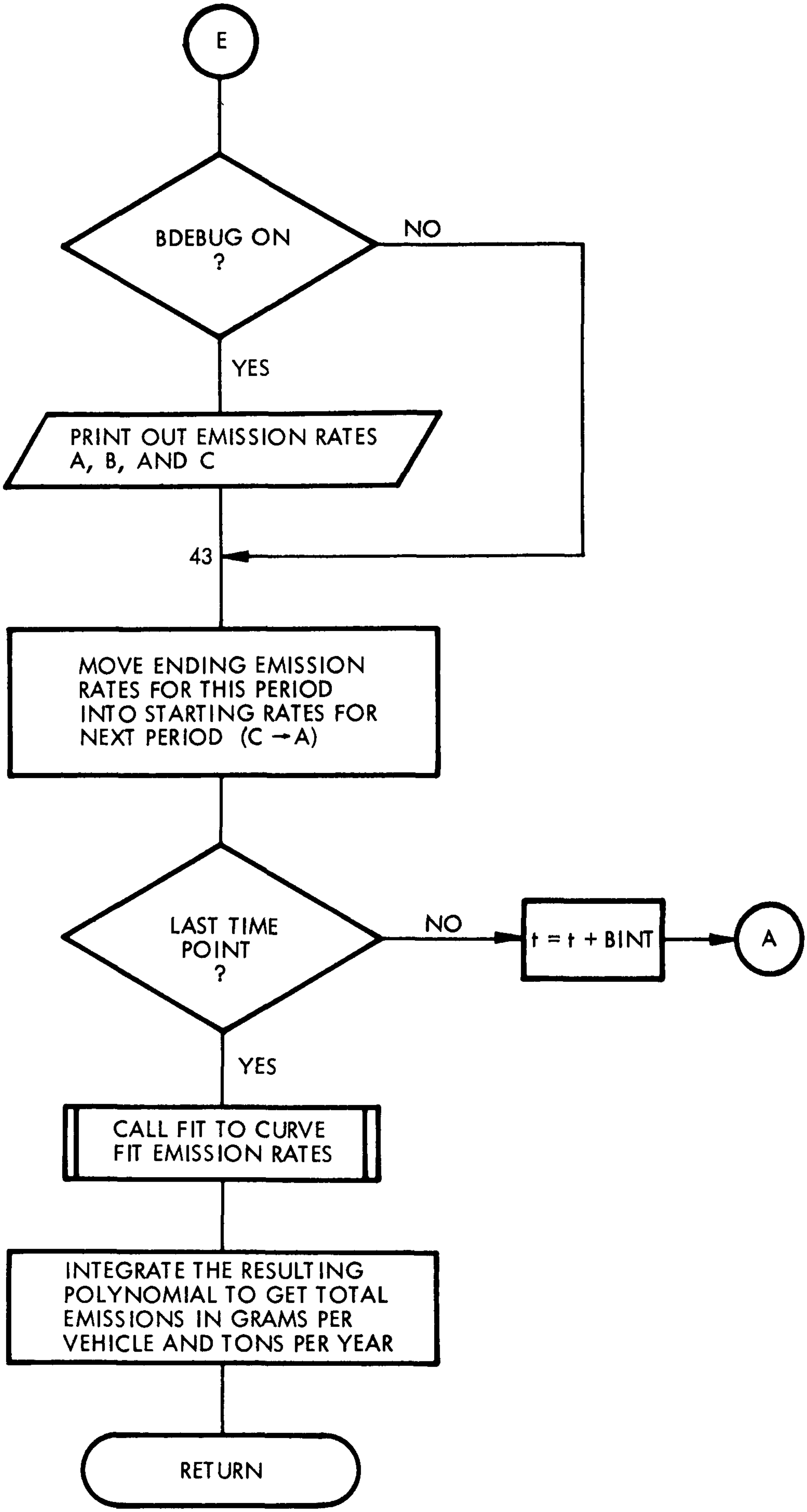


Figure 5-5 Subroutine BLINE Flowchart (cont.)

Table 5-5 SUBROUTINE BLINE LISTING

```
      SUBROUTINE BLINE
      DIMENSION A(15,3),B(15,3),C(15,3)
       COMMON /COMO1/ AMB(3),ALAB,        BINT,
     +    BAREA(3), BLD1,     BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +    BHIST(3,16),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COMO2/           CARA,     CARIY,    CARMY,    CARPOP(16),
     +    CARSY,    CBSUM,    CCCSTI,   CCCSTM,   CGTT,
     +    CINCON,   CPCE,  CPI,      CPVPY,    CSUM,     CARAY,
     +    CN(15,3,16),        CCEFB(15,3),        CCEFBP(10,15),
     +    CPART(10,15)
CC ACC2
       COMMON /CCMO3/           CELPCV,   CP(10,15),CELEM(3,16),CELI(3),
     + EMW(3),        EP(10,15),EFF(10),  DELIT(3),
     +    FRECA,    FRECB,    FFERC(10,3),
     +    HCRZN,    HCRZNY,
     +    HPC(15,16),         HPCS(15,16),        HPP(10,15,16),
     +    HPS(6,15,16),       HPT(5,16),          HPTCT(16),
     +    HPTCTS(16)
CC ACC3
       COMMON /COMO4/           ITE,      ITL,      ITP,      ITIME(16),
     +    KSTART,   KSTCP,    LCPT, LPICK(10),LLPICK,
     +    LIDLE,    LINT(16), LPSPP(10),LSTART,   LSTCP,
     +    MBASE,    MPH,      MSTART,   MSTOP,
     +    ML(10,3),   MMS,         MVPR(10,15)
CC ACC4
       COMMON /CCMO5/           NAME(50), NCNTR,    NEMIS,    NEMP,
     +    NINTR,    NINTRB,   NMODE,    NC,       NCPTS,    NPAR,
     +    NFTRN,    NPTS,     NSTEPS,   NTR,      NTRB,     NPICK(10),
     +    CCIY,     CCMY,     CPTI,     CPTM,OPTS(50),CVCHI(3),CVCHM(3)
CC ACC5
       COMMON /COMO6/PARM(3,3),  PART,     PAYNEW,   PAYOFF(3),
     +    PC(15),   PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15), PT(5),    PTOT,     PTS(5),   PAYADJ,
     +    PAR(10,15,3),       PARI(10,3,3),       PLUS(10,15),
     +    PM(10,15),          PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),  PTA(5),   PCCNF,    PARINT(10,10,9)
     + ,PAYFIN
       COMMON /CCMO7/           REINSP,   RNAME,    RSIZE,    RSTOP,
     +    RTYPE,
     +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
```

```
         +    SMODEL,   START(15,3), STAT,     STIME(3),
         +    SCALEBM(3),          SM(6,15),            SPAR(10,15,6),
         +    SXCUT(6,3),          SIG(10,3),            SIGCE(3),
         +    SIGME(10),           SIGMNE(10),          SIGP(10,15),
         +    SIGRATE,  SIST,       SIGS(6,15),          SIGSDE(3),
         +    STABLEX(33,6,15),     STABLEY(33,6,15)
           COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
         +    TINT,     TDBE(3),  TDNX,     TOTE(3),  TPDB(3),  TPDT(3),
         +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
         +    THIST(5,3,16),       THISTT(3,16),        TIMEC(10,15),
         +    TIMEM(10,15),        TABLEX(33,10,15),     TABLEY(33,10,15)
CC ADD10
           COMMON /COM11/          WF(10),
         +    X1BP(3,3,6), XINT,     XINTB,    XLANE,     XSUM, XCUT(10,3),
         +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
           COMMON /COM12/          Y1BP(3,3,10),        Y2BP(3,3,10),
         +    YES,      YSUM,      YTM(16),     Y1DBP(4,4,10),Y2DBP(4,4,10),
         +    Z1,       Z2,        Z3,       Z4,       Z5,        Z6,
         +    Z7,       Z8,        Z9,       Z10,      Z11,       Z12,
         +    Z13,      Z14,       Z15,      Z16,      Z17,
         +    ZCARI,    ZCARM,     ZIC,      ZSUM,
         +    ZZ(3,3)
CC ADD12
           COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,    DDEBUG,
         +    LDEBUG,   MDEBUG,    PDEBUG,   QDEBUG,   SDEBUG,    TDEBUG
CC ADDD
           REAL         ITE,       ITL,      ITP,      ITIME,
         +    MMS,      MPF,          MU,        MVPR,
         +    NAME,     NC,        LDEBUG,   MDEBUG,
         +    IN,       MISFIRE
           INTEGER      RNAME,     SITEI,    SITEM,    STAT,
         +    TDIST,    XLANE,     DPTI,     PPICK,    PPPICK
CC         ***  BASELINE EMISSIONS
CC         EMISSION SPECIE ---  HC,CO,NO  ---  NEMIS(I)
          DO 5 I=1,NEMIS
          BHIST(I,1)=0
          DO 4 JJ=1,NPTRN
          DO 4 K=1,NCNTR
          J=JJ+5*(K-1)
          A(J,I)=0.
          BHIST(I,1)=BHIST(I,1)+START(J,I)*TPER(1,J)
```

```
    4 CONTINUE
    5 CONTINUE
      IF(DEBUG.EQ.YES) WRITE (6,500)
  500 FORMAT(1H1,10(/),35X,50(1H*)//,45X,
     + *START OF THE BASELINE*/50X,*FLEET ANALYSIS*//
     + 35X,50(1H*))
      DO 50 N=2,NTRB
C:
C:       ADJUST EMISSION MEANS FOR INCOMING NEW CARS.
C:       10.8 PERCENT OF THE FLEET IS NEW EACH YEAR.
C:
      IF(N.EQ.2) GOTO 24
      DO 23 JJ=1,NPTRN
      J=JJ+10
      DO 23 I=1,3
      IF(TPER(N,J).LT.0.108/5.) GOTO 23
      IF(A(J,I).LE.0.) GOTO 23
C:
C:       THE A ARRAY IS A DELTA E ARRAY.  THERFORE, THE
C:       STARTING VALUE IS ZERO.
C:
      A(J,I)=A(J,I)*(TPER(N-1,J)-.108/5.)/TPER(N-1,J)
   23 CONTINUE
   24 CONTINUE
      DO 40 I=1,NEMIS
      SUMJ=0.
      DO 30 JJ=1,NPTRN
      DO 20 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      B(J,I)=A(J,I)+COEFB(J,I)*TMIL(N,J)*BINT
      DELB=0.
      DO 10 M=1,NPAR
       DELB=DELB+FPERC(M,K)*PAR(M,J,I)*BINT/12.
   10 CONTINUE
      C(J,I)=B(J,I)-DELB
      SUMJ=SUMJ+(B(J,I)+C(J,I)+2.*START(J,I))/2.*TPER(N,J)
   20 CONTINUE
   30 CONTINUE
      BHIST(I,N)=SUMJ
   40 CONTINUE
      IF(DEBUG.EQ.NO) GO TO 43
      WRITE (6,42) N
```

Table 5-5 SUBROUTINE BLINE LISTING (cont.)


```
 42    FORMAT(1H1,40X,*TIME HISTCRY PCINT *,I3,* --- *,
      + 2X,*EASELINE*,/)
       CALL PRINT2(A,
      + 50HEMISSICN DELTA BEFORE DECAY
      + ,B,50HEMISSICN DELTA AFTER DECAY
      + ,C,50HEMISSICN DELTA AFTER MAINTENANCE
      + )
 43    CC 45 I=1,NEMIS
       CO 45 JJ=1,NPTRN
       CO 45 K=1,NCNTR
       J=JJ+5*(K-1)
 45    A(J,I)=C(J,I)
 50    CCNTINUE
       CO 100 I=1,NEMIS
       CALL FIT(BHIST,NTRB,AA1,AA2,AA3,I)
       BAREA(I)=(AA1*XINTB+AA2*XINTB**2/2.+AA3*XINTB**3/3.)*
      + MEASE*BINT
       TCBE(I)=BAREA(I)*CARPOP(16)/CGTT
100    CCNTINUE
        RETURN
        END
```

to zero then represents the starting emission values (emission values in the A, B and C arrays are stored as differences from the starting value). Next, MICRO initializes the N loop, from 2 to NTR, where NTR is the number of inspection intervals. If the LPICK flag A is "turned on", MICRO calls OPTMUM to compute the optimal parameter cutpoints for an inspection/maintenance program. MICRO then adjusts the average emission rates to reflect new cars entering the population and starts the actual inspection/maintenance simulation.

Simulation of the inspection/maintenance process begins with the parameter deterioration routine which adjusts the engine parameters distributions based on parameter deterioration over time. MICRO then calls EDECAY to similarly deteriorate the vehicle emission levels. Subroutine TEST, which simulates the actual inspection process, is called next. TEST computes rejection rates and mean value of rejected parameters for each subfleet in the population. Subroutine TEST also calls the PMAINT routine which adjusts parameter distributions to account for mandatory maintenance. MICRO next calls MAINT which computes the actual emission reduction achieved due to the maintenance treatment.

MICRO then outputs these calculations, based on appropriate flags and updates the emission arrays. This is done by moving the BM array which represents the post maintenance emission rates back into the A array. The time value is incremented and, if the NPICT flag is set, the statistical routines are executed and MICRO proceeds to the next inspection interval.

After simulating the inspection/maintenance process over its entire time horizon, MICRO calls FIT to curve fit the emission time histories using a second degree polynomial. This polynomial is integrated to obtain total yearly emissions for the program. The mandatory and voluntary emission time histories are plotted by calling subroutine PLOT. Figure 5-6 contains a flowchart of MICRO and Table 5-6 a listing.

5.6 SUBROUTINE TEST

Subroutine TEST contains the logic and algorithms for performing a mandatory inspection on a vehicle population. Input to TEST are indicies JJ and N, where JJ is the parameter power train type and N is the inspection interval number. TEST initializes the appropriate variables to zero and branches on inspection type. For a parameter inspection, TEST computes the expected value of rejected parameters by calling AREA with the first argument equal to one and the expected rejection rates by calling AREA with the first argument equal to zero. TEST also calls PMAINT which updates the parameter distributions. For an Emission Inspection, TEST computes the rejection rate based on the mode emission distributions and specified cutpoints. These values are then used to adjust the parameter distributions. Subroutine TEST then computes, for both parameter and emission cases ,the total overall rejection rate for the vehicle population (i.e., number of cars that failed). Subroutine TEST also computes various cost information and prints out all computations when the TDEBUG flag is set to YES. TEST returns control to subroutine MICRO.

Output from subroutine TEST consists of the average rejection rates, mean value of the rejected parameters, and new post maintenance parameter distributions for each of the six distributed parameters. Figure 5-7 contains a flowchart of TEST and Table 5-7 a Listing.

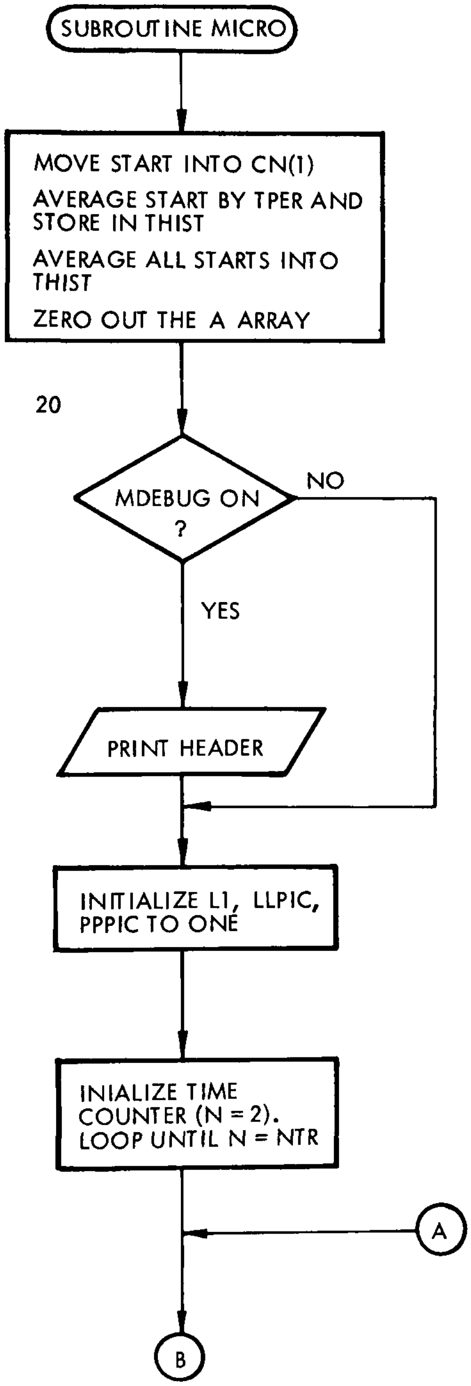


Figure 5-6 Subroutine MICRO Flowchart

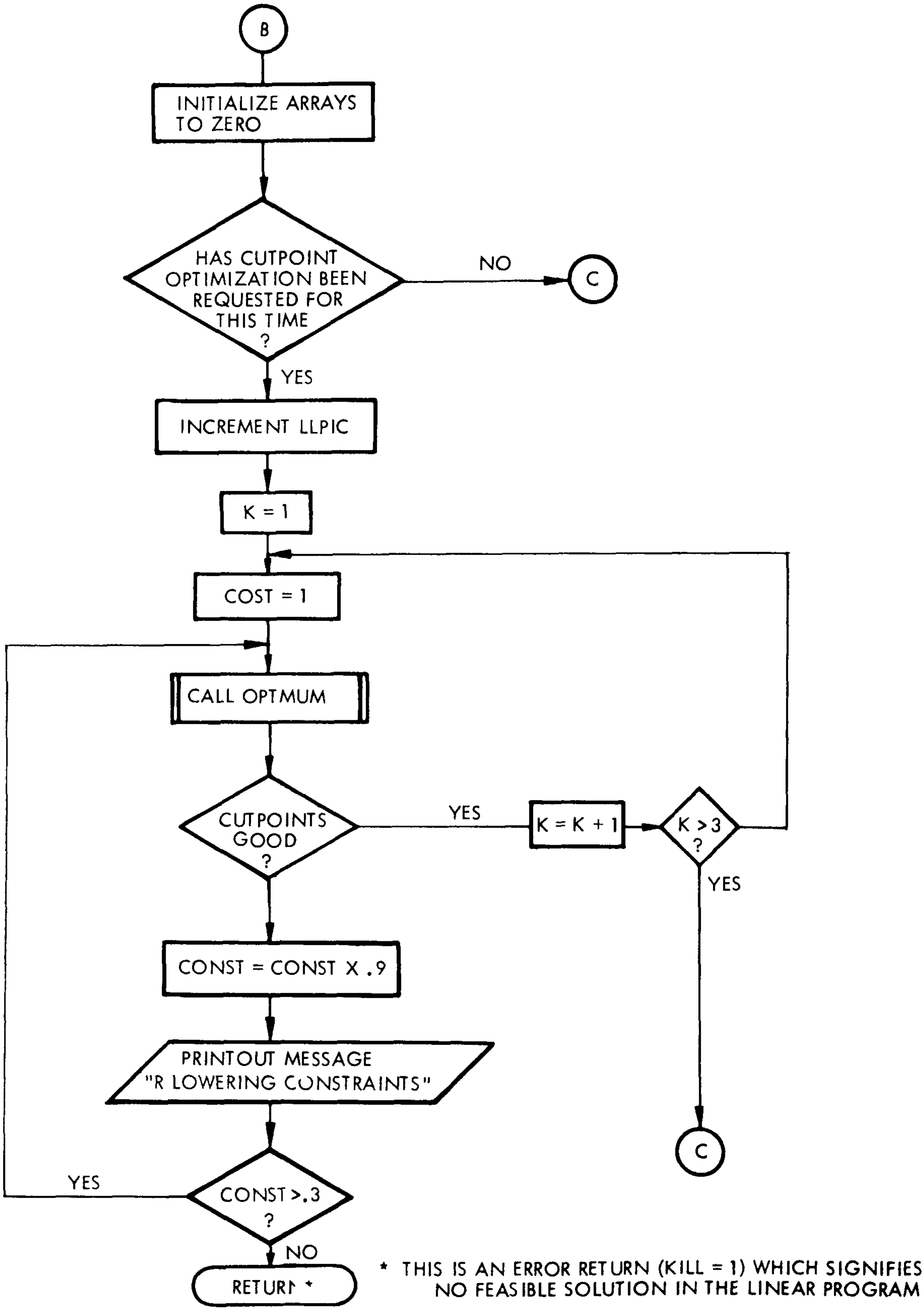


Figure 5-6 Subroutine MICRO Flowchart (cont.)

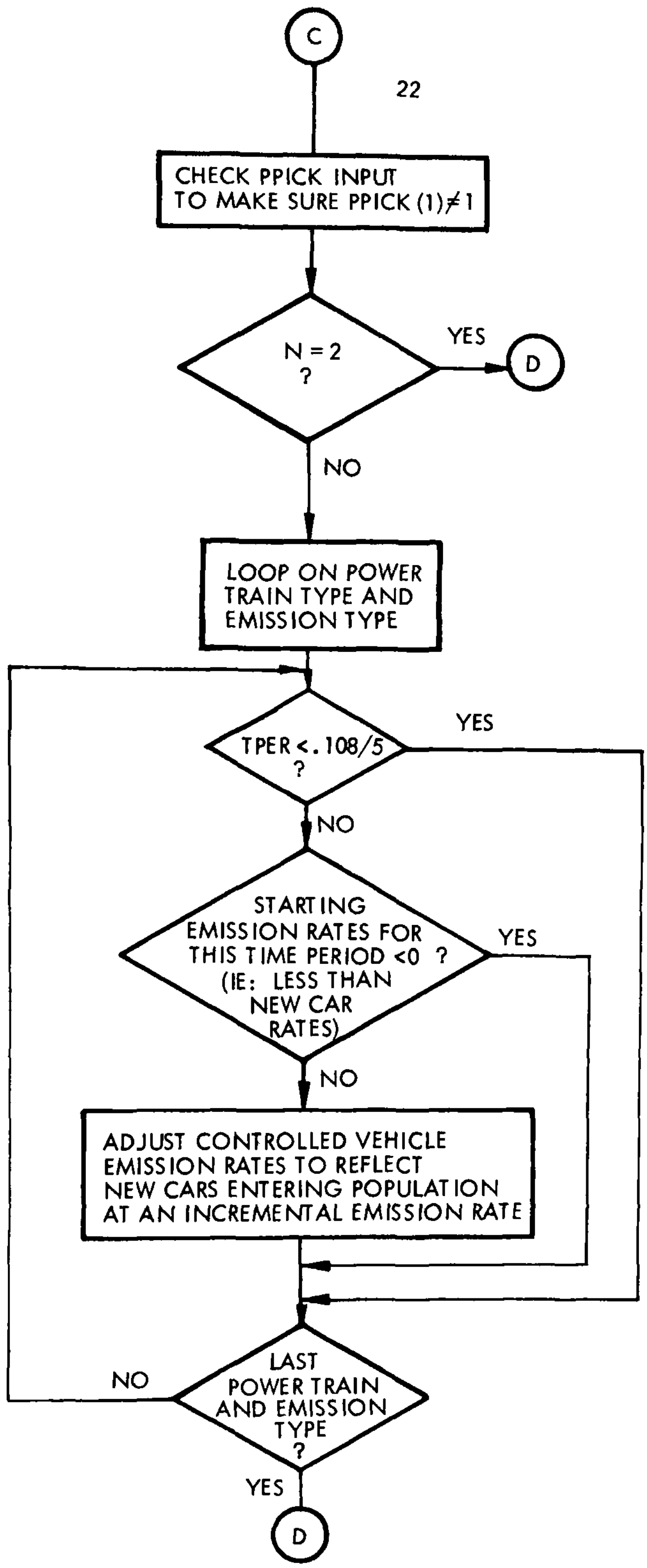


Figure 5-6 Subroutine MICRO Flowchart (cont.)

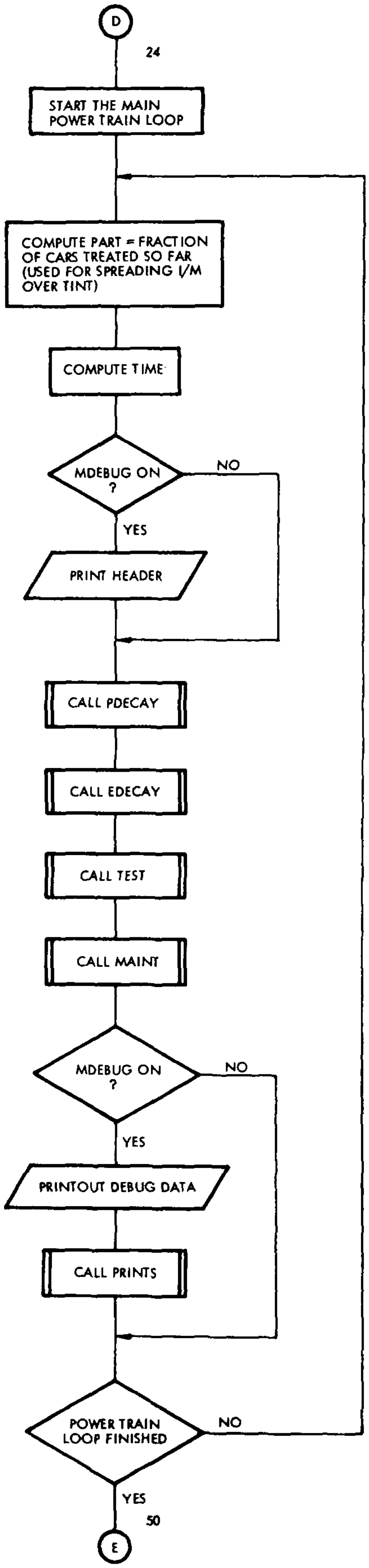


Figure 5-6 Subroutine MICRO Flowchart (cont.)

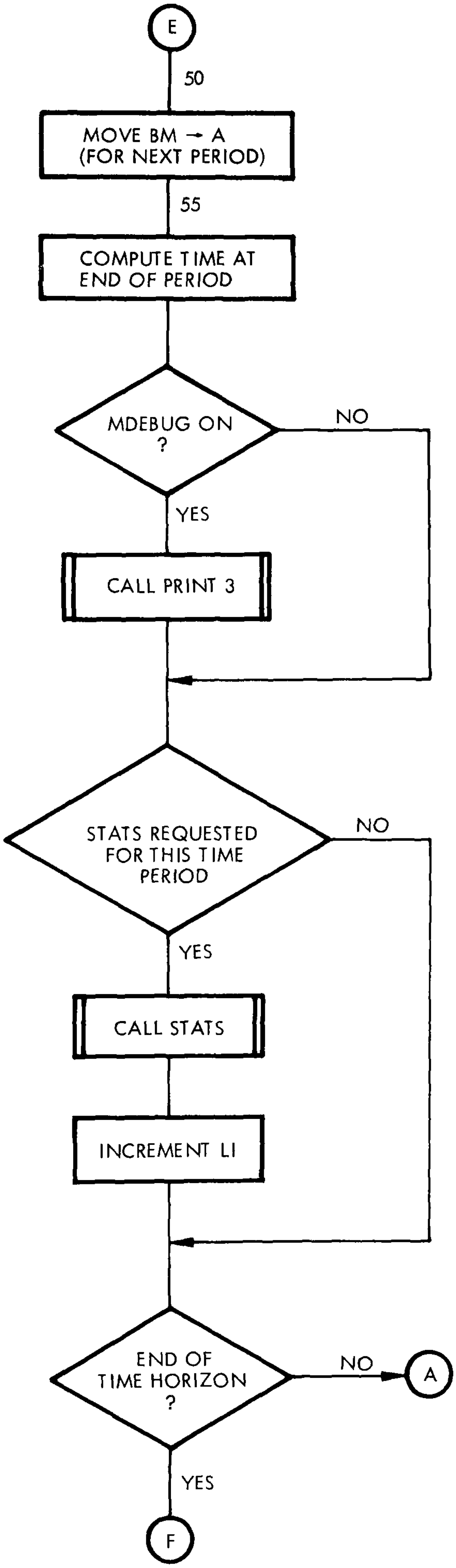


Figure 5-6 Subroutine MICRO Flowchart (cont.)

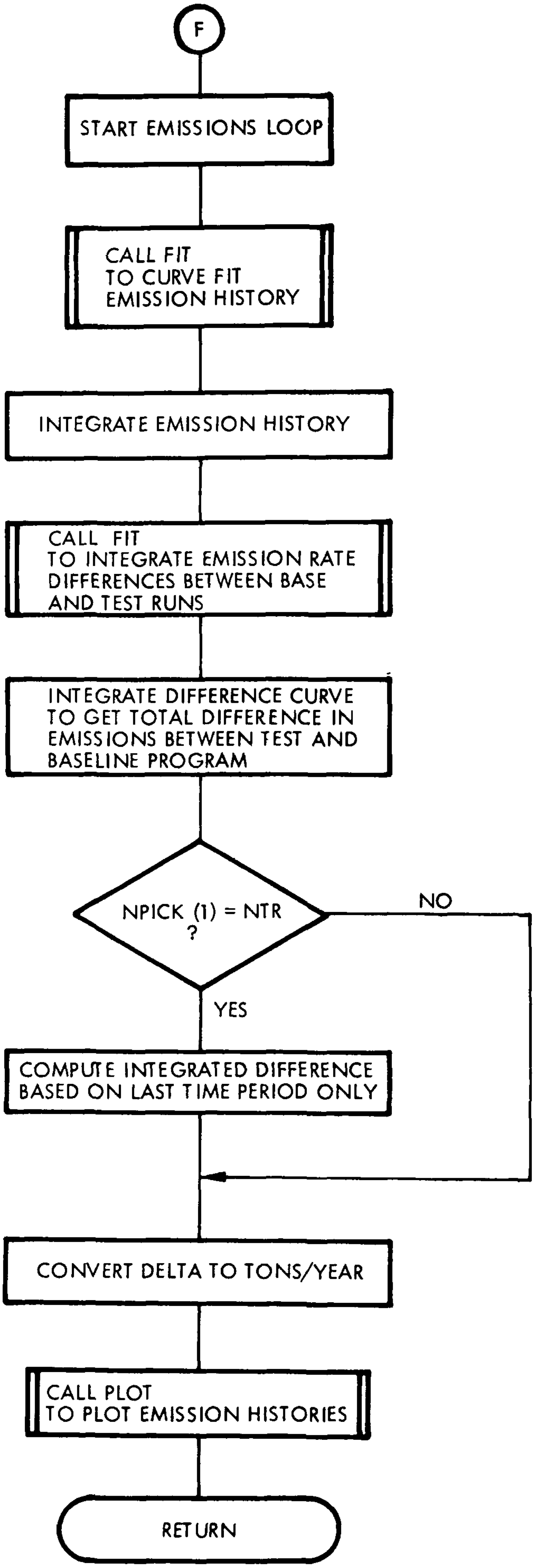


Figure 5-6 Subroutine MICRO Flowchart (cont.)

Table 5-6 SUBROUTINE MICRO LISTING

```
            SUBROUTINE MICRO (KILL)
           DIMENSION A(15,3),B(15,3),BM(15,3)
            COMMON /COM01/      AMB(3),ALAB,     AVV,  BINT,
     +         BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,    BSIZE,
     +         BHIST(3,16),         BMMI(10,15,3),
     +         ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
            COMMON /COM02/            CARA,      CARIY,    CAFMY,    CARPOP(16),
     +         CARSY,     CBSUM,    CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +         CINCON,    CPCB,  CPI,      CPVPY,    CSUM,     CARAY,
     +         CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
     +         CPART(10,15)
CC ADD2
            COMMON /COM03/            DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),  DELIT(3),
     +         FREQA,     FREQB,    FPERC(10,3),
     +         HORZN,     HORZNY,
     +         HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
     +         HPS(6,15,16),        HPT(5,16),           HPTOT(16),
     +         HPTOTS(16)
CC ADD3
            COMMON /COM04/            ITE,       ITL,      ITP,      ITIME(16),
     +         KSTART,    KSTOP,    LOPT,  LPICK(10),LLPICK,
     +         LIDLE,     LINT(16), LPSPP(10),LSTART,   LSTOP,
     +         MBASE,     MPH,      MSPEC(10),MSTART,   MSTOP,
     +         MU(10,3),    MMS(10,15),         MVPR(10,15)
CC ADD4
            COMMON /COM05/            NAME(50), NCNTR,    NEMIS,    NEMP,
     +         NINTR,     NINTRB,   NMODE,    NO,       NOPTS,    NPAR,
     +         NPTRN,     NPTS,     NSTEPS,   NTR,      NTRB,     NPICK(16),
     +         OCIY,      OCMY,     OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
            COMMON /COM06/PARM(3,3),  PART,     PAYNEW,   PAYOFF(3),
     +         PC(15),    PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +         PP(10,15),PS(6,15),  PT(5),    PTOT,     PTS(5),  PAYADJ,
     +         PAR(10,15,3),        PAR1(10,3,3),       PLUS(10,15),
     +         PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +         PSA(15),   PTA(5),   PCONF,    PARINT(10,10,9)
     + ,PAYFIN
            COMMON /COM07/            REINSP,   RNAME,    RSIZE,    RSTOP,
     +         RTYPE,
     +         SALE,      SALL,     SALP,     SITEI,    SITEM,    SLANE,
```

Table 5-6 SUBROUTINE MICRO LISTING (cont.)

```
          +     SMODEL,     START(15,3),  STAT,      STIME(3),  SUMBM(3),
          +     SCALEBM(3),             SM(6,15),              SPAR(10,15,6),
          +     SXCUT(6,3),             SIG(10,3),              SIGCE(3),
          +     SIGME(10),              SIGMNE(10),            SIGP(10,15),
          +     SIGRATE,   SIST,          SIGS(6,15),            SIGSDE(3),
          +     STABLEX(33,6,15),         STABLEY(33,6,15)
             COMMON /COM10/             TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
          +     TINT,      TOBF(3),     TONX,      TOTE(3),  TPDB(3),  TPOT(3),
          +     TXTRA,     TSIZE,        TSIG(3),  TPER(16,15),  TMIL(16,15),
          +     THIST(5,3,16),          THISTT(3,16),          TIMEC(10,15),
          +     TIMEM(10,15),           TABLEX(33,10,15),       TABLEY(33,10,15)
CC ADD10
             COMMON /COM11/             VF(10),
          +     XIBP(3,3,6), XINT,         XINTB,     XLANE,      XSUM, XCUT(10,3),
          +     XTM(16),   XBASE(9,3),YBASE(9,3)
CC ADD11
             COMMON /COM12/             Y1BP(3,3,10),          Y2BP(3,3,10),
          +     YES,       YSUM,        YTM(16),     Y1DBP(4,4,10),Y2DBP(4,4,10),
          +     Z1,        Z2,          Z3,        Z4,        Z5,        Z6,
          +     Z7,        Z8,          Z9,        Z10,       Z11,       Z12,
          +     Z13,       Z14,         Z15,       Z16,       Z17,
          +     ZCARI,     ZCARM,       ZIC,       ZSUM,
          +     ZZ(3,3)
CC ADD12
             COMMON /DEBUG/             ADEBUG,    BDEBUG,    CDEBUG,    DDEBUG,
          +     LDEBUG,    MDEBUG,      PDEBUG,    QDEBUG,    SDEBUG,    TDEBUG
CC ADDO
             REAL                ITE,         ITL,       ITP,       ITIME,
          +     MMS,       MPH,         MSPEC,     MU,        MVPR,
          +     NAME,      NO,          LDEBUG,    MDEBUG,
          +     IN,        MISFIRE
             INTEGER             RNAME,       SITEI,     SITEM,     STAT,
          +     TDIST,     XLANE,       OPTI,      PPICK,     PPPICK
            THISTT(1,1)=THISTT(2,1)=THISTT(3,1)=0.
            DO 20 I=1,NEMIS
            DO 20 JJ=1,NPTRN
            TH=0
            T=0
            DO 10 K=1,NCNTR
            J=JJ+5*(K-1)
            CN(J,I,1)=START(J,I)
            TH=TH+START(J,I)*TPER(1,J)
```

Table 5-6 SUBROUTINE MICRO LISTING (cont.)

```
           T=T+TPER(1,J)
   10      CONTINUE
           THIST(JJ,I,1)=TH/T
           THISTT(I,1)=THISTT(I,1)+THIST(JJ,I,1)*(TPER(1,JJ)
     +     +TPER(1,JJ+5)+TPER(1,JJ+10))
           DO 20 K=1,NCNTR
           J=JJ+5*(K-1)
           A(J,I)=0.
   20      CONTINUE
           IF(MDEBUG.EQ.YES) WRITE (6,505)
  505      FORMAT(1H1,10(/),35X,50(1H*)//,45X,*START OF THE*,
     +     * TESTING CYCLES*,/45X,*DECAY  -  TEST  -  MAINT*//
     +     35X,50(1H*))
           L1=1
           LLPICK=1
           PPPICK=1
           DO 100 N=2,NTR
           XTM(N)=YTM(N)=PART=THISTT(1,N)=THISTT(2,N)=THISTT(3,N)=0.
           HPTOT(N)=HPTOTS(N)=0.
C:
C:            CUTPOINT OPTIMIZATION WITH LINPRO.
C:
           IF(N.NE.LPICK(LLPICK)) GOTO 22
           LLPICK=LLPICK+1
           DO 21 K=1,3
           CONST=1.0
   15      CALL OPTMUM (K,KILL,N,CONST)
           IF(KILL.NE.1) GOTO 21
           CONST=CONST*0.9
           WRITE(6,998)
  998      FORMAT(/* NO FEASIBLE SOL. LOWERING CONSTRAINTS.*/)
           IF(CONST.GE.0.3) GOTO 15
           RETURN
   21      CONTINUE
   22      CONTINUE
           IF(N.GT.PPICK(PPPICK)) PPPICK=PPPICK+1
C:
C:            ADJUST EMISSION MEANS FOR INCOMING NEW CARS.
C:            10.8 PERCENT OF THE FLEET IS NEW EACH YEAR.
C:
           IF(N.EQ.2) GOTO 24
           DO 23 JJ=1,NPTRN
```

```
      J=JJ+10
      DO 23 I=1,3
      IF(TPER(N,J).LT.0.108/5.) GOTO 23
      IF(A(J,I).LE.0.) GOTO 23
C:
C:       THE A ARRAY IS A DELTA E ARRAY.  THERFORE, THE
C:       STARTING VALUE IS ZERO.
C:
      A(J,I)=A(J,I)*(TPER(N-1,J)-.108/5.)/TPER(N-1,J)
   23 CONTINUE
   24 CONTINUE
      DO 50 JJ=1,NPTRN
C:
C:       START THE POWER TRAIN LOOP.
C:
      PART=PART+TPER(1,JJ)+TPER(1,JJ+5)+TPER(1,JJ+10)
      TIME=TINT*(N-2+PART)
      IF(MDEBUG.EQ.YES) WRITE (6,25) TIME
       CALL PDECAY(JJ,N)
      CALL EDECAY(A,B,JJ,N)
      CALL TEST(JJ,N)
      CALL MAINT(B,BM,JJ,N)
   25 FORMAT(1H1,40X,*DEBUG  --  MICRO*//38X,*TIME DURATION IS *,
     + F5.1* MONTHS*)
      IF(MDEBUG.EQ.NO) GO TO 50
      WRITE (6,30) NAME(JJ+10)
   30 FORMAT(1H1,40X,A8//,
     +/,35X,*A -- EMISSION DELTA BEFORE DECAY*/
     + 35X,*B -- EMISSION DELTA AFTER DECAY*/,35X,
     + *C -- EMISSION DELTA AFTER DECAY AND MAINTENANCE*/)
      DO 40 I=1,NEMIS
      WRITE (6,35) NAME(I),NAME(4),NAME(5),NAME(6),
     + A(JJ,I),A(JJ+5,I),A(JJ+10,I),B(JJ,I),B(JJ+5,I),
     + B(JJ+10,I),BM(JJ,I),BM(JJ+5,I),BM(JJ+10,I)
   35 FORMAT(/,40X,A2,* EMISSION DELTA*,/,
     + /,26X,A8,12X,A8,12X,A8,//,18X,*A *,3(5X,E15.4),
     + /,18X,*B *,3(5X,E15.4)/,18X,*C *,3(5X,E15.4)/)
   40 CONTINUE
      IF (RTYPE.EQ.SMODEL) CALL PRINT5(
     + SM,50HMEAN VALUE OF THE MODE EMISSIONS
     + ,SIGS,50HSIGMA VALUES OF THE MODE EMISSIONS
     + )
```

Table 5-6 SUBROUTINE MICRO LISTING (cont.)

```
   50 CONTINUE
      NN=3*NPTRN
      DO 55 J=1,NN
      DO 55 I=1,NEMIS
 55   A(J,I)=BM(J,I)
      TIME=TINT*(N-1)
      N1=N-1
      IF(MDEBUG.EQ.YES) CALL PRINT3(
     + PM,50HPM   -  PARAMTER MEAN VALUES AFTER PDECAY
     + ,PLUS,50HPLUS  --  PARAMETER CHANGE   --  DECAY AND MAINT
     + )
      IF(N.NE.NPICK(L1)) GO TO 100
      L1=L1+1
      CALL STATS(N,1)
  100 CONTINUE
      DO 150 I=1,NEMIS
      CALL FIT(THISTT,NTR,CC1,CC2,CC3,I)
      TAREA(I)=(CC1*XINT+CC2*XINT**2/2.+CC3*XINT**3/3.)*
     *TINT*MBASE
      CALL FIT(DELEM,NTR,DD1,DD2,DD3,I)
      DELI(I)=(DD1*XINT+DD2*XINT**2/2.+
     + DD3*XINT**3/3.)*TINT*MBASE*CARPOP(16)
      IF(NPICK(1).EQ.NTR) DELI(I)=DELEM(I,NTR)*MBASE*TINT*CARPOP(NTR)
      DELIT(I)=DELI(I)/CGTT
      CALL PLOT(THISTT,BHIST,NTR,TXTRA,7,0,TINT,0.,PLTMAX(I),I)
  150 CONTINUE
  999 FORMAT(1H1)
      RETURN
      END
```

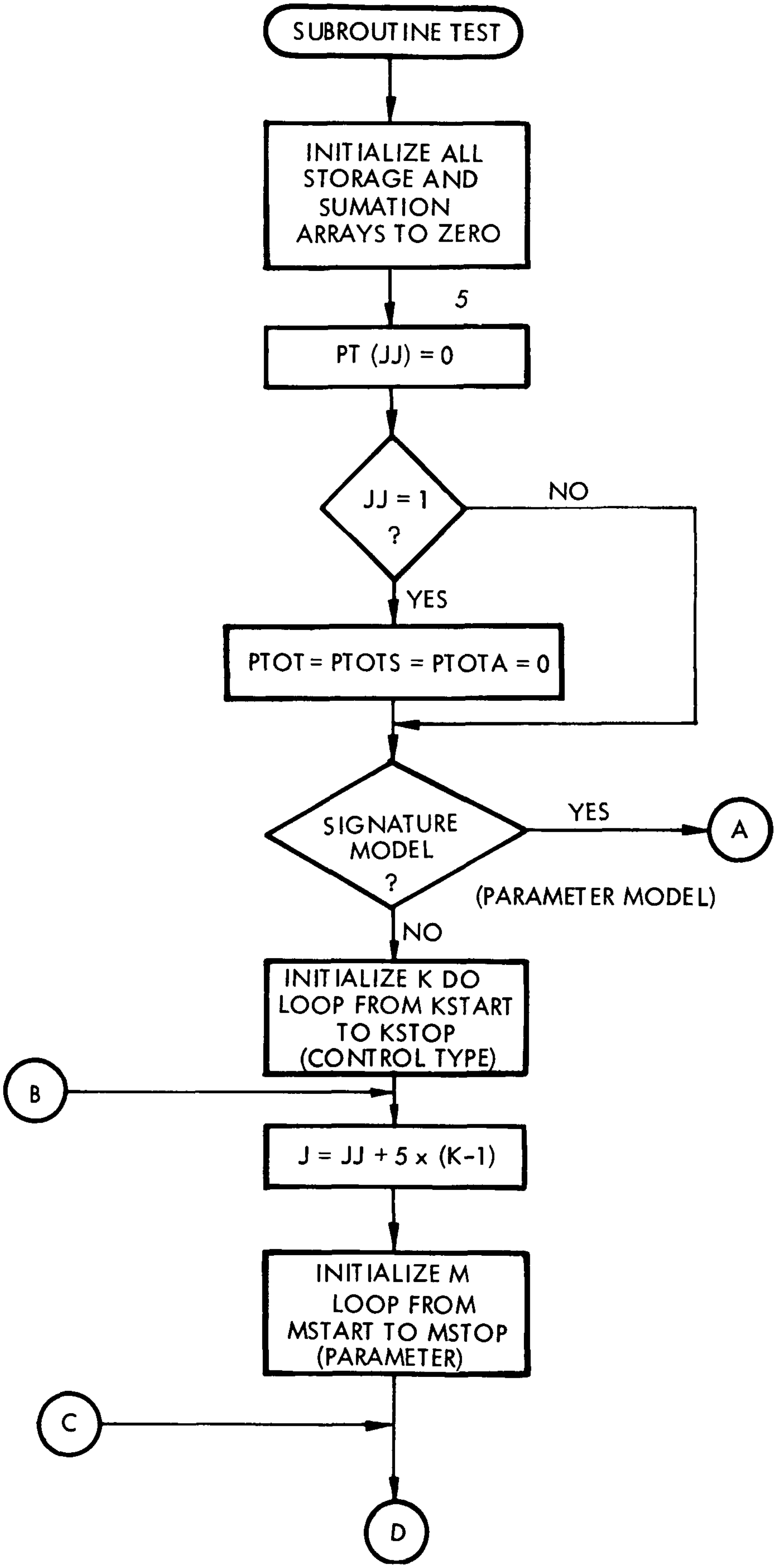


Figure 5-7 Subroutine TEST Flowchart

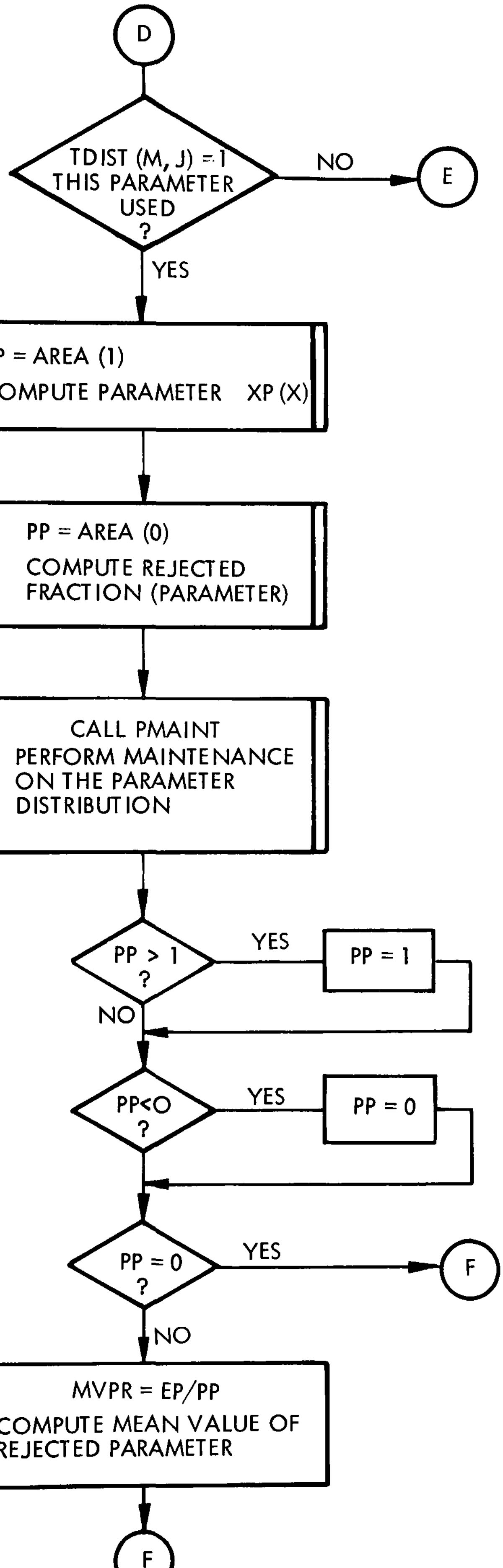


Figure 5-7 Subroutine TEST Flowchart (cont.)

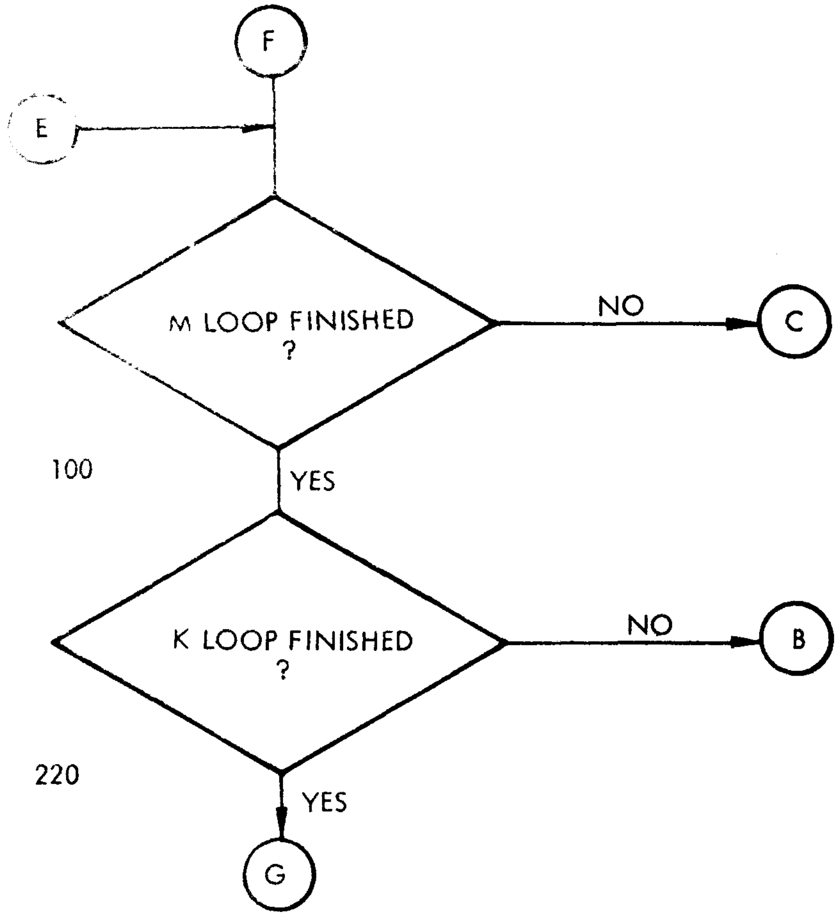


Figure 5-7 Subroutine TEST Flowchart (cont.)

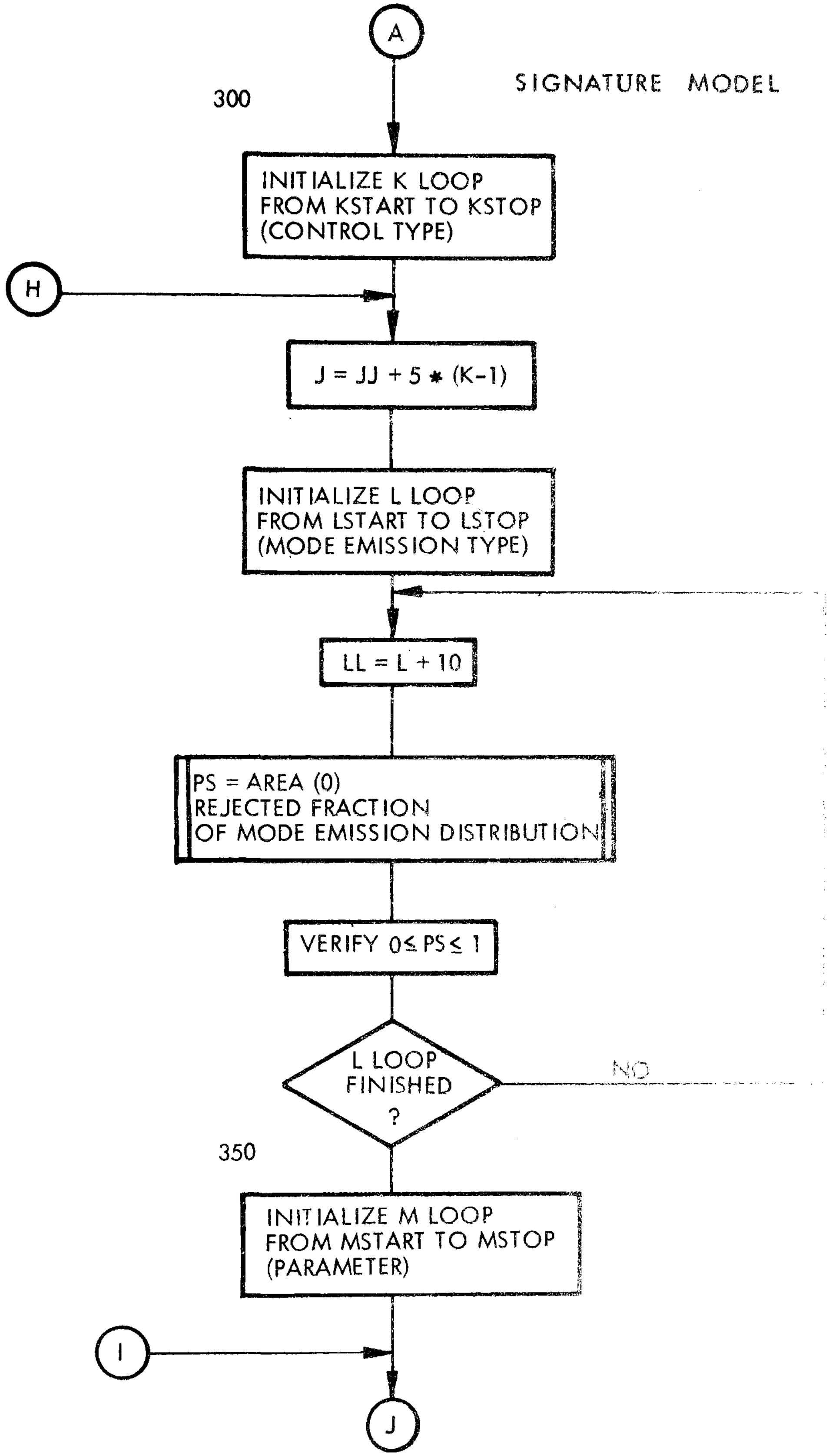


Figure 5-7 Subroutine TEST Flowchart (cont.)

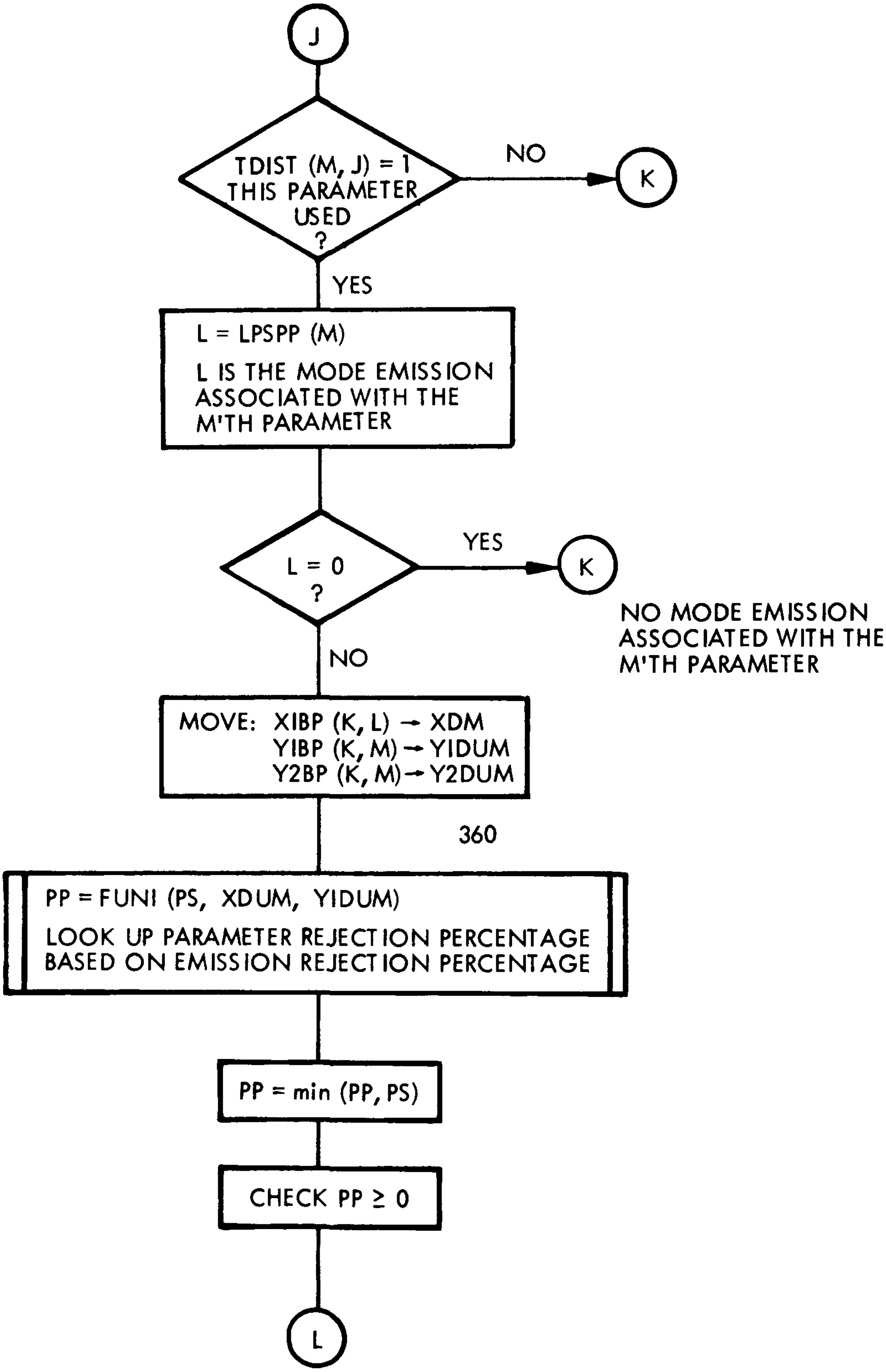


Figure 5-7 Subroutine TEST Flowchart (cont.)

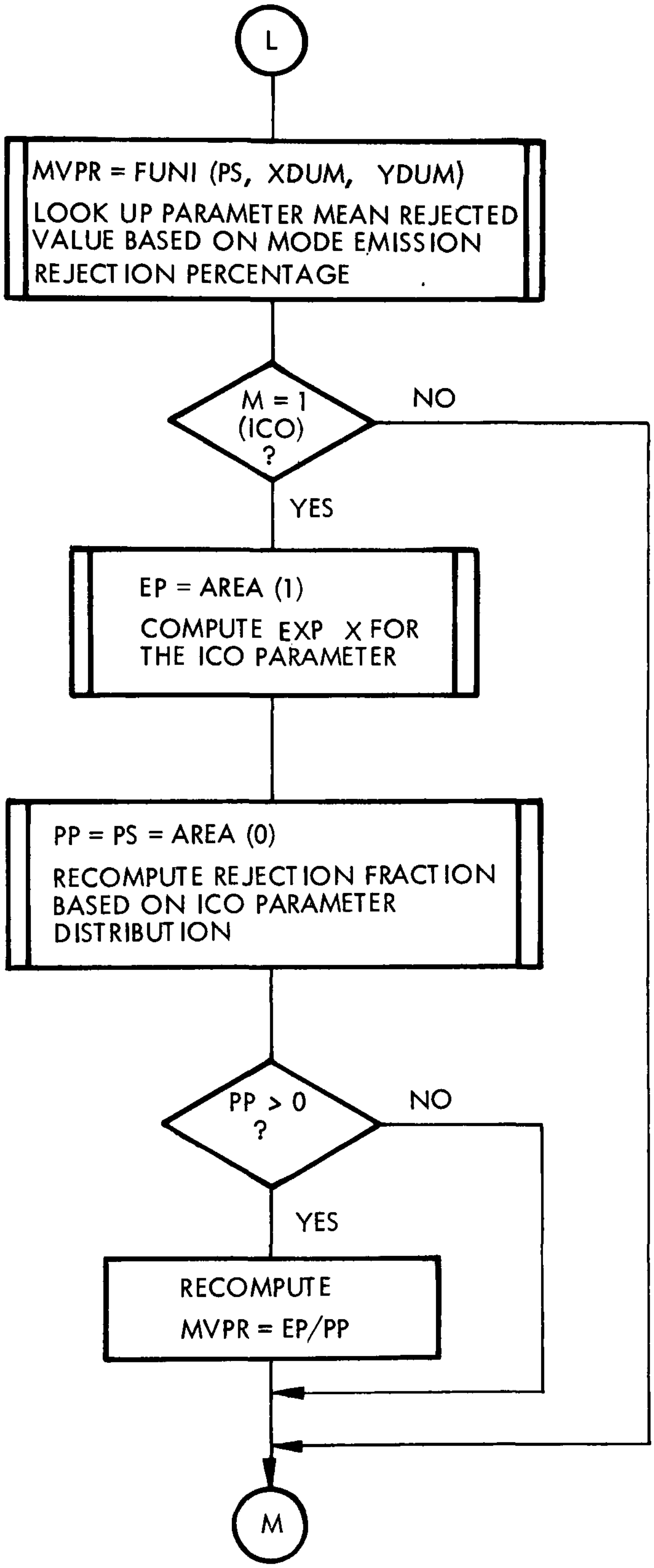


Figure 5-7 Subroutine TEST Flowchart (cont.)

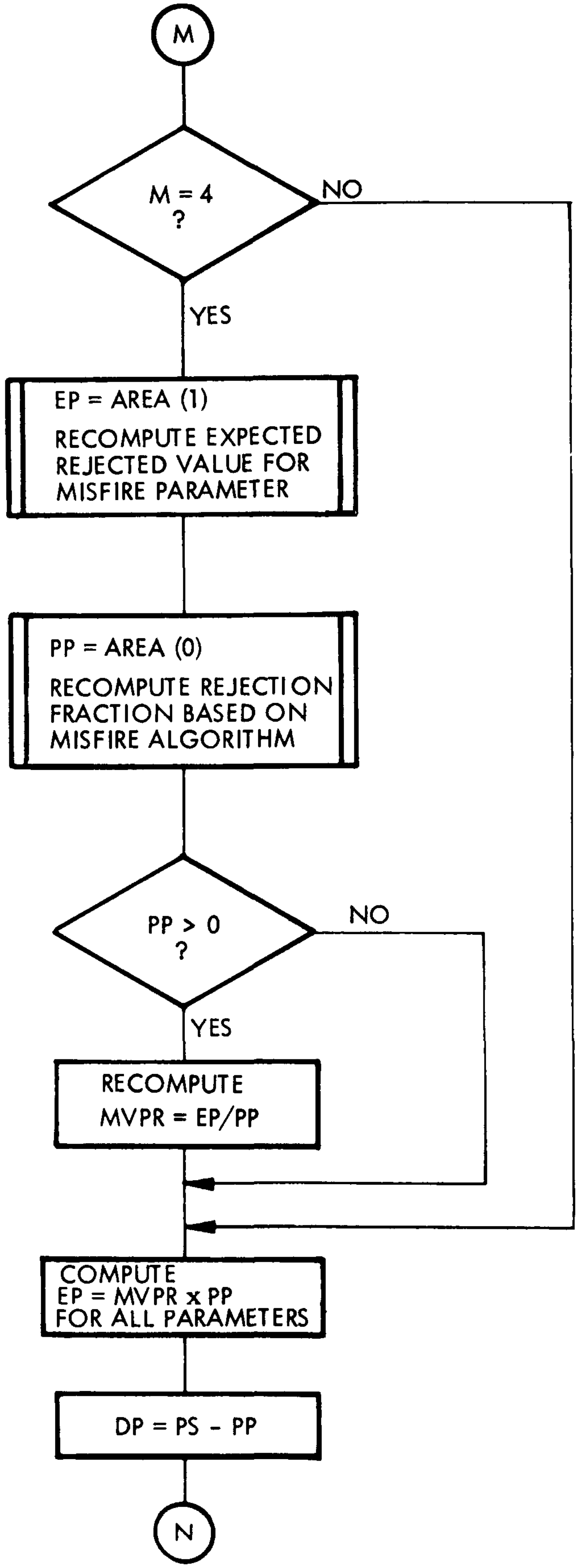


Figure 5-7 Subroutine TEST Flowchart (cont.)

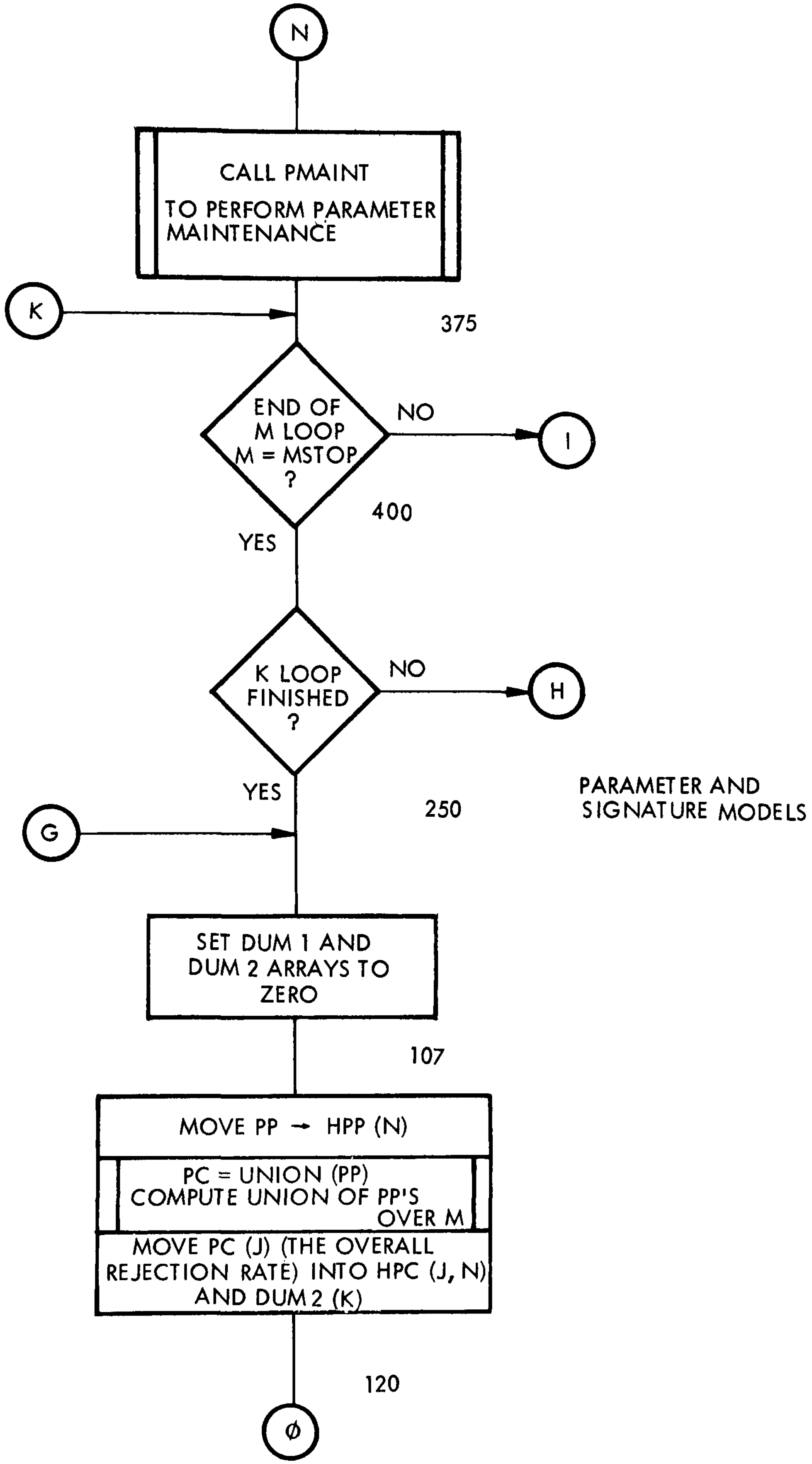


Figure 5-7 Subroutine TEST Flowchart (cont.)

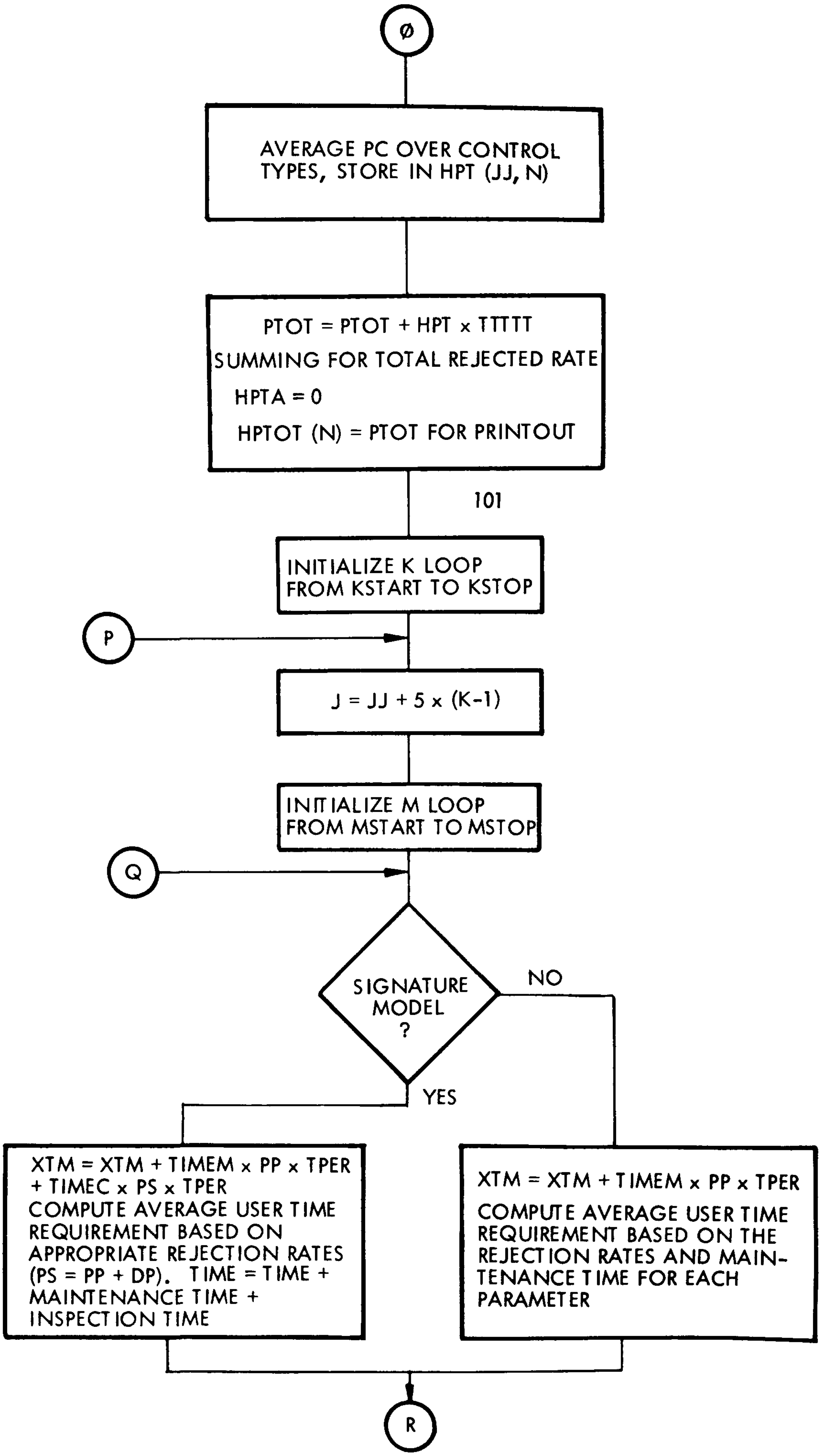


Figure 5-7 Subroutine TEST Flowchart (cont.)

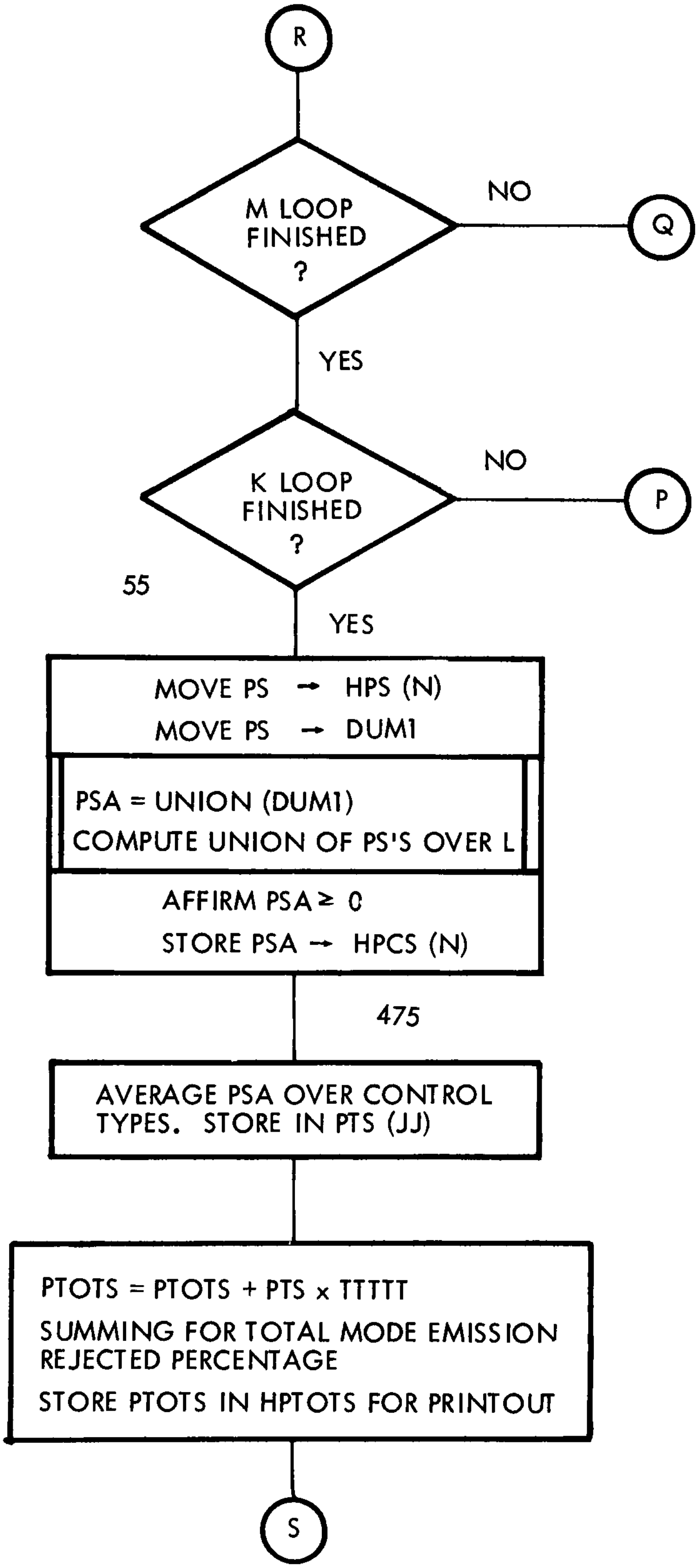


Figure 5-7 Subroutine TEST Flowchart (cont.)

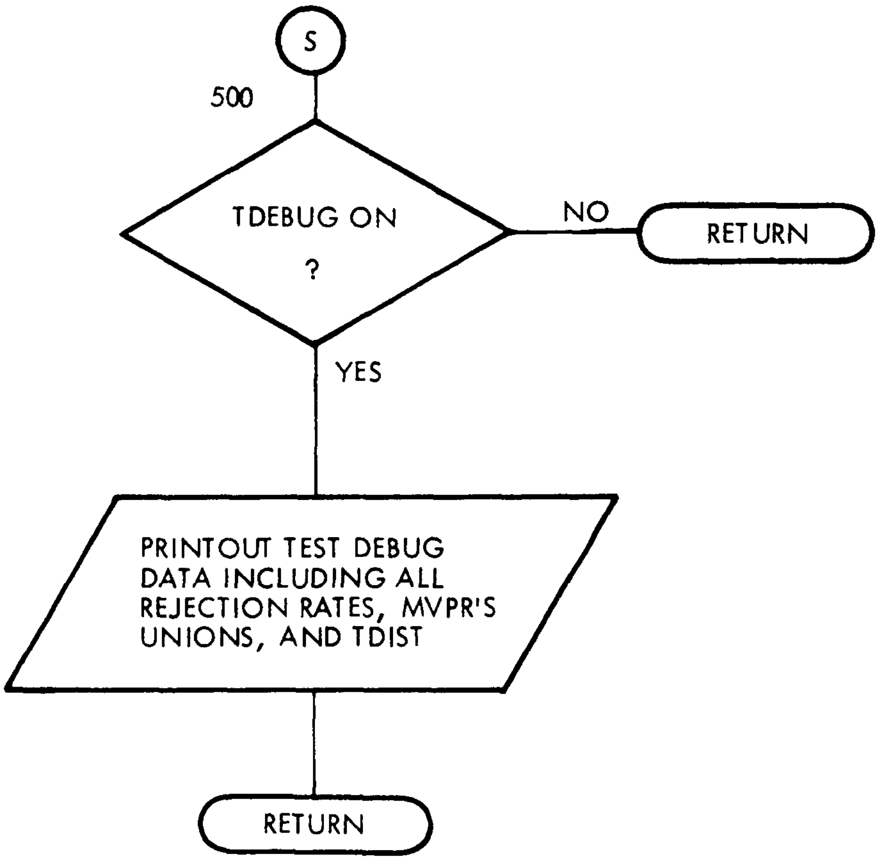


Figure 5-7 Subroutine TEST Flowchart (cont.)

Table 5-7 SUBROUTINE TEST LISTING

```
      SUBROUTINE TEST(JJ,N)
      DIMENSION DUM1(10),DUM2(3),DUM3(3)
      DIMENSION XDUM(3),Y1DUM(3),Y2DUM(3),Y1DDUM(3,3),Y2DDUM(3,3)
       COMMON /COM01/     AMB(3),ALAB,     AVV,  BINT,
     +    BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,     BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/          CARA,      CARIY,     CARMY,     CARPOP(16),
     +    CARSY,    CBSUM,     CCOEF(10),CCOSTI,   CCOSTM,    CGTT,
     +    CINCON,   CPCB,  CPI,       CPVPY,    CSUM,      CARAY,
     +    CN(15,3,16),         COEFB(15,3),        COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
       COMMON /COM03/          DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),      EP(10,15),EFF(10),  DELIT(3),
     +    FREQA,    FREQB,     FPERC(10,3),
     +    HORZN,    HORZNY,
     +    HPC(15,16),          HPCS(15,16),        HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),          HPTOT(16),
     +    HPTOTS(16)
CC ADD3
       COMMON /COM04/          ITE,       ITL,       ITP,       ITIME(16),
     +    KSTART,   KSTOP,     LOPT,  LPICK(10),LLPICK,
     +    LIDLE,    LINT(16), LPSPP(10),LSTART,  LSTOP,
     +    MBASE,    MPH,       MSPEC(10),MSTART,  MSTOP,
     +    MU(10,3),   MMS(10,15),      MVPR(10,15)
CC ADD4
       COMMON /COM05/          NAME(50), NCNTR,     NEMIS,     NEMP,
     +    NINTR,    NINTRB,    NMODE,     NO,        NOPTS,     NPAR,
     +    NPTRN,    NPTS,      NSTEPS,    NTR,       NTRB,      NPICK(16),
     +    OCIY,     OCMY,      OPTI,      OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/PARM(3,3),  PART,       PAYNEW,   PAYOFF(3),
     +    PC(15),   PCS(15),   PHI(14),   PLO(14),   PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15), PT(5),     PTOT,      PTS(5),   PAYADJ,
     +    PAR(10,15,3),        PAR1(10,3,3),       PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),  PTA(5),    PCONF,     PARINT(10,10,9)
     + ,PAYFIN
       COMMON /COM07/          REINSP,    RNAME,     RSIZE,     RSTOP,
     +    RTYPE,
```

```
     +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
     +    SMODEL,   START(15,3), STAT,    STIME(3), SUMBM(3),
     +    SCALEBM(3),         SM(6,15),           SPAR(10,15,6),
     +    SXCUT(6,3),         SIG(10,3),           SIGCE(3),
     +    SIGME(10),          SIGMNE(10),         SIGP(10,15),
     +    SIGRATE,  SIST,      SIGS(6,15),         SIGSDE(3),
     +    STABLEX(33,6,15),    STABLEY(33,6,15)
      COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TONX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),      THISTT(3,16),       TIMEC(10,15),
     +    TIMEM(10,15),       TABLEX(33,10,15),    TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/          WF(10),
     +    X1BP(3,3,6), XINT,     XINTB,    XLANE,    XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/          Y1BP(3,3,10),       Y2BP(3,3,10),
     +    YES,      YSUM,     YTM(16),  Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,       Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,       Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,      Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,    ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,   PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL                ITE,      ITL,      ITP,      ITIME,
     +    MMS,      MPH,      MSPEC,    MU,       MVPR,
     +    NAME,     NO,       LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER             RNAME,    SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,    OPTI,     PPICK,    PPPICK
C     PARAMETER MODEL
      DO 5 I=1,NEMIS
      DO 5 K=1,NCNTR
      DUM2(K)=DUM3(K)=0.
      J=JJ+5*(K-1)
      DO 5 M=1,NPAR
      DUM1(M)=0.
      DP(M,J)=0.
```

```
      EP(M,J)=0.
      PP(M,J)=0.
      PC(J)=0.
      MVPR(M,J)=0.
      DO 5 L=1,NMODE
      PS(L,J)=0.
    5 CONTINUE
      PT(JJ)=C.
      IF(JJ.EQ.1) PTOT=PTOTS=PTOTA=0.
      IF(RTYPE.EQ.SMODEL) GO TO 300
CC    ENGINE PARAMETERS
CC    M=1  DELTA CO
CC    M=2  DELTA RPM
CC    M=3  DELTA TIMING
CC    M=4  MISFIRE
CC    M=5  NOX CONTROL
CC    M=6  AIRPUMP
CC    M=7  PCV
CC    M=8  AIR CLEANER
CC    M=9  VACCUUM CHOKE KICK
CC    M=10 CHOKE BLADE SETTING
CC    L = 1  HC - IDLE
CC    L = 2  CO - IDLE
CC    L = 3  NO - IDLE
CC    L = 4  HC CRUISE (45)
CC    L = 5  CO CRUISE (45)
CC    L = 6  NO CRUISE (45)
CC    OPTI - 1  --  INSPECT PARAMETERS  1 2 3
CC         - 2  --  INSPECT PARAMETERS  1 2 3 4 5
CC         - 3  --  INSPECT PARAMETERS  1 2 3 4 5 6 7 8 9 10
      DO 220 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      DO 100 M=MSTART,MSTOP
      IF(TDIST(M,K).NE.1) GOTO 100
      EP(M,J)=AREA(1,M,J,K,N)*PI(J,M)
      PP(M,J)=AREA(0,M,J,K,N)*PI(J,M)
      CALL PMAINT(0,M,J,K,N)
      PP(M,J)=AMIN1(PP(M,J),1.0)
      PP(M,J)=AMAX1(PP(M,J),0.0)
      IF(PP(M,J).NE.0.) MVPR(M,J)=EP(M,J)/PP(M,J)
  100 CONTINUE
  220 CONTINUE
```

```
      GO TO 250
  300 CONTINUE
      DO 400 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      DO 350 L=LSTART,LSTOP
      LL=L+10
      PS(L,J)=AREA(0,LL,J,K,N)
      PS(L,J)=AMAX1(PS(L,J),0.)
      PS(L,J)=AMIN1(PS(L,J),1.)
  350 CONTINUE
      DO 375 M=MSTART,MSTOP
      IF(TDIST(M,K).NE.1) GOTO 375
      L=LPSPP(M)
      IF(L.EQ.0) GO TO 375
      DO 360 I1=1,3
      XDUM(I1)=X1BP(I1,K,L)
      Y1DUM(I1)=Y1BP(I1,K,M)
      Y2DUM(I1)=Y2BP(I1,K,M)
  360 CONTINUE
      PP(M,J)=FUN1(PS(L,J),XDUM,Y1DUM,3)
      PP(M,J)=AMIN1(PP(M,J),PS(L,J))
      IF(PP(M,J).LT.0.) PP(M,J)=0.
      MVPR(M,J)=FUN1(PS(L,J),XDUM,Y2DUM,3)
      IF(M.EQ.1) EP(M,J)=AREA(1,M,J,K,N)*PI(J,M)
      IF(M.EQ.1) PP(M,J)=PS(2,J)=AREA(0,1,J,K,N)*PI(J,M)
      IF(M.EQ.1.AND.PP(M,J).GT.1.E-5) MVPR(M,J)=EP(M,J)/PP(M,J)
      IF(M.EQ.4) EP(M,J)=AREA(1,M,J,K,N)*PI(J,M)
      IF(M.EQ.4) PP(M,J)=AREA(0,M,J,K,N)*PI(J,M)
      IF(M.EQ.4.AND.PP(M,J).GT.1.E-5) MVPR(M,J)=EP(M,J)/PP(M,J)
      EP(M,J)=PP(M,J)*MVPR(M,J)
      DP(M,J)=PS(L,J)-PP(M,J)
      CALL PMAINT(0,M,J,K,N)
  375 CONTINUE
  400 CONTINUE
  250 CONTINUE
C     PP - PROBABILITIES PER PARAMETER
C     PC - PROBABILITIES PER CONTROL CRITERIA
C     PT - PROBABILITIES PER POWERTRAINS
C     PTOT - TOTAL PROBABILITY
      DO 107 K=1,NCNTR
      DUM2(K)=0.
      DO 107 M=1,NPAR
```

Table 5-7 SUBROUTINE TEST LISTING (cont.)

```
      DUM1(M)=0.
  107 CONTINUE
      DO 120 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      DO 110 M=1,NPAR
      HPP(M,J,N)=PP(M,J)
  110 DUM1(M)=PP(M,J)
      PC(J)=UNION(DUM1,NPAR,1)
      HPC(J,N)=PC(J)
  120 DUM2(K)=PC(J)
      HPT(JJ,N)=PC(JJ)*TPER(N,JJ)+PC(JJ+5)*TPER(N,JJ+5)+PC(JJ+10)*TPER(N
     *,JJ+10)
      TTTTT=TPER(N,JJ)+TPER(N,JJ+5)+TPER(N,JJ+10)
      IF(TTTTT.GT.10.E-10) HPT(JJ,N)=HPT(JJ,N)/TTTTT
      PTOT=PTOT+HPT(JJ,N)*TTTTT
      HPTOT(N)=PTOT
      DO 55 K=KSTART,KSTOP
      J=JJ+5*(K-1)
       DO 55 M=MSTART,MSTOP
      IF(RTYPE.EQ.SMODEL)
     + XTM(N)=XTM(N)+TIMEM(M,J)*PP(M,J)*TPER(N,J)+
     + TIMEC(M,J)*(PP(M,J)+DP(M,J))*TPER(N,J)
      IF(RTYPE.NE.SMODEL)
     + XTM(N)=XTM(N)+TIMEM(M,J)*PP(M,J)*TPER(N,J)
      YTM(N)=YTM(N)+CPART(M,J)*PP(M,J)*TPER(N,J)
   55 CONTINUE
      DO 475 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      DO 450 L=1,NMODE
  450 HPS(L,J,N)=PS(L,J)
      DO 115 L=1,NMODE
  115 DUM1(L)=PS(L,J)
      PSA(J)=UNION(DUM1,NMODE,2)
       IF(PSA(J).LT.0.) PSA(J)=0.
  475 HPCS(J,N)=PSA(J)
      PTS(JJ)=PSA(JJ)*TPER(N,JJ)+PSA(JJ+5)*TPER(N,JJ+5)+PSA(JJ+10)*TPER
     +(N,JJ+10)
      IF(TTTTT.GT.1.E-10) PTS(JJ)=PTS(JJ)/TTTTT
      PTOTS=PTOTS+PTS(JJ)*TTTTT
      HPTOTS(N)=PTOTS
  500 IF(TDEBUG.EQ.NO) RETURN
      WRITE (6,999)
```

Table 5-7 SUBROUTINE TEST LISTING (cont.)

```
      WRITE (6,510)
  510 FORMAT(40X,*DEBUG -- TEST*)
      WRITE (6,520)
  520 FORMAT(//,40X,*VARIABLE  - A - PROBABILITY *
     + *PER PARAMETER -- PP*/40X,*VARIABLE  - B - EXPECTED *
     + ,*VALUE PER PARAMETER -- EP*/40X,*VARAIBLE  - C - *
     + ,*MEAN VALUE OF THE REJECTED PARAMETER -- MVPR*,/
     + 40X,*VARIABLE  - D -   PS - PP (SIGNATURE ONLY)*)
      WRITE (6,530) JJ,NAME(JJ+10),(J,J=1,10)
  530 FORMAT(/,40X,*POWERTRAIN*,I3,* -- *,A10//
     + * PARAMETER*,10(3X,I2,5X))
      DO 550 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      WRITE (6,540) NAME(K+3),(PP(M,J),M=1,10),
     + (EP(M,J),M=1,10),(MVPR(M,J),M=1,10),(DP(M,J),M=1,10)
  540 FORMAT(/,A8,* A*,10E10.2/8X,* B*,10E10.2/8X,* C*,10E10.2
     + /8X,* D*,10E10.2/)
  550 CONTINUE
      IF(JJ.EQ.5) WRITE (6,570) (PC(J),J=1,15),(PT(JJ),JJ=1,5),PTOT
     + ,XTM(N),YTM(N),PTOTS
  570 FORMAT(/,* PC = */10X,5E12.5/10X,5E12.5/10X,5E12.5//
     + * PT = */10X,5E12.5/* PTOT = *E12.5/,* XTM = *,
     + E15.5,5X,*YTM = *E15.5/,* PTOTS = *E15.5)
      WRITE(6,580) TDIST
 580  FORMAT(//,30X,*TDIST*,/3(5X,10I5/),//)
  999 FORMAT(1H1)
      RETURN
      END
```

5.7 MAINTENANCE ROUTINES

The maintenance routines estimate the effects of a specific maintenance treatment on the emission and parameter distributions. Estimates of the emission reduction achieved from maintenance are based on the influence coefficients and garage efficiency factors. Subroutine MAINT computes the adjustment in average emission rates based on maintenance, while subroutine PMAINT updates the parameter distributions.

5.7.1 Subroutine MAINT

Subroutine MAINT computes the reduction in the average vehicle emission rate based on the maintenance of parameters which were rejected by inspection. MAINT computes, for each control type, DELB, the effect of voluntary maintenance on emission rates and DELT the effect of mandatory maintenance. DDI, developed in Function EINT computes the impact of engine parameter on emission rates. MAINT subtracts DELB, DELT and DDI from the average emission rate A to compute AM, the post maintenance emission rate. MAINT then averages and summarizes the emission rates in the CN array for later use in MICRO. The THIST and THISTT matrices are updated and averaged for printout, curve fitting and plotting in MICRO.

Table 5-8 contains a complete listing of subroutine MAINT while Figure 5-8 documents its techniques and variables in an extensive flowchart.

5.7.2 Subroutine PMAINT

Subroutine PMAINT updates the parameter distributions based on maintenance treatment. Input to subroutine PMAINT are XOPT, M, the parameter number, J the control-power train type, K the control type

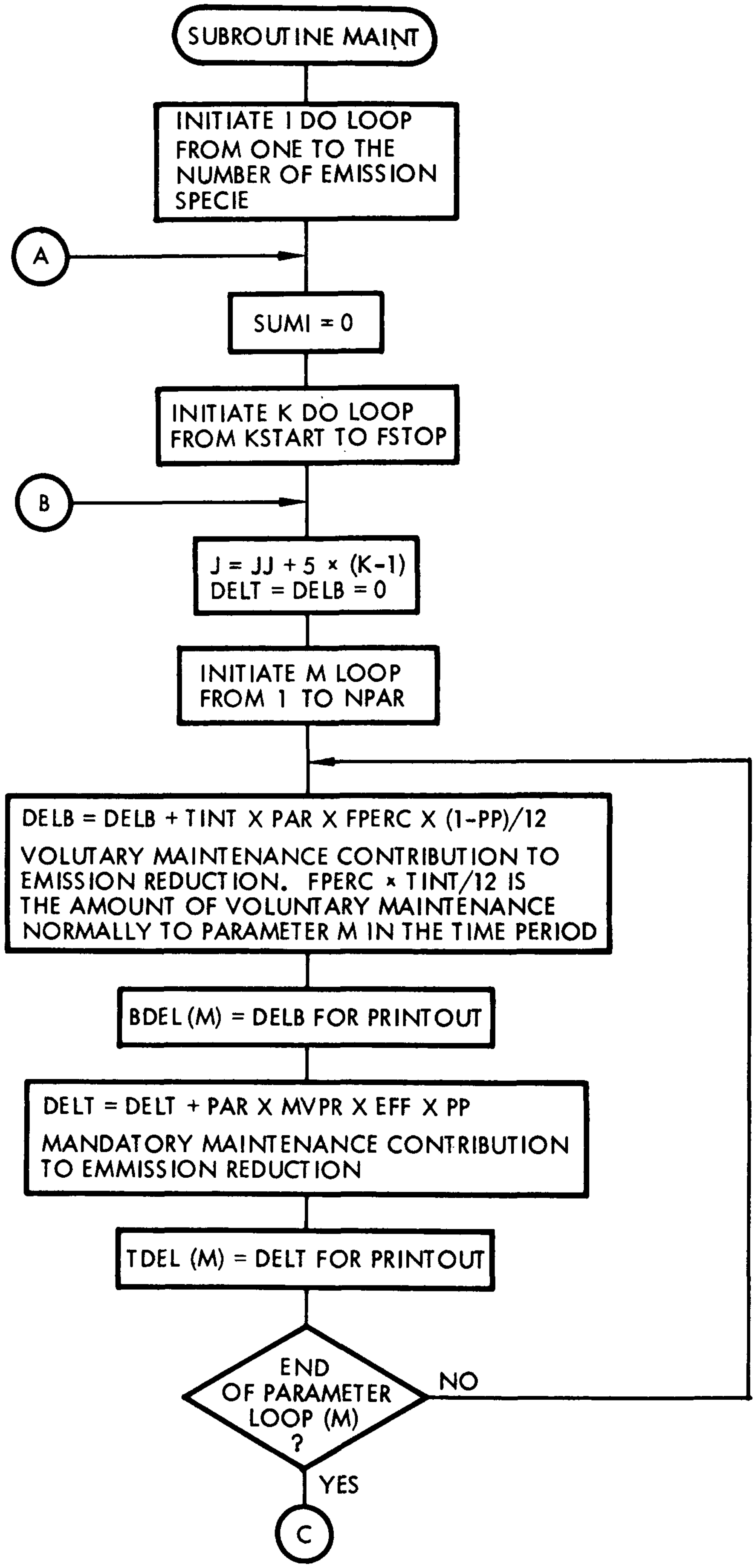


Figure 5-8 Subroutine MAINT Flowchart

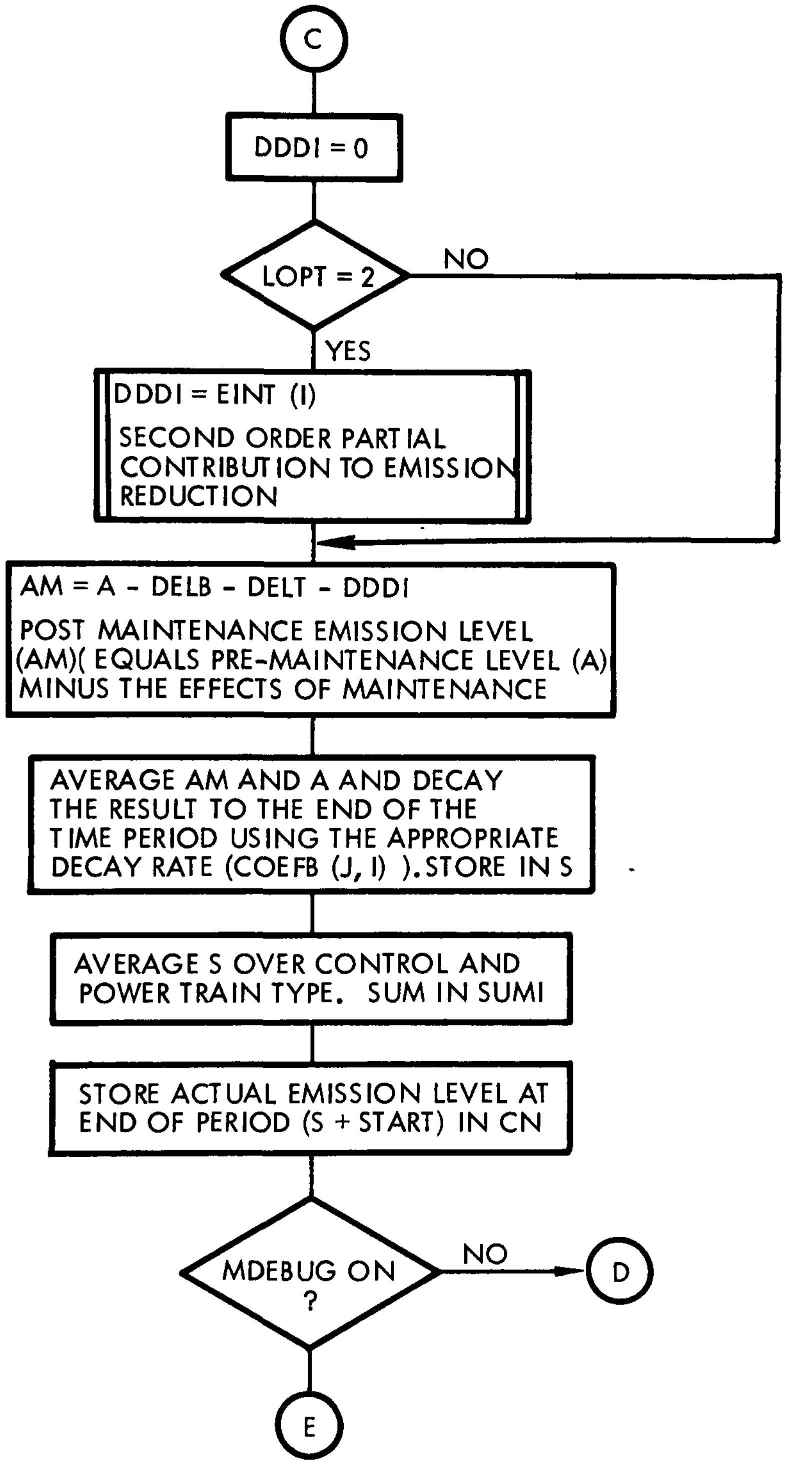


Figure 5-8 Subroutine MAINT Flowchart (cont.)

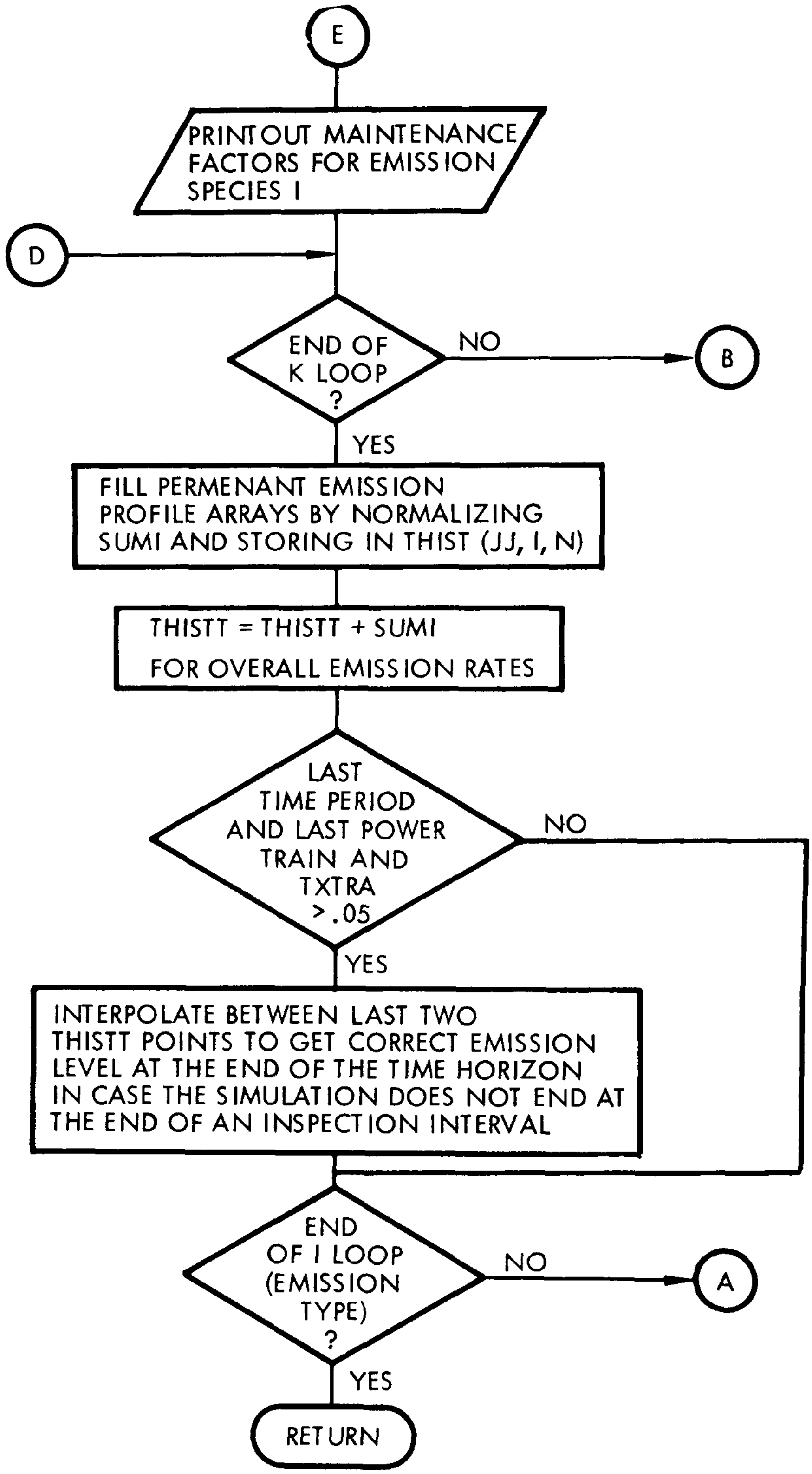


Figure 5-8 Subroutine MAINT Flowchart (cont.)

Table 5-8 SUBROUTINE MAINT LISTING

```
      SUBROUTINE MAINT(A,AM,JJ,N)
      DIMENSION A(15,3),AM(15,3),BDEL(10),TDEL(10)
       COMMON /COM01/      AMB(3),ALAB,    AVV,  BINT,
     +    BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,    BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/          CARA,      CARIY,    CARMY,    CARPOP(16),
     +    CARSY,    CBSUM,     CCOEF(10),CCOSTI,    CCOSTM,   CGTT,
     +    CINCON,   CPCB,  CPI,       CPVPY,    CSUM,     CARAY,
     +    CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
       COMMON /COM03/          DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),      EP(10,15),EFF(10),  DELIT(3),
     +    FREQA,    FREQB,     FPERC(10,3),
     +    HORZN,    HORZNY,
     +    HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),           HPTOT(16),
     +    HPTOTS(16)
CC ADD3
       COMMON /COM04/          ITE,       ITL,      ITP,      ITIME(16),
     +    KSTART,   KSTOP,     LOPT,   LPICK(10),LLPICK,
     +    LIDLE,    LINT(16), LPSPP(10),LSTART,   LSTOP,
     +    MBASE,    MPH,       MSPEC(10),MSTART,    MSTOP,
     +    MU(10,3),    MMS(10,15),          MVPR(10,15)
CC ADD4
       COMMON /COM05/          NAME(50), NCNTR,     NEMIS,    NEMP,
     +    NINTR,    NINTRB,    NMODE,    NO,        NOPTS,    NPAR,
     +    NPTRN,    NPTS,      NSTEPS,   NTR,       NTRB,     NPICK(16),
     +    OCIY,     OCMY,      OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/PARM(3,3), PART,      PAYNEW,   PAYOFF(3),
     +    PC(15),   PCS(15),   PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15), PT(5),    PTOT,     PTS(5),   PAYADJ,
     +    PAR(10,15,3),        PARI(10,3,3),        PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),  PTA(5),    PCONF,    PARINT(10,10,9)
     + ,PAYFIN
       COMMON /COM07/          REINSP,   RNAME,     RSIZE,    RSTOP,
     +    RTYPE,
     +    SALE,     SALL,      SALP,     SITEI,     SITEM,    SLANE,
```

```
     +    SMODEL,   START(15,3), STAT,     STIME(3), SUMBM(3),
     +    SCALEBM(3),          SM(6,15),           SPAR(10,15,6),
     +    SXCUT(6,3),          SIG(10,3),           SIGCE(3),
     +    SIGMF(10),           SIGMNE(10),         SIGP(10,15),
     +    SIGRATE,  SIST,       SIGS(6,15),          SIGSDE(3),
     +    STABLEX(33,6,15),     STABLEY(33,6,15)
      COMMON /COM10/           TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TONX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),       THISTT(3,16),       TIMEC(10,15),
     +    TIMEM(10,15),        TABLEX(33,10,15),    TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/           WF(10),
     +    X1BP(3,3,6), XINT,      XINTB,     XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/           Y1BP(3,3,10),       Y2BP(3,3,10),
     +    YES,      YSUM,      YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,        Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,        Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,       Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,     ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/           ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,    PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL                ITE,       ITL,      ITP,      ITIME,
     +    MMS,      MPH,       MSPEC,    MU,       MVPR,
     +    NAME,     NO,        LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER             RNAME,     SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,     OPTI,     PPICK,    PPPICK
      DO 50 I=1,NEMIS
      SUMI=0.
      DO 40 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      DELT=DELB=0.
      DO 30 M=1,NPAR
      DELB=DELB+TINT/12.*PAR(M,J,I)*FPERC(M,K)*(1.-PP(M,J))
      BDEL(M)=DELB
      DELT=DELT+PAR(M,J,I)*MVPR(M,J)*EFF(M)*PP(M,J)
```

Table 5-8 SUBROUTINE MAINT LISTING (cont.)

```
      TDEL(M)=DELT
   30 CONTINUE
      DDDI=0.
      IF(LOPT.EQ.2) DDDI=EINT(I,K ,J)
      AM(J,I)=A(J,I)-DELB-DELT-DDDI
   91 FORMAT(1X,F10.6)
      S=(AM(J,I)+A(J,I))/2.+COEFB(J,I)*TMIL(N,J)*TINT*(1.-PART)
      SUMI=SUMI+(S+START(J,I))*TPER(N,J)
      CN(J,I,N)=S+START(J,I)
      IF(MDEBUG.EQ.NO) GO TO 40
      WRITE(6,1234)  DDDI
 1234  FORMAT(1X,E20.10)
      WRITE (6,90)
   90 FORMAT(/,50X,*DEBUG  -  MAINT EFFECTS  SUMMED*)
      WRITE(6,100) NAME(I),NAME(K+3),(BDEL(M),M=1,NPAR),
     + (TDEL(M),M=1,NPAR)
  100 FORMAT(2X,A2,2X,A8,* BASE*,10E9.2/,14X,* TEST*,10E9.2)
   40 CONTINUE
C:
C:       FILL PERMENANT EMISSION PROFILE ARRAYS.
C:             (INSIDE I LOOP)
C:
      THIST(JJ,I,N)=SUMI/(TPER(N,JJ)+TPER(N,JJ+5)+TPER(N,JJ+10))
      THISTT(I,N)=THISTT(I,N)+SUMI
      IF(N.EQ.NTR.AND.TXTRA.GT..05.AND.J.EQ.NPTRN)
     +                                THISTT(I,N)=THISTT(I,N)-
     + (1.-TXTRA)*(THISTT(I,N)-THISTT(I,N-1))
   50 CONTINUE
      RETURN
      END
```

and N the inspection interval. Also input to PMAINT (via the common block) are the parameter or mode emission distributions stored in TABLEX, TABLEY, or STABLEX or STABLEY, respectively. Output from PMAINT is returned through the TABLEX, TABLEY and STABLEX, STABLEY matrices. Subroutine PMAINT first branches on parmeter or emission inspection type. For parameter inspection the limits of the rejected population are computed by reference to the LINT array which specifies upper and or lower end rejection. The TABLEX and TABLEY arrays are moved into the XBP and YBP working storage. For the emission case, since, for mode emissions, the upper end is always rejected, the rejection limits are set at the cutpoint and highest value in the STABLEX array, and the STABLEX and the STABLEY data is moved into XBP and YBP.

For both the emission and the parameter case subroutine PMAINT normalizes the parameter or mode emission distribution and calls AREA to compute the rejected fraction. The portion of the distribution which was rejected is then reduced by a factor of PI, the inspection efficiency parameter. The vehicles that were rejected and, therefore, maintained are then added back into the population at the manufacturer's specification point. The distribution is then packed to discard long tail ends and moved back into STABLEX or STABLEY or TABLEX, TABLEY.

Subroutine PMAINT provides debug output when the ADEBUG flag is turned on.

Table 5-9 contains a complete listing of subroutine PMAINT while Figure 5-9 displays graphically the PMAINT coding technique in a descriptive flowchart.

5.8 DETERIORATION SUBROUTINES

The Decay subroutines model the deterioration of emission rates,

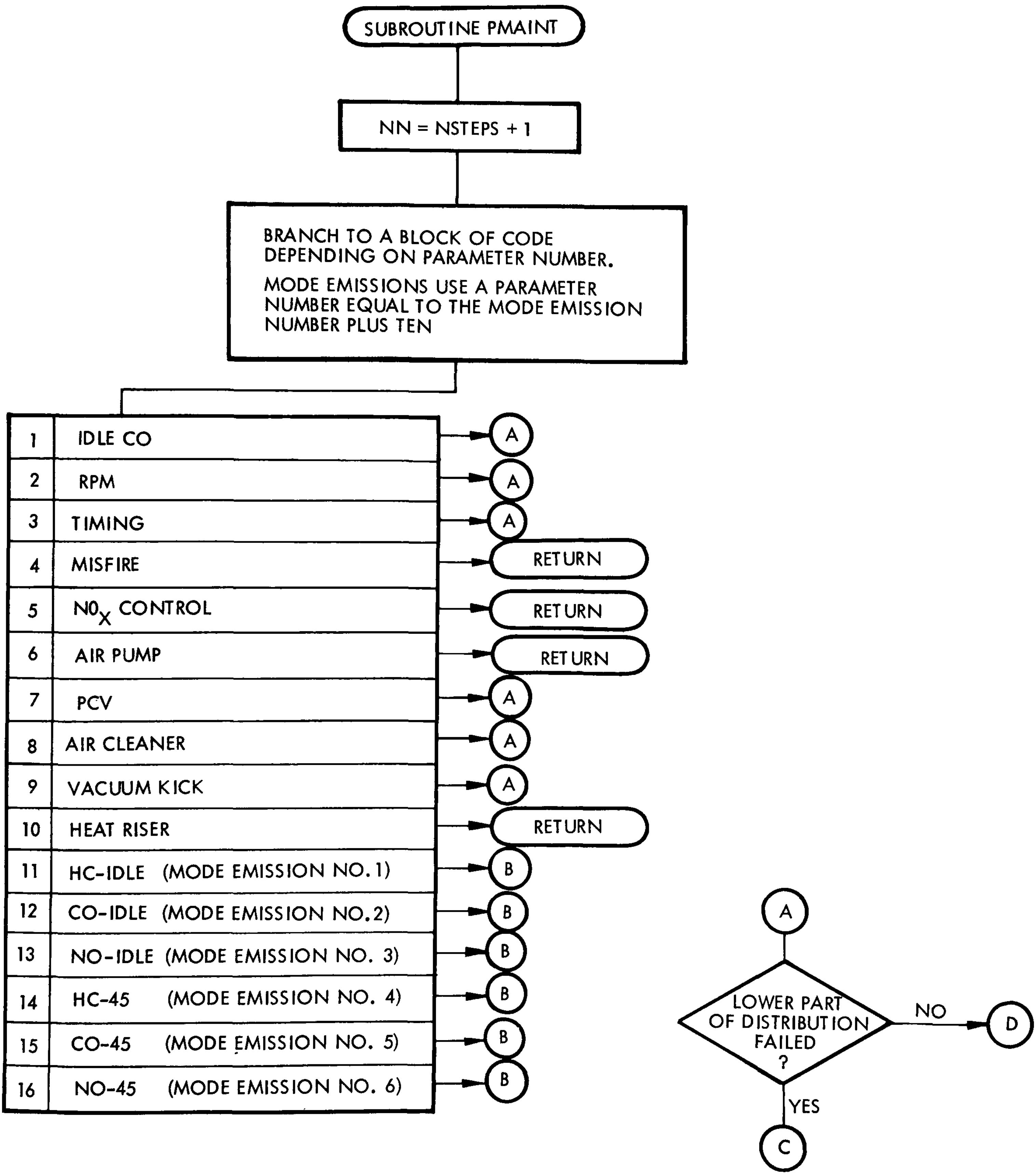


Figure 5-9 Subroutine PMAINT Flowchart

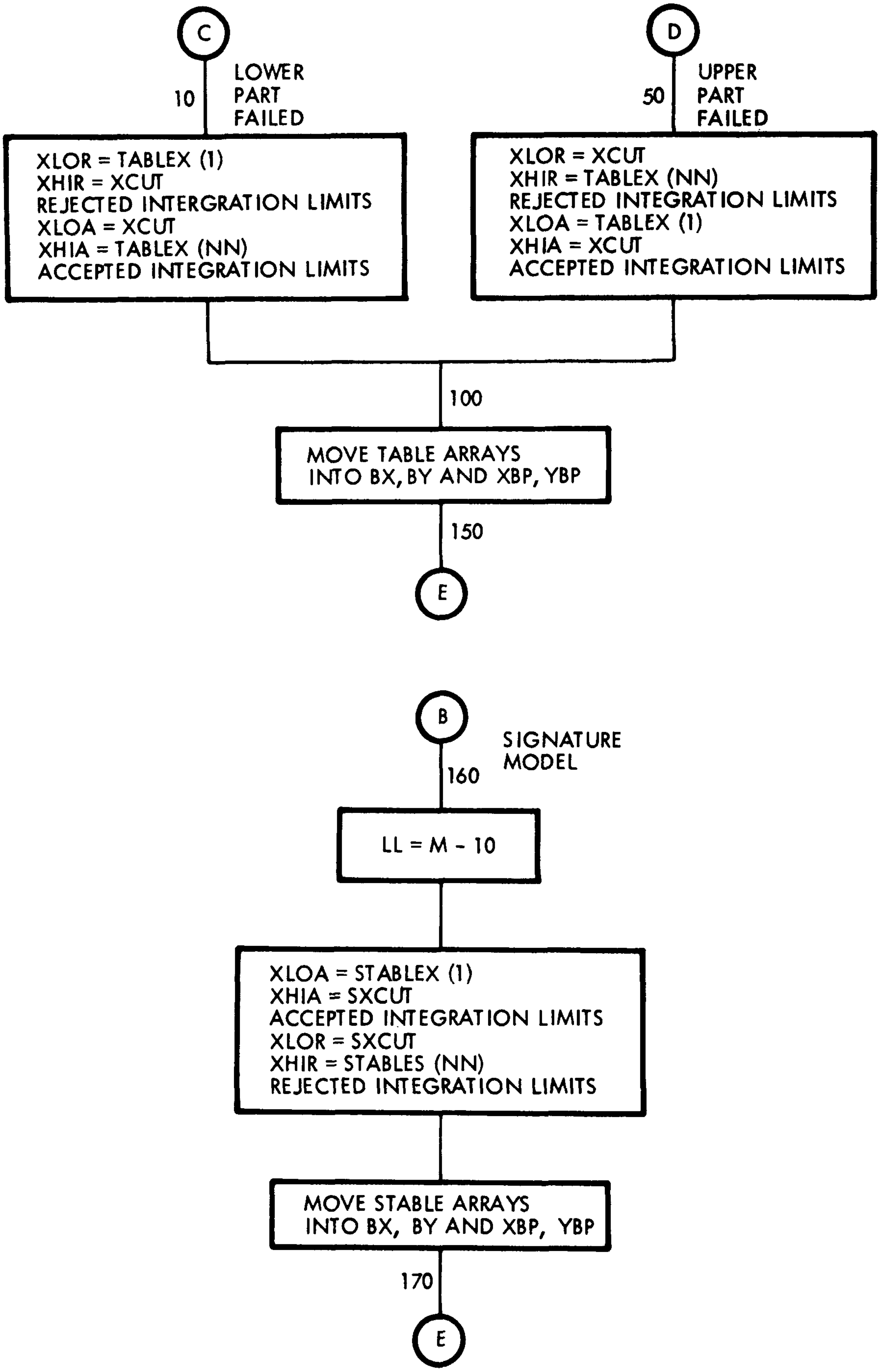


Figure 5-9 Subroutine PMAINT Flowchart (cont.)

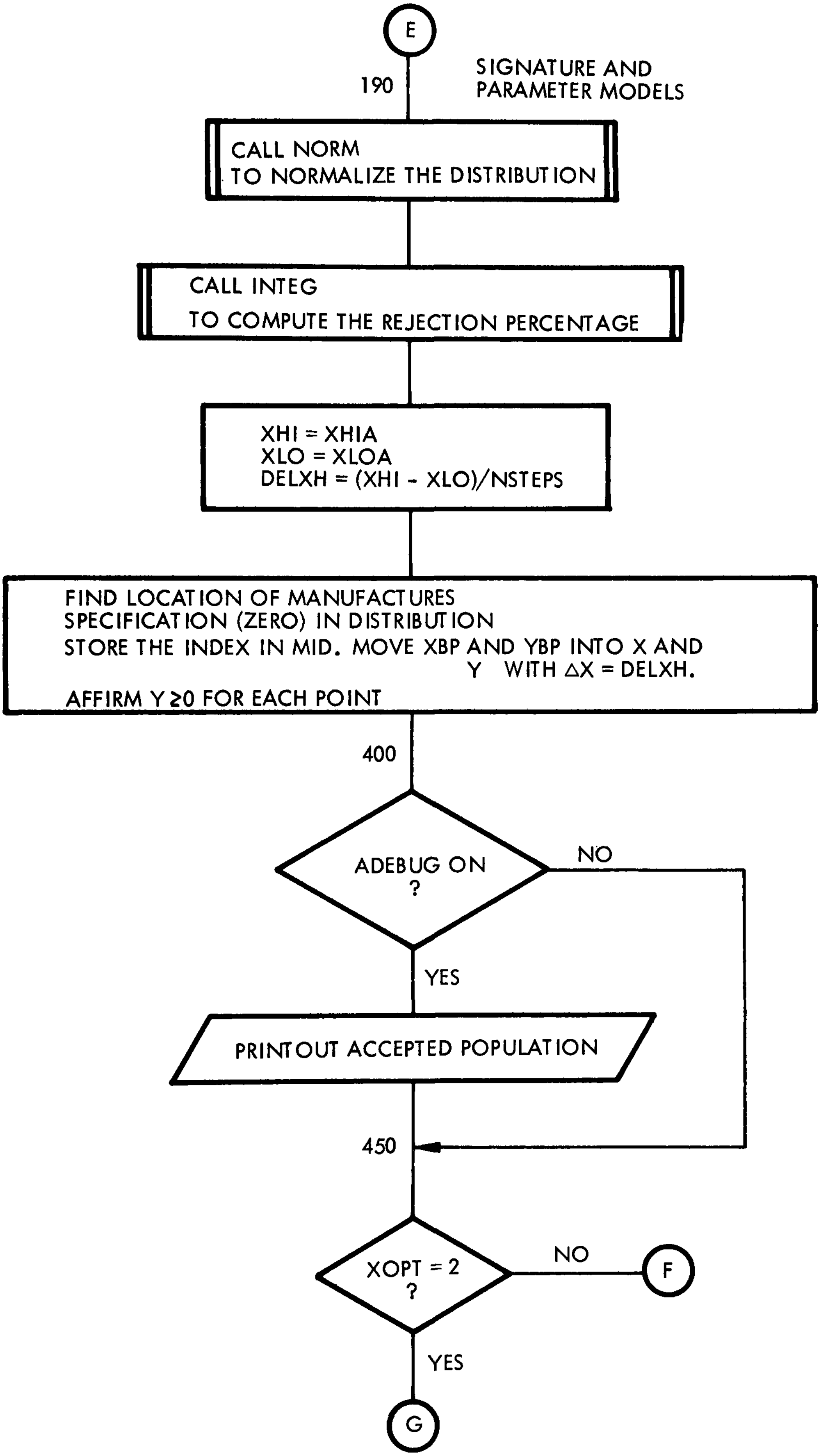


Figure 5-9 Subroutine PMAINT Flowchart (cont.)

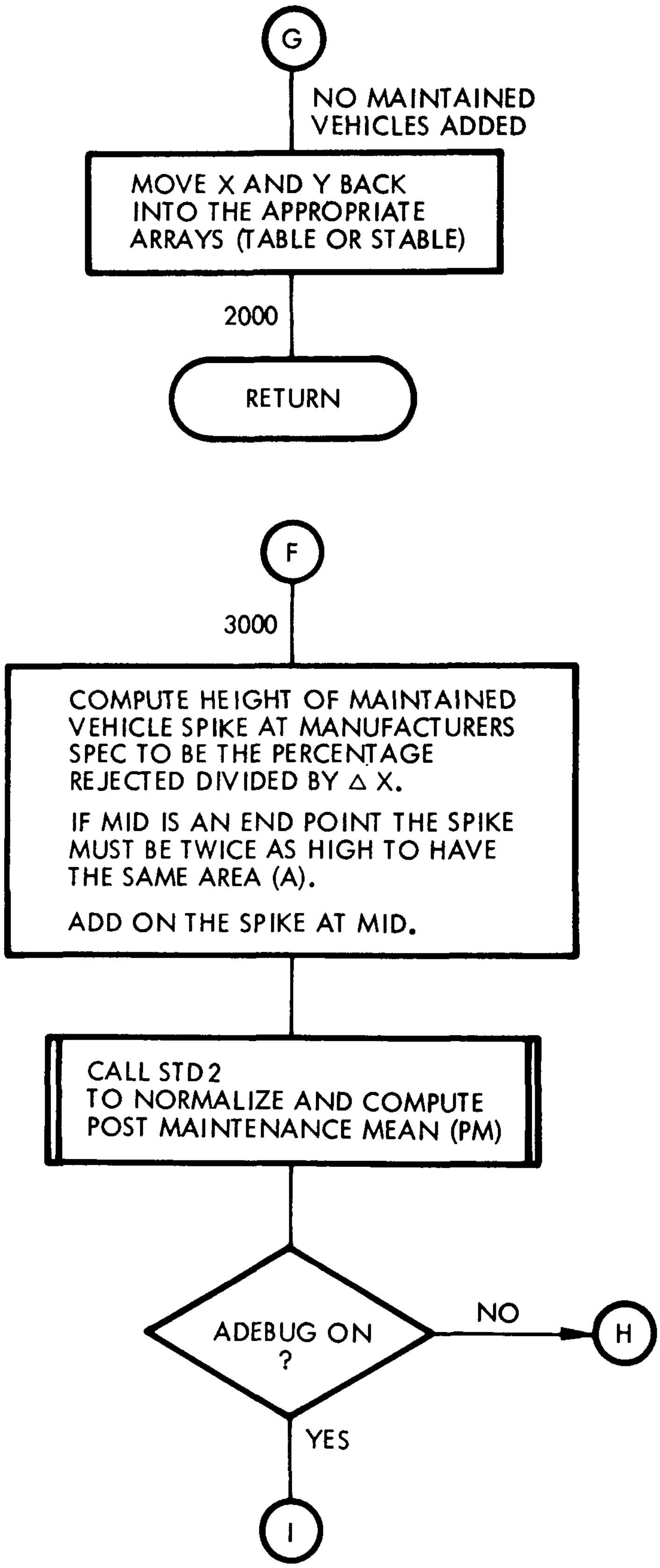


Figure 5-9 Subroutine PMAINT Flowchart (cont.)

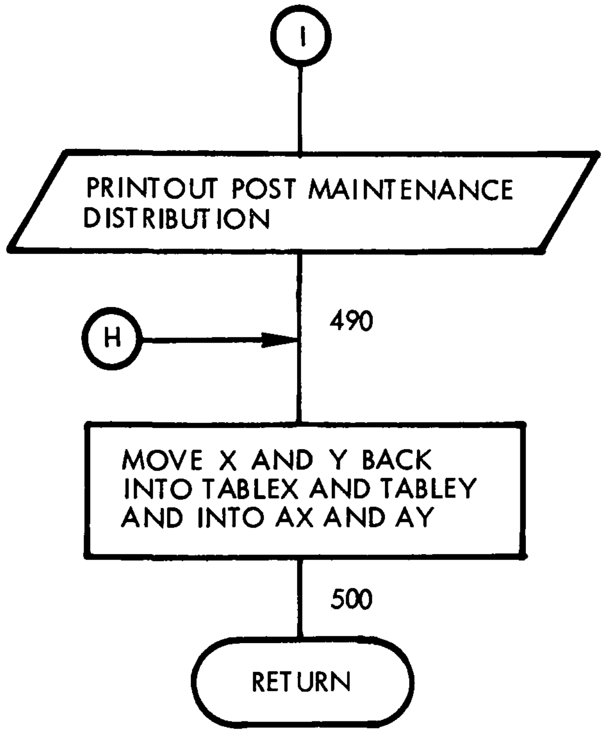


Figure 5-9 Subroutine PMAINT Flowchart (cont.)

Table 5-9 SUBROUTINE PMAINT LISTING

```
      SUBROUTINE PMAINT(XOPT,M,J,K,N)
      DIMENSION X(35),Y(35),XBP(35),YBP(35)
       COMMON /COM01/     AMB(3),ALAB,    AVV, BINT,
     +    BAREA(3), BLD1,     BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +    BHIST(3,16),        BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/         CARA,     CARIY,    CARMY,    CAPPDP(16),
     +    CARSY,    CBSUM,    CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +    CINCCN,   CPCB,  CPI,     CPVPY,   CSUM,    CARAY,
     +    CN(15,3,16),        COEFB(15,3),        COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
       COMMON /COM03/         DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),  DELIT(3),
     +   FREQA,    FREQB,     FPERC(10,3),
     +   HORZN,    HORZNY,
     +   HPC(15,16),          HPCS(15,16),        HPP(10,15,16),
     +   HPS(6,15,16),        HPT(5,16),          HPTOT(16),
     +   HPTOTS(16)
CC ADD3
       COMMON /COM04/         ITE,      ITL,      ITP,      ITIME(16),
     +   KSTART,   KSTOP,     LOPT, LPICK(10),LLPICK,
     +   LIDLE,    LINT(16),  LPSPP(10),LSTART,   LSTOP,
     +   MBASE,    MPH,       MSPEC(10),MSTART,   MSTOP,
     +   MU(10,3),    MMS(10,15),        MVPR(10,15)
CC ADD4
       COMMON /COM05/         NAME(50), NCNTR,    NEMIS,    NEMP,
     +   NINTR,    NINTRB,    NMODE,    NO,       NOPTS,    NPAR,
     +   NPTRN,    NPTS,      NSTEPS,   NTR,      NTRB,     NPICK(16),
     +   OCIY,     OCMY,      OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/PARM(3,3), PART,     PAYNEW,   PAYOFF(3),
     +   PC(15),   PCS(15),   PHI(14),  PLC(14),  PLTMAX(3),PMODEL,
     +   PP(10,15),PS(6,15),  PT(5),    PTOT,     PTS(5),   PAYADJ,
     +   PAR(10,15,3),        PAR1(10,3,3),       PLUS(10,15),
     +   PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +   PSA(15),  PTA(5),    PCONF,    PARINT(10,10,9)
     + ,PAYFIN
       COMMON /COM07/         REINSP,   RNAME,    RSIZE,    RSTOP,
     +   RTYPE,
     +   SALE,     SALL,      SALP,     SITEI,    SITEM,    SLANE,
```

```
                 +     SMODEL,   START(15,3), STAT,      STIME(3), SUMBM(3),
                 +     SCALEBM(3),            SM(6,15),           SPAR(10,15,6),
                 +     SXCUT(6,3),            SIG(10,3),            SIGCE(3),
                 +     SIGME(10),             SIGMNE(10),         SIGP(10,15),
                 +     SIGRATE,  SIST,         SIGS(6,15),          SIGSDE(3),
                 +     STABLEX(33,6,15),       STABLEY(33,6,15)
                    COMMON /COM10/            TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
                 +     TINT,     TOBE(3),     TONX,     TOTE(3),  TPDB(3),  TPDT(3),
                 +     TXTRA,    TSIZE,        TSIG(3),  TPER(16,15),  TMIL(16,15),
                 +     THIST(5,3,16),         THISTT(3,16),       TIMEC(10,15),
                 +     TIMEM(10,15),          TABLEX(33,10,15),    TABLEY(33,10,15)
          CC ADD10
                    COMMON /COM11/            WF(10),
                 +     X1BP(3,3,6), XINT,       XINTB,    XLANE,     XSUM, XCUT(10,3),
                 +     XTM(16),  XBASE(9,3),YBASE(9,3)
          CC ADD11
                    COMMON /COM12/            Y1BP(3,3,10),       Y2BP(3,3,10),
                 +     YES,      YSUM,        YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
                 +     Z1,       Z2,          Z3,       Z4,       Z5,       Z6,
                 +     Z7,       Z8,          Z9,       Z10,      Z11,      Z12,
                 +     Z13,      Z14,         Z15,      Z16,      Z17,
                 +     ZCARI,    ZCARM,       ZIC,      ZSUM,
                 +     ZZ(3,3)
          CC ADD12
                    COMMON /DEBUG/            ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
                 +     LDEBUG,   MDEBUG,      PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
          CC ADDD
                    REAL           ITE,       ITL,      ITP,      ITIME,
                 +     MMS,      MPH,         MSPEC,    MU,       MVPR,
                 +     NAME,     NO,          LDEBUG,   MDEBUG,
                 +     IN,       MISFIRE
                    INTEGER        RNAME,     SITEI,    SITEM,    STAT,
                 +     TDIST,    XLANE,       OPTI,     PPICK,    PPPICK
                    INTEGER XOPT
          CC      LINT  -  LIMITS OF INTEGERATION CRITERIA  (REJECTED)
          CC            -  1  --  XLO TO XCUT
          CC            -  2  --  XCUT TO XHI
                  NN=NSTEPS+1
                   GO TO (1,1,1,2,2,2,1,1,1,2,160,160,160,160,160,160) ,M
            2     RETURN
              1   IGO=LINT(M)
                  GO TO (10,50),IGO
```

```
   10 CONTINUE
CC     CUT LOWER PORTION OF DISTRIBUTION
       XLOR=TABLEX(1,M,J)
       XHIR=XCUT(M,K)
       XLOA=XCUT(M,K)
       XHIA=TABLEX(NN,M,J)
       GO TO 100
   50 CONTINUE
CC     CUT UPPER PORTION OF DISTRIBUTION
       XLOR=XCUT(M,K)
       XHIR=TABLEX(NN,M,J)
       XLOA=TABLEX(1,M,J)
       XHIA=XCUT(M,K)
  100 CONTINUE
       DO 150 L=1,NN
        XBP(L)=TABLEX(L,M,J)
        YBP(L)=TABLEY(L,M,J)
  150 CONTINUE
       GO TO 190
CC     SIGNATURE MODEL
  160 CONTINUE
       LL=M-10
       XLOA=STABLEX(1,LL,J)
       XHIA=SXCUT(LL,K)
       XLOR=SXCUT(LL,K)
       XHIR=STABLEX(NN,LL,J)
       DO 170 L=1,NN
        XBP(L)=STABLEX(L,LL,J)
        YBP(L)=STABLEY(L,LL,J)
  170 CONTINUE
  190 CALL NORM(XBP,YBP,NN)
CC     REJECTED PORTION
       CALL INTEG(XOPT,XHIR,XLOR,XBP,YBP,NSTEPS,A)
CC     ACCEPT PORTION
CC        SHRINK REJECTED PORTION
       XLO=XBP(1)
       XHI=XBP(NN)
       DELXH=(XHI-XLO)/NSTEPS
CC     LOACATION OF MANUFACTURERS SPEC. IN DIST≠N
       MID=2
       DO 400 I=1,NN
       X(I)=XLO+(I-1)*DELXH
```

Table 5-9 SUBROUTINE PMAINT LISTING (cont.)

```
      Y(I)=FUN1(X(I),XBP,YBP,NN)
      IF(ABS(X(I)-MMS(M,J)).LE.DELXH/2.) MID=I
      IF(Y(I).LT.0.) Y(I)=0.
CC       MAINTENANCE REMOVAL OF BAD CARS
      IF(X(I).GE.XLOR.AND.X(I).LE.XHIR) Y(I)=Y(I)*(1.-PI(J,M)
  400 CONTINUE
      IF(ADEBUG.EQ.NO) GO TO 450
      WRITE (6,410) (I,X(I),Y(I),I=1,NN)
 410  FORMAT(//,5X,*  POPULATION BEFORE ADDING MAINTENANCE*
     + //,3(3X,*N*,8X,*X*,15X,*Y*,5X)//
     + 13(I4,2E15.4,I4,2E15.4,I4,2E15.4/))
  450 CONTINUE
      IF(XOPT.NE.2) GO TO 3000
CC    STORAGE OF ACCEPTED PORTION
      CALL PACKD(X,Y,NN)
      DO 2000 L=1,NN
      IF(M-10) 1400,1600,1600
 1400 CONTINUE
CC    PARAMTER MODEL
      TABLEX(L,M,J)=X(L)
      TABLEY(L,M,J)=Y(L)
      GO TO 2000
 1600 CONTINUE
CC    SIGNATURE MODEL
       STABLEX(L,LL,J)=X(L)
       STABLEY(L,LL,J)=Y(L)
 2000 CONTINUE
      RETURN
 3000 CONTINUE
      BUP=A/DELXH*PI(J,M)
      Y(MID)=Y(MID)+BUP
      IF(MID.EQ.1.OR.MID.EQ.NN) Y(MID)=Y(MID)+BUP
      CALL PACKD(X,Y,NN)
      CALL STD2(X,Y,NN,PM(M,J),SD)
      IF(ADEBUG.EQ.NO) GO TO 490
      WRITE (6,465) (I,X(I),Y(I),I=1,NN)
  465 FORMAT(/,10X,*NEW PTS AFTER MAINTENANCE*//
     + 3(3X,*N*,8X,*X*,15X,*Y*,5X,),//,
     + 13(I4,2E15.4,I4,2E15.4,I4,2E15.4/))
  490 DO 500 L=1,NN
       TABLEX(L,M,J)=X(L)
       TABLEY(L,M,J)=Y(L)
```

Table 5-9 SUBROUTINE PMAINT LISTING (cont.)


```
  500 CONTINUE
  999  FORMAT(1H1)
       RETURN
       END
```

mode emissions, and parameters over time. The deterioration rates for each of these three dimensions of the vehicle have been developed empirically and are used to update emission levels between maintenance treatments. The three decay routines are called EDECAY, MDECAY and PDECAY.

5.8.1 Subroutine EDECAY

Subroutine EDECAY computes the deterioration in average vehicle emission rates over the inspection interval TINT. Input to EDECAY are A, the pre-decay emission rates, JJ the power train type and N the inspection interval number. Output from EDECAY consists of the array B representing the average emission rates of the vehicle population after deterioration. The emission rate of decay, COEFB, which was computed in subroutine INITIAL, is multiplied by the appropriate time interval and added to the emission level for determining the post deterioration value.

Figure 5-10 presents a flow chart and Table 5-10 contains a listing of subroutine EDECAY.

5.8.2 Subroutine MDECAY

Subroutine MDECAY deteriorates the mode emission levels based on estimated changes in the engine parameters. MDECAY uses a technique similar to that used in PDECAY in adjusting the mode emission distributions.

Table 5-11 contains a listing of MDECAY and Figure 5-11 a flow chart.

5.8.3 Subroutine PDECAY

Subroutine PDECAY is used to estimate the rate of parameter deterioration between inspection intervals. Figure 5-12 contains a complete

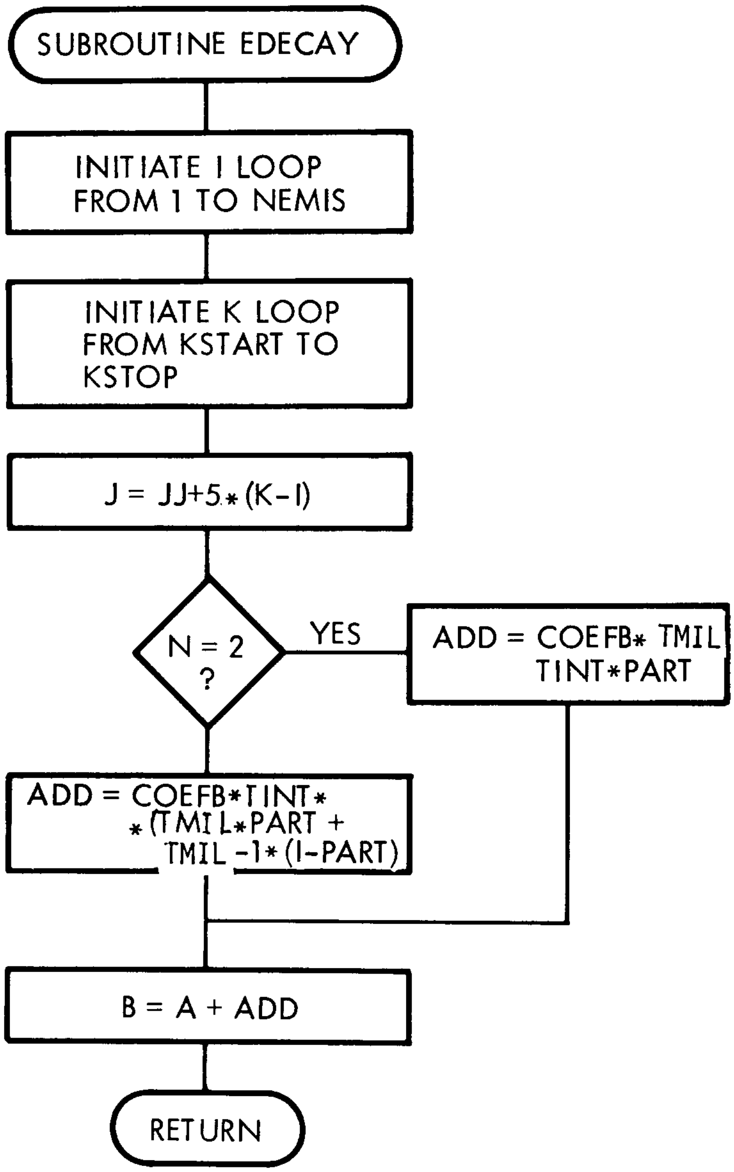


Figure 5-10 Subroutine EDECAY Flowchart

Table 5-10 SUBROUTINE EDECAY LISTING

```
      SUBROUTINE EDECAY(A,B,JJ,N)
      DIMENSION A(15,3),B(15,3)
        COMMON /COM01/     AMB(3),ALAB,     AVV,  BINT,
     +    BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,     BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
        COMMON /COM02/         CARA,      CARIY,     CARMY,     CARPOP(16),
     +    CARSY,     CBSUM,    CCOEF(10),CCOSTI,    CCOSTM,     CGTT,
     +    CINCON,    CPCB,  CPI,       CPVPY,     CSUM,       CARAY,
     +    CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
        COMMON /COM03/         DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),   DELIT(3),
     +    FREQA,     FREQB,    FPERC(10,3),
     +    HORZN,     HORZNY,
     +    HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),           HPTOT(16),
     +    HPTOTS(16)
CC ADD3
        COMMON /COM04/         ITE,       ITL,       ITP,       ITIME(16),
     +    KSTART,    KSTOP,    LOPT,  LPICK(10),LLPICK,
     +    LIDLE,     LINT(16), LPSPP(10),LSTART,    LSTOP,
     +    MBASE,     MPH,      MSPEC(10),MSTART,    MSTOP,
     +    MU(10,3),    MMS(10,15),           MVPR(10,15)
CC ADD4
        COMMON /COM05/         NAME(50), NCNTR,     NEMIS,     NEMP,
     +    NINTR,     NINTRB,   NMODE,     NO,        NOPTS,     NPAR,
     +    NPTRN,     NPTS,     NSTEPS,    NTR,       NTRB,      NPICK(16),
     +    OCIY,      OCMY,     OPTI,      OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
        COMMON /COM06/PARM(3,3),  PART,      PAYNEW,    PAYOFF(3),
     +    PC(15),    PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15), PT(5),     PTOT,      PTS(5),   PAYADJ,
     +    PAR(10,15,3),        PAR1(10,3,3),        PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),   PTA(5),   PCONF,     PARINT(10,10,9)
     + ,PAYFIN
        COMMON /COM07/         REINSP,    RNAME,     RSIZE,     RSTOP,
     +    RTYPE,
     +    SALE,      SALL,     SALP,      SITEI,     SITEM,     SLANE,
```

```
     +    SMODEL,   START(15,3), STAT,     STIME(3), SUMBM(3),
     +    SCALEBM(3),           SM(6,15),             SPAR(10,15,6),
     +    SXCUT(6,3),           SIG(10,3),              SIGCE(3),
     +    SIGME(10),            SIGMNE(10),           SIGP(10,15),
     +    SIGRATE,  SIST,        SIGS(6,15),            SIGSDE(3),
     +    STABLEX(33,6,15),      STABLEY(33,6,15)
      COMMON /COM10/            TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),    TONX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,       TSIG(3),  TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),        THISTT(3,16),         TIMEC(10,15),
     +    TIMEM(10,15),         TABLEX(33,10,15),      TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/            WF(10),
     +    X1BP(3,3,6), XINT,       XINTB,    XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/            Y1BP(3,3,10),         Y2BP(3,3,10),
     +    YES,      YSUM,       YTM(15),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,         Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,         Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,        Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,      ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/            ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,     PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL          ITE,        ITL,      ITP,      ITIME,
     +    MMS,      MPH,        MSPEC,    MU,       MVPR,
     +    NAME,     ND,         LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER       RNAME,      SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,      OPTI,     PPICK,    PPPICK
     DO 50 I=1,NEMIS
     DO 40 K=KSTART,KSTOP
     J=JJ+5*(K-1)
     ADD=COEFB(J,I)*TINT*(TMIL(N,J)*PART+TMIL(N-1,J)*(1.-PART))
     IF(N.EQ.2) ADD=COEFB(J,I)*TMIL(N,J)*TINT*PART
     B(J,I)=A(J,I)+ADD
  40 CONTINUE
  50 CONTINUE
     RETURN
     END
```

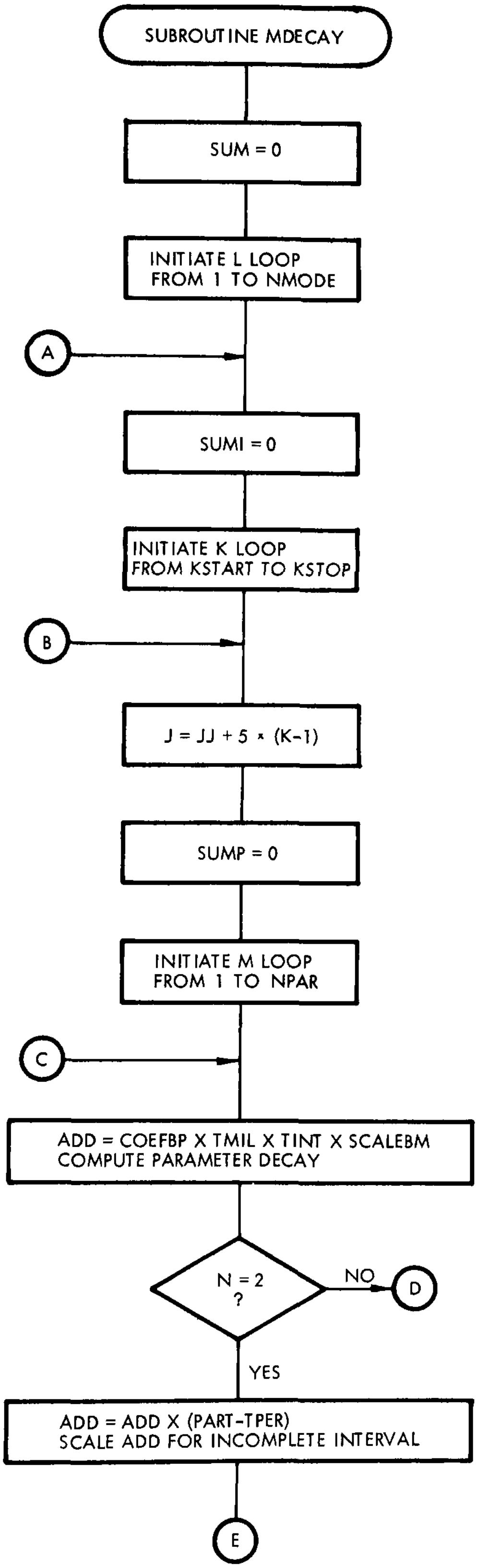
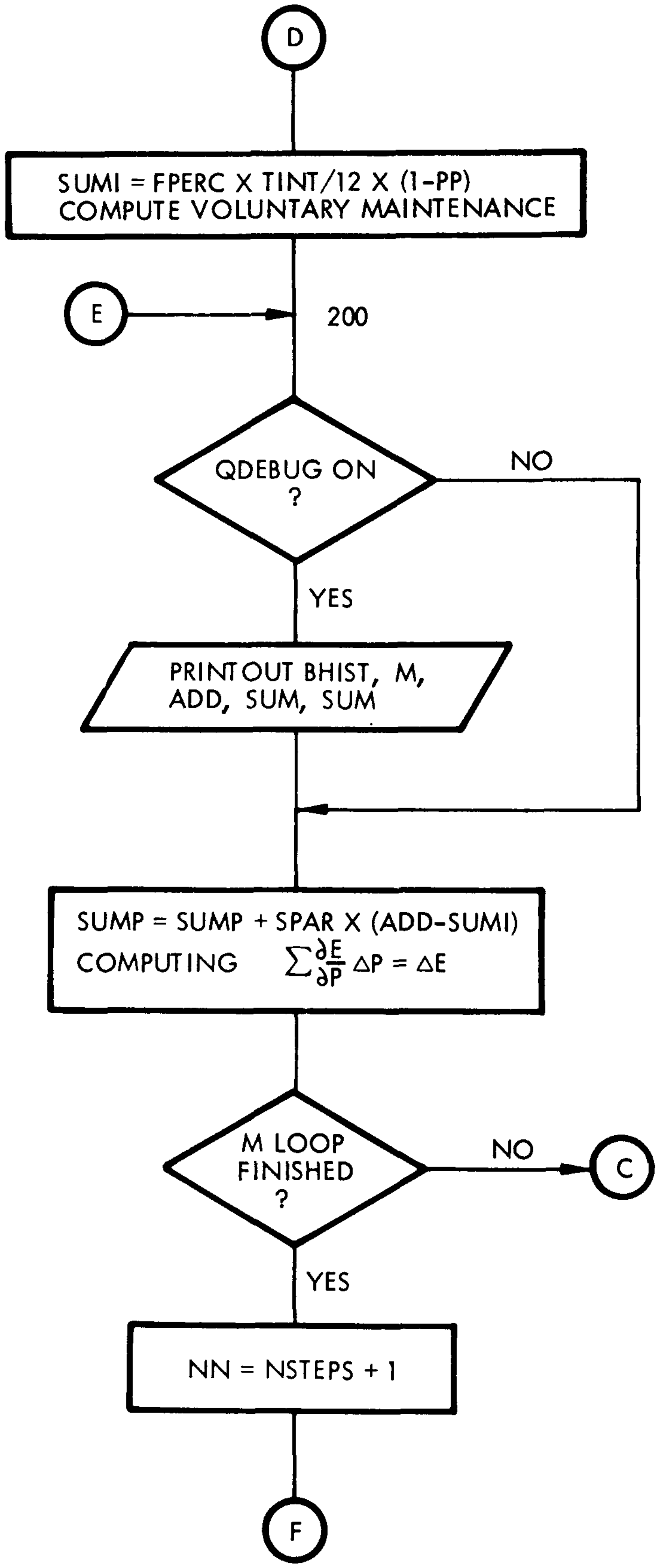


Figure 5-11 Subroutine MDECAY Flowchart



Fi :re 5-11 Subroutine MDECAY Flowchart (cont.)

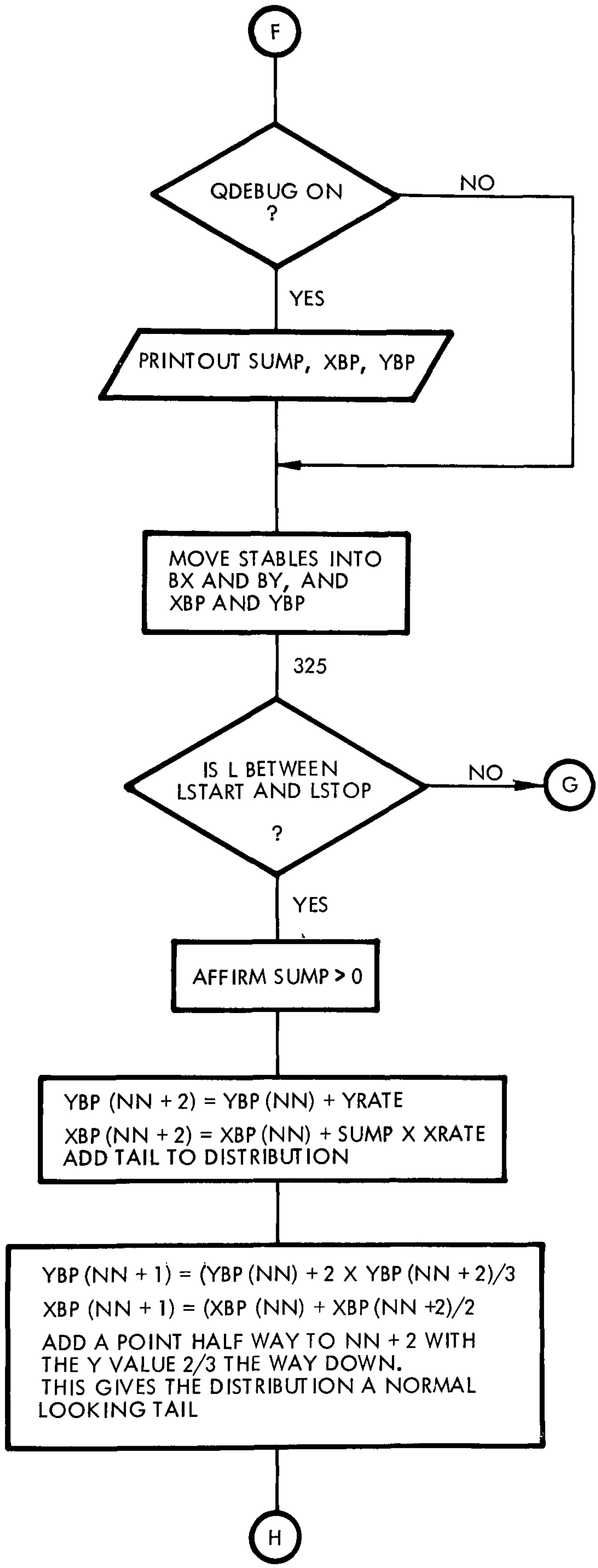


Figure 5-11 Subroutine MDECAY Flowchart (cont.)

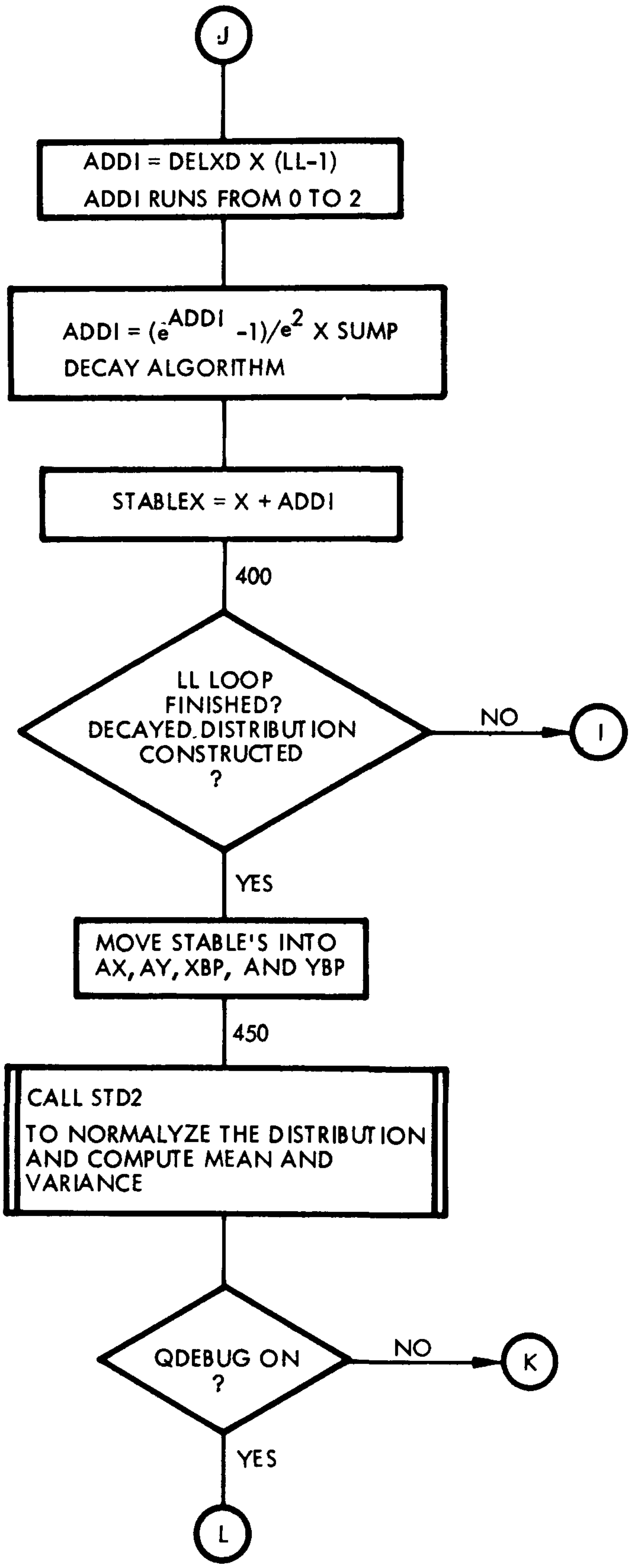


Figure 5-11 Subroutine MDECAY Flowchart (cont.)

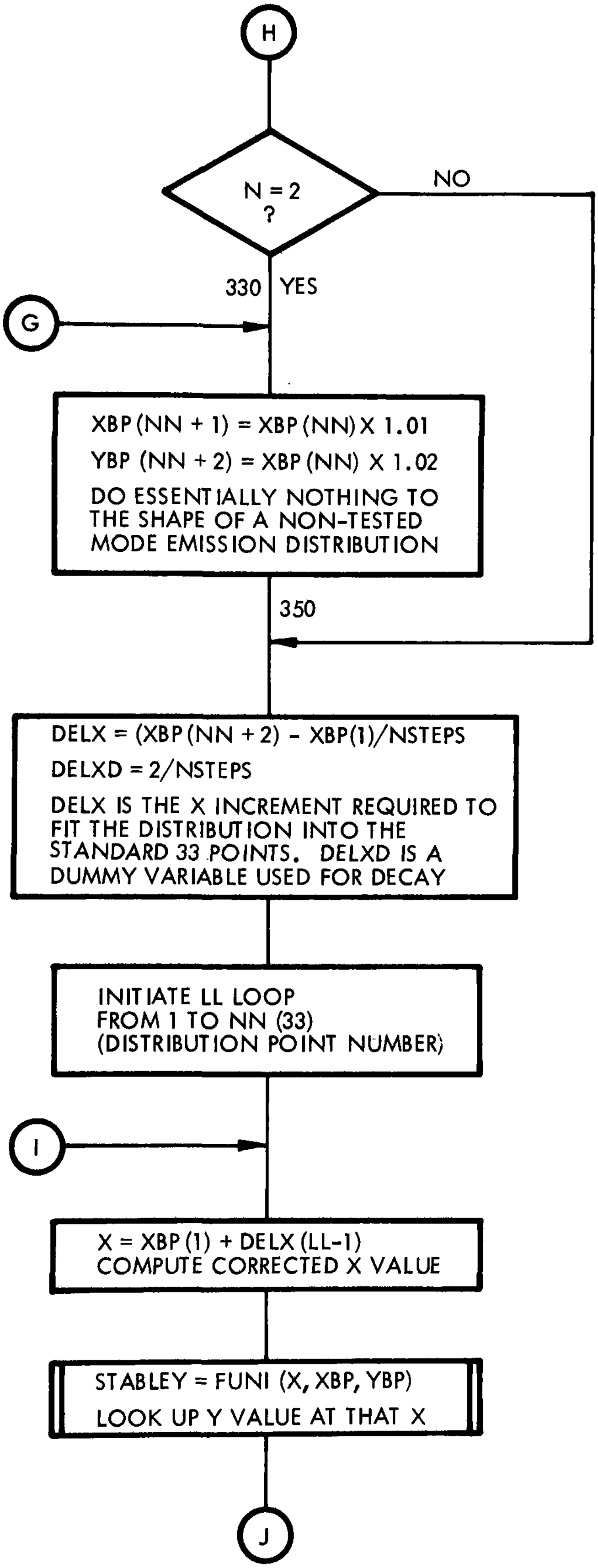


Figure 5-11 Subroutine MDECAY Flowchart (cont.)

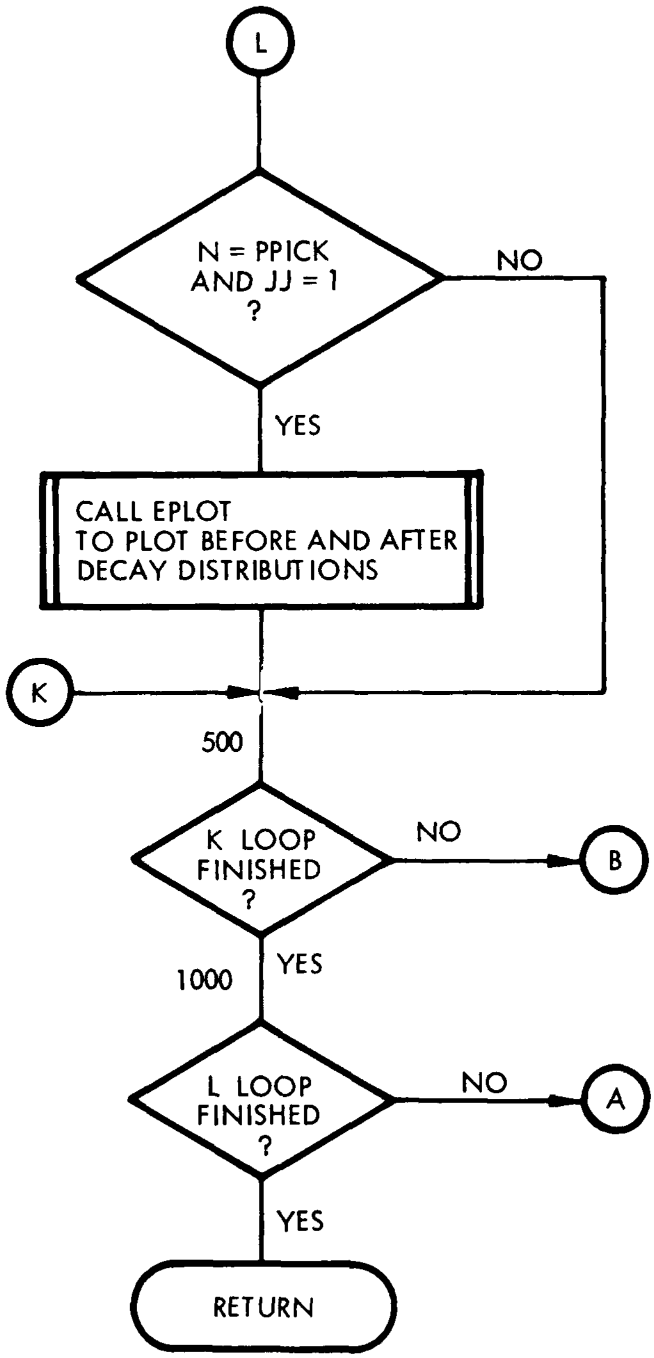


Figure 5-11 Subroutine MDECAY Flowchart (cont.)

Table 5-11 SUBROUTINE MDECAY LISTING

```
          SUBROUTINE MDECAY(JJ,N)
          DIMENSICN YRATE(6)
           DIMENSICN XRATE(6)
          DIMENSICN XBP(35),YBP(35)
           COMMON /COM01/      AMB(3),ALAB,     AVV,  BINT,
     +        BAREA(3), BLD1,       BLD2,       BSIG(3),  BXTRA,     BSIZE,
     +        BHIST(3,16),          BMMI(10,15,3);,
     +        ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
           COMMON /COM02/           CARA,       CARIY,      CARMY,      CARPOP(16),
     +        CARSY,     CBSUM,     CCOEF(10),CCOSTI,    CCOSTM,    CGTT,
     +        CINCON,    CPCB,  CPI,        CPVPY,     CSUM,      CARAY,
     +        CN(15,3,16),          COEFB(15,3),          COEFBP(10,15),
     +        CPART(10,15)
CC ADD2
           COMMON /COM03/           DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),        EP(10,15),EFF(10),  DELIT(3),
     +        FREQA,     FREQB,     FPERC(10,3),
     +        HORZN,     HORZNY,
     +        HPC(15,16),           HPCS(15,16),          HPP(10,15,16),
     +        HPS(6,15,16),         HPT(5,16),            HPTOT(16),
     +        HPTOTS(16)
CC ADD3
           COMMON /COM04/           ITE,        ITL,        ITP,        ITIME(16),
     +        KSTART,    KSTOP,     LOPT,  LPICK(10),LLPICK,
     +        LIDLE,     LINT(16),  LPSPP(10),LSTART,     LSTOP,
     +        MBASE,     MPH,       MSPEC(10),MSTART,     MSTOP,
     +        MU(10,3),    MMS(10,15),          MVPR(10,15)
CC ADD4
           COMMON /COM05/           NAME(50), NCNTR,     NEMIS,      NEMP,
     +        NINTR,     NINTRB,    NMODE,      NO,         NOPTS,      NPAR,
     +        NPTRN,     NPTS,      NSTEPS,     NTR,        NTRB,       NPICK(16),
     +        OCIY,      OCMY,      OPTI,       OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
           COMMON /COM06/PARM(3,3), PART,      PAYNEW,    PAYOFF(3),
     +        PC(15),    PCS(15),   PHI(14),    PLO(14),    PLTMAX(3),PMODEL,
     +        PP(10,15),PS(6,15),   PT(5),      PTOT,       PTS(5),   PAYADJ,
     +        PAR(10,15,3),         PAR1(10,3,3),         PLUS(10,15),
     +        PM(10,15),            PPICK(10),PPPICK,PSTAR,PI(15,10),
     +        PSA(15),   PTA(5),    PCONF,      PARINT(10,10,9)
     + ,PAYFIN
           COMMON /COM07/           REINSP,     RNAME,      RSIZE,      RSTOP,
```

Table 5-11 SUBROUTINE MDECAY LISTING (cont.)

```
     +    RTYPE,
     +    SALE,      SALL,      SALP,      SITEI,      SITEM,      SLANE,
     +    SMODEL,    START(15,3), STAT,      STIME(3), SUMBM(3),
     +    SCALEBM(3),           SM(6,15),             SPAR(10,15,6),
     +    SXCUT(6,3),           SIG(10,3),             SIGCE(3),
     +    SIGME(10),            SIGMNE(10),           SIGP(10,15),
     +    SIGRATE,   SIST,       SIGS(6,15),           SIGSDE(3),
     +    STABLEX(33,6,15),      STABLEY(33,6,15)
      COMMON /COM10/            TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,      TOBE(3),   TONX,      TOTE(3),   TPDB(3),   TPDT(3),
     +    TXTRA,     TSIZE,     TSIG(3),   TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),        THISTT(3,16),         TIMEC(10,15),
     +    TIMEM(10,15),         TABLEX(33,10,15),     TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/            WF(10),
     +    X1BP(3,3,6), XINT,     XINTB,     XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),   XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/            Y1BP(3,3,10),         Y2BP(3,3,10),
     +    YES,       YSUM,      YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,        Z2,        Z3,        Z4,        Z5,        Z6,
     +    Z7,        Z8,        Z9,        Z10,       Z11,       Z12,
     +    Z13,       Z14,       Z15,       Z16,       Z17,
     +    ZCARI,     ZCARM,     ZIC,       ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/            ADEBUG,    BDEBUG,    CDEBUG,    DDEBUG,
     +    LDEBUG,    MDEBUG,    PDEBUG,    QDEBUG,    SDEBUG,    TDEBUG
CC ADDD
      REAL       ITE,       ITL,       ITP,       ITIME,
     +    MMS,       MPH,       MSPEC,     MU,        MVPR,
     +    NAME,      NO,        LDEBUG,    MDEBUG,
     +    IN,        MISFIRE
      INTEGER    RNAME,     SITEI,     SITEM,     STAT,
     +    TDIST,     XLANE,     OPTI,      PPICK,     PPPICK
     DATA XRATE/3.,3.,3.,3.,8.,3./
     DATA YRATE/6*0.15/
     SUM=0.
     DO 1000 L=1,NMODE
     SUM1=0.
     DO 500 K=KSTART,KSTOP
     J=JJ+5*(K-1)
```

Table 5-11 SUBROUTINE MDECAY LISTING (cont.)

```
      SUMP=0.
      DO 300 M=1,NPAR
      ADD=COEFBP(M,J)*TINT*(PART*TMIL(N,J)+(1.-PART)*TMIL(N-1,J))
      IF(N.EQ.2) ADD=CCEFBP(M,J)*TINT*TMIL(N,J)*PART
       SUM1=FPERC(M,K)*TINT/12.*(1.-PP(M,J))
      IF(N.EQ.2) SUM1=SUM1*PART
  200 CONTINUE
      IF(QDEBUG.EQ.YES) WRITE (6,205) (BHIST(I,N-1),I=1,NEMIS)
  205 FORMAT(* BHIST = *,E15.5)
      IF(QDEBUG.EQ.YES) WRITE (6,250) M,ADD,SUM,SUM1
  250 FORMAT(* M = *I2,5X,*ADD = *E15.5,5X,* SUM = *E15.5,
     + 5X,*SUM1 = *E15.5)
      SUMP=SUMP+SPAR(M,J,L)*(ADD    -SUM1)
  300 CONTINUE
      NN=NSTEPS+1
      IF(QDEBUG.EQ.YES) WRITE (6,305) SUMP,XBP(NN),YBP(NN)
  305 FORMAT(* SUMP = *E15.4,5X,*X = *E15.4,5X,*Y = *E15.4/)
      DO 325 LL=1,NN
      XBP(LL)=STABLEX(LL,L,J)
      YBP(LL)=STABLEY(LL,L,J)
  325 CONTINUE
      IF(L.LT.LSTART.OR.L.GT.LSTOP) GO TO 330
      IF(SUMP.LT.0.) SUMP=0.01
      YBP(NN+2)=YBP(NN)*YRATE(L)
      XBP(NN+2)=XBP(NN)+SUMP*XRATE(L)
      XBP(NN+1)=(XBP(NN)+XBP(NN+2))/2.
      YBP(NN+1)=(YBP(NN)+2*YBP(NN+2))/3
      IF(N.NE.2) GO TO 350
  330 XBP(NN+1)=XBP(NN)*1.01
      XBP(NN+2)=XBP(NN)*1.02
  350 CONTINUE
      DELX=(XBP(NN+2)-XBP(1))/NSTEPS
      DELXD=2./NSTEPS
      DO 400 LL=1,NN
      X=XBP(1)+DELX*(LL-1)
      STABLEY(LL,L,J)=FUN1(X,XBP,YBP,NN+2)
      ADD1=DELXD*(LL-1)
      ADD1=(EXP(ADD1)-1.)/EXP(2.)*SUMP
      STABLEX(LL,L,J)=X+ADD1
  400 CONTINUE
      DO 450 LL=1,NN
      XBP(LL)=STABLEX(LL,L,J)
```

Table 5-11 SUBROUTINE MDECAY LISTING (cont.)

```
      YBP(LL)=STABLEY(LL,L,J)
  450 CONTINUE
      CALL STD2(XBP,YBP,NN,SM(L,J),SIGS(L,J))
C*****IF(ODEBUG.EQ.YES.AND.N.EQ.PPICK(PPPICK).AND.JJ.EQ.1)
C***** CALL EPLOT(BX,BY,AX,AY,NN,LINT(M))
  500 CONTINUE
 1000 CONTINUE
      RETURN
      END
```

flowchart of PDECAY which documents the programming techniques used. Table 5-12 gives the program listings.

5.9 SUBROUTINE COSTS

The General Economic Effectiveness Program contains data and algorithms for estimating the economic impact of a mandatory vehicle inspection and maintenance program. Subroutine COSTS contains the equations for estimating user inconvenience costs, inspection station land, building, and management costs and labor training costs. COSTS also computes the various figures-of-merit and average emission reductions. The listing and flowcharts contained in Table 5-13 and Figure 5-13 respectively describe in detail the techniques and data assumptions used.

5.10 SUBROUTINE STATS

Subroutine STATS contains the algorithms for conducting a statistical analysis of the predicted emission reduction results. The model makes two basic assumptions: 1) all distribution functions can be adequately described by tables regardless of their shape, and 2) these distribution functions are independent of each other.

The model begins with a set of engine parameter distributions that characterize the state of vehicles as they now exist in the population. These distributions are modified to reflect the maintenance treatment and various system errors. There are basically three classes of errors -- inspection, maintenance, and model generated. The resulting distribution yields an estimate of the emission variance for a fleet of vehicles that has passed through the inspection/maintenance process. The final distribution

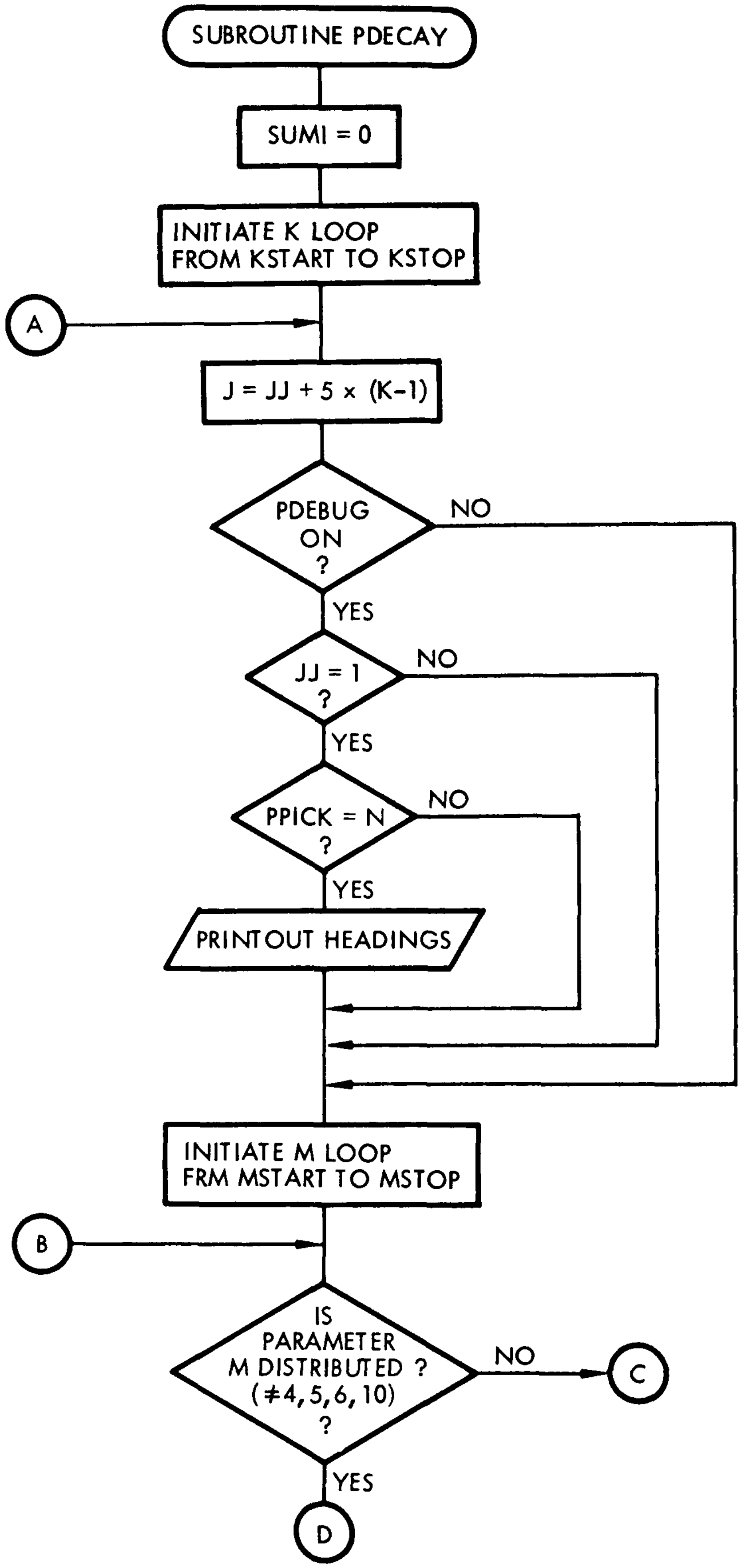


Figure 5-12 Subroutine PDECAY Flowchart

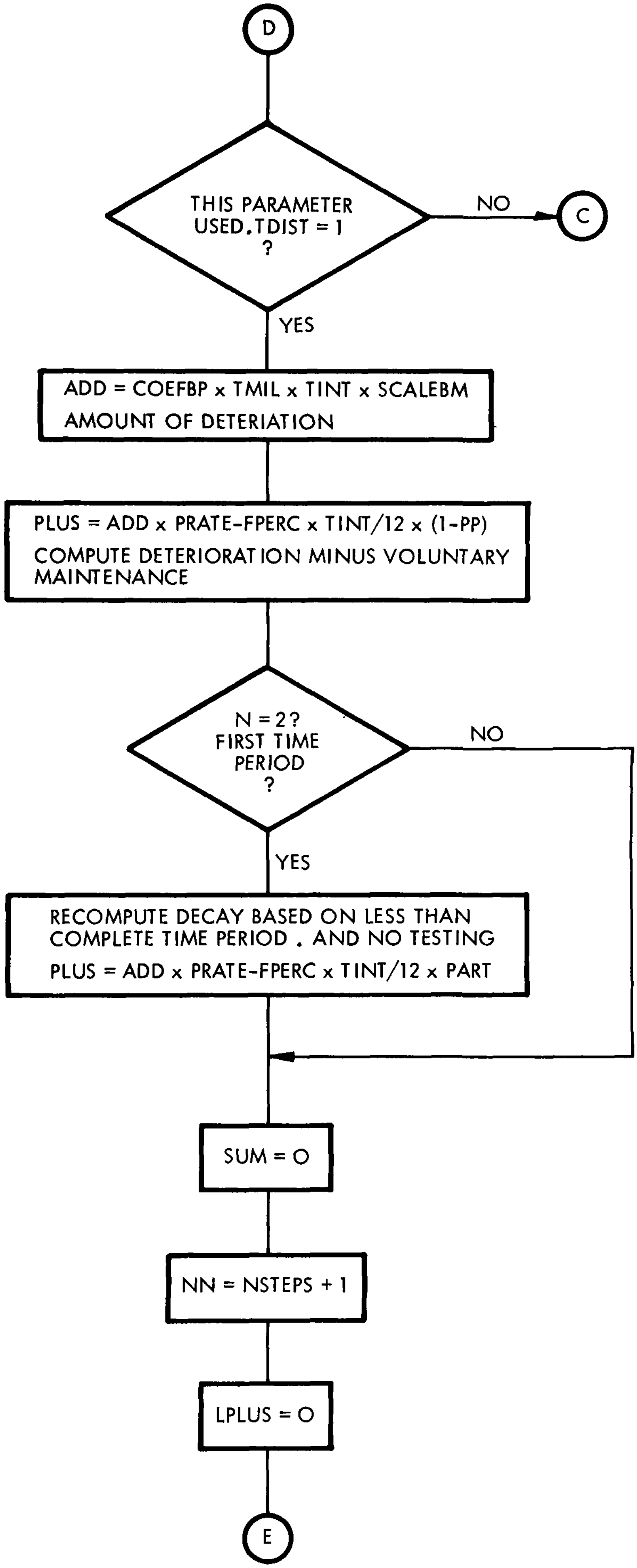


Figure 5-12 Subroutine PDECAY Flowchart (cont.)

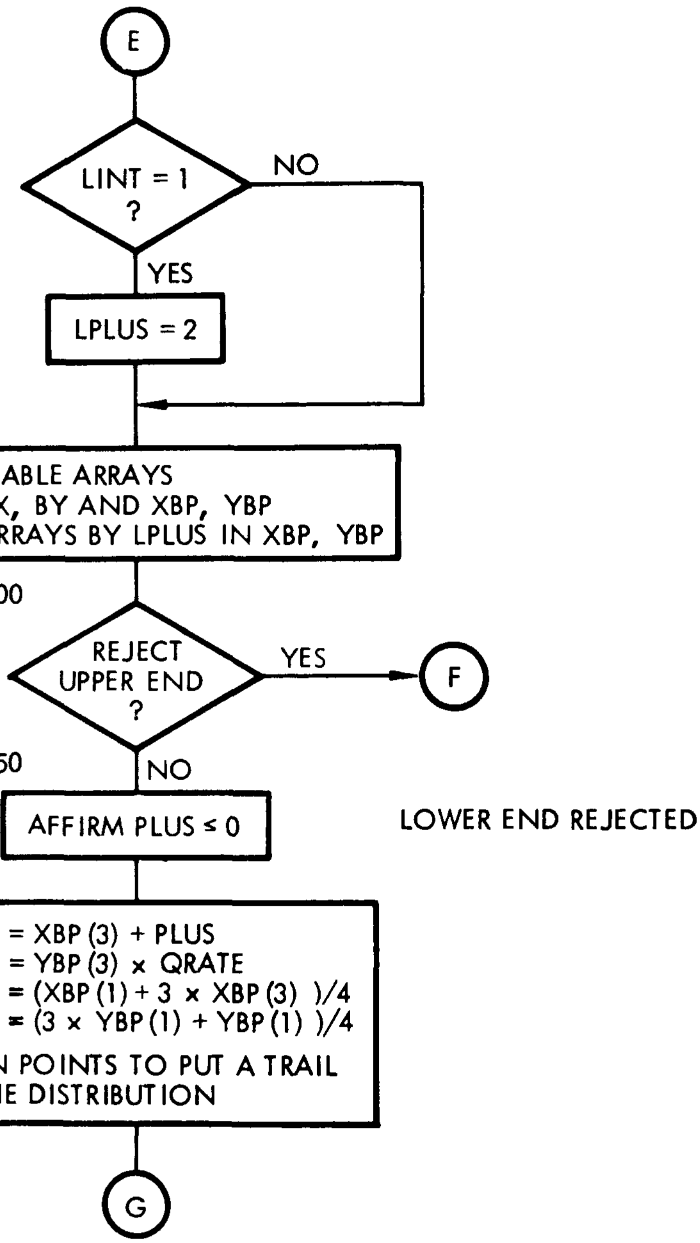


Figure 5-12 Subroutine PDECAY Flowchart (cont.)

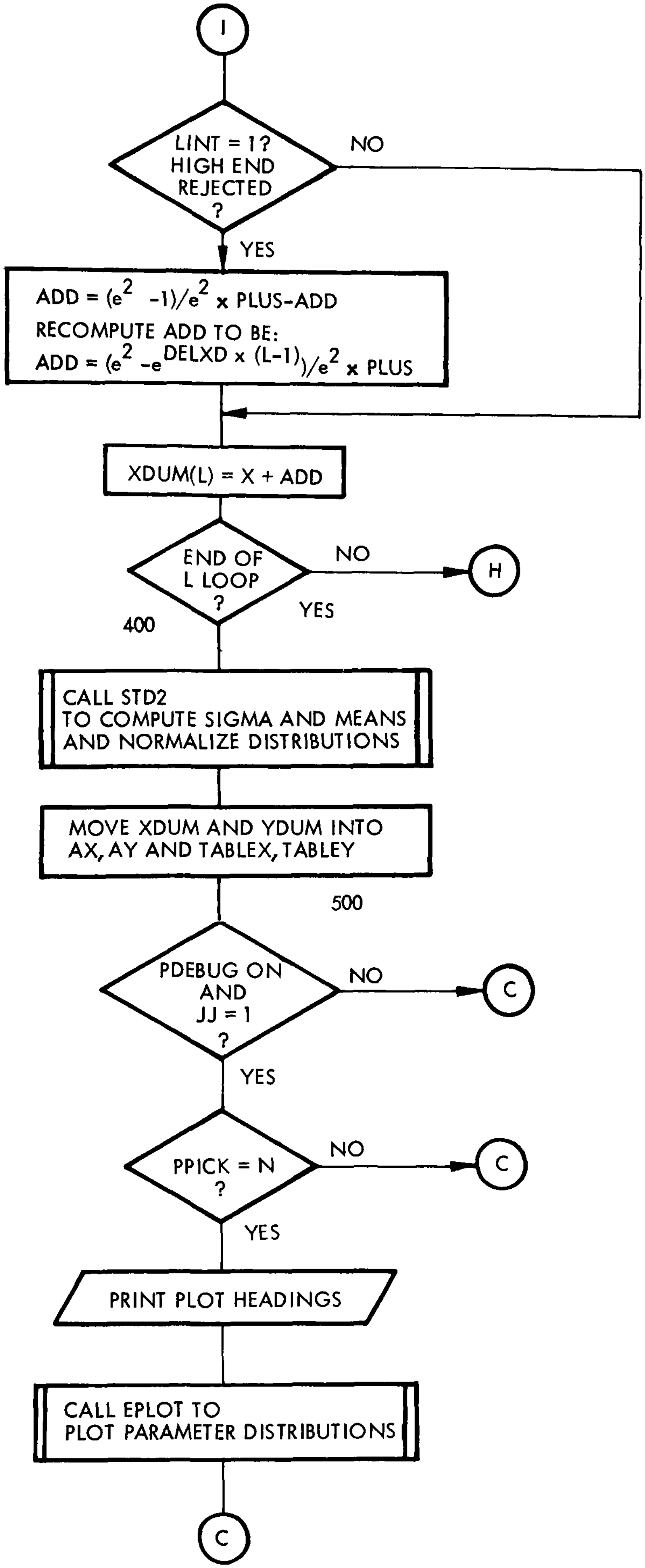


Figure 5-12 Subroutine PDECAY Flowchart (cont.)

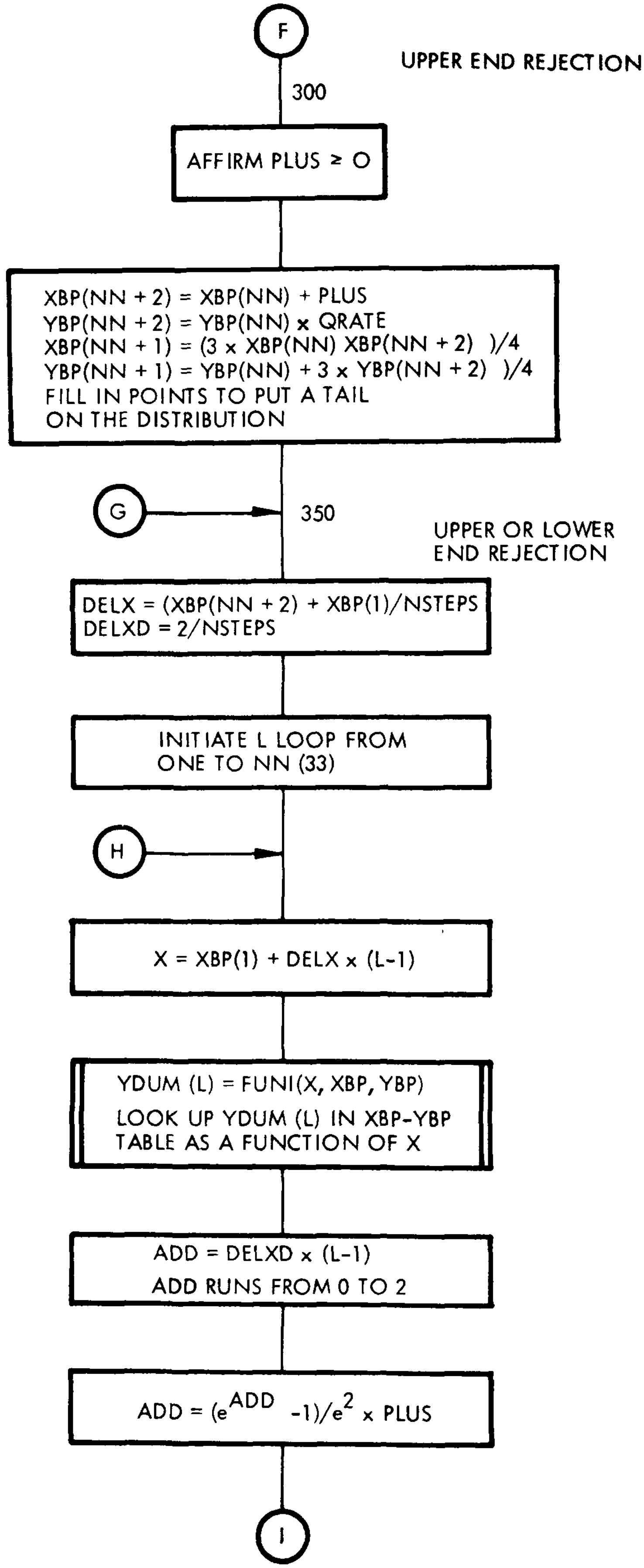


Figure 5-12 Subroutine PDECAY Flowchart (cont.)

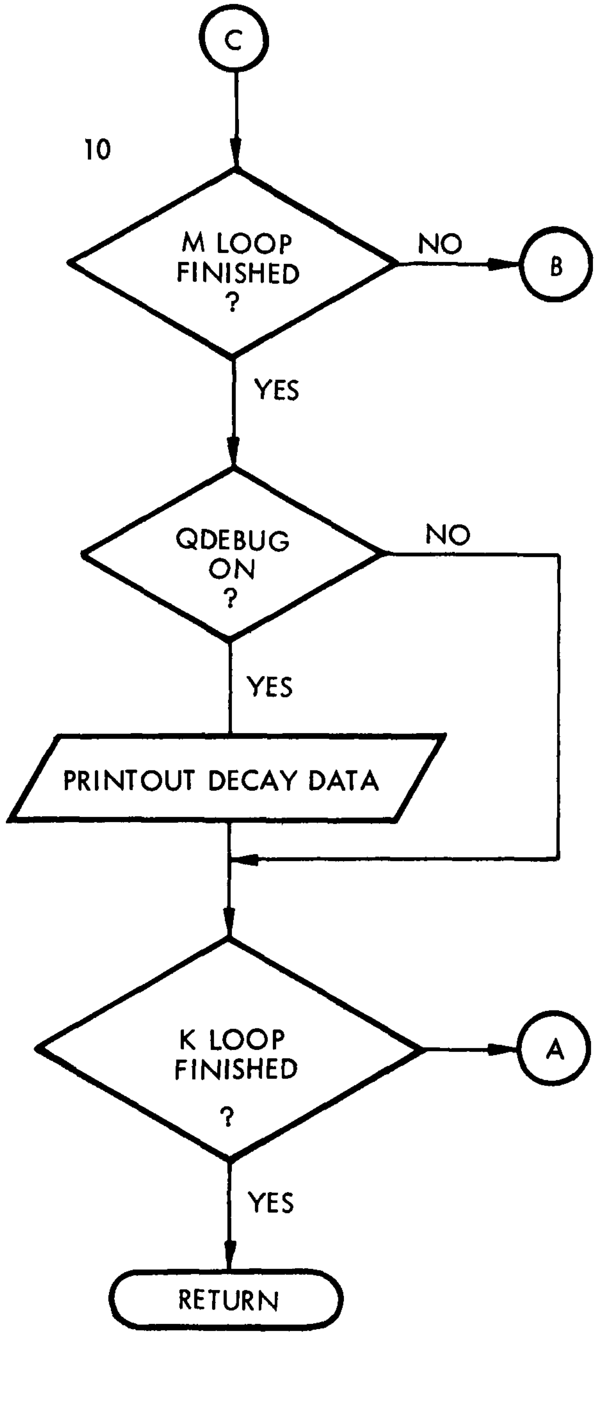


Figure 5-12 Subroutine PDECAY Flowchart (cont.)

Table 5-12 SUBROUTINE PDECAY LISTING

```
          SUBROUTINE PDECAY(JJ,N)
          DIMENSION  XBP(50),YBP(50)
          DIMENSION DRATE(10,3),PRATE(10,3)
          DIMENSION BX(35),BY(35),AX(35),AY(35)
           COMMON /COM01/       AMB(3),ALAB,    AVV,  BINT,
         +     BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,    BSIZE,
         +     BHIST(3,16),         BMMI(10,15,3),
         +     ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
           COMMON /COM02/             CARA,      CARIY,      CARMY,      CARPOP(16),
         +     CARSY,     CBSUM,      CCOEF(10),CCOSTI,     CCOSTM,     CGTT,
         +     CINCON,    CPCB,  CPI,       CPVPY,     CSUM,       CARAY,
         +     CN(15,3,16),            COEFB(15,3),             COEFBP(10,15),
         +     CPART(10,15)
      CC ADD2
          COMMON /COM03/           DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
         + EMW(3),        EP(10,15),EFF(10),  DELIT(3),
         +     FRECA,     FREQB,      FPFRC(10,3),
         +     HORZN,     HORZNY,
         +     HPC(15,16),           HPCS(15,16),         HPP(10,15,16),
         +     HPS(6,15,16),         HPT(5,16),           HPTOT(16),
         +     HPTOTS(16)
      CC ADD3
          COMMON /COM04/           ITE,       ITL,        ITP,        ITIME(16),
         +     KSTART,    KSTOP,      LOPT,  LPICK(10),LLPICK,
         +     LIDLE,     LINT(16),  LPSPP(10),LSTART,    LSTOP,
         +     MBASE,     MPH,       MSPEC(10),MSTART,    MSTOP,
         +     MU(10,3),    MMS(10,15),           MVPR(10,15)
      CC ADD4
          COMMON /COM05/           NAME(50), NCNTR,     NEMIS,      NEMP,
         +     NINTR,     NINTRB,    NMODE,     NO,        NOPTS,      NPAR,
         +     NPTRN,     NPTS,      NSTEPS,    NTR,       NTFB,       NPICK(16),
         +     OCIY,      OCMY,      OPTI,      OPTM,OPTS(50),OVCHI(3),OVCHM(3)
      CC ADD5
          COMMON /COM06/PARM(3,3), PART,      PAYNEW,    PAYOFF(3),
         +     PC(15),    PCS(15),   PHI(14),   PLO(14),   PLTMAX(3),PMODEL,
         +     PP(10,15),PS(6,15),  PT(5),     PTOT,      PTS(5),  PAYADJ,
         +     PAR(10,15,3),         PARI(10,3,3),        PLUS(10,15),
         +     PM(10,15),            PPICK(10),PPPICK,PSTAR,PI(15,10),
         +     PSA(15),  PTA(5),     PCONF,     PARINT(10,10,9)
         + ,PAYFIN
          COMMON /COM07/           REINSP,    RNAME,     RSIZE,     RSTOP,
```

```
     +    RTYPE,
     +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
     +    SMODEL,   START(15,3), STAT,      STIME(3), SUMBM(3),
     +    SCALEBM(3),         SM(6,15),           SPAR(10,15,6),
     +    SXCUT(6,3),         SIG(10,3),           SIGCE(3),
     +    SIGME(10),          SIGMNE(10),         SIGP(10,15),
     +    SIGRATE,  SIST,      SIGS(6,15),         SIGSDE(3),
     +    STABLEX(33,6,15),    STABLEY(33,6,15)
      COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TONX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15), TMIL(16,15),
     +    THIST(5,3,16),      THISTT(3,16),       TIMEC(10,15),
     +    TIMEM(10,15),       TABLEX(33,10,15),    TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/          WF(10),
     +    X1BP(3,3,6), XINT,     XINTB,    XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/          Y1BP(3,3,10),       Y2BP(3,3,10),
     +    YES,      YSUM,     YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,       Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,       Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,      Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,    ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,   PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL          ITE,      ITL,      ITP,      ITIME,
     +    MMS,      MPH,      MSPEC,    MU,       MVPR,
     +    NAME,     NO,       LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER       RNAME,    SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,    OPTI,     PPICK,    PPPICK
     DATA QRATE/.33,9*.16,.33,9*.16,.33,9*.16/
     DATA PRATE/2.,1.,9.,0.,0.,0.,1.,2.,1.,0.,2.,1.,12.,0.,0.,0.,1.,
     + 2.,1.,0.,2.,1.,9.,0.,0.,0.,1.,2.,1.,0./
     SUM1=0.
     DO 20 K=KSTART,KSTOP
     J=JJ+5*(K-1)
     IF(PDEBUG.EQ.NO) GO TO 5
```

```
      IF(JJ.NE.1) GOTO 5
      IF(PPICK(PPPICK).NE.N) GOTO 5
      WRITE (6,30)
      WRITE (6,55) NAME(JJ+10),NAME(K+3),(L,L=1,10),
     + (PM  (M,J),M=1,10),(SIGP(M,J),M=1,NPAR)
    5 DO 10 M=MSTART,MSTOP
      IF(M.EQ.5.OR.M.EQ.6) GO TO 10
      IF(M.EQ.4.OR.M.EQ.10) GO TO 10
      IF(TDIST(M,K).NE.1) GOTO 10
      ADD=COEFBP(M,J)*TINT*(PART*TMIL(N,J)+(1.-PART)*TMIL(N-1,J))
      IF(N.EQ.2) ADD=COEFBP(M,J)*TINT*TMIL(N,J)
      PLUS(M,J)=ADD*PRATE(M,K) -FPERC(M,K)*TINT/12.*(1.-PP(M,J))
      IF(N.EQ.2)PLUS(M,J)=(ADD*PRATE(M,K)-FPERC(M,K)*TINT/12.)*PART
      SUM=0.
      NN=NSTEPS+1
      LPLUS=0
      IF(LINT(M).EQ.1) LPLUS=2
      DO 200 L=1,NN
      BX(L)=XBP(L+LPLUS)=TABLEX(L,M,J)
      BY(L)=YBP(L+LPLUS)=TABLEY(L,M,J)
  200 CONTINUE
      IGO=LINT(M)
      GO TO (250,300),IGO
  250 CONTINUE
CC    REJECT LOWER PORTION
      IF(PLUS(M,J).GT.0.) PLUS(M,J)=-0.01
      XBP(1)=XBP(3)+ PLUS(M,J)
      YBP(1)=YBP(3)*QRATE(M,K)
      XBP(2)=(XBP(1)+3.*XBP(3))/4.
      YBP(2)=(YBP(3)+3.*YBP(1))/4.
      GO TO 350
  300 CONTINUE
      IF(PLUS(M,J).LT.0.) PLUS(M,J)=0.01
CC    REJECT UPPER PORTION
      XBP(NN+2)=XBP(NN)+ PLUS(M,J)
      YBP(NN+2)=YBP(NN)*QRATE(M,K)
      XBP(NN+1)=(3.*XBP(NN)+XBP(NN+2))/4.
      YBP(NN+1)=(YBP(NN)+3.*YBP(NN+2))/4.
  350 CONTINUE
      DELX=(XBP(NN+2)-XBP(1))/NSTEPS
      DELXD=2./NSTEPS
CC    DECAY OF ENTIRE DISTRIBUTION
```

Table 5-12 SUBROUTINE PDECAY LISTING (cont.)

```
      DO 400 L=1,NN
      X=XBP(1)+DELX*(L-1)
        AY(L)=FUN1(X,XBP,YBP,NN+2)
      ADD=DELXD*(L-1)
      ADD=(EXP(ADD)-1.)/EXP(2.)*PLUS(M,J)
      IF(LINT(M).EQ.1) ADD=(EXP(2.)-1.)/EXP(2.)*PLUS(M,J) -ADD
      AX(L) = X+ADD
  400 CONTINUE
      CALL PACKD(AX,AY,NN)
      CALL STD2(AX,AY,NN,PM(M,J),SIGP(M,J))
      DO 500 L=1,NN
      TABLEX(L,M,J)=AX(L)
      TABLEY(L,M,J)=AY(L)
 500  CONTINUE
   11  FORMAT(1H1,/40X,A10,/)
      IF(PDEBUG.NE.YES) GOTO 10
      IF(JJ.NE.1) GOTO 10
      IF(PPICK(PPPICK).NE.N) GOTO 10
       MM=30+M
      WRITE(6,11) NAME(MM)
       CALL EPLOT(BX,BY,AX,AY,NN,LINT(M))
   10 CONTINUE
      IF(ODEBUG.NE.YES) GOTO 20
   30 FORMAT(1H1,25X,*PARAMETER SETTINGS BEFORE DECAY AND MAINT*)
      WRITE (6,40)
   40 FORMAT(/,25X,*PARAMETER SETTINGS AFTER DECAY AND MAINT*)
      WRITE (6,55) NAME(JJ+10),NAME(K+3),(L,L=1,10),(PM  (M,J),
     + M=1,10),(SIGP(M,J),M=1,NPAR)
   55 FORMAT(//,25X,A8,*  --  *,A8//,* PARAMETER *,
     + 10(3X,I2,5X),//,3X,*PM*,5X,10E10.2/2X,*SIGP*,4X,10E10.2)
   20 CONTINUE
      RETURN
      END
```

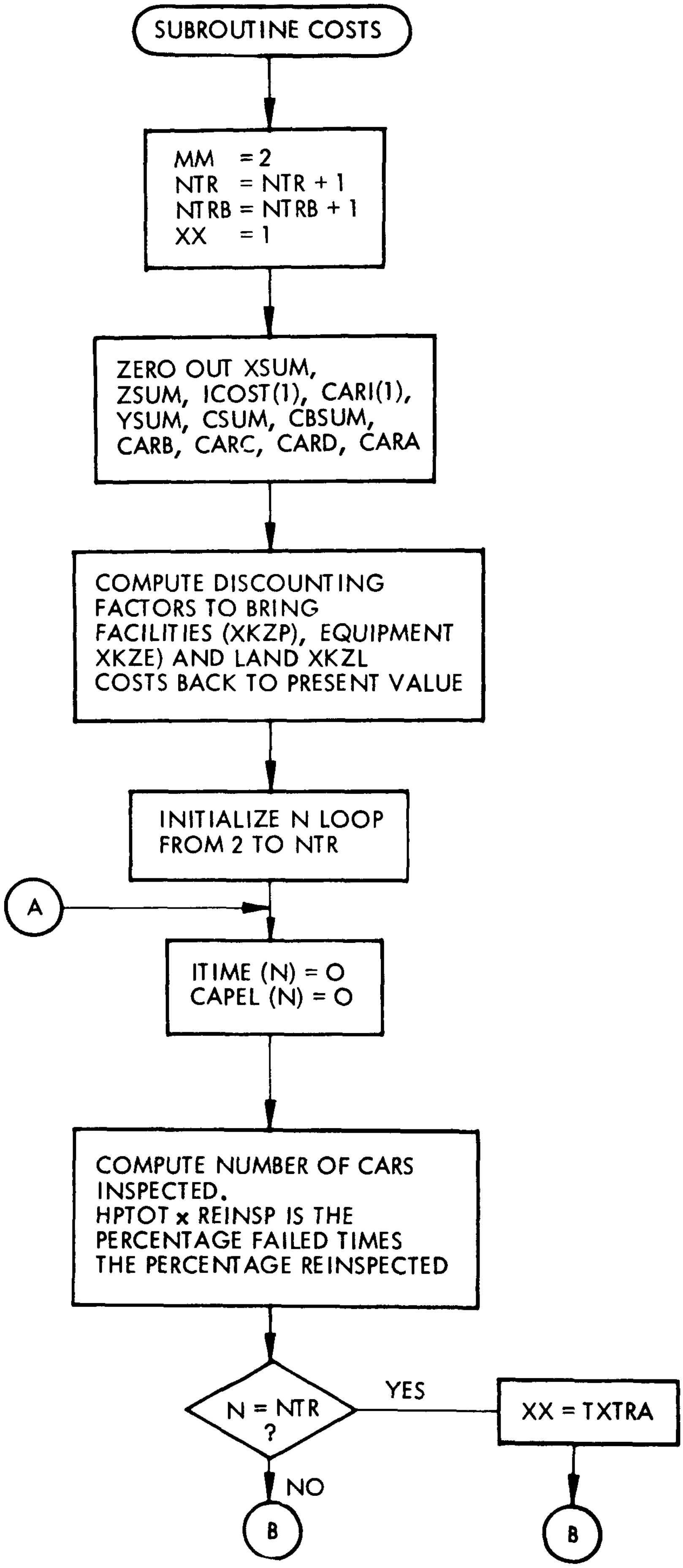


Figure 5-13 Subroutine COSTS Flowchart

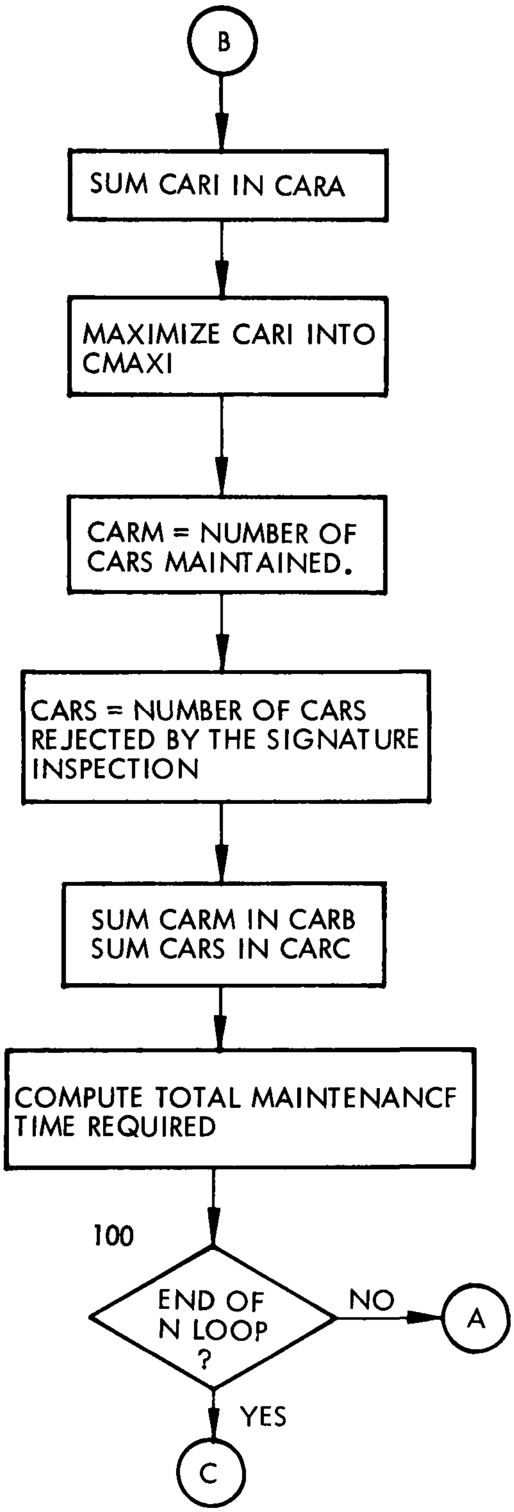


Figure 5-13 Subroutine COSTS Flowchart (cont.)

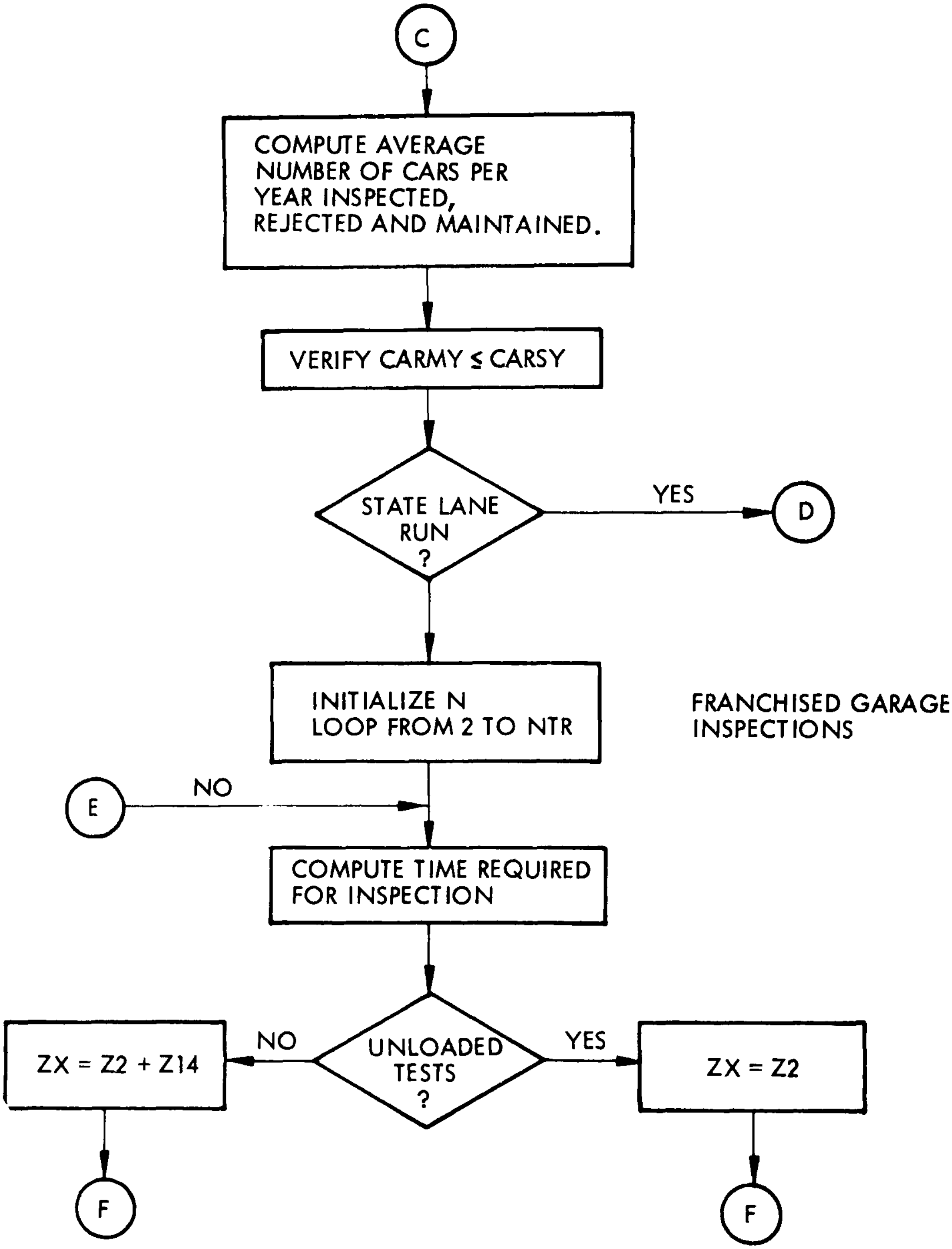


Figure 5-13 Subroutine COSTS Flowchart (cont.)

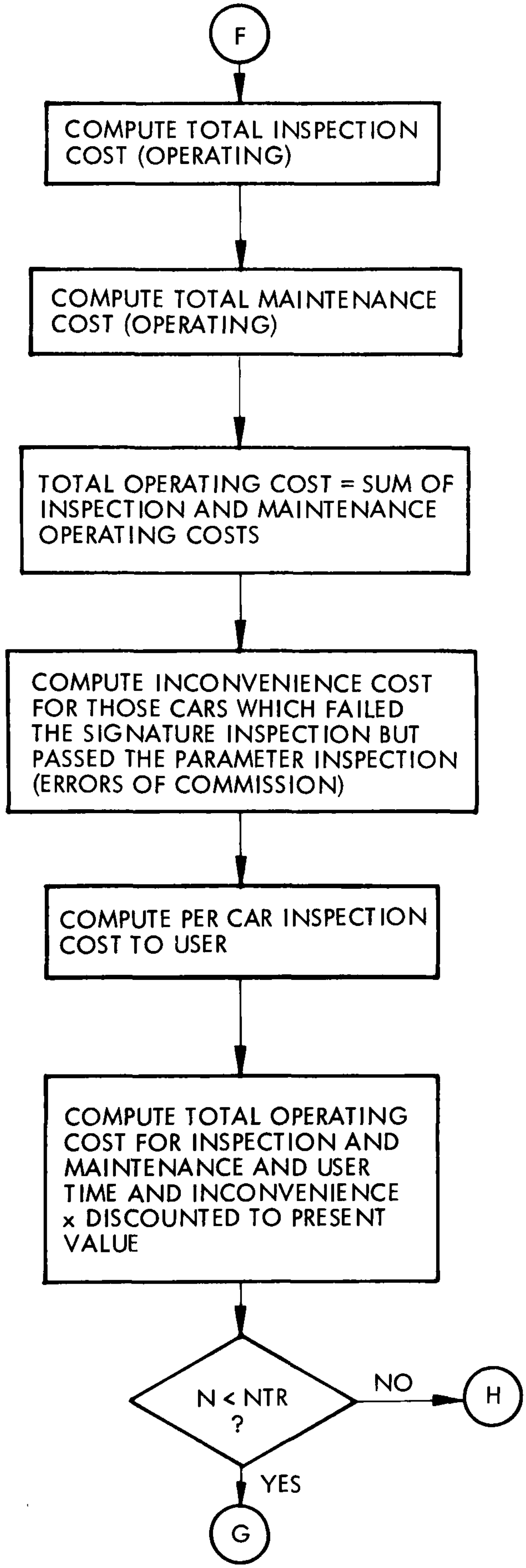


Figure 5-13 Subroutine COSTS Flowchart (cont.)

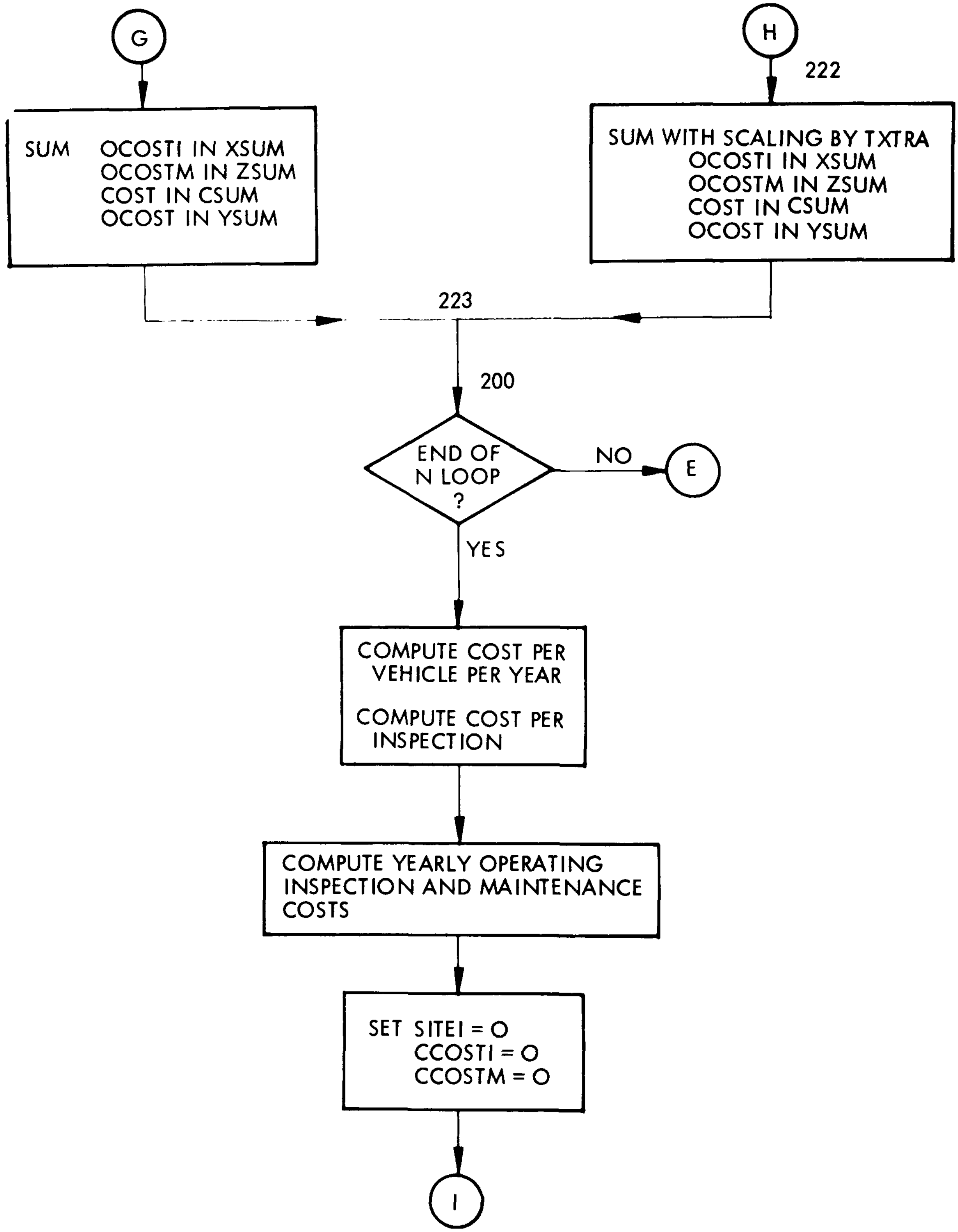


Figure 5-13 Subroutine COSTS Flowchart (cont.)

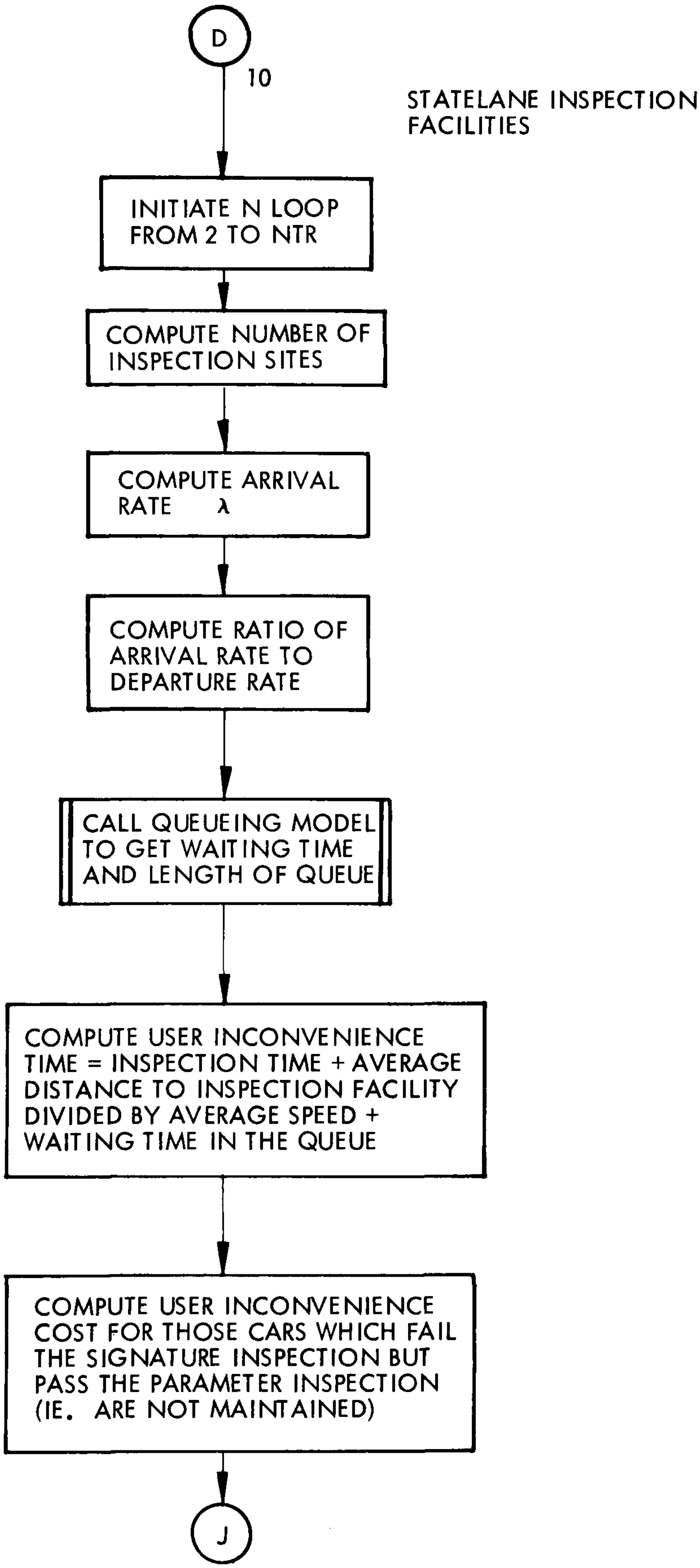


Figure 5-13 Subroutine COSTS Flowchart (cont.)

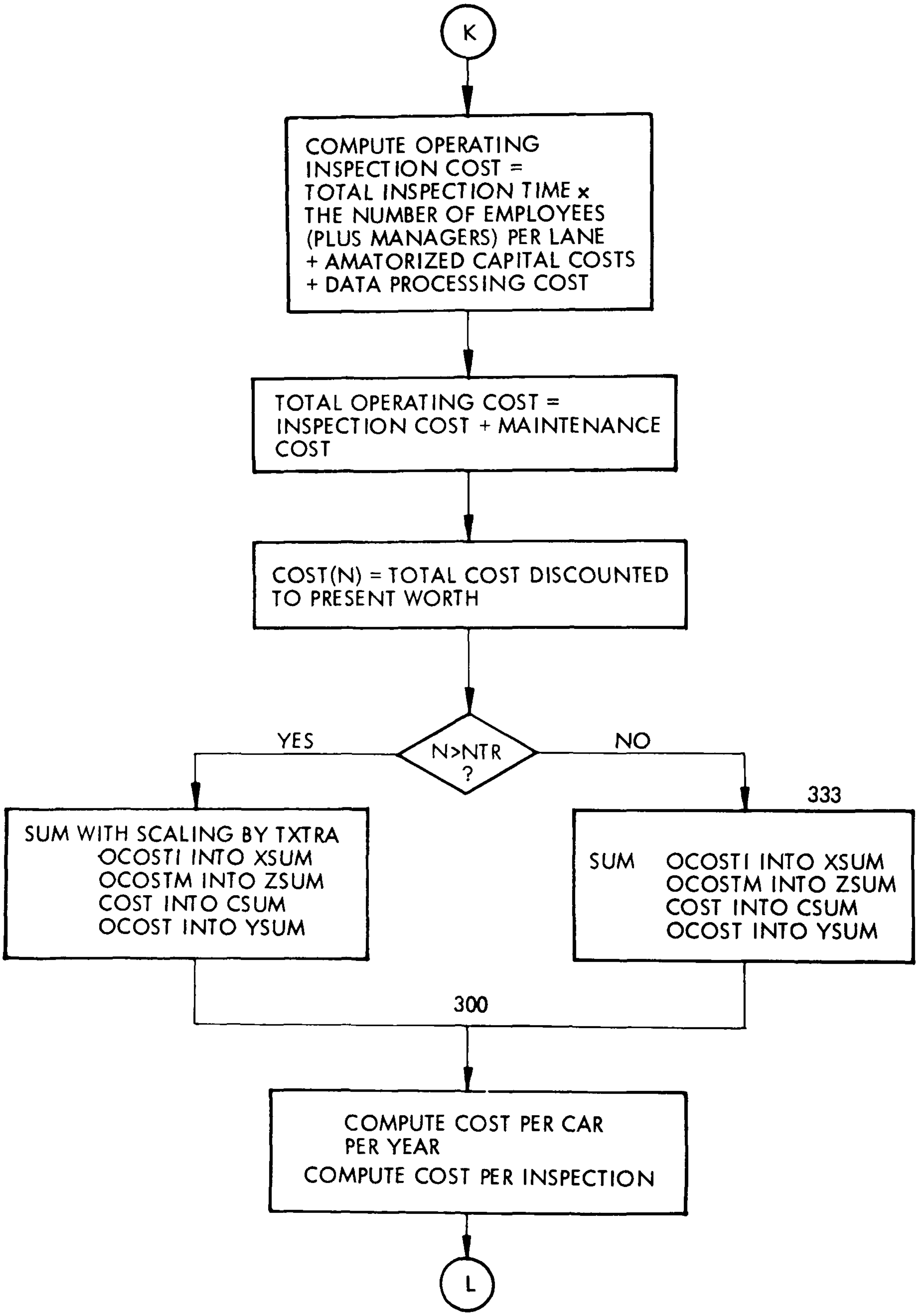


Figure 5-13 Subroutine COSTS Flowchart (cont.)

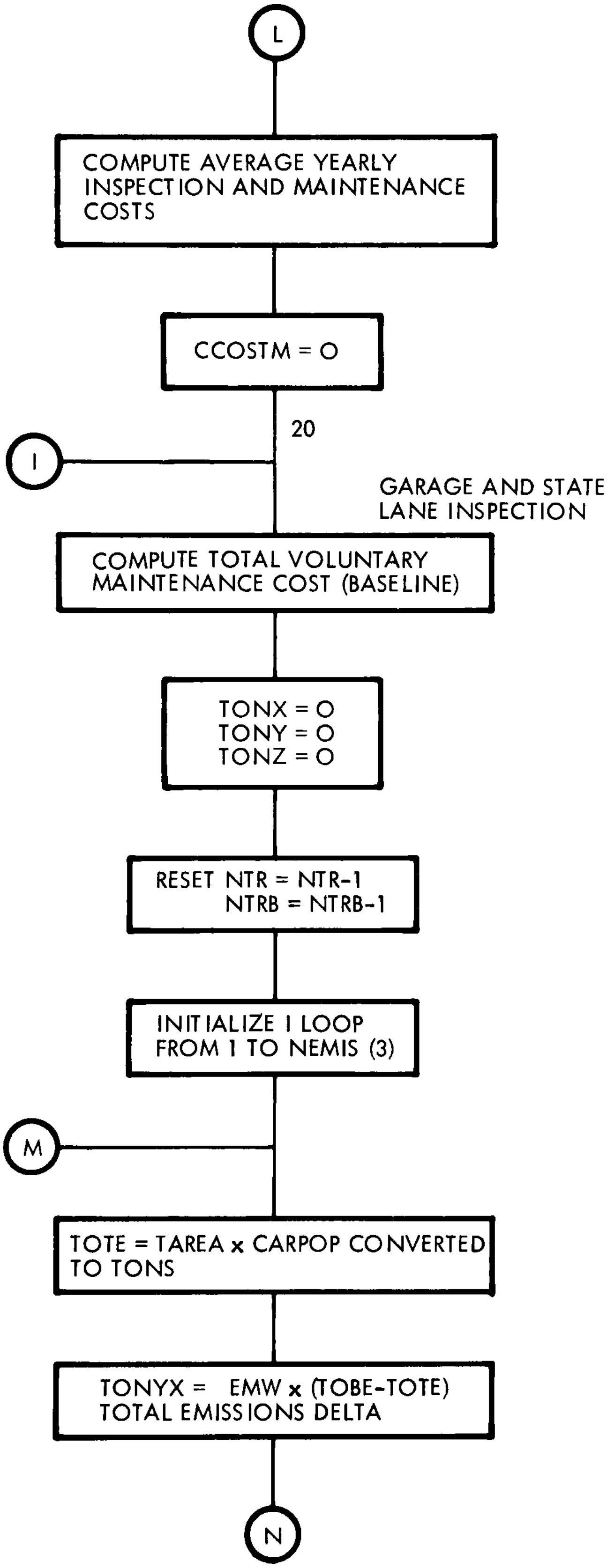


Figure 5-13 Subroutine COSTS Flowchart (cont.)

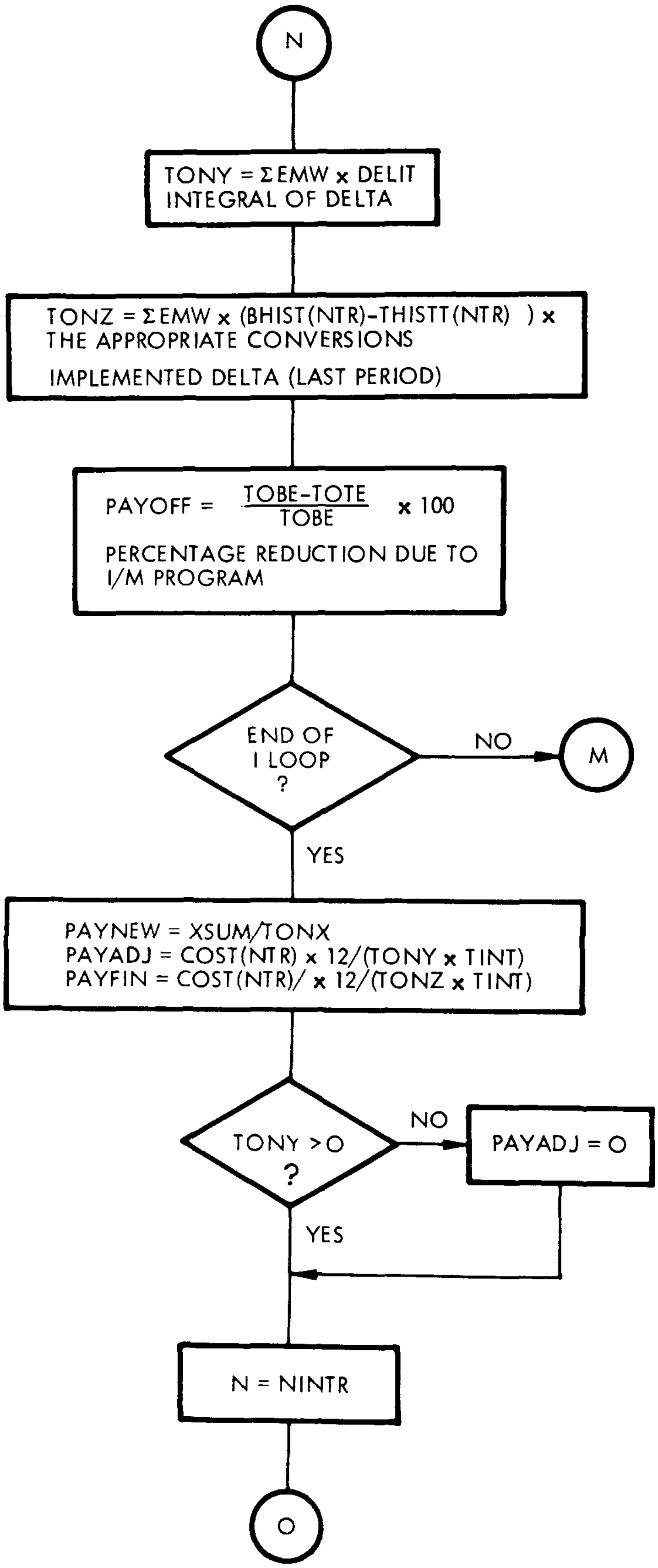


Figure 5-13 Subroutine COSTS Flowchart (cont.)

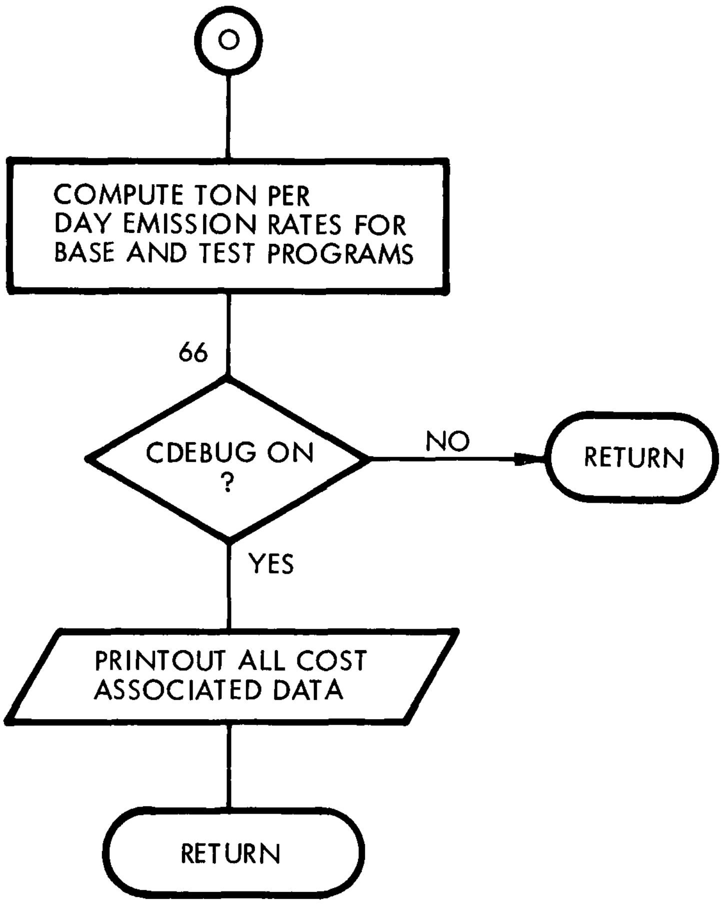


Figure 5-13 Subroutine COSTS Flowchart (cont.)

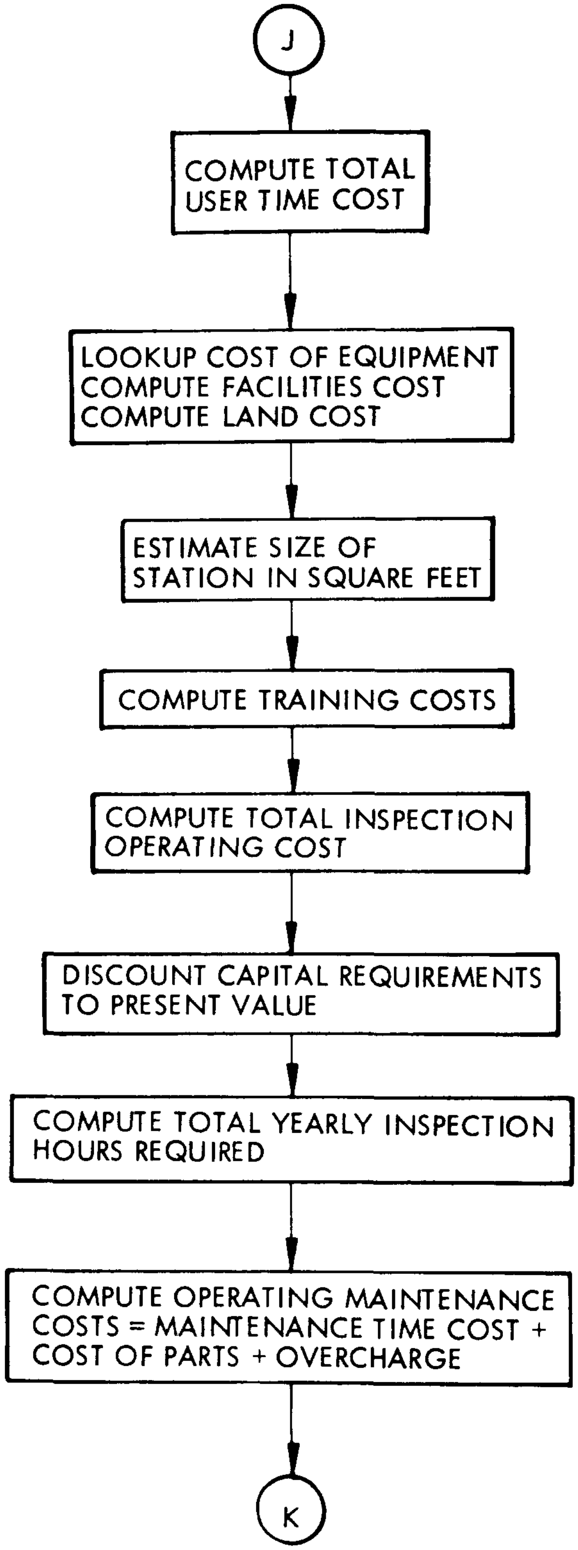


Figure 5-13 Subroutine COSTS Flowchart (cont.)

Table 5-13 SUBROUTINE COSTS LISTING

```
                SUBROUTINE COSTS
                DIMENSION CARI(16),CARM(16),TIM(16),TEIMEM(16),
              + TCP(16),TTI(16),OCOST(16),CUST(16),
              2 ICOST(16),CAPEL(16),ACAPC(16),COSTB(16),TTM(16),
              + OCOSTI(16),OCOSTM(16),WTIME(16)
                DIMENSION CARS(16),CARSA(16)
                COMMON /COM01/     AMB(3),ALAB,     AVV,  BINT,
              +    BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,    BSIZE,
              +    BHIST(3,16),         BMMI(10,15,3),
              +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
                COMMON /COM02/          CARA,      CARIY,     CARMY,     CARPOP(16),
              +    CARSY,     CBSUM,    CCOEF(10),CCOSTI,    CCOSTM,    CGTT,
              +    CINCON,    CPCB,  CPI,       CPVPY,     CSUM,      CARAY,
              +    CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
              +    CPART(10,15)
         CC ADD2
                COMMON /COM03/          DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
              + EMW(3),       EP(10,15),EFF(10),  DELIT(3),
              +    FREQA,     FREQB,    FPERC(10,3),
              +    HORZN,     HORZNY,
              +    HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
              +    HPS(6,15,16),        HPT(5,16),           HPTOT(16),
              +    HPTOTS(16)
         CC ADD3
                COMMON /COM04/          ITE,       ITL,       ITP,       ITIME(16),
              +    KSTART,    KSTOP,    LOPT,  LPICK(10),LLPICK,
              +    LIDLE,     LINT(16), LPSPP(10),LSTART,   LSTOP,
              +    MBASE,     MPH,      MSPEC(10),MSTART,   MSTOP,
              +    MU(10,3),    MMS(10,15),          MVPR(10,15)
         CC ADD4
                COMMON /COM05/          NAME(50), NCNTR,     NEMIS,     NEMP,
              +    NINTR,     NINTRB,   NMODE,     NO,        NOPTS,     NPAR,
              +    NPTRN,     NPTS,     NSTEPS,    NTR,       NTRB,      NPICK(16),
              +    OCIY,      OCMY,     OPTI,      OPTM,OPTS(50),OVCHI(3),OVCHM(3)
         CC ADD5
                COMMON /COM06/PARM(3,3), PART,     PAYNEW,    PAYOFF(3),
              +    PC(15),    PCS(15),  PHI(14),  PLO(14),   PLTMAX(3),PMODEL,
              +    PP(10,15),PS(6,15), PT(5),    PTOT,      PTS(5),   PAYADJ,
              +    PAR(10,15,3),        PAR1(10,3,3),        PLUS(10,15),
              +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
              +    PSA(15),  PTA(5),    PCONF,    PARINT(10,10,9)
```

Table 5-13 SUBROUTINE COSTS LISTING (cont.)

```
     + ,PAYFIN
       COMMON /COM07/         REINSP,  RNAME,   RSIZE,    RSTOP,
     +    RTYPE,
     +    SALE,     SALL,     SALP,    SITEI,   SITEM,    SLANE,
     +    SMODEL,   START(15,3), STAT,    STIME(3), SUMBM(3),
     +    SCALEBM(3),         SM(6,15),         SPAR(10,15,6),
     +    SXCUT(6,3),         SIG(10,3),         SIGCE(3),
     +    SIGME(10),          SIGMNE(10),        SIGP(10,15),
     +    SIGRATE,  SIST,      SIGS(3,15),        SIGSDE(3),
     +    STABLEX(33,6,15),    STABLEY(33,6,15)
       COMMON /COM10/         TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TONX,    TOTE(3), TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,     TSIG(3), TPER(16,15), TMIL(16,15),
     :    THIST(5,2,16),      THISTT(3,15),      TIMEC(10,15),
     +    TIMEM(10,15),       TABLEX(33,10,15),   TABLEY(33,10,15)
CC ADD10
       COMMON /COM11/         WF(10),
     +    X1BP(3,3,6), XINT,    XINTB,   XLANE,    XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
       COMMON /COM12/         Y1BP(3,3,10),      Y2BP(3,3,10),
     +    YES,      YSUM,     YTM(16),   Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,       Z3,      Z4,      Z5,       Z6,
     +    Z7,       Z8,       Z9,      Z10,     Z11,      Z12,
     +    Z13,      Z14,      Z15,     Z16,     Z17,
     +    ZCARI,    ZCARM,    ZIC,     ZSUM,
     +    ZZ(3,3)
CC ADD12
       COMMON /DEBUG/         ADEBUG,  BDEBUG,  CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,   PDEBUG,  QDEBUG,  SDEBUG,   TDEBUG
CC ADDD
       REAL           ITE,      ITL,     ITP,     ITIME,
     +    MMS,      MPH,      MSPEC,   MU,      MVPR,
     +    NAME,     NO,       LDEBUG,  MDEBUG,
     +    IN,       MISFIRE
       INTEGER        RNAME,    SITEI,   SITEM,   STAT,
     +    TDIST,    XLANE,    OPTI,    PPICK,   PPPICK
       REAL ICOST,LQ
CC                     ***  COST MODEL
       MM=2
       NTR=NTP+1
       NTRB=NTPB+1
```

```
      XSUM=ZSUM=0.
      ICOST(1)=0.
      CARI(1)=0.
      YSUM=CSUM=CBSUM=0.
      XX=1.
      CARB=CARC=0.
      CARA=0.
      XKZP=(1.-SALP)*ZIC*(1.+ZIC)**ITP/((1.+ZIC)**ITP-1.)+ZIC*SALP
      XKZE=(1.-SALE)*ZIC*(1.+ZIC)**ITE/((1.+ZIC)**ITE-1.)+ZIC*SALE
      XKZL=(1.-SALL)*ZIC*(1.+ZIC)**ITL/((1.+ZIC)**ITL-1.)+ZIC*SALL
      DO 100 N=2,NTR
      ITIME(N)=CAPEL(N)=0.
      CARI(N)=CARPOP(N)*(1.+HPTOT(N)*REINSP)
      IF(N.GE.NTR) XX=TXTRA
      CARA=CARA+CARI(N)*XX
      CMAXI=AMAX1(CARI(N-1),CARI(N))
      CARM(N)=HPTOT(N)*CARI(N)/(1.+HPTOT(N)*REINSP)
      CARS(N)=HPTOTS(N)*CARI(N)/(1.+HPTOTS(N)*REINSP)
      CARB=CARB+CARM(N)*XX
      CARC=CARC+CARS(N)*XX
      TTM(N)=XTM(N)*CARI(N)
      TCP(N)=YTM(N)*CARI(N)
  100 CONTINUE
      CARIY=CARA/HORZNY
      CARMY=CARB/HORZNY
      CARSY=CARC/HORZNY
      CARSY=CARMY
      IF(SLANE.EQ.10HSTATE      ) GO TO 10
      DO 200 N=2,NTR
CC     FRANCHISED GARAGE INSPECTION/MAINTENANCE
CC     NO FACILITIES SIZING
      TTI(N)=CARI(N)*TIMEI(OPTI,N)
      ZX=Z2
      IF(LIDLE.GT.1) ZX=Z2+Z14
      OCOSTI(N)=ZX*TTI(N)+Z15*CARI(N)+OVCHI(OPTI)*CARI(N)
      OCOSTM(N)=ZX*TTM(N)+TCP(N)+OVCHM(OPTI)*CARM(N)
      OCOST(N)=OCOSTI(N)+OCOSTM(N)
      ICOST(N)=Z9*(TIMEI(OPTI)+Z7)*(CARI(N)-CARM(N))
      CINCON=Z9*(TIMEI(OPTI)+Z7)
      COST(N)=(ICOST(N)+OCOST(N))*((1.+Z4)/(1.+Z5))**YR
      IF(N.GE.NTR) GOTO 222
      XSUM=XSUM+OCOSTI(N)
```

```
      ZSUM=ZSUM+OCOSTM(N)
      CSUM=CSUM+COST(N)
      YSUM=YSUM+OCOST(N)
      GOTO 223
  222 CONTINUE
      XSUM=XSUM+OCOSTI(N)*TXTRA
      ZSUM=ZSUM+OCOSTM(N)*TXTRA
      CSUM=CSUM+COST(N)   *TXTRA
      YSUM=YSUM+OCOST(N)  *TXTRA
  223 CONTINUE
  200 CONTINUE
      IF(CARB.GT.1.E-20)
     * CPVPY=ZSUM/CARB+XSUM/CARA
      CPI=YSUM/CARA
       OCIY=XSUM/HORZNY
      OCMY=ZSUM/HORZNY
      CCOSTM=0.
      SITEI=0
       CCOSTI=0.
      GO TO 20
CC    STATELANE INSPECTION
CC    FACILITIES SIZING  USING INCONVIENCE COSTS
   10 DO 300 N=2,NTR
      SITEI=STAT/XLANE+.99
      XLAM=CMAXI/(STAT*250.*8.*60.*TINT/12.)
      RHO=XLAM*STIME(OPTI)/XLANE
      CALL QUEUE(RHO,LQ,WTIME(N),XLANE)
      ITIME(N)=STIME(OPTI)+2.*SQRT((ALAB/SITEI)/3.1415)*2./
     + AVV*60.+WTIME(N)
      ICOST(N)=Z9*ITIME(N)/60.*(CARI(N)-CARM(N))
      CINCON=Z9*ITIME(N)/60.
CC    COSTS OF FACILITIES, EQUIPMENT,LAND
      CAE=ZZ(XLANE,LIDLE)
      CAP=Z10*(BLD1+BLD2*XLANE)
      CAL=Z13*((BLD1+BLD2)*10.+BLD2*XLANE*(1.+LQ))
      SIST=CAL/Z13
      CAT=Z6*(NEMP+Z1)*STAT
      CCOSTI=CAE+CAL+CAP+CAT
      CAPEL(N)=(XKZP*CAP+XKZE*CAE+XKZL*CAL+XKZE*CAT)*SITEI
      TTI(N)=CARI(N)*STIME(OPTI)/60.
      OCCSTM(N)=Z2*TTM(N)+TCP(N)+OVCHM(OPTI)*CARM(N)
      OCOSTI(N)=(Z1+NEMP)*Z16*TTI(N)+
```

```
     + CAPEL(N)+Z15*CARI(N)
      OCOST(N)=OCOSTI(N)+OCOSTM(N)
      COST(N)=(OCOST(N)+ICOST(N))*((1.+Z4)/(1.+Z5))**YR
      IF(N.GE.NTR) GOTO 333
      XSUM=XSUM+OCOSTI(N)
      ZSUM=ZSUM+OCOSTM(N)
      CSUM=CSUM+COST(N)
      YSUM=YSUM+OCOST(N)
      GOTO 300
  333  CONTINUE
      XSUM=XSUM+OCOSTI(N)*TXTRA
      ZSUM=ZSUM+OCOSTM(N)*TXTRA
      CSUM=CSUM+COST(N)   *TXTRA
      YSUM=YSUM+OCOST(N)  *TXTRA
  300 CONTINUE
      IF(CARB.GT.1.E-20)
     *CPVPY=ZSUM/CARB+XSUM/CARA
      CPI=YSUM/CARA
      OCMY=ZSUM/HORZNY
      OCIY=XSUM/HORZNY
      CCOSTM=0.
   20 CBSUM=(NTRB-2+BXTRA)*CPCB*CARPOP(16)
      TONX=TONY=0.
      TONZ=0.
      NTR=NTR-1
      NTRB=NTRB-1
      DO 33 I=1,NEMIS
      TOTE(I)=TAREA(I)*CARPOP(16)/CGTT
      TONX=TONX+EMW(I)*(TOBE(I)-TOTE(I))
      TONY=TONY+EMW(I)*DELIT(I)
      TONZ=TONZ+EMW(I)*(BHIST(I,NTR)-THISTT(I,NTR))*CARPOP(NTR)/CGTT*
     + MBASE*TINT
      PAYOFF(I)=(TOBE(I)-TOTE(I))/TOBE(I)*100.
   33 CONTINUE
      PAYNEW=CSUM/TONX
      PAYADJ=COST(NTR)*12./TINT
      PAYADJ=PAYADJ/TONY
      PAYFIN=COST(NTR)/TONZ*12./TINT
      IF(TONY.LT..001) PAYADJ=0.
      N=NINTR
      DO 66 I=1,NEMIS
      TPDT(I)=TOTE(I)/(HORZNY*365.)
```

Table 5-13 SUBROUTINE COSTS LISTING (cont.)

```
          TPDB(I)=TOBE(I)/(HORZNY*365.)
   66     CONTINUE
          IF(CDEBUG.EQ.NO) RETURN
           WRITE (6,504)
  504      FORMAT(1H1,*    FROM SUBROUTINE COST*//3X,*CARI*,6X,*CARM*,
         1 7X,*TTM*,6X,*TCP*,6X,*TTI*,5X*OCOST*,5X,*COST*,4X,*ITIME*,4X,
         2 *CAPEL*,4X,*OCOSTI*,3X,*OCOSTM*,3X,*COSTB*/)
           DO 505 N=1,NINTR
           WRITE (6,502) CARI(N),CARM(N),TTM(N),TCP(N),TTI(N),OCOST(N),
         1 COST(N),ITIME(N),CAPEL(N),OCOSTI(N),OCOSTM(N),COSTB(N)
  502      FORMAT(2X,12E9.2)
  505      CONTINUE
           WRITE(6,501)  CARIY,CARMY  ,XSUM,YSUM,ZSUM,CARA,CCOSTI,CPVPY,
         1 CPI,STAT,SITEI
  501       FORMAT(/* CARIY = *E12.5,10X,*CARMY = *E12.5,
         1 /* XSUM= *E12.5,13X,*YSUM= *E12.5,13X,*ZSUM= *E12.5,/
         2 * CARA = *E12.5/* CCOSTI = *E12.5/* CPVPY = *E12.5/* CPI = *
         3 E12.5/* STAT = *I5/* SITEI = *I4/)
          DO 530 I=1,NEMIS
          WRITE (6,510) NAME(I),TONX,PAYNEW,PAYOFF(I),TOTE(I),
         + TAREA(I),TPDT(I),TPDB(I)
  510     FORMAT(//,30X,A2,* EMISSION DELTA*//,5X,* TON = *E15.5,5X,
         + * PAYNEW = *E15.5,5X,* PAYOFF = *E15.5//5X,* TOTE = *
         + E15.5,5X,* TAREA = *E15.5//,5X,* TPDT = *E15.5,5X,
         + * TPDB = *E15.5/)
  530     CONTINUE
          RETURN
          END
```

is compared with the distribution from a base fleet that has not been subjected to a mandatory maintenance program. This comparison determines if the program has produced a statistically significant reduction in emissions for the species of interest.

The primary unit function of the statistical model is the integration of two distributions. This is accomplished mathematically by convoluting two distributions. The convolution procedure combines two independent distributions of a given population into a third distribution that represents the sum of the first two. Convolution is linear in the sense that the mean and variance of the new distribution are, respectively, the sums of the means and variances of the two input distributions. Similarly, the number of degrees of freedom of the output distribution is the sum of the degrees of freedom of the two input distributions i.e., $(n_1 - 1) + (n_2 - 1) = N_3$. Mathematically, the degrees of freedom represent the number of independent observations. If two independent distributions are added together, the number of independent variables would also be added to give the number of independent variables in the output distribution. If many distributions are added via convolution, the degrees of freedom of the resulting distribution would be expected to be large.

Also built into the convolution procedure is a test that determines whether or not a change in any one parameter distribution will have any significant effect on the total distribution. If one of the input ranges is sufficiently smaller than the other, then the smaller input will be ignored, and the convolution step will be by-passed. This check was built into the model to reduce the number of calculations during the convolution process. While the error introduced by ingoring distribution with relatively small standard deviations is at most 2.5%, the accumulative effect of this could bias the final distribution.

Those cars that fail the inspection test undergo a maintenance treatment. This treatment modifies the initial distribution according to the extent of maintenance and rejection rates. Next these engine component distributions are converted, using the influence coefficients to vehicle emission distributions. Lastly, the model errors (deterioration, influence coefficient) are convoluted to give a final distribution. This last step yields a distribution which corresponds to the mean emission levels forecasted with the E/E model.

Finally, the adjusted emission distribution (without model errors) is compared with the emission distribution of a base fleet. To do this, convolution is used to subtract the former distribution from the latter. This gives a distribution that represents the reduction in emission that is obtained from the specific program. By numerical integration, i.e. approximating the area under the "left hand side" of the distribution curve, the 10% level of this distribution is calculated, and this is used to test the statistical-significance of the emission reduction and determine confidence limits for emission reduction. This is the only valid method to obtain the confidence limits from this distribution. In particular, the standard normal test, also known as the z-score test, cannot be used since it assumes a normal distribution with mean equal to zero. However, the model contains an alternative test which compares the test fleet and base fleet distributions without first combining them into a single distribution.

An alternate method of testing the significance of the emission reduction is to compare the mean of the test fleet distribution and the mean of the base fleet distribution by using a t-test. First, the model uses an F-test to insure that the standard deviations are nearly equal. This test gives confidence limits similar to the ones found by using the numerical method. The t-test compares the two means with each other, and the model test works with the difference of the two means. The combination of the F-test followed by the t-test eliminates one convolution and the numerical integration approximation and is thus, computationally more efficient. However, these tests assume normal distributions, and if the emission rate distributions are skewed, they may yield misleading results.

Figure 5-14 presents a detailed flowchart for subroutine STATS. A computer listing of STATS is given in Table 5-14.

5.11 UTILITY ROUTINES

GEEP employs several functions and subroutines which perform such standard mathematical operations as computing means and standard deviations, curve fitting, linear interpolation and integration. These routines are further described in detail, with flowcharts and listings, in the following sections.

5.11.1 Subroutine CONVOL

Subroutine CONVOL is a generalized routine which convolutes two input distributions to generate a third. The input distributions are stored in P1 and Y1, P2 and Y2, with output in P3 and Y3. The sizes of the two input distributions are L1 and L2, while that of the output distributions is N3. All input to CONVOL comes through an argument list.

Subroutine CONVOL first checks if either distribution is an approximate

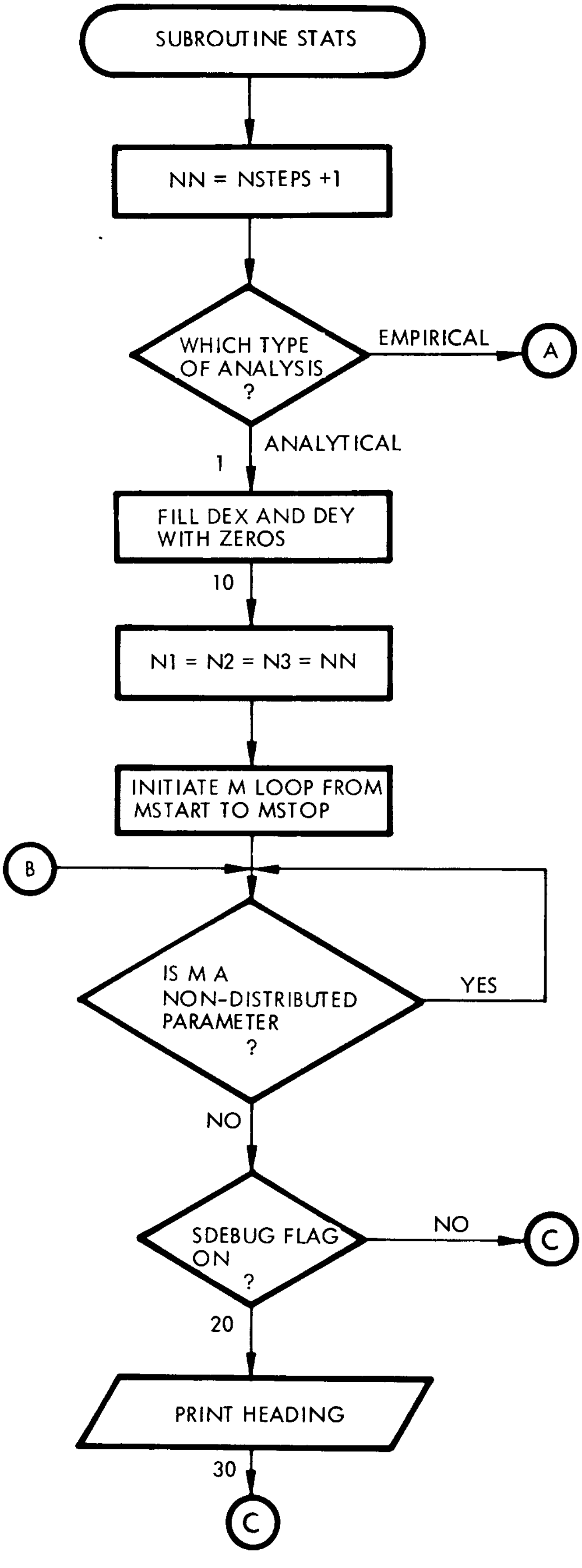


Figure 5-14 Subroutine STATS Flowchart

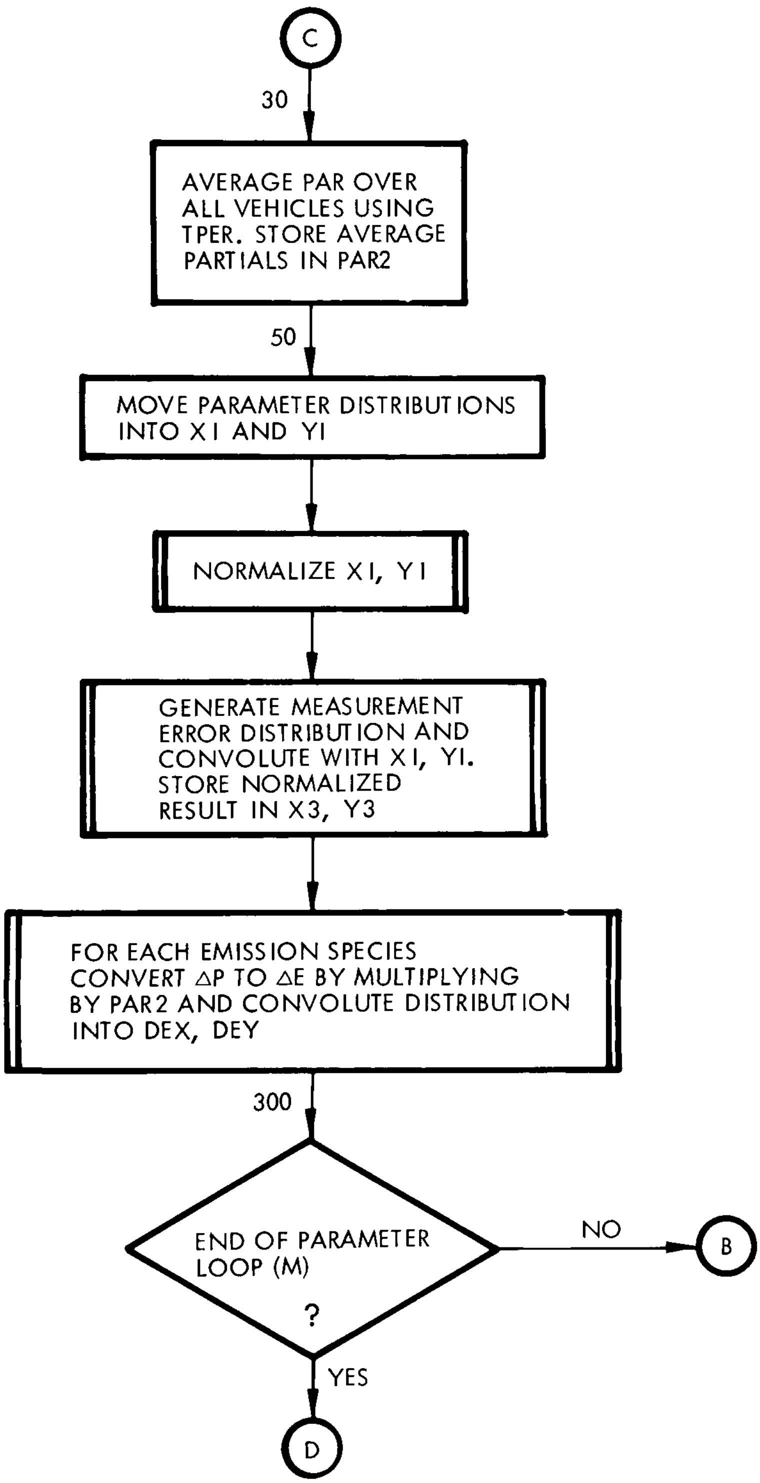


Figure 5-14 Subroutine STATS Flowchart (cont.)

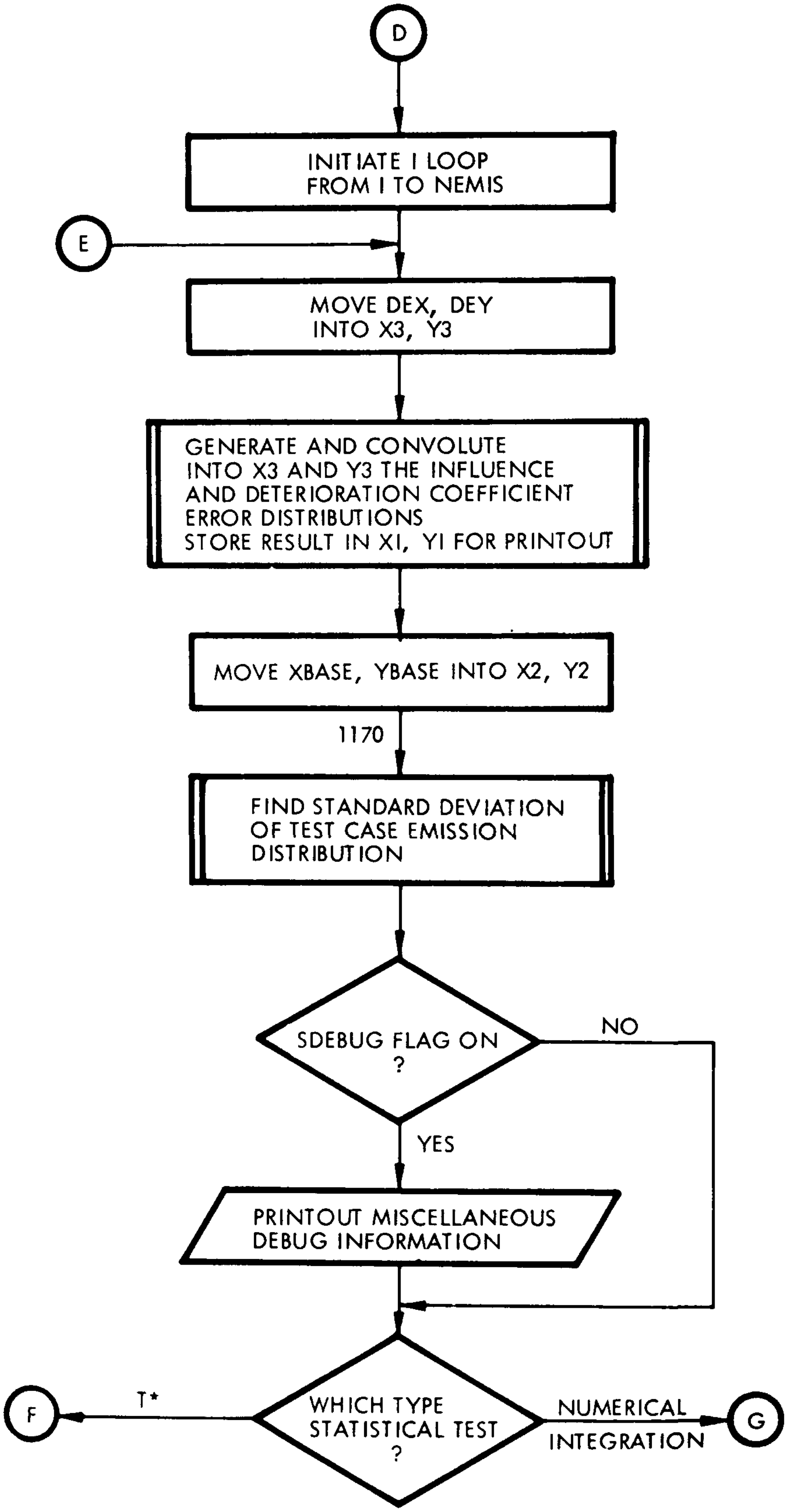


Figure 5-14 Subroutine STATS Flowchart (cont.)

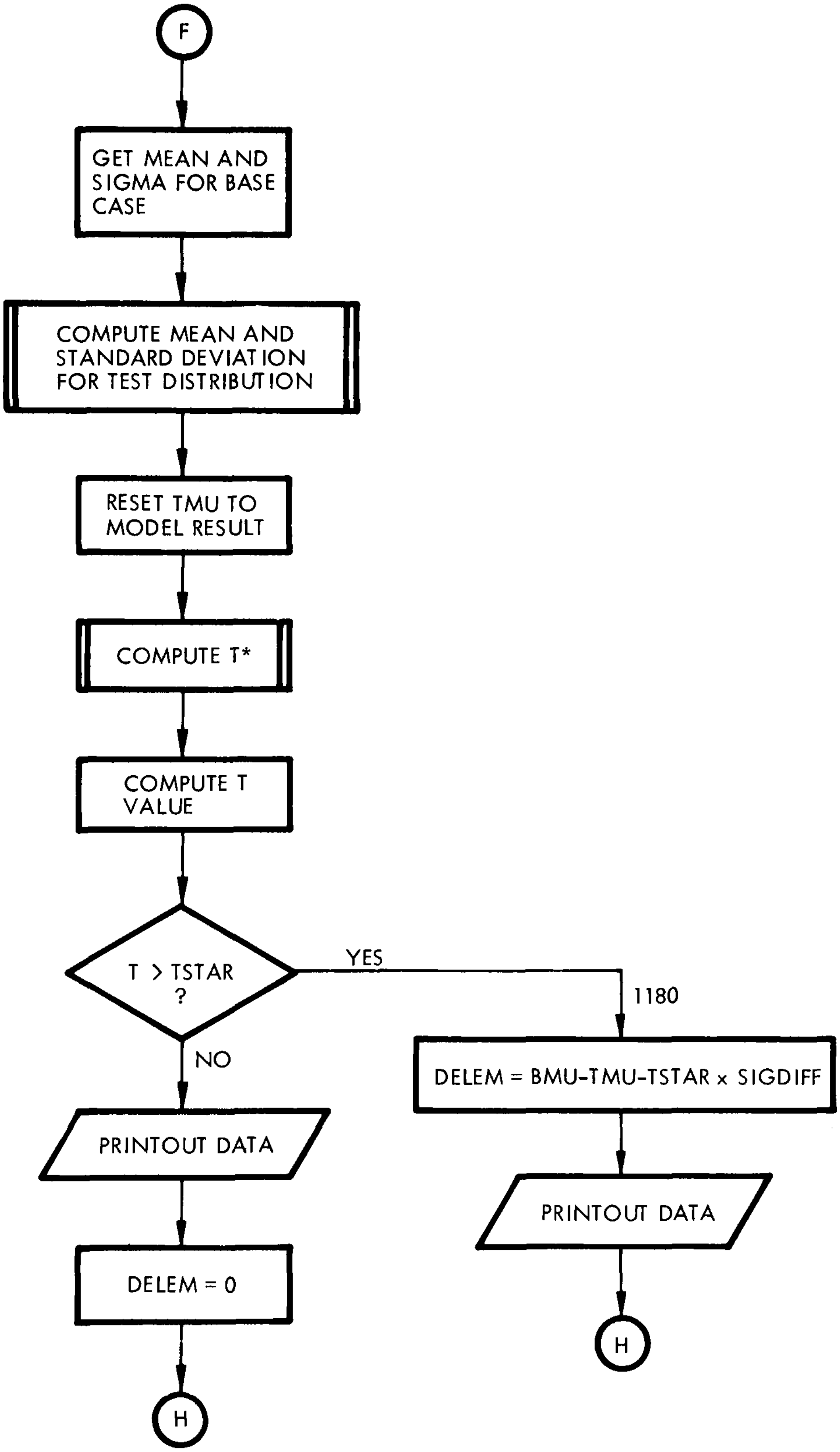


Figure 5-14 Subroutine STATS Flowchart (cont.)

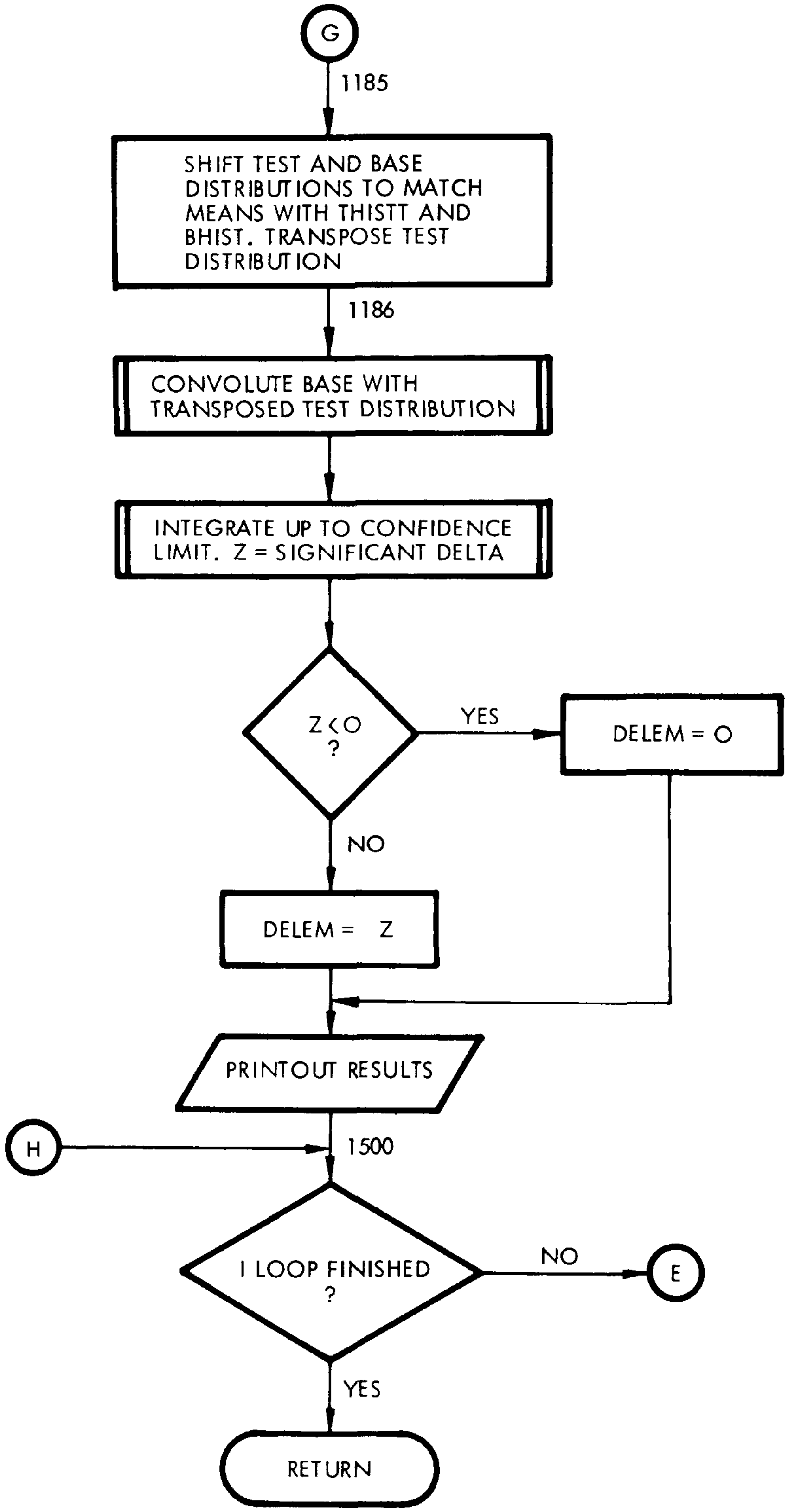


Figure 5-14 Subroutine STATS Flowchart (cont.)

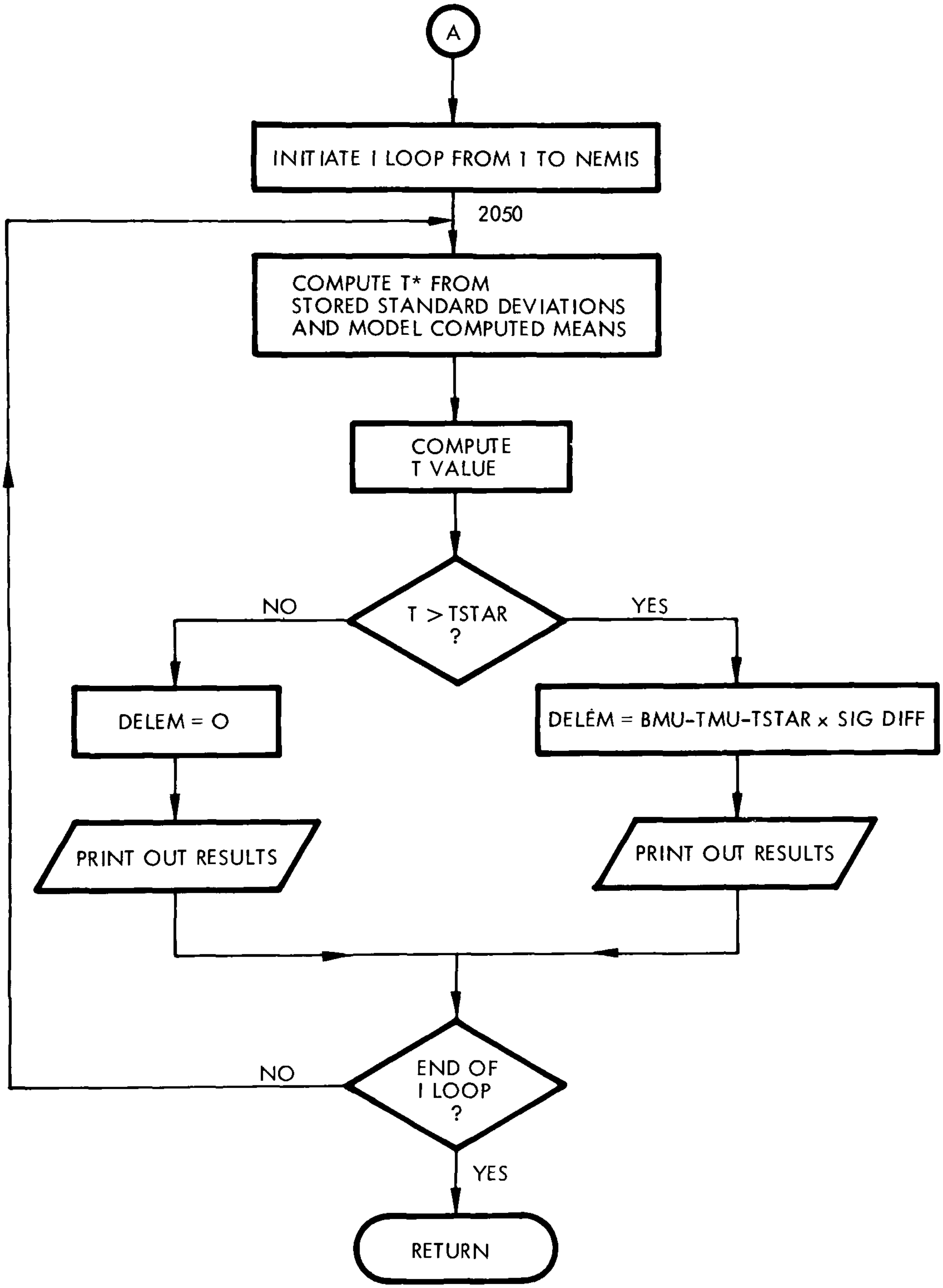


Figure 5-14 Subroutine STATS Flowchart (cont.)

Table 5-14 SUBROUTINE STATS LISTING

```
RUN2.3L  03/21/73. 17.56.03.

                 SUBROUTINE STATS(N,IOPT)
000005           DIMENSION DEX(33,3),DEY(33,3),X1(33),X2(33),X3(33),Y1(33),
                *  Y2(33),Y3(33),PCXBP(5),PCYBP(5),PAR2(3)
000005             COMMON /COM01/     AMB(3),ALAB,       BINT,
                +     BAREA(3), BLD1,     BLD2,     BSIG(3),  BXTRA,    BSIZE,
                +     BHIST(3,16),
                +     ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
000005             COMMON /COM02/          CARA,     CARIY,    CARMY,    CARPOP(16),
                +     CARSY,    CBSUM,    CCOSTI,   CCOSTM,   CGTT,
                +     CINCON,   CPCB,  CPI,      CPVPY,    CSUM,     CARAY,
                +     CN(15,3,16),         COEFB(15,3),        COEFBP(10,15),
                +     CPART(10,15)
             CC ADD2
000005             COMMON /COM03/          DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
                + EMW(3),       EP(10,15),EFF(10),  CELIT(3),
                +     FREQA,    FREQB,    FPERC(10,3),
                +     HORZN,    HORZNY,
                +     HPC(15,16),          HPCS(15,16),        HPP(10,15,16),
                +     HPS(6,15,16),        HPT(5,16),          HPTOT(16),
                +     HPTOTS(16)
             CC ADD3
000005             COMMON /COM04/          ITE,      ITL,      ITP,      ITIME(16),
                +     KSTART,   KSTOP,    LOPT, LPICK(10),LLPICK,
                +     LIDLE,    LINT(16), LPSPP(10),LSTART,   LSTOP,
                +     MBASE,    MPH,      MSTART,   MSTOP,
                +     MU(10,3),  MMS,          MVPR(10,15)
             CC ADD4
000005             COMMON /COM05/          NAME(50), NCNTR,    NEMIS,    NEMP,
                +     NINTR,    NINTRB,   NMODE,    NO,       NOPTS,    NPAR,
                +     NPTRN,    NPTS,     NSTEPS,   NTR,      NTRB,     NPICK(10),
                +     OCIY,     OCMY,     OPTI,     CPTM,OPTS(50),OVCHI(3),OVCHM(3)
             CC ADD5
000005             COMMON /COM06/PARM(3,3), PART,     PAYNEW,   PAYOFF(3),
                +     PC(15),   PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
                +     PP(10,15),PS(6,15), PT(5),    PTOT,     PTS(5),  PAYADJ,
                +     PAR(10,15,3),        PAR1(10,3,3),       PLUS(10,15),
                +     PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
```

```
                    +     PSA(15),   PTA(5),    PCONF,     PARINT(10,10,9)
                    +  ,PAYFIN
000005                COMMON /CCM07/            REINSP,    RNAME,     RSIZE,     RSTOP,
                    +     RTYPE,
                    +     SALE,      SALL,      SALP,      SITEI,     SITEM,     SLANE,
                    +     SMODEL,    START(15,3), STAT,      STIME(3),
                    +     SCALEBM(3),           SM(6,15),             SPAR(10,15,6),
                    +     SXCUT(6,3),           SIG(10,3),             SIGCE(3),
                    +     SIGME(10),            SIGMNE(10),           SIGP(10,15),
                    +     SIGRATE,   SIST,       SIGS(6,15),           SIGSDE(3),
                    +     STABLEX(33,6,15),      STABLEY(33,6,15)
000005                COMMON /COM10/            TAREA(3),  TDIST(10,3),TIDLE,TIMEI(3,16),
                    +     TINT,      TOBE(3),   TONX,      TOTE(3),   TPDB(3),   TPDT(3),
                    +     TXTRA,     TSIZE,      TSIG(3),   TPER(16,15),  TMIL(16,15),
                    +     THIST(5,3,16),        THISTT(3,16),         TIMEC(10,15),
                    +     TIMEM(10,15),         TABLEX(33,10,15),      TABLEY(33,10,15)
             CC ADD10
000005                COMMON /COM11/            WF(10),
                    +     X1BP(3,3,6), XINT,       XINTB,     XLANE,      XSUM, XCUT(10,3),
                    +     XTM(16),   XBASE(9,3),YBASE(9,3)
             CC ADD11
000005                COMMON /CCM12/            Y1BP(3,3,10),         Y2BP(3,3,10),
                    +     YES,       YSUM,      YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
                    +     Z1,        Z2,        Z3,        Z4,        Z5,        Z6,
                    +     Z7,        Z8,        Z9,        Z10,       Z11,       Z12,
                    +     Z13,       Z14,       Z15,       Z16,       Z17,
                    +     ZCARI,     ZCARM,     ZIC,       ZSUM,
                    +     ZZ(3,3)
             CC ADD12
000005                COMMON /DEBUG/            ADEBUG,    BDEBUG,    CDEBUG,    DDEBUG,
                    +     LDEBUG,    MDEBUG,    PDEBUG,    QDEBUG,    SDEBUG,    TDEBUG
             CC ADDD
000005                REAL       ITE,       ITL,       ITP,       ITIME,
                    +     MMS,       MPH,           MU,         MVPR,
                    +     NAME,      NO,        LDEBUG,    MDEBUG,
                    +     IN,        MISFIRE
000005                INTEGER    RNAME,     SITEI,     SITEM,     STAT,
                    +     TDIST,     XLANE,     OPTI,      PPICK,     PPPICK
```

Table 5-14 SUBROUTINE STATS LISTING (cont.)

```
RUN2.3L  03/21/73. 17.56.03.            STATS

000005            DATA PCXBP/80.,90.,95.,99.,99.9/
000005            DATA PCYBP/.84,1.28,1.645,2.33,3.08/
             CC    IOPT = 1 -- FOR GIVEN MEANS AND SIGMAS FROM GEEP
             CC    IOPT = 2 -- FOR STATS GENERATION OF MEANS AND SIGMAS
000005            NN=NSTEPS+1
000007            IF(IOPT.EQ.1) GO TO 2050
000011         1  DO 10 I=1,NEMIS
000013            DO 10 L=1,NN
000014            DEX(L,I)=DEY(L,I)=0.
000022       10   CONTINUE
000026            N1=N2=N3=NN
000032            DO 1000 M=1,10
000033            IF(M.EQ.4.OR.M.EQ.5.OR.M.EQ.6.OR.M.EQ.10) GO TO 1000
000053            IF(SDEBUG.EQ.2HNO) GO TO 30
000055            WRITE (6,20) M
000063        20  FORMAT(1H1,/5X,*PARAMETER NO. *,I2/)
000063        30  CONTINUE
000063            PAR2(1)=PAR2(2)=PAR2(3)=0.
000067            DO 100 JJ=1,NPTRN
000072            DO 100 K=1,NCNTR
000073            J = JJ+5*(K-1)
000077            DO 50 I=1,NEMIS
000100       50   PAR2(I) = PAR2(I) + PAR(M,J,I)*TPER(N,J)
000117       100  CONTINUE
000124            DO 101 L=1,NN
000126            X1(L)=TABLEX(L,M,J)
000135            Y1(L)=TABLEY(L,M,J)
000143       101  CONTINUE
000145            CALL NORM(X1,Y1,NN)
             CC    MEASUREMENT ERROR DIST.
             CC
000150            CALL TABLE (M,1,SIGME(M),0.0,X2,Y2,N2)
000160            CALL CONVOL (X1,Y1,X2,Y2,X3,Y3,N1,N2,N3)
000171            CALL DISTPR(X1,Y1,X2,Y2,X3,Y3,N1,N2,N3,
                + 50HENG. PARAMETER DIST. + MEASUREMENT ERRORS          )
000203            CALL NORM(X3,Y3,N3)
000206            DO 300 I=1,NEMIS
000211            IF(SDEBUG.EQ.3HYES) WRITE (6,190) I
```

Table 5-14 SUBROUTINE STATS LISTING (cont.)


```
000222      190 FORMAT(1H1,/5X,*EMISSION NO. *,I2/)
000222          DO 200 L=1,NN
000224          X3(L)=PAR2(I)*X3(L)
000230          X1(L)=DEX(L,I)
000235      200 Y1(L)=DEY(L,I)
000244          CALL NORM(X1,Y1,N1)
000246          CALL CONVOL(X1,Y1,X3,Y3,X2,Y2,N1,N3,N2)
000257          CALL DISTPR(X1,Y1,X3,Y3,X2,Y2,N1,N3,N2,
               + 50HCONVOL OF EMISSION DIST FOR PARAMETERS                    )
000271          DO 210 L=1,NN
000274          DEX(L,I)=X2(L)
000301      210 DEY(L,I)=Y2(L)
000310     300  CONTINUE
000312     1000 CONTINUE
           C
           C    DEX,DEY ARE THE TEST FLEET EMISSION SPECIE DECREMENT
           C         ERROR DIST.
           C
000314          DO 1500 I = 1,NEMIS
000316          IF(SDEBUG.EQ.3HYES) WRITE (6,190) I
000327          DO 1100 L=1,NN
000331          X3(L)=DEX(L,I)
000336     1100 Y3(L)=DEY(L,I)
000345          CALL TABLE(M,1,SIGCE(I),0.,X1,Y1,N1)
000355          CALL CONVOL(X3,Y3,X1,Y1,X2,Y2,N3,N1,N2)
000366          CALL DISTPR(X3,Y3,X1,Y1,X2,Y2,N3,N1,N2,
               + 50HSPECIE DIST + RESPONSE SURFACE ERRORS                 )
000400          CALL TABLE(M,1,SIGSDE(I),0.,X1,Y1,N1)
000410          CALL DISTPR(X2,Y2,X1,Y1,X1,Y1,N2,NN,N1)
000421          CALL DISTPR(X2,Y2,X1,Y1,X1,Y1,N2,N1,N1,
               + 50HEMIS. AND RESP. DIST. + EMISSICN DECAY ERROR
000433          DO 1170 L=1,NPTS
000436          X2(L)=XBASE(L,I)
000443          Y2(L)=YBASE(L,I)
000447     1170 CONTINUE
000452          CALL STD2(X1,Y1,N1,TMU,TSD)
000455          IF(SDEBUG.EQ.YES) WRITE(6,606) NAME(I),THISTT(I,N),TSD
000501      606 FORMAT(* EMISSION - *,A2,*      MEAN AND SD (COSMETICIZED) *,
```

Table 5-14 SUBROUTINE STATS LISTING (cont.)

```
RUN2.3L  03/21/73. 17.56.03.          STATS

                    + 2E15.8)
000501              IF(NTEST.GT.1) GOTO 1185
000505              BMU=BHIST(I,N)
000510              BSD=BSIG(I)
000513              CALL STD2(X3,Y3,N3,TMU,TSD)
000516              TMU=THISTT(I,N)
000523              TSTAR=FUN1(PCONF,PCXBP,PCYBP,5)
000527              SIGDIFF=SQRT(TSD*TSD/TSIZE+BSD*BSD/BSIZE)
000536              T=(BMU-TMU)/SIGDIFF
000541              IF(I.EQ.1) WRITE (6,505) N
000554       505    FORMAT(1H1,20X,*STATISICAL ANALYSIS OF EMISSION REDUCTIONS*,
                   + //,30X,*YEAR *,I2//)
000554              WRITE (6,1190) NAME(I)
000563              IF(T.GT.TSTAR) GO TO 1180
000570              WRITE (6,600) PCONF,T,TSTAR,TMU,BMU
000605        600   FORMAT(/,5X,*ACCEPT THE NULL HYPOTHESIS.*/
                   + 5X,*THERE IS NOT A SIGNIFICANT DIFFERENCE IN THE MEANS*,/
                   + 5X,*AT A CONFIDENCE LEVEL OF *,F10.2/
                   + 5X,* T = *E15.4,5X,*TSTAR = *E15.4/
                   + 5X,*TEST MU = *E15.4,5X,*BASE MU = *E15.4//)
000605              DELEM(I,N)=0.
000612              GOTO 1500
000612       1180   CONTINUE
000612              A=BMU-TMU-TSTAR*SIGDIFF
000616              DELEM(I,N)=A
000622              WRITE (6,700) PCONF,A,T,TSTAR,TMU,BMU
000641              GOTO 1500
000643        700   FORMAT(/,5X,*REJECT NULL HYPOTHESIS.*,/
                   + 5X,*THERE IS A SIGNIFICANT DIFFERENCE IN THE MEANS*,/
                   + 5X,*AT A CONFIDENCE LEVEL OF *,F1C.2/
                   + 5X,*THE LOWER CONFIDENCE LIMIT IS *,E15.4/
                   + 5X,*T = *E15.4,5X,*TSTAR = *E15.4/
                   + 5X,*TEST MU = *E15.4,5X,*BASE MU = *E15.4//)
000643       1185   CONTINUE
000643              CALL STD2(X2,Y2,NPTS,BMU,BSD)
000647              CALL STD2(X3,Y3,N3,TMU,TSD)
000653              DO 1187 L=1,NPTS
000656       1187   X2(L)=X2(L)+BHIST(I,N)-BMU
```

Table 5-14 SUBROUTINE STATS LISTING (cont.)


```
000670          DO 1186 L=1,NN
000671     1186 X3(L)=-X3(L)-THISTT(I,N)+TMU
000703          CALL CONVOL(X3,Y3,X2,Y2,X1,Y1,N3,NPTS,N1)
000713     1190 FORMAT(//,5X,A2,* EMISSION*)
000713          Z=XPT(X1,Y1,N1,PCONF)
000717          IF(Z.LT.0) Z=0
000723          DELEM(I,N)=Z
000727          WRITE(6,1400) PCONF,Z
000736     1400 FORMAT(//5X,*THERE EXISTS A*,
               + F6.0,* PERCENT CONFIDENCE LEVEL THAT EMISSIONS*,
               + * ARE REDUCED BY*,E14.3//)
000736          CALL DISTPR(X3,Y3,X2,Y2,X1,Y1,N3,NPTS,N1,
               + 50H -TEST DIST  +  BASE DIST  =  CONVOL B-T
000750     1500 CONTINUE
000754          RETURN
000755     2050 CONTINUE
000755          DO 2500 I=1,NEMIS
000757          TMU=THISTT(I,N)
000763          BMU=BHIST(I,N)
000766          TSD=TSIG(I)
000771          TSTAR=FUN1(PCONF,PCXBP,PCYBP,5)
000775          SIGDIFF=SQRT(TSD*TSD/TSIZE+BSD*BSD/BSIZE)
001004          T=(BMU-TMU)/SIGDIFF
001007          IF(I.EQ.1) WRITE (6,505) N
001022          WRITE (6,1190) NAME(I)
001031          IF(T.GT.TSTAR) GO TO 2100
001036          WRITE (6,600) PCONF,T,TSTAR,TMU,BMU
001053          DELEM(I,N)=0.
001060          GO TO 2500
001060     2100 CONTINUE
001060          A=BMU-TMU-TSTAR*SIGDIFF
001064          DELEM(I,N)=A
001070          WRITE (6,700) PCONF,A,T,TSTAR,TMU,BMU
001107     2500 CONTINUE
001113          RETURN
001114          END
```

identity with respect to the other. In this case, a convolution is not performed, but the mean of the non-identity distribution is shifted by the mean of the approximate identity and the new distribution is output in P3 and Y3.

If neither distribution is an approximate identity with respect to the other, CONVOL performs a standard numeric convolution of the two distributions. A flowchart of CONVOL is found is Figure 5-15 and a listing in Table 5-15.

5.11.2 Function AREA

The AREA routine integrates a parameter or mode emission distribution based on cutpoints stored in XCUT or SXCUT. The limits of the rejected portion of the distribution are determined by the LINT array and the upper and lower values stored in the distribution. If LINT for a parameter is one, indicating the lower portion of the distribution is rejected, the limits are set at the first entry and the cutpoint respectively. If LINT is two for a parameter, indicating the upper portion of the distribution is rejected, the limits are set at the cutpoint and the upper value of the distribution respectively. All mode emission distributions are rejected at the upper end, and therefore have no associated LINT value. After establishing the rejected fraction integration limits the AREA routine calls subroutine INTEG which performs a standard numerical (trapezoidal) integration of the distribution between the limits specified. The area under the rejected portion of the distribution is returned in AREA.

For non-distributive parameters such as NO_x control, air pump, choke blade, and misfire, algorithms have been incorporated into the

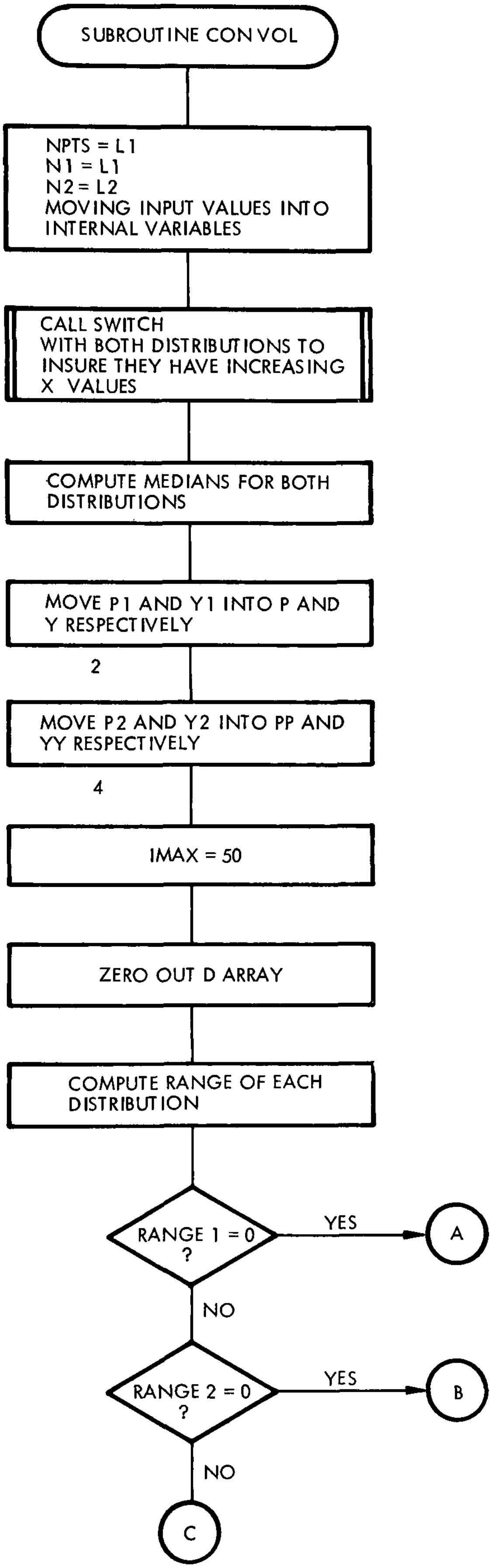


Figure 5-15 Subroutine CONVOL Flowchart

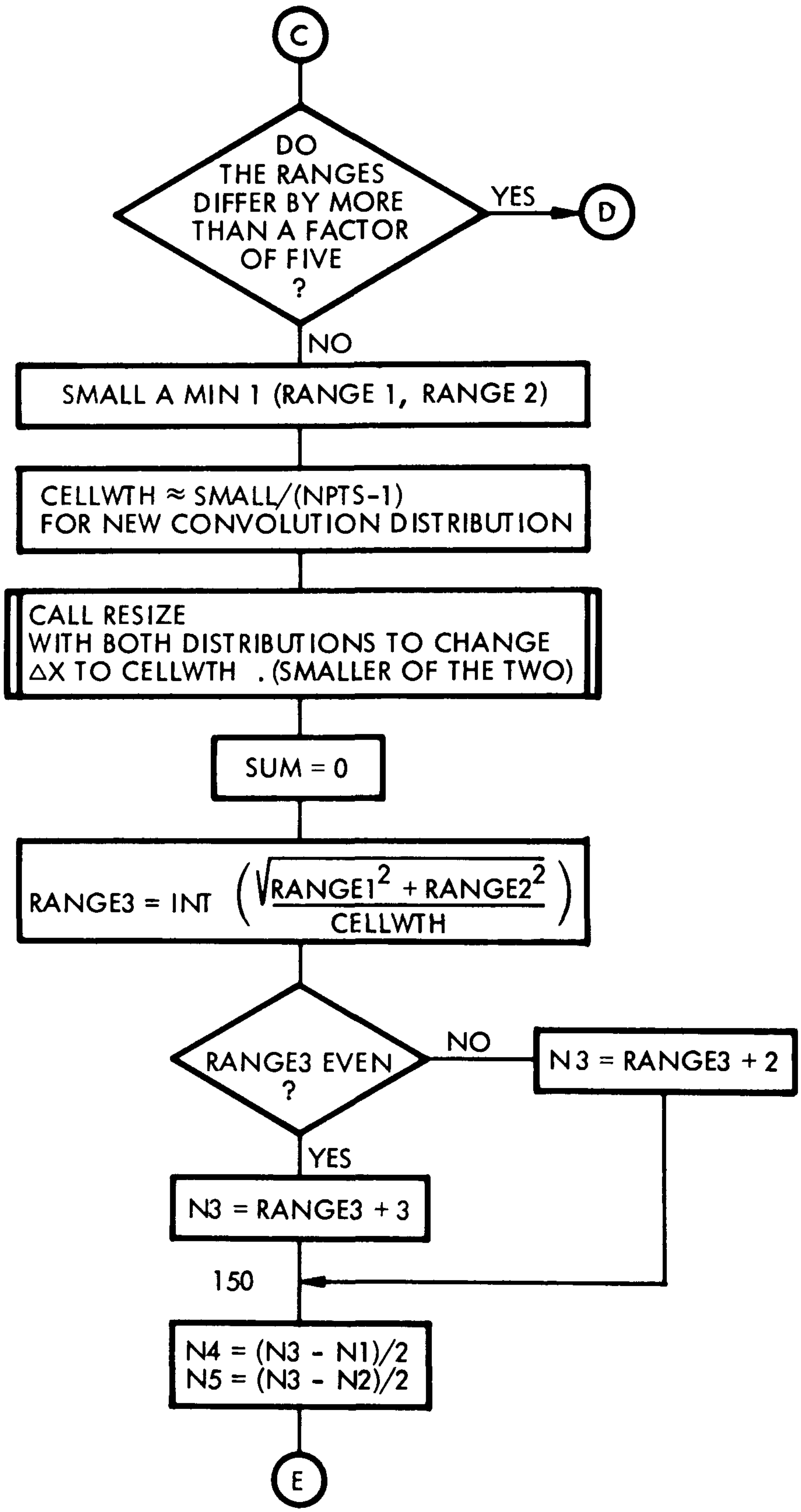


Figure 5-15 Subroutine CONVOL Flowchart (cont.)

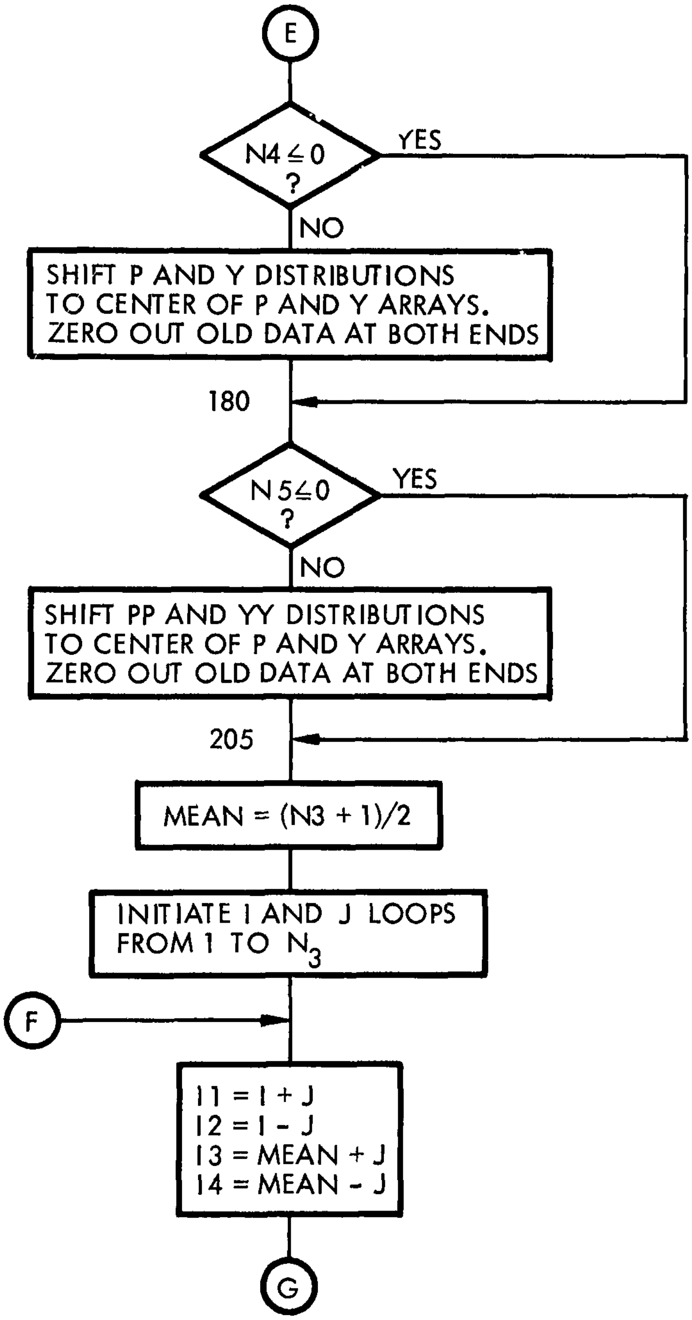


Figure 5-15 Subroutine CONVOL Flowchart (cont.)

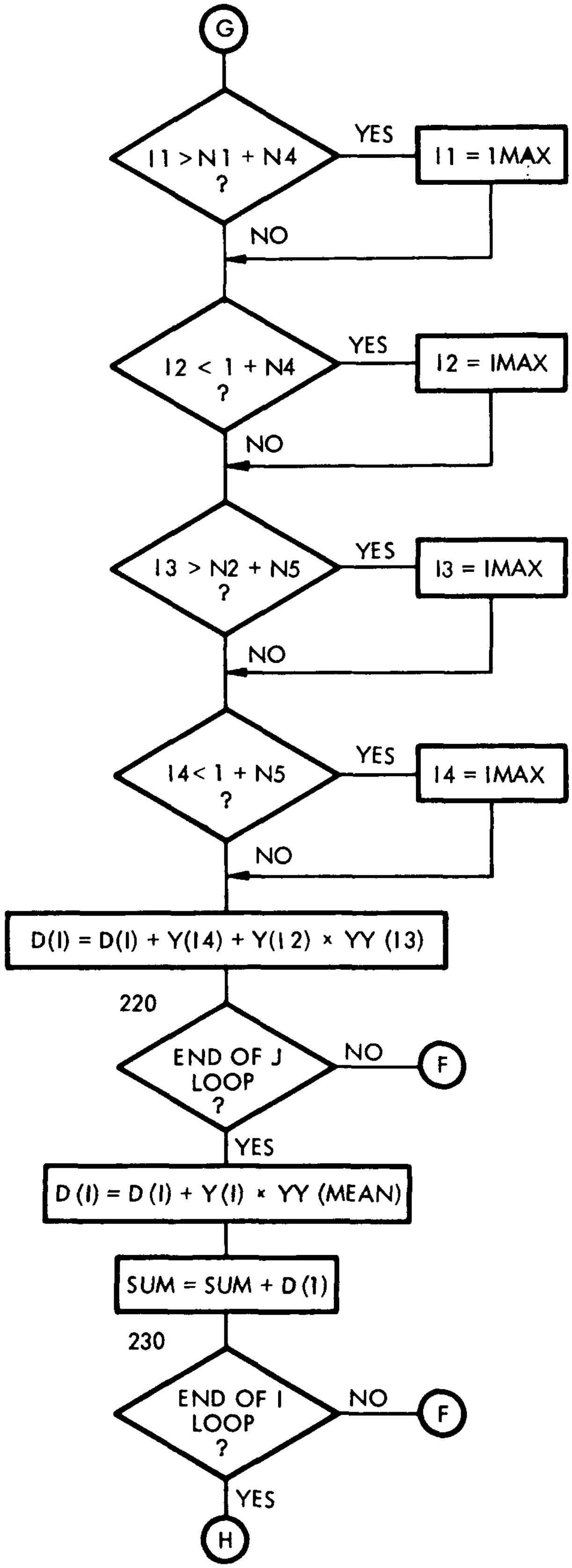


Figure 5-15 Subroutine CONVOL Flowchart (cont.)

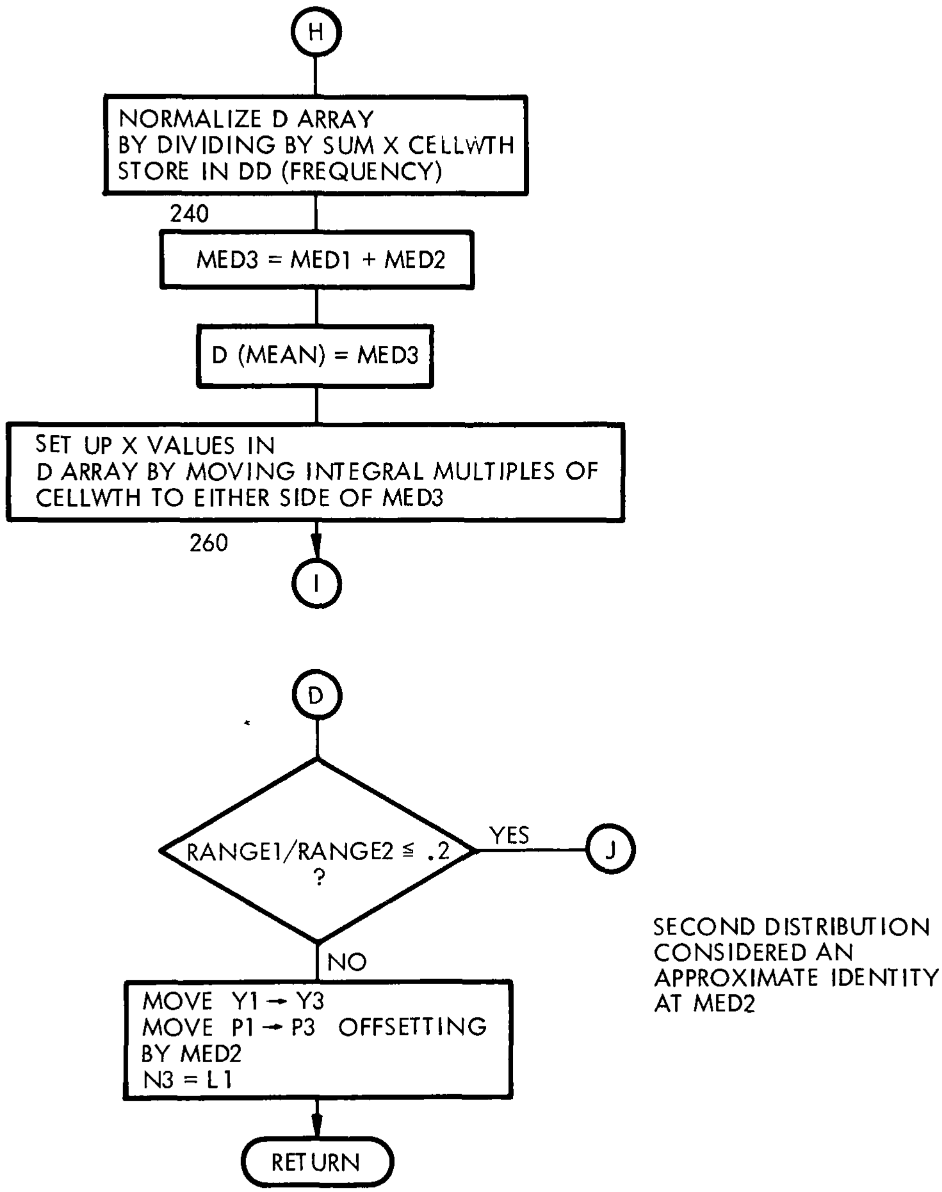


Figure 5-15 Subroutine CONVOL Flowchart (cont.)

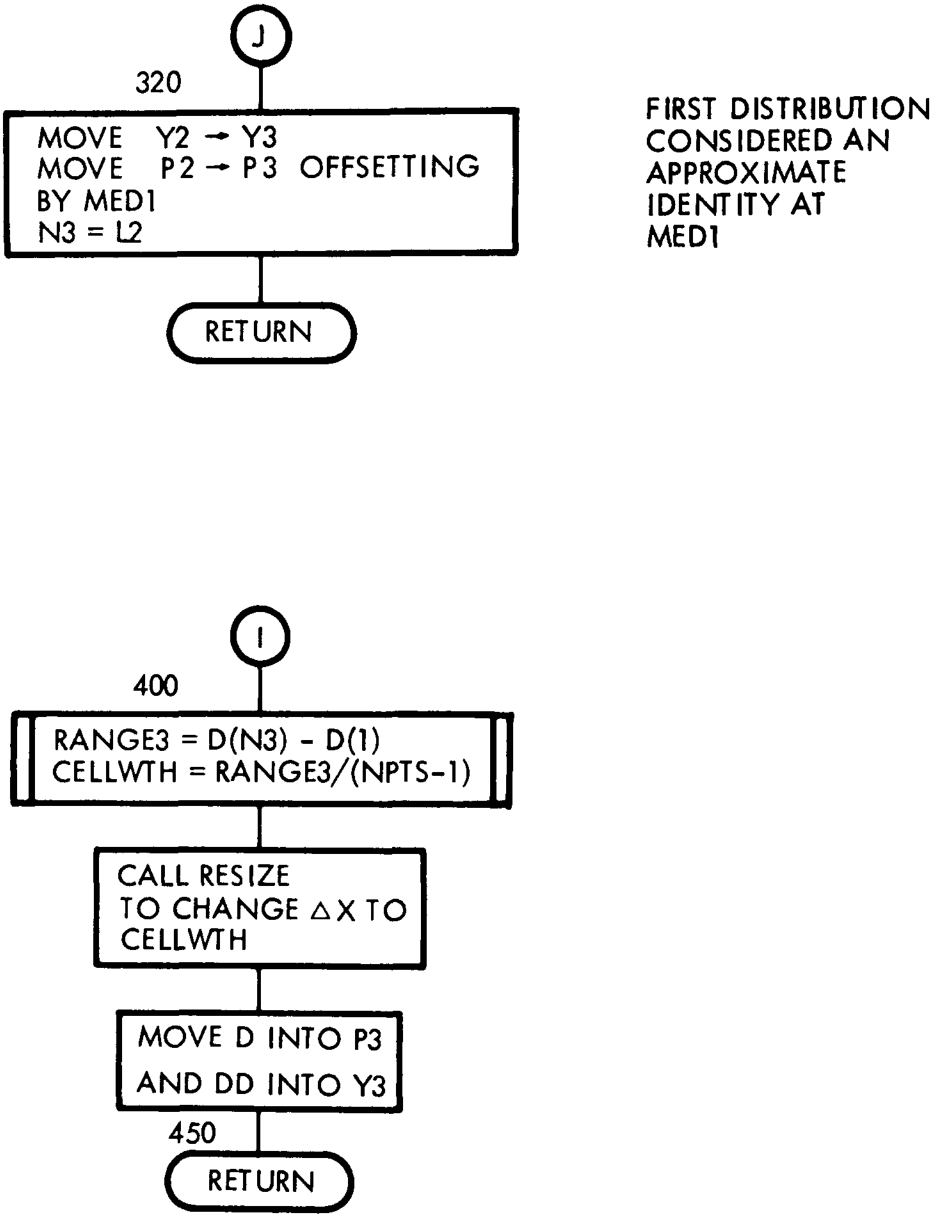


Figure 5-15 Subroutine CONVOL Flowchart (cont.)

Table 5-15 SUBROUTINE CONVOL LISTING

```
      SUBROUTINE CONVOL(P1,Y1,P2,Y2,P3,Y3,L1,L2,N3)
      DIMENSION P(50),Y(50),PP(50),YY(50),D(50),DD(50),
     +          P1(1),Y1(1),P2(1),Y2(1),P3(1),Y3(1)
      REAL MED1,MED2,MED3
      NPTS=L1
      N1 = L1
      N2 = L2
      CALL SWITCH(P1,Y1,N1)
      CALL SWITCH(P2,Y2,N2)
      MED1=P1((N1+1)/2)
      MED2=P2((N2+1)/2)
      DO 2 I = 1,N1
      P(I) = P1(I)
    2 Y(I) = Y1(I)
      DO 4 I= 1,N2
      PP(I) = P2(I)
    4 YY(I) = Y2(I)
      IMAX = 50
      DO 10 I = 1 ,IMAX
   10 D(I) = 0.0
C
C     CALC. RANGE1 AND RANGE2
C
      RANGE1 = ABS(P(N1)-P(1) )
      RANGE2 = ABS(PP(N2)-PP(1) )
      IF(RANGE1.EQ.0.) GO TO 320
      IF(RANGE2.EQ.0.) GO TO 305
C
C     CHECK FOR 5/1 RANGE RATIO
C
      IF(RANGE1/RANGE2 .GE. 5.0 .OR. RANGE1/RANGE2
     +     .LE. 0.20) GO TO 300
      SMALL = AMIN1(RANGE1,RANGE2)
      CELLWTH = SMALL/(NPTS-1)
      CALL RESIZE(CELLWTH,RANGE1,P,Y,N1)
      CALL RESIZE(CELLWTH,RANGE2,PP,YY,N2)
C
      SUM = 0.0
C
C     CALC. RANGE3 (ODD NUMBER)
C
```

Table 5-15 SUBROUTINE CONVOL LISTING (cont.)

```
            RANGE3=INT(SQRT(RANGE1*RANGE1+RANGE2*RANGE2)/CELLWTH)
            RTEST = RANGE3/2.0
            IF(RTEST-INT(RTEST) .LE. 0.0) GO TO 140
            N3 = RANGE3 + 2
            GO TO 150
      140   N3 = RANGE3 + 3
      150   N4 = (N3-N1)/2
            N5 = (N3-N2)/2
      C
      C     SHIFT BOTH PRIMARY AND SECONDARY TO FIT RESULTANT
      C
            IF(N4 .LE. 0) GO TO 180
            DO 160 I = 1,N1,1
            II = N1+N4-I+1
            IJ = N1-I+1
            P(II) = P(IJ)
      160   Y(II) = Y(IJ)
            DO 170 I = 1,N4,1
            P(I) =0.0
      170   Y(I) = 0.0
            II = N3-N4 +1
            DO 175 I = II,N3
            P(I) = 0.0
      175   Y(I) = 0.0
      180   IF(N5 .LE. 0) GO TO 210
            DO 190 I = 1,N2,1
            II = N2+N5-I+1
            IJ = N2-I+1
            PP(II) = PP(IJ)
      190   YY(II) = YY(IJ)
            DO 200 I = 1,N5,1
            PP(I) = 0.0
      200   YY(I) = 0.0
            II = N3-N5 +1
            DO 205 I = II,N3
            PP(I) = 0.0
      205   YY(I) = 0.0
      210   MEAN = (N3+1)/2
      C
      C     CONVOLUTION
      C
            DO 230 I = 1,N3,1
```

Table 5-15 SUBROUTINE CONVOL LISTING (cont.)

```
      DO 220 J = 1,N3,1
      I1 = I+J
      I2 = I-J
      I3 = MEAN + J
      I4 = MEAN -J
      IF(I1 .GT. N1+N4) I1 = IMAX
      IF(I2 .LT. 1 +N4) I2 = IMAX
      IF(I3 .GT. N2+N5) I3 = IMAX
      IF(I4 .LT. 1 +N5) I4 = IMAX
  220 D(I) = D(I) + Y(I1)*YY(I4) + Y(I2)*YY(I3)
      D(I) = D(I) + Y(I)*YY(MEAN)
  230 SUM = SUM + D(I)
      DO 240 I = 1,N3,1
  240 DD(I) = D(I)/(SUM*CELLWTH)
      MED3=MED1+MED2
      D(MEAN)=MED3
      DO 250 I=2,MEAN
      II = MEAN-I+1
  250 D(II) = D(II+1) - CELLWTH
      JJ = MEAN + 1
      DO 260 I = JJ,N3
  260 D(I) = D(I-1) + CELLWTH
      GO TO 400
C
C     CHECK IF RANGE2 GREATER THAN RANGE1
C
  300 IF(RANGE1/RANGE2 .LE. 0.20) GO TO 320
C
C     RANGE1 GREATER THAN RANGE2
C
  305 DO 310 I = 1,L1
      Y3(I) = Y1(I)
  310 P3(I)= P1(I) + MED2
      N3 = L1
      RETURN
C
C     RANGE2 GREATER THAN RANGE1
C
  320 DO 330 I = 1,L2
      Y3(I) = Y2(I)
  330 P3(I)= P2(I) + MED1
      N3 = L2
```

Table 5-15 SUBROUTINE CONVOL LISTING (cont.)

```
      RETURN
C
C     RESIZE THE RESULTANT
C
  400 RANGE3=D(N3)-D(1)
      CELLWTH = RANGE3/(NPTS-1)
      CALL RESIZE(CELLWTH,RANGE3,D,DD,N3)
      DO 450 I = 1,N3
      P3(I) = D(I)
  450 CONTINUE
      RETURN
      END
```

AREA function for estimating rejection rates. These algorithms utilize a rejected mean value of one (i.e., failed mode).

Figure 5-16 contains a detailed flowchart of the AREA function. Table 5-16 lists the corresponding computer code.

5.11.3 Subroutine INTEG

Subroutine INTEG integrates an unspecified function over some given bounds using a trapezoidal technique. The data is manipulated in tabular form as a set of x's and corresponding y's at N points. The trapezoidal technique utilizes the following equation:

$$\text{Area} = \sum_{i=1}^{N-1} \left\{ 1/2(Y_{i+1} + Y_i)\,\Delta X \right\}$$

Subroutine INTEG is listed in Table 5-17 and flowcharted in Figure 5-17.

5.11.4 Function FUN1

Many mathematical functions in GEEP are represented in tabular form. Function FUN1 returns an interpolated value for y given an arbitrary x and a table of values for x and y.

Function FUN1 is flowcharted and listed in Figure 5-18 and Table 5-18 respectively.

5.11.5 Function FUN2

Function FUN2 contains a double table look-up with linear interpolation routine. Input to FUN2 is a matrix containing values of the dependent variable and two coordinate vectors. FUN2 is called with X and Y values which are referenced against the coordinate vectors to

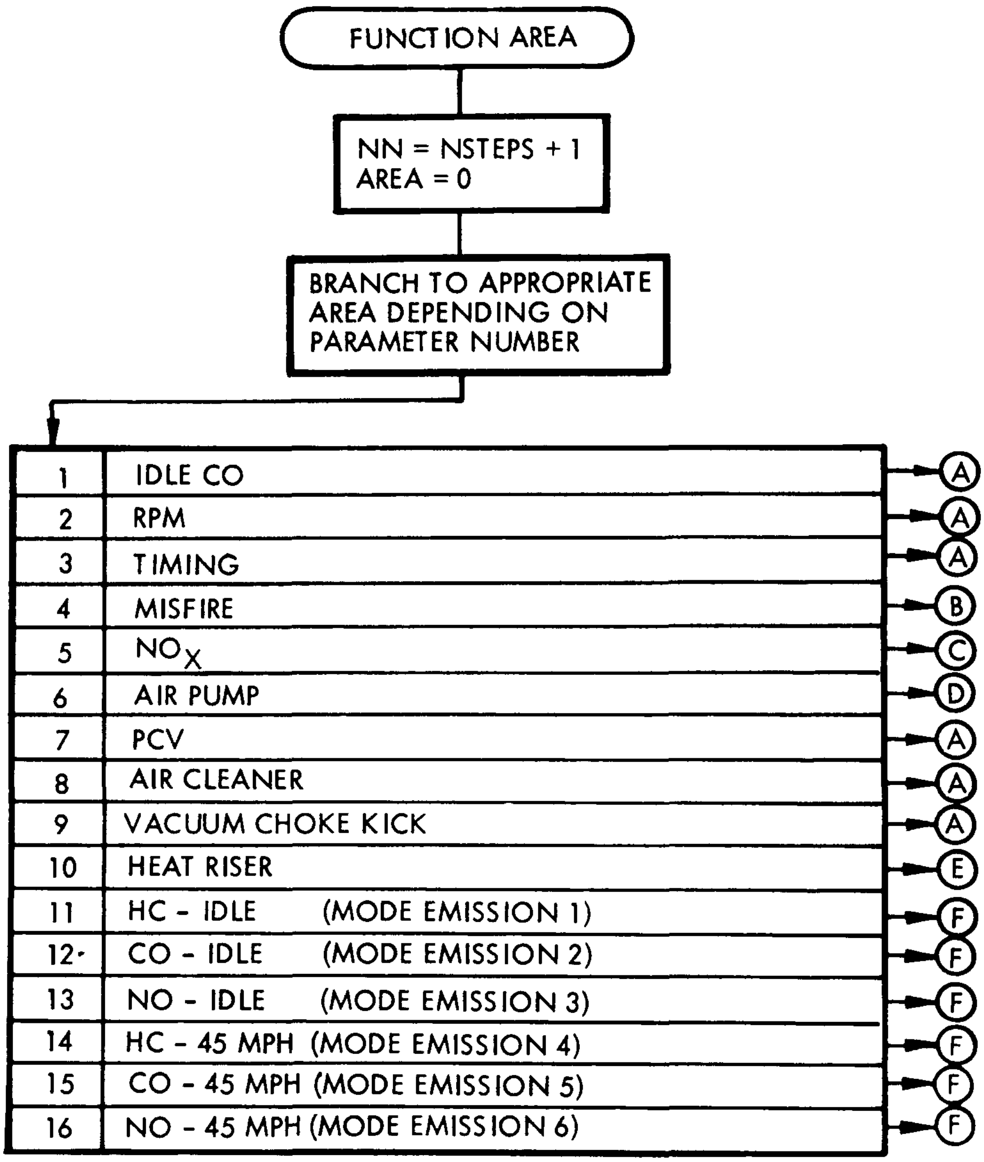


Figure 5-16 Function AREA Flowchart

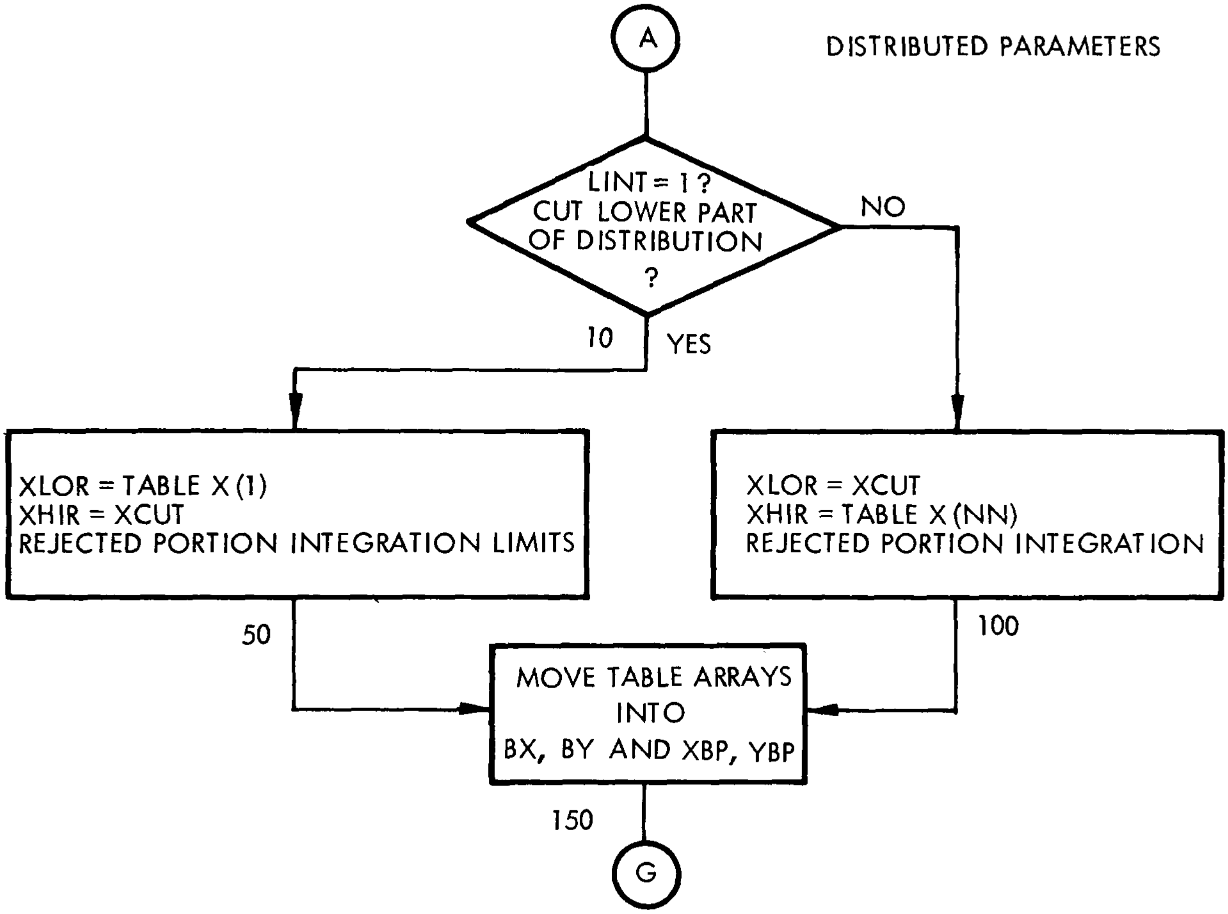


Figure 5-16 Function AREA Flowchart (cont.)

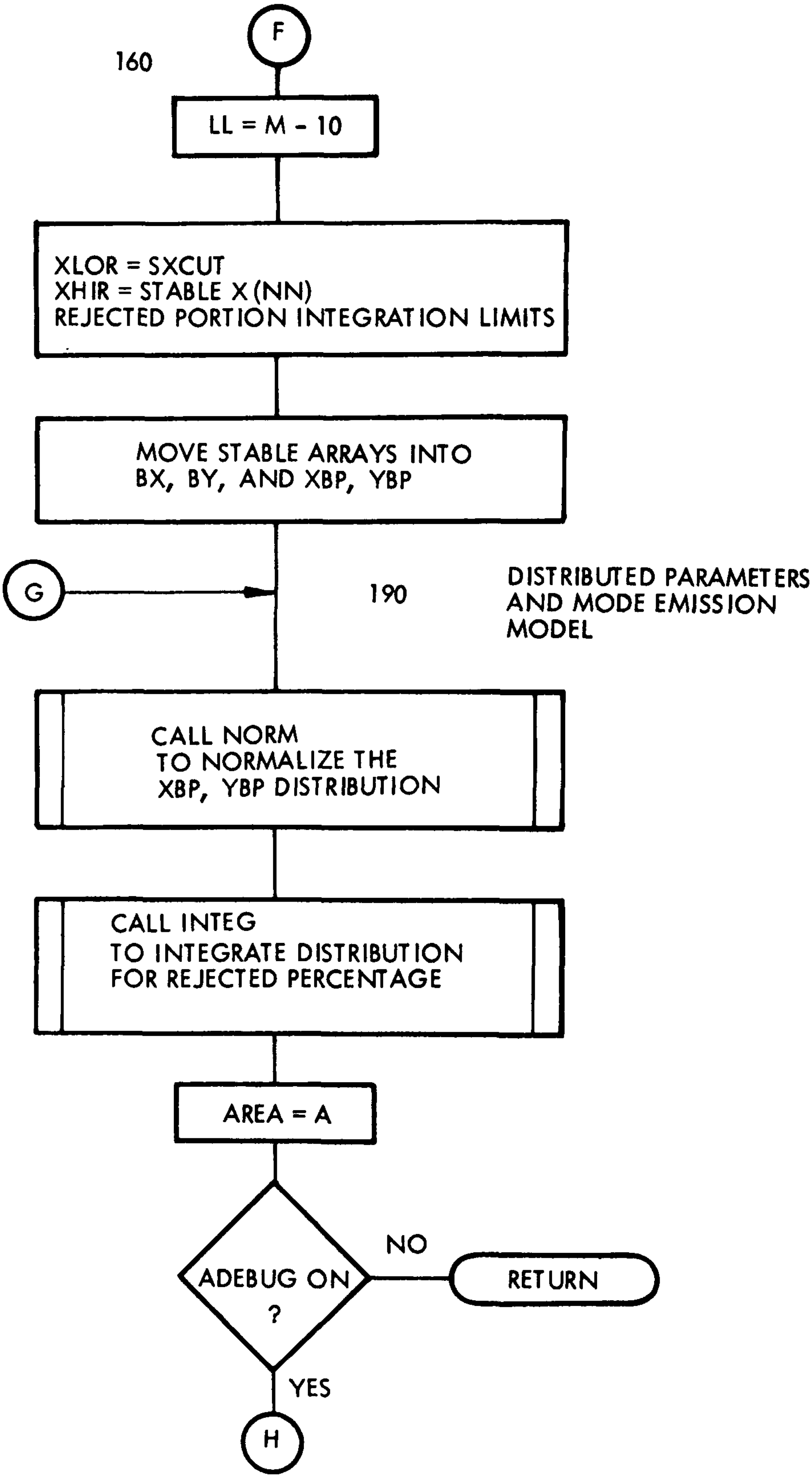


Figure 5-16 Function AREA Flowchart (cont.)

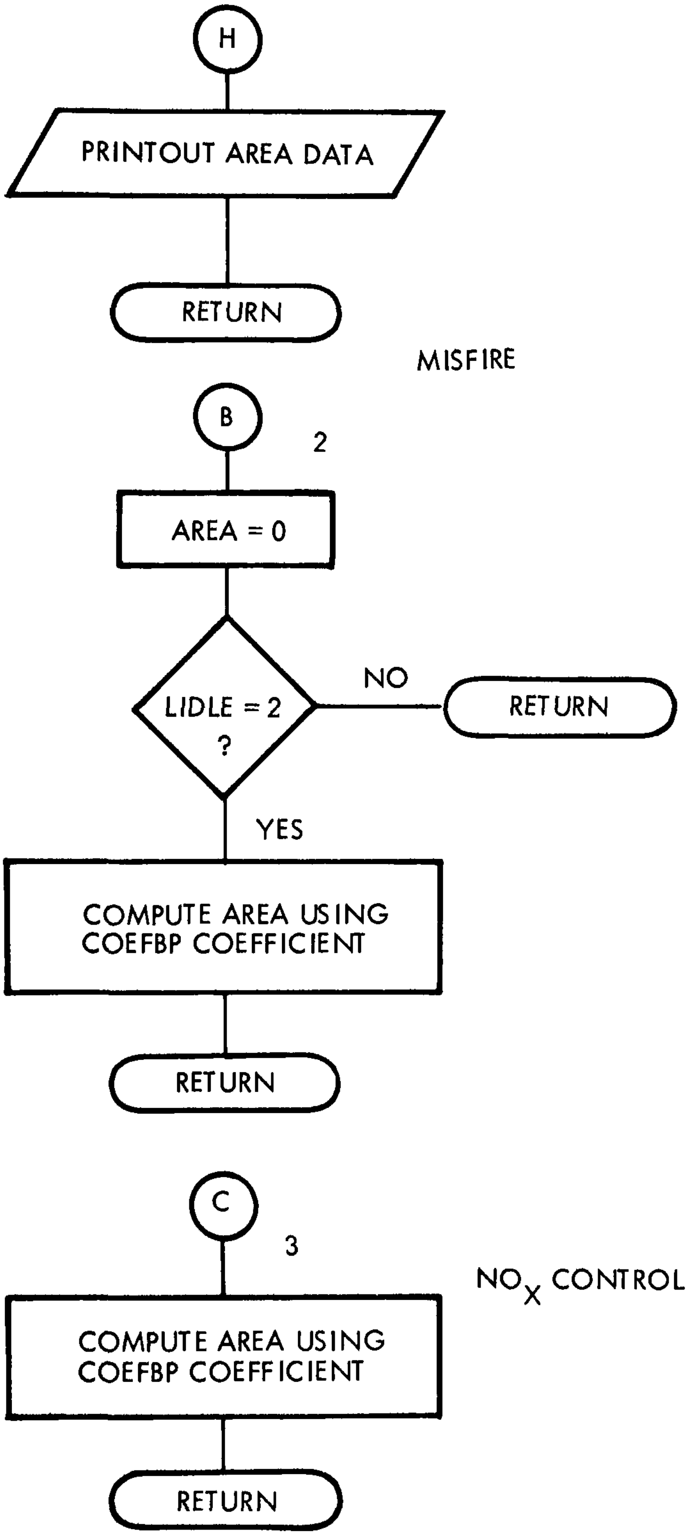


Figure 5-16 Function AREA Flowchart (cont.)

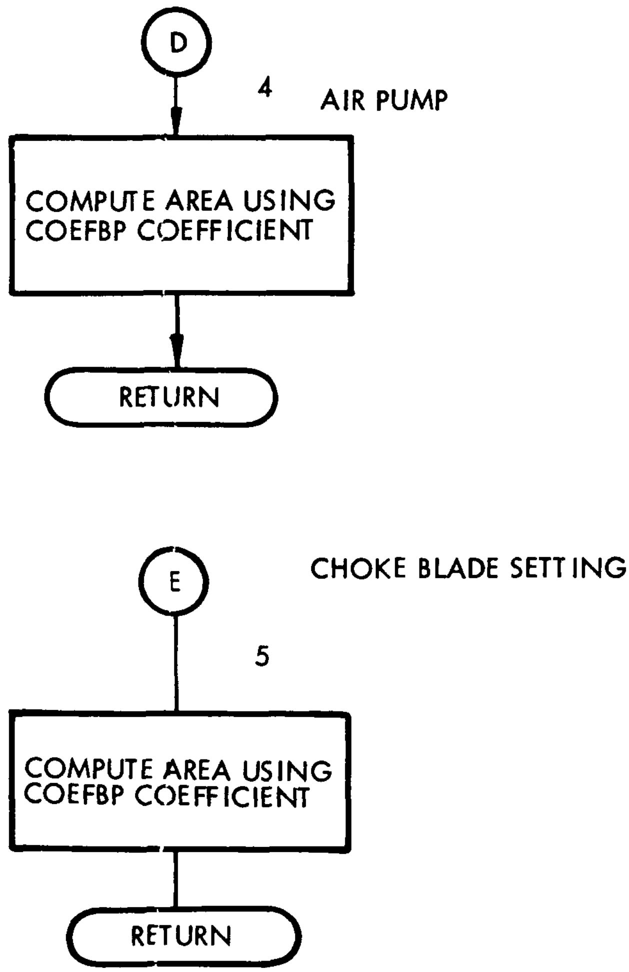


Figure 5-16 Function AREA Flowchart (cont.)

```
      FUNCTION AREA(XOPT,M,J,K,N)
      DIMENSION XBP(35),YBP(35)
       COMMON /COM01/      AMB(3),ALAB,     AVV, BINT,
     +    BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,     BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/          CARA,      CARIY,     CARMY,     CARPOP(16),
     +    CARSY,    CBSUM,     CCOEF(10),CCOSTI,    CCOSTM,    CGTT,
     +    CINCON,   CPCB,  CPI,       CPVPY,     CSUM,      CARAY,
     +    CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
       COMMON /COM03/          DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),      EP(10,15),EFF(10),  DELIT(3),
     +    FREQA,    FREQB,     FPERC(10,3),
     +    HORZN,    HORZNY,
     +    HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),           HPTOT(16),
     +    HPTOTS(16)
CC ADD3
       COMMON /COM04/          ITE,       ITL,       ITP,       ITIME(16),
     +    KSTART,   KSTOP,     LOPT, LPICK(10),LLPICK,
     +    LIDLE,    LINT(16),  LPSPP(10),LSTART,    LSTOP,
     +    MBASE,    MPH,       MSPEC(10),MSTART,    MSTOP,
     +    MU(10,3),    MMS(10,15),          MVPR(10,15)
CC ADD4
       COMMON /COM05/          NAME(50), NCNTR,     NEMIS,     NEMP,
     +    NINTR,    NINTRB,    NMODE,     NO,        NOPTS,     NPAR,
     +    NPTRN,    NPTS,      NSTEPS,    NTR,       NTRB,      NPICK(16),
     +    OCIY,     OCMY,      OPTI,      OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/PARM(3,3), PART,     PAYNEW,    PAYOFF(3),
     +    PC(15),   PCS(15),   PHI(14),   PLO(14),   PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15),  PT(5),     PTOT,      PTS(5),   PAYADJ,
     +    PAR(10,15,3),        PAR1(10,3,3),        PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),  PTA(5),    PCONF,     PARINT(10,10,9)
     + ,PAYFIN
       COMMON /COM07/          REINSP,    RNAME,     RSIZE,     RSTOP,
     +    RTYPE,
     +    SALE,     SALL,      SALP,      SITEI,     SITEM,     SLANE,
```

Table 5-16 FUNCTION AREA LISTING (cont.)

```
     +     SMODEL,   START(15,3), STAT,      STIME(3), SUMBM(3),
     +     SCALEBM(3),          SM(6,15),             SPAR(10,15,6),
     +     SXCUT(6,3),          SIG(10,3),             SIGCE(3),
     +     SIGME(10),           SIGMNE(10),           SIGP(10,15),
     +     SIGRATE,   SIST,      SIGS(6,15),           SIGSDE(3),
     +     STABLEX(33,6,15),     STABLEY(33,6,15)
        COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +     TINT,      TOBE(3),  TONX,      TOTE(3),  TPDB(3),   TPDT(3),
     +     TXTRA,     TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
     +     THIST(5,3,16),       THISTT(3,16),         TIMEC(10,15),
     +     TIMEM(10,15),        TABLEX(33,10,15),     TABLEY(33,10,15)
CC ADD10
        COMMON /COM11/          WF(10),
     +     X1BP(3,3,6), XINT,      XINTB,     XLANE,     XSUM, XCUT(10,3),
     +     XTM(16),   XBASE(9,3),YBASE(9,3)
CC ADD11
        COMMON /COM12/          Y1BP(3,3,10),         Y2BP(3,3,10),
     +     YES,       YSUM,     YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +     Z1,        Z2,       Z3,        Z4,        Z5,        Z6,
     +     Z7,        Z8,       Z9,        Z10,       Z11,       Z12,
     +     Z13,       Z14,      Z15,       Z16,       Z17,
     +     ZCARI,     ZCARM,    ZIC,       ZSUM,
     +     ZZ(3,3)
CC ADD12
        COMMON /DEBUG/          ADEBUG,    BDEBUG,    CDEBUG,    DDEBUG,
     +     LDEBUG,    MDEBUG,   PDEBUG,    QDEBUG,    SDEBUG,    TDEBUG
CC ADDD
        REAL            ITE,      ITL,       ITP,       ITIME,
     +     MMS,       MPH,      MSPEC,     MU,        MVPR,
     +     NAME,      NO,       LDEBUG,    MDEBUG,
     +     IN,        MISFIRE
        INTEGER         RNAME,    SITEI,     SITEM,     STAT,
     +     TDIST,     XLANE,    OPTI,      PPICK,     PPPICK
        INTEGER XOPT
CC      XOPT  - FUNCTION OPTION
CC          0 - F(X) -- FUNCTION
CC          1 - X*F(X) -- EXPECTION VALUE
CC         2 - F(X) -- ONLY (NO MAINTENANCE)
C:         3 - F(X) -- AREA ONLY (NO MAINTAINANCE AT ALL)
C:         4 - F(X)*X -- EXPECTED VALUE (NO MAINT.)
CC     LINT  -  LIMITS OF INTEGERATION CRITERIA
CC            -  1  --  XLO TO XCUT
```

```
CC           - 2 --  XCUT TO XHI
             NN=NSTEPS+1
             AREA=0.
              GO TO (1,1,1,2,3,4,1,1,1,5,160,160,160,160,160,160) ,M
           1 IGO=LINT(M)
             GO TO (10,50),IGO
          10 CONTINUE
CC           CUT LOWER PORTION OF DISTRIBUTION
             XLOR=TABLEX(1,M,J)
             XHIR=XCUT(M,K)
             GO TO 100
          50 CONTINUE
CC           CUT UPPER PORTION OF DISTRIBUTION
             XLOR=XCUT(M,K)
             XHIR=TABLEX(NN,M,J)
         100 CONTINUE
             DO 150 L=1,NN
              XBP(L)=TABLEX(L,M,J)
              YBP(L)=TABLEY(L,M,J)
         150 CONTINUE
             GO TO 190
CC           SIGNATURE MODEL
         160 CONTINUE
             LL=M-10
             XLOR=SXCUT(LL,K)
             XHIR=STABLEX(NN,LL,J)
             DO 170 L=1,NN
              XBP(L)=STABLEX(L,LL,J)
              YBP(L)=STABLEY(L,LL,J)
         170 CONTINUE
         190 CALL NORM(XBP,YBP,NN)
CC           REJECTED PORTION
             CALL INTEG(XOPT,XHIR,XLOR,XBP,YBP,NSTEPS,A)
             AREA=A
             IF(ADEBUG.EQ.NO) RETURN
             WRITE (6,225) M,J,K,XOPT,AREA,DELXL,XLOR,XHIR
         225 FORMAT(1H1,5X,*PARAMETER NO. *,I2,5X,*POWERTRAIN NO.*,
            + I2,5X,*CONTROL TYPE *,I2//5X,*XOPT = *,I2,
            + 5X,*AREA = *E15.4,5X,*DELX = *E15.4/
            + 5X,*XLO REJ = *E15.4,5X,*XHI REJ = *E15.4/)
             RETURN
         2   CONTINUE
```

Table 5-16 FUNCTION AREA LISTING (cont.)

```
C     MISFIRE DISTRIBUTION
CC    REJECTED PERCENTAGE
      AREA=0.
      IF(LIDLE.EQ.2) AREA=COEFBP(4,J)*TMIL(N,J)*TINT
     + *SCALEBM(1)
      RETURN
    3 CONTINUE
C     NOX DISTRIBUTION
      AREA=COEFBP(5,J)*TMIL(N,J)*TINT
     + *SCALEBM(1)
      RETURN
    4 CONTINUE
C     AIR PUMP DISTRIBUTION
      AREA=COEFBP(6,J)*TMIL(N,J)*TINT
     + *SCALEBM(1)
      RETURN
    5 CONTINUE
C     CHOKE BLADE SETTING
      AREA=COEFBP(10,J)*TMIL(N,J)*TINT
     + *SCALEBM(1)
      RETURN
      END
```

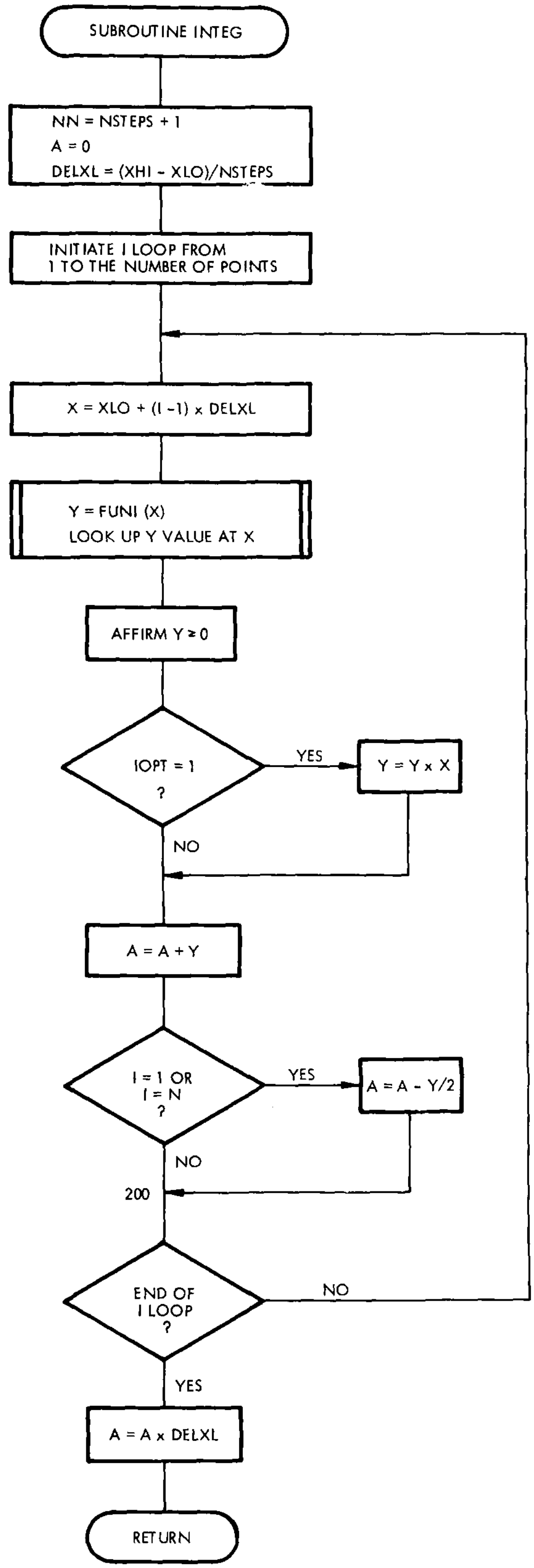


Figure 5-17 Subroutine INTEG Flowchart

Table 5-17 SUBROUTINE INTEG LISTING

```
      SUBROUTINE INTEG(IOPT,XHI,XLO,XBP,YBP,NSTEPS,A)
      DIMENSION XBP(1),YBP(1)
      NN=NSTEPS+1
      A=0.
      DELXL=(XHI-XLO)/NSTEPS
      DO 200 I=1,NN
      X=XLO+(I-1)*DELXL
      Y=FUN1(X,XBP,YBP,NN)
      IF(Y.LT.0.) Y=0.
      IF(IOPT.EQ.1) Y=Y*X
      A=A+Y
      IF(I.EQ.1) A=A-Y/2.
      IF(I.EQ.NN) A=A-Y/2.
  200 CONTINUE
      A=A*DELXL
      RETURN
      END
```

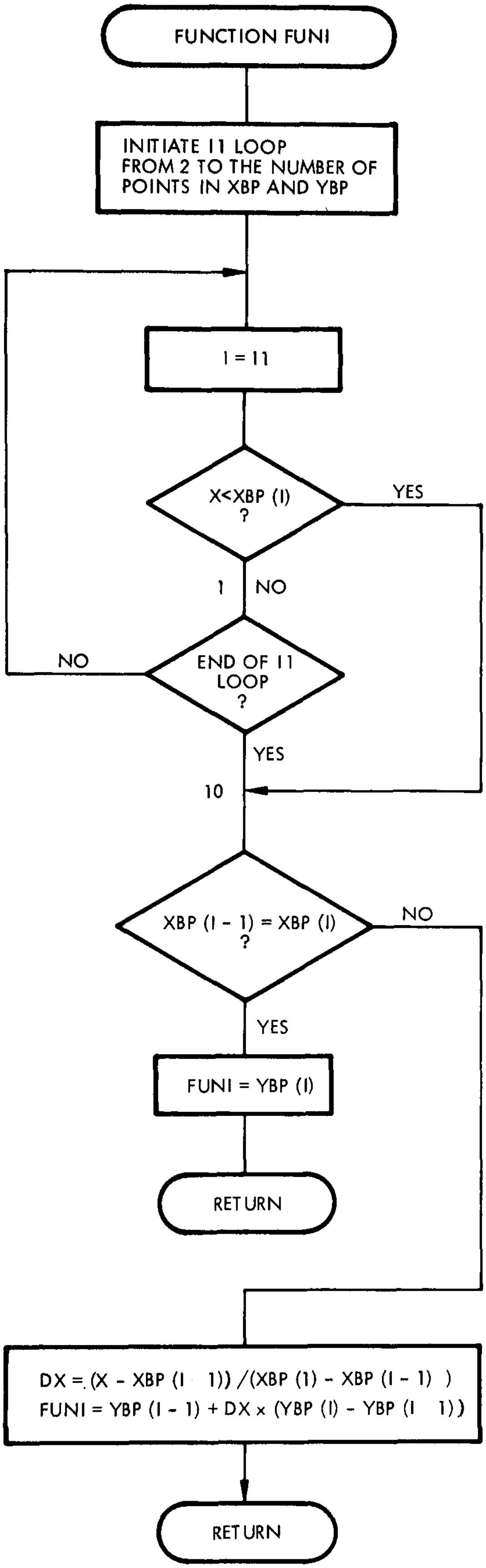


Figure 5-18 Function FUN1 Flowchart

Table 5-18 FUNCTION FUN1 LISTING

```
      FUNCTION FUN1(X,XBP,YBP,N)
CC
CC    LINEAR INTERPOLATION
CC
      DIMENSION XBP(N),YBP(N)
      DO 1 II=2,N
      I = II
1     IF(X .LT. XBP(I)) GO TO 10
10    IF(XBP(I-1).NE.XBP(I)) GOTO 20
      FUN1=YBP(I)
      RETURN
20    DX=(X-XBP(I-1))/(XBP(I)-XBP(I-1))
      FUN1 = YBP(I-1)+DX*(YBP(I)-YBP(I-1))
      RETURN
      END
```

get the appropriate entries in the storage matrix. A linear interpolation is performed (in two dimensions) to obtain the required value.

Figure 5-19 presents a flowchart and Table 5-19 contains a listing of FUN2.

5.11.6 Subroutine FIT

Subroutine FIT performs a least square binomial curve fit using orthonormal polynomials and inner products. The Chebyshev technique is used to generate an approximation from tabular data.

Figure 5-20 exhibits a flowchart and Table 5-20 provides a listing of subroutine FIT.

5.11.7 Function UNION

The function UNION computes the total rejection rate for N individual rejection fractions. Input to UNION are the individual probabilities, the number of values and a flag indicating whether these are parameter or mode emission rejection rates. For parameter rejection rates, function UNION simply computes the set theoretical union of probabilities and returns that value in functional variable UNION. For mode emission rejection rates the function computes the set theoretical union corrected for non-independence. This correction is necessary because of the statistically significant dependence observed between several of the mode emissions. Output from function UNION is the function itself. A flowchart of UNION is given in Figure 5-21 while Table 5-21 presents a computer listing.

5.11.8 Subroutine QUEUE

Subroutine QUEUE contains a standard queuing model for a multiple server Poission input queuing problem. Input to QUEUE is RHO, the ratio of arrival time to serving time and J, the number of lanes in the

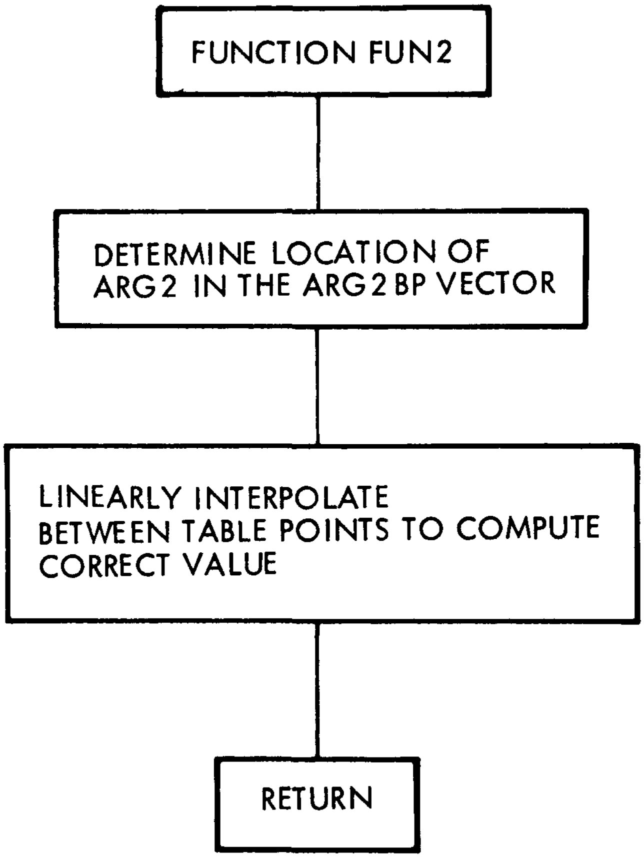


Figure 5-19 Function FUN2 Flowchart

Table 5-19 FUNCTION FUN2 LISTING

```
      FUNCTION FUN2(ARG1,ARG1BP,ARG2,ARG2BP,FUN2BP,I1,I2)
      DIMENSION ARG1BP(I1),ARG2BP(I2),FUN2BP(I1,I2)
      DO 10 JJ1=2,I1
      J1=JJ1
   10 IF(ARG1.LE.ARG1BP(J1)) GO TO 20
   20 DO 30 JJ2=2,I2
      J2=JJ2
   30 IF(ARG2.LE.ARG2BP(J2)) GO TO 40
   40 ARG=ARG1BP(J1-1)
      FUN=FUN2BP(J1-1,J2-1)
      DX=(ARG1-ARG)/(ARG1BP(J1)-ARG)
      DY=(ARG2-ARG2BP(J2-1))/(ARG2BP(J2)-ARG2BP(J2-1))
      FUNX=FUN+DX*(FUN2BP(J1,J2-1)-FUN)
      FUNY=FUN2BP(J1-1,J2)+DX*(FUN2BP(J1,J2)-FUN2BP(J1-1,J2))
      FUN2=FUNX+DY*(FUNY-FUNX)
      RETURN
      END
```

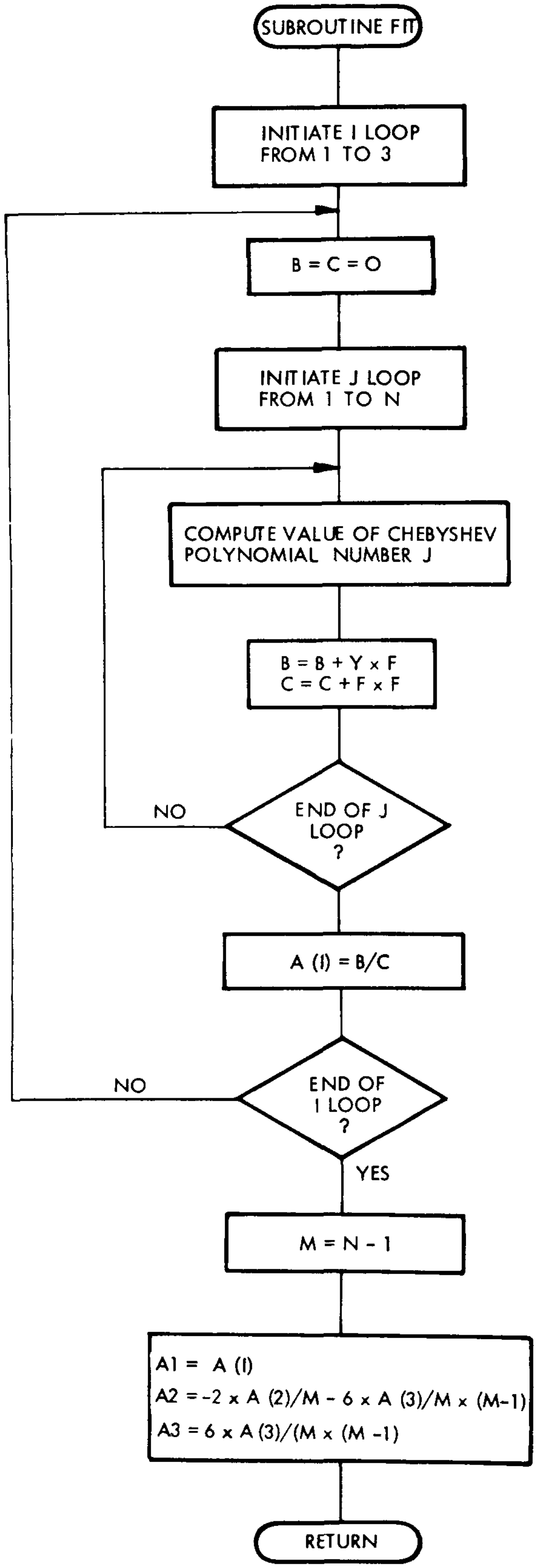


Figure 5-20 Subroutine FIT Flowchart

Table 5-20 SUBROUTINE FIT LISTING

```
      SUBROUTINE FIT(Y,N,A1,A2,A3,II)
      DIMENSION A(3),D(3,2)
      DIMENSICN Y(3,16)
      COMMON /COM99/ OPTI,OPTM,XLANE,SLANE,RTYPE,YES,NO,RSTOP,
     + SMODEL,PMODEL,NAME(50),OPTS(50),NOPTS,SITEI,SITEM,RNAME,LIDLE
      COMMON /DEBUG/ BDEBUG,MDEBUG,TDEBUG,GDEBUG,ADEBUG,LDEBUG,PDEBUG,
     + DDEBUG,QDEBUG,SDEBUG
      DATA D/0.,2.,2*0.,2*6./
      DO 30 I=1,3
      B=C=0.
      DO 20 J=1,N
      F=1.-D(I,1)*(J-1)/(N-1)+D(I,2)*(J-1)*(J-2)/((N-2)*(N-1))
      B=B+Y(II,J)*F
   20 C=C+F*F
   30 A(I)=B/C
      M=N-1
      A1=A(1)+A(2)+A(3)
      A2=-A(2)*2./M-A(3)*6./M-6.*A(3)/(M*(M-1))
      A3=A(3)*6./(M*(M-1))
   40 FORMAT(* A1 = *,E12.5,5X,*A2 = *,E12.5,5X,*A3 = *,E12.5/)
      RETURN
      END
```

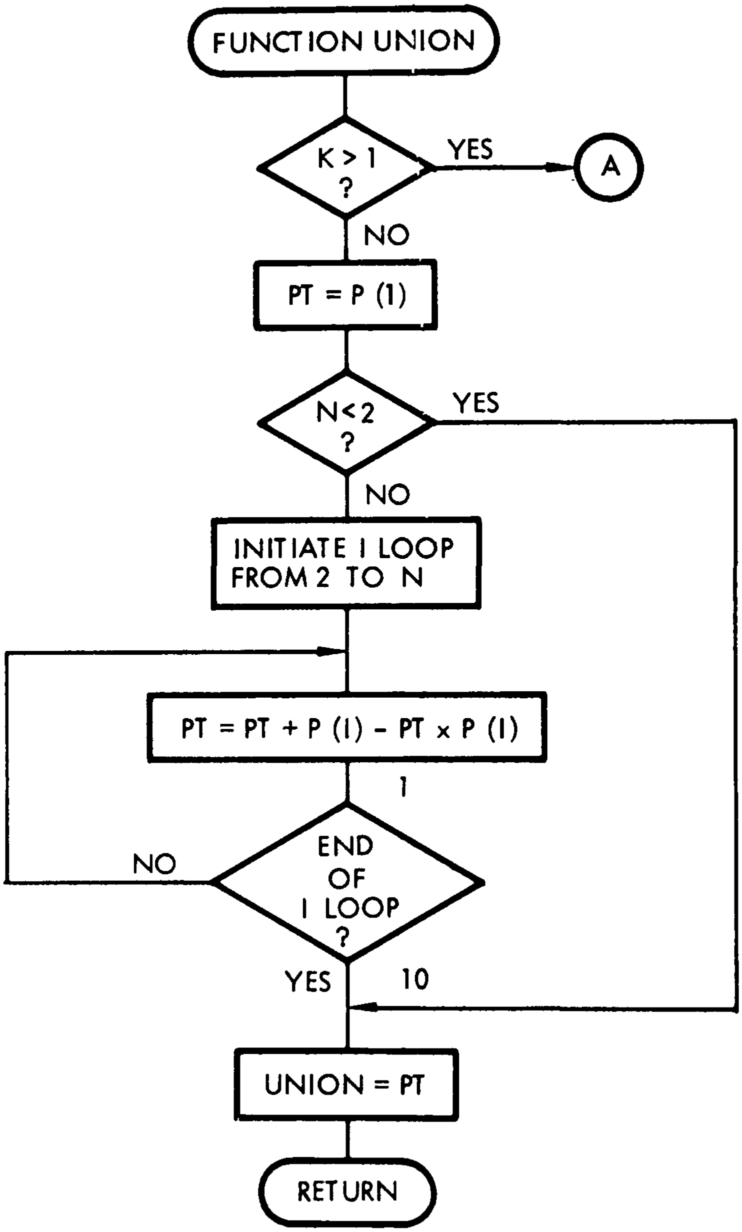


Figure 5-21 Function UNION Flowchart

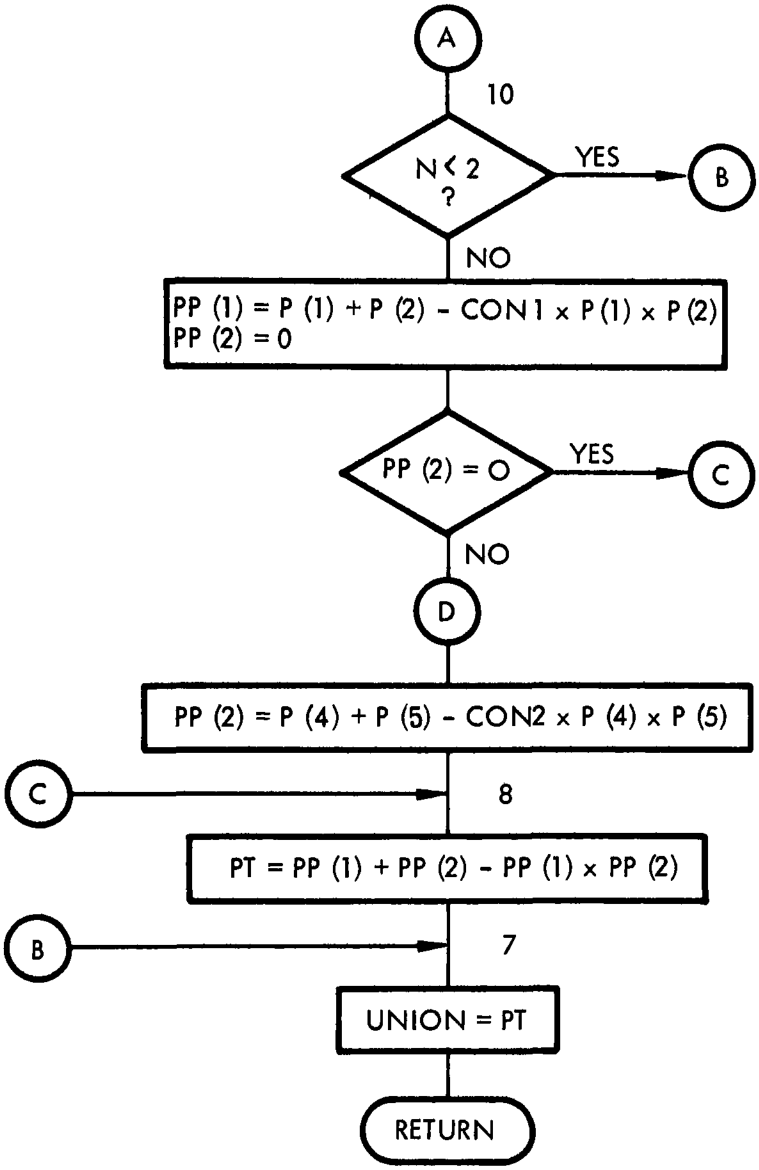


Figure 5-21 Function UNION Flowchart (cont.)

Table 5-21 FUNCTION UNION LISTING

```
      FUNCTION UNION(P,N,K)
      DIMENSION P(N)
      DIMENSICN PP(4)
      DATA CON1,CON2/1.2,1.05/
      IF(K.GT.1) GOTO 10
      PT= P(1)
      IF(N.LT.2) GO TO 5
      DO  1 I=2,N
    1 PT=PT+P(I)-PT*P(I)
    5 UNION=PT
      RETURN
   10 PT=P(1)
      IF(N.LT.2) GOTO 7
      PP(1)=P(1)+P(2)-CON1*P(1)*P(2)
      PP(2)=0.
      IF(P(4).LE.0.) GOTO 8
      PP(2)=P(4)+P(5)-CON2*P(4)*P(5)
    8 CONTINUE
      PT=PP(1)+PP(2)-PP(1)*PP(2)
    7 UNION=PT
      RETURN
      END
```

inspection station. Output from QUEUE are ZQUEI, the expected size of the queue and WTQI the expected waiting time in the queue. The equations for ZQUEI and WTQI are fully documented in Volume III. Figure 5-22 gives a flowchart for subroutine QUEUE. A detailed listing of QUEUE is present in Table 5-22.

5.11.9 Function IFACT

Function IFACT is a GEEP utility routine which computes the factorial of an input J. Output from IFACT is simply J factorial stored in the functional variable IFACT.

$$IFACT(J) = J! = \sum_{I=1}^{J} I$$

A flowchart of IFACT is given in Figure 5-23. Table 5-23 presents the actual computer code.

5.11.10 Subroutine STD

Subroutine STD, a GEEP utility routine, computes the mean and standard deviation of an input vector of N real numbers, X. The computations in STD are simply:

$$AVE = \frac{1}{N}\sum X$$

$$SD = \sqrt{\frac{(X-AVE)^2}{N-1}}$$

These are simply the standard equations for average and standard deviation. STD outputs AVE and STD. Figure 5-24 contains a flowchart and Table 5-24 a listing of STD.

5.11.11 Subroutine STD2

GEEP subroutine STD2 computes the mean and standard deviation of an input distribution. The input distribution is specified by two vectors, X and Y, and N the length of each vector. Output from STD2 is

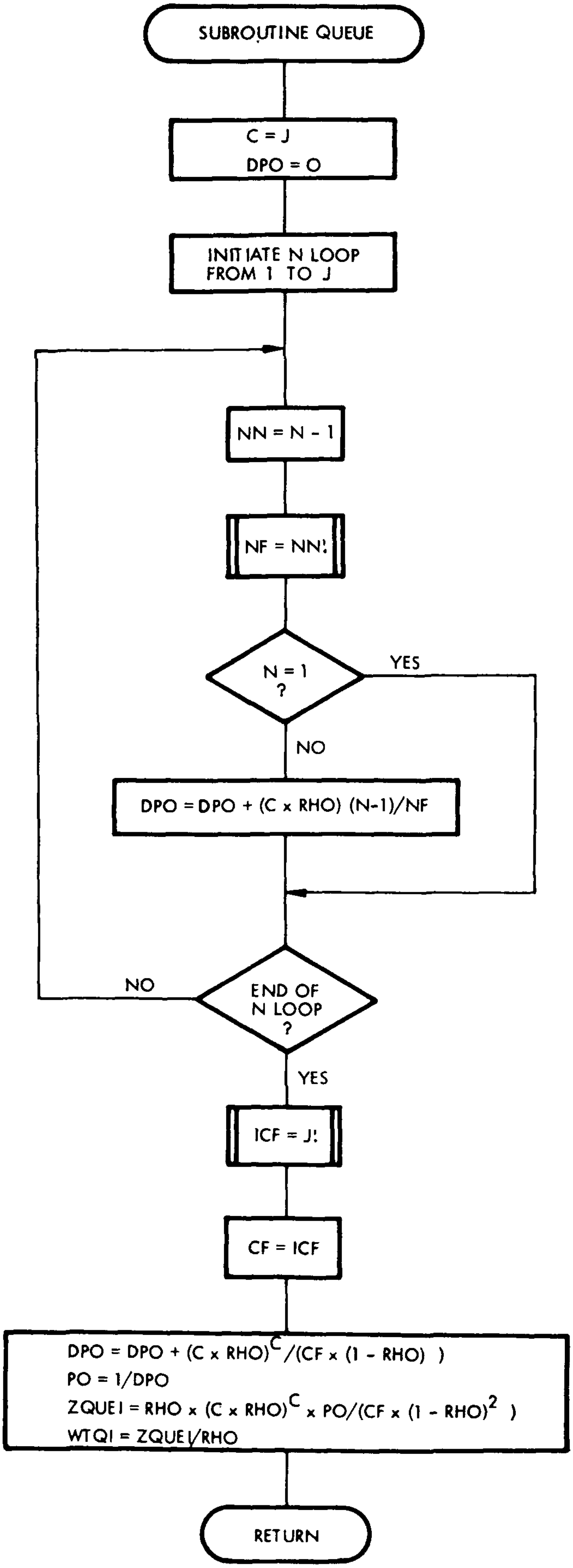


Figure 5-22 Subroutine QUEUE Flowchart

Table 5-22 SUBROUTINE QUEUE LISTING

```
      SUBROUTINE QUEUE(RHO,ZQUEI,WTQI,J)
       INTEGER C
       C=J
      DPO=0
      DO 10 N=1,J
      NN=N-1
       NF=IFACT(NN)
      IF(N.EQ.1) GO TO 10
      DPO=DPO+(C*RHO)**(N-1)/NF
   10 CONTINUE
       ICF=IFACT(J)
      CF=ICF
      DPO=DPO+(C*RHO)**C/(CF*(1.-RHO))
      PO=1/DPO
      ZQUEI=RHO*(C*RHO)**C*PO/(CF*(1.-RHO)**2)
      WTQI=ZQUEI/RHO
      RETURN
      END
```

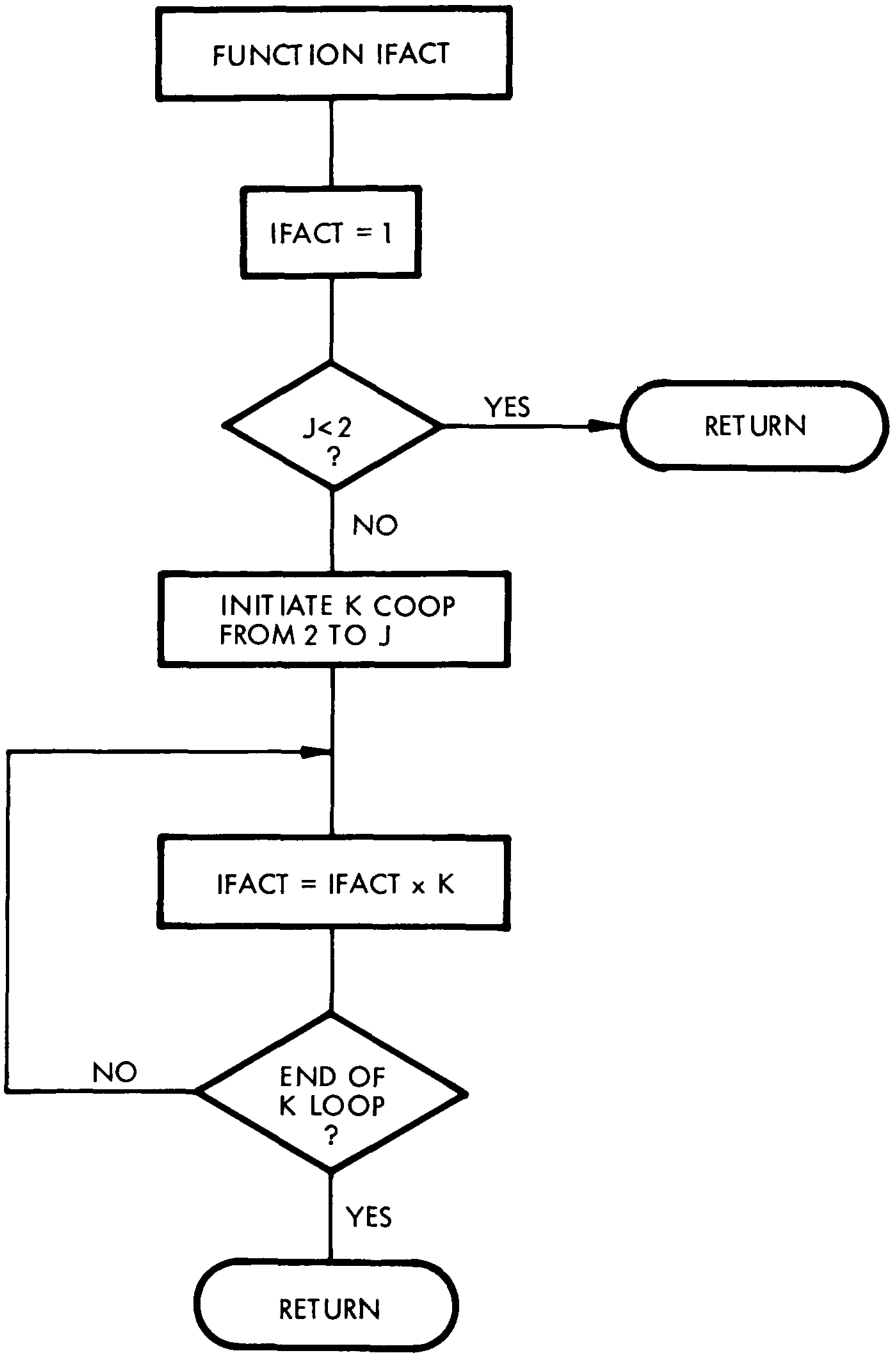


Figure 5-23 Function IFACT Flowchart

Table 5-23 FUNCTION IFACT LISTING

```
      FUNCTION IFACT(J)
      IFACT=1
      IF(J.LT.2) RETURN
      DO 10 K=2,J
   10 IFACT=IFACT*K
      RETURN
      END
```

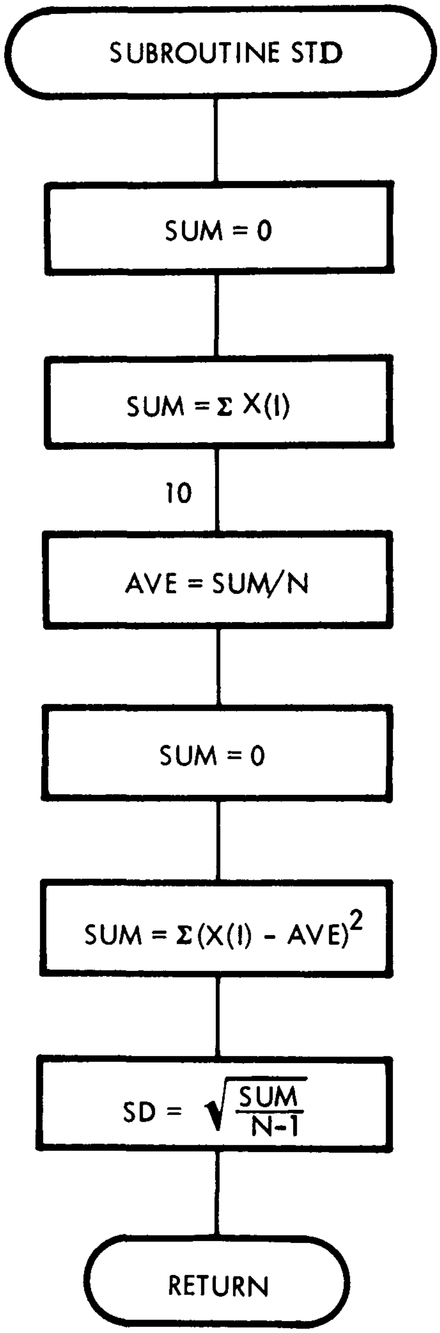


Figure 5-24 Subroutine STD Flowchart

Table 5-24 SUBROUTINE STD LISTING

```
      SUBROUTINE STD(X,N,AVE,SD)
      DIMENSICN X(N)
C     UNIFORM DISTRIBUTION
      SUM = 0.0
      DO 10 I=1,N
   10 SUM = SUM+X(I)
      AVE = SUM/N
      SUM = 0.0
      DO 20 I=1,N
   20 SUM=SUM+(X(I)-AVE)**2
      SD=SQRT(SUM/(N-1))
      RETURN
      END
```

AVE the mean and SD the standard deviation. AVE and SD are computed from standard moment equations using an arbitrary distribution.

The equations in STD2 are:

$v_1 = \sum X_i Y_i \Delta X$ (first moment about orgin)

$v_2 = \sum X_i^2 Y_i \Delta X$ (second moment about orgin)

$AVE = v_1$ (Mean)

$SD = \sqrt{v_2 - v_1^2}$ (Square root of variance)

Figure 5-25 gives a flowchart for STD2 and Table 5-25 presents a listing of the code.

5.11.12 Subroutine NORM

Subroutine NORM normalizes an input distribution X, Y of size N. NORM simply integrates the entire X, Y distribution and divides each Y value by that integral. The integral of the resultant distribution is unity, i.e. normalized.

This technique can be specified mathematically as:

$$C = \int_{-\infty}^{\infty} Y \, dx$$

$$\frac{Y_i}{C} \rightarrow Y_i \quad \text{for } i = 1 \text{ to } N$$

A flowchart of this routine is given in Figure 5-26. Table 5-26 presents a computer listing of subroutine NORM.

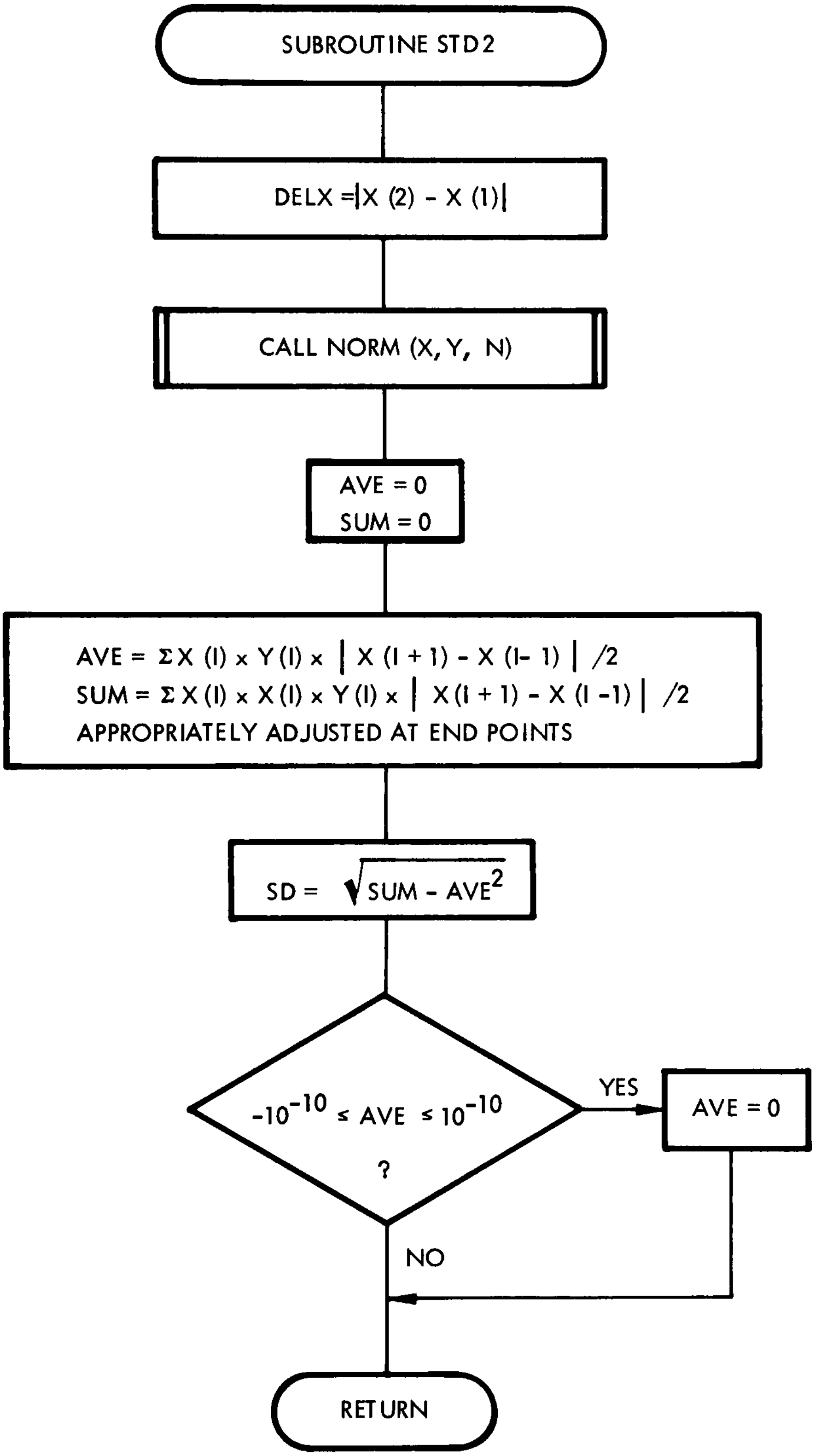


Figure 5-25 Subroutine STD2 Flowchart

Table 5-25 SUBROUTINE STD2 LISTING

```
      SUBROUTINE STD2(X,Y,N,AVE,SD)
C     PROBABILITY DISTRIBUTION (NORMAL,ETC)
      DIMENSION X(1),Y(1)
C
C     NORMALIZE INPUT
C
      DELX = ABS(X(2)-X(1))
      CALL NORM(X,Y,N)
      AVE = SUM = 0.0
      DO 10 I = 1,N
      IF(I.GT.1.AND.I.LT.N) DELX=ABS((X(I+1)-X(I-1))/2.)
      IF(I.EQ.N) DELX=ABS(X(N)-X(N-1))
      AVE = AVE+X(I)*Y(I)*DELX
   10 SUM = SUM+X(I)*X(I)*Y(I)*DELX
      SD = SQRT(SUM-AVE*AVE)
      IF(ABS(AVE) .LT. 1.E-10) AVE = 0.0
      RETURN
      END
```

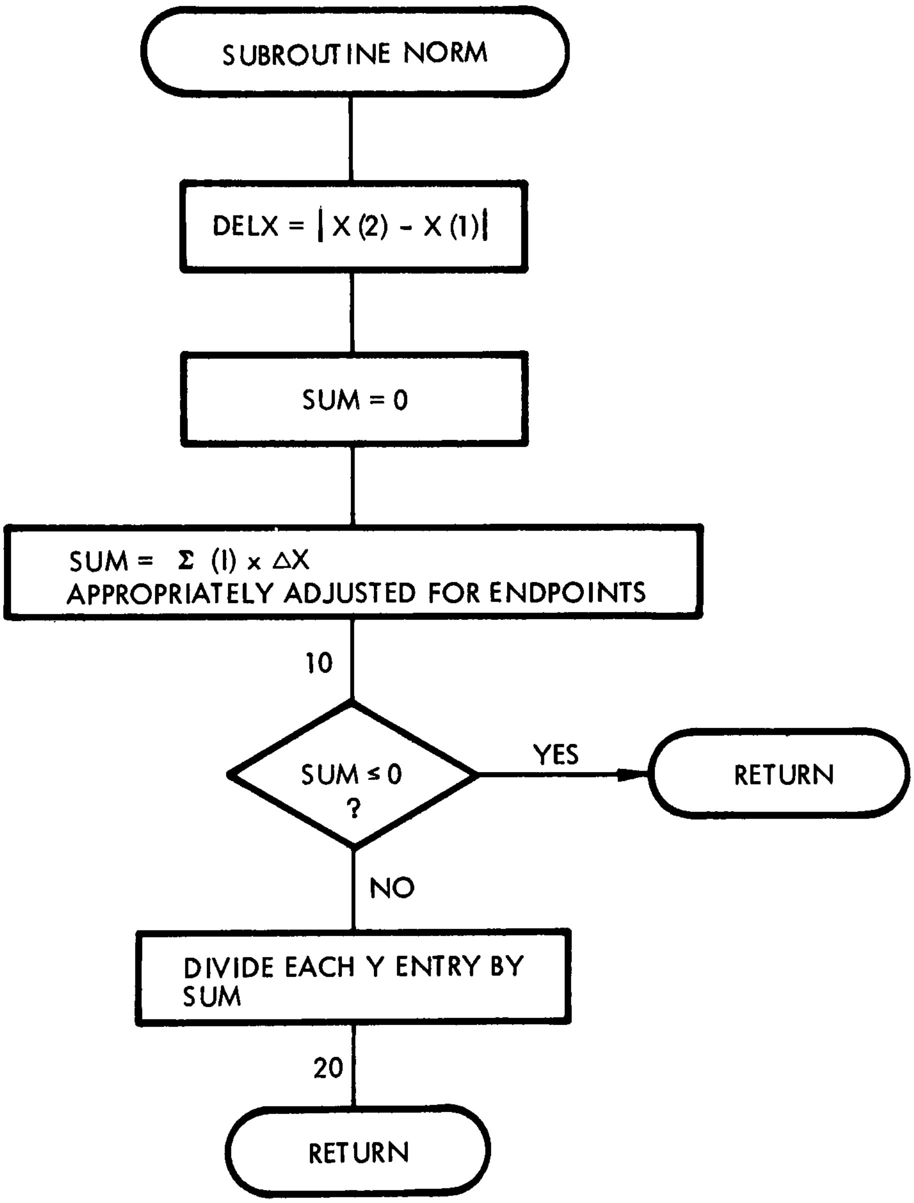


Figure 5-26 Subroutine NORM Flowchart

Table 5-26 SUBROUTINE NORM LISTING

```
      SUBROUTINE NORM(X,Y,N)
      DIMENSICN X(1),Y(1)
CC    NORMALIZE INPUT
      SUM=0.
      DO 10 I=1,N
      DELX=ABS(X(I+1)-X(I))
      IF(I.EQ.1) DELX=DELX/2.
      IF(I.EQ.N) DELX=ABS(X(N)-X(N-1))/2.
   10 SUM=SUM+Y(I)*DELX
      IF(SUM.LE.0.) RETURN
      DO 20 I=1,N
      Y(I)=Y(I)/SUM
   20 CONTINUE
      RETURN
      END
```

5.11.13 Subroutine RESIZE

Subroutine RESIZE resizes an arbitrary distribution based on an input range and cell width. Input to RESIZE consists of the old distribution X,Y with N1 equalling the number of points and the required width and range for the new distribution: WIDTH and R1. The distribution is resized to have range R1 with cell width WIDTH. The variable N1 is reset to the number of points in the new distribution.

The fundamental equations for RESIZE are:

$N2^1 = R1/(WIDTH \times 2)$	rounded up to an integer
$N2 = N2^1 \times 2 + 1$	total number of points in new distribution

After resizing the resultant distribution is normalized and returned in X and Y. Figure 5-27 presents a flowchart of RESIZE while Table 5-27 gives a listing of the code.

5.11.14 Function XPT

The function XPT computes the cutpoint required to yield a given rejection fraction. Input to XPT are the distribution X, Y and the number of points N, and the required rejection rate, A. Output is the computed cutpoint in the functional value XPT. Function XPT integrates the input distribution until the accepted area exceeds 1 minus the input rejection fraction. At that point a linear interpolation is performed between the boundary points on the distribution to estimate the exact cutpoint at which the input rejection fraction would be realized. Figure 5-28 contains a detailed flowchart for XPT while Table 5-28 presents a computer listing.

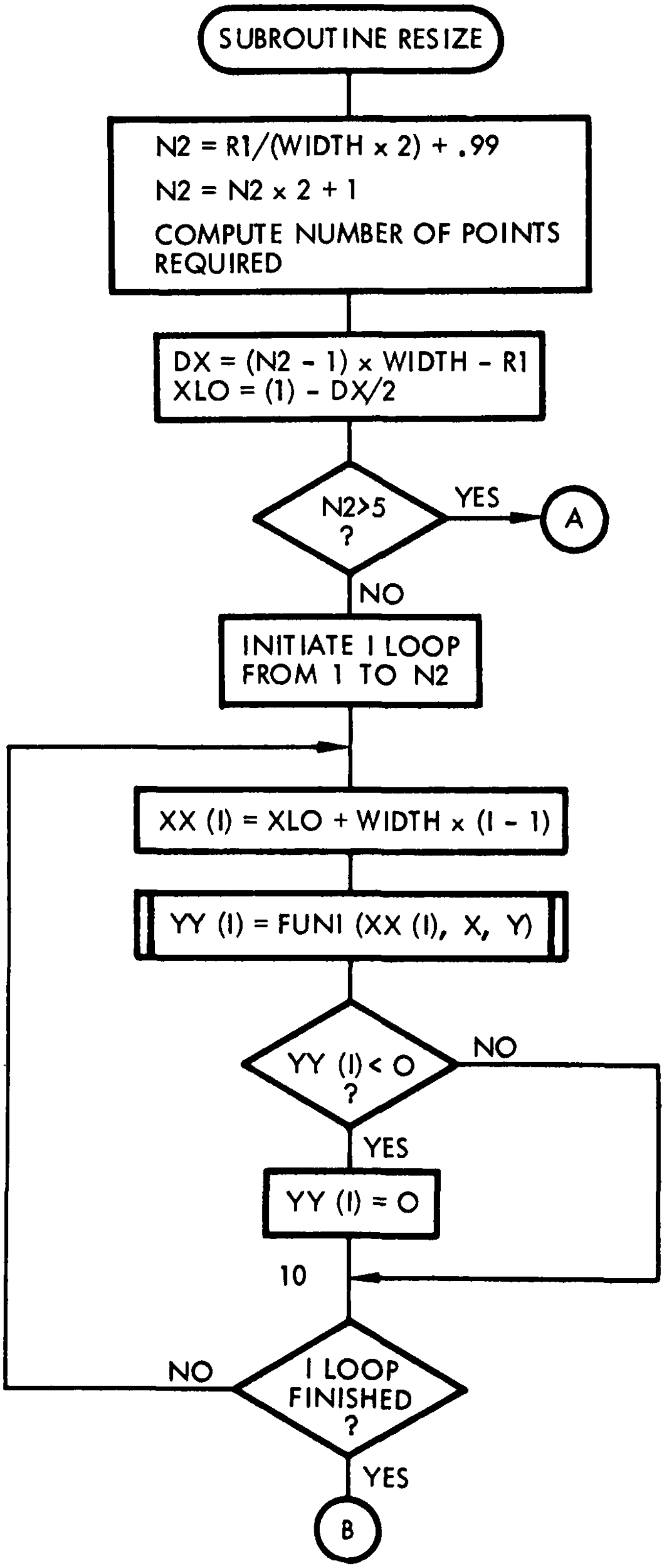


Figure 5-27 Subroutine RESIZE Flowchart

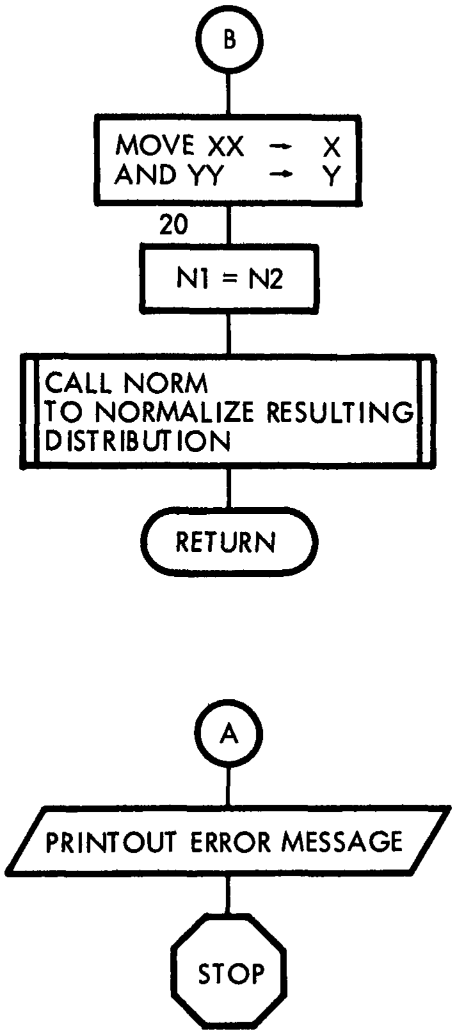


Figure 5-27 Subroutine RESIZE Flowchart (cont.)

Table 5-27 SUBROUTINE RESIZE LISTING

```
      SUBROUTINE RESIZE(WIDTH,R1,X,Y,N1)
      DIMENSICN X(1),Y(1),XX(50),YY(50)
      N2 = R1/(WIDTH*2.0) + .99
C
C     GET AVE FROM STD2
C
      N2=N2*2+1
      DX=(N2-1)*WIDTH-R1
      XLO=X(1)-DX/2.
      IF(N2.GT.50) GO TO 40
      DO 10 I = 1,N2
      XX(I) = XLO + WIDTH*(I-1)
      YY(I) = FUN1(XX(I),X,Y,N1)
   10 IF(YY(I) .LT. 0.) YY(I) = 0.0
      DO 20 I = 1,N2
      X(I) = XX(I)
   20 Y(I) = YY(I)
      N1 = N2
C
C     RE-NORMALIZE THE RE-SIZED CURVE
C
      CALL NORM(X,Y,N1)
      RETURN
   40 WRITE (6,50) N2
   50 FORMAT(//,* INSUFFICIENT DIMENSION SIZE IN RESIZE --*
     + *CALLED FROM CONVOL  --   *,I5//)
      STOP
      END
```

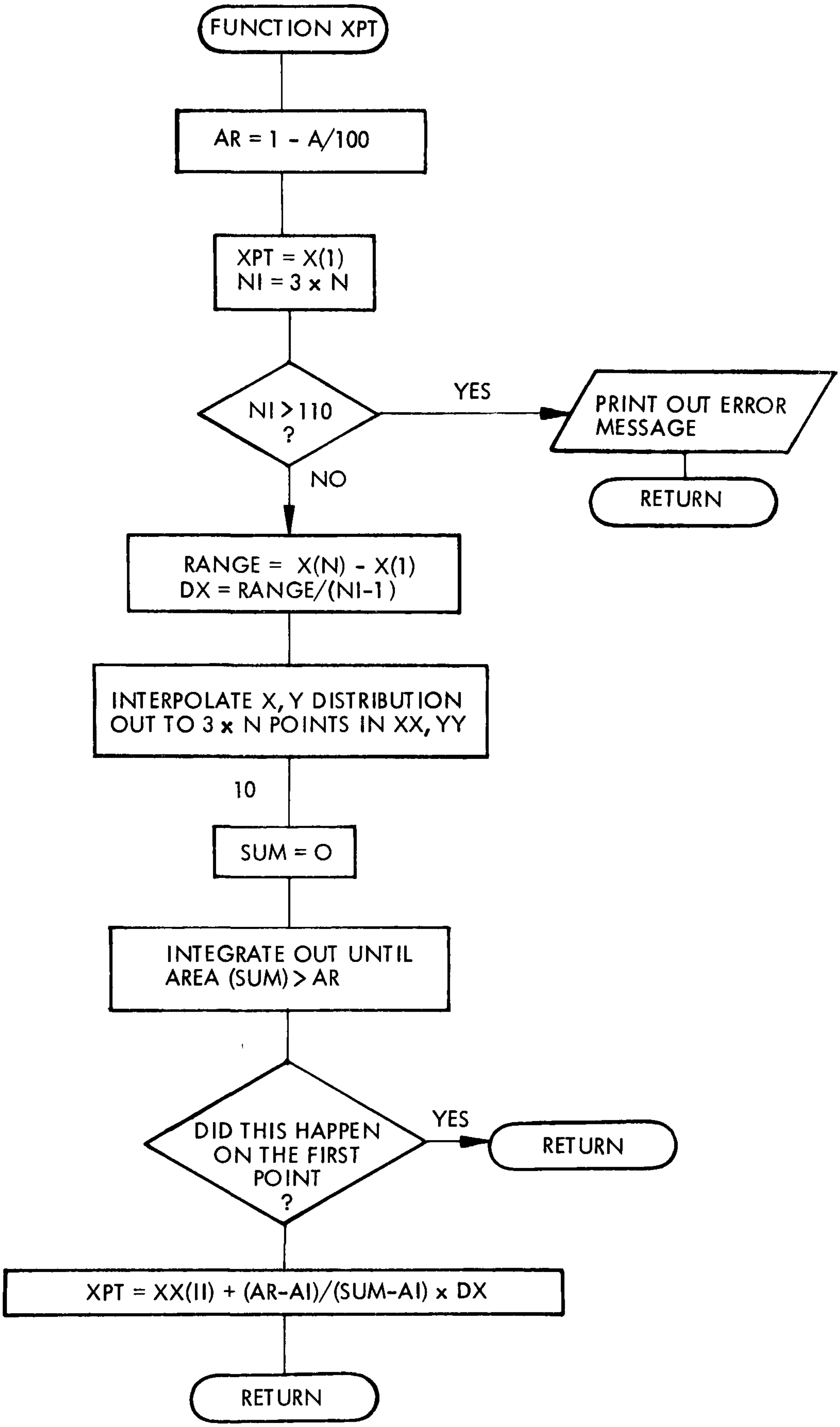


Figure 5-28 Function XPT Flowchart

Table 5-28 FUNCTION XPT LISTING

```
      FUNCTION XPT(X,Y,N,A)
CC    THIS SUBROUTINE SUPPORTS STATS BY INTEGRATING THE INPUT
CC    CURVE UNTIL AN AREA IS ACHEIVED AND RETURNING THE
CC    X-AXIS VALUE
      DIMENSION X(1),Y(1),XX(110),YY(110)
      AREA=1.-A/100.
      XPT=X(1)
      N1=3*N
      IF(N1.GT.110) GO TO 40
      RANGE=ABS(X(N)-X(1))
      DX=RANGE/(N1-1)
      DO 10 I=1,N1
      XX(I)=X(1)+DX*(I-1)
   10 YY(I)=FUN1(XX(I),X,Y,N)
      CALL NORM(XX,YY,N1)
      SUM=0.
      DO 20 I=1,N1
      I1=I-1
      I2=I
      A1=SUM
      SUM=SUM+YY(I)*DX
      IF(SUM.GT.AREA) GO TO 30
   20 CONTINUE
   30 IF(I1.EQ.0) RETURN
      XPT=XX(I1)+(AREA-A1)/(SUM-A1)*DX
      RETURN
   40 WRITE (6,50) N1
   50 FORMAT(//,* INSUFFICIENT DIMENSION IN XPT CALLED FROM *
     + , *STATS -- *,I5/)
      STOP
      END
```

5.11.15 Subroutine SWITCH

Subroutine SWITCH reorders a distribution for increasing values on the X axis. Input to subroutine SWITCH is a distribution X, Y and its size N. SWITCH assumes an odd number of points in the distribution and transposes the distribution around its central point - if and only if the distribution has decreasing X's - and therefore outputs a distribution identical to the input but reordered such that the last X value exceeds the first one. Figure 5-29 contains a detailed flowchart for subroutine SWITCH and Table 5-29 a listing of the code.

5.11.16 Subroutine ADD

Subroutine ADD mathematically adds two distributions X1, Y1 and X2, Y2, with sizes N1 and N2 respectively. Output consists of the sum distribution X3, Y3 with size N3. Subroutine ADD, expecting each vector to have nine points, checks to see if either distribution is empty and, if so, moves the non-empty distribution into the resultant and returns. If neither distribution is empty ADD creates a new distribution with domain equal to the union of the domains of the input vectors. Figure 5-30 contains a detailed flowchart of subroutine ADD and Table 5-30 a listing of the code.

5.11.17 Function EINT

Function EINT contains the algorithms for assessing the second order parameter interactions. While MICRO assumes a linear relationship between parameter adjustments and emission reductions, function EINT assesses the nonlinear second order parameter interactions which contribute to emission reductions. EINT outputs a value, DELI, for each

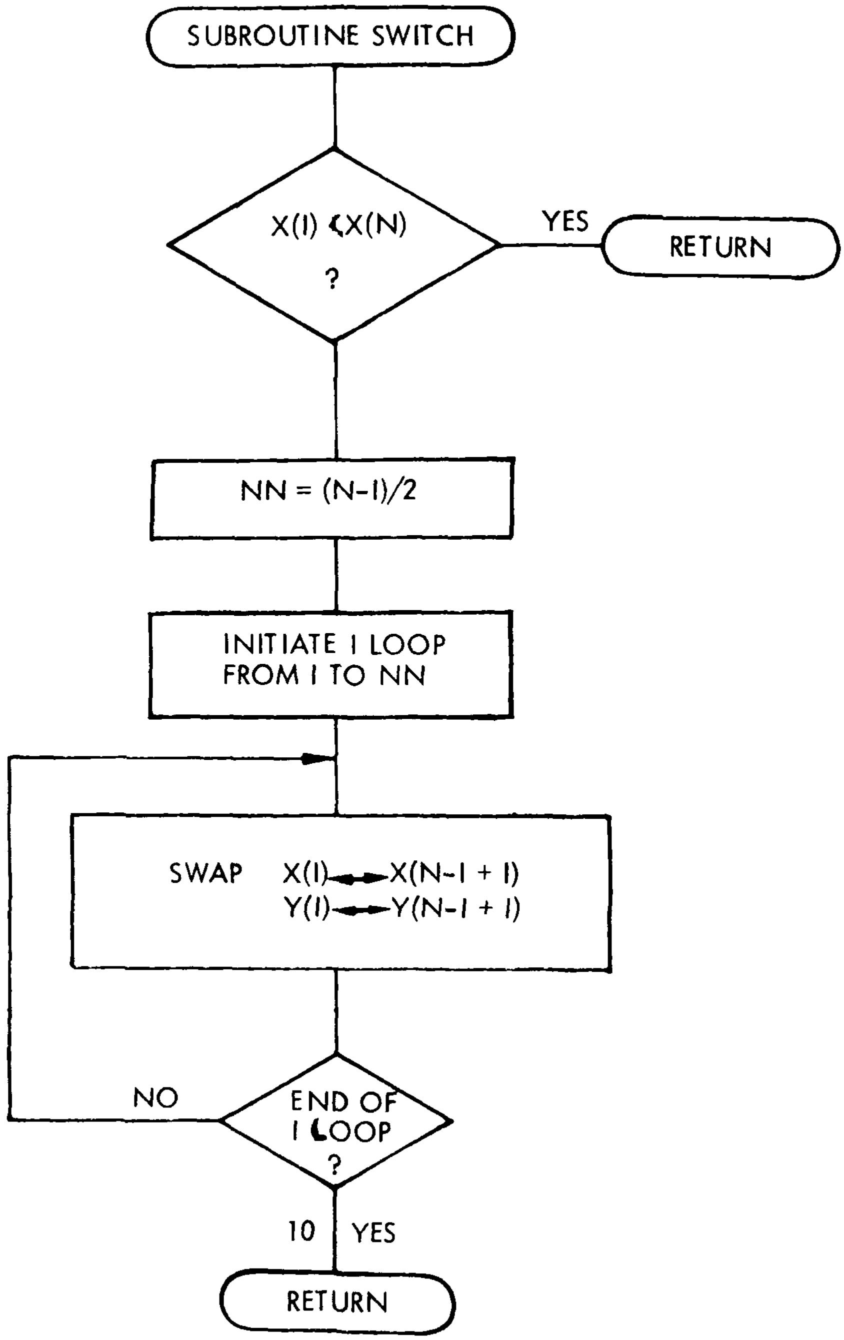


Figure 5-29 Subroutine SWITCH Flowchart

Table 5-29 SUBROUTINE SWITCH LISTING

```
      SUBROUTINE SWITCH(X,Y,N)
      DIMENSION X(1),Y(1)
CC    REORDER DIST FOR ODD NO OF PTS
      IF(X(1).LT.X(N)) RETURN
      NN=(N-1)/2
      DO 10 I=1,NN
      DUM=X(I)
      X(I)=X(N-I+1)
      X(N-I+1)=DUM
      DUM=Y(I)
      Y(I)=Y(N-I+1)
      Y(N-I+1)=DUM
   10 CONTINUE
      RETURN
      END
```

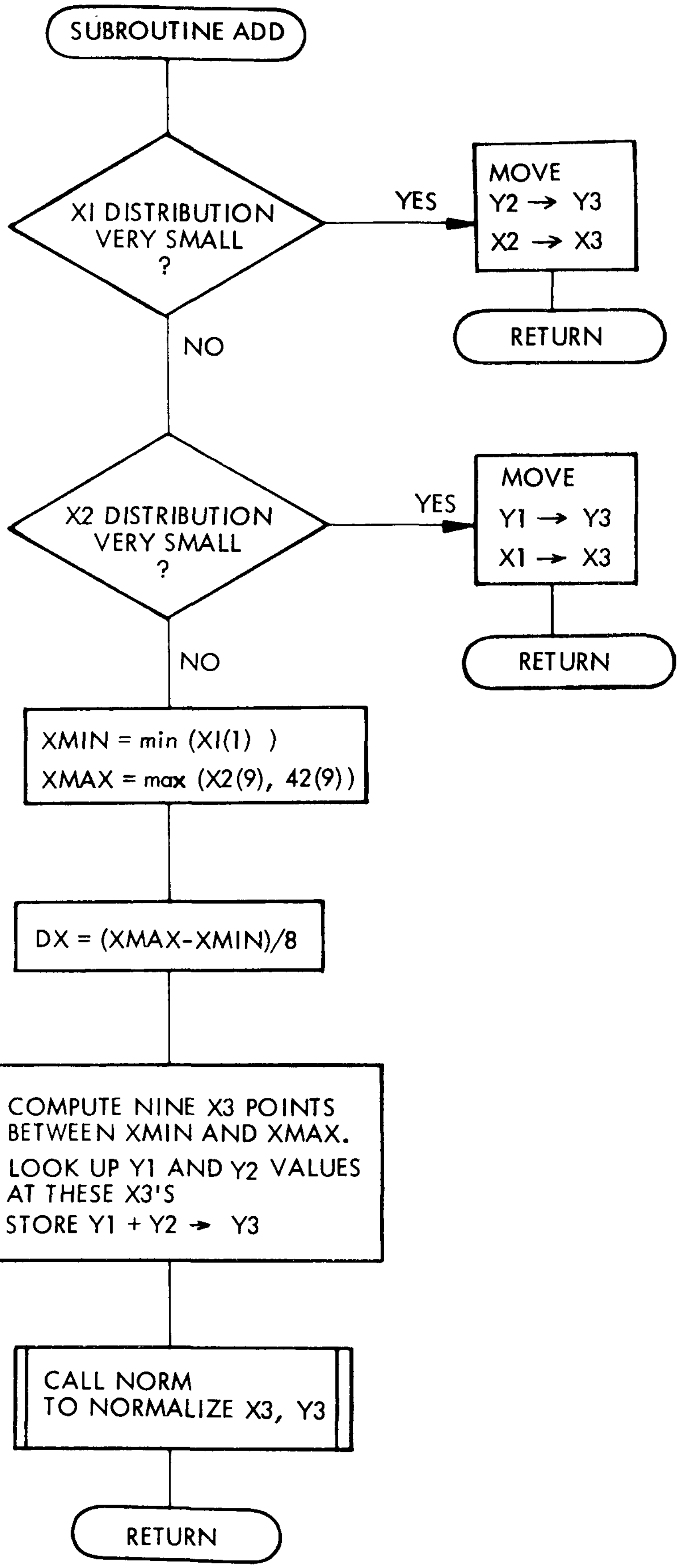


Figure 5-30 Subroutine ADD Flowchart

Table 5-30 SUBROUTINE ADD LISTING

```
      SUBROUTINE ADD(X1,Y1,X2,Y2,X3,Y3,N1,N2,N3)
      DIMENSION X1(9),Y1(9),X2(9),Y2(9),X3(9),Y3(9)
      IF(ABS(X1(1)-X1(9)).LT..01) GOTO 20
      IF(ABS(X2(1)-X2(9)).LT..01) GOTO 30
      XMIN=AMIN1(X1(1),X2(1))
      XMAX=AMAX1(X1(9),X2(9))
      DX=(XMAX-XMIN)/8
      DO 10 I=1,9
      X3(I)=XMIN+DX*(I-1)
      A1=FUN1(X3(I),X1,Y1,N1)
      IF(A1.LT.0.) A1=0.
      A2=FUN1(X3(I),X2,Y2,N2)
      IF(A2.LT.0.) A2=0.
      Y3(I)=A1+A2
   10 CONTINUE
      CALL NORM(X3,Y3,N3)
      RETURN
   20 DO 25 I=1,9
      X3(I)=X2(I)
   25 Y3(I)=Y2(I)
      N3=N2
      RETURN
   30 DO 35 I=1,9
      X3(I)=X1(I)
   35 Y3(I)=Y1(I)
      N3=N1
      RETURN
      END
```

emission species which is used in computing the total emission reduction achieved from the maintenance treatment. Figure 5-31 presents a flowchart of EINT and Table 5-31 gives a computer listing.

5.11.18 Subroutine PACKD

Subroutine PACKD eliminates the tail ends of parameter and mode emission distributions. It computes the 1 and 99 percent points of the distribution and resizes it to these endpoints. Input to PACKD is the distribution X, Y with size N. The packed and resized distribution is returned to the same vectors, X and Y. Figure 5-32 presents a flowchart of PACKD and Table 5-32 a listing.

5.12 VEHICLE POPULATION MODEL

The Vehicle Population Model (VPM) is a general methodology for projecting future distributions of vehicle population versus vintage year. Used in conjunction with GEEP, VPM can provide estimates of the vehicle population makeup for the period 1970 – 1980 under a variety of growth/ attrition rate combinations.

The basic model methodology involves analytically describing the "birth and death" process taking place within the vehicle population itself. Older vehicles are continually aging, with the oldest leaving the population entirely after many years of service. Simultaneously, new vehicles are being added to the population at some forecasted rate. Because of this process, the relative weights of various vehicle age groups in determining the net emissions change with time. Any accurate emissions projection must account for this phenomenon.

VPM computes the vehicle age distribution over time, adjusting for both new cars and vehicle attrition. This distribution provides a set of weighting factors for each age class and for each year analyzed.

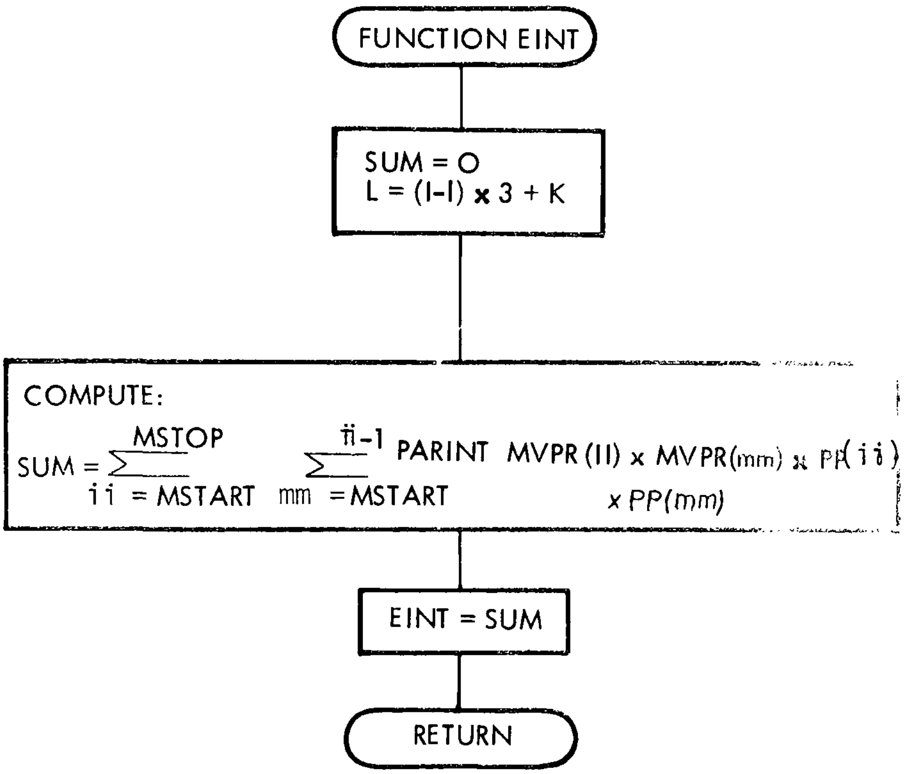


Figure 5-31 Function EINT Flowchart

Table 5-31 FUNCTION EINT LISTING

```
               FUNCTION EINT(I,K ,J)
                 COMMON /COM01/ AMB(3),ALAB,      AVV,   BINT,
     +              BAREA(3), BLD1,       BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +              BHIST(3,16),          BMMI(10,15,3),
     +              ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
                 COMMON /COM02/           CARA,     CARIY,    CARMY,    CARPOP(16),
     +              CARSY,    CBSUM,      CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +              CINCON,   CPCB,   CPI,      CPVPY,    CSUM,     CARAY,
     +              CN(15,3,16),          COEFB(15,3),        COEFBP(10,15),
     +              CPART(10,15)
CC ADD2
                 COMMON /COM03/           DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     +        EMW(3),         EP(10,15),EFF(10),  DELIT(3),
     +              FREQA,    FREQB,      FPEPL(10,3),
     +              HORZN,    HORZNY,
     +              HPC(15,16),           HPCS(15,16),        HPP(10,15,16),
     +              HPS(6,15,16),         HPT(5,16),          HPTOT(16),
     +              HPTOTS(16)
CC ADD3
                 COMMON /COM04/           ITE,      ITL,      ITP,      ITIME(16),
     +              KSTART,   KSTOP,      LOPT, LPICK(10),LLPICK,
     +              LIDLE,    LINT(16),   LPSPP(10),LSTART,   LSTOP,
     +              MBASE,    MPH,        MSPEC(10),MSTART,   MSTOP,
     +              MU(10,3),   MMS(10,15),         MVPR(10,15)
CC ADD4
                 COMMON /COM05/           NAME(50), NCNTR,    NEMIS,    NEMP,
     +              NINTR,    NINTRB,     NMODE,    NO,       NOPTS,    NPAR,
     +              NPTRN,    NPTS,       NSTEPS,   NTR,      NTRB,     NPICK(16),
     +              OCIY,     OCMY,       OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
                 COMMON /COM06/PARM(3,3), PART,       PAYNEW,   PAYOFF(3),
     +              PC(15),   PCS(15),    PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +              PP(10,15),PS(6,15),   PT(5),    PTOT,     PTS(5),   PAYADJ,
     +              PAR(10,15,3),         PAR1(10,3,3),       PLUS(10,15),
     +              PM(10,15),            PPICK(10),PPPICK,PSTAR,PI(15,10),
     +              PSA(15),  PTA(5),   PCONF,    PARINT(10,10,9)
     +        ,PAYFIN
                 COMMON /COM07/           REINSP,   RNAME,    RSIZE,    RSTOP,
     +              RTYPE,
     +              SALE,     SALL,       SALP,     SITEI,    SITEM,    SLANE,
     +              SMODEL,   START(15,3), STAT,     STIME(3), SUMBM(3),
```

Table 5-31 FUNCTION EINT LISTING (cont.)

```
     +    SCALEBM(3),             SM(6,15),             SPAR(10,15,6),
     +    SXCUT(6,3),             SIG(10,3),             SIGCE(3),
     +    SIGME(10),              SIGMNE(10),           SIGP(10,15),
     +    SIGRATE,  SIST,          SIGS(6,15),           SIGSDE(3),
     +    STABLEX(33,6,15),        STABLEY(33,6,15)
       COMMON /COM10/             TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),      TONX,     TOTE(3),   TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,         TSIG(3),   TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),          THISTT(3,16),         TIMEC(10,15),
     +    TIMEM(10,15),           TABLEX(33,10,15),      TABLEY(33,10,15)
CC ADD10
       COMMON /COM11/             WF(10),
     +    X1BP(3,3,6), XINT,         XINTB,      XLANE,      XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
       COMMON /COM12/             Y1BP(3,3,10),         Y2BP(3,3,10),
     +    YES,      YSUM,         YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,           Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,           Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,          Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,        ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
       COMMON /DEBUG/             ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,       PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
       REAL         ITE,          ITL,      ITP,      ITIME,
     +    MMS,      MPH,          MSPEC,    MU,       MVPR,
     +    NAME,     NO,           LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
       INTEGER      RNAME,        SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,        OPTI,     PPICK,    PPPICK
      SUM=0.
      L=(I-1)*3+K
      DO 100 II=MSTART,MSTOP
      DO 100 MM=MSTART,II
      IF(MM.GE.II) GO TO 100
       SUM=SUM + PARINT(II,MM,L)*
     + MVPR(II,J)*MVPR(MM,J)*PP(II,J)*PP(MM,J)*EFF(II)*EFF(MM)
  100 CONTINUE
      EINT=SUM
      RETURN
      END
```

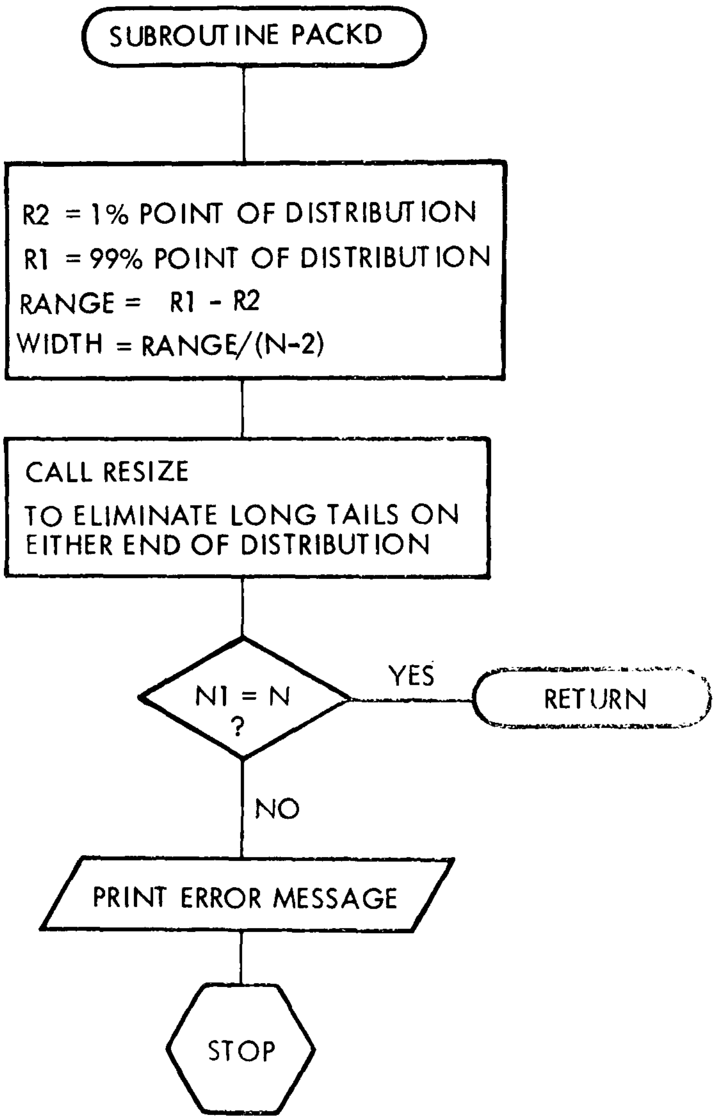


Figure 5-32 Subroutine PACKD Flowchart

Table 5-32 SUBROUTINE PACKD LISTING

```
      SUBROUTINE PACKD(X,Y,N)
      DIMENSION X(1),Y(1)
      R2=XPT(X,Y,N,1.0)
      R1=XPT(X,Y,N,99.0)
      RANGE=ABS(R1-R2)
      WIDTH=RANGE/(N-2)
      N1=N
      CALL RESIZE(WIDTH,RANGE,X,Y,N1)
      IF(N1.EQ.N)  RETURN
      WRITE(6,100)
  100 FORMAT(//*   NUMBER OF ENTRIES PROBLEM IN PACKD *,/////)
      STOP
      END
```

Combined with independently estimated vehicle emission rates, this distribution data can lead to emission projections weighted for changes in vehicle population characteristics.

This weighting process is crucial in making accurate projections. Under the current vehicle breakdown, three separate classes of light duty vehicles are considered: uncontrolled (pre-1968), controlled (1968 - 1970) and post 1970. Emission levels of the first two groups rise substantially over time due to vehicle deterioration. Yet, due to natural attrition processes, their numbers decline. The net contribution of these groups depends upon the interaction of both vehicle attrition and deterioration. Similarly, post-1970 vehicles have substantially reduced emission levels. (The emission levels for new cars are assumed to be in compliance with promulgated standards). As they enter the population and represent an increasingly large fraction, the aggregate emissions characteristics of the population will approach those of the post-1970 cars. It is this complex interaction between vehicle attrition, entrance of new cars and resultant population emission levels which is described quantitatively by VPM and which can provide a straightforward mechanism for projecting emission levels over future periods.

The following sections present detailed descriptions of the subroutines comprising VPM.

5.12.1 Subroutine PERMIL

Subroutine PERMIL is the attrition routine for VPM. PERMIL accepts as input TINT, the inspection interval, KSTART and KSTOP, the control type limits for the simulation, and NPTRN the number of power train types.

PERMIL calls the PERCNT and MILAGE subroutines which fill the PPER and PMILES arrays with the percentages and annual vehicle miles travelled of each control and power train type. PERMIL then interpolates these data to the TINT inspection interval and returns the percentage distribution of power trains and control type in TPER and annual vehicle miles travelled in TMIL. Both TPER and TMIL are referenced by inspection interval number, N. Present in Figure 5-33 is a flowchart for subroutine PERMIL. A listing of PERMIL is given in Table 5-33.

5.12.2 Subroutine PERCNT

Subroutine PERCNT simulates the vehicle age distribution over time to account for vehicle attrition and population growth. Input to PERCNT is N, the number of years since the start of the simulation. Output is PPER the vehicle age distribution by control and power train type, the J index. The main equation of PERCNT is:

$$X_{n+1}(L) = X_n(L-1) \times \frac{DIFF(L)}{DIFF(L-1)}$$

where the DIFF vector represents vehicle attrition rates and X is the vehicle age vector. For each year, PERCNT sums the appropriate entries in the X array to fill the PPER array with the percentages for uncontrolled, controlled and POST 70 vehicles.

Figure 5-34 is a complete flowchart of the PERCNT routine which pictorially describes the techniques used. Table 5-34 contains a listing.

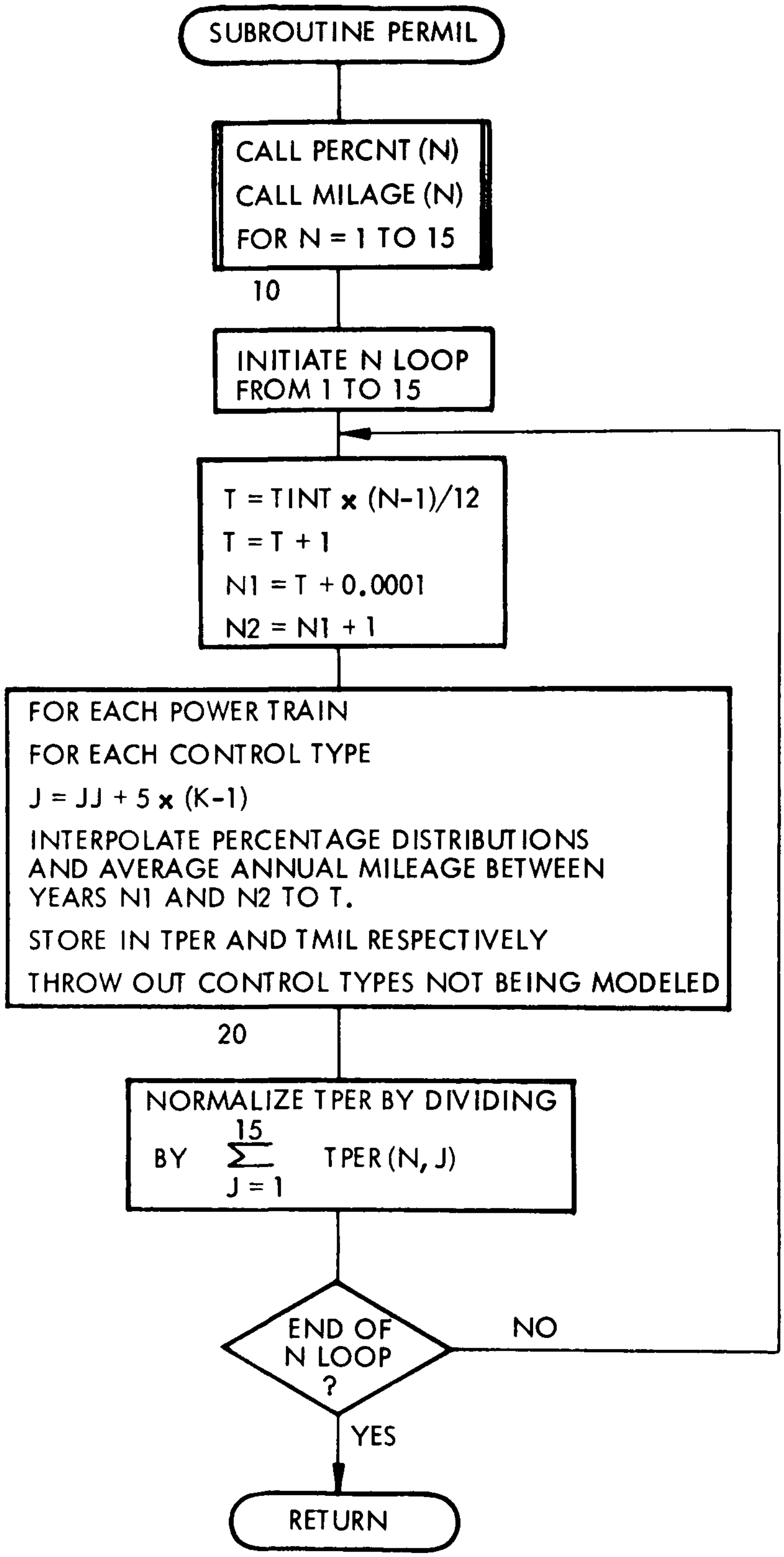


Figure 5-33 Subroutine PERMIL Flowchart

Table 5-33 SUBROUTINE PERMIL LISTING

```
      SUBROUTINE PERMIL(TPER,TMIL,TINT,KSTART,KSTOP,NPTRN)
      DIMENSION TPER(16,15),TMIL(16,15)
      COMMON /SAVE/ PPER(16,15),PMILES(16,15)
      DO 10 N=1,15
      CALL PERCNT(N)
   10 CALL MILAGE(N)
      DO 40 N=1,15
      T=TINT*(N-1)/12.
      T=T+1.
      N1=T+0.0001
      N2=N1+1
      DO 20 JJ=1,NPTRN
      DO 20 K=1,3
      J=JJ+5*(K-1)
      P=PPER(N1,J)+(PPER(N2,J)-PPER(N1,J))*(T-N1)
      TPER(N,J)=P
      IF(K.LT.KSTART.OR.K.GT.KSTOP) TPER(N,J)=0.
      XM=PMILES(N1,J)+(PMILES(N2,J)-PMILES(N1,J))*(T-N1)
      TMIL(N,J)=XM
   20 CONTINUE
      TT=0
      DO 30 K=KSTART,KSTOP
      DO 30 JJ=1,NPTRN
      J=JJ+5*(K-1)
   30 TT=TT+TPER(N,J)
      IF(TT.LT.0.0000001) TT=10.E30
      DO 40 J=1,15
      TPER(N,J)=TPER(N,J)/TT
   40 CONTINUE
      RETURN
      END
```

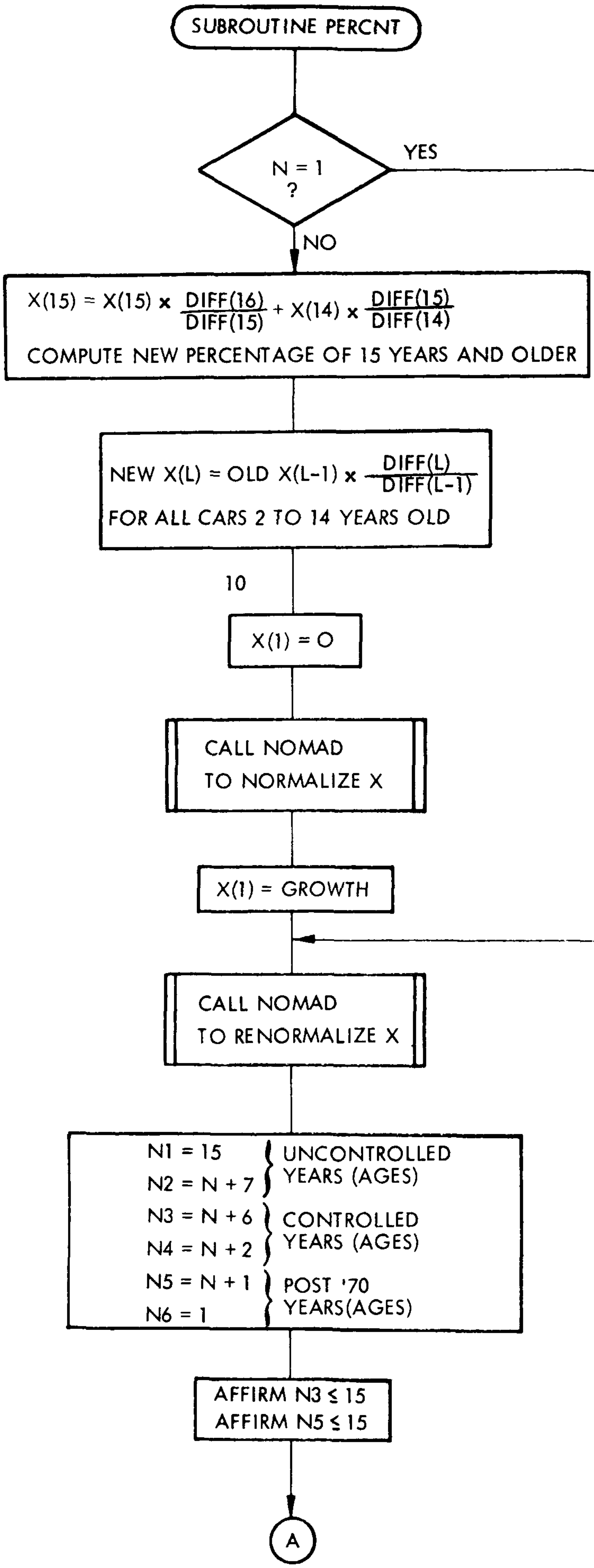


Figure 5-34 Subroutine PERCNT Flowchart

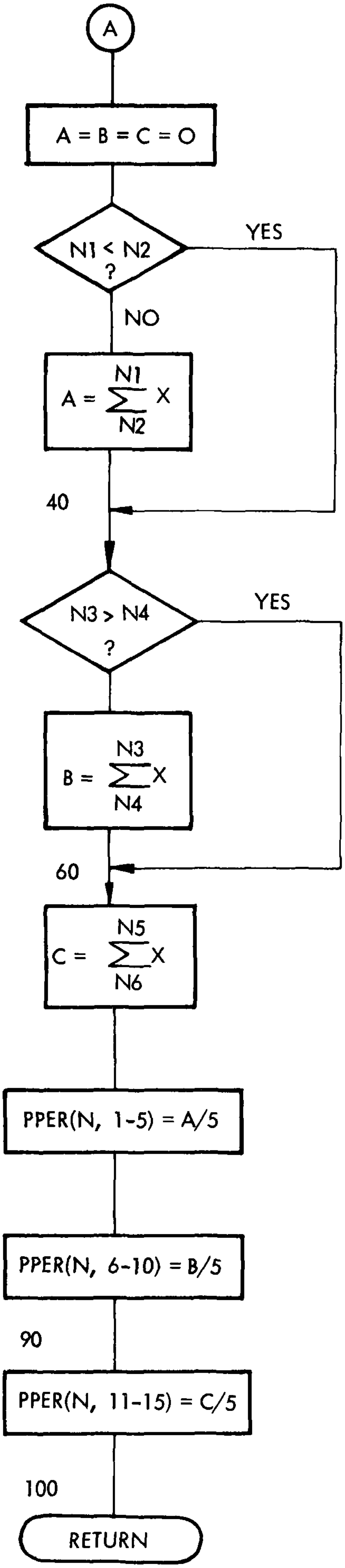


Figure 5-34 Subroutine PERCNT Flowchart (cont.)

Table 5-34 SUBROUTINE PERCNT LISTING

```
      SUBROUTINE PERCNT(N)
      COMMON /BADDOR/ X(15),ANNUAL(15)
      COMMON /SAVE/ PPER(16,15),PMILES(16,15)
      DIMENSION DIFF(16)
      DATA X/10.8,10.5,10.2,9.8,9.3,8.8,8.1,7.2,6.2,5.1,
     * 4.1,3.0,2.0,0.9,4.0/
      DATA DIFF/1.,1.,1.,.98,.96,.93,.86,.75,.61,.47,.34,
     * .25,.19,.13,.11,.08/
      DATA GROWTH/.121/
      IF(N.EQ.1) GOTO 15
      X(15)=X(15)*DIFF(16)/DIFF(15)+X(14)*DIFF(15)/DIFF(14)
      DO 10 J=2,14
      L=16-J
      M=L-1
   10 X(L)=X(M)*(DIFF(L)/DIFF(M))
      X(1)=0
      CALL NOMAD(X)
      X(1)=GROWTH
   15 CONTINUE
      CALL NOMAD(X)
      N1=15
      N2=N+7
      N3=N+6
      N4=N+2
      N5=N+1
      IF(N3.GT.15) N3=15
      IF(N5.GT.15) N5=15
      N6=1
      A=0
      B=0
      C=0
      IF(N1.LT.N2) GOTO 40
      DO 30 J=N2,N1
   30 A=A+X(J)
   40 IF(N3.LT.N4) GOTO 60
      DO 50 J=N4,N3
   50 B=B+X(J)
   60 DO 70 J=N6,N5
   70 C=C+X(J)
      DO 80 J=1,5
   80 PPER(N,J)=A/5.
```

Table 5-34 SUBROUTINE PERCNT LISTING (cont.)

```
      DO 90 J=6,10
90    PPER(N,J)=B/5.
      DO 100 J=11,15
100   PPER(N,J)=C/5.
      RETURN
      END
```

5.12.3 Subroutine NOMAD

Subroutine NOMAD is a GEEP utility routine which normalizes a population age distribution X. The fundamental equation for NOMAD is:

$$\frac{Xi}{\sum X} \longrightarrow Xi \quad \text{for each } i$$

which simply sums the X vector and divides each component by that sum. Figure 5-35 contains a flowchart of NOMAD. Table 5-35 presents a computer listing.

5.12.4 Subroutine MILAGE

Subroutine MILAGE computes the vehicle miles travelled distribution for a population at each time point in the simulation. MILAGE sums the annual vehicle miles travelled for each control and power train type (the J index) and stores the average mileage for each subfleet in the PMILES array. Input to subroutine MILAGE is the time period N. Output is the PMILES matrix which is returned through common block SAVE. Figure 5-36 contains a complete flowchart of the MILAGE routine and Table 5-36 a listing.

5.13 LINEAR PROGRAMMING MODEL

The Linear Programming Model is used for optmiizing the parameter cutpoints based on input influence coefficients and cost constraints. The model is contained in a series of four routines which solve for a set of optimal cutpoints. Basically, the process starts with a set of cutpoints and uses them to estimate the corresponding rejection fractions.

The final results of the analysis are a set of "optimal" cutpoints for the distributed parameters along with that combination of non-distributed parameters which yields the largest weighted emission reduction within the given cost constraints.

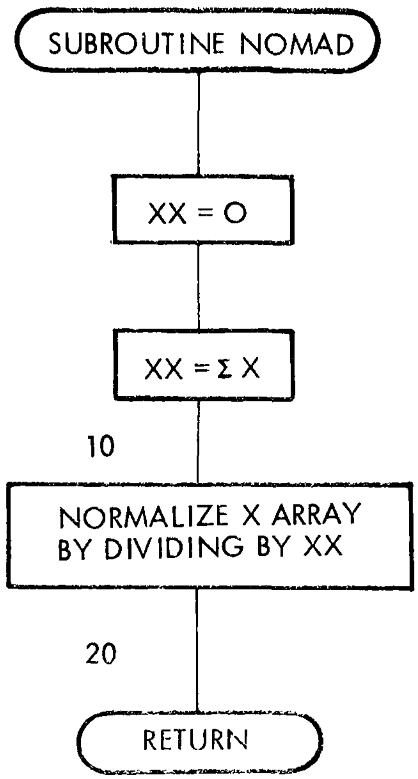


Figure 5-35 Subroutine NOMAD Flowchart

Table 5-35 SUBROUTINE NOMAD LISTING

```
      SUBROUTINE NOMAD(X)
      DIMENSION X(1)
      XX=0
      DO 10 J=1,15
   10 XX=XX+X(J)
      DO 20 J=1,15
   20 X(J)=X(J)/XX
      RETURN
      END
```

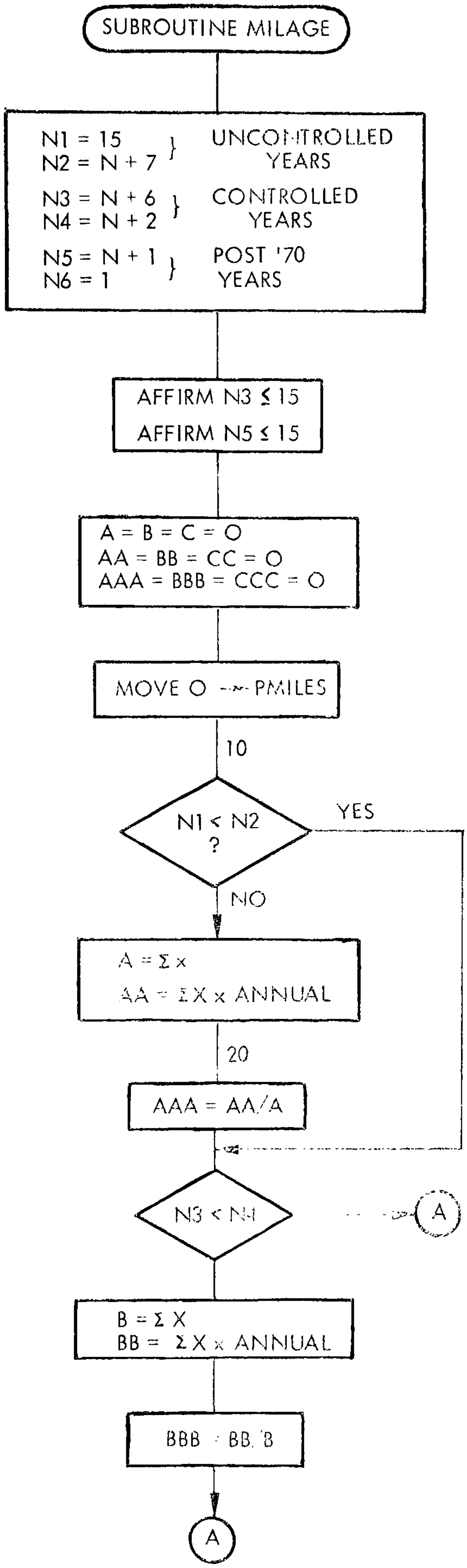


Figure 5-36 Subroutine MILAGE Flowchart

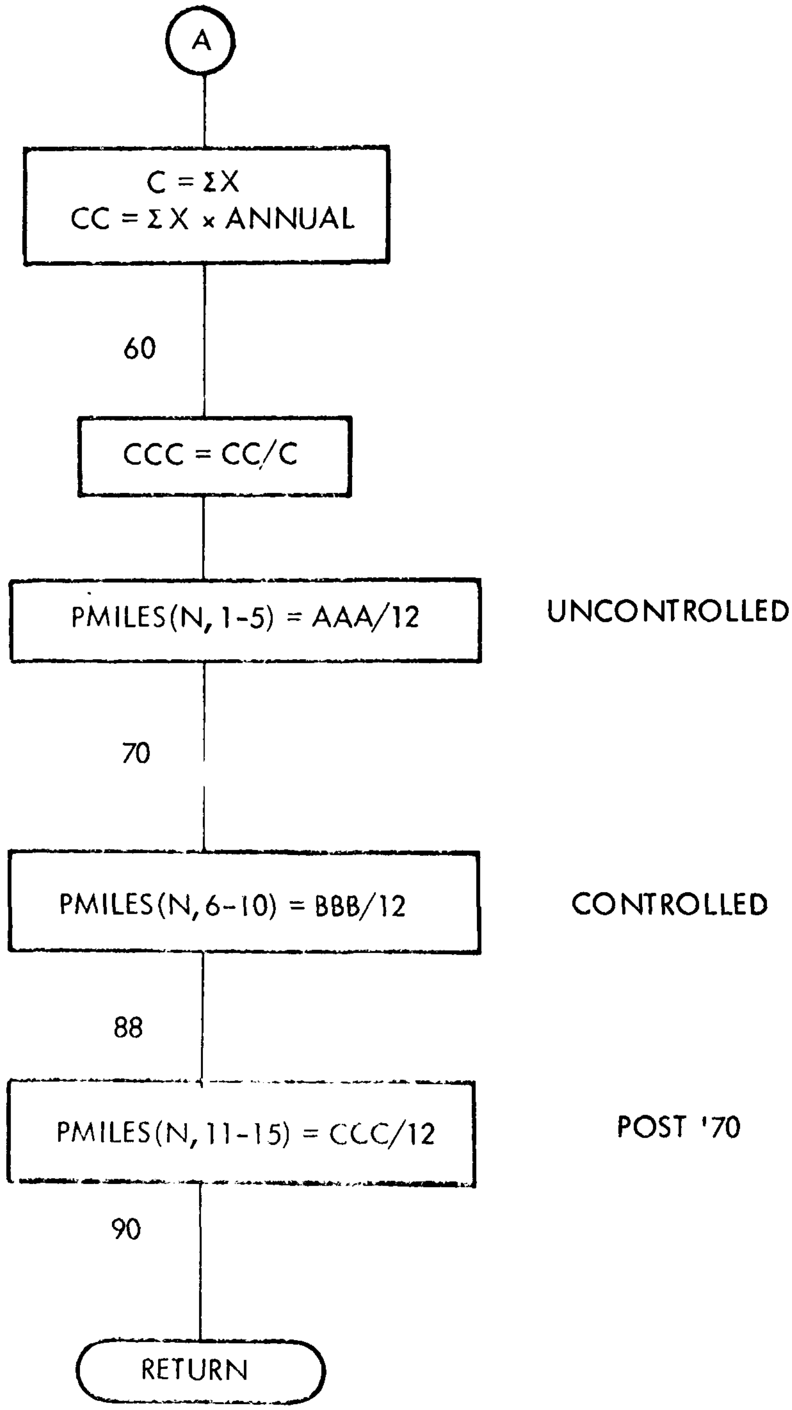


Figure 5-36 . Subroutine MILAGE Flowchart (cont.)

Table 5-36 SUBROUTINE MILAGE LISTING

```
      SUBROUTINE MILAGE(N)
      COMMON /BADDOR/ X(15),ANNUAL(15)
      COMMON /SAVE/ PPER(16,15),PMILES(16,15)
      N1=15
      N2=N+7
      N3=N+6
      N4=N+2
      N5=N+1
      N6=1
      IF(N3.GT.15) N3=15
      IF(N5.GT.15) N5=15
      A=0
      B=0
      C=0
      AA=0
      BB=0
      CC=0
      AAA=0
      BBB=0
      CCC=0
      DO 10 J=1,15
10    PMILES(N,J)=0
      IF(N1.LT.N2) GOTO 30
      DO 20 J=N2,N1
      A=A+X(J)
20    AA=AA+X(J)*ANNUAL(J)
      AAA=AA/A
30    IF(N3.LT.N4) GOTO 50
      DO 40 J=N4,N3
      B=B+X(J)
40    BB=BB+X(J)*ANNUAL(J)
      BBB=BB/B
50    DO 60 J=N6,N5
      C=C+X(J)
60    CC=CC+X(J)*ANNUAL(J)
      CCC=CC/C
      DO 70 J=1,5
70    PMILES(N,J)=AAA/12.
      DO 80 J=6,10
80    PMILES(N,J)=BBB/12.
      DO 90 J=11,15
```

Table 5-36 SUBROUTINE MILAGE LISTING (cont.)

```
   90 PMILES(N,J)=CCC/12.
      RETURN
      END
```

This iterative scheme then computes for the rejected vehicle population a set of mean value engine parameter settings. Using the basic engine parameter distributions, a systematic search is made to find the pass/fail criteria which will yield the optimal rejection fraction. In this manner, then, a linear programming algorithm can provide an approximate mechanism for determining pass/fail criteria for multi-parameter inspections.

5.13.1 Subroutine OPTMUM

Subroutine OPTMUM contains the logic for computing the optimal cutpoints for a set of engine parameters. OPTMUM sets up and solves the following linear program:

Maximize: $\sum C_i X_i$

where X_i are the distributed parameter rejection rates.

and C_i are $\sum EMW_j \times \frac{\partial E_j}{\partial P_i}$

Subject to:

$X_i \geq 0$ for i = 1 to 6

$X_i \leq b_i$ for i = 1 to 6 — where b_i is the rejection fraction based on a minimum deviation cutpoint.

$\sum A_{7i} X_i \leq COST$ — where A_{7i} is the cost of parameter maintenance and COST is the input cost constraint (adjusted for non-distributed parameter cost).

$\sum A_{ji} Xi \geq GOALS\ (j)$ — for j=1 to 3 (emission species) GOALS are the minimum percentage reductions and A_{ji} are $\frac{\partial E_j}{\partial P}$ in percent.

$\sum PS_i X_i \leq 1.05 \times P^*$

$\sum PS_i X_i \geq 0.95 \times P^*$

where P* is the input constant rejection rate and PS are the "union of X_i" coefficients from subroutine PXCOEF.

The linear program is solved sixteen times, once for each possible combination of non-distributed parameters. An array of possible combinations of the four non-distributed parameters is stored in the vector ITRYS and for each of the sixteen entries the linear programming loop is executed. OPTMUM then finds that combination of non-distributed parameters which yields the maximum emission reduction within the given cost constraints. That optimal solution along with the resulting cutpoints is returned in the TDIST and XCUT arrays, both of which are contained in the common blocks. OPTMUM outputs miscellaneous debugging information when the LDEBUG flag is set to YES. Figure 5-37 contains a flowchart of OPTMUM and Table 5-37 a listing.

5.13.2 Subroutine CUTPNT

Subroutine CUTPNT performs the final setup operations prior to optimizing the parameter cutpoints. Subroutine CUTPNT, which is called from OPTMUM, initializes the various arrays containing constraints coefficients, constraints and utility functions for use by LPAX, the linear programming algorithm. CUTPNT determines an optimal set of cutpoints by iterating on the rejection fractions for each parameter. Final output from CUTPNT consists of the converged cutpoints in the XCUT matrix and the optimal value of the corresponding utility function. Figure 5-38 details exactly the techniques and algorithms used for setting up the linear optimization program. Table 5-38 contains a complete listing.

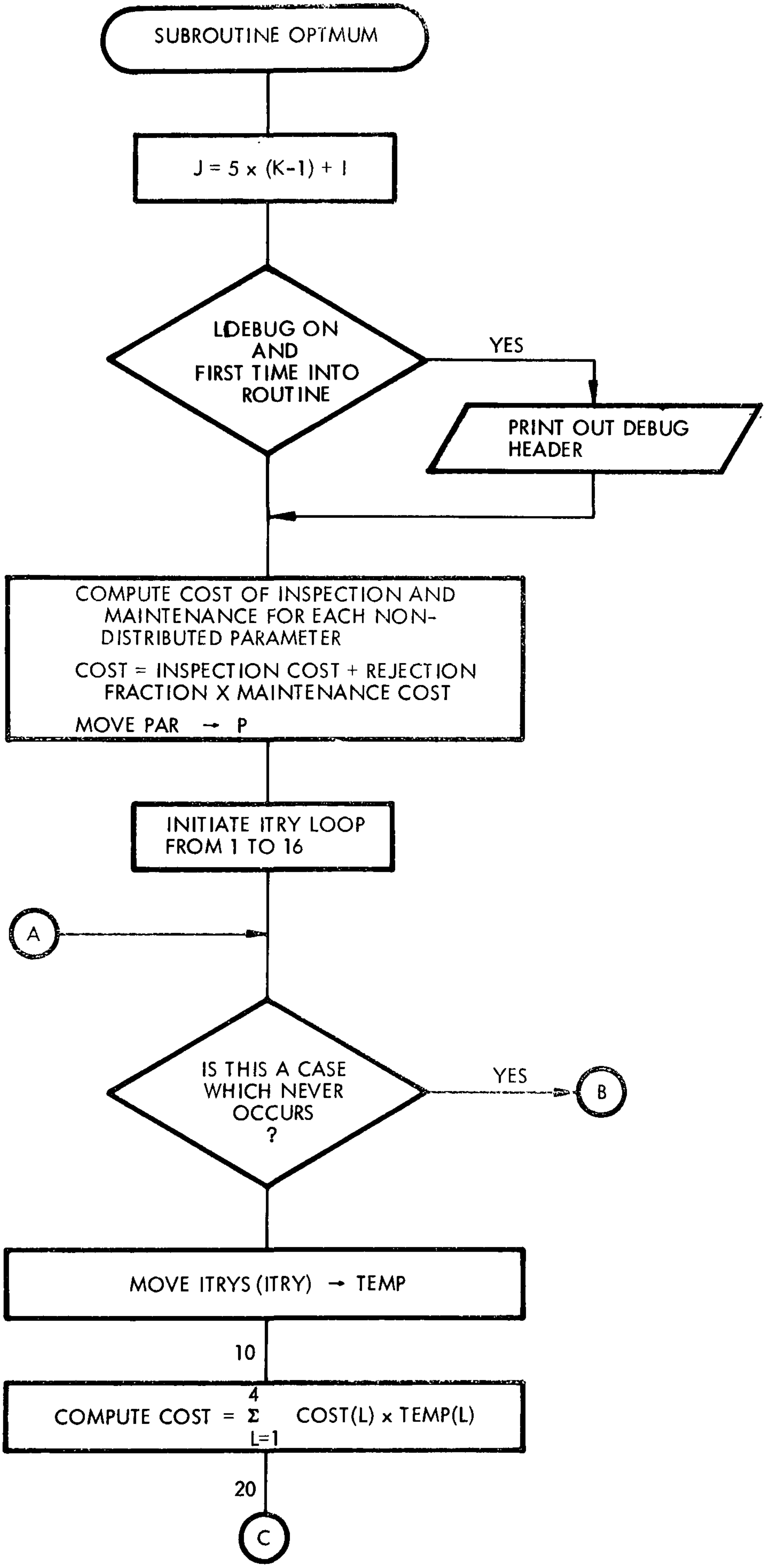


Figure 5-37 Subroutine OPTMUM Flowchart

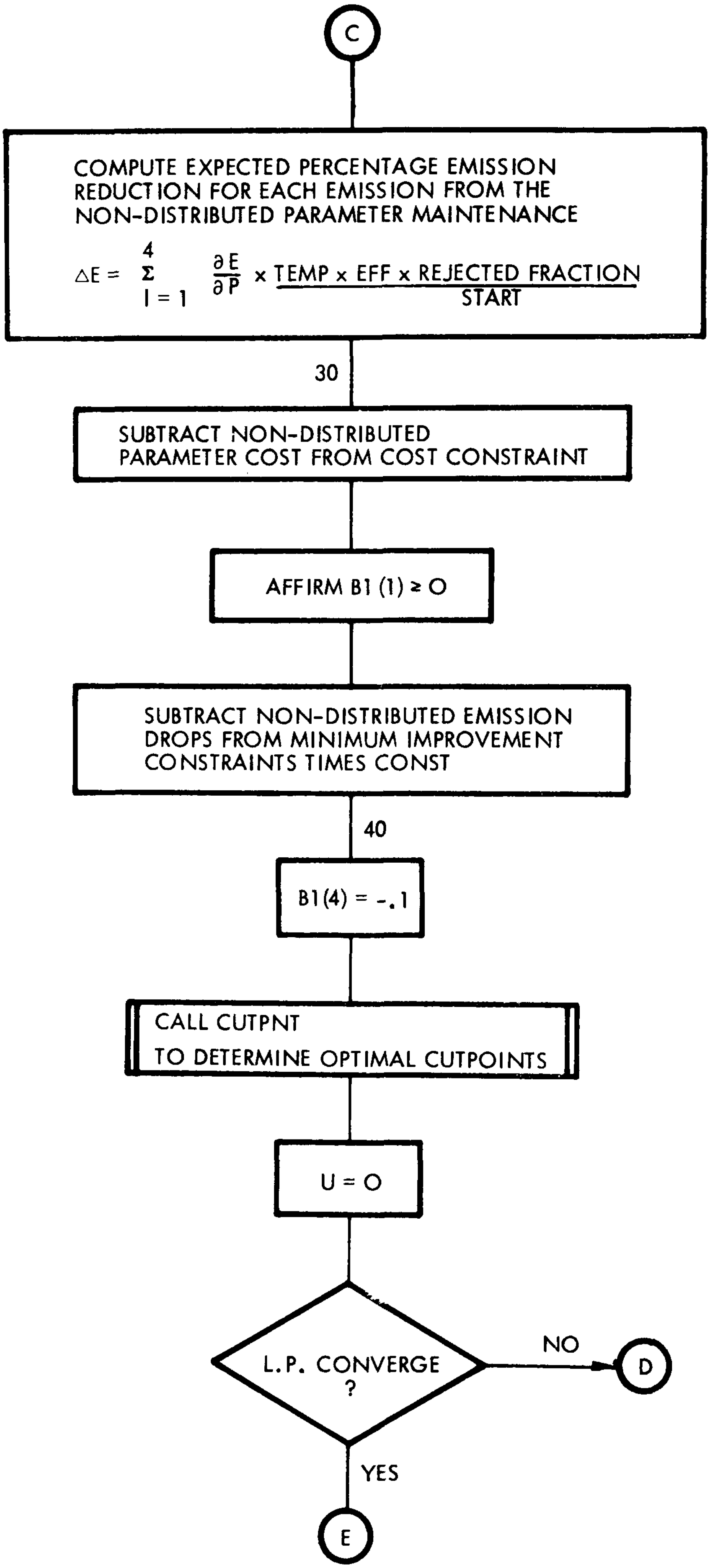


Figure 5-37 Subroutine OPTMUM Flowchart (cont.)

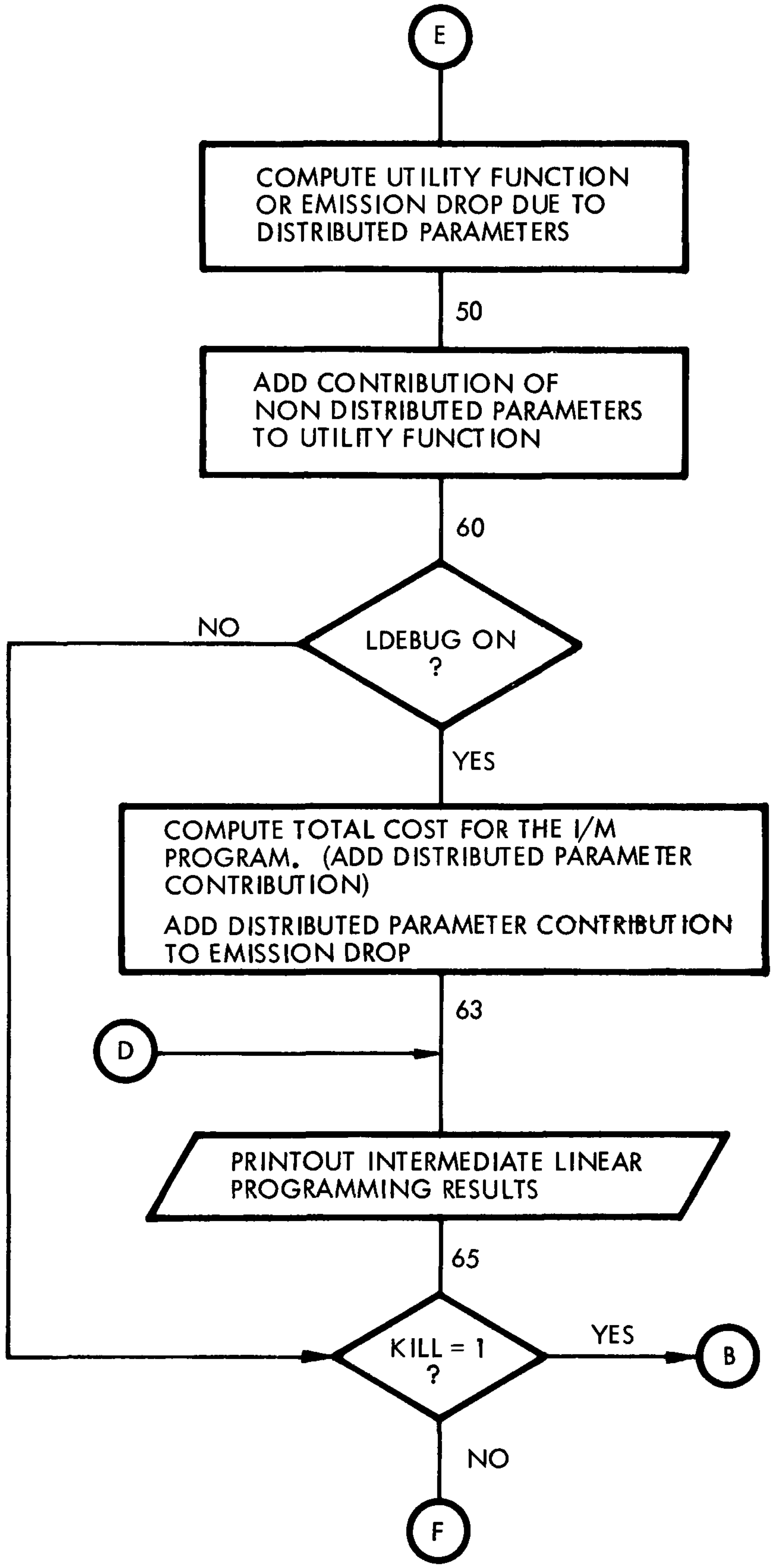


Figure 5-37 Subroutine OPTMUM Flowchart (cont.)

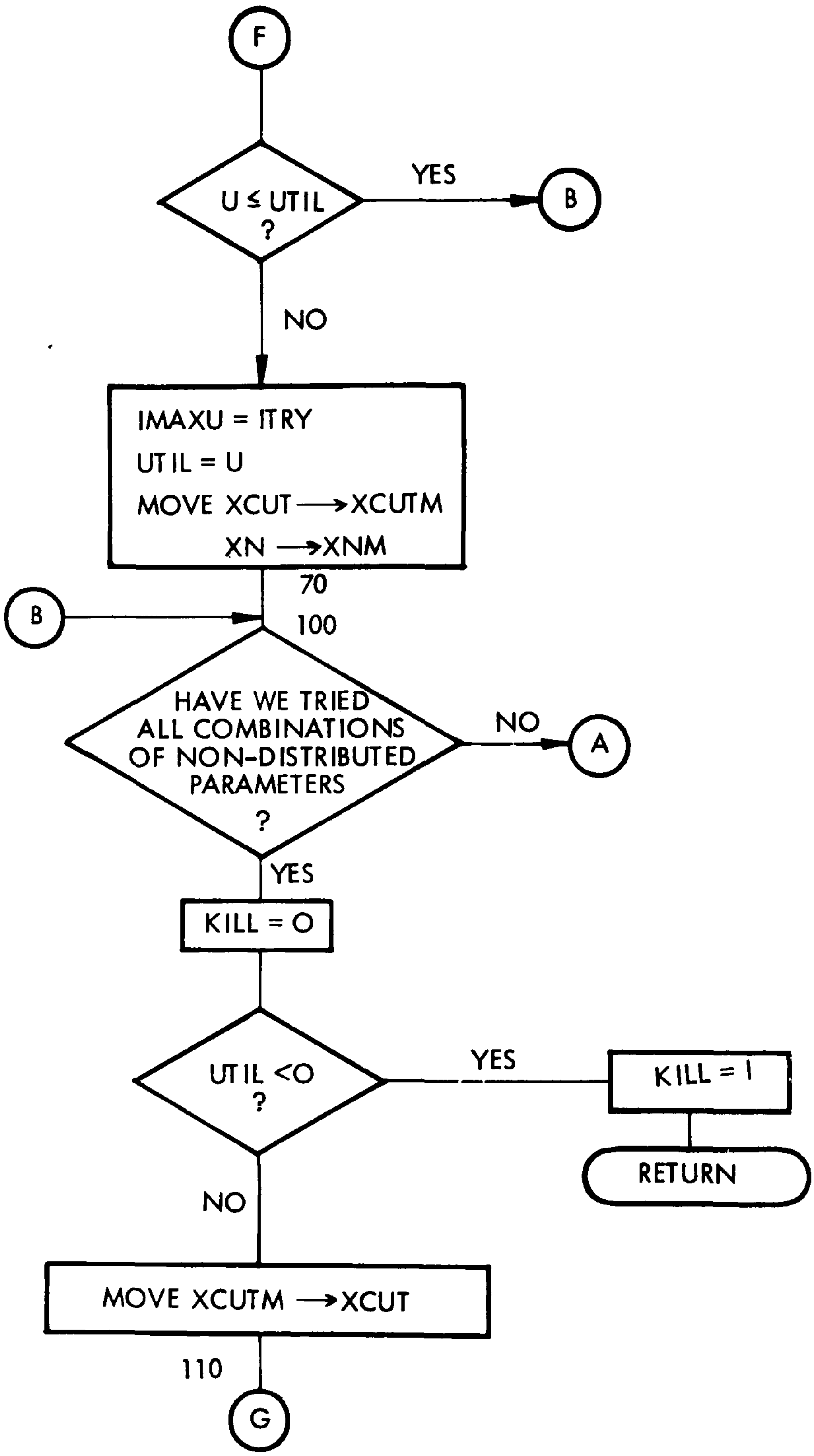


Figure 5-37 Subroutine OPTMUM Flowchart (cont.)

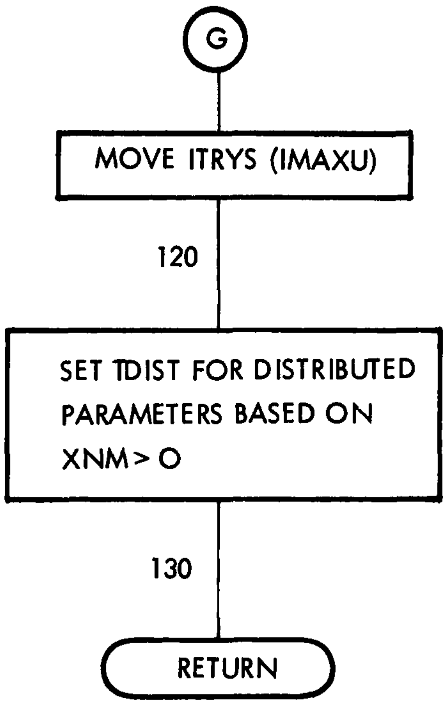


Figure 5-37 Subroutine OPTMUM Flowchart (cont.)

Table 5-37 SUBROUTINE OPTMUM LISTING

```
      SUBROUTINE OPTMUM(K,KILL,N,CONST)
      DIMENSICN BSAVE(4,3),B1(4),COST(4),LCODE(4),ITRYS(16,4)
      DIMENSION DROP(3),P(4,3),TEMP(4)
      DIMENSICN XCUTM(10),XNM(10)
      DIMENSION XN(6),C(6),NCODE(6),A(15,15)
       COMMON /COM01/ AMB(3),ALAB,     AVV,  BINT,
     +   BAREA(3), BLD1,      BLD2,     BSIG(3),  BXTRA,     BSIZE,
     +   BHIST(3,16),         BMMI(10,15,3),
     +   ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
       COMMON /COM02/         CARA,     CARIY,     CARMY,     CARPOP(16),
     +   CARSY,    CBSUM,     CCOEF(10),CCOSTI,    CCOSTM,    CGTT,
     +   CINCON,   CPCB,  CPI,        CPVPY,     CSUM,      CARAY,
     +   CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
     +   CPART(10,15)
CC ADD2
       COMMON /COM03/         DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),      EP(10,15),EFF(10),  DELIT(3),
     +   FREQA,    FREQB,     FPERC(10,3),
     +   HORZN,    HORZNY,
     +   HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
     +   HPS(6,15,16),        HPT(5,16),           HPTOT(16),
     +   HPTOTS(16)
CC ADD3
       COMMON /COM04/         ITE,      ITL,       ITP,       ITIME(16),
     +   KSTART,   KSTOP,     LOPT, LPICK(10),LLPICK,
     +   LIDLE,    LINT(16),  LPSPP(10),LSTART,    LSTOP,
     +   MBASE,    MPH,       MSPEC(10),MSTART,    MSTOP,
     +   MU(10,3),   MMS(10,15),        MVPR(10,15)
CC ADD4
       COMMON /COM05/         NAME(50), NCNTR,     NEMIS,     NEMP,
     +   NINTR,    NINTRB,    NMODE,    NO,        NOPTS,     NPAR,
     +   NPTRN,    NPTS,      NSTEPS,   NTR,       NTRB,      NPICK(16),
     +   OCIY,     OCMY,      OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
       COMMON /COM06/PARM(3,3), PART,     PAYNEW,   PAYOFF(3),
     +   PC(15),   PCS(15),   PHI(14),  PLO(14),   PLTMAX(3),PMODEL,
     +   PP(10,15),PS(6,15),  PT(5),    PTOT,      PTS(5),   PAYADJ,
     +   PAR(10,15,3),        PAR1(10,3,3),        PLUS(10,15),
     +   PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +   PSA(15),  PTA(5),    PCONF,    PARINT(10,10,9)
     + ,PAYFIN
```

Table 5-37 SUBROUTINE OPTMUM LISTING (cont.)

```
      COMMON /COM07/          REINSP,   RNAME,    RSIZE,    RSTOP,
     +    RTYPE,
     +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
     +    SMODEL,   START(15,3), STAT,    STIME(3), SUMBM(3),
     +    SCALEBM(3),         SM(6,15),           SPAR(10,15,6),
     +    SXCUT(6,3),         SIG(10,3),            SIGCE(3),
     +    SIGME(10),          SIGMNE(10),         SIGP(10,15),
     +    SIGRATE,  SIST,       SIGS(6,15),         SIGSDE(3),
     +    STABLEX(33,6,15),     STABLEY(33,6,15)
      COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TUNX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,      TSIG(3),  TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),      THISTT(3,16),       TIMEC(10,15),
     +    TIMEM(10,15),       TABLEX(33,10,15),     TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/          WF(10),
     +    X1BP(3,3,6), XINT,     XINTB,    XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/          Y1BP(3,3,10),       Y2BP(3,3,10),
     +    YES,      YSUM,     YTM(16),     Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,       Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,       Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,      Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,    ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,   PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL                ITE,      ITL,      ITP,      ITIME,
     +    MMS,      MPH,      MSPEC,    MU,       MVPR,
     +    NAME,     NO,       LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER             RNAME,    SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,    OPTI,     PPICK,    PPPICK
     DATA ITRYS/8*0,8*1,4*0,4*1,4*0,4*1,2*0,2*1,2*0,2*1,
     + 2*0,2*1,2*0,2*1,0,1,0,1,0,1,0,1,0,1,0,1,0,1,0,1/
     DATA LCODE/4,5,6,10/
     DATA BSAVE/10.,.03,.03,0.,15.,.10,.03,0.,20.,.10,.05,0./
     DATA NCODE/1,2,3,7,8,9/
     J=5*(K-1)+1
```

Table 5-37 SUBROUTINE OPTMUM LISTING (cont.)

```
      IF(LDEBUG.EQ.YES.AND.CONST.GT.0.99) WRITE(6,1000) K
      DO 5 L=1,4
      LL=LCODE(L)
      COST(L)=Z2*TIMEC(LL,J)+AREA(0,LL,J,K,N)*(Z2*TIMEM(LL,J)+
     * CPART(LL))
      DO 5 I=1,3
    5 P(L,I)=PAR(LL,J,I)
      UTIL=-100.
      IMAXU=0
      DO 100 ITRY=1,16
C:
C:       SET UP FOR THIS TRY AT AN UPTIMUM PARAMETERS 4,5,6
C:       AND 10 COMBINATION.
      IF(K.EQ.1.AND.ITRYS(ITRY,2)+ITRYS(ITRY,3).GE.1)GO TO 100
      IF(K.EQ.2.AND.ITRYS(ITRY,2).EQ.1) GO TO 100
      IF(K.EQ.3.AND.ITRYS(ITRY,3).EQ.1) GO TO 100
      DO 10 L=1,4
   10 TEMP(L)=ITRYS(ITRY,L)
C:
C:       COMPUTE COSTS
C:
      CC=0.
      DO 20 L=1,4
   20 CC=CC+COST(L)*TEMP(L)
C:
C:       COMPUTE EMISSION REDUCTION PERCENTAGES.
C:
      DO 30 I=1,3
      DROP(I)=0.
      DO 30 L=1,4
      LL=LCODE(L)
   30 DROP(I)=DROP(I)+P(L,I)*TEMP(L)*EFF(LL)/START(J,I)
     + *AREA(0,LL,J,K,N)
C:
C:       SUBTRACT C FROM COST CONSTRAINT.
C:
      B1(1)=BSAVE(1,OPTI)-CC
      IF(B1(1).LT.0.) B1(1)=0.
C:
C:       SUBTRACT DELTA EMISSIONS FROM CONSTRAINT
C:
      DO 40 I=1,3
```

Table 5-37 SUBROUTINE OPTMUM LISTING (cont.)

```
                  M=I+1
                  B1(M)=BSAVE(M,OPTI)*CONST-DROP(I)
            40    CONTINUE
                  B1(4)=-.1
      C:
      C:             CALL LINPRO
      C:
                  CALL CUTPNT(K,KILL,B1,C,XN,NCODE,N,A)
      C:
      C:             COMPUTE UTILITY FUNCTION
      C:
                  U=0.
                  IF(KILL.EQ.1) GOTO 63
                  DO 50 M=1,6
            50    U=U-XN(M)*C(M)
                  DO 60 I=1,3
            60    U=U+EMW(I)*DROP(I)*START(J,I)
      C:
      C:             MAXIMIZE THE UTILITY FUNCTION
      C:
                  IF(LDEBUG.NE.YES) GOTO 65
                  DO 62 M=1,6
                  CC=CC+A(7,M)*XN(M)
                  DO 62 I=1,3
                  II=I+7
            62    DROP(I)=DROP(I)-A(II,M)*XN(M)
            63     WRITE(6,1010) (ITRYS(ITRY,L),L=1,4),
                 + XN,CC,
                 + (DROP(I),I=1,3),U
            65     IF(KILL.EQ.1) GOTO 100
                   IF(U.LE.UTIL) GOTO 100
                   IMAXU=ITRY
                   UTIL=U
      C:
      C:             SAVE CUTPOINTS
      C:
                  DO 70 M=1,10
                  XCUTM(M)=XCUT(M,K)
            70    XNM(M)=XN(M)
      C:
      C:             SET UP OPTIMAL CASE AND RETURN.
```

Table 5-37 SUBROUTINE OPTMUM LISTING (cont)

```
C:          SET KILL=1 IF NO CASES WORKES
C:
  100  CONTINUE
       KILL=0
       IF(UTIL.LT.-5.) KILL=1
       IF(UTIL.LT.-5.) RETURN
C:
C:          MOVE BACK OPTIMAL CUTPOINTS
C:
       DO 110 M=1,10
  110  XCUT(M,K)=XCUTM(M)
C:
C:          FILL TDIST ARRAY
C:
       DO 120 L=1,4
       LL=LCODE(L)
  120  TDIST(LL,K)=ITRYS(IMAXU,L)
       DO 130 M=1,6
       MM=NCODE(M)
       TDIST(MM,K)=0
       IF(XNM(M).GT.1.E-5) TDIST(MM,K)=1
  130  CONTINUE
       RETURN
 1000  FORMAT(1H1,/40X,*CUTPOINT ANALYSIS (K=*,I2,*)*,//,
     + 62X,*DISCRETE PARAMETER*,/,
     + 20X,*PARAMETER REJECTION RATES*,13X,*I/M      EMISSION DELTA*,
     + *       WEIGHTED*,/,*  4 5  6 10     1*,7X,*2*,7X,*3*,7X,
     + *7*,7X,*8*,7X,*9   COSTS         PERCENT        EMISSION*
     +, /,69X,*HC     CO     NO    DROP*//)
 1010  FORMAT(1X,4I2,6F8.2,F6.2,1X,3F7.4,F7.4,/)
       END
```

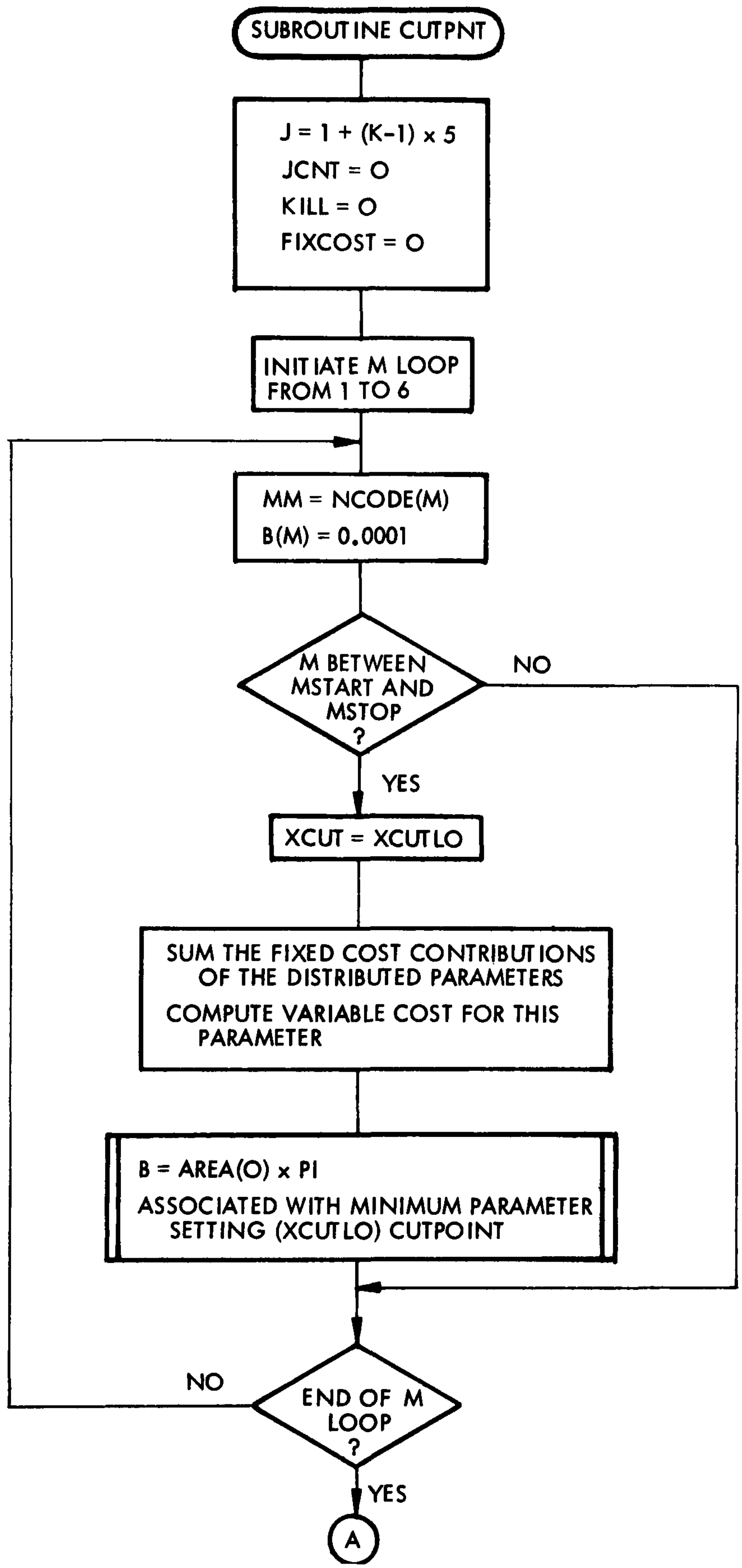


Figure 5-38 Subroutine CUTPNT Flowchart

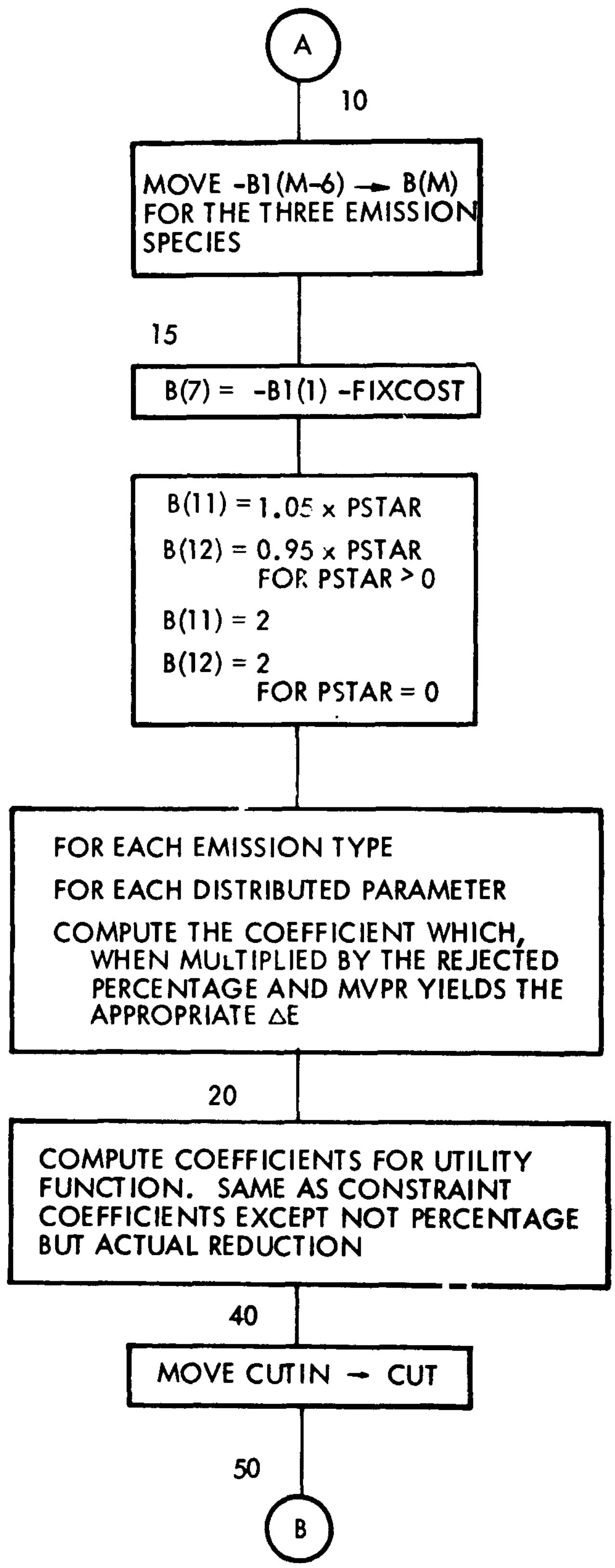


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

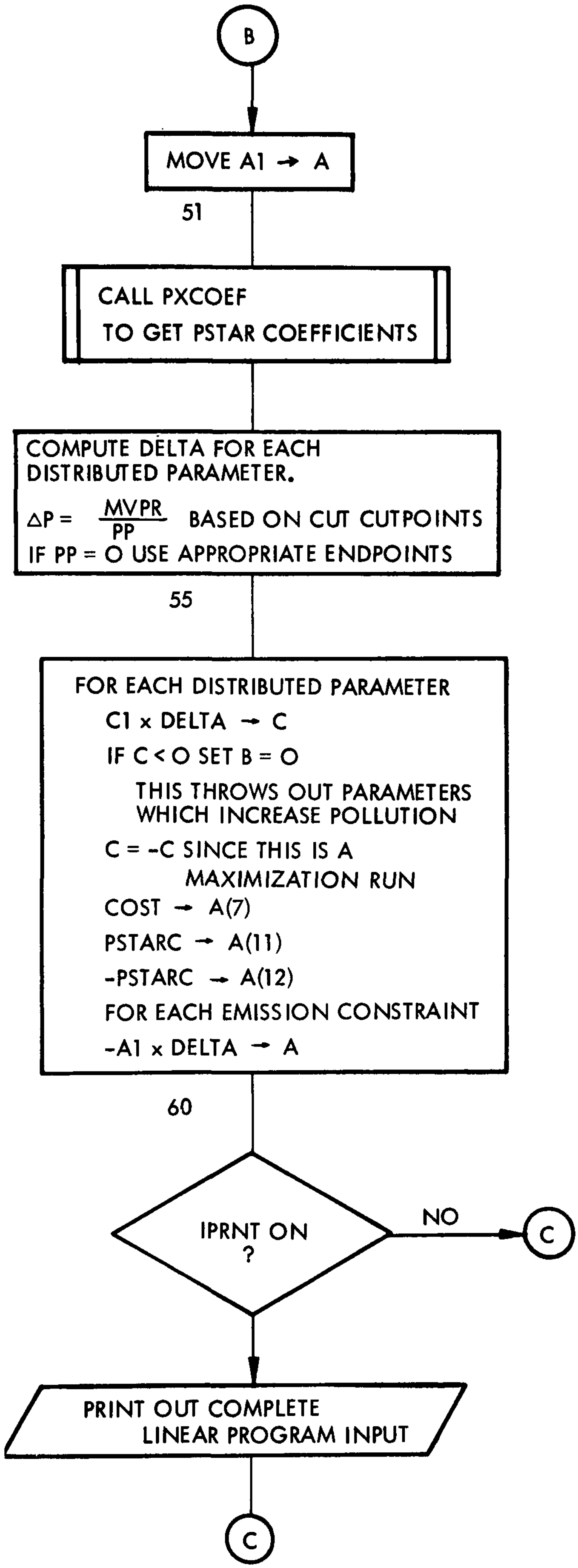


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

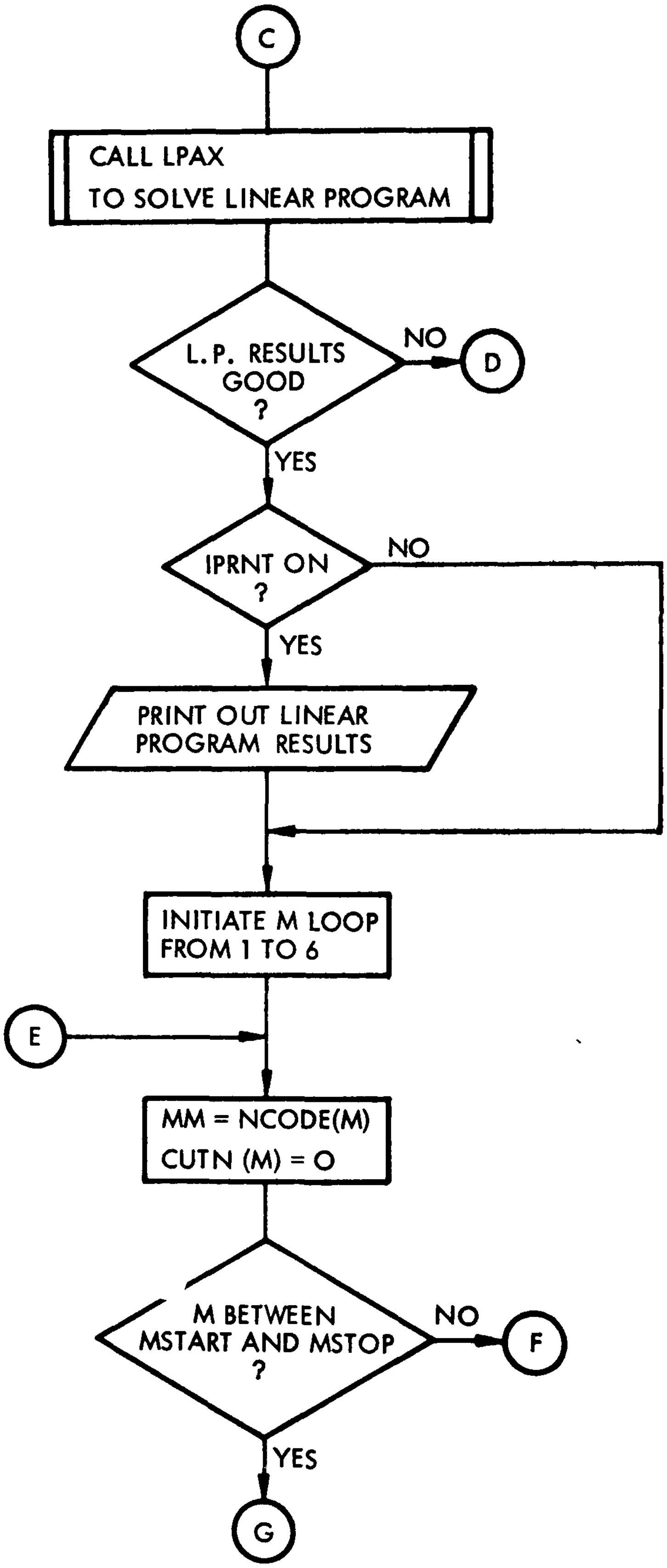


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

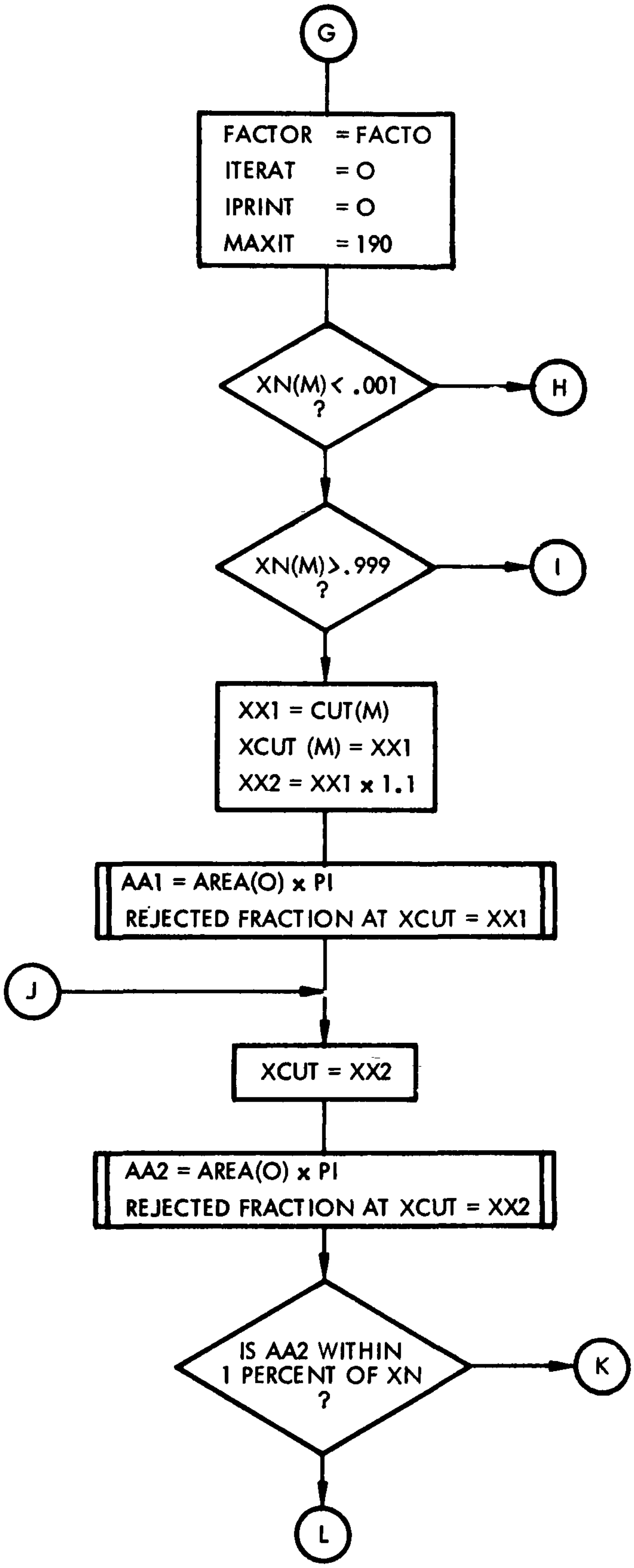


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

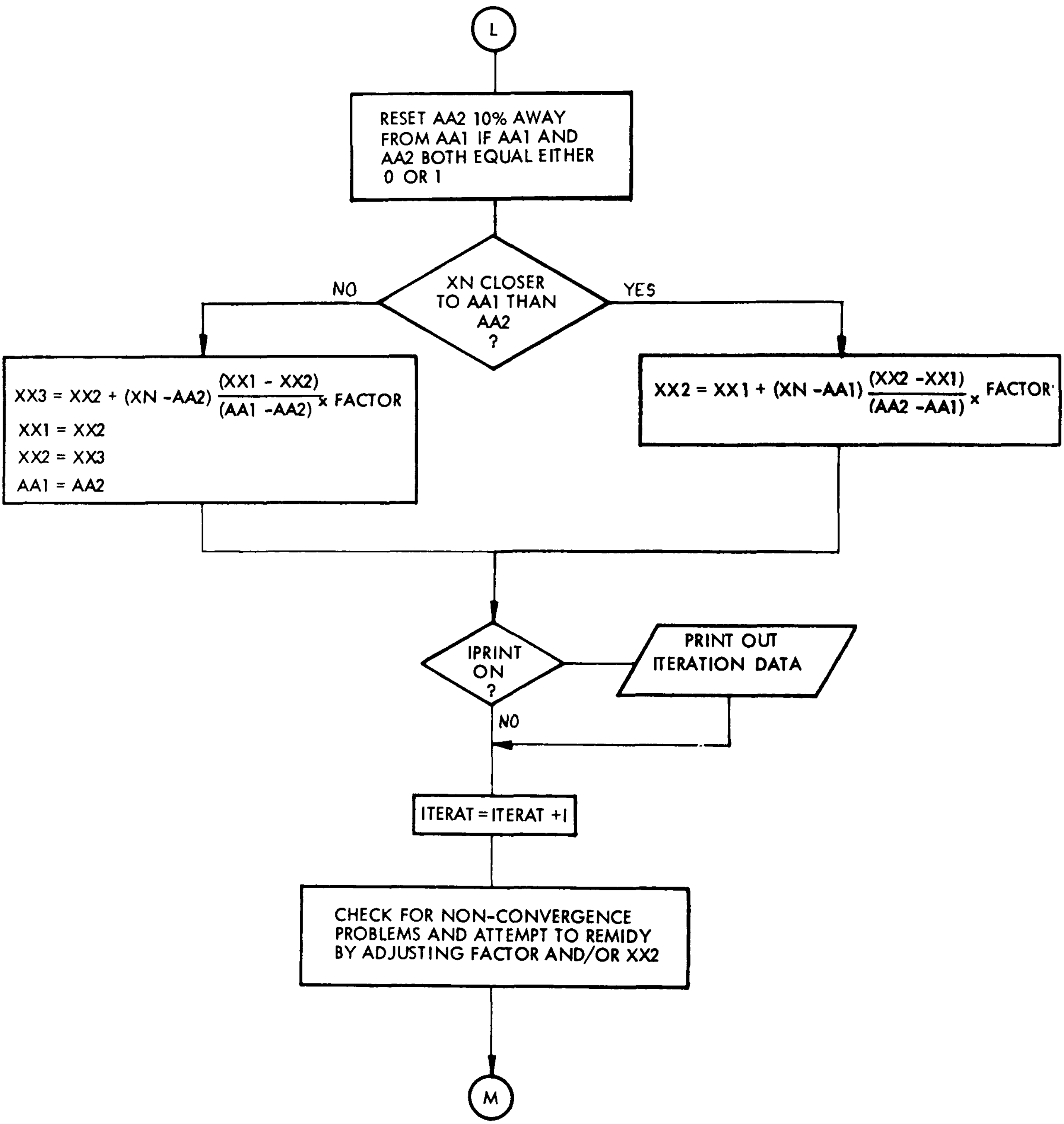
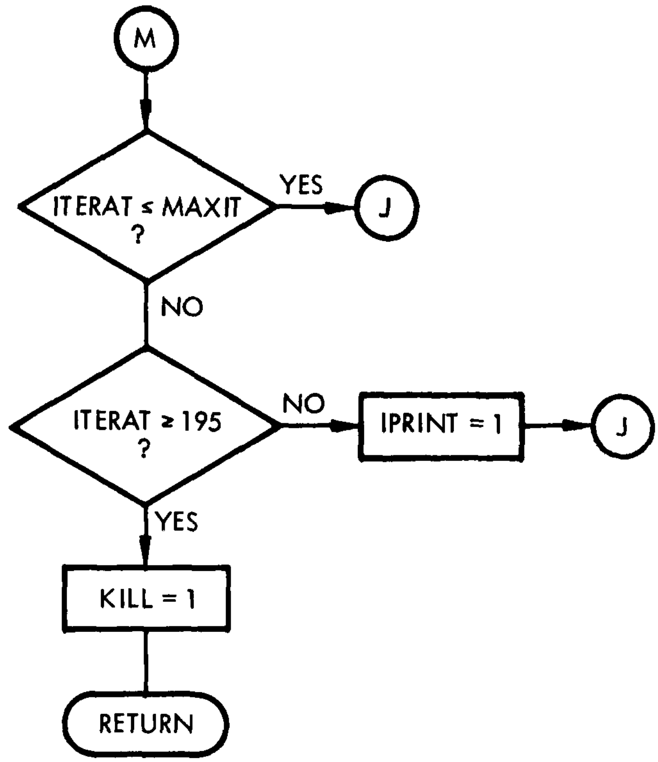


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)



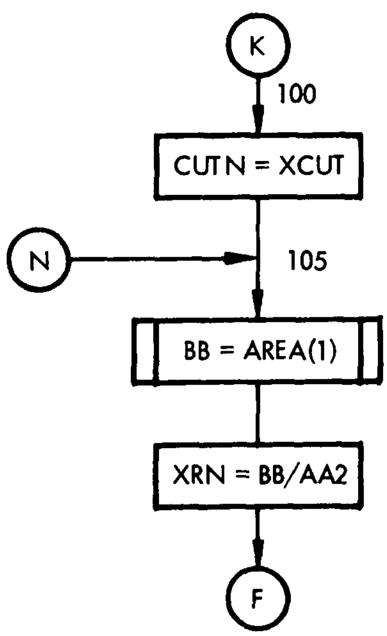


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

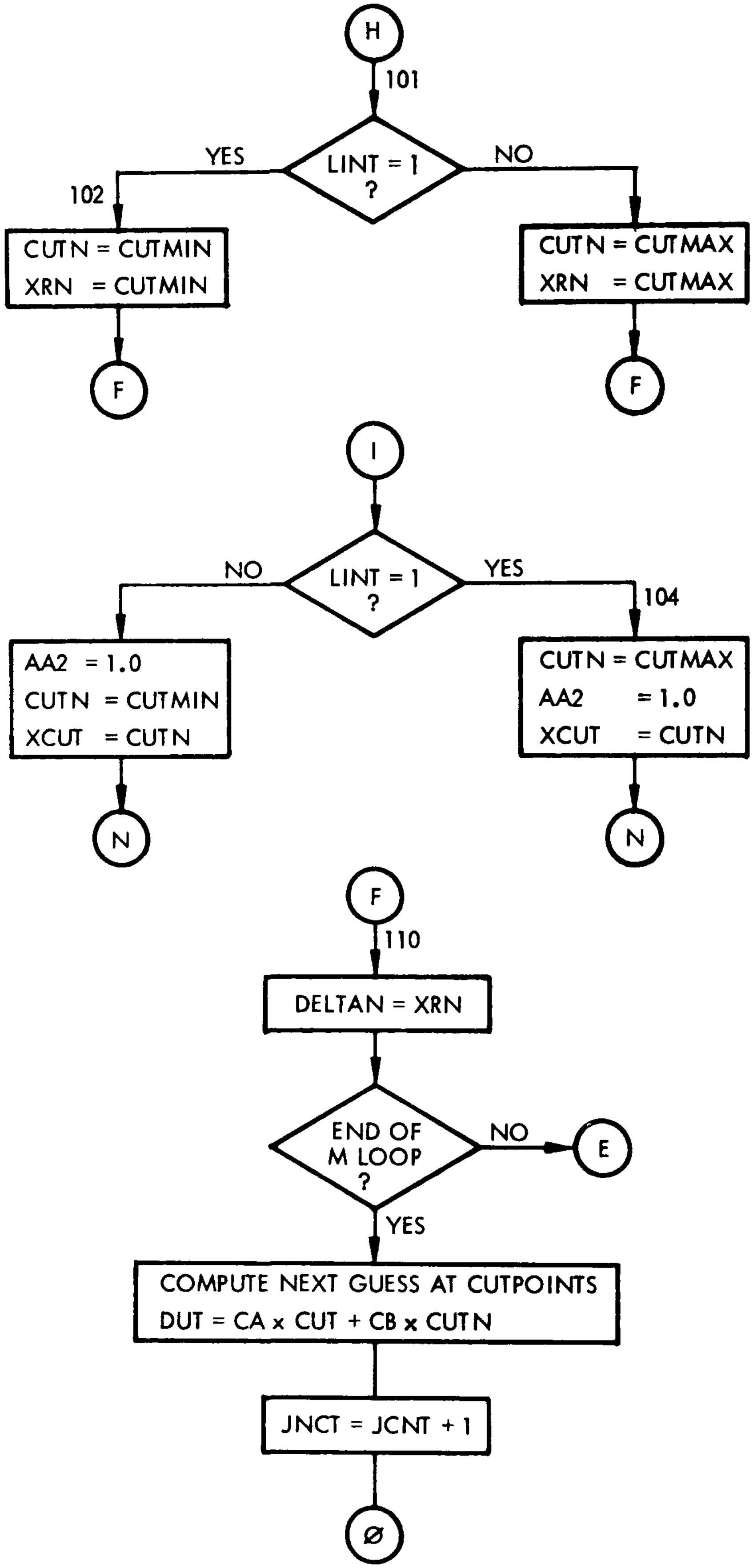


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

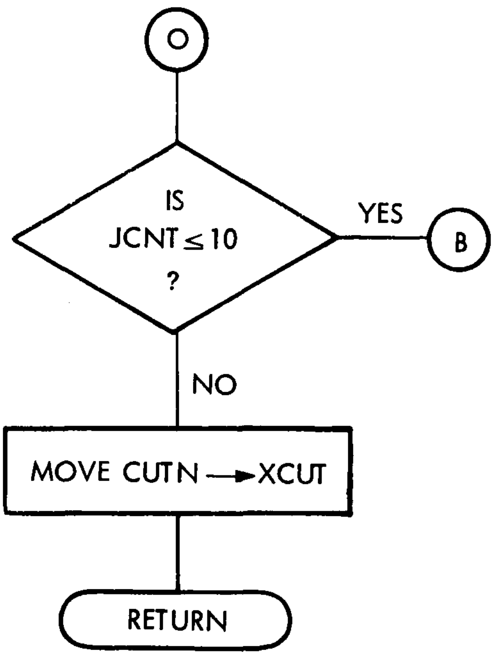


Figure 5-38 Subroutine CUTPNT Flowchart (cont.)

Table 5-38 SUBROUTINE CUTPNT LISTING

```
      SUBROUTINE CUTPNT(K,KILL,BI,C,XN,NCODE,N,A)
C:
C:       THIS ROUTINE USES A LINEAR PROGRAMMING PACKAGE
C:       (LINPRO) TO PRODUCE THE OPTIMAL PARAMETER
C:       CUTPOINTS.
C:
      COMMON /COM01/ AMB(3),ALAB,      AVV,  BINT,
     +   BAREA(3), BLD1,     BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +   BHIST(3,16),        BMMI(10,15,3),
     +   ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
      COMMON /COM02/           CARA,     CARIY,    CARMY,    CARPOP(16),
     +   CARSY,    CBSUM,    CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +   CINCON,   CPCB,  CPI,       CPVPY,    CSUM,     CARAY,
     +   CN(15,3,16),        COEFB(15,3),        COEFBP(10,15),
     +   CPART(10,15)
CC ADD2
      COMMON /COM03/           DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),  DELIT(3),
     +   FREQA,    FREQB,    FPERC(10,3),
     +   HORZN,    HORZNY,
     +   HPC(15,16),         HPCS(15,16),        HPP(10,15,16),
     +   HPS(6,15,16),       HPT(5,16),          HPTOT(16),
     +   HPTOTS(16)
CC ADD3
      COMMON /COM04/           ITE,      ITL,      ITP,      ITIME(16),
     +   KSTART,   KSTOP,    LOPT, LPICK(10),LLPICK,
     +   LIDLE,    LINT(16), LPSPP(10),LSTART,   LSTOP,
     +   MBASE,    MPH,      MSPEC(10),MSTART,   MSTOP,
     +   MU(10,3),   MMS(10,15),         MVPR(10,15)
CC ADD4
      COMMON /COM05/           NAME(50), NCNTR,    NEMIS,    NEMP,
     +   NINTR,    NINTRB,   NMODE,    NO,       NOPTS,    NPAR,
     +   NPTRN,    NPTS,     NSTEPS,   NTR,      NTRB,     NPICK(16),
     +   OCIY,     OCMY,     OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
      COMMON /COM06/PARM(3,3), PART,      PAYNEW,   PAYOFF(3),
     +   PC(15),   PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +   PP(10,15),PS(6,15), PT(5),    PTOT,     PTS(5),   PAYADJ,
     +   PAR(10,15,3),       PAR1(10,3,3),       PLUS(10,15),
     +   PM(10,15),          PPICK(10),PPPICK,PSTAR,PI(15,10),
     +   PSA(15),  PTA(5),   PCONF,    PARINT(10,10,9)
```

```
     + ,PAYFIN
       COMMON /COM07/          REINSP,   RNAME,    RSIZE,    RSTOP,
     +    RTYPE,
     +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
     +    SMODEL,   START(15,3), STAT,     STIME(3),
     +    SCALEBM(3),         SM(6,15),           SPAR(10,15,6),
     +    SXCUT(6,3),         SIG(10,3),            SIGCE(3),
     +    SIGME(10),          SIGMNE(10),         SIGP(10,15),
     +    SIGRATE,  SIST,      SIGS(6,15),          SIGSDE(3),
     +    STABLEX(33,6,15),    STABLEY(33,6,15)
       COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TONX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),      THISTT(3,16),       TIMEC(10,15),
     +    TIMEM(10,15),       TABLEX(33,10,15),    TABLEY(33,10,15)
CC ACC10
       COMMON /COM11/          WF(10),
     +    X1BP(3,3,6), XINT,     XINTB,    XLANE,    XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ACC11
       COMMON /COM12/          Y1BP(3,3,10),       Y2BP(3,3,10),
     +    YES,      YSUM,     YTM(16),  Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,       Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,       Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,      Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,    ZIC,      ZSUM,
     +    ZZ(3,3)
CC ACC12
       COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,   PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ACCD
       REAL           ITE,      ITL,      ITP,      ITIME,
     +    MMS,      MPH,         MU,       MVPR,
     +    NAME,     NC,       LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
       INTEGER        RNAME,    SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,    CPTI,     PPICK,    PPPICK
      DIMENSION CUT(6),X(6),XR(6),A(15,15),XRN(6),B(12),C(6),
     * C1(6),A1(10,6),DELTA(6),CUTN(6),DELTAN(6),XN(6),
     * CUM(60),NCODE(6),B1(4),XCUTLO(6),PSTARC(6)
      DIMENSION CUTMAX(6),CUTMIN(6)
      DIMENSION CUTIN(10),COST(6)
```

```
      DATA CUTMIN/-8.,-999.,-10.,-10.,-10.,-1./
      DATA CUTMAX/10.,999.,10.,5.,180.,1./
      DATA CA,CB/.7,.3/
      DATA A1/1.,0.,0.,0.,0.,0.,0.,0.,0.,0.,
     * 0.,1.,0.,0.,0.,0.,0.,0.,0.,0.,
     * 0.,0.,1.,0.,0.,0.,0.,0.,0.,0.,
     * 0.,0.,0.,1.,0.,0.,0.,0.,0.,0.,
     * 0.,0.,0.,0.,1.,0.,0.,0.,0.,0.,
     * 0.,0.,0.,0.,0.,1.,0.,0.,0.,0./
      DATA CUTIN/1.,-100.,2.,-1.,100.,-.1/
      DATA IPRNT/1/
      DATA XCUTLO/1.,-10.,1.,-.1,10.,-.05/
C:
C:       SET LP CONSTRAINT AND UTILITY FUNCTION MATRICES
C:
      NN=NSTEPS+1
      J=1+(K-1)*5
      JCNT=0
      KILL=0
      FIXCOST=0.
      DO 10 M=1,6
      MM=NCODE(M)
      E(M)=0.0001
      IF(MM.LT.MSTART.OR.MM.GT.MSTOP) GOTO 10
      XCUT(MM,K)=XCUTLO(M)
C:
C:       COMPUTE COST FOR THE DISTRIBUTED PARAMETERS
C:
      FIXCOST=FIXCOST+Z2*TIMEC(MM,J)
      COST(M)=Z2*TIMEM(MM,J)+CPART(MM)
   10 E(M)=AREA(C,MM,J,K,N)
C:
C:       MOVE THE EMISSION DELTA AND COST CONSTRAINTS INTO
C:       THE E ARRAY.  E(M)
C:
      DO 15 M=8,10
   15 E(M)=-B1(M-6)
      E(7)=B1(1)-FIXCOST
      E(11)=1.05*PSTAR
      E(12)=0.95*PSTAR
      IF(PSTAR.LT.1.E-5) E(11)=20.
      IF(PSTAR.LT.1.E-5) E(12)=-20.
```

```
C:
C:        COMPUTE EMISSION CONSTRAINT COEF.
C:
          DO 20 I=1,3
          II=I+7
          DO 20 M=1,6
          MM=NCODE(M)
   20     A1(II,M)=EFF(MM)*PAR(MM,J,I)/START(J,I)
C:
C:        MOVE TEMPORARY COEFFICIENTS INTO THE A ARRAY  -A(10,6)-
C:
          DO 40 M=1,6
          C1(M)=0.
          MM=NCODE(M)
          DO 40 I=1,3
   40     C1(M)=C1(M)+EMW(I)*PAR(MM,J,I)*EFF(MM)
          DO 50 I=1,6
   50     CUT(I)=CUTIN(I)
   54     DO 51 I=1,10
          DO 51 M=1,6
   51     A(I,M)=A1(I,M)
C:
C:        COMPUTE EXPECTED EMISSION DROP (DELTA)
C:
          DO 55 M=1,6
          MM=NCODE(M)
          XCUT(MM,K)=CUT(M)
          AA=AREA(0,MM,J,K,N)
          BB=AREA(1,MM,J,K,N)
          IF(LIMT(MM).EQ.1) XR(M)=CUTMIN(M)
          IF(LIMT(MM).EQ.2) XR(M)=CUTMAX(M)
          IF(AA.GT.0.00001) XR(M)=BB/AA
          X(M)=AA
          DELTA(M)=XR(M)
   55     CONTINUE
          CALL EXCOEF(X,PSTARC)
          DO 60 M=1,6
          C(M)=C1(M)*DELTA(M)
C*****IF(C(M).LT.0.) WRITE(6,56) M
   56     FORMAT(/11H SETTING B( ,I2,10H) TO ZERO    //)
C:
C:        THROW OUT NON POSITIVE CONTRIBUTING DISTRIBUTIVE PARAMETERS
```

Table 5-38 SUBROUTINE CUTPNT LISTING (cont.)

```
C:
      IF(C(M).LT.0.)  B(M)=0.0001
      C(M)=-C(M)
      A (7,M)=COST(M)
      A(11,M)=PSTARC(M)
      A(12,M)=-PSTARC(M)
      DO 60 L=8,10
   60 A(L,M)=-A1(L,M)*DELTA(M)
      IF(IPRNT.EQ.0) GOTO 70
      IF(JCNT.NE.0.AND.JCNT.NE.5.AND.JCNT.NE.10) GO TO 70
      WRITE(6,1010) C
      DO 65 L=1,12
   65 WRITE(6,1020) (A(L,M),M=1,6),B(L)
 1010 FORMAT(/6F10.4/)
 1020 FORMAT(7F10.4)
C:
C:       CALL LINEAR PROGRAMMING ROUTINE.
C:
   70 CALL LPAX(A,B,C,XN,DUM,15,12,6,IERR,0,2.)
C:
C:       COMPUTE OPTIMAL CUTPOINTS BASED ON THE OPTIMAL
C:       REJECTION FRACTION FROM LINPRG.
C:
      IF(IERR.NE.0) GOTO 95
      IF(IPRNT.EQ.1) WRITE(6,150) XN
      DO 110 M=1,6
      MM=NCODE(M)
      CUTN(M)=0.
      IF(MM.LT.MSTART.OR.MM.GT.MSTOP) GOTO 110
      IF(XN(M).LT.0.001) GOTO 101
      IF(XN(M).GT.0.999) GOTO 103
      XCUT(MM,K)=XPT(TABLEX(1,MM,J),TABLEY(1,MM,J),NN,XN(M))
      AA2=AREA(0,MM,J,K,N)
C:
C:       COMPUTE REJECTED POPULATION MEAN.
C:
      CUTN(M)=XCUT(MM,K)
  105 BB=AREA(1,MM,J,K,N)
      XRN(M)=BB/AA2
      GOTO 110
  101 IF(LINT(MM).EQ.1) GOTO 102
C:
```

Table 5-38 SUBROUTINE CUTPNT LISTING (cont.)

```
      C:     REJECT THE HIGH END.  REJECT FRACTICN=C.
      C:
             CLTN(M)=CLTMAX(M)
             XRN(M)=CUTMAX(M)
             GCTC 11C
      C:
      C:     REJECT THE LCWER END.  REJECT FRACTICN=0.
      C:
      102    CLTN(M)=CUTMIN(M)
             XRN(M)=CUTMIN(M)
             GCTC 11C
      103    IF(LINT(MM).EC.1) GCTC 104
      C:
      C:     REJECT THE HIGH END.  REJECT FRACTICN = 1.
      C:
             AA2=1.C
             CUTN(M)=CUTMIN(M)
             XCUT(MM,K)=CLTN(M)
             GCTC 1C5
      C:
      C:     REJECT THE LCWER END.  REJECT FRACTICN = 1.
      C:
       104   CUTN(M)=CUTMAX(M)
             AA2=1.C
             XCUT(MM,K)=CLTN(M)
             GCTC 1C5
       110   DELTAN(M)=XRN(M)
             DO 13C M=1,6
      C:
      C:        COMPUTE NEXT CUTPOINT GUESSES AND GC TO
      C:        THE TCP OF THE LOOP.
      C:
      130    CUT(M)=CA*CUT(M)+CB*CUTN(M)
       15C   FORMAT(* X*,F8.4,5F10.4)
             JCNT=JCNT+1
             IF(JCNT.LE.10) GCTC 54
      C:
      C:        MCVE OPTIMAL CUTPCINTS INTO XCUT
      C:
             DC 16C M=1,6
             MM=NCCDE(M)
      16C    XCUT(MM,K)=CLTN(M)
```

Table 5-38 SUBROUTINE CUTPNT LISTING (cont.)

```
      RETURN
   95 KILL=1
      RETURN
      END
```

5.13.3 Subroutine LPAX

Subroutine LPAX is the actual linear programming algorithm used in the model. LPAX is a TRW proprietary programming package and consequently has not been included in this writeup.

5.13.4 Subroutine PXCOEF

Subroutine PXCOEF computes the coefficients necessary for estimating the union of a set of parameter rejection rates. The coefficients are used in the linear programming model for the P* option in which a constant rejection rate is required. The fundamental equation of PXCOEF computes the union of probabilities for independent occurrences. The coefficients are computed for each of the distributed parameters and multiplied by the rejection rate X in the OPTMUM optimization loop. Figure 5-39 contains a complete flowchart of the subroutine while Table 5-39 includes a listing.

5.14 OUTPUT ROUTINES

Since GEEP is a user oriented program, an effort has been made to make the output as clear and self-explanatory as possible. This requirement has, of course, lead to a large number of specialized output routines with a variety of output options including plots, tables, debug information, and summary level results. The following routine descriptions provide an overview of the various output options. The reader is referred to Section 3.0 for more details on program output.

5.14.1 Subroutine DISTPR

Subroutine DISTPR is an output subroutine used in the convolution routine of GEEP. DISTPR prints out three distributions along with their respective means and standard deviations. Usually these distributions

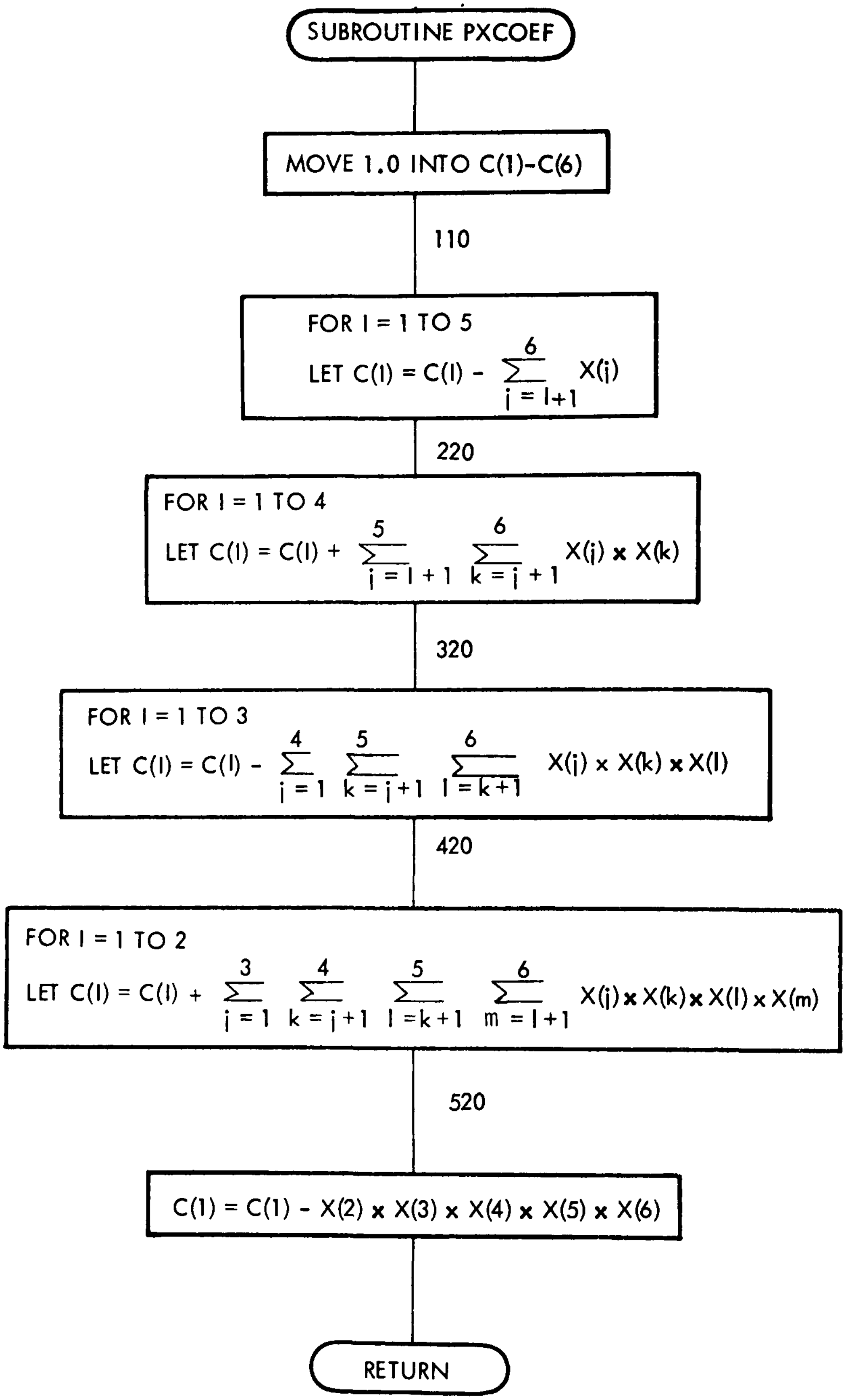


Figure 5-39 Subroutine PXCOEF Flowchart

Table 5-39 SUBROUTINE PXCOEF LISTING

```
      SUBROUTINE PXCOEF(X,C)
      DIMENSION X(1),C(1)
      DO 110 I=1,6
  110 C(I)=1.0
      DO 220 I=1,5
      J1=I+1
      A=0
      DO 210 J=J1,6
  210 A=A+X(J)
  220 C(I)=C(I)-A
      DO 320 I=1,4
      J1=I+1
      A=0
      DO 310 J=J1,5
      K1=J+1
      DO 310 K=K1,6
  310 A=A+X(J)*X(K)
  320 C(I)=C(I)+A
      DO 420 I=1,3
      J1=I+1
      A=0.
      DO 410 J=J1,4
      K1=J+1
      DO 410 K=K1,5
      L1=K+1
      DO 410 L=L1,6
  410 A=A+X(J)*X(K)*X(L)
  420 C(I)=C(I)-A
      DO 520 I=1,2
      J1=I+1
      A=0
      DO 510 J=J1,3
      K1=J+1
      DO 510 K=K1,4
      L1=K+1
      DO 510 L=L1,5
      M1=L+1
      DO 510 M=M1,6
  510 A=A+X(J)*X(K)*X(L)*X(M)
  520 C(I)=C(I)+A
      C(1)=C(1)-X(2)*X(3)*X(4)*X(5)*X(6)
      RETURN
      END
```

will be two arbitrary distributions and their convolution. A flowchart of DISTPR is found in Figure 5-40. Table 5-40 presents a listing of the code.

5.14.2 Subroutine OUT

Subroutine OUT is the main output routine for the General Economic Effectiveness Program. All computed cost values, payoff functions, Inspection/Maintenance descriptors, and emission time histories are printed by subroutine OUT. Several unit conversion and index calculations appear for referencing name arrays and outputting data in meaningful units. Figure 5-41 contains a summary level flowchart for subroutine OUT. Table 5-41 provides a complete listing of output variables and formats.

5.14.3 Subroutine GEEPER

Subroutine GEEPER is a header routine which prints a GEEP/CRC Logo on the first page of each run. GEEPER is called only once for each run. Figure 5-42 contains a flowchart for GEEPER while Table 5-42 contains a listing.

5.14.4 Plot Routines

Output from GEEP is provided in easy-to-read tables and plots. The following plot routines perform specialized functions involved in generating the summary and debug plotted output for a GEEP execution. The basic plot routine, PLOTJK, is a well known standard output routine for displaying data on a digital line printer. It works with an alphanumeric array initialized blank and fills it with characters for the functions being plotted. There is theoretically no limit to the number of functions which can be plotted on one graph, but for GEEP, in the interest of clarity, that number has been limited to two. Off-scale flags at both ends of the plot indicate out-of-bounds data, but since GEEP automatically adjusts the scales to the data, this data range error should never occur.

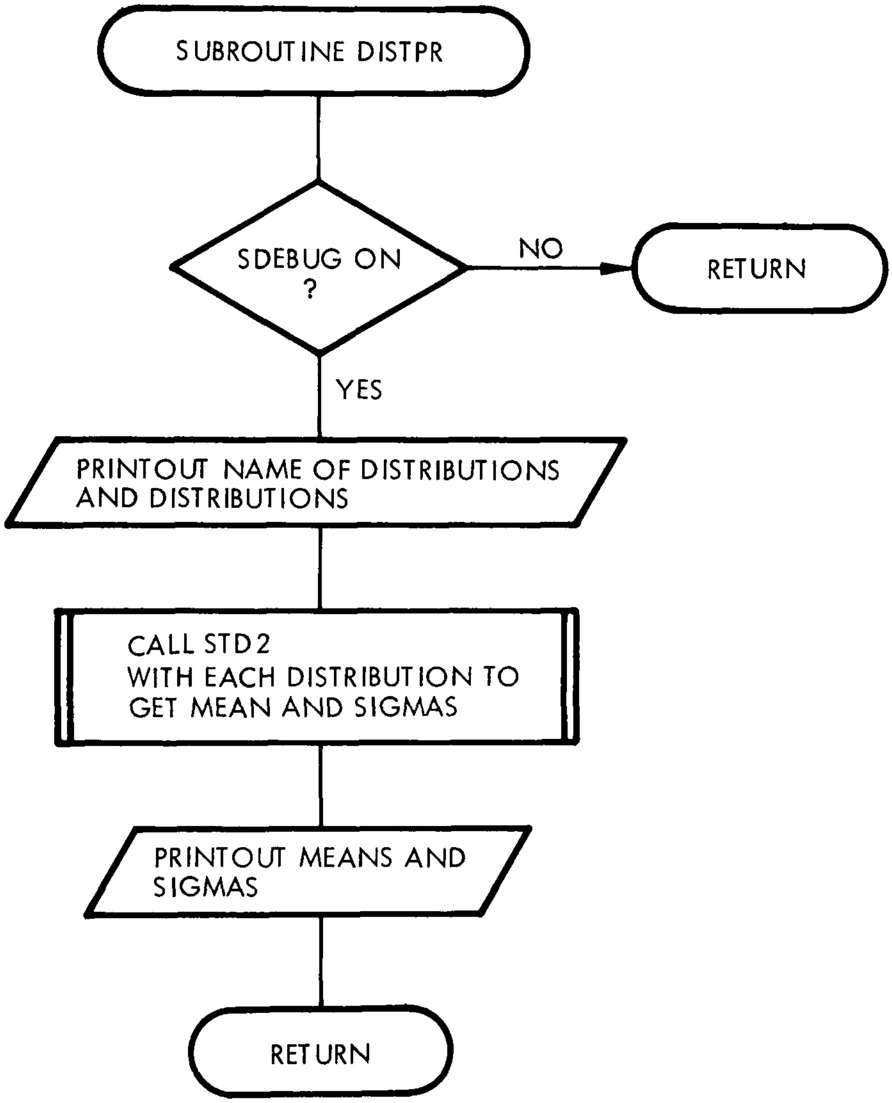


Figure 5-40 Subroutine DISTPR Flowchart

Table 5-40 SUBROUTINE DISTPR LISTING

```
      SUBROUTINE DISTPR(P,Y,PP,YY,D,DD,N1,N2,N3,NAME)
      DIMENSION P(1),Y(1),PP(1),YY(1),D(1),DD(1)
      REAL MU1,MU2,MU3,NAME(5)
      COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +   LDEBUG,   MDEBUG,    PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
      REAL LDEBUG,MDEBUG
CC
CC    CONVOLUTION DISTRIBUTION PRINT
CC
      IF(SDEBUG.EQ.2HNO) RETURN
      WRITE (6,800) NAME
  800 FORMAT(/,20X,5A10/)
      WRITE (6,900)
      WRITE (6,910) (I,P(I),Y(I),PP(I),YY(I),D(I),DD(I),I=1,N3)
      CALL STD2(P,Y,N1,MU1,SD1)
      CALL STD2(PP,YY,N2,MU2,SD2)
      CALL STD2(D,DD,N3,MU3,SD3)
      WRITE (6,920)
      WRITE (6,930) MU1,SD1,MU2,SD2,MU3,SD3
  900 FORMAT (/,11X,1HI,5X,2HAX,9X,2HAY,9X,2HBX,9X,2HBY,
     +         9X,2HCX,9X,2HCY,/)
  910 FORMAT (10X,I2,6E11.3)
  920 FORMAT (/,17X,3HMU1,8X,3HSD1,8X,3HMU2,8X,3HSD2,
     +         8X,3HMU3,8X,3HSD3,/)
  930 FORMAT (13X,6E11.3)
      RETURN
      END
```

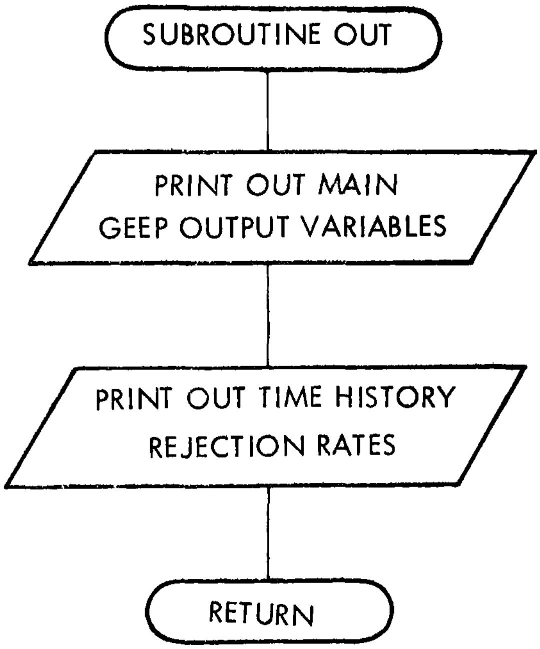


Figure 5-41 Subroutine OUT Flowchart

Table 5-41 SUBROUTINE OUT LISTING

```
                  SUBROUTINE OUT
                   COMMON /COM01/ AMB(3),ALAB,     AVV, BINT,
                +     BAREA(3), BLD1,     BLD2,     BSIG(3),  BXTRA,    BSIZE,
                +     BHIST(3,16),        BMMI(10,15,3),
                +     ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
                   COMMON /COM02/         CARA,     CARIY,    CARMY,    CARPOP(16),
                +     CARSY,    CBSUM,    CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
                +     CINCON,   CPCB,   CPI,      CPVPY,    CSUM,     CARAY,
                +     CN(15,3,16),        COEFB(15,3),        COEFBP(10,15),
                +     CPART(10,15)
            CC ADD2
                   COMMON /COM03/         DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
                + EMW(3),       EP(10,15),EFF(10),  DELIT(3),
                +     FREQA,    FREQB,    FPERC(10,3),
                +     HORZN,    HORZNY,
                +     HPC(15,16),         HPCS(15,16),        HPP(10,15,16),
                +     HPS(6,15,16),       HPT(5,16),          HPTOT(16),
                +     HPTOTS(16)
            CC ADD3
                   COMMON /COM04/         ITE,      ITL,      ITP,      ITIME(16),
                +     KSTART,   KSTOP,    LOPT, LPICK(10),LLPICK,
                +     LIDLE,    LINT(16), LPSPP(10),LSTART,   LSTOP,
                +     MBASE,    MPH,      MSPEC(10),MSTART,   MSTOP,
                +     MU(10,3),   MMS(10,15),        MVPR(10,15)
            CC ADD4
                   COMMON /COM05/         NAME(50), NCNTR,    NEMIS,    NEMP,
                +     NINTR,    NINTRB,   NMODE,    NO,       NOPTS,    NPAR,
                +     NPTRN,    NPTS,     NSTEPS,   NTR,      NTRB,     NPICK(16),
                +     OCIY,     OCMY,     OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
            CC ADD5
                   COMMON /COM06/PARM(3,3), PART,     PAYNEW,   PAYOFF(3),
                +     PC(15),   PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
                +     PP(10,15),PS(6,15), PT(5),    PTOT,     PTS(5),   PAYADJ,
                +     PAR(10,15,3),       PARI(10,3,3),       PLUS(10,15),
                +     PM(10,15),          PPICK(10),PPPICK,PSTAR,PI(15,10),
                +     PSA(15),  PTA(5),   PCONF,    PARINT(10,10,9)
                + ,PAYFIN
                   COMMON /COM07/         REINSP,   RNAME,    RSIZE,    RSTOP,
                +     RTYPE,
                +     SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
                +     SMODEL,   START(15,3), STAT,     STIME(3), SUMBM(3),
```

```
     +    SCALEBM(3),           SM(6,15),            SPAR(10,15,6),
     +    SXCUT(6,3),           SIG(10,3),             SIGCE(3),
     +    SIGME(10),            SIGMNE(10),          SIGP(10,15),
     +    SIGRATE,  SIST,        SIGS(6,15),           SIGSDE(3),
     +    STABLEX(33,6,15),      STABLEY(33,6,15)
      COMMON /COM10/            TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),    TONX,     TOTE(3),   TPDB(3),   TPDT(3),
     +    TXTRA,    TSIZE,       TSIG(3),   TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),        THISTT(3,16),        TIMEC(10,15),
     +    TIMEM(10,15),         TABLEX(33,10,15),     TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/            WF(10),
     +    X1BP(3,3,6), XINT,       XINTB,     XLANE,     XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/            Y1BP(3,3,10),        Y2BP(3,3,10),
     +    YES,      YSUM,       YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,         Z3,       Z4,       Z5,        Z6,
     +    Z7,       Z8,         Z9,       Z10,      Z11,       Z12,
     +    Z13,      Z14,        Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,      ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/            ADEBUG,   BDEBUG,   CDEBUG,    DDEBUG,
     +    LDEBUG,   MDEBUG,     PDEBUG,   QDEBUG,   SDEBUG,    TDEBUG
CC ADDD
      REAL          ITE,        ITL,      ITP,      ITIME,
     +    MMS,      MPH,        MSPEC,    MU,       MVPR,
     +    NAME,     NO,         LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER       RNAME,      SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,      OPTI,     PPICK,    PPPICK,     XNAME(6)
      DATA XNAME/4HIDLE,1H ,10HEXTENSIVE ,1HA,10HEXTENSIVE ,
     +1HB/
      I=OPTI
      VEHPOP=CARPOP(1)/1.E6
      NN=2*RNAME-1
      WRITE (6,1) NAME(20+NN),NAME(20+NN+1)
    1 FORMAT(1H1,/30X,2A10,* REGIONAL DATA*)
      WRITE (6,2)
    2 FORMAT(//20X,*EMISSION SURVEILLANCE DATA SOURCE*,T73,
     + *TRW/ARB*)
```

Table 5-41 SUBROUTINE OUT LISTING (cont.)

```
      WRITE (6,3) (AMB(I),I=1,NEMIS)
    3 FORMAT(/,20X,*FEDERAL 1975 MOTOR VEHICLE STANDARDS *,/,
     + 40X,*HC*,T71,F6.2,* G/MI*/40X,*CO*,T71,F6.2,* G/MI*,/
     + 40X,*NO*,T71,F6.2,* G/MI*)
      WRITE (6,4) (EMW(I),I=1,NEMIS)
    4 FORMAT(/,20X,*EMISSION SPECIE WEIGHTING FUNCTION*,/
     + /,40X,*HC*,T71,F6.2,/40X,*CO*,T71,F6.2,/
     + 40X,*NO*,T71,F6.2)
C*****WRITE (6,5) (GOALS(I),I=1,NEMIS)
    5 FORMAT(/,20X,*MINIMUM EMISSION REDUCTION GOALS*//
     + 40X,*HC*,T71,F6.2* PERCENT*/40X,*CO*,T71,F6.2,* PERCENT*/
     + 40X,*NO*,T71,F6.2,* PERCENT*)
      WRITE (6,6) RSIZE
    6 FORMAT(/,20X,*REGIONAL AREA*,T69,F8.2,* SQ MI*)
      WRITE (6,7) MPH
    7 FORMAT(/,20X,*AVERAGE VEHICLE SPEED*,T71,F6.2,* MPH*)
      WRITE (6,8) VEHPOP
    8 FORMAT(/,20X,*VEHICLE POPULATION*,T72,F5.2,* MILLION*,/)
      WRITE (6,9) SITEM
    9 FORMAT(20X,*NUMBER OF CLASS ≠A≠ FRANCHISED GARAGES*,
     + T71,I4)
      WRITE(6,10)
   10 FORMAT(1H1,/,36X,34(1H*)/36X,1H*,4X,
     + *TRW INSPECTION/MAINTENANCE*,2X,1H*,/36X,1H*,10X,
     + *SYSTEM MODEL*,10X,1H*,/36X,34(1H*),/)
      WRITE(6,25)
   25 FORMAT(43X,*SUMMARY INFORMATION*,/)
      WRITE (6,50) RTYPE,XNAME(2*I-1),XNAME(2*I)
   50 FORMAT(37X,*ENGINE *,A9,* STRATEGY   *,A10,A1)
      WRITE (6,20) TINT
   20 FORMAT(38X,*INSPECTION PERIOD IS*,F5.1,* MONTHS*)
      WRITE (6,60) PAYNEW
   60 FORMAT(//,T20,*PAYOFF FUNCTION UNADJUSTED (DOLLARS/*,
     + *WEIGHTED EMISSION) *,T90,F15.2)
      WRITE(6,65) PAYADJ
   65 FORMAT(T20,*PAYOFF FUNCTION STATISTICALLY ADJUSTED*,
     +* (DOLLARS/WEIGHTED EMISSION) *,T90,F15.2)
       WRITE (6,66) PAYFIN
   66  FORMAT(T20,*PAYOFF FUNCTION AT END OF LAST YEAR*,
     + * (DOLLARS/WEIGHTED EMISSION)*,T90,F15.2)
      WRITE (6,70) (NAME(I),PAYOFF(I),I=1,NEMIS)
   70 FORMAT(T20,A3,*EMISSION REDUCTION (PERCENT)*,T90,F15.2)
```

Table 5-41 SUBROUTINE OUT LISTING (cont.)

```
      WRITE (6,80) (NAME(I),TPOT(I),I=1,NEMIS)
   80 FORMAT(T20,A2,* AVERAGE EMISSIONS (TONS/DAY)*,T90,F15.2)
      YSUM=YSUM/HORZNY
      WRITE (6,90) YSUM
   90 FORMAT(T20,*TOTAL COSTS FOR MANDATORY PROGRAM*,
     +* (DOLLARS/YEAR)*,T90,F15.2)
      CBSUM=CBSUM/XINTB
      WRITE (6,100) CBSUM
  100 FORMAT(T20,*TOTAL COSTS FOR VOLUNTARY PROGRAM (DOLLARS/*,
     +*YEAR)*,T90,F15.2)
      RCS=(YSUM/CBSUM)*100.
      WRITE (6,215) RCS
      WRITE (6,110) CCOSTI
  110 FORMAT(T20,*INSPECTION CAPITAL COSTS (DOLLARS/STATION)*
     + ,T90,F15.2)
      WRITE (6,120) OCIY
  120 FORMAT(T20,*AVERAGE INSPECTION OPERATING COSTS (DOLLARS*,
     +*/YEAR)*,T90,F15.2)
      WRITE (6,130) CCOSTM
  130 FORMAT(T20,*MAINTENANCE CAPITAL COSTS (DOLLARS)*,T90,
     + F15.2)
      WRITE (6,140) OCMY
  140 FORMAT(T20,*AVERAGE MAINTENANCE OPERATING COSTS (DOLLARS*,
     +*/YEAR)*,
     + T90,F15.2)
      WRITE (6,150) CINCON
  150 FORMAT(T20,*USER COSTS (DOLLARS/CAR)   *,T90,F15.2)
      WRITE (6,160) CPI
  160 FORMAT(T20,*COST PER INSPECTION*,T90,F15.2)
      WRITE (6,170) CPVPY
  170 FORMAT(T20,*COST PER VEHICLE MAINTAINED*,
     + T90,F15.2)
      WRITE (6,180) CARIY
  180 FORMAT(T20,*AVERAGE NUMBER OF CARS INSPECTED/YEAR*,
     + T90,F15.2)
      WRITE (6,185) CARSY
  185 FORMAT(T20,*AVERAGE NUMBER OF CARS REJECTED/YEAR*,
     + T90,F15.2)
      WRITE (6,190) CARMY
  190 FORMAT(T20,*AVERAGE NUMBER OF CARS MAINTAINED/YEAR*,
     + T90,F15.2)
      AVEFAIL=CARMY/CARIY
```

```
      WRITE (6,210) AVEFAIL
  210 FORMAT(T20,*AVERAGE FAILURE PERCENTAGE*,T90,F15.2)
  215 FORMAT(T20,*RATIO OF MANDATORY TO VOLUNTARY COSTS (PERCENT)*
     +,T90,F15.2)
      WRITE (6,220) HORZNY
  220 FORMAT(T20,*TOTAL PROGRAM DURATION (YEARS)*,T90,F15.2)
      WRITE(6,230) (I,I=1,10)
  230 FORMAT(1H1,/,40X,*PASS/FAIL INSPECTION CRITERIA*,////,
     * 12X,*PARAMETER *,3X,10I8,/)
      WRITE(6,240) (NAME(K+3),(XCUT(M,K),M=1,3),(TDIST(M,K),M=
     + 4,6)        ,(XCUT(M,K),M=7,9)         , TDIST(10,K),K=1,3)
  240 FORMAT(17X,A10,F8.2,F8.0,F8.2,3(I6,2X),F8.4,F8.2,F8.4,I6)
      WRITE(6,250) (I,I=1,6)
  250 FORMAT(///,12X,*MODE EMMISIONS *,I6,5I8,/)
      WRITE(6,260) (NAME(K+3),(SXCUT(M,K),M=1,6),K=1,3)
  260 FORMAT(17X,A10,F8.0,F8.2,F8.0,F8.0,F8.2,F8.0)
      WRITE (6,420) (NAME(I),I=1,NEMIS),(TPDB(I),I=1,NEMIS),
     + (TPDT(I),I=1,NEMIS)
  420 FORMAT(///////,35X,* TOTAL EMISSION LEVELS (TONS/DAY)*,
     + /,T30,A2,T50,A2,T70,A2/20X,*BASE*,
     + T25,F10.2,T45,F10.2,T65,F10.2/,20X,*TEST*,
     + T25,F10.2,T45,F10.2,T65,F10.2/)
  310 FORMAT(//,20X,5(1H*),A4,*LEVEL  --  END OF *,
     + *INSPECTION INTERVAL (GR/VEHICLE-MILE) *,5(1H*)/)
  330 CONTINUE
      IF(RTYPE.EQ.PMODEL) GO TO 335
      WRITE (6,600)
  600 FORMAT(1H1,//,40X,*STATELANE INSPECTION CONFIGURATION*)
      WRITE (6,610) STAT
  610 FORMAT(///,20X,*TOTAL NUMBER OF STATE OPERATED INSPECTION*
     + ,* LANES*,T84,I3)
      WRITE (6,620) XLANE
  620 FORMAT(/,20X,*NUMBER OF LANES PER SITE*,T86,I1)
      NS=STAT/XLANE+.5
      WRITE (6,630) NS
  630 FORMAT(/,20X,*TOTAL NUMBER OF SITES*,T85,I3)
      WRITE (6,640) STIME
  640 FORMAT(/,20X,*VEHICLE INSPECTION TIMES*/
     + 25X,*IDLE*,T75,F15.2,* MIN*/25X,*LOADED*,T75,F15.2,* MIN*
     + /25X,*HYBRID*,T75,F15.2,* MIN*)
      WRITE (6,650)
  650 FORMAT(/,20X,*EQUIPMENT REQUIREMENTS AND COSTS*/
```

Table 5-41 SUBROUTINE OUT LISTING (cont.)

```
     + 25X,*NDIR*,T83,*2000 DOLLARS/LANE*/
     + 25X,*COMPUTER*,T82,*15000 DOLLARS/LANE*/
     + 25X,*MISC.*,T83,*3000 DOLLARS/LANE*/
     + 25X,*DYNO*,T83,*7000 DOLLARS/LANE*)
       WRITE (6,660) Z15
   660 FORMAT(/,20X,*INFORMATION PROCESSING COSTS*,T75,F15.2
     + * DOLLARS/CAR*)
       WRITE (6,670) Z9
   670 FORMAT(/,20X,*USER TIME COSTS*,T75,F15.2,* DOLLARS/HR.*)
       WRITE (6,680) ITIME(2)
  680  FORMAT(/,20X,*TOTAL USER TIME PER PERSON*,T75,F15.2,* MIN*)
       WRITE (6,690) NEMP
  690  FORMAT(/,20X,*NUMBER OF STATE EMPLOYEES PER LANE*,
     + T84,I3)
       SSIZE=BLD1+BLD2*XLANE
       WRITE (6,700) SSIZE
       WRITE (6,707) SIST
  700  FORMAT(/,20X,*STATION SIZE (FACILITIES ONLY)*
     +,T75,F15.2,* SQ. FT.*)
  707  FORMAT(/,20X,*STATION LAND SIZE*,T75,F15.2,* SQ. FT.*)
   335 WRITE (6,340)
  340  FORMAT(1H1,/,30X,*TEST CASE EMISSION HISTORIES*)
       DO 380 I=1,NEMIS
       IF(I.EQ.3) WRITE (6,999)
       WRITE (6,310) NAME(I)
       WRITE (6,350) (NAME(II),II=11,15)
  350  FORMAT(//,T40,*POWERTRAIN TYPE*//,5X,*TEST NO.*,
     + 4X,5(5X,A10)/)
       DO 370 N=1,NTR
       WRITE (6,360) N,(THIST(JJ,I,N),JJ=1,NPTRN)
  360  FORMAT(8X,I2,5X,5F15.4)
  370  CONTINUE
  380  CONTINUE
       WRITE (6,390) (NAME(I),I=1,NEMIS)
   390 FORMAT(1H0,5(/),40X,*SUMMARY EMISSION HISTORIES*
     + //,3X,*TEST*,3X,*TIME*,T32,A2,T55,A2,T80,A2,/
     + 4X,*NO*,5X,*MO*,T26,3(*BASE*,8X,*TEST*,8X)/)
       DO 410 N=1,NTR
       TIME=TINT*(N-1)
       IF(N.EQ.NTR) TIME=HORZN
       WRITE (6,400) N,TIME,(BHIST(I,N),THISTT(I,N),I=1,NEMIS)
  400  FORMAT(4X,I2,3X,F4.1,5X,6F12.3)
```

Table 5-41 SUBROUTINE OUT LISTING (cont.)

```
  410 CONTINUE
      DO 560 N=2,NTR
      TIME=(N-1)*TINT
      WRITE (6,500)
  500 FORMAT(1H1,45X,*FAILURE PROBABILITIES*)
      WRITE (6,510) N,TIME,HPTOT(N)
  510 FORMAT(/,28X,*TIME HISTORY POINT*,I3,F6.1,* MONTHS*,5X,
     + *TOTAL FAILURE IS *,F9.3,*≤*,/)
      DO 550 JJ=1,NPTRN
      WRITE (6,520) JJ,NAME(JJ+10),HPT(JJ,N),(II,II=1,10)
  520 FORMAT(/,35X,*POWERTRAIN TYPE*,I4,* -- *A8,F9.3,*≤*,
     + //,* PARAMETER*,5X,I2,9(7X,I2),4X,*UNION*)
      DO 540 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      WRITE (6,530) NAME(K+3),(HPP(M,J,N),M=1,NPAR),HPC(J,N)
      WRITE (6,535) (HPS(L,J,N),L=1,NMODE),HPCS(J,N)
  530 FORMAT(2X,A8,11F9.3)
  535 FORMAT(4X,*MODE*,2X,6F9.3,36X,F9.3)
  540 CONTINUE
  550 CONTINUE
  560 CONTINUE
      WRITE (6,999)
  999 FORMAT(1H1)
       RETURN
       END
```

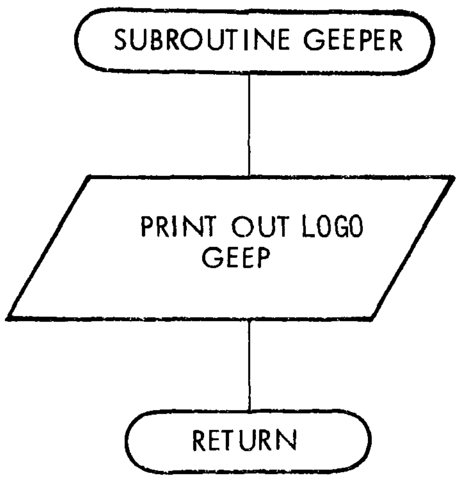


Figure 5-42 Subroutine GEEPER Flowchart

Table 5-42 SUBROUTINE GEEPER LISTING

```
      SUBROUTINE GEEPER
      DO 2 IIII=1,1
       WRITE (6,999)
      WRITE(6,50)
      WRITE(6,51)
      WRITE(6,52)
      WRITE(6,51)
      WRITE(6,50)
      WRITE(6,53)
      WRITE(6,54)
      WRITE(6,55)
      WRITE(6,56)
      WRITE(6,57)
      WRITE(6,50)
      WRITE(6,51)
      WRITE(6,52)
      WRITE(6,51)
      WRITE(6,50)
      WRITE(6,49)
      WRITE(6,58)
      WRITE(6,59)
      WRITE(6,60)
      WRITE(6,60)
      WRITE(6,61)
      WRITE(6,62)
      WRITE(6,63)
      WRITE (6,64)
      WRITE(6,64)
      WRITE(6,65)
      WRITE(6,66)
      WRITE(6,67)
    2 CONTINUE
   49 FORMAT(/////)
   50 FORMAT(19X,9(1HC))
   51 FORMAT(18X,11(1HC))
   52 FORMAT(18X,3(1HC))
   53 FORMAT(/3X,12(1HT),3X,10(1HR),4X,2(1HW),9X,2(1HW))
   54 FORMAT(3X,12(1HT),3X,2(1HR),7X,2(1HR),4X,2(1HW),3X,1HW,3X,2(1HW))
   55 FORMAT(8X,2(1HT),8X,10(1HR),6X,2(1HW),1X,3(1HW),1X,2(1HW))
   56 FORMAT(8X,2(1HT),8X,2(1HR),4X,2(1HR),9X,3(1HW),1X,3(1HW))
   57 FORMAT(8X,2(1HT),8X,2(1HR),5X,2(1HR),9X,1HW,3X,1HW /)
```

Table 5-42 SUBROUTINE GEEPER LISTING (cont.)

```
 58 FORMAT(27X,6(1HG),7X,10(1HE),5X,10(1HE),5X,9(1HP))
 59 FORMAT(26X,8(1HG),6X,10(1HE),5X,10(1HE),5X,10(1HP))
 60 FORMAT(25X,2(1HG),6X,2(1HG),5X,2(1HE),13X,2(1HE),13X,2(1HP),6X,
   X2(1HP))
 61 FORMAT(25X,2(1HG),13X,2(1HE),13X,2(1HE),13X,2(1HP),6X,2(1HP))
 62 FORMAT(25X,2(1HG),13X,5(1HE),10X,5(1HE),10X,10(1HP))
 63 FORMAT(25X,2(1HG),13X,5(1HE),10X,5(1HE),10X,9(1HP))
 64 FORMAT(25X,2(1HG),4X,4(1HG),5X,2(1HE),13X,2(1HE),13X,2(1HP))
 65 FORMAT(25X,2(1HG),6X,2(1HG),5X,2(1HE),13X,2(1HE),13X,2(1HP))
 66 FORMAT(26X,8(1HG),6X,10(1HE),5X,10(1HE),5X,2(1HP))
 67 FORMAT(27X,6(1HG),7X,10(1HE),5X,10(1HE),5X,2(1HP))
999  FORMAT(1H1)
     RETURN

     END
```

5.14.5 Subroutine EPLOT

Subroutine EPLOT graphically displays two parameter distributions - usually before and after maintenance. EPLOT accepts as input the two distributions stored in AX, AY and BX, BY respectively and N, containing the number of points in the two distributions. Computations include Y axis values for labeling and individual Y values to be plotted. Subroutine EPLOT calls the GEEP utility program PLOT JK to output each plot line. Figure 5-43 contains a flowchart for subroutine EPLOT. Table 5-43 contains a detailed listing of subroutine EPLOT which describes the techniques involved.

5.14.6 Subroutine PLOTJK

Subroutine PLOTJK is a standard utility plot program for displaying continuous information on a digital output device. Subroutine PLOTJK accepts as input three functions, their minimum and maximum values and an independent variable value to be printed. PLOTJK computes the appropriate column in which a character is to be plotted for each of the three functions and fills an output array (initialized blank) with the respective output characters. Figure 5-44 presents a flowchart of subroutine PLOTJK while Table 5-44 contains a computer listing.

5.14.7 Subroutine PLOT

Subroutine PLOT is the GEEP output routine which displays the emission rate time histories in graphical form. PLOT calls PLOTJK to print each individual line of output.

Figure 5-45 contains a flowchart of PLOT. The listing in Table 5-45 explains the looping required to set up the output plot.

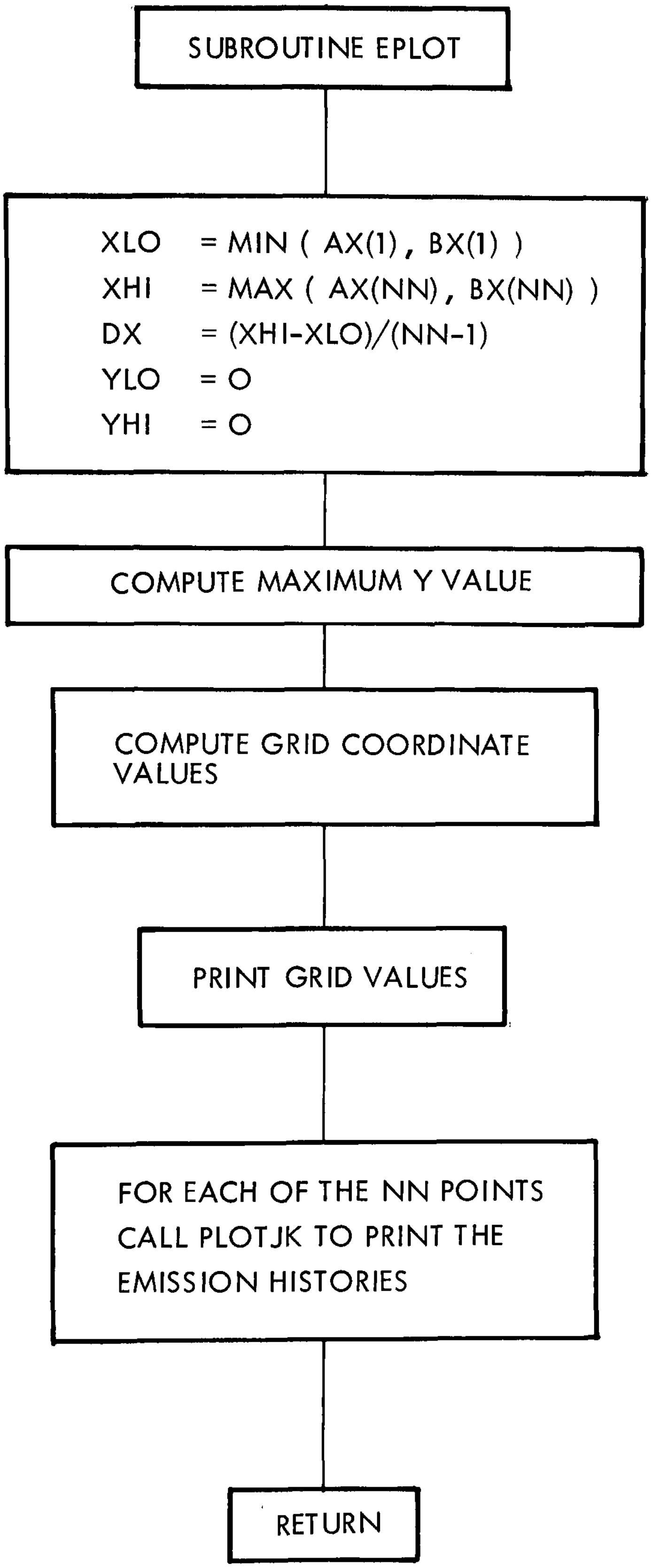


Figure 5-43 Subroutine EPLOT Flowchart

Table 5-43 SUBROUTINE EPLOT LISTING

```
      SUBROUTINE EPLOT(BX,BY,AX,AY,NN,LINT)
      DIMENSION BX(NN),BY(NN),AX(NN),AY(NN)
      XLO=AMIN1(BX(1),AX(1))
      XHI=AMAX1(BX(NN),AX(NN))
      DX=(XHI-XLO)/(NN-1)
      YLO=0.
      YHI=0.
      DO 10 I=1,NN
      YHI=AMAX1(BY(I),YHI)
   10 CONTINUE
      Y2=YHI/6.
      Y3=YHI/3.
      Y4=YHI/2.
      Y5=YHI*.66666666
      Y6=YHI*5./6.
      WRITE(6,105)YLO,Y2,Y3,Y4,Y5,Y6,YHI
  105 FORMAT(6X,F8.2,6(7X,F8.2))
      DO 100 I=1,NN
      X=XLO+DX*(I-1)
      Y1=FUN1(X,BX,BY,NN)
      Y2=FUN1(X,AX,AY,NN)
      IF(LINT.EQ.1.AND.X.LT.BX(1)) Y1=0.
      IF(LINT.EQ.2.AND.X.GT.BX(NN)) Y1=0.
      CALL PLOTJK(2,X,Y1,YHI,    0.,Y2,YHI,0.,0.,0.,0.)
  100 CONTINUE
      RETURN
      END
```

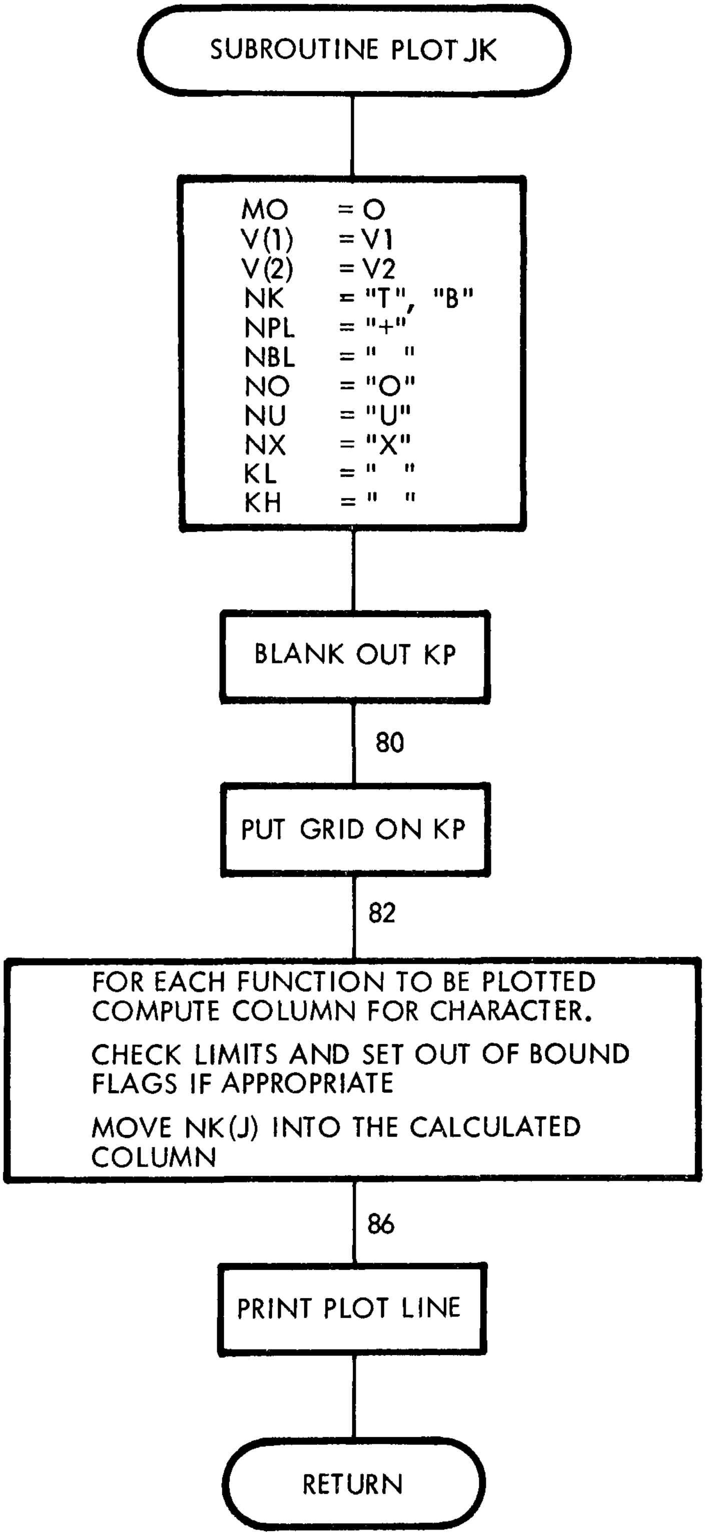


Figure 5-44 Subroutine PLOTJK Flowchart

Table 5-44 SUBROUTINE PLOTJK LISTING

```
      SUBROUTINE PLOTJK(NC,T,V1,VMX1,VMN1,V2,VMX2,VMN2,V3,VMX3,VMN3)
      DIMENSION V(3),VMX(3),VMN(3),CHI(3),NK(3),KP( 91),II(3)
      REAL NK,NPL,NBL,NO,NU,NX
      REAL KL,KP,KH
      MO=0
      MU=0
      V(1)=V1
      V(2)=V2
      V(3)=V3
      VMX(1)=VMX1
      VMX(2)=VMX2
      VMX(3)=VMX3
      VMN(1)=VMN1
      VMN(2)=VMN2
      VMN(3)=VMN3
      NK(1)=1HB
      NK(2)=1HA
      NK(3)=1H=
      NPL=1H+
      NBL=1H
      NO=1HO
      NU=1HU
      NX=1HX
      DO 80 I=1,91
      KP(I)=NBL
   80 CONTINUE
      DO 82 I=1,91,15
      KP(I)=NPL
   82 CONTINUE
      DO 86 J=1,NC
      CHI(J)=(VMX(J)-VMN(J))/90.
      II(J)=(V(J)-VMN(J))/CHI(J)+1.5
      IF(II(J)) 83,83,84
   83 MU=MU-1
      GO TO 86
   84 IF( 92-II(J)) 85,85,101
   85 MO=MO+1
      GO TO 86
  101 KK=II(J)
      KP(KK)=NK(J)
   86 CONTINUE
```

Table ~~5-44~~ SUBROUTINE PLOTJK LISTING (cont.)

```
      IF(NC.EQ.1) GO TO 111
      NC1=NC-1
      DO 303 I=1,NC1
      IP1=I+1
      DO 303 J=IP1,NC
      IF(II(I)-II(J)) 303,301,303
  301 IF(II(I)*( 92-II(I))) 303,303,302
  302 KK=II(I)
      KP(KK)=NX
  303 CONTINUE
  111 IF(MU) 201,202,202
  201 KL=NU
      GO TO 203
  202 KL=NBL
  203 IF(MO) 204,204,205
  204 KH=NBL
      GO TO 206
  205 KH=NO
  206 WRITE(6,150) T,KL,KP,KH
      RETURN
  150  FORMAT(1X,1E9.2,103A1)
      END
```

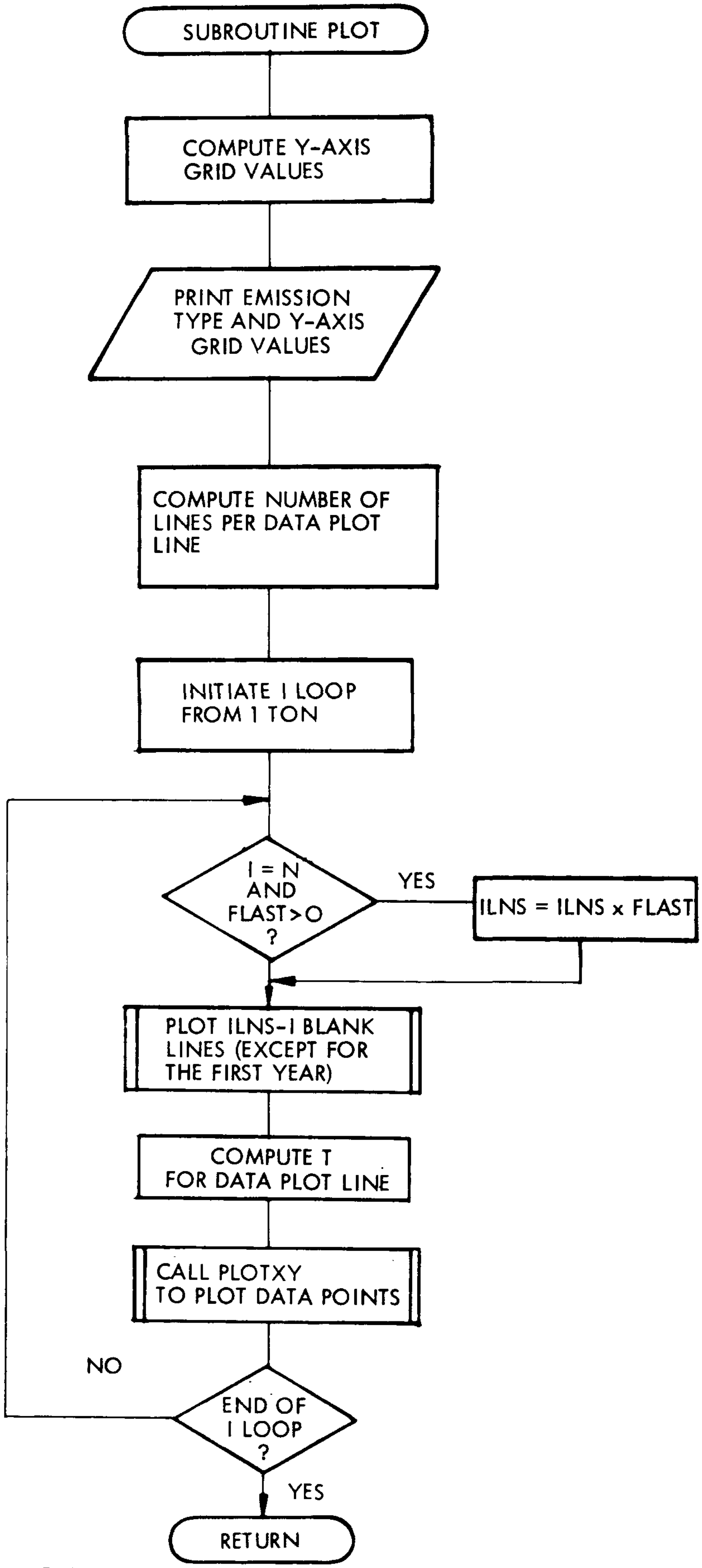


Figure 5-45 Subroutine PLOT Flowchart

Table 5-45 SUBROUTINE PLOT LISTING

```
      SUBROUTINE PLOT(A,B,N,FLAST,LENGTH,XO,DX,YMN,YMX,II)
      DIMENSION A(3,16),B(3,16)
      DIMENSION NAME(3)
      REAL NAME
      DATA NAME/2HHC,2HCO,2HNO/
      Y2=(5.*YMN+YMX)/6.
      Y3=(4.*YMN+2.*YMX)/6.
      Y4=(3.*YMN+3.*YMX)/6.
      Y5=(2.*YMN+4.*YMX)/6.
      Y6=(YMN+5.*YMX)/6.
       WRITE (6,10) NAME(II)
   10 FORMAT(1H1,30X,A2,
     + * DATA HISTORY  --  EMISSION(GPM) VS. TIME(MO.)*,
     + * B = BASE    T  =  TEST*//)
      WRITE(6,105) YMN,Y2,Y3,Y4,Y5,Y6,YMX
  105 FORMAT(6X,F8.2,6(7X,F8.2))
      ILNS=LENGTH*6/N
      DO 100 I=1,N
      IF (I.EQ.N.AND.FLAST.GT..05) ILNS=ILNS*FLAST
      KK=ILNS-1
      IF(I.EQ.1) GO TO 95
      IF(KK.LE.0) GO TO 95
      DO 90 J=1,KK
      T=XO+(I-2)*DX+J*DX/ILNS
      IF(I.EQ.N.AND.FLAST.GT..05) T=XO+(I-2)*DX+J*DX/ILNS*FLAST
   90 CALL PLOTXY (0,T,0.,0.,0.,0.)
   95 CONTINUE
      T=XO+(I-1)*DX
      IF (I.EQ.N.AND.FLAST.GT..05) T=T-DX+DX*FLAST
       CALL PLOTXY(2,T,A(II,I),B(II,I),YMX,YMN)
  100 CONTINUE
      RETURN
      END
```

5.14.8 Subroutine PLOTXY

Subroutine PLOTXY is a modified version of the utility routine PLOTJK which outputs one line of plotted data. PLOTXY uses a slightly different format than PLOTJK for grid spacing and independent variable display.

Figure 5-46 contains a flowchart and Table 5-46 a listing.

5.14.9 Array Output Routines

The array output routines were designed to provide the user with a maximum amount of debugging information in a compact tabular format. Each of the five subroutines outputs the values of a matrix of fixed dimensions along with its identifier name. Various other information labeling the dimensions of the matrix is also displayed.

5.14.10 Subroutine PRINT1

Subroutine PRINT1 displays two variables, each dimensioned 10×5×3. Inputs to PRINT1 are the variable names for the two matrices and their respective values. Figure 5-47 presents a flowchart of subroutine PRINT1 and Table 5-47 a listing.

5.14.11 Subroutine PRINT2

Displays output similar to PRINT1 (10×3 matrix). See 5.14.10 for flowchart and listing format.

5.14.12 Subroutine PRINT3

Displays output similar to PRINT1 (10×15 matrix). See 5.14.10 for flowchart and listing format.

5.14.13 Subroutine PRINT4

Displays output similar to PRINT1 (10×15×4 matrix). See 5.14.10 for flowchart and listing format.

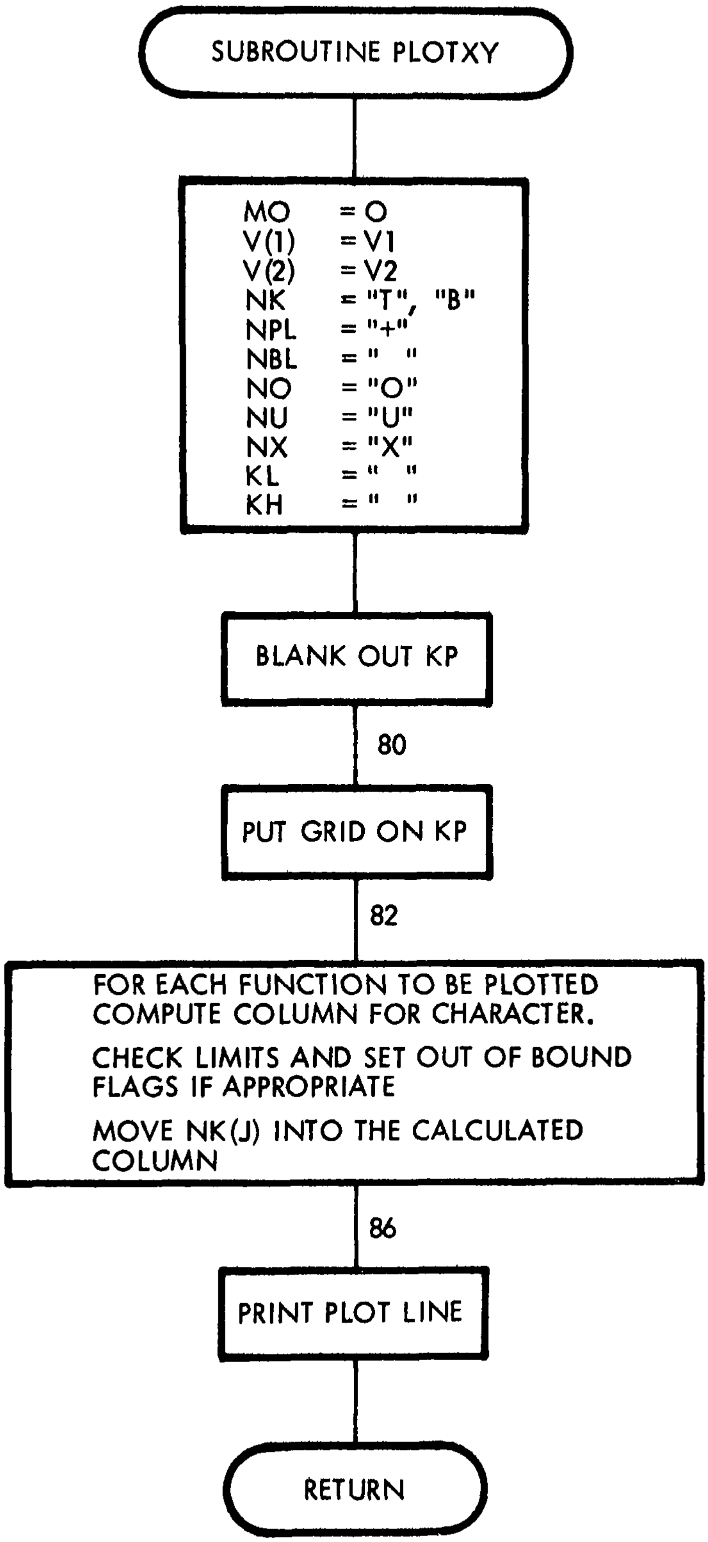


Figure 5-46 Subroutine PLOTXY Flowchart

Table 5-46 SUBROUTINE PLOTXY LISTING

```
      SUBROUTINE PLOTXY(NC,T,V1,V2,VMX,VMN)
      DIMENSION KP(91),V(2),NK(2)
      MO=0
C
C     DEFINE SYMBOLS
C
      V(1)=V1
      V(2)=V2
      NK(1)=1HT
      NK(2)=1HB
      NPL=1H+
      NBL=1H
      NO=1HO
      NU=1HU
      NX=1HX
      KL=NBL
      KH=NBL
C
C     FILL IN BLANK FIELD
C
      DO 80 I=1,91
   80 KP(I)=NBL
C
C     SET UP GRID
C
      DO 82 I=1,91,15
   82 KP(I)=NPL
      DO 86 J=1,NC
      IF (NC.EQ.0) GOTO 206
C
C     COMPUTE COLUMN NUMBER FOR EACH POINT
C
      CHI=(VMX-VMN)/90
      II=(V(J)-VMN)/CHI+1.5
      IF (II) 83,83,84
   83 MU=MU-1
      GO TO 86
   84 IF (92-II) 85,85,101
   85 MO=MO+1
      GO TO 86
  101 M=II
```

Table 5-46 SUBROUTINE PLOTXY LISTING (cont.)

```
                    KP(M)=NK(J)
                 86 CONTINUE
          C
          C         CHECK FOR POINTS THAT ARE OUT OF BOUNDS
          C
                111 IF(MU) 201,202,202
                201 KL=NU
                    GO TO 203
                202 KL=NBL
                203 IF(MO) 204,204,205
                204 KH=NBL
                    GO TO 206
                205 KH=NO
          C
          C         PRINT LINE
          C
                206 IT=T
                    WRITE (6,150) IT,KL,KP,KH
                150 FORMAT(5X,I3,2X,93A1)
                    RETURN
                    END
```

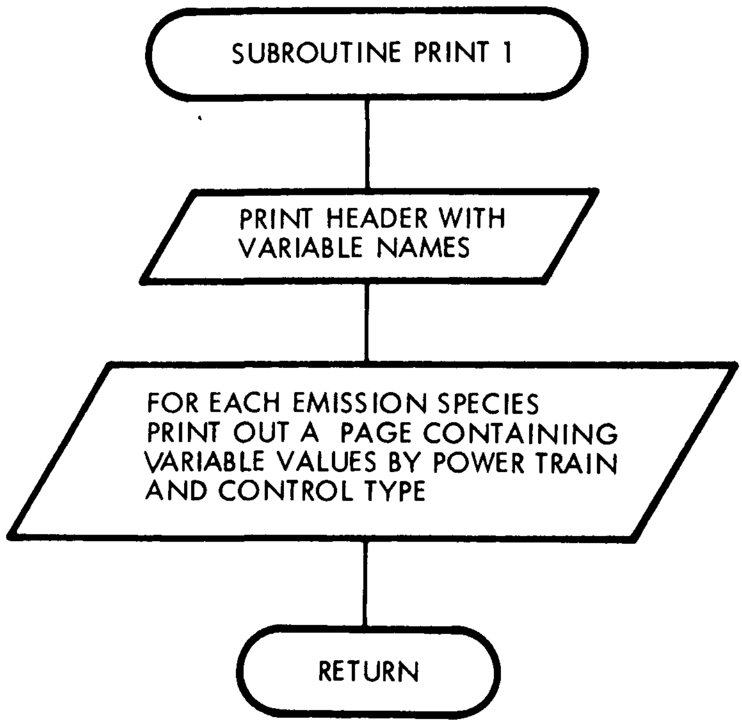


Figure 5-47 Subroutine PRINT1 Flowchart

Table 5-47 SUBROUTINE PRINT1 LISTING

```
      SUBROUTINE PRINT1(VAR1,VNAME1,VAR2,VNAME2)
      DIMENSION VAR1(10,15,3),VNAME1(5)
      DIMENSION VAR2(10,15,3),VNAME2(5)
        COMMON /COM01/ AMB(3),ALAB,      AVV, BINT,
     +    BAREA(3), BLD1,      BLD2,      BSIG(3),  BXTRA,     BSIZE,
     +    BHIST(3,16),         BMMI(10,15,3),
     +    ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
        COMMON /COM02/         CARA,      CARIY,    CARMY,     CARPOP(16),
     +    CARSY,     CBSUM,    CCOEF(10),CCOSTI,   CCOSTM,    CGTT,
     +    CINCON,    CPCB,  CPI,       CPVPY,    CSUM,      CARAY,
     +    CN(15,3,16),         COEFB(15,3),         COEFBP(10,15),
     +    CPART(10,15)
CC ADD2
        COMMON /COM03/         DELPCV,    DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),   DELIT(3),
     +    FREQA,     FREQB,    FPERC(10,3),
     +    HORZN,     HORZNY,
     +    HPC(15,16),          HPCS(15,16),         HPP(10,15,16),
     +    HPS(6,15,16),        HPT(5,16),           HPTOT(16),
     +    HPTCTS(16)
CC ADD3
        COMMON /COM04/         ITE,       ITL,      ITP,       ITIME(16),
     +    KSTART,    KSTOP,    LOPT, LPICK(10),LLPICK,
     +    LIDLE,     LINT(16), LPSPP(10),LSTART,    LSTOP,
     +    MBASE,     MPH,      MSPEC(10),MSTART,    MSTOP,
     +    MU(10,3),    MMS(10,15),           MVPR(10,15)
CC ADD4
        COMMON /COM05/         NAME(50), NCNTR,     NEMIS,     NEMP,
     +    NINTR,     NINTRB,   NMODE,    NO,        NOPTS,     NPAR,
     +    NPTRN,     NPTS,     NSTEPS,   NTR,       NTRB,      NPICK(16),
     +    OCIY,      OCMY,     OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
        COMMON /COM06/PARM(3,3), PART,      PAYNEW,   PAYOFF(3),
     +    PC(15),    PCS(15),  PHI(14),  PLO(14),   PLTMAX(3),PMODEL,
     +    PP(10,15),PS(6,15), PT(5),    PTOT,      PTS(5),  PAYADJ,
     +    PAR(10,15,3),        PAR1(10,3,3),        PLUS(10,15),
     +    PM(10,15),           PPICK(10),PPPICK,PSTAR,PI(15,10),
     +    PSA(15),   PTA(5),   PCONF,    PARINT(10,10,9)
     + ,PAYFIN
        COMMON /COM07/         REINSP,   RNAME,     RSIZE,     RSTOP,
     +    RTYPE,
```

```
     +    SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
     +    SMODEL,   START(15,3), STAT,     STIME(3), SUMBM(3),
     +    SCALEBM(3),         SM(6,15),           SPAR(10,15,6),
     +    SXCUT(6,3),         SIG(10,3),           SIGCE(3),
     +    SIGME(10),          SIGMNE(10),         SIGP(10,15),
     +    SIGRATE,  SIST,      SIGS(6,15),         SIGSDE(3),
     +    STABLEX(33,6,15),    STABLEY(33,6,15)
      COMMON /COM10/          TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +    TINT,     TOBE(3),  TONX,     TOTE(3),  TPDB(3),  TPDT(3),
     +    TXTRA,    TSIZE,     TSIG(3),  TPER(16,15),  TMIL(16,15),
     +    THIST(5,3,16),      THISTT(3,16),       TIMEC(10,15),
     +    TIMEM(10,15),       TABLEX(33,10,15),    TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/          WF(10),
     +    X1BP(3,3,6), XINT,     XINTB,    XLANE,    XSUM, XCUT(10,3),
     +    XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/          Y1BP(3,3,10),       Y2BP(3,3,10),
     +    YES,      YSUM,     YTM(16),     Y1DBP(4,4,10),Y2DBP(4,4,10),
     +    Z1,       Z2,       Z3,       Z4,       Z5,       Z6,
     +    Z7,       Z8,       Z9,       Z10,      Z11,      Z12,
     +    Z13,      Z14,      Z15,      Z16,      Z17,
     +    ZCARI,    ZCARM,    ZIC,      ZSUM,
     +    ZZ(3,3)
CC ADD12
      COMMON /DEBUG/          ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +    LDEBUG,   MDEBUG,   PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL                ITE,      ITL,      ITP,      ITIME,
     +    MMS,      MPH,      MSPEC,    MU,       MVPR,
     +    NAME,     NO,       LDEBUG,   MDEBUG,
     +    IN,       MISFIRE
      INTEGER             RNAME,    SITEI,    SITEM,    STAT,
     +    TDIST,    XLANE,    OPTI,     PPICK,    PPPICK
      WRITE (6,10) VNAME1,VNAME2
   10 FORMAT(35X,*VARIABLE  - A - *5A10/
     + 35X,*VARIABLE  - B - *5A10)
      DO 100 I=1,NEMIS
      IF(I.GT.1) WRITE (6,999)
      WRITE (6,200) NAME(I)
  200 FORMAT(/,43X,A2,* EMISSION DELTA*)
      DO 50 JJ=1,NPTRN
```

Table 5-47 SUBROUTINE PRINT1 LISTING (cont.)

```
      WRITE (6,20) JJ,NAME(JJ+10),(M,M=1,NPAR)
   20 FORMAT(/,40X,*POWERTRAIN*,I3,* -- *,A10//
     + * PARAMETER*,10(3X,I2,5X))
      DO 90 K=KSTART,KSTOP
      J=JJ+5*(K-1)
      WRITE (6,40) NAME(K+3),(VAR1(M,J,I),M=1,NPAR),
     + (VAR2(M,J,I),M=1,NPAR)
   40 FORMAT(/,A8,* A*,10E10.2/8X,* B*,10E10.2)
   90 CONTINUE
   50 CONTINUE
  100 CONTINUE
  999 FORMAT(1H1)
      RETURN
      END
```

5.14.14 Subroutine PRINT5

Displays output similar to PRINT1 (6×15 matrix). See 5.14.10 for flowchart and listing format.

5.14.15 Subroutine PRINT6

Subroutine PRINT6 is the main output routine for the attrition model. PRINT6 displays a summary of the vehicle population and annual miles travelled distributions along with a summary level emission rate report by control type. Figure 5-48 contains a flowchart of PRINT6 and Table 5-48 a listing.

5.15 BLOCK DATA ROUTINE

The majority of the data in GEEP is normally invariant under the various inspection/maintenance alternatives. Consequently, nominal values for all data sets are permanently stored in the BLOCK DATA routine. BLOCK DATA is a non-executable function, but provides a convenient method of grouping the data.

The listing in Table 5-49 contains detailed information concerning the values of the various data sets.

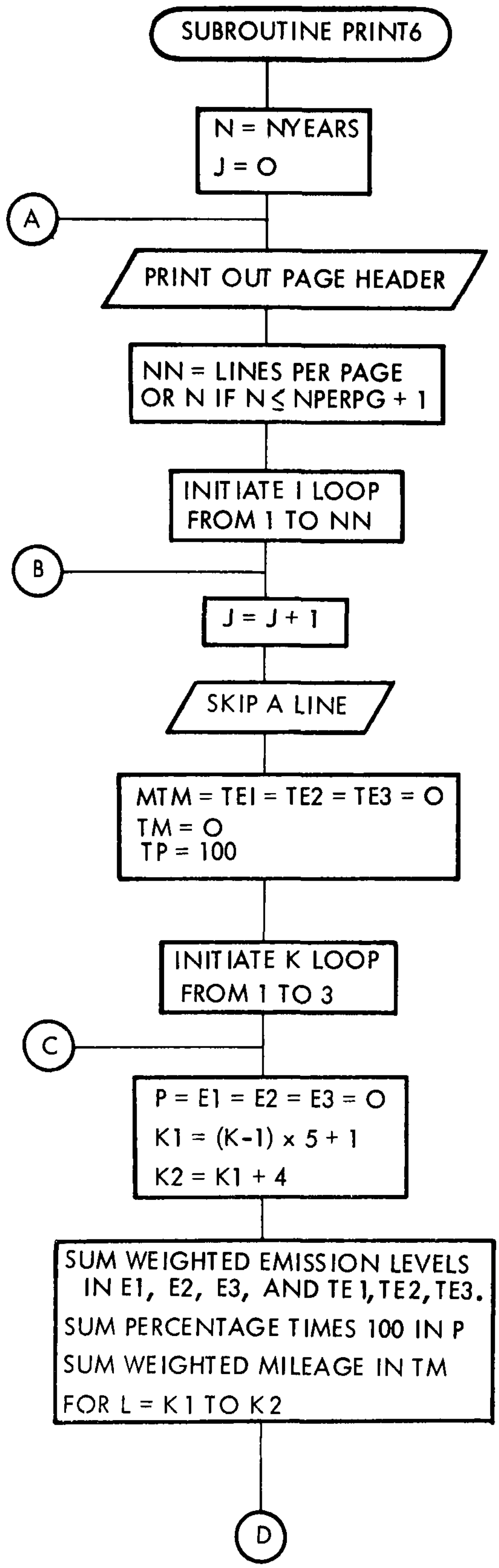


Figure 5-48 Subroutine PRINT6 Flowchart

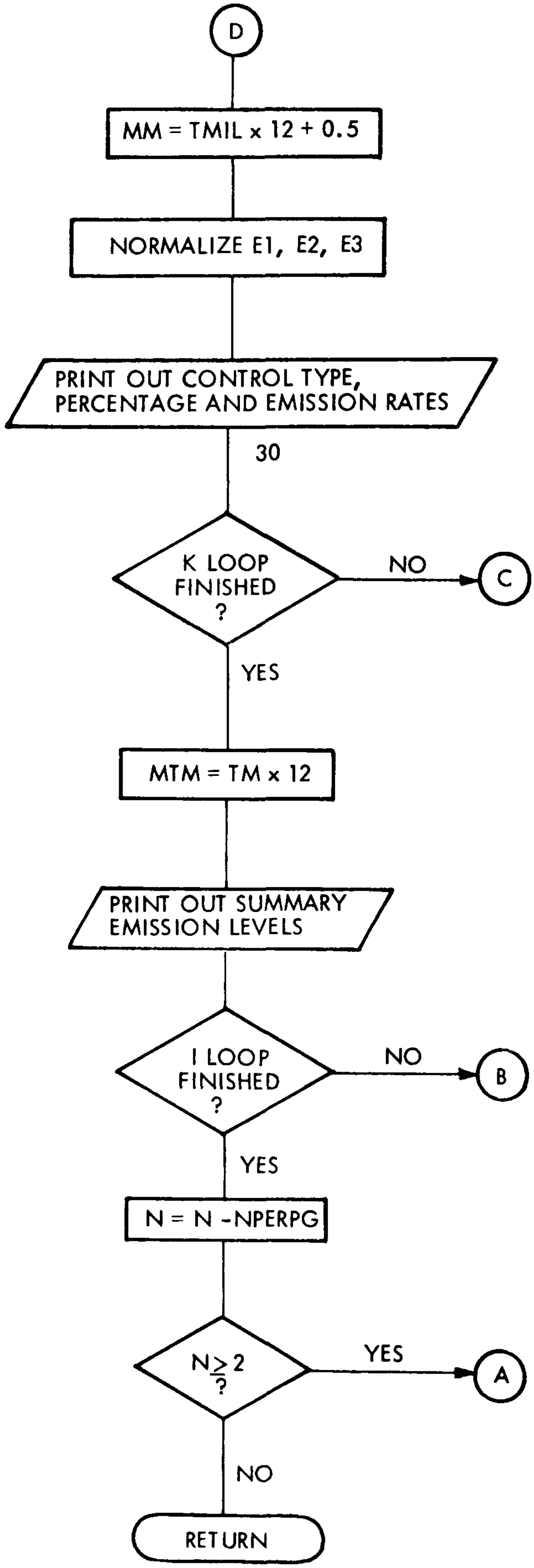


Figure 5-48 Subroutine PRINT6 Flowchart (cont.)

Table 5-48 SUBROUTINE PRINT6 LISTING

```
      SUBROUTINE PRINT6(EMIS,TPER,TMIL,NYEARS,CARPOP)
      DIMENSICN CARPOP(16)
      DIMENSICN EMIS(15,3,16),TPER(16,15),TMIL(16,15)
      DIMENSION HEAD(4,4)
      DATA HEAD/
     * 6HPRECCN,6HTROLLE,6HD     ,6H
     *,6HCONTRO,6HLLED (,6H1966-1,6H970)
     *,6HPOST 1,6H970   ,6H      ,6H
     *,6H      ,6HTOTALS,6H      ,6H
     *  /
      DATA NPERPG/6/
      N=NYEARS
      J=0
 10   WRITE(6,100)
      NN=NPERPG
      IF(N.LE.NPERPG+1) NN=N
      DO 20 I=1,NN
      J=J+1
      WRITE(6,110)
      MTM=TE1=TE2=TE3=0
      TM=0
      TP=100.
      DO 30 K=1,3
      P=0
      E1=0
      E2=0
      E3=0
      K1=(K-1)*5+1
      K2=K1+4
      DO 40 L=K1,K2
      P=P+TPER(J,L)*100
      E1=E1+EMIS(L,1,J)*TPER(J,L)
      E2=E2+EMIS(L,2,J)*TPER(J,L)
      E3=E3+EMIS(L,3,J)*TPER(J,L)
      TE1=TE1+EMIS(L,1,J)*TPER(J,L)
      TE2=TE2+EMIS(L,2,J)*TPER(J,L)
      TE3=TE3+EMIS(L,3,J)*TPER(J,L)
      TM=TM+TMIL(J,L)*TPER(J,L)
 40   CONTINUE
      MMM=TMIL(J,K1)*12.+0.5
      IF(P.GT.0.0001) E3=E3*100./P
```

Table 5-48 SUBROUTINE PRINT6 LISTING (cont.)

```
      IF(P.GT.0.0001) E2=E2*100./P
      IF(P.GT.0.0001) E1=E1*100./P
      WRITE(6,120) (HEAD(M,K),M=1,4),P,MMM,E1,E2,E3
   30 CONTINUE
      MTM=TM*12.
      WRITE(6,140) J,(HEAD(M,4),M=1,4),TP,MTM,TE1,TE2,TE3,CARPOP(J)
   20 CONTINUE
      N=N-NPERPG
      IF(N.GE.2) GOTO 10
      RETURN
  100 FORMAT(1H1,/,44X,*VEHICLE POPULATION CHARACTERISTICS*,
     * //, 1X,*YEAR*,24X,
     *        *VEHICLE DISTRIBUTION  INCREMENTAL ODOMETER*,
     * *   VEHICLE EMMISSION LEVELS  VEHICLE*,
     *                                   /,36X,*PERCENT*,17X,
     * *READING*,9X,*HC*,7X,*CO*,6X,*NO   POPULATION*,/,
     * 61X,*MILES*,15X,*GRAMS/MILE*)
  110  FORMAT(1H )
  120 FORMAT(7X,4A6,3X,F8.1,17X,I6,4X,F10.2,F9.2,F8.2)
  140 FORMAT(2X,I2,3X,4A6,3X,F8.1,17X,I6,4X,F10.2,F9.2,F8.2,F12.0)
  130 FORMAT(1H1)
      END
```

Table 5-49 BLOCK DATA ROUTINE LISTING

```
      BLOCK DATA
      COMMON /COM01/ AMB(3),ALAB,     AVV,  BINT,
     +   BAREA(3), BLD1,     BLD2,     BSIG(3),  BXTRA,    BSIZE,
     +   BHIST(3,16),        BMMI(10,15,3),
     +   ATABLEX(9,10,3),ATABLEY(9,10,3),ASTABLX(9,6,3),ASTABLY(9,6,3)
      COMMON /COM02/         CARA,     CARIY,    CARMY,    CARPOP(16),
     +   CARSY,    CBSUM,    CCOEF(10),CCOSTI,   CCOSTM,   CGTT,
     +   CINCON,   CPCB,  CPI,      CPVPY,    CSUM,     CARAY,
     +   CN(15,3,16),        COEFB(15,3),        COEFBP(10,15),
     +   CPART(10,15)
CC ADD2

      COMMON /COM03/         DELPCV,   DP(10,15),DELEM(3,16),DELI(3),
     + EMW(3),       EP(10,15),EFF(10),  DELIT(3),
     +   FREQA,    FREQB,    FPERC(10,3),
     +   HORZN,    HORZNY,
     +   HPC(15,16),         HPCS(15,16),        HPP(10,15,16),
     +   HPS(6,15,16),       HPT(5,16),          HPTOT(16),
     +   HPTOTS(16)
CC ADD3
      COMMON /COM04/         ITE,      ITL,      ITP,      ITIME(16),
     +   KSTART,   KSTOP,    LOPT, LPICK(10),LLPICK,
     +   LIDLE,    LINT(16), LPSPP(10),LSTART,   LSTOP,
     +   MBASE,    MPH,      MSPEC(10),MSTART,   MSTOP,
     +   MU(10,3),   MMS(10,15),         MVPR(10,15)
CC ADD4
      COMMON /COM05/         NAME(50), NCNTR,    NEMIS,    NEMP,
     +   NINTR,    NINTRB,   NMODE,    NO,       NOPTS,    NPAR,
     +   NPTRN,    NPTS,     NSTEPS,   NTR,      NTRB,     NPICK(16),
     +   OCIY,     OCMY,     OPTI,     OPTM,OPTS(50),OVCHI(3),OVCHM(3)
CC ADD5
      COMMON /COM06/PARM(3,3),  PART,     PAYNEW,   PAYOFF(3),
     +   PC(15),   PCS(15),  PHI(14),  PLO(14),  PLTMAX(3),PMODEL,
     +   PP(10,15),PS(6,15), PT(5),    PTOT,     PTS(5),   PAYADJ,
     +   PAR(10,15,3),       PAR1(10,3,3),       PLUS(10,15),
     +   PM(10,15),          PPICK(10),PPPICK,PSTAR,PI(15,10),
     +   PSA(15),  PTA(5),   PCONF,    PARINT(10,10,9)
     + ,PAYFIN
      COMMON /COM07/         REINSP,   RNAME,    RSIZE,    RSTOP,
     +   RTYPE,
     +   SALE,     SALL,     SALP,     SITEI,    SITEM,    SLANE,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     +     SMODEL,   START(15,3), STAT,       STIME(3), SUMBM(3),
     +     SCALEBM(3),          SM(6,15),             SPAK(10,15,6),
     +     SXCUT(6,3),          SIG(10,3),             SIGCE(3),
     +     SIGME(10),           SIGMNE(10),           SIGP(10,15),
     +     SIGRATE,  SIST,       SIGS(6,15),           SIGSDE(3),
     +     STABLEX(33,6,15),     STABLEY(33,6,15)
      COMMON /COM10/           TAREA(3), TDIST(10,3),TIDLE,TIMEI(3,16),
     +     TINT,     TOBE(3),   TONX,     TOTE(3),  TPDB(3),  TPUT(3),
     +     TXTRA,    TSIZE,      TSIG(3),  TPER(16,15),  TMIL(16,15),
     +     THIST(5,3,16),       THISTT(3,16),         TIMEC(10,15),
     +     TIMEM(10,15),        TABLEX(33,10,15),      TABLEY(33,10,15)
CC ADD10
      COMMON /COM11/           WF(10),
     +     X1BP(3,3,6), XINT,     XINTB,    XLANE,     XSUM, XCUT(10,3),
     +     XTM(16),  XBASE(9,3),YBASE(9,3)
CC ADD11
      COMMON /COM12/           Y1BP(3,3,10),         Y2BP(3,3,10),
     +     YES,      YSUM,      YTM(16),      Y1DBP(4,4,10),Y2DBP(4,4,10),
     +     Z1,       Z2,        Z3,       Z4,       Z5,       Z6,
     +     Z7,       Z8,        Z9,       Z10,      Z11,      Z12,
     +     Z13,      Z14,       Z15,      Z16,      Z17,
     +     ZCARI,    ZCARM,     ZIC,      ZSUM,
     +     ZZ(3,3)
CC ADD12
      COMMON /DEBUG/           ADEBUG,   BDEBUG,   CDEBUG,   DDEBUG,
     +     LDEBUG,   MDEBUG,    PDEBUG,   QDEBUG,   SDEBUG,   TDEBUG
CC ADDD
      REAL                 ITE,       ITL,      ITP,      ITIME,
     +     MMS,      MPH,       MSPEC,    MU,       MVPR,
     +     NAME,     NO,        LDEBUG,   MDEBUG,
     +     IN,       MISFIRE
      INTEGER              PNAME,     SITEI,    SITEM,    STAT,
     +     TDIST,    XLANE,     OPTI,     PPICK,    PPPICK
      DATA PI/150*1.0/
     DATA NAME/2HHC,2HCO,2HNO,8H UNCONTR,8H CONTR  ,8H POST 70,
     + 10H  IDLE     ,10H IGNITION ,10H INDUCTION ,
     + 1H ,8H   GM   ,8H  FORD  ,8H  CHRY  ,
     + 8H  AMC   ,8H IMPORTS ,5*1H ,
     + 10H   LOS ANG,10HELES BASIN,10H NEW YORK/,
     + 10HNEW JERSEY,10H    WASHIN,10HGTON D. C.,
     + 10H          ,10H    DENVER,10HDETROIT     ,1H ,
     + 10H IDLE CO  ,10H    RPM   ,10H TIMING   ,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     + 10H MISFIRE  ,10H   NOX    ,10H AIR PUMP ,
     + 10H   PCV    ,10HAIR CLEAN ,10HVAC KICK  ,
     + 10HHEAT RISER,
     + 10H HC - IDLE,10H CO - IDLE,10H NO - IDLE     ,
     + 10H HC - 45  ,10H CO - 45  ,10H NO - 45  /
CC    DATA FOR SUBROUTINE COST
      DATA REINSP,XLANE,TIDLE/0.,1,1./
       DATA BLD1,BLD2,ALAB,AVV/600.,600.,1250.,30./
       DATA SALE,SALL,SALP,ZIC,ITE,ITL,ITP/0.,1.,0.,.07,4.,30.,30./
      DATA NEMP/2/
       DATA CPCB/40./
      DATA Z1,Z2,Z3,Z4,Z5/.33,10.,10.,.07/
       DATA Z6,Z7,Z8,Z9,Z10/500.,.25,0.,2.,10./
      DATA Z11,Z12,Z13,Z14,Z15/16000.,5000.,2.,.5,1./
      DATA Z16,Z17/3.5,7000./
      DATA ZZ/20000.,33000.,45000.,32000.,54000.,76000.,
     + 35000.,60000.,85000./
      DATA STAT/80/
      DATA LIDLE/1/
      DATA YES,NO/3HYES,2HNO/
      DATA RSTOP,RTYPE/2HNO,9HPARAMETER/
      DATA PMODEL,SMODEL/9HPARAMETER,9HSIGNATURE/
      DATA BDEBUG,MDEBUG,TDEBUG,CDEBUG,ADEBUG,LDEBUG,PDEBUG,
     + DDEBUG,QDEBUG,SDEBUG/10*2HNO/
      DATA PLTMAX/10.,150.,10./
      DATA OPTS/10HDEBUG     ,10HPARAMETER ,10HSIGNATURE ,
     + 10HSTOP      ,10HUNCONTROL ,10HCONTROL   ,
     + 10HPOST 70   ,10HIDLE      ,10HIGNITION  ,10HINDUCTION ,
     + 10HBLINE     ,10HMICRO     ,10HTEST      ,
     + 10HCOSTS     ,10HAREA      ,10HCUTPTS    ,10HPDECAY     ,
     + 10HDATA      ,10HMDECAY    ,10HSTATS     ,
     + 10HLA        ,10HNY        ,10HWASH      ,
     + 10HDENVER    ,10HLOADED    ,10HUNLOADED  ,10HHYBRID     ,
     + 10HSTATE     ,10HGARAGE    ,
     + 10HICO       ,10HIHC       ,10HHC45      ,10HCO45       ,
     + 10HMISFIRE   ,10HDETROIT   ,10HINO       ,10HNO45        /
      DATA NPICK/16*0/
      DATA NOPTS/37/
      DATA DELPCV/5./
      DATA FPERC/.8,25.,1.0,.005,0.,0.,0.1,20.,0.,0.,
     * .9,30.,1.0,.005,0.,0.,0.1,30.,0.,0.,
     * 1.0,35.,1.0,.006,.1,0.,0.1,40.,0.,0./
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
      DATA LPSPP/2,1,1,4,0,5,5,5,0,0/
      DATA LINT /2,1,2,0,0,0,1,2,1,0,2,2,0,2,2,0/
      DATA PLO/.01,0.,0.,0.,0.,0.,-.4,0.,0.,0.,4*.01/
      DATA PHI/8.,0.,0.,5.,0.,0.,1.6,180.,0.,0.,8.,700.,
     + 500.,6./
      DATA SCALEBM/3*1./
      DATA HORZN,MBASE,TINT/60.,  685  ,12./
      DATA NEMIS,NPTRN,NCNTR,NPAR,NSTEPS,NPTS/3,5,3,10,32,9/
      DATA NMODE/6/
      DATA MMS/150*0./
      DATA FREQA,FREQB/.4,.6/
      DATA CGTT/9.08E5/
      DATA BINT/12./
      DATA OVCHI/1.5,5.0,5.0/
      DATA OVCHM/0.,12.,15./
CC    TIME ELEMENTS USED IN CALCULATION OF COSTS
      DATA TIMEM/
     + 0.1,0.1,0.1,1.0,0.,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.7,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.7,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.7,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.7,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.,0.7,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.75,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.75,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.75,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.75,0.,0.1,0.05,0.25,0.25,
     + 0.1,0.1,0.1,1.0,0.75,0.,0.1,0.05,0.25,0.25/
      DATA STIME/1.5,2.4,2.4/
      DATA TIMEC/
     + 0.05,0.05,0.05,0.15,0.,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.25,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.25,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.25,0.1,0.05,0.1,0.05,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     + 0.05,0.05,0.05,0.15,0.,0.25,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.,0.25,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.10,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.10,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.10,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.10,0.,0.1,0.05,0.1,0.05,
     + 0.05,0.05,0.05,0.15,0.10,0.,0.1,0.05,0.1,0.05/
      DATA CPART/
     + 0.,0.,0.,17.,0.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,47.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,47.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,47.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,47.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,0.,47.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,20.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,20.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,20.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,20.,0.,2.0,5.0,0.,0.,
     + 0.,0.,0.,17.,20.,0.,2.0,5.0,0.,0./
      DATA EFF/.60,.85,.70,.85,.20,.20,.80,.75,.20,.40/
      DATA WF/1.,2.,2.,7*1./
      DATA OPTI,OPTM/1,1/
      DATA (COEFBP(I),I=1,50) /
     + 2.50E-4,-1.0E-3,8.00E-5,5.2E-6,0.,0.,-5.00E-5,6.86E-3,-2.4E-6,
     + 5.99E-5,
     + 2.50E-4,-1.0E-3,8.00E-5,5.2E-6,0.,0.,-5.00E-5,6.86E-3,-2.4E-6,
     + 5.99E-5,
     + 2.50E-4,-1.0E-3,8.00E-5,5.2E-6,0.,0.,-5.00E-5,6.86E-3,-2.4E-6,
     + 5.99E-5,
     + 2.50E-4,-1.0E-3,8.00E-5,5.2E-6,0.,0.,-5.00E-5,6.86E-3,-2.4E-6,
     + 5.99E-5,
     + 2.50E-4,-1.0E-3,8.00E-5,5.2E-6,0.,0.,-5.00E-5,6.86E-3,-2.4E-6,
     + 5.99E-5/
      DATA (COEFBP(I),I=51,100) /
     +1.5E-4,-7.5E-4,6.7E-5,3.E-6,0.,8.15E-6,-3.25E-5,5.0E-3,-2.3E-6,
     + 3.76E-5,
     +1.5E-4,-7.5E-4,6.7E-5,3.E-6,0.,8.15E-6,-3.25E-5,5.0E-3,-2.3E-6,
     + 3.76E-5,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     +1.5E-4,-7.5E-4,6.7E-5,3.E-6,0.,3.15E-6,-3.25E-5,5.0E-3,-2.3E-6,
     + 3.76E-5,
     +1.5E-4,-7.5E-4,6.7E-5,3.E-6,0.,3.15E-6,-3.25E-5,5.0E-3,-2.3E-6,
     + 3.76E-5,
     +1.5E-4,-7.5E-4,6.7E-5,3.E-6,0.,3.15E-6,-3.25E-5,5.0E-3,-2.3E-6,
     + 3.76E-5/
      DATA (CCEFBP(I),I=101,150) /
     + 1.0E-4,-4.0E-4,4.E-5,1.5E-6,5.93E-6,0.,-2.00E-5,3.0E-3,
     + -1.8E-6,0.,
     + 1.0E-4,-4.0E-4,4.E-5,1.5E-6,5.93E-6,0.,-2.00E-5,3.0E-3,
     + -1.8E-6,0.,
     + 1.0E-4,-4.0E-4,4.E-5,1.5E-6,5.93E-6,0.,-2.00E-5,3.0E-3,
     + -1.8E-6,0.,
     + 1.0E-4,-4.0E-4,4.E-5,1.5E-6,5.93E-6,0.,-2.00E-5,3.0E-3,
     + -1.8E-6,0.,
     + 1.0E-4,-4.0E-4,4.E-5,1.5E-6,5.93E-6,0.,-2.00E-5,3.0E-3,
     + -1.8E-6,0./
      DATA PARM/3.E-5,9.6E-6,5.2E-6,2.E-4,1.2E-4,9.9E-5,
     + -8.8E-6,-6.6E-7,-5.9E-6/
CC    PARTIALS -- DELTA EMISSION/DELTA PARAMETER
      DATA (PAR(I),I=1,150)/
     + 0.3756,-3.73E-3,.08683,27.23,0.,0.,0.06192,7.48E-3,-1.372E-3,0.,
     + 0.3756,-3.73E-3,.08683,27.23,0.,0.,0.06192,7.48E-3,-1.372E-3,0.,
     + 0.3756,-3.73E-3,.08683,27.23,0.,0.,0.06192,7.48E-3,-1.372E-3,0.,
     + 0.3756,-3.73E-3,.08683,27.23,0.,0.,0.06192,7.48E-3,-1.372E-3,0.,
     + 0.3756,-3.73E-3,.08683,27.23,0.,0.,0.06192,7.48E-3,-1.372E-3,0.,
     + 0.0286,-5.5E-3,0.0498,22.71,0.,0.602,-0.0801,9.1E-4,0.,0.,
     + 0.0286,-5.5E-3,0.0498,22.71,0.,0.602,-0.0801,9.1E-4,0.,0.,
     + 0.0286,-5.5E-3,0.0498,22.71,0.,0.602,-0.0801,9.1E-4,0.,0.,
     + 0.0286,-5.5E-3,0.0498,22.71,0.,0.602,-0.0801,9.1E-4,0.,0.,
     + 0.0286,-5.5E-3,0.0498,22.71,0.,0.602,-0.0801,9.1E-4,0.,0.,
     + 0.09798,3.43E-4,0.11294,18.89,0.601,0.,-0.1758,1.31E-3,0.,0.,
     + 0.09798,3.43E-4,0.11294,18.89,0.601,0.,-0.1758,1.31E-3,0.,0.,
     + 0.09798,3.43E-4,0.11294,18.89,0.601,0.,-0.1758,1.31E-3,0.,0.,
     + 0.09798,3.43E-4,0.11294,18.89,0.601,0.,-0.1758,1.31E-3,0.,0.,
     + 0.09798,3.43E-4,0.11294,18.89,0.601,0.,-0.1758,1.31E-3,0.,0./
      DATA (PAR(I),I=151,300)/
     + 6.6214,0.0434,-1.066,0.,0.,0.,-2.729,0.1472,-0.041,0.,
     + 6.6214,0.0434,-1.066,0.,0.,0.,-2.729,0.1472,-0.041,0.,
     + 6.6214,0.0434,-1.066,0.,0.,0.,-2.729,0.1472,-0.041,0.,
     + 6.6214,0.0434,-1.066,0.,0.,0.,-2.729,0.1472,-0.041,0.,
     + 6.6214,0.0434,-1.066,0.,0.,0.,-2.729,0.1472,-0.041,0.,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     + 7.178,0.02124,-0.342,0.,0.,7.51,-1.912,0.0764,-0.2978,2.999,
     + 7.178,0.02124,-0.342,0.,0.,7.51,-1.912,0.0764,-0.2978,2.999,
     + 7.178,0.02124,-0.342,0.,0.,7.51,-1.912,0.0764,-0.2978,2.999,
     + 7.178,0.02124,-0.342,0.,0.,7.51,-1.912,0.0764,-0.2978,2.999,
     + 7.178,0.02124,-0.342,0.,0.,7.51,-1.912,0.0764,-0.2978,2.999,
     + 11.433,0.04845,-1.3477,0.,-7.302,0.,-9.751,0.1142,-0.2978,2.999,
     + 11.433,0.04845,-1.3477,0.,-7.302,0.,-9.751,0.1142,-0.2978,2.999,
     + 11.433,0.04845,-1.3477,0.,-7.302,0.,-9.751,0.1142,-0.2978,2.999,
     + 11.433,0.04845,-1.3477,0.,-7.302,0.,-9.751,0.1142,-0.2978,2.999,
     + 11.433,0.04845,-1.3477,0.,-7.302,0.,-9.751,0.1142,-0.2978,2.999/
      DATA (PAR(I),I=301,450)/
     + -0.1714,1.05E-3,0.1724,0.,0.,0.,0.037,-4.2E-3,0.1710,-0.439,
     + -0.1714,1.05E-3,0.1724,0.,0.,0.,0.037,-4.2E-3,0.1710,-0.439,
     + -0.1714,1.05E-3,0.1724,0.,0.,0.,0.037,-4.2E-3,0.1710,-0.439,
     + -0.1714,1.05E-3,0.1724,0.,0.,0.,0.037,-4.2E-3,0.1710,-0.439,
     + -0.1714,1.05E-3,0.1724,0.,0.,0.,0.037,-4.2E-3,0.1710,-0.439,
     + 0.0    ,2.5E-4,0.095,0.,0.,0.,0.0801,-2.1E-3,0.,0.,
     + 0.0    ,2.5E-4,0.095,0.,0.,0.,0.0801,-2.1E-3,0.,0.,
     + 0.0    ,2.5E-4,0.095,0.,0.,0.,0.0801,-2.1E-3,0.,0.,
     + 0.0    ,2.5E-4,0.095,0.,0.,0.,0.0801,-2.1E-3,0.,0.,
     + 0.0    ,2.5E-4,0.095,0.,0.,0.,0.0801,-2.1E-3,0.,0.,
     + -0.0271,4.34E-4,0.1558,0.,0.716,0.,0.132,-2.62E-3,0.,0.,
     + -0.0271,4.34E-4,0.1558,0.,0.716,0.,0.132,-2.62E-3,0.,0.,
     + -0.0271,4.34E-4,0.1558,0.,0.716,0.,0.132,-2.62E-3,0.,0.,
     + -0.0271,4.34E-4,0.1558,0.,0.716,0.,0.132,-2.62E-3,0.,0.,
     + -0.0271,4.34E-4,0.1558,0.,0.716,0.,0.132,-2.62E-3,0.,0./
      DATA COUEF/.165,.0066,.006,.2,0.,.02,2.,1.,.2,20./
      DATA (SPAR(I),I=1,150)/
     + 36.162,-1.655,17.81,137.57,0.,0.,0.,0.04749,0.,0.,
     + 36.162,-1.655,17.81,137.57,0.,0.,0.,0.04749,0.,0.,
     + 36.162,-1.655,17.81,137.57,0.,0.,0.,0.04749,0.,0.,
     + 36.162,-1.655,17.81,137.57,0.,0.,0.,0.04749,0.,0.,
     + 36.162,-1.655,17.81,137.57,0.,0.,0.,0.04749,0.,0.,
     + 8.2706,-0.549,7.97,137.57,0.,56.85,0.,0.1755,0.,0.,
     + 8.2706,-0.549,7.97,137.57,0.,56.85,0.,0.1755,0.,0.,
     + 8.2706,-0.549,7.97,137.57,0.,56.85,0.,0.1755,0.,0.,
     + 8.2706,-0.549,7.97,137.57,0.,56.85,0.,0.1755,0.,0.,
     + 8.2706,-0.549,7.97,137.57,0.,56.85,0.,0.1755,0.,0.,
     + 13.53,-0.3424,11.55,137.57,105.8,0.,-2.968,-0.09418,0.,0.,
     + 13.53,-0.3424,11.55,137.57,105.8,0.,-2.968,-0.09418,0.,0.,
     + 13.53,-0.3424,11.55,137.57,105.8,0.,-2.968,-0.09418,0.,0.,
     + 13.53,-0.3424,11.55,137.57,105.8,0.,-2.968,-0.09418,0.,0.,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     + 13.53,-0.3424,11.55,137.57,105.8,0.,-2.968,-0.09418,0.,0./
      DATA (SPAR(I),I=151,300)/
     + 0.951,0.,3.207E-3,0.,0.,0.,-0.01358,0.,0.,0.,
     + 0.951,0.,3.207E-3,0.,0.,0.,-0.01358,0.,0.,0.,
     + 0.951,0.,3.207E-3,0.,0.,0.,-0.01358,0.,0.,0.,
     + 0.951,0.,3.207E-3,0.,0.,0.,-0.01358,0.,0.,0.,
     + 0.951,0.,3.207E-3,0.,0.,0.,-0.01358,0.,0.,0.,
     + 0.8712,3.4E-4,1.19E-3,0.,0.,0.9796,0.,1.8E-4,0.,0.,
     + 0.8712,3.4E-4,1.19E-3,0.,0.,0.9796,0.,1.8E-4,0.,0.,
     + 0.8712,3.4E-4,1.19E-3,0.,0.,0.9796,0.,1.8E-4,0.,0.,
     + 0.8712,3.4E-4,1.19E-3,0.,0.,0.9796,0.,1.8E-4,0.,0.,
     + 0.8712,3.4E-4,1.19E-3,0.,0.,0.9796,0.,1.8E-4,0.,0.,
     + 1.027,-4.219E-4,3.08E-4,0.,0.02534,0.,-0.0125,7.942E-5,0.,0.,
     + 1.027,-4.219E-4,3.08E-4,0.,0.02534,0.,-0.0125,7.942E-5,0.,0.,
     + 1.027,-4.219E-4,3.08E-4,0.,0.02534,0.,-0.0125,7.942F-5,0.,0.,
     + 1.027,-4.219E-4,3.08E-4,0.,0.02534,0.,-0.0125,7.942E-5,0.,0.,
     + 1.027,-4.219E-4,3.08E-4,0.,0.02534,0.,-0.0125,7.942E-5,0.,0./
      DATA (SPAR(I),I=301,450)/
     + -9.845,0.05804,0.7348,0.,0.,0.,-1.043,-7.923E-3,0.,0.,
     + -9.845,0.05804,0.7348,0.,0.,0.,-1.043,-7.923E-3,0.,0.,
     + -9.845,0.05804,0.7348,0.,0.,0.,-1.043,-7.923E-3,0.,0.,
     + -9.845,0.05804,0.7348,0.,0.,0.,-1.043,-7.923E-3,0.,0.,
     + -9.845,0.05804,0.7348,0.,0.,0.,-1.043,-7.923E-3,0.,0.,
     + -2.752,0.1153,-0.230,0.,0.,-2.848,-2.548,0.0150,0.,0.,
     + -2.752,0.1153,-0.230,0.,0.,-2.848,-2.548,0.0150,0.,0.,
     + -2.752,0.1153,-0.230,0.,0.,-2.848,-2.548,0.0150,0.,0.,
     + -2.752,0.1153,-0.230,0.,0.,-2.848,-2.548,0.0150,0.,0.,
     + -2.752,0.1153,-0.230,0.,0.,-2.848,-2.548,0.0150,0.,0.,
     + -38.35,0.3857,0.4285,0.,40.0,0.,-3.941,-0.04358,0.,0.,
     + -38.35,0.3857,0.4285,0.,40.0,0.,-3.941,-0.04358,0.,0.,
     + -38.35,0.3857,0.4285,0.,40.0,0.,-3.941,-0.04358,0.,0.,
     + -38.35,0.3857,0.4285,0.,40.0,0.,-3.941,-0.04358,0.,0.,
     + -38.35,0.3857,0.4285,0.,40.0,0.,-3.941,-0.04358,0.,0./
      DATA (SPAR(I),I=451,600)/
     + 1.959,-0.02213,4.201,128.0,0.,0.,-5.916,0.08041,0.,0.,
     + 1.959,-0.02213,4.201,128.0,0.,0.,-5.916,0.08041,0.,0.,
     + 1.959,-0.02213,4.201,128.0,0.,0.,-5.916,0.08041,0.,0.,
     + 1.959,-0.02213,4.201,128.0,0.,0.,-5.916,0.08041,0.,0.,
     + 1.959,-0.02213,4.201,128.0,0.,0.,-5.916,0.08041,0.,0.,
     + 0.969,-0.0451,3.256,128.0,0.,-18.457,-0.541,-0.0744,0.,0.,
     + 0.969,-0.0451,3.256,128.0,0.,-18.457,-0.541,-0.0744,0.,0.,
     + 0.969,-0.0451,3.256,128.0,0.,-18.457,-0.541,-0.0744,0.,0.,
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     + 0.969,-0.0451,3.256,128.0,0.,-18.457,-0.541,-0.0744,0.,0.,
     + 0.969,-0.0451,3.256,128.0,0.,-18.457,-0.541,-0.0744,0.,0.,
     + 0.6026,-0.02285,4.049,128.0,11.2,0.,-6.854,0.08607,0.,0.,
     + 0.6026,-0.02285,4.049,128.0,11.2,0.,-6.854,0.08607,0.,0.,
     + 0.6026,-0.02285,4.049,128.0,11.2,0.,-6.854,0.08607,0.,0.,
     + 0.6026,-0.02285,4.049,128.0,11.2,0.,-6.854,0.08607,0.,0.,
     + 0.6026,-0.02285,4.049,128.0,11.2,0.,-6.854,0.08607,0.,0./
      DATA (SPAR(I),I=601,750)/
     + 0.01607,4.529E-5,8.585E-3,0.,0.,0.,-0.05327,1.619E-3,0.,0.,
     + 0.01607,4.529E-5,8.585E-3,0.,0.,0.,-0.05327,1.619E-3,0.,0.,
     + 0.01607,4.529E-5,8.585E-3,0.,0.,0.,-0.05327,1.619E-3,0.,0.,
     + 0.01607,4.529E-5,8.585E-3,0.,0.,0.,-0.05327,1.619E-3,0.,0.,
     + 0.01607,4.529E-5,8.585E-3,0.,0.,0.,-0.05327,1.619E-3,0.,0.,
     + 0.01736,0.,-2.96E-3,0.,0.,0.0815,-3.42E-3,2.79E-3,0.,0.,
     + 0.01736,0.,-2.96E-3,0.,0.,0.0815,-3.42E-3,2.79E-3,0.,0.,
     + 0.01736,0.,-2.96E-3,0.,0.,0.0815,-3.42E-3,2.79E-3,0.,0.,
     + 0.01736,0.,-2.96E-3,0.,0.,0.0815,-3.42E-3,2.79E-3,0.,0.,
     + 0.01736,0.,-2.96E-3,0.,0.,0.0815,-3.42E-3,2.79E-3,0.,0.,
     + -0.0108,0.,-0.01158,0.,-0.01464,0.,-0.1424,2.93E-3,0.,0.,
     + -0.0108,0.,-0.01158,0.,-0.01464,0.,-0.1424,2.93E-3,0.,0.,
     + -0.0108,0.,-0.01158,0.,-0.01464,0.,-0.1424,2.93E-3,0.,0.,
     + -0.0108,0.,-0.01158,0.,-0.01464,0.,-0.1424,2.93E-3,0.,0.,
     + -0.0108,0.,-0.01158,0.,-0.01464,0.,-0.1424,2.93E-3,0.,0./
      DATA (SPAR(I),I=751,900)/
     + 0.,0.2014,73.28,0.,0.,0.,-72.29,-0.9249,0.,0.,
     + 0.,0.2014,73.28,0.,0.,0.,-72.29,-0.9249,0.,0.,
     + 0.,0.2014,73.28,0.,0.,0.,-72.29,-0.9249,0.,0.,
     + 0.,0.2014,73.28,0.,0.,0.,-72.29,-0.9249,0.,0.,
     + 0.,0.2014,73.28,0.,0.,0.,-72.29,-0.9249,0.,0.,
     + 0.,0.0886,55.59,0.,0.,-99.44,9.429,0.5536,0.,0.,
     + 0.,0.0886,55.59,0.,0.,-99.44,9.429,0.5536,0.,0.,
     + 0.,0.0886,55.59,0.,0.,-99.44,9.429,0.5536,0.,0.,
     + 0.,0.0886,55.59,0.,0.,-99.44,9.429,0.5536,0.,0.,
     + 0.,0.0886,55.59,0.,0.,-99.44,9.429,0.5536,0.,0.,
     + -1.773,-0.04294,91.62,0.,313.6,0.,53.78,-0.6949,0.,0.,
     + -1.773,-0.04294,91.62,0.,313.6,0.,53.78,-0.6949,0.,0.,
     + -1.773,-0.04294,91.62,0.,313.6,0.,53.78,-0.6949,0.,0.,
     + -1.773,-0.04294,91.62,0.,313.6,0.,53.78,-0.6949,0.,0.,
     + -1.773,-0.04294,91.62,0.,313.6,0.,53.78,-0.6949,0.,0./
      DATA X1BP/.45,.28,.08,.36,.26,.2,.44,.31,.26,.41,.28,.18,
     + .41,.3,.19,.43,.3,.21,9*0.,9*1.,.44,.24,.1,.4,.21,
     + .05,.32,.17,.05,9*0./
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
      DATA Y1BP/.34,.28,.18,.35,.30,.19,.35,.3,.2,
     +.041,.027,.013,.11,.09,.07,.11,.10,.09,
     + .2,.11,.03,.13,.10,.08,.16,.07,.09,
     + .02,.02,.02,.02,.02,.02,.02,.02,.02,
     + 9*0.,
     + 3*0.,.01,.01,.01,3*0.,
     + .047,.047,.024,.027,.022,.014,.066,.044,.029,
     + .072,0.043,.014,.043,.022,.007,.046,.023,.008,
     + 18*0./
       DATA Y2BP/3.3,3.7,4.3,3.1,3.4,4.0,2.9,3.2,3.9,
     + -122.,-123.,-150.,-155.,-155.,-155.,-152.,-153.,-154.,
     * 3.0,4.0,5.,5.3,5.7,5.8,4.2,4.7,4.8,
     + 9*13.,9*0.,3*0.,3*1.0,3*0.,
     * -2.,-2.,-2.,-1.,-1.,-1.,-.6,-.6,-.6,
     + 136.,142.,143.,140.,143.,160.,137.,137.,150.,9*0.,9*0./
CC    DATA FOR SUBROUTINE STATS
      DATA SIGSDE/.15,1.3,0./
      DATA SIGMNE/10*0./
      DATA SIGME/.043,9*0./
      DATA SIGCE/.6,.8,.6/
      DATA XBASE/1.,3.,4.,5.,6.,8.,12.,15.,20.,
     + 10.,30.,40.,50.,60.,100.,130.,160.,200.,
     + 1.,2.,3.,4.,7.,9.,11.,13.,15./
      DATA YBASE/.021,.106,.113,.107,.095,.071,.035,.018,.008,
     + .002,.0086,.0093,.0091,.0084,.0056,.0038,.0026,.0013,
     + .03,.13,.17,.158,.075,.04,.022,.011,.005/
      DATA TSIZE,BSIZE/2*150./
      DATA PCONF/90./
      DATA TSIG,BSIG/.25,37.,2.,1.9,37.,2.1/
      DATA (PARINT(I),I=1,100)/
     * 0.,-.00039,.001254,0.,0.,0.,-3.38E-4 ,-1.56E-5,0.,0.,
     * 0.,0.,-.0006305,0.,0.,0.,0.,0.,0.,0.,
     * 0.,0.,0.,0.,0.,0.,1.23E-5,9.11E-7  ,0.,0.,
     * 10*0.0,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.
     *  /
      DATA (PARINT(I),I=101,200)/
```

Table 5-49 BLOCK DATA ROUTINE LISTING (cont.)

```
     * 0.,-.00016,0.,0.,0.,-.0726,0.,0.00046,0.,0.,
     * 0.,0.,-.000056,0.,0.,0.,0.,0.,0.,0.,
     * 0.,0.,0.,0.,0.,.0023,0.,.00005,0.,0.,
     * 0.,0.,0.,0.,6*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 20*0./
      DATA (PARINT(I),I=201,300)/
     * 0.,.000532,-.01211,0.,-.0379,0.,-0.117,4.54E-5,0.,0.,
     * 0.,0.,-.0000823,0.,-.0001623,0.,6.17E-5   ,0.,0.,0.,
     * 0.,0.,0.,0.,.00743,0.,0.,-2.13E-7,0.,0.,
     * 0.,0.,0.,0.,6*0.,
     * 0.,0.,0.,0.,0.,0.,0.,-7.72E-6,0.,0.,
     * 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,
     * 7*0.,-5.05E-7 ,0.,0.,
     * 8*0.,0.,0.,
     * 20*0./
      DATA (PARINT(I),I=301,400)/
     * 0.,.002938,-.10158,0.,0.,0.,0.,-6.43E-4,0.,0.,
     * 0.,0.,8*0.,
     * 3*0.,0.,0.,0.,1.71E-3,8.98E-7,0.,0.,
     * 4*0.,6*0.,
     * 5*0.,5*0.,
     * 6*0.,4*0.,
     * 7*0.,1.16E-6,0.,0.,
     * 10*0.,
     * 20*0./
      DATA (PARINT(I),I=401,500)/
     * 0.,.00738,-.102,0.,0.,-.7736,0.,-.0015,0.,0.,
     * 0.,0.,8*0.,
     * 3*0.,0.,0.,-.0102,-.0033,-.00017,0.,0.,
     * 4*0.,6*0.,
     * 5*0.,5*0.,
     * 6*0.,0.,-.0043,0.,0.,
     * 7*0.,-.00031,0.,0.,
     * 10*0.,
     * 20*0./
      DATA (PARINT(I),I=501,600)/
     * 0.,.00802,.01105,0.,.1342,0.,-.84,1.58E-4,0.,0.,
     * 2*0.,-.001986,0.,-.00708,0.,-8.95E-3,0.,0.,0.,
```

```
     * 3*0.,0.,.3624,0.,-0.1043,-7.2E-5,0.,0.,
     * 4*0.,6*0.,
     * 5*0.,0.,1.386 ,-4.0E-4,0.,0.,
     * 6*0.,4*0.,
     * 7*0.,-4.62E-4,0.,0.,
     * 8*0.,0.,0.,
     * 9*0.,.01167,10*0./
      DATA (PARINT(I),I=601,700)/
     * 0.,-.0000971,-.00998,0.,0.,0.,.0105,-4.9E-3,0.,0.,
     * 2*0.,8*0.,
     * 3*0.,0.,0.,0.,-.002151,1.625E-5,0.,0.,
     * 4*0.,6*0.,
     * 5*0.,5*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 20*0./
      DATA (PARINT(I),I=701,800)/
     * 0.,0.,.00148,0.,0.,0.,.004,.00026,0.,0.,
     * 0.,0.,.0000037,0.,0.,0.,0.,0.,0.,0.,
     * 3*0.,0.,0.,0.,.0088,.000028,0.,0.,
     * 4*0.,6*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 10*0.,
     * 20*0./
      DATA (PARINT(I),I=801,900)/
     * 0.,.0000348,-.01426,0.,-.04487,0.,8.79E-3,-3.14E-5,0.,0.,
     * 2*0.,-.000014,0.,-.000231,0.,5.58E-5,1.06E-7,0.,0.,
     * 3*0.,0.,.02487,0.,-0.01938,-1.45E-6,0.,0.,
     * 4*0.,6*0.,
     * 5*0.,0.,-7.73E-4,-3.4E-5,0.,0.,
     * 6*0.,4*0.,
     * 10*0.,
     * 10*0.,
     * 20*0./
      DATA Y1DBP,Y2DBP/160*0.,160*0./
      DATA LOPT/2/
      DATA PPICK/2,9*0/
      RETURN
      END
```

APPENDIX A

PROGRAM NOMENCLATURE

APPENDIX A

PROGRAM NOMENCLATURE

Table A-1 contains a complete nomenclature list for the General Economic Effectiveness Program. Variable names for all subroutines are included in alphabetical order. For those identifiers with more than one SIGNIFICANT meaning, several entries in the nomenclature list have been made. This list was designed for use by a FORTRAN IV programmer in conjunction with the flowcharts and listings in Section 5.

Table A-1 PROGRAM NOMENCLATURE

* * * CRC ECONOMIC EFFECTIVENESS PROGRAM NOMENCLATURE * * *

INSPECTION TYPE

IDLE	IDLE
EXTENSIVE A	IGNITION
EXTENSIVE B	INDUCTION

INSPECTION FACILITIES

STATE LANE	STATE
FRANCHISED GARAGE	GARAGE

REGION

LOS ANGELES	LA
NEW YORK	NY
WASHINGTON	WASH
DENVER	DEN
DETROIT	DET

* * ENGINE PARAMETERS * *

M=1 IDLE CO
M=2 DELTA RPM
M=3 DELTA TIMING
M=4 MISFIRE
M=5 NOX CONTROL
M=6 AIR PUMP
M=7 PCV
M=8 AIR CLEANER
M=9 BLADE SETTING (VACUUM KICK)
M=10 HEAT RISER

* * MODE EMISSIONS * *

L=1 ICO
L=2 IHC
L=3 INO
L=4 CCO (45)
L=5 CHC (45)
L=6 CNO (45)

NAME	DESCRIPTION	RANGE	UNITS
A	MEAN EMISSION LEVELS BEFORE DETERIORATION		GR/MI
A	PECENTAGE SUMMATION VARIABLE - UNCONTROLLED		
AA	SUMMING VARIABLE IN MILEAGE CALCULATION		MILES/YEAR
AAA	AVERAGE ANNUAL MILEAGE - UNCONTROLLED		MILES/YEAR
AA1	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
AA2	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
AA3	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		

Table A-1 PROGRAM NOMENCLATURE (cont.)

ADD	RATE OF EMISSION DETERIORATION X MILAGE ACCUMULATION		G/M
ADD	RATE OF MODE DETERIORATION X MILAGE ACCUMULATION		
	- HC		PPM/MILE
	- CO		PPM/MILE
	- NO		PPM/MILE
ADD	THE CHANGE IN PARAMETER SETTING DUE TO DECAY		
ADD1	MODE EMISSION DETERIORATION		G/MIL/MIL
ADEBUG	AREA DEBUG FLAG	2HNO	
ALAB	AREA REGIONAL BASIN	1250(LA)	SQ.MI.
AM	EMISSION AFTER MAINTENANCE		
AMB	FEDERAL 1976 AIR QUALITY CRITERIA HC,NOX- UG/M3, CO- MG/M3		
ANAME			
ANNUAL	ANNUAL MILEAGE AS A FUNCTION OF AGE.		
ANNUA1	ANNUAL MILEAGE DISTRIBUTION FOR LOS ANGELES FLEET		
ANNUA2	ANNUAL MILEAGE DISTRIBUTION FOR NEW YORK FLEET		
ANNUA3	ANNUAL MILEAGE DISTRIBUTION FOR WASHINGTON FLEET		
ANNUA4	ANNUAL MILEAGE DISTRIBUTION FOR DENVER FLEET		
ANNUA5	ANNUAL MILEAGE DISTRIBUTION FOR DETROIT FLEET		
AR	1- TARGET AREA IN XPT	0.-1.	
ASTABLX	MODE EMISSION INPUT DISTRIBUTION.X VALUES. 9 POINT		
ASTABLY	MODE EMISSION INPUT DISTRIBUTION.Y VALUES. 9 POINT		
ASTABX	INPUT MODE EMISSION DISTRIBUTION BY REGION -X		
ASTABY	INPUT MODE EMISSION DISTRIBUTION BY REGION -Y		
ATABLEX	PARAMETER INPUT DISTRIBUTION. X VALUES. 9 POINTS.		
ATABLEY	PARAMETER INPUT DISTRIBUTION. Y VALUES. 9 POINTS.		
ATABX	INPUT PARAMETER DISTRIBUTION BY REGION -X		
ATABY	INPUT PARAMETER DISTRIBUTION BY REGION -Y		
AVE	AVERAGE PARAMETER VALUE IN STATS		
AVEFAIL	AVERAGE FRACTION OF CARS FAILED FOR OUTPUT	0.-1.	
AX	TEMPORARY STORAGE FOR DISTRIBUTIONS TO BE PLOTTED		
AY	TEMPORARY STORAGE FOR DISTRIBUTIONS TO BE PLOTTED		
A1	TEMPORARY INTEGRAL (AT LAST POINT) IN XPT	0.-1.	
A1	X1-Y1 DISTRIBUTION POINT AT X3 IN ADD		
A2	X2-Y2 DISTRIBUTION POINT AT X3 IN ADD		
B	MEAN EMISSION LEVELS AFTER DETERIORATION		G/M
B	PECENTAGE SUMMATION VARIABLE - CONTROLLED		
BAREA	INTEGRATED EMISSION LEVEL		GRAMS
BB	SUMMING VARIABLE IN MILEAGE CALCULATION		MILES/YEAR
BBB	AVERAGE ANNUAL MILEAGE - CONTROLLED		MILES/YEAR
BDEBUG	BASELINE DEBUG FLAG	2HNO	
BDEL	EMISSION RATE IMPROVEMENT		

Table A-1 PROGRAM NOMENCLATURE (cont.)

BHIST	BASELINE EMISSION HISTORY		G/M
BHIST	EMISSION LEVEL AT TIME N FOR BASELINE		GR/MI
BINT	BASELINE INSPECTION TIME INTERVAL		MONTHS
BLD1	SURFACE AREA INSPECTION SHED	300	SQ.FT.
BLD2	SURFACE AREA INSPECTION LANE	300	SQ.FT.
BM	POST MAINTENANCE EMISSION RATES		G/MILE
BMU	MEAN EMISSION RATE FOR BASE CASE		
BSAVE	STORED CONSTRAINT VALUES BY OPTI IN OPTMUM		
BSD	EMISSION RATE STANDARD DEVIATION FOR BASE CASE		
BSIG	BASELINE EMISSION DISTRIBUTION ERROR		
BSIZE	SAMPLE SIZE FOR THE BASELINE FLEET		CARS
BUP	ADDITION AT MANUFACTURERS SPEC FOR MAINTENANCE		
BX	TEMPORARY STORAGE FOR DISTRIBUTIONS TO BE PLOTTED		
BXTRA	THAT PORTION OF THE FINAL TEST INTERVAL THAT WOULD EXTEND PAST THE TOTAL TEST DURATION		MONTHS
BY	TEMPORARY STORAGE FOR DISTRIBUTIONS TO BE PLOTTED		
B1	CONSTRAINT ARRAY FOR INPUT TO CUTPNT FROM OPTMUM		
C	EMISSION DELTA AFTER DECAY AND MAINTENANCE		GR/MI
C	PECENTAGE SUMMATION VARIABLE - POST 1970		
CA	COEFFICIENT FOR NEW CUTPOINT GUESS IN CUTPNT	0.-1.	
CAE	CAPITAL EQUIPMENT COST$		$
CAL	CAPITAL LAND COSTS		$
CAP	CAPITAL FACILITIES COST		$
CAPFL	CAPITAL COST FOR INSPECTION STATION(DISCOUNTED)		
CARA	SUM OF CARS INSPECTED OVER HORIZON		CARS
CARAV	AVERAGE NUMBER OF CARS IN POPULATION		CARS
CARB	SUM OF CARS MAINTAINED OVER HORIZON		CARS
CARC	TOTAL CARS FAILING SIGNATURE INSPECTION OVER TIME		CARS
CARI	NO. OF CARS UNDERGOING INSPECTION		CARS
CARIY	AVERAGE NO. OF CARS INSPECTED PER YEAR		CAR/YEAR
CARM	NO. OF CARS MAINTAINED		CARS
CARMY	AVERAGE NO. OF CARS MAINTAINED PER YEAR		CAR/YEAR
CARPOP	REGIONAL CAR POPULATION	4M(LA)	CARS
CARPOP	VEHICLE POPULATION		CARS
CARS	TOTAL CARS FAILING SIGNATURE INSPECTION		CARS/YEAR
CARSY	AVERAGE NUMBER OF MODE REJECTED CARS		CARS/YEAR
CAT	TRAINING COST		DOLLARS
CB	COEFFICIENT FOR NEW CUTPOINT GUESS IN CUTPNT	0.-1.	
CBSUM	VOLUNTARY I/M COST		DOLLARS
CC	SUMMING VARIABLE IN MILEAGE CALCULATION		MILES/YEAR
CCC	AVERAGE ANNUAL MILEAGE - POST 70		MILES/YEAR

Table A-1 PROGRAM NOMENCLATURE (cont.)

CCOSTI	INSPECTION CAPITAL COSTS		$
CCOSTM	MAINTENANCE CAPITAL COSTS		$
CC1	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
CC2	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
CC3	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
CDEBUG	COST DEBUG FLAG	2HNO	
CELLWTH	DELTA ON X-AXIS OF A DISTRIBUTION		
CF	J FACTORIAL IN QUEUE		
CGTT	CONVERT GRAMS TO TONS	9.08M	G/TONS
CHI	CHANGE IN Y PER COLLUMN		
CINCON	USER INCONVENIENCE COST		DOLLARS
CMAXI	MAXIMUM NO. OF CARS INSPECTED IN ANY ONE YEAR		CARS
CN	POST MAINTENANCE EMISSION RATES		GRAMS/MILE
COEFB	EMISSION DECAY RATES		G/MIL/MIL
COEFBP	PARAMETER DECAY RATE		
CONST	CUTPOINT OPTIMIZATION CONSTRAINT FACTOR	0.-1.	
CON1	CONSTANT REFLECTING MODE EMISSION NON-INDEPENDANCE		
CON2	CONSTANT REFLECTING MODE EMISSION NON-INDEPENDANCE		
COST	DISCOUNTED OCOST		$/YEAR
COSTB	BASELINE VOLUNTARY MAINTENANCE COST		DOLLARS
CPART	COST OF PARTS FOR MAINTENANCE		
CPCB	COST OF BASE MAINTENANCE TUNEUP	35-85	DOLLARS
CPI	COST PER INSPECTION		$/INSPECTION
CPVPY	COST PER VEHICLE PER YEAR		$/CAR/YEAR
CSUM	TOTAL COST FOR TEST PROGRAM		$
CUT	CURRENT CUTPOINT GUESS IN CUTPNT		
CUTIN	STARTING CUTPOINT GUESSES IN CUTPNT		
CUTMAX	UPPER LIMIT OF DISTRIBUTED PARAMETERS IN CUTPNT		
CUTMIN	LOWER LIMIT OF DISTRIBUTED PARAMETERS IN CUTPNT		
CUTN	NEW CUTPOINTS FROM L.P. MODEL IN CUTPNT		
C1	UTILITY FUNCTION COEFFICIENTS IN CUTPNT		
D	TEMPORARY DISTRIBUTION STORAGE IN CONVOL		
DD	TEMPORARY DISTRIBUTION STORAGE IN CONVOL AND DISTPR		
DDDI	SECOND PARTIAL CONTRIBUTION TO EMISSION DELTA		
DDEBUG	DATA DEBUG FLAG	2HNO	
DD1	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
DD2	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
DD3	COEFFICIENT FOR POLYNOMIAL CURVE-FIT		
DELB	EMISSION REDUCTION BASE MAINTENANCE		G/M
DELEM	DIFFERENCE BETWEEN TEST AND BASE EMISSION RATES		GRAMS/MILE
DELI	INTEGRAL OF BASE-TEST EMISSION RATES		GRAMS

Table A-1 PROGRAM NOMENCLATURE (cont.)

DELIT	INTEGRAL OF BASE-TEST EMISSION RATES		TONS
DELT	EMISSION REDUCTION TEST MAINTENANCE		G/M
DELTA	PARAMETER SETTING CHANGE DUE TO MAINTENANCE-CUTPNT		
DELTAN	NEW PARAMETER DELTA IN CUTPNT		
DELX	DELTA ON X-AXIS OF A DISTRIBUTION		
DELXD	DUMMY X VALUE FOR DETERIORATION. RANGES 0 TO 2		
DELXH	DELTA X IN MAINTAINED DISTRIBUTION		
DEX	TEST FLEET EMISSION SPECIE DECREMENT ERROR DIST.-X		
DEY	TEST FLEET EMISSION SPECIE DECREMENT ERROR DIST.-Y		
DIFF	ATTRITION RATES. DIFF(N)=PERCENTAGE OF N YEAR OLD CARS STILL IN USE		
DP	THE CHANGE IN PARAMETER MEANS FOR MAINTENANCE (SIG. ONLY)		
DPO	SUMMATION VARIABLE IN QUEUE FOR PO CALCULATION		1/PROBAB.
DROP	EMISSION REDUCTION FROM I/M OF NON-DISTRIBUTED P S		
DUM	TEMPORARY STORAGE IN SWITCH		
DUMX	TEMPORARY DISTRIBUTION STORAGE		
DUMY	TEMPORARY DISTRIBUTION STORAGE		
DUM1	TEMPORARY REJECTION RATE STORAGE FOR UNION		
DX	DELTA X IN A DISTRIBUTION		
EFF	MAINTENANCE EFFECTIVENESS FACTOR	100	
EMIS	EMISSION RATES FOR ATTRITION MODEL OUTPUT		
EMW	EMISSION WEIGHTING FACTORS		
EP	EXPECTED VALUE OF REJECTED PARAMETER		
E1	EMISSION SUMMING VARIABLE IN PRINT6 - HC		UG/M3
E2	EMISSION SUMMING VARIABLE IN PRINT6 - CO		MG/M3
E3	EMISSION SUMMING VARIABLE IN PRINT6 - NOX		UG/M3
F	VALUE OF CHEBYSHEV ORTHGONAL POLYNOMIAL		
FACTO	INITIAL FACTOR FOR ITERATION IN CUTPNT		
FACTOR	CONVERGENCE FACTOR IN CUTPNT		
FIXCOST	FIXED COST FOR I/M OF DISTRIBUTED PARAMETERS		DOLLARS
FLAST	FRACTION OF INSPECTION INTERVAL AT END		
FPERC	THAT PORTION OF THE BASELINE MAINTENANCE THAT AFFECTS THE PARAMETER DECAY RATES		
GROWTH	POPULATION GROWTH FACTOR		
HEAD	HEADING ARRAY CONTAING CONTROL TYPE NAMES		
HORZN	PROGRAM HORIZON	60	MONTHS
HORZNY	PROGRAM HORIZON		YEARS
HPC	HISTORY OF PC		
HPCS	UNION OF SIGNATURE INSPECTION REJECTION RATES	0.-1.	
HPP	HISTORY OF PP	0.-1.	
HPS	STORED SIGNATURE INSPECTION REJECTION RATES	0.-1.	
HPT	HISTORY OF PT		

Table A-1. PROGRAM NOMENCLATURE (cont.)

HPTOT	HISTORY OF PTOT		
HPTOTS	TOTAL UNION OF SIGNATURE REJECTION RATES	0.-1.	
I	EMISSION LOOP INDEX. 1=HC,2=CO,3=NOX	1-3	
ICOST	INCONVENIENCE COSTS		$
IERR	ERROR FLAG OUTPUT FROM LPAX IN CUTPNT	0	
IGO	COMPUTED GOTO INDEX.USED FOR ALL COMPUTED BRANCHES		
II	MISCELLANEOUS INDEX		
IJ	INDEX IN CONVOL		
ILNS	NUMBER OF LINES PER PAGE REQUESTED IN PLOT		LINES
IMAX	CONSTANT IN CONVOL	50	
IMAXU	ITRY AT MAXIMUM UTILITY FUNCTION IN OPTMUM		
IN	INPUT KEYWORD VECTOR.		
INT	NUMBER OF INSPECTION INTERVALS - TEST CASE		
INTB	NUMBER OF INSPECTION INTERVALS - BASE CASE		
IOPT	INTEGRATE F(X) OR X*F(X) FLAG		
IOPT	EMPIRICAL OR THEORETICAL STATISTICAL ANALYSIS FLAG		
IPLUS	TEMPORARY INDEX INCREASE IN PRINT2		
IPRINT	PRINT FLAG IN CUTPNT	0	
IPRNT	PRINT FLAG IN CUTPNT	0	
IP1	I PLUS 1 IN PLOTJK		
IT	INTEGRAL VALUE OF INDEPENDENT VARIABLE IN PLOTXY		
ITE	EQUIPMENT AMMORIZATION	4	YEARS
ITERAT	NUMBER OF ITERATIONS IN CUTPNT		
ITIME	INCONVENIENCE TIME		MIN
ITL	LAND AMMORIZATION	30	YEARS
ITP	FACILITY AMMORIZATION	30	YEARS
ITRY	COUNTER FOR ITRYS - COMB. OF NON-DISTR. PARAMETERS		
ITRYS	ARRAY OF POSSIBILITIES FOR NON-DISTR. PARAMETERS.		
I1	DO LOOP INDEX		
I1	INDEX FOR CONVOLUTION FUNCTION		
I2	INDEX FOR CONVOLUTION FUNCTION		
I3	INDEX FOR CONVOLUTION FUNCTION		
I4	INDEX FOR CONVOLUTION FUNCTION		
J	CONTROL TYPE-POWERTRAIN COUNTER=JJ+3*(K-1).	1-15	
JCNT	CUTPNT COUNTER FOR CUT POINT OPTIMIZATION	1-10	
JJ	POWER TRAIN TYPE INDEX		
K	CONTROL TYPE INDEX.1=GM,2=FORD,3=CHRY,4=AMC,5=IMPORTS		
KH	OUT OF BOUND-HIGH PLOT FLAG	1H OR 1HO	
KI	USES K=2 FOR K=3 CASE FOR DETROIT - NO CONTROLLED		
KILL	FATAL ERROR FLAG. IF KILL=1 THEN A SUBCASE ABORTS		
KK	TEMPORARY STORAGE OF COLUMN TO BE PLOTTED		

Table A-1 PROGRAM NOMENCLATURE (cont.)

KL	OUT OF BOUNDS-LOW PLOT FLAG		
KP	PLOTTING WORK AREA		
KSTART	LOWER BOUND FOR CONTROL TYPE. (K)	1	
KSTOP	UPPER BOUND FOR CONTROL TYPE. (K)		
K1	DO LOOP INDEX IN PXCOEF		
K1	STARTING J VALUE FOR CONTROL TYPE K	1,6,11	
K2	ENDING J VALUE FOR CONTROL TYPE K	5,10,15	
L	MODE EMISSION INDEX AND DISTRIBUTION MOVING DO-LOOP-INDEX		
LCODE	ARRAY DESIGNATING THE FOUR NON-DISTR. PARAMETERS.		
LDEBUG	LINEAR PROGRAM DEBUG FLAG	2HNO	
LENGTH	LENGTH OF PLOT		INCHES
LIDLE	LOADED INSPECTION FLAG.1=UNLOADED,2=LOADED,3=HYBRID		
LINT	LIMITS OF INTEGRATION	48	MONTHS
LL	MISCELLANEOUS DO LOOP INDEX		
LLPICK	COUNTER FOR LPICK		
LPICK	CUTPOINT OPTIMIZATION TIME PERIOD VECTOR		
LPLUS	TEMPORARY INDEX FOR HIGH OR LOW DECAY	0 OR 2	
LPSPP	A CORRELATION BETWEEN THE FOUR EMISSION MODES AND THE TEN PARAMETER		
LPSPP	MODE EMISSION TO PARAMETER RELATION		
LQ	LENGTH OF THE INSPECTION QUEUE		CARS
LSTART	LOWER LIMIT FOR MODE EMISSION INDEX. (L)	1-6	
LSTOP	UPPER LIMIT FOR MODE EMISSION INDEX. (L)	1-6	
L1	COUNTER FOR NPICK - STATS PICK VECTOR	1-NTR	
L1	SIZE OF INPUT CONVOLUTION DISTRIBUTION 1	33 NOMINALLY	
L2	SIZE OF INPUT CONVOLUTION DISTRIBUTION 2	33 NOMINALLY	
M	PARAMETER INDEX. RANGE IS MSTART TO MSTOP		
MATCH	VECTOR USED TO STORE INPUT KEYWORD CODE NUMBERS		
MAXIT	MAXIMUM ITERATIONS BEFORE DEBUG PRINT IN CUTPNT		
MBASE	BASE FLEET INSPECTION INTERVAL	12000	MILES
MDEBUG	MAINTENANCE DEBUG FLAG	2HNO	
MEAN	MIDPOINT OF DISTRIBUTION IN CONVOL		
MED1	MEDIAN OF INPUT CONVOLUTION DISTRIBUTION 1		
MED2	MEDIAN OF INPUT CONVOLUTION DISTRIBUTION 2		
MED3	MEDIAN OF OUTPUT CONVOLUTION DISTRIBUTION		
MID	LOCATION OF MANUFACTURERS SPEC IN DISTRIBUTION		
MISFIRE	MISFIRE FLAG. =3HYES FOR MISFIRE INSPECTION	2HNO	
MM	NAME VECTOR POINTER		
MMM	YEARLY MILEAGE, ROUNDED OFF (BY CONTROL TYPE)		MILES/YEAR
MMS	MANUFACTURERS RECOMMENDED PARAMETER SPECIFICATIONS	0	
MO	FLAG INDICATING OUT OF BOUNDS HIGH POINTS		

Table A-1 PROGRAM NOMENCLATURE (cont.)

MPH	AVERAGE TRIP SPEED		MPH
MSTART	LOWER LIMIT FOR PARAMETER INDEX (M)		
MSTOP	UPPER LIMIT FOR PARAMETER INDEX (M)		
MTM	AVERAGE YEARLY MILEAGE		MILES/YEAR
MU	FLAG INDICATING OUT OF BOUNDS LOW POINTS -PLOTJK		
MU	MEAN VALUE FOR A DISTRIBUTION		
MU1	MEAN OF PRINTOUT DISTRIBUTION IN DISTPR		
MU2	MEAN OF PRINTOUT DISTRIBUTION IN DISTPR		
MU3	MEAN OF PRINTOUT DISTRIBUTION IN DISTPR		
MVPR	MEAN VALUE OF THE REJECTED PARAMETER		
M1	DO LOOP INDEX IN PXCOEF		
N	TIME INTERVAL COUNTER		
NAME	MISCELLANEOUS NAME ARRAY		
NBL	CONSTANT	1H	
NC	NUMBER OF VARIABLES TO BE PLOTTED IN PLOTJK		
NCNTR	NO. OF POLLUTION CONTROL TYPES	3	
NCODE	ARRAY DESIGNATING THE SIX DISTRIBUTED PARAMETERS.		
NC1	NC-1 IN PLOTJK.NC=NUMBER OF VARIABLES FOR PLOTTING		
NEMIS	NO. OF EMISSION TYPES	3	
NEMP	NUMBER OF EMPLOYEES AT INSPECTION STATION		
NF	N FACTORIAL IN QUEUE		
NINS	NUMBER OF KEYWORDS INPUT		
NINTR	INTEGERIZED XINT		MONTHS
NINTRB	INTEGERIZED XINTB		MONTHS
NK	CONSTANT IN PLOTJK (PLOT CHARACTERS)	1HA,B,C	
NMODE	NO. OF THE EMISSION MODES		FOUR
NN	GENERALLY NUMBER OF POINTS IN A DISTRIBUTION		
NO	CONSTANT	2HNO	
NOPTS	NUMBER OF KEYWORD OPTIONS AVAILABLE	37	
NPAR	NO. OF ENGINE PARAMETERS CONSIDERED	10	
NPERPG	NUMBER OF YEARS PER PAGE TO BE DISPLAYED		YEARS
NPICK	TIME PERIOD FOR PAYOFF DELTA CALCULATIONS		
NPL	CONSTANT IN PLOTJK	1H+	
NPTRN	NO. OF POWER TRAIN TYPES	5	
NPTS	NUMBER OF POINTS IN A DISTRIBUTION		
NRUN	RUN NUMBER		
NS	INDEX FOR REGION NAME OUTPUT		
NSTEPS	NO. OF STEPS TAKEN FOR SIMPSON INTEGR. SCHEME		
NTR	NINTR+1=TIME HORIZON FOR TEST CASE		MONTHS
NTRB	NINTRB+1=TIME HORIZON FOR BASE CASE		MONTHS
NU	CONSTANT IN PLOTJK	1HU	

Table A-1 PROGRAM NOMENCLATURE (cont.)

NX	CONSTANT IN PLOTJK		1HX	
NYEARS	NUMBER OF YEARS TO BE PRINTED			YEARS
N1	ENDING YEAR OF UNCONTROLLED AGE GROUP			
N2	STARTING YEAR OF UNCONTROLLED AGE GROUP			
N3	ENDING YEAR OF CONTROLLED AGE GROUP			
N4	STARTING YEAR OF CONTROLLED AGE GROUP			
N5	ENDING YEAR OF POST 70 AGE GROUP			
N6	STARTING AGE YEAR FOR POST 70 CARS			
OCIY	AVERAGE INSPECTION OPERATING COSTS PER YEAR			$/YEAR
OCMY	AVERAGE MAINTENANCE OPERATING COSTS PER YEAR			$/YEAR
OCOST	OCOSTI+OCOSTM			$/YEAR
OCOSTI	YEARLY INSPECTION COSTS			$/YEAR
OCOSTM	YEARLY MAINTENANCE COSTS			$/YEAR
OPTI	INSPECTION TYPE INDEX,1=IDLE,2=IGNITION,3=INDUCTION			
OPTS	ARRAY OF KEYWORD OPTIONS			
OVCHI	OVERCHARGE FOR INSPECTION			
OVCHM	OVERCHARGE FOR MAINTENANCE			
P	TEMPORARY DISTRIBUTION STORAGE IN CONVOL			
PAR	EMISSION RESPONSE SURFACES		(SEE LISTING)	DE/DP
PARINT	SECOND PARTIAL DERIVETIVES OF E/P			
PARM	EMISSION DECAY NON-ATTRIBUTABLE TO PARAMETER DECAY			
PART	THAT PART OF THE TEST INTERVAL AT WHICH A PARTICULAR POWERTRAIN IS TESTED			
PAR1	DE/DP AVERAGED BY CONTROL TYPE			
PAR2	AVERAGE DE/DP FOR ALL VEHICLES			
PAYADJ	PAYOFF FUNCTION IN COST			
PAYFIN	PAYOFF FUNCTION IN COST			
PAYNEW	PAYOFF FUNCTION			$/DE
PAYOFF	PERCENTAGE REDUCTION IN EMISSIONS			
PC	UNION OF PARAMETER REJECTION RATES BY POWER TRAIN			
PC(J)	PROBABILITY OF REJECTION(CONTROL)			
PCONF	DESIRED CONFIDENCE LEVEL FOR STATS			
PCXBP	TSTAR TABLE BY CONFIDENCE LIMIT			
PCYBP	TSTAR TABLE BY CONFIDENCE LIMIT			
PDEBUG	PARAMETER DECAY DEBUG FLAG		2HNO	
PI	SUCCESSFUL INSPECTION PERCENTAGE			
PLTMAK	MAXIMUM PLOT LIMITS	- HC	10	G/M
		- CO	50	G/M
		- NO	10	G/M
PLUS	THE TOTAL CHANGE DUE TO DECAY AND MAINTENANCE			
PM	PARAMETER DISTRIBUTION MEAN VALUES			

Table A-1 PROGRAM NOMENCLATURE (cont.)

PMILES	MONTHY MILEAGE ON -J- PARAMETER. BASED ON YEARLY ATTRITION		
PMODEL	CONSTANT. PARAMETER CASE WHEN EQUAL TO RTYPE	9HPARAMETER	
PP	REJECTION RATE FOR PARAMETER INSPECTION	0.-1.	
PPER	YEARY POPULATION DISTRIBUTION BY -J- PARAMETER		
PPICK	VECTOR OF TIME PERIODS FOR PLOTTED OUTPUT		
PPPICK	COUNTER FOR PPICK - PLOT FLAG		
PO	PROBABILITY OF NO CARS IN THE INSPECTION QUEUE	0-1	
PRATE	PARAMETER DECAY FACTOR		
PS	MODE EMISSION REJECTION RATE	0.0-1.0	
PSA	UNION OF MODE EMISSION REJECTION RATES OVER MODES	0.0-1.0	
PSTAR	INPUT CONSTANT REJECTION RATE		
PSTARC	PSTAR CONSTRAINT COEFFICIENTS		
PT	UNION OF PARAMETER REJECTION RATES OVER POWER TRAIN		
PTOT	TOTAL REJECTION PROBABILITY		
PTOTS	TOTAL SIGNATURE REJECTION RATE		
PTS	UNION OF MODE EMISSION REJECTION RATES OVER JJ		
P1	INPUT DISTRIBUTIONS TO CONVOL		
P2	INPUT DISTRIBUTIONS TO CONVOL		
P3	INPUT DISTRIBUTIONS TO CONVOL		
QDEBUG	MODE EMISSION DECAY DEBUG FLAG		
QRATE	PARAMETER DECAY FACTOR		
RANGE	RANGE OF DISTRIBUTION IN XPT		
RANGE1	RANGE OF DISTRIBUTION IN CONVOL		
RANGE2	RANGE OF DISTRIBUTION IN CONVOL		
RANGE3	RANGE OF DISTRIBUTION IN CONVOL		
RCS	RATIO OF MANDATORY TO VOLUNTARY COST (PERCENT)		PERCENT
REINSP	PERCENTAGE OF CARS REINSPECTED	0	
RHO	RATIO OF CAR ARRIVALS TO DEPARTURES		
RNAME	RUN TYPE - SIGNATURE OR PARAMETER		
RPERC			
RSIZE	REGIONAL SIZE		SQ. MI.
RSTOP	PROGRAM STOPS EXECUTION AFTER SUBSEQUENTIAL	3HYES	2HNO
RTEST	TEST VALUE FOR RANGE3 EVEN		
RTYPE	PARAMETER MODEL ANALYSIS	9HPARAMETER	9HPARAMETER
	SIGNATURE ANALYSIS	9HSIGNATURE	
R1	1 PECENT POINT IN DISTRIBUTION - PACKD		
R2	99 PERCENT POINT IN DISTRIBUTION - PACKD		
S	EMISSION RATE SUMMING VARIABLE		
SALE	EQUIPMENT SALVAGE FRACTION	0	
SALL	LAND SALVAGE FRACTION	100	
SALP	FACILITIES SALVAGE FRACTION	0	

Table A-1 PROGRAM NOMENCLATURE (cont.)

SCALEBM	A SCALING VECTOR FOR BASELINE MAINTENANCE	
SD	STANDARD DEVIATION OF A DISTRIBUTION	
SDEBUG	STATS DEBUG FLAG	2HNO
SD1	STANDARD DEVIATION OF PRINTOUT DISTRIBUTION	
SD2	STANDARD DEVIATION OF PRINTOUT DISTRIBUTION	
SD3	STANDARD DEVIATION OF PRINTOUT DISTRIBUTION	
SIG	STANDARD DEVIATION OF PARAMETER DISTRIBUTIONS	
SIGCE	PARAMETER-EMISSION CORRELATION ERROR	
SIGDIFF	SIGNIFICANT DIFFERENCE	
SIGME	INSPECTION MEASUREMENT ERROR (INSTRUMENTATION)	
SIGMNE	MAINTENANCE EFFECTIVENESS ERROR - STANDARD DEVIATION	
SIGSDE	STANDARD DEVIATION OF DETERIORATION RATE ERRORS	
SIGP	PARAMETER DISTRIBUTION ERRORS	
SIGP	STANDARD DEVIATION PARAMETER SETTINGS	
SIGS	SIGNATURE MODE DISTRIBUTION ERRORS	
SIST	SIZE OF INSPECTION STATION	SQUARE FT
SITEI	NUMBER OF STATE LANE INSPECTION STATIONS	
SITEM	NO. OF MAINTENANCE SITES	SITES
SLANE	STATE LANE VS GARAGE FLAG. =10HSTATE,OR 10HGARAGE	
SM	SIGNATURE MODE DISTRIBUTION MEAN VALUES	
SMALL	SMALLER OF RANGE1 AND RANGE2 IN CONVOL	
SMODEL	CONSTANT. SIGNATURE CASE WHEN EQUAL TO RTYPE	9HSIGNATURE
SMS	MODE EMISSION MEAN	
SPAR	SIGNATURE (EMISSION) RESPONSE SURFACES	
SSIG	MODE EMISSION STANDARD DEVIATION	
SSIZE	SIZE OF INSPECTION FACILITY FOR OUTPUT -FACILITIES	SQUARE FT
STABLEX	MODE EMISSION DISTRIBUTION X VALUES. 33 POINTS.	
STABLEY	MODE EMISSION DISTRIBUTION Y VALUES. 33 POINTS.	
START	POPULATION STARTING EMISSION RATES	
START1	STARTING EMISSION LEVELS FOR LOS ANGELES FLEET	
START2	STARTING EMISSION LEVELS FOR NEW YORK FLEET	
START3	STARTING EMISSION LEVELS FOR WASHINGTON FLEET	
START4	STARTING EMISSION LEVELS FOR DENVER FLEET	
START5	STARTING EMISSION LEVELS FOR DETROIT FLEET	
STAT	TOTAL NUMBER OF LANES	LANES
STATSV	STAT SAVING VARIABLE IN CASE STAT IS CHANGED	
STIME	INSPECTION TIME IN A STATE LANE STATION	
SUM	EFFECT OF VOLUNTARY MAINTENANCE ON MODE EMISSIONS	
SUM	THE CHANGE IN PARAMETER SETTING DUE TO BASELINE MAINENANCE	
SUMI	SUMMING VARIABLE IN MAINT	
SUMJ	BASELINE EMISSION TIME HISTORY SUMMING VARIABLE	

Table A-1 PROGRAM NOMENCLATURE (cont.)

SUMP	TOTAL MODE EMISSION DECAY		
SUM1	EFFECT OF MANDATORY MAINTENANCE ON MODE EMISSIONS		
SXCUT	EMISSION PASS/FAIL CRITERIA		
SXCUTI	INPUT MODE EMISSION CUTPOINTS BY REGION		
T	FRACTION COUNTER FOR NORMALIZATION	0.-1.	
TABLEX	INITIAL PARAMETER DISTRIBUTION (X-AXIS)		
TABLEY	INITIAL PARAMETER DISTRIBUTION (Y-AXIS)		
TAREA	INTEGRATED THISTT		G
TCP	TOTAL PARTS COST PER PERIOD		$
TDEBUG	TEST DEBUG FLAG	2HNO	
TDEL	DELTA E STORAGE FOR PRINTOUT IN MAINT		
TDIST	ENGINE PARAMETER DISTRIBUTION TYPE 1-NORMAL		
TDST	INPUT PARAMETER USAGE FLAG VECTOR BY REGION		
TE1	OVERALL EMISSION SUMMING VARIABLES IN PRINT6		UG/M3
TE2	OVERALL EMISSION SUMMING VARIABLES IN PRINT6		MG/M3
TE3	OVERALL EMISSION SUMMING VARIABLES IN PRINT6		UG/M3
TH	FRACTION COUNTER FOR NORMALIZATION	0.-1.	
THIST	HISTORY OF EMISSIONS FOR EACH POWERTRAIN FOR TEST FLEET		GR/MI
THISTT	EMISSION LEVEL PER EMISSION TYPE FOR THE TEST FLEET		GR/MI
TIME	TIME AT INSPECTION INTERVAL		MONTHS
TIMEC	INSPECTION TIME BY PARAMETER AND VEHICLE TYPE		HOURS
TIMEI	ENGINE PARAMETER INSPECTION TIMES	(SEE LISTING)	MINUTES
TIMEM	ENGINE PARAMETER MAINTENANCE TIMES		MINUTES
TINT	INSPECTION INTERVAL	6-24	MONTHS
TM	MILEAGE SUMMING VARIABLE IN PRINT6		MILES/YEAR
TMIL	MONTHY MILEAGE ON -J- PARAMETER. BASED ON TINT		
TMU	MEAN EMISSION RATE FOR TEST CASE		
TOBE	TOTAL EMISSION QUANTITY FOR BASE FLEET		TONS
TONX	WEIGHTED SUM OF DIFFERENCE OF BASE-TEST		TONS
TONY	STATISTICALLY SIGNIFICANT BASE-TEST EMISSION RATES		TONS/YEAR
TONZ	BASE-TEST EMISSIONS BASED ON LAST TIME PERIOD		TONS/YEAR
TOTE	TOTAL EMISSION QUANTITY FOR TEST FLEET		TONS
TP	CONSTANT IN PRINT6	100.	PERCENT
TPDB	BASELINE EMISSION RATES		TONS/DAY
TPDT	TEST FLEET EMISSION LEVEL		TONS/DAY
TPER	POPULATION DISTRIBUTION B -J- PARAMETER BASED ON TINT.		
TSD	EMISSION RATE SIGMA FOR TEST CASE		
TSIG	TEST EMISSION DISTRIBUTION ERROR		
TSIZE	SAMPLE SIZE FOR THE TEST FLEET		
TSTAR	STATISTICAL SIGNIFICANCE TESTING PARAMETER		
TT	TOTAL FRACTION FOR NORMALIZING		

Table A-1 PROGRAM NOMENCLATURE (cont.)

TTI	TOTAL INSPECTION TIME PER PERIOD	MIN
TTM	TOTAL MAINTENANCE TIME	1
TTTTT	TOTAL FRACTION FOR NORMALIZING	
TXTRA	NINTR-XINT	MONTHS
U	UTILITY FUNCTION IN OPTMUM	
UTIL	MAXIMUM UTILITY FUNCTION IN OPTMUM	
V	ARRAY OF VARIABLE VALUES TO BE PLOTTED	
VAR1	VARIABLE VALUE TO BE PRINTED	
VAR2	VARIABLE VALUE TO BE PRINTED	
VAR3	VARIABLE VALUE TO BE PRINTED	
VEHPOP	STARTING VEHICLE POPULATION IN MILLIONS (OUTPUT)	CARS*10**6
VMN	ARRAY OF VARIABLE MINIMUMS	
VMN1	MINIMUM VALUE FOR VARIABLE 1 IN PLOTJK	
VMN2	MINIMUM VALUE FOR VARIABLE 2	
VMN3	MINIMUM VALUE FOR VARIABLE 3	
VMX	ARRAY OF VARIABLE MAXIMUMS	
VMX1	MAXIMUM VALUE FOR VARIABLE 1 IN PLOTJK	
VMX2	MAXIMUM VALUE FOR VARIABLE 2	
VMX3	MAXIMUM VALUE FOR VARIABLE 3	
VNAME1	VARIABLE NAME FOR ARRAY OUTPUT	
VNAME2	VARIABLE NAME FOR ARRAY OUTPUT	
VNAME3	VARIABLE NAME FOR ARRAY OUTPUT	
V1	VALUE OF VARIABLE 1 TO BE PLOTTED IN PLOTJK	
V2	VALUE OF VARIABLE 2 TO BE PLOTTED IN PLOTJK	
V3	VALUE OF VARIABLE 3 TO BE PLOTTED	
WIDTH	X AXIS POINT SPREAD FOR PACKED DISTRIBUTION-PACKD	
WF	PARAMETER DECAY WEIGHTS	
WQTI	WAITING TIME IN THE INSPECTION QUEUE	
WTIME	WAITING TIME IN THE INSPECTION QUEUE	MINUTES
WW1	TOTAL SUBPOPULATION PERCENTAGE FOR NORMALIZING	
X	VEHICLE AGE DISTRIBUTION OVER 15 YEARS	0.-1.
XBASE	DISTRIBUTION DISCRIPTION FOR BASELINE (X-AXIS)	
XBP	DUMMY ARRAY USED FOR MANIPULATING THE PARAMETER DIST.	
XCUT	PARAMETER PASS/FAIL CRITERIA	
XCUTI	INPUT PARAMETER CUTPOINTS BY REGION	
XCUTLO	MINIMUM SIGNIFICANT PARAMETER SETTING	
XCUTM	CUTPOINTS AT MAXIMUM UTILITY FUNCTION	
XDUM	TEMPORARY DISTRIBUTION STORAGE	
XHI	UPPER X INTEGRATION LIMIT	
XHIA	UPPER INTEGRATION LIMIT FOR ACCEPTED DISTRIBUTION	
XHIR	UPPER INTEGRATION LIMIT FOR REJECTED DISTRIBUTION	

Table A-1 PROGRAM NOMENCLATURE (cont.)

XINT	NO. OF INSPECTION INTERVALS(TEST)	48	MONTHS
XINTB	NO OF MAINTENANCE INTERVALS(BASELINE)	48	MONTHS
XKZE	AMORTIZATION CONSTANT FOR EQUIPMENT		
XKZL	AMORTIZATION CONSTANT FOR LAND		
XKZP	AMORTIZATION CONSTANT FOR FACILITIES		
XLAM	LAMBDA - ARRIVAL RATE		
XLANE	NO OF LANES PER STATION	1-4	LANES
XLO	LOWEST X VALUE		
XLOA	LOWER INTEGRATION LIMIT FOR ACCEPTED DISTRIBUTION		
XLOR	LOWER INTEGRATION LIMIT FOR REJECTED DISTRIBUTION		
XM	INTERPOLATED PERCENTAGE		
XMAX	LAGEST X VALUE IN X1 OR X2 IN ADD		
XMIN	SMALLEST X VALUE IN X1 OR X2 IN ADD		
XN	OPTIMAL REJECTION RATES RETURNED FROM CUTPNT	0.-1.	
XNAME	INSPECTION TYPE NAMES -OUTPUT ONLY		
XNM	OPTIMAL REJECTION RATES AT MAX UTILITY FUNCTION	0-1.	
XO	MINIMUM X VALUE IN A DISTRIBUTION OR PLOT		
XOPT	INTEGRATE F(X) OR X*F(X) FLAG		
XR	PARAMETER SETTING CHANGE DUE TO MAINTENANCE-CUTPNT		
XRATE	MODE EMISSION DECAY FACTOR		
XRN	NEW PARAMETER DELTA IN CUTPNT		
XSUM	SUMMING VARIABLE IN COST		
XTM	AVERAGE MAINTENACE TIME FOR TEST FLEET		
XX	TEMPORARY STORAGE		
X1	INITIAL VEHICLE DISTRIBUTION FOR LOS ANGELES FLEET		
X1BP	INTERPOLATION BREAK PTS (X-AXIS) FOR PP AND MVPR ESTIMATIONS (SIGNATURE ONLY)		
X2	INITIAL VEHICLE DISTRIBUTION FOR NEW YORK FLEET		
X3	INITIAL VEHICLE DISTRIBUTION FOR WASHINGTON FLEET		
X4	INITIAL VEHICLE DISTRIBUTION FOR DENVER FLEET		
X5	INITIAL VEHICLE DISTRIBUTION FOR DETROIT FLEET		
Y	TEMPORARY STORAGE OF DISTRIBUTION IN CONVOL		
YBASE	DISTRIBUTION DISCRIPTION FOR BASELINE (Y-AXIS)		
YBP	DUMMY ARRAY USED FOR MANIPULATING THE PARAMETER DIST.		
YES	CONSTANT FOR CHECKING FOR FLAGS ON OR OFF	3HYES	
YHI	MAXIMUM Y VALUE TO BE PLOTTED IN EPLOT		
YLO	LOWEST Y VALUE TO BE PLOTTED (ALWAYS ZERO) - EPLOT		
YMN	LOWEST Y VALUE TO BE PLOTTED (ALWAYS ZERO) - PLOT		
YMX	HIGEST Y VALUE TO BE PLOTTED IN PLOT		
YR	TIME AT AN INSPECTION INTERVAL		
YSUM	SUMMING VARIABLE IN COST		

Table A-1 PROGRAM NOMENCLATURE (cont.)

YTM	AVERAGE PARTS COST1FOR TEST FLEET		
YY	TEMPORARY STORAGE OF DISTRIBUTION IN CONVOL		
Y1	VALUE OF FIRST FUNCTION POINT TO BE PLOTTED-EPLOT		
Y1BP	INTERPOLATION BREAK PTS (Y-AXIS) FOR PP		
Y1DUM	TEMPORARY STORAGE FOR PARAM. REJECTION RATE TABLE		
Y2	Y AXIS NUMERICAL IDENTIFIER		
Y2	VALUE OF SECOND FUNCTION POINT TO BE PLOTTED-EPLOT		
Y2BP	INTERPOLATION BREAK PTS (Y-AXIS) FOR MVPR		
Y2DUM	TEMPORARY STORAGE FOR PARAM. EXPECTED VALUE TABLE		
Y3	Y AXIS NUMERICAL IDENTIFIER		
Y4	Y AXIS NUMERICAL IDENTIFIER		
Y5	Y AXIS NUMERICAL IDENTIFIER		
Y6	Y AXIS NUMERICAL IDENTIFIER IN EPLOT		
ZIC	COST OF CAPITAL	7	
ZQUEI	LENGTH OF WAITING LINE AT INSPECTION STATION		CARS
ZSUM	SUMMING VARIABLE IN COST		
ZX	TEMPORARY STORAGE OF CAPITAL COSTS		DOLLRS/DAY
ZZ	TEMPORARY STORAGE VARIABLE		
Z1	NUMBER OF SUPERVISORS PER LANE	50.	
Z2	MECHANICS HOURLY PAY RATE	10.	$/HOUR
Z3	FRANCHISED GARAGE PROFIT MARGIN	10.	
Z4	INFLATION RATE	6.	/YEAR
Z5	DISCOUNT RATE	7.	/YEAR
Z6	NOT USED	0	
Z7	NOT USED	0	
Z8	NOT USED	0	
Z9	INCONVENIENCE RATE(OF HOURLY RATE)	42.	
Z10	FACILITIES CONSTRUCTION COSTS	10.	$/SQ.FT.
Z11	FIXED EQUIPMENT COSTS	16000.	$/SITE
Z12	VARIABLE EQUIPMENT COSTS	2000.	$/LANE
Z13	LAND PURCHASING COSTS	2.	$/SQ.FT.
Z14	FIXED INFO. SYSTEM COSTS	0	$
Z15	INFO. PROCESSING COSTS	0.5	$/CAR
Z16	ATTENDENT HOURLY PAY RATE	3.5	$/HOUR
Z17	DYNAMOMETER COSTS	5000.	$/LANE

APPENDIX B

SAMPLE PROBLEMS

APPENDIX B

SAMPLE PROBLEMS

This appendix presents two sample cases which are designed to illustrate many of GEEP's input/output options. The data for the first case, consisting of an Engine Inspection coupled with Extensive B Maintenance, is given in Table B-1. In this example, the input includes all three control groups (Uncontrolled, Controlled and Post 1970). Shown in Table B-2 is computer output of the input data. This page is useful in checking for input errors. Tables B-3 through B-7 show typical output data for the selected case. These include a results summary, vehicle population characteristics, Los Angeles Basin data, pass/fail analysis for engine inspection, developed pass/fail inspection criteria, and resultant engine parameter rejection rates. Depending on the applications, the pass/fail criteria can be inputted directly or determined from the optimization algorithm. The XCUT vector specifies the pass/fail criteria for each of the ten engine parameters for each control fleet. The SXCUT vector performs a similar function for six exhaust mode emissions.

The program also generates a set of emission time history plots as depicted in Figures B-1 through B-3 for HC, CO and NO_x, respectively. These plots are augmented by actual numerical data as shown in Table B-9. Here, the emission histories are given by power train type for each inspection interval. Finally, Table B-10 presents the results of a statistical analysis for predicted emission reductons . In this example, results are shown for each exhaust emission at year six. This completes the standard output generated during a normal run. More detailed information can be obtained through the use of PPLOT and DEBUG options.

The second sample case selected for presentation involves an Emission Inspection with Extensive B Maintenance. The required input data is shown in B-11. It should be noted that only the data that is different from the first case need to be inputted. For example, both cases utilized all three control types and consequently it was not necessary to respecify them again in the second case. Table B-12 shows a computer generated listing of the input data for the second case. This output corresponds to the data shown in Table B-2. Table B-13 presents inputted and calculated data specific to the State Lane Emission Inspection Strategy. Input data includes total number of lanes for system, inspection times and equipment costs. Calculated output consists of total user time and facilities configuration. Lastly, Table B-14 gives the summary results for case 2. Results depicting the remaining standard output have not been shown since they are analoguous to those presented in the first case.

Table B-1 SAMPLE PROBLEM #1 (ENGINE INSPECTION EXTENSIVE B PROGRAM)

c
c
1

KEYWORD	DESCRIPTION
PARAMETER	Parameter Inspection
LA	Los Angeles Area
CONTROL	
UNCONTROL	Include all three control types.
POST 70	
CUTPTS	Cutpoint optimization debug output.
IDLE	
IGNITION	Include all ten parameters.
INDUCTION	
LOADED	Test under loaded conditions
THAT'S ALL	End of keyword data flag.
P$NAM1	Namelist input card.
PPICK = 0	No plotted output.
LPICK = 2	Optimize cutpoints at first period only.
NPICK = 6	Statistical analysis at last period only.
$END	End of namelist data and end of case flag.

Table B-2 INPUT DATA FOR FIRST CASE

RUN TYPE --	PARAMETER MODEL
AREA CONSIDERED --	LOS ANGELES BASIN
CAR POPULATION TYPE --	UNCONTR
	CONTR
	POST 70

PARAMETERS CONSIDERED --	1	IDLE CO
	2	RPM
	3	TIMING
	4	MISFIRE
	5	NOX
	6	AIR PUMP
	7	PCV
	8	AIR CLEAN
	9	VAC KICK
	10	HEAT RISER

DEBUG OPTIONS FOR THE FOLLOWING SUBROUTINES:

BLINE	NO
MICRO	NO
TEST	NO
COSTS	NO
AREA	NO
LINPRO	YES
PDECAY	NO
DATA	NO
STATS	NO

```
$NAM1
PPICK=0
LPICK=2
NPICK=6
$END
```

Table B-3 SUMMARY RESULTS FOR CASE 1

```
***********************************
*    TRW INSPECTION/MAINTENANCE   *
*           SYSTEM MODEL          *
***********************************
```

SUMMARY INFORMATION

ENGINE PARAMETER STRATEGY EXTENSIVE B
INSPECTION PERIOD IS 12.0 MONTHS

PAYOFF FUNCTION UNADJUSTED (DOLLARS/WEIGHTED EMISSION)	1863.76
PAYOFF FUNCTION STATISTICALLY ADJUSTED (DOLLARS/WEIGHTED EMISSION)	932.76
PAYOFF FUNCTION AT END OF LAST YEAR (DOLLARS/WEIGHTED EMISSION)	633.72
HC EMISSION REDUCTION (PERCENT)	10.70
CO EMISSION REDUCTION (PERCENT)	6.14
NO EMISSION REDUCTION (PERCENT)	-.87
HC AVERAGE EMISSIONS (TONS/DAY)	715.42
CO AVERAGE EMISSIONS (TONS/DAY)	9318.10
NO AVERAGE EMISSIONS (TONS/DAY)	541.08
TOTAL COSTS FOR MANDATORY PROGRAM (DOLLARS/YEAR)	105171879.78
TOTAL COSTS FOR VOLUNTARY PROGRAM (DOLLARS/YEAR)	172490930.25
RATIO OF MANDATORY TO VOLUNTARY COSTS (PERCENT)	60.97
INSPECTION CAPITAL COSTS (DOLLARS/STATION)	0.00
AVERAGE INSPECTION OPERATING COSTS (DOLLARS/YEAR)	56762290.23
MAINTENANCE CAPITAL COSTS (DOLLARS)	0.00
AVERAGE MAINTENANCE OPERATING COSTS (DOLLARS/YEAR)	48409589.55
USER COSTS (DOLLARS/CAR)	1.93
COST PER INSPECTION	24.04
COST PER VEHICLE MAINTAINED	33.09
AVERAGE NUMBER OF CARS INSPECTED/YEAR	4374727.91
AVERAGE NUMBER OF CARS REJECTED/YEAR	2406155.68
AVERAGE NUMBER OF CARS MAINTAINED/YEAR	2406155.68
AVERAGE FAILURE PERCENTAGE	.55
TOTAL PROGRAM DURATION (YEARS)	5.00

Table B-4 VEHICLE POPULATION CHARACTERISTICS

YEAR		VEHICLE DISTRIBUTION PERCENT	INCREMENTAL ODOMETER READING MILES	VEHICLE EMMISSION LEVELS HC GRAMS/MILE	CO GRAMS/MILE	NO GRAMS/MILE	VEHICLE POPULATION
	PRECONTROLLED	32.5	4157	11.94	129.60	5.47	
	CONTROLLED (1966-1970)	46.2	5418	7.20	85.59	5.54	
	POST 1970	21.3	14014	4.43	63.40	5.00	
1	TOTALS	100.0	8225	6.18	95.70	5.50	4060000
	PRECONTROLLED	24.5	3968	12.54	133.52	3.74	
	CONTROLLED (1966-1970)	43.5	7262	7.57	95.24	6.28	
	POST 1970	32.0	13722	4.77	73.67	5.84	
2	TOTALS	100.0	8281	7.39	96.92	5.51	4120000
	PRECONTROLLED	18.1	3753	12.56	132.54	3.55	
	CONTROLLED (1966-1970)	39.7	6265	7.50	93.26	6.16	
	POST 1970	42.3	12192	4.69	75.06	5.04	
3	TOTALS	100.0	8312	7.25	92.27	5.45	4243000
	PRECONTROLLED	13.2	3562	12.67	134.43	3.23	
	CONTROLLED (1966-1970)	34.6	5409	7.73	93.49	6.07	
	POST 1970	52.2	11471	4.54	78.20	5.41	
4	TOTALS	100.0	8323	6.77	90.91	5.35	4373900
	PRECONTROLLED	9.7	3403	12.74	135.62	2.94	
	CONTROLLED (1966-1970)	28.7	4743	7.87	92.69	5.98	
	POST 1970	61.6	10763	4.56	79.96	5.20	
5	TOTALS	100.0	8355	6.30	89.0[illegible]	5.21	4502035
	PRECONTROLLED	7.1	3268	12.78	136.35	2.66	
	CONTROLLED (1966-1970)	22.7	4442	8.01	91.31	5.90	
	POST 1970	70.2	10106	4.47	80.39	4.99	
6	TOTALS	100.0	8336	5.86	88.64	5.03	4637096

Table B-5 LOS ANGELES BASIN DATA

EMISSION SURVEILLANCE DATA SOURCE		TRW/ARB
FEDERAL 1975 MOTOR VEHICLE STANDARDS		
	HC	.41 G/MI
	CO	3.40 G/MI
	NO	3.00 G/MI
EMISSION SPECIE WEIGHTING FUNCTION		
	HC	.60
	CO	.10
	NO	.30
MINIMUM EMISSION REDUCTION GOALS		
	HC	10.00 PERCENT
	CO	10.00 PERCENT
	NO	0.00 PERCENT
REGIONAL AREA		1250.00 SQ MI
AVERAGE VEHICLE SPEED		30.00 MPH
VEHICLE POPULATION		4.00 MILLION
NUMBER OF CLASS ≠A≠ FRANCHISED GARAGES		1000

Table B-6 PASS/FAIL ANALYSIS FOR ENGINE INSPECTION

4 5 6 10	PARAMETER REJECTION RATES 1	2	3	7	8	9	I/M COSTS	DISCRETE PARAMETER EMISSION DELTA PERCENT HC	CO	NO	WEIGHTED EMISSION DROP
0 0 0 0	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	0.00	0.0000	0.0000	0.0000	0.0000
0 0 0 1	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	.50	0.0000	0.0000	0.0000	0.0000
0 1 0 0	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.58	.0021	-.0018	.0018	0.0000
0 1 0 1	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	2.08	.0021	-.0018	.0018	0.0000
1 0 0 0	.42	0.00	0.00	.39	.44	.14	6.38	.1023	.2074	-.0160	1.5581
1 0 0 1	.42	0.00	0.00	.39	.44	.14	6.88	.1023	.2074	-.0160	1.5581
1 1 0 0	.42	0.00	0.00	.39	.44	.14	7.96	.1044	.2056	-.0141	1.5557
1 1 0 1	.42	0.00	0.00	.39	.44	.14	8.46	.1044	.2056	-.0141	1.5557

Table B-7 PASS/FAIL INSPECTION CRITERIA

PARAMETER	1	2	3	4	5	6	7	8	9	10
UNCONTR	1.00	-999	10.00	1	0	0	-.1173	10.63	-1.0000	0
CONTR	1.00	-12	1.03	1	0	1	-.1138	10.69	-.0520	1
POST 70	1.00	-999	10.00	1	0	0	-.1124	10.32	-.0521	0

MODE EMMISIONS	1	2	3	4	5	6
UNCONTR	3000	6.00	4000	450	3.50	4000
CONTR	250	4.00	5000	250	1.50	5000
POST 70	2000	3.00	4000	200	1.00	4000

Table B-8 ENGINE PARAMETER REJECTION RATES FOR FIRST TIME INTERVAL

TIME HISTORY POINT 2 12.0 MONTHS TOTAL FAILURE IS .902≤

POWERTRAIN TYPE 1 -- GM .898≤

PARAMETER	1	2	3	4	5	6	7	8	9	10	UNION
UNCONTR	.354	0.000	0.000	.020	0.000	0.000	.477	.559	0.000	0.000	.834
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000
CONTR	.457	.510	.354	.022	0.000	.059	.430	.504	.129	.273	.972
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000
POST 70	.434	0.000	0.000	.020	0.000	0.000	.381	.434	.128	0.000	.830
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000

POWERTRAIN TYPE 2 -- FORD .900≤

PARAMETER	1	2	3	4	5	6	7	8	9	10	UNION
UNCONTR	.354	0.000	0.000	.020	0.000	0.000	.477	.559	0.000	0.000	.856
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000
CONTR	.471	.510	.354	.022	0.000	.059	.430	.504	.129	.273	.972
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000
POST 70	.450	0.000	0.000	.020	0.000	0.000	.381	.434	.128	0.000	.835
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000

POWERTRAIN TYPE 3 -- CHRY .902≤

PARAMETER	1	2	3	4	5	6	7	8	9	10	UNION
UNCONTR	.372	0.000	0.000	.020	0.000	0.000	.477	.559	0.000	0.000	.858
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000
CONTR	.482	.510	.354	.022	0.000	.059	.430	.504	.129	.273	.975
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000
POST 70	.464	0.000	0.000	.020	0.000	0.000	.381	.434	.128	0.000	.839
MODE	0.000	0.000	0.000	0.000	0.000	0.000					0.000

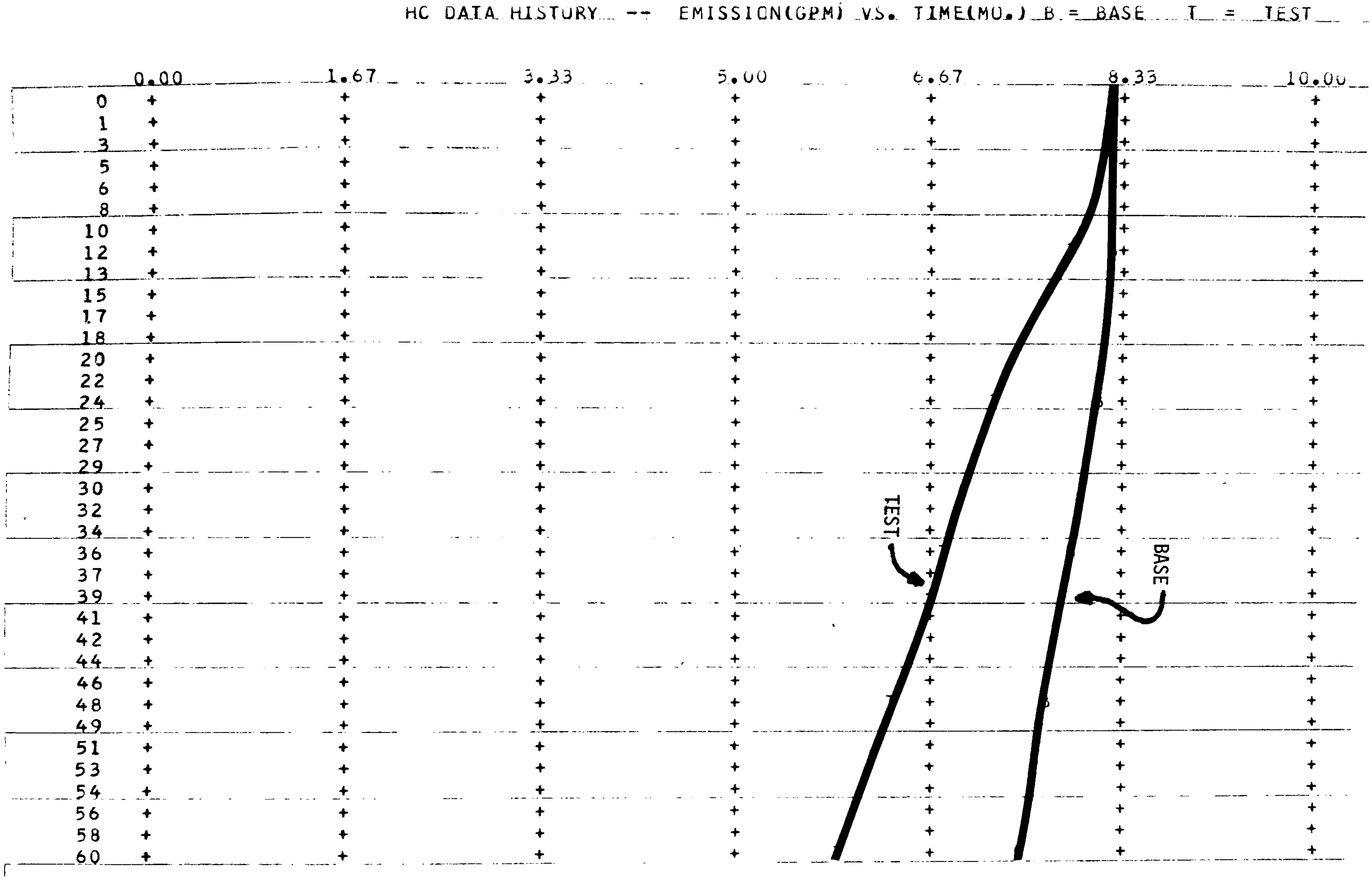


Figure B-1 HC Emission Time History Plot

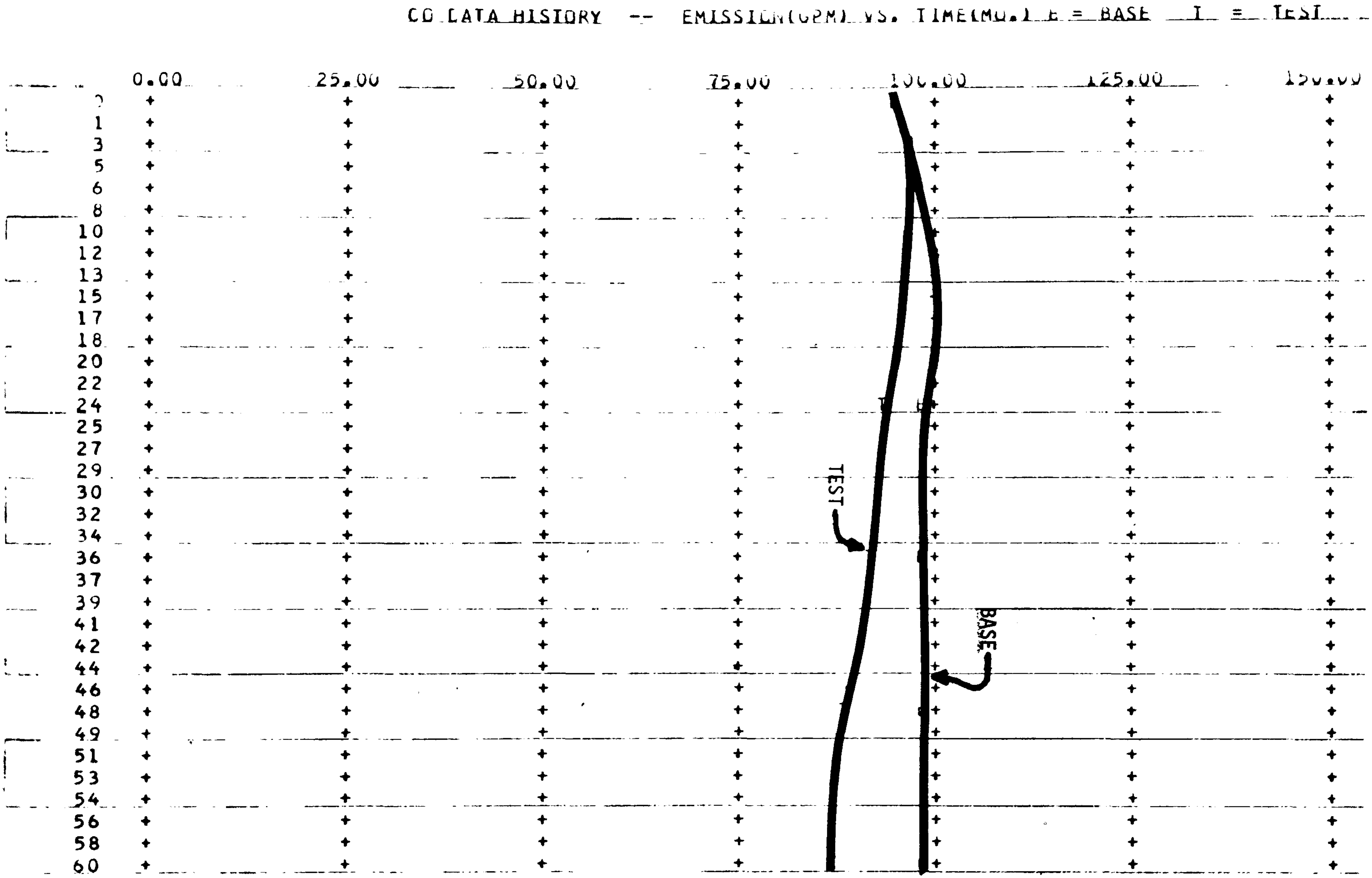


Figure B-2 CO Emission Time History Plot

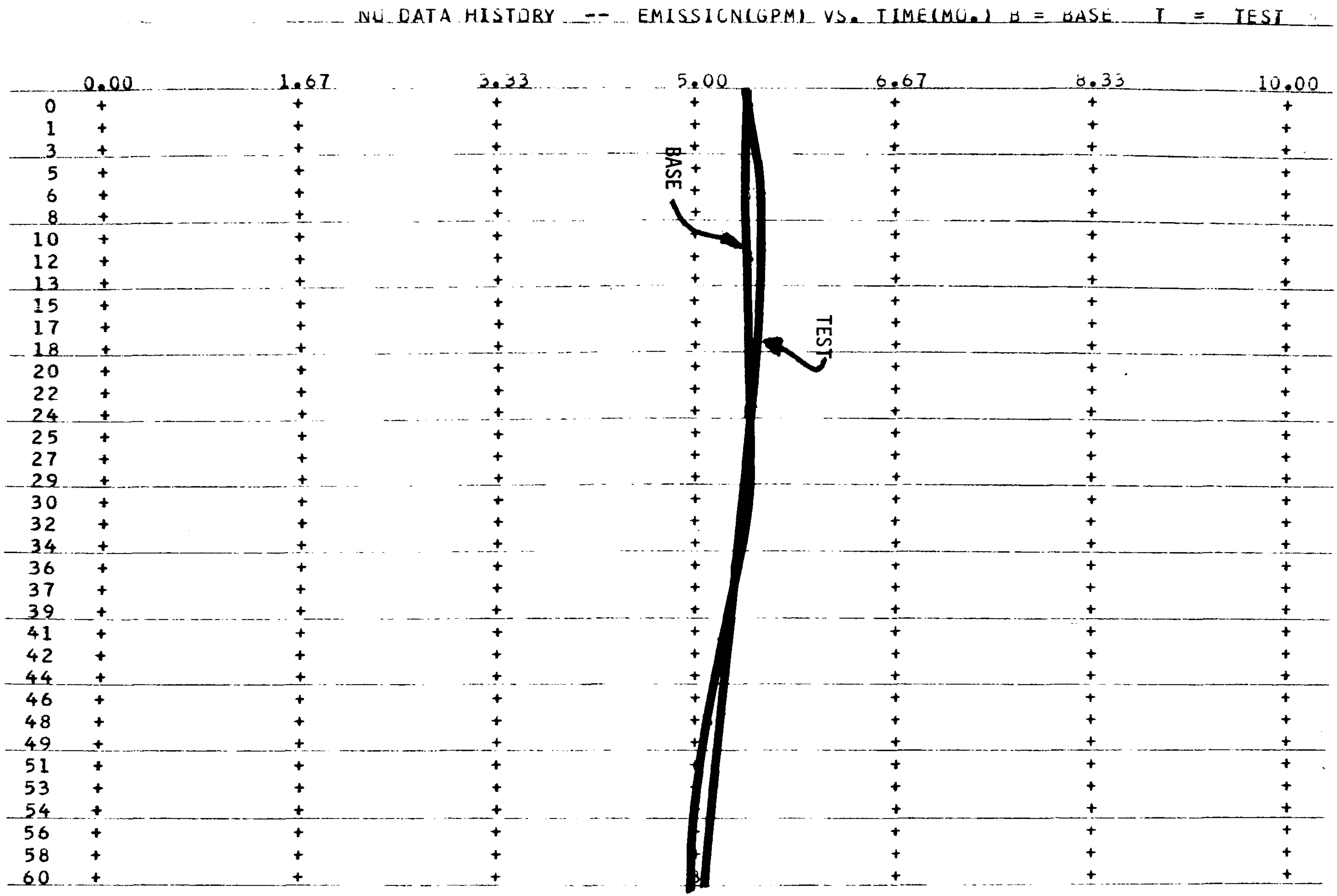


Figure B-3 NO_x Emission Time History Plot

Table B-9 EMISSION HISTORY SUMMARY

*****HC LEVEL -- END OF INSPECTION INTERVAL (GR/VEHICLE-MILE) *****

POWERTRAIN TYPE

TEST NO.	GM	FORD	CHRY	AMC	IMPORTS
1	8.1782	8.1782	8.1782	8.1782	8.1782
2	7.8958	7.8930	7.8909	7.8885	7.8862
3	7.2623	7.2571	7.2529	7.2483	7.2438
4	6.7786	6.7730	6.7682	6.7631	6.7581
5	6.3151	6.3091	6.3037	6.2981	6.2926
6	5.8697	5.8640	5.8589	5.8538	5.8490

*****CO LEVEL -- END OF INSPECTION INTERVAL (GR/VEHICLE-MILE) *****

POWERTRAIN TYPE

TEST NO.	GM	FORD	CHRY	AMC	IMPORTS
1	95.6984	95.6984	95.6984	95.6984	95.6984
2	97.2012	97.0448	96.9169	96.7786	96.6391
3	93.2939	92.9554	92.6685	92.3718	92.0685
4	91.7503	91.3432	90.9615	90.6204	89.8616
5	90.1879	89.7160	89.2778	88.5066	87.2906
6	88.3403	87.8751	87.2194	86.1241	84.6374

Table B-9 EMISSION HISTORY SUMMARY (cont.)

*****NO LEVEL -- END OF INSPECTION INTERVAL (GR/VEHICLE-MILE) *****

POWERTRAIN TYPE

TEST NO.	GM	FORD	CHRY	AMC	IMPORTS
1	5.4973	5.4973	5.4973	5.4973	5.4973
2	5.5064	5.5078	5.5089	5.5102	5.5114
3	5.4606	5.4630	5.4648	5.4668	5.4688
4	5.3489	5.3510	5.3527	5.3547	5.3565
5	5.2015	5.2035	5.2052	5.2071	5.2089
6	5.0273	5.0290	5.0305	5.0321	5.0335

SUMMARY EMISSION HISTORIES

TEST NO	TIME MO	HC BASE	HC TEST	CO BASE	CO TEST	NO BASE	NO TEST
1	0.0	8.178	8.178	95.698	95.698	5.497	5.497
2	12.0	8.228	7.891	99.817	96.916	5.470	5.509
3	24.0	8.071	7.253	99.120	92.672	5.396	5.465
4	36.0	7.877	6.768	98.535	90.911	5.293	5.353
5	48.0	7.663	6.304	98.103	88.996	5.147	5.205
6	60.0	7.445	5.859	97.761	86.839	4.972	5.030

Table B-10 STATISTICAL ANALYSIS OF PREDICTED EMISSION REDUCTIONS

YEAR 6

HC EMISSION

REJECT NULL HYPOTHESIS.
THERE IS A SIGNIFICANT DIFFERENCE IN THE MEANS
AT A CONFIDENCE LEVEL OF 90.00
THE LOWER CONFIDENCE LIMIT IS 1.3855E+00
T = 1.0135E+01 TSTAR = 1.2800E+00
TEST MU = 5.8551E+00 BASE MU = 7.4449E+00

CO EMISSION

REJECT NULL HYPOTHESIS.
THERE IS A SIGNIFICANT DIFFERENCE IN THE MEANS
AT A CONFIDENCE LEVEL OF 90.00
THE LOWER CONFIDENCE LIMIT IS 5.4533E+00
T = 2.5564E+00 TSTAR = 1.2800E+00
TEST MU = 8.6839E+01 BASE MU = 9.7761E+01

NO EMISSION

ACCEPT THE NULL HYPOTHESIS.
THERE IS NOT A SIGNIFICANT DIFFERENCE IN THE MEANS
AT A CONFIDENCE LEVEL OF 90.00
T = -2.4512E-01 TSTAR = 1.2800E+00
TEST MU = 5.0305E+00 BASE MU = 4.9724E+00

Table B-11 SAMPLE PROBLEM #2
(EMISSION INSPECTION EXTENSIVE B PROGRAM)

(CC1)

SIGNATURE	Mode emission inspection
IHC	Mode emissions (signatures) inspected
ICO	
CO45	
HC45	
STOP	Last case flag
THAT S ALL	End of case flag
P$NAM1	
NPICK=6	Statistical analysis at last time period
STAT=100	100 inspection stations
$END	

Note: Keyword and namelist input data from the previous cases is still in affect

Table B-12 INPUT DATA FOR SECOND CASE

RUN TYPE --	SIGNATURE MODEL	
AREA CONSIDERED --	LOS ANGELES BASIN	
CAR POPULATION TYPE --	UNCONTR	
	CONTR	
	POST 70	
PARAMETERS CONSIDERED --	1	IDLE CO
	2	RPM
	3	TIMING
	4	MISFIRE
	5	NOX
	6	AIR PUMP
	7	PCV
	8	AIR CLEAN
	9	VAC KICK
	10	HEAT RISER
SIGNATURE MODES CONSIDERED --	1	HC - IDLE
	2	CO - IDLE
	3	NO - IDLE
	4	HC - 45
	5	CO - 45
	6	NO - 45

DEBUG OPTIONS FOR THE FOLLOWING SUBROUTINES:

BLINE	NO
MICRO	NO
TEST	NO
COSTS	NO
AREA	NO
LINPRO	NO
PDECAY	NO
DATA	NO
STATS	NO

Table B-13 INSPECTION LANE SYSTEM

TOTAL NUMBER OF STATE OPERATED INSPECTION LANES	100
NUMBER OF LANES PER SITE	1
TOTAL NUMBER OF SITES	100
VEHICLE INSPECTION TIMES	
IDLE	1.50 MIN
LOADED	2.40 MIN
HYBRID	2.40 MIN
EQUIPMENT REQUIREMENTS AND COSTS	
NDIR	2000 DOLLARS/LANE
COMPUTER	15000 DOLLARS/LANE
MISC.	5000 DOLLARS/LANE
DYNO	7000 DOLLARS/LANE
INFORMATION PROCESSING COSTS	1.00 DOLLARS/CAR
USER TIME COSTS	2.00 DOLLARS/HR.
TOTAL USER TIME PER PERSON	28.96 MIN
NUMBER OF STATE EMPLOYEES PER LANE	2
STATION SIZE (FACILITIES ONLY)	600.00 SQ. FT.
STATION LAND SIZE	10153.55 SQ. FT.

Table B-14 SUMMARY RESULTS FOR CASE 2

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*********************************
*    TRW INSPECTION/MAINTENANCE  *
*          SYSTEM MODEL          *
*********************************
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SUMMARY INFORMATION

ENGINE SIGNATURE STRATEGY EXTENSIVE D
INSPECTION PERIOD IS 12.0 MONTHS

PAYOFF FUNCTION UNADJUSTED (DOLLARS/WEIGHTED EMISSION)	1473.40
PAYOFF FUNCTION STATISTICALLY ADJUSTED (DOLLARS/WEIGHTED EMISSION)	1043.63
PAYOFF FUNCTION AT END OF LAST YEAR (DOLLARS/WEIGHTED EMISSION)	511.07
HC EMISSION REDUCTION (PERCENT)	6.09
CO EMISSION REDUCTION (PERCENT)	3.41
NO EMISSION REDUCTION (PERCENT)	-.31
HC AVERAGE EMISSIONS (TONS/DAY)	739.73
CO AVERAGE EMISSIONS (TONS/DAY)	9569.50
NO AVERAGE EMISSIONS (TONS/DAY)	558.00
TOTAL COSTS FOR MANDATORY PROGRAM (DOLLARS/YEAR)	53570663.00
TOTAL COSTS FOR VOLUNTARY PROGRAM (DOLLARS/YEAR)	174989110.29
RATIO OF MANDATORY TO VOLUNTARY COSTS (PERCENT)	30.65
INSPECTION CAPITAL COSTS (DOLLARS/STATION)	183266.66
AVERAGE INSPECTION OPERATING COSTS (DOLLARS/YEAR)	10767139.75
MAINTENANCE CAPITAL COSTS (DOLLARS)	0.00
AVERAGE MAINTENANCE OPERATING COSTS (DOLLARS/YEAR)	43211343.32
USER COSTS (DOLLARS/CAR)	.97
COST PER INSPECTION	12.34
COST PER VEHICLE MAINTAINED	21.33
AVERAGE NUMBER OF CARS INSPECTED/YEAR	4374727.91
AVERAGE NUMBER OF CARS REJECTED/YEAR	2290254.92
AVERAGE NUMBER OF CARS MAINTAINED/YEAR	2290254.92
AVERAGE FAILURE PERCENTAGE	.52
TOTAL PROGRAM DURATION (YEARS)	5.00