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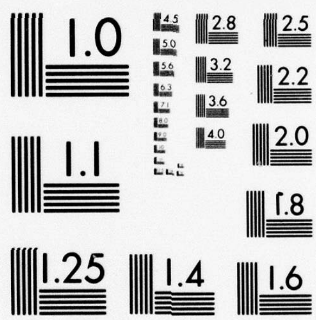

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Volume I

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PLOTTING LANGUAGE UTILIZING GRAPHICAL OPTICS (PLUGO)
Volume I: User's Guide

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MAY 1978

TECHNICAL REPORT AFFDL-TR-78-55
Final Report for Period November 1977 – February 1978

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AEROMECHANICS DIVISION
AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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This technical report has been reviewed and is approved for publication.

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FOR THE COMMANDER

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This report describes the function and use of a system of digital computer programs called PLUGO (Plotting Language Utilizing Graphical Optics). PLUGO combines batch processing with interactive graphics to provide the engineer with an analysis tool capable of handling large quantities of data. Basic input consists of a sequential file containing any number of fixed format data records. Data records contain values for up to 100 experimental → next page

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variables. Output consists of X-Y plots of user specified data subsets from the input data file. Plots are subject to inspection, editing, curve-fitting, and interpolation via an interactive graphics program. A special function creates trimmed plots of wind-tunnel generated force-moment data. Programs are written in CDC FORTRAN EXTENDED for execution on a CDC 6600 or CYBER 74 computer system.

PREFACE

This report was prepared by the University of Dayton Research Institute under Contract Number F33615-76-C-3067 EE 62. Work was performed at the request of the Flight Vehicle Branch, Aeromechanics Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio under Project Number 2404-16-02 during the period from November 1977 to February 1978. The author was Jerry G. Jensen with contributions from Dr. Duane G. Leet. The Project Engineer was James L. Terry.

Computer programs described in this paper were written by personnel from the Digital Programming Branch, Digital Processing Division, Air Force Aeronautical Systems Division Computer Center, Wright-Patterson Air Force Base, Ohio. Systems analysis was performed by Thomas S. Rowland. Programmers were Sharon J. Foley, Capt. Stephen E. Hamm, and Wayne A. Jansen.

SUMMARY

This report describes a system of digital computer programs called PLUGO (Plotting Language Utilizing Graphical Optics). This report is contained in two volumes - Volume I, PLUGO User's Guide; and Volume II, PLUGO System Description. The PLUGO systems consists of two phases. Phase I is a batch program that scans the input data tape, captures data points, and creates plots from these points. Phase II is an interactive graphics program that permits the user to modify and analyze the plots created by Phase I. The PLUGO programs are written in CDC FORTRAN EXTENDED and are designed to execute on a CDC 6600 or CYBER 74 computer system.

Basic input to PLUGO is a sequential file containing any number of fixed format data records (data points). Each data point may contain floating-point values for up to 100 experimental variables. Output consists of X-Y plots, drawn on a Calcomp plotter of data subsets from the input data file. The user defines conditions on the experimental variables that determine how the data points are grouped into these subsets. The resulting plots are subject to modification through the use of an interactive-graphics program executed at a CDC CYBERGRAPHICS CRT terminal.

Modification functions include:

Curve-fitting - Data points on the plots may be curve-fitted using a straight-line, least squares, or spline algorithm.

Editing - Data points may be added to or deleted from the plots.

Interpolation - Data values may be calculated from the coefficients calculated by the curve-fitting functions.

Trimming - Trimmed plots of wind-tunnel generated force-moment data may be obtained.

Plot Information - Listings of plot information (data point values, curve-fit coefficients, etc.) may be obtained.

Thus PLUGO provides the user with a powerful yet simple to use data analysis tool capable of handling large amounts of data in an efficient manner.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

SECTION I

OVERVIEW

1.1 INTRODUCTION

Many plotting, curve fitting, and data analysis computer programs currently exist that reduce and display numerical data. PLUGO is a system of CDC 6600/Cyber Series FORTRAN programs that combine these functions in a generalized manner, suitable to many types and levels of users. Although originally designed for the analysis of wind tunnel test data, the PLUGO system follows a general scheme for the reduction, collection, and plotting of subsets of data from a raw data file. Possible applications of PLUGO would include analysis of wind tunnel force-moment data, pressure test data, free flight data, and structural test data.

Historically, the PLUGO system was a single batch computer program that created plots of data points from a data tape generated at a wind tunnel test facility. The data tape was restricted to a pre-specified format. Later a second program was added to allow the user to display the plots created by the batch program on a graphics CRT terminal and perform certain interactive operations (i.e., editing of points, curve fitting) on these plots. Consequently, the batch program was rewritten to make it compatible with the graphics program and to remove most of the input tape format restrictions. When this was done, the system's capabilities were expanded enabling PLUGO to be used in fields other than aerodynamics with data tapes of any format. This is the basic form of the PLUGO system today: a Phase I batch program that does certain time consuming operations and a quick-response Phase II interactive graphics program.

The PLUGO system provides the user with a powerful data analysis tool. As with any tool, a good working knowledge of the tool's functions is required to utilize the tool efficiently and effectively. This manual is formatted to provide this information to the PLUGO user in a logical, manageable fashion.

Sections 1.2 through 1.6 briefly describe the capabilities and input data requirements of the PLUGO system. By reading these sections, a user can determine whether or not PLUGO can be of use to him. Sections 2 and 3 describe, in detail, the preparation and use of the Phase I and Phase II programs respectively. Because of the general nature of most PLUGO functions, many examples are used throughout this text to illustrate possible and specific uses of these functions.

Because of its origin, PLUGO offers a few functions solely for the processing of wind tunnel force-moment data. Wherever special procedures are required for use of these functions, they are stated separately from the general text so that the non-aeronautical user is not burdened by the necessary aero-terminology.

1.2 RAW INPUT DATA REQUIREMENTS

To be compatible with PLUGO, the user's data tape from the test facility (the Raw Data Tape), must satisfy a few general requirements:

1) The Raw Data Tape must consist of a single sequential file. The order of the records in this file is not important. There is no limit to the number of records in the file.

2) Each logical record in the file is called a Data Point. Each Data Point can contain floating point values for up to 100 experimental variables. The format of the Data Points must be constant throughout the file. The Data Point format is defined by the user.

3) Aeronautical engineers intending to use the TRIM function should format the Raw Data Tape in accordance with Table A-1 located in the Appendix, entitled "Suggested Variable Names for Aerodynamic Force-Moment Data."

Layout of the Raw Data Tape:

record 1 = point 1 = $(V_1^1, V_2^1, V_3^1, \ldots V_n^1)$ where $n \le 100$

record 2 = point 2 = $(V_1^2, V_2^2, V_3^2, \ldots V_n^2)$

⋮

record I = point I = $(V_1^I, V_2^I, V_3^I, \ldots V_n^I)$

End of file

1.3 CAPABILITIES OF THE PLUGO SYSTEM

1.3.1 Data Point Selection and Manipulation

PLUGO provides the user with a great deal of flexibility in selecting the Data Points to be plotted from the PLUGO Input Tape.* The criteria for selecting the Data Points are contained on a CONDITION card. This card specifies a condition that a Data Point must satisfy in order to be included on a plot. Each plot may have any number of CONDITION cards associated with it.

Example: A plot is to be constructed having V_1 as the X-axis variable and V_2 as the Y-axis variable. For notational purposes an arbitrary point on this plot will be represented as $(V_1{}^K, V_2{}^K)$. This point is a subpoint of Data Point K $(V_1{}^K, V_2{}^K, V_3{}^K, \ldots V_n{}^K)$ as found on the PLUGO Input Tape. CONDITION cards are input to PLUGO specifying conditions pertaining to variables V_5, V_{12}, and V_{25}. Upon execution, PLUGO scans the PLUGO Input Tape and test the values of V_5, V_{12}, and V_{25} on each Data Point against the conditions specified on the CONDITION card. If, for example, on Data Point 90 (Record 90) the values of $V_5{}^{90}$, $V_{12}{}^{90}$ and $V_{25}{}^{90}$ satisfy the specified conditions, then the subpoint $(V_1{}^{90}, V_2{}^{90})$ will be represented on the ensuing plot.

---

*The PLUGO Input Tape is a slightly modified version of the Raw Data Tape. A description of this tape is found in Section 1.5.1.

The user is not limited to plotting variable V_i vs. V_j. PLUGO allows the user to define functions of variables, thus enabling plots of $F(V_i)$ vs. $F(V_j)$ to be constructed. Definition of a function is accomplished by inserting function definition cards (FORTRAN statements) into the source code of the PLUGO Phase I program as described in Section 2.1.2. Up to 20 functions can be defined. For example, suppose the PLUGO Input Tape contains Data Points having values for the variables speed and time. The function $F_1 = \text{speed}^2$ can be defined and a plot of time vs. $(\text{speed})^2$ can be generated without having to recreate the PLUGO Input Tape.

1.3.2 Plot Creation Capabilities

PLUGO provides the user with a wide latitude of plot creation options. A basic PLUGO generated plot (Figure 1) has a nine inch X-axis and a six inch Y-axis with one variable associated with each axis. The individual axes can be scaled and labeled by the user. The user can provide up to three lines of title to each plot. There are provisions for plotting up to three independent Y-axes against one X-axis.

A plot scaling factor can be specified to change the physical size of the generated plots to any multiple of the standard nine inch by six inch size. Plots can be specified for the values of any variable or function values of a variable as a function of any other variable or function of a variable overall the Data Points.

The Data Points and their corresponding plotted points can be separated into groups (denoted by different point symbols) by use of the PARAMETER card. A PARAMETER card specifies conditions on any variable that determine which group of Data Points, and thus the symbol assigned to its corresponding point, a particular Data Point belongs to. Figure 2 illustrates the use of the PARAMETER card. An understanding of the parameter concept is essential to understanding many of the advanced PLUGO functions described in Section 1.3.3.

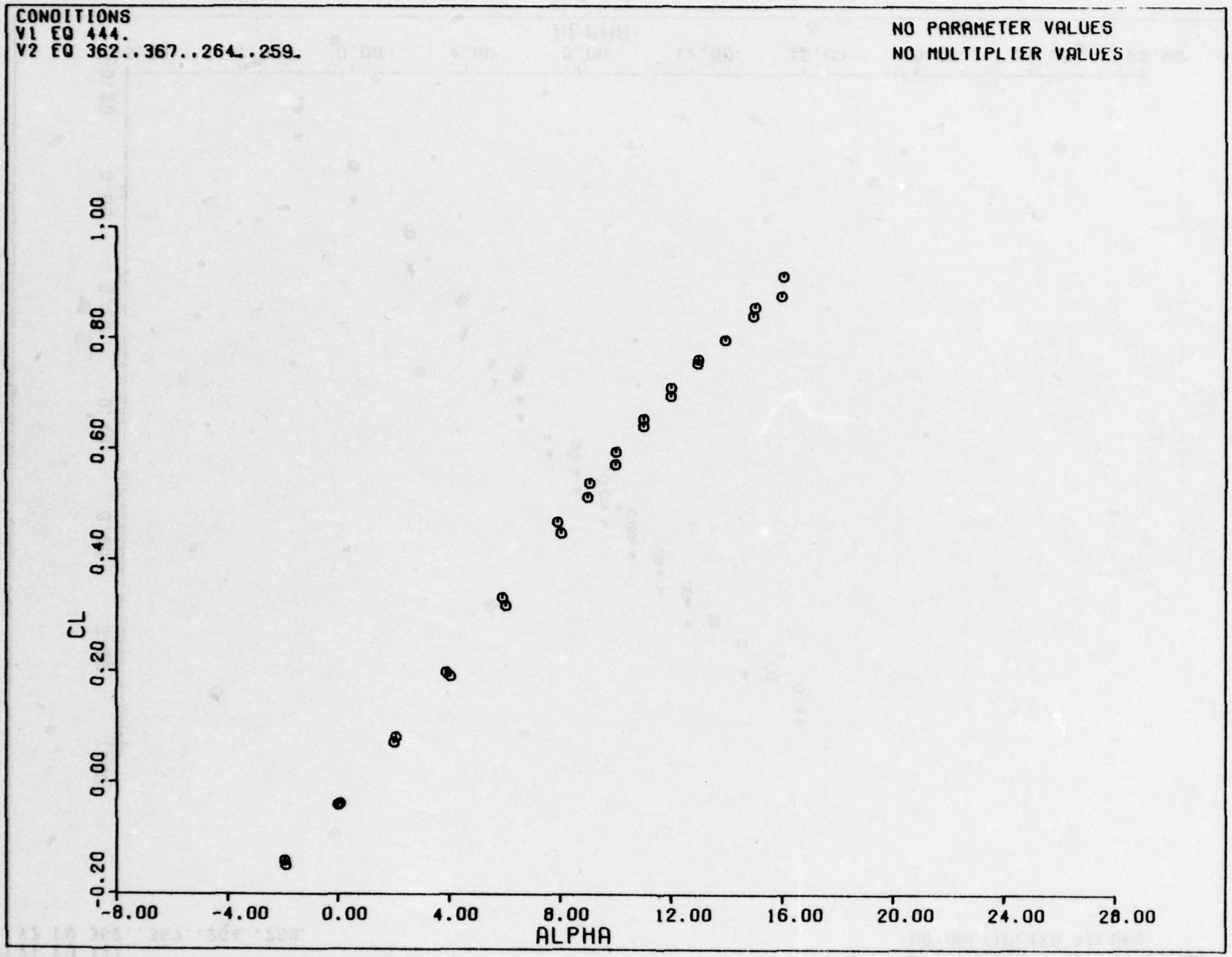

Figure 1. An example of a simple PLUGO plot. No Multiplier or Parameter values have been specified.

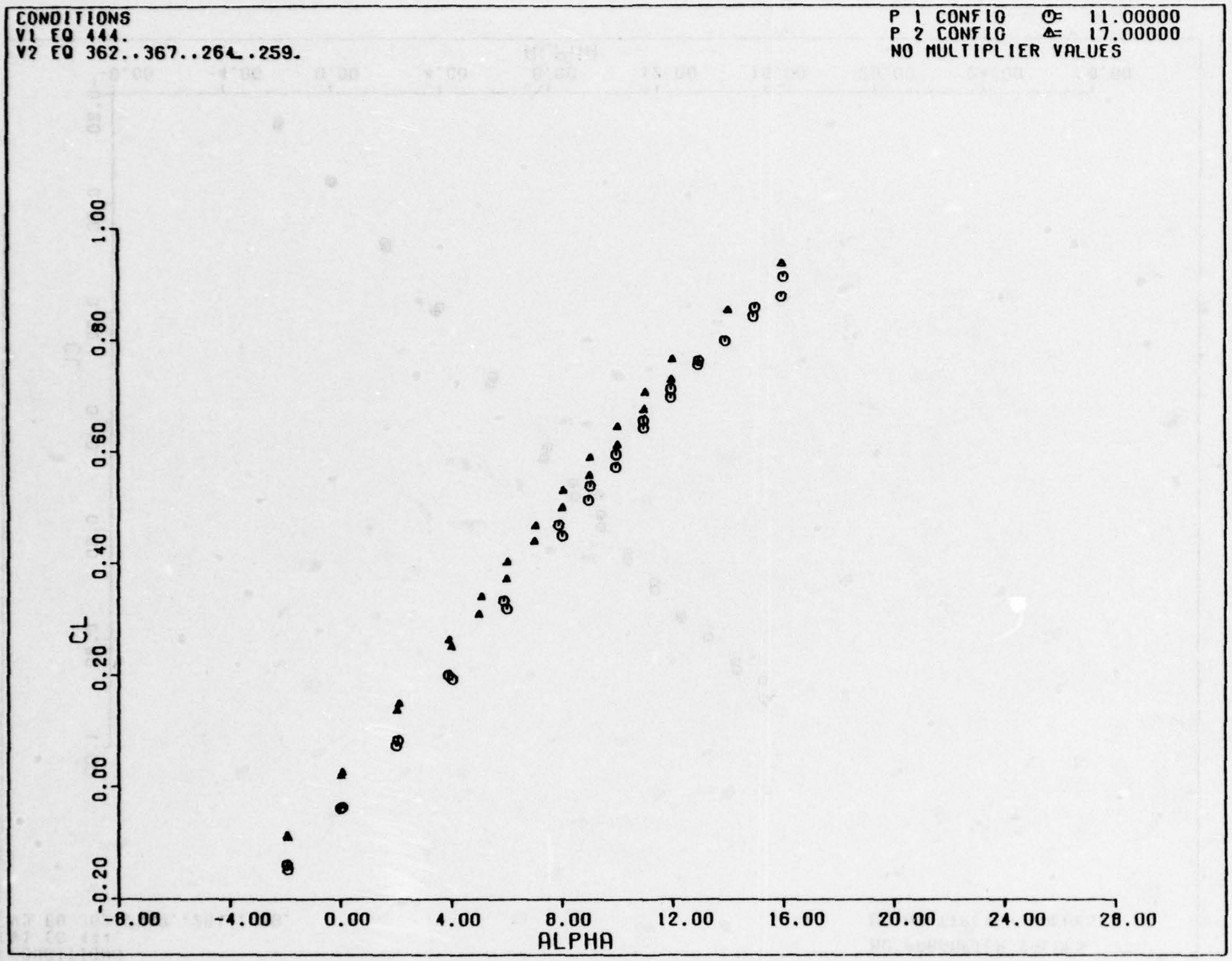

Figure 2. Example of a plot produced with a Parameter Card: PARAMETER CONFIG EQ 11.0, 17.0

Another method of grouping Data Points is by using a MULTIPLIER card. As with the PARAMETER card, the MULTIPLIER card separates Data Points into groups according to conditions specified on the card. PLUGO creates a separate plot for each group of points. By using a MULTIPLIER card, many similar plots can be generated from one card without having to redefine the plot axes or Data Point selection conditions. Figure 3 shows two plots generated from one MULTIPLIER card. Had the MULTIPLIER card not been used, the data points* on both plots would have been contained on a single plot. A set of plots generated from one MULTIPLIER card is referred to as "a string of multiplier plots."

1.3.3 Plot Manipulation Functions

PLUGO generated plots can be modified through the use of the PLUGO Phase II interactive graphics program run at a Cybergraphics CRT terminal. The following functions can be performed on all plots except those having multiple Y-axes.

Curve Fitting - Curves can be fit to data points using the spline, least squares, or straight-line curve fitting algorithms. Individual parameter data point groups on a plot can be pre-fitted with one command sequence.

Editing - Points can be added to or deleted from plots. Individual curves can be deleted from plots. Plots can be deleted from Plot Groups (groups of plots having CONDITION card specification is common).

Hardcopies - Modified plots can be routed to magnetic tape to be plotted on a Calcomp plotter.

Plot Data - Information about plots (scales, data points, curve fit coefficients) can be printed out.

Trim - This is a special feature for aeronautical engineers. This option is described in detail in Appendix A.

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*From now on, "data point" without capital letters refers to the plotted point corresponding to a Data Point, which is a vector of up to 100 dimensions.

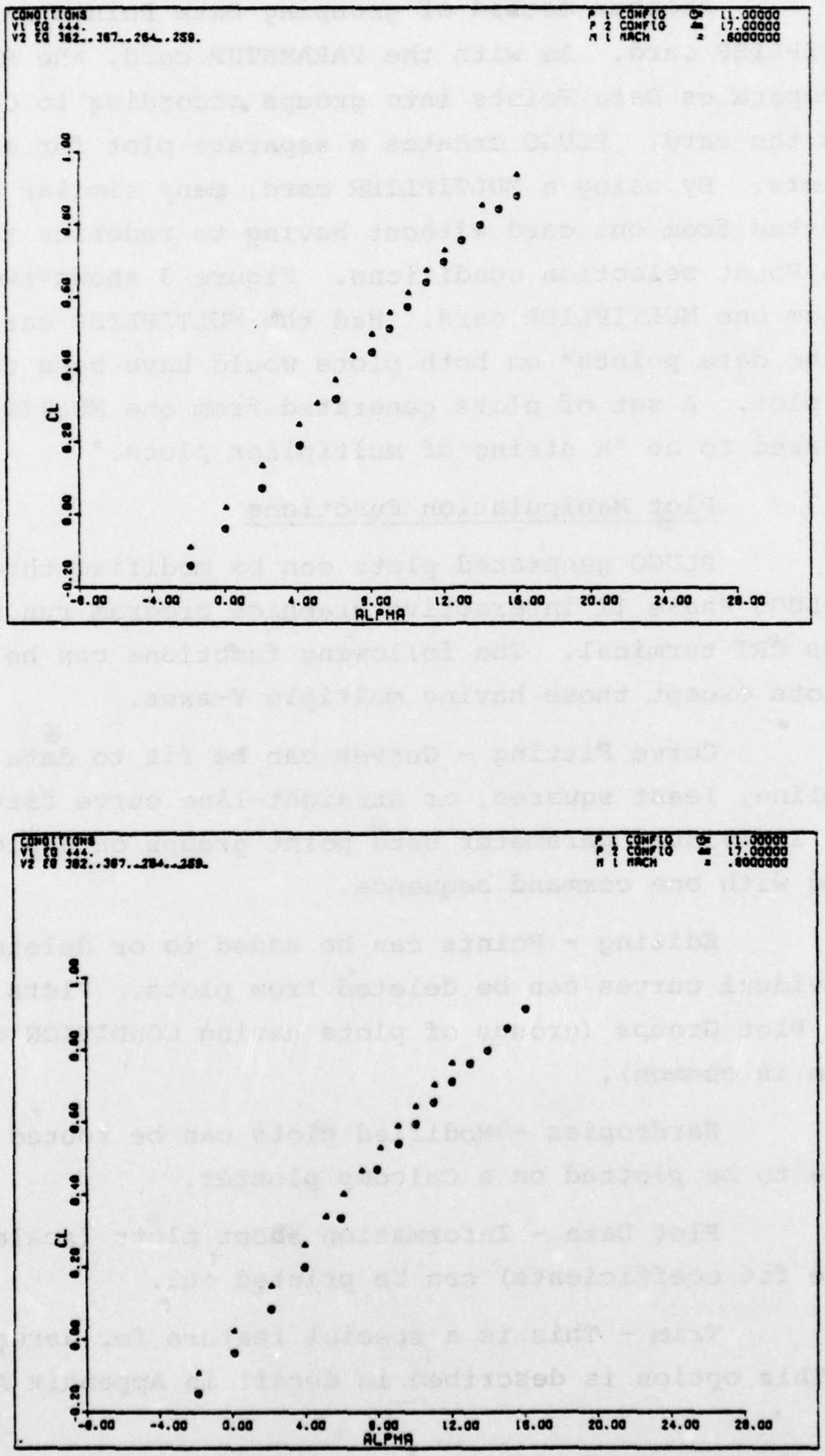
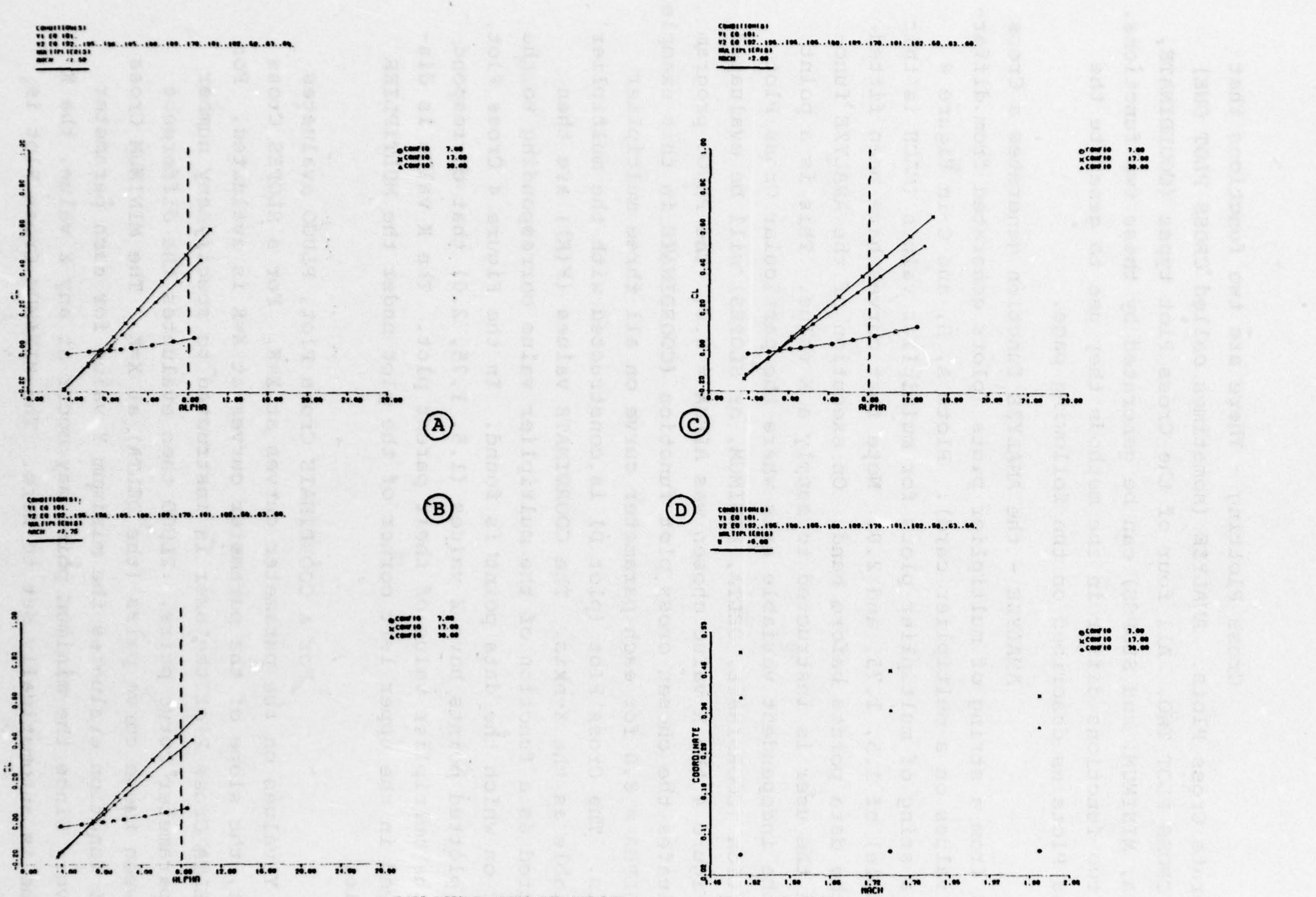


Figure 3. Example of plots produced with a Multiplier Card: MULTIPLIER MACH EQ .6, .8.

Cross Plotting - There are two functions that generate Cross Plots. ANALYZE (sometimes called CROSS PLOT ONE) and CROSS PLOT TWO. All four of the Cross Plot types (COORDINATE, DELTA, MINIMUM, and SLOPES) can be generated by these two functions. The two functions differ in the methods they use to generate the Cross Plots as described on the following page.

ANALYZE - the ANALYZE function generates a Cross Plot from a string of multiplier plots (plots generated from different values on a multiplier card). Plots A, B, and C in Figure 4 are a sting of multiplier plots for multiplier values (MACH is this example) of 1.5, 1.75, and 2.0. Note that curves have been fitted to the data points before hand. On execution of the ANALYZE function the user is instructed to supply a K value. This is a point on the independent variable axis where the particular Cross Plot function (COORDINATE, DELTA, MINIMUM, or SLOPES) will be evaluated. In Figure 4 the K value chosen was ALPHA = 8.0. The PLUGO program evaluates the chosen cross plot function (COORDINATE in this example) at ALPHA = 8.0 for each parameter curve on all three multiplier plots. The Cross Plot (plot D) is constructed with the multiplier variable as the X-axis. The COORDINATE values (F(K)) are then plotted as a function of the multiplier value corresponding to the plot on which the data point is found. In the Figure 4 Cross Plot, the plotted points have X values (1.5, 1.75, 2.0) that correspond to the multiplier value of their parent plot. The K value is displayed in the upper left corner of the plot under the MULTIPLIER lable.

For a COORDINATE Cross Plot, PLUGO evaluates the Y values on the parameter curves at X=K. For a SLOPES Cross Plot, the slope of the parameter curves at X=K is evaluated. For a DELTA Cross Plot the user is instructed to specify any number of parameter curve pairs. PLUGO then evaluates the difference between these curve pairs (the DELTA) at X=K. The MINIMUM Cross Plot function evaluates the minimum Y value for each parameter curve. Since the minimum point may occur at any X value, the K value is automatically set to zero. The MINIMUM Cross Plot is



ANALYZE CROSS PLOT

Figure 4. Cross Plot D results from parent plots A, B, and C. A K value of ALPHA=8.0 was chosen. Curve values at ALPHA=8.0 are then plotted on D as a function of their multiplier variable (MACH).

subject to a few constraints, described in Chapter IV under Usage of the Graphics Program, due to the nature of the minimum point routine incorporated by the program.

CROSS PLOT TWO - As with ANALYZE, CROSS PLOT TWO can generate the same four types of Cross Plots. However only one parent plot is required to generate a Cross Plot with the CROSS PLOT TWO option. The parent plot must have at least two parameters specified with the data points already curve fitted. The user is instructed to enter one to ten K values. PLUGO evaluates the Cross Plot function specified (COORDINATE, DELTA, MINIMUM, or SLOPES) at each K value for each parameter curve. The Cross Plot is constructed with the parameter variable as the X-axis. The K values picked become parameters. Figure 5 is an example of a CROSS PLOT TWO generated COORDINATE Cross Plot.

1.4 GENERAL SYSTEM DESCRIPTION

The PLUGO system is divided into two phases. Phase I extracts data points from the PLUGO Input Tape and creates basic plots. These plots are written to a magnetic tape (for subsequent plotting on a Calcomp plotter) and a permanent disc file. Phase II is an interactive graphics program that reads the disc file created by Phase I and allows the user to edit, modify, and analyze the plots on this file. These modified plots can be written to magnetic tape for off-line plotting and/or saved on a permanent disc file, similar in format to the file output from Phase I, for subsequent modification by Phase II.

1.5 PROCEDURES FOR EXECUTING PLUGO

A complete cycle of the PLUGO system is comprised of four user-executed procedures. The relationship between these procedures and the flow of data through the system is illustrated in Figure 6. Each procedure is briefly described in the next four sections.

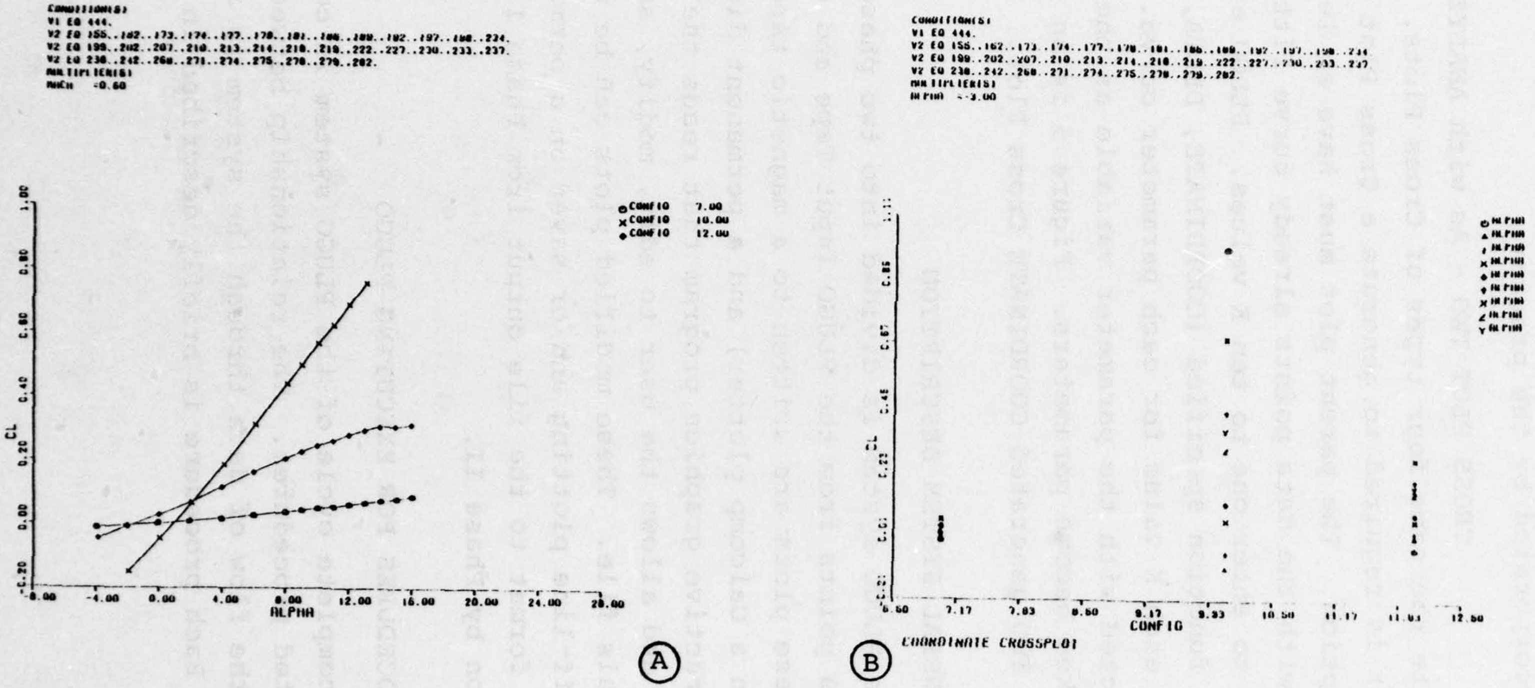


Figure 5. Sample of a CROSS PLOT TWO COORDINATE Cross Plot. K values chosen (ALPHA=) are displayed in the PARAMETER field in upper right corner of Cross Plot B. The parent plot is A.

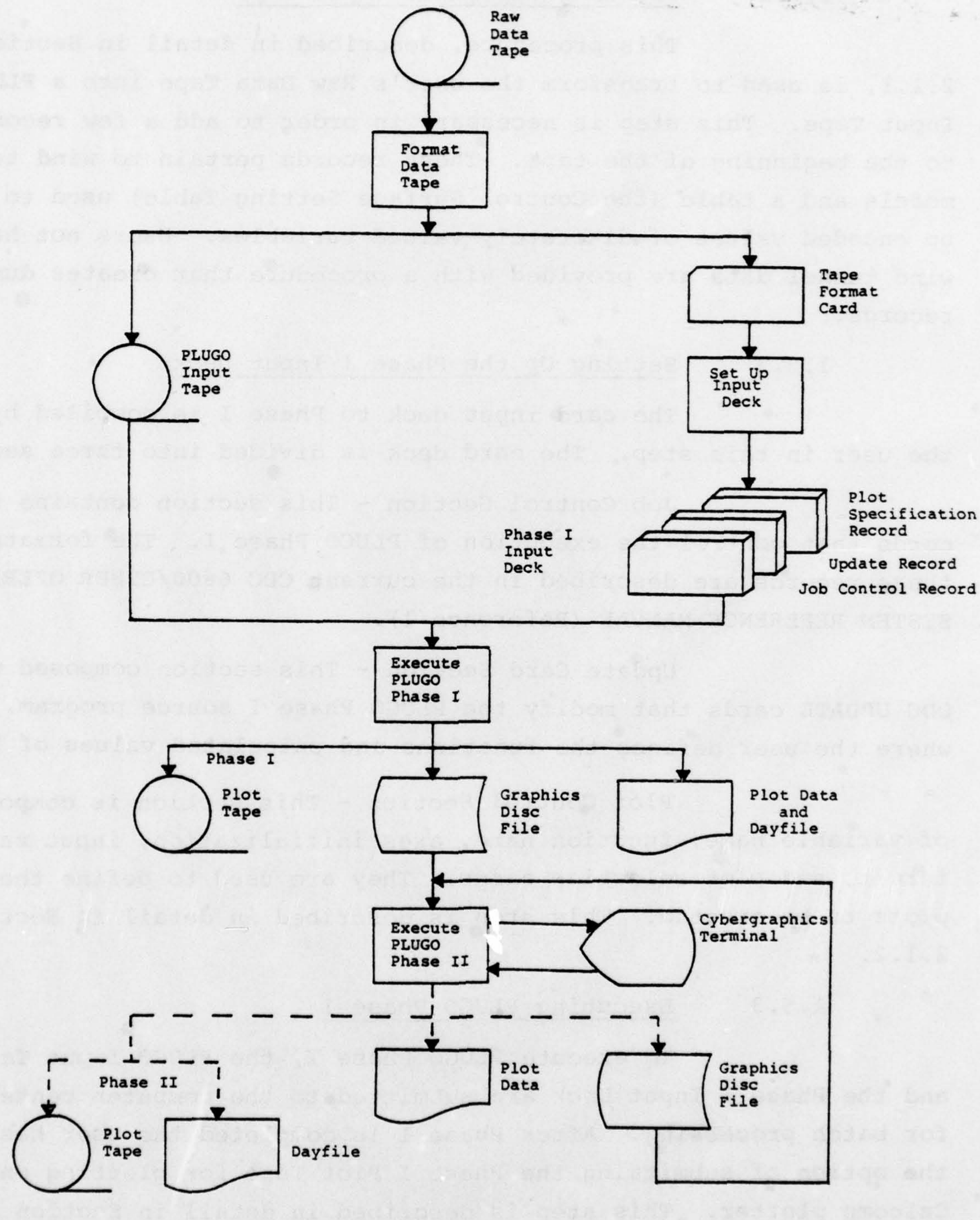


Figure 6. User operations and data flow through the PLUGO system.

1.5.1 Creating the PLUGO Input Tape

This procedure, described in detail in Section 2.1.1, is used to transform the user's Raw Data Tape into a PLUGO Input Tape. This step is necessary in order to add a few records to the beginning of the tape. These records pertain to wind tunnel models and a table (the Control Surface Setting Table) used to look up encoded values of discretely-valued variables. Users not having wind tunnel data are provided with a procedure that creates dummy records.

1.5.2 Setting Up the Phase I Input Deck

The card input deck to Phase I is compiled by the user in this step. The card deck is divided into three sections:

Job Control Section - This section contains records that control the execution of PLUGO Phase I. The formats of these records are described in the current CDC 6600/CYBER OPERATING SYSTEM REFERENCE MANUAL (Reference 1).

Update Card Section - This section composed of CDC UPDATE cards that modify the PLUGO Phase I source program, is where the user defines the functions and calculated values of PLUGO.

Plot Control Section - This section is composed of variable name, function name, axes initialization, input tape format, and plot selection cards. They are used to define the plots to be created. This step is described in detail in Section 2.1.2.

1.5.3 Executing PLUGO Phase I

To execute PLUGO Phase I, the PLUGO Input Tape and the Phase I Input Deck are submitted to the computer center for batch processing. After Phase I is completed the user has the option of submitting the Phase I Plot Tape for plotting on the Calcomp plotter. This step is described in detail in Section 2.2.

1.5.4 Executing PLUGO Phase II

To execute PLUGO Phase II, the user logs in under INTERCOM at a CDC Cybergraphics terminal. He then enters a procedure command: BEGIN, PLUGO, ... The program's output options are specified at this time. The user can interactively display plots created in Phase I, edit, curve fit, and/or modify them according to his objectives. These modified plots can be released to the Phase II Plot Tape for hardcopy if the appropriate options have been specified. When the user is finished using PLUGO Phase II, he exits by selecting the STOP light-button. The PLUGO system asks if the modified plots are to be saved on a Graphics Disc File for later use. If "YES" is entered, the file is cataloged as a permanent disc file. The user may re-enter PLUGO Phase II using this file as input instead of the Graphics Disc File created in Phase I. If the HARDCOPY option was selected, PLUGO will release a batch job to the computer's input queue to create the Phase II Plot Tape. A detailed description of this step is found in Section 3.2.

1.6 HARDWARE-SOFTWARE RESOURCE REQUIREMENTS

The PLUGO system is currently operational on the CDC 6600/CYBER computer system located at the ASD Computer Center, Wright-Patterson Air Force Base in Dayton, Ohio. This system consists of a CDC 6600 (A system) and a CDC CYBER 74 (B system) mainframe connected to several CDC 1700 remote batch terminals. Several of these terminals are wired to CDC 774 Cybergraphics terminals. Although the PLUGO system is compatible with both systems, location of the necessary permanent files will dictate which system PLUGO will execute on. The Phase I program requires two magnetic tape drives, a card reader, a printer, and disc drives necessary for the various disc files used. The Phase II program requires the use of a CDC 774 Cybergraphics terminal.

NOS/BE 1 is the current operating system (Reference 1) in use on both computer systems. Libraries required are:

- CCPLOT
- CC6600
- NOSLIB
- IGS777
- DRIVER

The Phase I and Phase II programs are written in CDC FORTRAN EXTENDED (Reference 2) and are written to be used with the 274 Interactive Graphics System (Reference 3).

SECTION II
PLUGO PHASE I USER GUIDE

This guide to PLUGO Phase I has four sections. The first three describe the input to, execution of, and output produced by the Phase I program. The last section describes how Phase I relates to Phase II and makes miscellaneous comments about Phase I.

2.1 PLUGO PHASE I INPUT DATA

2.1.1 Preparing the PLUGO Input Tape

The PLUGO Input Tape (Figure 7) is a single file consisting of two sets of records: a Control Surface Setting (CSS) Table, which was designed for certain aerodynamic data, and data records copied from the Raw Data Tape. Since PLUGO was initially designed to process data from wind tunnel experiments, it is necessary to input a CSS Table even though the data to be processed are not related to aerodynamics. A user does not need to know how to set up and use this table but may find it useful for applications other than aerodynamics.

This section is divided into two parts. The first part is a procedure for preparing the PLUGO Input Tape for the user who does not want to use the CSS Table. The second part describes the function of the CSS Table and gives the procedure to set up the table and create a PLUGO Input Tape using it.

2.1.1.1 Creating the PLUGO Input Tape With a Dummy CSS Table

Procedure 1 can be used to create a PLUGO Input Tape when the user does not wish to define a CSS Table.

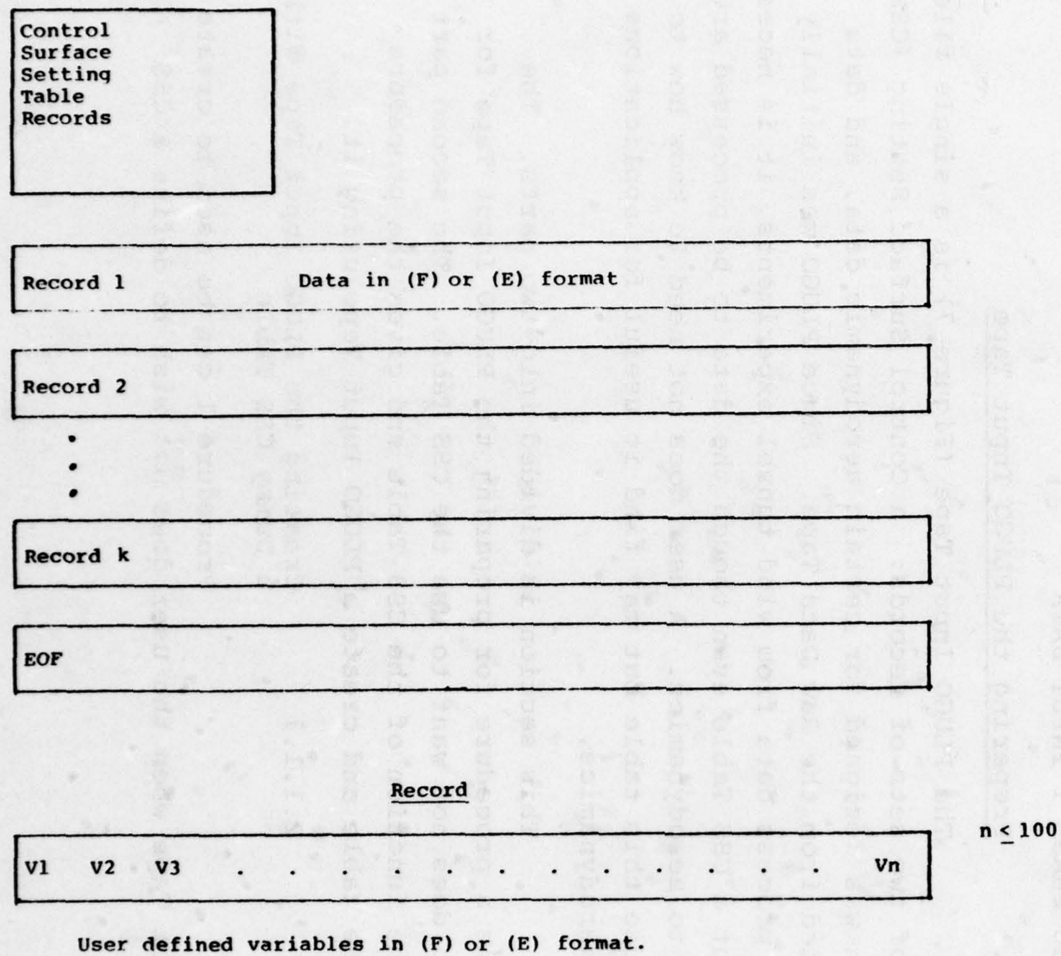


Figure 7. Diagram of the PLUGO Input Tape.

Procedure 1:	Creating the PLUGO Input Tape With a Dummy CSS Table.
1.	Obtain a dump of the Raw Data Tape.
2.	Change the circled statements in COPY (Figure 8) to match the format of the Raw Data Tape.
3.	Execute COPY.

The FORTRAN program COPY (Figure 8) creates a dummy CSS Table and then copies the data records from the Raw Data Tape to the PLUGO Input Tape. In the Figure 8 example, the Raw Data Tape has 37 variables in each record. COPY adds a 38th variable (record count) to each record. Execution of COPY results in a listing of all Data Points (including the record count variable) that are copied onto the PLUGO Input Tape. When the PLUGO Phase I program refers to a Data Point (e.g. when a list of points is printed or a tape read error occurs), the offset (record count) of the Data Point on the PLUGO Input Tape is printed also. Thus, execution of COPY provides the user with a list of Data Points, with their corresponding record counts, for cross-reference purposes.

Experience has shown that the process of a CDC system reading a magnetic tape created on another computer system gives the PLUGO user the most trouble. It is suggested that the following information be obtained from the facility that is producing the Raw Data Tape.

- the type of computer that generated the Raw Data Tape
- the operating system used
- the number of tracks on the Raw Data Tape (7 or 9)
- the Raw Data Tape density
- the Raw Data Tape blocking information
- the character code used
- label information

```
S?JGJ,TF8C,IO0F3,MT2,STC38.   X654321   TERRY/FXS/55006
FTN,A.
LABEL,TAPE7,W,L=TERRY,RING,VSN=X11161.   X654321   PLUGO INPUT TAPE
REQUEST,TAPE3,S,NORING,VSN=XC1999.   X654321      RAW DATA TAPE
FILE,TAPE3,BT=K,MBL=280,RB=1,RT=F,FL=274.
LDSET,FILES=TAPE3.
LGO.
EXIT.
(7/8/9) END OF RECORD
      PROGRAM COPY(TAPE3=/280,TAPE7=/290)
C       THIS PROGRAM INPUTS TAPE3 AND OUTPUTS TAPE7.  TAPE3 IS THE RAW
C       DATA TAPE FROM THE TEST FACILITY.  THE RAW DATA TAPE HAS 37
C       VARIABLES PER RECORD ON IT. THIS PROGRAM WRITES THREE RECORDS
C       TO THE BEGINNING OF THE OUTPUT TAPE(PLUGO INPUT TAPE). THESE
C       THREE RECORDS CONSTITUTE A DUMMY CONTROL SURFACE SETTING
C       TABLE.  THE RECORDS FROM THE RAW DATA TAPE ARE THEN COPIED TO THE
C       PLUGO INPUT TAPE WITH THE ADDITION OF V(38) A RECORD COUNT.
      DIMENSION V(100)
      ACOUNT = 0.0
      A = 1.0
      I = 1
C       WRITE THREE DUMMY RECORDS TO THE BEGINNING OF THE OUTPUT TAPE.
      REWIND7
      WRITE(7,100) A,I
      WRITE(7,101) I,I
      WRITE(7,102) I,A
C       READ THE INPUT TAPE,ADD ONE TO THE RECORD COUNT,WRITE TO TAPE7
 5    READ(3,103) (V(I),I=1,37)
      IF (EOF(3)) 1000,990
 990  ACOUNT = ACOUNT + 1
      V(38) = ACOUNT
      WRITE(7,104) (V(I),I=1,38)
      GO TO 5
 100  FORMAT(F7.4,I3)
 101  FORMAT(2I3)
 102  FORMAT(I3,F7.2)
 103  FORMAT(F4.0,F5.0,F3.0,F11.0,F6.3,F7.0,F9.0,2F6.2,2(F7.4,F8.5),
     *2F8.5,5F7.4,17F8.4)
 104  FORMAT(F4.0,F5.0,F4.0,F11.0,F6.3,F7.0,F9.0,2F6.2,2(F7.4,F8.5),
     *2F8.5,5F7.4,17F8.4,F7.0)
 1000 STOP
C       NOTE THE 104 FORMAT WILL BE USED AS INPUT TO PLUGO PHASE I
      END
(7/8/9) END OF RECORD
(6/7/8/9) END OF JOB
```

Figure 8. COPY - A FORTRAN program used to create a PLUGO Input Tape utilizing a dummy CSS Table.

A tape dump of the Raw Data Tape should also be performed to ascertain that the data are stored correctly on the tape. Section 6.2 of the ASD COMPUTER CENTER CDC NOS/BE USER'S GUIDE (Reference 4) contains specific information about tape handling that can be useful should problems be encountered in this area.

2.1.1.2 Creating the PLUGO Input Tape With a Control Surface Setting Table

Procedure 2 can be used to create a PLUGO Input Tape when the user intends to use a CSS Table.

Procedure 2: Creating the PLUGO Input Tape With a Control Surface Setting Table.

1. Define the CSS Table by filling the form in Table 1.
2. Create an input card deck from the CSS Table for the program COPY1.
3. Obtain a tape dump of the Raw Data Tape.
4. Change the circled cards (Figure 9) to match the format of the Raw Data Tape.
5. Execute COPY1.

2.1.1.3 Explanation of the CSS Table

PLUGO was originally created to process data generated during wind tunnel experiments of different aircraft model configurations. The input record size was limited to 135 characters by the specification that each data record should require no more than one line of a computer printout. This record size did not provide enough space to completely record all the data generated by an experiment. Since some variables, such as the settings of the model's control surfaces (flaps, rudder, etc.), have only a few values, it was decided to encode these variables into a single variable (V4). An algorithm in the Phase I program decodes the value of V4 using the CSS Table to determine the settings for the model's control surfaces.

2.1.1.4 How the CSS Table Works

Table 1 is a form used to define the CSS Table. To use the CSS Table, it is necessary to define the fourth variable (V4) on the Data Points as having F11.0 format. The CSS Table has 10 columns. Each of the possible 10 control surfaces (SURF1 through SURF10) is represented by a column in this table. Each control surface can have up to 10 settings (F7.2 format). V4 is defined as having 10 digits, each digit corresponds to a column of the CSS Table (i.e., the ones digit of V4 represents the SURF1 column, the tens digit of V4 represent the SURF2 column, etc). The actual value of the nth digit of V4 is the position in the nth column of the CSS Table where the setting for SURFn is found. Table 2 is a sample CSS Table in which six control surfaces are used. The 999. values in the table represent the case where that control surface has been removed from the model. This is called the OFF position for that particular control surface. In this sample, V4 having a value of 624012. would represent control surface six (SURF6) set to -30°., SURF5 set to 6.°, SURF4 set to -15.3°, SURF3 set to the OFF position, SURF2 set to 0.°, and SURF1 set to -20°.

2.1.1.5 How to Use the CSS Table

Suppose a user wishes to plot only Data Points that have control surface four (SURF4) set at -15.3°. PLUGO provides no easy way to test to see if the fourth digit of V4 is equal to four. Instead, points satisfying this condition can be selected by specifying (on a CONDITION, PARAMETER, or MULTIPLIER card) the condition SURF4 = -15.3. Likewise, points on which SURF3 is in the OFF position can be selected by specifying SURF3 = OFF. Although this example uses wind tunnel data, this table could be used for other applications. Example: The CSS Table columns represent chemical solutions - SOL1, SOL2, ... SOL10. The default column names (SURF1 through SURF10) are renamed to SOL1, SOL2, ... SOL10 as described in Section 2.1.2.3. The values within each column represent various reagent concentrations of their corresponding solutions.

TABLE 1

CONTROL SURFACE SETTINGS TABLE FORM

V4 DIGIT NUMBER	10	9	8	7	6	5	4	3	2	1
PROGRAM NAME → / CODE ↓	SURF10	SURF9	SURF8	SURF7	SURF6	SURF5	SURF4	SURF3	SURF2	SURF1
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

TABLE 2

CONTROL SURFACE SETTINGS TABLE FORM

V4 DIGIT NUMBER	10	9	8	7	6	5	4	3	2	1
PROGRAM NAME → / CODE ↓	SURF10	SURF9	SURF8	SURF7	SURF6	SURF5	SURF4	SURF3	SURF2	SURF1
0					999.	999.	999.	999.	999.	999.
1					0.	0.	0.	0.	0.	0.
2					5.	6.	- 5.3	5.	15.0	- 20.
3					10.		4.7	10.		
4					20.		- 15.3			
5					30.		14.7			
6					- 30.					
7					- 20.					
8										
9										

```
22JT,T5C5,10BCC,MT2,STCS3.  X654321    TERRY/FXS/55506
LABEL,TAPE7,W,L=TEFFY,SING,VSN=X11101.  X654321  PLUGO INPUT TAPE
REQUEST,TAPE3,S,NORING,VSN=X31099.   X654321  RAW DATA TAPE
FILE,TAPE3,BT=K,MBL=280,RB=1,RT=F,FL=274.
FTN,A,ML=10000C3.
LOSET,FILES=TAPE3.
LGO.
EXIT.
(7/8/9) END OF RECORD
      PROGRAM COPY1(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE3=/280,
     *TAPE7=/290)
C
C       THIS PROGRAM CREATES A PLUGO INPUT TAPE WITH A CONTROL SURFACE
C       SETTING TABLE.    TAPE3 IS THE RAW DATA TAPE.  TAPE7 IS THE
C       PLUGO INPUT TAPE.
C
      DIMENSION V(100)
      ACOUNT=0.0
C
C       READ CSS TABLE CARDS AND WRITE THEM TO TAPE7.
C
      CALL SURFAC(5,7)
      REWIND7
C
C       READ CSS TABLE FROM TAPE7 AND WRITE IT TO THE PRINTER.
C
      CALL SURFAC(7,6)
    5 READ(3,101)(V(I),I=1,37)
      IF(EOF(3))980,990
  990 ACOUNT=ACOUNT+1.0
      V(39)=ACOUNT
C
C       WRITE RAW DATA TO PLUGO INPUT TAPE AND TO PRINTER.
C
      WRITE(7,100)(V(I),I=1,39)
      WRITE(6,102)(V(I),I=1,39)
      GO TO 5
  980 STOP
  100 FORMAT(F4.0,F5.0,F4.0,F11.0,F6.3,F7.0,F9.0,2F6.2,2(F7.4,F8.5),
     *2F8.5,5F7.4,19F8.4,F7.0)
  101 FORMAT(F4.0,F5.0,F3.0,F11.0,F6.3,F7.0,F9.0,2F6.2,2(F7.4,F8.5),
     *2F8.5,5F7.4,17F8.4)
  102 FORMAT(X,F4.0,F5.0,F4.0,F11.0,F6.3,F7.0,F9.0,2F6.2,2(F7.4,F8.5),
     *2F8.5/5F7.4,10F8.4/8F8.4,F7.0)
      END
      SUBROUTINE SURFAC(INUNIT,OUTUNT)
C
C       THIS SUBROUTINE READS CONTROL SURFACE SETTING DATA FROM ARG1
C       FILE AND WRITES IT TO THE ARG2 FILE.
C
      INTEGER OUTUNT,CODE,SURDIG,FMT(4),SELFMT
      INTEGER FMT1(4),FMT2(4)
      DIMENSION CODE(10),VALUE(10)
      COMMON /LINECT/ NOFDIG
```

Figure 9. COPY1 - A FORTRAN program used to create a PLUGO Input Tape. The CSS Table values are input on cards.

Page 1 of 3

```
C
C     DUAL FORMATS ARE USED TO PROVIDE CONVENIENT CARD INPUT
C     DUAL FORMATS ARE USED TO PROVIDE CONVENIENT CARD INPUT
C
      DATA FMT(1) /13H(10(I3,F7.2))/
      DATA FMT(3) /12H(8(I3,F7.2))/
      DATA FMT1(1) /9H(F7.4,I3)/
      DATA FMT1(3) /11H(F10.0,I10)/
      DATA FMT2(1) /5H(2I3)/
      DATA FMT2(3) /6H(2I10)/
C
C     SUBROUTINE PUTS CONSTANTS ON TAPE
C     SELECT INPUT FORMAT NUMBER
C
      SELFMT=1
      IF(INUNIT .EQ. 5) SELFMT=3
C
C     GET  B/C AND NUMBER OF DIGITS IN CONSET WORD
C
      READ(INUNIT,FMT1(SELFMT)) BOVERC,NOFDIG
      WRITE(OUTUNT,FMT1(1)) BOVERC,NOFDIG
C
C     LOOP OVER NUMBER OF SURFACES
C
      DO 10 I=1,NOFDIG
C
C     GET CONTROL SURFACE DIGIT AND NO OF SETTINGS FOR THIS DIGIT
C
         READ(INUNIT,FMT2(SELFMT)) SURDIG,NOFSET
         WRITE(OUTUNT,FMT2(1)) SURDIG,NOFSET
C
C     GET CODES AND VALUES FOR THIS SURFACE
C
         READ(INUNIT,FMT(SELFMT)) (CODE(J),VALUE(J),J=1,NOFSET)
         WRITE(OUTUNT,FMT(1)) (CODE(J),VALUE(J),J=1,NOFSET)
   10 CONTINUE
      RETURN
      END
(7/8/9) END OF RECORD
 .335386     6
    1        3
0  999.  1   0.  2   -20.
    2        3
0  999.  1   0.  2    15.
    3        4
0  999.  1   0.  2     5.  3    10.
    4        6
0  999.  1   0.  2   -5.3  3    4.7  4  -15.3  5    14.7
    5        3
0  999.  1   0.  2     6.
    6        9
0  999.  1   0.  2     5.  3    10.  4    20.  5    30.  6  -30.  7  -20.
```

(Figure 9 - Continued)

```
(7/8/3) END OF RECORD
(6/7/3/5) END OF JOB
```

(Figure 9 - Continued)

NOTE: It is the user's responsibility to define the CSS Table and encode values of V4 as defined by the CSS Table when the Raw Data Tape is being created.

2.1.1.6 Inputting a CSS Table

After the user has defined the CSS Table by filling in Table 1, the next step is to transfer the table from paper to the PLUGO Input Tape. This can be done with the FORTRAN program COPY1 listed in Figure 9. The data cards in the listing are the ones used to input the sample table (Table 2).

The input deck to COPY1 consists of three card types: A, B, and C cards (Figure 10). The deck is comprised of one A card and one B-C card pair for each control surface (column) defined in the CSS Table. Figure 11 and Table 3 provide the exact card formats and a description of the variables on the. The first card in the deck, the A card, has two numbers on it. The first number, B/C, is an aerodynamic term (span/mean chord) relating to the size of the wind-tunnel model. The second number, J, is the number of B-C card pairs in the deck (this is also the number of CSS columns used). The B card has two numbers on it. The first number is the surface number (CSS Table column) that will be defined by this B-C card pair. The second number is the number of values that will be input to that table column on the following C card. The C card is comprised of code number-value pairs that fill in the column being defined. The code number is the position within the column where the corresponding value (the control surface setting) will be placed. The code number-value pair has a format of (I3, F7.2). Therefore, there is only space on a card for eight of the possible ten code number-value pairs. If nine or ten pairs are to be input it is necessary to place the last two pairs on a second C card (see bottom of Figure 11).

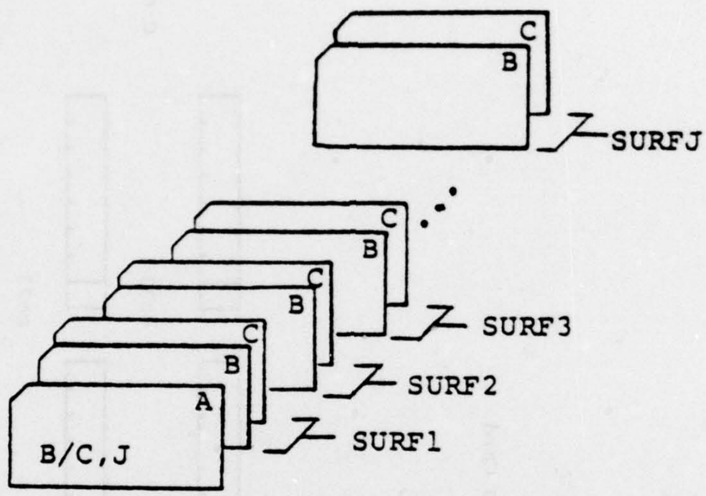


Figure 10. Input Card Deck to the COPY1 FORTRAN program. A, B, and C card layout.

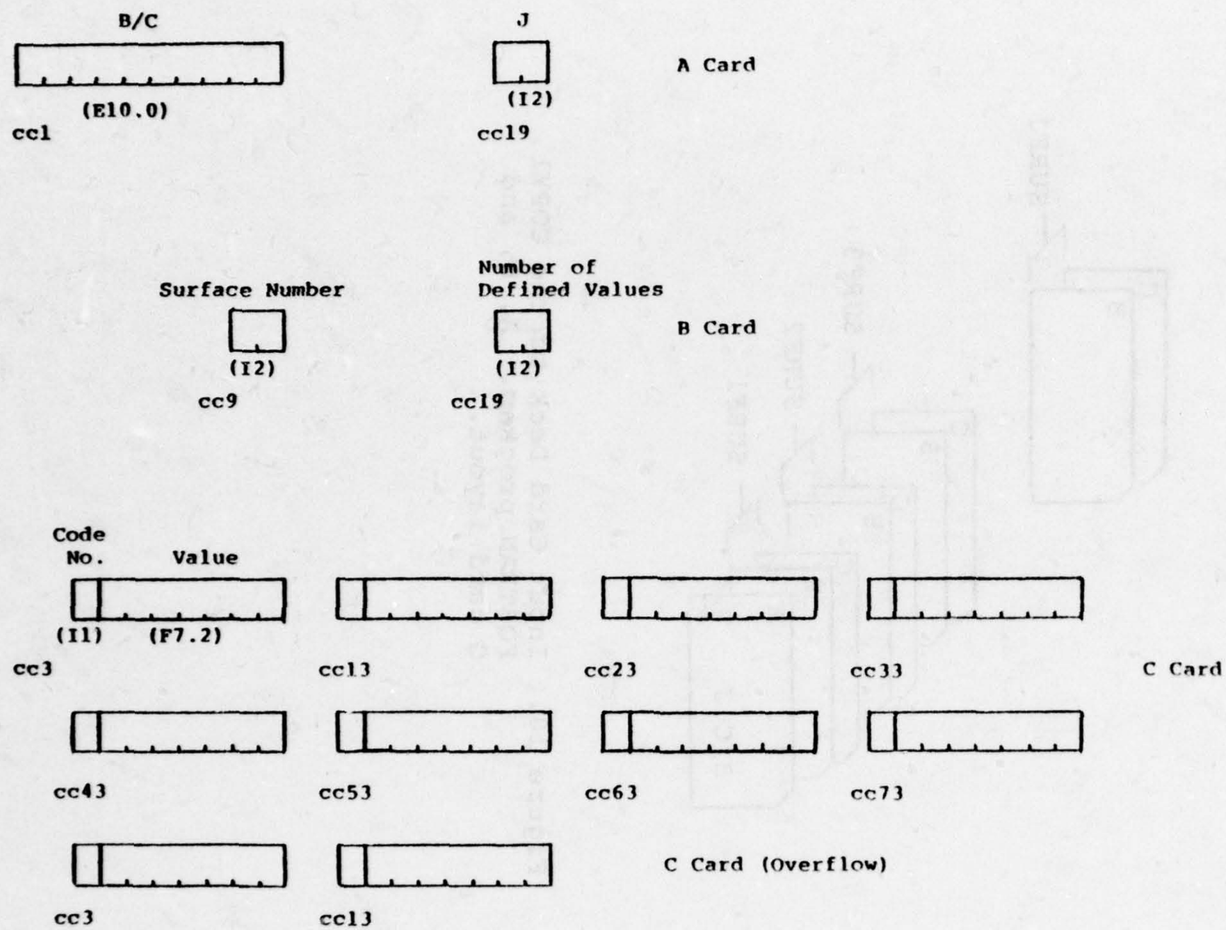


Figure 11. A, B, and C card format forms.

TABLE 3
DEFINITIONS OF CONTROL SURFACE SETTING TABLE
INPUT CARDS

Card Type	Variable	Format	Definition
A	B/C	E10.0	The reference span divided by the reference length. This value is used in the computed element routines (C1-C10, Table 5). For non-aeronautical data this number should be set to 1.0.
A	J	I2	This is the number of surfaces (columns) used in the Control Surface Setting Table. $0 < J \leq 10$
B	Surface Number	I2	The surface number (V4 digit number) that is to be defined by the following C card.
B	Number of Defined Values	I2	The number of code number-value pairs to be entered by the following C card.
C	Code Number	I1	The position in the surface number column where the corresponding value will be placed. $0 \leq$ code number ≤ 9
C	Value	F7.2	The control surface setting. This is given in degrees. For non-aeronautical data this value can represent what ever the user wants.

2.1.1.7 Adjusting the Tape Format Cards

The circled statements in Figure 9 should be changed to reflect the format of the Raw Data Input Tape and the resultant PLUGO Input Tape. The FILE card communicates the tape record size, block size, format, etc., of the Raw Data Tape to the CDC Record Manager software. For specific requirements for this card the CDC Record Manager manual (Reference 5) should be consulted. An explanation of the format cards can be found in the CDC FORTRAN EXTENDED manual (Reference 2). The format card at statement label 100 will be used later for input to PLUGO Phase I.

2.1.2 <u>Preparing the PLUGO Phase I Input Deck</u>

The PLUGO Phase I Input Deck is comprised of three records - job control, update, and plot specification (Figure 12).

2.1.2.1 The Job Control Record

The cards in the Job Control Record control the allocation of system resources and the execution of PLUGO Phase I. Figure 13 is a list of control cards that make up the Job Control Record used to execute the present version of PLUGO Phase I. In this figure the program source code has already been placed on a permanent disc file. The case where the source code is on magnetic tape is also noted. The Figure 13 control cards are valid when used on a CDC NOS/BE operating system. Since this system is constantly being modified, a current version of the CDC NOS/BE REFERENCE MANUAL (Reference 1) should be consulted should problems occur with these cards.

2.1.2.2 The Update Record

The Update Record of the Phase I Input Deck allows the user to modify Phase I source code statements. There are two reasons for doing this.

1. The PROGRAM statement for the (0,0) overlay must be changed to reflect the logical record length of the PLUGO Input Tape.

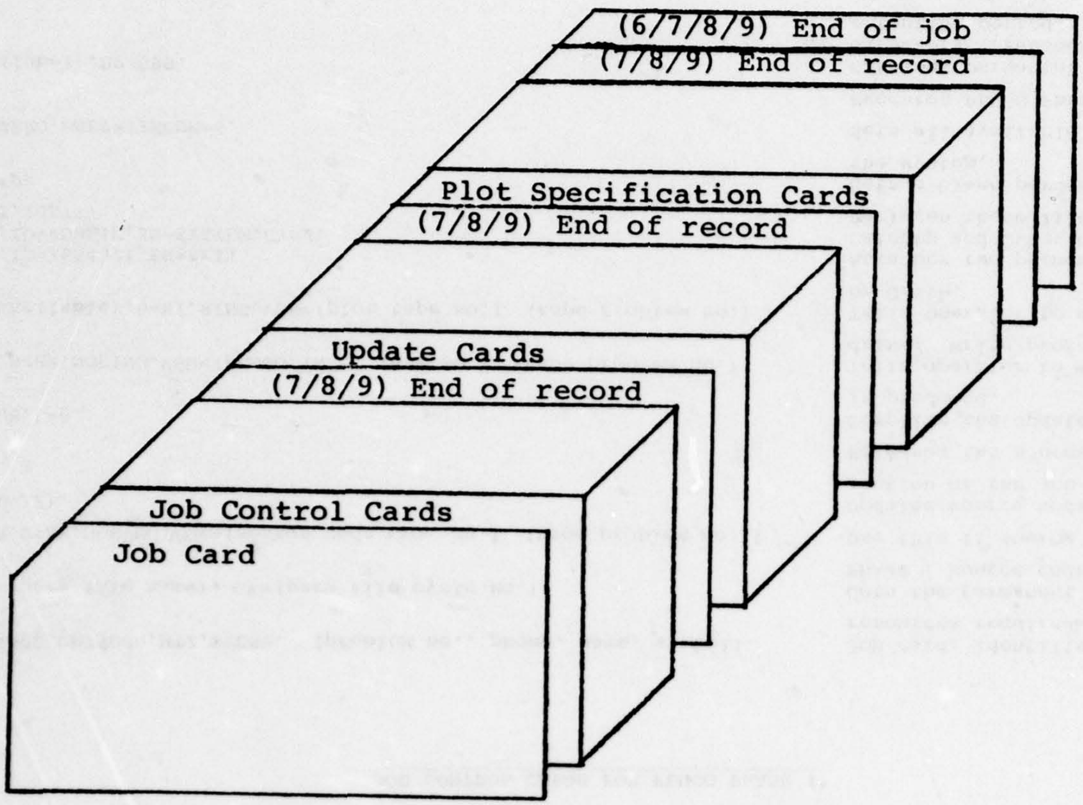


Figure 12. The PLUGO Phase I Input Deck.

JOB CONTROL CARDS FOR PLUGO PHASE I*

SJJ1,T2000,IO4000,CM75000,MT2,STCSB. (problem no., phone, name, symbol).	Job card; identifies job and system resources required.
ATTACH,OLDPL, (perm file name), CY=(perm file cycle no.).	Gets the permanent file containing PLUGO Phase I source code. Names this file OLDPL.
[LABEL,OLDPL,R,D=HY,NORING,VSN=(source code tape no.). (tape problem no.)]	Use this if source code is on tape.
UPDATE(F,R=C,L=12).	Updates source code with cards in the update section of the job deck.
RETURN,OLDPL.	Releases the source code file.
FTN,T,I=COMPILE,L=0.	Complile the updated source code. No listing is produced.
LABEL,TAPE3,R,D=HY,NORING,VSN=(PLUGO INPUT TAPE NO.). (tape problem no.)	Tells operator to mount PLUGO INPUT TAPE on drive. Write protected.
LABEL,TAPE7,W,L=(lable),D=HI,RING,VSN=(plot tape no.). (tape problem no.)	*Tells operator to mount Phase I PLOT TAPE* on drive.
ATTACH,CCPLOT,ID=X654321,SN=AFIT. ATTACH,IGS777,ID=PUBLIC,SN=SYSTEM,CY=2. LIBRARY,CCPLOT,IGS777.	Attaches two permanent files containing Calcomp and Cyber Graphics plot routines. Declares these files as library files.
REQUEST,DATA,*PF.	Gets a blank permanent file called DATA from the system.
LDSET,PRESET=ZERO,USEP=$INCOM=$.	Sets all available memory to zeros.
LGO.	Executes PLUGO Phase I.
CATALOG,DATA,(label),RP=999.	Catalogs permanent file DATA to system directory. Renames file to label. Infinite retention period.
EXIT.	If one of the above job steps terminates abnormally, the system processes this card next. This causes end-of-job to occur.
(7/8/9) END OF RECORD.	Signifies end of record control statement.

*Items enclosed in parenthesis are to provided by the user .

Figure 13. Job Control Cards and their functions for PLUGO Phase I.

2. PLUGO allows the user to define up to 35 functions that involve calculations using any of the variables or control surfaces on the PLUGO Input Tape. Definition of these optional functions involves modifying FORTRAN statements in the Phase I source code. The Update Record contains cards that control the modification of the Phase I source code. This section is divided into two parts - (a) a section describing modification of the PROGRAM statement; and (b) a section describing the definition of the optional functions.

(a) Modifying the PROGRAM Statement

The PROGRAM statement specifies information about files the Phase I program uses. The current PROGRAM statement is -

```
     67
      PROGRAM MAIN(INPUT,OUTPUT,PLOT,TAPE5=INPUT,TAPE6=OUTPUT,
     *TAPE3=/150,TAPE7=PLOT)
```

TAPE3 is the PLUGO Input Tape. It is defined as having a logical record length of 150 characters. Therefore, use of a PLUGO Input Tape that has a different logical record length requires that this statement be changed. Actually, the second card of the statement (a continuation card) is all that has to be changed. The following two cards should be included in the Update Record to affect this change.

```
1    6
*D DRIVER.49
     *TAPE3=/XXXX,TAPE7=PLOT)
```

The *D... card is an update card that deactivates the *TAPE3=/150... card in the original source code. The *TAPE3=/XXXX... card is the replacement for the deactivated card. XXXX represents the logical record length, in characters, of the PLUGO Input Tape to be used. If the logical record length of the PLUGO Input Tape is 150 characters, then these two cards need not be included in the Update Record. For a complete description of the PROGRAM card, refer to the CDC FORTRAN EXTENDED MANUAL (Reference 2).

(b) Function Definition

The 35 user-defined functions have the names FUN1 to FUN20 and C1 to C15. C1 through C10 have default definitions (Table 4); otherwise, there is no significance to the names and no restrictions on the functions that can be defined other than those defined by FORTRAN syntax. The 35 functions are defined in the COLLECT deck of the PLUGO Phase I OLDPL file (source code in UPDATE form).

The update record contains a pair of cards for each function that is defined. The first card of a pair is a CDC UPDATE card. The general format for this card is:

```
1
*D COLLECT.(address)
```

Address is the statement number within COLLECT where the defined function is located as specified in Table 5. This card causes the existing statement (a dummy function definition) to be deactivated. The second card of a pair is an arithmetic FORTRAN statement to replace the one just deactivated. This statement defines the function. The statement is in the form:

```
      7
      SPCVAL=CDC FORTRAN EXTENDED arithmetic expression.
```

TABLE 4

DEFINITION OF COMPUTED ELEMENT COEFFICIENTS*

Default Name	Suggested Name	Description	Program Equation
C1	CSIDEW	Wind axis side force coefficient	$-(CA)\cos\alpha\sin\beta + (CSIDE)\cos\beta - (CN)\sin\alpha\sin\beta$
C2	CMW	Wind axis pitching moment coefficient	$(CROLL)(B/C)\cos\alpha\sin\beta + (CM)\cos\beta + (CYAW)(B/C)\sin\alpha\sin\beta$
C3	CROLLW	Wind axis rolling moment coefficient	$(CROLL)\cos\alpha\cos\beta - (CM)(B/C)\sin\beta + (CYAW)\sin\alpha\sin\beta$
C4	CYAWW	Wind axis yawing moment coefficient	$-(CROLL)\sin\alpha + (CYAW)\cos\alpha$
C5	CROLLS	Stability axis rolling moment coefficient	$(CROLL)\cos\alpha + (CYAW)\sin\alpha$
C6	CDS	Stability axis drag coefficient	$(CA)\cos\alpha + (CN)\sin\alpha$
C7	CL	Wind axis lift coefficient	$(CN)\cos\alpha - (CA)\sin\alpha$
C8	CD	Wind axis drag coefficient	$(CA)\cos\alpha\cos\beta - (CSIDE)\sin\beta + (CN)\sin\alpha\cos\beta$
C9	LOD	Wind axis lift-to-drag ratio	$((CN)\cos\beta - (CA)\sin\alpha)/((CA)\cos\alpha\cos\beta - (CSIDE)\sin\beta + (CN)\sin\alpha\cos\beta)$
C10	MLOD	Wind axis mach-lift-to-drag parameter	$(MACH)((CN)\cos\alpha - (CA)\sin\alpha)/((CA)\cos\alpha\cos\alpha - (CSIDE)\sin\beta + (CN)\sin\alpha\cos\beta)$

*α = ALPHA (V9); β = BETA (V8).

TABLE 5

FUNCTION AND CALCULATED VALUE LOCATIONS IN PLUGO PHASE I SOURCE DECK*

Function or Calculated Value	Location	Function or Calculated Value	Location
FUN 1	1078	FUN 19	1168
FUN 2	1083	FUN 20	1173
FUN 3	1088	C1	1000
FUN 4	1093	C2	1005
FUN 5	1198	C3	1011
FUN 6	1103	C4	1016
FUN 7	1108	C5	1021
FUN 8	1113	C6	1026
FUN 9	1118	C7	1031
FUN 10	1123	C8	1036
FUN 11	1128	C9	1041
FUN 12	1133	C10	1047 and 1048
FUN 13	1138	C11	1053
FUN 14	1143	C12	1058
FUN 15	1148	C13	1063
FUN 16	1153	C14	1068
FUN 17	1158	C15	1073
FUN 18	1163		

*All functions and calculated values are located in the COLLECT deck of the Phase I program.

The arithmetic expression may contain any variable or control surface on the PLUGO Input Tape. These variables must be referenced by their default names (e.g., V1, V31, SURF7) but, since they are stored in an array, they must also be referred to as array elements (V1 would be referred to as V(1), SURF5 would be SURF(5)). A possible statement would be:

```
      7
      SPCVAL=(V(1)*V(35))**(LOG(SURF(2)+2.3))
```

SPCVAL is the defined variable for all statements regardless of the function involved. If the expression does not fit on one card, it can be continued on another in accordance with standard FORTRAN continuation rules. These card pairs should be arranged in the update record in ascending order as determined by the address on the *D card.

2.1.2.3 The Plot Specification Record

This section describes various input card formats that are used to build the Plot Specification Record. These card formats (card types) are the basic elements that form the PL (Plotting Language) of the PLUGO system.

The Plot Specification Record consists of an initialization section and a plot creation section. The initialization section performs the following functions:

- Renames variables, functions, surfaces, and calculated values*
- Changes the element's tolerances,
- Defines the size of the plots,
- Inputs the PLUGO Input Tape format,
- Inputs information defining which axis an element will be plotted on and what the axis scale will be,
- Creates a list of variable names and axis settings, and
- Causes a list of data points that appear on the plots to be printed.

*These four items, all of which can be plotted, are referred to as elements.

The plot creation section performs the following functions:

- Determines which elements will be plotted against each other
- Reads the PLUGO Input Tape, stripping off points that satisfy point selection conditions, and
- Creates the plots from these points and outputs them to a magnetic tape and a permanent disc file.

The input cards in both sections of the Plot Specification Record allow the use of free format, that is, input items may appear in any card column in alphanumeric form. Argument separation is accomplished by use of three separator symbols, comma (,), equals (=), and blank space ( ). These symbols perform the same functions and therefore may be used interchangeably. They should be selected for readability. Throughout this section the symbol "^" indicates a requirement for one or more separators. Keywords may be abbreviated. The necessary letter(s) of a keyword are underlined. When describing card content, parentheses are used to indicate items to be inserted by the user. When parentheses are not used, the exact numeric or alphanumeric phrase may be used. All arguments must be real numbers.

(a) The Initialization Section

Figure 14 is a list of cards that make up an initialization section. These sample cards provide examples of the possible card types used in this section. The cards appear in the order necessary for input to PLUGO Phase I Input Deck.

The first card in this section is the INITIALIZED ELEMENTS card. The format for this card is:

```
INITIALIZE ELEMENT
```

PAGE 1

```
INIT ELEM
OLD=V3 NEW=CONFIG TOL=2.1
OLD=V5 NEW=MACH
OLD=V7 NEW=RN/FT
OLD=V8 NEW=BETA
OLD=V9 NEW=ALPHA
OLD=V10 NEW=CN
OLD=V11 NEW=CAU
OLD=V12 NEW=CYB
OLD=V13 NEW=CMB
OLD=V14 NEW=CLLB
OLD=V15 NEW=CLNB
OLD=V16 NEW=CA
OLD=V17 NEW=CAC
OLD=V18 NEW=CL
OLD=V20 NEW=CD
OLD=V22 NEW=CM
OLD=V23 NEW=CY
OLD=V24 NEW=CLN
OLD=V25 NEW=CLL
OLD=V28 NEW=CAI
OLD=V29 NEW=CDI
OLD=C1 NEW=CYW
OLD=C2 NEW=CMW
OLD=C3 NEW=CLLW
OLD=C8 NEW=CDW
OLD=C9 NEW=L/DW
OLD=C10 NEW=M(L/D)
OLD=FUN1 NEW=L/D
OLD=FUN2 NEW=CANARD
OLD=FUN3 NEW=BIAS
OLD=FUN4 NEW=RUDDER
OLD=FUN8 NEW=ALERON
FINISH
FACTOR=1.
INITIALIZE READ  VAR = 35., FMT = 1.
(F4.0,F5.0,F4.0,F11.0,F6.3,F7.2,F9.0,2F5.2,2(F7.4,F8.5),4F8.5,17F7.4,F7.0)
INIT AXES
OLD=CL Y M=-.2 INCR=.2 X M=-.2 INCR=.2
OLD=CM X M=.25 INCR=-.05
OLD=ALPHA X M=-8. INCR=4.
OLD=BETA X M=-12. INCR=2.
OLD=CDI Y M=0.0 INCR=-.002
OLD=L/D Y M=0.0 INCR=2.
OLD=CD X M=0.0 INCR=.04 Y M=0.0 INCR=.05
OLD=CLN Y M=-.03 INCR=.01 X M=-.04 INCR=.01
OLD=CLL Y M=-.03 INCR=.01 X M=-.04 INCR=.01
OLD=CY Y M=-.06 INCR=.02 X M=-.06 INCR=.02
OLD=CL2 Y M=-.2 INCR=.2
FINISH
POINTS LIST
LIST AXES SURFACES ELEMENTS
FINISH INITIALIZATION
```

Figure 14. Sample listing of Initialization Section Cards from a PLUGO Phase I Input Deck.

This card places PLUGO in the initialize element mode. When in this mode, cards are assumed to have the following format.

```
OLD^(element name)^NEW^(new name)^TOLERANCE^(numeric value)
```

The first Figure 14 card in this format is

```
OLD=V3 NEW=CONFIG TOL=2.1
```

This card changes the name of V3 to CONFIG. The new name must be less than 11 characters long. Any characters except separators may be used. It also changes the variable's tolerance to 2.1. This card is optional. The TOL = (parameter) is optional. PLUGO exits the initialize element mode when a FINISH card is encountered. The format of a FINISH card is -

```
FINISH
```

The next card should be the FACTOR card. The general format is -

```
FACTOR^(real numeric value)
```

This card determines the size of the plots produced by PLUGO. The standard plot size has a nine-inch horizontal (X-) axis and a six-inch vertical (Y-) axis. The final plot size is defined as the standard plot size multiplied by the numeric value on the FACTOR card. Thus, if the numeric value was 3.0, the final plot size would be (9x6)*(3)=(27"x18").

The INITIALIZED READ card is used to input the format of the PLUGO Input Tape. The format is:

```
INITIALIZE^READ^VARIABLE^(numeric value 1)^FORMATS (numeric value 2)
```

Numeric value 1 is the number of variables on one tape record. Numeric value 2 is the number of format cards that follow. The INITIALIZE READ card in Figure 14 indicates that PLUGO Input Tape record contains 35 variables and that the next card in the deck contains the format of this record. There may be from one to three format cards. The format specification should be surrounded by parentheses and begin in column one. The format should be punched through column 80 and if necessary start in column one of the next card.

The INITIALIZE AXES card places PLUGO in the axes initialization mode. The card format is:

```
INITIALIZE^AXES
```

Once in this mode, PLUGO expects to read axis definition cards. These cards define and scale the plot axes. Table 6 defines the default axis values for each element; however, if an element is renamed, these values no longer apply. Thus, if a renamed element is to be plotted there must be an axis definition card for it. The format for an axis definition card is:

```
OLD^(element)^(axis)^MINIMUM^(value 1)^INCR (value 2)^
(axis)^MINIMUM^(value 3)^INCR^(value 4)
```

The first axis definition card in Figure 14 is:

```
OLD=CL Y M=-.2 INCR=.2 X M=-.2 INCR=.2
```

This axis definition is for the variable CL. When CL is plotted on the Y-axis, the axis will begin at -.2 with an increment of .2 units per inch. When plotted on the X-axis, the same scale will be drawn. MINIMUM is the value of the axis at the plot origin. Both MINIMUM and INCREMENT values may be negative. PLUGO exits from the axis initialization mode when a FINISH card is encountered.

TABLE 6

ELEMENT DEFAULT VALUES FOR AXES AND TOLERANCE

Default Name	Tolerance	X - Axis Minimum	X - Axis Units Per 1 Inch	Y - Axis Minimum	Y - Axis Units Per 1 Inch
V1	0.	0.	0.	0.	0.
V2	0.	0.	0.	0.	0.
V3	0.	0.	0.	0.	0.
V4	0.	0.	0.	0.	0.
V5	.05	0.	.4	0.	.4
V6	2.	0.	100.	0.	200.
V7	1.E5	1.E6	4.E6	1.E6	8.E6
V8	.4	-8.	2.	-12.	4.
V9	.4	-8.	8.	- 4.	4.
V10	.001	- .3	.2	- .4	.2
V11	.0001	- .04	.02	- .06	.04
V12	.001	- .04	.01	- .06	.02
V13	.0001	.04	-.01	- .06	.02
V14	.0001	- .04	.01	- .03	.01
V15	.001	- .04	.01	- .03	.01
V16	.001	- .8	.2	- .4	.2
V17	.0001	0.	.2	0.	.2
V18	.01	- .8	2.	- 4.	2.
V19	.001	-9.	2.	- 9.	4.
V20	.01	-9.	2.	- 9.	4.
V21	0.	--	--	--	--
↓	↓	↓	↓	↓	↓
V100	0.	--	--	--	--
FUN1	0.	0.	0.	0.	0.
↓	↓	↓	↓	↓	↓
FUN20	0.	0.	0.	0.	0.
C1	.001	- .04	.01	- .06	.02
C2	.0001	- .04	.02	- .06	.04
C3	.0001	- .04	.01	- .03	.01
C4	.001	- .04	.01	- .03	.01
C5	.0001	- .04	.01	- .03	.01
C6	.0001	0.	.05	0.	.05
C7	.001	- .8	.2	- .4	.2
C8	.0001	0.	.2	0.	.2
C9	.01	-8.	2.	- 4.	2.
C10	.3	0.	5.	0.	10.
C11	0.	0.	0.	0.	0.
↓	↓	↓	↓	↓	↓
C15	0.	0.	0.	0.	0.
SURF1	0.	-80.	20.	-60.	20.
SURF2	0.	-80.	20.	-60.	20.
SURF3	0.	-80.	20.	-60.	20.
SURF4	0.	-80.	20.	-60.	20.
SURF5	0.	-80.	20.	-60.	20.
SURF6	0.	-80.	20.	-60.	20.
SURF7	0.	-80.	20.	-60.	20.
SURF8	0.	-80.	20.	-60.	20.
SURF9	0.	-80.	20.	-60.	20.
SURF10	0.	-80.	20.	-60.	20.

NOTE: *If a default variable name is renamed (I.E. OLD = V1,* NEW = TEST) it's default values no longer apply. Therefore, if a renamed element is used as an axis, this axis must be initialized.

The LIST card has the format:

```
LIST^AXES^SURFACES^ELEMENTS
```

The AXES, SURFACES, and ELEMENTS arguments are optional. The AXES argument causes PLUGO to produce a list of axes names and scales. The SURFACES argument cause a list of surface names and settings to be produced. The ELEMENTS argument causes a list of element names to be printed.

The POINTS card has the format:

```
POINTS^LIST
```

This card causes PLUGO to print a list of X and Y coordinates, with their corresponding record number, for all points placed on each of the generated plots and is optional.

The initialization section is terminated with the FINISH INITIALIZATION card. The format is:

```
FINISH INITIALIZATION
```

Of all the cards in the initialization section the INITIALIZE READ card set is the only set required.

(b) The Create Plots Section

The simplest plot that can be created by PLUGO is one in which two elements are plotted against each other. A plot of this sort can be created with three cards. The format of the PLOT GROUP card is:

```
PLOT^GROUP
```

The PLOT GROUP card is simply a header card that groups together plots having certain characteristics in common. The AXIS card specifies which element will be plotted on which axis. These axes should have already been initialized in the initialization section. The FINISH card tells PLUGO that there are no more plots specified in the card deck.

```
PLOT GROUP
AXIS X (element 1) Y (element 2)
FINISH
```

These three cards will cause PLUGO to create a plot with element 1 on the X-axis and element 2 on the Y-axis. Every point on the PLUGO Input Tape will be included on the plot. Since most PLUGO Input Tapes will contain thousands of data points, a plot of this sort would be impractical. PLUGO allows the user to pick off only certain data points from the PLUGO Input Tape by means of CONDITION cards. These cards specify conditions a data point must satisfy in order to be included in a plot. The CONDITION card(s) should be placed after the PLOT GROUP card and before the AXES card(s). The format of the CONDITION card is:

```
CONDITION^(element)^(function)^(argument(s))
```

Function may be any function listed in Table 7. Arguments must be real numbers. There may be any number of arguments. Sample cards might be:

```
COND DATE RANGE 100177.  123177.
C V3 EQ 44., 78.2
```

TABLE 7

ARITHMETIC FUNCTIONS

Name	Meaning	Number of Arguments
EQ	Equal	Limited by card size
GE	Greater than or equal to	1
GT	Greater than	1
LE	Less than or equal to	1
LT	Less than	1
NE	Not equal	1
RANGE	Range *	2

*Argument 1 $\leq$ Range $\leq$ Argument 2.

This first card would pass points that have values for a variable named DATE between 100177. and 123177. inclusively. The second card would only pass points on which the variable V3 has a value of 44. or 78.2. There may be any number of CONDITION cards within a plot group. If multiple arguments are used, a data point will be accepted if any one argument is satisfied. If condition cards are present for more than one element, a record must satisfy the condition card for each element in order to be included on a plot.

PLUGO has provisions for placing titles on the plots. This is done with a TITLE card.

```
TITLE^(1 to 60 character title)
```

There may be zero to three TITLE cards within a plot group. Each TITLE card creates one line of title. The TITLE cards are placed immediately after the PLOT GROUP card. The title on these cards will appear on all plots within a plot group. The text of the title will appear horizontally centered and just above the plotting area.

A plot group may contain any number of AXES cards. There is a plot generated for each card. The card format is:

```
AXES^X^(element)^Y^(element)^Y^(element)^Y^(element)
```

The last two Y-axis elements are optional. If three Y-axes are specified, two appear on the left side of the plot and one on the right. If two Y-axes are specified, then both appear on the left side of the plot. If more than one Y-axis is specified, the resulting plot cannot be acted upon by PLUGO Phase II (the interactive program), nor can a PARAMETER card be used.

The PARAMETER card is used to divide the points that pass the CONDITION cards into groups represented by different symbols on the plots. The card format is:

PARAMETER^(element)^(function)^(argument(s))

There is a plot symbol associated with each argument of the PARAMETER card. A sample plot might have the following AXES and PARAMETER cards.

```
AXES X V5 Y V21
PARAMETER V7 EQ. 3., 5., 7.
```

The plot generated will be of V5 versus V21, with V5 on the X axis and V21 on the Y axis. Of the points that go on the plot, the ones that have variable V7 equal to 3. will be represented by an '0'. The points having a V7 value of 5. are plotted as 'X', and points having V7 equal to 7. are plotted as an 'Δ'. Keep in mind, the plot is of V5 versus V21. The variable V7 on the PARAMETER card is used only to group the points. Points that have V7 values of other than 3., 5., or 7. are <u>not</u> plotted. Parameters cannot be specified for plots having multiple Y axes.

The MULTIPLIER card is used to group points much like the PARAMETER card. The format is:

MULTIPLIER^(element)^(function)^(argument(s)).

Whereas each argument on the PARAMETER card is represented by a separate plot symbol, each argument on the MULTIPLIER card is represented as a separate plot. If a MULTIPLIER card appears after a PARAMETER card, then each plot generated by the MULTIPLIER card arguments will be divided into separate plot symbols in accordance with the PARAMETER card. Both, the MULTIPLIER and the PARAMETER cards are optional. The TOLERANCE specification can be used on both cards if the (EQ) function is being used. The special argument ALL can be used with the MULTIPLIER card, in which case a plot will be created for all values of the specified element. Points not satisfying the conditions specified on the MULTIPLIER card are <u>not</u> plotted.

A PARAMETER card used with a MULTIPLIER card is known as a PM Group. Any number of PM Groups may be associated with an AXES card. When this is the case, the PM Groups should be separated with an END card. The card format is:

```
END
```

The occurrence of an AXES card or a PLOT GROUP card also terminates a PM Group.

The LABEL card causes the minimum and maximum value of the specified elements to be written on a plot. The minimum-maximum values are only from the Data Points appearing on the plot. The format of the LABEL card is:

```
LABEL‸(element)‸(element)‸...‸(element)
```

The LABEL card is optional. Any number of LABEL cards may be used. Any number of elements may be specified on a LABEL card. The element's name and its minimum and maximum value appears under the condition specifications in the upper left corner of the plot. LABEL information will not appear on plots created or displayed with the Phase II program (i.e. the LABEL function is unique to the Phase I program). LABEL cards may occur anywhere within a set of Plot Group specification cards. All plot generating cards (AXIS and CONDITION cards) following a LABEL card will generate plots having the specified LABEL information on them.

The basic arrangement of the preceding cards in this section is as follows:

PLOT GROUP card
zero to three TITLE cards
zero or more CONDITION cards
AXIS card
PM Group { zero or more PARAMETER cards
zero or more MULTIPLIER cards
END card }

```
PM Group     { zero or more PARAMETER cards
               zero or more MULTIPLIER cards
               END card
                 :     :
               AXIS card
PM Group     { zero or more PARAMETER cards
               zero or more MULTIPLIER cards
               END card
PM Group     { zero or more PARAMETER cards
               zero or more MULTIPLIER cards
               END card
                 :
               PLOT GROUP card
                 .
               FINISH card
```

The plot creation section is terminated with a FINISH card.

```
FINISH
```

2.1.2.4 Phase I Input Deck Summary

Figure 15 is a listing of a complete Phase I Input Deck. This can be used as a guide when creating other PLUGO Input Decks.

2.2 EXECUTION OF PLUGO PHASE I

The present version of PLUGO Phase I requires 75000 (octal) words of memory to execute. In one example in which 15 plots were generated, execution time was 250 (octal) seconds of CPU time and 200 (octal) seconds of IO time. The figures should only be used as a rough estimate since the actual execution time will vary greatly depending on which PLUGO options are used and the length of the PLUGO Input Tape.

```
SJJ1,T2,CM,IO4000,CM75000,MT2,ST054.   X654321 J.JENSEN AFFDL/FXS 55006
ATTACH,OLDPL,SOURCE,CY=1.
UPDATE(F,F=C,L=12)
RETURN,OLDPL.
FTN,T,I=COMPILE,L=0.
LABEL,TAPE3,R,D=HY,NORING,VSN=L02034.   X654321
LABEL,TAPE7,W,L=TERRY,D=HI,RING,VSN=X03469.          X654321
ATTACH,CCPLOT,ID=X654321,SN=AFIT.
ATTACH,IGS777,ID=PUBLIC,SN=SYSTEM,CY=2.
LIBRARY,CCPLOT,IGS777.
REQUEST,DATA,*PF.
LDSET,PRESET=ZERO,USEP=$INCOM=$.
LGO.
CATALOG,DATA,ADCA,RP=999.
EXIT.
(7/8/9) END OF RECORD
*/ REDEFINE PROGRAM STATEMENT
*D DRIVER.49
     +TAPE3=/246,TAPE7=PLOT)
*/ DEFINE NEW COMPUTED OR FUNCTION VALUES IN SPCVAL
*D COLLECT.1076
      SPCVAL=V(18)/V(20)
*D COLLECT.1083
      SPCVAL=(SURF(1)+SURF(2))/2.
*D COLLECT.1088
      SPCVAL=(SURF(2)-SURF(1))/2.
*D COLLECT.1093
      SPCVAL=SURF(9)
*D COLLECT.1098
      SPCVAL=(SURF(3)+SURF(4))/2.
*D COLLECT.1103
      SPCVAL=(SURF(5)+SURF(6))/2.
*D COLLECT.1108
      SPCVAL=(SURF(7)+SURF(8))/2.
*D COLLECT.1113
      SPCVAL=(SURF(6)-SURF(5))/2.
*D COLLECT.1118
      SPCVAL=V(18)**2
*D COLLECT.1123
      SPCVAL=SURF(10)
(7/8/9) END OF RECORD
INIT ELEM
OLD=V3 NEW=CONFIG
OLD=V5 NEW=MACH
OLD=V7 NEW=RN/FT
OLD=V3 NEW=BETA
OLD=V9 NEW=ALPHA
OLD=V10 NEW=CM
OLD=V11 NEW=CAU
OLD=V12 NEW=CYB
OLD=V13 NEW=CMB
OLD=V14 NEW=CLLB
OLD=V15 NEW=CLNB
OLD=V16 NEW=CA
```

Figure 15. A sample listing of a complete Phase I Input Deck.

Page 1 of 3

```
OLD=V17 NEW=CAC
OLD=V18 NEW=CL
OLD=V19 NEW=CDU
OLD=V20 NEW=CD
OLD=V21 NEW=CDCS
OLD=V22 NEW=CM
OLD=V23 NEW=CY
OLD=V24 NEW=CLN
OLD=V25 NEW=CLL
OLD=V26 NEW=CALAV
OLD=V27 NEW=CDCAV
OLD=V28 NEW=CA1
OLD=V29 NEW=CD1
OLD=C1 NEW=CYW
OLD=C2 NEW=CNW
OLD=C3 NEW=CLLW
OLD=C8 NEW=CDW
OLD=C9 NEW=L/DW
OLD=C10 NEW=M(L/D)
OLD=FUN1 NEW=L/D
OLD=FUN2 NEW=CANARD
OLD=FUN3 NEW=BIAS
OLD=FUN4 NEW=RUDDER
OLD=FUN5 NEW=IBTEFL
OLD=FUN6 NEW=OBTEFL
OLD=FUN7 NEW=OBLEFL
OLD=FUN8 NEW=ALERON
OLD=FUN9 NEW=CL2
OLD=FUN10 NEW=IBLEFL
FACTOR=1.
INITIALIZE READ  VAR = 35., FMT = 1.
(F4.0,F5.0,F4.0,F11.0,F6.3,F7.2,F9.0,2F6.2,2(F7.4,F8.5),4F8.5,17F7.4,F7.0)
INIT AXES
OLD=CL Y M=-.2 INCR=.2 X M=-.2 INCR=.2
OLD=CM X M=.25 INCR=-.05
OLD=ALPHA X M=-8. INCR=4.
OLD=BETA X M=-12. INCR=2.
OLD=CDI Y M=0.0 INCR=-.002
OLD=L/D Y M=0.0 INCR=2.
OLD=CD X M=0.0 INCR=.04 Y M=0.0 INCR=.05
OLD=CLN Y M=-.03 INCR=.01 X M=-.04 INCR=.01
OLD=CLL Y M=-.03 INCR=.01 X M=-.04 INCR=.01
OLD=CY Y M=-.06 INCR=.02 X M=-.06 INCR=.02
OLD=CL2 Y M=-.2 INCR=.2
FINISH
FINISH INITIALIZATION
PLOT GROUP
C V1 EQ 444.
C V2 EQ 362.,367.,264.,259.
AXIS X=ALPHA Y=CL
PLOT GROUP
C V1 EQ 444.
C V2 EQ 362.
AXIS X=ALPHA Y=CL Y=CD Y=L/D
```

(Figure 15 - Continued)

Page 2 of 3

```
M MACH EQ .6 TOL .01
PLOT GROUP
C V1 EQ 444.
C V2 EQ 362.,367.,264.,269.
C CONFIG EQ 11.,17.
AXIS X=ALPHA Y=CL
M MACH EQ .6,.8, TOL .01
FINISH
(7/8/9) END OF RECORD
(6/7/8/9) END OF FILE
```

(Figure 15 - Continued)

Page 3 of 3

2.3 PLUGO PHASE I OUTPUT

2.3.1 Plot Tape

The Phase I Plot Tape is created by successful execution of PLUGO Phase I. The format of the tape is such that it may be directly plotted on the Calcomp off-line plotter. The approximate plotter time required to draw the plots is listed on the dayfile from PLUGO Phase I.

Creation of this tape may be suppressed by omitting the (LABEL, TAPE7, ...) card from Job Control Section of the Phase I Input Deck.

2.3.2 Graphics Disc File

The plots created by PLUGO Phase I are written to a permanent disc file in a format suitable for input to PLUGO Phase II. The user should verify that permanent file space is available before execution of PLUGO Phase I is attempted. This file is ADCA in Figure 16.

2.3.3 Phase I Listing

Figure 16 is a listing produced by execution of PLUGO Phase I. An explanation of each section of print is as follows:

- A - Output produced by execution of UPDATE.
- B - Listing of initialization cards in the Plot Specification Record.
- C - Listing of plot creation cards in the Plot Specification Record.
- D - Listing of subroutines executed by PLUGO Phase I when reading the plot creation cards. This is used for debugging purposes.

PGINIT	Reads a PLOT GROUP card.
AXSINIT	Reads an AXIS card.
PMINIT	Reads a PARAMETER card.
CB	Sets up plot specifications for one parameter value.

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
UNLABELED OLDPL          IDENT    RUNMOD                    UPDATE 1.2-77103.    12/22/77  16.33.59.     PAGE   1

/////     *IDENT RUNMOD
*****     */       DATA MANAGER MODS
/////     *DELETE DRIVER.66
/////     *DELETE DRIVER.80,DRIVER.81
/////     *DELETE DRIVER.108
/////     *DELETE DRIVER.48,DRIVER.49
/////     *DELETE PLOT.420
/////     *DELETE PLOT.524
/////     *INSERT MODB.17
/////     *DELETE PLOT.361
/////     *DELETE MODB.100
/////     *DELETE MODA.508,MODA.613
/////     *DELETE MODB.97
/////     *DELETE MODA.565,MODA.566
*****     */ DEFINE NEW COMPUTED OR FUNCTION VALUES IN SPCVAL
*****     */ FUNN   LOCATION  IS 1073 + 5*N ,  WHERE N LE 20
*****     */ FUN1   LOCATION  IS 1078                        (A)
/////     *DELETE COLLECT.1078
/////     *DELETE COLLECT.1083
/////     *DELETE COLLECT.1088
/////     *DELETE COLLECT.1093
/////     *DELETE COLLECT.1098
/////     *DELETE COLLECT.1103
/////     *DELETE COLLECT.1108
/////     *DELETE COLLECT.1113
/////     *DELETE COLLECT.1118
/////     *DELETE COLLECT.1123

          MODIFICATIONS / CONTROL CARDS

DRIVER    *CALL PG                                              MODA     2
DRIVER    *CALL AB                                              MODA     3
DRIVER    *CALL PM                                              MODA     4
DRIVER    *CALL PB                                              MODA     5
DRIVER    *CALL CB                                              MODA     6
COLLECT   *CALL PM                                              MODA   202
REFORM    *CALL TRIM                                            MODA   246
REFORM    *CALL AB          (A)                                 MODA   247
REFORM    *CALL CB                                              MODA   281
REFORM    *CALL PG                                              MODA   362
REFORM    *CALL PM                                              MODA   375
REFORM    *CALL TRIM                                            MODA   470
REFORM    *CALL AB                                              MODA   471
REFORM    *CALL PM                                              MODA   472
REFORM    *CALL PB                                              MODA   473

                INITIALIZATION PHASE

          INIT ELEM
          OLD=V3 NEW=CONFIG
          OLD=V5 NEW=MACH          (B)
          OLD=V7 NEW=RN/FT
          OLD=V8 NEW=BETA
```

Figure 16. Sample listing produced by PLUGO Phase I.

Page 1 of 7

```
OLD=V9 NEW=ALPHA
OLD=V10 NEW=CN
OLD=V11 NEW=CAU
OLD=V12 NEW=CYB
OLD=V13 NEW=CNB
OLD=V14 NEW=CLLB
OLD=V15 NEW=CLNB
OLD=V16 NEW=CA
OLD=V17 NEW=CAC
OLD=V18 NEW=CL
OLD=V19 NEW=CDU
OLD=V20 NEW=CD
OLD=V21 NEW=CDCS
OLD=V22 NEW=CM
OLD=V23 NEW=CY
OLD=V24 NEW=CLN
OLD=V25 NEW=CLL
OLD=V26 NEW=CACAV
OLD=V27 NEW=CDCAV
OLD=V28 NEW=CAI
OLD=V29 NEW=CDI
OLD=C1 NEW=CYW
OLD=C2 NEW=CNW
OLD=C3 NEW=CLLW
OLD=C8 NEW=CDN
OLD=C9 NEW=L/DW
OLD=C10 NEW=M(L/D)
OLD=FUN1 NEW=L/D
OLD=FUN2 NEW=CANARD
OLD=FUN3 NEW=HIAS
OLD=FUN4 NEW=RUDDER
OLD=FUN5 NEW=IBTEFL
OLD=FUN6 NEW=OBTEFL
OLD=FUN7 NEW=OBLEFL
OLD=FUN8 NEW=ALERON
OLD=FUN9 NEW=CL2
OLD=FUN10 NEW=IBLEFL
FACTOR=1.
INITIALIZE READ  VAR = 35., FMT = 1.
(F4.3,F5.0,F4.0,F11.0,F6.3,F7.2,F9.0,2F6.2,2(F7.4,F8.5),4F8.5,17F7.4,F7.0)
INIT AXES
OLD=CL Y M=-.2 INCR=.2 X M=-.2 INCR=.2
OLD=CM X M=.25 INCR=-.05
OLD=ALPHA X M=-8. INCR=4.
OLD=BETA X M=-12. INCR=2.
OLD=CDI Y M=0.0 INCR=-.002
OLD=L/D Y M=0.0 INCR=2.
OLD=CD X M=0.0 INCR=.04 Y M=0.0 INCR=.05
OLD=CLN Y M=-.03 INCR=.01 X M=-.04 INCR=.01
OLD=CLL Y M=-.03 INCR=.01 X M=-.04 INCR=.01
OLD=CY Y M=-.06 INCR=.02 X M=-.06 INCR=.02
OLD=CL2 Y M=-.2 INCR=.2
FINISH
FINISH INITIALIZATION
```

(Figure 16 - Continued)

PLOT SPECIFICATIONS

```
PLOT GROUP
C V1 EQ 444.
C V2 EQ 362.,367.,264.,259.
AXIS X=ALPHA Y=CL
P CONFIG EQ 11.,17.
PLOT GROUP
C V1 EQ 444.
C V2 EQ 362.,367.,264.,259.
AXIS X=ALPHA Y=CL
P CONFIG EQ 11.,17.
M MACH EQ .5,.8, TOL .01
FINISH
AFTER PGINIT
AFTER AXSINIT
AFTER PMINIT
AFTER MLTINIT
AT C3 0000042700
AT C3 0000050300
AFTER RESTRCT
AFTER PGINIT
AFTER AXSINIT
AFTER PMINIT
AFTER MLTINIT
AT C3 0000050500
AT C3 0000043200
AFTER RESTRCT
AFTER MLTINIT
AT C3 0000030500
AT C3 0000060200
AFTER RESTRCT
```

(C)

(D)

(Figure 16 - Continued)

```
CONDITIONS
V1 EQ 444.
V2 EQ 362..367..264..259.
        P 1 CONFIG    = 11.00000
        P 2 CONFIG    = 17.00000
NO MULTIPLIER VALUES
X AXIS = ALPHA
Y 1 AXIS = CL
TOTAL POINTS IN PLOT =    58
NUMBER OF POINTS NOT SHOWN =    4
NUMBER OF CURRENT TAPE BLOCK =    4
TOTAL PLOTS IN PLOT GROUP =  1
```

(E)

(Figure 16 - Continued)

```
CONDITIONS
V1 EQ 444.
V2 EQ 362.,367.,264.,259.
        P 1 CONFIG    = 11.00000
        P 2 CONFIG    = 17.00000
        M 1 MACH      = .6000000
X AXIS = ALPHA
Y 1 AXIS = CL
TOTAL POINTS IN PLOT =   38
NUMBER OF POINTS NOT SHOWN =    2
NUMBER OF CURRENT TAPE BLOCK =     5
```

(E)

(Figure 16 - Continued)

Page 5 of 7

```
CONDITIONS

V1 EQ 444.

V2 EQ 362.,367.,264.,259.

        P 1 CONFIG    =  11.00000

        P 2 CONFIG    =  12.00000

        M 1 MACH      =  .0000000

X AXIS = ALPHA

Y 1 AXIS = CL

TOTAL POINTS IN PLOT =     28

NUMBER OF POINTS NOT SHOWN =     2

NUMBER OF CURRENT TAPE BLOCK =     6

TOTAL PLOTS IN PLOT GROUP =     2

TOTAL PLOTS GENERATED IN RUN =     3
```

(Figure 16 - Continued)

```
 CS3    NOS/BE L414J        CYBR CNAJ 10/10/77
16.33.55.SJJMAIN  FROM    /MA
16.33.56.IP  00003576 WORDS - FILE INPUT , DC 00
16.33.56.SJJ1,T2000,IO=CCC,C475900,MT2,STCSB.  07
16.33.56.4GL2C J.JENSEN AFFCL/FXS 55006
16.33.57.ATTACH,OLDPL,SOURCE,CY=3.
16.33.59.UPDATE(F,P=C,L=12)
15.35.25. UPDATE COMPLETE.
16.35.25.RETURN,OLDPL.
16.36.26.FTN,T,I=COMPILE,L=0.
16.45.36.    15.801 CP SECONDS COMPILATION TIME
16.45.08.LABEL,TAPE3,R,D=HY,NORING,VSN=L02034.
16.45.CP.D740100
16.45.58.( MT32 ASSIGNED)
16.45.59.MT32 VOLUME SERIAL NUMBER IS L02034
16.46.00. LABEL READ WAS
16.45.00.    EDITION NUMBER    01
16.45.00.    RETENTION CYCLE   000
16.45.00.    CREATION DATE     77059
16.46.00.    REEL NUMBER       0001
16.45.00.LABEL,TAPE7,4,L=TERRY,D=HI,RING,VSN=X034
16.45.00.03.              D740100
16.47.28.( MT30 ASSIGNED)
15.47.28.MT30 VOLUME SERIAL NUMBER IS  X03409
16.47.29. LABEL WRITTEN WAS  TERRY
16.47.29.    EDITION NUMBER    01
16.47.29.    RETENTION CYCLE   000
15.47.29.    CREATION DATE     77356
16.47.29.    REEL NUMBER       0001
16.47.31.ATTACH,CCPLOT,ID=X654321,SN=AFIT.
16.47.31.PFN IS
16.47.31.CCPLOT
16.47.32.PF CYCLE NO. = 031
15.47.32.ATTACH,IGS777,ID=PUBLIC,SN=SYSTEM,CY=2.
15.47.32.
16.47.32.PFN IS
16.47.32.IGS777
16.47.32.LIBRARY,CCPLOT,IGS777.
16.47.32.REQUEST,DATA,*PF.
16.47.33.LDSET,PRESET=ZERO,USEP=$INCOM=$.
16.47.34.LGO.
17.22.46. APPROXIMATE TIME FOR THIS PLOT IS   4.5
17.22.46. MINUTES.
17.22.46.    STOP
17.22.46.    142.326 CP SECONDS EXECUTION TIME
17.22.46.CATALOG,DATA,ACCA,RP=999.
17.22.46.NEWCYCLE CATALOG
17.22.47.CT ID=  D740020 PFN=ADCA
17.22.47.CT CY= 011  00002368 WORDS.
17.22.47.EXIT.
17.22.47.OP  00001200 WORDS - FILE OUTPUT , DC 40
17.22.47.MT30  BLOCKS WRITTEN -060034
17.22.47.MS  164864  WORDS  (  164864 MAX USED)
17.22.47.SCM  70030  WORDS MAXIMUM
17.22.47.CPA    208.429 SEC.      98.479 ADJ.
17.22.47.IO     150.412 SEC.      79.253 ADJ.
17.22.47.CM    9587.673 KWS.      76.720 ADJ.
17.22.47.CRUS                    246.453
17.22.47.COST                 $   14.78
17.22.47.PP     300.260 SEC.    DATE 12/22/77
17.22.47.EJ  END OF JOB, 8A  D740020.
```

(Figure 16 - Continued)

Page 7 of 7

If PLUGO detects an error in the plot creation cards, the user can determine which card is in error by tracing through the plot creation card deck with the use of this section of print.

E - List of plot specifications for one plot. Each generated plot will have one plot specification page.

F - Dayfile. Errors in the Job Control Record or the UPDATE Record can be determined by this print section.

2.4 PLUGO PHASE I GENERAL COMMENTS

A maximum of 100 plots may be created by one run of PLUGO Phase I. Each plot may have up to 248 data points on it. No more than 20 curves (Parameter values) may appear on each plot. If the plot data created by PLUGO Phase I is to be input to PLUGO Phase II, then the number of cards in a Plot Group must be less than or equal to 17. If more cards are input, they will not appear on the PGSPECS display (Section 3.2.2).

SECTION 3

PLUGO PHASE II USERS GUIDE

3.1 PLUGO PHASE II INPUT DATA REQUIREMENTS

Input to PLUGO Phase II consists of a permanent Graphics Disc File. This file is originally created by PLUGO Phase I. It may be modified by PLUGO Phase II and cataloged as a modified Graphics Disc File that may also be input to PLUGO Phase II. This allows the user to extend modification efforts on a Graphics Disc File over several sessions.

3.2 EXECUTION OF THE PLUGO PHASE II PROGRAM

The first step in running PLUGO Phase II is to LOGIN to the INTERCOM system from a Cybergraphics terminal. This procedure is outlined in the ASD Computer Center INTERCOM Guide (Reference 6).

The next step is to execute a CCL (Cyber Control Language) cataloged procedure. This procedure will attach all necessary system files and initiate execution of PLUGO Phase II. Depending on the problem number the user has logged in under, it may be necessary to attach the permanent file on which this cataloged procedure resides. At the present time this file is PROCFIL, ID=A730528, SN=ASD on the A system and PROCFIL, ID=D740020, SN=AFFDL on the B system. To execute this procedure, the following statement should be entered. The problem number of the Graphics Disc file should be the number logged in under.

```
BEGIN, PLUGO,,DMN=DD,PL=ZZZ,CY=NN(,TID=TT)(,FID=FF)(,TAPE=XXX)
                                   (,TPB=YYY)(,HC=HH).
```

(Items not in parentheses must be included; all others are optional.)

DD Permanent Graphics Disc File name (resulting from a run of PLUGO Phase I). No default value for this.

NN Cycle number of above permfile. Again no default.

ZZZ OLD = Old Calcomp plotter. (Default).
NEW = New 1036 plotter.
ON = On line plots.

TT Terminal ID of the 1700 where you wish to have your output printed. Default is Ba. (+*)

FF ID on banner of your output. Default is JT. (+*)

XXX Physical tape number of your offline Calcomp plot. Must follow Lxxxxx or Xxxxxx convention. No default. (+*)

YYY Problem number that TAPE is under. With this specified it is unnecessary to submit a tape request. No default. (+)

HH Intermediate name given to the Calcomp plot file during processing. This should be specified to keep your Calcomp file separate from others. Default is PLH. (+)

EXAMPLES

BEGIN, PLUGO,,DMN=MYOWN,CY=1,TAPE=X01404,HC=ABC,TPB=D740188.

Will use Graphics Disc File MYOWN, cycle 1, tape X01404 under D740188, and use ABC as the intermediate Calcomp file name. FID and TID will be the default values.

BEGIN, PLUGO,,DMN=XYZ,CY=53.

Will use data manager file XYZ, cycle 53. No tape is specified for the Calcomp file, therefore no hardcopy will be saved.

BEGIN, PLUGO,,DMN=DATA,CY=2,TID=C,FID=J34,TAPE=L00123,HC=AAA, TPB=A750021,PL=NEW.

Will use data manager file DATA, cycle 2, problem number A750021, under the default ID. Any output will be printed at the central site (C) and returned to bin J34. Calcomp information will be placed on tape L00123 under problem number A750021, the intermediate hardcopy file is AAA, and plots will be generator for the 1036 Plotter.

---

*Only needed if you are saving print information.
+Only needed if you are saving hardcopy plots.

3.2.1 Initial Display (Figure 17)

After PLUGO Phase II is initiated, the Initial Display (Figure 17) is generated. This display consists of information about the originators of PLUGO. The only light pen selectable item displyed is the word EXECUTE at the bottom of the screen. Selecting this transfers execution to the Plot Group Specification display (Figure 18).

3.2.2 Plot Group Specification Display (Figure 18)

The Plot Group Specification (PGSPECS) Display is used to list the plot specification cards for plot groups created by PLUGO Phase I. The PGSPECS screen displays (from the Graphics Disc File) one Plot Group at a time. If the Phase II graphics file contains multiple plot groups, the user may move forward or backward through them by picking NEXT PLOT GROUP or PREVIOUS PLOT GROUP. There should be no more than 17 plot specification cards within a Plot Group.

The main purpose of this display is to choose which of the two plotting options will be used - CROSS PLOT or TRIM implications of each are:

<u>CROSS PLOT</u> - Plots are displayed by parameter multiplier (PM) groups. Before selecting CROSS PLOT the user must select a specification card from the plot specification card list that uniquely identifies a PM group (the system displays as <u>selectable</u> only those specifications that are unique, all non-unique specifications are displayed as non-selectable items). After this selection is made, select CROSS PLOT to proceed. The first plot of the specified series will be displayed on the MAIN display (Figure 19). In order to display plots within a different PM group, the user must return to the PGSPECS display, select the appropriate card which uniquely identifies the desired Plot Group and proceed from there.

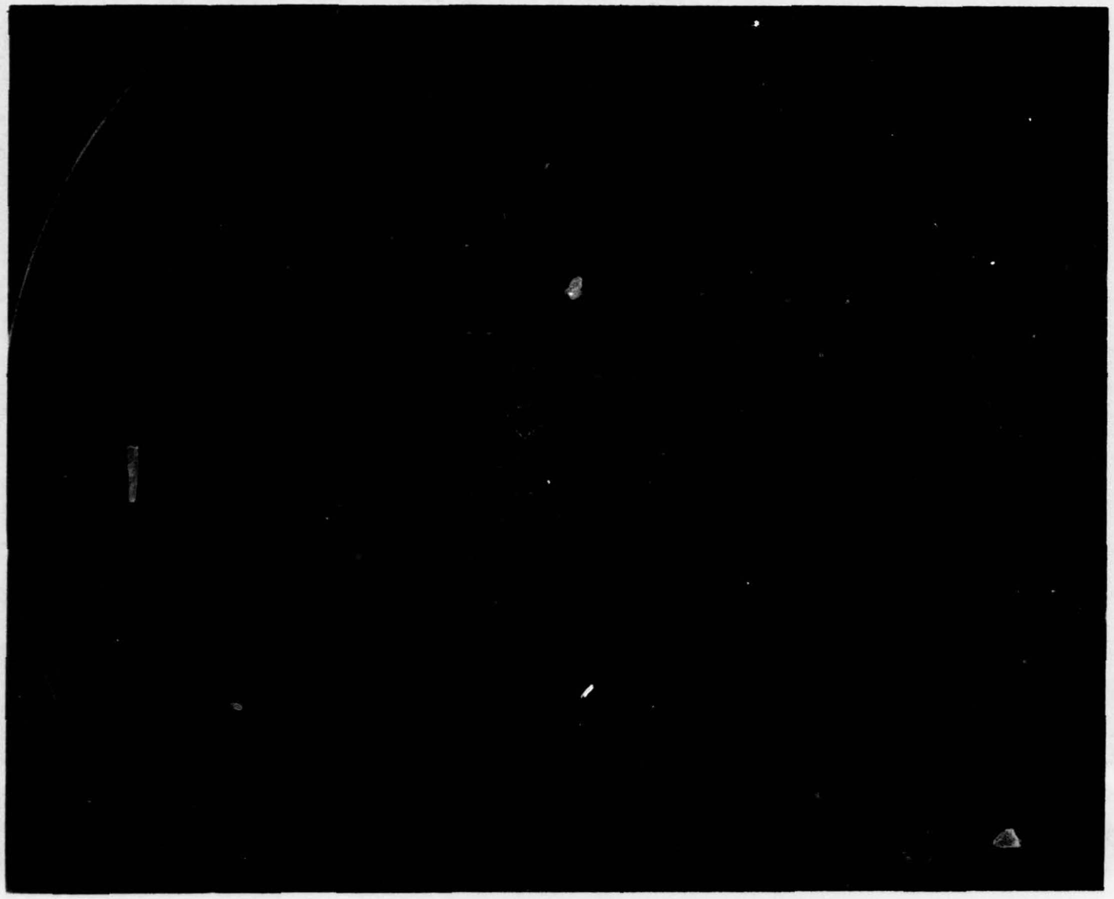


Figure 17. The INITIAL display. This is the first screen displayed after initiating PLUGO Phase II. EXECUTE is the only selectable item.

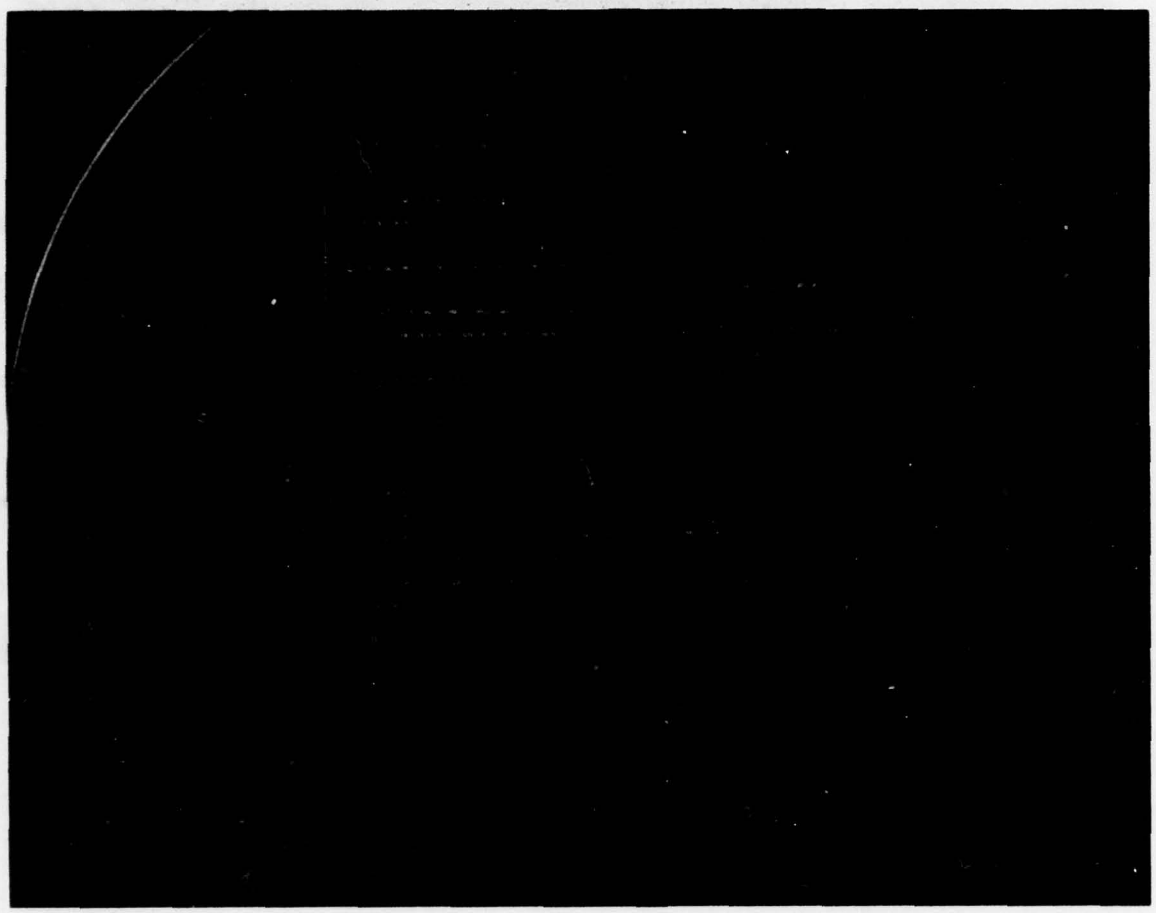


Figure 18. The PGSPECS display. Up to 17 Plot Group Specification cards are displayed for each Plot Group. Other Plot Groups on the Graphics Disc File may be accessed by selecting NEXT PLOT GROUP and/or PREVIOUS PLOT GROUP as required.

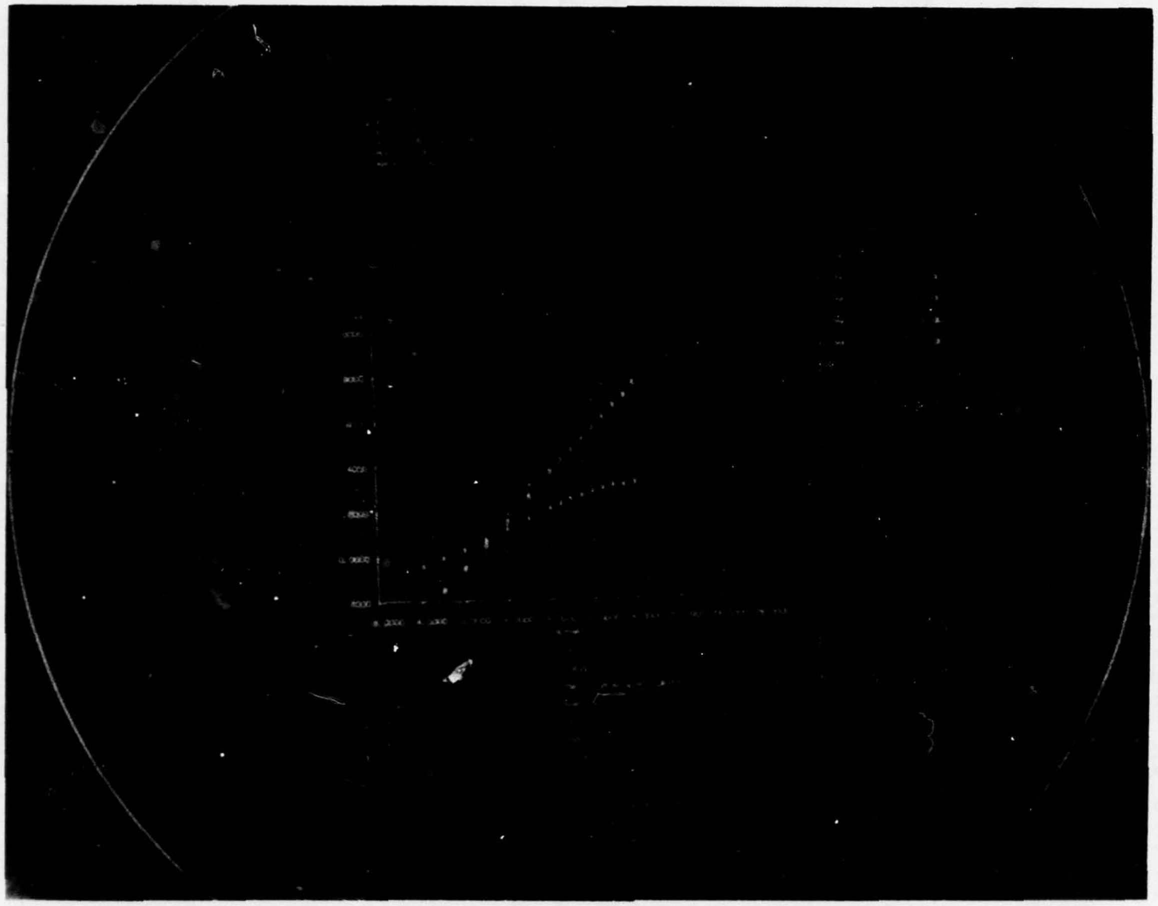


Figure 19. The MAIN display under the CROSS PLOT option. The Parameter values are listed in the CURVE DESCRIPTION box. PLUGO Phase II may be terminated by selecting STOP at the top of the screen.

TRIM - This is a PLUGO feature specifically for users with aerodynamic data. TRIM calculates values necessary to trim wind tunnel models. In order to use trim, the plots on the Graphics Disc File must satisfy certain prerequisites. These requirements as well as a detailed description of the TRIM feature, are explained in the Appendix.

3.2.3 Main Display (Figure 19)

This is the central display of PLUGO Phase II. A description of the displayed information is:

Middle of screen - All curves of the current plot displayed on 9 inch X and 6 inch Y axis.

Above graph - Identification of the current plot.

Right side of graph - Legend defining each curve by symbol. Called the curve description box.

Below graph - Menu items, dependent on the plot option.

The Main display can be displayed under both the TRIM and the CROSS PLOT options with different menus for each case. The menu displayed under the TRIM option is listed and explained in the Appendix. The menu displayed under the CROSS PLOT option is:

EDIT

CURVE FIT

PREFIT REMAINING CURVES

HARDCOPY

NEXT PLOT

ANALYZE

CHANGE SCALE

CHANGE AXIS NAMES

CHANGE TITLE

PRINT PLOT INFORMATION

PLOT TRIM

CROSS PLOT TWO

RETURN TO PLOT GROUP SPECIFICATIONS

An explanation of each menu item is given in the following paragraph.

3.2.4 Edit (Figure 20)

This selection executes the section of PLUGO Phase II that will edit the data points currently displayed on the screen. The user may add or delete points, delete the entire curve, or delete the entire plot.

Upon selecting EDIT, the list of menu items will be erased and the EDIT options and instructions will appear. An explanation of the edit functions is as follows:

Delete a point (Figure 21): Select the appropriate curve* in the curve description box and then pick DELETE POINT. All other curves will be erased from the plot and the tracking cross and radius menu will appear below the X-axis. Move the tracking cross to the point to be deleted and select a radius from the radius menu. All the data points that fall within the radius of the tracking cross will then be displayed to the left of the plot. Select those points that are to be deleted and then the word DELETE at the bottom. The curve will be redisplayed with the offending point(s) omitted. The user now has the option to (1) continue deleting (on this curve), (2) restore the curve (to the original data), or (3) select the next curve, which returns to the EDIT display.

Add a point (Figure 22): Select the appropriate curve in the curve description box and then select ADD POINT. Once again all other curves on the plot will be erased. The system will ask if the new point is to be entered via the tracking cross or the keyboard. If KEYBOARD is picked, a light register will be

*For editing purposes, curve refers to a set of points corresponding to a parameter value. The fact that these points have or have not been curve-fitted does not matter to the EDIT functions. When a set of points (curve) that has been curve-fitted is selected, the fitted curve is erased and only the points are displayed.

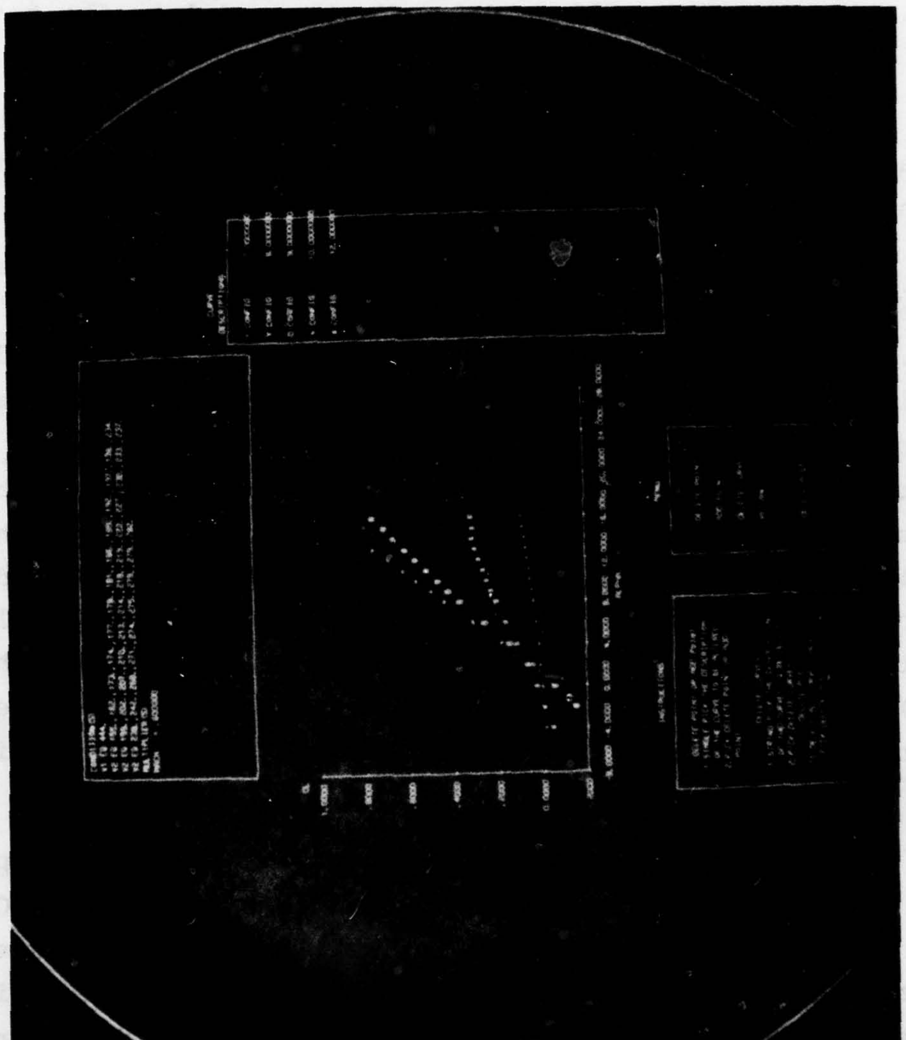


Figure 20. The EDIT screen.

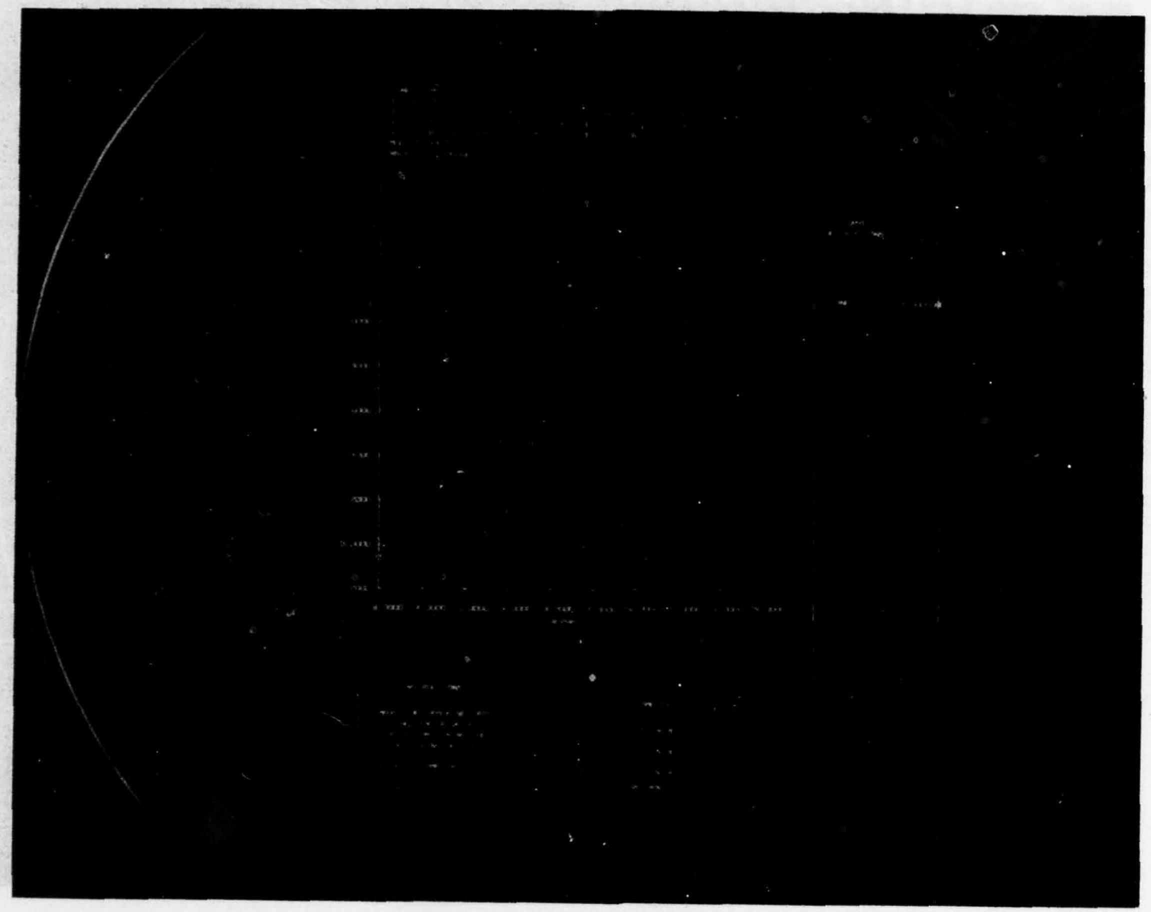


Figure 21. The DELETE POINTS screen displayed by the EDIT function.

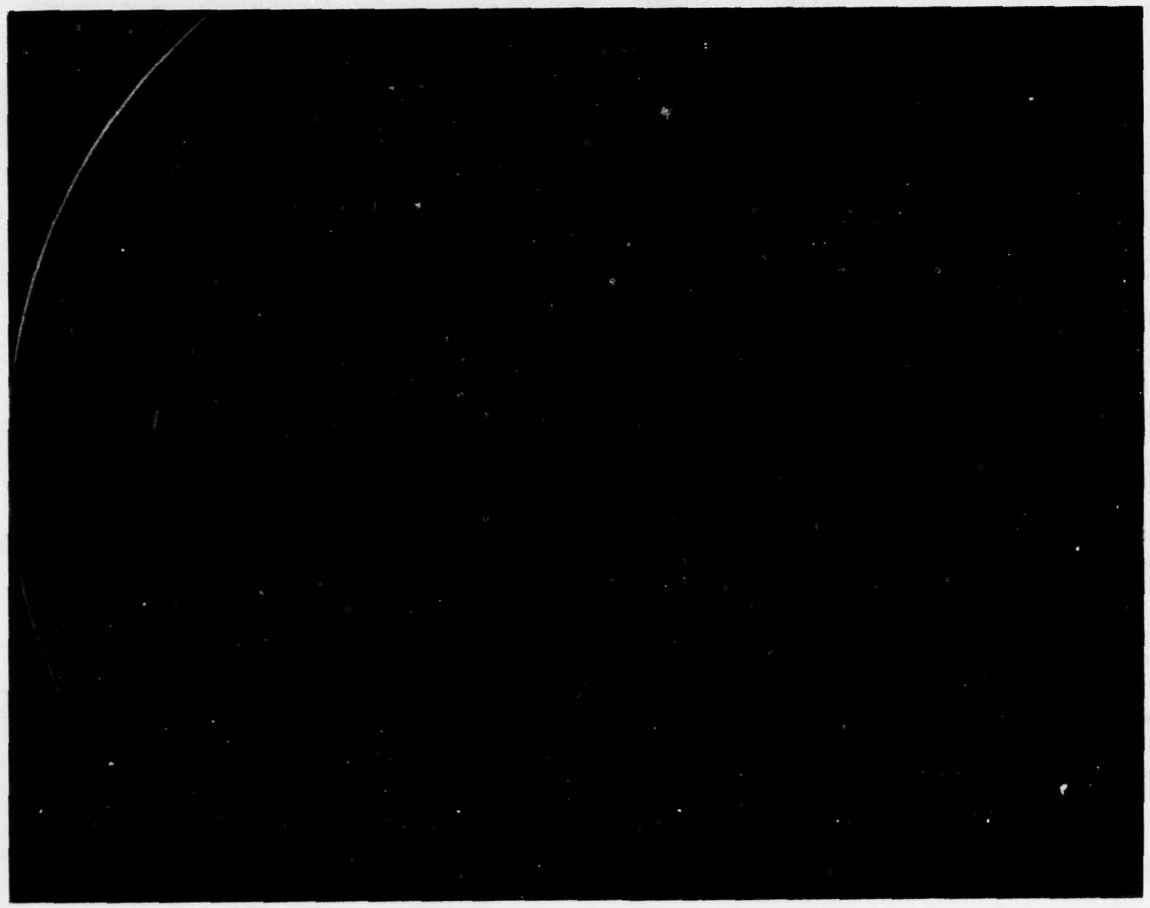


Figure 22. The ADD POINTS screen displayed by the EDIT function.

displayed for entering the X- and Y- coordinates. If TRACKING CROSS is selected, move it to the desired spot and select the word ADD. The curve will be redrawn with the new point. At this point the user has the choice of (1) continuing to add points (on that curve), (2) restoring the curve (to the original data), or (3) selecting the next curve (return to the EDIT display).

NOTE: Points may be added to or deleted from curves whether or not they have been curve-fitted. However, the curve fit will not be automatically recalculated to reflect the change: the curves must be refit.

Delete a curve: To delete a curve, the user selects the appropriate curve description (one or more) from the curve description box, then selects DELETE CURVE. The curves will be erased and a menu displayed, allowing you to: (1) restore the plot to the original condition, or (2) select the next curve (back to the EDIT display). Deleting a curve will also delete any associated curve-fit.

Delete plot: To delete the entire plot, the user should pick DELETE PLOT. The system will display ARE YOU SURE. If yes, pick YES. PLUGO will erase all curves and curve fits and delete the plot from the data stream.

NOTE: If it is necessary to delete an entire plot, that plot group will be impossible to trim. A pointer is set in the data that will call an error message if the TRIM option is picked.

Also note that there is a difference between deleting all of the curves on a plot and deleting a plot. In the former case, the particular plot will be displayed as an empty graph - the axes are displayed but no data points are plotted. If the plot has been deleted, it is gone and no remnants are left.

3.2.5 <u>Curve Fit (Figure 23)</u>

Picking CURVE FIT will execute a section of the program that will curve-fit sets of points. There are three curve-fitting algorithms available: least squares, spline and straight line.

After selecting CURVE FIT, the menu from the main display will be erased and replaced by the curve fit menu and instructions. At this point, the user is asked to select the curve descriptions of the set of data points to be fit followed by the type of fit.

The user may fit any number of curves at a time. When fitting all of the curves on the plot with the same type of fit, the user may find it more convenient to pick the "ALL" displayed at the lower right of the screen.

After making the curve selections, one of the curve fit types should be selected. Curves which are not involved in this operation will be erased. The system will ask for the independent variable. The user must enter either X or Y. If the least squares fit was selected, the user will be asked for the degree of the least squares polynomial. When all pertinent questions have been answered, the system will draw the curve fits and allow the user to: (1) return to the curve fit menu (to redo the fits or fit other curves on the plot), or (2) return to the master control menu (MAIN display).

Note, while the spline and straight line fits must go through the data points, the least squares fit only approximates the best polynomial fit and therefore does not necessarily pass through the points. Data points which are located extremely close together may cause the spline routine some difficulties. If they are located too close (i.e., doubly defined for the independent variable), it will cause a recoverable system error.

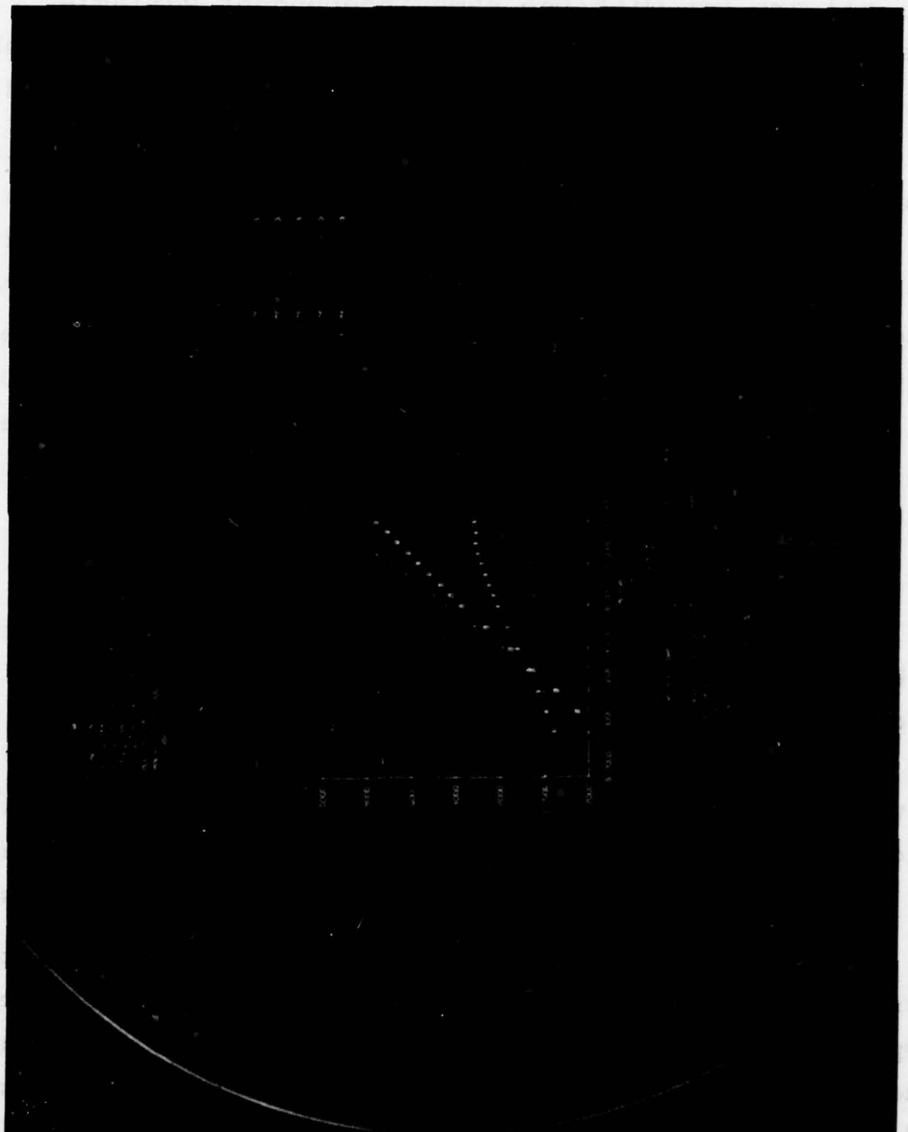


Figure 23. The Curve Fit selection display.

3.2.6 Prefit Remaining Curves

The selection is basically the same as the CURVE FIT except it produces fits for all curves on the current plot and all following plots in the Parameter-Multiplier series. This implies two things: (1) all curves are fit by the same fit type, and (2) all are fit with the same independent variable. This feature can save a lot of time, but it can also cause problems if the data are less than excellent (i.e., doubly defined points).

If the user is anticipating trimming his data, then he should not use this feature under the TRIM option. The reason for this is that the TRIM option requires the first two series of the plots to be fit with Y as the independent variable, and the last to be fit with X as the independent variable. The fastest way around this is to enter each series under CROSS PLOT, prefit all the curves with the appropriate independent variable, return to the PGSPECS display, and reenter the Plot Group under the TRIM option.

3.2.7 Hardcopy

Hardcopy in this case refers to the Calcomp plotter. When HARDCOPY is selected, the program creates an image of the plot currently on the screen. It uses the scale, X- and Y- axis names, titles, etc., as they are displayed. The Calcomp plot produced will be on 9 x 6 inch axes. The program will blink a star next to HARDCOPY to indicate that it has completed the hardcopy plot. The star will disappear when the next selection is made.

If any hardcopy information is saved, the plot time estimate will appear on the screen after the graphics session is complete.* The cataloged procedure must also create a job which will copy the Calcomp information from disk (where it must be stored during the graphics phase) to a tape (for the offline plotter).

*This is the <u>only</u> time and place this estimate appears, so do not miss it.

The dayfile from this job will be printed at the location specified in the BEGIN statement (TID parameter) and the banner will contain the FID field. Upon completion of this batch job, the off-line plot request can be submitted.

3.2.8 Next Plot (Figure 24)

Selecting this option causes PLUGO to display the next plot within the selected PM group. The path through the Plot Group depends on which plot option has been picked (CROSS PLOT or TRIM). When NEXT PLOT is selected from CROSS PLOT the next plot displayed is for the next multiplier value. If the plot for the last multiplier value within a PM group is displayed on the screen and NEXT PLOT is selected, an error message is flashed on the screen.

When NEXT PLOT is selected from TRIM, the next plot displayed is from the next PM group. The multiplier value remains constant. If a plot from the last PM group within a plot group is displayed and NEXT PLOT is picked, PLUGO will display the plot from the first PM group for the next multiplier value.

3.2.9 Change Scale

When this is selected the current scale factors and the maximum and minimum of the data are displayed to the left of the plot. To change one of the numbers, select the current value with the light pen. When the light register appears, enter the new value. When all changes have been made select ACCEPT. PLUGO will redraw the plot and axes in accordance to the new plot scale data. This change will be made to all multiplier value plots within the displayed PM group.

3.2.10 Change Axis Name

When this option is selected a menu will appear to the left of the plot with the current names of the axes. To change one, select the current name with the light pen. When the light register appears type in the new name. The new name must be ten or less characters in length.

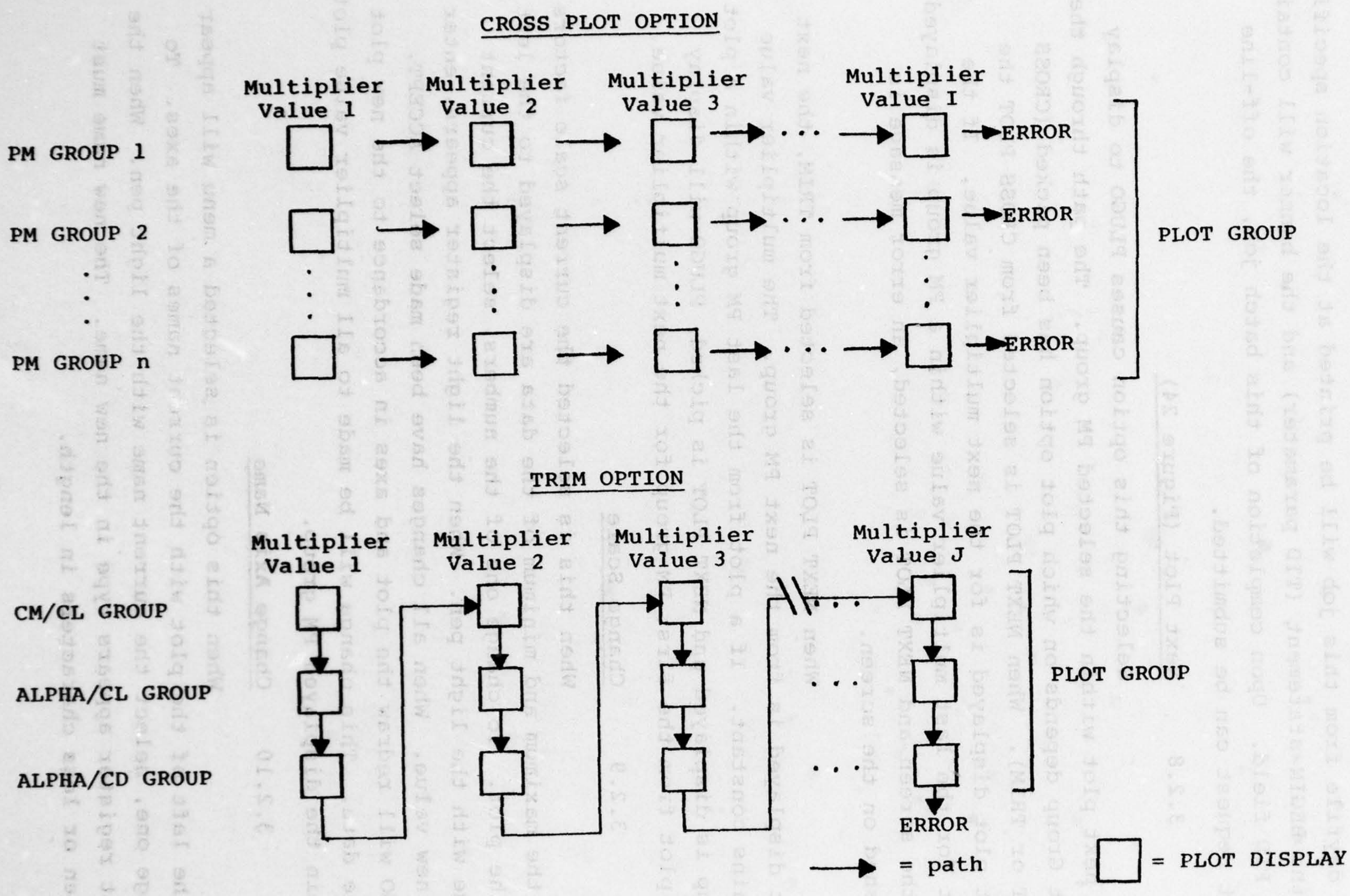


Figure 24. Path taken through a PLOT GROUP by the NEXT PLOT function.

3.2.11 Change Title

When this option is selected a light register will appear immediately above the plot. Type in the new title. The new title must be 40 characters or less. If an asterisk is entered, a blank title will be drawn.

3.2.12 Print Plot Information

This selection will cause all of the information about the current plot to be printed on the line printer (specified by the TID parameter in the BEGIN statement). As in the HARDCOPY selection, an asterisk will blink to indicate that the hardcopy has been made.

3.2.13 Plot Trim

This selection will display a previously calculated trim plot. It should only be made if the data has been set up for the TRIM option (Appendix), otherwise an error message will be displayed.

3.2.14 Return To Plot Group Specifications

This selection returns the program to the PGSPECS display. If the same group of plots is reentered from the PGSPECS display, all previous efforts (editing, curve fits, etc.) will still be in effect.

3.2.15 Analyze (Figure 25)

This option is sometimes referred to as CROSS PLOT ONE. Before this option is selected, it is necessary to curve-fit all data in the current PM group. Any curve fit algorithm can be used. When ANALYZE is selected, the user will be given a choice of four cross plot options: SLOPES, COORDINATE, DELTA, or MINIMUM. Samples of these cross plot types are given in Figures 26, 27 and 29. A description of each cross plot type is as follows.

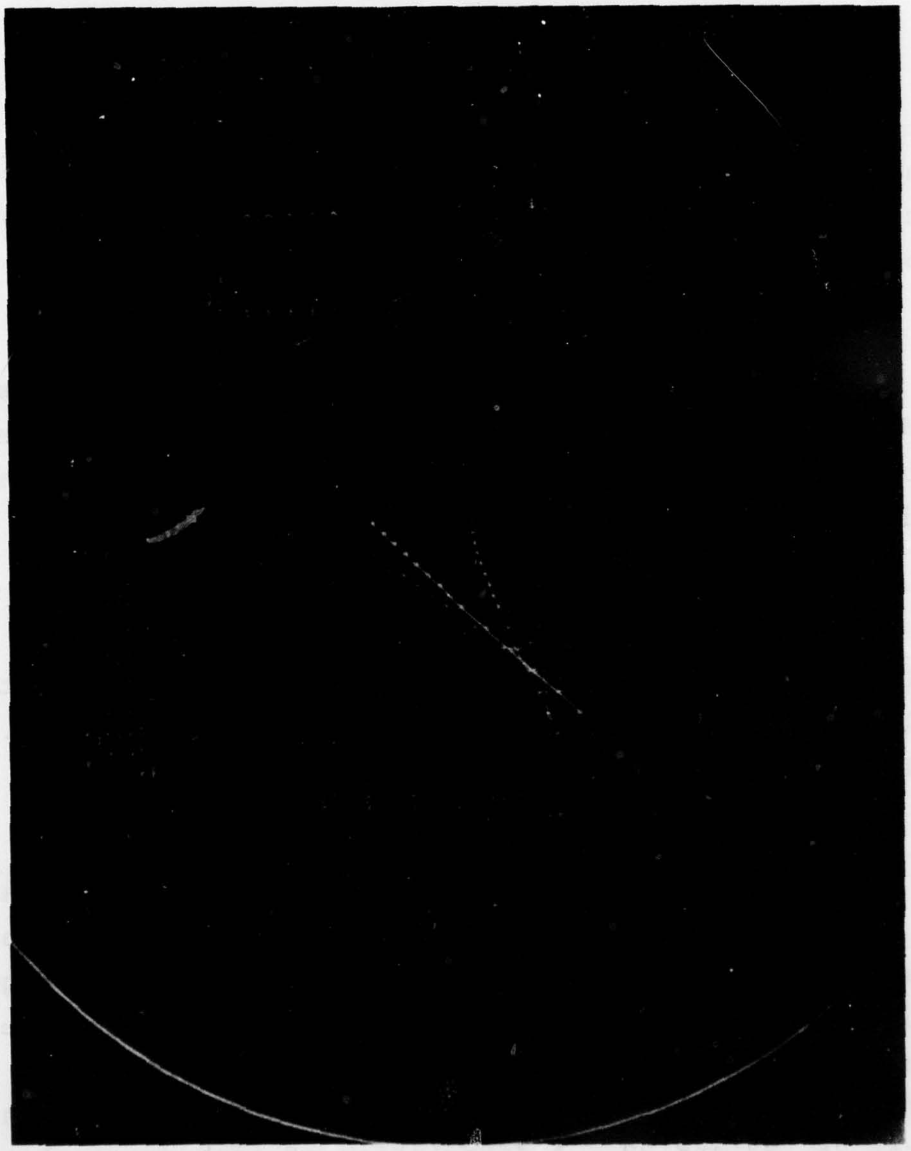
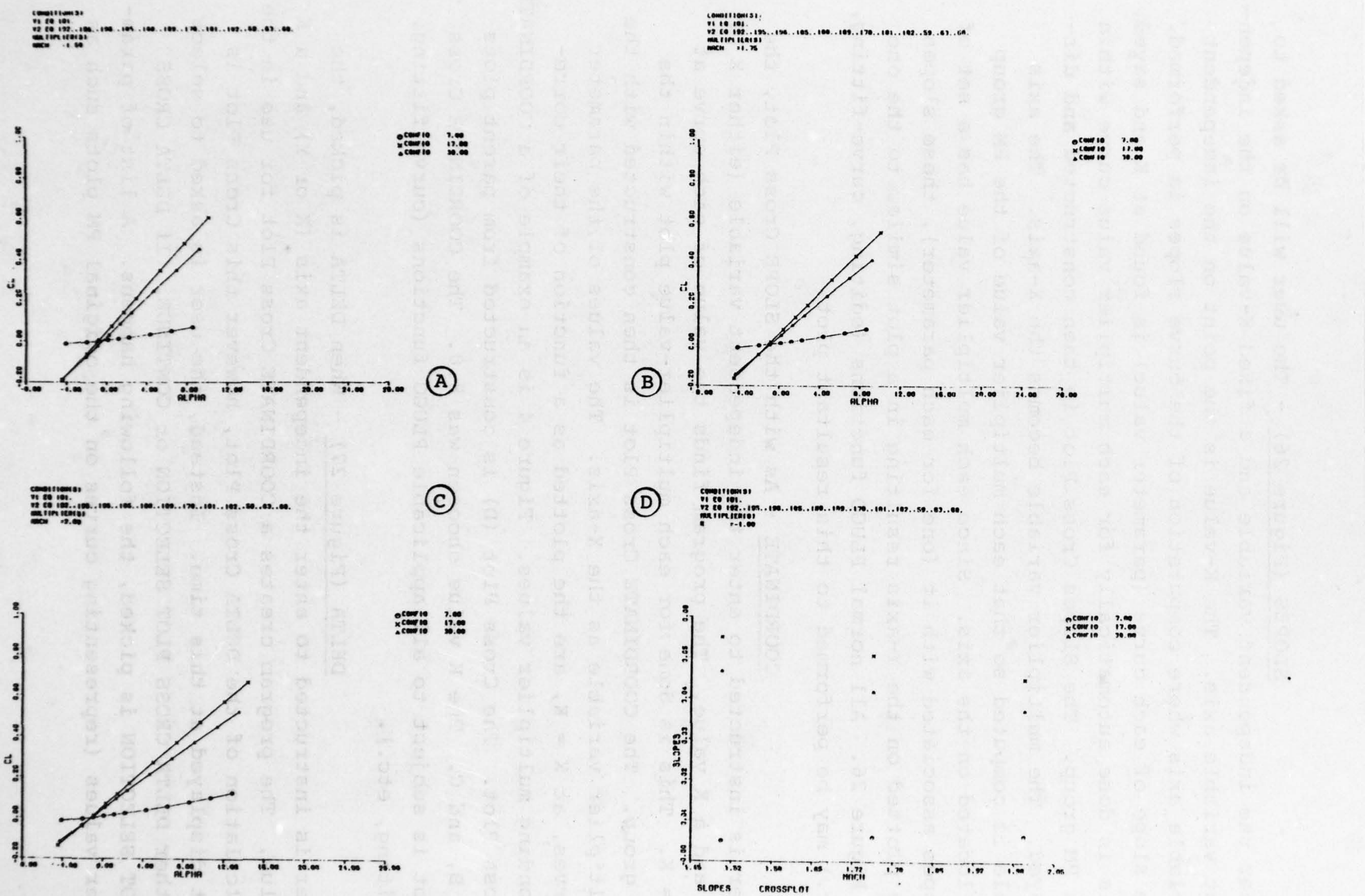


Figure 25. The Cross Plot selection screen.



ANALYZE SLOPES CROSS PLOT

Figure 26. A K value of ALPHA= -1.0 was chosen. Parent plots A, B, and C result in Cross Plot D.

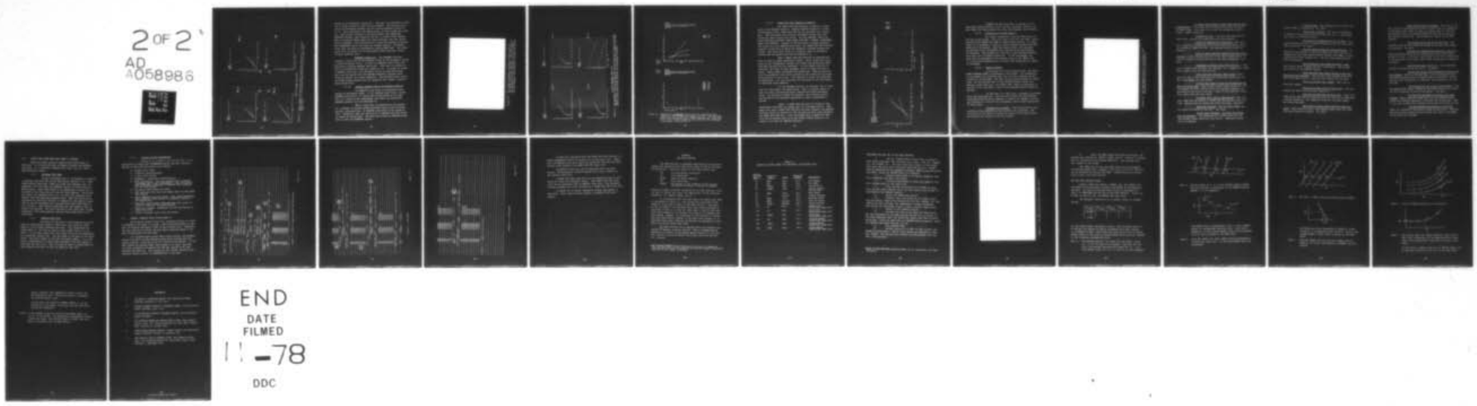
SLOPES (Figure 26) - The user will be asked to enter the independent variable and a fixed K-value on the independent variable axis. The K-value is the point on the independent variable axis where computation of the curve slopes is performed. The slope of each curve (parameter value) is found at K and saved. This is done automatically for each multiplier value curve within the PM group. The Slopes Cross Plot is then constructed and displayed. The multiplier variable becomes the X-axis. The axis scale is computed so that each multiplier value of the PM group is located on the axis. Since each multiplier value has a set of slopes associated with it (one for each parameter), these slopes are plotted on the Y-axis resulting in a plot similar to the one in Figure 26. All normal PLUGO functions (editing, curve-fitting, etc.) may be performed to this resultant plot.

COORDINATE - As with the SLOPE Cross Plot, the user is instructed to enter the independent variable (either X or Y) and a K value. The program finds the value of each curve at X = K. This is done for each multiplier-value plot within the PM group. The COORDINATE Cross Plot is then constructed with the multiplier variable as the X-axis. The values of the parameter curves, at X = K, are the plotted as a function of their corresponding multiplier values. Figure 4 is an example of a COORDINATE Cross Plot. The Cross Plot (D) is constructed from parent plots A, B, and C. The K value choosen was 8.0. The COORDINATE Cross Plot is subject to all applicable PLUGO functions (curve fitting, editing, etc.).

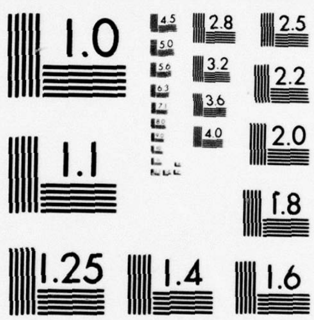
DELTA (Figure 27) - When DELTA is picked, the user is instructed to enter the independent axis (X or Y) and a K value. The program creates a COORDINATE Cross Plot for use in the calculation of the DELTA Cross Plot, however this Cross Plot is not displayed at this time. Instead, the user is asked to select either DELTA CROSS PLOT SELECTION or CONTINUE. If DELTA CROSS PLOT SELECTION is picked, the following happens. A list of parameter values (representing curves on the original PM plots such as

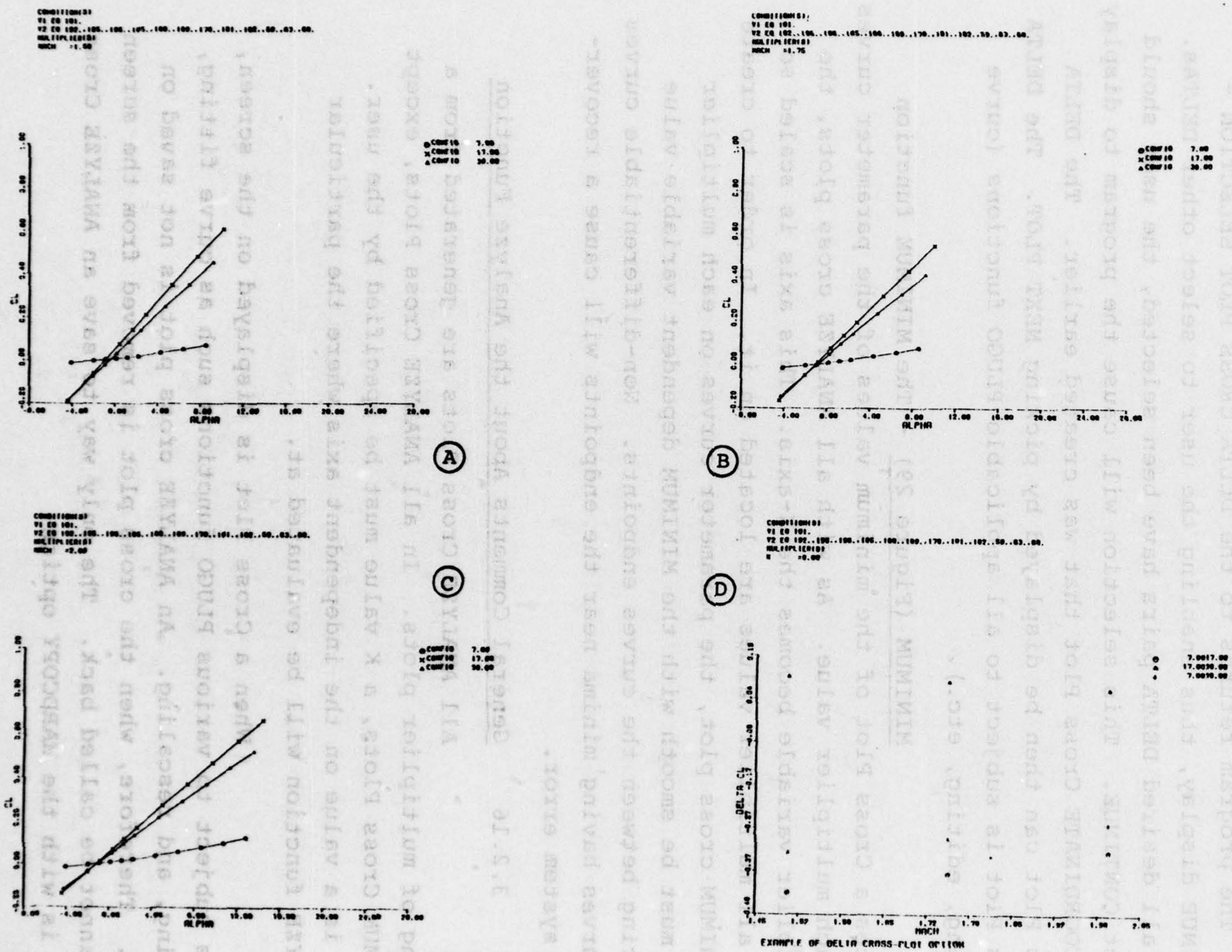
AD-A058 986 DAYTON UNIV OHIO RESEARCH INST F/G 9/2
PLOTTING LANGUAGE UTILIZING GRAPHICAL OPTICS (PLUGO). VOLUME I.--ETC(U)
MAY 78 J G JENSEN F33615-76-C-3076
UNCLASSIFIED UDR-TR-78-32 AFFDL-TR-78-55-VOL-1 NL

2 OF 2
AD
A058986



END
DATE
FILMED
11-78
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3



ANALYZE DELTA CROSS PLOT

Figure 27. Parent plots A, B, and C are used to construct Cross Plot D. Note the Delta notation in the Parameter description area in the upper right corner of D.

Figure 25 is displayed (Figure 28). The user is instructed to pick two of these values and then the word ACCEPT. The program calculates the difference between the two picked parameter curves at X = K. This difference (the DELTA value) is then stored for later use. The program returns to the DELTA CROSS PLOT SELECTION - CONTINUE display, thus enabling the user to select other DELTAs. When all desired DELTA pairs have been selected, the user should select CONTINUE. This selection will cause the program to display the COORDINATE Cross Plot that was created earlier. The DELTA Cross Plot can then be displayed by picking NEXT PLOT. The DELTA Cross Plot is subject to all applicable PLUGO functions (curve fitting, editing, etc.).

MINIMUM (Figure 29) - The MINIMUM function creates a Cross Plot of the minimum values of the parameter curves at each multiplier value. As with all ANALYZE cross plots, the multiplier variable becomes the X-axis. This axis is scaled so that all multiplier values are located on it. In order to create a MINIMUM cross plot, the parameter curves on each multiplier plot must be smooth with the MINIMUM dependent variable value accuring between the curves endpoints. Non-differentiable curves or curves having minima near the endpoints will cause a recoverable system error.

3.2.16 General Comments About the Analyze Function

All ANALYZE Cross Plots are generated from a string of multiplier plots. In all ANALYZE Cross Plots, except MINIMUM Cross Plots, a K value must be specified by the user. This is a value on the independent axis where the particular ANALYZE function will be evaluated at.

When a Cross Plot is displayed on the screen, it is subject to various PLUGO functions such as curve fitting, editing, and rescaling. An ANALYZE cross plot is not saved on disc. Therefore, when the cross plot is removed from the screen it cannot be called back. The only way to save an ANALYZE Cross Plot is with the HARDCOPY option.

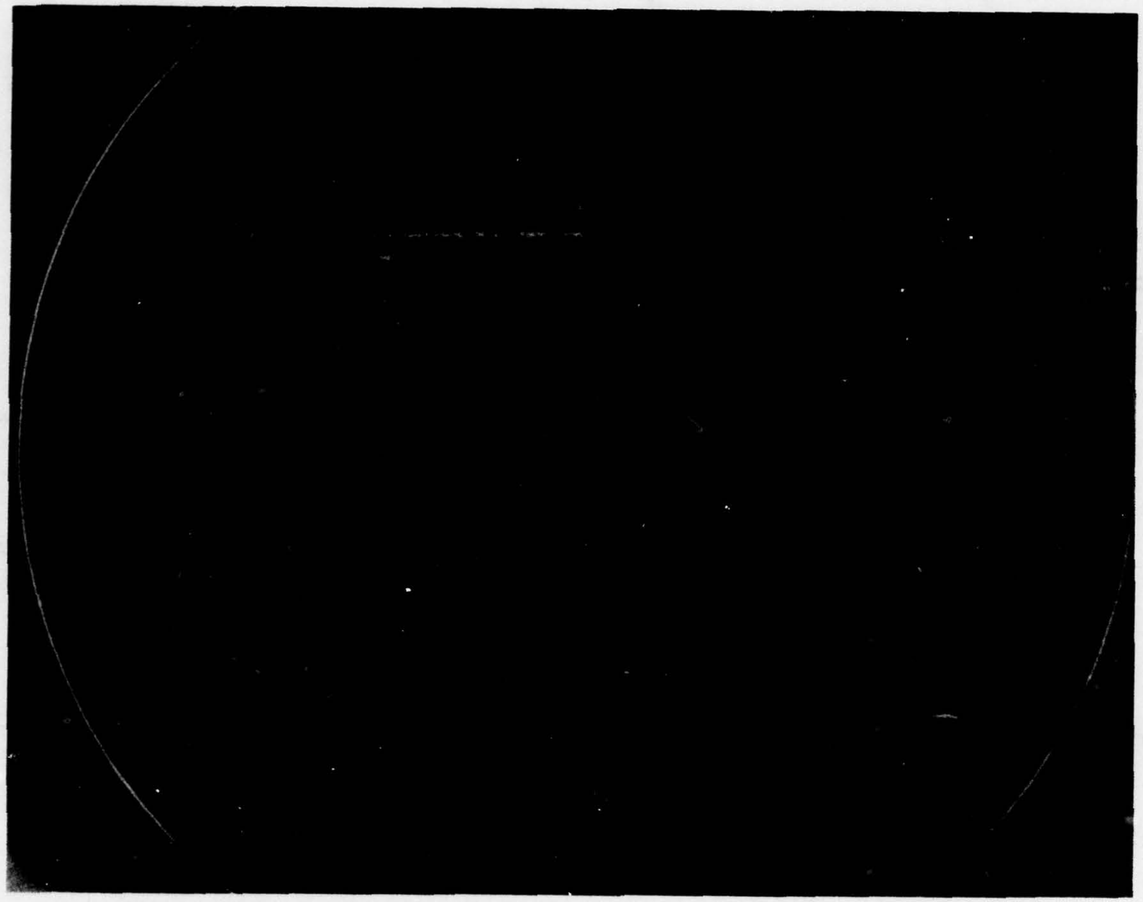
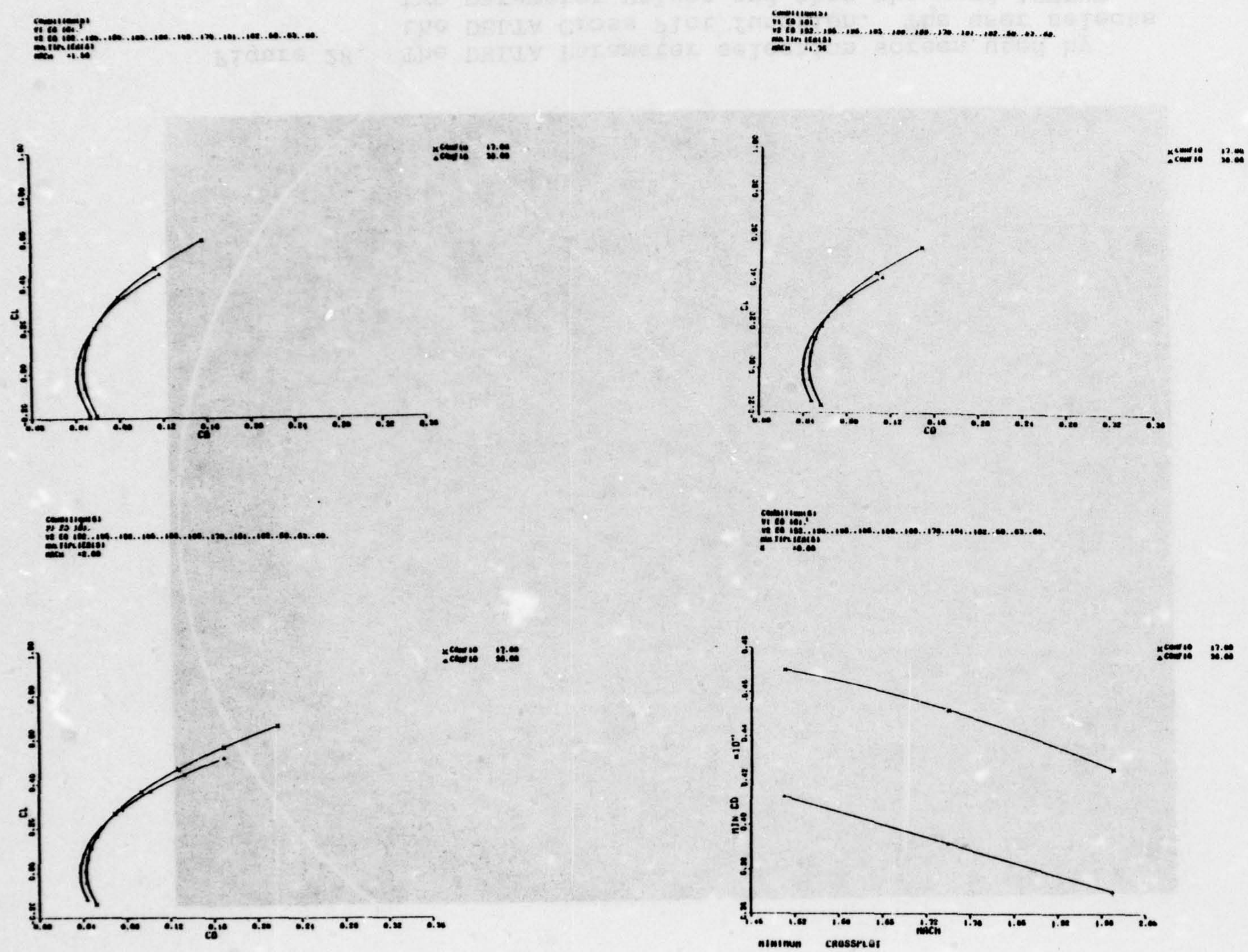


Figure 28. The DELTA Parameter selection screen used by the DELTA Cross Plot function. The user selects two parameter values and then the word ACCEPT. In this example the Parameter variable is CONFIG.



ANALYZE <u>MINIMUM</u> CROSS PLOT

Figure 29. The MINIMUM Cross Plot (D) has been curve-fitted with a degree two Least Squares curve. The parent plots A, B, and C have been curve-fitted with Spline curves where CL was declared the independent variable.

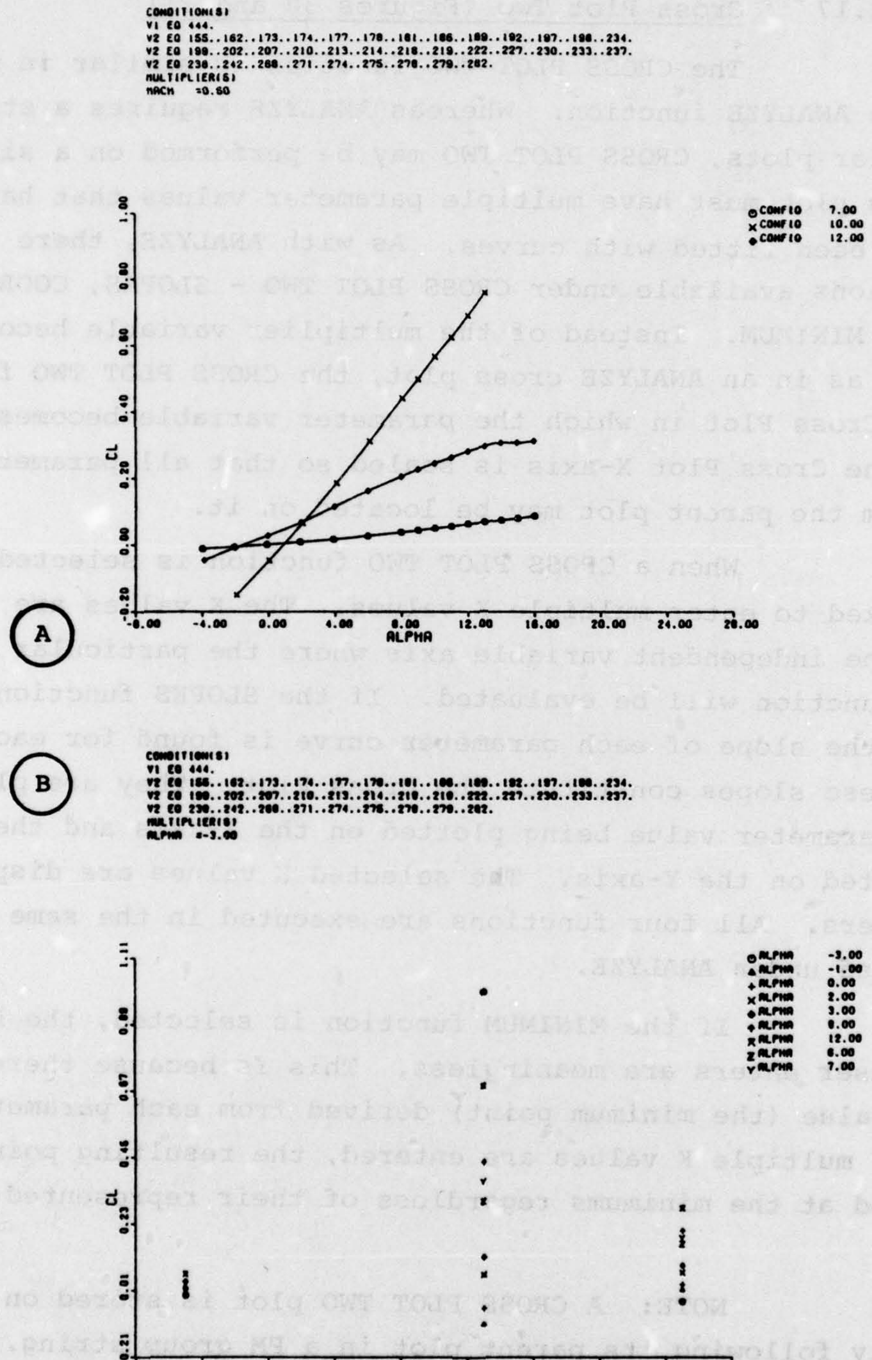


Figure 30. Example of a COORDINATE Cross Plot (B) obtained by the CROSS PLOT TWO function from parent plot (A). The Parameter variable on the parent plot (CONFIG) becomes the X-axis variable. The K values picked for the Cross Plot are displayed as Parameter values in plot B.

3.2.17 Cross Plot Two (Figures 30 and 31)

The CROSS PLOT TWO function is similar in many ways to the ANALYZE function. Whereas ANALYZE requires a string of multiplier plots, CROSS PLOT TWO may be performed on a single plot. This plot must have multiple parameter values that have previously been fitted with curves. As with ANALYZE, there are four functions available under CROSS PLOT TWO - SLOPES, COORDINATE, DELTA, and MINIMUM. Instead of the multiplier variable becoming the X-axis as in an ANALYZE cross plot, the CROSS PLOT TWO function creates a Cross Plot in which the parameter variable becomes the X-axis. The Cross Plot X-axis is scaled so that all parameter values from the parent plot may be located on it.

When a CROSS PLOT TWO function is selected the user is asked to enter multiple K values. The K values are locations on the independent variable axis where the particular CROSS PLOT TWO function will be evaluated. If the SLOPES function is selected, the slope of each parameter curve is found for each K value. These slopes constitute the Cross Plot. They are plotted with the parameter value being plotted on the X-axis and the slope being plotted on the Y-axis. The selected K values are displayed as parameters. All four functions are executed in the same manner as described under ANALYZE.

If the MINIMUM function is selected, the K values that the user enters are meaningless. This is because there is only one value (the minimum point) derived from each parameter curve. If multiple K values are entered, the resulting points are plotted at the minimums regardless of their represented K values.

NOTE: A CROSS PLOT TWO plot is stored on disc immediately following its parent plot in a PM group string. This means that once a CROSS PLOT TWO plot has been created, the ANALYZE function cannot be applied to that PM group without first deleting the CROSS PLOT TWO plot. This also means that a CROSS PLOT TWO plot can be brought back up to the screen without having to recreate it as with the ANALYZE function.

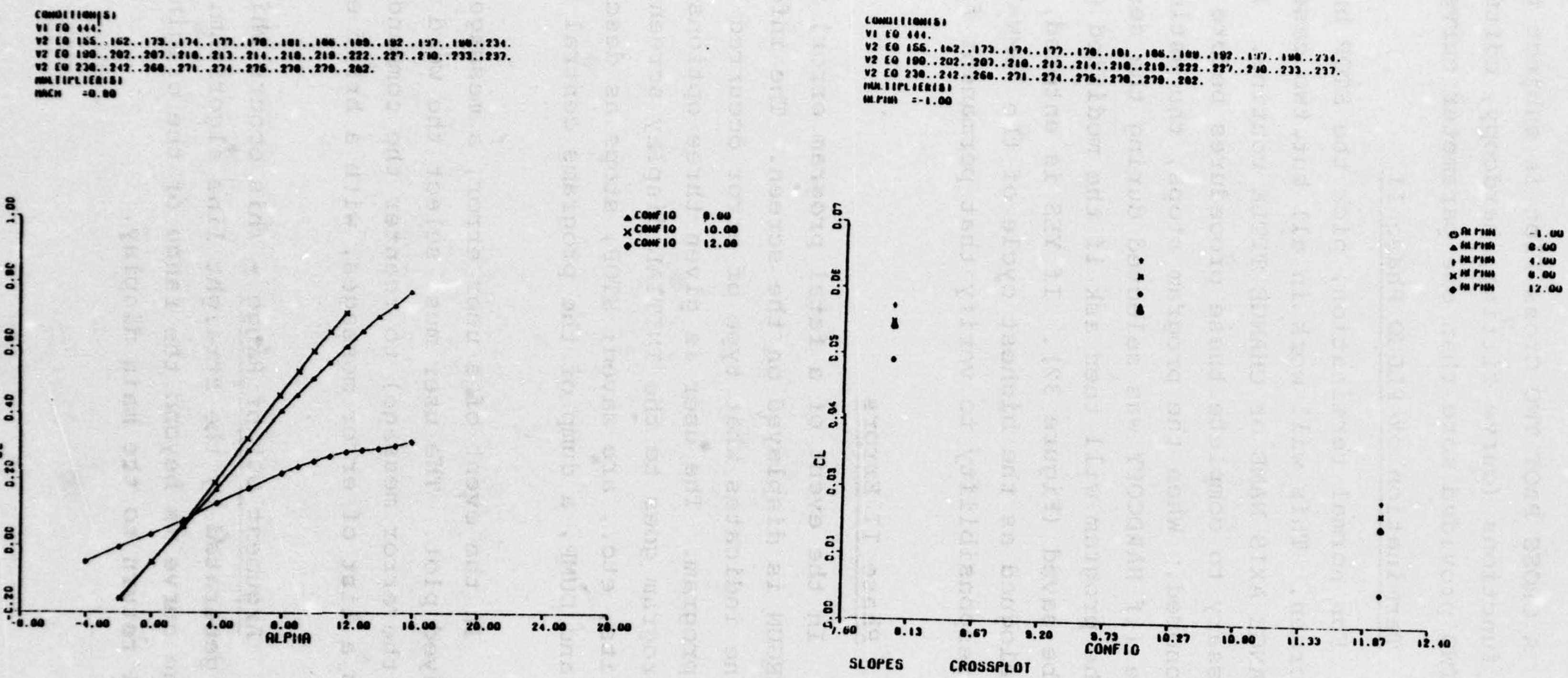


Figure 31. Sample of a CROSS PLOT TWO SLOPE Cross Plot.

A CROSS PLOT TWO Cross Plot is subject to all applicable PLUGO functions (curve fitting, hardcopy, editing, and even CROSS PLOT TWO provided more than one parameter curve exists).

3.2.18 Termination of PLUGO Phase II

For normal termination, pick the STOP button at the top of the screen. This will work in all but two cases - while executing the CHANGE AXIS NAME or CHANGE TITLE routine. In these cases it is necessary to complete these procedures before the STOP button will be honored. When the program stops, the estimated Calcomp plot time (if HARDCOPY was selected during the session) is displayed. The program will then ask if the modified Graphics Disc File is to be saved (Figure 32). If YES is entered, the data file is catalogued as the highest cycle of the "DMN=" file. It is the users responsibility to verify that permanent file space is available.

3.2.19 Phase II Errors

In the event of a fatal program error, the words ERROR RECOVERY BEGUN is displayed on the screen. The information on the second line indicates what type of error occurred and the location in the program. The user is given three options to choose from: GO, the program goes to the INITIAL display screen, all editing, curve fits, etc., are saved; STOP, stops as described in Section 3.2.18; and DUMP, a dump of the programs central memory is printed.

In the event of a user error, a message is blinked above the displayed plot. The user must select the word EXECUTE (displayed with the error message) to reenter the command in error. The following is a list of error messages, with a brief explanation of their cause.

<u>Argument Out of Range</u> - This occurs while cross-plotting curves generated by the straight line algorithm. The coordinate on the curve is beyond the range of the original data. The program will return to the main display.

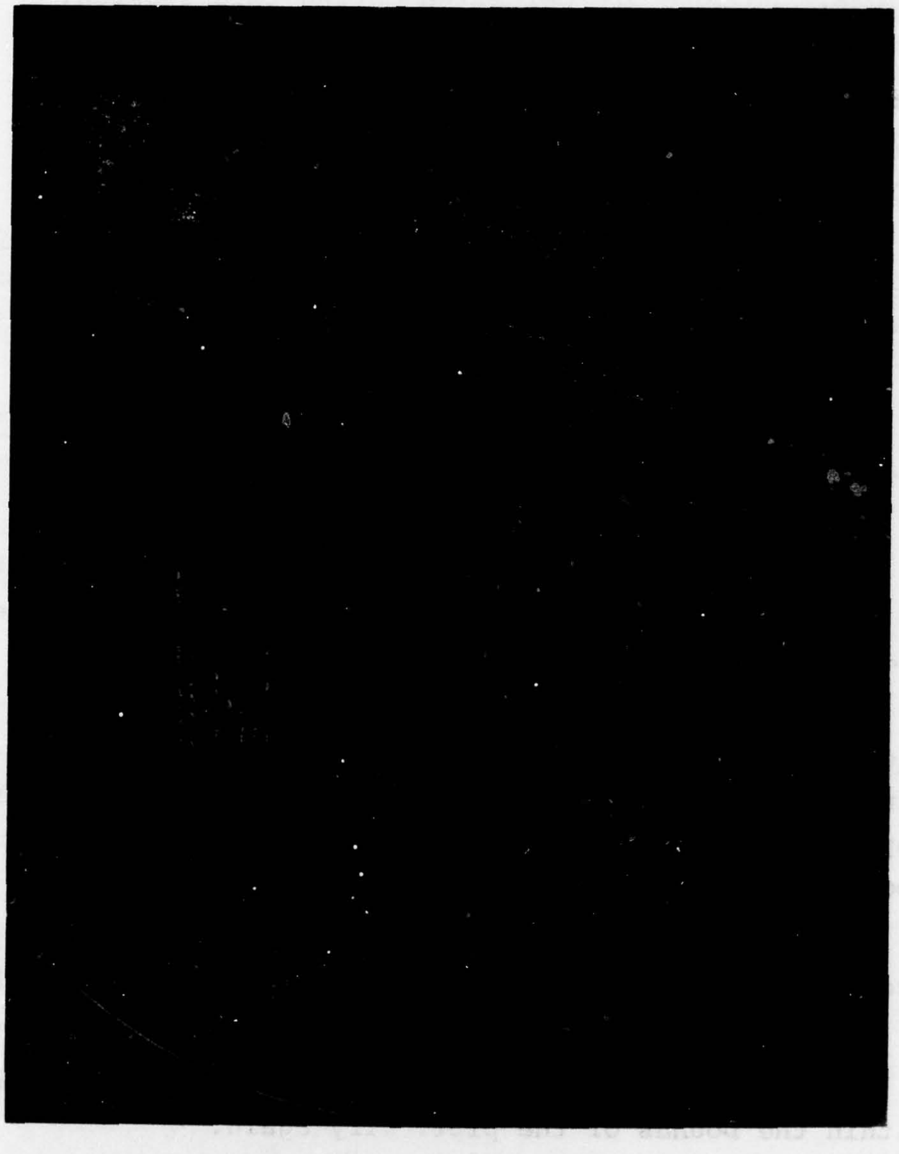


Figure 32. The TERMINATION screen is displayed after selecting STOP from any other display.

At Least Two Parameter Values Required For Delta Crossplotting - This occurs while crossplotting using the delta crossplot mode. There must be at least two parameter values to create a DELTA Cross Plot.

Calcomp File Full - The user has saved 100 Calcomp plots. No more are permitted during this session.

Curve Fits Required For Cross Plot - All point sets in the plot stream must have active curve-fits before selecting ANALYZE or CROSS PLOT TWO. The program returns to the main display.

Error In Least Squares--Possible Bad Independent Variable - Error flag has been set in the least squares curve fit routine, caused by either bad data or the wrong independent variable.

Independent Variable Error With Curve Fit - Same error as above with straight line (Aitken) fit. Program will simply return with no fits for the bad sets.

First Pick Plot Variable, Then Accept - When making X- and Y- axis selections for TRIM PLOTS, select the variable names before the word ACCEPT.

No More Than Twelve Points Can Be Displayed For Deletion At One Time - When deleting points from a point set, the coordinates of points falling within the requested diameter are displayed to the left of the plot. There is only room for twelve. More points than that were found.

No Single Pick, Follow Instructions - This message comes from the Analyze or CROSS PLOT TWO section of the program. The user did not select the Cross Plot type. Try again.

Point Out Of Range - The last point added was not within the bounds of the plot. Try again.

Points Limit Exceeded. The First 248 Points Will Be Displayed - The displayed plot contains more than 248 (the maximum number permitted) data points. Additional points are not displayed.

Repick Values - The program did not receive the proper number of selections. Try again.

Single Plot In Group - The user is attempting to ANALYZE a PM group that has only one plot in it. The program will return to the MAIN display.

The Degree You Submitted Is Out Of Range - For least squares curve fit, a degree between one and six inclusively, must be entered. Try again.

The Plot Specs Exceed The Allocated Space. No Specs Will Be Displayed - The total number of lines required to display the Plot Group specifications exceeds the number of lines allocated for their display (17). No Plot Group specifications will be displayed.

The Program Will Not Handle Multiple Y Axes - The program cannot display multiple Y-axis plots. The program will return to the PGSPECS display.

There Are More Than Twenty Curves In The Plot. Twenty Will Be Displayed - The original data includes plots with more than twenty curves. Only the first twenty will be drawn.

There Are No More Plot Groups - There are no more plot groups.

There Are No More Plots In This Group - You have reached the end of the PM group (Figure 24).

There Are No More Sets In This Group - Under the TRIM option, NEXT SET was selected while the last set of TRIM plots [(CM,CL),(ALPHA,CL), and (ALPHA,CD) plots for one MACH number] was being displayed.

There Are No Points Within Tracking Cross Diameter - When deleting points, the diameter chosen from the tracking cross contains no points. Try again.

These Plots Cannot Be Trimmed - The plots in the plot group are unacceptable for *TRIM*. *Either* they are incomplete, in the wrong order (both of these in original data) or the user has deleted a plot or performed CROSS PLOT TWO without deleting the resulting Cross Plot. The program will return to the MAIN display.

The Tracking Cross Was Not On The Plot - The tracking cross was not within the bounds of the plot when DELETE was selected. Try again.

You Did Not Indicate Which Curves to Curve Fit - Before selecting the curve fit algorithm you must select which curve(s) to fit. To do this, one or more of the curve descriptions or the word ALL at the lower right of the screen must be selected. Try again.

You Did Not Input "X" Or "Y" - The independent variable entered was not an X or Y. Try again.

You Did Not Pick A Curve Description Before Picking A Button - While in the EDIT mode, a curve description must be selected before selecting DELETE POINT or ADD POINT. If more than one curve description is selected, the program will use the last one.

You Did Not Pick Any Points To Be Deleted - From the DELETE POINT option, DELETE was selected without first selecting the coordinates of one or more points. Try again.

You Have Not Selected A PM Group To Be Cross Plotted - Before selecting CROSS PLOT from the PGSPECS Display, a card that uniquely describes a PM group must be selected. This is not true of TRIM which considers the entire Plot Group at once.

You Have Reached The Maximum Of 248 Points - There is a maximum of 248 points allowed in each curve. This message occurs while adding new points when this limit is exceeded. No new points are allowed.

3.3 OUTPUT DATA FROM THE PLUGO PHASE II PROGRAM

There are three optional outputs from PLUGO Phase II. They are: (1) a batch job that ultimately creates the Hardcopy Plot Tape; (2) a Permanent Graphics Disc File; and (3) a Plot Specification Listing.

3.3.1 Hardcopy Plot Tape

To get a hardcopy plot it is necessary to specify a hardcopy tape with the HC and TPB options (Section 3.2). With these options specified, PLUGO will copy the displayed plot to a permanent disc file when the HARDCOPY option is picked from the MAIN display. When PLUGO Phase II is terminated, a batch job is released to the Input Queue of the CDC 6600 computer. This batch job copies the permanent disc file, on which the hardcopy plots reside, onto the specified magnetic tape. When the batch job is completed the resulting dayfile is disposed to the terminal specified by the TID parameter that was specified when PLUGO Phase II was initiated. This dayfile signifies that the magnetic tape is ready to be plotted. The time required to plot this tape is <u>only</u> displayed on the Cybergraphics terminal when PLUGO Phase II is terminated.

3.3.2 Graphics Disc File

All plots on the user's input Graphics Disc File plus all modifications made to these plots are stored by PLUGO Phase II on an output Graphics Disc File. Upon termination of PLUGO Phase II, the user is asked if this output file is to be saved. If the user enters YES, the output file will be catalogued as a permanent system file. The file name is the same as the input files. The cycle number is the next available number. It is the user's responsiblity to ensure that permanent file disc space is available for this file. This file may be input to PLUGO Phase II, thus enabling the user to "pick up where he left off."

3.3.3 Listing of Plot Information

Figure 33 is a copy of the listing that is produced when the PRINT PLOT INFORMATION option has been selected. The key to this printed output is as follows:

A - Current plot title.

B - Condition specifications.

C - X and Y axis titles.

D - Parameter - multiplier specifications.

E - Axis information. Line one contains the X minimum, Y minimum, and X and Y increments. Line two has the data X minimum, X maximum, Y minimum, and Y maximum for the plot stream.

F - Listing of data points on curve.

G - 999 indicates this point was added under the ADD POINT edit option.

H - Least squares curve fit output. The listed parameters are polynomial coefficients (6 parameters implies a 5^{th} degree fit).

I - Negative record number indicates that this point is currently inactive (has been deleted).

J - Spline fit output. Parameters are the derivatives at each data point.

K - Aitken (straight line) curve fit output.

3.4 GENERAL COMMENTS ABOUT PLUGO PHASE II

The original Graphics Disc File (created by Phase I) cannot be damaged by the Phase II program. While executing Phase II, the user is actually modifying a copy of the original file. Therefore, the user need not be overly cautious while executing Phase II for fear of destroying his data base.

If a program error occurs while curve fitting, the probable cause is bad data (doubly-defined points while fitting with the spline routine), which the curve fit routine cannot handle. If for some reason the program hangs (gets caught in a loop), the user can abort execution by pressing the INT key, typing in %A, and pressing the SEND key. This terminates the current executing program and returns control of INTERCOM back to the user.

```
                               LISTING OF P-M GROUP      86336

 LISTING OF PLOT       86336
  90432       0        0      0    4480    4608   16832    4544    4736       J   86400       1 MACH               .60000

                      TITLE TEXT            4608
               9      38 ANGLE OF ATTACK  VS.  LIFT COEFFICIENT          (A)
   LISTING OF PLOT GROUP        4430
  8704        0        0  16832    4672       4       0

                     CONDITION TEXT         4672
              16640.  10 V1 EQ 444.
                     CONDITION TEXT        16640
              16704   70 V2 EQ 155.,162.,173.,174.,177.,178.,181.,183.,189.,192.,197.,199.,234.      (B)
                     CONDITION TEXT        16704
              16763   70 V2 EQ 139.,202.,207.,210.,213.,214.,218.,219.,222.,227.,230.,233.,237.
                     CONDITION TEXT        16768
               0      50 V2 EQ 239.,242.,268.,271.,274.,275.,278.,279.,282.
   LISTING OF AXIS        16832
  8320        0    16896  4735 ALPHA        I CL
                      AXIS TEXT            16896      (C)
               0      12 X=ALPHA Y=CL
   LISTING OF P-M         4736
   0          0    16960  17083   36336   17024   17152

                     PARAMETER TEXT        17024
               0      26 CONFIG EQ 7.,8.,9.,10.,12.           (D)
                     MULTIPLIER TEXT       17152
               0      36 MACH EQ .6,.8,.85,.9,1.2,1.3 TOL .01
   LISTING OF AXIS SCALE        4544
   -8.0000000       4.0000000      -.20000000       .20000000
   -6.1400000      15.630000      -.19740000       .82510000         (E)
       LISTING OF CURVE        86400
      113912          0 CONFIG          7.0000000        21   1    16576    12864   200704 X     200960

             REC                X                   Y
             999           -5.4400000         .20000000E-02
            8826           -3.9803000        -.13600000E-01
            8827           -2.0700000        -.43000000E-02
            8828            -.11000000        .17000000E-02
            8829            1.8803000         .94000000E-02
            8830            3.9000000         .17600000E-01        (F)
            8831            5.9500000         .28100000E-01
             999            7.0400000         .57000000E-01
            8832            7.9600000         .33300000E-01
            8833            8.9900000         .44300000E-01
            8834           10.003000          .51200000E-01
            8835           11.003000          .56100000E-01
            8836           11.993000          .63300000E-01
            8837           12.993000          .68400000E-01
            8838           14.003000          .74800000E-01
```

Figure 33. Phase II Output from the PLOT INFO option.

```
        8839          15.000000         .80600000E-01
        8840          16.000000         .87630000E-01
(G)      999          17.420000         .84030000E-01
         999          19.640000         .91030000E-01
         999          21.920000         .13210000
         999          23.720000         .34030000E-01
   LEASTSQUAR FIT          -5.44000     23.72000          .20000      (H)

        6 PARAMETERS ARE
              .56740692E-03   .74066068E-02   .27659064E-03  -.15016340E-03   .12728534E-04
             -.30737204E-06

 LISTING OF CURVE     110912
   131776  86400 CONFIG          8.0000000       14  2  110976  111040  111104 X    201024

      REC                  X                  Y
      9031           -1.9600000         -.14530000
      9032           -.10000000E-01     -.48610000E-01
      9033            2.0000000          .53330000E-01
      9034            4.0100000          .15600000
      9035            6.0000000          .26530000
      9036            8.0200000          .37710000
      9037            9.0000000          .42390000
     -9038           10.000000           .47210000
(I)   9039           10.930000           .51840000
     -9040           12.000000           .56930000
      9041           13.000000           .61500000
     -9042           14.003000           .66400000
      9043           15.000000           .70970000
      9044           16.010000           .75950000
   SPLINE     FIT          -1.96000     16.01000          .20000

       11 PARAMETERS ARE
              .49142761E-01   .50483710E-01   .50486193E-01   .52944654E-01   .55338333E-01
              .54540346E-01   .43674126E-01   .45719037E-01   .47895047E-01   .48167196E-01   (J)
              .50025313E-01

 LISTING OF CURVE     131776
   155840  110912 CONFIG         9.0000000       14  3  131840  131904  131968  0       0 **********

      REC                  X                  Y
      9243           -2.0000000         -.15020000
      9244           -.40000000E-01     -.54000000E-01
      9245            1.9500000          .47230000E-01
      9246            3.9400000          .14920000
      9247            5.9700000          .25030000
      9248            7.9900000          .36730000
      9249            9.0000000          .42150000
      9250           10.000000           .46710000
      9251           11.000000           .52130000
      9252           11.990000           .56330000
      9253           13.000000           .61410000
      9254           14.300000           .66050000
      9255           14.990000           .70730000
      9256           15.990000           .76150000

 LISTING OF CURVE     155840
   176704  131776 CONFIG        10.000000        14  4  200768  200832  200896 X    201088

      REC                  X                  Y
      9432           -1.9200000         -.14310000
      9433            .30000000E-01     -.46210000E-01
```

(Figure 33 - Continued)

```
      9434          2.0400000         .65590000E-01
       999          3.8400000         .11530000
      9435          4.0800000         .13630000
      9436          6.0800000         .31140000
      9437          8.0800000         .44110000
      9438          9.0200000         .49350000
      9439         10.040000          .56330000
      9440         11.020000          .62430000
      9441         12.020000          .65320000
      9442         13.040000          .75710000
       999         15.400000          .79900000
       999         17.920000          .82000000

   AITKEN     FIT        -1.92000       17.92000          .20000
   DEGREE   1

 LISTING OF CURVE      176704
      0  155840 CONFIG          12.000000       15   5  176768   176832   176896  0      0 **********

      REC                X                  Y
      9783         -3.8900000        -.45600000E-01
      9784         -2.0100000        -.73000000E-02
      9785         -.50000000E-01     .23500000E-01
      9786          1.9500000         .67900000E-01
      9787          3.9600000         .11530000
      9788          5.9700000         .16330000
      9789          7.9700000         .20630000
      9790          8.9900000         .22770000
      9791          9.9800000         .24610000
      9792         10.980000          .26310000
      9793         11.980000          .23130000
      9794         12.990000          .29620000
      9795         13.950000          .30720000
      9796         14.930000          .30740000
      9797         15.950000          .31250000

***********        JERRYJ0    //// END  OF LIST ////
```

(K)

(Figure 33 - Continued)

A cross plot generated with the CROSS PLOT TWO function is placed immediately after its parent plot on the disc file. Therefore, an ANALYZE cross plot cannot be generated from that PM group without first deleting the CROSS PLOT TWO Cross Plot.

An ANALYZE cross plot can be generated from a PM plot string. The Multiplier variable becomes the X-axis variable on the ensuing cross plot.

A CROSS PLOT TWO Cross Plot can be generated from any plot having at least two Parameter values. Thus CROSS PLOT TWO cross Plots can be generated from an ANALYZE cross plot. The Parameter variable becomes the X axis variable on a CROSS PLOT TWO Cross Plot.

A maximum of 20 curves (parameter values) may appear on each plot. Also, each plot may contain a maximum of 248 data points.

APPENDIX

THE TRIM FUNCTION

The TRIM function is designed specifically to trim force-moment data generated from wind-tunnel tests of various aircraft configurations. Necessary inputs to the TRIM function are -

CM*	pitching moment coefficient
CL	lift coefficient
ALPHA	angle of attack (degrees)
CD	drag coefficient
DELTAC	the setting of the trimming control surface (horizontal elevator or canard) in degrees.

Values for these variables, processed by the TRIM function, allow the user to create trim plots for combinations of the following variables - CL, DELTAC, ALPHA, and CD.

It is suggested that the user create the PLUGO Input Tape in accordance to Table A-1. This allows the calculated values (Table 4) to be used as input to the TRIM function. The value of B/C (on record 1 of the PLUGO Input Tape) must correspond to the model in that it is this B/C value that is used by the calculated value equations (C1 through C10, Table 4) to transfer the axis system. However, if corrections to the Table A-1 variables have been made before transfer to the other axis systems, it is suggested that these corrected coefficients be specified as variables (Vn) on the PLUGO Input Tape.

The TRIM function can be applied about any reference C.G. (center of gravity) location desired. This is accomplished by specifying a function in the Update Record (Section 2.1.2.2 (b)) that creates a new pitch moment coefficient about the desired C.G. location.

---

*The pitching moment coefficient may be any one of a number of user defined functions that define the pitching moment coefficient relative to any center of gravity.

TABLE A-1

SUGGESTED VARIABLE NAMES FOR AERODYNAMIC FORCE-MOMENT DATA

Default Variable Name	Suggested Name	Units	Suggested Format	Description
V1	TEST	None	F4.0	Test Number
V2	RUN	None	F5.0	Run Number
V3	CONFIG	None	F3.0	Configuration
V4	CONSET	None	F11.0	Control Surface Setting Code
V5	MACH	None	F6.3	Mach Number
V6	Q	Lbs/ft^2	F7.2	Dynamic Pressure
V7	REYN	1/ft	F9.0	Reynolds Number
V8	BETA	Degrees	F6.2	Side Slip Angle
V9	ALPHA	Degrees	F6.2	Angle-of-Attack
V10	CN	None	F7.4	Normal Force Coefficient (Body Axis)
V11	CA	None	F8.5	Axial Force Coefficient (Body Axis)
V12	CSIDE	None	F7.4	Side Force Coefficient (Body Axis)
V13	CM	None	F8.5	Pitching Moment Coefficient (Body Axis)
V14	CROLL	None	F8.5	Rolling Moment Coefficient (Body Axis)
V15	CYAW	None	F8.5	Yawing Moment Coefficient (Body Axis)

PROCEDURE FOR THE USE OF THE TRIM FUNCTION

1. Set up a PLUGO Phase I Input Deck to create a Plot Group containing the following axis cards - (CM, CL), (ALPHA, CL), and (ALPHA, CD). The axis cards must appear in that order. Each axis card must have a PM group specified with it. DELTAC must be specified as the parameter variable, MACH as the multiplier variable. Values for DELTAC must be in degrees.

2. Execute PLUGO Phase I to create a Graphics Disc File containing the above Plot Group.

3. Initiate PLUGO Phase II using the Graphics Disc File created above as the input file.

4. Skip through the various Plot Groups (if more than one have been created) until the Plot Group to be trimmed is displayed on the PGSPECS display.

5. Select the CROSS PLOT option.

6. Display, edit, and curve fit all plots within the Plot Group. When curve fitting the (CM, CL), (ALPHA, CL), and (ALPHA, CD) plot strings, the independent variable designated must be CL, CL, and ALPHA (y-axis, Y-axis, x-axis) respectively.

7. Return to the PGSPECS display.

8. Re-enter the Plot Group under the TRIM option. The menu displayed on the MAIN display (Figure 34) is similar to the menu displayed under the CROSS PLOT option with the following exceptions - picks for NEXT SET and COMPUTE TRIM are present, picks for ANALYZE and CROSS PLOT TWO are not.

9. Pick COMPUTE TRIM.

10. Current values for CL MIN, CL INC, CL MAX, and DEGREE are displayed.* Modify these values as required and then pick ACCEPT. The program will compute the TRIM tables (this may take a few minutes).

*Refer to HOW THE TRIM FUNCTION WORKS for an explanation of these variables.

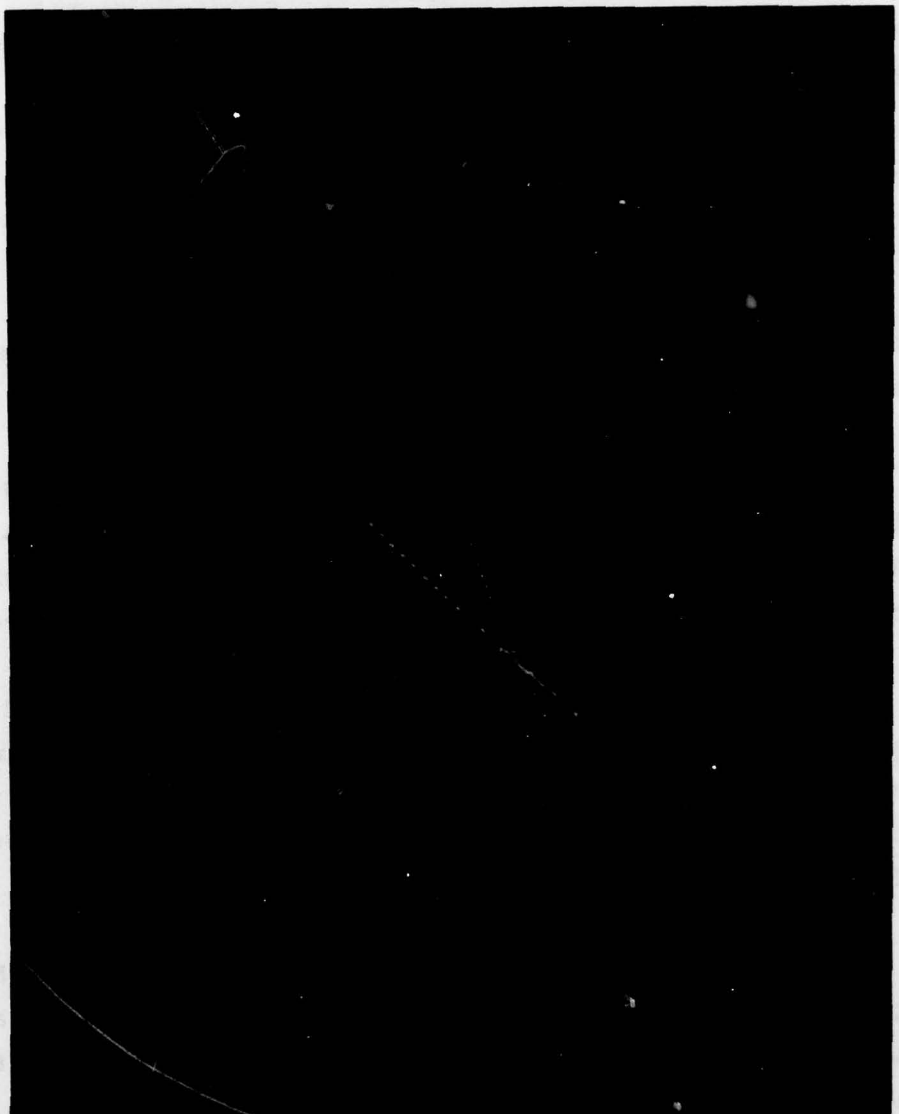


Figure 34. The MAIN display under the TRIM option.

11. After the TRIM tables have been calculated, the program will display CL, DELTAC, ALPHA, and CD. Pick an X variable and a Y variable for the desired TRIM plot. The selected plot will appear on the screen.

The TRIM plot for the next MACH value can be displayed, by selecting NEXT PLOT. Another X- and Y-axis set for a TRIM plot can be selected by picking PLOT TRIM. TRIM plots may be edited, curve fitted, and cross plotted.

HOW THE TRIM FUNCTION WORKS

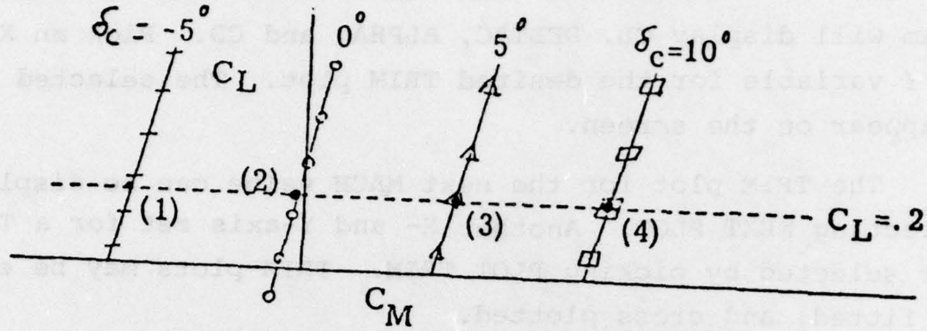
Given: Plots for (CM,CL), (ALPHA, CL), and (ALPHA, CD) with MACH as the multiplier variable and DELTAC as the parameter variable. All curves have been curve fitted in accordance to Step 6 of PROCEDURE FOR THE USE OF THE TRIM FUNCTION. Values for CL MIN, CL MAX, CL INC, and DEGREE have been input.

The program's objective is to create a table of trimmed values:

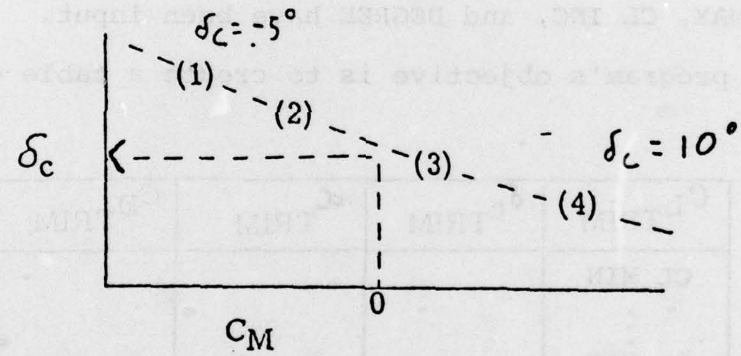
$C_{L_{TRIM}}$	$\delta_{c_{TRIM}}$	α_{TRIM}	$C_{D_{TRIM}}$
CL MIN			
⋮			
CL MAX			

for each MACH number (multiplier value). The CL values start at CL MIN and run through CL MAX by increments of CL INC, similar to a FORTRAN DO LOOP. Each table has room for up to 20 CL values. DEGREE refers to the first or second degree Atkin curve fit applied to the following intermediate plots.

Step 1: The program obtains a CL value from the table - CL(I). CL = .2 will be used as an example. From the (CM, CL) plot, the program calculates CM values for CL = .2 at each DELTAC value (-5°, 0°, 5°, and 10° in this example).

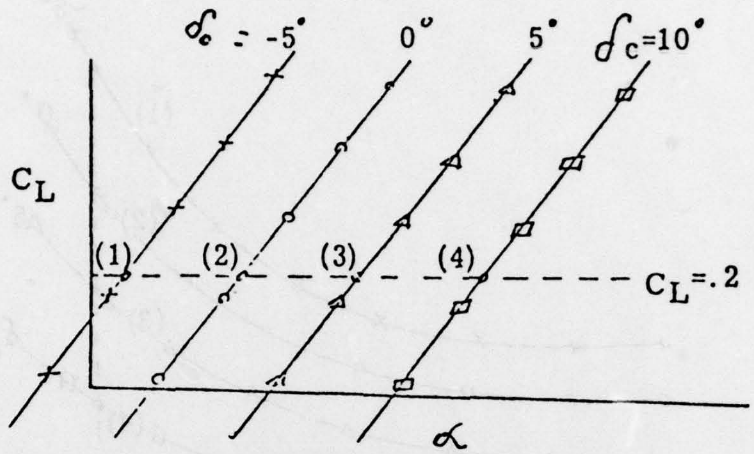


Step 2: The CM values (1, 2, 3, 4) are plotted against DELTAC and curve fitted in accordance to the DEGREE selected. DEGREE = 1.0 is suggested.

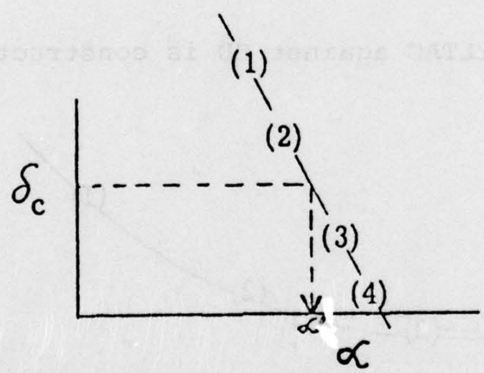


The DELTAC value corresponding to CM = 0 (the trimmed state) is interpolated from this plot. This value, DELTAC(I), is the trimmed DELTAC value that corresponds to CL(I) and is placed in the TRIM table.

Step 3: From the (ALPHA, CL) plot, ALPHA values corresponding to the CL(I) value (CL = .2) for each DELTAC value are calculated.

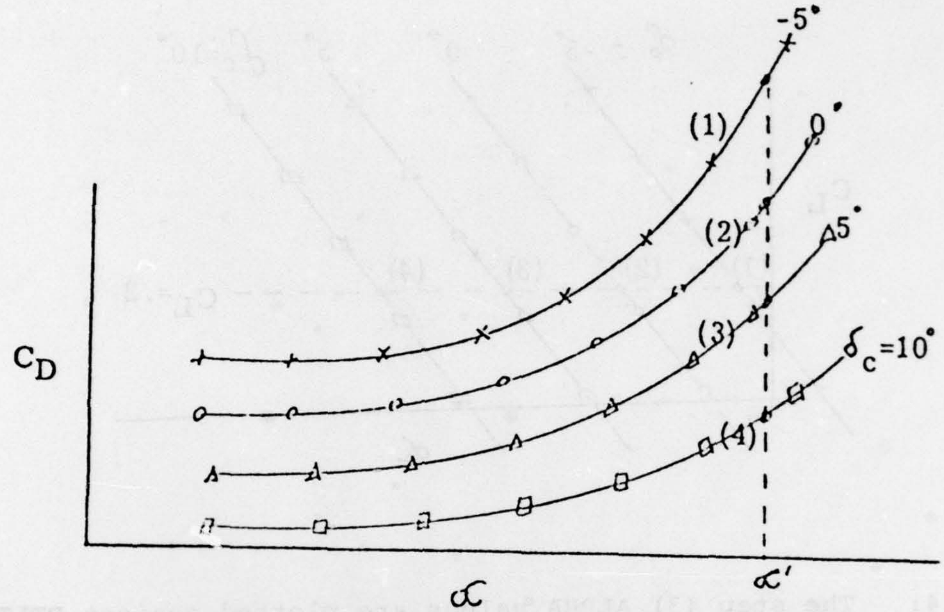


Step 4: The step (3) ALPHA values are plotted against DELTAC.

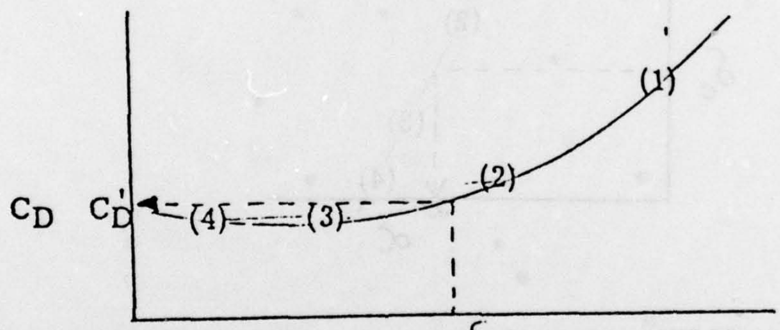


The ALPHA value that corresponds to DELTAC(I) (found in step 2) is interpolated from this plot. This is the trimmed ALPHA(I) value, which is placed in the TRIM table.

Step 5: From the (ALPHA, CD) plot and the trimmed value of ALPHA(I), CD values corresponding to ALPHA(I) are calculated.



Step 6: A Plot of DELTAC against CD is constructed.



Step 7: The program takes the trimmed DELTAC(I) value found in step 2 and interpolates the corresponding CD(I) value. This is the trimmed CD(I) value that is stored in the table.

At this point, trimmed values for CL, DELTAC, ALPHA, and CD have been obtained for one line of the TRIM table.

Steps 1 through 7 are repeated for each CL value, for one multiplier value. The entire process is repeated for each multiplier value.

At this point the items CL, DELTAC, ALPHA, and CD are displayed on the screen, indicating that the TRIM calculations are completed.

NOTE: If the trimmed values fall outside the DELTAC range (-5° --> 10° in the example) the program will extrapolate linearly outside the range. When COMPUTE TRIM is picked, the trim table is calculated for all MACH values.

REFERENCES

1. CDC NOS/BE 1 REFERENCE MANUAL, CDC Publication Number 60493800, Revision B, July 1976.

2. FORTRAN EXTENDED VERSION 4 REFERENCE MANUAL, CDC Publication Number 60497800, April 1977.

3. 274 INTERACTIVE GRAPHICS REFERENCE MANUAL, CDC Publication Number 60358800.

4. ASD COMPUTER CENTER CDC NOS/BE USER'S GUIDE, ASD Computer Center, Bldg. 676, Wright-Patterson Air Force Base, Dayton, Ohio, Revision E, January 1978.

5. CYBER RECORD MANAGER VERSION 1 USER's GUIDE, CDC Publication Number 60359600, Revision C, February 1975.

6. ASD Computer Center INTERCOM Guide, ASD Computer Center, Bldg. 676, Wright-Patterson Air Force Base, Dayton, Ohio, Revision A, September 1976.

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