COMPUTER PROGRAM FOR PLOTTING
AND FAIRING WIND-TUNNEL DATA

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SUMMARY

This report contains a detailed description of the Langley computer program PLOTWD which plots and fairs experimental wind-tunnel data. The program was written for use primarily on the Langley CDC computer and CALCOMP plotters. The fundamental operating features of the program are that the input data are read and written to a random-access file for use during program execution, that the data for a selected run can be sorted and edited to delete duplicate points, and that the data can be plotted and faired using tension splines, least-squares polynomial, or least-squares cubic-spline curves. The most noteworthy feature of the program is the simplicity of the user-supplied input requirements. Several subroutines are also included that can be used to draw grid lines, zero lines, axis scale values and labels, and legends. A detailed description of the program operational features and each subprogram are presented. The general application of the program is also discussed together with the input and output for two typical plot types. A listing of the program code, user-guide, and output description are presented in appendices. The program has been in use at Langley for several years and has proven to be both easy to use and versatile.
INTRODUCTION

Although the primary function of the existing NASA Langley wind-tunnel complex is the same as that of its earlier predecessor NACA, the capabilities of the existing facilities are far superior to those of its predecessor with regard to the relative speeds obtainable, Reynolds number range, and the types and quality of data that can be taken. The advent of modern strain-gage balances, pressure and acoustic transducers, flow visualization systems, engine simulators, attitude measuring devices, and tunnel control and data acquisition systems have resulted in a tremendous increase in the amount of data generated during a typical test program. The recent "explosion" in mini-computer technology has further enhanced the ability to acquire even more data. Without the availability of both on- and off-line high-speed digital and analog computers, the test engineers' ability to acquire, reduce, and analyze this large volume of data would be totally inadequate.

Following a typical wind-tunnel test program, the test engineer is faced with a large amount of data that must be plotted and faired for analysis and report presentation. During the earlier NACA period, these data were plotted and faired manually which required the services of a rather large supporting staff. This manual operation was slow, very tedious and monotonous, and often very inaccurate. However, since the introduction of high-speed computers with peripheral mechanical and optical plotting devices, manual plotting is no longer necessary or desirable. The Langley computing complex currently consists of some of the advanced CDC computers and CALCOMP plotting devices available. The speed, quality, and accuracy of the plots generated by the CALCOMP devices are generally far superior to those generated manually. The available CALCOMP computer software package is extremely versatile and relatively easy to use.
The purpose of this report is to describe the features and application of a computer program written specifically to plot and fair wind-tunnel generated data. This program has the internal designation "PLOTWD" and was written strictly for use on the Langley CDC computer and CALCOMP plotting systems. The program can, however, be adapted to other computer and plotting systems provided the computer has random-access file capability and the plotters have comparable system software routines. This computer program has been used extensively by personnel in the Langley 4-by-7-Meter and 7-by-10-Foot High-Speed wind tunnels for several years and has proven to be very reliable, flexible, and easy to use. In fact, one of the most noteworthy features of this program is the simplicity of the input requirements.

This report contains a discussion of the overall program capabilities and operational structure. A detailed description is included of each subprogram contained in the program. A listing of the computer code is presented in appendix A. Only the subprograms that were written specifically for this program are listed in the appendix. The external subroutines called that are part of the Langley CALCOMP software package are not listed. A description of the user-supplied input requirements and a description of a sample output are presented in appendixes B and C, respectively.
SYMBOLS

\( a_0, a_1, a_2, \ldots, a_m \) polynomial coefficients
\( c_i, d_i, e_i, f_i \) coefficients of spline equation
\( h_i \) increment in spline independent variable such as \( (x - x_i), (y - y_i), \) or \( (t - t_i) \)
\( M \) order of polynomial
\( N \) number of points
\( P(x) \) polynomial equation
\( S \) sum-of-squares of differences
\( SP \) cubic-spline smoothing parameter
\( W \) weighting factor
\( t \) independent variable
\( x \) \( x \)-axis dependent variable
\( x'' \) \( d^2x/dt^2 \)
\( y \) \( y \)-axis dependent variable
\( y'' \) \( d^2y/dt^2 \)
\( \delta \) spline tension factor
\( \delta \) increment

Subscripts:
\( o \) origin
\( P \) plotting sheet
\( sf \) scale factor
\( wt \) wind-tunnel data
PROGRAM OPERATIONAL FEATURES

The computer program PLOTWD was originally formulated to plot and fair sequentially obtained wind-tunnel data on the large 33-inch CALCOMP plotter paper with either 10 or 20 grid lines per inch. The plots generated could be used either as working figures or, after proper border masking and labeling, as final report figures. The later change in the Langley editorial figure presentation standards due to the enhancement of the CALCOMP software package allows for the acceptance of final report figures that are almost totally generated with computer graphics. As a result, additional subroutines were added to the original program version that can be used to draw grid lines, axis scale values and labels, and a legend containing the run numbers and corresponding plot symbols. These plots can be drawn on the plain white CALCOMP paper and, after additional legend information has been added, are suitable report quality figures.

The data on a figure for a particular run are identified by one of 22 available symbols as illustrated in Table I. Each symbol can be drawn with three basic sizes: (1) small (0.100 in.), (2) medium (0.132 in.), and (3) large (0.168 in.). The data are faired using the standard curve fairing technique which utilizes tension-splines to compute a maximum of 100 enhancement points between each pair of input data points. All enhancement points are plotted as a continuous solid line which intersects but does not pass through the symbol surrounding each input data point. During a typical wind-tunnel test, the engineer will often request that repeat data points be taken to either establish anomalies in performance trends or to provide a routine check value. (Fitting a spline curve through the input data with the repeat points included will almost always produce curves with unrealistic oscillations, especially between original and repeat data points.) To overcome this problem, a subroutine has been included in the plot program which first sorts
the data so that the data points are in monotonic increasing order and then deletes all but one data point in each cluster of duplicate data points. The deleted points are not used as input to the spline curve fit subroutines, but they are plotted as individual data points with the appropriate symbol.

Additional subroutines are available in the plot program that can compute and plot either least-squares polynomial or least-squares cubic-spline curve fits to the input data. These least-squares curve fits are plotted with a continuous dashed line corresponding to the particular symbol as illustrated in Table I. If the user desires, a group of subroutines are available to draw grid lines, axis scale values and labels, and legends. The axis labels that can be drawn consist of a set of nine standard aerodynamic coefficients as illustrated in Table II. A convenient place has been designated in the subroutine that draws labels where the user can add the coding needed to draw other axis labels. The character sets available in the CALCOMP software package are very versatile and the user should be able to draw almost any imaginable label.

The user-supplied input requirements were formulated to be simple and at the same time provide as much flexibility as possible. This flexibility consists of the ability to plot multiple figures on a single sheet, to plot almost any combination of data variables, and to plot almost any combination of runs on a sheet. The input requirements for the basic type of plot without drawn grid lines, axis scale values and labels, and legends are divided into two parts. The first part, designated as the plotting setup information, identifies the plotting sheet boundaries, the symbol size and starting number, curve fairing and editing options, the data array location of the independent test variable, and the combinations of test variables to be plotted with corresponding axis origin locations and scale factors. The second part, designated as the plotting sheet information, is a set of namelists, each
containing a sheet identification number and a list of the runs to be plotted on the sheets.

The wind-tunnel data to be plotted must be written on a file designated as TAPE1 and attached as part of the job execution procedure. The data must be written on TAPE1 with the following unformatted write statement:

```
WRITE(1) IRUN, ITEST, IPT, (DATA(I), I = 1, IMAX)
```

where IRUN is the run number, ITEST is the test number, IPT is the data point number, DATA is an array containing the wind-tunnel data, and IMAX is the maximum number of elements in the DATA array. This input data requirement should be able to accommodate almost any type of wind-tunnel data that is taken sequentially. After reading the setup information during program execution, a subroutine is called that reads the data on TAPE1 and reloads it on the random-access file TAPE2 with an equivalent run number indexing. Thereafter, anytime a particular run is to be plotted, the corresponding data for that run is read from the random-access file and loaded into a plotting array. Retrieving the data in this manner simply means that the file read of the data for a particular run begins immediately at the first data point rather than each time having to read the data file from the beginning to locate the first point. This random-access feature greatly reduces the total computing costs by reducing the execution time and the number of I/O operations.

DESCRIPTION OF COMPUTER PROGRAM

The wind-tunnel data plotting program PLOTWD consists of a main program, 18 subroutines, and 2 function subprograms. A computer listing of the program coding is presented in Appendix A. A description of the input requirements for the program is presented in Appendix B and a description of the output for a sample input case listed in Table III is presented in Appendix C. The primary function and execution sequence for the main program and each subprogram are discussed in this section. A supplemental list and corresponding description of the input variables and internal parameters for each routine is included.
Program PLOT

The function of program PLOT is to control the overall execution of the plotting process. Listed at the beginning of the program are a group of comment statements that describe the program input requirements. A group of dimension and common statements appear next consisting of the arrays containing the run numbers and plotting variables, axis origin locations, and axis scale and label information. Several global program constants are then defined and calls made to subroutines PSEUDO and LEROY to initialize the plot vector file SAVPLT for subsequent post-process plotting on a variety of plotters at Langley. A call is then made to subroutine SETUP which reads the input plotting setup data. This is followed by a call to subroutine DATADK which loads the input wind-tunnel data that is sequentially written on the input file TAPE1 into the random-access working file TAPE2. This subroutine is called only once during the program execution; therefore, if the plotting setup information is changed during the program execution, the test number may not change.

The data array locations of the independent and dependent variables to be plotted are then loaded into the work array NLOC. A check is then made to determine if any parts of the plotting setup have common abscissas or ordinates and, if so, the corresponding internal XPLT and YPLT array elements are set equal to 1.0. These internal arrays are checked during the axis labeling and zero-line drawing execution step to prevent duplication. The next execution step is the read of the input namelist SHEET which contains the sheet number and corresponding run numbers to be plotted. The test, sheet, and run numbers are then drawn at the bottom of the plotting sheet and the sheet frame drawn. Arrowheads are then drawn along the bottom and left-hand edge of the sheet frame to indicate the origins. The corresponding axis scale and label are then drawn adjacent to each arrowhead. Zero lines which run from the
arrowhead to the opposite frame border are then drawn if the parameter LZERO is equal to zero.

Execution then proceeds to plot the desired wind-tunnel data array variables for each run. The first step is an identification of the plotting symbol to use. The 22 symbols available are presented in Table I in the standard order. The number of the symbol to use is the same as the input order of the run number in the SHEET namelist. If the user desires to skip a particular symbol, simply input a run number of zero at the appropriate place in the run number list in the SHEET namelist. If the user desires to set up a symbol order different from the standard order, this can easily be accomplished by redefining the sequential values in the internal array LSYM.

The next step is to read the particular wind-tunnel data corresponding to the variable to be plotted from the random-access file TAPE2 and to load these data into the internal array VAR. The next step is to convert the wind-tunnel data from coefficient form to the equivalent $x_p$ and $y_p$ locations on the plotting sheet using equations

$$x_p = \frac{x_{wt}}{x_{sf}} - x_o$$

$$y_p = \frac{y_{wt}}{y_{sf}} - y_o,$$

and to load the converted values into arrays X and Y, respectively. At the same time, the values for the independent data variable are loaded into array T and a check is made of the $x_p$ and $y_p$ data to determine if any points are outside the sheet frame. If any points fall outside the sheet frame, a message will be printed stating the run and plot number and the number of points outside the frame. The next step is to sort and edit the $x_p$ and $y_p$ data if the user specified a nonzero value for the input parameter IEDIT. The final step is to call subroutine CURPLT which plots and fairs the $x_p$ and
After plotting all of the specified variable combinations for a particular run, the above sequence of steps is repeated for the next run.

After plotting all the specified runs for a particular sheet, the plotter is advanced to the start location for the next sheet, the next SHEET namelist read, and the entire sequence of scaling and plotting steps are repeated. The next execution step in the program is to print a summary of the sort and edit information. The final execution step is to draw a statement indicating that all plotting has been completed and to call subroutine CALPLT to close the plot vector file SAVPLT. The following is a list and description of the parameters used in this program:

**LSYM**
array containing integer values corresponding to the symbol order

**RUN**
array containing run numbers to be plotted

**NPT**
array containing the directory or index information on the random-access file TAPE2 (dimensional size equivalent to number of data points on input wind-tunnel data file TAPE1)

**XTAPE, YTAPE**
arrays containing wind-tunnel data array indices of $x_{wt}$ and $y_{wt}$ variables

**XOFFSET, YOFFSET**
arrays containing origin $x_0$ and $y_0$ locations on plotting sheet, in.

**XSCALE, YSCALE**
arrays containing axis scale factors $x_{sf}$ and $y_{sf}$, change in coefficient per inch

**XLABEL, YLABEL**
arrays containing x- and y-axis labels

**XPLT, YPLT**
arrays containing a value of 1.0 if the particular x- or y-axis is repeated

**X, Y**
arrays containing scale $x_p$ and $y_p$ values, in.

**T**
array containing value of independent variable
VAR  two-dimensional array containing $y_{wt}$ data in one level and $x_{wt}$ data in the next level
NLOC  array containing consecutive DATA array indices of $y_{wt}$ and $x_{wt}$ variables
NO  sheet number
NEWCASE  if = 1, new setup deck follows the current SHEET namelist
           if = 0, new SHEET namelist follows
JREAD  tape number of file containing input setup and namelist data
NRNMAX  maximum number of allowable RUNS per sheet
NPLMAX  maximum number of allowable plots per sheet
NDMAX  maximum number of allowable data points per run
NPMAX  maximum number of total data points on TAPE1
IPRT  if = 0, print sort- and-edit summary data
       if = 1, do not print sort- and-edit summary data
LZERO  if = 0, draw zero lines
       if = 1, do not draw zero lines
NORG  if = 0, draw arrowheads at axis origins
       if = 1, do not draw arrowhead at axis origins
IDISK  if = 0, random-access file TAPE2 has not been loaded
       if = 1, TAPE2 has been loaded
ITEST  test number
SHEETW, SHEETH  plotting sheet width and height, in.
SPACE  space between plotting sheets, in.
ISYM  starting symbol number
ISIZE  symbol size
IOP  data fairing option
TENSION  spline tension factor $\sigma$
**IEDIT**

Data sort-and-edit option

**TOLR**

Editing tolerance of independent variable

**IW**

DATA array index of independent variable

**NPLOT**

Number of desired plots per sheet

**IERR**

If = 1 after call to subroutine SETUP, indicates that last case has been read or error occurred

If = 1 after call to subroutine DATADK indicates that error occurred during either a read or write of TAPE2

**NVAR**

Number of variables read from TAPE2 for each data point

\((2\times NPLOT + 1)\)

**NP**

Number of data points to be plotted for a specified run

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**Subroutine SETUP**

The function of subroutine SETUP is to read and print the plotting setup information as described in Appendix B. A sample of the print formats are presented as page 1 output in Table IV. As various parameters are read from the input file, checks are performed to insure that the parameter is within the program limitations. If the particular parameter cannot be safely redefined within the program limitations, an error message is printed and program execution terminated. All the parameters in the subroutine argument list are defined in the description of program PLOT.

**Subroutine DATADK**

The primary function of subroutine DATADK is to read data from or write data to the random-access file TAPE2. If the ICODE parameter equals 0, the wind-tunnel data on the input file TAPE1 is read and then written on the random-access file using the mass storage write statement WRITMS. Each data point is read from TAPE1 using the following read statement:

```
READ(1) IRUN, ITEST, IPT, (DATA(I), I = 1, IMAX)
```
The information in the data array is then shifted forward three array locations and the values of IRUN, ITEST, and IPOINT loaded into the first three locations. The information in the resultant DATA array is then written on the random-access file TAPE2 and the access location loaded into the array NPT. This access location will be needed during all subsequent reads of this file; therefore, the user should not add any additional coding that would destroy the contents of this array. If the data being written on TAPE2 corresponds to that for the first point of each run, the run number and the array index in the NPT array are written on a local file TAPE12 for use during the later reads of TAPE2. The default value for the parameter IMAX is 300. If the input data tape contains either more or less variables for each data point, the value of IMAX must be redefined and the dimension size of the DATA array redefined to a value equal to IMAX + 3. After transferring the data on TAPE1 to TAPE2, a summary of the run numbers available and the total number of data points transferred is printed as illustrated in Table IV as page 2 output.

If the ICODE parameter equals 1, all the wind-tunnel data points for a specified run number IRUN are read from the random-access file TAPE2 and the specified variables defined by the user-supplied input values for XTAPE, YTAPE, and IW are then loaded into the two-dimensional array VAR. The random-access index location for the first point of the specified run is determined by reading the run and NPT array index information written previously on TAPE12. During the read of each data point on TAPE2, the data are loaded into the array DATA. The subsequent transfer of the information in the DATA array to the VAR array is shifted back three array locations to prevent loading the values for IRUN, ITEST, and IPT into the VAR array. The test number read from TAPE2 is, however, checked against the test number specified by the user in the setup information to ensure that the correct test data were input on TAPE1.
Several types of errors can occur which may cause the program execution to either terminate or proceed to the next specified run number. The types of errors that may occur include (1) there are no data on TAPE1, (2) the total number of input data points exceeds the allowable maximum, (3) the input and specified test numbers are different, (4) the specified run number is not on TAPE2, (5) number of data points for a specified run number exceeds the allowable maximum, (6) the number of data points on TAPE2 for a specified run cannot be determined from the information written on TAPE12, and (7) the specified XTAPE or YTAPE value exceeds the allowable maximum IMAX. If any of these errors occur, an appropriate error message will be printed. Most of the important parameters used in this subroutine are defined in the description of program PLOT. The following additional parameters are used in this subroutine:

- **DATA** array containing $x_{wt}$ and $y_{wt}$ data read from either TAPE1 or TAPE2 (must be dimensioned by IMAX+3)
- **IMAX** maximum number of elements in data array
- **IRUN** specified run number
- **IPT** input data point number
- **ICODE** if = 0, read data on TAPE1 and write to random-access file TAPE2
  
  if = 1, read data on TAPE2 for a specified run and load into the VAR array
- **OPENMS** system subroutine to open and initialize random-access file
- **READMS** system subroutine to read information from random-access file
- **WRITMS** system subroutine to write information on random-access file

**Subroutine EDIT**

The function of subroutine EDIT is to sort and edit a set of $x_p$ and $y_p$ data to be plotted for a specified run. If the user desires to fair
the wind-tunnel data with the tension spline method, the set of data to be faired must be arranged so that the corresponding values for the independent variable, t, are monotonically increasing, single-valued, and reasonably spaced to prevent large oscillations in the faired curve. The first time this subroutine is called with a specified run number, the results of the sort and edit procedure are written on the output file TAPE7 and the run number on output file TAPE11 for future printing during the call to subroutine PR TEDT. Therefore, the first execution step in this subroutine is a check of the information on TAPE11 to determine whether or not summary data have previously been written on TAPE7. If so, the parameter NSTORE is set equal to a value of 1.

The next execution step is to sort the input values of the independent variable, t, so that the final set of values are monotonically increasing. The sorting is accomplished in an iterative manner with the following steps:

1. Load remaining unsorted values of the independent variable and their corresponding indices into temporary arrays TEDT and IEDT, respectively.

2. Determine the minimum TEDT value and its corresponding index and load index value into array ISAVE.

3. Delete the minimum TEDT value from the TEDT array.

4. Repeat steps 1, 2, and 3 until all input values of the independent variable have been processed.

5. Load sorted independent variable values and corresponding yp values into temporary arrays using index information in the ISAVE array.

If the user specified on edit tolerance TOLR that is greater than zero, the sorted data will be edited next to delete all but one data point in each cluster of repeat points. Repeat points are defined as any two adjacent points whose difference in the absolute values of the independent variable
is less than a specified tolerance. The edit procedure consists simply of connecting the two data points adjacent to a particular cluster of repeat points with a straight line and then determining the point in the cluster closest to the line. The closest point will be saved and the remaining points in the cluster will be deleted. These deleted points are, however, plotted immediately on the plotting sheet with the appropriate symbol.

Although this editing procedure is simple, four problems may be encountered which will prevent the sorted data from being properly edited. If any of these particular problems occur, the error flag IERR will be set equal to the problem number, all data points input for the particular run plotted with the appropriate symbol, and control returned to the main program PLOT. Program execution will then proceed to plot and fair the next specified run number. The first error which may occur is that all the values for the sorted independent variable are within the specified tolerance TOLR. This error usually occurs because the user specified a tolerance which is too large. The remaining errors occur due to the presence of several adjacent clusters of repeat points which prevents formation of the straight line between adjacent data points. The second flagged error indicates that all data points except the last are clustered; the third flagged error, that all data points prior to the particular point being edited are clustered; and the fourth flagged error, that all data points except the first are clustered. If any of the latter three flagged errors are printed in the output, the user should carefully examine the data and decide which data points to delete.

Following the editing procedure, a summary of the sort and edit information is written on TAPE7 provided the value of the NSTORE parameter is zero. The last execution step is to reload the independent variable t, x_p, and y_p input arrays with the sorted and edited values. The following additional parameters are used in this subroutine:
KEDT number of run numbers written on TAPE11
TIN array containing input values of independent variable t
TEDT array containing sorted and edited values of independent variable
TSAVE, YSAVE temporary arrays containing values of t and yp
IEDT, ITEMP, temporary arrays containing indices of sorted or edited t values
ISAVE
TMIN minimum value of t
NSTORE if = 0, summary of sort and edit information for particular run is to be written on TAPE7
NSYM plot symbol number for deleted points

Subroutine PR TEDT

The function of subroutine PR TEDT is to read the sort and edit information generated during the calls to subroutine EDIT. This information is read from TAPE7 and consists of the input, sorted, edited, and deleted values of the independent variable t for all of the runs requested during the job execution. A sample of the output is illustrated as page 4 output in Table IV. As previously noted, the sort information is the same regardless of the number of times the particular run is plotted. However, the edit information is only applicable to the first plot of the run. All of the important parameters used in this subroutine are defined in the description of subroutine EDIT.

Subroutine ZEROLN

The function of subroutine ZEROLN is to draw heavy lines on the plot perpendicular to the axis at each XOFFSET and YOFFSET location to indicate origins or zero lines for the variables to be plotted. Each heavy line is generated by simply drawing a straight line perpendicular to the sheet border at the specified origin location and then drawing two additional lines
parallel to the original line and offset to either side of it. The following subroutine arguments and parameters are used:

**XO, YO** starting \( x_p \) and \( y_p \) plot locations of the zero line, in.

**DIST** length of zero line, in.

**LINE** if = 1, zero line parallel to \( x \)-axis
if = 2, zero line parallel to \( y \)-axis

**D** offset distance of additional lines drawn parallel to zero line (width of zero line = \( 2 \times D + \) plotting pen width), in.

Subroutine CURPLT

The function of subroutine CURPLT is to plot and fair a tension spline curve through an input set of \( x_p \) and \( y_p \) values. The subroutine contains a plot option to plot the symbols only (IOP = 0) and a plot option to plot the symbols and draw a faired curve between them (IOP = 1). For both plot options, the symbols are plotted by calls to subroutine PNTPLT which has been attached as part of the CALCOMP software package. If the curve fairing option has been chosen, the input data points \( x_p \) and \( y_p \) are faired with a tension spline that has a tension factor equal to the value of the input parameter TENSION. The coordinates of the faired curve are determined by fitting a tension spline through both the \( x_p \) and \( y_p \) as a function of the independent variable \( t \) and then interpolating the two curves to obtain the resultant \( y_p \) as a function of \( x_p \) faired curve which is then drawn on the plot. If the \( x_p \) is a scaler function of \( t \) (XTAPE value equals IW), the double interpolation process is not necessary. The input value of the parameter IVAR must be equal to 0 if \( x_p \) and \( t \) are equal and equal to 1 if they are not equal. The first execution step is a check to ensure that the independent variable values are monotonically increasing. The next step is a call to subroutine CUBSPL which determines the value of the second derivative \( x_p'' \) and \( y_p'' \) of the tension spline at the input points. The final execution step is to
interpolate a specified number of spline coordinates between each pair of input points and to draw the curve so that it does not cross the borders of the symbol surrounding each data point. This capability represents a unique feature of this program.

The following discussion outlines the procedure used to determine the intersection points of the spline curve with the border of each end point symbol and the number of coordinates to interpolate between the pair of points. The straight line distance between the pair of points is computed first. If the length of the line is less than the nominal width of the symbol, the spline curve cannot be drawn between the pair of symbols and execution advances to the next pair of points. If the length of the line is greater than the nominal width of the symbol, the interpolation increment of the independent variable, \( t \), between the pair of points is determined using the formula

\[
\delta = \frac{t_{i+1} - t_i}{(NH-1) I(t)}
\]

where \( NH = 101 \) and \( I(t) \) is the integer portion of \( (t_{i+1} - t_i) \). Spline coordinates are then computed at consecutive \( \delta \) increments between the pair of points.

The next step is to determine the intersection points between the spline curve and the borders of the symbols drawn at each point. This step is accomplished utilizing an iterative technique that is centered around the capabilities of subroutine SYMBOL which determines the coordinates of the border of a specified symbol as a function of the angular position of a radial line drawn through the symbol center. The iteration cycle begins at a point on the spline curve from the symbol center corresponding to a value of \( t \) equal to an
incremental value, \( H \), based on the symbol size. The coordinates of the spline curve are interpolated using the function subprogram FUNC and then the straight line length and angular location computed from the center of the symbol. The angular value is then input to subroutine SYMBOL which determines the corresponding coordinates on the symbol border. The straight line length from the symbol center to the border is then computed. If the spline straight line length is less than that from the center to the border, the value of \( t \) is incremented by \( H \) and the above steps are repeated. If the spline straight line length is greater than that from the center to the border, the increment \( H \) is halved and added to the previous \( t \) value and the above steps repeated. This procedure is repeated until the difference between the spline and symbol-border straight line lengths is within a tolerance equal to the value of the parameter EPS.

After determining the intersection coordinates of the spline curve and the symbol borders for a pair of points, the final step is to plot the spline curve between the intersection coordinates. The LINE subroutine, which is part of the CALCOMP software package, is used to plot this curve. This subroutine draws a series of connecting straight lines between an input set of coordinates. By plotting a relatively large number of closely spaced coordinates, the smoothness of the curve between each pair of input points is retained. The following additional subroutine arguments and parameters are used in this subroutine:

\[ \text{IVAR} \]
- if = 0, independent variable \( t \) is plotted on x-axis
- if = 1, a dependent variable is plotted on x-axis

\[ \text{IOP} \]
- if = 0, plot symbols only
- if = 1, plot symbols and spline curve
MX, MY

arrays containing second derivative values \( x'' \) and \( y'' \)
of tension spline curve fit

DS1, DS2

arrays containing interpolated \( x_p \) and \( y_p \) spline curve
coordinates between a pair of input points

DUMX, DUMY

arrays containing interpolated \( x_p \) and \( y_p \) spline
coordinates between the borders of the symbols surrounding
a pair of input points

NH

number of interpolated spline coordinates between a pair of
input points

EPS

tolerance used to determine the intersection point between
each symbol border and the spline curve

H

initial increment in \( t \) value

Function ATANF

The purpose of function subprogram ATANF is to compute the angular posi-
tion of a specified coordinate point in degrees with the quadrants defined
from 0 to 360 degrees. This function is used with subroutine CURPLT to deter-
mine the radial angle of a straight line connecting a specified point on the
spline curve and the center of the nearest symbol.

Subroutine SYMBOL

The function of subroutine SYMBOL is to compute the coordinates of the
intersection between the border of a specified symbol and a radial line drawn
from the center of the symbol. This requires that the border of each symbol
presented in Table I be defined as a function of the angular equivalent of
border coordinates with the origin of the axis system at the symbol center.
The shapes of 22 symbols are defined in this subroutine. The first 10 symbols
are the NASA standard open symbols: (1) circle, (2) square, (3) diamond,
(4) triangle, (5) right triangle, (6) quadrant, (7) dog house, (8) fan, (9)
long diamond, and (10) house. The next 10 symbols are the standard centered
(center of symbol indicated by +) symbols corresponding to the standard open symbols. The 21st symbol is a period and the 22nd symbol is a plus sign. The symbol border for the last two symbols is an imaginary circle with a radius 10 percent larger than the symbol height. The shapes of the 10 basic open and centered symbols are made up of various combinations of circles, squares, and triangles. Most of the symbols are symmetric about the local y-axis except the right triangle and the quadrant. The shape of each symbol is determined by computing the straight line or circular arc coordinates of the various segments that make up the symbol. The equations and angular positions of the segments that make up each of the 10 basic symbols are relatively easy to derive and, therefore, are not presented in this report. The following arguments and parameters are used in this subroutine:

**NO** symbol number

**IS** symbol size (1 for small, 2 for medium, and 3 for large)

**X,Y** \( x \) and \( y \) coordinates of intersection of symbol border and radial line drawn from the center of the symbol

**T** angular position of radial line, deg.

**SCALE** relative height of three basic symbol sizes, in.

**Subroutine CUBSPL**

The function of subroutine CUBSPL is to fit a cubic or tension spline through an input set of \( x \) and \( y \) values. The cubic spline represents a special case of the tension spline where the tension is zero. The input \( x \) and \( y \) data are used to compute a matrix of simultaneous equations in the form of

\[
e_i y_i' - d_i y_i + f_i y_{i+1} = c_i
\]  

for \( i = 2, 3, \ldots, N-1 \) where for the cubic spline

\[
e_i = \frac{h_{i-1}}{6}, \quad d_i = \frac{h_{i-1} + h_i}{3}, \quad \text{and} \quad f_i = \frac{h_i}{6}
\]
and for the tension spline

\[ c_i = \frac{1}{\sigma^2} \left[ \frac{1}{h_{i-1}} - \frac{\sigma}{\sinh(\sigma h_{i-1})} \right], \]

\[ d_i = \frac{1}{\sigma^2} \left[ \frac{\sigma \cosh(\sigma h_{i-1})}{\sinh(\sigma h_{i-1})} - \frac{1}{h_{i-1}} + \frac{\sigma \cosh(\sigma h_i)}{\sinh(\sigma h_i)} - \frac{1}{h_i} \right], \quad (6) \]

\[ f_i = \frac{1}{\sigma^2} \left[ \frac{1}{h_i} - \frac{\sigma}{\sinh(\sigma h_i)} \right]. \]

For both cubic and tension spline,

\[ c_i = \left( \frac{y_{i+1} - y_i}{h_i} \right) - \left( \frac{y_i - y_{i-1}}{h_{i-1}} \right), \]

\[ h_i = x_{i+1} - x_i, \quad (7) \]

\[ h_{i-1} = x_i - x_{i-1}. \]

For the tension spline, the tension parameter \( \sigma \) is the average tension per length of the input \( x \) values and determined using the equation

\[ \sigma = \frac{\bar{\sigma} (N-1)}{(x_N - x_1)} \quad (8) \]

where \( \bar{\sigma} \) is the user-supplied value of the input parameter TENSION and \( N \) is the number of input values. A complete derivation and description of cubic and tension splines are presented in reference 1.

The second derivatives are the unknowns in the system of equations generated by equation (4). The matrix of terms is tridiagonal with two less unknowns than equations; therefore, the second derivative at the end points must be specified. In this subroutine, the second derivatives at the end points are computed by fitting a second-order polynomial of the form

\[ y = a_1x^2 + a_2x + a_3 \quad (9) \]

to each end point and its two adjacent input points and then differentiating.
to determine the second derivative which is
\[ y'' = 2a_1 \]  \hspace{1cm} (10)

The resultant tridiagonal matrix can be solved using the Crout reduction
method which is described in detail in reference 2. Using this method, the
solution becomes a simple back substitution
\[ y_N'' = c_N \quad \text{for} \quad i = N \]  \hspace{1cm} (11)

and \[ y_i'' = \bar{c}_i - \bar{f}_i y_{i+1}'' \quad \text{for} \quad i = N-1, N-2, \ldots, 1 \]

where \( \bar{d}_i = d_i - e_i \bar{f}_i-1 \),
\[ \bar{f}_i = f_i / \bar{d}_i \]  \hspace{1cm} (12)

and
\[ \bar{c}_i = \frac{c_i - e_i \bar{c}_{i-1}}{\bar{d}_i} \]

The following is a description of the parameters in the argument list for this
subroutine:

\[ X,Y \hspace{1cm} \text{input arrays containing table of } x \text{- and } y \text{-values} \]
\[ N \hspace{1cm} \text{number of input coordinates} \]
\[ YPP \hspace{1cm} \text{output array containing } y'' \text{-values} \]
\[ TENSION \hspace{1cm} \text{input tension factor } \bar{\sigma} \]
\[ TENS \hspace{1cm} \text{output dimensionalized tension factor } \sigma \]
\[ A \hspace{1cm} \text{internal work array used during back-substitution process} \]

Function FUNC

The function of subprogram FUNC is to compute the \( y \)-value of a spline
curve at a given \( x \)-value in a specified interval \( x_i < x > x_{i+1} \).
The interpolation equation for the cubic spline is

\[ y(x) = y_i'' \left\{ \frac{(x_{i+1} - x)^3}{6h_i} - \frac{(x_{i+1} - x) h_{i+1}}{6} \right\} + \]

\[ y_{i+1}'' \left\{ \frac{(x - x_i)^3}{6h_i} - \frac{(x - x_i) h_i}{6} \right\} + \left[ \frac{y_i(x_{i+1} - x) + y_{i+1}(x - x_i)}{h_i} \right] \] (13)

and for the tension spline is

\[ y(x) = \frac{y_i''}{\sigma^2} \left\{ \frac{\sinh [g(x_{i+1} - x)]}{\sinh (gh_i)} - \frac{(x_{i+1} - x)}{h_i} \right\} + \]

\[ \frac{y_{i+1}''}{\sigma^2} \left\{ \frac{\sinh [g(x - x_i)]}{\sinh (gh_i)} - \frac{(x - x_i)}{h_i} \right\} + \left[ \frac{y_i(x_{i+1} - x) + y_{i+1}(x - x_i)}{h_i} \right] \] (14)

where \( h_i = (x - x_i) \).

Subroutine DASHLN

The function of subroutine DASHLN is to draw a dashed line spline curve through an input set of \( x_p \) and \( y_p \) values. The spline curve fit procedure for this subroutine is very similar to that described for subroutine CURPLT with the major difference being that symbols are not drawn around each symbol with this subroutine. Therefore, the complex procedure to determine the intersection between the spline curve and the symbol border is not included in this subroutine. The dashed lines that can be drawn consist of various combinations of long and short dashes as illustrated in table I.

The subroutine CUBSPL is called initially to determine the \( y''_p \) values of a tension or cubic spline fit of the input data. A specified number of equally spaced points are then interpolated between the input end points and the total length of the curve computed using a simple triangular summation method. The
basic length of the long and short dash combination and the space between combinations are then scaled so that the final plotted dashed line will start and end with a complete long and short dash combination. The scaled dashed line is then drawn using linear interpolation of the spline curve to determine the end points $x_p$ and $y_p$ values for each consecutive long or short dash. The following additional subroutine arguments and parameters are used in this subroutine:

- **NSYM** symbol or dashed line number
- **IOP** if = 0, plot symbols only
  if = 1, plot dashed line only
- **NL** number of long dashes in each combination
- **NS** number of short dashes in each combination
- **XI, YI** arrays containing interpolated $x_p$ and $y_p$ values of spline curve
- **S** array containing interpolated length of spline curve
- **NP** number of interpolated spline curve values
- **SL** length of long dash, in.
- **SS** length of short dash, in.
- **SP** length of space between dashes, in.
- **NLT** total number of long and short dash combinations to be plotted
- **DTN/DT** scaling factor for each dash combination

**Subroutine LINEAR**

The function of subroutine LINEAR is to determine the $x$ and $y$ values at a specified $t$ value using linear (straight line) interpolation. The first execution step is to determine the interval containing the specified $t$ value. The final step is to compute the corresponding $x$ and $y$ values using the following linear interpolation equations:
\[ x = x_{i-1} + \delta (x_i - x_{i-1}) \]
\[ y = y_{i-1} + \delta (y_i - y_{i-1}) \]

where \( \delta = (t - t_{i-1})/(t_i - t_{i-1}) \).

Subroutine LSQPLT

The function of subroutine LSQPLT is to draw a least-squares polynomial or least-squares cubic spline curve through an input set of x and y values. For each set of input data, the input points are plotted with the specified symbol and the least-squares curve plotted with the corresponding dashed line. The curve-fitting procedure used in this subroutine is similar to that used in subroutine CURPLT. A separate least-squares curve is determined for each set of input x and y values as a function of the independent variable t and a y(x) curve then obtained by interpolation. If the user specifies that a least-squares polynomial curve be drawn through the input data, subroutine LSQ is called which determines the coefficients of the specified-order polynomial. If the user specifies that a least-squares cubic-spline curve be drawn, subroutine CSDS is called which determines the coefficients of the third-order piecewise polynomials that constitute the spline curve.

Following the call to the selected least-squares subroutine, the x and y values at each input t value are computed and sum-of-the-squares of the differences between the input and least-squares values are computed. If the user specifies a nonzero value for the parameter IPRINT, a summary of the least-squares curve fit process will be printed as illustrated in table V and VI. The final execution step is a call to subroutine DASHLN which draws the least-squares compute x and y values with the specified dashed line. The following additional arguments and parameters are used in this subroutine:
ILSQ if = 0, fit input data with least-squares polynomial
if = 1, fit input data with least-squares cubic spline

NPOL order of polynomial if ILSQ = 0

DF standard deviation for least-squares cubic spline if ILSQ = 1

COEF two-dimensional array containing coefficients of piecewise third-order polynomials of cubic spline

CX,CY arrays containing coefficients of least-squares polynomial

XNEW,YNEW arrays containing new x and y values after curve fit

WT weighting factor used in least-squares polynomial curve fit

IPRINT if = 0, do not print summary data
if = 1, print summary data

ERRX,ERRY sum-of-squares of the differences between input and least-squares x and y data

Subroutine LSQ

The function of subroutine LSQ is to determine the coefficients of a polynomial that best fits an input set of weighted x and y data. The polynomial is in the form

\[ p(x_i) = a_0 + a_1 x_i + a_2 x_i^2 + \ldots + a_M x_i^M \]  \(\text{(16)}\)

where M is the order of the polynomial. The sum-of-the-squares differences between the weighted input and polynomial fit values are

\[ S = \sum_{i=1}^{N} (P(x_i) - w_i y_i)^2 \]  \(\text{(17)}\)
The least or minimum error is

$$\frac{\Delta S}{\Delta a_j} = 2 \sum_{i=1}^{N} \left[ P(x_i) - w_i y_i \right] x_i = 0$$

(18)

where \( j = 0, 1, 2 \ldots, M \). This reduces to a set of simultaneous equations in the form

$$a_0 \sum x_i^j + a_1 \sum x_i^{j+1} \ldots + a_M \sum x_i^{j+M} = \sum w_i y_i x_i^j$$

(19)

which can be solved for the polynomial coefficients \( a_j \) using a simplified solution technique that takes advantage of the symmetric properties of the matrix of terms generated by the left-hand side of equation (19). The following arguments and parameters are used in this subroutine:

- **X, Y** arrays containing input \( x_i \) and \( y_i \) data
- **W** array containing input weighting factor \( w_i \)
- **NP** number of input points \( N \)
- **N** order of polynomial \( M \)
- **C** array containing values of the coefficients of the least-squares polynomial
- **A** two-dimensional work array

Subroutine CSDS

The function of subroutine CSDS is to fit a least-squares cubic-spline through an input set of \( x \) and \( y \) data. The method used in this subroutine defines a continuous cubic-spline function in the form of the third-order polynomial

$$P(x) = a_0 + a_1 h_i + a_2 h_i^2 + a_3 h_i^3$$

(20)

for \( i = 1, 2, 3, \ldots, N - 1 \) where \( h_i = (x - x_i) \) and \( N \) is the number of input points. The coefficients \( a_0, a_1, a_2, \) and \( a_3 \) are computed in a least-squares manner so that
\[
\sum_{i=1}^{N} \left[ \frac{P(x_i) - y_i}{\delta y_i} \right] \leq SP
\]  \hspace{1cm} (21)

and \[
\int_{x_1}^{x_N} \left[ \frac{a^2P(x)}{dx^2} \right] dx \text{ is a minimum}
\]  \hspace{1cm} (22)

where the smoothing parameter SP is in the interval \(N - \sqrt{2N} \leq SP \leq N + \sqrt{2N}\) and \(\delta y_i\) is specified allowable standard deviation in the error in \(y_i\).

A detailed discussion of the least-squares cubic-spline method is presented in reference 3 and, therefore, will not be included in this report.

This subroutine is also a part of the standard math-library subprogram package available on the Langley CDC computer system and is identified by the same name and argument list. A complete description of the input and output parameters in the argument list are presented at the beginning of the listing of the subroutine in appendix A.

**Subroutine AXISLB**

The primary function of subroutine AXISLB is to draw scale values on the x or y axis. The scale value is drawn in one-inch increments starting at the origin and continuing for a specified length. Each scale value drawn is centered adjacent to the inch mark for the y-axis or centered below the inch mark for the x-axis. The following is a description of the subroutine arguments:

- **IAXIS**
  - if = 1, draw x-axis scale values
  - if = 2, draw y-axis scale values

- **XORG, YORG**
  - \(x_p\) and \(y_p\) values of axis origin, in.

- **ORG**
  - scale value at origin

- **SCALE**
  - increment in scale value per inch
The height of scale values, in.

NDIG number of significant figures to draw on the right side of the decimal point (NDIG = -1 will drop decimal point)

Subroutine COEFSY

The function of subroutine COEFSY is to draw a specified standard aerodynamic label as illustrated in table II. The first seven labels are the standard designations for the lift, drag, pitching-moment, rolling-moment, yawing-moment, and side-force coefficients and lift-drag ratio. The last two labels are the standard designations for the angle of attack and angle of sideslip. The width-height ratio for each label is also listed in table II and is useful to the user when determining the x_p and y_p values needed to position the label. If the user desires to add coding to draw other labels, the additional coding can be inserted following the statement 3 CONTINUE. The following is a description of the subroutine arguments:

XO x_p location of left-hand edge of main character in label, in.

YO y_p location of centerline of main character in label, in.

HT height of main character, in.

ISYM identifying number of label

Subroutine LAM

The function of subroutine LAM is to draw the script "7" character used as the subscript for the rolling-moment coefficient label generated by subroutine COEFSY. This special character is not available as part of the standard character series contained in the CALCOMP plotting subprogram package.

Subroutine GRIDLN

The function of subroutine GRIDLN is to draw a series of horizontal and vertical grid lines within a specified frame size. This process is
accomplished using simple straight line plotting pen movements. The following
is a description of the subroutine arguments:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XO, YO</td>
<td>$x_p$ and $y_p$ values for the lower left-hand corner of the frame, in.</td>
</tr>
<tr>
<td>XL</td>
<td>width of frame, in.</td>
</tr>
<tr>
<td>YH</td>
<td>height of frame, in.</td>
</tr>
<tr>
<td>NDIV</td>
<td>number of grid lines per inch</td>
</tr>
</tbody>
</table>

Subroutine RUNKEY

The function of subroutine RUNKEY is to draw a legend containing a list of run numbers for the data plotted and a corresponding list of symbols. The run numbers are spaced so that a corresponding list of descriptors can be typed on a sheet of gum-back paper using the IBM Executive model typewriter and then cut and attached to the legend adjacent to the list of run numbers. This particular typewriter is widely used at Langley to type figure titles and legends. After drawing the symbols and run numbers the words "Symbol" and "Run" are drawn and underlined above the corresponding lists. The user often desires to scale a series of plots to either a smaller or larger size using the magnification factors available as part of the postprocessor PLOT control card. Using these magnification factors would also cause a corresponding change in the legend which would prohibit the use of the IBM Executive Model typewriter to type the list of descriptors. To overcome this problem, a magnification factor, XM, has been included in this subroutine that adjusts the letter and number heights and spacings to compensate for the postprocessor scaling. The following subroutine arguments and parameters are used in this subroutine:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XO, YO</td>
<td>The $x_p$ and $y_p$ values of the lower left-hand corner of the legend, in.</td>
</tr>
</tbody>
</table>
RUN array containing input run numbers
LSYM array containing input symbol order
ISIZE symbol size
HT letter and number character height, in.
NRNMAX maximum allowable number of runs per sheet
XM magnification factor for character and spacings

APPLICATION OF COMPUTER PROGRAM

The basic program variables have been dimensioned for a maximum of 10 runs per sheet, 10 plots per sheet, 50 data points per run, 5000 data points per test, and 300 wind-tunnel test parameters per data point. The following procedure outlines the changes necessary to either increase or decrease these basic program variables:

(1) To change the maximum number of allowable runs per sheet, change the dimension of the variable RUN and the value of the parameter NRMAX in the program PLOT.

(2) To change the maximum number of plots per sheet, change the dimension of the variables XPLT, YPLT, YTAPE, YOFFSET, YSCALE, YLABEL, XTAPE, XOFFSET, XSCALE, XLABEL, VAR, and NLOC and the value of the parameter NPLMAX in program PLOT.

(3) To change the maximum number of points per run, change the dimension of the variables VAR, ARRAY1, ARRAY2 and the value of the parameter NDMAX in program PLOT; change the dimension of the variables TIN, TEDT, TSAVE, YSAVE, IEDT, ITEMP, and ISAVE in subroutine EDIT; change the dimension of the variables TIN, ISAVE, TSAVE, IEDT, TEDT, IUN, and TUN in subroutine PRTEDT; change the dimension of the variables MX, MY, and A in subroutines CURPLT and DASHLN; and change the dimension of the variables XNEW, YNEW, COEF, and SDV and the value of the parameter NMAX in subroutine LSQPLT.
(4) To change the maximum number of allowable data points per test, change the dimension of the variable NPT and the value of the parameter NPMAX in program PLOT.

(5) To change the maximum number of allowable wind-tunnel test parameters per data point, change the dimension of the variable DATA and the value of the parameter IMAX in subroutine DATADK.

The best way to demonstrate the application of the program is to present and discuss the output for several sample cases. Two sample cases will be presented (1) a single plot with three variables per sheet and (2) four plots with a single variable per sheet. The input data for these two cases are presented in table III. Both cases contain one sheet namelist with identical sheet and run numbers. The tabulated output for the first case is presented in table IV and the plotted output, in figure 1. If the user desires to plot dashed lines instead of symbols with connecting solid lines, the call to subroutine CURPLT in program PLOT can be replaced with a call to subroutine DASHLN which will produce the plot presented in figure 2. In a like manner, if the user desires to least-squares curve fit the input data, the call to CURPLT can be replaced with a call to subroutine LSQPLT which will produce the plot presented in figure 3(a) for the least-squares polynomial option and in figure 3(b) for the least-squares cubic-spline option. The programming changes required to obtain these optional plots are very simple and require very little programming knowledge.

Some programming knowledge is required if the user desires to generate a report quality plot on blank (no grid) paper by drawing the appropriate grid lines, axis scale values and labels, and the legends. The input requirements for the subroutines that generate the various parts of the plot are relatively simple and, after a short period of time, the average user should become very proficient in their use. The computer code required to generate report
quality plots for the two sample cases presented in table III are presented in table VII and VIII, respectively, and the corresponding plots in figures 4 and 5. Each set of code was inserted in the PLOT program following card number 233 (see appendix A) and the original code from cards number 237 to 269 deleted. Careful examination of the code for both cases will reveal that the same general procedure was used to generate a particular plot. This procedure is outlined as follows:

1. position plotting pen and draw grid lines (call subroutine GRIDLN)
2. draw all zero lines (call subroutine ZEROLN)
3. draw scale values on x-axis (call subroutine AXISLB)
4. position and draw label for x-axis (call subroutine COEFSY)
5. repeat steps 3 and 4 for y-axis
6. position and draw legend (call subroutine RUNKEY)

The two types of plots presented represent only a small example of the wide variety of the types of plots that can be generated using the PLOT program as the baseline. Most engineers that test in the same facility generally prefer to present the experimental data taken during a typical test program in a well-established standard format. The computer code to generate these standard report quality plots can be written by a programmer with more experience and simply inserted in the PLOT program code by the user with either the EDIT, XEDIT, UPDATE, or MODIFY editing postprocessor commands.

CONCLUDING REMARKS

The wind-tunnel data plotting program PLOTWD described in this report has been used successfully at Langley for several years with very few reported execution problems. The required format for the input data is somewhat restrictive, but the required user input is very simple and the variety of plots generated numerous. With relatively minor code changes, the original version of the program can be changed to handle either larger or smaller
amounts of test data. The program code presented in this report was written especially for use on the Langley CDC computer system. The program can be adapted to other computer systems provided the system selected has a random-access file capability and a similar CALCOMP software package. A copy of the basic source code for this program can be obtained using the following control statements:

GET, PLOTWD/UN = 621288N
UPDATE,F,P = PLOTWD, S = SOURCE, I = 0, L = 0.

REFERENCES


APPENDIX A

COMPUTER LISTING OF WIND-TUNNEL DATA PLOTTING PROGRAM PLOTWD

This appendix contains a computer listing of the wind-tunnel data plotting program PLOTWD which consists of a main program, eighteen subroutines, and two function subprograms.
<table>
<thead>
<tr>
<th>CARD NO.</th>
<th>DESCRIPTION</th>
<th>FORMAT</th>
<th>PT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TEST - TFSNMBR</td>
<td>(F10.0)</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>SHEETW - WIDTH OF PLOTTING SHEET (INCHES)</td>
<td>(3F10.0)</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>ISIZE - SYMBOL SIZE (1 = SMALL 2 = MEDIUM 3 = LARGE)</td>
<td>*</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>IOP - PLOTTING OPTION IOP=0 PLOT DATA ONLY IOP=1 PLOT AND FAIR DATA</td>
<td>(2F10.0)</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>TENSION - SPLINE TENSION FACTOR (FOR IOP=1 ONLY)</td>
<td>*</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>IW - DATA ARRAY LOCATION OF INDEPENDENT VARIABLE</td>
<td>(F10.0)</td>
<td>31</td>
</tr>
<tr>
<td>7</td>
<td>NPLLOT - NUMBER OF PLOTS PER SHEET</td>
<td>(F10.0)</td>
<td>33</td>
</tr>
<tr>
<td>8</td>
<td>YTAPE - ARRAY LOCATION OF Y VARIABLE</td>
<td>(2(3F10.0,A10))</td>
<td>35</td>
</tr>
<tr>
<td>9</td>
<td>XOFFSET - ORIGIN OFFSET OF Y VARIABLE (INCHES)</td>
<td>*</td>
<td>36</td>
</tr>
<tr>
<td>10</td>
<td>YSCALF - SCALE VALUE PER INCH FOR Y VARIABLE</td>
<td>*</td>
<td>37</td>
</tr>
<tr>
<td>11</td>
<td>YLABEL - LABEL FOR Y VARIABLE</td>
<td>*</td>
<td>38</td>
</tr>
<tr>
<td>12</td>
<td>XTAPET - ARRAY LOCATION OF X VARIABLE</td>
<td>*</td>
<td>39</td>
</tr>
<tr>
<td>13</td>
<td>PHRF - ORIGIN OFFSET OF X VARIABLE (INCHES)</td>
<td>*</td>
<td>40</td>
</tr>
</tbody>
</table>
LISTING OF DECK: PLOT

CARD NO.

41  C * XSCALE - SCALE VALUE PER INCH FOR X VARIABLE  * PT 41
    C * XLABEL - LABEL FOR X VARIABLE  * PT 42
    C * NOTE - CARD 8 IS REPEATED NPLT TIMES  * PT 43
    C *
45  C * -- DEFINITION OF SHEET NAMELIST PARAMETERS --  * PT 44
    C *
    C * $SHEET - NAMELIST LABEL  * PT 45
    C * NO - SHEET NUMBER  * PT 46
    C * RUN - RUN NUMBERS TO BE PLOTTED ON SHEET (MAXIMUM OF 10)  * PT 47
    C *
50  C * NEWCASE - IF NFW SETUP DECK FOLLOWS SET NEWCASE=1  * PT 48
    C * $END - END OF NAMELIST  * PT 49
    C *
    C ******************************************

55  C INTEGER RUN
    C DIMENSION ARRAY LSYM WHICH CONTAINS ORDER OF PLOTTING SYMBOLS
    C DIMENSION LSYM(22)

60  C DIMENSION RUN(NRNM) WHERE NRNM IS THE MAXIMUM NUMBER OF
    C ALLOWABLE RUNS PER SHEET
    C DIMENSION RUN(10)

65  C DIMENSION NPT(NPMAX) WHERE NPMAX IS THE MAXIMUM NUMBER OF DATA
    C POINTS FOR TOTAL PLOT
    C NOTE -- DO NOT DESTROY THIS ARRAY DURING PROGRAM EXECUTION
    C DIMENSION NPT(5000)

70  C DIMENSION EACH OF THE FOLLOWING ARRAYS BY NPLT MAX WHICH IS THE
    C MAXIMUM NUMBER OF ALLOWABLE PLOTS PER SHEET
    C DIMENSION XPLT(10), YPLT(10), YTAPE(10), YOFFSET(10), YSCALE(10),
    C YLABFL(10), XTAPE(10), XOFFSET(10), XSCALE(10), XLABEL(10)

75  C DIMENSION EACH OF THE FOLLOWING ARRAYS BY NDMAX WHICH IS THE
    C MAXIMUM NUMBER OF ALLOWABLE POINTS FOR A GIVEN RUN

80  C
LISTING OF DECK: PLOT

CARD NO.

01  DIMENSION X(50), Y(50), T(50)
     C
02  DIMENSION VAR(NMAX,NVAR) AND NLOC(NVAR) WHERE NVAR=2*NPLMAX+1
     C
03  DIMENSION VAR(50,21), NLOC(21)
     C
04  DIMENSION ARRAY1(7*NMAX,GE.500) AND ARRAY2(3*NMAX)
     C
05  COMMON /WORK/ ARRAY1(500)
     C
06  COMMON /PLT/ ARRAY2(150)
     C
07  SHEET NAMELIST PARAMETERS
     C
08  NAMELIST /SHEET/ NO, RUN, NEWCASE
     C
09  DEFINE INPUT TAPE NUMBER
     C
10  DATA JREAD/5/
     C
11  DEFINE ORDER OF PLOTTING SYMBOLS
     C
12  DATA LSYW/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22
     C
13  DEFINE MAXIMUM NUMBER OF ALLOWABLE RUNS PER SHEET
     C
14  DATA NRNMAX/10/
     C
15  DEFINE MAXIMUM NUMBER OF ALLOWABLE PLOTS PER SHEET
     C
16  DATA NPLMAX/10/
     C
17  DEFINE MAXIMUM NUMBER OF ALLOWABLE DATA POINTS FOR A GIVEN RUN
     C
18  DATA NDMAX/50/
     C
19  DEFINE MAXIMUM NUMBER OF ALLOWABLE TOTAL DATA POINTS
     C
20  NPMAX=5000
     C
LISTING OF DECK: PLOT

CARD NO.

121
CDEFINE PROGRAM OPTIONS
122
CIF IPRT=0, PRINT EDITED DATA
123
CIF IPRT=1, DO NOT PRINT EDITED DATA
125
IPRT=0
126
CLZERO=0, DRAW ZERO LINES
127
CLZERO=1, DO NOT DRAW ZERO LINES
128
LZERO=1
129
NORG=0, DRAW ARROWHEAD AT ORIGIN OF PLOTTING VARIABLES
130
NORG=1, DO NOT DRAW ARROWHEAD AT ORIGIN OF PLOTTING VARIABLES
131
NORG=0
132
CSET PROGRAM CONSTANTS
133
CIDISK=0
134
CINITIALIZE PLOTTING DEVICE
135
CQUIRE PSEUDO
136
CALL LEROD
137
CALL PSEUDO
138
CALL MEROD
139
CREAD SETUP DECK
140
CALL SETUP (ITEST, SHEETW, SHEETH, SPACE, ISYM, ISIZE, IOP, TENSION, IEDIT
141
1, TCLR, IPv, YPLODE, YOFFSET, YSCALE, YLABEL, XTAPD, XTOFFSET, XSCALE, X
142
LABEL, IREAD, NPLMAX, IERR)
143
IF (IERR \& NE=0) GO TO 23
144
CREWIND 7
145
REWIND 11
146
KEDT=0
147
CALL DATAK (0, ITEST, IRUN, VAR, NVAR, NLOC, NP, NPT, NMAX, NDMAX, IERR)
148
IF (IFRR \& NE=0) GO TO 23
149
CIDISK=1
150
PRINT 24
151

PAGE 4
LISTING CF DECK: PLOT

CARD NO.

161 C LOAD PLOTTING VARIABLES
   C
   DO 4 I=1,NPLOT
   JZ=2*I
   J1=J2-1
   NLOC(J1)=IFIX(YTAPF(I)+0.0001)
   NLOC(J2)=IFIX(XTAPF(I)+0.0001)
   4 NVAR=2*NPLOT+1
   NLOC(NVAR)=1W

170 C CHECK FOR DUPLICATE PLOTTING VARIABLES
   C
   DO 9 I=1,NPLOT
   YPLT(I)=XPLT(I)=0.
   IF (I.EQ.1) GO TO 9
   J1=I-1
   DO 8 J=1,J1
      5 IF (XTAPF(J)=XTAPE(I)) 6,5,6
      6 IF (XOFFSET(J),EQ,XOFFSET(I),AND,XSCALE(J),EQ,XSCALE(I)) XPLT(I)=1
      1,0
      5 IF (YTAPF(J)=YTAPF(I)) 7,5,6
      6 IF (YOFFSET(J),EQ,YOFFSET(I),AND,YSCALE(J),EQ,YSCALEF(I)) YPLT(I)=1
      1,0
     8 CONTINUE
    9 CONTINUE

180 C READ SHEET NUMBER AND PUNS TO BE PLOTTED
   C
   DO 10 I=1,NRNMAX
   10 RUN(I)=0
   NEWCASE=NO=0
   C
   READ (JREAD,SHEFT)
   C
   IF (EOF(JREAD)) 23,12
   12 CONTINUE
   C
   PRINT 25, NO, RUN
   C
   PERFORM GRID CHK
LISTING OF DECK: PLOT

CARD NO.

201  C
CALL CALPLT (O,,0,,3)
CALL GRIDCK

205  C
POSITION PLOTTING PEN AT LOWER LEFT HAND CORNER OF PLOTTING SHEET

210  C
CALL CALPLT (2,,2,,3)

C
LABEL TEST, SHEET, AND RUN NUMBERS

215  C
SZ=0.15
D=1.9

C
LABEL TEST NUMBER
CALL NOTATE (D,,2,,0,,SZ,,5,,HTEST,,O,,5)
D=30,,SZ/7,,+D
TP=FLOAT(ITEST)
CALL NUMBER (D,,2,,0,,SZ,,TP,,O,,N,,1)
D=36,,SZ/7,,+D

220  C
LABEL SHEET NUMBER
CALL NOTATE (D,,2,,0,,SZ,,7,,SHEET,,O,,7)
D=42,,SZ/7,,+D
TP=FLOAT(NO)
CALL NUMBER (D,,2,,0,,SZ,,TP,,O,,N,,1)
D=36,,SZ/7,,+D

225  C
LABEL RUN NUMBERS
CALL NOTATE (D,,2,,0,,SZ,,6,,RUNS,,O,,6)
D=42,,SZ/7,,+D
DO 13 I=1,3,1,NRMAX
TP=FLOAT(RUN(I))

230  C
CALL NUMBER (D,,2,,0,,SZ,,TP,,O,,N,,1)
D=42,,SZ/7,,+D
IX=IFIX(D)
DMAX=FLOAT(IX)+SPACE+2,,0

235  C
DRAW PLOTTING SHEET FRAME

240  C
CALL CALPLT (O,,0,,3)
CALL CALPLT (SHEET,,0,,2)
CALL CALPLT (SHEET,,SHEET,,2)
CALL CALPLT (O,,SHEET,,2)
LISTING OF DECK: PLOT

CARD NO.

241   CALL CALPLT (0,0,2)

245   DO 15 I=1,NPLOT
       IF (YPLT(I).EQ.1.) GO TO 14
       D=YOFFSET(I)
       IF (NORG.EQ.0) CALL PAREW (-0.3,0,0,0,D,-2,0,3)
       CALL NOTATE (-1.8,0,0.15,YLABEL(I),0,10)
       CALL NUMBER (-1.8,0,0.15,YSCALE(I),0,4)
       D=YOFFSET(I)
       IF (NORG.EQ.0) CALL PAREW (D,0,0.3,D,0,0,-2,0,3)
       D=XOFFSET(I)
       CALL NOTATE (D,-0.6,0.15,XLABEL(I),0,10)
       CALL NUMBER (D,-0.8,0.15,XSCALE(I),0,4)
       CONTINUE

260   DRAW ZERO LINES

265   IF (LZERO.NE.0) GO TO 18
       DO 17 I=1,NPLOT
       IF (YPLT(I).EQ.1.) GO TO 16
       CALL ZEROLN (0,YOFFSET(I),SHEETW,1)
       IF (XPLT(I).EQ.1.) GO TO 17
       CALL ZEROLN (XOFFSET(I),0,SHEETH,2)
       CONTINUE

270   READ DATA FROM DATA DISK AND PLOT

275   DO 21 IR=1,NRMAX
       DEFINE RUN NUMBER
       IRUN=RUN(IR)
       DEFINE PLOTTING SYMBOL
       KSYM=KSYM+1
       IF (KSYM.GT.22) KSYM=SYM

280
LISTING OF DECK: PLOT

CARD NO.

281 IF (KSYM.LT.1) KSYM=1
NSYM=LSYM(KSYM)

C

285 IF (IRUN.EQ.0) GO TO 21
READ DATA FROM DATA DISK
CALL DATADK (ITEST,IRUN,NVAR,NLOC,NP,NPT,NMAX,NMIX,IERR)
IF (IERR.NE.0) GO TO 21
LOAD AND PLOT DATA
DO 20 I=1,NPLOT
J2=2*I
J1=J2-1
IX=NLOC(J2)

C

290 LOAD PLOTTING ARRAYS
N=0
DO 19 J=1,NP
XP=VAR(J,J2)/XSCALE(I)+OFFSET(I)
YP=VAR(J,J1)/YSCALE(I)+OFFSET(I)
TP=VAR(J,NVAR)

C

295 CHECK TO SEE IF DATA IS WITHIN PLOTTING FRAME
IF (XP.LT.0.0.OR.XP.GT.SHEETW) GO TO 19
IF (YP.LT.0.0.n~.yp.GT.SHEETH) GO TO 19
N=N+1
X(N)=XP
Y(N)=YP
T(N)=TP
CONTINUE

C

300 PRINT MESSAGE IF SOME POINTS NOT WITHIN PLOTTING FRAME
JS=NP-N
IF (N.NE.NP) PRINT 26, IRUN, JS, I

C

305 EDIT DATA
IERR=0
IF (IEDIT.NE.0) CALL EDIT (T,X,Y,N,NSYM,ISIZE,IRUN,TOLP,KEDT,IERR)
IF (IERR.NE.0) GO TO 20
PLOT VARIABLES

C

310 JS=0
IF (IX.NE.IW) JS=1
CALL CURPLT (T,X,Y,N,JS,NSYM,ISIZE,JOP,IRUN,TENSION)
DO NEXT VARIABLE
CONTINUE

C

320 DO NEXT RUN
CONTINUE
ADVANCE TO ORIGIN OF NEXT FRAME
D=SHFW+SPACE+2.0
IF (D>LT.DMAX) D=DMAX
CALL NFRAME (D,O.)
READ NEXT SHEET NAMELIST UNLESS NEW SETUP DECK FOLLOWS
IF (NEWCASE.NF.0) GO TO 2?
GO TO 10
PRINT EDITED DATA
IF (EDIT.NE.0.AND.IPRT.EQ.0) CALL PR TED
PRINT 27
GO TO 1
IF (EDIT.NE.0.AND.IPRT.EQ.0) CALL PR TED
FINALIZE PLOTTING DEVICE
CALL NOTATE (2,2,0.5,15HE ND OF PLOTTING,90,15)
CALL NFRAME (4,0.)
CALL CALPT (0.,0.,999)
PRINT CLOSING MESSAGE
PRINT 28
STOP
FORMAT (1H1,3X,124DATA PLOTTED)
FORMAT (/4X,10HSHEET NO =,I5,5X,6HRUNS =,I7,1H,30X,9(I7,1H
1,1,I7))
FORMAT (/4X,9HFOR RUN =,I7,3H , ,I4,55H POINTS WERE NOT WITHIN PLO
ITTING SHEET FRAME FOR PLOT =,I3)
FORMAT (/4X,2HNEW CASE SHOULD FOLLOW)
FORMAT (/4X,2HALL PLOTTING COMPLETED)
END
LISTING OF DECK: SETUP

CARD NO.

1

SUBROUTINE SETUP (ITEST, SHEETW, SHEETH, SPACE, ISYM, ISIZE, IOP, TENSION)

1, IEDIT, TOLR, IW, NPLT, YTAE, YOFFSET, YSCALE, YLABEL, XTAPE, XOFFSET, XSC

ZALE, XLABEL, JREAD, NPLMAX, IERR)

5

C

ROUTINE TO READ PLOTTING SETUP DECK

C

CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AB 1983

C

PARAMETER DEFINITION

ITEST - TEST NUMBER

SHEETW - WIDTH OF PLOTTING SHEET (IN)

SHEETH - HEIGHT OF PLOTTING SHEET (IN)

SPACE - SPACE BETWEEN PLOTTING SHEETS (IN)

ISYM - STARTING SYMBOL NUMBER

IOP - PLOTTING OPTION - IOP=0, PLOT SYMBOLS ONLY

IOP=1, PLOT AND FAIR DATA

TENSION - SPLINE TENSION FACTOR

EDIT - EDIT OPTION - IEDIT=0, DO NOT SORT AND EDIT DATA

EDIT=1, SORT AND EDIT DATA

TOLR - EDIT TOLERANCE OF INDEPENDENT VARIABLE

IW - DATA ARRAY LOCATION OF INDEPENDENT VARIABLE

NPLT - NUMBER OF PLOTS PFR SHEET

YTAE - DATA ARRAY LOCATION OF Y VARIABLE

YOFFSET - ORIGIN OF Y VARIABLE (IN)

YSCALE - VALUE PER INCH FOR Y VARIABLE

YLABEL - LABEL FOR Y VARIABLE

XTAPE - DATA ARRAY LOCATION OF X VARIABLE

XOFFSET - ORIGIN OF X VARIABLE (IN)

XSCALE - VALUE PER INCH FOR X VARIABLE

XLABEL - LABEL FOR X VARIABLE

JREAD - TAPE NUMBER OF INPUT FILE

IERR - ERROR INDICATOR - IERR=0, NO ERRORS OCCURRED

IERR=1, ERRORS OCCURRED

XTAPE, XOFFSET, YSCALE, XLABEL, YTAPE, YOFFSET, YSCALE, AND YLABEL

MUST BE PROPERLY DIMENSIONED IN CALLING PROGRAM

DIMENSION XTAPE(1), XOFFSET(1), YSCALE(1), XLABEL(1), YTAPE(1), Y0

OFFSET(1), YSCALE(1), XLABEL(1)

NMAX

DIMENSION IS(3)
41 DATA IS/6SMALL,SMEDIUM,SLARGE /
45 C INITIALIZE ERROR INDICATOR
C IERP=0
50 C READ AND PRINT TEST NUMBER
C READ (JREAD,6) D1
1 IF (EOF(JREAD)) 4,1
C ITST=IFIX(D1+0.0001)
C PRINT 7, ITST
C C READ AND PRINT SHEETW, SHEETH, AND SPACE
55 C READ (JREAD,6) SHEETW, SHEETH, SPACE
C IF (SHEETW.LT.11.0) SHEETW=11.0
C PRINT 8, SHEETW, SHEETH, SPACE
C C READ AND PRINT ISYM AND ISIZE
60 C READ (JREAD,6) D1, D2
C ISYM=IFIX(D1+0.0001)
C ISIZE=IFIX(D2+0.0001)
C IF (ISYM.LT.1.0 OR ISYM.GT.22) ISYM=1
C IF (ISIZE.LT.1.0 OR ISIZE.GT.3) ISIZE=2
C PRINT 9, ISYM, ISIZE
C C READ AND PRINT IOP AND TENSION
70 C READ (JREAD,6) D1, TENSION
C IOP=IFIX(D1+0.0001)
C IF (IOP.LT.0.0 OR IOP.GT.1.0) IOP=0
C IF (IOP.EQ.0) PRINT 10
C IF (IOP.EQ.1) PRINT 11, TENSION
C C READ AND PRINT IEDIT AND TOLR
75 C READ (JREAD,6) D1, TOLR
C IEDIT=IFIX(D1+0.0001)

ST 41
ST 42
ST 43
ST 44
ST 45
ST 46
ST 47
ST 48
ST 49
ST 50
ST 51
ST 52
ST 53
ST 54
ST 55
ST 56
ST 57
ST 58
ST 59
ST 60
ST 61
ST 62
ST 63
ST 64
ST 65
ST 66
ST 67
ST 68
ST 69
ST 70
ST 71
ST 72
ST 73
ST 74
ST 75
ST 76
ST 77
ST 78
ST 79
ST 80
LISTING OF DECK: SFTUP

CARD NO.

81 IF (EDIT. LT. 0. OR. EDIT .GT. 1) IFEDIT = 0
IF (EDIT. EQ. 1) PRINT 12, TOLR
C
85 C READ AND PRINT IW
C
88 READ (JREAD, 6) DI
IW = IFIX(DI + 0.0001)
PRINT 13, IW
IF (IW .LE. 0) GO TO 4
C
90 C READ AND PRINT NPLST
C
92 READ (JREAD, 6) D1
NPLST = IFIX(D1 + 0.0001)
PRINT 14, NPLST
IF (NPLST .LE. 0. OR. NPLST .GT. NPLMAX) GO TO 3
C
95 C READ AND PRINT YTAPE, YOFFSET, YSCALE, YLABEL, XTAPE, XOFFSET, XSCALE,
AND XLABEL
C
99 DO 2 I = 1, NPLST
READ (JREAD, 15) YTAPE(I), YOFFSET(I), YSCALE(I), YLABEL(I), XTAPE(I), XOFFSET(I),
XSCALE(I), XLABEL(I)
2 CONTINUE
GO TO 5
C
100 PRINT ERROR MESSAGES THAT MAY HAVE OCCURRED
C
103 PRINT 17, NPLST
IERP = 1
GO TO 5
IERP = 1
C
105 C RETURN TO CALLING PROGRAM
C
109 C 5 RETURN
LISTING OF DECK: SETUP

CARD NO.

121  C
6    FORMAT (4F10,4)
7    FORMAT (1H1,3X,30X) PLOTTING SETUP DECK FOR TEST = ,I5)
8    FORMAT (4X,13H SHEET WIDTH = ,F8.2,5X,14H SHEET HEIGHT = ,F8.2,5X,22HS
125   1SPACE BETWEEN SHEETS = ,F8.2)
9    FORMAT (4X,24H STARTING SYMBOL NUMBER = ,I3,5X,15HSYMBOL SIZE IS ,A6
10   1)
11   FORMAT (4X,25H DATA WILL BE PLOTTED ONLY)
12   FORMAT (4X,59H DATA WILL BE FAIRED AND PLOTTED USING SPLINE WITH TF
13   1NSION = ,F6.2)
14   FORMAT (4X,44H DATA WILL BE EDITED WITH AN EDIT TOLERANCE = ,F6.2)
15   FORMAT (4X,39H TAPE LOCATION OF INDEPENDENT VARIABLE = ,I4)
16   FORMAT (4X,27H NUMBER OF PLOTS PER SHEET = ,I4,7X,8H PLOT NO. = ,I5,5HYT
17   1APE,5X,7HYOFFSET,6X,6HSCALE,6X,6H YLABEL,9X,5HTAPE,5X,7H XOFFSET,6
18   2X,6H XSCALE,6X,6H XLARFL)
19   FORMAT (3F10,4,A10,3F10,4,A10)
20   FORMAT (8X,13H Y,2(8X,I4,5X,F7.2,2Y,F12.4,2X,A10))
21   FORMAT (4X,40H ERROR OCCURRED -- IN SETUP DECK N PLOT = ,I4)
22   END
SUBROUTINE DATADK (ICODE, ITESC, IPUN, VAR, NVAR, NLOC, NP, NPT, NMAX, NDM)  
IAX, IERR)  

ROUTINE TO READ FROM OR WRITE TO A DATA DISK  

CODED BY -- HARRY L. MORGAN  
NASA/LARC/TAD/AAB  1983  

PARAMETER DEFINITION  

ICODE - READ OR WRITE OPTION  
ITEST - TEST NUMBER  
  ICODE = 0, WRITE IN DATA DISK  
  ICODE = 1, READ DATA FROM DATA DISK  
IRUN - RUN NUMBER TO BE READ FROM DATA DISK  
VAR(I, J) - TWO DIMENSIONAL ARRAY CONTAINING DATA READ FROM  
DATA DISK, (I = 1, ..., NP AND J = 1, ..., NVAR)  
NVAR - NUMBER OF VARIABLES READ FROM DISK FOR EACH POINT OF  
DATA  
NLOC(J) - ARRAY CONTAINING DATA ARRAY LOCATIONS OF DESIRED  
VARIABLES, (J = 1, ..., NVAR)  
NP - NUMBER OF DATA POINTS READ FROM DISK FOR DESIRED RUN  
NPT - ARRAY CONTAINING COUNT NUMBER OF DATA POINTS STORED ON  
THE DATA DISK  
NMAX - MAXIMUM NUMBER OF DATA POINTS  
NDMAX - MAXIMUM NUMBER OF ALLOWABLE DATA POINTS FOR ANY GIVEN  
RUN  
IERR - ERROR INDICATOR  
  IERR = 0, NO ERRORS OCCURRED  
  IERR = 1, ERROR OCCURRED DURING READ OR WRITE  
  IERR = 2, IRUN NOT ON DATA DISK  
NOTE -- VAR, NLOC, AND NPT MUST BE PROPERLY DIMENSIONED IN THE  
CALLING PROGRAM  

DIMENSION VAR(NMAX), NLOC(1), NPT(1)  

WORK ARRAY  

COMMON /PLT/ NPT(10)  


LISTING OF DECK: DATADK

CARD NO.

41
C DIMENSION DATA(IMAX+3) WHERE IMAX IS THE MAXIMUM NUMBER OF DATA
C VARIABLES STORED ON THE INPUT DATA TAPE
C
45
C COMMON /WORK/ DATA(303)
C
50
C DEFINE ITAPE (INPUT DATA TAPE NUMBER) AND NDISK (DATA DISK
C NUMBER)
C
DATA ITAPE/1/,NDISK/2/
C
55
C DEFINE IMAX
C DATA IMAX/300/
C
C COMPUTE ROUTINE CONSTANTS
C
IERR=0
I3=IMAX+3
REWIND 12
C
C SELECT READ OR WRITE PROCEDURE
C
60
C IF (ICODE) 1,1,16
C
C WRITE DATA ON DATA DISK
C
65
C INITIALIZE NPT
DO 2 I=1,NMAX
2 NPT(I)=0
C
C OPEN DATA DISK
CALL OPENHS (NDISK,NPT,NPHAX,0)
C
70
C COMPUTE NEEDED CONSTANTS
I1=IMAX+1
K=0
IRUNP=0
IC=0
C
75
C REWIND INPUT TAPE
REWIND ITAPE
C
70
C REWIND INPUT TAPE
C
80
CONTINUE
LISTING OF DECK: DATADK

CARD NO.

81 IF (IRUN,GT,9999) GO TO 10
IF (ITESTC,NE,ITEST) GO TO 15

C NOTE -- POINTS OR RUNS CAN BE VOIDED HERE

C LOAD DATA ARRAY
DO 5 I=1,IMAX
J=I-1
J3=J+3
DATA (J3)=DATA(J)
CONTINUE
DATA (1)=FLOAT(IRUN)
DATA (2)=FLOAT(ITESTC)
DATA (3)=FLOAT(IPT)
K=K+1

C CHECK TO SEE IF POINT COUNT EXCEEDS ALLOWABLE MAXIMUM
IF (K-NPMAK) 6,14,14
C WRITE ON TAPE 12 RUN NUMBER AND COUNT NUMBER OF FIRST DATA
C POINT OF RUN
5 WRITE (12) IRUN,K
IRUNP=IRUN
C WRITE DATA ON DATA DISK
9 CALL WRIT(S (NDISK,DATA,J3,K,0,0)
C READ NEXT DATA POINT ON INPUT TAPE
C GO TO 3
3 WRITE ON TAPE 12 RUN NUMBER AND COUNT NUMBER OF LAST DATA
C POINT + 1 OF RUN

10 K=K+1
WRITE (12) IRUNP,K
END FILE 12
C PRINT SUMMARY OF RUNS STORED ON DATA DISK

C PRINT 29, ITESTC
IF (IC.EQ.0) GO TO 13
REWIN(D 12
K=0
LISTING OF DECK: DATADK

CARD NO.

121 DO 12 I=1,1C  
READ (12) IRUN,JS  
K=K+1  
NPRT(K)=IRUN  
125 IF (K-10) 12,11,11  
11 PRINT 30, (NPRT(J),J=1,10)  
K=0  
12 CONTINUE  
IF (K.GT.0.AND.K.LT.10) PRINT 30, (NPRT(J),J=1,K)  
130 READ (12) IRUN,K  
K=K-1  
PRINT 31, K  
REWIND 12  
GO TO 20  
135 C PRINT ERROR THAT MAY HAVE OCCURRED DURING WRITE TO DISK  
C  
13 PRINT 32  
IERR=1  
GO TO 28  
140 GO TO 28  
14 PRINT 33, NPMAX  
IERR=1  
GO TO 28  
145 PRINT 34, ITEST,ITESTC  
IERR=1  
GO TO 28  
C READ DATA FROM DATA DISK  
C  
150 READ TAPE 12 TO FIND POINT COUNT OF FIRST DATA POINT FOR  
C DESIRED RUN  
C  
16 READ (12) J,K  
17 IF (EOF(12)) 23,17  
IF (J-IRUN) 16,18,16  
155 READ TAPE 12 TO FIND POINT COUNT OF FIRST DATA POINT FOR  
C NEXT RUN ON DATA DISK  
C  
18 READ (12) J,JS  
19 IF (EOF(12)) 24,19  
C COMPUTE NUMBER OF DATA POINTS ON DATA DISK FOR DESIRED RUN  
C  
160 NP=JS-K
LISTING OF DECK: DATADK

CARD NO.

161   C   IF (NP GT NDMAX) GO TO 26
      DO 22 I=1,NP
      CALL READMS (NDISK,DATA,I3,K)
      C   CHECK TEST NUMBER
      ITESTC=IFIX(DATA(2)+0.0001)
      IF (ITESTC.NE.ITEST) GO TO 25
      C   STORE DATA NEEDED FOR PLOTTING
      DO 21 J=1,NVAR
      J3=NLOC(J)+3
      IF (J3-I3) LT 20,20,27
      VAR(I,J)=DATA(J3)
      21   CONTINUE
      22   K=K+1
      GO TO 28
      C   PRINT ERROR THAT MAY HAVE OCCURRED DURING READ FROM DATA DISK
      C   PRINT 35, IRUN
      IERR=2
      GO TO 28
      24   PRINT 36, IRUN
      IERR=1
      GO TO 28
      25   PRINT 37, ITEST,IVESTC
      IERR=1
      GO TO 28
      26   PRINT 38, IRUN,NDMAX
      IERR=1
      GO TO 28
      27   PRINT 39, JS,IRUN,IMAX
      IERR=1
      C   RETURN TO CALLING PROGRAM
      195  C   RETURN
      28   FORMAT (1H1,5X,7I1)THE FOLLOWING LIST OF RUNS ARE AVAILABLE ON THE
      1DATA DISK FOR TEST NO. ,I5/)
      200  C   FORMAT (5X,10I10)
CARD NO.

201 31 FORMAT (/5X,29HTOTAL NUMBER OF DATA POINTS = ,17)       DK 201
    FORMAT (/5X,67ERROR OCCURRED DURING WRITE TO DATA DISK --- NO DA DK 202
    1TA ON INPUT TAPE)

205 33 FORMAT (/5X,92ERROR OCCURRED DURING WRITE TO DATA DISK --- POINT DK 204
    1 COUNT HAS EXCEEDED ALLOWABLE MAXIMUM OF ,17)       DK 205

34 FORMAT (/5X,71ERROR OCCURRED DURING WRITE TO DATA DISK --- REQUE DK 206
    1STFD TEST NUMBER IS ,15,344 AND TEST NUMBER ON INPUT TAPE IS ,15)       DK 207

35 FORMAT (/5X,5ERROR OCCURRED DURING READ FROM DATA DISK --- RUN DK 208
    1NUMBER ,17,15H IS NOT ON DISK)                        DK 209

210 36 FORMAT (/5X,91ERROR OCCURRED DURING READ FROM DATA DISK --- SEAR DK 210
    1CH FOR STARTING POINT FOR RUN FOLLOWING ,17,14H WAS NOT FOUND)       DK 211

37 FORMAT (/5X,72ERROR OCCURRED DURING READ FROM DATA DISK --- REQU DK 212
    1TESTED TEST NUMBER IS ,15,35H AND TEST NUMBER ON DISK IS ,15)       DK 213

38 FORMAT (/5X,47ERROR OCCURRED DURING READ FROM DATA DISK --- /5X, DK 214
    125HNUMBER OF POINTS FOR RUN ,17,30H EXCEEDS ALLOWABLE MAXIMUM OF ,214) DK 215

39 FORMAT (/5X,47ERROR OCCURRED DURING READ FROM DATA DISK --- /5X, DK 217
    118HVARIABLE LOCATION ,14,23H REQUESTED FOR RUN NO. ,17,30H EXCEEDS DK 218
    2 ALLOWABLE MAXIMUM OF ,14)                                     DK 219

220 END                                               DK 220-
SUBROUTINE EDIT (T,X,Y,NSYM,ISIZE,IRUN,TOLR,KEDT,IERR)  
ROUTINE TO SORT AND EDIT DATA  
CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AAR 1983

PARAMETER DEFINITION

T - ARRAY CONTAINING INDEPENDENT VARIABLE
X - ARRAY CONTAINING X VARIABLE
Y - ARRAY CONTAINING Y VARIABLE
N - NUMBER OF POINTS TO BE SORTED AND EDITED
NSYM - SYMBOL NUMBER TO BE USED TO PLOT UNEDITED POINTS
ISIZE - SYMBOL SIZE
IRUN - RUN NUMBER
TOLR - EDIT TOLERANCE OF INDEPENDENT VARIABLE
KEDT - NUMBER OF RUNS ALREADY EDITED AND STORED FOR FUTURE PRINT OUT
IERR - EDIT ERROR INDICATOR

IERR=0, NO ERRORS OCCURRED
IERR=1, DURING EDIT OF FIRST SORT POINT ALL GREATER POINTS ARE WITHIN EDIT TOLERANCE
IERR=2, DURING EDIT OF LAST SORT POINT ALL LESSER POINTS ARE WITHIN EDIT TOLERANCE
IERR=3, DURING EDIT OF INTERMEDIATE SORT POINT ALL LESSER POINTS ARE WITHIN EDIT TOLERANCE
IERR=4, DURING EDIT OF INTERMEDIATE SORT POINT ALL GREATER POINTS ARE WITHIN EDIT TOLERANCE

T, X, AND Y MUST BE PROPERLY DIMENSIONED IN CALLING PROGRAM

DIMENSION T(1), X(1), Y(1)
WORK ARRAYS
COMMON /WORK/ TIN(50), TEDIT(50), TSAVE(50), YSAVE(50), IEDIT(50), ITEMP(150), ISAVE(50)

CHECK TO SEE IF THIS RUN HAS ALREADY BEEN EDITED AND STORED FOR FUTURE PRINT OUT
IERR=0
IF (N.LT.1) RETURN
LISTING OF DECK: EDIT

CARD NO.

41  NSTORE=1
    REWIND 11
    IF (KEDT) 3,3,1
    READ (11) NRUN

45    IF (EOF(11)) 3,2
    2    IF (IRUN-NRUN) 1,4,1
    3    KEDT=KEDT+1
    NSTORE=0
    IF (KEDT*GT,1) BACKSPACE 11

50    WRITE (11) IRUN
    END FILE 11

4     IN=N

5     SET INITIAL VALUES OF TIN, TEDT, IEDT, AND ITEMP

55     DO 5 I=1,N
        TIN(I)=T(I)
        TEDT(I)=0.0
        ITEP(I)=1

60     NSORT DATA

65     DO 12 I=1,N
        IF (I.EQ.1) GO TO 7
        K=0
        DO 6 JJ=1,K1
        IF (JJ.EQ.JSAVE) GO TO 6
          K=K+1
        TDDT(K)=T(JJ)
        IEDT(K)=ITEP(JJ)
        CONTINUE
          TMIN=TEDT(1)
    6
        K1=K1-1
        GO TO 8
    7
        TMIN=T(1)
    8
        JSAVE=1
        DO 11 JJ=1,K1
    11    IF (I.EQ.1) TEDT(J)=T(J)
LISTING OF DECK: EDIT  

CARD NO.

81 IF (I.EQ.1) IEDT(J)=ITEMP(J)  
82 IF (TEDIT(J).LE.TMIN) GO TO 9  
83 GO TO 10  
9 JSAVE=J  
85 TMIN=TEDIT(J)  
86 T(J)=TEDIT(J)  
87 ITEMP(J)=IEDIT(J)  
88 CONTINUE  
89 ISAVE(I)=IEDIT(JSAVE)  
90 TSAVE(I)=TMIN  
91 DO 13 I=1, IN  
92 K1=ISAVE(I)  
93 YSAVE(I)=Y(K1)  
94 C  
95 C EDIT DATA  
C  
96 N1=N-1  
97 IF (N1.LT.1.OR.TOLR.LE.0.0) GO TO 31  
98 K1=0  
99 DO 15 I=1,N1  
100 ITEMP(I)=0  
101 DIFF=ABS(TSAVE(I+1)-TSAVE(I))  
102 IF (DIFF.LE.TOLR) GO TO 14  
103 GO TO 15  
104 C  
105 ITEMP(I)=I  
106 K1=1  
107 CONTINUE  
108 IF (K1.EQ.0) GO TO 31  
109 N=1  
110 I=1  
111 K1=I  
112 J=0  
113 IF (I.GT.N1) GO TO 27  
114 IF (ITEMP(I).NE.0) GO TO 17  
115 IEDIT(N)=ISAVE(I)  
116 N=N+1  
117 I=I+1  
118 IEDIT(N)=ISAVE(I)  
119 GO TO 16  
120 I=I+1  

PAGE 3
LISTING OF DECK: EDIT

CARD NO.

121   J=J+1
      IF (I1.EQ.IN) GO TO 21
      IF (ITEMP(I1).EQ.0) GO TO 18
      GO TO 17

125   18   K2=K1+J
      IF (K1.EQ.1) GO TO 19
      I1*K1-1
      I2*K2+1
      GO TO 23

130   19   I1=K2
      I2=I1+1
      I2=I1+1
      IF (I2.GT.IN) IFRT=1
      IF (I2.GT.IN) GO TO 29

135   20   DIFF=ABS(TSAVE(I2)-TSAVE(I1))
      IF (DIFF.LE.TOL) GO TO 20
      GO TO 23

140   21   I2=K1
      I2=I2-1
      I1=I2-1
      IF (I1.LT.1) IERR=2
      IF (I1.LT.1) GO TO 29
      DIFF=ABS(TSAVE(I2)-TSAVE(I1))
      IF (DIFF.LE.TOLP) GO TO 22

145   22   K2=K1+J
      IF (I1.LT.1) IERR=3
      IF (I1.LT.1) GO TO 29
      IF (I2.GT.IN) IERR=4
      IF (I2.GT.IN) GO TO 29

150   23   T(I1)=YSAVE(I1)*TSAVE(I2)-YSAVE(I2)*TSAVE(I1)
      T(I2)=YSAVE(I2)-YSAVE(I1)
      T(I3)=TSAVE(I2)-TSAVE(I1)
      TMIN=ABS(YSAVE(K1)-T(I1)+T(I2)*TSAVE(K1))/T(I3)

155   24   K1=K1+1
      DO 25 K=K1,K2
      DIFF=ABS(YSAVE(K)-T(I1)+T(I2)*TSAVE(K))/T(I3)
      IF (DIFF.LE.TMIN) GO TO 24
      GO TO 25

160   25   TMIN=DIFF
LISTING OF DECK: EDIT

CARD NO.

161 25 IEDT(N)=ISAVE(K)

165
N=N+1
I=I+1
GO TO 16
N=N+1
ISED(N)=ISAVE(IN)

170
DO 28 K=1,N
K1=ISED(K)
TEDT(K)=TIN(K1)
GO TO 33
IF (NSTORE.EQ.0) PRINT 40, IRUN,TDLR,IERR
DO 30 I=1,N
K1=ISAVE(I)
CALL PNTPLT (X(K1),Y(K1),NSYM,ISIZE)
IF (NSTORE.EQ.0) PRINT 41, I,K1,TSAVE(I),X(K1),Y(K1)
CONTINUE
RETURN

31 DO 32 I=1,N
K1=ISAVE(I)
TEDT(I)=TIN(K1)
ISED(I)=K1

32

C WRITE EDITED DATA ON TAPE 7 FOR USE IN SUBROUTINE PRTEDT

C

33 IF (NSTORE.EQ.0) GO TO 34
WRITE (7) IRUN,IN,N,TDLR
WRITE (7) (TIN(I),I=1,N)
WRITE (7) (ISAVE(I),TSAVE(I),I=1,N)
WRITE (7) (ISED(I),TEDT(I),I=1,N)

C REORDER T, X, AND Y FOR PLOTTING

34 DO 35 I=1,N
35 T(I)=TEDT(I)

36 DO 36 I=1,N
TS(K)=X(I)
TEDT(I)=Y(I)
LISTING OF DECK: EDIT

CARD NO.

201 DO 37 I=1,IN
   K=IEDT(I)
   X(I)=TSAVE(K)
   Y(I)=TEDT(K)
   CONTINUE
   END

37   CONTINUE

205 C
   IF (N.EQ.IN) RETURN
   DO 39 I=1,IN
   K1=0
   DO 38 J=1,N
   IF (IEDT(J).EQ.I) K1=1
   CONTINUE
   END

38   CONTINUE

210 C
   IF (K1.EQ.0) CALL PHTPLT (TSAVE(I), TECT(I), NSYM,ISTZE)
   IF ((K1.EQ.0).AND.(NSTORE.FQ.0)) WRITE (7) ISTIN(I)
   CONTINUE
   END

39   CONTINUE

215 C
   RETURN TO CALLING PROGRAM

C

220 C
   RETURN

C

40 FORMAT (/2X,10HATTEMPT TO EDIT RUN,1X,I7,1X,13HFAILED FOR AN EDIT TO 1
       ILENGTH,F8.3,10X,9HERROR NO.,13//4X,1HI,4X,2HIS,6X,1HT,9X,1HX,9X,  
       21HY/)

225 .FORMAT (215,3=F10.4)

41 END
LISTING OF DECK: PRTEDT

SUBROUTINE PRTEDT

ROUTINE TO PRINT EDITED DATA STORED ON TAPE 7

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WORK ARRAYS
COMMON /WORK/ TIN(50),ISAVE(50),TSAVE(50),IEDT(50),TEDIT(50),TUN(50)

END FILE 7
REWIND 7
PRINT 7

READ (7) IRUN,TN,N,TOLR
IF (EOF(7)) 6,2
NR=IN=N
READ (7) (TIN(I),I=1,N)
READ (7) (ISAVE(I),TSAVE(I),I=1,N)
READ (7) (IEDT(I),TEDIT(I),I=1,N)
IF (NR.LE.0) GO TO 4
DO 3 I=1,NR
READ (7) (TUN(I),I=1,NR)
PRINT 8, IRUN,TOLR
DO 5 I=1,IN
IF ((I.LE.N),AND.(I.LE.NR)) PRINT 9, I,TIN(I),ISAVE(I),TSAVE(I),IE
10T(I),TEDIT(I),TUN(I)
IF ((I.LE.N),AND.(I.GT.NR)) PRINT 10, I,TIN(I),ISAVE(I),TSAVE(I),I
10DO(I),TEDIT(I)
IF ((I.GT.N),AND.(I.LE.NR)) PRINT 11, I,TIN(I),ISAVE(I),TSAVE(I),I
10UN(I),TUN(I)
IF ((I.GT.N),AND.(I.GT.NR)) PRINT 12, I,TIN(I),ISAVE(I),TSAVE(I)
CONTINUE
GO TO 1
RETURN

FORMAT (1H1,10X,3SHTE THE FOLLOWING RUNS HAVE BEEN EDITED)
FORMAT (/1X,9HRUN NO. =I7,10X,11HTOLERANCE =F8.3//9X,5HTINPUT,19
1X,6HSTORED,19X,6HEDITED,F20X,7HDELETION//4(1X,9HPOINT NO.,3X,7H-VAL
2UE5X1)/

FORMAT (4(5X,T3,2X,F10.4,5X))
LISTING OF DECK: PR TEDT

CARD NO.

| 41 | 10 | FORMAT (3(5X,13,2Y,10,4,5X)) |
| 11 | FORMAT (2(5X,13,2X,10,4,5X),3DX,13,2X,10,4) |
| 12 | FORMAT (2(5X,13,2Y,10,4,5X)) |

END

PR 41
PR 42
PR 43
PR 44—
LISTING OF DECK: ZEROLN

CARD NO.

1

SUBROUTINE ZEROLN (X0,Y0,DIST.LINE)

C

ROUTINE TO DRAW ZERO LINES

C

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5

PARAMETER DEFINITION

X0,Y0 - STARTING LOCATION OF ZERO LINE

DIST = LENGTH OF ZFPO LINE

LINE = AXIS OPTION

LINE=1, ZERO LINE PARALLEL TO X-AXIS

LINE=2, ZERO LINE PARALLEL TO Y-AXIS

10

NOTE - THICKNESS OF ZERO LINE = 2.*D

15

D=0.014

CALL CALPLT (X0,Y0,3)

IF (LINE.EQ.2) GO TO 1

X=X0+DIST

CALL CALPLT (X,Y0,2)

Y=Y0+D

20

Y=YO-D

CALL CALPLT (X0,Y0,2)

CALL CALPLT (X0,Y0,2)

CALL CALPLT (X0,Y0,2)

GO TO 2

1

Y=YO+DIST

CALL CALPLT (X0,Y0,2)

X=X0+D

30

CALL CALPLT (X0,Y0,3)

X=X0+D

CALL CALPLT (X0,Y0,2)

CALL CALPLT (X0,Y0,2)

CALL CALPLT (X0,Y0,2)

35

CALL CALPLT (X0,Y0,2)

CALL CALPLT (X0,Y0,2)

CALL CALPLT (X0,Y0,2)

2

RETURN

END
LISTING OF DECK: CURPLT

SUBROUTINE CURPLT (T,X,Y,N,ivar,nsym,isize,iop,irun,tension)
ROUTINE TO PLOT AND FAIR DATA
CODED BY — HARRY L. MORGAN NASA/LARC/TAD/AAB 1983

PARAMETER DEFINITION
T — ARRAY CONTAINING INDEPENDENT VARIABLE
X — ARRAY CONTAINING X VARIABLE
Y — ARRAY CONTAINING Y VARIABLE
N — NUMBER OF POINTS TO BE PLOTTED
IVAR — VARIABLE CODE IVAR=0 IF X AND T ARE THE SAME
        IVAR=1 IF X AND T ARE DIFFERENT
NSYM — SYMBOL NUMBER
ISIZE — SYMBOL SIZE
IOP — PLOTTING OPTION IOP=0 PLOT SYMBOLS ONLY
       IOP=1 PLOT CURVE AND SYMBOLS
IRUN — RUN NUMBER
TENSION — SPLINE TENSION
T, X, AND Y MUST BE PROPERLY DIMENSIONED IN CALLING ROUTINE
DIMENSION T(N), X(N), Y(N), W(N)
WORK ARRAYS
COMMON /WORK/ DS1(105),DS2(105),DUMX(105),DUMY(105)
COMMON /PLT/ MX(50),MY(50),A(50)
REAL MX,MY
ROUTINE CONSTANTS
DATA NH/101/,NT/100/,EP/0.0001/,NTA/100/,HF/0.02/,03/,04/
SELECT PLOTTING OPTION
IF (IOP.EQ.0.OR.N.LT.3) GO TO 1
GO TO 3
PLOT SYMBOLS ONLY
DO 2 I=1,N
2 CALL PNTPLT (X(I),Y(I),NSYM,ISIZE)
RETURN
41 C PLOT CURVE AND SYMBOL
42 C
43 C CHECK TO SEE IF X OR T IS STRICTLY INCREASING
44 C
45 3 DO 5 I=2,N
46 IF (IVAR.EQ.1) GO TO 4
47 IF (X(I).LT.X(I-1)) GO TO 6
48 GO TO 5
49 4 IF (T(I).LT.T(I-1)) GO TO 6
50 5 CONTINUE
51 GO TO 7
52 C PRINT ERROR MESSAGE IF X OR T NOT STRICTLY INCREASING
53 IF (IVAR.EQ.0) PRINT 26, IRUN
54 IF (IVAR.EQ.0) PRINT 27, (X(I),Y(I),I=1,N)
55 IF (IVAR.EQ.1) PRINT 28, IRUN
56 IF (IVAR.EQ.1) PRINT 29, (T(I),Y(I),Y(I),I=1,N)
57 C PLOT SYMBOLS ONLY IF X OR T NOT STRICTLY INCREASING
58 GO TO 1
59 C FIT SPLINE CURVE THROUGH DATA POINTS
60 7 IF (IVAR.EQ.0) CALL CUBSPL (X,Y,N,XY,TENSION,TENS,A)
61 IF (IVAR.EQ.1) CALL CUBSPL (T,X,N,MY,TENSION,TENS,A)
62 IF (IVAR.EQ.1) CALL CUBSPL (T,Y,N,MY,TENSION,TENS,A)
63 C PLOT FIRST POINT
64 CALL PNTPL (X(I),Y(I),NSYM,ISIZE)
65 C PLOT AND FAIR REMAINING POINTS
66 NN=N-1
67 DO 25 I=1,NN
68 C COMPUTE STRAIGHT LINE DISTANCE BETWEEN TWO POINTS. IF DISTANCE
69 C LESS THAN SYMBOL DIAMETER, PLOT POINTS ONLY.
70 X1=X(I+1)-X(I)
71 Y1=Y(I+1)-Y(I)
72 DS=SQRT(X1*X1+Y1*Y1)
73 T1=ATANF(Y1,X1)
74 CALL SYMS (NSYM,ISIZE,XS1,YS1,T1)
75 OSS1=SQRT(XS1*X1+YS1*YS1)
76 X1=-X1
77 Y1=-Y1
78 T1=ATANF(Y1,X1)
79 CALL SYMS (NSYM,ISIZE,XS2,YS2,T1)
80 OSS2=SQRT(XS2*XS2+YS2*YS2)
LISTING OF DECK: CURPLT

CARD NO.

81   IF ((DSS1+DSS2) .GE. DS) GO TO 24
     C  COMPUTE DISTANCE ALONG CURVE AS A FUNCTION OF X OR T BETWEEN
     C  POINT I AND I+1
     C  IF (IVAR .EQ. 0) NT = IFIX(XNT * (X(I+1) - X(I))) + 1
     C  IF (IVAR .EQ. 1) NT = IFIX(YNT * (T(I+1) - T(I))) + 1
     C  IF (NT .LT. 3) NT = 3
     C  IF (NT .GT. NH) NT = NH
     C  IF (IVAR .EQ. 0) DELTA = (X(I+1) - X(I)) / FLOAT(NT - 1)
     C  IF (IVAR .EQ. 1) DELTA = (T(I+1) - T(I)) / FLOAT(NT - 1)
     C  DUMX(I) = X(I)
     C  DUMY(I) = Y(I)
     C  DSI(I) = 0.0
     C  IF (IVAR .EQ. 0) DA = X(I)
     C  IF (IVAR .EQ. 1) DA = T(I)

85

90   C  DO 9 J=2,NT
     C  DA = DA + DELTA
     C  IF (IVAR .EQ. 1) GO TO 8
     C  DUMX(J) = DA
     C  DUMY(J) = FUNC(DA, X(I), X(I+1), Y(I), Y(I+1), MX(I), MX(I+1), TENS)
     C  GO TO 9
     B  DUMY(J) = FUNC(DA, T(I), T(I+1), Y(I), Y(I+1), MY(I), MY(I+1), TENS)
     C  DUMX(J) = FUNC(DA, T(I), T(I+1), X(I), X(I+1), MX(I), MX(I+1), TENS)
     Q  DSI(J) = SQRT((DUMX(J) - X(I))**2 + (DUMY(J) - Y(I))**2)

100

105  C  DO 10 J=1,NT
     C  K = NT + J - 1
     C  DS2(J) = SQRT((DUMX(K) - X(I+1))**2 + (DUMY(K) - Y(I+1))**2)
     C  FIND X AND Y LOCATION WHERE SYMBOL AND CURVE INTERSECT
     C  DELTA = H(ISIZE)
     C  IF (IVAR .EQ. 0) DA = X(I)
     C  IF (IVAR .EQ. 1) DA = T(I)

110  C  DO 14 J=2,NTA
     C  DA = DA + DELTA
     C  IF (IVAR .EQ. 1) GO TO 11
     C  IF (DA .GE. X(I+1)) GO TO 15
     C  X1 = DA - X(I)
     C  Y1 = FUNC(DA, X(I), X(I+1), Y(I), Y(I+1), MX(I), MX(I+1), TENS) - Y(I)
     C  GO TO 12

115

120
LISTING OF DECK: CURP mắt

CARD NO.

121  11  IF (DA,GE,T(I+1)) GO TO 15
     Y1=FUNC(DA,T(I),T(I+1),Y(I),Y(I+1),MY(I),MY(I+1),TENS)-Y(I)
     X1=FUNC(DA,T(I),T(I+1),X(I),X(I+1),MX(I),MX(I+1),TENS)-X(I)
     DS=SQRT(X1*X1+Y1*Y1)
     CALL SYMS (NSYM,ISIZE,XS1,YS1,T1)
     DSS1=SQRT(XS1*XS1+YS1*YS1)
     IF (ABS(DS-DSS1)<LE,EPS) GO TO 15
     IF (DS>GT,DSS1) GO TO 13
     GO TO 10

130  13  DA=DA-DELT
     DELTA=DELT/2.
     CONTINUE

135  15  XS1=XS1+X(I)
     YS1=YS1+Y(I)
     DELTA=HEISIZE
     IF (IVAR.EQ.0) DA=X(I+1)
     IF (IVAR.EQ.1) DA=T(I+1)

140  16  DO 19 J=2,NTA
     DA=DA-DELT
     IF (IVAR.EQ.1) GO TO 16
     IF (DA.LE.X(I)) GO TO 20
     X1=DA-X(I+1)
     Y1=FUNC(DA,X(I),X(I+1),Y(I),Y(I+1),MX(I),MX(I+1),TENS)-Y(I+1)
     GO TO 17

145  17  IF (DA.LE.T(I)) GO TO 20
     Y1=FUNC(DA,T(I),T(I+1),Y(I),Y(I+1),MY(I),MY(I+1),TENS)-Y(I+1)
     X1=FUNC(DA,T(I),T(I+1),X(I),X(I+1),MX(I),MX(I+1),TENS)-X(I+1)
     DS=SQRT(X1*X1+Y1*Y1)
     T1=ATANF(Y1*X1)
     CALL SYMS (NSYM,ISIZE,XS2,YS2,T1)
     DSS2=SQRT(XS2*XS2+YS2*YS2)
     IF (ABS(DS-DSS2)<LE,EPS) GO TO 15
     GO TO 19

155  18  DA=DA+DELT
     DELTA=DELT/2.
     CONTINUE

160  19  CONTINUE

69
LISTING OF DECK: CURPLT

CARD NO.

161
C
20 XS2=XS2+X(I+1)
YS2=YS2+Y(I+1)
NP=1
NDS1=0
165
C
DO 21 J=2,NT
IF ((DS1(J)-LT.DSS1),.AND.(NDS1.EQ.0)) GO TO 21
IF ((DS1(J).GE.DSS1),.AND.(NDS1.EQ.0)) NDS1=1
170
NP=NP+1
DUMX(NP)=DUMX(J)
DUMY(NP)=DUMY(J)
CONTINUE
21
C PLOT CURVE BETWEEN POINTS
175.
DUMX(1)=XS1
DUMY(1)=YS1
DO 22 J=1,NT
IF (DS2(J).LE.DSS2) GO TO 22
GO TO 23
180.
NP=NP-1
NP=NP+1
DUMX(NP)=XS2
DUMY(NP)=YS2
DUMX(NP+1)=DUMY(NP+1)=0.0
DUMX(NP+2)=DUMY(NP+2)=1.0
CALL LINE (DUMX,DUMY,NP,1,0,0,0)
C PLOT SYMBOL AT POINT I+1
24 CALL PNTPLT (X(I+1),Y(I+1),NSYM,ISIZF)
C ADVANCE TO NEXT POINT
190.
25 CONTINUE
C
C RETURN TO CALLING PROGRAM
C
C
RETURN
195.
C
26 FORMAT (1H1//5X,36HX IS NOT STRICTLY INCREASING FOR RUN,I7//16X,1HX,13X,1HY/)
1,13X,1HY/
CU 196
1,13X,1HY/
CU 197
27 FORMAT (5X,2F15.4)
CU 198
28 FORMAT (1H1//5X,36HT IS NOT STRICTLY INCREASING FOR RUN,I7//16X,1HT,13X,1HY/)
1,13X,1HY,13X,1HY/
CU 200
LISTING OF DECK: CURPLT

CARD NO.
201    29    FORMAT (5X,3F15.4)
       END

PAGE 6
CU 201
CU 202-
FUNCTION ATANF (DY,DX)
C
C ROUTINE TO COMPUTE ARCTANGENT FOR ANGLES FROM 0 TO 360 DEGREES
C
C CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AA 1983
C
IF (DX.EQ.0.0) GO TO 1
ATANF=ABS(DY/DX)
ATANF=ATAN(ATANF)*57.2957795131
10. IF ((DX.GT.0.0).AND.(DY.LT.0.0)) ATANF=360.-ATANF
   IF ((DX.LT.0.0).AND.(DY.GT.0.0)) ATANF=180.-ATANF
   IF ((DX.LT.0.0).AND.(DY.LT.0.0)) ATANF=180.+ATANF
   RETURN
IF (DY.LT.0.0) ATANF=270.
15. IF (DY.GE.0.0) ATANF=90.
RETURN
END
SUBROUTINE SYMS (NO, IS, X, Y, T)

ROUTINE TO COMPUTE THE X AND Y INTERCEPTS OF A RADIAL LINE DRAWN FROM THE CENTER OF A GIVEN SYMBOL WITH THE SIDE OF THAT SYMBOL

coded by -- HARRY L. MORGAN NASA/LARC/TAD/AA9 1983

PARAMETER DEFINITION

NO - SYMBOL NUMBER

IS - SYMBOL SIZE 1-SMALL 2-MEDIUM 3-LARGE

X AND Y - INTERCEPT OF SYMBOL AND RADIAL DRAWN FROM SYMBOL CENTER

T - ANGLE OF RADIAL DRAWN FROM SYMBOL CENTER

DIMENSION SCALE(3)

DATA RAD/5.2957795131/, PI/3.141592654/

DATA DA/1.4142135624/, R/1.7320508076/, SCALE/13, 16, 19/

DATA T1/213.6900675260/, T2/326.3099324740/, T3/116.5550511771/, T4/3

133.434948229/, T7/11.3099324740/, T8/168.6900675260/, T9/218.6598082

2541/S1/321.3401917459/, S2/185.710593175/, S3/354.2894068625/, S4/1


4459/

IF ((NO.EQ.1).OR.(NO.EQ.11)) GO TO 1

IF ((NO.EQ.2).OR.(NO.EQ.12)) GO TO 2

IF ((NO.EQ.3).OR.(NO.EQ.13)) GO TO 3

IF ((NO.EQ.4).OR.(NO.EQ.14)) GO TO 4

IF ((NO.EQ.5).OR.(NO.EQ.15)) GO TO 5

IF ((NO.EQ.6).OR.(NO.EQ.16)) GO TO 6

IF ((NO.EQ.7).OR.(NO.EQ.17)) GO TO 7

IF ((NO.EQ.8).OR.(NO.EQ.18)) GO TO 8

IF ((NO.EQ.9).OR.(NO.EQ.19)) GO TO 9

IF ((NO.EQ.10).OR.(NO.EQ.20)) GO TO 10

IF ((NO.EQ.21).OR.(NO.EQ.22)) GO TO 11

IF (NO.GT.22) RETURN

SYMBOL NUMBER 1 OR 11

X=SCALE(IS)*.5525*COS(T/RAD)

Y=SCALE(IS)*.5525*SIN(T/RAD)
LISTING OF DECK: SYMS

CARD NO.

41
C
RETURN
SY 41
C
SYMBOL NUMBER 2 OR 12
C
45.
2
IF ((T.GE.0.) AND (T.LT.45.)) GO TO 3
IF ((T.GE.45.0) AND (T.LT.135.)) GO TO 4
IF ((T.GE.135.) AND (T.LT.225.)) GO TO 5
IF ((T.GE.225.) AND (T.LT.315.)) GO TO 6
IF ((T.GE.315.) AND (T.LE.360.)) GO TO 7
SY 42
50
3
X=SCALE(IS)/2.
Y=X*TAN(T/RAD)
RETURN
SY 43
4
Y=SCALE(IS)/2.
IF (T.EQ.90.) X=0.0
RETURN
SY 44
55
5
X=-SCALE(IS)/2.
Y=X*TAN(T/RAD)
RETURN
SY 45
60
6
Y=-SCALE(IS)/2.
IF (T.EQ.270.) X=0.0
IF (T.NE.270.) X=Y/TAN(T/RAD)
RETURN
SY 46
70
7
X=SCALE(IS)*DA/2. /(TAN(T/RAD)+1.)
Y=X*SCALE(IS)*DA/2.
RETURN
SY 47
80
8
SY 48
C
SYMBOL NUMBER 3 OR 13
C
70
8
IF ((T.GE.0.) AND (T.LT.90.)) GO TO 9
IF ((T.GE.90.) AND (T.LT.180.)) GO TO 10
IF ((T.GE.180.) AND (T.LT.270.)) GO TO 11
IF ((T.GE.270.) AND (T.LE.360.)) GO TO 12
SY 49
9
9
X=SCALE(IS)*DA/2. /(TAN(T/RAD)+1.)
Y=X*SCALE(IS)*DA/2.
RETURN
SY 50
10
10
IF (T.EQ.90.) X=0.0
IF (T.NE.90.) X=SCALE(IS)*DA/2. /(TAN(T/RAD)+1.)
Y=X*SCALE(IS)*DA/2.
RETURN
SY 51
11
11
SY 52
SY 53
SY 54
SY 55
SY 56
SY 57
SY 58
SY 59
SY 60
SY 61
SY 62
SY 63
SY 64
SY 65
SY 66
SY 67
SY 68
SY 69
SY 70
SY 71
SY 72
SY 73
SY 74
SY 75
SY 76
SY 77
SY 78
SY 79
SY 80

74
LISTING OF DECK: SYMS

CARD NO.

81 11  X=SCALE(IS)*DA/2./(TAN(T/RAD)+1.)
     Y=X-SCALE(IS)*DA/2.
     RETURN
     IF (T.EQ.270.)  X=0.0
     IF (T.NE.270.)  X=-SCALE(IS)*DA/2./TAN(T/RAD)-1.
     Y=X-SCALE(IS)*DA/2.
     RETURN

85  C  SYMBE NUMBER 4 OR 14
     C

90  13  IF ((T.GE.0.)AND.(T.LT.90.)) GO TO 14
     IF ((T.GE.90.)AND.(T.LT.T1)) GO TO 15
     IF ((T.GE.T1.)AND.(T.LT.T2)) GO TO 16
     X=(2./3.)*SCALE(IS)*1.105/(TAN(T/RAD)+2.)
     Y=2.*X+2.*SCALE(IS)*1.105/3.
     RETURN

95  15  IF (T.EQ.90.)  Y=0.0
     IF (T.NE.90.)  X=(2./3.)*SCALE(IS)*1.105/(TAN(T/RAD)-2.)
     Y=2.*X+2.*SCALE(IS)*1.105/3.
     RETURN

100  16  Y=SCALE(IS)*1.105/3.
     IF (T.NE.270.)  X=0.0
     IF (T.NE.270.)  X=Y/TAN(T/RAD)
     RETURN

105  C  SYMBE NUMBER 5 OR 15
     C

110  17  IF ((T.GE.0.)AND.(T.LT.T3)) GO TO 18
     IF ((T.GE.T3.)AND.(T.LT.225.)) GO TO 19
     IF ((T.GE.225.)AND.(T.LT.T4)) GO TO 20
     IF (T.EQ.90.)  X=0.0
     IF (T.NE.90.)  X=SCALE(IS)*1.22222/3./TAN(T/RAD)+1.
     Y=-X*SCALE(IS)*1.22222/3.
     RETURN

115  18  X=SCALE(IS)*1.22222/3.
     Y=X*TAN(T/RAD)
     RETURN

120  19  Y=SCALE(IS)*1.22222/3.
     IF (T.EQ.270.)  X=0.0
     IF (T.NE.270.)  X=Y/TAN(T/RAD)
LISTING OF DECK: SYMAS

CARD NO.

121
C
C
C
C
125
A=4.*SCALE(IS)*1.22222/(3.*PI)
B=SCALE(IS)*1.22222-A
T5=ATAN(A/B)*RAD
T6=360.-T5
T5=90.*T5
IF (T.EQ.0.0).AND.(T.LT.T5) GO TO 22
IF (T.GE.90.).AND.(T.LT.225.) GO TO 24
IF (T.GE.225.).AND.(T.LT.T6) GO TO 25
22
BB=-2.*A*(1.+TAN(T/RAD))
AA=TAN(T/RAD)**2+1.
CC=2.*AA-(SCALE(IS)*1.22222)**2
X=SORT(BB*BB-4.*AA*CC)/(2.*AA)
IF (T.GE.0.).AND.(T.LT.90.) X=X+BB/(2.*AA)
IF (T.GE.90.).AND.(T.LT.180.) X=-X+BB/(2.*AA)
140.
Y=X*TAN(T/RAD)
RETURN
23
X=0.0
Y=-A+SORT((SCALE(IS)*1.22222)**2-A*A)
145
RETURN
24
X=-A
Y=X*TAN(T/RAD)
RETURN
25
Y=-A
150.
IF (T.EQ.270.) X=0.0
IF (T.NE.270.) X=Y/TAN(T/RAD)
RETURN
C
C
155
C
C
156
IF (T.GE.0.0).AND.(T.LT.T7)) GO TO 27
IF (T.GE.7.)AND.(T.LT.T8) GO TO 22
IF (T.GE.T8).AND.(T.LT.T9) GO TO 29
IF (T.GE.T9).AND.(T.LT.S1) GO TO 30
160.
X=SCALE(IS)/2.0
LISTING OF DECK: SYMS

CARD NO.

161  Y=X*TAN(T/RAD)
     RETURN

28  X=SCALE(IS)*.1*SIN(T/RAD)*COS(T/RAD)+SCALE(IS)*COS(T/RAD)*SORT(.25)
     1-(.1*COS(T/RAD))*2)
     Y=X*TAN(T/RAD)
     RETURN

29  X=SCALE(IS)/2.
     Y=X*TAN(T/RAD)
     RETURN

30  Y=SCALE(IS)*.4
     IF (T.EQ.270.) X=0.0
     IF (T.NE.270.) X=Y/TAN(T/RAD)
     RETURN

175  C
     SYMBOL NUMBER 8 OR 18
     C

31  IF ((T.GE.0.0) AND (T.LT.90.)) GO TO 32
     IF ((T.GE.90.0) AND (T.LE.180.)) GO TO 33
     IF ((T.GT.270.0) AND (T.LE.360.)) GO TO 34

32  X=-.05*SCALE(IS)*SIN(T/RAD)*COS(T/RAD)+SCALE(IS)*COS(T/RAD)*SORT(.25)
     Y=X*TAN(T/RAD)
     RETURN

33  IF (T.EQ.270.) X=0.0
     IF (T.EQ.270.) Y=SCALE(IS)*.55
     IF (T.NE.270.) X=-SCALE(IS)*.55/(TAN(T/RAD)+1.)
     IF (T.NE.270.) Y=X*TAN(T/RAD)
     RETURN

34  X=SCALE(IS)*.55/(TAN(T/RAD)-1.)
     Y=X*TAN(T/RAD)
     RETURN

190  C
     SYMBOL NUMBER 9 OR 19
     C

35  IF ((T.GE.0.0) AND (T.LT.90.)) GO TO 36
     IF ((T.GE.90.0) AND (T.LT.180.)) GO TO 37
     IF ((T.GE.180.0) AND (T.LE.270.)) GO TO 38
     IF ((T.GE.270.0) AND (T.LE.360.)) GO TO 39

36  X=SCALE(IS)*R/2.*/(TAN(T/RAD)*R)
     Y=X*TAN(T/RAD)
RETURN

IF (T*EQ.90.) Y=0.0
IF (T*NE.90.) X=SCALE(IS)*R/2./TAN(T/RAD)-R
IF (T*EQ.90.) Y=SCALE(IS)*R/2.
IF (T*NE.90.) Y=X*TAN(T/RAD)
RETURN

38 IF (T,NE,90,) X=SCALE(IS)*R/2./TAN(T/RAD)+R
Y=X*TAN(T/RAD)
RETURN

IF (T*EQ.270.) X=0.0
IF (T*EQ.270.) Y=-SCALE(IS)*R/2.
IF (T*EQ.270.) Y=-SCALE(IS)*R/2./TAN(T/RAD)-R
IF (T*NE.270.) Y=X*TAN(T/RAD)
RETURN

C

SYMBOL NUMBER 10 OR 20

40 IF ((T*GE.0.0).AND.(T*LT.54)) GO TO 41
IF ((T*GE.40).AND.(T*LT.51)) GO TO 42
IF ((T*GE.54).AND.(T*LT.56)) GO TO 43
IF ((T*GE.54).AND.(T*LT.57)) GO TO 44

41 X=SCALE(IS)*R/2.
Y=X*TAN(T/RAD)
RETURN

42 IF (T*LT.90.) X=SCALE(IS)*R/6/TAN(T/RAD)+1.
IF (T*EQ.90.) X=0.0
IF (T*GT.90.) X=SCALE(IS)*R/6/TAN(T/RAD)-1.
IF (T*EQ.90.) Y=SCALE(IS)*R.
IF (T*NE.90.) Y=X*TAN(T/RAD)
RETURN

43 X=SCALE(IS)/2.
Y=X*TAN(T/RAD)
RETURN

44 Y=-SCALE(IS)*R.
RETURN

C

SYMBOL NUMBER 21 OR 22

C

37
201
205
210
215
220
225
230
235
240
LISTING OF DECK: SYMBS

CARD NO.  

241   45  

X=0.1*SCALE(IS)*COS(T/RAD)  SY 241  
Y=0.1*SCALE(IS)*SIN(T/RAD)   SY 242  
RETURN                        SY 243  
END                            SY 244
SUBROUTINE CUBSPL (X,Y,N,YPP,TENSION,TENS,A)

   THIS SUBROUTINE FITS A CUBIC SPLINE TO A SET OF Y VS X INPUT
   POINTS

   CODED BY -- HARRY L. MORGAN    NASA/LARC/TAD/AA9 1983
   IN CALLING PROGRAM DIMENSION X, Y, YPP, AND A BY N

DIMENSION X(N), Y(N), YPP(N), A(N)

   COMPUTE TENSION PARAMETER
   TENS=TENSION*FLOAT(N-1)/(X(N)-X(1))
   IF (TENS.LT.0.0) TENS=0.0

   COMPUTE SECOND DERIVATIVE AT END POINTS BY FITTING
   Y=A*X**2+B*X+C TO THE LAST THREE POINTS AND SOLVE FOR A.
   SECOND DERIVATIVE AT END POINT IS THEN EQUAL TO 2*A

   H1=X(2)-X(3)
   H2=X(3)-X(1)
   H3=X(1)-X(2)
   YPP(1)=2.0*(Y(1)*H1+Y(2)*H2+Y(3)*H3)/(H1*X(1)**2+H2*X(2)**2+H3*X(3)  
   I**2)
   H1=X(N-1)-X(N)
   H2=X(N)-X(N-2)
   H3=X(N-2)-X(N-1)
   YPP(N)=2.0*(Y(N-2)*H1+Y(N-1)*H2+Y(N)*H3)/(H1*X(N-2)**2+H2*X(N-1)**2+H3*X(N)**2)

   PERFORM FORWARD ELIMINATION
   N1=N-1
   H1=X(2)-X(1)
   IF (TENS.NE.0.0) GO TO 1
   CON=6.
   E=H1
   GO TO 2

   CON=TENS*TENS
LISTING OF DECK: CUBSPL

CARD NO.

41
H3=TENS/SINH(TENS*H1)
CTH=H3*COSH(TENS*H1)
E=1./H1-H3
DP=CTH-1./H1

45
A(I)=0.0
D0 5 I=2,N1
H2=X(I+1)-X(I)
C=CON*((Y(I+1)-Y(I))/H2-(Y(I)-Y(I-1))/H1)
IF (TENS#NE.0.0) GO TO 3
F=H2
D=H1*(2.*A(I-1))+2.*H2
GO TO 4

3
H3=TENS/SINH(TENS*H2)
CTH=H3*COSH(TENS*H2)
F=1./H2-H3
DN=CTH-1./H2
D=DN+DP-E*A(I-1)
DP=DN
A(I)=F/D

6
YPP(I)=(C-E*YPP(I-1))/D
E=F

5
H1=H2
C
PERFORM BACK SUBSTITUTION

65
J=N
D0 6 I=2,N1
J=J-1
YPP(J)=YPP(J)-A(J)*YPP(J+1)

70
RETURN TO CALLING PROGRAM
C
RETURN
C
END
FUNCTION FUNC (X,X1,X2,Y1,Y2,YPP1,YPP2,TENS)

ROUTINE TO COMPUTE Y-VALUE AT A GIVEN X-VALUE ALONG SPLINE CURVE

CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AAB 1983

DX1=X2-X
DX2=X-X1
DH=X2-X1

IF (TENS.EQ.0.0) GO TO 1
F1=YPP1/(TENS*TENS)
F2=YPP2/(TENS*TENS)
FUNC=(F1*SINH(TENS*DX1)+F2*SINH(TENS*DX2))/SINH(TENS*DH)+((Y1-F1)*
1DX1+(Y2-F2)*DX2)/DH
RETURN

FUNC*YPP1*DX1*3/(6.*DH)+YPP2*DX2*3/(6.*DH)+((Y1-YPP1*DH*DH/6.)*DX
11/DH+(Y2-YPP2*DH*DH/6.)*DX2/DH
RETURN
END
LISTING OF DECK: DASHLN

CARD NO.

1  SUBROUTINE DASHLN (T,X,Y,N,NSYM,IOP,ISIZE,IRUN,TENSION)  DH 1
2  ROUTINE TO FAIR DATA WITH DASH LINES  DH 2
3  CODED BY -- HARRY L. MORGAN  NASA/LARC/TAD/AAB  1983  DH 3
4  PARAMETER DEFINITION  DH 4
5  T - ARRAY CONTAINING INDEPENDENT VARIABLE  DH 5
6  X - ARRAY CONTAINING X VARIABLE  DH 6
7  Y - ARRAY CONTAINING Y VARIABLE  DH 7
8  N - NUMBER OF POINTS TO BE PLOTTED  DH 8
9  NSYM - LINE OR SYMBOL NUMBER  DH 9
10  IOP - PLOTTING OPTION  IOP=0 PLOT SYMBOLS ONLY  DH 10
11  IOP=1 PLOT DASH LINE  DH 11
12  ISIZE - SYMBOL SIZE  DH 12
13  IRUN - RUN NUMBER  DH 13
14  TENSION - SPLINE TENSION  DH 14
15  T, X, AND Y MUST BE PROPERLY DIMENSIONED IN CALLING ROUTINE  DH 15
16  DIMENSION T(1), X(1), Y(1), NL(22), NS(22)  DH 16
17  WORK ARRAYS  DH 17
18  COMMON /WORK/ S(166),YI(166),YI(166)  DH 18
19  COMMON /PLT/ MX(50),MY(50),A(50)  DH 19
20  REAL MX,MY  DH 20
21  ROUTINE CONSTANTS  DH 21
22  NL = NUMBER OF LONG DASHES AND NS = NUMBER OF SHORT DASHES  DH 22
23  DATA NL/1,1,1,1,1,2,2,2,2,2,2,3,3,3,3,3,3,3,4,4,4,4,4,4,4,4,4,4,5,5,5,5,5,5,5/  DH 23
24  DATA NS/0,1,1,2,2,2,2,2,3,3,3,3,4,4,4,4,4,4,4,4,4,4,5,5,5,5,5,5,5/  DH 24
25  ROUTINE CONSTANTS  DH 25
26  NP=166  DH 26
27  EPS=.02  DH 27
28  SL=.3  DH 28
29  IF (NSYM*EQ.2) SL=.2  DH 29
30  SS=.1  DH 30
31  SP=.1  DH 31
32  SELECT PLOTTING OPTION  DH 32
33

83
C  IF (IDP.EQ.0 .OR. NLT.3) GO TO 1
   GO TO 3
C   PLOT SYMBOLS ONLY
C   DO 2 I=1,N
C   1  CALL PNTPLT (X(I),Y(I),NSYM,ISIZE)
   RETURN
C   PLOT DASH LINE
C   CHECK TO SEE IF T IS STRICTLY INCREASING
C   DO 4 I=2,N
C   3  IF (T(I).LT.T(I-1)) GO TO 5
C   CONTINUE
   GO TO 6
C   PRINT ERROR MESSAGE IF T IS NOT STRICTLY INCREASING
   PRINT 15, IRUN
   PRINT 16, (T(I),X(I),Y(I),I=1,N)
C   IF T IS NOT STRICTLY INCREASING, PLOT SYMBOLS ONLY
   GO TO 1
C   FIT SPLINE CURVE THROUGH DATA POINTS
   CALL CUBSPL (T,PX,NSYM,TENSION,TEPS,A)
   CALL CUBSPL (T,MY,MY,TENSION,TEPS,A)
C   COMPUTE NP EQUALLY SPACED POINTS ALONG CURVE
   IF (NSYM.EQ.1) NP=NP-2
   DT=(T(N)-T(1))/FLOAT(NP-1)
   TI=T(1)
   S(I)=0.
   M=2
   DO 9 I=1,NP
   8  IF (TI.LT.T(I)) TI=T(I)
   IF (TI.GT.T(N)) TI=T(N)
   7  DO 9 J=M,N
   K=J-1
   6  IF (TI.GE.T(K) .AND. TI.LE.T(J)) GO TO 8
   CONTINUE
   M=K
   IF (M.LE.1) M=2
LISTING OF DECK: DASHN

CARD NO.

81  XI(I)=FUNC(TI+T(K),T(K+1),Y(K),Y(K+1),MX(K),MX(K+1),TENS)
     YI(I)=FUNC(TI+T(K),T(K+1),Y(K),Y(K+1),MY(K),MY(K+1),TENS)
     IF (I.EQ.1.OR.NSYM.EQ.1) GO TO 9
     S(I)=S(I-1)+SORT((XI(I)-XI(I-1))*2+(YI(I)-YI(I-1))*2)

85. 9  TI=TI+DT
     ST=S(NP)
     C  IF NSYM=1, PLOT CONTINUOUS LINE
     IF (NSYM.EQ.1) GO TO 13
     C  COMPUTE LENGTH OF LONG AND SHORT DASH AND SPACE BETWEEN EACH

90  NLG=NL(NSYM)
     NSG=NS(NSYM)
     DT=FLOAT(NLG)*SL+FLOAT(NSG)*SS+FLOAT(NLG+NSG)*SP
     NLT=IFIX((ST+SP)/DT)
     IF (NLT.EQ.0) NLT=1

95  DTN=(ST+SP)/FLOAT(NLT)
     TI=DTN/DT
     SL=SL+TI
     SS=SS+TI
     SP=SP+TI

100. C  POSITION PN AT START OF LINE
     SI=0.
     CALL CALPLT (XI(I),YI(I),3)
     JSTART=1
     C  PLOT NL LONG DASHES

105 10  DO 11 I=1,NLG
     SI=SI+SL
     IF (SI.EQ.0.EQ.0) SI=ST
     CALL LINEAR (SI,XI,YY,NP,S,SI,YI,JSTART)
     CALL CALPLT (XI,YY,2)

110 11  SI=SI+SP
     IF (SI.LE.ST) GO TO 14
     CALL LINEAR (SI,XI,YY,NP,S,SI,YI,JSTART)
     CALL CALPLT (XI,YY,3)
     CONTINUE

115 11  C  PLOT NS SHORT DASHES
     IF (NSG.EQ.0) GO TO 10
     DO 12 I=1,NSG
     SI=SI+SS
     IF (SI.EQ.0.EQ.0) SI=ST
     CALL LINEAR (SI,XI,YY,NP,S,SI,YI,JSTART)

120.   
LISTING OF DECK: DASHLN

CARD NO.

121 CALL CALPLT (XX,YY,2)  
   SI=SI+SP  
   IF (SI GE ST) GO TO 14  
   CALL LINEAR (SI,XX,YY,NI,S,XI,YI,START)  
125 CALL CALPLT (XX,YY,3)  
12 CONTINUE  
12 C CONTINUE PLOTTING DASH LINE  
   GO TO 10  
   C PLOT CONTINUOUS LINE  
130 13 XI(NP+1)=0.0  
   YI(NP+1)=0.0  
   XI(NP+2)=YI(NP+2)=1.0  
   CALL LINE (XI*YI*NP,1,0,0,0)  
135 C C RETURN TO START OF CURVE  
13 C C RETURN TO CALLING PROGRAM  
140 C C RETURN  
141 15 FORMAT (1X,15F11.4) IS NOT STRICTLY INCREASING FOR RUN, I7/16X, 1HT  
14 C  
145 16 FORMAT (5X,3F15.4)  
   END  

DP 121  
DP 122  
DP 123  
DP 124  
DP 125  
DP 126  
DP 127  
DP 128  
DP 129  
DP 130  
DP 131  
DP 132  
DP 133  
DP 134  
DP 135  
DP 136  
DP 137  
DP 138  
DP 139  
DP 140  
DP 141  
DP 142  
DP 143  
DP 144  
DP 145  
DP 146
SUBROUTINE LINEAR (TINT, XINT, YINT, N, T, X, Y, JSTART)

LINEAR INTERPOLATION METHOD

Coded by -- Harry L. Morgan

DIMENSION T(1), X(1), Y(1)

J = 1
IF (TINT .LE. T(1)) GO TO 3
J = N
IF (TINT .GE. T(N)) GO TO 3
JEND = JSTART
DO 1 I = JSTART, N
J = I
1 IF (T(J) - TINT) .LE. 0
JEND = J
2 DT = (TINT - T(J-1)) / (T(J) - T(J-1))
XINT = Y(J-1) + (X(J) - X(J-1)) * DT
YINT = Y(J-1) + (Y(J) - Y(J-1)) * DT
20 JSTART = JEND
RETURN
3 YINT = Y(J)
XINT = X(J)
JSTART = J
RETURN
END
<table>
<thead>
<tr>
<th>CARD NO.</th>
<th>STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SUBROUTINE LSQPLT (T,X,Y,N,NSYM,ISIZE,IOP,IRUN,TENSION,ILSQ,NPOL,O LS 1</td>
</tr>
<tr>
<td>1</td>
<td>IF</td>
</tr>
<tr>
<td>5</td>
<td>ROUTINE TO FAIR DATA WITH LFAST SQUARES CURVE FIT</td>
</tr>
<tr>
<td>5</td>
<td>C CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AAR 1983 LS 6</td>
</tr>
<tr>
<td>5</td>
<td>C PARAMETER DEFINITION</td>
</tr>
<tr>
<td>10</td>
<td>T - ARRAY CONTAINING INDEPENDENT VARIABLE LS 9</td>
</tr>
<tr>
<td>10</td>
<td>X - ARRAY CONTAINING X VARIABLE LS 10</td>
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<tr>
<td>10</td>
<td>Y - ARRAY CONTAINING Y VARIABLE LS 11</td>
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<td>15</td>
<td>N - NUMBER OF POINTS TO BE PLOTTED LS 12</td>
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<tr>
<td>15</td>
<td>NSYM - LINE AND SYMBOL NUMBER LS 13</td>
</tr>
<tr>
<td>15</td>
<td>ISIZE - SYMBOL SIZE LS 14</td>
</tr>
<tr>
<td>15</td>
<td>IOP - PLOTTING OPTION IOP = 0 PLOT SYMBOLS ONLY LS 15</td>
</tr>
<tr>
<td>15</td>
<td>IOP = 1 PLOT SYMBOLS AND CURVE LS 16</td>
</tr>
<tr>
<td>17</td>
<td>IRUN - RUN NUMBER LS 17</td>
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<tr>
<td>18</td>
<td>TENSION - SPLINE TENSION LS 18</td>
</tr>
<tr>
<td>20</td>
<td>ILSQ - LEAST SQUARES CURVE FIT OPTION LS 19</td>
</tr>
<tr>
<td>20</td>
<td>ILSQ = 0 LEAST SQUARES POLYNOMIAL CURVE FIT LS 20</td>
</tr>
<tr>
<td>20</td>
<td>ILSQ = 1 LEAST SQUARES CUBIC SPLINE FIT LS 21</td>
</tr>
<tr>
<td>22</td>
<td>NPOL - ORDER OF LEAST SQUARES POLYNOMIAL CURVE FIT LS 22</td>
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<td>23</td>
<td>OF - STANDARD DEVIATION FOR LEAST-SQUARES CUBIC-SPLINE FIT LS 23</td>
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<td>24</td>
<td>DIMENSION T, X, AND Y IN CALLING PROGRAM LS 24</td>
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<td>25</td>
<td>DIMENSION T(1), X(1), Y(1) LS 25</td>
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<td>WORK ARRAYS LS 26</td>
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<td>DIMENSION XNEW(50), YNEW(50) LS 27</td>
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<td>DIMENSION COEF(50,4) LS 28</td>
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<td>COMMON /WORK/ WK(50), SDV(50), CX(11), CY(11) LS 29</td>
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<td>30</td>
<td>C ROUTINE CONSTANTS LS 30</td>
</tr>
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<td>31</td>
<td>NMAX = 50 LS 33</td>
</tr>
<tr>
<td>31</td>
<td>WT = 1.0 LS 34</td>
</tr>
<tr>
<td>31</td>
<td>IPRINT = 0 LS 35</td>
</tr>
<tr>
<td>35</td>
<td>C SELECT PLOTTING OPTION LS 37</td>
</tr>
<tr>
<td>35</td>
<td>IF (ICP.EQ.0 .OR. N.LT.3) GO TO 1 LS 39</td>
</tr>
<tr>
<td>40</td>
<td>GO TO 3 LS 40</td>
</tr>
</tbody>
</table>
LISTING OF DECK: LSQPLT

CARD NO.

41   C   PLOT SYMBOLS ONLY
     C
1    DO 2 I=1,N
2    CALL PNTPLT (X(I),Y(I),NSYM,ISIZE)
     C
C CHECK TO SEE IF T IS STRICTLY INCREASING
3    DO 4 I=2,N
4    IF (T(I).LT.T(I-1)) GO TO 5
     C
5    PRINT 20, IRTN
     C
55   PPRINT 21, (T(I),X(I),Y(I),I=1,N)
     C
88   CONTINUE
     C
C PLOT DATA POINTS WITH SYMBOLS
6    DO 7 I=1,N
7    SDV(I)=WT
     C
8    IF (ILSQ.EQ.1) SDV(I)=DF
     C
77   CALL PNTPLT (X(I),Y(I),NSYM,ISIZE)
     C
85   CONTINUE
C
C COMPUTE LEAST SQUARES CURVE
9    IF (ILSQ.GT.0) GO TO 10
     C
10   COMPUTE COEFFICIENTS OF LEAST SQUARES POLYNOMIAL
70   MPOL=NPOL
     C
71   IF (MPOL.GT.N-1) MPOL=N-1
     C
72   IF (MPOL.LE.0) MPOL=1
     C
73   IF (MPOL.GT.10) MPOL=10
     C
74   M1=MPOL+1
     C
75   CALL LSO (T,X,SDV,N,MPOL,CX)
     C
83   CALL LSO (T,Y,SDV,N,MPOL,CY)
     C
C COMPUTE NEW X AND Y VALUES AND ERRCR SUMMATIONS
80   EPRX=ERRX=0.0
     C
81   DO 9 I=1,N
82   YNEW(I)=CX(1)
LISTING OF DECK: LSOPLT

CARD NO.

81   YNEW(I)=CY(I)
DELTA=1.0
DO 8 J=2,M1
DELTA=DELTA*T(I)
85   YNEW(I)=YNEW(I)+DELTA*CY(J)
88   YNEW(I)=YNEW(I)+DELTA*CY(J)
ERRX=ERRX+X(I)-XNEW(I)**2
ERRY=ERRY+(Y(I)-YNEW(I))**2
9   CONTINUE
GO TO 17
C   COMPUTE COEFFICIENTS OF LEAST SQUARES CUBIC SPLINE
C    FIT X
10   K=-1
SM=FLOAT(N)
95   CALL CSQS (NMAX,N,T,X,SDV,SM,K,COEF,WK,IERR)
   IF (IERR.NE.0) GO TO 19
C    COMPUTE NEW X AND ERROR SUMMATION
   ERRX=0.
   DO 13 I=1,N
   100  XNEW(I)=COEF(I,1)
   GO TO 12
11   K=I-1
DELTA=T(I)-T(K)
105  XNEW(I)=((COEF(K,4)*DELTA+COEF(K,3))*DELTA+COEF(K,2))*DELTA+COEF(K
   1,1)
12   ERRX=ERRX+(X(I)-XNEW(I))**2
13   CONTINUE
C    FIT Y
110  K=-1
SM=FLOAT(N)
115  CALL CSQS (NMAX,N,T,Y,SDV,SM,K,COEF,WK,IERR)
   IF (IERR.NE.0) GO TO 19
C    COMPUTE NEW Y AND ERROR SUMMATION
   ERRY=0.
   DO 16 I=1,N
   110 IF (I.EQ.N) GO TO 14
   YNEW(I)=COEF(I,1)
   GO TO 15
120  K=I-1

90
LISTING OF DECK: LSOPLT

CARD NO.

121  DELTA=T(I)-T(K)
     YNEW(I)=((COEF(K,4)*DELTA+COEF(K,3))*DELTA+COEF(K,2))*DELTA+COEF(K,1)

125  ERRY=ERRY+(Y(I)-YNEW(I))*2
     CONTINUE

C

130  PRINT DASHED LINE THRU NEW X AND Y VALUES
     TEN=TENSION
     IF (ILSQ.EQ.1) TEN=0.0
     CALL DASH1N (T,XNEW,YNEW,N,NSYM,IP,ISIZE,IRUN,TEN)

C

135  PRINT RESULTS OF LEAST SQUARES CURVE FIT
     IF (IPRINT.EQ.0) RETURN
     IF (ILSQ.EQ.0) PRINT ?2, IRUN,NSYM,MPOL
     IF (ILSQ.EQ.1) PRINT 23, IRUN,NSYM,DF
     DO 10 I=1,N
     DELTA=X(I)-XNEW(I)

140  SM=Y(I)-YNEW(I)
     PRINT 24, I,T(I),X(I),XNEW(I),DELTA,Y(I),YNEW(I),SM
     CONTINUE

145  PRINT 25, ERRY,ERRY
     RETURN

C

149  PRINT ERROR MESSAGE

150  PRINT 26, IERR,IRUN,NSYM
     GO TO 1

C

155  FORMAT (1H1//5,36HT IS NOT STRICTLY INCREASING FOR RUN,7/16X,1HT)
     1,13X,1HX,13X,1HY/)
     1,13X,1HX,13X,1HY/)

159  FORMAT (5X,3F15.4)

163  FORMAT (//5X,55HRESULTS OF LEAST SQUARES POLYNOMIAL CURVE FIT FOR LS
     1RUN =I4,3X,6HNSYM =I2,3X,6HNPOL =I3//4X,1HI,6X,1HT,9X,1HX,9X,4H)
     2XNEW=4X,6HX=XNEW,6X,1HY,9X,4HYNEW=4X,6HY-YNEW)

167  FORMAT (//5X,55HRESULTS OF LEAST SQUARES CUBIC SPLINE CURVE FIT FOR LS
     1RUN =I4,3X,6HNSYM =I2,3X,4HDF =F10.5//4X,1HI,6X,1HT,9X,1HX,9X)
     2,4HXNEW=4X,6HX=XNEW,6X,1HY,9X,4HYNEW=4X,6HY-YNEW)

171  FORMAT (I5,7F10.4)
LISTING OF DECK: LSOPLT

CARD NO.

161  25  FORMAT (/10X,12HERROR IN X =,E15.6,10X,12HERROR IN Y =,E15.6)   LS 161
     26  FORMAT (/5X,13HERROR NUMBER =,I3,42H OCCURRED IN CSDS CALL IN LSOPL LS 162
          IT FOR RUN =,I4,11H AND NSYM =,I3)                      LS 163
          END                                                            LS 164-
Listing of deck: LSQ

Card No. 1

SUBROUTINE LSQ (X,Y,W,NP,N,C)

LEAST SQUARES WEIGHTED POLYNOMIAL CURVE FIT ROUTINE

CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AAB 1983

PARAMETER DEFINITION

X - ARRAY CONTAINING INDEPENDENT VARIABLE
Y - ARRAY CONTAINING DEPENDENT VARIABLE
W - ARRAY CONTAINING WEIGHTING VALUES
NP - NUMBER OF POINTS
N - ORDER OF POLYNOMIAL
C - COEFFICIENTS OF POLYNOMIAL

NEW Y VALUE = C(1)+C(2)*X+C(3)*X**2+...+C(N+1)*X**N

DIMENSION X(NP), Y(NP), W(NP), AND C(N+1) IN CALLING PROGRAM

DIMENSION X(1), Y(1), W(1), C(1)

N=10 FOR THIS VERSION

COMMON /WORK/ A(11,12)

CALCULATE LEAST SQUARES MATRIX

N1=N+1
N2=N+2
DO 1 I=1,N1
DO 1 J=1,N2
A(I,J)=0.
DO 3 K=1,NP
1 T1=1.
DO 3 J=1,N1
T2=T1
DO 2 I=1,N1
A(J,I)=A(J,I)+T2*W(K)
2 T2=T2*X(K)
A(J,N2)=A(J,N2)-Y(K)*T1*W(K)
3 T1=T1*X(K)

SOLVE FOR COEFFICIENTS OF LEAST SQUARES POLYNOMIAL

SOLVE FOR COEFFICIENTS OF LEAST SQUARES POLYNOMIAL

93
LISTING OF DECK: LSO

CARD NO.

41

DO 4 K=1,N
DO 4 J=K,N
TI=A(J+1,K)/A(K,K)
DO 4 I=K,N2

45

A(J+1,I)=A(J+1,I)-A(K,I)*TI
C(N1)=-A(N1,N1)/A(N1,N1)
DO 5 I=2,N1
K=N2-I
C(K)=-A(K,N2)/A(K,K)
L=K+1

50

DO 5 J=L,N1
C(K)=C(K)-C(J)*A(K,J)/A(K,K)
RETURN
END
SUBROUTINE CSDS (MAX,IX,X,F,DF,S,IPT,COEF,WK,IERR)  

C**************************************************************************C
C**************************************************************************C
C
C* PURPOSE:  
C* SUBROUTINE CSDS FITS A SMOOTH CUBIC SPLINE TO A  
C* UNIVARIATE FUNCTION. DATA MAY BE UNEQUALLY SPACED.  
C*
C* USE:  
C* CALL CSDS(MAX,IX,X,F,DF,S,IPT,COEF,WK,IERR)  
C*
C* MAX  INPUT INTEGER SPECIFYING THE MAXIMUM NUMBER OF DATA  
C* POINTS FOR THE INDEPENDENT VARIABLE.  
C* IX  INPUT INTEGER SPECIFYING THE ACTUAL NUMBER OF DATA  
C* POINTS FOR THE INDEPENDENT VARIABLE. IX>MAX.  
C*
C* X ONE-DIMENSIONAL INPUT ARRAY DIMENSIONED AT LEAST  
C* IX IN THE CALLING PROGRAM. UPON ENTRY TO CSDS,  
C* X(I) MUST CONTAIN THE VALUE OF THE INDEPENDENT  
C* VARIABLE AT POINT I.  
C*
C* F ONE-DIMENSIONAL INPUT ARRAY DIMENSIONED AT LEAST  
C* IX IN THE CALLING PROGRAM. UPON ENTRY TO CSDS,  
C* F(I) MUST CONTAIN THE VALUE OF THE FUNCTION AT  
C* POINT X(I).  
C*
C* DF ONE-DIMENSIONAL INPUT ARRAY DIMENSIONED AT LEAST  
C* IX IN THE CALLING PROGRAM. UPON ENTRY TO CSDS,  
C* DF(I) MUST CONTAIN AN ESTIMATE OF THE STANDARD  
C* DEVIATION OF F(I).  
C*
C* S A NON-NEGATIVE INPUT PARAMETER WHICH CONTROLS THE  
C* EXTENT OF SMOOTHING. S SHOULD BE IN THE RANGE  
C* (IX-(2*IX)**.5)<S<(IX+(2*IX)**.5).  
C*
C* IPT INPUT INITIALIZATION PARAMETER. THE USER MUST  
C* SPECIFY IPT=-1 WHENEVER A NEW X ARRAY IS  
C* INPUT. THE ROUTINE WILL ALSO CHECK TO INSURE THAT  
C* THE X ARRAY IS IN STRICTLY INCREASING ORDER.  
C*
C**************************************************************************C
C**************************************************************************C

CARD NO.
C* COEF A TWO-DIMENSIONAL OUTPUT ARRAY DIMENSIONED (MAX, 4) • CS 41
C* IN THE CALLING PROGRAM. UPON RETURN, COEF(I, J) • CS 42
C* CONTAINS THE J-TH COEFFICIENT OF THE SPLINE FOR • CS 43
C* THE INTERVAL BEGINNING AT POINT X(I). THE • CS 44
C* FUNCTIONAL VALUE OF THE SPLINE AT ABSISSA X1, • CS 45
C* WHERE X(I) < X1 < X(I+1), IS GIVEN BY: • CS 46
C* F(X1) = (COEF(I, 4) + COEF(I, 3) + COEF(I, 2) + COEFC(I, 1)) • CS 47
C* + COEFF(I, 1) • CS 48
C* WHERE H = X1 - X(I) • CS 49
C* WK A ONE-DIMENSIONAL WORK AREA ARRAY DIMENSIONED AT • CS 50
C* LEAST (7*IX + 9) IN THE CALLING PROGRAM. • CS 51
C* IERR OUTPUT ERROR PARAMETER: • CS 52
C* =0 NORMAL RETURN. NO ERROR DETECTED. • CS 53
C* =J THE J-TH ELEMENT OF THE X ARRAY IS NOT IN • CS 54
C* STRICTLY INCREAASING ORDER. • CS 55
C* =-1 THERE ARE LESS THAN FOUR VALUES IN THE X ARRAY. • CS 56
C* UPON RETURN FROM CSDS, THIS PARAMETER SHOULD BE • CS 57
C* TESTED IN THE CALLING PROGRAM. • CS 58
C* REQUIRED ROUTINES -NONE • CS 59
C* SOURCE IMSL ROUTINE ICSSMU MODIFIED BY • CS 60
C* COMPUTER SCIENCES CORPORATION • CS 61
C* LANGUAGE -FORTRAN • CS 62
C* DATE RELEASED SEPTEMBER 5, 1973 • CS 63
C* LATEST REVISION MARCH 1975 • CS 64
C* DIMENSION X(1), F(1), DF(1), COEF(MAX, 4), WK(1) • CS 65
C* SET UP WORKING AREAS • CS 66
81   C IERR=0
     IF (IPT.NE.-1) GO TO 4
     IPT=0
85   IF (IX.LT.4) GO TO 1
     GO TO 2
     IERR=-1
     RETURN
     IX1=IX-1
90   DO 3 I=1,IX1
     IF (X(I+1)-X(I).GT.0) GO TO 3
     IERR=I+1
     RETURN
     CONTINUE
95   NP1=IX+1
     IB1=NP1
     IB2=IB1+NP1
     IB3=IB2+NP1+1
     IB4=IB3+NP1
     IB5=IB4+NP1
     IB6=IB5+NP1+1
     WK (1) =0.
     WK (2) =0.
     WK (IB2) =0.
     WK (IB3) =0.
     WK (IJK2) =0.
     IJK5=IB5+1
     WK (IJK5) =0.
     IJK5=IB5+2
     WK (IJK5) =0.
     WK (IB6) =0.
     WK (IJK2) =0.
     WK (IJK5) =0.
     WK (IJK6) =0.
     IJK5=IB5+NP1
     WK (IJK5) =0.
     CONTINUE
115   4 P=0.
H=X(2)-X(1)
     FZ=-S
     FF=(F(2)-F(1))/H
120   IF (IX.LT.3) GO TO 10
LISTING OF DECK: CSDS

CARD NO.

121  DO 5 I=3,IX  
     G=H  
     H=X(I)-X(I-1)  
     E=FF  

125  FF=(F(I)-F(I-1))/H  
     COFF(I-1)= FF=  
     IJK3=IB3+I  
     WK(IJK3)= (G+H)*66666666  
     IJK4=IB4+I  

130  WK(IJK4)=H/3.  
     IJK2=IB2+I  
     WK(IJK2)=DF(I-2)/G  
     WK(I)=DF(I)/H  
     IJK1=IB1+I  

135  CONTINUE  

DO 6 I=3,IX  
     IJK1=IB1+I  
     IJK2=IB2+I  

5     COEF(I-1.2)=WK(I)*WK(I) + WK(IJK1)*WK(IJK1) + WK(IJK2)*WK(IJK2)  
     COEF(I-1.3)=WK(I)*WK(IJK1+1)*WK(IJK1)*WK(IJK2+1)  
     COEF(I-1.4)=WK(I)*WK(IJK2+2)  
     CONTINUE  

6     NEXT ITERATION  

7     IF (IX.LT.3) GO TO 10  
     DO 8 I=3,IX  
     IJK1=IB1+I-1  

150    IJK0=I-1  
     WK(IJK1)=FF*WK(IJK0)  
     IJK2=IB2-I-2  
     IJKO=I-2  
     WK(IJK2)=G*WK(IJK0)  

155    IJK0=I  
     IJK3=IB3+I  
     WK(IJK0)=1.0*COFF(I-1.2)*WK(IJK3)-FF*WK(IJK1)-G*WK(IJK2)  
     IJK5=IB5+I  
     IJKN=IJK5-1  

160    IJK0=IJKN-1
CARD NO.

161     WK(IJK5)=COEF(I-1,1)-WK(IJK1)*WK(IJKN)-WK(IJK2)*WK(IJK0)   CS 161
       IJK4=IB4+I         CS 162
       FF=P*COEF(I-1,3)+WK(IJK4)-H*WK(IJK1)         CS 163
       G=H                 CS 164

165     8
       CONTINUE
       DO 9 I=3,IX
       J=IX-I+3
       IJK5=IB5+J

170     IJK6=IJK5+1
       IJK7=IJK6+1
       IJK1=IB1+J
       IJK2=IB2+J
       WK(IJK5)=WK(J)*WK(IJK5)-WK(IJK1)*WK(IJK6)-WK(IJK2)*WK(IJK7)   CS 174

175     9
       CONTINUE
       10
       E=0
       H=0

180     COMPUTE U AND ACCUMULATE E  
       DO 11 I=2,IX
       G=H
       IJK5=IB5+I
       H=WK(IJK5+1)-WK(IJK5)/(X(I)-X(I-1))   CS 183

185     IJK6=IB6+I
       WK(IJK6)=(H-G)*DF(I-1)*DF(I-1)
       E=E+WK(IJK6)*(H-G)

11     CONTINUE
       G=-H*DF(I)*DF(I)

190     IJK6=IB6+NP1
       WK(IJK6)=G
       E=E-G*H
       G=F2
       F2=E*P*P

195     IF (F2*CE*S*OR*FP*LF*G) GO TO 14
       FF=0
       IJK6=IB6+2
       H=WK(IJK6+1)-WK(IJK6)/(X(2)-X(1))
       IF (IX*LT,3) GO TO 13

200     DO 12 I=3,IX   CS 200
LISTING OF DECK: CSDS

CARD NO.

201

G=H
IJK6=IB6+1
H=(WK(IJK6+1)-WK(IJK6))/(X(I)-X(I-1))
IJK1=IB1+I-1
IJK2=IB2+I-2
G=G-WK(IJK1)*WK(I-1)-WK(IJK2)*WK(I-2)
FF=FF+G*WK(I)*G
WK(I)=G

12 CONTINUE

13 H=E-P*FF
IF (H LE 0) GO TO 14

C C

C

P=P+(S-F2)/((SQRT(S/E))*P)*H
GO TO 7

C C

C

IF E LESS THAN OR EQUAL TO S,
COMPUTE THE COEFFICIENTS AND RETURN.

C C

C

DO 15 I=2,NP1
IJK6=IB6+1

COEF(I-1,1)=F(I-1)-P*WK(IJK6)
IJK5=IB5+1

10 COEF(I-1,3)=WK(IJK5)
CONTINUE

DO 16 I=2,IX
H=X(I)-X(I-1)

230 COEF(I-1,4)=(COEF(I,3)-COEF(I-1,3))/(3.*H)

231 COEF(I-1,2)=(COEF(I,1)-COEF(I-1,1))/H-(H*COEF(I-1,4)+COEF(I-1,3))*H
CONTINUE

RETURN
END

END
LISTING OF DECK: AXISLB

CARD NO.

1 SUBROUTINE AXISLB (IAxis,XORG,YORG,Scale,DIST,HT,NDIG) XL 1
2 ROUTINE TO DRAW SCALE VALUES ON AXIS XL 2
3
4 CODED BY -- HARRY L. MORGAN NASA/LARC/TAO/AAB 1983 XL 5
6
7 PARAMETER DEFINITION
8 IAXIS = 1 - DRAW X-AXIS SCALES
9 IAXIS = 2 - DRAW Y-AXIS SCALES
10 XORG, YORG - X,Y COORDINATES OF BEGINNING OF AXIS
11 ORG - SCALE VALUE AT BEGINNING OF AXIS
12 SCALE - SCALE VALUE PER INCH
13 DIST - LENGTH OF AXIS
14 HT - HEIGHT OF VALUES DRAWN ON AXIS
15 NDIG - NUMBER OF SIGNIFICANT FIGURES TO RIGHT OF DECIMAL POINT
16 NDIG=-1 WILL DROP DECIMAL POINT
18
20 COMPUTE ROUTINE CONSTANTS
21 WADJ=0.0 XL 19
22 IF (HT.LE.0.1) WADJ=0.01 XL 20
23 CON5=6.*HT/7.*WADJ XL 21
24 CON52=2.*HT/7.* XL 22
25 ADJ=0.*4*HT XL 23
26 IF (ADJ.LT.0.1) ADJ=0.1 XL 24
27 NL=IFIX(DIST+0.0001)+1 XL 25
28 XO=XORG XL 26
29 YO=YORG XL 27
30 VALUE=ORG XL 28
32
33 POSITION PEN AT BEGINNING OF AXIS
34 CALL CALP1T (YORG,YORG,3) XL 30
36 DRAW AXIS VALUE AT EACH INCH MARK ALONG AXIS
37 DO P=1,NL XL 31
38 VALUE=SCALE*FLOAT(P-1)+ORG XL 32
39 COMPUTE NUMBER OF SIGNIFICANT FIGURES IN VALUE
40 NDIG=NDIG XL 33
42 VALUE=ABS(VALUE)
43 IF (VALUE.GT.0.0001) NDIG=1 XL 34
44
46 V=0.0
LISTING OF DECK: AXISLB

CARD NO.

41  VALUE=0.0
   GO TO 5
XL 41
2  NSIG=NDG+1
XL 42
3  S*V+SIGN(1,E-7,V)
XL 43
4  N=IFIX(S)
XL 44
5  IF (N) 5,5,4
XL 45
45  NSIG=NSIG+1
XL 46
V=0.1*V
XL 47
GO TO 3
XL 48
50  IF (VALUE.LT.0.0) NSIG=NSIG+1
XL 49
S=CONS*FLOAT(NSIG)-CONS
XL 50
C  POSITION AND DRAW AXIS VALUE
XL 51
IF (IAxis.EQ.2) GO TO 6
XL 52
XT=XO-0.5*S
XL 53
55  YT=Y0-HT-ADJ
XL 54
XO=XO+1*
XL 55
GO TO 7
XL 56
6  XT=XO-S-ADJ
XL 57
YT=Y0-0.5*HT
XL 58
60  YO=Y0+1*
XL 59
7  CALL NUMBER (XT,YT,HT,VALUE,0,NDG)
XL 60
C  ADVANCE TO NEXT INCH MARK
XL 61
8  CONTINUE
XL 62
C  RETURN TO BEGINNING OF AXIS
XL 63
65  CALL CALPLT(XORG,YORG,3)
XL 64
C  RETURN TO CALLING PROGRAM
XL 65
RETURN
XL 66
END
XL 67
Subroutine COEFSY (X0, Y0, HT, ISYM)

Routine to Draw Aerodynamic Coefficients

Coded By — Harry L. Morgan
NASA/LARC/TAD/AA8 1983

Parameter Definition
X0 — X Coordinate of Left-Hand Edge of Symbol
Y0 — Y Coordinate of Centerline of Main Letter of Symbol
HT — Symbol Height
ISYM = 1 — Lift
ISYM = 2 — Drag
ISYM = 3 — Pitching Moment
ISYM = 4 — Rolling Moment
ISYM = 5 — Yawing Moment
ISYM = 6 — Side Force
ISYM = 7 — Lift/Drage
ISYM = 8 — Alpha, DEG
ISYM = 9 — Beta, DEG

Initialize Character Sets
Call CharSt1
Call CharSt7
Call CharSt2

Position Pen at Start of Symbol
Call CalPlt (X0, Y0, 3)
Y1 = Y0 - 0.5 * HT
If (ISYM.EQ.7) Go To 1
If (ISYM.EQ.8 .Or. ISYM.EQ.9) Go To 2
If (ISYM.GT.9) Go To 3

Draw Letter C
Call CharAct (X0, Y1, HT, 2H)C, 0, 2, 0, 0
Call CharWH (W0, X1, Y1, HT, 2H)C, 2, 0, 0
X1 = X0 + 1.15 * WD
Y1 = Y0 - HT

Draw Subscript of C
If (ISYM.EQ.1) Call CharAct (X1, Y1, HT, 2H)L, 0, 2, 0, 0
If (ISYM.EQ.2) Call CharAct (X1, Y1, HT, 2H)O, 0, 2, 0, 0
If (ISYM.EQ.3) Call CharAct (X1, Y1, HT, 2H)M, 0, 2, 0, 0
If (ISYM.EQ.4) Call Lam (X1, Y1, HT)
LISTING OF DECK: COEFSY

CARD NO.

41 IF (ISYM.EQ.5) CALL CHARACT (Y1,Y1,HT,2H(N=0,,2,,0,,0)) CY 41
   IF (ISYM.EQ.6) CALL CHARACT (Y1,Y1,HT,2H(Y=0,,2,,0,,0)) CY 42
   GO TO 4 CY 43
   DRAW L/D CY 44
45 1 CALL CHARACT (X0,Y1,HT,4H)D/N,0,,4,,0,,25) CY 45
   GO TO 4 CY 46
   DRAW ALPHA,DEG OR BETA,DEG CY 47
   IF (ISYM.EQ.8) CALL CHARACT (X0,Y1,HT,11H$7(A$2,DEG,0,,11,,0,,20)) CY 48
   IF (ISYM.EQ.9) CALL CHARACT (X0,Y1,HT,11H$7(B$2,DEG,0,,11,,0,,20)) CY 49
50 GO TO 4 CY 50
   ADD ADDITIONAL SYMBOLS HERE AS DESIRED CY 51
   CONTINUE CY 52
   RETURN PEN TO START OF SYMBOL CY 53
   CALL CALPLT (X0,YM,3) CY 54
   CALL CHNGSET (1) CY 55
   RETURN TO CALLING PROGRAM CY 56
60 RETURN CY 57
   END CY 58
SUBROUTINE LAM (XO,YO,HT)

ROUTINE TO DRAW ROLLING MOMENT SUBSCRIPT

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PARAMETER DEFINITION
XO,YO - X,Y COORDINATES OF LOWER LEFT-HAND CORNER OF SYMBOL
HT - HEIGHT OF SYMBOL

DIMENSION XM(17), YM(17)
1,3./
DATA YM/43.,43.,7.,2.,0.,2.,5.,5.,2.,6.,1.,1.,2.,6.,7.,44.,44.,43./
HTH=HT/44.
CALL CALPLT (XO,YO,3)
DO 1 I=1,17.
K=2
IF (I.EQ.1) K=3
X=XO+(XM(I)+2.)*HTH
Y=YO+YM(I)*HTH
CALL CALPLT (X,Y,K)
1 CALL CALPLT (XO,YO,3)
RETURN 
END
<table>
<thead>
<tr>
<th>Card No.</th>
<th>Description</th>
<th>Line No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SUBROUTINE GRIDLN (XO,YO,XL,YH,NDIV)</td>
<td>GL 1</td>
</tr>
<tr>
<td></td>
<td>ROUTINE TO DRAW AREA OF GRID LINES</td>
<td>GL 2</td>
</tr>
<tr>
<td>5</td>
<td>CODED BY -- HARPY L. MORGAN NASA/LARC/TAD/AAB 1983</td>
<td>GL 3</td>
</tr>
<tr>
<td></td>
<td>PARAMETER DEFINITION</td>
<td>GL 4</td>
</tr>
<tr>
<td></td>
<td>X0,YO = X,Y COORDINATES OF LOWER LEFT-HAND CORNER OF GRID AREA</td>
<td>GL 5</td>
</tr>
<tr>
<td></td>
<td>XL = LENGTH OF GRID AREA</td>
<td>GL 6</td>
</tr>
<tr>
<td></td>
<td>YH = HEIGHT OF GRID AREA</td>
<td>GL 7</td>
</tr>
<tr>
<td></td>
<td>NDIV = NUMBER OF GRID LINES PER INCH</td>
<td>GL 8</td>
</tr>
<tr>
<td></td>
<td>COMPUTE NUMBER OF GRID LINES</td>
<td>GL 9</td>
</tr>
<tr>
<td></td>
<td>XD=FLOAT(NDIV)</td>
<td>GL 10</td>
</tr>
<tr>
<td></td>
<td>IF (XD*LE.0.0) XD=1.</td>
<td>GL 11</td>
</tr>
<tr>
<td></td>
<td>NGX=IFIX(XD*XL+0.0001)+1</td>
<td>GL 12</td>
</tr>
<tr>
<td></td>
<td>NGY=IFIX(XD*YH+0.0001)+1</td>
<td>GL 13</td>
</tr>
<tr>
<td></td>
<td>DRAW GRID LINES PARALLEL TO Y-AXIS</td>
<td>GL 14</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (XN,YD,3)</td>
<td>GL 15</td>
</tr>
<tr>
<td></td>
<td>DG=0.</td>
<td>GL 16</td>
</tr>
<tr>
<td></td>
<td>IF (NGX,GT.1) D=XL/FLOAT(NGX-1)</td>
<td>GL 17</td>
</tr>
<tr>
<td></td>
<td>X1=XL</td>
<td>GL 18</td>
</tr>
<tr>
<td></td>
<td>Y1=YO</td>
<td>GL 19</td>
</tr>
<tr>
<td></td>
<td>Y2=YO+YH</td>
<td>GL 20</td>
</tr>
<tr>
<td></td>
<td>L=0</td>
<td>GL 21</td>
</tr>
<tr>
<td></td>
<td>DO 3 I=1,NGX</td>
<td>GL 22</td>
</tr>
<tr>
<td></td>
<td>L=L+1</td>
<td>GL 23</td>
</tr>
<tr>
<td></td>
<td>X2=X1+D</td>
<td>GL 24</td>
</tr>
<tr>
<td></td>
<td>IF (L-1) 1,1,?</td>
<td>GL 25</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (X1,Y2,2)</td>
<td>GL 26</td>
</tr>
<tr>
<td></td>
<td>IF (I,EQ.NGX) GOTO 3</td>
<td>GL 27</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (Y2,Y2,3)</td>
<td>GL 28</td>
</tr>
<tr>
<td></td>
<td>GOTO 3</td>
<td>GL 29</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (X1,Y1,2)</td>
<td>GL 30</td>
</tr>
<tr>
<td></td>
<td>IF (I,EQ.NGX) GOTO 3</td>
<td>GL 31</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (Y2,Y1,3)</td>
<td>GL 32</td>
</tr>
<tr>
<td></td>
<td>GOTO 3</td>
<td>GL 33</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (X1,Y1,2)</td>
<td>GL 34</td>
</tr>
<tr>
<td></td>
<td>IF (I,EQ.NGX) GOTO 3</td>
<td>GL 35</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (Y2,Y1,3)</td>
<td>GL 36</td>
</tr>
<tr>
<td></td>
<td>L=0</td>
<td>GL 37</td>
</tr>
<tr>
<td></td>
<td>X1=X2</td>
<td>GL 38</td>
</tr>
<tr>
<td>3</td>
<td>DRAW GRID LINES PARALLEL TO X-AXIS</td>
<td>GL 39</td>
</tr>
<tr>
<td></td>
<td>CALL CALPLT (YD,YO,3)</td>
<td>GL 40</td>
</tr>
</tbody>
</table>
Listing of deck: Gridin

Card No.

41      D=0.*
      IF (NGY*GT.*1) D=Y4/FLOAT(NGY-1)
      Y1=Y0
      X1=X0
      X2=X0+XL
      L=0
      DO 6 I=1,NGY
      L=L+1
      Y2=Y1+D
      IF (L-1) 4,4,5
      CALL CALPLT (X2,Y1,2)
      IF (I.EQ.0,NGY) GO TO 6
      CALL CALPLT (X2,Y2,3)
      GO TO 6

50

4      CALL CALPLT (X2,Y1,2)
      IF (I.EQ.0,NGY) GO TO 6
      CALL CALPLT (X1,Y2,3)
      L=0
      Y1=Y2

6      C FRAME GRID AREA
      X1=X0+XL
      Y1=Y0+YM
      CALL CALPLT (X0,Y0,3)
      CALL CALPLT (X1,Y0,2)
      CALL CALPLT (X1,Y1,2)
      CALL CALPLT (X0,Y1,2)
      CALL CALPLT (X0,Y0,2)
      CALL CALPLT (X0,Y1,3)
      RETURN TO CALLING PROGRAM

60

5      RETURN
      END

70
LISTING OF DECK: RUNKEY

CARD NO.

1

SUBROUTINE RUNKEY (X0,Y0,RUN,LSYM,ISIZE,HT,NRMAX)                        KY 1

ROUTINE TO DRAW TITLE BLOCK CONTAINING SYMBOLS AND RUN NUMBERS            KY 2

CODED BY -- HARRY L. MORGAN NASA/LARC/TAD/AAB 1983                        KY 3

PARAMETER DEFINITION

X0,Y0 - X,Y COORDINATES OF LOWER LEFT-HAND CORNER OF KEY                   KY 4

RUN - RUN NUMBERS                                                          KY 5

LSYM - SYMBOL ORDER                                                        KY 6

ISIZE - SYMBOL SIZE                                                        KY 7

HT - SYMBOL HEIGHT                                                         KY 8

NRMAX - MAXIMUM NUMBER OF ALLOWABLE RUNS PER SHEET                          KY 9

10

DIMENSION RUN(1), LSYM(1)

WORK ARRAYS                                                               KY 10

COMMON /PLT/KRUN(10),NRUN(10),LRUN(22),JSYM(22)                             KY 11

C INTEGER RUN                                                               KY 12

C INITIALIZE ROUTINE CONSTANTS                                            KY 13

DATA XM/1.0/,XMarg/0.1/,XNSP/2.5/,SPC/0.2/                                  KY 14

C DEFINE LETTERING SIZE                                                    KY 15

SZ=HT*XN                                                             KY 16

C INITIALIZE CHARACTER SET                                               KY 17

CALL CHARSTZ                                                            KY 18

20

C DETERMINE THE NUMBER OF NON-ZERO RUNS AND CORRESPONDING SYMBOLS         KY 19

NR=0                                                                  KY 20

DO 2 I=1,NRMAX                                                          KY 21

IF (RUN(I)) I=2,1                                                      KY 22

1 NR=NR+1                                                           KY 23

LRUN(NR)=RUN(I)                                                  KY 24

JSYM(NP)=LSYM(I)                                                   KY 25

CONTINUE                                                               KY 26

2 IF (NR,EQ.0) RETURN                                                 KY 27

C COMPUTE WIDTH OF WORDS SYMBOL AND 99999                                KY 28

CALL CHARWH (SYMW,HA,HBS,SZ,BH)(SYMOL,B,SPC)                             KY 29

30

C
LISTING OF DECK: RUNKEY

CARD NO.

41  CALL CHARWH (WD, HA, HB, SZ, 5H99999, 5, SPC)  KY 41
    XS=XD+0.5*SYM+XARG  KY 42
    XR=XD+2.*SYM+0.5*WD+XARG  KY 43
    YSR=YD+XARG  KY 44

45  C  DRAW SYMBOL AND RUN NUMBER
C
C DO 6 L=1,NR
I=NR+1-L
ENCOD (10,7,MRUN) LRUN(I)  KY 46
DECOD (10,8,MRUN) KRUN  KY 47
C  FIND NUMBER OF DIGITS IN RUN NUMBER
DO 3 J=1,10  KY 48
3  NRUN(J)=1H  KY 49
55  KDIG=0  KY 50
DO 4 J=1,10  KY 51
5  IF (KRUN(J).EQ.1H ) GO TO 4  KY 52
KDIG=KDIG+1  KY 53
C  SHIFT RUN NUMBER FROM RIGHT TO LEFT JUSTIFIED
60  NRUN(KDIG)=KRUN(J)  KY 54
CONTINUE  KY 55
4  C  REFORMAT RUN NUMBER
C  ENCOD (10,8,MRUN) NRUN  KY 56
DECOD (10,9,MRUN) IRUN  KY 57
65  C  DRAW SYMBOL
Y2=YSR+0.5*SZ  KY 58
CALL PNTPT (XS,Y2,SYM(I),ISIZE)  KY 59
C  DRAW RUN NUMBER
IF (KDIG.EQ.0) GO TO 5  KY 60
70  CALL CHARWH (WD, HA, HB, SZ, IRUN, KDIG, SPC)  KY 61
XX=XR-0.5*WD  KY 62
CALL CHARACT (XX, YSR, SZ, IRUN, 0., KDIG, SPC)  KY 63
YSR=YSR+XNSP*SZ  KY 64
CONTINUE  KY 65
5  C  DRAW AND UNDERLINE WORD SYMBOL AND RUN
C  CALL CHARWH (WD, HA, HB, SZ, 5H)R(UN,5, SPC)
IF (HB.LT.HBS) HBS=HB  KY 66
XX=XS-0.5*(SYM+XARG)  KY 67

PAGE 2
LISTING OF DECK: RUNKEY

CARD NO.

81    CALL CALPLT (XX, YSR, 3)
      XX=XS*0.5*(SYM+XMARG)  KY 81
      CALL CALPLT (XX, YSR, 2)
      XX=XR-0.5*(WD+XMARG)  KY 83

85    CALL CALPLT (XX, YSR, 3)
      XX=XR+0.5*(WD+XMARG)  KY 85
      CALL CALPLT (XX, YSR, 2)
      YSR=YSR-HBS+0.5*XMARG  KY 87
      XX=XS-0.5*SYM  KY 89

90    CALL CALPLT (XX, YSR, 3)
      CALL CHARACT (XX, YSR, SZ,8H)S(YMBOL,0*8,SPC)  KY 91
      XX=XR-0.5*WD  KY 92
      CALL CHARACT (XX, YSR, SZ,5H)R(UN,0*5,SPC)  KY 93

95    C
      RETURN TO TITLE BLOCK ORIGIN  KY 95
      C

100    CALL CALPLT (XO, YO, 3)
       CALL CHARST1  KY 97
       C

105    RETURN  KY 100
       C

7    FORMAT (I10)  KY 101
8    FORMAT (1OA1)  KY 102
9    FORMAT (A10)  KY 103
105   END  KY 104
APPENDIX B

DESCRIPTION OF INPUT DATA FOR WIND-TUNNEL DATA

PLOTTING PROGRAM PLOTWD

This appendix contains a description of the input requirements for the wind-tunnel data plotting program PLOTWD. The input data is divided into two basic parts: (1) the plotting setup information and (2) the plotting sheet information. The setup information defines the data variables, axis scales and positions, and the type of data fairing desired. All setup variables are input as floating point quantities with a format of F10.0, except the YLABEL and XLABEL variables which are axis labels and are input with a format of A10.

Plotting Setup

<table>
<thead>
<tr>
<th>CARD</th>
<th>VARIABLE</th>
<th>VALUE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TEST</td>
<td>-</td>
<td>Test number</td>
</tr>
<tr>
<td>2</td>
<td>SHEETW</td>
<td>-</td>
<td>Total width of plotting sheet, in.</td>
</tr>
<tr>
<td></td>
<td>SHEETH</td>
<td>-</td>
<td>Total height of plotting sheet, in.</td>
</tr>
<tr>
<td></td>
<td>SPACE</td>
<td>-</td>
<td>Space between plotting sheets, in.</td>
</tr>
<tr>
<td>3</td>
<td>ISYM</td>
<td>-</td>
<td>Starting symbol number (See table I.)</td>
</tr>
<tr>
<td></td>
<td>ISIZE</td>
<td>1</td>
<td>Small symbol size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Medium symbol size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Large symbol size</td>
</tr>
<tr>
<td>4</td>
<td>IOP</td>
<td>0</td>
<td>Plot data points only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Plot data points and fair with tension spline</td>
</tr>
<tr>
<td></td>
<td>TENSION</td>
<td>-</td>
<td>Tension factor, $\bar{\sigma}$</td>
</tr>
<tr>
<td>5</td>
<td>IEDIT</td>
<td>0</td>
<td>Do not sort or edit data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Sort and edit data</td>
</tr>
<tr>
<td></td>
<td>TOLR</td>
<td>-</td>
<td>Edit tolerance of independent test variable (TOLR=0 for sort only)</td>
</tr>
<tr>
<td>6</td>
<td>IW</td>
<td>-</td>
<td>Data array location of independent test variable</td>
</tr>
<tr>
<td>CARD</td>
<td>VARIABLE</td>
<td>VALUE</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>7</td>
<td>NPLLOT</td>
<td>-</td>
<td>Number of plots per sheet</td>
</tr>
<tr>
<td>8</td>
<td>YTAPE</td>
<td>-</td>
<td>Data array location of y-axis variable</td>
</tr>
<tr>
<td></td>
<td>YOFFSET</td>
<td>-</td>
<td>Sheet height location of y-axis origin, in.</td>
</tr>
<tr>
<td></td>
<td>YSCALE</td>
<td>-</td>
<td>Scale value per inch for y-axis</td>
</tr>
<tr>
<td></td>
<td>YLABEL</td>
<td>-</td>
<td>Label for y-axis</td>
</tr>
<tr>
<td></td>
<td>XTAPE</td>
<td>-</td>
<td>Data array location of x-axis variable</td>
</tr>
<tr>
<td></td>
<td>XOFFSET</td>
<td>-</td>
<td>Sheet width location of x-axis origin, in.</td>
</tr>
<tr>
<td></td>
<td>XSCALE</td>
<td>-</td>
<td>Scale value per inch for x-axis</td>
</tr>
<tr>
<td></td>
<td>XLABEL</td>
<td>-</td>
<td>Label for x-axis</td>
</tr>
</tbody>
</table>

Card 8 is input NPLLOT times and NPLLOT is limited to a value of 10 for each setup.

<table>
<thead>
<tr>
<th>NAMELIST VARIABLE</th>
<th>VALUE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>$SHEET</td>
<td>-</td>
<td>Namelist label</td>
</tr>
<tr>
<td>NO</td>
<td>-</td>
<td>Sheet number</td>
</tr>
<tr>
<td>RUN</td>
<td>-</td>
<td>Run numbers to be plotted on sheet</td>
</tr>
<tr>
<td>NEWCASE</td>
<td>0 or default 1</td>
<td>A new SHEET namelist follows A new setup deck follows</td>
</tr>
<tr>
<td>$END</td>
<td>-</td>
<td>End of namelist</td>
</tr>
</tbody>
</table>

Note that no part of the namelist may be in column 1 and that a maximum of 10 run numbers may be input per sheet.
APPENDIX C

DESCRIPTION OF OUTPUT FOR WIND-TUNNEL DATA PLOTTING PROGRAM PLOTWD

This appendix contains a description of the typical output for the wind-tunnel data plotting program PLOTWD. A sample four-page output is presented in table IV and was generated from the upper set of sample input data presented in table III. Page 1 of the output is a printout of the input setup data as described in appendix B. This page should be carefully checked after each program execution to insure that the desired plotting variables and scales have been properly input. Page 2 of the output is a list of the run numbers contained in the data copied from the input file TAPE1 to the random-access file TAPE2. The total number of data points copied to the random-access file is printed following the list of run numbers. The quantity NPMAX and the dimensioned size of the array NPT in the main program PLOT should be equal to or greater than the total number of data points copied to file TAPE2.

Page 3 of the output is a list of the sheet and corresponding run numbers plotted. A run number with the value zero indicates that no data were plotted with the symbol corresponding to the order of the run number in the list. If the user-specified run number is not available on the random-access file, a message will be printed stating that the specified run could not be found. In addition, if during the plotting of the scaled data any data points fall outside the sheet boundaries, a message will be printed stating the number of data points outside the boundaries. These outside data points will not be plotted and, therefore, may require that the user redefine either the axis scale factors or the sheet height and width.

If the user selects the sort and edit option, page 4 will be output which contains a summary of the sort and edit information for each run called during the program execution. The first set of values listed in this summary are the input values of the independent variable t for the particular run. The sorted
t values listed next represent the results of the sorting procedure which simply reorders the input values in a monotonically increasing order. The sorted t values for a particular run will be the same regardless of the number of times the run is plotted. The edited and deleted t values listed last represent the results of the editing procedure which deletes all but one of the multiple data points within the specified tolerance TOLR. The data points deleted are selected based on the input y values for the particular part of the figure and, therefore, may be different for each part. The edited and deleted t values listed are only for the first part of the figure. The deleted points are not used during the spline curve fairing process, but nevertheless, they are plotted with the appropriate symbol.

If the user replaces the call to subroutine CURPLT in the main program PLOT with a call to subroutine LSQPLT, the sample output summary information presented in table V will be listed for the least-squares polynomial curve fit option and in table VI for the least-squares cubic-spline curve fit option. The parameter IPRINT in subroutine LSQPLT must also be set equal to 1 for the summary information to be listed. This information will appear in the output immediately following the print of the particular sheet and corresponding run numbers on page 3 of the basic output. The summary information will be listed each time the subroutine is called; therefore, the user is cautioned that a large amount of printed output can easily be generated even if a moderate number of plots and runs are specified.

The summary information presented in tables V and VI consists of a tabulated listing of the input t, x, and y values, the new x and y values generated by the least-squares curve fit, and the differences between input and new x and y values. Immediately following the tabulated listing, the sum-of-the-squares of the differences between the input and new x and y values are listed as an error-in-x and -y, respectively. If the independent
variable $t$ and the x-axis variable are the same as it is for the sample output case, the error-in-$x$ will be very small. If the least-square polynomial curve fit option is chosen, the error-in-$x$ and -$y$ will be a function of the degree of the polynomial. If the least-square cubic-spline option is chosen, the error-in-$x$ and -$y$ will always be equal to the product of the number of input points times the square of the standard deviation $DF$. 
<table>
<thead>
<tr>
<th>ISYM</th>
<th>SYMBOL</th>
<th>DASHED LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>◆</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>△</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>▽</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>○</td>
<td></td>
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<td>+ ◆ + △</td>
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TABLE II. - LIST OF STANDARD AERODYNAMIC SYMBOLS DRAWN BY SUBROUTINE COEFSY

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<th>WIDTH/HEIGHT</th>
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<td>Drag</td>
<td>$C_D$</td>
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<td>$C_m$</td>
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<td>Yawing Moment</td>
<td>$C_n$</td>
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<td>Lift-Drag Ratio</td>
<td>$L/D$</td>
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<td>Angle of Sideslip</td>
<td>$\beta, \text{deg}$</td>
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### TABLE III. LISTING OF SAMPLE INPUT CASES

#### CASE 1 - Single Plot with Three Variables

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#### CASE 2 - Four Plots with One Variable

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### TABLE IV. - SAMPLE OUTPUT FOR CASE 1 INPUT

#### PAGE 1 OUTPUT

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#### PAGE 2 OUTPUT

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**TOTAL NUMBER OF DATA POINTS = 4901**

#### PAGE 3 OUTPUT

Data plotted:

| SHEET NO = 206 | RUNS = 39, 59, 0, 0, 0, 0, 0, 0, 0, 0 |

119
### TABLE IV. - CONCLUDED

**PAGE 4 OUTPUT**

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ALL PLOTTING COMPLETED
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<td>20.3750</td>
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<td>22.3900</td>
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<td>28.3500</td>
<td>28.3500</td>
<td>0.0000</td>
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<td>.2056</td>
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**ERROR IN X = 0.154875E-22**  
**ERROR IN Y = 0.189547E+00**
### TABLE VI. - SAMPLE OF LEAST-SQUARES CUBIC-SPLINE CURVE FIT

**DATA PLOTTED**

<table>
<thead>
<tr>
<th>SHEET NO = 206</th>
<th>RUNS = 39, 59, 0, 0, 0, 0, 0, 0, 0, 0</th>
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**RESULTS OF LEAST SQUARES CUBIC SPLINE CURVE FIT FOR RUN = 39**  
**NSYM = 1**  
**DF = .10000**

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<thead>
<tr>
<th>I</th>
<th>T</th>
<th>X</th>
<th>XNEW</th>
<th>X-XNEW</th>
<th>Y</th>
<th>YNEW</th>
<th>Y-YNEW</th>
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<td>1.0207</td>
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</tr>
<tr>
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<td>1.9100</td>
<td>0.0000</td>
<td>1.4455</td>
<td>1.4164</td>
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</tr>
<tr>
<td>3</td>
<td>-1.8800</td>
<td>3.0600</td>
<td>3.0600</td>
<td>0.0000</td>
<td>1.7651</td>
<td>1.8793</td>
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<tr>
<td>4</td>
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<td>4.0850</td>
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<tr>
<td>5</td>
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<td>5.0050</td>
<td>5.0050</td>
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<tr>
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<td>6.1400</td>
<td>6.1400</td>
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<td>9.1600</td>
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<tr>
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<td>11.2000</td>
<td>11.2000</td>
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<td>5.2396</td>
<td>.1644</td>
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<tr>
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<td>12.4000</td>
<td>12.4000</td>
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<td>15.3750</td>
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<td>6.5800</td>
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</tr>
</tbody>
</table>

**ERROR IN X = .575553E-25**  
**ERROR IN Y = .190000E+00**
### TABLE VII. - COMPUTER CODE FOR CASE 1

```plaintext
C DEFINE HEIGHT OF COEFFICIENTS
  HT=0.4
C DEFINE HEIGHT OF AXIS LABELS
  SZ=0.75*HT
C PROVIDE A BLANK SPACE AT BOTTOM OF PLOT FOR FIGURE TITLE
  CALL CALPLT (0.0,4.0,-3)
C DRAW GRID LINES
  CALL GRIDLN (0.0,0.0,20.0,23.0,1)
C DRAW ZERO LINES
  CALL ZEROLN (4.0,0.0,23.0,2)
  CALL ZEROLN (0.0,2.0,20.0,1)
  CALL ZEROLN (0.0,11.0,20.0,1)
  CALL ZEROLN (0.0,20.0,20.0,1)
C DRAW AND LABEL X-AXIS ( ALPHA )
  CALL AXISLB (1.0,0.0,0.0,-9.0,2.0,20.0,SZ,-1)
  XO=(20.0-3.5*HT)/2.0
  YO=-1.0
  CALL COEFSY (XO,YO,HT,8)
C DRAW AND LABEL LOWER PORTION OF Y-AXIS ( CL )
  CALL AXISLB (2.0,0.0,0.0,-0.8,0.4,10.0,SZ,1)
  XO=-1.8
  YO=5.0
  CALL COEFSY (XO,YO,HT,1)
C DRAW AND LABEL MIDDLE PORTION OF Y-AXIS ( CD )
  CALL AXISLB (2.0,0.0,11.0,0.0,0.8,5.0,SZ,1)
  XO=-1.8
  YO=13.5
  CALL COEFSY (XO,YO,HT,2)
C DRAW AND LABEL UPPER PORTION OF Y-AXIS ( CM )
  CALL AXISLB (2.0,0.0,17.0,-1.2,0.4,6.0,SZ,1)
  XO=-1.8
  YO=20.0
  CALL COEFSY (XO,YO,HT,3)
C DRAW AND LABEL RUN KEY
  XO=2.0
  YO=HT+23.0
  CALL RUNKFY (XO,YO,RUN,LSYM,ISIZE,HT,10)
```

TABLE VIII.-COMPUTER CODE FOR CASE 2

```
C DEFINE HEIGHT OF COEFFICIENTS
HT=0.25
C DEFINE HEIGHT OF AXIS LABELS
SZ=0.75*HT
C PROVIDE A BLANK SPACE AT BOTTOM OF PLOT FOR FIGURE TITLE
CALL CALPLT (0.0,3.0,-3)
C
C LOWER LEFT-HAND PLOT (CM VS CL)
C
C DRAW GRID LINES AND ZERO LINES
CALL GRIDLN (0.0,0.0,5.0,5.01)
CALL ZEROLN (1.0,0.0,5.0,2)
CALL ZEPOLN (0.0,2.0,5.0,1)
C
C DRAW AND LABEL X-AXIS
CALL AXISLB (1,0.0,0.0,0.0,0.0,5.0,5.0,1)
XO=15.0-2.0*HT)/2.0
YO=0.8
CALL COEFSY (XO,YO,HT+1)
C
C DRAW AND LABEL Y-AXIS
CALL AXISLB (2,0.0,0.0,-0.8,0.8,5.0,5.0,1)
XO=1.0
YO=2.5
CALL COEFSY (XO,YO,HT,3)
C
C LOWER RIGHT-HAND PLOT (L/D VS ALPHA)
C
C DRAW GRID LINES AND ZERO LINES
CALL GRIDLN (7.0,0.0,5.0,5.01)
CALL ZEROLN (8.0,0.0,5.0,2)
CALL ZEPOLN (7.0,1.0,5.0,1)
C
C DRAW AND LABEL X-AXIS
CALL AXISLB (1,7.0,0.0,-10.0,10.0,5.0,5.0,1)
XO=7.0*(5.0-3.5*HT)/2.0
YO=0.8
CALL COEFSY (XO,YO,HT/8)
C
C DRAW AND LABEL Y-AXIS
CALL AXISLB (2,7.0,0.0,-4.0,4.0,5.0,5.0,1)
XO=6.0
YO=2.5
CALL COEFSY (XO,YO,HT,7)
C
C UPPER LEFT-HAND PLOT (CL VS ALPHA)
C
C DRAW GRID LINES AND ZERO LINES
CALL GRIDLN (0.0,7.0,5.0,5.01)
CALL ZEROLN (1.0,7.0,5.0,2)
CALL ZEPOLN (0.0,8.0,5.0,1)
C
C DRAW AND LABEL X-AXIS
CALL AXISLB (1,0.0,7.0,-10.0,10.0,5.0,5.0,1)
XO=5.0-3.5*HT)/2.0
YO=6.2
CALL COEFSY (XO,YO,HT/8)
C
C DRAW AND LABEL Y-AXIS
CALL AXISLB (2,0.0,7.0,-0.8,0.8,5.0,5.0,1)
XO=1.0
YO=9.5
CALL COEFSY (XO,YO,HT,1)
C
C UPPER RIGHT-HAND PLOT (CD VS CL)
C
C DRAW GRID LINES AND ZERO LINES
CALL GRIDLN (7.0,7.0,5.0,5.01)
CALL ZEROLN (8.0,7.0,5.0,2)
CALL ZEPOLN (7.0,7.0,5.0,1)
C
C DRAW AND LABEL X-AXIS
CALL AXISLB (1,7.0,7.0,-0.8,0.8,5.0,5.0,1)
XO=7.0*(5.0-2.0*HT)/2.0
YO=6.2
CALL COEFSY (XO,YO,HT/8)
C
C DRAW AND LABEL Y-AXIS
CALL AXISLB (2,7.0,7.0,0.0,0.0,5.0,5.0,1)
XO=6.0
YO=9.5
CALL COEFSY (XO,YO,HT,2)
C
C DRAW AND LABEL RUN KEY
C
XO=1.0
YO=12.0+HT
CALL RUNKEY (XO,YO,DRUN,LSYM,ISIZE,HT,10)
```
Figure 1. - Plot of Case 1 input with standard symbols and cubic-spline curve fairing.
Figure 2. - Plot of Case 1 input with standard dashed line combination and cubic-spline curve fairing.
Figure 3 - Plot of Case 1 input with least-squares curve fairing.
b) Least-Squares Cubic Spline

Figure 3. - Concluded.
Figure 4. - Plot of Case 1 input with grid lines, axis scale values and labels, and legend drawn.
<table>
<thead>
<tr>
<th>Symbol</th>
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<tbody>
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</tr>
<tr>
<td>[ ]</td>
<td>59</td>
</tr>
</tbody>
</table>

Figure 5. - Plot of Case 2 input with grid lines, axis scale values and labels, and legend drawn.
This report contains a detailed description of the Langley computer program PLOTWD which plots and fairs experimental wind-tunnel data. The program was written for use primarily on the Langley CDC computer and CALCOMP plotters. The fundamental operating features of the program are that the input data are read and written to a random-access file for use during program execution, that the data for a selected run can be sorted and edited to delete duplicate points, and that the data can be plotted and faired using tension splines, least-squares polynomial, or least-squares cubic-spline curves. The most noteworthy feature of the program is the simplicity of the user-supplied input requirements. Several subroutines are also included that can be used to draw grid lines, zero lines, axis scale values and labels, and legends. A detailed description of the program operational features and each subroutine are presented. The general application of the program is also discussed together with the input and output for two typical plot types. A listing of the program code, user-guide, and output description are presented in appendices. The program has been in use at Langley for several years and has proven to be both easy to use and versatile.
DO NOT REMOVE SLIP FROM MATERIAL

Delete your name from this slip when returning material to the library.

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<tr>
<th>NAME</th>
<th>MS</th>
</tr>
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<tr>
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