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A Device Independent Graphics Kernel

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Abstract

This paper describes an interface for programs which allows one to write graphics primitives to several devices without regard for the type of device. The most salient features are that it has low overhead, is transportable and can be expanded as the nature of the input/output devices changes. A conscious effort has been made to include all normal graphics primitives together with the most useful high level routines without compromising the use of special features of custom display units.

Keywords: device independence, display devices, graphics

1. INTRODUCTION

This paper describes a graphics package which is intended to ease the use of input/output devices in acquiring and displaying information graphically. The intent is to reduce the problem to its simplest level by allowing one to describe graphs in much the same way one thinks of them. A further intent is to make the user language truly device independent and allow a programmer or other user to switch devices interactively simply by identifying the desired input and output devices. As much as possible, the similarity in instructions to different devices is maintained. There are some limitations of course. Pen plotters do not normally come with erasers and most storage scopes (e.g., Tektronics) are not erasable on the individual pixel level. Beyond this no function which is available for a particular device, but not supported because there is no commonality amongst the devices, is rendered unavailable. Thus, even for specialized usage, this package will take care of normal initialization and setup.

The devices which are currently supported are Plot-10 emulators, CALCOMP pen plotters, a line printer and the Lexidata 3400/8100 series[1]. These devices encompass most protocols and slots have been left in the package for future expansion. We currently support these devices since those are the ones which are available. Any suggestions for expansion or additional functions are welcome.

2. OVERVIEW

Graphics application programs may be required to send output to or accept input from several devices. Since each output device is supported by different sets of graphics routines, writing application programs is normally

[1]Certain commerical equipment is identified in this paper in order to illustrate adequately certain device specific characteristics. Such idenification does not imply recommendation or indorsement by the National Bureau of Standards, nor does it imply that the equipment is necessarily the best availale for the purpose.

burdensome since applications may reguire several device-dependent versions of each program. Alternatively, each application could include all the device-dependent routines in one version of each program, and call only the routines required for a specific device, e.g., by means of GO TO statements. In either case, when a new device is added to the work environment, application programmers must learn another set of graphics routines and write new codes for each application. This reprogramming can be time-consuming and costly.

A graphics system which supports several input and output devices, while hiding the device-dependent routines from the user, is desirable. DEVICE is a package of FORTRAN subroutines for producing graphics output on several devices. The package consists of one standard routine for each output primitive (line, polygon, character, etc.). Once a device has been identified, a primitive is displayed through a call to the appropriate routine. This routine is also used to generate the same output on other devices. Hence DEVICE is an interface between the application program and the input/output devices since each standard routine is device-independent, as shown in Figure 1.

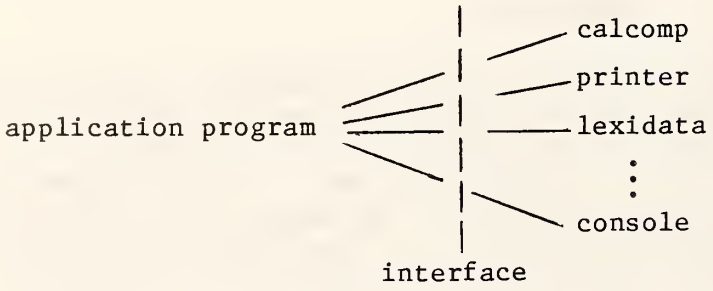


FIGURE 1

Every hardware interface routine is divided into sections. Each of these sections is devoted to a device. Once a primitive is called by a program, command goes to the section designed for the accessed device, as shown in table 1.

Table 1
A Sample of the Hardware Interface Protocol

```
      SUBROUTINE SAMPLE
      :
      :
      COMMON/DEV/IDEV
      GO TO (1,2,...n) IDEV

C     CALCOMP SECTION
1     :     graphics subroutines
      :
      RETURN

C     PRINTER SECTION
2     :     graphics subroutines
      :
      RETURN
      :
      :
      END
```

The coordinates used in labeling a viewing area differ for each device. Therefore, the user's data points must be converted into device coordinates (see section 5). This conversion is done by DEVICE before device-dependent routines are called. The format of a typical graphics subroutine is

```
      SUBROUTINE SAMPLE
      :
      :
      COMMON/DEV/IDEV
      GO TO (1,2,...n) IDEV

C     CALCOMP SECTION
1     convert to CALCOMP coordinates
      call CALCOMP graphics routines
      RETURN

C     PRINTER SECTION
2     convert to PRINTER coordinates
      call PRINTER graphics routines
      RETURN
      :
      :
C     CONSOLE SECTION
n     convert to CONSOLE coordinates
      call CONSOLE graphics routines
      RETURN
      END
```

2.1 Structure of the Package

These routines can be grouped into 6 categories summarized below and defined in table 2. More detail is given in the apprendixes.

1. Device Control - utility routines which include initialization and termination procedures for the device

2. Viewing - specify the part of the user's coordinate system to display and where to place the display on the viewing surface

3. Output Primitives - define objects and display them on the viewing surface

4. Attributes - define the appearance of the output primitives

5. Auxiliary - miscellaneous routines

6. Input - acquire data.

Table 2. Graphics Subroutines - General Format

1. Device Control	Function
DEVICE (n)	initialize a graphics device
NEWFRM	clear the screen and initialize a new frame
HDCOPY	generate a hard copy
FRAME	write out the buffer
ERASE	clear the screen (also done in "NEWFRM")
ENDFRM	close the graphics device

2. Viewing	Function
SCALNG (X1, Y1, X2, Y2, X1H, Y1H, X2H, Y2H, X1S, Y1S, X2S, Y2S)	define the window and viewport
DEFINE (X1, Y1, X2, Y2)	define the window (viewport defaults to entire viewing surface)

3. Output Primitives	Function
LINE (X1, Y1, X2, Y2)	draw a line between 2 points
LINES (X1, Y1, X2, Y2, N)	draw a line between points in an array of length n
LNPLOT (X, Y, I1, I2, I3)	draw lines between selected points of an array
PLYGON (X, Y, N)	draw a closed polygon
BOXPLT (X1, Y1, X2, Y2)	draw a rectangle
CIRCLE (X, Y, R)	draw a circle
SURFAC (Z, NX, NY, MODE)	performs surface plotting
CONTUR (F, TEST, NX, NY, FL)	performs contour plotting
VOLUME (MODE, F, NX, NY, NZ, CLEVEL, NCL, T, NT)	performs volume plotting (3 dimensional contouring)
SYMBOL (X, Y, CHAR)	draws a specified hardware character at a given point
CHPLOT (X, Y, CHAR, I1, I2, I3	draws a specified hardware character at selected points in an array
HHDRAW (X, Y, SX, SXY, ICHAR, NSET, NSET, IERR)	draws a particular character of the specified character set
WDDRAW (X, Y, DX, DY, SX, SXY SY, CHARS)	draws a character string

LABEL (CHARS, X1, Y1, X2, Y2, ANGLE)	draws a character string
ALABEL (CHARS, X1, X2, Y1, Y2, ANGLE)	draws a character string with aspect ratio 4/3
FNUMBR (X, Y, DX, DY, SX, SXY, SY, XNUMBR, WIDTH, DIGITS)	draws a real number in FORTRAN F-type format
ENUMBR (XNUMBR, X1, Y1, X2, Y2)	draws a real number in exponential (E) format (E - type)
GRAFIT (NPLT, X1, X2, X1R, X2R, XX1, XX2, Y1, Y2, Y1R, Y2R, YY1, YY2, XTIT, NDVX, YTIT, NDVY)	sets up a graph (x and y axis) for plotting data
PLYPLT (F, IS)	read in a "BUILD" formatted structure file, F and display according to IS
MAPIN (FW, V, NV, E, ES, NE, P, PS, NP)	read a "BUILD" file and return the vertices, edges and polygons. Files are appended after the initial call.
MAPOUT (W, V, NV, E, ES, NE, P, PS, NP)	display the specified edges as given
VIEWTR (X, W, V, NV, E, ES, NE, P, PS, NP)	display the specified edges and polygons using the transform matrix X.

4.

Attributes	Function
COLOR (N)	defines the color for drawing
LINWID (N)	defines the line width
FILTYP (N)	defines the appearance of the interior of polygons and circles
CHRSIZ (CHFRZ, GCHFRZ)	sets the size of the hardware characters
CHRSET (N)	changes the default character set

5.

Auxiliary	Function
IOWAIT (N)	puts a pause in the program
SETDEV (N1, N2)	changes logical units
DELAY (N)	delays for hard copy units
SETLUT	sets up the color look-up table

6. Input

DEVINP (I, status, X,Y,Z)	read input coordinates triplet from a device

3. COORDINATE SYSTEMS

The application must define the environment in which it will operate. For instance, temperature may be calculated in degrees celsius for one study, while length is measured in feet for another project. Data can be sent to the DEVICE routines directly from the application; no conversion to a standard unit is required of the user. Within the graphics package, however, the data coordinates must be converted to device-dependent coordinates for the individual hardware.

The user space is a 3-dimensional left-handed coordinate system (positive x-axis to the right, positive y-axis up, and positive z-axis into the viewing surface). Data points are added to the space in "application-dependent" coordinates. Before these points can be displayed, a window and a viewport must be specified.

The window, a rectangle in the x-y plane of the user space, encloses the points to be displayed. This window is mapped into the device's world space. The world space is labeled differently for each device. The world space is determined by the device's fixed points (X1S, Y1S) and (X2S, Y2S). The window is defined by the user who specifies the diagonal endpoints (X1, Y1) and (X2, Y2). The window is mapped to the world space by the scale factors:

```
XYCOORD(1) = (X2S - X1S)/(X2 - X1)
XYCOORD(2) = X1S - X1 * XYCOORD(1)
XYCOORD(3) = (Y2S - Y1S)/(Y2 - Y1)
XYCOORD(4) = Y1S - Y1 * XYCOORD(3)
```

A point (X,Y) in the user space is converted to the world coordinate (XS,YS) by the transformation:

```
XS = X * XYCOORD(1) + XYCOORD(2)
YS = Y * XYCOORD(3) + XYCOORD(4)
```

Any point within the user's window will be converted into valid world coordinates (i.e., X1S $\leq$ XS $\leq$ X2S and Y1S $\leq$ YS $\leq$ Y25) and can be plotted. Other points will be mapped out of the device's range and should not be displayed on the viewing surface.

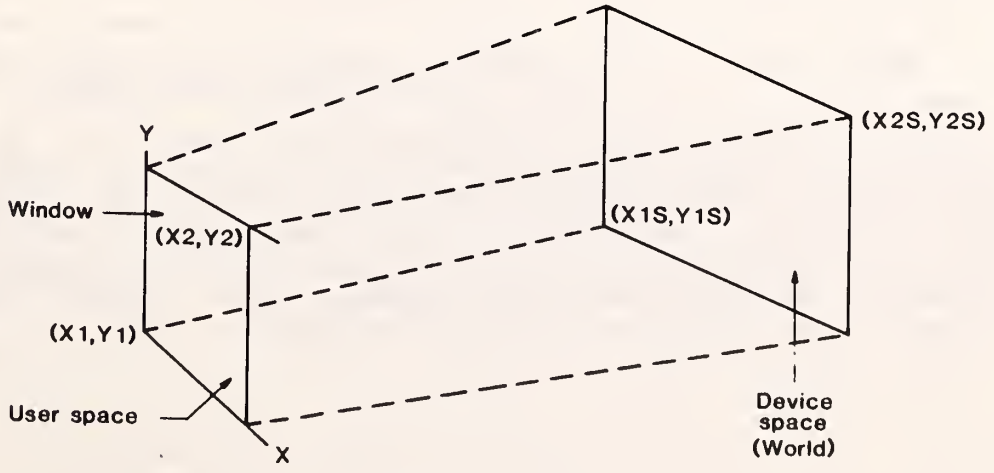


FIGURE 2

The part of the viewing surface which will contain the display is called the viewport. The viewport defaults to the entire viewing surface. In order to place the display on a smaller portion of the viewing surface, the desired rectangular area must be specified. The device coordinates (X1H, Y1H) and (X2H, Y2H) are used to define this viewport. The world space is then mapped onto the viewport. Hence, all data points in the user space are converted to device coordinates through 2 transformations. Only points in the user's window will be transformed into valid device coordinates (i.e., coordinates within the device's viewport).

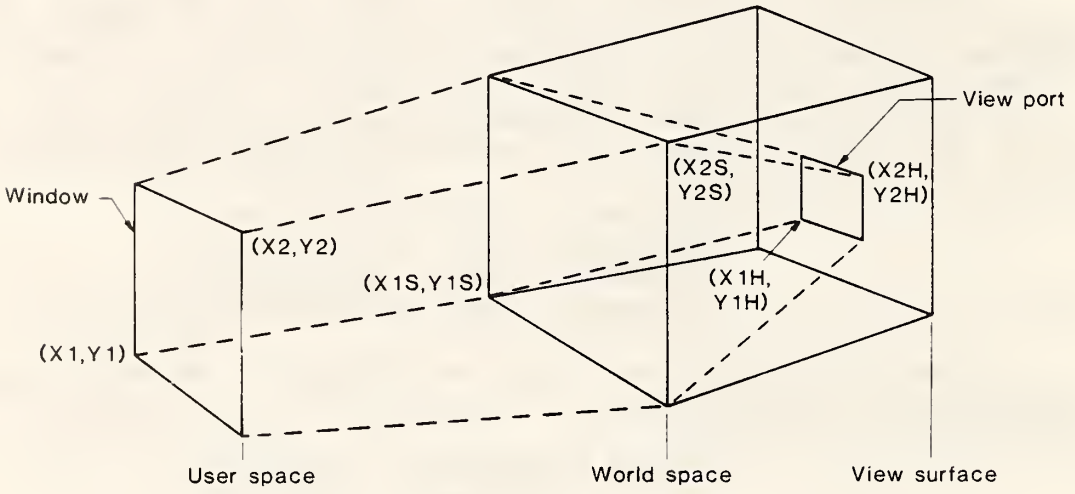


FIGURE 3

Usual usage is to transform the viewport to the entire viewable space (view surface). In this case a call to DEFINE is sufficient. The default values for the device world coordinate space are used, and the defined window is mapped to the maximum normalized device coordinates. Special applications might require other tranformations. Such a facility is provided by SCALNG. This routine specifies the transform from user space to world coordinate space, from world coordinate space to normalized device coordinates and finally to the device (or hardware) address units. Table 3 shows the default values for the current list of output device.

TABLE 3
DEVICE COORDINATES

OUTPUT	WORLD		NORMALIZED		PHYSICAL	
	X	Y	X	Y	X	Y
Lexidata	128000	102300	32700	26160	1279	1023
Tek 40XX	1280	1024	1029	1029	1023	768
CALCOMP	-	-	1029	1023	10.75	8.75
Printer	1279	1023	1279	1023	128	50

The physical (device) coordinates map windows to the full viewing space. Some applications require use of only a portion of this space. An example is the reduction of about 15% of the linear dimensions in order to fit into a 512 line raster scan television frame.

4. STRUCTURE DATA FILES

Several programs create and modify structure files for graphical display. The elements used to compose these structures are vertices, edges, and polygons. The elements are stored in user coordinates in the data file. Attributes for these elements along with the specifications of the user space, are also stored in this file.

Listed at the beginning of the data file are the dimensions of the user space and the window space. The boundaries of the window are put into the WINDOW array: WINDOW (1 → 4) {(left - bottom), and (right - top), respectively}, while the boundaries of the user space are sent to the WORLD array: WORLD (1 → 6) {left, bottom, front, and right, top, back}, respectively. This latter three dimensional space specification is not currently used.

The following two images in the data files specify the number of vertices, elements (defined as polygons + edges) and the number of edges, and a description of the elements by groups. This latter is currently implemented only in ADDMAP, described in Section 6.3.

The data for the elements and attributes comprise the remaining part of the file. The vertex coordinates (x,y,z) are stored next, followed by element pointers. The input routines read the data for the vertices into the array VERTEX (i,j). Here, the row index, i, (possible values = 1,2,3) refers to the i^{th} coordinate (x, y, or z, respectively) and the column vector j refers to the vertex number. For instance VERTEX (2,5) stores the value of the y coordinate of the 5^{th} vertex. In the file, each coordinate triplet is preceded by zero (0) or one (1). A zero indicates that the vertex was deleted from the user space (i.e., the vertex is not used for displaying or for constructing edges and polygons) but was not deleted from the data file. A one (1) specifies that the vertex exists in the user space. An example would be deleting a polygon without removing the corresponding vertices.

The vertices are grouped together to form edges and polygons. Following the list of vertex coordinates is the list of elements. Each element, either an edge or a polygon, is identified by its endpoints which are in

EDGE (i,j) or POLY(i,j),

where i specifies which of the two endpoints and j indicates the element number. For example, if the fourth edge is composed of vertices 6 and 10, we have

EDGE (1,4) = 6 and EDGE (2,4) = 10

Polygons are stored in a similar manner. POLY(i,j) contains the vertex number of the i^{th} vertex of the j^{th} polygon. Polygons have no more than NPVERT (currently 8) vertices.

Data for each edge or polygon fills one row of the data file. The element's vertices are listed first and are followed by the element's attributes. The attributes are read into the arrays ESPEC (i,j) or PSPEC (i,j) for edges and polygons, respectively. Here the i specifies the attribute and j indicates the element number.

i	ESPEC (i,j)
1	line width
2	color
3	line attribute
4	<unused>

i	PSPEC (i,j)
1	line width
2	color
3	fill type
4	polygon (≥0) or polyline (<0)

A sample data file is shown in Table 3. In this file there are 9 valid vertices, 1 "deleted" vertex, 1 edge, and 3 polygons. (Note that the last polygon is actually a polyline.) The same data as listed by the BUILD program is shown in Table 4.

Table 3

```
BUILD 0.00000E+00 0.00000E+00 1.28000E+03 1.02400E+03
-1.00000E+09-1.00000E+09-1.00000E+09 1.00000E+09 1.00000E+09 1.00000E+09
 1           10    4    1
 1           4
 1        1.55608E+02  7.37531E+02 0.00000E+00
 1        4.03576E+02  9.39818E+02 0.00000E+00
 1        5.00956E+02  7.45070E+02 0.00000E+00
 1        2.60015E+02  6.44554E+02 0.00000E+00
 0        4.36470E+02  3.88245E+02 0.00000E+00
 1        9.64768E+02  6.44554E+02 0.00000E+00
 1        5.30060E+02  3.68136E+02 0.00000E+00
 1        5.30070E+02  5.88014E+02 0.00000E+00
 1        8.03136E+02  5.88014E+02 0.00000E+00
 1        8.03136E+02  4.63627E+02 0.00000E+00
          4  6  0  0  0  0  0  0  0  2  1  0  0
          1  2  3  0  0  0  0  0  0  2  1  0  0
          6  7  8  9  0  0  0  0  0  2  8  1  0
          1  4  7  0  0  0  0  0  0  2  1  0 -1
```

The edge, polygon and polyline entries in Table 3 are integer format. In this case there are 13 entries for each element. For polygons and polylines, NPVERT entries, a zero for compatibility with"MOVIE.BYU" and the 4 NSPEC entries. For edges, here are two entries, seven zeros and the 4 ESPEC entries.

Table 4

	WORLD			WINDOW	
LEFT,BOTTOM,FRONT:	-1.0E+09	-1.0E+09	-1.0E+09	LEFT BOTTOM:	0.0 0.00
RIGHT, TOP, BACK:	1.0E+09	1.0E+09	1.0E+09	RIGHT,TOP:	1.3E+03 1.0E+03

	VERTEX(X,Y,Z)		
1)	155.61	737.53	0.00000
2)	403.58	939.82	0.00000
3)	500.96	745.07	0.00000
4)	260.02	644.55	0.00000
6)	964.77	644.55	0.00000
7)	530.07	368.14	0.00000
8)	530.07	588.01	0.00000
9)	803.14	588.01	0.00000
10)	803.14	463.63	0.00000

	EDGES									SPECS		
1)	4	6							2	1	0	0

	POLYGONS									SPECS		
1)	1	2	3	0	0	0	0	0	2	1	0	0
2)	6	7	8	9	0	0	0	0	2	8	1	0
3)	1	4	7	0	0	0	0	0	2	1	0	-1

5. INPUT/OUTPUT DEVICES

Currently four separate input and output devices are supported. These encompass all the common standard interfaces and the flexibility exists to include any future input/output device for which a transformation between the hardware and mathematical space can be given. The devices for output are a CALCOMP pen plotter (1012), Tektronix 40XX or emulator, Lexidata Displays (8100 and 3700) and a line printer. Devices for input are a digitizing tablet, a joystick, segments in the Lexidata picture descriptor lists which can be "picked" and ASCII input from a keyboard or file.

The software maintains three dimensional picture descriptors. Although only the Lexidata 3700 can utilize this capability directly, perspective and visual cuing can be shown on the other devices. The coordinate limits of the hardware are shown in Table 5.

TABLE 5

DEVICE	Xmin/Xmax	Ymin/Ymax	Zmin/Zmax
Tektronix 40XX	0/768	0/1023	-
Printer	1/128	format limited	-
Joystick	0/32767	0/26160	-
Lexidata 8100	0/1279	0/1023	-
Lexidata 3700	0/1279	0/1023	0/4095
Tablet	$0/12190_9$	$0/9142_9$	-
Segments	$0/\sim 10^9$	$0/\sim 10^9$	
Calcomp plotter	0/11.5	0/8.5	

These are the local address modes for pixels and not the normalized device coordinates (see section 3). This group of devices includes almost all standard protocols for graphics interfaces. These are the CORE standard, escape sequences, direct (DMA) input/output of pixels, line oriented input/output (ASCII) and the very early protocols formulated by Tektronix and CALCOMP. Slots have been left in the software to accomodate new devices. At the time of this writing, the GKS standard has not been formalized. However, if it is similar to the proposed standard then inclusion of devices which follow this protocol is straightforward.

6. IMPLEMENTATION

6.1 BUILD

The BUILD program is used to create, modify, or display files consisting of vertices, edges, and polygons. These files also contain the elements' characteristics: line width, color, and polygon fill type. The first step in creating a file is to specify the user space and the window. The user space defaults to a cube centered at the origin and having sides of length 6×10^9. Prompts are used by the programs when needed. There are no default values for the window space. The x and y coordinates of the window must be specified with a call to

WINDOW

At this point, data for the various structures may be entered and subsequently modified or displayed. The work file, however, need not be a new file. It is possible to alter or display data of an existing file. The command to access an old file is

GET [filename]

where the file defaults to INFILE, the last file accessed. Similarly, a work file may be saved by

SAVE [filename]

In this case, the default file is OUTFILE which is the last file that was saved. A check of the filenames stored in INFILE and OUTFILE is possible by calling

STATUS

This command also indicates the number of vertices, edges, and polygons in the work file along with the maximum number of each element allowed.

The work file is modified in several ways. Elements are added to the file with

ADD { VERTEX / EDGE / POLYGON } (default = VERTEX)

Vertices are input by specifying three (x,y,z) coordinates. Edges are specified by pointing to two vertices and polygons are defined by indicating a minimum of 3 vertices to a maximum of NPVERT vertices.

Elements can be added from any of the input devices. The command

SET { JOYSTICK / TABLET / KEYBOARD } (default = KEYBOARD)

sets the default input device. At the start of program execution, the keyboard is the data input device. To add data from a different device, SET must be used before ADD.

If the attributes of new edges or polygons are to be different than the default characteristics, the command

SELECT

must be used before the ADD command. SELECT allows the specification of the line width, color, polygon fill type and a user specification parameter, the fourth element in ESPEC and NSPEC. These new values then become the default attributes.

Elements are deleted from the file with the command

DELETE { VERTEX / EDGE / POLYGON } (default = VERTEX)

When a vertex is deleted, any edge or polygon containing that vertex is also deleted. It should be noted that the vertex is not deleted from the permanent data file; instead, this point is marked with a flag to indicate deletion from the user space. In order to remove vertices from the data file, the

SQUEEZE

command is used. All "flagged" vertices, along with any vertices in the user space which are not used by an edge or a polygon, are deleted from the data file by SQUEEZE. When the DELETE command is used for polygons and edges, however, these elements are removed from the user space and the data file.

Once added to the user space, the elements can be modified. Elements are moved to new locations through the command

$$\text{MOVE} \quad \left\{\begin{matrix}\text{VERTEX} \\ \text{EDGE} \\ \text{POLYGON}\end{matrix}\right\} \qquad \text{(default = VERTEX)}$$

A vertex can be moved by specifying its new (x,y,z) coordinates. Alternatively, a single vertex or a group of vertices can be moved a distance given by an (x,y,z) displacement vector. MOVE EDGE allows a single edge or a group of edges to change location by a specified (x,y,z) distance. Polygons are moved in the same manner as edges. "MOVE" makes new verticies when moving edges or polygons. In addition, duplicates of elements can be created with

$$\text{DUPLICATE} \quad \left\{\begin{matrix}\text{EDGE} \\ \text{POLYGON}\end{matrix}\right\} \qquad \text{(default = VERTEX)}$$

The new elements are positioned at the designated displacement from the original position.

In addition to modifying portions of the model, the entire structure can be transformed. The model is moved to another part of the user space with the command

TRANSLATE

accompanied by an (x,y,z) displacement vector. A rotation of the model about a specified point (default is the body center of gravity for the model) is possible with

ROTATE

The rotations occur about axes parallel to the x-, y-, or z-axes of coordinate system. The axis and angle of rotation are specified. The structure is scaled about its center point by

SCALE

which requires the input of a positive scale factor. If the scale factor is greater than one, the model will be magnified. If the factor is between zero and one, the structure will be reduced. Each scaling, rotation, and translation, along with the order of application, is recorded in a matrix called the transformation matrix. This matrix contains the information needed to directly convert the structure from the original configuration to the final position determined by the series of transformations.

A listing of the elements in the work file or of the transformation matrix can be obtained at the terminal with

$$\text{LIST} \quad \left\{\begin{matrix}\text{VERTEX}\\ \text{EDGE}\\ \text{POLYGON}\\ \text{MATRIX}\end{matrix}\right\} \qquad \text{(default = VERTEX)}$$

Heading the vertex list are the world and window coordinates of the work file. The (x,y,z) coordinates of a designated group of vertices follow. These vertices are listed by numbers; missing numbers correspond to vertices which were removed from the user space with DELETE. The LIST EDGE command also requires the specification of a group of edges. Each edge's number and endpoint vertices are listed on a row. Similarly, the polygon numbers and component vertices are listed for a group of polygons by the LIST POLYGON command. Finally the transformation matrix is displayed with LIST MATRIX.

The lists can be sent to the printer instead of the terminal with the command

$$\text{PRINT} \quad \left\{\begin{matrix}\text{VERTEX}\\ \text{EDGE}\\ \text{POLYGON}\\ \text{ALL}\\ \text{MATRIX}\end{matrix}\right\} \qquad \text{(default = ALL)}$$

The PRINT commands produce lists in the same format as the corresponding LIST commands. However, groups of elements are not specified by the user. The PRINT element command lists the first through the last "element" stored in the work file. The additional command, PRINT ALL, lists the world and window coordinates; all of the vertices, edges, and polygons; and the transformation matrix.

The contents of the work file can be displayed graphically. At the start of program execution, the output device for the display defaults to the Lexidata. A different device is selected with

$$\text{DEVICE} \quad \left\{\begin{matrix}\text{CALCOMP}\\ \text{PRINTER}\\ \text{LEXIDATA}\\ \text{CONSOLE}\end{matrix}\right\} \qquad \text{(default = LEXIDATA)}$$

The specified device becomes the new default for graphical display.

If the output device has associated hard copies, these copies can be generated with

$$\text{COPY} \quad \left\{\begin{matrix}\text{ON}\\ \text{OFF}\end{matrix}\right\} \qquad \text{(default = OFF)}$$

After COPY ON has been entered, a specified number of hard copies of each subsequent graphics diplay will be produced. To discontinue this automatic duplication, COPY OFF must be entered. Note that the copy switch is in the OFF position at the start of program execution.

The model is displayed with

DISPLAY { VERTEX / EDGE / POLYGON / ALL } (default = ALL)

If the ouptut device is a screen, the screen is cleared before the display is generated. Only the elements within the window are displayed. DISPLAY VERTEX plots the model's vertices and labels each vertex with its number. DISPLAY EDGE or DISPLAY POLYGON draws the models' edges or polygons, respectively without numbering them. All edges and polygons are shown with DISPLAY ALL. A screen can be cleared with

ERASE

Otherwise, the image will remain on the screen until DISPLAY is used again or until termination of the program.

The field of view for a display is altered with

FIELD

The point of observation can be moved relative to the x-y plane of the user's system. A distance of zero places the observer at the origin of the coordinate system. A positive distance, d, positions the observer d units on the negative z-axis. The perspective of the display changes as the viewer's distance is altered. In addition, the angle of view can be changed. This angle, originating at the observer and bisected by the z-axis, determines the scope of vision. For instance, as the angle is decreased, the scope of vision becomes narrower. At the start of program execution, the observer is positioned 10,000 units from the origin and the angle of view is 90°.

At times it is useful to modify a structure throughout a sequence of frames. The number of frames and the changes desired are specified with

ANIMATE

The structure can be translated, scaled about its center, or rotated about a particular point. Edges and polygons may be moved. The observer can be moved along the z-axis. Any combination of these modifications is possible. Note that ANIMATE only receives the parameters for each change. The sequence of frames is viewed with DISPLAY.

Some transformations may cause the model to be moved outside the window. If the location of the structure becomes unknown, there may be difficulties in retrieving the model. The model is found with

AUTO

The window and the observer are automatically moved so that the entire model can be seen. As a result of AUTO, the scale of the model may not be optimum for viewing. This situation is easily modified with SCALE and FIELD.

The commands and the user's reponses to the subsequent prompts do not have to be entered at the console. The input device is changed to a specified file with

INPUT

All input is read from this file until another input file is specified. The

EXIT

command changes the input device to the console.

Finally, the program is terminated with

END

While the program is running, the

HELP

command is used to list all the commands together with a brief description of them.

6.2 TITLES

The TITLES program is used to create and modify a series of colored pictures consisting of character strings, lines, and circles. The strings are positioned on the screen by means of a joystick. Characters from any combination of the 24 character sets (see Appendix C) are used to form a string. Lines, circles, and bullets also may be added to the picture. Elements are added in various colors and sizes. Once the pictures (usually called slides) have been created, hard copies may be generated. TITLES is commonly used to produce slide presentations.

At the start of program execution, there is the option of accessing an existing data file or composing a new file. The desired option is specified by entering the filename, or, to indicate the creation of a new file, by hitting the <RETURN> key.

Once an existing file has been read, the user is asked for a command with the prompt FUNCTION=. Prompts are given when needed. If the file is new, the command defaults to

NEW,

a new slide is created and added to the work file. The default color and character set for the text on this slide is specified. Lines of text are entered and then positioned with the cursor. Colors and character sets may be changed within a character string by means of control sequences. Control sequences are also used to add subscripts and superscripts and to change the justification of the text (see Appendix B). These attributes, however, are returned to the default values for the next line of text.

Once a character string is placed on the screen, modifications may be made. The string may be deleted, moved, centered on the line, and scaled. Note that the character size resulting from a scaling becomes the default size for all characters subsequently entered. This process of adding and modifying text is continued until the <RETURN> key is entered instead of text characters. At this point, the user is informed of the number of slides in the work file.

Slides are modified in several ways. Lines of text can be corrected one line at a time with the command

CORRECT

A character string can be deleted, moved, centered on the line and scaled. When all corrections have been made to one line of text, the process is repeated for the remaining character strings on the slide.

Various elements may be added to a slide. Text is added with the command

ADD

The default color and character set are selected. Lines of text are entered and modified as with the NEW command. Other types of elements are drawn in specified colors and at given locations. Bullets (filled circles) are added with the command

BULLET

A straight line is drawn between two specified points with

LINE

Finally, with a center point and a radial distance designated, a circle is added to the slide with

CIRCLE

Once drawn, each element may be corrected in the usual manner. It may be deleted, moved, centered, or scaled.

Specified slides in the work file may be displayed on the Lexidata with the command

VIEW

Hard copies are generated with the command

PROCESS

Slides are specified along with the desired number of copies of each slide. The delay time for the hard copy device is changed with

DELAY

and the work file may be written and saved as a data file with the command

SAVE

If the work file is new, a filename is specified by the user. Otherwise, the slides are automatically written to the file last accessed. In order to access another data file, the

REREAD

command is used.

The various character sets and colors may be referenced. The command

SET

displays a specified character set. Each set has been arranged to correspond to the 96 displayable ASCII characters. When adding text to a slide, a desired character is placed in the character string by entering the corresponding ASCII character. The command

COLORS (default = 1)

displays all the available colors in rows. The colors are numbered to correspond with the rows. The color in the top row is color number one, the next row is color number two, and so on.

The two remaining commands are HELP and END. The commands are listed (but not described) with

HELP

Finally, the program is terminated with

END

6.3 ADDMAP

This is a structure manipulation program to add pieces of structure file together. The commands are similar to those found in BUILD and TITLE. There are some additional commands to manipulate the individual pieces. The commands are

SET, NEW, GET, WINDOW, ADD, SAVE, DISPLAY, SPECS, DRAG, GROUP, TRANSLATE, ROTATE, SCALE, FIELD, DEVICE, HELP and END.

The only commands described here are those which differ from the explanation in sections 6.1 and 6.2. The implementation of several commands, such as SET and GET, differs in BUILD and TITLES, but accomplishes the same task.

The special commands to deal with adding structures involve those which force actions on only a portion of the total file. These are NEW, DRAG and

GROUP.

In general, all manipulation commands are applied to all extant vertices. However, as pieces are added with repeated GET requests, a table is maintained which points to each of these GROUPS of vertices, polygons, edges and polylines. In order to apply an operation to a single group, the command,

GROUP

is used. The response will be an integer from zero to a number no larger than the number of GETs which have been applied. If 0 is entered, then all groups are affected. If a non-zero number is used, then only that group is affected. An error is returned and the request repeated if a negative integer or a number which exceeds the maximum number of groups is entered.

DRAG

is similar to translate, but is done by a pointing device. When this command is invoked, a point to drag is specified. This is the initial point. Then a final or destination position is requested. The action is to move the appropriate vertices by this change. Essentially, it allows the user to specify a translation without knowing the actual coordinates of a map position on the screen. This program maintains the group designations internally whereas BUILD does not. The grouping is given on the third line (image) of the structures file.

The command

NEW

resets pointers and counters and is equivalent to restarting the program.

ACKNOWLEDGMENTS

As with any good software product, many people have contributed to the development of improvement of the package over several years. Special thanks to Jay Boris and Richard Peacock who wrote routines which appear here, and to the many users who have suffered through initial releases of the software, making sometimes pointed but useful comments on improvements which were needed, and usually made. Also to the numerous readers who caught poor explanations and unjustified assumptions.

APPENDIX A

The following is a description of each routine, together with its arguments. All routines are listed, although emphasis is on the higher level routines. For the "hackers", low level routines are included since special effects are sometimes desirable. The usual FORTRAN convention for integer and real (floating) numbers is maintained. Type is given only for arrays and character variables.

ALABEL

Purpose: to draw a character string with an aspect ratio of 4/3 given the width and an angle of rotation.

Usage: Call ALABEL (CHARS, X1, Y1, X2, Y2, ANGLE)

Description of Parameters:

CHARS - CHARACTER * 1 ARRAY - character string to be drawn

X1, Y1 - lower left starting point of the string

X2 - X coordinate of the right ending point of the string

Y2 - not used

ANGLE - angle (radians) by which to rotate the string. [A positive (negative) angle causes a counter-clockwise (clockwise) rotation about the lower left starting point.

Control Sequences: See Appendix B

Method: This routine calls the subroutine WDCOUNT to determine if the string contains characters. If characters exist, LABEL calculates the space size of the characters in order to create a 4/3 aspect ratio. Finally, the subroutine WDDRAW is called to plot the text.

BOXPLT

Purpose: to draw a rectangle given the endpoints of one of the diagonals.

Usage: Call BOXPLT (X1, Y1, X2, Y2)

Description of Parameters:

X1, Y1 - coordinates of lower left corner of the box

X2, Y2 - coordinates of the upper right corner of the box

Method: The routine determines the endpoints of each side of the rectangle. These endpoints are placed in an array and sent to the subroutine LINES which plots the four sides.

CHPLOT

Purpose: to draw a specified hardware character centered at selected points in an array.

Usage: Call CHPLOT (X, Y, CHAR, I1, I2, I3)

Description of Parameters:

X, Y - ARRAY - points at which to plot the character

CHAR - CHARACTER * 1 - character to be plotted

I1 - index of first point to plot

I2 - increment at which points are to be selected to plot

I3 - index of last point to plot

Method: The routine selects the points at which to plot the character. The subroutine SYMBOL is called to draw the character at each of these chosen points.

CHRSET

Purpose: to change the default character set

Usage: Call CHRSET (N)

Description of Parameters:

N - number (1-24) corresponding to a character set

CHRSIZ

Purpose: to set the size of the hardware character

Usage: Call CHRSIZ (CHFRZ, GCHFRZ)

Description of Parameters:

CHFRZ - a fraction specifying the size of the characters relative to the screen (default = .03)

GCHFRZ - a fraction specifying the size of the characters relative to the variables Y1R and Y2R in subroutine GRAFIT (default = .04)

CIRCLE

Purpose: to draw a circle of a given radius about a specified center point.

Usage: Call CIRCLE (X,Y,R)

Description of Parameters:

X,Y - center of the circle

R - radius of the circle

Method: The routine generates commands to transform the points from the user space to the raster space. It then generates commands to plot a circle centered at the point (X,Y) with a radius of R.

COLOR

Purpose: to define the color for drawing

Usage: Call COLOR(N)

Description of Parameters:

N - the number corresponding to a desired color

Method: This command is ignored for the printer and Tektronix. For the other devices, an integer is normalized between 1 and NUMCOLOR, where NUMCOLOR is the number of colors the device can display. The Calcomp and Lexidata possess 4 and 16 colors, respectively. The numbers are normalized by modular arithmetic and numbers less than 1 are set equal to 1:

```
COLOR = MOD(N-1, NUMCOLOR) + 1
COLOR = MAXØ(COLOR, 1)
```

CONTUR

Purpose: to perform surface plotting

Usage: Call CONTUR (F, TEST, NX, NY, FL)

Description of Parameters:

F - ARRAY (NX, NY) - real values of the function to be contoured

TEST - ARRAY (NX, NY) - user supplied scratch array having the same dimension as F

NX - range and dimension of i in F(i,j)

NY - range and dimension of j in F(i,j)

FL - value of F(i,j) for contouring

Method: Contours are plotted by looking at a projection of the function F(I,J) and determining if the function crosses the contouring interval within their box. Six interpolations are done. First I to I+1, then J to J+1 parallel crossings are considered. Finally, the four cases of diagonal crossings are considered by triangular interpolation of each tesselation of the box by the corner points with the center. The corner points are considered in pairs moving counterclockwise around the projected box.

DEFINE

Purpose: to define the correspondence between the user's window and the device's world space

Usage: Call DEFINE (X1, Y1, X2, Y2)

Description of Parameters:

X1, Y1 - coordinates of the window's lower left vertex

X2, Y2 - coordinates of the window's upper right vertex

Method: The differences X2-X1 and Y2-Y1 are checked. If either of the differences is equal to zero, the difference is set equal to one. The routine then calculates the transformation which maps objects from the user's window to the device's world space. The viewport defaults to the entire viewing surface.

DELAY

Purpose: to delay for hard copy units

Usage: Call DELAY(N)

Description of Parameters:

N - the number of seconds to delay

Method: This routine calls the system routing WAIT for the Tektronix and the Matrix camera.

DEVICE

Purpose: to initialize a device

Usage: Call DEVICE(N)

Description of Parameters:

N - defines a device

= 1 - Calcomp

= 2 - Printer

= 3 - Lexidata

= 4 - Textronix Console

= 5 - Empty Slot

Method: If a device is already open, execution of the program is terminated. Otherwise, the desired (device) file is connected to a unit. The device defaults to the printer if the specified number "n" does not correspond to an existing device.

DEVINP

Purpose: to get a coordinate triplet from an input device.

Usage: CALL DEVINP (INPUT, MASK, STATUS, X, Y, Z)

Description of Parameters:

INPUT - input device: 1 = joystick; 2 = tabet; 3 = keyboard.

MASK - button select - by power of 2.

1 = button 1

2 = button 2

4 = button 3

8 = button 4

STATUS - returns a value corresponding to MASK for the button pushed.
X,Y,Z - cordinate values returned. For two-dimensional devices, Z is always 0.

ENDFRM

Purpose: to close the graphics device

Usage: Call ENDFRM

Method: Closes logical units associate with DEVICE. Normally these are units 7, 8, and 9. This routine does not empty the I/O buffer but does send disconnect sequences and, for screen devices, erases the screen.

ENUMBR

Purpose: to draw a real decimal number expressed with powers of 10 such that the mantissa is between 1 and 10, i.e., $y*10^n$ where $1 < |y| < 10$

Usage: Call ENUMBR (XNUMBR, X1, Y1, X2, Y2)

Description of Parameters:

XNUMBR - number to be plotted in exponential format

X1, Y1 - starting point (lower left corner) of the first character drawn

X2, Y2 - terminating point (upper right corner) of the last character drawn

Method: A real number, not equal to zero, is normalized between 0 and 10. Then FNUMBR plots this portion as scaled by the starting and terminating points (X1, Y1) and (X2, Y2). The characters "10*" are then plotted, followed by a superscript containing the normalizing power of 10.

ERASE

Purpose: to erase the screen

Usage: Call ERASE

Method: This command is ignored for the Calcomp. For display devices a simple erase sequence is sent.

FILTYP

Purpose: to define the appearance of the interior of polygons and circles

Usage: Call FILTYP(N)

Description of Parameters:

N - the number corresponding to a desired fill type

Method: There are 9 fill types (0-8) for devices supporting filling patterns. The current devices, except for the Calcomp, support these patterns. Figure (4) shows the fill pattern numbered from 0 on the lower left to 8 at the upper right of the figure.

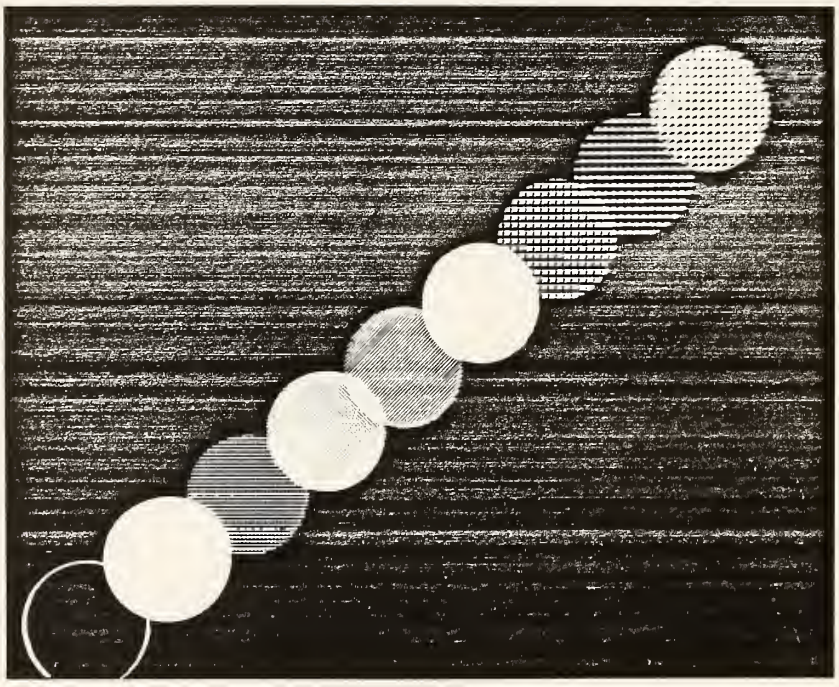


FIGURE 4

FNUMBR

Purpose: to draw a real number in FORTRAN F format

Usage: Call FNUMBR (X, Y, DX, DY, SX, SXY, SY, XNUMBR, IWIDTH, NDIGIT)

Description of Parameters:

X, Y - starting point (lower left corner) of the first character to be drawn

DX - increment added to the X-coordinate for each character drawn

DY - increment added to the Y-coordinate for each character drawn

SX - X space size for the characters

SXY - slant modifier for characters

SY - Y space size for the characters

XNUMBR - number to be plotted in F format

IWIDTH - total width of field including decimal point

NDIGIT - number of places to the right of the decimal point to be drawn

Method: The input "XNUMBR" is scaled to include the specified number of places to the right of the decimal point. Each digit in the number is converted to a literal character. Leading zeros are converted to blanks and the decimal point is inserted if NDIGIT is greater than zero. The subroutine WDDRAW is called to plot the literal data string. The parameters X, Y, DX, DY, SX, SXY, and SY have the same meaning as in WDDRAW.

FRAME

Purpose: to force out the contents of the buffer

Usage: Call FRAME

Method: This call should be used to terminate each series of graphics sequences. It is used to insure that the I/O buffers are empty and to synchronize the timing of the I/O channel.

GRAFIT

Purpose: to set up a graph (X and Y axis) for plotting data

Usage: Call GRAFIT (NPLT, X1, X2, X1R, X2R, XX1, XX2, Y1, Y2, Y1R, Y2R, YY1, YY2, XTIT, NDVX, YTIT, NDVY)

Description of Parameters:

NPLT	- number of the plot referenced (up to four graphs may be placed on one graph)
X1,X2	- labels of X-axis minimum and maximum, respectively. (The literal string 'NONE' produces no label.)
X1R,X2R	- user space value of X-axis minimum and maximum, respectively
XX1,XX2	- minimum and maximum values, respectively, of X in data to be plotted
Y1, Y2	- labels of Y-axis minimum and maximum, respectively. (The literal string 'NONE' produces no label.)
Y1R,Y2R	- user space value of y-axis minimum and maximum, respectively
YY1,YY2	- minimum and maximum values, respectively, of Y in data to be plotted.
XTIT - char	- title for X-axis (less than 30 characters and terminated by '|.')
NDVX	- number of intervals to be drawn on X-Axis
YTIT - char	- title for Y-axis (less than 30 characters and terminated by '|.')
NDVY	- number of intervals to be drawn on Y-axis

There are three additional entry points: PLOTCH, PLOTLN and GRISET.

PLOTCH (NPLT, X, Y, NP CHAR)	- where NPLT is the corresponding plot number
PLOTLN (NPLT, X, Y, NP)	- (See above), X and Y are coordinate arrays, NP is the number of points to plot (or connect) and CHAR is a character in CHARACTER *1 format
GRISET (XL, YL, XR, YT)	- see DEFINE

Purpose: to generate a hard copy

Usage: Call HDCOPY

Device	Associated Hard Copy
Calcomp	-
Printer	-
Lexidata	Camera
Tektronix	Activates screen copy unit

Method: This command is ignored for the Calcomp and the printer.

HHDRAW

Purpose: to draw a particular character of a specified character set

Usage: Call HHDRAW (X, Y, SX, SXY, SY, ICHAR, NSET, IERR)

Description of Parameters:

X, Y - starting point (lower left) of the character to be plotted

SX - X space size for character (user coordinate system)

SXY - slant modifier for character

SY - Y space size for character (user coordinate system)

ICHAR - index to specify characters within the chosen set

NSET - number specifying a particular character set

IERR - error flag

= 0 - no errors
= 1 - error in accessing set or character

Method: If the desired character is from the hardware set, then the subroutine SYMBOL is called to plot the character. For characters from other sets, HSETS is called to place the character's coordinates and pen values in arrays and then LINES is called to plot the character as a set of connected strokes.

IOWAIT

Purpose: to put a pause in the program

Usage: Call IOWAIT (N)

Description of Parameters:

N - number of milliseconds to pause

Method: This routine calls the system routine WAIT.

LABEL

Purpose: to draw a character string of a specified width and height (i.e., a rectangular area) at a specified location

Usage: Call LABEL (CHARS, X1, Y1, X2, Y2, ANGLE)

Description of Parameters:

CHARS - CHARACTER * 1 ARRAY	- character string to be drawn
X1, Y1	- lower left starting point of string
X2, Y2	- upper right ending point of string
ANGLE	- angle (radians) by which to rotate the string. [A positive (negative) angle causes a counter-clockwise (clockwise) rotation about the point (X1, Y1)].

Control Sequences: See Appendix B

Method: This routine calls the subroutine WDCOUNT to determine if the string contains characters. If characters exist, LABEL calculates the space size of the characters and calls the subroutine WDDRAW to plot the text.

LINE

Purpose: to draw a line between two given points

Usage: Call LINE (X1, Y1, X2, Y2)

Description of Parameters:

X1, Y1 - coordinates of first point

X2, Y2 - coordinates of second point

Method: The routine transforms the points from the user space to the raster space. Subroutine PUTLNV is then called to generate a line segment to connect the points.

LINES

Purpose: to draw lines between points in an array

Usage: Call LINES (X1, Y1, X2, Y2,N)

Description of Parameters:

X1, Y1-array - starting coordinates of the lines

X2, Y2-array - ending coordinates of the lines

N - number of line pairs: [X1(i), Y1(i)] → [X2(i), Y2(i)]

Method: The routine transforms the points from the user space to the raster space. Subroutine PUTLNV is then called to generate line segments to connect corresponding points.

LINWID

Purpose: to define the line width for plotting

Usage: Call LINWID(N)

Description of Parameters:

N - the number of strokes when drawing a line - not implemented for CALCOMP

Method: This routine sets the number of strokes for each line. (The strokes are drawn one pixel apart.)

LNPLOT

Purpose: to draw lines between selected points of an array

Usage: Call LNPLOT (X, Y, I1, I2, I3)

Description of Parameters:

X - array - X coordinates of data

Y - array - Y coordinates of data

I1 - index of first point to be connected

I2 - increment at which points are to be selected to plot

I3 - index of the last point in the data array

Method: The selected points are stored in new arrays and the subroutine LINES is called to generate each of the lines.

NEWFRM

Purpose: to erase the screen and initialize a new frame

Usage: Call NEWFRM

Method: Device dependent but in general clears buffers and initializes pointers.

PLYGON

Purpose: to draw a closed polygon

Usage: Call PLYGON (X,Y,N)

Description of Parameters:

X - array - X coordinates of the data
Y - array - Y coordinates of the data
N - number of vertices in the polygon

Method: The routine generates commands to transform coordinates from the user space to the raster space. It then generates commands to plot the polygon starting and ending at vertex (X(1), Y(1)).

SCALNG

Purpose: to define the window and the viewport

Usage: Call SCALNG (X1, Y1, X2, Y2, X1H, Y1H, X2H, Y2H, X1S, Y1S, X2S, Y2S)

Description of Parameters:

X1, Y1 - lower left corner of the window (user coordinates)

X2, Y2 - upper right corner of the window (user coordinates)

X1H, Y1H - lower left corner of viewport (device coordinates)

X2H, Y2H - upper right corner of viewport (device coordinates)

X1S, Y1S - lower left corner of world (world coordinates)

X2S, Y2S - upper right corner of world (world coordinates)

Method: Calculates the transformations to map objects from the user's window into the device's world and then into the viewport.

SETDEV

Purpose: to change logical units

Usage: Call SETDEV (N1, N2)

Description of Parameters:

N1 - logical unit for graphics output (0- ; default = 7)

N2 - logical unit for diagnostic output (1- ; default = 0)

Default Device Assignments:

Type	LU	Result
Diagnostics	0	no output
Graphics	7	normal - assigned
Camera*	8	assigned with Lexidata
Character set	0	unit zero-assigned
Calcomp	L7:	RS232 line
Printer	PR:	whatever
Lexidata	LEX:	DMA (L34DVR in system)
Matrix camera	L14:	RS232
Tektronix	C:	console
Open slot	NULL:	bit bucket
Console input	5	
Character set	9 (closed then opened)	
Tablet input*	8 (closed then opened)	

*Note: Camera and tablet cannot be active simultaneously

SETLUT

Purpose: to set color look-up table

Usage: Call SETLUT

Method: The default color look-up table is shown in Fig. (5) for the Lexidata 8100 . SETLUT is not currently used. It exists for users who must define look-up tables on other systems.

FIGURE 5

Purpose: construct and plot data surface

Usage: Call SURFAC (Z, NX, NY, MODE)

Description of Parameters:

Z - ARRAY (NX, NY) - data to be plotted as a surface

NX - dimension and range of i in Z(i,j)

NY - dimension and range of j in Z(i,j)

MODE - specifies the surface to plot
MODE = 1: upper surface
MODE = -1: lower surface

This subroutine and its entries construct and display plots of a surface function (two dimensional) with the hidden lines removed. The appearance of the plot is quite flexible and can include skirts around unobservable portions. It is possible to show just the upper or just the lower surface, or both together. The surface must be approximately horizontal.

SFRAME (MODE) - shows rectangular parallelpiped plotting region.

SSKIRT (Z,NX,NY,MODE) - draw skirts around the plotting region (See figure 6) - uses hidden surface algorithm, so should be called last

SRFSET (X,Y,Z MIN, Z MAX, NX, NY) - initiates the plotting region

THE GEOMETRY FOR "SURFAC" PLOTS

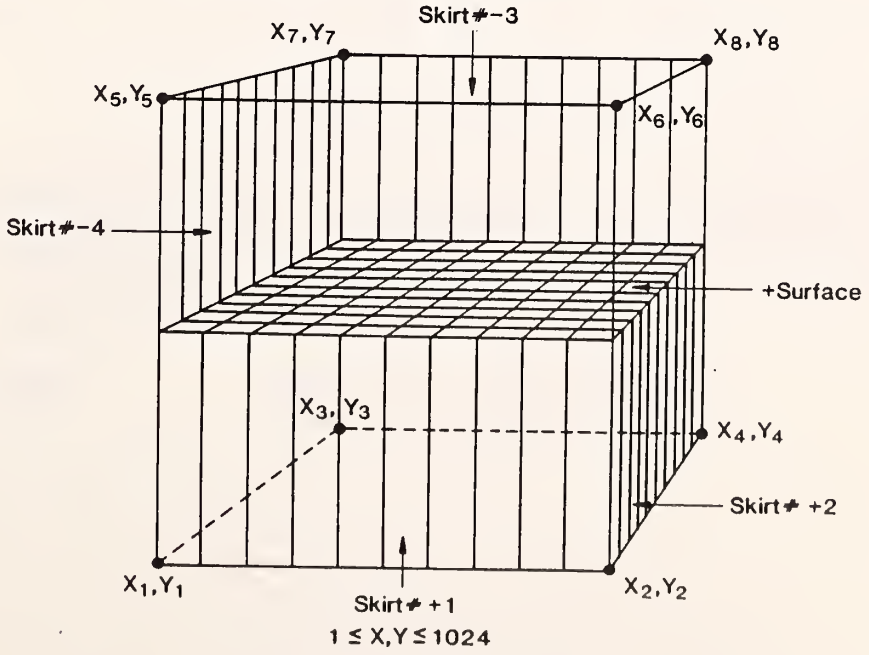


FIGURE 6

SYMBOL

Purpose: to draw a specified hardware character centred at a given point

Usage: Call SYMBOL (X, Y, CHAR)

Description of Parameters:

X, Y - location at which to plot the character

CHAR - CHARACTER*1 - character to be plotted

Method: The routine transforms the center point from the user space to the raster space. Subroutine PUTCH is then called to generate the commands to plot the character.

VOLUME

Purpose: To draw a two-dimension projection of a 3-dimensional array; simulates effect of "3D"

Usage: Call VOLUME (MODE, F, NX, NY, NZ, CLEVE, NCL, T, NT)

Description of Parameters:

F - ARRAY (NX, NY, NZ) - three-dimensional figure to be plotted

NX - range and dimension of i in F(i,j,k)

NY - range and dimension of j in F(i,j,k)

NZ - range and dimension of k in F(i,j,k)

T - ARRAY (NT, NT) - plotting array (boolean) to eliminate hidden lines

NT - dimension of the array T: T(NT,NT)

CLEVE - contour surface level for plotting

MODE - specifies the surface to be plotted

- ABS(MODE) = 1: plot contour level "CLEVE" in each plane; fix hidden line matrix, T
- ABS(MODE) = 2: find hidden line matrix, T, without plotting
- MODE < 0: "outside" is less than "CLEVE"
- MODE > 0: used when the value of the function on the "outside" is greater than "CLEVE"

NCL - number of pairs of (MODE, CLEVE) to be plotted

Method: Contours a Function F(See above) in three dimensions and projects the resultant plots onto a two dimensional plotting surface. Auxiliary entries are

VOLSET (X,Y,T,NT) - initialize the plot

VOLFRM (MODE) - MODE = 0 = corner vertices
- Mode = 1 = surrounding box

A three dimensional interpolation by triangular tesselation is used to find the contour crossing points. The technqiue is similar to that used in CONTUR. Once again, the hidden pixel (frame buffer) is filled as the figure is scanned back to front. A sample showing two overlapping spheroids and a cylinder is shown in Fig. 7. The functions plotted are

Cylinders: $F = (X-10.5)^2 + (Y-3.5)^2$

Sphere: $$F_1 = \frac{10}{(X-8)^2 + (Y-10.5)^2 + (Z-10.5)^2}$$

$$F_2 = \frac{20}{(X-13)^2 + (Y-10.5)^2 + (Z-10.5)^2}$$

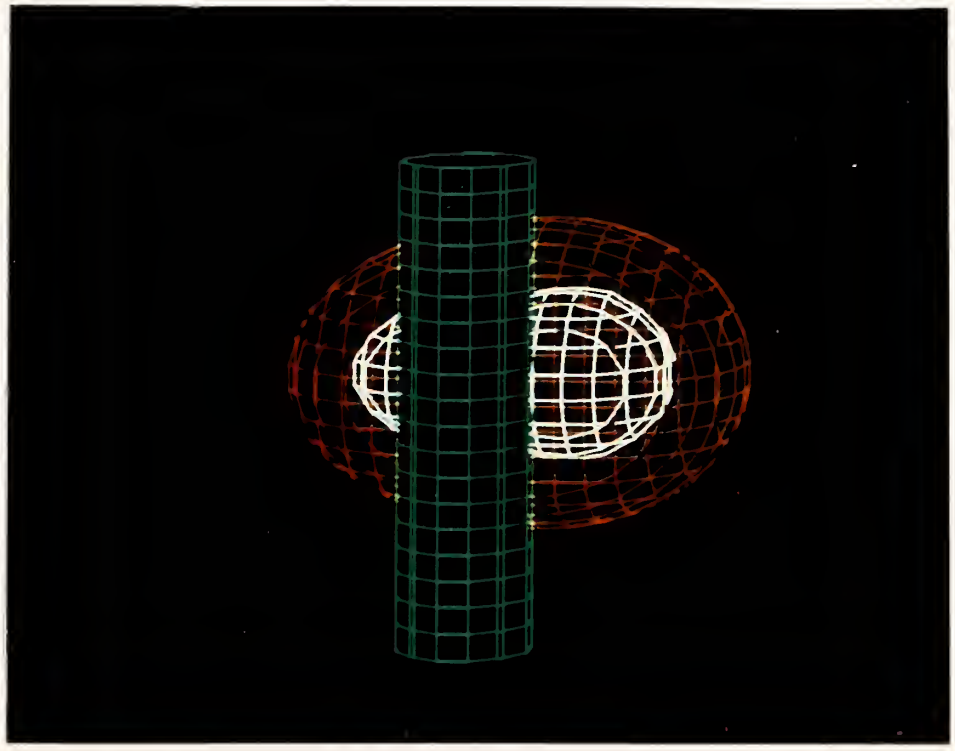


FIGURE 7

WDDRAW

Purpose: to draw a character string

Usage: Call WDDRAW (X, Y, DX, DY, SX, SXY, SY, CHARS)

Description of Parameters:

X, Y	- starting point of the character string (the string is plotted to the right of (X,Y) unless otherwise indicated by a control character)
DX	- increment to be added to the X-coordinate for each character drawn
DY	- increment to be added to the Y-coordinate for each character drawn
SX	- X space size for characters (user coordinate system)
SXY	- slant modifier for characters
SY	- Y space size for characters (user coordinate system)

CHARS - CHARACTER * 1 ARRAY - character string to be drawn

Control Sequences - See Appendix B

Method: This routine scans the string for control characters and text characters. When a text character is found, the corresponding character number is obtained by the function IDCHAR. The set number assumes the default value unless the number was changed by a control character within the string. The routine also executes scaling, shifting, and rotating transformations in order to determine the starting positions of the characters. Finally, the subroutine HHDRAW is called to plot the text characters.

APPENDIX B

Control Sequences for WDDRAW, LABEL, and ALABEL

The control sequence is "|" followed by an editing character which is one of the following:

L - justify the text to the left

M - center the text

R - justify the text to the right (default)

Hnn - change from default character set to set nn

U - draw the following characters in superscript

D - draw the following characters in subscript

O - reset character size and placement from superscript or subscript to original size

B - backspace over last character drawn (works only for one character, multiple backspaces will produce unpredictable results.)

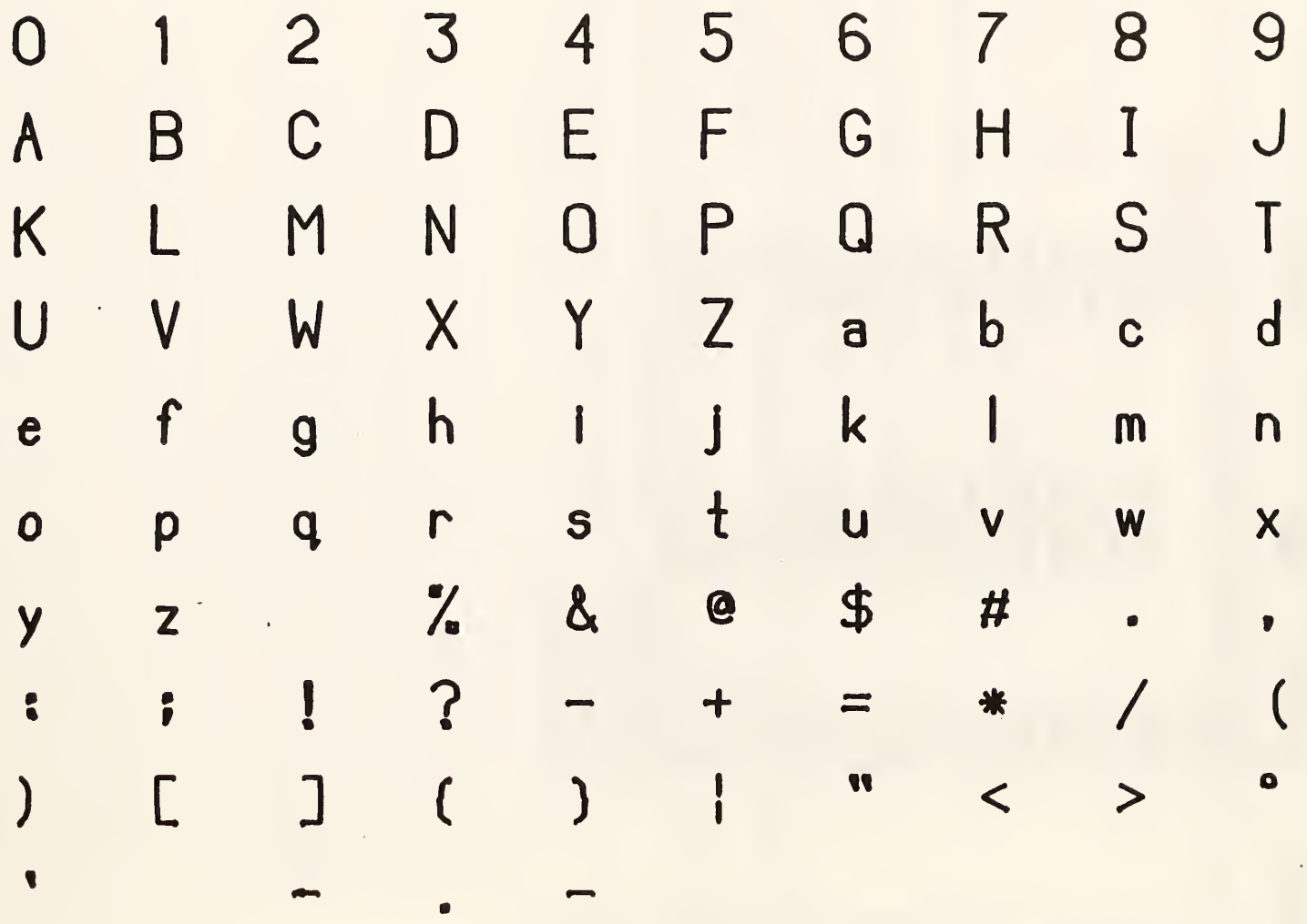
Cnn - change from the default color to color nn

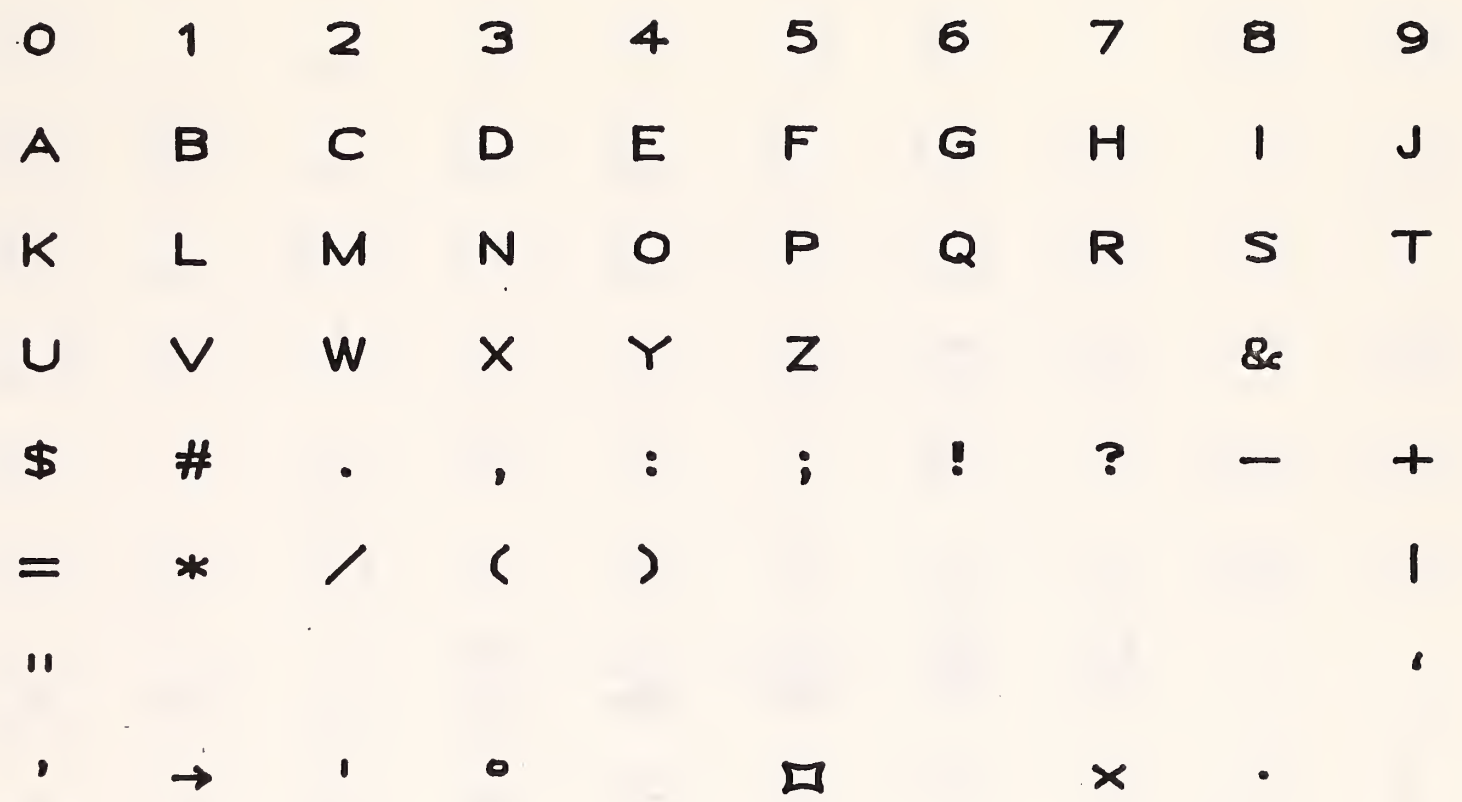
. - end of character string

APPENDIX C

Set Number	Alphabet	Style	Size
1	Roman (Hardware characters)		
2	Roman		Cartographic
3	Greek		Cartographic
4	Roman	Simplex	Print
5	Greek	Simplex	Print
6	Script	Simplex	Print
7	Roman	Complex	Index
8	Greek	Complex	Index
9	Italic	Complex	Index
10	Roman	Complex	Print
11	Greek	Complex	Print
12	Italic	Complex	Print
13	Script	Complex	Print
14	Roman	Duplex	Print
15	Roman	Triplex	Print
16	Italic	Triplex	Print
17	German	Gothic	Print
18	English	Gothic	Print
19	Italian	Gothic	Print
20	Cyrillic	Complex	Print
21	Miscellaneous		
22	Miscellaneous		
23	Miscellaneous		
24	Miscellaneous		

Set Number 1


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: ; ! ? - + = * / (
) [ ] { } ¦ " < > °
' ~ .


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z &
$ # . , : ; ! ? — +
= * / ( )
"
'
→
°
×
.

Set Number 3

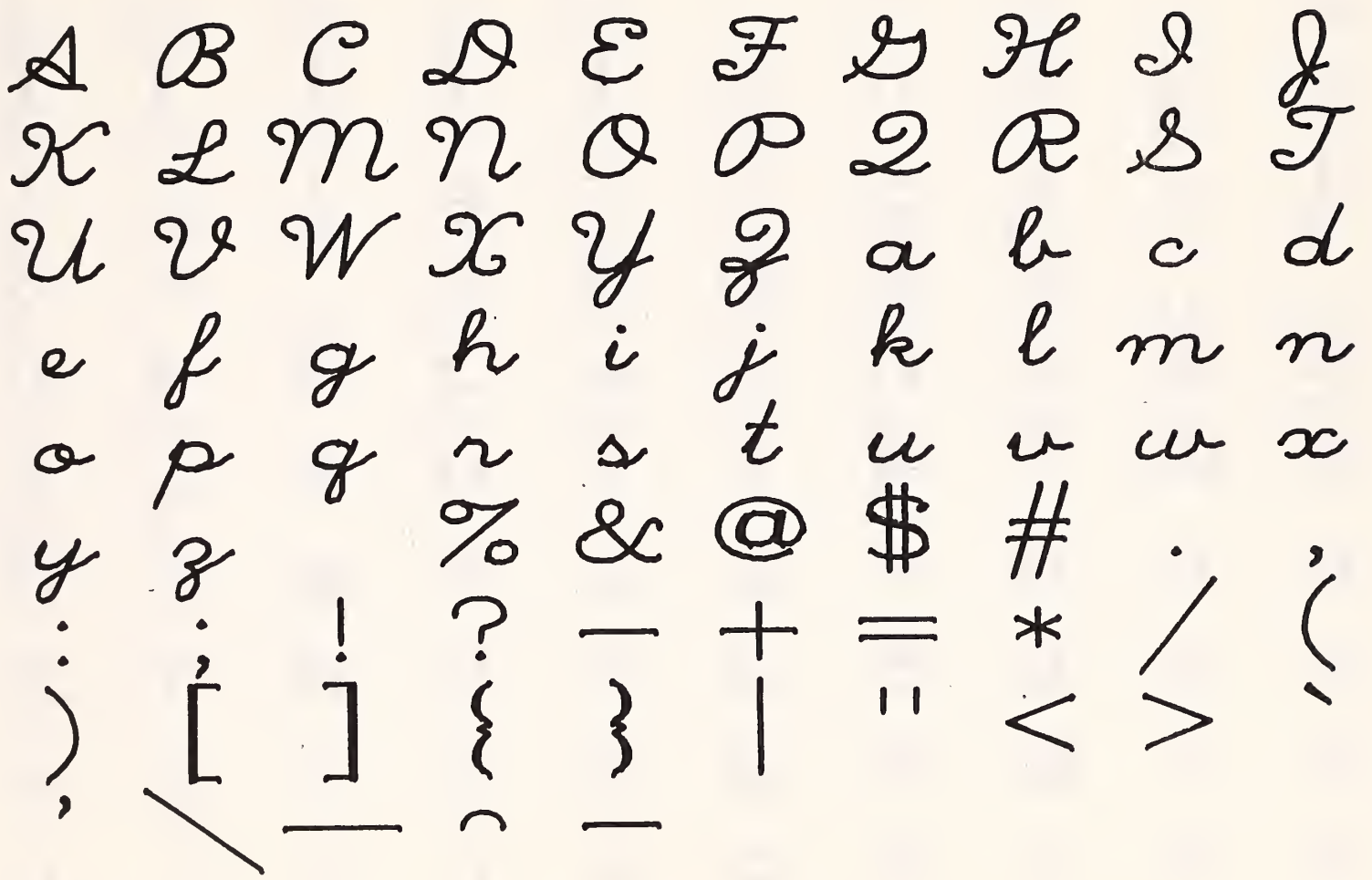
Α Β Ξ Δ Ε Γ Η Ι Θ

Κ Λ Μ Ν Ο Π Ρ Σ Τ

Υ Φ Ω Χ Ψ Ζ


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: ; ! ? — + = * / (
) [ ] { } | " < > '
' \ — ^ —

Set Number 5



0 1 2 3 4 5 6 7 8 9

A B C D E F G H I J

K L M N O P Q R S T

U V W X Y Z a b c d

e f g h i j k l m n

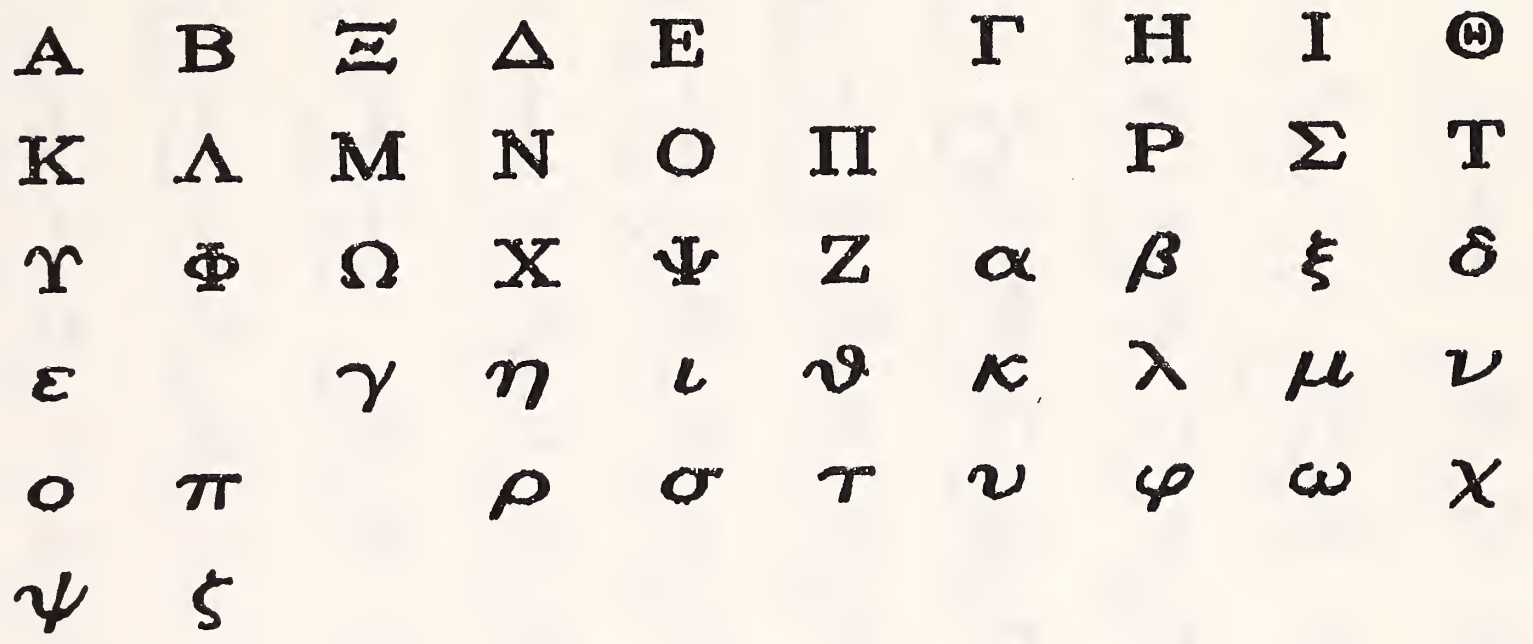
o p q r s t u v w x

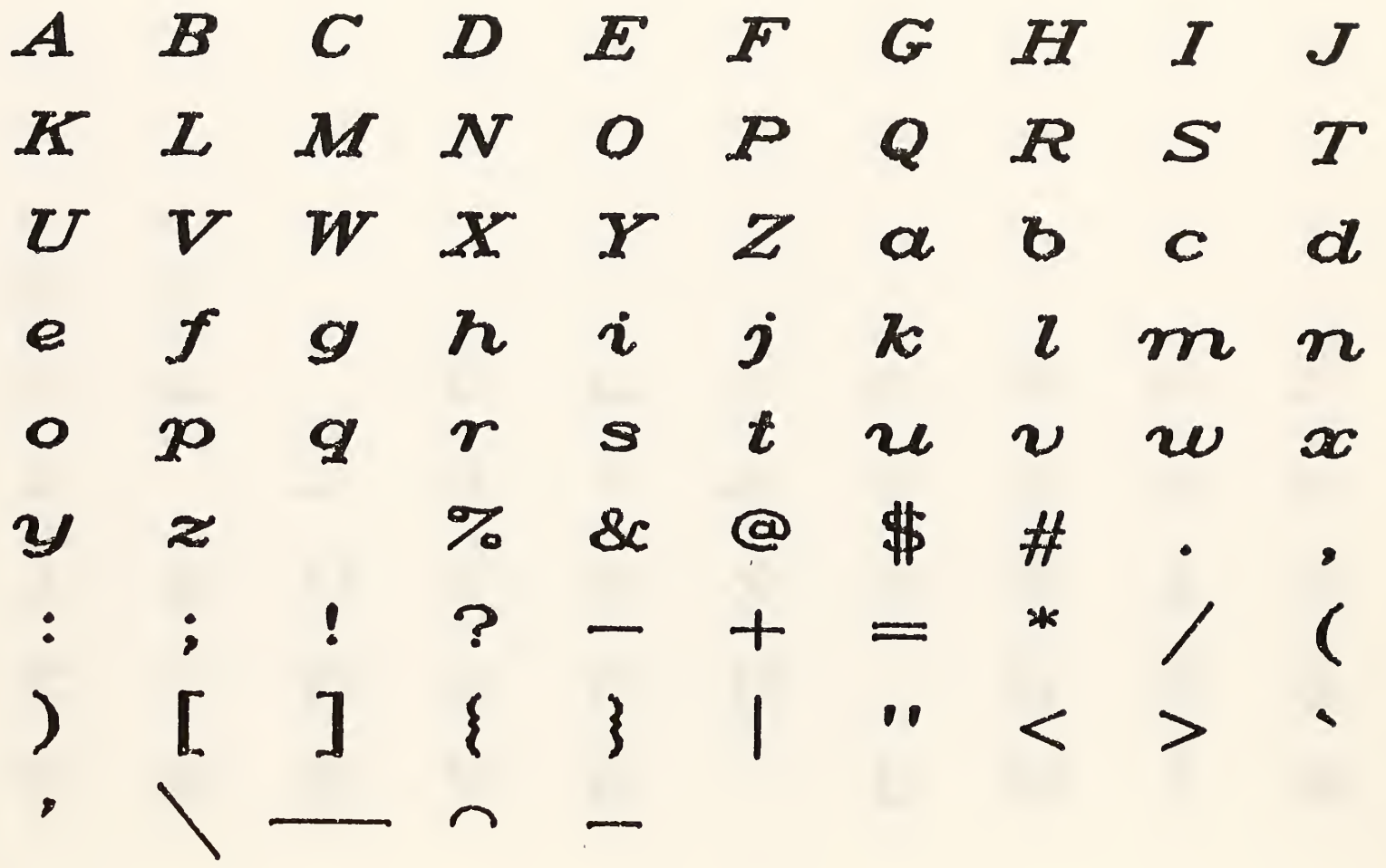
y z % & @ $ # . ,

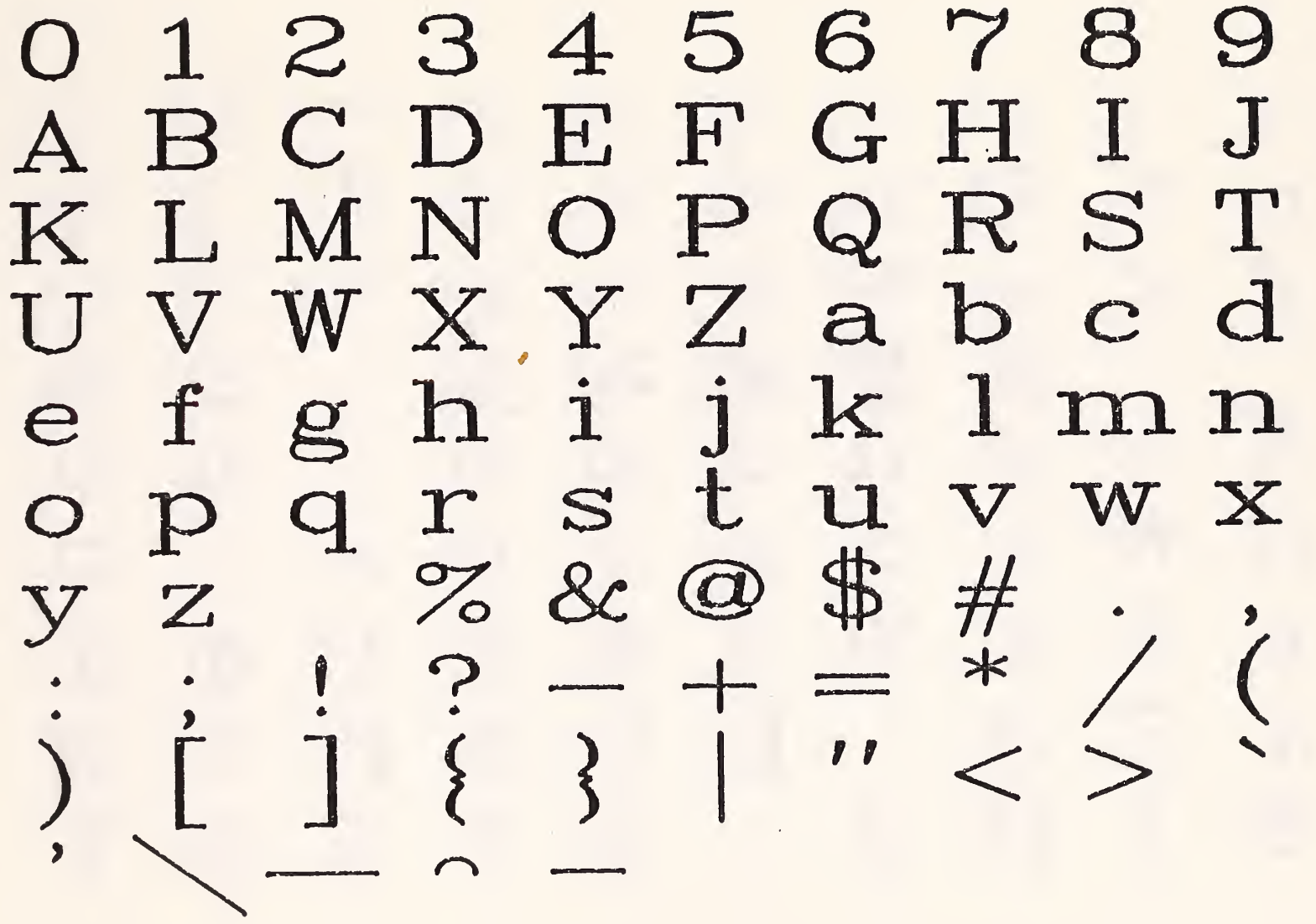
: ; ! ? — + = * / (

) [ ] { } | " < > `

' \ —— ⌒ —

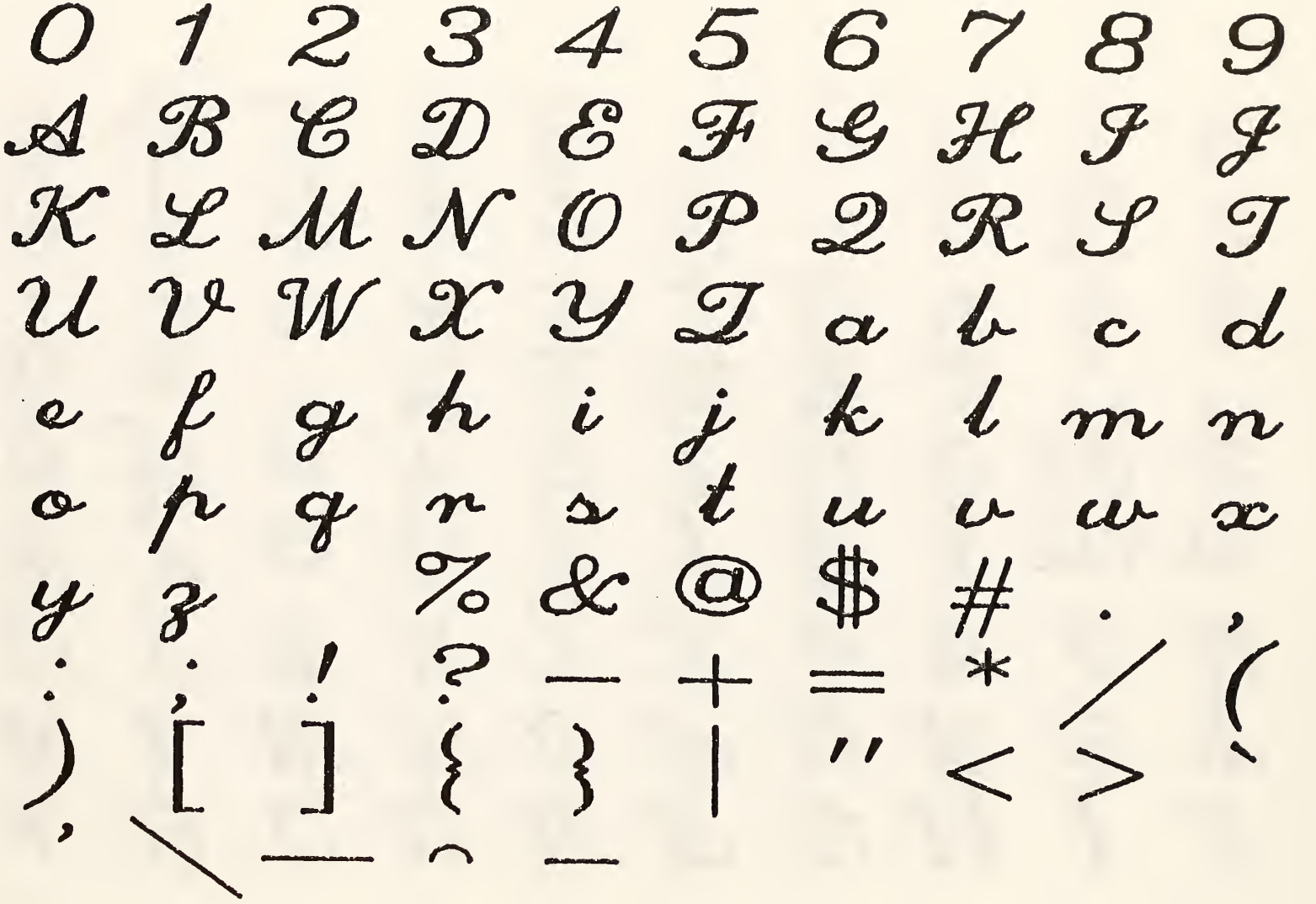

Α Β Ξ Δ Ε Γ Η Ι Θ
Κ Λ Μ Ν Ο Π Ρ Σ Τ
Υ Φ Ω Χ Ψ Ζ α β ξ δ
ε γ η ι ϑ κ λ μ ν
ο π ρ σ τ υ φ ω χ
ψ ζ


A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: ; ! ? — + = * / (
) [ ] { } | " < > `
' \ —— (—


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: . ! — + = * / (
) ;] } | " < > '
, [— — — \


Α Β Ξ Δ Ε Γ Η Ι Θ
Κ Λ Μ Ν Ο Π Ρ Σ Τ
ϒ Φ Ω Χ Ψ Ζ α β ξ δ
ε γ η ι ϑ κ λ μ ν
ο π ρ σ τ υ φ ω χ
ψ ζ % & @ $ # . ,
: ; ! — + = * / (
) [ ] } | " < > '
/ — ‾ —


A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: ; ! ? — + = * / (
) [ ] { } | " < > `
, \ — ^ —


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: ; ! ? — + = * / (
) [ ] { } | " < > '
, \ — ^ —


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ,
: ; ! ? — + = / (
) [ ] { } | " > '
, \ — (— ~ * < _

Set Number 15

0 1 2 3 4 5 6 7 8 9

A B C D E F G H I J

K L M N O P Q R S T

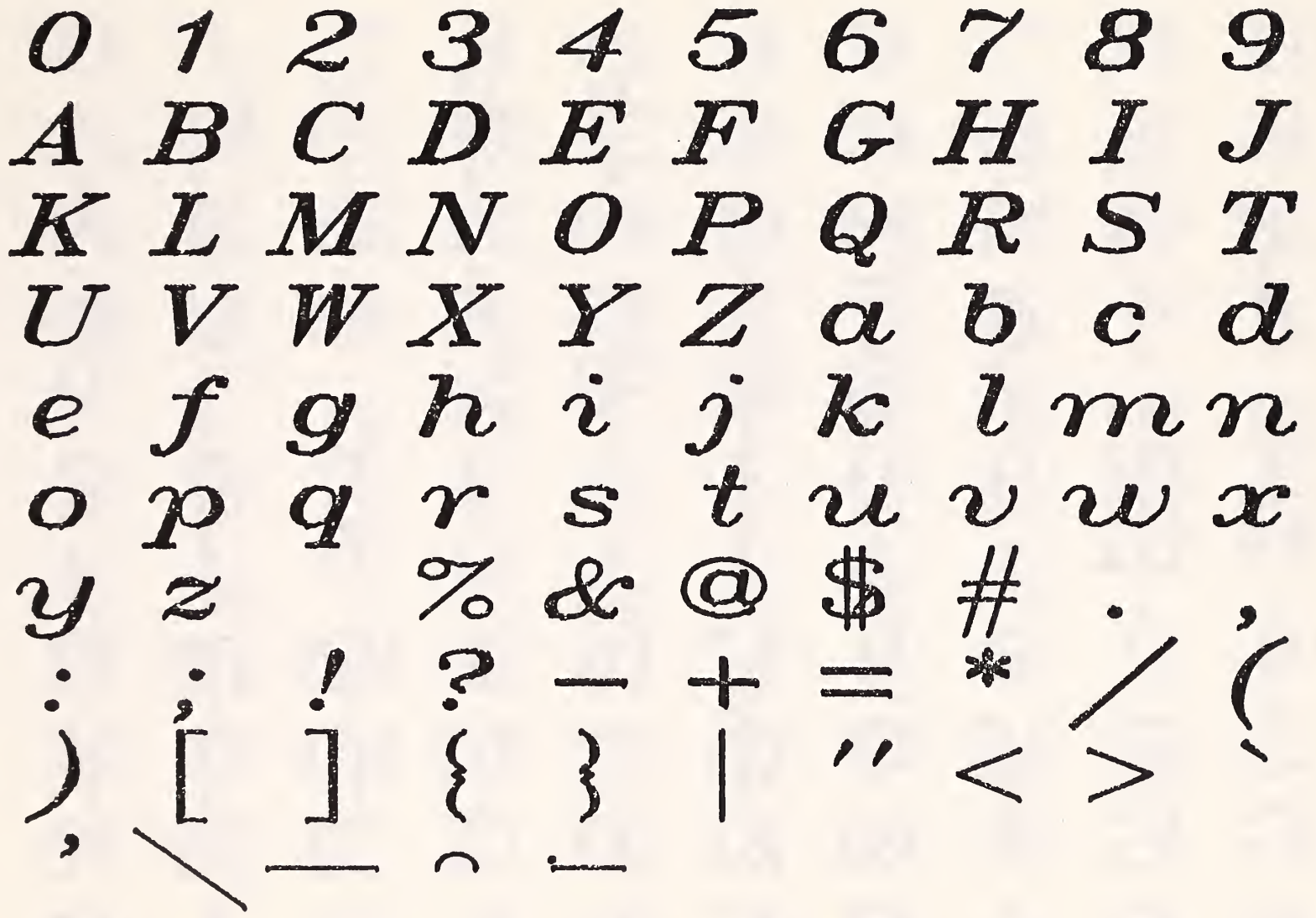
U V W X Y Z a b c d

e f g h i j k l m n

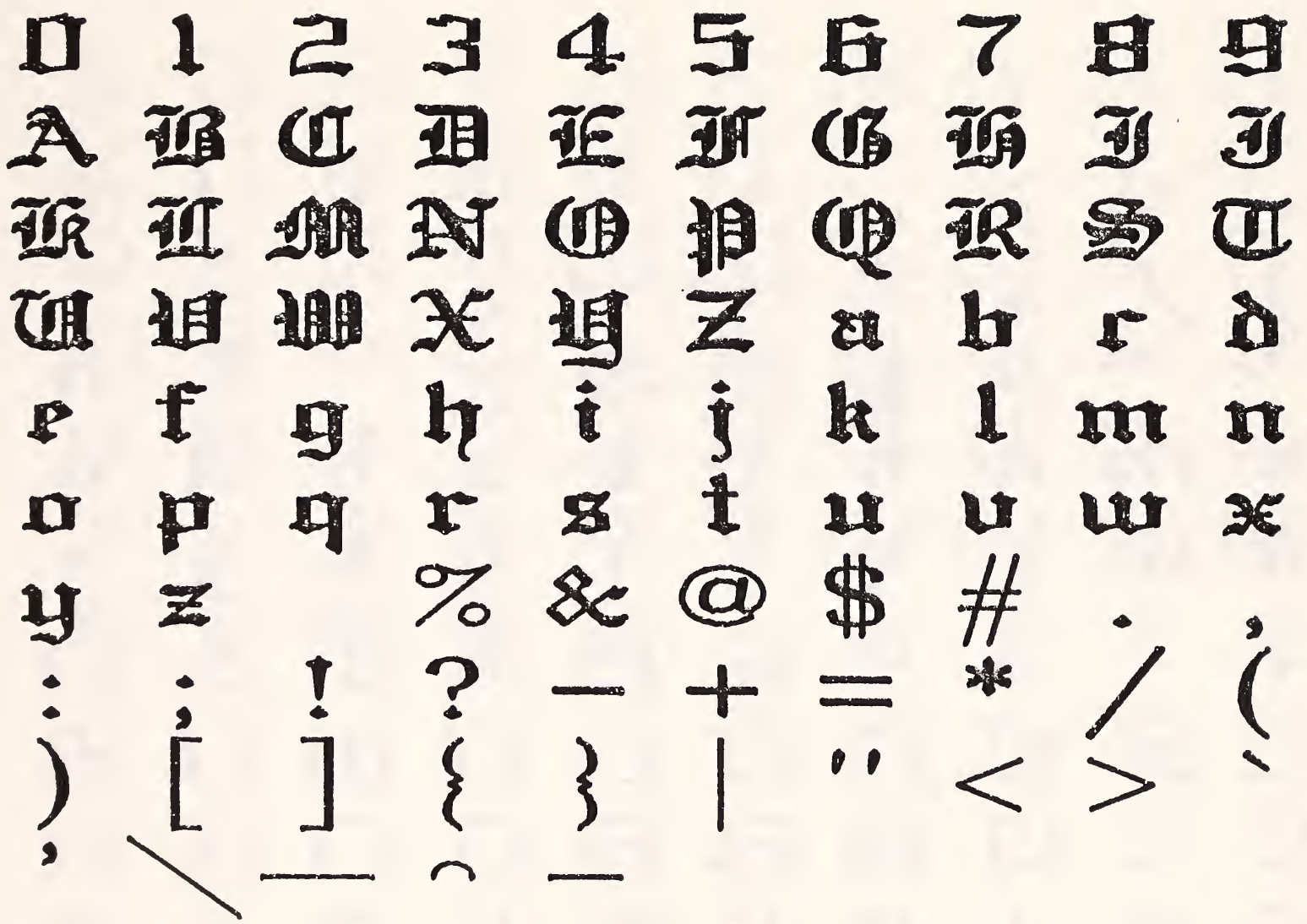
o p q r s t u v w x

y z & % @ $ # * ( ) ,

; : — | ~ + = \ ^ ' ;


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z % & @ $ # . ' ,
: ; ! ? — + = * / (
) [ ] { } | " < > `
, \ _ ~ _

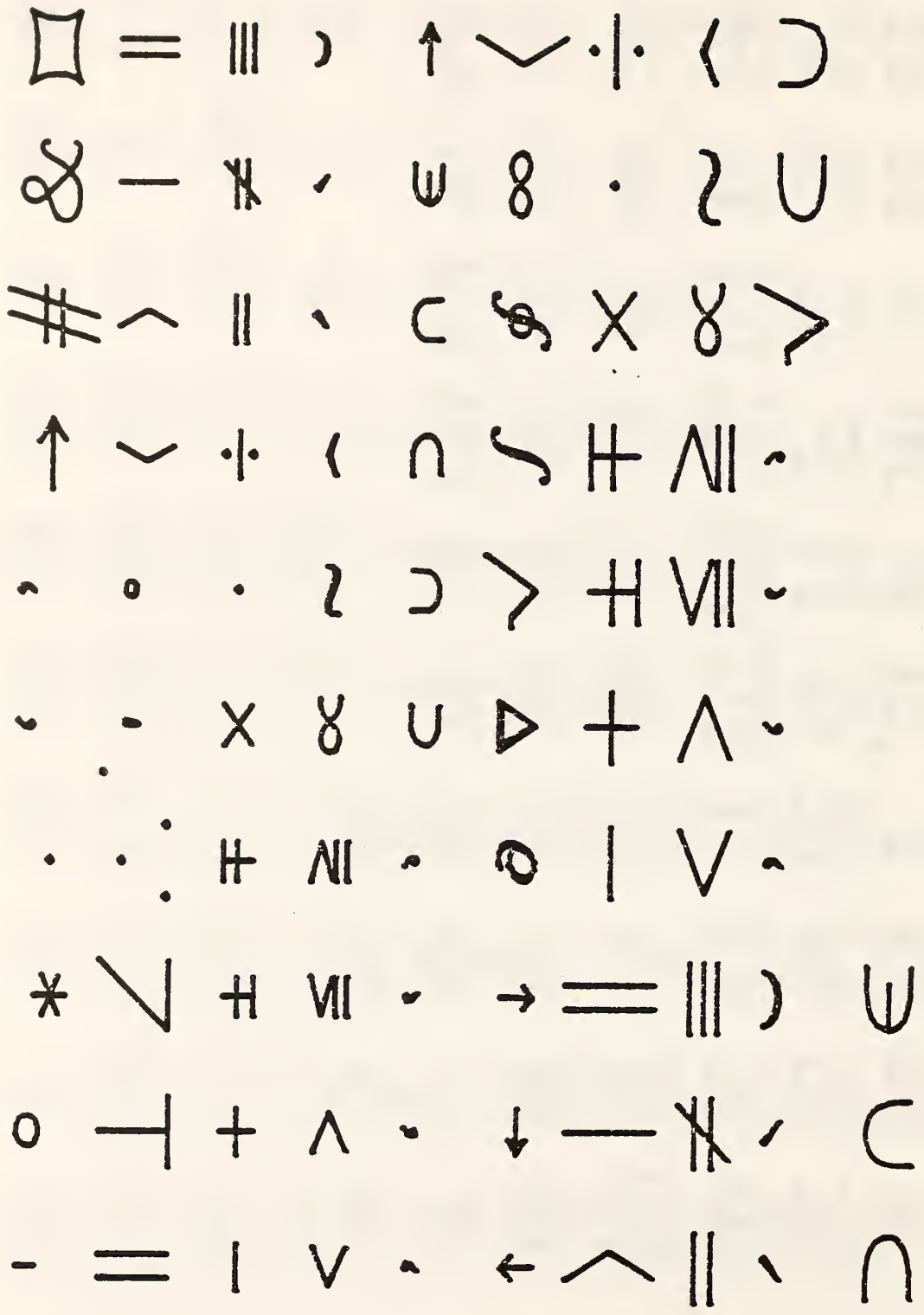
Set Number 17


0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
W V W X Y Z a b c d
e f g h i j k l m n
o p q r s t u v w x
y z ! ? & @ $ # . ,
; [ ] { } | = * / :
) ' — — — + " < > (

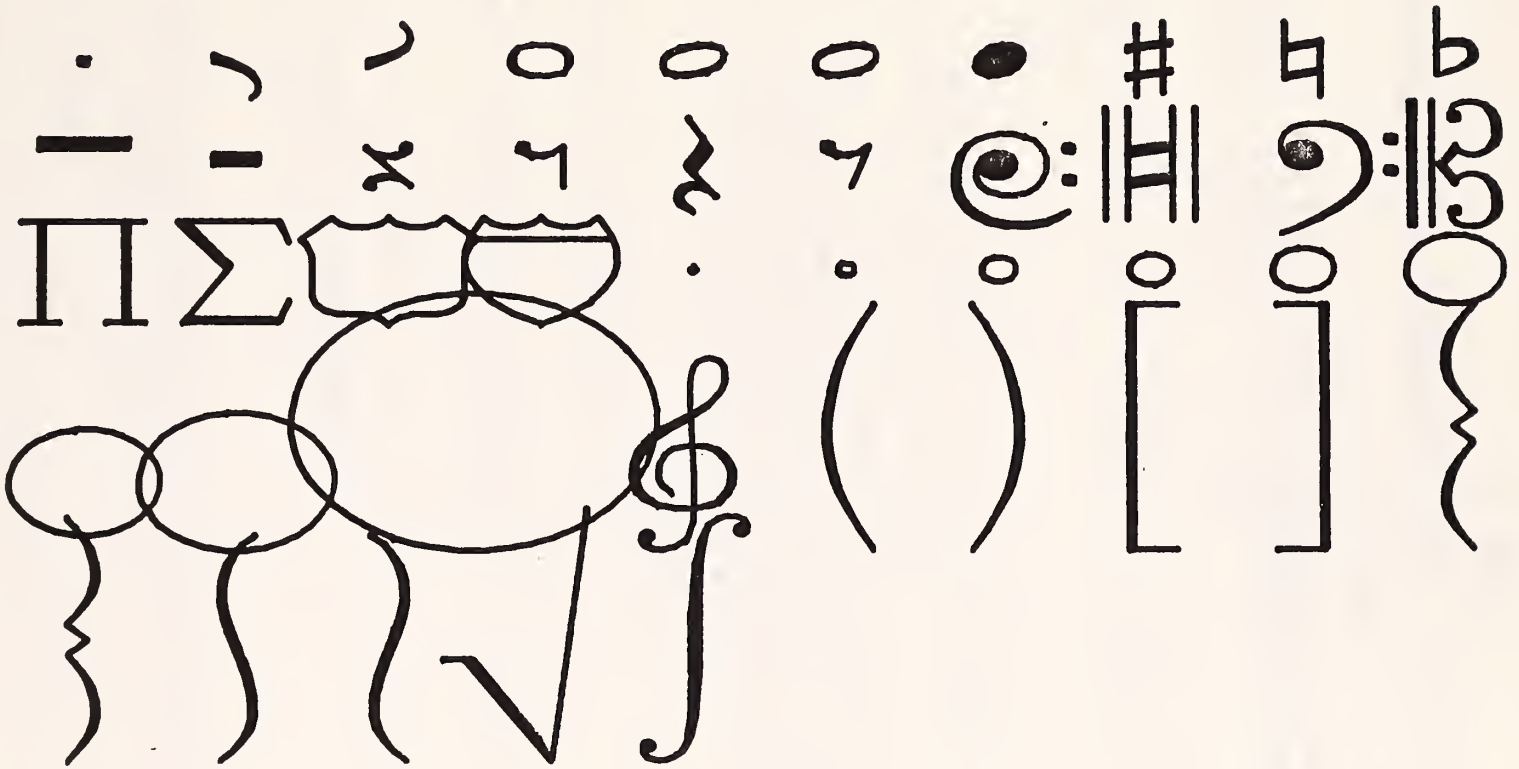
Set Number 19

А Б В Г Д Е Ж З И Й
К Л М Н О П Р С Т У
Ф Х Ц Ч Ш Щ Ъ Ы Ь Э
Ю Я а б в г д е ж з
и й к л м н о п р с
т у ф х ц ч ш щ ъ ы
ь э ю я

Set Number 21



Set Number 23



APPENDIX D

The following is a description of each BUILD command. The prompts associated with each command and the format of the user's response are indicated.

Note: When specifying a command, at least two letters of each word must be entered (e.g. AD PO means ADD POLYGON).

1. ADD

Elements are added to the arrays.

1.1 ADD VERTEX

```
ENTER (X,Y,Z) COORDINATES AND SELECT BUTTON
     BUTTON 1  (KEYBOARD = '1')-- ENTER VERTEX
     BUTTON 2  (KEYBOARD = '2')-- QUIT
```

If the input device is the joystick or the tablet, the vertex is selected with the picking implement and then button 1 is pressed. If the keyboard is used, the prompt

```
X,Y,Z,IDV=>
```

appears. Three real numbers, followed by the number 1, are entered. These numbers are separated by commas or spaces.

In both cases, the X,Y,Z coordinates of the vertex are stored in the VERTEX array. Vertices are added until the VERTEX array is filled or the user wants to quit. In order to quit, button 2 is pressed. At the keyboard, any three numbers, followed by the number 2, will terminate the process. (Alternatively, three commas followed by the number 2 can be entered: ,,,2)

1.2 ADD EDGE

```
BY VERTEX NO. (1) OR COORDINATES (2)?
```

An integer is entered. The number 1 is entered if the edges are to be composed of vertices in the VERTEX array. The number 2 is entered if the edges will be created from new vertices.

If the first method is chosen, there will be the prompt

```
ENTER ENDPOINTS -- 2 VERTEX NUMBERS
TO QUIT HIT <RETURN> OR ENTER 'QUIT'
VETEX NUMBERS:
```

Two integers, separated by a comma or space, ar entered. These numbers, indicating the vertices which define the edge, are stored in the EDGE array. The user is prompted for another edge by

```
VERTEX NUMBERS:
```

The process continues until the EDGE array is filled or the user has finished adding edges.

If the second method is selected (i.e. new vertices will be chosen), the user is prompted

```
ENTER 2 ENDPOINT COORDINATES:
     BUTTON 1 (KEYBOARD = '1') -- ENTER VERTEX FOR EDGE
     BUTTON 2 (KEYBOARD = '2') -- LAST VERTEX FOR EDGE
     BUTTON 3 (KEYBOARD = '4') -- QUIT
```

The vertices are specified as in ADD VERTEX. The first vertex of an edge is followed by button 1 ('1' on the keyboard) and the second vertex is followed by button 2 ('2' on the keyboard). The new vertices are added to the VERTEX array and the new edge is added to the EDGE array. Additional edges can be created until the VERTEX or EDGE array is filled or the user wants to quit. Button 3 ('4' on the keyboard) is used to terminate the process.

Note: In both cases, if a newly formed edge exists in the EDGE array, this element will not be stored again. A message will appear to inform the user of the condition.

1.3 ADD POLYGON

Polygons are added in the same manner as edges except that at least three vertices are needed to define a polygon. Also, there is a limit of NPVERT vertices for a polygon. Polygons can be created from existing vertices or from new vertices. When entering new vertices, button 1 ('1' on the keyboard) is pressed after each vertex except the last one in a polygon. This last vertex is followed by button 2 ('2' on the keyboard). Finally, button 3 ('4' on the keyboard) terminates the process.

New polygons are added to the POLY array provided that they don't already exist in the array. (Messages will appear to indicate existing polygons.) Any new vertices will be added to the VERTEX array.

2. ANIMATE

A sequence of frames is specified. This sequence is viewed with DISPLAY.

NUMBER OF FRAMES

An integer is entered to indicate the number of frames.

TOTAL TRANSLATION CHANGE (DX,DY,DZ)

Three real numbers separated by commas, are entered. These numbers indicate the total displacement of the model in the X,Y,Z directions.

TOTAL ROTATION CHANGE (DX,DY,DZ)

Three real numbers, separated by commas, are specified. The model can be rotated about a point (specified in the next step) with respect to X',Y',Z' axes. These axes pass through the specified point and are parallel to the X,Y,Z axes of the coordinate system. The three numbers entered indicate the angles (in degress) of rotation about the X',Y',Z' axes. Note that the rotations will be made in he X',Y',Z' order.

RELATIVE ORIGIN

The point about which rotations occur is specified. The center for the model is chosen by hitting the <RETURN> key. A different point is chosen by entering the appropriate X,Y,Z coordinates. The coordinates are entered as three real numbers separated by commas.

DISTANCE TO ORIGIN (DELTA)

A real number indicating the total change in the observer's position, is entered. A positive number moves the observer along the Z-axis in the negative direction (i.e. away from the viewing surface). A negative number causes the observer to move in the positive direction along the Z-axis.

SCALE FACTOR

A positive real number is entered. If the number is greater than one, the model is magnified. The model is reduced if the number is less than one.

MOVE EDGE(S)

There are several acceptable formats for the response:

```
n
n-m
n-
n BY X,Y,Z
n-m BY X,Y,Z
n- BY X,Y,Z
```

One edge (n) or a group of edges (n-m) may be moved. Note n- represents all the edges from n through the last element in the EDGE array. n and m are entered as positive integers. The relative displacement vector is specified by the real numbers X,Y,Z. If this displacement vector is not specified, the user is prompted for it.

MOVE POLYGON(S)

One polygon (n) or a group of polygons (n-m) may be moved by a distance X,Y,Z. The specifications are entered in the same format as for MOVE EDGE(S).

Note: Any of these transformations are omitted from the animated sequence by hitting <RETURN> after a particular prompt.

3. AUTO

The window and observer are moved so that the entire model appears in the field of view. This command is particularly useful if the location of the model outside the window becomes unknown to the user. New parameters are calculated by AUTO. A display does not automatically follow. The DISPLAY command must be used to view the model.

Note: The scaling of the model may be altered as a result of using AUTO. It may be necessary to compensate for this change by using the SCALE command.

4. COPY

The switch for hard copy of the graphics display is set.

4.1 COPY ON

NO. OF COPIES

An integer is entered to indicate the number of hard copies of each display to produce. This number defaults to one (1) if the <RETURN> key is pressed. Following each graphics display on the output device, hard copies, associated with this device, are generated.

4.2 COPY OFF

The automatic generation of hard copies after each graphics display is discontinued.

Note: At the start of program execution, the copy switch is set off.

5. DELETE

Elements are deleted from the arrays.

5.1 DELETE VERTEX

Vertices are not actually deleted from the VERTEX array. Instead, these "deleted" vertices are made unavailable for displaying and for constructing edges or polygons. Vertices are deleted from the array with the SQUEEZE command.

ENTER VERTEX LINE NUMBERS
HIT <RETURN> OR ENTER 'QUIT' WHEN DONE
VERTEX n=

There are three formats for entering vertices:

n
n-m
n-

where n and m are positive integers. One vertex (n) or a group of vertices (n-m) may be deleted. n- repesents all the vertices from n through the last element in the VERTEX array. Once these vertices are deleted, the user is prompted for other vertices to delete with

VERTEX n=

This process is repeated until all vertices are deleted or until the user has finished.

5.2 DELETE EDGE

ENTER LINE NUMBERS.
HIT <RETURN> OR ENTER QUIT' WHEN DONE
LINE NUMBER(S):

One edge (n) or a group of edges (n-m) may be deleted. These specifications are entered in the same format as the DELETE VERTEX. The user is prompted for LINE NUMBER(S): until the EDGE array is empty or the user is done.

5.3 DELETE POLYGON

```
ENTER LINE NUMBERS.
HIT <RETURN> OR ENTER 'QUIT' WHEN DONE
LINE NUMBER(S):
```

One polygon (n) or a group of polygons (n-m) may be deleted. These specifications are entered in the same format as the DELETE VERTEX. The user is prompted for LINE NUMBERS: until the POLY array is empty or the user is finished.

6. DEVICE

At the begining of program execution, the output device for graphics display defaults to the Lexidata. DEVICE is used to select a new default device. The possible selections are

DEVICE { CALCOMP | PRINTER | LEXIDATA | CONSOLE } (default = LEXIDATA)

7. DISPLAY

Array elements are displayed in graphics mode.

7.1 DISPLAY VERTEX

Each vertex in the model is displayed and labelled with its vertex number.

7.2 DISPLAY EDGE

The model's edges are displayed.

7.3 DISPLAY POLYGON

The model's polygons are displayed.

7.4 DISPLAY [ALL]

All the edges and polygons in the model are displayed.

8. DUPLICATE

Elements are duplicated at other locations. The new elements are added to the array.

8.1 DUPLICATE EDGE

WHICH EDGE(S)?

The specifications for duplicating edges are entered in one of several ways:

```
n
n-m
n-
n BY X,Y,Z
n-m BY X,Y,Z
n- BY X,Y,Z
```

where n and m are positive integers and X,Y,Z are real numbers. One edge (n) or a group of edges (n-m) may be duplicated. n- represents all the edges from n through the last element in the EDGE array. The displacement vector is specified by X,Y,Z. If this vector is not specified, the user is prompted for it. Edges can be duplicated until <RETURN> is pressed or QUIT is entered.

8.2 DUPLICATE POLYGON

WHICH POLYGON(S)?

One polygon (n) or a group of polygons (n-m) may be duplicated. The specifications are entered in the same format as for DUPLICATE EDGE. The process of duplicating polygons can be terminated by hitting <RETURN> or entering QUIT.

Note: In DUPLICATE, the displacment vector can be entered using a type of shorthand. A zero may be represented by a blank or by no character at all.

e.g.	long form	short form
	10,8,0	10,8
	0,7,0	,7
	0,0,6	,,6
	1,0,3	1,,3

9. END

The graphics display screen is erased. Execution of BUILD is terminated.

10. ERASE

The graphics display screen is erased. Note: this command is ignored for the CALCOMP.

11. EXIT

The command source is changed to the console.

12. FIELD

The field of view is altered by moving the observer and changing the angle of view.

CURRENT DISTANCE TO ORGIN: x.xx
NEW DISTANCE TO ORIGIN?

A positive real number, X, is entered. The observer is positioned at the point (0,-X); i.e. X units in front of the viewing surface.

CURRENT ANGLE OF VIEW: x.xx
NEW ANGLE OF VIEW?

The angle is measured in degrees. A positive real number in entered.

13. GET

A structure file is opened. Elements are read into variables and arrays. This file becomes the new INFILE.

GET FILENAME

The specified file is opened and read.

GET

The INFILE is opened and read. If there is no INFILE, the user is prompted for a filename.

14. HELP

The BUILD commands and their functions are listed at the console. Only a portion of the list appears followed by

CONTINUE? Y/N

Either the letter Y (for yes) or the letter N (for no) is entered. The remaining commands are listed if Y is entered. Nothing else is listed if N is entered.

15. INPUT

The command source is changed to a specified file. Possible formats are

INPUT filename
or
INPUT

The user is prompted for a filename in the latter case.

16. LIST

The array elements and/or the transformation matrix are listed at the console.

16.1 LIST VERTEX

The world and window coordinates are listed. The user is prompted for the vertices to list:

WHICH VERTICES?

There are three formats for entering vertices:

```
n
n-m
n-
```

where n and m are positive integers. One vertex (n) or a group of vertices (n-m) may be listed. n- represents all the vertices from n through the last element in the VERTEX array. The user is prompted for more vertices with

WHICH VERTICES?

This process is repeated until the user hits <RETURN> or types QUIT.

16.2 LIST EDGE

Only the model's edges are listed.

WHICH ELEMENTS?

One edge (n) or a group of edges (n-m) may be listed. These specifications are entered in the same format as in LIST VERTEX. The user is prompted for edges until <RETURN> is pressed or QUIT is entered.

16.3 LIST POLYGON

The model's polygons are listed.

WHICH ELEMENTS?

One polygon (n) or a group of polygons (n-m) may be listed. These specifications are entered in the same format as in LIST VERTEX. The user is prompted for polygons until <RETURN> is pressed or QUIT is entered.

16.4 LIST MATRIX

The transformation matrix is listed.

17. MOVE

Elements are moved to new locations.

17.1 MOVE VERTEX

VERTEX n =

There are several possible formats for response:

```
n
n-m
n-
n TO X,Y,Z
n BY X,Y,Z
n- BY X,Y,Z
```

One vertex (n) or a group of vertices (n-m) may be moved. Note: n- represents all the vertices from n through the last element in the VERTEX array. n and m are entered as positive integers. Vertices may be moved by a distance relative to the origin; the displacement vector is given by (X,Y,Z). In addition, a single vertex can be moved to a specific point (X,Y,Z). In both cases, X,Y,Z are entered as real numbers. If the input consists of only the vertex number(s), the user will be prompted for a relative displacement vector. This process of moving vertices will continue until <RETURN> is pressed or QUIT is entered.

17.2 MOVE EDGE

MOVE EDGE(S)

The specifications for moving the edges are entered in one of several ways:

```
n
n-m
n-
n BY X,Y,Z
n-m BY X,Y,Z
n- BY X,Y,Z
```

where n and m are positive integers and X,Y,Z are real numbers. One edge (n) or a group of edges (n-m) may be moved. n- represents all the edges from n through the last element in the EDGE array. The displacement vector is specified by X,Y,Z. If this vector is not specified, the user is prompted for it. Edges can be moved until <RETURN> is pressed or QUIT is entered.

17.3 MOVE POLYGON

MOVE POLYGON(S)

One polygon (n) or a group of polygons (n-m) may be moved. The specifications are entered in the same format as for MOVE EDGE. The process of moving polygons can be terminated by hitting <RETURN> or entering QUIT.

Note: In MOVE, the displacement vector can be entered using a type of shorthand. A zero may be represented by a blank character or by no character at all.

e.g.	long form	short form
	10,8,0	10,8
	0,7,0	,7
	0,0,6	,,6
	1,0,3	1,,3

18. PRINT

The array elements and/or the transformation matrix are listed at the printer.

18.1 PRINT VERTEX

The world and window coordinates are printed. Then all the vertices are listed.

18.2 PRINT EDGE

All of the model's edges are listed.

18.3 PRINT POLYGON

All of the polygons are printed.

18.4 PRINT MATRIX

The transformation matrix is printed.

18.5 PRINT ALL

The world and window coordinates are printed. All of the vertices, edges, and polygons are listed. The transformation matrix is printed.

19. ROTATE

The model is rotated about a specified point. Rotations take place about X',Y',Z' axes. These axes passing through the given point, are parallel to the X,Y,Z axes, respectively, of the coordinate system.

ANGLES? (X,Y,Z)

Three real numbers, separated by commas, are entered. These numbers specify the angles (in degrees) of rotation about the X', Y', Z' axes, respectively. Note that the rotations will be made in the X', Y', Z' order.

RELATIVE ORIGIN? (X,Y,Z)

The point about which rotations occur is specified. The center of the model is chosen by hitting the <RETURN> key. A different point is chosen by entering the appropriate X,Y,Z coordinates. These coordinates are entered as three real numbers separated by commas.

Note: After both prompts, the response can be entered using a type of shorthand. A zero may be represented by a blank character or by no character at all.

e.g.

long form	short form
10,8,0	10,8
0,7,0	,7
0,0,6	,,6
1,0,3	1,,3

20. SAVE

Variables and array elements are written to a file. This structure file is closed and becomes the new OUTFILE.

SAVE filename

The current work file is saved in the specified file.

SAVE

The work file is saved in the OUTFILE. If there is no OUTFILE, the user is prompted for a filename.

21. SCALE

All the vertices are scaled about the center point of the structure.

SCALE FACTOR?

A positive real number is entered. If the number is greater than one, the model is magnified. The model is reduced if the number is less than one.

22. SELECT

The defaults for line width, color, and polygon filling are chosen.

LINE WIDTH (0-15)

An integer is entered. As the numbers increase, the lines become wider. At the start of program execution, the default value is 2.

COLOR (1-15)

An integer, corresponding to the desired color, is entered. Initially, the default value is 1.

FILL TYPE (0-4)

An integer, indicating a particular polygon filling, is entered. At the start, the default value is 0. (See FILTYP in Appendix A).

Note: If the default value for an attribute is not to be changed, the <RETURN> key is pressed after the prompt.

23. SET

At the beginning of program execution, the input device for data (vertices, edges, and polygons) defaults to the keyboard. SET is used to select a new default input device. The possible selections are

SET { KEYBOARD / JOYSTICK / TABLET } (default = KEYBOARD)

24. SQUEEZE

Vertices which were deleted with the DELETE command and vertices which are not used in any polygon or edge are removed from the VERTEX array. The remaining vertices are shifted up in the array in order to fill empty slots. The EDGE and POLY arrays are adjusted to account for the new vertex numbers.

25. STATUS

Some general information concerning the work file appears at the console. The filenames of the INFILE and OUTFILE are listed. The number of elements in the VERTEX, EDGE, and POLY arrays are indicated along with the size of each array.

26. TRANSLATE

The vertices of the model are translated.

TRANSLATE VERTICES BY (DX,DY,DZ)

Three real numbers, separated by commas, are entered. These numbers indicate the total displacement of the model in the X,Y,Z directions. The numbers can be entered using a type of shorthand. A zero may be represented by a blank character or by no character at all.

e.g.	long form	short form
	10,8,0	10,8
	0,7,0	,7
	0,0,6	,,6
	1,0,3	1,,3

27. WINDOW

The boundaries of the window are specified.

ENTER THE LOWER LEFT VERTEX:

If the input device is the joystick or the tablet, the picking implement is used to point to the lower left corner of the window and then button 1 is pressed. If the keyboard is the input device, then the user in prompted

X,Y,Z,IDV=

Three real numbers, followed by the number 1, are entered. These numbers are separated by commas or spaces. The real numbers specify the X,Y,Z, coordinates, respectively, of the lower left corner of the window. Note: The Z-coordinate is assigned the value zero, regardless of the value entered by the user.

ENTER THE UPPER RIGHT VERTEX:

This vertex is entered in the same manner as the lower left vertex.

28. WORLD

The boundaries of the world space are specified.

ENTER THE LOWER LEFT FRONT VERTEX:

If the input device is the joystick or the tablet, the picking implement is used to point to the lower left front corner of the box which will be the world space. Button 1 is then pressed. If the keyboard is the input device, then the user is prompted

X,Y,Z,IDV=

Three real numbers, followed by the number 1, are entered. These numbers are separated by commas or spaces. The real numbers specify the X,Y,Z coordinates, respectively, of the lower left front corner of the box.

ENTER THE UPPER RIGHT BACK VERTEX:

This vertex is entered in the same manner as the lower left front vertex.

APPENDIX E

The following is a description of each TITLES command. The prompts corresponding to each command, together with the formats of the user's responses, are indicated.

1. ADD

Character strings are added to a specified slide.

FRAME=

An integer is entered to specify a slide

COLOR=

An integer (1-15) is entered to specify a default color for the new character strings.

SET=

An integer (1-24) is entered to specify a default character set for the new text.

INPUT THE STRING

The character string is entered. The character sets and colors used within the string are modified with control sequences. In addition, control sequences are used to place subscripts and superscripts in the string and to change the justification of the text. See Appendix B for a list of these sequences.

TOGGLE BUTTON FOR LOWER LEFT

The cursor is moved to select the location of the lower left corner of the string. Once the cursor is set in place, the text is displayed.

DEL(1), MOV(2), CENTER(3), SCALE(4)=

An integer (1-4) is entered:

1 - The string is deleted.

2 - The text will be moved. TOGGLE BUTTON TO MOVE LL CORNER. The cursor is positioned at the desired location of the lower left corner of the text. Once the cursor is set in place, the text is moved.

3 - The string is centered on the line.

4 - The text is scaled by a SCALE FACTOR which is specified as a positive real number.

<RETURN> - The string is not modified.

Only one correction can be made at a time. The prompt for corrections will reappear until the string is deleted or the <RETURN> key is entered.

INPUT THE STRING

Another string may be added to the slide. When no other strings are to be added, the <RETURN> key is entered.

2. BULLET

A bullet is drawn on a specified slide.

FRAME=

An integer is entered to specify the slide on which the bullet will be drawn.

COLOR=

An integer (1-15) is entered to select the color of the bullet.

TOGGLE FOR CENTER

The cursor is positioned at the desired location of the bullet. Once the cursor is set, the bullet is displayed.

3. CIRCLE

A circle is drawn on a specified slide.

FRAME=

An integer is entered to specify the slide on which the circle will be drawn.

COLOR=

An integer (1-15) is entered to select the color of the bullet.

TOGGLE FOR CENTER

The cursor is positioned at the location of the circle's center.

TOGGLE FOR RADIUS

The cursor is positioned at the location of any point on the circle. Once the cursor is set, the circle is drawn.

4. COLORS

All of the available colors are displayed.

5. CORRECT

The text on a slide is corrected one string at a time.

FRAME=

An integer is entered to specifiy the slide which will be corrected. A line of text is printed at the console, followed by

DEL(1), MOV(2), CENTER(3), SCALE(4)=

An integer (1-4) is entered:

1 - The string is deleted.
2 - The text will be moved. TOGGLE BUTTON TO MOVE LL CORNER. The cursor is positioned at the desired location of the lower left corner of the text. Once the cursor is set in place, the text is moved.
3 - The string is centered on the line.
4 - The text is scaled by a SCALE FACTOR which is specified as a positive real number.
<RETURN> - The string is not modified

Only one correction can be made at a time. This prompt for corrections will reappear until the string is deleted or the <RETURN> key is entered.

The next line of text, along with the prompt for corrections, is displayed on the console. This process is repeated for each line of the text on the slide.

6. DELAY

The delay time for the hard copy device is specified. An integer is entered for this delay time.

7. END

The program is terminated.

8. HELP

The TITLES commands are listed.

9. NEW

A new slide is created. The frame number is incremented. New character strings are added to this slide as with the ADD command.

10. LINE

A line is drawn on a specified slide.

FRAME=

An integer is entered to specify the slide on which the line will be drawn.

COLOR=

An integer (1-15) is entered to select the color of the line.

TOGGLE FOR START OF LINE

The cursor is positioned at the location of one of the line's endpoints.

TOGGLE FOR END OF LINE

The cursor is positioned at the location of the other endpoint of the line. Once the cursor is set, the line is drawn.

11. PROCESS

Hard copies of specified slides are generated.

INPUT SLIDE # (0 TO PROCESS.) AND FRAME COUNT =

Two integers are entered to indicate the slide number and the number of hard copies, respectively.

INPUT SLIDE# (0 TO PROCESS,) AND FRAME COUNT=

Another slide may be specified for copying. When all the desired slides have been specified, a zero is entered. The hard copies are then processed and the program is terminated.

12. REREAD

A file is opened and data is read into variables.

RESTART FILE

The name of a data file is entered. A new file may be started by just hitting

<RETURN>.

n SLIDES
FUNCTION=

The user is informed of the number of slides in the the data file. A command is then specified by the user.

13. SAVE

The slides in the work file are written to a data file. If a data file has been opened, the slides are written to this file. Otherwise, the user is prompted for

FILE NAME.

The name of the new data file is entered.

14. SET

A character set is displayed.

SET NO.=

A integer (1-24) is entered to select a character set.

15. VIEW

A slide is displayed.

NUMBER=

An integer is entered. This number indicates the slide to be displayed. Once the image has been generated, the process is repeated with the NUMBER= prompt. When no other slides are to be displayed, a zero or the <RETURN> key is entered.

Appendix F

```
      PROGRAM G2TEST
      INTEGER PB(6)
C
C     TEST EACH FUNCTION OF THE DEVICE INDEPENDENT PCKAGE
C
C
      WRITE(5,1) ' '
      WRITE(5,1) 'ANGLE  1'
      WRITE(5,1) 'CIRCLE  2'
      WRITE(5,1) 'FLYING CUBE  3'
      WRITE(5,1) 'GRAFIT(1)  4'
      WRITE(5,1) 'GRAFIT(2)  5'
      WRITE(5,1) 'GRAFIT(3)  6'
      WRITE(5,1) 'GRAFIT(4)  7'
      WRITE(5,1) 'PHASE SPACE PLOT (CONTOUR AND SURFACE PLOT)  8'
      WRITE(5,1) 'SINGLE ROOM FIRE  9'
      WRITE(5,1) 'SADDLE SURFACE 10'
      WRITE(5,1) 'HARDWARE/HERSHEY SYMBOLS 11'
      WRITE(5,1) '3D CONTOURING 12'
      WRITE(5,1) 'POLYGON FILLING 13'
      CALL SYSIO(PB,41,5,' TEST =',7,0)
      READ(5,3,END=4,ERR=4) I
C
C     GET THE DEVICE
C
      CALL SYSIO(PB,33,5,'DEVICE=',7,0)
      READ(5,2) ID
    2 FORMAT(I)
      CALL DEVICE(ID)
      GO TO (201,202,203,204,205,206,207,208,209,210,211,212,
     .                          213),I
      STOP 'NO SELECTION'
  201 CALL ANGTST
  202 CALL CIRC(ID)
  203 CALL CUBE
  204 CALL GRAFIT1(ID)
  205 CALL GRAFIT2(ID)
  206 CALL GRAFIT3(ID)
  207 CALL GRAFIT4(ID)
  208 CALL PHASE
  209 CALL RUMTST
  210 CALL SADDLE(ID)
  211 CALL SYMTST
  212 CALL VOLTST(ID)
  213 CALL FILNGT(ID)
    1 FORMAT(1X,A50)
    3 FORMAT(I)
    4 STOP
      END
C
```

```
      SUBROUTINE ANGTST
C
C     A SIMPLE TEST OF THE CHARACTER STUFF
C
      CHARACTER*1 TITLE(80)
      INTEGER PB(6)
      CHARACTER*80 STRING
C
C     FIRST A SIMPLE DEMONSTRATION
C
      CALL GRISET (0.,0.,100.,100.)
      CALL NEWFRM
      CALL WDDRAW (50.,90.,6.,0.,8.,0.,8.,'¶LL¶C02EFT¶.')
      CALL WDDRAW (50.,75.,6.,0.,8.,0.,8.,'¶M¶C01C¶C02ENTERED¶.')
      CALL WDDRAW (50.,60.,6.,0.,8.,0.,8.,'¶R¶C01R¶C02IGHT¶.')
      STRING='¶M¶C011¶C022¶C033¶C044¶C055¶C066¶C077¶C088¶C139¶C140¶.
     .'
      CALL WDDRAW (50.,45.,6.,0.,8.,0.,8.,STRING)
      STRING='¶M¶C01ALSO¶U¶C05SUPERSCRIPTS¶O ¶C01AND¶C05¶DSUBSCRIPTS
     .¶.'
      CALL WDDRAW (50.,30.,6.,0.,4.,0.,5.,STRING)
      STRING = '¶MABC¶U1.234¶.'
      CALL LABEL(STRING,60.,10.,90.,20.,.50)
C     STRING='¶M¶C01¶H04AND ¶C03YOU ¶C07¶H18CAN ¶H04CHANGE CHARACTER
C    . ¶C03¶H18SETS¶.'
C     CALL WDDRAW (50.,20.,6.,0.,4.,0.,5.,STRING)
      STRING = '¶C02¶H04S¶US¶US¶US¶.'
      CALL WDDRAW (10.,10.,6.,0.,4.,0.,5.,STRING)
      STRING = '¶C03¶OD¶DD¶DD¶DD¶.'
      CALL WDDRAW(20., 10., 6., 0., 4., 0., 5., STRING)
      STRING = '¶C08NOW TRY ONE YOURSELF!¶.'
      CALL WDDRAW(10.,1.,6.,0.,4.,0.,5.,STRING)
      CALL FRAME
      PAUSE
C
C     THE RESTART POSITION - SCART WITH THE ANGLE OF THE TEXT
C
    4 CALL SYSIO(PB,33,5,'ANGLE=',6,0)
      READ(5,1) ANGLE
    1 FORMAT(2F)
      IF(ANGLE.LT.0.0) GO TO 5
      THETA = ANGLE/57.295
      DO 7 I = 1, 80
    7 TITLE(I) = ' '
C
C     ERASE THE SCREEN AND PREPARE TO DRAW
C
      CALL NEWFRM
      CALL SYSIO(PB,33,5,'TEXT=',5,0)
      READ(5,3) TITLE
    3 FORMAT(80A1)
      DO 11 I = 1, 80
      II = 81 - I
      IF(TITLE(II).NE.' ') GO TO 12
   11 CONTINUE
```

```
106             GO TO 4
107      12     TITLE(II+1) = '¶'
108             TITLE(II+2) = '.'
109   C         CALL SYSIO(PB,33,5,'LINWID=',7,0)
110   C         READ(5,2) LW
111             CALL DEFINE (0., 0., 13., 13.)
112             CALL COLOR(4)
113   C         CALL LINWID(LW)
114             CALL BOXPLT (0.5, 0.5, 12.5, 12.5)
115             CALL COLOR(5)
116             CALL WDCOUNT(TITLE,NT)
117             IF(NT.EQ.0) GO TO 4
118   C
119   C     DRAW THE LABEL
120   C
121             YB = 5.0
122             XPOS = 5.0
123             XRIGHT = XPOS + MIN(FLOAT(NT),11.)
124             YTOP   = YB   + 1.
125             CALL LABEL(TITLE, XPOS, YB, XRIGHT, YTOP, THETA)
126             CALL FRAME
127             GO TO 4
128   C
129   C     CLOSE THE PLOTTING DEVICE AND ERASE NON-LOCAL SCREENS
130   C
131       5     CALL ENDFRM
132             STOP
133             END
```

```
      SUBROUTINE CIRC(ID)
      CALL NEWFRM
      IF(ID.NE.1) THEN
        CALL DEFINE (0.,0.,10.,10.)
      ELSE
        CALL SCALNG (0.,0.,10.,10.,0.,0.,7.9,7.9,0.,0.,0.,0.)
      ENDIF
      CALL COLOR(2)
      CALL LINWID(4)
      CALL FILTYP(1)
      CALL CIRCLE(5.,5.,4.)
      CALL FRAME
      PAUSE
      CALL ERASE
      CALL ENDFRM
      STOP
      END
```

```
      SUBROUTINE CUBE
      COMMON QNORM(3,6),VERT(3,8),IEDGV1(12),IEDGV2(12),
     . ISURF(6),IPEDG(24),NVERT,NEDGS,NSURF,F,SCALE(4)
      INTEGER IV(2)/2,0/
C
      DIMENSION T(4,4),QM(4,4),QMT(4,4)
      DX = 4.
      DY = 4.
      XL = -1.5 - 0.1*4.
      XR = +3. + .15*4.
      XB = -1.5 - 0.1*4.
      XT = +3. + 0.15*4.
      CALL DEFINE (XL, XB, XR, XT)
      CALL DELAY(26)
      CALL NEWFRM
      CALL COLOR(5)
      CALL LINWID(3)
      NVERT = 8
      NEDGS = 12
      NSURF = 6
      F = 3.
      XINCR = .5 / 95.
      DO 100 I = 1, 4
      DO 100 J = 1, 4
      T(I,J) = 0.0
      IF(I.EQ.J) T(I,I) = 1.0
100   CONTINUE
      XC = 0.5
      YC = 0.5
      ZC = 0.5
      CALL SETMAT (QM,1,1.0,0,0,0)
      DO 1000 I = 1, 95
      CALL TRANS(T)
      XC1 = XC - XINCR
      YC1 = YC - XINCR
      ZC1 = ZC - XINCR
      QM(1,4) = -(QM(1,1)*XC + QM(1,2)*YC) + XC1
      QM(2,4) = -(QM(2,1)*XC + QM(2,2)*YC) + YC1
      QM(3,4) = -ZC + ZC1
      XC = XC1
      YC = YC1
      ZC = ZC1
      CALL MM (T,QM,T)
1000  CONTINUE
      CALL TRANS(T)
      CALL SETMAT(QM,2,1.0,0,0,0)
      DO 2000 I = 1, 192
      F = F + .15
2000  CALL TRANS(T)
      CALL SETMAT(QM,3,1.0,0,0,0)
      DO 3000 I = 1, 192
      F = F - .15
      CALL MM(T,QM,T)
3000  CALL TRANS(T)
      CALL SETMAT(QM,1,1.0,0,0,0)
```

```
206             CALL SETMAT(QMT,2,1.0,0,0,0)
207             CALL MM(QM,QMT,QM)
208             DO 4000 I = 1, 96
209             CALL MM(T,QM,T)
210   4000      CALL TRANS(T)
211             CALL SETMAT(QMT,3,1.0,0,0,0)
212             CALL MM (QM,QMT,QM)
213             THETA = 3.14159265/180.
214             ANGLE8 = 3.141592 + THETA
215             DO 5000 I = 1, 360
216             XC1 = SIN(ANGLE8)
217             ZC1 = COS(ANGLE8)+ 1.0
218             YC1 = FLOAT(I)/360.
219             QM(1,4) = -(QM(1,1)*XC + QM(1,2)*YC + QM(1,3)*ZC) + XC1
220             QM(2,4) = -(QM(2,1)*XC + QM(2,2)*YC + QM(2,3)*ZC) + YC1
221             QM(3,4) = -(QM(3,1)*XC + QM(3,2)*YC + QM(3,3)*ZC) + ZC1
222             XC = XC1
223             YC = YC1
224             ZC = ZC1
225             ANGLE8 = ANGLE8 + THETA
226             CALL MM (T,QM,T)
227   5000      CALL TRANS(T)
228             CALL ENDFRM
229             STOP
230             END
```

```
231             SUBROUTINE MM(A,B,C)
232             DIMENSION A(4,4),B(4,4),C(4,4),D(4,4)
233             DO 10  I = 1, 4
234             DO 9 J = 1, 4
235             D(I,J) = 0.0
236             DO 8 K = 1, 4
237   8         D(I,J) = D(I,J) + B(I,K) * C(K,J)
238   9         CONTINUE
239   10        CONTINUE
240             DO 20 I = 1, 4
241             DO 20 J = 1, 4
242   20        A(I,J) = D(I,J)
243             RETURN
244             END
```

```
245             SUBROUTINE MM3(A,B,C,K)
246             DIMENSION B(4,4),A(3),C(3),D(3)
247             DO 10 I = 1, 3
248             IF(K.EQ.1) D(I) = B(I,4)
249             IF(K.NE.1) D(I) = 0.0
250             DO 9 J = 1, 3
251   9         D(I) = D(I) + B(I,J)*C(J)
252   10        CONTINUE
253             DO 20 I = 1, 3
254   20        A(I) = D(I)
255             RETURN
256             END
```

```
257             SUBROUTINE SETMAT(A,ITYPE,THETA,XT,YT,ZT)
258             DIMENSION A(4,4)
259             RAD = 3.141592 / 180.
260             DO 10 I = 1, 4
261             DO 10 J = 1, 4
262   10        A(I,J) = 0.0
263             A(4,4) = 1.0
264             ANGLE = THETA * RAD
265             CT = COS(ANGLE)
266             ST = SIN(ANGLE)
267             GO TO (100,200,300,400),ITYPE
268   100       A(1,1) = CT
269             A(2,1) = -ST
270             A(1,2) = ST
271             A(2,2) = CT
272             A(3,3) = 1.0
273             RETURN
274   200       A(1,1) = 1.0
275             A(2,2) = CT
276             A(3,2) = ST
277             A(2,3) = - ST
278             A(3,3) = CT
279             RETURN
280   300       A(1,1) = CT
281             A(3,1) = -ST
282             A(1,3) = ST
283             A(3,3) = CT
284             A(2,2) = 1.0
285             RETURN
286   400       A(1,1) = 1.0
287             A(2,2) = 1.0
288             A(3,3) = 1.0
289             A(1,4) = XT
290             A(2,4) = YT
291             A(3,4) = ZT
292             RETURN
293             END
```

```
294             SUBROUTINE TRANS(R)
295             COMMON QNORM(3,6),VERT(3,8),IEDGV1(12),IEDGV2(12),
296           .  ISURF(6),IPEDG(24),NVERT,NEDGS,NSURF,F,SCALE(4)
297             DIMENSION R(4,4),RVERT(3,8),QN(4)
298             DIMENSION IEDG(12),XP(12),YP(12)
299             DO 10 I = 1, NEDGS
300   10        IEDG(I) = 0
301             DO 20 I = 1, NVERT
302             CALL MM3(RVERT(1,I),R,VERT(1,I),1)
303   20        CONTINUE
304             IPTS = 1
305             DO 100 I = 1, NSURF
306             K = ISURF(I)
307             IPTF = IPTS + K - 1
308             CALL MM3(QN,R,QNORM(1,I),0)
309             K1 = IPEDG(IPTS)
310             K2 = IEDGV1(K1)
311             XN2 = -RVERT(1,K2)
312             YN2 = -RVERT(2,K2)
313             ZN2 = -RVERT(3,K2) - F
314             DOT = QN(1) * XN2 + QN(2) * YN2 + QN(3) * ZN2
315             IF(DOT.LE.0.0) GO TO 100
316             DO 30 J = IPTS, IPTF
317             JJ = IPEDG(J)
318   30        IEDG(JJ) = IEDG(JJ) +  1
319   100       IPTS = IPTF + 1
320             DO 200 I = 1, NVERT
321             ZPF = RVERT(3,I) + F
322             XP(I) = F * RVERT(1,I) / ZPF
323             YP(I) = F * RVERT(2,I) / ZPF
324   200       CONTINUE
325             CALL ERASE
326             DO 300 I = 1, NEDGS
327             IF(IEDG(I).EQ.0) GO TO 300
328             I1 = IEDGV1(I)
329             I2 = IEDGV2(I)
330             CALL LINE (XP(I1), YP(I1), XP(I2), YP(I2))
331   300       CONTINUE
332             CALL FRAME
333   C         CALL HDCOPY
334             RETURN
335             END
```

```
      BLOCKDATA BLK
      COMMON QNORM(3,6),VERT(3,8),IEDGV1(12),IEDGV2(12),
     .ISURF(6),IPEDG(24),NVERT,NEDGS,NSURF,F,SCALE(4)
      DATA QNORM/0,0,-1.,-1.,4*0.,2*1.,3*0.,-1.,0,0,1.,0/
      DATA VERT/4*0,1.,0,2*1.,0,1.,4*0,1.,0.,6*1.,0,1./
      DATA IEDGV1/1,2,3,4,5,6,7,8,1,2,3,4/
      DATA IEDGV2/2,3,4,1,6,7,8,5,5,6,7,8/
      DATA ISURF/6*4/
      DATA IPEDG/1,2,3,4,1,9,5,10,8,7,6,5,3,11,7,12,4,12,8,9,
     . 2,10,6,11/
      END
```

```
      SUBROUTINE GRAFIT1(ID)
C
      DIMENSION X(100), Y(100)
      CHARACTER*31 YAXIS/' IGNITION TIME (MINUTES)¶.'/
C
      CALL NEWFRM
C     CALL SETDEV(0,5)
      CALL COLOR(2)
      CALL GRISET (0., -50., 1023., 1023.)
      PIP = 3.1415
      PIM = - PIP
      CALL COLOR(3)
      CALL GRILAB(1,PIM,-2.,PIP,+2.)
      CALL GRAFIT (1,PIM, PIP, 200., 900., PIM, PIP, -2.0, +2.0,
     .  100., 800., -2.0, +2.0, 'X AXIS¶.', 3, YAXIS, 5)
      CALL COLOR(4)
      CALL GRILAB(2,PIM,-2.,PIP,+2.)
      CALL GRAFIT (2,PIM, PIP, 450., 650., PIM, PIP, -2.0, +2.0,
     .  200., 500., -2.0, +2.0, 'X AXIS¶.', 3, 'Y AXIS¶.', 5)
      XOFF = (PIP - PIM) / 100.
      DO 2 I = 1, 100
      XI = PIM + FLOAT(I-1) * XOFF
      YI = COS(XI)
      X(I) = XI
    2 Y(I) = YI
      CALL COLOR(1)
      CALL PLOTLN (1, X, Y, 100)
      CALL PLOTLN (2, X, Y, 100)
      CALL FRAME
      IF(ID.EQ.3) PAUSE
      CALL ENDFRM
      STOP
      END
```

```
380         SUBROUTINE GRAFIT2(ID)
381         DIMENSION X(100),Y(100)
382   C
383   C     READ IN SOME DATA (X VS Y)
384   C
385         LIN = 3
386         OPEN(UNIT=1,FILE='G1TEST2.DAT')
387         CALL RDCNL(Y,I1,IY,I2)
388         CALL RDCNL(X,I1,IX,I2)
389         IZ = MINO(IX, IY)
390         I3 = IZ/3
391       3 IREV = 0
392         DO 4 I = 1, IZ-1
393         II = I + 1
394         IF(X(I).LE.X(II)) GO TO 4
395         IREV = IREV + 1
396         XP = X(I)
397         YP = Y(I)
398         X(I) = X(II)
399         Y(I) = Y(II)
400         X(II) = XP
401         Y(II) = YP
402       4 CONTINUE
403         IF (IREV.GT.0) GO TO 3
404   C
405   C     SCALE - WE NOW KNOW HOW BIG TO MAKE THE AXES
406   C
407         XMAX = 0.0
408         XMIN = 1.E+10
409         YMAX = 0.0
410         YMIN = 1.E+10
411         DO 1 I = 1, IZ
412         XMAX = AMAX1(XMAX,X(I))
413         XMIN = AMIN1(XMIN,X(I))
414         YMAX = AMAX1(YMAX,Y(I))
415       1 YMIN = AMIN1(YMIN,Y(I))
416         YMINC = 1.E+10
417         YMAXC = 0.0
418         DO 5 I = 1, I3
419         YMINC = AMIN1(YMINC,Y(I3-1+I))
420       5 YMAXC = AMAX1(YMAXC,Y(I3-1+I))
421   C
422   C     NOW ROUND OFF THE AXES TO  APPROPRIATE WHOLE VALUES
423   C
424             YMIN = 0.0
425         DELTAX = (XMAX-XMIN)/9.
426         DELTAY = (YMAX-YMIN)/9.
427         XMAXA =       XMAX - DELTAX * 0.8
428         XMINA =       XMIN + DELTAX * 1.5
429         YMINA =       YMIN + DELTAY * 1.5
430         YMAXA =       YMAX - DELTAY * .8
431         XMINB = XMINA + DELTAX
432         XMAXB = XMAXA - 2.0*DELTAX
433         YMINB = YMINA + DELTAY * .76
434         YMAXB = YMAXA - 2.7*DELTAY
```

```
435         XMAX = IFIX(XMAX+DELTAX/2.)
436         YMAX = IFIX((YMAX+DELTAY)/100.)*100.
437         CALL NEWFRM
438         CALL LINWID(LIN)
439         CALL COLOR(1)
440         CALL GRISET (XMIN, YMIN, XMAX, YMAX)
441         CALL GRILAB(1,XMIN,YMIN,XMAX,YMAX)
442         CALL GRAFIT(1,XMIN,XMAX,XMINA,XMAXA,XMIN,XMAX,YMIN,YMAX,
443        . YMINA,YMAXA,YMIN,YMAX,' TIME(MINUTES)¶.',14,
444        . 'TEMPERATURE(K)¶.',12)
445         CALL GRILAB(2,X(I3),YMINC,X(2*I3),YMAXC)
446         CALL GRAFIT(2,X(I3),X(2*I3),XMINB,XMAXB,X(I3),X(2*I3),
447        . YMINC,YMAXC,YMINB,YMAXB,YMINC,YMAXC,
448        . 'TIME(MINUTES)¶.', 5, 'FLUE TEMPERATURE(K)¶.', 5)
449         CALL COLOR(2)
450         CALL LINWID(4)
451         CALL PLOTLN(1,X,Y,I3)
452         CALL COLOR(3)
453         CALL PLOTLN(1,X(I3-1),Y(I3-1),I3)
454         CALL PLOTLN(2,X(I3),Y(I3),I3)
455         CALL COLOR(2)
456         CALL PLOTLN(1,X(2*(I3-1)),Y(2*(I3-1)),IZ-2*(I3-1))
457         CALL FRAME
458         IF(ID.EQ.3) PAUSE
459         CALL ENDFRM
460         STOP
461         END
```

```
462         SUBROUTINE RDCNL (REED,ICNL,MAXR,IEOF)
463   C
464   C     RRRRRRR   RRRRRRR    RRRRRR   RR     RR  RR
465   C     RRRRRRRR  RRRRRRRR  RRRRRRRR  RRR    RR  RR
466   C     RR    RR  RR    RR  RR    RR  RRRR   RR  RR
467   C     RR    RR  RR    RR  RR        RR RR RR  RR
468   C     RRRRRRR   RR    RR  RR    RR  RR  RRRR  RR
469   C     RR   RR   RRRRRRRR  RRRRRRRR  RR   RRR  RRRRRRRR
470   C     RR    RR  RRRRRRR    RRRRRR   RR    RR  RRRRRRRR
471   C
472         DIMENSION REED(100)
473         READ (1,10) MAXR,ICNL,IEND
474         IF (IEND.EQ.999) THEN
475           IEOF=1
476         ELSE
477           IEOF=0
478           READ (1,20) (REED(IR),IR=1,MAXR)
479         END IF
480         RETURN
481   C
482   C
483   10    FORMAT (2I6,T78,I3)
484   20    FORMAT (7E11.5)
485   C
486         END
```

```
      SUBROUTINE GRAFIT3(ID)
C
      DIMENSION X(100), Y(100)
      CHARACTER*31 YAXIS/'TIME SINCE IGNITION¶.MINUTES)¶.'/
      CHARACTER IC/'Z'/
C
      CALL SETDEV(0,5)
      XMIN = 0.
      XMAX = 1000.
      YMIN = 0.
      YMAX = 1000.
      XMAXG = 0.0
      YMAXG = 0.0
      DO 3 J = 1, 5
      CALL NEWFRM
      XMAXG = XMAXG + XMAX
      YMAXG = YMAXG + YMAX
      CALL GRISET(XMIN,YMIN,XMAXG,YMAXG)
      PIP = 3.1415
      PIM = - PIP
      CALL COLOR(3)
      DX = XMAX - XMIN
      DY = YMAX - YMIN
      X200 = XMIN + .2 * DX
      X900 = XMAX - .1 * DX
      Y100 = YMIN + .2 * DY
      Y800 = YMAX - .1 * DY
      CALL GRILAB(1,PIM,-2.,PIP,+2.)
      CALL GRAFIT (1,PIM, PIP, X200, X900, PIM, PIP, -2.0, +2.0,
     .  Y100, Y800, -2.0, +2.0, 'X AXIS¶.', 3, YAXIS, 5)
      CALL COLOR(4)
      X450 = XMIN + .45 * DX
      X650 = XMAX - .35 * DX
      Y200 = YMIN + .30 * DY
      Y500 = YMAX - .40 * DY
      CALL GRILAB(2,PIM,-2.,PIP,+2.)
      CALL GRAFIT (2,PIM, PIP, X450, X650, PIM, PIP, -2.0, +2.0,
     .  Y200, Y500, -2.0, +2.0, 'X AXIS¶.', 3, 'Y AXIS¶.', 5)
      XOFF = (PIP - PIM) / 10.
      DO 2 I = 1, 10
      XI = PIM + FLOAT(I-1) * XOFF
      YI = COS(XI)
      X(I) = XI
    2 Y(I) = YI
      CALL COLOR(1)
      CALL PLOTLN (1, X, Y, 10)
      CALL CHRSIZ(0., .05)
      CALL PLOTCH (1,X,Y,10,'*A')
      CALL PLOTLN (2, X, Y, 10)
      CALL PLOTCH (2,X,Y,10,IC)
      CALL FRAME
      IF(ID.EQ.3) PAUSE
    3 CONTINUE
      CALL ENDFRM
      STOP
```

```
542             END
```

```
      SUBROUTINE GRAFIT4(ID)
      DIMENSION Q(550),VS(550),X(500),Y(500),TM(500),SQT(500)
      CHARACTER*16 FILE
      CHARACTER*40 TITLE/'GRAFIT(4)'/
C
      FILE = 'G1TEST4.DAT'
      TSTAR = 10.
      B = .321
      OPEN (UNIT=8,FILE=FILE)
      NP=0
      N1=1
    6 READ(8,3,END=5) N
    3 FORMAT(I2)
      READ(8,4) (VS(J),Q(J),TM(J),J=1,N)
      DO 10 I=1,N
      FT=B*SQRT(TM(I))
       IF(TM(I).GT.TSTAR) FM=1.
   10  SQT(I)=Q(I)*FT
    4 FORMAT(50X,3F10.2)
      N2=NP+(N-2)
      J=1
      DO 8, I=N1,N2
      Y(I)=VS(J)
      X(I)=SQT(J)
    8 J=J+1
      NP=N2
      N1=NP+1
      GO TO 6
    5 CONTINUE
      TYPE *, TITLE
      NP=N2
      CALL PLT(NP,X,Y)
      IF(ID.EQ.1) GO TO 50
      PAUSE
   50 CONTINUE
      CALL ENDFRM
      STOP
      END
C
```

```
582         SUBROUTINE PLT(N,X,Y)
583         DIMENSION X(550),Y(550)
584         CHARACTER*40 TITL
585         CHARACTER*25 YLABL
586         CHARACTER*25 XLABL
587   C
588         TITL = '  Rigid Foam¶.'
589         XLABL='q . F(t) (W/cm¶U2¶0)¶.'
590         YLABL='1/  V    (s/mm)¶.' .
591         ymax = 2.0
592         IYTIC = 10
593         CALL NEWFRM
594         CALL COLOR(1)
595         CALL GRISET(0.,0.,1100.,1100.)
596         CALL COLOR(8)
597         CALL GRAFIT(1,0.,6.,200.,900.,0.,6.,0.,YMAX,200.,900.,0.,YMAX,
598        &XLABL,6,YLABL,IYTIC)
599         CALL COLOR(1)
600         CALL PLOTCH(1,X,Y,N,'o')
601         CALL COLOR(5)
602         CALL LABEL(TITL,250.,950.,850.,1000.,0.0)
603         CALL FRAME
604         RETURN
605         END
```

```
      SUBROUTINE PHASE
      DIMENSION Z(30,30), X(8),Y(8), FL(8), TEST(30,30)
      DATA A/1./, B/-4./, C/5./, NINT/8/
      DATA X/100., 800., 250., 950., 100., 800., 250., 950./
      DATA Y/100., 100., 300., 300., 800., 800., 950., 950./
C
      DO 1 I = 1,30
      DO 1 J = 1, 30
1     Z(I,J) = A*COS(-.4+FLOAT(I)/5.)*
     . (1.+B*EXP(-C*(FLOAT(J-10)/7.)**2))+5
      ZMAX = -1.E+9
      ZMIN = +1.E+9
      DO 4 I = 1, 30
      DO 4 J = 1, 30
      ZMAX = MAX(ZMAX, Z(I,J))
4     ZMIN = MIN(ZMIN, Z(I,J))
      CALL LINWID(1)
      CALL NEWFRM
      CALL DEFINE(0.,-100.,1000.,1000.)
      CALL SRFSET(X,Y,0.,10.,30,30)
      CALL COLOR(2)
      CALL SURFAC(Z,30,30,1)
      CALL COLOR(3)
      CALL SURFAC(Z,30,30,-1)
C
C     SET UP A REASONABLE CONTOURING INTERVAL
C
      CALL CNTSET(X(1),Y(1),X(2),Y(2),X(4),Y(4),X(3),Y(3))
      DELTAZ = (ZMAX - ZMIN) * 0.9 / FLOAT (NINT)
      FL(1) = ZMIN + 0.5 * DELTAZ
      DO 2 I = 2, 8
2     FL(I) = FL(I-1) + DELTAZ
      DO 3 I = 1, 8
      CALL COLOR(I)
3     CALL CONTUR (Z, TEST, 30, 30, FL(I))
      CALL FRAME
      PAUSE
      CALL ENDFRM
      STOP
      END
```

```
646             SUBROUTINE RUMTST
647             COMMON/ROOMSZ/RML,RMR,RMB,RMT,SCALE(4),WALLSZ,CEILSZ
648             REAL*4 LSIZE, DELTA
649             CALL NEWFRM
650             CALL FILTYP(2)
651             CALL ROOM (0.0, 5.0, 0.0, 2.5, .05, 1.0, 0.7)
652             CALL VENTV (0.1, 0.5, 0.0, -1.)
653             A = -1.5 / 20.
654             B = 2.2 - A
655             I = 1
656             FSIZE = FLOAT(I)*A + B
657             LSIZE = FSIZE + 0.2
658             PSIZE = FSIZE
659             CALL FIRE (4.0, 0.5, 0.2, FSIZE)
660             CALL PLUME (4.0, 0.5, 0.5, PSIZE, 0.2)
661             CALL LAYER (0.05, 2.45, 4.95, 2.48)
662             CALL FRAME
663             CALL IOWAIT(1000)
664             DELTA = -A
665             DO 101 I = 1, 21
666             CALL FIRE (4.0, 0.5, 0.2, FSIZE)
667             CALL PLUME (4.0, 0.5, 0.5, PSIZE, 0.2)
668             FSIZE = FLOAT(I)*A + B
669             LSIZE = FSIZE + 0.2
670             PSIZE = FSIZE
671             CALL FIRE (4.0, 0.5, 0.2, FSIZE-2*DELTA)
672             CALL PLUME (4.0, 0.5, 0.5, PSIZE-DELTA, 0.2)
673             CALL LAYER(0.05, LSIZE-DELTA, 4.95, 2.48)
674             CALL FRAME
675             CALL IOWAIT(1000)
676  101        CONTINUE
677             PAUSE
678             CALL ENDFRM
679             STOP
680             END
```

```
      SUBROUTINE VENTV (BOTM, TOP, SIDE, THICK)
      COMMON/ROOMSZ/RML,RMR,RMB,RMT,SCALE(4),WALLSZ,CEILSZ
      REAL BOTM, TOP, SIDE
C
C     DRAW VERTICAL LINES IN BLACK AND HORIZONTAL LINES IN WHITE
C
      Y1 = BOTM
      Y2 = TOP
      DO 2 I = 1, 2
      X1 = SIDE + (I-1) * WALLSZ * THICK
      X2 = X1
    2 CALL LINE (X1, Y1, X2, Y2)
      X1 = SIDE
      X2 = WALLSZ * THICK
      DO 1 I = 1, 2
      Y1 = BOTM + (I-1) * (TOP-BOTM)
      Y2 = Y1
    1 CALL LINE (X1, Y1, X2, Y2)
      RETURN
      END
```

```
      SUBROUTINE LAYER (LEFT, BOTTOM, RIGHT, TOP)
C
C     DRAW SQUIGGLE FROM LEFT TO RIGHT TO REPRESENT
C     THE LAYER (HOT) ABOVE THE PLUME
C
      INTEGER DIVCNT
      REAL LEFT, RIGHT, BOTTOM, TOP, X(4), Y(4)
C
C     NOW DRAW THE SQUIGGLE
C
      CALL COLOR(2)
      X(1) = LEFT
      Y(1) = BOTTOM
      X(2) = LEFT
      Y(2) = TOP
      X(3) = RIGHT
      Y(3) = TOP
      X(4) = RIGHT
      Y(4) = BOTTOM
      CALL PLYGON(X, Y, 4)
      RETURN
      END
```

```
      SUBROUTINE FIRE (CENTER, WIDTH, HEIGHT, FSIZE)
      COMMON/ROOMSZ/RML,RMR,RMB,RMT,SCALE(4),WALLSZ,CEILSZ
C
C PLOT THE FIRE SOURCE
C
          CALL COLOR(3)
      CALL VBXPLT (CENTER-.5*WIDTH, 0.0,
     .             CENTER+.5*WIDTH,HEIGHT)
C
C START AT HEIGHT [HP=(1+EPS)*HEIGHT] AND TRACE THE PARABOLA
C
      CALL COLOR(8)
      HP = 1.2 * HEIGHT
      W5 = WIDTH * .5
      SLOPE = FSIZE / W5**2
      W20 = WIDTH / 20.
      YB = HP
      XB = CENTER - W5
      DO 1 I = 1, 21
      XA = XB
      YA = YB
      XB = CENTER - W5 + W20* FLOAT(I-1)
      YB = -(XB-CENTER)**2*SLOPE + HP + FSIZE
    1 CALL LINE (XA, YA, XB, YB)
      RETURN
      END
```

```
749             SUBROUTINE PLUME (CENTER, WIDTH, PBOTM, PTOP, FSOURC)
750   C
751   C       TO PUT THE PLUME IN, NORMALLY ABOVE THE FIRE
752   C       THIS ROUTINE ASSUMES A POINT SOURCE PLUME AT A
753   C       VIRTUAL DISTANCE BELOW THE FIRE SUCH THAT THE
754   C       PLUME SUBTENDS AN ANGLE OF 11 DEGREES AT THE FIRE
755   C       SOURCE.
756   C
757             REAL CENTER, WIDTH, PBOTM, PTOP, FSOURC
758             COMMON/ROOMSZ/RML,RMR,RMB,RMT,SCALE(4),WALLSZ,CEILSZ
759   C
760   C       PLOT THE PLUME
761   C
762             RADIUS = 0.5 * WIDTH
763             THETA = 11. / 57.1
764   C         VIRTUAL = RADIUS / ATAN(THETA)
765             RTAN = ATAN (THETA)
766   C
767   C       DRAW TWO LINES FROM THE VIRTUAL POINT WITH AN ANGLE
768   C       OF THETA AND VISIBLE SEGMENTS
769   C       FROM PBOTM TO PTOP
770   C
771             CALL COLOR(7)
772             Y1 = PBOTM
773             Y2 = PTOP
774             DO 1 I = 1, 2
775             PM = (-1.0)**I
776             X1 = CENTER + PM*(RADIUS+(PBOTM-FSOURC)*RTAN)
777             X2 = CENTER + PM*(RADIUS+(PTOP -FSOURC)*RTAN)
778         1   CALL LINE (X1, Y1, X2, Y2)
779             RETURN
780             END
```

```
781             SUBROUTINE ROOM (L, R, B, T, DW, FW, FH)
782             REAL L, R, T, B, F, SCALE(4)
783             COMMON/ROOMSZ/RML,RMR,RMB,RMT,SCALE,WALLSZ,CEILSZ
784   C
785   C - L = LEFT SIDE OF ROOM
786   C - R = RIGHT SIDE OF ROOM
787   C - T = TOP OF THE ROOM
788   C - B = BOTTOM OF THE ROOM
789   C - DW = WIDTH OF WALL
790   C - F IS THE FRACTION OF THE SCREEN TO BE USED
791   C
792             XFW = AMIN1 (1., FW)
793             XFH = AMIN1 (1., FH)
794             DWMIN = AMIN1 (R-L, T-B)
795             WALLSZ = DWMIN * DW
796             CEILSZ = 0.5 * XFW/XFH * WALLSZ
797             DY = T - B
798             DX = R - L
799             XL = L - DX/3.5
800             XR = R + DX/3.5
801             XB = B - DY/3.5
802             XT = T + DY/3.5
803             CALL DEFINE (XL, XB, XR, XT)
804             CALL COLOR(1)
805             DO 1 IW = 1, 2
806             WALL = WALLSZ * (IW-1)
807             CEIL = CEILSZ * (IW-1)
808             XL = L - WALL
809             XR = R + WALL
810             XB = B
811             XT = T + CEIL
812         1   CALL BOXPLT (XL, XB, XR, XT)
813             RETURN
814             END
```

```
      SUBROUTINE SADDLE(ID)
C
C     PROGRAM TO TEST THE SURFACE PLOTTING AND CONTOUR ROUTINES.
C
      PARAMETER (NX=25,NY=13,NP=4)
      REAL     Z(NX,NY), XP(8,9),YP(8,9), FL(16), TEST(NX,NY)
      INTEGER  INDX(NP)
      DATA     ZMIN, ZMAX /-0.75, 200./, MX, MY /1, 1/
      DATA     INDX/1,3,7,9/
      DATA     XP/
     1         100., 800., 250., 900., 100., 800., 250., 900.,
     2         100., 900., 200., 800., 100., 900., 200., 800.,
     3         200., 900., 100., 750., 200., 900., 100., 750.,
     4         100., 800., 250., 900., 100., 800., 250., 900.,
     5         100., 900., 200., 800., 100., 900., 200., 800.,
     6         200., 900., 100., 750., 200., 900., 100., 750.,
     7         100., 800., 250., 900., 100., 800., 250., 900.,
     8         100., 900., 200., 800., 100., 900., 200., 800.,
     9         200., 900., 100., 750., 200., 900., 100., 750./
      DATA     YP/
     1         100., 100., 250., 250., 800., 800., 900., 900.,
     2         100., 100., 250., 250., 800., 800., 900., 900.,
     3         100., 100., 250., 250., 800., 800., 900., 900.,
     4         100., 100., 200., 200., 900., 900., 800., 800.,
     5         100., 100., 200., 200., 900., 900., 800., 800.,
     6         100., 100., 200., 200., 900., 900., 800., 800.,
     7         200., 200., 100., 100., 900., 900., 750., 750.,
     8         200., 200., 100., 100., 900., 900., 750., 750.,
     9         200., 200., 100., 100., 900., 900., 750., 750./
C
C     INITIALIZE THE DATA
C
      DO 20 J = 1, NY
      DO 20 I = 1, NX
      Z(I,J) = ABS(FLOAT(J)-7.)**2 + (144.-ABS(FLOAT(I)-13.)**2)
20    CONTINUE
      DO 2 I = 1, 8
      FL(I) = -1.0 + FLOAT(I)*10.
2     FL(I+8) = 0.2 + FLOAT(I)*10.
C
C     INITIALIZE THE GRAPHICS PACKAGE
C
      CALL DEFINE (0., 0., 1023., 1023.)
      CALL NEWFRM
C
C     LOOP OVER THE VARIOUS PERSPECTIVE PLOTS.
C
      IPP = 3
      DO 100 IPP = 1, NP
      IP = INDX(IPP)
C
C     PLOT THE UPPER PART OF THE SURFACE WITH FRONT SKIRT.
C
      CALL SRFSET (XP(1,IP), YP(1,IP), ZMIN, ZMAX, NX, NY)
      CALL ERASE
```

```
870             CALL SETLUT
871             CALL COLOR(5)
872             CALL SURFAC (Z, NX, NY, +1)
873             CALL COLOR(4)
874             CALL SFRAME (2)
875             CALL FRAME
876             CALL IOWAIT(2000)
877   C
878   C       PLOT THE LOWER PART OF THE SURFACE.
879   C
880             CALL SRFSET (XP(1,IP), YP(1,IP), ZMIN, ZMAX, NX, NY)
881             CALL ERASE
882             CALL COLOR(7)
883             CALL SURFAC (Z, NX, NY, -1)
884             CALL COLOR(4)
885             CALL SFRAME (2)
886             CALL FRAME
887             CALL IOWAIT(2000)
888   C
889   C       PLOT BOTH PARTS OF THE SURFACE WITH SIDE SKIRTS.
890   C
891             CALL SRFSET (XP(1,IP), YP(1,IP), ZMIN, ZMAX, NX, NY)
892             CALL ERASE
893             CALL COLOR(5)
894             CALL SURFAC (Z, NX, NY, +1)
895             CALL COLOR(7)
896             CALL SURFAC (Z, NX, NY, -1)
897             CALL SFRAME (2)
898             CALL FRAME
899             IF(ID.EQ.3) THEN
900               PAUSE
901             ELSE
902               CALL IOWAIT(2000)
903             ENDIF
904     100     CONTINUE
905             CALL ENDFRM
906   C
907             STOP
908         END
```

```
909             SUBROUTINE SETCOL(IC)
910             DIMENSION LUT(16,3)
911   C
912             DO 1 I = 1, 3
913             DO 1 J = 1, 16
914   1         LUT(J,I) = 0
915             DO 2 I = 1, 8
916             LUT(I+1,2) = I*2 - 1
917   2         LUT(I+1,3) = I*2 - 1
918             DO 3 I = 1, 7
919             LUT(I+9,1) = I*2 + 1
920   3         LUT(I+9,2) = I*2 + 1
921             CALL DSLWT (16, 48, LUT)
922             RETURN
923             END
```

```
      SUBROUTINE SYMTST
C
C     A SIMPLE TEST OF THE CHARACTER STUFF
C
      CHARACTER*28 TITLE1/'A SET OF HARDWARE CHARACTERS'/
      CHARACTER*19 TITLE2/'¶1 SET FROM SET 1¶.'/
      CHARACTER*32 TITLE3/'¶:A SET ([§/*†]) FROM SET #10¶.'/
      ISC=0
    3 XSZ = 11. * 2.**ISC - 11.
      CALL NEWFRM
      CALL DEFINE(-XSZ, -XSZ, 11.+XSZ, 11.+XSZ)
      CALL COLOR(4)
      CALL BOXPLT (0.5, 0.5, 8.5, 4.5)
      CALL BOXPLT (0.5, 5.5, 8.5, 9.5)
      CALL BOXPLT (9.0, 0.5, 10.7, 9.5)
      DX = 5. / 28.
      XL = 4.5 - 14.*DX
      CALL COLOR(1)
      CALL CHRSIZ (DX/(11.+2.*XSZ),0.)
      DO 1 I = 1, 28
    1 CALL SYMBOL (XL+DX*FLOAT(I), 7.5, TITLE1(I:I))
      CALL COLOR(3)
      CALL LABEL(TITLE2, 2.0, 2.0, 8.0, 2.5, 0.0)
      CALL COLOR(2)
      CALL LABEL(TITLE3, 10.3, 1., 17.3, 2., 3.14/2.)
      CALL FRAME
      CALL IOWAIT(2000)
      ISC = ISC + 1
      IF(ID.NE.3) GO TO 4
      IF(ISC.GT.7) GO TO 4
      GO TO 3
    4 CALL ENDFRM
      STOP
      END
```

```
      SUBROUTINE VOLTST(ID)
C
C     VOLUME TEST PROGRAM WITH REDUCED RESOLUTION HIDDEN LINES.
C
C     THIS PROGRAM DEMONSTRATES THE USE OF THE "VOLUME" PLOTTER.
C     IT USES A SIMPLE SOLID ( TWO OVERLAPPING SPHERES)
C     WITH A SOLID PILLAR PLACED IN FRONT TO OBSCURE PART OF THE
C     SPHERES AND DEMOSTRATE THE HIDDEN LINE FEATURE.  THIS IS DONE
C     TOGETHER WITH THE NECESSARY INTERACTION WITH THE GRAPHICS
C     PACKAGE.  THIS SHOULD BE USED AS A MODEL FOR DESIGNING PROGRAMS UN
C     THE USER IS FAMILIAR WITH VOLUME.
C
          PARAMETER (NT=100, NT2=NT*NT)
          REAL T(NT2), CLEVE(2)
          REAL     XP(8,3), YP(8,3)
          REAL     F(20, 20, 20)
          INTEGER  MODE(2)
          DATA     NX,NY,NZ /20, 20, 20/
          DATA     MODE /-1, 2/, CLEVE /1.5, -1.0/
          DATA     NP, ITAPE /3, 105/
          DATA     XP/
     1             100., 800., 250., 900., 100., 800., 250., 900.,
     2             100., 900., 200., 800., 100., 900., 200., 800.,
     3             200., 900., 100., 750., 200., 900., 100., 750./
          DATA     YP/
     1             100., 100., 250., 250., 800., 800., 900., 900.,
     2             100., 100., 250., 250., 800., 800., 900., 900.,
     3             100., 100., 250., 250., 800., 800., 900., 900./
C
C     INITIALIZE THE PACKAGE
C
          CALL DEFINE(0., 0., 1024., 1024.)
C
C     LOOP OVER FOUR SIZES OF THE SPHERES
C
          DO 100 IPIC = 1,901,300
          NP = NP
          IP = 1
          FAC = 1.0 + 0.01*FLOAT(IPIC)
C
C     SET UP THE VALUE OF THE FUNCTION.
C     IT IS AN NRL PEANUT ( 2 OVERLAPPING SPHERES)
C     (X-13)**2 + (Y-10.5)**2 + (Z-10.5)**2
C     (X-8)**2 + (Y-10.5)**2 + (Z-10.5)**2
C
          DO 1 I = 1, NX
          DO 1 J = 1, NY
          DO 1 K = 1, NZ
          R1SQ = (I-8.0)**2 + (J-10.5)**2 + (K-10.5)**2
          R2SQ = (I-13.)**2 + (J-10.5)**2 + (K-10.5)**2
          F(I,J,K) = FAC/R1SQ + 2.0*FAC/R2SQ
    1     CONTINUE
C
C     CONSTRUCT THE PILLAR
C
```

```
1013            DO 2 I = 1, NX
1014            DO 2 J = 1, 5
1015            DO 2 K = 1, NZ
1016            RSQ = (I-10.5)**2 + (J-3.5)**2
1017            F(I,J,K) = -4.0/RSQ
1018        2   CONTINUE
1019  C
1020  C     INITIALIZE THE PLOTTING PACKAGE
1021  C
1022  C     IN THIS CASE, "VOLSET" IS CALLED FOR EACH CYCLE SO THAT THE
1023  C     VARIOUS CONTOUR LEVELS WILL BE PLOTTED.  THE PILLAR IS PLOTTED
1024  C     ONLY ONCE(THIRD CALL) BUT STUFF BEHIND IT IS ALWAYS HIDDEN
1025  C     (NCL=2, MODE=2, CLEVE=-1.).
1026  C
1027            CALL NEWFRM
1028  C
1029  C     DRAW THE FIGURE
1030  C
1031            CALL COLOR(1)
1032            CLEVE(1) = 1.5
1033            CALL VOLSET (XP(1,IP), YP(1,IP), T, NT)
1034            CALL VOLUME(MODE, F, NX,NY,NZ, CLEVE, 2, T, NT)
1035  C
1036            CALL COLOR(2)
1037            CLEVE(1) = 0.5
1038            CALL VOLSET (XP(1,IP), YP(1,IP), T, NT)
1039            CALL VOLUME(MODE, F, NX,NY,NZ, CLEVE, 2, T, NT)
1040  C
1041            CALL COLOR(3)
1042            CALL VOLSET (XP(1,IP), YP(1,IP), T, NT)
1043            CALL VOLUME (+1, F, NX,NY,NZ, -1.0, 1, T, NT)
1044  C
1045            CALL COLOR(4)
1046            CALL VOLUME (-2, F, NX,NY,NZ, 0.5, 1, T, NT)
1047  C         CALL VOLFRM (2)
1048            CALL FRAME
1049            CALL IOWAIT(2000)
1050  C
1051      100   CONTINUE
1052  C
1053  C     CLOSE-OUT GRAFIT.
1054  C
1055            IF(ID.EQ.3) PAUSE
1056            CALL ENDFRM
1057  C
1058            STOP
1059          END
```

```
1060        SUBROUTINE FILNGT
1061  C
1062        CALL NEWFRM
1063        CALL DEFINE(-11.,-11.,11.,11.)
1064        DO 2 I = 1, 9
1065        CALL FILTYP(I-1)
1066        X = -11. + FLOAT(I)*2.1
1067        Y = -11. + FLOAT(I)*2.1
1068        CALL CIRCLE(X, Y, 2.0)
1069  2     CONTINUE
1070        CALL FRAME
1071        PAUSE
1072        CALL ENDFRM
1073        STOP
1074        END
```

```
      SUBROUTINE ALABEL (CHARS, XL, XR, ANGLE)
      COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
      COMMON/GRFTYP/XNGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
      CHARACTER*1 CHARS(*)
      CALL WDCOUNT(CHARS, NC)
      IF(NC.LE.0) THEN
        IF(LUDIAG.GT.0) WRITE(LUDIAG,3) (CHARS(I),I=1,132)
    3   FORMAT(' NO ESCAPE SEQUENCE IN ALABEL -',/,1X,132A1)
        RETURN
      ENDIF
      DX = (XR - XL) / MAX(1.,FLOAT(NC))
      DY = 4./3. * DX * XYCOOD(1)/XYCOOD(3)
      XNGLE = ANGLE
      CALL WDDRAW (XL, YB, DX, 0.0, DX, 0.0, DY, CHARS)
      RETURN
      END
```

```
23            SUBROUTINE BOXPLT (X1, Y1, X2, Y2)
24  C
25  C*************************************************************************
26  C     BOXPLT
27  C*************************************************************************
28  C
29            REAL XA(4),XB(4),YA(4),YB(4)
30  C
31            ENTRY VBXPLT (X1, Y1, X2, Y2)
32            XA(1)=X1
33            YA(1)=Y1
34            XB(1)=X2
35            YB(1)=Y1
36            XA(2)=X2
37            YA(2)=Y1
38            XB(2)=X2
39            YB(2)=Y2
40            XA(3)=X2
41            YA(3)=Y2
42            XB(3)=X1
43            YB(3)=Y2
44            XA(4)=X1
45            YA(4)=Y2
46            XB(4)=X1
47            YB(4)=Y1
48            CALL LINES(XA,YA,XB,YB,4)
49            RETURN
50            END
```

```
      SUBROUTINE CHPLOT (XARRAY, YARRAY, CHARAC, I1, I2, I3)
C
C       XARRAY REAL    - AN ARRAY, DIMENSIONED N, OF X COORDINATES OF
C                        THE DATA (MATH SPACE)
C       YARRAY REAL    - AN ARRAY, DIMENSIONED N, OF Y COORDINATES OF
C                        THE DATA (MATH SPACE)
C       CHARAC LITERAL - CHARACTER TO BE PLOTTED
C       I1     INTEGER - INDEX OF FIRST POINT TO BE PLOTTED
C       I2     INTEGER - INCREMENT AT WHICH POINTS ARE TO BE SELECTED
C                        TO PLOT
C       I3     INTEGER - INDEX OF LAST POINT IN DATA ARRAYS
C*********************************************************************
C     CHPLOT
C*********************************************************************
C
          COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
          COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
          INTEGER I1, I2, I3, CHCODE
          REAL XARRAY(4), YARRAY(4)
          CHARACTER*1 CHARAC
          INTEGER IX,IY
          NOPTS = (I3-I1+I2) / I2
          I1M = I1 - I2
          DO 1 I=1,NOPTS
          II=I1M+I2*I
    1     CALL SYMBOL (XARRAY(II), YARRAY(II), CHARAC)
          RETURN
      END
```

```
      SUBROUTINE CIRCLE(X, Y, R)
C
C     DRAW A CIRLE OF WIDTH LINWDM AND FILL WITH LFLMAT.
C
      COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
      COMMON/GRFMOD/LFLMAT(5),LINWDM(5),LCLMAT(5)
      REAL XO, YO, XN, YN, DX, DY, THETA, ARC
C
      IF(IDEVIC.EQ.0) RETURN
      GO TO (1,1,2,1,1), IDEVIC
    1 ARC = 3.1415/50.
      THETA = 0.0
      XO = X + R
      YO = Y
      DO 10 I = 1, 101
      THETA = THETA + ARC
      XN =   R * COS(THETA) + X
      YN =   R * SIN(THETA) + Y
      CALL LINE(XO, YO, XN, YN)
      XO = XN
      YO = YN
   10 CONTINUE
      RETURN
    2 XL = MAX(X * XYCOOD(1) + XYCOOD(2),0.)
      YL = MAX(Y * XYCOOD(3) + XYCOOD(4),0.)
      RL = R * MIN(XYCOOD(1), XYCOOD(3))
      CALL GMOVA(XL, YL)
      CALL GCIRA(RL)
      RETURN
      END
```

```
109         SUBROUTINE CONTUR (F, TEST, NX, NY, FL)
110             PARAMETER (NPT=101)
111             REAL     F(NX,NY), TEST(NX,NY)
112             REAL     XT1(NPT), XT2(NPT), XT3(NPT), YT1(NPT), YT2(NPT),
113        1             YT3(NPT), FT1(NPT), FT2(NPT), FT3(NPT)
114             REAL     T00(NPT), T10(NPT), T01(NPT), T11(NPT)
115   C
116   C       SUBARRAYS OUT OF THE DATA CANNOT BE CONTOURED. THE
117   C      ENTIRE F(I,J) ARRAY IS CONTOURED SO A COPY OVER INTO SCRATCH SPACE
118   C      IS REQUIRED IF ONLY A PORTION OF F IS TO BE PLOTTED.
119   C
120   C      F       REAL ARRAY (NX,NY)  THE REAL VALUES OF THE FUNCTION TO
121   C                                   CONTOURED. A TOPOLOGICALLY SQUARE
122   C                                   GRID CELL IS ASSUMED AND DX = DY = 1.
123   C      TEST    REAL ARRAY (NX,NY)  A USER SUPPLIED SCRATCH ARRAY OF
124   C                                   THE SAME DIMENSIONALITY AS F.
125   C      NX      INTEGER             RANGE AND DIMENSION OF I IN F(I,J).
126   C      NY      INTEGER             RANGE AND DIMENSION OF J IN F(I,J).
127   C      FL      REAL                THE VALUE OF F(I,J) FOR CONTOURING.
128   C
129   C      CALCULATE THE AVERAGE VALUE OF F AT THE CENTERS OF THE CELLS.
130   C
131             NTMAX = NPT - 2
132             NTRIA = 0
133             NXM = NX - 1
134             NYM = NY - 1
135             DO 200 J = 1, NYM
136             DO 200 I = 1, NXM
137             TEST(I,J) = F(I,J) + F(I+1,J)
138             TEST(I,J) = TEST(I,J) + F(I,J+1)
139             TEST(I,J) = TEST(I,J) + F(I+1,J+1)
140     200     TEST(I,J) = 0.25*TEST(I,J)
141   C
142   C      NOW CALCULATE THE CROSSINGS WHICH PARELLEL THE "I" AXIS.
143   C
144             DO 310 J = 1, NY
145             DO 300 I = 1, NXM
146     300     T00(I) = (F(I+1,J) - FL)*(FL - F(I,J))
147   C
148   C      A CROSS OCCURS IF THE CONTOUR PASSES THRU F(I,J) IN THE BOX I->I+1
149   C
150             DO 309 I = 1, NXM
151             IF (T00(I) .LT. 0.0) GO TO 309
152   C
153   C      THE LINE SEGMENT IS A HIT. TREAT IN A SCALAR WAY FIRST THE UPPER
154   C      AND THEN THE LOWER TRIANGLE.
155   C
156             IF (J.EQ.NY) GO TO 305
157             IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
158        1        XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
159             NTRIA = NTRIA + 1
160             XT1(NTRIA) = FLOAT(I)
161             YT1(NTRIA) = FLOAT(J)
162             FT1(NTRIA) = F(I,J)
163             XT2(NTRIA) = FLOAT(I + 1)
```

```
164             YT2(NTRIA) = FLOAT(J)
165             FT2(NTRIA) = F(I+1,J)
166             XT3(NTRIA) = FLOAT(I) + 0.5
167             YT3(NTRIA) = FLOAT(J) + 0.5
168             FT3(NTRIA) = TEST(I,J)
169     305     IF (J.EQ.1) GO TO 309
170             IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
171        1        XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
172             NTRIA = NTRIA + 1
173             XT1(NTRIA) = FLOAT(I + 1)
174             YT1(NTRIA) = FLOAT(J)
175             FT1(NTRIA) = F(I+1,J)
176             XT2(NTRIA) = FLOAT(I)
177             YT2(NTRIA) = FLOAT(J)
178             FT2(NTRIA) = F(I, J)
179             XT3(NTRIA) = FLOAT(I) + 0.5
180             YT3(NTRIA) = FLOAT(J) - 0.5
181             FT3(NTRIA) = TEST(I,J-1)
182     309     CONTINUE
183     310     CONTINUE
184   C
185   C     NEXT CALCULATE THE CROSSINGS ALONG THE "J" AXIS.
186   C
187             DO 360 J = 1, NYM
188             DO 350 I = 1, NX
189     350     T11(I) = (F(I,J+1) - FL)*(FL - F(I,J))
190   C
191   C     CORSS OCCURS IF THE CONTOUR VALUE PASSES THRU THE BOX IN F(I,J)
192   C     IN THE RANGE J->J+1
193   C
194             DO 359 I = 1, NX
195             IF (T11(I) .LT. 0.0) GO TO 359
196   C
197   C     THE LINE SEGMENT IS A HIT. TREAT IN A SCALAR WAY FIRST THE RIGHT
198   C     AND THEN THE LEFT TRIANGLE.
199   C
200             IF (I.EQ.NX) GO TO 355
201             IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
202        1        XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
203             NTRIA = NTRIA + 1
204             XT1(NTRIA) = FLOAT(I)
205             YT1(NTRIA) = FLOAT(J + 1)
206             FT1(NTRIA) = F(I,J+1)
207             XT2(NTRIA) = FLOAT(I)
208             YT2(NTRIA) = FLOAT(J)
209             FT2(NTRIA) = F(I,J)
210             XT3(NTRIA) = FLOAT(I) + 0.5
211             YT3(NTRIA) = FLOAT(J) + 0.5
212             FT3(NTRIA) = TEST(I,J)
213     355     IF (I.EQ.1) GO TO 359
214             IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
215        1        XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
216             NTRIA = NTRIA + 1
217             XT1(NTRIA) = FLOAT(I)
218             YT1(NTRIA) = FLOAT(J)
```

```
219             FT1(NTRIA) =.F(I,J)
220             XT2(NTRIA) = FLOAT(I)
221             YT2(NTRIA) = FLOAT(J + 1)
222             FT2(NTRIA) = F(I,J+1)
223             XT3(NTRIA) = FLOAT(I) - 0.5
224             YT3(NTRIA) = FLOAT(J) + 0.5
225             FT3(NTRIA) = TEST(I-1,J)
226    359      CONTINUE
227    360      CONTINUE
228  C
229  C      NOW SEEK ALL TRIANGLES WITH TWO DIAGONAL CROSSINGS.
230  C
231             DO 490 J = 1, NYM
232             DO 420 I = 1, NXM
233             T00(I) = (TEST(I,J) - FL)*(FL - F(I,J))
234             T10(I) = (FL - TEST(I,J))*(F(I+1,J) - FL)
235             T01(I) = (FL - TEST(I,J))*(F(I,J+1) - FL)
236    420      T11(I) = (TEST(I,J) - FL)*(FL - F(I+1,J+1))
237  C
238  C      CONSIDER THE LOWER TRIANGLE IN THE SQUARE.
239  C
240             DO 430 I = 1, NXM
241             IF (AMIN1(T00(I), T10(I)) .LT. 0.0) GO TO 430
242             IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
243       1         XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
244             NTRIA = NTRIA + 1
245             XT1(NTRIA) = FLOAT(I) + 0.5
246             YT1(NTRIA) = FLOAT(J) + 0.5
247             FT1(NTRIA) = TEST(I,J)
248             XT2(NTRIA) = FLOAT(I)
249             YT2(NTRIA) = FLOAT(J)
250             FT2(NTRIA) = F(I,J)
251             XT3(NTRIA) = FLOAT(I + 1)
252             YT3(NTRIA) = FLOAT(J)
253             FT3(NTRIA) = F(I+1,J)
254    430      CONTINUE
255  C
256  C      CONSIDER THE RIGHT TRIANGLE IN THE SQUARE.
257  C
258             DO 440 I = 1, NXM
259             IF (AMIN1(T10(I), T11(I)) .LT. 0.0) GO TO 440
260             IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
261       1         XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
262             NTRIA = NTRIA + 1
263             XT1(NTRIA) = FLOAT(I) + 0.5
264             YT1(NTRIA) = FLOAT(J) + 0.5
265             FT1(NTRIA) = TEST(I,J)
266             XT2(NTRIA) = FLOAT(I + 1)
267             YT2(NTRIA) = FLOAT(J)
268             FT2(NTRIA) = F(I+1,J)
269             XT3(NTRIA) = FLOAT(I + 1)
270             YT3(NTRIA) = FLOAT(J + 1)
271             FT3(NTRIA) = F(I+1,J+1)
272    440      CONTINUE
273  C
```

```
C     CONSIDER THE UPPER TRIANGLE IN THE SQUARE.
C
          DO 450 I = 1, NXM
          IF (AMIN1(T11(I), T01(I)) .LT. 0.0) GO TO 450
          IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
     1         XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
          NTRIA = NTRIA + 1
          XT1(NTRIA) = FLOAT(I) + 0.5
          YT1(NTRIA) = FLOAT(J) + 0.5
          FT1(NTRIA) = TEST(I,J)
          XT2(NTRIA) = FLOAT(I + 1)
          YT2(NTRIA) = FLOAT(J + 1)
          FT2(NTRIA) = F(I+1,J+1)
          XT3(NTRIA) = FLOAT(I)
          YT3(NTRIA) = FLOAT(J + 1)
          FT3(NTRIA) = F(I,J+1)
  450     CONTINUE
C
C     CONSIDER THE LEFT TRIANGLE IN THE SQUARE.
C
          DO 460 I = 1, NXM
          IF (AMIN1(T01(I), T00(I)) .LT. 0.0) GO TO 460
          IF (NTRIA .GE. NTMAX) CALL PROPOL (NTRIA, XT1,YT1,FT1,
     1         XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
          NTRIA = NTRIA + 1
          XT1(NTRIA) = FLOAT(I) + 0.5
          YT1(NTRIA) = FLOAT(J) + 0.5
          FT1(NTRIA) = TEST(I,J)
          XT2(NTRIA) = FLOAT(I)
          YT2(NTRIA) = FLOAT(J + 1)
          FT2(NTRIA) = F(I,J+1)
          XT3(NTRIA) = FLOAT(I)
          YT3(NTRIA) = FLOAT(J)
          FT3(NTRIA) = F(I,J)
  460     CONTINUE
  490     CONTINUE
C
C     IF THE BUFFER IS ONLY PARTIALLY FULL, FLUSH AT THE END.
C
          IF (NTRIA .GT. 0) CALL PROPOL (NTRIA, XT1,YT1,FT1,
     1         XT2,YT2,FT2, XT3,YT3,FT3, FL, NX, NY)
C
          RETURN
        END
```

```
318             SUBROUTINE DEVICE (N)
319   C
320   C     DEVICE          1 CALCOMP PLOTTER
321   C                     2 PRINTER PLOT
322   C                     3 LEXIDATA DISPLAY UNIT WITH MATRIX CAMERA
323   C                     4 ADM WITH RETROGRAPHICS OR TEK 40XX SERIES
324   C                     5 EMPTY SLOT
325   C
326   C     COMMANDS            DEVICE - SELECT DEVICE (1-5)
327   C                         SETDEV - SET THE LOGICAL UNITS FRO OUTPUT
328   C                         LINWID - NUMBER OF STROKES IN A LINE
329   C                         FILTYP - TYPE OF FILLING FOR POLYGONS AND CIRCL
330   C                         CHRSIZ - HEIGHT OF CHARACTERS (IN RASTER UNITS)
331   C
332   C                     1   NEWFRM - SET UP DEVICE FOR A NEW PLOT
333   C                     2   FRAME  - FORCE A FLUSH OF ALL BUFFERS
334   C                     3   ERASE  - ERASE THE SCREEEN
335   C                     4   HDCOPY - HARD COPY COMMAND - SHUTTER ON MATRIX
336   C                     5   COLOR  - SELECT THE COLOR TO DRAW
337   C                     6   SCALE  - SCALE FOR PHYSICAL DEVICE
338   C                     7   ENDFRM - TERMINATE THE DEVICE AND ADVANCE
339   C
340   C     DEFAULT DEVICE ASSIGNMENTS
341   C
342   C                     TYPE                LU    RESULT
343   C
344   C                     DIAGNOSTICS         0     NO OUTPUT
345   C                     GRAPHICS            7     NORMAL - ASSIGNED
346   C                     CAMERA              8     ASSIGNED WITH LEXIDATA
347   C                     CHARACTER SET       0     UNIT 0 - ASSIGNED
348   C                     CALCOMP             L7:   RS232 LINE
349   C                     PRINTER             PR:   WHATEVER
350   C                     LEXIDATA            LEX:  DMA (L34DVR IN SYSTEM)
351   C                     MATRIX CAMERA       LE:   RS232
352   C                     TEKTRONIX           C:    CONSOLE
353   C                     OPEN SLOT           NULL: BIT BUCKET
354   C                     CONSOLE INPUT       5
355   C                     CHARACTER SET       9 (CLOSED THEN OPENED)
356   C                     TABLET INPUT        8 (CLOSED THEN OPENED -
357   C                                           CAMERA AND TABLET CAN
358   C                                           NOT BE ACTIVE SIMULTANEOUSLY)
359   C
360             INTEGER  LB, COUNT(5), NFRAME(5), PEN, COMMND, DEVID, PBLK(6)
361             CHARACTER*8 IDFLTO(5), MATFIL, TABFIL
362             INTEGER ICODET(2), ICTRLX(2), ICHANX(2,2), SCRATCH(60)
363             INTEGER HBLANK, HMINUS, HAPOSA, HAPOSB, HASTRA, HASTRB, NHOLD
364             INTEGER VSNUM(2), TEKRAS(4), LEXRAS(4), HWSIZE(20), CALRAS(4)
365             INTEGER LPAGE(30,65), START, LINE, SLASH, ENDIT
366             INTEGER MATUNT, TABUNT, USPAT(12,4)
367             LOGICAL LSW, LTSW, OPEN, OPENANY, OPNCAL, OPNLEX, IRVRSE
368             LOGICAL OPNMAT, OPNTAB, OPENTB
369             COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
370             COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
371             COMMON/DEVPOS/X1R(5),Y1R(5),X2R(5),Y2R(5)
372             COMMON/GRFMOD/LFLMAT(5),LINWDM(5),LCLMAT(5)
```

```
373             EQUIVALENCE (HWSIZE(1),CALRAS),(HWSIZE(9),LEXRAS)
374             EQUIVALENCE (HWSIZE(13),TEKRAS)
375             DATA START,LINE,SLASH,ENDIT/4H(    , 4H108H, 4H   /, 4H   ) /
376             DATA HBLANK, HMINUS, HAPOSA, HAPOSB, HASTRA, HASTRB
377            1    /4H     , 4H---- , 4H¶    , 4H   ¶ , 4H*--- , 4H---* /
378             DATA OPENANY/.FALSE./, OPNLEX/.TRUE./
379             DATA ITIMET/20/, IDLETM/50/, LUDIAG/0/
380             DATA COUNT/5*0/, NFRAME/5*0/, ANGLE/0.0/
381             DATA TEKRAS/0,0,1022,768/,LEXRAS/50,50,32700,26160/
382             DATA CALRAS/0, 0, 10750, 7900/
383             DATA IDFLTO/'L7: ','PR: ','LEX:','C:','NULL:'/
384             DATA X1R/0.,0.,1.E+7,0.,0./, X2R/2*1279.,11279000.,2*1279./
385             DATA Y1R/0.,0.,1.E+7,0.,0./, Y2R/2*1023.,11023000.,2*1023./
386             DATA LUSET/7/, ICODET/27,23/, ICTRLX/31,24/
387             DATA ICHANX/27,97,27,127/, OPNCAL/.TRUE./
388             DATA NFRAME/5*0/,COUNT/5*0/,LUHSET/9/, OPNMAT/.TRUE./
389             DATA LFLMAT/0,0,1,0,0/, LINWDM/ 1,1,2,1,1/, LCLMAT/5*1/
390             DATA MATUNT/8/, MATFIL/'L14:'/, TABFIL/'L19:'/, TABUNT/8/
391             DATA XYCOOD/1.,0.,1.,0./, OPNTAB/.TRUE./
392             DATA CHSIZE/31.,31.,0.3,0.5,0.04,0.58,0.,0.,.03/
393             DATA USPAT/3*3640,3*455,3*3640,3*455,0,0,778,
394            .    992,504,240,240,504,992,778,0,0,2*0,Z20,Z70,ZF8,
395            .    Z1FC,Z3FE,Z7FF,4*0,
396            .    0,96,240,504,1020,2046,4095,3999,3855,3591,3075,2049/
397   C
398   C      *** START OF THE SECTION WHICH HANDELS FUNCTIONS
399   C
400   C
401   C      DEVICE
402   C
403                 IF(OPENANY) GO TO 1100
404                 IDEVIC = N
405                 LUOUT = LUSET
406                 ITKWIT = 40
407                 IF (IDEVIC.LT.1.OR.IDEVIC.GT.5) IDEVIC = 4
408                 CLOSE(LUOUT)
409                 OPEN(UNIT=LUOUT,IOSTAT=IOS,ERR=901,FILE=IDFLTO(IDEVIC),
410            1    TYPE='DEVICE',SHARE='ERW',RKEY=0,WKEY=0)
411                 OPENANY = .TRUE.
412                 IF (LUDIAG.NE.0) WRITE (LUDIAG,1003) IDEVIC
413                 RETURN
414   C
415   C      ERROR ON CALL TO DEVICE
416   C
417       901       CLOSE(LUOUT)
418                 IF (LUDIAG.NE.0) WRITE (LUDIAG,1014) IDEVIC, IOS
419   C
420   C      SET A VALUE OF ZERO IN THE DEVICE TYPE TO INDICATE THAT
421   C      A DEVICE CAN NOT BE ACCESSED. ADDED 1/24/85
422   C
423                 IDEVIC = 0
424                 RETURN
425   C
426   C      SETDEV - CHANGE THE LOGICAL UNIT
427   C
```

```
428           ENTRY SETDEV (N1, N2)
429           IF (N1.GT.0) LUSET = N1
430           IF (N2.GE.0) LUDIAG = N2
431           IF (LUDIAG.NE.0) WRITE (LUDIAG, 1005) LUOUT, LUSET
432           RETURN
433   C
434   C     NEWFRM
435   C
436           ENTRY NEWFRM
437           MODEP = 1
438           IF (.NOT.OPENANY) GO TO 1000
439           COUNT(IDEVIC) = COUNT(IDEVIC) + 1
440           NFRAME(IDEVIC) = 1
441           IRVRSE = .FALSE.
442           IF (LUDIAG.NE.0) WRITE (LUDIAG, 1101) COUNT(IDEVIC)
443           GO TO (1,2,3,4,5), IDEVIC
444   C
445   C     FRAME - FORCE A WRITE OF THE BUFFER
446   C
447           ENTRY FRAME
448           MODEP = 2
449           IF (.NOT.OPENANY) GO TO 1000
450           NFRAME(IDEVIC) = NFRAME(IDEVIC) + 1
451           IF (LUDIAG.NE.0) WRITE (LUDIAG, 1001) NFRAME(IDEVIC),IDEVIC
452           GO TO (1,2,3,4,5), IDEVIC
453   C
454   C     ERASE
455   C
456           ENTRY ERASE
457           MODEP = 3
458           IF (.NOT.OPENANY) GO TO 1000
459           IF (LUDIAG.NE.0) WRITE (LUDIAG,1501) NFRAME(IDEVIC)
460           GO TO (1,2,3,4,5), IDEVIC
461   C
462   C     HARD COPY
463   C
464           ENTRY HDCOPY
465           MODEP = 4
466           IF (.NOT.OPENANY) GO TO 1000
467           IF (LUDIAG.NE.0) WRITE (LUDIAG,1502) NFRAME(IDEVIC)
468           GO TO (1,2,3,4,5), IDEVIC
469   C
470   C     COLOR
471   C
472           ENTRY COLOR (N)
473           MODEP = 5
474           IF(.NOT.OPENANY) GO TO 1000
475           ICOLOR = N
476           IF (LUDIAG.NE.0) WRITE (LUDIAG, 1214) ICOLOR
477           GO TO (1,2,3,4,5), IDEVIC
478   C
479   C     SET THE TYPE FOR POLYGON AND CIRCLE FILLING 0, 1, 2, OR 3
480   C
481           ENTRY FILTYP(IFIL)
482           IF(.NOT.OPENANY) GO TO 1000
```

```
483             LFLMAT(IDEVIC) = IFIL
484             IF(LUDIAG.GT.0) WRITE(LUDIAG,1503) LFLMAT
485             MODEP = 5
486             GO TO (1,2,3,4,5), IDEVIC
487   C
488   C     SET THE SIZE OF THE HARDWARE CHARACTERS
489   C
490             ENTRY CHRSIZ (CHFRZ, GCHFRZ)
491             IF(.NOT.OPENANY) GO TO 1000
492             IF(CHFRZ.GT.0) CHSIZE(9) = CHFRZ
493             CHSIZE(1) = CHSIZE(9) * (Y2R(IDEVIC)-Y1R(IDEVIC))
494             CHSIZE(2) = CHSIZE(1)
495             IF(GCHFRZ.GT.0) CHSIZE(5) = GCHFRZ
496             IF(LUDIAG.GT.0) WRITE(LUDIAG,1505) CHFRZ, GCHFRZ
497             MODEP = 5
498             RETURN
499   C
500   C     SET THE LINE WIDTH
501   C
502             ENTRY LINWID(LINWD)
503             IF(.NOT.OPENANY) GO TO 1000
504             LINWDM(IDEVIC) = MAX0(LINWD,1)
505             IF(LUDIAG.GT.0) WRITE(LUDIAG,1504) LINWDM
506             MODEP = 5
507             GO TO (1,2,3,4,5), IDEVIC
508   C
509   C     SCALE
510   C
511             ENTRY SCALNG(X1,Y1,X2,Y2,X1H,Y1H,X2H,Y2H,X1S,Y1S,X2S,Y2S)
512             IF(.NOT.OPENANY) GO TO 1000
513             IND = (IDEVIC-1)*4
514             IF(IDEVIC.EQ.1) THEN
515               SCLRAS = 1000.
516             ELSE
517               SCLRAS = 1.
518             ENDIF
519             IF (X1H.GE.0.0) HWSIZE(IND+1) = X1H * SCLRAS
520             IF (Y1H.GT.0.0) HWSIZE(IND+2) = Y1H * SCLRAS
521             IF (X2H.GE.0.0) HWSIZE(IND+3) = X2H * SCLRAS
522             IF (Y2H.GT.0.0) HWSIZE(IND+4) = Y2H * SCLRAS
523             IF (X1S.NE.0.0) X1R(IDEVIC) = X1S
524             IF (X2S.NE.0.0) X2R(IDEVIC) = X2S
525             IF (Y1S.NE.0.0) Y1R(IDEVIC) = Y1S
526             IF (Y2S.NE.0.0) Y2R(IDEVIC) = Y2S
527             GO TO 11
528             ENTRY DEFINE (X1, Y1, X2, Y2)
529        11   MODEP = 6
530             IF(.NOT.OPENANY) GO TO 1000
531             DX = X2 - X1
532             IF (DX.EQ.0.0) DX = 1.0
533             XYCOOD(1) = (X2R(IDEVIC) - X1R(IDEVIC))/DX
534             XYCOOD(2) = X1R(IDEVIC) - XYCOOD(1)*X1
535             DY = Y2 - Y1
536             IF (DY.EQ.0.0) DY = 1.0
537             XYCOOD(3) = (Y2R(IDEVIC) - Y1R(IDEVIC))/DY
```

```
538             XYCOOD(4) = Y1R(IDEVIC) - XYCOOD(3)*Y1
539             IF (LUDIAG.NE.0) WRITE (LUDIAG, 1400) XYCOOD
540             CHSIZE(1) = CHSIZE(9) * (Y2R(IDEVIC)-Y1R(IDEVIC))
541             CHSIZE(2) = CHSIZE(1)
542             GO TO (1,2,3,4,5), IDEVIC
543   C
544   C      ENDFRM - TO CLOSE THE LOGICAL UNIT
545   C
546             ENTRY ENDFRM
547             IF(.NOT.OPENANY) GO TO 1000
548             MODEP = 7
549             IF (LUDIAG.NE.0) WRITE (LUDIAG,1201) COUNT(IDEVIC),
550          .  NFRAME(IDEVIC)
551             NFRAME(IDEVIC) = 0
552             GO TO (1,2,3,4,5), IDEVIC
553      10     CLOSE(7)
554             OPENANY = .FALSE.
555             IDEVIC = 0
556             RETURN
557   C
558   C      *** START OF THE SECTION WHICH HANDELS THE HARDWARE ***
559   C
560   C
561   C      CALCOMP SECTION
562   C
563       1     GO TO (101,102,103,103,105,106,107), MODEP
564   C
565   C      CALCOMP INITIALIZATION
566   C
567     101     CALL CALBUF (LUOUT,0,1,IDXX)
568             IF(OPNCAL) CALL CALPLT (0.0, +1.0, 1007)
569             OPNCAL = .FALSE.
570             CALL CALPLT (FLOAT(CALRAS(3))/((X2R(1)-X1R(1))*1000.),
571          .   FLOAT(CALRAS(4))/((Y2R(1)-Y1R(1))*1000.), 1001)
572             CALL CALPEN (1)
573             LSW = .TRUE.
574             RETURN
575   C
576   C      CALCOMP FRAME (FLUSH BUFFER AND RESET, IGNORE HARDCOPY)
577   C
578     102     RETURN
579   C
580   C      ERASE THE SCREEN AND PRINT HARDCOPY ARE IGNORED FOR THE CALCOMP
581   C
582     103     RETURN
583   C
584   C      COLOR SELECTION PRINTOUT.
585   C
586     105     PEN = MOD(ICOLOR-1,4) + 1
587             PEN = MINO(MAXO(PEN,1),4)
588             LCLMAT(IDEVIC) = PEN
589             CALL CALPEN(PEN)
590             RETURN
591   C
592   C      CALCOMP AXIS SET.
```

```
593  C
594    106     CONTINUE
595            CALL CALPLT (FLOAT(CALRAS(3))/((X2R(1)-X1R(1))*1000.),
596           .  FLOAT(CALRAS(4))/((Y2R(1)-Y1R(1))*1000.), 1001)
597            RETURN
598  C
599  C     ENDFRM FOR CALCOMP
600  C
601    107     CONTINUE
602            CALL CALPLT(0., 0., 999)
603            GO TO 10
604  C
605  C     PAPER PLOT SECTION
606  C
607      2     GO TO (201,202,203,204,205,206,207), MODEP
608  C
609  C     PAPER PLOT INITIALIZATION.
610  C     THE PAGE PLOT IS OUTPUT AS ONE LARGE VARIABLE FORMAT.
611  C     SET UP THE FORMAT STATEMENT IN LPAGE.
612  C
613    201     CONTINUE
614    203     DO 211 J=1,65
615            LPAGE(2,J)=LINE
616    211     LPAGE(30,J)=SLASH
617            LPAGE(1,1)=START
618            LPAGE(30,65)=ENDIT
619  C
620  C     SET UP THE PAGE AND CLEAN THE WORK AREA.
621  C
622            DO 221 J = 1, 65
623            DO 221 I = 4, 29
624    221     LPAGE(I,J) = HBLANK
625            DO 222 I = 5, 28
626            LPAGE(I,1) = HMINUS
627    222     LPAGE(I,63) = HMINUS
628            DO 223 J = 2, 62
629            LPAGE(4,J) = HAPOSA
630    223     LPAGE(29,J) = HAPOSB
631            LPAGE(29,1) = HASTRB
632            LPAGE(29,63) = HASTRB
633            LPAGE(4,63) = HASTRA
634            LPAGE(4, 1) = HASTRA
635            RETURN
636  C
637  C     PAPER PLOT- WRITE OUT THE PAGE AS IT IS.
638  C
639    202     WRITE(LUOUT, LPAGE)
640            RETURN
641  C
642  C     HARDCOPY COMMAND
643  C
644    204     RETURN
645  C
646  C     COLOR SELECTION PRINTOUT.
647  C
```

```
  205     RETURN
C
C     SET SCALING FOR PAGE PLOT
C
  206     RETURN
C
C     ENDFRM FOR THE PAPER PLOTTER
C
  207     WRITE (LUOUT,1212)
          GO TO 10
C
C     LEXIDATA/MATRIX SECTION
C
    3     GO TO (301,302,303,304,305,306,307), MODEP
C
C     INITIALIZE THE LEXIDATA/MATRIX - OPEN AND SET THE LUT ONLY
C     IF THE DEVICE IS/WAS CLOSED
C
  301     IF(OPNLEX) THEN
          CALL GSOPN(LUOUT, 1, LIERR)
          IF(LIERR.NE.0) GO TO 1002
C
C     CURSOR OFFSET - THIS IS INSTALLATION SPECIFIC
C
          CALL DSCSL(10, 153, 75)
          CALL DSCER
          CALL SETLUT ; SET THE DEFAULT LOOK UP TABLE
          CALL GSTYPE(3)
C
C     SET VIEW CORRESPONDENCE
C
          CALL GDEFVS (1, 15, 0, 1, 4, 0)
          CALL GINTVS (1)
          CALL GACTVS (1)
          CALL GDFWIN (1, X1R(IDEVIC), Y1R(IDEVIC), X2R(IDEVIC),
     .      Y2R(IDEVIC))
          CALL GDFVP  (1, LEXRAS(1), LEXRAS(2), LEXRAS(3), LEXRAS(4))
          VSNUM(1) = 2
          VSNUM(2) = 0
          CALL GDFVU  (1, 1, 1, VSNUM)
          CALL GACTVU(1)
          CALL GDASEG
          CALL GCRSEG(100)
          DO 3001 I = 1, 4
 3001     CALL GDPAT(100+I, USPAT(1,I))
          CALL GCLSEG
          CALL GSVUAS(100, VSNUM)
          CALL GDLSEG(100)
          CALL GSIVIS(1)
          CALL GSVUAS (0, VSNUM)
C
C  DEFINE LOCATOR PORT EXTENTS AND SET TRACKING TYPE
C
          CALL GDVINI(DEVID, 2, 1)
          CALL GDFLPT(DEVID, LEXRAS(1),LEXRAS(2),LEXRAS(3),LEXRAS(4))
```

```
703             CALL GSTTRK(DEVID, 2, 1)
704   C
705   C  SET ECHO TYPE
706   C
707             CALL GSTDVE(DEVID, 1, 1)
708             CALL GDVENB(DEVID)
709             CALL GRSLG (DEVID, 255)
710             OPNLEX = .FALSE.
711             ENDIF
712   C
713   C      SET THE PARAMETERS FOR THE LEXIDATA DISPLAY
714   C
715             CALL GCLSEG
716             CALL DSCLR(-1)
717             CALL GCTSEG
718             CALL GSFTYP(LFLMAT(IDEVIC))
719             CALL GSLWID(LINWDM(IDEVIC))
720             CALL GSCHSZ(CHSIZE(2))
721             CALL GSCNDX (1)
722             RETURN
723   C
724   C      FRAME - FORCE OUT THE CONTENTS OF THE BUFFER
725   C
726     302     CALL GCLSEG
727             CALL GMPCUR
728             CALL GCTSEG
729             RETURN
730   C
731   C      ERASE THE SCREEN AND THE CURSOR
732   C
733     303     CALL DSCLR(-1)
734             CALL DSCSL (10, 153, 75)
735             RETURN
736   C
737   C      HARD COPY - CAMERA
738   C
739     304     IF(OPNMAT) THEN
740               CLOSE(MATUNT)
741               OPNTAB = .TRUE.
742               OPEN(UNIT=MATUNT,IOSTAT=IOS,ERR=314,FILE=MATFIL,
743          .    TYPE='DEVICE',SHARE='ERW',RKEY=0,WKEY=0)
744               OPNMAT = .FALSE.
745             ENDIF
746             IF(LUDIAG.NE.0) WRITE(LUDIAG,1003) MATUNT
747             CALL SYSIO(PBLK,41,MATUNT,'.CE.',4,0)
748             CALL WAIT(ITIMET,2,IOS)
749             RETURN
750   C
751   C      ERROR ON CALL TO DEVICE
752   C
753     314     CLOSE(MATUNT)
754             IF (LUDIAG.NE.0) WRITE (LUDIAG,1014) MATUNT, IOS
755             STOP 'camera can not be accessed'
756   C
757   C      SET COLOR - THIS APPLIES TO WHAT IS IN THE LUT
```

```
758  C
759    305      LEXCOL = MOD(ICOLOR-1,15) + 1
760             LEXCOL = MAX0(LEXCOL,1)
761             LCLMAT(IDEVIC) = LEXCOL
762             CALL GSCNDX(LCLMAT(IDEVIC))
763             CALL GSLWID(LINWDM(IDEVIC))
764             LFLLEX = LFLMAT(IDEVIC)
765             IF(LFLLEX.LE.4) THEN
766               CALL GSFTYP(LFLLEX)
767             ELSE
768               CALL GSFTYP(96+LFLLEX)
769             ENDIF
770             RETURN
771  C
772  C      SET THE WINDOW AND AREA OF NORMALIZED DEVICE COORDINATES
773  C
774    306      IF(OPNLEX) GO TO 301
775             CALL GCLSEG
776             CALL GDAVU(1)
777             CALL GDFWIN (1, X1R(IDEVIC), Y1R(IDEVIC), X2R(IDEVIC),
778        .      Y2R(IDEVIC))
779             CALL GDFVP  (1, LEXRAS(1), LEXRAS(2), LEXRAS(3), LEXRAS(4))
780             CALL GDFVU  (1, 1, 1, VSNUM)
781             CALL GACTVU (1)
782  C
783  C      OPEN A NEW SEGMENT
784  C
785             CALL GCTSEG
786             RETURN
787  C
788  C
789    307      OPNLEX = .TRUE.
790             IF (.NOT.OPNMAT) THEN
791               CLOSE(MATUNT)
792               OPNMAT = .TRUE.
793             ENDIF
794             CALL GCLSEG
795             CALL GDASEG
796             CALL GFRAME
797             CALL DSCLR(-1)
798             CALL GRSLG(DEVID,255)
799             CALL GDVDSB(DEVID)
800             GO TO 10
801  C
802  C      TEKTRONIX SECTION
803  C
804      4      GO TO (401,402,403,404,405,406,407), MODEP
805  C
806  C      TEKTRONIX INITIALIZATION
807  C
808    401      CALL TEKINT (120)
809             CALL SWINDO (TEKRAS(1),TEKRAS(3),TEKRAS(2),TEKRAS(4))
810             CALL VWINDO (X1R(IDEVIC), X2R(IDEVIC)-X1R(IDEVIC),
811        .                 Y1R(IDEVIC), Y2R(IDEVIC)-Y1R(IDEVIC))
812             LTSW = .TRUE.
```

```
813             CALL TEKHOM
814             CALL TTKSND
815             CALL WAIT (IDLETM, 1, IS)
816             RETURN
817   C
818   C     FRAME (NO MODE SWITCHING)
819   C
820      402    CONTINUE
821             CALL TTKSND
822             CALL WAIT (IDLETM, 1, IS)
823             RETURN
824   C
825   C     ERASE THE SCREEN
826   C
827      403    CONTINUE
828             CALL TEKHOM
829             CALL TEKERA
830             CALL TOUTST (2, ICTRLX)
831             CALL TTKSND
832             CALL WAIT (IDLETM, 1, IS)
833             RETURN
834   C
835   C     ISSUE HARD COPY COMMAND
836   C
837      404    CONTINUE
838             CALL TOUTST (2, ICODET)
839             CALL TEKHOM
840             CALL TTKSND
841             CALL WAIT (ITIMET, 2, IS)
842             RETURN
843   C
844   C     COLOR - DOES NOT APPLY TO ADM OR TEKTRONIX 4054
845   C
846      405    CONTINUE
847             RETURN
848   C
849   C     SET SCREEN CORRESPONDENCE
850   C
851      406    CONTINUE
852             CALL SWINDO(TEKRAS(1),TEKRAS(3),TEKRAS(2),TEKRAS(4))
853             CALL VWINDO (X1R(IDEVIC), X2R(IDEVIC)-X1R(IDEVIC),
854            .                Y1R(IDEVIC), Y2R(IDEVIC)-Y1R(IDEVIC))
855             RETURN
856   C
857   C     END THE FRAME ON THE ADM OR TEK 4054
858   C
859      407    CALL TEKHOM
860             CALL TOUTST (2, ICTRLX)
861             CALL TTKSND
862             CALL WAIT (IDLETM, 1, IS)
863             CALL SVSTAT (SCRATCH)
864             GO TO 10
865   C
866   C     SLOT FOR AN EXTRA DEVICE
867   C
```

```
868       5     STOP 74
869   C
870   C     DELAY IN SECONDS FOR HARD COPY UNITS
871   C
872           ENTRY DELAY(ITIME)
873           ITIMET = ITIME
874           RETURN
875   C
876   C     IOWAIT
877   C
878           ENTRY IOWAIT(IT)
879           CALL WAIT (IT, 1, IS)
880           RETURN
881   C
882   C     GET THE DEVICE ID FOR THE LEXIDATA TRACKING TYPE
883   C
884           ENTRY LEXDID(IDVL)
885           IDVL = DEVID
886           RETURN
887   C
888   C     OPEN ACCESS TO THE TABLET - IF POSSIBLE
889   C
890           ENTRY TABLET (OPENTB)
891           OPENTB = .FALSE.
892           IF(OPNTAB) THEN
893             IF(.NOT.OPNMAT) CLOSE(MATUNT)
894             OPEN(UNIT=TABUNT,IOSTAT=IOS,ERR=1304,FILE=TABFIL,
895          .                          TYPE='DEVICE',SHARE='ERW',RKEY=0,
896          .                          WKEY=0)
897               OPNTAB = .FALSE.
898               OPENTB = .TRUE.
899               OPNMAT = .TRUE.
900           ELSE
901             IF(LUDIAG.GT.0) WRITE(LUDIAG,1302)
902             OPENTB = .TRUE.
903           ENDIF
904           RETURN
905   C
906   C     THE TABLET HAS GENERATED AN ERROR
907   C
908    1304   CLOSE(TABUNT)
909           IF(LUDIAG.GT.0) WRITE(LUDIAG,1303) TABUNT,IOS
910           STOP 'can not access tablet'
911   C
912   C     PUNISH IF NOT INITIALIZED.
913   C
914    1000   IF (LUDIAG.NE.0) WRITE (LUDIAG, 1004) MODEP, IDEVIC
915           IDEVIC = 0
916           RETURN
917    1002   IF (LUDIAG.NE.0) WRITE(LUDIAG, 1013)LIERR
918           STOP 'Lexidata can not be accessed'
919    1100   IF (LUDIAG.NE.0) WRITE(LUDIAG, 1006) IDEVIC
920           RETURN
921   C
922   C     FORMATS
```

```
C
 1001     FORMAT (' FRAMES PLOTTED = ',I5,' ON DEVICE ',I3)
 1003     FORMAT (' DEVICE = ',I2,' INITIALIZED')
 1004     FORMAT (' DEVICE NOT INITIALIZED. ', 2I5)
 1005     FORMAT (' LUOUT = ',I3,' AND WILL BE SET TO ',I3,
     .    ' AT THE NEXT CALL TO "DEVICE"')
 1006     FORMAT (' DEVICE ',I3,' IS ALREADY OPEN')
 1013     FORMAT (' CAN NOT OPEN LEXIDATA, ERROR =',I3)
 1014     FORMAT (' DEVICE ',I3,' CAN NOT BE ACESSED, ERROR =',I3)
 1101     FORMAT (' FRAME NUMBER ',I5,' INITIALIZED')
 1201     FORMAT (' PLOTTER CLOSED WITH',2I5,' FRAMES')
 1212     FORMAT ('1')
 1214     FORMAT (' COLOR SELECT = ',I3)
 1302     FORMAT(' CAMERA IS ALREADY AVAILABLE')
 1303     FORMAT (' CAMERA ',I3,' CAN NOT BE ACESSED, ERROR =',I3)
 1400     FORMAT (' FACTOR ',4F8.2)
 1501     FORMAT (' ERASE COMMAND ISSUED AT FRAME ',I5)
 1502     FORMAT (' HARDCOPY COMMAND ISSUED AT FRAME ',I5)
 1503     FORMAT (' SET THE FILL TYPE FOR SURFACES ',5I3)
 1504     FORMAT (' SET THE LINE WIDTH ',5I3)
 1505     FORMAT (' SET THE CHARACTER SIZE (%) ',2F6.3)
      END
```

```
945           SUBROUTINE DEVINP(INPUT,BTMASK,IDV,X,Y,Z)
946           LOGICAL JFIRST/.TRUE./, TFIRST/.TRUE./, KFIRST/.TRUE./
947           INTEGER BTMASK,DEVID,PBLK(6),TLOOK(4)/1,2,4,8/
948           CHARACTER*1 INST(2)/Z1B,'A'/
949           CHARACTER*20 DATAIN
950           COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
951           COMMON/TXXDAT/TABIN,TABWIN,TABXYC
952           REAL TABIN(2),TABWIN(4),TABXYC(4)
953           COMMON/DEVPOS/X1R(5),Y1R(5),X2R(5),Y2R(5)
954   C
955   C       SELECT THE INPUT FROM THE DEVICE CODE
956   C
957           X = 0.
958           Y = 0.
959           Z = 0.
960           IDV = 0
961           IF(INPUT.LT.1.OR.INPUT.GT.3) RETURN
962           IF(INPUT.NE.1.AND.(.NOT.JFIRST)) THEN
963             CALL DSCSL (10, 153, 75)
964             JFIRST = .TRUE.
965           ENDIF
966           GO TO (10, 20, 30), INPUT
967   C
968   C       GET THE DEVICE ID FOR THE JOYSTICK
969   C
970       10  IF(JFIRST) THEN
971             CALL LEXDID(DEVID)
972             CALL GDFBGF(DEVID, 15, 0, IDUM)
973             CALL DSCSL (8, 153, 75)
974             JFIRST = .FALSE.
975           ENDIF
976   C
977   C       SET APPROPRIATE LIGHTS
978   C
979           CALL GSLTG(DEVID,BTMASK)
980   C
981   C       READ THE LOCATOR
982   C
983           XWC = 0.0
984           YWC = 0.0
985        3  CALL GRBTG(DEVID, IDV)
986           IDV = IAND(IAND(IDV,BTMASK),15)
987           IF(IDV.EQ.0) GO TO 3 ; NO SWITCH HAS BEEN TOGGLED
988           CALL GSLC(DEVID, IDVV, LCX, LCY, XWC, YWC)
989           IF(LCX.LT.0) GO TO 3
990           CALL GRSLG (DEVID, 255)
991        2  CALL GRBTG (DEVID, IDVV)
992           IF(IDVV.NE.0) GO TO 2
993   C
994   C       NORMALIZE TO <RE>WINDOWED COORDINATES
995   C
996           X = (XWC-XYCOOD(2)) / XYCOOD(1)
997           Y = (YWC-XYCOOD(4)) / XYCOOD(3)
998           Z = 0.0
999           RETURN
```

```
1000  C
1001  C     THE TABLET HAS BEEN SELECTED
1002  C
1003      20   IF(TFIRST) THEN
1004             TFIRST = .FALSE.
1005             CALL TABLET(OPENTB)
1006             IF(IDEVIC.EQ.0) THEN
1007               DX = 1280.
1008               DY = 1024.
1009             ELSE
1010               DX = (X2R(IDEVIC)-X1R(IDEVIC)) / XYCOOD(1)
1011               DY = (Y2R(IDEVIC)-Y1R(IDEVIC)) / XYCOOD(3)
1012             ENDIF
1013             TABXYC(1) = 8.2034E-5 * DX
1014             TABXYC(2) = 0.0
1015             TABXYC(3) = 1.0938E-4 * DY
1016             TABXYC(4) = 0.0
1017           ENDIF
1018      21   CALL SYSIO(PBLK,72,8,DATAIN,20,0)
1019           READ(DATAIN,22,ERR=21) IX,IY,IBT
1020      22   FORMAT(1X,I5,2X,I5,1X,I2)
1021           IF(IBT.EQ.0) GO TO 21
1022  C
1023  C     CONVERT THE CURSOR BUTTON TO A STANDARD FORMAT
1024  C
1025           IDV = TLOOK(IBT)
1026           IDV = IAND(BTMASK, IDV)
1027           IF(IDV.EQ.0) GO TO 21
1028           TABIN(1) = IX
1029           TABIN(2) = IY
1030           X = FLOAT(IX)*TABXYC(1) + TABXYC(2)
1031           Y = FLOAT(IY)*TABXYC(3) + TABXYC(4)
1032           Z = 0.0
1033           RETURN
1034  C
1035  C     INPUT FROM THE KEYBOARD
1036  C
1037      30   CALL SYSIO (PBLK,41,5,'X,Y,Z,IDV = ',12,0)
1038           READ(5,32,END=33,ERR=30) XCOR,YCOR,ZCOR,IDV
1039      32   FORMAT(3F,I)
1040           X = XCOR
1041           Y = YCOR
1042           Z = ZCOR
1043           IDV = IAND(BTMASK,IDV)
1044           RETURN
1045      33   IDV = BTMASK
1046           RETURN
1047           END
```

```
1048        SUBROUTINE ENUMBR (REALNO, XR1, YR1, XR2, YR2)
1049  C
1050  C*************************************************************************
1051  C     ENUMBR
1052  C*************************************************************************
1053  C
1054              DX = (XR2 - XR1)/10.0
1055              THENO = REALNO
1056              EXPON = 0.001
1057              IF (REALNO .EQ. 0.0) GO TO 10
1058      12      IF (ABS(THENO) .LT. 10.0) GO TO 11
1059              EXPON = EXPON + 1.0
1060              THENO = THENO*0.1000001
1061              GO TO 12
1062      11      IF (ABS(THENO) .GE. 1.0) GO TO 10
1063              EXPON = EXPON - 1.0
1064              THENO = THENO*9.99999
1065              GO TO 11
1066      10      CALL FNUMBR (XR1, YR1, DX, 0.0, 0.7*DX, 0.0, YR2-YR1,
1067        1         THENO, 5, 2)
1068              CALL WDDRAW (XR1+5.0*DX, YR1, DX, 0.0, 0.7*DX, 0.0,
1069        1         YR2-YR1, '*10¶.')
1070              CALL FNUMBR (XR1+8.0*DX, (YR1+YR2)/2.0, 0.66*DX, 0.0,
1071        1         0.75*DX, 0.0, 0.64*(YR2-YR1), EXPON, 3, 0)
1072  C     1         0.50*DX, 0.0, 0.6*(YR2-YR1), EXPON, 3, 0)
1073              RETURN
1074          END
```

```
      SUBROUTINE FNUMBR (XSTART, YSTART, DX, DY, SX, SXY, SY,
     1    NUMBR, WIDTH, DIGITS)
C
C       X       REAL    - X COORDINATE (MATHEMATICAL SPACE) OF THE FIRST
C                         CHARACTER TO BE DRAWN
C       Y       REAL    - Y COORDINATE (MATHEMATICAL SPACE) OF THE FIRST
C                         CHARACTER TO BE DRAWN
C       DX      REAL    - INCREMENT TO BE ADDED TO THE X COORDINATE FOR
C                         EACH CHARACTER DRAWN
C       DY      REAL    - INCREMENT TO BE ADDED TO THE Y COORDINATE FOR
C                         EACH CHARACTER DRAWN
C       SX      REAL    - X MATH SPACE SIZE FOR CHARACTERS
C       SXY     REAL    - SLANT MODIFIER FOR CHARACTERS
C       SY      REAL    - Y MATH SPACE SIZE FOR CHARACTERS
C       RNUMB   REAL    - NUMBER TO BE PLOTTED IN F FORMAT
C       WIDTH   INTEGER - TOTAL WIDTH OF FIELD INCLUDING DECIMAL POINT
C       DIGITS  INTEGER - NUMBER TO FRACTIONAL PLACES TO BE DRAWN
C
          REAL NUMBER, NUMBR, TEST(6)
          INTEGER    WIDTH, DIGITS, NUM, NN(22)
          LOGICAL  SPACE
          INTEGER   WORD(7), HASTR, HTEMP, SFIL(3)
          INTEGER TEXT(13)
          CHARACTER*1 WWORD(28), BLANK, HMINUS
          DATA TEXT /Z00000030, Z00000031, Z00000032, Z00000033,
     1               Z00000034, Z00000035, Z00000036, Z00000037,
     2               Z00000038, Z00000039, Z00000020, Z0000002E,
     3               Z0000007C /
          DATA SFIL / '*¶..', '**¶.', '***¶' /
          DATA HMINUS, HASTR / '-   ', '****' /, BLANK/' '/
          EQUIVALENCE (WORD(1),TEST(1),WWORD(1))
C
          I1 = 1
          I2 = 1
          NUMBER = ABS(NUMBR)
          IF (DIGITS.EQ.0)  NUM = NUMBER + 0.5
          IF (DIGITS.EQ.0)  GO TO 5
C
          WIDTH = WIDTH - 1
          NUM = NUMBER*10**DIGITS +0.5
    5     DO 10  I = 1,WIDTH
          J = WIDTH - I + 1
          NN(J) = NUM - 10*(NUM/10)
C
C     BREAK OUT THE DIGITS.
C
          NUM = NUM/10
   10     CONTINUE
          J = WIDTH - DIGITS
          IF(J .NE. 0) GO TO 18
          WORD(1) = TEXT(11)
          I1 = I1 + 1
          GO TO 25
   18     SPACE = .TRUE.
          DO 20  K = 1,J
```

```
1130            I = NN(K)
1131  C
1132  C     LEADING ZERO = SPACE
1133  C
1134            IF (I.NE.0)  SPACE = .FALSE.
1135            IF(K .EQ. J .AND. SPACE) SPACE = .FALSE.
1136            IF (I.EQ.0.AND.SPACE)  I = 10
1137            I1 = I1 + 1
1138            HTEMP = ISHFT(WORD(I2), 8)
1139            WORD(I2) = IOR(HTEMP,TEXT(I+1))
1140            IF(I1 .LT. 5) GO TO 20
1141            I2 = I2 + 1
1142            I1 = 1
1143     20     CONTINUE
1144            IF (DIGITS.EQ.0)  GO TO 40
1145  C
1146  C     PUT IN DECIMAL POINT
1147  C
1148     25     I1 = I1 + 1
1149            HTEMP = ISHFT(WORD(I2), 8)
1150            WORD(I2) = IOR(HTEMP,TEXT(12))
1151            IF(I1 .LT. 5) GO TO 26
1152            I2 = I2 + 1
1153            I1 = 1
1154     26     DO 30  K = 1,DIGITS
1155            I = NN(J+K)
1156            I1 = I1 + 1
1157            HTEMP = ISHFT(WORD(I2), 8)
1158            WORD(I2) = IOR(HTEMP,TEXT(I+1))
1159            IF(I1 .LT. 5) GO TO 30
1160            I2 = I2 + 1
1161            I1 = 1
1162   30       CONTINUE
1163            WIDTH = WIDTH + 1
1164  C
1165  C     PUT IN ¶.  (END OF TEXT)
1166  C
1167     40     I1 = I1 + 1
1168            HTEMP = ISHFT(WORD(I2), 8)
1169            WORD(I2) = IOR(HTEMP,TEXT(13))
1170            IF(I1 .LT. 5) GO TO 42
1171            I2 = I2 + 1
1172            I1 = 1
1173     42     HTEMP = ISHFT(WORD(I2), 8)
1174            WORD(I2) = IOR(HTEMP,TEXT(12))
1175  C
1176  C  LEFT JUSTIFY LAST WORD.
1177  C
1178     44     I1 = I1 + 1
1179            IF(I1 .GE. 5) GO TO 46
1180            WORD(I2) = ISHFT(WORD(I2), 8)
1181            GO TO 44
1182  C
1183  C     PUT IN THE MINUS SIGN
1184  C
```

```
1185      46      IF (NUMBR .GE. 0.0) GO TO 50
1186              IF(WWORD(1).NE.BLANK) GO TO 60
1187              NUMMX = 4 * I2
1188              DO 47 I = 2, NUMMX
1189              IP = I
1190              IF(WWORD(I).NE.BLANK) GO TO 48
1191      47      CONTINUE
1192      48      WWORD(IP-1) = HMINUS
1193              GO TO 50
1194      60      I2 = WIDTH/4
1195              IF(I2 .EQ. 0)GO TO 64
1196              DO 62 K = 1, I2
1197      62      WORD(K) = HASTR
1198      64      I1 = WIDTH - 4*I2
1199              IF(I1 .GT. 0) WORD(I2+1) = SFIL(I1)
1200  C
1201      50      CALL WDDRAW(XSTART,YSTART,DX,DY,SX,SXY,SY,WORD)
1202              RETURN
1203              END
```

```
1204        SUBROUTINE GRAFIT (NPL,X1,X2,X1R,X2R,IX1,IX2,Y1,Y2,Y1R,Y2R,IY1,
1205       .    IY2,XTIT,NDVX,YTIT,NDVY)
1206  C
1207  C      NPL     INTEGER - THE NUMBER OF THE PLOT REFERENCED.  UP TO FOUR
1208  C                        PLOTS MAY BE PLACED ON ONE GRAPH
1209  C      X1      REAL    - A FLOATING POINT NUMBER, THE LABEL OF THE X
1210  C                        AXIS MINIMUM.  THE LITERAL STRING 'NONE'
1211  C                        PRODUCES NO LABEL
1212  C      X2      REAL    - A FLOATING POINT NUMBER, THE LABEL OF THE X AXIS
1213  C                        MAXIMUM.  THE LITERAL STRING 'NONE' PRO-
1214  C                        DUCES NO LABEL
1215  C      X1R     REAL    - THE USER SPACE VALUE OF THE X AXIS MINIMUM
1216  C      X2R     REAL    - THE USER SPACE VALUE OF THE X AXIS MAXIMUM
1217  C      IX1     REAL    - THE MINIMUM VALUE OF X IN THE DATA TO BE PLOTTED
1218  C      IX2     REAL    - THE MAXIMUM VALUE OF X IN THE DATA TO BE PLOTTED
1219  C      Y1      REAL    - A FLOATING POINT NUMBER, THE LABEL OF THE Y
1220  C                        AXIS MINIMUM.  THE LITERAL STRING 'NONE'
1221  C                        PRODUCES NO LABEL.
1222  C      Y2      REAL    - A FLOATING POINT NUMBER, THE LABEL OF THE Y
1223  C                        AXIS MAXIMUM.  THE LITERAL STRING 'NONE'
1224  C                        PRODUCES NO LABEL
1225  C      Y1R     REAL    - THE USER SPACE VALUE OF THE Y AXIS MINIMUM
1226  C      Y2R     REAL    - THE USER SPACE VALUE OF THE Y AXIS MAXIMUM
1227  C      IY1     REAL    - THE MINIMUM VALUE OF Y IN THE DATA TO BE PLOTTED
1228  C      IY2     REAL    - THE MAXIMUM VALUE OF Y IN THE DATA TO BE PLOTTED
1229  C      XTIT    CHAR    - A STRING OF LITERAL CHARACTERS TERMINATED BY
1230  C                        A ¶.  THIS IS THE TITLE FOR THE X AXIS AND
1231  C                        SHOULD BE LESS THAN 30 CHARACTERS
1232  C      NDVX    INTEGER - THE NUMBER OF INTERVALS TO BE DRAWN ON THE
1233  C                        X AXIS
1234  C      YTIT    CHAR    - A STRING OF LITERAL CHARACTERS TERMINATED BY
1235  C                        A ¶.  THIS IS THE TITLE FOR THE Y AXIS AND
1236  C                        SHOULD BE LESS THAN 30 CHARACTERS
1237  C      NDVY    INTEGER - THE NUMBER OF INTERVALS TO BE DRAWN ON THE
1238  C                        Y AXIS
1239  C
1240  C      ENTRY POINTS (WITH ARGUMENTS):
1241  C
1242  C      PLOTCH (NPL,X,Y,N,CHARAC) - PLOTS ALPHANUMERIC CHARACTERS AT THE
1243  C                                  COORDINATES PROVIDED
1244  C      X       REAL    - A ONE DIMENSIONAL ARRAY CONTAINING THE
1245  C                        COORDINATES FOR X
1246  C      Y       REAL    - A ONE DIMENSIONAL ARRAY CONTAINING THE
1247  C                        COORDINATES FOR Y
1248  C      N       INTEGER - THE NUMBER OF ENTRIES IN 'X' AND 'Y'.  IF 'N' =
1249  C                        NO COORDINATES ARE PLOTTED.
1250  C      PCHR    CHAR*1  - A SINGLE CHARACTER TO BE USED FOR PLOTTING
1251  C
1252  C      PLOTLN (NPL,X,Y,N) - PLOTS STRAIGHT LINES THROUGH THE COORDINATES
1253  C                           PROVIDED.  ARGUMENTS ARE THE SAME AS FOR
1254  C                           PLOTCH.
1255  C
1256        PARAMETER (NLINES=200,NPLTMX=4)
1257        REAL IX1, IX2, IY1, IY2, NONE, HOLD(12,NPLTMX), WX(NLINES)
1258        REAL CC(16), C(16), WY(NLINES)
```

```
      CHARACTER*1 XTIT(NDVX), YTIT(NDVY), PCHR, TITLE(132)
      INTEGER  IX, IY, IT, NTX, NTY, INDX(16)
      DIMENSION X(1), Y(1) , XL(1), YB(1), XR(1), YT(1)
      LOGICAL PLOTON(NPLTMX)/NPLTMX*.FALSE./
      LOGICAL LLABPL(NPLTMX)/NPLTMX*.FALSE./
      DIMENSION NTICX(NPLTMX),NTICY(NPLTMX),XMINO(NPLTMX),XMAXO(NPLTMX)
      DIMENSION YMINO(NPLTMX),YMAXO(NPLTMX)
      COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
      COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG
      DATA NONE/'NONE'/
      DATA CC/.0500,.0600,.0310,.0600,.11,.15,
     .        .0800,.0781,.1780,.2500,.0300,.0315,.0600,.040,
     .        .020,.025/
      DATA INDX/3,3,3,9,9,9,3,3,3,3,9,9,9,3,3,9/
C
C     THIS ROUTINE INITIALIZES A GRAPHICS GRID OR CONTOUR DIAGRAM
C     WITH A FULL SET OF LABELS AND SWITCHES THE REST OF THE CONTOUR
C     GRAPHICS MATERIAL TO THE GRAPHICS MODE.
C
C     DEFINE THE PLOTTING REGIONS.
C
      CHSIZE(4) = .44
      IF(NPL.GT.NPLTMX.OR.NPL.LT.1) STOP 72
      PLOTON(NPL) = .TRUE.
      HOLD(1,NPL) = X1
      HOLD(2,NPL) = X2
      HOLD(3,NPL) = X1R
      HOLD(4,NPL) = X2R
      HOLD(5,NPL) = IX1
      HOLD(6,NPL) = IX2
      HOLD(7,NPL) = Y1
      HOLD(8,NPL) = Y2
      HOLD(9,NPL) = Y1R
      HOLD(10,NPL) = Y2R
      HOLD(11,NPL) = IY1
      HOLD(12,NPL) = IY2
      IF(LLABPL(NPL)) THEN
        HOLD(1,NPL) = XMINO(NPL)
        HOLD(2,NPL) = XMAXO(NPL)
        HOLD(5,NPL) = XMINO(NPL)
        HOLD(6,NPL) = XMAXO(NPL)
        HOLD(7,NPL) = YMINO(NPL)
        HOLD(8,NPL) = YMAXO(NPL)
        HOLD(11,NPL) = YMINO(NPL)
        HOLD(12,NPL) = YMAXO(NPL)
      ENDIF
      CALL BOXPLT (X1R, Y1R, X2R, Y2R)
      DO 11 I = 1, 16
   11 C(I) = CC(I) * (HOLD(INDX(I)+1,NPL)-HOLD(INDX(I),NPL))
C
C     DETERMINE NUMBER OF CHARACTERS IN AXIS TITLES.
C
      TITLE(1) = '¶'
      TITLE(2) = 'M'
      MAXT = 130
```

```
1314          CALL WDCOUNT(XTIT, NTX)
1315          IF (NTX.LT.1) THEN
1316            IF (LUDIAG.GT.0) WRITE (LUDIAG,12)
1317          ELSE
1318            DO 15 I = 1, MAXT
1319       15   TITLE(I+2) = XTIT(I)
1320            C(8) =   (X2R+X1R)/2.
1321            XRR = C(8) + NTX*C(1)
1322            CALL LABEL(TITLE, C(8), Y1R-C(6), XRR, Y1R-C(6)+C(13), 0.0)
1323          END IF
1324       12 FORMAT(' NO ESCAPE SEQUENCE IN TITLE - GRAFIT')
1325          CALL WDCOUNT(YTIT, NTY)
1326          IF(NTY.LT.1) THEN
1327            IF (LUDIAG.GT.0) WRITE (LUDIAG,12)
1328          ELSE
1329            C(11) = (Y1R+Y2R) / 2.
1330            DO 16 I = 1, MAXT
1331       16   TITLE(I+2) = YTIT(I)
1332            CALL LABEL(TITLE, X1R-C(7), C(11), X1R-C(7)+NTY*C(1),
1333         .  C(11)+C(13), 1.5707)
1334          ENDIF
1335    C
1336    C      DECIDE WHICH LABELS TO USE
1337    C
1338          IF(LLABPL(NPL)) THEN
1339            CALL FNUMBR (X1R-C(10), Y1R-C(16), C(3), 0.0,
1340         .    C(2),0.0,C(4), YMINO(NPL), 6, 1)
1341            CALL FNUMBR (X1R-C(10), Y2R-C(16), C(3), 0.0,
1342         .    C(2),0.0,C(4), YMAXO(NPL), 6, 1)
1343            CALL FNUMBR (X1R-C(9), Y1R-C(5), C(3), 0.0,
1344         .    C(2),0.0,C(4), XMINO(NPL), 6, 1)
1345            CALL FNUMBR (X2R-C(9), Y1R-C(5), C(3), 0.0,
1346         .    C(2),0.0,C(4), XMAXO(NPL), 6, 1)
1347          ELSE
1348            IF(Y1.NE.NONE)
1349         .    CALL FNUMBR (X1R-C(10), Y1R-C(16), C(3), 0.0,
1350         .    C(2),0.0,C(4), Y1, 6, 1)
1351            IF(Y2.NE.NONE)
1352         .    CALL FNUMBR (X1R-C(10), Y2R-C(16), C(3), 0.0,
1353         .    C(2),0.0,C(4), Y2, 6, 1)
1354            IF(X1.NE.NONE)
1355         .    CALL FNUMBR (X1R-C(9), Y1R-C(5), C(3), 0.0,
1356         .    C(2),0.0,C(4), X1, 6, 1)
1357            IF(X2.NE.NONE)
1358         .    CALL FNUMBR (X2R-C(9), Y1R-C(5), C(3), 0.0,
1359         .    C(2),0.0,C(4), X2, 6, 1)
1360          ENDIF
1361    C
1362    C     PUT TIKS ON THE GRAPH IF THE NUMBER IS GREATER THAN ZERO.
1363    C
1364          IF(LLABPL(NPL)) THEN
1365            NDVXLL = NTICX(NPL)
1366            NDVYLL = NTICY(NPL)
1367          ELSE
1368            NDVXLL = NDVX
```

```
1369          NDVYLL = NDVY
1370        ENDIF
1371        IF (NDVXLL.GT.1) THEN
1372          DELX = (X2R - X1R)/FLOAT(NDVXLL)
1373          DO 3 I = 1, NDVXLL-1
1374          XX = X1R + FLOAT(I)*DELX
1375      3   CALL LINE (XX, Y1R, XX, Y1R+C(16))
1376          DO 7 I = 1, NDVXLL-1
1377          XX = X1R + FLOAT(I)*DELX
1378      7   CALL LINE(XX, Y2R, XX, Y2R-C(16))
1379        END IF
1380        IF (NDVYLL.GT.1) THEN
1381          DELY = (Y2R - Y1R)/FLOAT(NDVYLL)
1382          DO 4 I = 1, NDVYLL-1
1383          YY = Y1R + FLOAT(I)*DELY
1384      4   CALL LINE (X1R, YY, X1R+C(15), YY)
1385          DO 8 I = 1, NDVYLL-1
1386          YY = Y1R + FLOAT(I)*DELY
1387      8   CALL LINE(X2R, YY, X2R-C(15), YY)
1388        END IF
1389        RETURN
1390  C
1391        ENTRY PLOTCH (NPL, X, Y, N, PCHR)
1392  C
1393        IF (N.LE.0) RETURN
1394        IF(NPL.GT.NPLTMX.OR.NPL.LT.1) STOP 72
1395        IF(.NOT.PLOTON(NPL)) RETURN
1396        DX = (HOLD(4,NPL)-HOLD(3,NPL)) / (HOLD(6,NPL)-HOLD(5,NPL))
1397        DY=(HOLD(10,NPL)-HOLD(9,NPL))/(HOLD(12,NPL)-HOLD(11,NPL))
1398        CHSIZE(2) = (HOLD(10,NPL)-HOLD(9,NPL)) * XYCOOD(3) * CHSIZE(5)
1399        NLM = 1
1400     13 IST = NLM
1401        NLM = MIN(NLM-1+NLINES, N)
1402        DO 5 I = IST, NLM
1403        WX(I-IST+1) = HOLD(3,NPL) + DX * (X(I)-HOLD(5,NPL))
1404      5 WY(I-IST+1) = HOLD(9,NPL) + DY * (Y(I)-HOLD(11,NPL))
1405        CALL CHPLOT (WX, WY, PCHR, 1, 1, NLM-IST+1)
1406        IF(NLM.LT.N) GO TO 13
1407        CHSIZE(2) = CHSIZE(1)
1408        RETURN
1409  C
1410        ENTRY PLOTLN (NPL, X, Y, N)
1411  C
1412        IF (N.LE.0) RETURN
1413        IF(NPL.GT.NPLTMX.OR.NPL.LT.1) STOP 72
1414        IF(.NOT.PLOTON(NPL)) RETURN
1415        DX = (HOLD(4,NPL)-HOLD(3,NPL)) / (HOLD(6,NPL)-HOLD(5,NPL))
1416        DY=(HOLD(10,NPL)-HOLD(9,NPL))/(HOLD(12,NPL)-HOLD(11,NPL))
1417        NLM = 1
1418     14 IST = NLM
1419        NLM = MIN(NLM-1+NLINES,N)
1420        DO 6 I = IST, NLM
1421        WX(I-IST+1) = HOLD(3,NPL) + DX * (X(I)-HOLD(5,NPL))
1422      6 WY(I-IST+1) = HOLD(9,NPL) + DY * (Y(I)-HOLD(11,NPL))
1423        CALL LNPLOT (WX, WY, 1, 1, NLM-IST+1)
```

```
1424        IF(NLM.GE.N) RETURN
1425        GO TO 14
1426  C
1427        ENTRY PLOTBAR (NPL, XL, YB, XR, YT, N, VALUE)
1428  C
1429        IF (N.LE.0) RETURN
1430        IF(NPL.GT.NPLTMX.OR.NPL.LT.1) STOP 72
1431        IF(.NOT.PLOTON(NPL)) RETURN
1432        DX = (HOLD(4,NPL)-HOLD(3,NPL)) / (HOLD(6,NPL)-HOLD(5,NPL))
1433        DY = (HOLD(10,NPL)-HOLD(9,NPL)) / (HOLD(12,NPL)-HOLD(11,NPL))
1434        NLM = 1
1435     20 IST = NLM
1436        NLM = MIN(NLM-1+NLINES,N)
1437        CALL LINWID(1)
1438        DO 21 I = IST, NLM
1439        X1 =     HOLD(3,NPL) + DX * (XR(I)-HOLD(5,NPL))
1440        X0 =     HOLD(3,NPL) + DX * (XL(I)-HOLD(5,NPL))
1441        Y1 =     HOLD(9,NPL) + DY * (YT(I)-HOLD(11,NPL))
1442        Y0 =     HOLD(9,NPL) + DY * (YB(I)-HOLD(11,NPL))
1443        WX(1) = X0
1444        WX(2) = X0
1445        WX(3) = X1
1446        WX(4) = X1
1447        WY(1) = Y0
1448        WY(2) = Y1
1449        WY(3) = Y1
1450        WY(4) = Y0
1451        CALL PLYGON(WX, WY, 4)
1452        TX = X1 - X0
1453        TY = HOLD(10,NPL) - HOLD(9,NPL)
1454        IDIGIT = 0
1455        IF (ABS(VALUE).LT.10.) IDIGIT = 1
1456        NDIG = 3
1457        IF(ABS(VALUE).GE.1000.) NDIG = 4
1458        YOFF = Y1 - .02 * TY
1459        IF (VALUE.LT.0.0) YOFF = Y0 - 0.15 * TY
1460        FAC = 1. / FLOAT(NDIG)
1461        XST = FAC * .95
1462        IF(VALUE.NE.0.0) CALL FNUMBR(X0+0.01*TX,YOFF, ; -.025->+.01
1463       . FAC*TX,0.0,XST*TX,0.0,0.12*TY,ABS(VALUE),NDIG,IDIGIT)
1464     21 CONTINUE
1465        CALL LINWID(3)
1466        IF(NLM.GE.N) RETURN
1467        GO TO 20
1468  C
1469        ENTRY GRISET (XL, YB, XR, YT)
1470  C
1471        CALL DEFINE (XL, YB, XR, YT)
1472        RETURN
1473  C
1474        ENTRY GRILAB (NPL, XLL, YBT, XRT, YTT)
1475        DX = (XRT-XLL) / 3.
1476        DY = (YTT-YBT) / 3.
1477        XINT1 = 10.**(INT(ALOG10(DX)))
1478        YINT1 = 10.**(INT(ALOG10(DY)))
```

```
      XINT2 = DX / XINT1
      YINT2 = DY / YINT1
      IF(XINT2.LT.2.0) THEN
        DX = XINT1
      ELSE IF (XINT2.LT.5.0) THEN
        DX = 2.*XINT1
      ELSE IF (XINT2.LT.10.) THEN
        DX = 5.*XINT1
      ELSE
        DX = 10.*XINT1
      ENDIF
      IF(YINT2.LT.2.0) THEN
        DY = YINT1
      ELSE IF (YINT2.LT.5.0) THEN
        DY = 2.*YINT1
      ELSE IF (YINT2.LT.10.) THEN
        DY = 5.*YINT1
      ELSE
        DY = 10.*YINT1
      ENDIF
      XINT2 = XLL / DX
      YINT2 = YBT / DY
      IF(XINT2.LT.0.0) XINT2 = XINT2 - 0.99999
      IF(YINT2.LT.0.0) YINT2 = YINT2 - 0.99999
      XMINO(NPL) = DX * (INT(ABS(XINT2))*SIGN(1.,XINT2))
      YMINO(NPL) = DY * (INT(ABS(YINT2))*SIGN(1.,YINT2))
      XINT2 = XRT / DX
      YINT2 = YTT / DY
      IF(XINT2.GT.0.0) XINT2 = XINT2 + 0.99999
      IF(YINT2.GT.0.0) YINT2 = YINT2 + 0.99999
      XMAXO(NPL) = DX * (INT(ABS(XINT2))*SIGN(1.,XINT2))
      YMAXO(NPL) = DY * (INT(ABS(YINT2))*SIGN(1.,YINT2))
      NTICX(NPL) = (XMAXO(NPL)-XMINO(NPL)+0.5) / DX
      NTICY(NPL) = (YMAXO(NPL)-YMINO(NPL)+0.5) / DY
      LLABPL(NPL) = .TRUE.
      RETURN
      END
```

```
      SUBROUTINE HHDRAW (XCHAR, YCHAR, SX,SXY,SY, CHNUMB, SET, IERR)
C
C      XCHAR  REAL    - X STARTING COORDINATE OF THE CHARACTER TO BE
C                       DRAWN
C      YCHAR  REAL    - Y STARTING COORDINATE OF THE CHARACTER TO BE
C                       DRAWN
C      SX     REAL    - X MATH SPACE SIZE FOR CHARACTERS
C      SXY    REAL    - SLANT MODIFIER FOR CHARACTERS
C      SY     REAL    - Y MATH SPACE SIZE FOR CHARACTERS
C      CHNUMB INTEGER - INDEXX TO IDENTIFY CHARACTERS WITHIN THE SPECI-
C                       FIED SET
C      SET    INTEGER - NUMBER SPECIFYING A PARTICULAR CHARACTER SET
C
C
          REAL        XCHAR,YCHAR,SX,SXY,SY,X(128),Y(128)
          INTEGER    M, CHNUMB,SET,PEN(128),ERROR,IERR
          CHARACTER*1 CHRIRV
          COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
          COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
C
C
          IERR = 1
          IF (SET.GT.1) GO TO 3
          IF (SET.LT.1) RETURN
C
          IRV = IREVCH(CHNUMB, CHRIRV)
          CALL SYMBOL(XCHAR+CHSIZE(7),YCHAR+CHSIZE(8),CHRIRV)
          RETURN
C
    3     CALL HSETS (CHNUMB,X,Y,PEN,N,SET-1,ERROR)
          IF(ERROR.NE.0) RETURN
          IERR = 0
C
          M = N
          IF (M.EQ.0) RETURN
C
C     ROTATE COORDINATES IF ANGLE>0.0
C
          SXP = ABS(XYCOOD(1))
          SYP = ABS(XYCOOD(3))
          OSXP = 1. / SXP
          OSYP = 1. / SYP
          SXP = SXP * SX
          SYP = SYP * SY
          DO 9 I = 1, M
          X(I) = X(I) * 0.216 * SXP
    9     Y(I) = Y(I) * 0.0800 * SYP + X(I) * SXY
          IF (ANGLE.EQ.0.0) GO TO 4
          SINX = SIN(ANGLE)
          COSX = COS(ANGLE)
          DO 6 I = 1, M
          XP = X(I)*COSX - Y(I)*SINX
          YP = X(I)*SINX + Y(I)*COSX
          X(I) = XP
    6     Y(I) = YP
```

```
1571      4     DO 1 I = 1, M
1572            X(I) = X(I) * OSXP
1573      1     Y(I) = Y(I) * OSYP
1574  C
1575  C     ADD THE ABSOLUTE POSITION
1576  C
1577            DO 7 I = 1, M
1578            X(I) = X(I) + XCHAR
1579      7     Y(I) = Y(I) + YCHAR
1580  C
1581  C     WRITE THE CHARACTER AS A SET OF CONNECTED STROKES
1582  C
1583            IS = 1
1584            IL = IS
1585     10     IF(PEN(IL+1).EQ.0.OR.IL.GE.M) GO TO 2
1586            IL = IL + 1
1587            GO TO 10
1588      2     IF(IL.GT.IS) CALL LINES(X(IS),Y(IS),X(IS+1),Y(IS+1),IL-IS)
1589            IF(IL.GE.M) RETURN
1590            IL = IL + 1
1591            IS = IL
1592            GO TO 10
1593            RETURN
1594          END
```

```
1595        SUBROUTINE HSETS (CHNUMB,XX,YY,PEN,N,SET,ERROR)
1596  C
1597  C*************************************************************************
1598  C    HSETS
1599  C*************************************************************************
1600  C
1601  C THIS SUBROUTINE RECEIVES A SET NUMBER AND A CHARACTER NUMBER
1602  C AND SEARCHES THROUGH 'HSETS.DAT' (FILE CONTAINING THE PACKED
1603  C HERSHEY CHARACTER SUBSETS) TO FIND THE CHARACTER'S COORDINATES
1604  C AND CORRESPONDING 'PEN' VALUES.
1605  C
1606        PARAMETER(MAXSET=23,MAX1=24)
1607        LOGICAL FOPEN/.FALSE./
1608        INTEGER IN(125,96),IOS,CHAR,SET,COORD,ERROR
1609        INTEGER  CHNUMB,PEN(125),MASK1,MASK2,TABLE(MAX1)
1610        INTEGER FIRST,LAST,NCHAR(MAXSET),TT(64),IOB(64),IOBC
1611        EQUIVALENCE (TT(1),TABLE(1)),(TT(33),NCHAR(1))
1612        DATA MASK2/ZFFFF/,MASK1/Z7FFFFFFF/,NSET/-1/
1613        REAL  XX(125),YY(125)
1614        COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
1615  C
1616  C OPEN FILE CONTAINING PACKED HERSHEY CHARACTER SETS IF NOT
1617  C PREVIOUSLY OPENED
1618  C
1619            IF(SET.EQ.NSET.AND.FOPEN) GO TO 41
1620            CLOSE(LUHSET)
1621  C
1622  C  OPEN A NEW FILE FOR THE PACKED HERSHEY CHARACTER SUBSETS
1623  C
1624            OPEN(UNIT=LUHSET,IOSTAT=IOS,ERR=50,FILE='SYS:H1.CAT/S',
1625       *    ACCESS='DIRECT',FORM='BINARY',RECL=256,SIZE=730,
1626       *    BLOCKSIZE=256,TYPE='CONTIG')
1627            REWIND LUHSET
1628            FOPEN=.TRUE.
1629            IF(LUDIAG.NE.0) WRITE(LUDIAG,20) LUHSET
1630  20        FORMAT(' HSET CHARACTER FILE OPENED TO UNIT =',I3)
1631  C
1632  C     READ STARTING RECORD POSITIONS OF THE SETS INTO 'TABLE'
1633  C     READ THE NUMBER OF CHARACTERS IN EACH SET INTO 'NCHAR'
1634  C
1635            READ(LUHSET) TT
1636  C
1637  C CHECK THAT THE SET AND CHARACTER NUMBERS ARE VALID
1638  C
1639            ERROR=0
1640            IF(SET.GT.MAXSET) THEN      ;SET NOT IN FILE
1641                ERROR=1
1642                GO TO 52
1643            ENDIF
1644            IF(CHNUMB.GT.NCHAR(SET)) THEN    ,CHARACTER NOT IN SET
1645                ERROR=2
1646                GO TO 52
1647            ENDIF
1648  C
1649  C READ THE CHARACTERS' COORDINATES INTO THE 'IN' ARRAY
```

```
1650  C
1651            NSET = SET
1652            FIRST=TABLE(SET)   ;FIRST RECORD OF SET
1653            LAST=TABLE(SET+1) - 1    ;LAST RECORD OF SET
1654            CHAR=1
1655            COORD=0
1656            DO 30 I=FIRST,LAST
1657            READ(LUHSET,REC=I) IOB
1658  C
1659  C   STORE DATA IN ARRAY ELEMENTS FOR 1 CHARACTER AT A TIME
1660  C
1661            J=0
1662  32        J=J+1
1663            COORD=COORD+1
1664            IN(COORD,CHAR)=IOB(J)
1665            IF((IOB(J).NE.MASK1).AND.(J.LT.64)) GO TO 32
1666  C
1667  C   END OF CHARACTER FOUND; READ COORDINATES FOR NEXT CHARACTER
1668  C
1669            IF(IOB(J).EQ.MASK1) THEN
1670                CHAR=CHAR+1
1671                COORD=0
1672            IF(CHAR.GT.NCHAR(SET)) GO TO 31
1673            ENDIF
1674            IF(J.LT.64) GO TO 32
1675  30        CONTINUE   ;READ NEXT RECORD
1676  31        CLOSE(LUHSET)
1677  C
1678  C UNPACK THE DATA FOR THE SPECIFIED CHARACTER & DETERMINE THE REAL
1679  C VALUES OF THE COORDINATES AND THE INTEGER VALUE OF THE PEN.
1680  C
1681  41    N=0
1682  40    IF(IN(N+1,CHNUMB).EQ.MASK1) RETURN    ;END OF CHARACTER
1683        N=N+1
1684  C
1685  C   FIND THE 'PEN' VALUE & ELIMINATE 'PEN' BIT FROM PACKED WORD
1686  C
1687        PEN(N)=ISHFT(IN(N,CHNUMB),-31)
1688        IOBC=IAND(IN(N,CHNUMB),MASK1)
1689  C
1690  C   FIND THE X & Y COORDINATES
1691  C
1692        XX(N)=(ISHFT(IOBC,-16))/100.00
1693        YY(N)=(IAND(IN(N,CHNUMB),MASK2))/100.0
1694        GO TO 40     ;UNPACK NEXT COORDINATE AND PEN VALUE
1695  C
1696  C ERROR
1697  C
1698  50    ERROR = IOS
1699        IF(LUDIAG.NE.0) WRITE(LUDIAG,51) IOS
1700  51    FORMAT(' ERROR IN HSET - UNABLE TO OPEN CHARACTER FILE, ERROR =',
1701       . I4)
1702  52    CLOSE(LUHSET)
1703        RETURN
1704        END
```

```
1705              INTEGER FUNCTION IDCHAR (CHARX)
1706  C
1707  C*************************************************************************
1708  C     IDHCAR
1709  C*************************************************************************
1710  C
1711              LOGICAL ZEROP/.TRUE./
1712              INTEGER  IDN(128), CHAR, KA, MASK/127/
1713              CHARACTER*1 CHARX, CHARXX(4), JA(4), CHRIRV
1714              CHARACTER*8  ASCII(16)
1715              CHARACTER*1  ASCIII(128)
1716              EQUIVALENCE (CHAR,CHARXX)
1717              EQUIVALENCE (JA,KA), (ASCII,ASCIII)
1718              DATA ASCII/'01234567','89ABCDEF','GHIJKLMN','OPQRSTUV',
1719             .    'WXYZabcd','efghijkl','mnopqrst','uvwxyz %',
1720             .    '&@$#.,:;','!?-+=*/(',')[]§†¶"<','>°'' _.-',
1721             .    4*'         '/
1722  C
1723  C     THIS ROUTINE INITIALIZES THE IDENTITY ARRAY ID TO THE IDENTITY
1724  C     NUMBER OF THE ACCEPTED ASCII TERMINAL CHARACTERS.
1725  C
1726              IF(ZEROP) THEN
1727              DO 2 I = 1, 128
1728          2   IDN(I) = 127
1729              DO 1 I = 1, 128
1730              JA(4) = ASCIII(I)
1731              KA = IAND(KA, MASK)
1732          1   IF(IDN(KA+1).EQ.127) IDN(KA+1) = I
1733              ZEROP = .FALSE.
1734              ENDIF
1735  C
1736  C         THIS INTEGER FUNCTION RETURNS THE IDENTITY NUMBER OF THE ONE
1737  C     BYTE CHARACTER ENTERED THROUGH THE ARGUMENT LIST AS A CHARACTER*1
1738  C     VARIABLE.
1739  C
1740              CHARXX(4) = CHARX
1741              CHAR = IAND(CHAR, MASK)
1742              IDCHAR = IDN(CHAR+1)
1743              RETURN
1744  C
1745  C     THIS ENTRY REVERSES THE CHARACTER PROCESS - USED BY HHDRAW WHEN
1746  C     CALLING SYMBOL. CHANGES THE NUMBER BACK INTO A CHARACTER
1747  C
1748              ENTRY IREVCH (ICHR, CHRIRV)
1749              IREVCH = 0
1750              IF(ICHR.GE.1.AND.ICHR.LE.128) CHRIRV = ASCIII(ICHR)
1751              RETURN
1752              END
```

```
 1753            SUBROUTINE LABEL (CHARS, XL, YB, XR, YT, ANGLE)
 1754            COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
 1755            COMMON/GRFTYP/XNGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
 1756            CHARACTER*1 CHARS(*)
 1757            CALL WDCOUNT(CHARS, NC)
 1758            IF(NC.LE.0) THEN
 1759              IF(LUDIAG.GT.0) WRITE(LUDIAG,3) (CHARS(I),I=1,132)
 1760       3      FORMAT(' NO ESCAPE SEQUENCE IN LABEL -',/,1X,132A1)
 1761              RETURN
 1762            ENDIF
 1763            DX = (XR - XL) / MAX(1.,FLOAT(NC))
 1764            DY = (YT - YB)
 1765            XNGLE = ANGLE
 1766            CALL WDDRAW (XL, YB, DX, 0.0, DX, 0.0, DY, CHARS)
 1767            RETURN
 1768            END
```

```
1769            SUBROUTINE LINE (X1, Y1, X2, Y2)
1770  C
1771  C*************************************************************************
1772  C     LINE
1773  C*************************************************************************
1774  C
1775            COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
1776  C
1777  C     THIS ROUTINE PLOTS A LINE FROM (X1,Y1) TO (X2,Y2).
1778  C     THE PRESENT ALGORITHM ALWAYS PLOTS FROM THE CURRENT LOCATION TO
1779  C     THE TARGET POINT THUS INSURING PERFECT LINE CONTINUITY.
1780  C
1781  C
1782            REAL IX1, IX2, IY1, IY2, IDX, IDY
1783  C
1784            IX1 = XYCOOD(1)*X1 + XYCOOD(2)
1785            IX2 = XYCOOD(1)*X2 + XYCOOD(2)
1786            IY1 = XYCOOD(3)*Y1 + XYCOOD(4)
1787            IY2 = XYCOOD(3)*Y2 + XYCOOD(4)
1788            IDX =IX2 - IX1
1789            IDY = IY2 - IY1
1790            CALL PUTLNV (IX1,IY1,IDX,IDY,1)
1791            RETURN
1792            END
```

```
1793            SUBROUTINE LINES(X1,Y1,X2,Y2,NL)
1794  C
1795  C       THIS SUBROUTINE PLOTS LINES FROM (X1(J),Y1(J)) TO (X2(J),Y2(J))
1796  C       WHILE CONVERTING TO RASTER NUMBERS THROUGH SCALE.
1797  C
1798  C*************************************************************************
1799  C     LINES
1800  C*************************************************************************
1801  C
1802            PARAMETER (NLINES=200)
1803            COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
1804            COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
1805            REAL X1(NL),X2(NL),Y1(NL),Y2(NL)
1806            REAL IX1(NLINES), IY1(NLINES), IDX(NLINES), IDY(NLINES)
1807  C
1808  C
1809            NLM = NL
1810            I2 = 1
1811       5    I1 = I2
1812            I2 = MIN0(I2-1+NLINES,NL)
1813            NLMIN = I2 - I1 + 1
1814            DO 10 I = I1, I2
1815            IX1(I-I1+1)=XYCOOD(1)*X1(I)+XYCOOD(2)
1816            IDX(I-I1+1)=XYCOOD(1)*X2(I)+XYCOOD(2)-IX1(I-I1+1)
1817            IY1(I-I1+1)=XYCOOD(3)*Y1(I)+XYCOOD(4)
1818      10    IDY(I-I1+1)=XYCOOD(3)*Y2(I)+XYCOOD(4)-IY1(I-I1+1)
1819  C
1820            CALL PUTLNV(IX1,IY1,IDX,IDY,NLMIN)
1821            IF (I2.GE.NL) RETURN
1822            GO TO 5
1823            RETURN
1824            END
```

```
1825            SUBROUTINE LNPLOT (XARRAY, YARRAY, I1, I2, I3)
1826  C
1827            PARAMETER (NLINES=200)
1828            REAL       XARRAY(1), YARRAY(1)
1829            REAL XA(NLINES),YA(NLINES),XB(NLINES),YB(NLINES)
1830            INTEGER    I1, I2, I3, IST, I, NOPTS, NOPT
1831  C
1832            NOPTS=(I3-I1+I2)/I2-1
1833            IST=I1
1834       2    NOPT=NOPTS
1835            NOPT = MINO (NLINES,NOPT)
1836            DO 1 I=1,NOPT
1837            XA(I)=XARRAY(IST+I2*I-I2)
1838            YA(I)=YARRAY(IST+I2*I-I2)
1839            XB(I)=XARRAY(IST+I2*I)
1840            YB(I)=YARRAY(IST+I2*I)
1841       1    CONTINUE
1842            CALL LINES(XA,YA,XB,YB,NOPT)
1843            NOPTS=NOPTS-NOPT
1844            IST=IST+I2*NOPT
1845            IF(NOPTS.GT.0) GO TO 2
1846            RETURN
1847          END
```

```
1852        SUBROUTINE MAPIN (MAPFIL,
1853       . WIN, XYZ, NV, NE, NES, NEX, NP, NPS, NPX)
1854  C
1855        PARAMETER (NVM=4000,NEM=400,NPM=400)
1856        CHARACTER*16 MAPFIL
1857        REAL XYZ(3,NV), WIN(4)
1858        INTEGER  NP(8,NPM), NPS(4,NPM),  NE(2,NEM), NES(4,NEM)
1859        LOGICAL FIRSTC/.TRUE./
1860  C
1861  C     INITIALIZE THE COUNTERS THE FIRST TIME THRU THIS ROUTINE
1862  C
1863        IF(FIRSTC) THEN
1864          NV = 0
1865          NEX = 0
1866          NPX = 0
1867          FIRSTC = .FALSE.
1868        ENDIF
1869  C
1870  C     OPEN AND INPUT A STRUCTURES FILE
1871  C
1872        NV1 = NVM
1873        NE1 = NEM
1874        NP1 = NPM
1875        CALL PLYPLT (MAPFIL,0)
1876        CALL PLYGNS(WIN, XYZ(1,NV+1), NV1, NE(1,NEX+1), NES(1,NEX+1),
1877       . NE1, NP(1,NPX+1), NPS(1,NPX+1), NP1)
1878        IF(NV1.LE.0) RETURN
1879  C
1880  C     UPDATE THE EDGE AND POLYGON POINTERS
1881  C
1882        DO 132 I = NEX+1, NEX+1+NE1
1883        DO 132 J = 1, 2
1884    132 NE(J,I) = NE(J,I) + NV
1885        DO 133 I = NPX+1, NPX+1+NP1
1886        DO 133 J = 1, 8
1887        IF(NP(J,I).GT.0) NP(J,I) = NP(J,I) + NV
1888    133 CONTINUE
1889        NV = NV + NV1
1890        NEX = NEX + NE1
1891        NPX = NPX + NP1
1892        RETURN
1893        END
```

```
1894        SUBROUTINE MAPOUT(WIN, XYZ, NV, NE, NES, NEX, NP, NPS, NPX)
1895  C
1896  $INCLUDE BUILD.COM (NLIST)
1897        REAL XYZ(3,NV), WIN(4)
1898        INTEGER  NP(NPVERT,NPX), NPS(NSPEC,NPX), NE(2,NEX), NES(NSPEC,NEX)
1899  C
1900        CALL DEFINE(WIN(1),WIN(2),WIN(3),WIN(4))
1901        CALL PLYPL4(NE,NEX,XYZ,WIN,NES)
1902        CALL PLYPL5(NP,NPX,XYZ,WIN,NPS,NPVERT)
1903        CALL FRAME
1904        RETURN
1905        END
```

```
1906            SUBROUTINE PLYGON(X, Y, N)
1907  C
1908  C     DRAW A COMPLETE POLYGON AND FILL IT WITH 'LFLMAT'
1909  C
1910            PARAMETER (NPMAX=32)
1911            COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
1912            COMMON/GRFMOD/LFLMAT(5),LINWDM(5),LCLMAT(5)
1913            DIMENSION X(N), Y(N), XL(2*NPMAX)
1914  C
1915            IF(IDEVIC.EQ.0) RETURN
1916            NL = MINO(NPMAX, N)
1917            GO TO (1,1,3,1,1), IDEVIC
1918       1    DO 11 I = 1, N-1
1919      11    CALL LINE(X(I), Y(I), X(I+1), Y(I+1))
1920            CALL LINE(X(N), Y(N), X(1), Y(1))
1921            RETURN
1922       3    DO 31 I = 1, NL
1923            XL(2*I-1) = MAX(X(I) * XYCOOD(1) + XYCOOD(2), 0.0)
1924      31    XL(2*I) = MAX(Y(I) * XYCOOD(3) + XYCOOD(4), 0.0)
1925            CALL GMOVA(XL(1), XL(2))
1926            CALL GPOLA (XL(3), NL-1)
1927            RETURN
1928            END
```

```
1929          SUBROUTINE PLYPL1(CHOOSE,ENDSTR,SSTART,SFIRST,SLAST,SVALID,
1930         1IBLANK)
1931    C
1932    C     THIS ROUTINE FINDS POSITIONS OF SUBSTRINGS WITHIN A CHARACTER
1933    C   STRING.  COMMAS AND SPACES ARE SUBSTRING DELIMITERS.  WHEN
1934    C   A VALID SUBSTRING IS FOUND, ITS FIRST AND LAST CHARACTER
1935    C   POSITIONS ARE RETURNED TO THE CALLING ROUTINE.
1936    C     THIS ROUTINE ALSO INCLUDES THE OPTION OF CONSIDERING A GROUP
1937    C   OF BLANKS SET OF BY COMMAS TO BE A VALID SUBSTRING.  IF SUCH
1938    C   A SUBSTRING IS FOUND, THE POSITIONS OF THE FIRST AND LAST
1939    C   BLANKS ARE NOT RETURNED, BUT RATHER THE POSITIONS OF THE
1940    C   DELIMITERS (COMMAS).
1941    C
1942    C   VARIABLES USED:
1943    C    CFIND  = POSITION OF 1ST COMMA FOUND (IF 'BLANK' OPTION SET)
1944    C    CHOOSE = INTEGER CONTAINING CHARACTER STRING
1945    C    ENDSTR = NUMBER OF CHARACTERS IN THE ENTIRE STRING
1946    C    IBLANK = 'BLANK' FLAG
1947    C       (input) = 0 - BLANKS NOT VALID SUBSTRING
1948    C       (input) = 1 - BLANKS FOLLOWED BY 1 COMMA - VALID SUBSTRING
1949    C       (input) = 2 - BLANKS FOLLOWED BY 2 COMMAS - VALID SUBSTRING
1950    C       (output)= -1,-2 - SPECIFIED BLANKS (1 OR 2) FOUND
1951    C    SFIRST  = POSITION OF FIRST CHARACTER OF SUBSTRING
1952    C    SLAST   = POSITION OF LAST CHARACTER OF SUBSTRING
1953    C    SSTART  = STARTING POSITION FOR SUBSTRING SEARCH
1954    C    STRING  = CHARACTER ARRAY CONTAINING THE CHARACTER STRING
1955    C    SVALID  = 'VALID SUBSTRING' FLAG
1956    C                = TRUE - VALID SUBSTRING FOUND
1957    C                = FALSE - NO VALID SUBSTRING FOUND
1958    C
1959          LOGICAL SVALID
1960          INTEGER SFIRST,SLAST,SSTART,ENDSTR
1961          INTEGER IBLANK,CFIND,CHOOSE(20),STR(20)
1962          CHARACTER*1 STRING(80),SPACE/' '/,CR/ZD/,COMMA/Z2C/
1963          EQUIVALENCE (STR,STRING)
1964    C
1965    C     ASSUME VALID SUBSTRING
1966    C
1967          SVALID=.TRUE.
1968    C
1969    C     FORM AN EQUIVALENT CHARACTER STRING
1970    C
1971          DO 10 I=1,20
1972    10    STR(I)=CHOOSE(I)
1973    C
1974    C     INVALID STARTING POSITION - PAST END OF STRING
1975    C
1976          IF(ENDSTR.LT.SSTART) GO TO 40
1977    C
1978    C     FIND POSITION OF FIRST ELEMENT OF SUBSTRING
1979    C
1980          CFIND=0
1981          DO 20 I=SSTART,ENDSTR
1982          SFIRST=I
1983    C
```

```
1984  C     A COMMA FOUND
1985  C
1986        IF (IBLANK.NE.0.AND.STRING(I).EQ.COMMA) THEN
1987  C
1988  C        FOUND FIRST COMMA
1989  C
1990           IF (CFIND.EQ.0) THEN
1991              CFIND=I
1992              IF (IBLANK.EQ.2) GO TO 20
1993           ENDIF
1994  C
1995  C        FOUND BLANK SUBSTRING; NOTE POSITIONS OF DELIMITERS (COMMAS)
1996  C
1997           SLAST=SFIRST
1998           SFIRST=CFIND
1999           IBLANK=-IBLANK
2000           GO TO 100
2001        ENDIF
2002  C
2003  C     FOUND FIRST CHARACTER OF SUBSTRING - NOW FIND LAST
2004  C
2005        IF((STRING(I).NE.SPACE).AND.(STRING(I).NE.CR).AND.
2006       1 (STRING(I).NE.COMMA)) GO TO 60
2007  20    CONTINUE
2008  C
2009  C     NO SUBSTRING FOUND - ONLY DELIMITER
2010  C
2011        WRITE(6,998)
2012  998   FORMAT(' REACHED THE END WITHOUT FINDING A NON-BLANK CHARACTER')
2013        GO TO 40
2014  C
2015  C     FIND POSITION OF LAST CHARACTER OF SUBSTRING
2016  C
2017  60    IF (SFIRST.EQ.ENDSTR) GO TO 45
2018        DO 50 J=SFIRST+1,ENDSTR
2019        SLAST=J-1
2020  C
2021  C     FOUND SUBSTRING DELIMITER - CAN RETURN NOW
2022  C
2023        IF((STRING(J).EQ.SPACE).OR.(STRING(J).EQ.COMMA)) GO TO 100
2024  50    CONTINUE
2025  C
2026  C     NO SUBSTRING DELIMITER => LAST CHARACTER OF SUBSTRING IS THE
2027  C     LAST CHARACTER OF THE STRING
2028  C
2029  45    SLAST=ENDSTR
2030        GO TO 100
2031  C
2032  C  NO SUBSTRING FOUND
2033  C
2034  40    SVALID=.FALSE.
2035  100   RETURN
2036        END
```

```
2037        SUBROUTINE PLYPL2(WINDOW,OPENN,WORLD)
2038  C
2039  C  READ WINDOW COORDINATES AND STORE THEM IN 'WINDOW' ARRAY.  ALSO
2040  C  CHECK VALIDITY OF COORDINATES.  IF VALID, 'OPENN' IS TRUE;
2041  C  OTHERWISE, 'OPENN' IS FALSE. WINDOW COORDINATES WILL BE STORED
2042  C  AS FOLLOWS:
2043  C                       INDEX / WINDOW(INDEX)
2044  C                       -----   -------------
2045  C                         1          left
2046  C                         2          bottom
2047  C                         3          right
2048  C                         4          top
2049  C
2050        LOGICAL OPENN
2051        REAL WINDOW(4),WORLD(6)
2052  C
2053  C     INITIALIZE
2054  C
2055        OPENN=.FALSE.   ;ASSUME INVALID COORDINATES
2056  C
2057  C  CHECK VALIDITY OF WINDOW COORDINATES
2058  C
2059        DO 30 I=1,2
2060        IF(WINDOW(I).GE.WINDOW(I+2)) RETURN    ;INVALID COORDINATES
2061  30    CONTINUE
2062  C
2063  C  WINDOW COORDINATES VALID
2064  C
2065        OPENN=.TRUE.
2066        RETURN
2067        END
```

```
2068        SUBROUTINE PLYPL3(ARRAY,NARRAY,SP,NPNT,NVERT)
2069  C
2070  C  THIS SUBROUTINE PLOTS VERTICES FOUND WITHIN THE WINDOW AND THEIR
2071  C  CORRESPONDING LINE NUMBERS.
2072  C
2073        INTEGER CHARAC/'.    '/,NARRAY,CHR,NPNT(NVERT),DIGITS
2074        REAL ARRAY(3,NARRAY),SP(4),NUM,NUMBR,SSP(4)
2075        REAL NX,NY,XINC,XSTART
2076        COMMON/PLSCMR/DOZ,WCX,WCY,FANGLE,TANAL
2077        COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
2078  C
2079  C  DEFINE THE WINDOW SPACE
2080  C
2081        DO 1 I = 1, 4
2082  1     SSP(I) = XYCOOD(I)
2083        CALL DEFINE(SP(1),SP(2),SP(3),SP(4))
2084  C
2085  C  PLOT 1 VERTEX AND NUMBER AT A TIME
2086  C
2087        DO 20 I=1,NARRAY
2088  C
2089  C  DO NOT PLOT A 'DELETED' VERTEX
2090  C
2091        IF(NPNT(I).EQ.0) GO TO 20
2092  C
2093  C  ADD PERSPECTIVE
2094  C
2095        D = DOZ/((DOZ+ARRAY(3,I))*TANAL)
2096        XX = (ARRAY(1,I)-WCX)*D + WCX
2097        YY = (ARRAY(2,I)-WCY)*D + WCY
2098  C
2099  C  DO NOT PLOT A VERTEX WHICH IS OUTSIDE OF WINDOW
2100  C
2101        IF((XX.LT.SP(1)).OR.(XX.GT.SP(3))) GO TO 20
2102        IF((YY.LT.SP(2)).OR.(YY.GT.SP(4))) GO TO 20
2103  C
2104  C  PLOT THE VERTEX USING THE CHARACTER MODE OF THE HARDWARE
2105  C
2106        CALL SYMBOL(XX,YY,CHARAC)
2107  C
2108  C  SCALE MULTIPLIERS FOR NUMBERS
2109  C
2110        XINC=0.025*(SP(3)-SP(1))
2111        NX=0.035*(SP(3)-SP(1))
2112        NY=0.035*(SP(4)-SP(2))
2113        NUMBR=I
2114  C
2115  C  DETERMINE NUMBER OF DIGITS 'NUM' (THE VERTEX LINE NUMBER)
2116  C
2117        NUM=I
2118        DIGITS=0
2119  10    NUM=NUM/10.0
2120        DIGITS=DIGITS+1
2121        IF (NUM.GE.1) GO TO 10
2122  C
```

```
2123  C  CALCULATE X COORDINATE OF FIRST DIGIT OF THE NUMBER
2124  C
2125         IF (DIGITS.EQ.1) THEN
2126             XSTART=XX
2127         ELSE
2128             IF (MOD(DIGITS,2).EQ.0) THEN
2129                 XSTART=XX-(DIGITS*XINC)/4
2130             ELSE
2131                 XSTART=XX-(DIGITS*XINC)/2
2132             ENDIF
2133         ENDIF
2134  C
2135  C  PLOT THE NUMBER
2136  C
2137         CALL FNUMBR(XSTART,YY-NY,XINC,0.0,NX,0.0,
2138        * NY,NUMBR,DIGITS,0)      ;PRINT VERTEX NUMBER
2139  20     CONTINUE
2140  C
2141  C      RESTORE THE COORDINATE SYSTEM

2142  C
2143         DO 2 I = 1, 4
2144  2      XYCOOD(I) = SSP(I)
2145         RETURN
2146         END
```

```
2147        SUBROUTINE PLYPL4(ARRAY,NARRAY,VERTX,SP,SPEC)
2148  C
2149  C  THIS SUBROUTINE PLOTS EDGES WHICH ARE WITHIN THE WINDOW OR
2150  C  EDGE SEGMENTS WHICH CROSS A PORTION OF THE WINDOW.
2151  C
2152        LOGICAL VALID
2153        INTEGER ARRAY(2,NARRAY), SPEC(4,NARRAY)
2154        REAL VERTX(3,NARRAY),SP(4),SSP(4),U1,V1,U2,V2
2155        COMMON/PLSCMR/DOZ,WCX,WCY,FANGLE,TANAL
2156        COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
2157  C
2158  C  DEFINE THE WINDOW SPACE
2159  C
2160        DO 1 I = 1, 4
2161  1     SSP(I) = XYCOOD(I)
2162        CALL DEFINE(SP(1),SP(2),SP(3),SP(4))
2163  C
2164  C  PLOT ONE EDGE AT A TIME
2165  C
2166        LWD = -1
2167        LCL = -1
2168        DO 150 J=1,NARRAY
2169  C
2170  C  ADD PERSPECTIVE
2171  C
2172        D = DOZ/((DOZ+VERTX(3,ARRAY(1,J)))*TANAL)
2173        U1=(VERTX(1,ARRAY(1,J))-WCX)*D + WCX
2174        V1=(VERTX(2,ARRAY(1,J))-WCY)*D + WCY
2175        D = DOZ/((DOZ+VERTX(3,ARRAY(2,J)))*TANAL)
2176        U2=(VERTX(1,ARRAY(2,J))-WCX)*D + WCX
2177        V2=(VERTX(2,ARRAY(2,J))-WCY)*D + WCY
2178  C
2179  C  CLIP LEFT EDGE
2180  C
2181        IF (U1.GE.SP(1).AND.U2.GE.SP(1)) GO TO 50
2182        IF (U1.LT.SP(1).AND.U2.LT.SP(1)) GO TO 150
2183        IF (U1.GT.SP(1)) GO TO 40
2184        V1 = (V1-V2)*U1/(U2-U1)+V1
2185        U1 = SP(1)
2186        GO TO 50
2187  40    V2 = (V2-V1)*U2/(U1-U2)+V2
2188        U2 = SP(1)
2189  C
2190  C  CLIP RIGHT EDGE
2191  C
2192  50    IF (U1.LE.SP(3).AND.U2.LE.SP(3)) GO TO 70
2193        IF (U1.GT.SP(3).AND.U2.GT.SP(3)) GO TO 150
2194        IF (U1.GT.SP(3)) GO TO 60
2195        V2 = (V2-V1)*(SP(3)-U1)/(U2-U1)+V1
2196        U2 = SP(3)
2197        GO TO 70
2198  60    V1 = (V1-V2)*(SP(3)-U2)/(U1-U2)+V2
2199        U1 = SP(3)
2200  C
2201  C  CLIP BOTTOM EDGE
```

```
2202  C
2203  70    IF (V1.GE.SP(2).AND.V2.GE.SP(2)) GO TO 90
2204        IF (V1.LT.SP(2).AND.V2.LT.SP(2)) GO TO 150
2205        IF (V1.GT.SP(2)) GO TO 80
2206        U1 = (U1-U2)*V1/(V2-V1)+U1
2207        V1 = SP(2)
2208        GO TO 90
2209  80    U2 = (U2-U1)*V2/(V1-V2)+U2
2210        V2 = SP(2)
2211  C
2212  C  CLIP TOP EDGE
2213  C
2214  90    IF (V1.LE.SP(4).AND.V2.LE.SP(4)) GO TO 110
2215        IF (V1.GT.SP(4).AND.V2.GT.SP(4)) GO TO 150
2216        IF (V1.GT.SP(4)) GO TO 100
2217        U2 = (U2-U1)*(SP(4)-V1)/(V2-V1)+U1
2218        V2  = SP(4)
2219        GO TO 110
2220  100   U1 = (U1-U2)*(SP(4)-V2)/(V1-V2)+U2
2221        V1 = SP(4)
2222  C
2223  C  PLOT THE EDGE
2224  C
2225  110   IF(LWD.NE.SPEC(1,J)) THEN
2226          LWD = SPEC(1,J)
2227          CALL LINWID(LWD)
2228        ENDIF
2229        IF(LCL.NE.SPEC(2,J)) THEN
2230          LCL = SPEC(2,J)
2231          CALL COLOR(LCL)
2232        ENDIF
2233        CALL LINE(U1, V1, U2, V2)
2234  150    CONTINUE
2235  C
2236  C     RESTORE THE ORIGINAL COORDINATE SYSTEM
2237  C
2238        DO 2 I = 1, 4
2239  2     XYCOOD(I) = SSP(I)
2240        RETURN
2241        END
```

```
2242        SUBROUTINE PLYPL5(ARRAY,NARRAY,VERTX,SP,SPEC,NPVERT)
2243  C
2244  C  THIS SUBROUTINE GRAPHS POLYGONS WHICH ARE WITHIN THE WINDOW OR
2245  C  PARTS OF POLYGONS WHICH CROSS A PORTION OF THE WINDOW
2246  C
2247        PARAMETER(MAXLN=10)
2248        LOGICAL PASS1
2249        INTEGER ARRAY(NPVERT,NARRAY),NARRAY,FIRST,SECOND,NUM,S1
2250        INTEGER INVALD,VINDX,ENDPT,SPEC(4,NARRAY)
2251        REAL VERTX(3,NARRAY),SP(4),D,SSP(4)
2252        REAL X1,X2,Y1,Y2,X(MAXLN),Y(MAXLN)
2253        COMMON/PLSCMR/DOZ,WCX,WCY,FANGLE,TANAL
2254        COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
2255  C
2256  C  DEFINE WINDOW SPACE
2257  C
2258        DO 1 I = 1, 4
2259  1     SSP(I) = XYCOOD(I)
2260        CALL DEFINE(SP(1),SP(2),SP(3),SP(4))
2261  C
2262  C  PLOT POLYGONS ONE AT A TIME
2263  C
2264        LWD = -1
2265        NDX = -1
2266        LFL = -1
2267        DO 10 I = 1, NARRAY
2268        NUM=0
2269  C
2270  C     DETERMINE THE NUMBER OF VERTICES (NON-ZERO ENTRIES) IN THE
2271  C     POLYGON
2272  C
2273        DO 15 J=1,NPVERT
2274        IF(ARRAY(J,I).NE.0) NUM=NUM+1 ;NUMBER OF VERTICES IN POLYGON
2275  15    CONTINUE
2276  C
2277  C     FIND THE PERSPECTIVE
2278  C
2279        DO 60 IV=1,NUM
2280        D = DOZ/((DOZ+VERTX(3,ARRAY(IV,I)))*TANAL)
2281        X(IV) = (VERTX(1,ARRAY(IV,I)) - WCX)*D  +  WCX
2282        Y(IV) = (VERTX(2,ARRAY(IV,I)) - WCY)*D  +  WCY
2283  60    CONTINUE
2284  C
2285  C  PLOT THE POLYGON
2286  C
2287        IF(SPEC(1,I).NE.LWD) THEN
2288          LWD = SPEC(1,I)
2289          CALL LINWID(LWD)
2290        ENDIF
2291        IF(SPEC(2,I).NE.NDX) THEN
2292          NDX = SPEC(2,I)
2293          CALL COLOR(NDX)
2294        ENDIF
2295        IF(SPEC(3,I).NE.LFL) THEN
2296          LFL = SPEC(3,I)
```

```
2302           CALL LINES(X(1), Y(1), X(2), Y(2), NUM-1)
2303         ENDIF
2304   10    CONTINUE                        ;GET NEXT POLYGON
2305   C
2306   C     RESTORE THE COORDINATE SYSTEM
2307   C
2308         DO 2 I = 1, 4
2309   2     XYCOOD(I) = SSP(I)
2310         RETURN
2311         END
```

```
      SUBROUTINE PLYPLT(FILE,OPTION)
$INCLUDE BUILD.COM
      PARAMETER    (NPART=20)
      LOGICAL      EXIST, VALID
      INTEGER      NVERTO, NELMTO, NEDGEO, NPOLYO, FIRST, LAST, IOS
      INTEGER      EDGS(NSPEC,NEDGE), POLS(NSPEC,NPOLY), SELECT
      INTEGER      FNM(5), OPTION, EDG(2,NEDGE), POL(NPVERT,NPOLY)
      INTEGER      NPL(2,NPART), ISPEC(NSPEC), JP(NPVERT)
      REAL         WIN(4), VER(3,NVERT), SPACE(4)
      CHARACTER*5  SOURCE
      CHARACTER*17 FNAME, FILENM, OLDFIL, FILE
      CHARACTER*20 NOREC, BLANK
      DATA         VALID/.FALSE./, BLANK/' '/, LUNIT/9/, OLDFIL/' '/
      DATA         IUNIT/5/, ZERO/0/
      EQUIVALENCE  (FILENM,FNM)
      COMMON/PLSCMR/DOZ,WCX,WCY,FANGLE,TANAL
      COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
C*********************************************************************
C     DATA FILE
C*********************************************************************
C
C  CREATE EQUIVALENT CHARACTER STRING OF FILENAME
C
      FILENM = FILE
      IF(FILENM.EQ.OLDFIL) GO TO 1100
C
C  READ FILENAME
C
      CLOSE (LUNIT)
      CALL PLYPL1(FNM,17,1,FIRST,LAST,EXIST,0)
      IF(.NOT.EXIST) GO TO 90
      FNAME = BLANK
      DO 10 I = FIRST, LAST
      J = I - FIRST + 1
   10 FNAME(J:J) = FILENM(I:I)
C
C  FILE EXIST?
C
      INQUIRE(FILE=FNAME,IOSTAT=IOS,ERR=91,EXIST=EXIST)
      IF(.NOT.EXIST) GO TO 93
C
C  OPEN FILE
C
      OPEN(UNIT=LUNIT,IOSTAT=IOS,ERR=94,FILE=FNAME,STATUS='OLD')
      REWIND LUNIT
C
C  GET(1)    READ DATA INTO VARIABLES AND ARRAYS
C
      READ(LUNIT,FMT=1500,ERR=98) SOURCE,(WINDOW(I),I=1,4)
      IF(SOURCE.NE.'BUILD'.AND.SOURCE.NE.'MOVIE'.AND.SOURCE.NE.'FILNG')
     .  GO TO 98
      READ(LUNIT,FMT=1510,ERR=98) (WORLD(I),I=1,6)
      READ(LUNIT,FMT=1520,ERR=98) NPARTO,NVERTO,NELMTO,NEDGEO
      IF (NPARTO.LT.0) GO TO 98
      NPOLYO=NELMTO-NEDGEO
```

```
2367         READ(LUNIT,FMT=1520,ERR=98) ((NPL(I,J),I=1,2),J=1,NPARTO)
2368         IF(NVERTO.LE.0) GO TO 1090
2369         DO 1020 J=1,NVERTO
2370  1020   READ(LUNIT,FMT=1530,ERR=98) NPOINT(J),(VERTEX(I,J),I=1,3)
2371         IF (NELMTO.LE.0) GO TO 1090
2372  C
2373  C      INITIALIZE EDGE AND POLYGON COUNTERS
2374  C
2375        NE=0
2376        NP=0
2377        DO 1080 J=1,NELMTO
2378           READ(LUNIT,FMT=1525,ERR=98) (JP(I),I=1,NPVERT),(ISPEC(I),I=1,
2379       1   NSPEC)
2380  C
2381  C        COUNT NUMBER OF VERTICES IN ELEMENT
2382  C
2383           NCON=0
2384           DO 1030 I=1,NPVERT
2385           IF (JP(I).EQ.0) GO TO 1035
2386  1030     NCON=NCON+1
2387  C
2388  C        ELEMENT IS EDGE
2389  C
2390  1035     IF (NCON.EQ.2) THEN
2391              NE=NE+1
2392              DO 1040 I=1,2
2393  1040        EDGE(I,NE)=JP(I)
2394              DO 1050 I=1,NSPEC
2395  1050        ESPEC(I,NE)=ISPEC(I)
2396  C
2397  C        ELEMENT IS POLYGON
2398  C
2399           ELSE
2400              NP=NP+1
2401              DO 1060 I=1,NCON
2402  1060        POLY(I,NP)=JP(I)
2403              IF (NCON.LT.NPVERT) THEN
2404                 DO 1065 I=NCON+1,NPVERT
2405  1065           POLY(I,NP)=0
2406              ENDIF
2407              DO 1070 I=1,NSPEC
2408  1070        PSPEC(I,NP)=ISPEC(I)
2409           ENDIF
2410  1080  CONTINUE
2411  1090  CLOSE(LUNIT)
2412  C*********************************************************************
2413  C  DISPLAY
2414  C*********************************************************************
2415  C
2416  C **SPECIFY WINDOW**
2417  C
2418  1100  IF (NVERTO.NE.0) THEN
2419           CALL PLYPL2(WINDOW,VALID,WORLD)
2420        ELSE
2421            NOREC = 'NO RECORDS'
```

```
2422            IF(LUDIAG.GT.0) WRITE(LUDIAG,108) NOREC
2423            RETURN
2424         ENDIF
2425  C
2426  C  IF VALID WINDOW , SET 'SPACE' COORDINATES TO 'WINDOW' ,OTHERWISE
2427  C  SET THE 'SPACE' COORDINATES TO 'WORLD'
2428  C
2429         IF(VALID) THEN           ;VALID WINDOW
2430            DO 40 I=1,4
2431  40        SPACE(I)=WINDOW(I)
2432         ELSE
2433            IF(LUDIAG.GT.0) WRITE(LUDIAG,107)
2434            DO 41 I=1,2
2435  41        SPACE(I)=WORLD(I)
2436            DO 42 I=3,4
2437  42        SPACE(I)=WORLD(I+1)
2438         ENDIF
2439  C
2440  C  **FIND CENTER OF WINDOW**
2441  C
2442         WCX=(SPACE(3)+SPACE(1))/2
2443         WCY=(SPACE(4)+SPACE(2))/2
2444  C
2445  C  **INITIALIZE FIELD OF VIEW**
2446  C
2447         DOZ=10000.
2448         FANGLE=90.
2449         TANAL=1.0
2450  C
2451  C     INITIALIZE AND SET UP FOR A SINGLE GRAPH - 'NOREC', IF SET, WILL
2452  C     INDICATE THAT THERE ARE NO RECORDS TO BE DISPLAYED
2453  C
2454         NOREC=BLANK
2455  C
2456         IF (OPTION.EQ.0) THEN     ;NO PLOTS - READ IN DATA FILE ONLY
2457            RETURN
2458         ELSE IF (OPTION.EQ.1) THEN
2459            IF (NEDGEO.EQ.0) NOREC='NO EDGES'
2460         ELSE IF(OPTION.EQ.2) THEN
2461            IF (NVERTO.EQ.0) NOREC='NO VERTICES'
2462         ELSE IF (OPTION.EQ.3) THEN
2463            IF (NPOLYO.EQ.0) NOREC='NO POLYGONS'
2464         ELSE IF (OPTION.EQ.4) THEN
2465            IF (NEDGEO.EQ.0.AND.NPOLYO.EQ.0) NOREC='NO EDGES OR POLYGONS'
2466         ELSE
2467            NOREC='INVALID OPTION'
2468            IF(LUDIAG.GT.0) WRITE(LUDIAG,108) NOREC
2469            RETURN
2470         ENDIF
2471  C
2472  C  **PLOT**
2473  C
2474         IF (NOREC.EQ.BLANK) THEN
2475            IF (OPTION.EQ.1) THEN
2476               CALL PLYPL4(EDGE,NEDGEO,VERTEX,SPACE,ESPEC)
```

```
2477           ELSE IF (OPTION.EQ.2) THEN
2478              CALL PLYPL3(VERTEX,NVERTO,SPACE,NPOINT,NVERT)
2479           ELSE IF (OPTION.EQ.3) THEN
2480              CALL PLYPL5(POLY,NPOLYO,VERTEX,SPACE,PSPEC,NPVERT)
2481           ELSE IF (OPTION.EQ.4) THEN
2482               IF(NEDGEO.GT.0) CALL PLYPL4(EDGE,NEDGEO,VERTEX,SPACE,ESPEC)
2483               IF(NPOLYO.GT.0) CALL PLYPL5(POLY,NPOLYO,VERTEX,SPACE,PSPEC,
2484      .        NPVERT)
2485           ENDIF
2486        ELSE
2487           IF(LUDIAG.GT.0) WRITE(LUDIAG,108) NOREC
2488        ENDIF
2489        RETURN
2490  C*********************************************************************
2491  C   ENTRY PLYGNS
2492  C*********************************************************************
2493  C
2494  C     A ROUTINE TO RETURN THE COORDINATE ARRAY VALUES FROM A DATA FILE
2495  C
2496        ENTRY PLYGNS(WIN,VER,NVM,EDG,EDGS,NEM,POL,POLS,NPM)
2497        NVM = MIN(NVERT,NVM,NVERTO)
2498        DO 80 I = 1, 4
2499  80    WIN(I) = WINDOW(I)
2500        DO 81 I = 1, NVM
2501        DO 82 J = 1, 3
2502  82    VER(J,I) = VERTEX(J,I)
2503  81    CONTINUE
2504        NEM = MIN(NEDGE,NEM,NE)
2505        DO 88 I = 1, NEM
2506        DO 83 J = 1, 2
2507  83    EDG(J,I) = EDGE(J,I)
2508        DO 84 J = 1, NSPEC
2509  84    EDGS(J,I) = ESPEC(J,I)
2510  88    CONTINUE
2511        NPM = MIN(NPOLY,NPM,NP)
2512        DO 85 I = 1, NPM
2513        DO 86 J = 1, NPVERT
2514  86    POL(J,I) = POLY(J,I)
2515        DO 87 J = 1, NSPEC
2516  87    POLS(J,I) = PSPEC(J,I)
2517  85    CONTINUE
2518        RETURN
2519  C
2520  C  ERRORS
2521  C
2522  90    IF(LUDIAG.GT.0) WRITE(LUDIAG,100) FILE
2523        RETURN
2524  91    CLOSE(LUNIT)
2525        IF (IOS.EQ.349) THEN
2526           IF(LUDIAG.GT.0) WRITE(LUDIAG,100) FNAME
2527        ELSE IF (IOS.EQ.324) THEN
2528           IF(LUDIAG.GT.0) WRITE(LUDIAG,101)
2529        ELSE
2530           IF(LUDIAG.GT.0) WRITE(LUDIAG,102)  IOS
2531        ENDIF
```

```
2532          RETURN
2533    93    IF(LUDIAG.GT.0) WRITE(LUDIAG,103)
2534          RETURN
2535    94    CLOSE(UNIT=LUNIT,IOSTAT=IOS,ERR=95)
2536    95    IF(LUDIAG.GT.0)WRITE(LUDAIG,104) IOS
2537          RETURN
2538    98    IF(LUDIAG.GT.0) WRITE(LUDIAG,110)
2539          RETURN
2540    C
2541    C  FORMATS
2542    C
2543    100   FORMAT(' INVALID FILE DESCRIPTOR',2X,A17)
2544    101   FORMAT(' NO RECORDS IN FILE')
2545    102   FORMAT(' INQUIRE ERROR = ',I4)
2546    103   FORMAT(' FILE DOES NOT EXIST')
2547    104   FORMAT(' FILE ERROR',I4)
2548    107   FORMAT(' WINDOW DEFAULTS TO "WORLD"')
2549    108   FORMAT(1X,A20,/,/)
2550    110   FORMAT(' ERROR - DATA  FORMAT PROBLEMS -- ENTER NEW COMMAND')
2551    1500  FORMAT(A5,4E12.5)
2552    1510  FORMAT(6E12.5)
2553    1520  FORMAT(16I5)
2554    1525  FORMAT(8I5,5X,8I5)
2555    1530  FORMAT(I5,3E12.5)
2556          END
```

```
2557        SUBROUTINE PROPOL (NTRIA, XT1,YT1,FT1,XT2,YT2,FT2,XT3,YT3,FT3,
2558       1        FL, NX, NY)
2559  C
2560            PARAMETER (NPT=101)
2561            REAL     XT1(NTRIA), XT2(NTRIA), XT3(NTRIA)
2562            REAL     YT1(NTRIA), YT2(NTRIA), YT3(NTRIA)
2563            REAL     FT1(NTRIA), FT2(NTRIA), FT3(NTRIA)
2564            INTEGER  MASK(NPT)
2565            REAL     DIFF1(NPT), DIFF2(NPT), DIFF3(NPT)
2566            REAL     SGN1(NPT),  SGN2(NPT),  SGN3(NPT)
2567            REAL     DFL1(NPT),  DFL2(NPT),  DFL3(NPT)
2568            REAL     ALF1(NPT), ALF2(NPT), ALF3(NPT), X1(NPT), X2(NPT)
2569            REAL     X3(NPT), Y1(NPT), Y2(NPT), Y3(NPT), TEST(NPT)
2570            REAL     DELTA, MASK1, MASKS, RMASK(NPT)
2571            EQUIVALENCE (MASK(1), RMASK(1))
2572            DATA     MASK1, DELTA, MASKS / 1.0, 1.0E-20, Z80000000/
2573            DATA XMN1,YMN1,XMN2,YMN2,XMX1,YMX1,XMX2,YMX2/4*0.,4*100./
2574  C
2575  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2576  C
2577  C     PROPOL (NTRIA, XT1, YT1, FT1, XT2, YT2, FT2, XT3, YT3, FT3,
2578  C                 FL, NX, NY)
2579  C
2580  C     NTRIA  INTEGER              NUMBER OF TRIANGLES IN LIST          I
2581  C     XT1    REAL ARRAY(NTRIA)    X POSITIONS OF FIRST VERTICES        I
2582  C     YT1    REAL ARRAY(NTRIA)    Y POSITIONS OF FIRST VERTICES        I
2583  C     FT1    REAL ARRAY(NTRIA)    FUNCTION VALUES AT FIRST VERTICES    I
2584  C     XT2    REAL ARRAY(NTRIA)    X POSITIONS OF SECOND VERTICES       I
2585  C     YT2    REAL ARRAY(NTRIA)    Y POSITIONS OF SECOND VERTICES       I
2586  C     FT2    REAL ARRAY(NTRIA)    FUNCTION VALUES AT SECOND VERTICES   I
2587  C     XT3    REAL ARRAY(NTRIA)    X POSITIONS OF THIRD VERTICES        I
2588  C     YT3    REAL ARRAY(NTRIA)    Y POSITIONS OF THIRD VERTICES        I
2589  C     FT3    REAL ARRAY(NTRIA)    FUNCTION VALUES AT THIRD VERTICES    I
2590  C     FL     REAL                 VALUE OF F AT WHICH CONTOUR IS DRAWN I
2591  C     NX     INTEGER              MAXIMUM VALUE OF X POSITIONS         I
2592  C     NY     INTEGER              MAXIMUM VALUE OF Y POSITIONS         I
2593  C
2594  C      PROPOL ASSUMES A CONTOUR CROSSING LIES
2595  C     BETWEEN (XT1,YT1) AND (XT2,YT2). THE VERTICES MUST BE NUMBERED
2596  C     COUNTER-CLOCKWISE AROUND THE TRIANGLE. THE CODE IN PROPOL IS SPEC-
2597  C     IALIZED TO THE RECTANGULAR X-Y CASE BY THE TRANSFORMATION OF DO
2598  C     LOOP 145. PLOAR PLOTS CAN BE FORMED BY CHANGING THIS TRANSFORMA-
2599  C     TION.
2600  C
2601  C     ENTRY POINTS:  CNTSET, CNTFRM (SEE DOCUMENTATION OR LISTING BELOW)
2602  C
2603  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2604  C
2605            IF (NTRIA .GT. NPT) NTRIA = NPT
2606            XD = (XMN2-XMN1) / FLOAT(NX-1)
2607            XB = ((XMN2-XMN1)-(XMN3-XMN4)) / FLOAT((NY-1)*(NX-1))
2608            XC = (XMN4 - XMN1) / FLOAT(NY-1)
2609            YD = (YMN4 - YMN1 ) / FLOAT(NX-1)
2610            YB = ((YMN4-YMN1)-(YMN3-YMN2)) / FLOAT((NY-1)*(NX-1))
2611            YC = (YMN2 - YMN1) / FLOAT(NX-1)
```

```
2612  C
2613              DO 100 I = 1, NTRIA
2614              DIFF3(I) = FT2(I) - FT1(I)
2615              DIFF1(I) = FT3(I) - FT1(I)
2616              DIFF2(I) = FT3(I) - FT2(I)
2617              SGN3(I) = SIGN (1.0, DIFF3(I))
2618              SGN1(I) = SIGN (1.0, DIFF1(I))
2619     100      SGN2(I) = SIGN (1.0, DIFF2(I))
2620              DO 110 I = 1, NTRIA
2621              DIFF3(I) = ABS(DIFF3(I)) + DELTA
2622              DIFF1(I) = ABS(DIFF1(I)) + DELTA
2623              DIFF2(I) = ABS(DIFF2(I)) + DELTA
2624              DFL3(I) = SGN3(I)*(FL - FT1(I))
2625              DFL1(I) = SGN1(I)*(FL - FT1(I))
2626     110      DFL2(I) = SGN2(I)*(FL - FT2(I))
2627              DO 120 I = 1, NTRIA
2628              ALF3(I) = DFL3(I)/DIFF3(I)
2629              ALF1(I) = DFL1(I)/DIFF1(I)
2630              ALF2(I) = DFL2(I)/DIFF2(I)
2631              X3(I) = XT1(I) + ALF3(I)*(XT2(I) - XT1(I))
2632              Y3(I) = YT1(I) + ALF3(I)*(YT2(I) - YT1(I))
2633              X1(I) = XT1(I) + ALF1(I)*(XT3(I) - XT1(I))
2634              Y1(I) = YT1(I) + ALF1(I)*(YT3(I) - YT1(I))
2635              X2(I) = XT2(I) + ALF2(I)*(XT3(I) - XT2(I))
2636              Y2(I) = YT2(I) + ALF2(I)*(YT3(I) - YT2(I))
2637     120      TEST(I) = (1.0 - ALF2(I))*ALF2(I)
2638  C
2639  C      IF TEST IS LESS THAN ZERO, THEN MISS, OTHERWISE HIT.
2640  C
2641              DO 130 I = 1, NTRIA
2642              MASK(I) = LSHF  (TEST(I), -31)
2643              MASK(I) = MASK(I) - 1
2644              X2(I) = AND (RMASK(I), X2(I))
2645     130      Y2(I) = AND (RMASK(I), Y2(I))
2646              DO 140 I = 1, NTRIA
2647              MASK(I) = -1 - MASK(I)
2648              X1(I) = AND (RMASK(I), X1(I))
2649              Y1(I) = AND (RMASK(I), Y1(I))
2650              X1(I) = X1(I) + X2(I)
2651     140      Y1(I) = Y1(I) + Y2(I)
2652  C
2653  C      NOW PLOT THE LINE SEGMENTS.
2654  C
2655              DO 145 I = 1, NTRIA
2656              X1(I) = (X1(I)-1.)*(XD-XB*(Y1(I)-1.))+XC*(Y1(I)-1.)+XMN1
2657              X3(I) = (X3(I)-1.)*(XD-XB*(Y3(I)-1.))+XC*(Y3(I)-1.)+XMN1
2658              Y1(I) = (Y1(I)-1.)*(YD-YB*(X1(I)-1.))+YC*(X1(I)-1.)+YMN1
2659     145      Y3(I) = (Y3(I)-1.)*(YD-YB*(X3(I)-1.))+YC*(X3(I)-1.)+YMN1
2660              DO 150 I = 1, NTRIA
2661              X3(I) = AMIN1(XMAX, AMAX1(XMIN, X3(I)))
2662              X1(I) = AMIN1(XMAX, AMAX1(XMIN, X1(I)))
2663              Y3(I) = AMIN1(YMAX, AMAX1(YMIN, Y3(I)))
2664     150      Y1(I) = AMIN1(YMAX, AMAX1(YMIN, Y1(I)))
2665              CALL LINES (X3, Y3, X1, Y1, NTRIA)
2666              NTRIA = 0
```

```
2667            RETURN
2668  C
2669  C
2670  C     ------------------------------------------------------------
2671  C
2672          ENTRY CNTSET (XM1, YM1, XM2, YM2, XM3, YM3, XM4, YM4)
2673  C
2674  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2675  C
2676  C     DESCRIPTION:  CNTSET MAY BE CALLED BY THE USER TO MOVE THE CONTOUR
2677  C      PLOT GENERATED AROUND ON THE PLOTTING REGION OR TO STRETCH OR
2678  C     COMPRESS THE PLOT. THE DATA STATEMENT GIVES THE DEFAULT FOR A
2679  C     LARGE SQUARE PLOT. THE PLOT WILL EXTEND FROM XXMIN TO XXMAX IN THE
2680  C     HORIZONTAL AND FROM YYMIN TO YYMAX IN THE VERTICAL. ALL FOUR OF
2681  C     THESE VALUES SHOULD BE IN THE RANGE 1 TO 1023.
2682  C
2683  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2684  C
2685            XMN1 = XM1
2686            YMN1 = YM1
2687            XMN2 = XM2
2688            YMN2 = YM2
2689            XMN3 = XM3
2690            YMN3 = YM3
2691            XMN4 = XM4
2692            YMN4 = YM4
2693            XMAX = MAX(XMN1, XMN2, XMN3, XMN4)
2694            XMIN = MIN(XMN1, XMN2, XMN3, XMN4)
2695            YMAX = MAX(YMN1, YMN2, YMN3, YMN4)
2696            YMIN = MIN(YMN1, YMN2, YMN3, YMN4)
2697            RETURN
2698  C
2699  C
2700  C     ------------------------------------------------------------
2701  C
2702          ENTRY CNTFRM
2703  C
2704  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2705  C
2706  C     DESCRIPTION:  CNTFRM IS A USER-CALLED ROUTINE TO PLOT THE RECTAN-
2707  C     GULAR BOUNDARY OF THE CONTOURED REGION. CNTFRM HAS NO ARGUMENTS
2708  C     SINCE THE REGION IS SPECIFIED BY DEFAULT OR VIA A PREVIOUS CALL TO
2709  C     CNTSET.
2711  C
2712  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2713  C
2714            CALL LINE(XMN1,YMN1,XMN2,YMN2)
2715            CALL LINE(XMN2,YMN2,XMN3,YMN3)
2716            CALL LINE(XMN3,YMN3,XMN4,YMN4)
2717            CALL LINE(XMN4,YMN4,XMN1,YMN1)
2718            RETURN
2719          END
```

```
      SUBROUTINE PUTCH (X, Y, CHARAC)
C
      INTEGER LPAGE(30, 65)
      COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
      COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
      CHARACTER*1 CHARAC, CH(4)
      EQUIVALENCE (CH,ICH)
      INTEGER K, K1, M, IK, IM, MASK(5)
      INTEGER ISHFT, AND, OR
      LOGICAL LSW, LTSW
      DATA MASK /ZFFFF00FF, ZFF00FFFF, Z00FFFFFF, ZFFFFFF00,
     .     ZFF000000/, CHSZ/0.0/
C
      ICH = 0
      CH(1) = CHARAC
      CHS = CHSIZE(2)
      GO TO  (1,2,3,5), IDEVIC
C
C     CALCOMP SECTION.
C
    1     CALL CALSYM (X, Y, CHS, CH, 0, 0.0, 1)
          LSW = .TRUE.
          RETURN
C
C     PAGE PLOT SECTION.
C
    2     JX1 = MAX(0, MIN(IFIX(X),1023))
          JY1 = MAX(0, MIN(IFIX(Y),1023))
          I = (JX1 + 5)/10 + 1
          J = 65 - (JY1+8)/16
          K = I/4
          M = I - 4*K
          K1 = 4 - M
          IF(M .EQ. 0) K = K - 1
          IM = IAND(LPAGE(K+4, J), MASK(K1))
          IK = IAND(ICH, MASK(5))
          IF(M .EQ. 0) IK = ISHFT(IK, -24)
          IF(M .EQ. 3) IK = ISHFT(IK, -16)
          IF(M .EQ. 2) IK = ISHFT(IK, -8)
          LPAGE(K+4, J) = IOR(IK, IM)
          RETURN
C
C     LEXIDATA/MATRIX SECTION
C
    3     CALL GSCHSZ (CHS)
          XL = MAX(X,0.)
          YL = MAX(Y,0.)
          CALL GMOVA (XL, YL)
          CALL GTXTWC (CH, 1)
          RETURN
C
C     TEKTRONIX SECTION
C
    5     CONTINUE
          CALL MOVEA(X,Y)
```

```
2775            CALL A1OUT(1,ICH)
2776            LTSW=.TRUE.
2777            RETURN
2778        END
```

```
      SUBROUTINE PUTLNV (X1, Y1, DX, DY,  NL)
C
      PARAMETER (NLINES=200)
      INTEGER LENGTH, COUNT
      REAL X1(NL), Y1(NL), DX(NL), DY(NL)
      INTEGER MASK1/15/,OP11/12/,IVERT/1023/
      INTEGER LPAGE(30,65), HSYMBL, HDOT, HAPOS, HMINUS
      REAL JX1(NLINES),JY1(NLINES),JX2(NLINES),JY2(NLINES)
      REAL XY(2,NLINES), JXS, JYS, IDDX, IDDY
      COMMON/DEVTYP/IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
      COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
      COMMON/GRFMOD/LFLMAT(5),LINWDM(5),LCLMAT(5)
      INTEGER K, K1, M, M1, IK, IM, MASK(4)
      LOGICAL LSW, LTSW, IRVRSE, LEXLSW
      DATA HDOT, HAPOS, HMINUS /Z00000002E, Z00000027, Z00000002D /
      DATA MASK /ZFFFF00FF, ZFF00FFFF, Z00FFFFFF, ZFFFFFF00 /
      DATA JXS, JYS / 2*0.0 /
C
      IF(IDEVIC.EQ.0) RETURN
      IF(NL.GT.NLINES.AND.LUDIAG.GT.0) WRITE(LUDIAG,1002)
 1002 FORMAT(' *** BUFFER SPACE EXCEEDED IN PUTLNV ***')
      NLP = MINO(NLINES,NL)
C
C     MASK THE LINE SEGMENT FOR CALCOMP AND PAPER, AND TEKTRONIX.
C
      DO 10 I=1,NLP
      JX1(I) = X1(I)
      JY1(I) = Y1(I)
      JX2(I) = JX1(I) + DX(I)
   10 JY2(I) = JY1(I) + DY(I)
      DO 11 I = 1, NLP
      JX1(I) = MAX(JX1(I),0.)
      JY1(I) = MAX(JY1(I),0.)
      JX2(I) = MAX(JX2(I),0.)
   11 JY2(I) = MAX(JY2(I),0.)
      GO TO (1,2,3,5), IDEVIC
C
C     CALCOMP SECTION.
C
    1 DO 16 I = 1, NLP
      IF(LSW) GO TO 12
      IF(JXS.EQ.JX1(I) .AND. JYS.EQ.JY1(I))GO TO 15
   12 CALL CALPLT(JX1(I), JY1(I), 3)
      LSW =.FALSE.
   15 CALL CALPLT(JX2(I), JY2(I), 2)
      JXS=JX2(I)
      JYS=JY2(I)
   16 CONTINUE
      RETURN
C
C     PAGE PLOT SECTION.
C
    2 DO 22 I=1,NLP
      HSYMBL = HDOT
      IF(DX(I).GT.2*DY(I))HSYMBL=HMINUS
```

```
2834              IF(DY(I).GT.2*DX(I))HSYMBL=HAPOS
2835              IDDX=JX2(I)-JX1(I)
2836              IDDY=JY2(I)-JY1(I)
2837              DO 20 L = 1, 9
2838              JX=JX1(I)+((L-1)*IDDX)/8
2839              JY=JY1(I)+((L-1)*IDDY)/8
2840              IX= (JX+5)/10 + 1
2841              IY= 65 - (JY+8)/16
2842              K=IX/4
2843              M = IX- 4*K
2844              IK = HSYMBL
2845              K1 = 4 - M
2846              M1 = 8*K1
2847              IF(M .EQ. 0) K = K - 1
2848              IM = IAND(LPAGE(K+4,IY), MASK(K1))
2849              IF( M .NE. 0) IK = ISHFT(HSYMBL, M1)
2850     20       LPAGE(K+4,IY) = IOR(IM, IK)
2851     22       CONTINUE
2852              RETURN
2853  C
2854  C      LEXIDATA/MATRIX SECTION
2855  C
2856       3      IL = 1
2857      32      IS = 1
2858              CALL GMOVA(JX1(IL),JY1(IL))
2859              XY(1,IS) = JX2(IL)
2860              XY(2,IS) = JY2(IL)
2861      31      IL = IL + 1
2862              IF(JX1(IL).NE.XY(1,IS).OR.JY1(IL).NE.XY(2,IS).OR.IL.GT.NLP)
2863        .     GO TO 30
2864              IS = IS + 1
2865              XY(1,IS) = JX2(IL)
2866              XY(2,IS) = JY2(IL)
2867              GO TO 31
2868      30      CALL GPLNA(XY,IS)
2869              IF(IL.GT.NLP) RETURN
2870              GO TO 32
2871              RETURN
2872  C
2873  C      TEKTRONIX SECTION
2874  C
2875       5      CONTINUE
2876              DO 40 I=1,NLP
2877              IF(LTSW) GO TO 42
2878              IF(JXS.EQ.JX1(I).AND.JYS.EQ.JY1(I)) GO TO 45
2879      42      CALL MOVEA(JX1(I),JY1(I))
2880              LTSW=.FALSE.
2881      45      CALL DRAWA(JX2(I),JY2(I))
2882              JXS=JX2(I)
2883              JYS=JY2(I)
2884      40      CONTINUE
2885              RETURN
2886         END
```

```
2887          SUBROUTINE SETLUT
2888    C
2889          DIMENSION LUT(48)
2890          DATA LUT/0,15,15,0,0,15,15,0,15,1,3,5,7,9,11,13,
2891         . 0,15,0,15,0,15,0,15,8,1,3,5,7,9,11,13,
2892         . 0,15,0,0,15,0,15,15,0,1,3,5,7,9,11,13/
2893    C
2894          CALL DSLWT (16, 48, LUT)
2895          RETURN
2896          END
```

```
2897          SUBROUTINE SRFSET(XX, YY, ZZMIN, ZZMAX, NX, NY)
2898    C
2899    C       THIS SUBROUTINE AND ITS ASSOCIATED ENTRIES CONSTRUCT AND
2900    C       DELIVER PLOTS OF A SURFACE Z(I,J) WITH HIDDEN LINES REMOVED
2901    C       FOR I = 1, ..., NX AND J = 1, ..., NY.  THE TYPE, ORIENTATION,
2902    C       AND DETAILS OF THE PLOTS ARE QUITE FLEXIBLE AS SEEN BY CAREFUL
2903    C       STUDY OF THE TEST PROGRAM AND THE RESULTING OUTPUT
2904    C       THE PARTICULAR VERSION IS AN INTERFACE TO THE GENERAL PURPOSE
2905    C       PLOTTING PACKAGE WHICH CAN DRAW COLOR PLOTS ON THE CALCOMP,
2906    C       LEXIDATA, PRINTER OR TEKTRONICS (4000'S SERIES).
2907    C
2908    C       SURFACE INITIALIZES THE SURFACE PLOTTING PACKAGE AND MUST
2909    C       BE CALLED EACH TIME A NEW PLOT IS DESIRED TO RESET THE
2910    C       HIDDEN LINE ARRAYS.
2911    C       NOTE THAT MAX(NX,NY) MUST BE LESS THAN NPT
2912    C
2913    C       THE LOGICAL PLOTTING REGION IS A 3D RECTANGULAR PARALLELE-
2914    C       PIPED WITH 8 CORNER VERTICES.
2915    C       XX      REAL    - ARRAY DIMENSIONED 8 CONTAINING THE 8 CORNER
2916    C                         VERTEX X LOCATIONS. THE VERTICES ARE NUMBERED
2917    C                         AS SHOWN ON THE SURFACE GEOMETRY SHEET (AVAILABL
2918    C                         FROM THE SPL LIBRARIAN OR THE AUTHOR).
2919    C       YY      REAL    - ARRAY DIMENSIONED 8 CONTAINING THE 8 CORNER
2920    C                         VERTEX Y LOCATIONS.  THE VERTICES ARE NUMBERED
2921    C                         AS SHOWN ON THE SURFACE GEOMETRY SHEET WHICH IS
2922    C                         AVAILABLE FROM THE SPL LIBRARIAN OR THE AUTHOR.
2923    C       ZZMIN   REAL    - THE VALUE OF Z(I,J) TO BE PLOTTED AT THE
2924    C                         BOTTOM SURFACE OF THE PARALLELEPIPED.
2925    C                         SMALLER Z(I,J) ARE SET (I.E. LIMITED) TO
2926    C                         ZZMIN.
2927    C       ZZMAX   REAL    - THE VALUE OF Z(I,J) TO BE PLOTTED AT THE
2928    C                         UPPER SURFACE OF THE PARALLELEPIPED.
2929    C                         LARGER Z(I,J) ARE SET (I.E. LIMITED) TO
2930    C                         ZZMAX.
2931    C       NX      INTEGER - DIMENSION AND RANGE OF I IN Z(I,J)
2932    C       NY      INTEGER - DIMENSION AND RANGE OF J IN Z(I,J)
2933    C
2934    C       SFRAME (MODE1) - PLOTS THE FRAME OF THE RECTANGULAR PARALLELE-
2935    C              PIPED PLOTTING REGION.
2936    C       MODE1   INTEGER - MODE1 = 1  PLOTS + AT THE VERTICES
2937    C                               = 2  ALSO PLOTS LINE SEGMENTS
2938    C                                    CONNECTING THE VERTICES.
2939    C
2940    C       SSKIRT (ZZ, NX, NY, MODE2) - PLOTS ANY OF THE SKIRTS WHICH MAY
2941    C              BE DESIRED.  ONLY ONE SKIRT IS PLOTTED PER CALL AND THE
2942    C              HIDDEN LINE ALGORITHM IS INVOKED.  THEREFORE, THE SIDE
2943    C              SKIRTS (+2, -2, +4, -4) AND THE DATA SURFACE BACK SKIRTS
2944    C              (+3, -3) SHOULD ONLY BE PLOTTED AFTER THE DATA SURFACE
2945    C              HAS BEEN CONSTRUCTED USING SURFACE.  THIS ENTRY DOES NOT
2946    C              PLOT THE Z SURFACE (HERE THE DATA ARE CALLED ZZ TO AVOID
2947    C              DECLARATION CONFLICTS).  HOWEVER Z(I,J) ARE NEEDED TO
2948    C              DEFINE THE SKIRT POSITIONS.
2949    C       ZZ      REAL    - ARRAY CONTAINING THE DATA TO BE PLOTTED AS A
2950    C                         SURFACE
2951    C       NX      INTEGER - DIMENSION AND RANGE OF I IN Z(I,J)
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```
C       NY      INTEGER - DIMENSION AND RANGE OF J IN Z(I,J)
C       MODE2   INTEGER - MODE2 = 1(-1) LOWER (UPPER) FRONT SKIRT
C                               = 2(-2) LOWER (UPPER) RIGHT SKIRT
C                               = 3(-3) LOWER (UPPER) BACK SKIRT
C                               = 4(-4) LOWER (UPPER) LEFT SKIRT
C       SURFAC (Z, NX, NY, MODE3) - CONSTRUCTS AND PLOTS THE DATA SUR-
C              FACE AND SETS THE HIDDEN LINE ARRAYS WHICH ARE USED IN
C              SURFSK.
C       Z       REAL    - ARRAY DIMENSIONED (NX,NY) CONTAINING THE DATA
C                         TO BE PLOTTED AS A SURFACE
C       NX      INTEGER - DIMENSION AND RANGE OF I IN Z(I,J)
C       NY      INTEGER - DIMENSION AND RANGE OF J IN Z(I,J)
C       MODE3   INTEGER - MODE3 = 1  PLOTS THE UPPER SURFACE
C                               =-1  PLOTS THE LOWER SURFACE
C
          PARAMETER (NPT=101)
          LOGICAL  SW(1024)
          REAL     XX(8), YY(8)
          REAL     X(8), Y(8), H(1280), G(1280)
C         REAL     AJ1(NPT), AJN(NPT), AI1(NPT), AIN(NPT), ZVAL(NPT)
C         REAL     RDZVB(NPT), RDZTV(NPT)
          LOGICAL  SWITCH
          REAL     Z(NX,NY), X1(NPT), X2(NPT), Y1(NPT), Y2(NPT)
          REAL     ZZ(NX, NY)
          COMMON /SURCMN/  X, Y, ZMIN, ZMAX, RDZ, RNXM1, RNYM1, NNX, NNY
C
C     INITIALIZE HIDDEN LINE ARRAYS.
C
          NNX = NX
          NNY = NY
          IF(MAX0(NX,NY).GT.NPT) STOP 76
          YMIN = 1.E+25
          YMAX = -1.E+25
          DO 3 I = 1, 8
          YMIN = AMIN1(YMIN, YY(I))
    3     YMAX = AMAX1(YMAX, YY(I))
          DO 1 I = 1, 1280
          G(I) = YMAX
    1     H(I) = YMIN
C
C     FOR SPECIAL EFFECTS ZBOT AND ZTOP MAY DIFFER FROM ZMIN AND ZMAX.
C
          ZBOT = ZZMIN
          ZTOP = ZZMAX
          ZMIN = ZZMIN
          ZMAX = ZZMAX
          RDZ = 1.0/(ZTOP - ZBOT)
          DO 2 I = 1, 8
          X(I) = XX(I)
    2     Y(I) = YY(I)
          RNXM1 = 1.0/FLOAT(NX - 1)
          RNYM1 = 1.0/FLOAT(NY - 1)
          RETURN
C
C
```

```
C     ------------------------------------------------------------------
C
          ENTRY SFRAME (MODE1)
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     DESCRIPTION:  SURFRM PLOTS THE FRAME OF THE RECTANGULAR PARALLELO-
C     PIPED PLOTTING REGION.
C
C      ARGUMENTS:
C     MODE1  INTEGER                MODE1 = 1  PLOTS + AT THE VERTICES.
C                                   MODE1 = 2  ALSO PLOTS LINE SEGMENTS
C                                              CONNECTING THE VERTICES.
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
          CALL CHPLOT (X, Y, '+', 1, 1, 8)
C
C     NOW CHECK THE VARIOUS LINES.
C
          IF (MODE1 .LE. 1) GO TO 12
          CALL SURF5 (X(1), Y(1), X(2), Y(2))
          CALL SURF5 (X(6), Y(6), X(2), Y(2))
          CALL SURF5 (X(6), Y(6), X(5), Y(5))
          CALL SURF5 (X(1), Y(1), X(5), Y(5))
          IF (Y(7).GT.Y(5) .OR. X(7).LT.X(5))
     1        CALL SURF5 (X(5), Y(5), X(7), Y(7))
          IF (Y(8).GT.Y(6) .OR. X(8).GT.X(6))
     1        CALL SURF5 (X(8), Y(8), X(6), Y(6))
          IF (Y(3).LT.Y(1) .OR. X(3).LT.X(1))
     1        CALL SURF5 (X(1), Y(1), X(3), Y(3))
          IF (Y(4).LT.Y(2) .OR. X(4).GT.X(2))
     1        CALL SURF5 (X(2), Y(2), X(4), Y(4))
          IF (Y(7).GE.Y(5) .AND. Y(8).GE.Y(6))
     1        CALL SURF5 (X(8), Y(8), X(7), Y(7))
          IF (X(8).GE.X(6) .AND. X(4).GE.X(2))
     1        CALL SURF5 (X(8), Y(8), X(4), Y(4))
          IF (Y(4).LE.Y(2) .AND. Y(3).LE.Y(1))
     1        CALL SURF5 (X(4), Y(4), X(3), Y(3))
          IF (X(3).LE.X(1) .AND. X(7).LE.X(5))
     1        CALL SURF5 (X(7), Y(7), X(3), Y(3))
     12   CONTINUE
          RETURN
C
C
C     ------------------------------------------------------------------
C
          ENTRY SSKIRT (ZZ, NX, NY, MODE2)
C
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     DESCRIPTION:  SURFSK PLOTS ANY OF THE SKIRTS WHICH MAY BE DESIRED.
C     ONLY ONE SKIRT IS PLOTTED PER CALL AND THE HIDDEN LINE ALGORITHM
C     IS INVOKED. THEREFORE, THE SIDE SKIRTS (+2, -2, +4, -4) AND THE
```

```
3062  C     BACK SKIRTS (+3, -3) SHOULD ONLY BE PLOTTED AFTER THE DATA SURFACE
3063  C     HAS BEEN CONSTRUCTED USING SURFACE. THIS ENTRY DOES NOT PLOT THE Z
3064  C     SURFACE (HERE THE DATA ARE CALLED ZZ TO AVOID DECLARATION CON-
3065  C     FLICTS). HOWEVER Z(I,J) ARE NEEDED TO DEFINE THE SKIRT POSITIONS.
3066  C
3067  C      ARGUMENTS:
3068  C     ZZ      REAL ARRAY (NX,NY)  THE DATA TO BE PLOTTED AS A SURFACE. I
3069  C     NX      INTEGER             DIMENSION AND RANGE OF I IN Z(I,J).  I
3070  C     NY      INTEGER             DIMENSION AND RANGE OF J IN Z(I,J).  I
3071  C     MODE2   INTEGER             MODE2 = 1(-1) LOWER (UPPER) FRONT SKIRT
3072  C                                 MODE2 = 2(-2) LOWER (UPPER) RIGHT SKIRT
3073  C                                 MODE2 = 3(-3) LOWER (UPPER) BACK SKIRT
3074  C                                 MODE2 = 4(-4) LOWER (UPPER) LEFT SKIRT
3075  C
3076  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
3077  C
3078            NSKIRT = IABS(MODE2)
3079            GO TO (21, 22, 23, 22), NSKIRT
3080  C
3081  C     THE FRONT SKIRT IS ADDED.
3082  C
3083     21     CONTINUE
3084            XL = X(1)
3085            XR = X(2)
3086            YL = Y(1)
3087            YR = Y(2)
3088            IF (MODE2 .GT. 0) GO TO 211
3089            XL = X(5)
3090            XR = X(6)
3091            YL = Y(5)
3092            YR = Y(6)
3093    211     DO 212 I = 1, NX
3094            FI1 = FLOAT(I-1)/FLOAT(NX-1)
3095            FIN = FLOAT(NX-I)/FLOAT(NX-1)
3096            XA = XR*FI1 + XL*FIN
3097            YA = YR*FI1 + YL*FIN
3098            CALL SURF4 (XB,YB, I,1, ZZ(I,1))
3099    212     CALL SURF5 (XA, YA, XB, YB)
3100            RETURN
3101  C
3102  C     THE RIGHT OR LEFT SIDE SKIRT IS ADDED. IF IT IS OBSCURED THE
3103  C     HIDDEN LINE ALGORITHMS ARE USED SO CALL ONLY AFTER SURFACE IS USED
3104     22     NSK = (4 - NSKIRT)/2
3105            I = 1 + (NX-1)*NSK
3106            XST = X(NSK+1)
3107            YST = Y(NSK+1)
3108            XND = X(NSK+3)
3109            YND = Y(NSK+3)
3110            IF (MODE2 .GT. 0) GO TO 221
3111            XST = X(NSK+5)
3112            YST = Y(NSK+5)
3113            XND = X(NSK+7)
3114            YND = Y(NSK+7)
3115    221     DO 222 J = 1, NY
3116            FJ1 = FLOAT(J-1)/FLOAT(NY-1)
```

```
3117            FJN = FLOAT(NY-J)/FLOAT(NY-1)
3118            XA = XND*FJ1 + XST*FJN
3119            YA = YND*FJ1 + YST*FJN
3120            CALL SURF4 (XB,YB, I,J, ZZ(I,J))
3121  C
3122  C     THE SKIRT MAY BE OBSCURED. CHECK ON TOP OR BOTTOM.
3123  C
3124            K = XB + 0.5
3125            IF (MODE2 .GT. 0) YB = AMIN1(YB, G(K))
3126            IF (MODE2 .LT. 0) YB = AMAX1(YB, H(K))
3127            IF (MODE2.GT.0 .AND. YA.LT.G(K)) CALL SURF5 (XA, YA, XB, YB)
3128            IF (MODE2.LT.0 .AND. YA.GT.H(K)) CALL SURF5 (XA, YA, XB, YB)
3129     222    CONTINUE
3130            RETURN
3131  C
3132  C     THE BACK SKIRT IS ADDED (ASSUMED CALLED AFTER SURFACE).
3133  C
3134      23    CONTINUE
3135            XL = X(3)
3136            YL = Y(3)
3137            XR = X(4)
3138            YR = Y(4)
3139            IF (MODE2.GT.0) GO TO 231
3140            XL = X(7)
3141            YL = Y(7)
3142            XR = X(8)
3143            YR = Y(8)
3144     231    DO 232 I = 1, NX
3145            FI1 = FLOAT(I-1)/FLOAT(NX-1)
3146            FIN = FLOAT(NX-I)/FLOAT(NX-1)
3147            XA = XR*FI1 + XL*FIN
3148            YA = YR*FI1 + YL*FIN
3149            CALL SURF4 (XB,YB, I,NY, ZZ(I,NY))
3150            K = XB + 0.5
3151            IF (MODE2 .GT. 0) YB = AMIN1 (YB, G(K))
3152            IF (MODE2 .LT. 0) YB = AMAX1 (YB, H(K))
3153            IF (FLOAT(MODE2)*(YB-YA) .GT. 0.0) CALL SURF5(XA, YA, XB, YB)
3154     232    CONTINUE
3155            RETURN
3156  C
3157  C
3158  C     ------------------------------------------------------------
3159  C
3160        ENTRY SURFAC (Z, NX, NY, MODE3)
3161  C
3162  C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
3163  C
3164  C     DESCRIPTION: SURFACE CONSTRUCTS AND PLOTS THE DATA SURFACE AND SET
3165  C     THE HIDDEN LINE ARRAYS WHICH ARE USED IN SURFSK.
3166  C
3167  C      ARGUMENTS:
3168  C     Z       REAL ARRAY (NX,NY)  THE DATA TO BE PLOTTED AS A SURFACE. I
3169  C     NX      INTEGER             DIMENSION AND RANGE OF I IN Z(I,J).  I
3170  C     NY      INTEGER             DIMENSION AND RANGE OF J IN Z(I,J).  I
3171  C     MODE3   INTEGER             MODE3 = 1   PLOTS THE UPPER SURFACE  I
```

```
3227            YA = AMAX1(Y1(I), H(IXH))
3228            YB = AMAX1(Y2(I), H(IXH))
3229            IF (YB.GT.YA) CALL SURF5 (X1(I),YA, X2(I),YB)
3230            GO TO 35
3231     39     YA = AMIN1(Y1(I), G(IXH))
3232            YB = AMIN1(Y2(I), G(IXH))
3
 233            IF (YB.LT.YA) CALL SURF5 (X1(I),YA, X2(I),YB)
3234            GO TO 35
3235  C
3236  C     THIS IS A SLANTED LINE SEGMENT.
3237  C
3238     38     DIX = 1.0/FLOAT(IXB - IXA)
3239            SWITCH = .TRUE.
3240            NSWT = IXB - IXA + 1
3241            DO 36 K = IXA, IXB
3242            SW(K) = .TRUE.
3243            IF (X2(I).GT.X1(I)) YK = Y1(I)*(IXB-K)*DIX + Y2(I)*(K-IXA)*DIX
3244            IF (X2(I).LT.X1(I)) YK = Y2(I)*(IXB-K)*DIX + Y1(I)*(K-IXA)*DIX
3245            IF ((MODE3.LT.0 .AND. G(K).GE.YK-0.5)
3246       1        .OR. (MODE3.GT.0 .AND. H(K).LE.YK+0.5)) GO TO 36
3247            SWITCH = .FALSE.
3248            SW(K) = .FALSE.
3249            NSWT = NSWT - 1
3250     36     CONTINUE
3251             IF (SWITCH) CALL SURF5 (X1(I), Y1(I), X2(I), Y2(I))
3252            IF (SWITCH .OR. NSWT.EQ.0) GO TO 35
3253  C
3254  C     PART OF THE LINE IS OBSCURED SO WE NEED TO PLOT SEGMENTS.
3255  C
3256            SW(IXA-1) = .FALSE.
3257            SW(IXB+1) = .FALSE.
3258            DO 41 K = IXA, IXB
3259            IF (X2(I).GT.X1(I)) YK = Y1(I)*(IXB-K)*DIX + Y2(I)*(K-IXA)*DIX
3260            IF (X2(I).LT.X1(I)) YK = Y2(I)*(IXB-K)*DIX + Y1(I)*(K-IXA)*DIX
3261            IF (.NOT.SW(K) .OR. SW(K-1)) GO TO 51
3262            XA = K
3263            YA = YK
3264            IF (K.EQ.IXA) GO TO 51
3265            IF (MODE3.GT.0) YA = AMIN1 (H(K), YK)
3266            IF (MODE3.LT.0) YA = AMAX1 (G(K), YK)
3267     51     IF (.NOT.SW(K) .OR. SW(K+1)) GO TO 41
3268            IF (K.EQ.IXB) GO TO 52
3269            IF (MODE3.GT.0) YK = AMIN1 (H(K), YK)
3270            IF (MODE3.LT.0) YK = AMAX1 (G(K), YK)
3271     52     CALL SURF5 (XA,YA,FLOAT(K),YK)
3272     41     CONTINUE
3273     35     CONTINUE
3274     37     CONTINUE
3275  C
3276  C     PLOT THE I TO I+1 LINE SEGMENTS IF NOT HIDDEN.
3277  C
3278            DO 33 I = 2, NX
3279            IXB = X2(I) + 0.5
3280            IXA = X2(I-1)
3281            DIX = 1.0/FLOAT(IXB - IXA)
```

```
3282            SWITCH = .TRUE.
3283            NSWT = IXB - IXA + 1
3284            DO 34 K = IXA, IXB
3285            SW(K) = .TRUE.
3286            YK = Y2(I-1)*(IXB-K)*DIX + Y2(I)*(K-IXA)*DIX
3287            IF (MODE3.GT.0) H(K) = AMAX1(H(K), YK)
3288            IF (MODE3.LT.0) G(K) = AMIN1(G(K), YK)
3289            IF ((MODE3.LT.0 .AND. G(K).GE.YK-0.5)
3290           1        .OR. (MODE3.GT.0 .AND. H(K).LE.YK+0.5)) GO TO 34
3291            SWITCH = .FALSE.
3292            SW(K) = .FALSE.
3293            NSWT = NSWT - 1
3294        34  CONTINUE
3295            IF (SWITCH) CALL SURF5 (X2(I-1), Y2(I-1), X2(I), Y2(I))
3296            IF (SWITCH .OR. NSWT.EQ.0) GO TO 33
3297    C
3298    C     PART OF THE LINE IS OBSCURED SO WE NEED TO PLOT SEGMENTS.
3299    C
3300            SW(IXA-1) = .FALSE.
3301            SW(IXB+1) = .FALSE.
3302            DO 44 K = IXA, IXB
3303            YK = Y2(I-1)*(IXB-K)*DIX + Y2(I)*(K-IXA)*DIX
3304            IF (SW(K) .AND. .NOT.SW(K-1)) XA = K
3305            IF (SW(K) .AND. .NOT.SW(K-1)) YA = YK
3306            IF (SW(K) .AND. .NOT.SW(K+1)) CALL SURF5 (XA,YA,FLOAT(K),YK)
3307        44  CONTINUE
3308        33  CONTINUE
3309    C
3310        31  CONTINUE
3311            RETURN
3312        END
```

```
      SUBROUTINE SURF4 (XVAL, YVAL, I, J, ZIN)
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     THIS IS AN AUXILIARY ROUTINE TO SURFACE. IT PERFORMS A TRILINEAR I
C     TERPOLATION IN THE 3D RECTANGLE OUTLINED BT (X(I), Y(I)) ON THE
C     PLOTTING SURFACE FOR I = 1, ..., 8. THE TEXT WILL BE SUBSTITUTED
C     IN LINE WHEN THE ASC COMPILER BUG HAS BEEN FIXED.
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
          REAL     X(8), Y(8)
          COMMON /SURCMN/  X, Y, ZMIN, ZMAX, RDZ, RNXM1, RNYM1, NNX, NNY
C
          FI1 = FLOAT(I-1)*RNXM1
          FJ1 = FLOAT(J-1)*RNYM1
          FIN = FLOAT(NNX-I)*RNXM1
          FJN = FLOAT(NNY-J)*RNYM1
          ZVAL = AMAX1 (ZIN, ZMIN)
          ZVAL = AMIN1 (ZVAL, ZMAX)
          XVAL  = RDZ*(ZVAL-ZMIN)*(FJN*(FI1*X(6) + FIN*X(5))
     1              + FJ1*(FI1*X(8) + FIN*X(7)))
     2          + RDZ*(ZMAX-ZVAL)*(FJN*(FI1*X(2) + FIN*X(1))
     3              + FJ1*(FI1*X(4) + FIN*X(3)))
          YVAL  = RDZ*(ZVAL-ZMIN)*(FJN*(FI1*Y(6) + FIN*Y(5))
     1              + FJ1*(FI1*Y(8) + FIN*Y(7)))
     2          + RDZ*(ZMAX-ZVAL)*(FJN*(FI1*Y(2) + FIN*Y(1))
     3              + FJ1*(FI1*Y(4) + FIN*Y(3)))
          RETURN
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     THIS SUBROUTINE IS A GENERAL-PURPOSE GRAPHICS INTERFACE FOR USE
C     WITH THE SURFACE SUBROUTINE FOR 3D SURFACE PLOTS WITH HIDDEN LINES
C     REMOVED.
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
      ENTRY SURF5 (X1, Y1, X2, Y2)
C
          IF ( ((X1-X2)**2 + (Y1-Y2)**2) .GT. 2.25)
     1        CALL LINE (X1, Y1, X2, Y2)
          RETURN
      END
```

```
3357            SUBROUTINE SYMBOL (XCHAR, YCHAR, CHARAC)
3358  C
3359            COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
3360            COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
3361            CHARACTER*1 CHARAC
3362  C
3363  C     THIS SUBROUTINE USES THE HARWARE CHARACTERS TO PLOT DATA
3364  C     POINTS AT THE LOCATION SPECIFIED BY (XCHAR,YCHAR) IN THE PLOTTING
3365  C     REGION DETERMINED BY XYCOOD.
3366  C
3367            IF (IDEVIC.EQ.4) CALL IOWAIT(8)
3368            X = XYCOOD(1)*XCHAR + XYCOOD(2) - CHSIZE(2)*CHSIZE(3)
3369            Y = XYCOOD(3)*YCHAR + XYCOOD(4) - CHSIZE(2)*CHSIZE(4)
3370            CALL PUTCH (X, Y, CHARAC)
3371            RETURN
3372            END
```

```
      SUBROUTINE VIEWTR(XDC,WINDOW,VERTEX,NV,EDGE,ESPEC,NE,
     . POLY,PSPEC,NP)
C
C  THIS SUBROUTINE PLOTS EDGES AND POLYGONS WHICH ARE WITHIN THE WINDOW
C  EDGE SEGMENTS WHICH CROSS A PORTION OF THE WINDOW.
C
      REAL VERTEX(3,NV), WINDOW(4), XYZ(3,8)
      INTEGER EDGE(2,NE), ESPEC(4,NE), POLY(8,NP), PSPEC(4,NP)
      REAL U1,V1,U2,V2,X(8),Y(8),XDC(4,4)
C
C  DEFINE THE WINDOW SPACE
C
      CALL DEFINE(WINDOW(1),WINDOW(2),WINDOW(3),WINDOW(4))
C
      DOZ=10000.
      FANGLE=90.
      TANAL = 1.0
      WCX = 0.5 * (WINDOW(1)+WINDOW(3))
      WCY = 0.5 * (WINDOW(2)+WINDOW(4))
C
C  PLOT ONE EDGE AT A TIME
C
      LWD = -1
      LCL = -1
      LFL = -1
      DO 150 J=1,NE
C
C     MOVE VERTICES INTO A LOCAL WORK ARRAY
C
      DO 151 I = 1, 2
      DO 151 K = 1, 3
  151 XYZ(K,I) = VERTEX(K,EDGE(I,J))
C
C     APPLY THE TRANSFORM
C
      DO 152 I = 1, 2
      U1 = XYZ(1,I)
      U2 = XYZ(2,I)
      U3 = XYZ(3,I)
      XYZ(1,I) = XDC(1,1)*U1 + XDC(1,2)*U2 + XDC(1,3)*U3 + XDC(1,4)
      XYZ(2,I) = XDC(2,1)*U1 + XDC(2,2)*U2 + XDC(2,3)*U3 + XDC(2,4)
  152 XYZ(3,I) = XDC(3,1)*U1 + XDC(3,2)*U2 + XDC(3,3)*U3 + XDC(3,4)
C
C  ADD PERSPECTIVE
C
      D = DOZ/((DOZ+XYZ(3,1))*TANAL)
      U1=(XYZ(1,1)-WCX)*D + WCX
      V1=(XYZ(2,1)-WCY)*D + WCY
      D = DOZ/((DOZ+XYZ(3,2))*TANAL)
      U2=(XYZ(1,2)-WCX)*D + WCX
      V2=(XYZ(2,2)-WCY)*D + WCY
C
C  CLIP LEFT EDGE
C
      IF (U1.GE.WINDOW(1).AND.U2.GE.WINDOW(1)) GO TO 50
```

```
3428          IF (U1.LT.WINDOW(1).AND.U2.LT.WINDOW(1)) GO TO 150
3429          IF (U1.GT.WINDOW(1)) GO TO 40
3430          V1 = (V1-V2)*U1/(U2-U1)+V1
3431          U1 = WINDOW(1)
3432          GO TO 50
3433    40    V2 = (V2-V1)*U2/(U1-U2)+V2
3434          U2 = WINDOW(1)
3435    C
3436    C  CLIP RIGHT EDGE
3437    C
3438    50    IF (U1.LE.WINDOW(3).AND.U2.LE.WINDOW(3)) GO TO 70
3439          IF (U1.GT.WINDOW(3).AND.U2.GT.WINDOW(3)) GO TO 150
3440          IF (U1.GT.WINDOW(3)) GO TO 51
3441          V2 = (V2-V1)*(WINDOW(3)-U1)/(U2-U1)+V1
3442          U2 = WINDOW(3)
3443          GO TO 70
3444    51    V1 = (V1-V2)*(WINDOW(3)-U2)/(U1-U2)+V2
3445          U1 = WINDOW(3)
3446    C
3447    C  CLIP BOTTOM EDGE
3448    C
3449    70    IF (V1.GE.WINDOW(2).AND.V2.GE.WINDOW(2)) GO TO 90
3450          IF (V1.LT.WINDOW(2).AND.V2.LT.WINDOW(2)) GO TO 150
3451          IF (V1.GT.WINDOW(2)) GO TO 80
3452          U1 = (U1-U2)*V1/(V2-V1)+U1
3453          V1 = WINDOW(2)
3454          GO TO 90
3455    80    U2 = (U2-U1)*V2/(V1-V2)+U2
3456          V2 = WINDOW(2)
3457    C
3458    C  CLIP TOP EDGE
3459    C
3460    90    IF (V1.LE.WINDOW(4).AND.V2.LE.WINDOW(4)) GO TO 110
3461          IF (V1.GT.WINDOW(4).AND.V2.GT.WINDOW(4)) GO TO 150
3462          IF (V1.GT.WINDOW(4)) GO TO 100
3463          U2 = (U2-U1)*(WINDOW(4)-V1)/(V2-V1)+U1
3464          V2  = WINDOW(4)
3465          GO TO 110
3466    100   U1 = (U1-U2)*(WINDOW(4)-V2)/(V1-V2)+U2
3467          V1 = WINDOW(4)
3468    C
3469    C  PLOT THE EDGE
3470    C
3471    110    IF(LWD.NE.ESPEC(1,J)) THEN
3472             LWD = ESPEC(1,J)
3473             CALL LINWID(LWD)
3474           ENDIF
3475           IF(LCL.NE.ESPEC(2,J)) THEN
3476             LCL = ESPEC(2,J)
3477             CALL COLOR(LCL)
3478           ENDIF
3479           CALL LINE(U1, V1, U2, V2)
3480    150    CONTINUE
3481    C
3482    C      PLOT POLYGONS ON TOP OF EDGES
```

```
3483  C
3484        DO 10 J = 1, NP
3485        NUM=0
3486  C
3487  C     DETERMINE THE NUMBER OF VERTICES (NON-ZERO ENTRIES) IN THE
3488  C     POLYGON
3489  C
3490        DO 15 I=1,8
3491        IF(POLY(I,J).NE.0) NUM=NUM+1 ;NUMBER OF VERTICES IN POLYGON
3492  15    CONTINUE
3493  C
3494  C     MOVE THE VERTICES INTO A LOCAL WORK ARRAY
3495  C
3496        DO 61 I = 1, NUM
3497        DO 61 K = 1, 3
3498     61 XYZ(K,I) = VERTEX(K,POLY(I,J))
3499  C
3500  C     APPLY THE TRANSFORM
3501  C
3502        DO 62 I = 1, NUM
3503        U1 = XYZ(1,I)
3504        U2 = XYZ(2,I)
3505        U3 = XYZ(3,I)
3506        XYZ(1,I) = XDC(1,1)*U1 + XDC(1,2)*U2 + XDC(1,3)*U3 + XDC(1,4)
3507        XYZ(2,I) = XDC(2,1)*U1 + XDC(2,2)*U2 + XDC(2,3)*U3 + XDC(2,4)
3508     62 XYZ(3,I) = XDC(3,1)*U1 + XDC(3,2)*U2 + XDC(3,3)*U3 + XDC(3,4)
3509  C
3510  C     ADD PERSPECTIVE
3511  C
3512        DO 60 IV=1,NUM
3513        D = DOZ/((DOZ+XYZ(3,IV))*TANAL)
3514        X(IV) = (XYZ(1,IV) - WCX)*D  +  WCX
3515     60 Y(IV) = (XYZ(2,IV) - WCY)*D  +  WCY
3516  C
3517  C  PLOT THE POLYGON
3518  C
3519        IF(PSPEC(1,J).NE.LWD) THEN
3520          LWD = PSPEC(1,J)
3521          CALL LINWID(LWD)
3522        ENDIF
3523        IF(PSPEC(2,J).NE.LCL) THEN
3524          LCL = PSPEC(2,J)
3525          CALL COLOR(LCL)
3526        ENDIF
3527        IF(PSPEC(3,J).NE.LFL) THEN
3528          LFL = PSPEC(3,J)
3529          CALL FILTYP(LFL)
3530        ENDIF
3531        IF(PSPEC(4,J).GE.0) THEN
3532          CALL PLYGON(X, Y, NUM)
3533        ELSE
3534          CALL LINES(X(1), Y(1), X(2), Y(2), NUM-1)
3535        ENDIF
3536  10    CONTINUE                    ;GET NEXT POLYGON
3537        RETURN
```

```
3538        END
3539  C
```

```
3540        SUBROUTINE VOLFRM (MODE1)
3541  C
3542  C     THIS ENTRY PUTS A FRAME AROUND THE REGION IF DESIRED.
3543  C     FIRST PLOT + AT ALL OF THE VERTICES.
3544  C
3545            COMMON/VOLCOM/XR,YR,A,TP,AP,DX,DY,DZ,X,Y,Z,SC1,FSEG,NTT
3546            LOGICAL A(1)
3547            INTEGER TP,AP
3548            DIMENSION XR(8),YR(8),DX(4),DY(4),DZ(4),X(4),Y(4),Z(4),SC1(4)
3549            DO 101 I = 1, 8
3550     101    CALL CHPLOT (SC1, XR(I), YR(I), '+¶.', 1,1,1)
3551  C
3552  C     NOW CHECK THE VARIOUS LINES.
3553  C
3554            IF (MODE1 .LE. 1) GO TO 102
3555            CALL LINE (XR(1),YR(1), XR(2),YR(2))
3556            CALL LINE (XR(6),YR(6), XR(2),YR(2))
3557            CALL LINE (XR(6),YR(6), XR(5),YR(5))
3558            CALL LINE (XR(1),YR(1), XR(5),YR(5))
3559            CALL VOLUM8 (XR(4),YR(4), XR(3),YR(3), T, NT)
3560            CALL VOLUM8 (XR(4),YR(4), XR(8),YR(8), T, NT)
3561            CALL VOLUM8 (XR(7),YR(7), XR(8),YR(8), T, NT)
3562            CALL VOLUM8 (XR(7),YR(7), XR(3),YR(3), T, NT)
3563            CALL VOLUM8 (XR(4),YR(4), XR(2),YR(2), T, NT)
3564            CALL VOLUM8 (XR(1),YR(1), XR(3),YR(3), T, NT)
3565            CALL VOLUM8 (XR(6),YR(6), XR(8),YR(8), T, NT)
3566            CALL VOLUM8 (XR(7),YR(7), XR(5),YR(5), T, NT)
3567     102    CONTINUE
3568            RETURN
3569        END
3570  C
```

```
3571          SUBROUTINE VOLUMO (Q, R, NX, NY, NZ)
3572    C
3573               REAL      X(8), Y(8), Q(8), R(8)
3574               RNX = 1.0/FLOAT(NX-1)
3575               RNY = 1.0/FLOAT(NY-1)
3576               RNZ = 1.0/FLOAT(NZ-1)
3577               FNX = NX
3578               FNY = NY
3579               FNZ = NZ
3580               DO 1 I = 1, 8
3581               X(I) = Q(I)
3582         1     Y(I) = R(I)
3583               RETURN
3584    C
3585    C
3586          ENTRY VOLUM6 (XA,YA, XG,YG,ZG)
3587    C
3588               DI1 = (FNX - XG)*RNX
3589               DJ1 = (FNY - YG)*RNY
3590               DK1 = (FNZ - ZG)*RNZ
3591               DIN = 1.0 - DI1
3592               DJN = 1.0 - DJ1
3593               DKN = 1.0 - DK1
3594               XA = ((X(1)*DI1+X(2)*DIN)*DJ1 + (X(3)*DI1+X(4)*DIN)*DJN)*DK1
3595         1        + ((X(5)*DI1+X(6)*DIN)*DJ1 + (X(7)*DI1+X(8)*DIN)*DJN)*DKN
3596               YA = ((Y(1)*DI1+Y(2)*DIN)*DJ1 + (Y(3)*DI1+Y(4)*DIN)*DJN)*DK1
3597         1        + ((Y(5)*DI1+Y(6)*DIN)*DJ1 + (Y(7)*DI1+Y(8)*DIN)*DJN)*DKN
3598               RETURN
3599          END
3600    C
```

```
3601          SUBROUTINE VOLUM7 (CLEVEL, F00,F10,F11,F01, NSEG, X, Y)
3602    C
3603               REAL      X(4), Y(4)
3604    C
3605    C     AT LEAST ONE CROSSING WILL BE FOUND. TEST THE LOWER SEGMENT FIRST.
3606    C
3607               ISEG = 0
3608               IF (F00.NE.F10) DX = (CLEVEL-F00)/(F10-F00)
3609               IF (F00.EQ.F10) DX = 0.0
3610               IF (DX.GE.1.0 .OR. DX.LE.0.0) GO TO 2
3611    C
3612    C     RECORD THE LOWER CROSSING.
3613    C
3614               ISEG = ISEG + 1
3615               X(ISEG) = DX
3616               Y(ISEG) = 0.0
3617    C
3618    C     TEST THE RIGHT SEGMENT.
3619    C
3620         2     IF (F10.NE.F11) DY = (CLEVEL-F10)/(F11-F10)
3621               IF (F10.EQ.F11) DY = 0.0
3622               IF (DY.GE.1.0 .OR. DY.LE.0.0) GO TO 3
3623    C
3624    C     RECORD THE RIGHT SIDE CROSSING.
3625    C
3626               ISEG = ISEG + 1
3627               X(ISEG) = 1.0
3628               Y(ISEG) = DY
3629    C
3630    C     TEST THE TOP SEGMENT.
3631    C
3632         3     IF (F11.NE.F01) DX = (CLEVEL-F01)/(F11-F01)
3633               IF (F11.EQ.F01) DX = 1.0
3634               IF (DX.GE.1.0 .OR. DX.LE.0.0) GO TO 4
3635    C
3636    C     RECORD THE TOP CROSSING.
3637    C
3638               ISEG = ISEG + 1
3639               X(ISEG) = DX
3640               Y(ISEG) = 1.0
3641    C
3642    C     TEST THE LEFT SIDE SEGMENT.
3643    C
3644         4     IF (F01.NE.F00) DY = (CLEVEL-F00)/(F01 - F00)
3645               IF (F01.EQ.F00) DY = 1.0
3646               IF (DY.GE.1.0 .OR. DY.LE.0.0) GO TO 5
3647    C
3648    C     RECORD THE LEFT SIDE CROSSING.
3649    C
3650               ISEG = ISEG + 1
3651               X(ISEG) = 0.0
3652               Y(ISEG) = DY
3653    C
3654    C     SAVE ANY LINE SEGMENTS FOUND
3655    C
```

```
3656       5     NSEG = ISEG
3657             RETURN
3658           END
```

```
      SUBROUTINE VOLUM8 (XA, YA, XB, YB, T, NT)
C
          COMMON/VOLCOM/XR,YR,A,TP,AP,DX,DY,DZ,P,Q,R,SC1,FSEG,NTT
          DIMENSION XR(8),YR(8),DX(4),DY(4),DZ(4),P(4),Q(4),R(4),SC1(4)
          LOGICAL T(NT, NT)
          DATA     KINC / 1 /
          LOGICAL  SW1
C
          IF (SQRT((XB-XA)**2 + (YB-YA)**2) .LT. 1.9) RETURN
C
C     CHECK FOR HIDDEN PORTIONS OF THE LINE.
C
          RSEG=FLOAT(NTT)/1024.
          IAT = RSEG*XA
          IBT = RSEG*XB
          JAT = RSEG*YA
          JBT = RSEG*YB
          KI = ABS(XB-XA)
          KJ = ABS(YB-YA)
          IF (KI.GT.120 .OR. KJ.GT.120) GO TO 1
          IF (.NOT.T(IAT,JAT) .OR. .NOT.T(IBT,JBT)) GO TO 1
          CALL LINE (XA,YA, XB,YB)
          RETURN
C
C     AT LEAST PART OF THE LINE IS HIDDEN. FIND REASONABLE LIMITS.
C
    1     KMAX = (MAXO(KI,KJ)/KINC)*KINC + 1
          IF (KMAX .LT. 2) RETURN
C
C     NOW CHECK EACH SEGMENT ALONG THE LINE.
C
          SW1 = .FALSE.
          DO 2 K = 1, KMAX, KINC
          FA = FLOAT(K-1)/FLOAT(KMAX-1)
          X = XA + FA*(XB - XA)
          Y = YA + FA*(YB - YA)
          IX = RSEG*X
          IY = RSEG*Y
          IF (SW1) GO TO 3
C
C     UPDATE THE FIRST POINT IF SW1 IS .FALSE.
C
          IF (.NOT.T(IX,IY)) GO TO 3
          XST = X
          YST = Y
          SW1 = .TRUE.
C
C     SET THE END POINT.
C
    3     IF (T(IX,IY) .AND. K.NE.KMAX) GO TO 2
          IF (.NOT.SW1) GO TO 2
          FB = FLOAT(K-1-KINC)/FLOAT(KMAX-1)
          XND = XA + FB*(XB - XA)
          YND = YA + FB*(YB - YA)
          CALL LINE (XST,YST, XND,YND)
```

```
3714                SW1 = .FALSE.
3715          2     CONTINUE
3716                RETURN
3717              END
3718  C
```

```
      SUBROUTINE VOLUME (MODE, F, NX,NY,NZ, CLEVE, NCL, T, NT)
C
C
C     THIS SET OF ROUTINES IS DESIGNED TO DRAW ON A DEVICE, SUCH AS
C     A PRINTER, A PLOTTER, THE SC4020 OR THE TEKTRONICS GRAPHICS
C     TERMINAL,  A TWO-DIMENSION PROJECTION OF A THREE DIMENSIONAL
C     ARRAY (FIGURE).  THE HIDDEN LINES ARE ELIMINATED TO SIMULATE
C     THE EFFECT OF "3D".
C
C     THE COLOR OF THE FIGURES (FOR THE SC4020 ONLY) MUST BE SET
C     BY THE USER IN THE CALLING PROGRAM USING THE APPROPRIATE CALLS
C     TO THE GRAPHICS PACKAGE.
C
C     THE AXIS ARE LABELED AS FOLLOWS: X IS LEFT TO RIGHT
C                                      Y IS INTO THE PAGE
C                                      Z IS BOTTOM TO TOP
C
C     TO INITIALIZE THE PLOTTING PACKAGE, "VOLSET" MUST BE CALLED.
C     IF A FRAME SURROUNDING THE DRAWING IS WANTED, CALL "VOLFRM".
C     THE ROUTINE LOOPS OVER THE Y AXIS FROM FRONT TO BACK, PLOTTING
C     EACH SUCCESSIVE (X,Z) PLANE.  AT THE END OF THE (X,Z) CYCLE,
C     THE ARRAY "T" IS SET TO INDICATE WHAT WILL BE HIDDEN BY THE
C     CURRENT PLANE.
C
C   . CALLING SEQUENCE OR OPERATIONAL PROCEDURE:
C
C     CALL VOLSET(XP, YP, T, NT)
C     CALL VOLUME (MODE, F, NX, NY, NZ, CLEVE, NCL)
C     CALL VOLFRM(MODE1)
C
C   . ARGUMENTS (TYPE AND SIGNIFICANCE) AND/OR INITIAL CONDITIONS:
C
C      XP CONTAINS THE LOCATIONS OF THE X POSITION OF THE VERTICES (8)
C      YP CONTAINS THE CORRESPONDING Y VALUES (8)
C      T IS THE PLOTTING ARRAY (BOOLEAN) TO ELIMINATE THE HIDDEN LINES
C        WHICH IS NT X NT IN SIZE (THIS ARRAY TOGETHER WITH
C        NX,NY,NZ DETERMINE THE FINESSE OF THE PLOT).
C      MODE DETERMINES WHICH SURFACE IS PLOTTED (USED WITH CLEVE)
C       ABS(MODE)=1 WILL PLOT THE CONTOUR LEVEL "CLEVE" IN EACH PLANE
C                   AND THEN FIXES THE HIDDEN LINE MATRIX "T".
C       ABS(MODE)=2 SIMPLY FIXES THE HIDDEN LINE MATRIX "T" WITHOUT
C                   PLOTTING.  THIS IS USEFUL IN AVOIDING MULTIPLE
C                   PLOTS OF THE SAME FIXED FIGURE.
C       MODE<0      IS USED WHEN THE VALUE OF THE FUNCTION ON THE
C                   "OUTSIDE" IS LESS THAN "CLEVE".
C       MODE>0      IS USED WHEN THE VALUE OF THE FUNCTION ON THE
C                   "OUTSIDE" IS GREATER THAN "CLEVE".
C      F IS THE THREE-DIMENSIONAL FIGURE TO BE PLOTTED.
C      NX,NY,NZ ARE THE DIMENSIONS OF THIS ARRAY <F(NX,NY,NZ)>
C      CLEVE IS THE CONTOUR SURFACE LEVEL FOR PLOTTING.
C      NCL IS THE NUMBER OF PAIRS OF (MODE,CLEVE) TO BE PLOTTED.
C      MODE1 IS THE MODE OF FRAMING 0=> "+" AT THE EIGHT VERTICES;
C                                   1=> A BOX FORMED BY LINES.
C
```

```
3774  C
3775            COMMON/VOLCOM/XR,YR,A,TP,AP,DX,DY,DZ,X,Y,Z,SC1,FSEG,NTT
3776            LOGICAL T(NT,NT)
3777            DIMENSION XR(8),YR(8),DX(4),DY(4),DZ(4),X(4),Y(4),Z(4),SC1(4)
3778            INTEGER  MODE(NCL)
3779            REAL     F(NX,NY,NZ), CLEVE(NCL)
3780            REAL XP(8), YP(8)
3781  C
3782            CALL VOLUM0 (XR,YR, NX,NY,NZ)
3783  C
3784  C     THE OUTER LOOP IS OVER THE I,K SURFACES MOVING BACK.
3785  C
3786            DO 1 J = 1, NY
3787            IF (J.EQ.1) GO TO 2
3788  C
3789  C     THEN LOOP OVER THE VARIOUS CONTOUR LEVELS.
3790  C
3791            DO 20 LL = 1, NCL
3792            CLEVEL = CLEVE(LL)
3793            MODEL = MODE(LL)
3794            IF (IABS (MODEL) .EQ. 2) GO TO 20
3795  C
3796  C     FIRST COMPUTE THE FRONT-TO-BACK LINE SEGMENTS.
3797  C
3798            DO 3 I = 1, NX
3799            DO 4 K = 2, NZ
3800            FMAX = AMAX1 (F(I,J-1,K-1), F(I,J,K-1), F(I,J,K), F(I,J-1,K))
3801            FMIN = AMIN1 (F(I,J-1,K-1), F(I,J,K-1), F(I,J,K), F(I,J-1,K))
3802            IF (FMAX.LT.CLEVEL .OR. FMIN.GT.CLEVEL) GO TO 4
3803            CALL VOLUM7 (CLEVEL, F(I,J-1,K-1), F(I,J,K-1),
3804     1          F(I,J,K), F(I,J-1,K), NSEG, DY, DZ)
3805            IF (NSEG .LE. 1) GO TO 4
3806            DO 5 L = 1, NSEG
3807            X(L) = FLOAT(I)
3808            Y(L) = FLOAT(J-1) + DY(L)
3809       5    Z(L) = FLOAT(K-1) + DZ(L)
3810            CALL VOLUM6 (XA,YA, X(1),Y(1),Z(1))
3811            CALL VOLUM6 (XB,YB, X(2),Y(2),Z(2))
3812            CALL VOLUM8 (XA,YA, XB,YB, T, NT)
3813            IF (NSEG.NE.4) GO TO 4
3814            CALL VOLUM6 (XA,YA, X(3),Y(3),Z(3))
3815            CALL VOLUM6 (XB,YB, X(4),Y(4),Z(4))
3816            CALL VOLUM8 (XA,YA, XB,YB, T, NT)
3817       4    CONTINUE
3818       3    CONTINUE
3819            DO 6 K = 1, NZ
3820            DO 7 I = 2, NX
3821            FMAX = AMAX1 (F(I-1,J-1,K), F(I,J-1,K), F(I,J,K), F(I-1,J,K))
3822            FMIN = AMIN1 (F(I-1,J-1,K), F(I,J-1,K), F(I,J,K), F(I-1,J,K))
3823            IF (FMAX.LT.CLEVEL .OR. FMIN.GT.CLEVEL) GO TO 7
3824            CALL VOLUM7 (CLEVEL, F(I-1,J-1,K), F(I,J-1,K),
3825     1          F(I,J,K), F(I-1,J,K), NSEG, DX, DY)
3826            IF (NSEG .LE. 1) GO TO 7
3827            DO 8 L = 1, NSEG
3828            X(L) = FLOAT(I-1) + DX(L)
```

```
3829              Y(L) = FLOAT(J-1) + DY(L)
3830        8     Z(L) = FLOAT(K)
3831              CALL VOLUM6 (XA,YA, X(1),Y(1),Z(1))
3832              CALL VOLUM6 (XB,YB, X(2),Y(2),Z(2))
3833              CALL VOLUM8 (XA,YA, XB,YB, T, NT)
3834              IF (NSEG.NE.4) GO TO 7
3835              CALL VOLUM6 (XA,YA, X(3),Y(3),Z(3))
3836              CALL VOLUM6 (XB,YB, X(4),Y(4),Z(4))
3837              CALL VOLUM8 (XA,YA, XB,YB, T, NT)
3838        7     CONTINUE
3839        6     CONTINUE
3840       20     CONTINUE
3841  C
3842  C       NOW PLOT THE X-Z SURFACE CONTOURS BEFORE CORRECTING THE HIDDEN
3843  C       LINE ARRAY.
3844  C
3845        2     DO 21 LL = 1, NCL
3846              CLEVEL = CLEVE(LL)
3847              MODEL = MODE(LL)
3848              IF (IABS (MODEL) .EQ. 2) GO TO 21
3849              DO 9 K = 2, NZ
3850              DO 10 I = 2, NX
3851              FMAX = AMAX1 (F(I-1,J,K-1), F(I,J,K-1), F(I,J,K), F(I-1,J,K))
3852              FMIN = AMIN1 (F(I-1,J,K-1), F(I,J,K-1), F(I,J,K), F(I-1,J,K))
3853              IF (FMAX.LT.CLEVEL .OR. FMIN.GT.CLEVEL) GO TO 10
3854              CALL VOLUM7 (CLEVEL, F(I-1,J,K-1), F(I,J,K-1),
3855        1         F(I,J,K), F(I-1,J,K), NSEG, DX, DZ)
3856              IF (NSEG .LE. 1) GO TO 10
3857              DO 11 L = 1, NSEG
3858              X(L) = FLOAT(I-1) + DX(L)
3859              Y(L) = FLOAT(J)
3860       11     Z(L) = FLOAT(K-1) + DZ(L)
3861              CALL VOLUM6 (XA,YA, X(1),Y(1),Z(1))
3862              CALL VOLUM6 (XB,YB, X(2),Y(2),Z(2))
3863              CALL VOLUM8 (XA,YA, XB,YB, T, NT)
3864              IF (NSEG.NE.4) GO TO 10
3865              CALL VOLUM6 (XA,YA, X(3),Y(3),Z(3))
3866              CALL VOLUM6 (XB,YB, X(4),Y(4),Z(4))
3867              CALL VOLUM8 (XA,YA, XB,YB, T, NT)
3868       10     CONTINUE
3869        9     CONTINUE
3870       21     CONTINUE
3871  C
3872  C       FILL THE HIDDEN LINE ARRAY AFTER PLOTTING IN THE NEW PLANE.
3873  C
3874              DO 22 LL = 1, NCL
3875              CLEVEL = CLEVE(LL)
3876              MODEL = MODE(LL)
3877              DO 12 K = 2, NZ
3878              DO 13 I = 2, NX
3879              IF (MODEL.GT.0 .AND. AMIN1(F(I-1,J,K-1), F(I,J,K-1),
3880        1         F(I-1,J,K), F(I,J,K)).GT.CLEVEL) GO TO 13
3881              IF (MODEL.LT.0 .AND. AMAX1(F(I-1,J,K-1), F(I,J,K-1),
3882        1         F(I-1,J,K), F(I,J,K)).LT.CLEVEL) GO TO 13
3883  C
```

```
3884  C     THERE IS HIDDEN STUFF SOMEWHERE IN THE CELL. FIRST FIND THE LIMITS
3885  C     OF THE CELL.
3886  C
3887            CALL VOLUM6 (X00,Y00, FLOAT(I-1), FLOAT(J), FLOAT(K-1))
3888            CALL VOLUM6 (X10,Y10, FLOAT(I  ), FLOAT(J), FLOAT(K-1))
3889            CALL VOLUM6 (X11,Y11, FLOAT(I  ), FLOAT(J), FLOAT(K  ))
3890            CALL VOLUM6 (X01,Y01, FLOAT(I-1), FLOAT(J), FLOAT(K  ))
3891            DXMAX = AMAX1 (ABS(X10-X00),ABS(X11-X01))
3892            DYMAX = AMAX1 (ABS(Y01-Y00),ABS(Y11-Y10))
3893            NSEGX = (DXMAX + FSEG)/FSEG
3894            NSEGZ = (DYMAX + FSEG)/FSEG
3895            DII = 1.0/NSEGX
3896            DKK = 1.0/NSEGZ
3897            DO 14 II = 1, NSEGX
3898            XGRID = (FLOAT(II) - 0.5)*DII
3899            DO 15 KK = 1, NSEGZ
3900            ZGRID = (FLOAT(KK) - 0.5)*DKK
3901            CALL VOLUM6 (XA,YA,XGRID+FLOAT(I-1),FLOAT(J),ZGRID+FLOAT(K-1))
3902            IXA = XA/FSEG
3903            IYA = YA/FSEG
3904            IF (.NOT.T(IXA,IYA)) GO TO 15
3905  C
3906  C     FIND THE VALUE OF F AT THE POINT UNDER SCRUTINY.
3907  C
3908            FVAL = (F(I-1,J,K-1)*(1.0-XGRID)+F(I,J,K-1)*XGRID)*(1.0-ZGRID)
3909       1         +  (F(I-1,J,K)*(1.0-XGRID) +F(I,J,K)*XGRID)*ZGRID
3910            IF (MODEL.GT.0.AND.FVAL.LT.CLEVEL) T(IXA,IYA) = .FALSE.
3911            IF (MODEL.LT.0.AND.FVAL.GT.CLEVEL) T(IXA,IYA) = .FALSE.
3912       15   CONTINUE
3913       14   CONTINUE
3914  C
3915       13   CONTINUE
3916       12   CONTINUE
3917       22   CONTINUE
3918        1   CONTINUE
3919            RETURN
3920  C
3921       ENTRY VOLSET (XP, YP, T, NT)
3922  C
3923  C         THIS FIRST ENTRY INITIALIZES THE PLOT GEOMETRY AND FILLS THE
3924  C     HIDDEN LINE ARRAY T WITH THE INITIAL .TRUE. FOR TRANSPARENT. THE
3925  C     ARRAY T IS NT X NT (OR 16K WORDS MAX) AND IS PASSED IN FROM THE
3926  C     OUTSIDE. THIS CORRESPONDS TO 1024/NT RASTER UNITS ON THE SC4020.
3927  C
3928  C
3929            SC1(1) = 1.0
3930            SC1(2) = 0.0
3931            SC1(3) = 1.0
3932            SC1(4) = 0.0
3933            DO 100 I = 1, NT
3934            DO 100 J = 1, NT
3935       100  T(I,J) = .TRUE.
3936            FSEG = 1024.0/FLOAT(NT)
3937            DO 103 I = 1, 8
3938            XR(I) = XP(I)
```

```
3939    103     YR(I) = YP(I)
3940            NTT = NT
3941            RETURN
3942        END
```

```
3943            SUBROUTINE WDCOUNT(W,NC)
3944  C
3945  C     COUNT THE NUMBER OF CHARACTERS (LEGITIMATE) IN A STRING
3946  C
3947            CHARACTER*1 W(*), E, P, B,  H, U, D, L, C, R, O, M
3948            DATA E/'¶'/,P/'.'/,B/'B'/,H/'H'/,U/'U'/,D/'D'/,L/'L'/
3949            DATA C/'C'/,R/'R'/,O/'O'/,M/'M'/
3950  C
3951            IP = 0 ; NO CHARACTERS
3952            I = 1
3953    100     IF(W(I).EQ.E) THEN
3954              IF(W(I+1).EQ.H) THEN
3955                I = I + 2
3956              ELSE
3957                IF(W(I+1).EQ.U) THEN
3958                ELSE
3959                  IF(W(I+1).EQ.D) THEN
3960                  ELSE
3961                    IF(W(I+1).EQ.L.OR.W(I+1).EQ.R.OR.W(I+1).EQ.M) THEN
3962                    ELSE
3963                      IF(W(I+1).EQ.B) THEN
3964                      ELSE
3965                        IF(W(I+1).EQ.O) THEN
3966                        ELSE
3967                          IF(W(I+1).EQ.C) THEN
3968                            I = I + 2
3969                          ELSE
3970                            IF(W(I+1).EQ.E) THEN
3971                              GO TO 200
3972                            ELSE
3973                              IF(W(I+1).EQ.P) THEN
3974                                GO TO 300
3975                              ELSE
3976                                GO TO 101
3977                              ENDIF
3978                            ENDIF
3979                          ENDIF
3980                        ENDIF
3981                      ENDIF
3982                    ENDIF
3983                  ENDIF
3984                ENDIF
3985              ENDIF
3986            ELSE
3987              GO TO 200
3988            ENDIF
3989  C
3990    101     I = I + 2
3991            IF(I.GT.132) GO TO 400 ; QUIT ANYHOW
3992            GO TO 100
3993  C
3994  C     COUNT A CHARACTER
3995  C
3996    200     I = I + 1
3997            IP = IP + 1
```

```
3998              GO TO 100
3999  C
4000  C       TERMINATE
4001  C
4002     300      NC = IP
4003              RETURN
4004  C
4005  C       TERMINATE
4006  C
4007     400      NC = 0
4008              RETURN
4009              END
```

```
4010            SUBROUTINE WDDRAW(XSTART, YSTART, DX, DY, SX, SXY, SY, W)
4011  C
4012  C       XSTART REAL     - X COORDINATE (MATHEMATICAL SPACE) OF THE FIRST
4013  C                         CHARACTER TO BE DRAWN
4014  C       YSTART REAL     - Y COORDINATE (MATHEMATICAL SPACE) OF THE FIRST
4015  C                         CHARACTER TO BE DRAWN
4016  C       DX      REAL    - INCREMENT TO BE ADDED TO THE X COORDINATE FOR
4017  C                         EACH CHARACTER DRAWN
4018  C       DY      REAL    - INCREMENT TO BE ADDED TO THE Y COORDINATE FOR
4019  C                         EACH CHARACTER DRAWN
4020  C       SX      REAL    - X MATH SPACE SIZE FOR CHARACTERS
4021  C       SXY     REAL    - SLANT MODIFIER FOR CHARACTERS
4022  C       SY      REAL    - Y MATH SPACE SIZE FOR CHARACERS
4023  C       W               - CHARACTER STRING TO BE DRAWN.
4024  C
4025  C     CONTROL CHARACTERS¶L - TEXT IS DRAWN TO THE LEFT OF XSTART,YSTART
4026  C                         ¶M - TEXT IS CENTERED AT XSTART,YSTART
4027  C                         ¶R - TEXT IS DRAWN TO THE RIGHT OF XSTART,YSTART
4028  C
4029  C                         ¶H - CHANGE CHARACTER SETS ... ¶H01, ¶H02,
4030  C                              ... ¶H20, ¶H21 FOR CHARACTER SETS
4031  C                              1, 2, ... 20, AND 21.
4032  C
4033  C                         ¶U - DRAW THE FOLLOWING CHARACTERS IN
4034  C                              SUPERSCRIPT.
4035  C                         ¶D - DRAW THE FOLLOWING CHARACTERS IN SUBSCRIPT.
4036  C                         ¶O - RESET CHARACTER SIZE AND PLACEMENT FROM
4037  C                              SUPERSCRIPT OR SUBSCRIPT TO ORIGINAL
4038  C                              SIZE.
4039  C
4040  C                         ¶B - BACKSPACE OVER LAST CHARACTER DRAWN.
4041  C                              WORKS ONLY FOR ONE CHARACTER.  MULTIPLE
4042  C                              BACKSPACES WILL PRODUCE UNPREDICTABLE
4043  C                              RESULTS.
4044  C
4045  C                         ¶C - CHANGE COLOR, ¶C00, ¶C01, ... TO CHANGE
4046  C                              TO COLOR 0, 1, ...
4047  C
4048  C                         ¶. - END OF CHARACTER STRING.
4049  C*************************************************************************
4050  C     WDDRAW
4051  C*************************************************************************
4052  C
4053            INTEGER CHNUMB, SDFLT
4054            CHARACTER*1 W(1), E, P, B, CC(4), H, U, D, L, C
4055            CHARACTER*1 CENTER, R, O, M
4056            DATA E/'¶'/,P/'.'/,B/'B'/,H/'H'/,U/'U'/,D/'D'/,L/'L'/
4057            DATA C/'C'/,R/'R'/,O/'O'/,M/'M'/, SDFLT/4/, SE/4/
4058            REAL   X(132),Y(132),SCL(132),XLL(125),YLL(125),PEN(125)
4059            COMMON /DEVTYP/ IDEVIC,LSW,LTSW,XYCOOD(4),LUOUT,LPAGE
4060            COMMON/GRFTYP/ANGLE,IRVRSE,CHSIZE(9),ITKWIT,LUDIAG,LUHSET
4061            EQUIVALENCE  (CC,CHNUMB)
4062            INTEGER  SETL(132), SE, CH(132), ICL(132)
4063  C
4064  C
```

```
4065  C     SET THE PLOTTING SPACE PARAMETERS
4066  C
4067            CHSIZE(2) = SY * XYCOOD(3) * CHSIZE(6)
4068            CHSIZE(7) = CHSIZE(2)*(CHSIZE(3)+.5*(1.8-CHSIZE(6)))/XYCOOD(1)
4069            CHSIZE(8) = CHSIZE(2)*(CHSIZE(4)+.5*(1.8-CHSIZE(6)))/XYCOOD(3)
4070  C
4071            XL = 0.0
4072            YL = 0.0
4073            IP = 0
4074            ICOL = 0
4075            XLAST = XL
4076            WIDTH = 0.0
4077            SC = 1.0
4078            IC = 1
4079            I = 1
4080            CENTER = 'R'
4081  C
4082  C     SCAN THE INPUT STRING FOR JUSTIFICATION AND END OF TEXT
4083  C
4084    100     IF(W(I).EQ.E) THEN
4085              IF(W(I+1).EQ.H) THEN
4086                SE = CTOI(W(I+2),IC)*10 + CTOI(W(I+3),IC)
4087                IF (SE.LT.1.OR.SE.GT.24) SE = SDFLT
4088                I = I + 2
4089              ELSE
4090                IF(W(I+1).EQ.U) THEN
4091                  XL = XL + SX * 0.20 * SC
4092                  YL = YL + SY * 0.8 * SC
4093                  SC = SC * 0.6
4094                ELSE
4095                  IF(W(I+1).EQ.D) THEN
4096                    XL = XL + SX * 0.06 * SC
4097                    YL = YL - SY * 0.20 * SC
4098                    SC = SC * 0.6
4099                  ELSE
4100                    IF(W(I+1).EQ.L.OR.W(I+1).EQ.R.OR.W(I+1).EQ.M) THEN
4101                      CENTER = W(I+1)
4102                    ELSE
4103                      IF(W(I+1).EQ.B) THEN
4104                        XL = XL - WLAST
4105                      ELSE
4106                        IF(W(I+1).EQ.O) THEN
4107                          YL = 0.0
4108                          SC = 1.0
4109                        ELSE
4110                          IF(W(I+1).EQ.C) THEN
4111                            ICOL = CTOI(W(I+2),IC)*10 + CTOI(W(I+3),IC)
4112                            I = I + 2
4113                          ELSE
4114                            IF(W(I+1).EQ.E) THEN
4115                              GO TO 200
4116                            ELSE
4117                              IF(W(I+1).EQ.P) THEN
4118                                GO TO 300
4119                              ELSE
```

```
4120                                  I = I - 1
4121                                  GO TO 101
4122                                ENDIF
4123                              ENDIF
4124                            ENDIF
4125                          ENDIF
4126                        ENDIF
4127                      ENDIF
4128                    ENDIF
4129                  ENDIF
4130                ENDIF
4131              ELSE
4132                GO TO 200
4133              ENDIF
4134  C
4135     101      I = I + 2
4136              IF(I.GT.132) GO TO 300 ; QUIT ANYHOW
4137              GO TO 100
4138  C
4139  C      WE HAVE A CHARACTER
4140  C
4141     200      IF(SE.EQ.1) THEN
4142                CC(1) = W(I)
4143                CWMIN = 0.
4144                CWMAX = SX
4145              ELSE
4146                CHNUMB = IDCHAR(W(I))
4147                CALL HSETS (CHNUMB,XLL,YLL,PEN,NR,SE-1,IER)
4148                IF(IER.NE.0) THEN
4149                  IF(LUDIAG.GT.0) WRITE(LUDIAG,201) CHNUMB,SE,W(I)
4150     201          FORMAT(' CHARACTER ',Z10,' NOT FOUND IN SET ',I4,Z5)
4151                  GO TO 203
4152                ENDIF
4153                IF(NR.EQ.0) THEN
4154                  CWMIN  = 0.0
4155                  CWMAX = SX * 0.6
4156                ELSE
4157                  CWMIN = 1.0E+10
4158                  CWMAX = 0.
4159                  DO 202  J = 1, NR
4160                  XLL(J) = XLL(J) * 0.216 * SX
4161                  CWMIN = MIN (CWMIN, XLL(J))
4162     202          CWMAX = MAX (CWMAX, XLL(J))
4163                ENDIF
4164              ENDIF
4165  C
4166  C      STORE ITS PARAMETERS IN LOCAL SPACE
4167  C
4168              XLAST = XL
4169              IP = IP + 1
4170              X(IP) = XL - CWMIN
4171              Y(IP) = YL
4172              ICL(IP) = ICOL
4173              SCL(IP) = SC
4174              CH(IP) = CHNUMB
```

```
4175              SETL(IP) = SE
4176              WLAST = (0.500*SC+0.5)*(CWMAX-CWMIN) + 0.20*SC*DX
4177              XL = XL + WLAST
4178              YL = YL + DY
4179     203      I = I + 1
4180              GO TO 100
4181   C
4182   C      DRAW IT - FIRST SET THE CORRECT CENTERING
4183   C
4184     300      XOFF = X(1)
4185              WIDTH = XL - XOFF
4186              IF (CENTER.EQ.R) THEN
4187                DXX = 0.0
4188              ELSE IF (CENTER.EQ.M) THEN
4189                DXX = WIDTH / 2.
4190              ELSE IF (CENTER.EQ.L) THEN
4191                DXX = WIDTH
4192              END IF
4193              DO 301 I = 1, IP
4194     301      X(I) = X(I) - XOFF - DXX
4195   C
4196   C      DO ANY SHIFTING AND NECESSARY ROTATIONS
4197   C
4198              COSX = COS(ANGLE)
4199              SINX = SIN(ANGLE)
4200              SXX = ABS(XYCOOD(1))
4201              SYY = ABS(XYCOOD(3))
4202              OSX = 1. / SXX
4203              OSY = 1. / SYY
4204              DO 304 I = 1, IP
4205              XI = X(I) * COSX * SXX - Y(I) * SINX * SYY
4206              YI = X(I) * SINX * SXX + Y(I) * COSX * SYY
4207              X(I) = XI * OSX + XSTART
4208     304      Y(I) = YI * OSY + YSTART
4209   C
4210   C      NOW DO THE DRAW
4211   C
4212              IF(IP.LE.0) GO TO 303 ; NOTHING TO DO
4213              ICOL = 0
4214              DO 305 J = 1, IP
4215              IF(ICL(J).NE.0.AND.ICL(J).NE.ICOL) THEN
4216                CALL COLOR(ICL(J))
4217                ICOL = ICL(J)
4218              ENDIF
4219     305      CALL HHDRAW (X(J), Y(J), SX*SCL(J), SXY, SY*SCL(J),
4220         .     CH(J), SETL(J), IER)
4221     303      CHSIZE(2) = CHSIZE(1)
4222              ANGLE = 0.0
4223              RETURN
4224   C
4225   C      CHANGE THE DEFAULT CHARACTER SET - BYPASS THE ESCAPE SEQUENCE
4226   C
4227              ENTRY CHRSET (ISET)
4228              IF(ISET.GT.0) SE = ISET
4229              IF(LUDIAG.GT.0) WRITE(LUDIAG,302) ISET
```

```
4230              RETURN
4231     302      FORMAT(' CHANGE THE DEFAULT CHARACTER SET TO #',I3)
4232              RETURN
4233              END
```

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11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This paper describes an interface for programs which allows one to write graphics primitives to several devices without regard for the type of device. The most salient features are that it has low overhead, is transportable and can be expanded as the nature of the input/output devices changes. A conscious effort has been made to include all normal graphics primitives together with the most useful high level routines without compromising the use of special features of custom display units.

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