ORNL-3581
UC-32 – Mathematics and Computers
TID-4500 (26th ed.)

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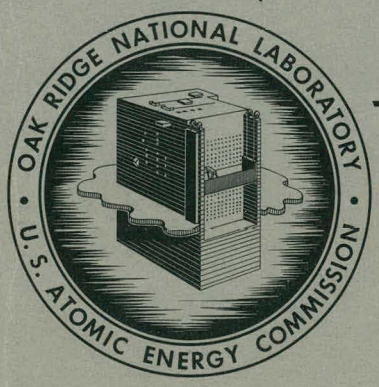

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ORNL-3581

Contract No. W-7405-eng-26

Neutron Physics Division

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MARCH 1964

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Abstract

An IBM-7090 subroutine package has been written to facilitate the plotting of curves and points on linear, logarithmic, and semi-logarithmic graphs using the CALCOMP plotter. The subroutines accomplish the necessary computations and prepare a magnetic tape for use by the plotter.

The CALCOMP Digital Incremental Plotter may be used to plot curves and points from data placed on tape by the IBM-7090 or certain other computers. A FORTRAN subroutine package has been written to aid the programmer when making linear, log-log, or semilog plots. These routines make use of FAP subroutines similar to those described by Cavin.[1] The package is very similar to a CDC-1604 package described previously.[2] The package prepares a magnetic tape written in density of 556 bits per inch. In the explanation which follows, a knowledge of FORTRAN will be assumed.

The height of the graphs is fixed at 10 in. but the width is under control of the user. The width of the plotting area should be set at 7 in. if an $8\frac{1}{2}$ x 11 in. graph is desired. The number of cycles is optional and so blank paper should be used in general but, with care, lined paper may also be used. There are three lines drawn per cycle at the values 10^N, 2×10^N, and 5×10^N.

The number of vertical lines drawn on the semilog and linear grids and the number of horizontal lines drawn on the linear grid are under the control of the user. An option is available which produces only 1/4-in. lines on the x and y axes rather than the full grid. It will, in general, be used with lined paper. If blank paper is used, a dummy graph with the full grid should be made first to initialize the pen. The plotting time is significantly reduced if this option is used. Each line is labeled.

The spacing between lines (called an "interval") is a parameter needed by the linear routines. Various labeling fixed-point formats are used to ensure at least two-figure accuracy on the x axis (independent variable) and at least three-figure accuracy on the y axis (dependent variable). To avoid truncation error in the labeling, the values of the interval should conform to the above specified accuracy. The maximum limits of the linear variables are -999 and 9999.

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1. D. K. Cavin, "CALCOMP Plotter Subroutine Package," unpublished memorandum.

2. D. K. Trubey and M. B. Emmett, A CDC-1604 Subroutine Package for Making Linear, Logarithmic, and Semilogarithmic Graphs Using the CALCOMP Plotter, ORNL-3447 (June 10, 1963).

Data points may be shown, or curves drawn, or both done as desired. If any data points lie outside the range specified for the graph, these points will not be plotted. The entire curve will be drawn except for portions connecting points which do not lie on the graph. The various data points available are shown in Fig. 1. A curve is drawn by connecting given points by straight lines. An option in the subroutine POINT allows one to mark the point only or draw a straight line to the point before marking it. If it is desired to fit a curve through a number of data points, a large number of values may be generated between data points by Lagrangian interpolation[3] or by some other means. Then straight lines are drawn between these points.

The axes may be labeled and a title written at the top of the graph through a subroutine which uses Hollerith characters.

The logical tape assignment is a parameter supplied to the subroutine. The user writes a main program which calls the various subroutines of the package as desired. The parameters in the call statements are integers or floating point numbers consistent with FORTRAN nomenclature. The use of each part of the package is as follows:

1. MAIN (calling program supplied by user)

    a. Must have a 6-cell array for passing information from one subroutine to another

    b. Must call LINEAR, SEMILOG, or LOGLOG before calling any other routine (except HOLLER) in the package

2. LOGLOG

    The routine is called by

    CALL LOGLOG(NCY,ITOPY,ITOPX,NCX,WIDTH,JTAPE,A)

where

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3. S. K. Penny and M. B. Emmett, An IBM-7090 Subroutine Package for Lagrangian Interpolation, ORNL-3428 (1962).

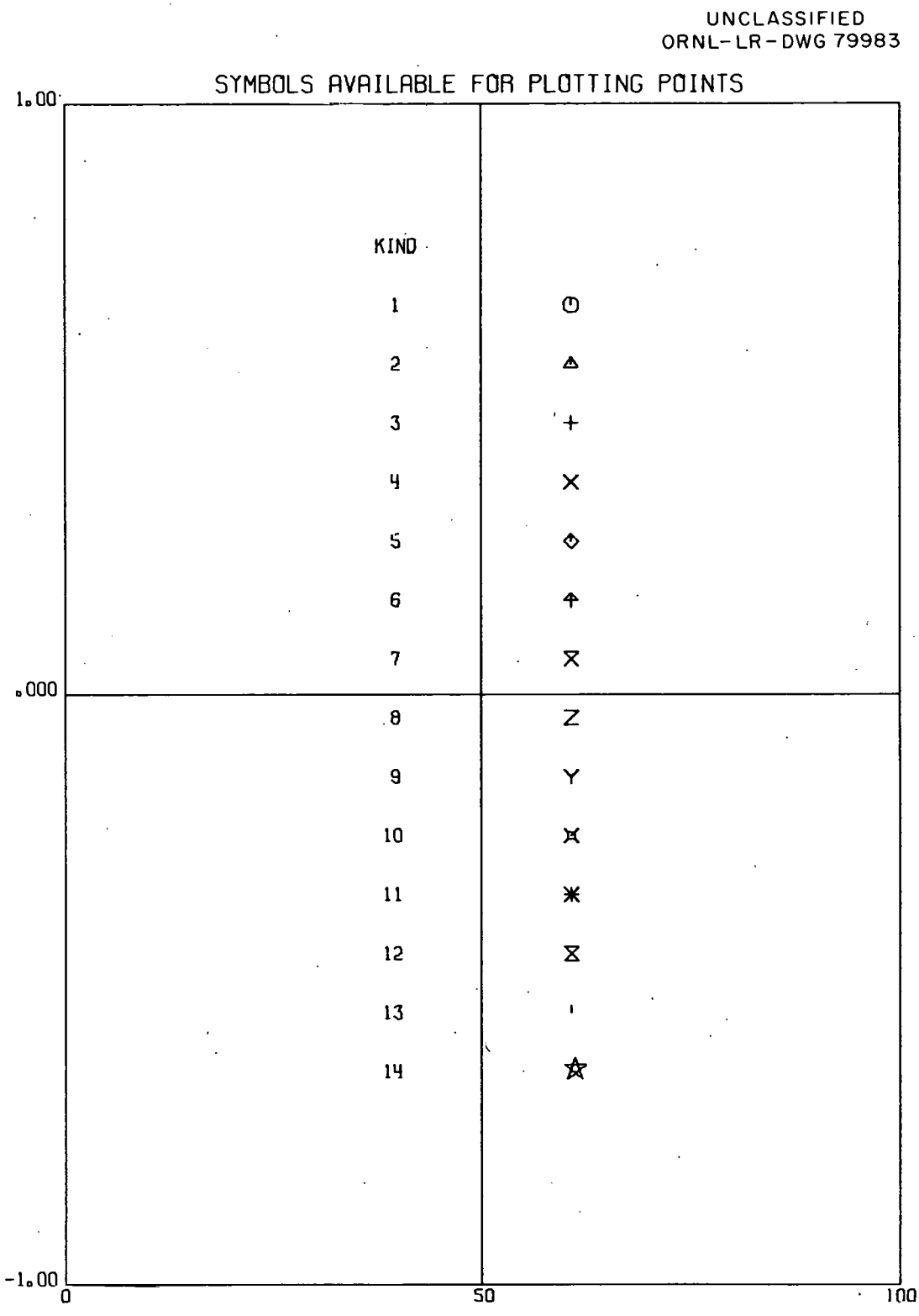

Fig. 1. Example of Linear Grid Showing Symbols Available for Plotting Points.

NCY = number of cycles of dependent variable (y)

ITOPY = largest exponent of 10 on y axis; the largest possible value of y is 10^{ITOPY}

ITOPX = largest exponent of 10 on x axis

NCX = number of cycles of independent variable (x)

WIDTH = width of plotting area in inches (if negative, the 1/4-in. lines are drawn; if positive, the whole grid)

JTAPE = logical tape unit used for CALCOMP tape

A = 6-cell array described for main routine (Sec. 1a)

This routine performs initialization which includes drawing the grid. An example is shown in Fig. 2.

3. SEMLOG

The routine is called by

CALL SEMLOG(NCY,ITOPY,XZERO,DELX,NOINT,WIDTH,JTAPE,A)

for a graph that is linear along the x axis and logarithmic along the y axis, where

NCY = number of cycles of dependent variable (y)

ITOPY = largest exponent of 10 on y axis

XZERO = smallest value of independent variable (x)

DELX = "interval" width (described above) on x axis or space between grid lines in units of the x variable (in Fig. 3, DELX = 2)

NOINT = number of "intervals" along x axis; the largest value of x is XZERO + NOINT * DELX (in Fig. 3, NOINT = 5)

WIDTH = width of plotting area in inches (use of sign to control grid described above)

JTAPE = logical tape unit used for CALCOMP tape

A = 6-cell array described for main routine

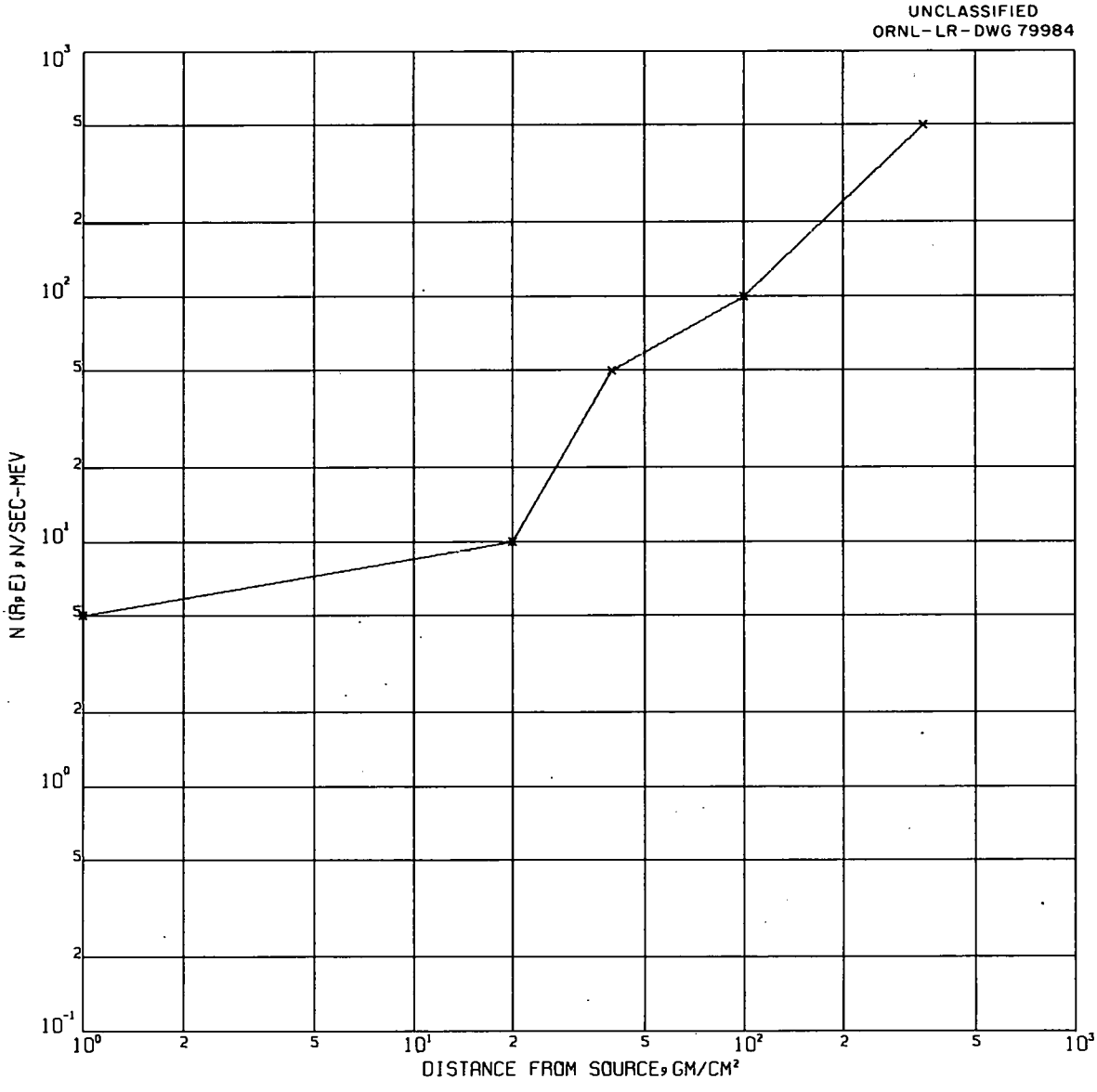

Fig. 2. Example of Log-Log Plot.

Reverse Option

The routine is called by

CALL SEMLOG(YZERO,DELY,NOINT,NCX,ITOPX,WIDTH,JTAPE,A)

for a graph that is linear along the y axis and logarithmic along the x axis where the parameters follow the above description with the interchange of x and y.* This routine initializes and draws the grid.

4. LINEAR

The routine is called by

CALL LINEAR(YZERO,DELY,NOINTY,XZERO,DELX,NOINTX,WIDTH,JTAPE,A)

where

YZERO = smallest value of dependent variable (y)

DELY = "interval" width on y axis or space between grid lines in units of the y variable

NOINTY = number of "intervals" along y axis; the largest value of y is YZERO + NOINTY * DELY

XZERO = smallest value of independent variable (x)

DELX = "interval" width along x axis

NOINTX = number of "intervals" along x axis

WIDTH = width of plotting area in inches (use of sign to control grid described above)

JTAPE = logical tape unit used for CALCOMP tape

A = 6-cell array described for main routine

This routine initializes and draws the grid.

5. CURVE

The routine is called by

CALL CURVE(N,X,Y,A)

---

*This option was originally coded by D. C. Irving.

where

N = 1 for the first point on a curve
≠ 1 for second and subsequent points

X = value of x

Y = value of y

A = 6-cell array described for main routine

The routine must be called for every point (x,y) on the curve to be plotted. A straight line will be drawn between successive points provided both points are on the graph. Each time CURVE is called, the pen moves to (x,y), with the pen either up (N=1) or down (N≠1). The value of N must be 1 for the first point on the curve. If the points are supplied by means of a loop, it is often convenient to set the value of N equal to the loop index.

6. POINT

The routine is called by

CALL POINT(N,X,Y,KIND,SIZE,THETA,I,A)

where

N = 1 for the first point on a curve (see definition of I)
≠ 1 for the second and subsequent points

X = value of x

Y = value of y

KIND = type of symbol to be plotted (see Fig. 1); $1 \leq \text{KIND} \leq 14$

SIZE = height of field of character to be plotted; for best results, SIZE should be an integral multiple of 0.04; in Fig. 1, SIZE = 0.12; in Figs. 2 and 3, SIZE = 0.08

THETA = angle (counterclockwise) in degrees at which the point symbol is to be rotated (in Fig. 1, THETA=0)

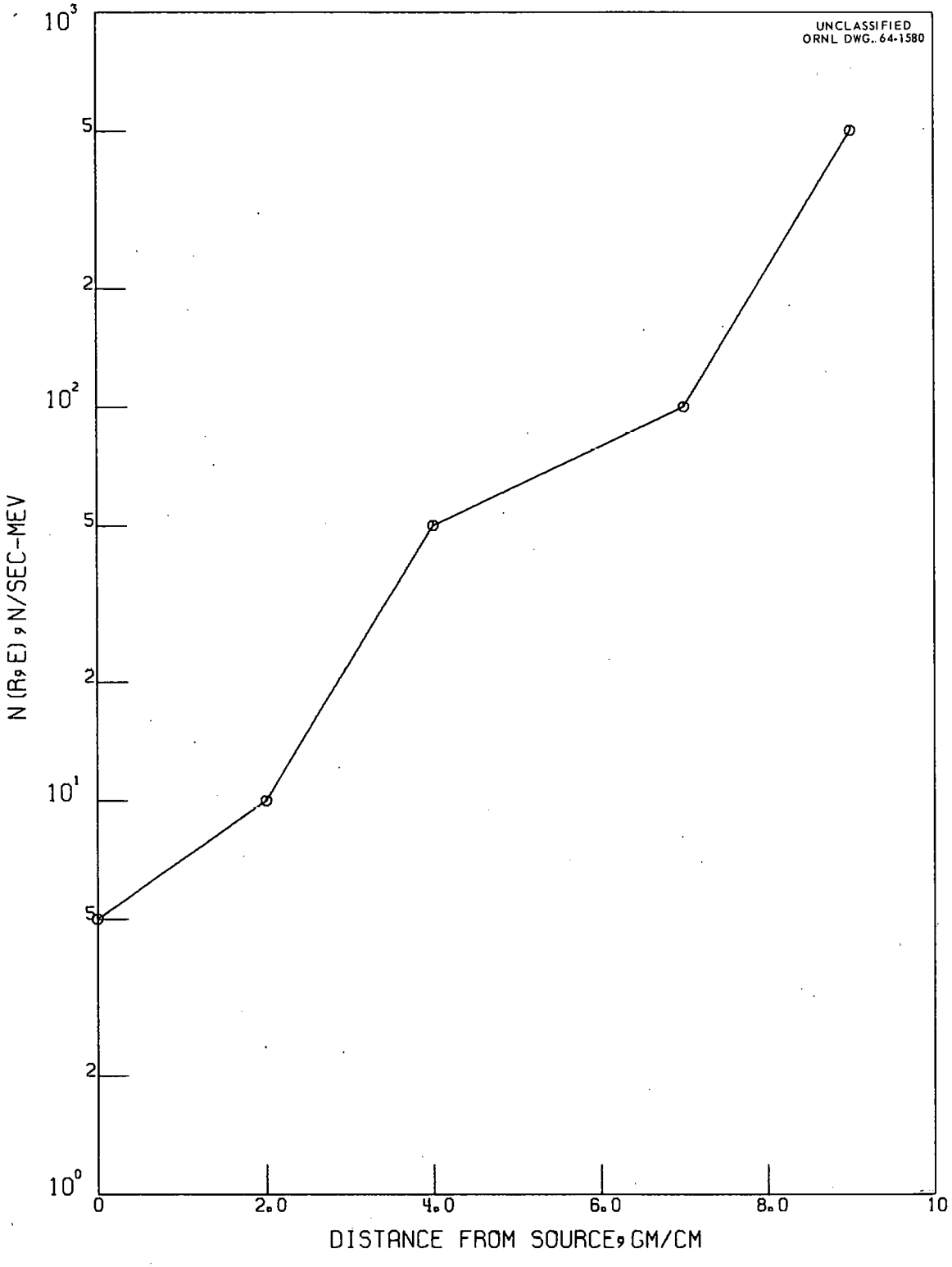

Fig. 3. Example of Semi-Log Plot.

I = curve option
  = 1 for point symbols only (value of N immaterial)
  $\geq$ 2 for point symbols plus a straight line drawn from previous point to (x,y)

A = 6-cell array described for main routine

7. LETTER

The purpose of this subroutine is to label the x axis and y axis or to provide a title at the top. The routine is called by

CALL LETTER(LPOS,NL,nH----,A)

where

LPOS = lettering position
  = 0 for a title at the top
  = 1 for x axis labeling
  = 2 for y axis labeling

NL = number of Hollerith characters (including spaces)

n = NL

---- = Hollerith characters

A = 6-cell array described for main routine

The Hollerith array will be centered and will be of a size shown in the figures. There will be 8.333 characters plotted per inch. Thus the limit of characters depends on the field width. If LPOS = 2, the field width (graph height) is 10 in. Otherwise it is the graph width.

If a title is read into memory with input cards using HOLLER, the parameter nH--- is replaced by TITLE(K) in the call statement (see Sec. 9).

8. EXPON

This routine will provide an exponent for any of the Hollerith characters provided by LETTER. The routine is called by

CALL EXPON(LPOS,NL,L,1H-,A)

where

LPOS = lettering position (see Sec. 7)

NL = number of Hollerith characters in corresponding LETTER statement

L = position of exponent; the Lth character will have the exponent

\- = exponent desired

A = 6-cell array described for main routine

9. HOLLER

This routine will read a title from input cards (via input tape) for use in LETTER. This provides flexibility in that the main program need not contain Hollerith titling. The routine is called by

CALL HOLLER(NL,K,TITLE,INTAPE)

where

NL = number of Hollerith characters to be read in (including blanks) starting in col. 1

K = parameter for use in LETTER (computed by HOLLER)

TITLE = array for storing the Hollerith characters (dimensioned by NL/6 or larger)

INTAPE = logical number of input tape

The input for HOLLER is as follows:

CARD 1 FORMAT (I5) NL

CARD 2 FORMAT (12A6) Hollerith title

10. ADVANC

The routine is called by

CALL ADVANC(A)

where A = 6-cell array described for main program. The routine must be called at the conclusion of each graph. The paper is then advanced, ready for the next plot.

Copies of the source or object decks may be obtained from the authors.

Appendix

The following subroutines are in the package and consequently none of the user's routines can have the same names.

General Purpose CALCOMP Routines*

NUMBER
SYMBOL
PLOT
PLOTS
TRW
TRWS
MSG

Special Routines for the Present Package

RS
TENS
XTENS
YS
REVRSE
MBE

Note: The subroutine TRW is designed to locate the tape address in the IOU table of the Oak Ridge Monitor System. If this routine is used with another monitor, the system of locating the tape address may have to be changed.

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*See Ref. 1.

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