JAERI-M
88-036

A USERS' GUIDE OF A PLOTTING PROGRAM PLTJOINT

February 1988

Makoto SASAKI,* Wakaei SATO*
Masayuki NAKAGAWA and Takamasa MORI

日 本 原 子 力 研 究 所
Japan Atomic Energy Research Institute

JAERI-Mレポートは，日本原子力研究所が不定期に公刊している研究報告書です。
入手の問合わせは，日本原子力研究所技術情報部情報資料課（〒319-11 茨城県那珂郡東海村）あて，お申しこしください。なお，このほかに財団法人原子力弘済会資料センター（〒319-11 茨城県那珂郡東海村日本原子力研究所内）で複写による実費頒布をおこなっております。

JAERI-M reports are issued irregularly.
Inquiries about availability of the reports should be addressed to Information Division Department of Technical Information, Japan Atomic Energy Research Institute, Tokaimura, Naka-gun, Ibaraki-ken 319-11, Japan.

編集兼発行　日本原子力研究所
印　　刷　日青工業株式会社

A Users' Guide of a Plotting Program PLTJOINT

Makoto SASAKI*, Wakaei SATO*, Masayuki NAKAGAWA
and Takamasa MORI

Department of Reactor Engineering
Tokai Research Establishment
Japan Atomic Energy Research Institute
Tokai-mura, Naka-gun, Ibaraki-ken

(Received January 29, 1988)

A plotting program PLTJOINT is able to plot various types of input and output data from neutronics calculations with two dimensional coordinates. These data include cross sections, neutron flux or spectrum, reaction rate distribution and auxiliary data. These are read from the input and output files of the JOINT system and the transport code system using double differential form cross section, and from arbitrary BCD input file. General purpose option is also available.

Much care is taken in lettering such as types of characters (italic, Greek letters and characters), super and subscript of alphabet and numeral. Users can design their own characters by using a program IGDRASIL. Most of input data can be read in free format. The code has been programed so flexibly that new functions can be easily added to.

Keywords: Users' Guide, Plotting Program, Neutronics, JOINT System, Transport Code System, Letter and Characters Design.

---

* On leave from JAIS

作図用プログラムPLTJOINTの使用手引書

日本原子力研究所東海研究所原子炉工学部
佐々木 誠*・佐藤 若英*・中川 正幸・森 貴正

（1988年1月29日受理）

作図用プログラムPLTJOINTは，ニュートロニクス計算で使用又は出力される様々なタイプのデータを作図する事が出来る。これらのデータには断面積，中性子束やスペクトル，反応率分布の他，補助的なデータがある。データは，JOINTシステムや二重微分断面積を用いる輸送計算システムの入出力及び任意のＢＣＤ形式の入力ファイルから読み込まれる。又一般目的に使用可能なオプションも備えている。

特に，文字や記号（例えばイタリック体，ギリシャ文字や記号）また，アルファベットや数字の上付や下付などのデザインに配慮がなされている。ユーザーは，もし必要ならプログラムIGDRASILを用いて自分の欲しい文字や記号を作ることや変形する事も可能である。入力データの多くは，フリーフォーマットで与える事が出来る。そしてこのコードは，フレキシブルにプログラムされて居るので，新しい機能の追加は容易に出来るであろう。

東海研究所：〒319-11　茨城県那珂郡東海村白方字白根2－4
＊外来研究員，JAIS

Contents

目　　次

1. Introduction

Recent trend of software development shows rapid increase of number of statements in a program and systematization embracing many unit programs. In such a program and/or a code system, volume of input and output data increases as a result. For many users, it needs much effort and time to judge whether solutions obtained are reasonable or not or to select which data base is appropriate to solve their problems. Moreover, it is sometimes not easy to intercompare the solutions obtained by different runs by seeing digital values in output.

To reduce such labor and to make the computed results easily understandable for other persons, visualization of such data is very helpful. For these purposes, a plotting program would be necessary for a recent large code system. Though many plotting programs such as GPLP[1], GPLOTZ[2] and PLOT-FBR[3] have been developped, their purposes and styles of graphs are often different with each other depending on a field applying a code system.

A code, PLTJOINT, was developped based on PLOT-FBR to be used for fast reactor calculation system, especially for the JOINT code system[4]. The code has been modified to be able to plot the output data from the transport calculation code system using double differential form cross section which includes the ANISN-DD[5], DOT-DD[6] and MORSE-DD[7] codes. Moreover, a function to plot arbitrary BCD input data has been implimented to add flexibility to this code. Much care has been taken in lettering on a graph. For example, Italic and Greek letters can be plotted in addition to the super- and/or sub-script of alphabet and numeral in a title or a legend. Users can also select thickness of line and characters, symbols of data points and scale of coordinates. Most of input data can be punched in free format, which will be helpful to decrease input errors. As the program is flexibly made, new functions can be added as occasional calls.

A standard output device of graph plotted is FACOM NLP while other devices such as CRT displays (eg. TEKTRONIX, D-SCAN) are available by minor change in linkage step of a program. This program can be used in any computer systems if they have built in subroutines equivalent to the FACOM PSP system. This program can be used also in TSS mode.

In Appendix B, description on a design code of characters, IGDRASIL, is given so that users can add or change the style of characters to arbitrary ones they want.

2 Input Data of PLTJOINT

2.1 General Remarks and Rules of Input Data Preparation

Input data of PLTJOINT consist of four data blocks as follows:

(1) Comment card: comment to input data (up to 72 characters).
(2) Block A: data for each line to be plotted (x-y data, input file number etc.).
(3) Block B: data for a graph (graph size, title etc.).
(4) END data: characters 'END' on column 1 to 3 present end of plotting.

Data blocks (1),(2) and (3) are necessary for every graph, and only data block (2) is required if other lines are plotted in the same graph. If other graphs are necessary to be plotted in different sheets, feed the data blocks (1),(2) and (3) repeatedly.

If users need input data other than those stored in unit FT05F001, users can specify them in BCD input data by data set names. For this purpose, users can input data (0) described below before the data block (1) as many as users need. These data would be useful for executing PLTJOINT in TSS mode.

(0) '%%FTnn "data set name" '

The "nn" shows an I/O unit number, and the data assigned after '%%FTnn ' is allocated to this I/O unit. Accordingly this data has the same meaning as '//FTnnF001 DD DSN= ... ' in JCL. The data set name must be written in a full name.

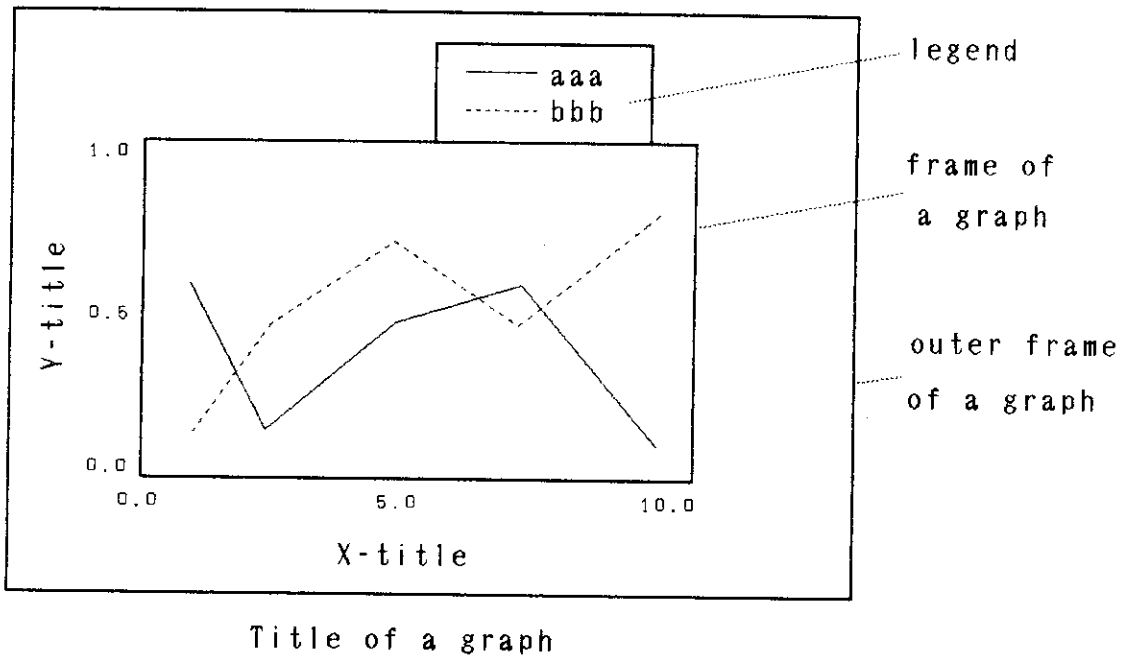
Details of input data are described in the following two sections 2.2 and 2.3. Meanings of notations used in these sections are as follows:

* 'A-1', 'B-3' etc. are card numbers, and data after this card numbers must begin by a new card.
* Input formats are described in parentheses after each card number ((*) means free form input).
* Cards having << >> after card numbers are necessary only if condi-

tions in << >> are satisfied.

* Figures in < > are default values.

Names of parts in a graph are as follows:



2.2 Description of Input Data

I. Comment (72 characters)

II. Data Block A

A-1 (*)

(1) IOP: Type of data to be plotted.

= 1 : Data from BCD input.
= 2 : - Not used.
= 3 : - Not used.
= 4 : - Not used.
= 5 : Neutron energy spectrum calculated by CITATION-FBR[8] (I/O unit 34)
= 6 : Neutron flux distribution calculated by CITATION-FBR (I/O unit 9 or 34) or TWOTRAN2[9] (unit 8 or 9).
= 7 : - Not used.
= 8 : - Not used.
= 9 : JFS2[10] or JFS3[11] type cross section (70 or 25 group structure)
= 10: - Not used.
= 11: Cross section in a PDS file produced by the JOINT system.
= 12: Energy spectrum of neutron flux from CITATION-FBR output file (I/O unit 9). (JOINT system)
= 13: Energy spectrum of neutron flux from a PDS file (JOINT system. One dimensional data only)
= 14: Reaction rate distribution calculated by REACCIT[12].
= 15: Groupwise contribution of a reaction rate calculated by CIPER[13].
= 16: Neutron flux in an output file of MORSE-DD.
= 17: Microscopic cross section from a SRAC[14]-type library.
= 18: - Not used.
= 19: Energy spectrum of neutron flux calculated by ANISN-DD.
= 20: Neutron flux calculated by DOT-DD.
= 21: - Not used.
= 22: Letters and Characters. (O.H.P. mode)

If IOP = 999, data block A is completed. Block B starts from the next card.

(2) IDX: Not used

(3) IOUT: Not used

(4) IPRT: 1 = print out all input data

0 = no

(5) NCUT: If greater than 0, (NCUT-1) vertical lines are drawn and they divide this graph into NCUT parts and each part can have its title. This parameter is effective only in the first A-1 card of a graph.

A-2 Data depend on an IOP value. See next section.

A-3 << IOP ≠ 22 >> (4I3,3F6.0,A40)

(1) KD2: Line type.

-1 = data points are smoothly connected by quadratic line.

0 = no line. (only data point)

1 = solid line. 2 = broken line 3 = dotted line

4 = dashed line

5 = thick solid 6 = thick broken 7 = thick dotted

8 = thick dashed

(2) KD3: Symbol mark of plotted points.

0 = no symbol mark.

1 = a symbol mark is determined automatically.

< 0 or > 100 : code number of symbol mark is |KD3|.

(see Appendix C)

(3) KD4: Option for error bar, and interpretation of input error data if IOP = 1.

-1 = absolute value. 0 = no error bar. 1 = relative value.

(4) KD5: Type of graph.

0 = non histgram. 1 = histgram.

2 = step line (vertical lines are removed from histgram).

(5) TS: Lower limit of x-value. < 0.0 >

(if the value 0.0 is set, the minimum x value in input data is automatically searched.)

(6) TE: Upper limit of x-value. < 0.0 >

(if the value 0.0 is set, the minimum x value in input data is automatically searched.)

Data points having x coordinate values smaller than TS and greater than TE are not plotted.

(7) DF: Multiplication factor for y-value. < 0.0 >
(0.0 means no multiplication)

(8) TST: Legend of the line.

III. Data Block B

This data block must be ommitted if IOP of A-1 is equal to 22.

B-0.1 (7(2A4,2X)) << NCUT > 0 >>

((TIT(i,j),i=1,2),j=1,NCUT): Titles of each divided part.

B-0.2 (*) << NCUT > 1 >>

(REG(j),j=1,NCUT-1): X-coordinates of boundary lines.

B-1 (*)

(1) NMA: x-values.
0 = use different x-data for each line in the graph.
1 = use same x-data for each line in the graph.
(Input data of x-values for the first line are commonly used.)

(2) ITX: Scale of x-coordinate axis.
1 = linear. 2 = log.

(3) ITY: Scale of y-coordinate axis.
1 = linear. 2 = log.

(4) NFX: Vertical grid.
0 = no
1 = coarse grid (solid line) -1 = coarse grid (broken line)
2 = fine grid (solid line) -2 = fine grid (broken line)

"Fine" and "coarse" are concerning a number of grid lines, and not the fineness of dashes in grid lines. An interval of grid lines are automatically set in the code.

(5) NFY: Horizontal grid.
the same as option NFX.

(6) IPR: Option for print out of input data.
0 = no
1 = option data
2 = option data and plotted values.

(7) NSB: Legend.
0 = no 1 = plot.
-1 = plot, and the position should be given in B-2.

(8) IBULD: Size of graph.
0 = default values given in B-3.
1 = input in B-3.

(9) INUM*10 + IPTN

IPTN: Position of a title of a graph. The title is drawn under the graph.
0 = center of the title is adjusted to the center of the graph. The title is plotted outside of the outer frame.
1 = position of the first character of the title is adjusted to the same position of the left edge of the graph. The title is plotted outside of the outer frame.
2 = the same as 0 but plotted inside of the outer frame.
3 = the same as 1 but plotted inside of the outer frame.

INUM: If this value is not zero, users can add comments (for example, nuclide names) to each data of histgram.

0 = no
1 = vertically and over histgram bar.
2 = horizontally and over histgram bar.
3 = horizontally and under x-axis.
4 = vertically and under x-axis.

B-2 (*)

(1) XMI: Minimum value of x-coordinate axis
(2) XMA: Maximum value of x-coordinate axis
(3) YMI: Minimum value of y-coordinate axis
(4) YMA: Maximum value of y-coordinate axis

The values of (1) - (4) are set automatically if input values are 0.0 .

(5) STLT: Position of the left edge of a legend box.
(if STLT=0.0 and NSB=1, this is set at the center of the graph)
(6) STBM: Position of the lowest line for a legend box.
(if STBM=0.0 and NSB=1, outside of the upper frame of the graph)

If NSB (see B-1) = 1, STLT and STBM are distances from the left and lower lines of the outer frame, respectively (cm unit). If NSB=-1, they are relative values to the lengths of x- and y- coordinate axes, where the origins are y- and x- coordinate axes, respectively.

B-3.1 (*) << IBULD ≠0 >>

(1) KP1: Pen type for frame of graph and title < 2 >
1 = thin 2 = thick
(2) KP1: Pen type for grid lines. < 1 >
1 = thin 2 = thick
(3) KP3: Not used.
(4) SX: Length of x-coordinate axis (cm) < 28.0 >

If SX < 0.0, |SX|, SY, SX0 and SY0 are multiplied by SCREEN (see B-3.2).

(5) SY: Length of y-coordinate axis (cm) < 20.0 >
(6) SX0: Length of horizontal line for outer frame (cm) < 33.0 >
(7) SY0: Length of vertical line for outer frame (cm) < 25.0 >
(8) SIM: Character size of main title (cm) < 0.3 >

If SIM < 0.0, |SIM| and values of (9)-(13) are multiplied by CSIZE (see B-3.2).

(9) SIX: Character size of title for x-coordinate axis (cm) < 0.3 >
(10) SIY: Character size of title for y-coordinate axis (cm) < 0.3 >
(11) SIS: Character size of legend (cm) < 0.3 >
(12) SLIN: Character size for linear scale (cm) < 0.3 >
(13) SLOG: Character size for logarithmic scale (cm) < 0.3 >

B-3.2 (*) << SX < 0.0 or SIM < 0.0 >>

(1) SCREEN: Multiplication factor to frame and graph sizes.
(2) CSIZE: Multiplication factor to character size.

B-4 (A72) Main title.

B-5 (A72) X coordinate axis title.

B-6 (A72) Y coordinate axis title.

B-7 (A10) << INUM ≠ 0 >>

Comments for each data

2.3 Detailed Description of Input Data A-2

Data A-2 depend on the option IOP in card A-1.

*** IOP = 1: Data from BCD input.**

A-2.1 (*)

JJ: Arbitrary integer. If JJ > 0, data DX,DY and DE in this card are effective. If JJ < 0, this card indicates the end of a sequence of Card A-2.1's, and DX,DY and DE are meaningless.

DX: X-coordinate value.

DY: Y-coordinate value.

DE: Error data. See the description of parameter KD5 in A-3. (set DE = 0.0 if KD5 = 0)

Repeat these data as many times as necessary. The last data must be JJ < 0 and DX,DY,DE = 0.0.

If users want to plot a histgram (KD5≠0), number of the data DX should be the number of data DY plus one. In this case, DY and DE in the last A-2.1 card, having positive JJ, are ignored.

A-2.2 (*)

MULT: Multiplication of data DY by FACT (given in A-2.3).

0 = no 1 = yes

NORM: Normalization of data (multiply all the data DY so as to normalize a DY value of a point assigned in A-2.4 to a specified one.).

0 = no 1 = yes

A-2.3 (*) << MULT = 1 >>

FACT: Multiplication factor. All DY values are multiplied by this factor.

A-2.4 (*) << NORM = 1 >>

NPOT: All DY values are multiplied to normalize the NPOT'th

value of DY to FNOR.

FNOR: Factor of normalization as mentioned above.

*** IOP = 5: Neutron energy spectrum calculated by CITATION-FBR**

A-2.1 (*)

IGRP: Number of energy groups to be plotted.

IGRP0: Number of energy groups before collapsing energy groups.

IOFX: Unit number of output flux file (output by CITATION-FBR on unit 34). If IOFX = 0, data are read from cards.

IRGN: Region number whose spectrum is plotted. (IOFX > 0)

A-2.2 (*) << IGRP ≠ IGRP0 >>

(KB(i),i=1,IGRP): Lowest group number for each collapsed group (KB(IGRP) must be IGRP0).

A-2.3 (*) << IOFX = 0 >>

(AVFX(i),i=1,IGRP): Neutron energy spectrum.

*** IOP = 6: Neutron flux distribution calculated by CITATION or TWOTRAN2.**

A-2.1 (*)

NCT: 1/2 = CITATION/TWOTRAN2

NUNT: Unit number of input flux file (in CITATION, flux is written on unit 9 or 34, and in TWOTRAN2 unit 8 or 9 (restart file)).

NDRT: Direction to plot flux.

< 2 dimension > 1/2/3 = R / Z / -

< 3 dimension > 1/2/3 = X / Y / Z

JXR,IYZ,KZZ : A transverse flux distribution is plotted at this mesh position. (set equal to zero for unnecessary parameters)

< 2 dimension > JXR / IYZ / KZZ = R / Z / -

< 3 dimension> JXR / IYZ / KZZ = X / Y / Z

NGRP: Energy group number to be plotted.

ND: = 0 Flux file has no information about mesh points.
(eg. CITATION's output on unit FT09F001)
= 1 Flux file has informations about mesh points.
(CITATION's output on unit FT34F001)

NGEM: Geometry.
1/2/3 = 2-D XY / 2-D RZ / 3-D XYZ

A-2.2 (*) << ND = 0 >>

JMAX: Number of meshes in X or R direction.

IMAX: Number of meshes in Y or Z direction.

KBMAX: Number of meshes in Z direction. (3-D only)

KMAX: Number of energy groups.

A-2.3 (*) << NCT = 1 and ND = 0 >>

Intervals and numbers of mesh points for each region. Same as section "004" of CITATION input data. (Symbol "004" is not necessary.)

A-2.4 (24I3) << NCT = 2 >>

Division numbers of coarse mesh intervals.

A-2.5 (*) << NCT = 2 >>

Outer boundaries of coarse mesh intervals.

*** IOP = 9: JFS2 or JFS3 type cross section (70 or 25 groups)**

A-2.1 (*)

MNUM: Code number of nuclide.

NUBR: Type of cross section.

1 = σ_f 2 = ν 3 = σ_c

4 = σ_{in} 5 = σ_{el} 10 = σ_a

11 = $\nu\sigma_f$ 12 = σ_t

KMAX: Number of energy groups (should be 70 or 25).

INT: Unit number of library file.

*** IOP = 11: Cross section stored in a PDS file made by JOINT system**

A-2.1 (*)

IGRP: Number of energy group.

IDEF: Comparison of two cross sections in a member of PDS file. Values obtained by subtracting the second cross sections from the first ones are plotted.

0 = no 1 = yes

NC1: Type of cross section.

	macroscopic	microscopic
1	Σ_a	σ_a
2	$\nu\Sigma_f$	$\nu\sigma_f$
3	D_a	σ_{tr}
4	$D_\perp$	σ_f
5	$D_\parallel$	σ_s
6	Σ_{tr}	σ_{in}
7	Σ_t	$\sigma_{n,2n}$
8	Σ_f	μ
9	Σ_s	σ_D
10	Σ_{in}	
11	$\Sigma_{n,2n}$	

NCODE1: Code number of nuclide. (if NMCT = 1)

NC2: The same identification as NC1 for another nuclide when IDEF = 1.

NCODE2: Code number of another nuclide when IDEF = 1.

If NC2 = 0, NCODE = 0 and IDEF = 1, NC2 and NCODE2 are set to the same ones as NC1 and NCODE1, respectively.

A-2.2 (I3,2A8)

NMCT: 0/1 = macroscopic/microscopic cross section.

NAME: Member name in a PDS file.

NRPROG: Program name by which this cross section was made.

*** IOP = 12: Energy spectrum of neutron flux from CITATION-FBR output file (I/O unit 9). (JOINT system)**

A-2.1 (*)

IGRP: Number of energy groups.
IOFX: Unit number of input neutron flux file.
(=0 : input by BCD data)
IFLUX: 1/0 = forward flux/ adjoint flux

A-2.2 (*)

IMAX: Total number of meshes in X-direction.
JMAX: Total number of meshes in Y-direction.
KBMAX: Total number of meshes in Z-direction.

A-2.3 (3A8,3I3)

PDSNAM: DDname of a PDS file.
NAME: Member name ('ID' member, get energy boundary data from this member).
NPROG: Program name by which flux was calculated.
IX: Mesh position number in X-direction.
JY: Mesh position number in Y-direction.
KZ: Mesh position number in Z-direction.

*** IOP = 13: Energy spectrum of neutron flux from PDS file (JOINT system. One dimensional data only)**

A-2.1 (*)

IGRP: Number of energy groups.

A-2.2 (4A8)

NAME1: Member name ('ID' member)
NPROG1: Program name by which this PDS member was made.

NAME2: Member name having neutron flux data.
NPROG2: Program name by which this PDS member was made.

The PDS files must be allocated on unit "USERPDS" for NAME1 and NPROG1, and unit "USERPDS1" for NAME2 and NPROG2. A file name on "USERPDS1" is usually the same one on "USERPDS".

*** IOP = 14: Reaction rate distribution calculated by REACCIT.**

A-2.1 (*)

N: Unit number of input reaction rate input file.

A-2.2 (18A4)

(ID(i),i=1,18): The name of reaction rate plotted (ID must be the same one written in the input file).

*** IOP = 15: Groupwise contribution of reaction rate calculated by CIPER.**

A-2.1 (*)

IGRP: Number of energy groups.

A-2.2 (3A8)

PDSNUM: DD name of a PDS file.
NMEN: Member name ("ID" member)
NPROG: Program name by which this member was made.

A-2.3 (A8,I2)

MEMBER: Member name of reaction rate data on a PDS file having DDname "CIPOUT".
INUM: Reaction type.

1 = ν*fission 2 = absorption 3 = scattering
4 = leakage 5 = DB^2 6 = total

*** IOP = 16: Neutron flux in an output file of MORSE-DD.**

A-2.1 (*)

IGRP: Number of energy groups.
IANG: Number of angles.
IDETE: Number of detectors.

A-2.2 (*)

NFILE : Unit number of input file.
NPLT: 1/0 = total flux / angular flux
NDETE: Detector number to be plotted.

A-2.3 (*) (NPLT = 0)

NERG: Energy group number to be plotted.
NANG: Angle number to be plotted.
(Either NERG or NANG must be zero. If NERG = 0, energy dependence is plotted, and if NANG = 0, angle dependence is plotted.)

*** IOP = 17: Microscopic cross section from SRAC-type library.**

A-2.1 (A8)

LIBNAM: DD name of a PDS file.

A-2.2 (A8)

IDENT: Member name in a PDS file.

A-2.3 (*)

ISIG: Reaction type.

1 = transport	2 = fission	3 = ν
4 = capture	5 = elastic	7 = fission spectrum

* **IOP = 19: Energy spectrum of neutron flux calculated by ANISN-DD.**

A-2 (*)

IANG: Angle number if angular flux is necessary.
NDETE: Mesh number to be plotted.
NPLT: -1 = angular flux per unit energy.
0 = angular flux per unit lethargy.
1 = total flux per unit lethargy.
NFILE: Unit number of an input flux file.
(FT30F001 by ANISN-DD)

* **IOP = 20: Neutron flux calculated by DOT-DD.**

A-2.1 (*)

NFILE: Input file number.

|NFILE| > 100 : I/O unit 41 in DOT-DD (scalar flux file)
(NFILE is reset to |NFILE| - 100.)
|NFILE| < 100 : I/O unit NAFT in DOT-DD (angular flux file)

If NFILE < 0, enter a multiplication factor described below.

IPLOT: Type of flux plotted. This parameter consists of three subparameters IBND, SIG and IPL.

IPLOT = (IBND*10 + IPL)*SIG

(IBND= 0,1 or 2, IPL= 1,2 or 3, and SIG= +1 or -1)

IBND shows a plotting position in a spatial mesh (see figure 2.3.1).

IBND = 0 : mesh center.
1 : mesh boundary in axial direction (axial boundary).
2 : mesh boundary in radial direction (radial boundary).

"Radial" and "axial" mean R and Z directions in R-Z geometry, respectively. They are X and Y directions for X-Y geometry or R and θ directions for R-θ geometry. Users can use non zero IBND only for angular flux files.

IPL*SIG shows type of flux as follows.

1 : energy spectrum (per lethargy)
-1 : energy spectrum (per energy)
2 : angular distribution (μ direction, per weight)
-2 : angular distribution (η direction, per weight)
3 : spatial distribution (R or X direction)
-3 : spatial distribution (Z, Y or θ direction)

A-2.2 (*) << NFILE < 0 >>

FACT: multiplication factor.

A-2.3 (*)

Ranges of plotting or averaging for energy, angle and space.

IE1,IE2: from energy group IE1 to IE2.

When |IPL| = 2 or 3, integrated flux from group IE1 to IE2 is plotted. If IE1 = 0, IE1 and IE2 are set to be 1 and the last energy group solved by DOT-DD, respectively.

IAM1,IAM2: from angle level IAM1 to IAM2 in μ direction.
IAE1,IAE2: from angle level IAE1 to IAE2 in η direction.

Angle level numbers are defined as shown in figure 2.3.2. When |IPL| = 1 or 3, averaged flux within this range is plotted (weight factor is Sn weight). If IAM1 = 0, IAM1 and IAM2 is set to be 1 and the maximum number of angle level in μ direction, respectively, and similar for IAE1 and IAE2 if IAE1 = 0 .

IR1,IR2: from R-mesh IR1 to IR2.
(If fluxes on mesh boundaries are required, the center axis (R = 0.0) is the position number 1.)

IZ1,IZ2: from Z-mesh IZ1 to IZ2.
(If fluxes on mesh boundaries are required, the bottom plane (Z = 0.0) is the position number 1.)

When |IPL| = 1 or 2, volume averaged flux within this range is plotted if IBND = 0, and averaged flux using boundary areas as weight factors is plotted if IBND is not equal to 0.

A-2.4 (*) << |IPL| = 1, and NFILE has no energy boundary data. >>

NUENGY: I/O unit number of BCD data set on which energy boundary data are written in free format from the highest boundary to the lowest boundary (total number of data is number of energy group plus one). NFILE has no energy boundary data when the option parameter ITI of DOT-DD (54'th entry of 61$) is equal to zero.

*** IOP = 22: Letters and Characters (O.H.P. mode)**

This option is useful for users to make a manuscript for a transparency sheet or add a detailed comment to a graph. When this option is selected, data A-3 and all of data block B must be ommitted.

A-2.1 (A1,*) Size specification. Having '#' on column 1.

NPEN: Pen type. <1>
H: Character height (cm) <0.4>
W: Character width (relative to H) <1.0>
SCOL: Pitch of columns (relative value to H) <0.95>
SROW: Pitch of rows (relative value to H) <1.5>
XMAX: Horizontal size of outer frame. (cm) <29.5>
YMAX: Vertical size of outer frame. (cm) <21.0>
XITA: Parameter for Italic letter. XITA= tanθ, where θ is

a tilting angle. 0.0 means non Italic letter. <0.0>

A-2.2 (A1,*) Characters.

Column 1: Control of page and line.

'1' = start a new page.
' ' = start a new line
'+' = overwrite on the last line.
'-' = continue to the 72'nd column of the last line.

Column 2-72: Input characters.

A-2.3 (A1) End of input data. Punch 'Z' on column 1.

The first card must be A-2.1, but in the following cards users can repeat A-2.2 and A-2.1 as many times as they need.

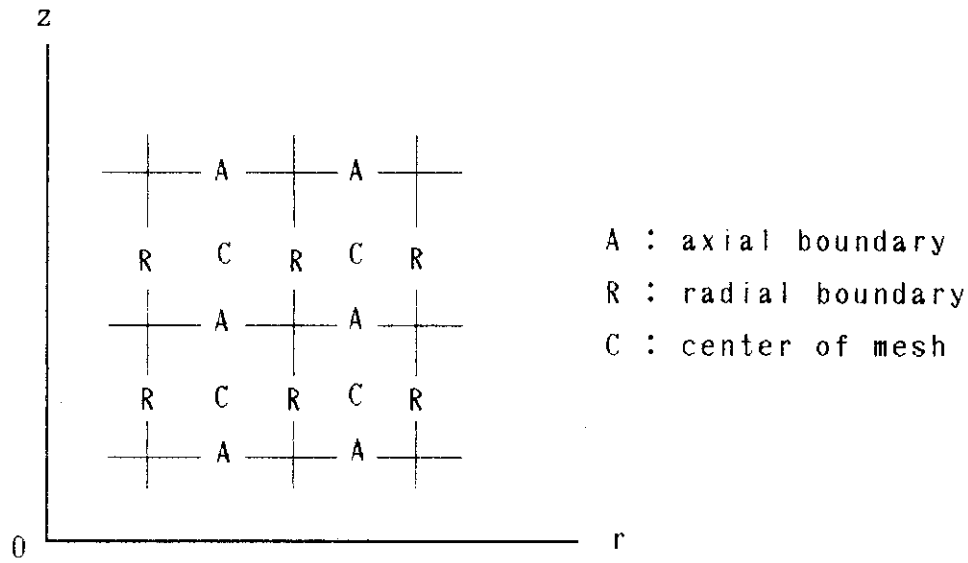


Fig. 2.3.1 Plotting positions for DOT-DD output (IOP=22).

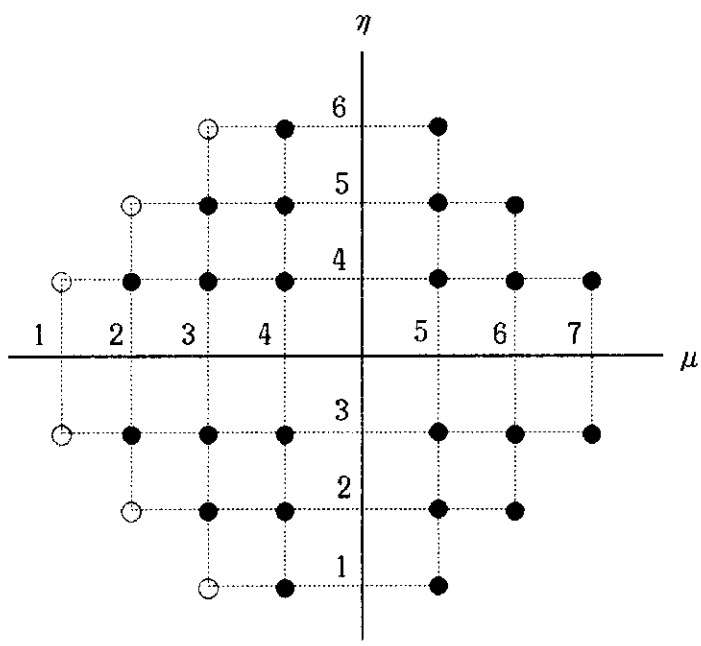


Fig. 2.3.2 Definition of angle level numbers in μ and η directions, for S_6 quadrature.

2.4 Special Feature of Symbol Plotting Routine

The symbol plotting routine of PLTJOINT is able to plot small letters, Greek letters and other characters. Moreover users can specify super- and/or sub-scripts basing on the following rule.

(1) Capital and small letters

The code can distinguish capital and small letters according to input data. If users punch a character string " Radius (cm) ", then "R" is written as a capital letter , and "a","d","i" and etc. are as small letters.

(2) Greek letters and other special symbols

To plot Greek letters, sandwich corresponding alphabets by shift character "£" (pound). Other symbols having no corresponding characters on a keyboard can be plotted in the same manner. See table 2.4.1.

Example:

£abgdezhciklmnxoprstufyvw£ → αβγδεζηθικλμνξοπρστυφχψω

£ABGDEZHCIKLMNXOPRSTUFYVW£ → ΑΒΓΔΕΖΗΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

£m£ = 0.997 → μ = 0.997 £!£ → ∞

(3) Super- or sub- scripts

superscript: sandwich a character or a character string by "¯".

subscript: sandwich a character or a character string by "_".

Example: ¯238¯U → ^{238}U UO_2_ → UO_2

If users want to use "¯" or "_" as a bar or an underline, sandwich it by shift character "£" (pound).

Character "{" shifts position of a character to that of the last character (backspace). Use when users want to write super- and sub-scripts at the same column or to add an under line to a character string, and etc.

Example: A_0_¯{1¯→ A_0^1 19{{£___£ → $\underline{19}$

Table 2.4.1 Symbols plotted by using shift character (£).

Key in	Plot	Code	Key in	Plot	Code
a	α	154	K	K	187
b	β	155	L	Λ	188
g	γ	156	M	M	189
d	δ	157	N	N	190
e	ε	158	X	Ξ	191
z	ζ	159	O	O	192
h	η	160	P	Π	193
c	θ	161	R	P	194
i	ι	162	S	Σ	195
k	κ	163	T	T	196
l	λ	164	U	Υ	197
m	μ	165	F	Φ	198
n	ν	166	Y	X	199
x	ξ	167	V	Ψ	200
o	o	168	W	Ω	201
p	π	169	0	0	113
r	ρ	170	1	1	114
s	σ	171	2	2	115
t	τ	172	3	3	116
u	υ	173	4	4	117
f	φ	174	5	5	118
y	χ	175	6	6	119
v	ψ	176	7	7	119
w	ω	177	8	8	120
A	A	178	9	9	121
B	B	179	!	∞	106
G	Γ	180	"	$\approx$	31
D	Δ	181	#	$\neq$	22
E	E	182	$	$\int$	27
Z	Z	183	%	$\div$	49
H	H	184	&	Σ	48
C	Θ	185	(	[	53
I	I	186	)	]	54

(continued to next page)

Table 2.4.1 (continued)

Key in	Plot	Code	Key in	Plot	Code
≈	≡	19			
—	—	26			
|	~	30			
–	∇	206			
¬	∂	205			
¥	Δ	52			
~	°	202			
{	{	33			
@	√	57			
}	}	32			
;	≥	51			
:	≤	50			
<	blank	25			
>	⊃	28			
*	×	61			
+	±	23			
_	_	24			
.	·	207			
/	//	208			
¦	→	20			
?	–	109			
blank	blank	25			

* "Code" is a character code number. See Appendix C.

3. Execution of PLTJOINT

3.1 File Requirements and Sample JCL

I/O files required by PLTJOINT are as follows;

1. BCD input ... FT05F001
2. Print out ... FT06F001
4. Input data file required for each option if any
   ... From FT10F001 to FT90F001
5. Work file ... FT91F001 and FT92F001

```
      Example of JCL & Data                          :  Comment
.............................................................
//JCLG   JOB                                          :
// EXEC  JCLG                                         :
//SYSIN  DD  DATA,DLM='++'                            :
// JUSER  ????????,MAKOTO,????.??                      :
  I.3  C.0  T.1  W.0  P.0  GRP  NLP                  :
  OPTP  NOTIFY=J????,PASSWORD=?                      :
//PLTJOINT  EXEC  LMGO,LM=J2350.PLTJOINT,             :
//    PNM=PLTJOINT                                   :
//FT06F001 DD  SYSOUT=*                              :
//FT91F001 DD  SPACE=(TRK,(5,10)),UNIT=WK10          : work files
//FT92F001 DD  SPACE=(TRK,(5,10)),UNIT=WK10          :
// EXPAND  GRNLP,SYSOUT=M                            :
//SYSIN  DD  *                                       :
**** U-238 CAPTURE RATE  J-2  ,  TWO ROD              : Comment
1  4  11  0  0                                       : A-1 (IOP=1)
  1   0.0            8.7303E-01 0.0                  : A-2-1     1
  2   1.9700E-01     9.1492E-01 0.0                  : A-2-1     2
  3   2.7600E-01     1.2249E+00 0.0                  : A-2-1     3
  4   3.3500E-01     0.0        0.0                  : A-2-1     4
 -1   0.0            0.0        0.0                  : A-2-1     5
  0     0                                            : A-2-2
  5  0  0  1   0.0   0.0   0.0PuO_2_/UO_2_            : A-3
1  4  12  0  0                                       : A-1
  1   0.0            8.8876E-01 0.0                  : A-2-1
  2   1.9700E-01     9.2793E-01 0.0                  : A-2-1
```

```
  3   2.7600E-01   1.1945E+00 0.0                 : A-2-1
  4   3.3500E-01   0.0         0.0                 : A-2-1
 -1   0.0          0.0           0.0               : A-2-1
  0     0                                          : A-2-2
  6  0  0  1   0.0   0.0   0.0depl.  UO_2_         : A-3
999  0  0  0                                       : A-1 Block A end
  0  1  1  0  0  0  1  1  0                        : B-1
  0.0 0.0 0.001 1.99 6.4  12.7                     : B-2
  3*1 19.8 12.7 29.7 21.0 0.37 3*0.35 2*0.3        : B-3
 Distribution of ¯238¯U capture rate               : B-4 Main title
Radius (cm)                                        : B-5 X-title
Rate (relative value)                              : B-6 Y-title
END                                                : end
++
//
```

3.2 Execution of PLTJOINT in TSS Mode

If users want to run PLTJOINT in TSS mode, use the following TSS command procedure. This command is for output to NLP. So if users want to use a graphic terminal etc., make a load module usable for the device according to JCL in chapter 3.3, and add output file allocations to this command procedure if any.

```
PROC 0  LM(PLTJOINT) CLASS(M)
CONTROL NOFLUSH LIST MSG
ATTN DO
    .FREEALL
     EXIT
END
ERROR DO
     RETURN
END
.FREEALL
 FREE F(FT05F001 FT06F001)
/*************************************************************
/**        INPUT (BCD DATA :  FT05F001)
/*************************************************************
 WRITENR  BCD INPUT DATASET NAME ===>
 READ
 ALLOC F(FT05F001) DA(&SYSDVAL) SHR
/********* GRNLP
WW: ALLOC F(MPTMST) DA('SYS1.KPATNLIB') SHR
    ALLOC F(GDFILE) SYSOUT(&CLASS)
/*************************************************************
/**        INPUT FILE OTHER THAN FT05F001 (IF ANY)
/*************************************************************
 WRITE << SPECIFY OTHER INPUT FILES >>
XX: WRITENR  %% I/O UNIT    (' ' FOR END ) ==>
    READ &N
    IF &N  = &STR() THEN GOTO YY
    WRITENR  %% DATASET NAME (' ' FOR END) ==>
    READ
    IF &SYSDVAL = &STR() THEN GOTO YY
    SET &NN = &N
```

```
    IF &LENGTH(&N) = 1 THEN -
       DO
         SET &NN = &STR(0)&N
       END
    ALLOC F(FT&NN.F001) DA(&SYSDVAL) SHR
  GOTO XX
/*************************************************************
/**          SPECIFY THE DESTINATION OF PRINT OUT
/*************************************************************
YY: WRITENR PRINT?( 1 = DUMMY, 2 = CRT ,3 = DATASET ) =>
  READ PRINT
  IF &PRINT = 1 THEN  ALLOC F(FT06F001) DUMMY
  IF &PRINT = 2 THEN  ALLOC F(FT06F001) DA(*)
  IF &PRINT = 3 THEN  -
    DO
        WRITENR PRINTOUT DATASET  ==>
        READ
        WRITENR DISP OF PRINT DATASET ( NEW OR OLD ) ==>
        READ &DDD
        SET &DIS = &SUBSTR(1,&DDD)
        IF &DIS = &STR( ) OR &DIS = &STR(O) THEN -
            ALLOC F(FT06F001) DA(&SYSDVAL.) SHR
        IF &DIS = &STR(N) THEN -
            DO
        FREE ATTR(OUT)
        ATTR OUT RECFM(F B A) LRECL(137) BLKSIZE(19043)
        ALLOC F(FT06F001) DA(&SYSDVAL.) NEW SP(20 10) T -
              USING(OUT)
        FREE ATTR(OUT)
            END
    END
/*********
ZZ: CALL 'J2350.PLTJOINT.LOAD(&LM.)'
.FREEALL
END
```

3.3 Updating of PLTJOINT

In order to plot data of a different type from those described in chapter 2.3, users must add a new subroutine as follows to PLTJOINT;

```
      SUBROUTINE XXXXXX(A,MEMORY,IDX, DX,DY,DE, LDATA)
C*********
      DIMENSION A(MEMORY), DX(LDATA), DY(LDATA), DE(LDATA)
        ...
        ...  (source lines written by users)
        ...
      RETURN
      END
```

where;

XXXXXX: Name of the new subroutine.

DX,DY,DE: Arrays in which x- and y-coordinate data and error data are to be stored, respectively (the data should be stored sequentially from the first element of arrays).

IDX: Number of data points stored in these arrays (must be given in this subroutine or other subroutines called by this subroutine).

LDATA: The length of DX,DY and DE arrays (IDX should be less than LDATA).

A: Working area. Users can use this array arbitrarily.

Moreover, a subroutine NEWOP in PLTJOINT should be modified as follows to call the subroutine XXXXXX when a new IOP (Card A-1) value set by users is read in BCD input (in the following example, the value is 23).

```
      SUBROUTINE NEWOP(IOP,A,MEMORY,IDX,DX,DY,DE,LDATA,ICHK)
      DIMENSION A(MEMORY),DX(LDATA),DY(LDATA),DE(LDATA)
      ICHK = 0
      IF(IOP.EQ.23) THEN
         CALL XXXXXX(A,MEMORY,IDX,DX,DY,DE,LDATA)
```

```
CCCCC ELSE IF(IOP.EQ.99) THEN
CCCCC     CALL YYYYYY(A,MEMORY,IDX,DX,DY,DE,LDATA)
      ELSE
         ICHK = 1
      ENDIF
      RETURN
      END
```

Users can update their load module according to the following JCL. If users want to increase memory size and/or to make a load module usable for devices other than NLP, change the parameter LIMIT and LDATA in the main program and/or the graphic library parameter (GRLIB) in linkage step, respectively.

```
//JCLG  JOB
// EXEC JCLG
//SYSIN DD DATA,DLM='++'
// JUSER ????????,?????,????.??
   I.3  C.1  T.2  W.2
   OPTP MSGCLASS=X,PASSWORD=?????
// EXEC FORT77
      PARAMETER ( LIMIT = 20000 , LDATA = 1000 )
C*** LIMIT IS THE SIZE OF WORK AREA.
C*** LDATA IS THE MAXIMUM NUMBER OF INPUT DATA POINTS.
      COMMON /AREA/ A(LIMIT)
      DIMENSION DX(LDATA),DY(LDATA),DE(LDATA)
      CALL MAGR(A,LIMIT,DX,DY,DE,LDATA)
      STOP
      END
// EXEC PGM=CALLUTY,COND=(4,LT),
//  PARM='GEM3/- GROUP A MODN¬=MAXLIN/- PUT A,PS,NOIDENT/'
//SUBSYS DD SUBSYS=(VPCS,'SIZE=(00000K,00M)')
//STEPLIB DD DSN=SYS9.GENUTY.LOAD,DISP=SHR
//PSLIB DD DSN=&&SOURCE,DISP=(NEW,PASS),UNIT=WK10,
//       SPACE=(TRK,(50,30),RLSE)
//SYSPRINT DD SYSOUT=*
//GEMLIB DD DSN=J2350.PLTJOINT.FORT77,DISP=SHR,LABEL=(,,,IN)
```

```
//SYSIN DD DSN=&&WORK,UNIT=WK10,SPACE=(TRK,(1))
//*********************************************
// EXEC FORT77,SO=&&&&SOURCE,Q=,DISP=MOD
//SYSPRINT DD DUMMY
//****** OPTIONAL ROUTINE BY USER, IF ANY ******
//* EXEC FORT77,SO=J????.XXXXXX.FORT77,Q=,DISP=MOD
// EXEC LKED77,CNTL=NO,A='MAP,OVLY',PRVLIB='J2031.LIB431',
//     GRLIB=PNL        /* NLP */
//*** GRLIB=PTS        /* TEKTRONIX */
//SYSLMOD DD DSN=J????.PLTJOINT.LOAD,DISP=SHR,UNIT=?????
//SYSIN   DD *  (OVERLAY)
 ENTRY MAIN
 OVERLAY LEVEL1
   INSERT  CSPLT,SPECC,SLMFLX,PLTCIP,SRAC
   INSERT  SUBS,PDSPLT,MICR,SPEC2,SMFLX2,SRACLB,SRACP,CIPINP
   OVERLAY LEVEL 2
     INSERT PUTIDX,GETMAC,GETMIC,NAMSET,PDSGET
     INSERT PDSERR,RWPDSF
 OVERLAY LEVEL1
   INSERT CAIN,SPECTR,CSLB,PLMORS,ANICNT
   INSERT DOTDDX,DOT35,DOT35B
   INSERT SPEC1,BOUND,TMG,WORTHF,MORS2,AN1DDX,DOTEDT
 OVERLAY LEVEL1
   INSERT PFLX,FDIST,VOLSET,PF3D
 OVERLAY LEVEL1
   INSERT IPL1,AREAC,PLT1,GPL1
   INSERT SETN,SET1,CBLK,SUB1,LINTYP,SCXY,GRXY,FGRI,DNOR
   INSERT LPLT,SMOOTH,REGION
   OVERLAY LEVEL 2
     INSERT SYMBOL,PLOT,PLOTS,SCALE,NEWPEN
     INSERT DASHPT,DASHP,NUMBER
 NAME PLTJOINT(R)
++
//
```

Acknowledgements

The authors are indebted to Messrs. S. Iijima and H. Ihara for an offer of basic subroutines. They thank to Mr. M. Nagatani (ISL) for assistance in programming. They also acknowledge to Dr. H. Takano, Mr. H. Akie and other members of the Reactor System Laboratory for their valuable comments.

References

1) Ihara, H.:"GPLP: General Purpose Line Plotting Programme," JAERI-M 82-197 (1982)
2) Hasegawa, A.:"Multi Data Comparing Subroutine GPLOTZ: the Extension of General-Purpose Graph Producing Subroutine GPLOT1, and Application to the NESTOR Data Information System," JAERI-M 5550 (1974)
3) Iijima, S.:"PLOT-FBR", private communication.
4) Nakagawa, M., Abe, J., Sato, W.:"Code System for Fast Reactor Neutronics Analysis," JAERI-M 83-066 (1983).
5) Mori, T., Sasaki, M., Nakagawa, M.:"ANISN-DD: One Dimensional Sn Transport Code Using Multi-group Double-differential Form Cross Sections," JAERI-M 87-123 (1987).
6) Mori, T., et al.:"DOT-DD", to be published in JAERI-M report.
7) Nakagawa, M., Mori, T.:"MORSE-DD: A Monte Carlo Code Using Multi-group Double-differential Form Cross Sections," JAERI-M 84-126 (1984).
8) Iijima, S.:"CITATION-FBR", unpublished.
9) Lathrop, K.D., Brinkley, F.W.:"TWOTRAN-II: An Interfaced, Exportable Version of the TWOTRAN Code for Two-dimensional Transport", LA-4848-MS (1973).
10) Takano, H., Hasegawa, A., Nakagawa, M., et al.:"JAERI Fast Reactor Group Constants Set, Version II," JAERI-1255 (1978).
11) Takano, H., Ishiguro, Y.:"Production and Benchmark Tests of Fast Reactor Group Constant Set JFS-3-J2," JAERI-M 82-135 (1982).
12) Takano, H.:"REACCIT" unpublished.
13) Nakagawa, M., Tokuno, Y.:"CIPER: A Two- and Three- Dimensional Perturbation Code Based on Diffusion Theory," JAERI-M 6722 (1976)
14) Tsuchihashi, K., Ishiguro, Y., Kaneko, K., Ido, M.:"Revised SRAC Code System," JAERI 1302 (1986).

Acknowledgements

The authors are indebted to Messrs. S. Iijima and H. Ihara for an offer of basic subroutines. They thank to Mr. M. Nagatani (ISL) for assistance in programming. They also acknowledge to Dr. H. Takano, Mr. H. Akie and other members of the Reactor System Laboratory for their valuable comments.

References

1) Ihara, H.:"GPLP: General Purpose Line Plotting Programme," JAERI-M 82-197 (1982)
2) Hasegawa, A.:"Multi Data Comparing Subroutine GPLOTZ: the Extension of General-Purpose Graph Producing Subroutine GPLOT1, and Application to the NESTOR Data Information System," JAERI-M 5550 (1974)
3) Iijima, S.:"PLOT-FBR", private communication.
4) Nakagawa, M., Abe, J., Sato, W.:"Code System for Fast Reactor Neutronics Analysis," JAERI-M 83-066 (1983).
5) Mori, T., Sasaki, M., Nakagawa, M.:"ANISN-DD: One Dimensional Sn Transport Code Using Multi-group Double-differential Form Cross Sections," JAERI-M 87-123 (1987).
6) Mori, T., et al.:"DOT-DD", to be published in JAERI-M report.
7) Nakagawa, M., Mori, T.:"MORSE-DD: A Monte Carlo Code Using Multi-group Double-differential Form Cross Sections," JAERI-M 84-126 (1984).
8) Iijima, S.:"CITATION-FBR", unpublished.
9) Lathrop, K.D., Brinkley, F.W.:"TWOTRAN-II: An Interfaced, Exportable Version of the TWOTRAN Code for Two-dimensional Transport", LA-4848-MS (1973).
10) Takano, H., Hasegawa, A., Nakagawa, M., et al.:"JAERI Fast Reactor Group Constants Set, Version II," JAERI-1255 (1978).
11) Takano, H., Ishiguro, Y.:"Production and Benchmark Tests of Fast Reactor Group Constant Set JFS-3-J2," JAERI-M 82-135 (1982).
12) Takano, H.:"REACCIT" unpublished.
13) Nakagawa, M., Tokuno, Y.:"CIPER: A Two- and Three- Dimensional Perturbation Code Based on Diffusion Theory," JAERI-M 6722 (1976)
14) Tsuchihashi, K., Ishiguro, Y., Kaneko, K., Ido, M.:"Revised SRAC Code System," JAERI 1302 (1986).

Appendix A Examples of Input Data and Plotted Graphs

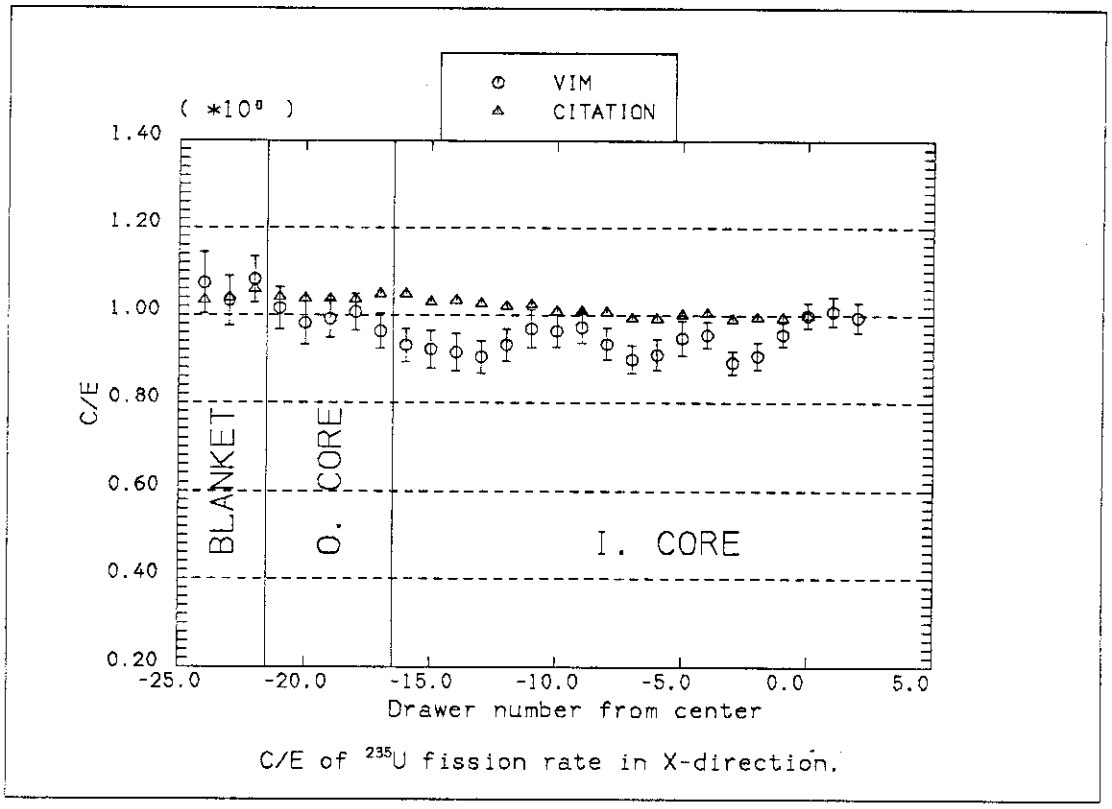
* Example 1: Data from BCD input (IOP=1) and division of a graph into three parts.

```
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..
0**** U-235 FISSION      X-DIRECTION     77.0 MM    ( X 10E-18 )
1 33  0 0 3  /
   6      2.0  0.99558E+00  0.03360
   7      1.0  0.10091E+01  0.03200
   8      0.0  0.10000E+01  0.02970
   9     -1.0  0.95626E+00  0.02820
  10     -2.0  0.90751E+00  0.03330
  11     -3.0  0.89205E+00  0.03020
  12     -4.0  0.95526E+00  0.03140
  13     -5.0  0.94802E+00  0.04210
  14     -6.0  0.90969E+00  0.03880
  15     -7.0  0.89902E+00  0.03560
  16     -8.0  0.93421E+00  0.03890
  17     -9.0  0.97284E+00  0.03730
  18    -10.0  0.96423E+00  0.03880
  19    -11.0  0.96944E+00  0.04420
  20    -12.0  0.93220E+00  0.03920
  21    -13.0  0.90494E+00  0.04130
  22    -14.0  0.91539E+00  0.04620
  23    -15.0  0.92285E+00  0.04730
  24    -16.0  0.93135E+00  0.04130
  25    -17.0  0.96385E+00  0.04190
  26    -18.0  0.10074E+01  0.04150
  27    -19.0  0.99267E+00  0.04300
  28    -20.0  0.98209E+00  0.05020
  29    -21.0  0.10163E+01  0.04720
  30    -22.0  0.10822E+01  0.04890
  31    -23.0  0.10333E+01  0.05450
  32    -24.0  0.10736E+01  0.06580
  33    -25.0  0.10460E+01  0.07260
  -1   0.0   0.0   0.0
  0 0
  0  1  1  0    0.0    0.0    0.0VIM
  1 33 0 0 0 /
   8      0.0  0.10000E+01  0.0
   9     -1.0  0.99368E+00  0.0
  10     -2.0  0.99496E+00  0.0
  11     -3.0  0.99070E+00  0.0
  12     -4.0  0.10045E+01  0.0
  13     -5.0  0.10010E+01  0.0
  14     -6.0  0.99279E+00  0.0
  15     -7.0  0.99332E+00  0.0
  16     -8.0  0.10066E+01  0.0
  17     -9.0  0.10097E+01  0.0
  18    -10.0  0.10084E+01  0.0
  19    -11.0  0.10243E+01  0.0
  20    -12.0  0.10205E+01  0.0
  21    -13.0  0.10269E+01  0.0
  22    -14.0  0.10340E+01  0.0
  23    -15.0  0.10306E+01  0.0
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..

*** CONTINUE ***
```

```
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..
  24    -16.0  0.10488E+01  0.0
  25    -17.0  0.10485E+01  0.0
  26    -18.0  0.10357E+01  0.0
  27    -19.0  0.10367E+01  0.0
  28    -20.0  0.10375E+01  0.0
  29    -21.0  0.10413E+01  0.0
  30    -22.0  0.10591E+01  0.0
  31    -23.0  0.10395E+01  0.0
  32    -24.0  0.10336E+01  0.0
  33    -25.0  0.97152E+00  0.0
  -1   0.0   0.0   0.0
  0 0
  0  1  0  0   0.0   0.0   0.0CITATION
999 0 0 0
BLANKET   O. CORE   I. CORE                                        / B-0.1
 -21.5      -16.5                                                  / B-0.2
  0  1  1  0 -1  0  1  1  4                                        / B-1
  0.0 0.0 0.3 1.3    0.0  0.0                                      / B-2
 1 1 1 -20.0 14.0 29.0 21.0 -0.35 0.35 0.35 0.3  0.3  0.3          / B-3.1
    0.5    0.6                                                     / B-3.2
C/E of ¯235¯U fission rate in X-direction.
Drawer number from center
C/E
END
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..

*** INPUT DATA END ***
```



C/E of ^{235}U fission rate in X-direction.

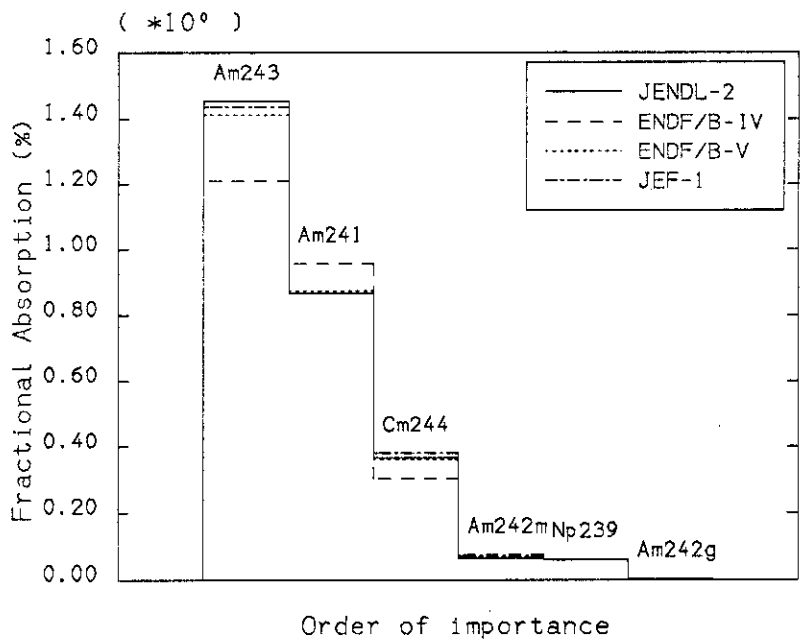
* Example 2: A histgram with comments for each data point.

```
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..
** fractional absorption rate
 1  9  0  0  0  /
   1  0.0 0.0          0.0 /
   2  1.0 1.453E+00   0.0 /AM3
   3  2.0 8.672E-01   0.0 /AM1
   4  3.0 3.663E-01   0.0 /CM4
   5  4.0 6.548E-02   0.0 /AMM
   6  5.0 5.896E-02   0.0 /NP9
   7  6.0 1.246E-03   0.0 /AMG
   8  7.0 0.0          0.0 /
   9  8.0 0.0          0.0 /
 -1 0.0 0.0 0.0 /
  0  0 /
  1  0  0  1   0.0   0.0   0.0JENDL-2
 1  9  0  0  0  /
   1  0.0 0.0          0.0 /
   2  1.0 1.208E+00   0.0 /AM3
   3  2.0 9.573E-01   0.0 /AM1
   4  3.0 3.038E-01   0.0 /CM4
   5  4.0 7.379E-02   0.0 /AMM
   6  5.0 5.936E-02   0.0 /NP9
   7  6.0 1.380E-03   0.0 /AMG
   8  7.0 0.0          0.0 /
   9  8.0 0.0          0.0 /
 -1 0.0 0.0 0.0 /
  0  0 /
  2  0  0  1   0.0   0.0   0.0ENDF/B-IV
 1  9  0  0  0  /
   1  0.0 0.0          0.0 /
   2  1.0 1.413E+00   0.0 /AM3
   3  2.0 8.757E-01   0.0 /AM1
   4  3.0 3.622E-01   0.0 /CM4
   5  4.0 7.287E-02   0.0 /AMM
   6  5.0 5.895E-02   0.0 /NP9
   7  6.0 5.344E-04   0.0 /AMG
   8  7.0 0.0          0.0 /
   9  8.0 0.0          0.0 /
 -1 0.0 0.0 0.0 /
  0  0 /
  3  0  0  1   0.0   0.0   0.0ENDF/B-V
 1  9  0  0  0  /
   1  0.0 0.0          0.0 /
   2  1.0 1.435E+00   0.0 /AM3
   3  2.0 8.687E-01   0.0 /AM1
   4  3.0 3.803E-01   0.0 /CM4
   5  4.0 6.844E-02   0.0 /AMM
   6  5.0 5.896E-02   0.0 /NP9
   7  6.0 1.255E-03   0.0 /AMG
   8  7.0 0.0          0.0 /
   9  8.0 0.0          0.0 /
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..

*** CONTINUE ***
```

```
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..
 -1 0.0 0.0 0.0 /
  0  0 /
  4  0  0  1   0.0   0.0   0.0JEF-1
999 0 0 0 /
 0 1 1 0 0    0 -1 1 22    /  B-1
 0.0 0.0 0.0 0.0 0.6 0.70  /  B-2
 1 1 1 -18.0 14.0 29.5 21.1 -0.4 0.35 0.35  0.3 0.3 0.3  / B-3.1
 0.50  0.65     / B-3.2
Comparison of fractional absorptions for minor actinides.
Order of importance
Fractional Absorption (%)
                /  B-7
Am243           /  B-7
Am241           /  B-7
Cm244           /  B-7
Am242m          /  B-7
Np239           /  B-7
Am242g          /  B-7
                /  B-7
                /  B-7
END
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..

*** INPUT DATA END ***
```



Comparison of fractional absorptions for minor actinides.

* Example 3: A table plotted by using O.H.P. option (IOP=22).

```
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..
**** sample data of O.H.P mode (IOP=22) ****************
  22  0 0 0 0 /
# 3 0.45 0.86 0.91 1.5 18.0  14.0  0.0  / A-2.1


          1987    Japan Ice Hockey League
# 2 0.32 0.86 0.91 1.5 18.0  14.0  0.0  / A-2.1

   £????????????????????????????????????????????????????????????????????????????????????£
     TEAM     | O       KO      SN      SE      JU      FU     | TOTAL
   £????????????????????????????????????????????????????????????????????????????????????£
              |                                                |
    Oji       | ***     3-1(2)  2-3(1)  4-2     6-0     6-0    | 21- 6(3)<45>
              |                                                |
    Kokudo    | 1-3(2)  ***     4-0(2)  3-3     6-0     6-0    | 20- 6(4)<44>
              |                                                |
    Snow      | 3-2(1)  0-4(2)  ***     3-2(1)  4-1(1)  6-0    | 16- 9(5)<37>
              |                                                |
    Seibu     | 2-4     3-3     2-3(1)  ***     1-4(1)  4-1(1) | 12-15(3)<27>
              |                                                |
    Jujo      | 0-6     0-6     1-4(1)  4-1(1)  ***     1-4(1) |  6-21(3)<15>
              |                                                |
    Furukawa  | 0-6     0-6     0-6     1-4(1)  4-1(1)  ***    |  5-23(2)<12>
              |                                                |
   £????????????????????????????????????????????????????????????????????????????????????£

                                  ( ) = draw    < > = winning point
Z
END
....*....1....*....2....*....3....*....4....*....5....*....6....*....7..

*** INPUT DATA END ***
```

1987 Japan Ice Hockey League

TEAM	O	KO	SN	SE	JU	FU	TOTAL
Oji	***	3-1(2)	2-3(1)	4-2	6-0	6-0	21- 6(3)<45>
Kokudo	1-3(2)	***	4-0(2)	3-3	6-0	6-0	20- 6(4)<44>
Snow	3-2(1)	0-4(2)	***	3-2(1)	4-1(1)	6-0	16- 9(5)<37>
Seibu	2-4	3-3	2-3(1)	***	1-4(1)	4-1(1)	12-15(3)<27>
Jujo	0-6	0-6	1-4(1)	4-1(1)	***	1-4(1)	6-21(3)<15>
Furukawa	0-6	0-6	0-6	1-4(1)	4-1(1)	***	5-23(2)<12>

( ) = draw < > = winning point

Appendix B Character Shape Design Program (IGDRASIL)

For the purpose of designing characters with arbitrary shapes, we have developped a program IGDRASIL to generate character shape data. The characters used in PLTJOINT have been generated using this program.

B.1 How to Define Character Shape

A character is drawn by using coordinates data and up-down control data of a pen. These data are made through the following two steps.

1) Construct characters by arcs and straight lines.
2) Transform the coordinate data made in 1), if necessary.

The characters consist of a combination of straight lines and arcs. The way of specifying lines and arcs are as follows.

line; (0.0,0.5)-(0.2,0.1)
arc; (0.2,0.5)@(0.3,0.8)@(1.0,0.1)

In the above data, figures in parentheses show the values of x and y coordinates of points (eg. (0.0,0.5) and (1.0,0.1)).

A character "-" between two coordinates data indicates to draw a straight line between two points defined by the coordinates. Two characters "@" among three coordinates data indicate to draw an arc from the first point to the last point through the second point. When an arc is drawn, coordinates of points on the arc are calculated as many as enough to draw the shape of a smooth arc.

Transformations are made to the coordinates of calculated points on arcs as well as to the points given in input data. Four types of transformation are possible as shown below (and see figure B.1);

* Parallel shift P(a,b)

$$\begin{cases} x \rightarrow x+a \\ y \rightarrow y+b \end{cases}$$

* Extension E(a,b)

$$\begin{cases} x \rightarrow ax \\ y \rightarrow by \end{cases}$$

* Rotation R(θ,a,b) : counter-clockwise rotation by angle θ (degree

unit). (a,b) is the rotation center.

$$\begin{cases} x \rightarrow (x-a)\cos\theta-(y-b)\sin\theta+a \\ y \rightarrow (x-a)\sin\theta+(y-b)\cos\theta+b \end{cases}$$

* Shear $S(a,b)$: transformation like "shearing distortion".

$$\begin{cases} x \rightarrow x+ay \\ y \rightarrow bx+y \end{cases}$$

Any character should be defined in the area { (x,y) | 0≦x≦1, 0≦y≦1 } .

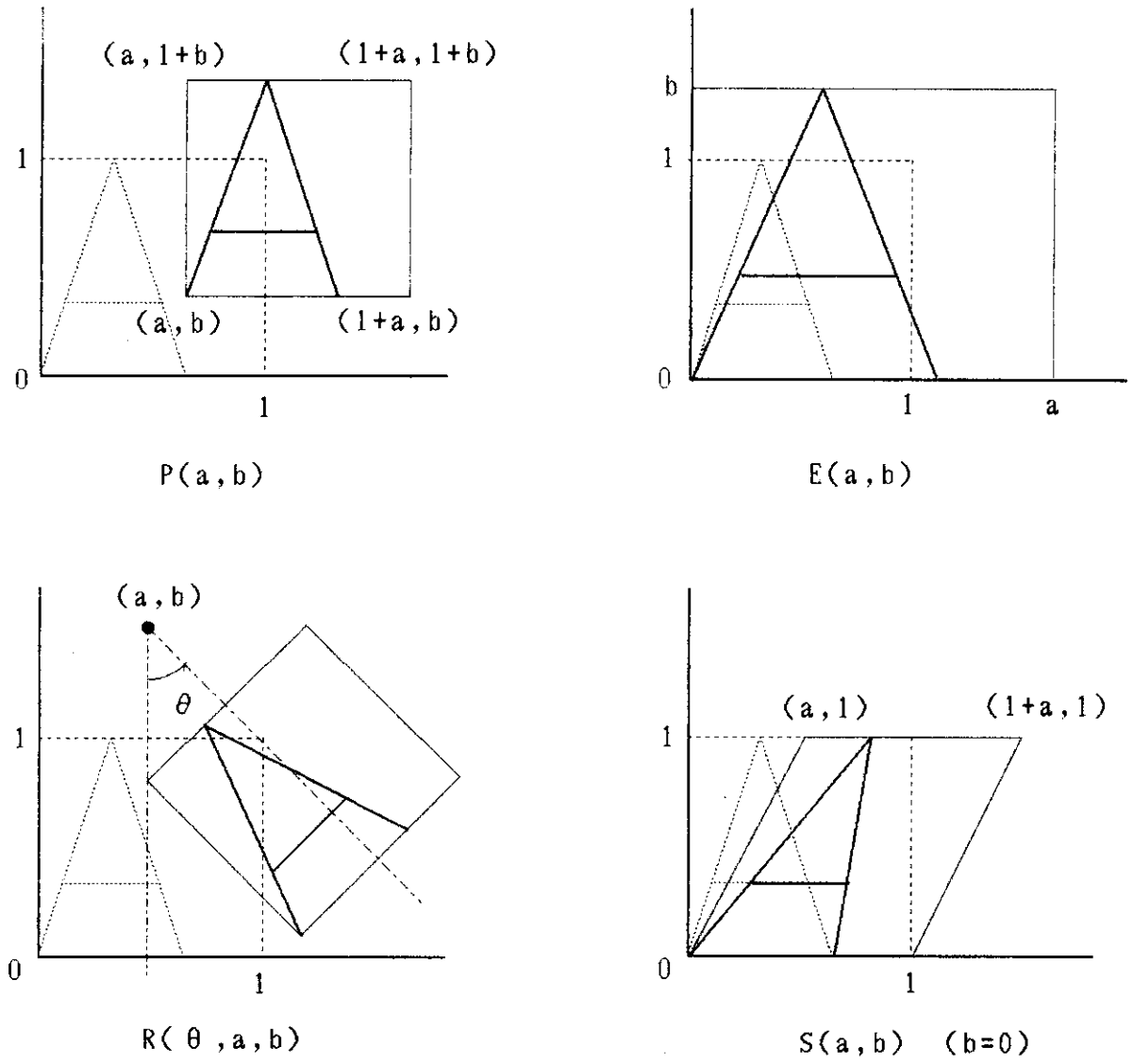


Fig B.1 Coordinate transformations available in IGDRASIL.

Examples.

```
*159 zeta ------------------------------------------------------------
¥ E(1.1,0.7) S(0.3,0.0) P(-0.1,0.0)
 (0.0,1.0)@(0.2,0.8)@(0.4,1.0)-(0.05,0.1)@( 0.05,0.03)@
 (0.1,0.0)-(0.4,0.0)@(0.5,-0.1)@(0.45,-0.18)-(0.31,-0.32)
```

Plotted Character: 

```
*146 S ---------------------------------------------------------------
¥
 (0.0,0.265)@(0.076 ,.077 )@(0.265,0.0)-(0.402,0.0)@
 (0.667,0.265)@(0.402,0.53)-(0.255,0.53)@(0.03,0.765)@
 (0.265,1.0)-(0.402,1.0)@(0.5681,0.93)@(0.6367,0.775)
```

Plotted Character: 

```
*161 theta ------------------------------------------------------------
¥ E(1.0,2.5)  S(0.3,0.0)
 (0.0,0.2)-(0.4,0.2)@(0.2,0.4)@(0.0,0.2)
 (0.0,0.2)@(0.2,0.0)@(0.4,0.2)
```

Plotted Character: 

As shown in these examples, users can use "-" or pairs of "@" any times within a sequence of points, that is, a point in input data can define an end point and also a start point of lines or arcs.

B.2 Input BCD Data

Block 1: Definition of Character Shape

1. Comment for a character data. Punch a symbol "*" in column 1.

   This presents the beginning of input data for each character.

2. Transformation data. Punch a symbol "¥" in column 1 for every card.

   Users can define the following four types of transformation as explained in B.1 in an arbitrary order;

   $E(a,b), P(a,b), R(\theta,a,b), S(a,b)$

   Each transformation data can be repeated by five times at the maximum. Users can use more than one "¥" line for a character. These data are effective until the next group of "¥" lines are encountered.

   To determine fineness of interpolation in drawing arcs, a "D" data is used as follows;

   $D(n)$: data to determine angular intervals of interpolated points, where n indicates that the intervals is π/n radian arround the center of an arc.

   n is set to be 8 as a default value.

3. Coordinates and conjunctions: data to determine a character shape by lines and arcs as explained in B.1.

4. End of data: punch "*END" on column 1 to 4.

   Repeat data 1,2 and 3 as users need.
   Users must keep the following rules and limitations.

* If users do not specify x or y coordinate value, the same value as the one of the last point is used, for example;

"(0.33,0.25)-(,0.50)" is equivalent to "(0.33,0.25)-(0.33,0.50)".

* The maximum number of points users can input for a character is 70.
* The first non-blank character on an input card of data 3 must be "(". If users need to connect the last point defined in a card and the first point given in the following card, users must put "-" or "@" after the last coordinate data on the first card.
* If column 2 to 8 in "¥" card is blank, the following coordinate data are not transformed.

Block 2

Data in block 2 are necessary to use the character pattern data defined in block 1 in the plotting routine.

1. Initial or default values. (*)

XB: X-coordinates of the lower left corner.

YB: Y-coordinates of the lower left corner.

HTC: Character height. "Height" means a distance between points $(x,0.0)$ and $(x,1.0)$.

THC: Plotting direction. Angle from the horizontal line (degree unit).

ASPECT: Ratio of width to height of character. "Width" means a distance between points $(0.0,y)$ and $(1.0,y)$.

TALIC: A parameter to define slant characters, which is a similar one to the parameter a described in the definition of transformation $S(a,0.0)$.

SPACE: Distance between left edges of successive two characters in a charecter string (relative value to HTC).

The concepts of parameters ASPECT,TALIC and SPACE are based on those in the "LETTER" routine (Computer Information No.29 (1977), JAERI Computer Center).

2. Special characters to indicate "shift","superscript", "subscript" and "backspace". (4(A1,1X))

As described in chapter 2.4, in PLTJOINT they are;

"£" ... shift "¯" ... superscript
"_" ... subscript "{" ... backspace.

3. Characters used in "shift" mode. (A72)

In shift mode, these characters are interpretted to characters having character code numbers defined in the following data 4 (character code numbers are given sequentially from 0 (not 1) according to the order in data block 1).

4. Character code numbers corresponding to shift charcaters defined in the preceding data 3.

B.3 New SYMBOL Routine.

To utilize character data, we made a program having functions similar to a routine "SYMBOL" of PLOT-10 (or FACOM PSP) system. This program plots characters which was designed by IGDRASIL and included
in a fortran source of PLTJOINT as a block data. This routine is called as follows;

CALL SYMBOL(X,Y,HEIGHT,NBCD,THETA,N)

These arguments have the same meanings as SYMBOL as described below;

* X,Y coordinates of the lower left corner of the chracter string plotted.
* HEIGHT height of chracters.
* NBCD array name in which character string is stored (N>0) or character code number (N<0).
* THETA slant angle of chacter string (degree).
* N > 0: number of characters plotted (>0)
  < 0: plot one chracter or center symbol specified

by the character code NBCD.

Furthermore, this routine has the following functions.

1. To calculate the length of the chracter string plotted.

```
CALL SYMBOL(XL,0.0,HEIGHT,NBCD,-999.0,N)
```

Set the second and fifth arguments 0.0 and −999.0, respectively, and the users can get the length of character string NBCD (N characters) on the plotting field (paper or CRT) in XL when the character height is HEIGHT. This function is useful when NBCD includes subscripts, superscripts and/or backspaces, and users want to know the real length of the character string.

2. To change the parameters.

```
CALL SYMBOL(ASPECT,TALLIC,-1.0,SPACE,0)
```

Set HEIGHT less than 0.0, and users can change the values of ASPECT,TALLIC and SPACE. If the values of ASPECT,TALLIC and/or SPACE are equal to 999.0, their values are not changed.

B.4 Sample JCL and Input Data

The following JCL and input data have been used in generating character data for PLTJOINT.

```
//JCLG    JOB
//        EXEC JCLG
//SYSIN DD DATA,DLM='++'
// JUSER 21959021,SASAQ,0431.01
   I.4 C.1 T.2 W.1  GRP
   OPTP MSGCLASS=X,PASSWORD=SASAQ,NOTIFY=J9021
//****
//  EXEC  FORT77,SO=J9021.SASAKI,A='ELM(CHOPIN),SOURCE'
//  EXEC LKED77,GRLIB=PNL
//  EXEC GO
//FT06F001 DD SYSOUT=*
//FT10F001 DD DSN=&&LET,DISP=(,PASS),DCB=(RECFM=VBS,BLKSIZE=19069),
//  UNIT=WK10,SPACE=(TRK,(10,10),RLSE)
//FT15F001 DD UNIT=WK10,SPACE=(TRK,(10,10))
//******************************** GRNLP
// EXPAND GRNLP,SYSOUT=M
//*
//******** CREATED BLOCK DATA ************************************
//FT20F001 DD DSN=J9021.BLOCK.FORT77,DISP=(,CATLG),UNIT=TSSWK,    *
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=3120),SPACE=(TRK,(10,20),RLSE)  *
//****************************************************************
//*
//SYSIN DD *
*0 center symbol 0 - - square  - - - - - - - - - - - - - - - - - - -
¥  E(0.9,0.9)
 (0.0,0.0)-(0.0,0.5)-(-0.5,0.5)-(-0.5,-0.5)-(0.5,-0.5)-(0.5,0.5)-
 (0.0,0.5)
*1 center symbol 1 - - circle  - - - - - - - - - - - - - - - - - - -
¥
 (0.0,0.0)-(0.0,0.5)@(-0.5,0.0)@(0.0,-0.5)@(0.5,0.0)@(0.0,0.5)
*2 center symbol 2 - - triangle  - - - - - - - - - - - - - - - - - -
 (0.0,0.0)-(0.0,0.5)-(-0.5,-0.25)-(0.5,-0.25)-(0.0,0.5)
*3 center symbol 3 - - cross - - - - - - - - - - - - - - - - - - - -
 (0.0,0.5)-(0.0,-0.5) (-0.5,0.0)-(0.5,0.0)
*4 center symbol 4 - - peke  - - - - - - - - - - - - - - - - - - - -
¥ E(0.85,0.85)
 (0.5,0.5)-(-0.5,-0.5) (-0.5,0.5)-(0.5,-0.5)
*5 center symbol 5 - - square  - - - - - - - - - - - - - - - - - - -
¥
 (0.0,0.0)-(0.0,0.5)-(-0.5,0.0)-(0.0,-0.5)-(0.5,0.0)-(0.0,0.5)
*6 center symbol 6 - - umbrella- - - - - - - - - - - - - - - - - - -
 (0.0,-0.5)-(0.0,0.5)-(-0.5,0.0)-(0.5,0.0)-(0.0,0.5)
*7 center symbol 7 - - stool - - - - - - - - - - - - - - - - - - - -
¥ E(0.85,0.85)
 (-0.5,-0.5)-(0.5,0.5)-(-0.5,0.5)-(0.5,-0.5)
*8 center symbol 8 - - Z - - - - - - - - - - - - - - - - - - - - - -
¥ E(0.85,0.85)
 (-0.5,0.5)-(0.5,0.5)-(-0.5,-0.5)-(0.5,-0.5) (-0.2,0.0)-(0.2,0.0)
*9 center symbol 9   - Y - - - - - - - - - - - - - - - - - - - - - -
¥
 (0.0,0.0)-(-0.5,0.5) (0.0,-0.5)-(0.0,0.0)-(0.5,0.5)
*10 center symbol 10    - - - - - - - - - - - - - - - - - - - - - - -
 (0.0,0.0)-(0.5,0.5) (0.25,-0.25)-(0.25,0.25)-(-0.25,0.25)-(-0.5,0.5)
 (-0.25,0.25)-(-0.25,-0.25)-(-0.5,-0.5) (-0.25,-0.25)-(0.25,-0.25)-
 (0.5,-0.5)
*11 center symbol 11 - rice  - - - - - - - - - - - - - - - - - - - -
¥ E(0.85,0.85)
 (0.0,-0.5)-(0.0,0.5) (-0.5,-0.5)-(0.5,0.5) (-0.5,0.0)-(0.5,0.0)
 (-0.5,0.5)-(0.5,-0.5)
*12 center symbol 12  - - - - - - - - - - - - - - - - - - - - - - -
¥ E(0.85,0.85)
 (0.0,0.0)-(-0.5,0.5)-(0.5,0.5)-(-0.5,-0.5)-(0.5,-0.5)-(0.0,0.0)
*13 center symbol 13  -|- - - - - - - - - - - - - - - - - - - - - -
¥
 (0.0,-0.5)-(0.0,0.5)
*14 center symbol 14  -jew's star - - - - - - - - - - - - - - - - -
¥ E(0.9,1.0)
 (0.0,0.0)-(0.0,0.5)-(-0.5,-0.25)-(0.5,-0.25)-(0.0,0.5)
 (0.5,0.25)-(-0.5,0.25)-(0.0,-0.5)-(0.5,0.25)
*15 center symbol 15  - bar - - - - - - - - - - - - - - - - - - - -
¥
 (-0.5,0.0)-(0.5,0.0)
*16 |||||  ==========================================================
 (0.333,0.0)-( ,1.0)
*17 BACK SPACE ======================================================
 (-1.0,0.0)
*18 and    ==========================================================
 (0.0,0.0)-(0.275,0.6667)-(0.55,0.0)
*19 equivalent ======================================================
 (0.0,0.5   )-(0.6667,0.5   ) (0.0,0.3   )-(0.6667,0.3   )
 (0.0,0.1) - (0.6667,0.1)
*20 arrow ===========================================================
  (0.0,0.333)-(0.6667,0.333)-(0.45,0.533) (0.6667,0.333)-(0.45,0.133)
*21 CARRIER RETURN ==================================================
  (0.0,0.0)
*22 not equal ===r===================================================
¥ E(1.0,0.8)
 (0.1,0.5)-(0.667, )
  (0.1,0.25)-(0.6667,0.25) (0.3,0.0)-(0.4667,0.75)
*23 plus-minus ======================================================
¥ E(0.62,0.62) P(0.05,0.10)
  (0.0,0.0)-(1.0,0.0) (0.5,0.0)-(0.5,1.0) (0.0,0.5)-(1.0,0.5)
*24 under line ======================================================
¥
  (0.0,-0.25)-(0.9, )
*25 NULL ( no operation ) ===========================================
  (0.0,0.0)
*26 bar =============================================================
  (0.0,1.1)-(0.9, )
*27 integral ========================================================
¥ P(0.3,-0.1) E(1.0,1.1)
  (0.0,0.05)@(0.1,0.0)@(0.19,0.15)-(0.01,0.85)@(0.1,1.0)@(0.2,0.95)
*28 involve  ========================================================
¥
 (0.0,0.6)-(0.45,0.6)@(0.7,0.35)@(0.45,0.1)-(0.0,0.1)
*29 or       =======================================================
 (0.0,0.667)-(0.275,0.0)-(0.55,0.667)
*30 wave     =======================================================
 (0.0,0.333)@(0.1667,0.45)@(0.3333,0.3333)@
(0.5,0.2167)@(0.6667,0.3333)
```

```
*31 double wave ==================================================
 (0.0,0.433)@(0.1667,0.55)@(0.3333,0.4333)@
(0.5,0.3167)@(0.6667,0.4333)
 (0.0,0.233)@(0.1667,0.35)@(0.3333,0.2333)@
(0.5,0.1167)@(0.6667,0.2333)
*32 > ============================================================
¥ P(0.2,0.0)
 (0.0,1.0)@(0.1414,0.9414)@(0.2,0.8)-(0.2,0.55)-(0.25,0.5)-(0.3,0.5)
 (0.25,0.5)-(0.2,0.45)-(0.2,0.2)@(0.1414,0.0586)@(0.0,0.0)
*33 < ============================================================
¥ R(180.,0.333,0.5) P(-0.2,0.0)
 (0.0,1.0)@(0.1414,0.9414)@(0.2,0.8)-(0.2,0.55)-(0.25,0.5)-(0.3,0.5)
 (0.25,0.5)-(0.2,0.45)-(0.2,0.2)@(0.1414,0.0586)@(0.0,0.0)
*34 mu     ---------------------------------------------------
¥ S(0.3,0.0) P(0.08,0.0)
 (-0.05,-0.25)-(0.0,0.0)-( ,0.67)
 ( ,0.2)@(0.25,0.07)@(0.45,0.27)-(  ,0.67)
 (  ,0.2)-( ,0.05)-(0.55,0.0)
*35 pi     ---------------------------------------------------
¥ E(1.0,0.6) S(0.3,0.0)
 (-0.15,1.0)-(0.05,1.05)-(0.25,0.95)-(0.45,1.0)
 (0.1,1.01)-(0.0,0.0) (0.27,1.0)-( ,0.5)-(0.35,0.2)-(0.55,0.0)
*36 phai   ---------------------------------------------------
¥ P(0.0,-0.2)
 (0.2,0.0)-(0.5,1.0) (0.35,0.2)@(0.05,0.5)@(0.35,0.8)@(0.65,0.5)@
 (0.35,0.2)
*37 theta  ---------------------------------------------------
¥ E(1.0,2.5)  S(0.3,0.0)
 (0.0,0.2)-(0.4,0.2)@(0.2,0.4)@(0.0,0.2) (0.0,0.2)@(0.2,0.0)@(0.4,0.2)
*38 psi    ---------------------------------------------------
¥ E(1.2,1.0) S(0.3,0.0) P(-0.15,0.0)
 (0.0,0.6)-( ,0.4)@(0.2,0.2)@(0.4,0.6) (0.2,0.9)-(0.2,0.0)
*39 chi    ---------------------------------------------------
¥ E(1.0,0.7) S(0.3,0.0)
 (0.0,0.0)-(0.4,1.0) (0.0,1.0)@(0.1414,0.9414)@(0.2,0.8)-( ,0.2)@
 (0.2586,0.0586)@(0.4,0.0)
*40 omega  ---r-----------------------------------------------
¥ E(0.35,0.67) S(0.3,0.0)
  (0.15,1.0)@(0.35,0.0)@(0.85,1.0)@(1.35,0.0)@(1.55,1.0)
*41 lambda ----r----------------------------------------------
¥  E(1.2,1.0) S(0.2,0.0)
  (0.05,0.0)-(0.25,0.67)
  (0.05,1.0)@(0.1917,0.9417)@(0.25,0.8)-(0.25,0.2)@(0.3083,0.0583)@
  (0.45,0.0)
*42 alpha  ---------------------------------------------------
¥ S(0.3,0.0)
 (0.5,0.8)-(0.5,0.3)@(-0.1,0.29)@(0.412,0.512)-(0.6,0.0)-(0.667,0.0)
*43 delta  ---------------------------------------------------
¥ E(0.45,0.6) S(0.3,0.0) P(-0.05,0.0)
 (0.5,1.0)@(1.0,0.5)@(0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(0.15,1.35)@
 (0.5,1.7)-(0.8,1.7)-(1.1,1.6)
*44 epsiron --------------------------------------------------
¥ E(1.1,0.80) S(0.3,0.0) P(0.1,0.0)
 (0.2414,0.0586)@(0.1,0.0)@(0.09,0.4)-(0.19,0.4)
 (0.09,0.4)@(-0.08,0.58)@(0.22,0.73)
*45 eta ------------------------------------------------------
¥ S(0.3,0.0)
(0.0,0.1 )-(0.0,0.65)-(-0.05,0.67) (0.0,0.467)@(0.2,0.67)@(0.4,0.467)-
 (0.4,0.2)-(0.35,0.0)-(0.35,-0.1)-(0.4,-0.25)
*46 UPPER SUBSCRIPT ==============================================
¥
 (0.0,0.0)
*47 LOWER SUBSCRIPT ==============================================
¥
 (0.0,0.0)
*48 SIGMA ----------------------------------------------------
 (0.6,0.8)-( ,1.0)-(0.0,1.0)-(0.3,0.5)-(0.0,0.0)-(0.6,0.0)-(,0.2)
*49 divide ===========================================================
¥
 (0.0,0.4)-(0.7,0.4)
 (0.375,0.55)-(0.325, )-( ,0.65)-(0.375, )-(,0.55)
 (0.375,0.15)-(0.325, )-( ,0.25)-(0.375, )-(,0.15)
*50 less than or equal ===========================================
¥ E(0.667,0.667)
 (1.0,1.1)-(0.0,0.75)-(1.0,0.3) (0.0,0.1)-(1.0,0.1)
*51 greater than or equal ========================================
¥ E(0.6667,0.6667)
 (0.0,1.1)-(1.0,0.75)-(0.0,0.3) (1.0,0.1)-(0.0,0.1)
*52 DELTA ----------------------------------------------------
¥
   (0.0,0.0)-(0.3,1.0)-(0.6,0.0)-(0.0,0.0)
*53 left square parenthesis ======================================
¥ P(0.2,0.0)
 (0.3,1.0)-(0.0,1.0)-(0.0,0.0)-(0.3,0.0)
*54 right square parenthesis =====================================
¥ P(-0.2,0.0)
 (0.3,1.0)-(0.6,1.0)-(0.6,0.0)-(0.3,0.0)
*55 inverse slash ================================================
¥
 (0.0,1.0)-(0.6667,0.0)
* tau      ---------------------------------------------------
¥  E(1.0,0.95) S(0.1,0.0) P(0.05,0.0)
 (0.5,0.6667)-(0.35,0.64)-(0.25,0.64)-(0.15,0.69)-(0.05,0.69)-
 (-0.05,0.667) (0.15,0.69)-( ,0.15)@(0.185,0.045)@(0.3,0.0)-(0.5,0.0)
*57 root =========================================================
¥
 (0.3,0.2)-(0.5,0.0)-(0.7,1.1)-(1.0,1.1)
*58  ?? ==========================================================
¥ P(0.3,0.0)
 (0.0,1.0)-(0.0,0.0) (-0.1,0.75)-(0.1,) (-0.1,0.25)-(0.1,)
*59 ??? ==========================================================
 (0.0,1.0)-(0.0,0.0) (-0.1,0.8167)-(0.1,) (-0.1,0.5)-(0.1,)
 (-0.1,0.1667)-(0.1, )
*60 arrow ========================================================
¥ R(180.,0.3333,0.3333)
  (0.0,0.333)-(0.6667,0.333)-(0.6,0.433) (0.6667,0.333)-(0.6,0.233)
*61 multiply =====================================================
¥ E(0.5,0.5) P(0.083,0.15)
 (0.0,0.0)-(1.0,1.0) (0.0, )-(1.0,0.0)
*62 arrow ========================================================
```

```
¥
  (0.3,0.0)-(0.3,1.0)-(0.2,0.9) (0.3,1.0)-(0.4,0.9)
*63 arrow ==========================================================
¥
  (0.3,1.0)-(0.3,0.0)-(0.2,0.1) (0.3,0.0)-(0.4,0.1)
*64 BLANK ==========================================================
¥
 (0.0,0.0)
*65 a  ------r-------------------------------------------------
¥  E(0.95,0.9)
 (0.6,0.1)-(0.45,0.04)-(0.25,0.0)@(0.0,0.21)@(0.25,0.42)-(0.45,0.38)-
 (0.6,0.34) (0.1,0.65)@(0.3,0.75)@(0.6,0.55)-(   ,0.05)-(0.667,0.0)-
 (0.72,0.0)
*66 b  -------------------------------------------------------
¥
 (0.0,0.0)-(0.0,1.0) (0.0,0.13)-(0.1,0.05)-(0.2667,0.0)@(0.6,0.3333)@
 (0.2667,0.6667)-(0.1,0.6167)-(0.0,0.5367)
*67 c  -------------------------------------------------------
 (0.6,0.1)-(0.5,0.03)-(0.3333,0.0)@(0.0,0.3333)@(0.3333,0.6667)-
 (0.5,0.6367)-(0.6,0.5667)
*68 d  -------------------------------------------------------
 (0.6,0.1)-(0.5,0.03)-(0.3333,0.0)@(0.0,0.3333)@(0.3333,0.6667)-
 (0.5,0.6367)-(0.6,0.5667)  (0.6,1.0)-(0.6,0.0)
*69 e  -------------------------------------------------------
 (0.6,0.1)-(0.5,0.03)-(0.3333,0.0)@(0.0,0.3333)@(0.3333,0.6667)-
 (0.5,0.6267)-(0.6,0.5)-(0.6,0.4)-(0.01,0.4)
*70 f  -------------------------------------------------------
 (0.2,0.0)-(0.2,0.8)-(0.25,0.925)-(0.35,1.0)-(0.45, )-(0.55,0.925)-
 (0.6,0.9)  (0.0,0.6  )-(0.5,0.6  )
*71 g  ------------r-----------------------------------------
 (0.1,-0.2)@(0.3,-0.3)@(0.6,0.0)-( ,0.6667)
 (0.6,0.13)-(0.5,0.06)-(0.3333,0.03)@(0.0,0.3333)@(0.3333,0.6667)-
 (0.5,0.6367)-(0.6,0.5667)
*72 h  ------------------------------r------------------------
 (0.0,0.0)-( ,1.0) (0.0,0.3667)@(0.3,0.6367)@(0.6,0.3667)-(0.6,0.0)
*73 i  -------------------------------------------------------
¥ P(0.1,0.0)
 (0.25,0.0)-( ,0.66)-(0.1, ) (0.275,0.85)-(0.225, )-( ,0.9)-
 (0.275, )-(,0.85) (0.275,0.9)-(0.225,0.85) (0.225,0.9)-(0.275,0.85)
 (0.07,0.0)-(0.43,0.0)
*74 ?  ==========================================================
¥ E(1.0,0.6667)
   (0.333,-0.2)-(0.333,1.2)
   (0.6667,0.8)@(0.3,1.0)@(0.0667,0.8)-(0.0,0.6)-
   (0.0,0.40)-(0.0667,0.2)@(0.3,0.0)@(0.6667,0.2)
*75 .  ==========================================================
¥ P(0.2,0.0)
 (0.1,0.0)-(0.0, )-( ,0.1)-(0.1, )-(0.1,0.0)
 (0.1,0.1)-(0.0,0.0) (0.0,0.1)-(0.1,0.0)
*76 less than ======================================================
¥ E(0.6667,0.6667)
 (1.0,1.0)-(0.0,0.5)-(1.0,0.0)
*77 (        ====================================================
¥ E(0.6,1.0) P(0.3,0.0)
 (0.4,1.0)@(0.0,0.5)@(0.4,0.0)
*78 +        ====================================================
¥ E(0.5,0.5) P(0.083,0.2)
 (0.5,1.0)-(0.5,0.0) (0.0,0.5)-(1.0,0.5)
*79 |        ====================================================
¥
 (0.0,1.0)-(,0.0)
*80 &        ====================================================
¥ P(0.55,-0.2) R(35.,0.0,0.0) E(0.9,0.8)
 (0.0,-0.2)-(0.0,0.8)@(0.201,0.99)@(0.20,0.6)-(-0.1,0.6)@
 (-0.4,0.3)@(-0.1,0.0)-(0.3,0.0)
*81 j  -------------------------------------------------------
¥
 (0.0,0.0)-(0.0,-0.075)@(0.175,-0.25)@(0.35,-0.075)-
 ( ,0.66)-(0.2, ) (0.375,0.85)-(0.325, )-( ,0.9)-(0.375, )-( ,0.85 )
 (0.375,0.9)-(0.325,0.85)  (0.325,0.9)-(0.375,0.85)
*82 k  -------------------------------------------------------
 (0.0,0.0)-( ,1.0) (0.0,0.35)-(0.5,0.65) (0.15,0.425)-(0.6,0.0)
*83 l  -------------------------------------------------------
 (0.25,1.0)-( ,0.05)-(0.3,0.0)-(0.5,0.0)
*84 m  --r----------------------------------------------------
¥ E(1.25,0.95) P(-0.05,0.0)
 (0.1,0.0)-(0.1,0.62)-(0.05,0.667)
 (0.1,0.522)@(0.225,0.667)@(0.35,0.522)-(   ,0.0)
 (   ,0.522)@(0.475,0.667)@(0.6,0.522)-( ,0.0)
*85 n  -------------------------------------------------------
¥ P(-0.05,0.0)
 (0.1,0.0)-(0.1,0.62)-(0.05,0.667)
 (0.1,0.417)@(0.35,0.667)@(0.667,0.417)-( ,0.0)
*86 o -----r-------------------------------------------------
¥
 (0.6,0.3)@(0.3,0.0)@(0.0,0.3)-(0.0,0.3667)@(0.3,0.6667)@(0.6,0.3667)-
 (0.6,0.3)
*87 p  -------------r---------------------------------------
 (0.0,-0.28)-(0.0,0.6667)
  (0.0,0.14)-(0.1,0.08)-(0.2667,0.04)@(0.55,0.3333)@
 (0.2667,0.6667)-(0.1,0.6267)-(0.0,0.5667)
*88 q  -------------r-------------------------------------------
 (0.55,0.14)-(0.45,0.09)-(0.3333,0.04)@(0.0,0.3333)@(0.3333,0.6667)-
 (0.45,0.6167)-(0.55,0.5667)  (0.55,0.6667)-( ,-0.2)-(0.63,-0.28)-
 (0.6667, )
*89 r  -------------r-----------------------------------------
  (0.12,0.0)-(,0.600)-(0.02,0.667)
  (0.12,0.35)-(0.20,0.52)@(0.32,0.667)@(0.57,0.63)
*90 !  ==========================================================
¥ P(0.225,0.0)
 (0.02,1.0)-(0.025,0.2)-(0.03,1.0)-(0.02,)
 (0.05,0.0)-(0.0, )-( ,0.05)-(0.05, )-( ,0.0)
*91 ¥  ==========================================================
¥ P(0.3,0.0)
 (-0.3,1.0)-(0.0,0.6)-(0.3,1.0) (-0.25,0.6)-(0.25, ) (-0.25,0.4)-
 (0.25,0.4)  (0.0,0.6)-(0.0,0.0)
*92 *  ==========================================================
¥ E(0.667,0.667) P(0.0,0.1)
 (0.5,1.0)-(0.5,0.0) (0.0,0.25)-(1.0,0.75) (0.0,0.75)-(1.0,0.25)
*93 )        ====================================================
```

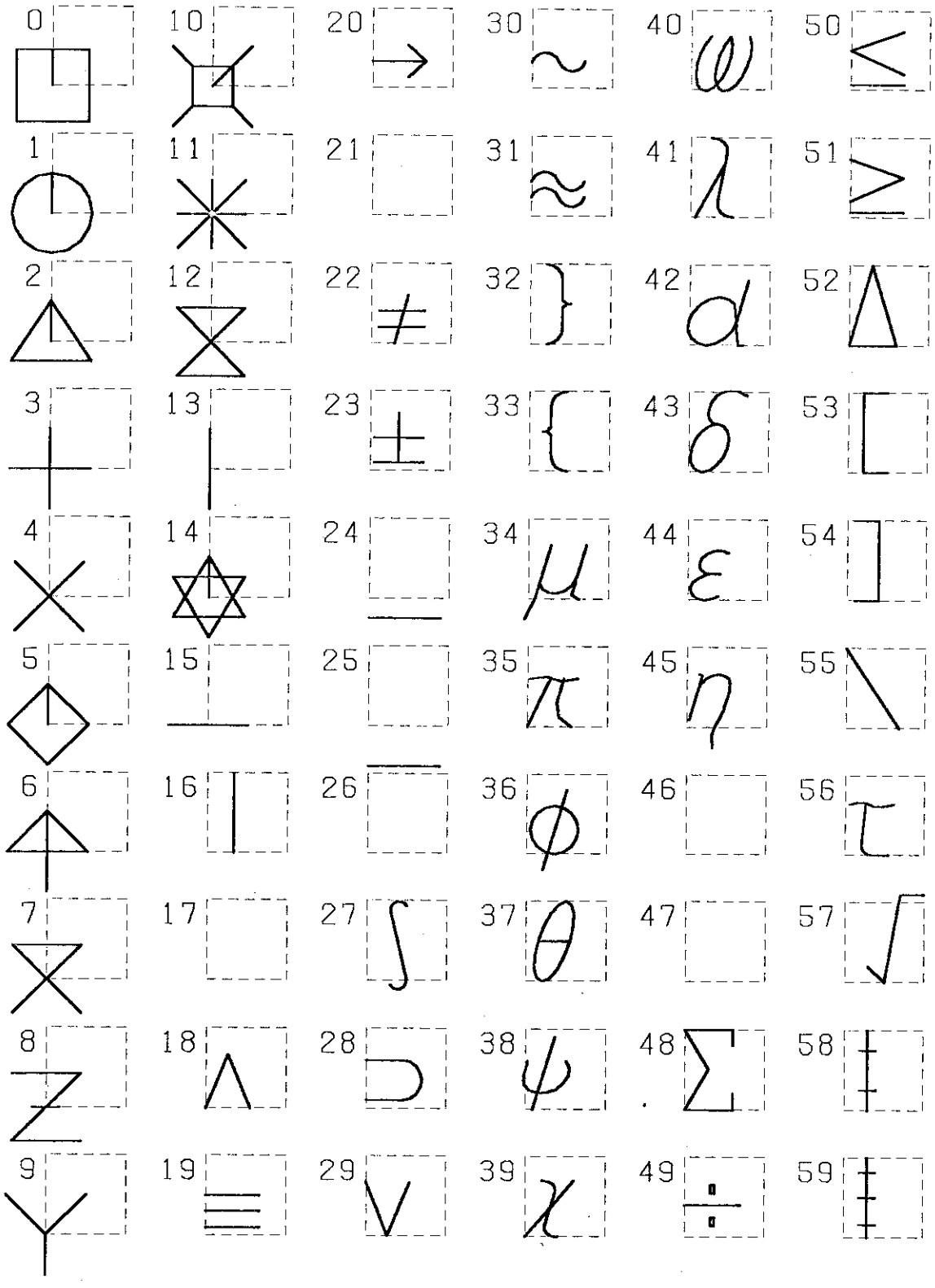
```
¥ E(0.6,1.0) P(0.12,0.0)
 (0.0,1.0)@(0.4,0.5)@(0.0,0.0)
*94 ;  ==========================================================
¥ P(0.3,0.0)
 (0.1,0.5)-(0.0, )-( ,0.6)-(0.1, )-(0.1,0.5)
 (0.1,0.6)-(0.0,0.5) (0.0,0.6)-(0.1,0.5)
 (0.1,0.0)-(0.0, )-( ,0.1)-(0.1, )-(0.1,0.0)
 (0.1,0.1)-(0.0,0.0) (0.0,0.1)-(0.1,0.0)-(0.0,-0.15)
*95 ¬  ==========================================================
¥
 (0.0,0.45)-(0.667,  )-(  ,0.2)
*96 -  ==========================================================
¥
 (0.1,0.45)-(0.5667, )
*97 /  ==========================================================
 (0.0,0.0)-(0.667,1.0)
*98 s  ----------------------------------------------------------
¥  E(0.8,0.6667)
 (0.0,0.265)@(0.077 ,.077 )@(0.265,0.0)-(0.402,0.0)@(0.667,0.265)@
 (0.402,0.53)-(0.265,0.53)@(0.03,0.765)@(0.265,1.0)-(0.402,1.0)@
 (0.5681,0.93)@(0.6367,0.765)
*99 t  ----------------------------------------------------------
¥
 (0.0,0.667)-(0.5,0.667) (0.2,0.90)-( ,0.2)@(0.4,0.0)@(0.6,0.2)
*100 u  ------r---------------------------------------------------
¥ R(180.,0.3,0.3333)  E(1.1,1.0)
 (0.1,0.0)-(0.1,0.62)-(0.0,0.667)
 (0.1,0.417)@(0.35,0.667)@(0.6,0.417)-( ,0.0)
*101 v  ---------------------------------------------------------
¥ E(0.9,0.6667)
 (0.0,1.0)-(0.3333,0.0)-(0.6667,1.0)
*102 w  ---------------------------------------------------------
¥ E(1.0,0.6667)
 (0.0,1.0)-(0.16667,0.0)-(0.33333,0.9)-(0.5,0.0)-(0.66667,1.0)
*103 x  ---------------------------------------------------------
¥ E(0.9,0.6667)
 (0.0,0.0)-(0.6667,1.0) (0.0, )-(0.6667,0.0)
*104 y  ------r---------------------------------------------------
¥
              (0.05,-0.25)-(0.15, )-(0.6,0.6667)
 (0.0,0.667)-(0.33,0.12)
*105 z  ---------------------------------------------------------
¥ E(0.9,0.6667)
 (0.0333,1.0)-(0.63333,  )-(0.0,0.0)-(0.66667,0.0)
*106 infinity ==r=======================================================
¥  E(0.38,0.34) P(0.0 ,0.1)
(1.0,0.5)@(0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(1.0,0.5)@(1.5,0.0)@(2.0,0.5)@
 (1.5,1.0)@(1.0,0.5)
*107 , ==========================================================
¥ P(0.1,0.0)
 (0.1,0.0)-(0.0, )-( ,0.1)-(0.1, )-(0.1,0.0)
 (0.1,0.1)-(0.0,0.0) (0.0,0.1)-(0.1,0.0)-(0.0,-0.15)
*108 % ==========================================================
¥ P(0.05,0.0)
 (0.0,0.0)-(0.7,0.9)
 (0.0,0.7)@(0.15,0.85)@(0.3,0.7)@(0.15,0.55)@(0.0,0.7)
 (0.4,0.2)@(0.55,0.35)@(0.7,0.2)@(0.55,0.05)@(0.4,0.2)
*109 middle bar ==========================================================
¥
 (0.0,0.333)-(1.0, )
*110 greater than ========================================================
¥ E(0.6667,0.6667)
 (0.0,1.0)-(1.0,0.5)-(0.0,0.0)
*111 ?  ==========================================================
¥ P(0.325)
 (-0.3,0.7)@(0.01,0.99)@(0.0,0.4)-(0.0,0.2)
 (0.025,0.0)-(-0.025, )-( ,0.05)-(0.025, )-(,0.0)
*112 0
¥ R(22.5,0.5,0.5) E(0.6,1.0)
 (0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(1.0,0.5)@(0.0,0.5)
*113 1
¥ P(0.1,0.0)
 (0.0,0.9)-(0.15,1.0)-(  ,0.0) (0.0,0.0)-(0.3,0.0)
*114 2
¥ P(0.0,0.3) E(0.6,0.55)
 (0.0,1.0)@(0.51,1.49)@(0.859,0.650)-(0.0,-0.3)-(1.05,)
*115 3
¥ E(0.7692,0.7692) P(0.04,0.0)
 (0.03,1.1)-(0.18,1.24)-(0.29,1.28)-(0.44,1.3)-(0.6,1.25)-(0.7,1.14)-
 (0.71,1.0)-(0.69,0.85)-(0.58,0.7)-(0.32,0.7)
 (0.58,0.7)-(0.7,0.63)-(0.8,0.48)-(0.8,0.29)-(0.7,0.1)-(0.55,0.02)-
 (0.4,0.0)-(0.2,0.02)-(0.0,0.08)
*116 4
¥
 (0.41,1.0)-(0.0,0.3)-(0.6,0.3) (0.45,0.55)-(0.45,0.0)
*117 5
¥ E(1.0,1.08) P(0.0,0.02)
 (0.0,0.15)-(0.05,0.10)@(0.6,0.3)@(0.05,0.45)-(0.05,0.9)-(0.55,0.9)
*118 6
¥
 (0.0,0.3)@(0.3,0.0)@(0.6,0.3)@(0.3,0.6)@(0.0,0.3)@(0.0,0.43)@
 (0.02,0.63)@(0.12,0.81)@(0.26,0.92)@(0.4,0.98)@(0.53,1.0)
*119 7
 (0.05,1.0)-(0.6,1.0)-(0.27,0.0)
*120 8
¥ E(0.6,0.556)
(0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(0.1,1.4)@(0.5,1.8)@(0.9,1.4)@
(0.5,1.0)@(1.0,0.5)@(0.5,0.0)
*121 9
¥ R(180.,0.3,0.5) E(1.0,1.0)
 (0.0,0.3)@(0.3,0.0)@(0.6,0.3)@(0.3,0.6)@(0.0,0.3)@(0.0,0.43)@
 (0.02,0.63)@(0.12,0.81)@(0.26,0.92)@(0.4,0.98)@(0.53,1.0)
*122 :  ==========================================================
¥ P(0.3,0.0)
 (0.1,0.5)-(0.0, )-( ,0.6)-(0.1, )-(0.1,0.5)
 (0.1,0.6)-(0.0,0.5) (0.0,0.6)-(0.1,0.5)
 (0.1,0.0)-(0.0, )-( ,0.1)-(0.1, )-(0.1,0.0)
 (0.1,0.1)-(0.0,0.0) (0.0,0.1)-(0.1,0.0)
*123 #  ==========================================================
¥ E(0.667,0.7)
```

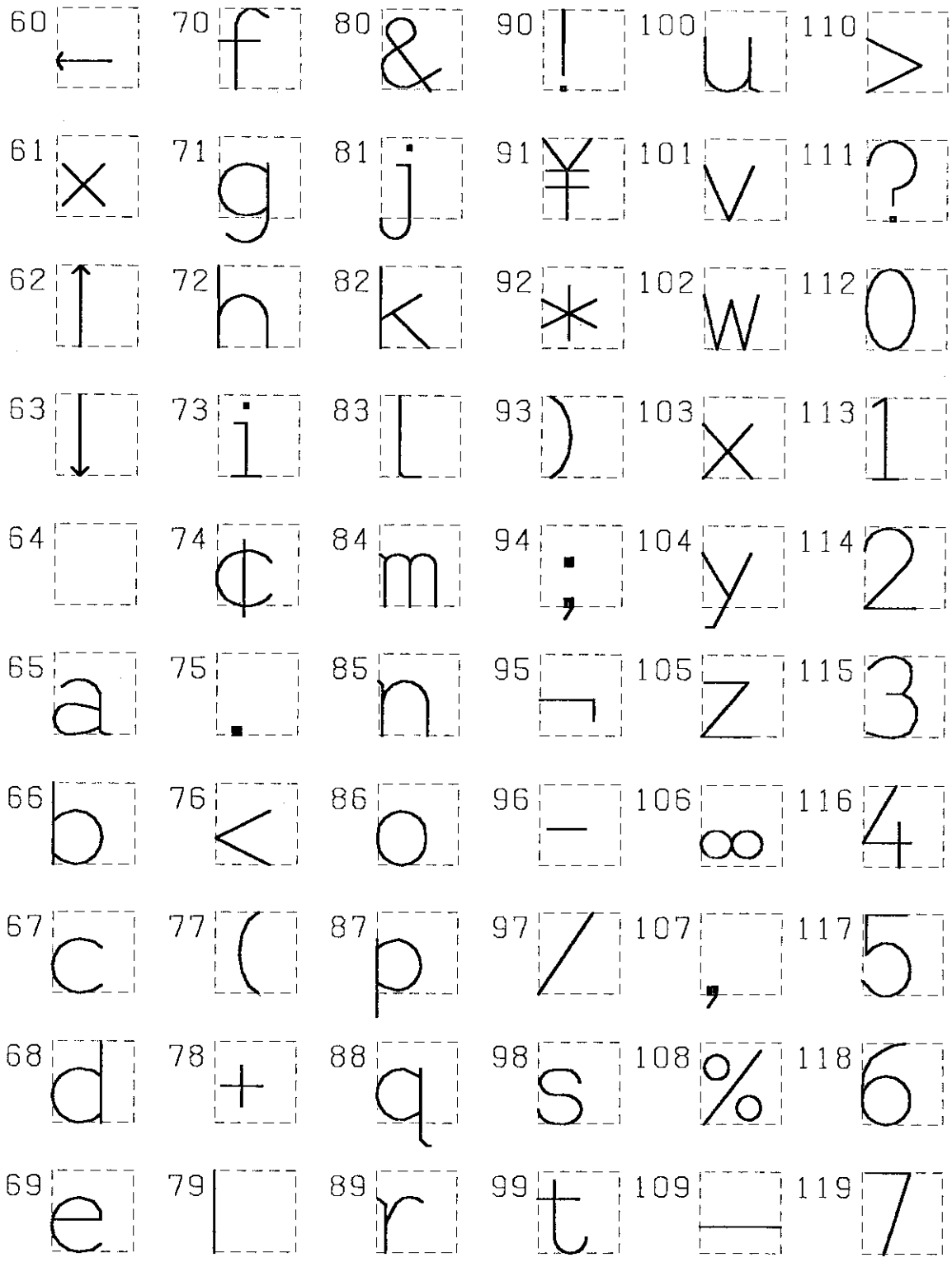
```
 (0.25,0.0)-(,1.0) (0.75, )-( ,0.0)
 (0.0,0.7)-(1.0,0.8)  (0.0,0.2)-(1.0,0.3)
*124 @  ==========================================================
¥ E(0.667,0.7)
 (0.0,0.7)@(0.5,1.1)@(1.0,0.6)-(1.0,0.2)@(0.85,0.0)@(0.7,0.2)-( ,0.6)
 (   ,0.5)@(0.0,0.35)@(0.7,0.2)
*125 '  ==========================================================
¥ P(0.333,0.0)
 (0.025,1.0)-(-0.025,1.0)-(0.0,0.75)-(0.025,1.0)
*126 =  ==========================================================
¥
 (0.1,0.5)-(0.667, ) (0.1,0.25)-(0.667, )
*127 "  ==========================================================
¥ P(0.333,0.0)
 (0.025,1.0)-(-0.025,1.0)-(0.0,0.75)-(0.025,1.0)
 (0.15,1.0)-(0.1,1.0)-(0.125,0.75)-(0.15,1.0)
*128 A  ----------------------------------------------------------
¥
   (0.,0.)-(0.3333,1.0)-(0.6667,0.0) (0.1167,0.35)-(0.55,0.35)
*129 B  ----------------------------------------------------------
   (0.0,0.0)-(0.0,1.0)-(0.38,1.0)@(0.615 ,0.765)@(0.38,0.53)-
   (0.0,0.53) (0.38 ,0.53)@(0.645,0.265)@(0.38,0.0)-(0.0,0.0)
*130 C  ----------------------------------------------------------
   (0.6667,0.8)@(0.3,1.0)@(0.0667,0.8)-(0.0,0.6)-
   (0.0,0.40)-(0.0667,0.2)@(0.3,0.0)@(0.6667,0.2)
*131 D  ----------------------------------------------------------
   (0.0,0.0)-(0.0,1.0)-(0.30,1.0)@(0.5593,0.8926)@(0.6667,0.63333)-
   (0.6667,0.366)@(0.5593,0.1074)@(0.3,0.0)-(0.0,0.0)
*132 E  ----------------------------------------------------------
   (0.03,0.0)-(0.03,1.0)-(0.6667,1.0) (0.03,0.53)-(0.6,0.53)
   (0.03,0.0)-(0.6667,0.0)
*133 F  ----------------------------------------------------------
   (0.0,0.0)-(0.0,1.0)-(0.6667,1.0) (0.0,0.53)-(0.6,0.53)
*134 G  ----------------------------------------------------------
   (0.6667,0.8)@(0.3,1.0)@(0.0667,0.8)-(0.0,0.60)-
   (0.0  ,0.40)-(0.0667,0.2)@(0.3,0.0)@(0.6667,0.2)-(0.6667,0.45)-
   (0.4  ,    )
*135 H  ----------------------------------------------------------
   (0.0,0.0)-( ,1.0)  (0.0,0.53)-(0.667, )  (0.667 ,1.0)-(,0.0)
*136 I  ----------------------------------------------------------
   (0.25,0.0)-(0.45, ) (0.35,0.0)-( ,1.0)  (0.25,1.0)-(0.45, )
*137 J  ----------------------r-----------------------------------
   (0.0,0.25)@(0.25,0.0)@(0.5,0.25)-( ,1.0)  (0.40,1.0)-(0.6,1.0)
*138 K  ----------------------------------------------------------
  (0.0,0.0)-(0.0,1.0) (0.6667,1.0)-(0.0,0.45) (0.17,0.56)-(0.6667,0.0)
*139 L  ----------------------------------------------------------
  (0.0,1.0)-(0.0,0.0)-(0.667,0.0)-(,0.15)
*140 M  ----------------------------------------------------------
  (0.0,0.0)-(0.0,1.0)-(0.3333,0.45)-(0.6667,1.0)-(0.6667,0.0)
*141 N  ----------------------------------------------------------
  (0.02,0.0)-(0.02,1.0)-(0.6667,0.0)-(0.6667,1.0)
*142 O  ----------------------------------------------------------
 (0.0,0.3333)-(  ,0.6667)@(0.3333,1.0)@(0.6667,0.6667)-(, 0.3333)@
 (0.3333,0.0 )@(0.0,0.3333)
*143 P  ----------------------------------------------------------
 (0.05,0.0)-(0.05,1.0)-(0.43,1.0)@(0.665 ,0.765)@(0.43,0.53)-
 (0.05,0.53)   (0.0,0.0)-(0.1,0.0)
*144 Q  ----------------------------------------------------------
 (0.0,0.3333)-(  ,0.6667)@(0.3333,1.0)@(0.6667,0.6667)-(, 0.3333)@
 (0.3333,0.0 )@(0.0,0.3333) (0.4,0.25)-(0.6667,0.0)
*145 R  ----------------------------------------------------------
 (0.0,0.0)-(0.0,1.0)-(0.38,1.0)@(0.615 ,0.765)@(0.38,0.53)-
 (0.0,0.53) (0.38,0.53)-(0.666,0.0)
*146 S  ----------------------------------------------------------
¥
 (0.0,0.265)@(0.076 ,.077 )@(0.265,0.0)-(0.402,0.0)@(0.667,0.265)@
 (0.402,0.53)-(0.255,0.53)@(0.03,0.765)@(0.265,1.0)-(0.402,1.0)@
 (0.5681,0.93)@(0.6367,0.775)
*147 T  ----------------------------------------------------------
 (0.0,1.0)-(0.6667, ) (0.3333,1.0)-(  ,0.0)
*148 U  ---r------------------------------------------------------
 (0.0,1.0)-(0.0,0.3)@(0.325,0.0)@(0.65,0.3)-(  , 1.0)
*149 V  ----------------------------------------------------------
 (0.0,1.0)-(0.3333,0.0)-(0.6667,1.0)
*150 W  --r-------------------------------------------------------
¥ E(1.1,1.0)
 (0.0,1.0)-(0.16667,0.0)-(0.33333,0.9)-(0.5,0.0)-(0.66667,1.0)
*151 X  ----------------------------------------------------------
¥         *
 (0.0,0.0)-(0.6667,1.0) (0.0, )-(0.6667,0.0)
*152 Y  ----------------------------------------------------------
 (0.3333,0.0)-(  ,0.53)-(0.66667,1.0)  (0.0,  )-(0.33333, 0.53)
*153 Z  ----------------------------------------------------------
 (0.0333,1.0)-(0.63333,  )-(0.0,0.0)-(0.66667,0.0)
*154 alpha -------------------------------------------------------
¥ S(0.3,0.0)
 (0.5,0.8)-(0.5,0.3)@(-0.1,0.29)@(0.412,0.512)-(0.6,0.0)-(0.667,0.0)
*155 beta  -------------------------------------------------------
¥ S(0.3,0.0)
 (0.1,-0.25)-(0.1,0.8)@(0.31,0.99)@(0.3,0.6)-(0.15,0.6)
 (0.3,0.6)@(0.6,0.3)@(0.27,0.02)-(0.15,0.05)
*156 gamma -------------------------------------------------------
¥ S(0.05,0.0)
 (0.0,0.0)@(0.2,0.33)@(0.0,0.7) (0.0,0.0)-(0.2,0.39)-
 (0.35,0.6)-(0.7,0.9)
*157 delta -------------------------------------------------------
¥ E(0.45,0.6) S(0.3,0.0) P(-0.05,0.0)
 (0.5,1.0)@(1.0,0.5)@(0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(0.15,1.35)@
 (0.5,1.7)-(0.8,1.7)-(1.1,1.6)
*158 epsiron -----------------------------------------------------
¥ E(1.2,0.90) S(0.3,0.0) P(0.1,0.0)
 (0.2414,0.0586)@(0.1,0.0)@(0.09,0.4)-(0.19,0.4)
 (0.09,0.4)@(-0.08,0.58)@(0.22,0.73)
*159 zeta    -----------------------------------------------------
¥ E(1.1,0.7) S(0.3,0.0) P(-0.1,0.0)
 (0.0,1.0)@(0.2,0.8)@(0.4,1.0)-(0.05,0.1)@( 0.05,0.03)@(0.1,0.0)-
 (0.4,0.0)@(0.5,-0.1)@(0.45,-0.18)-(0.31,-0.32)
*160 eta ---------------------------------------------------------
¥ S(0.3,0.0)
(0.0,0.1 )-(0.0,0.65)-(-0.05,0.67) (0.0,0.467)@(0.2,0.67)@(0.4,0.467)-
```

```
 (0.4,0.2)-(0.35,0.0)-(0.35,-0.1)-(0.4,-0.25)
*161 theta ----------------------------------------------------
¥ E(1.0,2.5)  S(0.3,0.0)
 (0.0,0.2)-(0.4,0.2)@(0.2,0.4)@(0.0,0.2) (0.0,0.2)@(0.2,0.0)@(0.4,0.2)
*162 iota  ----------------------------------------------------
¥ S(0.3,0.0)
 (0.0,0.67)-(0.0,0.15)@(0.15,0.0)@(0.3 ,0.15)
*163 kappa ----------------------------------------------------
¥ E(1.0,0.7) S(0.3,0.0)
  (0.0,0.0)-(0.05,0.21)-(0.1,0.5)-(0.05,0.8)-(0.0,1.0)
  (0.4,1.0)@(0.2,0.8)@(0.1,0.55)@(0.2,0.38)@(0.5,0.0)
*164 lambda ---------r--------------------------------------------
¥  E(1.2,1.0) S(0.2,0.0)
  (0.05,0.0)-(0.25,0.67)
  (0.05,1.0)@(0.1917,0.9417)@(0.25,0.8)-(0.25,0.2)@(0.3083,0.0583)@
  (0.45,0.0)
*165 mu     ----------------------------------------------------
¥ S(0.3,0.0) P(0.08,0.0)
 (-0.05,-0.25)-(0.0,0.0)-( ,0.67)
 ( ,0.2)@(0.25,0.07)@(0.45,0.27)-(  ,0.67)
 (  ,0.2)-( ,0.05)-(0.55,0.0)
*166 nu     ----------------------------------------------------
¥ S(0.3,0.0)
 (0.0,0.0)-(0.04,0.15)-(0.07,0.333)-(0.04,0.52)-(0.0,0.67)
(0.0,0.0)-(0.15,0.1)-(0.3,0.25)-(0.5,0.67)
*167 xi     ----------------------------------------------------
¥ E(1.0,0.45) S(0.3,0.0)
 (0.0,2.0)@(0.1172,1.7172)@(0.4,1.6) @(0.0,1.2)@(0.4,0.8) @
 (0.0,0.4)@(0.3,0.0)@(0.4,-0.1)@(0.3,-0.2)
*168 omicron --------------------------------------------------
¥ E(0.6,0.65) S(0.3,0.0)
 (0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(1.0,0.5)@(0.0,0.5)
*169 pi     ----------------------------------------------------
¥ E(1.0,0.6) S(0.3,0.0)
 (-0.15,1.0)-(0.05,1.05)-(0.25,0.95)-(0.45,1.0)
 (0.1,1.01)-(0.0,0.0) (0.27,1.0)-( ,0.5)-(0.35,0.2)-(0.55,0.0)
*170 rho    ----------------------------------------------------
¥ E(0.8,1.0) S(0.3,0.0)
 (0.05,-0.25)-(0.05,0.333)@(0.383,0.667)@(0.667,0.333)@
 (0.383,0.0)@(0.05,0.333)
*171 sigma  ----------------------------------------------------
¥ E(0.8,1.0) S(0.2,0.0)
 (0.75,0.75)-(0.57,0.69)-(0.31,0.65)@
 (0.0,0.333)@(0.3333,0.0)@(0.6667,0.3333)@(0.3333,0.67)
*172 tau    ----------------------------------------------------
¥  E(1.0,0.95) E(1.0,1.0)
¥  S(0.3,0.0) P(-0.05,0.0)
 (0.5,0.6667)-(0.35,0.64)-(0.25,0.64)-(0.15,0.69)-(0.05,0.69)-
 (-0.05,0.667) (0.15,0.69)-( ,0.15)@(0.185,0.045)@(0.3,0.0)-(0.5,0.0)
*173 upsiron --------------------------------------------------
¥  S(0.3,0.0)  E(1.1,1.0)
 (0.0,0.67)-(0.05,0.5)-(0.05,0.35)-(0.0,0.2)@(0.2,0.0)@(0.4,0.2)-
 (0.4,0.4)-(0.38,0.5)-(0.35,0.667)
*174 phai   ----------------------------------------------------
¥ P(0.0,-0.2) E(1.0,1.0)
 (0.2,0.0)-(0.5,1.0) (0.35,0.2)@(0.05,0.5)@(0.35,0.8)@(0.65,0.5)@
 (0.35,0.2)
*175 chi    ----------------------------------------------------
¥ E(1.0,0.7) S(0.3,0.0)
 (0.0,0.0)-(0.4,1.0) (0.0,1.0)@(0.1414,0.9414)@(0.2,0.8)-( ,0.2)@
 (0.2586,0.0586)@(0.4,0.0)
*176 psi    ----------------------------------------------------
¥ E(1.2,1.0) S(0.3,0.0) P(-0.15,0.0)
 (0.0,0.6)-( ,0.4)@(0.2,0.2)@(0.4,0.6) (0.2,0.9)-(0.2,0.0)
*177 omega  ----------------------------------------------------
¥ E(0.35,0.67) S(0.3,0.0)
  (0.15,1.0)@(0.35,0.0)@(0.85,1.0)@(1.35,0.0)@(1.55,1.0)
*178 ALPHA  ----------------------------------------------------
¥ S(0.2,0.0)
   (0.,0.)-(0.3333,1.0)-(0.6667,0.0) (0.150,0.45)-(0.5167,0.45)
*179 BETA ------------------------------------------------------
   (0.0,0.0)-(0.0,1.0)-(0.38,1.0)@(0.615,0.765)@(0.38,0.53)-
   (0.0,0.53) (0.38,0.53)@(0.645,0.265)@(0.38,0.0)-(0.0,0.0)
*180 GAMMA ------------------------------------------------------
   (0.0,0.0)-(0.0,1.0)-(0.6,1.0)-(0.6,0.9)
*181 DELTA ------------------------------------------------------
   (0.0,0.0)-(0.2,1.0)-(0.6,0.0)-(0.0,0.0)
*182 EPSIRON ----------------------------------------------------
   (0.0,0.0)-(0.0,1.0)-(0.6,1.0) (0.0,0.53)-(0.5,0.53)
   (0.0,0.0)-(0.6,0.0)
*183 ZETA -------------------------------------------------------
 (0.0333,1.0)-(0.6,  )-(0.0,0.0)-(0.6,0.0)
*184 ETA --------------------------------------------------------
   (0.0,0.0)-( ,1.0)  (0.0,0.53)-(0.6 , )  (0.6   ,1.0)-(,0.0)
*185 THETA ------------------------------------------------------
¥ E(0.6,1.0)  S(0.2,0.0)
   (0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(1.0,0.5)@(0.5,0.0)
   (0.2,0.4)-(0.2,0.6) (0.2,0.5)-(0.8,0.5) (0.8,0.6)-(0.8,0.4)
*186 IOTA -------------------------------------------------------
¥  S(0.2,0.0)
   (0.25,0.0)-(0.45, ) (0.35,0.0)-( ,1.0)  (0.25,1.0)-(0.45, )
*187 KAPPA ------------------------------------------------------
  (0.0,0.0)-(0.0,1.0) (0.6,1.0)-(0.0,0.45) (0.17,0.58)-(0.6,0.0)
*188 LAMBDA -----------------------------------------------------
  (0.0,0.0)-(0.3,1.0)-(0.55,0.0) (0.45,0.0)-(0.65,0.0)
*189 MU ---------------------------------------------------------
  (0.0,0.0)-(0.0,1.0)-(0.3,0.50)-(0.6,1.0)-(0.6,0.0)
*190 NU ---------------------------------------------------------
  (0.0,0.0)-(0.0,1.0)-(0.6,0.0)-(0.6,1.0)
*191 XI ---------------------------------------------------------
¥ E(0.67,1.0) S(0.2,0.0)
   (0.0,0.8)-(0.0,1.0)-(1.0,1.0)-(1.0,0.8)
   (0.2,0.4)-(0.2,0.6) (0.2,0.5)-(0.8,0.5) (0.8,0.6)-(0.8,0.4)
   (0.0,0.2)-(0.0,0.0)-(1.0,0.0)-(1.0,0.2)
*192 OMICRON ----------------------------------------------------
¥ E(0.6,1.0) S(0.2,0.0)
 (0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(1.0,0.5)@(0.0,0.5)
*193 PI ---------------------------------------------------------
¥ E(1.15,1.0) S(0.2,0.0)
 (0.0,1.0)-(0.6,1.0) (0.15,1.0)-( ,0.0) (0.45,1.0)-( ,0.0)
```

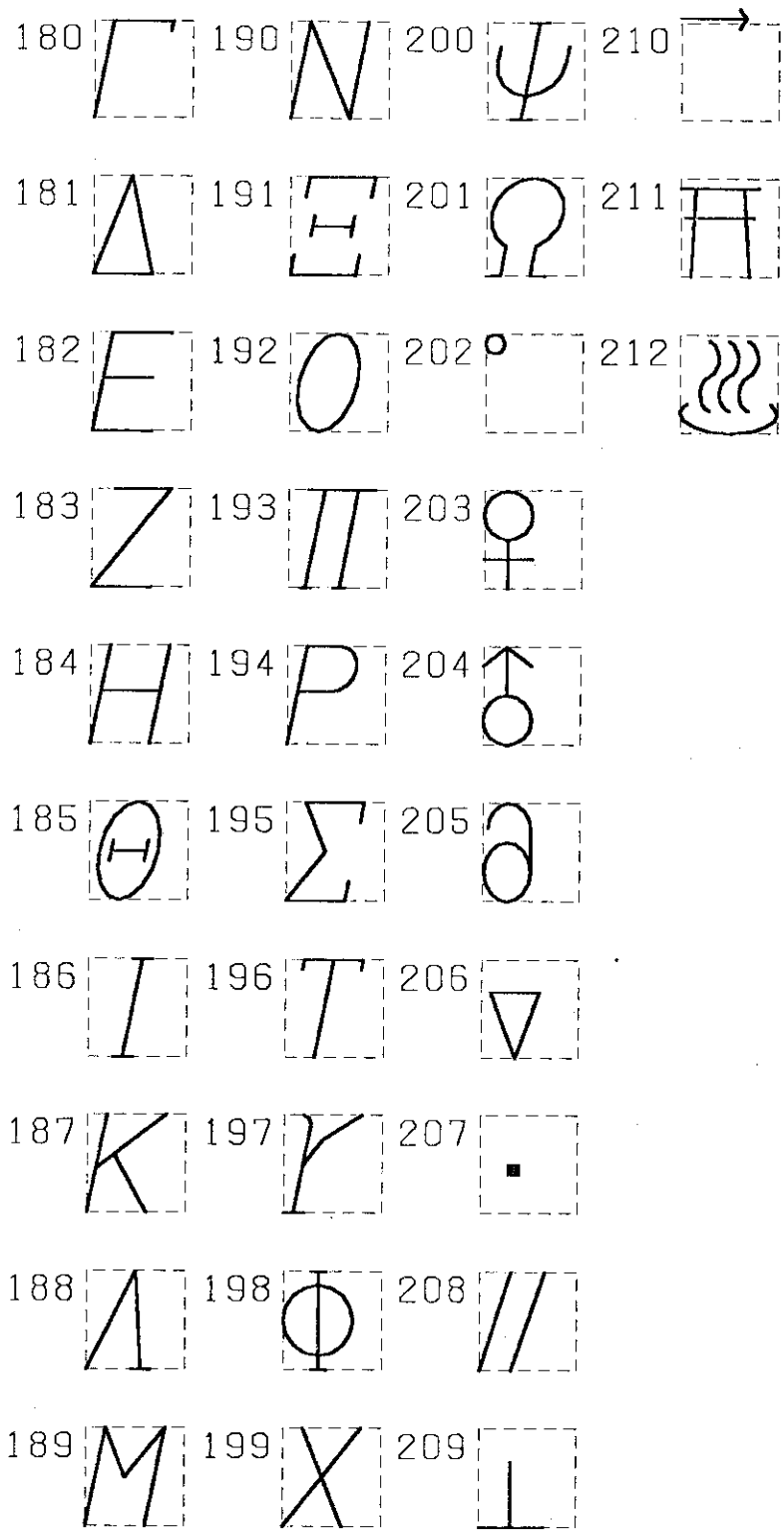
```
 (0.1,0.0)-(0.2, )   (0.4,0.0) -(0.5, )
*194 RHO-------------------------------------------------------
¥ E(0.9,1.0) S(0.2,0.0)
 (0.0,0.0)-(0.0,1.0)-(0.38,1.0)@(0.615 ,0.765)@(0.38,0.53)-
 (0.0,0.53)
*195 SIGMA ----------------------------------------------------
¥ S(0.2,0.0)
 (0.6,0.8)-( ,1.0)-(0.0,1.0)-(0.3,0.5)-(0.0,0.0)-(0.6,0.0)-(,0.2)
*196 TAU   ----------------------------------------------------
 (0.0,0.9)-(0.0,1.0)-(0.6,1.0)-(0.6,0.9)  (0.3,1.0)-(, 0.0)
*197 UPSIRON --------------------------------------------------
  (0.0,1.0)-(0.0707,0.9707)-(0.1,0.9)-(0.1,0.0) (0.0,0.0)-(0.2,)
  (0.1,0.5)-(0.25,0.75)-(0.6,1.0)
*198 PHAI -----------------------------------------------------
¥ P(0.0,0.2) E(0.714,0.714) S(0.2,0.0)
 (0.5,0.0)@(0.0,0.5)@(0.5,1.0)@(1.0,0.5)@(0.0,0.5)
 (0.5,-0.2)-(0.5,1.2) (0.6, )-(0.4, ) ( ,-0.2)-(0.6, )
*199 CHI ------------------------------------------------------
¥ S(0.2,0.0)
 (0.0,0.0)-(0.6,1.0) (0.0, )-(0.6,0.0)
*200 PSI    ---------------------------------------------------
¥ S(0.2,0.0)
 (0.0,0.75)-( ,0.6)@(0.35,0.25)@(0.7,0.6)-(,0.75) (0.35,0.0)-(,1.0)
 (0.45,1.0)-(0.25,) ( ,0.0)-(0.45,)
*201 OMEGA  ---------------------------------------------------
 (0.0,0.0)-(0.15,)-(,0.3)@(0.3,1.0)@(0.45,0.3)-( ,0.0)-(0.6, )
*202 DEGREE ---------------------------------------------------
¥
 (0.0,0.9)@(0.1,1.0)@(0.2,0.9)@(0.1,0.8)@(0.0,0.9)
*203        ----------------------------------------------------
¥
 (0.25,0.5)@(0.0,0.75)@(0.25,1.0)@(0.5,0.75)@(0.25,0.5)-
 (0.25,0.0) (0.0,0.3)-(0.5,)
*204        ----------------------------------------------------
¥
 (0.25,0.5)@(0.5,0.25)@(0.25,0.0)@(0.0,0.25)@(0.25,0.5)-
 (0.25,1.0)-(0.0,0.8) (0.25,1.0)-(0.5,0.8)
*205 partial differentiation ----------------------------------
¥ E(-0.8,1.0) P(0.5,0.0) S(0.1,0.0)
 (0.0,0.3)@(0.3,0.0)@(0.6,0.3)@(0.3,0.6)@(0.0,0.3)-(0.0,0.7)@
 (0.3,1.0)@(0.55,0.75)
*206 nabra ----------------------------------------------------
¥
 (0.6,0.67)-(0.1,)-(0.35,0.0)-(0.6,0.67)
*207 scalor product of vectors --------------------------------
¥ P(0.3,0.4)
 (0.1,0.0)-(0.0, )-( ,0.1)-(0.1, )-(0.1,0.0)
 (0.1,0.1)-(0.0,0.0) (0.0,0.1)-(0.1,0.0)
*208 parallel -------------------------------------------------
¥
 (0.0,0.0)-(0.33,1.0)  (0.667,1.0)-(0.33,0.0)
*209 perpendicular --------------------------------------------
 (0.0,0.0)-(0.66,0.0)  (0.33,0.66)-(,0.0)
*210 vector arrow  --------------------------------------------
  (0.0,1.05)-(0.6667,)-(0.6,0.95) (0.6667,1.05)-(0.6,1.15)
*211 natural behaviour forbidden -------------------------------
¥
  (0.0,0.9)-(0.8,0.9) (0.05,0.6)-(0.75,0.6)
   (0.15,0.9)-(0.1,0.0)  (0.65,0.9)-(0.7,0.0)
*212  hot spring ----------------------------------------------
¥ E(1.0,0.4) D(20)
  (0.06699,0.75)@(0.0,0.5)@(0.5,0.0)@(1.0,0.5)@(0.93301,0.75)
¥ E(1.0,1.2) P(0.0,0.22) D(12)
  (0.3,0.0)@(0.2,0.15)@(0.3,0.3)@(0.4,0.45)@(0.3,0.6)
  (0.5,0.0)@(0.4,0.15)@(0.5,0.3)@(0.6,0.45)@(0.5,0.6)
  (0.7,0.0)@(0.6,0.15)@(0.7,0.3)@(0.8,0.45)@(0.7,0.6)
*END
0.0 0.0 2.8 0.0 1.0 0.0 0.95  /XB,YB,HTC,THC,ASPECT,TALIC,SPACE
£ ¯   {              / SHIFT KEY, UPPER SUB. ,LOWER SUB. ,BACK SPACE
1234567890!"#$%&()=¯|-¬¥`{@};:<>*+_.,/!?jqJQ
  113 114 115 116 117    118 119 120 121 112
  106  31  22  27  49     48  53  54  19  26
   30 206 205  52 202     33  57  32  51  50
   25  28  61  23  24    207 209 208  20 109 203 204 211 212
   28*25  /
/*
++
//
```

Appendix C Plotted Characters and Code Numbers




60 ←
70 f
80 &
90 !
100 u
110 >
61 x
71 g
81 j
91 ¥
101 v
111 ?
62 ↑
72 h
82 k
92 *
102 w
112 0
63 ↓
73 i
83 [
93)
103 x
113 1
64
74 ¢
84 m
94 ;
104 y
114 2
65 a
75 .
85 n
95 ¬
105 z
115 3
66 b
76 <
86 o
96 −
106 ∞
116 4
67 c
77 (
87 p
97 /
107 ,
117 5
68 d
78 +
88 q
98 s
108 %
118 6
69 e
79 |
89 r
99 t
109 ¯
119 7

120 8	130 C	140 M	150 W	160 η	170 ρ
121 9	131 D	141 N	151 X	161 θ	171 σ
122 :	132 E	142 O	152 Y	162 ι	172 τ
123 #	133 F	143 P	153 Z	163 κ	173 υ
124 @	134 G	144 Q	154 α	164 λ	174 φ
125 '	135 H	145 R	155 β	165 μ	175 χ
126 =	136 I	146 S	156 γ	166 ν	176 ψ
127 "	137 J	147 T	157 δ	167 ξ	177 ω
128 A	138 K	148 U	158 ε	168 ο	178 Α
129 B	139 L	149 V	159 ζ	169 π	179 Β


180
190
200
210
181
191
201
211
182
192
202
212
183
193
203
184
194
204
185
195
205
186
196
206
187
197
207
188
198
208
189
199
209