27/10/17/77 25 cp. to NTIS

K/CSD/TM-11

COMPUTER SCIENCES DIVISION

HEATPLOT -

A TEMPERATURE DISTRIBUTION PLOTTING PROGRAM FOR HEATING5

D. C. Elrod
W. D. Turner

MASTER

UNION CARBIDE

OAK RIDGE GASEOUS DIFFUSION PLANT
OAK RIDGE, TENNESSEE

prepared for the **U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**
under **U.S. GOVERNMENT** *Contract W-7405 eng 26*

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy $~~5.00~~; Microfiche $3.00
6.00

K/CSD/TM-11

Contract No. W-7405 eng 26

COMPUTER SCIENCES DIVISION

HEATPLOT -

A TEMPERATURE DISTRIBUTION PLOTTING PROGRAM FOR HEATING5

D. C. Elrod
W. D. Turner

Computing Applications Department

JULY 1977

UNION CARBIDE CORPORATION, NUCLEAR DIVISION
Operating the
Oak Ridge Gaseous Diffusion Plant · Oak Ridge National Laboratory
Oak Ridge Y-12 Plant · Paducah Gaseous Diffusion Plant
for the
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

FOREWORD

The Office of Waste Isolation (OWI) requested Computer Sciences Division to update, implement, and document the plotting code HEATPLOT to aid in the interpretation of results obtained from thermal analyses performed using the HEATING5 code. HEATPLOT was developed from a previously existing, undocumented plotting program and has been modified to be compatible with the DISSPLA plotting package now in use at the Oak Ridge National Laboratory and at the Oak Ridge Gaseous Diffusion Plant. Specific capability additions made at OWI's request include: (1) logarithmic scaled axes, (2) temperature as a function of distance for a specified region, and (3) change in temperature from its initial value as a function of time.

TABLE OF CONTENTS

TABLE OF CONTENTS (contd.)

Blank Page

LIST OF FIGURES

Blank Page

LIST OF FIGURES (contd.)

Blank Page

LIST OF TABLES

HEATPLOT

A Temperature Distribution

Plotting Program for HEATING5

D. C. Elrod
W. D. Turner

ABSTRACT

HEATPLOT is a temperature distribution plotting program that may be used with HEATING5, a generalized heat conduction code. HEATPLOT is capable of drawing temperature contours (isotherms), temperature-time profiles, and temperature-distance profiles from the current HEATING5 temperature distribution or from temperature changes relative to the initial temperature distribution. Contour plots may be made for two- or three-dimensional models. Temperature-time profiles and temperature-distance profiles may be made for one-, two-, and three-dimensional models.

HEATPLOT is an IBM 360/370 computer code which uses the DISSPLA plotting package. Plots may be created on the CALCOMP pen-and-ink, and CALCOMP cathode ray tube (CRT), or the EAI pen-and-ink plotters. Printer plots may be produced or a compressed data set that may be routed to any of the available plotters may be made.

Blank Page

1. INTRODUCTION

HEATPLOT is a plotting program that may be used with HEATING5 (Ref. [1]), a generalized heat conduction code, to produce plots of temperature distributions. HEATPLOT allows the user to plot temperature contours (isotherms), temperature-time profiles, and temperature-distance profiles. The isotherms and temperature profiles may be made from the current temperature distribution or from temperature changes relative to the initial temperature distribution. HEATPLOT requires as input the data set created by the plotting option of HEATING5 and user-supplied control data. The code determines from the input data which plotter is to be used, the type of plots to be made, how the plots are to be scaled, and the times for which the plots are to be made. For temperature contours it also determines the number of isotherms, the planes and the region for which isotherms are to be plotted, and whether or not the axes are to be reversed and/or switched. For temperature-time profiles and for temperature-distance profiles it determines the nodes or the lines for which profiles are to be plotted and whether or not each profile should appear on a separate plot or all profiles should appear on a single plot.

HEATPLOT has been stored on disks at the Computing Centers at ORNL and ORGDP. This program is operational on the CALCOMP pen-and-ink and the CALCOMP cathode ray tube (CRT) plotters at ORNL and on the EAI and the CALCOMP pen-and-ink plotters at ORGDP. Printer plots may be produced for quick, low quality plots, or compressed data sets may be stored to later produce plots on any of the available plotters.

Section 2 of this report discusses the capabilities available for one-, two-, and three-dimensional models. The input data is described in Section 3, and the program output is described in Section 4. The appendices contain a description of the job control cards necessary to use the code at ORNL or at ORGDP, an explanation of how to modify the main program, and an example of HEATPLOT printed output and plots.

2. CAPABILITIES

2.1 General

For two- and three-dimensional models HEATPLOT may be used to plot temperature contours, temperature-time profiles, and temperature-distance profiles. Temperature-time profiles and temperature-distance profiles may be made for one-dimensional models.

Pen-and-ink plots may be made by the CALCOMP or EAI plotters, or 35 mm film plots may be produced by the CALCOMP CRT plotters. DISSPLA (Display Integrated Software System and Plotting Language), the plotting package used by HEATPLOT, makes the appropriate calls based on the input data which specifies which plotter is to be used. A compressed data set may be created and then used to make plots on any of the available plotters.

The maximum allowable lengths of the horizontal and vertical axes of the plot to be generated depend on the physical limitations of the plotter being used. These limitations will be described in Section 3 of this report. If the lengths of the axes are not specified, default values of 8.0 inches will be used for the horizontal and the vertical axes.

The axial scale factors may also be input to HEATPLOT. A scale factor is defined as the difference of the maximum and the minimum axial values divided by the axis length (units/inch). If temperature-time or temperature-distance profiles are to be made, the minimum temperature may be specified. The user may input the maximum and the minimum time desired for temperature-time profiles, and the maximum and the minimum distance for temperature-distance profiles. If the scale factors or the minimum or maximum temperature, time, or distance are not specified they will be calculated by the program.

The time, temperature, and distance units must be specified with up to four alphanumeric characters. These units will be used for labeling the axes and for writing the legend.

The times of the temperature distribution from which the temperature contours or the temperature-distance profiles are to be made may be input to HEATPLOT. If no times are specified, the isotherms or the temperature-distance profiles will be produced for every temperature distribution on the data set. Every temperature distribution on the data set will be used to plot temperature-time profiles unless the maximum and the minimum times are specified.

HEATPLOT uses the job description from the HEATING5 input as the title of the plots. Greek letters will be written in the plot title if the corresponding English letters are surrounded by questions marks in the job description. For example, including ?P? in the HEATING5 job description will cause π to be written in the plot title. As a result of this capability, extraneous question marks should not be included in the HEATING5 job description if HEATPLOT is to run on the HEATING5 data set. See Table 2.1 for the Greek letters and their corresponding English letters.

2.2 Temperature Contours

Temperature contours (isotherms) may be made for two- or three-dimensional models. Isotherms may be drawn of temperature values or of changes in temperatures relative to the initial temperature values. The user may specify the values of the isotherms to be plotted or simply specify the number of isotherms desired. If only the number of isotherms is specified, the code will find the maximum and the minimum temperatures

Table 2.1. Greek Alphabet and
Corresponding English Alphabet

ASCI-II Code	English	Greek
34	A	A
35	B	B
36	C	H
37	D	Δ
38	E	E
39	F	Φ
40	G	Γ
41	H	X
42	I	I
43	J	
44	K	K
45	L	Λ
46	M	M
47	N	N
48	O	O
49	P	π
50	Q	Θ
51	R	R
52	S	Σ
53	T	T
54	U	Υ
55	V	
56	W	Ω
57	X	Ξ
58	Y	ψ
59	Z	Z

of the distribution to be plotted, take their difference and divide it by the number of isotherms to be drawn. This will be the interval between the isotherms plotted. The value of the first isotherm that will be plotted will be the minimum temperature in that temperature distribution plus half the interval between the isotherms.

The option to specify the region for which isotherms are to be drawn allows the user to plot isotherms in a selected portion of his model. Note, the region specified for the contour plots is also the region for which the temperature-distance profiles will be made. The region must be specified by the fine grid line numbers of the HEATING5 model. If the region is not specified, isotherms are drawn over the entire specified plane.

HEAPLOT will draw indentations or holes if they appear in the region of the model for which contours are to be drawn. However, an indentation or hole will be recognized only if there is a fine grid line passing through the interior of the indentation or hole parallel to each axis of the model.

The user may specify that any axis be reversed, i.e., the X-, and Y-, or Z-axis values (or the R-, θ-, or Z-axis values) will range from maximum to minimum rather than from minimum to maximum, which is the default. The option to switch the axes of a contour plot causes the vertical axis to be drawn horizontally and the horizontal axis to be drawn vertically.

When plotting temperature contours for three-dimensional models, the user must specify the number of planes and their positions normal to each of the X, Y, and Z (or R, θ, and Z) axes for which temperature contours are to be made. The positions of the planes must be specified by the fine grid line numbers of the HEATING5 model.

2.3 Temperature-time Profiles

Temperature-time profiles may be made for one-, two-, or three-dimensional models. Profiles of up to 20 nodes may be made. The node numbers must be specified from the HEATING5 model. The user has the option to plot the nodal temperature or the nodal temperature change (the current nodal temperature minus the initial nodal temperature) of the nodes specified. The profiles of each node may be on separate plots, or the profiles of all the nodes may be on one plot.

The time axis of the temperature-time profiles may be linear or logarithmic. The minimum and the maximum times to be plotted may be input. If the user wishes to use the semi-log plot option and his first time is zero, he should input his minimum time to be equal to the next time step; otherwise, HEATPLOT will print a warning message, and the plots may or may not be drawn correctly.

2.4 Temperature-distance Profiles

Temperature-distance profiles may be plotted along a line parallel to any axis. For two-dimensional problems, the user must specify the total number of profiles to be plotted parallel to each axis, as well as the corresponding fine grid line numbers along which the profiles are to be plotted. As an example, assume the user wishes to draw temperature-distance profiles for the two-dimensional model given in Figure 2.1. If three profiles are to be drawn parallel to the X-axis and two are to be drawn parallel to the Y-axis, the numbers of the fine grid lines along which the profiles are to be plotted would be j_2, j_k and j_ℓ on the Y-axis, and i_2 and i_ℓ on the X-axis.

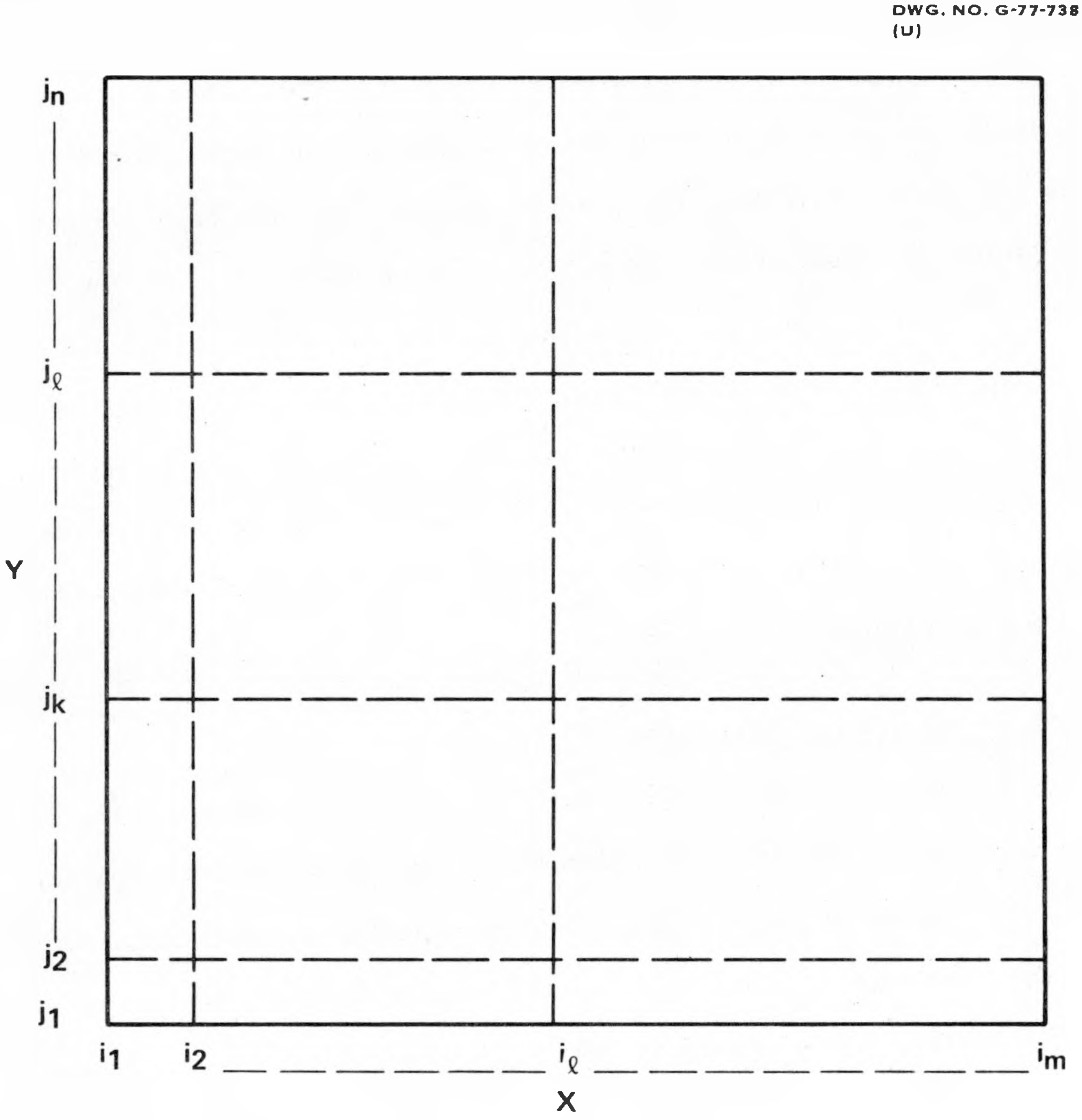

Figure 2.1. An Example of a Two-dimensional Model for Which Temperature-distance Profiles Are to be Plotted

For three-dimensional problems, the user must specify the total number of profiles to be plotted parallel to each axis, and the corresponding fine grid line numbers which define the orthogonal planes along whose intersection the profiles are to be plotted. Assume the user wishes to draw two temperature-distance profiles parallel to the Z-axis for the three-dimensional model given in Figure 2.2. The numbers of the fine grid lines along which the profiles are to be plotted would be i_k and j_k on the X- and Y-axis, respectively, for the first profile, and i_ℓ and j_ℓ on the X- and the Y-axis, respectively, for the second profile. The same principle would be used for drawing profiles parallel to the X- and to the Y-axes.

If the temperature-distance profiles are to be made for one-dimensional models, the user need specify only whether the profiles for each time are to be on the same plot or on separate plots, and the times at which the profiles are to be made.

The user may specify that the <u>changes</u> in temperature from the initial temperature distribution rather than the actual temperatures are to be plotted. The temperature-distance profiles may be plotted with the profiles for all the times on one plot, or with the profile for each time on a separate plot.

The distance axis of temperature-distance profiles may be linear or logarithmic. The minimum and the maximum distances to be plotted may be input. If the minimum and the maximum are specified, the region for the contour plots will also be delimited by these bounds. If a semi-log plot is to be made and the minimum distance for the specified profile is zero, the minimum distance should be input to be the value of the next fine grid line. If the minimum distance is zero for a semi-lot plot, a warning will be printed and the plots may or may not be drawn correctly.

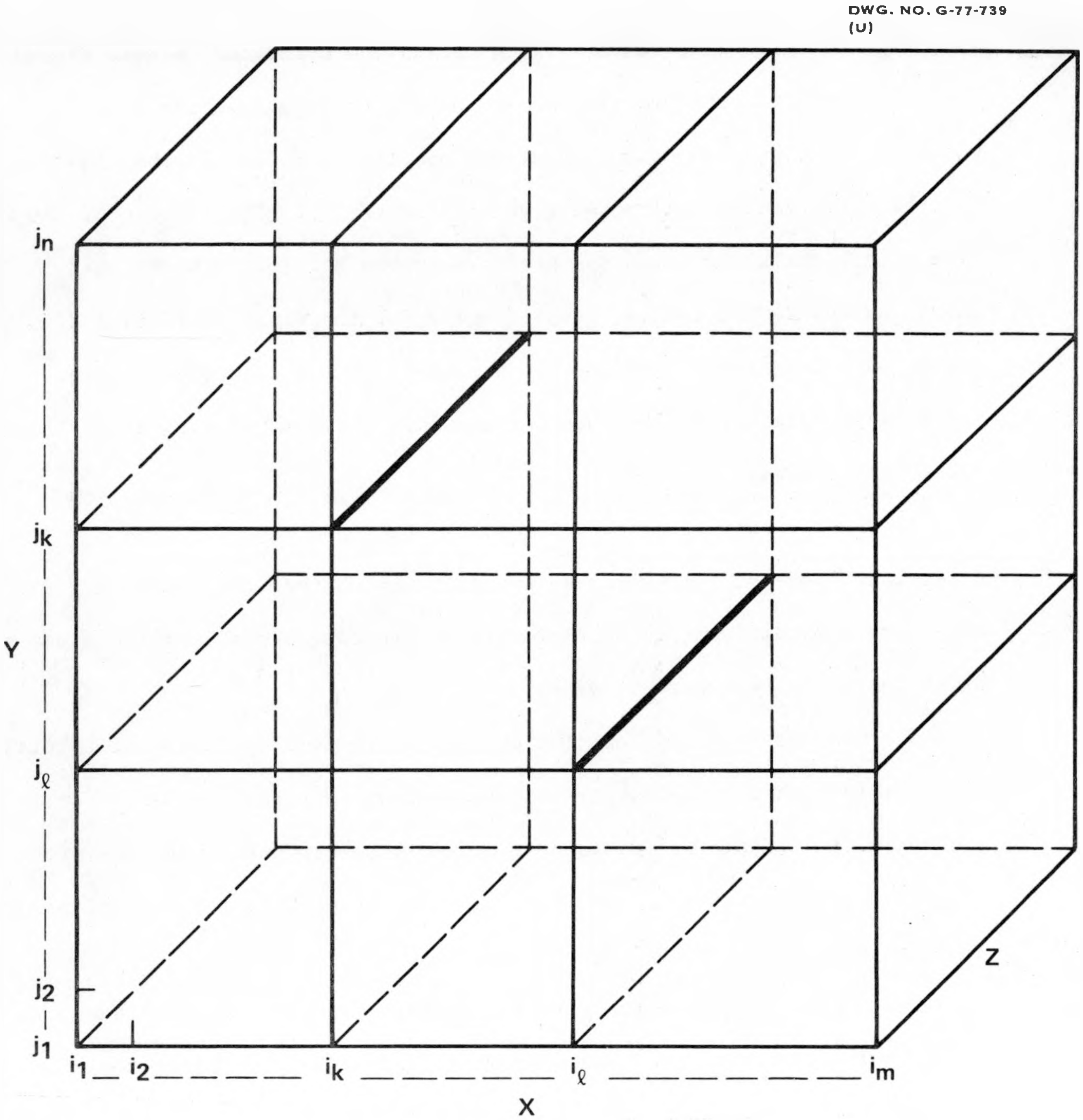

Figure 2.2. An Example of a Three-dimensional Model For Which Temperature-distance Profiles Are to be Plotted

3. INPUT DESCRIPTION

A detailed description of the card input is presented below. All integer fields are five columns. Integers must be right-adjusted, i.e., the last digit of each integer must appear in a column which is a multiple of five. All floating point fields are ten columns. Columns 71 through 80 of each card may be used for identification to aid the user in the preparation and handling of the data.

3.1 Card 1 - Input Parameters

Format (A4, 1X, 2E10.0)

PLOTER - Type of plotter to be used, must be 'EAI' if plots are to be made on EAI pen-and-ink plotter, 'CAL' if plots are to be made on CALCOMP pen-and-ink plotter, 'CRT' if plots are to be made on CALCOMP CRT plotter, 'PRT' if the printer is to be used, and 'EAI3' if EAI plotter with 30 x 30 paper is to be used. Enter 'CMP' to create a compressed data set. This entry must begin in Column 1.

XAX - Length of the horizontal axis in inches. If blank, the default is 8.0 inches.

YAX - Length of the vertical axis in inches. If blank, the default is 8.0 inches.

The lengths of the axes are bounded by the physical limitations of the plotter:

CALCOMP Pen-and-Ink (11" paper)	- XAX has no limits
	$0.0 < YAX \leq 9.0$
CALCOMP Pen-and-Ink (30" paper)	- XAX has no limits
	$0.0 < YAX \leq 28.0$
CALCOMP CRT	- $0.0 < XAX \leq 9.0$
	$0.0 < YAX \leq 12.5$
EAI Pen-and-Ink	- $0.0 < XAX \leq 12.5$
	$0.0 < YAX \leq 8.25$
EAI30 Pen-and-Ink	- $0.0 < XAX \leq 25.0$
	$0.0 < YAX \leq 28.0$
Printer Plot	- $0.0 < XAX \leq 11.0$
	$0.0 < YAX \leq 11.0$

3.2 Card 2 - Input Parameters

Format (10I5)

NL - Number of temperature contour levels to be plotted is equal to $|NL|$. If negative, the contour values will be calculated by the program. If zero, no contours will be plotted. If positive, the contour values will be read in. NL should equal the number of values to be read from the VALUES card. $0 \leq |NL| \leq 50$.

NTIME - The number of time positions for which contours or temperature-distance profiles are to be plotted. If zero, all time positions will be plotted. If not zero, the times will be read from the TIMES card. $0 \leq$ NTIME ≤ 20.

NPLANE(1) - Number of Y-Z or θ-Z planes for which contours are to be plotted if the problem is three dimensional. The X-axis positions will be read from the XPLANES card. $0 \leq$ NPLANE(1) ≤ 10.

NPLANE(2) - Number of X-Z or R-Z planes for which contours are to be plotted if the problem is three dimensional. The Y-axis positions will be read from the YPLANES card. $0 \leq$ NPLANE(2) ≤ 10.

NPLANE(3) - Number of X-Y or R-θ planes for which contours are to be plotted if the problem is three dimensional. The Z-axis positions will be read from the ZPLANES card. $0 \leq$ NPLANE(3) ≤ 10.

ITMVTP - Option for temperature-time profiles. If negative, temperatures for |ITMVTP| nodes will be plotted on one graph. If zero, no temperature-time profiles will be made. If positive, temperatures for ITMVTP nodes will be plotted one node on each graph. The node numbers will be read from the NODES card. $0 \leq$ |ITMVTP| ≤ 20.

LPLOT - Option for temperature-distance profiles. If -1, profiles along a line at every time will be on one plot. If zero, no temperature-distance profiles will be plotted. If 1, one profile will be on each graph. The times will be read from the TIMES card.

IRISCN - Option to plot temperature changes for contour plots. If zero, and NL ≠ 0, temperature contours will be plotted. If 1, and NL ≠ 0, contours of temperature changes relative to the initial temperature distribution will be plotted.

IRISTM - Option to plot temperature changes for temperature-time plots. If zero, and ITMVTP ≠ 0, temperatures will be plotted. If 1, and ITMVTP ≠ 0, temperature changes will be plotted.

IRISDS - Option to plot temperature changes for temperature-distance plots. If zero, and LPLOT ≠ 0, temperatures will be plotted. If 1, and LPLOT ≠ 0, temperature changes will be plotted.

3.3 Card 3 - Input Parameters

Format (7I5)

NSCAL - Option to input the scale factors. If any scale factors are to be read in, NSCAL must be 1. The scale factors will be read from the SCAL1 and SCAL2 cards. If NSCAL is zero, the program will compute the scale factors.

LREG - Option to specify region on which temperature contours will be plotted. If the region is to be read in, LREG must be 1. The region will be read from the REGION card. If zero, contours will be drawn over the entire region for each plane specified.

LREV(1) - Option to reverse X-axis of contour plots. If zero, X-axis will be from minimum to maximum. If 1, X-axis will be from maximum to minimum.

LREV(2) - Option to reverse Y-axis of contour plots. If zero, Y-axis will be from minimum to maximum. If 1, Y-axis will be from maximum to minimum.

LREV(3) - Option to reverse Z-axis of contour plots. If zero, Z-axis will be from minimum to maximum. If 1, Z-axis will be from maximum to minimum.

LAX(1) - Option to switch the Y-Z or θ-Z axes of contour plots. If zero, axes will not be switched. If 1, axes will be switched.

LAX(2) - Option to switch the X-Z or R-Z axes of contour plots. If zero, axes will not be switched. If 1, axes will be switched.

LAX(3) - Option to switch the X-Y or R-θ axes of contour plots. If zero, axes will not be switched. If 1, axes will be switched.

LOGTIM - Option to specify log scale for time axis of temperature-time profile. If 1, log scale will be used. Note, minimum time should not be zero if log scale is used. If zero, linear scale will be used.

LOGDIS - Option to specify log scale for distance axis of temperature-distance profile. If 1, log scale will be used. Note, minimum distance should not be zero if log scale is used. If zero, linear scale will be used.

3.4 Card UNITS - Units Data

Format (3(A4, 1X))

UNITS(1) - Time units for labels and legend.

UNITS(2) - Temperature units for labels and legend.

UNITS(3) - Distance units for labels and legend.

3.5 Card VALUES - Isotherm Values

Format (7E10.0)

VALUE(I),I=1,NL - Values of isotherms to be plotted. Omit if NL≤0. Maximum entries 50.

3.6 Card TIMES - Output Times

Format (7E10.0)

TIME(I),I=1,NTIME - The times for which contours and temperature-versus distance profiles will be made. If the input time is not the same as a time on the temperature distribution data set, the time on the data set closest to the input time will be used. Omit if NTIME=0. Maximum 20 entries.

3.7 Card XPLANES - Output Planes

Format (10I5)

IPLANE(I,1),I=1,NPLANE(1) - Numbers of the fine grid lines on the X-axis for which Y-Z or θ-Z contours are to be plotted. Omit if NPLANE(1)=0. Maximum 10 entries.

3.8 Card YPLANES - Output Planes

Format (10I5)

IPLANE(I,2),I=1,NPLANE(2) - Numbers of the fine grid lines on the Y-axis for which X-Z or R-Z contours are to be plotted. Omit if NPLANE(2)=0. Maximum 10 entries.

3.9 Card ZPLANES - Output Planes

Format (10I5)

IPLANE(I,3),I=1,NPLANE(3) - Numbers of the fine grid lines on the Z-axis for which X-Y or R-θ contours are to be plotted. Omit if NPLANE(3)=0. Maximum 10 entries.

3.10 Card SCAL1 - Scaling Factors*

Format (3E10.0)

Scale factors in units/inch for axes involving temperature contours:

RSCAL - Scale factor for X- or R-axis.

THSCAL - Scale factor for Y- or θ-axis.

ZSCAL - Scale factor for Z-axis.

---

*Card SCAL1 and Card SCAL2 are coupled. If NSCAL=1, both cards must be included. Scale factors will be computed for those scale factors left blank. Minimum temperature will be zero if left blank. Omit both cards if NSCAL=0.

Scale factors in units/inch for temperature-distance profiles:

DSCAL - Scale factor for distance axis of temperature-distance profiles.

TSCAL - Scale factor for temperature axis of temperature-distance profiles.

TVDMIN - Minimum temperature of temperature-distance profiles.

3.11 Card SCAL2 - Scaling Factors*

Format (6E10.0)

Scale factors in units/inch for temperature-time profiles:

TMSCAL - Scale factor for time axis of temperature-time profiles.

TPSCAL - Scale factor for temperature axis of temperature-time profiles.

TVTMIN - Minimum temperature of temperature-time profiles.

TIMMIN - Minimum time of temperature-time profiles.

TIMMAX - Maximum time of temperature-time profiles.

3.12 Card REGION - Contour Region

Format (6I5)

This card contains the grid line numbers bounding the region for which temperature contours are to be plotted. Omit this card if LREG=0.

NB(1) - Number corresponding to the fine grid line of the minimum X value in region.

NE(1) - Number corresponding to the fine grid line of the maximum X value in region.

---

*Card SCAL1 and Card SCAL2 are coupled. If NSCAL=1, cards must be included. Scale factors will be computed for those scale factors left blank. Minimum temperature will be zero if left blank. Omit both cards if NSCAL=0.

NB(2) - Number corresponding to the fine grid line of the minimum Y value in region.

NE(2) - Number corresponding to the fine grid line of the maximum Y value in region.

NB(3) - Number corresponding to the fine grid line of the minimum Z value in region.

NE(3) - Number corresponding to the fine grid line of the maximum Z value in region.

3.13 Card NODES - Nodes for Temperature-time Profiles

Format (15I5)

NODE(I),I=1,ABS(ITMVTP) - Node numbers for which temperature-time profiles are to be plotted. Maximum of 20 entries. Omit if ITMVTP=0.

3.14 Card PROFILES - Number of Temperature-distance Profiles

Format (3I5)

Omit this card if LPLOT=0, or if model is one-dimensional. The default maximum number of profiles is 5. This may be changed in the main routine (see Appendix B).

NPRFIL(1) - The number of temperature-distance profiles to be plotted parallel to the X-axis, or normal to the Y-Z plane, for two- or three-dimensional models.

NPRFIL(2) - The number of temperature-distance profiles to be plotted parallel to the Y-axis, or normal to the X-Z plane, for two- or three-dimensional models.

NPRFIL(3) - The number of temperature-distance profiles to be plotted parallel to the Z-axis, or normal to the X-Y plane, for two- or three-dimensional models.

3.15 Card INDX1 - X Profiles

Format (14I5)

INDEX(1,J),INDEX(2,J),J=1,NPRFIL(1) - The numbers of the fine grid lines of the Y and Z axes, respectively, which define the XZ and XY planes whose intersection is the line along which the temperature-distance profiles are to be plotted parallel to the X-axis. For two-dimensional problems, the number of the fine grid line for the missing axis must be one or zero. Omit if NPRFIL(1)=0.

3.16 Card INDX2 - Y Profiles

Format (14I5)

INDEX(1,K),INDEX(2,K),K=1,NPRFIL(2) - The numbers of the fine grid lines of the X and Z axes, respectively, which define the YZ and XY planes whose intersection is the line along which the temperature-distance profiles are to be plotted. For two-dimensional problems, the number of the fine grid line for the missing axis must be one or zero. Omit if NPRFIL(2)=0.

3.17 Card INDX3 - Z Profiles

Format (14I5)

INDEX(1,N),INDEX(2,N),N=1,NPRFIL(3) - The numbers of the fine grid lines of the X and Y axes, respectively, which define the YZ and XY planes whose intersection is the line along which the temperature-distance profiles are to be plotted. For two-dimensional problems, the number of the fine grid line for the missing axis must be one or zero. Omit if NPRFIL(3)=0.

3.18 Problem Size Limits

The problem size limits are summarized in Table 3.1.

Table 3.1. Problem Size Limits

Item	Size
Contour levels	50
Times for contour plots and temperature-distance profiles	20
YZ or θZ planes to be plotted, if three dimensional	10
XZ or RZ planes to be plotted, if three dimensional	10
XY or Rθ planes to be plotted, if three dimensional	10
Nodes for time-temperature profiles	20

3.19 Summary and Format of Input

Table 3.2 summarizes the format and information needed to prepare the input deck. On all cards, columns 71 through 80 are reserved for identification, which the user may or may not wish to punch. Proposed identification names appear in these columns in the table. Each box includes the variable name actually used in the program, the format with which that variable is read, and a brief description of the variable. Additional comments have been included on some of the cards.

TABLE 3.2 Summary and Format of Input Data for HEATPLOT

Columns 1-5	Columns 6-10	Columns 11-15	Columns 16-20	Columns 21-25	Columns 26-30	Columns 31-35	Columns 36-40	Columns 41-45	Columns 46-50	Columns 51-55	Columns 56-60	Columns 61-65	Columns 66-70	Columns 71-75	Columns 76-80
PLOTER (A4) Plotter type use CAL,CRT or EAI, EAI3, CMP, PRT.	XAX (E10.0) Length of horizontal axis in inches, default 8.0.		YAX (E10.0) Length of vertical axis in inches, default 8.0		Maximum axis length: CALCOMP Pen & Ink (11" paper) XAX has no limit $0.0 < YAX \leq 9.0$ CALCOMP Pen & Ink (30" paper) XAX has no limit $0.0 < YAX \leq 28.0$ CALCOMP CRT $0.0 < XAX \leq 9.0$ $0.0 < YAX \leq 12.5$			EAI Pen & Ink $0.0 < XAX \leq 12.5$ $0.0 < YAX \leq 8.5$ EAI30 Pen & Ink $0.0 < XAX \leq 25.0$ $0.0 < YAX \leq 28.0$ Printer Plot $0.0 < XAX \leq 11.0$ $0.0 < YAX \leq 11.0$							Card 1
NL (I5) Number Contour levels to be plotted. Maximum 50 If neg, contour values will be calculated. If blank no contours will be plotted. If pos. contour values will be read	NTIME (I5) Number time positions for contours profiles to be plotted. Maximum 20 If every time positions is to be plotted, leave blank	NPLANE(1) (I5) Number YZ or θZ planes to be plotted if 3-dim. Maximum 10	NPLANE(2) (I5) Number XZ or RZ planes to be plotted if 3-dim. Maximum 10	NPLANE(3) (I5) Number XY or Rθ planes to be plotted if 3-dim. Maximum 10	ITMVTP (I5) Option for temperature-time profiles. Maximum 20 ABS (ITMVTP) is the number profiles to be plotted. If neg., all profiles will be on one plot. If blank, no profiles will be plotted. If pos, each profile will be on a separate plot.	LPLOT (I5) Option for temperature-distance profiles If -1, all profiles will be on one plot. If blank no profiles will be plotted. If 1, each profile will be on a separate plot.	IRISCN (I5) Option to plot temperature changes for contour plots. If temperature changes are to be plotted, enter 1; otherwise, leave blank.	IRISTM (I5) Option to plot temperature changes for temperature-time profiles. If temperature changes are to be plotted, enter 1; otherwise, leave blank.	IRISDS (I5) Option to plot temperature changes for temperature-distance profiles. If temperature changes are to be plotted, enter 1; otherwise, leave blank.						Card 2
NSCAL (I5) Option to input scale factors. If scale factors are to be input enter 1; otherwise, leave blank.	LREG (I5) Option to specify region. If region is to be specified enter 1; otherwise, leave blank	LREV(1) (I5) Option to reverse X-axis of contours If axis is to be reversed enter 1; otherwise, leave blank.	LREV(2) (I5) Option to reverse Y-axis of contours If axis is to be reversed enter 1; otherwise, leave blank	LREV(3) (I5) Option to reverse Z-axis of contours If axis is to be reversed enter 1; otherwise, leave blank	LAX(1) (I5) Option to switch YZ or θZ axes of contours. If axes are to be switched enter 1; otherwise leave blank.	LAX(2) (I5) Option to switch XZ or RZ axes of contours. If axes are to be switched enter 1; otherwise leave blank.	LAX(3) (I5) Option to switch XY or Rθ axes of contours. If axes are to be switched enter 1; otherwise leave blank.	LOGTIM (I5) Option to specify log axis for temperature-time profiles. If log axis is to be used enter 1; otherwise leave blank.	LOGDIS (I5) Option to specify log axis for temperature-distance profiles. If log axis is to be used enter 1; otherwise leave blank.						Card 3
UNITS(1) (A4) Time Units Col. 5 blank	UNITS (2) (A4) Temperature Units Col. 10 blank	UNITS(3) (A4) Distance Units Col. 15 blank													
VALUE(1) (E10.0) Value of isotherm to be plotted		VALUE(2) (E10.0) Value of isotherm to be plotted		VALUE(3) (E10.0) Value of isotherm to be plotted		Can be repeated for up to 50 isotherms (but equal to NL), omit if NL=0									Card VALUES
TIME(1) (E10.0) Time at which plot is to be made		TIME(2) (E10.0) Time at which plot is to be made		TIME(3) (E10.0) Time at which plot is to be made		Can be repeated for up to 20 time positions (but equal to NTIME), omit if NTIME=0									Card TIMES
IPLANE (1,1) (I5)	IPLANE (2,1) (I5)	IPLANE (3,1) (I5)	IPLANE (4,1) (I5)	IPLANE (5,1) (I5)	Numbers of the X-axis fine grid lines for which Y-Z or θ-Z plane contours are to be plotted. Can be repeated for up to 10 positions (but equal to NPLANE(1)), omit if NPLANE(1)=0.										Card XPLANES
IPLANE (1,2) (I5)	IPLANE (2,2) (I5)	IPLANE (3,2) (I5)	IPLANE (4,2) (I5)	IPLANE (5,2) (I5)	Numbers of the Y-axis fine grid lines for which X-Z or R-Z plane contours are to be plotted. Can be repeated for up to 10 positions (but equal to NPLANE(2)), omit if NPLANE(2)=0.										Card YPLANES
IPLANE (1,3) (I5)	IPLANE (2,3) (I5)	IPLANE (3,3) (I5)	IPLANE (4,3) (I5)	IPLANE (5,3) (I5)	Numbers of the Z-axis fine grid lines for which X-Y or R-θ plane contours are to be plotted. Can be repeated for up to 10 positions (but equal to NPLANE(3)), omit if NPLANE(3)=0.										Card ZPLANES
RSCAL (E10.0) Scale factor for X or R axis for isotherms		THSCAL (E10.0) Scale factor for Y or θ axis for isotherms		ZSCAL (E10.0) Scale factor for Z axis for isotherms		DSCAL (E10.0) Scale factor for distance axis for temperature-distance profiles		TSCAL (E10.0) Scale factor for temperature axis for temperature-distance profiles		TVDMIN (E10.0) Minimum temperature for temperature-distance profiles					Card SCAL1 (Coupled - Omit if NSCAL = 0)
THSCAL (E10.0) Scale factor for time axis for temperature-time profiles		TPSCAL (E10.0) Scale factor for temperature axis for temperature-time profiles		TVTMIN (E10.0) Minimum temperature for temperature-time profiles		TIMMIN (E10.0) Minimum time for temperature-time profiles		TIMMAX (E10.0) Maximum time for temperature-time profiles							Card SCAL2 (Coupled - Omit if NSCAL = 0)
NB(1) (I5) Number of the fine grid line of minimum X value	NE(1) (I5) Number of the fine grid line of maximum X value	NB(2) (I5) Number of the fine grid line of minimum Y value	NE(2) (I5) Number of the fine grid line of maximum Y value	NB(3) (I5) Number of the fine grid line of minimum Z value	NE(3) (I5) Number of the fine grid line of maximum Z value	Omit if LREG=0									Card REGION
NODE(1) (I5)	NODE(2) (I5)	NODE(3) (I5)	NODE(4) (I5)	NODE(5) (I5)	Nodes whose temperature is to be plotted for temperature-time profiles. Can be repeated for up to 20 nodes (but equal to ABS(ITMVTP)), omit if ITMVTP=0.										Card NODES
NPRFIL(1) (I5) Number of temperature-distance profiles plotted parallel to X-axis	NPRFIL(2) (I5) Number of temperature-distance profiles plotted parallel to Y-axis	NPRFIL(3) (I5) Number of temperature-distance profiles plotted parallel to Z-axis													Card PROFILES
INDEX(1,J) (I5)	INDEX(2,J) (I5)	INDEX(1,J+1) (I5)	INDEX(2,J+1) (I5)	INDEX(1,J+2) (I5)	INDEX(2,J+2) (I5)	Numbers of the Y and Z axes fine grid lines, respectively, which define the XZ and the XY planes, whose intersection is the line along which the temperature-distance profiles are to be plotted. Must be repeated for NPRFIL(1) pairs, omit if NPRFIL(1)=0.									Card INDEX1
INDEX(1,K) (I5)	INDEX(2,K) (I5)	INDEX(1,K+1) (I5)	INDEX(2,K+1) (I5)	INDEX(1,K+2) (I5)	INDEX(2,K+2) (I5)	Numbers of the X and Z axes fine grid lines, respectively, which define the YZ and the XY planes, whose intersection is the line along which the temperature-distance profiles are to be plotted. Must be repeated for NPRFIL(2) pairs, omit if NPRFIL(2)=0.									Card INDEX2
INDEX(1,N) (I5)	INDEX(2,N) (I5)	INDEX(1,N+1) (I5)	INDEX(2,N+1) (I5)	INDEX(1,N+2) (I5)	INDEX(2,N+2) (I5)	Numbers of the X and Y axes fine grid lines, respectively, which define the YZ and the XZ planes, whose intersection is the line along which the temperature-distance profiles are to be plotted. Must be repeated for NPRFIL(3) pairs, omit if NPRFIL(3)=0.									Card INDEX3

4. OUTPUT DESCRIPTION

HEATPLOT printer output describes each of the input parameters which will be used to draw the plots. The types of plots that are to be drawn are described and the values which will be plotted are given. The time positions for which contours and temperature-distance profiles will be made will be output, if the times are specified. If contour plots are to be made, the temperatures or the temperature changes that are to be plotted are listed. If profiles are to be plotted, a message will be printed stating whether or not the profiles will be drawn on the same plot or on different plots, and whether profiles are to be made of the temperatures, or the temperature changes relative to the initial temperature distribution.

HEATPLOT also prints messages describing the HEATING5 temperature distribution data set that is being read. This information includes the data set job description, the model geometry type number, and the number of nodes and the number of boundary conditions for that model. The axial fine grid line numbers and their values are printed for each axial direction.

As each plot is produced, DISSPLA describes that plot. The plot title and identification label are given along with a description of the data for that plot. At the end of each plot, HEATPLOT prints a message stating that the plot has been completed.

Examples of HEATPLOT printed output and plots are shown in Appendix C.

ACKNOWLEDGMENTS

This work was primarily funded by the Office of Waste Isolation and its predecessor programs at the Oak Ridge National Laboratory. A portion of the funds for the support of the project was provided by the Oak Ridge National Laboratory Engineering Technology Division's High Temperature Gas-Cooled Reactor Safety Studies program funded by the Regulatory Segment of the U.S. Nuclear Regulatory Commission.

The authors gratefully acknowledge the contributions of the following people to the successful completion of this project:

P. G. Fowler for providing programming support on the initial version of the code,

P. T. Smith, a summer employee in the Computer Sciences Division, and G. E. Giles for providing programming support on intermediate versions of the code,

J. S. Crowell and J. E. Cope for the use of the subroutines (namely HOLES3 and CONDRW) which determine the temperature contours,

R. D. Cheverton for providing suggestions concerning features for the initial version of the code.

B. R. Becker, K. W. Childs and I. I. Siman-Tov for their constructive review of the manuscript, and

T. L. Stanton for typing the manuscript.

REFERENCES

1. W. D. Turner, D. C. Elrod, and I. I. Siman-Tov, *HEATING5 - An IBM 360 Heat Conduction Program*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March, 1977, (ORNL/CSD/TM-15).

2. *CSD Programmer's Notebook*, Union Carbide Corporation, Nuclear Division, Oak Ridge, Tennessee, December, 1975.

3. "DISSPLA Local Considerations", August 10, 1976, Internal Memorandum, Kathy N. Fischer.

4. "Execution of DISSPLA TEKTRONIX Postprocessor on TSO", August 13, 1976, Internal Memorandum, Kathy N. Fischer.

5. *CSD Newsletter*, October 25, 1976, "Changes in the Use of Job Submission Forms at X-10 Effective November 4, 1976".

6. *CSD Newsletter*, January 28, 1975, "SPDA: Semipermanent Direct Access Facility".

7. *DISSPOP User Manual*, Integrated Software Systems Corporation, San Diego, California, February, 1976.

8. "Use of DISSPLA on the IBM/360 Systems", December 10, 1976, Internal Memorandum, Kathy N. Fischer.

APPENDICES

APPENDIX A

CONTROL CARDS

This appendix discusses the Job Control Language (JCL) which is required to execute the HEATPLOT program and produce plots on the plotters available at ORNL and at ORGDP. For additional information concerning JCL, the user is referred to the *Oak Ridge Programmer's Notebook* (Ref. [2]) and to the CSD memorandums (Refs. [3, 4]) concerning DISSPLA.

The control cards which are necessary to run HEATPLOT at ORNL and at ORGDP are presented in Figures A-1 through A-11. The JOB statement and the CLASS statement are the first two control cards of the job. The basic format of a JOB statement is:

//job name JOB (cccc), 'programmer name'.

The job name must be of the form UIDXX where UID is the userid assigned to the user by the Computer Sciences Division and the characters XX are replaced by up to five characters which make the job name unique. The accounting field (cccc) contains a four- or five-digit charge number. The programmer name field should contain information to route the output back to the user. Since the default on the required core size will be exceeded by HEATPLOT, a class card must be included.

HEATPLOT uses the DISSPLA plotting package to allow the user to generate plots on any of the available plotters. In the link-edit step (LKED) of the JCL, the cataloged data set DISSPLA.LOAD must be available to the link-edit SYSLIB concatenation. Therefore, it is necessary to include in the LKED step, JCL of the form

```
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=DISSPLA.LOAD,DISP=SHR    .
```

When the EAI plotter is being used, the library DISSPLA.LOAD must precede the normal EAI library SYS1.EAILIB. In this case the LKED step would include the statements

```
//LKED.SYSLIB DD
//            DD
//            DD DSN=DISSPLA.LOAD,DISP=SHR
//            DD DSN=SYS1.EAILIB,DISP=SHR     .
```

Object modules of the FORTRAN for HEATPLOT are stored on disks at ORNL and at ORGDP. These modules may be executed by FORTHLG. The JCL necessary to access the object module at ORNL is as follows:

```
//LKED.HEATPL DD DSN=ONLINEA.DXCHF961.HEATPLOT,DISP=SHR
//LKED.SYSIN DD *
 INCLUDE HEATPL                                  .
```

These cards must immediately follow the link-edit SYSLIB cards for DISSPLA. At ORGDP, the object module may be accessed by including in the link-edit step the statements

```
//LKED.HEATPL DD DSN=A.DXCHF961.HEATPLOT,DISP=SHR
//LKED.SYSIN DD *
 INCLUDE HEATPL
```

immediately following the link-edit SYSLIB cards for DISSPLA.

The temperature distribution data set used by HEATPLOT is created by the plotting option of HEATING5 and must be saved either on tape or on disk. To create this data set, a DD statement must be inserted in the HEATING5 JCL before the

```
//GO.FT05F001 DD *
```

card. If a data set involving 450 nodes and two boundary conditions is to be saved on tape, then a typical DD card might be

```
//GO.FT08F001 DD UNIT=TAPE9,DISP=OLD,LABEL=(,NL),
// VOL=SER=###2,DCB=(RECFM=VBS,LRECL=3620,BLKSIZE=3624)
```

where 8 is the unit number which must be inserted in entry 3 of card 3 of the HEATING5 data deck, and ###2 is the number of the tape on which the temperature distributions are to be written. This may be 'POOL' if a pool tape is to be used, or the tape number of a prelogged tape. The SPECIAL=TAPES parameter must be added to the class card for a job which is to be run at ORNL. A job submission form must be submitted to the dispatcher of the computer center requesting that the tape is to be saved. See *HEATING5 - An IBM 360 Heat Conduction Program* (ORNL/CSD/TM-15) (Ref. [1]) for further information concerning HEATING5 JCL and input data.

In order for HEATPLOT to read the temperature distribution data set, a DD card describing the data set must be inserted before the

```
//GO.FT05F001 DD *
```

card of the HEATPLOT JCL. Assuming the data set was written with the DD card in the example above, this DD card should appear as follows:

```
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER=###2,DISP=OLD
```

where ###2 is the number of the tape on which the temperature distribution was written. Again, the SPECIAL=TAPES parameter must be added to the CLASS card for a job which is to be run at ORNL.

The output plot data set created by HEATPLOT must also be described using a DD statement which must precede the

```
//GO.FT05F001 DD *
```

card. The format of this statement depends on the type of plotter which is to be used. This DD card will be described in the following sections.

A.1 JCL for CALCOMP Pen-and-Ink Plotting

The JCL required to use the disk plot capability for CALCOMP pen-and-ink plots at ORNL appears in Figure A-1. Disk plotting eliminates the need for a plot tape. The //GO.FT49F001 card defines the data set for disk plotting. The zz field specifies the type of paper to be used on the plotter. For plain white 11-inch paper, 00 should be used. See the *Oak Ridge Programmer's Notebook* (Ref. [2]) for other paper types available. The yyyyy field must be replaced by a data set name which must include the programmer's job initials. This data set name is used to separate and identify each user's plot. The ###2 field should be replaced by the number of the tape from which the temperature distributions are to be read.

If the user wishes to use a CALCOMP plot tape for the pen-and-ink plotter at ORNL, the JCL in Figure A-2 should be followed. Including the//*NOSEQCARD, //*NOTES, and //*PLOT statements in the JCL eliminates the necessity of filling out the job submission and the CALCOMP work

```
// jobname JOB (cccc ),' programmer-name    '
//*CLASS CPU91=30S,PRINT=5,REGION=400,IO=5,SPECIAL=TAPES
//HEAT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1'
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=DISSPLA.LOAD,DISP=SHR
//LKED.PLOTSUBS DD DISP=(SHR,PASS),DSN=JGSPLOTH
//LKED.HEATPL DD DISP=SHR,DSN=ONLINEA.DXCHF961.HEATPLOT
//LKED.SYSIN DD *
 INCLUDE PLOTSUBS
 INCLUDE HEATPL
/*
//GO.FT49F001 DD UNIT=IN2OU2,DISP=(NEW,KEEP),
// SPACE=(3208,30,RLSE),DSN=PLOTzz.yyyyy,
// DCB=(RECFM=VS,LRECL=3204,BLKSIZE=3208)
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER= ###2 ,DISP=OLD
//GO.FT05F001 DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-1. Format of JCL for CALCOMP Pen-and-Ink Disk Plotting at ORNL

```
//*NOSEQCARD
// jobname   JOB ( cccc ). ' programmer-name     '
//*CLASS CPU91=30S.PRINT=5.FEGICN=400.IO=5.SPECIAL=TAPES
//*NOTES PLEASE DO NOT RE-ENCUEUE JCB
//*PLOT TYPE=CAL925
//HEAT EXEC FORTHLG.REGICN.GC=400K.PARM.GO='EU=-1'
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=DISSPLA.LOAD.DISP=SHR
//LKED.HEATPL DD DISP=SHR.DSN=ONLINEA.DXCHF961.HEATPLOT
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GC.PLOTTAPE UNIT=TAPE7.VOL=SER= ###1 .LABEL=(.NL).DISP=OLD
//GO.FT10F001 DD UNIT=TAPE9.VOL=SEP= ###2 .DISP=OLD
//GO.FT05F001 DD *
     (INSERT DATA DECK FEFE)
/*
//
```

Figure A-2. Format of JCL for CALCOMP Pen-and-Ink Plots Using a Tape at ORNL request forms. For options available with the //*PLOT card and their default values, see Chapter 13 of the *ORNL Programmer's Notebook* (Ref. [2]) and the CSD Newsletter of October 25, 1976 (Ref. [5]). The ###1 field should be replaced by 'POOL' if the plot data set is to be written on a pool tape or by a tape number if a prelogged tape is to be used, and the ###2 field should be defined as above.

The JCL required to make CALCOMP pen-and-ink plots at ORGDP appears in Figure A-3. A plot tape must be created. The ###2 field should be defined as above. At ORGDP, job submission and plotter work request forms must be submitted to the dispatcher of the computer center.

A.2 JCL for CALCOMP CRT Plotting at ORNL

The CALCOMP CRT plotter produces plots on 35 mm film. A plot tape is required for CRT plots. The JCL for this type of plot is shown in Figure A-4. The //*NOSEQCARD, //*NOTES, and //*PLOT statements eliminate the necessity of submitting a job submission form and a CALCOMP work request form. The TYPE=FILM on the //*PLOT card specifies that CRT plots are to be produced. For other options available with the //*PLOT card, and their default values, see Chapter 13 of the *ORNL Programmer's Notebook* (Ref. [1]) and the CSD Newsletter of October 25, 1976 (Ref. [5]). The ###1 field should be replaced by 'POOL' if the plot data set is to be written on a pool tape, or by a tape number if a prelogged tape is to be used. The ###2 field should be replaced by the number of the tape from which the temperature distribution is to be read.

```
//*NOSEQCARD
// jobname JOB ( cccc ),' programmer-name'
//*CLASS CPU95=30S,PRINT=5,REGION=400K,IO=5
//PLOT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1',
// PLOT=PLT,LIB=LAB
//LKED.SYSLIB DD
//             DD
//             DD
//             DD DSN=DISSPLA.LOAD,DISP=SHR
//             DD DSN=SYS1.EAILIB,DISP=SHR
//LKED.HEATPL DD DSN=A.DXCHF961.HEATPLOT,DISP=SHR
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.FT23F001 DD UNIT=SYSDA,SPACE=(2400,(600))
//GO.FT54F001 DD UNIT=TAPE9,LABEL=(,NL),
// DISP=(NEW,KEEP),DCB=(RECFM=VS,LRECL=364,BLKSIZE=368)
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER=###2,DISP=OLD
//GO.FT05F001 DD *
   (INSERT DATA DECK HERE)
/*
//
```

Figure A-3. Format of JCL for CALCOMP Pen-and-Ink Plots at ORGDP

```
//*NOSEQCARD
// jobname    JOB ( cccc  ), '   programmer name        '
//*CLASS CPU91=30S,PRINT=5,REGION=400K,IO=5,SPECIAL=TAPES
//*NOTES  PLEASE DO NOT RE-ENQUEUE JOB
//*PLOT  TYPE=FILM
//HEAT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1'
//LKED.SYSLIB DD
//             DD
//             DD
//             DD DSN=DISSPLA.LOAD,DISP=SHR
//LKED.HEATPL DD DISP=SHR,DSN=ONLINEA.DXCHF961.HEATPLOT
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.CRTTAPE DD UNIT=TAPE9,VOL=SER= ###1 ,LABEL=(,NL),DISP=OLD
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER=###2  ,DISP=OLD
//GO.FT05F001 DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-4. Format of JCL for CALCOMP CRT Plots at ORNL

A.3 JCL for EAI Pen-and-Ink Plots at ORGDP

The JCL required to make EAI pen-and-ink plots at ORGDP appears in Figure A-5. A plot tape must be created for the EAI plotter; therefore, job submission and plotter work request forms must be submitted to the dispatcher of the ORGDP computer center. The value of the ###2 field should be as described previously.

A.4 JCL for Line Printer Plots

The line printer may be used to produce quick, low-quality plots. The JCL to produce plots on the line printer at ORNL appears in Figure A-6, and the JCL to produce plots on the line printer at ORGDP appears in Figure A-7. The ###2 field should have the same meaning as in previous examples.

A.5 JCL for Creating a Compressed Data Set

A device-independent plot data set may be generated and later processed on any of the local plotters. Figure A-8 shows an example of the JCL needed to create a semipermanent compressed plot data set on a disk. The compressed data set may reside on any device supporting fixed records of length 4000. It may be necessary to allow more than five tracks of space if a large number of plots are to be generated. In this example, the ddd in the data set name should be the userid. The cccc should be the last four digits of the charge number, and r should indicate the length of time the data set should be retained. To retain the data set the maximum length of time, r should be replaced by 0. The optional field of the data set name may be replaced by a one-word description of the data set. See CSD Newsletter of January 28, 1975 (Ref. [6]), for further information.

```
// jobname   JOB  (  cccc ),' programmer-name          '
//*CLASS CPU95=30S,PRINT=7,REGION=400K,IO=5
//STEP0 EXEC PGM=PLTSTART
//FT15F001  DD UNIT=TAPE7,DISP=(,PASS),DSN=&&PLOT
//PLOT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1',LIB=LAB
//LKED.SYSLIB DD
//              DD
//              DD DSN=DISSPLA.LOAD,DISP=SHR
//              DD DSN=SYS1.EAILIB,DISP=SHR
//LKED.HEATPL DD DSN=A.DXCHF961.HEATPLOT,DISP=SHR
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.FT15F001  DD DSN=&&PLOT,DISP=OLD,UNIT=TAPE7
//GO.FT10F001  DD UNIT=TAPE9,VOL=SER= ###2 ,DISP=OLD,
//GO.FT05F001  DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-5. Format of JCL for EAI Pen-and-Ink Plots at ORGDP

```
// jobname JOB (cccc ),' programmer-name    '
//*CLASS CPU91=30S,PRINT=5,REGION=400,IO=5,SPECIAL=TAPES
//HEAT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1'
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=DISSPLA.LOAD,DISP=SHR
//LKED.HEATPL DD DISP=SHR,DSN=ONLINEA.DXCHF961.HEATPLOT
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER=###2 ,DISP=OLD
//GO.FT05F001 DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-6. Format of JCL for Line Printer Plots at ORNL

```
// jobname   JOB ( cccc ),' programmer-name         '
//*CLASS CPU95=30S,PRINT=7,REGION=400K,IO=5
//PLOT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1',LIB=LAB
//LKED.SYSLIB DD
//             DD
//             DD DSN=DISSPLA.LOAD,DISP=SHR
//             DD DSN=SYS1.FAILIB,DISP=SHR
//LKED.HEATPL DD DSN=A.DXCHF961.HEATPLOT,DISP=SHR
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER= ###2 ,DISP=OLD,
//GO.FT05F001 DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-7. Format of JCL for Line Printer Plots at ORGDP

```
// jobname JOB (cccc ),'programmer-name      '
//*CLASS CPU91=30S,PRINT=5,REGION=400,IO=5,SPECIAL=TAPES
//HEAT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1'
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=DISSPLA.LOAD,DISP=SHR
//LKED.HEATPL DD DISP=SHR,DSN=ONLINEA.DXCHF961.HEATPLOT
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.COMPOUT DD UNIT=SPDA,DISP=(NEW,CATLG),
// SPACE=(4000,(5,5),RLSE),DSN= T.dddrcccc.optional
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER= ###2 ,DISP=OLD
//GO.FT05F001 DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-8. Format of JCL for Creating a Compressed Plot Data Set at ORNL

Figure A-9 is an example of the necessary JCL to create a semipermanent data set on disk at ORGDP. The data set name should follow the conventions described above.

A.6 JCL for Postprocessing Compressed Plot Data Sets

Postprocessing is the method by which compressed plot data sets are translated into plots for a particular device. A postprocessor exists for each local plotting device, therefore, allowing a compressed plot data set to be plotted on any device as many times as necessary with one run of HEATPLOT.

Besides generating plots from compressed plot data sets, postprocessors provide a variety of other functions such as:

- Plotting selected plots only
- Scaling plots
- Positioning plots on the output medium
- Superimposing plots
- Plotting a selected sub-area of a plot.

Commands must be input to the postprocessor program in order to request the various functions listed above. Refer to the DISSPOP User's Manual (Ref. [7]) for the syntax and description of the various commands available.

The postprocessor library, DISSPLA.DISSPOP.LOAD is a partitioned data set, a member of which is executed to decompress to a specific plotting device. The members, PRTRPOP, CALCPOP, DSKPOP, EAIPOP, FILMPOP, and TEKPOP, allow a compressed file to be plotted on the line printer, CALCOMP pen-and-ink using a tape or disk plot, EAI pen-and-ink, CALCOMP CRT, or TEKTRONIX plotters, respectively.

```
//  jobname   JOB (  cccc ),' programmer-name        '
//*CLASS CPU95=30S,PRINT=7,REGICN=400K,IO=5
//PLOT EXEC FORTHLG,REGION.GO=400K,PARM.GO='EU=-1',LIB=LAB
//LKED.SYSLIB DD
//             DD
//             DD DSN=DISSPLA.LOAD,DISP=SHR
//             DD DSN=SYS1.EAILIB,DISP=SHR
//LKED.HEATPL DD DSN=A.DXCHFS61.HEATPLOT.DISP=SHR
//LKED.SYSIN DD *
 INCLUDE HEATPL
/*
//GO.COMPOUT DD UNIT=2314,VOL=SER=TEMP41,DISP=(NEW,CATLG),
// SPACE=(4000,(5,5),RLSE),DSN=T.dddrcccc.optional
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER=###2  ,DISP=OLD,
//GO.FT05F001 DD *
     (INSERT DATA DECK HERE)
/*
//
```

Figure A-9. Format of JCL for Creating a Compressed Plot Data Set at ORGDP

Figure A-10 is an example of the JCL required to postprocess a compressed plot data set that is stored on SPDA at ORNL to create CALCOMP pen-and-ink plots using disk plot. The data set name should appear exactly like the data set name used when the data set was created.

The JCL required to postprocess a data set stored on TEMP41 disk at ORGDP and create a plot tape for the EAI pen-and-ink plotter is shown in Figure A-11. The data set name should appear exactly like the data set name used when the data set was created.

See the CSD memorandum on DISSPLA of December 10, 1976 (Ref. [8]), for further information on JCL to postprocess a compressed data set for other available plotters.

```
// jobname   JOB ( cccc ),' programmer-name              '
//*CLASS CPU91=30S,PRINT=5,REGION=110K,IO=5
//STEPA EXEC PGM=DSKPOP,REGION=110K
//STEPLIB DD DISP=SHR,DSN=DISSPLA.DISSPOP.LOAD
//FT06F001 DD SYSOUT=A
//COMPIN DD DSN=T. dddrccc.optional    ,DISP=SHR
//FT49F001 DD UNIT=IN20U2,DCB=(RECFM=VS,LRECL=3204,BLKSIZE=3208),
// DISP=(NEW,KEEP),SPACE=(3208,30,RLSE),DSN=PLOTzz.yyyyy
//PLOTSUBS DD DISP=(SHR,PASS),DSN=JCSPLOTH
//FT05F001 DD DUMMY
//
```

Figure A-10. Format of JCL for Postprocessing a Compressed Plot Data Set for CALCOMP Pen-and-Ink Disk Plotting at ORNL

```
// jobname  JOB ( cccc ),' programmer-name          '
//*CLASS CPU95=30S,PRINT=7,REGION=110K,IO=5
//STEP0 EXEC PGM=PLTSTART
//FT15F001 DD UNIT=TAPE7,DISP=(,PASS),DSN=&&PLOT
//STEP1 EXEC PGM=EIAPOP,REGION=110K
//STEPLIB DD DSN=DISSPLA.DISSPOP.LOAD,DISP=SHR
//FT06F001 DD SYSOUT=A
//COMPIN DD DSN=T. dddrcccc . optional ,DISP=SHR
//FT15F001 DD UNIT=TAPE7,DISP=(,PASS),DSN=&&PLOT
//FT05F001 DD DUMMY
//
```

Figure A-11. Format of JCL for Postprocessing a Compressed Plot Data Set for EAI Pen-and-Ink Plotting at ORGDP

APPENDIX B

MODIFYING THE MAIN PROGRAM

The main program of HEATPLOT is shown in Figure B-1 as it appears in the source of the program stored on-line. This version of the main program allows the user to use a temperature distribution data set that has up to 100 nodes with no more than 25 nodes in any one direction. There may be up to five temperature-distance profiles plotted if the model is two or three dimensional.

The user may run a larger version of HEATPLOT by modifying the block data and the main program and including this version of the main program with his JCL. Figure B-2 shows an example of the JCL necessary to run HEATPLOT at ORNL using CALCOMP pen-and-ink disk plotting when the main program is modified.

The dimensions of the problem to be run must be entered into the program by an INTEGER statement in the block data subprogram. In the INTEGER statement, MAXNDS must be set greater than or equal to the total number of nodes in the HEATING5 model. The value of MAXVAL should be greater than or equal to the maximum number of nodes in any one direction. The variables MAXHOR and MAXVER are the maximum number of values on any horizontal axis plus two, and the maximum number of values on any vertical axis plus two, respectively. If contours are to be plotted for a X-Y model which has 25 fine grid lines in the X direction, and 40 fine grid lines in the Y direction, for example, MAXHOR would be set to the number of X fine grid lines plus two (or 27), and MAXVER would be set to the number of Y fine

```
C ***********************************************************************
C ***
C ***  HEATPLOT
C ***
C ***********************************************************************
C ***
      BLOCK DATA
      COMMON /NPOINT/ MAXNDS, MAXHOR, MAXVER, MAXVAL
      COMMON /NOPROF/ MAXPRF, PRFVAL, PRFTIM
C ***
C ***********************************************************************
C ***
C ***  LET MAXNDS = MAXIMUM NUMBER OF NODES  IN THE DATA SET
C ***  LET MAXVAL = MAXIMUM NUMBER OF R, TH, OR Z VALUES TO BE READ FROM
C ***               THE DATA SET
C ***  LET MAXHOR = MAXIMUM NUMBER OF VALUES ON ANY HORIZONTAL AXIS + 2
C ***  LET MAXVER = MAXIMUM NUMBER OF VALUES ON ANY VERTICAL AXIS + 2
C ***  LET MAXPRF = MAXIMUM NUMBER OF PROFILES TO BE PLOTTED
C ***  LET PRFVAL = MAXIMUM NUMBER OF R, TH, OR Z VALUES TO BE
C ***               READ FROM THE DATA SET IF DISTANCE VS TEMPERATURE
C ***               PROFILES ARE TO BE MADE
C ***  LET PRFTIM = MAXIMUM NUMBER OF TIMES FOR WHICH PROFILES
C ***               WILL BE MADE
C ***
C ***  THE FOLLOWING STATEMENTS MUST BE MODIFIED AS INDICATED:
C ***  INTEGER MAXNDS/#MAXNDS/, MAXHOR/#MAXHOR/,MAXVER/#MAXVER/,
C *** 1  MAXVAL/#MAXVAL/
C ***  INTEGER MAXPRF /#MAXPRF/, PRFVAL/#PRFVAL/, PRFTIM/#PRFTIM/
C ***  END
C ***  REAL*8 DCORE(3*MAXVAL + PRFVAL*MAXPRF + 2*MAXNDS)
C ***  REAL*4 CORE(MAXHOR*(3*MAXVER+20)+PRFTIM*PRFVAL*MAXPRF+2*MAXPRF)
C ***  INTEGER*2 ICORE(MAXHOR*MAXVER + 3*MAXNDS + MAXPRF*(PRFVAL+5))
C ***
C ***********************************************************************
C ***
      INTEGER   MAXNDS/100/,   MAXHOR/27/,   MAXVER/27/,   MAXVAL/25/
      INTEGER   MAXPRF/5/,     PRFVAL/25/,   PRFTIM/10/
      END
      REAL*8       DCORE(400)
      REAL*4       CORE(3987)
      INTEGER*2    ICORE(1179)
C ***
C ***********************************************************************
C ***
      CALL PLOTMN(DCORE,CORE,ICORE)
      STOP
      END
```

Figure B-1. Main Program of HEATPLOT

```
//jobname JOB (cccc),'programmer-name '
//*CLASS CPU91=30S,PRINT=5,REGION=400,IO=5,SPECIAL=TAPES
//HEAT EXEC FORTHCLG,REGION.GO=400K,PARM.GO='EU=-1'
//FORT.SYSIN DD *
  (INSERT FORTRAN DECK HERE)
/*
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=DISSPLA.LOAD,DISP=SHR
//LKED.PLOTSUBS DD DISP=(SHR,PASS),DSN=JGSPLOTH
//LKED.HEATPL DD DISP=SHR,DSN=ONLINEA.DXCHF961.HEATPLOT
//LKED.SYSIN DD *
 INCLUDE PLOTSUBS
 INCLUDE HEATPL
/*
//GO.FT49F001 DD UNIT=IN2OU2,DISP=(NEW,KEEP),
// SPACE=(3208,30,RLSE),DSN=PLOT zz yyyyy,
// DCB=(RECFM=VS,LRECL=3204,BLKSIZE=3208
//GO.FT10F001 DD UNIT=TAPE9,VOL=SER= ###2 ,DISP=OLD
//GO.FT05F001 DD *
    (INSERT DATA DECK HERE)
/*
//
```

Figure B-2. Format of JCL for CALCOMP Pen-and-Ink Disk Plotting at ORNL when FORTRAN Is Modified grid lines plus two (or 42), and MAXVAL would be set to 40. However, if the user wishes to plot temperature-time profiles and there are 35 temperature distributions on the data set, MAXHOR would have to be set greater than or equal to the number of times on the temperature distribution data set plus two (or 37), and MAXVER would have to be greater than or equal to MAXHOR, since for any node there must be a temperature saved at every time. Since MAXHOR must be large enough to accomodate both cases, it must be set to the number of times stored on the data set plus two (or 37).

If the problem is two or three dimensional and the user wishes to plot temperature-distance profiles, MAXPRF should be set to the maximum number of profiles made. The variable PRFVAL should be given the maximum number of nodes in any direction for which profiles will be made. The number of times for which profiles will be made should be entered for PRFTIM.

The arrays DCORE, CORE, and ICORE should be given the dimensions computed using Equations B-1, B-2, and B-3, respectively.

$$X = 3*MAXVAL + PRFVAL*MAXPRF + 2*MAXNDS \quad \text{(B-1)}$$

$$Y = MAXHOR*(3*MAXVER+20) + PRFTIM*PRFVAL*MAXPRF + 2*MAXPRF \quad \text{(B-2)}$$

$$Z = MAXHOR*MAXVER + 3*MAXNDS + MAXPRF*(PRFVAL+5) \quad \text{(B-3)}$$

The DCORE array should be declared REAL*8, CORE should be declared REAL*4, and ICORE should be declared INTEGER*2. The main program must call the subroutine PLOTMN with the arguments DCORE, CORE, and ICORE in that order. All comment statements may be omitted from the block data and the main program.

APPENDIX C

SAMPLE OUTPUT AND PLOTS

Three sample problems were run on HEATPLOT and plots were produced. A discussion of each of the sample problems and their output is presented in the following sections.

C.1 Two-dimensional R-Z Model Using Default Input Options

The first sample problem is a two-dimensional R-Z model. A listing of the HEATPLOT input data for this problem is given in Fig. C-1. The printed output is shown in Fig. C-2 and the plots appear in Fig. C-3. The scale factors for all of the plots drawn in this example were computed by HEATPLOT.

A contour plot (Fig. C-3.1) was drawn for five isotherms whose values were computed by the program. The contours were drawn for the entire region of the model. The contour plot was drawn at time=1000.0 years.

Temperature-time profiles (Fig. C-3.2) were plotted for three nodes on one graph. The profiles were drawn at every time on the temperature distribution data set. The time axis was drawn with a linear scale.

A temperature-distance profile (Fig. C-3.3) was plotted for a distance parallel to the R-axis. The line for which the profile was drawn was defined at the twenty-second Z fine grid line. The profile was plotted at every distance parallel to the entire R-axis on a linear scale at time=1000.0 years.

```
CAL                                                              CARD 1
    -5      1                    -3    -1                        CARD 2
                                                                 CARD 3
YEAR F      FEET                                             CARD UNITS
   1000.0                                                    CARD TIMES
  652   659 1582                                             CARD NODES
    1                                                        CARD PRFIL
          22                                                 CARD INDX1
```

Figure C-1

Input Data for Sample

Problem 1

```
THIS PLOT WILL BE CREATED ON THE CAL  PLOTTER
THE LENGTH OF THE X-AXIS WILL BE  8.00 INCHES
THE LENGTH OF THE Y-AXIS WILL BE  8.00 INCHES

JOB DESCRIPTION - 883 ACRE DOME REPOSITORY 10 YR OLD SPENT FUEL 150 KW/A GHL 12/09/76
GEOMETRY TYPE NUMBER -    3(OR RZ  )
DATE OF RUN - 04-07-77
JOB NAME - DXCCAL
NUMBER OF NODES -  1612
TOTAL NUMBER OF BOUNDARY CONDITIONS -      2

THE CONTOUR VALUES ARE CALCULATED BY THE PROGRAM
THE NUMBER OF CONTOURS TO BE PLOTTED IS     5

THE NUMBER OF TIME STEPS TO BE PLOTTED IS     1
THE TIME POSITIONS ARE:   1.0000E 03


ALL SCALE FACTORS WILL BE COMPUTED BY THE PROGRAM


UNITS -
          TIME IS IN YEAR
          TEMPERATURE IS IN DEGREES F
          DISTANCE IS IN FEET
```

Figure C-2

Computer Output for Sample

Problem 1

```
THE REGION OF THE GRAPH IS NOT SPECIFIED IN THE INPUT

INDEX DESCRIBING REGION FOR WHICH TO PLOT CONTOURS
        BEGIN X    1      END X   31
        BEGIN Y    1      END Y    1
        BEGIN Z    1      END Z   52

THERE ARE  31 X (OR R) VALUES:
        1.000000D 00 5.000000D 02 1.000000D 03 1.500000D 03 2.000000D 03
        2.500000D 03 3.000000D 03 3.500000D 03 3.750000D 03 4.000000D 03
        4.250000D 03 4.500000D 03 4.750000D 03 5.000000D 03 5.250000D 03
        5.500000D 03 5.750000D 03 6.000000D 03 6.250000D 03 6.500000D 03
        7.000000D 03 7.500000D 03 8.000000D 03 8.500000D 03 9.000000D 03
        9.500000D 03 1.000000D 04 1.050000D 04 1.100000D 04 1.150000D 04
        1.200000D 04

THERE ARE   1 Y (OR TH) VALUES:
        0.0

THERE ARE  52 Z VALUES:
        0.0          2.000000D 02 4.000000D 02 6.000000D 02 8.000000D 02
        1.000000D 03 1.100000D 03 1.200000D 03 1.300000D 03 1.400000D 03
        1.500000D 03 1.600000D 03 1.700000D 03 1.750000D 03 1.800000D 03
        1.850000D 03 1.900000D 03 1.925000D 03 1.950000D 03 1.975000D 03
        1.990000D 03 2.000000D 03 2.012500D 03 2.025000D 03 2.050000D 03
        2.075000D 03 2.100000D 03 2.150000D 03 2.200000D 03 2.250000D 03
        2.300000D 03 2.400000D 03 2.500000D 03 2.600000D 03 2.700000D 03
        2.800000D 03 2.900000D 03 3.000000D 03 3.250000D 03 3.500000D 03
        3.750000D 03 4.000000D 03 4.500000D 03 5.000000D 03 5.500000D 03
        6.000000D 03 7.000000D 03 8.000000D 03 9.000000D 03 1.000000D 04
        1.100000D 04 1.200000D 04
```

Figure C-2 (contd.)

```
TIME-TEMPERATURE PROFILES WILL BE PLOTTED FOR  3 NODES ON ONE GRAPH
NODES TO BE PLOTTED  FOR TIME-TEMPERATURE PROFILES  652  659 1582

THERE WILL BE   1 TEMPERATURE-DISTANCE PROFILES PLOTTED FOR DISTANCES PARALLEL
          TO THE X OR R AXIS, OR NORMAL TO THE Y-Z OR TH-Z PLANES.
          WITH ALL TIME STEPS ON ONE GRAPH.
THE INDEXES OF THE PLANES WHOSE INTERSECTION DEFINES THE LINE ALONG
          WHICH THE PROFILES ARE PLOTTED FOLLOW:
               NUMBER       Y-PLANE       Z-PLANE
                  1            1            22

PROFIL NO.=  1
```

NODE NO.	RADIUS
652	1.00000D 00
653	5.00000D 02
654	1.00000D 03
655	1.50000D 03
656	2.00000D 03
657	2.50000D 03
658	3.00000D 03
659	3.50000D 03
660	3.75000D 03
661	4.00000D 03
662	4.25000D 03
663	4.50000D 03
664	4.75000D 03
665	5.00000D 03
666	5.25000D 03
667	5.50000D 03
668	5.75000D 03
669	6.00000D 03
670	6.25000D 03
671	6.50000D 03
672	7.00000D 03
673	7.50000D 03
674	8.00000D 03
675	8.50000D 03
676	9.00000D 03
677	9.50000D 03
678	1.00000D 04
679	1.05000D 04
680	1.10000D 04
681	1.15000D 04
682	1.20000D 04

TOTAL NUMBER OF NODES 31

Figure C-2 (contd.)

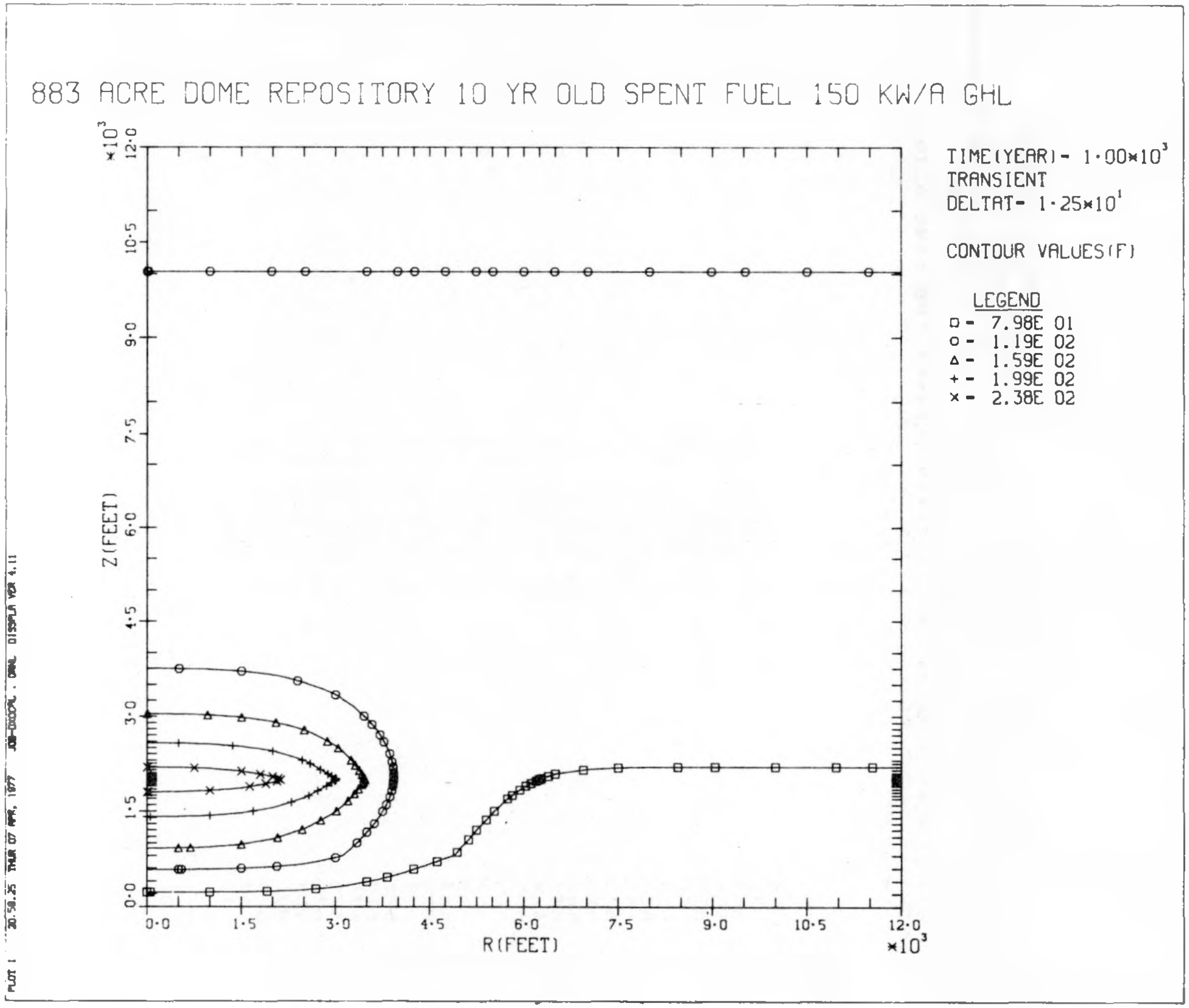

Figure C-3.1

Contour Plot

Problem 1

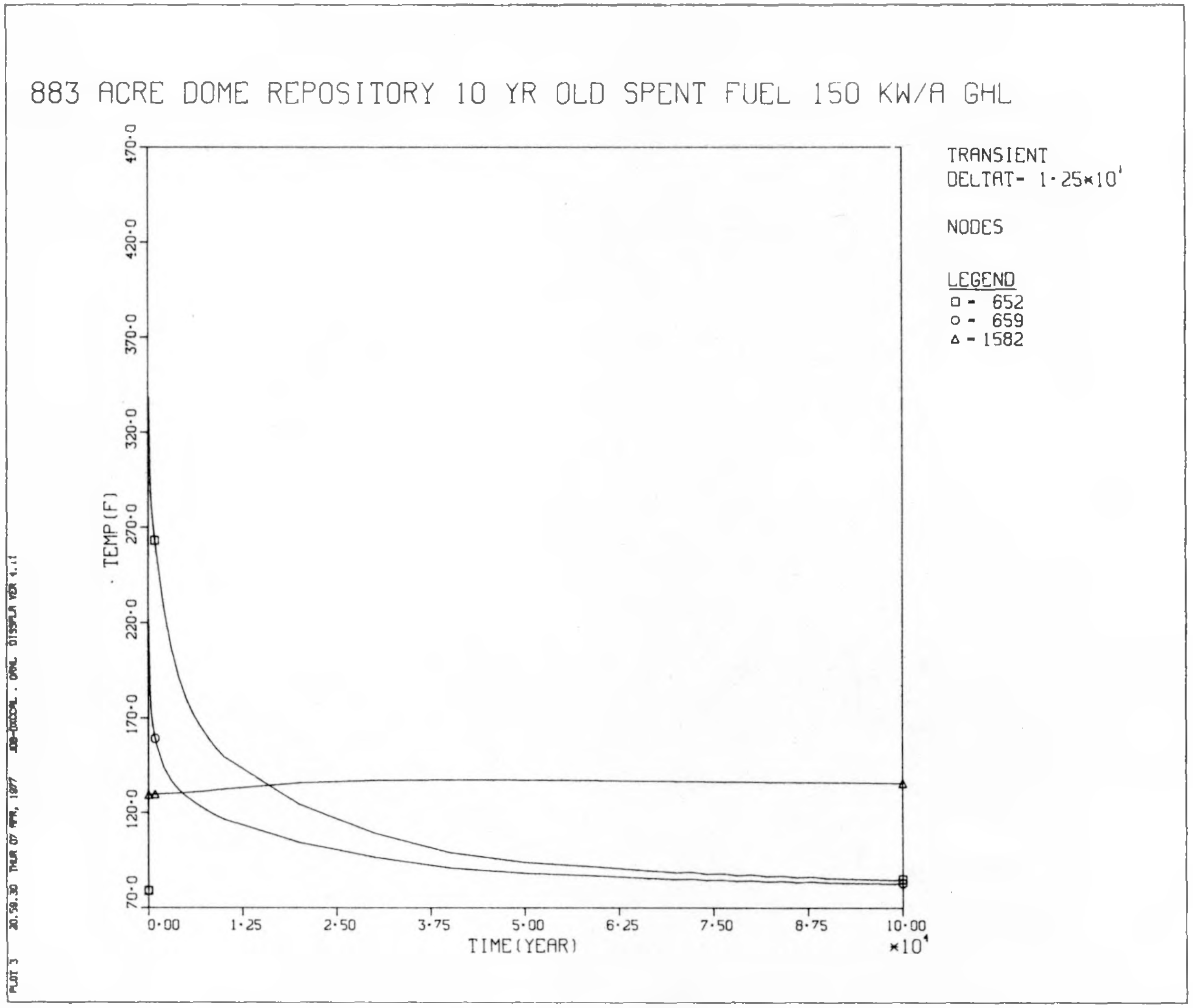

Figure C-3.2

Temperature-time Profile

Problem 1

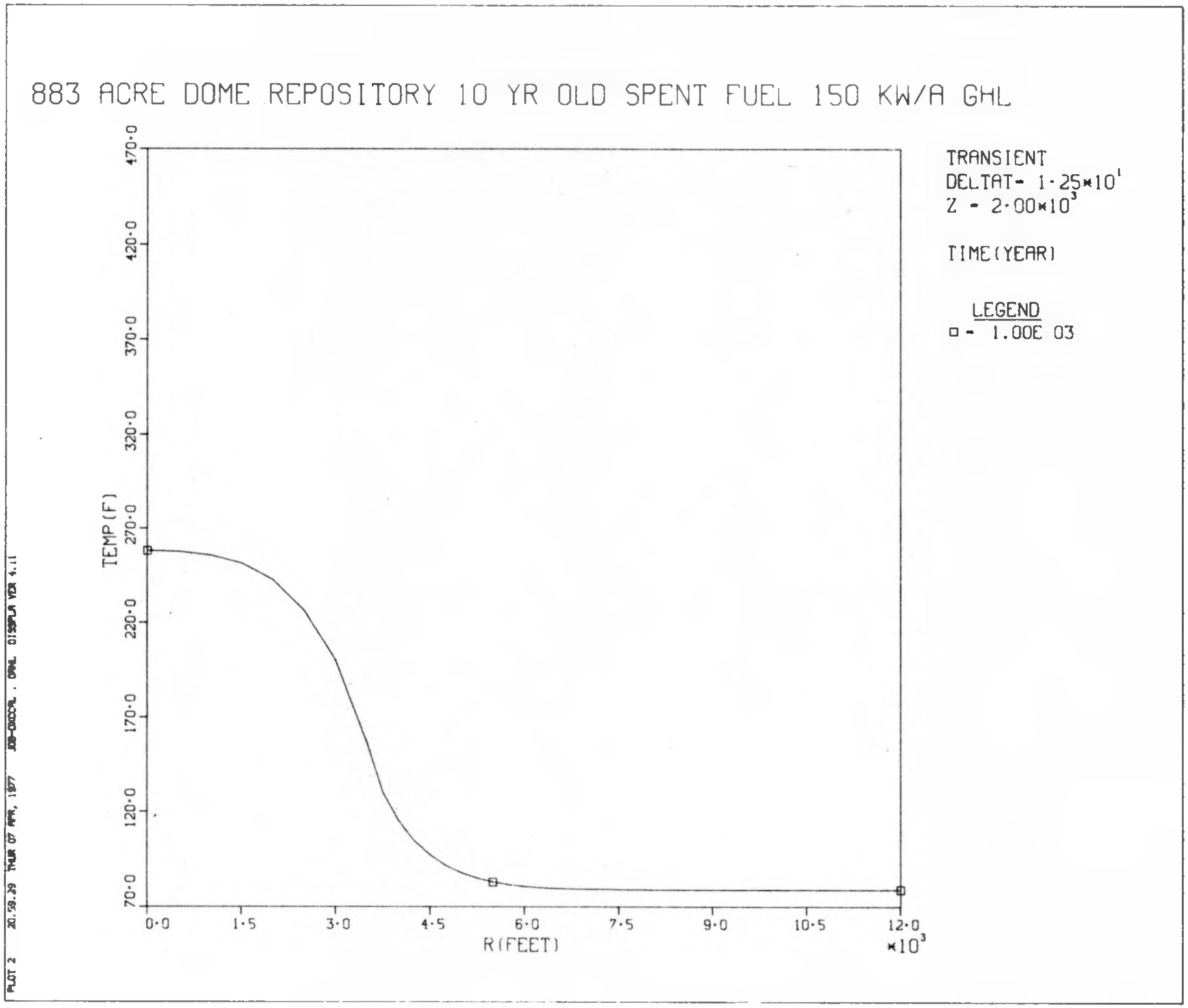

Figure C-3.3

Temperature-distance Profile

Problem 1

C.2 Two-dimensional R-Z Model Specifying Input Options

The second sample problem uses the same HEATING5 input data set as the first problem. However, this problem illustrates how the plots may be changed by specifying some of the input options. A listing of the HEATPLOT input data for this problem is given in Fig. C-4. The printed output and the plots appear in Fig. C-5 and C-6, respectively.

A contour plot (Fig. C-6.1) was drawn for the region between the first and the twelfth R fine grid line, i.e., between 1.0 and 4500.0 feet, and between the first and the forty-third Z fine grid line, i.e., between 0.0 and 4500.0 feet. The Z-axis was drawn from maximum to minimum. The temperatures for which isotherms were to be drawn were specified as 80.0, 120.0, 160.0, 200.0, and 235.0 degrees F. The contour plot was drawn for time=1000.0 years. The scale factors were computed by the program.

Temperature-time profiles (Fig. C-6.2) were plotted for three nodes on one graph. The minimum time was input as 10.0 and the maximum time was not specified. The time axis was drawn with a log scale. The scaling factors were computed by HEATPLOT.

A temperature-distance profile (Fig. C-6.3) was plotted for a distance parallel to the R-axis defined by the twenty-second Z fine grid line. The R-axis was drawn from the first (1.0 feet) to the twelfth (4500.0 feet) fine grid line. The minimum temperature was specified as 50.0 degrees F, and the scaling factor for the temperature axis was input as 35.0 units/inch. The distance axis was drawn on a linear scale, and the profile was made at time=1000.0 years.

```
CAL                                                                      CARD 1
    5    1                  -3   -1         1                            CARD 2
    1    1              1                   1                            CARD 3
YEAR F    FEET                                                        CARD UNITS
      80.0     120.0     160.0     200.0     235.0                    CARD VALS
    1000.0                                                            CARD TIMES
                                              35.C      50.0          CARD SCAL1
                                    10.0                              CARD SCAL2
    1   12              1   43                                        CARD REG
  652  659 1582                                                       CARD NODES
    1                                                                 CARD PRFIL
        22                                                            CARD INDX1
```

Figure C-4

Input Data for Sample

Problem 2

```
THIS PLOT WILL BE CREATED ON THE CAL  PLOTTER
THE LENGTH OF THE X-AXIS WILL BE  8.00 INCHES
THE LENGTH OF THE Y-AXIS WILL BE  8.00 INCHES

JOB DESCRIPTION - 883 ACRE DOME REPOSITORY 10 YR OLD SPENT FUEL 150 KW/A GHL 12/09/76
GEOMETRY TYPE NUMBER -    3(OR RZ   )
DATE OF RUN - 04-07-77
JOB NAME - DXCCAL2
NUMBER OF NODES -  1612
TOTAL NUMBER OF BOUNDARY CONDITIONS -      2

THE CONTOUR VALUES ARE READ BY THE PROGRAM
THE NUMBER OF CONTOURS TO BE PLOTTED IS     5
THE CONTOUR VALUES ARE:
         8.00000E 01 1.20000E 02 1.60000E 02 2.00000E 02 2.35000E 02

THE NUMBER OF TIME STEPS TO BE PLOTTED IS     1
THE TIME POSITIONS ARE:    1.0000E 03



THE SCALE FACTORS ARE READ BY THE PROGRAM
THOSE EQUAL TO ZERO ARE COMPUTED

THE INPUT SCALE FACTORS FOR THE CONTOUR PLOTS ARE:
          X OR R       0.0
          Y OR TH      0.0
          Z            0.0

THE INPUT SCALE FACTORS FOR THE TEMPERATURE-TIME PROFILES ARE:
          TIME                   0.0
          TEMPERATURE            0.0
          MINIMUM TEMPERATURE    0.0
          MINIMUM TIME           1.0000E 01
          MAXIMUM TIME           0.0

THE INPUT SCALE FACTORS FOR THE TEMPERATURE-DISTANCE PROFILES ARE:
          DISTANCE               0.0
          TEMPERATURE            3.5000E 01
          MINIMUM TEMPERATURE    5.0000E 01


THE Z AXIS WILL BE FROM MAXIMUM TO MINIMUM



UNITS -
          TIME IS IN YEAR
          TEMPERATURE IS IN DEGREES F
          DISTANCE IS IN FEET
```

Figure C-5

Computer Output for Sample

Problem 2

```
TIME-TEMPERATURE PROFILES WILL BE MADE OF TEMPERATURE RISES
          FOR  3 NODES ON ONE GRAPH.
THE TIME AXIS WILL BE DRAWN ON A LOG SCALE
NODES TO BE PLOTTED  FOR TIME-TEMPERATURE PROFILES  652  659 1582

THERE WILL BE   1 TEMPERATURE-DISTANCE PROFILES PLOTTED FOR DISTANCES PARALLEL
           TO THE X OR R AXIS, OR NORMAL TO THE Y-Z OR TH-Z PLANES.
           WITH ALL TIME STEPS ON ONE GRAPH.
THE INDEXES OF THE PLANES WHOSE INTERSECTION DEFINES THE LINE ALONG
           WHICH THE PROFILES ARE PLOTTED FOLLOW:
                NUMBER      Y-PLANE      Z-PLANE
                    1            1           22


PROFIL NC.=  1

           NODE NO.                          RADIUS
              652                         1.00000D 00
              653                         5.00000D 02
              654                         1.00000D 03
              655                         1.50000D 03
              656                         2.00000D 03
              657                         2.50000D 03
              658                         3.00000D 03
              659                         3.50000D 03
              660                         3.75000D 03
              661                         4.00000D 03
              662                         4.25000D 03
              663                         4.50000D 03
TOTAL NUMBER OF NODES 12
```

Figure C-5 (contd.)

```
THE REGION OF THE GRAPH IS SPECIFIED IN THE INPUT

INDEX DESCRIBING REGION FOR WHICH TO PLOT CONTOURS
         BEGIN X    1       END X   12
         BEGIN Y    0       END Y    0
         BEGIN Z    1       END Z   43

THERE ARE  31  X (OR R) VALUES:
         1.000000D 00 5.000000D 02 1.000000D 03 1.500000D 03 2.000000D 03
         2.500000D 03 3.000000D 03 3.500000D 03 3.750000D 03 4.000000D 03
         4.250000D 03 4.500000D 03 4.750000D 03 5.000000D 03 5.250000D 03
         5.500000D 03 5.750000D 03 6.000000D 03 6.250000D 03 6.500000D 03
         7.000000D 03 7.500000D 03 8.000000D 03 8.500000D 03 9.000000D 03
         9.500000D 03 1.000000D 04 1.050000D 04 1.100000D 04 1.150000D 04
         1.200000D 04

THERE ARE   1  Y (OR TH) VALUES:
         0.0

THERE ARE  52  Z VALUES:
         0.0          2.000000D 02 4.000000D 02 6.000000D 02 8.000000D 02
         1.000000D 03 1.100000D 03 1.200000D 03 1.300000D 03 1.400000D 03
         1.500000D 03 1.600000D 03 1.700000D 03 1.750000D 03 1.800000D 03
         1.850000D 03 1.900000D 03 1.925000D 03 1.950000D 03 1.975000D 03
         1.990000D 03 2.000000D 03 2.012500D 03 2.025000D 03 2.050000D 03
         2.075000D 03 2.100000D 03 2.150000D 03 2.200000D 03 2.250000D 03
         2.300000D 03 2.400000D 03 2.500000D 03 2.600000D 03 2.700000D 03
         2.800000D 03 2.900000D 03 3.000000D 03 3.250000D 03 3.500000D 03
         3.750000D 03 4.000000D 03 4.500000D 03 5.000000D 03 5.500000D 03
         6.000000D 03 7.000000D 03 8.000000D 03 9.000000D 03 1.000000D 04
         1.100000D 04 1.200000D 04
```

Figure C-5 (contd.)

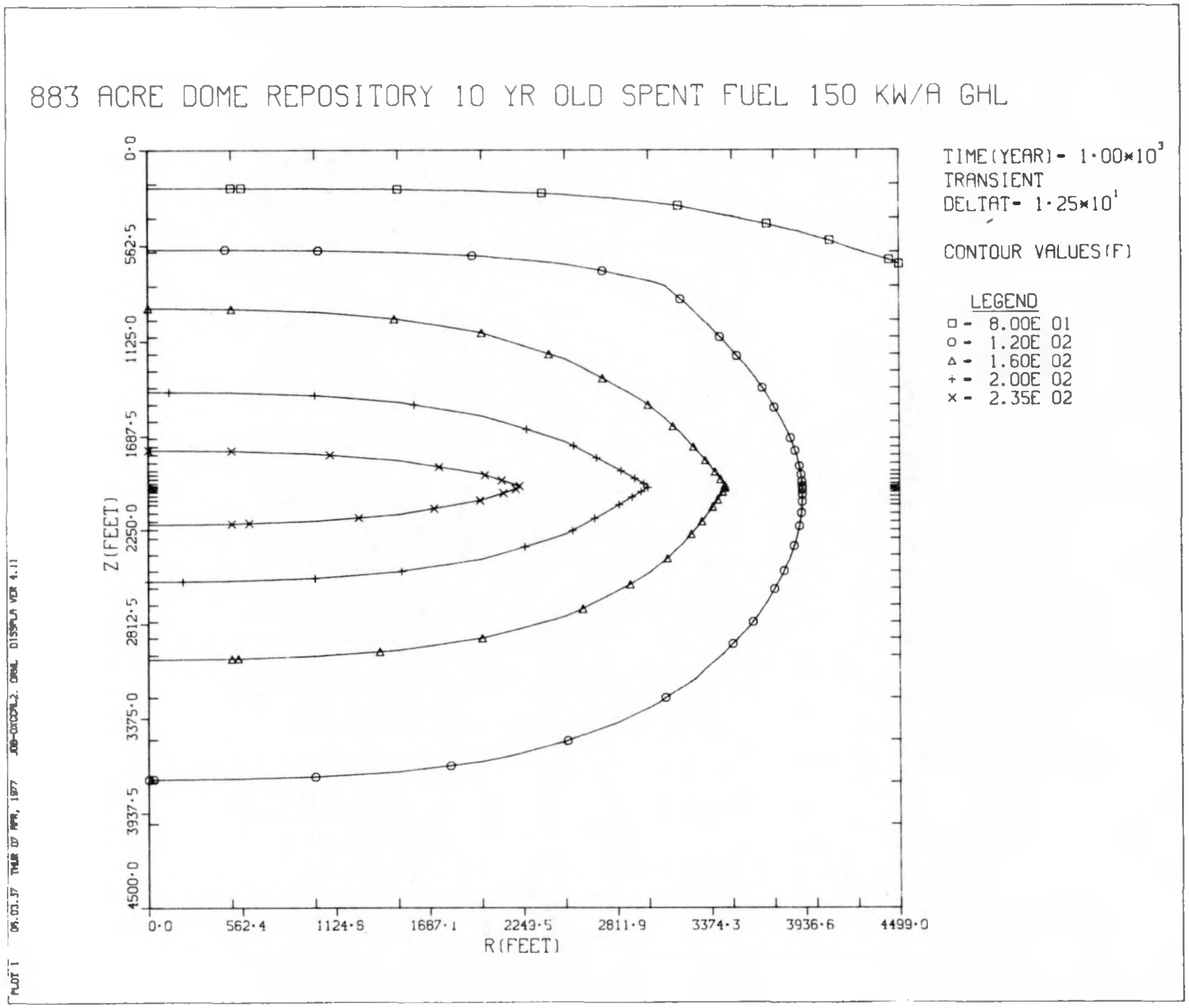

Figure C-6.1

Contour Plot

Problem 2

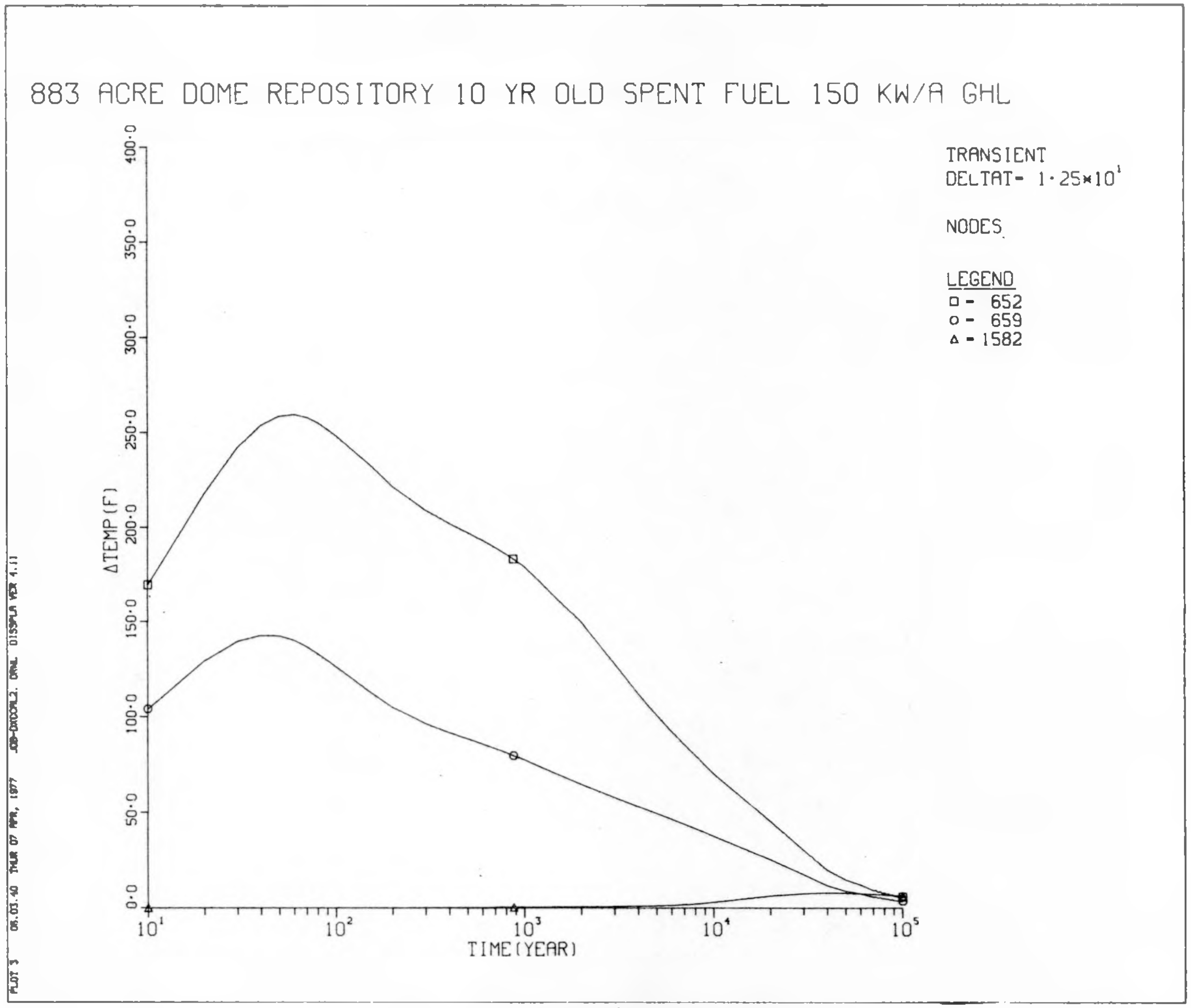

Figure C-6.2

Temperature-time Profile

Problem 2

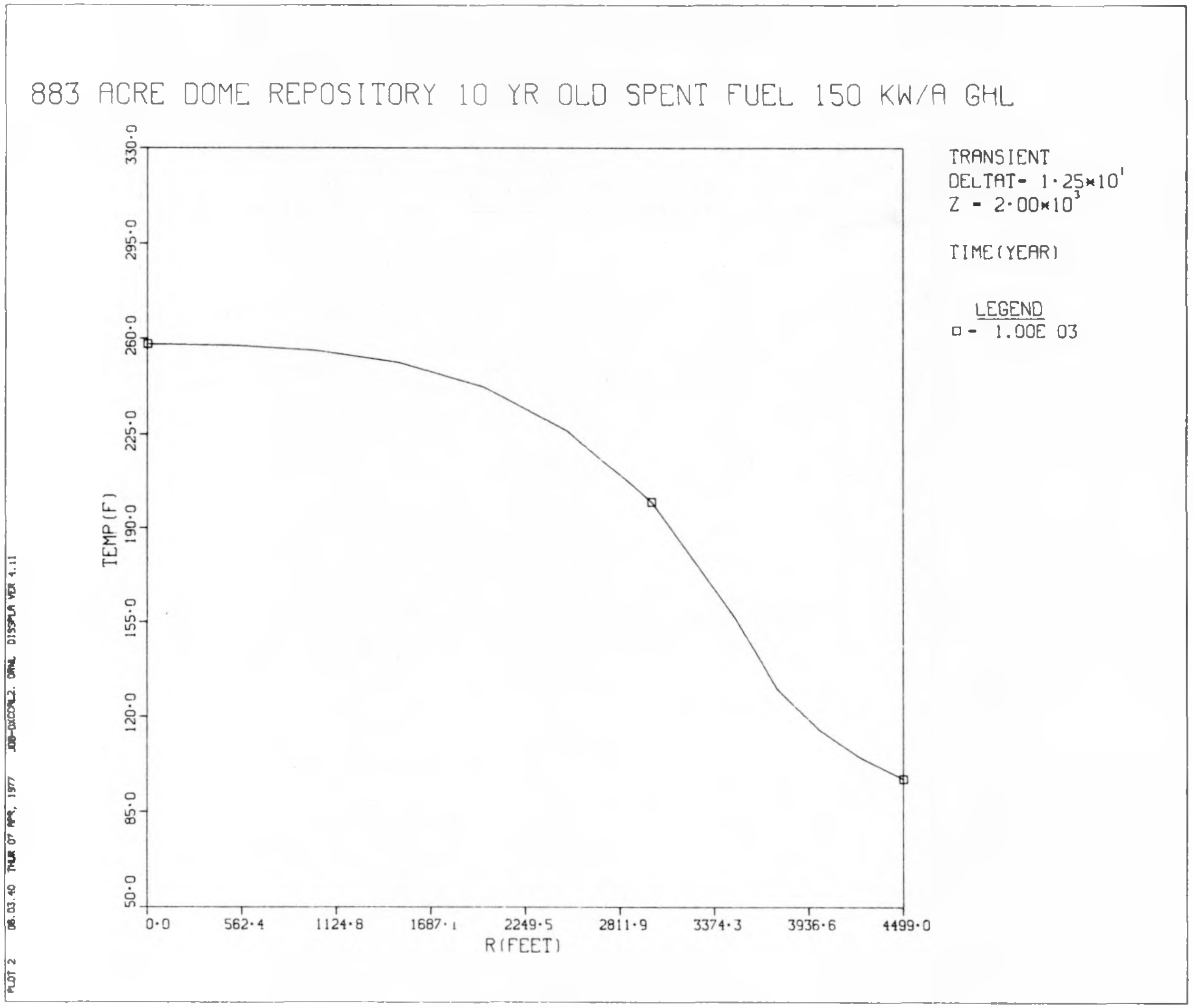

Figure C-6.3

Temperature-distance Profile

Problem 2

C.3 One-dimensional Z Model

The third sample problem is a one-dimensional Z model. A listing of the input data is given in Fig. C-7. The printed output is shown in Fig. C-8. The plot output appears in Fig. C-9. Contour plots may not be drawn for one dimensional problems.

Temperature-time profiles (Fig. C-9.1) were drawn for three nodes on one graph. The profiles were drawn for every time on the temperature distribution data set. The time axis was drawn with a linear scale. All scale factors were computed by the program.

Temperature-distance (Fig. C-9.2) profiles were drawn for the entire Z-axis at times=0.0, 10.0, 50.0, 100.0, 500.0, and 1000.0 years. The profiles for each time were drawn on the same graph. The minimum temperature was input as 50.0 degrees F. The scale factor for the temperature axis was specified to be 15.0 units/inch.

```
CAL                                                                      CARD 1
          6                        -3    -1                              CARD 2
    1                                                                    CARD 3
YEAR F       FEET                                                        CARD UNITS
       0.0          10.       50.       100.      500.     1000.0        CARD TIMES
                                                  15.0       50.0        CARD SCAL1
                                                                         CARD SCAL2
    6    22    38                                                        CARD NODES
```

Figure C-7

Input Data for Sample

Problem 3

```
THIS PLOT WILL BE CREATED ON THE CAL  PLOTTER
THE LENGTH OF THE X-AXIS WILL BE  8.00 INCHES
THE LENGTH OF THE Y-AXIS WILL BE  8.00 INCHES

JOB DESCRIPTION - 883 ACRE DOME REPOSITORY 10 YR OLD SPENT FUEL 50 KW/A(1-Z TRAN 12000)
GEOMETRY TYPE NUMBER -    5(OR Z    )
DATE OF RUN - 04-17-77
JOB NAME - DXCCAL3
NUMBER OF NODES -     52
TOTAL NUMBER OF BOUNDARY CONDITIONS -      2

THERE WILL BE NO CONTOURS PLOTTED

THE NUMBER OF TIME STEPS TO BE PLOTTED IS     6
THE TIME POSITIONS ARE:    0.0          1.0000E 01   5.0000E 01   1.0000E 02   5.0000E 02   1.0000E 03



THE SCALE FACTORS ARE READ BY THE PROGRAM
THOSE EQUAL TO ZERO ARE COMPUTED

THE INPUT SCALE FACTORS FOR THE CONTOUR PLOTS ARE:
          X OR R       0.0
          Y OR TH      0.0
          Z            0.0

THE INPUT SCALE FACTORS FOR THE TEMPERATURE-TIME PROFILES ARE:
          TIME                    0.0
          TEMPERATURE             0.0
          MINIMUM TEMPERATURE     0.0
          MINIMUM TIME            0.0
          MAXIMUM TIME            0.0

THE INPUT SCALE FACTORS FOR THE TEMPERATURE-DISTANCE PROFILES ARE:
          DISTANCE                0.0
          TEMPERATURE             1.5000E 01
          MINIMUM TEMPERATURE     5.0000E 01



UNITS -
          TIME IS IN YEAR
          TEMPERATURE IS IN DEGREES F
          DISTANCE IS IN FEET
```

Figure C-8

Computer Output for Sample

Problem 3

```
THE REGION OF THE GRAPH IS NOT SPECIFIED IN THE INPUT

INDEX DESCRIBING REGION FOR WHICH TO PLOT CONTOURS
          BEGIN X    1      END X    1
          BEGIN Y    1      END Y    1
          BEGIN Z    1      END Z   52

THERE ARE    1 X (OR R) VALUES:
          0.0

THERE ARE    1 Y (OR TH) VALUES:
          0.0

THERE ARE   52 Z VALUES:
          0.0           2.00000D 02 4.00000D 02 6.00000D 02 8.00000D 02
          1.00000D 03 1.10000D 03 1.20000D 03 1.30000D 03 1.40000D 03
          1.50000D 03 1.60000D 03 1.70000D 03 1.75000D 03 1.80000D 03
          1.85000D 03 1.90000D 03 1.92500D 03 1.95000D 03 1.97500D 03
          1.99000D 03 2.00000D 03 2.01250D 03 2.02500D 03 2.05000D 03
          2.07500D 03 2.10000D 03 2.15000D 03 2.20000D 03 2.25000D 03
          2.30000D 03 2.40000D 03 2.50000D 03 2.60000D 03 2.70000D 03
          2.80000D 03 2.90000D 03 3.00000D 03 3.25000D 03 3.50000D 03
          3.75000D 03 4.00000D 03 4.50000D 03 5.00000D 03 5.50000D 03
          6.00000D 03 7.00000D 03 8.00000D 03 9.00000D 03 1.00000D 04
          1.10000D 04 1.20000D 04


TIME-TEMPERATURE PROFILES WILL BE PLOTTED FOR  3 NODES ON ONE GRAPH
NODES TO BE PLOTTED  FOR TIME-TEMPERATURE PROFILES    6   22   38

DISTANCE-TEMPERATURE PROFILES WILL BE PLOTTED
           WITH ALL TIME STEPS ON ONE GRAPH.
```

Figure C-8 (contd.)

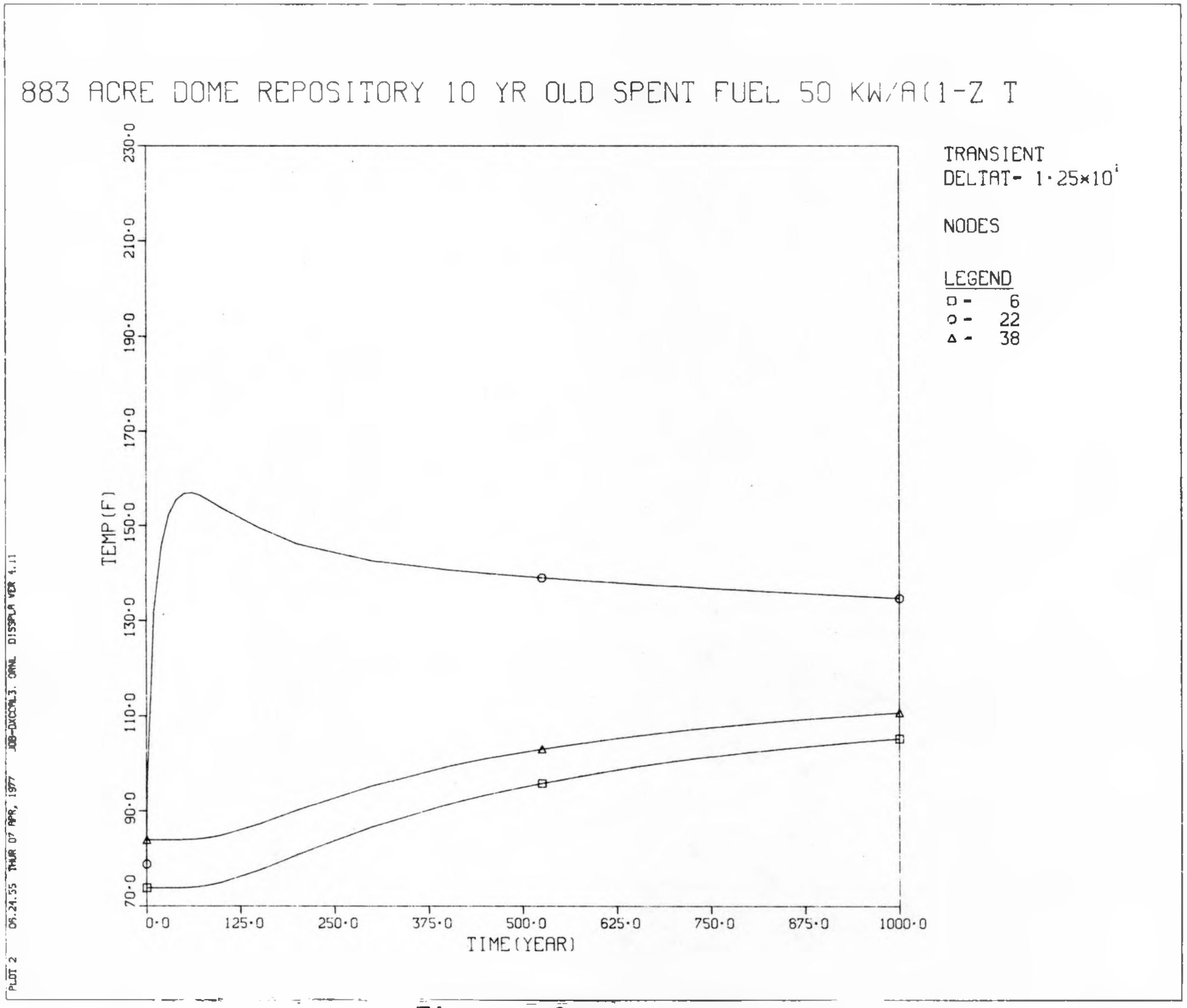

Figure C-9.1

Temperature-time Profile

Problem 3

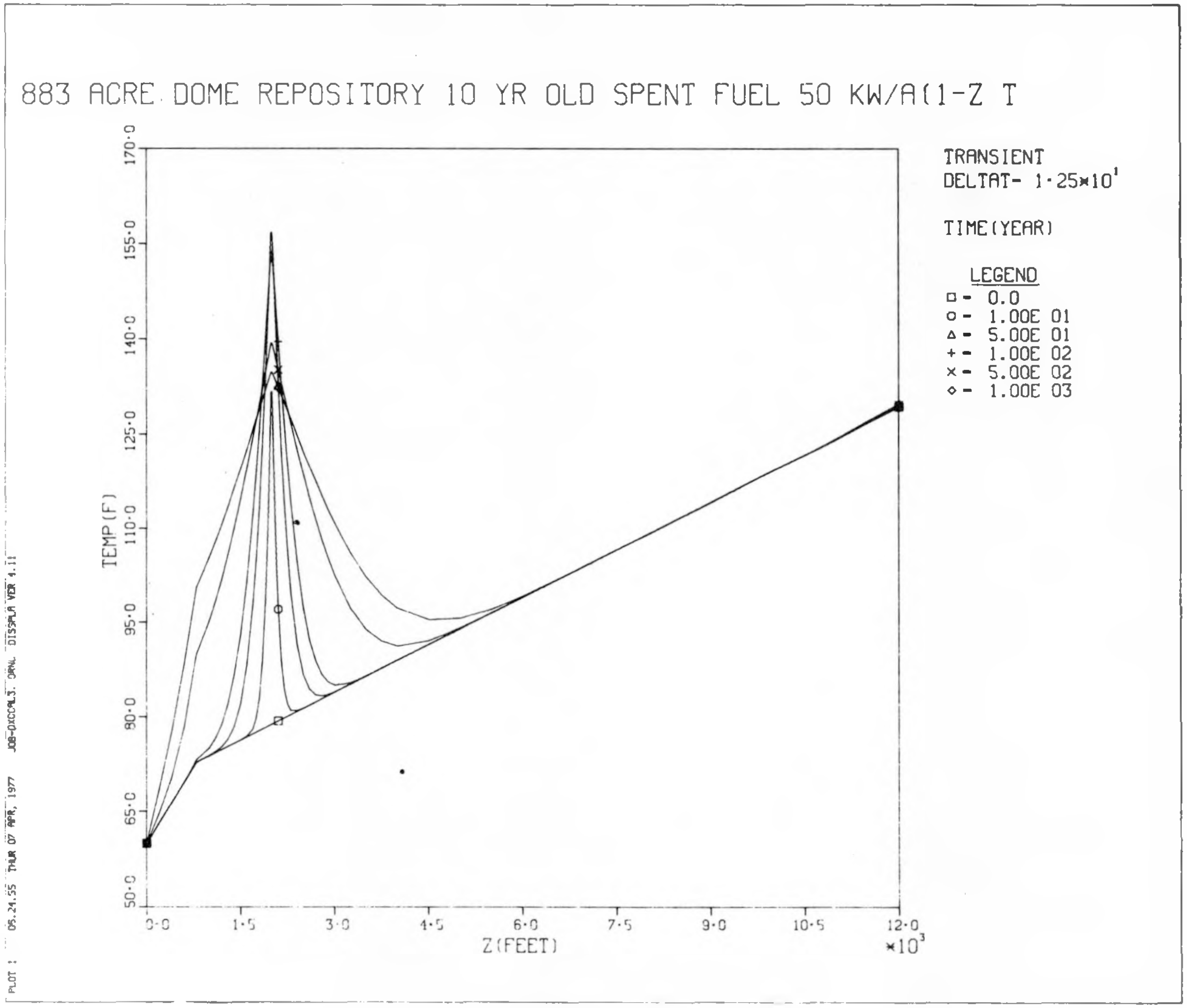

Figure C-9.2

Temperature-distance Profile

Problem 3