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SRB THERMAL CURTAIN DESIGN SUPPORT

OCTOBER 1990 INTERIM REPORT TO

U.S. POLYMERIC
B.P. CHEMICALS
SANTA ANA, CALIFORNIA 92705

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October 1990 Interim Report

to

U.S. POLYMERIC
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Advanced Materials Division
Fibers and Materials
700 East Dyer Road
Santa Ana, California 92705

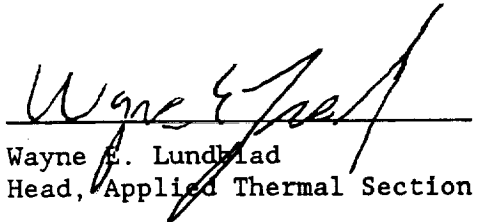
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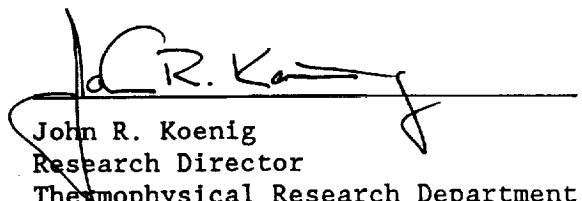
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ERRATA: All references to E-glass should read as S-2 glass.

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INTRODUCTION

This is an interim report for the work performed under purchase order number 62550, NASA prime contract NAS8-38261, "SRB Thermal Curtain Redesign Support". This report covers the period from 1 April to 31 October 1990.

Two topics are covered in this report. They are:

- 1] Preliminary thermophysical properties estimations.
- 2] Computer-aided thermal analysis.

OBJECTIVE

The objective during this time period was to perform a preliminary thermal analysis using some measured and estimated thermal properties on the angle-interlock materials. This preliminary thermal analysis is to serve as a guide for identifying any potential problems in blanket construction and identifying future tests.

1] Preliminary Thermophysical Properties Estimations

Three materials were received for thermophysical properties measurements. They were:

- 1] Angle-interlock Quartz
- 2] Angle-interlock E-glass
- 3] Angle-interlock Kevlar

Densities were evaluated for each material. Table 1 lists the densities, material thicknesses and maximum use temperatures.

Thermal conductivity and specific heat were to be measured on each material. The temperature ranges of interest were as follows:

Quartz	70 °F to 2500 °F
E-glass	70 °F to 1800 °F
Kevlar	70 °F to 600 °F

Preliminary low temperature data (less than 1000 °F) were obtained on all three materials. These low temperature data were then extrapolated with a best "engineering estimate" of the high temperature behavior. Figures 1 through 6 depict these estimated thermal properties for the angle-interlock woven materials. The conductivity curves are non-conservative estimates since potential radiation transport is neglected. Specific heat estimates are based on data obtained at SRI on similar materials. These estimated properties were used in the preliminary thermal analysis presented in Section 2 of this report. The actual data, both low and high temperature, will be reported at a later time.

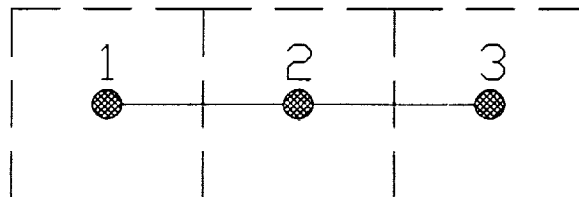
All the curves were fitted by polynomials for input into the computer data base. Table 2 lists the curve fits. The preliminary thermal evaluations indicated that a low conductivity filler material may be required. Fiberfrax was selected. Its estimated properties are also given in Table 2. It should be noted that should a low conductivity filler material be required its thermal properties will have to be measured.

2] Computer-Aided Thermal Analysis

A finite element computer program was developed to aid in the preliminary thermal analysis and redesign of the SRB Thermal curtain.

An implicit, forward-differencing technique was used with the nodal spacing taken at the interface of each blanket layer. Figure 7 shows the nodal configuration for a blanket comprised of angle interlock quartz, fiberfrax, angle interlock E-glass, fiberfrax and angle interlock Kevlar. The thicknesses of all the layers is the same and taken to be an average of 0.250 inches. The computer program is versatile in that the user may select the combination of materials and thicknesses, although all thicknesses must be the same. The program can be modified to handle different thicknesses. The thermal properties for each material are stored in a data file that is accessed by the computer. Thermal conductivity and specific heat, as functions of temperature, are stored in these files. Density is taken to be a constant and is also stored in a file. These files are easily changed to accommodate different materials.

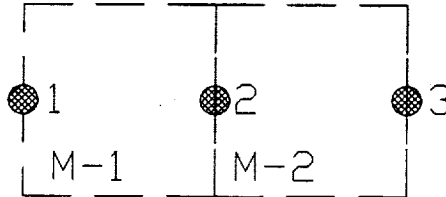
The implicit technique involves evaluating an energy balance on a node. Consider a small section of a large plate. The section is divided into three nodes as shown below:



An energy balance has the heat flow from 1-2 minus the heat flow from 2-3 equal to the amount of heat stored in node 2. That is:

$$q_{1 \rightarrow 2} - q_{2 \rightarrow 3} = \rho v c \frac{\partial T}{\partial t}$$

It is necessary to write an energy balance for a composite material. To do this the nodes are selected such that a node lies on an interface:



Here node 2 lies at the interface of materials 1 and 2. Since node 2 is actually made up of two materials the energy storage term is adjusted to reflect an average value:

$$q_{1 \rightarrow 2} - q_{2 \rightarrow 3} = \frac{\rho_1 v_1 c_1 + \rho_2 v_2 c_2}{2} \frac{\partial T}{\partial t}$$

Table 3 depicts the implicit equations for the exterior and interior nodes of the blanket configuration in Figure 7. These equations are then put into matrix form (Table 4), with the coefficients of the matrix given in Table 5. Node 6 is fixed at 70 °F, a necessary boundary condition. Later on in the program this node will be modified to include radiation and convection effects from the surface. Matrix coefficients are recalculated at every iteration to reflect the changing thermal properties. Gaussian elimination is used to solve for the temperatures. Heat flux is varied as a function of time. The heat flux curve was obtained from NASA SRB thermal design data (Figure 8).

Although Tables 3 through 5 reflect only a five node system the matrix can be expanded if a larger layer system is selected.

SUMMARY

The computer has coded the materials as follows:

<u>Code Letter</u>	<u>Material</u>
A	Kevlar
B	E-glass
C	Quartz
D	Fiberfrax

Consider a thermal blanket design of:

C - D - B - D - A

Figure 9 shows the temperature-time response of this blanket, subjected to the design flux for 120 seconds. As can be seen the temperature of the first node (surface of quartz) is at about 2700 °F after 120 seconds. This is above the recommended use temperature which should be less than 2500 °F.

Figure 10 is a C-B-A combination. Although the quartz temperature is low the Kevlar temperature is high (about 400 °F). This may still be a viable combination since interfacial resistances, which are not included in the analysis, will reduce the Kevlar temperature.

A combination of C-B-D-A is shown in Figure 11. This looks like it may work well. The fiberfrax insulation helps to keep the operating temperature of the Kevlar below 500 °F. The quartz temperature is within its operating range.

The low temperature thermal data, and estimated high temperature data, indicate that a viable combination of layers is possible for the SRB blanket. It is recommended that the two blanket configurations:

C - B - A

and

C - B - D - A

be evaluated for effective thermal conductivity. Thermal response testing should also be performed on these two designs. However, the low conductivity filler (fiberfrax) was arbitrarily selected. More thought needs to go into this selection before further testing.

Appendices A, B and C are the output files for the blanket configurations analyzed above. Appendix D lists the source code and subroutines used in the thermal analysis. Appendix E contains instructions for operating the computer code.

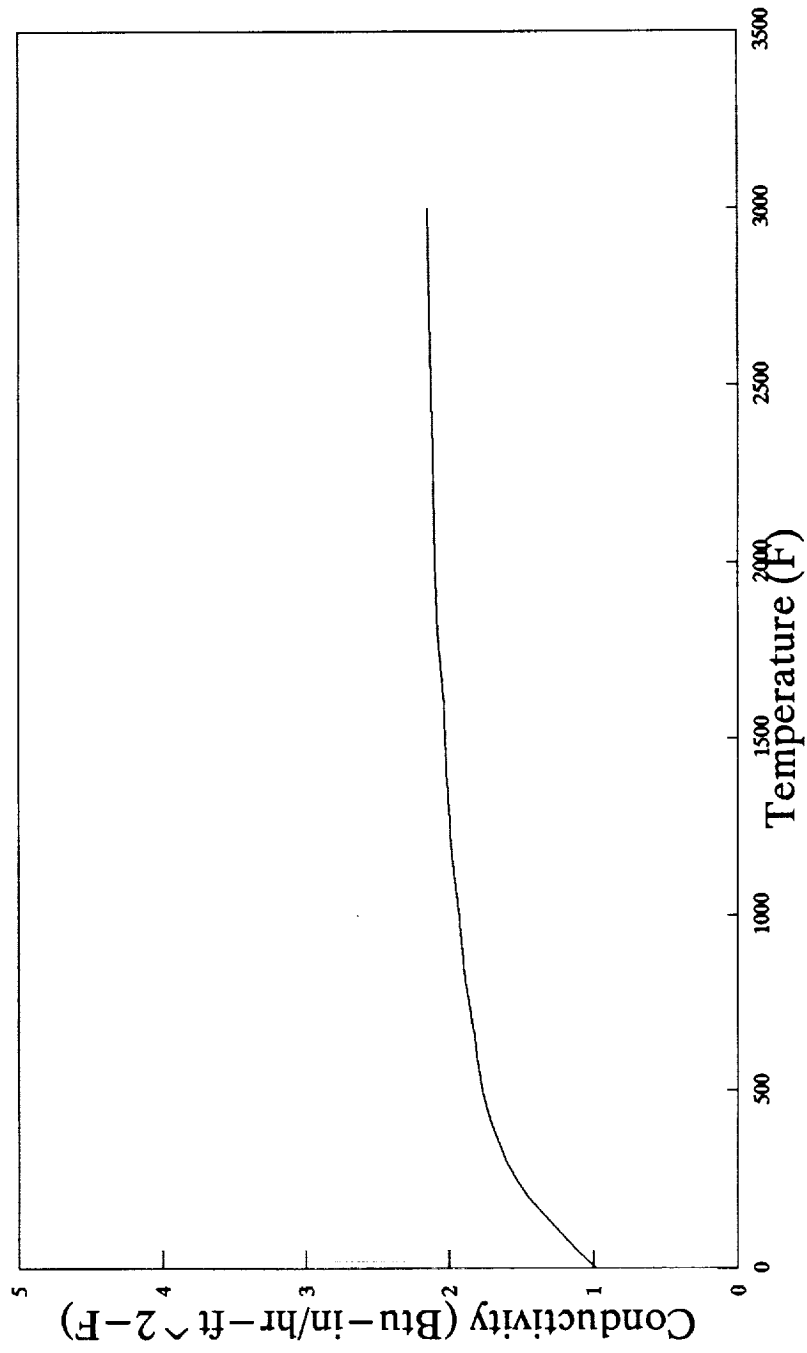


Figure 1. Estimated Conductivity of Angle-Interlock Quartz

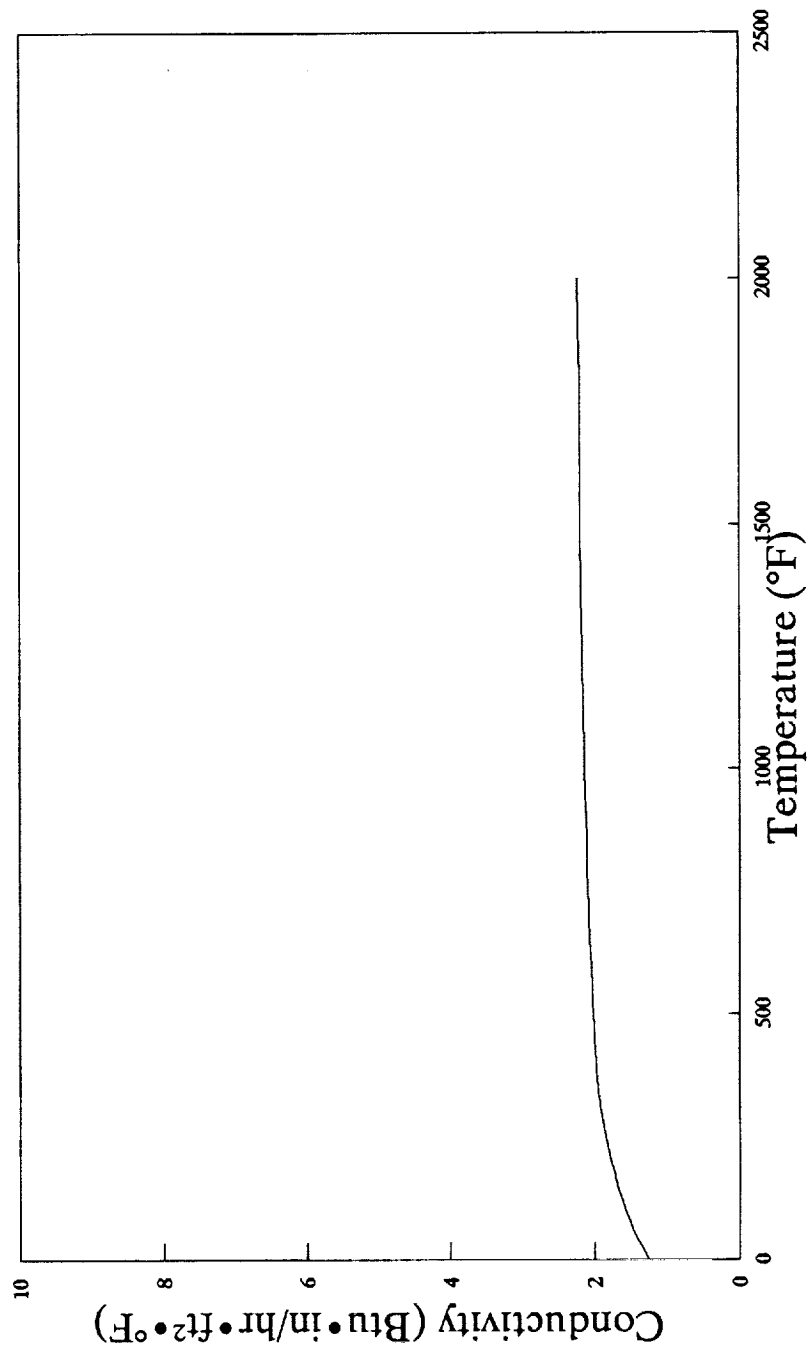


Figure 2. Estimated Conductivity of Angle-Interlock E-glass

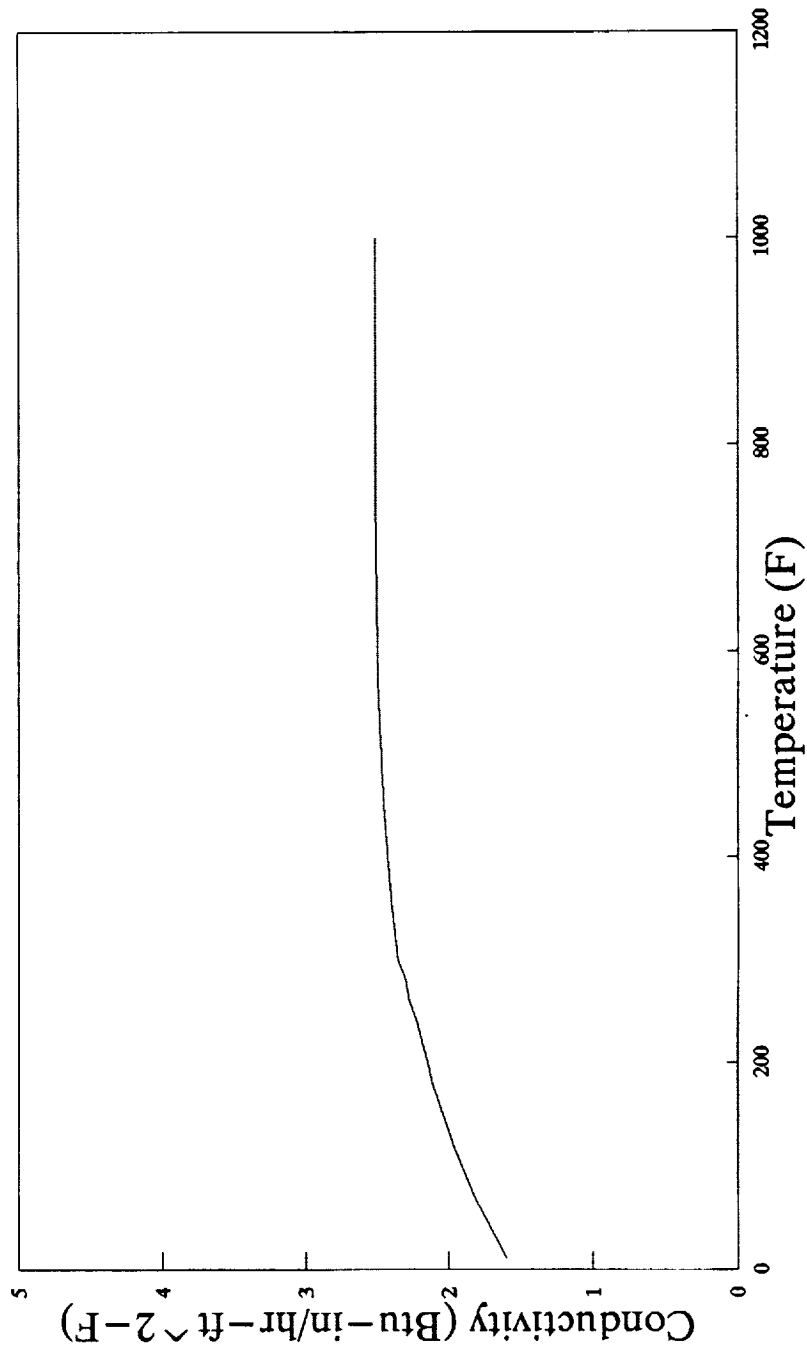


Figure 3. Estimated Conductivity of Angle-Interlock Kevlar

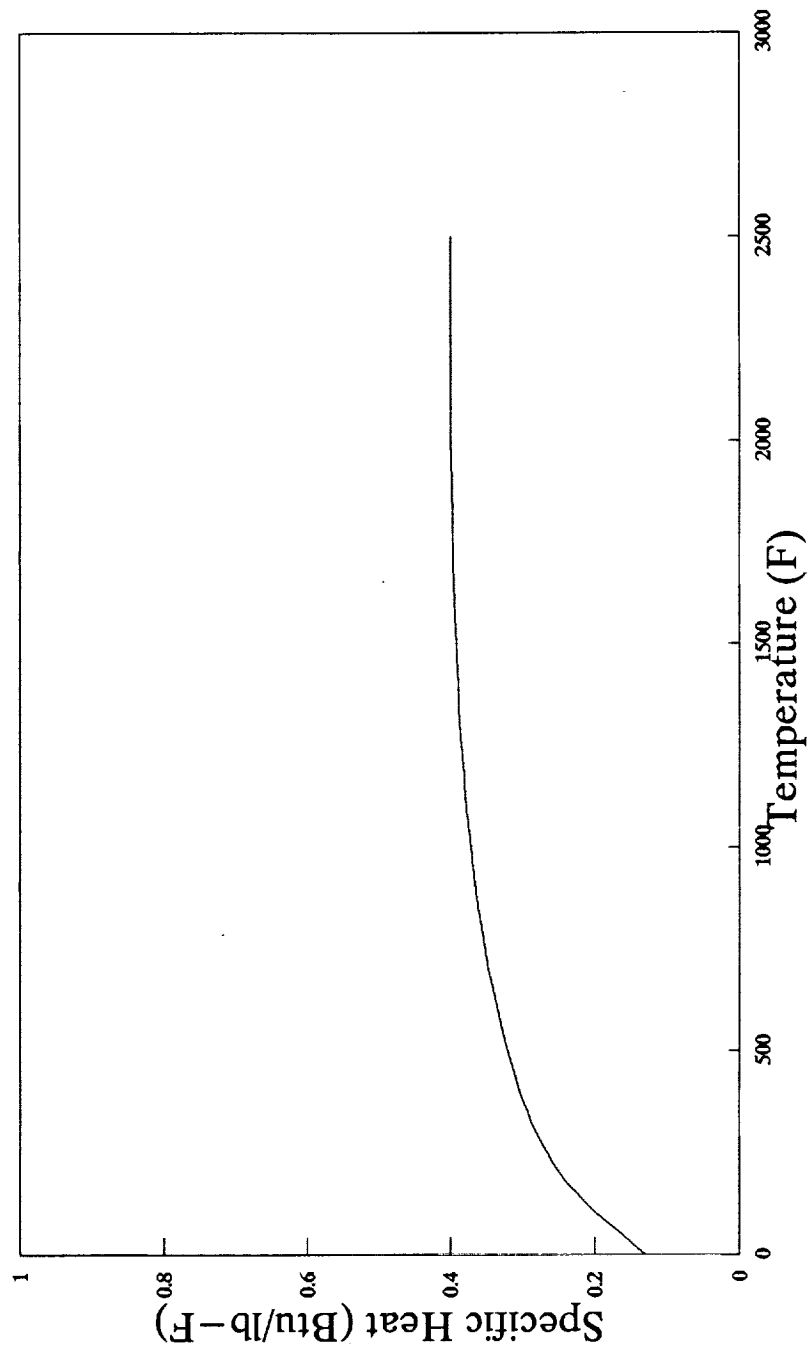


Figure 4. Estimated Specific Heat of Angle-Interlock Quartz

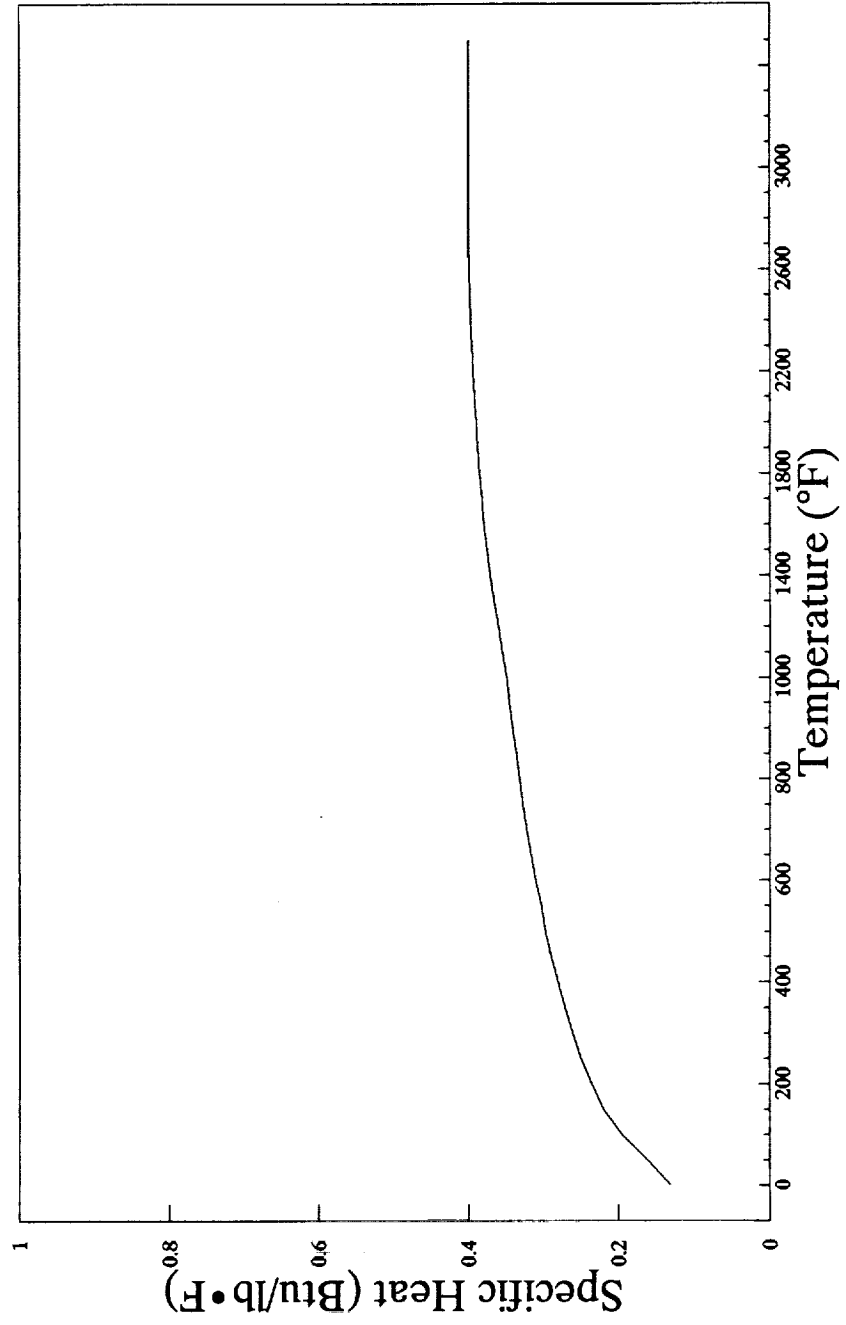


Figure 5. Estimated Specific Heat of Angle-Interlock E-glass

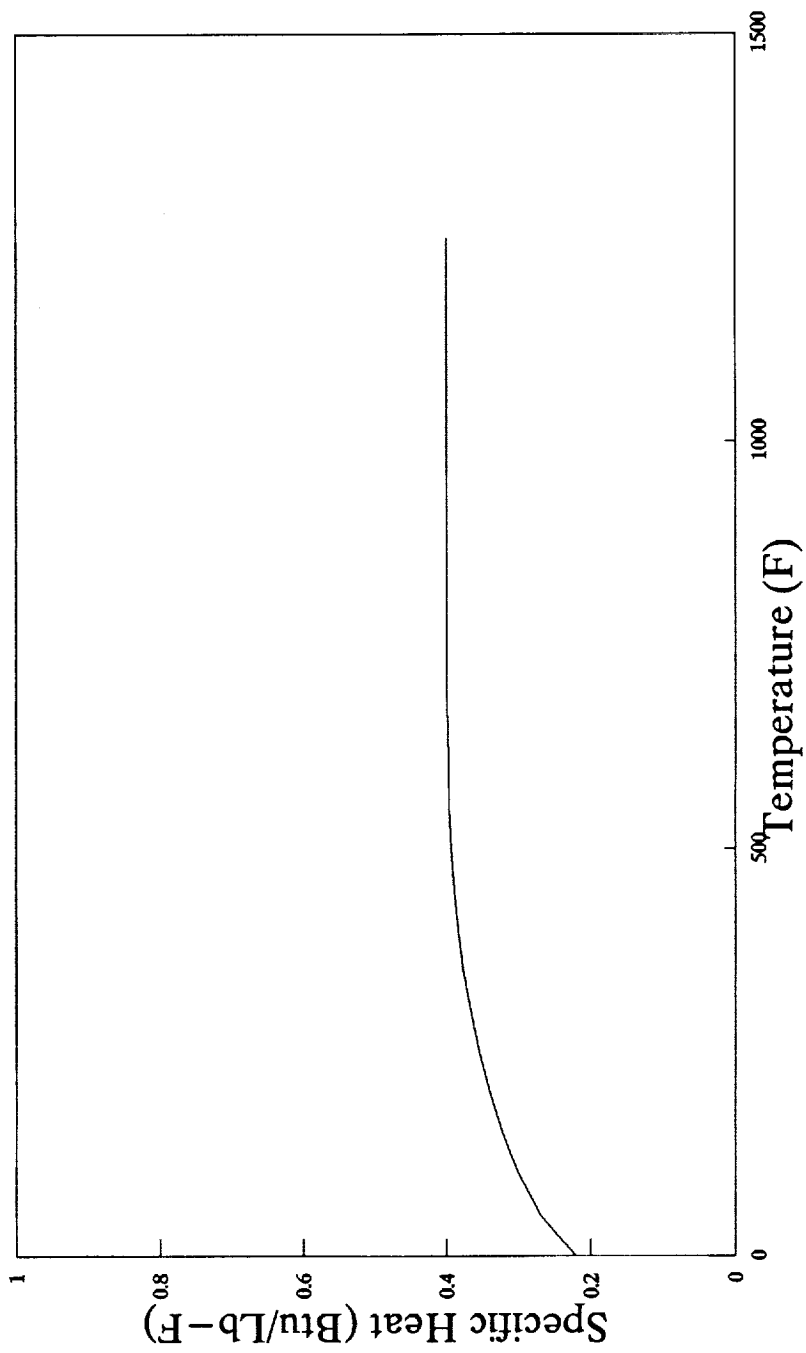


Figure 6. Estimated Specific Heat of Angle-Interlock Kevlar

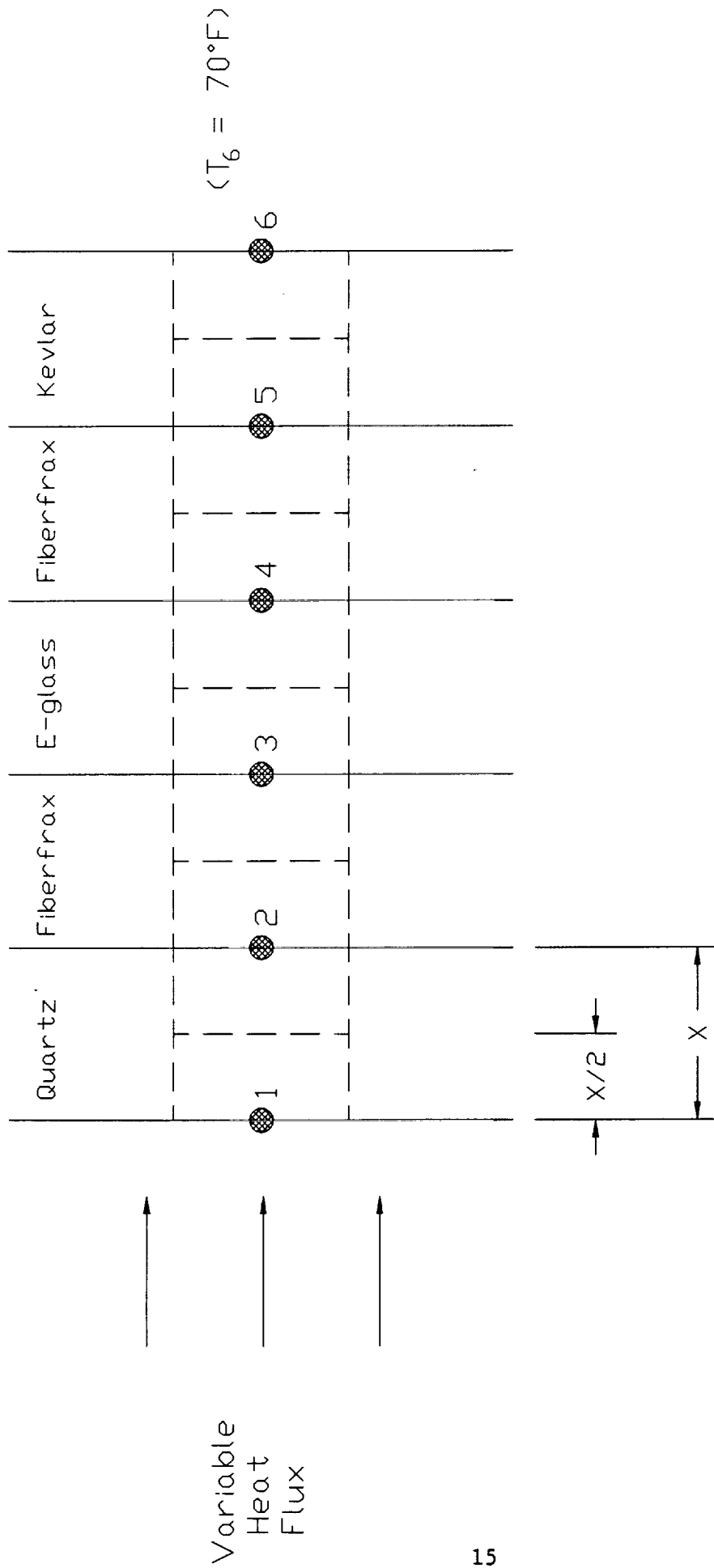


Figure 7. Nodal Configuration

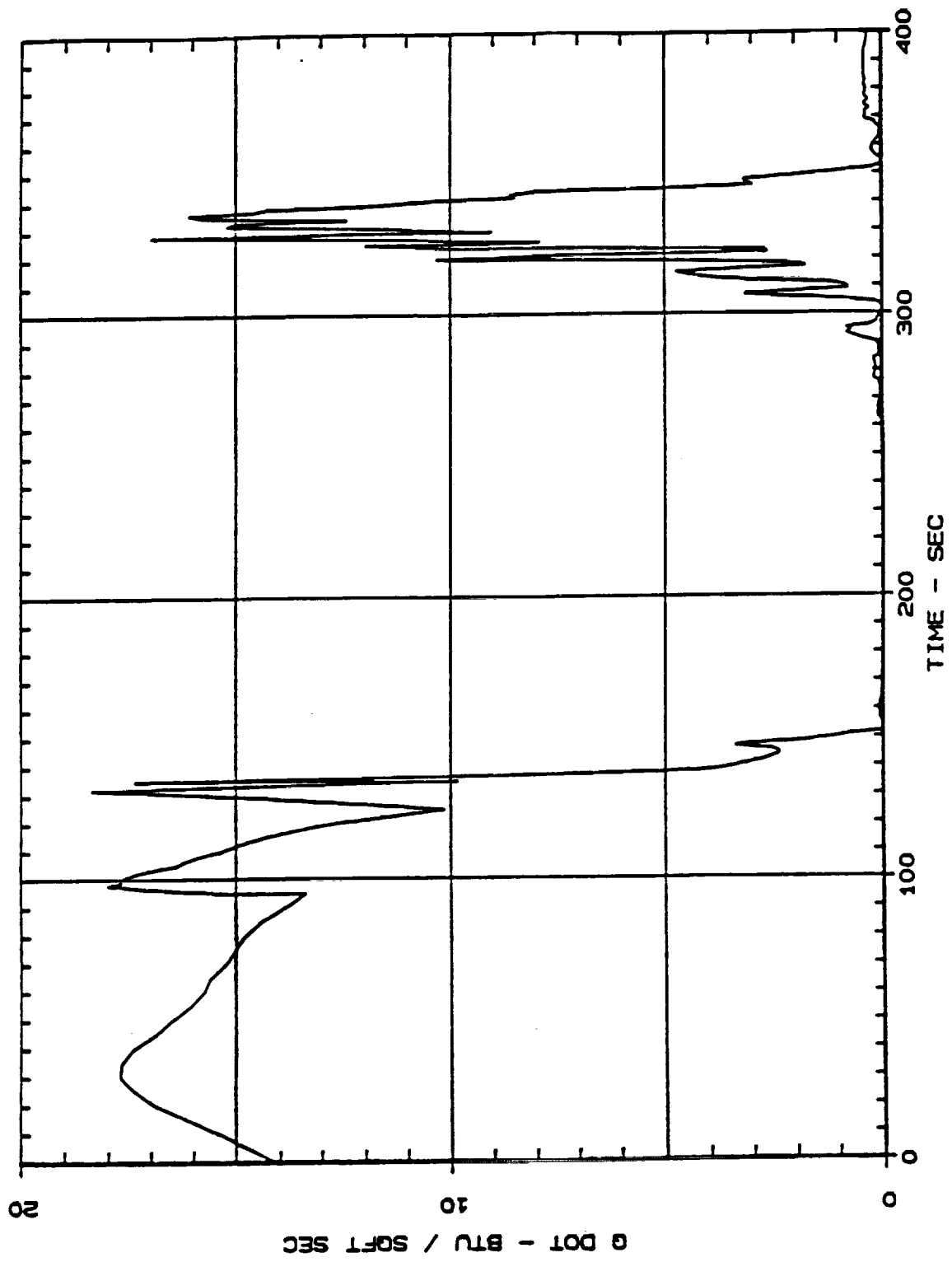


Figure 8. Heat Flux Input as a Function of Time

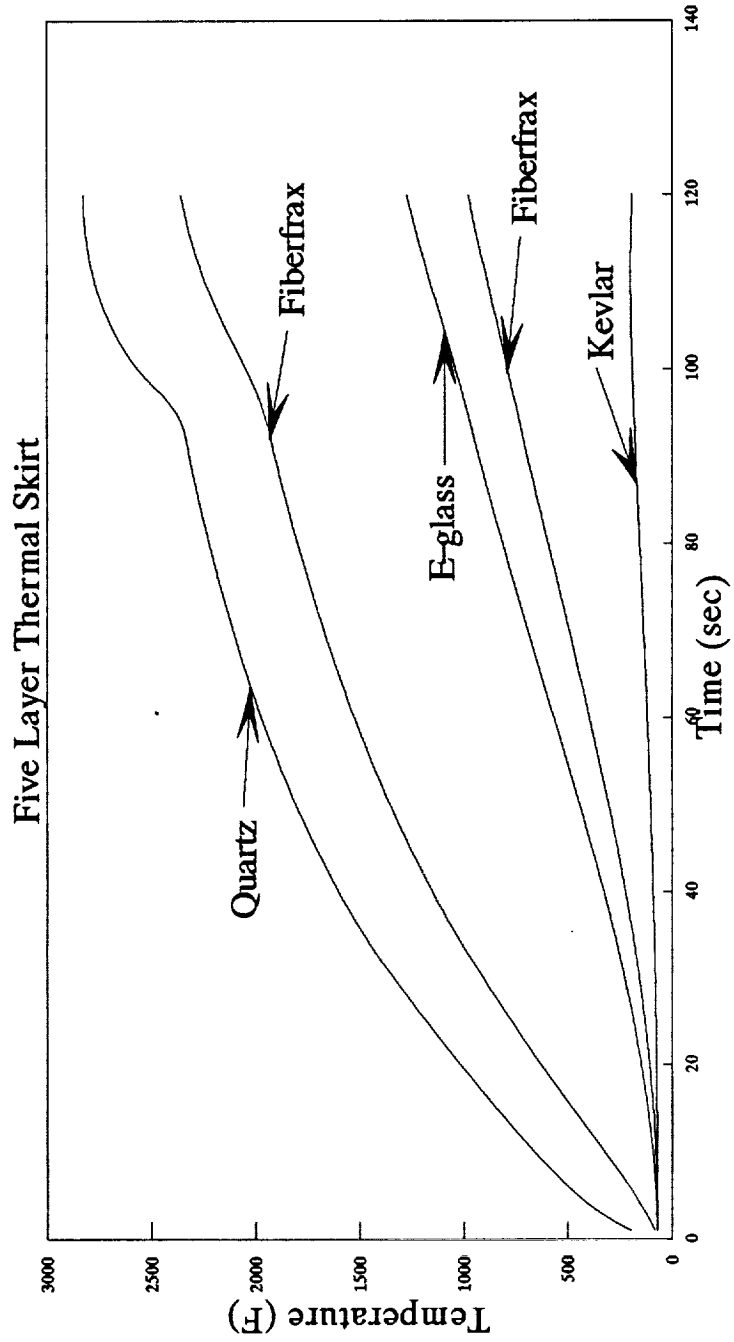


Figure 9. Thermal Response of Blanket Configuration C-D-B-D-A

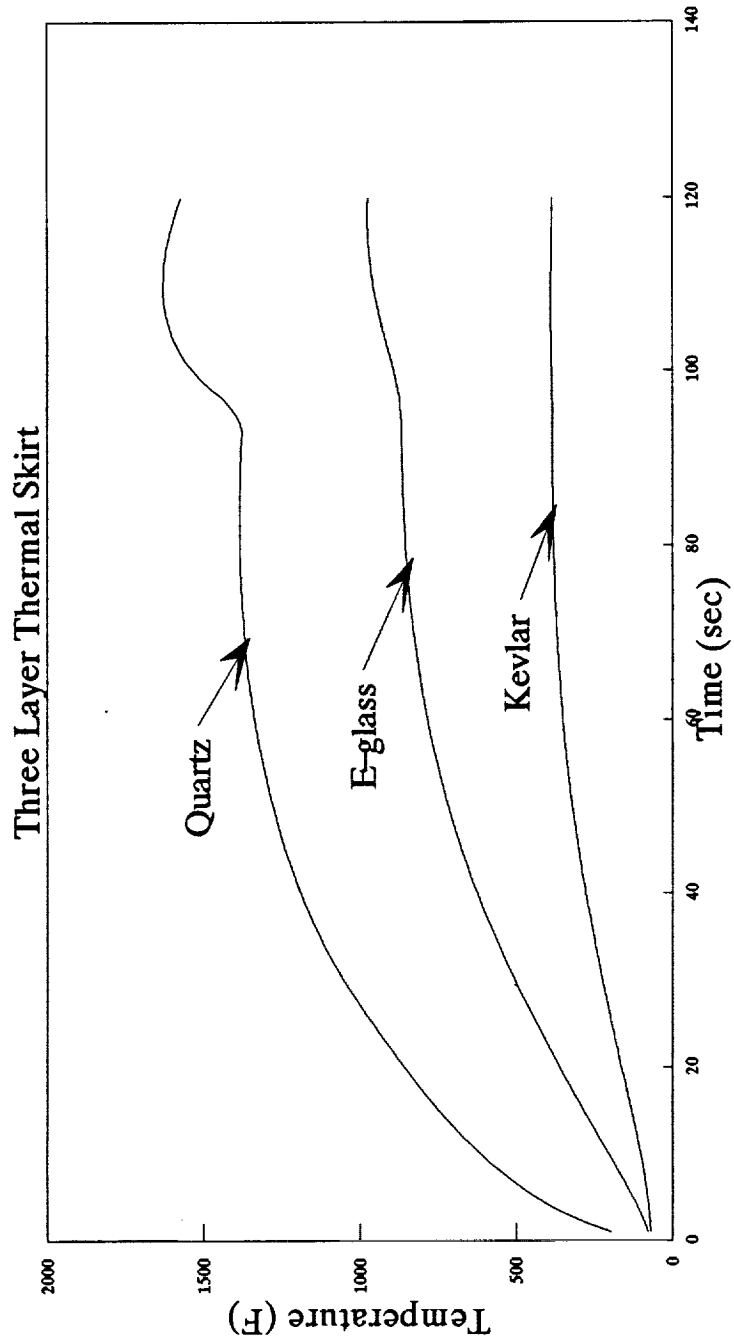


Figure 10. Thermal Response of Blanket Configuration C-B-A

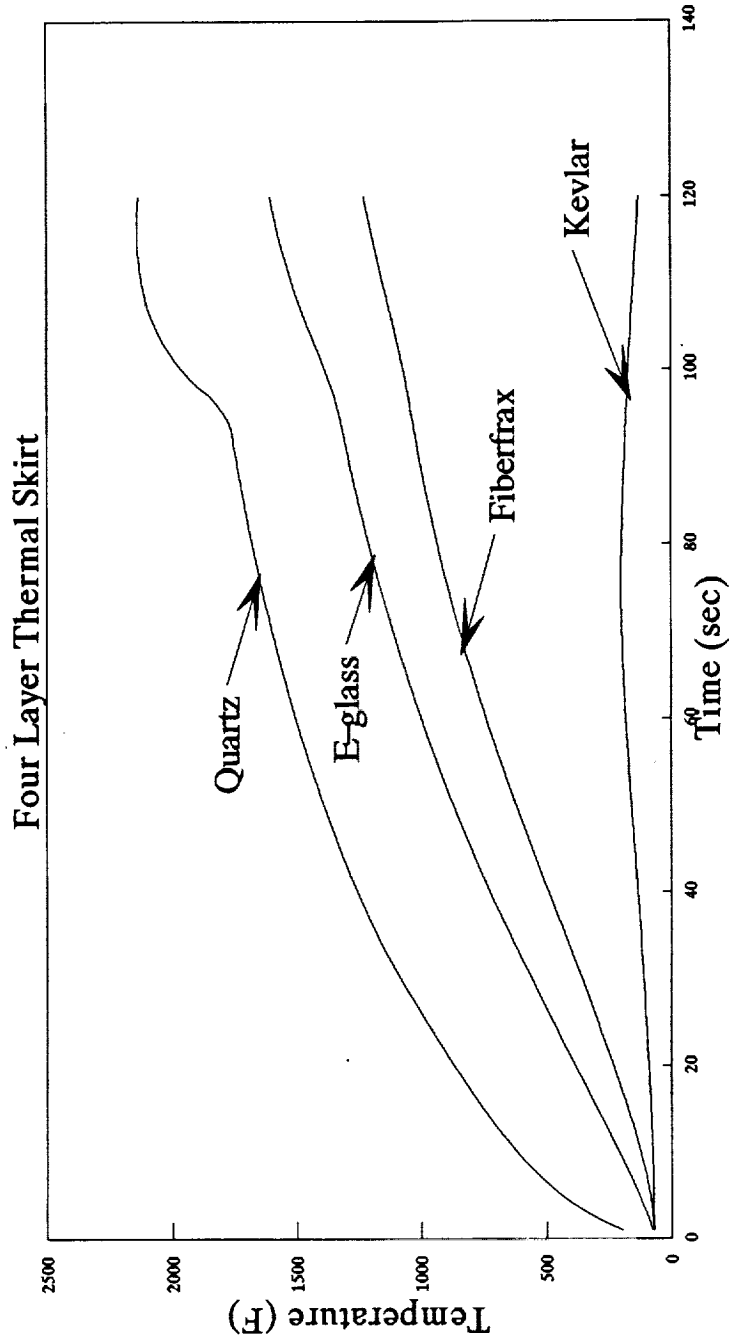


Figure 11. Thermal Response of Blanket Configuration C-B-D-A

Table 1
Material Thicknesses and Densities

<u>Material</u>	<u>Density</u>	<u>Thickness</u>	<u>Maximum Use Short Time Temperature</u>
Quartz	53.88 lb/ft ³	0.248 in.	2700 °F
E-glass	62.90 lb/ft ³	0.236 in.	1700 °F
Kevlar	37.41 lb/ft ³	0.221 in.	600 °F

Table 2

Estimated Thermophysical Properties in Polynomial Form

Quartz

$$K = 0.96668 + 3.2353E-3T - 4.9604E-6T^2 + 4.2154E-9T^3 - 1.9331E-12T^4 + 4.485E-16T^5 - 4.1285E-20T^6$$

$$C_p = 0.12914 + 7.9542E-4T - 1.3367E-6T^2 + 1.263E-9T^3 - 6.7072E-13T^4 + 1.9852E-16T^5 - 3.0384E-20T^6 + 1.8532E-24T^7$$

E-glass

$$K = 1.2292 + 4.0169E-3T - 8.5928E-6T^2 + 1.0037E-8T^3 - 6.3611E-12T^4 + 2.0532E-15T^5 - 2.641E-19T^6$$

$$C_p = 0.13348 + 6.8486E-4T - 8.6683E-7T^2 + 6.1745E-10T^3 - 2.2943E-13T^4 + 3.4227E-17T^5$$

Kevlar

$$K = 1.5544 + 4.2148E-3T - 6.7157E-6T^2 + 4.229E-9T^3 - 1.0567E-12T^4$$

$$C_p = 0.2815 + 9.5004E-4T - 3.909E-6T^2 + 8.8455E-9T^3 - 1.0357E-11T^4 + 4.879E-15T^5$$

Fiberfrax

$$K = 0.417 + 1.519E-4T$$

$$C_p = 0.15651 + 3.609E-4T - 4.5935E-7T^2 + 3.2081E-10T^3 - 1.1115E-13T^4 + 1.4762E-17T^5$$

Table 3

Nodal Equations

Node 1 (given Q)	$\left[1 + \frac{2K_1 \Delta t}{\rho_1 C_1 \Delta X^2} \right] T_1^1 - \frac{2K_1 \Delta t}{\rho_1 C_1 \Delta X^2} T_2^1 - \frac{2Q \Delta t}{\rho_1 C_1 \Delta X} + T_1$	
Node 2 (Composite)	$\frac{K_1}{\Delta X} [T_1^1 - T_2^1] + \frac{K_2}{\Delta X} [T_3^1 - T_2^1] - \left[\frac{\rho_1 C_1 + \rho_2 C_2}{2} \right] \frac{\Delta X}{\Delta t} [T_2^1 - T_2]$	
Node 3	$\frac{K_2}{\Delta X} [T_2^1 - T_3^1] + \frac{K_3}{\Delta X} [T_4^1 - T_3^1] - \left[\frac{\rho_2 C_2 + \rho_3 C_3}{2} \right] \frac{\Delta X}{\Delta t} [T_3^1 - T_3]$	
Node 4	$\frac{K_3}{\Delta X} [T_3^1 - T_4^1] + \frac{K_4}{\Delta X} [T_5^1 - T_4^1] - \left[\frac{\rho_3 C_3 + \rho_4 C_4}{2} \right] \frac{\Delta X}{\Delta t} [T_4^1 - T_4]$	
Node 5	$\frac{K_4}{\Delta X} [T_4^1 - T_5^1] + \frac{K_5}{\Delta X} [T_6^1 - T_5^1] - \left[\frac{\rho_4 C_4 + \rho_5 C_5}{2} \right] \frac{\Delta X}{\Delta t} [T_5^1 - T_5]$	
Node 6	Fix at some T_6	

Table 4

Matrix Form of Nodal Equations

$$\begin{aligned}
 \text{Node 1} \quad & \left[1 + \frac{2K_1 \Delta t}{\rho_1 C_1 \Delta X^2} \right] T_1^1 - \left[\frac{2K_1 \Delta t}{\rho_1 C_1 \Delta X^2} \right] T_2^1 - \left[\frac{2Q \Delta t}{\rho_1 C_1 \Delta X} \right] + T_1 \\
 \text{Node 2} \quad & - \left[\frac{2K_1 \Delta t}{(\rho_1 C_1 + \rho_2 C_2) \Delta X^2} \right] T_1^1 + \left[\frac{2 \Delta t}{(\rho_1 C_1 + \rho_2 C_2) \Delta X} \right] T_2^1 - \left[\frac{K_1 + K_2}{\Delta X} + \frac{(\rho_1 C_1 + \rho_2 C_2) \Delta X}{2 \Delta t} \right] T_3^1 - \left[\frac{2K_2 \Delta t}{(\rho_1 C_1 + \rho_2 C_2) \Delta X^2} \right] T_3^1 - T_2 \\
 \text{Node 3} \quad & - \left[\frac{2K_2 \Delta t}{(\rho_2 C_2 + \rho_3 C_3) \Delta X^2} \right] T_2^1 + \left[\frac{2 \Delta t}{(\rho_2 C_2 + \rho_3 C_3) \Delta X} \right] T_3^1 - \left[\frac{K_2 + K_3}{\Delta X} + \frac{(\rho_2 C_2 + \rho_3 C_3) \Delta X}{2 \Delta t} \right] T_4^1 - \left[\frac{2K_3 \Delta t}{(\rho_2 C_2 + \rho_3 C_3) \Delta X^2} \right] T_4^1 - T_3 \\
 \text{Node 4} \quad & - \left[\frac{2K_3 \Delta t}{(\rho_3 C_3 + \rho_4 C_4) \Delta X^2} \right] T_3^1 + \left[\frac{2 \Delta t}{(\rho_3 C_3 + \rho_4 C_4) \Delta X} \right] T_4^1 - \left[\frac{K_3 + K_4}{\Delta X} + \frac{(\rho_3 C_3 + \rho_4 C_4) \Delta X}{2 \Delta t} \right] T_5^1 - \left[\frac{2K_4 \Delta t}{(\rho_3 C_3 + \rho_4 C_4) \Delta X^2} \right] T_5^1 - T_4 \\
 \text{Node 5} \quad & - \left[\frac{2K_4 \Delta t}{(\rho_4 C_4 + \rho_5 C_5) \Delta X^2} \right] T_4^1 + \left[\frac{2 \Delta t}{(\rho_4 C_4 + \rho_5 C_5) \Delta X} \right] T_5^1 - \left[\frac{K_4 + K_5}{\Delta X} + \frac{(\rho_4 C_4 + \rho_5 C_5) \Delta X}{2 \Delta t} \right] T_6^1 - \left[\frac{2K_5 \Delta t}{(\rho_4 C_4 + \rho_5 C_5) \Delta X^2} \right] T_6^1 + T_5
 \end{aligned}$$

Table 5

Matrix Coefficients

A_{11}	-	$[1 + 2K_1\Delta T/\rho_1 C_1 \Delta X^2]$
A_{12}	-	$[2K_1\Delta t/\rho_1 C_1 \Delta X^2]$
A_{21}	-	$[2K_1\Delta t/(\rho_1 C_1 + \rho_2 C_2) \Delta X^2]$
A_{22}	-	$[(2\Delta t/(\rho_1 C_1 + \rho_2 C_2) \Delta X) (K_1 + K_2/\Delta X + (\rho_1 C_1 + \rho_2 C_2) \Delta X/2\Delta t)]$
A_{23}	-	$[2K_2\Delta t/(\rho_1 C_1 + \rho_2 C_2) \Delta X^2]$
A_{32}	-	$[2K_2\Delta t/(\rho_2 C_2 + \rho_3 C_3) \Delta X^2]$
A_{33}	-	$[(2\Delta t/(\rho_2 C_2 + \rho_3 C_3) \Delta X) (K_2 + K_3/\Delta X + (\rho_2 C_2 + \rho_3 C_3) \Delta X/2\Delta t)]$
A_{34}	-	$[2K_3\Delta t/(\rho_2 C_2 + \rho_3 C_3) \Delta X^2]$
A_{43}	-	$[2K_3\Delta t/(\rho_3 C_3 + \rho_4 C_4) \Delta X^2]$
A_{44}	-	$[(2\Delta t/(\rho_3 C_3 + \rho_4 C_4) \Delta X) (K_3 + K_4/\Delta X + (\rho_3 C_3 + \rho_4 C_4) \Delta X/2\Delta t)]$
A_{45}	-	$[2K_4\Delta t/(\rho_3 C_3 + \rho_4 C_4) \Delta X^2]$
A_{54}	-	$[2K_4\Delta t/(\rho_4 C_4 + \rho_5 C_5) \Delta X^2]$
A_{55}	-	$[(2\Delta t/(\rho_4 C_4 + \rho_5 C_5) \Delta X) (K_4 + K_5/\Delta X + (\rho_4 C_4 + \rho_5 C_5) \Delta X/2\Delta t)]$
Z	-	$2Q\Delta t/\rho_1 C_1 \Delta X$
W	-	$[2K_5\Delta t/(\rho_4 C_4 + \rho_5 C_5) \Delta X^2] T_6$

LIST OF APPENDICES

- A DATA FOR FIVE LAYER BLANKET
- B DATA FOR THREE LAYER BLANKET
- C DATA FOR FOUR LAYER BLANKET
- D SOURCE CODE AND SUBROUTINES
- E CODE OPERATING INSTRUCTIONS

APPENDIX A

DATA FOR FIVE LAYER BLANKET

RESULTS OF HEAT TRANSFER ANALYSIS FOR A THERMAL BLANKET
CONSISTING OF 5 LAYERS OF THE FOLLOWING COMPOSITIONS:

Layer 1 is Quartz
Layer 2 is Fiberfrax
Layer 3 is E-glass
Layer 4 is Fiberfrax
Layer 5 is Kevlar

where layer 1 is the high-temperature side.

AT t - 1.0 SECONDS

T 1 -	192.7903	Degrees F
T 2 -	83.4797	Degrees F
T 3 -	70.4936	Degrees F
T 4 -	70.0343	Degrees F
T 5 -	70.0013	Degrees F
T 6 -	70.0000	Degrees F

AT t - 2.0 SECONDS

T 1 -	274.2036	Degrees F
T 2 -	102.0491	Degrees F
T 3 -	71.4662	Degrees F
T 4 -	70.1786	Degrees F
T 5 -	70.0075	Degrees F
T 6 -	70.0000	Degrees F

AT t - 3.0 SECONDS

T 1 -	340.4485	Degrees F
T 2 -	124.3413	Degrees F
T 3 -	72.9156	Degrees F
T 4 -	70.4715	Degrees F
T 5 -	70.0228	Degrees F
T 6 -	70.0000	Degrees F

AT t - 4.0 SECONDS

T 1 -	397.8817	Degrees F
T 2 -	149.2825	Degrees F
T 3 -	74.8109	Degrees F

T 4 - 70.9422 Degrees F
T 5 - 70.0514 Degrees F
T 6 - 70.0000 Degrees F

AT t - 5.0 SECONDS

T 1 - 449.4568 Degrees F
T 2 - 176.1331 Degrees F
T 3 - 77.1139 Degrees F
T 4 - 71.6109 Degrees F
T 5 - 70.0976 Degrees F
T 6 - 70.0000 Degrees F

AT t - 6.0 SECONDS

T 1 - 496.8718 Degrees F
T 2 - 204.3625 Degrees F
T 3 - 79.7890 Degrees F
T 4 - 72.4908 Degrees F
T 5 - 70.1649 Degrees F
T 6 - 70.0000 Degrees F

AT t - 7.0 SECONDS

T 1 - 541.2167 Degrees F
T 2 - 233.5767 Degrees F
T 3 - 82.8065 Degrees F
T 4 - 73.5898 Degrees F
T 5 - 70.2567 Degrees F
T 6 - 70.0000 Degrees F

AT t - 8.0 SECONDS

T 1 - 583.2394 Degrees F
T 2 - 263.4767 Degrees F
T 3 - 86.1429 Degrees F
T 4 - 74.9116 Degrees F
T 5 - 70.3756 Degrees F
T 6 - 70.0000 Degrees F

AT t - 9.0 SECONDS

T 1 - 623.4745 Degrees F
T 2 - 293.8326 Degrees F
T 3 - 89.7802 Degrees F
T 4 - 76.4574 Degrees F

T 5 - 70.5238 Degrees F
T 6 - 70.0000 Degrees F

AT t - 10.0 SECONDS

T 1 - 662.3146 Degrees F
T 2 - 324.4656 Degrees F
T 3 - 93.7052 Degrees F
T 4 - 78.2266 Degrees F
T 5 - 70.7029 Degrees F
T 6 - 70.0000 Degrees F

AT t - 11.0 SECONDS

T 1 - 700.0527 Degrees F
T 2 - 355.2367 Degrees F
T 3 - 97.9082 Degrees F
T 4 - 80.2175 Degrees F
T 5 - 70.9143 Degrees F
T 6 - 70.0000 Degrees F

AT t - 12.0 SECONDS

T 1 - 736.9099 Degrees F
T 2 - 386.0377 Degrees F
T 3 - 102.3821 Degrees F
T 4 - 82.4277 Degrees F
T 5 - 71.1587 Degrees F
T 6 - 70.0000 Degrees F

AT t - 13.0 SECONDS

T 1 - 773.0540 Degrees F
T 2 - 416.7847 Degrees F
T 3 - 107.1219 Degrees F
T 4 - 84.8546 Degrees F
T 5 - 71.4368 Degrees F
T 6 - 70.0000 Degrees F

AT t - 14.0 SECONDS

T 1 - 808.6122 Degrees F
T 2 - 447.4131 Degrees F
T 3 - 112.1236 Degrees F
T 4 - 87.4952 Degrees F
T 5 - 71.7489 Degrees F

T 6 - 70.0000 Degrees F

AT t - 15.0 SECONDS

T 1 - 843.6813 Degrees F
T 2 - 477.8732 Degrees F
T 3 - 117.3847 Degrees F
T 4 - 90.3469 Degrees F
T 5 - 72.0952 Degrees F
T 6 - 70.0000 Degrees F

AT t - 16.0 SECONDS

T 1 - 878.3339 Degrees F
T 2 - 508.1279 Degrees F
T 3 - 122.9027 Degrees F
T 4 - 93.4069 Degrees F
T 5 - 72.4755 Degrees F
T 6 - 70.0000 Degrees F

AT t - 17.0 SECONDS

T 1 - 912.6245 Degrees F
T 2 - 538.1499 Degrees F
T 3 - 128.6760 Degrees F
T 4 - 96.6724 Degrees F
T 5 - 72.8899 Degrees F
T 6 - 70.0000 Degrees F

AT t - 18.0 SECONDS

T 1 - 946.5933 Degrees F
T 2 - 567.9194 Degrees F
T 3 - 134.7029 Degrees F
T 4 - 100.1412 Degrees F
T 5 - 73.3381 Degrees F
T 6 - 70.0000 Degrees F

AT t - 19.0 SECONDS

T 1 - 980.2697 Degrees F
T 2 - 597.4231 Degrees F
T 3 - 140.9819 Degrees F
T 4 - 103.8107 Degrees F
T 5 - 73.8197 Degrees F
T 6 - 70.0000 Degrees F

AT t - 20.0 SECONDS

T 1 -	1013.6750	Degrees F
T 2 -	626.6526	Degrees F
T 3 -	147.5115	Degrees F
T 4 -	107.6786	Degrees F
T 5 -	74.3346	Degrees F
T 6 -	70.0000	Degrees F

AT t - 21.0 SECONDS

T 1 -	1046.8230	Degrees F
T 2 -	655.6035	Degrees F
T 3 -	154.2903	Degrees F
T 4 -	111.7429	Degrees F
T 5 -	74.8823	Degrees F
T 6 -	70.0000	Degrees F

AT t - 22.0 SECONDS

T 1 -	1079.7250	Degrees F
T 2 -	684.2745	Degrees F
T 3 -	161.3167	Degrees F
T 4 -	116.0013	Degrees F
T 5 -	75.4626	Degrees F
T 6 -	70.0000	Degrees F

AT t - 23.0 SECONDS

T 1 -	1112.3880	Degrees F
T 2 -	712.6672	Degrees F
T 3 -	168.5890	Degrees F
T 4 -	120.4519	Degrees F
T 5 -	76.0751	Degrees F
T 6 -	70.0000	Degrees F

AT t - 24.0 SECONDS

T 1 -	1144.8150	Degrees F
T 2 -	740.7848	Degrees F
T 3 -	176.1055	Degrees F
T 4 -	125.0927	Degrees F
T 5 -	76.7195	Degrees F
T 6 -	70.0000	Degrees F

AT t - 25.0 SECONDS

T 1 -	1177.0090	Degrees F
T 2 -	768.6323	Degrees F
T 3 -	183.8645	Degrees F
T 4 -	129.9216	Degrees F
T 5 -	77.3955	Degrees F
T 6 -	70.0000	Degrees F

AT t - 26.0 SECONDS

T 1 -	1208.9730	Degrees F
T 2 -	796.2161	Degrees F
T 3 -	191.8639	Degrees F
T 4 -	134.9369	Degrees F
T 5 -	78.1028	Degrees F
T 6 -	70.0000	Degrees F

AT t - 27.0 SECONDS

T 1 -	1240.7070	Degrees F
T 2 -	823.5433	Degrees F
T 3 -	200.1018	Degrees F
T 4 -	140.1366	Degrees F
T 5 -	78.8413	Degrees F
T 6 -	70.0000	Degrees F

AT t - 28.0 SECONDS

T 1 -	1272.2130	Degrees F
T 2 -	850.6221	Degrees F
T 3 -	208.5762	Degrees F
T 4 -	145.5188	Degrees F
T 5 -	79.6106	Degrees F
T 6 -	70.0000	Degrees F

AT t - 29.0 SECONDS

T 1 -	1303.4930	Degrees F
T 2 -	877.4612	Degrees F
T 3 -	217.2848	Degrees F
T 4 -	151.0816	Degrees F
T 5 -	80.4107	Degrees F
T 6 -	70.0000	Degrees F

AT t - 30.0 SECONDS

T 1 -	1334.6050	Degrees F
T 2 -	904.0748	Degrees F
T 3 -	226.2256	Degrees F
T 4 -	156.8233	Degrees F
T 5 -	81.2414	Degrees F
T 6 -	70.0000	Degrees F

AT t - 31.0 SECONDS

T 1 -	1364.6590	Degrees F
T 2 -	930.3901	Degrees F
T 3 -	235.3946	Degrees F
T 4 -	162.7419	Degrees F
T 5 -	82.1025	Degrees F
T 6 -	70.0000	Degrees F

AT t - 32.0 SECONDS

T 1 -	1393.7480	Degrees F
T 2 -	956.3570	Degrees F
T 3 -	244.7862	Degrees F
T 4 -	168.8349	Degrees F
T 5 -	82.9939	Degrees F
T 6 -	70.0000	Degrees F

AT t - 33.0 SECONDS

T 1 -	1421.9510	Degrees F
T 2 -	981.9396	Degrees F
T 3 -	254.3938	Degrees F
T 4 -	175.1000	Degrees F
T 5 -	83.9155	Degrees F
T 6 -	70.0000	Degrees F

AT t - 34.0 SECONDS

T 1 -	1449.3310	Degrees F
T 2 -	1007.1140	Degrees F
T 3 -	264.2100	Degrees F
T 4 -	181.5341	Degrees F
T 5 -	84.8672	Degrees F
T 6 -	70.0000	Degrees F

AT t - 35.0 SECONDS

T 1 -	1475.9440	Degrees F
T 2 -	1031.8640	Degrees F
T 3 -	274.2271	Degrees F
T 4 -	188.1340	Degrees F
T 5 -	85.8488	Degrees F
T 6 -	70.0000	Degrees F

AT t - 36.0 SECONDS

T 1 -	1501.8350	Degrees F
T 2 -	1056.1810	Degrees F
T 3 -	284.4368	Degrees F
T 4 -	194.8964	Degrees F
T 5 -	86.8603	Degrees F
T 6 -	70.0000	Degrees F

AT t - 37.0 SECONDS

T 1 -	1527.0460	Degrees F
T 2 -	1080.0610	Degrees F
T 3 -	294.8309	Degrees F
T 4 -	201.8174	Degrees F
T 5 -	87.9014	Degrees F
T 6 -	70.0000	Degrees F

AT t - 38.0 SECONDS

T 1 -	1551.6110	Degrees F
T 2 -	1103.5060	Degrees F
T 3 -	305.4008	Degrees F
T 4 -	208.8933	Degrees F
T 5 -	88.9719	Degrees F
T 6 -	70.0000	Degrees F

AT t - 39.0 SECONDS

T 1 -	1575.5620	Degrees F
T 2 -	1126.5170	Degrees F
T 3 -	316.1383	Degrees F
T 4 -	216.1200	Degrees F
T 5 -	90.0716	Degrees F
T 6 -	70.0000	Degrees F

AT t - 40.0 SECONDS

T 1 -	1598.9260	Degrees F
T 2 -	1149.1000	Degrees F
T 3 -	327.0348	Degrees F
T 4 -	223.4933	Degrees F
T 5 -	91.2002	Degrees F
T 6 -	70.0000	Degrees F

AT t - 41.0 SECONDS

T 1 -	1621.7280	Degrees F
T 2 -	1171.2620	Degrees F
T 3 -	338.0821	Degrees F
T 4 -	231.0091	Degrees F
T 5 -	92.3575	Degrees F
T 6 -	70.0000	Degrees F

AT t - 42.0 SECONDS

T 1 -	1643.9920	Degrees F
T 2 -	1193.0120	Degrees F
T 3 -	349.2718	Degrees F
T 4 -	238.6632	Degrees F
T 5 -	93.5432	Degrees F
T 6 -	70.0000	Degrees F

AT t - 43.0 SECONDS

T 1 -	1665.7380	Degrees F
T 2 -	1214.3580	Degrees F
T 3 -	360.5957	Degrees F
T 4 -	246.4513	Degrees F
T 5 -	94.7568	Degrees F
T 6 -	70.0000	Degrees F

AT t - 44.0 SECONDS

T 1 -	1686.9860	Degrees F
T 2 -	1235.3100	Degrees F
T 3 -	372.0459	Degrees F
T 4 -	254.3691	Degrees F
T 5 -	95.9981	Degrees F
T 6 -	70.0000	Degrees F

AT t - 45.0 SECONDS

T 1 - 1707.7540 Degrees F
T 2 - 1255.8770 Degrees F
T 3 - 383.6143 Degrees F
T 4 - 262.4125 Degrees F
T 5 - 97.2666 Degrees F
T 6 - 70.0000 Degrees F

AT t - 46.0 SECONDS

T 1 - 1728.0600 Degrees F
T 2 - 1276.0700 Degrees F
T 3 - 395.2933 Degrees F
T 4 - 270.5772 Degrees F
T 5 - 98.5619 Degrees F
T 6 - 70.0000 Degrees F

AT t - 47.0 SECONDS

T 1 - 1747.9200 Degrees F
T 2 - 1295.8970 Degrees F
T 3 - 407.0751 Degrees F
T 4 - 278.8591 Degrees F
T 5 - 99.8837 Degrees F
T 6 - 70.0000 Degrees F

AT t - 48.0 SECONDS

T 1 - 1767.3470 Degrees F
T 2 - 1315.3700 Degrees F
T 3 - 418.9521 Degrees F
T 4 - 287.2542 Degrees F
T 5 - 101.2313 Degrees F
T 6 - 70.0000 Degrees F

AT t - 49.0 SECONDS

T 1 - 1786.3580 Degrees F
T 2 - 1334.4980 Degrees F
T 3 - 430.9171 Degrees F
T 4 - 295.7585 Degrees F
T 5 - 102.6044 Degrees F
T 6 - 70.0000 Degrees F

AT t - 50.0 SECONDS

T	1	-	1804.9650	Degrees	F
T	2	-	1353.2900	Degrees	F
T	3	-	442.9625	Degrees	F
T	4	-	304.3679	Degrees	F
T	5	-	104.0026	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 51.0 SECONDS

T	1	-	1823.1820	Degrees	F
T	2	-	1371.7560	Degrees	F
T	3	-	455.0814	Degrees	F
T	4	-	313.0786	Degrees	F
T	5	-	105.4252	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 52.0 SECONDS

T	1	-	1841.0200	Degrees	F
T	2	-	1389.9050	Degrees	F
T	3	-	467.2667	Degrees	F
T	4	-	321.8868	Degrees	F
T	5	-	106.8718	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 53.0 SECONDS

T	1	-	1858.4920	Degrees	F
T	2	-	1407.7450	Degrees	F
T	3	-	479.5115	Degrees	F
T	4	-	330.7888	Degrees	F
T	5	-	108.3419	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 54.0 SECONDS

T	1	-	1875.6090	Degrees	F
T	2	-	1425.2860	Degrees	F
T	3	-	491.8092	Degrees	F
T	4	-	339.7809	Degrees	F
T	5	-	109.8350	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 55.0 SECONDS

T 1 - 1892.3810 Degrees F
T 2 - 1442.5350 Degrees F
T 3 - 504.1533 Degrees F
T 4 - 348.8593 Degrees F
T 5 - 111.3506 Degrees F
T 6 - 70.0000 Degrees F

AT t - 56.0 SECONDS

T 1 - 1908.8180 Degrees F
T 2 - 1459.5000 Degrees F
T 3 - 516.5372 Degrees F
T 4 - 358.0206 Degrees F
T 5 - 112.8883 Degrees F
T 6 - 70.0000 Degrees F

AT t - 57.0 SECONDS

T 1 - 1924.9310 Degrees F
T 2 - 1476.1880 Degrees F
T 3 - 528.9547 Degrees F
T 4 - 367.2611 Degrees F
T 5 - 114.4475 Degrees F
T 6 - 70.0000 Degrees F

AT t - 58.0 SECONDS

T 1 - 1940.7290 Degrees F
T 2 - 1492.6090 Degrees F
T 3 - 541.3998 Degrees F
T 4 - 376.5774 Degrees F
T 5 - 116.0278 Degrees F
T 6 - 70.0000 Degrees F

AT t - 59.0 SECONDS

T 1 - 1956.2190 Degrees F
T 2 - 1508.7670 Degrees F
T 3 - 553.8665 Degrees F
T 4 - 385.9659 Degrees F
T 5 - 117.6287 Degrees F
T 6 - 70.0000 Degrees F

AT t - 60.0 SECONDS

T 1 - 1971.4120 Degrees F

T 2 - 1524.6700 Degrees F
T 3 - 566.3489 Degrees F
T 4 - 395.4231 Degrees F
T 5 - 119.2498 Degrees F
T 6 - 70.0000 Degrees F

AT t - 61.0 SECONDS

T 1 - 1986.3140 Degrees F
T 2 - 1540.3240 Degrees F
T 3 - 578.8417 Degrees F
T 4 - 404.9457 Degrees F
T 5 - 120.8906 Degrees F
T 6 - 70.0000 Degrees F

AT t - 62.0 SECONDS

T 1 - 2000.9340 Degrees F
T 2 - 1555.7360 Degrees F
T 3 - 591.3394 Degrees F
T 4 - 414.5301 Degrees F
T 5 - 122.5509 Degrees F
T 6 - 70.0000 Degrees F

AT t - 63.0 SECONDS

T 1 - 2015.2780 Degrees F
T 2 - 1570.9120 Degrees F
T 3 - 603.8367 Degrees F
T 4 - 424.1728 Degrees F
T 5 - 124.2300 Degrees F
T 6 - 70.0000 Degrees F

AT t - 64.0 SECONDS

T 1 - 2029.3540 Degrees F
T 2 - 1585.8570 Degrees F
T 3 - 616.3286 Degrees F
T 4 - 433.8704 Degrees F
T 5 - 125.9277 Degrees F
T 6 - 70.0000 Degrees F

AT t - 65.0 SECONDS

T 1 - 2043.1690 Degrees F
T 2 - 1600.5760 Degrees F

T 3 - 628.8103 Degrees F
T 4 - 443.6194 Degrees F
T 5 - 127.6436 Degrees F
T 6 - 70.0000 Degrees F

AT t - 66.0 SECONDS

T 1 - 2056.7290 Degrees F
T 2 - 1615.0750 Degrees F
T 3 - 641.2772 Degrees F
T 4 - 453.4163 Degrees F
T 5 - 129.3773 Degrees F
T 6 - 70.0000 Degrees F

AT t - 67.0 SECONDS

T 1 - 2070.0400 Degrees F
T 2 - 1629.3580 Degrees F
T 3 - 653.7247 Degrees F
T 4 - 463.2576 Degrees F
T 5 - 131.1285 Degrees F
T 6 - 70.0000 Degrees F

AT t - 68.0 SECONDS

T 1 - 2083.1070 Degrees F
T 2 - 1643.4300 Degrees F
T 3 - 666.1485 Degrees F
T 4 - 473.1396 Degrees F
T 5 - 132.8967 Degrees F
T 6 - 70.0000 Degrees F

AT t - 69.0 SECONDS

T 1 - 2095.9360 Degrees F
T 2 - 1657.2960 Degrees F
T 3 - 678.5446 Degrees F
T 4 - 483.0588 Degrees F
T 5 - 134.6815 Degrees F
T 6 - 70.0000 Degrees F

AT t - 70.0 SECONDS

T 1 - 2108.5330 Degrees F
T 2 - 1670.9590 Degrees F
T 3 - 690.9091 Degrees F

T 4 - 493.0116 Degrees F
T 5 - 136.4826 Degrees F
T 6 - 70.0000 Degrees F

AT t - 71.0 SECONDS

T 1 - 2120.9020 Degrees F
T 2 - 1684.4250 Degrees F
T 3 - 703.2382 Degrees F
T 4 - 502.9943 Degrees F
T 5 - 138.2994 Degrees F
T 6 - 70.0000 Degrees F

AT t - 72.0 SECONDS

T 1 - 2133.0480 Degrees F
T 2 - 1697.6960 Degrees F
T 3 - 715.5283 Degrees F
T 4 - 513.0033 Degrees F
T 5 - 140.1315 Degrees F
T 6 - 70.0000 Degrees F

AT t - 73.0 SECONDS

T 1 - 2144.9760 Degrees F
T 2 - 1710.7760 Degrees F
T 3 - 727.7759 Degrees F
T 4 - 523.0349 Degrees F
T 5 - 141.9783 Degrees F
T 6 - 70.0000 Degrees F

AT t - 74.0 SECONDS

T 1 - 2156.6910 Degrees F
T 2 - 1723.6680 Degrees F
T 3 - 739.9780 Degrees F
T 4 - 533.0852 Degrees F
T 5 - 143.8391 Degrees F
T 6 - 70.0000 Degrees F

AT t - 75.0 SECONDS

T 1 - 2168.1960 Degrees F
T 2 - 1736.3770 Degrees F
T 3 - 752.1314 Degrees F
T 4 - 543.1505 Degrees F

T 5 - 145.7132 Degrees F
T 6 - 70.0000 Degrees F

AT t - 76.0 SECONDS

T 1 - 2179.4950 Degrees F
T 2 - 1748.9040 Degrees F
T 3 - 764.2331 Degrees F
T 4 - 553.2270 Degrees F
T 5 - 147.5997 Degrees F
T 6 - 70.0000 Degrees F

AT t - 77.0 SECONDS

T 1 - 2190.5930 Degrees F
T 2 - 1761.2530 Degrees F
T 3 - 776.2805 Degrees F
T 4 - 563.3108 Degrees F
T 5 - 149.4977 Degrees F
T 6 - 70.0000 Degrees F

AT t - 78.0 SECONDS

T 1 - 2201.4910 Degrees F
T 2 - 1773.4270 Degrees F
T 3 - 788.2708 Degrees F
T 4 - 573.3980 Degrees F
T 5 - 151.4060 Degrees F
T 6 - 70.0000 Degrees F

AT t - 79.0 SECONDS

T 1 - 2212.1950 Degrees F
T 2 - 1785.4290 Degrees F
T 3 - 800.2015 Degrees F
T 4 - 583.4849 Degrees F
T 5 - 153.3233 Degrees F
T 6 - 70.0000 Degrees F

AT t - 80.0 SECONDS

T 1 - 2222.7060 Degrees F
T 2 - 1797.2600 Degrees F
T 3 - 812.0701 Degrees F
T 4 - 593.5673 Degrees F
T 5 - 155.2480 Degrees F

T 6 - 70.0000 Degrees F

AT t - 81.0 SECONDS

T 1 - 2233.0290 Degrees F
T 2 - 1808.9240 Degrees F
T 3 - 823.8745 Degrees F
T 4 - 603.6415 Degrees F
T 5 - 157.1786 Degrees F
T 6 - 70.0000 Degrees F

AT t - 82.0 SECONDS

T 1 - 2243.1670 Degrees F
T 2 - 1820.4230 Degrees F
T 3 - 835.6123 Degrees F
T 4 - 613.7034 Degrees F
T 5 - 159.1130 Degrees F
T 6 - 70.0000 Degrees F

AT t - 83.0 SECONDS

T 1 - 2253.1220 Degrees F
T 2 - 1831.7570 Degrees F
T 3 - 847.2815 Degrees F
T 4 - 623.7491 Degrees F
T 5 - 161.0490 Degrees F
T 6 - 70.0000 Degrees F

AT t - 84.0 SECONDS

T 1 - 2262.8970 Degrees F
T 2 - 1842.9310 Degrees F
T 3 - 858.8799 Degrees F
T 4 - 633.7747 Degrees F
T 5 - 162.9841 Degrees F
T 6 - 70.0000 Degrees F

AT t - 85.0 SECONDS

T 1 - 2272.4940 Degrees F
T 2 - 1853.9460 Degrees F
T 3 - 870.4057 Degrees F
T 4 - 643.7760 Degrees F
T 5 - 164.9157 Degrees F
T 6 - 70.0000 Degrees F

AT t - 86.0 SECONDS

T 1 -	2281.9170	Degrees F
T 2 -	1864.8030	Degrees F
T 3 -	881.8568	Degrees F
T 4 -	653.7490	Degrees F
T 5 -	166.8405	Degrees F
T 6 -	70.0000	Degrees F

AT t - 87.0 SECONDS

T 1 -	2291.1670	Degrees F
T 2 -	1875.5040	Degrees F
T 3 -	893.2313	Degrees F
T 4 -	663.6898	Degrees F
T 5 -	168.7552	Degrees F
T 6 -	70.0000	Degrees F

AT t - 88.0 SECONDS

T 1 -	2300.2460	Degrees F
T 2 -	1886.0520	Degrees F
T 3 -	904.5273	Degrees F
T 4 -	673.5943	Degrees F
T 5 -	170.6561	Degrees F
T 6 -	70.0000	Degrees F

AT t - 89.0 SECONDS

T 1 -	2309.1570	Degrees F
T 2 -	1896.4460	Degrees F
T 3 -	915.7432	Degrees F
T 4 -	683.4586	Degrees F
T 5 -	172.5390	Degrees F
T 6 -	70.0000	Degrees F

AT t - 90.0 SECONDS

T 1 -	2317.9030	Degrees F
T 2 -	1906.6900	Degrees F
T 3 -	926.8770	Degrees F
T 4 -	693.2785	Degrees F
T 5 -	174.3997	Degrees F
T 6 -	70.0000	Degrees F

AT t - 91.0 SECONDS

T 1 -	2326.4840	Degrees F
T 2 -	1916.7840	Degrees F
T 3 -	937.9268	Degrees F
T 4 -	703.0500	Degrees F
T 5 -	176.2333	Degrees F
T 6 -	70.0000	Degrees F

AT t - 92.0 SECONDS

T 1 -	2334.9030	Degrees F
T 2 -	1926.7310	Degrees F
T 3 -	948.8911	Degrees F
T 4 -	712.7692	Degrees F
T 5 -	178.0349	Degrees F
T 6 -	70.0000	Degrees F

AT t - 93.0 SECONDS

T 1 -	2343.0000	Degrees F
T 2 -	1936.5140	Degrees F
T 3 -	959.7673	Degrees F
T 4 -	722.4318	Degrees F
T 5 -	179.7991	Degrees F
T 6 -	70.0000	Degrees F

AT t - 94.0 SECONDS

T 1 -	2358.7110	Degrees F
T 2 -	1946.8850	Degrees F
T 3 -	970.5747	Degrees F
T 4 -	732.0360	Degrees F
T 5 -	181.5204	Degrees F
T 6 -	70.0000	Degrees F

AT t - 95.0 SECONDS

T 1 -	2381.2970	Degrees F
T 2 -	1958.4180	Degrees F
T 3 -	981.3540	Degrees F
T 4 -	741.5829	Degrees F
T 5 -	183.1933	Degrees F
T 6 -	70.0000	Degrees F

AT t - 96.0 SECONDS

T 1 -	2410.1460	Degrees F
T 2 -	1971.5540	Degrees F
T 3 -	992.1603	Degrees F
T 4 -	751.0784	Degrees F
T 5 -	184.8121	Degrees F
T 6 -	70.0000	Degrees F

AT t - 97.0 SECONDS

T 1 -	2444.7410	Degrees F
T 2 -	1986.6240	Degrees F
T 3 -	1003.0570	Degrees F
T 4 -	760.5329	Degrees F
T 5 -	186.3717	Degrees F
T 6 -	70.0000	Degrees F

AT t - 98.0 SECONDS

T 1 -	2488.6600	Degrees F
T 2 -	2004.2580	Degrees F
T 3 -	1014.1220	Degrees F
T 4 -	769.9620	Degrees F
T 5 -	187.8670	Degrees F
T 6 -	70.0000	Degrees F

AT t - 99.0 SECONDS

T 1 -	2527.9260	Degrees F
T 2 -	2023.6510	Degrees F
T 3 -	1025.4090	Degrees F
T 4 -	779.3842	Degrees F
T 5 -	189.2930	Degrees F
T 6 -	70.0000	Degrees F

AT t - 100.0 SECONDS

T 1 -	2563.1780	Degrees F
T 2 -	2044.1720	Degrees F
T 3 -	1036.9390	Degrees F
T 4 -	788.8171	Degrees F
T 5 -	190.6447	Degrees F
T 6 -	70.0000	Degrees F

AT t - 101.0 SECONDS

T 1 -	2594.9330	Degrees F
T 2 -	2065.3190	Degrees F
T 3 -	1048.7080	Degrees F
T 4 -	798.2759	Degrees F
T 5 -	191.9169	Degrees F
T 6 -	70.0000	Degrees F

AT t - 102.0 SECONDS

T 1 -	2623.6100	Degrees F
T 2 -	2086.7010	Degrees F
T 3 -	1060.6980	Degrees F
T 4 -	807.7724	Degrees F
T 5 -	193.1037	Degrees F
T 6 -	70.0000	Degrees F

AT t - 103.0 SECONDS

T 1 -	2649.5510	Degrees F
T 2 -	2108.0090	Degrees F
T 3 -	1072.8770	Degrees F
T 4 -	817.3139	Degrees F
T 5 -	194.1988	Degrees F
T 6 -	70.0000	Degrees F

AT t - 104.0 SECONDS

T 1 -	2673.0340	Degrees F
T 2 -	2129.0090	Degrees F
T 3 -	1085.2070	Degrees F
T 4 -	826.9034	Degrees F
T 5 -	195.1951	Degrees F
T 6 -	70.0000	Degrees F

AT t - 105.0 SECONDS

T 1 -	2694.2930	Degrees F
T 2 -	2149.5150	Degrees F
T 3 -	1097.6430	Degrees F
T 4 -	836.5396	Degrees F
T 5 -	196.0850	Degrees F
T 6 -	70.0000	Degrees F

AT t - 106.0 SECONDS

T 1 -	2713.5170	Degrees F
T 2 -	2169.3920	Degrees F
T 3 -	1110.1420	Degrees F
T 4 -	846.2169	Degrees F
T 5 -	196.8603	Degrees F
T 6 -	70.0000	Degrees F

AT t - 107.0 SECONDS

T 1 -	2730.8650	Degrees F
T 2 -	2188.5370	Degrees F
T 3 -	1122.6570	Degrees F
T 4 -	855.9263	Degrees F
T 5 -	197.5125	Degrees F
T 6 -	70.0000	Degrees F

AT t - 108.0 SECONDS

T 1 -	2746.4710	Degrees F
T 2 -	2206.8750	Degrees F
T 3 -	1135.1440	Degrees F
T 4 -	865.6555	Degrees F
T 5 -	198.0333	Degrees F
T 6 -	70.0000	Degrees F

AT t - 109.0 SECONDS

T 1 -	2760.4480	Degrees F
T 2 -	2224.3560	Degrees F
T 3 -	1147.5610	Degrees F
T 4 -	875.3899	Degrees F
T 5 -	198.4146	Degrees F
T 6 -	70.0000	Degrees F

AT t - 110.0 SECONDS

T 1 -	2772.8910	Degrees F
T 2 -	2240.9480	Degrees F
T 3 -	1159.8690	Degrees F
T 4 -	885.1127	Degrees F
T 5 -	198.6489	Degrees F
T 6 -	70.0000	Degrees F

AT t - 111.0 SECONDS

T	1	-	2783.8860	Degrees	F
T	2	-	2256.6280	Degrees	F
T	3	-	1172.0320	Degrees	F
T	4	-	894.8057	Degrees	F
T	5	-	198.7300	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 112.0 SECONDS

T	1	-	2793.5050	Degrees	F
T	2	-	2271.3910	Degrees	F
T	3	-	1184.0190	Degrees	F
T	4	-	904.4501	Degrees	F
T	5	-	198.6529	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 113.0 SECONDS

T	1	-	2801.8100	Degrees	F
T	2	-	2285.2390	Degrees	F
T	3	-	1195.8020	Degrees	F
T	4	-	914.0265	Degrees	F
T	5	-	198.4142	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 114.0 SECONDS

T	1	-	2808.8600	Degrees	F
T	2	-	2298.1760	Degrees	F
T	3	-	1207.3560	Degrees	F
T	4	-	923.5157	Degrees	F
T	5	-	198.0128	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 115.0 SECONDS

T	1	-	2814.7030	Degrees	F
T	2	-	2310.2190	Degrees	F
T	3	-	1218.6620	Degrees	F
T	4	-	932.8994	Degrees	F
T	5	-	197.4494	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 116.0 SECONDS

T	1	-	2819.3880	Degrees	F
T	2	-	2321.3790	Degrees	F
T	3	-	1229.7030	Degrees	F
T	4	-	942.1592	Degrees	F
T	5	-	196.7266	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 117.0 SECONDS

T	1	-	2822.9570	Degrees	F
T	2	-	2331.6780	Degrees	F
T	3	-	1240.4630	Degrees	F
T	4	-	951.2786	Degrees	F
T	5	-	195.8497	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 118.0 SECONDS

T	1	-	2825.4480	Degrees	F
T	2	-	2341.1350	Degrees	F
T	3	-	1250.9340	Degrees	F
T	4	-	960.2421	Degrees	F
T	5	-	194.8255	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 119.0 SECONDS

T	1	-	2826.8990	Degrees	F
T	2	-	2349.7710	Degrees	F
T	3	-	1261.1060	Degrees	F
T	4	-	969.0356	Degrees	F
T	5	-	193.6628	Degrees	F
T	6	-	70.0000	Degrees	F

AT t - 120.0 SECONDS

T	1	-	2827.3440	Degrees	F
T	2	-	2357.6080	Degrees	F
T	3	-	1270.9730	Degrees	F
T	4	-	977.6468	Degrees	F
T	5	-	192.3722	Degrees	F
T	6	-	70.0000	Degrees	F

APPENDIX B

DATA FOR THREE LAYER BLANKET

RESULTS OF HEAT TRANSFER ANALYSIS FOR A THERMAL BLANKET
CONSISTING OF 3 LAYERS OF THE FOLLOWING COMPOSITIONS:

Layer 1 is Quartz
Layer 2 is E-glass
Layer 3 is Kevlar

where layer 1 is the high-temperature side.

AT t - 1.0 SECONDS

T 1 -	192.0011	Degrees F
T 2 -	77.6181	Degrees F
T 3 -	70.5710	Degrees F
T 4 -	70.0000	Degrees F

AT t - 2.0 SECONDS

T 1 -	271.7956	Degrees F
T 2 -	87.8398	Degrees F
T 3 -	71.7947	Degrees F
T 4 -	70.0000	Degrees F

AT t - 3.0 SECONDS

T 1 -	335.4980	Degrees F
T 2 -	99.9387	Degrees F
T 3 -	73.6954	Degrees F
T 4 -	70.0000	Degrees F

AT t - 4.0 SECONDS

T 1 -	389.4540	Degrees F
T 2 -	113.3264	Degrees F
T 3 -	76.2505	Degrees F
T 4 -	70.0000	Degrees F

AT t - 5.0 SECONDS

T 1 - 436.6357 Degrees F
T 2 - 127.6051 Degrees F
T 3 - 79.4127 Degrees F
T 4 - 70.0000 Degrees F

AT t - 6.0 SECONDS

T 1 - 478.7747 Degrees F
T 2 - 142.4984 Degrees F
T 3 - 83.1227 Degrees F
T 4 - 70.0000 Degrees F

AT t - 7.0 SECONDS

T 1 - 517.0031 Degrees F
T 2 - 157.8094 Degrees F
T 3 - 87.3174 Degrees F
T 4 - 70.0000 Degrees F

AT t - 8.0 SECONDS

T 1 - 552.1157 Degrees F
T 2 - 173.3948 Degrees F
T 3 - 91.9334 Degrees F
T 4 - 70.0000 Degrees F

AT t - 9.0 SECONDS

T 1 - 584.6975 Degrees F
T 2 - 189.1487 Degrees F
T 3 - 96.9104 Degrees F
T 4 - 70.0000 Degrees F

AT t - 10.0 SECONDS

T 1 - 615.1941 Degrees F
T 2 - 204.9919 Degrees F
T 3 - 102.1919 Degrees F
T 4 - 70.0000 Degrees F

AT t - 11.0 SECONDS

T 1 - 643.9526 Degrees F
T 2 - 220.8647 Degrees F
T 3 - 107.7264 Degrees F
T 4 - 70.0000 Degrees F

AT t - 12.0 SECONDS

T 1 - 671.2491 Degrees F
T 2 - 236.7216 Degrees F
T 3 - 113.4671 Degrees F
T 4 - 70.0000 Degrees F

AT t - 13.0 SECONDS

T 1 - 697.3057 Degrees F
T 2 - 252.5282 Degrees F
T 3 - 119.3721 Degrees F
T 4 - 70.0000 Degrees F

AT t - 14.0 SECONDS

T 1 - 722.3034 Degrees F
T 2 - 268.2577 Degrees F
T 3 - 125.4044 Degrees F
T 4 - 70.0000 Degrees F

AT t - 15.0 SECONDS

T 1 - 746.3907 Degrees F
T 2 - 283.8899 Degrees F
T 3 - 131.5314 Degrees F
T 4 - 70.0000 Degrees F

AT t - 16.0 SECONDS

T 1 - 769.6906 Degrees F
T 2 - 299.4095 Degrees F
T 3 - 137.7248 Degrees F
T 4 - 70.0000 Degrees F

AT t - 17.0 SECONDS

T	1	-	792.3055	Degrees	F
T	2	-	314.8046	Degrees	F
T	3	-	143.9601	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 18.0 SECONDS

T	1	-	814.3207	Degrees	F
T	2	-	330.0664	Degrees	F
T	3	-	150.2162	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 19.0 SECONDS

T	1	-	835.8081	Degrees	F
T	2	-	345.1885	Degrees	F
T	3	-	156.4755	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 20.0 SECONDS

T	1	-	856.8281	Degrees	F
T	2	-	360.1663	Degrees	F
T	3	-	162.7231	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 21.0 SECONDS

T	1	-	877.4315	Degrees	F
T	2	-	374.9965	Degrees	F
T	3	-	168.9468	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 22.0 SECONDS

T	1	-	897.6614	Degrees	F
T	2	-	389.6772	Degrees	F
T	3	-	175.1367	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 23.0 SECONDS

T 1 - 917.5546 Degrees F
T 2 - 404.2074 Degrees F
T 3 - 181.2848 Degrees F
T 4 - 70.0000 Degrees F

AT t - 24.0 SECONDS

T 1 - 937.1422 Degrees F
T 2 - 418.5868 Degrees F
T 3 - 187.3851 Degrees F
T 4 - 70.0000 Degrees F

AT t - 25.0 SECONDS

T 1 - 956.4508 Degrees F
T 2 - 432.8158 Degrees F
T 3 - 193.4330 Degrees F
T 4 - 70.0000 Degrees F

AT t - 26.0 SECONDS

T 1 - 975.5031 Degrees F
T 2 - 446.8952 Degrees F
T 3 - 199.4252 Degrees F
T 4 - 70.0000 Degrees F

AT t - 27.0 SECONDS

T 1 - 994.3182 Degrees F
T 2 - 460.8264 Degrees F
T 3 - 205.3597 Degrees F
T 4 - 70.0000 Degrees F

AT t - 28.0 SECONDS

T 1 - 1012.9130 Degrees F
T 2 - 474.6110 Degrees F
T 3 - 211.2352 Degrees F
T 4 - 70.0000 Degrees F

AT t - 29.0 SECONDS

T 1 - 1031.3020 Degrees F
T 2 - 488.2509 Degrees F
T 3 - 217.0512 Degrees F
T 4 - 70.0000 Degrees F

AT t - 30.0 SECONDS

T 1 - 1049.5560 Degrees F
T 2 - 501.7513 Degrees F
T 3 - 222.8081 Degrees F
T 4 - 70.0000 Degrees F

AT t - 31.0 SECONDS

T 1 - 1066.7620 Degrees F
T 2 - 515.0692 Degrees F
T 3 - 228.5035 Degrees F
T 4 - 70.0000 Degrees F

AT t - 32.0 SECONDS

T 1 - 1083.0310 Degrees F
T 2 - 528.1729 Degrees F
T 3 - 234.1339 Degrees F
T 4 - 70.0000 Degrees F

AT t - 33.0 SECONDS

T 1 - 1098.4570 Degrees F
T 2 - 541.0378 Degrees F
T 3 - 239.6948 Degrees F
T 4 - 70.0000 Degrees F

AT t - 34.0 SECONDS

T 1 - 1113.1190 Degrees F
T 2 - 553.6454 Degrees F
T 3 - 245.1818 Degrees F
T 4 - 70.0000 Degrees F

AT t - 35.0 SECONDS

T 1 - 1127.0840 Degrees F
T 2 - 565.9819 Degrees F
T 3 - 250.5900 Degrees F
T 4 - 70.0000 Degrees F

AT t - 36.0 SECONDS

T 1 - 1140.4100 Degrees F
T 2 - 578.0371 Degrees F
T 3 - 255.9147 Degrees F
T 4 - 70.0000 Degrees F

AT t - 37.0 SECONDS

T 1 - 1153.1440 Degrees F
T 2 - 589.8043 Degrees F
T 3 - 261.1513 Degrees F
T 4 - 70.0000 Degrees F

AT t - 38.0 SECONDS

T 1 - 1165.3300 Degrees F
T 2 - 601.2788 Degrees F
T 3 - 266.2955 Degrees F
T 4 - 70.0000 Degrees F

AT t - 39.0 SECONDS

T 1 - 1177.0030 Degrees F
T 2 - 612.4582 Degrees F
T 3 - 271.3431 Degrees F
T 4 - 70.0000 Degrees F

AT t - 40.0 SECONDS

T 1 - 1188.1940 Degrees F
T 2 - 623.3415 Degrees F
T 3 - 276.2902 Degrees F
T 4 - 70.0000 Degrees F

AT t - 41.0 SECONDS

T 1 - 1198.9310 Degrees F
T 2 - 633.9290 Degrees F
T 3 - 281.1332 Degrees F
T 4 - 70.0000 Degrees F

AT t - 42.0 SECONDS

T 1 - 1209.2370 Degrees F
T 2 - 644.2219 Degrees F
T 3 - 285.8685 Degrees F
T 4 - 70.0000 Degrees F

AT t - 43.0 SECONDS

T 1 - 1219.1330 Degrees F
T 2 - 654.2225 Degrees F
T 3 - 290.4930 Degrees F
T 4 - 70.0000 Degrees F

AT t - 44.0 SECONDS

T 1 - 1228.6370 Degrees F
T 2 - 663.9333 Degrees F
T 3 - 295.0037 Degrees F
T 4 - 70.0000 Degrees F

AT t - 45.0 SECONDS

T 1 - 1237.7660 Degrees F
T 2 - 673.3572 Degrees F
T 3 - 299.3979 Degrees F
T 4 - 70.0000 Degrees F

AT t - 46.0 SECONDS

T 1 - 1246.5330 Degrees F
T 2 - 682.4979 Degrees F
T 3 - 303.6730 Degrees F
T 4 - 70.0000 Degrees F

AT t - 47.0 SECONDS

T 1 - 1254.9520 Degrees F
T 2 - 691.3589 Degrees F
T 3 - 307.8268 Degrees F
T 4 - 70.0000 Degrees F

AT t - 48.0 SECONDS

T 1 - 1263.0340 Degrees F
T 2 - 699.9440 Degrees F
T 3 - 311.8571 Degrees F
T 4 - 70.0000 Degrees F

AT t - 49.0 SECONDS

T 1 - 1270.7890 Degrees F
T 2 - 708.2573 Degrees F
T 3 - 315.7625 Degrees F
T 4 - 70.0000 Degrees F

AT t - 50.0 SECONDS

T 1 - 1278.2290 Degrees F
T 2 - 716.3027 Degrees F
T 3 - 319.5412 Degrees F
T 4 - 70.0000 Degrees F

AT t - 51.0 SECONDS

T 1 - 1285.3600 Degrees F
T 2 - 724.0844 Degrees F
T 3 - 323.1922 Degrees F
T 4 - 70.0000 Degrees F

AT t - 52.0 SECONDS

T 1 - 1292.1920 Degrees F
T 2 - 731.6063 Degrees F
T 3 - 326.7146 Degrees F
T 4 - 70.0000 Degrees F

AT t - 53.0 SECONDS

T 1 - 1298.7320 Degrees F
T 2 - 738.8725 Degrees F
T 3 - 330.1077 Degrees F
T 4 - 70.0000 Degrees F

AT t - 54.0 SECONDS

T 1 - 1304.9860 Degrees F
T 2 - 745.8872 Degrees F
T 3 - 333.3713 Degrees F
T 4 - 70.0000 Degrees F

AT t - 55.0 SECONDS

T 1 - 1310.9610 Degrees F
T 2 - 752.6545 Degrees F
T 3 - 336.5055 Degrees F
T 4 - 70.0000 Degrees F

AT t - 56.0 SECONDS

T 1 - 1316.6640 Degrees F
T 2 - 759.1782 Degrees F
T 3 - 339.5106 Degrees F
T 4 - 70.0000 Degrees F

AT t - 57.0 SECONDS

T 1 - 1322.0990 Degrees F
T 2 - 765.4625 Degrees F
T 3 - 342.3873 Degrees F
T 4 - 70.0000 Degrees F

AT t - 58.0 SECONDS

T 1 - 1327.2730 Degrees F
T 2 - 771.5115 Degrees F
T 3 - 345.1366 Degrees F
T 4 - 70.0000 Degrees F

AT t - 59.0 SECONDS

T 1 - 1332.1910 Degrees F
T 2 - 777.3289 Degrees F
T 3 - 347.7599 Degrees F
T 4 - 70.0000 Degrees F

AT t - 60.0 SECONDS

T 1 - 1336.8570 Degrees F
T 2 - 782.9188 Degrees F
T 3 - 350.2587 Degrees F
T 4 - 70.0000 Degrees F

AT t - 61.0 SECONDS

T 1 - 1341.2760 Degrees F
T 2 - 788.2851 Degrees F
T 3 - 352.6350 Degrees F
T 4 - 70.0000 Degrees F

AT t - 62.0 SECONDS

T 1 - 1345.4540 Degrees F
T 2 - 793.4319 Degrees F
T 3 - 354.8910 Degrees F
T 4 - 70.0000 Degrees F

AT t - 63.0 SECONDS

T 1 - 1349.3940 Degrees F
T 2 - 798.3630 Degrees F
T 3 - 357.0291 Degrees F
T 4 - 70.0000 Degrees F

AT t - 64.0 SECONDS

T 1 - 1353.1010 Degrees F
T 2 - 803.0823 Degrees F
T 3 - 359.0520 Degrees F
T 4 - 70.0000 Degrees F

AT t - 65.0 SECONDS

T 1 - 1356.5780 Degrees F
T 2 - 807.5938 Degrees F
T 3 - 360.9627 Degrees F
T 4 - 70.0000 Degrees F

AT t - 66.0 SECONDS

T 1 - 1359.8310 Degrees F
T 2 - 811.9014 Degrees F
T 3 - 362.7643 Degrees F
T 4 - 70.0000 Degrees F

AT t - 67.0 SECONDS

T 1 - 1362.8630 Degrees F
T 2 - 816.0090 Degrees F
T 3 - 364.4601 Degrees F
T 4 - 70.0000 Degrees F

AT t - 68.0 SECONDS

T 1 - 1365.6780 Degrees F
T 2 - 819.9207 Degrees F
T 3 - 366.0536 Degrees F
T 4 - 70.0000 Degrees F

AT t - 69.0 SECONDS

T 1 - 1368.2800 Degrees F
T 2 - 823.6403 Degrees F
T 3 - 367.5482 Degrees F
T 4 - 70.0000 Degrees F

AT t - 70.0 SECONDS

T 1 - 1370.6730 Degrees F
T 2 - 827.1719 Degrees F
T 3 - 368.9477 Degrees F
T 4 - 70.0000 Degrees F

AT t - 71.0 SECONDS

T 1 - 1372.8620 Degrees F
T 2 - 830.5193 Degrees F
T 3 - 370.2559 Degrees F
T 4 - 70.0000 Degrees F

AT t - 72.0 SECONDS

T 1 - 1374.8480 Degrees F
T 2 - 833.6868 Degrees F
T 3 - 371.4765 Degrees F
T 4 - 70.0000 Degrees F

AT t - 73.0 SECONDS

T 1 - 1376.6370 Degrees F
T 2 - 836.6780 Degrees F
T 3 - 372.6135 Degrees F
T 4 - 70.0000 Degrees F

AT t - 74.0 SECONDS

T 1 - 1378.2330 Degrees F
T 2 - 839.4971 Degrees F
T 3 - 373.6705 Degrees F
T 4 - 70.0000 Degrees F

AT t - 75.0 SECONDS

T 1 - 1379.6390 Degrees F
T 2 - 842.1480 Degrees F
T 3 - 374.6515 Degrees F
T 4 - 70.0000 Degrees F

AT t - 76.0 SECONDS

T 1 - 1380.8580 Degrees F
T 2 - 844.6348 Degrees F
T 3 - 375.5603 Degrees F
T 4 - 70.0000 Degrees F

AT t - 77.0 SECONDS

T 1 - 1381.8950 Degrees F
T 2 - 846.9612 Degrees F
T 3 - 376.4005 Degrees F
T 4 - 70.0000 Degrees F

AT t - 78.0 SECONDS

T 1 - 1382.7530 Degrees F
T 2 - 849.1314 Degrees F
T 3 - 377.1758 Degrees F
T 4 - 70.0000 Degrees F

AT t - 79.0 SECONDS

T 1 - 1383.4370 Degrees F
T 2 - 851.1492 Degrees F
T 3 - 377.8899 Degrees F
T 4 - 70.0000 Degrees F

AT t - 80.0 SECONDS

T 1 - 1383.9490 Degrees F
T 2 - 853.0186 Degrees F
T 3 - 378.5462 Degrees F
T 4 - 70.0000 Degrees F

AT t - 81.0 SECONDS

T 1 - 1384.2930 Degrees F
T 2 - 854.7432 Degrees F
T 3 - 379.1480 Degrees F
T 4 - 70.0000 Degrees F

AT t - 82.0 SECONDS

T 1 - 1384.4740 Degrees F
T 2 - 856.3270 Degrees F
T 3 - 379.6986 Degrees F
T 4 - 70.0000 Degrees F

AT t - 83.0 SECONDS

T 1 - 1384.4940 Degrees F
T 2 - 857.7737 Degrees F
T 3 - 380.2012 Degrees F
T 4 - 70.0000 Degrees F

AT t - 84.0 SECONDS

T 1 - 1384.3580 Degrees F
T 2 - 859.0873 Degrees F
T 3 - 380.6587 Degrees F
T 4 - 70.0000 Degrees F

AT t - 85.0 SECONDS

T 1 - 1384.0690 Degrees F
T 2 - 860.2712 Degrees F
T 3 - 381.0738 Degrees F
T 4 - 70.0000 Degrees F

AT t - 86.0 SECONDS

T 1 - 1383.6300 Degrees F
T 2 - 861.3292 Degrees F
T 3 - 381.4494 Degrees F
T 4 - 70.0000 Degrees F

AT t - 87.0 SECONDS

T 1 - 1383.0460 Degrees F
T 2 - 862.2648 Degrees F
T 3 - 381.7880 Degrees F
T 4 - 70.0000 Degrees F

AT t - 88.0 SECONDS

T 1 - 1382.3190 Degrees F
T 2 - 863.0817 Degrees F
T 3 - 382.0919 Degrees F
T 4 - 70.0000 Degrees F

AT t - 89.0 SECONDS

T 1 - 1381.4540 Degrees F
T 2 - 863.7831 Degrees F
T 3 - 382.3634 Degrees F
T 4 - 70.0000 Degrees F

AT t - 90.0 SECONDS

T 1 - 1380.4530 Degrees F
T 2 - 864.3726 Degrees F
T 3 - 382.6046 Degrees F
T 4 - 70.0000 Degrees F

AT t - 91.0 SECONDS

T 1 - 1379.3210 Degrees F
T 2 - 864.8534 Degrees F
T 3 - 382.8175 Degrees F
T 4 - 70.0000 Degrees F

AT t - 92.0 SECONDS

T 1 - 1378.0600 Degrees F
T 2 - 865.2289 Degrees F
T 3 - 383.0038 Degrees F
T 4 - 70.0000 Degrees F

AT t - 93.0 SECONDS

T 1 - 1376.5020 Degrees F
T 2 - 865.4933 Degrees F
T 3 - 383.1648 Degrees F
T 4 - 70.0000 Degrees F

AT t - 94.0 SECONDS

T 1 - 1383.1000 Degrees F
T 2 - 866.0792 Degrees F
T 3 - 383.3282 Degrees F
T 4 - 70.0000 Degrees F

AT t - 95.0 SECONDS

T 1 - 1396.9630 Degrees F
T 2 - 867.3301 Degrees F
T 3 - 383.5214 Degrees F
T 4 - 70.0000 Degrees F

AT t - 96.0 SECONDS

T 1 - 1417.3160 Degrees F
T 2 - 869.5161 Degrees F
T 3 - 383.7701 Degrees F
T 4 - 70.0000 Degrees F

AT t - 97.0 SECONDS

T 1 - 1443.4810 Degrees F
T 2 - 872.8467 Degrees F
T 3 - 384.0967 Degrees F
T 4 - 70.0000 Degrees F

AT t - 98.0 SECONDS

T 1 - 1479.1230 Degrees F
T 2 - 877.7024 Degrees F
T 3 - 384.5323 Degrees F
T 4 - 70.0000 Degrees F

AT t - 99.0 SECONDS

T 1 - 1509.2910 Degrees F
T 2 - 883.6548 Degrees F
T 3 - 385.0553 Degrees F
T 4 - 70.0000 Degrees F

AT t - 100.0 SECONDS

T 1 - 1534.7590 Degrees F
T 2 - 890.3528 Degrees F
T 3 - 385.6372 Degrees F
T 4 - 70.0000 Degrees F

AT t - 101.0 SECONDS

T 1 - 1556.1650 Degrees F
T 2 - 897.5112 Degrees F
T 3 - 386.2455 Degrees F
T 4 - 70.0000 Degrees F

AT t - 102.0 SECONDS

T 1 - 1574.0380 Degrees F
T 2 - 904.8983 Degrees F
T 3 - 386.8471 Degrees F
T 4 - 70.0000 Degrees F

AT t - 103.0 SECONDS

T 1 - 1588.8160 Degrees F
T 2 - 912.3264 Degrees F
T 3 - 387.4102 Degrees F
T 4 - 70.0000 Degrees F

AT t - 104.0 SECONDS

T 1 - 1600.8620 Degrees F
T 2 - 919.6448 Degrees F
T 3 - 387.9072 Degrees F
T 4 - 70.0000 Degrees F

AT t - 105.0 SECONDS

T 1 - 1610.4810 Degrees F
T 2 - 926.7325 Degrees F
T 3 - 388.3154 Degrees F
T 4 - 70.0000 Degrees F

AT t - 106.0 SECONDS

T 1 - 1617.9280 Degrees F
T 2 - 933.4933 Degrees F
T 3 - 388.6183 Degrees F
T 4 - 70.0000 Degrees F

AT t - 107.0 SECONDS

T 1 - 1623.4160 Degrees F
T 2 - 939.8520 Degrees F
T 3 - 388.8060 Degrees F
T 4 - 70.0000 Degrees F

AT t - 108.0 SECONDS

T 1 - 1627.1250 Degrees F
T 2 - 945.7502 Degrees F
T 3 - 388.8745 Degrees F
T 4 - 70.0000 Degrees F

AT t - 109.0 SECONDS

T 1 - 1629.2080 Degrees F
T 2 - 951.1439 Degrees F
T 3 - 388.8257 Degrees F
T 4 - 70.0000 Degrees F

AT t - 110.0 SECONDS

T 1 - 1629.7970 Degrees F
T 2 - 956.0007 Degrees F
T 3 - 388.6666 Degrees F
T 4 - 70.0000 Degrees F

AT t - 111.0 SECONDS

T 1 - 1629.0020 Degrees F
T 2 - 960.2985 Degrees F
T 3 - 388.4083 Degrees F
T 4 - 70.0000 Degrees F

AT t - 112.0 SECONDS

T 1 - 1626.9210 Degrees F
T 2 - 964.0229 Degrees F
T 3 - 388.0652 Degrees F
T 4 - 70.0000 Degrees F

AT t - 113.0 SECONDS

T 1 - 1623.6360 Degrees F
T 2 - 967.1671 Degrees F
T 3 - 387.6536 Degrees F
T 4 - 70.0000 Degrees F

AT t - 114.0 SECONDS

T 1 - 1619.2220 Degrees F
T 2 - 969.7288 Degrees F
T 3 - 387.1913 Degrees F
T 4 - 70.0000 Degrees F

AT t - 115.0 SECONDS

T 1 - 1613.7420 Degrees F
T 2 - 971.7112 Degrees F
T 3 - 386.6967 Degrees F
T 4 - 70.0000 Degrees F

AT t - 116.0 SECONDS

T 1 - 1607.2550 Degrees F
T 2 - 973.1208 Degrees F
T 3 - 386.1875 Degrees F
T 4 - 70.0000 Degrees F

AT t - 117.0 SECONDS

T 1 - 1599.8120 Degrees F
T 2 - 973.9673 Degrees F
T 3 - 385.6809 Degrees F
T 4 - 70.0000 Degrees F

AT t - 118.0 SECONDS

T 1 - 1591.4590 Degrees F
T 2 - 974.2623 Degrees F
T 3 - 385.1924 Degrees F
T 4 - 70.0000 Degrees F

AT t - 119.0 SECONDS

T	1	-	1582.2390	Degrees	F
T	2	-	974.0195	Degrees	F
T	3	-	384.7357	Degrees	F
T	4	-	70.0000	Degrees	F

AT t - 120.0 SECONDS

T	1	-	1572.1910	Degrees	F
T	2	-	973.2542	Degrees	F
T	3	-	384.3226	Degrees	F
T	4	-	70.0000	Degrees	F

APPENDIX C

DATA FOR FOUR LAYER BLANKET

RESULTS OF HEAT TRANSFER ANALYSIS FOR A THERMAL BLANKET
CONSISTING OF 4 LAYERS OF THE FOLLOWING COMPOSITIONS:

Layer 1 is Quartz
Layer 2 is E-glass
Layer 3 is Fiberfrax
Layer 4 is Kevlar

where layer 1 is the high-temperature side.

AT t - 1.0 SECONDS

T 1 -	192.0047	Degrees F
T 2 -	77.6452	Degrees F
T 3 -	70.9110	Degrees F
T 4 -	70.0334	Degrees F
T 5 -	70.0000	Degrees F

AT t - 2.0 SECONDS

T 1 -	271.8125	Degrees F
T 2 -	87.9477	Degrees F
T 3 -	72.8756	Degrees F
T 4 -	70.1294	Degrees F
T 5 -	70.0000	Degrees F

AT t - 3.0 SECONDS

T 1 -	335.5456	Degrees F
T 2 -	100.2056	Degrees F
T 3 -	75.9381	Degrees F
T 4 -	70.3126	Degrees F
T 5 -	70.0000	Degrees F

AT t - 4.0 SECONDS

T 1 -	389.5589	Degrees F
T 2 -	113.8516	Degrees F
T 3 -	80.0682	Degrees F
T 4 -	70.6010	Degrees F
T 5 -	70.0000	Degrees F

AT t - 5.0 SECONDS

T 1 -	436.8340	Degrees F
T 2 -	128.5049	Degrees F
T 3 -	85.1977	Degrees F
T 4 -	71.0065	Degrees F
T 5 -	70.0000	Degrees F

AT t - 6.0 SECONDS

T 1 -	479.1118	Degrees F
T 2 -	143.9024	Degrees F
T 3 -	91.2414	Degrees F
T 4 -	71.5352	Degrees F
T 5 -	70.0000	Degrees F

AT t - 7.0 SECONDS

T 1 -	517.5341	Degrees F
T 2 -	159.8564	Degrees F
T 3 -	98.1091	Degrees F
T 4 -	72.1889	Degrees F
T 5 -	70.0000	Degrees F

AT t - 8.0 SECONDS

T 1 -	552.9044	Degrees F
T 2 -	176.2301	Degrees F
T 3 -	105.7126	Degrees F
T 4 -	72.9657	Degrees F
T 5 -	70.0000	Degrees F

AT t - 9.0 SECONDS

T 1 -	585.8163	Degrees F
T 2 -	192.9219	Degrees F
T 3 -	113.9687	Degrees F
T 4 -	73.8617	Degrees F
T 5 -	70.0000	Degrees F

AT t - 10.0 SECONDS

T 1 -	616.7230	Degrees F
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T 2 - 209.8548 Degrees F
T 3 - 122.8019 Degrees F
T 4 - 74.8710 Degrees F
T 5 - 70.0000 Degrees F

AT t - 11.0 SECONDS

T 1 - 645.9786 Degrees F
T 2 - 226.9698 Degrees F
T 3 - 132.1438 Degrees F
T 4 - 75.9873 Degrees F
T 5 - 70.0000 Degrees F

AT t - 12.0 SECONDS

T 1 - 673.8657 Degrees F
T 2 - 244.2215 Degrees F
T 3 - 141.9339 Degrees F
T 4 - 77.2035 Degrees F
T 5 - 70.0000 Degrees F

AT t - 13.0 SECONDS

T 1 - 700.6119 Degrees F
T 2 - 261.5743 Degrees F
T 3 - 152.1189 Degrees F
T 4 - 78.5127 Degrees F
T 5 - 70.0000 Degrees F

AT t - 14.0 SECONDS

T 1 - 726.4034 Degrees F
T 2 - 279.0004 Degrees F
T 3 - 162.6516 Degrees F
T 4 - 79.9081 Degrees F
T 5 - 70.0000 Degrees F

AT t - 15.0 SECONDS

T 1 - 751.3933 Degrees F
T 2 - 296.4777 Degrees F
T 3 - 173.4914 Degrees F
T 4 - 81.3834 Degrees F
T 5 - 70.0000 Degrees F

AT t - 16.0 SECONDS

T 1 -	775.7083	Degrees F
T 2 -	313.9890	Degrees F
T 3 -	184.6024	Degrees F
T 4 -	82.9326	Degrees F
T 5 -	70.0000	Degrees F

AT t - 17.0 SECONDS

T 1 -	799.4540	Degrees F
T 2 -	331.5204	Degrees F
T 3 -	195.9539	Degrees F
T 4 -	84.5503	Degrees F
T 5 -	70.0000	Degrees F

AT t - 18.0 SECONDS

T 1 -	822.7188	Degrees F
T 2 -	349.0612	Degrees F
T 3 -	207.5191	Degrees F
T 4 -	86.2314	Degrees F
T 5 -	70.0000	Degrees F

AT t - 19.0 SECONDS

T 1 -	845.5765	Degrees F
T 2 -	366.6027	Degrees F
T 3 -	219.2749	Degrees F
T 4 -	87.9714	Degrees F
T 5 -	70.0000	Degrees F

AT t - 20.0 SECONDS

T 1 -	868.0895	Degrees F
T 2 -	384.1381	Degrees F
T 3 -	231.2014	Degrees F
T 4 -	89.7661	Degrees F
T 5 -	70.0000	Degrees F

AT t - 21.0 SECONDS

T 1 -	890.3103	Degrees F
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T 2 - 401.6620 Degrees F
T 3 - 243.2818 Degrees F
T 4 - 91.6118 Degrees F
T 5 - 70.0000 Degrees F

AT t - 22.0 SECONDS

T 1 - 912.2828 Degrees F
T 2 - 419.1702 Degrees F
T 3 - 255.5013 Degrees F
T 4 - 93.5051 Degrees F
T 5 - 70.0000 Degrees F

AT t - 23.0 SECONDS

T 1 - 934.0447 Degrees F
T 2 - 436.6596 Degrees F
T 3 - 267.8476 Degrees F
T 4 - 95.4430 Degrees F
T 5 - 70.0000 Degrees F

AT t - 24.0 SECONDS

T 1 - 955.6273 Degrees F
T 2 - 454.1276 Degrees F
T 3 - 280.3100 Degrees F
T 4 - 97.4227 Degrees F
T 5 - 70.0000 Degrees F

AT t - 25.0 SECONDS

T 1 - 977.0572 Degrees F
T 2 - 471.5724 Degrees F
T 3 - 292.8796 Degrees F
T 4 - 99.4418 Degrees F
T 5 - 70.0000 Degrees F

AT t - 26.0 SECONDS

T 1 - 998.3568 Degrees F
T 2 - 488.9927 Degrees F
T 3 - 305.5488 Degrees F
T 4 - 101.4979 Degrees F
T 5 - 70.0000 Degrees F

AT t - 27.0 SECONDS

T 1 -	1019.5450	Degrees F
T 2 -	506.3875	Degrees F
T 3 -	318.3112	Degrees F
T 4 -	103.5892	Degrees F
T 5 -	70.0000	Degrees F

AT t - 28.0 SECONDS

T 1 -	1040.6380	Degrees F
T 2 -	523.7561	Degrees F
T 3 -	331.1615	Degrees F
T 4 -	105.7139	Degrees F
T 5 -	70.0000	Degrees F

AT t - 29.0 SECONDS

T 1 -	1061.6500	Degrees F
T 2 -	541.0985	Degrees F
T 3 -	344.0951	Degrees F
T 4 -	107.8703	Degrees F
T 5 -	70.0000	Degrees F

AT t - 30.0 SECONDS

T 1 -	1082.6480	Degrees F
T 2 -	558.4175	Degrees F
T 3 -	357.1084	Degrees F
T 4 -	110.0573	Degrees F
T 5 -	70.0000	Degrees F

AT t - 31.0 SECONDS

T 1 -	1102.7250	Degrees F
T 2 -	575.6684	Degrees F
T 3 -	370.1942	Degrees F
T 4 -	112.2735	Degrees F
T 5 -	70.0000	Degrees F

AT t - 32.0 SECONDS

T 1 -	1121.9880	Degrees F
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T 2 - 592.8171 Degrees F
T 3 - 383.3436 Degrees F
T 4 - 114.5177 Degrees F
T 5 - 70.0000 Degrees F

AT t - 33.0 SECONDS

T 1 - 1140.5310 Degrees F
T 2 - 609.8372 Degrees F
T 3 - 396.5465 Degrees F
T 4 - 116.7887 Degrees F
T 5 - 70.0000 Degrees F

AT t - 34.0 SECONDS

T 1 - 1158.4290 Degrees F
T 2 - 626.7078 Degrees F
T 3 - 409.7924 Degrees F
T 4 - 119.0850 Degrees F
T 5 - 70.0000 Degrees F

AT t - 35.0 SECONDS

T 1 - 1175.7490 Degrees F
T 2 - 643.4130 Degrees F
T 3 - 423.0708 Degrees F
T 4 - 121.4053 Degrees F
T 5 - 70.0000 Degrees F

AT t - 36.0 SECONDS

T 1 - 1192.5460 Degrees F
T 2 - 659.9408 Degrees F
T 3 - 436.3706 Degrees F
T 4 - 123.7483 Degrees F
T 5 - 70.0000 Degrees F

AT t - 37.0 SECONDS

T 1 - 1208.8670 Degrees F
T 2 - 676.2821 Degrees F
T 3 - 449.6814 Degrees F
T 4 - 126.1127 Degrees F
T 5 - 70.0000 Degrees F

AT t - 38.0 SECONDS

T	1	-	1224.7500	Degrees	F
T	2	-	692.4306	Degrees	F
T	3	-	462.9926	Degrees	F
T	4	-	128.4969	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 39.0 SECONDS

T	1	-	1240.2320	Degrees	F
T	2	-	708.3819	Degrees	F
T	3	-	476.2942	Degrees	F
T	4	-	130.8996	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 40.0 SECONDS

T	1	-	1255.3390	Degrees	F
T	2	-	724.1334	Degrees	F
T	3	-	489.5765	Degrees	F
T	4	-	133.3193	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 41.0 SECONDS

T	1	-	1270.0990	Degrees	F
T	2	-	739.6837	Degrees	F
T	3	-	502.8300	Degrees	F
T	4	-	135.7545	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 42.0 SECONDS

T	1	-	1284.5310	Degrees	F
T	2	-	755.0323	Degrees	F
T	3	-	516.0458	Degrees	F
T	4	-	138.2036	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 43.0 SECONDS

T	1	-	1298.6560	Degrees	F
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T 2 - 770.1800 Degrees F
T 3 - 529.2154 Degrees F
T 4 - 140.6649 Degrees F
T 5 - 70.0000 Degrees F

AT t - 44.0 SECONDS

T 1 - 1312.4890 Degrees F
T 2 - 785.1277 Degrees F
T 3 - 542.3305 Degrees F
T 4 - 143.1366 Degrees F
T 5 - 70.0000 Degrees F

AT t - 45.0 SECONDS

T 1 - 1326.0440 Degrees F
T 2 - 799.8772 Degrees F
T 3 - 555.3834 Degrees F
T 4 - 145.6165 Degrees F
T 5 - 70.0000 Degrees F

AT t - 46.0 SECONDS

T 1 - 1339.3350 Degrees F
T 2 - 814.4305 Degrees F
T 3 - 568.3667 Degrees F
T 4 - 148.1024 Degrees F
T 5 - 70.0000 Degrees F

AT t - 47.0 SECONDS

T 1 - 1352.3720 Degrees F
T 2 - 828.7900 Degrees F
T 3 - 581.2734 Degrees F
T 4 - 150.5917 Degrees F
T 5 - 70.0000 Degrees F

AT t - 48.0 SECONDS

T 1 - 1365.1650 Degrees F
T 2 - 842.9585 Degrees F
T 3 - 594.0969 Degrees F
T 4 - 153.0815 Degrees F
T 5 - 70.0000 Degrees F

AT t - 49.0 SECONDS

T	1	-	1377.7230	Degrees	F
T	2	-	856.9385	Degrees	F
T	3	-	606.8309	Degrees	F
T	4	-	155.5683	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 50.0 SECONDS

T	1	-	1390.0550	Degrees	F
T	2	-	870.7327	Degrees	F
T	3	-	619.4695	Degrees	F
T	4	-	158.0486	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 51.0 SECONDS

T	1	-	1402.1670	Degrees	F
T	2	-	884.3440	Degrees	F
T	3	-	632.0071	Degrees	F
T	4	-	160.5181	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 52.0 SECONDS

T	1	-	1414.0660	Degrees	F
T	2	-	897.7753	Degrees	F
T	3	-	644.4383	Degrees	F
T	4	-	162.9719	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 53.0 SECONDS

T	1	-	1425.7580	Degrees	F
T	2	-	911.0294	Degrees	F
T	3	-	656.7581	Degrees	F
T	4	-	165.4049	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 54.0 SECONDS

T	1	-	1437.2490	Degrees	F
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T 2 - 924.1089 Degrees F
T 3 - 668.9617 Degrees F
T 4 - 167.8112 Degrees F
T 5 - 70.0000 Degrees F

AT t - 55.0 SECONDS

T 1 - 1448.5430 Degrees F
T 2 - 937.0164 Degrees F
T 3 - 681.0448 Degrees F
T 4 - 170.1844 Degrees F
T 5 - 70.0000 Degrees F

AT t - 56.0 SECONDS

T 1 - 1459.6460 Degrees F
T 2 - 949.7545 Degrees F
T 3 - 693.0030 Degrees F
T 4 - 172.5176 Degrees F
T 5 - 70.0000 Degrees F

AT t - 57.0 SECONDS

T 1 - 1470.5610 Degrees F
T 2 - 962.3255 Degrees F
T 3 - 704.8322 Degrees F
T 4 - 174.8035 Degrees F
T 5 - 70.0000 Degrees F

AT t - 58.0 SECONDS

T 1 - 1481.2930 Degrees F
T 2 - 974.7318 Degrees F
T 3 - 716.5287 Degrees F
T 4 - 177.0340 Degrees F
T 5 - 70.0000 Degrees F

AT t - 59.0 SECONDS

T 1 - 1491.8450 Degrees F
T 2 - 986.9755 Degrees F
T 3 - 728.0890 Degrees F
T 4 - 179.2008 Degrees F
T 5 - 70.0000 Degrees F

AT t - 60.0 SECONDS

T	1	-	1502.2220	Degrees	F
T	2	-	999.0583	Degrees	F
T	3	-	739.5095	Degrees	F
T	4	-	181.2954	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 61.0 SECONDS

T	1	-	1512.4250	Degrees	F
T	2	-	1010.9820	Degrees	F
T	3	-	750.7869	Degrees	F
T	4	-	183.3089	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 62.0 SECONDS

T	1	-	1522.4590	Degrees	F
T	2	-	1022.7490	Degrees	F
T	3	-	761.9182	Degrees	F
T	4	-	185.2321	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 63.0 SECONDS

T	1	-	1532.3260	Degrees	F
T	2	-	1034.3610	Degrees	F
T	3	-	772.9003	Degrees	F
T	4	-	187.0562	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 64.0 SECONDS

T	1	-	1542.0280	Degrees	F
T	2	-	1045.8180	Degrees	F
T	3	-	783.7305	Degrees	F
T	4	-	188.7722	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 65.0 SECONDS

T	1	-	1551.5680	Degrees	F
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T 2 - 1057.1210 Degrees F
T 3 - 794.4063 Degrees F
T 4 - 190.3716 Degrees F
T 5 - 70.0000 Degrees F

AT t - 66.0 SECONDS

T 1 - 1560.9480 Degrees F
T 2 - 1068.2730 Degrees F
T 3 - 804.9250 Degrees F
T 4 - 191.8463 Degrees F
T 5 - 70.0000 Degrees F

AT t - 67.0 SECONDS

T 1 - 1570.1710 Degrees F
T 2 - 1079.2740 Degrees F
T 3 - 815.2847 Degrees F
T 4 - 193.1887 Degrees F
T 5 - 70.0000 Degrees F

AT t - 68.0 SECONDS

T 1 - 1579.2370 Degrees F
T 2 - 1090.1240 Degrees F
T 3 - 825.4829 Degrees F
T 4 - 194.3921 Degrees F
T 5 - 70.0000 Degrees F

AT t - 69.0 SECONDS

T 1 - 1588.1500 Degrees F
T 2 - 1100.8250 Degrees F
T 3 - 835.5179 Degrees F
T 4 - 195.4505 Degrees F
T 5 - 70.0000 Degrees F

AT t - 70.0 SECONDS

T 1 - 1596.9100 Degrees F
T 2 - 1111.3770 Degrees F
T 3 - 845.3878 Degrees F
T 4 - 196.3591 Degrees F
T 5 - 70.0000 Degrees F

AT t - 71.0 SECONDS

T 1 -	1605.5200	Degrees F
T 2 -	1121.7800	Degrees F
T 3 -	855.0911	Degrees F
T 4 -	197.1141	Degrees F
T 5 -	70.0000	Degrees F

AT t - 72.0 SECONDS

T 1 -	1613.9790	Degrees F
T 2 -	1132.0340	Degrees F
T 3 -	864.6264	Degrees F
T 4 -	197.7129	Degrees F
T 5 -	70.0000	Degrees F

AT t - 73.0 SECONDS

T 1 -	1622.2900	Degrees F
T 2 -	1142.1400	Degrees F
T 3 -	873.9927	Degrees F
T 4 -	198.1542	Degrees F
T 5 -	70.0000	Degrees F

AT t - 74.0 SECONDS

T 1 -	1630.4530	Degrees F
T 2 -	1152.0980	Degrees F
T 3 -	883.1892	Degrees F
T 4 -	198.4380	Degrees F
T 5 -	70.0000	Degrees F

AT t - 75.0 SECONDS

T 1 -	1638.4690	Degrees F
T 2 -	1161.9080	Degrees F
T 3 -	892.2151	Degrees F
T 4 -	198.5654	Degrees F
T 5 -	70.0000	Degrees F

AT t - 76.0 SECONDS

T 1 -	1646.3400	Degrees F
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T 2 - 1171.5710 Degrees F
T 3 - 901.0704 Degrees F
T 4 - 198.5390 Degrees F
T 5 - 70.0000 Degrees F

AT t - 77.0 SECONDS

T 1 - 1654.0650 Degrees F
T 2 - 1181.0850 Degrees F
T 3 - 909.7545 Degrees F
T 4 - 198.3623 Degrees F
T 5 - 70.0000 Degrees F

AT t - 78.0 SECONDS

T 1 - 1661.6450 Degrees F
T 2 - 1190.4510 Degrees F
T 3 - 918.2679 Degrees F
T 4 - 198.0403 Degrees F
T 5 - 70.0000 Degrees F

AT t - 79.0 SECONDS

T 1 - 1669.0820 Degrees F
T 2 - 1199.6690 Degrees F
T 3 - 926.6109 Degrees F
T 4 - 197.5785 Degrees F
T 5 - 70.0000 Degrees F

AT t - 80.0 SECONDS

T 1 - 1676.3740 Degrees F
T 2 - 1208.7390 Degrees F
T 3 - 934.7842 Degrees F
T 4 - 196.9838 Degrees F
T 5 - 70.0000 Degrees F

AT t - 81.0 SECONDS

T 1 - 1683.5240 Degrees F
T 2 - 1217.6610 Degrees F
T 3 - 942.7888 Degrees F
T 4 - 196.2634 Degrees F
T 5 - 70.0000 Degrees F

AT t - 82.0 SECONDS

T 1 -	1690.5300	Degrees F
T 2 -	1226.4340	Degrees F
T 3 -	950.6255	Degrees F
T 4 -	195.4254	Degrees F
T 5 -	70.0000	Degrees F

AT t - 83.0 SECONDS

T 1 -	1697.3940	Degrees F
T 2 -	1235.0590	Degrees F
T 3 -	958.2960	Degrees F
T 4 -	194.4783	Degrees F
T 5 -	70.0000	Degrees F

AT t - 84.0 SECONDS

T 1 -	1704.1150	Degrees F
T 2 -	1243.5360	Degrees F
T 3 -	965.8016	Degrees F
T 4 -	193.4308	Degrees F
T 5 -	70.0000	Degrees F

AT t - 85.0 SECONDS

T 1 -	1710.6950	Degrees F
T 2 -	1251.8650	Degrees F
T 3 -	973.1443	Degrees F
T 4 -	192.2921	Degrees F
T 5 -	70.0000	Degrees F

AT t - 86.0 SECONDS

T 1 -	1717.1320	Degrees F
T 2 -	1260.0450	Degrees F
T 3 -	980.3259	Degrees F
T 4 -	191.0710	Degrees F
T 5 -	70.0000	Degrees F

AT t - 87.0 SECONDS

T 1 -	1723.4270	Degrees F
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T 2 - 1268.0770 Degrees F
T 3 - 987.3484 Degrees F
T 4 - 189.7768 Degrees F
T 5 - 70.0000 Degrees F

AT t - 88.0 SECONDS

T 1 - 1729.5800 Degrees F
T 2 - 1275.9600 Degrees F
T 3 - 994.2143 Degrees F
T 4 - 188.4182 Degrees F
T 5 - 70.0000 Degrees F

AT t - 89.0 SECONDS

T 1 - 1735.5920 Degrees F
T 2 - 1283.6970 Degrees F
T 3 - 1000.9250 Degrees F
T 4 - 187.0040 Degrees F
T 5 - 70.0000 Degrees F

AT t - 90.0 SECONDS

T 1 - 1741.4620 Degrees F
T 2 - 1291.2850 Degrees F
T 3 - 1007.4850 Degrees F
T 4 - 185.5426 Degrees F
T 5 - 70.0000 Degrees F

AT t - 91.0 SECONDS

T 1 - 1747.1910 Degrees F
T 2 - 1298.7270 Degrees F
T 3 - 1013.8940 Degrees F
T 4 - 184.0418 Degrees F
T 5 - 70.0000 Degrees F

AT t - 92.0 SECONDS

T 1 - 1752.7790 Degrees F
T 2 - 1306.0210 Degrees F
T 3 - 1020.1560 Degrees F
T 4 - 182.5093 Degrees F
T 5 - 70.0000 Degrees F

AT t - 93.0 SECONDS

T	1	-	1758.0600	Degrees	F
T	2	-	1313.1610	Degrees	F
T	3	-	1026.2730	Degrees	F
T	4	-	180.9522	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 94.0 SECONDS

T	1	-	1771.1510	Degrees	F
T	2	-	1320.5610	Degrees	F
T	3	-	1032.2840	Degrees	F
T	4	-	179.3779	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 95.0 SECONDS

T	1	-	1791.2160	Degrees	F
T	2	-	1328.5620	Degrees	F
T	3	-	1038.2520	Degrees	F
T	4	-	177.7917	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 96.0 SECONDS

T	1	-	1817.5340	Degrees	F
T	2	-	1337.4320	Degrees	F
T	3	-	1044.2550	Degrees	F
T	4	-	176.1954	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 97.0 SECONDS

T	1	-	1849.4840	Degrees	F
T	2	-	1347.3840	Degrees	F
T	3	-	1050.3810	Degrees	F
T	4	-	174.5863	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 98.0 SECONDS

T	1	-	1890.6260	Degrees	F
---	---	---	-----------	---------	---

T 2 - 1358.7940 Degrees F
T 3 - 1056.7400 Degrees F
T 4 - 172.9584 Degrees F
T 5 - 70.0000 Degrees F

AT t - 99.0 SECONDS

T 1 - 1926.6260 Degrees F
T 2 - 1371.2510 Degrees F
T 3 - 1063.3880 Degrees F
T 4 - 171.2995 Degrees F
T 5 - 70.0000 Degrees F

AT t - 100.0 SECONDS

T 1 - 1958.1770 Degrees F
T 2 - 1384.4140 Degrees F
T 3 - 1070.3490 Degrees F
T 4 - 169.5961 Degrees F
T 5 - 70.0000 Degrees F

AT t - 101.0 SECONDS

T 1 - 1985.8530 Degrees F
T 2 - 1398.0120 Degrees F
T 3 - 1077.6200 Degrees F
T 4 - 167.8360 Degrees F
T 5 - 70.0000 Degrees F

AT t - 102.0 SECONDS

T 1 - 2010.1340 Degrees F
T 2 - 1411.8250 Degrees F
T 3 - 1085.1800 Degrees F
T 4 - 166.0099 Degrees F
T 5 - 70.0000 Degrees F

AT t - 103.0 SECONDS

T 1 - 2031.4200 Degrees F
T 2 - 1425.6810 Degrees F
T 3 - 1092.9960 Degrees F
T 4 - 164.1123 Degrees F
T 5 - 70.0000 Degrees F

AT t - 104.0 SECONDS

T 1 -	2050.0480	Degrees F
T 2 -	1439.4400	Degrees F
T 3 -	1101.0280	Degrees F
T 4 -	162.1416	Degrees F
T 5 -	70.0000	Degrees F

AT t - 105.0 SECONDS

T 1 -	2066.3020	Degrees F
T 2 -	1452.9950	Degrees F
T 3 -	1109.2300	Degrees F
T 4 -	160.0997	Degrees F
T 5 -	70.0000	Degrees F

AT t - 106.0 SECONDS

T 1 -	2080.4210	Degrees F
T 2 -	1466.2600	Degrees F
T 3 -	1117.5560	Degrees F
T 4 -	157.9924	Degrees F
T 5 -	70.0000	Degrees F

AT t - 107.0 SECONDS

T 1 -	2092.6130	Degrees F
T 2 -	1479.1690	Degrees F
T 3 -	1125.9600	Degrees F
T 4 -	155.8278	Degrees F
T 5 -	70.0000	Degrees F

AT t - 108.0 SECONDS

T 1 -	2103.0510	Degrees F
T 2 -	1491.6720	Degrees F
T 3 -	1134.3980	Degrees F
T 4 -	153.6165	Degrees F
T 5 -	70.0000	Degrees F

AT t - 109.0 SECONDS

T 1 -	2111.8860	Degrees F
-------	-----------	-----------

T 2 - 1503.7290 Degrees F
T 3 - 1142.8260 Degrees F
T 4 - 151.3705 Degrees F
T 5 - 70.0000 Degrees F

AT t - 110.0 SECONDS

T 1 - 2119.2500 Degrees F
T 2 - 1515.3120 Degrees F
T 3 - 1151.2050 Degrees F
T 4 - 149.1027 Degrees F
T 5 - 70.0000 Degrees F

AT t - 111.0 SECONDS

T 1 - 2125.2530 Degrees F
T 2 - 1526.3990 Degrees F
T 3 - 1159.5000 Degrees F
T 4 - 146.8264 Degrees F
T 5 - 70.0000 Degrees F

AT t - 112.0 SECONDS

T 1 - 2129.9950 Degrees F
T 2 - 1536.9760 Degrees F
T 3 - 1167.6760 Degrees F
T 4 - 144.5547 Degrees F
T 5 - 70.0000 Degrees F

AT t - 113.0 SECONDS

T 1 - 2133.5610 Degrees F
T 2 - 1547.0330 Degrees F
T 3 - 1175.7050 Degrees F
T 4 - 142.3001 Degrees F
T 5 - 70.0000 Degrees F

AT t - 114.0 SECONDS

T 1 - 2136.0260 Degrees F
T 2 - 1556.5630 Degrees F
T 3 - 1183.5600 Degrees F
T 4 - 140.0745 Degrees F
T 5 - 70.0000 Degrees F

AT t - 115.0 SECONDS

T	1	-	2137.4550	Degrees	F
T	2	-	1565.5640	Degrees	F
T	3	-	1191.2180	Degrees	F
T	4	-	137.8886	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 116.0 SECONDS

T	1	-	2137.9080	Degrees	F
T	2	-	1574.0330	Degrees	F
T	3	-	1198.6570	Degrees	F
T	4	-	135.7518	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 117.0 SECONDS

T	1	-	2137.4360	Degrees	F
T	2	-	1581.9730	Degrees	F
T	3	-	1205.8600	Degrees	F
T	4	-	133.6724	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 118.0 SECONDS

T	1	-	2136.0860	Degrees	F
T	2	-	1589.3850	Degrees	F
T	3	-	1212.8120	Degrees	F
T	4	-	131.6575	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 119.0 SECONDS

T	1	-	2133.8970	Degrees	F
T	2	-	1596.2710	Degrees	F
T	3	-	1219.4980	Degrees	F
T	4	-	129.7129	Degrees	F
T	5	-	70.0000	Degrees	F

AT t - 120.0 SECONDS

T	1	-	2130.9080	Degrees	F
---	---	---	-----------	---------	---

T 2 - 1602.6360 Degrees F
T 3 - 1225.9070 Degrees F
T 4 - 127.8433 Degrees F
T 5 - 70.0000 Degrees F

APPENDIX D

SOURCE CODE AND SUBROUTINES

```

C *****
C *
C *          THERMAL CURTAIN ANALYSIS PROGRAM          *
C *              Version 1.20                          *
C *              Coded by Dale E. Matthews              *
C *              September 1990                        *
C *
C *              Applied Thermal Section                *
C *              Southern Research Institute             *
C *              Birmingham, Alabama                   *
C *
C *****

```

```

INTERFACE TO SUBROUTINE LETTER [C] ()

```

```

END

```

```

INTERFACE TO SUBROUTINE CAPS [C] ()

```

```

END

```

```

INCLUDE 'FGRAPH.FI'

```

```

INCLUDE 'FGRAPH.FD'

```

```

REAL T[ALLOCATABLE](:),TMOD[ALLOCATABLE](:),K[ALLOCATABLE](:,:)

```

```

REAL C[ALLOCATABLE](:,:),P[ALLOCATABLE](:),A[ALLOCATABLE](:,:)

```

```

REAL W,Z,Q,DX,DX2,DT,DT2,TINC,TF

```

```

INTEGER I,J,N,COUNT,NODE_ID[ALLOCATABLE](:),NUMK,NUMC,L

```

```

INTEGER ISCOMP[ALLOCATABLE](:),NUMP

```

```

INTEGER*2 X1,X2,Y1,Y2,D2

```

```

CHARACTER*30 OUTPUT,SPRD,STR30

```

```

CHARACTER*1 COMP[ALLOCATABLE](:),ASK

```

```

CHARACTER STR*2,STR2*12,BEEP,STR5*5,STR8*8,STRA*2,STRB*2

```

```

CHARACTER*12 TYPE[ALLOCATABLE](:)

```

```

RECORD /RCCOORD /CURPOS

```

```

RECORD /VIDEOCONFIG/VC

```

```

C Function statements for heat flux

```

```

QQ1(X)=(0.120*X+13.90)*3600

```

```

QQ2(X)=(19.643-0.071*X)*3600

```

```

QQ3(X)=(1.850*X-159.050)*3600

```

```

QQ4(X)=(-0.433*X+65.682)*3600

```

```

CALL GETVIDEOCONFIG(VC)

```

```

X1=(VC.NUMTEXTCOLS)/15

```

```

X2=X1*4

```

```

Y1=(VC.NUMTEXTROWS)/5

```

```

Y2=Y1*15

```

```

D2=SETBKCOLOR(7)

```

```

CALL CLEARSCREEN($GCLEARSCREEN)
D2-SETBKCOLOR(4)
D2-SETTEXTCOLOR(15)
CALL SETTEXTWINDOW(X1+18,Y1,X2+2,Y2)
CALL CLEARSCREEN($GWINDOW)
CALL SETTEXTPOSITION(X1+10,Y1+9,CURPOS)
CALL OUTTEXT('Developed by Southern Research Institute')
D2-SETBKCOLOR(1)
CALL SETTEXTWINDOW(X1-2,Y1,X2,Y2)
D2-SETTEXTCOLOR(15)
CALL CLEARSCREEN($GWINDOW)
CALL SETTEXTPOSITION(X1-3,Y1+8,CURPOS)
CALL OUTTEXT('AFT SKIRT THERMAL CURTAIN ANALYSIS PROGRAM')
CALL SETTEXTPOSITION(X1-1,Y1+6,CURPOS)
CALL OUTTEXT('To use this program, you will be asked to enter')
CALL SETTEXTPOSITION(X1+1,Y1+6,CURPOS)
CALL OUTTEXT('a blanket construction configuration code and to')
CALL SETTEXTPOSITION(X1+3,Y1+6,CURPOS)
CALL OUTTEXT('specify an output file for both a spreadsheet file
$')
CALL SETTEXTPOSITION(X1+5,Y1+6,CURPOS)
CALL OUTTEXT('and a text file. ')
CALL SETTEXTPOSITION(X1+11,Y1+17,CURPOS)
CALL OUTTEXT('Press a key to begin.....')
CALL LETTER()

CALL GETTIM(IHR1,IMIN1,ISEC1,I100TH1)
CALL CLEARSCREEN($GWINDOW)
D2-SETBKCOLOR(4)
D2-SETTEXTCOLOR(15)
CALL SETTEXTWINDOW(X1+18,Y1,X2+2,Y2)
CALL CLEARSCREEN($GWINDOW)
CALL SETTEXTPOSITION(X1+12,Y1+4,CURPOS)
CALL OUTTEXT('Aft Skirt Thermal Curtain Analysis Program   SRI 19

```


\$90')

```
CALL SETTEXTWINDOW(X1-2,Y1,X2,Y2)
D2-SETBKCOLOR(1)
CALL CLEARSCREEN($GWINDOW)

CALL SETTEXTPOSITION(X1-1,Y1+6,CURPOS)
CALL OUTTEXT('Name of output file? -----> ')
CALL SETTEXTPOSITION(X1,Y1+6,CURPOS)
CALL OUTTEXT('(include drive spec)')
CALL SETTEXTPOSITION(X1-1,Y1+37,CURPOS)
READ(*,'(A)')OUTPUT
CALL SETTEXTPOSITION(X1+3,Y1+6,CURPOS)
CALL OUTTEXT('Name of spreadsheet file? ---> ')
CALL SETTEXTPOSITION(X1+4,Y1+6,CURPOS)
CALL OUTTEXT('(include drive spec)')
CALL SETTEXTPOSITION(X1+3,Y1+37,CURPOS)
READ(*,'(A)')SPRD
CALL SETTEXTPOSITION(X1+7,Y1+6,CURPOS)
CALL OUTTEXT('Number of blanket layers? ---> ')
READ*,N
CALL SETTEXTPOSITION(X1+10,Y1+6,CURPOS)
CALL OUTTEXT('Thickness (in inches) of')
CALL SETTEXTPOSITION(X1+11,Y1+6,CURPOS)
CALL OUTTEXT('each blanket layer? -----> ')
READ*,DX

CALL CLEARSCREEN($GWINDOW)
```

C Open datafiles containing polynomial coefficients for the conductivity,
C heat capacity, and density curves.

```
OPEN(6,FILE='KDATA')
OPEN(7,FILE='CDATA')
OPEN(8,FILE='PDATA')
OPEN(10,FILE=OUTPUT)
OPEN(11,FILE=SPRD)
```

C The first entry in each datafile is the order+1 of the curve.
C It is read here.

```
READ(6,*)NUMK
```

```
READ(7,*)NUMC
READ(8,*)NUMP
```

C Allocate memory to the thermal property arrays.

```
ALLOCATE(K(NUMK,4),C(NUMC,4),P(NUMP))
```

C Read the thermal property coefficients

```
DO 5 I=1,NUMK
READ(6,*)(K(I,J),J=1,4)
CONTINUE
```

5

```
DO 10 I=1,NUMC
READ(7,*)(C(I,J),J=1,4)
CONTINUE
```

10

```
DO 15 I=1,NUMP
READ(8,*)P(I)
CONTINUE
```

15

C Initializations

```
DX=DX/12.0
DX2=DX**2
TING=0.000
DT=1.0/3600.0
DT2=2*DT
COUNT=0
BEEP=CHAR(07)
```

```
D2=SETBKCOLOR(3)
```

```
D2=SETTEXTCOLOR(5)
```

```
CALL SETTEXTWINDOW(X1+5,Y1+6,X1+9,Y2-6)
```

```
CALL CLEARSCREEN($GWINDOW)
```

```
WRITE(*,*)BEEP
```

```
CALL SETTEXTPOSITION(X1-2,Y1+12,CURPOS)
```

```
CALL OUTTEXT('LOCK CAPS BEFORE PROCEEDING')
```

```
CALL CAPS()
```

```
D2=SETBKCOLOR(1)
```

```
D2=SETTEXTCOLOR(15)
```

```
CALL SETTEXTWINDOW(X1-2,Y1,X2,Y2)
```

```
CALL CLEARSCREEN($GWINDOW)
```

C Allocate memory to the matrix terms and node identification variables.

```
ALLOCATE(A(N,N),T(N+1),TMOD(N+1),COMP(N),ISCOMP(N),TYPE(N))
ALLOCATE(NODE_ID(N))
```

C Initialize matrix coefficients at zero and temperatures at 70 F.

```

DO 21 I=1,N
DO 20 J=1,N
A(I,J)=0.00
20 CONTINUE
21 CONTINUE

DO 22 I=1,N+1
T(I)=70.000
22 CONTINUE

C Fix back-face node at 70 F

TF=T(N+1)
TMOD(N+1)=70.00

C Prompt the user for description of the blanket.
23 CONTINUE

DO 24 I=1,N

CALL SETTEXTPOSITION(X1-3,Y1+3,CURPOS)

CALL OUTTEXT('You now need to enter the composition of the blank
$t.')

CALL SETTEXTPOSITION(X1-1,Y1-1,CURPOS)

CALL OUTTEXT('Using the following codes, enter the composition of
$ the blanket.')

CALL SETTEXTPOSITION(X1+1,Y1+7,CURPOS)

CALL OUTTEXT('Begin with the high-temperature (nozzle) side.')

CALL SETTEXTPOSITION(X1+5,Y1+24,CURPOS)
CALL OUTTEXT('A = Kevlar')
CALL SETTEXTPOSITION(X1+6,Y1+24,CURPOS)
CALL OUTTEXT('B = E-glass')
CALL SETTEXTPOSITION(X1+7,Y1+24,CURPOS)
CALL OUTTEXT('C = Quartz')
CALL SETTEXTPOSITION(X1+8,Y1+24,CURPOS)
CALL OUTTEXT('D = Fiberfrax')

IF (I.EQ.1)THEN
CALL SETTEXTPOSITION(X1+10,Y1+14,CURPOS)
CALL OUTTEXT('Press ENTER when ready to continue')
READ(*,*)
CALL SETTEXTPOSITION(X1+10,Y1+14,CURPOS)
CALL OUTTEXT(' ')
ELSE
END IF

CALL SETTEXTPOSITION(X1+12,Y1+6,CURPOS)

WRITE(STR,'(I2)')I

CALL OUTTEXT('Material code for blanket layer '//STR//'----->')

READ(*,'(A)')COMP(I)

CALL CLEARSCREEN($GWINDOW)

```

```

DO 28 I=1,N
  IF(COMP(I).EQ.'A')THEN
    TYPE(I)='Kevlar'
  ELSE IF(COMP(I).EQ.'B')THEN
    TYPE(I)='E-glass'
  ELSE IF(COMP(I).EQ.'C')THEN
    TYPE(I)='Quartz'
  ELSE IF(COMP(I).EQ.'D')THEN
    TYPE(I)='Fiberfrax'
  ELSE

    D2=SETBKCOLOR(3)
    D2=SETTEXTCOLOR(5)
    CALL SETTEXTWINDOW(X1+5,Y1+6,X1+9,Y2-6)
    CALL CLEARSCREEN($GWINDOW)
    CALL SETTEXTPOSITION(X1-2,Y1+12,CURPOS)
    WRITE(*,*)BEEP
    WRITE(STR,'(A)')COMP(I)

    CALL OUTTEXT('Unrecognized material ID code: '//STR)
    READ(*,*)
    CALL CLEARSCREEN($GWINDOW)
    D2=SETBKCOLOR(1)
    D2=SETTEXTCOLOR(15)
    CALL SETTEXTWINDOW(X1-2,Y1,X2,Y2)
    CALL CLEARSCREEN($GWINDOW)

    GO TO 23
  END IF
28 CONTINUE
1280 CONTINUE

CALL CLEARSCREEN($GWINDOW)

CALL SETTEXTPOSITION(X1-3,Y1+13,CURPOS)

CALL OUTTEXT('BLANKET CONSTRUCTION VERIFICATION')

L=1
DO 29 I=1,N
  CALL SETTEXTPOSITION(X1-2+L,Y1+13,CURPOS)

  IF(MOD(I,13).EQ.0)THEN
    CALL SETTEXTPOSITION(X1+12,Y1+13,CURPOS)
    CALL OUTTEXT('Press ENTER for more')
    READ(*,*)
    CALL CLEARSCREEN($GWINDOW)
    CALL SETTEXTPOSITION(X1-3,Y1+8,CURPOS)
    CALL OUTTEXT('BLANKET CONSTRUCTION VERIFICATION (continued)')
    L=0
  CALL SETTEXTPOSITION(X1-1,Y1+13,CURPOS)

  ELSE
  END IF

  WRITE(STR,'(I2)')I
  WRITE(STR2,'(A)')TYPE(I)
  CALL OUTTEXT('Layer '//STR//' of the blanket is '//STR2)
  L=L+1
29 CONTINUE

```

```

30 CALL SETTEXTPOSITION(X1-3+(2*7+1),Y1+17,CURPOS)
CALL OUTTEXT('Are these correct (y/n) ? ')
READ(*,'(A)')ASK
IF(ASK.EQ.'Y')THEN
CONTINUE
ELSE IF(ASK.EQ.'N')THEN
CALL CLEARSCREEN($GWINDOW)
GO TO 23
ELSE
D2=SETBKCOLOR(3)
D2=SETTEXTCOLOR(5)
CALL SETTEXTWINDOW(X1+5,Y1+6,X1+9,Y2-6)
CALL CLEARSCREEN($GWINDOW)
CALL SETTEXTPOSITION(X1-2,Y1+12,CURPOS)
WRITE(*,*)BEEP
WRITE(STR,'(A)')ASK

CALL OUTTEXT('Invalid response: '//STR)
READ(*,*)
CALL CLEARSCREEN($GWINDOW)
D2=SETBKCOLOR(1)
D2=SETTEXTCOLOR(15)
CALL SETTEXTWINDOW(X1-2,Y1,X2,Y2)
CALL CLEARSCREEN($GWINDOW)
GO TO 1280
END IF

CALL CLEARSCREEN($GWINDOW)
C This loop determines whether or not each node is composite.
ISCOMP(1)=0
DO 31 I=1,N-1
IF(COMP(I).EQ.COMP(I+1))THEN
ISCOMP(I+1)=0
ELSE
ISCOMP(I+1)=1
END IF
31 CONTINUE

C This loop assigns an identification integer to each node.
DO 35 I=1,N
IF(COMP(I).EQ.'A')THEN
NODE_ID(I)=1
ELSE IF(COMP(I).EQ.'B')THEN
NODE_ID(I)=2
ELSE IF(COMP(I).EQ.'C')THEN
NODE_ID(I)=3
ELSE IF(COMP(I).EQ.'D')THEN
NODE_ID(I)=4
ELSE
END IF
35 CONTINUE

WRITE(10,300)N
300 FORMAT(//20X,'RESULTS OF HEAT TRANSFER ANALYSIS FOR A THERMAL BLAN
$KET '
$/20X,'CONSISTING OF ',I2,' LAYERS OF THE FOLLOWING COMPOSITIONS: '//

```

\$/)

```
DO 36 I=1,N
WRITE(10,301)I,TYPE(I)
301  FORMAT(30X,'Layer ',I2,' is ',A)
36   CONTINUE

WRITE(10,302)
302  FORMAT(//20X,'where layer 1 is the high-temperature side.'////)

DEALLOCATE(COMP)

C    The actual analysis begins here.

40   TINC=TINC+1.00
      COUNT=COUNT+1

C    Determine the heat flux for the current time.

      IF(TINC.LT.30)THEN
      Q=QQ1(TINC)
      ELSE IF(TINC.GE.30.AND.TINC.LT.93)THEN
      Q=QQ2(TINC)
      ELSE IF(TINC.GE.93.AND.TINC.LT.98)THEN
      Q=QQ3(TINC)
      ELSE
      Q=QQ4(TINC)
      END IF

C    The matrix coefficients are determined here.

45   W=TF*(2*PN(K,TF,NODE_ID(N),NUMK)*DT) / (( P(NODE_ID(N-1))*PN(C,
$ TF,NODE_ID(N-1),NUMC) + P(NODE_ID(N))*PN(C,TF,NODE_ID(N),NUMC))
$ *DX2)

      Z=(2*Q*DT)/(P(NODE_ID(1))*PN(C,T(1),NODE_ID(1),NUMC)*DX)

      A(1,1)= 1.00 + ((2*PN(K,T(1),NODE_ID(1),NUMK)*DT)/(P(NODE_ID(1))*
$ PN(C,T(1),NODE_ID(1),NUMC)*DX2))

      A(1,2)= -(2*PN(K,T(2),NODE_ID(1),NUMK)*DT) / (P(NODE_ID(1))*PN(C,
$ T(2),NODE_ID(1),NUMC)*DX2)

DO 50 I=2,N

C    Composite node terms.

      A(I,I-1)=-(2*PN(K,T(I-1),NODE_ID(I-1),NUMK)*DT) /
$ ((P(NODE_ID(I-1))*PN(C,T(I-1),NODE_ID(I-1),NUMC) + P(NODE_ID(I))*
```

```

$ PN(C,T(I-1),NODE_ID(I),NUMC))*DX2)

A(I,I)=-((DT2)/((P(NODE_ID(I-1))*PN(C,T(I),NODE_ID(I-1),NUMC)
$ +P(NODE_ID(I))*PN(C,T(I),NODE_ID(I),NUMC))*DX))*
$ (((PN(K,T(I),NODE_ID(I-1),NUMK)+PN(K,T(I),NODE_ID(I),NUMK))/DX)
$ + ((P(NODE_ID(I-1))*PN(C,T(I),NODE_ID(I-1),NUMC)+P(NODE_ID(I))
$ * PN(C,T(I),NODE_ID(I),NUMC))*DX)/(DT2))

IF(I.LT.N)THEN
A(I,I+1)--(2*PN(K,T(I+1),NODE_ID(I),NUMK)*DT)/((P(NODE_ID(I-1))
$ *PN(C,T(I+1),NODE_ID(I),NUMC)+P(NODE_ID(I))*PN(C,T(I+1),
$ NODE_ID(I),NUMC))*DX2)

ELSE
END IF
50 CONTINUE

T(1)=T(1)+Z
T(N)=T(N)+W

C Solve the matrix.
CALL TRIDIAG(A,T,N,TMOD)

DO 55 I=1,N
T(I)=TMOD(I)
55 CONTINUE
100 CONTINUE

WRITE(10,216)TINC
216 FORMAT(4(/),25X,'AT t = ',F5.1,' SECONDS'//)

CALL SETTEXTPOSITION(X1-3,Y1+17,CURPOS)
WRITE(STR5,'(F5.1)')TINC
CALL OUTTEXT('At t = '//STR5// seconds;')

WRITE(11,261,ERR=119)TINC,(T(I),I=1,N+1)
261 FORMAT(F5.1,',',30(F8.3,','),F8.3)
119 CONTINUE

DO 120 I=1,N+1
CALL SETTEXTPOSITION(X1-2+I,Y1+15,CURPOS)
WRITE(STR8,'(F8.3)')T(I)
WRITE(STR,'(I2)')I
CALL OUTTEXT('T '//STR// - '//STR8// degrees F')
WRITE(10,217)I,T(I)
217 FORMAT(30X,'T ',I2,' - ',F11.4,' Degrees F')
120 CONTINUE

```

```

IF(TINC.LT.120)GOTO 40

CALL GETTIM(IHR2,IMIN2,ISEC2,I100TH2)

IF(ISEC2.LT.ISEC1)THEN
ISEC2=ISEC2+60
IMIN2=IMIN2-1
ELSE
END IF

IF(IMIN2.LT.IMIN1)THEN
IMIN2=IMIN2+60
IHR2=IHR2-1
ELSE
END IF

IHR=IHR2-IHR1
IMIN=IMIN2-IMIN1
ISEC=ISEC2-ISEC1
I100TH=I100TH2-I100TH1

CALL CLEARSCREEN($GWINDOW)

CALL SETTEXTPOSITION(X1+1,Y1+13,CURPOS)

WRITE(STR,'(I2)')IHR

WRITE(STRA,'(I2)')IMIN

WRITE(STRB,'(I2)')ISEC

CALL OUTTEXT('Total CPU time : '//STR//' : '//STRA//' : '//STRB)

CALL SETTEXTPOSITION(X1+5,Y1+13,CURPOS)

WRITE(STR30,'(A)')OUTPUT

CALL OUTTEXT('Results are in textfile '//STR30)

CALL SETTEXTPOSITION(X1+7,Y1+13,CURPOS)

WRITE(STR30,'(A)')SPRD

CALL OUTTEXT('and in spreadsheet file '//STR30)

CALL SETTEXTPOSITION(X1+12,Y1+13,CURPOS)

CALL OUTTEXT('Press a key to exit.....')

CALL LETTER()

D2=SETVIDEOMODE($DEFAULTMODE)

END

```


SUBROUTINE TRIDIAG(A,S,N,X)

C Subroutine to solve a tridiagonal (only) matrix.

C Developed by Dale E. Matthews

C Applied Thermal Section

C Southern Research Institute

C Birmingham, Alabama

REAL A(N,N),S(N),X(N)

INTEGER I,N

DO 20 I=1,N-1

A(I+1,I+1)=A(I+1,I+1)-((A(I+1,I)*A(I,I+1))/A(I,I))

S(I+1)=S(I+1)-((A(I+1,I)*S(I))/A(I,I))

20 CONTINUE

X(N)=S(N)/A(N,N)

DO 30 I=N-1,1,-1

X(I)=(S(I)-A(I,I+1)*X(I+1))/A(I,I)

30 CONTINUE

RETURN

END

FUNCTION PN(X,T,J,ORDER)

C This subroutine takes the coefficients of a polynomial from
C a datafile and evaluates the polynomial, using the variable
C "T" as it's argument.

C Developed by Dale E. Matthews
C Applied Thermal Section
C Southern Research Institute
C Birmingham, Alabama

REAL SUM,T
INTEGER J,ORDER
DIMENSION X(ORDER,4)

SUM=0.00

DO 10 I=1,ORDER

SUM=SUM+X(I,J)*(T**(I-1))

10 CONTINUE

PN=SUM

RETURN

END

APPENDIX E

CODE OPERATING INSTRUCTIONS

This program will run on any IBM or compatible computer having a standard amount of memory (640K). It has not been tested on computers having less memory, but it does not require an extensive amount of memory and should run on machines having 512K or maybe less. A math co-processor is recommended but not required. It will also run directly off of the diskette on which it came, but will run considerably faster if it is copied (with the three accompanying datafiles) to a hard drive and run from it.

To run the program, make the drive/directory containing the program and datafiles (they must exist in the same directory) the current directory and type "ASTC". After a brief introduction, you will be prompted for two datafile names, one of which is for a text file containing the results of the program for easy review, the other being a spreadsheet file containing the results in comma-separated ASCII format for easy importation to most spreadsheets, including Lotus, Supercalc, or Harvard Graphics. The datafiles may be written to any drive or directory by including the drive/directory specification in the filename specified, for example, to name the textfile "OUTPUT.TXT" and write it to the A:> drive, enter "A:\OUTPUT.TXT" at the textfile prompt. The spreadsheet file works the same way. Do not specify the same name for both files.

The next several prompts will be for the thermal curtain configuration to be analyzed. After the number of curtain layers and their thickness has been entered (if they differ, use an average), a menu will be displayed listing the material codes for Quartz, E-glass, Fiberfrax, and Kevlar. It will ask for each layer beginning at the high temperature side, so simply enter the code (A,B,C, or D) for the composition of each layer. It will then display what has been entered for verification, allowing for changes if necessary, and then begin the analysis.

Once the program has finished the analysis, it will display again where the output has been placed for retrieval.