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Westinghouse
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Heat Transfer Design Criteria For Electrical Transducers In A Nuclear Environment

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HEAT TRANSFER CALCULATIONS AND DESIGN CRITERIA
FOR ELECTRICAL TRANSDUCERS OPERATING IN A
NUCLEAR ENVIRONMENT

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1.0 INTRODUCTION

This report investigates the heat transfer characteristics of several types of NERVA candidate electrical transducers. Analysis of heat transfer aspects prior to irradiation is helpful in predicting the internal temperature during irradiation and thus, aids in selecting suitable types for testing. In general, the purpose of the heat transfer analysis is to guarantee a completely safe test, predict operational parameters, prevent effort on instruments which will obviously fail during testing and also help an instrument designer select arrangements for new designs that will give satisfactory heat transfer performance and thereby satisfy NERVA requirements.

Various materials of construction are discussed with respect to their thermal operating characteristics in a radiation environment. A method for calculating the internal temperatures of an instrument operating in a nuclear environment is presented.

2.0 NUCLEAR HEATING

Predicting the internal temperatures of an electrical instrument operating in a nuclear radiation environment is usually difficult from the heat transfer standpoint because of its complicated internal geometry and many heat flow paths. However, the calculations of the internal temperatures of an instrument can be made with reasonable accuracy with a computer. A digital or analog computer may be used if the details of the dimensions and materials of the internal parts are known and a few assumptions are made for the heat flow paths.

The major thermal problem for the instrument designer then, is to determine the effect of the temperatures on the operation and performance of the instrument. Except in cases where the calculated temperatures are high enough to cause obvious failure due to the limits of material properties, the effect of heating upon the operation of the instrument is unknown until it is tested. In some cases previous irradiation test data of a similar

instrument can be used to predict performance. A heat transfer analysis can predict total instrument failure but performance changes and degradation can only be accurately determined by irradiation tests.

A conservative approach is to establish during the initial design phase, the maximum temperature level which must not be exceeded and design the instrument accordingly. The thermal properties of the materials and heat flow paths should be considered in the design along with the electrical and mechanical design problems. In some cases internal cooling which has not been widely adapted for nuclear instrumentation can be used. At present, most of the effort has been directed toward modifying conventional type instruments for reactor applications. For these instruments there are usually areas where the thermal performance can be improved. This report provides information to assist in selecting the optimum designs for NERVA applications.

3.0 HEAT TRANSFER DESIGN CRITERIA

3.1 HEAT GENERATION

The internal temperatures of an instrument operating in a gamma and neutron flux field depend upon a thermal balance of the amount of heat generated internally and the resistance of heat flow through the instrument to the outside heat sink. Most of the heat generated internally is due to the primary gammas from the reactor which are converted into heat energy. The heat generated in a material is described by the following relation:

$$Q = \frac{\mu}{\rho} M I_{\gamma} C$$

Where: Q = Heat Generated, BTU/hr

$\frac{\mu}{\rho}$ = Mass absorption coefficient, cm^2/gm

M = Weight of material, lbs

I_{γ} = Gamma Flux, $\text{Mev}/\text{cm}^2\text{sec}$

C = Conversion Constant = 2.48×10^{-10} ,
BTU/Mev x gm/lb x sec/hr

It should be noted that the mass absorption coefficient is a function of the energy level of the gamma flux and the material. The coefficients for typical instrument materials are given in Table I. The heating due to activation from the neutron flux is usually not sufficient to be included in the calculations unless strong neutron absorbers such as boron and cadmium are present in the instrument. Materials with high cross sections for (n, γ) reaction and inelastic scattering should be avoided. For most materials the heat due to neutron activity can be disregarded. However, any design should be checked for materials

Table I⁽¹⁾
Mass Absorption Coefficients for Various Materials
Mass Absorption Coefficient, $\frac{\mu}{\rho}$ (cm²/gm)

Material	Energy (Mev)				
	0.5	1.0	2.0	4.0	8.0
Beryllium	0.0264	0.0248	0.0210	0.0164	0.0127
Carbon	0.0297	0.0280	0.0237	0.0190	0.0153
Nickel	0.0297	0.0280	0.0238	0.0193	0.0158
Magnesium	0.0293	0.0276	0.0237	0.0203	0.0182
Aluminum	0.0286	0.0270	0.0232	0.0200	0.0183
Iron	0.0294	0.0261	0.0231	0.0224	0.0239
Copper	0.0296	0.0260	0.0229	0.0227	0.0248
Molybdenum	0.0348	0.0263	0.0233	0.0250	0.0296
Tungsten	0.0786	0.0353	0.0271	0.0311	0.0390

1. Reference 1, page 7-63.

with high cross sections⁽¹⁾. If a high cross section material must be used, the higher heat generation rate will require special calculations to determine heat input from gammas generated in the material.

The thermal performance of an instrument requires an estimate of its internal resistance to heat flow. The following paragraphs outline methods for predicting these resistances to heat flow by conduction, convection and thermal radiation. The information can be used as a guide to help the designer select instrument configurations and materials that will give better thermal performance.

3.2 CONDUCTION

In the case of instruments heated by gamma radiation the physical properties of thermal conductivity and density are the most important. The heat generated is proportional to the density of the material and the conductance of heat from the material is proportional to the thermal conductivity. Table 2 lists the thermal performance of materials in decreasing order. A high ratio of K/ρ is desirable for instruments operating in a nuclear radiation environment.

3.3 GAS FILLED GAPS

In order to determine the heat transfer across gas filled gaps in the instruments, it is necessary to determine if the heat flow is controlled by free convection or conduction through the gas. This is determined by obtaining the ratio of the fluid buoyant forces to the viscous forces for a particular geometry (Grashof Number). For an annular gap, which is the most common for the electrical transducer because most of the parts are cylindrical, the product of Grashof Number and Prandtl Number⁽²⁾ is used to determine the dominate mechanism of heat transfer.

1. Reference 1, page 7-74

Table 2. List of Materials in Order of Thermal Performance

Material*	Density ρ	Thermal Conductivity -K	K/ρ
	109 lb/ft ³	88.9 $\frac{\text{BTU}}{\text{hr-ft-}^\circ\text{F}}$	.815
Magnesium	169	133	.787
Aluminum	115	85.0	.739
Beryllium	178	72.0	.405
BeO	655	238.0	.363
Silver	612	212.0	.347
Copper	517	125	.242
Beryllium Copper (Alloy 35)	550	109.0	.198
Bronze (90 Cu-10 Zn)	131	21.1	.162
**Boron Nitride	532	70.0	.132
Brass (70 Cu-30 Zn)	638	82.2	.129
Molybdenum	555	32.0	.058
Nickel	1200	70.0	.058
Tungsten	490	25.0	.051
Steel (mild 1%-C)	230	11.0	.048
Al ₂ O ₃ (pure)	282	11.5	.041
Titanium	1035	35.5	.035
Tantalum	530	14.0	.026
Mu-Metal (77 Ni, 5 Cu)	705	18.0	.026
Lead	488	11.0	.023
Stainless Steel (347)	548	8.7	.016
Inconel (76 Ni)	512	7.5	.015
Ni-Span C	169	1.45	.0086
Alsimag 645 (MgO)	181	0.965	.0053
Alsimag 508 (ZrO ₂)			

* Values are for pure metals unless specified. (T = 572°F)

** Boron Nitride may generate excessive amounts of heat due to neutron reaction for fluxes greater than 10^{10} n/cm² sec.

These quantities are defined as follows:

$$N_{Gr} = \frac{\rho^2 g \beta (T - T_{\infty}) X^3}{\mu^2} \text{ (Grashof Number)}$$

Where:

$$\rho = \text{Density, lb/ft}^3$$

$$g = \text{Acceleration due to gravity, } 4.17 \times 10^8 \text{ ft/hr}^2 \text{ (on earth)}$$

Note: This quantity will vary for space applications

$$\beta = \text{Coefficient of volumetric expansion, } 1/^{\circ}\text{F}$$

$$T = \text{Heat source temperature, } ^{\circ}\text{F}$$

$$T_{\infty} = \text{Heat sink temperature, } ^{\circ}\text{F}$$

$$X = \text{Gap thickness, ft}$$

$$\mu = \text{Viscosity, lb/hr-ft}$$

$$N_{Pr} = C_p \mu / K \text{ (Prandtl Number)}$$

Where:

$$C_p = \text{Specific heat of fluid, BTU/lb-}^{\circ}\text{F}$$

$$\mu = \text{Viscosity, lb/hr-ft}$$

$$K = \text{Thermal conductivity, BTU/hr-ft-}^{\circ}\text{F}$$

When the product of these two quantities is less than 1000 the dominant heat transfer mechanism is conduction and the heat flowing across an annular gap is calculated as

follows:

$$q = \frac{2\pi LK (T_1 - T_2)}{\ln D_2/D_1}$$

Where:

$$q = \text{BTU/hr}$$

$$L = \text{Length, ft}$$

$$K = \text{Thermal conductivity, BTU/hr-ft-}^\circ\text{F}$$

$$D_1 = \text{Inside diameter}$$

$$D_2 = \text{Outside diameter}$$

$$T_1 = \text{Inside temperature, }^\circ\text{F}$$

$$T_2 = \text{Outside temperature, }^\circ\text{F}$$

Figure 1 may be used for estimating the mechanism that must be considered. With conduction the heat flow across a gas filled gap is directly proportional to the thermal conductivity of the gas. There are many gases which can be used. Hydrogen gas is preferable from the conductivity standpoint, but due to its chemical activity, helium is usually the better choice. In the case where gaps are large and free convection is the controlling factor, the heat convection rates can be calculated using correlations developed by Bechmann and reported by Jakob⁽³⁾.

Since the thermal conductivity of a gas is not a function of its pressure,* pressurizing a gap will not improve its heat transfer characteristics if conduction is controlling. However, in the case where free convection is controlling, pressurization will improve the heat transfer and should be considered for designs with large gas gaps or cavities.

3. Reference 3, page 339.

* In a range near atmospheric conditions - Ref. 3, p. 71 - Ref. 4, p. 43.

$T_{\text{Gas}} = 200^{\circ}\text{F}$

$\Delta T \text{ (Between surfaces)} = 100^{\circ}\text{F}$

Figure I. Heat Transfer Mechanisms Across Gas Filled Gaps

3.4 EVACUATED GAPS

Heat transfer across partially evacuated gaps is a function of the molecular activity in the gap. As pressure is reduced, the mean free path of a molecule of gas increases. Eventually, the point is reached where the mean free path is equal to or greater than the dimensions of the gap or cavity in the instrument. At this condition the molecules will collide more frequently with the walls of the instrument than with each other, and the gas flow is said to be of the molecular type. With molecular flow, the heat transferred by the gas is too small to be considered within the range of most calculations. The heat transferred for this arrangement then must be determined by evaluating the radiation heat transfer. A plot is presented in Figure 2 which can be used to determine if an evacuated gap has molecular flow⁽⁴⁾. Any point on the plot above the shaded area indicates the ordinary type viscous flow, and below the shaded area molecular flow. The plot can be used for air and helium. For values which fall in the transition range, a detailed method of calculation is described in Reference 4.

3.5 RADIATION

The amount of heat transferred by thermal radiation between surfaces in the instrument is usually less than that by conduction and convection. However, for highly evacuated gaps it is the dominant type of heat transfer. It also may become an important heat transfer mechanism for gas filled gaps when the temperature differences across the gaps are high. This latter situation is described in Reference 5.

The rate of heat transfer by radiation between two surfaces is calculated as follows:

$$q = A_1 F_{1-2} \sigma (T_1^4 - T_2^4) \text{ BTU/hr}$$

Where:

$$A_1 = \text{Surface area of heat source, ft}^2$$

$$F_{1-2} = \text{Grey body shape factor}$$

Figure 2. Flow Regimes of Evacuated Gaps

σ = Stefan-Boltzmann constant, BTU/hr-ft²-°R (0.1714 x 10⁻⁸)

T_1 = Source temperature, °R

T_2 = Sink temperature, °R

The grey body shape factor is a function of the thermal emissivity of the transmitting and receiving surfaces and the geometrical configuration.

For two parallel flat plates, neglecting end effects the shape factor is as follows:

$$F_{1-2} = \frac{1}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1}$$

where ϵ_1 and ϵ_2 are the emissivities of the transmitting and receiving surfaces, respectively. (See Reference 2 for these values).

For concentric cylinders the shape factor is as follows:

$$F_{1-2} = \frac{1}{\frac{1}{\epsilon_1} + \frac{A_1}{A_2} \left(\frac{1}{\epsilon_2} - 1 \right)}$$

From these equations it is evident that the temperature levels are of primary importance for high radiation heat transfer. For a fixed temperature difference the radiation heat transfer from a surface may be increased by enlarging the total radiating surface or improving the shape factor. Coatings may be applied to increase the emissivity of a surface. Generally, the rougher and blacker the surface the higher the thermal emissivity.

3.6 THERMAL CONDUCTION ACROSS JOINTS

The thermal conductance of metal joints must be considered for designs of most instruments. Thermal performance can be improved by using polished surfaces, high contact pressures and ductile materials. The curves shown in Figures 3 and 4 are results of heat conduction tests across metal joints. Two dimensionless parameters developed by W.J. Graff⁽⁶⁾ are used for these correlations. They are as follows:

Figure 3 Dimensionless Plot of Thermal Conductance Versus Pressure for Various Aluminum Alloys

Figure 4 Dimensionless Plot of Thermal Conductance Versus Pressure for Ferrous Materials at Mean Interface Temperatures of 70-200 F.

$hp/k\rho$ = Dimensionless conductance

h = Thermal conductance coefficient for joint interface

$$= \text{BTU/hr-ft}^2\text{-F}$$

p = Pressure with which the two metal surfaces are pressed together, lb/ft^2

k = Thermal conductivity of material, BTU/hr-ft-F

ρ = Density of material, lb/ft^3

The second parameter:

P/B = Dimensionless pressure

p = Same as above

B = Brinell hardness number

The temperature drop across a joint can be calculated by the following relation using the thermal conductance coefficient h .

$$\Delta T = q/hA, ^\circ\text{F}$$

Where:

q = Heat flow across joint, BTU/hr

h = Joint thermal conductance coefficient, $\text{BTU/hr - ft}^2\text{-}^\circ\text{F}$

A = Area of joint interface perpendicular to heat flow path, ft^2

When designing components which require heat transfer across joints, particular attention must be given to the thermal expansion characteristics of the materials used. If dissimilar materials are used at a joint, allowance must be made for change in contact pressures due to thermal expansion.

3.7 THERMAL CONDUCTION THROUGH POWDERS

Frequently, electrical instruments which generate heat internally have poor heat conduction paths from the interior to the exterior because the materials used for electrical insulation are also thermal insulators. In order to improve the thermal conductivity and maintain the desired electrical characteristics, it is often necessary to use ceramic materials. Since ceramic parts are difficult to fabricate, the powdered form is desirable. Beryllium oxide powder is a good candidate because of its high thermal conductivity.*

A method of calculation of the heat transfer characteristics of powder has been established analytically and checked experimentally with good agreement by Deissler and Eian⁽⁷⁾, and a curve derived by this investigation is shown in Figure 5.

To use this curve it is necessary to know the thermal conductivities of the powdered material as a solid and of the gas filling the voids, and also, the volume fraction of gas space. The conductivities of the solid and gas are available in the literature and the volume fraction can be determined by observing the weight of powder and the volume of cavity filled. Since density of the powdered material in solid form is known, the void can be determined. A typical example with a BeO powder and helium gas is:

$$\text{Assume: } V_g/V_s = \text{Volume gas/Volume solid} = 0.20$$

$$K_s = 72.0 \text{ BTU/hr-ft-F BeO Thermal Conductivity}$$

$$K_g = 0.10 \text{ BTU/hr-ft-F He Thermal Conductivity}$$

$$\text{Then: } K_s/K_g = 72.0/0.10 = 720$$

From Figure 5:

$$K/K_g = 68.0$$

$$K = 68.0 \times 0.10 = 6.8 \text{ BTU/hr-ft-F}$$

$$= \text{Thermal Conductivity of Powder}$$

*It should be noted that this material is highly toxic and special precautions are necessary for handling.

Figure 5 Curves for Predicting Effective Thermal Conductivity of Powder

This shows the magnitude of improvement in heat conductivity which can be achieved by using a BeO filled gap instead of a gas filled one. In this case the improvement was a factor of 68 for a BeO filled gap over a helium filled gap. It should be noted, however, that some heat is generated in the BeO powder but this detracts only slightly from the improvement.

4.0 HEAT TRANSFER CALCULATIONS

A modified version of an IBM 7094 computer code developed by ORNL⁽⁸⁾ will rapidly determine the balance of heat input and the resistance to heat flow in many exit paths. Briefly, the computer code, called TOSS (Transient or Steady State), is set up to solve the problem by dividing the instrument into many cells or internal nodes. Each internal node is described by its physical dimensions and physical properties of conductivity, heat generation rate and the volume which determines its thermal performance. Other nodes called surface nodes are established to describe the surface area in contact with a cooling fluid and its film coefficient. The heat flow paths are described by connectors which are a function of thermal conductivity, the path length, and the area perpendicular to the heat flow. A model of the instrument is described by these nodes and transformed to input for the IBM 7094 computer. The program can handle a problem with a maximum of 450 internal nodes and 250 surface nodes. The connectors are limited to seven from each internal node.

The computer solves the problem by simultaneous solution of the many linear equations describing the heat flow paths. When the heat balance is established by the computer, all of the temperatures of the nodes are calculated and printed. The calculation usually requires about 2 minutes of computer time for an instrument with 100 nodes. A typical heat transfer calculation for a pressure transducer is presented in Appendix A. Appendix B contains results of TOSS calculations for several instruments.

5.0 REFERENCES

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7. NACA RM E52C05, "Investigation of Effective Thermal Conductivities of Powders," R. G. Deissler and C. S. Eian, June, 1952.
8. D. Bagwell, "TOSS-An IBM-7090 Code for Computing Transient or Steady Temperature Distributions", Union Carbide Nuclear Company, K-1494, December, 1961.

APPENDIX A

*Sample Calculation of Internal
Temperatures of an Electrical Transducer
by the TOSS Code*

Sample Calculation of Internal Temperatures of an Electrical Transducer by the TOSS Computer Code

The pressure transducer shown in Figure A-1 is a candidate for NERVA application, and must be tested in a nuclear radiation environment prior to use in a NERVA reactor. The transducer will be irradiated in the Plum Brook Test Reactor if the instrument is judged to be satisfactory by some preliminary analysis and performance tests conducted prior to irradiation. Prior to irradiation testing the instrument must be carefully checked for its thermal performance. If a calculation of its internal temperatures shows that it will obviously fail during test at Plum Brook it will be modified or dropped from the test program.

Presented here is a typical calculation of the internal temperatures of a pressure transducer operating with water flowing past its surfaces and with an internal heat generation rate of 4.0 watts per gram. These are the conditions to which the instrument will be subjected during tests at Plum Brook. A plot of gamma heat generation rate for the HT-1 tube used by Westinghouse is shown in Figure A-2.

Figure A-3 is a working sketch of the instrument divided into cells or nodes for the computer calculation. Two major tasks are required to prepare the input data for the TOSS computer code: The preparation of the internal node input data and the node connector input data. The internal node input contains the following information:

1. Node number (from Figure A-1, 1 to 450)
2. Node material (Code No., from material list)
3. Length, in.
4. Width, in.
5. Depth, in.
6. Base heat generation rate, BTU/hr-in^3

Figure A-2. Gamma Heating Rate in Plum Brook Test Reactor

The internal node material is specified by a material list that gives each material a code number, specific heat, density and thermal conductivity. The geometry of the node is specified by length, width, and depth. Since this instrument is cylindrical in shape, all of the nodes are described by length, width and mean circumference. The mean circumference is 2π times the radius of the node at its center.

The base heat generation rate can be selected as 1.0 watt per gram which will be multiplied by 4.0 from the power factor input. Figure A-2 shows the best available heat generation rate in the Plum Brook test reactor at the location used for NERVA irradiation tests. Each material will have its own heat generation rate dependent on its density. The following equation can be solved to give the base heat generation rate:

$$\begin{aligned}(\text{BTU/hr-in}^3) &= 1.0 \text{ watt/gm} \times 3.413 \text{ BTU/hr-watt} \times 454 \text{ gm/lb} \times \rho \text{ lb/in}^3 \\ &= 1549.5 \times \rho \text{ lb/in}^3\end{aligned}$$

In this case there are 81 internal nodes. The internal connectors describe the arrangement in which internal nodes are connected with respect to the heat conduction geometry.

Each connector contains the following information:

1. Node I (Node No. I connected to Node J)
2. Node J
3. Length from center of Node I to its boundary in contact with Node J (in.)
4. Length from center of Node J to its boundary in contact with Node I (in.)
5. Width of the contact area (in.)
6. Depth of contact area (in.)

The width and depth are multiplied by the computer to give an area perpendicular to the direction of heat flow. From this and the physical properties of the materials the computer establishes the thermal conductance or admittance along this heat flow path. Other similar connectors connect internal nodes to surface nodes (designated by numbers between

1001 and 1250). Surface connectors describe the heat transfer characteristic of the surface of the instrument. In this case forced convection with a film coefficient of $1000 \text{ BTU/hr-ft}^2 \text{ } ^\circ\text{F}$ is used. A boundary node (number 2001 for this example) is specified as the heat sink and in this case is set at 150° , the maximum temperature of the coolant water at the test location in Plum Brook. An estimate of the internal temperatures is required but it need not be carefully selected, unless computer time is excessive, since this is an iterative process. In this case 212°F was put in for all nodes. It should be noted that the calculation shown has no thermal radiation factors; therefore, all temperatures are in Fahrenheit. If it is required to include radiation heat transfer, when temperature differences across gaps are high, the temperatures must be put into the computer in absolute units.

The input data is then recorded on punched IBM cards. A listing of these cards is shown in Table A-1. The output for this problem is shown on the pages following the input. The computer has established a heat balance and the internal and surface temperatures are printed with its identifying node number. Table A-2 shows the output for this problem. The results of this output are shown in Figure A-4.

Table A-I

INTERNAL TEMPS.- PHYSICAL SCIENCES PRESSURE TRANSDUCER									
0.		0.	.01	0.01		2	1	LIMIT	
								BLANK	
1	212.0	2	212.0	3	212.0	4	212.0	TP	
5	212.0	6	212.0	7	212.0	8	212.0	TP	
9	212.0	10	212.0	11	212.0	12	212.0	TP	
13	212.0	14	212.0	15	212.0	16	212.0	TP	
17	212.0	18	212.0	19	212.0	20	212.0	TP	
21	212.0	22	212.0	23	212.0	24	212.0	TP	
25	212.0	26	212.0	27	212.0	28	212.0	TP	
29	212.0	30	212.0	31	212.0	32	212.0	TP	
33	212.0	34	212.0	35	212.0	36	212.0	TP	
37	212.0	38	212.0	39	212.0	40	212.0	TP	
41	212.0	42	212.0	43	212.0	44	212.0	TP	
45	212.0	46	212.0	47	212.0	48	212.0	TP	
49	212.0	50	212.0	51	212.0	52	212.0	TP	
53	212.0	54	212.0	55	212.0	56	212.0	TP	
57	212.0	58	212.0	59	212.0	60	212.0	TP	
61	212.0	62	212.0	63	212.0	64	212.0	TP	
65	212.0	66	212.0	67	212.0	68	212.0	TP	
69	212.0	70	212.0	71	212.0	72	212.0	TP	
73	212.0	74	212.0	75	212.0	76	212.0	TP	
77	212.0	78	212.0	79	212.0	80	212.0	TP	
81	212.0							TP	
1034	212.0	1036	212.0	1037	212.0	1038	212.0	TP	
1039	212.0	1052	212.0	1060	212.0	1061	212.0	TP	
1062	212.0	1063	212.0	1064	212.0	1065	212.0	TP	
1068	212.0	1069	212.0	1077	212.0			TP	
2001	150.							TP	
								BLANK	
								BLANK	
INC600	21	0.12	0.286	8.66				MATRL	
COIL	22	0.100	0.118	5.0				MATRL	
HELIUM	23	1.24	3.7E-6	0.115				MATRL	
INC750	24	0.12	0.286	9.00				MATRL	
316 SS	25	0.12	0.286	10.0				MATRL	
304 SS	26	0.12	0.286	10.0				MATRL	
TIAL15	27	0.12	0.298	9.0				MATRL	
QUARTZ	28	0.20	0.098	0.2				MATRL	
								BLANK	
	1	24	.20	.0125	.0393	444.		IN	
	2	27	.20	.0525	.239	462.		IN	
	3	23	.20	.010	.392	000.		IN	
	4	21	.20	.0125	.483	444.		IN	
	5	21	.098	.0125	.483	444.		IN	
	6	21	.098	.0125	.483	444.		IN	
	7	21	.187	.0125	.552	444.		IN	
	8	21	.187	.0125	.525	444.		IN	

Table A-I (Cont'd)

9	22	.187	.130	1.00	182.	IN
10	22	.187	.130	1.00	182.	IN
11	28	.187	.0025	1.44	152.	IN
12	28	.187	.0025	1.44	152.	IN
13	21	.010	.16	1.00	444.	IN
14	21	.020	.16	1.00	444.	IN
15	21	.020	.16	1.00	444.	IN
16	23	.080	.070	0.22	0.0	IN
17	21	.020	.070	0.22	444.	IN
18	21	.035	.030	0.345	444.	IN
19	21	.165	.040	.125	444.	IN
20	21	.100	.030	.095	444.	IN
21	21	.080	.040	.125	444.	IN
22	21	.200	.040	.125	444.	IN
23	21	.120	.030	.095	444.	IN
24	25	.125	.065	1.13	444.	IN
25	25	.085	.090	1.07	444.	IN
26	25	.050	.080	1.07	444.	IN
27	25	.05	.07	1.57	444.	IN
28	25	.05	.05	1.95	444.	IN
29	24	.150	.05	1.95	444.	IN
30	24	.065	.05	1.95	444.	IN
31	24	.065	.025	1.70	444.	IN
32	24	.050	.025	1.70	444.	IN
33	24	.105	.035	1.73	444.	IN
34	24	.082	.030	2.32	444.	IN
35	24	.110	.030	2.32	444.	IN
36	24	.180	.030	2.32	444.	IN
37	24	.200	.030	2.32	444.	IN
38	24	.200	.030	2.32	444.	IN
39	24	.110	.120	2.82	444.	IN
40	23	.187	.0185	1.54	0.0	IN
41	23	.187	.0185	1.54	0.0	IN
42	24	.085	.0125	.0393	444.	IN
43	24	.090	.0125	.0393	444.	IN
44	24	.125	.0125	.0393	444.	IN
45	24	.125	.01	.125	444.	IN
46	24	.005	.075	.235	444.	IN
47	24	.005	.060	.625	444.	IN
48	24	.005	.090	1.065	444.	IN
49	24	.005	.120	1.57	444.	IN
50	24	.005	.040	1.88	444.	IN
51	24	.025	.025	1.88	444.	IN
52	24	.125	.085	2.14	444.	IN
53	24	.255	.035	1.76	444.	IN
54	24	.050	.090	1.57	444.	IN
55	24	.042	.077	1.03	444.	IN
56	24	.065	.050	0.628	444.	IN

Table A-I (Cont'd)

57	21	.060	.130	0.85	444.	IN
58	21	.040	.080	1.51	444.	IN
59	24	.150	.045	.345	444.	IN
60	24	.140	.050	.628	444.	IN
61	24	.080	.070	1.03	444.	IN
62	24	.080	.090	1.57	444.	IN
63	24	.130	.040	1.95	444.	IN
64	24	.075	.055	2.20	444.	IN
65	24	.080	.035	2.32	444.	IN
66	23	.005	.250	1.91	0.0	IN
67	23	.005	.105	1.91	0.0	IN
68	24	.250	.085	2.08	444.	IN
69	24	.100	.085	2.08	444.	IN
70	23	.005	.050	1.95	0.0	IN
71	23	.050	.005	1.91	0.0	IN
72	24	.035	.035	1.95	444.	IN
73	24	.025	.02	1.55	444.	IN
74	23	.17	.05	.25	0.0	IN
75	21	.11	.10	.35	444.	IN
76	21	.11	.10	.35	444.	IN
77	21	.11	.20	1.40	444.	IN
78	23	.15	.15	1.32	0.0	IN
79	23	.34	.14	1.80	0.0	IN
80	23	.25	.02	2.20	0.0	IN
81	23	.04	.22	1.0	0.0	IN
BLANK						
1	2	.00625	.026	.20	.079	IC
1	16	.10	.04	.0125	.039	IC
1	42	.010	.042	.0125	.039	IC
2	3	.026	.005	.20	.392	IC
2	16	.10	.04	.04	.220	IC
2	74	.10	.08	.045	.220	IC
3	4	.005	.006	.20	.440	IC
4	5	.10	.049	.0125	.470	IC
4	6	.10	.049	.0125	.470	IC
4	7	.0625	.0625	.10	.500	IC
4	8	.0625	.0625	.10	.500	IC
4	13	.0625	.080	.010	.500	IC
5	7	.0625	.0625	.10	.500	IC
5	14	.048	.08	.0125	.470	IC
5	74	.005	.025	.10	.44	IC
6	8	.0625	.0625	.10	.500	IC
6	15	.048	.08	.0125	.470	IC
6	17	.048	.035	.018	.440	IC
7	9	.0625	.065	.187	.595	IC
7	13	.093	.08	.0125	.565	IC
7	14	.093	.08	.0125	.565	IC
8	10	.0625	.065	.187	.595	IC

Table A-1 (Cont'd)

8	13	.093	.08	.0125	.565	IC
8	15	.093	.08	.0125	.565	IC
9	11	.065	.0012	.187	1.44	IC
9	13	.0935	.005	.130	1.00	IC
9	14	.0935	.010	.130	1.00	IC
10	12	.065	.0012	.187	1.44	IC
10	13	.0935	.005	.130	1.00	IC
10	15	.0935	.010	.130	1.00	IC
11	40	.00125	.0092	.187	1.44	IC
12	41	.00125	.0092	.187	1.44	IC
14	57	.010	.030	.130	0.85	IC
15	18	.08	.015	.020	0.44	IC
15	78	.015	.075	.17	0.95	IC
16	17	.040	.010	.070	.220	IC
17	18	.035	.020	.030	0.346	IC
17	19	.035	.080	.040	0.125	IC
19	20	.080	.050	.030	0.095	IC
20	21	.050	.040	.030	0.095	IC
20	75	.015	.050	.10	.19	IC
21	22	.040	.100	.040	0.125	IC
22	23	.100	.060	.030	0.095	IC
23	76	.015	.050	.10	.19	IC
24	25	.061	.042	.065	1.13	IC
24	79	.030	.080	.25	1.35	IC
25	26	.042	.025	.080	1.13	IC
25	75	.04	.050	.06	.82	IC
26	27	.040	.035	.050	1.32	IC
26	75	.04	.050	.05	.82	IC
26	78	.025	.075	.08	1.10	IC
27	28	.035	.025	.050	1.78	IC
27	78	.025	.075	.06	1.57	IC
28	29	.025	.07	.015	2.07	IC
28	70	.025	.0025	.050	1.95	IC
29	30	.075	.030	.050	1.95	IC
29	70	.075	.0025	.050	1.95	IC
29	78	.025	.075	.15	1.82	IC
29	80	.025	.010	.25	2.10	IC
30	31	.025	.0125	.065	1.76	IC
31	32	.032	.027	.025	1.68	IC
31	41	.012	.009	.060	1.58	IC
32	33	.027	.050	.025	1.68	IC
32	41	.012	.009	.050	1.58	IC
33	41	.017	.009	.100	1.58	IC
33	53	.050	.125	.035	1.73	IC
33	67	.017	.0025	.100	1.82	IC
34	35	.040	.050	.030	2.32	IC
34	69	.040	.070	.030	2.32	IC
34	1034	.015		.08	2.39	IC

Table A-I (Cont'd)

35	36	.055	.090	.030	2.32	IC
35	39	.015	.060	.110	2.42	IC
35	80	.015	.010	.25	2.20	IC
36	37	.090	.100	.030	2.32	IC
36	1036	.015		.18	2.39	IC
37	38	.100	.100	.030	2.32	IC
37	79	.015	.080	.25	2.20	IC
37	1037	.015		.20	2.39	IC
38	77	.02	.10	.03	2.20	IC
38	1038	.015		.20	2.39	IC
39	1039	.050		.30	2.82	IC
40	53	.009	.017	.187	1.58	IC
40	41	.05	.05	.018	1.50	IC
42	43	.045	.045	.0125	.039	IC
42	74	.0062	.025	.080	.079	IC
43	44	.045	.060	.0125	.039	IC
43	74	.0062	.025	.080	.079	IC
44	45	.00625	.00625	.125	0.392	IC
44	46	.062	.0025	.0125	.039	IC
45	46	.062	.0025	.01	0.235	IC
46	47	.035	.030	.005	0.505	IC
47	48	.030	.045	.005	0.82	IC
48	49	.045	.060	.005	1.25	IC
49	50	.060	.020	.005	1.82	IC
50	51	.0025	.012	.025	1.88	IC
50	72	.0025	.017	.035	1.88	IC
51	52	.025	.060	.035	1.88	IC
51	54	.025	.060	.005	1.88	IC
52	54	.042	.045	.060	1.90	IC
52	65	.060	.035	.030	2.26	IC
52	68	.060	.130	.085	2.13	IC
52	1052	.045		.12	2.39	IC
53	66	.017	.0025	.255	1.91	IC
53	73	.125	.012	.020	1.70	IC
54	55	.045	.035	.040	0.125	IC
55	56	.035	.025	.050	0.82	IC
55	81	.02	.02	.18	1.56	IC
57	58	.065	.025	.040	.125	IC
57	74	.065	.025	.06	.44	IC
57	81	.03	.02	.18	1.56	IC
58	71	.025	.0025	.040	.157	IC
58	73	.025	.010	.010	1.58	IC
59	60	.022	.025	.130	.502	IC
60	61	.025	.0350	.080	.820	IC
60	1060	.070		.05	0.60	IC
61	62	.035	.045	.080	1.26	IC
61	1061	.030		.07	1.06	IC
62	63	.045	.02	.090	1.82	IC

Table A-I (Cont'd)

62	1062	.030		.08	1.57	IC
63	64	.02	.03	.072	2.08	IC
63	1063	.045		.04	1.90	IC
64	65	.037	.04	.035	2.30	IC
64	1064	.025		.10	2.39	IC
65	1065	.015		.075	2.39	IC
66	68	.0025	.045	.250	1.89	IC
67	69	.0025	.100	.100	1.89	IC
68	69	.125	.050	.090	2.14	IC
68	1068	.045		.25	2.39	IC
69	1069	.045		.10	2.39	IC
71	73	.0025	.010	.025	1.63	IC
76	77	.050	.10	.10	1.45	IC
77	79	.050	.160	.20	1.35	IC
77	1077	.050		.20	1.45	IC
						BLANK
						BLANK
1034	2001	.08	2.39	1000.		BC
1036	2001	.18	2.39	1000.		BC
1037	2001	.20	2.39	1000.		BC
1038	2001	.20	2.39	1000.		BC
1039	2001	.30	2.82	1000.		BC
1052	2001	.12	2.39	1000.		BC
1060	2001	.05	0.60	1000.		BC
1061	2001	.07	1.06	1000.		BC
1062	2001	.08	1.57	1000.		BC
1063	2001	.04	1.90	1000.		BC
1064	2001	.10	2.39	1000.		BC
1065	2001	.075	2.39	1000.		BC
1068	2001	.25	2.39	1000.		BC
1069	2001	.10	2.39	1000.		BC
1077	2001	.20	1.45	1000.		BC
						BLANK
4.0	0.00					POWER
						BLANK
						BLANK
						BLANK

Table A-2

TOSS A TRANSIENT OR STEADY STATE TEMPERATURE DISTRIBUTION PROGRAM

INTERNAL TEMPS.- PHYSICAL SCIENCES PRESSURE TRANSDUCER.

11/24/64

TIME= 15.350

SPECIFICATIONS

INITIAL TIME 0.	FINAL TIME 0.	TIME INCREMENT 0.0100	CONVERGE CRITERIA 0.0100	CONVERGE AFTER -0.	TYPE 2	1
BOUNDARY AND SURFACE TEMPERATURES						
NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE
1034	212.00	1036	212.00	1037	212.00	1038
1052	212.00	1060	212.00	1061	212.00	1062
1064	212.00	1065	212.00	1068	212.00	1069
2001	150.00					1077

BOUNDARY TEMPERATURE TABLES

NODE	TEMP	TIME	TEMP	TIME	TEMP	TIME	TEMP	TIME	TEMP	TIME
------	------	------	------	------	------	------	------	------	------	------

MATERIALS

	NO.	HEAT CAP.	DENSITY	CONDUCTIVITY
INC600	21	0.1200	0.2860	8.6600
COIL	22	0.1000	0.1180	5.0000
HELIUM	23	1.2400	0.	0.1150
INC750	24	0.1200	0.2860	9.0000
316 SS	25	0.1200	0.2860	10.0000
304 SS	26	0.1200	0.2860	10.0000
TIAL15	27	0.1200	0.2980	9.0000
QUARTZ	28	0.2000	0.0980	0.2000

INTERNAL NODES

NODE	MATERIAL	LENGTH	WIDTH	DEPTH	VOLUME	BASE GEN.	CAPACITY
1	INC750 24	0.2000	0.0125	0.0393	0.0001	0.4440E 03	0.2023E-03
2	TIAL15 27	0.2000	0.0525	0.2390	0.0025	0.4620E 03	0.5384E-02
3	HELIUM 23	0.2000	0.0100	0.3920	0.0008	0.	0.
4	INC600 21	0.2000	0.0125	0.4830	0.0012	0.4440E 03	0.2486E-02
5	INC600 21	0.0980	0.0125	0.4830	0.0006	0.4440E 03	0.1218E-02
6	INC600 21	0.0980	0.0125	0.4830	0.0006	0.4440E 03	0.1218E-02
7	INC600 21	0.1870	0.0125	0.5520	0.0013	0.4440E 03	0.2657E-02
8	INC600 21	0.1870	0.0125	0.5250	0.0012	0.4440E 03	0.2527E-02
9	COIL 22	0.1870	0.1300	1.0000	0.0243	0.1820E 03	0.1721E-01
10	COIL 22	0.1870	0.1300	1.0000	0.0243	0.1820E 03	0.1721E-01
11	QUARTZ 28	0.1870	0.0025	1.4400	0.0007	0.1520E 03	0.7917E-03
12	QUARTZ 28	0.1870	0.0025	1.4400	0.0007	0.1520E 03	0.7917E-03

Table A-2 (Cont'd)

13	INC600	21	0.0100	0.1600	1.0000	0.0016	0.4440E 03	0.3295E-02
14	INC600	21	0.0200	0.1600	1.0000	0.0032	0.4440E 03	0.6589E-02
15	INC600	21	0.0200	0.1600	1.0000	0.0032	0.4440E 03	0.6589E-02
16	HELIUM	23	0.0800	0.0700	0.2200	0.0012	0.	0.
17	INC600	21	0.0200	0.0700	0.2200	0.0003	0.4440E 03	0.6342E-03
18	INC600	21	0.0350	0.0300	0.3450	0.0004	0.4440E 03	0.7459E-03
19	INC600	21	0.1650	0.0400	0.1250	0.0008	0.4440E 03	0.1699E-02
20	INC600	21	0.1000	0.0300	0.0950	0.0003	0.4440E 03	0.5869E-03
21	INC600	21	0.0800	0.0400	0.1250	0.0004	0.4440E 03	0.8237E-03
22	INC600	21	0.2000	0.0400	0.1250	0.0010	0.4440E 03	0.2059E-02
23	INC600	21	0.1200	0.0300	0.0950	0.0003	0.4440E 03	0.7042E-03
24	316 SS	25	0.1250	0.0650	1.1300	0.0092	0.4440E 03	0.1891E-01
25	316 SS	25	0.0850	0.0900	1.0700	0.0082	0.4440E 03	0.1686E-01
26	316 SS	25	0.0500	0.0800	1.0700	0.0043	0.4440E 03	0.8813E-02
27	316 SS	25	0.0500	0.0700	1.5700	0.0055	0.4440E 03	0.1132E-01
28	316 SS	25	0.0500	0.0500	1.9500	0.0049	0.4440E 03	0.1004E-01
29	INC750	24	0.1500	0.0500	1.9500	0.0146	0.4440E 03	0.3012E-01
30	INC750	24	0.0650	0.0500	1.9500	0.0063	0.4440E 03	0.1305E-01
31	INC750	24	0.0650	0.0250	1.7000	0.0028	0.4440E 03	0.5689E-02
32	INC750	24	0.0500	0.0250	1.7000	0.0021	0.4440E 03	0.4376E-02
33	INC750	24	0.1050	0.0350	1.7300	0.0064	0.4440E 03	0.1309E-01
34	INC750	24	0.0820	0.0300	2.3200	0.0057	0.4440E 03	0.1175E-01
35	INC750	24	0.1100	0.0300	2.3200	0.0077	0.4440E 03	0.1577E-01
36	INC750	24	0.1800	0.0300	2.3200	0.0125	0.4440E 03	0.2580E-01
37	INC750	24	0.2000	0.0300	2.3200	0.0139	0.4440E 03	0.2866E-01
38	INC750	24	0.2000	0.0300	2.3200	0.0139	0.4440E 03	0.2866E-01
39	INC750	24	0.1100	0.1200	2.8200	0.0372	0.4440E 03	0.7665E-01
40	HELIUM	23	0.1870	0.0185	1.5400	0.0053	0.	0.
41	HELIUM	23	0.1870	0.0185	1.5400	0.0053	0.	0.
42	INC750	24	0.0850	0.0125	0.0393	0.0000	0.4440E 03	0.8598E-04
43	INC750	24	0.0900	0.0125	0.0393	0.0000	0.4440E 03	0.9104E-04
44	INC750	24	0.1250	0.0125	0.0393	0.0001	0.4440E 03	0.1264E-03
45	INC750	24	0.1250	0.0100	0.1250	0.0002	0.4440E 03	0.3217E-03
46	INC750	24	0.0050	0.0750	0.2350	0.0001	0.4440E 03	0.1815E-03
47	INC750	24	0.0050	0.0600	0.6250	0.0002	0.4440E 03	0.3861E-03
48	INC750	24	0.0050	0.0900	1.0650	0.0005	0.4440E 03	0.9869E-03
49	INC750	24	0.0050	0.1200	1.5700	0.0009	0.4440E 03	0.1940E-02
50	INC750	24	0.0050	0.0400	1.8800	0.0004	0.4440E 03	0.7743E-03
51	INC750	24	0.0250	0.0250	1.8800	0.0012	0.4440E 03	0.2420E-02
52	INC750	24	0.1250	0.0850	2.1400	0.0227	0.4440E 03	0.4682E-01
53	INC750	24	0.2550	0.0350	1.7600	0.0157	0.4440E 03	0.3235E-01
54	INC750	24	0.0500	0.0900	1.5700	0.0071	0.4440E 03	0.1455E-01
55	INC750	24	0.0420	0.0770	1.0300	0.0033	0.4440E 03	0.6859E-02
56	INC750	24	0.0650	0.0500	0.6280	0.0020	0.4440E 03	0.4203E-02
57	INC600	21	0.0600	0.1300	0.8500	0.0066	0.4440E 03	0.1365E-01
58	INC600	21	0.0400	0.0800	1.5100	0.0048	0.4440E 03	0.9950E-02
59	INC750	24	0.1500	0.0450	0.3450	0.0023	0.4440E 03	0.4795E-02
60	INC750	24	0.1400	0.0500	0.6280	0.0044	0.4440E 03	0.9052E-02

Table A-2 (Cont'd)

61	INC750	24	0.0800	0.0700	1.0300	0.0058	0.4440E 03	0.1188E-01
62	INC750	24	0.0800	0.0900	1.5700	0.0113	0.4440E 03	0.2328E-01
63	INC750	24	0.1300	0.0400	1.9500	0.0101	0.4440E 03	0.2088E-01
64	INC750	24	0.0750	0.0550	2.2000	0.0091	0.4440E 03	0.1869E-01
65	INC750	24	0.0800	0.0350	2.3200	0.0065	0.4440E 03	0.1338E-01
66	HELIUM	23	0.0050	0.2500	1.9100	0.0024	0.	0.
67	HELIUM	23	0.0050	0.1050	1.9100	0.0010	0.	0.
68	INC750	24	0.2500	0.0850	2.0800	0.0442	0.4440E 03	0.9102E-01
69	INC750	24	0.1000	0.0850	2.0800	0.0177	0.4440E 03	0.3641E-01
70	HELIUM	23	0.0050	0.0500	1.9500	0.0005	0.	0.
71	HELIUM	23	0.0500	0.0050	1.9100	0.0005	0.	0.
72	INC750	24	0.0350	0.0350	1.9500	0.0024	0.4440E 03	0.4919E-02
73	INC750	24	0.0250	0.0200	1.5500	0.0008	0.4440E 03	0.1596E-02
74	HELIUM	23	0.1700	0.0500	0.2500	0.0021	0.	0.
75	INC600	21	0.1100	0.1000	0.3500	0.0038	0.4440E 03	0.7928E-02
76	INC600	21	0.1100	0.1000	0.3500	0.0038	0.4440E 03	0.7928E-02
77	INC600	21	0.1100	0.2000	1.4000	0.0308	0.4440E 03	0.6342E-01
78	HELIUM	23	0.1500	0.1500	1.3200	0.0297	0.	0.
79	HELIUM	23	0.3400	0.1400	1.8000	0.0857	0.	0.
80	HELIUM	23	0.2500	0.0200	2.2000	0.0110	0.	0.
81	HELIUM	23	0.0400	0.2200	1.0000	0.0088	0.	0.

INTERNAL CONNECTORS

NODES		MATERIAL	LENGTH	MATERIAL	LENGTH	WIDTH	DEPTH
1	2	INC750 24	0.0062	TIAL15 27	0.0260	0.2000	0.0790
1	16	INC750 24	0.1000	HELIUM 23	0.0400	0.0125	0.0390
1	42	INC750 24	0.0100	INC750 24	0.0420	0.0125	0.0390
2	3	TIAL15 27	0.0260	HELIUM 23	0.0050	0.2000	0.3920
2	16	TIAL15 27	0.1000	HELIUM 23	0.0400	0.0400	0.2200
2	74	TIAL15 27	0.1000	HELIUM 23	0.0800	0.0450	0.2200
3	4	HELIUM 23	0.0050	INC600 21	0.0060	0.2000	0.4400
4	5	INC600 21	0.1000	INC600 21	0.0490	0.0125	0.4700
4	6	INC600 21	0.1000	INC600 21	0.0490	0.0125	0.4700
4	7	INC600 21	0.0625	INC600 21	0.0625	0.1000	0.5000
4	8	INC600 21	0.0625	INC600 21	0.0625	0.1000	0.5000
4	13	INC600 21	0.0625	INC600 21	0.0800	0.0100	0.5000
5	7	INC600 21	0.0625	INC600 21	0.0625	0.1000	0.5000
5	14	INC600 21	0.0480	INC600 21	0.0800	0.0125	0.4700
5	74	INC600 21	0.0050	HELIUM 23	0.0250	0.1000	0.4400
6	8	INC600 21	0.0625	INC600 21	0.0625	0.1000	0.5000
6	15	INC600 21	0.0480	INC600 21	0.0800	0.0125	0.4700
6	17	INC600 21	0.0480	INC600 21	0.0350	0.0180	0.4400
7	9	INC600 21	0.0625	COIL 22	0.0650	0.1870	0.5950
7	13	INC600 21	0.0930	INC600 21	0.0800	0.0125	0.5650
7	14	INC600 21	0.0930	INC600 21	0.0800	0.0125	0.5650
8	10	INC600 21	0.0625	COIL 22	0.0650	0.1870	0.5950
8	13	INC600 21	0.0930	INC600 21	0.0800	0.0125	0.5650
8	15	INC600 21	0.0930	INC600 21	0.0800	0.0125	0.5650

Table A-2 (Cont'd)

9	11	COIL	22	0.0650	QUARTZ	28	0.0012	0.1870	1.4400
9	13	COIL	22	0.0935	INC600	21	0.0050	0.1300	1.0000
9	14	COIL	22	0.0935	INC600	21	0.0100	0.1300	1.0000
10	12	COIL	22	0.0650	QUARTZ	28	0.0012	0.1870	1.4400
10	13	COIL	22	0.0935	INC600	21	0.0050	0.1300	1.0000
10	15	COIL	22	0.0935	INC600	21	0.0100	0.1300	1.0000
11	40	QUARTZ	28	0.0012	HELIUM	23	0.0092	0.1870	1.4400
12	41	QUARTZ	28	0.0012	HELIUM	23	0.0092	0.1870	1.4400
14	57	INC600	21	0.0100	INC600	21	0.0300	0.1300	0.8500
15	18	INC600	21	0.0800	INC600	21	0.0150	0.0200	0.4400
15	78	INC600	21	0.0150	HELIUM	23	0.0750	0.1700	0.9500
16	17	HELIUM	23	0.0400	INC600	21	0.0100	0.0700	0.2200
17	18	INC600	21	0.0350	INC600	21	0.0200	0.0300	0.3460
17	19	INC600	21	0.0350	INC600	21	0.0800	0.0400	0.1250
19	20	INC600	21	0.0800	INC600	21	0.0500	0.0300	0.0950
20	21	INC600	21	0.0500	INC600	21	0.0400	0.0300	0.0950
20	75	INC600	21	0.0150	INC600	21	0.0500	0.1000	0.1900
21	22	INC600	21	0.0400	INC600	21	0.1000	0.0400	0.1250
22	23	INC600	21	0.1000	INC600	21	0.0600	0.0300	0.0950
23	76	INC600	21	0.0150	INC600	21	0.0500	0.1000	0.1900
24	25	316 SS	25	0.0610	316 SS	25	0.0420	0.0650	1.1300
24	79	316 SS	25	0.0300	HELIUM	23	0.0800	0.2500	1.3500
25	26	316 SS	25	0.0420	316 SS	25	0.0250	0.0800	1.1300
25	75	316 SS	25	0.0400	INC600	21	0.0500	0.0600	0.8200
26	27	316 SS	25	0.0400	316 SS	25	0.0350	0.0500	1.3200
26	75	316 SS	25	0.0400	INC600	21	0.0500	0.0500	0.8200
26	78	316 SS	25	0.0250	HELIUM	23	0.0750	0.0800	1.1000
27	28	316 SS	25	0.0350	316 SS	25	0.0250	0.0500	1.7800
27	78	316 SS	25	0.0250	HELIUM	23	0.0750	0.0600	1.5700
28	29	316 SS	25	0.0250	INC750	24	0.0700	0.0150	2.0700
28	70	316 SS	25	0.0250	HELIUM	23	0.0025	0.0500	1.9500
29	30	INC750	24	0.0750	INC750	24	0.0300	0.0500	1.9500
29	70	INC750	24	0.0750	HELIUM	23	0.0025	0.0500	1.9500
29	78	INC750	24	0.0250	HELIUM	23	0.0750	0.1500	1.8200
29	80	INC750	24	0.0250	HELIUM	23	0.0100	0.2500	2.1000
30	31	INC750	24	0.0250	INC750	24	0.0125	0.0650	1.7600
31	32	INC750	24	0.0320	INC750	24	0.0270	0.0250	1.6800
31	41	INC750	24	0.0120	HELIUM	23	0.0090	0.0600	1.5800
32	33	INC750	24	0.0270	INC750	24	0.0500	0.0250	1.6800
32	41	INC750	24	0.0120	HELIUM	23	0.0090	0.0500	1.5800
33	41	INC750	24	0.0170	HELIUM	23	0.0090	0.1000	1.5800
33	53	INC750	24	0.0500	INC750	24	0.1250	0.0350	1.7300
33	67	INC750	24	0.0170	HELIUM	23	0.0025	0.1000	1.8200
34	35	INC750	24	0.0400	INC750	24	0.0500	0.0300	2.3200
34	69	INC750	24	0.0400	INC750	24	0.0700	0.0300	2.3200
34	1034	INC750	24	0.0150				0.0800	2.3900
35	36	INC750	24	0.0550	INC750	24	0.0900	0.0300	2.3200
35	39	INC750	24	0.0150	INC750	24	0.0600	0.1100	2.4700

Table A-2 (Cont'd)

35	80	INC750	24	0.0150	HELIUM	23	0.0100	0.2500	2.2000
36	37	INC750	24	0.0900	INC750	24	0.1000	0.0300	2.3200
36	1036	INC750	24	0.0150				0.1800	2.3900
37	38	INC750	24	0.1000	INC750	24	0.1000	0.0300	2.3200
37	79	INC750	24	0.0150	HELIUM	23	0.0800	0.2500	2.2000
37	1037	INC750	24	0.0150				0.2000	2.3900
38	77	INC750	24	0.0200	INC600	21	0.1000	0.0300	2.2000
38	1038	INC750	24	0.0150				0.2000	2.3900
39	1039	INC750	24	0.0500				0.3000	2.8200
40	53	HELIUM	23	0.0090	INC750	24	0.0170	0.1870	1.5800
40	41	HELIUM	23	0.0500	HELIUM	23	0.0500	0.0180	1.5000
42	43	INC750	24	0.0450	INC750	24	0.0450	0.0125	0.0390
42	74	INC750	24	0.0062	HELIUM	23	0.0250	0.0800	0.0790
43	44	INC750	24	0.0450	INC750	24	0.0600	0.0125	0.0390
43	74	INC750	24	0.0062	HELIUM	23	0.0250	0.0800	0.0790
44	45	INC750	24	0.0062	INC750	24	0.0062	0.1250	0.3920
44	46	INC750	24	0.0620	INC750	24	0.0025	0.0125	0.0390
45	46	INC750	24	0.0620	INC750	24	0.0025	0.0100	0.2350
46	47	INC750	24	0.0350	INC750	24	0.0300	0.0050	0.5050
47	48	INC750	24	0.0300	INC750	24	0.0450	0.0050	0.8200
48	49	INC750	24	0.0450	INC750	24	0.0600	0.0050	1.2500
49	50	INC750	24	0.0600	INC750	24	0.0200	0.0050	1.8200
50	51	INC750	24	0.0025	INC750	24	0.0120	0.0250	1.8800
50	72	INC750	24	0.0025	INC750	24	0.0170	0.0350	1.8800
51	52	INC750	24	0.0250	INC750	24	0.0600	0.0350	1.8800
51	54	INC750	24	0.0250	INC750	24	0.0600	0.0050	1.8800
52	54	INC750	24	0.0420	INC750	24	0.0450	0.0600	1.9000
52	65	INC750	24	0.0600	INC750	24	0.0350	0.0300	2.2600
52	68	INC750	24	0.0600	INC750	24	0.1300	0.0850	2.1300
52	1052	INC750	24	0.0450				0.1200	2.3900
53	66	INC750	24	0.0170	HELIUM	23	0.0025	0.2550	1.9100
53	73	INC750	24	0.1250	INC750	24	0.0120	0.0200	1.7000
54	55	INC750	24	0.0450	INC750	24	0.0350	0.0400	0.1250
55	56	INC750	24	0.0350	INC750	24	0.0250	0.0500	0.8200
55	81	INC750	24	0.0200	HELIUM	23	0.0200	0.1800	1.5600
57	58	INC600	21	0.0650	INC600	21	0.0250	0.0400	0.1250
57	74	INC600	21	0.0650	HELIUM	23	0.0250	0.0600	0.4400
57	81	INC600	21	0.0300	HELIUM	23	0.0200	0.1800	1.5600
58	71	INC600	21	0.0250	HELIUM	23	0.0025	0.0400	0.1570
58	73	INC600	21	0.0250	INC750	24	0.0100	0.0100	1.5800
59	60	INC750	24	0.0220	INC750	24	0.0250	0.1300	0.5020
60	61	INC750	24	0.0250	INC750	24	0.0350	0.0800	0.8200
60	1060	INC750	24	0.0700				0.0500	0.6000
61	62	INC750	24	0.0350	INC750	24	0.0450	0.0800	1.2600
61	1061	INC750	24	0.0300				0.0700	1.0600
62	63	INC750	24	0.0450	INC750	24	0.0200	0.0900	1.8200
62	1062	INC750	24	0.0300				0.0800	1.5700
63	64	INC750	24	0.0200	INC750	24	0.0300	0.0720	2.0800

Table A-2 (Cont'd)

63	1063	INC750	24	0.0450				0.0400	1.9000
64	65	INC750	24	0.0370	INC750	24	0.0400	0.0350	2.3000
64	1064	INC750	24	0.0250				0.1000	2.3900
65	1065	INC750	24	0.0150				0.0750	2.3900
66	68	HELIUM	23	0.0025	INC750	24	0.0450	0.2500	1.8900
67	69	HELIUM	23	0.0025	INC750	24	0.1000	0.1000	1.8900
68	69	INC750	24	0.1250	INC750	24	0.0500	0.0900	2.1400
68	1068	INC750	24	0.0450				0.2500	2.3900
69	1069	INC750	24	0.0450				0.1000	2.3900
71	73	HELIUM	23	0.0025	INC750	24	0.0100	0.0250	1.6300
76	77	INC600	21	0.0500	INC600	21	0.1000	0.1000	1.4500
77	79	INC600	21	0.0500	HELIUM	23	0.1600	0.2000	1.3500
77	1077	INC600	21	0.0500				0.2000	1.4500

VARIABLE FILM COEFF.

TABLE	TIME	COEFF	TIME	COEFF	TIME	COEFF	TIME	COEFF	TIME	COEFF
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SURFACE CONNECTORS

NODES		MECHANISM	WIDTH	DEPTH	AREA	FILM COEF
1034	2001	FORCE CONVEC	0.0800	2.3900	0.0013	1000.0000
1036	2001	FORCE CONVEC	0.1800	2.3900	0.0030	1000.0000
1037	2001	FORCE CONVEC	0.2000	2.3900	0.0033	1000.0000
1038	2001	FORCE CONVEC	0.2000	2.3900	0.0033	1000.0000
1039	2001	FORCE CONVEC	0.3000	2.8200	0.0059	1000.0000
1052	2001	FORCE CONVEC	0.1200	2.3900	0.0020	1000.0000
1060	2001	FORCE CONVEC	0.0500	0.6000	0.0002	1000.0000
1061	2001	FORCE CONVEC	0.0700	1.0600	0.0005	1000.0000
1062	2001	FORCE CONVEC	0.0800	1.5700	0.0009	1000.0000
1063	2001	FORCE CONVEC	0.0400	1.9000	0.0005	1000.0000
1064	2001	FORCE CONVEC	0.1000	2.3900	0.0017	1000.0000
1065	2001	FORCE CONVEC	0.0750	2.3900	0.0012	1000.0000
1068	2001	FORCE CONVEC	0.2500	2.3900	0.0041	1000.0000
1069	2001	FORCE CONVEC	0.1000	2.3900	0.0017	1000.0000
1077	2001	FORCE CONVEC	0.2000	1.4500	0.0020	1000.0000

INITIAL INTERNAL TEMPERATURES

NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP
1	212.00	2	212.00	3	212.00	4	212.00	5	212.00
6	212.00	7	212.00	8	212.00	9	212.00	10	212.00
11	212.00	12	212.00	13	212.00	14	212.00	15	212.00
16	212.00	17	212.00	18	212.00	19	212.00	20	212.00
21	212.00	22	212.00	23	212.00	24	212.00	25	212.00
26	212.00	27	212.00	28	212.00	29	212.00	30	212.00
31	212.00	32	212.00	33	212.00	34	212.00	35	212.00
36	212.00	37	212.00	38	212.00	39	212.00	40	212.00
41	212.00	42	212.00	43	212.00	44	212.00	45	212.00
46	212.00	47	212.00	48	212.00	49	212.00	50	212.00
51	212.00	52	212.00	53	212.00	54	212.00	55	212.00

Table A-2 (Cont'd)

56	212.00	57	212.00	58	212.00	59	212.00	60	212.00
61	212.00	62	212.00	63	212.00	64	212.00	65	212.00
66	212.00	67	212.00	68	212.00	69	212.00	70	212.00
71	212.00	72	212.00	73	212.00	74	212.00	75	212.00
76	212.00	77	212.00	78	212.00	79	212.00	80	212.00
81	212.00								

INTERNAL GEN. MULTIPLIER		LIBRARY									
FACTOR	TIME	FACTOR	TIME	FACTOR	TIME	FACTOR	TIME	FACTOR	TIME	FACTOR	TIME
4.0000	-0.	4.0000	10.0000								
INTERNAL ADMITTANCES											
INTERNAL NODE	SELF ADMIT	BORDER NODE	ADMIT	BORDER NODE	ADMIT	BORDER NODE	ADMIT	BORDER NODE	ADMIT	BORDER NODE	ADMIT
1	-0.3746										
2	-0.5116	2	0.3674	16	0.0001	42	0.0070				
3	-0.3069	1	0.3674	3	0.1409	16	0.0020	74	0.0012		
4	-0.8256	2	0.1409	4	0.1660						
		3	0.1660	5	0.0285	6	0.0285	7	0.2887	8	0.2887
		13	0.0253								
5	-0.3671	4	0.0285	7	0.2887	14	0.0331	74	0.0168		
6	-0.4191	4	0.0285	8	0.2887	15	0.0331	17	0.0689		
7	-1.0949	4	0.2887	5	0.2887	9	0.4586	13	0.0295	14	0.0295
8	-1.0949	4	0.2887	6	0.2887	10	0.4586	13	0.0295	15	0.0295
9	-2.7473	7	0.4586	11	1.1811	13	0.5620	14	0.5456		
10	-2.7473	8	0.4586	12	1.1811	13	0.5620	14	0.5456		
11	-1.4412	9	1.1811	40	0.2602						
12	-1.4412	10	1.1811	41	0.2602						
13	-1.2082	4	0.0253	7	0.0295	8	0.0295	9	0.5620	10	0.5620
14	-2.6018	5	0.0331	7	0.0295	9	0.5456	57	1.9936		
15	-0.6956	6	0.0331	8	0.0295	10	0.5456	18	0.0668	78	0.0206
16	-0.0058	1	0.0001	2	0.0020	17	0.0037				
17	-0.2401										

Table A-2 (Cont'd)

18	-0.2030	6	0.0689	16	0.0037	18	0.1362	19	0.0314
19	-0.0472	15	0.0668	17	0.1362				
20	-0.2456	17	0.0314	20	0.0158				
21	-0.0486	19	0.0158	21	0.0229	75	0.2109		
22	-0.0386	20	0.0229	22	0.0258				
23	-0.2238	21	0.0258	23	0.0129				
24	-0.6345	22	0.0129	76	0.2109				
25	-2.1381	25	0.5943	79	0.0403				
26	-2.2185	24	0.5943	26	1.1244	75	0.4195		
27	-1.9814	25	1.1244	27	0.7333	75	0.3496	78	0.0112
28	-1.8231	26	0.7333	28	1.2361	78	0.0120		
29	-1.7407	27	1.2361	29	0.2518	70	0.3352		
30	-2.9844	28	0.2518	30	0.6964	70	0.2702	78	0.0347
31	-2.9212	29	0.6964	31	2.2880				80 0.4876
32	-1.0257	30	2.2880	32	0.5339	41	0.0993		
33	-1.4748	31	0.5339	33	0.4091	41	0.0827		
34	-10.6145	32	0.4091	41	0.1643	53	0.2595	67	0.6419
35	-4.1192	35	0.5800	69	0.4745	1034	9.5600		
36	-22.1447	34	0.5800	36	0.3600	39	2.6620	80	0.5172
37	-24.5015	35	0.3600	37	0.2747	1036	21.5100		
38	-24.5604	36	0.2747	38	0.2610	79	0.0657	1037	23.9000
39	-15.3520	37	0.2610	77	0.3994	1038	23.9000		
40	-0.5700	35	2.6620	1039	12.6900				
41	-0.6090	11	0.2602	53	0.3072	41	0.0026		

Table A-2 (Cont'd)

42	-0.0135	12	0.2602	31	0.0993	32	0.0827	33	0.1643	40	0.0026
43	-0.0100	1	0.0070	43	0.0041	74	0.0024				
44	-2.9492	42	0.0041	44	0.0035	74	0.0024				
45	-2.9673	43	0.0035	45	2.9400	46	0.0057				
46	-0.0621	44	2.9400	46	0.0273						
47	-0.0701	44	0.0057	45	0.0273	47	0.0291				
48	-0.0856	46	0.0291	48	0.0410						
49	-0.1300	47	0.0410	49	0.0446						
50	-5.0471	48	0.0446	50	0.0853						
51	-3.0946	49	0.0853	51	2.4310	72	2.5308				
52	-7.5933	50	2.4310	52	0.5806	54	0.0829				
53	-2.4706	51	0.5806	54	0.9828	65	0.5353	68	0.7147	1052	4.7800
54	-1.1126	33	0.2595	40	0.3072	66	1.7178	73	0.1861		
55	-0.6722	51	0.0829	52	0.9828	55	0.0469				
56	-0.5125	54	0.0469	56	0.5125	81	0.1329				
57	-2.1754	55	0.5125								
58	-0.3907	14	1.9936	58	0.0401	74	0.0098	81	0.1319		
59	-1.0414	57	0.0401	71	0.0213	73	0.3293				
60	-2.1828	60	1.0414								
61	-3.6200	59	1.0414	61	0.8200	1060	0.3214				
62	-5.9750	60	0.8200	62	0.9450	1061	1.8550				
63	-5.4031	61	0.9450	63	1.8900	1062	3.1400				
64	-10.2005	62	1.8900	64	2.2464	1063	1.2667				
65	-10.2819	63	2.2464	65	0.7841	1064	7.1700				

Table A-2 (Cont'd)

66	-3.1903	52	0.5353	64	0.7841	1065	8.9625				
67	-1.1213	53	1.7178	68	1.4726						
68	-12.9710	33	0.6419	69	0.4794						
69	-5.7628	52	0.7147	66	1.4726	69	0.8254	1068	9.9583		
70	-0.6054	34	0.4745	67	0.4794	68	0.8254	1069	3.9833		
71	-0.1699	28	0.3352	29	0.2702						
72	-2.5308	58	0.0213	73	0.1486						
73	-0.6641	50	2.5308								
74	-0.0326	53	0.1861	58	0.3293	71	0.1486				
75	-0.9800	2	0.0012	5	0.0168	42	0.0024	43	0.0024	57	0.0098
76	-0.9086	20	0.2109	25	0.4195	26	0.3496				
77	-5.2988	23	0.2109	77	0.6976						
78	-0.0785	38	0.3994	76	0.6976	79	0.0161	1077	4.1857		
79	-0.1221	15	0.0206	26	0.0112	27	0.0120	29	0.0347		
80	-1.0047	24	0.0403	37	0.0657	77	0.0161				
81	-0.2648	29	0.4876	35	0.5172						
		55	0.1329	57	0.1319						

SURFACE ADMITTANCES

SURFACE NODE	INTERNAL NODE	ADMIT	BOUNDARY NODE	ADMIT	BOUNDARY NODE	ADMIT	BOUNDARY NODE	ADMIT	BOUNDARY NODE	ADMIT
1034	34	9.5600	2001	1.3278						
1036	36	21.5100	2001	2.9875						
1037	37	23.9000	2001	3.3194						
1038	38	23.9000	2001	3.3194						
1039	39	12.6900	2001	5.8750						
1052	52	4.7800								

Table A-2 (Cont'd)

1060	60	0.3214	2001	1.9917
1061	61	1.8550	2001	0.2083
1062	62	3.1400	2001	0.5153
1063	63	1.2667	2001	0.8722
1064	64	7.1700	2001	0.5278
1065	65	8.9625	2001	1.6597
1068	68	9.9583	2001	1.2448
1069	69	3.9833	2001	4.1493
1077	77	4.1857	2001	1.6597
			2001	2.0139

Table A-2 (Cont'd)

OUTPUT NO. 1

INTERNAL TEMPS.- PHYSICAL SCIENCES PRESSURE TRANSDUCER H.O.BLINN

THE TEMPERATURES AT TIME 0.
0. PERCENT OF TOTAL TIME

INTERNAL TEMPERATURES

NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP
1	707.11	2	707.52	3	676.61	4	650.37	5	639.32
6	651.91	7	635.78	8	645.14	9	620.06	10	633.79
11	589.22	12	610.93	13	630.43	14	630.51	15	644.77
16	683.32	17	669.14	18	664.29	19	708.95	20	695.28
21	628.65	22	542.02	23	230.15	24	701.30	25	698.05
26	683.03	27	643.49	28	612.71	29	496.35	30	493.09
31	487.18	32	449.25	33	379.13	34	180.72	35	203.61
36	163.82	37	162.67	38	162.51	39	181.27	40	447.63
41	505.58	42	661.37	43	578.92	44	420.44	45	420.27
46	392.17	47	354.94	48	320.36	49	269.53	50	223.32
51	219.67	52	199.73	53	327.23	54	227.15	55	547.54
56	554.61	57	630.30	58	461.27	59	195.12	60	191.15
61	182.93	62	179.01	63	176.90	64	171.57	65	172.83
66	271.87	67	305.48	68	207.30	69	206.87	70	560.78
71	422.65	72	224.99	73	417.13	74	636.21	75	699.08
76	208.26	77	191.84	78	584.37	79	344.12	80	345.66
81	588.77								

SURFACE TEMPERATURES

NODE	TEMP	CONNECT	FILM COEF	SURFACE FLUX	CONNECT	FILM COEF	SURFACE FLUX
1034	176.98						
		2001	1000.000	0.2698E 05			
1036	162.14						
		2001	1000.000	0.1214E 05			
1037	161.12						
		2001	1000.000	0.1112E 05			
1038	160.99						
		2001	1000.000	0.1099E 05			
1039	171.37						
		2001	1000.000	0.2137E 05			
1052	185.10						
		2001	1000.000	0.3510E 05			
1060	174.97						
		2001	1000.000	0.2497E 05			
1061	175.77						
		2001	1000.000	0.2577E 05			
1062	172.70						
		2001	1000.000	0.2270E 05			

Table A-2 (Cont'd)

1063	168.99	2001	1000.000	0.1899E 05
1064	167.52	2001	1000.000	0.1752E 05
1065	170.04	2001	1000.000	0.2004E 05
1068	190.45	2001	1000.000	0.4045E 05
1069	190.14	2001	1000.000	0.4014E 05
1077	178.25	2001	1000.000	0.2825E 05

BOUNDARY TEMPERATURES

NODE	TEMP
2001	150.00

NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP
------	------	------	------	------	------	------	------

RATE OF TEMPERATURE CHANGE

NODE	RATE	NODE	RATE	NODE	RATE	NODE	RATE	NODE	RATE
1	0.	2	0.	3	0.	4	0.	5	0.
6	0.	7	0.	8	0.	9	0.	10	0.
11	0.	12	0.	13	0.	14	0.	15	0.
16	0.	17	0.	18	0.	19	0.	20	0.
21	0.	22	0.	23	0.	24	0.	25	0.
26	0.	27	0.	28	0.	29	0.	30	0.
31	0.	32	0.	33	0.	34	0.	35	0.
36	0.	37	0.	38	0.	39	0.	40	0.
41	0.	42	0.	43	0.	44	0.	45	0.
46	0.	47	0.	48	0.	49	0.	50	0.
51	0.	52	0.	53	0.	54	0.	55	0.
56	0.	57	0.	58	0.	59	0.	60	0.
61	0.	62	0.	63	0.	64	0.	65	0.
66	0.	67	0.	68	0.	69	0.	70	0.
71	0.	72	0.	73	0.	74	0.	75	0.
76	0.	77	0.	78	0.	79	0.	80	0.
81	0.								

THE TEMPERATURE DISTRIBUTION HAS REACHED A STEADY STATE CONDITION

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Figure A-4. Calculated Internal Temperatures of Physical Sciences Pressure Transducer

APPENDIX B

Results of TOSS Calculations

The following instruments have been investigated by use of the TOSS code and the results are shown.

	<u>Figure No.</u>
1. Calculated Internal Temperatures During Irradiation Testing - Wiancko Pressure Transducer	B-1
2. Wiancko Pressure Transducer Coil Assembly	B-2
3. Calculated Internal Temperatures of Clevite Accelerometer	B-3
4. Estimated Internal Temperatures of Wiancko AX-44-I Accelerometer During Irradiation	B-4
5. Cross Section of Wiancko AX-44-I Accelerometer Estimated Temperatures of Top Assembly	B-5
6. Estimated Internal Temperatures of CCC Pressure Transducer During Irradiation	B-6
7. Estimated Internal Temperatures of Physical Sciences Displacement Transducer Model DT-4002-20	B-7
8. Calculated Internal Temperatures of Wiancko AX-44 Accelerometer (Modified)	B-8
9. Calculated Temperatures of Top Assembly	B-9

Figure B-1. Calculated Internal Temperatures During Irradiation Testing

Figure B-2. Wiancko Pressure Transducer Coil Assembly

Temperatures - °F
Heat Generation Rate - 4.0 watts/gm

Figure B-3. Calculated Internal Temperatures of Clevite Accelerometer

TEST CONDITIONS

HEAT GENERATION RATE - 3.0 WATTS/GRAM

HELIUM FILLED

EXTERNAL COOLANT - WATER 150°F

TEMPERATURES - °F

Figure B-4. Calculated Internal Temperatures of Wiancko AX-44-1 Accelerometer During Irradiation

Figure B-5. Cross Section of Wiancko AX-44-1 Accelerometer
Calculated Temperatures of Top Assembly

TEST CONDITIONS

HEAT GENERATION RATE - 4.2 WATTS/GRAM

AIR FILLED

EXTERNAL COOLANT - WATER 150°F

TEMPERATURES - °F

Figure B-6. Calculated Internal Temperatures of CCC Pressure Transducer
During Irradiation

TEST CONDITIONS

HEAT GENERATION RATE - 4.1 WATTS/GRAM

HELIUM FILLED

COOLANT - WATER 150°F

TEMPERATURES - °F

Figure B-7. Calculated Internal Temperatures of Physical Sciences Displacement Transducer Model DT-4002-20

Figure B-8. Calculated Internal Temperatures of Wiancko AX-44 Accelerometer (Modified with "E" core)

Figure B-9. Calculated Temperatures of Top Assembly