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THULIUM OXIDE FUEL CHARACTERIZATION STUDY

SANDERS NUCLEAR CORPORATION

95 Canal Street, Nashua, New Hampshire

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THULIUM OXIDE FUEL CHARACTERIZATION STUDY (THULIUM-170 FUELED CAPSULE PARAMETRIC DESIGN)

Prepared By

DR. NICHOLAS H. DESCHAMPS

For

DIVISION OF ISOTOPES DEVELOPMENT
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SECTION 1

SUMMARY

An analytical parametric study was made on an infinitely long cylindrical fuel capsule containing three different internal thulia fuel forms and encapsulations. A doubly encapsulated thulia wafer, i. e., individually lined wafers stacked one upon another inside a fuel capsule was the first configuration to be studied. The wafer thickness was held constant at 0.060 inch while the diameter was varied between 0.6 and 3.0 inches. The temperature profiles were determined for thulia power densities ranging from 8 to 24 w/cc and fuel capsule surface temperatures ranging from 1000°F (538°C) to 2000°F (1093°C).

Parametric studies were also carried out on a singly encapsulated configuration in which the thulia wafers were stacked face to face in an infinitely long, lined cylinder. The parameters investigated were essentially the same as for the doubly encapsulated wafers. Using this same type of capsule the thermal profiles were also investigated for the case of thulia microspheres as the fuel form.

Results of the study indicated that, under similar circumstances, the doubly encapsulated wafer configuration yielded a lower centerline temperature than the singly encapsulated capsule. Only in extreme cases of a large wafer diameter in combination with a high thulia power density did the fuel capsule centerline temperature exceed the thulia melt temperature of 4172°F (2300°C).

Results are also given for the maximum radius attainable without having centerline melting when using a thulia microsphere fuel form. Two separate

sets of data are given in this analysis as a result of having insufficient data available on the thermal conductivity of thulia microspheres. One set of curves results from use of emperical data available on the thermal conductivity of packed bids, whereas the second set of data is the result of using the thermal conductivity of PuO_2 microspheres as supplied by Mound Laboratories.

The graphical results presented in this report were prepared from a specific set of geometrical parameters and fixed dimensions. In some instances slight variations in the dimensions that were assumed to be fixed could have considerable influence on the thermal profiles. The figures presented, therefore, should be considered as an aid to the designer in helping to establish a design starting point. Once the designer has established the desired fuel capsule surface temperature, diameter, liner thickness, interface gaps, as well as other pertinent parameters, then the analytical procedures set forth in this report should be used to determine the capsule thermal profile. Computer codes are included in the appendices to expedite the calculation of the profiles for a given set of design parameters.

SECTION 2

INTRODUCTION

During the early stages of design for a radioisotopic thermoelectric generator, isotopic thermionic converter, or any system employing a radioisotopic heat source, it becomes necessary to acquire a knowledge of the operating characteristics of the isotopic fuel capsule. Of specific interest to the designer are the thermal profiles which exist within the isotopic fuel capsule during system operation.

Depending upon the system under consideration there is usually a specific fuel capsule surface temperature required for optimum system operation. Knowledge of the required fuel capsule surface temperature enables the engineer to design the fuel capsule in a manner which will allow the internals of the capsule to operate at a safe temperature level. With a fixed design surface temperature the internal temperatures are a function of fuel capsule diameter, fuel power density, fill gas, interface resistances, material thermal conductivities, and other geometric and materials parameters.

It was the objective of this parametric design study to develop a series of thermal profiles defining the radial temperature distribution in three different proposed thulia fuel capsules. Two fuel forms (wafer and microsphere) and two encapsulation techniques (single and double encapsulation) were investigated. Past experience in fuel form technology dictated the forms and encapsulations to be investigated.

Figure 1 shows the three types of fuel capsules under investigation. All of these configurations were considered infinitely long circular cylinders. As explained in Para. 3.1 the heat transfer was taken to be one-dimensional radial flow.

(a) Double Wafer Encapsulation

(b) Single Wafer Encapsulation

(c) Single Microsphere Encapsulation

Figure 1. Encapsulation

Figure 1 (a) shows the doubly encapsulated wafer design. At Sanders Nuclear major emphasis has been placed on this type of encapsulation for thulia wafers. In double encapsulation each wafer is individually encapsulated and then placed with others as a group into an additional encapsulation known as the fuel capsule.

One of thulium's most advantageous characteristics is its ability to be handled and processed in the nonradioactive state. This means that source fabrication can be carried through a number of steps without the complex requirements of remote hot cell operations, clean rooms, radiation hazards, etc. Owing to its high neutron absorption cross section, however, a thin wafer irradiation geometry is required to obtain near uniform generation of radioactive thulium. Thus, the price paid for elimination of the processing of radioactive materials is a limitation on the size of the unit that can be cold encapsulated and irradiated. This limit is about one-tenth of an inch (cross section thickness). The oxide of thulium is the favored form for several reasons but results in a limit on the diameter of about 1-1/2 to 2 inches. Such a geometry results in a moderately fragile source. By judicious selection of a liner material having a low neutron absorption cross section and low hazard radiation products (short half-life, low energy), it is possible to encapsulate the thulia wafer prior to irradiation; thus, obtain a heat source that is rugged, clean, and self-contained.

Because of the size of the basic source unit, most applications will require a number of wafers in the system. Thus, the encapsulation must be as thin and compact as possible to retain a reasonable source power density. This is important for reasons of system weight (higher shield weight for a low power density source) and system size (insulation increases considerably with source size).

Thus, the requirements of the encapsulation design can be summed up as follows:

- ① Encapsulated wafers must be thin and compact
- ② Encapsulated wafers must be rugged

- Encapsulated wafers must stack well
- Reasonably inexpensive.

As mentioned before, the liner material requirements are as follows:

- Low neutron absorption cross section
- Low energy irradiation products of short half-life
- High melting point
- Compatible with Thulia.

Experiments have been performed and processes developed to encapsulate wafers which are 0.060 inch thick by 0.6 inch in diameter. On a wafer of this thickness, an encapsulation 0.005 inch thick means a minimum reduction of power density of 16 percent in the axial direction alone. With gaps and stacking tolerances this reduction is increased. Thus, an encapsulation thickness of 0.001 inch to 0.003 inch is more desirable. It was found that 0.001 inch was not readily fabricated; 0.002 and 0.003 are readily fabricated and provide sufficient protection to the wafer. A thickness of 0.003 inch was chosen for the parametric analysis.

With material this thin only two fabrication methods suggested themselves:

- Welded stamped cup enclosure
- Plated enclosure.

It was felt that the irregular wafer surface and sharp edges would not result in a plated surface that would reliably contain the wafer and its particles in the event of fracture.

As a result, the tapered nesting cup design was accepted as providing a rugged, compact enclosure for the thulium oxide heat source.

Figure 2 is a detailed view of the wafer encapsulation as it is fabricated at Sanders Nuclear. Figure 3 is a radioisotope thermoelectric generator that was designed and built by Sanders Nuclear and incorporates 14 of the doubly encapsulated thulia wafers.

Figure 1(b) shows a view of a singly encapsulated wafer. In this system the bare wafers are stacked next to each other inside a double walled capsule. The inside liner serves as a reaction and diffusion barrier between the outer structural capsule and the wafer. This wafer encapsulation technique is less costly than the double encapsulation technique but has the disadvantage of requiring handling of irradiated ceramic wafers. That is, the wafers are irradiated without being encased in a protective metal cover; they are then transported and installed in the fuel capsule. The internal liner and the outer housing cap are then welded in their respective places.

The single encapsulation configuration is more adaptable to a one dimensional solution of thermal profiles than is the double encapsulation configuration. This, of course, is a result of the homogeneity of the materials in the radial direction. That is, at any given radius, the material will be the same at any point along the length of the capsule. This allows use of one-dimensional heat

Figure 2. Detail View of Encapsulated Wafers.

Figure 3. Step I Generator

transfer methods to be employed with no resulting error. This method of encapsulation also affords less error in the thermal analysis because the material interface voids and other interface characteristics are better defined than in the case of the doubly encapsulated technique.

The third type of thulia encapsulation (see Figure 1c) to be investigated for thermal profiles was a double-walled, singly encapsulated thulia microsphere system. This capsule system also lends itself well to a one-dimensional radial heat transfer analysis. The major difficulty which appeared in this analysis was the determination of the thermal conductivity of the thulia microsphere packed bed. No data exists on the thermal conductivity of thulia microspheres and only scattered experimental data exists on other oxide microspheres of the same size and with the same environmental gases present.

It should be noted that the thermal profiles in this study are for infinitely long fuel capsules. This assumption would not be valid in many cases where thulia is employed as the fuel. The STEP I * generator shown in Figure 3 incorporates a fuel capsule in which the principal direction of heat transfer is in the axial direction. In a case such as this the design engineer would have to determine the series resistances resulting from the stacked wafers and then attempt to arrive at a thermal profile for his specific geometric configuration.

The analytical procedures used in determining the thermal profiles in the three different fuel capsule systems are given in Section 3. The parameters chosen for this thermal analysis were arrived at by judicious selection which took into consideration the extreme limits of the applications and materials of future capsule needs.

* T.M. Sanders Nuclear Corporation

SECTION 3

PARAMETRIC DESIGN

3.1 ANALYTICAL APPROACH

To arrive at the temperature distribution in the doubly encapsulated configuration, three different approaches were taken. Each of the approaches had a varying degree of sophistication. The first approach was to develop the differential equations which described the temperature profile in a two-dimensional representative section of an infinitely long capsule, as shown in Figure 4. Because of the discontinuities at the interfaces this approach could not readily be solved by analytical methods and as a result a numerical solution involving a nodal system would have had to be used. A less sophisticated approach to the two-dimensional analysis was to assume no axial heat flow within either the liner or the fuel wafer but account for heat transfer axially between the fuel wafer and the liner. The resulting differential equations again did not lend themselves to a direct analytical solution.

The third approach was to assume no axial heat transfer anywhere in the representative thermal region. Before proceeding with this approach, an error analysis was made to determine the maximum error that could possibly occur in the temperature at any given radius as a result of assuming a one-dimensional approach. The maximum error would occur in the one-dimensional analysis if, in a hypothetical case, all of the heat generated in the fuel wafer were to flow axially out of the wafer and cross axially to the outer boundary of the liner. This, of course, cannot happen because there is no heat flow across the outer axial

Figure 4. Thulium Fuel Capsule Configuration Using Double Encapsulation

boundaries of the liners because of capsule system symmetry. This error analysis, however, does indicate the maximum temperature deviation from a two-dimensional analysis which could exist at the center plane of the wafer ($X = 0$). This error is shown in Paragraph 3.2 to be less than one percent.

Once the equations defining the temperature distribution in the fuel capsule were established for the case of double encapsulation, the solution for the single encapsulation was also at hand. Similar computer codes were used for the two capsule configurations; the only difference being that a series of "DO" loops were necessary for the doubly encapsulated configuration as a result of the six different liner materials under investigation.

Because of the absence of the individual wafer liners with the single encapsulation, as well as the assumption of an infinitely long fuel capsule, the use

of a one-dimensional radial heat transfer analysis resulted in no analytical error.

The thermal profiles within the microsphere (fueled capsule) were determined using the standard one-dimensional heat transfer equation for heat flow in a cylinder with internal heat generation. The thermal conductivity for thulia microspheres was not available for the calculations. As a result the experimental data available on plutonium microspheres were used together with empirical data available on porous packed beds.

The results of the analysis on microspheres led to a plot of maximum fuel capsule diameter without centerline melting versus thulia power density. The plot enables the determination of the maximum fuel capsule diameter attainable without having the centerline temperature exceed 4172°F (2300°C). In this analysis the temperature drop across the fuel capsule walls was not taken into consideration, it is available and identical for similar power densities in plots presented for singly and doubly encapsulated wafer fuel forms.

3.2 DOUBLY ENCAPSULATED WAFER

Figure 4 represents a solid Tm_2O_3 wafer which is doubly encapsulated. In this figure, B is the gas filled gap separating wafer A from liner C. Gap D is present because of loose fit of the encapsulated wafer in the fuel capsule housing E.

The fuel capsule, as given, is assumed to be infinitely long in the X direction. As a result of this condition the heat transfer in the capsule only occurs in a radial direction. The thermal profile resulting from the assumption of one-dimensional heat transfer varies less than 1 percent from the profile given by the more rigorous two-dimensional analysis.

The total heat generated in the thulia wafer is given by:

$$Q = \pi R_1^2 L_A A_O \quad (1)$$

where A_O is the heat generated per unit volume. The outer fuel capsule housing temperature T_5 , is considered to be a known parameter. Knowing that the heat generated in the wafer must pass through the fuel capsule housing it is possible to obtain temperature T_4 with the use of the equation for heat conduction thru a cylinder with a concentrated heat source at the center.

$$Q = \frac{2\pi K_E L_C (T_4 - T_5)}{\ln\left(\frac{R_5}{R_5 - t_E}\right)} \quad (2)$$

or upon rearranging

$$T_4 = \frac{\ln\left(\frac{R_5}{R_5 - t_E}\right) Q}{2\pi K_E L_C} + T_5 \quad (3)$$

Substituting the value of Q from equation (1) into equation (3) yields

$$T_4 = \frac{\left[\ln\left(\frac{R_5}{R_5 - t_E}\right)\right] R_1^2 L_A A_O}{2K_E L_C} + T_5 \quad (4)$$

Once T_4 is obtained it is possible to calculate T_3 by considering the conduction through the gas gap in parallel with the radiation heat transfer across the gap.

$$Q = Q_{\text{conduction}} + Q_{\text{radiation}}$$

$$Q = \frac{K_D \pi \left(\frac{R_3 + R_5 - t_E}{2}\right) 2L_C (T_3 - T_4)}{R_5 - t_E - R_3} + \frac{\sigma \pi \left(\frac{R_3 + R_5 - t_E}{2}\right) 2L_C (T_3^4 - T_4^4)}{\frac{1}{\epsilon_E} + \frac{1}{\epsilon_C} - 1} \quad (5)$$

Substitution of equation (1) into equation (5) and simplifying yields

$$\frac{R_1^2 L_A A_O}{(R_3 + R_5 - t_E) L_C} = \frac{K_D (T_3 - T_4)}{R_5 - t_E - R_3} + \frac{\sigma}{\left[\frac{1}{\epsilon_E} + \frac{1}{\epsilon_C} - 1 \right]} (T_3^4 - T_4^4) \quad (6)$$

where:

K_D = thermal conductivity of the interstitial gas, B/hr-ft-°F

σ = Stefan - Boltzmann constant, 0.1714×10^{-8} B/hr-ft² - °R⁴

ϵ_E = Emissivity of the inner surface of the fuel capsule housing

ϵ_C = Emissivity of the liner

Equation (6) yields an implicit relationship for T_3 and hence has to be solved by trial and error.

T_2 is determined by considering the temperature drop across the liner C, between R_3 and $R_3 - t_C$. This can be expressed as

$$Q = \frac{2\pi K_C L_C (T_2 - T_3)}{\ln \frac{R_3}{R_3 - t_C}} \quad (7)$$

or

$$T_2 = \frac{R_1^2 L_A A_O \ln \left(\frac{R_3}{R_3 - t_C} \right)}{2K_C L_C} + T_3 \quad (8)$$

where K_C is the thermal conductivity of the liner material in B/hr ft °F.

In order to obtain T_1 , it is necessary to consider three parallel heat transfer paths. These are:

- Conduction heat transfer through the gas B
- Radiation across the gap containing gas B
- Conduction heat transfer through the liner material.

The region of concern for determining T_1 once T_2 is known is shown in Figure 5.

Figure 5. Heat Transfer Region for Determination of T_1

The heat transfer can be expressed as

$$Q = Q_{\text{radiation}} + Q_{\text{gas conduction}} + Q_{\text{solid conduction}}$$

$$Q = \frac{\sigma 2\pi \left(\frac{R_1 + R_3 - t_C}{2} \right) (L_C - 2t_C)}{\frac{1}{\epsilon_A} + \frac{1}{\epsilon_C} - 1} (T_1^4 - T_2^4) + \frac{2\pi \left(\frac{R_1 + R_3 - t_C}{2} \right) (L_C - 2t_C) K_B (T_1 - T_2)}{R_3 - t_C - R_1}$$

$$+ \frac{K_c 2\pi \left(\frac{R_1 + R_3 - t_C}{2} \right) 2t_C (T_1 - T_2)}{R_3 - t_C - R_1} \quad (9)$$

Substitution of equation (1) into equation (9) and reducing yields

$$\begin{aligned} \frac{R_1^2 L_A A_O}{(R_1 + R_3 - t_C) (L_C - 2t_C)} &= \frac{\sigma}{\frac{1}{\epsilon_A} + \frac{1}{\epsilon_C} - 1} (T_1^4 - T_2^4) \\ + \frac{K_B (T_1 - T_2)}{R_3 - t_C - R_1} &+ \frac{2K_C t_C (T_1 - T_2)}{(L_C - 2t_C) (R_3 - t_C - R_1)} \end{aligned} \quad (10)$$

Again the equation results in an implicit relationship for the unknown temperature T_1 and hence has to be solved by trial and error.

The relationship for the temperature in a right circular cylinder with internal heat generation is

$$T = \frac{A(R_1^2 - r^2)}{4K_1} + T_1 \quad (11)$$

where:

A = effective heat generation per unit volume B/hr-ft³

K_1 = effective conductivity of the cylinder, B/hr-ft-°F

r = radius of cylinder at which the temperature T exists, ft

When considering the cylinder of radius R_1 it is necessary to determine the effective heat generation per unit volume, A , and the effective radial thermal conductivity, K_1 , of the cylinder with length L_C . The effective heat generation is given by the relation

$$A = A_O \frac{\text{Volume of Thulia}}{\text{Volume of Thulia} + \text{Volume of Liner}} \quad (12)$$

or

$$A = A_O \left[\frac{\pi R_1^2 L_A}{\pi R_1^2 L_A + \pi R_1^2 2t_C} \right] \quad (13)$$

And for the effective thermal conductivity

$$K_1 = \frac{K_A L_A + 2K_C t_C}{L_A + 2t_C} \quad (14)$$

Substituting equation (13) and (14) into equation (11) and solving for the centerline temperature T_O yields

$$T_O = \frac{A_O L_A R_1^2}{4(K_A L_A + 2K_C t_C)} + T_1 \quad (15)$$

In using the above technique for determination of the radial temperature profile, any error which results is due mainly to the assumption of no axial heat transfer between the wafer and the fuel liner. To determine the maximum attainable error in this analysis it is only necessary to assume that all of the heat which is generated in the thulia wafer be transferred axially from the wafer across gap B to the liner. The temperature difference between the centerline of the wafer and the surface of the liner is then the maximum for which the calculated radial thermal profile can be expected to deviate from the radial profile which would exist in an exact two-dimensional analysis.

Referring to Figure 4, the temperature profile within the thulia wafer in the axial direction between the center of the wafer and the surface of the wafer can be expressed as

$$T_{A-X} = \frac{A_O \left[\left(\frac{L_A}{2} \right)^2 - X^2 \right]}{2K_A} + T_{A\text{-surface}} \quad (16)$$

The axial temperature drop across the gas filled gap B is given by

$$\frac{A_O L_A}{2} = \frac{K_b (T_{A\text{-surface}} - T_C)}{\frac{L_C}{2} - \left(t_c + \frac{L_A}{2}\right)} + \frac{\sigma}{\frac{1}{\epsilon_A} + \frac{1}{\epsilon_C} - 1} (T_{A\text{-surface}}^4 - T_C^4) \quad (17)$$

Solving equation (16) for the temperature at $x = 0$ and then substituting the relationship for $T_{A\text{-surface}}$ into equation (17) yields

$$\frac{A_O L_A}{2} = \frac{K_B \left(T_{A-O} - \frac{A_O L_A^2}{8K_A} - T_C \right)}{\frac{L_C}{2} - \left(t_c + \frac{L_A}{2}\right)} + \frac{\sigma}{\frac{1}{\epsilon_A} + \frac{1}{\epsilon_C} - 1} \left[\left(T_{A-O} - \frac{A_O L_A^2}{8K_A} \right)^4 - T_C^4 \right] \quad (18)$$

Equation (18) enables the temperature drop between the center of the wafer, T_{A-O} , and the surface of the liner, T_C , to be obtained for any given value of T_{A-O} . This temperature difference is the maximum deviation from the two-dimensional radial temperature profile. For instance, if the temperature difference, $T_{A-O} - T_C$, was calculated, by means of equation (18), to be 10°F and T_O from equation (15) was calculated to be 2500°F , then the maximum deviation of T_O would be $2500 \pm 5^\circ\text{F}$. For the parameters investigated to date the error involved has been less than one percent.

In order to obtain the temperature profile in the fuel capsule a computer was used to solve Equations (1) through (18). The results are shown graphically in Figures 6 through 41. Radial temperatures are given in the figures as a function of the radius of the fuel capsule. The gases present in the internal voids were taken to be argon or helium and are indicated as such on the curves. The thermal conductivity of the gases was determined as a function of the average temperature in the fuel capsule and was calculated by a subroutine within the computer code.

Three thulium fuel wafer diameters and three power densities were examined. The diameters and power densities used in the calculations were chosen because they encompassed what was thought to be the practical constraints on thulia wafer design when considering an infinitely long fuel capsule configuration. The wafer thickness was held constant at 0.060 inch.

Two thulia thermal conductivities were used in the parametric analysis. These two conductivities, 1.5 and 3.0 B/hr-ft- $^{\circ}$ F (SRL DP-114)¹, are representative of Thulia at the temperatures being considered in this analysis.

Parameters which were assumed constant during the analysis were:

- Gap thickness between the thulia wafer and the liner, 0.001 inch
- Gap distance between the liner and the housing, 0.008 inch
- Containment wall thickness, 0.100 inch
- Liner thickness, 0.003,inch.

The housing material was also assumed fixed and was taken to be Haynes 25. The thermal resistance of the outer liner materials proved to have little effect on the thermal profile of the fuel capsule in general.

Temperatures of 1000, 1500, and 2000 $^{\circ}$ F were chosen as the external fuel capsule surface temperatures. Since Hastelloy X and Haynes 25 were to be used as inner liner materials in the operating range up to 1830 $^{\circ}$ F, the outer capsule wall temperature was set at 1000 $^{\circ}$ F for these two liner materials. Likewise, the outer wall temperature was set at 1500 $^{\circ}$ F for the fuel capsule having inner liner materials of platinum or T-222 (operating range 1830 $^{\circ}$ F - 2730 $^{\circ}$ F), and 2000 $^{\circ}$ F for the outer wall temperature of the fuel capsule having inner liner materials of molybdenum or tungsten (operating range 2730 $^{\circ}$ F - 3630 $^{\circ}$ F).

Figure 3. Fuel Capsule Profiles for Hastelloy X (Plot No. 1)

Figure 4. Fuel Capsule Profiles for Hastelloy X (Plot No. 2)

Figure 5. Fuel Capsule Profiles for Hastelloy X (Plot No. 3)

Figure 6. Fuel Capsule Profiles for Hastelloy X (Plot No. 4)

Figure 7. Fuel Capsule Profiles for Hastelloy X (Plot No. 5)

Figure 8. Fuel Capsule Profiles for Hastelloy X (Plot No. 6)

Figure 9. Fuel Capsule Profiles for Haynes 25 (Plot No. 1)

Figure 10. Fuel Capsule Profiles for Haynes 25 (Plot No. 2)

Figure 11. Fuel Capsule Profiles for Haynes 25 (Plot No. 3)

Figure 13. Fuel Capsule Profiles for Haynes 25 (Plot No. 5)

Figure 12. Fuel Capsule Profiles for Haynes 25 (Plot No. 4)

Figure 14. Fuel Capsule Profiles for Haynes 25 (Plot No. 6)

Figure 15. Fuel Capsule Profiles for Platinum (Plot No. 1)

Figure 17. Fuel Capsule Profiles for Platinum (Plot No. 3)

Figure 16. Fuel Capsule Profiles for Platinum (Plot No. 2)

Figure 18. Fuel Capsule Profiles for Platinum (Plot No. 4)

Figure 19. Fuel Capsule Profiles for Platinum (Plot No. 5)

Figure 21. Fuel Capsule Profiles for T-222 (Plot No. 1)

Figure 20. Fuel Capsule Profiles for Platinum (Plot No. 6)

Figure 22. Fuel Capsule Profiles for T-222 (Plot No. 2)

Figure 23. Fuel Capsule Profiles for T-222 (Plot No. 3)

Figure 24. Fuel Capsule Profiles for T-222 (Plot No. 4)

Figure 25. Fuel Capsule Profiles for T-222 (Plot No. 5)

Figure 26. Fuel Capsule Profiles for T-222 (Plot No. 6)

Figure 27. Fuel Capsule Profiles for Molybdenum (Plot No. 1)

Figure 28. Fuel Capsule Profiles for Molybdenum (Plot No. 2)

Figure 29. Fuel Capsule Profiles for Molybdenum (Plot No. 3)

Figure 30. Fuel Capsule Profiles for Molybdenum (Plot No. 4)

Figure 31. Fuel Capsule Profiles for Molybdenum (Plot No. 5)

Figure 32. Fuel Capsule Profiles for Molybdenum (Plot No. 6)

Figure 33. Fuel Capsule Profiles for Tungsten (Plot No. 1)

Figure 34. Fuel Capsule Profiles for Tungsten (Plot No. 2)

Figure 35. Fuel Capsule Profiles for Tungsten (Plot No. 3)

Figure 36. Fuel Capsule Profiles for Tungsten (Plot No. 4)

Figure 37. Fuel Capsule Profiles for Tungsten (Plot No. 5)

Figure 38. Fuel Capsule Profiles for Tungsten (Plot No. 6)

For reasons of clarity the abscissa for each of Figures 6 through 41 has superimposed on it a sectioned view of the thulia encapsulation. It should be noted that the abscissa is not to scale. Because of the large temperature changes across the interfaces it was necessary to exaggerate the interface distances. The ordinate represents the center line and is the point of maximum temperature within the fuel capsule.

3.3 SINGLY ENCAPSULATED WAFERS

Essentially the same set of equations were used to calculate the thermal profiles in the singly encapsulated configuration as were used in Paragraph 3.2. Referring to Figure 4 (page 11) it can be seen that if the inner liner (C) is removed from above and below the wafer and subsequently the wafer thickness is allowed to assume the value L_c , then the figure is indicative of the single encapsulation as depicted in Figure 1b (page 4).

As a result of removing the individual liner, Equation 10, which defines the heat transfer between the wafer and the inner liner, assumes the form:

$$\frac{R_1^2 A_0}{R_1 + R_3 - t_c} = \frac{T}{\frac{1}{\epsilon_A} + \frac{1}{\epsilon_C} - 1} (T_1^4 - T_2^4) + \frac{K_B (T_1 - T_2)}{R_3 - t_c - R_1} \quad (19)$$

This equation allows T_1 to be solved by trial and error techniques.

In Equation 12 the volume of the liner has a value of zero and $A = A_0$. This allows the temperature distribution through the wafer to be determined using the relationship set forth in Equation 11, where K_1 is now the conductivity of the thulia wafer.

The analysis involving the singly encapsulated wafers utilized the following parameters:

- Fuel capsule wall thickness - 0.1 inch
- Thulia thermal conductivity - 1.5 to 3.0 B/hr-ft-°F
- Liner thickness - 0.020 inch
- Gap between liner and capsule - 0.004 inch

●	Gap between wafer and liner	-	0.002 inch
●	Wafer thickness	-	0.060 inch
●	Capsule emissivity	-	0.3
●	Liner emissivity	-	0.3
●	Wafer emissivity	-	0.3

For the numerous thermal profiles obtained for the single encapsulation the capsule material was assumed to be Haynes 25 and the inner liner platinum. The capsule surface temperature was assigned three separate values of 1000, 1500, and 2000°F. For these surface temperatures the thermal profiles were determined for power densities of 8, 16, and 24 w/cc, capsule diameters of 0.6, 1.8, and 3.0 inches, and argon or helium as the internal gas. The results of the investigation are given in Figures 42 through 59. (Identification of capsule and liner materials as Haynes-25 and platinum is of little consequence to results, i.e., had refractories or other materials been identified for capsule and/or liner material the wafer diameter for centerline melting would be changed only by a few mils for any given fuel power density.)

3.4 THULIA MICROSPHERES

In addition to employing thulia in the wafer form it is also possible to make use of thulia microspheres. The major difficulties involved in using a microsphere heat source is the reduction in power density resulting from the void fraction as well as the extremely low thermal conductivity of microsphere beds.

A recent article written by Luikov, Shashkov, Vasilieu, and Fraimar² shows that the thermal conductivity of a porous system can be given by the following expression:

$$K_{\text{eff}} = K_g + K_{\gamma} \quad (20)$$

where:

K_g - component of thermal conductivity due to the interstitial gas

K_{γ} - component of thermal conductivity due to radiation

For porous systems having particle diameters in the 25 to 200 micron range and an interstitial pressure of 0.01 atmosphere or greater, the gas component of thermal conductivity, K_g , is simply the thermal conductivity of the gas itself. The radiation component for the porous system can be given by:

$$K_{\gamma} = f D_p \epsilon \sigma T^3 \quad (21)$$

where:

f - void fraction

D_p - particle diameter

ϵ - effective emissivity of an individual microsphere

σ - Stephan-Boltzmann constant

T - absolute temperature

For a helium filled porous system consisting of 75 micron diameter (0.003 inch) thulia spheres having an emissivity of 0.3 and a void fraction of 0.38, the effective overall thermal conductivity of the system can be given as:

$$K_{\text{eff}} = 0.084 + (T - 460) \times 7.5 \times 10^{-5} + (0.38) \frac{(0.003)}{12} (0.3)(4)(0.1714 \times 10^{-2}) \left(\frac{T}{100}\right)^3 \quad (22)$$

or

$$K_{\text{eff}} = 0.084 + (T - 460) \times 7.5 \times 10^{-5} + 1.706 \left(\frac{T}{100}\right)^3 \times 10^{-7} \quad (23)$$

Assuming that again the fuel capsule is an infinitely long circular cylinder, the radial temperature profile is given by:

$$T_r = \frac{A_o (\gamma_o^2 - r^2)}{4 K_{eff}} + T_s \quad (24)$$

where:

γ_o - the outer radius of the porous system

T_s - surface temperature of the porous system

T_r - temperature at radius γ

Using a power density of 16 watts/cc for thulia and taking into consideration the void fraction in the porous system the resulting heat generation is:

$$A_o = \frac{\left(16 \frac{W}{cm^3}\right) (0.62) (3.41 \frac{B}{hr-W})}{3.53 \times 10^{-5} \frac{ft^3}{cm^3}} = 9.58 \times 10^5 \frac{B}{hr-ft^3} \quad (25)$$

With the properties outlined above for the porous bed of thulia microspheres, it is desirable to know the maximum diameter fuel capsule which can be made and not have melting take place at the center. Thulia melts at $4632^\circ R$. Assuming an outside wall temperature of $1960^\circ R$ and an average temperature in the fuel capsule of $3296^\circ R$ ($\frac{T_{melt} + T_s}{2}$) Equation (24) can be written as:

$$(4632 - 1960) = \frac{(9.58 \times 10^5) (\gamma_o^2)}{(4) \left[0.084 + (3296 - 460) (7.5 \times 10^{-5}) + 1.706 \left(\frac{3296^3}{100} \right) \times 10^{-7} \right]} \quad (26)$$

Rearranging and solving for γ_o yields:

$$\gamma_o = 0.700 \text{ inches} \quad (27)$$

This is the maximum capsule radius for which thulia microspheres can be considered without having melting take place at the capsule centerline when containment surface is constrained at 1500°F or less. A lesser radius results if surface temperature exceeds 1500°F .

The dashed curves in Figure 60 show the maximum radius without centerline melting as a function of power density with fill gas as the parameter.

Figure 60. Characteristics for Thulia Microsphere Filled Fuel Capsules

Shortly after the analysis using the empirical data was performed, experimental data on the thermal conductivity of PuO_2 microspheres (50 to 250 microns) was supplied by Mound Laboratories⁽³⁾. The data given are shown in Table 1.

TABLE 1
THERMAL PROPERTIES OF PuO_2

GAS	PRESSURE, (TORR)	CONDUCTIVITY, (B/hr-ft-°F)
Helium	716	0.532
	728	0.870
	760*	0.532
	760*	0.894
Argon	19	0.108
	76	0.145
	684	0.315
	750	0.242
	760	0.290
*Note: Annular cylinders (other solid cylinders) surface temperature constant at 540°C (1004°F)		

Using an average value of PuO_2 microsphere thermal conductivity (0.727 B/hr-ft-°F when helium is present and 0.290 B/hr-ft-°F when argon is present) and assuming that the solid thulia conductivity is approximately the same as that of solid PuO_2 , the maximum permissible radius was again calculated. Using Equation 24 and rearranging to obtain an explicit relation for γ_o yields:

$$\gamma_o = \sqrt{(T_o - T_s) \frac{4 K_{eff}}{A_o}} \quad (28)$$

The solid curves in Figure 60 give the maximum radius without melting for an assumed porosity of 38 percent and a solid thulia power density ranging from 0 to 24 watts/cc. The fuel capsule surface temperature was again set at 1500°F. It was also assumed that no temperature drop existed across the fuel capsule walls as was the case with computations using the empirical data. (The assumption that the PuO_2 thermal conductivity data related to a void fraction of 38 percent rather than 30 percent, which is most likely true, has the effect of translating the solid curves of Figure 60 slightly to the right of position they would occupy had a 30 percent void fraction been used; ie, for a given solid power density the maximum diameter without fuel melting is reduced by about 11 percent if void fraction is 30 percent rather than 38 percent.)

SECTION 4

RESULTS

The values for thulia power density and thermal conductivity chosen for this parametric analysis were assumed to cover the range which would be met in practice. At present only scattered data exists on the thermal conductivity of thulia. Extrapolation of available data led to a conductivity of 3.0 B/hr-ft- $^{\circ}$ F at 2000 $^{\circ}$ F and 1.5 B/hr-ft- $^{\circ}$ F at 4000 $^{\circ}$ F. Extrapolation was based on thulia conductivity behaving in the same manner as BeO; that is, having the conductivity drop off rapidly with increasing temperature until at approximately 2000 $^{\circ}$ F (1093 $^{\circ}$ C) it begins to level off and by 3000 $^{\circ}$ F (1649 $^{\circ}$ C) it becomes almost flat.

During the course of this investigation the thulia conductivity was assumed independent of temperature for individual thermal profiles. If thulia does in fact behave like BeO and approach a stable value of thermal conductivity at 2000 to 3000 $^{\circ}$ F then the thermal profiles established in this report will be valid. If on the other hand, the thermal conductivity proves to be strongly dependent upon temperature in the temperature range of concern then attempts should be made to include a temperature dependent conductivity in the thermal analysis.

In comparing the data of the doubly and singly encapsulated wafers it is noted that the centerline temperature is the highest for the singly encapsulated wafer when similar fuel capsule parameters are compared. This is primarily a consequence of the additional radial conduction path offered by the individually lined wafers. As can be seen by comparing Figure 9 to Figure 44 the temperature difference between the centerline and the wafer outer diameter is greater for the singly encapsulated wafer. It should also be noted that the temperature difference

across the gap between the wafer and the liner is much less for the individual wafer encapsulation. This is also a consequence of the additional radial heat transfer offered by the individual liner material.

The gap between the inner liner and the fuel capsule is taken to be 0.008 inch in the case of the doubly encapsulated wafer whereas it is only 0.004 inch in the case of the singly encapsulated wafer. The larger gap causes a greater temperature difference but the gap is necessary with the double encapsulation because of the manner in which the individually lined wafers are fabricated and stacked upon one another.

Each of Figures 6 through 59 show a design limit line. Above this limit some material within the fuel capsule will be operating in the molten state. In some instances the capsule is limited by the thulia whereas in other instances it is the temperature limit of the liner material which is restricting the geometry of the capsule.

The higher centerline temperatures existing in the singly encapsulated wafers should not necessarily be taken as a negative factor. Since thulia is the only material existing within the interior of the singly encapsulated fuel capsule, the operating temperature is limited by the thulia and not by the liner material as is the case with some of the doubly encapsulated wafers. As an example, Figure 14 shows that for a 1.8 inch diameter wafer having a conductivity of 3.0 B/hr-ft- $^{\circ}$ F and a power density of 16 watts/cc, the Haynes 25 liner will melt prior to the thulia melting when an argon atmosphere is present within the capsule. On the other hand, Figure 44 indicates that using the single encapsulation the centerline temperature is much higher for the same 1000 $^{\circ}$ F surface temperature but this higher temperature has not compromised the integrity of the fuel capsule materials.

The liner materials having the lowest operating temperatures, namely Haynes 25 and Hastelloy X, were investigated only when operating with a fuel capsule surface temperature of 1000 $^{\circ}$ F (Figures 6 to 17). The capsule surface operating temperature was restricted to 1000 $^{\circ}$ F because of the relatively low

operating temperature of these two metals. Similarly, platinum and T-222 were investigated as a liner candidate with a fuel capsule surface temperature of 1500°F (Figures 18 to 29) and tungsten and molybdenum were investigated as a liner candidate when the fuel capsule temperature was at 2000°F (Figures 30 to 41).

The curves indicate that the liner material has a considerable influence on the temperature within the wafer in doubly encased systems. For instance, the values of thermal conductivity used for molybdenum and tungsten were 42 and $60.5 \text{ B/hr-ft-}^{\circ}\text{F}$ respectively; as a result of this difference in thermal conductivity the centerline temperature was 4000°F and 3750°F for molybdenum and tungsten respectively as can be witnessed by Figures 35 and 41 for 16 w/cc power density and argon as the fill gas.

SECTION 5

CONCLUSIONS

The high operating temperature of thulia allows the use of relatively large diameter fuel capsules without compromising the integrity of the fuel capsule. In the case of the doubly encapsulated wafers the capsule is temperature limited by the liner material when using Haynes 25, Hastelloy X, and platinum and by the thulia fuel when using T-222, molybdenum, and tungsten. The fuel capsule design should be such that the temperature within the capsule at no point exceeds the softening temperature of the liner material. If the liner material melts during operation it is conceivable that the thulia can come into contact with the fuel capsule wall and result in reduced fuel capsule life and potential safety hazards.

With singly encapsulated configurations the design is limited only by the melt temperature of the thulia. The phenomenon which takes place within a capsule having a molten center core must, however, be examined in more detail before use is made of this untried concept.

Because of the relatively large temperature drops occurring across the materials interfaces it would behoove the designer to concentrate on achieving high emissivities on the housing and liner interfaces to aid in the radiation heat transfer. In addition, care should be taken in selecting the fits between the wafers, liners, and housings so that a minimum void gap will exist after assembly. Of course, in some instances temperatures within the fuel capsule will not be a problem because of low heat requirements and as a result readily achieved emissivities and tolerances may be used.

For a fixed fuel capsule diameter and thoria conductivity, a doubly encapsulated wafer configuration having helium as the interstitial gas gives the lowest centerline temperature. In addition, the higher the thermal conductivity of the liner material the lower the centerline temperature. Hence, a helium filled capsule having a tungsten liner yields the lowest centerline temperature for a given surface temperature.

APPENDIX A

COMPUTER CODES AND NOMENCLATURE FOR DETERMINATION OF THERMAL PROFILES IN AN INFINITELY LONG CIRCULAR FUEL CAPSULE

NOMENCLATURE

K_1 - conductivity of fill gas
 K_2 - conductivity of liner or inner tube
 K_3 - conductivity of outer tube
 K_4 - conductivity of fill gas
 B - Boltzman constant
 E_1 and E_2 - emissivity
 A - power density of thulia
 S_1 - maximum error possible

S_8 - N_1

S_5 - F_1

S_6 - F_2

S_7 - F_3

B_1 - F_4

B_2 - F_5

B_3 - N

B_4

B_5

B_6

D_1

D_2

D_3

D_4

D_5

D_6

D_7

Intermediate
Program Variables

Figure A-1 Nomenclature for Computer Codes

```

125 LET N= 1.0
130 LET K2 = 15.7
140 PRINT "LINER MATERIAL IS HASTELLOY X ...THERMAL CONDUCTIVITY =15.7"
145 PRINT "-----"
146 PRINT
147 PRINT
150 GOSUB 320
160 LET K2 =15.9
170 PRINT "LINER MATERIAL IS HAYNES 25 ...THERMAL CONDUCTIVITY =15.9"
175 PRINT "-----"
176 PRINT
177 PRINT
180 GOSUB 320
185 LET N =2.0
190 LET K2 =57
200 PRINT "LINER MATERIAL IS PLATINUM ...THERMAL CONDUCTIVITY =57.0"
205 PRINT "-----"
206 PRINT
207 PRINT
210 GOSUB 320
222 LET K2 =31.8
230 PRINT "LINER MATERIAL IS T-222 ...THERMAL CONDUCTIVITY =31.8"
235 PRINT "-----"
236 PRINT
237 PRINT
240 GOSUB 320
250 LET K2 =42
255 LET N=3.0
260 PRINT "LINER MATERIAL IS MOLYBDENUM ...THERMAL CONDUCTIVITY =42.0"
265 PRINT "-----"
266 PRINT
267 PRINT
270 GOSUB 320
280 LET K2 =60.5
290 PRINT "LINER MATERIAL IS TUNGSTEN ...THERMAL CONDUCTIVITY =60.5"
295 PRINT "-----"
296 PRINT
297 PRINT
300 GOSUB 320
310 GO TO 1330
320 LET T5 = 1460 +(N-1)*500
330 LET K3=12.0
340 FOR R =.025 TO .125 STEP .050
350 FOR A = .77305E6 TO 2.3192E6 STEP .77305E6
360 FOR K1 =1.5 TO 3.1 STEP 1.5
370 FOR N1= 1.0 TO 2.1
380 LET H3 =.009/12
390 LET H4=.0083/12

```

```

400 LET H5 = .1/12
410 LET X1 = .201/12
420 LET R1 = R+X1+H3
430 LET R2 = R1 +H4
440 LET R3 = R2 +H5
450 LET H1 = .205
460 LET H2 = .00025
470 LET H0 = H1+2*(H2+X1)
480 LET E1 = .3
490 LET E2 = .3
500 LET B = .1714
510 LET X2 = .20694
520 LET X2 = X2/12
530 LET S6 = A*H1*(R^2)*LOG(R3/R2)
540 LET D5 = .5*S6/(K3*H0)
550 LET T4 = T5+D5
560 LET B5 = A*H1*(R^2)/(H0*(R1+R2))
570 LET T3 = T4 +1.0
580 LET S5 = (T3+T4-920)/2
590 IF N1 =2.0 THEN 620
600 LET K4 = .084 +S5*7.5E-5
610 GO TO 640
620 LET S5 = (S5*5/9)-32
630 LET K4 = .015 +S5*1.1E-5
640 REM
650 LET B6 = K4*(T3-T4)/H4 +E2*B*((T3/100)^4-(T4/100)^4)
660 IF B6>B5 THEN 690
670 LET T3 = T3 +1.0
680 GO TO 580
690 LET D4 = T3-T4
700 LET S7 = A*(R^2)*H1*LOG(R1/(R+X1))
710 LET D3 = .5*S7/(K2*H0)
720 LET T2 = T3+D3
730 LET B3 = .5*A*(R^2)*H1/((R+(X1/2))*(H1+X1))
740 LET T1 = T2+1.0
750 LET S5 = (T2+T1-920)/2
760 IF N1 =2.0 THEN 790
770 LET K4 = .084 +S5*7.5E-5
780 GO TO 810
790 LET S5 = (S5*5/9)-32
800 LET K4 = .015 +S5 *1.1 E-5
810 LET B4 = K4*(T1-T2)/X1 +E1*B*((T1/100)^4 -(T2/100)^4)
815 LET B4 = D4 +2*K2*H2*(T1-T2)/((H1+X1)*X1)
820 IF B4>B3 THEN 850
830 LET T1 = T1+1.0
840 GO TO 750
850 LET D2 = T1-T2
860 LET K5 = K1*H1 +2*K2*H2
870 LET D1 = A*(R^2)*H1/(4*K5)
880 LET T0 = T1 +D1
890 LET T8 = T2
900 LET S8 = A*(H1/2)^2

```

```

910 LET D6 = .5*S8/K1
920 LET T7 = T8 + 1.0
930 LET B1 = A*H1/2
940 LET S5 = (T7 + T8 - 920)/2
950 IF N1 = 2.0 THEN 980
960 LET K4 = .084 + S5*7.5E-5
970 GO TO 1020
980 LET S5 = (S5*5/9) - 32
990 LET K4 = .015 + S5 * 1.1 E-5
1000 LET B2 = K4*(T7-T8)/X1 + E1*B*((T7/100)^4 - (T8/100)^4)
1010 IF B2 > B1 THEN 1040
1020 LET T7 = T7 + 1.0
1030 GO TO 940
1040 LET D7 = T7 - T8
1050 LET S1 = D6 + D7
1060 LET F1 = T1 - 460
1070 LET F0 = T0 - 460
1080 LET F2 = T2 - 460
1090 LET F3 = T3 - 460
1100 LET F4 = T4 - 460
1110 LET F5 = T5 - 460
1120 IF N1 = 2.0 THEN 1150
1130 PRINT "FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F =" K4
1140 GO TO 1160
1150 REM
1151 PRINT "FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F =" K4
1160 PRINT "THULIUM CONDUCTIVITY IN BTU/HR-FT-F =" K1
1170 LET M5 = A/9.663 E 4
1180 PRINT "POWER DELSITY IN WATTS/CC =" M5
1190 LET M6 = R*24
1200 PRINT "THULIUM WAFER DIA. IN INCHES =" M6
1210 PRINT
1220 PRINT "C.L.", "FUEL O.D.", "LINER O.D.", "WALL O.D.", "MAX. ERROR"
1230 PRINT
1240 PRINT F0, F1, F3, F5, S1
1250 PRINT
1260 PRINT
1270 PRINT
1280 NEXT N1
1290 NEXT K1
1300 NEXT A
1310 NEXT R
1320 RETURN
1330 REM
1350 END

```

DOUBLY ENCAPSULATED CONFIGURATION

LINER MATERIAL IS HASTELLOY X ...THERMAL CONDUCTIVITY =15.7

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .162129
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1081.57	1042.22	1040.82	1000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.20988 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1255.57	1216.22	1214.82	1000	9.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .162129
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.,	WALL O.D.	MAX. ERROR
1068.65	1042.22	1040.82	1000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.20988 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1242.65	1216.22	1214.82	1000	8.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .165109
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1160.14	1081.45	1079.65	1000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.32796 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1486.14	1407.45	1404.65	1000	17.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .165109
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1134.31	1081.45	1079.65	1000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.32796 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1460.31	1407.45	1404.65	1000	15.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .160013
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1236.71	1120.67	1117.47	1000	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43229 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1693.71	1575.67	1572.47	1000	23.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .168013
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D-	WALL O.D.	MAX. ERROR
1199.96	1120.67	1117.47	1000	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43229 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1654.96	1575.67	1572.47	1000	21.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .168341
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1480.15	1126.04	1122.83	1000	2.61252

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43863 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1946.15	1592.04	1588.83	1000	8.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .168341
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1363.92	1126.04	1122.83	1000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43863 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1829.92	1592.04	1588.83	1000	7.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .177157
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1952.3	1244.09	1238.66	1000	5.22124

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.70022 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2728.3	2020.09	2013.66	1000	14.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .177157
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1719.84	1244.09	1238.66	1000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.70022 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2495.84	2020.09	2013.66	1000	12.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .185522
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2419.45	1357.13	1348.49	1000	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.90435 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3415.45	2353.13	2344.49	1000	19.9316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .185522
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2072.77	1357.13	1348.49	1000	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.90435 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3066.77	2353.13	2344.49	1000	17.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .174414
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2191.64	1228.02	1202.99	1000	2.61252

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.62226 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2877.64	1894.02	1888.99	1000	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .174414
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1868.79	1228.02	1202.99	1000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.62226 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2554.79	1894.02	1888.99	1000	6.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .188478
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3364.29	1397.04	1387.98	1000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.96571 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4424.29	2457.04	2446.98	1000	13.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .188478
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2718.58	1397.04	1387.98	1000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.96571 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3778.58	2457.04	2446.98	1000	11.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201492
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4522.93	1572.06	1558.97	1000	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .032172
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5819.93	2869.06	2854.97	1000	17.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201492
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3554.37	1572.06	1558.97	1000	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .032172
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4851.37	2869.06	2854.97	1000	15.4158

LINER MATERIAL IS HAYNES 25 ...THERMAL CONDUCTIVITY =15.9

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .162129
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1081.31	1042.22	1040.82	1000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.20958 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1255.31	1216.22	1214.82	1000	9.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .162129
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1063.53	1042.22	1040.82	1000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.20988 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1242.53	1216.22	1214.82	1000	8.82526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .165108
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1159.62	1081.44	1079.65	1000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.32796 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1484.62	1406.44	1404.65	1000	17.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .165108
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1134.07	1081.44	1079.65	1000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.32796 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1459.07	1406.44	1404.65	1000	15.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .168012
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0023
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1237.93	1120.66	1117.47	1000	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43228 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1692.93	1575.66	1572.47	1000	23.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F< .168012
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1199.5	1120.66	1117.47	1000	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43228 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1654.6	1575.66	1572.47	1000	21.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .16834
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1477.84	1126.03	1122.83	1000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43862 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1943.84	1592.03	1588.83	1000	2.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .16834
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1362.87	1126.03	1122.83	1000	1.82526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.43862 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1828.87	1592.03	1588.83	1000	7.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .177154
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0022
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1947.68	1244.06	1238.66	1000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .027002
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 15.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2722.68	2019.06	2013.66	1000	14.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .177154
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1717.74	1244.06	1238.66	1000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .027002
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0022
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2492.74	2019.06	2013.66	1000	12.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .185519
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2412.53	1357.09	1348.49	1000	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.90433 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3408.53	2353.09	2344.49	1000	19.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .185519
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2267.61	1357.09	1348.49	1000	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.90433 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3063.61	2353.09	2344.49	1000	17.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .174412
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2185.25	1207.99	1202.99	1000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.62224 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2871.25	1893.99	1888.99	1000	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .174412
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1865.89	1207.99	1202.99	1000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.62224 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2551.89	1893.99	1888.99	1000	6.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .188474
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3351.5	1396.99	1327.98	1000	5.22124

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.96568 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.-	WALL O.D.	MAX. ERROR
4410.5	2455.99	2446.98	1000	13.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .188474
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.-	WALL O.D.	MAX. ERROR
2712.77	1396.99	1387.98	1000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.96568 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3771.77	2455.99	2446.98	1000	11.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201486
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4523.76	1571.98	1558.97	1000	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.2171 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5800.76	2868.98	2854.97	1000	17.8315

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201486
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3545.66	1571.98	1558.97	1000	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.21715 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.2003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4842.66	2868.98	2854.97	1000	15.4158

LINER MATERIAL IS PLATINUM ...THERMAL CONDUCTIVITY =57.6

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .19900E
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1550.71	1533.93	1532.82	1500	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.48195 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1678.71	1661.93	1662.82	1500	8.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .19900E
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1547.82	1533.93	1532.82	1500	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.48195 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1675.82	1661.93	1662.82	1500	7.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201515
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1600.42	1566.87	1565.65	1500	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.57205 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1840.41	1806.87	1805.65	1500	15.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201515
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1594.64	1566.87	1565.65	1500	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.57205 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = -16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1834.64	1806.87	1805.65	1500	13.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .203940
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1649.13	1598.8	1597.47	1500	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65421 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1989.13	1938.8	1937.47	1500	21.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .203948
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1642.45	1598.8	1597.47	1500	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65421 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1980.45	1938.8	1937.47	1500	19.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .2042
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1754.15	1603.16	1601.83	1500	2.61252

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65901 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2103.15	1952.16	1950.83	1500	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .2042
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1725.12	1603.16	1601.83	1500	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65901 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2077.12	1952.16	1950.83	1500	6.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .2116
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.2002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2003.3	1701.33	1699.66	1500	5.22124

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.87239 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2601.3	2299.33	2297.66	1500	13.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .2116
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1951.24	1701.33	1699.66	1500	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.87239 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2549.24	2299.33	2297.66	1500	11.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .218699
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2249.45	1796.49	1793.49	1500	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.04603 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3035.45	2582.49	2579.49	1500	18.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .218699
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2171.36	1796.49	1793.49	1500	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.04605 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D-	WALL O.D.	MAX. ERROR
2957.36	2582.49	2579.49	1500	16.4158

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .209254
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2089.96	1670.55	1668.99	1500	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.80836 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2615.96	2196.55	2194.99	1500	7.61052

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .209254
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2017.64	1670.55	1668.99	1500	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.80836 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2543.64	2196.55	2194.99	1500	6.80526

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .221182
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2668.91	1832.1	1826.98	1500	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.09928 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3510.91	2672.1	2668.98	1500	12.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .221182
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2524.29	1830.1	1826.98	1500	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.09928 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3366.29	2672.1	2668.98	1500	10.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .232436
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3238.87	1980.65	1975.97	1500	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.32236 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.2003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4294.87	3036.65	3031.97	1500	16.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .232436
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3021.93	1980.65	1975.97	1500	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.32236 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4277.93	3036.65	3031.97	1500	14.4158

LINER MATERIAL IS T-222 ...THERMAL CONDUCTIVITY =31.8

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .199014
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1559.83	1534.02	1532.82	1500	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.48201 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1687.83	1662.02	1660.82	1500	8.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .199014
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1553.57	1534.02	1532.82	1500	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.48201 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1681.57	1662.02	1660.82	1500	7.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201528
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1618.66	1567.04	1565.65	1500	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.57216 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1858.66	1807.04	1805.65	1500	15.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .201528
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1606.13	1567.04	1565.65	1500	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.57216 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1846.13	1807.04	1805.65	1500	13.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .203967
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1676.49	1599.06	1597.47	1500	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65437 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2016.49	1939.06	1937.47	1500	21.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .203967
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1657.7	1599.06	1597.47	1500	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65437 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1997.7	1939.06	1937.47	1500	19.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .20422
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1835.72	1603.43	1601.83	1500	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65917 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2184.72	1952.43	1950.83	1500	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F< .20422
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1779.34	1603.43	1601.83	1500	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.65917 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2128.34	1952.43	1950.83	1500	6.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .211639
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2167.43	1702.86	1699.66	1500	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.87271 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 15.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.-	MAX. ERROR
2765.43	2302.86	2297.66	1500	13.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .211639
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.,	MAX. ERROR
2054.67	1702.86	1699.66	1500	3.61252

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.87271 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2652.67	2300.86	2297.66	1500	11.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .218759
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.2003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.,	MAX. ERROR
2495.15	1798.29	1793.49	1500	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.04653 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3281.15	2584.29	2579.49	1500	18.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .218759
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2326.01	1798.29	1793.49	1500	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.04653 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3112.01	2584.29	2579.49	1500	16.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .209287
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2317.23	1671.99	1668.99	1500	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.80863 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2843.23	2197.99	2194.99	1500	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .209287
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 2.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2160.62	1671.99	1668.99	1500	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.80863 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2686.62	2197.99	2194.99	1500	6.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .221249
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3122.47	1831.98	1826.98	1500	5.22124

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.09982 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3964.47	2673.98	2668.98	1500	12.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .221249
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2809.24	1831.98	1826.98	1500	3.61252

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.09982 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3651.24	2673.98	2668.98	1500	10.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .232536
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3918.7	1982.98	1975.97	1520	7.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.32317 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4974.7	3038.98	3031.97	1500	16.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .232536
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3448.86	1982.98	1975.97	1500	5.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.32317 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4504.86	3038.98	3031.97	1500	14.4158

LINER MATERIAL IS TUNGSTEN ...THERMAL CONDUCTIVITY =60.5

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .236132
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2044.93	2028.93	2027.82	2000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.76153 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2135.93	2119.93	2118.82	2000	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .236132
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2042.27	2028.93	2027.82	2000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.76153 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2133.27	2.19.93	2118.82	2000	6.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .238264
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2088.85	2056.85	2055.65	2000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.83024 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2261.85	2229.85	2228.65	2000	14.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .238264
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2083.55	2056.85	2055.65	2000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.83024 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2256.55	2229.85	2228.65	2000	12.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .240284
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2131.78	2083.78	2082.47	2000	6.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89375 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2379.78	2331.78	2330.47	2000	19.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .240284
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2123.82	2083.78	2082.47	2000	4.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89375 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2371.82	2331.78	2330.47	2000	17.4153

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .240573
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2232.13	2088.15	2086.83	2000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89764 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2487.13	2343.15	2341.83	2000	6.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .240573
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2208.27	2088.15	2086.83	2000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89764 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2463.27	2343.15	2341.83	2000	5.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .246997
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2461.26	2173.29	2171.66	2000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.06914 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2909.26	2621.29	2619.66	2000	13.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .246997
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2413.53	2173.29	2171.66	2000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.06914 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2861.53	2621.29	2619.66	2000	11.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .253083
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2687.4	2255.44	2252.49	2000	6.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.21437 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3290.4	2858.44	2855.49	2000	17.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .253083
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.0003
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2615.8	2255.44	2252.49	2000	4.41573

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.21437 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.0003
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3218.8	2858.44	2855.49	2000	15.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .244951
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2546.48	2146.52	2144.99	2000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.01642 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2937.48	2537.52	2535.99	2000	6.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .244951
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2480.19	2146.52	2144.99	2000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.01642 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2871.19	2537.52	2535.99	2000	5.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .255303
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3084.96	2285.03	2281.98	2000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.26057 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3735.96	2936.03	2932.98	2000	12.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .255303
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2952.38	2285.03	2281.98	2000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.26057 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3603.38	2936.03	2932.98	2000	10.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .265166
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3616.44	2416.55	2412.97	2000	6.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.45553 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4453.44	3253.55	3249.97	2000	16.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .265166
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3417.57	2416.55	2412.97	2000	4.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.45553 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4254.57	3253.55	3249.97	2000	14.4158

LINER MATERIAL IS MOLYBDENUM...THERMAL CONDUCTIVITY = 42.0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .236135
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2250.16	2028.97	2027.82	2000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.76156 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2141.16	2119.97	2118.82	2000	7.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .236135
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2245.75	2028.97	2027.82	2000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.76156 E-2
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2136.75	2119.97	2118.82	2000	6.80526

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .238271
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2099.33	2056.95	2055.65	2000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.83029 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D-	MAX. ERROR
2272.33	2229.95	2228.65	2000	14.221

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .238271
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D-	MAX. ERROR
2090.5	2056.95	2055.65	2000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.83029 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2263.5	2229.95	2228.65	2000	12.6105

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .240294
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2147.49	2083.92	2082.47	2000	6.53156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89383 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2395.49	2331.92	2330.47	2000	19.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .240294
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2134.25	2083.92	2082.47	2000	4.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89383 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2382.25	2331.92	2330.47	2000	17.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .240584
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2279.	2088.28	2086.83	2000	2.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89772 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2534.	2343.28	2341.83	2000	6.61052

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .242584
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2239.27	2088.28	2086.83	2000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 2.89772 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2494.27	2343.28	2341.83	2000	5.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .247018
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0022
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2556.01	2174.57	2171.66	2000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.06931 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3004.01	2622.57	2619.66	2000	13.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .247018
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2476.54	2174.57	2171.66	2000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.06931 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2924.54	2622.57	2619.66	2000	11.6105

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .253114
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2828.01	2255.85	2252.49	2000	6.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.21463 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3431.01	2858.85	2855.49	2000	17.8316

FILL GAS IS HELIUM...THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .253114
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2708.81	2255.85	2252.49	2000	4.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.21463 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0203
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3311.81	2858.85	2855.49	2020	15.4158

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .244969
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2676.53	2146.75	2144.99	2000	2.61252

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.01656 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3067.53	2537.75	2535.99	2000	6.61252

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .244969
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2566.16	2146.75	2144.99	2000	1.80526

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.01656 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2957.16	2537.75	2535.99	2000	5.80526

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .255337
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3345.25	2285.5	2281.98	2000	5.22104

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.26235 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3996.05	2936.5	2932.98	2000	12.221

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .255337
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3124.31	2225.5	2281.98	2000	3.61052

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.26285 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.0002
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3775.31	2936.5	2932.98	2000	10.6125

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .265219
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4007.58	2418.25	2412.97	2000	6.83156

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.45595 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4844.58	3255.25	3249.97	2000	16.8316

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .265219
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. FRROR
3676.47	2418.25	2412.97	2000	4.41578

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = 3.45595 E-2
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.0003
 THULIUM WAFER DIA. IN INCHES = 3.

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4513.47	3255.25	3249.97	2000	14.4158

APPENDIX B

COMPUTER PRINT OUT FOR THERMAL PROFILES
IN AN INFINITELY LONG CIRCULAR FUEL CAPSULE

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/
300 PRINT "PROGRAM FOR THULIA WAFERS INCASED WITH 2 CONCENTRIC TUBES"
305 PRINT
307 PRINT
308 FOR N = 1 TO 3.1 STEP 1.0
310 LET K2 = 20.0
320 LET T5 = 1460 + (N-1)*500
330 LET K3 = 20.0
340 FOR R = .025 TO .125 STEP .050
350 FOR A = .77305E6 TO 2.3192E6 STEP .77305E6
360 FOR K1 = 1.5 TO 3.1 STEP 1.5
370 FOR N1 = 1.0 TO 2.1
380 LET H3 = .020/12
390 LET H4 = .004/12
400 LET H5 = .1/12
410 LET X1 = .002/12
415 LET X2 = 0
420 LET R1 = R + X1 + H3
430 LET R2 = R1 + H4
440 LET R3 = R2 + H5
450 LET H1 = .005
460 LET H2 = 0
470 LET H0 = H1 + 2*(H2 + X2)
480 LET E1 = .3
490 LET E2 = .3
500 LET B = .1714
530 LET S6 = A * H1 * (R^2) * LOG(R3/R2)
540 LET D5 = .5 * S6 / (K3 * H0)
550 LET T4 = T5 + D5
560 LET B5 = A * H1 * (R^2) / (H0 * (R1 + R2))
570 LET T3 = T4 + 1.0
580 LET S5 = (T3 + T4 - 920) / 2
590 IF N1 = 2.0 THEN 620
600 LET K4 = .084 + S5 * 7.5E-5
610 GO TO 640
620 LET S5 = (S5 * 5 / 9) - 32
630 LET K4 = .015 + S5 * 1.1E-5
640 REM
650 LET B6 = K4 * (T3 - T4) / H4 + E2 * B * ((T3 / 100)^4 - (T4 / 100)^4)
660 IF B6 > B5 THEN 690
670 LET T3 = T3 + 1.0
680 GO TO 580
690 LET D4 = T3 - T4

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CONDUCTION
THRU TUBE
WALL

RADIATION +
GAS CONDUCTION
ACROSS GAP
BETWEEN TUBE
WALL &
LINER

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700 LET S7 = A*(R^2)*H1*LOG(R1/(R+X1))
710 LET D3 = .5*S7/(K2*H0)
720 LET T2 = T3+D3
725 IF H3 = 0 THEN 855
730 LET B3 = .5*A*(R^2)*H1/((R+(X1/2))*(H1+X2))
740 LET T1 = T2+1.0
750 LET S5 = (T2+T1-920)/2
760 IF N1 = 2.0 THEN 790
770 LET K4 = .084 + S5*7.5E-5
780 GO TO 810
790 LET S5 = (S5*5/9)-32
800 LET K4 = .015 + S5 *1.1 E-5
810 LET B4 = K4*(T1-T2)/X1 + E1*B*((T1/100)^4 - (T2/100)^4)
815 LET B4 = B4 + 2*K2*H2*(T1-T2)/((H1+X2)*X1)
820 IF B4 > B3 THEN 850
830 LET T1 = T1+1.0
840 GO TO 750
850 LET D2 = T1-T2
854 GO TO 860
855 LET T1 = T2
860 LET K5 = K1*H1 + 2*K2*H2
870 LET D1 = A*(R^2)*H1/(4*K5)
880 LET T0 = T1 + D1
885 IF H2 = 0 THEN 1055
890 LET T8 = T2
900 LET S8 = A*(H1/2)^2
910 LET D6 = .5*S8/K1
920 LET T7 = T8 + 1.0
930 LET B1 = A*H1/2
940 LET S5 = (T7 + T8 - 920)/2
950 IF N1 = 2.0 THEN 980
960 LET K4 = .084 + S5*7.5E-5
970 GO TO 1000
980 LET S5 = (S5*5/9)-32
990 LET K4 = .015 + S5 *1.1 E-5
1000 LET B2 = K4*(T7-T8)/X2 + E1*B*((T7/100)^4 - (T8/100)^4)
1010 IF B2 > B1 THEN 1040
1020 LET T7 = T7 + 1.0
1030 GO TO 940
1040 LET D7 = T7-T8
1050 LET S1 = D6+D7
1052 GO TO 1060
1055 LET S1 = 0
1060 LET F1 = T1-460
1070 LET F0 = T0-460
1080 LET F2 = T2-460
1090 LET F3 = T3-460
1100 LET F4 = T4-460
1110 LET F5 = T5-460
1120 IF N1 = 2.0 THEN 1150
1130 PRINT "FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F="^
K4

```

← CONDUCTION
THRU LINER

← RADIATION
+ GAS CONDUCTION
+ METAL CONDUCTION
BETWEEN LINER
AND OUTER
SURFACE OF
FUEL ELEMENT

← CONDUCTION
THRU TUBULAR
WATER.

← MAX ERROR
LOOP

```

1142 GO TO 1160
1150 REM
1151 PRINT "FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F =" ^
K4
1160 PRINT "THULIUM CONDUCTIVITY IN BTU/HR-FT-F =" K1
1170 LET M5=A/9.663 E 4
1180 PRINT "POWER DENSITY IN WATTS/CC =" M5
1190 LET M6 =R*24
1200 PRINT "THULIUM WAFER DIA. IN INCHES =" M6
1210 PRINT
1215 IF H3 = 0 THEN 1225
1220 PRINT "C.L.", "FUEL O.D.", "LINER O.D.", "WALL O.D.", "MAX. ERROR"
1222 GO TO 1230
1225 PRINT "C.L.", "FUEL O.D.", "WALL O.D.", "MAX. ERROR"
1230 PRINT
1240 PRINT F0, F1, F3, F5, S1
1250 PRINT
1260 PRINT
1270 PRINT
1280 NEXT N1
1290 NEXT K1
1300 NEXT A
1310 NEXT R
1315 NEXT N
1330 REM
1350 END

```

*

SINGLY ENCAPSULATED CONFIGURATION

PROGRAM FOR THULIA WAFERS INCASED WITH 2 CONCENTRIC TUBES

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16110046
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1113.5322	1033.0061	1022.2316	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2177359E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1281.5322	1201.0061	1130.2316	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16110046
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1073.2691	1033.0061	1022.2316	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2177359E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1241.2691	1201.0061	1130.2316	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16312592
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1226.0644	1065.0123	1043.4632	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2271168E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1546.0644	1385.0123	1252.4632	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16312592
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1145.5383	1065.0123	1043.4632	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2271168E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1465.5383	1385.0123	1252.4632	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16511388
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1337.5966	1096.0185	1064.6948	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2358866E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1797.5966	1556.0135	1367.6948	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16511388
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1216.8075	1096.0135	1064.6948	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2353866E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1676.8075	1556.0135	1367.6948	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16545241
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1825.2665	1100.5321	1069.1481	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2369875E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2298.2665	1573.5321	1386.1481	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16545241
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1462.8993	1100.5321	1069.1481	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2369875E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1935.8993	1573.5321	1386.1481	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .17160482
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2645.5331	1196.0643	1135.2961	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2610367E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3482.5331	2033.0643	1711.2961	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .17160482
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1920.7987	1196.0643	1135.2961	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2610367E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2757.7987	2033.0643	1711.2961	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .17753224
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3461.7996	1287.5965	1199.4442	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2814497E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4591.7996	2417.5965	1992.4442	1000	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .17753224
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2374.6981	1287.5965	1199.4442	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2814497E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3504.6981	2417.5965	1992.4442	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16973711
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3180.3125	1167.1615	1115.1671	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2538315E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3908.3125	1895.1615	1614.1671	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .16973711
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2173.737	1167.1615	1115.1671	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2538315E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2901.737	1895.1615	1614.1671	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .17968673
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5346.6251	1320.323	1223.3342	1000	0

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FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2881247E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
6566.6251	2540.323	2087.3342	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .17968673
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3333.4741	1320.323	1223.3342	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2881247E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4553.4741	2540.323	2087.3342	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .18922384
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
7505.9377	1466.4846	1327.5014	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3152058E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
9080.9377	3041.4846	2468.5014	1000	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .18922384
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4486.2111	1466.4846	1327.5014	1000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3152068E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
6061.2111	3041.4846	2468.5014	1000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .19822546
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1607.5322	1527.0061	1518.2316	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2463359E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1743.5322	1663.0061	1604.2316	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .19822546
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1567.2691	1527.0061	1518.2316	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2463359E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1703.2691	1663.0061	1604.2316	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .19995092
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1715.0644	1554.0123	1536.4632	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2540057E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1976.0644	1815.0123	1702.4632	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .19995092
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1634.5383	1554.0123	1536.4632	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2540057E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1895.5383	1815.0123	1702.4632	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20160138
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1821.5966	1580.0185	1553.6948	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2612477E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2198.5966	1957.0185	1796.6948	1500	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20160138
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1700.8075	1580.0185	1553.6948	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2612477E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2077.8075	1957.0185	1796.6948	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20193991
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. LRROR
2309.2665	1584.5321	1558.1481	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2621347E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2696.2665	1971.5321	1811.1481	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20193991
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
1946.8993	1584.5321	1558.1481	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2621347E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2333.8993	1971.5321	1811.1481	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20707982
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3113.5331	1664.0643	1613.2961	1500	0

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FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2824256E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3812.5331	2363.0643	2081.2961	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20707982
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2388.7987	1664.0643	1613.2961	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2824256E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3087.7987	2363.0643	2081.2961	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .21221974
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3917.7996	1743.5965	1668.4442	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2999664E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4871.7996	2697.5965	2318.4442	1500	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .21221974
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2830.6981	1743.5965	1668.4442	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2999664E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3784.6981	2697.5965	2318.4442	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20547461
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3652.3125	1639.1615	1596.1671	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2762898E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4257.3125	2244.1615	2000.1671	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .20547461
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2645.737	1639.1615	1596.1671	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2762898E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3250.737	2244.1615	2000.1671	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .21407423
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5797.6251	1771.323	1689.3342	1500	0

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FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3058164E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
6832.6251	2806.323	2400.3342	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .21407423
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3784.4741	1771.323	1689.3342	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3058164E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4819.4741	2806.323	2400.3342	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .22229884
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
7936.9377	1897.4846	1778.5014	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3298123E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
9294.9377	3255.4846	2732.5014	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .22229884
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4917.2111	1897.4846	1778.5014	1500	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3298123E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
6275.2111	3255.4846	2732.5014	1500	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .23553796
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2104.5322	2024.0061	2016.2316	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .275272E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2212.5322	2132.0061	2082.2316	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .23553796
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2064.2691	2024.0061	2016.2316	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .275272E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2172.2691	2132.0061	2082.2316	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .23700092
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2208.0644	2047.0123	2031.4632	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2815057E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2417.0644	2256.0123	2161.4632	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .23700092
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2127.5383	2047.0123	2031.4632	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2815057E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2336.5383	2256.0123	2161.4632	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .23842638
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2310.5966	2069.0185	2046.6948	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2874033E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2614.5966	2373.0185	2236.6948	2000	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .23842638
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2189.8075	2069.0185	2046.6948	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2874033E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = .6

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2493.8075	2373.0185	2236.6948	2000	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .23868991
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001034
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2797.2665	2072.5321	2050.1481	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .288168E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 8.0001034
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3110.2665	2385.5321	2249.1481	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .23868991
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001034
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2434.8993	2072.5321	2050.1481	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .288168E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 8.0001034
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2747.8993	2385.5321	2249.1481	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24319232
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
POWER DENSITY IN WATTS/CC = 16.000206
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3591.5331	2142.0643	2098.2961	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3050672E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4164.5331	2715.0643	2470.2961	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24319232
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
2866.7987	2142.0643	2098.2961	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3050672E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3439.7987	2715.0643	2470.2961	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24769474
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4385.7996	2211.5965	2146.4442	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3200414E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5177.7996	3003.5965	2669.4442	2000	0

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FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24769474
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3298.6981	2211.5965	2146.4442	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3200414E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 1.8

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4090.6981	3003.5965	2669.4442	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24177461
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4133.3125	2120.1615	2083.1671	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2999093E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4627.3125	2614.1615	2403.1671	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24177461
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3126.737	2120.1615	2083.1671	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .2999093E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 8.0001034
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
3620.737	2614.1615	2403.1671	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .24928673
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
6261.6251	2235.323	2164.3342	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3250664E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
7124.6251	3098.323	2738.3342	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .24928673
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
4248.4741	2235.323	2164.3342	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .3250664E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
 POWER DENSITY IN WATTS/CC = 16.000206
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5111.4741	3098.323	2738.3342	2000	0

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F= .25653634
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
8385.9377	2346.4846	2242.5014	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .346129E-01
 THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 1.5
 POWER DENSITY IN WATTS/CC = 24.00031
 THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
9536.9377	3497.4846	3024.5214	2000	0

SANDERS NUCLEAR
CORPORATION

FILL GAS IS HELIUM..THERMAL CONDUCTIVITY IN BTU./HR.-FT.-F = .25653634
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
5366.2111	2346.4846	2242.5014	2000	0

FILL GAS IS ARGON...THERMAL CONDUCTIVITY IN BTU/HR.-FT.-F = .346129E-01
THULIUM CONDUCTIVITY IN BTU/HR-FT-F = 3
POWER DENSITY IN WATTS/CC = 24.00031
THULIUM WAFER DIA. IN INCHES = 3

C.L.	FUEL O.D.	LINER O.D.	WALL O.D.	MAX. ERROR
6517.2111	3497.4846	3024.5014	2000	0

APPENDIX C

BIBLIOGRAPHY

1. Smith, P.K.; Keski, J.R.; and Angerman, C.L.; Properties of Thulium Metal and Oxide, AEC Research and Development Report DP-1114.
2. Linkov, A.V.; Shashkov, A.E.; Vasiliev, L.L.; Fraiman, YU.E.; Thermal Conductivity of Porous System, International Journal of Heat and Mass Transfer, Vol. 11, pp 117-140, Pergamon Press 1968.
3. Contact Report, Sanders Nuclear Corporation, July 10, 1968. Telephone conversation between Mr. Warren Eister of U.S.A.E.C., Div. of Isotopes DW., Washington, D.C., and Mr. J. Fretague of Sanders Nuclear Corp.

U.S. ATOMIC ENERGY COMMISSION
**CONTRACTOR'S RECOMMENDATION FOR
DISPOSITION OF RESEARCH DOCUMENT**

(See Instructions on Reverse Side)

☒ **TITLE OF DOCUMENT** THULIUM OXIDE FUEL CHARACTERIZATION STUDY
(Thulium-170 Fueled Capsule Parametric Design)

2. PERSONAL AUTHOR(S)
Dr. Nicholas H. DesChamps

3. CONTRACTOR'S NAME AND ADDRESS
SANDERS NUCLEAR CORPORATION
95 Canal Street, Nashua, New Hampshire 03060

4. CONTRACT NUMBER
AT-(40-1)-3693

5. DATE OF DOCUMENT
October 1968

6. REPORT NUMBER
ORO-3693-1

Complete only one item below, either 7, or 8, or 9.

☐ **7. DOCUMENT HAS BEEN
OR WILL BE SUBMITTED
FOR JOURNAL PUBLICA-
TION.**

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d. ☐ AEC's standard announcement and distribution procedures may prevail after date of meeting.

e. ☐ Recommend that there be no public announcement or distribution because:

☒ **8. DOCUMENT HAS BEEN
OR WILL BE PRESENTED
ORALLY.**

☒ **9. DOCUMENT IS A PROG-
RESS REPORT NOT IN-
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PUBLICATION OR ORAL
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a. ☒ AEC's standard announcement and distribution procedures may prevail.

b. ☐ Recommend that there be no public announcement or distribution.

**SUBMITTED
BY**

(Please print
or type)

NAME

W. J. Fretague

ORGANIZATION

Sanders Nuclear Corporation

TITLE

Program Manager

DATE

October 1968

SIGNATURE

☒ *William J. Fretague*

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