

# **AGR-2 Daily As-run Thermal Analyses**

Grant Hawkes

August 2014



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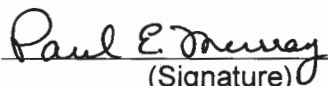
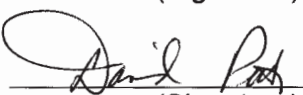

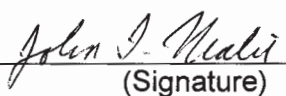

**Idaho National Laboratory  
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## Engineering Calculations and Analysis

ECAR Title: AGR-2 Daily As-Run Thermal Analyses

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1. Confirmation of completeness, mathematical accuracy, and correctness of data and appropriateness of assumptions.
2. Concurrence of method or approach. See definition, LWP-10106.
3. Concurrence of procedure compliance. Concurrence with method/approach and conclusion.
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## REVISION LOG

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7. Objective/Purpose:  The purpose of this report is to document the results of the thermal analyses performed to calculate the Advanced Gas-Cooled Reactor (AGR)-2 as-run daily temperatures of the fuel compacts. Time average volume average data provided by this report will be used to determine fuel performance in post-irradiation examination.		
8. If revision, please state the reason and list sections and/or pages being affected:  NA		
9. Conclusions/Recommendations:  This report documents the results of thermal analyses to predict the daily as-run temperatures for the AGR-2 experiment. Control gas gaps and compact-graphite holder gas gaps were modeled to change linearly with time (fast neutron fluence). Graphite shrinkage rates were taken from the AGC-1 Experiment. Daily heat rates for each compact and component in the models were input from daily as-run physics analyses. Daily gas compositions and component fast neutron fluences were also input. Six different finite element models were created for the six different AGR-2 capsules. Each capsule had a different gas gap that was implemented to control the temperature of the experiment.  Gas mixture thermal conductivity was implemented using kinetic theory of gases. Fluence and temperature-dependent thermal conductivity was used for the graphite components and fuel compacts. Radiation heat transfer was implemented with emissivity of all graphite surfaces being 1.0 and stainless steel at 0.4.  Ten of the fourteen predicted temperatures were within 20 to 50 °C of the measured thermocouples temperatures, while three of the other four were within about 100°C. All of the thermocouples failed during the experiment. Heat rates, and hence temperatures, were very sensitive to the outer shim control cylinders, which is typical for B experimental positions in the Advanced Test Reactor. Volume average time average temperature values were calculated and reported herein.		

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## PROJECT ROLES AND RESPONSIBILITIES

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Performer	Grant L. Hawkes	C120	All
Checker <sup>a</sup>	Paul E. Murray	C660	All
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Quality Assurance	Kirk W. Bailey	Q510	

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## SCOPE AND BRIEF DESCRIPTION

This report documents the daily as-run thermal analyses performed on the Advanced Gas-Cooled Reactor (AGR)-2 Experiment in the Advanced Test Reactor (ATR) for Capsules 2, 3, 5, and 6. Capsule 1 (French) results are in Appendix F, while Capsule 4 (South African) results are in Appendix G. Appendix F and G are separate documents from this report. Due to CRADA agreements, Appendix F and Appendix G are not available for distribution.

Several fuel and material irradiation experiments, which support development of the Next Generation Nuclear Plant, are planned for the Advanced Gas Reactor Fuel Development and Qualification Program. The goals of these experiments are to provide irradiation performance data to support fuel process development, to qualify fuel for normal operating conditions, to support development and validation of fuel performance and fission product transport models and codes, and to provide irradiated fuel and materials for post-irradiation examination (PIE) and safety testing. AGR-2 was the second in this series of planned experiments to test tri-structural-isotropic (TRISO)-coated, low-enriched uranium oxy-carbide fuel. The AGR-2 experiment was intended to serve as a follow-on to the AGR-1 experiment. The AGR-2 experiment is a high-temperature fuel particle test. The test train planned for AGR-2 is based on the experience gained from previous irradiations in ATR, using instrumented lead experiments. Instrumented lead experiments are used for irradiations requiring a controlled environment and monitored parameters. The experiment test train positions the fuel within the test location and contains sweep gas lines and thermocouple wiring that is routed through access ports to external support systems.

The AGR-2 experiment is comprised of six individual capsules, approximately 1.375-in. in diameter by 6-in. long, stacked on top of each other to form the test train. Each capsule contains 12 fueled compacts that are approximately 0.5-in. in diameter by 1-in. long. The compacts are composed of fuel particles bound together by a carbon matrix. Each compact contains approximately 4,150 fissile particles (35 vol% particle packing fraction). Each capsule will be supplied with a flowing helium/neon gas mixture to control the test temperature and to sweep any fission gases that are released to the fission product monitoring system. Temperature control is accomplished by adjusting the gas mixture ratio of the two gases (i.e., helium and neon) with differing thermal conductivities.

Many similarities exist between this thermal analysis for AGR-2 and the AGR-1 daily as-run report in Reference [1]. Gas gaps were taken from as-built drawings in Reference [2]. The finite element heat transfer code ABAQUS [3] was used to perform the thermal analysis.

The AGR-2 experiment was placed in the B-12 position in the ATR core as shown in Figure 1. The AGR-2 experiment capsule assembly consists of six capsules axially stacked. Each capsule contains a graphite holder with three equally spaced fuel compact holder openings as shown in Figure 2. Each holder opening accommodates four axially stacked fuel compacts. Thus, each capsule has three stacks with four fuel compacts per stack for a total of 12 fuel compacts per capsule. Therefore, within the entire AGR-2 experiment capsule assembly, there are six capsules with 12 fuel compacts per capsule for a total of 72 fuel compacts. Six finite element heat transfer models were created (i.e., one for each capsule), each with a corresponding gas gap.

AGR-2 uses uranium oxycarbide (UCO) kernels with slightly increased diameters. AGR-2 fuel also contains  $\text{UO}_2$  kernels typical of the fuel from German and South African pebble bed designs. Consequently, fuels containing UCO and  $\text{UO}_2$  were irradiated in the AGR-2 experiment. Both types are included as one variant in separate capsules. In addition to United States' produced fuel,  $\text{UO}_2$  fuels produced in France and South Africa are included in AGR-2; however, these foreign fuels are not discussed in this document. Each AGR-2 fuel compact was subdivided into two equal-sized cells/nodes. Thus, Stack 2 is comprised of Nodes 1 through 48 (eight nodes per capsule times six

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capsules), Stack 1 is comprised of Nodes 97 through 144, and Stack 3 is comprised of Nodes 49 through 96. These node numbers are a legacy of translating and rotating the physics model from the AGR-1 B-10 position to the AGR-2 B-12 position. Figure 3 shows the axial arrangement for Stack 1. The ABAQUS models have a direct volume-for-volume correlation with the physics model for the heating of the compacts as described above (each compact is evenly axially divided into two equal parts). An axial cut of a typical capsule is shown in Figure 4.

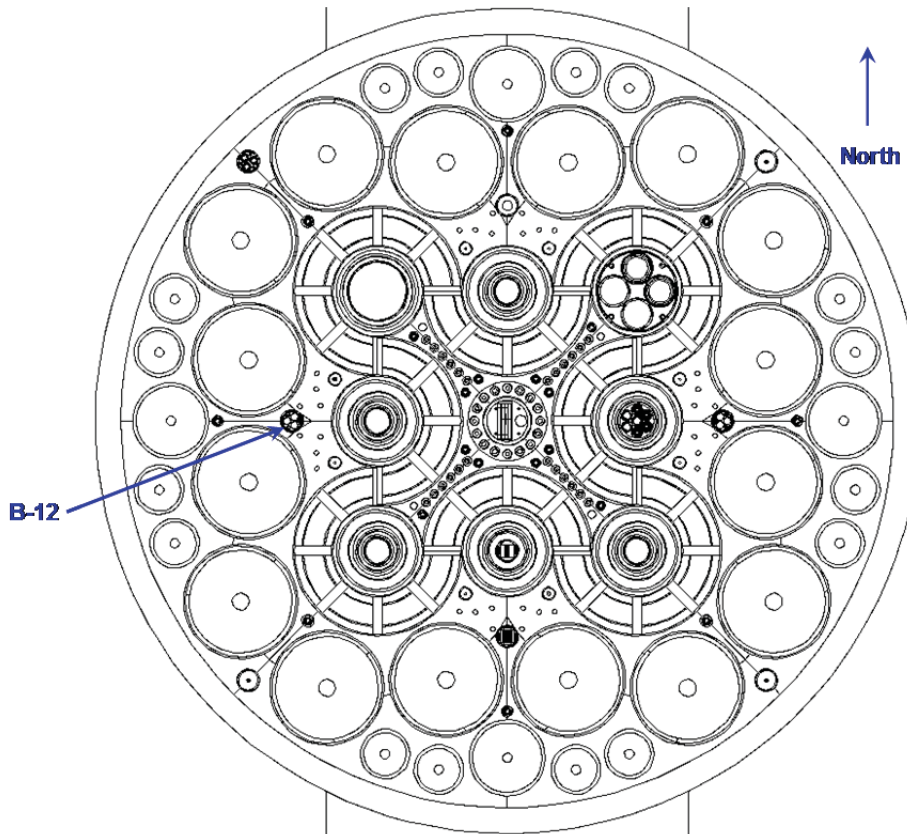


Figure 1. Cross-section view of the ATR core, B-12 irradiation test position.

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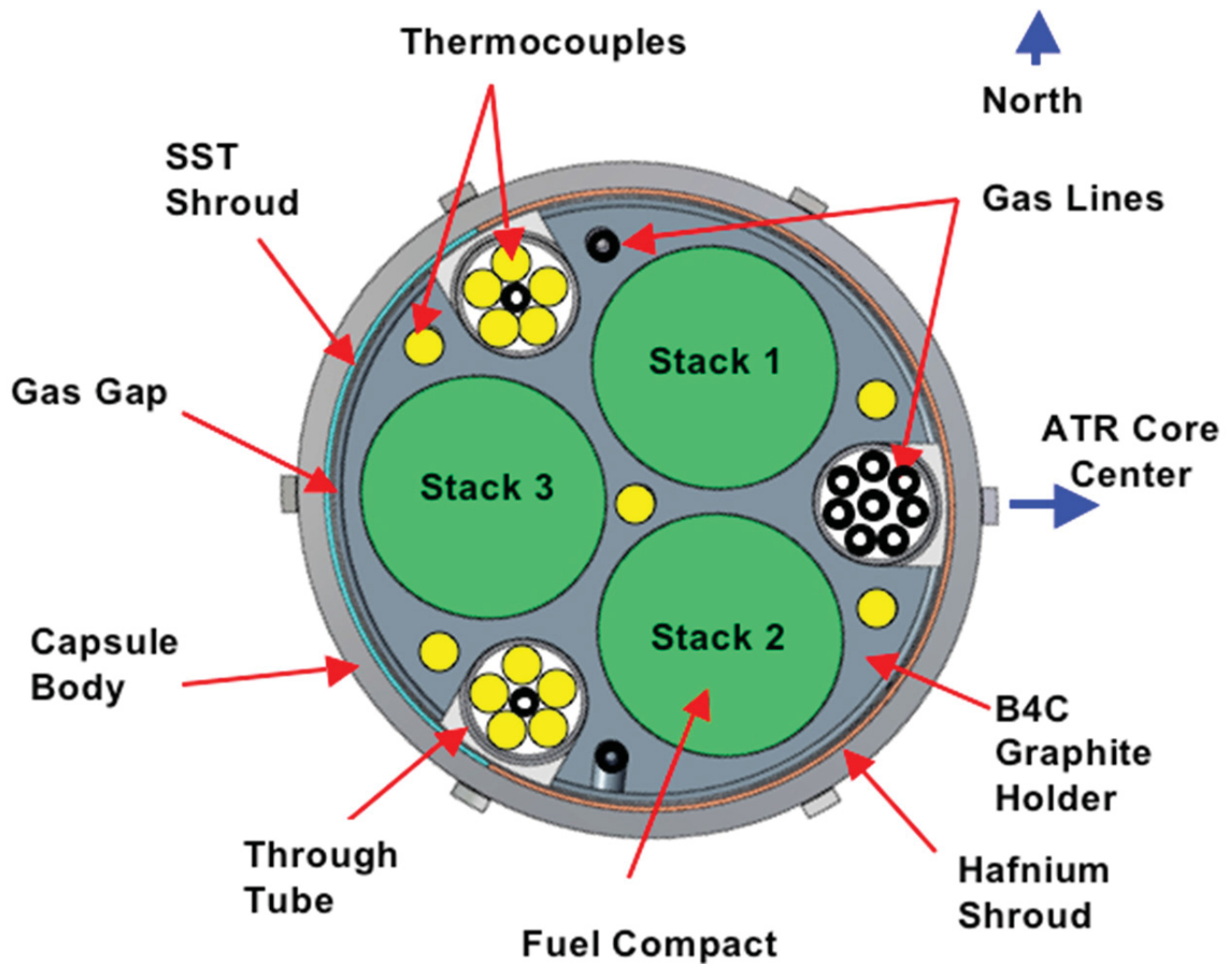


Figure 2. Schematic of the cross section of an AGR-2 capsule.

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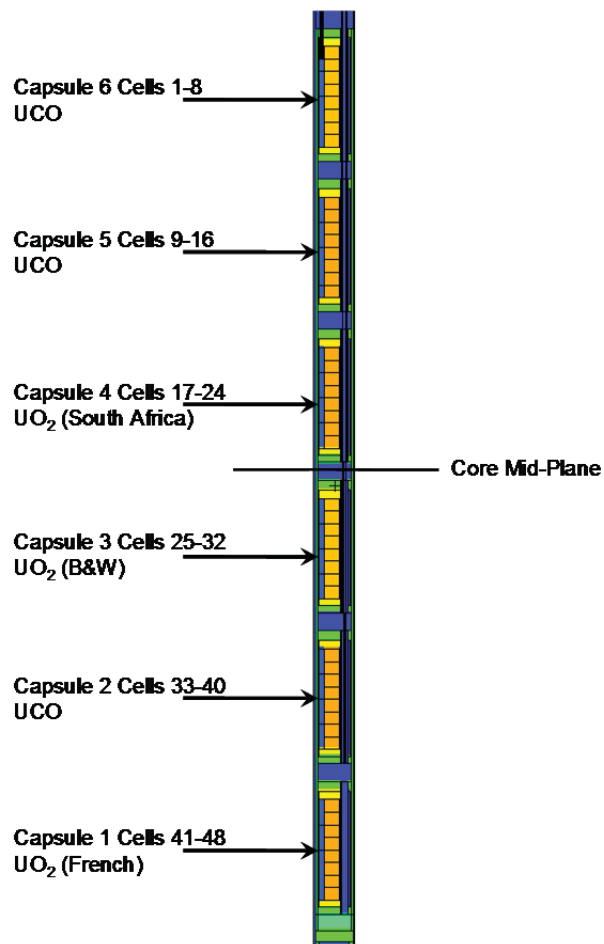


Figure 3. Axial cross-section view of the six capsules in an AGR-2 experiment capsule assembly.

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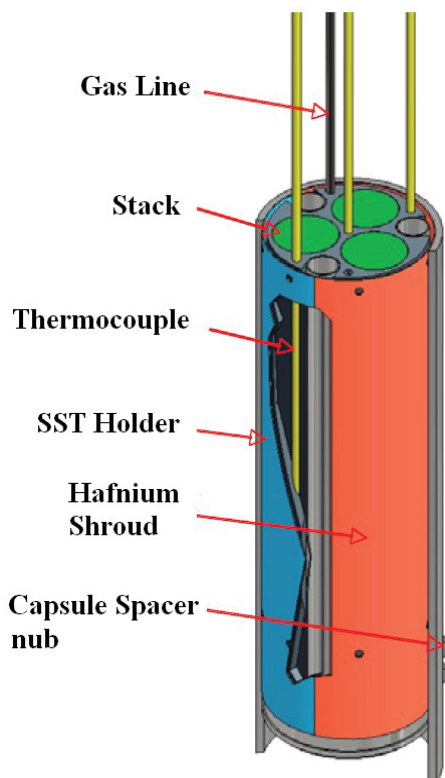


Figure 4. Three-dimensional cutaway rendering of single AGR-2 capsule.

## DESIGN OR TECHNICAL PARAMETER INPUT AND SOURCES

R. G. Ambrosek, "Thermal Evaluations for AGR-2 Design," ECAR-377, April 2010.

G. L. Hawkes, "AGR-2 Irradiation Experiment Thermal Projections," ECAR-1692 Rev 0, Jan 2012.

## RESULTS OF LITERATURE SEARCHES AND OTHER BACKGROUND DATA

G. L. Hawkes, "AGR-1 Daily As-run Thermal Analyses," ECAR-968, Revision 3, January 2012.

INL Drawing	Revision	Drawing Title
600915	2	ATR Advanced Gas Reactor 2 (AGR-2) Capsule 6 Assemblies and Details
600914	1	ATR Advanced Gas Reactor 2 (AGR-2) Capsule 5 Assemblies and Details
600912	2	ATR Advanced Gas Reactor 2 (AGR-2) Capsule 3 Assemblies and Details
600911	3	ATR Advanced Gas Reactor 2 (AGR-2) Capsule 2 Assemblies And Details

## ASSUMPTIONS

1. All model dimensions are as-built AGR-2 experiment dimensions and are taken to be the AGR-2 experiment in-reactor "hot" dimensions, with the exceptions noted below.

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2. The gap between the hafnium/stainless steel filler and the capsule is assumed to be closed due to thermal expansion.
3. The gap between the stainless steel retainer and the hafnium/stainless steel filler is assumed to be 0.001-in. at hot temperature. Thermal gap conductance for this gap is taken as 10 times that of pure helium because of unknown contact and dimensions/tolerances of the retainer and surrounding parts.
4. Compact heat rates were taken from Reference [4].
5. All other component heat rates were taken from a typical full-power day from Reference [4].
6. Graphite and compact thermal conductivity vary with fluence and temperature. Graphite conductivity for Capsules 6 and 3 is taken having 4.5% B<sub>4</sub>C, while capsules 5 and 2 are 5.5% B<sub>4</sub>C.
7. The gas mixture thermal conductivity is correlated from the Kinetic Theory of Gases [5].
8. Heat transfer through gas is done by conduction and radiation only and not advection.
9. Radiation heat transfer occurs from the graphite holder to the stainless steel retainer, graphite holder to thru tubes, and thru tubes to stainless steel retainer. An emissivity of 0.4 was assumed for the stainless steel retainer and an emissivity of 1.0 for the graphite and thru tubes. Thru tubes are considered to be covered with graphite dust.
10. There is no axial heat conduction from one capsule to the next. Water inlet temperatures for each capsule increases as water flows through the core from Capsules 6 to 1. These temperatures are: 125, 128, 132, 136, 140, and 143°F (Capsules 6 to 1) or 52, 53, 56, 58, 60, and 62°C.
11. Control gas gaps (i.e., gaps between the graphite holder and stainless steel retainer) and compact-graphite holder gas gaps vary based on fast neutron fluence.
12. Finite element models from the AGR-1 experiment were used. The control gas gaps and compact-graphite holder gas gaps are ratioed by the AGR-1 model gaps and the AGR-2 gaps.

## **COMPUTER CODE VALIDATION**

ABAQUS Version 6.9-2 was used to do the mesh creation, boundary conditions, solving, and post processing. The High-Performance Computing computer named Quark was used to run ABAQUS. Appendix A is the validation report of ABAQUS Version 6.9-2 run on Quark. The report is comprised of 10 thermal models validating different aspects of ABAQUS' heat transfer abilities. The maximum difference between the ABAQUS-calculated values and exact theoretical values is just under 2.0%. Many of the test problems have 0% error. For the main AGR-2 daily capsule calculations, each run (consisting of about 55 timesteps or days) was done with four CPUs running in parallel. The average run took approximately 1.3 hours of wall clock.

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Quark

- 384-core Dell distributed memory system
- 768 GB total memory
- One login node, Dell PowerEdge R610
  - Two-socket (6-core) Intel Xeon X5650 (Westmere), 12 x 2.67 GHz
  - 48 GB of memory
- 32 compute nodes, PowerEdge R410
  - Two-socket (6-core) Intel Xeon X5650 (Westmere), 12 x 2.67 GHz
  - 24 GB of memory per node (2 GB per core)
- QDR InfiniBand interconnect network
- Operating System: OpenSUSE 11.4
- LINPACK: 3.19 TFlops

## MODEL DESCRIPTION

Figures 5 through 19 are used in the description of the model. The finite element mesh is discussed first, followed by a description of the material properties (also displayed in detail in Appendix B), and ending with the volumetric heat rates imposed on the model.

### Finite Element Mesh

Figure 5 shows the finite element mesh with a cutaway view of the entire model. About 350,000 eight-noded hexahedral brick elements were entirely used in all models. A set of diffusion-convection elements was used to model the flow of water. All other elements were modeled solely for diffusion heat transfer. Four small areas shown in Figure 5 have an unstructured mesh. These areas exist because a “cross” was placed on the meshing surface where the thermocouples (TCs) are located, thus ensuring an exact x-y location of the TCs. Figure 6 shows a zoomed-in view of the model, with colored element set entities. Figure 7 shows a sideways cutaway view of a typical capsule. The beryllium reflector, water channel, pressure boundary, hafnium shroud, and stainless steel filler were all modeled at 6.1-in. long. The length of these components has a minimal effect on the water temperature rise. Shown in red in Figure 7 is the stainless steel retainer.

The graphite holder and fuel compacts were modeled as 4 in. in length, but most of the heat comes from the compacts and not from the outer components. The water is the ultimate heat sink for each capsule. For the inner part of the model, the graphite holder with its two end-cap spacers and ring were modeled. Previous models discussed in Reference [1] included the components on the top and bottom of the holder such as the stainless-steel head and grafoil. This present model did not include these components because they do not affect the temperatures of the compacts or TC locations. A radiation boundary sink temperature of 400°F (204.4°C) is placed on the top and bottom of each graphite end cap. This value came from previous models in Reference [1] for typical operating conditions.

Figure 8 shows a zoomed-in cutaway view of a typical capsule near the top of the model. This area shows the graphite end caps and graphite ring.

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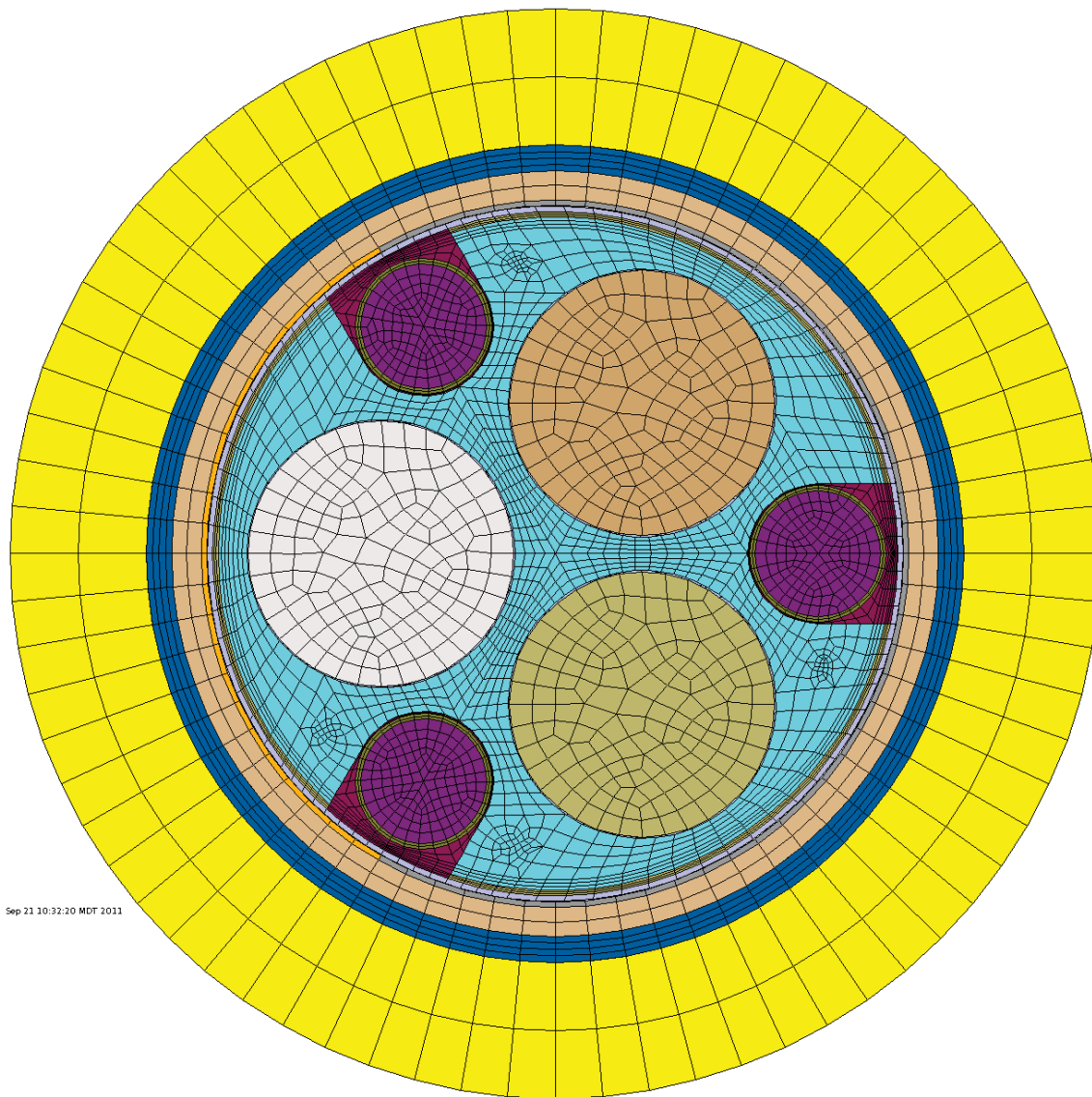


Figure 5. Cross-section view of the Capsule 4 finite element mesh.

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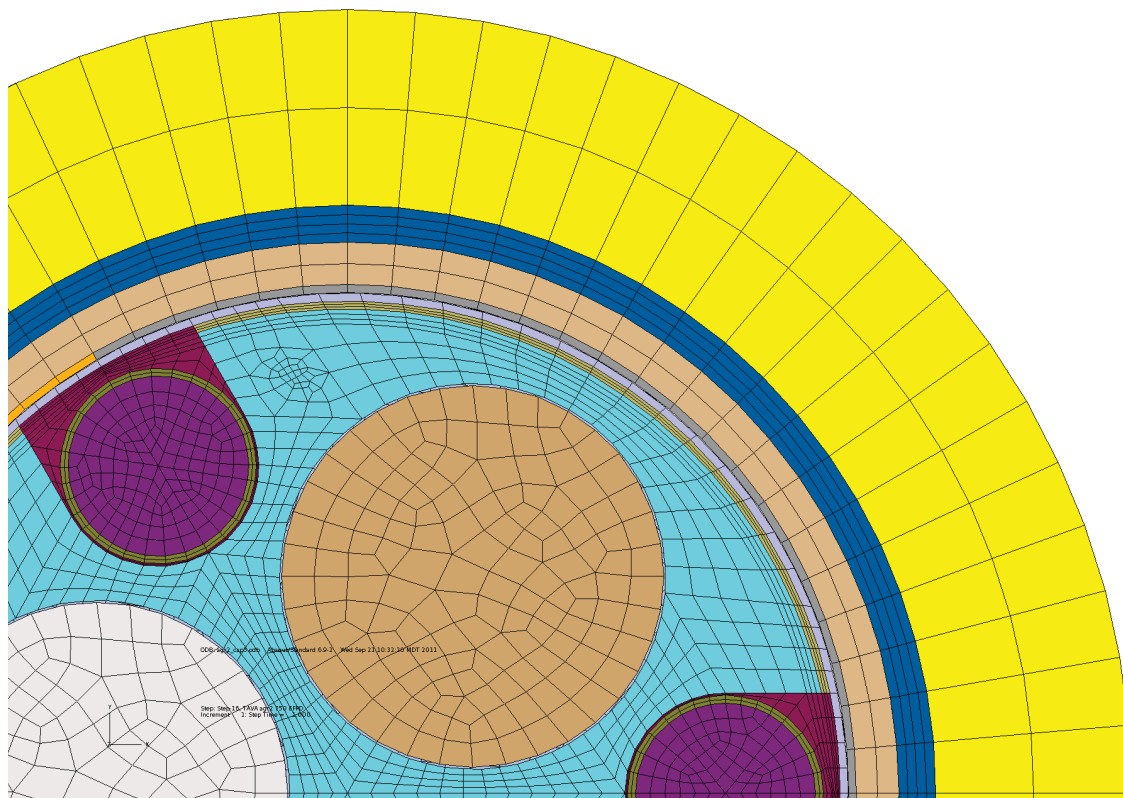


Figure 6. Zoomed-in view of colored mesh with different entities.

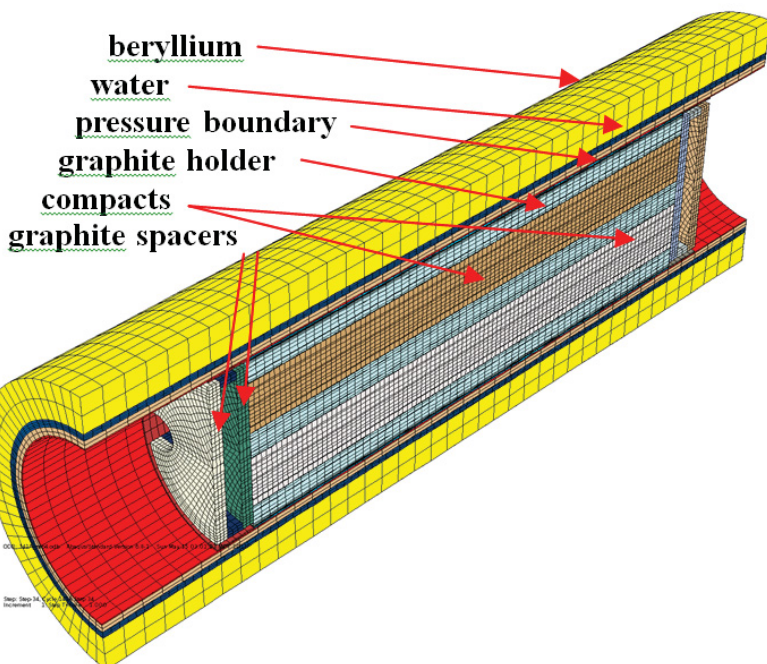


Figure 7. Sideways cutaway view of mesh with colored entities.

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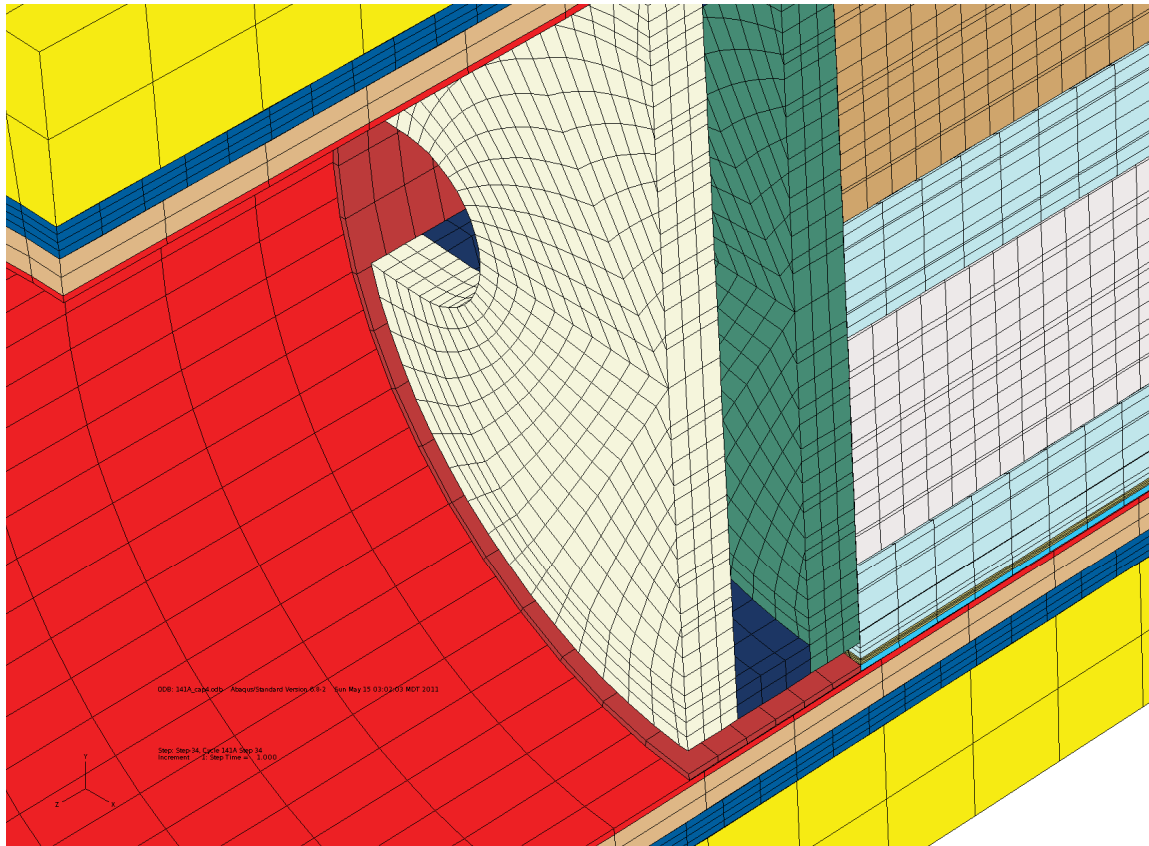


Figure 8. Zoomed-in view of the top of the capsule with a sideways cutaway view.

## Fuel Compact Thermal Conductivity

The fuel compact thermal conductivity was taken from correlations presented from Gontard [6], which gives correlations for conductivity, taking into account temperature, temperature of heat treatment, neutron fluence, and TRISO particle packing fraction. In this work, the convention used to quantify neutron damage is fast neutron fluence ( $E > 0.18$  MeV); however, in the work by Gontard [6], the unit used was the dido nickel equivalent (i.e., DNE). In order to convert from the dido nickel equivalent convention to the fast fluence  $> 0.18$  MeV, the following conversion was used:

$$\Gamma_{>0.18\text{MeV}} = 1.52 \Gamma_{\text{DNE}} \quad (1)$$

where  $\Gamma$  is the fast neutron. The correlations in the report by Gontard [6] were further adjusted to account for differences in fuel compact density. The correlations were developed for a fuel compact matrix density of 1.75 g/cm<sup>3</sup>, whereas the compact matrix used in AGR-2 had a density of approximately 1.6 and 1.68 g/cm<sup>3</sup> for UCO and UO<sub>2</sub> compacts, respectively. The thermal conductivities were scaled according to the ratio of densities (0.91 for UCO and 0.96 for UO<sub>2</sub>) in order to correct for this difference. Figure 9 shows a three-dimensional plot of the fuel compact thermal conductivity, varying with fluence and temperature for UCO and UO<sub>2</sub>, respectively. For fluences greater than  $1.0 \times 10^{25}$  neutrons/m<sup>2</sup> ( $E > 0.18$  MeV), the conductivity increases as fluence increases for higher temperatures, while the opposite occurs at lower temperatures because of the annealing of radiation-induced defects in the material with high temperatures.

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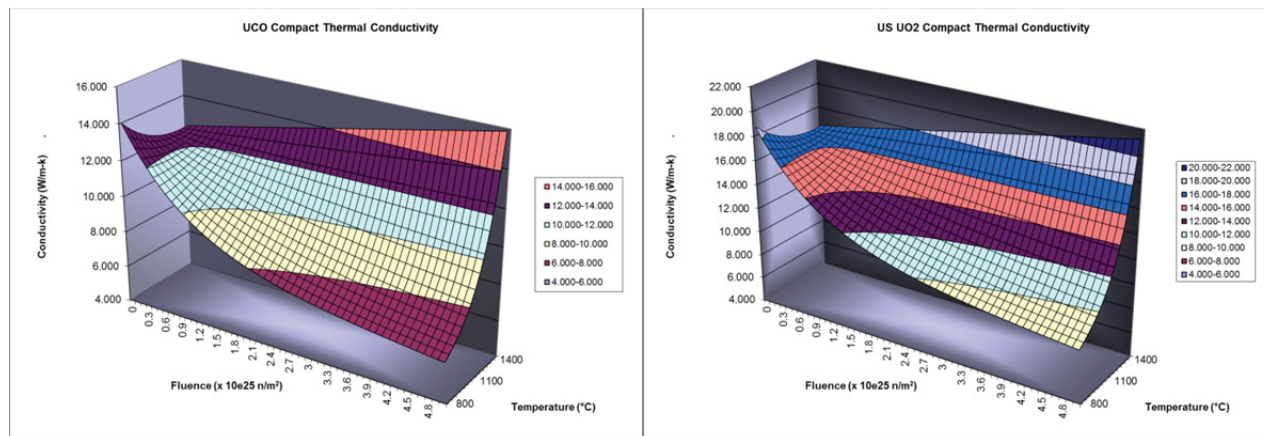


Figure 9. Three-dimensional plot of fuel UCO and  $\text{UO}_2$  compact thermal conductivity ( $\text{W/m-K}$ ), varying with fluence and temperature.

## Graphite Thermal Conductivity

Unirradiated graphite thermal conductivity data for the holders were provided by the vendor, GrafTech [7]. Figure 10 shows unirradiated thermal conductivity of two different types of boronated graphite. The percentages indicate the weight percent of boron present in the material. The 5.5% against grain (AG) was used in the holders for Capsules 6 and 3, while the 4.5% AG shown in Figure 11 was used in Capsules 5 and 2. The boron content was placed where the temperature targets could be met. The higher boron content provided a flatter compact heating profile through the irradiation when compared with no boron. Appendix B shows the vendor data sent from GrafTech for the 4.5%  $\text{B}_4\text{C}$ . Reference [1] shows the vendor data for the 5.5%  $\text{B}_4\text{C}$ .

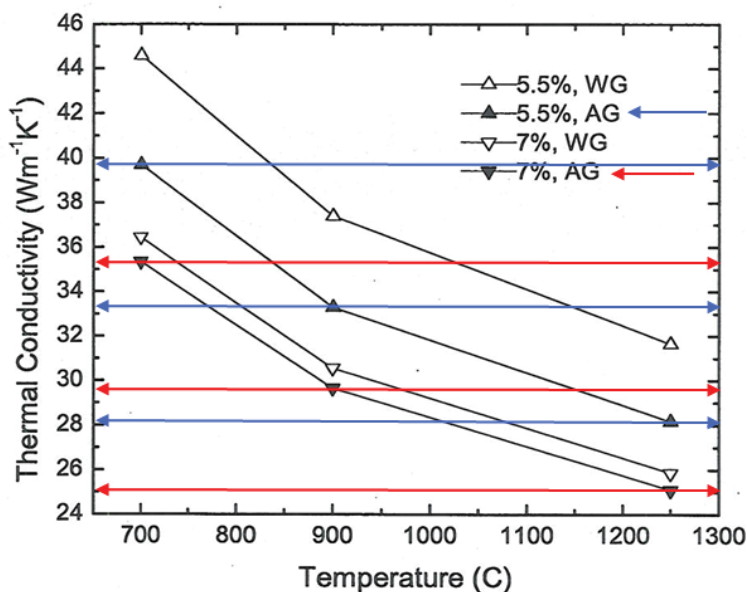


Figure 10. Thermal conductivity of 5.5%  $\text{B}_4\text{C}$  unirradiated, boronated graphite holders [1].

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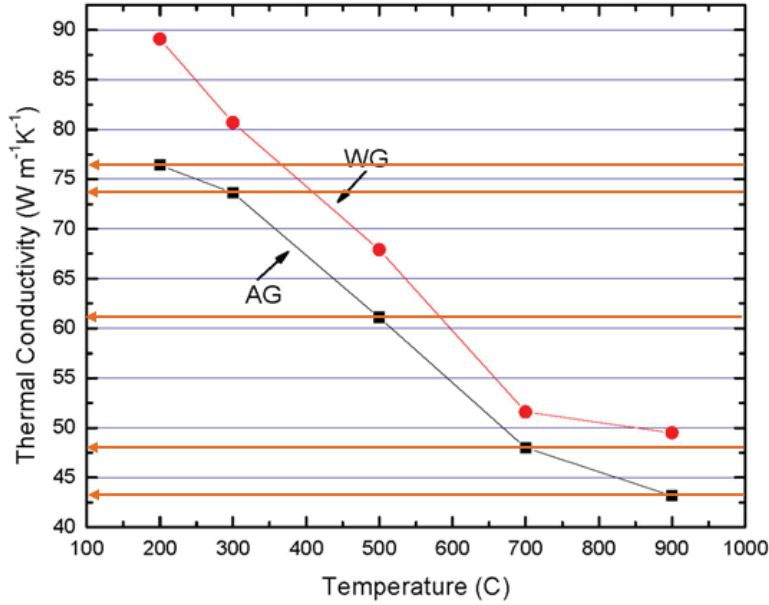


Figure 11. Thermal conductivity of 4.5% B<sub>4</sub>C unirradiated, boronated graphite holders [7].

The effect of irradiation on the thermal conductivity of the graphite was accounted for in this analysis using the following correlation by Snead [8]:

$$\frac{k_{irr}}{k_0} = (0.25 - 0.00017 * T_{irr}) * A * \log(dpa) + 0.000683 * T_{irr} \quad (2)$$

$$A = -1.0$$

where  $k_0$  and  $k_{irr}$  are thermal conductivity of unirradiated and irradiated graphite respectively,  $T_{irr}$  is the irradiation temperature (°C), and  $dpa$  is displacements per atom. The multiplier used to convert fast fluence (>0.18 MeV) to dpa is  $8.23 \times 10^{-26}$  dpa/(n/m<sup>2</sup>) and comes from Sterbentz [9]. Figure 12 shows a 3-D plot of this ratio  $k_{irr}/k_0$ , varying with dpa and temperature. The ratio of unirradiated to irradiated thermal conductivity increases for higher temperatures and decreases for higher dpa. The model used this ratio as a constant above a dpa of 1.0 as it would fail above this value.

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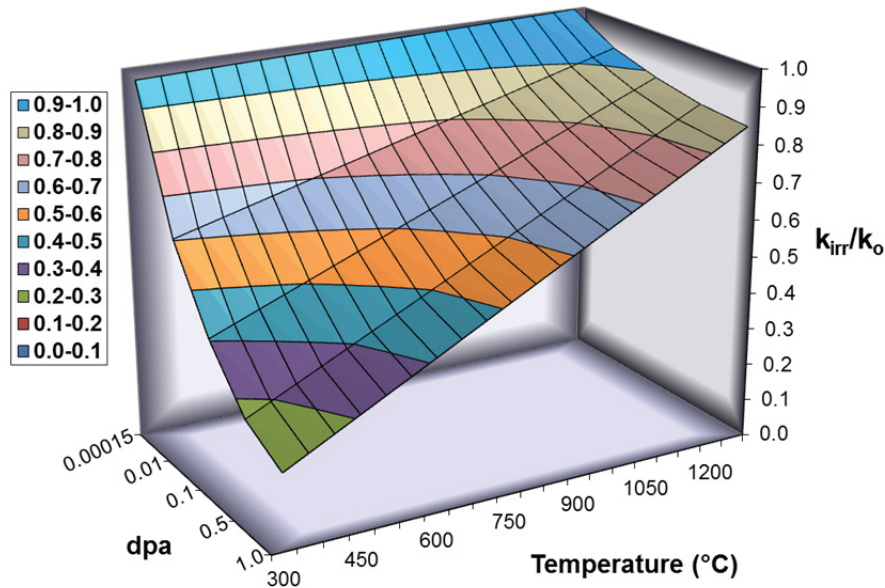


Figure 12. Graphite thermal conductivity plot of the ratio of irradiated to unirradiated ( $k_{irr}/k_o$ ), varying with temperature and dpa.

### Gas Mixture Thermal Conductivity

Heat produced in the fuel compacts is transferred through the gas gaps surrounding the compacts into the graphite holder via a gap conductance model using the gap width and the conductivity of the sweep gas as discussed below. Radiative heat transfer was considered across this gap with the graphite surface emissivity of 1.0 and stainless steel of 0.4. Heat is transferred across the outer gas gap (sweep gas flow region) between the outside of the graphite holder and the inside of the stainless steel liner via radiation between the two surfaces and conduction through the He/Ne sweep gas. Because the thermal capacitance of the sweep gas is very low (30 cc/min), advection is not considered in the sweep gas and it is modeled as stationary. The convective heat transfer from these sweep gases would be less than 0.01% of the heat transfer across the gap because of the low density, low flow rate, and low thermal capacitance. The thermal conductivity of the sweep gas mixture was determined using the Kinetic Theory of Gases as explained in [5]. Figure 13 shows a three dimensional plot of the He-Ne gas mixture, varying with mole fraction and temperature.

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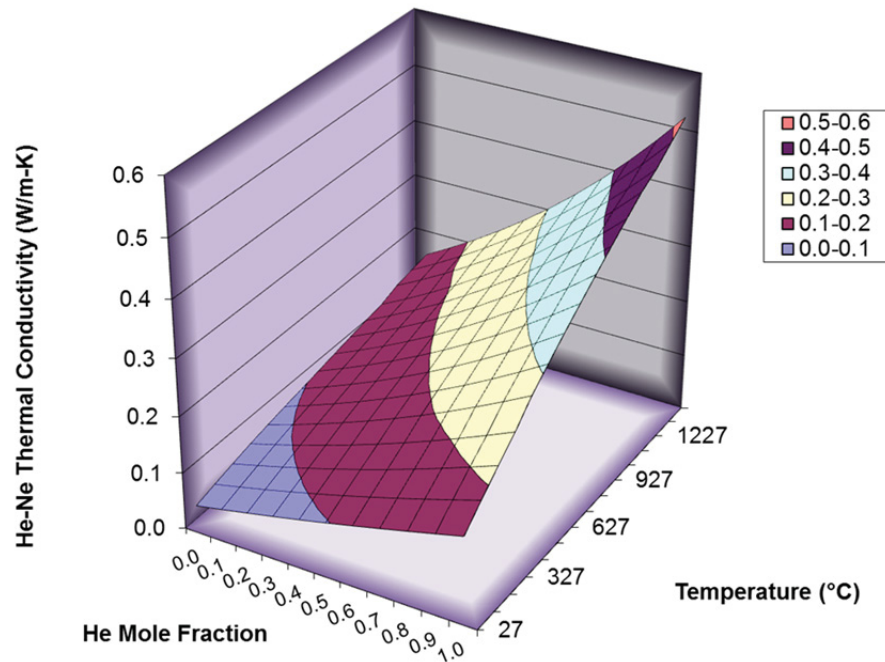


Figure 13. Sweep gas thermal conductivity versus temperature and mole fraction helium.

## Conduction and Radiation Heat Transfer

The governing equation of steady-state heat transfer for the model is taken as

$$\rho c_p \left( u_x \frac{\partial T}{\partial x} + u_y \frac{\partial T}{\partial y} + u_z \frac{\partial T}{\partial z} \right) = \frac{\partial}{\partial x} \left( k(T) \frac{\partial T}{\partial x} \right) + \frac{\partial}{\partial y} \left( k(T) \frac{\partial T}{\partial y} \right) + \frac{\partial}{\partial z} \left( k(T) \frac{\partial T}{\partial z} \right) + Q \quad (3)$$

where  $\rho$  is the density,  $c_p$  is the specific heat,  $u_x$ ,  $u_y$ , and  $u_z$  are the three directional velocities,  $T$  is temperature,  $x$ ,  $y$ , and  $z$  are directions,  $k(T)$  is the thermal conductivity varying with temperature, and  $Q$  is the heat source. The velocity of the water ( $u_z$ ) was taken from Reference [1]. The gas gaps between the graphite holder and the stainless steel retainer sleeve used the above-mentioned gas mixture conductivity correlation and were modeled with solid eight-noded brick elements with diffusion heat transfer. Gaps vary from 0.0155 in. in Capsule 5 to 0.031 in. in Capsule 3.

Conduction heat transfer across gas gaps using the ABAQUS \*Gap Conductance model was implemented on the gaps between the following surface pairs followed by gap distance:

- Fuel compacts and graphite holder ( 0.0025 in.)
- Bottom and top graphite spacers with stainless steel retainer sleeve (0.038 in.)
- Bottom and top graphite rings with stainless steel retainer sleeve (0.038 in.)
- Graphite spacers with graphite spacers on top and bottom (0.125 in.).

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The governing equation for radiation heat transfer across the gas gaps is taken as

$$q_{net} = \frac{\sigma(T_1^4 - T_2^4)}{\frac{(1-\varepsilon_1)}{\varepsilon_1 A_1} + \frac{1}{A_1 F_{12}} + \frac{(1-\varepsilon_2)}{\varepsilon_2 A_2}} \quad (4)$$

where  $q$  is the net heat flux,  $\sigma$  is the Stephan Boltzmann constant,  $T_1$  and  $T_2$  are the surface temperatures,  $\varepsilon_1$  and  $\varepsilon_2$  are the emissivities of Surfaces 1 and 2,  $A_1$  and  $A_2$  are the areas of Surfaces 1 and 2, and  $F_{12}$  is the view factor from Surface 1 to 2.

Radiation heat transfer using the ABAQUS \*Gap Radiation model was implemented on the following surface pairs:

- Graphite holder with stainless steel retainer sleeve
- Graphite holder with thru tubes
- Thru tubes with stainless steel retainer sleeve
- Graphite holder with shield (Capsule 6 only)
- Shield with stainless steel retainer sleeve (Capsule 6 only)
- Bottom and top graphite spacers with stainless steel retainer sleeve
- Bottom and top graphite rings with stainless steel retainer sleeve
- Graphite spacers with graphite spacers on top and bottom.

A surface radiation boundary condition using the ABAQUS \*Surface Radiation model was placed on the top of the top graphite spacer and the bottom of the bottom graphite spacer and radiated to an infinite medium of 400°F (204.4°C). View factors for each surface pair were set at 1.0. Emissivity values of 0.4 were set for the stainless steel retainer and heat shield, and set to 1.0 for all other surfaces.

## Daily Gas Mixtures

The daily gas mixtures were taken from Nuclear Data Management and Analysis System (NDMAS) data. NDMAS logged all of the data for the AGR-2 experiment. Data in the NDMAS system provides a separate flow rate for helium and neon for each capsule. Data taken from ATR shows that these gas flow rate values were taken every 5 minutes. These values were averaged by NDMAS to get a daily average. The neon fraction was taken as Field Variable 1 in the ABAQUS calculations. Measured data on gas mixtures are given in Appendix C.

## Fluence

Graphite and fuel compact material properties vary with fluence. This was taken as Field Variable 2 in the ABAQUS input model. Fluence values were taken from as-run predictions given by Sterbentz [4]. Figure 14 shows the axial profile of fast neutron fluence in the graphite holders at the end of cycles 150B and 154B. A peak value of  $3.2 \times 10^{25}$  n/m<sup>2</sup> was the peak in Capsule 3.

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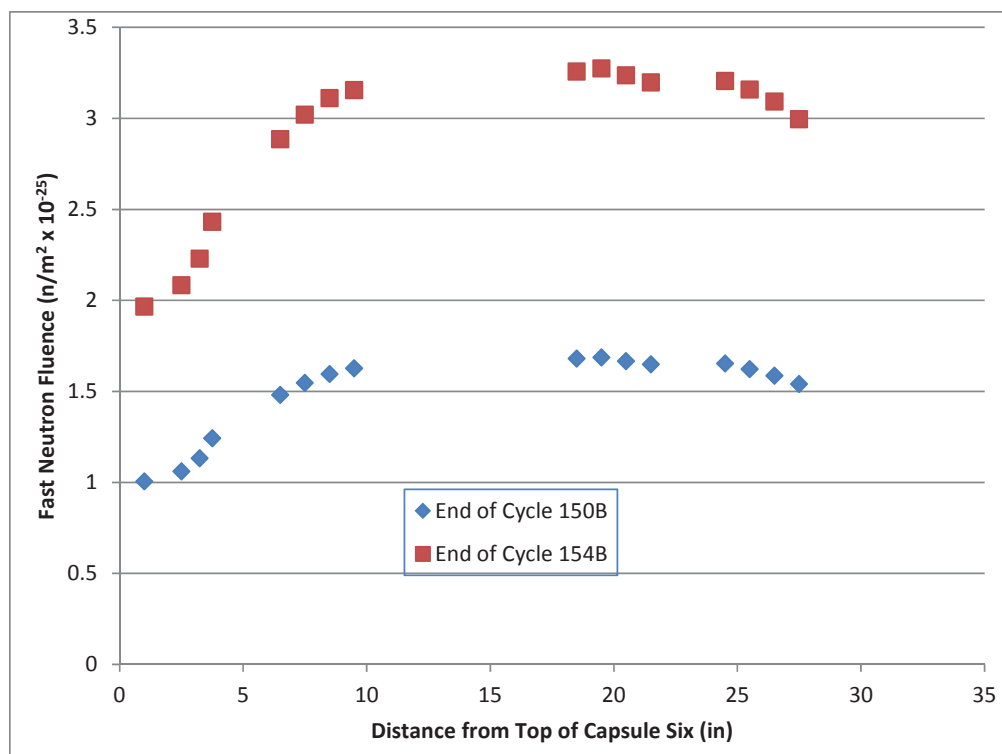


Figure 14. Axial profiles of fast neutron fluence ( $\text{n/m}^2 \times 10^{25}$ ) in the graphite holders at the end of Cycles 150B and 154B.

## Component Heat Rates

Gamma heating for the various components (including the fuel compacts) were taken from Sterbentz [4]. The water heat rate and the beryllium heat raises the water temperature as it flows by the capsule, but is only a small fraction of the total heat. The components inside the capsule had the greatest effect on the temperature of the fuel compacts and TC locations. Table 1 shows the correlation between the physics analysis and the ABAQUS element groups for component heat generation.

Because the original AGR-1 finite element model was used for each capsule, a multiplier on the graphite holder heat rate was implemented to take into account the difference in the AGR-1 and AGR-2 holder diameters to ensure that the total heat input into the holder would be correct for each capsule. This was done on the \*AMPLITUDE in ABAQUS. Heat generation rates for the thru tubes and material inside the thru tubes were taken as a fraction of the stainless steel retainer heat rate for each capsule for each day. The multiplying factors used were 0.83, 0.69, and 0.69 for the material inside the thru tubes for the ABAQUS element groups Intub1, Intub2, and Intub3, respectively. The multiplying factors for the thru tubes themselves for Tubes 1, 2, and 3 are 1.65, 1.38, and 1.38, respectively.

Figure 15 shows the daily graphite heat rates for the graphite holders varying with Effective Full Power Days (EFPD). Note how the heat rates diminish as the  $\text{B}_4\text{C}$  gets burned out. Figure 16 shows the time-varying heat rates for the top and bottom graphite spacers. These heat rates remain fairly constant because there is no boron in the graphite spacers. Figure 17 shows the heat rates of the various parts of the hafnium shroud as a function of EFPD. Daily heat rates for the stainless steel components and ATR coolant are shown in Figure 18 and Figure 19.

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Table 1. Component description and correlation with physics analysis.

MCNP			(Lower)	(Upper)		ABAQUS	
Component			ATR Core	ATR Core		Element	
Cell	Component	Capsule	Elevation Range	Elevation Range		Group	
No.	Description	No.	(inches)	(inches)		Name	
95001	Borated Graphite Holders	6	40.0	40.5		Hold_4_elem	
95002	Borated Graphite Holders	6	39.5	40.0		Hold_3_elem	
95003	Borated Graphite Holders	6	38.5	39.5		Hold_2_elem	
95004	Borated Graphite Holders	6	36.5	38.5		Hold_1_elem	
95005	Borated Graphite Holders	5	33.5	34.5		Hold_4_elem	
95006	Borated Graphite Holders	5	32.5	33.5		Hold_3_elem	
95007	Borated Graphite Holders	5	31.5	32.5		Hold_2_elem	
95008	Borated Graphite Holders	5	30.5	31.5		Hold_1_elem	
95009	Borated Graphite Holders	4	27.5	28.5		Hold_4_elem	
95010	Borated Graphite Holders	4	26.5	27.5		Hold_3_elem	
95011	Borated Graphite Holders	4	25.5	26.5		Hold_2_elem	
95012	Borated Graphite Holders	4	24.5	25.5		Hold_1_elem	
95013	Borated Graphite Holders	3	21.5	22.5		Hold_4_elem	
95014	Borated Graphite Holders	3	20.5	21.5		Hold_3_elem	
95015	Borated Graphite Holders	3	19.5	20.5		Hold_2_elem	
95016	Borated Graphite Holders	3	18.5	19.5		Hold_1_elem	
95017	Borated Graphite Holders	2	15.5	16.5		Hold_4_elem	
95018	Borated Graphite Holders	2	14.5	15.5		Hold_3_elem	
95019	Borated Graphite Holders	2	13.5	14.5		Hold_2_elem	
95020	Borated Graphite Holders	2	12.5	13.5		Hold_1_elem	
95021	Borated Graphite Holders	1	9.5	10.5		Hold_4_elem	
95022	Borated Graphite Holders	1	8.5	9.5		Hold_3_elem	
95023	Borated Graphite Holders	1	6.5	8.5		Hold_2_elem and Hold_1_elem	
9481	SS Inner Sleeve Capsule	Capsule 6				Ssretain	
9482	SS Inner Sleeve Capsule	Capsule 5				Ssretain	
9483	SS Inner Sleeve Capsule	Capsule 4				Ssretain	
9484	SS Inner Sleeve Capsule	Capsule 3				Ssretain	
9485	SS Inner Sleeve Capsule	Capsule 2				Ssretain	
9486	SS Inner Sleeve Capsule	Capsule 1				Ssretain	
9026	Hf Shroud (Azimuthal section)	Capsule 6	1	above stack 1		Hafnium_1	
9027	Hf Shroud (Azimuthal section)	Capsule 5	1	above stack 1		Hafnium_1	
9028	Hf Shroud (Azimuthal section)	Capsule 4	1	above stack 1		Hafnium_1	
9029	Hf Shroud (Azimuthal section)	Capsule 3	1	above stack 1		Hafnium_1	
9030	Hf Shroud (Azimuthal section)	Capsule 2	1	above stack 1		Hafnium_1	
9031	Hf Shroud (Azimuthal section)	Capsule 1	1	above stack 1		Hafnium_1	
9032	Hf Shroud (Azimuthal section)	Capsule 6	2	infront of stack 1, facing core		Hafnium_2	
9033	Hf Shroud (Azimuthal section)	Capsule 5	2	infront of stack 1, facing core		Hafnium_2	
9034	Hf Shroud (Azimuthal section)	Capsule 4	2	infront of stack 1, facing core		Hafnium_2	
9035	Hf Shroud (Azimuthal section)	Capsule 3	2	infront of stack 1, facing core		Hafnium_2	
9036	Hf Shroud (Azimuthal section)	Capsule 2	2	infront of stack 1, facing core		Hafnium_2	
9037	Hf Shroud (Azimuthal section)	Capsule 1	2	infront of stack 1, facing core		Hafnium_2	
9038	Hf Shroud (Azimuthal section)	Capsule 6	3	infront of stack 3, facing core		Hafnium_3	
9039	Hf Shroud (Azimuthal section)	Capsule 5	3	infront of stack 3, facing core		Hafnium_3	
9040	Hf Shroud (Azimuthal section)	Capsule 4	3	infront of stack 3, facing core		Hafnium_3	
9041	Hf Shroud (Azimuthal section)	Capsule 3	3	infront of stack 3, facing core		Hafnium_3	
9042	Hf Shroud (Azimuthal section)	Capsule 2	3	infront of stack 3, facing core		Hafnium_3	
9043	Hf Shroud (Azimuthal section)	Capsule 1	3	infront of stack 3, facing core		Hafnium_3	
9044	Hf Shroud (Azimuthal section)	Capsule 6	4	below stack 3		Hafnium_4	
9045	Hf Shroud (Azimuthal section)	Capsule 5	4	below stack 3		Hafnium_4	
9046	Hf Shroud (Azimuthal section)	Capsule 4	4	below stack 3		Hafnium_4	
9047	Hf Shroud (Azimuthal section)	Capsule 3	4	below stack 3		Hafnium_4	
9048	Hf Shroud (Azimuthal section)	Capsule 2	4	below stack 3		Hafnium_4	
9049	Hf Shroud (Azimuthal section)	Capsule 1	4	below stack 3		Hafnium_4	
9050	SS Shroud section (120 deg)	Capsule 6				SSShroud	
9051	SS Shroud section (120 deg)	Capsule 5				SSShroud	
9052	SS Shroud section (120 deg)	Capsule 4				SSShroud	
9053	SS Shroud section (120 deg)	Capsule 3				SSShroud	
9054	SS Shroud section (120 deg)	Capsule 2				SSShroud	
9055	SS Shroud section (120 deg)	Capsule 1				SSShroud	
9507	Outer Capsule Wall	Average over the full length of six capsules				Pbond	
9368	ATR Coolant H2O	Average over the full length of six capsules				Water	
17301	Top Graphite Spacer	Capsule 6				Top_Spacer	
17311	Bottom Graphite Spacer	Capsule 6				Bot_Spacer	
17302	Top Graphite Spacer	Capsule 5				Top_Spacer	
17312	Bottom Graphite Spacer	Capsule 5				Bot_Spacer	
17303	Top Graphite Spacer	Capsule 4				Top_Spacer	
17313	Bottom Graphite Spacer	Capsule 4				Bot_Spacer	
17304	Top Graphite Spacer	Capsule 3				Top_Spacer	
17314	Bottom Graphite Spacer	Capsule 3				Bot_Spacer	
17305	Top Graphite Spacer	Capsule 2				Top_Spacer	
17315	Bottom Graphite Spacer	Capsule 2				Bot_Spacer	
17306	Top Graphite Spacer	Capsule 1				Top_Spacer	
17316	Bottom Graphite Spacer	Capsule 1				Bot_Spacer	

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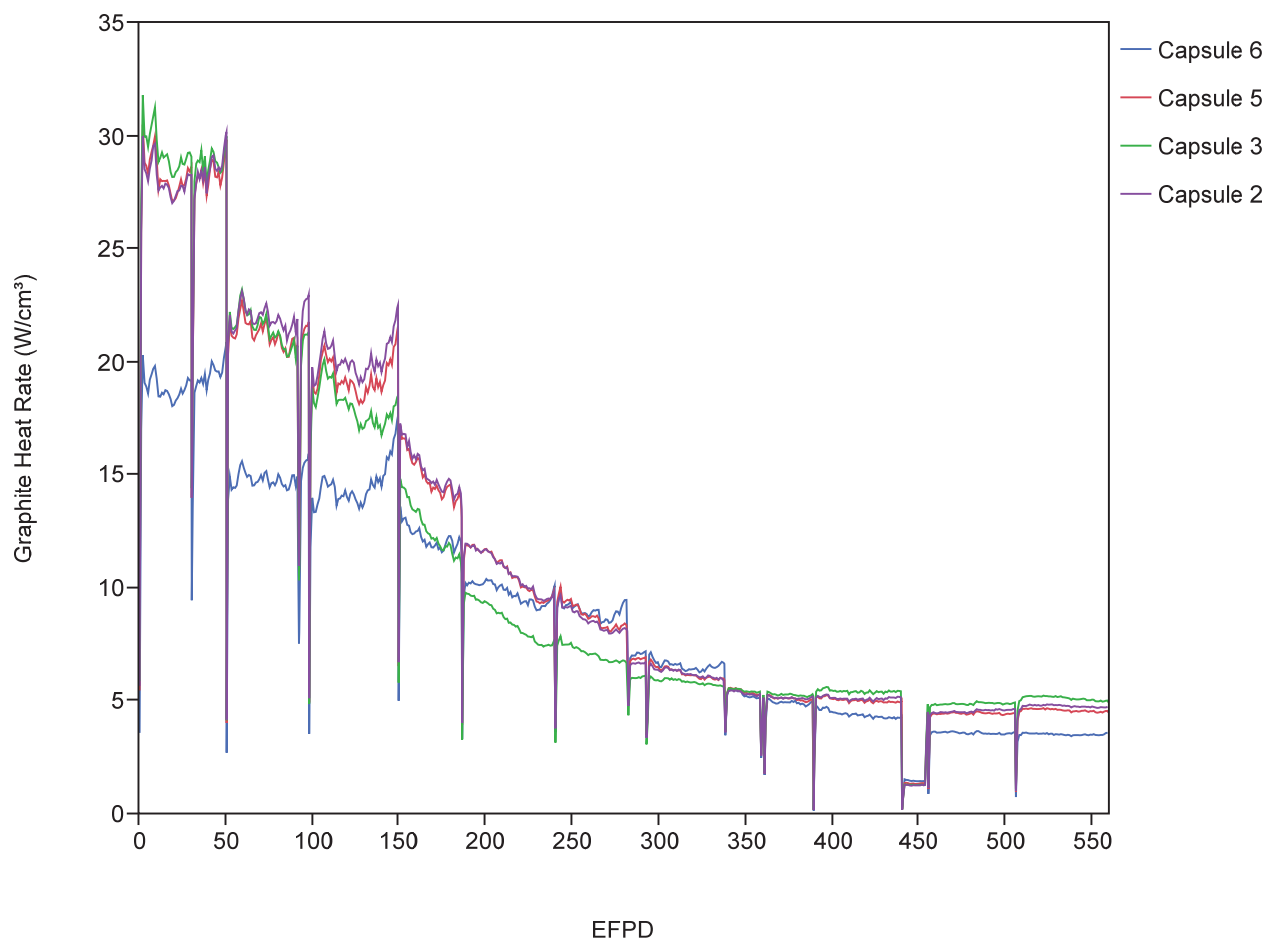


Figure 15. Daily graphite heat rates versus EFPD.

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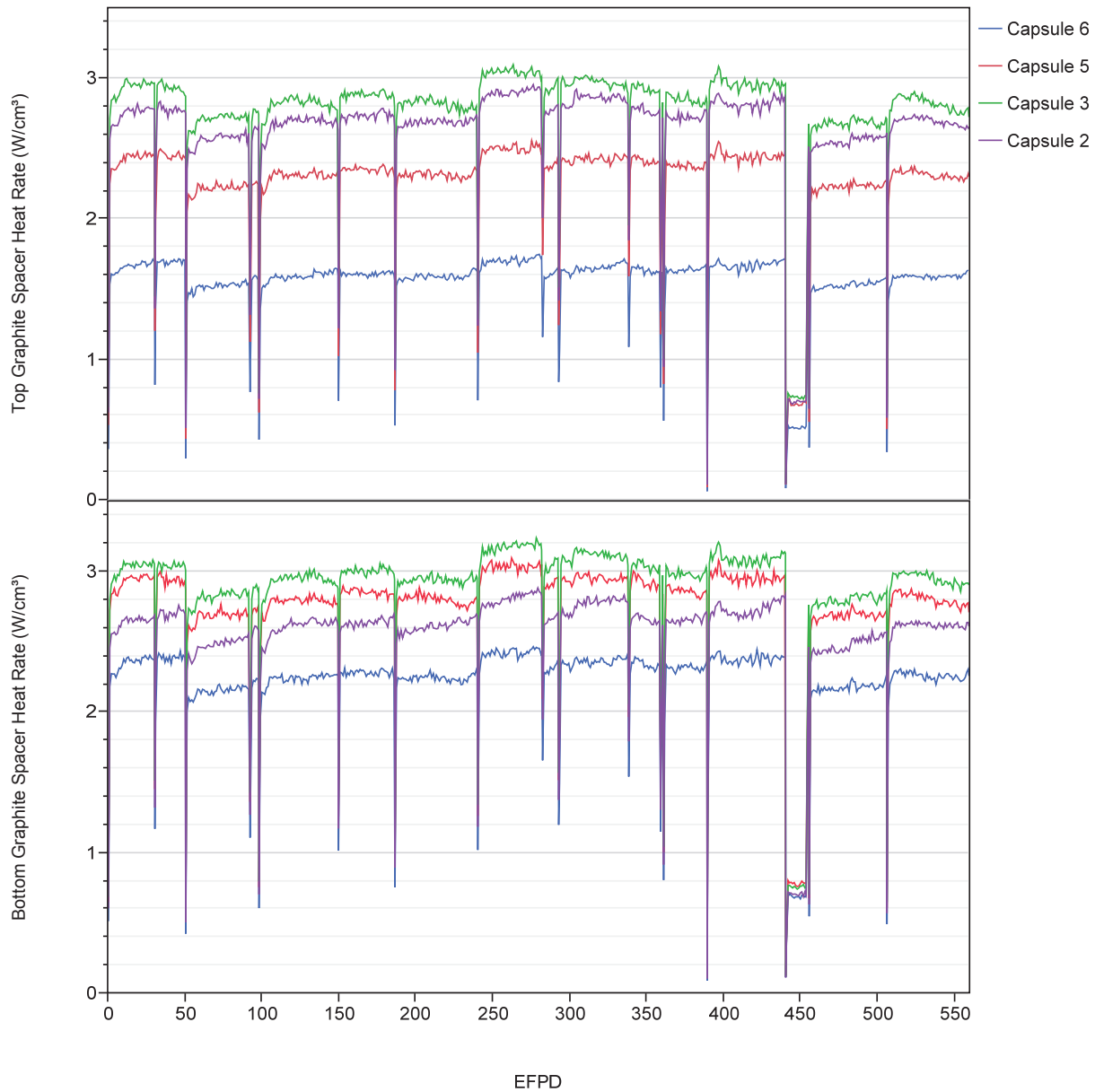


Figure 16. Daily top and bottom graphite spacer heat rates versus EFPD.

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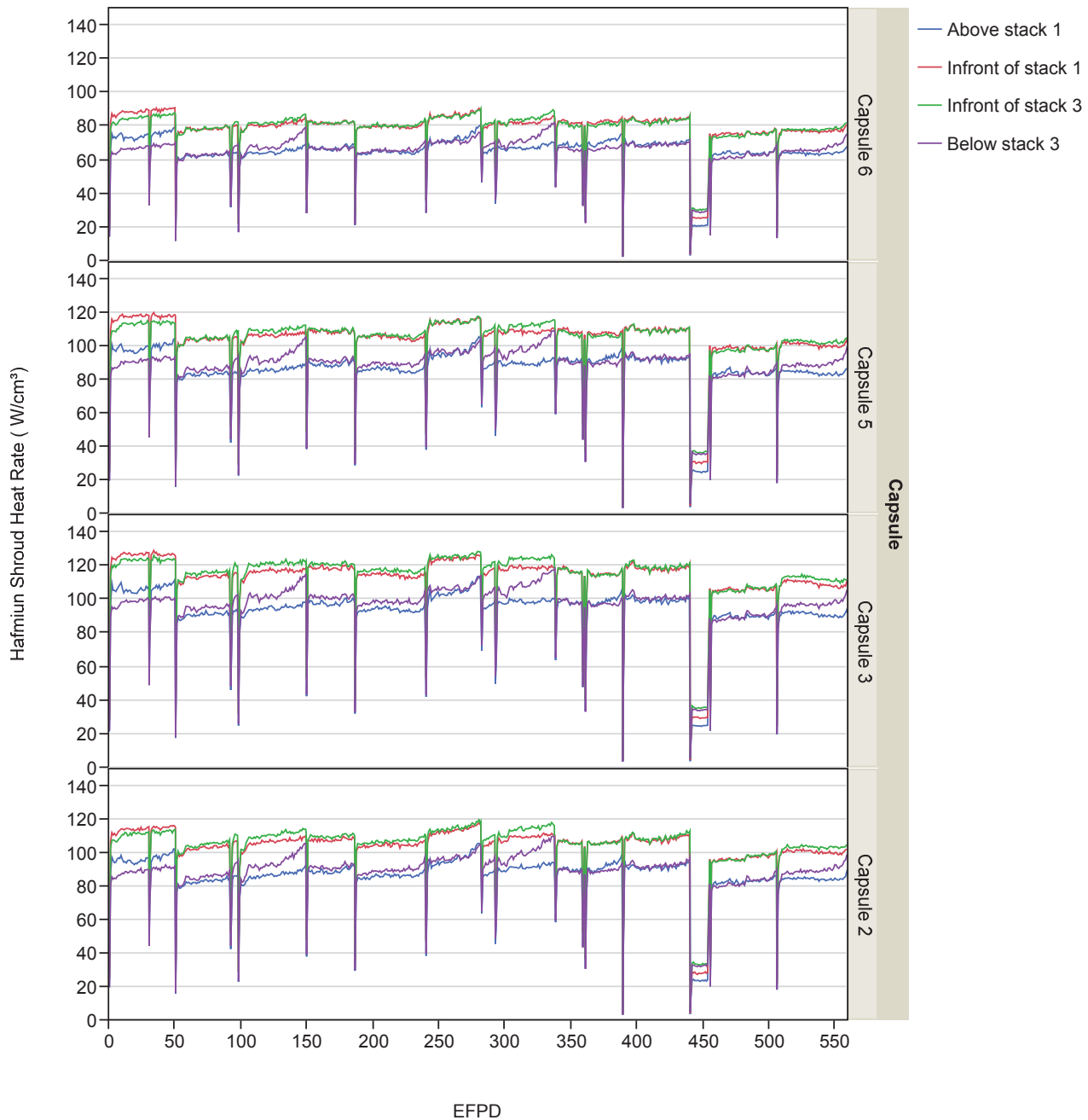


Figure 17. Daily component heat rates versus EFPD for hafnium shroud.

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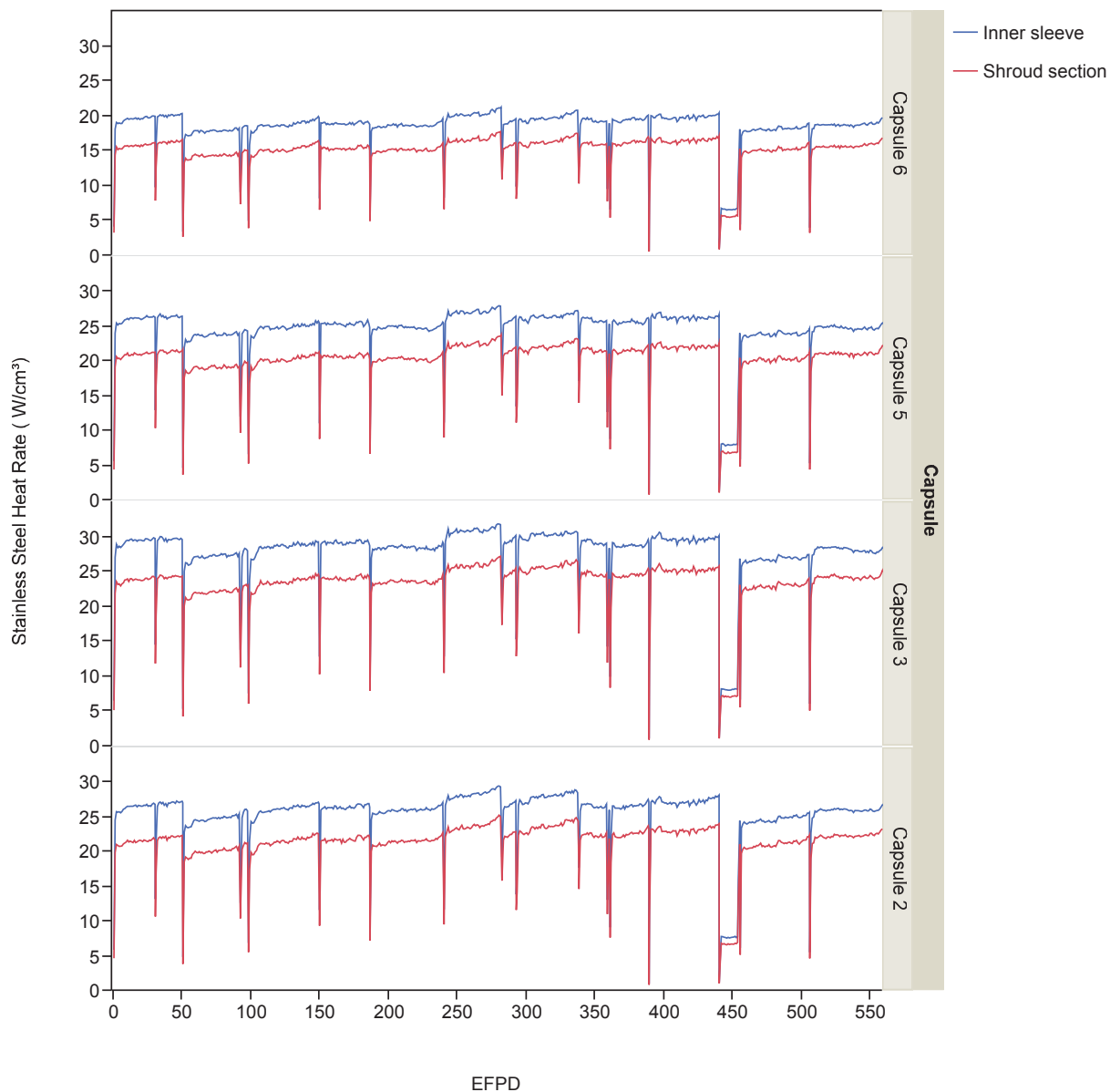


Figure 18. Daily component heat rates versus EFPD for stainless steel inner sleeve and shroud.

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Figure 19 shows the daily volumetric heat rates for the outer stainless steel wall and coolant water varying with EFPD.

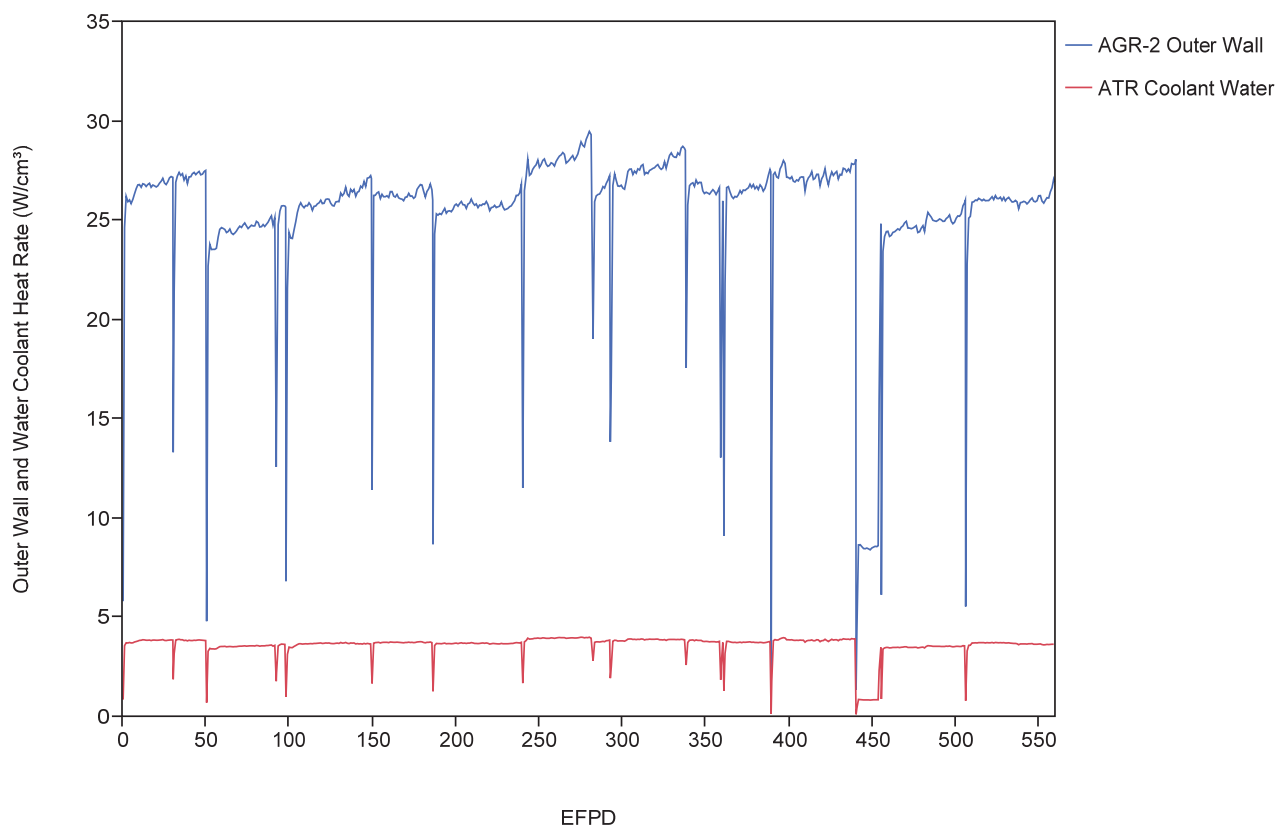


Figure 19. Daily volumetric heat rates for the AGR-2 outer wall and ATR coolant versus EFPD.

## Fuel Compact Heat Rates

Fuel compact heat rates were taken from Sterbentz [4]. The ABAQUS model and the MCNP model used to do the physics calculations use the exact same volumes for the fuel compacts. The heating volumes in ABAQUS were described with element groups matching one-half of each compact split at the midpoint from top to bottom. These one-half fuel compact heat rates were input into the ABAQUS input file for each day for each cycle. Figure 20 shows the daily average fuel compact heat rates for each capsule versus EFPDs for the entire AGR-2 experiment. Fuel compact heat rates peak during the middle of irradiation of the experiment as the B<sub>4</sub>C burns out. Large spikes occur at the end of each cycle due to the proximity of the B-12 position with the outer shim control cylinders (OSCC). The same heat rate data are shown in Figure 21, with a smoothing function in the plotting software.

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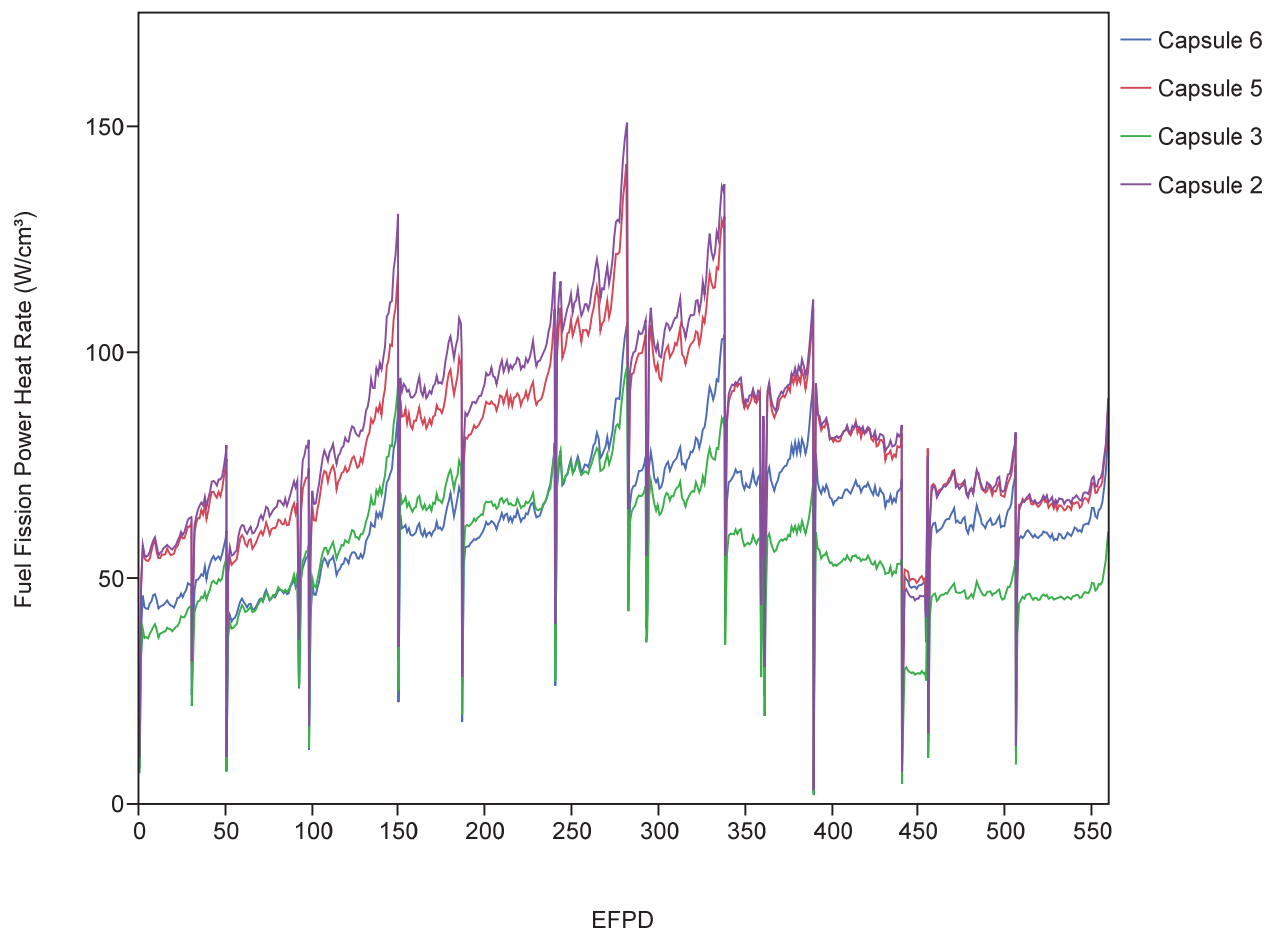


Figure 20. Daily capsule average volumetric heat rates for fuel compacts versus EFPD.

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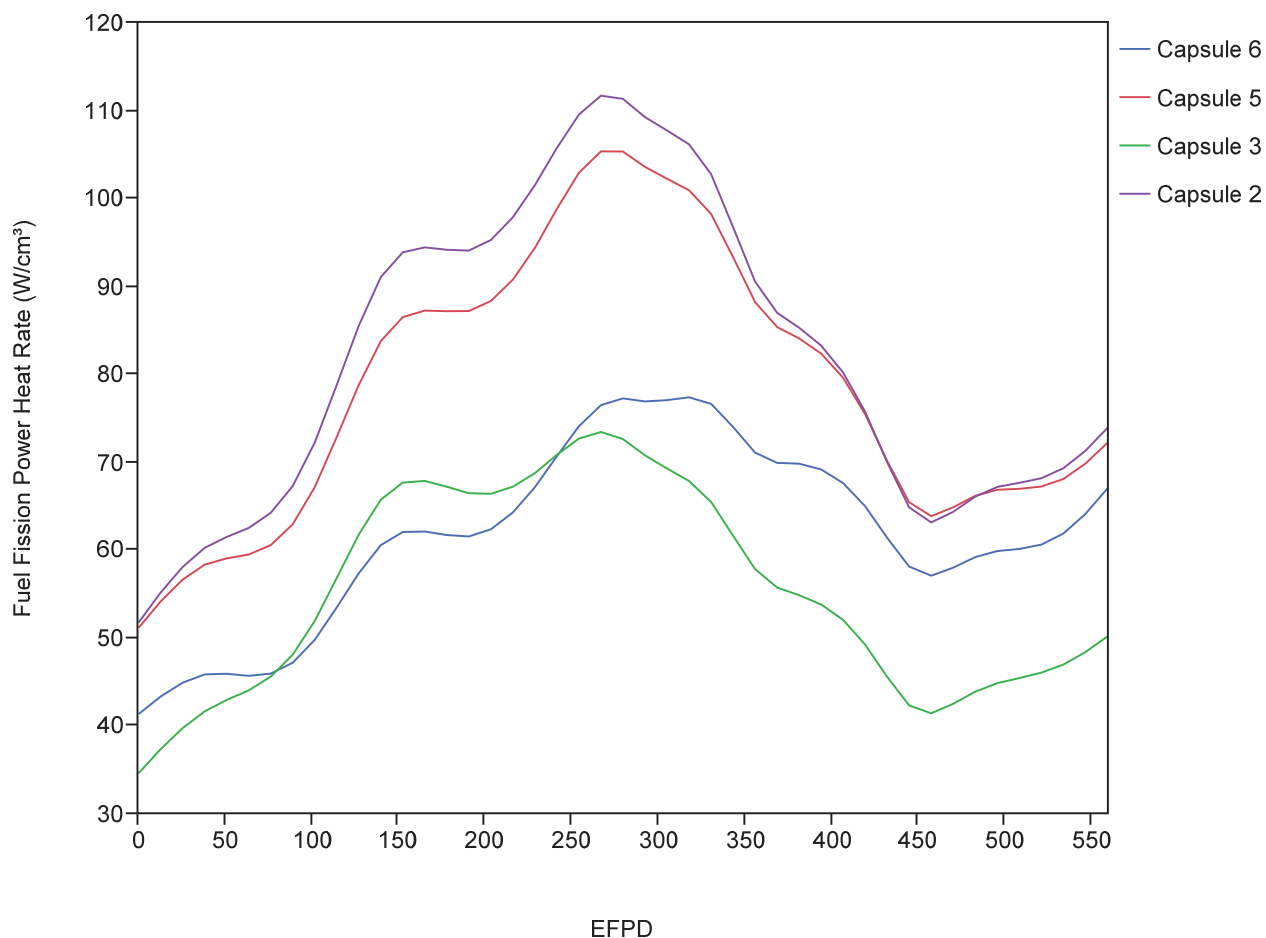


Figure 21. Smooth plot of daily capsule average volumetric heat rates in compacts versus EFPD.

Figure 22 shows the compact volumetric heat rate versus EFPD for each stack. Stacks 1 and 2 are closest to the ATR core center, while Stack 3 is on the west side and shielded by Stacks 1 and 2. As shown in Figure 22, Stack 3 starts with a lower heat rate and eventually reaches the same heat rate as Stacks 1 and 2 about two-thirds of the way through irradiation.

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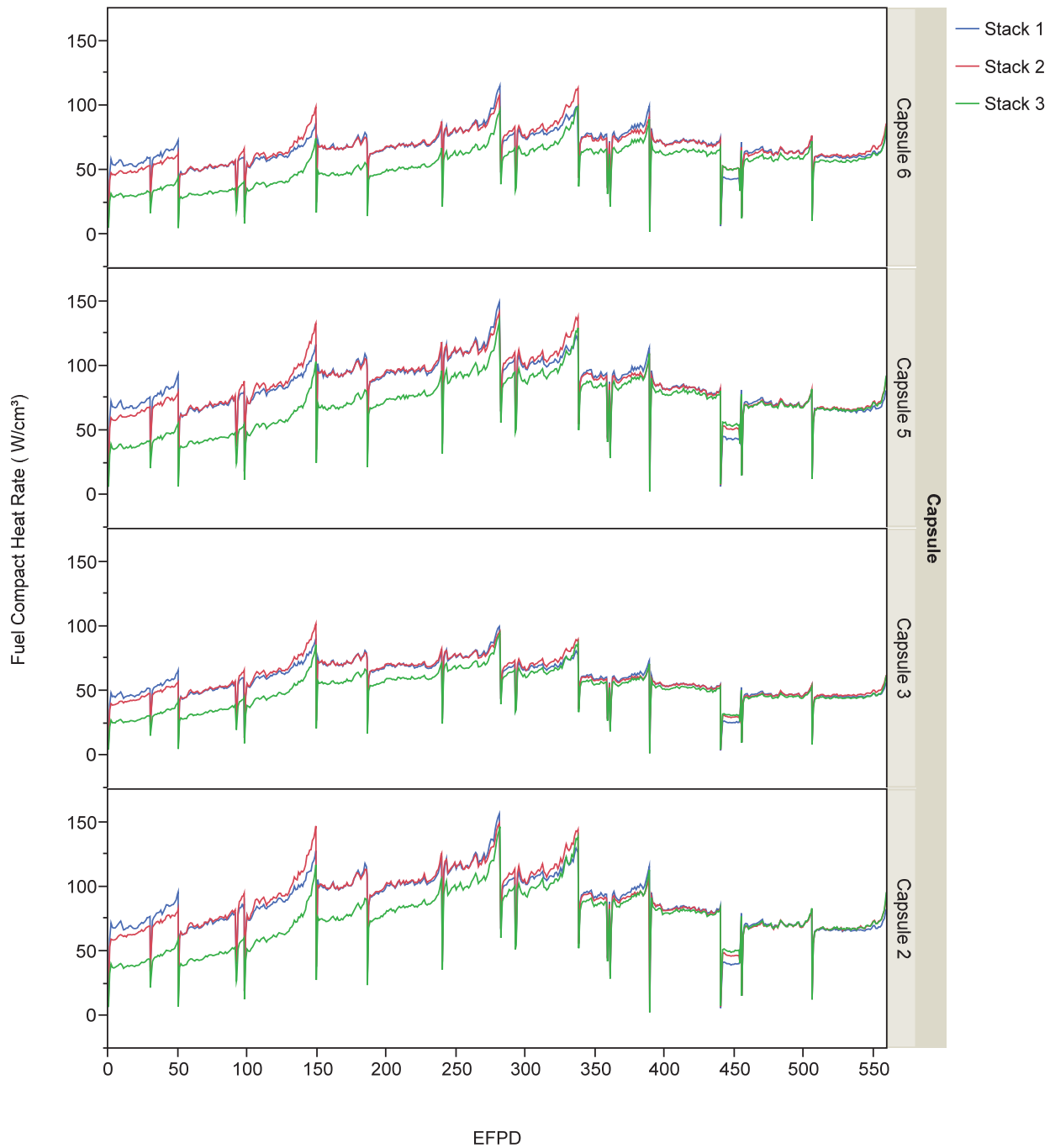


Figure 22. Daily capsule and stack average volumetric heat rates for fuel compacts versus EFPD.

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## Water Boundary Conditions

Separate water inlet temperatures were used for each capsule. Boundary inlet temperatures for Capsules 6 through 1 were 125, 128, 132, 136, 140, and 143°F (52, 53, 56, 58, 60, and 62°C), respectively. These temperature inlet conditions match within 1°F of the calculated temperatures discussed in the Results section. A water flow rate [1] of 8.1 lb/(s-in<sup>2</sup>) was used in all models. A heat transfer coefficient between the water and its surroundings of 0.00694 Btu/(s-in<sup>2</sup>-°F) was also implemented [1].

## Gas Gaps Changing with Fast Neutron Fluence

Appendix D shows the original as-built gas gaps and TC locations. The control gas gap and the compact-graphite holder gas gaps were modeled as changing with fast neutron fluence. This was accomplished by having the control gap conductivity of each capsule change with neutron fluence. Fluence was set as Field Variable 2 in the ABAQUS model. The original finite element mesh models created in ABAQUS were done with the as-built dimensions for the gas gaps. The gas gaps were assumed to be the hot gas gap dimension, since the difference between the hot gas gap dimension and room temperature gas gap dimension is negligible. Experimental data from Figure 44 of Reference [10] obtained from the AGR-1 experiment was used for compact shrinkage, while Figures 63, 71, and 72 of Reference [10] were used for the graphite holder holes and holder outside diameter dimensional change. This was done because the compacts are very closely related in properties and the borated graphite in AGR-1 Capsules 1 and 6 are nearly identical to the amount of B<sub>4</sub>C in the AGR-2 capsules. Table 2 shows the  $\Delta r/r$  values obtained from the measured values of the AGR-1 compact, holder holes, and holder outside diameter as noted in [10]. Compact shrinkage values remain constant above a fluence of 3.0. Holder holes show a shrinkage rate of -0.23% per  $1 \times 10^{25}$  n/m<sup>2</sup>, while the holder outside diameter is at -0.18%.

Table 2. Compact and graphite holder shrinkage, varying with fast neutron fluence.

Fast Fluence (n/m <sup>2</sup> x 10 <sup>-25</sup> ) E > 0.18 MeV	AGR-1 Compacts actual $\Delta r/r$	Holder Holes $\Delta r/r$	Holder OD $\Delta r/r$
0.0	0.0000	0.0000	0.0000
1.0	-0.0059	-0.0023	-0.0018
2.0	-0.0095	-0.0045	-0.0036
3.0	-0.0110	-0.0068	-0.0054
4.0	-0.0110	-0.0091	-0.0072
6.0	-0.0110	-0.0136	-0.0108
8.0	-0.0110	-0.0181	-0.0144

## DISCUSSION/ANALYSIS

Figures 21 through 46 show the results of the daily as-run calculated heat transfer analyses. Typical temperature contour plots of various components and fuel compacts are discussed first, followed by historical plots of daily temperatures, TC predictions, comparisons with experimental TCs, and time average volume average (TAVA) temperatures.

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## Temperature Results

Temperature contour plots of the various components begin on the outer portion of the model and work toward the center where the fuel compacts are located. These plots are for Capsule 3 during day 8 of Cycle 151A, because this appears to be an average day during the experiment. Figure 21 shows a cutaway view of the beryllium. An adiabatic boundary condition was placed on the top, bottom, and outside of this component. Heat generated in the beryllium is transported directly to the water. Water flows from left to right in the figure. A temperature contour plot of the water channel is shown in Figure 22. A temperature boundary condition on the inlet of 136°F (57.78°C) was implemented. The typical temperature rise through each capsule is about 4 to 5°F (2 to 3°C).

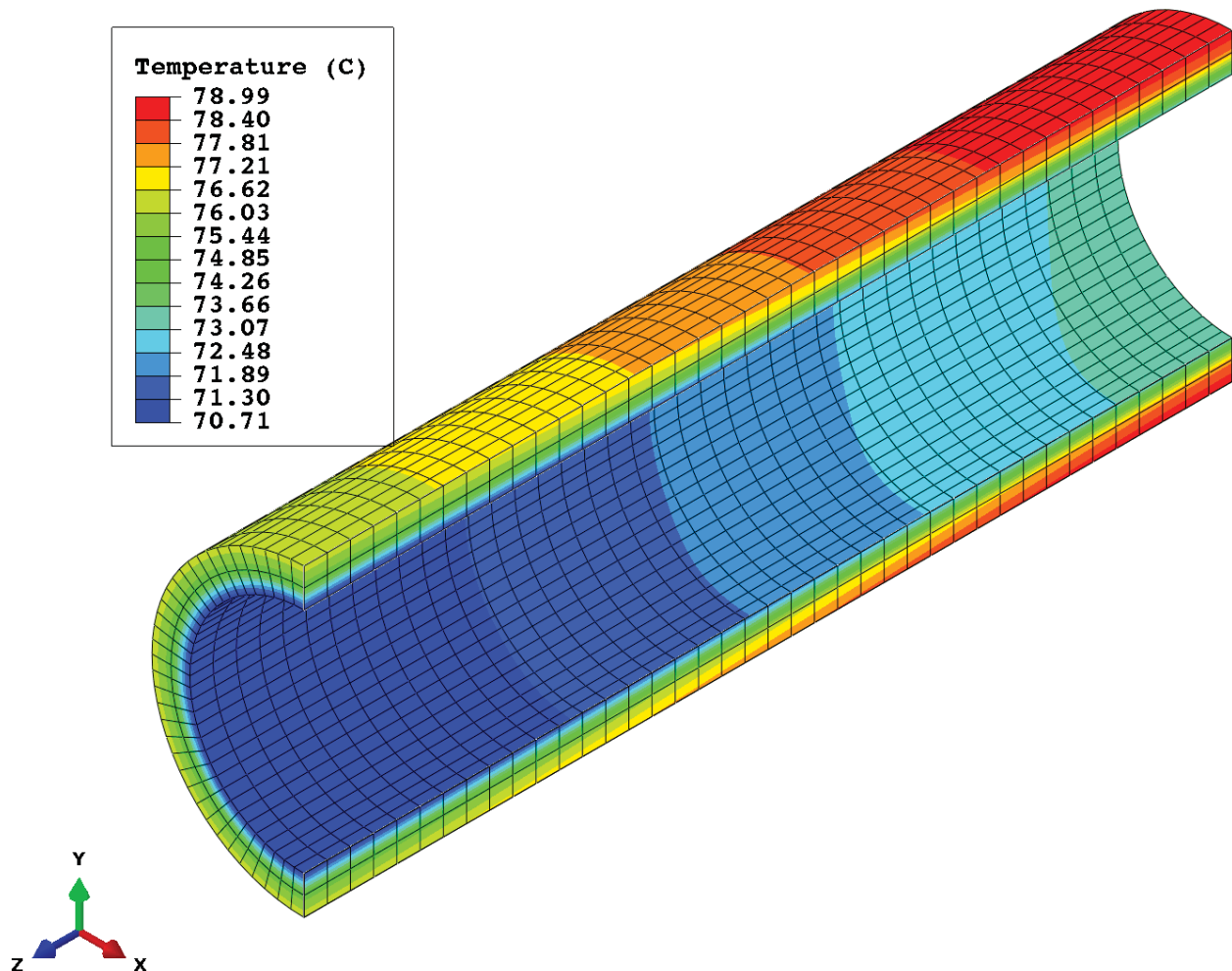


Figure 21. Temperature (°C) contour plot of a cutaway view of beryllium.

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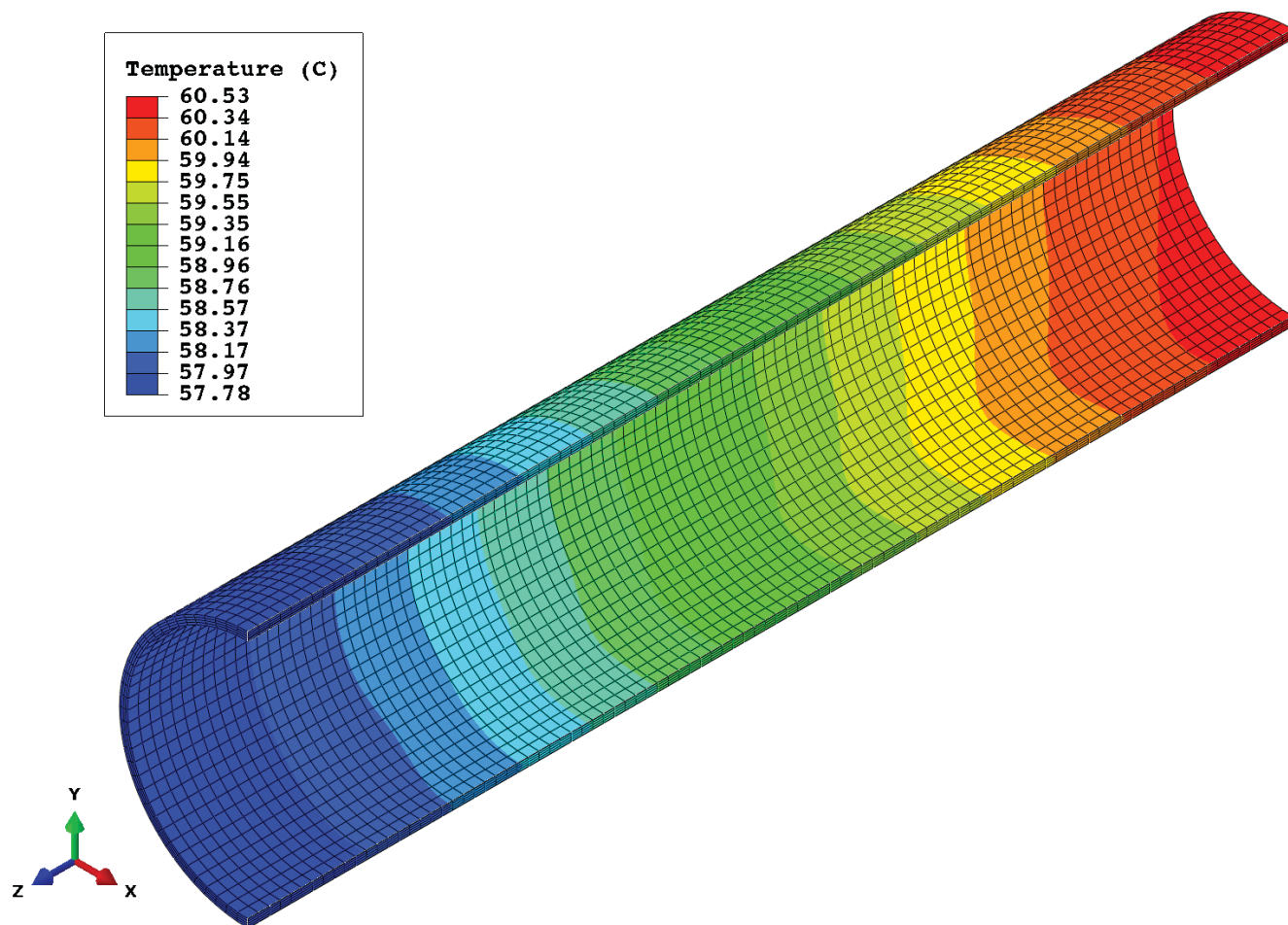


Figure 22. Temperature (°C) contour plot of the water channel.

Figure 23 shows a cutaway view of the temperature contours of the stainless steel pressure boundary. The inner surface shows a streak of higher temperature across from the thru tube region. The maximum temperature is 109°C. Figure 24 shows the entire hafnium neutron absorber, while Figure 25 shows the stainless steel filler.

A temperature contour plot of the stainless steel retainer is shown in Figure 26. Again, a hot streak occurs across the gap from the thru tubes. This stainless steel retainer is an extension of the mesh used for the graphite holder and gas gaps for the center portion. Notice that the mesh changes near the top and bottom. These small mesh areas were added later in the modeling to allow heat transfer from the graphite spacers and rings on the top and bottom of the model. A \*Tie Constraint was used in the ABAQUS model to intimately connect the different meshes. The thru tubes were not extended into these upper and lower regions; therefore, no radiation heat was transferred from the thru tubes to the stainless steel retainer. The graphite spacers at the top and bottom radiate and conduct the heat to the stainless steel retainer. This accounts for the dark blue region in the top and bottom areas of the attached mesh.

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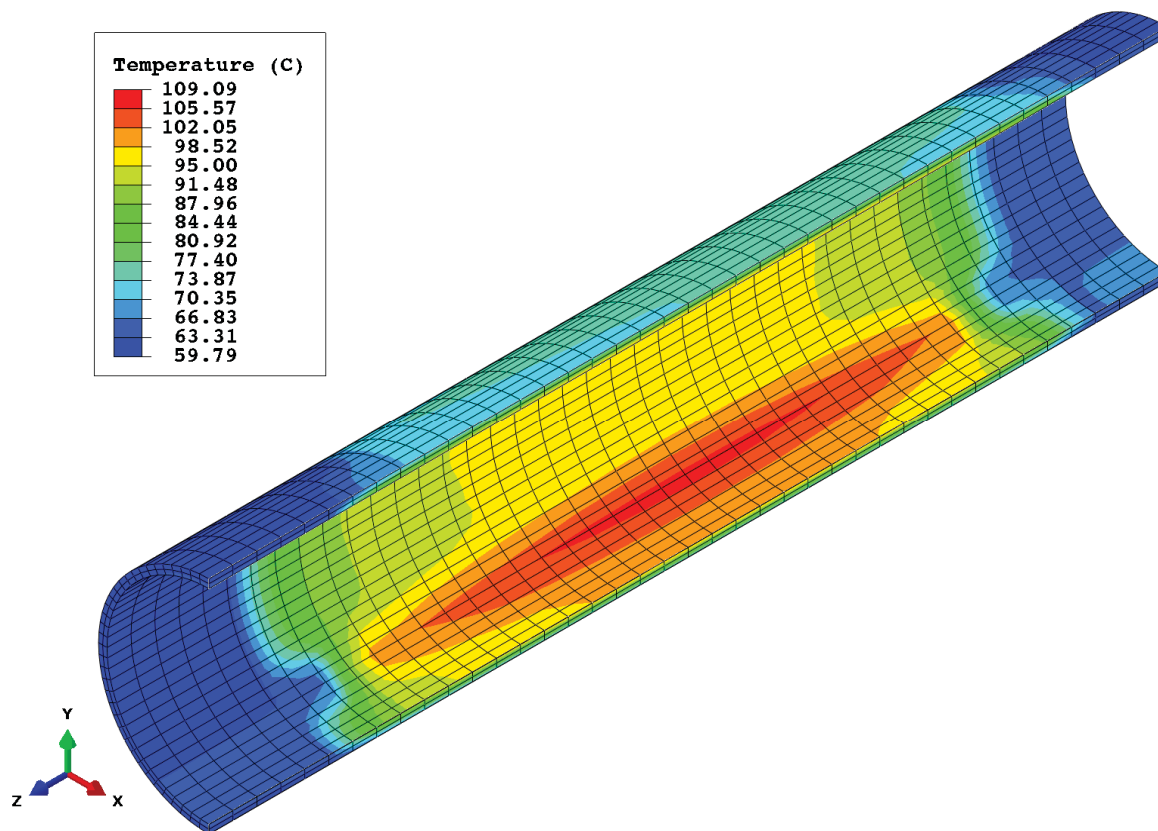


Figure 23. Temperature (°C) contour plot of a cutaway view of the pressure boundary.

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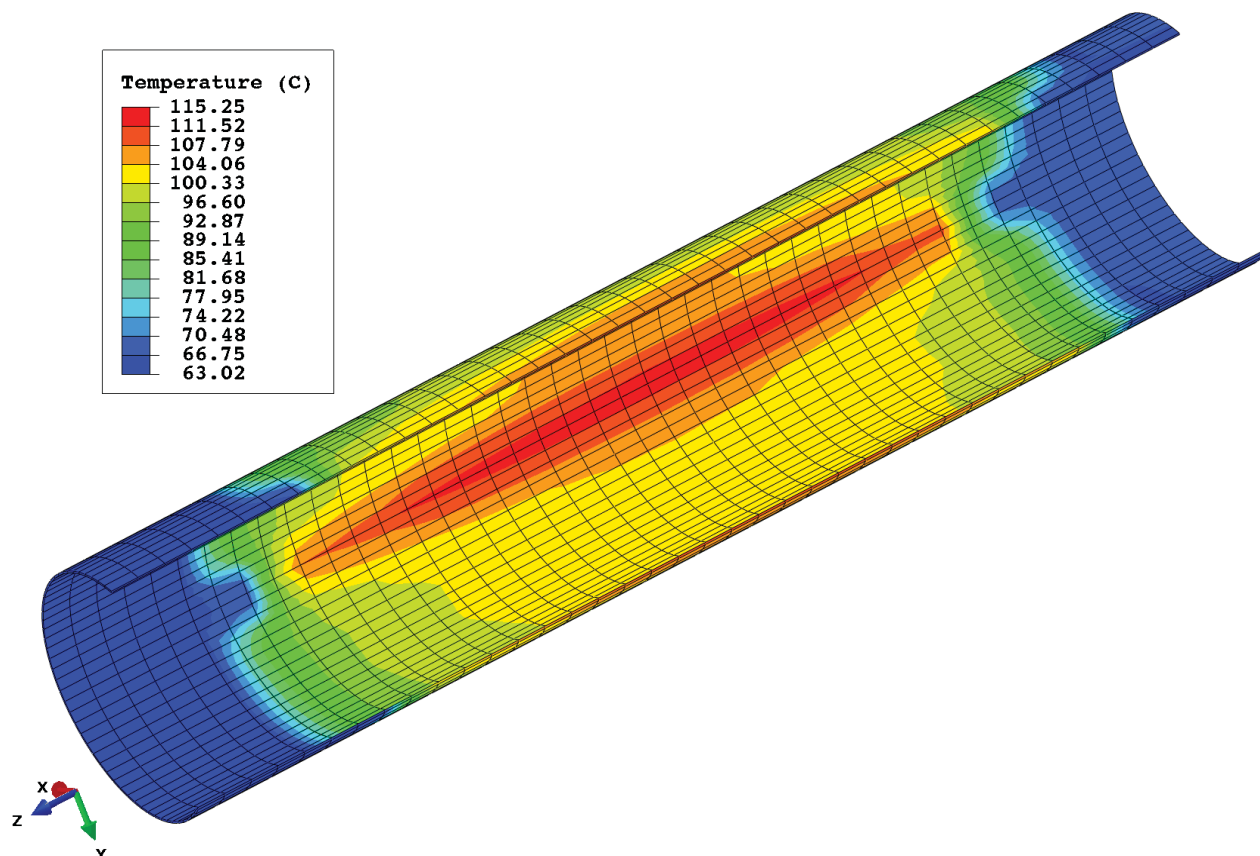


Figure 24. Temperature (°C) contour plot of hafnium.

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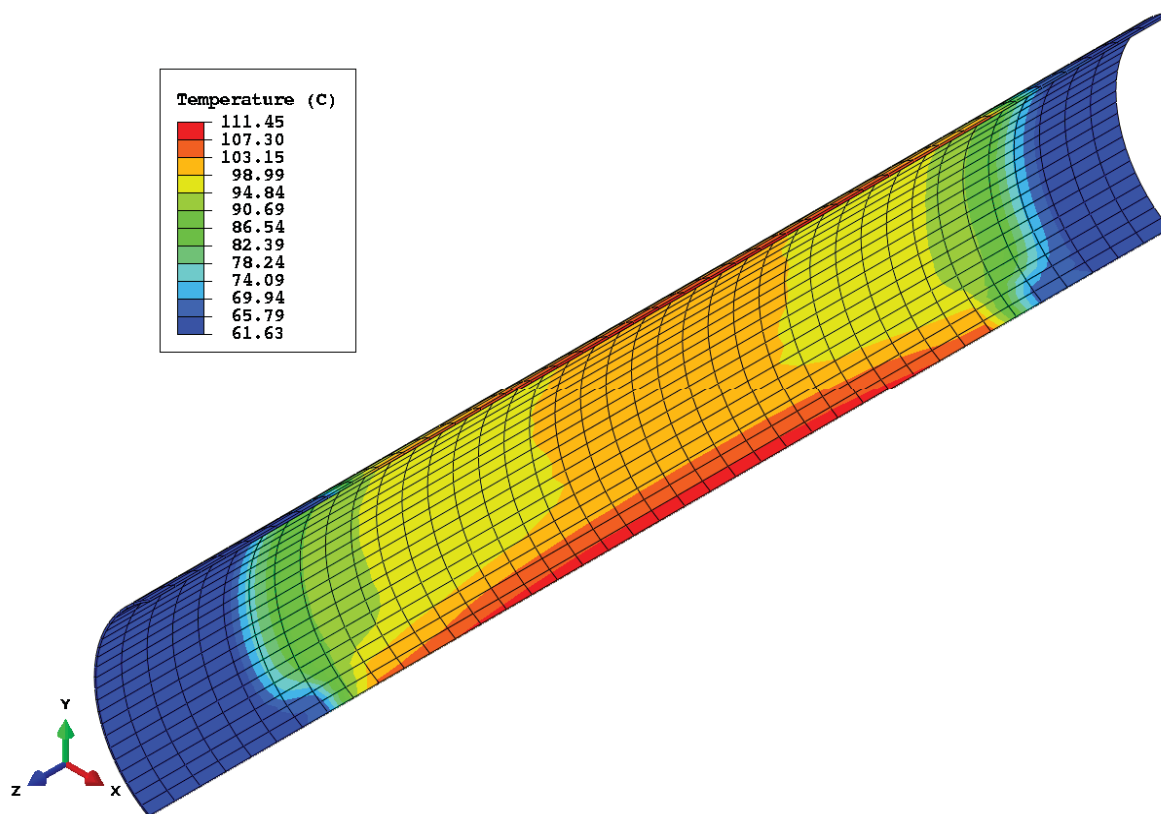


Figure 25. Temperature (°C) contour plot of the stainless steel filler.

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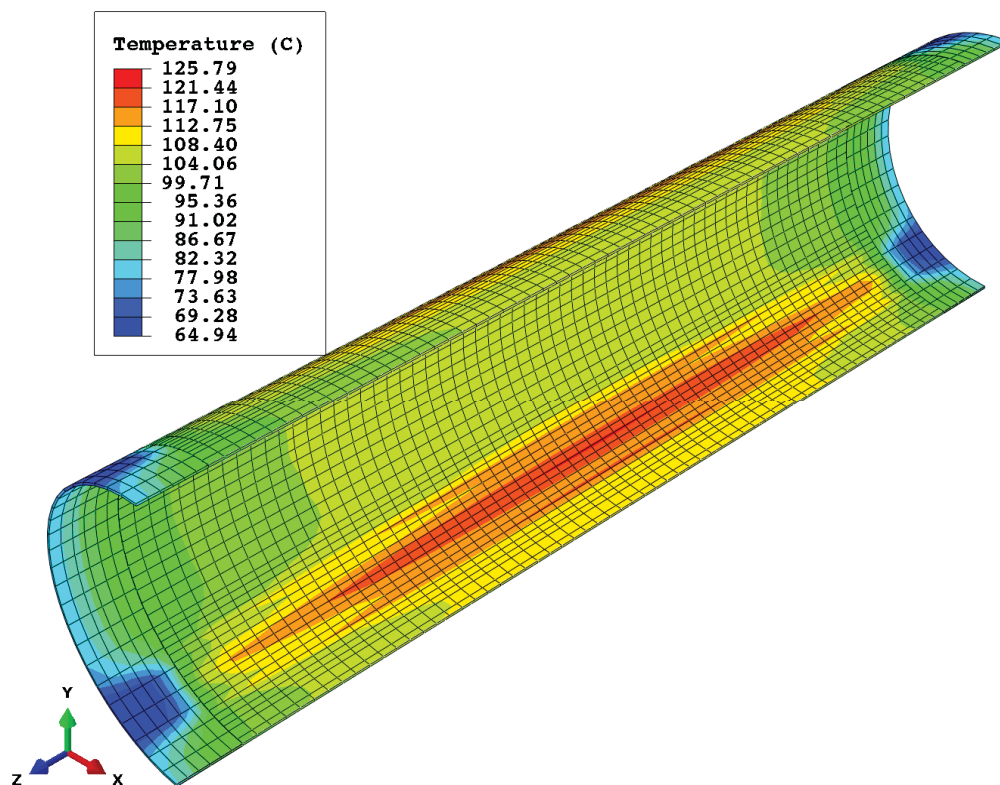


Figure 26. Temperature (°C) contour plot of the stainless steel retainer.

Figure 27 shows a cutaway view of the temperature contour plot of the gas. Four finite elements are used through the gas gap. The hottest portion of the gas is between the thru tube and the graphite holder. This occurs because it is nearest the fuel compacts. This small gap between the graphite holder and the stainless steel retainer was machined differently for each capsule to give the desired temperatures for each individual capsule.

The thru tubes temperature contour plots are shown in Figure 28. The hottest temperatures occur near the axial center of each capsule, while the coolest portions are near the top and bottom (away from the experiment centerline). Figure 29 shows a temperature contour plot with a cutaway view of the graphite holder. All heat generated in the fuel compacts is conducted through this entity. Radiation heat transfer occurs from the compacts to the holder and the outer surfaces of the graphite holder to the stainless steel retainer. The emissivity of the graphite and the stainless steel was assumed to be 1.0. A view factor of 1.0 was also assumed for the radiation across this small gas gap. Temperature-dependent and fluence-dependent thermal conductivity was modeled for the graphite components in the AGR-2 experiment. Neutron damage has less of an effect on the thermal conductivity at higher temperatures when the reactor is running at full power compared to lower temperatures during startup and 100% helium flow. Figure 30 shows a cutaway view of the temperature contour plot of the graphite holder. The hottest region occurs in the very center of the holder.

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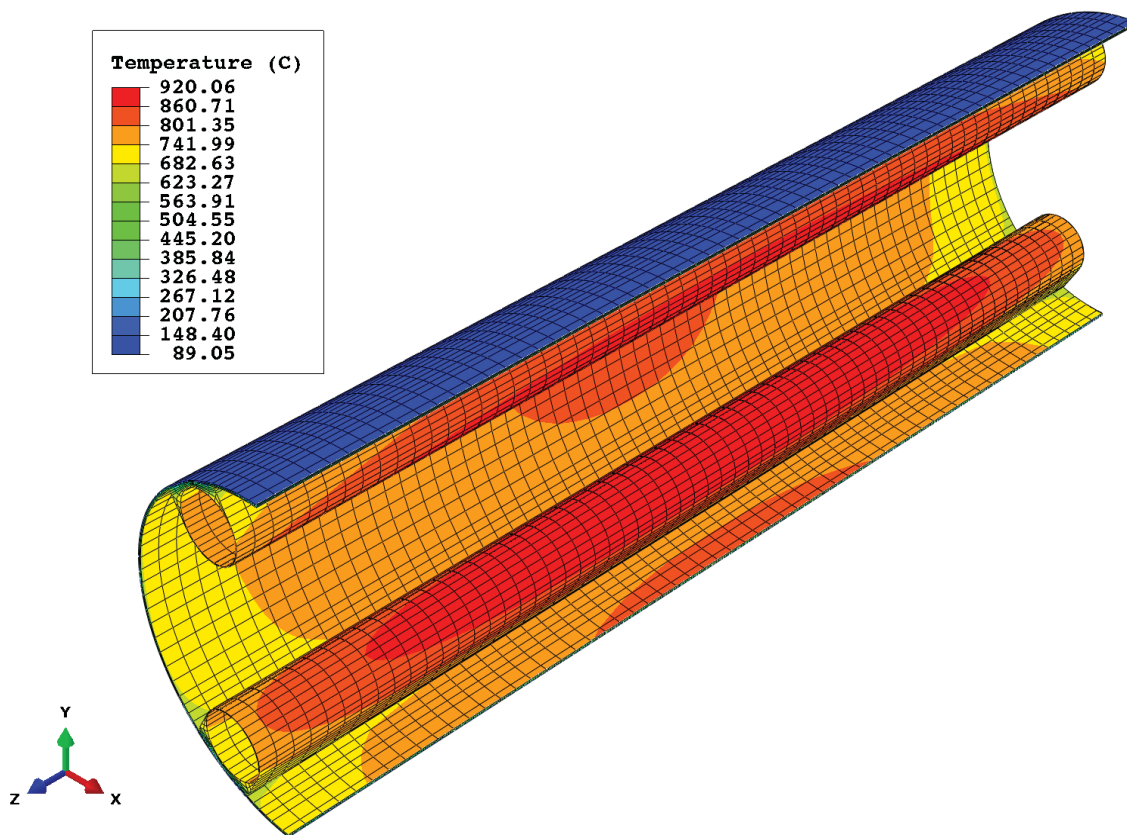


Figure 27. Temperature (°C) contour plot of the cutaway view of gas surrounding the graphite holder and thru tube.

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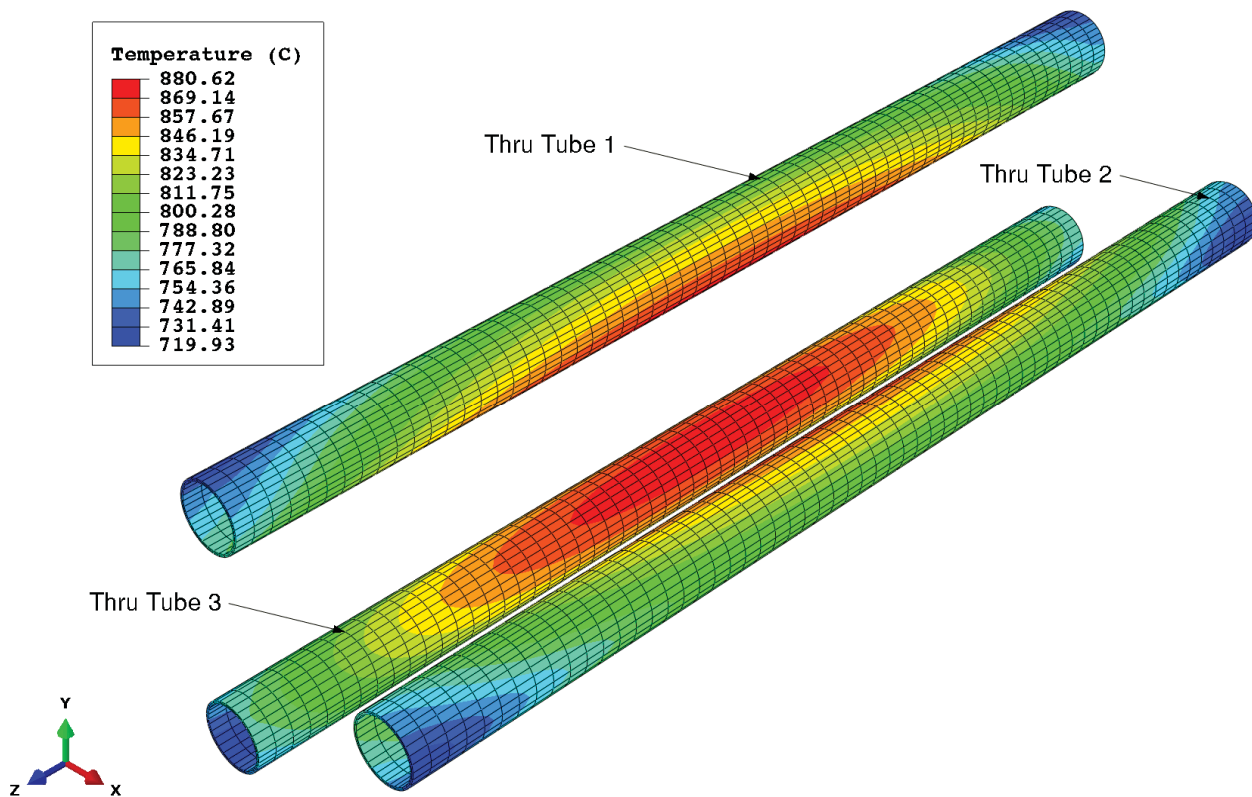


Figure 28. Temperature (°C) contour plot of the thru tubes.

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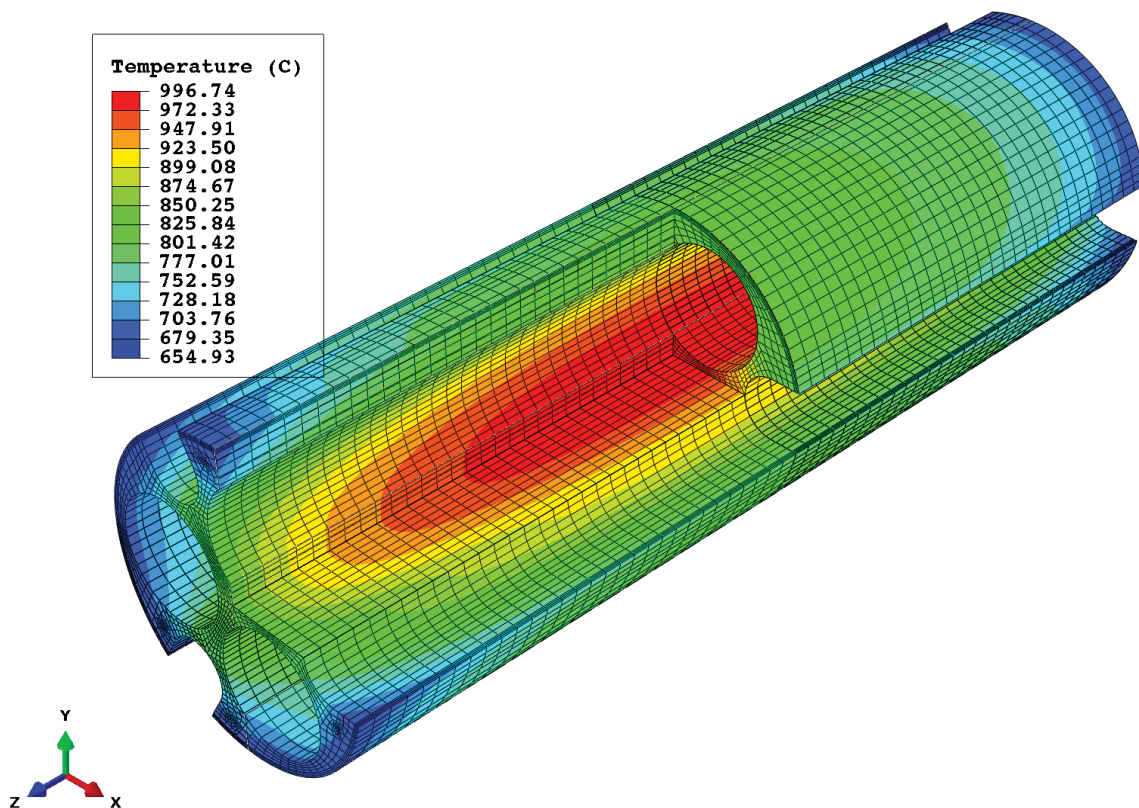


Figure 29. Temperature (°C) contour plot of the cutaway view of the graphite holder.

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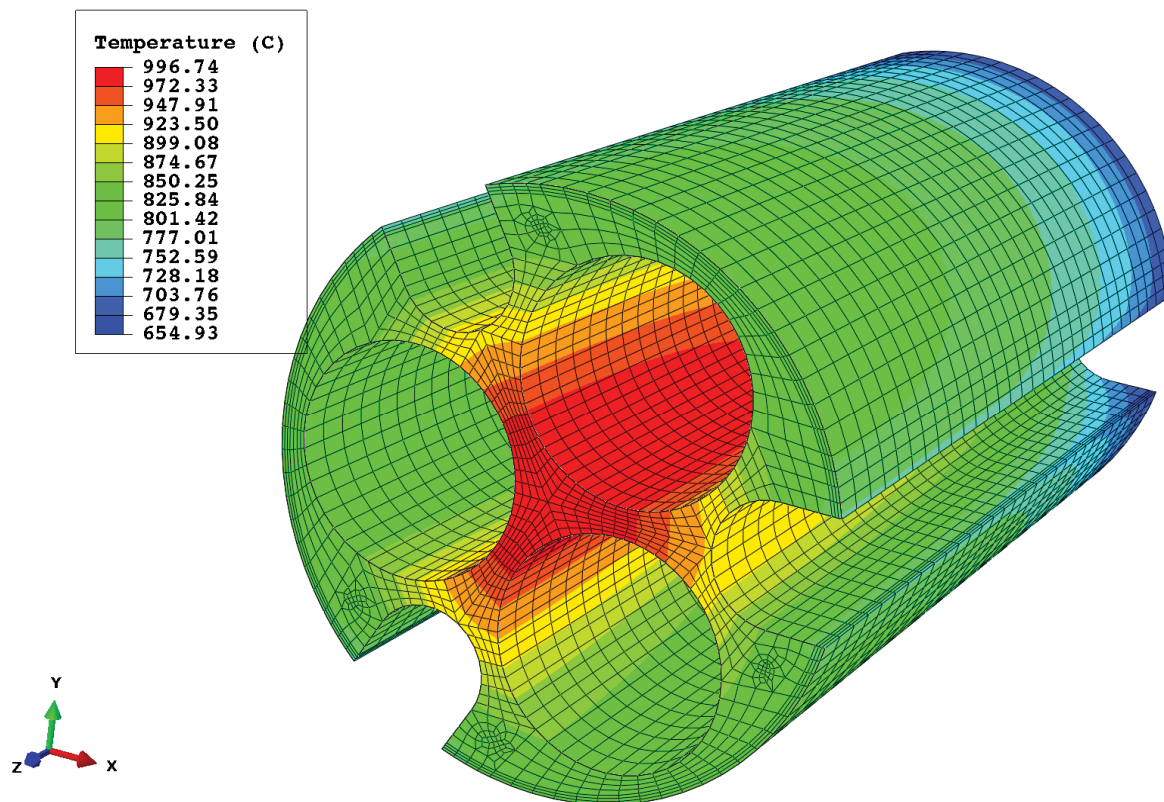


Figure 30. Temperature (°C) contour plot cutaway view of the graphite holder.

Figure 31 shows a cutaway view of the three fuel compact stacks. Temperatures range from 750°C to a maximum of 1013°C. Stacks 1 and 2 have higher temperatures than Stack 3 because they are closer to the core center. Figures 32, 33, and 34 show the temperature contours of Stacks 1, 2, and 3, respectively. Each figure is a cutaway view so that the hottest region can be clearly seen. Figure 35 shows a temperature contour plot of the bottom 0.15 in. of the graphite holder, along with the graphite spacer, graphite ring, and another graphite spacer. A \*Tie Constraint option is used in the ABAQUS input model that intimately links these components together from a heat transfer standpoint. Gap conductance and radiation occurs between the two spacers and the outer surfaces to the stainless steel retainer. The radial gap between these bottom three parts and the stainless steel retainer is 0.038 in. In ABAQUS, a \*Surface Radiation boundary condition was placed on the bottom surface of the bottom graphite spacer, radiating to 400°F (204.4°C). This value was similarly used in the AGR-1 model.

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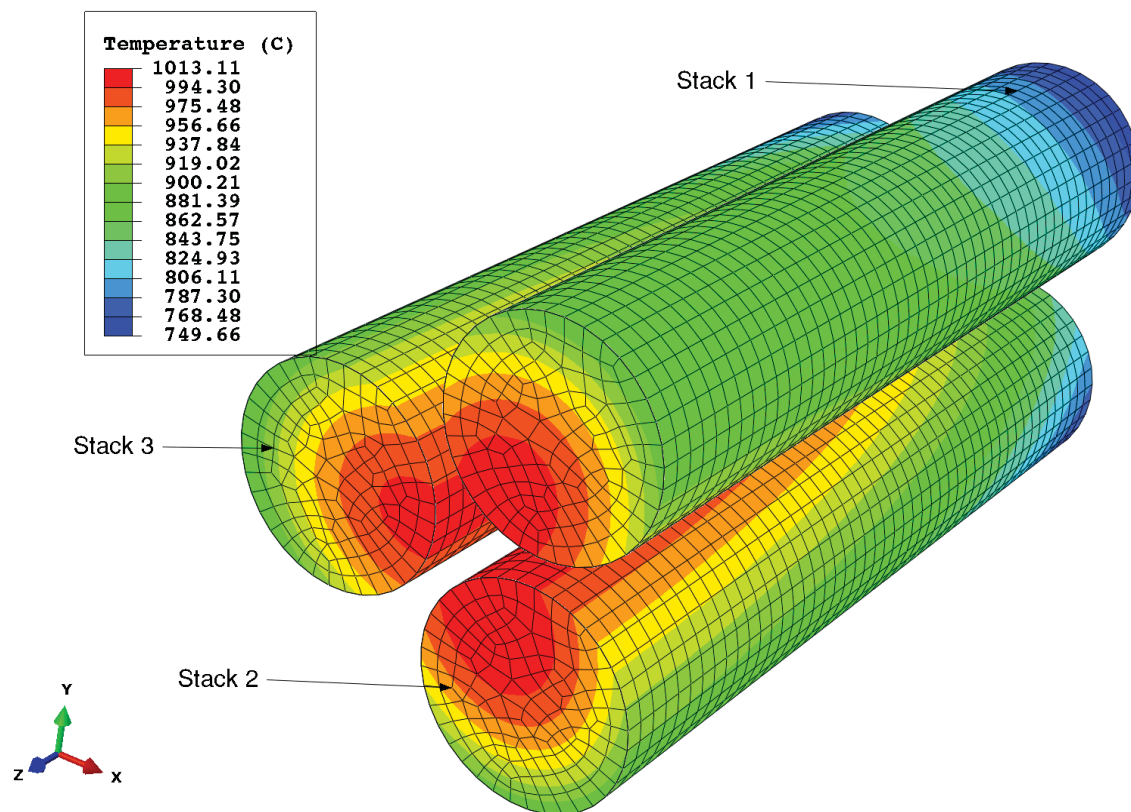


Figure 31. Temperature ( $^{\circ}\text{C}$ ) contour plot cutaway view of the three fuel stacks.

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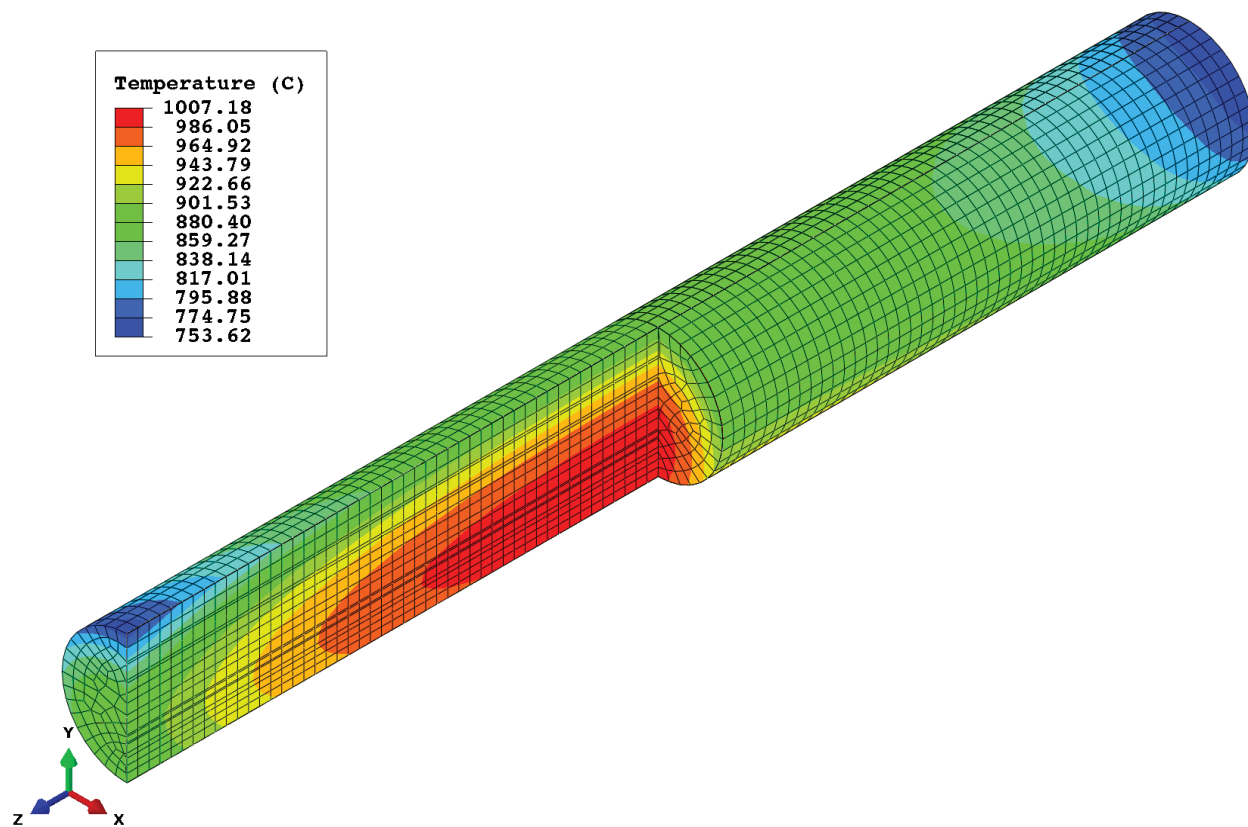


Figure 32. Temperature (°C) contour plot of Stack 1.

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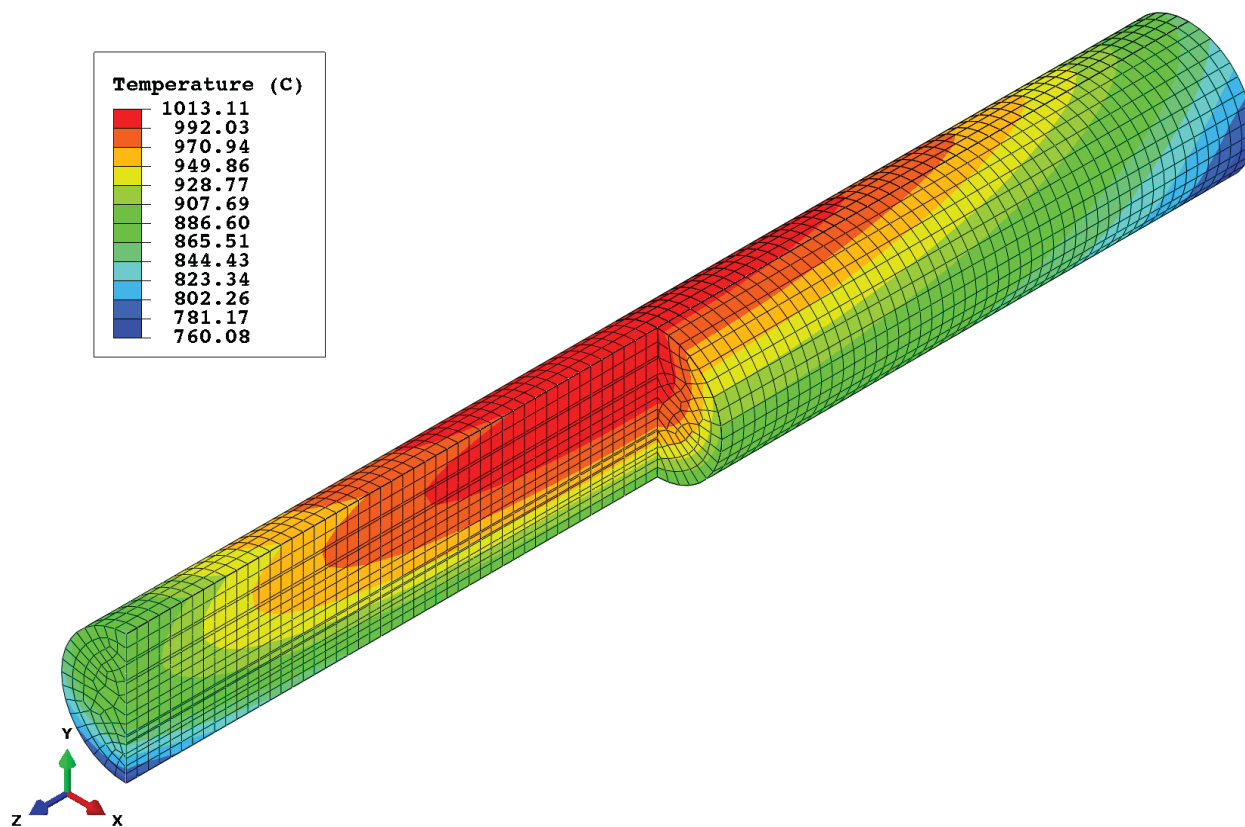


Figure 33. Temperature (°C) contour plot of Stack 2.

Title: AGR-2 Daily As-Run Thermal Analyses

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Date: 08/13/2014

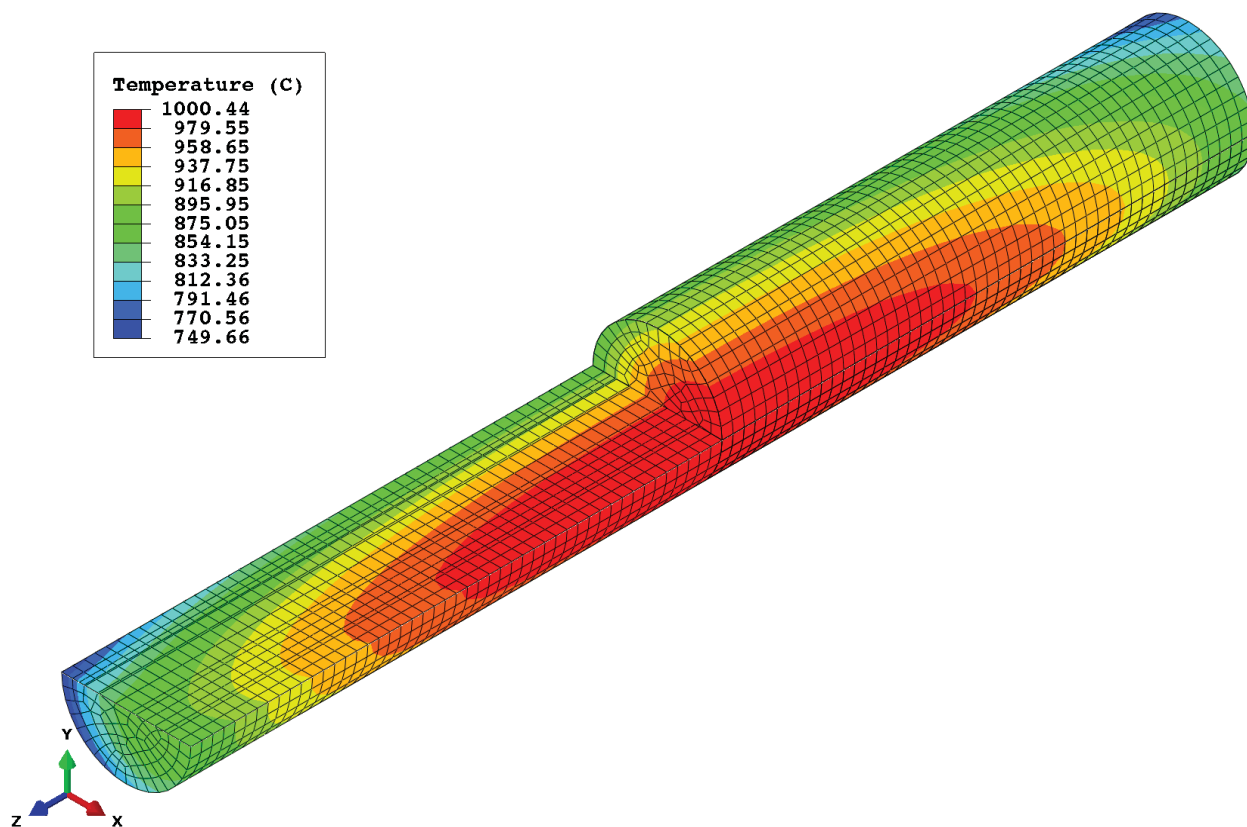


Figure 34. Temperature (°C) contour plot of Stack 3.

Title: AGR-2 Daily As-Run Thermal Analyses

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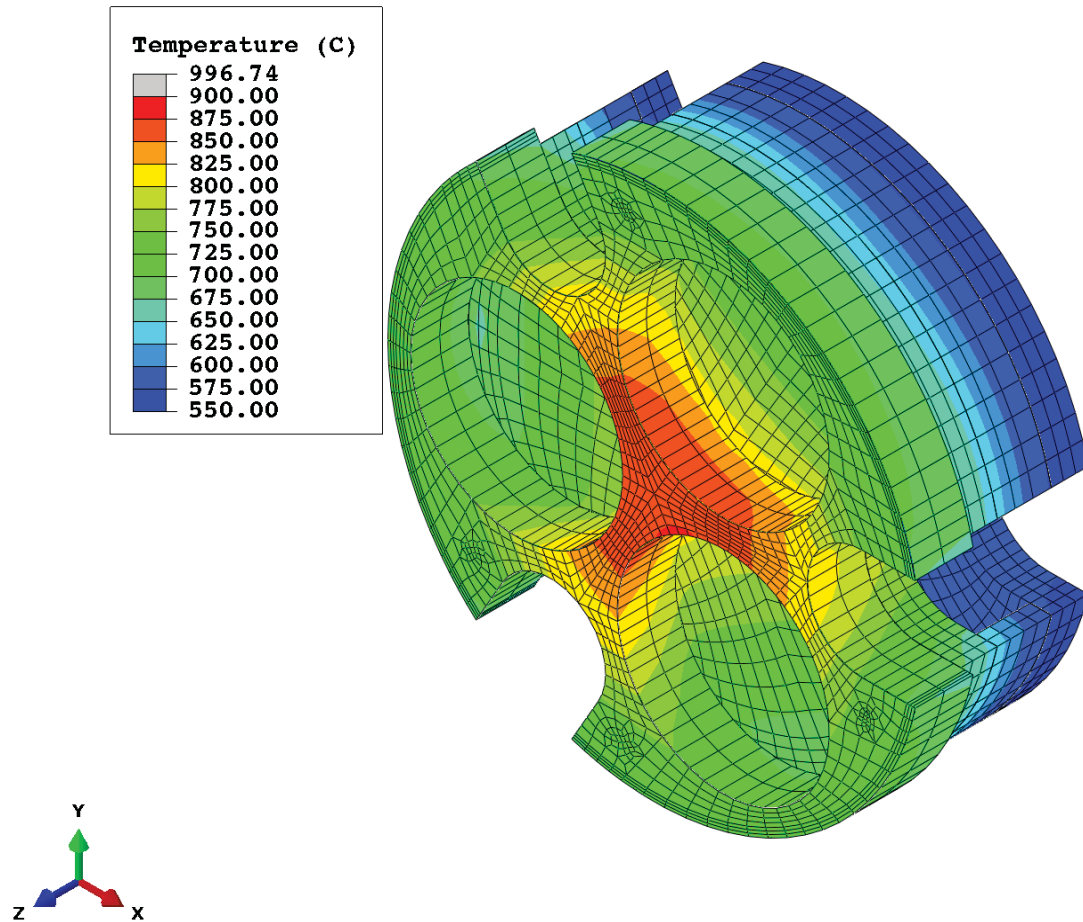


Figure 35. Temperature (°C) contour plot of the bottom 0.15 in. of the graphite holder, bottom graphite spacers, and bottom graphite ring.

Figure 36 shows a temperature contour plot of the graphite spacer next to the bottom of the graphite holder, while Figure 37 shows a temperature contour plot of the graphite ring next to the spacer. Figure 38 shows a temperature contour plot of the bottom graphite spacer. All of these graphite components are near the same temperature as the end of the graphite holder.

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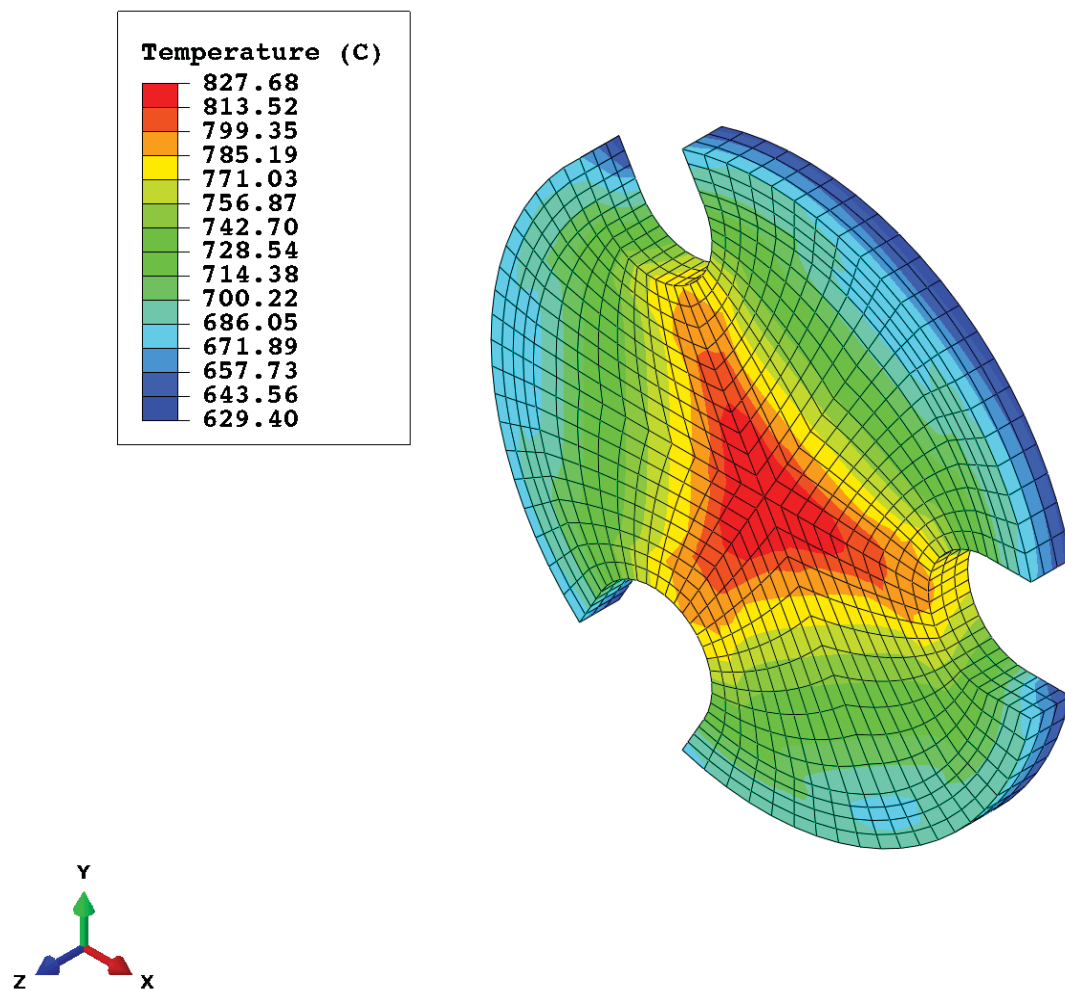


Figure 36. Temperature (°C) contour plot of the graphite spacer next to the bottom of the graphite holder.

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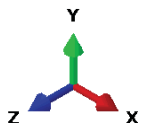
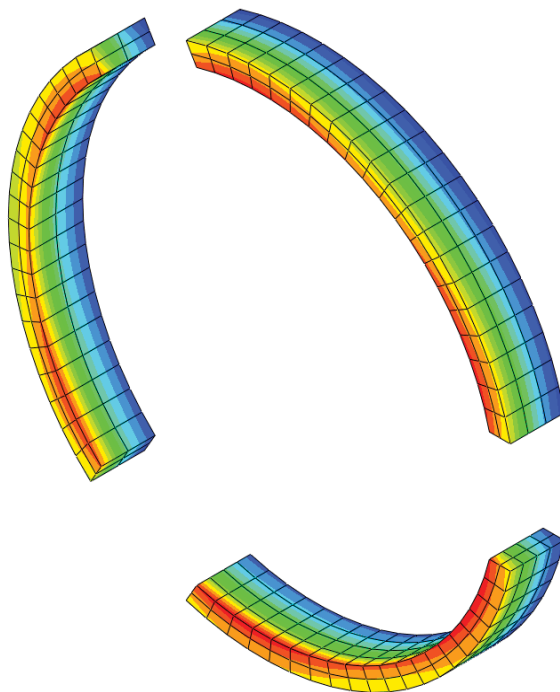
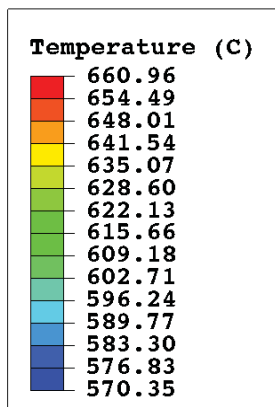


Figure 37. Temperature (°C) contour plot of the bottom graphite ring.

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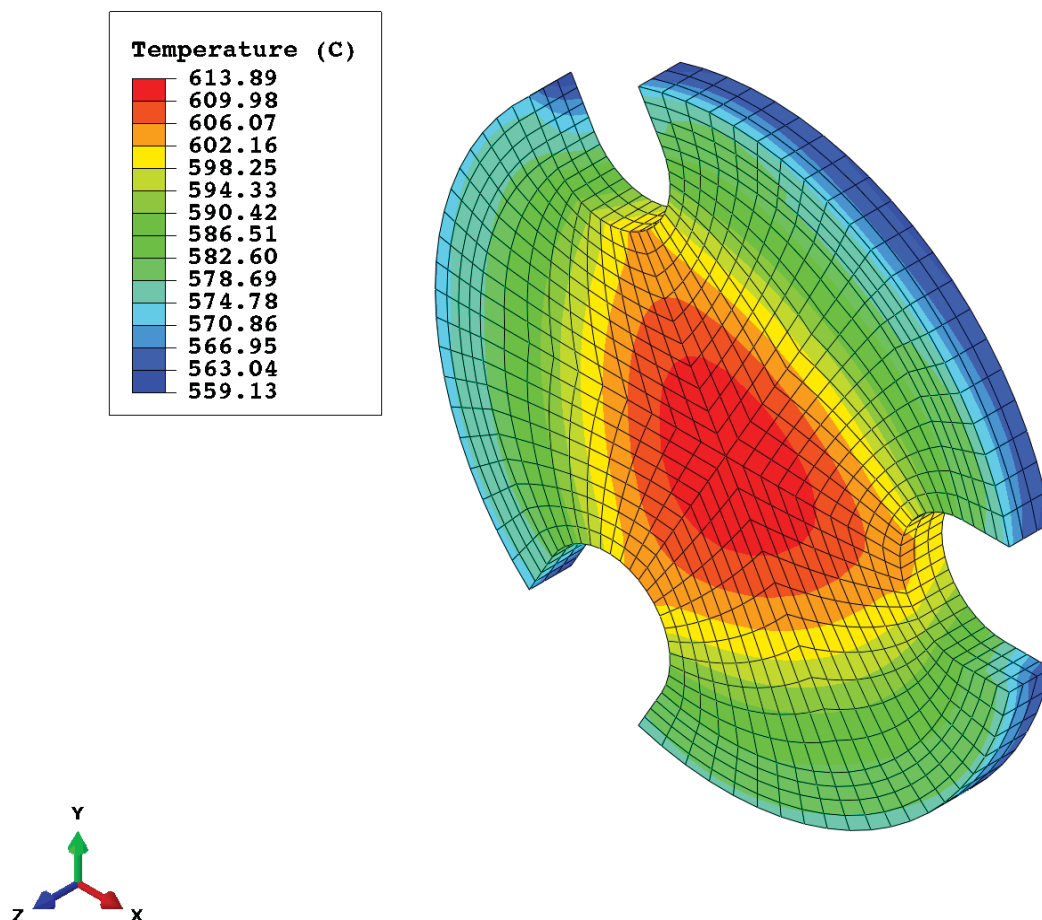


Figure 38. Temperature (°C) contour plot of the bottom graphite spacer.

## History Plots and Results

Figure 39 shows the calculated daily capsule average compact maximum, average, and minimum temperature. Note that the maximum and minimum temperatures are point values, whereas the average is a volume average. The following equation was used to calculate the capsule average fuel temperatures:

$$T_{ave} = \frac{\sum T_i V_i}{\sum V_i} \quad (5)$$

where  $T_{ave}$  is the average capsule temperature,  $T_i$  is the finite element average temperature from each fuel compact finite element in ABAQUS, and  $V_i$  is the finite element volume for each finite element from ABAQUS.

Figure 40 shows the daily average TC temperature for each TC in each capsule. All of the TCs eventually failed in the AGR-2 experiment. Capsule 6 shows that all five of its TCs lasted the longest because the neutron fluence was lowest. Figure 41 shows the daily average TC measured and predicted temperatures. The TC data is from the NDMAS database and is considered final.

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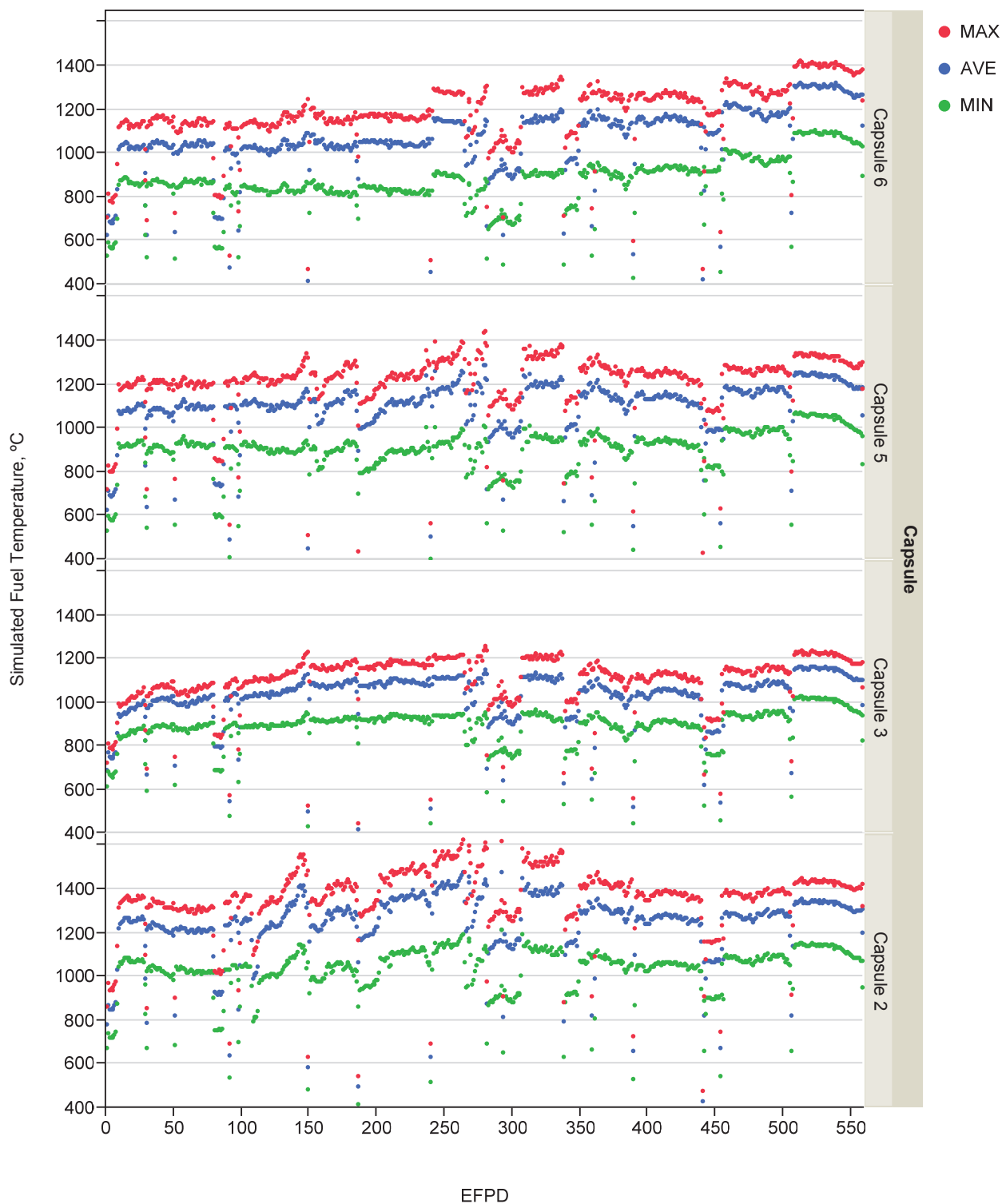


Figure 39. Calculated temperature history of daily capsule minimum, maximum, and volume average for AGR-2 Capsules 6, 5, 3, and 2.

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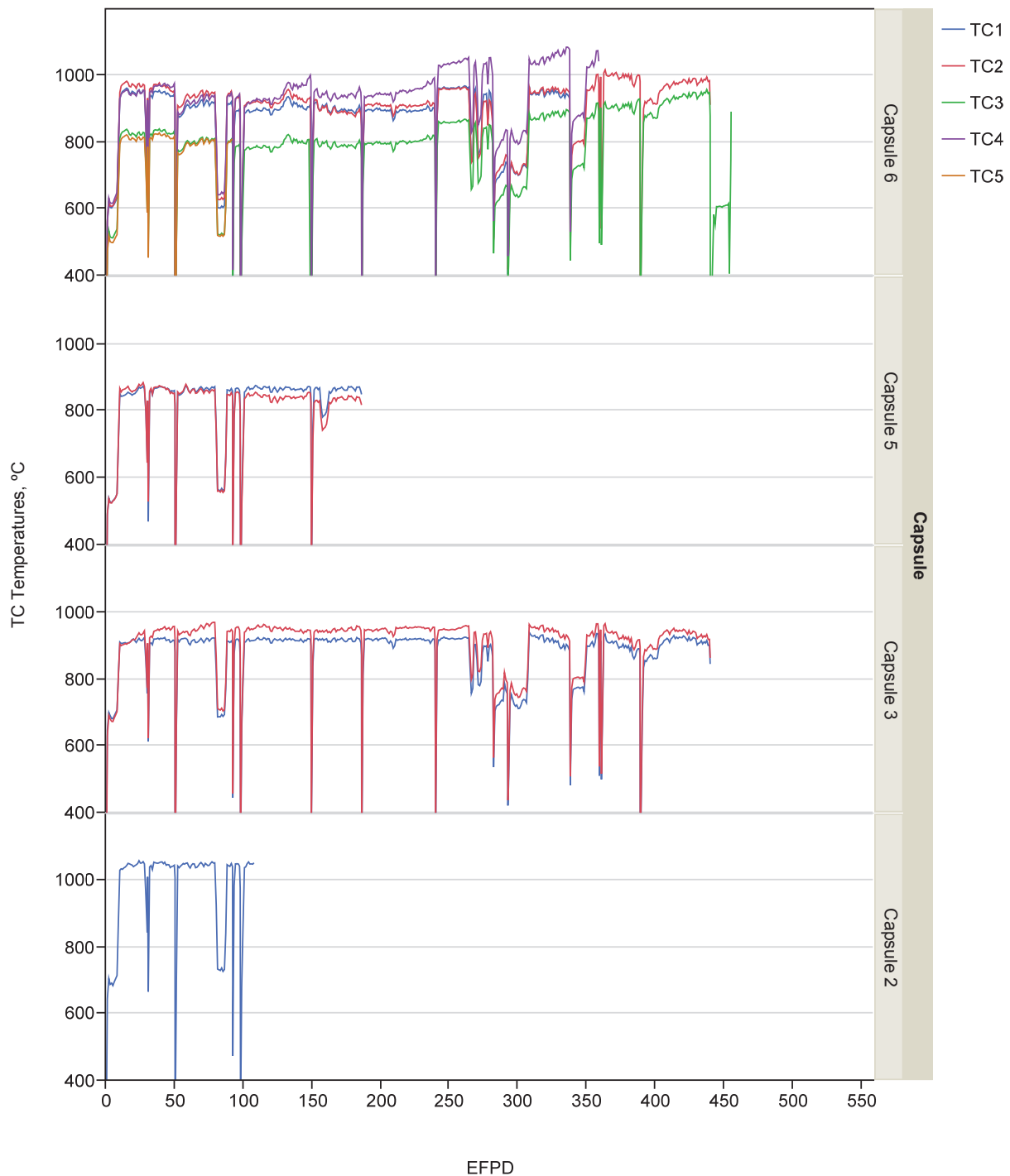


Figure 40. Recorded TC temperatures.

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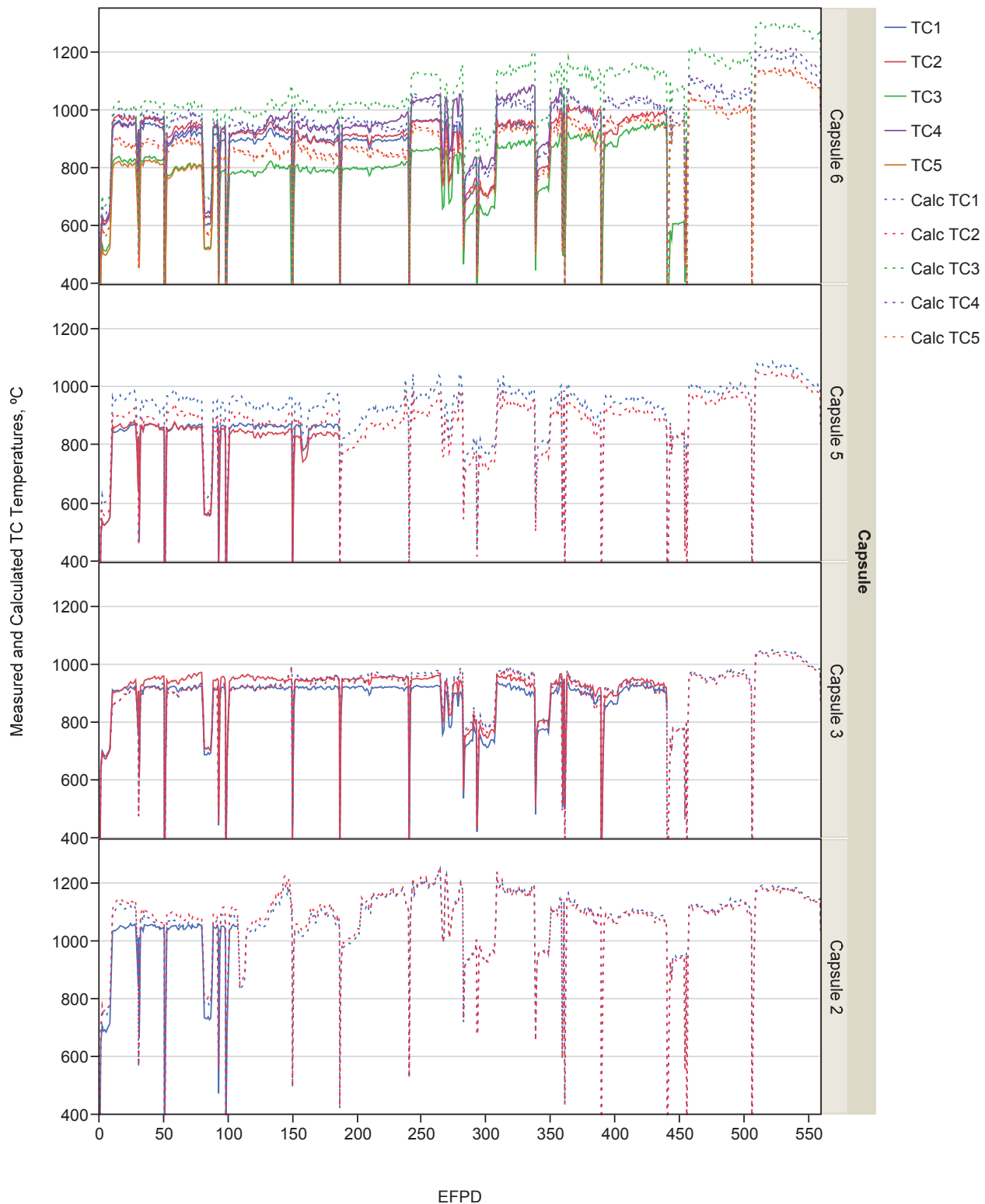


Figure 41. Measured and predicted TC temperatures.

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Measured temperatures come from Reference [12]. The temperature difference shown in Figure 42 is defined as measured minus calculated. Notice a ramp sloping upward for each different ATR cycle. This ramp can be explained by a difference between the N-16 power calculations and the water power calculator. The MCNP model uses the N-16 power. Except for TC3 in capsule 6, the error is within  $\pm 100^\circ\text{C}$  and, in many cases is within  $\pm 20$ - $50^\circ\text{C}$ . TC3 in capsule 6 should be showing high temperatures since it is located at the center of the holder, but it is not. It seems that TC3 is giving incorrect temperature readings. Capsule 5 shows very close agreement with measured minus calculated at about  $-20^\circ\text{C}$  average. Capsule 3 is almost right on with a very small discrepancy between the measured and calculated. Capsule 2 shows very close agreement for the short time the TC provided data. No effort was made to obtain better agreement between measured and calculated TC temperatures by adjusting the gas gaps to account for uncertainties. Unplanned gas mixing in the lead-out could explain some of this uncertainty.

### Time Average Volume Average Results

Figure 43 shows the TAVA, time average maximum, and time average minimum fuel temperatures for Capsules 6, 5, 3, and 2 varying with EFPD. The TAVA value is described as

$$TAVA = \frac{\sum T_{ave,i} \Delta t_i}{\sum \Delta t_i} \quad (6)$$

where  $T_{ave,i}$  is each finite element centroidal temperature described in Equation 5, and  $\Delta t_i$  is the time difference from one time step to the next. All capsules appear to be nearly level at the end of irradiation.

### End-of-Irradiation Results

Figure 44 shows the TAVA values for each fuel compact for each stack and capsule at the very end of irradiation. Stack 3 is noticeably cooler than stacks 1 or 2 because it is farther away from the core center. The top of Capsule 6 is plotted on the left side of the plot, while the bottom of Capsule 2 is on the right side of the plot. These final values (end of irradiation) of TAVA will be useful when doing post-irradiation examination of the AGR-2 experiment. Figure 45 shows the time average peak temperature for each fuel compact, while Figure 46 shows the time average minimum temperature for each fuel compact.

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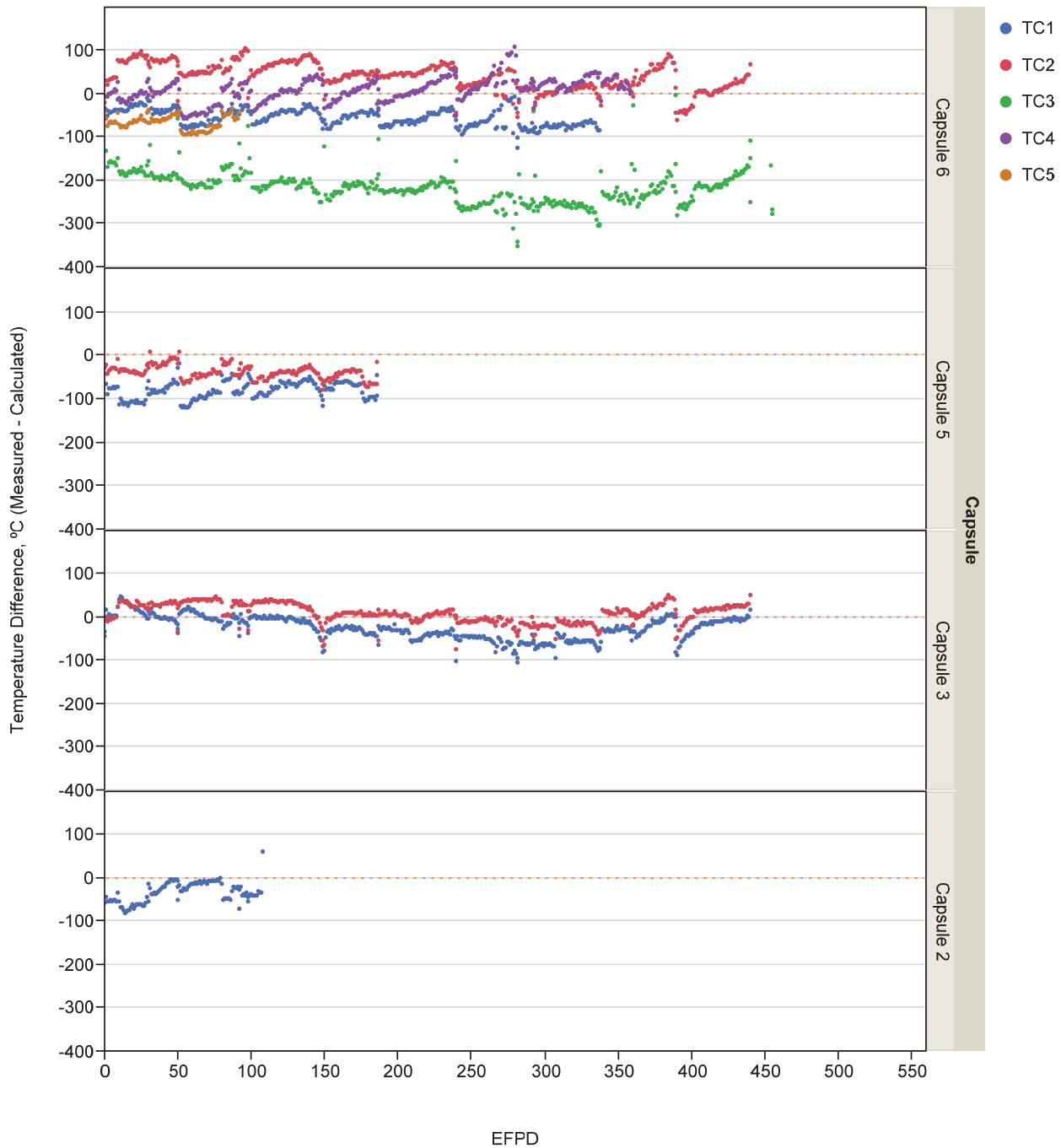


Figure 42. Difference between measured and predicted TC temperatures.

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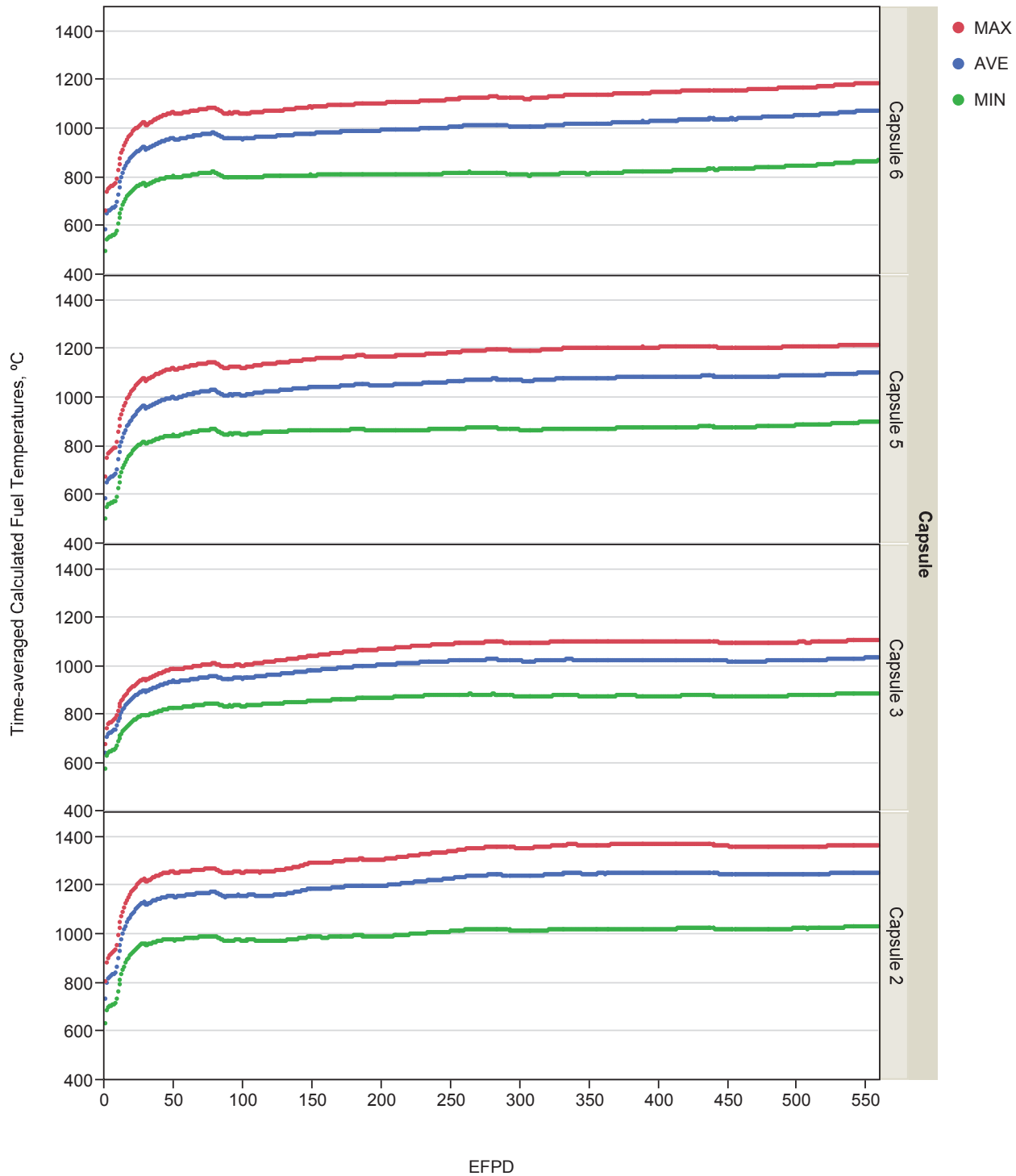


Figure 43. Calculated time average minimum, time average maximum, and TAVA fuel temperatures for Capsules 6, 5, 3, and 2.

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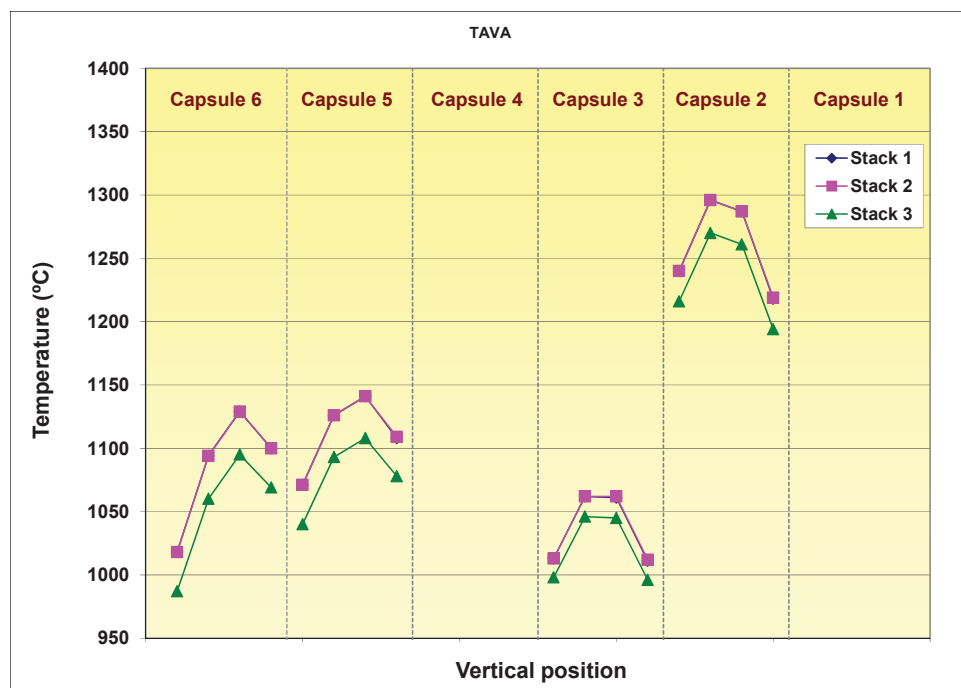


Figure 44. TAVA temperatures for fuel compacts 1 through 4 for all stacks and all capsules at the very end of irradiation.

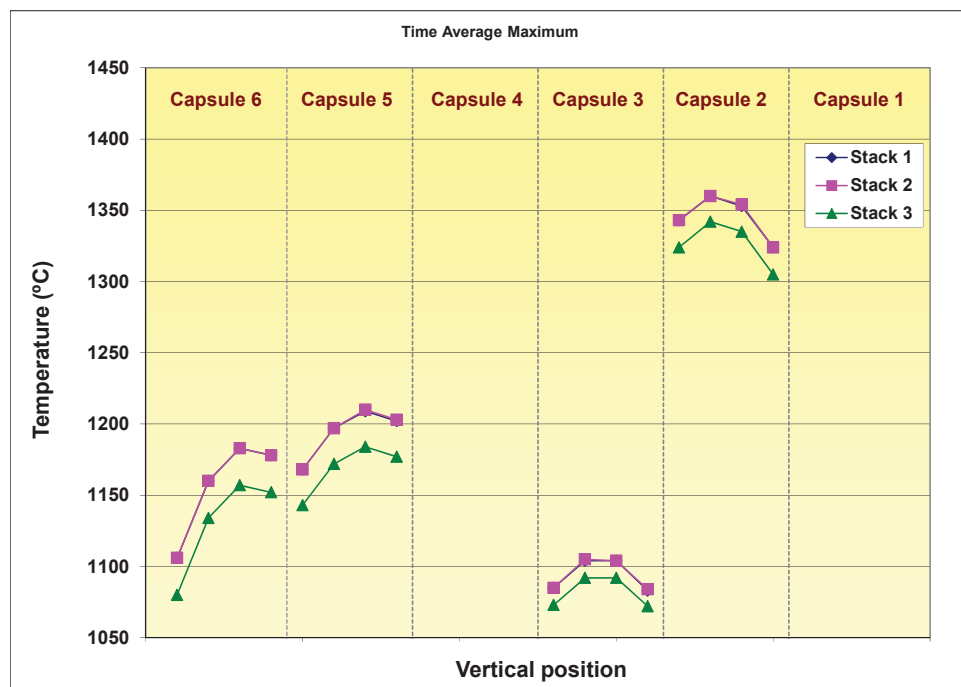


Figure 45. Time average peak temperatures for fuel compacts 1 through 4 for all stacks and all capsules at the very end of irradiation.

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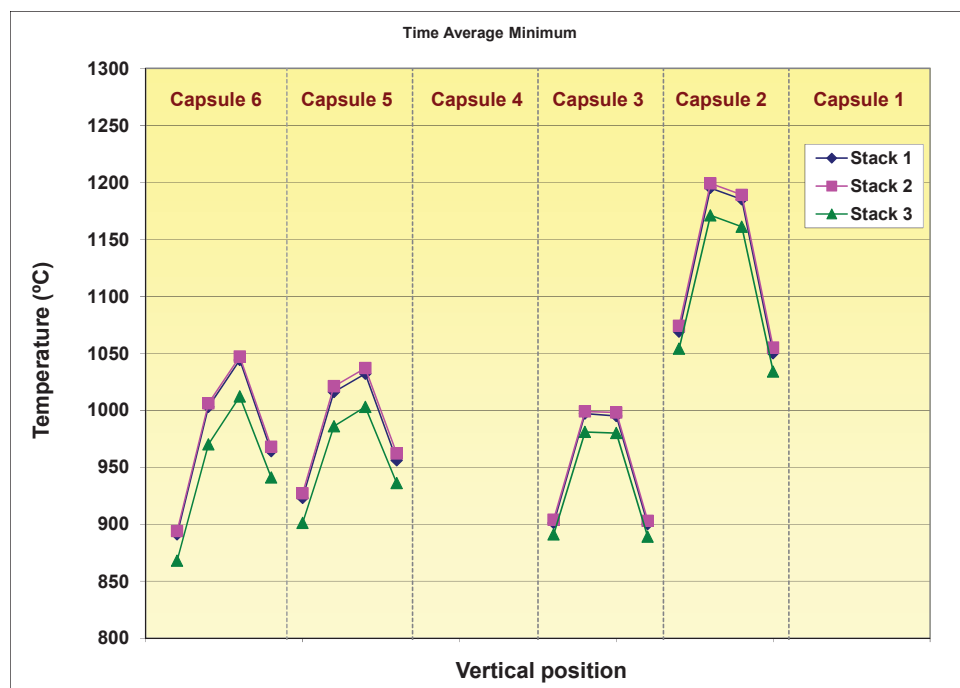


Figure 46. Time average minimum temperatures for fuel compacts 1 through 4 for all stacks and all capsules at the very end of irradiation.

Figures 47 through 49 show the percentage of the fuel exceeding the time average temperature varying with temperature for Capsules 6, 5, 3, and 2. For low temperatures, nearly all of the fuel exceeds the time average temperature, while the opposite is true for high temperatures. These calculations take into account the finite element volume for each finite element in each compact. They also take into account the number of partial and full days of power in the reactor.

Figures 50 through 52 show waterfall plots of the proportion of fuel greater than specified temperature bands varying with EFPD. These are useful to determine the volume of each fuel compact that was above different temperatures varying with EFPD. Capsules 6 and 5 are plotted together as they are both UCO fuel in the same temperature range. Capsule 3 is plotted separately because it is UO2 fuel. Capsule 2 is plotted separately since it is UCO fuel at a very high temperature.

Tables 3 and 4 show the TAVA, time average maximum, and time average minimum.

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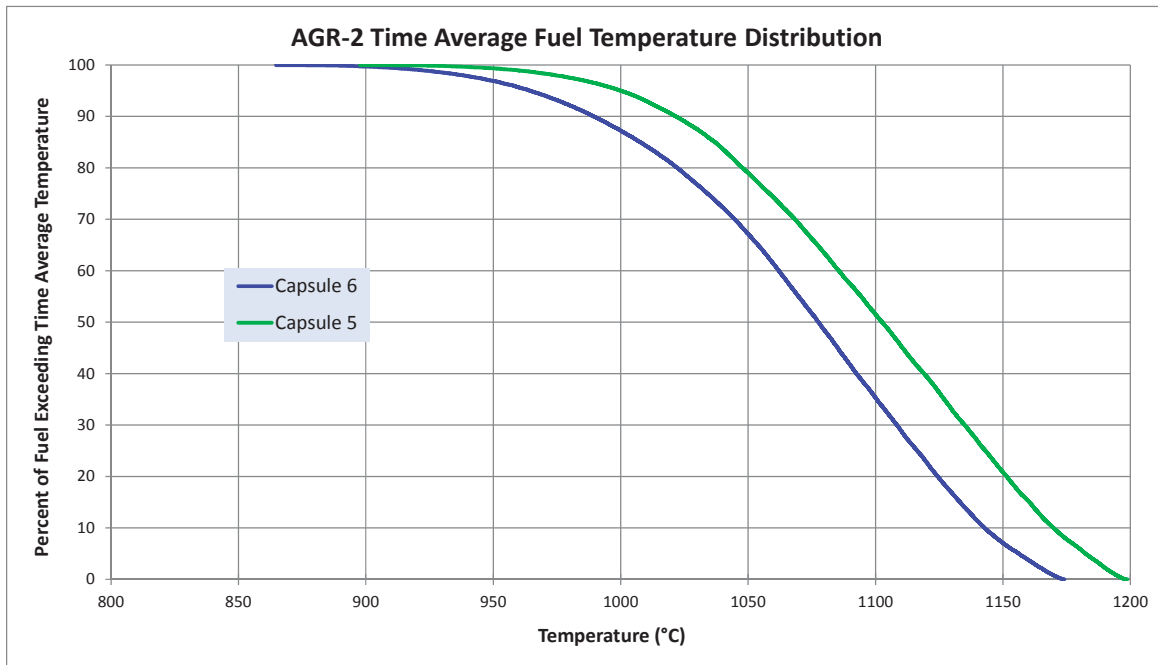


Figure 47. Percent of fuel exceeding time average temperature varying with temperature for Capsules 6 and 5.

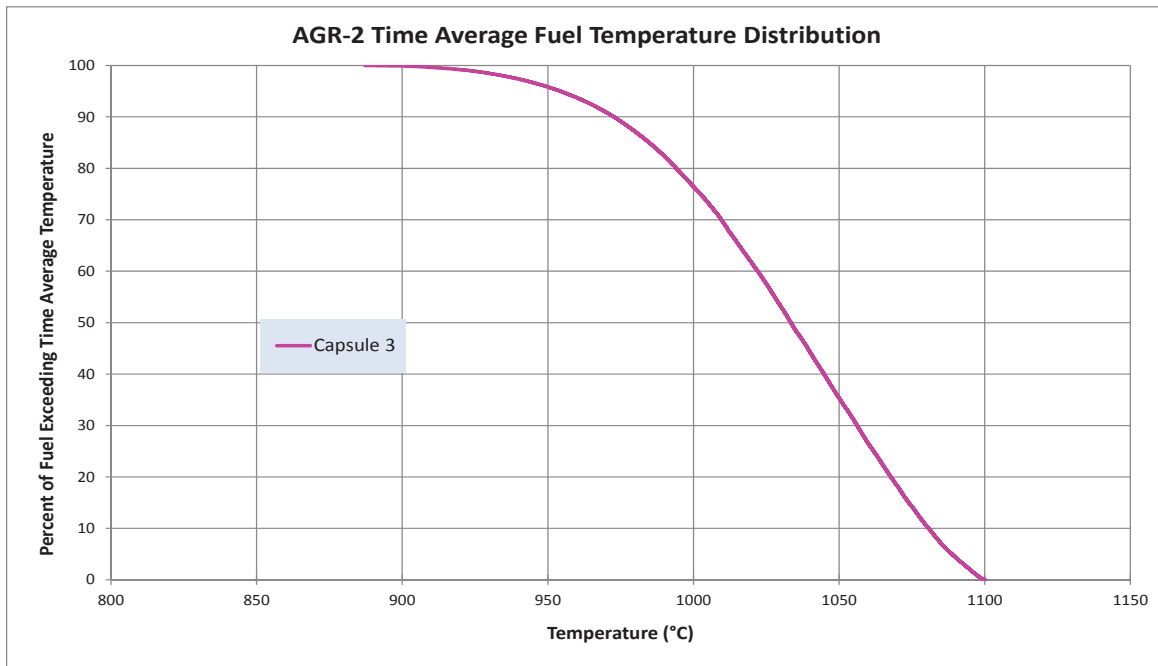


Figure 48. Percent of fuel exceeding time average temperature varying with temperature for Capsule 3.

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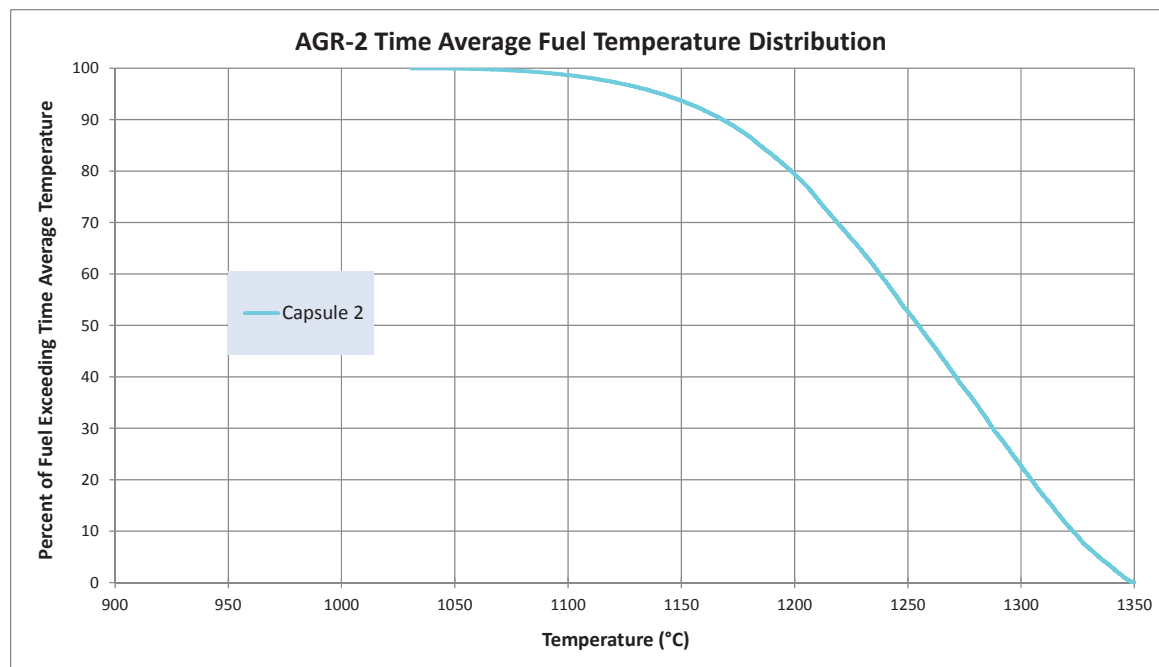


Figure 49. Percent of fuel exceeding time average temperature varying with temperature for Capsule 2.

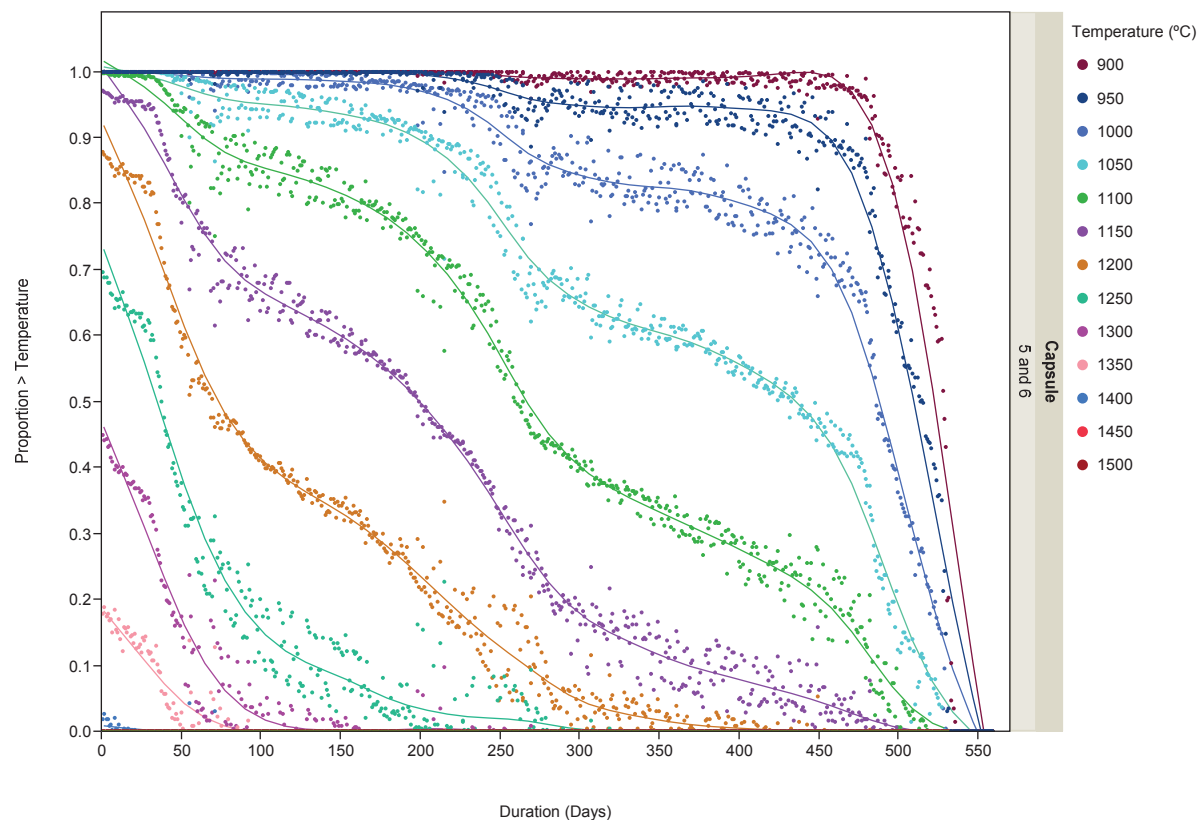


Figure 50. Waterfall plot of proportion of fuel greater than specified temperature bands varying with EFPD for Capsules 6 and 5.

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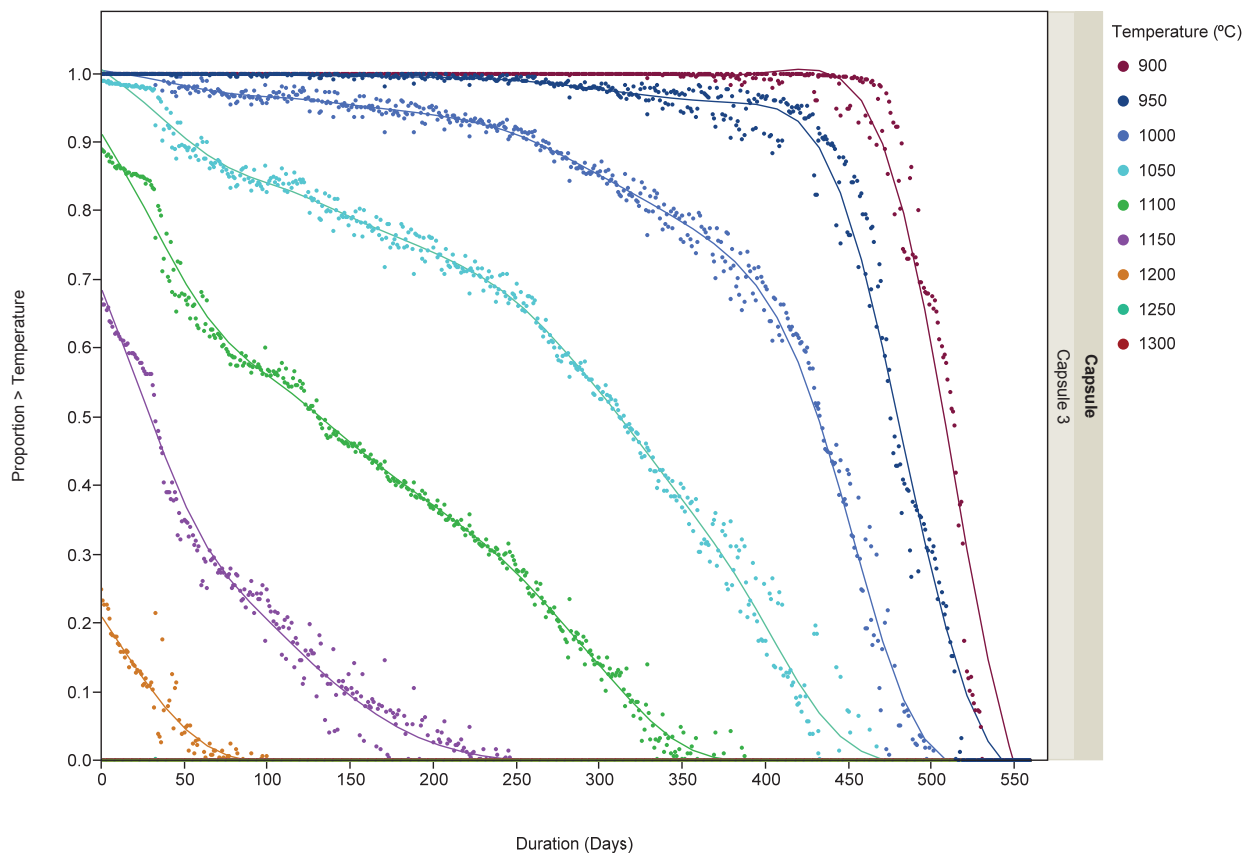


Figure 51. Waterfall plot of proportion of fuel greater than specified temperature bands varying with EFPD for Capsule 3.

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Rev. No.: 1

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Date: 08/13/2014

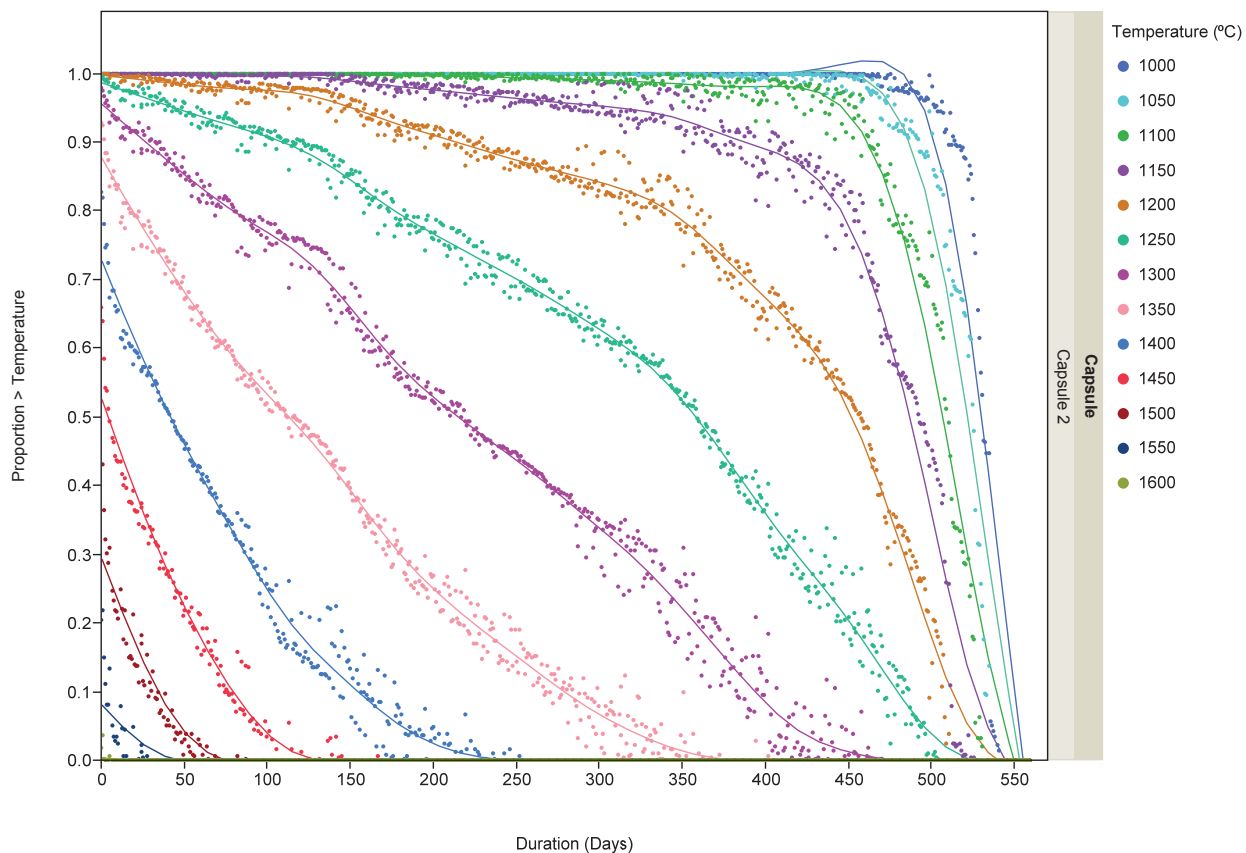


Figure 52. Waterfall plot of proportion of fuel greater than specified temperature bands varying with EFPD for Capsule 2.

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Table 3. Compact temperature data for Capsules 6 and 5 at the end of irradiation.

Capsule	Stack	Compact	TAVA Temperature (°C)	Time Average Minimum Temperature (°C)	Time Average Maximum Temperature (°C)
6 (top)	1	4	1018	891	1106
		3	1094	1003	1160
		2	1129	1044	1183
		1	1100	964	1178
	2	4	1018	894	1106
		3	1094	1006	1160
		2	1129	1047	1183
		1	1100	968	1178
	3	4	987	868	1080
		3	1060	970	1134
		2	1095	1012	1157
		1	1069	941	1152
All Capsule 6 Compacts			1074	868	1183
5	1	4	1071	923	1168
		3	1126	1016	1197
		2	1141	1032	1209
		1	1108	956	1202
	2	4	1071	927	1168
		3	1126	1021	1197
		2	1141	1037	1210
		1	1109	962	1203
	3	4	1040	901	1143
		3	1093	986	1172
		2	1108	1003	1184
		1	1078	936	1177
All Capsule 5 Compacts			1101	901	1210

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Table 4. Compact temperature data for Capsules 3 and 2 at the end of irradiation.

Capsule	Stack	Compact	TAVA Temperature (°C)	Time Average Minimum Temperature (°C)	Time Average Maximum Temperature (°C)
3	1	4	1013	901	1085
		3	1062	997	1104
		2	1061	995	1104
		1	1011	900	1083
	2	4	1013	904	1085
		3	1062	999	1105
		2	1062	998	1104
		1	1012	903	1084
	3	4	998	891	1073
		3	1046	981	1092
		2	1045	980	1092
		1	996	889	1072
All Capsule 3 Compacts			1032	889	1105
2	1	4	1240	1069	1343
		3	1296	1195	1360
		2	1287	1185	1353
		1	1218	1050	1324
	2	4	1240	1074	1343
		3	1296	1199	1360
		2	1287	1189	1354
		1	1219	1055	1324
	3	4	1216	1054	1324
		3	1270	1171	1342
		2	1261	1161	1335
		1	1194	1034	1305
All Capsule 2 Compacts			1252	1034	1360

## DATA RETENTION

All data files to produce the temperature results are on the high performance computer named Quark in the /home/haw/agr/agr2/dailycalcs/1st\_run/vargap directory. The NDMAS database has all of the heat rate data for all components and temperatures of all fuel compacts and neon fractions. Data will be retained on Quark for several years.

Appendix E has the entire data structure on Quark.

Each cycle directory has all of the input files and results for the calculations. The ABAQUS output files end in .dat and .fil. The TAVA data ends in .outc. Input that is added to the base file for daily heat rates, gas flows, and fluences end in .steps. Directory master contains the master file writer step\_writer\_agr2\_1st\_run.x that creates the .steps files. This master directory also contains agrcomp\_reader\_predictions.exe, which reads the .fil files and calculates the TAVA data and outputs the .outc files. Also included in the directory are the files in the AGR2 file directory that was set up special for this project /projects/agr/agr2. This area is shared between the physics calculations and the thermal analysis. The gas mixtures, compact heat rates, compact fluences, graphite heat rates, graphite fluences, and component heat rates all come from these files.

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## **CONCLUSIONS and RECOMMENDATIONS**

This report documents the results of thermal analyses to predict the daily as-run temperatures for the AGR-2 experiment. Control gas gaps and compact-graphite holder gas gaps were modeled to change with fast neutron fluence. Daily heat rates for each compact and component in the models were input from daily as-run physics analyses. Daily gas compositions and component fast neutron fluences were also input. Six different finite element models were created for the six different AGR-2 capsules. Each capsule had a different gas gap that was implemented to control the temperature of the experiment. Capsules on the top and bottom had larger gas gaps, while capsules in the middle were smaller.

Gas mixture thermal conductivity was implemented using the kinetic theory of gases. Fluence and temperature-dependent thermal conductivity was used for the graphite components and the fuel compacts. Radiation heat transfer was implemented.

Ten of the fourteen predicted temperatures were within 20 to 50 °C of the measured thermocouple temperatures, while three of the other four were within about 100°C. According to Fig 42, the error is within  $\pm 100^{\circ}\text{C}$  (except for TC3 in capsule 6,) and, in many cases, is within  $\pm 50^{\circ}\text{C}$ . All of the TCs failed during the experiment. Heat rates, and hence temperatures, were very sensitive to the outer shim control cylinders. TAVA temperature values were calculated in order to be used in post-irradiation examination and experiment analyses.

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## Appendix A

### ABAQUS Version 6.9-2 Validation Report on Quark

```
ABQ EXE: abq692
COMPUTER: quark_inel_gov
OS: Linux
OS TYPE: 2.6.37.6-0.20-default
t1
=====O
DB: Test-1
dictTest[Test-1].Keys: ['Grp1']
#####
      NT11-n325
Max error: 1.20% <-----
  Max1: 37.3320  Min1: 10.5200 Range: 26.8120
Abq Max2: 37.7813  Abq Min2: 10.6362 Range: 27.1451
      NT11-n281
Max error: 1.48% <-----
  Max1: 55.1070  Min1: 13.9970 Range: 41.1100
Abq Max2: 54.7760  Abq Min2: 14.2043 Range: 40.5717
=====
t2
=====
ODB: Test-2
dictTest[Test-2].Keys: ['Grp2', 'Grp1']
#####
      NT15-n61
Max error: 1.34% <-----
  Max1: 37.3320  Min1: 10.5200 Range: 26.8120
Abq Max2: 37.7366  Abq Min2: 10.6609 Range: 27.0756
#####
      NT11-n61
Max error: 1.54% <-----
  Max1: 55.1070  Min1: 13.9970 Range: 41.1100
Abq Max2: 54.7444  Abq Min2: 14.2131 Range: 40.5313
=====
t3
=====
ODB: Test-3
dictTest[Test-3].Keys: ['Grp1']
#####
      NT11-n130
Max error: 1.65% <-----
  Max1: 44.5920  Min1: 12.5210 Range: 32.0710
Abq Max2: 44.7825  Abq Min2: 12.7270 Range: 32.0555
      NT11-n59
Max error: 1.85% <-----
  Max1: 55.3390  Min1: 14.7770 Range: 40.5620
Abq Max2: 55.0396  Abq Min2: 15.0511 Range: 39.9885
=====
t4
=====
ODB: Test-4
dictTest[Test-4].Keys: ['Grp1']
#####
      NT11-n281
Error: 0.00% <-----
Ans: 13.7600  Abq: 13.7600
      NT11-n303
Error: 0.00% <-----
Ans: 11.3200  Abq: 11.3200
      NT11-n325
Error: 0.00% <-----
Ans: 4.0000  Abq: 4.0000
      NT11-n314
Error: 0.00% <-----
Ans: 8.2700  Abq: 8.2700
      NT11-n292
Error: 0.00% <-----
Ans: 13.1500  Abq: 13.1500
=====
```

```
t5
=====
ODB: Test-5
dictTest[Test-5].Keys: ['Grp3', 'Grp2', 'Grp1', 'Grp5', 'Grp4']
#####
      NT13-n62
Error: 0.00% <-----
Ans: 11.3200  Abq: 11.3200
#####
      NT12-n62
Error: 0.00% <-----
Ans: 13.1500  Abq: 13.1500
#####
      NT11-n62
Error: 0.00% <-----
Ans: 13.7600  Abq: 13.7600
#####
      NT15-n62
Error: 0.00% <-----
Ans: 4.0000  Abq: 4.0000
#####
      NT14-n62
Error: 0.00% <-----
Ans: 8.2700  Abq: 8.2700
=====
t6
=====
ODB: Test-6
dictTest[Test-6].Keys: ['Grp1']
#####
      NT11-n533
Max error: 0.39% <-----
  Max1: 80.7640  Min1: 61.8970 Range: 18.8670
Abq Max2: 80.4914  Abq Min2: 61.7364 Range: 18.7551
      NT11-n803
Max error: 0.38% <-----
  Max1: 94.5930  Min1: 71.5310 Range: 23.0620
Abq Max2: 94.3007  Abq Min2: 71.2781 Range: 23.0226
=====
t7
=====
ODB: Test-7
dictTest[Test-7].Keys: ['Grp1']
#####
      HFL-e56
Error: 0.19% <-----
Ans: -0.1700  Abq: -0.1697
=====
t8
=====
ODB: Test-8
dictTest[Test-8].Keys: ['Grp1']
#####
      HFL-e1121
Error: 1.74% <-----
Ans: 0.1710  Abq: 0.1740
      HFL-e3678
Error: 2.25% <-----
Ans: -0.1620  Abq: -0.1656
=====
t9
=====
ODB: Test-9
dictTest[Test-9].Keys: ['Grp1']
#####
      NT11-n13
```

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```

Error: 0.01% <-----
Ans: 50.0010 Abq: 50.0036
      NT11-n17
Error: 0.00% <-----
Ans: 55.5500 Abq: 55.5500
      NT11-n328
Error: 0.20% <-----
Ans: 51.6040 Abq: 51.7074
      NT11-n38
Error: 0.05% <-----
Ans: 50.0890 Abq: 50.1148
      NT11-n28
Error: 0.11% <-----
Ans: 50.7010 Abq: 50.7550
      NT11-n218
Error: 0.01% <-----
Ans: 50.0110 Abq: 50.0176
      NT11-n32
Error: 0.10% <-----
Ans: 50.3060 Abq: 50.3555
      NT11-n324
Error: 0.20% <-----
Ans: 52.4260 Abq: 52.5321
      NT11-n4
Error: 0.08% <-----
Ans: 51.0600 Abq: 51.1006
      NT11-n320
Error: 0.16% <-----
Ans: 53.6690 Abq: 53.7552
=====

```

```

t10
=====
ODB: Test-10
dictTest[Test-10].Keys: ['Grp1']
#### #####
      NT11-n325
Error: 0.15% <-----
Ans: 215.7130 Abq: 216.0345
=====

t11
=====
ODB: Test-11
dictTest[Test-11].Keys: ['Grp1']
#### #####
      HFL-e55
Error: 0.02% <-----
Ans: -5.5000 Abq: -5.4989
=====

t12
=====
ODB: Test-12
dictTest[Test-12].Keys: ['Grp1']
#### #####
      NT11-n336
Error: 0.00% <-----
Ans: 406.6667 Abq: 406.6667
=====

```

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## Appendix B

### Material Properties Used in ABAQUS

#### Capsule 2

```

**
** MATERIALS
**
*Material, name=BE
*Conductivity
0.001968, 100.
0.0001319, 1000.
*Density
0.066,
*Elastic
1e+06, 0.
*Expansion
1.333e-05,
*Specific Heat
0.5,
*Material, name=FUEL
*Conductivity, dependencies=2
0.0001884, 1472., 0., 0.
0.0001765, 1742., 0., 0.
0.0001692, 2012., 0., 0.
0.0001654, 2282., 0., 0.
0.0001648, 2642., 0., 0.
0.0001884, 1472., 1., 0.
0.0001765, 1742., 1., 0.
0.0001692, 2012., 1., 0.
0.0001654, 2282., 1., 0.
0.0001648, 2642., 1., 0.
0.0001546, 1472., 0., 0.5
0.0001548, 1742., 0., 0.5
0.0001566, 2012., 0., 0.5
0.0001603, 2282., 0., 0.5
0.0001695, 2642., 0., 0.5
0.0001546, 1472., 1., 0.5
0.0001548, 1742., 1., 0.5
0.0001566, 2012., 1., 0.5
0.0001603, 2282., 1., 0.5
0.0001695, 2642., 1., 0.5
0.0001326, 1472., 0., 1.
0.000139, 1742., 0., 1.
0.0001466, 2012., 0., 1.
0.0001559, 2282., 0., 1.
0.0001742, 2642., 0., 1.
0.0001326, 1472., 1., 1.
0.000139, 1742., 1., 1.
0.0001466, 2012., 1., 1.
0.0001559, 2282., 1., 1.
0.0001742, 2642., 1., 1.
0.0001078, 1472., 0., 2.
0.0001188, 1742., 0., 2.
0.0001319, 2012., 0., 2.
0.000149, 2282., 0., 2.
0.0001836, 2642., 0., 2.
0.0001078, 1472., 1., 2.
0.0001188, 1742., 1., 2.
0.0001319, 2012., 1., 2.
0.000149, 2282., 1., 2.
0.0001836, 2642., 1., 2.
9.549e-05, 1472., 0., 3.
0.0001068, 1742., 0., 3.
0.0001219, 2012., 0., 3.
0.0001439, 2282., 0., 3.
0.0001931, 2642., 0., 3.
9.549e-05, 1472., 1., 3.
0.0001068, 1742., 1., 3.
0.0001219, 2012., 1., 3.
0.0001439, 2282., 1., 3.
0.0001931, 2642., 1., 3.
8.811e-05, 1472., 0., 4.
9.892e-05, 1742., 0., 4.
0.0001147, 2012., 0., 4.
0.00014, 2282., 0., 4.
0.0002026, 2642., 0., 4.
8.811e-05, 1472., 1., 4.
9.892e-05, 1742., 1., 4.
0.0001147, 2012., 1., 4.
0.00014, 2282., 1., 4.
0.0002026, 2642., 1., 4.
8.27e-05, 1472., 0., 5.
9.296e-05, 1742., 0., 5.
0.000109, 2012., 0., 5.
0.0001371, 2282., 0., 5.
0.0002122, 2642., 0., 5.
8.27e-05, 1472., 1., 5.
9.296e-05, 1742., 1., 5.
0.000109, 2012., 1., 5.
0.0001371, 2282., 1., 5.
0.0002122, 2642., 1., 5.
*Density
0.000981,
*Expansion
3.88084e-06,
*Specific Heat
4.89,
*Material, name=GRAFOIL
*Conductivity, type=ORTHO
0.001852, 0.001852, 6.944e-05, 70.
0.0007716, 0.0007716, 3.858e-05, 1500.
0.0002315, 0.0002315, 3.858e-05, 3500.
*Density
0.0628,
*Specific Heat
0.3,
*Material, name=GRAPH
*Conductivity, dependencies=2
0.001095, 572., 0., 0.
0.0006021, 1292., 0., 0.
0.0005085, 1652., 0., 0.
0.0004282, 2282., 0., 0.
0.001095, 572., 1., 0.
0.0006021, 1292., 1., 0.
0.0005085, 1652., 1., 0.
0.0004282, 2282., 1., 0.
8.99e-05, 572., 0., 0.001
0.0002392, 1292., 0., 0.001
0.0002821, 1652., 0., 0.001
0.0003557, 2282., 0., 0.001
8.99e-05, 572., 1., 0.001
0.0002392, 1292., 1., 0.001
0.0002821, 1652., 1., 0.001
0.0003557, 2282., 1., 0.001
0.0001335, 572., 0., 0.01
0.000255, 1292., 0., 0.01
0.000292, 1652., 0., 0.01
0.0003589, 2282., 0., 0.01
0.0001335, 572., 1., 0.01
0.000255, 1292., 1., 0.01
0.000292, 1652., 1., 0.01
0.0003589, 2282., 1., 0.01
0.000177, 572., 0., 0.1
0.0002708, 1292., 0., 0.1
0.0003019, 1652., 0., 0.1
0.0003621, 2282., 0., 0.1
0.000177, 572., 1., 0.1
0.0002708, 1292., 1., 0.1
0.0003019, 1652., 1., 0.1
0.0003621, 2282., 1., 0.1
0.0002206, 572., 0., 1.
0.0002865, 1292., 0., 1.
0.0003117, 1652., 0., 1.
0.0003653, 2282., 0., 1.
0.0002206, 572., 1., 1.
0.0002865, 1292., 1., 1.
0.0003117, 1652., 1., 1.
0.0003653, 2282., 1., 1.
0.000251, 572., 0., 5.
0.0002976, 1292., 0., 5.
0.0003186, 1652., 0., 5.
0.0003675, 2282., 0., 5.
0.000251, 572., 1., 5.
0.0002976, 1292., 1., 5.
0.0003186, 1652., 1., 5.
0.0003675, 2282., 1., 5.
*Density
0.0628,
*Specific Heat
0.3,
*Material, name=GRAPH55
**** DPA = Fluence (n/m**2) X 8.23e-26 for graphite (Sterbentz
Letter)
**** based on k(irr)=((0.25-
0.00017*T(irr))*A*log(DPA)+0.000683*T(irr))*k(non)
**** A = -1.0, Temp in deg C for correlation
** 5.5% Boron Graphtec
** cond, temp, %Ne, Fluence

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```
*Conductivity, dependencies=2
0.001095, 572., 0., 0.
0.0006021, 1292., 0., 0.
0.0005085, 1652., 0., 0.
0.0004282, 2282., 0., 0.
0.001095, 572., 1., 0.
0.0006021, 1292., 1., 0.
0.0005085, 1652., 1., 0.
0.0004282, 2282., 1., 0.
0.0008961, 572., 0., 0.001
0.0005312, 1292., 0., 0.001
0.0004647, 1652., 0., 0.001
0.0004151, 2282., 0., 0.001
0.0008961, 572., 1., 0.001
0.0005312, 1292., 1., 0.001
0.0004647, 1652., 1., 0.001
0.0004151, 2282., 1., 0.001
0.0006783, 572., 0., 0.01
0.0004523, 1292., 0., 0.01
0.0004154, 1652., 0., 0.01
0.000399, 2282., 0., 0.01
0.0006783, 572., 1., 0.01
0.0004523, 1292., 1., 0.01
0.0004154, 1652., 1., 0.01
0.000399, 2282., 1., 0.01
0.0004605, 572., 0., 0.1
0.0003734, 1292., 0., 0.1
0.0003661, 1652., 0., 0.1
0.000383, 2282., 0., 0.1
0.0004605, 572., 1., 0.1
0.0003734, 1292., 1., 0.1
0.0003661, 1652., 1., 0.1
0.000383, 2282., 1., 0.1
0.0002427, 572., 0., 1.
0.0002945, 1292., 0., 1.
0.0003167, 1652., 0., 1.
0.0003669, 2282., 0., 1.
0.0002427, 572., 1., 1.
0.0002945, 1292., 1., 1.
0.0003167, 1652., 1., 1.
0.0003669, 2282., 1., 1.
9.042e-05, 572., 0., 5.
0.0002394, 1292., 0., 5.
0.0002823, 1652., 0., 5.
0.0003557, 2282., 0., 5.
9.042e-05, 572., 1., 5.
0.0002394, 1292., 1., 5.
0.0002823, 1652., 1., 5.
0.0003557, 2282., 1., 5.
*Material, name=GRAPH70
**** DPA = Fluence (n/m**2) X 8.23e-26 for graphite (Sterbentz
Letter)
**** based on k(irr)=(0.25-
0.00017*T(irr))*A*log(DPA)+0.000683*T(irr))*k(non)
**** A = -1.0, Temp in deg C for correlation
** 7.0% Boron Graphtec
** cond, temp, %Ne, Fluence
*Conductivity, dependencies=2
0.0007085, 572., 0., 0.
0.0004738, 1292., 0., 0.
0.0003962, 1652., 0., 0.
0.0003359, 2282., 0., 0.
0.0007085, 572., 1., 0.
0.0004738, 1292., 1., 0.
0.0003962, 1652., 1., 0.
0.0003359, 2282., 1., 0.
0.0005801, 572., 0., 0.001
0.000418, 1292., 0., 0.001
0.000362, 1652., 0., 0.001
0.0003257, 2282., 0., 0.001
0.0005801, 572., 1., 0.001
0.000418, 1292., 1., 0.001
0.000362, 1652., 1., 0.001
0.0003257, 2282., 1., 0.001
0.0004391, 572., 0., 0.01
0.0003559, 1292., 0., 0.01
0.0003236, 1652., 0., 0.01
0.0003131, 2282., 0., 0.01
0.0004391, 572., 1., 0.01
0.0003559, 1292., 1., 0.01
0.0003236, 1652., 1., 0.01
0.0003131, 2282., 1., 0.01
0.0002981, 572., 0., 0.1
0.0002938, 1292., 0., 0.1
0.0002852, 1652., 0., 0.1
0.0003005, 2282., 0., 0.1
0.0002981, 572., 1., 0.1
0.0002938, 1292., 1., 0.1
0.0002852, 1652., 1., 0.1
0.0003005, 2282., 1., 0.1
0.0001571, 572., 0., 1.
0.0002318, 1292., 0., 1.
0.0002468, 1652., 0., 1.
0.0002879, 2282., 0., 1.
0.0001571, 572., 1., 1.
0.0002318, 1292., 1., 1.
0.0002468, 1652., 1., 1.
0.0002879, 2282., 1., 1.
5.853e-05, 572., 0., 5.
0.0001884, 1292., 0., 5.
0.0002199, 1652., 0., 5.
0.0002791, 2282., 0., 5.
5.853e-05, 572., 1., 5.
0.0001884, 1292., 1., 5.
0.0002199, 1652., 1., 5.
0.0002791, 2282., 1., 5.
*Material, name=HAF
*Conductivity
0.0003079, 80.,
0.0002986, 260.,
0.0002847, 620.,
0.0002778, 980.
*Density
0.48,
*Specific Heat
0.035,
*Material, name=HE-NE
*Conductivity, dependencies=1
2.077e-06, 80., 0.
2.91e-06, 440., 0.
3.679e-06, 800., 0.
4.403e-06, 1160., 0.
5.334e-06, 1652., 0.
6.157e-06, 2120., 0.
6.962e-06, 2600., 0.
1.761e-06, 80., 0.2
2.438e-06, 440., 0.2
3.059e-06, 800., 0.2
3.639e-06, 1160., 0.2
4.379e-06, 1652., 0.2
5.024e-06, 2120., 0.2
5.659e-06, 2600., 0.2
1.457e-06, 80., 0.4
2.001e-06, 440., 0.4
2.495e-06, 800., 0.4
2.954e-06, 1160., 0.4
3.537e-06, 1652., 0.4
4.041e-06, 2120., 0.4
4.542e-06, 2600., 0.4
1.172e-06, 80., 0.6
1.602e-06, 440., 0.6
1.99e-06, 800., 0.6
2.347e-06, 1160., 0.6
2.801e-06, 1652., 0.6
3.193e-06, 2120., 0.6
3.589e-06, 2600., 0.6
9.062e-07, 80., 0.8
1.241e-06, 440., 0.8
1.54e-06, 800., 0.8
1.812e-06, 1160., 0.8
2.158e-06, 1652., 0.8
2.46e-06, 2120., 0.8
2.772e-06, 2600., 0.8
6.598e-07, 80., 1.
9.14e-07, 440., 1.
1.137e-06, 800., 1.
1.338e-06, 1160., 1.
1.593e-06, 1652., 1.
1.822e-06, 2120., 1.
2.067e-06, 2600., 1.
*Density
2.89e-05,
*Elastic
1000., 0.
*Expansion
1.35e-08,
*Specific Heat
0.245,
*Material, name=HE-NER
*Conductivity, dependencies=1
2.088e-06, 80., 0.
2.976e-06, 440., 0.
3.763e-06, 800., 0.
4.485e-06, 1160., 0.
6.11e-06, 2060., 0.
1.769e-06, 80., 0.2
2.485e-06, 440., 0.2
3.118e-06, 800., 0.2
3.688e-06, 1160., 0.2
4.966e-06, 2060., 0.2
1.463e-06, 80., 0.4
2.031e-06, 440., 0.4
2.533e-06, 800., 0.4
2.978e-06, 1160., 0.4
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3.975e-06,2060., 0.4	7.43e-07,1160., 0.6, 4.
1.176e-06, 80., 0.6	8.866e-07,1652., 0.6, 4.
1.618e-06, 440., 0.6	1.011e-06,2120., 0.6, 4.
2.011e-06, 800., 0.6	1.136e-06,2600., 0.6, 4.
2.351e-06,1160., 0.6	2.868e-07, 80., 0.8, 4.
3.122e-06,2060., 0.6	3.927e-07, 440., 0.8, 4.
9.082e-07, 80., 0.8	4.873e-07, 800., 0.8, 4.
1.245e-06, 440., 0.8	5.735e-07,1160., 0.8, 4.
1.545e-06, 800., 0.8	6.83e-07,1652., 0.8, 4.
1.798e-06,1160., 0.8	7.785e-07,2120., 0.8, 4.
2.385e-06,2060., 0.8	8.774e-07,2600., 0.8, 4.
6.6e-07, 80., 1.	2.088e-07, 80., 1., 4.
9.077e-07, 440., 1.	2.893e-07, 440., 1., 4.
1.13e-06, 800., 1.	3.599e-07, 800., 1., 4.
1.309e-06,1160., 1.	4.235e-07,1160., 1., 4.
1.744e-06,2060., 1.	5.043e-07,1652., 1., 4.
*Density	5.768e-07,2120., 1., 4.
2.89e-05,	6.542e-07,2600., 1., 4.
*Elastic	
1000.,0.	*Density
*Expansion	2.89e-05,
1.35e-08,	*Elastic
*Specific Heat	1000.,0.
0.245,	*Expansion
*Material, name=HE-NE_Gas_Control	1.35e-08,
*Conductivity, dependencies=2	*Specific Heat
7.622e-07, 80., 0., 0.	0.245,
1.068e-06, 440., 0., 0.	*Material, name=HELIUM
1.35e-06, 800., 0., 0.	*Conductivity
1.616e-06,1160., 0., 0.	6.6e-07, 80.
1.957e-06,1652., 0., 0.	7.899e-07, 260.
2.259e-06,2120., 0., 0.	9.077e-07, 440.
2.555e-06,2600., 0., 0.	1.028e-06, 620.
6.462e-07, 80., 0.2, 0.	1.13e-06, 800.
8.948e-07, 440., 0.2, 0.	1.224e-06, 980.
1.123e-06, 800., 0.2, 0.	1.309e-06,1160.
1.335e-06,1160., 0.2, 0.	1.4e-06,1340.
1.607e-06,1652., 0.2, 0.	1.493e-06,1520.
1.844e-06,2120., 0.2, 0.	1.581e-06,1700.
2.077e-06,2600., 0.2, 0.	1.665e-06,1880.
5.348e-07, 80., 0.4, 0.	1.744e-06,2060.
7.341e-07, 440., 0.4, 0.	*Density
9.157e-07, 800., 0.4, 0.	2.89e-05,
1.084e-06,1160., 0.4, 0.	*Elastic
1.298e-06,1652., 0.4, 0.	1000.,0.
1.483e-06,2120., 0.4, 0.	*Expansion
1.667e-06,2600., 0.4, 0.	1.35e-08,
4.301e-07, 80., 0.6, 0.	*Specific Heat
5.878e-07, 440., 0.6, 0.	0.245,
7.304e-07, 800., 0.6, 0.	*Material, name=INSL
8.614e-07,1160., 0.6, 0.	*Conductivity
1.028e-06,1652., 0.6, 0.	6.6e-07, 80.
1.172e-06,2120., 0.6, 0.	7.899e-07, 260.
1.317e-06,2600., 0.6, 0.	9.077e-07, 440.
3.325e-07, 80., 0.8, 0.	1.028e-06, 620.
4.552e-07, 440., 0.8, 0.	1.13e-06, 800.
5.65e-07, 800., 0.8, 0.	1.224e-06, 980.
6.649e-07,1160., 0.8, 0.	1.309e-06,1160.
7.918e-07,1652., 0.8, 0.	1.4e-06,1340.
9.026e-07,2120., 0.8, 0.	1.493e-06,1520.
1.017e-06,2600., 0.8, 0.	1.581e-06,1700.
2.421e-07, 80., 1., 0.	1.665e-06,1880.
3.354e-07, 440., 1., 0.	1.744e-06,2060.
4.173e-07, 800., 1., 0.	*Density
4.91e-07,1160., 1., 0.	0.0404,
5.847e-07,1652., 1., 0.	*Specific Heat
6.688e-07,2120., 1., 0.	0.17,
7.585e-07,2600., 1., 0.	*Material, name=MIX
6.574e-07, 80., 0., 4.	*Conductivity
9.21e-07, 440., 0., 4.	0.00147, 93.3
1.164e-06, 800., 0., 4.	0.000579, 304.4
1.394e-06,1160., 0., 4.	0.0004327, 610.
1.688e-06,1652., 0., 4.	0.0003462, 826.7
1.949e-06,2120., 0., 4.	0.0002596, 1204.4
2.203e-06,2600., 0., 4.	*Density
5.574e-07, 80., 0.2, 4.	0.00796,
7.717e-07, 440., 0.2, 4.	*Elastic
9.683e-07, 800., 0.2, 4.	2.88e+07,0.
1.152e-06,1160., 0.2, 4.	*Expansion
1.386e-06,1652., 0.2, 4.	8.89e-06, 100.
1.59e-06,2120., 0.2, 4.	9.56e-06, 600.
1.791e-06,2600., 0.2, 4.	1.094e-05,1000.
4.613e-07, 80., 0.4, 4.	*Specific Heat
6.332e-07, 440., 0.4, 4.	0.502,
7.898e-07, 800., 0.4, 4.	*Material, name=NIOB
9.349e-07,1160., 0.4, 4.	*Conductivity
1.12e-06,1652., 0.4, 4.	0.0006329, 180.
1.279e-06,2120., 0.4, 4.	0.0006824, 451.
1.438e-06,2600., 0.4, 4.	0.0007399, 975.
3.71e-07, 80., 0.6, 4.	0.0007453,1312.
5.07e-07, 440., 0.6, 4.	0.0008804,2098.
6.3e-07, 800., 0.6, 4.	*Density
	0.309,

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*Expansion      5.28e-06, 0., 80., , 1.
8.5e-06,        5.28e-06, 0.3, 80., , 1.
*Specific Heat  7.262e-06, 0., 440., , 1.
0.063,          7.262e-06, 0.3, 440., , 1.
*Material, name=SS      9.04e-06, 0., 800., , 1.
*Conductivity      9.04e-06, 0.3, 800., , 1.
0.0002069, 100.      1.047e-05, 0., 1160., , 1.
0.0003206,1300.      1.047e-05, 0.3, 1160., , 1.
*Density      1.396e-05, 0., 2060., , 1.
0.286,        1.396e-05, 0.3, 2060., , 1.
*Elastic      0., 0.3003, 2060., , 1.
1e+06,0.
*Expansion      *Gap Radiation
8.85e-06, 212.      1., 1.
1.148e-05,1112.      1., 0.
*Specific Heat      1., 1.
0.12,          0., 1.001
*Material, name=WATER      *Surface Interaction, name=CondRad_Graph_SS
*Conductivity      1.,
0.1,          *Gap Conductance, dependencies=1
*Density      5.495e-05, 0., 80., , 0.
0.00112287,      5.495e-05, 0.3, 80., , 0.
*Expansion      7.832e-05, 0., 440., , 0.
1e-05, 40.      7.832e-05, 0.3, 440., , 0.
0.000328,160.      9.902e-05, 0., 800., , 0.
0.000694,360.      9.902e-05, 0.3, 800., , 0.
0.00236,600.      0.000118, 0., 1160., , 0.
*Specific Heat      0.000118, 0.3, 1160., , 0.
1.,          0.0001608, 0., 2060., , 0.
**          0.0001608, 0.3, 2060., , 0.
**          4.656e-05, 0., 80., , 0.2
** INTERACTION PROPERTIES      4.656e-05, 0.3, 80., , 0.2
**          6.539e-05, 0., 440., , 0.2
*Surface Interaction, name=Compacts-Spacers      6.539e-05, 0.3, 440., , 0.2
1.,          8.205e-05, 0., 800., , 0.2
*Gap Radiation      8.205e-05, 0.3, 800., , 0.2
1., 1.          9.706e-05, 0., 1160., , 0.2
1., 0.          9.706e-05, 0.3, 1160., , 0.2
1., 1.          0.0001307, 0., 2060., , 0.2
0., 1.001      0.0001307, 0.3, 2060., , 0.2
*Surface Interaction, name=CondRad_Graph_Graph      3.851e-05, 0., 80., , 0.4
1.,          3.851e-05, 0.3, 80., , 0.4
*Gap Conductance, dependencies=1      5.344e-05, 0., 440., , 0.4
1.671e-05, 0., 80., , 0.      5.344e-05, 0.3, 440., , 0.4
1.671e-05, 0.3, 80., , 0.      6.667e-05, 0., 800., , 0.4
2.381e-05, 0., 440., , 0.      6.667e-05, 0.3, 800., , 0.4
2.381e-05, 0.3, 440., , 0.      7.837e-05, 0., 1160., , 0.4
3.01e-05, 0., 800., , 0.      7.837e-05, 0.3, 1160., , 0.4
3.01e-05, 0.3, 800., , 0.      0.0001046, 0., 2060., , 0.4
3.588e-05, 0., 1160., , 0.      0.0001046, 0.3, 2060., , 0.4
3.588e-05, 0.3, 1160., , 0.      3.094e-05, 0., 80., , 0.6
4.888e-05, 0., 2060., , 0.      3.094e-05, 0.3, 80., , 0.6
4.888e-05, 0.3, 2060., , 0.      4.258e-05, 0., 440., , 0.6
1.416e-05, 0., 80., , 0.2      4.258e-05, 0.3, 440., , 0.6
1.416e-05, 0.3, 80., , 0.2      5.292e-05, 0., 800., , 0.6
1.988e-05, 0., 440., , 0.2      5.292e-05, 0.3, 800., , 0.6
1.988e-05, 0.3, 440., , 0.2      6.187e-05, 0., 1160., , 0.6
2.494e-05, 0., 800., , 0.2      6.187e-05, 0.3, 1160., , 0.6
2.494e-05, 0.3, 800., , 0.2      8.216e-05, 0., 2060., , 0.6
2.951e-05, 0., 1160., , 0.2      8.216e-05, 0.3, 2060., , 0.6
2.951e-05, 0.3, 1160., , 0.2      2.39e-05, 0., 80., , 0.8
3.973e-05, 0., 2060., , 0.2      2.39e-05, 0.3, 80., , 0.8
3.973e-05, 0.3, 2060., , 0.2      3.276e-05, 0., 440., , 0.8
1.171e-05, 0., 80., , 0.4      3.276e-05, 0.3, 440., , 0.8
1.171e-05, 0.3, 80., , 0.4      4.067e-05, 0., 800., , 0.8
1.625e-05, 0., 440., , 0.4      4.067e-05, 0.3, 800., , 0.8
1.625e-05, 0.3, 440., , 0.4      4.732e-05, 0., 1160., , 0.8
2.027e-05, 0., 800., , 0.4      4.732e-05, 0.3, 1160., , 0.8
2.027e-05, 0.3, 800., , 0.4      6.276e-05, 0., 2060., , 0.8
2.382e-05, 0., 1160., , 0.4      6.276e-05, 0.3, 2060., , 0.8
2.382e-05, 0.3, 1160., , 0.4      1.737e-05, 0., 80., , 1.
3.18e-05, 0., 2060., , 0.4      1.737e-05, 0.3, 80., , 1.
3.18e-05, 0.3, 2060., , 0.4      2.389e-05, 0., 440., , 1.
9.407e-06, 0., 80., , 0.6      2.389e-05, 0.3, 440., , 1.
9.407e-06, 0.3, 80., , 0.6      2.974e-05, 0., 800., , 1.
1.294e-05, 0., 440., , 0.6      2.974e-05, 0.3, 800., , 1.
1.294e-05, 0.3, 440., , 0.6      3.446e-05, 0., 1160., , 1.
1.609e-05, 0., 800., , 0.6      3.446e-05, 0.3, 1160., , 1.
1.609e-05, 0.3, 800., , 0.6      4.591e-05, 0., 2060., , 1.
1.881e-05, 0., 1160., , 0.6      4.591e-05, 0.3, 2060., , 1.
1.881e-05, 0.3, 1160., , 0.6      0., 0.3003, 2060., , 1.
2.498e-05, 0., 2060., , 0.6
2.498e-05, 0.3, 2060., , 0.6
7.265e-06, 0., 80., , 0.8
7.265e-06, 0.3, 80., , 0.8
9.959e-06, 0., 440., , 0.8
9.959e-06, 0.3, 440., , 0.8
1.236e-05, 0., 800., , 0.8
1.236e-05, 0.3, 800., , 0.8
1.438e-05, 0., 1160., , 0.8
1.438e-05, 0.3, 1160., , 0.8
1.908e-05, 0., 2060., , 0.8
1.908e-05, 0.3, 2060., , 0.8
*Gap Radiation      *Gap Radiation
1., 1.      1., 0.4
1., 0.      1., 0.
1., 1.      1., 1.
0., 1.001      0., 1.001
*Surface Interaction, name=Graphrad_Ssrad      *Surface Interaction, name=Graphrad_Ssrad
1.,          1.,
*Gap Radiation      *Gap Radiation
1., 0.4      1., 0.4
1., 0.      1., 0.
1., 1.      1., 1.
0., 1.001      0., 1.001
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*Surface Interaction, name=Graphrad_Tuberad	0.002027,	0.3,	2120.,	0.6,	0.
1.,	0.002279,	0.,	2600.,	0.6,	0.
*Gap Radiation	0.002279,	0.3,	2600.,	0.6,	0.
1., 1.	0.0005753,	0.,	80.,	0.8,	0.
1., 0.	0.0005753,	0.3,	80.,	0.8,	0.
1., 1.	0.0007876,	0.,	440.,	0.8,	0.
0., 1.001	0.0007876,	0.3,	440.,	0.8,	0.
*Surface Interaction, name=INT1	0.0009775,	0.,	800.,	0.8,	0.
1.,	0.0009775,	0.3,	800.,	0.8,	0.
*Gap Conductance	0.00115,	0.,	1160.,	0.8,	0.
0.00694, 0., 0.	0.00115,	0.3,	1160.,	0.8,	0.
0.00694, 0.3, 0.	0.00137,	0.,	1652.,	0.8,	0.
0.00694, 0., 2000.	0.00137,	0.3,	1652.,	0.8,	0.
0.00694, 0.3, 2000.	0.001562,	0.,	2120.,	0.8,	0.
*Surface Interaction, name=INT2	0.001562,	0.3,	2120.,	0.8,	0.
1.,	0.00176,	0.,	2600.,	0.8,	0.
*Gap Conductance	0.00176,	0.3,	2600.,	0.8,	0.
0.03, 0., 0.	0.0004189,	0.,	80.,	1.,	0.
0.03, 0.3, 0.	0.0004189,	0.3,	80.,	1.,	0.
0.03, 0., 158.	0.0005803,	0.,	440.,	1.,	0.
0.03, 0.3, 158.	0.0005803,	0.3,	440.,	1.,	0.
0.03, 0., 968.	0.000722,	0.,	800.,	1.,	0.
0.03, 0.3, 968.	0.000722,	0.3,	800.,	1.,	0.
0.03, 0., 2000.	0.0008494,	0.,	1160.,	1.,	0.
0.03, 0.3, 2000.	0.0008494,	0.3,	1160.,	1.,	0.
*Surface Interaction, name=INT3	0.001012,	0.,	1652.,	1.,	0.
1.,	0.001012,	0.3,	1652.,	1.,	0.
*Gap Conductance	0.001157,	0.,	2120.,	1.,	0.
0.028, 0., 0.	0.001157,	0.3,	2120.,	1.,	0.
0.028, 0.3, 0.	0.001312,	0.,	2600.,	1.,	0.
0.028, 0., 158.	0.001312,	0.3,	2600.,	1.,	0.
0.028, 0.3, 158.	0.0008504,	0.,	80.,	0.,	1.
0.028, 0., 968.	0.0008504,	0.3,	80.,	0.,	1.
0.028, 0.3, 968.	0.001191,	0.,	440.,	0.,	1.
0.028, 0., 2000.	0.001191,	0.3,	440.,	0.,	1.
0.028, 0.3, 2000.	0.001506,	0.,	800.,	0.,	1.
*Surface Interaction, name=INT4	0.001506,	0.3,	800.,	0.,	1.
1.,	0.001803,	0.,	1160.,	0.,	1.
*Gap Conductance, dependencies=2	0.001803,	0.3,	1160.,	0.,	1.
0.001319, 0., 80., , 0., 0.	0.002184,	0.,	1652.,	0.,	1.
0.001319, 0.3, 80., , 0., 0.	0.002184,	0.3,	1652.,	0.,	1.
0.001848, 0., 440., , 0., 0.	0.002521,	0.,	2120.,	0.,	1.
0.001848, 0.3, 440., , 0., 0.	0.002521,	0.3,	2120.,	0.,	1.
0.002336, 0., 800., , 0., 0.	0.00285,	0.,	2600.,	0.,	1.
0.002336, 0.3, 800., , 0., 0.	0.00285,	0.3,	2600.,	0.,	1.
0.002795, 0., 1160., , 0., 0.	0.000721,	0.,	80.,	0.2,	1.
0.002795, 0.3, 1160., , 0., 0.	0.000721,	0.3,	80.,	0.2,	1.
0.003387, 0., 1652., , 0., 0.	0.0009984,	0.,	440.,	0.2,	1.
0.003387, 0.3, 1652., , 0., 0.	0.0009984,	0.3,	440.,	0.2,	1.
0.003909, 0., 2120., , 0., 0.	0.001253,	0.,	800.,	0.2,	1.
0.003909, 0.3, 2120., , 0., 0.	0.001253,	0.3,	800.,	0.2,	1.
0.00442, 0., 2600., , 0., 0.	0.00149,	0.,	1160.,	0.2,	1.
0.00442, 0.3, 2600., , 0., 0.	0.00149,	0.3,	1160.,	0.2,	1.
0.001118, 0., 80., , 0.2, 0.	0.001793,	0.,	1652.,	0.2,	1.
0.001118, 0.3, 80., , 0.2, 0.	0.001793,	0.3,	1652.,	0.2,	1.
0.001548, 0., 440., , 0.2, 0.	0.002057,	0.,	2120.,	0.2,	1.
0.001548, 0.3, 440., , 0.2, 0.	0.002057,	0.3,	2120.,	0.2,	1.
0.001942, 0., 800., , 0.2, 0.	0.002317,	0.,	2600.,	0.2,	1.
0.001942, 0.3, 800., , 0.2, 0.	0.002317,	0.3,	2600.,	0.2,	1.
0.00231, 0., 1160., , 0.2, 0.	0.0005968,	0.,	80.,	0.4,	1.
0.00231, 0.3, 1160., , 0.2, 0.	0.0005968,	0.3,	80.,	0.4,	1.
0.002781, 0., 1652., , 0.2, 0.	0.0008191,	0.,	440.,	0.4,	1.
0.002781, 0.3, 1652., , 0.2, 0.	0.0008191,	0.3,	440.,	0.4,	1.
0.00319, 0., 2120., , 0.2, 0.	0.001022,	0.,	800.,	0.4,	1.
0.00319, 0.3, 2120., , 0.2, 0.	0.001022,	0.3,	800.,	0.4,	1.
0.003593, 0., 2600., , 0.2, 0.	0.001209,	0.,	1160.,	0.4,	1.
0.003593, 0.3, 2600., , 0.2, 0.	0.001209,	0.3,	1160.,	0.4,	1.
0.0009253, 0., 80., , 0.4, 0.	0.001448,	0.,	1652.,	0.4,	1.
0.0009253, 0.3, 80., , 0.4, 0.	0.001448,	0.3,	1652.,	0.4,	1.
0.00127, 0., 440., , 0.4, 0.	0.001654,	0.,	2120.,	0.4,	1.
0.00127, 0.3, 440., , 0.4, 0.	0.001654,	0.3,	2120.,	0.4,	1.
0.001584, 0., 800., , 0.4, 0.	0.00186,	0.,	2600.,	0.4,	1.
0.001584, 0.3, 800., , 0.4, 0.	0.00186,	0.3,	2600.,	0.4,	1.
0.001875, 0., 1160., , 0.4, 0.	0.0004799,	0.,	80.,	0.6,	1.
0.001875, 0.3, 1160., , 0.4, 0.	0.0004799,	0.3,	80.,	0.6,	1.
0.002246, 0., 1652., , 0.4, 0.	0.0006558,	0.,	440.,	0.6,	1.
0.002246, 0.3, 1652., , 0.4, 0.	0.0006558,	0.3,	440.,	0.6,	1.
0.002566, 0., 2120., , 0.4, 0.	0.0008149,	0.,	800.,	0.6,	1.
0.002566, 0.3, 2120., , 0.4, 0.	0.0008149,	0.3,	800.,	0.6,	1.
0.002884, 0., 2600., , 0.4, 0.	0.0009611,	0.,	1160.,	0.6,	1.
0.002884, 0.3, 2600., , 0.4, 0.	0.0009611,	0.3,	1160.,	0.6,	1.
0.0007441, 0., 80., , 0.6, 0.	0.001147,	0.,	1652.,	0.6,	1.
0.0007441, 0.3, 80., , 0.6, 0.	0.001147,	0.3,	1652.,	0.6,	1.
0.001017, 0., 440., , 0.6, 0.	0.001307,	0.,	2120.,	0.6,	1.
0.001017, 0.3, 440., , 0.6, 0.	0.001307,	0.3,	2120.,	0.6,	1.
0.001264, 0., 800., , 0.6, 0.	0.001469,	0.,	2600.,	0.6,	1.
0.001264, 0.3, 800., , 0.6, 0.	0.001469,	0.3,	2600.,	0.6,	1.
0.00149, 0., 1160., , 0.6, 0.	0.000371,	0.,	80.,	0.8,	1.
0.00149, 0.3, 1160., , 0.6, 0.	0.000371,	0.3,	80.,	0.8,	1.
0.001778, 0., 1652., , 0.6, 0.	0.000508,	0.,	440.,	0.8,	1.
0.001778, 0.3, 1652., , 0.6, 0.	0.000508,	0.3,	440.,	0.8,	1.
0.002027, 0., 2120., , 0.6, 0.	0.0006304,	0.,	800.,	0.8,	1.

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0.0006304,	0.3,	800.,	0.8,	1.	0.001004,	0.3,	2600.,	0.8,	2.
0.0007419,	0.,	1160.,	0.8,	1.	0.0002388,	0.,	80.,	1.,	2.
0.0007419,	0.3,	1160.,	0.8,	1.	0.0002388,	0.3,	80.,	1.,	2.
0.0008835,	0.,	1652.,	0.8,	1.	0.0003309,	0.,	440.,	1.,	2.
0.0008835,	0.3,	1652.,	0.8,	1.	0.0003309,	0.3,	440.,	1.,	2.
0.001007,	0.,	2120.,	0.8,	1.	0.0004117,	0.,	800.,	1.,	2.
0.001007,	0.3,	2120.,	0.8,	1.	0.0004117,	0.3,	800.,	1.,	2.
0.001135,	0.,	2600.,	0.8,	1.	0.0004843,	0.,	1160.,	1.,	2.
0.001135,	0.3,	2600.,	0.8,	1.	0.0004843,	0.3,	1160.,	1.,	2.
0.0002701,	0.,	80.,	1.,	1.	0.0005768,	0.,	1652.,	1.,	2.
0.0002701,	0.3,	80.,	1.,	1.	0.0005768,	0.3,	1652.,	1.,	2.
0.0003742,	0.,	440.,	1.,	1.	0.0006598,	0.,	2120.,	1.,	2.
0.0003742,	0.3,	440.,	1.,	1.	0.0006598,	0.3,	2120.,	1.,	2.
0.0004656,	0.,	800.,	1.,	1.	0.0007483,	0.,	2600.,	1.,	2.
0.0004656,	0.3,	800.,	1.,	1.	0.0007483,	0.3,	2600.,	1.,	2.
0.0005478,	0.,	1160.,	1.,	1.	0.0008082,	0.,	80.,	0.,	3.
0.0005478,	0.3,	1160.,	1.,	1.	0.0008082,	0.3,	80.,	0.,	3.
0.0006524,	0.,	1652.,	1.,	1.	0.001132,	0.,	440.,	0.,	3.
0.0006524,	0.3,	1652.,	1.,	1.	0.001132,	0.3,	440.,	0.,	3.
0.0007462,	0.,	2120.,	1.,	1.	0.001432,	0.,	800.,	0.,	3.
0.0007462,	0.3,	2120.,	1.,	1.	0.001432,	0.3,	800.,	0.,	3.
0.0008463,	0.,	2600.,	1.,	1.	0.001713,	0.,	1160.,	0.,	3.
0.0008463,	0.3,	2600.,	1.,	1.	0.001713,	0.3,	1160.,	0.,	3.
0.0007519,	0.,	80.,	0.,	2.	0.002076,	0.,	1652.,	0.,	3.
0.0007519,	0.3,	80.,	0.,	2.	0.002076,	0.3,	1652.,	0.,	3.
0.001053,	0.,	440.,	0.,	2.	0.002396,	0.,	2120.,	0.,	3.
0.001053,	0.3,	440.,	0.,	2.	0.002396,	0.3,	2120.,	0.,	3.
0.001332,	0.,	800.,	0.,	2.	0.002709,	0.,	2600.,	0.,	3.
0.001332,	0.3,	800.,	0.,	2.	0.002709,	0.3,	2600.,	0.,	3.
0.001594,	0.,	1160.,	0.,	2.	0.0006852,	0.,	80.,	0.2,	3.
0.001594,	0.3,	1160.,	0.,	2.	0.0006852,	0.3,	80.,	0.2,	3.
0.001931,	0.,	1652.,	0.,	2.	0.0009488,	0.,	440.,	0.2,	3.
0.001931,	0.3,	1652.,	0.,	2.	0.0009488,	0.3,	440.,	0.2,	3.
0.002229,	0.,	2120.,	0.,	2.	0.00119,	0.,	800.,	0.2,	3.
0.002229,	0.3,	2120.,	0.,	2.	0.00119,	0.3,	800.,	0.2,	3.
0.00252,	0.,	2600.,	0.,	2.	0.001416,	0.,	1160.,	0.2,	3.
0.00252,	0.3,	2600.,	0.,	2.	0.001416,	0.3,	1160.,	0.2,	3.
0.0006375,	0.,	80.,	0.2,	2.	0.001704,	0.,	1652.,	0.2,	3.
0.0006375,	0.3,	80.,	0.2,	2.	0.001704,	0.3,	1652.,	0.2,	3.
0.0008827,	0.,	440.,	0.2,	2.	0.001955,	0.,	2120.,	0.2,	3.
0.0008827,	0.3,	440.,	0.2,	2.	0.001955,	0.3,	2120.,	0.2,	3.
0.001107,	0.,	800.,	0.2,	2.	0.002202,	0.,	2600.,	0.2,	3.
0.001107,	0.3,	800.,	0.2,	2.	0.002202,	0.3,	2600.,	0.2,	3.
0.001317,	0.,	1160.,	0.2,	2.	0.0005671,	0.,	80.,	0.4,	3.
0.001317,	0.3,	1160.,	0.2,	2.	0.0005671,	0.3,	80.,	0.4,	3.
0.001585,	0.,	1652.,	0.2,	2.	0.0007784,	0.,	440.,	0.4,	3.
0.001585,	0.3,	1652.,	0.2,	2.	0.0007784,	0.3,	440.,	0.4,	3.
0.001819,	0.,	2120.,	0.2,	2.	0.000971,	0.,	800.,	0.4,	3.
0.001819,	0.3,	2120.,	0.2,	2.	0.000971,	0.3,	800.,	0.4,	3.
0.002049,	0.,	2600.,	0.2,	2.	0.001149,	0.,	1160.,	0.4,	3.
0.002049,	0.3,	2600.,	0.2,	2.	0.001149,	0.3,	1160.,	0.4,	3.
0.0005276,	0.,	80.,	0.4,	2.	0.001376,	0.,	1652.,	0.4,	3.
0.0005276,	0.3,	80.,	0.4,	2.	0.001376,	0.3,	1652.,	0.4,	3.
0.0007242,	0.,	440.,	0.4,	2.	0.001572,	0.,	2120.,	0.4,	3.
0.0007242,	0.3,	440.,	0.4,	2.	0.001572,	0.3,	2120.,	0.4,	3.
0.0009034,	0.,	800.,	0.4,	2.	0.001767,	0.,	2600.,	0.4,	3.
0.0009034,	0.3,	800.,	0.4,	2.	0.001767,	0.3,	2600.,	0.4,	3.
0.001069,	0.,	1160.,	0.4,	2.	0.000456,	0.,	80.,	0.6,	3.
0.001069,	0.3,	1160.,	0.4,	2.	0.000456,	0.3,	80.,	0.6,	3.
0.00128,	0.,	1652.,	0.4,	2.	0.0006232,	0.,	440.,	0.6,	3.
0.00128,	0.3,	1652.,	0.4,	2.	0.0006232,	0.3,	440.,	0.6,	3.
0.001463,	0.,	2120.,	0.4,	2.	0.0007745,	0.,	800.,	0.6,	3.
0.001463,	0.3,	2120.,	0.4,	2.	0.0007745,	0.3,	800.,	0.6,	3.
0.001644,	0.,	2600.,	0.4,	2.	0.0009134,	0.,	1160.,	0.6,	3.
0.001644,	0.3,	2600.,	0.4,	2.	0.0009134,	0.3,	1160.,	0.6,	3.
0.0004243,	0.,	80.,	0.6,	2.	0.00109,	0.,	1652.,	0.6,	3.
0.0004243,	0.3,	80.,	0.6,	2.	0.00109,	0.3,	1652.,	0.6,	3.
0.0005798,	0.,	440.,	0.6,	2.	0.001242,	0.,	2120.,	0.6,	3.
0.0005798,	0.3,	440.,	0.6,	2.	0.001242,	0.3,	2120.,	0.6,	3.
0.0007205,	0.,	800.,	0.6,	2.	0.001396,	0.,	2600.,	0.6,	3.
0.0007205,	0.3,	800.,	0.6,	2.	0.001396,	0.3,	2600.,	0.6,	3.
0.0008498,	0.,	1160.,	0.6,	2.	0.0003526,	0.,	80.,	0.8,	3.
0.0008498,	0.3,	1160.,	0.6,	2.	0.0003526,	0.3,	80.,	0.8,	3.
0.001014,	0.,	1652.,	0.6,	2.	0.0004827,	0.,	440.,	0.8,	3.
0.001014,	0.3,	1652.,	0.6,	2.	0.0004827,	0.3,	440.,	0.8,	3.
0.001156,	0.,	2120.,	0.6,	2.	0.0005991,	0.,	800.,	0.8,	3.
0.001156,	0.3,	2120.,	0.6,	2.	0.0005991,	0.3,	800.,	0.8,	3.
0.001299,	0.,	2600.,	0.6,	2.	0.000705,	0.,	1160.,	0.8,	3.
0.001299,	0.3,	2600.,	0.6,	2.	0.000705,	0.3,	1160.,	0.8,	3.
0.0003281,	0.,	80.,	0.8,	2.	0.0008396,	0.,	1652.,	0.8,	3.
0.0003281,	0.3,	80.,	0.8,	2.	0.0008396,	0.3,	1652.,	0.8,	3.
0.0004491,	0.,	440.,	0.8,	2.	0.0009571,	0.,	2120.,	0.8,	3.
0.0004491,	0.3,	440.,	0.8,	2.	0.0009571,	0.3,	2120.,	0.8,	3.
0.0005574,	0.,	800.,	0.8,	2.	0.001079,	0.,	2600.,	0.8,	3.
0.0005574,	0.3,	800.,	0.8,	2.	0.001079,	0.3,	2600.,	0.8,	3.
0.0006559,	0.,	1160.,	0.8,	2.	0.0002567,	0.,	80.,	1.,	3.
0.0006559,	0.3,	1160.,	0.8,	2.	0.0002567,	0.3,	80.,	1.,	3.
0.0007811,	0.,	1652.,	0.8,	2.	0.0003556,	0.,	440.,	1.,	3.
0.0007811,	0.3,	1652.,	0.8,	2.	0.0003556,	0.3,	440.,	1.,	3.
0.0008904,	0.,	2120.,	0.8,	2.	0.0004425,	0.,	800.,	1.,	3.
0.0008904,	0.3,	2120.,	0.8,	2.	0.0004425,	0.3,	800.,	1.,	3.
0.001004,	0.,	2600.,	0.8,	2.	0.0005206,	0.,	1160.,	1.,	3.

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0.0005206, 0.3, 1160., , 1., 3.  
 0.00062, 0., 1652., , 1., 3.  
 0.00062, 0.3, 1652., , 1., 3.  
 0.0007092, 0., 2120., , 1., 3.  
 0.0007092, 0.3, 2120., , 1., 3.  
 0.0008043, 0., 2600., , 1., 3.  
 0.0008043, 0.3, 2600., , 1., 3.  
 0.001029, 0., 80., , 0., 4.  
 0.001029, 0.3, 80., , 0., 4.  
 0.001442, 0., 440., , 0., 4.  
 0.001442, 0.3, 440., , 0., 4.  
 0.001823, 0., 800., , 0., 4.  
 0.001823, 0.3, 800., , 0., 4.  
 0.002181, 0., 1160., , 0., 4.  
 0.002181, 0.3, 1160., , 0., 4.  
 0.002643, 0., 1652., , 0., 4.  
 0.002643, 0.3, 1652., , 0., 4.  
 0.003051, 0., 2120., , 0., 4.  
 0.003051, 0.3, 2120., , 0., 4.  
 0.003449, 0., 2600., , 0., 4.  
 0.003449, 0.3, 2600., , 0., 4.  
 0.0008725, 0., 80., , 0.2, 4.  
 0.0008725, 0.3, 80., , 0.2, 4.  
 0.001208, 0., 440., , 0.2, 4.  
 0.001208, 0.3, 440., , 0.2, 4.  
 0.001516, 0., 800., , 0.2, 4.  
 0.001516, 0.3, 800., , 0.2, 4.  
 0.001803, 0., 1160., , 0.2, 4.  
 0.001803, 0.3, 1160., , 0.2, 4.  
 0.00217, 0., 1652., , 0.2, 4.  
 0.00217, 0.3, 1652., , 0.2, 4.  
 0.002489, 0., 2120., , 0.2, 4.  
 0.002489, 0.3, 2120., , 0.2, 4.  
 0.002804, 0., 2600., , 0.2, 4.  
 0.002804, 0.3, 2600., , 0.2, 4.  
 0.0007221, 0., 80., , 0.4, 4.  
 0.0007221, 0.3, 80., , 0.4, 4.  
 0.0009912, 0., 440., , 0.4, 4.  
 0.0009912, 0.3, 440., , 0.4, 4.  
 0.001236, 0., 800., , 0.4, 4.  
 0.001236, 0.3, 800., , 0.4, 4.  
 0.001463, 0., 1160., , 0.4, 4.  
 0.001463, 0.3, 1160., , 0.4, 4.  
 0.001752, 0., 1652., , 0.4, 4.  
 0.001752, 0.3, 1652., , 0.4, 4.  
 0.002002, 0., 2120., , 0.4, 4.  
 0.002002, 0.3, 2120., , 0.4, 4.  
 0.00225, 0., 2600., , 0.4, 4.  
 0.00225, 0.3, 2600., , 0.4, 4.  
 0.0005807, 0., 80., , 0.6, 4.  
 0.0005807, 0.3, 80., , 0.6, 4.  
 0.0007936, 0., 440., , 0.6, 4.  
 0.0007936, 0.3, 440., , 0.6, 4.  
 0.0009861, 0., 800., , 0.6, 4.  
 0.0009861, 0.3, 800., , 0.6, 4.  
 0.001163, 0., 1160., , 0.6, 4.  
 0.001163, 0.3, 1160., , 0.6, 4.  
 0.001388, 0., 1652., , 0.6, 4.  
 0.001388, 0.3, 1652., , 0.6, 4.  
 0.001582, 0., 2120., , 0.6, 4.  
 0.001582, 0.3, 2120., , 0.6, 4.  
 0.001778, 0., 2600., , 0.6, 4.  
 0.001778, 0.3, 2600., , 0.6, 4.  
 0.000449, 0., 80., , 0.8, 4.  
 0.000449, 0.3, 80., , 0.8, 4.  
 0.0006147, 0., 440., , 0.8, 4.  
 0.0006147, 0.3, 440., , 0.8, 4.  
 0.0007628, 0., 800., , 0.8, 4.  
 0.0007628, 0.3, 800., , 0.8, 4.  
 0.0008977, 0., 1160., , 0.8, 4.  
 0.0008977, 0.3, 1160., , 0.8, 4.  
 0.001069, 0., 1652., , 0.8, 4.  
 0.001069, 0.3, 1652., , 0.8, 4.  
 0.001219, 0., 2120., , 0.8, 4.  
 0.001219, 0.3, 2120., , 0.8, 4.  
 0.001373, 0., 2600., , 0.8, 4.  
 0.001373, 0.3, 2600., , 0.8, 4.  
 0.0003269, 0., 80., , 1., 4.  
 0.0003269, 0.3, 80., , 1., 4.  
 0.0004528, 0., 440., , 1., 4.  
 0.0004528, 0.3, 440., , 1., 4.  
 0.0005634, 0., 800., , 1., 4.  
 0.0005634, 0.3, 800., , 1., 4.  
 0.0006629, 0., 1160., , 1., 4.  
 0.0006629, 0.3, 1160., , 1., 4.  
 0.0007895, 0., 1652., , 1., 4.  
 0.0007895, 0.3, 1652., , 1., 4.  
 0.000903, 0., 2120., , 1., 4.  
 0.000903, 0.3, 2120., , 1., 4.  
 0.001024, 0., 2600., , 1., 4.  
 0.001024, 0.3, 2600., , 1., 4.  
 0., 0.3003, 2600., , 1., 4.

\*Gap Radiation  
 1., 1.  
 1., 0.  
 1., 1.  
 0., 1.001  
 \*Surface Interaction, name=Ssrad\_Tuberad  
 1.,  
 \*Gap Radiation  
 1., 1.  
 1., 0.  
 1., 1.  
 0., 1.001  
 \*\*

**Capsule 3 Control Gas Gap**

\*Material, name=HE-NE\_Gas\_Control

\*Conductivity, dependencies=2

6.7e-07, 80., 0., 0.  
 9.387e-07, 440., 0., 0.  
 1.187e-06, 800., 0., 0.  
 1.42e-06, 1160., 0., 0.  
 1.721e-06, 1652., 0., 0.  
 1.986e-06, 2120., 0., 0.  
 2.246e-06, 2600., 0., 0.  
 5.68e-07, 80., 0.2, 0.  
 7.865e-07, 440., 0.2, 0.  
 9.868e-07, 800., 0.2, 0.  
 1.174e-06, 1160., 0.2, 0.  
 1.413e-06, 1652., 0.2, 0.  
 1.621e-06, 2120., 0.2, 0.  
 1.825e-06, 2600., 0.2, 0.  
 4.701e-07, 80., 0.4, 0.  
 6.453e-07, 440., 0.4, 0.  
 8.05e-07, 800., 0.4, 0.  
 9.528e-07, 1160., 0.4, 0.  
 1.141e-06, 1652., 0.4, 0.  
 1.303e-06, 2120., 0.4, 0.  
 1.465e-06, 2600., 0.4, 0.  
 3.781e-07, 80., 0.6, 0.  
 5.167e-07, 440., 0.6, 0.  
 6.42e-07, 800., 0.6, 0.  
 7.572e-07, 1160., 0.6, 0.  
 9.035e-07, 1652., 0.6, 0.  
 1.03e-06, 2120., 0.6, 0.  
 1.158e-06, 2600., 0.6, 0.  
 2.923e-07, 80., 0.8, 0.  
 4.002e-07, 440., 0.8, 0.  
 4.966e-07, 800., 0.8, 0.  
 5.845e-07, 1160., 0.8, 0.  
 6.96e-07, 1652., 0.8, 0.  
 7.934e-07, 2120., 0.8, 0.  
 8.942e-07, 2600., 0.8, 0.  
 2.128e-07, 80., 1., 0.  
 2.948e-07, 440., 1., 0.  
 3.668e-07, 800., 1., 0.  
 4.316e-07, 1160., 1., 0.  
 5.14e-07, 1652., 1., 0.  
 5.879e-07, 2120., 1., 0.  
 6.668e-07, 2600., 1., 0.  
 5.883e-07, 80., 0., 4.  
 8.243e-07, 440., 0., 4.  
 1.042e-06, 800., 0., 4.  
 1.247e-06, 1160., 0., 4.  
 1.511e-06, 1652., 0., 4.  
 1.744e-06, 2120., 0., 4.  
 1.972e-06, 2600., 0., 4.  
 4.988e-07, 80., 0.2, 4.  
 6.907e-07, 440., 0.2, 4.  
 8.666e-07, 800., 0.2, 4.  
 1.031e-06, 1160., 0.2, 4.  
 1.241e-06, 1652., 0.2, 4.  
 1.423e-06, 2120., 0.2, 4.  
 1.603e-06, 2600., 0.2, 4.  
 4.128e-07, 80., 0.4, 4.  
 5.667e-07, 440., 0.4, 4.  
 7.069e-07, 800., 0.4, 4.  
 8.367e-07, 1160., 0.4, 4.  
 1.002e-06, 1652., 0.4, 4.  
 1.145e-06, 2120., 0.4, 4.  
 1.287e-06, 2600., 0.4, 4.  
 3.32e-07, 80., 0.6, 4.  
 4.537e-07, 440., 0.6, 4.  
 5.638e-07, 800., 0.6, 4.  
 6.649e-07, 1160., 0.6, 4.  
 7.934e-07, 1652., 0.6, 4.  
 9.044e-07, 2120., 0.6, 4.  
 1.017e-06, 2600., 0.6, 4.  
 2.567e-07, 80., 0.8, 4.  
 3.514e-07, 440., 0.8, 4.  
 4.361e-07, 800., 0.8, 4.  
 5.133e-07, 1160., 0.8, 4.  
 6.112e-07, 1652., 0.8, 4.

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6.967e-07,2120., 0.8, 4.  
7.852e-07,2600., 0.8, 4.  
1.869e-07, 80., 1., 4.  
2.589e-07, 440., 1., 4.  
3.221e-07, 800., 1., 4.  
3.79e-07,1160., 1., 4.  
4.514e-07,1652., 1., 4.  
5.162e-07,2120., 1., 4.  
5.855e-07,2600., 1., 4.

**Capsule 3 Compact – Graphite Holder Gap**

\*Surface Interaction, name=INT4

1,

\*Gap Conductance, dependencies=2

0.001432, 0., 80., , 0., 0.  
0.001432, 0.3, 80., , 0., 0.  
0.002007, 0., 440., , 0., 0.  
0.002007, 0.3, 440., , 0., 0.  
0.002537, 0., 800., , 0., 0.  
0.002537, 0.3, 800., , 0., 0.  
0.003036, 0., 1160., , 0., 0.  
0.003036, 0.3, 1160., , 0., 0.  
0.003679, 0., 1652., , 0., 0.  
0.003679, 0.3, 1652., , 0., 0.  
0.004246, 0., 2120., , 0., 0.  
0.004246, 0.3, 2120., , 0., 0.  
0.004801, 0., 2600., , 0., 0.  
0.004801, 0.3, 2600., , 0., 0.  
0.001214, 0., 80., , 0.2, 0.  
0.001214, 0.3, 80., , 0.2, 0.  
0.001682, 0., 440., , 0.2, 0.  
0.001682, 0.3, 440., , 0.2, 0.  
0.00211, 0., 800., , 0.2, 0.  
0.00211, 0.3, 800., , 0.2, 0.  
0.002509, 0., 1160., , 0.2, 0.  
0.002509, 0.3, 1160., , 0.2, 0.  
0.00302, 0., 1652., , 0.2, 0.  
0.00302, 0.3, 1652., , 0.2, 0.  
0.003465, 0., 2120., , 0.2, 0.  
0.003465, 0.3, 2120., , 0.2, 0.  
0.003903, 0., 2600., , 0.2, 0.  
0.003903, 0.3, 2600., , 0.2, 0.  
0.001005, 0., 80., , 0.4, 0.  
0.001005, 0.3, 80., , 0.4, 0.  
0.00138, 0., 440., , 0.4, 0.  
0.00138, 0.3, 440., , 0.4, 0.  
0.001721, 0., 800., , 0.4, 0.  
0.001721, 0.3, 800., , 0.4, 0.  
0.002037, 0., 1160., , 0.4, 0.  
0.002037, 0.3, 1160., , 0.4, 0.  
0.002439, 0., 1652., , 0.4, 0.  
0.002439, 0.3, 1652., , 0.4, 0.  
0.002787, 0., 2120., , 0.4, 0.  
0.002787, 0.3, 2120., , 0.4, 0.  
0.003132, 0., 2600., , 0.4, 0.  
0.003132, 0.3, 2600., , 0.4, 0.  
0.0008083, 0., 80., , 0.6, 0.  
0.0008083, 0.3, 80., , 0.6, 0.  
0.001105, 0., 440., , 0.6, 0.  
0.001105, 0.3, 440., , 0.6, 0.  
0.001373, 0., 800., , 0.6, 0.  
0.001373, 0.3, 800., , 0.6, 0.  
0.001619, 0., 1160., , 0.6, 0.  
0.001619, 0.3, 1160., , 0.6, 0.  
0.001932, 0., 1652., , 0.6, 0.  
0.001932, 0.3, 1652., , 0.6, 0.  
0.002202, 0., 2120., , 0.6, 0.  
0.002202, 0.3, 2120., , 0.6, 0.  
0.002475, 0., 2600., , 0.6, 0.  
0.002475, 0.3, 2600., , 0.6, 0.  
0.0006249, 0., 80., , 0.8, 0.  
0.0006249, 0.3, 80., , 0.8, 0.  
0.0008555, 0., 440., , 0.8, 0.  
0.0008555, 0.3, 440., , 0.8, 0.  
0.001062, 0., 800., , 0.8, 0.  
0.001062, 0.3, 800., , 0.8, 0.  
0.00125, 0., 1160., , 0.8, 0.  
0.00125, 0.3, 1160., , 0.8, 0.  
0.001488, 0., 1652., , 0.8, 0.  
0.001488, 0.3, 1652., , 0.8, 0.  
0.001696, 0., 2120., , 0.8, 0.  
0.001696, 0.3, 2120., , 0.8, 0.  
0.001912, 0., 2600., , 0.8, 0.  
0.001912, 0.3, 2600., , 0.8, 0.  
0.000455, 0., 80., , 1., 0.  
0.000455, 0.3, 80., , 1., 0.  
0.0006303, 0., 440., , 1., 0.  
0.0006303, 0.3, 440., , 1., 0.  
0.0007842, 0., 800., , 1., 0.  
0.0007842, 0.3, 800., , 1., 0.  
0.0009227, 0., 1160., , 1., 0.  
0.0009227, 0.3, 1160., , 1., 0.

0.001099, 0., 1652., , 1., 0.  
0.001099, 0.3, 1652., , 1., 0.  
0.001257, 0., 2120., , 1., 0.  
0.001257, 0.3, 2120., , 1., 0.  
0.001425, 0., 2600., , 1., 0.  
0.001425, 0.3, 2600., , 1., 0.  
0.0008967, 0., 80., , 0., 1.  
0.0008967, 0.3, 80., , 0., 1.  
0.001256, 0., 440., , 0., 1.  
0.001256, 0.3, 440., , 0., 1.  
0.001588, 0., 800., , 0., 1.  
0.001588, 0.3, 800., , 0., 1.  
0.001901, 0., 1160., , 0., 1.  
0.001901, 0.3, 1160., , 0., 1.  
0.002303, 0., 1652., , 0., 1.  
0.002303, 0.3, 1652., , 0., 1.  
0.002658, 0., 2120., , 0., 1.  
0.002658, 0.3, 2120., , 0., 1.  
0.003006, 0., 2600., , 0., 1.  
0.003006, 0.3, 2600., , 0., 1.  
0.0007603, 0., 80., , 0.2, 1.  
0.0007603, 0.3, 80., , 0.2, 1.  
0.001053, 0., 440., , 0.2, 1.  
0.001053, 0.3, 440., , 0.2, 1.  
0.001321, 0., 800., , 0.2, 1.  
0.001321, 0.3, 800., , 0.2, 1.  
0.001571, 0., 1160., , 0.2, 1.  
0.001571, 0.3, 1160., , 0.2, 1.  
0.001891, 0., 1652., , 0.2, 1.  
0.001891, 0.3, 1652., , 0.2, 1.  
0.002169, 0., 2120., , 0.2, 1.  
0.002169, 0.3, 2120., , 0.2, 1.  
0.002443, 0., 2600., , 0.2, 1.  
0.002443, 0.3, 2600., , 0.2, 1.  
0.0006292, 0., 80., , 0.4, 1.  
0.0006292, 0.3, 80., , 0.4, 1.  
0.0008637, 0., 440., , 0.4, 1.  
0.0008637, 0.3, 440., , 0.4, 1.  
0.001077, 0., 800., , 0.4, 1.  
0.001077, 0.3, 800., , 0.4, 1.  
0.001275, 0., 1160., , 0.4, 1.  
0.001275, 0.3, 1160., , 0.4, 1.  
0.001527, 0., 1652., , 0.4, 1.  
0.001527, 0.3, 1652., , 0.4, 1.  
0.001745, 0., 2120., , 0.4, 1.  
0.001745, 0.3, 2120., , 0.4, 1.  
0.001961, 0., 2600., , 0.4, 1.  
0.001961, 0.3, 2600., , 0.4, 1.  
0.000506, 0., 80., , 0.6, 1.  
0.000506, 0.3, 80., , 0.6, 1.  
0.0006915, 0., 440., , 0.6, 1.  
0.0006915, 0.3, 440., , 0.6, 1.  
0.0008593, 0., 800., , 0.6, 1.  
0.0008593, 0.3, 800., , 0.6, 1.  
0.001013, 0., 1160., , 0.6, 1.  
0.001013, 0.3, 1160., , 0.6, 1.  
0.001209, 0., 1652., , 0.6, 1.  
0.001209, 0.3, 1652., , 0.6, 1.  
0.001378, 0., 2120., , 0.6, 1.  
0.001378, 0.3, 2120., , 0.6, 1.  
0.001549, 0., 2600., , 0.6, 1.  
0.001549, 0.3, 2600., , 0.6, 1.  
0.0003912, 0., 80., , 0.8, 1.  
0.0003912, 0.3, 80., , 0.8, 1.  
0.0005356, 0., 440., , 0.8, 1.  
0.0005356, 0.3, 440., , 0.8, 1.  
0.0006647, 0., 800., , 0.8, 1.  
0.0006647, 0.3, 800., , 0.8, 1.  
0.0007823, 0., 1160., , 0.8, 1.  
0.0007823, 0.3, 1160., , 0.8, 1.  
0.0009316, 0., 1652., , 0.8, 1.  
0.0009316, 0.3, 1652., , 0.8, 1.  
0.001062, 0., 2120., , 0.8, 1.  
0.001062, 0.3, 2120., , 0.8, 1.  
0.001197, 0., 2600., , 0.8, 1.  
0.001197, 0.3, 2600., , 0.8, 1.  
0.0002848, 0., 80., , 1., 1.  
0.0002848, 0.3, 80., , 1., 1.  
0.0003946, 0., 440., , 1., 1.  
0.0003946, 0.3, 440., , 1., 1.  
0.0004909, 0., 800., , 1., 1.  
0.0004909, 0.3, 800., , 1., 1.  
0.0005776, 0., 1160., , 1., 1.  
0.0005776, 0.3, 1160., , 1., 1.  
0.0006879, 0., 1652., , 1., 1.  
0.0006879, 0.3, 1652., , 1., 1.  
0.0007868, 0., 2120., , 1., 1.  
0.0007868, 0.3, 2120., , 1., 1.  
0.0008924, 0., 2600., , 1., 1.  
0.0008924, 0.3, 2600., , 1., 1.  
0.0007879, 0., 80., , 0., 2.  
0.0007879, 0.3, 80., , 0., 2.

Title: AGR-2 Daily As-run Thermal Analyses

ECAR No.: 2476

Rev. No.: 1

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0.001104,	0.,	440.,	0.,	2.	0.002519,	0.,	2120.,	0.,	3.
0.001104,	0.3,	440.,	0.,	2.	0.002519,	0.3,	2120.,	0.,	3.
0.001396,	0.,	800.,	0.,	2.	0.002848,	0.,	2600.,	0.,	3.
0.001396,	0.3,	800.,	0.,	2.	0.002848,	0.3,	2600.,	0.,	3.
0.00167,	0.,	1160.,	0.,	2.	0.0007205,	0.,	80.,	0.2,	3.
0.00167,	0.3,	1160.,	0.,	2.	0.0007205,	0.3,	80.,	0.2,	3.
0.002024,	0.,	1652.,	0.,	2.	0.0009976,	0.,	440.,	0.2,	3.
0.002024,	0.3,	1652.,	0.,	2.	0.0009976,	0.3,	440.,	0.2,	3.
0.002336,	0.,	2120.,	0.,	2.	0.001252,	0.,	800.,	0.2,	3.
0.002336,	0.3,	2120.,	0.,	2.	0.001252,	0.3,	800.,	0.2,	3.
0.002641,	0.,	2600.,	0.,	2.	0.001489,	0.,	1160.,	0.2,	3.
0.002641,	0.3,	2600.,	0.,	2.	0.001489,	0.3,	1160.,	0.2,	3.
0.000668,	0.,	80.,	0.2,	2.	0.001792,	0.,	1652.,	0.2,	3.
0.000668,	0.3,	80.,	0.2,	2.	0.001792,	0.3,	1652.,	0.2,	3.
0.000925,	0.,	440.,	0.2,	2.	0.002056,	0.,	2120.,	0.2,	3.
0.000925,	0.3,	440.,	0.2,	2.	0.002056,	0.3,	2120.,	0.2,	3.
0.001161,	0.,	800.,	0.2,	2.	0.002315,	0.,	2600.,	0.2,	3.
0.001161,	0.3,	800.,	0.2,	2.	0.002315,	0.3,	2600.,	0.2,	3.
0.00138,	0.,	1160.,	0.2,	2.	0.0005963,	0.,	80.,	0.4,	3.
0.00138,	0.3,	1160.,	0.2,	2.	0.0005963,	0.3,	80.,	0.4,	3.
0.001661,	0.,	1652.,	0.2,	2.	0.0008185,	0.,	440.,	0.4,	3.
0.001661,	0.3,	1652.,	0.2,	2.	0.0008185,	0.3,	440.,	0.4,	3.
0.001906,	0.,	2120.,	0.2,	2.	0.001021,	0.,	800.,	0.4,	3.
0.001906,	0.3,	2120.,	0.2,	2.	0.001021,	0.3,	800.,	0.4,	3.
0.002147,	0.,	2600.,	0.2,	2.	0.001208,	0.,	1160.,	0.4,	3.
0.002147,	0.3,	2600.,	0.2,	2.	0.001208,	0.3,	1160.,	0.4,	3.
0.0005529,	0.,	80.,	0.4,	2.	0.001447,	0.,	1652.,	0.4,	3.
0.0005529,	0.3,	80.,	0.4,	2.	0.001447,	0.3,	1652.,	0.4,	3.
0.0007589,	0.,	440.,	0.4,	2.	0.001653,	0.,	2120.,	0.4,	3.
0.0007589,	0.3,	440.,	0.4,	2.	0.001653,	0.3,	2120.,	0.4,	3.
0.0009467,	0.,	800.,	0.4,	2.	0.001858,	0.,	2600.,	0.4,	3.
0.0009467,	0.3,	800.,	0.4,	2.	0.001858,	0.3,	2600.,	0.4,	3.
0.001121,	0.,	1160.,	0.4,	2.	0.0004795,	0.,	80.,	0.6,	3.
0.001121,	0.3,	1160.,	0.4,	2.	0.0004795,	0.3,	80.,	0.6,	3.
0.001342,	0.,	1652.,	0.4,	2.	0.0006553,	0.,	440.,	0.6,	3.
0.001342,	0.3,	1652.,	0.4,	2.	0.0006553,	0.3,	440.,	0.6,	3.
0.001533,	0.,	2120.,	0.4,	2.	0.0008143,	0.,	800.,	0.6,	3.
0.001533,	0.3,	2120.,	0.4,	2.	0.0008143,	0.3,	800.,	0.6,	3.
0.001723,	0.,	2600.,	0.4,	2.	0.0009604,	0.,	1160.,	0.6,	3.
0.001723,	0.3,	2600.,	0.4,	2.	0.0009604,	0.3,	1160.,	0.6,	3.
0.0004446,	0.,	80.,	0.6,	2.	0.001146,	0.,	1652.,	0.6,	3.
0.0004446,	0.3,	80.,	0.6,	2.	0.001146,	0.3,	1652.,	0.6,	3.
0.0006076,	0.,	440.,	0.6,	2.	0.001306,	0.,	2120.,	0.6,	3.
0.0006076,	0.3,	440.,	0.6,	2.	0.001306,	0.3,	2120.,	0.6,	3.
0.000755,	0.,	800.,	0.6,	2.	0.001468,	0.,	2600.,	0.6,	3.
0.000755,	0.3,	800.,	0.6,	2.	0.001468,	0.3,	2600.,	0.6,	3.
0.0008905,	0.,	1160.,	0.6,	2.	0.0003707,	0.,	80.,	0.8,	3.
0.0008905,	0.3,	1160.,	0.6,	2.	0.0003707,	0.3,	80.,	0.8,	3.
0.001063,	0.,	1652.,	0.6,	2.	0.0005075,	0.,	440.,	0.8,	3.
0.001063,	0.3,	1652.,	0.6,	2.	0.0005075,	0.3,	440.,	0.8,	3.
0.001211,	0.,	2120.,	0.6,	2.	0.0006299,	0.,	800.,	0.8,	3.
0.001211,	0.3,	2120.,	0.6,	2.	0.0006299,	0.3,	800.,	0.8,	3.
0.001361,	0.,	2600.,	0.6,	2.	0.0007413,	0.,	1160.,	0.8,	3.
0.001361,	0.3,	2600.,	0.6,	2.	0.0007413,	0.3,	1160.,	0.8,	3.
0.0003438,	0.,	80.,	0.8,	2.	0.0008828,	0.,	1652.,	0.8,	3.
0.0003438,	0.3,	80.,	0.8,	2.	0.0008828,	0.3,	1652.,	0.8,	3.
0.0004706,	0.,	440.,	0.8,	2.	0.001006,	0.,	2120.,	0.8,	3.
0.0004706,	0.3,	440.,	0.8,	2.	0.001006,	0.3,	2120.,	0.8,	3.
0.0005841,	0.,	800.,	0.8,	2.	0.001134,	0.,	2600.,	0.8,	3.
0.0005841,	0.3,	800.,	0.8,	2.	0.001134,	0.3,	2600.,	0.8,	3.
0.0006874,	0.,	1160.,	0.8,	2.	0.0002699,	0.,	80.,	1.,	3.
0.0006874,	0.3,	1160.,	0.8,	2.	0.0002699,	0.3,	80.,	1.,	3.
0.0008186,	0.,	1652.,	0.8,	2.	0.0003739,	0.,	440.,	1.,	3.
0.0008186,	0.3,	1652.,	0.8,	2.	0.0003739,	0.3,	440.,	1.,	3.
0.0009331,	0.,	2120.,	0.8,	2.	0.0004652,	0.,	800.,	1.,	3.
0.0009331,	0.3,	2120.,	0.8,	2.	0.0004652,	0.3,	800.,	1.,	3.
0.001052,	0.,	2600.,	0.8,	2.	0.0005474,	0.,	1160.,	1.,	3.
0.001052,	0.3,	2600.,	0.8,	2.	0.0005474,	0.3,	1160.,	1.,	3.
0.0002503,	0.,	80.,	1.,	2.	0.0006519,	0.,	1652.,	1.,	3.
0.0002503,	0.3,	80.,	1.,	2.	0.0006519,	0.3,	1652.,	1.,	3.
0.0003467,	0.,	440.,	1.,	2.	0.0007456,	0.,	2120.,	1.,	3.
0.0003467,	0.3,	440.,	1.,	2.	0.0007456,	0.3,	2120.,	1.,	3.
0.0004314,	0.,	800.,	1.,	2.	0.0008457,	0.,	2600.,	1.,	3.
0.0004314,	0.3,	800.,	1.,	2.	0.0008457,	0.3,	2600.,	1.,	3.
0.0005075,	0.,	1160.,	1.,	2.	0.001097,	0.,	80.,	0.,	4.
0.0005075,	0.3,	1160.,	1.,	2.	0.001097,	0.3,	80.,	0.,	4.
0.0006045,	0.,	1652.,	1.,	2.	0.001537,	0.,	440.,	0.,	4.
0.0006045,	0.3,	1652.,	1.,	2.	0.001537,	0.3,	440.,	0.,	4.
0.0006914,	0.,	2120.,	1.,	2.	0.001943,	0.,	800.,	0.,	4.
0.0006914,	0.3,	2120.,	1.,	2.	0.001943,	0.3,	800.,	0.,	4.
0.0007841,	0.,	2600.,	1.,	2.	0.002325,	0.,	1160.,	0.,	4.
0.0007841,	0.3,	2600.,	1.,	2.	0.002325,	0.3,	1160.,	0.,	4.
0.0008498,	0.,	80.,	0.,	3.	0.002817,	0.,	1652.,	0.,	4.
0.0008498,	0.3,	80.,	0.,	3.	0.002817,	0.3,	1652.,	0.,	4.
0.001191,	0.,	440.,	0.,	3.	0.003251,	0.,	2120.,	0.,	4.
0.001191,	0.3,	440.,	0.,	3.	0.003251,	0.3,	2120.,	0.,	4.
0.001505,	0.,	800.,	0.,	3.	0.003676,	0.,	2600.,	0.,	4.
0.001505,	0.3,	800.,	0.,	3.	0.003676,	0.3,	2600.,	0.,	4.
0.001801,	0.,	1160.,	0.,	3.	0.0009299,	0.,	80.,	0.2,	4.
0.001801,	0.3,	1160.,	0.,	3.	0.0009299,	0.3,	80.,	0.2,	4.
0.002182,	0.,	1652.,	0.,	3.	0.001288,	0.,	440.,	0.2,	4.
0.002182,	0.3,	1652.,	0.,	3.	0.001288,	0.3,	440.,	0.2,	4.

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0.001615,	0.,	800.,	0.2,	4.	1.291e-06,	440.,	0.4,	0.
0.001615,	0.3,	800.,	0.2,	4.	1.61e-06,	800.,	0.4,	0.
0.001921,	0.,	1160.,	0.2,	4.	1.906e-06,	1160.,	0.4,	0.
0.001921,	0.3,	1160.,	0.2,	4.	2.282e-06,	1652.,	0.4,	0.
0.002313,	0.,	1652.,	0.2,	4.	2.607e-06,	2120.,	0.4,	0.
0.002313,	0.3,	1652.,	0.2,	4.	2.93e-06,	2600.,	0.4,	0.
0.002653,	0.,	2120.,	0.2,	4.	7.561e-07,	80.,	0.6,	0.
0.002653,	0.3,	2120.,	0.2,	4.	1.033e-06,	440.,	0.6,	0.
0.002988,	0.,	2600.,	0.2,	4.	1.284e-06,	800.,	0.6,	0.
0.002988,	0.3,	2600.,	0.2,	4.	1.514e-06,	1160.,	0.6,	0.
0.0007696,	0.,	80.,	0.4,	4.	1.807e-06,	1652.,	0.6,	0.
0.0007696,	0.3,	80.,	0.4,	4.	2.06e-06,	2120.,	0.6,	0.
0.001056,	0.,	440.,	0.4,	4.	2.315e-06,	2600.,	0.6,	0.
0.001056,	0.3,	440.,	0.4,	4.	5.846e-07,	80.,	0.8,	0.
0.001318,	0.,	800.,	0.4,	4.	8.004e-07,	440.,	0.8,	0.
0.001318,	0.3,	800.,	0.4,	4.	9.933e-07,	800.,	0.8,	0.
0.00156,	0.,	1160.,	0.4,	4.	1.169e-06,	1160.,	0.8,	0.
0.00156,	0.3,	1160.,	0.4,	4.	1.392e-06,	1652.,	0.8,	0.
0.001868,	0.,	1652.,	0.4,	4.	1.587e-06,	2120.,	0.8,	0.
0.001868,	0.3,	1652.,	0.4,	4.	1.788e-06,	2600.,	0.8,	0.
0.002134,	0.,	2120.,	0.4,	4.	4.256e-07,	80.,	1.,	0.
0.002134,	0.3,	2120.,	0.4,	4.	5.897e-07,	440.,	1.,	0.
0.002398,	0.,	2600.,	0.4,	4.	7.336e-07,	800.,	1.,	0.
0.002398,	0.3,	2600.,	0.4,	4.	8.631e-07,	1160.,	1.,	0.
0.0006189,	0.,	80.,	0.6,	4.	1.028e-06,	1652.,	1.,	0.
0.0006189,	0.3,	80.,	0.6,	4.	1.176e-06,	2120.,	1.,	0.
0.0008458,	0.,	440.,	0.6,	4.	1.334e-06,	2600.,	1.,	0.
0.0008458,	0.3,	440.,	0.6,	4.	1.043e-06,	80.,	0.,	4.
0.001051,	0.,	800.,	0.6,	4.	1.462e-06,	440.,	0.,	4.
0.001051,	0.3,	800.,	0.6,	4.	1.848e-06,	800.,	0.,	4.
0.00124,	0.,	1160.,	0.6,	4.	2.211e-06,	1160.,	0.,	4.
0.00124,	0.3,	1160.,	0.6,	4.	2.679e-06,	1652.,	0.,	4.
0.001479,	0.,	1652.,	0.6,	4.	3.092e-06,	2120.,	0.,	4.
0.001479,	0.3,	1652.,	0.6,	4.	3.497e-06,	2600.,	0.,	4.
0.001686,	0.,	2120.,	0.6,	4.	8.845e-07,	80.,	0.2,	4.
0.001686,	0.3,	2120.,	0.6,	4.	1.225e-06,	440.,	0.2,	4.
0.001895,	0.,	2600.,	0.6,	4.	1.537e-06,	800.,	0.2,	4.
0.001895,	0.3,	2600.,	0.6,	4.	1.828e-06,	1160.,	0.2,	4.
0.0004785,	0.,	80.,	0.8,	4.	2.2e-06,	1652.,	0.2,	4.
0.0004785,	0.3,	80.,	0.8,	4.	2.523e-06,	2120.,	0.2,	4.
0.0006551,	0.,	440.,	0.8,	4.	2.842e-06,	2600.,	0.2,	4.
0.0006551,	0.3,	440.,	0.8,	4.	7.32e-07,	80.,	0.4,	4.
0.000813,	0.,	800.,	0.8,	4.	1.005e-06,	440.,	0.4,	4.
0.000813,	0.3,	800.,	0.8,	4.	1.253e-06,	800.,	0.4,	4.
0.0009568,	0.,	1160.,	0.8,	4.	1.483e-06,	1160.,	0.4,	4.
0.0009568,	0.3,	1160.,	0.8,	4.	1.776e-06,	1652.,	0.4,	4.
0.001139,	0.,	1652.,	0.8,	4.	2.029e-06,	2120.,	0.4,	4.
0.001139,	0.3,	1652.,	0.8,	4.	2.281e-06,	2600.,	0.4,	4.
0.001299,	0.,	2120.,	0.8,	4.	5.886e-07,	80.,	0.6,	4.
0.001299,	0.3,	2120.,	0.8,	4.	8.045e-07,	440.,	0.6,	4.
0.001464,	0.,	2600.,	0.8,	4.	9.996e-07,	800.,	0.6,	4.
0.001464,	0.3,	2600.,	0.8,	4.	1.179e-06,	1160.,	0.6,	4.
0.0003484,	0.,	80.,	1.,	4.	1.407e-06,	1652.,	0.6,	4.
0.0003484,	0.3,	80.,	1.,	4.	1.604e-06,	2120.,	0.6,	4.
0.0004826,	0.,	440.,	1.,	4.	1.802e-06,	2600.,	0.6,	4.
0.0004826,	0.3,	440.,	1.,	4.	4.551e-07,	80.,	0.8,	4.
0.0006005,	0.,	800.,	1.,	4.	6.231e-07,	440.,	0.8,	4.
0.0006005,	0.3,	800.,	1.,	4.	7.733e-07,	800.,	0.8,	4.
0.0007065,	0.,	1160.,	1.,	4.	9.1e-07,	1160.,	0.8,	4.
0.0007065,	0.3,	1160.,	1.,	4.	1.084e-06,	1652.,	0.8,	4.
0.0008414,	0.,	1652.,	1.,	4.	1.235e-06,	2120.,	0.8,	4.
0.0008414,	0.3,	1652.,	1.,	4.	1.392e-06,	2600.,	0.8,	4.
0.0009624,	0.,	2120.,	1.,	4.	3.314e-07,	80.,	1.,	4.
0.0009624,	0.3,	2120.,	1.,	4.	4.59e-07,	440.,	1.,	4.
0.001091,	0.,	2600.,	1.,	4.	5.711e-07,	800.,	1.,	4.
0.001091,	0.3,	2600.,	1.,	4.	6.72e-07,	1160.,	1.,	4.
0., 0.3003,	2600.,	1.,	4.	8.003e-07,	1652.,	1.,	4.	
*Gap Radiation					9.153e-07,	2120.,	1.,	4.
1., 1.					1.038e-06,	2600.,	1.,	4.
1., 0.								
1., 1.								
0., 1.001								

### Capsule 5 Control Gas Gap

\*Material, name=HE-NE\_Gas\_Control

\*Conductivity, dependencies=2

1.34e-06,	80.,	0.,	0.
1.877e-06,	440.,	0.,	0.
2.374e-06,	800.,	0.,	0.
2.841e-06,	1160.,	0.,	0.
3.441e-06,	1652.,	0.,	0.
3.972e-06,	2120.,	0.,	0.
4.491e-06,	2600.,	0.,	0.
1.136e-06,	80.,	0.2,	0.
1.573e-06,	440.,	0.2,	0.
1.974e-06,	800.,	0.2,	0.
2.347e-06,	1160.,	0.2,	0.
2.825e-06,	1652.,	0.2,	0.
3.241e-06,	2120.,	0.2,	0.
3.651e-06,	2600.,	0.2,	0.
9.403e-07,	80.,	0.4,	0.

### Capsule 5 Compact – Graphite Holder Gap

\*Surface Interaction, name=INT4

1.,

\*Gap Conductance, dependencies=2

0.0009549,	0.,	80.,	0.,	0.
0.0009549,	0.3,	80.,	0.,	0.
0.001338,	0.,	440.,	0.,	0.
0.001338,	0.3,	440.,	0.,	0.
0.001691,	0.,	800.,	0.,	0.
0.001691,	0.3,	800.,	0.,	0.
0.002024,	0.,	1160.,	0.,	0.
0.002024,	0.3,	1160.,	0.,	0.
0.002452,	0.,	1652.,	0.,	0.
0.002452,	0.3,	1652.,	0.,	0.
0.002831,	0.,	2120.,	0.,	0.
0.002831,	0.3,	2120.,	0.,	0.
0.003201,	0.,	2600.,	0.,	0.
0.003201,	0.3,	2600.,	0.,	0.
0.0008096,	0.,	80.,	0.2,	0.
0.0008096,	0.3,	80.,	0.2,	0.
0.001121,	0.,	440.,	0.2,	0.

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0.001121,	0.3,	440.,	0.2,	0.	0.001652,	0.3,	2120.,	0.2,	1.
0.001407,	0.,	800.,	0.2,	0.	0.001861,	0.,	2600.,	0.2,	1.
0.001407,	0.3,	800.,	0.2,	0.	0.001861,	0.3,	2600.,	0.2,	1.
0.001673,	0.,	1160.,	0.2,	0.	0.0004793,	0.,	80.,	0.4,	1.
0.001673,	0.3,	1160.,	0.2,	0.	0.0004793,	0.3,	80.,	0.4,	1.
0.002013,	0.,	1652.,	0.2,	0.	0.000658,	0.,	440.,	0.4,	1.
0.002013,	0.3,	1652.,	0.2,	0.	0.000658,	0.3,	440.,	0.4,	1.
0.00231,	0.,	2120.,	0.2,	0.	0.0008207,	0.,	800.,	0.4,	1.
0.00231,	0.3,	2120.,	0.2,	0.	0.0008207,	0.3,	800.,	0.4,	1.
0.002602,	0.,	2600.,	0.2,	0.	0.0009714,	0.,	1160.,	0.4,	1.
0.002602,	0.3,	2600.,	0.2,	0.	0.0009714,	0.3,	1160.,	0.4,	1.
0.0006701,	0.,	80.,	0.4,	0.	0.001163,	0.,	1652.,	0.4,	1.
0.0006701,	0.3,	80.,	0.4,	0.	0.001163,	0.3,	1652.,	0.4,	1.
0.0009198,	0.,	440.,	0.4,	0.	0.001329,	0.,	2120.,	0.4,	1.
0.0009198,	0.3,	440.,	0.4,	0.	0.001329,	0.3,	2120.,	0.4,	1.
0.001147,	0.,	800.,	0.4,	0.	0.001494,	0.,	2600.,	0.4,	1.
0.001147,	0.3,	800.,	0.4,	0.	0.001494,	0.3,	2600.,	0.4,	1.
0.001358,	0.,	1160.,	0.4,	0.	0.0003854,	0.,	80.,	0.6,	1.
0.001358,	0.3,	1160.,	0.4,	0.	0.0003854,	0.3,	80.,	0.6,	1.
0.001626,	0.,	1652.,	0.4,	0.	0.0005268,	0.,	440.,	0.6,	1.
0.001626,	0.3,	1652.,	0.4,	0.	0.0005268,	0.3,	440.,	0.6,	1.
0.001858,	0.,	2120.,	0.4,	0.	0.0006546,	0.,	800.,	0.6,	1.
0.001858,	0.3,	2120.,	0.4,	0.	0.0006546,	0.3,	800.,	0.6,	1.
0.002088,	0.,	2600.,	0.4,	0.	0.000772,	0.,	1160.,	0.6,	1.
0.002088,	0.3,	2600.,	0.4,	0.	0.000772,	0.3,	1160.,	0.6,	1.
0.0005388,	0.,	80.,	0.6,	0.	0.0009212,	0.,	1652.,	0.6,	1.
0.0005388,	0.3,	80.,	0.6,	0.	0.0009212,	0.3,	1652.,	0.6,	1.
0.0007364,	0.,	440.,	0.6,	0.	0.00105,	0.,	2120.,	0.6,	1.
0.0007364,	0.3,	440.,	0.6,	0.	0.00105,	0.3,	2120.,	0.6,	1.
0.0009151,	0.,	800.,	0.6,	0.	0.00118,	0.,	2600.,	0.6,	1.
0.0009151,	0.3,	800.,	0.6,	0.	0.00118,	0.3,	2600.,	0.6,	1.
0.001079,	0.,	1160.,	0.6,	0.	0.000298,	0.,	80.,	0.8,	1.
0.001079,	0.3,	1160.,	0.6,	0.	0.000298,	0.3,	80.,	0.8,	1.
0.001288,	0.,	1652.,	0.6,	0.	0.000408,	0.,	440.,	0.8,	1.
0.001288,	0.3,	1652.,	0.6,	0.	0.000408,	0.3,	440.,	0.8,	1.
0.001468,	0.,	2120.,	0.6,	0.	0.0005064,	0.,	800.,	0.8,	1.
0.001468,	0.3,	2120.,	0.6,	0.	0.0005064,	0.3,	800.,	0.8,	1.
0.00165,	0.,	2600.,	0.6,	0.	0.0005959,	0.,	1160.,	0.8,	1.
0.00165,	0.3,	2600.,	0.6,	0.	0.0005959,	0.3,	1160.,	0.8,	1.
0.0004166,	0.,	80.,	0.8,	0.	0.0007097,	0.,	1652.,	0.8,	1.
0.0004166,	0.3,	80.,	0.8,	0.	0.0007097,	0.3,	1652.,	0.8,	1.
0.0005704,	0.,	440.,	0.8,	0.	0.000809,	0.,	2120.,	0.8,	1.
0.0005704,	0.3,	440.,	0.8,	0.	0.000809,	0.3,	2120.,	0.8,	1.
0.0007078,	0.,	800.,	0.8,	0.	0.0009117,	0.,	2600.,	0.8,	1.
0.0007078,	0.3,	800.,	0.8,	0.	0.0009117,	0.3,	2600.,	0.8,	1.
0.000833,	0.,	1160.,	0.8,	0.	0.000217,	0.,	80.,	1.,	1.
0.000833,	0.3,	1160.,	0.8,	0.	0.000217,	0.3,	80.,	1.,	1.
0.0009921,	0.,	1652.,	0.8,	0.	0.0003006,	0.,	440.,	1.,	1.
0.0009921,	0.3,	1652.,	0.8,	0.	0.0003006,	0.3,	440.,	1.,	1.
0.001131,	0.,	2120.,	0.8,	0.	0.000374,	0.,	800.,	1.,	1.
0.001131,	0.3,	2120.,	0.8,	0.	0.000374,	0.3,	800.,	1.,	1.
0.001274,	0.,	2600.,	0.8,	0.	0.00044,	0.,	1160.,	1.,	1.
0.001274,	0.3,	2600.,	0.8,	0.	0.00044,	0.3,	1160.,	1.,	1.
0.0003033,	0.,	80.,	1.,	0.	0.0005241,	0.,	1652.,	1.,	1.
0.0003033,	0.3,	80.,	1.,	0.	0.0005241,	0.3,	1652.,	1.,	1.
0.0004202,	0.,	440.,	1.,	0.	0.0005994,	0.,	2120.,	1.,	1.
0.0004202,	0.3,	440.,	1.,	0.	0.0005994,	0.3,	2120.,	1.,	1.
0.0005228,	0.,	800.,	1.,	0.	0.0006798,	0.,	2600.,	1.,	1.
0.0005228,	0.3,	800.,	1.,	0.	0.0006798,	0.3,	2600.,	1.,	1.
0.0006151,	0.,	1160.,	1.,	0.	0.0006183,	0.,	80.,	0.,	2.
0.0006151,	0.3,	1160.,	1.,	0.	0.0006183,	0.3,	80.,	0.,	2.
0.0007326,	0.,	1652.,	1.,	0.	0.0008663,	0.,	440.,	0.,	2.
0.0007326,	0.3,	1652.,	1.,	0.	0.0008663,	0.3,	440.,	0.,	2.
0.0008379,	0.,	2120.,	1.,	0.	0.001095,	0.,	800.,	0.,	2.
0.0008379,	0.3,	2120.,	1.,	0.	0.001095,	0.3,	800.,	0.,	2.
0.0009503,	0.,	2600.,	1.,	0.	0.001311,	0.,	1160.,	0.,	2.
0.0009503,	0.3,	2600.,	1.,	0.	0.001311,	0.3,	1160.,	0.,	2.
0.0006831,	0.,	80.,	0.,	1.	0.001588,	0.,	1652.,	0.,	2.
0.0006831,	0.3,	80.,	0.,	1.	0.001588,	0.3,	1652.,	0.,	2.
0.000957,	0.,	440.,	0.,	1.	0.001833,	0.,	2120.,	0.,	2.
0.000957,	0.3,	440.,	0.,	1.	0.001833,	0.3,	2120.,	0.,	2.
0.00121,	0.,	800.,	0.,	1.	0.002072,	0.,	2600.,	0.,	2.
0.00121,	0.3,	800.,	0.,	1.	0.002072,	0.3,	2600.,	0.,	2.
0.001448,	0.,	1160.,	0.,	1.	0.0005242,	0.,	80.,	0.2,	2.
0.001448,	0.3,	1160.,	0.,	1.	0.0005242,	0.3,	80.,	0.2,	2.
0.001754,	0.,	1652.,	0.,	1.	0.0007259,	0.,	440.,	0.2,	2.
0.001754,	0.3,	1652.,	0.,	1.	0.0007259,	0.3,	440.,	0.2,	2.
0.002025,	0.,	2120.,	0.,	1.	0.0009107,	0.,	800.,	0.2,	2.
0.002025,	0.3,	2120.,	0.,	1.	0.0009107,	0.3,	800.,	0.2,	2.
0.00229,	0.,	2600.,	0.,	1.	0.001083,	0.,	1160.,	0.2,	2.
0.00229,	0.3,	2600.,	0.,	1.	0.001083,	0.3,	1160.,	0.2,	2.
0.0005792,	0.,	80.,	0.2,	1.	0.001304,	0.,	1652.,	0.2,	2.
0.0005792,	0.3,	80.,	0.2,	1.	0.001304,	0.3,	1652.,	0.2,	2.
0.0008019,	0.,	440.,	0.2,	1.	0.001496,	0.,	2120.,	0.2,	2.
0.0008019,	0.3,	440.,	0.2,	1.	0.001496,	0.3,	2120.,	0.2,	2.
0.001006,	0.,	800.,	0.2,	1.	0.001685,	0.,	2600.,	0.2,	2.
0.001006,	0.3,	800.,	0.2,	1.	0.001685,	0.3,	2600.,	0.2,	2.
0.001197,	0.,	1160.,	0.2,	1.	0.0004339,	0.,	80.,	0.4,	2.
0.001197,	0.3,	1160.,	0.2,	1.	0.0004339,	0.3,	80.,	0.4,	2.
0.00144,	0.,	1652.,	0.2,	1.	0.0005956,	0.,	440.,	0.4,	2.
0.00144,	0.3,	1652.,	0.2,	1.	0.0005956,	0.3,	440.,	0.4,	2.
0.001652,	0.,	2120.,	0.2,	1.	0.0007429,	0.,	800.,	0.4,	2.

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0.0007429,	0.3,	800.,	0.4,	2.	0.001435,	0.3,	2600.,	0.4,	3.
0.0008793,	0.,	1160.,	0.4,	2.	0.0003702,	0.,	80.,	0.6,	3.
0.0008793,	0.3,	1160.,	0.4,	2.	0.0003702,	0.3,	80.,	0.6,	3.
0.001053,	0.,	1652.,	0.4,	2.	0.000506,	0.,	440.,	0.6,	3.
0.001053,	0.3,	1652.,	0.4,	2.	0.000506,	0.3,	440.,	0.6,	3.
0.001203,	0.,	2120.,	0.4,	2.	0.0006288,	0.,	800.,	0.6,	3.
0.001203,	0.3,	2120.,	0.4,	2.	0.0006288,	0.3,	800.,	0.6,	3.
0.001352,	0.,	2600.,	0.4,	2.	0.0007416,	0.,	1160.,	0.6,	3.
0.001352,	0.3,	2600.,	0.4,	2.	0.0007416,	0.3,	1160.,	0.6,	3.
0.0003489,	0.,	80.,	0.6,	2.	0.0008849,	0.,	1652.,	0.6,	3.
0.0003489,	0.3,	80.,	0.6,	2.	0.0008849,	0.3,	1652.,	0.6,	3.
0.0004768,	0.,	440.,	0.6,	2.	0.001009,	0.,	2120.,	0.6,	3.
0.0004768,	0.3,	440.,	0.6,	2.	0.001009,	0.3,	2120.,	0.6,	3.
0.0005925,	0.,	800.,	0.6,	2.	0.001134,	0.,	2600.,	0.6,	3.
0.0005925,	0.3,	800.,	0.6,	2.	0.001134,	0.3,	2600.,	0.6,	3.
0.0006988,	0.,	1160.,	0.6,	2.	0.0002863,	0.,	80.,	0.8,	3.
0.0006988,	0.3,	1160.,	0.6,	2.	0.0002863,	0.3,	80.,	0.8,	3.
0.0008339,	0.,	1652.,	0.6,	2.	0.0003919,	0.,	440.,	0.8,	3.
0.0008339,	0.3,	1652.,	0.6,	2.	0.0003919,	0.3,	440.,	0.8,	3.
0.0009505,	0.,	2120.,	0.6,	2.	0.0004864,	0.,	800.,	0.8,	3.
0.0009505,	0.3,	2120.,	0.6,	2.	0.0004864,	0.3,	800.,	0.8,	3.
0.001068,	0.,	2600.,	0.6,	2.	0.0005724,	0.,	1160.,	0.8,	3.
0.001068,	0.3,	2600.,	0.6,	2.	0.0005724,	0.3,	1160.,	0.8,	3.
0.0002698,	0.,	80.,	0.8,	2.	0.0006817,	0.,	1652.,	0.8,	3.
0.0002698,	0.3,	80.,	0.8,	2.	0.0006817,	0.3,	1652.,	0.8,	3.
0.0003693,	0.,	440.,	0.8,	2.	0.000777,	0.,	2120.,	0.8,	3.
0.0003693,	0.3,	440.,	0.8,	2.	0.000777,	0.3,	2120.,	0.8,	3.
0.0004583,	0.,	800.,	0.8,	2.	0.0008757,	0.,	2600.,	0.8,	3.
0.0004583,	0.3,	800.,	0.8,	2.	0.0008757,	0.3,	2600.,	0.8,	3.
0.0005394,	0.,	1160.,	0.8,	2.	0.0002084,	0.,	80.,	1.,	3.
0.0005394,	0.3,	1160.,	0.8,	2.	0.0002084,	0.3,	80.,	1.,	3.
0.0006424,	0.,	1652.,	0.8,	2.	0.0002887,	0.,	440.,	1.,	3.
0.0006424,	0.3,	1652.,	0.8,	2.	0.0002887,	0.3,	440.,	1.,	3.
0.0007322,	0.,	2120.,	0.8,	2.	0.0003592,	0.,	800.,	1.,	3.
0.0007322,	0.3,	2120.,	0.8,	2.	0.0003592,	0.3,	800.,	1.,	3.
0.0008252,	0.,	2600.,	0.8,	2.	0.0004226,	0.,	1160.,	1.,	3.
0.0008252,	0.3,	2600.,	0.8,	2.	0.0004226,	0.3,	1160.,	1.,	3.
0.0001964,	0.,	80.,	1.,	2.	0.0005034,	0.,	1652.,	1.,	3.
0.0001964,	0.3,	80.,	1.,	2.	0.0005034,	0.3,	1652.,	1.,	3.
0.0002721,	0.,	440.,	1.,	2.	0.0005757,	0.,	2120.,	1.,	3.
0.0002721,	0.3,	440.,	1.,	2.	0.0005757,	0.3,	2120.,	1.,	3.
0.0003385,	0.,	800.,	1.,	2.	0.000653,	0.,	2600.,	1.,	3.
0.0003385,	0.3,	800.,	1.,	2.	0.000653,	0.3,	2600.,	1.,	3.
0.0003983,	0.,	1160.,	1.,	2.	0.000795,	0.,	80.,	0.,	4.
0.0003983,	0.3,	1160.,	1.,	2.	0.000795,	0.3,	80.,	0.,	4.
0.0004744,	0.,	1652.,	1.,	2.	0.001114,	0.,	440.,	0.,	4.
0.0004744,	0.3,	1652.,	1.,	2.	0.001114,	0.3,	440.,	0.,	4.
0.0005426,	0.,	2120.,	1.,	2.	0.001408,	0.,	800.,	0.,	4.
0.0005426,	0.3,	2120.,	1.,	2.	0.001408,	0.3,	800.,	0.,	4.
0.0006153,	0.,	2600.,	1.,	2.	0.001685,	0.,	1160.,	0.,	4.
0.0006153,	0.3,	2600.,	1.,	2.	0.001685,	0.3,	1160.,	0.,	4.
0.0006561,	0.,	80.,	0.,	3.	0.002042,	0.,	1652.,	0.,	4.
0.0006561,	0.3,	80.,	0.,	3.	0.002042,	0.3,	1652.,	0.,	4.
0.0009193,	0.,	440.,	0.,	3.	0.002357,	0.,	2120.,	0.,	4.
0.0009193,	0.3,	440.,	0.,	3.	0.002357,	0.3,	2120.,	0.,	4.
0.001162,	0.,	800.,	0.,	3.	0.002665,	0.,	2600.,	0.,	4.
0.001162,	0.3,	800.,	0.,	3.	0.002665,	0.3,	2600.,	0.,	4.
0.001391,	0.,	1160.,	0.,	3.	0.000674,	0.,	80.,	0.2,	4.
0.001391,	0.3,	1160.,	0.,	3.	0.000674,	0.3,	80.,	0.2,	4.
0.001685,	0.,	1652.,	0.,	3.	0.0009332,	0.,	440.,	0.2,	4.
0.001685,	0.3,	1652.,	0.,	3.	0.0009332,	0.3,	440.,	0.2,	4.
0.001945,	0.,	2120.,	0.,	3.	0.001171,	0.,	800.,	0.2,	4.
0.001945,	0.3,	2120.,	0.,	3.	0.001171,	0.3,	800.,	0.2,	4.
0.002199,	0.,	2600.,	0.,	3.	0.001393,	0.,	1160.,	0.2,	4.
0.002199,	0.3,	2600.,	0.,	3.	0.001393,	0.3,	1160.,	0.2,	4.
0.0005563,	0.,	80.,	0.2,	3.	0.001676,	0.,	1652.,	0.2,	4.
0.0005563,	0.3,	80.,	0.2,	3.	0.001676,	0.3,	1652.,	0.2,	4.
0.0007703,	0.,	440.,	0.2,	3.	0.001923,	0.,	2120.,	0.2,	4.
0.0007703,	0.3,	440.,	0.2,	3.	0.001923,	0.3,	2120.,	0.2,	4.
0.0009664,	0.,	800.,	0.2,	3.	0.002166,	0.,	2600.,	0.2,	4.
0.0009664,	0.3,	800.,	0.2,	3.	0.002166,	0.3,	2600.,	0.2,	4.
0.001149,	0.,	1160.,	0.2,	3.	0.0005578,	0.,	80.,	0.4,	4.
0.001149,	0.3,	1160.,	0.2,	3.	0.0005578,	0.3,	80.,	0.4,	4.
0.001383,	0.,	1652.,	0.2,	3.	0.0007657,	0.,	440.,	0.4,	4.
0.001383,	0.3,	1652.,	0.2,	3.	0.0007657,	0.3,	440.,	0.4,	4.
0.001587,	0.,	2120.,	0.2,	3.	0.0009551,	0.,	800.,	0.4,	4.
0.001587,	0.3,	2120.,	0.2,	3.	0.0009551,	0.3,	800.,	0.4,	4.
0.001788,	0.,	2600.,	0.2,	3.	0.00113,	0.,	1160.,	0.4,	4.
0.001788,	0.3,	2600.,	0.2,	3.	0.00113,	0.3,	1160.,	0.4,	4.
0.0004604,	0.,	80.,	0.4,	3.	0.001354,	0.,	1652.,	0.4,	4.
0.0004604,	0.3,	80.,	0.4,	3.	0.001354,	0.3,	1652.,	0.4,	4.
0.000632,	0.,	440.,	0.4,	3.	0.001547,	0.,	2120.,	0.4,	4.
0.000632,	0.3,	440.,	0.4,	3.	0.001547,	0.3,	2120.,	0.4,	4.
0.0007883,	0.,	800.,	0.4,	3.	0.001738,	0.,	2600.,	0.4,	4.
0.0007883,	0.3,	800.,	0.4,	3.	0.001738,	0.3,	2600.,	0.4,	4.
0.0009331,	0.,	1160.,	0.4,	3.	0.0004486,	0.,	80.,	0.6,	4.
0.0009331,	0.3,	1160.,	0.4,	3.	0.0004486,	0.3,	80.,	0.6,	4.
0.001117,	0.,	1652.,	0.4,	3.	0.000613,	0.,	440.,	0.6,	4.
0.001117,	0.3,	1652.,	0.4,	3.	0.000613,	0.3,	440.,	0.6,	4.
0.001277,	0.,	2120.,	0.4,	3.	0.0007618,	0.,	800.,	0.6,	4.
0.001277,	0.3,	2120.,	0.4,	3.	0.0007618,	0.3,	800.,	0.6,	4.
0.001435,	0.,	2600.,	0.4,	3.	0.0008985,	0.,	1160.,	0.6,	4.

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0.0008985,	0.3,	1160.,	0.6,	4.	6.53e-06,2120.,	0.,	4.	
0.001072,	0.,	1652.,	0.6,	4.	7.383e-06,2600.,	0.,	4.	
0.001072,	0.3,	1652.,	0.6,	4.	1.868e-06,	80.,	0.2,	4.
0.001222,	0.,	2120.,	0.6,	4.	2.586e-06,	440.,	0.2,	4.
0.001222,	0.3,	2120.,	0.6,	4.	3.244e-06,	800.,	0.2,	4.
0.001374,	0.,	2600.,	0.6,	4.	3.859e-06,1160.,	0.2,	4.	
0.001374,	0.3,	2600.,	0.6,	4.	4.644e-06,1652.,	0.2,	4.	
0.0003468,	0.,	80.,	0.8,	4.	5.328e-06,2120.,	0.2,	4.	
0.0003468,	0.3,	80.,	0.8,	4.	6.001e-06,2600.,	0.2,	4.	
0.0004748,	0.,	440.,	0.8,	4.	1.546e-06,	80.,	0.4,	4.
0.0004748,	0.3,	440.,	0.8,	4.	2.122e-06,	440.,	0.4,	4.
0.0005893,	0.,	800.,	0.8,	4.	2.646e-06,	800.,	0.4,	4.
0.0005893,	0.3,	800.,	0.8,	4.	3.132e-06,1160.,	0.4,	4.	
0.0006935,	0.,	1160.,	0.8,	4.	3.751e-06,1652.,	0.4,	4.	
0.0006935,	0.3,	1160.,	0.8,	4.	4.285e-06,2120.,	0.4,	4.	
0.0008259,	0.,	1652.,	0.8,	4.	4.817e-06,2600.,	0.4,	4.	
0.0008259,	0.3,	1652.,	0.8,	4.	1.243e-06,	80.,	0.6,	4.
0.0009414,	0.,	2120.,	0.8,	4.	1.699e-06,	440.,	0.6,	4.
0.0009414,	0.3,	2120.,	0.8,	4.	2.111e-06,	800.,	0.6,	4.
0.001061,	0.,	2600.,	0.8,	4.	2.489e-06,1160.,	0.6,	4.	
0.001061,	0.3,	2600.,	0.8,	4.	2.97e-06,1652.,	0.6,	4.	
0.0002525,	0.,	80.,	1.,	4.	3.386e-06,2120.,	0.6,	4.	
0.0002525,	0.3,	80.,	1.,	4.	3.806e-06,2600.,	0.6,	4.	
0.0003498,	0.,	440.,	1.,	4.	9.61e-07,	80.,	0.8,	4.
0.0003498,	0.3,	440.,	1.,	4.	1.316e-06,	440.,	0.8,	4.
0.0004352,	0.,	800.,	1.,	4.	1.633e-06,	800.,	0.8,	4.
0.0004352,	0.3,	800.,	1.,	4.	1.922e-06,1160.,	0.8,	4.	
0.0005121,	0.,	1160.,	1.,	4.	2.288e-06,1652.,	0.8,	4.	
0.0005121,	0.3,	1160.,	1.,	4.	2.608e-06,2120.,	0.8,	4.	
0.0006099,	0.,	1652.,	1.,	4.	2.94e-06,2600.,	0.8,	4.	
0.0006099,	0.3,	1652.,	1.,	4.	6.997e-07,	80.,	1.,	4.
0.0006975,	0.,	2120.,	1.,	4.	9.693e-07,	440.,	1.,	4.
0.0006975,	0.3,	2120.,	1.,	4.	1.206e-06,	800.,	1.,	4.
0.0007911,	0.,	2600.,	1.,	4.	1.419e-06,1160.,	1.,	4.	
0.0007911,	0.3,	2600.,	1.,	4.	1.69e-06,1652.,	1.,	4.	
0.,	0.3003,	2600.,	1.,	4.	1.933e-06,2120.,	1.,	4.	
					2.192e-06,2600.,	1.,	4.	

\*Gap Radiation

1., 1.

1., 0.

1., 1.

0., 1.001

### Capsule 6 Control Gas Gap

\*Material, name=HE-NE\_Control

\*Conductivity, dependencies=2

2.619e-06,	80.,	0.,	0.
3.669e-06,	440.,	0.,	0.
4.639e-06,	800.,	0.,	0.
5.551e-06,	1160.,	0.,	0.
6.725e-06,	1652.,	0.,	0.
7.763e-06,	2120.,	0.,	0.
8.778e-06,	2600.,	0.,	0.
2.22e-06,	80.,	0.2,	0.
3.074e-06,	440.,	0.2,	0.
3.857e-06,	800.,	0.2,	0.
4.588e-06,	1160.,	0.2,	0.
5.522e-06,	1652.,	0.2,	0.
6.335e-06,	2120.,	0.2,	0.
7.135e-06,	2600.,	0.2,	0.
1.838e-06,	80.,	0.4,	0.
2.522e-06,	440.,	0.4,	0.
3.146e-06,	800.,	0.4,	0.
3.724e-06,	1160.,	0.4,	0.
4.46e-06,	1652.,	0.4,	0.
5.095e-06,	2120.,	0.4,	0.
5.727e-06,	2600.,	0.4,	0.
1.478e-06,	80.,	0.6,	0.
2.02e-06,	440.,	0.6,	0.
2.509e-06,	800.,	0.6,	0.
2.96e-06,	1160.,	0.6,	0.
3.532e-06,	1652.,	0.6,	0.
4.025e-06,	2120.,	0.6,	0.
4.525e-06,	2600.,	0.6,	0.
1.143e-06,	80.,	0.8,	0.
1.564e-06,	440.,	0.8,	0.
1.941e-06,	800.,	0.8,	0.
2.285e-06,	1160.,	0.8,	0.
2.721e-06,	1652.,	0.8,	0.
3.101e-06,	2120.,	0.8,	0.
3.495e-06,	2600.,	0.8,	0.
8.319e-07,	80.,	1.,	0.
1.152e-06,	440.,	1.,	0.
1.434e-06,	800.,	1.,	0.
1.687e-06,	1160.,	1.,	0.
2.009e-06,	1652.,	1.,	0.
2.298e-06,	2120.,	1.,	0.
2.606e-06,	2600.,	1.,	0.
2.203e-06,	80.,	0.,	4.
3.086e-06,	440.,	0.,	4.
3.902e-06,	800.,	0.,	4.
4.669e-06,	1160.,	0.,	4.
5.657e-06,	1652.,	0.,	4.

### Capsule 6 Compact – Graphite Holder Gap

\*Surface Interaction, name=INT4

1.,

\*Gap Conductance, dependencies=2

0.0009441,	0.,	80.,	0.,	0.
0.0009441,	0.3,	80.,	0.,	0.
0.001323,	0.,	440.,	0.,	0.
0.001323,	0.3,	440.,	0.,	0.
0.001672,	0.,	800.,	0.,	0.
0.001672,	0.3,	800.,	0.,	0.
0.002001,	0.,	1160.,	0.,	0.
0.002001,	0.3,	1160.,	0.,	0.
0.002424,	0.,	1652.,	0.,	0.
0.002424,	0.3,	1652.,	0.,	0.
0.002799,	0.,	2120.,	0.,	0.
0.002799,	0.3,	2120.,	0.,	0.
0.003164,	0.,	2600.,	0.,	0.
0.003164,	0.3,	2600.,	0.,	0.
0.0008004,	0.,	80.,	0.2,	0.
0.0008004,	0.3,	80.,	0.2,	0.
0.001108,	0.,	440.,	0.2,	0.
0.001108,	0.3,	440.,	0.2,	0.
0.001391,	0.,	800.,	0.2,	0.
0.001391,	0.3,	800.,	0.2,	0.
0.001654,	0.,	1160.,	0.2,	0.
0.001654,	0.3,	1160.,	0.2,	0.
0.001991,	0.,	1652.,	0.2,	0.
0.001991,	0.3,	1652.,	0.2,	0.
0.002284,	0.,	2120.,	0.2,	0.
0.002284,	0.3,	2120.,	0.2,	0.
0.002572,	0.,	2600.,	0.2,	0.
0.002572,	0.3,	2600.,	0.2,	0.
0.0006625,	0.,	80.,	0.4,	0.
0.0006625,	0.3,	80.,	0.4,	0.
0.0009093,	0.,	440.,	0.4,	0.
0.0009093,	0.3,	440.,	0.4,	0.
0.001134,	0.,	800.,	0.4,	0.
0.001134,	0.3,	800.,	0.4,	0.
0.001343,	0.,	1160.,	0.4,	0.
0.001343,	0.3,	1160.,	0.4,	0.
0.001608,	0.,	1652.,	0.4,	0.
0.001608,	0.3,	1652.,	0.4,	0.
0.001837,	0.,	2120.,	0.4,	0.
0.001837,	0.3,	2120.,	0.4,	0.
0.002065,	0.,	2600.,	0.4,	0.
0.002065,	0.3,	2600.,	0.4,	0.
0.0005327,	0.,	80.,	0.6,	0.
0.0005327,	0.3,	80.,	0.6,	0.
0.000728,	0.,	440.,	0.6,	0.
0.000728,	0.3,	440.,	0.6,	0.
0.0009047,	0.,	800.,	0.6,	0.
0.0009047,	0.3,	800.,	0.6,	0.
0.001067,	0.,	1160.,	0.6,	0.
0.001067,	0.3,	1160.,	0.6,	0.

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0.001273,	0.,	1652.,	0.6,	0.	0.0004047,	0.,	440.,	0.8,	1.
0.001273,	0.3,	1652.,	0.6,	0.	0.0004047,	0.3,	440.,	0.8,	1.
0.001451,	0.,	2120.,	0.6,	0.	0.0005022,	0.,	800.,	0.8,	1.
0.001451,	0.3,	2120.,	0.6,	0.	0.0005022,	0.3,	800.,	0.8,	1.
0.001631,	0.,	2600.,	0.6,	0.	0.0005911,	0.,	1160.,	0.8,	1.
0.001631,	0.3,	2600.,	0.6,	0.	0.0005911,	0.3,	1160.,	0.8,	1.
0.0004119,	0.,	80.,	0.8,	0.	0.0007039,	0.,	1652.,	0.8,	1.
0.0004119,	0.3,	80.,	0.8,	0.	0.0007039,	0.3,	1652.,	0.8,	1.
0.0005639,	0.,	440.,	0.8,	0.	0.0008024,	0.,	2120.,	0.8,	1.
0.0005639,	0.3,	440.,	0.8,	0.	0.0008024,	0.3,	2120.,	0.8,	1.
0.0006998,	0.,	800.,	0.8,	0.	0.0009043,	0.,	2600.,	0.8,	1.
0.0006998,	0.3,	800.,	0.8,	0.	0.0009043,	0.3,	2600.,	0.8,	1.
0.0008236,	0.,	1160.,	0.8,	0.	0.0002152,	0.,	80.,	1.,	1.
0.0008236,	0.3,	1160.,	0.8,	0.	0.0002152,	0.3,	80.,	1.,	1.
0.0009808,	0.,	1652.,	0.8,	0.	0.0002982,	0.,	440.,	1.,	1.
0.0009808,	0.3,	1652.,	0.8,	0.	0.0002982,	0.3,	440.,	1.,	1.
0.001118,	0.,	2120.,	0.8,	0.	0.000371,	0.,	800.,	1.,	1.
0.001118,	0.3,	2120.,	0.8,	0.	0.000371,	0.3,	800.,	1.,	1.
0.00126,	0.,	2600.,	0.8,	0.	0.0004364,	0.,	1160.,	1.,	1.
0.00126,	0.3,	2600.,	0.8,	0.	0.0004364,	0.3,	1160.,	1.,	1.
0.0002999,	0.,	80.,	1.,	0.	0.0005198,	0.,	1652.,	1.,	1.
0.0002999,	0.3,	80.,	1.,	0.	0.0005198,	0.3,	1652.,	1.,	1.
0.0004154,	0.,	440.,	1.,	0.	0.0005945,	0.,	2120.,	1.,	1.
0.0004154,	0.3,	440.,	1.,	0.	0.0005945,	0.3,	2120.,	1.,	1.
0.0005169,	0.,	800.,	1.,	0.	0.0006743,	0.,	2600.,	1.,	1.
0.0005169,	0.3,	800.,	1.,	0.	0.0006743,	0.3,	2600.,	1.,	1.
0.0006081,	0.,	1160.,	1.,	0.	0.0006138,	0.,	80.,	0.,	2.
0.0006081,	0.3,	1160.,	1.,	0.	0.0006138,	0.3,	80.,	0.,	2.
0.0007243,	0.,	1652.,	1.,	0.	0.0008599,	0.,	440.,	0.,	2.
0.0007243,	0.3,	1652.,	1.,	0.	0.0008599,	0.3,	440.,	0.,	2.
0.0008284,	0.,	2120.,	1.,	0.	0.001087,	0.,	800.,	0.,	2.
0.0008284,	0.3,	2120.,	1.,	0.	0.001087,	0.3,	800.,	0.,	2.
0.0009395,	0.,	2600.,	1.,	0.	0.001301,	0.,	1160.,	0.,	2.
0.0009395,	0.3,	2600.,	1.,	0.	0.001301,	0.3,	1160.,	0.,	2.
0.0006776,	0.,	80.,	0.,	1.	0.001576,	0.,	1652.,	0.,	2.
0.0006776,	0.3,	80.,	0.,	1.	0.001576,	0.3,	1652.,	0.,	2.
0.0009493,	0.,	440.,	0.,	1.	0.00182,	0.,	2120.,	0.,	2.
0.0009493,	0.3,	440.,	0.,	1.	0.00182,	0.3,	2120.,	0.,	2.
0.0012,	0.,	800.,	0.,	1.	0.002057,	0.,	2600.,	0.,	2.
0.0012,	0.3,	800.,	0.,	1.	0.002057,	0.3,	2600.,	0.,	2.
0.001436,	0.,	1160.,	0.,	1.	0.0005204,	0.,	80.,	0.2,	2.
0.001436,	0.3,	1160.,	0.,	1.	0.0005204,	0.3,	80.,	0.2,	2.
0.00174,	0.,	1652.,	0.,	1.	0.0007206,	0.,	440.,	0.2,	2.
0.00174,	0.3,	1652.,	0.,	1.	0.0007206,	0.3,	440.,	0.2,	2.
0.002009,	0.,	2120.,	0.,	1.	0.0009041,	0.,	800.,	0.2,	2.
0.002009,	0.3,	2120.,	0.,	1.	0.0009041,	0.3,	800.,	0.2,	2.
0.002271,	0.,	2600.,	0.,	1.	0.001075,	0.,	1160.,	0.2,	2.
0.002271,	0.3,	2600.,	0.,	1.	0.001075,	0.3,	1160.,	0.2,	2.
0.0005745,	0.,	80.,	0.2,	1.	0.001294,	0.,	1652.,	0.2,	2.
0.0005745,	0.3,	80.,	0.2,	1.	0.001294,	0.3,	1652.,	0.2,	2.
0.0007954,	0.,	440.,	0.2,	1.	0.001485,	0.,	2120.,	0.2,	2.
0.0007954,	0.3,	440.,	0.2,	1.	0.001485,	0.3,	2120.,	0.2,	2.
0.000998,	0.,	800.,	0.2,	1.	0.001672,	0.,	2600.,	0.2,	2.
0.000998,	0.3,	800.,	0.2,	1.	0.001672,	0.3,	2600.,	0.2,	2.
0.001187,	0.,	1160.,	0.2,	1.	0.0004307,	0.,	80.,	0.4,	2.
0.001187,	0.3,	1160.,	0.2,	1.	0.0004307,	0.3,	80.,	0.4,	2.
0.001429,	0.,	1652.,	0.2,	1.	0.0005912,	0.,	440.,	0.4,	2.
0.001429,	0.3,	1652.,	0.2,	1.	0.0005912,	0.3,	440.,	0.4,	2.
0.001639,	0.,	2120.,	0.2,	1.	0.0007374,	0.,	800.,	0.4,	2.
0.001639,	0.3,	2120.,	0.2,	1.	0.0007374,	0.3,	800.,	0.4,	2.
0.001846,	0.,	2600.,	0.2,	1.	0.0008729,	0.,	1160.,	0.4,	2.
0.001846,	0.3,	2600.,	0.2,	1.	0.0008729,	0.3,	1160.,	0.4,	2.
0.0004754,	0.,	80.,	0.4,	1.	0.001045,	0.,	1652.,	0.4,	2.
0.0004754,	0.3,	80.,	0.4,	1.	0.001045,	0.3,	1652.,	0.4,	2.
0.0006526,	0.,	440.,	0.4,	1.	0.001194,	0.,	2120.,	0.4,	2.
0.0006526,	0.3,	440.,	0.4,	1.	0.001194,	0.3,	2120.,	0.4,	2.
0.0008141,	0.,	800.,	0.4,	1.	0.001342,	0.,	2600.,	0.4,	2.
0.0008141,	0.3,	800.,	0.4,	1.	0.001342,	0.3,	2600.,	0.4,	2.
0.0009635,	0.,	1160.,	0.4,	1.	0.0003463,	0.,	80.,	0.6,	2.
0.0009635,	0.3,	1160.,	0.4,	1.	0.0003463,	0.3,	80.,	0.6,	2.
0.001154,	0.,	1652.,	0.4,	1.	0.0004733,	0.,	440.,	0.6,	2.
0.001154,	0.3,	1652.,	0.4,	1.	0.0004733,	0.3,	440.,	0.6,	2.
0.001318,	0.,	2120.,	0.4,	1.	0.0005882,	0.,	800.,	0.6,	2.
0.001318,	0.3,	2120.,	0.4,	1.	0.0005882,	0.3,	800.,	0.6,	2.
0.001482,	0.,	2600.,	0.4,	1.	0.0006937,	0.,	1160.,	0.6,	2.
0.001482,	0.3,	2600.,	0.4,	1.	0.0006937,	0.3,	1160.,	0.6,	2.
0.0003823,	0.,	80.,	0.6,	1.	0.0008277,	0.,	1652.,	0.6,	2.
0.0003823,	0.3,	80.,	0.6,	1.	0.0008277,	0.3,	1652.,	0.6,	2.
0.0005225,	0.,	440.,	0.6,	1.	0.0009435,	0.,	2120.,	0.6,	2.
0.0005225,	0.3,	440.,	0.6,	1.	0.0009435,	0.3,	2120.,	0.6,	2.
0.0006493,	0.,	800.,	0.6,	1.	0.001061,	0.,	2600.,	0.6,	2.
0.0006493,	0.3,	800.,	0.6,	1.	0.001061,	0.3,	2600.,	0.6,	2.
0.0007658,	0.,	1160.,	0.6,	1.	0.0002678,	0.,	80.,	0.8,	2.
0.0007658,	0.3,	1160.,	0.6,	1.	0.0002678,	0.3,	80.,	0.8,	2.
0.0009137,	0.,	1652.,	0.6,	1.	0.0003666,	0.,	440.,	0.8,	2.
0.0009137,	0.3,	1652.,	0.6,	1.	0.0003666,	0.3,	440.,	0.8,	2.
0.001042,	0.,	2120.,	0.6,	1.	0.000455,	0.,	800.,	0.8,	2.
0.001042,	0.3,	2120.,	0.6,	1.	0.000455,	0.3,	800.,	0.8,	2.
0.001171,	0.,	2600.,	0.6,	1.	0.0005355,	0.,	1160.,	0.8,	2.
0.001171,	0.3,	2600.,	0.6,	1.	0.0005355,	0.3,	1160.,	0.8,	2.
0.0002956,	0.,	80.,	0.8,	1.	0.0006377,	0.,	1652.,	0.8,	2.
0.0002956,	0.3,	80.,	0.8,	1.	0.0006377,	0.3,	1652.,	0.8,	2.

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0.0007269,	0.,	2120.,	0.8,	2.	0.0003564,	0.,	800.,	1.,	3.
0.0007269,	0.3,	2120.,	0.8,	2.	0.0003564,	0.3,	800.,	1.,	3.
0.0008192,	0.,	2600.,	0.8,	2.	0.0004194,	0.,	1160.,	1.,	3.
0.0008192,	0.3,	2600.,	0.8,	2.	0.0004194,	0.3,	1160.,	1.,	3.
0.000195,	0.,	80.,	1.,	2.	0.0004995,	0.,	1652.,	1.,	3.
0.000195,	0.3,	80.,	1.,	2.	0.0004995,	0.3,	1652.,	1.,	3.
0.0002701,	0.,	440.,	1.,	2.	0.0005713,	0.,	2120.,	1.,	3.
0.0002701,	0.3,	440.,	1.,	2.	0.0005713,	0.3,	2120.,	1.,	3.
0.000336,	0.,	800.,	1.,	2.	0.0006479,	0.,	2600.,	1.,	3.
0.000336,	0.3,	800.,	1.,	2.	0.0006479,	0.3,	2600.,	1.,	3.
0.0003954,	0.,	1160.,	1.,	2.	0.0007875,	0.,	80.,	0.,	4.
0.0003954,	0.3,	1160.,	1.,	2.	0.0007875,	0.3,	80.,	0.,	4.
0.0004709,	0.,	1652.,	1.,	2.	0.001103,	0.,	440.,	0.,	4.
0.0004709,	0.3,	1652.,	1.,	2.	0.001103,	0.3,	440.,	0.,	4.
0.0005386,	0.,	2120.,	1.,	2.	0.001395,	0.,	800.,	0.,	4.
0.0005386,	0.3,	2120.,	1.,	2.	0.001395,	0.3,	800.,	0.,	4.
0.0006108,	0.,	2600.,	1.,	2.	0.001669,	0.,	1160.,	0.,	4.
0.0006108,	0.3,	2600.,	1.,	2.	0.001669,	0.3,	1160.,	0.,	4.
0.0006511,	0.,	80.,	0.,	3.	0.002022,	0.,	1652.,	0.,	4.
0.0006511,	0.3,	80.,	0.,	3.	0.002022,	0.3,	1652.,	0.,	4.
0.0009121,	0.,	440.,	0.,	3.	0.002335,	0.,	2120.,	0.,	4.
0.0009121,	0.3,	440.,	0.,	3.	0.002335,	0.3,	2120.,	0.,	4.
0.001153,	0.,	800.,	0.,	3.	0.00264,	0.,	2600.,	0.,	4.
0.001153,	0.3,	800.,	0.,	3.	0.00264,	0.3,	2600.,	0.,	4.
0.00138,	0.,	1160.,	0.,	3.	0.0006677,	0.,	80.,	0.2,	4.
0.00138,	0.3,	1160.,	0.,	3.	0.0006677,	0.3,	80.,	0.2,	4.
0.001672,	0.,	1652.,	0.,	3.	0.0009245,	0.,	440.,	0.2,	4.
0.001672,	0.3,	1652.,	0.,	3.	0.0009245,	0.3,	440.,	0.2,	4.
0.00193,	0.,	2120.,	0.,	3.	0.00116,	0.,	800.,	0.2,	4.
0.00193,	0.3,	2120.,	0.,	3.	0.00116,	0.3,	800.,	0.2,	4.
0.002182,	0.,	2600.,	0.,	3.	0.00138,	0.,	1160.,	0.2,	4.
0.002182,	0.3,	2600.,	0.,	3.	0.00138,	0.3,	1160.,	0.2,	4.
0.000552,	0.,	80.,	0.2,	3.	0.00166,	0.,	1652.,	0.2,	4.
0.000552,	0.3,	80.,	0.2,	3.	0.00166,	0.3,	1652.,	0.2,	4.
0.0007643,	0.,	440.,	0.2,	3.	0.001905,	0.,	2120.,	0.2,	4.
0.0007643,	0.3,	440.,	0.2,	3.	0.001905,	0.3,	2120.,	0.2,	4.
0.000959,	0.,	800.,	0.2,	3.	0.002146,	0.,	2600.,	0.2,	4.
0.000959,	0.3,	800.,	0.2,	3.	0.002146,	0.3,	2600.,	0.2,	4.
0.001141,	0.,	1160.,	0.2,	3.	0.0005526,	0.,	80.,	0.4,	4.
0.001141,	0.3,	1160.,	0.2,	3.	0.0005526,	0.3,	80.,	0.4,	4.
0.001373,	0.,	1652.,	0.2,	3.	0.0007585,	0.,	440.,	0.4,	4.
0.001373,	0.3,	1652.,	0.2,	3.	0.0007585,	0.3,	440.,	0.4,	4.
0.001575,	0.,	2120.,	0.2,	3.	0.0009462,	0.,	800.,	0.4,	4.
0.001575,	0.3,	2120.,	0.2,	3.	0.0009462,	0.3,	800.,	0.4,	4.
0.001774,	0.,	2600.,	0.2,	3.	0.00112,	0.,	1160.,	0.4,	4.
0.001774,	0.3,	2600.,	0.2,	3.	0.00112,	0.3,	1160.,	0.4,	4.
0.0004569,	0.,	80.,	0.4,	3.	0.001341,	0.,	1652.,	0.4,	4.
0.0004569,	0.3,	80.,	0.4,	3.	0.001341,	0.3,	1652.,	0.4,	4.
0.0006271,	0.,	440.,	0.4,	3.	0.001532,	0.,	2120.,	0.4,	4.
0.0006271,	0.3,	440.,	0.4,	3.	0.001532,	0.3,	2120.,	0.4,	4.
0.0007822,	0.,	800.,	0.4,	3.	0.001722,	0.,	2600.,	0.4,	4.
0.0007822,	0.3,	800.,	0.4,	3.	0.001722,	0.3,	2600.,	0.4,	4.
0.0009259,	0.,	1160.,	0.4,	3.	0.0004444,	0.,	80.,	0.6,	4.
0.0009259,	0.3,	1160.,	0.4,	3.	0.0004444,	0.3,	80.,	0.6,	4.
0.001109,	0.,	1652.,	0.4,	3.	0.0006073,	0.,	440.,	0.6,	4.
0.001109,	0.3,	1652.,	0.4,	3.	0.0006073,	0.3,	440.,	0.6,	4.
0.001267,	0.,	2120.,	0.4,	3.	0.0007546,	0.,	800.,	0.6,	4.
0.001267,	0.3,	2120.,	0.4,	3.	0.0007546,	0.3,	800.,	0.6,	4.
0.001424,	0.,	2600.,	0.4,	3.	0.00089,	0.,	1160.,	0.6,	4.
0.001424,	0.3,	2600.,	0.4,	3.	0.00089,	0.3,	1160.,	0.6,	4.
0.0003674,	0.,	80.,	0.6,	3.	0.001062,	0.,	1652.,	0.6,	4.
0.0003674,	0.3,	80.,	0.6,	3.	0.001062,	0.3,	1652.,	0.6,	4.
0.0005021,	0.,	440.,	0.6,	3.	0.001211,	0.,	2120.,	0.6,	4.
0.0005021,	0.3,	440.,	0.6,	3.	0.001211,	0.3,	2120.,	0.6,	4.
0.0006239,	0.,	800.,	0.6,	3.	0.001361,	0.,	2600.,	0.6,	4.
0.0006239,	0.3,	800.,	0.6,	3.	0.001361,	0.3,	2600.,	0.6,	4.
0.0007358,	0.,	1160.,	0.6,	3.	0.0003436,	0.,	80.,	0.8,	4.
0.0007358,	0.3,	1160.,	0.6,	3.	0.0003436,	0.3,	80.,	0.8,	4.
0.000878,	0.,	1652.,	0.6,	3.	0.0004704,	0.,	440.,	0.8,	4.
0.000878,	0.3,	1652.,	0.6,	3.	0.0004704,	0.3,	440.,	0.8,	4.
0.001001,	0.,	2120.,	0.6,	3.	0.0005837,	0.,	800.,	0.8,	4.
0.001001,	0.3,	2120.,	0.6,	3.	0.0005837,	0.3,	800.,	0.8,	4.
0.001125,	0.,	2600.,	0.6,	3.	0.000687,	0.,	1160.,	0.8,	4.
0.001125,	0.3,	2600.,	0.6,	3.	0.000687,	0.3,	1160.,	0.8,	4.
0.0002841,	0.,	80.,	0.8,	3.	0.0008181,	0.,	1652.,	0.8,	4.
0.0002841,	0.3,	80.,	0.8,	3.	0.0008181,	0.3,	1652.,	0.8,	4.
0.0003889,	0.,	440.,	0.8,	3.	0.0009326,	0.,	2120.,	0.8,	4.
0.0003889,	0.3,	440.,	0.8,	3.	0.0009326,	0.3,	2120.,	0.8,	4.
0.0004826,	0.,	800.,	0.8,	3.	0.001051,	0.,	2600.,	0.8,	4.
0.0004826,	0.3,	800.,	0.8,	3.	0.001051,	0.3,	2600.,	0.8,	4.
0.000568,	0.,	1160.,	0.8,	3.	0.0002502,	0.,	80.,	1.,	4.
0.000568,	0.3,	1160.,	0.8,	3.	0.0002502,	0.3,	80.,	1.,	4.
0.0006764,	0.,	1652.,	0.8,	3.	0.0003465,	0.,	440.,	1.,	4.
0.0006764,	0.3,	1652.,	0.8,	3.	0.0003465,	0.3,	440.,	1.,	4.
0.000771,	0.,	2120.,	0.8,	3.	0.0004312,	0.,	800.,	1.,	4.
0.000771,	0.3,	2120.,	0.8,	3.	0.0004312,	0.3,	800.,	1.,	4.
0.0008689,	0.,	2600.,	0.8,	3.	0.0005073,	0.,	1160.,	1.,	4.
0.0008689,	0.3,	2600.,	0.8,	3.	0.0005073,	0.3,	1160.,	1.,	4.
0.0002068,	0.,	80.,	1.,	3.	0.0006042,	0.,	1652.,	1.,	4.
0.0002068,	0.3,	80.,	1.,	3.	0.0006042,	0.3,	1652.,	1.,	4.
0.0002865,	0.,	440.,	1.,	3.	0.000691,	0.,	2120.,	1.,	4.
0.0002865,	0.3,	440.,	1.,	3.	0.000691,	0.3,	2120.,	1.,	4.

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0.0007837,	0.,	2600.,	,	1.,	4.	1.,	0.
0.0007837,	0.3,	2600.,	,	1.,	4.	1.,	1.
	0.,	0.3003,	2600.,	,	1.,	4.	0., 1.001

\*Gap Radiation  
1., 1.

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Excerpt from letter from GrafTech International Ltd. providing properties for graphite used in the AGR-2 holders (Albers 2009).



UCAR CARBON COMPANY INC., a GrafTech International Ltd. company

12900 Snow Road • Parma, Ohio 44130

Tracy L. Albers, Ph. D.  
Research and Development Scientist  
Nuclear Graphite Specialist

(216) 676-2307  
Facsimile (216) 676-2276  
tracy.albers@graftech.com

October 5, 2009

Dear Mr. Doug Stacey:

Please find the attached chemical and physical properties of the materials shipped under contract #88582-2120. These samples have been sampled from 1 end for chemical determination of Boron Carbide and Boron. The remaining samples are included in this shipment, as specified in the order instructions.

The physical properties listed here have been reproduced from the original order processed under Purchase Order # 00050342.

**Physical Properties of Boronated Graphite\*-Post Purification:**

FO#	Density	WG Flexural Strength	WG Youngs Modulus	WG Specific Resistance	WG CTE (1" cube)	AG CTE (1" cube)	WG Thermal Conductivity (200C)	AG Thermal Conductivity (200C)
	g/cc	psi	x 10 <sup>6</sup> Psi	m ohm m	ppm/K	ppm/K	w/mK	w/mK
LP-61-6.2-1 (4 cores)	1.72	3168 (21.84Mpa)	2.10 (14.47Gpa)	8.38	1.58	1.98	89.1	76.4
LP-61-7.9-2 (4 cores)	1.70	2036 (14.03Mpa)	2.53 (17.44Gpa)	9.21	1.03	1.01	73.1	71.1

\*All testing reported in this table was carried out a room temperature.

**Physical Properties at Elevated Temperature (700-1300°C):**

	Core ID#	Core ID#
	LP61-6.2-1	LP61-7.9-2
Unirradiated Thermal Conductivity (wg/ag)	See below.	
Average Coefficient of Thermal Expansion (calculated) x ppm/°C	WG: 2.62 – 3.08 AG: 3.02 – 3.48	WG: 2.07 – 2.53 AG: 2.05 – 2.51
Average Specific Heat (700 – 1300 C) (J/kg-K) -	1807 @ 700 °C 2041 @ 1300 °C	1812 @ 700 °C 2048 @ 1300 °C

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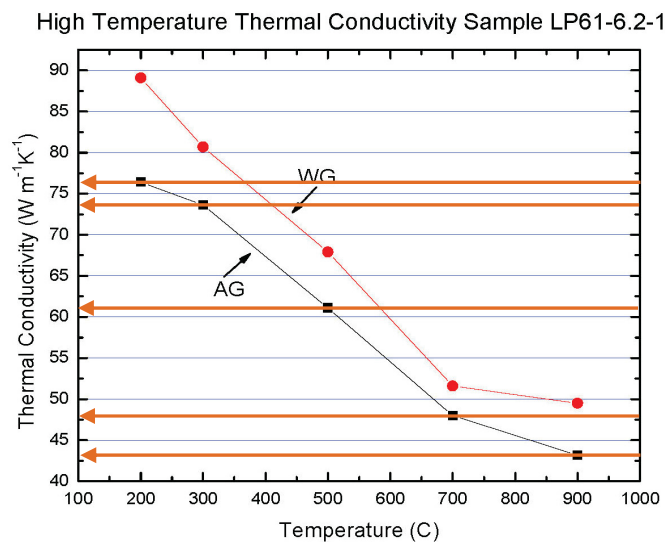
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Date: 08/13/2014

Continuation of letter from GrafTech by (Albers 2009).

• **Unirradiated Thermal Conductivity (200-900C)**



**Elemental Analysis of Boronated Graphite-Post Purification\*\*:**

	Core ID# LP61-6.2-1	Core ID# LP61-7.9-2
	Concentration (ppm)	Concentration (ppm)
Fe	0.57	0.55
V	2.5	3.8
Ti	1.8	<0.1
Ca	< 0.5	< 0.5
Cr	< 0.5	< 0.5
Mn	< 0.05	< 0.05
Co	< 0.05	< 0.05
Ni	1.5	9.5
Al	0.12	2.2
Cl	4.9	5.8
Total Ash	8.0%	13.6%

\*\* Results obtained by GDMS analysis (Shiva Technologies).

**Total Boron/Boron Carbide Content (by Titration)-Post Purification (Measured 9/22/2009):**

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Continuation of letter from GrafTech by (Albers 2009).

<b>LIMS ID</b>	<b>Sample Description</b>	<b>% B4C</b>	<b>% B</b>
2009-08737	LP61-6.2-1B	4.83	3.78
2009-08738	LP61-6.2-1C	4.94	3.87
2009-08739	LP61-6.2-1D	3.62	2.84
2009-08740	LP61-6.2-1E	4.29	3.36
2009-08741	LP61-7.9-2B	5.90	4.61
2009-08742	LP61-7.9-2C	4.92	3.85
2009-08743	LP61-7.9-2D	5.34	4.18
2009-08744	LP61-7.9-2E	5.75	4.50

**Grain Size Analysis:**

- Average Grain Size = 11.42  $\mu\text{m}$

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Project No.: 23843

Date: 08/13/2014

Sterbentz e-mail communication to G. L. Hawkes concerning conversion of fluence to dpa for graphite.



James W  
Sterbentz/BNZ/CC01/INEEL/U  
S

08/05/2009 05:39 PM

To Grant L Hawkes/HAW/CC01/INEEL/US@INEL

cc Misti A Lillo/LILLMA/CC01/INEEL/US@INEL

bcc

Subject Fast Flux to DPA multiplier

History:

This message has been replied to.

Grant,

The conversion factor for converting Misti's fast neutron fluence (neutrons/m<sup>2</sup>) greater than 0.18 MeV to dpa in graphite (borated graphite holders) is  $8.23271\text{E-}26$  which has units of (dpa/(n/m<sup>2</sup>)). Note the fast fluence value units are (neutrons per square meter).

The factor is virtually constant for all the borated graphite holder cells in the capsule—the fast fluence will of course vary from capsule to capsule because of the axial position in the ATR core and hence so will the capsule dpa.

This value checks out nicely with previously calculated dpa data.

Jim Sterbentz

Title: AGR-2 Daily As-run Thermal Analyses

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**Appendix C****Daily Gas Mixtures (Neon Fraction)****Cycle 147A**

Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.011
0.000	0.014	0.000	0.000
0.014	0.000	0.000	0.000
0.000	0.000	0.017	0.000
0.000	0.000	0.000	0.000
0.006	0.005	0.000	0.006
0.005	0.006	0.005	0.005
0.359	0.224	0.380	0.323
0.798	0.486	0.815	0.701
0.881	0.507	0.813	0.770
0.872	0.499	0.815	0.770
0.888	0.504	0.817	0.773
0.893	0.512	0.821	0.779
0.891	0.501	0.823	0.777
0.891	0.502	0.822	0.753
0.890	0.520	0.823	0.738
0.879	0.542	0.820	0.738
0.874	0.571	0.818	0.764
0.865	0.565	0.820	0.750
0.861	0.554	0.815	0.732
0.841	0.532	0.807	0.703
0.835	0.540	0.810	0.714
0.835	0.538	0.809	0.698
0.829	0.536	0.813	0.690
0.829	0.536	0.815	0.687
0.819	0.530	0.809	0.689
0.769	0.533	0.759	0.661
0.518	0.351	0.577	0.430
0.185	0.064	0.188	0.080
0.673	0.458	0.663	0.627
0.000	0.000	0.000	0.000
0.182	0.125	0.194	0.158
0.731	0.484	0.723	0.674
0.705	0.472	0.718	0.658
0.646	0.450	0.660	0.629
0.698	0.495	0.708	0.664
0.663	0.481	0.691	0.647
0.669	0.499	0.707	0.661
0.630	0.482	0.680	0.630
0.672	0.509	0.729	0.677
0.636	0.488	0.690	0.629
0.605	0.463	0.666	0.603
0.548	0.437	0.626	0.581
0.551	0.442	0.621	0.579
0.537	0.432	0.615	0.570
0.532	0.433	0.618	0.573
0.517	0.429	0.595	0.552
0.503	0.420	0.580	0.545
0.491	0.412	0.575	0.530
0.453	0.394	0.530	0.493
0.428	0.368	0.507	0.483
0.344	0.276	0.406	0.366

**Cycle 148A**

Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.176	0.000
0.037	0.026	0.078	0.025
0.857	0.661	0.907	0.784
0.877	0.671	0.932	0.812
0.877	0.671	0.932	0.812
0.877	0.671	0.931	0.812
0.877	0.671	0.931	0.812
0.807	0.608	0.912	0.796
0.773	0.581	0.898	0.783
0.758	0.566	0.858	0.783
0.740	0.548	0.834	0.783
0.749	0.563	0.843	0.787
0.771	0.598	0.867	0.800
0.771	0.598	0.867	0.799
0.756	0.598	0.858	0.800
0.753	0.608	0.857	0.808
0.754	0.611	0.859	0.809
0.754	0.611	0.859	0.809
0.754	0.611	0.859	0.809
0.743	0.611	0.849	0.809
0.714	0.588	0.820	0.804
0.705	0.581	0.805	0.767
0.705	0.581	0.806	0.767
0.674	0.581	0.791	0.767
0.671	0.586	0.789	0.767
0.704	0.598	0.807	0.767
0.704	0.598	0.807	0.767
0.704	0.598	0.808	0.767
0.702	0.612	0.807	0.766
0.686	0.597	0.802	0.761
0.392	0.339	0.457	0.430
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.214	0.170	0.235	0.207
0.654	0.501	0.742	0.656
0.629	0.494	0.734	0.667
0.650	0.516	0.751	0.687
0.632	0.497	0.738	0.668
0.605	0.481	0.713	0.622
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.518	0.408	0.546	0.482
0.605	0.464	0.694	0.566
0.592	0.456	0.667	0.538
0.574	0.441	0.643	0.513
0.545	0.413	0.618	0.519
0.399	0.296	0.464	0.405

Title: AGR-2 Daily As-run Thermal Analyses

ECAR No.: 2476

Rev. No.: 1

Project No.: 23843

Date: 08/13/2014

**Cycle 148B**

Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000
0.051	0.051	0.040	0.049
0.287	0.208	0.300	0.283
0.755	0.557	0.802	0.737
0.764	0.566	0.813	0.744
0.744	0.546	0.794	0.719
0.721	0.523	0.772	0.694
0.640	0.451	0.700	0.631
0.602	0.423	0.671	0.601
0.575	0.399	0.648	0.586
0.398	0.410	0.667	0.592
0.000	0.433	0.716	0.610
0.000	0.433	0.696	0.611
0.000	0.431	0.667	0.586
0.000	0.399	0.645	0.566
0.121	0.423	0.655	0.585
0.464	0.469	0.688	0.631
0.464	0.468	0.689	0.630
0.464	0.452	0.675	0.615
0.464	0.420	0.647	0.585
0.464	0.419	0.647	0.583
0.464	0.405	0.632	0.567
0.465	0.380	0.591	0.533
0.464	0.382	0.594	0.538
0.464	0.382	0.596	0.539
0.464	0.382	0.596	0.538
0.464	0.384	0.582	0.539
0.465	0.386	0.567	0.541
0.464	0.395	0.593	0.549
0.464	0.412	0.624	0.561
0.464	0.381	0.596	0.561
0.464	0.382	0.593	0.572
0.464	0.378	0.582	0.583
0.464	0.363	0.573	0.567
0.464	0.329	0.545	0.566
0.464	0.311	0.524	0.550
0.464	0.286	0.486	0.502
0.461	0.291	0.478	0.473
0.465	0.300	0.473	0.439
0.465	0.253	0.435	0.425
0.465	0.261	0.438	0.426
0.465	0.247	0.427	0.418
0.464	0.259	0.439	0.399
0.465	0.232	0.413	0.384
0.465	0.228	0.399	0.352
0.465	0.169	0.345	0.316
0.465	0.153	0.320	0.290
0.401	0.148	0.313	0.264
0.332	0.146	0.314	0.260
0.332	0.113	0.283	0.234
0.237	0.099	0.273	0.223
0.000	0.066	0.229	0.194
0.000	0.027	0.163	0.153

**Cycle 149A**

Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000
0.118	0.171	0.193	0.192
0.320	0.376	0.507	0.565
0.319	0.377	0.513	0.569
0.319	0.376	0.512	0.570
0.319	0.381	0.520	0.547
0.319	0.377	0.518	0.509
0.313	0.393	0.416	0.535
0.313	0.401	0.329	0.567
0.313	0.379	0.329	0.546
0.313	0.379	0.329	0.546
0.313	0.363	0.330	0.534
0.306	0.331	0.377	0.472
0.385	0.366	0.480	0.491
0.477	0.371	0.481	0.486
0.478	0.371	0.483	0.487
0.477	0.404	0.526	0.536
0.477	0.402	0.525	0.536
0.399	0.370	0.495	0.496
0.426	0.401	0.524	0.498
0.474	0.378	0.505	0.480
0.474	0.386	0.510	0.486
0.474	0.369	0.492	0.468
0.473	0.374	0.492	0.468
0.474	0.362	0.480	0.479
0.474	0.366	0.486	0.476
0.396	0.368	0.512	0.446
0.366	0.355	0.535	0.428
0.367	0.330	0.504	0.394
0.366	0.316	0.487	0.379
0.365	0.287	0.467	0.360
0.366	0.307	0.477	0.371
0.367	0.353	0.500	0.394
0.284	0.353	0.500	0.394
0.241	0.327	0.474	0.377
0.242	0.287	0.433	0.361
0.242	0.279	0.413	0.341
0.196	0.251	0.356	0.298

Title: AGR-2 Daily As-run Thermal Analyses

ECAR No.: 2476

Rev. No.: 1

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**Cycle 149B**

Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000
0.169	0.298	0.192	0.345
0.297	0.499	0.336	0.613
0.297	0.496	0.337	0.607
0.297	0.496	0.337	0.607
0.296	0.493	0.337	0.604
0.296	0.476	0.338	0.587
0.296	0.470	0.338	0.582
0.296	0.468	0.338	0.578
0.296	0.469	0.338	0.578
0.296	0.469	0.338	0.579
0.296	0.464	0.337	0.575
0.296	0.429	0.337	0.544
0.296	0.428	0.336	0.539
0.296	0.419	0.337	0.508
0.296	0.429	0.336	0.511
0.382	0.435	0.357	0.515
0.521	0.433	0.391	0.512
0.522	0.432	0.394	0.507
0.523	0.412	0.396	0.517
0.523	0.418	0.395	0.525
0.522	0.437	0.448	0.523
0.502	0.433	0.439	0.468
0.412	0.403	0.454	0.418
0.441	0.436	0.479	0.450
0.552	0.475	0.465	0.491
0.551	0.453	0.466	0.463
0.551	0.488	0.462	0.498
0.551	0.477	0.463	0.492
0.551	0.488	0.459	0.498
0.552	0.484	0.459	0.493
0.552	0.467	0.460	0.477
0.552	0.445	0.461	0.456
0.553	0.445	0.460	0.458
0.553	0.461	0.455	0.475
0.553	0.478	0.452	0.473
0.553	0.466	0.453	0.454
0.553	0.445	0.455	0.446
0.553	0.451	0.455	0.452
0.553	0.442	0.456	0.438
0.553	0.415	0.458	0.415
0.554	0.422	0.458	0.410
0.553	0.462	0.453	0.437
0.553	0.475	0.452	0.449
0.554	0.476	0.454	0.448
0.554	0.473	0.455	0.447
0.554	0.450	0.458	0.433
0.555	0.438	0.461	0.422
0.554	0.422	0.463	0.421
0.554	0.428	0.461	0.413
0.494	0.356	0.438	0.341
0.412	0.367	0.594	0.331
0.312	0.357	0.427	0.329
0.236	0.300	0.318	0.278
0.185	0.205	0.250	0.183

**Cycle 150B**

Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.290	0.329	0.282	0.397
0.400	0.321	0.339	0.505
0.458	0.291	0.484	0.435
0.484	0.391	0.396	0.564
0.496	0.379	0.395	0.554
0.496	0.375	0.408	0.534
0.496	0.357	0.391	0.515
0.496	0.342	0.378	0.481
0.496	0.323	0.363	0.455
0.496	0.356	0.387	0.501
0.497	0.346	0.382	0.494
0.497	0.335	0.367	0.466
0.496	0.323	0.357	0.441
0.497	0.346	0.356	0.469
0.497	0.364	0.371	0.498
0.497	0.357	0.398	0.483
0.497	0.355	0.440	0.470
0.497	0.354	0.425	0.454
0.497	0.365	0.432	0.473
0.497	0.356	0.424	0.457
0.497	0.345	0.416	0.433
0.497	0.329	0.434	0.394
0.497	0.312	0.450	0.368
0.499	0.299	0.411	0.337
0.234	0.111	0.282	0.089
0.000	0.000	0.000	0.000
0.010	0.010	0.010	0.010
0.488	0.297	0.313	0.341
0.500	0.281	0.278	0.346
0.299	0.161	0.131	0.156
0.005	0.037	0.000	0.000
0.033	0.002	0.038	0.003
0.094	0.003	0.094	0.004
0.111	0.151	0.183	0.100
0.131	0.174	0.212	0.122
0.131	0.171	0.205	0.120
0.131	0.179	0.178	0.124
0.047	0.046	0.044	0.066
0.111	0.094	0.244	0.000
0.109	0.087	0.207	0.000
0.038	0.039	0.030	0.026
0.000	0.000	0.000	0.000

Title: AGR-2 Daily As-run Thermal Analyses

ECAR No.: 2476

Rev. No.: 1

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Cycle 151A				Cycle 151B			
Cap02	Cap03	Cap05	Cap06	Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000	0.008	0.009	0.009	0.008
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.000	0.000	0.000	0.000	0.163	0.160	0.161	0.153
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.000	0.147	0.109	0.020	0.162	0.160	0.161	0.15
0.000	0.000	0.000	0.000	0.162	0.160	0.161	0.153
0.087	0.000	0.004	0.019	0.162	0.159	0.161	0.153
0.668	0.151	0.000	0.089	0.353	0.320	0.325	0.315
0.000	0.000	0.000	0.000	0.557	0.533	0.536	0.532
0.000	0.000	0.000	0.000	0.533	0.531	0.533	0.534
0.000	0.000	0.000	0.000	0.533	0.531	0.534	0.534
0.009	0.009	0.007	0.004	0.534	0.530	0.534	0.534
0.000	0.000	0.000	0.000	0.525	0.521	0.524	0.524
0.000	0.000	0.000	0.000	0.505	0.500	0.503	0.502
0.000	0.000	0.000	0.000	0.550	0.541	0.548	0.545
0.000	0.000	0.000	0.000	0.607	0.591	0.605	0.600
0.000	0.000	0.000	0.000	0.608	0.591	0.606	0.599
0.000	0.000	0.000	0.000	0.608	0.591	0.605	0.598
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.124	0.123	0.124	0.122
0.000	0.000	0.000	0.000	0.648	0.637	0.647	0.634
0.000	0.000	0.000	0.000	0.620	0.606	0.616	0.604
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.229	0.260	0.108	0.178	0.000	0.000	0.000	0.000
0.629	0.470	0.352	0.512	0.238	0.233	0.234	0.231
0.499	0.441	0.534	0.458	0.627	0.611	0.618	0.527
0.499	0.428	0.534	0.446	0.618	0.600	0.607	0.594
0.499	0.425	0.393	0.434	0.613	0.595	0.602	0.590
0.499	0.417	0.384	0.425	0.613	0.595	0.602	0.588
0.499	0.447	0.582	0.465	0.613	0.595	0.602	0.587
0.499	0.496	0.496	0.490	0.613	0.595	0.601	0.587
0.499	0.496	0.496	0.490	0.598	0.577	0.582	0.569
0.499	0.496	0.496	0.490	0.556	0.528	0.529	0.521
0.499	0.496	0.496	0.491	0.556	0.528	0.529	0.520
0.493	0.490	0.490	0.484	0.553	0.526	0.527	0.518
0.432	0.426	0.428	0.419	0.526	0.498	0.498	0.454
0.432	0.426	0.428	0.420	0.478	0.445	0.446	0.437
0.432	0.426	0.428	0.420	0.478	0.445	0.446	0.437
0.432	0.426	0.428	0.420	0.477	0.445	0.446	0.437
0.432	0.426	0.428	0.420	0.472	0.439	0.440	0.431
0.432	0.426	0.428	0.420	0.455	0.412	0.413	0.404
0.404	0.401	0.401	0.392	0.462	0.412	0.412	0.404
0.386	0.385	0.384	0.375	0.462	0.410	0.411	0.402
0.357	0.354	0.354	0.346	0.458	0.405	0.406	0.398
0.298	0.295	0.295	0.287	0.433	0.378	0.379	0.370
0.277	0.274	0.274	0.266	0.410	0.354	0.354	0.346
0.265	0.261	0.262	0.254	0.356	0.294	0.295	0.291
0.265	0.261	0.262	0.254	0.355	0.294	0.295	0.293
0.265	0.261	0.262	0.254	0.355	0.294	0.295	0.294
0.253	0.252	0.250	0.242	0.355	0.294	0.295	0.294
0.231	0.236	0.228	0.220	0.324	0.260	0.261	0.261
0.215	0.222	0.212	0.204	0.282	0.212	0.213	0.213
0.186	0.187	0.180	0.172	0.248	0.194	0.179	0.177
0.173	0.163	0.162	0.154				
0.157	0.142	0.142	0.130				

Title: AGR-2 Daily As-run Thermal Analyses

ECAR No.: 2476

Rev. No.: 1

Project No.: 23843

Date: 08/13/2014

Cycle	152B		
Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000
0.001	0.001	0.001	0.000
0.492	0.486	0.532	0.525
0.550	0.543	0.597	0.589
0.551	0.543	0.597	0.589
0.552	0.545	0.596	0.589
0.553	0.533	0.596	0.588
0.550	0.531	0.594	0.587
0.552	0.534	0.596	0.589
0.552	0.534	0.596	0.589
0.552	0.535	0.596	0.589
0.553	0.536	0.596	0.589
0.554	0.537	0.596	0.589
0.586	0.579	0.595	0.588
0.598	0.595	0.595	0.587
0.598	0.595	0.595	0.587
0.599	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.599	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.587	0.583	0.587	0.580
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.594	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.594	0.595	0.587
0.598	0.595	0.595	0.587
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.588
0.598	0.595	0.595	0.587
0.598	0.595	0.595	0.587
0.598	0.595	0.595	0.588
0.573	0.570	0.570	0.563
0.528	0.524	0.528	0.521
0.529	0.525	0.528	0.521
0.306	0.313	0.278	0.288

Cycle	153B			
Cap02	Cap03	Cap05	Cap06	
0.000	0.000	0.000	0.000	
0.000	0.000	0.000	0.000	
0.373	0.322	0.379	0.364	
0.918	0.862	0.974	0.941	
0.791	0.780	0.780	0.776	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.976	0.930	0.927	
0.976	0.975	0.938	0.944	

Title: AGR-2 Daily As-run Thermal Analyses

ECAR No.: 2476

Rev. No.: 1

Project No.: 23843

Date: 08/13/2014

Cycle 154A				Cycle 154B			
Cap02	Cap03	Cap05	Cap06	Cap02	Cap03	Cap05	Cap06
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.361	0.345	0.322	0.341	0.000	0.000	0.000	0.000
0.734	0.720	0.709	0.722	0.604	0.604	0.603	0.603
0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
0.534	0.530	0.528	0.526	1.000	1.000	1.000	1.000
0.861	0.856	0.856	0.850	1.000	1.000	1.000	1.000
0.862	0.857	0.857	0.851	1.000	1.000	1.000	1.000
0.847	0.843	0.844	0.827	1.000	1.000	1.000	1.000
0.860	0.855	0.855	0.840	1.000	1.000	1.000	1.000
0.869	0.864	0.864	0.842	1.000	1.000	1.000	1.000
0.861	0.856	0.858	0.843	1.000	1.000	1.000	1.000
0.849	0.845	0.847	0.839	1.000	1.000	1.000	1.000
0.849	0.845	0.847	0.835	1.000	1.000	1.000	1.000
0.842	0.826	0.827	0.822	1.000	1.000	1.000	1.000
0.819	0.815	0.816	0.808	1.000	1.000	1.000	1.000
0.814	0.810	0.811	0.800	1.000	1.000	1.000	1.000
0.792	0.788	0.789	0.782	1.000	1.000	1.000	1.000
0.770	0.767	0.770	0.762	1.000	1.000	1.000	1.000
0.732	0.732	0.738	0.729	1.000	1.000	1.000	1.000
0.785	0.785	0.786	0.781	1.000	1.000	1.000	1.000
0.799	0.798	0.798	0.791	1.000	1.000	1.000	1.000
0.799	0.798	0.798	0.788	1.000	1.000	1.000	1.000
0.799	0.798	0.798	0.786	1.000	1.000	1.000	1.000
0.799	0.798	0.798	0.784	1.000	1.000	1.000	1.000
0.802	0.800	0.800	0.782	1.000	1.000	1.000	1.000
0.807	0.802	0.802	0.779	1.000	1.000	1.000	1.000
0.799	0.794	0.795	0.776	1.000	1.000	1.000	1.000
0.799	0.794	0.795	0.774	1.000	1.000	1.000	1.000
0.807	0.802	0.802	0.773	1.000	1.000	1.000	1.000
0.868	0.863	0.861	0.787	1.000	1.000	1.000	1.000
0.819	0.816	0.816	0.764	1.000	1.000	1.000	1.000
0.759	0.755	0.750	0.682	0.982	0.981	0.978	0.980
0.777	0.773	0.770	0.695	0.990	0.990	0.991	0.990
0.801	0.797	0.798	0.708	0.989	0.989	0.990	0.989
0.841	0.833	0.830	0.709	0.976	0.976	0.974	0.976
0.875	0.867	0.862	0.716	0.982	0.982	0.981	0.982
0.877	0.877	0.879	0.716	0.977	0.976	0.975	0.976
0.866	0.867	0.869	0.712	0.968	0.968	0.966	0.967
0.803	0.808	0.813	0.723	0.936	0.937	0.936	0.937
0.819	0.822	0.829	0.746	0.924	0.924	0.923	0.924
0.860	0.861	0.865	0.752	0.917	0.918	0.917	0.917
0.857	0.856	0.858	0.749	0.918	0.918	0.918	0.918
0.839	0.837	0.837	0.743	0.887	0.887	0.887	0.887
0.816	0.815	0.815	0.736	0.850	0.850	0.850	0.850
0.810	0.809	0.811	0.732	0.851	0.851	0.851	0.851
0.879	0.877	0.877	0.747	0.868	0.868	0.868	0.869
0.879	0.877	0.877	0.746	0.853	0.853	0.853	0.853
0.882	0.877	0.879	0.753	0.828	0.828	0.828	0.828
0.858	0.855	0.858	0.745	0.833	0.833	0.833	0.833
0.794	0.797	0.803	0.719	0.809	0.809	0.809	0.809
0.763	0.765	0.773	0.696	0.760	0.760	0.760	0.760
0.757	0.756	0.757	0.692	0.707	0.707	0.707	0.707
0.682	0.682	0.685	0.656	0.613	0.613	0.613	0.613
0.644	0.644	0.647	0.626	0.303	0.303	0.303	0.306
0.405	0.418	0.450	0.429				

Title: AGR-2 Daily As-run Thermal Analyses

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## Appendix D

### AGR-2 As-Built Gas Gaps

Stacey email communication to G. L. Hawkes concerning as-built gas gaps.



**Douglas E Stacey/STACDE/CC01/INEEL/US**  
11/29/2011 03:13 PM

To Grant L Hawkes/HAW/CC01/INEEL/US@INEL

cc

bcc

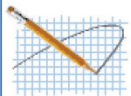
Subject Re: AGR-2 Measurements and Data Summary (Doug Stacey) TAVA Calcs.xlsx 

Grant,

These are the gas gaps that I calculated for AGR-2 using the QA as-built measurements of the ID of each capsule body and the OD of each graphite holder. The QA inspections sheets are included in the following work orders. I believe the work orders have been scanned into the Project File.

Work Order #	Work Order Title/ Work Scope
WR 09-208	FABRICATE AGR-2 QUALITY LEVEL 1 COMPONENTS
WR 09-209	FABRICATE AGR-2 QUALITY LEVEL 2 COMPONENTS

Grant L Hawkes/HAW/CC01/INEEL/US



**Grant L Hawkes/HAW/CC01/INEEL/US**  
11/23/2011 03:46 PM

To Douglas E Stacey/STACDE/CC01/INEEL/US@INEL

cc

Subject AGR-2 Measurements and Data Summary (Doug Stacey) TAVA Calcs.xlsx

Doug,

I am writing an ECAR concerning the thermal predictions for the AGR-2 experiment. You sent me this file earlier. Would you please send me back an email stating that these gas gaps are the as-built gaps for AGR-2. I need this for a reference for the gas gaps.

You'll notice that I've added two tabs for my own thermal calculation purposes.

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Capsule 6 (dwg 600915)			
Measured ID of Capsule Body	Measured OD of Graphite Holder	Thickness of Heat Shield	Actual Gas Gap (ID - OD)/2 - .002
1.257	1.207	0.002	0.023
Capsule 5 (dwg 600914)			
Measured ID of Capsule Body	Measured OD of Graphite Holder	Thickness of Heat Shield	Actual Gas Gap (ID - OD)/2
1.256	1.225	NA	0.016

Capsule 3 (dwg 600912)			
Measured ID of Capsule Body	Measured OD of Graphite Holder	Thickness of Heat Shield	Actual Gas Gap (ID - OD)/2
1.257	1.195	NA	0.031
Capsule 2 (dwg 600911)			
Measured ID of Capsule Body	Measured OD of Graphite Holder	Thickness of Heat Shield	Actual Gas Gap (ID - OD)/2
1.257	1.207	NA	0.025

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<b>Capsule 6 (dwg 600915)</b>				
Measured ID of Fuel Holes in Graphite	Smallest Fuel Compact OD	Largest Fuel Compact OD	Largest Annulus (ID - SOD)/2	Smallest Annulus (ID -
0.488	0.4836	0.4836	0.0022	0.0022
<b>Capsule 5 (dwg 600914)</b>				
Measured ID of Fuel Holes in Graphite	Smallest Fuel Compact OD	Largest Fuel Compact OD	Largest Annulus (ID - SOD)/2	Smallest Annulus (ID -
0.488	0.4836	0.4837	0.0022	0.0021

<b>Capsule 3 (dwg 600912)</b>				
Measured ID of Fuel Holes in Graphite	Smallest Fuel Compact OD	Largest Fuel Compact OD	Largest Annulus (ID - SOD)/2	Smallest Annulus (ID -
0.486	0.4830	0.4832	0.0015	0.0014
<b>Capsule 2 (dwg 600911)</b>				
Measured ID of Fuel Holes in Graphite	Smallest Fuel Compact OD	Largest Fuel Compact OD	Largest Annulus (ID - SOD)/2	Smallest Annulus (ID -
0.487	0.4838	0.4839	0.0016	0.0016

Title: AGR-2 Daily As-run Thermal Analyses

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Capsule 6 (dwg 600915)					
TC	Radius	Angle from Due North (Clockwise)	Designed TC Insertion Depth Into Graphite	Measured TC Length From Bottom of Capsule	Actual TC Depth (Measured - Head)
T-6-1	0.535	353.0	3.00	3.342	2.999
T-6-2	0.535	307.0	0.75	1.120	0.777
T-6-3	0	Center of Holder	0.75	1.120	0.777
T-6-4	0.535	113.0	2.00	2.365	2.022
T-6-5	0.535	233.0	0.75	1.120	0.777
Capsule 5 (dwg 600914)					
TC	Radius	Angle from Due North (Clockwise)	Designed TC Insertion Depth Into Graphite	Measured TC Length From Bottom of Capsule	Actual TC Depth (Measured - Head)
T-5-1	0.535	307.0	3.00	3.500	3.157
T-5-2	0.535	233.0	0.75	1.078	0.735

Capsule 3 (dwg 600912)					
TC	Radius	Angle from Due North (Clockwise)	Designed TC Insertion Depth Into Graphite	Measured TC Length From Bottom of Capsule	Actual TC Depth (Measured - Head)
T-3-1	0.535	307.0	3.00	3.605	3.262
T-3-2	0.535	233.0	0.75	1.078	0.735
Capsule 2 (dwg 600911)					
TC	Radius	Angle from Due North (Clockwise)	Designed TC Insertion Depth Into Graphite	Measured TC Length From Bottom of Capsule	Actual TC Depth (Measured - Head)
T-2-1	0.535	307.0	3.00	3.605	3.262
T-2-2	0.535	233.0	0.75	1.078	0.735

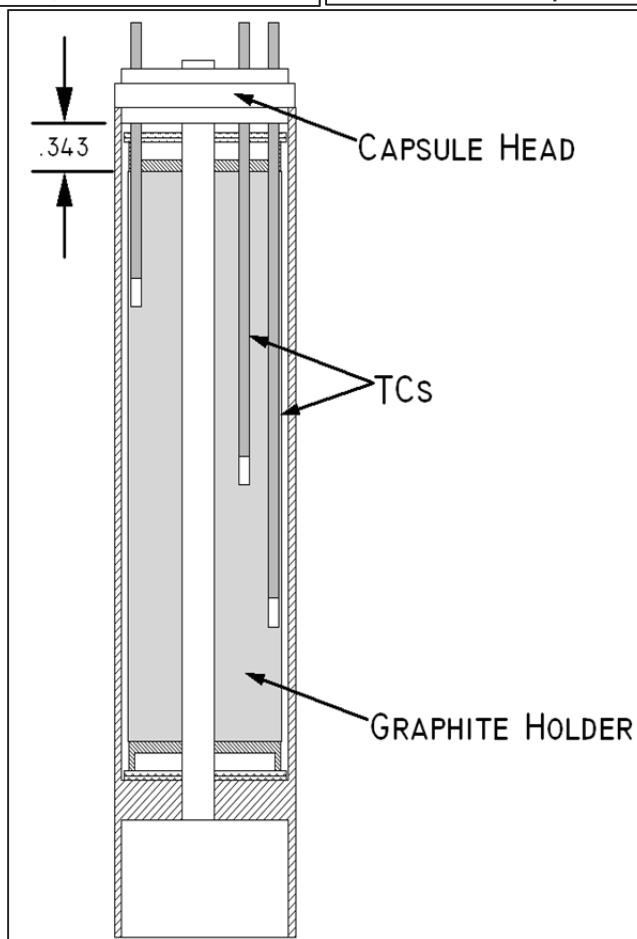
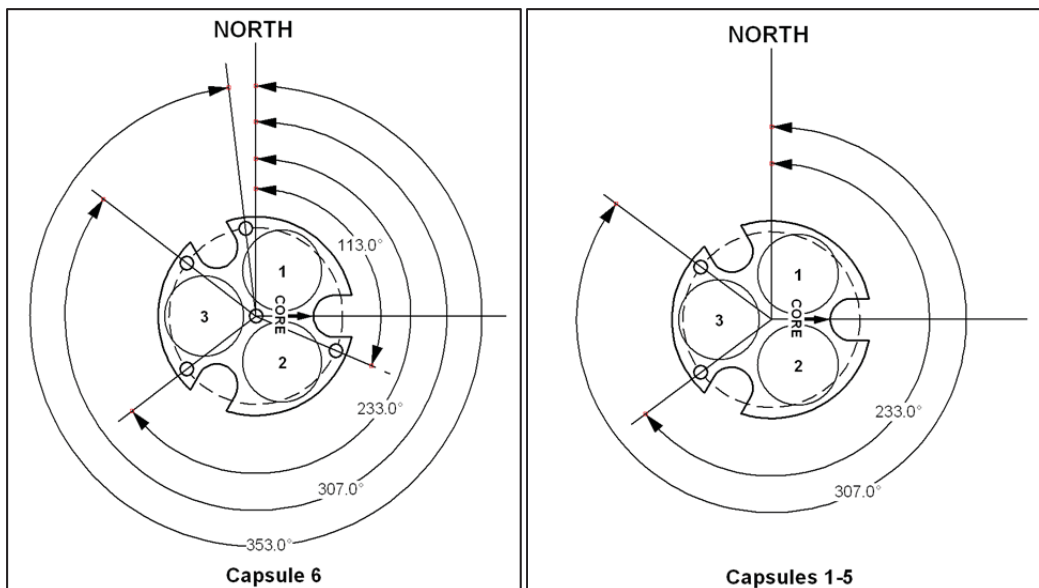
Title: AGR-2 Daily As-run Thermal Analyses

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## Appendix E

### Computer Files on Quark

#### Shared AGR2 Directory

```
quark.1031 /projects/agr/agr2/1st_run => ll
drwxrws--- 14 agr 4096 Nov 6 17:32 ./
drwxrws--- 4 agr 4096 Mar 29 2012 ../
drwxrws--- 3 agr 4096 Apr 17 2013 147A/
drwxrws--- 3 agr 4096 Jun 6 2012 148A/
drwxrws--- 3 agr 4096 Jun 7 2012 148B/
drwxrws--- 3 agr 4096 Jun 7 2012 149A/
drwxrws--- 3 agr 4096 Oct 17 2012 149B/
drwxrws--- 3 agr 4096 Feb 24 09:40 150B/
drwxrws--- 3 agr 4096 Oct 17 2012 151B/
drwxrws--- 3 agr 4096 Apr 24 2013 151A/
drwxrws--- 3 agr 4096 Oct 17 2012 151B/
drwxrws--- 3 agr 4096 Jul 30 2013 152B/
drwxrws--- 3 agr 4096 Jul 31 2013 153B/
drwxrws--- 3 agr 4096 Jul 30 2013 154A/
drwxrws--- 3 agr 4096 Nov 13 16:28 154B/
```

```
quark.1032 /projects/agr/agr2/1st_run => ll 147A
drwxrws--- 3 agr 4096 Apr 17 2013 ./
drwxrws--- 14 agr 4096 Nov 6 17:32 ../
-rwxrwx--- 1 agr 2214 Mar 15 2012 147A_Neon_Fraction*
-rwxrwx--- 1 agr 4987323 Oct 25 2011 b8comp2.check.1*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.10*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.11*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.12*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.13*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.14*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.15*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.16*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.17*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.18*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.19*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.2*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.20*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.21*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.22*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.23*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.24*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.25*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.26*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.27*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.28*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.29*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.3*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.30*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.31*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.32*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.33*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.34*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.35*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.36*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.37*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.38*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.39*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.4*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.40*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.41*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.42*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.43*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.44*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.45*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.46*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.47*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.48*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.49*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.5*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.50*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.51*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.52*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.53*
```

```
-rwxrwx--- 1 agr 2666881 Oct 25 2011 b8comp2.check.54*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.6*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.7*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.8*
-rwxrwx--- 1 agr 2694097 Oct 25 2011 b8comp2.check.9*
-rwxrwx--- 1 agr 158784 Oct 25 2011 combobor.hawkes.147A.output*
-rwxrwx--- 1 agr 923267 Oct 25 2011 combo.hawkes.147A.output*
-rwxrwx--- 1 agr 2927 Mar 13 2012 grepper_147A*
drwxrws--- 2 agr 4096 Mar 30 2012 heat/
-rwxrwx--- 1 agr 172343 Oct 26 2011
heatr4.17.components.147A.output*
```

```
quark.1034 /projects/agr/agr2/1st_run => ll 147A/heat
drwxrws--- 2 agr 4096 Mar 30 2012 ./
drwxrws--- 3 agr 4096 Apr 17 2013 ../
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.01*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.02*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.03*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.04*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.05*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.06*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.07*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.08*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.09*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.10*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.11*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.12*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.13*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.14*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.15*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.16*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.17*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.18*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.19*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.20*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.21*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.22*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.23*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.24*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.25*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.26*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.27*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.28*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.29*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.30*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.31*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.32*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.33*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.34*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.35*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.36*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.37*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.38*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.39*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.40*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.41*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.42*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.43*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.44*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.45*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.46*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.47*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.48*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.49*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.50*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.51*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.52*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.53*
-rwxrwx--- 1 agr 11895 Mar 13 2012 147A_fiss.54*
```

Title: AGR-2 Daily As-run Thermal Analyses

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Rev. No.: 1

Project No.: 23843

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**AGR2 Working Directory**

```
quark.1187 ~/agr/agr2/dailycalcs/1st_run/vargap => ls -al 147A*

drwxr-xr-x 2 haw haw 73728 Apr 16 10:12 .
drwxr-xr-x 17 haw haw 4096 Jan 2 15:22 ..
-rw-r--r-- 1 haw haw 323140752 Dec 24 13:35 147A_cap1.fil
-rw-r--r-- 1 haw haw 17 Dec 24 12:17 147A_cap1.if
-rw-r--r-- 1 haw haw 144 Dec 24 13:35 147A_cap1.of
-rw-r--r-- 1 haw haw 23555 Dec 24 13:35 147A_cap1.out
-rw-r--r-- 1 haw haw 23384 Dec 24 13:35 147A_cap1.outc
-rwxr--r-- 1 haw haw 17198 Dec 24 12:20 147A_cap1_vargap.com
-rw-r--r-- 1 haw haw 156326605 Dec 24 13:35 147A_cap1_vargap.dat
-rw-r--r-- 1 haw haw 35055395 Dec 24 11:56 147A_cap1_vargap.inp
-rw-r--r-- 1 haw haw 428916 Dec 24 13:35 147A_cap1_vargap.msg
-rw-r--r-- 1 haw haw 1576 Dec 24 12:17 147A_cap1_vargap.sh
-rw-r--r-- 1 haw haw 3987 Dec 24 13:35 147A_cap1_vargap.sta
-rw-r--r-- 1 haw haw 323140752 Dec 24 13:33 147A_cap2.fil
-rw-r--r-- 1 haw haw 17 Dec 24 12:17 147A_cap2.if
-rw-r--r-- 1 haw haw 144 Dec 24 13:33 147A_cap2.of
-rw-r--r-- 1 haw haw 23555 Dec 24 13:33 147A_cap2.out
-rw-r--r-- 1 haw haw 23384 Dec 24 13:33 147A_cap2.outc
-rwxr--r-- 1 haw haw 17198 Dec 24 12:20 147A_cap2_vargap.com
-rw-r--r-- 1 haw haw 156326547 Dec 24 13:33 147A_cap2_vargap.dat
-rw-r--r-- 1 haw haw 35053102 Dec 24 11:56 147A_cap2_vargap.inp
-rw-r--r-- 1 haw haw 426766 Dec 24 13:33 147A_cap2_vargap.msg
-rw-r--r-- 1 haw haw 1576 Dec 24 12:17 147A_cap2_vargap.sh
-rw-r--r-- 1 haw haw 3987 Dec 24 13:33 147A_cap2_vargap.sta
-rw-r--r-- 1 haw haw 323140752 Dec 24 13:34 147A_cap3.fil
-rw-r--r-- 1 haw haw 17 Dec 24 12:17 147A_cap3.if
-rw-r--r-- 1 haw haw 144 Dec 24 13:34 147A_cap3.of
-rw-r--r-- 1 haw haw 23555 Dec 24 13:34 147A_cap3.out
-rw-r--r-- 1 haw haw 23384 Dec 24 13:34 147A_cap3.outc
-rwxr--r-- 1 haw haw 17198 Dec 24 12:20 147A_cap3_vargap.com
-rw-r--r-- 1 haw haw 156326605 Dec 24 13:34 147A_cap3_vargap.dat
-rw-r--r-- 1 haw haw 35055341 Dec 24 11:56 147A_cap3_vargap.inp
-rw-r--r-- 1 haw haw 427202 Dec 24 13:34 147A_cap3_vargap.msg
-rw-r--r-- 1 haw haw 1576 Dec 24 12:17 147A_cap3_vargap.sh
-rw-r--r-- 1 haw haw 3987 Dec 24 13:34 147A_cap3_vargap.sta
-rw-r--r-- 1 haw haw 323140752 Dec 24 13:34 147A_cap4.fil
-rw-r--r-- 1 haw haw 17 Dec 24 12:17 147A_cap4.if
-rw-r--r-- 1 haw haw 144 Dec 24 13:34 147A_cap4.of
-rw-r--r-- 1 haw haw 23555 Dec 24 13:34 147A_cap4.out
-rw-r--r-- 1 haw haw 23384 Dec 24 13:34 147A_cap4.outc
-rwxr--r-- 1 haw haw 17198 Dec 24 12:20 147A_cap4_vargap.com
-rw-r--r-- 1 haw haw 156326605 Dec 24 13:34 147A_cap4_vargap.dat
-rw-r--r-- 1 haw haw 35055410 Dec 24 11:56 147A_cap4_vargap.inp
-rw-r--r-- 1 haw haw 427233 Dec 24 13:34 147A_cap4_vargap.msg
-rw-r--r-- 1 haw haw 1576 Dec 24 12:17 147A_cap4_vargap.sh
```

```
-rw-r--r-- 1 haw haw 3987 Dec 24 13:34 147A_cap4_vargap.sta
-rw-r--r-- 1 haw haw 323140752 Dec 24 13:36 147A_cap5.fil
-rw-r--r-- 1 haw haw 17 Dec 24 12:17 147A_cap5.if
-rw-r--r-- 1 haw haw 144 Dec 24 13:36 147A_cap5.of
-rw-r--r-- 1 haw haw 23555 Dec 24 13:36 147A_cap5.out
-rw-r--r-- 1 haw haw 23384 Dec 24 13:36 147A_cap5.outc
-rwxr--r-- 1 haw haw 17198 Dec 24 12:20 147A_cap5_vargap.com
-rw-r--r-- 1 haw haw 156326547 Dec 24 13:36 147A_cap5_vargap.dat
-rw-r--r-- 1 haw haw 35053118 Dec 24 11:56 147A_cap5_vargap.inp
-rw-r--r-- 1 haw haw 429547 Dec 24 13:36 147A_cap5_vargap.msg
-rw-r--r-- 1 haw haw 1576 Dec 24 12:17 147A_cap5_vargap.sh
-rw-r--r-- 1 haw haw 3987 Dec 24 13:36 147A_cap5_vargap.sta
-rw-r--r-- 1 haw haw 321544296 Dec 24 13:29 147A_cap6.fil
-rw-r--r-- 1 haw haw 17 Dec 24 12:17 147A_cap6.if
-rw-r--r-- 1 haw haw 144 Dec 24 13:29 147A_cap6.of
-rw-r--r-- 1 haw haw 23555 Dec 24 13:29 147A_cap6.out
-rw-r--r-- 1 haw haw 23384 Dec 24 13:29 147A_cap6.outc
-rwxr--r-- 1 haw haw 17198 Dec 24 12:20 147A_cap6_vargap.com
-rw-r--r-- 1 haw haw 153497070 Dec 24 13:29 147A_cap6_vargap.dat
-rw-r--r-- 1 haw haw 33535767 Dec 24 11:56 147A_cap6_vargap.inp
-rw-r--r-- 1 haw haw 430180 Dec 24 13:29 147A_cap6_vargap.msg
-rw-r--r-- 1 haw haw 1576 Dec 24 12:17 147A_cap6_vargap.sh
-rw-r--r-- 1 haw haw 3987 Dec 24 13:29 147A_cap6_vargap.sta
-rw-r--r-- 1 haw haw 5 Dec 24 12:06 147A.if
-rw-r--r-- 1 haw haw 32 Dec 24 11:56 147A.of
```

**AGR2 Models Directory**

quark.1206 ~/agr/agr2/models =&gt; ll

```
drwxr-xr-x 2 haw 4096 Apr 16 10:19 ./
drwxr-xr-x 12 haw 4096 Nov 13 16:10 ../
-rw-r--r-- 1 haw 170 Jul 9 2012 agr2_cap1_nset
-rw-r--r-- 1 haw 170 Jul 9 2012 agr2_cap2_nset
-rw-r--r-- 1 haw 170 Jul 9 2012 agr2_cap3_nset
-rw-r--r-- 1 haw 170 Jul 9 2012 agr2_cap4_nset
-rw-r--r-- 1 haw 170 Jul 9 2012 agr2_cap5_nset
-rw-r--r-- 1 haw 232 Jul 9 2012 agr2_cap6_nset
-rw-r--r-- 1 haw 34818362 Dec 24 10:50 cap1_agr2_vargap.inp
-rw-r--r-- 1 haw 34816069 Dec 24 10:48 cap2_agr2_vargap.inp
-rw-r--r-- 1 haw 34818308 Dec 24 10:48 cap3_agr2_vargap.inp
-rw-r--r-- 1 haw 34818378 Dec 24 10:48 cap4_agr2_vargap.inp
-rw-r--r-- 1 haw 34816085 Dec 24 10:48 cap5_agr2_vargap.inp
-rw-r--r-- 1 haw 33298734 Dec 24 10:48 cap6_agr2_vargap.inp
-rwxr--r-- 1 haw 458 Dec 24 10:48 catter_vargap_nset*
```