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Simulation of Transient Prescription Experiments in the

Transient Reactor Test Facility (TREAT) Using Serpent

by

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A thesis

submitted in partial fulfillment

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Transient Reactor Test Facility (TREAT) Using Serpent

Thesis Abstract -- Idaho State University (2018)

The Transient Reactor Test Facility, or TREAT, is a test reactor designed for putting materials and fuels under extreme conditions that ran for almost 35 years until it was put on standby in 1994. After the nuclear accident at Fukushima Daiichi in 2011, there became a renewed awareness of the need for the accident testing for reactors. There were calls for TREAT to be brought back into operation. This would allow further accident testing of nuclear fuels and materials to restart. TREAT achieved its first criticality after 23 years on November 14, 2017. But something else has happened while TREAT was offline. Computers have gotten faster, and accurate simulations and models of reactor behavior has become financially and technologically viable. Using Serpent, a Monte Carlo reactor physics code developed at the VTT Technical Research Centre in Finland, we can show that it is possible to accurately model transients for TREAT.

Key Words: Kinetics, Modeling, Monte Carlo, Serpent, Transients, TREAT

Introduction to TREAT

TREAT is a graphite moderated, air-cooled research reactor designed to test reactor fuel pins under extreme conditions of overheating and overpowering. These operations are called transients tests, where the target is placed in the reactor and subjected to a rapid pulse of high-power radiation. The transients can emulate fuel meltdowns, metal-water reactions resulting from both high and low pressure steam, thermal interaction between overheated fuel and coolant, and the transient behavior of ceramic fuel for high temperature systems [Freund, 1958]. TREAT is a great resource for engineers to safely test their designs for worst-case scenarios.

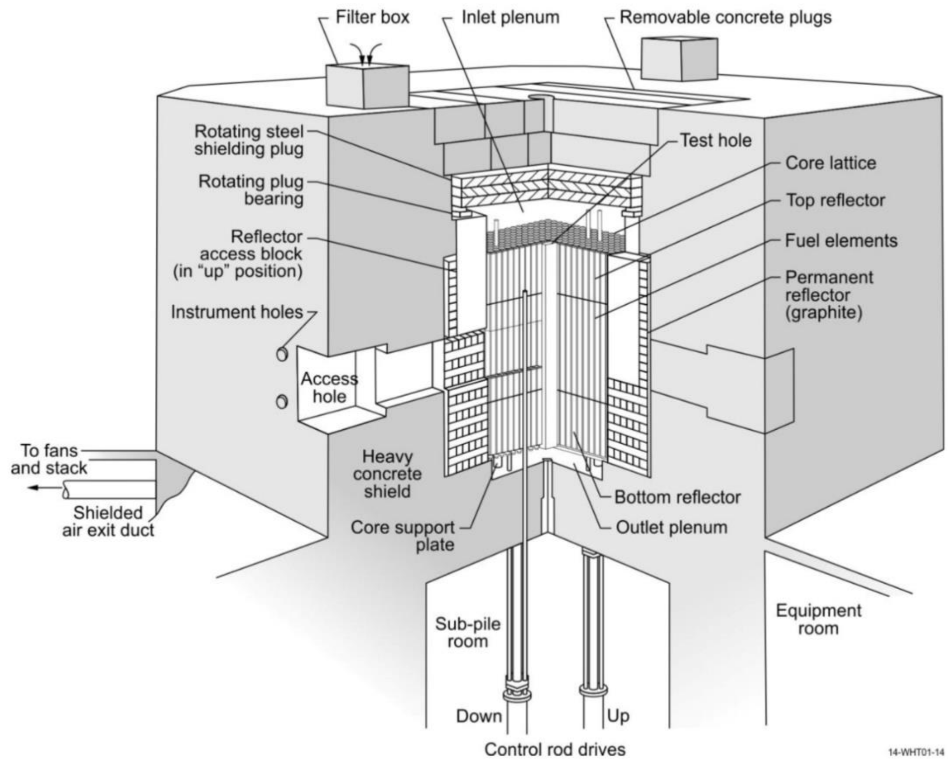

Figure 1 — TREAT Design [Bess & DeHart, 2015]

The TREAT complex was constructed in 1958 at Argonne National Laboratory's Argonne-West, now part of Idaho National Laboratory. Located 28 miles west of Idaho Falls, TREAT is comprised of two buildings, the reactor building and the control building. The reactor building is an aluminum-sided structure with a steel frame and has a 35 ft. tall high bay area where the reactor, fuel storage pit, instrument room, and equipment are housed. The control rod driving mechanisms are housed directly underneath the reactor in the basement. There is also a bridge crane for moving materials into and out of the reactor. The control building was single-story and made of concrete, and houses the control room, where the reactor is remotely controlled [ANL-6034]. In the 1980s it was changed to a portable building. The TREAT facility's close proximity to hot cells at the Materials and Fuels Complex- the Hot Fuels Examination Facility and the Fuel Conditioning Facility, allows ample opportunity for post-irradiation testing to be done with the transients run at TREAT. In 1994, TREAT was placed on standby. After the accident at the Fukushima Daiichi Power Plant in 2011, an effort was made to have TREAT restarted to continue performing safety tests on nuclear fuels and materials. A congressional mandate to restart TREAT for more accident-tolerant fuels was passed. TREAT achieved its first criticality after 23 years on November 14, 2017.

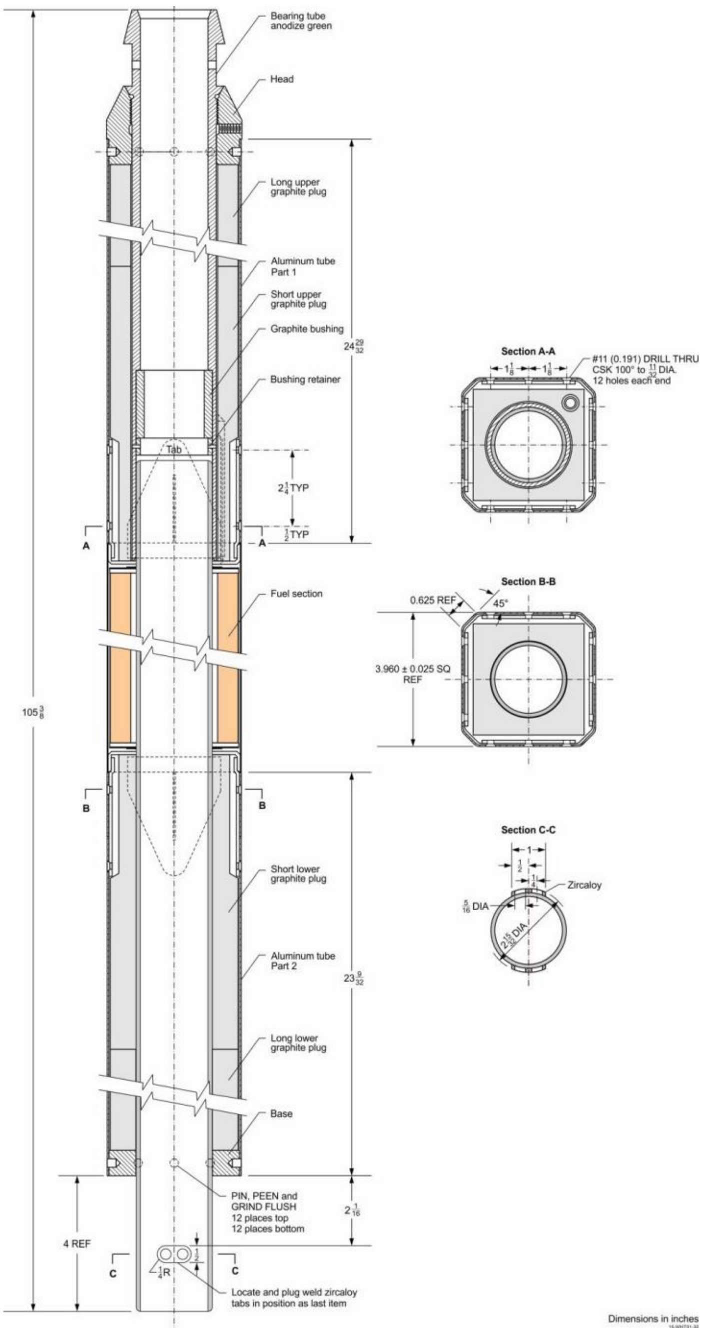

Figure 2 — Fuel Assembly

Fuel

The fuel used by TREAT is UO_2 mixed in graphite. The graphite serves as both a moderator and a heat sink. TREAT has a very strong negative temperature coefficient. The carbon-to-uranium-235 atom ratio of TREAT is 10,000: 1. The uranium is enriched with a weight percentage of 93.24 wt.%.

The fuel was produced by a baking process that resulted in partial graphitization. First, they took the uranium, in the form of U_3O_8, graphite flour, thermax (a carbon product from Thermatomic), and Koppers coal tar and pressed it together. This mixture was then baked at 950°C, allowing it to partially graphitize. The heat converted most of the U_3O_8 to UO_2, but the carbon could not fully graphitize at this temperature. Only 59% of the carbon was turned into graphite after baking [Bess & DeHart, 2015]. The reason 950°C was chosen was to avoid the uranium converting to uranium carbide [Pavone, 1957].

Reactor Core

TREAT's core region is a 6 ft. 4 in. square by 4 ft tall. It has fuel composed of graphite-urania blocks cladded in zircaloy. Graphite-urania fuel was chosen because of three advantages for a reactor that will receive large pulses of thermal neutrons. Those advantages are thermal shock resistance from the extreme heat input of transients, a large negative temperature coefficient of reactivity, and graphite's ability to serve as a heat sink for the heat generated during transients. Attached above and below the fuel are blocks of graphite reflector cladded in aluminum, making the 8 ft. tall 4 in.^{2} fuel assembly. There are also control rod fuel assemblies, which differ from the standard fuel assembly by having a hole down the center of the assembly so the control rods can be vertically moved. Some assemblies contain no fuel, and act as a thermal buffer for the fueled regions of the core. The thermocouple fuel assemblies are fitted with thermocouples to measure temperature in specific regions in the reactor. The positioning of the thermocouples was made with the hottest sections of the reactor in mind. Finally, at the very center of the core is the test hole, where the test sample is placed. The assemblies are arranged in a 19x19 square lattice, with 2 in.

air gaps [Bess & DeHart, ANL-6034, Transient Workshop Summary]. The core is surrounded in 2 ft. of permanent graphite reflector, and then with 5 ft. of concrete shielding.

Control Rods

TREAT's control rods are 16.78 ft. long [Bess & DeHart, 2015] and are made up with an upper grappling adapter, followed up with a boron carbide poison section cladded in steel, a graphite section cladded in zircaloy, and then two more graphite sections cladded in steel (see Fig. 3). The rods are connected at the base of the control rod drives [Bess & DeHart, 2015]. TREAT has three types of control rods based on functionality, although they are identical in make and manufacturing. There are the control/shutdown rods, compensation rods, and transient rods, and

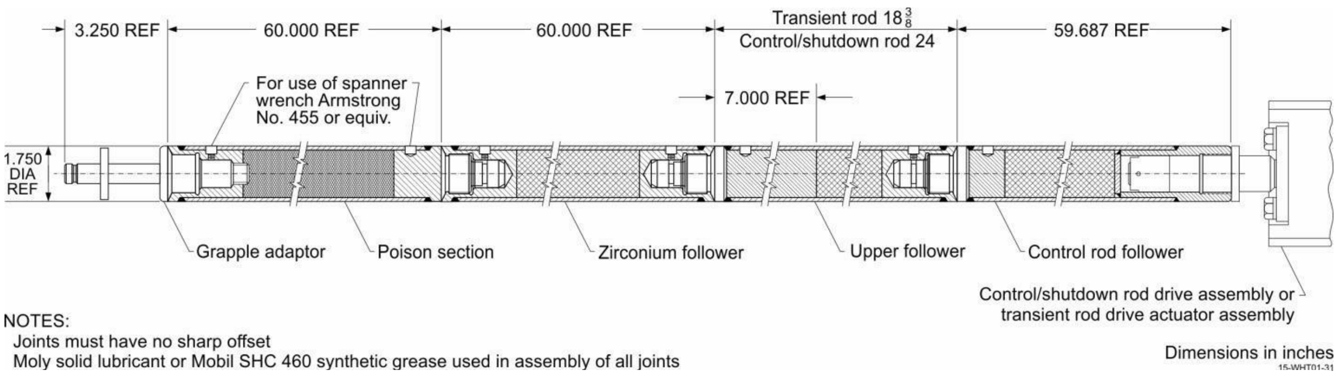

Figure 3 — Control Rod Configuration

they are distributed throughout the core in two rings. The inner ring is comprised of compensation rods, which are collectively worth $11.60 in reactivity. The control/shutdown rods make up the upper and lower control rods in the outer ring. Their collective worth in reactivity is $11. Finally, the transient rods make the left and right sides of the outer ring, with a collective reactivity worth of $4 [CONF-820406—29].

Heat Removal

TREAT is air-cooled with a once-through induced-draft system. Up to 6,000 cfm (cubic feet per minute) of air is drawn through the reactor by two turbocompressors. The air passes through filters as it enters the reactor and is filtered again as it exits through a 60 ft. stack into the atmosphere. This amount allows for constant 100 kW steady state operations and will cool the reactor after a transient in several hours [Bess & DeHart, 2015].

Transient Operations

There are three modes of operations possible for TREAT. There are two transient modes and a steady-state mode. The steady state mode is limited to 100 kW but can provide the neutron flux required for neutron radiography. The first transient mode is a single burst of power by a sudden increase in reactivity. These result in a Gaussian shaped power curve and last under a second before negative temperature coefficient of reactivity terminates the reaction. Peak power can reach up to 18 GW, and core energy generation peaks at 2900 MJ, though these peak values are only reached for under 100 ms. The second transient mode is for 'shaped transients,' where shape refers to the fact that the shape is formed using control rod motion after the initial transient rod pull. The later rod movements are done by computer control rather than by manual control. These transients last for tens of seconds and can reach up to a peak power of 10 GW. A variety of shapes are possible, depending on what is needed for the experiment [INL/EXT-09-16392].

Introduction to Monte Carlo Methods

"Monte Carlo" was a name applied to a class of mathematical methods by Los Alamos scientists in 1940, during the development of nuclear weapons [Kalos & Whitlock, 2008]. The Monte Carlo method is a technique using a large amount of random numbers in a probabilistic model to approximate the solution to a numerical problem. The use of this method can range from economics to quantum mechanics.

We will be using the Monte Carlo method to simulate the steady-state neutron behavior as described by the neutron transport equation. In particular, we are interested in determining the critical eigenvalue, k using:

$$\hat{\Omega} \cdot \nabla\psi\left(\vec{r}, E, \hat{\Omega}\right) + \sigma(\vec{r}, E)\, \psi\left(\vec{r}, \hat{\Omega}, E\right) =$$

$$\int d\hat{\Omega} \int dE'\, \sigma_S(\vec{r}, E' \to E, \hat{\Omega}' \cdot \hat{\Omega})\, \psi\left(\vec{r}, \hat{\Omega}', E'\right)$$

$$+ \frac{\chi(E)}{k} \int dE' \nu\, \sigma_f(\vec{r}, E') \int d\hat{\Omega}\;\; \psi\left(\vec{r}, \hat{\Omega}', E'\right)$$

Where:

$\hat{\Omega}$ is the unit vector solid angle.

$\psi\left(\vec{r}, E, \hat{\Omega}\right)$ is the angular neutron flux

$\sigma(\vec{r}, E)$ is the total macroscopic cross section

E is the energy

ν is the average number of neutrons produced by fission

$\sigma_S(\vec{r}, E' \to E, \hat{\Omega}' \cdot \hat{\Omega})$ is the macroscopic cross section for scattering

$\sigma_f(\vec{r}, E')$ is the macroscopic cross section for fission

And k is the multiplication factor, which is included in the equation to ensure a balance. k is also known as the eigenvalue.

It's important to understand that our intention is to have a critical system, where the value of k is close to 1, so that k disappears from the solution.

First, we will construct a distribution of fission neutrons and track them through their lifetimes to determine the number of fission neutrons created in the subsequent generation. The first generation is calculated with an initial guess and is then fed into a steady-state form of the transport equation or its appropriate multigroup approximation [Lewis & Miller, 1993]. The eigenvalue k will converge to a value as more random calculations are made. Here, k will be defined as the ratio of the number of neutrons in the jth generation, F_j, and the j-1 generation, F_{j-1}.

$$k = \frac{F_j}{F_{j-1}}$$

After a sufficient number of iterations, the number of neutrons per generation will converge to a value that will remain close to constant. This ratio is the eigenvalue, k. For transients, an initial state neutron source distribution must be used as a basis. Then we can change the system and see how this neutron distribution interacts with its altered environment.

Calculation methods of Serpent

Serpent 2 is a Monte Carlo reactor physics code developed at VTT in Finland. The software makes its particle interaction calculations via pseudo-random number generators. Let's say for example, you have a particle with a total microscopic cross section of $\sigma = 100$ b, and is distributed in the following manner:

$\sigma_s = 50$ b $\quad\quad \sigma_f = 20$ b $\quad\quad \sigma_\gamma = 30$ b

Let's say our particle collides with a neutron. To determine what happens to the particle, we generate a random number R between 0 and 1. If the value is $0 \leq R \leq 0.50$, we designate it as a scatter. If the value is $0.51 \leq R \leq 0.70$, it absorbs the neutron and fissions. If the value is $0.71 \leq$

$R \leq 1$, the neutron is absorbed and a gamma is emitted. Once a neutron has been absorbed or has left the system, Serpent will "kill" it and cease tracking it.

Transients in Serpent

The primary reason we are using Serpent for modelling is its ability to simulate transients. There are two stages in the simulation of transients. First, we run a source-generating steady state model that gives us a neutron source distribution file. This file stores neutrons at random points of their lifetime in a uniform period of time and includes both prompt and delayed neutrons. We are only creating delayed neutron precursors in this step. The precursors give us the delayed neutron population. The source distribution file is basically a snapshot of the simulation in a random point of time. In it, we can see the neutrons in their random position in x, y, and z in cartesian coordinates with a random energy. The second stage is the transient itself, where a time-dependent action occurs, say the movement of a control rod. The source distribution file is used to generate neutrons over the allotted period of time, and detectors (known as tallies in MCNP) can be used to gather information on fission energy

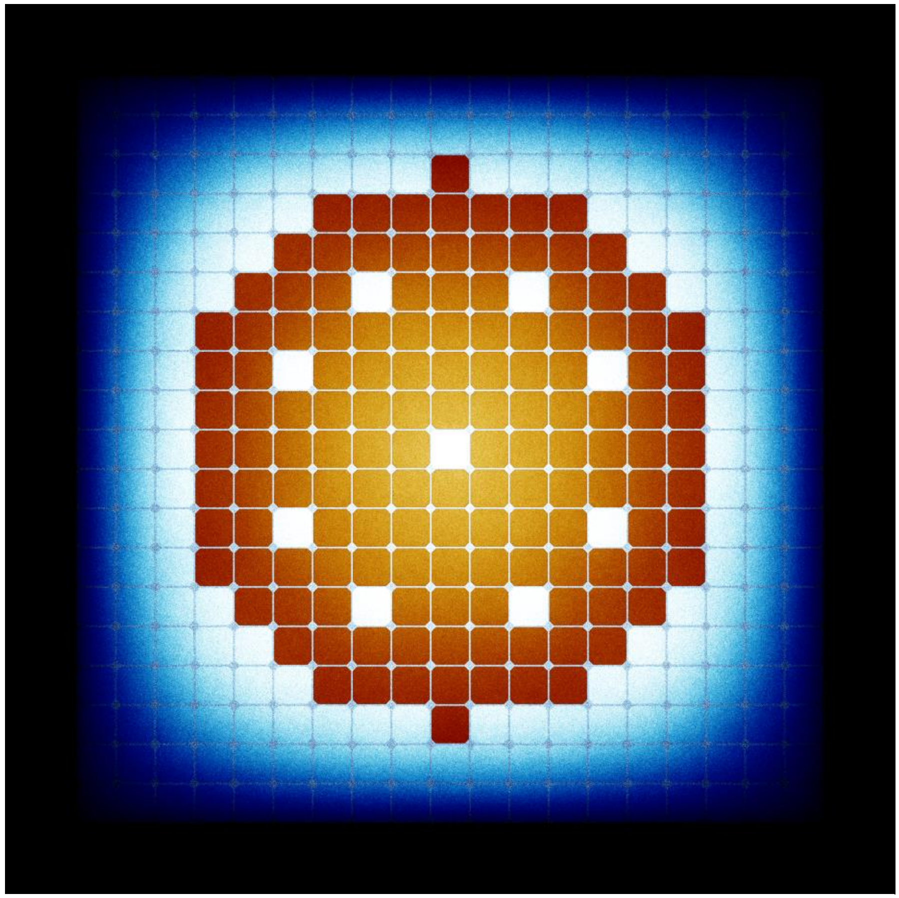

Figure 4 — TREAT Fission Mesh

deposition, neutron population, (n,f) interactions in particular geometries or materials, and much more. [V. Valtavirta et al., 2016].

Uncertainty and Shannon Entropy

One important factor with Monte Carlo methods in nuclear experiments is making sure we get accurate values for k-eff, reaction rates, and the source distribution. When using Monte Carlo to calculate values we start with an initial guess for the answer, and repeatedly make guesses until we converge to an average value. This method is a generational method. Each iteration, or “batch,” is calculated with the previous generation’s fission neutrons. However, we have to make sure that we have used a sufficient number of iterations that our initial guess is not influencing our final answer. Therefore, Serpent runs inactive cycles before running the active cycles. The inactive cycles are calculations made with their results discarded due to their proximity to the initial guess.

When using Monte Carlo techniques, we must make sure that our statistics are good enough that our data is not affected by our initial seed. One of these methods is verifying the Shannon entropy. Shannon entropy is the application of entropy on probability. A good explanation of this can be found from “Shannon Entropy, Information Gain, and Picking Balls from Buckets” by Luis Serrano from Medium on November 5, 2017. A link to the article has been included in the appendix.

Shannon entropy is another way of presenting the uncertainty in a stochastic assessment. Serpent allows for the calculation of the Shannon entropy of k-eff via the Set History card. Serpent will make an initial guess to the value of the Shannon entropy, and each history will reevaluate the entropy, and over time it will converge to a value.

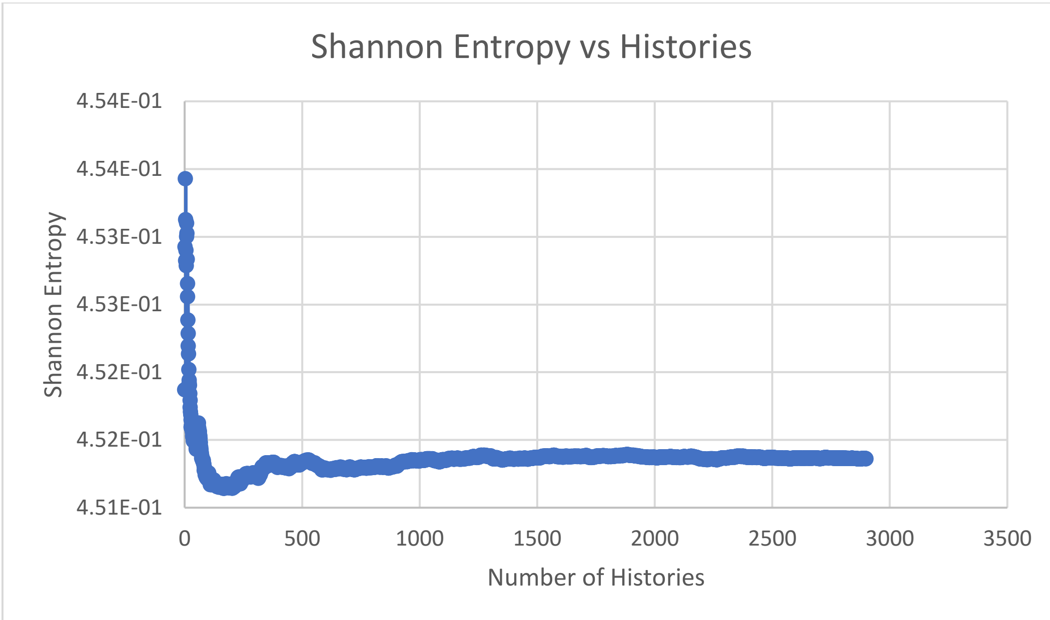

Figure 5 — Shannon Entropy vs Histories for M8CAL Steady State

Methods

Our objective is to use Serpent 2 to simulate a power excursion at TREAT. Starting from a steady state (k-eff = 1.000) condition, the transient control rods will be fully removed. Power will exponentially increase over the following seconds. The model will measure the change in power over time. Now, in an actual transient, power will exponentially increase until the negative temperature coefficient of the graphite drives reactivity down. This simulation would allow INL to have a Serpent model for TREAT that could be modified for any given experiment.

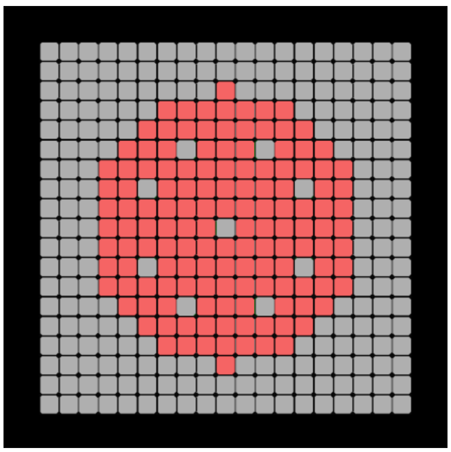

Figure 6 – Preliminary TREAT Simple Model

Simulations were done using the INL supercluster Falcon. Falcon has 972 nodes, each equipped with two 18-core processors with 128 GB RAM per node. Because of HPC time limitations, not all runs were allowed to reach completion.

Simple Model

The first step was to use a simple, steady state model of TREAT and create a time-dependent transient simulation from this. This model did not have control rods that entered fuel assemblies, but instead had graphite rods that appeared between the fuel assemblies, making up full squares in the 19x19 lattice. When in preliminary stages, the model was further simplified to a 3x3 lattice with 1 graphite rod and 8 fuel rods. B_4C, boron carbide, was added to the model, and placed in the vertical center of each graphite rod. This was to allow for an increase in reactivity upon rod removal. I learned to use the *trans* (transformation) card and show instantaneous control rod movements, with an appropriate change in reactivity. Next, I used the *transv* (transformation velocity) card to give the control rods a velocity and slowly move out of the reactor over 1 second. Geometric plots were used to give a visual verification of the control rod movement. Because of the simplicity of the design of this model, which is for steady state operations, it did not have the graphite follower included in its base design, so it needed to be added. I then added detectors, to track the energy deposition in the fuel over time.

The L91-60-1 Model

After successfully getting the simple model to show a power excursion, the next model to apply the transient was the L91-60-1 model of TREAT. This model is made up of multiple input files and one main file that would call to the other files. These separate files setup the geometry, the materials, the control rods, the fuel assemblies, the geometric plots, and the detectors. Because this is a fully detailed model, control rods would drop into their respective fuel assemblies. While the transient, control/shutdown, and compensation rods are all identical, they are defined with different universes. Each rod type was raised by a differing

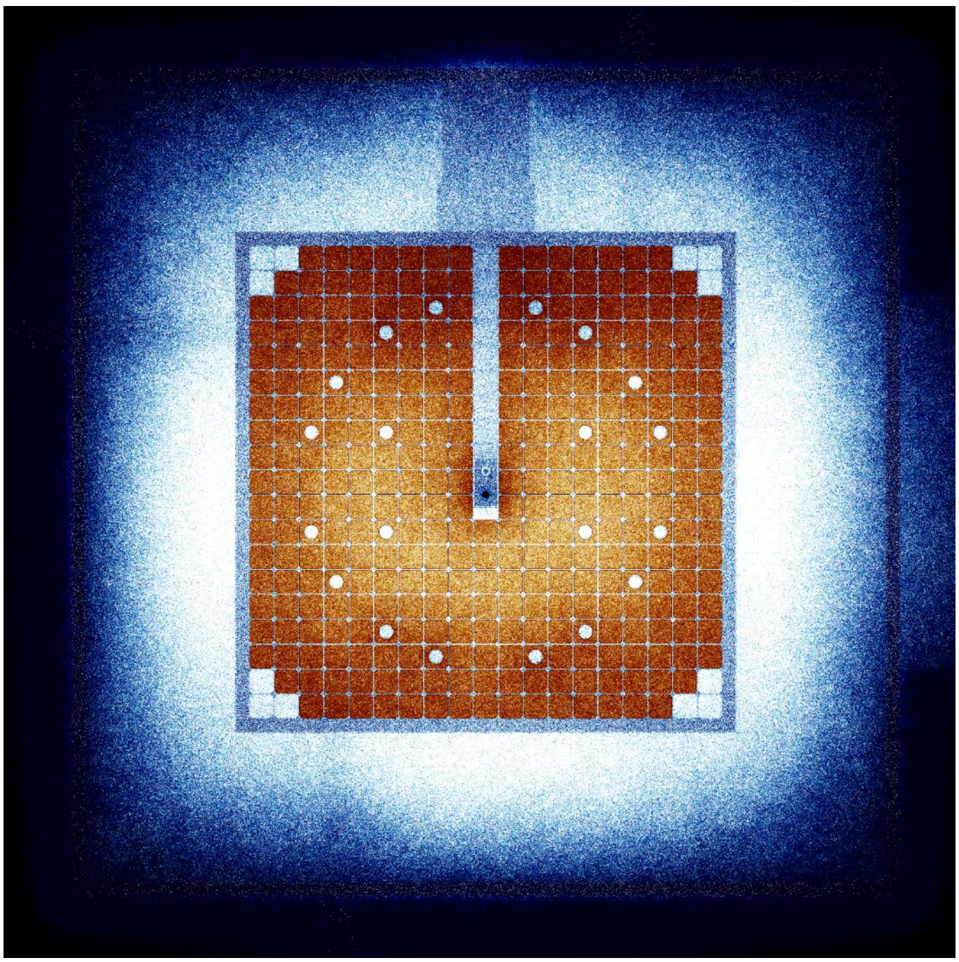

Figure 7 —L91-60-1 TREAT Model Mesh

amount for the k-eff = 1.000 model. Control/shutdown rods are always raised fully out 58.5 in, compensation rods are placed at 28.72 in for the critical position, and transient rods raised 26.5 in. The steady state case is run with 5,000,000 neutrons for 4000 generations, with the first 50 used as inactive cycles. The transient case is run with 5,000,000 neutrons for 1000 cycles but will time out due to 48-hour time constraints. A full run would take 250 hours with our presets, which are 20 nodes with 24 cores.

The M8CAL Model

For our final model, we used the M8CAL TREAT core. This model is the same as L91-60-1, modified to have the transient prescription experiment inserted into the center hole. The objective is to see how the Serpent TREAT model experiment compares to the measured data from a real experiment. We initially chose to model Transient No. 2893T, a 2.6 %Δk/k increase in reactivity, conducted on May 14, 2018, but later switched to Transient No. 2890T, a 1.5 %Δk/k increase in reactivity, conducted on May 2, 2018. This was due to the desire to try a smaller change in reactivity. First, we set up the control rod positions for the steady state source generation file. The compensation rods were fully removed at 58.5", the control/shutdown rods are raised 27.1", and the transient rods were raised 27.9".

Next, we prepared for the transient. For the simulation, the movement of the rods was averaged, and a uniform movement was made for all 4 rods. The transient rods were moved 12.1" out to be fully raised at 40" .

The problem we discovered is that our Serpent model was supercritical at the critical rod positions, with $k_{eff} = 1.0225 \pm 4.1 \times 10^{-5}$. If k is not sufficiently close to 1.00, the data results of the transient will be affected drastically. If the change in reactivity is small, the transient will have minimal changes. Large changes in reactivity will give an unrealistic power increase of up to 50 orders of magnitude. We made a slight increase in the boron content in the fuel, while remaining within the uncertainty in the total boron content of TREAT fuel, to make $k_{eff} \sim 1$ at the critical positions. Another realization was the necessity of a sufficient number of neutrons being used per history. This was discovered by seeing a difference in results from models that only differed in the number of neutrons per batch (200,000 neutrons for 100 cycles vs 20,000 neutrons for 1000 cycles). After discussing with Dr. Ville Valtavirta from VTT, he suspected that for super prompt critical systems, Serpent is particularly sensitive to the number of neutrons per batch, due to the fact that a small number of fission chains experience the largest multiplication and most of the power increase comes from a relatively small number of initial prompt chains. For the full model run we wanted to use 50 million neutrons, but due to memory limitations we created 50 separate identical input files, each running 100,000 neutrons for one cycle. Serpent generates its random seed based off the computer time when the input file is read, so each run had a unique seed and varying results.

One way we can measure the accuracy of our Serpent simulations is by the reactor period. The reactor period is the time it takes the neutron density to change by a factor of e. To calculate the reactor period from Serpent, we can find the slope of the neutron density over time and take the reciprocal. Because we have a semilog format (time is linear, neutron density is exponential) we will solve for the slope with the following equation:

$$Slope = \frac{\ln(Y_f) - \ln(Y_0)}{X_f - X_0}$$

Where Y_0 is the initial value of the Y-axis, Y_f is the final value of the Y-axis, X_0 is the initial value of the X-axis, and X_f is the final value of the X-axis. Then we take the reciprocal:

$$\tau_e = \frac{1}{Slope}$$

It should be kept in mind that this method is only valid if the data is linear. So, we need to do a linear fit to the data and determine the slope of the fit line. From here, we can compare our result with the measured values.

Pitfalls and Troubleshooting

When making input files, many errors had to be avoided. One of the first issues discovered was with not having a high enough value for the "set nbuf" and "set pbuf" cards. These are the neutron buffer and precursor buffer cards and are multiplication factors that determine the amount of memory allotted for the upcoming generation of neutrons and precursors. These values had to be raised for the transient simulations with a high count of neutrons. Another issue was with the time intervals. One error that commonly came up was "Population exceeds maximum at 3.00E+00 seconds, adjust time cut-off." From a discussion on the Serpent forum, this comes from the neutron population weight increasing 16 orders of magnitude from the initial weight. By changing the number of time bins, this error can be avoided. However, having too many time bins can also affect the output of the detectors, resulting in minimal changes in power and neutron populations. Another important factor that should be considered is which cross-section data library you are using in Serpent and how it relates to both past models. Due to the slight differences between libraries, particularly the major changes in carbon cross sections in recent evaluations, one might have different critical rod positions for their model.

Results

The sss2_treat model was used for learning how to use Serpent. Its simple design allowed for an easy opportunity to learn to make control rod movements and produce a transient.

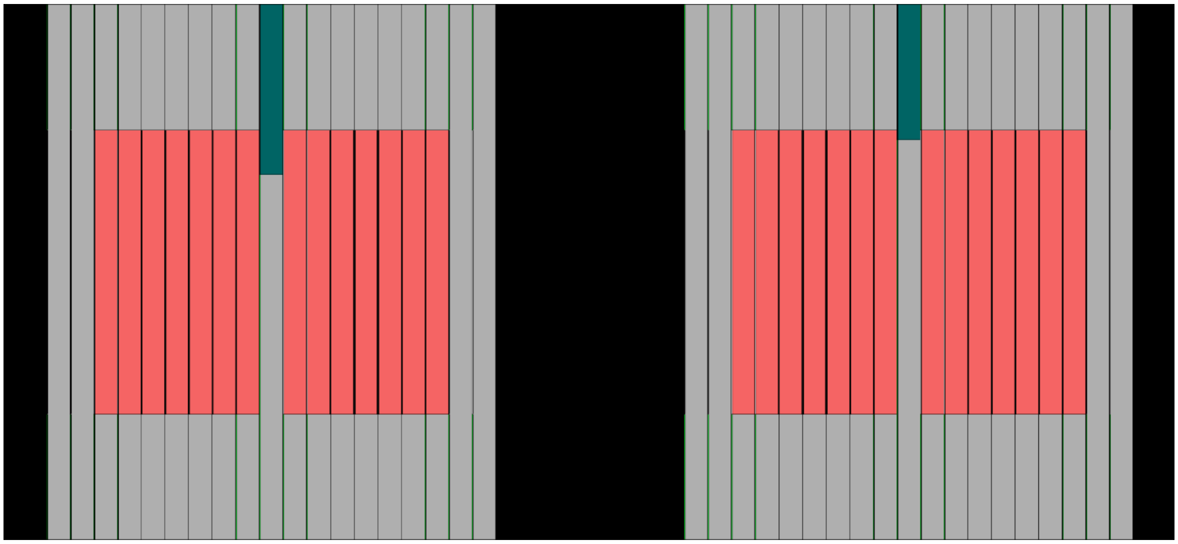

Figure 8 —TREAT Simple Model Control Rod Movement at t=0 (left) and t=0.2 (right)

Moving the boron portions of the control rods (blue-green) results in an increase in reactivity, giving us a small transient. The transients done using the sss2_treat_excursion were done with only 5000 neutrons for only 200 batches, so the data will be a bit rough, but show proof of concept.

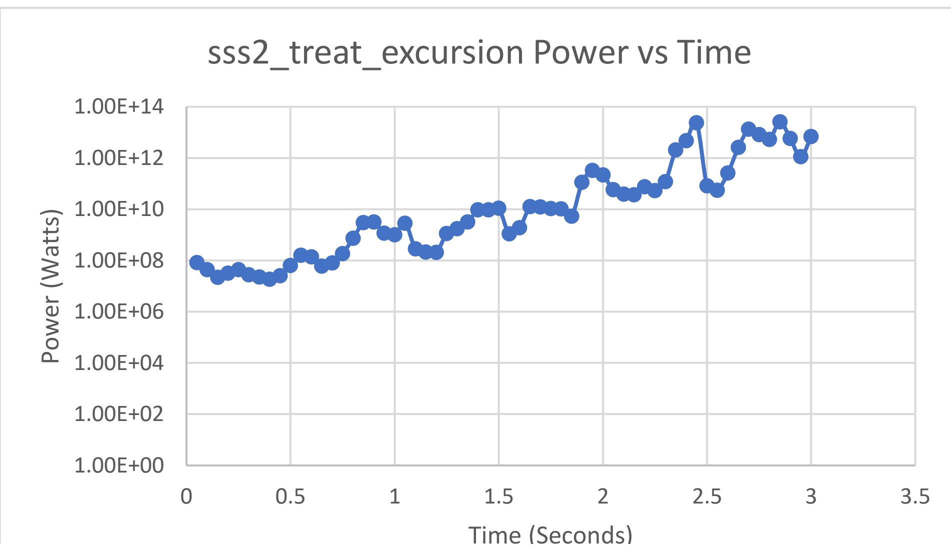

Figure 9 - sss2_treat Model Change in Power

Using the L91-60-1 model for a generic TREAT experiment showed some promise. It should be noted that for the L91-60-1 run, the power was normalized to 1 watt. During the transient, the total power was raised to 1.00954 ± 0.92266 x 10^{13} Watts. On the detector end, neutron populations raised from 1.4 x 10^7 neutrons/cm^3 to 8.5 x 10^{20} neutrons/cm^3. Near 1.5 seconds, we see an inflection point in the power generation and neutron population (Fig. 10 and Fig. 11). The likely cause of this is the random walk of Monte Carlo. As you make more and more random movements, it's possible to have a divergence from the original path, or trend. This change cascades through the rest of the run, unless the random walk by chance returns to the prior path.

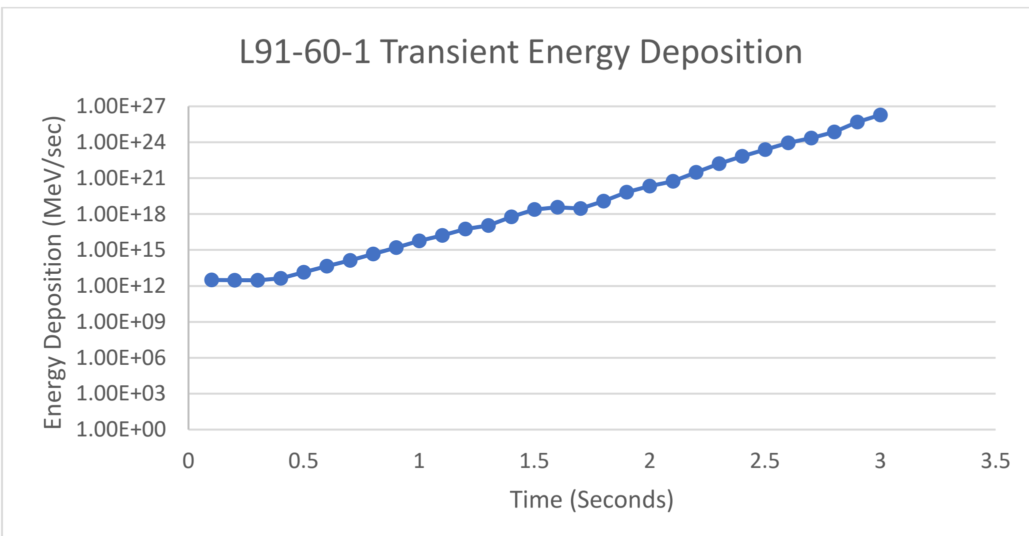

Figure 10 - L91-60-1 Energy Deposition

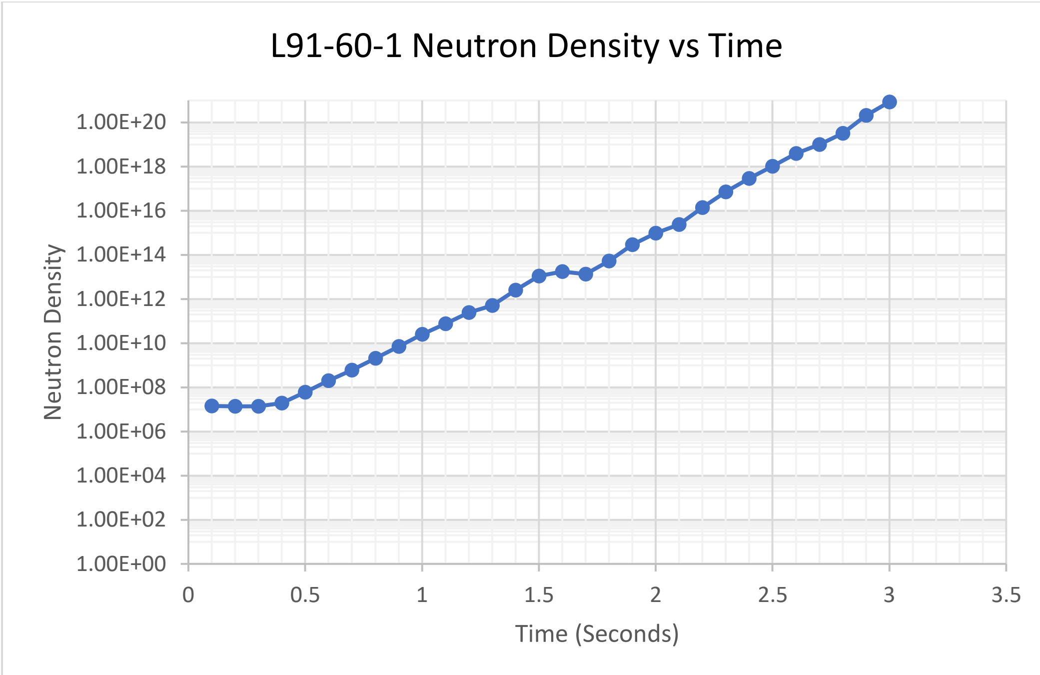

Figure 11- L91-60-1 Change in Neutron Population

The reactor period was calculated with both the neutron population and the energy deposition, equaling 10.5716 and 10.5739 respectively.

The transient prescription configuration using recent (2018) measurements is the final model used, and the goal was originally to simulate the 2893T 2.6% Clipped transient experiment, but later changed to the 2890T OTP-18-002 1.5% transient. This decision was made because it was considered worthwhile to model a smaller change in reactivity due to issues with memory and neutron populations. It was mentioned earlier that if k-eff is not close to 1.000, the transient will not perform correctly. For a large reactivity change (12% Δk/k), Serpent will give results of up to 10 x 10^{75} watts, as seen in one faulty simulation from the 2.6% model.

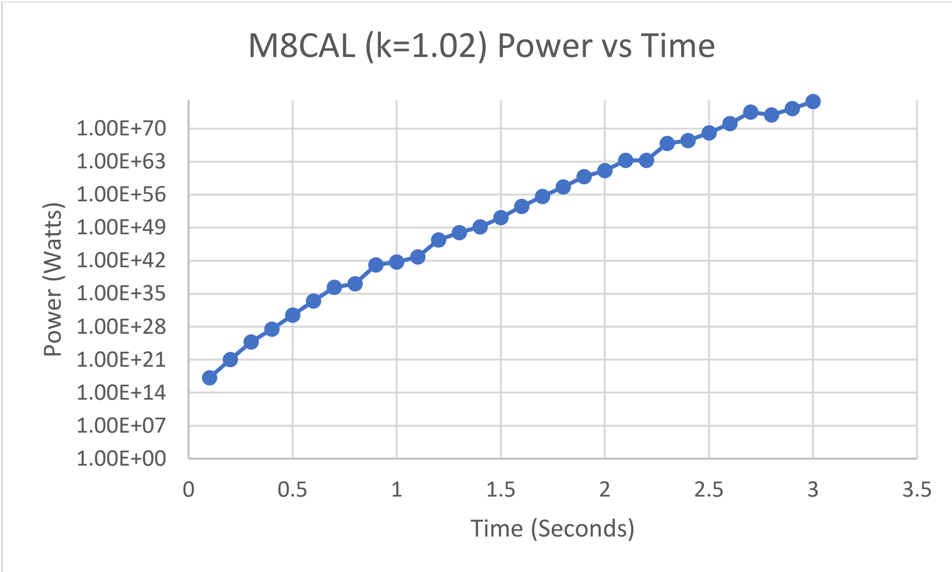

Figure 12 - M8CAL 2.6% Massive Change in Power

When we switched to the 1.5% run, we again focused on the changes in neutron population and reactor power, and then inspected the reactor period. The experimental measured reactor period for experiment 2890T was 0.112 sec^{-1}. The reactor period from our 50,000,000 particle run, which is the average of fifty separate 100,000 particle runs, was 0.130 ± 0.0123 sec^{-1}. Our reactor period was within two standard deviations of the measured result. In the experiment, the reactor power went from 1kW to around 611MW, an increase of 5 orders of magnitude. In our model, reactor power went from 1kW to 86GW, an increase of 7 orders of magnitude. A larger increase in power is to be expected due to the current lack of thermal feedback in Serpent. Looking at Figures 13 and 14, we see a discontinuity after 1 second has passed. Again, the probable cause is random walk. Another side effect of the random walk is the increase in error in each time step.

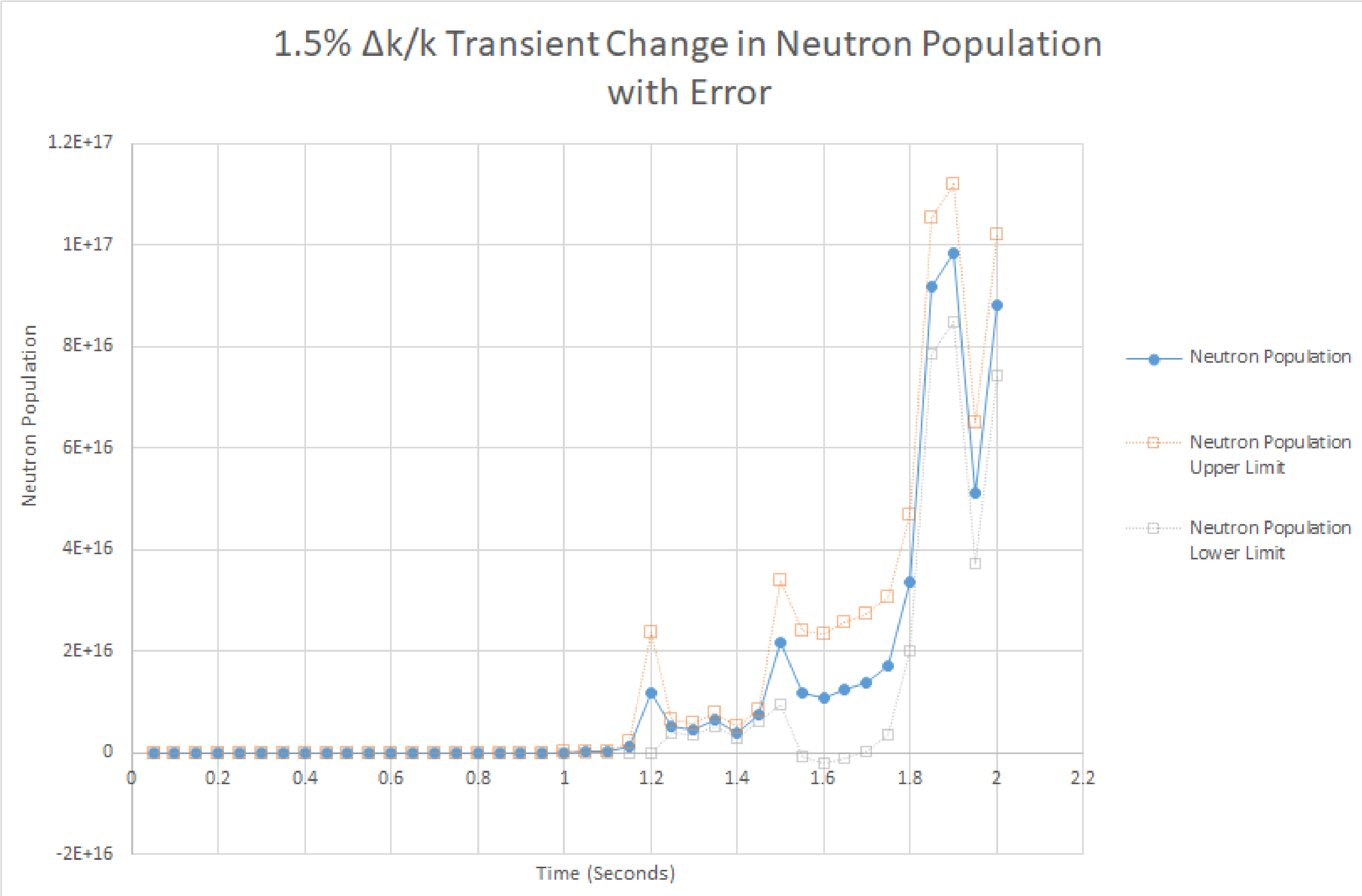

Figure 13 - 1.5% Change in Neutron Population

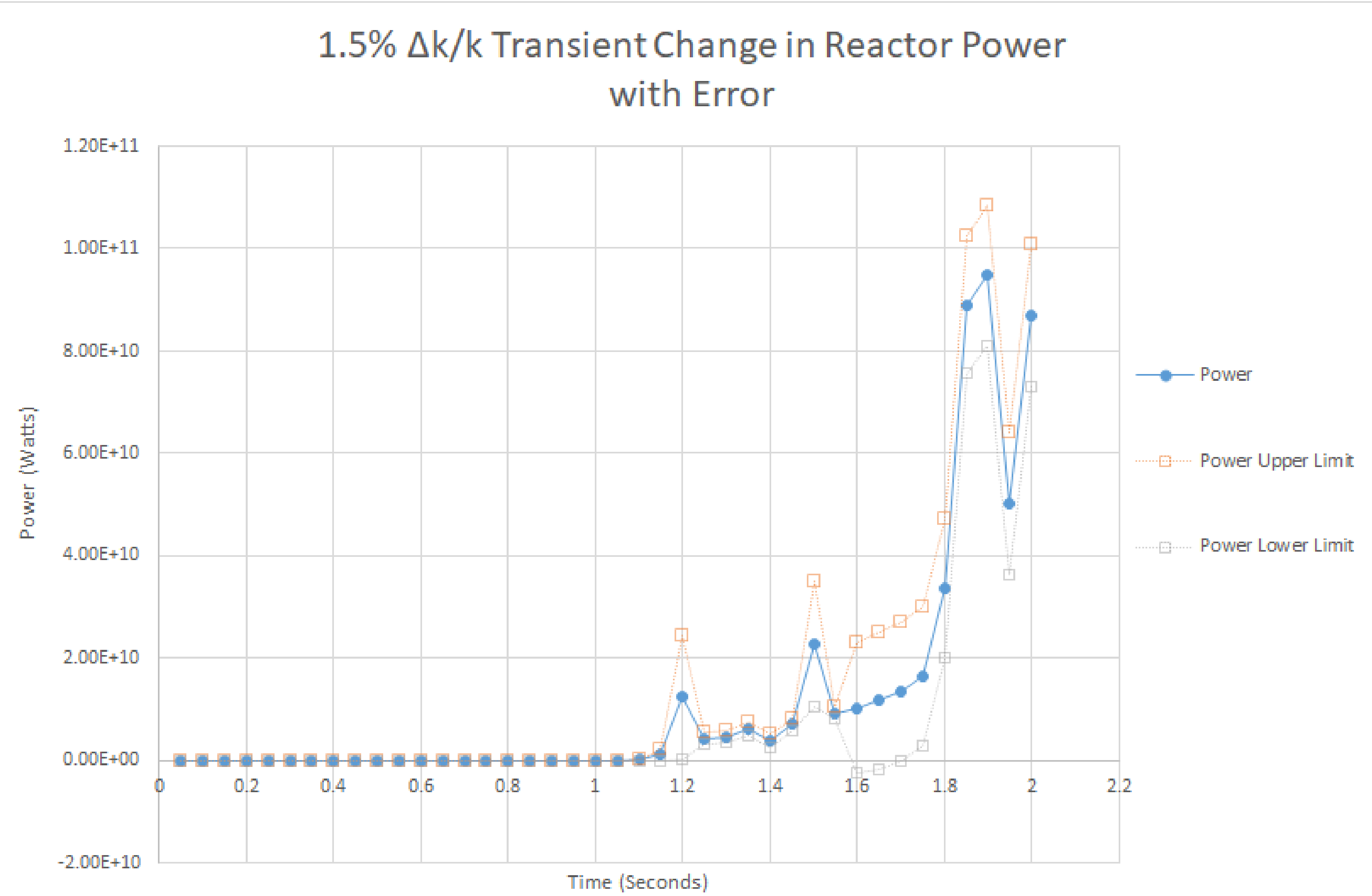

Figure 14 - 1.5% Change in Power

Future Work

Moving forward, there are more things that can be done for modeling transients with Serpent. The FINIX code, developed at VTT Finland, supports multi-physics simulations such as coupled reactor-physics/fuel-performance or thermal-hydraulics/fuel-performance simulations [Ikonen et al, 2015]. FINIX may be coupled with Serpent 2 at the source code level, which allows for direct memory access between Serpent and FINIX to simplifying solution transfers. A coupled Serpent/FINIX model would be able to provide the negative reactivity feedback that is not directly available within Serpent 2. Other less sophisticated coupling approaches are also possible with Serpent [Leppänen et al., 2012]. The negative temperature feedback from the graphite in TREAT will dramatically lead to a reduction in reactivity. Another consideration would be an alteration of the duration of the transient. Experimental transients can last from about a second to several minutes. Our models ran from 2 to 3 seconds, which may have been unnecessarily long for our circumstances. In the future, an effort should be made to simulate the different transient modes of TREAT. Lastly, attempting to model more transient TREAT experiments with varying amounts of changes in reactivity would be good to test the consistency of Serpent's transient modelling.

Appendix:

Input Files

File: sss2_treat_steady_state.i

```
set acelib "/home/wetzmark/endfb7u.xsdata"

% treat fuel element

surf  8 octa 0.0 0.0 4.8260 6.0313
surf  9 octa 0.0 0.0 4.9657 6.2288
surf 10 octa 0.0 0.0 5.0292 6.3186
surf 11 octa 0.0 0.0 4.9022 6.1390

surf 20 cuboid -5.08 5.08 -5.08 5.08 -121.76125 125.88875
surf 21 cuboid -5.08 5.08 -5.08 5.08 -250.0 125.88875
surf 40 pz 61.11875
surf 50 pz -61.11875
surf 60 cuboid -96.52 96.52 -96.52 96.52 -121.76125 125.88875
surf 70 pz 125.88875
surf 80 pz -121.76125
surf 81 pz -250.00

% universe 1 - fuel element
cell 1001 1 fuel -8 -40 50
cell 1002 1 air -9 8 -40 50
cell 1004 1 clad -10 9 -40 50
cell 1005 1 air -20 10
cell 1006 1 graphite -11 -70 40
cell 1007 1 graphite -11 -50 80
cell 1008 1 aluminum -10 11 -70 40
cell 1009 1 aluminum -10 11 -50 80
cell 1010 1 outside 20

% universe 2 - graphite element
cell 2001 2 graphite -8 -40 50
cell 2002 2 air -9 8 -40 50
cell 2004 2 clad -10 9 -40 50
cell 2005 2 air -20 10
cell 2006 2 graphite -11 -70 40
cell 2007 2 graphite -11 -50 80
cell 2008 2 aluminum -10 11 -70 40
cell 2009 2 aluminum -10 11 -50 80
cell 2010 2 outside 20
```

```
% universe 4 - movable boron carbide element
cell 4001 4 boron_carbide -8 -40 50
cell 4002 4 air -9 8 -40 50
cell 4004 4 clad -10 9 -40 50
cell 4005 4 air -21 10
cell 4006 4 graphite -11 -70 40
cell 4007 4 graphite -11 -50 81
cell 4008 4 aluminum -10 11 -70 40
cell 4009 4 aluminum -10 11 -50 81
cell 4010 4 outside 21

% universe 3 - core array
lat 3 1 0.0 0.0 19 19 10.16
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 2 2 1 1 1 4 1 1 1 4 1 1 1 2 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 1 1 4 1 1 1 1 1 1 1 4 1 1 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 1 1 1 1 1 1 4 1 1 1 1 1 1 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 1 1 4 1 1 1 1 1 1 1 4 1 1 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 2 1 1 1 4 1 1 1 4 1 1 1 2 2 2 2
2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2

% universe 0 - full model
cell 100 0 fill 3 -60 -70 80
cell 200 0 outside 60
cell 201 0 outside 70
cell 202 0 outside -80

%     MATERIAL DEFINITIONS
therm graph  gre7.00t

mat fuel sum      rgb 245 100 100 moder graph 6012
        92235.03c 8.65408E-06
        92238.03c 6.31316E-07
         6012.03c 8.62392E-02
```

```
        5010.03c 1.14290E-07
        5011.03c 4.44130E-08
       26000.03c 1.85516E-05

mat clad sum rgb 222 222 222
       50112.03c 7.53438E-07
       50114.03c 5.12648E-07
       50115.03c 2.64092E-07
       50116.03c 1.12938E-05
       50117.03c 5.96536E-06
       50118.03c 1.88126E-05
       50119.03c 6.67220E-06
       50120.03c 2.53062E-05
       50122.03c 3.59631E-06
       50124.03c 4.49732E-06
       40000.03c 4.20848E-02

mat graphite sum     rgb 175 175 175 moder graph 6012
        6012.03c 8.37491E-02
        5010.03c 4.44130E-08
        5011.03c 1.78768E-07
       26000.03c 1.80175E-05

mat boron_carbide sum     rgb 0 100 100
        6000.03c -0.217390
        5010.03c -0.15573939
        5011.03c -0.62687061


mat zirc2 sum    rgb 100 100 245
       26000.03c 9.55002E-05
       50112.03c 4.68066E-06
       50114.03c 3.18478E-06
       50115.03c 1.64064E-06
       50116.03c 7.01616E-05
       50117.03c 3.70592E-05
       50118.03c 1.16872E-04
       50119.03c 4.14504E-05
       50120.03c 1.57212E-04
       50122.03c 2.23417E-05
       50124.03c 2.79392E-05
       40000.03c 4.25479E-02
       24000.03c 7.59773E-05
       28000.03c 3.70193E-05
       72000.03c 2.21330E-06
```

```
mat air sum    rgb 10 10 10
        6000.03c 7.58114E-09
        7014.03c 3.94836E-05
        8016.03c 1.06081E-05

mat aluminum sum rgb 0 200 30
       13027.03c 6.03073E-02

set pop 5000 100 200
set power 500e6
set cpd 1 6 -121.76125 125.88875
set savesrc "./steady_state_source" 1e-1 0.25 1 1 1

% --- Transformations
trans  U 4                    0 0 122

set nbuf 1000

% --- Geometry and mesh plots:

plot 3 1000 1000   0 -115.0 115.0 -115.0 115.0
plot 3 1000 1000  70 -115.0 115.0 -115.0 115.0
plot 3 1000 1000 -70 -115.0 115.0 -115.0 115.0
plot 1 1000 1000   0 -115.0 115.0 -115.0 115.0
mesh 3 5000 5000  0 -115.0 115.0 -115.0 115.0 0 100
mesh 3 5000 5000  0 -115.0 115.0 -115.0 115.0 -5 5
mesh 3 5000 5000  0 -115.0 115.0 -115.0 115.0 50 60


set bc 1
set his 1
```

File: sss2_treat_excursion.i

```
set acelib "/home/wetzmark/endfb7u.xsdata"

% treat fuel element

surf  8 octa 0.0 0.0 4.8260 6.0313
surf  9 octa 0.0 0.0 4.9657 6.2288
surf 10 octa 0.0 0.0 5.0292 6.3186
surf 11 octa 0.0 0.0 4.9022 6.1390

surf 20 cuboid -5.08 5.08 -5.08 5.08 -121.76125 125.88875
surf 21 cuboid -5.08 5.08 -5.08 5.08 -250.0 125.88875
```

```
surf 40 pz 61.11875
surf 50 pz -61.11875
surf 60 cuboid -96.52 96.52 -96.52 96.52 -121.76125 125.88875
surf 70 pz 125.88875
surf 80 pz -121.76125
surf 81 pz -250.00

% universe 1 - fuel element
cell 1001 1 fuel -8 -40 50
cell 1002 1 air -9 8 -40 50
cell 1004 1 clad -10 9 -40 50
cell 1005 1 air -20 10
cell 1006 1 graphite -11 -70 40
cell 1007 1 graphite -11 -50 80
cell 1008 1 aluminum -10 11 -70 40
cell 1009 1 aluminum -10 11 -50 80
cell 1010 1 outside 20

% universe 2 - graphite element
cell 2001 2 graphite -8 -40 50
cell 2002 2 air -9 8 -40 50
cell 2004 2 clad -10 9 -40 50
cell 2005 2 air -20 10
cell 2006 2 graphite -11 -70 40
cell 2007 2 graphite -11 -50 80
cell 2008 2 aluminum -10 11 -70 40
cell 2009 2 aluminum -10 11 -50 80
cell 2010 2 outside 20

% universe 4 - movable boron carbide element
cell 4001 4 boron_carbide -8 -40 50
cell 4002 4 air -9 8 -40 50
cell 4004 4 clad -10 9 -40 50
cell 4005 4 air -21 10
cell 4006 4 graphite -11 -70 40
cell 4007 4 graphite -11 -50 81
cell 4008 4 aluminum -10 11 -70 40
cell 4009 4 aluminum -10 11 -50 81
cell 4010 4 outside 21

% universe 3 - core array
lat 3 1 0.0 0.0 19 19 10.16
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 2 2 2 2 2 2
```

```
2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 2 2 1 1 1 4 1 1 1 4 1 1 1 2 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 1 1 4 1 1 1 1 1 1 1 4 1 1 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 1 1 1 1 1 1 4 1 1 1 1 1 1 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 1 1 4 1 1 1 1 1 1 1 4 1 1 2 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 2 2 1 1 1 4 1 1 1 4 1 1 1 2 2 2 2
2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2

% universe 0 - full model
cell 100 0 fill 3 -60 -70 80
cell 200 0 outside 60
cell 201 0 outside 70
cell 202 0 outside -80

%     MATERIAL DEFINITIONS
therm graph  gre7.00t

mat fuel sum      rgb 245 100 100 moder graph 6012
        92235.03c 10.89408E-06
        92238.03c 6.31316E-07
         6012.03c 8.62392E-02
         5010.03c 1.14290E-07
         5011.03c 4.44130E-08
        26000.03c 1.85516E-05

mat clad sum rgb 222 222 222
        50112.03c 7.53438E-07
        50114.03c 5.12648E-07
        50115.03c 2.64092E-07
        50116.03c 1.12938E-05
        50117.03c 5.96536E-06
        50118.03c 1.88126E-05
        50119.03c 6.67220E-06
        50120.03c 2.53062E-05
        50122.03c 3.59631E-06
        50124.03c 4.49732E-06
        40000.03c 4.20848E-02
```

```
mat graphite sum     rgb 175 175 175 moder graph 6012
         6012.03c 8.37491E-02
         5010.03c 4.44130E-08
         5011.03c 1.78768E-07
        26000.03c 1.80175E-05

mat boron_carbide sum     rgb 0 100 100
         6000.03c -0.217390
         5010.03c -0.15573939
         5011.03c -0.62687061
mat zirc2 sum    rgb 100 100 245
        26000.03c 9.55002E-05
        50112.03c 4.68066E-06
        50114.03c 3.18478E-06
        50115.03c 1.64064E-06
        50116.03c 7.01616E-05
        50117.03c 3.70592E-05
        50118.03c 1.16872E-04
        50119.03c 4.14504E-05
        50120.03c 1.57212E-04
        50122.03c 2.23417E-05
        50124.03c 2.79392E-05
        40000.03c 4.25479E-02
        24000.03c 7.59773E-05
        28000.03c 3.70193E-05
        72000.03c 2.21330E-06

mat air sum    rgb 10 10 10
         6000.03c 7.58114E-09
         7014.03c 3.94836E-05
         8016.03c 1.06081E-05

mat aluminum sum rgb 0 200 30
        13027.03c 6.03073E-02
% --- Link source (use point-wise precursor tracking)

set nps 5000 200 simutime
set dynsrc "./steady_state_source_excursion" 1
set savesrc "./excursion_source_end" 1
set cfe 10
set power 250e6
set cpd 1 6 -61.11875 61.11875
set pbuf 999
set nbuf 2000

% --- 30 time bins for detector
```

```
tme dettime 2 60 0 2

% --- 1 time interval for simulation (no population control)

tme simutime 2 60 0 2

% --- Detectors
det POW
du 3
dm fuel
di dettime


% --- Transformations
trans  U 4                  0 0  103.0
transv U 4 tlim 0.0 1 1       0 0   10.0


% --- Geometry and mesh plots:

%plot 1 1000 1000   0 -115.0 115.0 -115.0 115.0
mesh 3 5000 5000  0 -115.0 115.0 -115.0 115.0 0 100
mesh 3 5000 5000  0 -115.0 115.0 -115.0 115.0 -5 5
mesh 3 5000 5000  0 -115.0 115.0 -115.0 115.0 50 60

set bc 1
```

File: L91-60-1_steady.sss

```
%
% Ben Baker, modified by Mark Wetzel
% Idaho National Laboratory
% Jan 21 2016
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


% Surfaces
include "surfaces.sss"
include "Ex-Core-Definition.sss"
include "Ex-Core-Surfaces.sss"
include "Extra_Surfaces.sss"  % Depends on the problem

% Materials
```

```
include "mat.sss"

% --- Cross section library file path:
set acelib "/hpc-common/data/serpent/xsdata/endfb71r1"

% Assemblies
include "A0.sss"
include "B0.sss"

include "CR-Type.sss"
include "C0_48inch.sss"
include "C1-C10.sss"
include "C9_Half-Slot.sss"
include "D0.sss"
include "D1-Half.sss"

include "A-s.sss"                          % Depends on the problem
include "Rods0.018.sss"                    % Depends on the problem
include "M8Center_wDy-22R-fuel-region.sss"    % Depends on the problem

% Universe Definitions
%   11100 - A1: Sub-Universes 11101-11113
%   11200 - A2: Sub-Universes 11201-11213
%    ...
%   14000 - A30: Sub-Universes 14001-14013
%
%   1100  - B1: Sub-Universes 1101 - 1113
%   1200  - B2: Sub-Universes 1201 - 1213
%   ...
%   2000  - B10: Sub-Universes 2001 - 2013
%
%   5100 - C1:  Sub-Universes 5101-5113
%   5150 - C2:  Sub-Universes 5150-5173
%   5200 - C3:  Sub-Universes 5201-5213
%   ...
%
%   5900 - C-Half-Slotted Assembly:
%
%   6000 - D0:  Sub-Universe 6001-6013  (ZRD - Zr clad dummy assemblies)
%   6100 - D1-Half: (Zr half clad dummy)
%
%   9000 - M8 Test Location

%

% Universe Definitions for Homogenization
```

```
%  ##### WARNING ###### Cannot use A0 level for Homogenization. ##########
%        11101 - 11113  A1
%        11x01 - 11x13  Pattern: Ax = A1-A10
%        12x01 - 12x13  A11-A20
%        13x01 - 13x13  A21-A30
%
%        Largest = 13500 for A's
%        Largest = 2000 for B's
%

% Dummy Zone for M8 calibration
cell 9900 9900 air_out    -5999

% Rotate C & D half assemblies 180 Degrees
%trans 6100 0 0 0 0 0 180   % Flit D1-Half 180Deg  (No Longer Needed)
% 6200 is the same as 6100, but faces 180 deg
trans 5900 0 0 0 0 0 180   % Flit C-Half 180Deg

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build  159 assembly core
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
lat 101 1 0.0 0.0 19 19 10.16 % core array

6000   6000   12700  12700  12700  12700  12600  12600  12600  12600  12600  12600  12600
       12700  12700  12700  12700  6000   6000
6000   12700  12700  12700  12400  12400  11100  11100  11200  12100  11200  11100  11100
       12400  12400  12700  12700  12700  6000
12700  12700  12700  12400  11100  11100  11100  1300   11200  12100  11200  1300   11100
       11100  11100  12400  12700  12700  12700
12700  12700  12400  12400  11100  1400   11100  11100  11200  12100  11200  11100  11100
       1400   11100  12400  12400  12700  12700
12700  12400  11400  11400  11100  11100  11100  12100  12100  12100  12100  12100  11100
       11100  11100  11400  11400  12400  12700
12700  12400  11400  1900   11400  12200  12200  12100  12100  12100  12100  12100  12200
       12200  11400  1900   11400  12400  12700
12400  11400  11400  11400  11400  12000  12000  12100  11800  11800  11800  12100  12000
       12000  11400  11400  11400  11400  12400
12400  11400  2000   11400  12000  1600   12000  12100  11800  11800  11800  12100  12000
       1600   12000  11400  2000   11400  12400
12400  11400  11400  11400  12000  12000  12000  12100  11700  6100   11700  12100  12000
       12000  12000  11400  11400  11400  12400
12400  12300  12300  12300  12200  12200  12200  12100  11700  9900   11700  12100  12200
       12200  12200  12300  12300  12300  12400
```

```
12400  11300  11300  11300  11900  11900  11900  12100  11700  5900   11700  12100  11900
       11900  11900  11300  11300  11300  12400
12400  11300  1800   11300  11900  1500   11900  12100  11600  5100   11600  12100  11900
       1500   11900  11300  1800   11300  12400
12400  11300  11300  11300  11300  11900  11900  12100  11600  5150   11600  12100  11900
       11900  11300  11300  11300  11300  12400
12500  12400  11300  1700   11300  12200  12200  12100  11600  5200   11600  12100  12200
       12200  11300  1700   11300  12400  12500
12500  12400  11300  11300  11200  11200  11200  12100  11600  5250   11600  12100  11200
       11200  11200  11300  11300  12400  12500
12500  12500  12400  12400  11200  1200   11200  11200  11500  5300   11500  11200  11200
       1200   11200  12400  12400  12500  12500
12500  12500  12500  12400  11200  11200  11200  1100   11500  5350   11500  1100   11200
       11200  11200  12400  12500  12500  12500
6000   12500  12500  12500  12400  12400  11200  11200  11500  5400   11500  11200  11200
       12400  12400  12500  12500  12500  6000
6000   6000   12500  12500  12500  12500  12500  12500  12500  5450   12500  12500  12500
       12500  12500  12500  12500  6000   6000

cell 8500 100 fill 9000   -9081   % Add Test Region
cell 8501 100 fill 101   9081

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     RUN/PLOT OPTIONS
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% --- boundary conditions (1-black, 2-reflective , 3-periodic):
set bc 1 1 1

% estimators use  (0/1   0 - collision 1- track-length)
% if 1 dt is switched off
%set tle 0

% --- Neutron population and criticality cycles:
%set pop 2000000 20000 100
set pop 2500000  4000 50
set cfe 10

set nbuf 7

% --- Fission Source Entropy
%set his 1
%set entr 5 5 5 -25.4 25.4 -25.4 25.4 0 255

% normalization to power (1 W)
```

```
set power 1.0
set U235H 182.0  %U235 Heating value Default: 202.27MeV
%set fissh <ZAI1><H1><ZAI2><H2>...

%% --- Geometry and mesh plots:
include "plots.sss"    % Depends on the problem

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%        XS preparation settings
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
set micro eg1
ene eg1 1 1.00000E-11 2.00100E-08 4.73020E-08 7.64970E-08 2.09610E-07 6.25000E-07
8.100030E-06
                        1.32700E-04 3.48110E-03 1.15620E-01    2.00000E+01


% include "gcu.sss"     % Depends on the problem
set gcu -1
set savesrc "./TREAT_source" 0.10 1.0  1 1 1
set impl 0 0 0

%%% Extra on GCU
%%% Detector
%%350
%%
%%% Air Channel w/ Det
%%300
%%
%%301
%%302
%%303
%%304
%%305
%%306
%%307
%%308
%%309
%%310
%%311
%%312
%%313

set blockdt b4c_new Dy
```

set nfg 10 2.00100E-08 4.73020E-08 7.64970E-08 2.09610E-07 6.25000E-07 8.100030E-06 1.32700E-04 3.48110E-03 1.15620E-01

%include "Detectors.sss"   % Depends on the problem

%%
%%

File: L91-60-1_trans.sss

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Transient calculation
% Mark DeHart, based on original model by Ben Baker, modified by Mark Wetzel
% Idaho National Laboratory
% Nov 17 2017
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% transient settings
tme simutime 2 10 0 3            % --- 20 time intervals for simulation
tme dettime 2 30 0 3             % --- 50 time bins for detector
set nps 5000000 1000 simutime    % --- Neutron population:
set outp 10                      % --- Output after each 10 cycles
set dynsrc "./TREAT_source" 1    % --- Link source (use point-wise precursor tracking)
det 1 dr -15 void di dettime     % --- Neutron population as a function of time
det 2 dr -8 void di dettime      % --- Fission energy deposition as a function of time
set gcu -1
set impl 0 0 0
set nbuf 3000
set pbuf 500
%# velocity transformation on universe 802 (transient rods), between 0.0 and 0.02 seconds.
%# Motion stops (v returns to 0) at 0.02 sec.

transv U 802 tlim 0.0 0.0794 1 0.0 0.0 431.8 % transient rods travel from 67.31 cm to 101.6 cm, fully removed.


% Surfaces
include "surfaces.sss"
include "Ex-Core-Definition.sss"
include "Ex-Core-Surfaces.sss"
include "Extra_Surfaces.sss"  % Depends on the problem

% Materials
```

```
include "mat.sss"

% --- Cross section library file path:
set acelib "/hpc-common/data/serpent/xsdata/endfb71r1"

% Assemblies
include "A0.sss"
include "B0.sss"

include "CR-Type.sss"
include "C0_48inch.sss"
include "C1-C10.sss"
include "C9_Half-Slot.sss"
include "D0.sss"
include "D1-Half.sss"

include "A-s.sss"                      % Depends on the problem
include "Rods0.018.sss"                % Depends on the problem
include "M8Center_wDy-22R-fuel-region.sss"    % Depends on the problem

% Universe Definitions
%   11100 - A1: Sub-Universes 11101-11113
%   11200 - A2: Sub-Universes 11201-11213
%    ...
%   14000 - A30: Sub-Universes 14001-14013
%
%   1100  - B1: Sub-Universes 1101 - 1113
%   1200  - B2: Sub-Universes 1201 - 1213
%    ...
%   2000  - B10: Sub-Universes 2001 - 2013
%
%   5100 - C1:  Sub-Universes 5101-5113
%   5150 - C2:  Sub-Universes 5150-5173
%   5200 - C3:  Sub-Universes 5201-5213
%    ...
%
%   5900 - C-Half-Slotted Assembly:
%
%   6000 - D0:  Sub-Universe 6001-6013  (ZRD - Zr clad dummy assemblies)
%   6100 - D1-Half: (Zr half clad dummy)
%
%   9000 - M8 Test Location

%

% Universe Definitions for Homogenization
```

```
%  ##### WARNING ###### Cannot use A0 level for Homogenization. ##########
%        11101 - 11113  A1
%        11x01 - 11x13  Pattern: Ax = A1-A10
%        12x01 - 12x13  A11-A20
%        13x01 - 13x13  A21-A30
%
%        Largest = 13500 for A's
%        Largest = 2000 for B's
%

% Dummy Zone for M8 calibration
cell 9900 9900 air_out    -5999

% Rotate C & D half assemblies 180 Degrees
%trans 6100 0 0 0 0 0 180   % Flit D1-Half 180Deg  (No Longer Needed)
% 6200 is the same as 6100, but faces 180 deg
trans 5900 0 0 0 0 0 180   % Flit C-Half 180Deg

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%
% Build  159 assembly core
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%
lat 101 1 0.0 0.0 19 19 10.16 % core array

6000   6000   12700  12700  12700  12700  12600  12600  12600  12600  12600  12600  12600
       12700  12700  12700  12700  6000   6000
6000   12700  12700  12700  12400  12400  11100  11100  11200  12100  11200  11100  11100
       12400  12400  12700  12700  12700  6000
12700  12700  12700  12400  11100  11100  11100  1300   11200  12100  11200  1300   11100
       11100  11100  12400  12700  12700  12700
12700  12700  12400  12400  11100  1400   11100  11100  11200  12100  11200  11100  11100
       1400   11100  12400  12400  12700  12700
12700  12400  11400  11400  11100  11100  11100  12100  12100  12100  12100  12100  11100
       11100  11100  11400  11400  12400  12700
12700  12400  11400  1900   11400  12200  12200  12100  12100  12100  12100  12100  12200
       12200  11400  1900   11400  12400  12700
12400  11400  11400  11400  11400  12000  12000  12100  11800  11800  11800  12100  12000
       12000  11400  11400  11400  11400  12400
12400  11400  2000   11400  12000  1600   12000  12100  11800  11800  11800  12100  12000
       1600   12000  11400  2000   11400  12400
12400  11400  11400  11400  12000  12000  12000  12100  11700  6100   11700  12100  12000
       12000  12000  11400  11400  11400  12400
12400  12300  12300  12300  12200  12200  12200  12100  11700  9900   11700  12100  12200
       12200  12200  12300  12300  12300  12400
```

```
12400 11300 11300 11300 11900 11900 11900 12100 11700 5900  11700 12100 11900
      11900 11900 11300 11300 11300 12400
12400 11300 1800  11300 11900 1500  11900 12100 11600 5100  11600 12100 11900
      1500  11900 11300 1800  11300 12400
12400 11300 11300 11300 11300 11900 11900 12100 11600 5150  11600 12100 11900
      11900 11300 11300 11300 11300 12400
12500 12400 11300 1700  11300 12200 12200 12100 11600 5200  11600 12100 12200
      12200 11300 1700  11300 12400 12500
12500 12400 11300 11300 11200 11200 11200 12100 11600 5250  11600 12100 11200
      11200 11200 11300 11300 12400 12500
12500 12500 12400 12400 11200 1200  11200 11200 11500 5300  11500 11200 11200
      1200  11200 12400 12400 12500 12500
12500 12500 12500 12400 11200 11200 11200 1100  11500 5350  11500 1100  11200
      11200 11200 12400 12500 12500 12500
6000  12500 12500 12500 12400 12400 11200 11200 11500 5400  11500 11200 11200
      12400 12400 12500 12500 12500 6000
6000  6000  12500 12500 12500 12500 12500 12500 12500 5450  12500 12500 12500
      12500 12500 12500 12500 6000  6000

cell 8500 100 fill 9000   -9081   % Add Test Region
cell 8501 100 fill 101   9081

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     RUN/PLOT OPTIONS
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% --- boundary conditions (1-black, 2-reflective , 3-periodic):
set bc 1 1 1

% estimators use  (0/1   0 - collision 1- track-length)
% if 1 dt is switched off
%set tle 0


% --- Fission Source Entropy
%set his 1
%set entr 5 5 5 -25.4 25.4 -25.4 25.4 0 255

% normalization to power (1 W)
set power 1.0
set U235H 182.0  %U235 Heating value Default: 202.27MeV
%set fissh <ZAI1><H1><ZAI2><H2>...

%% --- Geometry and mesh plots:
include "plots.sss"    % Depends on the problem
```

```
mesh 3 5000 5000  0 -388.059 388.059 -388.059 388.059 -194 194
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%        XS preparation settings
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%set micro eg1
%ene eg1 1 1.00000E-11 2.00100E-08 4.73020E-08 7.64970E-08 2.09610E-07 6.25000E-07
8.100030E-06
%                    1.32700E-04 3.48110E-03 1.15620E-01 2.00000E+01
%
%
% include "gcu.sss"     % Depends on the problem
%%% Extra on GCU
%%% Detector
det POW du 101 dm fuel di dettime
det NPOP dr -15 fuel di dettime
det POW_test dr -8 fuel di dettime

%%350
%%
%%% Air Channel w/ Det
%%300
%%
%%301
%%302
%%303
%%304
%%305
%%306
%%307
%%308
%%309
%%310
%%311
%%312
%%313

%set blockdt b4c_new Dy
%set nfg 10 2.00100E-08 4.73020E-08 7.64970E-08 2.09610E-07 6.25000E-07 8.100030E-06
1.32700E-04 3.48110E-03 1.15620E-01

include "Detectors.sss"   % Depends on the problem
set his 1
%%
%%
```

File: M8CAL.sss

```
% Transient Prescription
% Javier Ortensi, modified by Mark Wetzel
% Idaho National Laboratory
% March 20 2018
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% --- Cross section library file path:
set acelib "/hpc-common/data/serpent/xsdata/endfb71r1"

% Surfaces
include "../M8_new/surfaces.sss"
include "../M8_new/Ex-Core-Surfaces.sss"

% Materials
%include "..//M8_new/mat.sss"
%include "../../dehart/M8_mark/mat.sss"
include "mat.sss"

% Assemblies
include "../M8_new/Assemblies_Core_Cells/A/A0.sss"
include "../M8_new/Assemblies_Core_Cells/B/B0.sss"
include "../M8_new/Assemblies_Core_Cells/C/C0_48inch.sss"
include "../M8_new/Assemblies_Core_Cells/C/C1-C10.sss"
include "../M8_new/Assemblies_Core_Cells/C/C9_Half-Slot.sss"
include "../M8_new/Assemblies_Core_Cells/D/D0.sss"
include "../M8_new/Assemblies_Core_Cells/D/D1-Half.sss"
%% include "../M8_new/M8Center_wDy-22R-fuel-region.sss"
include "../M8_new/M8Center-Transient-Prescription.sss"

include "../M8_new/Ex-Core-Definition.sss"
include "../M8_new/CR-Type_cyl.sss"
include "../M8_new/Extra_Surfaces.sss"
include "../M8_new/A-s.sss"
include "../M8_new/Rods.sss"
%include "../M8_new/plots.sss"
include "../M8_new/Detectors.sss"

% Description of Placement: C/S-1 & 4 (North) at 22" = 55.88cm
% Description of Placement: Comp-1 & 4 (North) at 58.5" = 148.59cm
```

```
% Description of Placement: Trans-1 & 4 (North) at 40.0" = 101.6cm
trans 801 0 0 148.59  % compensation rods full out 58.5"
trans 802 0 0 68.88  % safety rods 27.1"
trans 803 0 0 70.87  % transient rods 27.9"

%Transient Data Summary Sheet for Transient 2893T on 2018.5.14
%trans 801 0 0 148.59  % compensation rods full out 58.5 in
%trans 802 0 0 79.934  % safety rods average raised 31.47 in
%trans 803 0 0 59.0296  % transient rods raised 23.24 in

% Dummy Zone for M8 calibration
cell 9900 9900 air_out    -5999

% Rotate C & D half assemblies 180 Degrees
%trans 6100 0 0 0 0 0 180   % Flit D1-Half 180Deg
trans 5900 0 0 0 0 0 180   % Flit C-Half 180Deg
trans 9000 0 0 0 0 0 180   % Flit M8 vehicle

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%
% Build  159 assembly core
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%
lat 101 1 0.0 0.0 19 19 10.16 % core array
6000 6000 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 6000 6000
6000 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 11100 6000
11100 11100 11100 11100 11100 11100 11100 1200 11100 11100 11100 1200 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 1200 11100 11100 11100 11100 11100 11100 11100 1200
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 1300 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 1300 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 1300 11100 11100 1100 11100 11100 11100 11100 11100 11100 11100 1100 11100
11100 1300 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 6100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 9900 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 5900 11100 11100 11100 11100
11100 11100 11100 11100 11100
```

```
11100 11100 1300 11100 11100 1100 11100 11100 11100 5100 11100 11100 11100 1100 11100
11100 1300 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 1300 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 1300 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 1200 11100 11100 11100 5100 11100 11100 11100 1200 11100
11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 1200 11100 5100 11100 1200 11100 11100 11100
11100 11100 11100 11100
6000 11100 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 11100 11100 11100 6000
6000 6000 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100 11100
11100 11100 6000 6000

cell 8500 100 fill 9000   -9081   % Add Test Region
cell 8501 100 fill 101   9081

cell 5590 0 fill 1      -570 571 -572
cell 5591 0 outside      570
cell 5592 0 outside     -571 -570
cell 5593 0 outside      572 -570

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     RUN/PLOT OPTIONS
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% --- boundary conditions (1-black, 2-reflective , 3-periodic):
set bc 1 1 1

% --- Neutron population and criticality cycles:
%set pop 2800000 4000 100
set pop 2000000 1000 10
%set pop 10000 100 10
set nbuf 30
set outp 10
% normalization to power (1000 W)
set power 1000.0

set U235H 182.0  %U235 Heating value Default: 202.27MeV
%set fissh <ZAI1><H1><ZAI2><H2>...

%% Cross section regions
```

```
%% add high energy groups at 1E5 and 1E6 eV
set savesrc "./M8_1.5_source" 0.04 1.0  1 1 1
set his 1
```

File: M8CAL_100k_*.sss (* varying from values 1 to 50)

```
% Transient Prescription
% Javier Ortensi, modified by Mark Wetzel
% Idaho National Laboratory
% July 6 2018
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% --- Cross section library file path:
set acelib "/hpc-common/data/serpent/xsdata/endfb71r1"

% Surfaces
include "../M8_new/surfaces.sss"
include "../M8_new/Ex-Core-Surfaces.sss"

% Materials
include "mat.sss"

% Assemblies
include "../M8_new/Assemblies_Core_Cells/A/A0.sss"
include "../M8_new/Assemblies_Core_Cells/B/B0.sss"
include "../M8_new/Assemblies_Core_Cells/C/C0_48inch.sss"
include "../M8_new/Assemblies_Core_Cells/C/C1-C10.sss"
include "../M8_new/Assemblies_Core_Cells/C/C9_Half-Slot.sss"
include "../M8_new/Assemblies_Core_Cells/D/D0.sss"
include "../M8_new/Assemblies_Core_Cells/D/D1-Half.sss"
%% include "M8Center_wDy-22R-fuel-region.sss"
include "../M8_new/M8Center-Transient-Prescription.sss"

include "../M8_new/Ex-Core-Definition.sss"
include "../M8_new/CR-Type_cyl.sss"
include "../M8_new/Extra_Surfaces.sss"
include "../M8_new/A-s.sss"
include "../M8_new/Rods.sss"
%include "../M8_new/plots.sss"
%include "../M8_new/Detectors.sss"

% Description of Placement: C/S-1 & 4 (North) at 22" = 55.88cm
% Description of Placement: Comp-1 & 4 (North) at 58.5" = 148.59cm
% Description of Placement: Trans-1 & 4 (North) at 40.0" = 101.6cm
```

```
%Transient Data Summary Sheet for Transient 2893T on 2018.5.14
%trans 801 0 0 148.59  % compensation rods full out 58.5 in
%trans 802 0 0 79.934  % safety rods average raised 31.47 in
%trans 803 0 0 59.0296  % transient rods raised 23.24 in


trans 801 0 0 148.59  % compensation rods full out 58.5"
trans 802 0 0 68.88  % safety rods 27.1"
trans 803 0 0 70.87  % transient rods 27.9"

%transv U 802 tlim 0.0 0.09859 1 0.0 0.0 431.8 % reactivity test control rods average moved out
39.12 cm
%transv U 803 tlim 0.0 0.19718 1 0.0 0.0 215.9 % transient rods moved slower
transv U 803 tlim 0.0 0.142334 1 0.0 0.0 215.9 % transient rods moved slower

%trans 801 0 0 148.59  % compensation rods full out 58.5 inches
%trans 802 0 0 58.83  % safety rods
%trans 803 0 0 65.0889  % transient rods

% Dummy Zone for M8 calibration
cell 9900 9900 air_out    -5999

% Rotate C & D half assemblies 180 Degrees
%trans 6100 0 0 0 0 0 180   % Flit D1-Half 180Deg
trans 5900 0 0 0 0 0 180   % Flit C-Half 180Deg
trans 9000 0 0 0 0 0 180   % Flit M8 vehicle

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%
% Build  159 assembly core
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%
lat 101 1 0.0 0.0 19 19 10.16 % core array
6000 6000 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 6000 6000
6000 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 11100 6000
11100 11100 11100 11100 11100 11100 11100 1200 11100 11100 11100 1200 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 1200 11100 11100 11100 11100 11100 11100 11100 1200
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 1300 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 1300 11100 11100 11100
```

```
11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 1300 11100 11100 1100 11100 11100 11100 11100 11100 11100 11100 1100 11100
11100 1300 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 6100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 9900 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 5900 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 1300 11100 11100 1100 11100 11100 11100 5100 11100 11100 11100 1100 11100
11100 1300 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 1300 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 1300 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 11100 11100 11100 11100
11100 11100 11100 11100 11100 1200 11100 11100 11100 5100 11100 11100 11100 1200 11100
11100 11100 11100 11100
11100 11100 11100 11100 11100 11100 11100 1200 11100 5100 11100 1200 11100 11100 11100
11100 11100 11100 11100
6000 11100 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100
11100 11100 11100 11100 6000
6000 6000 11100 11100 11100 11100 11100 11100 11100 5100 11100 11100 11100 11100 11100
11100 11100 6000 6000

cell 8500 100 fill 9000   -9081   % Add Test Region
cell 8501 100 fill 101   9081

cell 5590 0 fill 1      -570 571 -572
cell 5591 0 outside      570
cell 5592 0 outside     -571 -570
cell 5593 0 outside      572 -570

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     RUN/PLOT OPTIONS
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% --- boundary conditions (1-black, 2-reflective , 3-periodic):
set bc 1 1 1

tme simutime 2 10000 0 2            % --- 10 time interval for simulation (no population control)
tme dettime 2 40 0 2            % --- 30 time bins for detector
```

```
det 1 dr -15 void di dettime      % --- Neutron population as a function of time
det 2 dr -8 void di dettime       % --- Fission energy deposition as a function of time
det POW du 101 dm fuel di dettime
det NPOP dr -15 fuel di dettime
det POW_test dr -8 fuel di dettime

% --- Neutron population and criticality cycles:
%set pop 2800000 1000 100
%set savesrc "./M8_mark_source" 0.10 1.0  1 1 1
set dynsrc "./M8_1.5_source" 1
set nps 100000 1 simutime
set nbuf 3000
set pbuf 999

% normalization to power (1000 W)

set power 1000.0

set U235H 182.0  %U235 Heating value Default: 202.27MeV
%set fissh <ZAI1><H1><ZAI2><H2>...

%% Cross section regions
%% add high energy groups at 1E5 and 1E6 eV
set his 1
```

Subfiles:

Surfaces.sss

```
% TREAT - surfaces
% Javier Ortensi
% Idaho National Laboratory
% July 14 2015

% Ben Baker
% Added Slotted 48 inch assembly surfaces
% Modified: Changed surf 4, changed R2, R2 = 6.0207 (Was 6.0900)
%          I calculate it to be 6.02 and it was 6.02 on the original Afull_1_1.sss file as well.

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     STD ASSEMBLY SURFACES
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% STD Assembly Radial surfaces
```

```
surf  1 octa 0.0 0.0 4.82600 6.04775 % outside of fuel -- revision
surf  2 octa 0.0 0.0 4.96570 6.25511 % outside of fuel gap
surf  3 octa 0.0 0.0 5.02920 6.31860 % outside of fuel clad (also outside of Al clad)
surf  4 octa 0.0 0.0 4.8006  6.0207  % outside of graphite
% Changed surf 4, R2 = 6.0207 from 6.0900 on Jan 28, 2016
surf  5 octa 0.0 0.0 4.9022  6.19161 % inside of Al clad
surf  6 cuboid -4.1656 4.1656 -4.1656 4.1656 -500.0 500.0  % square graphite
surf  7 cyl 0.0 0.0 0.36195 183.556250 190.39825  % off gas tube  inner
surf  8 cyl 0.0 0.0 0.47625 184.556250 190.51255  % off gas tube  outer
surf  9 cyl 0.0 0.0 0.9525  184.556250 206.62250  % hole in top reflector -- fuel assembly

% STD Assembly axial surfaces
surf 11 pz  3.486          % Bottom SS Grid + Al bottom fitting
surf 12 pz  30.486         % oct graphite XS region 1
surf 13 pz  53.1747500     % oct graphite XS region 2
surf 14 pz  62.0647500     % square graphite bottom
surf 15 pz  62.1917500     % Al clad
surf 16 pz  62.5092500     % air
surf 17 pz  62.8267500     % Zr spacer + plate
surf 18 pz  82.8267500     % Fuel XS region 1
surf 19 pz  163.814250     % Fuel XS region 2 - mod to match sertta
surf 20 pz  183.794250     % Fuel XS region 1
surf 21 pz  184.111750     % Zr spacer + plate
surf 22 pz  184.429250     % air
surf 23 pz  184.556250     % Al clad
surf 24 pz  193.446250     % square graphite
surf 25 pz  206.622500     % oct graphite w hole
surf 26 pz  220.262500     % oct graphite XS region 2
surf 27 pz  247.262500     % oct graphite XS region 1

%     11  Length  3.486
%     12  Length  27
%     13  Length  22.68875
%     14  Length  8.89
%     17  Length  0.762
%     18  Length  20
%     19  Length  80.9675
%     20  Length  20
%     23  Length  0.762
%     25  Length  22.06625
%     26  Length  13.64
%     27  Length  27
% upto 522 Length  8.02675
```

```
%
%
%surf 30 pz 192.643125 % end of off gas tube inner
%surf 31 pz 192.757425 % end of off gas tube outer

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%       CR ASSEMBLY SURFACES
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% CR radial surfaces
surf 48 cyl 0.0 0.0 1.099852263   -500.0 500.0  % CR region 1
surf 49 cyl 0.0 0.0 1.555425987   -500.0 500.0  % CR region 2
surf 50 cyl 0.0 0.0 1.9050   -500.0 500.0  % CR region 3
surf 51 cyl 0.0 0.0 2.2225   -500.0 500.0  % cladding with 1.75" OD
surf 52 cyl 0.0 0.0 2.54     -500.0 500.0  % air in fuel and top oct graphite region
surf 53 cyl 0.0 0.0 2.8575   -500.0 500.0  % zirc-2 tube with 2.25" OD
surf 54 cyl 0.0 0.0 2.86893   -500.0 500.0  % air gap between zirc2 and aluminum in top sqr graphite

surf 55 cyl 0.0 0.0 2.877344 -500.0 500.0  % air gap /hole in lower short/long graphite
surf 56 cyl 0.0 0.0 2.897188 -500.0 500.0  % air gap /spacers
surf 57 cyl 0.0 0.0 2.9591   -500.0 500.0  % air gap /hole in fuel block
surf 58 cyl 0.0 0.0 3.15595  -500.0 500.0  % Al tube in upper sqr graphite region
surf 59 cyl 0.0 0.0 3.175    -500.0 500.0  % Al in upper oct graphite regions
% Slopes up from 58 to 59 as the you go up the Bearing Tube.
surf 60 cyl 0.0 0.0 3.25755  -500.0 500.0  % air gap /hole in upper short/long graphite
surf 61 cyl 0.0 0.0 2.25552  -500.0 500.0  % inside diameter for graphite bushing

surf 65 octa 0.0 0.0 4.9022  6.192348 % inside of Al clad/Base
% Un-necessary, 65 Same as 5. Only difference is if the base or end tube is used to calculate R2.

% Off-gas Tube
surf 77 cyl 3.143089642 3.143089642 0.36195 0.0 194.60195  % off gas tube  inner
surf 78 cyl 3.143089642 3.143089642 0.47625 0.0 194.71625  % off gas tube  outer
surf 79 cyl 3.143089642 3.143089642 0.63500 0.0 195.03375  % hole in top reflector -- CR assembly

% CR axial surfaces
surf 10 pz 2.143125        % Bottom SS Grid
surf 28 pz 198.52625         % Surf 24 (TOP square) + 2inch = x + 5.08cm [Top of Graphite Bushing for CR]

% revised CR positions - based on the transient rod position
```

%%%
% Control/Shutdown Specific Pz for CR at Position 0. As shown in M8-Cal report p.17
%%%

```
surf 851 pz   -306.64673      %Begin Graphite                              -Crontrol Rod Follower (For Shutdown Rod)
surf 852 pz   -167.74175      %Top of Graphite                             - Control Rod Follower
surf 853 pz   -163.93175      %Top of Steel plug                           - Control Rod Follower
surf 854 pz   -157.89925      %Top Zr/Steel plug/Bottom Graphite           - Control Rod Follower
surf 855 pz   -120.75175      %Top of P1/P2 Graphite                       - Upper Follower
surf 856 pz   -102.97175      %Top of steel plug                           - Upper Follower
surf 857 pz   -96.93925       %Top of Zr/Steel plug                        - Zr follower
surf 858 pz    43.39575       %Top of Graphite                             - Zr follower
surf 859 pz    49.42825       %Top of Zr/Steel plug                        - Zr follower
surf 860 pz    53.23825       %Top of Steel plug                           -Poison Section
surf 861 pz    195.79575      %Top of B4C                                  -Poison Section
surf 862 pz    201.82825      %Top of grapple adaptor coupling             -Poison Section
surf 863 pz    210.08325      %Top of grapple adaptor
```

%%%
% Transient Rods Specific Pz for CR at Position 0. As shown in M8-Cal report p.17
%%%

```
surf 871 pz   -258.38673      %Begin Graphite                              -Crontrol Rod Follower (For Shutdown Rod)
surf 872 pz   -119.48175      %Top of Graphite                             - Control Rod Follower
surf 873 pz   -115.67175      %Top of Steel plug                           - Control Rod Follower
surf 874 pz   -109.63925      %Top Zr/Steel plug/Bottom Graphite           - Control Rod Follower
surf 875 pz   -86.77925       %Top of P1/P2 Graphite                       - Upper Follower
surf 876 pz   -68.99925       %Top of steel plug                           - Upper Follower
surf 877 pz   -62.96675       %Top of Zr/Steel plug                        - Zr follower
surf 878 pz    77.36825       %Top of Graphite                             - Zr follower
surf 879 pz    83.40075       %Top of Zr/Steel plug                        - Zr follower
surf 880 pz    87.21075       %Top of Steel plug                           -Poison Section
surf 881 pz    229.76825      %Top of B4C                                  -Poison Section
surf 882 pz    235.80075      %Top of grapple adaptor coupling             -Poison Section
surf 883 pz    244.05575      %Top of grapple adaptor
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%
% Old CR - Min Critical (placed so that graphite cut out is 1.9" above core)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%
surf 891 pz   -171.26473      %Begin Graphite                                              -
Crontrol Rod Follower (For Shutdown Rod)
surf 892 pz   -32.35975      %Top of Graphite                                    - Control Rod
Follower
surf 893 pz   -28.54975      %Top of Steel plug              - Control Rod Follower
surf 894 pz   -22.51725      %Top Zr/Steel plug/Bottom Graphite    - Control Rod Follower
surf 895 pz   14.63025      %Top of P1/P2 Graphite                               - Upper
Follower
surf 896 pz   32.41025      %Top of steel plug                                   - Upper
Follower
surf 897 pz   38.44275      %Top of Zr/Steel plug                    - Zr follower
surf 898 pz   178.77775      %Top of Graphite                              - Zr follower
surf 899 pz   184.81025      %Top of Zr/Steel plug                         - Zr follower
surf 900 pz   188.62025      %Top of Steel plug                            -Poison Section
surf 901 pz   230.53025      %Origianl Section w/o B4C (Make it 16.5". It says removed 18" and
42" b4c but that isn't possible. The 1.5" is steel)
surf 902 pz   331.17775      %Top of B4C                              -Poison Section
surf 903 pz   337.21025      %Top of grapple adaptor coupling              -Poison Section
surf 904 pz   345.46525      %Top of grapple adaptor


surf 90 inf % dummy domain

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%      48-inch Slotted ASSEMBLY SURFACES    (H1-H-8 & H-11-H-18)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% STD Slotted Radial surfaces
surf  5051 octa 0.0 0.0 5.02920 6.31860                       % outside of all cladding
surf  5052 octa 0.0 0.0 4.9657  6.2551                       % inside of Zr clad in Slot Region
surf  5053 octa 0.0 0.0 4.9022  6.19161                      % inside of Al clad/(2x)Zr clad
surf  5054 octa 0.0 0.0 4.8006  6.02072                      % outside of graphite/lead
surf  5055 cuboid -3.4925 3.4925 -5.02920 5.02920 30.0 210.0             % Slot Region (open
region x 2-3/4 in)
surf  5056 cuboid -4.1671875 4.1671875 -4.1671875 4.1671875 30.0 210.0      % Square
graphite
surf  5057 octa -5.8954 0.0 2.1997 2.1997                       % Smaller Zr support for LHS
surf  5058 octa -5.8954 0.0 2.2632 2.2632                       % Support outer surface for LHS
surf  5059 octa  5.8954 0.0 2.1997 2.1997                       % Smaller Zr support for RHS
```

```
surf  5060 octa  5.8954 0.0 2.2632 2.2632                        % Support outer surface for RHS

% STD Slotted axial surfaces
surf 5070 pz 1.723875    % Start HERE
surf 5071 pz 3.628875    % Al clad
surf 5072 pz 8.78825    % Top of Lead
surf 5073 pz 44.34825    % Top of Reflector #2 (14 inch)
surf 5074 pz 51.8095    % Top of Reflector #1
surf 5075 pz 59.4295    % Begin Zr (2x) Wall on Below Slot
surf 5076 pz 61.017    % Top of Square Graphite Below Slot
surf 5077 pz 61.0805    % Top of Zr Clad, End of (2x) Zr wall, begin (Zr shell + Air)
surf 5078 pz 62.3505    % Top of Zr before Slot, end (Zr shell+Air)
surf 5079 pz 184.2705    % Top of Slot Region, begin (Zr Shell + Air)
surf 5080 pz 185.5405    % Top of Zr Clad after Slot, end (Zr shell + Air), begin Zr (2x) wall
surf 5081 pz 185.604    % Top of Al Clad above Slot Region, begin square Reflector
surf 5082 pz 187.1915    % End of Zr (2x) Wall after slot
surf 5083 pz 194.8115    % Top of Square Graphite Above Slot
surf 5084 pz 206.559    % Top of Reflector #1 (above Slot)
surf 5085 pz 242.119    % Top of Reflector #2 (14 inch)
surf 5086 pz 247.2625    % Top of Lead above Slot (Really continues until 262.741 cm)

% Add Artificial pz to off-set air region in slotted assembly by a little bit
%surf 5087 pz 61.0800 % Just below air region (surf 5077)
%surf 5088 pz 185.5410 % Just above air region (surf 5080)

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% outer surface
surf 5999 cyl 0. 0. 500.0 % dummy domain

% Single Assembly Definition: outside domain
surf 5900 cuboid -5.08   5.08  -5.08   5.08 -160.0 500

% M8 Cal Vehicle
surf 9099 cuboid -5.08 5.08  -10.16  10.16  0.0  500.0

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Additional Plains for half-slotted assembly (H-21) and Half-Graphite Assembly

% Additional planes
surf 5151 py  -0.2667                % Outside of Zr clad on cut mark
surf 5152 py  -0.3302                % inside of Zr clad on cut mark
surf 5153 py  -0.3937                % Stiffener thickness on cut
surf 5154 px  -4.0132    % LHS begin stiffener
```

```
surf 5155 px  -3.9497    % LHS end   stiffener
surf 5156 px   4.0132    % RHS end   stiffener
surf 5157 px   3.9497    % RHS begin stiffener

% Radial Surfaces
surf 5158 cuboid -4.9657 -4.0132    -3.13182 -2.17932    0.0 210.0  % LHS square inner
surf 5159 cuboid  4.0132 4.9657     -3.13182 -2.17932    0.0 210.0  % RHS square inner
surf 5160 cuboid -4.9022 -3.9497     -3.19532 -2.11582    0.0 210.0 % LHS square outer
surf 5161 cuboid  3.9497  4.9022     -3.19532 -2.11582    0.0 210.0 % RHS square outer

% Additional axial surfaces
%surf 5165 pz    1.3118               % Bottom Fitting (Al-6061)
surf 5166 pz    3.2168              % P2 Extension (Al-6061)
%surf 5167 pz    23.5368              % Lead Brick
surf 5168 pz    43.8568              % Lead Brick
surf 5169 pz    59.747              % Graphite
surf 5170 pz    59.8105              % Zr Divider
surf 5171 pz    186.8105              % Air 50-inch slot
surf 5172 pz    186.874              % Zr Divider
surf 5173 pz    223.08424              % Graphite
surf 5174 pz    243.40424              % Lead Brick
surf 5175 pz    245.30924              % P1 Extension (Al-6061)
surf 5176 pz    247.2625              % Top Fitting (Al-6061)

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%      ENCLOSING BODIES FOR FULL ASSEMBLY AND CORE GEOMETRY
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
surf 500 cuboid   -5.080   5.080   -5.080  5.080  0.0 255.289250        % assembly boundary
surf 520 cuboid  -96.520  96.520  -96.520  96.520 0.0 255.289250     % 19x19 array boundary
surf 521 cuboid   -15.24   15.24   -15.24  15.24  0.0 255.289250      % 3x3 array boundary
surf 522 cuboid  -25.400  25.400  -25.400  25.400 0.0 255.289250      % 5x5 array boundary
surf 523 cuboid   -15.24   15.24   -20.32  20.32  0.0 255.289250      % 3x4 array boundary

% Page 15 on ANL-6174 for dimensions of gaps and clad of PR
surf 530 cuboid -101.600 101.600 -101.600 101.600 0.0 255.289250     % 2" air gap outside core
surf 540 cuboid -102.235 102.235 -102.235 102.235 0.0 255.289250     % 0.25" thick aluminum
wall inside reflector

% Permanent Reflector (7ft-8in High - 2ft wide)
% Use 7-7/8" for the width of the PR 1 & PR 2 to match the Cavity Inserts for holes
surf 550 cuboid -122.2375 122.2375 -122.2375 122.2375 0.0 255.289250     % graphite PR 1   7-
7/8" inch wide
surf 551 cuboid -142.24   142.24   -142.24   142.24   0.0 255.289250     % graphite PR 2   7-7/8"
inch wide
```

surf 552 cuboid -163.195 163.195 -163.195 163.195 0.0 255.289250 % graphite PR 3 8-1/4" inch wide

surf 560 cuboid -163.83 163.83 -163.83 163.83 0.0 255.289250 % 0.25" thick aluminum wall outside reflector
surf 561 cuboid -168.91 168.91 -168.91 168.91 0.0 422.4 % 2" air gap between PR and Shield

% Shielding (Its ~ 5ft thick)
% The Walls are 15' on the long side and 4'-3" on the corners
% I'm assuming the corner angles are 45degrees which seems to be correct
% Based on the assumtion the thickness of the concrete is ~5ft thick even on the corners.
%surf 570 cuboid -321.31 321.31 -321.31 321.31 0.0 350.0 % Concrete shield
%surf 570 cuboid -198.12 198.12 -198.12 198.12 0.0 350.0 % Concrete shield MAMMOTH model

% R1 ~= 10.5ft R2~= 12.73ft
surf 570 octa 0 0 320.197 388.059

surf 571 pz 0.0 % Start of Reactor
surf 572 pz 422.4 % Top of Reactor

% Air above the PR and other material to match up with the core
surf 555 pz 233.68 %Start of Air above Reflector and liners
surf 557 pz 270.0 %Approx end of air until concrete

%%
% Core Axial CenterLine = 123.311 cm (Ref for Holes)
%%

Ex-Core-Definition.sss

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Detector Ports
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% Startup & Steady State Det Ports
% West Wall
  % Upper
  % SS-DIS-Detector UPPER A Position
  cell 300 300 air 710
  cell 301 300 fill 350 -710
  cell 302 350 SS_DIS -90
  % Lower
```

```
   cell 305 301 air        706
   cell 306 301 fill 351  -706
   cell 307 351 SS_RTS_A  -90
% North Wall
   % Upper
   cell 310 302 air -90
   % Lower
   cell 315 303 air -90
% South Wall
   % Upper
   cell 320 304 air         728
   cell 321 304 fill 354   -728
   cell 322 354 Startup_DIS_A -90
   % Lower
   cell 325 305 air         729
   cell 326 305 fill 355   -729
   cell 327 355 SS_RTS_B    -90

%% Transient Det Ports
% North-West
   % Upper
   cell 330 306 air          777
   cell 331 306 fill 360    -776
   cell 332 306 fill 361    -777  776
   cell 333 360 B10TransA_up  -90
   cell 334 361 Cd_filter     -90

   % Lower
   cell 335 307 air           742
   cell 336 307 fill 362     -741
   cell 337 307 fill 363     -742  741
   cell 338 362 B10TransA_down  -90
   cell 339 363 Cd_filter       -90

% North-East
   % Upper
   cell 340 308 air           779
   cell 341 308 fill 364     -778
   cell 342 308 fill 365     -779 778
   cell 343 364 B10TransARCS_up  -90
   cell 344 365 Cd_filter        -90

   % Lower
   cell 345 309 air          744
   cell 346 309 fill 366    -743
   cell 347 309 fill 367    -744 743
```

```
   cell 348 366 B10TransARCS_down  -90
   cell 349 367 Cd_filter          -90

% South-West
   % Upper
   cell 350 310 air          781
   cell 351 310 fill 368     -780
   cell 352 310 fill 369     -781 780
   cell 353 368 B10TransB_up     -90
   cell 354 369 Cd_filter        -90

   % Lower
   cell 355 311 air         746
   cell 356 311 fill 370    -745
   cell 357 311 fill 371    -746 745
   cell 358 370 B10TransB_down     -90
   cell 359 371 Cd_filter          -90

% South-East
   % Upper
   cell 360 312 air          783
   cell 361 312 fill 372     -782
   cell 362 312 fill 373     -783 782
   cell 363 372 B10TransC_up     -90
   cell 364 373 Cd_filter        -90

   % Lower
   cell 365 313 air         748
   cell 366 313 fill 374    -747
   cell 367 313 fill 375    -748 747
   cell 368 374 B10TransC_down     -90
   cell 369 375 Cd_filter          -90

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  Full Core
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Air Gap & Al Liner
cell 400 401 air -530:-610:-650:-660:-700:-702:-720:-722:-724:-726          % 2" air gap and
opening in liner for North Face
cell 401 401 aluminum  530 610 650 660 700 702 720 722 724 726          % Al clad PR liner
inside
%%%%%%%%%%%%%% REFLECTOR %%%%%%%%%%%%%%
% PR 1
   % North Cavity
   cell 405 402 air      -620              % First part of first Insert
```

```
   cell 406 402 air       -623              % First part of second Insert
   cell 407 402 air       -625              % First part of third Insert
   % West Cavity
   cell 408 402 graphite       -650              % First part of Insert
   % South Cavity
   cell 409 402 graphite       -660              % First part of Insert

% Reflector PR1 Graphite
cell 416 402 graphite  620 623 625 650 660

% PR 2
   % North Cavity
   cell 421 403 air       -621              % Second part of first Insert
   cell 422 403 air       -624              % Second part of second Insert
   cell 423 403 air       -626              % Second part of third Insert
   % West Cavity
   cell 425 403 graphite       -651              % Second Part of Insert
   % South Cavity
   cell 426 403 graphite       -661              % Second Part of Insert

% Reflector PR2 Graphite
cell 435 403 graphite  621 624 626 651 661

% PR 3
   % North Cavity
   cell 440 404 air      -628               % Hodoscope Air Hole
   % West Cavity
   cell 441 404 graphite      -651               % Extension after Second Part
   % South Cavity
   cell 442 404 graphite      -661               % Extension after Second Part
% Reflector PR3 Graphite
cell 449 404 graphite  628 651 661

%%%%%%%%%%% Air Gap %%%%%%%%%%%%%%%%

% Al Liner and Air Gap
cell 450 405 air       560:-628:-651:-661
cell 451 405 aluminum  -560  628 651 661

%%%%%%%%%%%% SHIELD %%%%%%%%%%%%%%%%%

% ThermoColumn
cell 460 406 graphite   -680:-681
cell 461 406 concrete   680 681
```

```
%%%%%%%%%%% Build Whole CORE --- COMBINE IT %%%%%%%%%%%%%%%%%

cell 550 150 fill 100     -520                  % 19x19 array region
cell 551 150 fill 401  -540 520  -555       % 2" air gap with Al liner  (Limit on Height)
cell 552 150 fill 402  -550 540  -555     700 701 702 703 720 721 722 723 724 725 726 727      %
PR 1                   (Limit on Height)
cell 553 150 fill 403  -551 550  -555     700 701 702 703 720 721 722 723 724 725 726 727      %
PR 2                   (Limit on Height)
cell 554 150 fill 404  -552 551  -555     700 701 702 703 720 721 722 723 724 725 726 727      %
PR 3                   (Limit on Height)
cell 555 150 fill 405  -561 552  -555     700 701 702 703 720 721 722 723 724 725 726 727
                              750 752 754 756 760 762 764 766                 % 2" air gap with Al
liner  (Limit on Height)

cell 556 150 air          520 -561 555 -557                                   % Air above PR
regions and liners (Adds Height)
cell 559 150 fill 406       (561:557) (700 701 702 703 720 721 722 723 724 725 726 727
                            750 751 752 753 754 755 756 757
                            760 761 762 763 764 765 766 767)        % Shield
   % Instr. Holes
   cell 560 150 fill 300      (-700:-701) 540      % Fill West Upper Inst. Hole
   cell 561 150 fill 301      (-702:-703) 540      % Fill West Lower Inst. Hole
   cell 562 150 fill 302      (-720:-721) 540      % Fill North Upper Inst. Hole
   cell 563 150 fill 303      (-724:-725) 540      % Fill North Lower Inst. Hole
   cell 564 150 fill 304      (-722:-723) 540      % Fill South Upper Inst. Hole
   cell 565 150 fill 305      (-726:-727) 540      % Fill South Lower Inst. Hole

   % Trans. Holes
   %%%%%%%%%%
   % Upper
   %%%%%%%%%%
   cell 566 150 fill 306      (-750:-751) 552      % Fill North-West Inst. Hole
   cell 567 150 fill 308      (-752:-753) 552      % Fill North-East Inst. Hole
   cell 568 150 fill 310      (-754:-755) 552      % Fill South-West Inst. Hole
   cell 569 150 fill 312      (-756:-757) 552      % Fill South-East Inst. Hole

   %%%%%%%%%%
   % Lower
   %%%%%%%%%%
   cell 570 150 fill 307      (-760:-761) 552      % Fill North-West Inst. Hole
   cell 571 150 fill 309      (-762:-763) 552      % Fill North-East Inst. Hole
   cell 572 150 fill 311      (-764:-765) 552      % Fill South-West Inst. Hole
   cell 573 150 fill 313      (-766:-767) 552      % Fill South-East Inst. Hole
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%
%
% Generate cross section regions beyond the 19x19
cell 580 4000 fill 150  -1000                      % 19x19
% zone PR1
cell 581 4101 fill 150  (-1022:-1023:-1024:-1025) -265   % air,liner,pr corner
cell 582 4102 fill 150  (-1022:-1023:-1024:-1025)  265   % air,liner,pr corner
cell 583 4401 fill 150  1000 -1001 (-1030:-1031:-1032:-1033:-1034:-1035)  % det penetrations
cell 584 4201 fill 150  1000 -1001 -1036                      % hodoscope
cell 585 4001 fill 150  (1000 -1001) (#581) (#583) (#584) -265  %air, liner, pr
cell 586 4002 fill 150  (1000 -1001) (#582) 265 %air, liner, pr
% zone PR2-6
cell 590 4302 fill 150  1001 -1005 -1036 % hodoscope hole
cell 591 4602 fill 150  1002 -1003 -729 %detector S lower
cell 592 4603 fill 150  1002 -1003 -728 %detector S upper
cell 593 4604 fill 150  1002 -1003 -706 %detector W lower
cell 594 4605 fill 150  1002 -1003 -710 %detector W upper
cell 595 4601 fill 150  1001 -1004 (-1030:-1031:-1032:-1033:-1034:-1035) (#591) (#592) (#593)
(#594) %detector hole empty
cell 596 4301 fill 150  1001 -1004 (#590) (#591) (#592) (#593) (#594) (#595) -265 %solid
cell 597 4303 fill 150  1001 -1004  265  %solid pr with top air
% zone PR7
cell 600 4703 fill 150  (-1026:-1027:-1028:-1029) -265   % out air,liner,pr corner
cell 601 4704 fill 150  (-1026:-1027:-1028:-1029)  265   % out air,liner,pr,top air corner
cell 603 4701 fill 150  1004 -1005 (#590) (#595) (#600)  -265   % out air,liner,pr
cell 604 4702 fill 150  1004 -1005 (#601) 265   % out air,liner,pr,top air
% zone PR8-10
cell 610 4706 fill 150  -1037 % air TC
cell 611 4707 fill 150   1005 -1007 (-1030:-1031:-1032:-1033:-1034:-1035)  % air concrete in
detector hole
cell 612 4705 fill 150   1005 -1007 1042 1043 1044 1045 (#610) (#611)
cell 613 4901 fill 150  -743 % detector lower NE
cell 614 4902 fill 150  -778 % detector upper NE
cell 615 4903 fill 150  -747 % detector lower SE
cell 616 4904 fill 150  -782 % detector upper SE
cell 617 4905 fill 150  -745 % detector lower SW
cell 618 4906 fill 150  -780 % detector upper SW
cell 619 4907 fill 150  -741 % detector lower NW
```

```
cell 620 4908 fill 150  -776 % detector upper NW
cell 621 4802 fill 150  (-1046:-1047:-1048:-1049:-1050:-1051:-1052:-1053)
                    (#600) (#601) (#613) (#614) (#615) (#616) (#617) (#618) (#619) (#620)  %
concrete w detector hole
cell 622 4801 fill 150  (-1042:-1043:-1044:-1045) 1046 1047 1048 1049 1050 1051 1052 1053
(#600) (#601)  % concrete in corner outside holes
cell 623 4999 fill 150  1007

%
% rebuild core
cell 630 1 fill 4000   -1000                      % 19x19
% zone PR1
cell 631 1 fill 4101   (-1022:-1023:-1024:-1025) -265 % air,liner,pr corner
cell 632 1 fill 4102   (-1022:-1023:-1024:-1025)  265% air,liner,pr corner
cell 633 1 fill 4401   1000 -1001 (-1030:-1031:-1032:-1033:-1034:-1035)  % det penetrations
cell 634 1 fill 4201   1000 -1001 -1036                   % hodoscope
cell 635 1 fill 4001   (1000 -1001) (#581) (#583) (#584) -265  %air, liner, pr
cell 636 1 fill 4002   (1000 -1001) (#582) 265 %air, liner, pr
% zone PR2-6
cell 640 1 fill 4302  1001 -1005 -1036 % hodoscope hole
cell 641 1 fill 4602  1002 -1003 -729 %detector S lower
cell 642 1 fill 4603  1002 -1003 -728 %detector S upper
cell 643 1 fill 4604  1002 -1003 -706 %detector W lower
cell 644 1 fill 4605  1002 -1003 -710 %detector W upper
cell 645 1 fill 4601  1001 -1004 (-1030:-1031:-1032:-1033:-1034:-1035) (#591) (#592) (#593)
(#594) %detector hole empty
cell 646 1 fill 4301  1001 -1004 (#590) (#591) (#592) (#593) (#594) (#595) -265 %solid
cell 647 1 fill 4303   1001 -1004  265  %solid pr with top air
% zone PR7
cell 650 1 fill 4703  (-1026:-1027:-1028:-1029) -265   % out air,liner,pr corner
cell 651 1 fill 4704  (-1026:-1027:-1028:-1029)  265   % out air,liner,pr corner
cell 652 1 fill 4701  1004 -1005 (#590) (#595) (#600)  -265   % out air,liner,pr
cell 653 1 fill 4702  1004 -1005 (#601) 265   % out air,liner,pr,top air
% zone PR8-10
cell 660 1 fill 4706  -1037 % air TC
cell 661 1 fill 4707   1005 -1007  (-1030:-1031:-1032:-1033:-1034:-1035)  % air concrete in
detector hole
cell 662 1 fill 4705   1005 -1007 1042 1043 1044 1045 (#610) (#611)
cell 663 1 fill 4901  -743 % detector lower NE
cell 664 1 fill 4902  -778 % detector upper NE
cell 665 1 fill 4903  -747 % detector lower SE
cell 666 1 fill 4904  -782 % detector upper SE
cell 667 1 fill 4905  -745 % detector lower SW
cell 668 1 fill 4906  -780 % detector upper SW
cell 669 1 fill 4907  -741 % detector lower NW
cell 670 1 fill 4908  -776 % detector upper NW
```

cell 671 1 fill 4802 (-1046:-1047:-1048:-1049:-1050:-1051:-1052:-1053)
(#600) (#601) (#613) (#614) (#615) (#616) (#617) (#618) (#619) (#620) %
concrete w detector hole
cell 672 1 fill 4801 (-1042:-1043:-1044:-1045) 1046 1047 1048 1049 1050 1051 1052 1053
(#600) (#601) % concrete in corner outside holes
cell 673 1 fill 4999 1007

Ex-Core-Surfaces.sss

%%
%%%%%%%%
% Core Axial CenterLine = 123.3105 cm (Ref for Holes)
%%
%%%%%%%%

%%%
% Hodoscope (North Wall) - 600's
%%%

% Long Cavity Insert (PR) Part
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Real Dimensions (see Drawing 23201 - Reflector) 1st part 5-13/16" wide x 7-7/8" long x 60-3/4" height
% 2nd part 4-1/8" wide x 7-7/8" long same height

%% Liner on North Wall (12" above/below Axial Centerline and 7-1/8" right/left of Centerline)
% (x left) (x right) (y start) (y end) (z bottom) (z top)
% Actual
% surf 610 cuboid -18.0975 18.0975 101.600 102.235 82.6705 163.9505 % Al liner hole on North Wall (14-1/4" wide x 32" High)
% INF version
surf 610 cuboid -18.0975 18.0975 0.0 500.0 82.6705 163.9505 % Al liner hole on North Wall (14-1/4" wide x 32" High)

%% North Cavity
% y-axis starts after Al liner for Inserts. Assume Cavity is also 32" high.
% PR 1 & PR 2 lineup with the 1st and 2nd parts of the cavity

% Left Cavity (x left) (x right) (y start) (y end) (z bottom) (z top)
% Actual Size
% surf 620 cuboid -20.0025 -5.23875 102.235 122.2375 82.6705 163.9505 % 1st part of first Insert
% surf 621 cuboid -17.859375 -7.381875 122.2375 142.24 82.6705 163.9505 % 2nd part of first Insert

% INF Size
surf 620 cuboid -20.0025 -5.23875 50.0 500.0 82.6705 163.9505 % 1st part of first Insert
surf 621 cuboid -17.859375 -7.381875 50.0 500.0 82.6705 163.9505 % 2nd part of first Insert

% Center Cavity (x left) (x right) (y start) (y end) (z bottom) (z top)
% Actual Size
% surf 623 cuboid -5.23875 5.23875 102.235 122.2375 82.6705 163.9505 % 1st part of second Insert
% surf 624 cuboid -7.381875 7.381875 122.2375 142.24 82.6705 163.9505 % 2nd part of second Insert
% INF Size
surf 623 cuboid -5.23875 5.23875 50.0 500.0 82.6705 163.9505 % 1st part of second Insert
surf 624 cuboid -7.381875 7.381875 50.0 500.0 82.6705 163.9505 % 2nd part of second Insert

% Right Cavity (x left) (x right) (y start) (y end) (z bottom) (z top)
% Actual Size
% surf 625 cuboid 5.23875 20.0025 102.235 122.2375 82.6705 163.9505 % 1st part of third Insert
% surf 626 cuboid 7.381875 17.859375 122.2375 142.24 82.6705 163.9505 % 2nd part of third Insert
% INF Size
surf 625 cuboid 5.23875 20.0025 50.0 500.0 82.6705 163.9505 % 1st part of third Insert
surf 626 cuboid 7.381875 17.859375 50.0 500.0 82.6705 163.9505 % 2nd part of third Insert

% I have no record for the Tapper after the Inserts. I'm assuming air for now.
% Air after Inserts (x left) (x right) (y start) (y end) (z bottom) (z top)
% INF Size
surf 628 cuboid -17.859375 17.859375 0.0 500.0 82.6705 163.9505 % Air after Inserts in Cavity
% (Extended it all the way to the concrete to cut through Al-outside + 2" air gap)

% Concrete Part
%%%%%%%%%%%%%%%%%%%%%%%%%%%
% First hodoscope hole starts 12" below centerline and is 2ft high x 2ft wide x (~2.5'depth)
% Second hole is 3ft high x (2'=LHS of Centerline, 1'-4"=RHS of CL := 3'-4" wide) x 2.5' depth

% Additional pyramids can be added to be an apature for the beam. I will leave it open for now.

% First hole (x left) (x right) (y start) (y end) (z bottom) (z top)
surf 630 cuboid -30.48 30.48 168.91 245.11 92.8305 153.7905 % First Hole in Concrete (NORTH)
surf 631 cuboid -60.96 40.64 245.11 321.31 92.8305 153.7905 % Second Hole in Concrete (NORTH)

%%
% West Wall Cavity - 650's
%%
% Size: First part=~5-7/8" wide x 7-15/16 long x 24" high, Second Part=~4.25" wide x 7.9" long x 24" high
% Centered on Centerline
% West Wall Cavity (x left) (x right) (y start) (y end) (z bottom) (z top)
% INF Size
surf 650 cuboid -500.0 -50.0 -7.46125 7.46125 92.8305 153.7905 % 1st part of Insert
surf 651 cuboid -500.0 -50.0 -5.3975 5.3975 92.8305 153.7905 % 2nd part of Insert
% The second part can extend through the reflector and Al liner.

%%
% South Wall Cavity - 660's
%%
% Size: First part=~5-7/8" wide x 7-15/16 long x 24" high, Second Part=~4.25" wide x 7.9" long x 24" high
% Centered on Centerline
% West Wall Cavity (x left) (x right) (y start) (y end) (z bottom) (z top)
% INF Size
surf 660 cuboid -7.46125 7.46125 -500.0 -50.0 92.8305 153.7905 % 1st part of Insert
surf 661 cuboid -5.3975 5.3975 -500.0 -50.0 92.8305 153.7905 % 2nd part of Insert
% The second part can extend through the reflector and Al liner.
% Note there is a retrofit block that is a wedge 2" high

%%%
% Thermo-column - 680's
%%%
%
% Thermocolumn liner is 32" wide x 4'-8" tall
% The graphite is actually 5'x 5' until 1/2 way through the concrete (ie. 2.5ft) then it's 5'-8" x 5'-8"
% Start (x) End (x) Start(y) End(y) z1 z2

```
% Actual Size
% surf 680 cuboid   168.91     245.11   -76.2     76.2    47.1105   199.5105     % First Graphite Blocks
% surf 681 cuboid   245.11     321.31   -86.36    86.36   36.9505   209.6705     % Second Graphite Blocks
% Inf Size
  surf 680 cuboid    0.0      500.0   -76.2     76.2    47.1105   199.5105     % First Graphite Blocks
  surf 681 cuboid  245.11     500.0   -86.36    86.36   36.9505   209.6705     % Second Graphite Blocks
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% West Instrument Holes - 700's
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% This applies to all the holes that go through the permeant reflector

% Instrument Holes are located 1Ft above and below core CenterLine and 2ft from the core x-y center lines
% The holes are R=3.25" with a sleve of 6" OD in the Reflector.
% The sleve is 55-3/8" long which travels from the reflector into the shield.
% The hole changes to 8" dia for the last 2'-6.75" of the Shield.

   %%%%%%%%%%%%%%%%
   % Upper Hole (DIS-SS in Upper A)
   %%%%%%%%%%%%%%%%
   %                y0       z0       r     start(x1)     End(x2)
   % Actual Location
   % surf 700 cylx    60.96     153.7905   7.62   -243.205     -102.235        % 6" Hole
   % surf 701 cylx    60.96     153.7905   10.16  -321.31      -243.205        % 8" Hole
   % INF Location
   %  surf 700 cylx    60.96     153.7905   7.62    -500        -60           % 6" Hole
   %  surf 701 cylx    60.96     153.7905   10.16   -500       -243.205        % 8" Hole
   % replace with rectangular hole with same volume
     surf 700 cuboid    -500  -60       55.88 66.04   144.813399 162.767601          % 6" Hole
     surf 701 cuboid    -500  -243.205  55.38 66.54   139.2612533 168.3197467       % 8" Hole

   %%%%%%%%%%%%%%%%
   % Lower Hole
   %%%%%%%%%%%%%%%%
   %                y0       z0       r     start(x1)     End(x2)
   % Actual Location
   % surf 702 cylx    60.96     92.8305    7.62   -243.205     -102.235        % 6" Hole
   % surf 703 cylx    60.96     92.8305    10.16  -321.31      -243.205        % 8" Hole
   %  surf 702 cylx    60.96     92.8305    7.62   -500        -60            % 6" Hole
   %  surf 703 cylx    60.96     92.8305    10.16  -500        -243.205        % 8" Hole
```

```
% replace with rectangular hole with same volume
  surf 702 cuboid    -500  -60       55.88 66.04   83.85339899 101.807601          % 6" Hole
  surf 703 cuboid    -500  -243.205  55.38 66.54   78.30125329 107.3597467         % 8" Hole

  %surf 706 cylx    60.96     92.8305    2.54   -145.733     -122.2375       % West-Lower Det
  surf 706 cuboid  -137.08380   -127.07620   55.95620   65.96380   87.28695
97.13455          % lower square detector
%%%%%%%%%%%%
% Interface
%%%%%%%%%%%%%
  surf 705 px                          -243.205                    % 8" to 6" interface

% Cylinder for Detector
% Using the 8" to 6" dia holes and the det drawings the 6" dia region for the SS chamber
% is up to ~47.5" this means the closest to the core the detector can be is ~16" into the
reflector
% or 8" into the reflector from the core side. This is the end of the detector. Det Length =
12.94"
% The furthest away (ref being bottom of detector) is ~16.3" from the start of the concrete.
%
% Det Specs
% Active length = 9.25"
% Dia = 1.99", Fill Gas = N2, B-10 Lined.
%%%%%%%%%%
% DIS-SS Chamber
%%%%%%%%%%
%                 y0       z0       r     start(x1)     End(x2)
%surf 710 cylx    60.96     153.7905   2.54   -145.733     -122.2375
%surf 712 cylx   60.96      153.791    3.04  -146.233     -121.7375 % 1st Filter 0.5 cm thick

surf 710 cuboid  -137.08380   -127.07620   55.95620   65.96380   147.28695
157.13455          % upper square detector
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
surf 711 cylx   60.96     153.791   7.62   -103.235     -102.235  % puck in front of DIS-SS
Upper A hole
surf 713 cylx   60.96     153.791   7.62   -163.195     -102.235  % dummy upper hole


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% North & South Instrument Holes - 720's
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%%%%%%%%%%%%%%%
% Upper Hole
%%%%%%%%%%%%%%%%%
%                 x0          z0       r     start(y1)      End(y2)
```

% INF Location
% surf 720 cyly   60.96   153.7905   7.62   60   500   % 6" Hole (North)
% surf 721 cyly   60.96   153.7905   10.16 243.205   500   % 8" Hole (North)
% surf 722 cyly   -60.96   153.7905   7.62   -500   -60   % 6" Hole (South)
% surf 723 cyly   -60.96   153.7905   10.16   -500   -243.205   % 8" Hole (South)

% replace with rectangular hole with same volume
surf 720 cuboid   55.88 66.04 60   500.0   144.813399 162.767601   % 6" Hole (North)
surf 721 cuboid   55.88 66.04 243.205 500.0   139.2612533 168.3197467   % 8" Hole (North)
surf 722 cuboid -66.04 -55.88   -500   -60.0   144.813399 162.767601   % 6" Hole (South)
surf 723 cuboid -66.04 -55.88   -500   -243.205 139.2612533 168.3197467   % 8" Hole (South)

%surf 728 cyly   -60.96   153.7905   2.54   -145.733   -122.2375   % South-Upper Det
surf 728 cuboid   -65.96380   -55.95620   -137.08380   -127.07620   147.28695 157.13455   % upper square detector
%%%%%%%%%%%%%%%%%%
% Lower Hole
%%%%%%%%%%%%%%%%%%
%   x0   z0   r   start(y1)   End(y2)
% INF Location
% surf 724 cyly   60.96   92.8305   7.62   60   500   % 6" Hole (North)
% surf 725 cyly   60.96   92.8305   10.16   243.205   500   % 8" Hole (North)
% surf 726 cyly -60.96   92.8305   7.62   -500   -60   % 6" Hole (South)
% surf 727 cyly -60.96   92.8305   10.16   -500   -243.205   % 8" Hole (South)

% replace with rectangular hole with same volume
surf 724 cuboid   55.88 66.04 60   500.0   83.85339899 101.807601   % 6" Hole (North)
surf 725 cuboid   55.88 66.04 243.205 500.0   78.30125329 107.3597467   % 8" Hole (North)
surf 726 cuboid -66.04 -55.88   -500   -60.0   83.85339899 101.807601   % 6" Hole (South)
surf 727 cuboid -66.04 -55.88   -500   -243.205 78.30125329 107.3597467   % 8" Hole (South)

%surf 729 cyly   -60.96   92.8305   2.54   -145.733   -122.2375   % South-Lower Det
surf 729 cuboid   -65.96380   -55.95620   -137.08380   -127.07620   87.28695 97.13455   % lower square detector
%%%%%%%%%%%%
% Interface

```
%%%%%%%%%%%%%
%           x0      z0     r    start(y1)    End(y2)
 surf 730 py                     243.205              % 8" to 6" interface (North)
 surf 731 py                    -243.205              % 8" to 6" interface (South)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% North-West & South-East Instrument Holes - 750-760's
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  %%%%%%%%%%%%%%%%%%%%
  % Upper Hole
  %%%%%%%%%%%%%%%%%%%%
  %           x0      y0     r    start(y1)    End(y2)
  % INF Location
   surf 750 cyl   0.0      0.0   7.62     -320.0       -30.0            % 6" Hole (North-West)
   surf 751 cyl   0.0      0.0   10.16    -500.0       -309.905         % 8" Hole (North-West)
   surf 752 cyl   0.0      0.0   7.62     -320.0       -30.0            % 6" Hole (North-East)
   surf 753 cyl   0.0      0.0   10.16    -500.0       -309.905         % 8" Hole (North-East)
   surf 754 cyl   0.0      0.0   7.62      30.0        320.0            % 6" Hole (South-West)
   surf 755 cyl   0.0      0.0   10.16     309.905      500.0           % 8" Hole (South-West)
   surf 756 cyl   0.0      0.0   7.62      30.0        309.905          % 6" Hole (South-East)
   surf 757 cyl   0.0      0.0   10.16     309.905      500.0           % 8" Hole (South-East)

   % Translate up 153.7905 on z-axis then rotate about x-axis -90 Deg (sends to x-y plane)
   % then +/- 45 deg about y-axis which is really z-axis after rotating on x-axis
   trans S 750 0  0 153.7905   -90   -45   0 1
   trans S 751 0  0 153.7905   -90   -45   0 1
   trans S 752 0  0 153.7905   -90    45   0 1
   trans S 753 0  0 153.7905   -90    45   0 1
   trans S 754 0  0 153.7905   -90    45   0 1
   trans S 755 0  0 153.7905   -90    45   0 1
   trans S 756 0  0 153.7905   -90   -45   0 1
   trans S 757 0  0 153.7905   -90   -45   0 1

       %%%%%%%% ADDED For Tallies For the Air Chamber (Starts = ~239cm, Ends =
~309.905cm Length ~27.9")
       surf 770 cyl  0.0  0.0  7.62  -309.905 -239.0    % NW-up Air Chamber
       surf 771 cyl  0.0  0.0  7.62  -240.0   -239.0    % NW-up puck
       surf 772 cyl  0.0  0.0  7.62   239.0    309.905  % SW-up Air Chamber
       surf 773 cyl  0.0  0.0  7.62   239.0    240.0    % SW-up puck
       surf 774 cyl  0.0  0.0  7.62  -309.905 -239.0    % NE-up Air Chamber
       surf 775 cyl  0.0  0.0  7.62   239.0    309.905  % SE-up Air Chamber

       trans S 770 0  0 153.7905   -90   -45   0 1   % NW Air
```

```
trans S 771 0  0 153.7905   -90   -45   0 1   % NW-puck
trans S 772 0  0 153.7905   -90    45   0 1   % SW Air
trans S 773 0  0 153.7905   -90    45   0 1   % SW-puck
trans S 774 0  0 153.7905   -90    45   0 1   % NE Air
trans S 775 0  0 153.7905   -90   -45   0 1   % SE Air


surf 776 cuboid   -187.8838   -177.8762   177.8762   187.8838   147.28695
157.13455          % NW upper square detector - det
surf 777 cuboid   -187.96     -177.8      177.8      187.96     147.21075
157.21075          % NW upper square detector - Cd
surf 778 cuboid    177.8762    187.8838   177.8762   187.8838   147.28695
157.13455          % NE upper square detector - det
surf 779 cuboid    177.8       187.96     177.8      187.96     147.21075   157.21075          %
NE upper square detector - Cd
surf 780 cuboid   -187.8838   -177.8762  -187.8838  -177.8762   147.21075
157.13455          % SW upper square detector - det
surf 781 cuboid   -187.96     -177.8     -187.96    -177.8      147.21075
157.21075          % SW upper square detector - Cd
surf 782 cuboid    177.8762    187.8838  -187.8838  -177.8762   147.28695
157.13455          % SE upper square detector - det
surf 783 cuboid    177.8       187.96    -187.96    -177.8      147.21075
157.21075          % SE upper square detector - Cd



%%%%%%%%%%%%%%%%%%%%
% Lower Hole
%%%%%%%%%%%%%%%%%%%%
%              x0       y0     r    start(y1)     End(y2)
% INF Location
  surf 760 cyl   0.0       0.0   7.62     -320.0       -30.0            % 6" Hole (North-West)
  surf 761 cyl   0.0       0.0   10.16    -500.0       -309.905         % 8" Hole (North-West)
  surf 762 cyl   0.0       0.0   7.62     -320.0       -30.0            % 6" Hole (North-East)
  surf 763 cyl   0.0       0.0   10.16    -500.0       -309.905         % 8" Hole (North-East)
  surf 764 cyl   0.0       0.0   7.62      30.0        320.0            % 6" Hole (South-West)
  surf 765 cyl   0.0       0.0   10.16     309.905     500.0            % 8" Hole (South-West)
  surf 766 cyl   0.0       0.0   7.62      30.0        309.905          % 6" Hole (South-East)
  surf 767 cyl   0.0       0.0   10.16     309.905     500.0            % 8" Hole (South-East)

  % Rotate surface -90 deg around y-axis, -45 deg about z-axis then translate up 153.7905 on
z-axis (2=Rotation before Translation)
  trans S 760 0 0 92.8305   -90   -45   0  1
  trans S 761 0 0 92.8305   -90   -45   0  1
  trans S 762 0 0 92.8305   -90    45   0  1
```

```
trans S 763 0 0 92.8305   -90    45   0  1
trans S 764 0 0 92.8305   -90    45   0  1
trans S 765 0 0 92.8305   -90    45   0  1
trans S 766 0 0 92.8305   -90   -45   0  1
trans S 767 0 0 92.8305   -90   -45   0  1

    %%%%%%% ADDED For Tallies For the Air Chamber (Starts = ~239cm, Ends =
~309.905cm Length ~27.9")
    surf 735 cyl  0.0  0.0  7.62  -309.905 -239.0    % NW-down Air Chamber
    surf 736 cyl  0.0  0.0  7.62  -240.0   -239.0    % NW-down puck
    surf 737 cyl  0.0  0.0  7.62   239.0    309.905  % SW-down Air Chamber
    surf 738 cyl  0.0  0.0  7.62   239.0    240.0    % SW-down puck
    surf 739 cyl  0.0  0.0  7.62  -309.905 -239.0    % NE-down Air Chamber
    surf 740 cyl  0.0  0.0  7.62   239.0    309.905  % SE-down Air Chamber

    trans S 735 0  0 92.8305   -90   -45   0 1   % NW Air
    trans S 736 0  0 92.8305   -90   -45   0 1   % NW-puck
    trans S 737 0  0 92.8305   -90    45   0 1   % SW Air
    trans S 738 0  0 92.8305   -90    45   0 1   % SW-puck
    trans S 739 0  0 92.8305   -90    45   0 1   % NE Air
    trans S 740 0  0 92.8305   -90   -45   0 1   % SE Air

    %%%%%%% ADDED For Chamber and Cd Filter (nominal=30mills = 0.0762cm)
    %%%%%% Choose Close or Far From the Reflector

    surf 741 cuboid   -187.8838   -177.8762   177.8762   187.8838   87.21075
97.21075        % NW lower square detector - det
    surf 742 cuboid   -187.96     -177.8      177.8      187.96     87.21075   97.21075        %
NW lower square detector - Cd
    surf 743 cuboid    177.8762    187.8838   177.8762   187.8838   87.21075
97.21075        % NE lower square detector - det
    surf 744 cuboid    177.8       187.96     177.8      187.96     87.21075   97.21075        %
NE lower square detector - Cd
    surf 745 cuboid   -187.8838   -177.8762  -187.8838  -177.8762   87.21075
97.21075        % SW lower square detector - det
    surf 746 cuboid   -187.96     -177.8     -187.96    -177.8      87.21075   97.21075        %
SW lower square detector - Cd
    surf 747 cuboid    177.8762    187.8838  -187.8838  -177.8762   87.21075
97.21075        % SE lower square detector - det
    surf 748 cuboid    177.8       187.96    -187.96    -177.8      87.21075   97.21075        %
SE lower square detector - Cd


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Diagonal Cuts for PR to make North/South/East/West sides
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
surf 790 plane -1 -1 0 0
surf 791 plane 1 -1 0 0

% Planes for axial cuts in PR & Liner
surf 792 pz  85.2105
surf 793 pz 100.4505
surf 794 pz 146.1705
surf 795 pz 161.4105


% surfaces to define cross section regions beyond the 19x19
surf 1000 cuboid   -96.52    96.52   -96.52   96.52  -100.0 400   % 19x19
surf 1001 cuboid   -106.68  106.68  -106.68  106.68  -100.0 400   % PR1
surf 1002 cuboid   -127.0   127.0   -127.0   127.0  -100.0 400   % PR3
surf 1003 cuboid   -137.16  137.16  -137.16  137.16  -100.0 400   % PR4
surf 1004 cuboid   -157.48  157.48  -157.48  157.48  -100.0 400   % PR6
surf 1005 cuboid   -167.64  167.64  -167.64  167.64  -100.0 400   % PR7
surf 1006 cuboid   -177.8   177.8   -177.8   177.8   -100.0 400   % PR8
surf 1007 cuboid   -198.12  198.12  -198.12  198.12   -100.0 400   % PR10

surf 1022 cuboid    96.52   106.68    96.52  106.68 -100.0 400 % NE corner air pr liner
surf 1023 cuboid    96.52   106.68  -106.68  -96.52 -100.0 400 % SE corner air pr liner
surf 1024 cuboid  -106.68   -96.52  -106.68  -96.52 -100.0 400 % SW corner air pr liner
surf 1025 cuboid  -106.68   -96.52    96.52  106.68 -100.0 400 % NW corner air pr liner

surf 1026 cuboid    157.48  167.64   157.48  167.64 -100.0 400  % NE corner outer air pr liner
surf 1027 cuboid    157.48  167.64  -167.64 -157.48  -100.0 400 % SE corner outer air pr liner
surf 1028 cuboid   -167.64 -157.48  -167.64 -157.48 -100.0 400  % SW corner outer air pr liner
surf 1029 cuboid   -167.64 -157.48   157.48 167.64 -100.0 400  % NW corner outer air pr liner

surf 1030 cuboid    55.88  66.04  96.52   200.0  137.21075 163.79425 % N upper penetration
surf 1031 cuboid    55.88  66.04  96.52   200.0   82.82675 107.21075 % N lower penetration
surf 1032 cuboid   -200.0 -96.52  55.88   66.04   137.21075 163.79425 % W upper penetration
surf 1033 cuboid   -200.0 -96.52  55.88   66.04    82.82675 107.21075 % W lower penetration
surf 1034 cuboid   -66.04 -55.88 -200.0 -96.52   137.21075 163.79425 % S upper penetration
surf 1035 cuboid   -66.04 -55.88 -200.0 -96.52    82.82675 107.21075 % S lower penetration

surf 1036 cuboid   -25.4   25.4   96.52  167.64    82.82675 163.79425 % hodoscope hole
surf 1037 cuboid   167.64  198.12  -66.04  66.04    41.830375 206.6225 % Thermal column

surf 1042 cuboid   157.48   198.12   157.48  198.12  -100.0 400 % 4x4 NE corner
surf 1043 cuboid   157.48   198.12  -198.12 -157.48  -100.0 400 % 4x4 SE corner
surf 1044 cuboid  -198.12  -157.48  -198.12 -157.48  -100.0 400 % 4x4 SW corner
surf 1045 cuboid  -198.12  -157.48   157.48  198.12  -100.0 400 % 4x4 NW corner
```

surf 1046 cuboid 157.48 198.12 157.48 198.12 137.21075 163.79425 % 4x4 NE corner upper hole region only
surf 1047 cuboid 157.48 198.12 -198.12 -157.48 137.21075 163.79425 % 4x4 SE corner upper hole region only
surf 1048 cuboid -198.12 -157.48 -198.12 -157.48 137.21075 163.79425 % 4x4 SW corner upper hole region only
surf 1049 cuboid -198.12 -157.48 157.48 198.12 137.21075 163.79425 % 4x4 NW corner upper hole region only

surf 1050 cuboid 157.48 198.12 157.48 198.12 82.82675 107.21075 % 4x4 NE corner lower hole region only
surf 1051 cuboid 157.48 198.12 -198.12 -157.48 82.82675 107.21075 % 4x4 SE corner lower hole region only
surf 1052 cuboid -198.12 -157.48 -198.12 -157.48 82.82675 107.21075 % 4x4 SW corner lower hole region only
surf 1053 cuboid -198.12 -157.48 157.48 198.12 82.82675 107.21075 % 4x4 NW corner lower hole region only

mat.sss

%%% Fuel at 293.6K
%%% all other materials at 293.6K
%%% low boron

% Boron Detectors
%%%

% Boron Detectors
%%
%% Startup & Steady-State %
%%
% West-Upper: A = SS-DIS-Linear (Linear Oper.), B = Startup-DIS-A (Startup A)
mat SS_DIS sum tmp 294.0 rgb 15 29 200 %% DIS-SS (West-Upper)

5010.80c 1.5616E-06 % Based on B4c

% West-Lower: A = SS-RTS-A-Linear (Linear A), B = SS-RTS-A-Log/Period (Log/Period A)
mat SS_RTS_A sum tmp 294.0 rgb 15 29 200 %% (West-Lower)
5010.80c 1.5616E-06 % Based on B4c

% South-Upper: A = Startup-DIS-B (Startup B), B = No INFO.
mat Startup_DIS_A sum tmp 294.0 rgb 15 29 200 %% (South-Upper)
5010.80c 1.5616E-06 % Based on B4c

% South-Lower: A = SS-RTS-B-Linear (Linear B), B = SS-RTS-B-Log/Period (Log/Period B)

```
mat SS_RTS_B sum tmp 294.0 rgb 15 29 200  %% (South-Lower)
5010.80c 1.5616E-06  % Based on B4c

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% Transient B-10 Detectors %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% NW-Upper: A = Trans-RTS-A-Linear (Linear A), B = Trans-RTS-A-Energy (Energy A)
mat B10TransA_up sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% NW-Lower: A = , B = Trans-RTS-A-Log/Period (Log/Period A) (Could be A)
mat B10TransA_down sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% SW-Upper: A = Trans-RTS-B-Linear (Linear B), B = Trans-RTS-B-Energy (Energy B)
mat B10TransB_up sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% SW-Lower: A = , B = Trans-RTS-B-Log/Period (Log/Period B) (Could be A)
mat B10TransB_down sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% SE-Upper: A = Trans-RTS-C-Linear (Linear C), C = Trans-RTS-C-Energy (Energy C)
mat B10TransC_up sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% SE-Lower: A = , B = Trans-RTS-C-Log/Period (Log/Period C) (Could be A)
mat B10TransC_down sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% NE-Upper: A = ARCS-Linear, B = ARCS-Log/Period
mat B10TransARCS_up sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c

% NE-Lower: A = No INFO., B = No INFO.
mat B10TransARCS_down sum tmp 294.0 rgb 15 29 200
5010.80c 1.5616E-06  % Based on B4c
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%% Cd Filter on Detectors
mat Cd_filter sum tmp 294.0 rgb 255 5 10
48106.80c   5.8259E-04
48108.80c   4.1480E-04
48110.80c   5.8305E-03
```

```
48111.80c   5.9704E-03
48112.80c   1.1246E-02
48113.80c   5.6954E-03
48114.80c   1.3386E-02
48116.80c   3.4815E-03


% Boron Filter on Detectors
mat B_filter sum tmp 294.0 rgb 215 229 200
5010.80c 1.5616E-02  % Based on B4c

% Indium Filter
mat In_filter sum tmp 294.0 rgb 200 129 100
49113.80c   1.6448E-03
49115.80c   3.6695E-02

% Hafnium
mat Hafnium_filter sum tmp 294.0 rgb 100 229 50
72174.80c   7.05541E-05
72176.80c   0.002319467
72177.80c   0.008201917
72178.80c   0.012029479
72179.80c   0.00600592
72180.80c   0.015468993

% Silver
mat Silver_filter sum tmp 294.0 rgb 50 220 150
47107.80c   3.0387E-02
47109.80c   2.8231E-02


% --- Materials:
%mat fuel sum tmp 294.0 moder gra_300 6000 rgb 238 59 59
%6000.80c    5.0874E-02
%6002.80c    3.5353E-02
%% NOT 5.9 ppm but 7.6 ppm boron
%5010.80c    1.4495E-07
%5011.80c    5.8343E-07
%% 7.6 ppm boron
%%5010.80c    1.8672E-07
%%5011.80c    7.5154E-07
%92235.80c   8.6849E-06
%92238.80c   6.2967E-07
%26054.80c   6.5286E-07
%26056.80c   1.0239E-05
%26057.80c   2.3659E-07
```

```
%26058.80c   3.1248E-08
%8016.80c    1.8623E-05

% -- Michigan fuel
mat fuel sum tmp 294.0 moder gra_300 6000 rgb 238 59 59
  6000.80c  5.1039E-02
  6002.80c  3.5468E-02
  5010.80c  1.4440E-07
  5011.80c  5.8124E-07
  8016.80c  1.8685E-05
 23050.80c  1.5339E-09
 23051.80c  6.1201E-07
 26054.80c  2.9114E-07
 26056.80c  4.5703E-06
 26057.80c  1.0555E-07
 26058.80c  1.4047E-08
 92234.80c  8.5472E-08
 92235.80c  8.7202E-06
 92236.80c  4.0790E-08
 92238.80c  4.9986E-07
% 900 ppm hydrogen impurity
  1001.80c  9.3015E-04
  1002.80c  1.0698E-07

%%%%%%%%%%%%%%%%%
% Experiment
%%%%%%%%%%%%%%%%%
%  Transient Prescription

% wire: Dia=1.59 mm or 1.82 mm (not sure)
% actual heights are set to be 5 mm. But I am using 2cm for better stats.
%
% U235 is 0.36 wt% and 0.36 at%
% Assuming density = 19.1 g/cm^3 for DU then
% U238 = 4.815E22 at/cm^3 = 0.04815 at/b-cm
% U235 = 1.739E20 at/cm^3 = 0.0001739 at/b-cm

% If we homogenize the wire with the air for larger volume (use area's lengths are equal)
% Area of Wire = pi*(0.159cm/2)^2 = 0.019856 cm^2
% Area of Titanium Tube = pi*(0.3175cm^2-0.2286cm^2) = 0.1525 cm^2
% Total Area = pi*(1.4224cm)^2 = 6.356 cm^2
% Area of Air = pi*((1.4224cm)^2)- Area of Titanium - Area of Wire = 6.18376 cm^2
% Ratio of Areas:  Air/Total = 0.97288, Wire/Total = 3.12E-3, Ti/Total = 0.023995
%
mat FissionWire sum tmp 294.0 rgb 135 29 48
% U (only ballpark numbers)
```

```
92238.80c      1.504254E-04
92235.80c      5.433401E-07
% Air
6000.80c    7.375505E-09
7014.80c    3.841322E-05
8016.80c    1.032032E-05
% Titanium
%22000.80c    1.3605E-04
22046.80c   1.12241E-05
22047.80c   1.01221E-05
22048.80c   1.00296E-04
22049.80c   7.36030E-06
22050.80c   7.04739E-06

mat WireHolder sum tmp 294.0 rgb 0 120 120
% Titanium -  Actual 5.6698E-03 at/b-cm (total)
%22000.80c     1.99405E-04 % Homogenized with Air
22046.80c   1.64509E-05
22047.80c   1.48357E-05
22048.80c   1.47002E-04
22049.80c   1.07878E-05
22050.80c   1.03292E-05
% Air
6000.80c    7.31448E-09
7014.80c    3.80954E-05
8016.80c    1.02349E-05

% Flux Wires
mat FeWire sum tmp 294.0 rgb 20 29 20
% Iron Fe54 (n,p) Reaction
26054.80c 6.14E-06

mat TiWire sum tmp 294.0 rgb 30 30 30
% Ti46(n,p) Reaction
22046.80c  5.77905E-06

mat NbWire sum tmp 294.0 rgb 50 50 50
% Nb93(n,gamma) and (n,n') Reactions
41093.80c  6.86411E-05

mat CoWire sum tmp 294.0 rgb 60 60 60
% Co59(n,gamma) Reaction
27059.80c  1.12377E-7
%13027.80c  7.43892e-5

mat PerDuWire sum tmp 294.0 rgb 135 29 48  %% Peripheral Du Wires
```

```
% U (only ballpark numbers)
92238.80c     3.116038E-03
92235.80c     1.125520E-05
% Air
6000.80c   3.321630E-09
7014.80c   1.729976E-05
8016.80c   4.647854E-06
% Titanium
22046.80c  2.32506E-04
22047.80c  2.09678E-04
22048.80c  2.07762E-03
22049.80c  1.52467E-04
22050.80c  1.45985E-04

% FROM M8
%%% Test Sample: U-Zr: 19.8wt % U-235 and 6.0 wt. % Uranium  (About 2mg/inch)
%%%  mat test_pin sum tmp 294.0 rgb 238 59 59
%%%  % U
%%%  92235.80c  2.488346E-04
%%%  92238.80c  9.951746E-04
%%%  % Zr
%%%  40090.80c  2.610042E-02
%%%  40091.80c  5.691869E-03
%%%  40092.80c  8.700138E-03
%%%  40094.80c  8.816817E-03
%%%  40096.80c  1.420431E-03

%%  mat air_fuel1 sum tmp 294.0  rgb 238 59 59 %rgb 204 255 255
%%  %  U  (See the Test-Assembly.xlsx file inside of the T-TestCenter folder on my desktop)
%%  92235.80c  3.173910E-07
%%  92238.80c  1.269355E-06
%%  % Zr
%%  40090.80c  3.329135E-05
%%  40091.80c  7.260037E-06
%%  40092.80c  1.109712E-05
%%  40094.80c  1.124594E-05
%%  40096.80c  1.811774E-06
%%  % air
%%  6000.80c   7.59330E-09
%%  7014.80c   3.95476E-05
%%  8016.80c   1.06251E-05
%%
%%  %mat fuel2 sum tmp 294.0 moder gra_300 6000 rgb 238 59 59
%%  %6000.80c   5.0874E-02
%%  %6002.80c   3.5353E-02
%%  %92235.80c  1.1000E-04
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

mat air_fuel1 sum tmp 294.0  rgb 238 59 59 %rgb 204 255 255
%  U  (See the Test-Assembly.xlsx file inside of the T-TestCenter folder on my desktop)
92235.80c   3.173910E-07
92238.80c   1.269355E-06
% Zr
40090.80c   3.329135E-05
40091.80c   7.260037E-06
40092.80c   1.109712E-05
40094.80c   1.124594E-05
40096.80c   1.811774E-06
% air
6000.80c    7.59330E-09
7014.80c    3.95476E-05
8016.80c    1.06251E-05


%mat fuel2 sum tmp 294.0 moder gra_300 6000 rgb 238 59 59
%6000.80c    5.0874E-02
%6002.80c    3.5353E-02
%92235.80c   1.1000E-04



mat zr  sum  tmp 294.0 rgb 160 160 160
% B
5010.80c    1.3751E-07
5011.80c    5.9006E-07
% Cr
24050.80c   9.8706E-08
24052.80c   1.9013E-06
24053.80c   2.1556E-07
24054.80c   5.3551E-08
% Fe
26054.80c   1.1659E-05
26056.80c   1.8285E-04
26057.80c   4.2252E-06
26058.80c   5.5804E-07
% Ni
28058.80c    2.2803E-07
28060.80c    8.7821E-08
28061.80c    3.8183E-09
```

28062.80c 2.2207E-08
28064.80c 3.1149E-09
% Zr
40090.80c 2.2054E-02
40091.80c 4.8095E-03
40092.80c 7.3513E-03
40094.80c 7.4499E-03
40096.80c 1.2002E-03
% Cd
48106.80c 8.7468E-11
48108.80c 6.2277E-11
48110.80c 8.7398E-10
48111.80c 8.9567E-10
48112.80c 1.6885E-09
48113.80c 8.5508E-10
48114.80c 2.0104E-09
48116.80c 5.2411E-10
% Sn
50112.80c 8.9997E-07
50114.80c 6.1235E-07
50115.80c 3.1545E-07
50116.80c 1.3490E-05
50117.80c 7.1255E-06
50118.80c 2.2471E-05
50119.80c 7.9698E-06
50120.80c 3.0228E-05
50122.80c 4.2957E-06
50124.80c 5.3720E-06
% Hf
72174.80c 3.5695E-09
72176.80c 1.1471E-07
72177.80c 4.0996E-07
72178.80c 6.0146E-07
72179.80c 3.0030E-07
72180.80c 7.7339E-07

mat air_sal sum tmp 294.0 rgb 255 160 122
6000.80c 7.5811E-09

mat air sum tmp 294.0 rgb 204 255 255
6000.80c 7.5811E-09
7014.80c 3.9484E-05
8016.80c 1.0608E-05

```
% add absorber to prevent problem with XS
mat airCR sum tmp 294.0  rgb 204 255 255
6000.80c  7.5811E-09
7014.80c  3.9484E-05
8016.80c  1.0608E-05
5010.80c  5.0000E-07

mat air_out sum tmp 294.0  rgb 0 0 128
6000.80c  7.5811E-09
7014.80c  3.9484E-05
8016.80c  1.0608E-05

mat air_Test sum tmp 294.0  rgb 245 96 197
6000.80c  7.5811E-09
7014.80c  3.9484E-05
8016.80c  1.0608E-05

mat air_hmg sum tmp 294.0  rgb 204 255 255
6000.80c  7.5811E-09
7014.80c  3.9484E-05
8016.80c  1.0608E-05

mat reflector sum tmp 294.0 moder gra_300 6000 rgb 199 199 199
5010.80c  3.517E-08
5011.80c  1.509E-07
6000.80c  4.9360E-02
6002.80c  3.4300E-02
26054.80c  1.054E-06
26056.80c  1.652E-05
26057.80c  3.818E-07
26058.80c  5.043E-08

mat graphite sum tmp 294.0 moder gra_300 6000 rgb 203 203 203
5010.80c  3.517E-08
5011.80c  1.509E-07
6000.80c  4.9360E-02
6002.80c  3.4300E-02
26054.80c  1.054E-06
26056.80c  1.652E-05
26057.80c  3.818E-07
26058.80c  5.043E-08

mat aluminum sum rgb 50 250 50 tmp 294.0  rgb 204 0 204
13027.80c 5.9477E-02
26054.80c 2.5591E-05
26056.80c 4.0136E-04
```

```
26057.80c 9.2739E-06
26058.80c 1.2249E-06

mat aluminum_TF sum rgb 50 250 50 tmp 294.0  rgb 204 0 204
13027.80c 5.9477E-02
26054.80c 2.5591E-05
26056.80c 4.0136E-04
26057.80c 9.2739E-06
26058.80c 1.2249E-06

mat aluminum_BF sum rgb 50 250 50 tmp 294.0  rgb 204 0 204
13027.80c 5.9477E-02
26054.80c 2.5591E-05
26056.80c 4.0136E-04
26057.80c 9.2739E-06
26058.80c 1.2249E-06

%####################################################
%          Old Control Rod  1.6 g/cc
%####################################################
mat b4c sum  tmp 294.0    rgb 255 130 171
5010.80c 1.3881E-02
5011.80c 5.5872E-02
6000.80c 1.7438E-02
%####################################################
%          New Control Rod  1.8 g/cc
%####################################################
mat b4c_new sum  tmp 294.0    rgb 255 130 171
5010.80c 1.5616E-02
5011.80c 6.2854E-02
6000.80c 2.3562E-01
%####################################################

mat steel sum  tmp 294.0   rgb 133 99 99
26054.80c 5.0819E-03
26056.80c 7.6860E-02
26057.80c 1.7447E-03
26058.80c 2.2647E-04
42092.80c 8.11748E-05
42094.80c 5.05975E-05
42095.80c 8.70824E-05
42096.80c 9.12396E-05
42097.80c 5.22385E-05
42098.80c 1.31991E-04
42100.80c 5.26761E-05
6000.80c 1.4000E-03
```

```
mat zirc2 sum  tmp 294.0   rgb 160 160 160
26054.80c 5.5868E-06
26056.80c 8.7621E-05
26057.80c 2.0246E-06
26058.80c 2.6740E-07
24050.80c 3.3050E-06
24052.80c 6.3661E-05
24053.80c 7.2178E-06
24054.80c 1.7931E-06
28058.80c 2.5203E-05
28060.80c 9.7065E-06
28061.80c 4.2202E-07
28062.80c 1.3438E-06
28064.80c 3.4428E-07
40090.80c 2.18909E-02
40091.80c 4.77387E-03
40092.80c 7.29696E-03
40094.80c 7.39483E-03
40096.80c 1.19134E-03
50112.80c 4.68066E-06
50114.80c 3.18478E-06
50115.80c 1.64064E-06
50116.80c 7.01616E-05
50117.80c 3.70592E-05
50118.80c 1.16872E-04
50119.80c 4.14504E-05
50120.80c 1.57212E-04
50122.80c 2.23417E-05
50124.80c 2.79392E-05
72174.80c 3.58555E-09
72176.80c 1.15224E-07
72177.80c 4.11807E-07
72178.80c 6.04165E-07
72179.80c 3.01651E-07
72180.80c 7.76868E-07

% mixture of aluminum and steel for all assemblies except CR
% to model steel grid and bottom fitting area
mat Al_steel sum  tmp 294.0  rgb 165 165 165
6000.80c 6.956295E-04
13027.80c 2.209049E-02
26054.80c 2.534587E-03
26056.80c 3.833907E-02
26057.80c 8.703466E-04
26058.80c 1.129828E-04
```

```
42092.80c 4.033393E-05
42094.80c 2.514076E-05
42095.80c 4.326928E-05
42096.80c 4.533490E-05
42097.80c 2.595614E-05
42098.80c 6.558336E-05
42100.80c 2.617357E-05
7014.80c 5.200443E-06
8016.80c 1.397181E-06

% mixture of aluminum and air
% to model the top fitting area
mat Al_air sum  tmp 294.0  rgb 165 165 165
6000.80c 4.082824E-09
13027.80c 2.744548E-02
26054.80c 1.180889E-05
26056.80c 1.852064E-04
26057.80c 4.279413E-06
26058.80c 5.652264E-07
7014.80c 2.126423E-05
8016.80c 5.712970E-06

% mixture of zr-3 and steel for the Zr follower plugs
mat zr_steel  sum  tmp 294.0 rgb 160 160 160
5010.80c 9.4717E-08
5011.80c 4.0643E-07
6000.80c 4.3568E-04
24050.80c 6.7988E-08
24052.80c 1.3096E-06
24053.80c 1.4848E-07
24054.80c 3.6886E-08
26054.80c 1.5895E-03
26056.80c 2.4045E-02
26057.80c 5.4587E-04
26058.80c 7.0862E-05
28058.80c 1.5707E-07
28060.80c 6.0491E-08
28061.80c 2.6300E-09
28062.80c 1.5296E-08
28064.80c 2.1455E-09
40090.80c 1.5191E-02
40091.80c 3.3128E-03
40092.80c 5.0636E-03
40094.80c 5.1315E-03
40096.80c 8.2669E-04
42092.80c 2.5262E-05
```

42094.80c 1.5746E-05
42095.80c 2.7100E-05
42096.80c 2.8394E-05
42097.80c 1.6257E-05
42098.80c 4.1076E-05
42100.80c 1.6393E-05
48106.80c 6.0248E-11
48108.80c 4.2896E-11
48110.80c 6.0200E-10
48111.80c 6.1694E-10
48112.80c 1.1630E-09
48113.80c 5.8898E-10
48114.80c 1.3848E-09
48116.80c 3.6101E-10
50112.80c 6.1990E-07
50114.80c 4.2179E-07
50115.80c 2.1728E-07
50116.80c 9.2919E-06
50117.80c 4.9080E-06
50118.80c 1.5478E-05
50119.80c 5.4896E-06
50120.80c 2.0821E-05
50122.80c 2.9589E-06
50124.80c 3.7002E-06
72174.80c 2.4587E-09
72176.80c 7.9012E-08
72177.80c 2.8238E-07
72178.80c 4.1428E-07
72179.80c 2.0685E-07
72180.80c 5.3271E-07

% to modle the top graple in the CR
mat Air_steel sum tmp 294.0 rgb 165 162 165
6000.80c 3.249E-04
7014.80c 3.032E-05
8016.80c 8.146E-06
26054.80c 1.179E-03
26056.80c 1.783E-02
26057.80c 4.048E-04
26058.80c 5.255E-05
42092.80c 1.884E-05
42094.80c 1.174E-05
42095.80c 2.021E-05
42096.80c 2.117E-05
42097.80c 1.212E-05
42098.80c 3.063E-05

```
42100.80c 1.222E-05

mat lead sum tmp 294.0  rgb 100 100 100
83209.51c 3.2964E-02

mat Dy sum tmp 294.0  rgb 0 255 0
68162.80c 2.1370E-08
68164.80c 2.4614E-07
68166.80c 5.1507E-06
68167.80c 3.5159E-06
68168.80c 4.1476E-06
68170.80c 2.2923E-06
67165.80c 1.5591E-05
66156.80c 1.7705E-05
66158.80c 3.0036E-05
66160.80c 7.3636E-04
66161.80c 5.9721E-03
66162.80c 8.0544E-03
66163.80c 7.8713E-03
66164.80c 8.9349E-03

% From Connie
mat concrete sum moder lwtr 1001 moder hwtr 1002 rgb 0 102 0
20040.80c  2.5914E-03
20042.80c  1.7296E-05
20043.80c  3.6088E-06
20044.80c  5.5763E-05
20046.80c  1.0693E-07
20048.80c  4.9989E-06
14028.80c  1.5236E-03
14029.80c  7.7399E-05
14030.80c  5.1082E-05
13027.80c  1.1921E-03
26054.80c  1.0360E-03
26056.80c  1.6262E-02
26057.80c  3.7557E-04
26058.80c  4.9981E-05
12024.80c  9.5284E-04
12025.80c  1.2063E-04
12026.80c  1.3281E-04
16032.80c  4.8069E-05
16033.80c  3.7953E-07
16034.80c  2.1507E-06
16036.80c  5.0604E-09
19039.80c  2.0056E-05
19040.80c  2.5162E-09
```

19041.80c 1.4474E-06
11023.80c 3.2685E-05
25055.80c 2.8557E-05
23050.80c 4.0548E-08
23051.80c 1.6178E-05
24050.80c 1.1582E-07
24052.80c 2.2335E-06
24053.80c 2.5326E-07
24054.80c 6.3043E-08
22046.80c 5.9935E-05
22047.80c 5.4050E-05
22048.80c 5.3556E-04
22049.80c 3.9303E-05
22050.80c 3.7632E-05
8016.80c 4.7228E-02
8017.80c 1.7953E-05
1001.80c 2.3634E-02
1002.80c 2.7182E-06
% Total 9.6208E-02

% new homogenized mixtures for CR
mat HS1 sum tmp 294.0 rgb 165 162 165
24050.80c   1.928821E-08
24052.80c   3.715340E-07
24053.80c   4.212344E-08
24054.80c   1.046452E-08
26054.80c   4.091111E-03
26056.80c   6.187640E-02
26057.80c   1.404592E-03
26058.80c   1.823241E-04
28058.80c   4.456035E-08
28060.80c   1.716126E-08
28061.80c   7.461334E-10
28062.80c   4.339481E-09
28064.80c   6.086809E-10
40090.80c   4.309655E-03
40091.80c   9.398372E-04
40092.80c   1.436537E-03
40094.80c   1.455802E-03
40096.80c   2.345321E-04
42092.80c   6.531234E-05
42094.80c   4.071015E-05
42095.80c   7.006544E-05
42096.80c   7.341033E-05
42097.80c   4.203054E-05
42098.80c   1.061984E-04

42100.80c 4.238259E-05
48106.80c 1.709231E-11
48108.80c 1.216960E-11
48110.80c 1.707867E-10
48111.80c 1.750252E-10
48112.80c 3.299460E-10
48113.80c 1.670931E-10
48114.80c 3.928631E-10
48116.80c 1.024180E-10
5010.80c 2.687113E-08
5011.80c 1.153042E-07
50112.80c 1.758651E-07
50114.80c 1.196612E-07
50115.80c 6.164236E-08
50116.80c 2.636106E-06
50117.80c 1.392400E-06
50118.80c 4.391099E-06
50119.80c 1.557395E-06
50120.80c 5.906906E-06
50122.80c 8.394355E-07
50124.80c 1.049747E-06
6000.80c 1.126423E-03
72174.80c 6.975285E-10
72176.80c 2.241567E-08
72177.80c 8.011103E-08
72178.80c 1.175315E-07
72179.80c 5.868286E-08
72180.80c 1.511295E-07

mat HS2 sum tmp 294.0 rgb 165 162 165
24050.80c 4.666503E-08
24052.80c 8.988726E-07
24053.80c 1.019115E-07
24054.80c 2.531739E-08
26054.80c 2.684829E-03
26056.80c 4.060936E-02
26057.80c 9.218580E-04
26058.80c 1.196654E-04
28058.80c 1.078073E-07
28060.80c 4.151918E-08
28061.80c 1.805161E-09
28062.80c 1.049874E-08
28064.80c 1.472615E-09
40090.80c 1.042658E-02
40091.80c 2.273800E-03
40092.80c 3.475493E-03

40094.80c 3.522101E-03
40096.80c 5.674163E-04
42092.80c 4.279789E-05
42094.80c 2.667649E-05
42095.80c 4.591234E-05
42096.80c 4.810427E-05
42097.80c 2.754182E-05
42098.80c 6.958966E-05
42100.80c 2.777245E-05
48106.80c 4.135236E-11
48108.80c 2.944258E-11
48110.80c 4.131936E-10
48111.80c 4.234480E-10
48112.80c 7.982564E-10
48113.80c 4.042575E-10
48114.80c 9.504753E-10
48116.80c 2.477854E-10
5010.80c 6.501080E-08
5011.80c 2.789618E-07
50112.80c 4.254800E-07
50114.80c 2.895028E-07
50115.80c 1.491347E-07
50116.80c 6.377676E-06
50117.80c 3.368710E-06
50118.80c 1.062363E-05
50119.80c 3.767891E-06
50120.80c 1.429090E-05
50122.80c 2.030892E-06
50124.80c 2.539711E-06
6000.80c 7.381206E-04
72174.80c 1.687569E-09
72176.80c 5.423145E-08
72177.80c 1.938170E-07
72178.80c 2.843503E-07
72179.80c 1.419747E-07
72180.80c 3.656359E-07

mat HS3 sum tmp 294.0 rgb 165 162 165
26054.80c 2.82689E-03
26056.80c 4.27538E-02
26057.80c 9.70536E-04
26058.80c 1.25983E-04
42092.80c 4.51591E-05
42094.80c 2.81465E-05
42095.80c 4.84450E-05
42096.80c 5.07549E-05

```
42097.80c   2.90589E-05
42098.80c   7.34269E-05
42100.80c   2.93015E-05
6000.80c    7.78831E-04

% s alpha betas
therm lwtr lwtr.10t
therm hwtr hwtr.10t

therm gra_300 grph.10t
therm gra_350 350.0 grph.10t grph.11t
therm gra_400 grph.11t
therm gra_450 450.0 grph.11t grph.12t
therm gra_500 grph.12t
therm gra_550 550.0 grph.12t grph.13t
therm gra_600 grph.13t
therm gra_650 650.0 grph.13t grph.14t
```

mat.sss (modifications done for M8CAL 1.5% run)

```
% -- Michigan fuel
mat fuel sum tmp 294.0 moder gra_300 6000 rgb 238 59 59
  6000.80c  5.1039E-02
  6002.80c  3.5468E-02
  5010.80c  1.9240E-07
  5011.80c  8.8524E-07
  8016.80c  1.8685E-05
 23050.80c  1.5339E-09
 23051.80c  6.1201E-07
 26054.80c  2.9114E-07
 26056.80c  4.5703E-06
 26057.80c  1.0555E-07
 26058.80c  1.4047E-08
 92234.80c  8.5472E-08
 92235.80c  8.7202E-06
 92236.80c  4.0790E-08
 92238.80c  4.9986E-07
```

A0.sss

```
% TREAT std assembly, HEU fuel
% Model for cross section preparation
%
% Combines most homogenization models:
%  - Full no channels
%  - Full w channels
%
```

```
% Javier Ortensi
% Idaho National Laboratory
% August 18 2015
%
% Modified: 20 Jan 2015 by Ben Baker
% -Changed the total length of the graphite in the bottom of the core to be 19.5625inch =([14-
3/8]+[8-11/16]-[3-1/2]) inch
%   I had to modify most of the pz locates.
% -Extended the off gas hole in the graphite to (8-11/16 inch) which is all the way through the
square and the oct graphite piece.
% -Modified surfaces 7,8, and 9 to reflect changes in heights because of the graphite change.
%   And I saw the Al off-gas shell had a 3/8 inch inside diameter when it was the outside. The
lengths were kept the same.
%
% Modified: 25 Jan 2015 by Ben Baker
% - Changed the model to do only a homogenized and homogenized with air channels models



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% for cross section preparation we have the following regions
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  universe     material
%    11001       Steel Grid Plate + Aluminum bottom fitting
%    11013       Al top fitting
%
%     full homogenization universes (not including air channel)
%
%    11030       Oct graphite XS region 1 + air gap + Al clad - bot
%    11031       Oct graphite XS region 2 + air gap + Al clad - bot
%    11032       square graphite   + air gap + Al clad - bot
%    11033       axial interface
%    11034       Fuel XS region 1  + air gap + Zr clad
%    11035       Fuel XS region 2  + air gap + Zr clad
%    11036       Fuel XS region 3  + air gap + Zr clad
%    11037       axial interface
%    11038       square graphite w hole + Oct graphite with hole + air + Al clad - top
%    11039       Oct graphite XS region 2 + air gap + Al clad - top
%    11040       Oct graphite XS region 1 + air gap + Al clad - top
%
%     full homogenization universes (with air channel)
%
%    11001       Oct graphite XS region 1 + air gap + Al clad + air channel - bot
%    11002       Oct graphite XS region 2 + air gap + Al clad + air chan31nel - bot
```

```
%    11003        square graphite + air gap + Al clad + air channel - bot
%    11004        axial interface + air channel - bot
%    11005        Fuel XS region 1  + air gap + Zr clad + air channel
%    11006        Fuel XS region 2  + air gap + Zr clad + air channel
%    11007        Fuel XS region 3  + air gap + Zr clad + air channel
%    11008        axial interface + air channel - top
%    11009        square graphite w hole  + Oct graphite with hole + air + Al clad + air channel -
top
%    11010        Oct graphite XS region 2 + air gap + Al clad + air channel - top
%    11011        Oct graphite XS region 1 + air gap + Al clad + air channel - top
%############################################################################
##
%############################################################################
##
%  Reserve
%  Universe    [11000-11013, 11030-11040] [Final 11000]
%  Cells       [11000-11077]
%  Surf        [1-27]
%############################################################################
##
%############################################################################
##
%   Full homogenization with air channel separated
%############################################################################
##
%############################################################################
##
%     Reflector Oct graphite XS region 1
cell 11000 11030 reflector   -4        % graphite
cell 11001 11030 air         -5  4     % air gap
cell 11002 11030 aluminum    -90 5     % INF Al clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Reflector Oct graphite XS region 2
cell 11003 11031 reflector   -4        % graphite
cell 11004 11031 air         -5  4     % air gap
cell 11005 11031 aluminum    -90 5     % INF Al clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Bottom reflector square graphite XS region
cell 11006 11032 reflector   -6        % graphite
cell 11007 11032 air         -5  6     % air gap
cell 11008 11032 aluminum    -90 5     % INF Al clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Zr and Air in spacers + Al clad before axial interface
cell 11009 11033 aluminum    -90      -15  % Al cap before axial interface
cell 11010 11033 air         -2    15 -16  % air in Zr spacer region axially --bottom
cell 11011 11033 zr          -2    16      % Zr
```

```
cell 11012 11033 zr          2 15      % Zr
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 1
cell 11013 11034 fuel       -1        % fuel 1
cell 11014 11034 air        -2  1     % air gap
cell 11015 11034 zr         -90 2     % INF zr clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 2
cell 11016 11035 fuel       -1        % fuel 2
cell 11017 11035 air        -2  1     % air gap
cell 11018 11035 zr         -90 2     % INF zr clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 3
cell 11019 11036 fuel       -1        % fuel 3
cell 11020 11036 air        -2  1     % air gap
cell 11021 11036 zr         -90 2     % INF zr clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Zr and Air in spacers + Al clad after axial interface
cell 11022 11037 zr         -2    -21   % Zr
cell 11023 11037 air        -2    21 -22   % air in Zr spacer region axially --top
cell 11024 11037 zr          2 15 -22   % Zr in Zr spacer region --bottom/top
cell 11025 11037 aluminum     7 22       % Al cap after axial interface
cell 11026 11037 air        -7   22      % air hole to let out gasses through Al plate
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Top reflector square graphite XS region
cell 11027 11038 air        -7          % inner outgas tube
cell 11028 11038 aluminum   -8  7       % outer outgas tube
cell 11029 11038 air        -9  8       % hole in square graphite top
cell 11030 11038 reflector  -6  9   -24  % square graphite top
cell 11031 11038 air        -5  6   -24  % air outside square graphite top up to fuel surface
cell 11032 11038 reflector  -4  9 24     % Oct graphite w hole top
cell 11033 11038 air        -5  4 24     % air gap up to fuel surface
cell 11034 11038 aluminum   -90 5
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Reflector Oct graphite XS region 2
cell 11035 11039 reflector  -4       % graphite
cell 11036 11039 air        -5  4    % air gap
cell 11037 11039 aluminum   -90 5    % INF Al clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Reflector Oct graphite XS region 1
cell 11038 11040 reflector  -4       % graphite
cell 11039 11040 air        -5  4    % air gap
cell 11040 11040 aluminum   -90 5    % INF Al clad
%##########################################################################
##
```

```
%################################################################################
##
%    Full homogenization with homogenized channels
%################################################################################
##
%################################################################################
##

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    steel grid plate + bottom fitting
cell 11041 11001 Al_steel    -90          % steel grid + partial Al fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Reflector Oct graphite XS region 1
cell 11042 11002 fill 11030   -3       % graphite + air gap + clad
cell 11043 11002 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Reflector Oct graphite XS region 2
cell 11044 11003 fill 11031   -3       % graphite + air gap + clad
cell 11045 11003 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Bottom reflector square graphite XS region
cell 11046 11004 fill 11032   -3       % graphite + air gap + clad
cell 11047 11004 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Axial interface
cell 11048 11005 fill 11033   -3       % AI
cell 11049 11005 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Fuel region 1
cell 11050 11006 fill 11034   -3       % fuel1 + air gap + clad
cell 11051 11006 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 2
cell 11052 11007 fill 11035   -3       % fuel 2 + air gap + clad
cell 11053 11007 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 3
cell 11054 11008 fill 11036   -3       % fuel 3 + air gap + clad
cell 11055 11008 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Axial interface
cell 11056 11009 fill 11037   -3       % AI
cell 11057 11009 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Top reflector square graphite XS region
cell 11058 11010 fill 11038   -3       % top sq graphite + air gap + clad
```

```
cell 11059 11010 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Reflector Oct graphite XS region 2
cell 11060 11011 fill 11039   -3        % graphite + air gap + clad
cell 11061 11011 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Reflector Oct graphite XS region 1
cell 11062 11012 fill 11040   -3        % graphite + air gap + clad
cell 11063 11012 air_out       3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Al top fitting
cell 11064 11013 Al_air      -90          % Al at top end cap up to fuel surface
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


%##############################################################################
##
%##############################################################################
##
% Build std assembly
%##############################################################################
##
%##############################################################################
##
%%% start at bottom then from the center out
%%cell 11065 11000 fill 11001          -11   % Steel Grid Plate + Aluminum bottom fitting
%%cell 11066 11000 fill 11002        11 -12   % Oct graphite XS region 1 -- bottom
%%cell 11067 11000 fill 11003        12 -13   % Oct graphite XS region 2 -- bottom
%%cell 11068 11000 fill 11004        13 -14   % square graphite bottom + air gap + Al clad
%%cell 11069 11000 fill 11005        14 -17   % axial interface
%%cell 11070 11000 fill 11006        17 -18   % Fuel1 bottom
%%cell 11071 11000 fill 11007        18 -19   % Fuel2
%%cell 11072 11000 fill 11008        19 -20   % Fuel1 top
%%cell 11073 11000 fill 11009        20 -23   % aixal interface
%%cell 11074 11000 fill 11010        23 -25   % square graphite w hole top + Oct graphite with
hole + air + Al clad
%%cell 11075 11000 fill 11011        25 -26   % Oct graphite XS region 2 -- top
%%cell 11076 11000 fill 11012        26 -27   % Oct graphite XS region 1 -- top
%%cell 11077 11000 fill 11013        27        % top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 11000 -5900
%
%%%%%%% --- Geometry and mesh plots:
%plot 3 1000 1000    1.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000    5.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   31.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   54.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   62.1    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   62.3    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   62.6   -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   70.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   90.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   170.0    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   183.9    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   184.2    -5.08 5.08   -5.08    5.08        % xy-plot %21
%plot 3 1000 1000   184.5    -5.08 5.08   -5.08    5.08        % xy-plot
%plot 3 1000 1000   185.0    -5.08 5.08   -5.08    5.08        % xy-plot above al plat (al hole and
pin)
%plot 3 1000 1000   190.4    -5.08 5.08   -5.08    5.08        % xy-plot (Inside pin clad)
%plot 3 1000 1000   191.0    -5.08 5.08   -5.08    5.08        % xy-plot (square + air, no pin)
%plot 3 1000 1000   194.0    -5.08 5.08   -5.08    5.08        % xy-plot (hex + air hole)
%plot 3 1000 1000   207.0    -5.08 5.08   -5.08    5.08        % xy-plot (hex + no hole)
%plot 3 1000 1000   222.0    -5.08 5.08   -5.08    5.08        % xy-plot (hex + no hole)
%plot 3 1000 1000   249.0    -5.08 5.08   -5.08    5.08        % xy-plot (hex + no hole)
%
%plot 2 800  4000    0.0    -5.08 5.08     -3.0    260.65       % xz-plot
%
%plot 1 800  4000    -5.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000    -4.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000    -3.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000    -2.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000    -1.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000    0.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000     1.0    -5.08 5.08    0.0    247.65       % yz-plot
```

```
%plot 1 800  4000     2.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000     3.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000     4.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 1 800  4000     5.0    -5.08 5.08    0.0    247.65       % yz-plot
```

B0.sss

```
% TREAT CR assembly, HEU fuel  -- OLD SHORT ROD
% Model for cross section preparation
%
%
%
%
% Ben Baker derived from Javi Ortensi's model
% Feb 11, 2016

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% for cross section preparation we have the following regions
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  universe     material
%    1001        Steel Grid Plate + Aluminum bottom fitting
%    1013        Al top fitting
%
%     full homogenization universes (not including air channel)
%
%    1030        Oct graphite XS region 1 + air gap + Al clad - bot
%    1031        Oct graphite XS region 2 + air gap + Al clad - bot
%    1032        square graphite   + air gap + Al clad - bot
%    1033        axial interface
%    1034        Fuel XS region 1  + air gap + Zr clad
%    1035        Fuel XS region 2  + air gap + Zr clad
%    1036        Fuel XS region 3  + air gap + Zr clad
%    1037        axial interface
%    1038        square graphite w hole + Oct graphite with hole + air + Al clad - top
%    1039        Oct graphite XS region 2 + air gap + Al clad - top
%    1040        Oct graphite XS region 1 + air gap + Al clad - top
%
%     full homogenization universes (with air channel)
%
%    1001        Oct graphite XS region 1 + air gap + Al clad + air channel - bot
%    1002        Oct graphite XS region 2 + air gap + Al clad + air chan31nel - bot
%    1003        square graphite + air gap + Al clad + air channel - bot
%    1004        axial interface + air channel - bot
%    1005        Fuel XS region 1  + air gap + Zr clad + air channel
%    1006        Fuel XS region 2  + air gap + Zr clad + air channel
```

```
%    1007        Fuel XS region 3  + air gap + Zr clad + air channel
%    1008        axial interface + air channel - top
%    1009        square graphite w hole  + Oct graphite with hole + air + Al clad + air channel - top
%    1010        Oct graphite XS region 2 + air gap + Al clad + air channel - top
%    1011        Oct graphite XS region 1 + air gap + Al clad + air channel - top
%################################################################################
##
%################################################################################
##
%  Reserve
%  Universe    [1000-1013, 1030-1040] [Final 1000]
%  Cells       [900-944,1000-1083]
%  Surf        [10,28, 48-61, 65, 77-79]
%################################################################################
##
%
%################################################################################
##
% Bottom long lower graphite plug
cell 1000 1030 air         -52                          % air gap between CR and Zirc2 tube
          **(Removed Surf 51)**
cell 1001 1030 zirc2       -53  52           % Zirc2 tubing
cell 1002 1030 air         -55  53           % air gap between Zirc2 tube and Bottom Oct Plug
cell 1003 1030 reflector   -4   55           % Oct graphite long lower plug
cell 1004 1030 air         -5   4            % air gap between graphite and clad
cell 1005 1030 aluminum    -90  5            % aluminum clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
% Bottom short lower graphite plug - Oct region
cell 1006 1031 air         -52                          % air gap between CR and Zirc2 tube
          **(Removed Surf 51)**
cell 1007 1031 zirc2       -53  52           % Zirc2 tubing
cell 1008 1031 air         -55  53           % air gap between Zirc2 tube and Bottom Oct Plug
cell 1009 1031 reflector   -4   55           % Oct graphite long lower plug
cell 1010 1031 air         -5   4            % air gap between graphite and clad
cell 1011 1031 aluminum    -90  5            % aluminum clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
% Square graphite Bottom
cell 1012 1032 air         -52               % air gap between CR and Zirc2 tube
          **(Removed Surf 51)**
cell 1013 1032 zirc2       -53  52           % Zirc2 tubing
```

```
cell 1014 1032 air        -55  53           % air gap between Zirc2 tube and Bottom square graphite
cell 1015 1032 reflector   -6  55           % Square graphite bottom
cell 1016 1032 air        -5   6            % air gap between graphite and clad
cell 1017 1032 aluminum    -90  5           % aluminum clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Bottom Axial Interface
cell 1018 1033 air        -52               % air gap between CR and Zirc2 tube           **(Removed Surf 51)**
cell 1019 1033 zirc2       -53  52          % Zirc2 tubing
% Al clad before axial interface
%                              Pz
cell 1020 1033 air        -55  53    -15      % Air gap between CR tube and aluminum cap
cell 1021 1033 aluminum        55    -15      % Aluminum cap
% Zr clad
cell 1022 1033 air        -2   53     15  -16  % Air gap between CR tube and Zr clad
cell 1023 1033 zr               2     15  -16  % Zr clad
%
cell 1024 1033 air        -56  53          16  % Air gap between CR tube and Zr bacon strips
cell 1025 1033 zr              56          16  % Zr bacon strip until clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Fuel Region 1
cell 1026 1034 air        -52               % air gap between CR and Zirc2 tube           **(Removed Surf 51)**
cell 1027 1034 zirc2       -53  52          % Zirc2 tubing
cell 1028 1034 air        -57  53           % air gap between zirc2 tube and fuel
cell 1029 1034 fuel        -1   57          % fuel
cell 1030 1034 air        -2    1           % air gap between fuel and clad
cell 1031 1034 zr         -90   2           % zr clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Fuel Region 2
cell 1032 1035 air        -52               % air gap between CR and Zirc2 tube           **(Removed Surf 51)**
cell 1033 1035 zirc2       -53  52          % Zirc2 tubing
cell 1034 1035 air        -57  53           % air gap between zirc2 tube and fuel
cell 1035 1035 fuel        -1   57          % fuel
cell 1036 1035 air        -2    1           % air gap between fuel and clad
cell 1037 1035 zr         -90   2           % zr clad
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
% Fuel Region 3
cell 1038 1036 air        -52              % air gap between CR and Zirc2 tube           **(Removed
Surf 51)**
cell 1039 1036 zirc2      -53  52          % Zirc2 tubing
cell 1040 1036 air        -57  53          % air gap between zirc2 tube and fuel
cell 1041 1036 fuel        -1   57         % fuel
cell 1042 1036 air        -2    1          % air gap between fuel and clad
cell 1043 1036 zr         -90   2          % zr clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
% Top axial interface region
cell 1044 1037 air          -52            % air gap between CR and Zirc2 tubing        **(Removed
Surf 51)**
cell 1045 1037 zirc2         -53  52          % Zirc2 tubing -- bottom ref
% Zr clad and bacon strips - before axial interface
cell 1046 1037 air          -56  53      -21  % air between CR tube and Zr bacon strips
cell 1047 1037 zr            56          -21  % Zr bacon strips until clad top
% Zr clad and air
cell 1048 1037 air           53   -2   21 -22  % air between CR tube and zr clad
cell 1049 1037 zr             2       21 -22  % side Zr clad
% hole for outgas tube
cell 1050 1037 air              -77       22  % hole Al clad top
% Al clad - after axial interface
cell 1051 1037 air          -55  53       22  % air betwen Zirc2 clad and Al cald cap
cell 1052 1037 aluminum       55  77       22  % Al clad cap
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%
% Square graphite and oct Top
cell 1053 1038 air          -52         -24  % air gap between CR and Zirc2 tube stop at end of
square  **(Removed Surf 51)**
cell 1054 1038 zirc2         -53  52       -24  % Zirc2 tubing stop at top of square graphite
% hole for outgas
cell 1055 1038 air          -77              % Inside off gas tube
cell 1056 1038 aluminum      -78  77           % aluminum off gas tube
cell 1057 1038 air          -79  78           % air outside of Al tube upto graphite
% Square graphite
cell 1058 1038 air          -54  53      -24  % air gap between Al and zirc2 tube
cell 1059 1038 aluminum      -58  54       -24  % aluminum after zirc2 tube
```

```
cell 1060 1038 air          -60  58       -24  % air gap between Al and graphite
cell 1061 1038 reflector     60  79  -6   -24  % square graphite minus off gas hole and center hole
cell 1062 1038 air           -5       6   -24  % air up to Al clad
% Oct-region                Added 61 for bushing I.D.
%   bushing region until aluminum
cell 1063 1038 air          -61        24 -28  % air gap between CR clad and graphite bushing
                  **(Removed Surf 51)**
cell 1064 1038 reflector    -54  61    24 -28  % graphite bushing
%   all other in Oct-region
cell 1065 1038 air          -52            28  % air between CR clad and aluminum tube above
bushing           **(Removed Surf 51)**
cell 1066 1038 aluminum     -54  52        28  % aluminum tube after gap and until aluminum
tube where bushing ends radially
cell 1067 1038 aluminum     -59  54    24      % aluminum after bushing radially
cell 1068 1038 air          -60  59    24      % air gap between aluminum tube and graphite oct
cell 1069 1038 reflector     60  79 -4 24      % Oct-reflector minus CR hole and Off-gas hole
cell 1070 1038 air           -5      4 24      % air gap up to aluminum clad
%   Cladding
cell 1071 1038 aluminum     -90  5             % aluminum clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%
% Short upper graphite plug - Oct region  (No OFF-Gas hole)
cell 1072 1039 air        -52                        % air gap between CR and Zirc2 tube
          **(Removed Surf 51)**
cell 1073 1039 aluminum    -59  52           % Aluminum bearing tube
cell 1074 1039 air        -60  59           % air gap between Al bearing tube and Oct Plug
cell 1075 1039 reflector   -4   60           % Oct graphite long lower plug
cell 1076 1039 air        -5   4           % air gap between graphite and clad
cell 1077 1039 aluminum    -90  5           % aluminum clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%
% Short upper graphite plug - Oct region  (No OFF-Gas hole)
cell 1078 1040 air        -52                        % air gap between CR and Zirc2 tube
          **(Removed Surf 51)**
cell 1079 1040 aluminum    -59  52           % Aluminum bearing tube
cell 1080 1040 air        -60  59           % air gap between Al bearing tube and Oct Plug
cell 1081 1040 reflector   -4   60           % Oct graphite long lower plug
cell 1082 1040 air        -5   4           % air gap between graphite and clad
cell 1083 1040 aluminum    -90  5           % aluminum clad
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    full homogenization universes (w air channel)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%   Steel Grid Plate + Aluminum base  (Bottom)
cell 900 1001 air            -52               % air between CR clad and Zirc2 tubing -- bottom ref
          **(Removed Surf 51)**
cell 901 1001 zirc2          -53  52           % Zirc2 tubing -- bottom ref
cell 902 1001 air            -55  53           % air between zirc2 and core grid & aluminum base
cell 903 1001 steel           55        -10  % steel grid
cell 904 1001 aluminum        55  -3  10      % Al base
cell 905 1001 air_out         3       10      % air around base
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Oct graphite XS region 1 + air gap + Al clad - bot
cell 906 1002 fill 1030       -3          % graphite
cell 907 1002 air_out           3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Oct graphite XS region 2 + air gap + Al clad - bot
cell 908 1003 fill 1031       -3           % air gap before Al clad
cell 909 1003 air_out           3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% square graphite   + air gap + Al clad - bot
cell 910 1004 fill 1032       -3          % air gap before Al clad
cell 911 1004 air_out           3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Axial Interface Bottom
cell 912 1005 fill 1033       -3          % air outside fuel region
cell 913 1005 air_out           3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Fuel XS region 1  + air gap + Zr clad
cell 914 1006 fill 1034       -3          % air outside fuel region
cell 915 1006 air_out           3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Fuel XS region 2  + air gap + Zr clad
cell 916 1007 fill 1035       -3          % air outside fuel region
cell 917 1007 air_out           3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Fuel XS region 3  + air gap + Zr clad
```

```
cell 918 1008 fill 1036       -3          % air outside fuel region
cell 919 1008 air_out          3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% AI
cell 920 1009 fill 1037       -3          % air outside fuel region
cell 921 1009 air_out          3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% square graphite w hole + Oct graphite with hole + air + Al clad - top
cell 922 1010 fill 1038       -3           % air gap before Al clad
cell 923 1010 air_out          3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Oct graphite XS region 2 + air gap + Al clad - top
cell 924 1011 fill 1039       -3           % air gap before Al clad
cell 925 1011 air_out          3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Oct graphite XS region 1 + air gap + Al clad - top
cell 926 1012 fill 1040       -3           % air gap before Al clad
cell 927 1012 air_out          3        % air channel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Al top fitting
cell 928 1013 air            -52          % air between CR clad and Al tubing -- top oct region
          **(Removed Surf 51)**
cell 929 1013 aluminum        -59   52      % Al tubing -- top oct region
cell 930 1013 air            -60   59      % air after Al tubing -- top ref
cell 931 1013 aluminum             60      % Al top fittig



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%% Build CR assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%% start at bottom of assembly with regions outside CR
%%cell 932 1000 fill 1001         -11   % Steel Grid Plate + Aluminum bottom fitting
%%cell 933 1000 fill 1002        11 -12   % Oct graphite XS region 1 -- bot
%%cell 934 1000 fill 1003        12 -13   % Oct graphite XS region 2 -- bot
%%cell 935 1000 fill 1004        13 -14   % square graphite bottom + air gap + Al clad - bot
%%cell 936 1000 fill 1005        14 -17   % aixal interface - bot
%%cell 937 1000 fill 1006        17 -18   % Fuel1
%%cell 938 1000 fill 1007        18 -19   % Fuel2
%%cell 939 1000 fill 1008        19 -20   % Fuel3
%%cell 940 1000 fill 1009        20 -23   % aixal interface - top
%%cell 941 1000 fill 1010        23 -25   % square graphite w hole top + Oct graphite with hole -
top
%%cell 942 1000 fill 1011        25 -26   % Oct graphite XS region 2 -- top
```

```
%%cell 943 1000 fill 1012        26 -27   % Oct graphite XS region 1 -- top
%%cell 944 1000 fill 1013        27       % top Al fitting



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 1000 -5900
%
%%%%%%%% --- Geometry and mesh plots:
%plot 2 800  4000    0.0    -5.08 5.08     -160.0    250.00      % xz-plot
%plot 1 800  4000    0.0    -5.08 5.08    -160.0    250.00     % yz-plot
%
%plot 3 1000 1000    1.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    5.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   31.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   54.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.1    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.3    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.6   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   70.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   90.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   170.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   183.9    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   184.2    -5.08 5.08   -5.08    5.08       % xy-plot %21
%plot 3 1000 1000   184.5    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   185.0    -5.08 5.08   -5.08    5.08       % xy-plot square w/ everything
%plot 3 1000 1000   193.5    -5.08 5.08   -5.08    5.08       % xy-plot oct w/ everything
%plot 3 1000 1000   194.7    -5.08 5.08   -5.08    5.08       % xy-plot oct in-between Al off-gas
tube
%plot 3 1000 1000   194.8    -5.08 5.08   -5.08    5.08       % xy-plot oct w/o Al off-gas
%plot 3 1000 1000   195.1    -5.08 5.08   -5.08    5.08       % xy-plot oct No off-gas
%plot 3 1000 1000   198.6    -5.08 5.08   -5.08    5.08       % xy-plot oct No Bushing
%plot 3 1000 1000   207.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   222.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   249.0    -5.08 5.08   -5.08    5.08       % xy-plot



%plot 1 800  4000    -5.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 1 800  4000    -4.0    -5.08 5.08    0.0    247.65      % yz-plot
```

```
%plot 1 800  4000   -3.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000   -2.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000   -1.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000   0.0   -5.08 5.08   -160.0   247.65      % yz-plot
%plot 1 800  4000    1.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000    2.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000    3.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000    4.0   -5.08 5.08   0.0   247.65      % yz-plot
%plot 1 800  4000    5.0   -5.08 5.08   0.0   247.65      % yz-plot
```

CR-Type.sss

```
%###############################################################################
##
%  Reserve
%  Universe    [C/S = 800, Comp = 801, Trans. = 802]
%  Cells       [800-853]
%  Surf        [50, 851-863, 871-883]
%###############################################################################
##

%###############################################################################
##
% CONTROL ROD REGIONS  (Control/Shutdown Rods)
%###############################################################################
##
%   Dynamic Control Rod
cell 800 800 steel       -50          -851      %  Bottom Adaptor - Control Rod Follower
cell 801 800 graphite    -50    851   -852      %  Graphite       - Control Rod Follower
cell 802 800 steel       -50    852   -853      %  Steel plug     - Control Rod Follower
cell 803 800 zr_steel    -50    853   -854      %  Zr/Steel plug  - Control Rod Follower
cell 804 800 graphite    -50    854   -855      %  Graphite       - Upper follower
cell 805 800 steel           -50    855   -856      %  Steel plug     - Upper follower
cell 806 800 zr_steel    -50    856   -857      %  Zr/Steel plug  - Zr follower
cell 807 800 graphite    -50    857   -858      %  Graphite       - Zr follower
cell 808 800 zr_steel    -50    858   -859      %  Zr/Steel plug  - Zr follower
cell 809 800 steel       -50    859   -860      %  Steel plug     - poison section
cell 810 800 b4c_new       -50    860   -861      %  B4C            - poison section
cell 811 800 steel       -50    861   -862      %  steel plug | grapple adaptor

cell 812 800 steel        50          -856      %  lower carbon steel clad
cell 813 800 zr           50    856   -859      %  zirc-3 clad (zirc follower)
cell 814 800 steel        50    859   -861      %  upper carbon steel clad
cell 815 800 steel        50    861   -862      %  steel plug | grapple adaptor
cell 816 800 Air_steel          862   -863      %  grapple and air
cell 817 800 air                863             %  air above CR
```

```
%################################################################################
##



%################################################################################
##
% CONTROL ROD REGIONS  (Compensation Rods)
%################################################################################
##
%   Dynamic Control Rod
cell 818 801 steel       -50          -851      %  Bottom Adaptor - Control Rod Follower
cell 819 801 graphite    -50    851   -852      %  Graphite       - Control Rod Follower
cell 820 801 steel       -50    852   -853      %  Steel plug     - Control Rod Follower
cell 821 801 zr_steel    -50    853   -854      %  Zr/Steel plug  - Control Rod Follower
cell 822 801 graphite    -50    854   -855      %  Graphite       - Upper follower
cell 823 801 steel            -50    855   -856     %  Steel plug     - Upper follower
cell 824 801 zr_steel    -50    856   -857      %  Zr/Steel plug  - Zr follower
cell 825 801 graphite    -50    857   -858      %  Graphite       - Zr follower
cell 826 801 zr_steel    -50    858   -859      %  Zr/Steel plug  - Zr follower
cell 827 801 steel       -50    859   -860      %  Steel plug     - poison section
cell 828 801 b4c_new         -50    860   -861      %  B4C            - poison section
cell 829 801 steel       -50    861   -862      %  steel plug | grapple adaptor

cell 830 801 steel        50          -856      %  lower carbon steel clad
cell 831 801 zr           50    856   -859      %  zirc-3 clad (zirc follower)
cell 832 801 steel        50    859   -861      %  upper carbon steel clad
cell 833 801 steel        50    861   -862      %  steel plug | grapple adaptor
cell 834 801 Air_steel          862   -863      %  grapple and air
cell 835 801 air                863             %  air above CR
%################################################################################
##



%################################################################################
##
% CONTROL ROD REGIONS  (Transient Rods)
%################################################################################
##
%   Dynamic Control Rod
cell 836 802 steel       -50          -871      %  Bottom Adaptor - Control Rod Follower
cell 837 802 graphite    -50    871   -872      %  Graphite       - Control Rod Follower
cell 838 802 steel       -50    872   -873      %  Steel plug     - Control Rod Follower
cell 839 802 zr_steel    -50    873   -874      %  Zr/Steel plug  - Control Rod Follower
cell 840 802 graphite    -50    874   -875      %  Graphite       - Upper follower
```

```
cell 841 802 steel            -50    875   -876      %  Steel plug     - Upper follower
cell 842 802 zr_steel    -50    876   -877      %  Zr/Steel plug  - Zr follower
cell 843 802 graphite    -50    877   -878      %  Graphite       - Zr follower
cell 844 802 zr_steel    -50    878   -879      %  Zr/Steel plug  - Zr follower
cell 845 802 steel       -50    879   -880      %  Steel plug     - poison section
cell 846 802 b4c_new        -50    880   -881      %  B4C            - poison section
cell 847 802 steel       -50    881   -882      %  steel plug | grapple adaptor

cell 848 802 steel        50          -876      %  lower carbon steel clad
cell 849 802 zr           50    876   -879      %  zirc-3 clad (zirc follower)
cell 850 802 steel        50    879   -881      %  upper carbon steel clad
cell 851 802 steel        50    881   -882      %  steel plug | grapple adaptor
cell 852 802 Air_steel          882   -883      %  grapple and air
cell 853 802 air                883             %  air above CR
%#############################################################################
##


%%%############################################################################
#####
%%% OLD CONTROL ROD REGIONS  (Old Rods-MinCritical)
%%%############################################################################
#####
%%%   Dynamic Control Rod
%%cell 854 803 steel       -50          -891      %  Bottom Adaptor - Control Rod Follower
%%cell 855 803 graphite    -50    891   -892      %  Graphite       - Control Rod Follower
%%cell 856 803 steel       -50    892   -893      %  Steel plug     - Control Rod Follower
%%cell 857 803 zr_steel    -50    893   -894      %  Zr/Steel plug  - Control Rod Follower
%%cell 858 803 graphite    -50    894   -895      %  Graphite       - Upper follower
%%cell 859 803 steel      -50    895   -896      %  Steel plug     - Upper follower
%%cell 860 803 zr_steel    -50    896   -897      %  Zr/Steel plug  - Zr follower
%%cell 861 803 graphite    -50    897   -898      %  Graphite       - Zr follower
%%cell 862 803 zr_steel    -50    898   -899      %  Zr/Steel plug  - Zr follower
%%cell 863 803 steel       -50    899   -900      %  Steel plug     - poison section
%%cell 864 803 b4c    -50    900   -901
%%cell 865 803 b4c         -50    901   -902      %  B4C            - poison section
%%cell 866 803 steel       -50    902   -903      %  steel plug | grapple adaptor
%%
%%cell 867 803 steel        50          -896      %  lower carbon steel clad
%%cell 868 803 zr           50    896   -899      %  zirc-3 clad (zirc follower)
%%cell 869 803 steel        50    899   -902      %  upper carbon steel clad
%%cell 870 803 steel        50    902   -903      %  steel plug | grapple adaptor
%%cell 871 803 Air_steel          903   -904      %  grapple and air
%%cell 872 803 air                904             %  air above CR
%%%############################################################################
#####
```

C0_48inch.sss

```
% TREAT 48 inch Slotted Assembly (H1-H8 and H11-H18)

% Ben Baker
% Idaho National Laboratory
% Jan 20, 2016



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% for cross section preparation we have the following regions
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  universe     material
%
%
%    5021       Aluminum base
%    5022       Lead
%    5023       Oct Graphite Reflector
%    5024       Square Graphite Reflector
%    5025       Zr caps
%    5026       Zr complete shell + Air
%    5027       Zr cut shell + supports + Air
%
%    5028       Al-steel for baseplate
%    5029       Al top fitting (The slotted assembly has lead all the way up)
%
%    5020       Build Assembly
%    5001-5013  Copy Assembly
%    5000       Reconstruct with Homogenized zones
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Universe 5000 - 5029
% Surfaces 5051 - 5086  (Reserve 5900 & 5999 for outside definitions)
% Cells    5000 - 5099

% Building in order from bottom
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Aluminum & air at end caps (Cells 4650-4659)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
cell 5001 5021 aluminum   -5051        % Aluminum Bottom, Artificially Long
cell 5002 5021 air_out    -5999 5051   % Air outside of clad

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Lead (Bottom to Top)            (Cells 4660-4669)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5003 5022 lead       -5054                 % lead base or top
cell 5004 5022 air        -5053 5054            % air between clad and contents
cell 5005 5022 aluminum   -5051 5053            % aluminum clad
cell 5006 5022 air_out    -5999 5051            % Air outside of clad

% Notes: Cut at 5071 -5072 and 5085 -5086

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Graphite Reflector #1,#2 (Bottom to Top) (Cells 4670-4679)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5007 5023 reflector  -5054                 % reflector graphite
cell 5008 5023 air        -5053 5054            % air between clad and contents
cell 5009 5023 aluminum   -5051 5053            % aluminum clad
cell 5010 5023 air_out    -5999 5051            % Air outside of clad

% Notes: Cut at 5072 -5074 and 5083 -5085

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Square Graphite Reflector (Bottom to Top) (Cells 4680-4689)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5011 5024 reflector  -5056                 % square Graphite reflector
cell 5012 5024 air        -5053 5056            % air between clad and contents
cell 5013 5024 aluminum   -5051 5053      -5075   % Aluminum clad
cell 5014 5024 zr         -5051 5053 5075 -5082   % 2x thick Zr clad
cell 5015 5024 aluminum   -5051 5053 5082         % Aluminum clad
cell 5016 5024 air_out    -5999 5051            % Air outside of clad

% Notes: Cut at 5074 -5076 and 5081 -5083

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Zr Cap (Bottom to Top)                (Cells 4690-4699)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
% Bottom Zr Cap
cell 5017 5025 zr        -5051        % Zr Cap at bottom until Zr Cap at top
cell 5018 5025 air_out   -5999 5051   % Air outside of clad

% Notes: Cut at 5076 -5077 and 5080 -5081

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%           Zr + Air Slot and Shell Zones    (Cells 4700-4709)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Air + Zr shell NOT cut (Bottom until Top)
cell 5030 5026 zr        -5051  5052          % Air + Zr shell all around (Bottom)
cell 5031 5026 zr        -5058  5057   -5052    % Zr Support LHS
cell 5032 5026 zr        -5060  5059   -5052    % Zr Support RHS
cell 5033 5026 air       -5052 -5057          % Air between support and shell LHS
cell 5034 5026 air       -5052 -5059          % Air between support and shell RHS
cell 5035 5026 air       -5052  5058 5060      % Air between shell and outside supports
cell 5036 5026 air_out   -5999  5051          % Air outside of clad

% Notes: Cut at 5077 -5078 and 5079 -5080

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%           Cut Zr Shell + Large Air Slot    (Cells 4710-4719)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Center 48 inch hole cut through
                % Inside Outside others ..
cell 5040 5027 zr        -5051  5052    5055      % Zr shell for Large Void Region
cell 5041 5027 zr        -5058  5057   -5052      % Zr Support LHS
cell 5042 5027 air       -5052 -5057             % Air between support and shell LHS
cell 5043 5027 zr        -5060  5059   -5052      % Zr Support RHS
cell 5044 5027 air       -5052 -5059             % Air between support and shell RHS
cell 5045 5027 air       -5052  5058   5055 5060   % Air inside shell, outside suppor, until large
void
cell 5046 5027 air       -5055                  % Large Void Region
cell 5047 5027 air_out   -5999 5051    5055       % Complete void zone outside

% Notes: Cut at 5078 -5079

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%           INF top and bottom               (Cells 4720-4725)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
% Infinite Aluminum base
cell 5050 5028 Al_steel    -5999                  % Solid base - INF down and INF across
cell 5051 5029 Al_air      -5999                  % Solid base - INF down and INF across

% Notes: Used below 5070 and above 5086

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build H1-H8, H11-H18 Slotted assembly           (Cells 4600-4649)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% start at bottom then from the center out
cell 5060 5020 fill 5028          -5070   % Fill Area below
cell 5061 5020 fill 5021     5070 -5071   % Aluminum at bottom
cell 5062 5020 fill 5022     5071 -5072   % Lead at bottom
cell 5063 5020 fill 5023     5072 -5074   % Octa Graphite Reflector (Bottom)
cell 5064 5020 fill 5024     5074 -5076   % Square Graphite Reflector (Bottom)
cell 5065 5020 fill 5025     5076 -5077   % Zr solid base (Bottom)
cell 5066 5020 fill 5026     5077 -5078   % Zr + air base region (Bottom)
cell 5067 5020 fill 5027     5078 -5079   % Air + Zr cut shell (48 inch)
cell 5068 5020 fill 5026     5079 -5080   % Zr + air base region (Top)
cell 5069 5020 fill 5025     5080 -5081   % Zr solid base (Top)
cell 5070 5020 fill 5024     5081 -5083   % Square Graphite Reflector (Top)
cell 5071 5020 fill 5023     5083 -5085   % Octa Graphite Reflector (Top)
cell 5072 5020 fill 5022     5085 -5086   % Lead at top
cell 5073 5020 fill 5029     5086         % Fill Area above


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Copy Assembly to multiple universes to match STD assembly   (Cells 4650-4669)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5074 5001 fill 5020     -90
cell 5075 5002 fill 5020     -90
cell 5076 5003 fill 5020     -90
cell 5077 5004 fill 5020     -90
cell 5078 5005 fill 5020     -90
cell 5079 5006 fill 5020     -90
cell 5080 5007 fill 5020     -90
cell 5081 5008 fill 5020     -90
cell 5082 5009 fill 5020     -90
cell 5083 5010 fill 5020     -90
cell 5084 5011 fill 5020     -90
cell 5085 5012 fill 5020     -90
cell 5086 5013 fill 5020     -90
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build Assembly to match universe sizes in STD assembly   (Cells 4670-4689)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5087 5000 fill 5001          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5088 5000 fill 5002        11 -12   % Oct graphite XS region 1 -- bottom
cell 5089 5000 fill 5003        12 -13   % Oct graphite XS region 2 -- bottom
cell 5090 5000 fill 5004        13 -14   % square graphite bottom + air gap + Al clad
cell 5091 5000 fill 5005        14 -17   % axial interface
cell 5092 5000 fill 5006        17 -18   % Fuel1 bottom
cell 5093 5000 fill 5007        18 -19   % Fuel2
cell 5094 5000 fill 5008        19 -20   % Fuel1 top
cell 5095 5000 fill 5009        20 -23   % aixal interface
cell 5096 5000 fill 5010        23 -25   % square graphite w hole top + Oct graphite with hole +
air + Al clad
cell 5097 5000 fill 5011        25 -26   % Oct graphite XS region 2 -- top
cell 5098 5000 fill 5012        26 -27   % Oct graphite XS region 1 -- top
cell 5099 5000 fill 5013        27      % top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 5000 -5900
```

```
%
%
%%%%%% --- Geometry and mesh plots:
%plot 3 1000 1000    2.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    7.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   42.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   50.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   57.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   59.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   59.48   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   184.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   187.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   187.18    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   188.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   196.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   208.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   243.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   247.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   248.0    -5.08 5.08   -5.08    5.08       % xy-plot
%
%plot 2 800  4000    0.0    -5.08 5.08    0.0    247.65      % xz-plot
%
%plot 2 800  4000   -5.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000   -4.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000   -3.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000   -2.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000   -1.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    0.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    1.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    2.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    3.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    4.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    5.0    -5.08 5.08    0.0    247.65      % yz-plot
%
```

C1-C10.sss

```
% TREAT 50 inch Half-Slotted Assembly (H-21)

% Ben Baker
% Idaho National Laboratory
% Feb 12, 2016

%###################################################################################
##
%  Reserve
%  Universe    [5100-5563] where base-level is every 50. 5100,5150,5200 ...
```

```
%                          and homoginization universes are XX01-XX13.
%  Cells       [5YXX-5YXX] where XX is 01-26 (C1,C3,...C9) and 50-76 for (C2,C4..C10) and Y
is 1-5
%  Surf        Same as C0
%###############################################################################
##

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C1
% Description of placement:

% COPY UNIVERSES
cell 5101 5101 fill 5020     -90
cell 5102 5102 fill 5020     -90
cell 5103 5103 fill 5020     -90
cell 5104 5104 fill 5020     -90
cell 5105 5105 fill 5020     -90
cell 5106 5106 fill 5020     -90
cell 5107 5107 fill 5020     -90
cell 5108 5108 fill 5020     -90
cell 5109 5109 fill 5020     -90
cell 5110 5110 fill 5020     -90
cell 5111 5111 fill 5020     -90
cell 5112 5112 fill 5020     -90
cell 5113 5113 fill 5020     -90

%% BUILD C1
cell 5114 5100 fill 5101          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5115 5100 fill 5102       11 -12   % Oct graphite XS region 1 -- bottom
cell 5116 5100 fill 5103       12 -13   % Oct graphite XS region 2 -- bottom
cell 5117 5100 fill 5104       13 -14   % square graphite bottom + air gap + Al clad
cell 5118 5100 fill 5105       14 -17   % axial interface
cell 5119 5100 fill 5106       17 -18   % Fuel1 bottom
cell 5120 5100 fill 5107       18 -19   % Fuel2
cell 5121 5100 fill 5108       19 -20   % Fuel1 top
cell 5122 5100 fill 5109       20 -23   % aixal interface
cell 5123 5100 fill 5110       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5124 5100 fill 5111       25 -26   % Oct graphite XS region 2 -- top
cell 5125 5100 fill 5112       26 -27   % Oct graphite XS region 1 -- top
cell 5126 5100 fill 5113       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
% Define C2
% Description of placement:

% COPY UNIVERSES
cell 5151 5151 fill 5020    -90
cell 5152 5152 fill 5020    -90
cell 5153 5153 fill 5020    -90
cell 5154 5154 fill 5020    -90
cell 5155 5155 fill 5020    -90
cell 5156 5156 fill 5020    -90
cell 5157 5157 fill 5020    -90
cell 5158 5158 fill 5020    -90
cell 5159 5159 fill 5020    -90
cell 5160 5160 fill 5020    -90
cell 5161 5161 fill 5020    -90
cell 5162 5162 fill 5020    -90
cell 5163 5163 fill 5020    -90

%% BUILD C2
cell 5164 5150 fill 5151        -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5165 5150 fill 5152      11 -12   % Oct graphite XS region 1 -- bottom
cell 5166 5150 fill 5153      12 -13   % Oct graphite XS region 2 -- bottom
cell 5167 5150 fill 5154      13 -14   % square graphite bottom + air gap + Al clad
cell 5168 5150 fill 5155      14 -17   % axial interface
cell 5169 5150 fill 5156      17 -18   % Fuel1 bottom
cell 5170 5150 fill 5157      18 -19   % Fuel2
cell 5171 5150 fill 5158      19 -20   % Fuel1 top
cell 5172 5150 fill 5159      20 -23   % aixal interface
cell 5173 5150 fill 5160      23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5174 5150 fill 5161      25 -26   % Oct graphite XS region 2 -- top
cell 5175 5150 fill 5162      26 -27   % Oct graphite XS region 1 -- top
cell 5176 5150 fill 5163      27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C3
% Description of placement:

% COPY UNIVERSES
cell 5201 5201 fill 5020    -90
cell 5202 5202 fill 5020    -90
cell 5203 5203 fill 5020    -90
cell 5204 5204 fill 5020    -90
cell 5205 5205 fill 5020    -90
```

```
cell 5206 5206 fill 5020     -90
cell 5207 5207 fill 5020     -90
cell 5208 5208 fill 5020     -90
cell 5209 5209 fill 5020     -90
cell 5210 5210 fill 5020     -90
cell 5211 5211 fill 5020     -90
cell 5212 5212 fill 5020     -90
cell 5213 5213 fill 5020     -90

%% BUILD C3
cell 5214 5200 fill 5201          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5215 5200 fill 5202       11 -12   % Oct graphite XS region 1 -- bottom
cell 5216 5200 fill 5203       12 -13   % Oct graphite XS region 2 -- bottom
cell 5217 5200 fill 5204       13 -14   % square graphite bottom + air gap + Al clad
cell 5218 5200 fill 5205       14 -17   % axial interface
cell 5219 5200 fill 5206       17 -18   % Fuel1 bottom
cell 5220 5200 fill 5207       18 -19   % Fuel2
cell 5221 5200 fill 5208       19 -20   % Fuel1 top
cell 5222 5200 fill 5209       20 -23   % aixal interface
cell 5223 5200 fill 5210       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5224 5200 fill 5211       25 -26   % Oct graphite XS region 2 -- top
cell 5225 5200 fill 5212       26 -27   % Oct graphite XS region 1 -- top
cell 5226 5200 fill 5213       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C4
% Description of placement:

% COPY UNIVERSES
cell 5251 5251 fill 5020     -90
cell 5252 5252 fill 5020     -90
cell 5253 5253 fill 5020     -90
cell 5254 5254 fill 5020     -90
cell 5255 5255 fill 5020     -90
cell 5256 5256 fill 5020     -90
cell 5257 5257 fill 5020     -90
cell 5258 5258 fill 5020     -90
cell 5259 5259 fill 5020     -90
cell 5260 5260 fill 5020     -90
cell 5261 5261 fill 5020     -90
cell 5262 5262 fill 5020     -90
cell 5263 5263 fill 5020     -90
```

```
%% BUILD C4
cell 5264 5250 fill 5251         -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5265 5250 fill 5252       11 -12   % Oct graphite XS region 1 -- bottom
cell 5266 5250 fill 5253       12 -13   % Oct graphite XS region 2 -- bottom
cell 5267 5250 fill 5254       13 -14   % square graphite bottom + air gap + Al clad
cell 5268 5250 fill 5255       14 -17   % axial interface
cell 5269 5250 fill 5256       17 -18   % Fuel1 bottom
cell 5270 5250 fill 5257       18 -19   % Fuel2
cell 5271 5250 fill 5258       19 -20   % Fuel1 top
cell 5272 5250 fill 5259       20 -23   % aixal interface
cell 5273 5250 fill 5260       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5274 5250 fill 5261       25 -26   % Oct graphite XS region 2 -- top
cell 5275 5250 fill 5262       26 -27   % Oct graphite XS region 1 -- top
cell 5276 5250 fill 5263       27        % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C5
% Description of placement:

% COPY UNIVERSES
cell 5301 5301 fill 5020     -90
cell 5302 5302 fill 5020     -90
cell 5303 5303 fill 5020     -90
cell 5304 5304 fill 5020     -90
cell 5305 5305 fill 5020     -90
cell 5306 5306 fill 5020     -90
cell 5307 5307 fill 5020     -90
cell 5308 5308 fill 5020     -90
cell 5309 5309 fill 5020     -90
cell 5310 5310 fill 5020     -90
cell 5311 5311 fill 5020     -90
cell 5312 5312 fill 5020     -90
cell 5313 5313 fill 5020     -90

%% BUILD C5
cell 5314 5300 fill 5301         -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5315 5300 fill 5302       11 -12   % Oct graphite XS region 1 -- bottom
cell 5316 5300 fill 5303       12 -13   % Oct graphite XS region 2 -- bottom
cell 5317 5300 fill 5304       13 -14   % square graphite bottom + air gap + Al clad
cell 5318 5300 fill 5305       14 -17   % axial interface
cell 5319 5300 fill 5306       17 -18   % Fuel1 bottom
cell 5320 5300 fill 5307       18 -19   % Fuel2
cell 5321 5300 fill 5308       19 -20   % Fuel1 top
```

```
cell 5322 5300 fill 5309       20 -23   % aixal interface
cell 5323 5300 fill 5310       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5324 5300 fill 5311       25 -26   % Oct graphite XS region 2 -- top
cell 5325 5300 fill 5312       26 -27   % Oct graphite XS region 1 -- top
cell 5326 5300 fill 5313       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C6
% Description of placement:

% COPY UNIVERSES
cell 5351 5351 fill 5020     -90
cell 5352 5352 fill 5020     -90
cell 5353 5353 fill 5020     -90
cell 5354 5354 fill 5020     -90
cell 5355 5355 fill 5020     -90
cell 5356 5356 fill 5020     -90
cell 5357 5357 fill 5020     -90
cell 5358 5358 fill 5020     -90
cell 5359 5359 fill 5020     -90
cell 5360 5360 fill 5020     -90
cell 5361 5361 fill 5020     -90
cell 5362 5362 fill 5020     -90
cell 5363 5363 fill 5020     -90

%% BUILD C6
cell 5364 5350 fill 5351          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5365 5350 fill 5352       11 -12   % Oct graphite XS region 1 -- bottom
cell 5366 5350 fill 5353       12 -13   % Oct graphite XS region 2 -- bottom
cell 5367 5350 fill 5354       13 -14   % square graphite bottom + air gap + Al clad
cell 5368 5350 fill 5355       14 -17   % axial interface
cell 5369 5350 fill 5356       17 -18   % Fuel1 bottom
cell 5370 5350 fill 5357       18 -19   % Fuel2
cell 5371 5350 fill 5358       19 -20   % Fuel1 top
cell 5372 5350 fill 5359       20 -23   % aixal interface
cell 5373 5350 fill 5360       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5374 5350 fill 5361       25 -26   % Oct graphite XS region 2 -- top
cell 5375 5350 fill 5362       26 -27   % Oct graphite XS region 1 -- top
cell 5376 5350 fill 5363       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C7
% Description of placement:

% COPY UNIVERSES
cell 5401 5401 fill 5020    -90
cell 5402 5402 fill 5020    -90
cell 5403 5403 fill 5020    -90
cell 5404 5404 fill 5020    -90
cell 5405 5405 fill 5020    -90
cell 5406 5406 fill 5020    -90
cell 5407 5407 fill 5020    -90
cell 5408 5408 fill 5020    -90
cell 5409 5409 fill 5020    -90
cell 5410 5410 fill 5020    -90
cell 5411 5411 fill 5020    -90
cell 5412 5412 fill 5020    -90
cell 5413 5413 fill 5020    -90

%% BUILD C7
cell 5414 5400 fill 5401        -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5415 5400 fill 5402      11 -12   % Oct graphite XS region 1 -- bottom
cell 5416 5400 fill 5403      12 -13   % Oct graphite XS region 2 -- bottom
cell 5417 5400 fill 5404      13 -14   % square graphite bottom + air gap + Al clad
cell 5418 5400 fill 5405      14 -17   % axial interface
cell 5419 5400 fill 5406      17 -18   % Fuel1 bottom
cell 5420 5400 fill 5407      18 -19   % Fuel2
cell 5421 5400 fill 5408      19 -20   % Fuel1 top
cell 5422 5400 fill 5409      20 -23   % aixal interface
cell 5423 5400 fill 5410      23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5424 5400 fill 5411      25 -26   % Oct graphite XS region 2 -- top
cell 5425 5400 fill 5412      26 -27   % Oct graphite XS region 1 -- top
cell 5426 5400 fill 5413      27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C8
% Description of placement:

% COPY UNIVERSES
cell 5451 5451 fill 5020    -90
cell 5452 5452 fill 5020    -90
cell 5453 5453 fill 5020    -90
```

```
cell 5454 5454 fill 5020    -90
cell 5455 5455 fill 5020    -90
cell 5456 5456 fill 5020    -90
cell 5457 5457 fill 5020    -90
cell 5458 5458 fill 5020    -90
cell 5459 5459 fill 5020    -90
cell 5460 5460 fill 5020    -90
cell 5461 5461 fill 5020    -90
cell 5462 5462 fill 5020    -90
cell 5463 5463 fill 5020    -90

%% BUILD C8
cell 5464 5450 fill 5451       -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5465 5450 fill 5452     11 -12   % Oct graphite XS region 1 -- bottom
cell 5466 5450 fill 5453     12 -13   % Oct graphite XS region 2 -- bottom
cell 5467 5450 fill 5454     13 -14   % square graphite bottom + air gap + Al clad
cell 5468 5450 fill 5455     14 -17   % axial interface
cell 5469 5450 fill 5456     17 -18   % Fuel1 bottom
cell 5470 5450 fill 5457     18 -19   % Fuel2
cell 5471 5450 fill 5458     19 -20   % Fuel1 top
cell 5472 5450 fill 5459     20 -23   % aixal interface
cell 5473 5450 fill 5460     23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5474 5450 fill 5461     25 -26   % Oct graphite XS region 2 -- top
cell 5475 5450 fill 5462     26 -27   % Oct graphite XS region 1 -- top
cell 5476 5450 fill 5463     27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C9
% Description of placement:

% COPY UNIVERSES
cell 5501 5501 fill 5020    -90
cell 5502 5502 fill 5020    -90
cell 5503 5503 fill 5020    -90
cell 5504 5504 fill 5020    -90
cell 5505 5505 fill 5020    -90
cell 5506 5506 fill 5020    -90
cell 5507 5507 fill 5020    -90
cell 5508 5508 fill 5020    -90
cell 5509 5509 fill 5020    -90
cell 5510 5510 fill 5020    -90
cell 5511 5511 fill 5020    -90
cell 5512 5512 fill 5020    -90
```

```
cell 5513 5513 fill 5020     -90

%% BUILD C9
cell 5514 5500 fill 5501          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5515 5500 fill 5502       11 -12   % Oct graphite XS region 1 -- bottom
cell 5516 5500 fill 5503       12 -13   % Oct graphite XS region 2 -- bottom
cell 5517 5500 fill 5504       13 -14   % square graphite bottom + air gap + Al clad
cell 5518 5500 fill 5505       14 -17   % axial interface
cell 5519 5500 fill 5506       17 -18   % Fuel1 bottom
cell 5520 5500 fill 5507       18 -19   % Fuel2
cell 5521 5500 fill 5508       19 -20   % Fuel1 top
cell 5522 5500 fill 5509       20 -23   % aixal interface
cell 5523 5500 fill 5510       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5524 5500 fill 5511       25 -26   % Oct graphite XS region 2 -- top
cell 5525 5500 fill 5512       26 -27   % Oct graphite XS region 1 -- top
cell 5526 5500 fill 5513       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C10
% Description of placement:

% COPY UNIVERSES
cell 5551 5551 fill 5020     -90
cell 5552 5552 fill 5020     -90
cell 5553 5553 fill 5020     -90
cell 5554 5554 fill 5020     -90
cell 5555 5555 fill 5020     -90
cell 5556 5556 fill 5020     -90
cell 5557 5557 fill 5020     -90
cell 5558 5558 fill 5020     -90
cell 5559 5559 fill 5020     -90
cell 5560 5560 fill 5020     -90
cell 5561 5561 fill 5020     -90
cell 5562 5562 fill 5020     -90
cell 5563 5563 fill 5020     -90

%% BUILD C10
cell 5564 5550 fill 5551          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5565 5550 fill 5552       11 -12   % Oct graphite XS region 1 -- bottom
cell 5566 5550 fill 5553       12 -13   % Oct graphite XS region 2 -- bottom
cell 5567 5550 fill 5554       13 -14   % square graphite bottom + air gap + Al clad
cell 5568 5550 fill 5555       14 -17   % axial interface
cell 5569 5550 fill 5556       17 -18   % Fuel1 bottom
```

```
cell 5570 5550 fill 5557       18 -19   % Fuel2
cell 5571 5550 fill 5558       19 -20   % Fuel1 top
cell 5572 5550 fill 5559       20 -23   % aixal interface
cell 5573 5550 fill 5560       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5574 5550 fill 5561       25 -26   % Oct graphite XS region 2 -- top
cell 5575 5550 fill 5562       26 -27   % Oct graphite XS region 1 -- top
cell 5576 5550 fill 5563       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C11
% Description of placement:

% COPY UNIVERSES
cell 5601 5601 fill 5020     -90
cell 5602 5602 fill 5020     -90
cell 5603 5603 fill 5020     -90
cell 5604 5604 fill 5020     -90
cell 5605 5605 fill 5020     -90
cell 5606 5606 fill 5020     -90
cell 5607 5607 fill 5020     -90
cell 5608 5608 fill 5020     -90
cell 5609 5609 fill 5020     -90
cell 5610 5610 fill 5020     -90
cell 5611 5611 fill 5020     -90
cell 5612 5612 fill 5020     -90
cell 5613 5613 fill 5020     -90

%% BUILD C11
cell 5614 5600 fill 5601          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5615 5600 fill 5602       11 -12   % Oct graphite XS region 1 -- bottom
cell 5616 5600 fill 5603       12 -13   % Oct graphite XS region 2 -- bottom
cell 5617 5600 fill 5604       13 -14   % square graphite bottom + air gap + Al clad
cell 5618 5600 fill 5605       14 -17   % axial interface
cell 5619 5600 fill 5606       17 -18   % Fuel1 bottom
cell 5620 5600 fill 5607       18 -19   % Fuel2
cell 5621 5600 fill 5608       19 -20   % Fuel1 top
cell 5622 5600 fill 5609       20 -23   % aixal interface
cell 5623 5600 fill 5610       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5624 5600 fill 5611       25 -26   % Oct graphite XS region 2 -- top
cell 5625 5600 fill 5612       26 -27   % Oct graphite XS region 1 -- top
cell 5626 5600 fill 5613       27       % top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C12
% Description of placement:

% COPY UNIVERSES
cell 5651 5651 fill 5020    -90
cell 5652 5652 fill 5020    -90
cell 5653 5653 fill 5020    -90
cell 5654 5654 fill 5020    -90
cell 5655 5655 fill 5020    -90
cell 5656 5656 fill 5020    -90
cell 5657 5657 fill 5020    -90
cell 5658 5658 fill 5020    -90
cell 5659 5659 fill 5020    -90
cell 5660 5660 fill 5020    -90
cell 5661 5661 fill 5020    -90
cell 5662 5662 fill 5020    -90
cell 5663 5663 fill 5020    -90

%% BUILD C12
cell 5664 5650 fill 5651       -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5665 5650 fill 5652     11 -12  % Oct graphite XS region 1 -- bottom
cell 5666 5650 fill 5653     12 -13  % Oct graphite XS region 2 -- bottom
cell 5667 5650 fill 5654     13 -14  % square graphite bottom + air gap + Al clad
cell 5668 5650 fill 5655     14 -17  % axial interface
cell 5669 5650 fill 5656     17 -18  % Fuel1 bottom
cell 5670 5650 fill 5657     18 -19  % Fuel2
cell 5671 5650 fill 5658     19 -20  % Fuel1 top
cell 5672 5650 fill 5659     20 -23  % aixal interface
cell 5673 5650 fill 5660     23 -25  % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5674 5650 fill 5661     25 -26  % Oct graphite XS region 2 -- top
cell 5675 5650 fill 5662     26 -27  % Oct graphite XS region 1 -- top
cell 5676 5650 fill 5663     27      % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C13
% Description of placement:

% COPY UNIVERSES
cell 5701 5701 fill 5020    -90
```

```
cell 5702 5702 fill 5020     -90
cell 5703 5703 fill 5020     -90
cell 5704 5704 fill 5020     -90
cell 5705 5705 fill 5020     -90
cell 5706 5706 fill 5020     -90
cell 5707 5707 fill 5020     -90
cell 5708 5708 fill 5020     -90
cell 5709 5709 fill 5020     -90
cell 5710 5710 fill 5020     -90
cell 5711 5711 fill 5020     -90
cell 5712 5712 fill 5020     -90
cell 5713 5713 fill 5020     -90

%% BUILD C13
cell 5714 5700 fill 5701          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5715 5700 fill 5702       11 -12   % Oct graphite XS region 1 -- bottom
cell 5716 5700 fill 5703       12 -13   % Oct graphite XS region 2 -- bottom
cell 5717 5700 fill 5704       13 -14   % square graphite bottom + air gap + Al clad
cell 5718 5700 fill 5705       14 -17   % axial interface
cell 5719 5700 fill 5706       17 -18   % Fuel1 bottom
cell 5720 5700 fill 5707       18 -19   % Fuel2
cell 5721 5700 fill 5708       19 -20   % Fuel1 top
cell 5722 5700 fill 5709       20 -23   % aixal interface
cell 5723 5700 fill 5710       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5724 5700 fill 5711       25 -26   % Oct graphite XS region 2 -- top
cell 5725 5700 fill 5712       26 -27   % Oct graphite XS region 1 -- top
cell 5726 5700 fill 5713       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C14
% Description of placement:

% COPY UNIVERSES
cell 5751 5751 fill 5020     -90
cell 5752 5752 fill 5020     -90
cell 5753 5753 fill 5020     -90
cell 5754 5754 fill 5020     -90
cell 5755 5755 fill 5020     -90
cell 5756 5756 fill 5020     -90
cell 5757 5757 fill 5020     -90
cell 5758 5758 fill 5020     -90
cell 5759 5759 fill 5020     -90
cell 5760 5760 fill 5020     -90
```

```
cell 5761 5761 fill 5020     -90
cell 5762 5762 fill 5020     -90
cell 5763 5763 fill 5020     -90

%% BUILD C14
cell 5764 5750 fill 5751          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5765 5750 fill 5752       11 -12   % Oct graphite XS region 1 -- bottom
cell 5766 5750 fill 5753       12 -13   % Oct graphite XS region 2 -- bottom
cell 5767 5750 fill 5754       13 -14   % square graphite bottom + air gap + Al clad
cell 5768 5750 fill 5755       14 -17   % axial interface
cell 5769 5750 fill 5756       17 -18   % Fuel1 bottom
cell 5770 5750 fill 5757       18 -19   % Fuel2
cell 5771 5750 fill 5758       19 -20   % Fuel1 top
cell 5772 5750 fill 5759       20 -23   % aixal interface
cell 5773 5750 fill 5760       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5774 5750 fill 5761       25 -26   % Oct graphite XS region 2 -- top
cell 5775 5750 fill 5762       26 -27   % Oct graphite XS region 1 -- top
cell 5776 5750 fill 5763       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C15
% Description of placement:

% COPY UNIVERSES
cell 5801 5801 fill 5020     -90
cell 5802 5802 fill 5020     -90
cell 5803 5803 fill 5020     -90
cell 5804 5804 fill 5020     -90
cell 5805 5805 fill 5020     -90
cell 5806 5806 fill 5020     -90
cell 5807 5807 fill 5020     -90
cell 5808 5808 fill 5020     -90
cell 5809 5809 fill 5020     -90
cell 5810 5810 fill 5020     -90
cell 5811 5811 fill 5020     -90
cell 5812 5812 fill 5020     -90
cell 5813 5813 fill 5020     -90

%% BUILD C15
cell 5814 5800 fill 5801          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5815 5800 fill 5802       11 -12   % Oct graphite XS region 1 -- bottom
cell 5816 5800 fill 5803       12 -13   % Oct graphite XS region 2 -- bottom
cell 5817 5800 fill 5804       13 -14   % square graphite bottom + air gap + Al clad
```

```
cell 5818 5800 fill 5805       14 -17   % axial interface
cell 5819 5800 fill 5806       17 -18   % Fuel1 bottom
cell 5820 5800 fill 5807       18 -19   % Fuel2
cell 5821 5800 fill 5808       19 -20   % Fuel1 top
cell 5822 5800 fill 5809       20 -23   % aixal interface
cell 5823 5800 fill 5810       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5824 5800 fill 5811       25 -26   % Oct graphite XS region 2 -- top
cell 5825 5800 fill 5812       26 -27   % Oct graphite XS region 1 -- top
cell 5826 5800 fill 5813       27       % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define C16
% Description of placement:

% COPY UNIVERSES
cell 5851 5851 fill 5020     -90
cell 5852 5852 fill 5020     -90
cell 5853 5853 fill 5020     -90
cell 5854 5854 fill 5020     -90
cell 5855 5855 fill 5020     -90
cell 5856 5856 fill 5020     -90
cell 5857 5857 fill 5020     -90
cell 5858 5858 fill 5020     -90
cell 5859 5859 fill 5020     -90
cell 5860 5860 fill 5020     -90
cell 5861 5861 fill 5020     -90
cell 5862 5862 fill 5020     -90
cell 5863 5863 fill 5020     -90

%% BUILD C16
cell 5864 5850 fill 5851          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5865 5850 fill 5852       11 -12   % Oct graphite XS region 1 -- bottom
cell 5866 5850 fill 5853       12 -13   % Oct graphite XS region 2 -- bottom
cell 5867 5850 fill 5854       13 -14   % square graphite bottom + air gap + Al clad
cell 5868 5850 fill 5855       14 -17   % axial interface
cell 5869 5850 fill 5856       17 -18   % Fuel1 bottom
cell 5870 5850 fill 5857       18 -19   % Fuel2
cell 5871 5850 fill 5858       19 -20   % Fuel1 top
cell 5872 5850 fill 5859       20 -23   % aixal interface
cell 5873 5850 fill 5860       23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 5874 5850 fill 5861       25 -26   % Oct graphite XS region 2 -- top
cell 5875 5850 fill 5862       26 -27   % Oct graphite XS region 1 -- top
```

```
cell 5876 5850 fill 5863       27        % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/C/C0_48inch.i"
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 5550 -5900
%
%
%%%%%% --- Geometry and mesh plots:
%plot 3 1000 1000    2.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    7.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   42.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   50.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   57.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   59.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   59.48   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   184.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   187.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   187.18    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   188.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   196.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   208.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   243.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   247.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   248.0    -5.08 5.08   -5.08    5.08       % xy-plot
%
%plot 2 800  4000    0.0    -5.08 5.08    0.0    247.65      % xz-plot
%
%plot 2 800  4000    -5.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    -4.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    -3.0    -5.08 5.08    0.0    247.65      % yz-plot
```

```
%plot 2 800  4000    -2.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    -1.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    0.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000     1.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000     2.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000     3.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000     4.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000     5.0    -5.08 5.08    0.0    247.65       % yz-plot
```

C9_Half-Slot.sss

```
% TREAT 50 inch Half-Slotted Assembly (H-21)

% Ben Baker
% Idaho National Laboratory
% Feb 2, 2016


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Half-Slotted Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% for cross section preparation we have the following regions
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  universe     material
%
%
%    5921       Aluminum base
%    5922       Lead
%    5923       Oct Graphite Reflector
%    5924       Zr caps
%    5925       Zr cut shell + supports + Air
%
%    5926       Al-steel for baseplate
%    5927       Al top fitting (The slotted assembly has lead all the way up)
%
%    5920       Build Assembly
%    5901-5913  Copy Assembly
%    5900       Reconstruct with Homogenized zones
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%
%  Reserve
%  Universe    [5900, 5920-5927] [Final 5900]
%  Cells       [5900-5986]
%  Surf        [5151-5176]   Also dependent on full-48inch slotted surfaces
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Aluminum & Zr Clad  (Bottom, Top Fittings, P1 & P2 Extensions)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Aluminum is filling to Zr clad
%                             y-axis-cuts
cell 5900  5921 aluminum      -5052       -5152    % Fittings and Extensions
cell 5901  5921 zr           -5051  5052 -5152    % Zr clad except cut
cell 5902  5921 zr           -5051  5152 -5151    % Zr clad at cut
cell 5903  5921 air_out       -5999  5051 -5151    % Air outside of clad until cut
cell 5904  5921 air_out       -5999        5151    % Air outside of clad above cut

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Lead (Bottom to Top)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Lead is filling to Zr clad
cell 5905  5922 lead          -5052       -5152    % Lead
cell 5906  5922 zr           -5051  5052 -5152    % Zr clad except cut
cell 5907  5922 zr           -5051  5152 -5151    % Zr clad at cut
cell 5908  5922 air_out       -5999  5051 -5151    % Air outside of clad until cut
cell 5909  5922 air_out       -5999        5151    % Air outside of clad above cut

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Graphite Reflector (Bottom to Top)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Graphite filling to Zr clad
cell 5910  5923 reflector     -5052       -5152    % Graphite
cell 5911  5923 zr           -5051  5052 -5152    % Zr clad except cut
cell 5912  5923 zr           -5051  5152 -5151    % Zr clad at cut
cell 5913  5923 air_out       -5999  5051 -5151    % Air outside of clad until cut
cell 5914  5923 air_out       -5999        5151    % Air outside of clad above cut

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                   Zr Cap/Divider (Bottom to Top)
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5915  5924 zr           -5051       -5151    % Zr divider
cell 5916  5924 air_out       -5999  5051 -5151    % Air outside of clad until cut
cell 5917  5924 air_out       -5999        5151    % Air outside of clad above cut

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                 Cut Zr Shell + Large Air Slot
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Use surf 5053 (2x-Zr or Al octa) for part of stiffener

cell 5918 5925 zr         -5051  5052    5055  -5152       % Zr shell for Large Void Region
cell 5919 5925 zr         -5051          5055  -5151  5152
cell 5920 5925 zr         -5052  5053    5055  -5152        5158  5159   % Stiffener on wall (minus
square)
cell 5921 5925 zr              -5053    5055  -5152  5153              % Stiffener up by cut
cell 5922 5925 zr                                 -5160 5158    % Stiffener square
cell 5923 5925 zr                                 -5161 5159    % Stiffener square
cell 5924 5925 air                                -5158        % Air inside square
cell 5925 5925 air                                     -5159    % Air inside square
cell 5926 5925 zr         -5053  5154  -5155   -5153            5160    % Flat stiffener on LHS
cell 5927 5925 zr         -5053  5157  -5156   -5153            5161    % Flat stiffener on RHS
cell 5928 5925 air        -5053 -5154         -5153            5160    % Air on LHS
cell 5929 5925 air        -5053         5156   -5153            5161    % Air on RHS
cell 5930 5925 air        -5055              -5151                  % Large Void Region
cell 5931 5925 air        -5053 5055    5155   -5157   -5153            % Air between Large void and
stiffener flat sides
cell 5932 5925 air_out       -5999  5051 -5151    % Air outside of clad until cut
cell 5933 5925 air_out       -5999        5151    % Air outside of clad above cut

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             INF top and bottom               (Cells 4720-4725)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Infinite Aluminum base
cell 5934 5926 Al_steel    -5999                   % Solid base - INF down and INF across
cell 5935 5927 Al_air      -5999                   % Solid base - INF down and INF across
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                    Build Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
cell 5950  5920  fill 5926           -5070        % Al-steel outside
cell 5951  5920  fill 5921        5070 -5166       % Al Fitting & P2
cell 5952  5920  fill 5922        5166 -5168       % Lead bottom
cell 5953  5920  fill 5923        5168 -5169       % Graphite bottom
cell 5954  5920  fill 5924        5169 -5170       % Zr divider
cell 5955  5920  fill 5925        5170 -5171       % Air Slot
cell 5956  5920  fill 5924        5171 -5172       % Zr divider
cell 5957  5920  fill 5923        5172 -5173       % Graphite top
cell 5958  5920  fill 5922        5173 -5174       % Lead top
cell 5959  5920  fill 5921        5174 -5176       % Al Fitting & P1
cell 5960  5920  fill 5927             5086       % Fill Area above

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Copy Assembly to multiple universes to match STD assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5961 5901 fill 5920     -90
cell 5962 5902 fill 5920     -90
cell 5963 5903 fill 5920     -90
cell 5964 5904 fill 5920     -90
cell 5965 5905 fill 5920     -90
cell 5966 5906 fill 5920     -90
cell 5967 5907 fill 5920     -90
cell 5968 5908 fill 5920     -90
cell 5969 5909 fill 5920     -90
cell 5970 5910 fill 5920     -90
cell 5971 5911 fill 5920     -90
cell 5972 5912 fill 5920     -90
cell 5973 5913 fill 5920     -90

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build Assembly to match universe sizes in STD assembly    (North-Side)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5974 5900 fill 5901            -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5975 5900 fill 5902         11 -12   % Oct graphite XS region 1 -- bottom
cell 5976 5900 fill 5903         12 -13   % Oct graphite XS region 2 -- bottom
cell 5977 5900 fill 5904         13 -14   % square graphite bottom + air gap + Al clad
cell 5978 5900 fill 5905         14 -17   % axial interface
cell 5979 5900 fill 5906         17 -18   % Fuel1 bottom
cell 5980 5900 fill 5907         18 -19   % Fuel2
cell 5981 5900 fill 5908         19 -20   % Fuel1 top
cell 5982 5900 fill 5909         20 -23   % aixal interface
```

```
cell 5983 5900 fill 5910        23 -25   % square graphite w hole top + Oct graphite with hole + 
air + Al clad
cell 5984 5900 fill 5911        25 -26   % Oct graphite XS region 2 -- top
cell 5985 5900 fill 5912        26 -27   % Oct graphite XS region 1 -- top
cell 5986 5900 fill 5913        27       % top fitting

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 1/2 Slotted Assembly South Facing
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5987 5951 fill 5920    -90
cell 5988 5952 fill 5920    -90
cell 5989 5953 fill 5920    -90
cell 5990 5954 fill 5920    -90
cell 5991 5955 fill 5920    -90
cell 5992 5956 fill 5920    -90
cell 5993 5957 fill 5920    -90
cell 5994 5958 fill 5920    -90
cell 5995 5959 fill 5920    -90
cell 5996 5960 fill 5920    -90
cell 5997 5961 fill 5920    -90
cell 5998 5962 fill 5920    -90
cell 5999 5963 fill 5920    -90

trans 5951 0 0 0 0 0 180
trans 5952 0 0 0 0 0 180
trans 5953 0 0 0 0 0 180
trans 5954 0 0 0 0 0 180
trans 5955 0 0 0 0 0 180
trans 5956 0 0 0 0 0 180
trans 5957 0 0 0 0 0 180
trans 5958 0 0 0 0 0 180
trans 5959 0 0 0 0 0 180
trans 5960 0 0 0 0 0 180
trans 5961 0 0 0 0 0 180
trans 5962 0 0 0 0 0 180
trans 5963 0 0 0 0 0 180

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build Assembly to match universe sizes in STD assembly   ( South-Side)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 5899 5950 fill 5951          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 5898 5950 fill 5952        11 -12   % Oct graphite XS region 1 -- bottom
cell 5897 5950 fill 5953        12 -13   % Oct graphite XS region 2 -- bottom
cell 5896 5950 fill 5954        13 -14   % square graphite bottom + air gap + Al clad
```

```
cell 5895 5950 fill 5955        14 -17   % axial interface
cell 5894 5950 fill 5956        17 -18   % Fuel1 bottom
cell 5893 5950 fill 5957        18 -19   % Fuel2
cell 5892 5950 fill 5958        19 -20   % Fuel1 top
cell 5891 5950 fill 5959        20 -23   % aixal interface
cell 5890 5950 fill 5960        23 -25   % square graphite w hole top + Oct graphite with hole +
air + Al clad
cell 5889 5950 fill 5961        25 -26   % Oct graphite XS region 2 -- top
cell 5888 5950 fill 5962        26 -27   % Oct graphite XS region 1 -- top
cell 5887 5950 fill 5963        27     % top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 5900 -5900
%
%
%%%%%% --- Geometry and mesh plots:
%plot 3 1000 1000    1.5    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    2.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    42.0   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    59.0   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    59.8   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   186.7   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   186.85  -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   222.0   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   243.1   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   247.1   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   248.1   -5.08 5.08   -5.08    5.08       % xy-plot
```

D0.sss

```
% TREAT Dummy Zirconium Clad Assembly
% Type D

% Modification: NO outgas hole.

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% for cross section preparation we have the following regions
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% universe    material
%
%
%   6021       Oct graphite XS + air gap + Al clad + air channel
%   6022       Square graphite + air gap + Al clad + air channel + Oct Graphite on top
%   6023       axial interface + air channel
%   6024       Fuel region + air gap + Zr clad + air channel
%
%   6001      Al-steel for baseplate
%   6013      Al top fitting (The slotted assembly has lead all the way up)
%
%   6002-12   Copy universes to build final
%   6000      Build Assembly
%
%##########################################################################
##
%##########################################################################
##
%
% Universe 6000 - 6024
% Surfaces     -     (Uses same surfaces as A's)
% Cells    6000 - 6047
%
%##########################################################################
##
%##########################################################################
##
%   Full homogenization with homogenized channels
%##########################################################################
##
%##########################################################################
##
%    Reflector Oct graphite XS
cell 6001 6021 reflector   -4          % Oct graphite reflector
cell 6002 6021 air         -5    4     % air gap
cell 6003 6021 aluminum    -3    5     % Al clad
cell 6004 6021 air_out          3      % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%   Square reflector up to top Oct XS region
cell 6005 6022 reflector  -6        -24  % Square graphite bottom to top
cell 6006 6022 air        -5   6    -24  % air gap between square graphite
cell 6007 6022 reflector  -4     24      % Oct graphite no hole on top
cell 6008 6022 air        -5   4 24      % air gap between oct graphite and clad
cell 6009 6022 aluminum   -3   5         % Al clad
```

```
cell 6010 6022 air_out     3            % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Axial interface
cell 6011 6023 aluminum    -3      -15  % Al cap before axial interface
cell 6012 6023 air        -2    15 -16  % air in Zr spacer region axially --bottom
cell 6013 6023 zr         -2    16 -21  % Zr
cell 6014 6023 air        -2    21 -22  % air in Zr spacer region axially --top
cell 6015 6023 zr         -3  2 15 -22  % Zr in Zr spacer region --bottom/top
cell 6016 6023 aluminum    -3    22     % Al cap after axial interface
cell 6017 6023 air_out      3           % air out
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region
cell 6018 6024 reflector   -1           % Graphite in fuel region
cell 6019 6024 air        -2   1       % air gap
cell 6020 6024 zr         -3   2       % zr clad
cell 6021 6024 air_out      3           % air out

% SETUP to Build Assembly. NEED independent Universes
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Reflector Oct Region 1 Bottom
cell 6022 6002 fill 6021  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Reflector Oct Region 2 Bottom
cell 6023 6003 fill 6021  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Square Reflector Region Bottom
cell 6024 6004 fill 6022  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Axial interface        Bottom
cell 6025 6005 fill 6023   -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 1          Bottom
cell 6026 6006 fill 6024   -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Fuel region 2          Middle
cell 6027 6007 fill 6024   -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Fuel region 1         Top
cell 6028 6008 fill 6024   -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%     Axial interface       Top
cell 6029 6009 fill 6023   -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Square Reflector top + Oct Xs region Top
cell 6030 6010 fill 6022   -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%    Reflector Oct Region 2 Top
cell 6031 6011 fill 6021  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%    Reflector Oct Region 1 Top
cell 6032 6012 fill 6021  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              INF top and bottom
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Infinite Aluminum base
cell 6033 6001 Al_steel    -90          % Solid base - INF down and INF across
cell 6034 6013 Al_air      -90          % Solid base - INF down and INF across

%###########################################################################
##
%###########################################################################
##
% Build std assembly
%###########################################################################
##
%###########################################################################
##
% start at bottom then from the center out
cell 6035 6000 fill 6001          -11   % Steel Grid Plate + Aluminum bottom fitting
cell 6036 6000 fill 6002        11 -12   % Oct graphite XS region 1 -- bottom
cell 6037 6000 fill 6003        12 -13   % Oct graphite XS region 2 -- bottom
cell 6038 6000 fill 6004        13 -14   % square graphite bottom + air gap + Al clad
cell 6039 6000 fill 6005        14 -17   % axial interface
cell 6040 6000 fill 6006        17 -18   % Fuel1 bottom
cell 6041 6000 fill 6007        18 -19   % Fuel2
cell 6042 6000 fill 6008        19 -20   % Fuel1 top
cell 6043 6000 fill 6009        20 -23   % aixal interface
cell 6044 6000 fill 6010        23 -25   % square graphite w hole top + Oct graphite with hole +
air + Al clad
cell 6045 6000 fill 6011        25 -26   % Oct graphite XS region 2 -- top
cell 6046 6000 fill 6012        26 -27   % Oct graphite XS region 1 -- top
cell 6047 6000 fill 6013        27       % top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 6000 -5900

%%%%% --- Geometry and mesh plots:
%plot 3 1000 1000    1.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    5.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   31.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   54.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.1    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.3    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   62.6   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   70.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   90.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   170.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   183.9    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   184.2    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   184.5    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   185.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   194.0    -5.08 5.08   -5.08    5.08       % xy-plot (hex + air hole)
%plot 3 1000 1000   207.0    -5.08 5.08   -5.08    5.08       % xy-plot (hex + no hole)
%plot 3 1000 1000   222.0    -5.08 5.08   -5.08    5.08       % xy-plot (hex + no hole)
%plot 3 1000 1000   249.0    -5.08 5.08   -5.08    5.08       % xy-plot (hex + no hole)


%plot 2 800  4000    0.0    -5.08 5.08    0.0    247.65      % xz-plot

%plot 1 800  4000    0.0    -5.08 5.08    0.0    247.65      % yz-plot
```

D1-Half.sss

```
% TREAT Half Assembly (Next to M8)

% Ben Baker
% Idaho National Laboratory
% Feb 2, 2016


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Half-Slotted Assembly
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%  Reserve
%  Universe    [6100, 6101-6113, 6120] [Final 6100]
%  Cells       [6100-6132]
%  Surf        Derived from half-slotted

% We can use many of the same surfaces or universes as the half-slotted assembly

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                    Build Assembly  (Surf and fill universes come from Half-Slotted)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 6100  6120  fill 5926          -5070       % Al-steel outside
cell 6101  6120  fill 5921       5070 -5166       % Al Fitting & P2
cell 6102  6120  fill 5922       5166 -5168       % Lead bottom
cell 6103  6120  fill 5923       5168 -5174       % Graphite
cell 6104  6120  fill 5924       5174 -5176       % Al Fitting & P1
cell 6105  6120  fill 5927           5176       % Fill Area above

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Copy Assembly to multiple universes to match STD assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 6106 6101 fill 6120    -90
cell 6107 6102 fill 6120    -90
cell 6108 6103 fill 6120    -90
cell 6109 6104 fill 6120    -90
cell 6110 6105 fill 6120    -90
cell 6111 6106 fill 6120    -90
cell 6112 6107 fill 6120    -90
cell 6113 6108 fill 6120    -90
cell 6114 6109 fill 6120    -90
cell 6115 6110 fill 6120    -90
cell 6116 6111 fill 6120    -90
cell 6117 6112 fill 6120    -90
cell 6118 6113 fill 6120    -90

cell 6206 6201 fill 6120    -90
cell 6207 6202 fill 6120    -90
cell 6208 6203 fill 6120    -90
cell 6209 6204 fill 6120    -90
cell 6210 6205 fill 6120    -90
```

```
cell 6211 6206 fill 6120    -90
cell 6212 6207 fill 6120    -90
cell 6213 6208 fill 6120    -90
cell 6214 6209 fill 6120    -90
cell 6215 6210 fill 6120    -90
cell 6216 6211 fill 6120    -90
cell 6217 6212 fill 6120    -90
cell 6218 6213 fill 6120    -90

% Switch Directions 180 degrees
trans 6201 0 0 0 0 0 180
trans 6202 0 0 0 0 0 180
trans 6203 0 0 0 0 0 180
trans 6204 0 0 0 0 0 180
trans 6205 0 0 0 0 0 180
trans 6206 0 0 0 0 0 180
trans 6207 0 0 0 0 0 180
trans 6208 0 0 0 0 0 180
trans 6209 0 0 0 0 0 180
trans 6210 0 0 0 0 0 180
trans 6211 0 0 0 0 0 180
trans 6212 0 0 0 0 0 180
trans 6213 0 0 0 0 0 180

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build Assembly to match universe sizes in STD assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 6120 6100 fill 6101        -11   % Steel Grid Plate + Aluminum bottom fitting
cell 6121 6100 fill 6102      11 -12   % Oct graphite XS region 1 -- bottom
cell 6122 6100 fill 6103      12 -13   % Oct graphite XS region 2 -- bottom
cell 6123 6100 fill 6104      13 -14   % square graphite bottom + air gap + Al clad
cell 6124 6100 fill 6105      14 -17   % axial interface
cell 6125 6100 fill 6106      17 -18   % Fuel1 bottom
cell 6126 6100 fill 6107      18 -19   % Fuel2
cell 6127 6100 fill 6108      19 -20   % Fuel1 top
cell 6128 6100 fill 6109      20 -23   % aixal interface
cell 6129 6100 fill 6110      23 -25   % square graphite w hole top + Oct graphite with hole + air
+ Al clad
cell 6130 6100 fill 6111      25 -26   % Oct graphite XS region 2 -- top
cell 6131 6100 fill 6112      26 -27   % Oct graphite XS region 1 -- top
cell 6132 6100 fill 6113      27       % top fitting

% Copy but Reverse Direction
cell 6220 6200 fill 6201        -11   % Steel Grid Plate + Aluminum bottom fitting
```

```
cell 6221 6200 fill 6202        11 -12   % Oct graphite XS region 1 -- bottom
cell 6222 6200 fill 6203        12 -13   % Oct graphite XS region 2 -- bottom
cell 6223 6200 fill 6204        13 -14   % square graphite bottom + air gap + Al clad
cell 6224 6200 fill 6205        14 -17   % axial interface
cell 6225 6200 fill 6206        17 -18   % Fuel1 bottom
cell 6226 6200 fill 6207        18 -19   % Fuel2
cell 6227 6200 fill 6208        19 -20   % Fuel1 top
cell 6228 6200 fill 6209        20 -23   % aixal interface
cell 6229 6200 fill 6210        23 -25   % square graphite w hole top + Oct graphite with hole +
air + Al clad
cell 6230 6200 fill 6211        25 -26   % Oct graphite XS region 2 -- top
cell 6231 6200 fill 6212        26 -27   % Oct graphite XS region 1 -- top
cell 6232 6200 fill 6213        27      % top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/C/C1_Half-Slot.i"
%include "/Users/bakeba/Desktop/HPC-Serpent/Assemblies/DebugAssembly.i"
%cell 3 1 fill 6100 -5900
%
%%%%%%% --- Geometry plots:
%plot 3 1000 1000    1.5    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    2.0    -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    42.0   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    59.0   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000    59.8   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   186.7   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   186.85  -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   222.0   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   243.1   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   247.1   -5.08 5.08   -5.08    5.08       % xy-plot
%plot 3 1000 1000   248.1   -5.08 5.08   -5.08    5.08       % xy-plot

%plot 2 800  4000    -5.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    -4.0    -5.08 5.08    0.0    247.65      % yz-plot
%plot 2 800  4000    -3.0    -5.08 5.08    0.0    247.65      % yz-plot
```

```
%plot 2 800  4000   -2.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000   -1.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    0.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    1.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    2.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    3.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    4.0    -5.08 5.08    0.0    247.65       % yz-plot
%plot 2 800  4000    5.0    -5.08 5.08    0.0    247.65       % yz-plot
%
%plot 1 800  4000   -5.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000   -4.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000   -3.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000   -2.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000   -1.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000    0.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000    1.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000    2.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000    3.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000    4.0    -5.08 5.08    0.0    247.65       % xz-plot
%plot 1 800  4000    5.0    -5.08 5.08    0.0    247.65       % xz-plot
```

M8Center_wDy-22R-fuel-region.sss

```
% TREAT M8-Calibration Vehicle

% Ben Baker
% Idaho National Laboratory
% Feb 2, 2016
% 4"x8" M8-Cal vehicle

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%      M8 VEHICLE
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Core CenterLine = 123.3105 cm

% Test Sample (Flux Wire 60" about core center line)
% U-Zr Sample 0.040" = 0.1016cm in diameter. R = 0.0508 cm
surf 9049 cyl  0.0 -5.08 0.0508  %62.82675 183.79425  %47.1105    % Radius of flux-wire

% Experiment Leg (Guess Center at x-y (0,-5.08))
surf 9050 cyl 0.0 -5.08 1.4224              % Stainless Steel Outer Tube I.D. (1.12" = 2.8448cm, R = 1.4224cm)
surf 9051 cyl 0.0 -5.08 1.5875              % SS Outer Tube O.D. (1.25" = 3.125 cm, R = 1.5875cm)
surf 9052 cyl 0.0 -5.08 1.63703              % SS Cal. Loop Test Section I.D. (1.289" = 3.27406cm, R =1.63703cm)
```

surf 9053 cyl 0.0 -5.08 2.56921 % SS Cal. Loop Test Section O.D. (2.023" = 5.13842cm, R =2.56921 cm)
surf 9054 cyl 0.0 -5.08 2.5781 % Al Sleeve I.D. (2.03" = 5.1562 cm, R = 2.5781 cm)
surf 9055 cyl 0.0 -5.08 2.7051 % Al Sleeve O.D. (2.13" = 5.4102 cm, R = 2.7051 cm) also SS Sleeve I.D. (2.13"): Al-Part1,2,3 Length (14-3/4",15",10")
surf 9056 cyl 0.0 -5.08 2.86258 % SS Sleeve O.D. (2.254" = 5.72516 cm, R = 2.86258 cm) SS-Part1,2 Length (14-3/4", 15")
surf 9057 cyl 0.0 -5.08 2.86766 % SS & Dy collar: Part 6 (SS) O.D. (I.D. 2.254" OD = 2.258" = 5.73532 cm, R = 2.86766 cm) Length = 3.5" Lower 4" Upper, Same OD for initial Dy 0.002" thick
surf 9058 cyl 0.0 -5.08 2.90576 % SS & Dy Coller: O.D (I.D. 2.258" OD = 2.288" = 5.81152 cm, R =2.90576 cm) SS Lengths = 6-3/4" (Both sides)
surf 9059 cyl 0.0 -5.08 2.91338 % SS & Dy Coller: (I.D. 2.288" OD = 2.294" = 5.82676 cm, R = 2.91338 cm) SS Lengths = 12" (Both Sides- Part 4)
surf 9060 cyl 0.0 -5.08 3.03022 % SS Dummy Heaters (I.D. 2.294" OD = 2.386" = 6.06044 cm, R = 3.03022 cm)

% Pump Leg (Guess Center at x-y (0,1.75" = 4.445cm))
surf 9061 cyl 0.0 4.445 1.063625 % Clamp says 1.464" OD and Pump Leg Flow meter Magnet 1.4375" OD. Assume 0.3" thick. Thus, R = 1.063625 cm
surf 9062 cyl 0.0 4.445 1.82563 % R = 1.82563 cm or OD 1.4375 use flow magnet"

% Axial regions for Experimental Leg
surf 9070 pz 21.7105 % Start of SS + Al support for Dy
surf 9071 pz 47.1105 % Lower End (Start of Dy full thickness)
surf 9072 pz 92.8305 % Lower End (Start of Dy 0.015 + 0.002" thick zone)
surf 9073 pz 106.1655 % Lower End (Start of Dy 0.002" thick)
surf 9074 pz 114.4205 % Lower End (End of Dy 0.002" thick)
surf 9075 pz 133.4705 % Upper End (Start of Dy 0.002" thick)
surf 9076 pz 140.4555 % Upper End (Start of Dy 0.015 + 0.002" thick)
surf 9077 pz 153.7905 % Upper End (Start of Dy 0.02" thick)
surf 9078 pz 198.2405 % Upper End (End of Dy and everything else up to Al)

% Calibration Vehicle Container
surf 9079 cuboid -4.7117 4.7117 -9.7917 9.7917 0.3175 255.289250 %258.148965 % Assume 1/8" thick steel (0.3175cm)
surf 9080 cuboid -5.02920 5.02920 -10.1092 10.1092 0.0 255.289250 %258.148965 % Outside of can
surf 9081 cuboid -5.08 5.08 -10.16 10.16 0.0 258.148965 % Cuboid must match definition for 19x19 lat cuboid or greater

% M8 Cal Vehicle
surf 9099 cuboid -5.08 5.08 -10.16 10.16 0.0 500.0

%%%%%%%%%%%
% Test Leg (Mainly in Order)

```
%
%
%           xxxxxxxxxxxx  Al_air
%              x   x    Common Internals
%              x   x    "
%              x   x    Common Internals
%            xxx w xxx   End Dy and Al (0.02")
%            xxx w xxx   Dy (0.02")
%            xxx w xxx   Dy (0.02")
%            xxx w xxx   Step up to Dy (0.02")
%             xx w xx    Dy (0.017")
%             xx w xx    Dy (0.017")
%             xx w xx    Step up to Dy (0.017")
%              x w x     Dy (0.002")
%              x w x     Step up to Dy (0.002")
%             -x w x-    Steel
%              x w x     Dy (0.002")
%              x w x     Step down to Dy (0.002")
%             xx w xx    Dy (0.017")
%             xx w xx    Dy (0.017")
%             xx w xx    Step down to Dy (0.017")
%            xxx w xxx   Dy (0.02")
%            xxx w xxx   Dy (0.02")
%            xxx w xxx   Dy (0.02")
%            xxx w xxx   Start Dy (0.02") and wire
%            xxx   xxx   Al + Steel (No Dy)
%            xxx   xxx   Start Al (No Dy)
%              x   x    Common Internals
%              x   x    "
%              x   x    Common Internals
%           xxxxxxxxxxxx  Al_steel
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%           INF top and bottom
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Infinite Aluminum base
%cell 9098 9098 Al_steel    -90                   % Solid base - INF down and INF across
%cell 9099 9099 Al_air      -90                   % Solid base - INF down and INF across
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%            Fuel Pin
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%surf 9047 pz 62.85       % Bottom of fuel pin
%surf 9048 pz 183.75       % Top of fuel pin

cell 9179 9136 air_fuel1    17 -20      % 9047 -9048
cell 9181 9136 air             -17  % -9047
cell 9182 9136 air         20      % 9048

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Common Internals (Level 5 )
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9151 9128 fill 9136  -9050                          % Air inside tube + fuel pin (Dispersed pin)
cell 9152 9128 steel      -9051   9050                    % SS Cal Test Outer Tube
cell 9153 9128 air        -9052   9051                    % Air gap
cell 9154 9128 steel      -9053   9052                    % SS Cal Loop Test Section (Extends all
the way)
cell 9155 9128 air              9053                    % Inf Air outside
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Common Al + Steel shells (shells Al + steel all the way out) (Level 4)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9156 9129 fill  9128 -9054                          % Common Internals
cell 9157 9129 aluminum   -9055   9054                        % Al cylinder
cell 9158 9129 steel             9055                    % Steel
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Inner Tube         (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9160 9137 fill 9128  -90    % Need to move back an extra level to align with others
cell 9162 9130 fill 9137  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             Al Tube Empty      (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9161 9131 fill 9129  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%             First Dy region - Bottom (0.02" thick)   (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9163 9132 fill  9129  -9056                    % Common Internals
cell 9164 9132 Dy         -9059  9056                    %  CHANGE FROM Dy layer
```

```
cell 9165 9132 steel          9059               % Steel outer layer
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%          Second Dy region - Bottom (0.002" + 0.015" thick) (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9168 9133 fill  9129  -9056                % Common Internals
cell 9169 9133 Dy        -9058  9056               % CHANGE FROM Dy layer
cell 9170 9133 steel          9058               % Steel outer layer
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%          Third Dy region - Bottom (0.002" thick)  (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9173 9134 fill  9129  -9056                % Common Internals
cell 9174 9134 Dy        -9057  9056               % CHANGED FROM Dy layer
cell 9175 9134 steel          9057               % Steel outer layer
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%          Space between regions (Steel)  (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9178 9135 fill  9129     -90               % Common Internals

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%          Build Experiment Leg  (Level 2 & 1)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% XS generattion -- axial partition
cell 9101 9101 Al_steel       -90
cell 9102 9102 fill  9130     -90
cell 9103 9103 fill  9131     -90
cell 9104 9104 fill  9131     -90
cell 9105 9105 fill  9132     -90
cell 9106 9106 fill  9132     -90
cell 9107 9107 fill  9132     -90
cell 9108 9108 fill  9132     -90
cell 9109 9109 fill  9132     -90
cell 9110 9110 fill  9133     -90
cell 9111 9111 fill  9134     -90
cell 9112 9112 fill  9135     -90
cell 9113 9113 fill  9134     -90
cell 9114 9114 fill  9133     -90
cell 9115 9115 fill  9132     -90
cell 9116 9116 fill  9132     -90
```

```
cell 9117 9117 fill  9132      -90
cell 9118 9118 fill  9132      -90
cell 9119 9119 fill  9130      -90
cell 9120 9120 fill  9130      -90
cell 9121 9121 fill  9130      -90
cell 9122 9122 Al_air          -90

cell 9125 9100 fill 9101            -11          % Steel Grid Plate + Aluminum bottom fitting
cell 9126 9100 fill 9102         11  -9070         % Common Internals (Begin Al + shells)
cell 9127 9100 fill 9103       9070  -12           % ref1  + Normal Pipe
cell 9128 9100 fill 9104         12  -9071         % Start Dy  + Test_begin
cell 9129 9100 fill 9105       9071  -13           % ref2 + Dy (0.2" thick) + Test
cell 9130 9100 fill 9106         13  -14          % ref3 + Dy (0.2")       + Test
cell 9131 9100 fill 9107         14  -17          % Al   + Dy (0.2")       + Test
cell 9132 9100 fill 9108         17  -18          % Fuel1+ Dy (0.2")       + Test
cell 9133 9100 fill 9109         18  -9072         % Fuel2+ Start Dy (0.017")+ Test
cell 9134 9100 fill 9110       9072  -9073          % Fuel2 + End Dy(0.017")  + Test
cell 9135 9100 fill 9111       9073  -9074          % Fuel2 + End Dy(0.002")  + Test
cell 9136 9100 fill 9112       9074  -9075          % Fuel2 + Steel Zone      + Test
cell 9137 9100 fill 9113       9075  -9076          % Fuel2 + Dy(0.002")      + Test
cell 9138 9100 fill 9114       9076  -9077          % Fuel2 + Dy(0.017")      + Test
cell 9139 9100 fill 9115       9077  -19           % Fuel2_end + Dy(0.02")   + Test
cell 9140 9100 fill 9116         19  -20          % Fuel3_+end+ Dy(0.02")   + Test
cell 9141 9100 fill 9117         20  -23          % Al       + Dy(0.02")   + Test
cell 9142 9100 fill 9118         23  -9078         % Ref3_start+ Dy_end      + Test_end
cell 9143 9100 fill 9119       9078  -25           % Ref3_end  + Normal Pipe
cell 9144 9100 fill 9120         25  -26          % Ref2
cell 9145 9100 fill 9121         26  -27          % Ref1
cell 9146 9100 fill 9122         27               % top fitting

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Pump Leg
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9250 9250 air        -9061                         % Inside of pump leg
cell 9251 9250 steel             9061                    % Steel cladding
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Build Pump Leg
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9201 9201 Al_steel        -90
cell 9202 9202 fill  9250      -90
cell 9203 9203 fill  9250      -90
cell 9204 9204 fill  9250      -90
```

```
cell 9205 9205 fill  9250      -90
cell 9206 9206 fill  9250      -90
cell 9207 9207 fill  9250      -90
cell 9208 9208 fill  9250      -90
cell 9209 9209 fill  9250      -90
cell 9210 9210 fill  9250      -90
cell 9211 9211 fill  9250      -90
cell 9212 9212 fill  9250      -90
cell 9213 9213 fill  9250      -90
cell 9214 9214 fill  9250      -90
cell 9215 9215 fill  9250      -90
cell 9216 9216 fill  9250      -90
cell 9217 9217 fill  9250      -90
cell 9218 9218 fill  9250      -90
cell 9219 9219 fill  9250      -90
cell 9220 9220 fill  9250      -90
cell 9221 9221 fill  9250      -90
cell 9222 9222 Al_air          -90

cell 9225 9200 fill 9201            -11    % Steel Grid Plate + Aluminum bottom fitting
cell 9226 9200 fill 9202         11  -9070  % Common Internals (Begin Al + shells)
cell 9227 9200 fill 9203       9070  -12    % ref1  + Normal Pipe
cell 9228 9200 fill 9204         12  -9071  % Start Dy  + Test_begin
cell 9229 9200 fill 9205       9071  -13    % ref2 + Dy (0.2" thick) + Test
cell 9230 9200 fill 9206         13  -14    % ref3 + Dy (0.2")       + Test
cell 9231 9200 fill 9207         14  -17    % Al   + Dy (0.2")       + Test
cell 9232 9200 fill 9208         17  -18    % Fuel1+ Dy (0.2")       + Test
cell 9233 9200 fill 9209         18  -9072  % Fuel1+ Start Dy (0.017")+ Test
cell 9234 9200 fill 9210       9072  -9073  % Fuel1 + End Dy(0.017")  + Test
cell 9235 9200 fill 9211       9073  -9074  % Fuel1 + End Dy(0.002")  + Test
cell 9236 9200 fill 9212       9074  -9075  % Fuel1 + Steel Zone      + Test
cell 9237 9200 fill 9213       9075  -9076  % Fuel1 + Dy(0.002")      + Test
cell 9238 9200 fill 9214       9076  -9077  % Fuel1 + Dy(0.017")      + Test
cell 9239 9200 fill 9215       9077  -19    % Fuel1_end + Dy(0.02")   + Test
cell 9240 9200 fill 9216         19  -20    % Fuel2_+end+ Dy(0.02")   + Test
cell 9241 9200 fill 9217         20  -23    % Al       + Dy(0.02")   + Test
cell 9242 9200 fill 9218         23  -9078  % Ref3_start+ Dy_end      + Test_end
cell 9243 9200 fill 9219       9078  -25    % Ref3_end  + Normal Pipe
cell 9244 9200 fill 9220         25  -26    % Ref2
cell 9245 9200 fill 9221         26  -27    % Ref1
cell 9246 9200 fill 9222         27         % top fitting

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Air Between pump and experiment legs and vehicle clad
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% cell 9350 9350 fuel2  -90   % replace air with fuel

cell 9301 9301 Al_steel       -90
cell 9302 9302 air            -90
cell 9303 9303 air            -90
cell 9304 9304 air            -90
cell 9305 9305 air            -90
cell 9306 9306 air            -90
cell 9307 9307 air            -90
cell 9308 9308 air            -90
cell 9309 9309 air            -90
cell 9310 9310 air            -90
cell 9311 9311 air            -90
cell 9312 9312 air            -90
cell 9313 9313 air            -90
cell 9314 9314 air            -90
cell 9315 9315 air            -90
cell 9316 9316 air            -90
cell 9317 9317 air            -90
cell 9318 9318 air            -90
cell 9319 9319 air            -90
cell 9320 9320 air            -90
cell 9321 9321 air            -90
cell 9322 9322 Al_air         -90

cell 9325 9300 fill 9301           -11    % Steel Grid Plate + Aluminum bottom fitting
cell 9326 9300 fill 9302        11  -9070  % Common Internals (Begin Al + shells)
cell 9327 9300 fill 9303      9070  -12    % ref1  + Normal Pipe
cell 9328 9300 fill 9304        12  -9071  % Start Dy  + Test_begin
cell 9329 9300 fill 9305      9071  -13    % ref2 + Dy (0.2" thick) + Test
cell 9330 9300 fill 9306        13  -14    % ref3 + Dy (0.2")       + Test
cell 9331 9300 fill 9307        14  -17    % Al   + Dy (0.2")       + Test
cell 9332 9300 fill 9308        17  -18    % Fuel1+ Dy (0.2")       + Test
cell 9333 9300 fill 9309        18  -9072  % Fuel1+ Start Dy (0.017")+ Test
cell 9334 9300 fill 9310      9072  -9073  % Fuel1 + End Dy(0.017")  + Test
cell 9335 9300 fill 9311      9073  -9074  % Fuel1 + End Dy(0.002")  + Test
cell 9336 9300 fill 9312      9074  -9075  % Fuel1 + Steel Zone      + Test
cell 9337 9300 fill 9313      9075  -9076  % Fuel1 + Dy(0.002")      + Test
cell 9338 9300 fill 9314      9076  -9077  % Fuel1 + Dy(0.017")      + Test
cell 9339 9300 fill 9315      9077  -19    % Fuel1_end + Dy(0.02")   + Test
cell 9340 9300 fill 9316        19  -20    % Fuel2_+end+ Dy(0.02")   + Test
cell 9341 9300 fill 9317        20  -23    % Al       + Dy(0.02")   + Test
cell 9342 9300 fill 9318        23  -9078  % Ref3_start+ Dy_end      + Test_end
cell 9343 9300 fill 9319      9078  -25    % Ref3_end  + Normal Pipe
```

```
cell 9344 9300 fill 9320          25  -26    % Ref2
cell 9345 9300 fill 9321          26  -27    % Ref1
cell 9346 9300 fill 9322          27         % top fitting


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  Steel Frame on Cal Vehicle
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9451 9450 steel        -9080           % Steel Walls
cell 9452 9450 air_out            9080       % Air outside of walls

cell 9401 9401 Al_steel        -90
cell 9402 9402 fill  9450      -90
cell 9403 9403 fill  9450      -90
cell 9404 9404 fill  9450      -90
cell 9405 9405 fill  9450      -90
cell 9406 9406 fill  9450      -90
cell 9407 9407 fill  9450      -90
cell 9408 9408 fill  9450      -90
cell 9409 9409 fill  9450      -90
cell 9410 9410 fill  9450      -90
cell 9411 9411 fill  9450      -90
cell 9412 9412 fill  9450      -90
cell 9413 9413 fill  9450      -90
cell 9414 9414 fill  9450      -90
cell 9415 9415 fill  9450      -90
cell 9416 9416 fill  9450      -90
cell 9417 9417 fill  9450      -90
cell 9418 9418 fill  9450      -90
cell 9419 9419 fill  9450      -90
cell 9420 9420 fill  9450      -90
cell 9421 9421 fill  9450      -90
cell 9422 9422 Al_air          -90

cell 9425 9400 fill 9401              -11    % Steel Grid Plate + Aluminum bottom fitting
cell 9426 9400 fill 9402           11  -9070  % Common Internals (Begin Al + shells)
cell 9427 9400 fill 9403        9070  -12    % ref1  + Normal Pipe
cell 9428 9400 fill 9404          12  -9071  % Start Dy  + Test_begin
cell 9429 9400 fill 9405        9071  -13    % ref2 + Dy (0.2" thick) + Test
cell 9430 9400 fill 9406          13  -14    % ref3 + Dy (0.2")       + Test
cell 9431 9400 fill 9407          14  -17    % Al   + Dy (0.2")       + Test
cell 9432 9400 fill 9408          17  -18    % Fuel1+ Dy (0.2")       + Test
cell 9433 9400 fill 9409          18  -9072  % Fuel1+ Start Dy (0.017")+ Test
cell 9434 9400 fill 9410        9072  -9073  % Fuel1 + End Dy(0.017")  + Test
```

```
cell 9435 9400 fill 9411        9073  -9074  % Fuel1 + End Dy(0.002")  + Test
cell 9436 9400 fill 9412        9074  -9075  % Fuel1 + Steel Zone      + Test
cell 9437 9400 fill 9413        9075  -9076  % Fuel1 + Dy(0.002")      + Test
cell 9438 9400 fill 9414        9076  -9077  % Fuel1 + Dy(0.017")      + Test
cell 9439 9400 fill 9415        9077  -19    % Fuel1_end + Dy(0.02")   + Test
cell 9440 9400 fill 9416          19  -20    % Fuel2_+end+ Dy(0.02")   + Test
cell 9441 9400 fill 9417          20  -23    % Al        + Dy(0.02")   + Test
cell 9442 9400 fill 9418          23  -9078  % Ref3_start+ Dy_end      + Test_end
cell 9443 9400 fill 9419        9078  -25    % Ref3_end  + Normal Pipe
cell 9444 9400 fill 9420          25  -26    % Ref2
cell 9445 9400 fill 9421          26  -27    % Ref1
cell 9446 9400 fill 9422          27         % top fitting

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build Entire Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9070 9000 fill 9100   -9079 -9060                 % Exp  leg
cell 9071 9000 fill 9200   -9079 -9062                 % pump leg
cell 9072 9000 fill 9300   -9079  9060  9062      % air inside vehicle
cell 9073 9000 fill 9400          9079            % veh wall


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Run Parameters
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%set micro eg1
%ene eg1 1 1.00000E-11 2.00100E-08 4.73020E-08 7.64970E-08 2.09610E-07 6.25000E-07
8.100030E-06
%                     1.32700E-04 3.48110E-03 1.15620E-01 3.32870E+00  2.00000E+01
%
%set gcu    9101  9201  9301  9401
%                     9102  9202  9302  9402
%                     9103  9203  9303  9403
%                     9104  9204  9304  9404
%                     9105  9205  9305  9405
%                     9106  9206  9306  9406
%                     9107  9207  9307  9407
%                     9108  9208  9308  9408
%                     9109  9209  9309  9409
%                     9110  9210  9310  9410
%                     9111  9211  9311  9411
%                     9112  9212  9312  9412
```

```
%                     9113  9213  9313  9413
%                     9114  9214  9314  9414
%                     9115  9215  9315  9415
%                     9116  9216  9316  9416
%                     9117  9217  9317  9417
%                     9118  9218  9318  9418
%                     9119  9219  9319  9419
%                     9120  9220  9320  9420
%                     9121  9221  9321  9421
%                     9122  9222  9322  9422
%
%set blockdt Dy
%
%set nfg 11 2.00100E-08 4.73020E-08 7.64970E-08 2.09610E-07 6.25000E-07 8.100030E-06
1.32700E-04 3.48110E-03 1.15620E-01 3.32870E+00
%
%det Flux du 0 de eg1  dx -0.7112 0.7112 1  dy -5.7912 -4.3688 1  dz 62.826700 183.7942500
40  % ~every 3 cm

%% Power in fuel zone
%det  1 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  62.8267500  82.8267500  2 dr -8
void  % fuel region 1
%det  2 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  82.8267500  92.83058    1 dr -8
void  % fuel region 2
%det  3 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  92.83058    106.1655    1 dr -8
void  % fuel region 2
%det  4 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  106.1655    114.4205    1 dr -8
void  % fuel region 2
%det  5 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  114.4205    133.4705    2 dr -8
void  % fuel region 2
%det  6 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  133.4705    140.4555    1 dr -8
void  % fuel region 2
%det  7 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  140.4555    153.7905    1 dr -8
void  % fuel region 2
%det  8 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  153.7905    163.79425   1 dr -8
void  % fuel region 2
%det  9 du 0 dm fuel dx -5.08 5.08 1 dy -10.16  10.16 1 dz  163.79425   183.79425   2 dr -8
void  % fuel region 1
%
%% Power in experiment zone
%det  11 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  62.8267500
82.8267500  2 dr -8 void  % fuel region 1
%det  12 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  82.8267500
92.83058    1 dr -8 void  % fuel region 2
%det  13 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  92.83058
106.1655    1 dr -8 void  % fuel region 2
```

```
%det  14 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  106.1655
114.4205    1 dr -8 void  % fuel region 2
%det  15 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  114.4205
133.4705    2 dr -8 void  % fuel region 2
%det  16 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  133.4705
140.4555    1 dr -8 void  % fuel region 2
%det  17 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  140.4555
153.7905    1 dr -8 void  % fuel region 2
%det  18 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  153.7905
163.79425   1 dr -8 void  % fuel region 2
%det  19 du 0 dm air_fuel1 dx  -1.4225 1.4225  1   dy -6.5025 -3.6577 1 dz  163.79425
183.79425   2 dr -8 void  % fuel region 1

%plot 3 500 500    82.83    -1.4225 1.4225   -6.5025 -3.6577
%plot 1 2500 6000   0        -10.16  10.16    0   250
%plot 3 500 1000    82.83    -5.08 5.08  -10.16 10.16

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%    Debug Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%
%%
%cell 1 0 fill 9000 -9099  % surf 5900 4"x4" and surf 9099 for 4"x8"
%cell 2 0 outside 9099  % Outside of cladding
%
%% Surfaces
%include "surfaces_new.inp"
%
%% Materials
%include "mat_Ben.inp"
%
%% --- Cross section library file path:
%%set acelib "/Users/ortej/CODES/SERPENT/xsdata/ser_xsdir_endfb7.r1"
%%set acelib "/home/ortej/SERPENT/data/ENDFB-VII.r1/ser_xsdir_endfb7.r1"
%set acelib "/Users/bakeba/Desktop/Serpent2/SerpentData/ser_xsdir_desktop"
%
%% --- Reflective boundary condition (1-black, 2-reflective , 3-periodic):
%set bc 2 2 1
%
%% estimators use  (0/1   0 - collision 1- track-length)
%% if 1 dt is switched off
%set tle 0
%
%% --- Neutron population and criticality cycles:
```

```
%set pop 1000000 800 50
%set nbuf 7
%
%
%
%
%%%%%%%% --- Geometry and mesh plots:
%plot 3 1000 1000    2.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000    7.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   42.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   50.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   57.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   59.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   59.48     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   62.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   72.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   82.0      -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   184.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   187.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   187.18    -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   188.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   196.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   208.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   243.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   247.0     -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   248.0     -10.16  10.16   -10.16  10.16       % xy-plot
%
%plot 1  1000  2000    0.0    -10.16  10.16   -10.0    250.65      % xz-plot
```

M8Center-Transient-Prescription.sss

```
% TREAT M8-Calibration Vehicle

% Ben Baker
% Idaho National Laboratory
% Feb 2, 2016
% 4"x8" M8-Cal vehicle

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%      M8 VEHICLE
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Core CenterLine = 123.3105 cm

% Test Sample (Flux Wire 60" about core center line)
% U-Zr Sample 0.040" = 0.1016cm in diameter. R = 0.0508 cm
% surf 9049 cyl  0.0 5.08 0.0508  %62.82675 183.79425  %47.1105    % Radius of flux-wire
```

% Experiment Leg (Guess Center at x-y (0,-5.08))
surf 9050 cyl 0.0 5.08 1.4224 % Stainless Steel Outer Tube I.D. (1.12" = 2.8448cm, R = 1.4224cm)
surf 9051 cyl 0.0 5.08 1.5875 % SS Outer Tube O.D. (1.25" = 3.125 cm, R = 1.5875cm)
surf 9052 cyl 0.0 5.08 1.63703 % SS Cal. Loop Test Section I.D. (1.289" = 3.27406cm, R =1.63703cm)
surf 9053 cyl 0.0 5.08 2.56921 % SS Cal. Loop Test Section O.D. (2.023" = 5.13842cm, R =2.56921 cm)
surf 9054 cyl 0.0 5.08 2.5781 % Al Sleeve I.D. (2.03" = 5.1562 cm, R = 2.5781 cm)
surf 9055 cyl 0.0 5.08 2.7051 % Al Sleeve O.D. (2.13" = 5.4102 cm, R = 2.7051 cm) also SS Sleeve I.D. (2.13"): Al-Part1,2,3 Length (14-3/4",15",10")
surf 9056 cyl 0.0 5.08 2.86258 % SS Sleeve O.D. (2.254" = 5.72516 cm, R = 2.86258 cm) SS-Part1,2 Length (14-3/4", 15")
surf 9057 cyl 0.0 5.08 2.86766 % SS & Dy collar: Part 6 (SS) O.D. (I.D. 2.254" OD = 2.258" = 5.73532 cm, R = 2.86766 cm) Length = 3.5" Lower 4" Upper, Same OD for initial Dy 0.002" thick
surf 9058 cyl 0.0 5.08 2.90576 % SS & Dy Coller: O.D (I.D. 2.258" OD = 2.288" = 5.81152 cm, R =2.90576 cm) SS Lengths = 6-3/4" (Both sides)
surf 9059 cyl 0.0 5.08 2.91338 % SS & Dy Coller: (I.D. 2.288" OD = 2.294" = 5.82676 cm, R = 2.91338 cm) SS Lengths = 12" (Both Sides- Part 4)
surf 9060 cyl 0.0 5.08 3.03022 % SS Dummy Heaters (I.D. 2.294" OD = 2.386" = 6.06044 cm, R = 3.03022 cm)

% Pump Leg (Guess Center at x-y (0,1.75" = 4.445cm))
surf 9061 cyl 0.0 -4.445 1.063625 % Clamp says 1.464" OD and Pump Leg Flow meter Magnet 1.4375" OD. Assume 0.3" thick. Thus, R = 1.063625 cm
surf 9062 cyl 0.0 -4.445 1.82563 % R = 1.82563 cm or OD 1.4375 use flow magnet"

% Axial regions for Experimental Leg
surf 9070 pz 21.7105 % Start of SS + Al support for Dy
surf 9071 pz 47.1105 % Lower End (Start of Dy full thickness)
surf 9072 pz 92.8305 % Lower End (Start of Dy 0.015 + 0.002" thick zone)
surf 9073 pz 106.1655 % Lower End (Start of Dy 0.002" thick)
surf 9074 pz 114.4205 % Lower End (End of Dy 0.002" thick)
surf 9075 pz 133.4705 % Upper End (Start of Dy 0.002" thick)
surf 9076 pz 140.4555 % Upper End (Start of Dy 0.015 + 0.002" thick)
surf 9077 pz 153.7905 % Upper End (Start of Dy 0.02" thick)
surf 9078 pz 198.2405 % Upper End (End of Dy and everything else up to Al)

% Calibration Vehicle Container
surf 9079 cuboid -4.7117 4.7117 -9.7917 9.7917 0.3175 255.289250 %258.148965 % Assume 1/8" thick steel (0.3175cm)
surf 9080 cuboid -5.02920 5.02920 -10.1092 10.1092 0.0 255.289250 %258.148965 % Outside of can

```
surf 9081 cuboid -5.08 5.08  -10.16  10.16  0.0 258.148965    % Cuboid must match definition
for 19x19 lat cuboid or greater


%%%%%%%%%%%
% Test Leg (Mainly in Order)
%
%
%           xxxxxxxxxxxx  Al_air
%              x   x     Common Internals
%              x   x     "
%              x   x     Common Internals
%             xxx w xxx   End Dy and Al (0.02")
%             xxx w xxx   Dy (0.02")
%             xxx w xxx   Dy (0.02")
%             xxx w xxx   Step up to Dy (0.02")
%              xx w xx    Dy (0.017")
%              xx w xx    Dy (0.017")
%              xx w xx    Step up to Dy (0.017")
%               x w x     Dy (0.002")
%               x w x     Step up to Dy (0.002")
%              -x w x-    Steel
%               x w x     Dy (0.002")
%               x w x     Step down to Dy (0.002")
%              xx w xx    Dy (0.017")
%              xx w xx    Dy (0.017")
%              xx w xx    Step down to Dy (0.017")
%             xxx w xxx   Dy (0.02")
%             xxx w xxx   Dy (0.02")
%             xxx w xxx   Dy (0.02")
%             xxx w xxx   Start Dy (0.02") and wire
%             xxx   xxx   Al + Steel (No Dy)
%             xxx   xxx   Start Al (No Dy)
%              x   x     Common Internals
%              x   x     "
%              x   x     Common Internals
%           xxxxxxxxxxxx  Al_steel
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%            INF top and bottom
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Infinite Aluminum base
%cell 9098 9098 Al_steel    -90                 % Solid base - INF down and INF across
%cell 9099 9099 Al_air      -90                 % Solid base - INF down and INF across
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Experiment Region
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Wire  Diameter = 0.0625cm
% Wire holder titanium Diameter = 0.635 cm


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Core Axial CenterLine = 123.3105 cm (Ref for Holes)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Increase Length of DU wires from 0.5cm to 2cm for stats, centered on DU position.

% Position A Centered 18inch above Centerline
% Position B Centered 5.13inch above Centerline
% Position C Centered 0.25inch below Centerline
% Position D Centered 5.38inch below Centerline
% Position E Centered 18inch below Centerline

% Du is centered 1cm below Position Centers
% CoAl is centered 0.5cm below Position Centers
% Nb is centered at Position Centers
% Ti is centered 0.5cm above Position Centers
% Fe is centered 1cm above Position Centers

% Surface Tracking (Use 2cm for each wire)
%                    Radius     Z1       Z2
surf 9082 cyl 0.0 5.08 1.4224  169.0305  247.2625
surf 9083 cyl 0.0 5.08 1.4224  167.0305  169.0305  % Wire A
surf 9084 cyl 0.0 5.08 1.4224  136.3407  167.0305
surf 9085 cyl 0.0 5.08 1.4224  134.3407  136.3407  % Wire B
surf 9086 cyl 0.0 5.08 1.4224  122.6755  134.3407
surf 9087 cyl 0.0 5.08 1.4224  120.6755  122.6755  % Wire C
surf 9088 cyl 0.0 5.08 1.4224  109.6453  120.6755
surf 9089 cyl 0.0 5.08 1.4224  107.6453  109.6453  % Wire D
surf 9090 cyl 0.0 5.08 1.4224   77.5905  107.6453
surf 9091 cyl 0.0 5.08 1.4224   75.5905   77.5905  % Wire E
surf 9092 cyl 0.0 5.08 1.4224   3.486     75.5905

cell 9048 9112 fill 9013         27
cell 9049 9112 fill 9012       -9082
cell 9050 9112 fill 9011       -9083  % Wire A
```

```
cell 9051 9112 fill 9010       -9084
cell 9052 9112 fill 9009       -9085  % Wire B
cell 9053 9112 fill 9008       -9086
cell 9054 9112 fill 9007       -9087  % Wire C
cell 9055 9112 fill 9006       -9088
cell 9056 9112 fill 9005       -9089  % Wire D
cell 9057 9112 fill 9004       -9090
cell 9058 9112 fill 9003       -9091  % Wire E
cell 9059 9112 fill 9002       -9092
cell 9060 9112 fill 9001         -11

cell 9061 9013 Al_air           -90
cell 9062 9012 WireHolder       -90
cell 9063 9011 FissionWire      -90
cell 9064 9010 WireHolder       -90
cell 9065 9009 FissionWire      -90
cell 9066 9008 WireHolder       -90
cell 9067 9007 FissionWire      -90
cell 9068 9006 WireHolder       -90
cell 9069 9005 FissionWire      -90
cell 9070 9004 WireHolder       -90
cell 9071 9003 FissionWire      -90
cell 9072 9002 WireHolder       -90
cell 9073 9001 Al_steel         -90

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              Common Al + Steel shells (shells Al + steel all the way out) (Level 4)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9082 9115 steel      -9051   9050                    % SS Cal Test Outer Tube
cell 9083 9115 air        -9052   9051                    % Air gap
cell 9084 9115 steel      -9053   9052                    % SS Cal Loop Test Section (Extends all
the way)
cell 9085 9115 air        -9054   9053                    % Inf Air outside
cell 9087 9115 aluminum   -9055   9054                    % Al cylinder
cell 9088 9115 steel              9055                    % Steel

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              HOMOGENIZATION REGIONS outside the wire radius 1.4224
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              Bottom fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9151 9119 Al_steel     -90                    % bottom fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Inner Tube        (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9152 9120 steel      -9051   9050                  % SS Cal Test Outer Tube
cell 9153 9120 air        -9052   9051                  % Air gap
cell 9154 9120 steel      -9053   9052                  % SS Cal Loop Test Section (Extends all
the way)
cell 9155 9120 air                9053                  % Inf Air outside
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Al Tube Empty      (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9161 9121 fill 9115  -90
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               First Dy region - Bottom (0.02" thick)   (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9163 9122 fill  9115  -9056                        % Common Internals
cell 9164 9122 Dy          -9059  9056                  %  CHANGE FROM Dy layer
cell 9165 9122 steel              9059                  % Steel outer layer
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Second Dy region - Bottom (0.002" + 0.015" thick) (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9168 9123 fill  9115  -9056                        % Common Internals
cell 9169 9123 Dy          -9058  9056                  % CHANGE FROM Dy layer
cell 9170 9123 steel              9058                  % Steel outer layer
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Third Dy region - Bottom (0.002" thick)  (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9173 9124 fill  9115  -9056                        % Common Internals
cell 9174 9124 Dy          -9057  9056                  % CHANGED FROM Dy layer
cell 9175 9124 steel              9057                  % Steel outer layer
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Space between regions (Steel)  (Level 3)
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9178 9125 fill  9115     -90                          % Common Internals
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9179 9126 Al_air     -90                          % top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               PUT BOTH HOMOGENIZATION REGIONS TOGETHER
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               bottom fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9180 9129 fill 9112  -9050
cell 9181 9129 fill 9119   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Inner Tube         (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9182 9130 fill 9112  -9050
cell 9183 9130 fill 9120   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Al Tube Empty      (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9185 9131 fill 9112  -9050
cell 9186 9131 fill 9121   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               First Dy region - Bottom (0.02" thick)   (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9188 9132 fill 9112  -9050
cell 9189 9132 fill 9122   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%               Second Dy region - Bottom (0.002" + 0.015" thick) (Level 3)
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9190 9133 fill 9112  -9050
cell 9192 9133 fill 9123   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              Third Dy region - Bottom (0.002" thick)  (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9194 9134 fill 9112  -9050
cell 9195 9134 fill 9124   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              Space between regions (Steel)  (Level 3)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9198 9135 fill 9112  -9050
cell 9199 9135 fill 9125   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9210 9136 fill 9112  -9050
cell 9211 9136 fill 9126   9050
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%              Build Experiment Leg  (Level 2 & 1)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% XS generattion -- axial partition
cell 9125 9100 fill 9129          -11          % Steel Grid Plate + Aluminum bottom fitting
cell 9126 9100 fill 9130        11  -9070        % Common Internals (Begin Al + shells)
cell 9127 9100 fill 9131      9070  -9071        % Start Dy  + Test_begin
cell 9129 9100 fill 9132      9071  -9072        % Dy (0.2" thick) + Test
cell 9134 9100 fill 9133      9072  -9073        % Dy(0.017")  + Test
cell 9135 9100 fill 9134      9073  -9074        % Dy(0.002")  + Test
cell 9136 9100 fill 9135      9074  -9075        % Steel Zone     + Test
cell 9137 9100 fill 9134      9075  -9076        % Dy(0.002")     + Test
cell 9138 9100 fill 9133      9076  -9077        % Dy(0.017")     + Test
cell 9139 9100 fill 9132      9077  -9078        % Dy(0.02")   + Test
cell 9143 9100 fill 9130      9078  -27        % Normal Pipe
cell 9146 9100 fill 9136        27          % top fitting

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
% Pump leg + air + Steel Frame on Cal Vehicle
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9348 9350 air        -9061                    % Inside of pump leg
cell 9349 9350 steel      9061  -9062              % Steel cladding
cell 9350 9350 air        9062  -9079   % replace air with fuel
cell 9351 9350 steel      9079  -9080   % Steel Walls
cell 9352 9350 air_out    9080          % Air outside of walls

cell 9353 9351 Al_steel     -90                    % bottom fitting
cell 9354 9352 Al_air       -90                    % top fitting

cell 9301 9300 fill 9351        -11
cell 9303 9300 fill 9350      11 -27
cell 9304 9300 fill 9352      27
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Build Entire Assembly
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cell 9470 9500 fill 9100   -9060               % Exp  leg
cell 9472 9500 fill 9300    9060               % Pump leg & air inside & vehicle wall

% chop into 30 axial levels
cell 9501 9501 fill 9500 -90  %%  Steel Grid Plate + Aluminum bottom fitting
cell 9502 9502 fill 9500 -90  %% Added Region
cell 9503 9503 fill 9500 -90  %% Added Region
cell 9504 9504 fill 9500 -90  %%  Oct graphite XS region 1 -- bottom
cell 9505 9505 fill 9500 -90  %% Added Region
cell 9506 9506 fill 9500 -90  %%  Oct graphite XS region 2 -- bottom
cell 9507 9507 fill 9500 -90  %%  square graphite bottom + air gap + Al clad
cell 9508 9508 fill 9500 -90  %%  axial interface
cell 9509 9509 fill 9500 -90  %% Added Region
cell 9510 9510 fill 9500 -90  %%  Fuel1 bottom
cell 9511 9511 fill 9500 -90  %% Added Region
cell 9512 9512 fill 9500 -90  %% Added Region
cell 9513 9513 fill 9500 -90  %% Added Region
cell 9514 9514 fill 9500 -90  %% Added Region
cell 9515 9515 fill 9500 -90  %% Added Region
cell 9516 9516 fill 9500 -90  %% Added Region
cell 9517 9517 fill 9500 -90  %% Added Region
cell 9518 9518 fill 9500 -90  %% Added Region
cell 9519 9519 fill 9500 -90  %%  Fuel2
cell 9520 9520 fill 9500 -90  %% Added Region
cell 9521 9521 fill 9500 -90  %%  Fuel1 top
cell 9522 9522 fill 9500 -90  %%  aixal interface
```

```
cell 9523 9523 fill 9500 -90   %% Added Region
cell 9524 9524 fill 9500 -90    %% Added Region
cell 9525 9525 fill 9500 -90   %%  square graphite w hole top + Oct graphite with hole + air + Al
clad
cell 9526 9526 fill 9500 -90  %%  Oct graphite XS region 2 -- top
cell 9527 9527 fill 9500 -90   %% Added Region
cell 9528 9528 fill 9500 -90    %% Added Region
cell 9529 9529 fill 9500 -90   %%  Oct graphite XS region 1 -- top
cell 9530 9530 fill 9500 -90  %%  top fitting

% put together again
cell 9541 9000 fill 9501       -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 9542 9000 fill 9502  11   -250   %% Added Region
cell 9543 9000 fill 9503  250   -251  %% Added Region
cell 9544 9000 fill 9504  251   -12   %%  Oct graphite XS region 1 -- bottom
cell 9545 9000 fill 9505  12   -252   %% Added Region
cell 9546 9000 fill 9506  252   -13   %%  Oct graphite XS region 2 -- bottom
cell 9547 9000 fill 9507  13   -14    %%  square graphite bottom + air gap + Al clad
cell 9548 9000 fill 9508  14   -17    %%  axial interface
cell 9549 9000 fill 9509  17   -253   %% Added Region
cell 9550 9000 fill 9510  253   -18   %%  Fuel1 bottom
cell 9551 9000 fill 9511  18   -254   %% Added Region
cell 9552 9000 fill 9512  254   -255  %% Added Region
cell 9553 9000 fill 9513  255   -256  %% Added Region
cell 9554 9000 fill 9514  256   -257  %% Added Region
cell 9555 9000 fill 9515  257   -258  %% Added Region
cell 9556 9000 fill 9516  258   -259  %% Added Region
cell 9557 9000 fill 9517  259   -260  %% Added Region
cell 9558 9000 fill 9518  260   -261  %% Added Region
cell 9559 9000 fill 9519  261   -19   %%  Fuel2
cell 9560 9000 fill 9520  19   -262   %% Added Region
cell 9561 9000 fill 9521  262   -20   %%  Fuel1 top
cell 9562 9000 fill 9522  20   -23    %%  aixal interface
cell 9563 9000 fill 9523  23   -263    %% Added Region
cell 9564 9000 fill 9524  263   -264    %% Added Region
cell 9565 9000 fill 9525  264   -25    %%  square graphite w hole top + Oct graphite with hole +
air + Al clad
cell 9566 9000 fill 9526  25   -26    %%  Oct graphite XS region 2 -- top
cell 9567 9000 fill 9527  26   -265    %% Added Region
cell 9568 9000 fill 9528  265   -266    %% Added Region
cell 9569 9000 fill 9529  266   -27    %%  Oct graphite XS region 1 -- top
cell 9580 9000 fill 9530  27          %%  top fitting


%plot 3 1000 1000   2.50    -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   11.00    -10.16  10.16   -10.16  10.16       % xy-plot
```

```
%plot 3 1000 1000   30.00    -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   76.00    -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   80.00    -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   100.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   108.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   112.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   121.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   130.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   135.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   138.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   150.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   168.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   190.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   220.00   -10.16  10.16   -10.16  10.16       % xy-plot
%plot 3 1000 1000   250.00   -10.16  10.16   -10.16  10.16       % xy-plot
%
%plot 1  1000  2000    0.0    -10.16  10.16   -10.0    250.65      % xz-plot
```

CR-Type_cyl.sss

```
%%  Javier Ortensi
%%  Assume that the CRs are banked together for the three types
%%  separate cross section regions for the 3 types
%################################################################################
##
% CONTROL ROD REGIONS  (Compensation Rods)
%################################################################################
##
%   Dynamic Control Rod
cell 800 811 graphite    -50        %  Graphite       - Upper follower
cell 801 811 steel        50        %  lower carbon steel clad
cell 802 812 steel    -50        %  Steel plug     - Upper follower
cell 803 812 steel     50        %  lower carbon steel clad
cell 804 813 zr_steel    -50        %  Zr/Steel plug  - Zr follower
cell 805 813 zr          50        %  zirc-3 clad (zirc follower)
cell 806 814 graphite    -50        %  Graphite       - Zr follower
cell 807 814 zr           50        %  zirc-3 clad (zirc follower)
cell 808 815 zr_steel    -50        %  Zr/Steel plug  - Zr follower
cell 809 815 zr        50        %  zirc-3 clad (zirc follower)
cell 810 816 steel    -50        %  Steel plug     - poison section
cell 811 816 steel     50        %  upper carbon steel clad
cell 812 817 b4c_new     -50        %  B4C            - poison section
cell 813 817 steel        50        %  upper carbon steel clad
cell 814 818 steel    -50        %  steel plug | grapple adaptor
cell 815 818 steel     50        %  steel plug | grapple adaptor
cell 816 819 Air_steel    -90          %  grapple and air
cell 817 820 airCR         -90           %  air above CR
```

```
%################################################################################
##
cell 820 801 fill 811              -855 % P1/P2 Graphite
cell 821 801 fill 812        855   -856 % steel plug
cell 822 801 fill 813        856   -857 % Zr/Steel plug
cell 823 801 fill 814        857   -858 % Graphite
cell 824 801 fill 815        858   -859 % Zr/Steel plug
cell 825 801 fill 816        859   -860 % Steel plug
cell 826 801 fill 817        860   -861 % B4C
cell 827 801 fill 818        861   -862 % Top of grapple adaptor coupling
cell 828 801 fill 819        862   -863 % Top of grapple adaptor
cell 829 801 fill 820        863        % air
%################################################################################
##
% CONTROL ROD REGIONS  (Control/Shutdown Rods)
%################################################################################
##
%   Dynamic Control Rod
cell 830 831 graphite    -50        %  Graphite       - Upper follower
cell 831 831 steel        50        %  lower carbon steel clad
cell 832 832 steel    -50        %  Steel plug     - Upper follower
cell 833 832 steel     50        %  lower carbon steel clad
cell 834 833 zr_steel    -50        %  Zr/Steel plug  - Zr follower
cell 835 833 zr          50        %  zirc-3 clad (zirc follower)
cell 836 834 graphite    -50        %  Graphite       - Zr follower
cell 837 834 zr           50        %  zirc-3 clad (zirc follower)
cell 838 835 zr_steel    -50        %  Zr/Steel plug  - Zr follower
cell 839 835 zr        50        %  zirc-3 clad (zirc follower)
cell 840 836 steel    -50        %  Steel plug     - poison section
cell 841 836 steel     50        %  upper carbon steel clad
cell 842 837 b4c_new     -50        %  B4C            - poison section
cell 843 837 steel        50        %  upper carbon steel clad
cell 844 838 steel    -50        %  steel plug | grapple adaptor
cell 845 838 steel     50        %  steel plug | grapple adaptor
cell 846 839 Air_steel    -90          %  grapple and air
cell 847 840 airCR         -90          %  air above CR
%################################################################################
##
% (Control/Shutdown Rods)
cell 850 802 fill 831              -855 % P1/P2 Graphite
cell 851 802 fill 832        855   -856 % steel plug
cell 852 802 fill 833        856   -857 % Zr/Steel plug
cell 853 802 fill 834        857   -858 % Graphite
cell 854 802 fill 835        858   -859 % Zr/Steel plug
cell 855 802 fill 836        859   -860 % Steel plug
cell 856 802 fill 837        860   -861 % B4C
```

```
cell 857 802 fill 838        861   -862 % Top of grapple adaptor coupling
cell 858 802 fill 839        862   -863 % Top of grapple adaptor
cell 859 802 fill 840        863        % air
%#############################################################################
##
% CONTROL ROD REGIONS  (Transient Rod)
%#############################################################################
##
%   Dynamic Control Rod
cell 860 851 graphite   -50      %  Graphite      - Upper follower
cell 861 851 steel      50       %  lower carbon steel clad
cell 862 852 steel      -50      %  Steel plug    - Upper follower
cell 863 852 steel      50       %  lower carbon steel clad
cell 864 853 zr_steel   -50      %  Zr/Steel plug  - Zr follower
cell 865 853 zr         50       %  zirc-3 clad (zirc follower)
cell 866 854 graphite   -50      %  Graphite      - Zr follower
cell 867 854 zr         50       %  zirc-3 clad (zirc follower)
cell 868 855 zr_steel   -50      %  Zr/Steel plug  - Zr follower
cell 869 855 zr         50       %  zirc-3 clad (zirc follower)
cell 870 856 steel      -50      %  Steel plug    - poison section
cell 871 856 steel      50       %  upper carbon steel clad
cell 872 857 b4c_new    -50      %  B4C           - poison section
cell 873 857 steel      50       %  upper carbon steel clad
cell 874 858 steel      -50      %  steel plug | grapple adaptor
cell 875 858 steel      50       %  steel plug | grapple adaptor
cell 876 859 Air_steel  -90      %  grapple and air
cell 877 860 airCR      -90      %  air above CR
%#############################################################################
##
cell 880 803 fill 851              -875 % P1/P2 Graphite
cell 881 803 fill 852        875   -876 % steel plug
cell 882 803 fill 853        876   -877 % Zr/Steel plug
cell 883 803 fill 854        877   -878 % Graphite
cell 884 803 fill 855        878   -879 % Zr/Steel plug
cell 885 803 fill 856        879   -880 % Steel plug
cell 886 803 fill 857        880   -881 % B4C
cell 887 803 fill 858        881   -882 % Top of grapple adaptor coupling
cell 888 803 fill 859        882   -883 % Top of grapple adaptor
cell 889 803 fill 860        883        % air
```

Extra_Surfaces.sss

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%  Added Plains for extra cuts
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

surf 250  pz  12.486    %% Extra Axial Cut
```

```
surf 251  pz  21.486    %% Extra Axial Cut
surf 252  pz  41.830375   %% Extra Axial Cut
surf 253  pz  72.82675    %% Extra Axial Cut
surf 254  pz  87.21075    %% Extra Axial Cut
surf 255  pz  97.21075    %% Extra Axial Cut
surf 256  pz  107.21075   %% Extra Axial Cut
surf 257  pz  117.21075   %% Extra Axial Cut
surf 258  pz  127.21075   %% Extra Axial Cut
surf 259  pz  137.21075   %% Extra Axial Cut
surf 260  pz  147.21075   %% Extra Axial Cut
surf 261  pz  156.46075   %% Extra Axial Cut
surf 262  pz  172.21075   %% Extra Axial Cut
surf 263  pz  188.81075   %% Extra Axial Cut
surf 264  pz  195.589375    %% Extra Axial Cut
surf 265  pz  229.2625    %% Extra Axial Cut
surf 266  pz  238.2625    %% Extra Axial Cut
```

A-s.sss

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A1
% Description of Placement:

% Copy Universes
cell 11101     11101  fill 11001        -90  %% Axial Position to end at = 3.486
cell 11102     11102  fill 11002        -90  %% Axial Position to end at = 30.486
cell 11103     11103  fill 11003        -90  %% Axial Position to end at = 53.17475
cell 11104     11104  fill 11004        -90  %% Axial Position to end at = 62.06475
cell 11105     11105  fill 11005        -90  %% Axial Position to end at = 62.82675
cell 11106     11106  fill 11006        -90  %% Axial Position to end at = 82.82675
cell 11107     11107  fill 11006        -90  %% Added Lines for axial position 106.1655
cell 11108     11108  fill 11006        -90  %% Added Lines for axial position 109.11825
cell 11109     11109  fill 11006        -90  %% Added Lines for axial position 114.4205
cell 11110     11110  fill 11007        -90  %% Axial Position to end at = 163.79425
cell 11111     11111  fill 11008        -90  %% Axial Position to end at = 183.79425
cell 11112     11112  fill 11009        -90  %% Axial Position to end at = 184.55625
cell 11113     11113  fill 11010        -90  %% Axial Position to end at = 206.6225
cell 11114     11114  fill 11011        -90  %% Axial Position to end at = 220.2625
cell 11115     11115  fill 11012        -90  %% Axial Position to end at = 247.2625
cell 11116     11116  fill 11013        -90  %% All the way to the top

%% BUILD A1
cell 11117     11100 fill 11101              -11   %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11118     11100 fill 11102       11  -12   %%  Oct graphite XS region 1 -- bottom
cell 11119     11100 fill 11103       12  -13   %%  Oct graphite XS region 2 -- bottom
cell 11120     11100 fill 11104       13  -14   %%  square graphite bottom + air gap + Al clad
```

```
cell 11121        11100 fill 11105        14   -17    %%  axial interface
cell 11122        11100 fill 11106        17   -18    %%  Fuel1 bottom
cell 11123        11100 fill 11107        18   -250    %% Added Region
cell 11124        11100 fill 11108        250   -251    %% Added Region
cell 11125        11100 fill 11109        251   -252    %% Added Region
cell 11126        11100 fill 11110        252   -19    %%  Fuel2
cell 11127        11100 fill 11111        19   -20    %%  Fuel1 top
cell 11128        11100 fill 11112        20   -23    %%  aixal interface
cell 11129        11100 fill 11113        23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11130        11100 fill 11114        25   -26    %%  Oct graphite XS region 2 -- top
cell 11131        11100 fill 11115        26   -27    %%  Oct graphite XS region 1 -- top
cell 11132        11100 fill 11116        27         %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A2
% Description of Placement:

% Copy Universes
cell 11201        11201   fill 11001              -90   %% Axial Position to end at = 3.486
cell 11202        11202   fill 11002              -90   %% Axial Position to end at = 30.486
cell 11203        11203   fill 11003              -90   %% Axial Position to end at = 53.17475
cell 11204        11204   fill 11004              -90   %% Axial Position to end at = 62.06475
cell 11205        11205   fill 11005              -90   %% Axial Position to end at = 62.82675
cell 11206        11206   fill 11006              -90   %% Axial Position to end at = 82.82675
cell 11207        11207   fill 11006              -90   %% Added Lines for axial position 106.1655
cell 11208        11208   fill 11006              -90   %% Added Lines for axial position 109.11825
cell 11209        11209   fill 11006              -90   %% Added Lines for axial position 114.4205
cell 11210        11210   fill 11007              -90   %% Axial Position to end at = 163.79425
cell 11211        11211   fill 11008              -90   %% Axial Position to end at = 183.79425
cell 11212        11212   fill 11009              -90   %% Axial Position to end at = 184.55625
cell 11213        11213   fill 11010              -90   %% Axial Position to end at = 206.6225
cell 11214        11214   fill 11011              -90   %% Axial Position to end at = 220.2625
cell 11215        11215   fill 11012              -90   %% Axial Position to end at = 247.2625
cell 11216        11216   fill 11013              -90   %% All the way to the top

%% BUILD A2
cell 11217        11200 fill 11201                 -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11218        11200 fill 11202        11   -12    %%  Oct graphite XS region 1 -- bottom
cell 11219        11200 fill 11203        12   -13    %%  Oct graphite XS region 2 -- bottom
cell 11220        11200 fill 11204        13   -14    %%  square graphite bottom + air gap + Al clad
cell 11221        11200 fill 11205        14   -17    %%  axial interface
cell 11222        11200 fill 11206        17   -18    %%  Fuel1 bottom
cell 11223        11200 fill 11207        18   -250    %% Added Region
cell 11224        11200 fill 11208        250   -251    %% Added Region
cell 11225        11200 fill 11209        251   -252    %% Added Region
```

```
cell 11226        11200fill 11210        252   -19    %%  Fuel2
cell 11227        11200fill 11211        19   -20    %%  Fuel1 top
cell 11228        11200fill 11212        20   -23    %%  aixal interface
cell 11229        11200fill 11213        23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11230        11200fill 11214        25   -26    %%  Oct graphite XS region 2 -- top
cell 11231        11200fill 11215        26   -27    %%  Oct graphite XS region 1 -- top
cell 11232        11200fill 11216        27          %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A3
% Description of Placement:

% Copy Universes
cell 11301        11301  fill 11001            -90   %% Axial Position to end at = 3.486
cell 11302        11302  fill 11002            -90   %% Axial Position to end at = 30.486
cell 11303        11303  fill 11003            -90   %% Axial Position to end at = 53.17475
cell 11304        11304  fill 11004            -90   %% Axial Position to end at = 62.06475
cell 11305        11305  fill 11005            -90   %% Axial Position to end at = 62.82675
cell 11306        11306  fill 11006            -90   %% Axial Position to end at = 82.82675
cell 11307        11307  fill 11006            -90   %% Added Lines for axial position 106.1655
cell 11308        11308  fill 11006            -90   %% Added Lines for axial position 109.11825
cell 11309        11309  fill 11006            -90   %% Added Lines for axial position 114.4205
cell 11310        11310  fill 11007            -90   %% Axial Position to end at = 163.79425
cell 11311        11311  fill 11008            -90   %% Axial Position to end at = 183.79425
cell 11312        11312  fill 11009            -90   %% Axial Position to end at = 184.55625
cell 11313        11313  fill 11010            -90   %% Axial Position to end at = 206.6225
cell 11314        11314  fill 11011            -90   %% Axial Position to end at = 220.2625
cell 11315        11315  fill 11012            -90   %% Axial Position to end at = 247.2625
cell 11316        11316  fill 11013            -90   %% All the way to the top

%% BUILD A3
cell 11317        11300fill 11301                 -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11318        11300fill 11302        11   -12    %%  Oct graphite XS region 1 -- bottom
cell 11319        11300fill 11303        12   -13    %%  Oct graphite XS region 2 -- bottom
cell 11320        11300fill 11304        13   -14    %%  square graphite bottom + air gap + Al clad
cell 11321        11300fill 11305        14   -17    %%  axial interface
cell 11322        11300fill 11306        17   -18    %%  Fuel1 bottom
cell 11323        11300fill 11307        18   -250    %% Added Region
cell 11324        11300fill 11308        250   -251    %% Added Region
cell 11325        11300fill 11309        251   -252    %% Added Region
cell 11326        11300fill 11310        252   -19    %%  Fuel2
cell 11327        11300fill 11311        19   -20    %%  Fuel1 top
cell 11328        11300fill 11312        20   -23    %%  aixal interface
cell 11329        11300fill 11313        23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
```

```
cell 11330        11300fill 11314        25   -26    %%  Oct graphite XS region 2 -- top
cell 11331        11300fill 11315        26   -27    %%  Oct graphite XS region 1 -- top
cell 11332        11300fill 11316        27          %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A4
% Description of Placement:

% Copy Universes
cell 11401        11401  fill 11001               -90   %% Axial Position to end at = 3.486
cell 11402        11402  fill 11002               -90   %% Axial Position to end at = 30.486
cell 11403        11403  fill 11003               -90   %% Axial Position to end at = 53.17475
cell 11404        11404  fill 11004               -90   %% Axial Position to end at = 62.06475
cell 11405        11405  fill 11005               -90   %% Axial Position to end at = 62.82675
cell 11406        11406  fill 11006               -90   %% Axial Position to end at = 82.82675
cell 11407        11407  fill 11006               -90   %% Added Lines for axial position 106.1655
cell 11408        11408  fill 11006               -90   %% Added Lines for axial position 109.11825
cell 11409        11409  fill 11006               -90   %% Added Lines for axial position 114.4205
cell 11410        11410  fill 11007               -90   %% Axial Position to end at = 163.79425
cell 11411        11411  fill 11008               -90   %% Axial Position to end at = 183.79425
cell 11412        11412  fill 11009               -90   %% Axial Position to end at = 184.55625
cell 11413        11413  fill 11010               -90   %% Axial Position to end at = 206.6225
cell 11414        11414  fill 11011               -90   %% Axial Position to end at = 220.2625
cell 11415        11415  fill 11012               -90   %% Axial Position to end at = 247.2625
cell 11416        11416  fill 11013               -90   %% All the way to the top

%% BUILD A4
cell 11417        11400fill 11401                   -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11418        11400fill 11402        11   -12    %%  Oct graphite XS region 1 -- bottom
cell 11419        11400fill 11403        12   -13    %%  Oct graphite XS region 2 -- bottom
cell 11420        11400fill 11404        13   -14    %%  square graphite bottom + air gap + Al clad
cell 11421        11400fill 11405        14   -17    %%  axial interface
cell 11422        11400fill 11406        17   -18    %%  Fuel1 bottom
cell 11423        11400fill 11407        18   -250    %% Added Region
cell 11424        11400fill 11408        250   -251    %% Added Region
cell 11425        11400fill 11409        251   -252    %% Added Region
cell 11426        11400fill 11410        252   -19    %%  Fuel2
cell 11427        11400fill 11411        19   -20    %%  Fuel1 top
cell 11428        11400fill 11412        20   -23    %%  aixal interface
cell 11429        11400fill 11413        23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11430        11400fill 11414        25   -26    %%  Oct graphite XS region 2 -- top
cell 11431        11400fill 11415        26   -27    %%  Oct graphite XS region 1 -- top
cell 11432        11400fill 11416        27          %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A5
```

```
% Description of Placement:

% Copy Universes
cell 11501      11501  fill 11001           -90   %% Axial Position to end at = 3.486
cell 11502      11502  fill 11002           -90   %% Axial Position to end at = 30.486
cell 11503      11503  fill 11003           -90   %% Axial Position to end at = 53.17475
cell 11504      11504  fill 11004           -90   %% Axial Position to end at = 62.06475
cell 11505      11505  fill 11005           -90   %% Axial Position to end at = 62.82675
cell 11506      11506  fill 11006           -90   %% Axial Position to end at = 82.82675
cell 11507      11507  fill 11006           -90   %% Added Lines for axial position 106.1655
cell 11508      11508  fill 11006           -90   %% Added Lines for axial position 109.11825
cell 11509      11509  fill 11006           -90   %% Added Lines for axial position 114.4205
cell 11510      11510  fill 11007           -90   %% Axial Position to end at = 163.79425
cell 11511      11511  fill 11008           -90   %% Axial Position to end at = 183.79425
cell 11512      11512  fill 11009           -90   %% Axial Position to end at = 184.55625
cell 11513      11513  fill 11010           -90   %% Axial Position to end at = 206.6225
cell 11514      11514  fill 11011           -90   %% Axial Position to end at = 220.2625
cell 11515      11515  fill 11012           -90   %% Axial Position to end at = 247.2625
cell 11516      11516  fill 11013           -90   %% All the way to the top

%% BUILD A5
cell 11517      11500fill 11501                 -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11518      11500fill 11502      11   -12    %%  Oct graphite XS region 1 -- bottom
cell 11519      11500fill 11503      12   -13    %%  Oct graphite XS region 2 -- bottom
cell 11520      11500fill 11504      13   -14    %%  square graphite bottom + air gap + Al clad
cell 11521      11500fill 11505      14   -17    %%  axial interface
cell 11522      11500fill 11506      17   -18    %%  Fuel1 bottom
cell 11523      11500fill 11507      18   -250    %% Added Region
cell 11524      11500fill 11508      250   -251    %% Added Region
cell 11525      11500fill 11509      251   -252    %% Added Region
cell 11526      11500fill 11510      252   -19    %%  Fuel2
cell 11527      11500fill 11511      19   -20    %%  Fuel1 top
cell 11528      11500fill 11512      20   -23    %%  aixal interface
cell 11529      11500fill 11513      23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11530      11500fill 11514      25   -26    %%  Oct graphite XS region 2 -- top
cell 11531      11500fill 11515      26   -27    %%  Oct graphite XS region 1 -- top
cell 11532      11500fill 11516      27          %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A6
% Description of Placement:

% Copy Universes
cell 11601      11601  fill 11001           -90   %% Axial Position to end at = 3.486
cell 11602      11602  fill 11002           -90   %% Axial Position to end at = 30.486
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```
cell 11603        11603  fill 11003              -90   %% Axial Position to end at = 53.17475
cell 11604        11604  fill 11004              -90   %% Axial Position to end at = 62.06475
cell 11605        11605  fill 11005              -90   %% Axial Position to end at = 62.82675
cell 11606        11606  fill 11006              -90   %% Axial Position to end at = 82.82675
cell 11607        11607  fill 11006              -90   %% Added Lines for axial position 106.1655
cell 11608        11608  fill 11006              -90   %% Added Lines for axial position 109.11825
cell 11609        11609  fill 11006              -90   %% Added Lines for axial position 114.4205
cell 11610        11610  fill 11007              -90   %% Axial Position to end at = 163.79425
cell 11611        11611  fill 11008              -90   %% Axial Position to end at = 183.79425
cell 11612        11612  fill 11009              -90   %% Axial Position to end at = 184.55625
cell 11613        11613  fill 11010              -90   %% Axial Position to end at = 206.6225
cell 11614        11614  fill 11011              -90   %% Axial Position to end at = 220.2625
cell 11615        11615  fill 11012              -90   %% Axial Position to end at = 247.2625
cell 11616        11616  fill 11013              -90   %% All the way to the top

%% BUILD A6
cell 11617        11600fill 11601                 -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11618        11600fill 11602        11   -12    %%  Oct graphite XS region 1 -- bottom
cell 11619        11600fill 11603        12   -13    %%  Oct graphite XS region 2 -- bottom
cell 11620        11600fill 11604        13   -14    %%  square graphite bottom + air gap + Al clad
cell 11621        11600fill 11605        14   -17    %%  axial interface
cell 11622        11600fill 11606        17   -18    %%  Fuel1 bottom
cell 11623        11600fill 11607        18   -250    %% Added Region
cell 11624        11600fill 11608        250   -251    %% Added Region
cell 11625        11600fill 11609        251   -252    %% Added Region
cell 11626        11600fill 11610        252   -19    %%  Fuel2
cell 11627        11600fill 11611        19   -20    %%  Fuel1 top
cell 11628        11600fill 11612        20   -23    %%  aixal interface
cell 11629        11600fill 11613        23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11630        11600fill 11614        25   -26    %%  Oct graphite XS region 2 -- top
cell 11631        11600fill 11615        26   -27    %%  Oct graphite XS region 1 -- top
cell 11632        11600fill 11616        27         %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A7
% Description of Placement:

% Copy Universes
cell 11701        11701  fill 11001              -90   %% Axial Position to end at = 3.486
cell 11702        11702  fill 11002              -90   %% Axial Position to end at = 30.486
cell 11703        11703  fill 11003              -90   %% Axial Position to end at = 53.17475
cell 11704        11704  fill 11004              -90   %% Axial Position to end at = 62.06475
cell 11705        11705  fill 11005              -90   %% Axial Position to end at = 62.82675
cell 11706        11706  fill 11006              -90   %% Axial Position to end at = 82.82675
cell 11707        11707  fill 11006              -90   %% Added Lines for axial position 106.1655
```

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cell 11708         11708  fill 11006              -90   %% Added Lines for axial position 109.11825
cell 11709         11709  fill 11006              -90   %% Added Lines for axial position 114.4205
cell 11710         11710  fill 11007              -90   %% Axial Position to end at = 163.79425
cell 11711         11711  fill 11008              -90   %% Axial Position to end at = 183.79425
cell 11712         11712  fill 11009              -90   %% Axial Position to end at = 184.55625
cell 11713         11713  fill 11010              -90   %% Axial Position to end at = 206.6225
cell 11714         11714  fill 11011              -90   %% Axial Position to end at = 220.2625
cell 11715         11715  fill 11012              -90   %% Axial Position to end at = 247.2625
cell 11716         11716  fill 11013              -90   %% All the way to the top

%% BUILD A7
cell 11717         11700fill 11701                   -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11718         11700fill 11702        11   -12    %%  Oct graphite XS region 1 -- bottom
cell 11719         11700fill 11703        12   -13    %%  Oct graphite XS region 2 -- bottom
cell 11720         11700fill 11704        13   -14    %%  square graphite bottom + air gap + Al clad
cell 11721         11700fill 11705        14   -17    %%  axial interface
cell 11722         11700fill 11706        17   -18    %%  Fuel1 bottom
cell 11723         11700fill 11707        18   -250    %% Added Region
cell 11724         11700fill 11708        250   -251    %% Added Region
cell 11725         11700fill 11709        251   -252    %% Added Region
cell 11726         11700fill 11710        252   -19    %%  Fuel2
cell 11727         11700fill 11711        19   -20    %%  Fuel1 top
cell 11728         11700fill 11712        20   -23    %%  aixal interface
cell 11729         11700fill 11713        23   -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11730         11700fill 11714        25   -26    %%  Oct graphite XS region 2 -- top
cell 11731         11700fill 11715        26   -27    %%  Oct graphite XS region 1 -- top
cell 11732         11700fill 11716        27          %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A8
% Description of Placement:

% Copy Universes
cell 11801         11801  fill 11001              -90   %% Axial Position to end at = 3.486
cell 11802         11802  fill 11002              -90   %% Axial Position to end at = 30.486
cell 11803         11803  fill 11003              -90   %% Axial Position to end at = 53.17475
cell 11804         11804  fill 11004              -90   %% Axial Position to end at = 62.06475
cell 11805         11805  fill 11005              -90   %% Axial Position to end at = 62.82675
cell 11806         11806  fill 11006              -90   %% Axial Position to end at = 82.82675
cell 11807         11807  fill 11006              -90   %% Added Lines for axial position 106.1655
cell 11808         11808  fill 11006              -90   %% Added Lines for axial position 109.11825
cell 11809         11809  fill 11006              -90   %% Added Lines for axial position 114.4205
cell 11810         11810  fill 11007              -90   %% Axial Position to end at = 163.79425
cell 11811         11811  fill 11008              -90   %% Axial Position to end at = 183.79425
cell 11812         11812  fill 11009              -90   %% Axial Position to end at = 184.55625
```

```
cell 11813        11813  fill 11010            -90  %% Axial Position to end at = 206.6225
cell 11814        11814  fill 11011            -90  %% Axial Position to end at = 220.2625
cell 11815        11815  fill 11012            -90  %% Axial Position to end at = 247.2625
cell 11816        11816  fill 11013            -90  %% All the way to the top

%% BUILD A8
cell 11817        11800fill 11801                -11   %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11818        11800fill 11802        11  -12   %%  Oct graphite XS region 1 -- bottom
cell 11819        11800fill 11803        12  -13   %%  Oct graphite XS region 2 -- bottom
cell 11820        11800fill 11804        13  -14   %%  square graphite bottom + air gap + Al clad
cell 11821        11800fill 11805        14  -17   %%  axial interface
cell 11822        11800fill 11806        17  -18   %%  Fuel1 bottom
cell 11823        11800fill 11807        18  -250   %% Added Region
cell 11824        11800fill 11808        250  -251   %% Added Region
cell 11825        11800fill 11809        251  -252   %% Added Region
cell 11826        11800fill 11810        252  -19   %%  Fuel2
cell 11827        11800fill 11811        19  -20   %%  Fuel1 top
cell 11828        11800fill 11812        20  -23   %%  aixal interface
cell 11829        11800fill 11813        23  -25   %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11830        11800fill 11814        25  -26   %%  Oct graphite XS region 2 -- top
cell 11831        11800fill 11815        26  -27   %%  Oct graphite XS region 1 -- top
cell 11832        11800fill 11816        27        %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A9
% Description of Placement:

% Copy Universes
cell 11901        11901  fill 11001            -90  %% Axial Position to end at = 3.486
cell 11902        11902  fill 11002            -90  %% Axial Position to end at = 30.486
cell 11903        11903  fill 11003            -90  %% Axial Position to end at = 53.17475
cell 11904        11904  fill 11004            -90  %% Axial Position to end at = 62.06475
cell 11905        11905  fill 11005            -90  %% Axial Position to end at = 62.82675
cell 11906        11906  fill 11006            -90  %% Axial Position to end at = 82.82675
cell 11907        11907  fill 11006            -90  %% Added Lines for axial position 106.1655
cell 11908        11908  fill 11006            -90  %% Added Lines for axial position 109.11825
cell 11909        11909  fill 11006            -90  %% Added Lines for axial position 114.4205
cell 11910        11910  fill 11007            -90  %% Axial Position to end at = 163.79425
cell 11911        11911  fill 11008            -90  %% Axial Position to end at = 183.79425
cell 11912        11912  fill 11009            -90  %% Axial Position to end at = 184.55625
cell 11913        11913  fill 11010            -90  %% Axial Position to end at = 206.6225
cell 11914        11914  fill 11011            -90  %% Axial Position to end at = 220.2625
cell 11915        11915  fill 11012            -90  %% Axial Position to end at = 247.2625
cell 11916        11916  fill 11013            -90  %% All the way to the top
```

```
%% BUILD A9
cell 11917      11900fill 11901              -11    %%  Steel Grid Plate + Aluminum bottom
fitting
cell 11918      11900fill 11902     11  -12    %%  Oct graphite XS region 1 -- bottom
cell 11919      11900fill 11903     12  -13    %%  Oct graphite XS region 2 -- bottom
cell 11920      11900fill 11904     13  -14    %%  square graphite bottom + air gap + Al clad
cell 11921      11900fill 11905     14  -17    %%  axial interface
cell 11922      11900fill 11906     17  -18    %%  Fuel1 bottom
cell 11923      11900fill 11907     18  -250    %% Added Region
cell 11924      11900fill 11908     250  -251    %% Added Region
cell 11925      11900fill 11909     251  -252    %% Added Region
cell 11926      11900fill 11910     252  -19    %%  Fuel2
cell 11927      11900fill 11911     19  -20    %%  Fuel1 top
cell 11928      11900fill 11912     20  -23    %%  aixal interface
cell 11929      11900fill 11913     23  -25    %%  square graphite w hole top + Oct graphite
with hole + air + Al clad
cell 11930      11900fill 11914     25  -26    %%  Oct graphite XS region 2 -- top
cell 11931      11900fill 11915     26  -27    %%  Oct graphite XS region 1 -- top
cell 11932      11900fill 11916     27        %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A10
% Description of Placement:

% Copy Universes
cell 12001      12001       fill 11001          -90   %% Axial Position to end at = 3.486
cell 12002      12002       fill 11002          -90   %% Axial Position to end at = 30.486
cell 12003      12003       fill 11003          -90   %% Axial Position to end at =
53.17475
cell 12004      12004       fill 11004          -90   %% Axial Position to end at =
62.06475
cell 12005      12005       fill 11005          -90   %% Axial Position to end at =
62.82675
cell 12006      12006       fill 11006          -90   %% Axial Position to end at =
82.82675
cell 12007      12007       fill 11006          -90   %% Added Lines for axial position
106.1655
cell 12008      12008       fill 11006          -90   %% Added Lines for axial position
109.11825
cell 12009      12009       fill 11006          -90   %% Added Lines for axial position
114.4205
cell 12010      12010       fill 11007          -90   %% Axial Position to end at =
163.79425
cell 12011      12011   fill 11008          -90   %% Axial Position to end at = 183.79425
cell 12012      12012       fill 11009          -90   %% Axial Position to end at =
184.55625
```

cell 12013 12013 fill 11010 -90 %% Axial Position to end at = 206.6225
cell 12014 12014 fill 11011 -90 %% Axial Position to end at = 220.2625
cell 12015 12015 fill 11012 -90 %% Axial Position to end at = 247.2625
cell 12016 12016 fill 11013 -90 %% All the way to the top

%% BUILD A10
cell 12017 12000 fill 12001 -11 %% Steel Grid Plate + Aluminum bottom fitting
cell 12018 12000 fill 12002 11 -12 %% Oct graphite XS region 1 -- bottom
cell 12019 12000 fill 12003 12 -13 %% Oct graphite XS region 2 -- bottom
cell 12020 12000 fill 12004 13 -14 %% square graphite bottom + air gap + Al clad
cell 12021 12000 fill 12005 14 -17 %% axial interface
cell 12022 12000 fill 12006 17 -18 %% Fuel1 bottom
cell 12023 12000 fill 12007 18 -250 %% Added Region
cell 12024 12000 fill 12008 250 -251 %% Added Region
cell 12025 12000 fill 12009 251 -252 %% Added Region
cell 12026 12000 fill 12010 252 -19 %% Fuel2
cell 12027 12000 fill 12011 19 -20 %% Fuel1 top
cell 12028 12000 fill 12012 20 -23 %% aixal interface
cell 12029 12000 fill 12013 23 -25 %% square graphite w hole top + Oct graphite with hole + air + Al clad
cell 12030 12000 fill 12014 25 -26 %% Oct graphite XS region 2 -- top
cell 12031 12000 fill 12015 26 -27 %% Oct graphite XS region 1 -- top
cell 12032 12000 fill 12016 27 %% top fitting
%%
% Define A11
% Description of Placement:

% Copy Universes
cell 12101 12101 fill 11001 -90 %% Axial Position to end at = 3.486
cell 12102 12102 fill 11002 -90 %% Axial Position to end at = 30.486
cell 12103 12103 fill 11003 -90 %% Axial Position to end at = 53.17475
cell 12104 12104 fill 11004 -90 %% Axial Position to end at = 62.06475
cell 12105 12105 fill 11005 -90 %% Axial Position to end at = 62.82675
cell 12106 12106 fill 11006 -90 %% Axial Position to end at = 82.82675
cell 12107 12107 fill 11006 -90 %% Added Lines for axial position 106.1655

```
cell 12108        12108            fill 11006              -90   %% Added Lines for axial position
109.11825
cell 12109        12109            fill 11006              -90   %% Added Lines for axial position
114.4205
cell 12110        12110  fill 11007              -90   %% Axial Position to end at = 163.79425
cell 12111        12111  fill 11008              -90   %% Axial Position to end at = 183.79425
cell 12112        12112  fill 11009              -90   %% Axial Position to end at = 184.55625
cell 12113        12113  fill 11010              -90   %% Axial Position to end at = 206.6225
cell 12114        12114  fill 11011              -90   %% Axial Position to end at = 220.2625
cell 12115        12115  fill 11012              -90   %% Axial Position to end at = 247.2625
cell 12116        12116  fill 11013              -90   %% All the way to the top

%% BUILD A11
cell 12117        12100            fill 12101                  -11    %%  Steel Grid Plate + Aluminum
bottom fitting
cell 12118        12100            fill 12102         11   -12    %%  Oct graphite XS region 1 -- bottom
cell 12119        12100            fill 12103         12   -13    %%  Oct graphite XS region 2 -- bottom
cell 12120        12100            fill 12104         13   -14    %%  square graphite bottom + air gap +
Al clad
cell 12121        12100            fill 12105         14   -17    %%  axial interface
cell 12122        12100            fill 12106         17   -18    %%  Fuel1 bottom
cell 12123        12100            fill 12107         18   -250    %% Added Region
cell 12124        12100            fill 12108         250   -251    %% Added Region
cell 12125        12100            fill 12109         251   -252    %% Added Region
cell 12126        12100            fill 12110         252   -19    %%  Fuel2
cell 12127        12100            fill 12111         19   -20    %%  Fuel1 top
cell 12128        12100            fill 12112         20   -23    %%  aixal interface
cell 12129        12100            fill 12113         23   -25    %%  square graphite w hole top + Oct
graphite with hole + air + Al clad
cell 12130        12100            fill 12114         25   -26    %%  Oct graphite XS region 2 -- top
cell 12131        12100            fill 12115         26   -27    %%  Oct graphite XS region 1 -- top
cell 12132        12100            fill 12116         27         %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A12
% Description of Placement:

% Copy Universes
cell 12201        12201            fill 11001              -90   %% Axial Position to end at = 3.486
cell 12202        12202            fill 11002              -90   %% Axial Position to end at = 30.486
cell 12203        12203            fill 11003              -90   %% Axial Position to end at =
53.17475
cell 12204        12204            fill 11004              -90   %% Axial Position to end at =
62.06475
cell 12205        12205            fill 11005              -90   %% Axial Position to end at =
62.82675
```

cell 12206 12206 fill 11006 -90 %% Axial Position to end at =
82.82675
cell 12207 12207 fill 11006 -90 %% Added Lines for axial position
106.1655
cell 12208 12208 fill 11006 -90 %% Added Lines for axial position
109.11825
cell 12209 12209 fill 11006 -90 %% Added Lines for axial position
114.4205
cell 12210 12210 fill 11007 -90 %% Axial Position to end at =
163.79425
cell 12211 12211 fill 11008 -90 %% Axial Position to end at = 183.79425
cell 12212 12212 fill 11009 -90 %% Axial Position to end at =
184.55625
cell 12213 12213 fill 11010 -90 %% Axial Position to end at =
206.6225
cell 12214 12214 fill 11011 -90 %% Axial Position to end at =
220.2625
cell 12215 12215 fill 11012 -90 %% Axial Position to end at =
247.2625
cell 12216 12216 fill 11013 -90 %% All the way to the top

%% BUILD A12
cell 12217 12200 fill 12201 -11 %% Steel Grid Plate + Aluminum
bottom fitting
cell 12218 12200 fill 12202 11 -12 %% Oct graphite XS region 1 -- bottom
cell 12219 12200 fill 12203 12 -13 %% Oct graphite XS region 2 -- bottom
cell 12220 12200 fill 12204 13 -14 %% square graphite bottom + air gap +
Al clad
cell 12221 12200 fill 12205 14 -17 %% axial interface
cell 12222 12200 fill 12206 17 -18 %% Fuel1 bottom
cell 12223 12200 fill 12207 18 -250 %% Added Region
cell 12224 12200 fill 12208 250 -251 %% Added Region
cell 12225 12200 fill 12209 251 -252 %% Added Region
cell 12226 12200 fill 12210 252 -19 %% Fuel2
cell 12227 12200 fill 12211 19 -20 %% Fuel1 top
cell 12228 12200 fill 12212 20 -23 %% aixal interface
cell 12229 12200 fill 12213 23 -25 %% square graphite w hole top + Oct
graphite with hole + air + Al clad
cell 12230 12200 fill 12214 25 -26 %% Oct graphite XS region 2 -- top
cell 12231 12200 fill 12215 26 -27 %% Oct graphite XS region 1 -- top
cell 12232 12200 fill 12216 27 %% top fitting
%%
% Define A13
% Description of Placement:

% Copy Universes

cell 12301 12301 fill 11001 -90 %% Axial Position to end at = 3.486
cell 12302 12302 fill 11002 -90 %% Axial Position to end at = 30.486
cell 12303 12303 fill 11003 -90 %% Axial Position to end at = 53.17475
cell 12304 12304 fill 11004 -90 %% Axial Position to end at = 62.06475
cell 12305 12305 fill 11005 -90 %% Axial Position to end at = 62.82675
cell 12306 12306 fill 11006 -90 %% Axial Position to end at = 82.82675
cell 12307 12307 fill 11006 -90 %% Added Lines for axial position 106.1655
cell 12308 12308 fill 11006 -90 %% Added Lines for axial position 109.11825
cell 12309 12309 fill 11006 -90 %% Added Lines for axial position 114.4205
cell 12310 12310 fill 11007 -90 %% Axial Position to end at = 163.79425
cell 12311 12311 fill 11008 -90 %% Axial Position to end at = 183.79425
cell 12312 12312 fill 11009 -90 %% Axial Position to end at = 184.55625
cell 12313 12313 fill 11010 -90 %% Axial Position to end at = 206.6225
cell 12314 12314 fill 11011 -90 %% Axial Position to end at = 220.2625
cell 12315 12315 fill 11012 -90 %% Axial Position to end at = 247.2625
cell 12316 12316 fill 11013 -90 %% All the way to the top

%% BUILD A13
cell 12317 12300 fill 12301 -11 %% Steel Grid Plate + Aluminum bottom fitting
cell 12318 12300 fill 12302 11 -12 %% Oct graphite XS region 1 -- bottom
cell 12319 12300 fill 12303 12 -13 %% Oct graphite XS region 2 -- bottom
cell 12320 12300 fill 12304 13 -14 %% square graphite bottom + air gap + Al clad
cell 12321 12300 fill 12305 14 -17 %% axial interface
cell 12322 12300 fill 12306 17 -18 %% Fuel1 bottom
cell 12323 12300 fill 12307 18 -250 %% Added Region
cell 12324 12300 fill 12308 250 -251 %% Added Region
cell 12325 12300 fill 12309 251 -252 %% Added Region
cell 12326 12300 fill 12310 252 -19 %% Fuel2
cell 12327 12300 fill 12311 19 -20 %% Fuel1 top
cell 12328 12300 fill 12312 20 -23 %% aixal interface
cell 12329 12300 fill 12313 23 -25 %% square graphite w hole top + Oct graphite with hole + air + Al clad

cell 12330 12300 fill 12314 25 -26 %% Oct graphite XS region 2 -- top
cell 12331 12300 fill 12315 26 -27 %% Oct graphite XS region 1 -- top
cell 12332 12300 fill 12316 27 %% top fitting
%%
% Define A14
% Description of Placement:

% Copy Universes
cell 12401 12401 fill 11001 -90 %% Axial Position to end at = 3.486
cell 12402 12402 fill 11002 -90 %% Axial Position to end at = 30.486
cell 12403 12403 fill 11003 -90 %% Axial Position to end at =
53.17475
cell 12404 12404 fill 11004 -90 %% Axial Position to end at =
62.06475
cell 12405 12405 fill 11005 -90 %% Axial Position to end at =
62.82675
cell 12406 12406 fill 11006 -90 %% Axial Position to end at =
82.82675
cell 12407 12407 fill 11006 -90 %% Added Lines for axial position
106.1655
cell 12408 12408 fill 11006 -90 %% Added Lines for axial position
109.11825
cell 12409 12409 fill 11006 -90 %% Added Lines for axial position
114.4205
cell 12410 12410 fill 11007 -90 %% Axial Position to end at =
163.79425
cell 12411 12411 fill 11008 -90 %% Axial Position to end at = 183.79425
cell 12412 12412 fill 11009 -90 %% Axial Position to end at =
184.55625
cell 12413 12413 fill 11010 -90 %% Axial Position to end at =
206.6225
cell 12414 12414 fill 11011 -90 %% Axial Position to end at =
220.2625
cell 12415 12415 fill 11012 -90 %% Axial Position to end at =
247.2625
cell 12416 12416 fill 11013 -90 %% All the way to the top

%% BUILD A14
cell 12417 12400 fill 12401 -11 %% Steel Grid Plate + Aluminum
bottom fitting
cell 12418 12400 fill 12402 11 -12 %% Oct graphite XS region 1 -- bottom
cell 12419 12400 fill 12403 12 -13 %% Oct graphite XS region 2 -- bottom
cell 12420 12400 fill 12404 13 -14 %% square graphite bottom + air gap +
Al clad
cell 12421 12400 fill 12405 14 -17 %% axial interface
cell 12422 12400 fill 12406 17 -18 %% Fuel1 bottom

cell 12423 12400 fill 12407 18 -250 %% Added Region
cell 12424 12400 fill 12408 250 -251 %% Added Region
cell 12425 12400 fill 12409 251 -252 %% Added Region
cell 12426 12400 fill 12410 252 -19 %% Fuel2
cell 12427 12400 fill 12411 19 -20 %% Fuel1 top
cell 12428 12400 fill 12412 20 -23 %% aixal interface
cell 12429 12400 fill 12413 23 -25 %% square graphite w hole top + Oct graphite with hole + air + Al clad
cell 12430 12400 fill 12414 25 -26 %% Oct graphite XS region 2 -- top
cell 12431 12400 fill 12415 26 -27 %% Oct graphite XS region 1 -- top
cell 12432 12400 fill 12416 27 %% top fitting
%%
% Define A15
% Description of Placement:

% Copy Universes
cell 12501 12501 fill 11001 -90 %% Axial Position to end at = 3.486
cell 12502 12502 fill 11002 -90 %% Axial Position to end at = 30.486
cell 12503 12503 fill 11003 -90 %% Axial Position to end at = 53.17475
cell 12504 12504 fill 11004 -90 %% Axial Position to end at = 62.06475
cell 12505 12505 fill 11005 -90 %% Axial Position to end at = 62.82675
cell 12506 12506 fill 11006 -90 %% Axial Position to end at = 82.82675
cell 12507 12507 fill 11006 -90 %% Added Lines for axial position 106.1655
cell 12508 12508 fill 11006 -90 %% Added Lines for axial position 109.11825
cell 12509 12509 fill 11006 -90 %% Added Lines for axial position 114.4205
cell 12510 12510 fill 11007 -90 %% Axial Position to end at = 163.79425
cell 12511 12511 fill 11008 -90 %% Axial Position to end at = 183.79425
cell 12512 12512 fill 11009 -90 %% Axial Position to end at = 184.55625
cell 12513 12513 fill 11010 -90 %% Axial Position to end at = 206.6225
cell 12514 12514 fill 11011 -90 %% Axial Position to end at = 220.2625
cell 12515 12515 fill 11012 -90 %% Axial Position to end at = 247.2625
cell 12516 12516 fill 11013 -90 %% All the way to the top

%% BUILD A15

cell 12517 12500 fill 12501 -11 %% Steel Grid Plate + Aluminum bottom fitting
cell 12518 12500 fill 12502 11 -12 %% Oct graphite XS region 1 -- bottom
cell 12519 12500 fill 12503 12 -13 %% Oct graphite XS region 2 -- bottom
cell 12520 12500 fill 12504 13 -14 %% square graphite bottom + air gap + Al clad
cell 12521 12500 fill 12505 14 -17 %% axial interface
cell 12522 12500 fill 12506 17 -18 %% Fuel1 bottom
cell 12523 12500 fill 12507 18 -250 %% Added Region
cell 12524 12500 fill 12508 250 -251 %% Added Region
cell 12525 12500 fill 12509 251 -252 %% Added Region
cell 12526 12500 fill 12510 252 -19 %% Fuel2
cell 12527 12500 fill 12511 19 -20 %% Fuel1 top
cell 12528 12500 fill 12512 20 -23 %% aixal interface
cell 12529 12500 fill 12513 23 -25 %% square graphite w hole top + Oct graphite with hole + air + Al clad
cell 12530 12500 fill 12514 25 -26 %% Oct graphite XS region 2 -- top
cell 12531 12500 fill 12515 26 -27 %% Oct graphite XS region 1 -- top
cell 12532 12500 fill 12516 27 %% top fitting
%%%
% Define A16
% Description of Placement:

% Copy Universes
cell 12601 12601 fill 11001 -90 %% Axial Position to end at = 3.486
cell 12602 12602 fill 11002 -90 %% Axial Position to end at = 30.486
cell 12603 12603 fill 11003 -90 %% Axial Position to end at = 53.17475
cell 12604 12604 fill 11004 -90 %% Axial Position to end at = 62.06475
cell 12605 12605 fill 11005 -90 %% Axial Position to end at = 62.82675
cell 12606 12606 fill 11006 -90 %% Axial Position to end at = 82.82675
cell 12607 12607 fill 11006 -90 %% Added Lines for axial position 106.1655
cell 12608 12608 fill 11006 -90 %% Added Lines for axial position 109.11825
cell 12609 12609 fill 11006 -90 %% Added Lines for axial position 114.4205
cell 12610 12610 fill 11007 -90 %% Axial Position to end at = 163.79425
cell 12611 12611 fill 11008 -90 %% Axial Position to end at = 183.79425
cell 12612 12612 fill 11009 -90 %% Axial Position to end at = 184.55625

```
cell 12613       12613          fill 11010              -90   %% Axial Position to end at =
206.6225
cell 12614       12614          fill 11011              -90   %% Axial Position to end at =
220.2625
cell 12615       12615          fill 11012              -90   %% Axial Position to end at =
247.2625
cell 12616       12616          fill 11013              -90   %% All the way to the top

%% BUILD A16
cell 12617       12600          fill 12601                 -11    %%  Steel Grid Plate + Aluminum
bottom fitting
cell 12618       12600          fill 12602        11   -12    %%  Oct graphite XS region 1 -- bottom
cell 12619       12600          fill 12603        12   -13    %%  Oct graphite XS region 2 -- bottom
cell 12620       12600          fill 12604        13   -14    %%  square graphite bottom + air gap +
Al clad
cell 12621       12600          fill 12605        14   -17    %%  axial interface
cell 12622       12600          fill 12606        17   -18    %%  Fuel1 bottom
cell 12623       12600          fill 12607        18   -250    %% Added Region
cell 12624       12600          fill 12608        250   -251    %% Added Region
cell 12625       12600          fill 12609        251   -252    %% Added Region
cell 12626       12600          fill 12610        252   -19    %%  Fuel2
cell 12627       12600          fill 12611        19   -20    %%  Fuel1 top
cell 12628       12600          fill 12612        20   -23    %%  aixal interface
cell 12629       12600          fill 12613        23   -25    %%  square graphite w hole top + Oct
graphite with hole + air + Al clad
cell 12630       12600          fill 12614        25   -26    %%  Oct graphite XS region 2 -- top
cell 12631       12600          fill 12615        26   -27    %%  Oct graphite XS region 1 -- top
cell 12632       12600          fill 12616        27          %%  top fitting
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define A17
% Description of Placement:

% Copy Universes
cell 12701       12701          fill 11001              -90   %% Axial Position to end at = 3.486
cell 12702       12702          fill 11002              -90   %% Axial Position to end at = 30.486
cell 12703       12703          fill 11003              -90   %% Axial Position to end at =
53.17475
cell 12704       12704          fill 11004              -90   %% Axial Position to end at =
62.06475
cell 12705       12705          fill 11005              -90   %% Axial Position to end at =
62.82675
cell 12706       12706          fill 11006              -90   %% Axial Position to end at =
82.82675
cell 12707       12707          fill 11006              -90   %% Added Lines for axial position
106.1655
```

cell 12708 12708 fill 11006 -90 %% Added Lines for axial position 109.11825
cell 12709 12709 fill 11006 -90 %% Added Lines for axial position 114.4205
cell 12710 12710 fill 11007 -90 %% Axial Position to end at = 163.79425
cell 12711 12711 fill 11008 -90 %% Axial Position to end at = 183.79425
cell 12712 12712 fill 11009 -90 %% Axial Position to end at = 184.55625
cell 12713 12713 fill 11010 -90 %% Axial Position to end at = 206.6225
cell 12714 12714 fill 11011 -90 %% Axial Position to end at = 220.2625
cell 12715 12715 fill 11012 -90 %% Axial Position to end at = 247.2625
cell 12716 12716 fill 11013 -90 %% All the way to the top

%% BUILD A17
cell 12717 12700 fill 12701 -11 %% Steel Grid Plate + Aluminum bottom fitting
cell 12718 12700 fill 12702 11 -12 %% Oct graphite XS region 1 -- bottom
cell 12719 12700 fill 12703 12 -13 %% Oct graphite XS region 2 -- bottom
cell 12720 12700 fill 12704 13 -14 %% square graphite bottom + air gap + Al clad
cell 12721 12700 fill 12705 14 -17 %% axial interface
cell 12722 12700 fill 12706 17 -18 %% Fuel1 bottom
cell 12723 12700 fill 12707 18 -250 %% Added Region
cell 12724 12700 fill 12708 250 -251 %% Added Region
cell 12725 12700 fill 12709 251 -252 %% Added Region
cell 12726 12700 fill 12710 252 -19 %% Fuel2
cell 12727 12700 fill 12711 19 -20 %% Fuel1 top
cell 12728 12700 fill 12712 20 -23 %% aixal interface
cell 12729 12700 fill 12713 23 -25 %% square graphite w hole top + Oct graphite with hole + air + Al clad
cell 12730 12700 fill 12714 25 -26 %% Oct graphite XS region 2 -- top
cell 12731 12700 fill 12715 26 -27 %% Oct graphite XS region 1 -- top
cell 12732 12700 fill 12716 27 %% top fitting

Rods.sss

%%%
% Define B100 - Comp rods
%%%
%% COPY UNIVERSES from Static Part
cell 1101 1101 fill 1001 -90 %% Axial Position to end at = 3.486

```
cell 1102 1102 fill 1002          -90  %% Axial Position to end at = 30.486
cell 1103 1103 fill 1003          -90  %% Axial Position to end at = 53.17475
cell 1104 1104 fill 1004          -90  %% Axial Position to end at = 62.06475
cell 1105 1105 fill 1005          -90  %% Axial Position to end at = 62.82675
cell 1106 1106 fill 1006          -90  %% Axial Position to end at = 82.82675
cell 1107 1107 fill 1007          -90  %% Axial Position to end at = 163.79425
cell 1108 1108 fill 1008          -90  %% Axial Position to end at = 183.79425
cell 1109 1109 fill 1009          -90  %% Axial Position to end at = 184.55625
cell 1110 1110 fill 1010          -90  %% Axial Position to end at = 206.6225
cell 1111 1111 fill 1011          -90  %% Axial Position to end at = 220.2625
cell 1112 1112 fill 1012          -90  %% Axial Position to end at = 247.2625
cell 1113 1113 fill 1013          -90  %% All the way to the top

% Copy Universes
cell 1120   1121    fill 801   -90   %% Axial Position to end at = 3.486
cell 1121   1122    fill 801   -90   %% Added Lines for axial position 12.486
cell 1122   1123    fill 801   -90   %% Added Lines for axial position 21.486
cell 1123   1124    fill 801   -90   %% Axial Position to end at = 30.486
cell 1124   1125    fill 801   -90   %% Added Lines for axial position 41.830375
cell 1125   1126    fill 801   -90   %% Axial Position to end at = 53.17475
cell 1126   1127    fill 801   -90   %% Axial Position to end at = 62.06475
cell 1127   1128    fill 801   -90   %% Axial Position to end at = 62.82675
cell 1128   1129    fill 801   -90   %% Added Lines for axial position 72.82675
cell 1129   1130    fill 801   -90   %% Axial Position to end at = 82.82675
cell 1130   1131    fill 801   -90   %% Added Lines for axial position 87.21075
cell 1131   1132    fill 801   -90   %% Added Lines for axial position 97.21075
cell 1132   1133    fill 801   -90   %% Added Lines for axial position 107.21075
cell 1133   1134    fill 801   -90   %% Added Lines for axial position 117.21075
cell 1134   1135    fill 801   -90   %% Added Lines for axial position 127.21075
cell 1135   1136    fill 801   -90   %% Added Lines for axial position 137.21075
cell 1136   1137    fill 801   -90   %% Added Lines for axial position 147.21075
cell 1137   1138    fill 801   -90   %% Added Lines for axial position 157.21075
cell 1138   1139    fill 801   -90   %% Axial Position to end at = 163.79425
cell 1139   1140    fill 801   -90   %% Added Lines for axial position 172.21075
cell 1140   1141    fill 801   -90   %% Axial Position to end at = 183.79425
cell 1141   1142    fill 801   -90   %% Axial Position to end at = 184.55625
cell 1142   1143    fill 801   -90   %% Added Lines for axial position 188.81075
cell 1143   1144    fill 801   -90   %% Added Lines for axial position 195.589375
cell 1144   1145    fill 801   -90   %% Axial Position to end at = 206.6225
cell 1145   1146    fill 801   -90   %% Axial Position to end at = 220.2625
cell 1146   1147    fill 801   -90   %% Added Lines for axial position 229.2625
cell 1147   1148    fill 801   -90   %% Added Lines for axial position 238.2625
cell 1148   1149    fill 801   -90   %% Axial Position to end at = 247.2625
cell 1149   1150    fill 801   -90   %% All the way to the top

%% BUILD complete CR element - outside CR
```

```
cell 1150   1100  fill 1101 51     -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 1151   1100  fill 1102 51 11   -250    %% Added Region
cell 1152   1100  fill 1102 51 250   -251    %% Added Region
cell 1153   1100  fill 1102 51 251   -12    %%  Oct graphite XS region 1 -- bottom
cell 1154   1100  fill 1103 51 12   -252    %% Added Region
cell 1155   1100  fill 1103 51 252   -13    %%  Oct graphite XS region 2 -- bottom
cell 1156   1100  fill 1104 51 13   -14    %%  square graphite bottom + air gap + Al clad
cell 1157   1100  fill 1105 51 14   -17    %%  axial interface
cell 1158   1100  fill 1106 51 17   -253    %% Added Region
cell 1159   1100  fill 1106 51 253   -18    %%  Fuel1 bottom
cell 1160   1100  fill 1107 51 18   -254    %% Added Region
cell 1161   1100  fill 1107 51 254   -255    %% Added Region
cell 1162   1100  fill 1107 51 255   -256    %% Added Region
cell 1163   1100  fill 1107 51 256   -257    %% Added Region
cell 1164   1100  fill 1107 51 257   -258    %% Added Region
cell 1165   1100  fill 1107 51 258   -259    %% Added Region
cell 1166   1100  fill 1107 51 259   -260    %% Added Region
cell 1167   1100  fill 1107 51 260   -261    %% Added Region
cell 1168   1100  fill 1107 51 261   -19    %%  Fuel2
cell 1169   1100  fill 1108 51 19   -262    %% Added Region
cell 1170   1100  fill 1108 51 262   -20    %%  Fuel1 top
cell 1171   1100  fill 1109 51 20   -23    %%  aixal interface
cell 1172   1100  fill 1110 51 23   -263    %% Added Region
cell 1173   1100  fill 1110 51 263   -264    %% Added Region
cell 1174   1100  fill 1110 51 264   -25    %%  square graphite w hole top + Oct graphite with
hole + air + Al clad
cell 1175   1100  fill 1111 51 25   -26    %%  Oct graphite XS region 2 -- top
cell 1176   1100  fill 1112 51 26   -265    %% Added Region
cell 1177   1100  fill 1112 51 265   -266    %% Added Region
cell 1178   1100  fill 1112 51 266   -27    %%  Oct graphite XS region 1 -- top
cell 1179   1100  fill 1113 51 27          %%  top fitting

%% BUILD complete CR element - inside CR
cell 1180   1100  fill 1121 -51      -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 1181   1100  fill 1122 -51 11   -250    %% Added Region
cell 1182   1100  fill 1123 -51 250   -251    %% Added Region
cell 1183   1100  fill 1124 -51 251   -12    %%  Oct graphite XS region 1 -- bottom
cell 1184   1100  fill 1125 -51 12   -252    %% Added Region
cell 1185   1100  fill 1126 -51 252   -13    %%  Oct graphite XS region 2 -- bottom
cell 1186   1100  fill 1127 -51 13   -14    %%  square graphite bottom + air gap + Al clad
cell 1187   1100  fill 1128 -51 14   -17    %%  axial interface
cell 1188   1100  fill 1129 -51 17   -253    %% Added Region
cell 1189   1100  fill 1130 -51 253   -18    %%  Fuel1 bottom
cell 1190   1100  fill 1131 -51 18   -254    %% Added Region
cell 1191   1100  fill 1132 -51 254   -255    %% Added Region
cell 1192   1100  fill 1133 -51 255   -256    %% Added Region
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```
cell 1193   1100  fill 1134 -51 256   -257    %% Added Region
cell 1194   1100  fill 1135 -51 257   -258    %% Added Region
cell 1195   1100  fill 1136 -51 258   -259    %% Added Region
cell 1196   1100  fill 1137 -51 259   -260    %% Added Region
cell 1197   1100  fill 1138 -51 260   -261    %% Added Region
cell 1198   1100  fill 1139 -51 261   -19    %%  Fuel2
cell 1199   1100  fill 1140 -51 19   -262    %% Added Region
cell 1200   1100  fill 1141 -51 262   -20    %%  Fuel1 top
cell 1201   1100  fill 1142 -51 20   -23    %%  aixal interface
cell 1202   1100  fill 1143 -51 23   -263    %% Added Region
cell 1203   1100  fill 1144 -51 263   -264    %% Added Region
cell 1204   1100  fill 1145 -51 264   -25    %%  square graphite w hole top + Oct graphite with
hole + air + Al clad
cell 1205   1100  fill 1146 -51 25   -26    %%  Oct graphite XS region 2 -- top
cell 1206   1100  fill 1147 -51 26   -265    %% Added Region
cell 1207   1100  fill 1148 -51 265   -266    %% Added Region
cell 1208   1100  fill 1149 -51 266   -27    %%  Oct graphite XS region 1 -- top
cell 1209   1100  fill 1150 -51 27          %%  top fitting

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define B1200 - Comp rods
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% COPY UNIVERSES from Static Part
cell 1301 1201 fill 1001         -90  %% Axial Position to end at = 3.486
cell 1302 1202 fill 1002         -90  %% Axial Position to end at = 30.486
cell 1303 1203 fill 1003         -90  %% Axial Position to end at = 53.17475
cell 1304 1204 fill 1004         -90  %% Axial Position to end at = 62.06475
cell 1305 1205 fill 1005         -90  %% Axial Position to end at = 62.82675
cell 1306 1206 fill 1006         -90  %% Axial Position to end at = 82.82675
cell 1307 1207 fill 1007         -90  %% Axial Position to end at = 163.79425
cell 1308 1208 fill 1008         -90  %% Axial Position to end at = 183.79425
cell 1309 1209 fill 1009         -90  %% Axial Position to end at = 184.55625
cell 1310 1210 fill 1010         -90  %% Axial Position to end at = 206.6225
cell 1311 1211 fill 1011         -90  %% Axial Position to end at = 220.2625
cell 1312 1212 fill 1012         -90  %% Axial Position to end at = 247.2625
cell 1313 1213 fill 1013         -90  %% All the way to the top

% Copy Universes
cell 1320   1221    fill 802  -90   %% Axial Position to end at = 3.486
cell 1321   1222    fill 802  -90   %% Added Lines for axial position 12.486
cell 1322   1223    fill 802  -90   %% Added Lines for axial position 21.486
cell 1323   1224    fill 802  -90   %% Axial Position to end at = 30.486
cell 1324   1225    fill 802  -90   %% Added Lines for axial position 41.830375
cell 1325   1226    fill 802  -90   %% Axial Position to end at = 53.17475
```

```
cell 1326   1227    fill 802  -90   %% Axial Position to end at = 62.06475
cell 1327   1228    fill 802  -90   %% Axial Position to end at = 62.82675
cell 1328   1229    fill 802  -90   %% Added Lines for axial position 72.82675
cell 1329   1230    fill 802  -90   %% Axial Position to end at = 82.82675
cell 1330   1231    fill 802  -90   %% Added Lines for axial position 87.21075
cell 1331   1232    fill 802  -90   %% Added Lines for axial position 97.21075
cell 1332   1233    fill 802  -90   %% Added Lines for axial position 107.21075
cell 1333   1234    fill 802  -90   %% Added Lines for axial position 117.21075
cell 1334   1235    fill 802  -90   %% Added Lines for axial position 127.21075
cell 1335   1236    fill 802  -90   %% Added Lines for axial position 137.21075
cell 1336   1237    fill 802  -90   %% Added Lines for axial position 147.21075
cell 1337   1238    fill 802  -90   %% Added Lines for axial position 157.21075
cell 1338   1239    fill 802  -90   %% Axial Position to end at = 163.79425
cell 1339   1240    fill 802  -90   %% Added Lines for axial position 172.21075
cell 1340   1241    fill 802  -90   %% Axial Position to end at = 183.79425
cell 1341   1242    fill 802  -90   %% Axial Position to end at = 184.55625
cell 1342   1243    fill 802  -90   %% Added Lines for axial position 188.81075
cell 1343   1244    fill 802  -90   %% Added Lines for axial position 195.589375
cell 1344   1245    fill 802  -90   %% Axial Position to end at = 206.6225
cell 1345   1246    fill 802  -90   %% Axial Position to end at = 220.2625
cell 1346   1247    fill 802  -90   %% Added Lines for axial position 229.2625
cell 1347   1248    fill 802  -90   %% Added Lines for axial position 238.2625
cell 1348   1249    fill 802  -90   %% Axial Position to end at = 247.2625
cell 1349   1250    fill 802  -90   %% All the way to the top

%% BUILD complete CR element - outside CR
cell 1350   1200  fill 1201 51     -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 1351   1200  fill 1202 51 11   -250    %% Added Region
cell 1352   1200  fill 1202 51 250   -251    %% Added Region
cell 1353   1200  fill 1202 51 251   -12    %%  Oct graphite XS region 1 -- bottom
cell 1354   1200  fill 1203 51 12   -252    %% Added Region
cell 1355   1200  fill 1203 51 252   -13    %%  Oct graphite XS region 2 -- bottom
cell 1356   1200  fill 1204 51 13   -14    %%  square graphite bottom + air gap + Al clad
cell 1357   1200  fill 1205 51 14   -17    %%  axial interface
cell 1358   1200  fill 1206 51 17   -253    %% Added Region
cell 1359   1200  fill 1206 51 253   -18    %%  Fuel1 bottom
cell 1360   1200  fill 1207 51 18   -254    %% Added Region
cell 1361   1200  fill 1207 51 254   -255    %% Added Region
cell 1362   1200  fill 1207 51 255   -256    %% Added Region
cell 1363   1200  fill 1207 51 256   -257    %% Added Region
cell 1364   1200  fill 1207 51 257   -258    %% Added Region
cell 1365   1200  fill 1207 51 258   -259    %% Added Region
cell 1366   1200  fill 1207 51 259   -260    %% Added Region
cell 1367   1200  fill 1207 51 260   -261    %% Added Region
cell 1368   1200  fill 1207 51 261   -19    %%  Fuel2
cell 1369   1200  fill 1208 51 19   -262    %% Added Region
```

```
cell 1370   1200  fill 1208 51 262   -20    %%  Fuel1 top
cell 1371   1200  fill 1209 51 20   -23    %%  aixal interface
cell 1372   1200  fill 1210 51 23   -263    %% Added Region
cell 1373   1200  fill 1210 51 263   -264    %% Added Region
cell 1374   1200  fill 1210 51 264   -25    %%  square graphite w hole top + Oct graphite with hole + air + Al clad
cell 1375   1200  fill 1211 51 25   -26    %%  Oct graphite XS region 2 -- top
cell 1376   1200  fill 1212 51 26   -265    %% Added Region
cell 1377   1200  fill 1212 51 265   -266    %% Added Region
cell 1378   1200  fill 1212 51 266   -27    %%  Oct graphite XS region 1 -- top
cell 1379   1200  fill 1213 51 27          %%  top fitting

%% BUILD complete CR element - inside CR
cell 1380   1200  fill 1221 -51      -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 1381   1200  fill 1222 -51 11   -250    %% Added Region
cell 1382   1200  fill 1223 -51 250   -251    %% Added Region
cell 1383   1200  fill 1224 -51 251   -12    %%  Oct graphite XS region 1 -- bottom
cell 1384   1200  fill 1225 -51 12   -252    %% Added Region
cell 1385   1200  fill 1226 -51 252   -13    %%  Oct graphite XS region 2 -- bottom
cell 1386   1200  fill 1227 -51 13   -14    %%  square graphite bottom + air gap + Al clad
cell 1387   1200  fill 1228 -51 14   -17    %%  axial interface
cell 1388   1200  fill 1229 -51 17   -253    %% Added Region
cell 1389   1200  fill 1230 -51 253   -18    %%  Fuel1 bottom
cell 1390   1200  fill 1231 -51 18   -254    %% Added Region
cell 1391   1200  fill 1232 -51 254   -255    %% Added Region
cell 1392   1200  fill 1233 -51 255   -256    %% Added Region
cell 1393   1200  fill 1234 -51 256   -257    %% Added Region
cell 1394   1200  fill 1235 -51 257   -258    %% Added Region
cell 1395   1200  fill 1236 -51 258   -259    %% Added Region
cell 1396   1200  fill 1237 -51 259   -260    %% Added Region
cell 1397   1200  fill 1238 -51 260   -261    %% Added Region
cell 1398   1200  fill 1239 -51 261   -19    %%  Fuel2
cell 1399   1200  fill 1240 -51 19   -262    %% Added Region
cell 1400   1200  fill 1241 -51 262   -20    %%  Fuel1 top
cell 1401   1200  fill 1242 -51 20   -23    %%  aixal interface
cell 1402   1200  fill 1243 -51 23   -263    %% Added Region
cell 1403   1200  fill 1244 -51 263   -264    %% Added Region
cell 1404   1200  fill 1245 -51 264   -25    %%  square graphite w hole top + Oct graphite with hole + air + Al clad
cell 1405   1200  fill 1246 -51 25   -26    %%  Oct graphite XS region 2 -- top
cell 1406   1200  fill 1247 -51 26   -265    %% Added Region
cell 1407   1200  fill 1248 -51 265   -266    %% Added Region
cell 1408   1200  fill 1249 -51 266   -27    %%  Oct graphite XS region 1 -- top
cell 1409   1200  fill 1250 -51 27          %%  top fitting
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define B1300 - Comp rods
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% COPY UNIVERSES from Static Part
cell 1501 1301 fill 1001     -90  %% Axial Position to end at = 3.486
cell 1502 1302 fill 1002     -90  %% Axial Position to end at = 30.486
cell 1503 1303 fill 1003     -90  %% Axial Position to end at = 53.17475
cell 1504 1304 fill 1004     -90  %% Axial Position to end at = 62.06475
cell 1505 1305 fill 1005     -90  %% Axial Position to end at = 62.82675
cell 1506 1306 fill 1006     -90  %% Axial Position to end at = 82.82675
cell 1507 1307 fill 1007     -90  %% Axial Position to end at = 163.79425
cell 1508 1308 fill 1008     -90  %% Axial Position to end at = 183.79425
cell 1509 1309 fill 1009     -90  %% Axial Position to end at = 184.55625
cell 1510 1310 fill 1010     -90  %% Axial Position to end at = 206.6225
cell 1511 1311 fill 1011     -90  %% Axial Position to end at = 220.2625
cell 1512 1312 fill 1012     -90  %% Axial Position to end at = 247.2625
cell 1513 1313 fill 1013     -90  %% All the way to the top

% Copy Universes
cell 1520   1321   fill 803  -90   %% Axial Position to end at = 3.486
cell 1521   1322   fill 803  -90   %% Added Lines for axial position 12.486
cell 1522   1323   fill 803  -90   %% Added Lines for axial position 21.486
cell 1523   1324   fill 803  -90   %% Axial Position to end at = 30.486
cell 1524   1325   fill 803  -90   %% Added Lines for axial position 41.830375
cell 1525   1326   fill 803  -90   %% Axial Position to end at = 53.17475
cell 1526   1327   fill 803  -90   %% Axial Position to end at = 62.06475
cell 1527   1328   fill 803  -90   %% Axial Position to end at = 62.82675
cell 1528   1329   fill 803  -90   %% Added Lines for axial position 72.82675
cell 1529   1330   fill 803  -90   %% Axial Position to end at = 82.82675
cell 1530   1331   fill 803  -90   %% Added Lines for axial position 87.21075
cell 1531   1332   fill 803  -90   %% Added Lines for axial position 97.21075
cell 1532   1333   fill 803  -90   %% Added Lines for axial position 107.21075
cell 1533   1334   fill 803  -90   %% Added Lines for axial position 117.21075
cell 1534   1335   fill 803  -90   %% Added Lines for axial position 127.21075
cell 1535   1336   fill 803  -90   %% Added Lines for axial position 137.21075
cell 1536   1337   fill 803  -90   %% Added Lines for axial position 147.21075
cell 1537   1338   fill 803  -90   %% Added Lines for axial position 157.21075
cell 1538   1339   fill 803  -90   %% Axial Position to end at = 163.79425
cell 1539   1340   fill 803  -90   %% Added Lines for axial position 172.21075
cell 1540   1341   fill 803  -90   %% Axial Position to end at = 183.79425
cell 1541   1342   fill 803  -90   %% Axial Position to end at = 184.55625
cell 1542   1343   fill 803  -90   %% Added Lines for axial position 188.81075
cell 1543   1344   fill 803  -90   %% Added Lines for axial position 195.589375
cell 1544   1345   fill 803  -90   %% Axial Position to end at = 206.6225
```

```
cell 1545   1346    fill 803  -90   %% Axial Position to end at = 220.2625
cell 1546   1347    fill 803  -90   %% Added Lines for axial position 229.2625
cell 1547   1348    fill 803  -90   %% Added Lines for axial position 238.2625
cell 1548   1349    fill 803  -90   %% Axial Position to end at = 247.2625
cell 1549   1350    fill 803  -90   %% All the way to the top

%% BUILD complete CR element - outside CR
cell 1550   1300  fill 1301 51     -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 1551   1300  fill 1302 51 11   -250    %% Added Region
cell 1552   1300  fill 1302 51 250   -251    %% Added Region
cell 1553   1300  fill 1302 51 251   -12    %%  Oct graphite XS region 1 -- bottom
cell 1554   1300  fill 1303 51 12   -252    %% Added Region
cell 1555   1300  fill 1303 51 252   -13    %%  Oct graphite XS region 2 -- bottom
cell 1556   1300  fill 1304 51 13   -14    %%  square graphite bottom + air gap + Al clad
cell 1557   1300  fill 1305 51 14   -17    %%  axial interface
cell 1558   1300  fill 1306 51 17   -253    %% Added Region
cell 1559   1300  fill 1306 51 253   -18    %%  Fuel1 bottom
cell 1560   1300  fill 1307 51 18   -254    %% Added Region
cell 1561   1300  fill 1307 51 254   -255    %% Added Region
cell 1562   1300  fill 1307 51 255   -256    %% Added Region
cell 1563   1300  fill 1307 51 256   -257    %% Added Region
cell 1564   1300  fill 1307 51 257   -258    %% Added Region
cell 1565   1300  fill 1307 51 258   -259    %% Added Region
cell 1566   1300  fill 1307 51 259   -260    %% Added Region
cell 1567   1300  fill 1307 51 260   -261    %% Added Region
cell 1568   1300  fill 1307 51 261   -19    %%  Fuel2
cell 1569   1300  fill 1308 51 19   -262    %% Added Region
cell 1570   1300  fill 1308 51 262   -20    %%  Fuel1 top
cell 1571   1300  fill 1309 51 20   -23    %%  aixal interface
cell 1572   1300  fill 1310 51 23   -263    %% Added Region
cell 1573   1300  fill 1310 51 263   -264    %% Added Region
cell 1574   1300  fill 1310 51 264   -25    %%  square graphite w hole top + Oct graphite with
hole + air + Al clad
cell 1575   1300  fill 1311 51 25   -26    %%  Oct graphite XS region 2 -- top
cell 1576   1300  fill 1312 51 26   -265    %% Added Region
cell 1577   1300  fill 1312 51 265   -266    %% Added Region
cell 1578   1300  fill 1312 51 266   -27    %%  Oct graphite XS region 1 -- top
cell 1579   1300  fill 1313 51 27          %%  top fitting

%% BUILD complete CR element - inside CR
cell 1580   1300  fill 1321 -51      -11    %%  Steel Grid Plate + Aluminum bottom fitting
cell 1581   1300  fill 1322 -51 11   -250    %% Added Region
cell 1582   1300  fill 1323 -51 250   -251    %% Added Region
cell 1583   1300  fill 1324 -51 251   -12    %%  Oct graphite XS region 1 -- bottom
cell 1584   1300  fill 1325 -51 12   -252    %% Added Region
cell 1585   1300  fill 1326 -51 252   -13    %%  Oct graphite XS region 2 -- bottom
```

```
cell 1586   1300  fill 1327 -51 13   -14    %%  square graphite bottom + air gap + Al clad
cell 1587   1300  fill 1328 -51 14   -17    %%  axial interface
cell 1588   1300  fill 1329 -51 17   -253    %% Added Region
cell 1589   1300  fill 1330 -51 253   -18    %%  Fuel1 bottom
cell 1590   1300  fill 1331 -51 18   -254    %% Added Region
cell 1591   1300  fill 1332 -51 254   -255    %% Added Region
cell 1592   1300  fill 1333 -51 255   -256    %% Added Region
cell 1593   1300  fill 1334 -51 256   -257    %% Added Region
cell 1594   1300  fill 1335 -51 257   -258    %% Added Region
cell 1595   1300  fill 1336 -51 258   -259    %% Added Region
cell 1596   1300  fill 1337 -51 259   -260    %% Added Region
cell 1597   1300  fill 1338 -51 260   -261    %% Added Region
cell 1598   1300  fill 1339 -51 261   -19    %%  Fuel2
cell 1599   1300  fill 1340 -51 19   -262    %% Added Region
cell 1600   1300  fill 1341 -51 262   -20    %%  Fuel1 top
cell 1601   1300  fill 1342 -51 20   -23    %%  aixal interface
cell 1602   1300  fill 1343 -51 23   -263    %% Added Region
cell 1603   1300  fill 1344 -51 263   -264    %% Added Region
cell 1604   1300  fill 1345 -51 264   -25    %%  square graphite w hole top + Oct graphite with
hole + air + Al clad
cell 1605   1300  fill 1346 -51 25   -26    %%  Oct graphite XS region 2 -- top
cell 1606   1300  fill 1347 -51 26   -265    %% Added Region
cell 1607   1300  fill 1348 -51 265   -266    %% Added Region
cell 1608   1300  fill 1349 -51 266   -27    %%  Oct graphite XS region 1 -- top
cell 1609   1300  fill 1350 -51 27          %%  top fitting
```

Excel Data Tables

sss2_treat

Time Intervals	Power (MeV/sec)	Power (Watts)
0.05	5.04E+20	8.08E+07
0.1	2.69E+20	4.30E+07
0.15	1.36E+20	2.18E+07
0.2	1.95E+20	3.13E+07
0.25	2.70E+20	4.32E+07
0.3	1.72E+20	2.75E+07
0.35	1.41E+20	2.25E+07
0.4	1.14E+20	1.83E+07
0.45	1.57E+20	2.52E+07
0.5	3.90E+20	6.25E+07
0.55	9.80E+20	1.57E+08
0.6	8.50E+20	1.36E+08
0.65	3.72E+20	5.96E+07
0.7	4.96E+20	7.95E+07
0.75	1.16E+21	1.85E+08
0.8	4.50E+21	7.21E+08
0.85	1.88E+22	3.01E+09
0.9	1.99E+22	3.19E+09
0.95	7.25E+21	1.16E+09
1	6.31E+21	1.01E+09
1.05	1.78E+22	2.85E+09
1.1	1.76E+21	2.83E+08
1.15	1.31E+21	2.10E+08
1.2	1.27E+21	2.03E+08
1.25	6.89E+21	1.10E+09
1.3	1.09E+22	1.75E+09
1.35	1.96E+22	3.14E+09
1.4	5.83E+22	9.34E+09
1.45	5.83E+22	9.35E+09
1.5	6.69E+22	1.07E+10
1.55	6.72E+21	1.08E+09
1.6	1.16E+22	1.86E+09
1.65	7.73E+22	1.24E+10
1.7	7.54E+22	1.21E+10
1.75	6.68E+22	1.07E+10
1.8	6.49E+22	1.04E+10
1.85	3.31E+22	5.31E+09

1.9	6.91E+23	1.11E+11
1.95	2.01E+24	3.23E+11
2	1.35E+24	2.16E+11
2.05	3.59E+23	5.74E+10
2.1	2.39E+23	3.84E+10
2.15	2.26E+23	3.62E+10
2.2	4.64E+23	7.43E+10
2.25	3.29E+23	5.27E+10
2.3	7.47E+23	1.20E+11
2.35	1.27E+25	2.03E+12
2.4	2.89E+25	4.63E+12
2.45	1.47E+26	2.36E+13
2.5	5.15E+23	8.25E+10
2.55	3.44E+23	5.51E+10
2.6	1.60E+24	2.56E+11
2.65	1.58E+25	2.54E+12
2.7	8.18E+25	1.31E+13
2.75	5.06E+25	8.11E+12
2.8	3.29E+25	5.27E+12
2.85	1.59E+26	2.54E+13
2.9	3.54E+25	5.66E+12
2.95	6.86E+24	1.10E+12
3	4.27E+25	6.85E+12
Period:	3.78	0.264378382

L91-60-1

Time (seconds)	Energy Deposition MeV/sec	Energy Deposition (Watts)	Neutron Density
0.1	3.22E+12	1.30E-01	1.44E+07
0.2	3.02E+12	1.21E-01	1.37E+07
0.3	3.03E+12	1.22E-01	1.38E+07
0.4	4.27E+12	1.72E-01	1.92E+07
0.5	1.35E+13	5.45E-01	6.04E+07
0.6	4.52E+13	1.83E+00	2.01E+08
0.7	1.34E+14	5.42E+00	5.93E+08
0.8	4.60E+14	1.86E+01	2.06E+09
0.9	1.62E+15	6.53E+01	7.20E+09
1	5.68E+15	2.31E+02	2.55E+10
1.1	1.69E+16	6.81E+02	7.50E+10
1.2	5.57E+16	2.25E+03	2.48E+11
1.3	1.12E+17	4.52E+03	5.04E+11
1.4	5.82E+17	2.35E+04	2.56E+12

1.5	2.49E+18	1.00E+05	1.11E+13
1.6	3.77E+18	1.54E+05	1.75E+13
1.7	2.96E+18	1.21E+05	1.34E+13
1.8	1.20E+19	4.84E+05	5.32E+13
1.9	6.56E+19	2.65E+06	2.92E+14
2	2.18E+20	8.80E+06	9.68E+14
2.1	5.31E+20	2.14E+07	2.37E+15
2.2	3.16E+21	1.27E+08	1.37E+16
2.3	1.61E+22	6.50E+08	7.19E+16
2.4	6.58E+22	2.66E+09	2.93E+17
2.5	2.40E+23	9.63E+09	1.04E+18
2.6	8.74E+23	3.53E+10	3.90E+18
2.7	2.27E+24	9.15E+10	1.01E+19
2.8	7.21E+24	2.91E+11	3.19E+19
2.9	4.73E+25	1.91E+12	2.08E+20
3	1.92E+26	7.76E+12	8.54E+20

M8CAL (bad)

Time (seconds)	Neutron Population
0.025	2.60E+09
0.05	2.94E+09
0.075	6.01E+09
0.1	2.07E+10
0.125	9.33E+10
0.15	5.75E+11
0.175	2.59E+12
0.2	1.44E+13
0.225	8.71E+13
0.25	5.20E+14
0.275	4.57E+15
0.3	2.76E+16
0.325	2.22E+17
0.35	9.94E+17
0.375	6.66E+18
0.4	3.35E+19
0.425	1.12E+20
0.45	1.16E+21
0.475	8.05E+21
0.5	2.38E+22
0.525	9.04E+22

0.55	5.38E+23
0.575	4.01E+24
0.6	1.42E+25
0.625	5.77E+25
0.65	2.94E+26
0.675	7.50E+26
0.7	1.38E+27
0.725	8.22E+27
0.75	5.43E+28
0.775	1.70E+29
0.8	8.90E+29
0.825	4.41E+30
0.85	2.10E+31
0.875	3.68E+31
0.9	1.19E+32
0.925	2.20E+32
0.95	1.64E+33
0.975	1.72E+34
1	9.83E+34
1.025	2.44E+35
1.05	8.90E+35
1.075	2.25E+37
1.1	5.18E+37
1.125	6.50E+36
1.15	2.63E+37
1.175	1.19E+38
1.2	1.03E+39
1.225	4.28E+39
1.25	1.74E+40
1.275	9.19E+40
1.3	9.92E+40
1.325	2.47E+41
1.35	1.43E+42
1.375	1.22E+43
1.4	9.06E+43
1.425	5.86E+44
1.45	9.99E+45
1.475	4.84E+46
1.5	5.25E+47
1.525	3.86E+48
1.55	5.24E+49
1.575	3.63E+50
1.6	4.90E+50

1.625	1.96E+49
1.65	1.20E+50
1.675	1.04E+51
1.7	1.05E+51
1.725	3.54E+50
1.75	1.81E+50
1.775	8.26E+50
1.8	1.96E+51
1.825	4.12E+51
1.85	1.18E+52
1.875	2.91E+52
1.9	1.59E+53
1.925	1.06E+54
1.95	5.77E+54
1.975	2.40E+55
2	9.98E+55
2.025	5.35E+56
2.05	3.80E+57
2.075	1.83E+58
2.1	1.83E+58
2.125	8.33E+58
2.15	5.97E+59
2.175	1.27E+60
2.2	5.08E+60
2.225	3.90E+61
2.25	2.89E+62
2.275	1.49E+63
2.3	8.64E+63
2.325	5.54E+64
2.35	2.62E+65
2.375	2.51E+66
2.4	1.90E+67
2.425	7.39E+67
2.45	1.54E+68
2.475	4.03E+68
2.5	9.81E+68
2.525	5.37E+69
2.55	4.96E+70
2.575	5.73E+71
2.6	3.26E+72
2.625	3.31E+73
2.65	1.81E+74
2.675	6.82E+74

2.7	3.68E+75
2.725	2.88E+75
2.75	4.82E+73
2.775	4.34E+73
2.8	2.15E+73
2.825	1.79E+74
2.85	1.03E+75
2.875	8.14E+75
2.9	5.37E+76
2.925	4.60E+77
2.95	2.79E+78
2.975	8.65E+78
3	1.14E+79

1.5% delta k/k

Average Neutron Population	Average error	Average abs stdv	Average variance
5.27E+09	0.02068	1.09E+08	1.19E+16
6.97E+09	0.04275	2.98E+08	8.89E+16
1.15E+10	0.06111	7.00E+08	4.91E+17
2.16E+10	0.08417	1.82E+09	3.31E+18
4.03E+10	0.11313	4.56E+09	2.07E+19
1.23E+11	0.13474	1.66E+10	2.76E+20
1.12E+11	0.16141	1.81E+10	3.29E+20
1.46E+11	0.18199	2.65E+10	7.02E+20
2.38E+11	0.20613	4.90E+10	2.40E+21
3.98E+11	0.23452	9.33E+10	8.70E+21
6.29E+11	0.26517	1.67E+11	2.78E+22
1.14E+12	0.30699	3.51E+11	1.23E+23
3.02E+12	0.36681	1.11E+12	1.23E+24
6.73E+12	0.40246	2.71E+12	7.33E+24
5.77E+12	0.43332	2.50E+12	6.25E+24
1.06E+13	0.47596	5.06E+12	2.56E+25
1.26E+13	0.50186	6.33E+12	4.01E+25
2.15E+13	0.52576	1.13E+13	1.27E+26
2.80E+13	0.53988	1.51E+13	2.28E+26
5.23E+13	0.56570	2.96E+13	8.77E+26
6.76E+13	0.55486	3.75E+13	1.41E+27
1.52E+14	0.58830	8.93E+13	7.97E+27
1.13E+15	0.59657	6.73E+14	4.52E+29
1.17E+16	0.59556	6.99E+15	4.89E+31

5.24E+15	0.61344	3.21E+15	1.03E+31
4.59E+15	0.60329	2.77E+15	7.68E+30
6.48E+15	0.60399	3.91E+15	1.53E+31
3.94E+15	0.60911	2.40E+15	5.77E+30
7.39E+15	0.60807	4.49E+15	2.02E+31
2.17E+16	0.60948	1.32E+16	1.75E+32
1.16E+16	0.62177	7.24E+15	5.24E+31
1.07E+16	0.63698	6.80E+15	4.62E+31
1.24E+16	0.66668	8.26E+15	6.82E+31
1.37E+16	0.67706	9.28E+15	8.62E+31
1.71E+16	0.67616	1.16E+16	1.34E+32
3.35E+16	0.67187	2.25E+16	5.06E+32
9.19E+16	0.66837	6.14E+16	3.77E+33
9.85E+16	0.68009	6.70E+16	4.49E+33
5.11E+16	0.69992	3.58E+16	1.28E+33
8.83E+16	0.69521	6.14E+16	3.77E+33

Slope	7.730836262
Period (seconds)	0.130471925
Standard Deviation	0.01231

Power (Average)	Error	Average abs stdv	Average variance
5092.415	0.0218512	1.112753786	1.238220989
6807.224118	0.04358	2.96658827	8.800645966
11244.85706	0.061818	6.951345737	48.32120755
21179.03235	0.0850918	18.02161985	324.7787821
39772.74412	0.1137942	45.25907599	2048.383959
127042.3794	0.135614	172.2872524	29682.89734
106325.9735	0.1619184	172.1613151	29639.51842
142406.2853	0.1828388	260.3739432	67794.59027
231655.0294	0.2069022	479.2993523	229727.8691
389277	0.2358892	918.2624011	843205.8372
614892.4412	0.2666606	1639.675873	2688536.968
1123785.206	0.3087014	3469.140664	12034936.94
2973915.882	0.3685826	10961.33648	120150897.4
6438674.735	0.402657	25925.77453	672145784.9
5668130.353	0.4339446	24596.54559	604990054.8
10535226.18	0.4768028	50232.2534	2523279281
12330345	0.5029108	62010.63668	3845319062
20696506.76	0.5250492	108666.8432	11808482810
27569935.59	0.5408332	149107.3649	22233006261

51491279.41	0.5653564	291109.2436	84744591707
65791970.59	0.5548076	365018.853	1.33239E+11
156493556.5	0.5899896	923295.7078	8.52475E+11
1168518456	0.5956318	6960067.512	4.84425E+13
12377531915	0.5958094	73746498.64	5.43855E+15
4418393494	0.6120482	27042697.85	7.31308E+14
4672659632	0.6021964	28138588.09	7.9178E+14
6211907203	0.6034712	37487070.94	1.40528E+15
3883156244	0.6085154	23629603.75	5.58358E+14
7175043426	0.6080148	43625325.94	1.90317E+15
22725918100	0.609663	138551514.1	1.91965E+16
9346881491	0.623082	58238736.13	3.39175E+15
10376583891	0.6374154	66141943.72	4.37476E+15
11740334676	0.6679816	78423275.42	6.15021E+15
13396724265	0.6773466	90742256.32	8.23416E+15
16435244676	0.6748678	110916174.2	1.23024E+16
33652780971	0.6728758	226441419.2	5.12757E+16
88940699765	0.6688252	594857813.1	3.53856E+17
94755332118	0.6804478	644760572.8	4.15716E+17
50200974294	0.7003766	351595876.9	1.2362E+17
86919280206	0.694878	603982955.9	3.64795E+17

Slope	7.735570338
Period (seconds)	0.130399765
Standard Deviation	0.012350098

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