SAND2015-5358R

NEUTRON REFERENCE BENCHMARK FIELD SPECIFICATION: ACRR POLYETHYLENE-LEAD-GRAPHITE (PLG) BUCKET ENVIRONMENT (ACRR-PLG-CC-32-CL)

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ABSTRACT

This report was put together to support the International Atomic Energy Agency (IAEA) REAL-2016 activity to validate the dosimetry community's ability to use a consistent set of activation data and to derive consistent spectral characterizations. The report captures details of integral measurements taken in the Annular Core Research Reactor (ACRR) central cavity with the Polyethylene-Lead-Graphite (PLG) bucket, reference neutron benchmark field. The field is described and an "a priori" calculated neutron spectrum is reported, based on MCNP6 calculations, and a subject matter expert (SME) based covariance matrix is given for this "a priori" spectrum. The results of 37 integral dosimetry measurements in the neutron field are reported.

Key Words: Spectrum Adjustment, Spectrum Unfolding, Reactor Dosimetry

1 FIELD DESCRIPTION

The ACRR is a pulse and steady-state, pool-type research reactor that maintains a large, dry irradiation cavity at the center of its core. The ACRR is typically used to perform irradiation testing where a high neutron fluence is required for a short period of time. Historically, the ACRR has been used for a wide variety of experiment campaigns including electronics damage testing, nuclear fuels testing, space nuclear thermal propulsion testing, and medical isotope production. The ACRR is currently fully operational. The ACRR's main attributes include a large, dry central irradiation cavity, epithermal neutron fluence, and large pulsing capabilities.

Figure 1 shows the ACRR looking into the pool during a 2 MW steady-state power operation. The ACRR core is shown on the left in the figure. The 23.3 cm diameter dry cavity extends from above the pool through the center of the core. The reactor facility also accommodates the fueled ring external cavity-II (FREC-II), shown on the right in the figure, which maintains a larger dry cavity and uses uranium/zirconium-hydride (U-ZrH) TRIGA fuel as a subcritical multiplier. FREC-II provides the user with a larger experimental volume and the fuel arrangement limits the neutron fluence gradient across the test volume.

*Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Figure 1. The ACRR and FREC-II operating at 2-MW steady-state power.

The ACRR maintains an epithermal neutron fluence spectrum in the core and central cavity. This allows for the neutron energy fluence spectrum to be tailored to the desired specifications of an experiment by introducing various spectrum modifying buckets. Moderators can be used within the cavity to thermalize the neutron spectrum. Boron and lead can be used to increase the fast neutron fluence ratio and decrease the gamma-ray fluence, respectively. For an unmoderated condition, the neutron fluence at the center of the central cavity, at the core axial center-line, is $\approx 2.0\times10^{13}$ n/cm^2 per MJ of reactor energy. About 46% of the neutron fluence is above 100 keV and 58% above 10 keV. The 1 MeV damage-equivalent silicon fluence is $\approx 7.6\times10^{12}$ n/cm^2 per MJ of reactor energy. The prompt gamma-ray dose at the same position is $\approx 7.9\times10^{3}$ rad(Si) per MJ. The delayed gamma-ray dose is $\approx 3.4\times10^{3}$ rad(Si) per MJ.

The ACRR can operate in a steady-state, transient, or pulse mode. In the steady-state mode, the operating power level is limited to 4 MW. In the pulse mode, a maximum pulse size of 250 MJ with a full-width half-maximum (FWHM) of 6 ms can be attained. In the transient mode, the reactor power shape can be tailored to the desired requirements for a total reactor energy deposition of 300 MJ. The transient mode can be used to increase the reactor power quickly; for example a ramp increase in power level linear with time from low power to high power. The ACRR is fueled by a 236 element array of UO_2-BeO fuel elements. The fuel is uranium enriched to 35 weight percent ^{235}U, with 21.5 weight percent UO_2 and 78.5 weight percent BeO. The ACRR fuel elements are stainless steel clad, 3.747 cm in outer diameter and 52.25 cm in fuel length. Within the elements are niobium cups that hold the UO_2BeO fuel pieces. The ACRR is controlled by two fuel-followed safety rods, three poison (void-followed) transient rods, and six fuel-followed control rods. The

control rods make up part of the 236 elements for the normal core configuration. Further information regarding the ACRR can be found in SAND2006-3067 [1].

There are two PLG buckets, PLG-1 and PLG-2, that are identical in design and construction. The purpose of the PLG bucket is to fit within the 23.3 cm diameter ACRR central cavity and partially thermalize the neutron fluence while attenuating, to some degree, the gamma-ray fluence. This produces a larger thermal neutron fluence environment, a lower 1-MeV damage equivalent in silicon neutron fluence, and a lower gamma-ray fluence as compared to the free-field (no bucket) environment. This environment has been used extensively in the past by facility experimenters. The PLG bucket configuration maintains and inner irradiation diameter of about 18 cm and an overall height of about 79 cm. The two PLG buckets were designed and constructed in CY1995. The PLG design contains an outer annular volume filled with high density polyethylene, an annulus of lead, and an inner annulus of graphite. A drawing of the PLG-1 bucket is shown in Figure 2. The bucket weighs approximately 45.4 kg and can support an additional experiment payload of up to 113.4 kg. A thermocouple fixture can be inserted into the polyethylene region of the bucket to measure temperature as a function of time at power, thus permitting use during long steady-state irradiations. The bucket can be operated at up to 200 MJ in an un-instrumented (no TC) condition. The measured reactivity worth of the PLG bucket, compared to the free-field condition, is about +$0.75.

This document presents the benchmark data necessary to perform a spectrum adjustment for the ACRR PLG-1 environment. The designation for this environment is ACRR-PLG-CC-32-cl. The necessary data includes an "a priori" spectrum with associated uncertainties and correlations, and the measured activities of neutron activation foils irradiated in the environment. Table I details the set of spectrum characterization irradiations that were performed in 2013 in order to characterize this neutron field for electronics damage testing. When gathering spectrum characterization data, a series of separate reactor operations were used. High purity germanium (HPGe) detectors were used for reading the dosimetry foils. Typically the detectors will yield values for the activity of the same foil that are reproducible to within 1-3%. If detector counts total more than 10^4 and background counts are low so that statistical uncertainties are small, then the uncertainty of an activity measurement is less than $\approx 5\%$. Cadmium and boron covers were used to alter the region of energy response for some of the activation foils. The boron balls were large enough to alter the neutron field in the surrounding region, so each boron-covered activation foil was exposed on a separate operation. Fission foils were not stacked in the boron ball since previous testing had shown that the neutron scattering between adjacent fission foils thermalized enough neutrons to alter the dosimeter response of ^{235}U and ^{239}Pu foils. The ^{58}Ni(n,p) reaction was used to normalize the separate reactor operations to a uniform neutron fluence. Hence, every irradiation contained at least one Ni foil for the purpose of normalization.

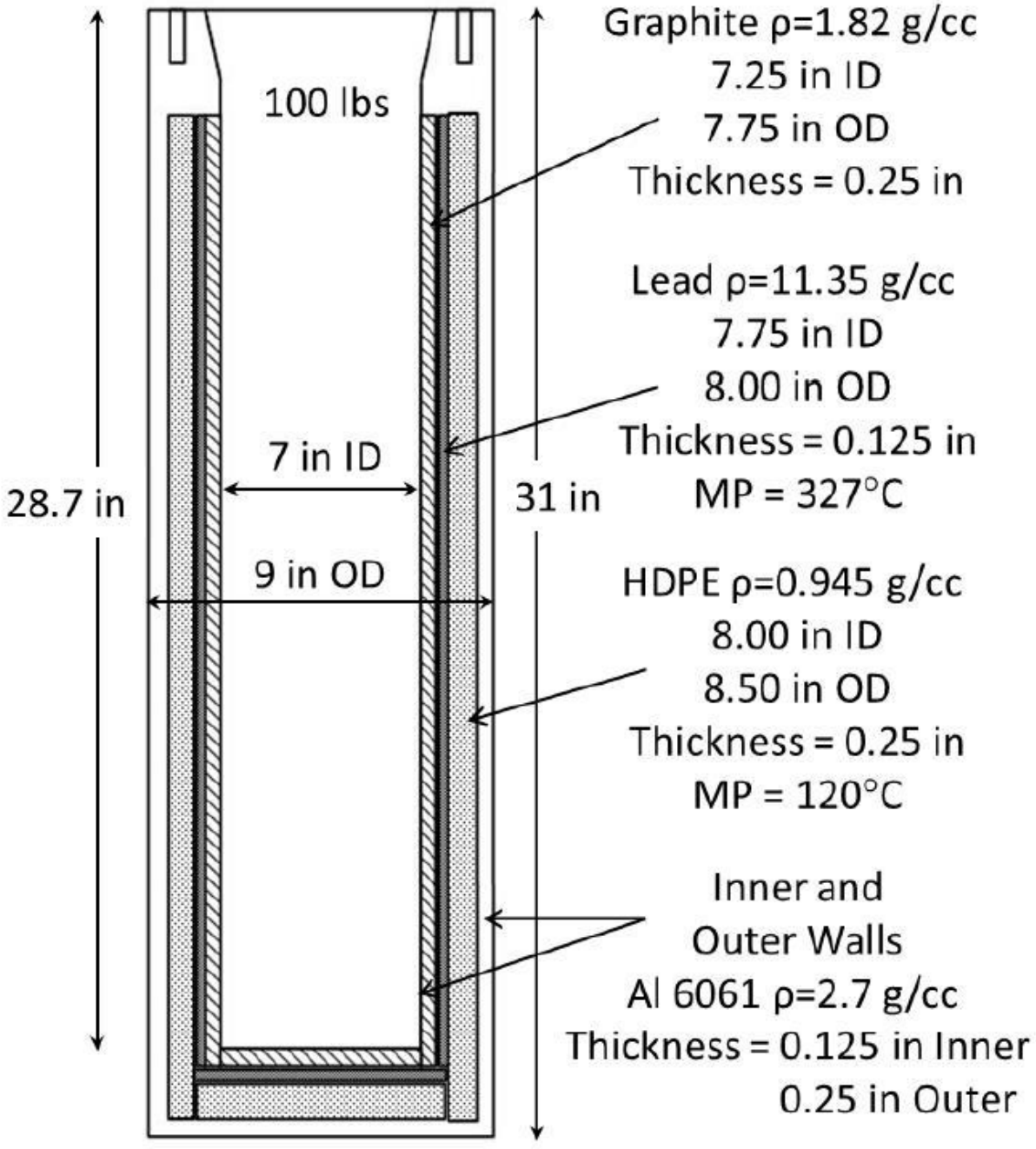


Figure 2. Details of the PLG-1 bucket.

Table I. Irradiations performed to characterize the ACRR PLG-1 environment for experimenters.

Date	Shot number	Type	Reactor energy	Description
6/25/2013	10530	Pulse	140.7 MJ	Axial flux mapping via sulfur tablets at 1 cm increments along the axis of the central cavity
7/11/2013	10547	Pulse	140.5 MJ	Radial flux mapping using sulfur and dilute gold tablets at the axial fuel centerline
6/25/2013	10532	Pulse	70.0 MJ	Axial gamma flux mapping via TLDs at 1 cm increments along the axis of the central cavity
6/27/2013	10535	Pulse	143.8 MJ	Activation foil set 1: Co, Fe, Sc, Ni, and Ti
7/1/2013	10537	Steady State	146.2 MJ	Activation foil set 1: Co, Fe, Sc, Ni, and Ti
6/27/2013	10536	Pulse	145.2 MJ	Activation foil set 2: Zr, Mo, Ag, Au, Au, Au-dilute, and W
7/3/2013	10538	Pulse	139.8 MJ	Activation foil sets 3 and 4: Na, Mg, Mn, Fe, Cu, Zn, In, Nb, and Al
7/8/2013	10541	Pulse	142.3 MJ	Cd covered activation foil sets 5 and 6: Co, Fe, Sc, Ni, Mo, Ag, Au, and Au-dilute
7/9/2013	10542	Pulse	139.4 MJ	Cd covered activation foil sets 7 and 8: Na, Mg, Mn, Fe, In, Cu
7/10/2014	10544	Pulse	144.4 MJ	Depleted U activation foil in Cd cover and B_4C ball
7/10/2014	10545	Pulse	140.6 MJ	Enriched U activation foil in Cd cover and B_4C ball
7/11/2014	10546	Pulse	143.1 MJ	Pu activation foil in Cd cover and B_4C ball

2 MCNP MODEL OF THE REACTOR ENVIRONMENT

High fidelity calculations were performed to provide the best possible calculated neutron spectrum. This is the spectrum that should be used as input to various spectrum adjustment codes, or as the trial spectrum in iterative unfolding codes. The radiation transport was performed with the continuous energy, three dimensional Monte Carlo particle transport code MCNP [2]. The MCNP model of the ACRR with the PLG-1 bucket on the 32-inch pedestal is shown in Figure 3. The MCNP input file is included in Appendix A of this document.

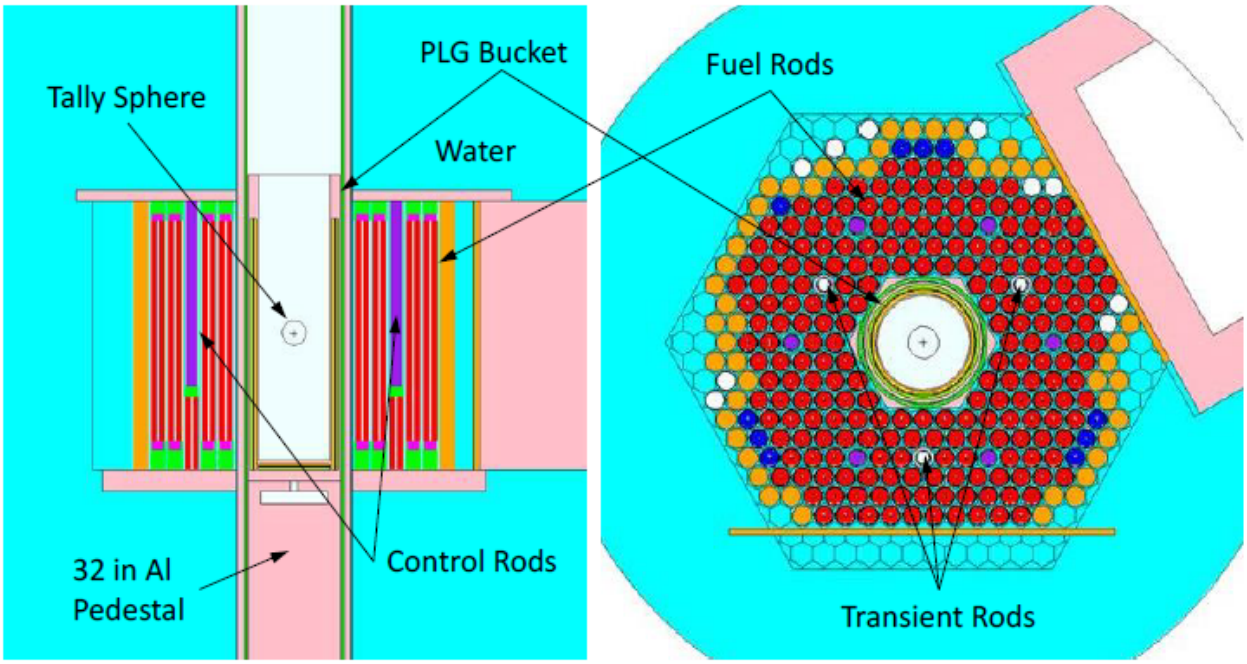


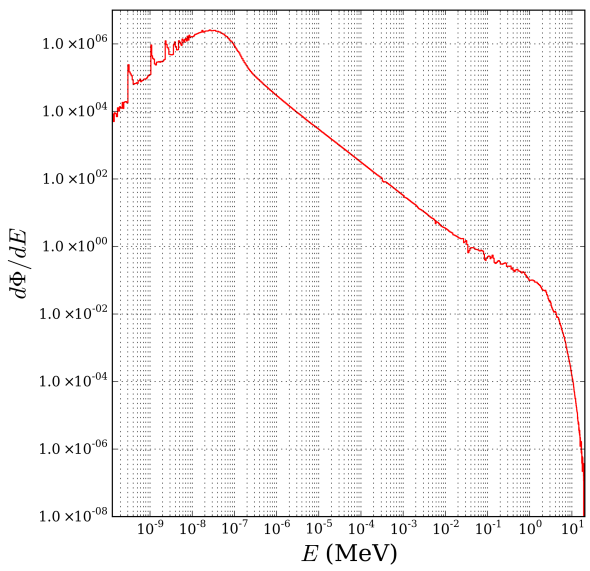
Figure 3. MCNP model of the ACRR and the central cavity with the PLG-1 bucket on the 32-inch pedestal.

The model does not include the FREC-II. The reason for this is that, although the FREC-II is located within the core tank, the normal operating mode is to have it tilted back and decoupled from the core using a nickel plate. In this position the FREC-II has only a small effect on the neutronic behavior of the ACRR. The MCNP model of the ACRR includes all of the fuel elements and the control, safety, and transient rods that make up the core. The control, safety, and transient rods can be adjusted in the vertical direction in the model to whatever position is desired. Typically, the model is run with the safety and transient rods in the full-out position and the control rods in the full-out, full-in, or delayed critical (dc) position. The calculated dc position can be found for the model by iterating on the control rod position until the multiplication factor is equal to unity.

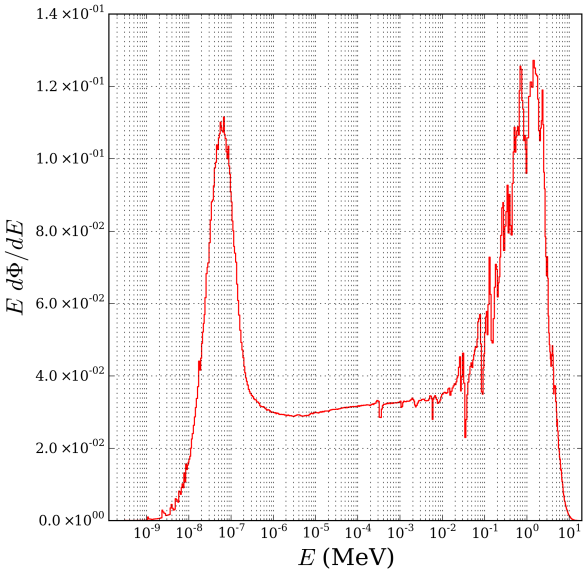
Neutron, prompt gamma-ray, and delayed gamma-ray energy spectra and fluence per fission were calculated using a 6 cm diameter tally sphere. For the ACRR-PLG-CC-32-cl position, the sphere was positioned at the radial center of the cavity and at the axial center-line of the core. Calculations were performed using the MCNP k-code mode for the neutron and prompt gamma-ray environments, and in the source mode for the delayed gamma-ray environment.

3 CALCULATED TRIAL SPECTRUM

Included in Appendix B is a 640 group representation of the calculated ACRR PLG-1 neutron spectrum normalized to a fluence of 1 n/cm^2. The energy grid is the SAND 640 group structure. The spectrum is given in various representations. This spectrum was calculated using the MCNP input model given in Appendix A. The statistical uncertainties in the Monte Carlo calculation were less than 10% for energies above 7×10^{-10} MeV and below 14.4 MeV. They were less than 1% for energies above 4.5×10^{-9} MeV and below 8.2 MeV. The number fractions in column 5 of the table sum to unity. The differential number spectrum is shown in Figure 4a. These quantities, appearing in column 7 of the spectrum table in Appendix B, when integrated over energy, give unity. Figure 4b shows the differential energy spectrum, also known as a lethargy plot. In a lethargy plot, equal areas under the curve correspond to equal neutron number fractions when plotted with a linear scale for the ordinate and a logarithmic scale for the abscissa.



(a) Differential number spectrum



(b) Differential energy spectrum

Figure 4. Calculated spectrum in the ACRR PLG-1 bucket environment.

4 "A PRIORI" SPECTRUM COVARIANCE

An "a priori" spectrum covariance matrix was derived using the methods detailed in reference [3] and subject-matter expertise. The data needed to construct the covariance matrix is given in Appendix C. The representation is consistent with the format used in the LSL-M2 code [4]. To capture the covariance matrix, the number of energy groups is given, followed by the energy bin boundaries, the number fraction representation of the spectrum in this energy group structure, the standard deviations of the "a priori" spectral representation given as relative percentages, and finally an upper triangular representation of the relative correlation matrix. This information is given in Appendix C for an energy group structure containing 89 groups. This 89 group structure is used in the NuGET code [5]. From these inputs a covariance matrix can be constructed. Figure 5 shows the relative correlation matrix indexed by the energy bin number.

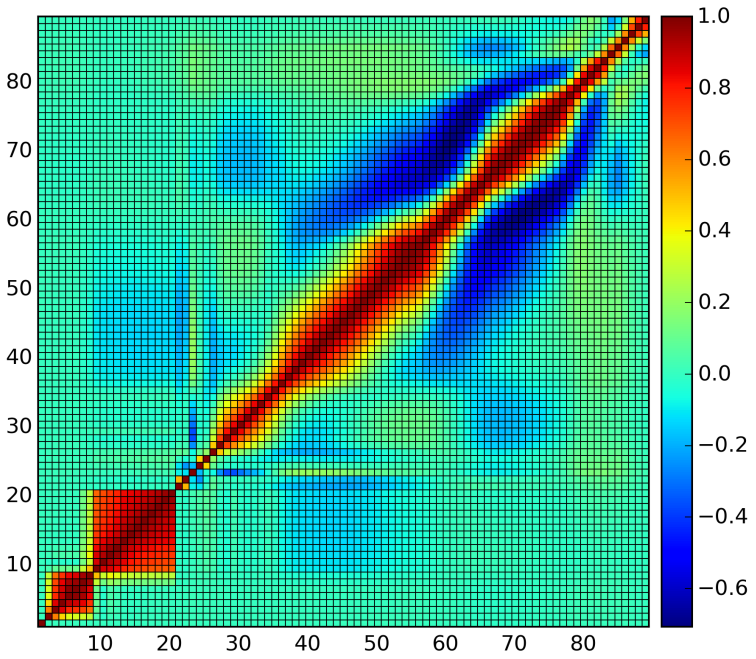


Figure 5. "A priori" energy dependent relative correlation matrix.

The correlation matrix given in Appendix C, which is plotted above is positive definite. The eigenvalues for this matrix in decreasing order are: 14.8981300, 12.2849300, 10.0621200, 7.7950160, 5.9110270, 5.3517120, 4.8017120, 3.3126650, 2.6560090, 2.5149120, 2.0359850, 1.6995120, 1.5272690, 1.1547350, 1.0825790, 0.9996860, 0.9817168, 0.8736243, 0.8227887, 0.7263104, 0.5934130, 0.5249314, 0.5058728, 0.4294668, 0.3796267, 0.3622244, 0.3112166, 0.2968668, 0.2799906, 0.2513204, 0.2475556, 0.2170641, 0.2003623, 0.1774060, 0.1735353, 0.1559922, 0.1546250, 0.1415990, 0.1251129, 0.1224620, 0.1130707, 0.1044534, 0.1036463, 0.0964680, 0.0908926, 0.0906644, 0.0846754, 0.0782366, 0.0708390, 0.0648958, 0.0631134, 0.0563052, 0.0518462, 0.0508790, 0.0471177, 0.0453902, 0.0419312, 0.0381065, 0.0353970, 0.0346231, 0.0323773, 0.0304041, 0.0302616, 0.0283036, 0.0271123, 0.0266694, 0.0247934, 0.0245922, 0.0237395, 0.0234506, 0.0221410, 0.0213517, 0.0202276, 0.0191136, 0.0178306, 0.0168899, 0.0166768, 0.0150095, 0.0146645, 0.0130603, 0.0103949, 0.0088689, 0.0081492, 0.0062384, 0.0047913, 0.0032360, 0.0023521, 0.0016471, 0.0000007.

5 MEASURED ACTIVITIES WITH UNCERTAINTIES

Table III lists a set of 37 reactions and associated covers where good measurements were made during this spectral characterization effort. In general, the saturated activity is given in units of Bq per atom of the target isotope or as fissions per atom of the target fissionable isotope. Any special considerations are addressed in the next section. The uncertainty is given as a fractional uncertainty, e.g. an entry of "0.045" means that this activity measurement had an uncertainty of 4.5% due to systematic and random considerations. Uncertainty considerations included the calibration of the energy-dependent HPGe detector, reproducibility of the foil placement on the counter, counting statistics, and the peak fitting algorithm.

Table III. Measured activities for 37 reactions resulting from 20 different activation foils irradiated in the PLG-1 environment of the ACRR central cavity.

Number	Reaction	Cover	Activity (Bq/atom) or (fissions/atom)	Relative uncertainty
1	^{58}Ni(n,p)^{58}Co	Bare	7.7936×10^{-18}	0.017
2	^{24}Mg(n,p)^{24}Na	Bare	9.8561×10^{-18}	0.018
3	^{27}Al(n,α)^{24}Na	Bare	4.8547×10^{-18}	0.022
4	^{32}S(n,p)^{32}P	Bare	2.2756×10^{-17}	0.036
5	^{46}Ti(n,p)^{46}Sc	Bare	6.1277×10^{-19}	0.016
6	^{47}Ti(n,p)^{47}Sc	Bare	3.0287×10^{-17}	0.031
7	^{48}Ti(n,p)^{48}Sc	Bare	7.1657×10^{-19}	0.010
8	^{55}Mn(n,2n)^{54}Mn	Bare	3.5325×10^{-21}	0.202
9	^{54}Fe(n,p)^{54}Mn	Bare	1.2772×10^{-18}	0.027
10	^{56}Fe(n,p)^{56}Mn	Bare	4.6190×10^{-17}	0.018
11	^{59}Co(n,p)^{59}Fe	Bare	1.4707×10^{-19}	0.027
12	^{59}Co(n,2n)^{58}Co	Bare	1.2657×10^{-20}	0.181
13	^{58}Ni(n,2n)^{57}Ni	Bare	1.1537×10^{-20}	0.062
14	^{60}Ni(n,p)^{60}Co	Bare	5.2239×10^{-21}	0.031
15	^{63}Cu(n,α)^{60}Co	Bare	1.4983×10^{-21}	0.079
16	^{64}Zn(n,p)^{64}Cu	Bare	3.7146×10^{-16}	0.030
17	^{90}Zr(n,2n)^{89}Zr	Bare	1.4115×10^{-19}	0.030
18	^{93}Nb(n,2n)^{92m}Nb	Bare	1.9054×10^{-19}	0.012
19	^{115}In(n,n')^{115m}In	Bare	7.0790×10^{-15}	0.056
20	^{23}Na(n,γ)^{24}Na	Bare	3.9324×10^{-15}	0.021
21	^{45}Sc(n,γ)^{46}Sc	Bare	1.6579×10^{-15}	0.007
22	^{58}Fe(n,γ)^{59}Fe	Bare	1.6831×10^{-16}	0.014
23	^{59}Co(n,γ)^{60}Co	Bare	1.1350×10^{-16}	0.014
24	^{63}Cu(n,γ)^{64}Cu	Bare	5.0078×10^{-14}	0.031
25	^{98}Mo(n,γ)^{99}Mo	Bare	2.5304×10^{-15}	0.012
26	^{197}Au(n,γ)^{198}Au	Bare	7.1560×10^{-13}	0.018
27	^{23}Na(n,γ)^{24}Na	Cd[†]	4.1746×10^{-16}	0.013
28	^{45}Sc(n,γ)^{46}Sc	Cd	1.2948×10^{-16}	0.013
29	^{55}Mn(n,γ)^{56}Mn	Cd	1.1075×10^{-13}	0.017
30	^{58}Fe(n,γ)^{59}Fe	Cd	2.6925×10^{-17}	0.021
31	^{59}Co(n,γ)^{60}Co	Cd	2.2206×10^{-17}	0.015
32	^{63}Cu(n,γ)^{64}Cu	Cd	7.5389×10^{-15}	0.031
33	^{98}Mo(n,γ)^{99}Mo	Cd	2.3306×10^{-15}	0.011
34	^{197}Au(n,γ)^{198}Au	Cd	5.3238×10^{-13}	0.018
35	^{235}U(n,f)FF	BB	2.5730×10^{-9}	0.020
36	^{238}U(n,f)FF	BB	2.1936×10^{-10}	0.021
37	^{239}Pu(n,f)FF	BB	2.5696×10^{-9}	0.020

[†] The Cd cover for the Na reaction was actually of the thicker type placed in the boron balls for the fission foils due to the dosimeter's pellet shape.

6 FOIL COVERS AND SELF-SHIELDING CONSIDERATIONS

The covers used for some of the foils are shown in Figure 6. Included in this figure is the stand that was used to hold the boron balls at the axial core center-line during irradiation. The notation for the covers as indicated in Table III is explained in the following list:

- The configuration notated as "Bare" represents a foil with no cover material, with a thickness between 5 and 10 mils.
- The configuration notated as "Cd" consists of a cylindrical Cadmium cover with an areal thickness of 2.587×10^{-3} atoms/barn.
- The configuration notated as "BB" consists of an inner thick Cadmium cover with an areal thickness of 4.705×10^{-3} atoms/barn and an outer spherical boron ball. The boron ball is a spherical shell with an outer diameter of 4.76 cm and thickness of 1.03 cm. The B_4C has a density of 2.5 g/cm^3 with enriched Boron (91.67% ^{10}B and 8.33% ^{11}B).

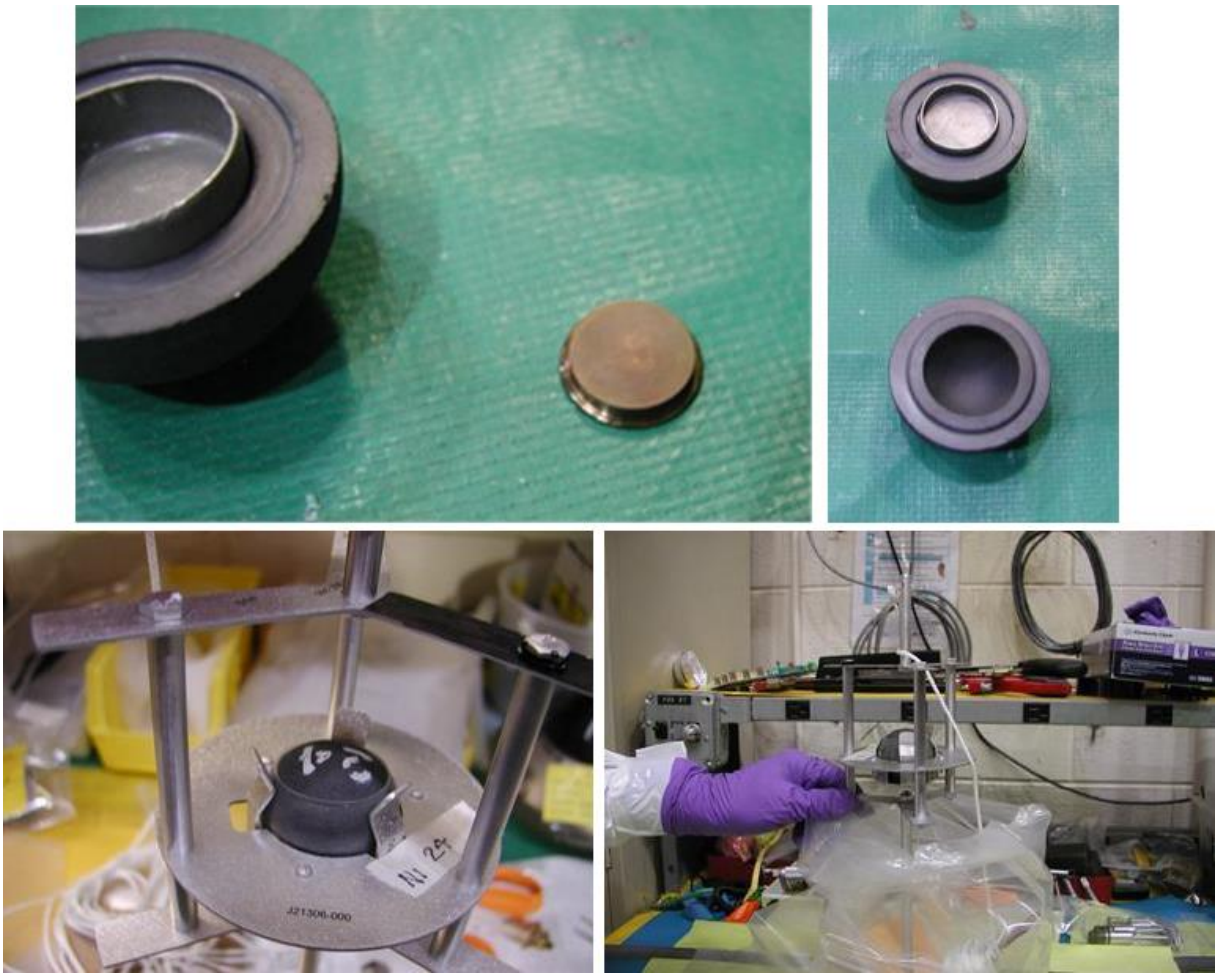


Figure 6. Boron ball and cadmium cover configuration with irradiation stand.

A detailed description of the covers and a discussion of how self-shielding effects are rigorously addressed in Sandia's use of activation measurements to characterize the spectra in our facilities can be found in reference [6]. The energy dependent cover corrections and self-shielding factors are available from the authors in the form of a spreadsheet for each of the reactions listed in Table III.

Some foils may have more than one reaction path that results in the same residual product. The following items provide detail that support taking this into consideration in any analysis:

- The ^{46}Ti(n,p)^{46}Sc entry measured the ^{46}Sc product and represents the ^{nat}Ti(n,X)^{46}Sc reaction. The activity is reported per atom of the ^{46}Ti in the foil.
- The ^{47}Ti(n,p)^{47}Sc entry measured the ^{47}Sc product and represents the ^{nat}Ti(n,X)^{47}Sc reaction. The activity is reported per atom of the ^{47}Ti in the foil.
- The ^{48}Ti(n,p)^{48}Sc entry measured the ^{48}Sc product and represents the ^{nat}Ti(n,X)^{48}Sc reaction. The activity is reported per atom of the ^{48}Ti in the foil.
- The ^{63}Cu(n,γ)^{64}Cu entry measured the ^{64}Cu product and represents the combination of the ^{63}Cu(n,γ) and ^{65}Cu(n,2n) reactions in a copper foil with the natural abundances of the isotopes. The activity is reported per atom of the ^{63}Cu in the foil.
- The ^{238}U(n,f)FF entry measured the total fissions in a depleted uranium oxide foil, a sintered UO_2 foil measuring 0.5 inch by 0.03 inch. The activity is reported per atom of the ^{238}U in the foil. The foil had a nominal mass of 1.3 gram (total pellet mass). The oxide/metal ratio in the foil was 1.995. The isotopic mix in the depleted uranium foil is given in Table IV.

Table IV. Isotopic mix of depleted uranium foil.

Isotope	Atom Fraction
^{238}U	0.99790
^{234}U	0.00001
^{235}U	0.00205
^{236}U	0.00004

- The ^{235}U(n,f)FF entry measured the total fissions in an enriched uranium oxide foil, a sintered UO_2 foil measuring 0.5 inch by 0.03 inch. The activity is reported per atom of the ^{235}U in the foil. The foil had a nominal mass of 1.0 gram (total pellet mass). The oxide/metal ratio in the foil was 1.990. The isotopic mix in the enriched uranium foil is given in Table V.

Table V. Isotopic mix of enriched uranium foil.

Isotope	Atom Fraction
^{235}U	0.93000
^{234}U	0.00981
^{236}U	0.00359
^{238}U	0.05660

- The ^{239}Pu(n,f)FF entry measured the total fissions in a plutonium oxide foil. The activity is reported per atom of the ^{239}Pu in the foil. The foil had a nominal mass of 1.2 gram (total pellet mass). The oxide/metal ratio in the foil was 1.886. The isotopic mix of metal (fissionable isotopes) in the plutonium foil is given in Table VI.

Table VI. Isotopic mix of plutonium foil.

Isotope	Atom fraction
239Pu	0.869965000
238Pu	0.000679800
240Pu	0.115968688
241Pu	0.010797000
242U	0.002359360
235U	0.000199946
237Np	0.000029990

Note: Atom fractions sum so that the number of atoms of the prime sensor element, plutonium, is unity. Due to the contaminants, the total sum above is greater than 1.0.

7 CORRELATION BETWEEN MEASURED ACTIVITIES

At this time there has been no analysis to identify a correlation between activity measurements. While the energy-dependent calibration and the use of the same foil for reading several activity products will introduce some correlation in the uncertainty contributions, the dominant uncertainty contribution is in the counting statistics, peak fitting and the background. The current recommendation is that these activity measurements can be treated as being uncorrelated. Future work at the facility will focus on a better characterization of any correlation between activity measurements.

8 SUMMARY

This report has documented a set of data that can be used as part of the REAL-2016 IAEA-sponsored exercise to examine the consistency of state-of-the-art approaches to spectrum adjustment when applied to the PLG-1 environment in the ACRR central cavity reference neutron field. Other validation data exists for this benchmark neutron field [7], but this report captures all the field characterization data relevant to this IAEA exercise.

9 REFERENCES

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APPENDIX A MCNP INPUT FILE FOR THE ACRR PLG-1 ENVIRONMENT

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STANDARD ACRR Model (Extended Cavity, 32" Pedestal, Pb-B4C Bucket)
C
C  Origianl Model Developed by W. Fan
C  Modified by P. Cooper and E. Parma with new cavity
C  Macrobody Model Developed by R. DePriest
C  New 44" Pb-B4C Bucket LB44 Model Developed by T. Trinh
C
C
C     standard 236-element core configuration with new cavity
C     no FREC
C     room temp 70c cross sections with S(a,b)
C     LB-44-cl-32 - 44inch lead/boron bucket on 32inch pedestal
C     tally is a 6cm diameter sphere at fuel centerline
C         89 and 640 neutron energy groups
C         48 gamma energy groups
C
C       control rods   : variable
C       safety rods    : variable
C       transient rods : variable
C
C
C        1         2         3         4         5         6         7         8
C 34567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
C ********************************************************************************
C *                               CELL CARDS                                     *
C ********************************************************************************
C
C
C  Universe definitions for the standard 236-element core.
C
C     U=1:fuel rods              U=2:water rods
C     U=3:control rods           U=4:safety rods
C     U=5:transient rods         U=6:nickel rods
C     U=7:90% fuel rods          U=9:al rods (empty)
C
C   ********  U=8 is the reactor core fill.  *******
C
C
C  Regular Fuel Elements
C
10  0            -10              U=1  IMP:N,P=1 $Void
11  1   -3.3447    10 -11          U=1  IMP:N,P=1 $UO2-BeO fuel
14  0             11 -14          U=1  IMP:N,P=1 $Void
15  2   -8.4000    14 -15          U=1  IMP:N,P=1 $Niobium
16  0             15 -16          U=1  IMP:N,P=1 $Void Gap
17  4   -2.8000   -17              U=1  IMP:N,P=1 $Lower BeO Plug
18  4   -2.8000   -18              U=1  IMP:N,P=1 $Upper BeO Plug
19  3   -8.0300    17 -19          U=1  IMP:N,P=1 $Lower SS Plug
20  3   -8.0300    18 -20          U=1  IMP:N,P=1 $Upper SS Plug
21  3   -8.0300    19  20  16 -21  U=1  IMP:N,P=1 $SS304
22  5   -1.0000    21 -22          U=1  IMP:N,P=1 $Water
C
C
C  Water Rods
C
23  5   -1.0000   -22              U=2  IMP:N,P=1 $Water
C
C
C  Control Rods:  Poison section
C
25  8   -2.4800   -25              U=3  IMP:N,P=1 $B4C poison
26  0             25 -26          U=3  IMP:N,P=1 $Void Cap
27  3   -8.0300    26 -27          U=3  IMP:N,P=1 $Poison sleeve
28  3   -8.0300   -28              U=3  IMP:N,P=1 $Magnaform plug
29  5   -1.0000    27  28 -29      U=3  IMP:N,P=1 $Water
C
C  Control Rods:  Fuel follower
C
30  0            -30              U=3  IMP:N,P=1 $Void
31  1   -3.3447    30 -31          U=3  IMP:N,P=1 $UO2-BeO fuel
32  0             31 -32          U=3  IMP:N,P=1 $Void
33  2   -8.4000    32 -33          U=3  IMP:N,P=1 $Niobium
34  0             33 -34          U=3  IMP:N,P=1 $Void gap
35  4   -2.8000   -35              U=3  IMP:N,P=1 $BeO plug
36  0            -36              U=3  IMP:N,P=1 $Void
37  3   -8.0300    34  35 36 -37   U=3  IMP:N,P=1 $SS304
```

```
38  5   -1.0000    37 -38          U=3  IMP:N,P=1 $Water
C
C
C  Safety Rods:  Poison section
C
39  8   -2.4800   -39              U=4  IMP:N,P=1 $B4C poison
40  0              39 -40          U=4  IMP:N,P=1 $Void cap
41  3   -8.0300    40 -41          U=4  IMP:N,P=1 $Poison sleeve
42  3   -8.0300   -42              U=4  IMP:N,P=1 $Magnaform plug
43  5   -1.0000    41  42 -43      U=4  IMP:N,P=1 $Water
C
C  Safety Rods:  Fuel follower
C
44  0             -44              U=4  IMP:N,P=1 $Void
45  1   -3.3447    44 -45          U=4  IMP:N,P=1 $UO2-BeO fuel
46  0              45 -46          U=4  IMP:N,P=1 $Void
47  2   -8.4000    46 -47          U=4  IMP:N,P=1 $Niobium
48  0              47 -48          U=4  IMP:N,P=1 $Void gap
49  4   -2.8000   -49              U=4  IMP:N,P=1 $BeO plug
50  0             -50              U=4  IMP:N,P=1 $Void
51  3   -8.0300    48 49  50 -51   U=4  IMP:N,P=1 $SS304
52  5   -1.0000    51 -52          U=4  IMP:N,P=1 $Water
C
C
C  Transient Rods:  Void section
C
53  0             -53              U=5  IMP:N,P=1 $Void
54  7   -2.7000    53 -54 58 60 61 U=5  IMP:N,P=1 $Al tubing
55  5   -1.0000    54 -55          U=5  IMP:N,P=1 $Water
56  7   -2.7000    55 -56          U=5  IMP:N,P=1 $Al guidex
57  5   -1.0000    56 -57          U=5  IMP:N,P=1 $Water
58  7   -2.7000   -58              U=5  IMP:N,P=1
C
C  Transient Rods:  Poison section
C
59  8   -2.4800   -59              U=5  IMP:N,P=1 $Poison
60  7   -2.7000    59 -60          U=5  IMP:N,P=1 $Inner sleeve
61  0             -61              U=5  IMP:N,P=1 $Void
62  7   -2.7000   -62  54          U=5  IMP:N,P=1 $End plug
C
C
C  Nickel Rods
C
65  6   -8.9000   -21              U=6  IMP:N,P=1 $Nickel
66  5   -1.0000    21 -22          U=6  IMP:N,P=1 $Water
C
C
C  90% Fuel Element
C
70  0             -10              U=7  IMP:N,P=1 $Void
71  11  -3.0102    10 -11          U=7  IMP:N,P=1 $UO2-BeO fuel
74  0              11 -14          U=7  IMP:N,P=1 $Void
75  2   -8.4000    14 -15          U=7  IMP:N,P=1 $Niobium
76  0              15 -16          U=7  IMP:N,P=1 $Void Gap
77  4   -2.8000   -17              U=7  IMP:N,P=1 $Lower BeO Plug
78  4   -2.8000   -18              U=7  IMP:N,P=1 $Upper BeO Plug
79  3   -8.0300    17 -19          U=7  IMP:N,P=1 $Lower SS Plug
80  3   -8.0300    18 -20          U=7  IMP:N,P=1 $Upper SS Plug
81  3   -8.0300    19  20  16 -21  U=7  IMP:N,P=1 $SS304
82  5   -1.0000    21 -22          U=7  IMP:N,P=1 $Water
C
C
C  Empty Aluminum Rod
C
600  0             -90              U=25  IMP:N,P=1 $Void
601  7   -2.7000    90 -21          U=25  IMP:N,P=1 $Al Rod
602  5   -1.0000    21 -22          U=25  IMP:N,P=1 $Water
C
C
C  Empty Aluminum Rod
C
90  0             -90              U=9  IMP:N,P=1 $Void
91  7   -2.7000    90 -21          U=9  IMP:N,P=1 $Al Rod
92  5   -1.0000    21 -22          U=9  IMP:N,P=1 $Water
C
C
C  Core  (UNIVERSE = 8)
C
  1  0  -300 311 210 211 213 220  fill=8   IMP:N,P=1
C
```

```
  2  5   -1.0000  -320     lat=2   U=8  IMP:N,P=1
              fill -12:12 -12:12 0:0
C
C
C  This fuel loading reflects the board as of May 2003.
C
C        1         2         3         4         5         6         7         8
C 34567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
C
                 2 24r
                2 24r
               2 24r
              2 9r 2  6  1      1  1  1  1  1  1  1  1     1  6  2 2   $ interface with frec
             2 8r 6  6  1  1     1  1  1  1  1  1  1     1  1  6  6 2
            2 7r 6  1  1  1  1     1  1  1  1  1  1    1  1  1  1  6 2
           2 6r 6  7  1  1  1  3   1   1  5   1   1  3  1  1  1  7  6 2
          2 5r 6  7  1  1  1  1  1   1  1  1  1  1    1  1  1  1  7  6 2
         2 4r 6  7  1  1  1  1  1   1  1  1  1  1   1  1  1  1  1  7  6 2
        2 3r 9  6  1  1  1  4  1   1   2 2 2 2   1   1  1  1  1  1  6  2 2
       2 2r 2  9  6  1  1  1  1   1   2 2 2 2 2   1   1  1  1  1  6  6  2 2
      2  2 2  6  6  1  1  1  1   1   2 2 2 2 2 2   1   1  1  1  1  6  2  2 2
        2 2  2  6  1  1  3  1   1   2 2 2 2 2 2 2   1   1  3  1  1  6  2  2 2   $ center line
        2 2  6  6  1  1  1  1   1   2 2 2 2 2 2   1   1  1  1  1  9  6  2 2 2
         2 2  6  1  1  1  1  1   1   2 2 2 2 2   1   1  1  1  1  1  9  2 2 2r
          2 6  1  1  1  1  5  1   1   2 2 2 2   1   1  5  1  1  1  1  2 2 3r
           2 6  1  1  1  1  1  1   1  1  1  1  1   1  1  1  1  1  1  2 2 4r
            2 6  1  1  1  1  1  1    1  1  1  1   1  1  1  1  1  1  2 2 5r
             2 6  1  1  1  1  3   1   1  4   1   1  3  1  1  1  1  2 2 6r
              2 6  7  1  1  1     1  1  1  1  1  1    1  1  1  1  2 2 7r
               2 6  6  6  1     1  1  1  1  1  1  1     1  9  9  2 2 8r
                2 2  9  6      6  6  1  1  1  1  6  6     6  6  2 2 9r
                 2 2  2      9  2  6  7  7  7  6  2  6      2  2 2 10r
                  2 2 2 2       25  6  6  6  6  9         2 2 2 2 11r
                   2 24r
C
C
C ********  END OF UNIVERSE DEFINITIONS AND CORE FILL  ********
C
C
C  NEW CENTRAL CAVITY
C
C   To add 32-in pedestal, remove C from line 2.
C   To add 8-in pedestal, remove C from line 2 and 3.
C   You must also remove the C's from the cells in the pedestal
C    descriptions (Cells 110-116).
C
C    Use Line 4 of Cell 100 to exclude surface of buckets and experiments.
C     Exclude surface 706 for Pb-B4C; Exclude surface 711 for Al dosimetry bucket;
C     Exclude surface 725 for LP-1
C     Exclude surfaces 730, 731, and 734 for Boom Box
C
100  702 -1.0245e-3  -100
                     110
C                    113 114 116
                     740              IMP:N,P=1 $Void
C   for LB44                    899              IMP:N,P=1 $Void
101  3  -8.0300    100 -101          IMP:N,P=1 $Stainless liner
102  7  -2.7000   -311  101 -102     IMP:N,P=1 $Aluminum
103  5  -1.0000   -311  102          IMP:N,P=1 $Water
C
C
C  Central Cavity Additions (32" and 8" Pedestals)
C
C  32-in pedestal
C
110  7  -2.7000      -110  111  112        IMP:N,P=1 $32-in pedestal
111  702 -1.0245e-3  -111                 IMP:N,P=1 $32-in pedestal inset
112  702 -1.0245e-3  -112                 IMP:N,P=1 $Inset Notch
C
C
C  8-in pedestal
C
C 113  7  -2.7000   -113                IMP:N,P=1 $Bottom plate
C 114  7  -2.7000   -114                IMP:N,P=1 $Top plate
C 115  702 -1.0245e-3   -115               IMP:N,P=1 $Center Void
C 116  7  -2.7000   -116  115            IMP:N,P=1 $Support Tube
C
C
C   End of Central Cavity Additions
C
```

```
C
C  Top and Bottom Grid Plates
C
200  7  -2.7000   -200  311  201        IMP:N,P=1 $Top plate
201  5  -1.0000   -200  220 -201        IMP:N,P=1 $Water
202  7  -2.7000   -202  311             IMP:N,P=1 $Bottom plate
C
C
C  Nickel Plate and Window to the Radiography Lab
C
210  6  -8.9000   -210                 IMP:N,P=1 $Nickel Plate
211  5  -1.0000   -211  210 -900        IMP:N,P=1 $Water
212  0           -212 -900             IMP:N,P=1 $Void
213  7  -2.7000   -213  212 -900        IMP:N,P=1 $Aluminum
C
C
C  FREC-II Side Ni Plate
C
220  6  -8.9000   -220                 IMP:N,P=1
C
C
C  Surrounding Water
C
230  5  -1.0000   -900  220 213 212 211 202 200
                       300 311         IMP:N,P=1
C
C
C
C   EXPERIMENTAL or SPECTRUM MODIFYING BUCKETS  (700's)
C
C  Pb-B4C Bucket  (700-706)
C  Weight of Bucket per L. Martin (8/21/2003) - 446 lbs
C  Weight of Model Bucket                     - 450.81
C  Density of B4C layer changed to 2.12 g/cc to make weight 446.19 lbs
C
C
C 700  702  -1.0245e-3  -700              IMP:N,P=1 $Inside Bucket
C 701   7   -2.7100  -701  700            IMP:N,P=1 $1/16" Al liner
C 702  700  -11.350  -702 701 7091 7092   IMP:N,P=1 $1" Pb on bottom
C 703  701  -2.5300  -703  7091 7092      IMP:N,P=1 $Boral on bottom
C 707   0           -707  702            IMP:N,P=1 $Slop between Cannister and Pb
C 708   8   -2.1200  -708                IMP:N,P=1 $B4C layer on the bottom
C
C 704   7   -2.7100  -704  703  707  708
C                          7091 7092     IMP:N,P=1 $Al layer
C 705   8   -2.1200  -705  704           IMP:N,P=1 $B4C layer
C 706   7   -2.7100 -706 705 7091 7092   IMP:N,P=1 $Al exterior
C 7091  3   -8.0300 -7091               IMP:N,P=1 $Dowel 1
C 7092  3   -8.0300 -7092               IMP:N,P=1 $Dowel 2
C
C
C
C
C  Standard Aluminum Experiment Bucket (710-711)
C   Add -900 to 710 and 711 if using 24" Bucket
C
C 710  702 -1.0245e-3  -710              IMP:N,P=1 $Inside Bucket
C 711  7   -2.7000     -711  710         IMP:N,P=1 $Aluminum Bucket
C
C
C
C
C  Pb-Poly Bucket (720-725) -- Designated as LP-1
C
C 720  702 -1.0245e-3  -720              IMP:N,P=1 $Bottom of Inside
C 721  7   -2.7000  -721  720  726       IMP:N,P=1 $1/16" Al Liner
C 722  700 -11.350  -722  721  724  726  IMP:N,P=1 $0.4" Pb Layer
C 723  704 -0.9450  -723  722  726       IMP:N,P=1 $0.8" HDPE
C 724  704 -0.9450  -724                 IMP:N,P=1 $HDPE fill-in
C 725  7   -2.7000  -725  721  723  726  IMP:N,P=1 $Al Container
C 726  702 -1.0245e-3  -726              IMP:N,P=1 $Top of Inside
C
C
C
C
C
C  Boombox for NG testing (730-738)
C
C 730  765 -7.28    -730  736  737  738  IMP:N,P=1 $Lower Boom Box
C 731  765 -7.28    -731  733            IMP:N,P=1 $Upper part of clamping ring
```

```
C 732  765 -7.28    -732  733              IMP:N,P=1 $Lower part of clamping ring
C 733  702 -1.0245e-3  -733                IMP:N,P=1 $"Void" in clamping ring
C 734  702 -1.0245e-3  -734 732            IMP:N,P=1 $"Void" at ring lip
C 735  765 -7.28    -735                   IMP:N,P=1 $Plug
C 736  702 -1.0245e-3  -736 735            IMP:N,P=1 $"Void" around the plug
C 737  702 -1.0245e-3  -737                IMP:N,P=1 $Lower "void"
C 738  702 -1.0245e-3  -738                IMP:N,P=1 $Lip "void"
C
C
C  PLG-1 Bucket (740-747)
C  RT Bucket --> Designated as PLG-1
C
740  7  -2.7000    -740 741  742  743  744 #745 #746 #747   IMP:N,P=1 $ Al Plate
741 704 -0.9450    -741                                    IMP:N,P=1 $ Bottom Poly
742 700 -11.350    -742                                    IMP:N,P=1 $ Bottom Lead
743 780 -1.8200    -743                                    IMP:N,P=1 $ Bottom Graphite
744 702 -1.0245e-3 -744 1001                               IMP:N,P=1 $ Cavity
C
745 704 -0.9450    -745  746                               IMP:N,P=1 $ Poly Wall
746 700 -11.350    -746  747                               IMP:N,P=1 $ Lead Wall
747 780 -1.8200    -747  748                               IMP:N,P=1 $ Graphite Wall
C
C
C
C
C
C New 44" Pb-B4C Bucket
C Base Plate w/ B4C Volume
C From Ktech drawing labeled "PbB BASEII"
C  800  8   -1.274704138 (-802):(817 -815):(818 -816)       IMP:N,P=1 $ B4C Cavity
C  801  766 -7.83 -803:-809                                 IMP:N,P=1 $ All-threads
C    From McMaster-Carr catalog, Item # 98914A033, Threaded Rods and Studs, General Purpose Steel
C  802  767 -7.82 (805 -806):(811 -812)                     IMP:N,P=1 $ Washers
C    From McMaster-Carr catalog, Item #94744A285, Zinc-Plated Steel Washer for Soft Materials (Type
C  803  767 -7.82 (803 -807):(809 -813)                     IMP:N,P=1 $ All-thread nuts
C    From McMaster-Carr catalog, Item # 93939A823, Hex Nut, Grade 8 Steel
C  804  702 -1.0245e-3 (803 -804):(809 -810):(803 -805):(809 -811):
C                   (806 807 803 -808):(812 813 809 -814) IMP:N,P=1 $ Void inside this thread, washe
C  805  7 -2.704  (-817 819):(-818 820)                      IMP:N,P=1 $ Al6061 plugs
C    From McMaster-Carr catalog, Item # 44705K334, Low-Pressure Aluminum Threaded Square-Socket Plug
C  806  702 -1.0245e-3 (-819):(-820)                        IMP:N,P=1 $ Void in this area
C  807  7 -2.704       (-800:-801) 802 804 808 810 814 815 816
C                                                         IMP:N,P=1 $ Al6061 Base Plate
C Containment Base
C From Ktech drawing labeled "CONTAINMENT BASE II"
C  830  702 -1.0245e-3  801 -830                           IMP:N,P=1 $ Void
C  831  7 -2.704       (830 833 834 -831):(831 -832)       IMP:N,P=1 $ Al6061 Containment Base
C  832  766 -7.83      -833:-834                           IMP:N,P=1 $ All-threads, General Purpose St
C Lead Material
C Unchamfered lead rings
C  840  702 -1.0245e-3 -853                                IMP:N,P=1 $ Void inside lead rings
C  841  766 -7.83      -847:-848                           IMP:N,P=1 $ All-threads, General Purpose St
C  842  702 -1.0245e-3 (847 -843):(848 -844)               IMP:N,P=1 $ Void between All-threads and Pb
C  843  702 -1.0245e-3 -849:-851                           IMP:N,P=1 $ Void inside Al6061 tubing
C  844  7 -2.704  (849 -850):(851 -852)                    IMP:N,P=1 $ Al6061 tubing
C  845  702 -1.0245e-3 (850 -845):(852 -846)               IMP:N,P=1 $ Void between tubing and Pb hole
C  846  700 -11.35     (862 863 860 843 844 845 846 -842):(-840 843 844 845 846):
C                   (853 -854 843 844 845 846)           IMP:N,P=1 $ Unchamfered lead rings
C Inner Aluminum 6061 Sleeves (Items #14 and 15 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C  860  7 -2.704       -860                                IMP:N,P=1 $ Al6061 bottom plate
C  861  702 -1.0245e-3 (-861 1001):-863                    IMP:N,P=1 $ Aluminum sleeve void
C  862  7 -2.704        861 -862                           IMP:N,P=1 $ Al6061 sleeve
C Al6061 Double Wall Weldment (Item #9 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C  870  702 -1.0245e-3 (840 842 831 854 -868):
C                   (840 842 831 854 -870):
C                   (840 842 831 854 -872)               IMP:N,P=1 $ Void Between Pb Ring and Double
C  871  7 -2.704       (868 -869):(870 -871):(872 -873):
C                   (874 -875):(876 -877):(878 -879)     IMP:N,P=1 $ Al6061 Inner and Outer Skins
C  872  8 -1.449249072 (869 -874):(871 -885):(886 -876):
C                            (873 -883):(-878 884)     IMP:N,P=1 $ B4C Powder
C PbB Top: Top Plate (Item #1 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C  880  702 -1.0245e-3 -880:-881:(-887 848):(-888 847):
C                   -891:-892:-893:-894                  IMP:N,P=1 $ Voids
C  881  7 -2.704       (880 881 -882 887 888 889 890 891 892 893 894):
C                   (883 -884):(885 -886)                IMP:N,P=1 $ Top Plate
C Modified Hex Head Plugs, 1/4 NPT, AL6061-T6 (Item #16 in DWG titled "LEAD BORON BUCKET ASSEMBLY")
C From McMaster-Carr catalog, Item # 3867T65, High-Pressure Aluminum Pipe Fitting
C  882  7 -2.704       (-821 852):(-822 852):(-823 850):(-824 850)
C                                                         IMP:N,P=1 $ Modified Hex Head Plugs
C Outside World
```

```
C  889  702 -1.0245e-3 -899 800 831 832 875 877 879 821 822 823 824
C                    882 847 848 850 852                IMP:N,P=1 $ Enclosing surface
C
C     EXPERIMENT PACKAGES (1000's)
C   1001  702 -1.0245e-3 -1001 1002                       IMP:N,P=1 $ 6 cm dia scoring sphere
C   1002  6   -8.902     -1002                           IMP:N,P=1 $ Ni Foil
1001  702 -1.0245e-3 -1001                              IMP:N,P=1 $ 6 cm dia scoring sphere
C
C
C
C
C     EXTERNAL WORLD
C
C
C
900 0              900                    IMP:N,P=0 $Outside world

C        1         2         3         4         5         6         7         8
C 345678901234567890123456789012345678901234567890123456789012345678901234567890
C ********************************************************************************
C *                              SURFACE CARDS                                   *
C ********************************************************************************
C
C    Fuel Elements
C
10  RCC  0.000  0.000  23.32  0.000  0.000  52.25  0.2413  $Void
11  RCC  0.000  0.000  23.32  0.000  0.000  52.25  1.6840  $Fuel
14  RCC  0.000  0.000  23.32  0.000  0.000  52.25 1.72025  $Void
15  RCC  0.000  0.000  23.32  0.000  0.000  52.25 1.77125  $Niobium
16  RCC  0.000  0.000  23.32  0.000  0.000  52.25 1.82225  $Void gap
17  RCC  0.000  0.000 21.415  0.000  0.000  1.905 1.48700  $Lower plug
18  RCC  0.000  0.000  75.57  0.000  0.000  1.905 1.48700  $Upper plug
19  RCC  0.000  0.000  16.32  0.000  0.000  7.000 1.82225  $Lower plug
20  RCC  0.000  0.000  75.57  0.000  0.000  5.000 1.82225  $Upper plug
21  RCC  0.000  0.000  16.32  0.000  0.000  98.89 1.87325  $
22  RCC  0.000  0.000  16.32  0.000  0.000  98.89 5.00000  $Water
C
C   Control Rods
C
25 3 RCC 0.000  0.000  78.11  0.000  0.000  52.25 1.46050  $B4C poison
26 3 RCC 0.000  0.000  78.11  0.000  0.000  98.89 1.50495  $Void cap
27 3 RCC 0.000  0.000  78.11  0.000  0.000  98.89 1.74625  $poison sleeve
28 3 RCC 0.000  0.000  75.57  0.000  0.000   2.54 1.74625  $Magnaform plug
29 3 RCC 0.000  0.000  75.57  0.000  0.000 101.43 5.00000  $Water
30 3 RCC 0.000  0.000  23.32  0.000  0.000  52.25 0.24130  $Void
31 3 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.68400  $Fuel
32 3 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.72025  $Void
33 3 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.77125  $Niobium
34 3 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.82225  $Void gap
35 3 RCC 0.000  0.000  20.78  0.000  0.000   2.54 1.82225  $BeO plug
36 3 RCC 0.000  0.000 -79.22  0.000  0.000 100.00 1.82225  $Void
37 3 RCC 0.000  0.000 -79.22  0.000  0.000 154.79 1.87325  $SS304
38 3 RCC 0.000  0.000 -79.22  0.000  0.000 154.79 5.00000  $Water
C
C    Safety Rods
C
39 4 RCC 0.000  0.000  78.11  0.000  0.000  52.25 0.57150  $B4C poison
40 4 RCC 0.000  0.000  78.11  0.000  0.000  98.89 0.83185  $Void cap
41 4 RCC 0.000  0.000  78.11  0.000  0.000  98.89 1.74625  $Poison sleeve
42 4 RCC 0.000  0.000  75.57  0.000  0.000   2.54 1.74625  $Magnaform plug
43 4 RCC 0.000  0.000  75.57  0.000  0.000 101.43 5.00000  $Water
44 4 RCC 0.000  0.000  23.32  0.000  0.000  52.25 0.24130  $Void
45 4 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.68400  $Fuel
46 4 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.72025  $Void
47 4 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.77125  $Niobium
48 4 RCC 0.000  0.000  23.32  0.000  0.000  52.25 1.82225  $Void gap
49 4 RCC 0.000  0.000  20.78  0.000  0.000   2.54 1.82225  $BeO plug
50 4 RCC 0.000  0.000 -79.22  0.000  0.000 100.00 1.82225  $Void
51 4 RCC 0.000  0.000 -79.22  0.000  0.000 154.79 1.87325  $SS304
52 4 RCC 0.000  0.000 -79.22  0.000  0.000 154.79 5.00000  $Water
C
C    Transient Rods
C
53 5 RCC 0.000  0.0 -76.2762  0.000  0.0  73.1012 1.20000  $Void
54   RCC 0.000  0.000 -79.22  0.000  0.000 200.00 1.27000  $Al tubing
55   RCC 0.000  0.000 -79.22  0.000  0.000 200.00 1.49860  $Water
56   RCC 0.000  0.000 -79.22  0.000  0.000 200.00 2.02438  $Al guidex
57   RCC 0.000  0.000 -79.22  0.000  0.000 200.00 5.00000  $Water
58 5 RCC 0.000  0.000 -3.175  0.000  0.000  3.174 1.20000
59 5 RCC 0.000  0.000 -0.001  0.000  0.000 76.201 0.88000  $Poison
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60 5 RCC 0.000  0.000 -0.001  0.000  0.000 76.201 1.20000  $Inner sleeve
61 5 RCC 0.000  0.000  76.20  0.000  0.000 123.80 1.20000  $Void
62 5 RCC 0.000  0.000 -100.0  0.000  0.00 23.7238 1.20000  $End plug
C
C    Aluminum Rods
C
90  RCC  0.000  0.000  15.41  0.000  0.000  66.14 1.77125  $Void in Al rod
C
C    Central Cavity Surfaces
C
100 RCC  0.000  0.000  -67.395  0.000  0.000  202.395 11.6450  $Void
101 RCC  0.000  0.000  -67.395  0.000  0.000  202.395 12.2800
102 RCC  0.000  0.000  -67.395  0.000  0.000  202.395 13.9700
C
C   Cavity Additions
C
110 RCC  0.000  0.000 -67.395  0.000  0.000 81.28 11.4300  $32-in pedestal
111 RCC  0.000  0.000 8.4748  0.000  0.000 2.8702  8.2550  $32-in inset
112 RPP -0.9525 0.9525  -8.255  8.255  11.345  13.885      $Inset Notch
113 RCC  0.000  0.000 13.885  0.000  0.000  1.270 10.3188  $Bottom plate (8-in)
114 RCC  0.000  0.000 32.935  0.000  0.000  1.270 10.3188  $Top plate (8-in)
115 RCC  0.000  0.000 15.155  0.000  0.000  17.78  5.7150  $Center void (8-in)
116 RCC  0.000  0.000 15.155  0.000  0.000  17.78  6.3500  $Support tube (8-in)
C
C    Top and Bottom Grid Plates
C
200 RCC  0.000  0.000  80.55  0.000  0.000   2.54 53.3500  $Top plate
201 PY  -34.925                                          $Cutoff of top plate
202 RCC  0.000  0.000  11.33  0.000  0.000   5.08 47.0000  $Bottom plate
C
C
C    Window to Radiography Lab
C
210  1 RPP  38.100 39.370  -26.670 26.670  16.41 80.55     $Ni plate
211  1 RPP  38.100 39.370  -38.100 38.100  16.41 80.55     $Water
212  1 RPP  48.895 100.00  -26.670 26.670  16.41 80.55     $Void
213  1 RPP  39.370 100.00  -38.100 38.100  16.41 80.55     $Aluminum
C
C   Nickel Plate near FREC-II
C
220  RPP  -36.830 36.830  -36.195 -34.925  16.41 83.09     $Nickel Plate
C
C    Hexes for the lattice, inner and outer core, and core boundary
C
320  RHP  0.0 0.0 -132.0  0.0 0.0 400.0 2.0855 0.0 0.0    $Lattice element
300  1 RHP  0.0 0.0 16.41 0.0 0.0 64.14 42.7 0.0 0.0      $outer core bound
310  1 RHP  0.0 0.0 -67.395  0.000  0.000  202.395 11.65 0. 0.0      $Inner liner of cavity
311  1 RHP  0.0 0.0 -67.395  0.000  0.000  202.395 12.285 0. 0.      $Outer liner of cavity
C
C
C   Buckets  (700's)
C
C  Pb-B4C Bucket
C
 700 7 RCC  0.0 0.0 6.35     0.0 0.0 85.09    6.27380 $Void
 701 7 RCC  0.0 0.0 6.26872  0.0 0.0 85.17128 6.35508 $0.032" Al liner
 702 7 RCC  0.0 0.0 3.65125  0.0 0.0 87.78875 9.76630 $Pb layers
 703 7 RCC  0.0 0.0 3.01625  0.0 0.0  0.63500 9.17575 $Boral
 704 7 RCC  0.0 0.0 1.90500  0.0 0.0 89.53500 10.1600 $Al layer
 705 7 RCC  0.0 0.0 1.90500  0.0 0.0 89.53500 11.1125 $B4C
 706 7 RCC  0.0 0.0 0.00000  0.0 0.0 91.44000 11.4300 $Al layer
 707 7 RCC  0.0 0.0 3.65125  0.0 0.0 87.78875 9.84250
 708 7 RCC  0.0 0.0 1.90500  0.0 0.0  0.63500 7.62000 $B4C bottom
7091 7 RCC  0.0 -8.890 0.00  0.0 0.0 91.44000 0.31750 $Dowel 1
7092 7 RCC  0.0  8.890 0.00  0.0 0.0 91.44000 0.31750 $Dowel 2
C
C  14" Aluminum Bucket
C
 710 7 RCC  0.0 0.0 0.15875  0.0 0.0 35.40125 11.27125   $Void
 711 7 RCC  0.0 0.0 0.00000  0.0 0.0 35.56000 11.43000   $Al bucket
C
C USE these for a 24" Aluminum Bucket
C
C 710 7 RCC  0.0 0.0 0.15875  0.0 0.0 60.80125 11.27125   $Void
C 711 7 RCC  0.0 0.0 0.00000  0.0 0.0 60.96000 11.43000   $Al bucket
C
C  LP-1 Surfaces
C
 720 7 RCC  0.0 0.0 5.74675  0.0 0.0 62.18825  7.46125   $Inside
 721 7 RCC  0.0 0.0 5.58800  0.0 0.0 73.15200  7.62000   $Al liner
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 722 7 RCC  0.0 0.0 3.55600  0.0 0.0 64.37900  8.63600   $Pb
 723 7 RCC  0.0 0.0 2.54000  0.0 0.0 65.39500 10.66800   $HDPE
 724 7 RCC  0.0 0.0 3.55600  0.0 0.0  1.01600  7.62000   $HDPE fill-in
 725 7 RCC  0.0 0.0 0.00000  0.0 0.0 78.74000 11.43000   $Al Container
 726 7 RCC  0.0 0.0 67.9350  0.0 0.0 10.80500  7.46125
C
C  Boom Box Surfaces
C
 730  7 RCC  0.0 0.0 0.0      0.0 0.0 65.786   9.8425
 731  7 RCC  0.0 0.0 65.913   0.0 0.0  3.048   9.8425
 732  7 RCC  0.0 0.0 65.786   0.0 0.0  0.127   8.1280
 733  7 RCC  0.0 0.0 65.786   0.0 0.0  3.175   5.0800
 734  7 RCC  0.0 0.0 65.786   0.0 0.0  0.127   9.8425
 735  7 RCC  0.0 0.0 59.436   0.0 0.0  6.350   6.6675
 736  7 RCC  0.0 0.0 59.436   0.0 0.0  6.350   6.7945
 737  7 RCC  0.0 0.0  2.540   0.0 0.0 54.864   7.9375
 738  7 RCC  0.0 0.0 57.404   0.0 0.0  2.032   5.0800
C
C  PLG-1 Surfaces
C
 740  7 RCC  0.0 0.0 0.0      0.0 0.0 72.8726  11.4300
 741  7 RCC  0.0 0.0 2.54     0.0 0.0  0.635   8.8900
 742  7 RCC  0.0 0.0 3.175    0.0 0.0  0.3175  8.8900
 743  7 RCC  0.0 0.0 3.4925   0.0 0.0  0.635   8.8900
 744  7 RCC  0.0 0.0 4.7625   0.0 0.0 68.1101  8.8900
 745  7 RCC  0.0 0.0 2.54     0.0 0.0 60.0964  10.7950
 746  7 RCC  0.0 0.0 2.54     0.0 0.0 60.0964  10.1600
 747  7 RCC  0.0 0.0 2.54     0.0 0.0 60.0964  9.8425
 748  CZ     9.2075
C
C
C New 44" Pb-B4C Bucket
C Base Plate w/ B4C Volume
C From Ktech drawing labeled "PbB BASEII"
C
800  7 RCC  0.000  0.000  0.000  0.000  0.000  1.905  11.43  $ Base Plate Bottom
801  7 RCC  0.000  0.000  1.905  0.000  0.000  1.905  7.9375 $ Base Plate Top
802  7 RCC  0.000  0.000  2.2225 0.000  0.000  1.27   7.62   $ B4C Cavity
C Bolts/Bolt Holes
C Big Bolts/Bolt Holes
C From McMaster-Carr catalog, Item # 98914A033, Threaded Rods and Studs
803  7 RCC  8.890  0.000  0.000  0.000  0.000  1.905  0.53594  $ All-Thread #1
804  7 RCC  8.890  0.000  1.524  0.000  0.000  0.381  0.65151  $ All-Thread Hole #1
805  7 RCC  8.890  0.000  1.2954 0.000  0.000  0.2286 0.674688 $ All-Thread Washer Void #1
806  7 RCC  8.890  0.000  1.2954 0.000  0.000  0.2286 1.27     $ All-Thread Washer #1
807  7 RCC  8.890  0.000  0.50165 0.000 0.000  0.79375 0.9525  $ All-Thread Nut #1
808  7 RCC  8.890  0.000  0.000  0.000  0.000  1.524  1.5875   $ All-Thread Nut Hole #1
809  7 RCC -8.890  0.000  0.000  0.000  0.000  1.905  0.53594  $ All-Thread #2
810  7 RCC -8.890  0.000  1.524  0.000  0.000  0.381  0.65151  $ All-Thread Hole #2
811  7 RCC -8.890  0.000  1.2954 0.000  0.000  0.2286 0.674688 $ All-Thread Washer Void #2
812  7 RCC -8.890  0.000  1.2954 0.000  0.000  0.2286 1.27     $ All-Thread Washer #2
813  7 RCC -8.890  0.000  0.50165 0.000 0.000  0.79375 0.9525  $ All-Thread Nut #2
814  7 RCC -8.890  0.000  0.000  0.000  0.000  1.524  1.5875   $ All-Thread Nut Hole #2
C Small Bolts/Bolt Holes
C From McMaster-Carr catalog, Item # 44705K334, Low-Pressure Aluminum Threaded Square-Socket Plug
815  7 RCC  0.000  5.3975 0.000  0.000  0.000  2.2225 0.71374 $ Small Hole #1
816  7 RCC  0.000 -5.3975 0.000  0.000  0.000  2.2225 0.71374 $ Small Hole #2
817  7 RCC  0.000  5.3975 0.000  0.000  0.000  1.2192 0.71374 $ Plug #1
818  7 RCC  0.000 -5.3975 0.000  0.000  0.000  1.2192 0.71374 $ Plug #2
819  7 RPP -0.357188 0.357188  5.040313  5.754688 0.000 0.862648 $ Plug #1 9/32" Hole
820  7 RPP -0.357188 0.357188 -5.754688 -5.040313 0.000 0.862648 $ Plug #2 9/32" Hole
C
C Containment Base
C From Ktech drawing labeled "CONTAINMENT BASE II"
C
830  7 RCC  0.000  0.000  1.905  0.000  0.000  1.905  7.9883 $ Inner void
831  7 RCC  0.000  0.000  1.905  0.000  0.000  1.905  9.779  $ Inner Disc Region
832  7 RCC  0.000  0.000  1.905  0.000  0.000  0.635  11.43  $ Outer Disc Region
833  7 RCC  8.890  0.000  1.905  0.000  0.000  1.905  0.53594 $ All-thread #1, General purpose steel
834  7 RCC -8.890  0.000  1.905  0.000  0.000  1.905  0.53594 $ All-thread #2, General purpose steel
C
C Lead Bottom, Floor, and Rings (Items #4, 5, and 6 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C Drawn March 22, 2010 by S. Padias
C Unchamfered lead components
C
840  7 RCC  0.000  0.000  3.810  0.000  0.000  2.540  9.7663  $ Lead bottom disc
C 841  7 RCC  0.000  0.000  6.350  0.000  0.000  100.33 6.477   $ Inner lead void
842  7 RCC  0.000  0.000  6.350  0.000  0.000  100.33 9.7663  $ Lead ring
843  7 RCC  8.89   0.000  3.810  0.000  0.000  106.68 0.65532 $ Right-side big lead hole
844  7 RCC -8.89   0.000  3.810  0.000  0.000  106.68 0.65532 $ Left-side big lead hole
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845  7 RCC  0.000  8.89   3.810  0.000  0.000  106.68 0.32639 $ Top-side small lead hole
846  7 RCC  0.000 -8.89   3.810  0.000  0.000  106.68 0.32639 $ Bottom-side small lead hole
C From McMaster-Carr catalog, Item # 98914A033, Threaded Rods and Studs
847  7 RCC  8.89   0.000  3.810  0.000  0.000  113.665 0.53594 $ Right-side All-Thread
848  7 RCC -8.89   0.000  3.810  0.000  0.000  113.665 0.53594 $ Left-side All-Thread
C General Purpose Aluminum Tubing
C From McMaster-Carr catalog, Item # 89965K42, General Purpose Aluminum Tubing
849  7 RCC  0.000  8.89   3.810  0.000  0.000  111.76  0.2286  $ Top-side inner radius Al6061 Tubing
850  7 RCC  0.000  8.89   3.810  0.000  0.000  111.76  0.3175  $ Top-side outer radius Al6061 Tubing
851  7 RCC  0.000 -8.89   3.810  0.000  0.000  111.76  0.2286  $ Bottom-side inner radius Al6061 Tub
852  7 RCC  0.000 -8.89   3.810  0.000  0.000  111.76  0.3175  $ Bottom-side outer radius Al6061 Tub
C Chamfered lead components
853  7 TRC  0.000  0.000  106.68 0.000  0.000  3.81   6.477  7.62  $ Chamfered lead ring void
854  7 RCC  0.000  0.000  106.68 0.000  0.000  3.81   9.7663  $ Chamfered lead ring radius
C
C Inner Aluminum 6061 Sleeves (Items #14 and 15 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C
860  7 RCC  0.000  0.000  6.35   0.000  0.000  0.08255 6.477  $ Al6061 Base Plate
861  7 RCC  0.000  0.000  6.43255 0.000 0.000  100.1776 6.39445 $ Al6061 Sheet void
862  7 RCC  0.000  0.000  6.43255 0.000 0.000  100.1776 6.477 $ Al6061 Sheet
863  7 RCC  0.000  0.000  106.6102 0.000 0.000 0.0698   6.477 $ Void
C
C PbB base II Double Wall Weldment (Item #9 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C
868  7 RCC  0.000  0.000  2.54   0.000  0.000  107.315 9.8425 $ Inner Surface of Inner Skin II L1
869  7 RCC  0.000  0.000  2.54   0.000  0.000  107.315 10.16  $ Inner Skin II L1
870  7 RCC  0.000  0.000  109.855 0.000  0.000  0.254  9.8425 $ Inner Surface of Inner Skin II L2
871  7 RCC  0.000  0.000  109.855 0.000  0.000  0.254  10.16  $ Inner Skin II L2
872  7 RCC  0.000  0.000  110.109 0.000  0.000  0.381  9.8425 $ Inner Surface of Inner Skin II L3
873  7 RCC  0.000  0.000  110.109 0.000  0.000  0.381  10.16  $ Inner Skin II L3
874  7 RCC  0.000  0.000  2.54   0.000  0.000  107.315 11.1125 $ B4C Powder Region L1
875  7 RCC  0.000  0.000  2.54   0.000  0.000  107.315 11.43  $ Outer Skin II L1
876  7 RCC  0.000  0.000  109.855 0.000  0.000  0.254  11.1125 $ B4C Powder Region L2
877  7 RCC  0.000  0.000  109.855 0.000  0.000  0.254  11.43  $ Outer Skin II L2
878  7 RCC  0.000  0.000  110.109 0.000  0.000  0.381  11.1125 $ B4C Powder Region L3
879  7 RCC  0.000  0.000  110.109 0.000  0.000  0.381  11.43  $ Outer Skin II L3
C
C PbB Top: Top Plate (Item #1 in DWG titled "LEAD BORON BUCKET ASSEMBLY II")
C
880  7 RCC  0.000  0.000  110.49 0.000  0.000  0.4318 7.62    $ Lower void
881  7 TRC  0.000  0.000  110.9218 0.000 0.000 0.8382 7.62 8.103935 $ Upper void
882  7 RCC  0.000  0.000  110.49 0.000  0.000  1.27   11.43   $ Al6061 Disc
883  7 RCC  0.000  0.000  110.49 0.000  0.000 -0.381  10.1727 $ Lower B4C Cap void
884  7 RCC  0.000  0.000  110.49 0.000  0.000 -0.381  11.0998 $ B4C Cap
885  7 TRC  0.000  0.000  109.855 0.000 0.000  0.254  10.4267 10.1727 $ Inner chamfer
886  7 TRC  0.000  0.000  109.855 0.000 0.000  0.254  10.8458 11.0998 $ Outer chamfer
C Top Plate holes
887  7 RCC -8.89   0.000  110.49 0.000  0.000  1.27   0.65151 $ Left Large hole
888  7 RCC  8.89   0.000  110.49 0.000  0.000  1.27   0.65151 $ Right Large hole
889  7 RCC  0.000 -8.89   110.49 0.000  0.000  1.27   0.65151 $ Bottom Large hole
890  7 RCC  0.000  8.89   110.49 0.000  0.000  1.27   0.65151 $ Top Large hole
891  7 RCC  -2.54  8.89   110.49 0.000  0.000  1.27   0.3175  $ Small Hole #1
892  7 RCC   2.54  8.89   110.49 0.000  0.000  1.27   0.3175  $ Small Hole #2
893  7 RCC  -2.54 -8.89   110.49 0.000  0.000  1.27   0.3175  $ Small Hole #1
894  7 RCC   2.54 -8.89   110.49 0.000  0.000  1.27   0.3175  $ Small Hole #2
C Modified Hex Head Plugs, 1/4 NPT, AL6061-T6 (Item #16 in DWG titled "LEAD BORON BUCKET ASSEMBLY")
C From McMaster-Carr catalog, Item # 3867T65, High-Pressure Aluminum Pipe Fitting
821  7 RCC  0.000 -8.89   111.76 0.000  0.000 -1.27   0.65151 $ Bottom Hex Thread
822  7 RCC  0.000 -8.89   111.76 0.000  0.000  0.635  0.79375 $ Bottom Hex Head
823  7 RCC  0.000  8.89   111.76 0.000  0.000 -1.27   0.65151 $ Top Hex Thread
824  7 RCC  0.000  8.89   111.76 0.000  0.000  0.635  0.79375 $ Top Hex Head
C
C Enclosing surface for the 44" Pb-B4C bucket
C
899  7 RCC  0.000  0.000  0.000  0.000  0.000  117.475 11.43  $ Enclosing surface
C
C
C  EXPERIMENT SURFACES
C
1001 6 SO   3.                                  $ 6 cm dia scoring sphere
1002 6 rcc  0. -0.013301675 0.   0. 0.026603351 0.   0.635     $ Nickel Foil
C
C    External Cutoff
C
900 RCC  0.000  0.000 -67.395  0.000  0.000  202.395 72.0000

C ***************************
C *     TRANSFORMATIONS     *
C ***************************
C
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C  TR1 rotates the hexes for the outer core bound and the cavity liner
C
*TR1   0 0 0 30 60 90 120 30 90
C
C  TR3-->Movement of control rods -0.001 (full up) to -55.001 (full down)
C
C
C   Measured Up DC with 32-in pedestal is -39.731                (03/03/2004)
C   Measured Down DC is -30.851                                  (03/03/2004)
C    -->Up DC position of 1527 Rod Units
C    -->Down DC position of 2415 Rod Units
C   Measured Up DC with 8-in + 32-in pedestal is -40.421         (03/01/2004)
C   Measured Down DC with 8-in + 32-in pedestal is -31.291       (03/01/2004)
C    -->Up DC position of 1428 Rod Units
C    -->Down DC position of 2371 Rod Units
C   Measured Up DC with Pb-B4C on 32-in pedestal is -22.951      (03/09/2004)
C   Measured Down DC with Pb-B4C on 32-in pedestal is -10.741    (03/09/2004)
C    -->Up DC position of 3205 Rod Units
C    -->Down DC position of 4426 Rod Units
C   Measured DC with LP-1 on 32-in pedestal is -31.941           (03/11/2004)
C   Measured Down DC with LP-1 on 32-in pedestal is -23.721      (03/11/2004)
C    -->Up DC position of 2306 Rod Units
C    -->Down DC position of 3128 Rod Units
C
*TR3   0 0 -41.50
C
C  TR4-->Movement of safety rods 0.001 (full up) to -54.999 (full down)
C
C    Measured worth of safety rods:  -$2.12                      (03/30/2004)
C
*TR4   0 0  0.001
C
C  TR5-->Movement of transient rods 0 (full down) to 90 (full up)
C
C    Measured worth of transient rods:  -$4.14                   (03/30/2004)
C
*TR5   0 0  90
C
C  TR6-->Moves experiment package from origin (0 0 0) to fuel centerline
C
*TR6   0  0  49.445
C
C  TR7-->Puts buckets on 8" (34.205) or 32" (13.885) pedestals
C   Use 32" pedestal for LP-1
C   Use 8" for Standard Al buckets
C
*TR7   0  0  13.885
C
C ********************
C *  MATERIAL CARDS  *
C ********************
C  Materials cards use the latest available cross sections
C
C  UO2-BeO fuel (3.3447 g/cc)  (XSEC Temp - 293.6 K)
C
C
M1      4009.70c -0.2827602   8016.70c -0.5277690  92235.70c -0.0662957
       92238.70c -0.1222844  92234.70c -0.0004547  92236.70c -0.0004358
MT1     beo.60t      $ S(alpha, beta) for UO2-BeO (Temp - 294 K)
C
C
C  UO2-BeO fuel (3.0102 g/cc)  -- This is the 90% fuel
C                                (XSEC Temp - 293.6 K)
C   Included as a separate material to avoid warning message
C
C
M11     4009.70c -0.2827602   8016.70c -0.5277690  92235.70c -0.0662957
       92238.70c -0.1222844  92234.70c -0.0004547  92236.70c -0.0004358
MT11    beo.60t      $ S(alpha, beta) for BeO (Temp - 294 K)
C
C     NIOBIUM (8.4 g/cc)
C
M2     41093.70c  1.0000
C
C
C  SS-304L from Ktech Materials Database Rev. 118
C   Material Number:  3410
C     Values are weight %
C      Si: 0.0100  Cr: 0.1900  Mn: 0.0200  Fe: 0.6800  Ni: 0.1000
C
```

```
C FM multiplier (neutrons):  1.76109641E-10  3410  -4   1
C FM multiplier (photons):   1.76109641E-10  3410  -5  -6
C
C  Density:  7.896 g/cc
C
M3     14028.70c -0.009187  14029.70c -0.000483  14030.70c -0.000329
       24050.70c -0.007930  24052.70c -0.159029  24053.70c -0.018380
       24054.70c -0.004661  25055.70c -0.020000  26054.70c -0.038390
       26056.70c -0.624930  26057.70c -0.014691  26058.70c -0.001989
       28058.70c -0.067198  28060.70c -0.026776  28061.70c -0.001183
       28062.70c -0.003834  28064.70c -0.001009
C
C
C     BeO (2.8 g/cc)
C
M4      4009.70c  0.5000     8016.70c  0.4998096    8017.70c  0.0001904
MT4     beo.60t      $ S(alpha, beta) for BeO (Temp - 294 K)
C
C     Water (1 g/cc)
C
M5    1001.70c  0.6665667    1002.70c  0.000100
      8016.70c  0.3332063    8017.70c  0.000127
MT5    lwtr.60t     $ S(alpha, beta) for water (Temp - 294 K)
C
C
C  Ni reflector
C           Values are weight %
C           Ni-58: 67.19780  Ni-60: 26.77586  Ni-61:  1.18346
C           Ni-62:  3.83429  Ni-64:  1.00859
C    Converted Data from Nuclear Wallet Card to w/o with "Weight_Frac" program
C  Density:  8.9020 g/cc
C
C
M6    28058.70c -0.6719780 28060.70c -0.2677586 28061.70c -0.0118346
      28062.70c -0.0383429 28064.70c -0.0100859
C
C
C  Al-6061 from Ktech Materials Database Rev. 118
C    Material Number:  3110
C     Values are weight %
C      Mg: 0.0110  Al: 0.9670  Si: 0.0080  Ti: 0.0007
C      Cr: 0.0020  Mn: 0.0013  Fe: 0.0056  Ni: 0.0004
C      Cu: 0.0030  Zn: 0.0010
C
C FM multiplier (neutrons):  3.55249469E-10  3110  -4   1
C FM multiplier (photons):   3.55249469E-10  3110  -5  -6
C
C  Density:  2.704 g/cc
C
M7     12000.66c -0.011000  13027.70c -0.967000  14028.70c -0.007350
       14029.70c -0.000387  14030.70c -0.000263  22000.66c -0.000700
       24050.70c -0.000084  24052.70c -0.001674  24053.70c -0.000193
       24054.70c -0.000049  25055.70c -0.001300  26054.70c -0.000316
       26056.70c -0.005147  26057.70c -0.000121  26058.70c -0.000016
       28058.70c -0.000269  28060.70c -0.000107  28061.70c -0.000005
       28062.70c -0.000015  28064.70c -0.000004  29063.70c -0.002055
       29065.70c -0.000945  30000.42c -0.001000
C
C
C    B4C poison (2.48 g/cc)
C    Composition data taken from Jeff Wemple (KTech) Memo dated June 18, 2010
C    and titled "Re: Drawing of new Lead-boron bucket"
C    Manufacturer of powder is READE ADVANCED MATERIALS
C    Density of packed powder in the 44" Pb-B4C bucket is 1.2505 (half of 2.51 g/cc)
C
M8      6000.70c  0.20000   5010.70c  0.159200   5011.70c  0.640800
C
C
C  Natural Lead
C  True Weight %:  Pb-204:  1.37808  Pb-206: 23.95550
C                  Pb-207: 22.07430  Pb-208: 52.59212
C  Weight % based on Available MCNP XSEC:
C                  Pb-206: 24.29024  Pb-207: 22.38275
C                  Pb-208: 53.32701
C
C    Converted Data from Nuclear Wallet Card to w/o with "Weight_Frac" program
C  Density is 11.35 g/cc from Nuclear Wallet Cards.
C
C
M700  82206.70c -0.2429024  82207.70c -0.2238275
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      82208.70c -0.5332701
C
C
C Boral Plate Composition
C
C  Composition found in Nuclear Science and Engineering
C   Vol. 65, No. 1, pgs. 41-48, January 1978.
C   Values are weight %
C         B: 27.40   C:  7.61  Al: 63.68
C        Cu:  0.09  Zn:  0.16  Fe:  0.45
C        Cr:  0.10  Mn:  0.10  Mg:  0.05
C        Ti:  0.10  Li:  0.26
C
C   Density:  2.53 g/cc
C
C
M701   5010.70c -0.050242   5011.70c -0.223758    6000.70c -0.076100
      13027.70c -0.636800  29063.70c -0.000616   29065.70c -0.000284
      30000.42c -0.001600  26056.70c -0.004500   24050.70c -0.000042
      24052.70c -0.000837  24053.70c -0.000097   24054.70c -0.000024
      25055.70c -0.001000  12000.66c -0.000500   22000.66c -0.001000
       3006.70c -0.000171   3007.70c -0.002429
C
C
C
C  Air
C   Standard Density:  1.205e-3 g/cc @ 20 deg C, 1 atm
C   Albuquerque:       1.0245e-3 g/cc in ABQ
C  See Attix p.531-532
C
M702   7014.70c -0.752308   7015.70c -0.002960   8016.70c -0.231687
       8017.70c -0.000094   6000.70c -0.000124  18000.42c -0.012827
C
C
C   HELIUM  For Leak Test
C    @ 2 atm density = 3.57e-4 g/cc
C
M703   2003.70c 0.00000137  2004.70c  0.99999863
C
C
C HDPE-> (C2H4)n    --          --
C                   |   H    H   |
C                   |   |    |   |
C                  -|-  C -- C  -|-
C                   |   |    |   |
C                   |   H    H   |
C                    --          --
C
M704   1001.70c  0.666667   6000.70c  0.333333
MT704  poly.60t
C
C
C   A517 Carbon Steel  (den = 7.28 g/cc)
C     Modified to match the mill test cert.
C     from Tubos de Acero de Mexico, S.A.
C
C   Summary of MatMCNP Calculations:
C
C  Isotope  Number Fraction    Weight Fraction       Atoms/b-cm
C   C-12       0.0118115          0.0025688          0.0009385
C   C-13       0.0001326          0.0000312          0.0000105
C  Si-28       0.0048924          0.0024807          0.0003887
C  Si-29       0.0002484          0.0001305          0.0000197
C  Si-30       0.0001638          0.0000890          0.0000130
C  Cr-50       0.0000184          0.0000167          0.0000015
C  Cr-52       0.0003557          0.0003348          0.0000283
C  Cr-53       0.0000403          0.0000387          0.0000032
C  Cr-54       0.0000100          0.0000098          0.0000008
C  Mn-55       0.0078340          0.0078003          0.0006225
C  Fe-54       0.0568920          0.0556172          0.0045205
C  Fe-56       0.8930822          0.9053674          0.0709617
C  Fe-57       0.0206252          0.0212829          0.0016388
C  Fe-58       0.0027448          0.0028820          0.0002181
C  Cu-63       0.0007628          0.0008700          0.0000606
C  Cu-65       0.0003400          0.0004001          0.0000270
C  Mo-92       0.0000068          0.0000114          0.0000005
C  Mo-94       0.0000043          0.0000072          0.0000003
C  Mo-95       0.0000073          0.0000126          0.0000006
C  Mo-96       0.0000077          0.0000133          0.0000006
C  Mo-97       0.0000044          0.0000077          0.0000003
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C  Mo-98       0.0000111          0.0000197          0.0000009
C  Mo-100      0.0000044          0.0000080          0.0000004
C
C  The total compound atom density (atom/b-cm):  0.07945702
C
M765    06000.70c  0.0119440  14028.70c  0.0048924  14029.70c  0.0002484
        14030.70c  0.0001638  24050.70c  0.0000184  24052.70c  0.0003557
        24053.70c  0.0000403  24054.70c  0.0000100  25055.70c  0.0078340
        26054.70c  0.0568920  26056.70c  0.8930822  26057.70c  0.0206252
        26058.70c  0.0027448  29063.70c  0.0007628  29065.70c  0.0003400
        42000.66c  0.0000460
C
C
C
C  General Purpose Steel, Grade B7
C   7 Comment Cards
C
C  1
C  2 The weight fraction for elements of General Purpose Steel, Grade B7 is
C  3 The weight fractions are used for each element.
C  4 The density of natural cadmium is 7.83 g/cc,
C  5 The MCNP material number is found after the material.
C  6 The line below "7" gives the density.
C  7
C
C   Summary of MatMCNP Calculations:
C
C  Isotope  Number Fraction    Weight Fraction       Atoms/b-cm
C   C-12       0.0194064          0.0042483          0.0016694
C   C-13       0.0002178          0.0000517          0.0000187
C  Mn-55       0.0087306          0.0087500          0.0007510
C   P-31       0.0006194          0.0003500          0.0000533
C   S-32       0.0006498          0.0003790          0.0000559
C   S-33       0.0000051          0.0000031          0.0000004
C   S-34       0.0000288          0.0000178          0.0000025
C   S-36       0.0000001          0.0000001          0.0000000
C  Si-28       0.0045003          0.0022968          0.0003871
C  Si-29       0.0002285          0.0001208          0.0000197
C  Si-30       0.0001506          0.0000824          0.0000130
C  Cr-50       0.0004466          0.0004069          0.0000384
C  Cr-52       0.0086125          0.0081607          0.0007409
C  Cr-53       0.0009766          0.0009432          0.0000840
C  Cr-54       0.0002431          0.0002392          0.0000209
C  Mo-92       0.0001696          0.0002843          0.0000146
C  Mo-94       0.0001057          0.0001811          0.0000091
C  Mo-95       0.0001819          0.0003150          0.0000157
C  Mo-96       0.0001906          0.0003335          0.0000164
C  Mo-97       0.0001091          0.0001929          0.0000094
C  Mo-98       0.0002758          0.0004925          0.0000237
C  Mo-100      0.0001101          0.0002006          0.0000095
C  Fe-54       0.0557637          0.0548720          0.0047968
C  Fe-56       0.8753707          0.8932369          0.0753001
C  Fe-57       0.0202161          0.0209977          0.0017390
C  Fe-58       0.0026904          0.0028434          0.0002314
C
C  The total compound atom density (atom/b-cm):  0.08602087
C
C  This material contains an isotope that is often
C  modified by an S(alpha,beta). Check MCNP
C  Manual Appendix G to see if an
C  S(alpha,beta) is required.
C
C  MCNP Material 766
C
M766    06000.70c  0.0196242
        25055.70c  0.0087306
        15031.70c  0.0006194
        16000.66c  0.0006838
        14028.70c  0.0045003
        14029.70c  0.0002285
        14030.70c  0.0001506
        24050.70c  0.0004466
        24052.70c  0.0086125
        24053.70c  0.0009766
        24054.70c  0.0002431
        42000.66c  0.0011428
        26054.70c  0.0557637
        26056.70c  0.8753707
        26057.70c  0.0202161
        26058.70c  0.0026904
```

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C
C  Caution: The natural zaid is used for Carbon.
C
C  Caution: The natural zaid is used for Sulfur.
C
C  Caution: The natural zaid is used for Molybdenum.
C
C  If the natural zaid is used for any element, the atom fractions of each isotope
C  of that element are added together and listed with the natural zaid just once.
C
C  To convert a particle flux to rad[Material]
C  use FM  1.76023016E-10 766  -4 1 for neutrons
C   or FM  1.76023016E-10 766  -5 -6 for photons.
C
C
C  Carbon Steel
C   8 Comment Cards
C
C  1
C  2 The weight fraction for elements of carbon steel is used.
C  3 The weight fractions are used for each element.
C  4 Data obtained from MCNP Primer by C.D. Harmon and R.D. Busch (1994)
C  5 The density of natural cadmium is 7.82 g/cc,
C  6 The MCNP material number is found after the material.
C  7 The line below "8" gives the density.
C  8
C
C   Summary of MatMCNP Calculations:
C
C  Isotope  Number Fraction    Weight Fraction       Atoms/b-cm
C   C-12       0.0225772          0.0049399          0.0019386
C   C-13       0.0002534          0.0000601          0.0000218
C  Fe-54       0.0571155          0.0561733          0.0049043
C  Fe-56       0.8965919          0.9144202          0.0769875
C  Fe-57       0.0207062          0.0214957          0.0017780
C  Fe-58       0.0027556          0.0029108          0.0002366
C
C  The total compound atom density (atom/b-cm):  0.08586678
C
C  This material contains an isotope that is often
C  modified by an S(alpha,beta). Check MCNP
C  Manual Appendix G to see if an
C  S(alpha,beta) is required.
C
C  MCNP Material 767
C
M767    06000.70c  0.0228306
        26054.70c  0.0571155
        26056.70c  0.8965919
        26057.70c  0.0207062
        26058.70c  0.0027556
C
C  Caution: The natural zaid is used for Carbon.
C
C
C
C  Graphite (den = 1.82 --> From PJC's model of LPG1)
C
M780    06000.70c  1.000000
MT780   grph.60t
c
C  Caution: The natural zaid is used for Carbon.
c
C  If the natural zaid is used for any element, the atom fractions of each isotope
C  of that element are added together and listed with the natural zaid just once.
C
C  To convert a particle flux to rad[Material]
C  use FM  1.75917531E-10 767  -4 1 for neutrons
C   or FM  1.75917531E-10 767  -5 -6 for photons.
C
C
C ********************
C * TALLIES  *
C ********************
C
F14:P   1001
FC14    gamma fluence  g/cm**2/source neutron - 48 group
E14    1.38880e-10
        1.00E-03 1.00E-02 2.00E-02 3.00E-02 4.50E-02
        6.00E-02 8.00E-02 1.00E-01 1.50E-01 2.00E-01
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         3.00E-01 4.00E-01 4.50E-01 5.00E-01 5.25E-01
         6.00E-01 7.00E-01 8.00E-01 9.00E-01 1.00E+00
         1.13E+00 1.20E+00 1.33E+00 1.50E+00 1.66E+00
         1.88E+00 2.00E+00 2.33E+00 2.50E+00 2.67E+00
         3.00E+00 3.50E+00 4.00E+00 4.50E+00 5.00E+00
         5.50E+00 6.00E+00 6.50E+00 7.00E+00 7.50E+00
         8.00E+00 9.00E+00 1.00E+01 1.20E+01 1.40E+01
         1.70E+01 2.00E+01 3.00E+01 5.00E+01
C
F24:N   1001
FC24    neutron fluence  n/cm**2/source neutron - 640 group
E24    1.000e-10   1.050e-10   1.100e-10   1.150e-10   1.200e-10   1.275e-10
       1.350e-10   1.425e-10   1.500e-10   1.600e-10   1.700e-10   1.800e-10
       1.900e-10   2.000e-10   2.100e-10   2.200e-10   2.300e-10   2.400e-10
       2.550e-10   2.700e-10   2.800e-10   3.000e-10   3.200e-10   3.400e-10
       3.600e-10   3.800e-10   4.000e-10   4.250e-10   4.500e-10   4.750e-10
       5.000e-10   5.250e-10   5.500e-10   5.750e-10   6.000e-10   6.300e-10
       6.600e-10   6.900e-10   7.200e-10   7.600e-10   8.000e-10   8.400e-10
       8.800e-10   9.200e-10   9.600e-10   1.000e-09   1.050e-09   1.100e-09
       1.150e-09   1.200e-09   1.275e-09   1.350e-09   1.425e-09   1.500e-09
       1.600e-09   1.700e-09   1.800e-09   1.900e-09   2.000e-09   2.100e-09
       2.200e-09   2.300e-09   2.400e-09   2.550e-09   2.700e-09   2.800e-09
       3.000e-09   3.200e-09   3.400e-09   3.600e-09   3.800e-09   4.000e-09
       4.250e-09   4.500e-09   4.750e-09   5.000e-09   5.250e-09   5.500e-09
       5.750e-09   6.000e-09   6.300e-09   6.600e-09   6.900e-09   7.200e-09
       7.600e-09   8.000e-09   8.400e-09   8.800e-09   9.200e-09   9.600e-09
       1.000e-08   1.050e-08   1.100e-08   1.150e-08   1.200e-08   1.275e-08
       1.350e-08   1.425e-08   1.500e-08   1.600e-08   1.700e-08   1.800e-08
       1.900e-08   2.000e-08   2.100e-08   2.200e-08   2.300e-08   2.400e-08
       2.550e-08   2.700e-08   2.800e-08   3.000e-08   3.200e-08   3.400e-08
       3.600e-08   3.800e-08   4.000e-08   4.250e-08   4.500e-08   4.750e-08
       5.000e-08   5.250e-08   5.500e-08   5.750e-08   6.000e-08   6.300e-08
       6.600e-08   6.900e-08   7.200e-08   7.600e-08   8.000e-08   8.400e-08
       8.800e-08   9.200e-08   9.600e-08   1.000e-07   1.050e-07   1.100e-07
       1.150e-07   1.200e-07   1.275e-07   1.350e-07   1.425e-07   1.500e-07
       1.600e-07   1.700e-07   1.800e-07   1.900e-07   2.000e-07   2.100e-07
       2.200e-07   2.300e-07   2.400e-07   2.550e-07   2.700e-07   2.800e-07
       3.000e-07   3.200e-07   3.400e-07   3.600e-07   3.800e-07   4.000e-07
       4.250e-07   4.500e-07   4.750e-07   5.000e-07   5.250e-07   5.500e-07
       5.750e-07   6.000e-07   6.300e-07   6.600e-07   6.900e-07   7.200e-07
       7.600e-07   8.000e-07   8.400e-07   8.800e-07   9.200e-07   9.600e-07
       1.000e-06   1.050e-06   1.100e-06   1.150e-06   1.200e-06   1.275e-06
       1.350e-06   1.425e-06   1.500e-06   1.600e-06   1.700e-06   1.800e-06
       1.900e-06   2.000e-06   2.100e-06   2.200e-06   2.300e-06   2.400e-06
       2.550e-06   2.700e-06   2.800e-06   3.000e-06   3.200e-06   3.400e-06
       3.600e-06   3.800e-06   4.000e-06   4.250e-06   4.500e-06   4.750e-06
       5.000e-06   5.250e-06   5.500e-06   5.750e-06   6.000e-06   6.300e-06
       6.600e-06   6.900e-06   7.200e-06   7.600e-06   8.000e-06   8.400e-06
       8.800e-06   9.200e-06   9.600e-06   1.000e-05   1.050e-05   1.100e-05
       1.150e-05   1.200e-05   1.275e-05   1.350e-05   1.425e-05   1.500e-05
       1.600e-05   1.700e-05   1.800e-05   1.900e-05   2.000e-05   2.100e-05
       2.200e-05   2.300e-05   2.400e-05   2.550e-05   2.700e-05   2.800e-05
       3.000e-05   3.200e-05   3.400e-05   3.600e-05   3.800e-05   4.000e-05
       4.250e-05   4.500e-05   4.750e-05   5.000e-05   5.250e-05   5.500e-05
       5.750e-05   6.000e-05   6.300e-05   6.600e-05   6.900e-05   7.200e-05
       7.600e-05   8.000e-05   8.400e-05   8.800e-05   9.200e-05   9.600e-05
       1.000e-04   1.050e-04   1.100e-04   1.150e-04   1.200e-04   1.275e-04
       1.350e-04   1.425e-04   1.500e-04   1.600e-04   1.700e-04   1.800e-04
       1.900e-04   2.000e-04   2.100e-04   2.200e-04   2.300e-04   2.400e-04
       2.550e-04   2.700e-04   2.800e-04   3.000e-04   3.200e-04   3.400e-04
       3.600e-04   3.800e-04   4.000e-04   4.250e-04   4.500e-04   4.750e-04
       5.000e-04   5.250e-04   5.500e-04   5.750e-04   6.000e-04   6.300e-04
       6.600e-04   6.900e-04   7.200e-04   7.600e-04   8.000e-04   8.400e-04
       8.800e-04   9.200e-04   9.600e-04   1.000e-03   1.050e-03   1.100e-03
       1.150e-03   1.200e-03   1.275e-03   1.350e-03   1.425e-03   1.500e-03
       1.600e-03   1.700e-03   1.800e-03   1.900e-03   2.000e-03   2.100e-03
       2.200e-03   2.300e-03   2.400e-03   2.550e-03   2.700e-03   2.800e-03
       3.000e-03   3.200e-03   3.400e-03   3.600e-03   3.800e-03   4.000e-03
       4.250e-03   4.500e-03   4.750e-03   5.000e-03   5.250e-03   5.500e-03
       5.750e-03   6.000e-03   6.300e-03   6.600e-03   6.900e-03   7.200e-03
       7.600e-03   8.000e-03   8.400e-03   8.800e-03   9.200e-03   9.600e-03
       1.000e-02   1.050e-02   1.100e-02   1.150e-02   1.200e-02   1.275e-02
       1.350e-02   1.425e-02   1.500e-02   1.600e-02   1.700e-02   1.800e-02
       1.900e-02   2.000e-02   2.100e-02   2.200e-02   2.300e-02   2.400e-02
       2.550e-02   2.700e-02   2.800e-02   3.000e-02   3.200e-02   3.400e-02
       3.600e-02   3.800e-02   4.000e-02   4.250e-02   4.500e-02   4.750e-02
       5.000e-02   5.250e-02   5.500e-02   5.750e-02   6.000e-02   6.300e-02
       6.600e-02   6.900e-02   7.200e-02   7.600e-02   8.000e-02   8.400e-02
       8.800e-02   9.200e-02   9.600e-02   1.000e-01   1.050e-01   1.100e-01
       1.150e-01   1.200e-01   1.275e-01   1.350e-01   1.425e-01   1.500e-01
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        1.600e-01   1.700e-01   1.800e-01   1.900e-01   2.000e-01   2.100e-01
        2.200e-01   2.300e-01   2.400e-01   2.550e-01   2.700e-01   2.800e-01
        3.000e-01   3.200e-01   3.400e-01   3.600e-01   3.800e-01   4.000e-01
        4.250e-01   4.500e-01   4.750e-01   5.000e-01   5.250e-01   5.500e-01
        5.750e-01   6.000e-01   6.300e-01   6.600e-01   6.900e-01   7.200e-01
        7.600e-01   8.000e-01   8.400e-01   8.800e-01   9.200e-01   9.600e-01
        1.000e+00   1.100e+00   1.200e+00   1.300e+00   1.400e+00   1.500e+00
        1.600e+00   1.700e+00   1.800e+00   1.900e+00   2.000e+00   2.100e+00
        2.200e+00   2.300e+00   2.400e+00   2.500e+00   2.600e+00   2.700e+00
        2.800e+00   2.900e+00   3.000e+00   3.100e+00   3.200e+00   3.300e+00
        3.400e+00   3.500e+00   3.600e+00   3.700e+00   3.800e+00   3.900e+00
        4.000e+00   4.100e+00   4.200e+00   4.300e+00   4.400e+00   4.500e+00
        4.600e+00   4.700e+00   4.800e+00   4.900e+00   5.000e+00   5.100e+00
        5.200e+00   5.300e+00   5.400e+00   5.500e+00   5.600e+00   5.700e+00
        5.800e+00   5.900e+00   6.000e+00   6.100e+00   6.200e+00   6.300e+00
        6.400e+00   6.500e+00   6.600e+00   6.700e+00   6.800e+00   6.900e+00
        7.000e+00   7.100e+00   7.200e+00   7.300e+00   7.400e+00   7.500e+00
        7.600e+00   7.700e+00   7.800e+00   7.900e+00   8.000e+00   8.100e+00
        8.200e+00   8.300e+00   8.400e+00   8.500e+00   8.600e+00   8.700e+00
        8.800e+00   8.900e+00   9.000e+00   9.100e+00   9.200e+00   9.300e+00
        9.400e+00   9.500e+00   9.600e+00   9.700e+00   9.800e+00   9.900e+00
        1.000e+01   1.010e+01   1.020e+01   1.030e+01   1.040e+01   1.050e+01
        1.060e+01   1.070e+01   1.080e+01   1.090e+01   1.100e+01   1.110e+01
        1.120e+01   1.130e+01   1.140e+01   1.150e+01   1.160e+01   1.170e+01
        1.180e+01   1.190e+01   1.200e+01   1.210e+01   1.220e+01   1.230e+01
        1.240e+01   1.250e+01   1.260e+01   1.270e+01   1.280e+01   1.290e+01
        1.300e+01   1.310e+01   1.320e+01   1.330e+01   1.340e+01   1.350e+01
        1.360e+01   1.370e+01   1.380e+01   1.390e+01   1.400e+01   1.410e+01
        1.420e+01   1.430e+01   1.440e+01   1.450e+01   1.460e+01   1.470e+01
        1.480e+01   1.490e+01   1.500e+01   1.510e+01   1.520e+01   1.530e+01
        1.540e+01   1.550e+01   1.560e+01   1.570e+01   1.580e+01   1.590e+01
        1.600e+01   1.610e+01   1.620e+01   1.630e+01   1.640e+01   1.650e+01
        1.660e+01   1.670e+01   1.680e+01   1.690e+01   1.700e+01   1.710e+01
        1.720e+01   1.730e+01   1.740e+01   1.750e+01   1.760e+01   1.770e+01
        1.780e+01   1.790e+01   1.800e+01   1.810e+01   1.820e+01   1.830e+01
        1.840e+01   1.850e+01   1.860e+01   1.870e+01   1.880e+01   1.890e+01
        1.900e+01   1.910e+01   1.920e+01   1.930e+01   1.940e+01   1.950e+01
        1.960e+01   1.970e+01   1.980e+01   1.990e+01   2.000e+01
C
F34:N   1001
FC34    neutron fluence  n/cm**2/source neutron - 89 group
E34     1.39E-10 1.00E-09 5.00E-09 1.00E-08 3.00E-08 7.00E-08 1.00E-07
        1.52E-07 2.00E-07 4.14E-07 6.00E-07 8.00E-07 1.13E-06 3.06E-06
        5.04E-06 8.32E-06 1.37E-05 2.26E-05 3.73E-05 6.14E-05 1.01E-04
        1.67E-04 2.75E-04 3.54E-04 4.54E-04 5.83E-04 7.49E-04 9.61E-04
        1.09E-03 1.23E-03 1.40E-03 1.58E-03 1.80E-03 2.03E-03 2.31E-03
        2.61E-03 2.96E-03 3.35E-03 3.80E-03 4.31E-03 4.88E-03 5.53E-03
        6.27E-03 7.10E-03 8.05E-03 9.12E-03 1.03E-02 1.17E-02 1.33E-02
        1.50E-02 1.70E-02 1.93E-02 2.19E-02 2.48E-02 2.61E-02 2.81E-02
        3.18E-02 4.09E-02 5.25E-02 6.74E-02 8.65E-02 1.11E-01 1.43E-01
        1.83E-01 2.35E-01 3.02E-01 3.88E-01 4.39E-01 4.98E-01 5.64E-01
        6.39E-01 7.24E-01 8.21E-01 9.30E-01 1.05E+00 1.19E+00 1.35E+00
        1.74E+00 2.23E+00 2.87E+00 3.68E+00 4.72E+00 6.07E+00 7.79E+00
        1.00E+01 1.19E+01 1.35E+01 1.49E+01 1.69E+01 2.00E+01
C
F44:N  1001
FC44   total neutron fluence  n/cm**2/source neutron
C
C
MODE N P
C  20B
KCODE 10000000 1.0 3 2000
c  KCODE 10000 1.0 3 200
KSRC   20 0 50  0 20 60  30 0 40  0 30 60
C    PRINT  10 60 100 110
RAND  GEN=2 SEED=19073486328125 STRIDE=152917
PRDMP  50 50 0 1 0
```

APPENDIX B CALCULATED SPECTRUM

Table VII. 640 group representation of the calculated spectrum.

Group number	Lower energy (MeV)	Upper energy (MeV)	Midpoint energy (MeV)	Φ (n/cm^2)[‡]	Relative statistical uncertainty [§]	$d\Phi/dE$	$E\ d\Phi/dE$
1	1.000E-10	1.050E-10	1.0250E-10	4.67194E-08	0.3143	9.34388E+03	9.57748E-07
2	1.050E-10	1.100E-10	1.0750E-10	4.09326E-08	0.3202	8.18653E+03	8.80052E-07
3	1.100E-10	1.150E-10	1.1250E-10	4.88026E-08	0.2835	9.76051E+03	1.09806E-06
4	1.150E-10	1.200E-10	1.1750E-10	6.73653E-08	0.2631	1.34731E+04	1.58308E-06
5	1.200E-10	1.275E-10	1.2375E-10	6.03808E-08	0.2598	8.05078E+03	9.96283E-07
6	1.275E-10	1.350E-10	1.3125E-10	6.31968E-08	0.2393	8.42625E+03	1.10594E-06
7	1.350E-10	1.425E-10	1.3875E-10	3.79397E-08	0.2890	5.05863E+03	7.01885E-07
8	1.425E-10	1.500E-10	1.4625E-10	6.86099E-08	0.2484	9.14799E+03	1.33789E-06
9	1.500E-10	1.600E-10	1.5500E-10	8.61986E-08	0.2228	8.61986E+03	1.33608E-06
10	1.600E-10	1.700E-10	1.6500E-10	7.06865E-08	0.2281	7.06865E+03	1.16633E-06
11	1.700E-10	1.800E-10	1.7500E-10	1.28238E-07	0.1639	1.28238E+04	2.24416E-06
12	1.800E-10	1.900E-10	1.8500E-10	1.02788E-07	0.2010	1.02788E+04	1.90158E-06
13	1.900E-10	2.000E-10	1.9500E-10	1.38716E-07	0.1716	1.38716E+04	2.70496E-06
14	2.000E-10	2.100E-10	2.0500E-10	1.29854E-07	0.1800	1.29854E+04	2.66200E-06
15	2.100E-10	2.200E-10	2.1500E-10	1.25083E-07	0.1784	1.25083E+04	2.68929E-06
16	2.200E-10	2.300E-10	2.2500E-10	1.85716E-07	0.1517	1.85716E+04	4.17861E-06
17	2.300E-10	2.400E-10	2.3500E-10	1.23053E-07	0.1758	1.23053E+04	2.89175E-06
18	2.400E-10	2.550E-10	2.4750E-10	2.80459E-07	0.1233	1.86973E+04	4.62758E-06
19	2.550E-10	2.700E-10	2.6250E-10	2.94107E-07	0.1183	1.96071E+04	5.14688E-06
20	2.700E-10	2.800E-10	2.7500E-10	1.96174E-07	0.1382	1.96174E+04	5.39478E-06
21	2.800E-10	3.000E-10	2.9000E-10	3.61885E-07	0.1034	1.80943E+04	5.24734E-06
22	3.000E-10	3.200E-10	3.1000E-10	4.84514E-06	0.0307	2.42257E+05	7.50996E-05
23	3.200E-10	3.400E-10	3.3000E-10	2.95555E-06	0.0394	1.47778E+05	4.87666E-05

[‡] Integral fluence in each bin, normalized so that the sum of all integral bin fluences equals unity.

[§] These are the uncertainties associated with the statistical Monte Carlo transport method, and not the uncertainties associated with the spectrum itself.

24	3.400E-10	3.600E-10	3.5000E-10	2.58533E-06	0.0417	1.29267E+05	4.52434E-05
25	3.600E-10	3.800E-10	3.7000E-10	2.28542E-06	0.0450	1.14271E+05	4.22802E-05
26	3.800E-10	4.000E-10	3.9000E-10	1.73261E-06	0.0507	8.66306E+04	3.37859E-05
27	4.000E-10	4.250E-10	4.1250E-10	1.59936E-06	0.0530	6.39743E+04	2.63894E-05
28	4.250E-10	4.500E-10	4.3750E-10	1.67707E-06	0.0510	6.70829E+04	2.93488E-05
29	4.500E-10	4.750E-10	4.6250E-10	1.69128E-06	0.0517	6.76511E+04	3.12886E-05
30	4.750E-10	5.000E-10	4.8750E-10	1.78133E-06	0.0505	7.12533E+04	3.47360E-05
31	5.000E-10	5.250E-10	5.1250E-10	1.70491E-06	0.0503	6.81963E+04	3.49506E-05
32	5.250E-10	5.500E-10	5.3750E-10	2.02749E-06	0.0461	8.10996E+04	4.35910E-05
33	5.500E-10	5.750E-10	5.6250E-10	2.06294E-06	0.0475	8.25177E+04	4.64162E-05
34	5.750E-10	6.000E-10	5.8750E-10	2.28114E-06	0.0443	9.12457E+04	5.36068E-05
35	6.000E-10	6.300E-10	6.1500E-10	2.28742E-06	0.0436	7.62474E+04	4.68921E-05
36	6.300E-10	6.600E-10	6.4500E-10	2.44351E-06	0.0423	8.14504E+04	5.25355E-05
37	6.600E-10	6.900E-10	6.7500E-10	2.47935E-06	0.0419	8.26449E+04	5.57853E-05
38	6.900E-10	7.200E-10	7.0500E-10	2.60639E-06	0.0416	8.68798E+04	6.12503E-05
39	7.200E-10	7.600E-10	7.4000E-10	3.66937E-06	0.0346	9.17343E+04	6.78834E-05
40	7.600E-10	8.000E-10	7.8000E-10	3.66610E-06	0.0348	9.16526E+04	7.14890E-05
41	8.000E-10	8.400E-10	8.2000E-10	3.76078E-06	0.0341	9.40195E+04	7.70960E-05
42	8.400E-10	8.800E-10	8.6000E-10	4.01380E-06	0.0331	1.00345E+05	8.62968E-05
43	8.800E-10	9.200E-10	9.0000E-10	4.48531E-06	0.0312	1.12133E+05	1.00919E-04
44	9.200E-10	9.600E-10	9.4000E-10	4.58384E-06	0.0311	1.14596E+05	1.07720E-04
45	9.600E-10	1.000E-09	9.8000E-10	4.89202E-06	0.0300	1.22301E+05	1.19855E-04
46	1.000E-09	1.050E-09	1.0250E-09	6.22486E-06	0.0269	1.24497E+05	1.27610E-04
47	1.050E-09	1.100E-09	1.0750E-09	4.65175E-05	0.0100	9.30350E+05	1.00013E-03
48	1.100E-09	1.150E-09	1.1250E-09	2.22354E-05	0.0144	4.44707E+05	5.00296E-04
49	1.150E-09	1.200E-09	1.1750E-09	1.88855E-05	0.0156	3.77710E+05	4.43809E-04
50	1.200E-09	1.275E-09	1.2375E-09	2.67049E-05	0.0131	3.56066E+05	4.40632E-04
51	1.275E-09	1.350E-09	1.3125E-09	1.92255E-05	0.0154	2.56340E+05	3.36446E-04
52	1.350E-09	1.425E-09	1.3875E-09	1.79469E-05	0.0159	2.39292E+05	3.32018E-04
53	1.425E-09	1.500E-09	1.4625E-09	2.16600E-05	0.0147	2.88800E+05	4.22370E-04
54	1.500E-09	1.600E-09	1.5500E-09	2.92071E-05	0.0127	2.92071E+05	4.52710E-04
55	1.600E-09	1.700E-09	1.6500E-09	3.00563E-05	0.0126	3.00563E+05	4.95929E-04

56	1.700E-09	1.800E-09	1.7500E-09	2.87815E-05	0.0127	2.87815E+05	5.03677E-04
57	1.800E-09	1.900E-09	1.8500E-09	3.04408E-05	0.0137	3.04408E+05	5.63156E-04
58	1.900E-09	2.000E-09	1.9500E-09	2.97988E-05	0.0128	2.97988E+05	5.81077E-04
59	2.000E-09	2.100E-09	2.0500E-09	3.09738E-05	0.0122	3.09738E+05	6.34964E-04
60	2.100E-09	2.200E-09	2.1500E-09	3.35637E-05	0.0118	3.35637E+05	7.21620E-04
61	2.200E-09	2.300E-09	2.2500E-09	3.48323E-05	0.0115	3.48323E+05	7.83727E-04
62	2.300E-09	2.400E-09	2.3500E-09	1.23619E-04	0.0062	1.23619E+06	2.90504E-03
63	2.400E-09	2.550E-09	2.4750E-09	1.46059E-04	0.0057	9.73727E+05	2.40997E-03
64	2.550E-09	2.700E-09	2.6250E-09	1.18688E-04	0.0063	7.91253E+05	2.07704E-03
65	2.700E-09	2.800E-09	2.7500E-09	7.14401E-05	0.0081	7.14401E+05	1.96460E-03
66	2.800E-09	3.000E-09	2.9000E-09	9.88624E-05	0.0069	4.94312E+05	1.43351E-03
67	3.000E-09	3.200E-09	3.1000E-09	9.65316E-05	0.0069	4.82658E+05	1.49624E-03
68	3.200E-09	3.400E-09	3.3000E-09	9.55528E-05	0.0070	4.77764E+05	1.57662E-03
69	3.400E-09	3.600E-09	3.5000E-09	9.77725E-05	0.0069	4.88863E+05	1.71102E-03
70	3.600E-09	3.800E-09	3.7000E-09	1.89517E-04	0.0050	9.47586E+05	3.50607E-03
71	3.800E-09	4.000E-09	3.9000E-09	2.29659E-04	0.0045	1.14830E+06	4.47835E-03
72	4.000E-09	4.250E-09	4.1250E-09	2.07946E-04	0.0047	8.31785E+05	3.43111E-03
73	4.250E-09	4.500E-09	4.3750E-09	1.66861E-04	0.0053	6.67444E+05	2.92007E-03
74	4.500E-09	4.750E-09	4.6250E-09	1.69962E-04	0.0052	6.79849E+05	3.14430E-03
75	4.750E-09	5.000E-09	4.8750E-09	3.11232E-04	0.0039	1.24493E+06	6.06903E-03
76	5.000E-09	5.250E-09	5.1250E-09	2.83705E-04	0.0041	1.13482E+06	5.81595E-03
77	5.250E-09	5.500E-09	5.3750E-09	2.50924E-04	0.0043	1.00370E+06	5.39486E-03
78	5.500E-09	5.750E-09	5.6250E-09	2.26327E-04	0.0046	9.05308E+05	5.09236E-03
79	5.750E-09	6.000E-09	5.8750E-09	3.47313E-04	0.0037	1.38925E+06	8.16185E-03
80	6.000E-09	6.300E-09	6.1500E-09	3.89966E-04	0.0035	1.29989E+06	7.99430E-03
81	6.300E-09	6.600E-09	6.4500E-09	3.38377E-04	0.0037	1.12792E+06	7.27510E-03
82	6.600E-09	6.900E-09	6.7500E-09	4.09152E-04	0.0034	1.36384E+06	9.20592E-03
83	6.900E-09	7.200E-09	7.0500E-09	4.32406E-04	0.0033	1.44135E+06	1.01615E-02
84	7.200E-09	7.600E-09	7.4000E-09	4.91824E-04	0.0031	1.22956E+06	9.09875E-03
85	7.600E-09	8.000E-09	7.8000E-09	6.77525E-04	0.0026	1.69381E+06	1.32117E-02
86	8.000E-09	8.400E-09	8.2000E-09	5.21800E-04	0.0030	1.30450E+06	1.06969E-02
87	8.400E-09	8.800E-09	8.6000E-09	7.26229E-04	0.0026	1.81557E+06	1.56139E-02

88	8.800E-09	9.200E-09	9.0000E-09	6.28253E-04	0.0028	1.57063E+06	1.41357E-02
89	9.200E-09	9.600E-09	9.4000E-09	6.52037E-04	0.0027	1.63009E+06	1.53229E-02
90	9.600E-09	1.000E-08	9.8000E-09	6.58868E-04	0.0027	1.64717E+06	1.61423E-02
91	1.000E-08	1.050E-08	1.0250E-08	8.27935E-04	0.0024	1.65587E+06	1.69727E-02
92	1.050E-08	1.100E-08	1.0750E-08	8.27797E-04	0.0024	1.65559E+06	1.77976E-02
93	1.100E-08	1.150E-08	1.1250E-08	8.90593E-04	0.0023	1.78119E+06	2.00384E-02
94	1.150E-08	1.200E-08	1.1750E-08	9.60620E-04	0.0022	1.92124E+06	2.25746E-02
95	1.200E-08	1.275E-08	1.2375E-08	1.45844E-03	0.0018	1.94458E+06	2.40642E-02
96	1.275E-08	1.350E-08	1.3125E-08	1.50587E-03	0.0018	2.00783E+06	2.63528E-02
97	1.350E-08	1.425E-08	1.3875E-08	1.54990E-03	0.0018	2.06653E+06	2.86731E-02
98	1.425E-08	1.500E-08	1.4625E-08	1.60311E-03	0.0017	2.13748E+06	3.12607E-02
99	1.500E-08	1.600E-08	1.5500E-08	2.17915E-03	0.0015	2.17915E+06	3.37768E-02
100	1.600E-08	1.700E-08	1.6500E-08	2.24399E-03	0.0015	2.24399E+06	3.70258E-02
101	1.700E-08	1.800E-08	1.7500E-08	2.51889E-03	0.0014	2.51889E+06	4.40805E-02
102	1.800E-08	1.900E-08	1.8500E-08	2.24895E-03	0.0015	2.24895E+06	4.16057E-02
103	1.900E-08	2.000E-08	1.9500E-08	2.30297E-03	0.0014	2.30297E+06	4.49080E-02
104	2.000E-08	2.100E-08	2.0500E-08	2.39061E-03	0.0014	2.39061E+06	4.90075E-02
105	2.100E-08	2.200E-08	2.1500E-08	2.42403E-03	0.0014	2.42403E+06	5.21167E-02
106	2.200E-08	2.300E-08	2.2500E-08	2.42335E-03	0.0014	2.42335E+06	5.45253E-02
107	2.300E-08	2.400E-08	2.3500E-08	2.42357E-03	0.0014	2.42357E+06	5.69540E-02
108	2.400E-08	2.550E-08	2.4750E-08	3.73441E-03	0.0011	2.48961E+06	6.16178E-02
109	2.550E-08	2.700E-08	2.6250E-08	3.90097E-03	0.0011	2.60064E+06	6.82669E-02
110	2.700E-08	2.800E-08	2.7500E-08	2.54578E-03	0.0014	2.54578E+06	7.00090E-02
111	2.800E-08	3.000E-08	2.9000E-08	4.91272E-03	0.0010	2.45636E+06	7.12345E-02
112	3.000E-08	3.200E-08	3.1000E-08	4.95714E-03	0.0010	2.47857E+06	7.68357E-02
113	3.200E-08	3.400E-08	3.3000E-08	5.03424E-03	0.0010	2.51712E+06	8.30650E-02
114	3.400E-08	3.600E-08	3.5000E-08	5.03540E-03	0.0010	2.51770E+06	8.81195E-02
115	3.600E-08	3.800E-08	3.7000E-08	4.78972E-03	0.0010	2.39486E+06	8.86098E-02
116	3.800E-08	4.000E-08	3.9000E-08	4.74487E-03	0.0010	2.37243E+06	9.25249E-02
117	4.000E-08	4.250E-08	4.1250E-08	5.90872E-03	0.0009	2.36349E+06	9.74939E-02
118	4.250E-08	4.500E-08	4.3750E-08	5.65948E-03	0.0009	2.26379E+06	9.90408E-02
119	4.500E-08	4.750E-08	4.6250E-08	5.61393E-03	0.0009	2.24557E+06	1.03858E-01

120	4.750E-08	5.000E-08	4.8750E-08	5.26133E-03	0.0010	2.10453E+06	1.02596E-01
121	5.000E-08	5.250E-08	5.1250E-08	5.16051E-03	0.0010	2.06421E+06	1.05791E-01
122	5.250E-08	5.500E-08	5.3750E-08	4.97377E-03	0.0010	1.98951E+06	1.06936E-01
123	5.500E-08	5.750E-08	5.6250E-08	4.89558E-03	0.0010	1.95823E+06	1.10151E-01
124	5.750E-08	6.000E-08	5.8750E-08	4.62357E-03	0.0010	1.84943E+06	1.08654E-01
125	6.000E-08	6.300E-08	6.1500E-08	5.25665E-03	0.0010	1.75222E+06	1.07761E-01
126	6.300E-08	6.600E-08	6.4500E-08	4.99567E-03	0.0010	1.66522E+06	1.07407E-01
127	6.600E-08	6.900E-08	6.7500E-08	4.95870E-03	0.0010	1.65290E+06	1.11571E-01
128	6.900E-08	7.200E-08	7.0500E-08	4.54305E-03	0.0011	1.51435E+06	1.06762E-01
129	7.200E-08	7.600E-08	7.4000E-08	5.70876E-03	0.0009	1.42719E+06	1.05612E-01
130	7.600E-08	8.000E-08	7.8000E-08	5.22825E-03	0.0010	1.30706E+06	1.01951E-01
131	8.000E-08	8.400E-08	8.2000E-08	4.87931E-03	0.0010	1.21983E+06	1.00026E-01
132	8.400E-08	8.800E-08	8.6000E-08	4.81387E-03	0.0010	1.20347E+06	1.03498E-01
133	8.800E-08	9.200E-08	9.0000E-08	4.35642E-03	0.0011	1.08910E+06	9.80194E-02
134	9.200E-08	9.600E-08	9.4000E-08	4.07456E-03	0.0011	1.01864E+06	9.57522E-02
135	9.600E-08	1.000E-07	9.8000E-08	3.70841E-03	0.0012	9.27103E+05	9.08561E-02
136	1.000E-07	1.050E-07	1.0250E-07	4.29599E-03	0.0011	8.59197E+05	8.80677E-02
137	1.050E-07	1.100E-07	1.0750E-07	3.85208E-03	0.0012	7.70416E+05	8.28198E-02
138	1.100E-07	1.150E-07	1.1250E-07	3.56067E-03	0.0012	7.12135E+05	8.01152E-02
139	1.150E-07	1.200E-07	1.1750E-07	3.22498E-03	0.0013	6.44996E+05	7.57870E-02
140	1.200E-07	1.275E-07	1.2375E-07	4.48091E-03	0.0011	5.97455E+05	7.39351E-02
141	1.275E-07	1.350E-07	1.3125E-07	4.08219E-03	0.0012	5.44292E+05	7.14383E-02
142	1.350E-07	1.425E-07	1.3875E-07	3.53269E-03	0.0013	4.71025E+05	6.53547E-02
143	1.425E-07	1.500E-07	1.4625E-07	3.12031E-03	0.0014	4.16041E+05	6.08460E-02
144	1.500E-07	1.600E-07	1.5500E-07	3.66534E-03	0.0013	3.66534E+05	5.68128E-02
145	1.600E-07	1.700E-07	1.6500E-07	3.18908E-03	0.0014	3.18908E+05	5.26199E-02
146	1.700E-07	1.800E-07	1.7500E-07	2.81363E-03	0.0015	2.81363E+05	4.92386E-02
147	1.800E-07	1.900E-07	1.8500E-07	2.55024E-03	0.0015	2.55024E+05	4.71795E-02
148	1.900E-07	2.000E-07	1.9500E-07	2.30963E-03	0.0016	2.30963E+05	4.50378E-02
149	2.000E-07	2.100E-07	2.0500E-07	2.07752E-03	0.0017	2.07752E+05	4.25892E-02
150	2.100E-07	2.200E-07	2.1500E-07	1.90075E-03	0.0018	1.90075E+05	4.08660E-02
151	2.200E-07	2.300E-07	2.2500E-07	1.75329E-03	0.0019	1.75329E+05	3.94490E-02

152	2.300E-07	2.400E-07	2.3500E-07	1.63879E-03	0.0019	1.63879E+05	3.85116E-02
153	2.400E-07	2.550E-07	2.4750E-07	2.27218E-03	0.0017	1.51479E+05	3.74910E-02
154	2.550E-07	2.700E-07	2.6250E-07	2.07335E-03	0.0017	1.38223E+05	3.62836E-02
155	2.700E-07	2.800E-07	2.7500E-07	1.29684E-03	0.0022	1.29684E+05	3.56631E-02
156	2.800E-07	3.000E-07	2.9000E-07	2.42376E-03	0.0016	1.21188E+05	3.51445E-02
157	3.000E-07	3.200E-07	3.1000E-07	2.23154E-03	0.0017	1.11577E+05	3.45889E-02
158	3.200E-07	3.400E-07	3.3000E-07	2.07519E-03	0.0017	1.03760E+05	3.42407E-02
159	3.400E-07	3.600E-07	3.5000E-07	1.92381E-03	0.0018	9.61904E+04	3.36666E-02
160	3.600E-07	3.800E-07	3.7000E-07	1.80671E-03	0.0019	9.03355E+04	3.34241E-02
161	3.800E-07	4.000E-07	3.9000E-07	1.71108E-03	0.0019	8.55542E+04	3.33661E-02
162	4.000E-07	4.250E-07	4.1250E-07	1.98941E-03	0.0018	7.95766E+04	3.28253E-02
163	4.250E-07	4.500E-07	4.3750E-07	1.87030E-03	0.0018	7.48119E+04	3.27302E-02
164	4.500E-07	4.750E-07	4.6250E-07	1.75003E-03	0.0019	7.00012E+04	3.23756E-02
165	4.750E-07	5.000E-07	4.8750E-07	1.62788E-03	0.0020	6.51151E+04	3.17436E-02
166	5.000E-07	5.250E-07	5.1250E-07	1.54098E-03	0.0020	6.16393E+04	3.15901E-02
167	5.250E-07	5.500E-07	5.3750E-07	1.46471E-03	0.0021	5.85883E+04	3.14912E-02
168	5.500E-07	5.750E-07	5.6250E-07	1.39746E-03	0.0021	5.58983E+04	3.14428E-02
169	5.750E-07	6.000E-07	5.8750E-07	1.34142E-03	0.0022	5.36566E+04	3.15233E-02
170	6.000E-07	6.300E-07	6.1500E-07	1.52547E-03	0.0021	5.08489E+04	3.12721E-02
171	6.300E-07	6.600E-07	6.4500E-07	1.44029E-03	0.0021	4.80095E+04	3.09661E-02
172	6.600E-07	6.900E-07	6.7500E-07	1.37053E-03	0.0022	4.56843E+04	3.08369E-02
173	6.900E-07	7.200E-07	7.0500E-07	1.29855E-03	0.0022	4.32851E+04	3.05160E-02
174	7.200E-07	7.600E-07	7.4000E-07	1.65643E-03	0.0020	4.14107E+04	3.06439E-02
175	7.600E-07	8.000E-07	7.8000E-07	1.57021E-03	0.0020	3.92552E+04	3.06191E-02
176	8.000E-07	8.400E-07	8.2000E-07	1.48419E-03	0.0021	3.71046E+04	3.04258E-02
177	8.400E-07	8.800E-07	8.6000E-07	1.40281E-03	0.0021	3.50703E+04	3.01605E-02
178	8.800E-07	9.200E-07	9.0000E-07	1.32945E-03	0.0022	3.32363E+04	2.99127E-02
179	9.200E-07	9.600E-07	9.4000E-07	1.27718E-03	0.0023	3.19295E+04	3.00137E-02
180	9.600E-07	1.000E-06	9.8000E-07	1.22307E-03	0.0023	3.05768E+04	2.99653E-02
181	1.000E-06	1.050E-06	1.0250E-06	1.45817E-03	0.0021	2.91634E+04	2.98924E-02
182	1.050E-06	1.100E-06	1.0750E-06	1.38540E-03	0.0022	2.77080E+04	2.97861E-02
183	1.100E-06	1.150E-06	1.1250E-06	1.32702E-03	0.0022	2.65404E+04	2.98579E-02

184	1.150E-06	1.200E-06	1.1750E-06	1.25745E-03	0.0023	2.51489E+04	2.95500E-02
185	1.200E-06	1.275E-06	1.2375E-06	1.80184E-03	0.0019	2.40245E+04	2.97303E-02
186	1.275E-06	1.350E-06	1.3125E-06	1.69329E-03	0.0020	2.25772E+04	2.96325E-02
187	1.350E-06	1.425E-06	1.3875E-06	1.58639E-03	0.0020	2.11519E+04	2.93482E-02
188	1.425E-06	1.500E-06	1.4625E-06	1.50526E-03	0.0021	2.00701E+04	2.93526E-02
189	1.500E-06	1.600E-06	1.5500E-06	1.89596E-03	0.0019	1.89596E+04	2.93873E-02
190	1.600E-06	1.700E-06	1.6500E-06	1.77730E-03	0.0019	1.77730E+04	2.93255E-02
191	1.700E-06	1.800E-06	1.7500E-06	1.67725E-03	0.0020	1.67725E+04	2.93518E-02
192	1.800E-06	1.900E-06	1.8500E-06	1.57787E-03	0.0020	1.57787E+04	2.91906E-02
193	1.900E-06	2.000E-06	1.9500E-06	1.49743E-03	0.0021	1.49743E+04	2.92000E-02
194	2.000E-06	2.100E-06	2.0500E-06	1.41438E-03	0.0022	1.41438E+04	2.89949E-02
195	2.100E-06	2.200E-06	2.1500E-06	1.35363E-03	0.0022	1.35363E+04	2.91029E-02
196	2.200E-06	2.300E-06	2.2500E-06	1.29785E-03	0.0023	1.29785E+04	2.92015E-02
197	2.300E-06	2.400E-06	2.3500E-06	1.23715E-03	0.0023	1.23715E+04	2.90730E-02
198	2.400E-06	2.550E-06	2.4750E-06	1.75645E-03	0.0019	1.17097E+04	2.89815E-02
199	2.550E-06	2.700E-06	2.6250E-06	1.65907E-03	0.0020	1.10605E+04	2.90338E-02
200	2.700E-06	2.800E-06	2.7500E-06	1.05159E-03	0.0025	1.05159E+04	2.89186E-02
201	2.800E-06	3.000E-06	2.9000E-06	1.99070E-03	0.0018	9.95352E+03	2.88652E-02
202	3.000E-06	3.200E-06	3.1000E-06	1.85960E-03	0.0019	9.29800E+03	2.88238E-02
203	3.200E-06	3.400E-06	3.3000E-06	1.75725E-03	0.0019	8.78623E+03	2.89946E-02
204	3.400E-06	3.600E-06	3.5000E-06	1.66300E-03	0.0020	8.31498E+03	2.91024E-02
205	3.600E-06	3.800E-06	3.7000E-06	1.58063E-03	0.0021	7.90315E+03	2.92416E-02
206	3.800E-06	4.000E-06	3.9000E-06	1.49896E-03	0.0021	7.49478E+03	2.92296E-02
207	4.000E-06	4.250E-06	4.1250E-06	1.77163E-03	0.0019	7.08651E+03	2.92319E-02
208	4.250E-06	4.500E-06	4.3750E-06	1.66005E-03	0.0020	6.64020E+03	2.90509E-02
209	4.500E-06	4.750E-06	4.6250E-06	1.56444E-03	0.0021	6.25777E+03	2.89422E-02
210	4.750E-06	5.000E-06	4.8750E-06	1.48077E-03	0.0021	5.92309E+03	2.88750E-02
211	5.000E-06	5.250E-06	5.1250E-06	1.41122E-03	0.0022	5.64488E+03	2.89300E-02
212	5.250E-06	5.500E-06	5.3750E-06	1.34575E-03	0.0022	5.38301E+03	2.89337E-02
213	5.500E-06	5.750E-06	5.6250E-06	1.29070E-03	0.0023	5.16281E+03	2.90408E-02
214	5.750E-06	6.000E-06	5.8750E-06	1.23457E-03	0.0023	4.93827E+03	2.90123E-02
215	6.000E-06	6.300E-06	6.1500E-06	1.41944E-03	0.0022	4.73145E+03	2.90984E-02

216	6.300E-06	6.600E-06	6.4500E-06	1.35111E-03	0.0022	4.50368E+03	2.90488E-02
217	6.600E-06	6.900E-06	6.7500E-06	1.29132E-03	0.0023	4.30441E+03	2.90548E-02
218	6.900E-06	7.200E-06	7.0500E-06	1.24462E-03	0.0023	4.14874E+03	2.92486E-02
219	7.200E-06	7.600E-06	7.4000E-06	1.59074E-03	0.0021	3.97686E+03	2.94288E-02
220	7.600E-06	8.000E-06	7.8000E-06	1.52023E-03	0.0021	3.80058E+03	2.96445E-02
221	8.000E-06	8.400E-06	8.2000E-06	1.44704E-03	0.0022	3.61761E+03	2.96644E-02
222	8.400E-06	8.800E-06	8.6000E-06	1.37372E-03	0.0022	3.43431E+03	2.95351E-02
223	8.800E-06	9.200E-06	9.0000E-06	1.32437E-03	0.0023	3.31092E+03	2.97983E-02
224	9.200E-06	9.600E-06	9.4000E-06	1.26622E-03	0.0023	3.16556E+03	2.97563E-02
225	9.600E-06	1.000E-05	9.8000E-06	1.22420E-03	0.0023	3.06051E+03	2.99930E-02
226	1.000E-05	1.050E-05	1.0250E-05	1.46026E-03	0.0021	2.92053E+03	2.99354E-02
227	1.050E-05	1.100E-05	1.0750E-05	1.38744E-03	0.0022	2.77489E+03	2.98300E-02
228	1.100E-05	1.150E-05	1.1250E-05	1.32532E-03	0.0023	2.65065E+03	2.98198E-02
229	1.150E-05	1.200E-05	1.1750E-05	1.26583E-03	0.0023	2.53167E+03	2.97471E-02
230	1.200E-05	1.275E-05	1.2375E-05	1.81396E-03	0.0019	2.41862E+03	2.99304E-02
231	1.275E-05	1.350E-05	1.3125E-05	1.71928E-03	0.0020	2.29237E+03	3.00874E-02
232	1.350E-05	1.425E-05	1.3875E-05	1.62045E-03	0.0020	2.16060E+03	2.99783E-02
233	1.425E-05	1.500E-05	1.4625E-05	1.54772E-03	0.0021	2.06362E+03	3.01805E-02
234	1.500E-05	1.600E-05	1.5500E-05	1.94045E-03	0.0019	1.94045E+03	3.00769E-02
235	1.600E-05	1.700E-05	1.6500E-05	1.83472E-03	0.0019	1.83472E+03	3.02729E-02
236	1.700E-05	1.800E-05	1.7500E-05	1.73120E-03	0.0020	1.73120E+03	3.02961E-02
237	1.800E-05	1.900E-05	1.8500E-05	1.63746E-03	0.0020	1.63746E+03	3.02930E-02
238	1.900E-05	2.000E-05	1.9500E-05	1.55398E-03	0.0021	1.55398E+03	3.03025E-02
239	2.000E-05	2.100E-05	2.0500E-05	1.47354E-03	0.0021	1.47354E+03	3.02075E-02
240	2.100E-05	2.200E-05	2.1500E-05	1.41599E-03	0.0022	1.41599E+03	3.04437E-02
241	2.200E-05	2.300E-05	2.2500E-05	1.35998E-03	0.0022	1.35998E+03	3.05996E-02
242	2.300E-05	2.400E-05	2.3500E-05	1.30267E-03	0.0023	1.30267E+03	3.06126E-02
243	2.400E-05	2.550E-05	2.4750E-05	1.86054E-03	0.0019	1.24036E+03	3.06988E-02
244	2.550E-05	2.700E-05	2.6250E-05	1.75698E-03	0.0020	1.17132E+03	3.07471E-02
245	2.700E-05	2.800E-05	2.7500E-05	1.11720E-03	0.0025	1.11720E+03	3.07229E-02
246	2.800E-05	3.000E-05	2.9000E-05	2.12015E-03	0.0018	1.06008E+03	3.07422E-02
247	3.000E-05	3.200E-05	3.1000E-05	1.98855E-03	0.0018	9.94275E+02	3.08225E-02

248	3.200E-05	3.400E-05	3.3000E-05	1.86338E-03	0.0019	9.31688E+02	3.07457E-02
249	3.400E-05	3.600E-05	3.5000E-05	1.76607E-03	0.0020	8.83036E+02	3.09063E-02
250	3.600E-05	3.800E-05	3.7000E-05	1.67095E-03	0.0020	8.35475E+02	3.09126E-02
251	3.800E-05	4.000E-05	3.9000E-05	1.59007E-03	0.0021	7.95034E+02	3.10063E-02
252	4.000E-05	4.250E-05	4.1250E-05	1.88406E-03	0.0019	7.53623E+02	3.10870E-02
253	4.250E-05	4.500E-05	4.3750E-05	1.78114E-03	0.0020	7.12454E+02	3.11699E-02
254	4.500E-05	4.750E-05	4.6250E-05	1.68731E-03	0.0020	6.74926E+02	3.12153E-02
255	4.750E-05	5.000E-05	4.8750E-05	1.60472E-03	0.0021	6.41887E+02	3.12920E-02
256	5.000E-05	5.250E-05	5.1250E-05	1.52111E-03	0.0021	6.08442E+02	3.11827E-02
257	5.250E-05	5.500E-05	5.3750E-05	1.45814E-03	0.0022	5.83256E+02	3.13500E-02
258	5.500E-05	5.750E-05	5.6250E-05	1.38749E-03	0.0022	5.54996E+02	3.12186E-02
259	5.750E-05	6.000E-05	5.8750E-05	1.33295E-03	0.0023	5.33179E+02	3.13242E-02
260	6.000E-05	6.300E-05	6.1500E-05	1.53137E-03	0.0021	5.10455E+02	3.13930E-02
261	6.300E-05	6.600E-05	6.4500E-05	1.45807E-03	0.0022	4.86025E+02	3.13486E-02
262	6.600E-05	6.900E-05	6.7500E-05	1.40079E-03	0.0022	4.66930E+02	3.15178E-02
263	6.900E-05	7.200E-05	7.0500E-05	1.33711E-03	0.0023	4.45704E+02	3.14221E-02
264	7.200E-05	7.600E-05	7.4000E-05	1.70317E-03	0.0020	4.25793E+02	3.15087E-02
265	7.600E-05	8.000E-05	7.8000E-05	1.61847E-03	0.0021	4.04617E+02	3.15601E-02
266	8.000E-05	8.400E-05	8.2000E-05	1.53717E-03	0.0021	3.84292E+02	3.15120E-02
267	8.400E-05	8.800E-05	8.6000E-05	1.46635E-03	0.0022	3.66587E+02	3.15265E-02
268	8.800E-05	9.200E-05	9.0000E-05	1.40335E-03	0.0022	3.50837E+02	3.15753E-02
269	9.200E-05	9.600E-05	9.4000E-05	1.34270E-03	0.0023	3.35674E+02	3.15534E-02
270	9.600E-05	1.000E-04	9.8000E-05	1.29042E-03	0.0023	3.22605E+02	3.16153E-02
271	1.000E-04	1.050E-04	1.0250E-04	1.54918E-03	0.0021	3.09836E+02	3.17582E-02
272	1.050E-04	1.100E-04	1.0750E-04	1.46866E-03	0.0022	2.93733E+02	3.15763E-02
273	1.100E-04	1.150E-04	1.1250E-04	1.41209E-03	0.0022	2.82418E+02	3.17721E-02
274	1.150E-04	1.200E-04	1.1750E-04	1.34897E-03	0.0023	2.69793E+02	3.17007E-02
275	1.200E-04	1.275E-04	1.2375E-04	1.93103E-03	0.0019	2.57471E+02	3.18621E-02
276	1.275E-04	1.350E-04	1.3125E-04	1.81770E-03	0.0019	2.42360E+02	3.18097E-02
277	1.350E-04	1.425E-04	1.3875E-04	1.72484E-03	0.0020	2.29979E+02	3.19096E-02
278	1.425E-04	1.500E-04	1.4625E-04	1.63527E-03	0.0020	2.18036E+02	3.18878E-02
279	1.500E-04	1.600E-04	1.5500E-04	2.06039E-03	0.0018	2.06039E+02	3.19360E-02

280	1.600E-04	1.700E-04	1.6500E-04	1.94084E-03	0.0019	1.94084E+02	3.20239E-02
281	1.700E-04	1.800E-04	1.7500E-04	1.82720E-03	0.0019	1.82720E+02	3.19759E-02
282	1.800E-04	1.900E-04	1.8500E-04	1.72694E-03	0.0020	1.72694E+02	3.19483E-02
283	1.900E-04	2.000E-04	1.9500E-04	1.63102E-03	0.0021	1.63102E+02	3.18049E-02
284	2.000E-04	2.100E-04	2.0500E-04	1.56075E-03	0.0021	1.56075E+02	3.19953E-02
285	2.100E-04	2.200E-04	2.1500E-04	1.49490E-03	0.0021	1.49490E+02	3.21403E-02
286	2.200E-04	2.300E-04	2.2500E-04	1.43401E-03	0.0022	1.43401E+02	3.22652E-02
287	2.300E-04	2.400E-04	2.3500E-04	1.36533E-03	0.0022	1.36533E+02	3.20853E-02
288	2.400E-04	2.550E-04	2.4750E-04	1.96270E-03	0.0019	1.30847E+02	3.23845E-02
289	2.550E-04	2.700E-04	2.6250E-04	1.85514E-03	0.0019	1.23676E+02	3.24649E-02
290	2.700E-04	2.800E-04	2.7500E-04	1.19664E-03	0.0024	1.19664E+02	3.29076E-02
291	2.800E-04	3.000E-04	2.9000E-04	2.29020E-03	0.0017	1.14510E+02	3.32078E-02
292	3.000E-04	3.200E-04	3.1000E-04	2.12787E-03	0.0018	1.06394E+02	3.29820E-02
293	3.200E-04	3.400E-04	3.3000E-04	1.73121E-03	0.0020	8.65605E+01	2.85650E-02
294	3.400E-04	3.600E-04	3.5000E-04	1.62936E-03	0.0021	8.14682E+01	2.85139E-02
295	3.600E-04	3.800E-04	3.7000E-04	1.66731E-03	0.0020	8.33654E+01	3.08452E-02
296	3.800E-04	4.000E-04	3.9000E-04	1.62972E-03	0.0021	8.14860E+01	3.17795E-02
297	4.000E-04	4.250E-04	4.1250E-04	1.94830E-03	0.0019	7.79319E+01	3.21469E-02
298	4.250E-04	4.500E-04	4.3750E-04	1.83825E-03	0.0019	7.35301E+01	3.21694E-02
299	4.500E-04	4.750E-04	4.6250E-04	1.74333E-03	0.0020	6.97333E+01	3.22517E-02
300	4.750E-04	5.000E-04	4.8750E-04	1.66332E-03	0.0020	6.65328E+01	3.24347E-02
301	5.000E-04	5.250E-04	5.1250E-04	1.57669E-03	0.0021	6.30676E+01	3.23221E-02
302	5.250E-04	5.500E-04	5.3750E-04	1.51081E-03	0.0021	6.04324E+01	3.24824E-02
303	5.500E-04	5.750E-04	5.6250E-04	1.44594E-03	0.0022	5.78376E+01	3.25336E-02
304	5.750E-04	6.000E-04	5.8750E-04	1.37533E-03	0.0022	5.50131E+01	3.23202E-02
305	6.000E-04	6.300E-04	6.1500E-04	1.58267E-03	0.0021	5.27558E+01	3.24448E-02
306	6.300E-04	6.600E-04	6.4500E-04	1.51494E-03	0.0021	5.04981E+01	3.25713E-02
307	6.600E-04	6.900E-04	6.7500E-04	1.43948E-03	0.0022	4.79825E+01	3.23882E-02
308	6.900E-04	7.200E-04	7.0500E-04	1.38401E-03	0.0022	4.61337E+01	3.25243E-02
309	7.200E-04	7.600E-04	7.4000E-04	1.75870E-03	0.0020	4.39675E+01	3.25359E-02
310	7.600E-04	8.000E-04	7.8000E-04	1.67237E-03	0.0020	4.18093E+01	3.26113E-02
311	8.000E-04	8.400E-04	8.2000E-04	1.58697E-03	0.0021	3.96742E+01	3.25328E-02

312	8.400E-04	8.800E-04	8.6000E-04	1.51618E-03	0.0021	3.79044E+01	3.25978E-02
313	8.800E-04	9.200E-04	9.0000E-04	1.45376E-03	0.0022	3.63440E+01	3.27096E-02
314	9.200E-04	9.600E-04	9.4000E-04	1.39103E-03	0.0022	3.47757E+01	3.26892E-02
315	9.600E-04	1.000E-03	9.8000E-04	1.34040E-03	0.0023	3.35101E+01	3.28399E-02
316	1.000E-03	1.050E-03	1.0250E-03	1.61091E-03	0.0021	3.22183E+01	3.30237E-02
317	1.050E-03	1.100E-03	1.0750E-03	1.45621E-03	0.0022	2.91241E+01	3.13084E-02
318	1.100E-03	1.150E-03	1.1250E-03	1.40300E-03	0.0022	2.80600E+01	3.15676E-02
319	1.150E-03	1.200E-03	1.1750E-03	1.38855E-03	0.0022	2.77710E+01	3.26310E-02
320	1.200E-03	1.275E-03	1.2375E-03	2.00112E-03	0.0019	2.66816E+01	3.30185E-02
321	1.275E-03	1.350E-03	1.3125E-03	1.87999E-03	0.0019	2.50665E+01	3.28998E-02
322	1.350E-03	1.425E-03	1.3875E-03	1.77700E-03	0.0020	2.36933E+01	3.28745E-02
323	1.425E-03	1.500E-03	1.4625E-03	1.69421E-03	0.0020	2.25895E+01	3.30371E-02
324	1.500E-03	1.600E-03	1.5500E-03	2.12856E-03	0.0018	2.12856E+01	3.29927E-02
325	1.600E-03	1.700E-03	1.6500E-03	2.00210E-03	0.0019	2.00210E+01	3.30347E-02
326	1.700E-03	1.800E-03	1.7500E-03	1.90067E-03	0.0019	1.90067E+01	3.32618E-02
327	1.800E-03	1.900E-03	1.8500E-03	1.81137E-03	0.0020	1.81137E+01	3.35103E-02
328	1.900E-03	2.000E-03	1.9500E-03	1.73719E-03	0.0020	1.73719E+01	3.38752E-02
329	2.000E-03	2.100E-03	2.0500E-03	1.63300E-03	0.0021	1.63300E+01	3.34765E-02
330	2.100E-03	2.200E-03	2.1500E-03	1.53730E-03	0.0021	1.53730E+01	3.30519E-02
331	2.200E-03	2.300E-03	2.2500E-03	1.41979E-03	0.0022	1.41979E+01	3.19452E-02
332	2.300E-03	2.400E-03	2.3500E-03	1.33664E-03	0.0023	1.33664E+01	3.14110E-02
333	2.400E-03	2.550E-03	2.4750E-03	1.93231E-03	0.0019	1.28820E+01	3.18830E-02
334	2.550E-03	2.700E-03	2.6250E-03	1.85758E-03	0.0019	1.23838E+01	3.25076E-02
335	2.700E-03	2.800E-03	2.7500E-03	1.20107E-03	0.0024	1.20107E+01	3.30295E-02
336	2.800E-03	3.000E-03	2.9000E-03	2.29051E-03	0.0017	1.14525E+01	3.32124E-02
337	3.000E-03	3.200E-03	3.1000E-03	2.14125E-03	0.0018	1.07063E+01	3.31894E-02
338	3.200E-03	3.400E-03	3.3000E-03	2.02971E-03	0.0019	1.01485E+01	3.34902E-02
339	3.400E-03	3.600E-03	3.5000E-03	1.91648E-03	0.0019	9.58238E+00	3.35383E-02
340	3.600E-03	3.800E-03	3.7000E-03	1.81499E-03	0.0020	9.07497E+00	3.35774E-02
341	3.800E-03	4.000E-03	3.9000E-03	1.70211E-03	0.0020	8.51055E+00	3.31911E-02
342	4.000E-03	4.250E-03	4.1250E-03	2.00651E-03	0.0019	8.02605E+00	3.31075E-02
343	4.250E-03	4.500E-03	4.3750E-03	1.89613E-03	0.0019	7.58451E+00	3.31822E-02

344	4.500E-03	4.750E-03	4.6250E-03	1.79491E-03	0.0020	7.17963E+00	3.32058E-02
345	4.750E-03	5.000E-03	4.8750E-03	1.72495E-03	0.0020	6.89978E+00	3.36364E-02
346	5.000E-03	5.250E-03	5.1250E-03	1.68280E-03	0.0020	6.73119E+00	3.44973E-02
347	5.250E-03	5.500E-03	5.3750E-03	1.60008E-03	0.0021	6.40032E+00	3.44017E-02
348	5.500E-03	5.750E-03	5.6250E-03	1.49686E-03	0.0022	5.98743E+00	3.36793E-02
349	5.750E-03	6.000E-03	5.8750E-03	1.19073E-03	0.0024	4.76292E+00	2.79821E-02
350	6.000E-03	6.300E-03	6.1500E-03	1.63789E-03	0.0021	5.45965E+00	3.35768E-02
351	6.300E-03	6.600E-03	6.4500E-03	1.58807E-03	0.0021	5.29358E+00	3.41436E-02
352	6.600E-03	6.900E-03	6.7500E-03	1.53537E-03	0.0021	5.11789E+00	3.45458E-02
353	6.900E-03	7.200E-03	7.0500E-03	1.44951E-03	0.0022	4.83171E+00	3.40636E-02
354	7.200E-03	7.600E-03	7.4000E-03	1.80885E-03	0.0020	4.52211E+00	3.34636E-02
355	7.600E-03	8.000E-03	7.8000E-03	1.66266E-03	0.0021	4.15665E+00	3.24218E-02
356	8.000E-03	8.400E-03	8.2000E-03	1.58798E-03	0.0021	3.96994E+00	3.25535E-02
357	8.400E-03	8.800E-03	8.6000E-03	1.53300E-03	0.0021	3.83249E+00	3.29594E-02
358	8.800E-03	9.200E-03	9.0000E-03	1.48270E-03	0.0022	3.70674E+00	3.33607E-02
359	9.200E-03	9.600E-03	9.4000E-03	1.45501E-03	0.0022	3.63753E+00	3.41928E-02
360	9.600E-03	1.000E-02	9.8000E-03	1.42104E-03	0.0022	3.55260E+00	3.48155E-02
361	1.000E-02	1.050E-02	1.0250E-02	1.70793E-03	0.0020	3.41586E+00	3.50126E-02
362	1.050E-02	1.100E-02	1.0750E-02	1.64045E-03	0.0021	3.28089E+00	3.52696E-02
363	1.100E-02	1.150E-02	1.1250E-02	1.57634E-03	0.0021	3.15267E+00	3.54676E-02
364	1.150E-02	1.200E-02	1.1750E-02	1.50753E-03	0.0022	3.01506E+00	3.54270E-02
365	1.200E-02	1.275E-02	1.2375E-02	2.13216E-03	0.0018	2.84288E+00	3.51807E-02
366	1.275E-02	1.350E-02	1.3125E-02	2.02114E-03	0.0019	2.69486E+00	3.53700E-02
367	1.350E-02	1.425E-02	1.3875E-02	1.96814E-03	0.0019	2.62419E+00	3.64107E-02
368	1.425E-02	1.500E-02	1.4625E-02	1.87869E-03	0.0019	2.50493E+00	3.66345E-02
369	1.500E-02	1.600E-02	1.5500E-02	2.23674E-03	0.0018	2.23674E+00	3.46694E-02
370	1.600E-02	1.700E-02	1.6500E-02	2.16738E-03	0.0018	2.16738E+00	3.57617E-02
371	1.700E-02	1.800E-02	1.7500E-02	2.09480E-03	0.0018	2.09480E+00	3.66590E-02
372	1.800E-02	1.900E-02	1.8500E-02	2.01292E-03	0.0019	2.01292E+00	3.72389E-02
373	1.900E-02	2.000E-02	1.9500E-02	1.94027E-03	0.0019	1.94027E+00	3.78352E-02
374	2.000E-02	2.100E-02	2.0500E-02	1.83347E-03	0.0020	1.83347E+00	3.75860E-02
375	2.100E-02	2.200E-02	2.1500E-02	1.78403E-03	0.0020	1.78403E+00	3.83566E-02

376	2.200E-02	2.300E-02	2.2500E-02	1.75345E-03	0.0020	1.75345E+00	3.94526E-02
377	2.300E-02	2.400E-02	2.3500E-02	1.70360E-03	0.0020	1.70360E+00	4.00345E-02
378	2.400E-02	2.550E-02	2.4750E-02	2.56910E-03	0.0017	1.71274E+00	4.23902E-02
379	2.550E-02	2.700E-02	2.6250E-02	2.58760E-03	0.0016	1.72506E+00	4.52829E-02
380	2.700E-02	2.800E-02	2.7500E-02	1.30334E-03	0.0023	1.30334E+00	3.58419E-02
381	2.800E-02	3.000E-02	2.9000E-02	2.73861E-03	0.0016	1.36931E+00	3.97099E-02
382	3.000E-02	3.200E-02	3.1000E-02	2.98640E-03	0.0015	1.49320E+00	4.62891E-02
383	3.200E-02	3.400E-02	3.3000E-02	2.30262E-03	0.0017	1.15131E+00	3.79933E-02
384	3.400E-02	3.600E-02	3.5000E-02	1.31374E-03	0.0023	6.56869E-01	2.29904E-02
385	3.600E-02	3.800E-02	3.7000E-02	1.50969E-03	0.0022	7.54844E-01	2.79292E-02
386	3.800E-02	4.000E-02	3.9000E-02	1.78357E-03	0.0020	8.91785E-01	3.47796E-02
387	4.000E-02	4.250E-02	4.1250E-02	2.32063E-03	0.0017	9.28253E-01	3.82905E-02
388	4.250E-02	4.500E-02	4.3750E-02	2.31351E-03	0.0017	9.25405E-01	4.04865E-02
389	4.500E-02	4.750E-02	4.6250E-02	2.30457E-03	0.0017	9.21827E-01	4.26345E-02
390	4.750E-02	5.000E-02	4.8750E-02	2.23654E-03	0.0018	8.94617E-01	4.36126E-02
391	5.000E-02	5.250E-02	5.1250E-02	2.06451E-03	0.0018	8.25803E-01	4.23224E-02
392	5.250E-02	5.500E-02	5.3750E-02	2.06661E-03	0.0018	8.26643E-01	4.44320E-02
393	5.500E-02	5.750E-02	5.6250E-02	2.03816E-03	0.0019	8.15262E-01	4.58585E-02
394	5.750E-02	6.000E-02	5.8750E-02	2.00620E-03	0.0019	8.02482E-01	4.71458E-02
395	6.000E-02	6.300E-02	6.1500E-02	2.34577E-03	0.0017	7.81922E-01	4.80882E-02
396	6.300E-02	6.600E-02	6.4500E-02	2.22605E-03	0.0018	7.42016E-01	4.78601E-02
397	6.600E-02	6.900E-02	6.7500E-02	2.23048E-03	0.0018	7.43495E-01	5.01859E-02
398	6.900E-02	7.200E-02	7.0500E-02	2.33889E-03	0.0017	7.79629E-01	5.49638E-02
399	7.200E-02	7.600E-02	7.4000E-02	3.01426E-03	0.0015	7.53566E-01	5.57639E-02
400	7.600E-02	8.000E-02	7.8000E-02	2.92205E-03	0.0016	7.30512E-01	5.69799E-02
401	8.000E-02	8.400E-02	8.2000E-02	2.38207E-03	0.0017	5.95518E-01	4.88325E-02
402	8.400E-02	8.800E-02	8.6000E-02	1.65563E-03	0.0021	4.13908E-01	3.55961E-02
403	8.800E-02	9.200E-02	9.0000E-02	1.55379E-03	0.0021	3.88448E-01	3.49603E-02
404	9.200E-02	9.600E-02	9.4000E-02	1.79534E-03	0.0020	4.48836E-01	4.21906E-02
405	9.600E-02	1.000E-01	9.8000E-02	1.88062E-03	0.0019	4.70156E-01	4.60753E-02
406	1.000E-01	1.050E-01	1.0250E-01	2.53208E-03	0.0017	5.06416E-01	5.19076E-02
407	1.050E-01	1.100E-01	1.0750E-01	2.61792E-03	0.0016	5.23584E-01	5.62853E-02

408	1.100E-01	1.150E-01	1.1250E-01	2.56950E-03	0.0017	5.13899E-01	5.78137E-02
409	1.150E-01	1.200E-01	1.1750E-01	2.18634E-03	0.0018	4.37267E-01	5.13789E-02
410	1.200E-01	1.275E-01	1.2375E-01	3.61943E-03	0.0014	4.82591E-01	5.97206E-02
411	1.275E-01	1.350E-01	1.3125E-01	4.16092E-03	0.0013	5.54790E-01	7.28162E-02
412	1.350E-01	1.425E-01	1.3875E-01	3.37903E-03	0.0014	4.50538E-01	6.25121E-02
413	1.425E-01	1.500E-01	1.4625E-01	2.55210E-03	0.0017	3.40280E-01	4.97659E-02
414	1.500E-01	1.600E-01	1.5500E-01	3.16833E-03	0.0015	3.16833E-01	4.91091E-02
415	1.600E-01	1.700E-01	1.6500E-01	3.38384E-03	0.0014	3.38384E-01	5.58334E-02
416	1.700E-01	1.800E-01	1.7500E-01	3.68651E-03	0.0014	3.68651E-01	6.45140E-02
417	1.800E-01	1.900E-01	1.8500E-01	3.82920E-03	0.0014	3.82920E-01	7.08402E-02
418	1.900E-01	2.000E-01	1.9500E-01	3.56219E-03	0.0014	3.56219E-01	6.94627E-02
419	2.000E-01	2.100E-01	2.0500E-01	3.01621E-03	0.0015	3.01621E-01	6.18323E-02
420	2.100E-01	2.200E-01	2.1500E-01	3.05746E-03	0.0015	3.05746E-01	6.57353E-02
421	2.200E-01	2.300E-01	2.2500E-01	2.99588E-03	0.0015	2.99588E-01	6.74074E-02
422	2.300E-01	2.400E-01	2.3500E-01	3.09928E-03	0.0015	3.09928E-01	7.28331E-02
423	2.400E-01	2.550E-01	2.4750E-01	4.77791E-03	0.0012	3.18528E-01	7.88356E-02
424	2.550E-01	2.700E-01	2.6250E-01	4.94080E-03	0.0012	3.29386E-01	8.64639E-02
425	2.700E-01	2.800E-01	2.7500E-01	3.19715E-03	0.0015	3.19715E-01	8.79217E-02
426	2.800E-01	3.000E-01	2.9000E-01	5.15002E-03	0.0012	2.57501E-01	7.46753E-02
427	3.000E-01	3.200E-01	3.1000E-01	5.25232E-03	0.0012	2.62616E-01	8.14110E-02
428	3.200E-01	3.400E-01	3.3000E-01	5.17577E-03	0.0012	2.58788E-01	8.54002E-02
429	3.400E-01	3.600E-01	3.5000E-01	5.29743E-03	0.0012	2.64872E-01	9.27050E-02
430	3.600E-01	3.800E-01	3.7000E-01	4.29744E-03	0.0013	2.14872E-01	7.95026E-02
431	3.800E-01	4.000E-01	3.9000E-01	4.62389E-03	0.0012	2.31195E-01	9.01659E-02
432	4.000E-01	4.250E-01	4.1250E-01	4.94174E-03	0.0012	1.97670E-01	8.15387E-02
433	4.250E-01	4.500E-01	4.3750E-01	4.51102E-03	0.0012	1.80441E-01	7.89428E-02
434	4.500E-01	4.750E-01	4.6250E-01	5.03765E-03	0.0012	2.01506E-01	9.31966E-02
435	4.750E-01	5.000E-01	4.8750E-01	5.22581E-03	0.0012	2.09033E-01	1.01903E-01
436	5.000E-01	5.250E-01	5.1250E-01	5.30320E-03	0.0012	2.12128E-01	1.08716E-01
437	5.250E-01	5.500E-01	5.3750E-01	4.73655E-03	0.0012	1.89462E-01	1.01836E-01
438	5.500E-01	5.750E-01	5.6250E-01	4.71185E-03	0.0012	1.88474E-01	1.06017E-01
439	5.750E-01	6.000E-01	5.8750E-01	4.58569E-03	0.0012	1.83428E-01	1.07764E-01

440	6.000E-01	6.300E-01	6.1500E-01	5.30945E-03	0.0012	1.76982E-01	1.08844E-01
441	6.300E-01	6.600E-01	6.4500E-01	4.95659E-03	0.0012	1.65220E-01	1.06567E-01
442	6.600E-01	6.900E-01	6.7500E-01	5.28065E-03	0.0012	1.76022E-01	1.18815E-01
443	6.900E-01	7.200E-01	7.0500E-01	5.34442E-03	0.0011	1.78147E-01	1.25594E-01
444	7.200E-01	7.600E-01	7.4000E-01	6.74387E-03	0.0010	1.68597E-01	1.24762E-01
445	7.600E-01	8.000E-01	7.8000E-01	5.95622E-03	0.0011	1.48906E-01	1.16146E-01
446	8.000E-01	8.400E-01	8.2000E-01	5.54835E-03	0.0011	1.38709E-01	1.13741E-01
447	8.400E-01	8.800E-01	8.6000E-01	4.88516E-03	0.0012	1.22129E-01	1.05031E-01
448	8.800E-01	9.200E-01	9.0000E-01	4.73219E-03	0.0012	1.18305E-01	1.06474E-01
449	9.200E-01	9.600E-01	9.4000E-01	4.36869E-03	0.0013	1.09217E-01	1.02664E-01
450	9.600E-01	1.000E+00	9.8000E-01	3.91785E-03	0.0013	9.79463E-02	9.59874E-02
451	1.000E+00	1.100E+00	1.0500E+00	1.00761E-02	0.0008	1.00761E-01	1.05800E-01
452	1.100E+00	1.200E+00	1.1500E+00	1.01950E-02	0.0008	1.01950E-01	1.17243E-01
453	1.200E+00	1.300E+00	1.2500E+00	9.69768E-03	0.0009	9.69768E-02	1.21221E-01
454	1.300E+00	1.400E+00	1.3500E+00	8.87292E-03	0.0009	8.87292E-02	1.19784E-01
455	1.400E+00	1.500E+00	1.4500E+00	8.77327E-03	0.0009	8.77327E-02	1.27212E-01
456	1.500E+00	1.600E+00	1.5500E+00	8.07104E-03	0.0009	8.07104E-02	1.25101E-01
457	1.600E+00	1.700E+00	1.6500E+00	7.48060E-03	0.0010	7.48060E-02	1.23430E-01
458	1.700E+00	1.800E+00	1.7500E+00	7.02503E-03	0.0010	7.02503E-02	1.22938E-01
459	1.800E+00	1.900E+00	1.8500E+00	6.29778E-03	0.0011	6.29778E-02	1.16509E-01
460	1.900E+00	2.000E+00	1.9500E+00	5.52612E-03	0.0011	5.52612E-02	1.07759E-01
461	2.000E+00	2.100E+00	2.0500E+00	5.12137E-03	0.0012	5.12137E-02	1.04988E-01
462	2.100E+00	2.200E+00	2.1500E+00	5.04593E-03	0.0012	5.04593E-02	1.08488E-01
463	2.200E+00	2.300E+00	2.2500E+00	4.91338E-03	0.0012	4.91338E-02	1.10551E-01
464	2.300E+00	2.400E+00	2.3500E+00	5.06464E-03	0.0012	5.06464E-02	1.19019E-01
465	2.400E+00	2.500E+00	2.4500E+00	4.46722E-03	0.0013	4.46722E-02	1.09447E-01
466	2.500E+00	2.600E+00	2.5500E+00	3.77647E-03	0.0014	3.77647E-02	9.63000E-02
467	2.600E+00	2.700E+00	2.6500E+00	3.46108E-03	0.0014	3.46108E-02	9.17186E-02
468	2.700E+00	2.800E+00	2.7500E+00	2.85300E-03	0.0016	2.85300E-02	7.84576E-02
469	2.800E+00	2.900E+00	2.8500E+00	2.55896E-03	0.0017	2.55896E-02	7.29303E-02
470	2.900E+00	3.000E+00	2.9500E+00	2.29488E-03	0.0017	2.29488E-02	6.76989E-02
471	3.000E+00	3.100E+00	3.0500E+00	2.39193E-03	0.0017	2.39193E-02	7.29538E-02

472	3.100E+00	3.200E+00	3.1500E+00	2.12726E-03	0.0018	2.12726E-02	6.70088E-02
473	3.200E+00	3.300E+00	3.2500E+00	1.73989E-03	0.0020	1.73989E-02	5.65464E-02
474	3.300E+00	3.400E+00	3.3500E+00	1.54827E-03	0.0021	1.54827E-02	5.18671E-02
475	3.400E+00	3.500E+00	3.4500E+00	1.40985E-03	0.0022	1.40985E-02	4.86398E-02
476	3.500E+00	3.600E+00	3.5500E+00	1.31363E-03	0.0023	1.31363E-02	4.66340E-02
477	3.600E+00	3.700E+00	3.6500E+00	1.22429E-03	0.0024	1.22429E-02	4.46864E-02
478	3.700E+00	3.800E+00	3.7500E+00	1.13791E-03	0.0025	1.13791E-02	4.26715E-02
479	3.800E+00	3.900E+00	3.8500E+00	1.18927E-03	0.0024	1.18927E-02	4.57870E-02
480	3.900E+00	4.000E+00	3.9500E+00	1.16503E-03	0.0024	1.16503E-02	4.60189E-02
481	4.000E+00	4.100E+00	4.0500E+00	1.19418E-03	0.0024	1.19418E-02	4.83642E-02
482	4.100E+00	4.200E+00	4.1500E+00	1.10507E-03	0.0025	1.10507E-02	4.58603E-02
483	4.200E+00	4.300E+00	4.2500E+00	9.93015E-04	0.0026	9.93015E-03	4.22031E-02
484	4.300E+00	4.400E+00	4.3500E+00	8.05070E-04	0.0029	8.05070E-03	3.50206E-02
485	4.400E+00	4.500E+00	4.4500E+00	8.39597E-04	0.0029	8.39597E-03	3.73621E-02
486	4.500E+00	4.600E+00	4.5500E+00	8.05419E-04	0.0029	8.05419E-03	3.66466E-02
487	4.600E+00	4.700E+00	4.6500E+00	7.93343E-04	0.0030	7.93343E-03	3.68905E-02
488	4.700E+00	4.800E+00	4.7500E+00	7.84311E-04	0.0030	7.84311E-03	3.72548E-02
489	4.800E+00	4.900E+00	4.8500E+00	6.77750E-04	0.0032	6.77750E-03	3.28709E-02
490	4.900E+00	5.000E+00	4.9500E+00	6.65529E-04	0.0032	6.65529E-03	3.29437E-02
491	5.000E+00	5.100E+00	5.0500E+00	5.95600E-04	0.0034	5.95600E-03	3.00778E-02
492	5.100E+00	5.200E+00	5.1500E+00	5.08919E-04	0.0037	5.08919E-03	2.62093E-02
493	5.200E+00	5.300E+00	5.2500E+00	5.31951E-04	0.0036	5.31951E-03	2.79274E-02
494	5.300E+00	5.400E+00	5.3500E+00	4.64870E-04	0.0039	4.64870E-03	2.48705E-02
495	5.400E+00	5.500E+00	5.4500E+00	4.53292E-04	0.0039	4.53292E-03	2.47044E-02
496	5.500E+00	5.600E+00	5.5500E+00	4.11233E-04	0.0041	4.11233E-03	2.28234E-02
497	5.600E+00	5.700E+00	5.6500E+00	3.54194E-04	0.0044	3.54194E-03	2.00120E-02
498	5.700E+00	5.800E+00	5.7500E+00	3.46041E-04	0.0045	3.46041E-03	1.98974E-02
499	5.800E+00	5.900E+00	5.8500E+00	3.28132E-04	0.0046	3.28132E-03	1.91957E-02
500	5.900E+00	6.000E+00	5.9500E+00	2.95165E-04	0.0049	2.95165E-03	1.75623E-02
501	6.000E+00	6.100E+00	6.0500E+00	2.78001E-04	0.0050	2.78001E-03	1.68191E-02
502	6.100E+00	6.200E+00	6.1500E+00	2.76596E-04	0.0050	2.76596E-03	1.70107E-02
503	6.200E+00	6.300E+00	6.2500E+00	2.48952E-04	0.0053	2.48952E-03	1.55595E-02

504	6.300E+00	6.400E+00	6.3500E+00	2.19708E-04	0.0056	2.19708E-03	1.39514E-02
505	6.400E+00	6.500E+00	6.4500E+00	2.20687E-04	0.0056	2.20687E-03	1.42343E-02
506	6.500E+00	6.600E+00	6.5500E+00	2.12763E-04	0.0057	2.12763E-03	1.39360E-02
507	6.600E+00	6.700E+00	6.6500E+00	1.90424E-04	0.0061	1.90424E-03	1.26632E-02
508	6.700E+00	6.800E+00	6.7500E+00	1.68739E-04	0.0064	1.68739E-03	1.13899E-02
509	6.800E+00	6.900E+00	6.8500E+00	1.57312E-04	0.0067	1.57312E-03	1.07758E-02
510	6.900E+00	7.000E+00	6.9500E+00	1.56308E-04	0.0067	1.56308E-03	1.08634E-02
511	7.000E+00	7.100E+00	7.0500E+00	1.41624E-04	0.0070	1.41624E-03	9.98447E-03
512	7.100E+00	7.200E+00	7.1500E+00	1.29339E-04	0.0073	1.29339E-03	9.24771E-03
513	7.200E+00	7.300E+00	7.2500E+00	1.12838E-04	0.0079	1.12838E-03	8.18075E-03
514	7.300E+00	7.400E+00	7.3500E+00	1.01555E-04	0.0083	1.01555E-03	7.46432E-03
515	7.400E+00	7.500E+00	7.4500E+00	9.50168E-05	0.0086	9.50168E-04	7.07875E-03
516	7.500E+00	7.600E+00	7.5500E+00	9.19411E-05	0.0087	9.19411E-04	6.94155E-03
517	7.600E+00	7.700E+00	7.6500E+00	8.31850E-05	0.0091	8.31850E-04	6.36366E-03
518	7.700E+00	7.800E+00	7.7500E+00	7.28016E-05	0.0098	7.28016E-04	5.64213E-03
519	7.800E+00	7.900E+00	7.8500E+00	6.84105E-05	0.0101	6.84105E-04	5.37023E-03
520	7.900E+00	8.000E+00	7.9500E+00	6.65387E-05	0.0102	6.65387E-04	5.28983E-03
521	8.000E+00	8.100E+00	8.0500E+00	6.38876E-05	0.0104	6.38876E-04	5.14295E-03
522	8.100E+00	8.200E+00	8.1500E+00	5.63710E-05	0.0111	5.63710E-04	4.59424E-03
523	8.200E+00	8.300E+00	8.2500E+00	5.30833E-05	0.0114	5.30833E-04	4.37937E-03
524	8.300E+00	8.400E+00	8.3500E+00	4.82843E-05	0.0120	4.82843E-04	4.03174E-03
525	8.400E+00	8.500E+00	8.4500E+00	4.57472E-05	0.0123	4.57472E-04	3.86564E-03
526	8.500E+00	8.600E+00	8.5500E+00	4.28335E-05	0.0127	4.28335E-04	3.66226E-03
527	8.600E+00	8.700E+00	8.6500E+00	3.95755E-05	0.0132	3.95755E-04	3.42328E-03
528	8.700E+00	8.800E+00	8.7500E+00	3.59669E-05	0.0138	3.59669E-04	3.14710E-03
529	8.800E+00	8.900E+00	8.8500E+00	3.51357E-05	0.0140	3.51357E-04	3.10951E-03
530	8.900E+00	9.000E+00	8.9500E+00	3.26417E-05	0.0145	3.26417E-04	2.92143E-03
531	9.000E+00	9.100E+00	9.0500E+00	3.01480E-05	0.0151	3.01480E-04	2.72840E-03
532	9.100E+00	9.200E+00	9.1500E+00	2.74758E-05	0.0158	2.74758E-04	2.51404E-03
533	9.200E+00	9.300E+00	9.2500E+00	2.65422E-05	0.0160	2.65422E-04	2.45516E-03
534	9.300E+00	9.400E+00	9.3500E+00	2.35838E-05	0.0170	2.35838E-04	2.20508E-03
535	9.400E+00	9.500E+00	9.4500E+00	2.17563E-05	0.0178	2.17563E-04	2.05597E-03

536	9.500E+00	9.600E+00	9.5500E+00	2.03723E-05	0.0184	2.03723E-04	1.94556E-03
537	9.600E+00	9.700E+00	9.6500E+00	1.87889E-05	0.0191	1.87889E-04	1.81313E-03
538	9.700E+00	9.800E+00	9.7500E+00	1.67864E-05	0.0202	1.67864E-04	1.63667E-03
539	9.800E+00	9.900E+00	9.8500E+00	1.58628E-05	0.0209	1.58628E-04	1.56249E-03
540	9.900E+00	1.000E+01	9.9500E+00	1.48271E-05	0.0215	1.48271E-04	1.47530E-03
541	1.000E+01	1.010E+01	1.0050E+01	1.38505E-05	0.0222	1.38505E-04	1.39197E-03
542	1.010E+01	1.020E+01	1.0150E+01	1.26083E-05	0.0232	1.26083E-04	1.27974E-03
543	1.020E+01	1.030E+01	1.0250E+01	1.22605E-05	0.0236	1.22605E-04	1.25671E-03
544	1.030E+01	1.040E+01	1.0350E+01	1.17045E-05	0.0241	1.17045E-04	1.21142E-03
545	1.040E+01	1.050E+01	1.0450E+01	1.09382E-05	0.0251	1.09382E-04	1.14305E-03
546	1.050E+01	1.060E+01	1.0550E+01	1.01113E-05	0.0262	1.01113E-04	1.06674E-03
547	1.060E+01	1.070E+01	1.0650E+01	9.37239E-06	0.0270	9.37239E-05	9.98160E-04
548	1.070E+01	1.080E+01	1.0750E+01	8.99669E-06	0.0279	8.99669E-05	9.67144E-04
549	1.080E+01	1.090E+01	1.0850E+01	8.10340E-06	0.0293	8.10340E-05	8.79219E-04
550	1.090E+01	1.100E+01	1.0950E+01	7.05532E-06	0.0311	7.05532E-05	7.72558E-04
551	1.100E+01	1.110E+01	1.1050E+01	6.58563E-06	0.0324	6.58563E-05	7.27713E-04
552	1.110E+01	1.120E+01	1.1150E+01	5.81092E-06	0.0344	5.81092E-05	6.47917E-04
553	1.120E+01	1.130E+01	1.1250E+01	5.25548E-06	0.0362	5.25548E-05	5.91242E-04
554	1.130E+01	1.140E+01	1.1350E+01	4.91269E-06	0.0371	4.91269E-05	5.57590E-04
555	1.140E+01	1.150E+01	1.1450E+01	4.88792E-06	0.0370	4.88792E-05	5.59667E-04
556	1.150E+01	1.160E+01	1.1550E+01	4.20229E-06	0.0405	4.20229E-05	4.85364E-04
557	1.160E+01	1.170E+01	1.1650E+01	3.85517E-06	0.0419	3.85517E-05	4.49127E-04
558	1.170E+01	1.180E+01	1.1750E+01	3.62357E-06	0.0433	3.62357E-05	4.25770E-04
559	1.180E+01	1.190E+01	1.1850E+01	3.14171E-06	0.0465	3.14171E-05	3.72293E-04
560	1.190E+01	1.200E+01	1.1950E+01	3.15736E-06	0.0463	3.15736E-05	3.77304E-04
561	1.200E+01	1.210E+01	1.2050E+01	3.02736E-06	0.0473	3.02736E-05	3.64797E-04
562	1.210E+01	1.220E+01	1.2150E+01	3.19361E-06	0.0461	3.19361E-05	3.88024E-04
563	1.220E+01	1.230E+01	1.2250E+01	2.56466E-06	0.0515	2.56466E-05	3.14171E-04
564	1.230E+01	1.240E+01	1.2350E+01	2.27278E-06	0.0541	2.27278E-05	2.80688E-04
565	1.240E+01	1.250E+01	1.2450E+01	2.29937E-06	0.0542	2.29937E-05	2.86272E-04
566	1.250E+01	1.260E+01	1.2550E+01	1.91893E-06	0.0593	1.91893E-05	2.40826E-04
567	1.260E+01	1.270E+01	1.2650E+01	1.93544E-06	0.0593	1.93544E-05	2.44833E-04

568	1.270E+01	1.280E+01	1.2750E+01	1.75381E-06	0.0631	1.75381E-05	2.23611E-04
569	1.280E+01	1.290E+01	1.2850E+01	1.67808E-06	0.0644	1.67808E-05	2.15634E-04
570	1.290E+01	1.300E+01	1.2950E+01	1.48988E-06	0.0669	1.48988E-05	1.92940E-04
571	1.300E+01	1.310E+01	1.3050E+01	1.37080E-06	0.0691	1.37080E-05	1.78889E-04
572	1.310E+01	1.320E+01	1.3150E+01	1.26727E-06	0.0732	1.26727E-05	1.66646E-04
573	1.320E+01	1.330E+01	1.3250E+01	1.25346E-06	0.0752	1.25346E-05	1.66083E-04
574	1.330E+01	1.340E+01	1.3350E+01	1.23566E-06	0.0748	1.23566E-05	1.64961E-04
575	1.340E+01	1.350E+01	1.3450E+01	1.12056E-06	0.0783	1.12056E-05	1.50716E-04
576	1.350E+01	1.360E+01	1.3550E+01	8.06824E-07	0.0907	8.06824E-06	1.09325E-04
577	1.360E+01	1.370E+01	1.3650E+01	8.92177E-07	0.0868	8.92177E-06	1.21782E-04
578	1.370E+01	1.380E+01	1.3750E+01	7.28321E-07	0.0980	7.28321E-06	1.00144E-04
579	1.380E+01	1.390E+01	1.3850E+01	6.75008E-07	0.0989	6.75008E-06	9.34886E-05
580	1.390E+01	1.400E+01	1.3950E+01	6.61356E-07	0.1002	6.61356E-06	9.22592E-05
581	1.400E+01	1.410E+01	1.4050E+01	5.64571E-07	0.1088	5.64571E-06	7.93222E-05
582	1.410E+01	1.420E+01	1.4150E+01	5.43202E-07	0.1134	5.43202E-06	7.68631E-05
583	1.420E+01	1.430E+01	1.4250E+01	6.29394E-07	0.1031	6.29394E-06	8.96886E-05
584	1.430E+01	1.440E+01	1.4350E+01	5.45697E-07	0.1118	5.45697E-06	7.83075E-05
585	1.440E+01	1.450E+01	1.4450E+01	5.57961E-07	0.1090	5.57961E-06	8.06254E-05
586	1.450E+01	1.460E+01	1.4550E+01	3.63494E-07	0.1299	3.63494E-06	5.28884E-05
587	1.460E+01	1.470E+01	1.4650E+01	4.29929E-07	0.1256	4.29929E-06	6.29846E-05
588	1.470E+01	1.480E+01	1.4750E+01	3.51168E-07	0.1359	3.51168E-06	5.17973E-05
589	1.480E+01	1.490E+01	1.4850E+01	3.11539E-07	0.1466	3.11539E-06	4.62635E-05
590	1.490E+01	1.500E+01	1.4950E+01	3.31741E-07	0.1412	3.31741E-06	4.95953E-05
591	1.500E+01	1.510E+01	1.5050E+01	2.76577E-07	0.1601	2.76577E-06	4.16249E-05
592	1.510E+01	1.520E+01	1.5150E+01	3.61890E-07	0.1388	3.61890E-06	5.48264E-05
593	1.520E+01	1.530E+01	1.5250E+01	2.53316E-07	0.1638	2.53316E-06	3.86307E-05
594	1.530E+01	1.540E+01	1.5350E+01	2.76741E-07	0.1543	2.76741E-06	4.24797E-05
595	1.540E+01	1.550E+01	1.5450E+01	2.17908E-07	0.1788	2.17908E-06	3.36669E-05
596	1.550E+01	1.560E+01	1.5550E+01	1.21784E-07	0.2380	1.21784E-06	1.89373E-05
597	1.560E+01	1.570E+01	1.5650E+01	2.21978E-07	0.1764	2.21978E-06	3.47395E-05
598	1.570E+01	1.580E+01	1.5750E+01	2.13767E-07	0.1857	2.13767E-06	3.36683E-05
599	1.580E+01	1.590E+01	1.5850E+01	1.53838E-07	0.2095	1.53838E-06	2.43833E-05

600	1.590E+01	1.600E+01	1.5950E+01	1.45364E-07	0.2158	1.45364E-06	2.31856E-05
601	1.600E+01	1.610E+01	1.6050E+01	1.71763E-07	0.1961	1.71763E-06	2.75680E-05
602	1.610E+01	1.620E+01	1.6150E+01	1.28463E-07	0.2334	1.28463E-06	2.07468E-05
603	1.620E+01	1.630E+01	1.6250E+01	1.39157E-07	0.2270	1.39157E-06	2.26131E-05
604	1.630E+01	1.640E+01	1.6350E+01	1.28637E-07	0.2257	1.28637E-06	2.10321E-05
605	1.640E+01	1.650E+01	1.6450E+01	1.22841E-07	0.2431	1.22841E-06	2.02073E-05
606	1.650E+01	1.660E+01	1.6550E+01	7.88797E-08	0.2949	7.88797E-07	1.30546E-05
607	1.660E+01	1.670E+01	1.6650E+01	1.67114E-07	0.2144	1.67114E-06	2.78245E-05
608	1.670E+01	1.680E+01	1.6750E+01	1.57305E-07	0.2076	1.57305E-06	2.63485E-05
609	1.680E+01	1.690E+01	1.6850E+01	7.23135E-08	0.3021	7.23135E-07	1.21848E-05
610	1.690E+01	1.700E+01	1.6950E+01	8.81728E-08	0.2712	8.81728E-07	1.49453E-05
611	1.700E+01	1.710E+01	1.7050E+01	8.17128E-08	0.2949	8.17128E-07	1.39320E-05
612	1.710E+01	1.720E+01	1.7150E+01	3.83821E-08	0.4214	3.83821E-07	6.58253E-06
613	1.720E+01	1.730E+01	1.7250E+01	6.26223E-08	0.3575	6.26223E-07	1.08023E-05
614	1.730E+01	1.740E+01	1.7350E+01	4.16561E-08	0.4163	4.16561E-07	7.22733E-06
615	1.740E+01	1.750E+01	1.7450E+01	3.61473E-08	0.3834	3.61473E-07	6.30770E-06
616	1.750E+01	1.760E+01	1.7550E+01	2.18549E-08	0.5554	2.18549E-07	3.83553E-06
617	1.760E+01	1.770E+01	1.7650E+01	5.26634E-08	0.3848	5.26634E-07	9.29510E-06
618	1.770E+01	1.780E+01	1.7750E+01	5.89830E-08	0.3465	5.89830E-07	1.04695E-05
619	1.780E+01	1.790E+01	1.7850E+01	3.43880E-08	0.4514	3.43880E-07	6.13827E-06
620	1.790E+01	1.800E+01	1.7950E+01	5.59167E-08	0.3757	5.59167E-07	1.00371E-05
621	1.800E+01	1.810E+01	1.8050E+01	2.69376E-08	0.5110	2.69376E-07	4.86224E-06
622	1.810E+01	1.820E+01	1.8150E+01	2.92755E-08	0.5120	2.92755E-07	5.31350E-06
623	1.820E+01	1.830E+01	1.8250E+01	3.39390E-08	0.5030	3.39390E-07	6.19387E-06
624	1.830E+01	1.840E+01	1.8350E+01	2.59724E-08	0.5406	2.59724E-07	4.76593E-06
625	1.840E+01	1.850E+01	1.8450E+01	3.10169E-08	0.4505	3.10169E-07	5.72262E-06
626	1.850E+01	1.860E+01	1.8550E+01	2.38081E-08	0.5109	2.38081E-07	4.41640E-06
627	1.860E+01	1.870E+01	1.8650E+01	2.39405E-08	0.5592	2.39405E-07	4.46489E-06
628	1.870E+01	1.880E+01	1.8750E+01	1.64193E-08	0.6335	1.64193E-07	3.07861E-06
629	1.880E+01	1.890E+01	1.8850E+01	1.15710E-08	0.7101	1.15710E-07	2.18113E-06
630	1.890E+01	1.900E+01	1.8950E+01	0.00000E+00	0.0000	0.00000E+00	0.00000E+00
631	1.900E+01	1.910E+01	1.9050E+01	3.73311E-08	0.4550	3.73311E-07	7.11157E-06

632	1.910E+01	1.920E+01	1.9150E+01	2.61738E-08	0.5336	2.61738E-07	5.01228E-06
633	1.920E+01	1.930E+01	1.9250E+01	1.18593E-08	0.6899	1.18593E-07	2.28292E-06
634	1.930E+01	1.940E+01	1.9350E+01	1.23242E-08	0.7820	1.23242E-07	2.38474E-06
635	1.940E+01	1.950E+01	1.9450E+01	0.00000E+00	0.0000	0.00000E+00	0.00000E+00
636	1.950E+01	1.960E+01	1.9550E+01	5.81422E-09	1.0000	5.81422E-08	1.13668E-06
637	1.960E+01	1.970E+01	1.9650E+01	2.40404E-08	0.5030	2.40404E-07	4.72394E-06
638	1.970E+01	1.980E+01	1.9750E+01	0.00000E+00	0.0000	0.00000E+00	0.00000E+00
639	1.980E+01	1.990E+01	1.9850E+01	3.46987E-09	0.7367	3.46987E-08	6.88770E-07
640	1.990E+01	2.000E+01	1.9950E+01	6.27240E-09	1.0000	6.27240E-08	1.25134E-06

APPENDIX C SPECTRUM UNCERTAINTIES AND CORRELATIONS

Number of Energy Groups
89
Energy Grid (low to high in units of eV)
1.00000E-04 1.00000E-03 5.00000E-03 1.00000E-02 3.00000E-02 7.00000E-02 1.00000E-01 1.52300E-01
2.00000E-01 4.14000E-01 6.00000E-01 8.00000E-01 1.12500E+00 3.05900E+00 5.04300E+00 8.31500E+00
1.37100E+01 2.26000E+01 3.72700E+01 6.14400E+01 1.01300E+02 1.67000E+02 2.75400E+02 3.53600E+02
4.54000E+02 5.83000E+02 7.48500E+02 9.61100E+02 1.08900E+03 1.23400E+03 1.39800E+03 1.58500E+03
1.79600E+03 2.03500E+03 2.30600E+03 2.61300E+03 2.96000E+03 3.35500E+03 3.80100E+03 4.30700E+03
4.88100E+03 5.53100E+03 6.26700E+03 7.10200E+03 8.04700E+03 9.11900E+03 1.03300E+04 1.17100E+04
1.32700E+04 1.50300E+04 1.70400E+04 1.93000E+04 2.18800E+04 2.47900E+04 2.60600E+04 2.80900E+04
3.18300E+04 4.08700E+04 5.24800E+04 6.73800E+04 8.65200E+04 1.11100E+05 1.42600E+05 1.83200E+05
2.35200E+05 3.02000E+05 3.87700E+05 4.39400E+05 4.97900E+05 5.64200E+05 6.39300E+05 7.24400E+05
8.20800E+05 9.30100E+05 1.05400E+06 1.19400E+06 1.35300E+06 1.73800E+06 2.23100E+06 2.86500E+06
3.67900E+06 4.72400E+06 6.06500E+06 7.78800E+06 1.00000E+07 1.19100E+07 1.35000E+07 1.49200E+07
1.69000E+07 2.00000E+07
Number Fraction Representation
1.28118E-04 4.31573E-03 1.01319E-02 4.63256E-02 6.38443E-02 2.38102E-02 2.00176E-02 8.87691E-03
1.85092E-02 8.87994E-03 6.78536E-03 8.73483E-03 2.92370E-02 1.51680E-02 1.58436E-02 1.70433E-02
1.64519E-02 1.66604E-02 1.69565E-02 1.71013E-02 1.36971E-02 1.44466E-02 8.68397E-03 8.78788E-03
7.89460E-03 7.87530E-03 9.11521E-03 4.76606E-03 4.89456E-03 4.82057E-03 4.61224E-03 4.81256E-03
4.60608E-03 4.29358E-03 3.90216E-03 3.72225E-03 4.39087E-03 4.57948E-03 4.65618E-03 4.84014E-03
4.89676E-03 4.43949E-03 4.98109E-03 4.66946E-03 4.70892E-03 4.87304E-03 5.05037E-03 5.03241E-03
5.13129E-03 5.09598E-03 5.27794E-03 5.42928E-03 5.79021E-03 2.49024E-03 3.50350E-03 5.80217E-03
8.79175E-03 1.17702E-02 1.32731E-02 1.39194E-02 1.33808E-02 1.67388E-02 1.59745E-02 1.85035E-02
2.15142E-02 2.41131E-02 1.09478E-02 1.34078E-02 1.41197E-02 1.43655E-02 1.64185E-02 1.55931E-02
1.41973E-02 1.36729E-02 1.59919E-02 1.61492E-02 3.31252E-02 2.97829E-02 2.63556E-02 1.50975E-02
1.04552E-02 7.08919E-03 2.91683E-03 7.40874E-04 1.52886E-04 3.41923E-05 9.84257E-06 4.33286E-06
9.35970E-07
Standard deviation (%)
1.26890E+02 8.66160E+01 7.46200E+01 6.92284E+01 6.82591E+01 7.11047E+01 7.61774E+01 7.34224E+01
5.55030E+01 5.72649E+01 5.53492E+01 5.05319E+01 3.94359E+01 3.70610E+01 3.38539E+01 2.96237E+01
2.63054E+01 2.37904E+01 2.19240E+01 2.04267E+01 1.85799E+01 1.57487E+01 1.07799E+01 1.24463E+01
1.37113E+01 1.38471E+01 1.44641E+01 1.42807E+01 1.42350E+01 1.41969E+01 1.39565E+01 1.35245E+01
1.29687E+01 1.22221E+01 1.13254E+01 1.05724E+01 1.07318E+01 1.11420E+01 1.15611E+01 1.18703E+01
1.21836E+01 1.23120E+01 1.23054E+01 1.23036E+01 1.22583E+01 1.23642E+01 1.24232E+01 1.26025E+01
1.27497E+01 1.29198E+01 1.30928E+01 1.33236E+01 1.36093E+01 1.38300E+01 1.39947E+01 1.42425E+01
1.47127E+01 1.52331E+01 1.55322E+01 1.55590E+01 1.53453E+01 1.49184E+01 1.44785E+01 1.40699E+01
1.37054E+01 1.32665E+01 1.27579E+01 1.22529E+01 1.16007E+01 1.09078E+01 1.01666E+01 9.50377E+00
9.02061E+00 8.67301E+00 8.39116E+00 8.17781E+00 7.55289E+00 6.75618E+00 6.52862E+00 6.63356E+00
6.86553E+00 6.78687E+00 5.86931E+00 6.83243E+00 6.30578E+00 8.71462E+00 1.26289E+01 1.73785E+01
2.64556E+01
Correlation matrix (upper triangular)
1.00000E+00 7.96230E-04 9.31477E-04 1.00469E-03 1.01858E-03 9.78335E-04 7.09340E-04 4.89397E-04
1.13936E-04 -4.84334E-06 -2.25794E-05 3.01630E-05 3.33780E-04 4.09859E-04 5.54092E-04 8.06168E-04
1.05815E-03 1.29635E-03 1.51745E-03 1.75179E-03 3.11580E-03 3.90220E-03 6.68180E-03 5.78882E-03
5.27697E-03 4.77291E-03 3.49248E-03 3.10729E-03 2.77322E-03 2.63643E-03 2.58109E-03 2.62817E-03
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