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Radiation Characterization Summary: WSMR Fast Burst Reactor Environment at the 6-Inch and 24-Inch Irradiation Locations

Danielle R. Redhouse, Edward S. Lum, Johnathon Koglin

with Edward J. Parma, Curtis D. Peters, Mikhail Finko, Jesse M. Roebuck, Dave W. Vehar, Frank Sage, Andrew M. Tonigan, Ryan Mulcahy, Thomas A. Ball, Elliott Pelfrey, Melissa Moreno, Karissa Currie, and Patrick J. Griffin

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico
87185 and Livermore,
California 94550

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Radiation Characterization Summary: WSMR-Molly G at the 6-Inch and 24-Inch Irradiation Locations¹

Danielle R. Redhouse², Edward S. Lum³, Johnathon Koglin⁴

with Edward Parma, Curtis Peters, Mikhail Finko, Jesse Roebuck, Dave Vehar, Frank Sage,
Andrew Tonigan, Ryan Mulcahy, Thomas Ball, Elliott Pelfrey, Melissa A. Moreno, Karissa
Currie, and Patrick Griffin

Sandia National Laboratories¹
P.O. Box 5800
Albuquerque, NM 87185

ABSTRACT

This document presents the facility-recommended characterization of the neutron, prompt gamma-ray, and delayed gamma-ray radiation fields for the White Sands Missile Range (WSMR) Fast Burst Reactor, also known as molybdenum-alloy Godiva (Molly-G), at the 6-inch and the 24-inch irradiation locations. The neutron, prompt gamma-ray, and delayed gamma-ray energy spectra, uncertainties, and covariance matrices are presented. Code dependent recommended constants are given to facilitate the conversion of various dosimetry readings into radiation metrics desired by experimenters. Representative pulse operations are presented with conversion examples.

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² R&D Scientist and Engineer, Radiation Modeling and Metrology, Sandia National Laboratories, P.O. Box 5800, MS 1141, Albuquerque, New Mexico 87185, USA

³ R&D Engineer, Advanced Engineering and Analysis, Los Alamos National Laboratory, P.O. Box 1663, MS A142, Los Alamos, New Mexico 87545, USA

⁴ Design Physicist, Weapons Physics and Design, Lawrence Livermore National Laboratory, P.O. Box 808 Livermore, CA 94551, USA

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CONTENTS

1. Introduction	13
2. Environment Description	15
2.1. WSMR Description.....	15
2.2. 6-inch and 24-inch Y-Plate Environment	19
2.2.1. Free-Field Description.....	19
3. Neutronic Models.....	20
3.1. SNL MCNP Model.....	20
3.2. LANL MCNP Model	21
3.3. LLNL MERCURY Model.....	23
3.4. Tri-Lab MCNP and MERCURY k_{eff} variations	25
4. Spectrum Characterization.....	26
4.1. Neutron.....	26
4.1.1. SNL MCNP Model Neutron Energy Spectra Results	26
4.1.2. LANL MCNP Model Neutron Energy Spectra Results.....	29
4.1.3. LLNL MERCURY Model Neutron Energy Spectra Results	32
4.2. Dosimetry Foils	35
4.3. LSL Spectrum Unfold Results.....	39
4.3.1. SNL LSL Spectrum Results	41
4.3.2. LANL LSL Spectrum Results.....	54
4.3.3. LLNL LSL Spectrum Results	68
4.4. Prompt Gamma-Ray.....	82
4.4.1. SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum Results	83
4.4.2. LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum Results	90
4.4.3. LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum Results	97
4.5. Delayed Gamma-Ray.....	104
4.5.1. SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum Results	105
4.5.2. LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum Results.....	112
4.5.3. LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum Results ..	119
5. Radial and Axial Fluence Profiles	127
5.1. Neutron-Sulfur Map	127
6. Sample Operations	130
6.1. Maximum Pulse at 6-inch Location.....	130
6.2. Maximum Pulse at 24-inch Location	132
7. Conclusions	135
Appendix A. SNL MCNP WSMR Model	137
Appendix B. LANL MCNP WSMR Model.....	149
Appendix C. Input Deck for Neutron Spectrum Adjustment Using LSL-M3 Code for SNL MCNP Model at 6-inch position.....	158
Appendix D. Input Deck for Neutron Spectrum Adjustment Using LSL-M3 Code for LANL MCNP Model at 6-inch position.....	159
Appendix E. Input Deck for Neutron Spectrum Adjustment Using LSL-M3 Code for LLNL MERCURY MODEL at 6-inch position.....	160

Appendix F.	SNL LSL-M3 Format Neutron Output	161
Appendix G.	LANL LSL-M3 Format Neutron Output	168
Appendix H.	LLNL LSL-M3 Format Neutron Output	175

LIST OF FIGURES

Figure 1.	WSMR FBR pictured at LANL Kiva 2 in 1964, before its relocation to WSMR.	16
Figure 2.	WSMR Molly-G Fast Burst Reactor and test table.	17
Figure 3.	WSMR Test table with the y-plate installed. Curved dosimetry plates are shown at the 6-inch position on the ‘A-Leg’, B-Leg, and ‘C-Leg’ of the y-plate.	18
Figure 4.	Engineering Schematic of the tabletop	19
Figure 5.	SNL MCNP Model (XZ) of the WSMR Fast Burst Reactor with tally sphere shown.....	20
Figure 6.	SNL MCNP Model (XY) of the WSMR Fast Burst Reactor.....	21
Figure 7.	LANL MCNP Model (XZ) of the WSMR Fast Burst Reactor with tally spheres shown. ..	22
Figure 8.	LANL MCNP Model (XY) of the WSMR Fast Burst Reactor.	22
Figure 9.	LLNL MERCURY Model (XZ) of the WSMR Fast Burst Reactor (North-South).....	23
Figure 10.	LLNL MERCURY Model (XY) of the WSMR Fast Burst Reactor.	24
Figure 11.	A 3D rendered WSMR FBR model from the MERCURY code.....	24
Figure 12.	SNL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).	27
Figure 13.	SNL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).....	27
Figure 14.	SNL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).	28
Figure 15.	SNL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).....	28
Figure 16.	LANL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).	30
Figure 17.	LANL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).	30
Figure 18.	LANL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).	31
Figure 19.	LANL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).	32
Figure 20.	LLNL WSMR 6-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).	33
Figure 21.	LLNL WSMR 6-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).	33
Figure 22.	LLNL WSMR 24-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).	34
Figure 23.	LLNL WSMR 24-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).	34
Figure 24.	Typical Dosimetry Foils – Characterization Test Setup.....	39
Figure 25.	WSMR 6-inch - Relative Reaction Probabilities for the Complete Dosimetry Reaction Set.....	40
Figure 26.	WSMR 24-inch - Relative Reaction Probabilities for the Complete Dosimetry Reaction Set.....	41

Figure 27. WSMR 6-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).....	42
Figure 28. WSMR 6-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).....	42
Figure 29. WSMR 24-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).....	43
Figure 30. WSMR 24-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).....	43
Figure 31. WSMR 6-inch – SNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.	44
Figure 32. WSMR 24-inch – SNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum	44
Figure 33. WSMR 6-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).....	55
Figure 34. WSMR 6-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).....	56
Figure 35. WSMR 24-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).....	56
Figure 36. WSMR 24-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).....	57
Figure 37. WSMR 6-inch – LANL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.	57
Figure 38. WSMR 24-inch – LANL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.	58
Figure 39. WSMR 6-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (linear-log).....	69
Figure 40. WSMR 6-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (log-log).....	70
Figure 41. WSMR 24-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (linear-log).....	70
Figure 42. WSMR 24-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (log-log).....	71
Figure 43. WSMR 6-inch – LLNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.	72
Figure 44. WSMR 24-inch – LLNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.	72
Figure 45. WSMR 6-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).....	84
Figure 46. WSMR 6-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).....	84
Figure 47. WSMR 24-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).....	85
Figure 48. WSMR 24-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).....	85
Figure 49. WSMR 6-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).....	91
Figure 50. WSMR 6-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).....	91

Figure 51. WSMR 24-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).....	92
Figure 52. WSMR 24-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).....	92
Figure 53. WSMR 6-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).....	98
Figure 54. WSMR 6-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).....	98
Figure 55. WSMR 24-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).....	99
Figure 56. WSMR 24-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).....	99
Figure 57. Delayed Gamma-Ray Source Distribution Used for MCNP and MERCURY Analysis.	105
Figure 58. WSMR 6-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).....	106
Figure 59. WSMR 6-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).....	107
Figure 60. WSMR 24-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).....	107
Figure 61. WSMR 24-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).....	108
Figure 62. WSMR 6-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).....	113
Figure 63. WSMR 6-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).....	114
Figure 64. WSMR 24-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).....	114
Figure 65. WSMR 24-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).....	115
Figure 66. WSMR 6-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).....	120
Figure 67. WSMR 6-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).....	121
Figure 68. WSMR 24-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).....	121
Figure 69. WSMR 24-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).....	122
Figure 70. WSMR Sulfur Axial Neutron Fluence Profile at 6-inch location, from the bottom of Molly-G.	128
Figure 71. A-Leg and B-Leg Nickel and Sulfur Normalized Radial Neutron Fluence Profiles, referenced from the center of Molly-G.	129
Figure 72. PCD Transient Response for Pulse Operation #21661 – 2.9 MJ (log-lin).	130
Figure 73. PCD Transient Response for Pulse Operation #21661 – 2.9 MJ (log-log).	131
Figure 74. Si Calorimeter Transient Response for Pulse Operation #10724 – 2.9 MJ.	131
Figure 75. Bi Calorimeter Transient Response for Pulse Operation #21661 – 2.9 MJ.	132
Figure 76. PCD Transient Response for Pulse Operation #21662 – 2.2 MJ (log-lin).	133
Figure 77. PCD Transient Response for Pulse Operation #21662 – 2.2 MJ (log-log).	133
Figure 78. Bi Calorimeter Transient Response for Pulse Operation #21662 – 2.2 MJ	134

LIST OF TABLES

Table 1. In-Core Operation Metrics.....	25
Table 2. WSMR In-Core Model verification activation foil set	25
Table 3. MCNP and MERCURY model k_{eff} for WSMR core configurations.....	25
Table 4. Neutron Activation Dosimetry Used for WSMR 6-inch.....	37
Table 5. Neutron Activation Dosimetry Used for WSMR 24-inch.....	38
Table 6. WSMR 6-inch - C/E Values for the Trial and Adjusted SNL LSL Neutron Energy Spectrum.	45
Table 7. WSMR 24-inch - C/E Values for the Trial and Adjusted SNL LSL Neutron Energy Spectrum.	46
Table 8. SNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 6-inch Location.	48
Table 9. SNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 24-inch Location.	50
Table 10. WSMR 6-inch Location – SNL Integral Neutron Spectrum Metrics and Associated Uncertainties.....	52
Table 11. WSMR 24-inch Location – SNL Integral Neutron Spectrum Metrics and Associated Uncertainties.....	53
Table 12. WSMR 6-inch Location – Other SNL Neutron Spectrum Metrics.....	54
Table 13. WSMR 24-inch Location - Other SNL Neutron Spectrum Metrics.....	54
Table 14. WSMR 6-inch - C/E Values for the Trial and Adjusted LANL LSL Neutron Energy Spectrum.	59
Table 15. WSMR 24-inch - C/E Values for the Trial and Adjusted LANL LSL Neutron Energy Spectrum.	60
Table 16. LANL Neutron 89-Group Adjusted Energy Spectrum for WSMR 6-inch Location.....	62
Table 17. LANL Neutron 89-Group Adjusted Energy Spectrum for WSMR 24-inch Location.....	64
Table 18. WSMR 6-inch Location – LANL Integral Neutron Spectrum Metrics and Associated Uncertainties.....	66
Table 19. WSMR 24-inch Location – LANL Integral Neutron Spectrum Metrics and Associated Uncertainties.....	67
Table 20. WSMR 6-inch Location - Other LANL Neutron Spectrum Metrics.	68
Table 21. WSMR 24-inch Location - Other LANL Neutron Spectrum Metrics.....	68
Table 22. WSMR 6-inch - C/E Values for the Trial and Adjusted LLNL LSL Neutron Energy Spectrum.	73
Table 23. WSMR 24-inch - C/E Values for the Trial and Adjusted LLNL LSL Neutron Energy Spectrum.	74
Table 24. LLNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 6-inch Location.	76
Table 25. LLNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 24-inch Location.	78
Table 26. WSMR 6-inch Location – LLNL Integral Neutron Spectrum Metrics and Associated.....	80
Table 27. WSMR 24-inch Location – LLNL Integral Neutron Spectrum Metrics and Associated Uncertainties.....	81
Table 28. WSMR 6-inch Location - Other LLNL Neutron Spectrum Metrics.....	82
Table 29. WSMR 24-inch Location - Other LLNL Neutron Spectrum Metrics.	82
Table 30. Prompt Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 6-inch Location.	87
Table 31. Prompt Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 24-inch Location.	88
Table 32. SNL WSMR 6-inch Location - Prompt Gamma-Ray Spectrum Metrics.....	89
Table 33. SNL WSMR 24-inch Location - Prompt Gamma-Ray Spectrum Metrics.	90
Table 34. Prompt Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 6-inch Location.....	94
Table 35. Prompt Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 24-inch Location...	95

Table 36. LANL WSMR 6-inch Location - Prompt Gamma-Ray Spectrum Metrics.	96
Table 37. LANL WSMR 24-inch Location - Prompt Gamma-Ray Spectrum Metrics.	97
Table 38. Prompt Gamma-Ray 48-Group Energy Spectrum for LLNL WSMR 6-inch Location. ..	101
Table 39. Prompt Gamma-Ray 48-Group Energy Spectrum for LLNL WSMR 24-inch Location. ..	102
Table 40. LLNL WSMR 6-inch Location - Prompt Gamma-Ray Spectrum Metrics.	103
Table 41. LLNL WSMR 24-inch Location - Prompt Gamma-Ray Spectrum Metrics.	104
Table 42. Delayed Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 6-inch Location.	109
Table 43. Delayed Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 24-inch Location. ..	110
Table 44. SNL WSMR 6-inch Location - Delayed Gamma-Ray Spectrum Metrics.	111
Table 45. SNL WSMR 24-inch Location - Delayed Gamma-Ray Spectrum Metrics.	112
Table 46. Delayed Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 6-inch Location. ..	116
Table 47. Delayed Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 24-inch Location.	117
Table 48. LANL WSMR 6-inch Location - Delayed Gamma-Ray Spectrum Metrics.	118
Table 49. LANL WSMR 24-inch Location - Delayed Gamma-Ray Spectrum Metrics.	119
Table 50. Delayed Gamma-Ray 48-Group Energy Spectrum for LLNL WSMR 6-inch Location. ..	123
Table 51. Delayed Gamma-Ray 48-Group Energy Spectrum for WSMR 24-inch Location.	124
Table 52. LLNL WSMR 6-inch Location - Delayed Gamma-Ray Spectrum Metrics.	125
Table 53. LLNL WSMR 24-inch Location - Delayed Gamma-Ray Spectrum Metrics.	126

ACRONYMS AND DEFINITIONS

ASTM	American Society for Testing and Materials
Al	aluminum
B	boron
B ₄ C	boron carbide
Bi	Bismuth
Bq	Becquerel (disintegrations/second)
C/E	calculated to experimental ratio
Cd	cadmium
dc	delayed critical
E _{th}	threshold energy
eV	electron volt
FBR	Fast Burst Reactor
FP	Frenkel Pair
FWHM	full-width at half-maximum
GenSpec	An SNL code that uses a genetic algorithm for neutron energy spectrum adjustment
Gy	Gray – unit of absorbed dose equal to 100 rad
k _{eff}	k-effective multiplying constant
keV	kilo-electron volt
krad	kilorad – unit of absorbed dose equal to 1000 rad
LANL	Los Alamos National Laboratory
lbs	pounds
LLNL	Lawrence Livermore National Laboratory
LSL-M3	Least-Squares Logarithmic Adjustment code, version 3
mb	Millibarns
MERCURY	A next-generation, general-purpose radiation transport code developed by LLNL
Molly-G	WSMR FBR or the Molybdenum-Alloyed Godiva Device
MCNP	Monte Carlo N-Particle Code
MeV	mega-electron volt
MJ	megajoule
ms	millisecond
MW	megawatts
Ni	nickel
n/cm ²	unit of fluence (neutrons per square centimeter)
NNSA	National Nuclear Security Administration
Pb	lead

PCD	photo-conducting detector
PKA	primary knock-on atom
rad	unit of absorbed dose equal to 100 erg/gram in a specified material
Si	Silicon
SNL	Sandia National Laboratories
Tri-Labs	LANL, LLNL, and SNL
TC	thermocouple
TLD	thermoluminescent dosimeter
WSMR	White Sands Missile Range

1. INTRODUCTION

Characterization of the neutron and gamma-ray environments in White Sands Missile Range (WSMR) Fast Burst Reactor (FBR), nicknamed Molly-G, is important to maintain a high degree of fidelity in performing qualification for the National Nuclear Security Administration (NNSA) stockpile stewardship programs at Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and Sandia National Laboratories (SNL). Characterization of the WSMR FBR includes both modeling and experimental efforts by the NNSA Tri-Labs. Redundant accurate neutronic models of Molly-G can be used by experimenters, for planning and designing experiments, and in assessing experimental results. Experimental observations, including passive and active dosimetry, are important to determine the accuracy of the model, the energy dependent neutron fluence, the conversion constants for radiation metrics, the axial and radial neutron and gamma-ray fluence profiles, and the time-dependent responses for different pulse sizes are presented.

This document presents the laboratory-recommended characterizations of the radiation fields at the WSMR FBR. These radiation fields include the 6-inch and 24-inch leakage free-field environment external to the FBR core radially spaced on y-Plate at the axial fluence maximum. The WSMR FBR test table is roughly 8ft (243.80 cm) by 4ft (122.56 cm) and is the most common test location. The free-field environment is the radiation environment on the test table at the designated 6-inch and 24-inch locations on the y-plate without the presence of any spectrum modifying materials.

The neutron, prompt gamma-ray, and delayed gamma-ray energy spectra, and uncertainties (and covariance matrices) are presented at 6-inch and 24-inch location of the y-plate, roughly 3.25 inches above the test table, the peak neutron fluence location. In addition, radial and axial neutron, and gamma-ray fluence profiles are provided within the available experiment area around the WSMR FBR. Recommended constants are given that facilitate the conversion of various dosimetry readings into radiation metrics desired by experimenters. Temporal profiles for representative pulse operations are presented with conversion examples for the radiation metrics.

The neutronics model for The WSMR FBR was redundantly modeled in MCNP by both LANL and SNL and modeled by LLNL in their proprietary neutronic code MERCURY. The SNL WSMR MCNP model was originally assembled by R. L. Coats and later heavily modified by K. Russell DePriest in 2004. A completely new model was created in 2022 by Curtis D. Peters and Danielle R. Redhouse. The LANL WSMR MCNP model was originally assembled by Bob Kimpland and Jeff Goettee in 2011. A completely new model was created in 2022 by Edward S. Lum. The LLNL WSMR MERCURY model was originally assembled by Richard ‘Spike’ Procassini in 2003. A completely new model was created in 2022 by Johnathon Koglin and Mikhail Finko.

Details of each laboratory’s neutronic model and calculations are described later in this document. A 640-group and 89-group neutron energy spectra and a 48-group gamma-ray energy spectrum was calculated using either MCNP6.2 or MCNP6.3 and MERCURY Version 5.30. MCNP calculations used the ENDF/B-VIII.0 cross sections for the WSMR model with scoring spheres at the 6-inch and 24-inch location on the y-plate. MERCURY calculations utilized the ENDL 2009.4 cross sections for the WSMR FBR with tally signifiers at both the 6-inch and 24-inch location on the y-plate. The calculated neutron spectra from each model can then be used with activation foil measurements and dosimetry cross sections, as the trial function in the SNL unfolding codes GenSpec or LSL-M3, a heavily modified version of LSL-M2 (Stallman, 1985). MERCURY is not available for general

download. It is an export-controlled code and is only accessible to LLNL users. Additionally, both SNL unfolding codes used herein are Sandia Proprietary, and not available for general download.

For this work a total of 23 different foil types, resulting in 35 different reactions, were irradiated at both 6-inch and 24-inch test locations. The LSL-M3 code and the IRDFF-II dosimetry cross sections (IRDFF, 2014; Capote, 2012; Zsolnay, 2012), were used in the unfolding analysis.

2. ENVIRONMENT DESCRIPTION

2.1. WSMR Description

In the late 1950's, Los Alamos National Laboratory (LANL) designed and developed the Moly-Godiva reactor during the Rover program period at the Pajarito Site. It was designed by Dr. Thomas F. Whimett and Dr. Gordon E. Hansen to perform neutron studies in a burst environment. The core was designed as an unreflected, unmoderated, cylindrical annulus of uranium-molybdenum alloy. The fuel was fabricated in Golden, Colorado by Dow Chemical Corporation and shipped back to Los Alamos Scientific Laboratory on September 17th, 1963. From October 21st to 31st of 1963 tests were conducted by the LANL N-2 Group under the direction of Dr. Thomas F. Whimett to determine the critical mass of an FBR core and to measure the reactivity worth of various components. The assembly was finally moved to the U.S. Army's Survivability, Vulnerability, and Testing Directorate (SVAD) at White Sands Missile Range (WSMR) in June of 1964. The Moly-Godiva reactor was renamed the WSMR Fast Burst Reactor (FBR), nicknamed Molly-G.

The WSMR FBR is located at WSMR, an Army Military Base and testing range in southern New Mexico, about 30 minutes east of Las Cruces, New Mexico. Molly-G was designed and configured similarly to Godiva-II but had a molybdenum fuel loading of 10%. The stand is designed so that it can be moved by a forklift for experiments in different orientations. Molly-G was developed to conduct neutronic studies by providing an intense neutron burst over a narrow pulse width, with high dose capabilities. Figure 1 and Figure 2 show Molly-G along with its irradiation table. Molly-G is a bare metal, fast system reactor. Historically, WSMR has been used for a wide variety of experiment campaigns including those for space applications and radiation effects sciences. The WSMR FBR reactor is currently fully operational. WSMR's main irradiation location is within the reactor room on a risen table. The table features a y-plate, that makes standard reproducible test positions simple for 1/5-inch increments down three separate 'legs'. The tabletop and y-plate can be seen in Figure 3. The WSMR FBR reactor is mainly driven by fast neutrons and has a shock-induced scram that causes the separation of the safety block from the core after a pulse. WSMR FBR is capable of pulse operations and steady-state operations for reactor power levels between 8kW up to 120,000kW. Initial criticality of the Molly-G at WSMR was achieved on July 7th 1964.

Figure 1 shows Molly-G at the LANL Pajarito Site's Kiva 2 in 1964, a few months before it was transferred to WSMR. Figure 3 shows the y-plate with 3 legs that extend out to the edges of the test table, these include the 'A-Leg', 'B-Leg', and 'C-Leg'. Each leg is oriented in different coordinate directions, but it is commonly understood that: 'A-Leg' or 'Long Leg' extends from the core west, 'B-Leg' extends N-NE (~60° angle), and 'C-Leg' extends S-SE (~60° angle). Each leg allows for the placement of this project's curved test plates a 1/5-inch increments. Experiments are classically placed at the axial fluence maximum outside of the core, roughly 3-inches from the bottom of the core.

WSMR FBR maintains a fast neutron fluence spectrum in-core and in leakage ex-core locations. For an unmoderated condition, the neutron fluence at the 6-inch position, at the axial fluence maximum is $\sim 2.4\text{E}+13$ n/cm² per MJ of reactor energy. About 0.1% of the neutron fluence is below 1 keV and 96% above 100 keV. The 1-MeV Damage-Equivalent Silicon (DES) fluence is $\sim 2.2\text{E}+13$ n/cm² per MJ of reactor energy. The prompt gamma-ray dose at the same position is $\sim 2.5\text{E}+03$ rad(Si) per MJ. The delayed gamma-ray dose is $1.3\text{E}+03$ rad(Si) per MJ.

For an unmoderated condition, the neutron fluence at the 24-inch position, at the axial fluence maximum is $\sim 1.3\text{E}+12$ n/cm² per MJ of reactor energy. About 1.7% of the neutron fluence is below 1 keV and 92% above 100 keV. The 1-MeV Damage-Equivalent Silicon (DES) fluence is $\sim 1.1\text{E}+12$ n/cm² per MJ of reactor energy. The prompt gamma-ray dose at the same position is $\sim 1.2\text{E}+02$ rad(Si) per MJ. The delayed gamma-ray dose is $\sim 5.8\text{E}+01$ rad(Si) per MJ.

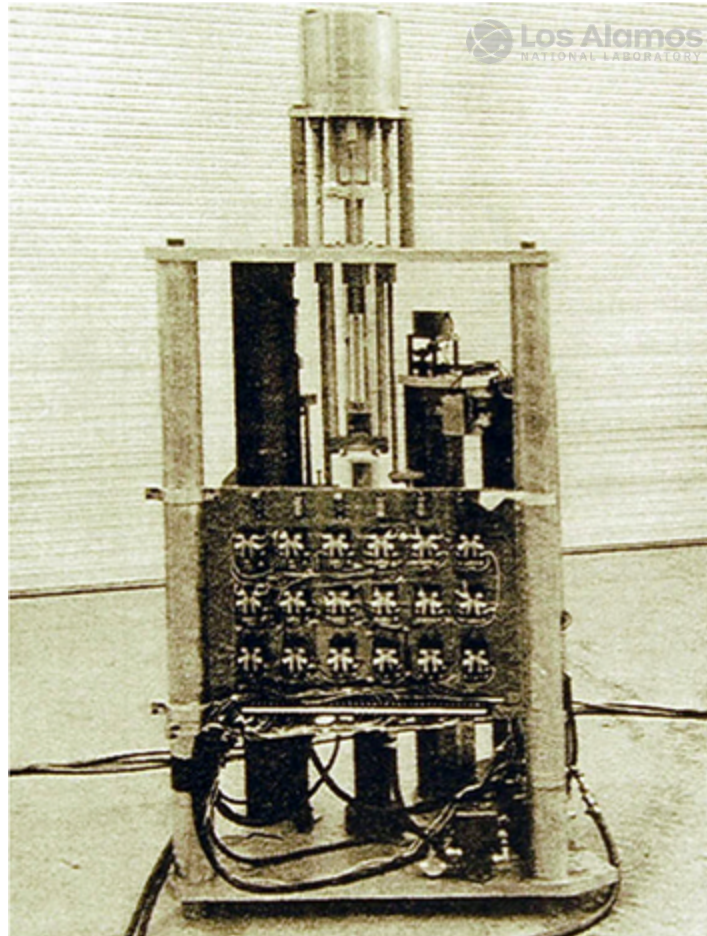


Figure 1. WSMR FBR pictured at LANL Kiva 2 in 1964, before its relocation to WSMR.

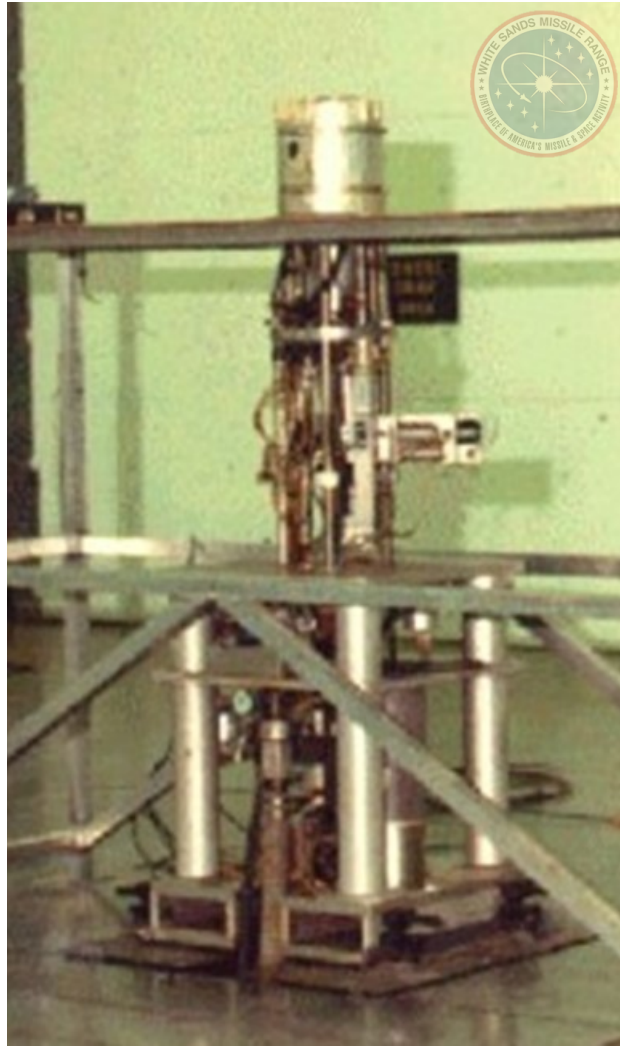


Figure 2. WSMR Molly-G Fast Burst Reactor and test table.

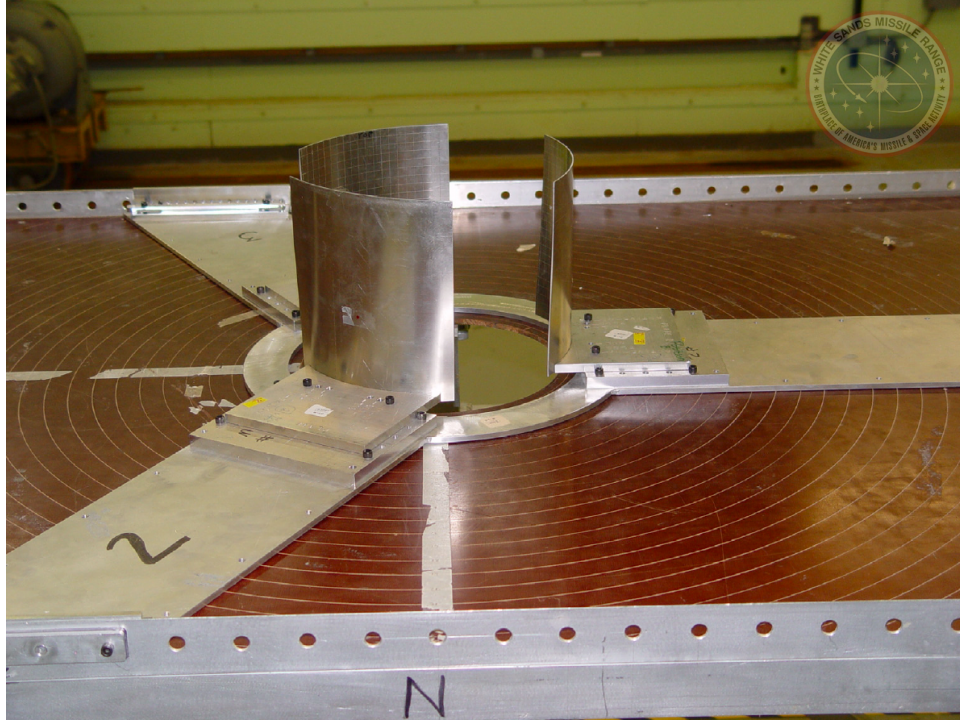


Figure 3. WSMR Test table with the y-plate installed. Curved dosimetry plates are shown at the 6-inch position on the 'A-Leg', B-Leg, and 'C-Leg' of the y-plate.

WSMR FBR can operate in a steady-state or pulse mode. In the steady-state mode, the operating power level is limited to 8kW. In pulse mode, a maximum pulse size of 2.0 MJ (ΔT of 250°C) with a full-width half-maximum (FWHM) of 50 μ s can be attained.

The WSMR FBR is fueled by six uranium-molybdenum solid metal ring elements. The fuel uses uranium enriched to 93.0 weight percent U-235 and 10.0 weight percent of molybdenum. Molly-G fuel elements are clad in 6061-aluminum at 0.5 cm thick. Each fuel rings dimensions are an internal diameter of 2 inches (5.08 cm) and an external diameter 4 inches (10.18 cm), with an individual height of 1.28 inches (3.25 cm). WSMR FBR is controlled by two fuel control rods, one fuel burst rod, and a fueled safety block. The control rods are positioned axially in 5 fuel elements, while the burst rod is positioned axially in 4 fuel elements in the normal core configuration.

The WSMR FBR fast spectrum can be modified using moderator or scattering materials to give a softer spectrum. Spectrum-modifying polyethylene or lead, provide the facility with the ability to change the inherent neutron spectrum found in the reactor as well as allowing adjustment of the neutron-to-gamma dose ratio.

The WSMR FBR is situated in an open-air cell approximately 48 ft (14.63 m) by 48 ft (14.63 m), and a 23 ft (7.01 m) height to the ceiling. Molly-G features a new state-of-the-art cooling system allowing continued safe pulsing operations. Cooling is done in both steady-state mode and after pulses using chilled/dried compressed air.

2.2. 6-inch and 24-inch Y-Plate Environment

2.2.1. Free-Field Description

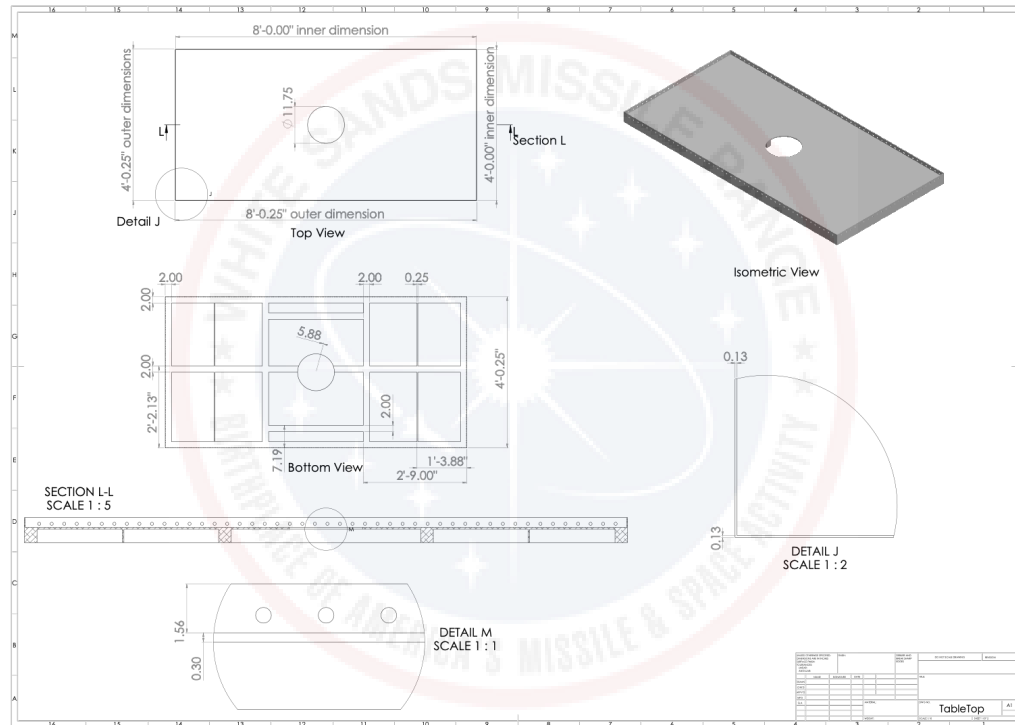


Figure 4. Engineering Schematic of the tabletop

The free-field environment does not provide any attenuation of gamma-rays that accompany fission. Thus, if the desire is to attempt to isolate the effect of neutron irradiation in an experiment, a spectrum altering material containing lead should be used at positions that allow dimensionally and neutronically for them.

Figure 4 shows the schematic of the test table, a commonly used item at WSMR when fielding experiments. The Tabletop ensures the placement of test items next to the FBR core, while the y-plate ensures standardized, reproducible positions on the table can be achieved.

3. NEUTRONIC MODELS

3.1. SNL MCNP Model

The MCNP model of the WSMR FBR is shown in XY and XZ plane views in Figure 5 and Figure 6, respectively. The MCNP model includes the uranium-molybdenum fuel elements, safety block, control rods, and burst rod. The control rods and burst rods can be adjusted in the vertical direction in the model to whatever position is desired. The model is typically run at standard temperature and pressure, using room-temperature cross sections (293.6 K) from ENDF/B-VIII.0. Various cross section temperatures can be modeled if desired.

Neutron, prompt gamma-ray, and delayed gamma-ray energy spectra and fluence per fissions were calculated using a 6-cm diameter tally spheres located inside and outside of the long leg (i.e. A Leg) level with centerline, and in mirror positions on the opposite side of the reactor from the long leg. 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.

In addition to calculating the neutron, prompt gamma-ray, and delayed gamma-ray energy spectra, radial and axial neutron flux maps were generated for comparison to experimental results.

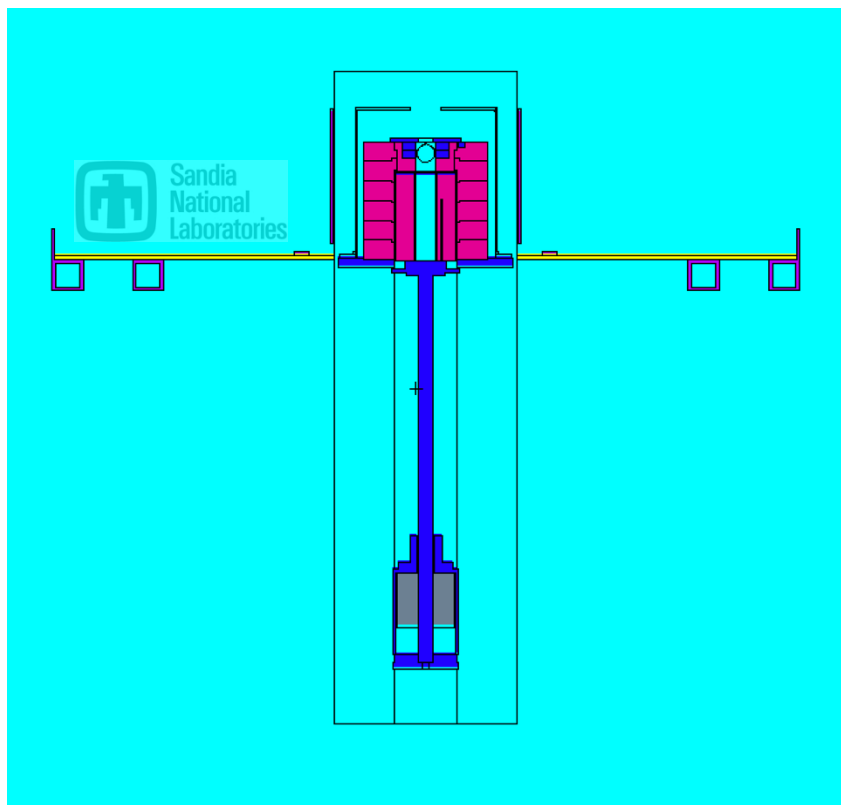


Figure 5. SNL MCNP Model (XZ) of the WSMR Fast Burst Reactor with tally sphere shown.

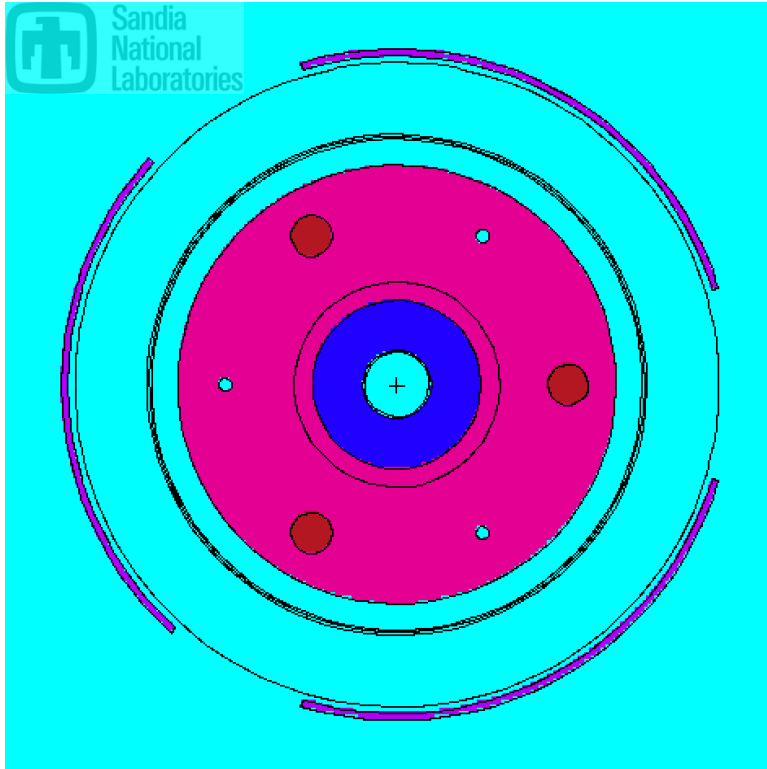


Figure 6. SNL MCNP Model (XY) of the WSMR Fast Burst Reactor.

3.2. LANL MCNP Model

The MCNP model of the WSMR FBR is shown in XY and XZ plane views in Figure 7 and Figure 8, respectively. The MCNP model includes the uranium-molybdenum fuel elements, safety block, control rods, and burst rod. The control rods and burst rods can be adjusted in the vertical direction in the model to whatever position is desired. The model is typically run at standard temperature and pressure, using room-temperature cross sections (293.6 K) from ENDF/B-VIII.0. Various cross section temperatures can be modeled if desired.

Neutron, prompt gamma-ray, and delayed gamma-ray energy spectra and fluence per fissions were calculated using a 6-cm diameter tally spheres located inside and outside of the long leg (i.e. A Leg) level with centerline, and in mirror positions on the opposite side of the reactor from the long leg. 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.

In addition to calculating the neutron, prompt gamma-ray, and delayed gamma-ray energy spectra, radial and axial neutron flux maps were generated for comparison to experimental results.

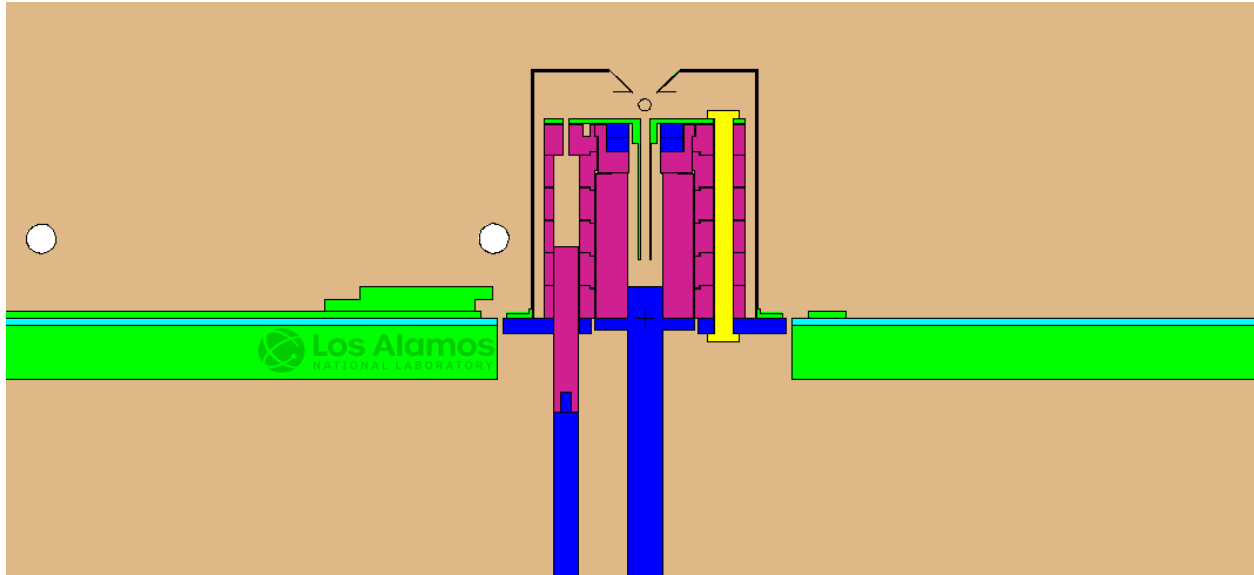


Figure 7. LANL MCNP Model (XZ) of the WSMR Fast Burst Reactor with tally spheres shown.

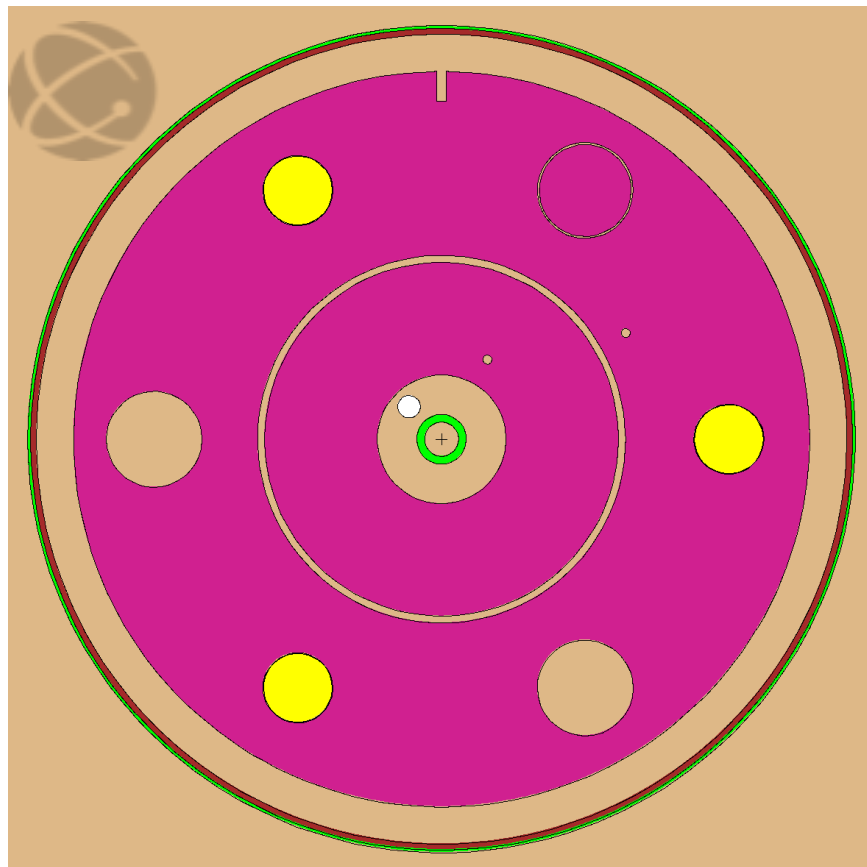


Figure 8. LANL MCNP Model (XY) of the WSMR Fast Burst Reactor.

3.3. LLNL MERCURY Model

The MERCURY model of the WSMR FBR is shown in XZ and XY plane views in Figure 9 and Figure 10, respectively. Figure 11 displays a 3D rendered model of the WSMR FBR core, a unique capability of MERCURY. The MERCURY model includes the uranium-molybdenum fuel elements, safety block, control rods, and burst rod. The rods can be adjusted in the vertical direction in the model to whatever position is desired. The model is typically run using FUDGE-processed ENDL2009.4 nuclear data library in General Nuclear Data Structure (GNDS) format implemented with GIDI+. Various cross section temperatures can be modeled if desired, but for this case room temperature (300K) was used.

Neutron, prompt gamma-ray, and delayed gamma-ray energy spectra and fluence per fissions were calculated using a 6-cm diameter tally on the long leg. (i.e. A Leg) level with the reactor centerline. Calculations were performed using the MERCURY static k-code mode for the neutron and prompt gamma-ray environments, and in the source mode for the delayed gamma-ray environment. Neutron flux maps were generated for comparison to experimental results.

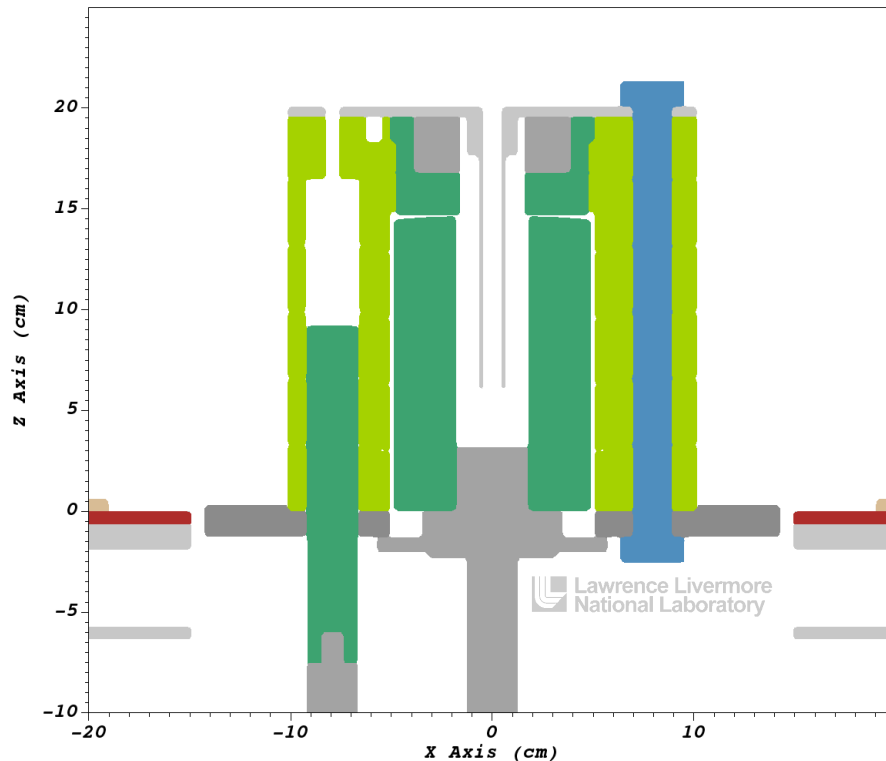


Figure 9. LLNL MERCURY Model (XZ) of the WSMR Fast Burst Reactor (North-South).

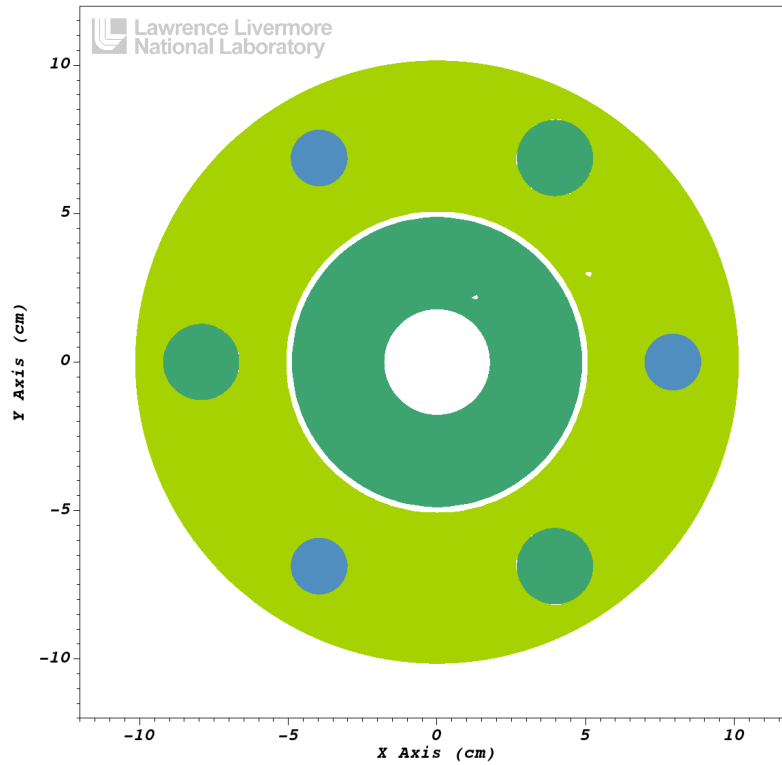


Figure 10. LLNL MERCURY Model (XY) of the WSMR Fast Burst Reactor.

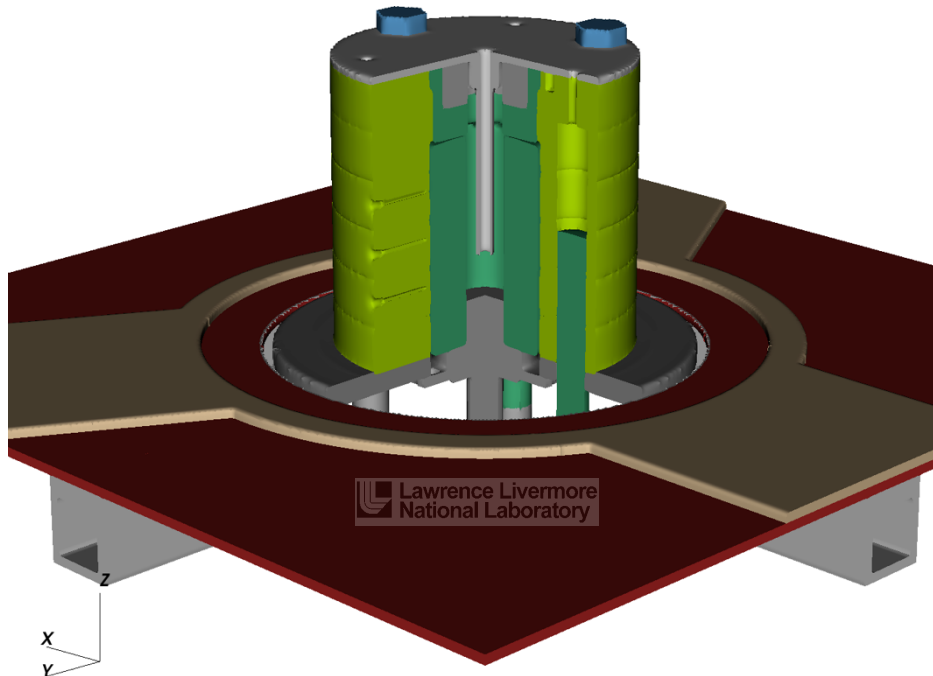


Figure 11. A 3D rendered WSMR FBR model from the MERCURY code.

3.4. Tri-Lab MCNP and MERCURY k_{eff} variations

MCNP and MERCURY models of the WSMR FBR has been developed to estimate the reactivity worth of experiment packages and to analyze the radiation environments inside and outside (leakage) for the FBR core. Table 1 shows in-core operation metrics and Table 2 shows the activities of the foil set from the in-core irradiation operation. To establish a comparison between the tri-labs, Table 3 shows the current k_{eff} for each model, for similar operation configurations. These k_{eff} values are presented for informational purposes.

Table 1. In-Core Operation Metrics

Operation Type:	Pulse (Op # 21628) In-Core Characterization Foils
Event Time:	11:52:33 AM
ΔT (° Celsius):	169.7 (T1=236, T2=181.2, T3=185.2)
Period (s):	P1 = 22.470E-6 P2 = 22.530E-6
Reactivity:	6¢ experiment worth
Test Location:	In-core center/ 3.5” above bottom of core

Table 2. WSMR In-Core Model verification activation foil set

Activation Reaction	Half-Life	Activity (Bq/atom-iso)	Uncertainty (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$	70.83 d	2.4160E-18	4.4
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	44.495 d	1.9197E-17	7.4
$^{59}\text{Co}(n,2n)^{58}\text{Co}$	70.83 d	6.0294E-21	24.1
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	83.788 d	2.3490E-19	6.3
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	3.349 d	9.8741E-18	5.9
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	43.67 h	2.8024E-19	3.6

Table 3. MCNP and MERCURY model k_{eff} for WSMR core configurations.

Core Configuration	Rod Position (Rod Units - mils)	Model Information	k_{eff} (±)
Standard Model with an Empty Central Cavity, All Rods In	BR: Full-In CR 1: 2838 CR 2: 2800	SNL MCNP Model	1.00019 (± 0.00001)
		LANL MCNP Model	0.99957 (± 0.00001)
		LLNL MERCURY Model	1.00103 (± 0.00001)

4. SPECTRUM CHARACTERIZATION

4.1. Neutron

The neutron environment includes both prompt and delayed neutrons from the WSMR core. The neutron energy spectrum is first calculated using either MCNP or MERCURY and then a least-squares spectrum adjustment is performed using passive neutron activation dosimetry measurements to produce a “characterized” neutron spectrum. The process for determining a characterized neutron spectrum is to first generate an *a priori* 640-group and 89-group neutron energy trial spectra from the MCNP or MERCURY models presented in Section 2 at the 6-cm diameter tally sphere location. To provide reasonable statistics in all of the energy groups, each model was run on a parallel machine for 20 billion source neutrons. The 89-group neutron spectra result represents the trial function that is then adjusted using a least-squares-based unfolding code. For this work a total of 23 different dosimetry foil types, resulting in 35 different transmutation reactions, were irradiated at both the WSMR FBR 6-inch and 24-inch locations. The LSL-M3 code (Stallmann, 1985) and the IRDFF-II dosimetry cross sections (IRDFF, 2014; Capote, 2012; Zsolnay, 2012), were used in the unfolding analysis to determine the characterized neutron energy spectrum.

4.1.1. SNL MCNP Model Neutron Energy Spectra Results

The neutron energy spectrum was calculated for a 640-group and an 89-group energy structure using the MCNP model presented in Section 2 for the 6-cm diameter tally sphere. MCNP6.2 version was used with the ENDF/B-VIII.0 cross sections. The MCNP model with the free-field environment of WSMR is included in Appendix A of this report. Room temperature cross sections were used for the calculations. The model was run in the k-code mode using both neutrons and photons. This allowed for both the neutron energy spectra and the prompt gamma-ray energy spectrum to be generated in one run. The gamma-ray spectrum used a 48-group energy structure. To attain reasonable statistics in all the energy groups, the model was run on a parallel machine for 20 billion source neutrons. The results generated in the tally sphere were in units of neutron fluence per source neutron. These results were then converted to fluence per fission in a spreadsheet. The neutron fluence results were converted from fluence per fission to fluence per MJ of reactor power using 192.4 MeV per fission. This value represents the fission fragment, neutron, prompt gamma-ray, capture gamma-ray and delayed gamma-ray energy deposition in the reactor core per fission event. These energy deposition values were calculated using MCNP with the exception of the delayed gamma-ray energy, which was assumed to be the total delayed gamma energy of 6.33 MeV per fission as characterized in the ENDF/B-VIII.0 nuclear data file. The 89-group neutron energy spectrum result was used as the trial function for the LSL-M3 code.

Figure 12 and Figure 13 show the MCNP generated 640-group and 89-group neutron energy fluence at the 6-inch position on a linear and logarithmic y-axis, respectively. Figure 14 and Figure 15 show the MCNP generated 640-group and 89-group neutron energy fluence at the 24-inch position on a linear and logarithmic y-axis, respectively as well. The units on the y-axis are in lethargy fluence or energy fluence, equal to $E d\phi/dE$ (MeV/MeV-cm²-MJ). With the energy fluence represented linearly on the y-axis and the neutron energy on the x-axis represented logarithmically, the area under the curve represents the total neutron fluence. This representation allows for the best visual depiction of the fluence over the complete neutron energy range.

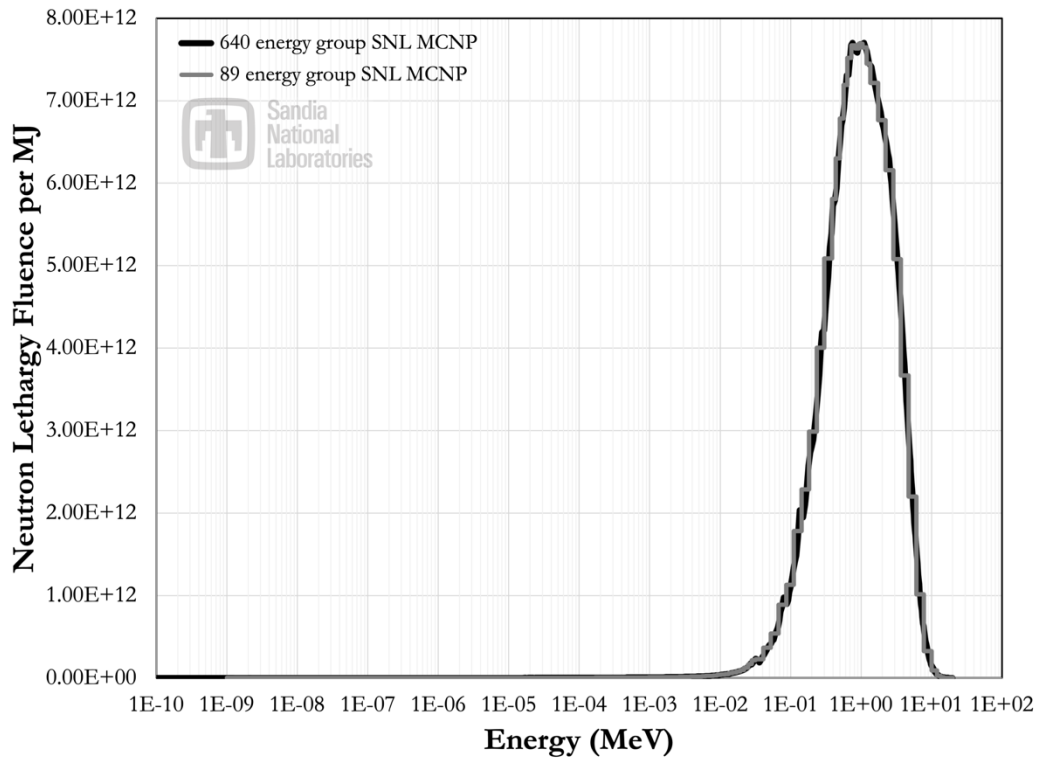


Figure 12. SNL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).

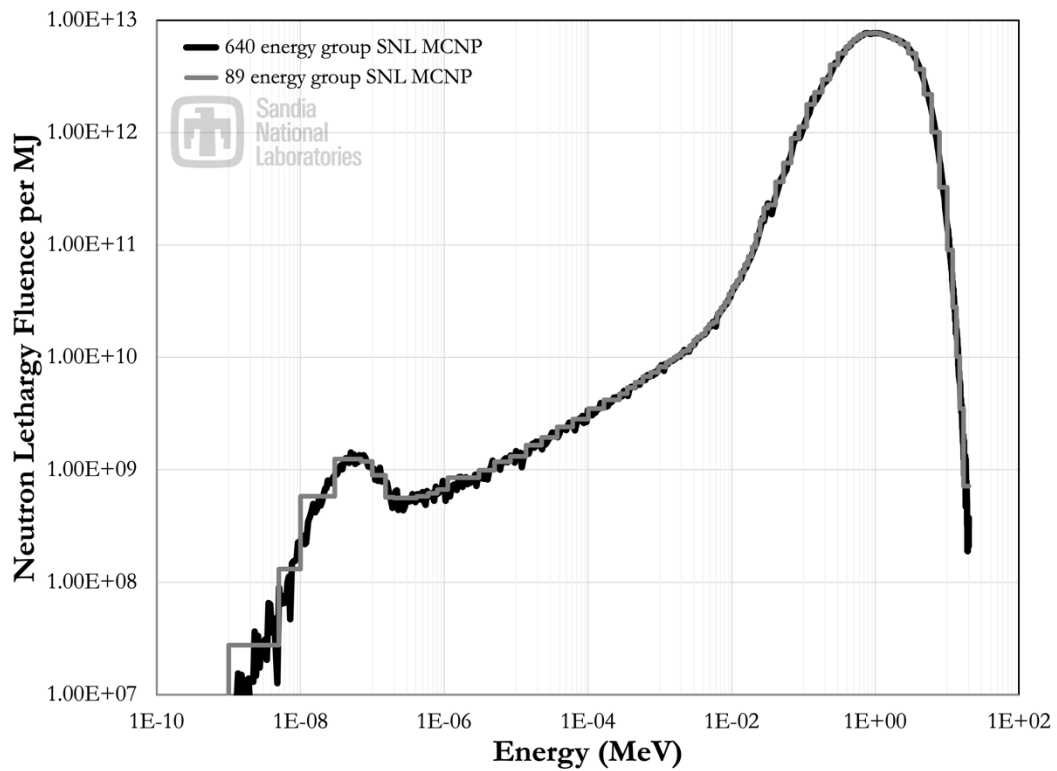


Figure 13. SNL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).

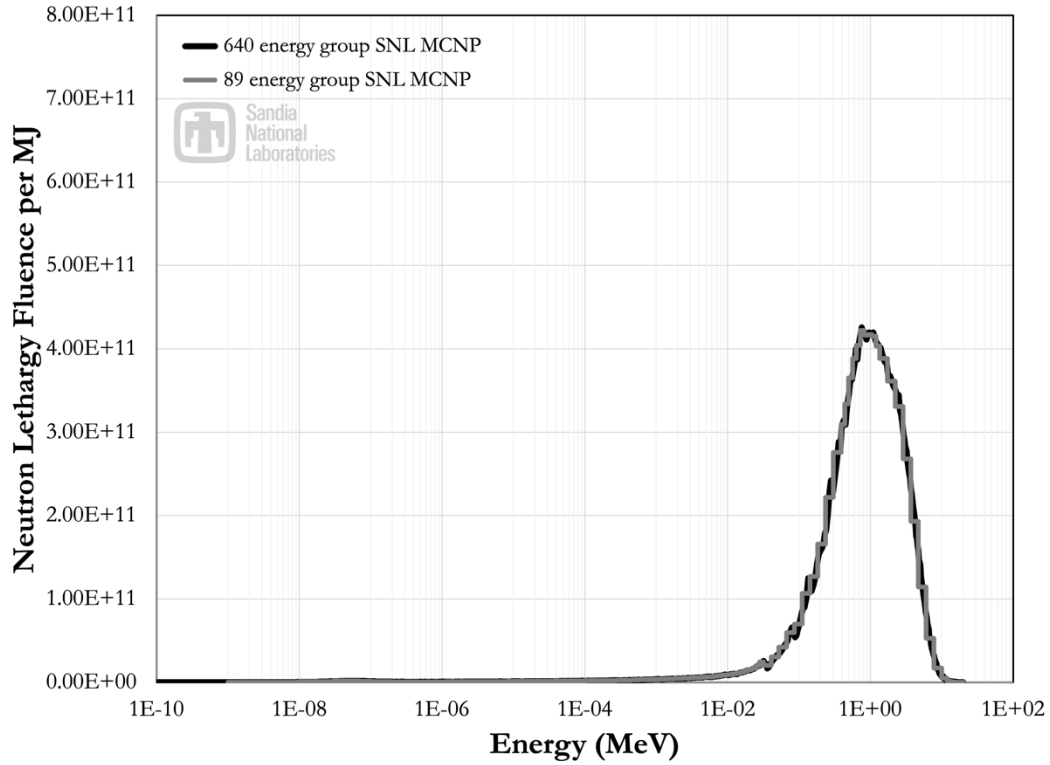


Figure 14. SNL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).

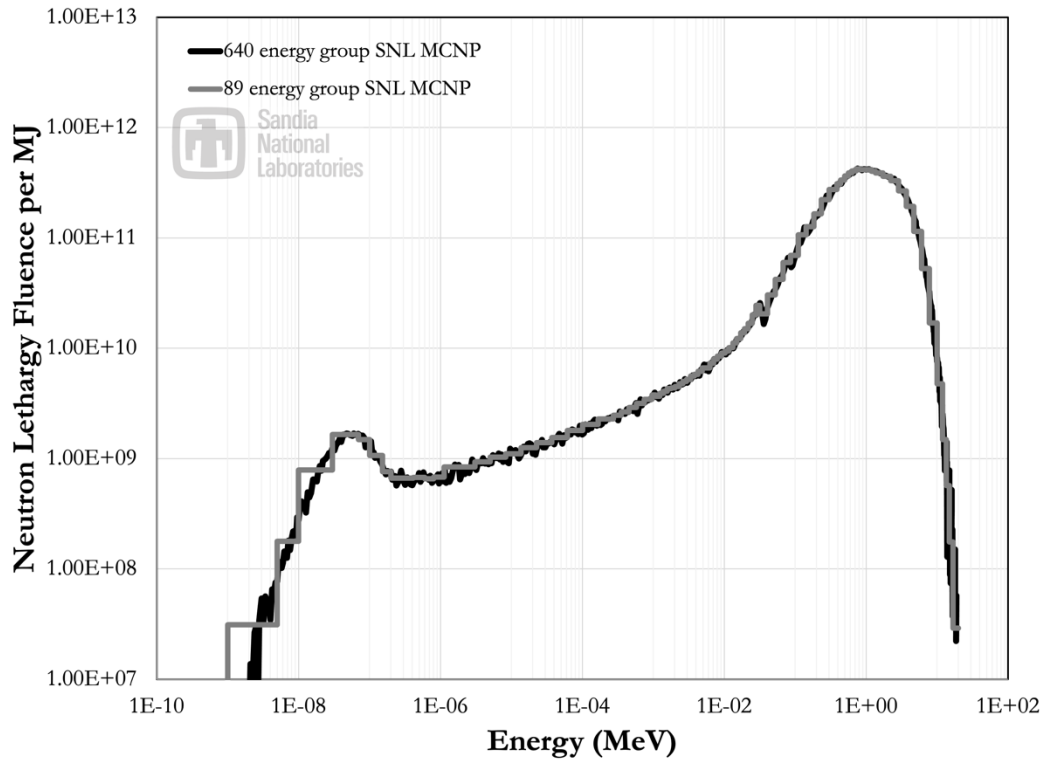


Figure 15. SNL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).

The energy fluence is found to peak near 1 MeV. The thermal peak occurs at ~ 0.07 eV ($7.0\text{E-}8$ MeV). The results for the 640-group and 89-group neutron energy fluence are in very close agreement, as expected. The 640-group energy fluence calculation shows higher fidelity in the spectrum, which is more notably observed in the energy range of $1\text{E-}4$ to 1 MeV. This structure is considered to be real and not an artifact of the code or cross section set. It is caused by resonances in the cross sections, especially from the oxygen elastic scattering cross section. The calculated standard deviation for each energy bin in the 640-group energy fluence in the energy range from 0.005 eV ($5.0\text{E-}9$ MeV) to 6 MeV is less than 1%. A similar but less resolved structure is also seen in the 89-group energy fluence. The 89-group energy structure is the energy grouping used in the NuGET code (DePriest, 2004).

4.1.2. LANL MCNP Model Neutron Energy Spectra Results

The neutron energy spectrum was calculated for a 640-group and an 89-group energy structure using the MCNP model presented in Section 2 for the 6-cm diameter tally sphere. MCNP6.3 Release Candidate version was used with the ENDF/B-VIII cross sections. The MCNP model with the free-field environment of WSMR is included in Appendix A of this report. Room temperature cross sections were used for the calculations. The model was run in the k-code mode using both neutrons and photons. This allowed for both the neutron energy spectra and the prompt gamma-ray energy spectrum to be generated in one run. The gamma-ray spectrum used a 48-group energy structure. In order to have reasonable statistics in all of the energy groups, the model was run on a parallel machine for 20 billion source neutrons. The results generated in the tally sphere were in units of neutron fluence per source neutron. These results were then converted to fluence per fission in a spreadsheet. The neutron fluence results were converted from fluence per fission to fluence per MJ of reactor power using 192.4 MeV per fission. This value represents the fission fragment, neutron, prompt gamma-ray, capture gamma-ray and delayed gamma-ray energy deposition in the reactor core and surrounding water, per fission event. These energy deposition values were calculated using MCNP with the exception of the delayed gamma-ray energy, which was assumed to be the total delayed gamma energy of 6.33 MeV per fission as characterized in the ENDF/B-VIII nuclear data file. The 89-group neutron energy spectrum result was used as the trial function for the LSL-M3 code.

Figure 16 and Figure 17 show the MCNP generated 640-group and 89-group neutron energy fluence at the 6-inch position on a linear and logarithmic y-axis, respectively. Figure 18 and Figure 19 show the MCNP generated 640-group and 89-group neutron energy fluence at the 24-inch position on a linear and logarithmic y-axis, respectively as well. The units on the y-axis are in lethargy fluence or energy fluence, equal to $E d\Phi/dE$ ($\text{MeV}/\text{MeV-cm}^2\text{-MJ}$). With the energy fluence represented linearly on the y-axis and the neutron energy on the x-axis represented logarithmically, the area under the curve represents the total neutron fluence. This representation allows for the best visual depiction of the fluence over the complete neutron energy range.

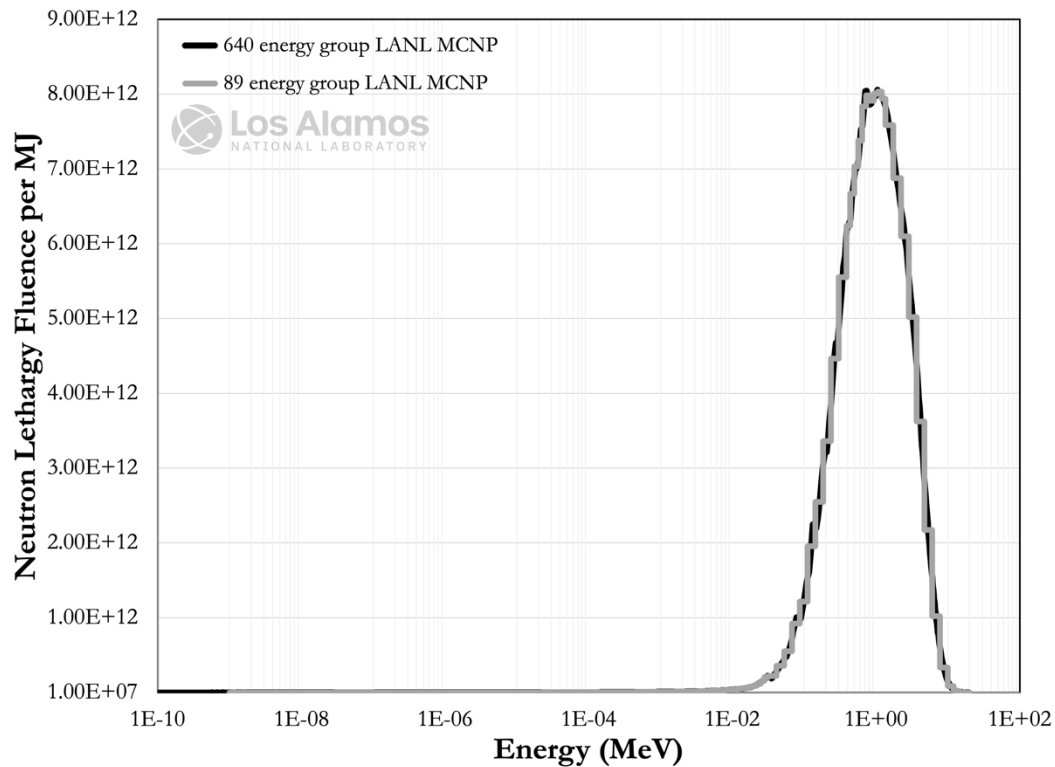


Figure 16. LANL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).

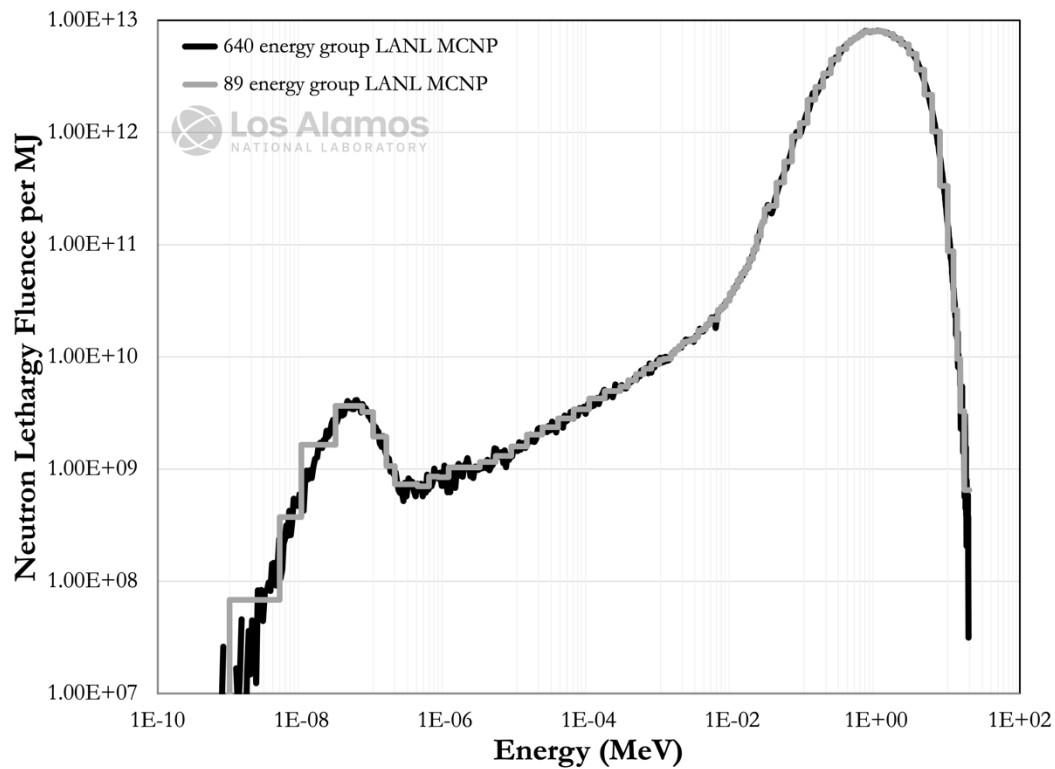


Figure 17. LANL WSMR 6-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).

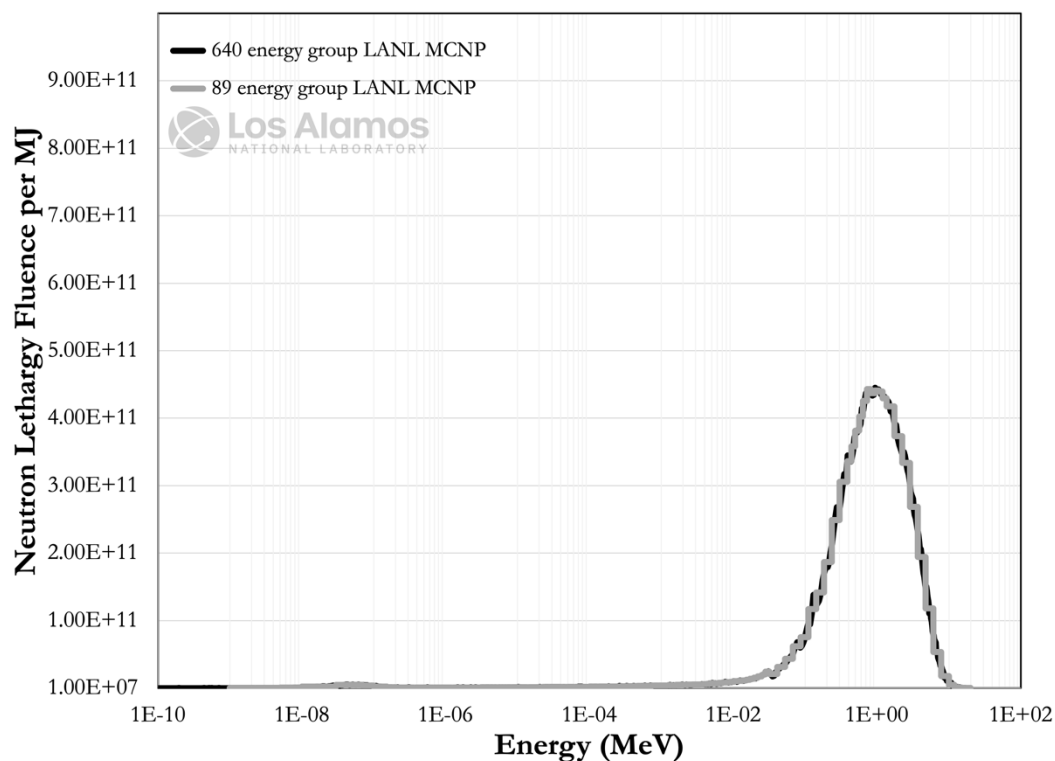


Figure 18. LANL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).

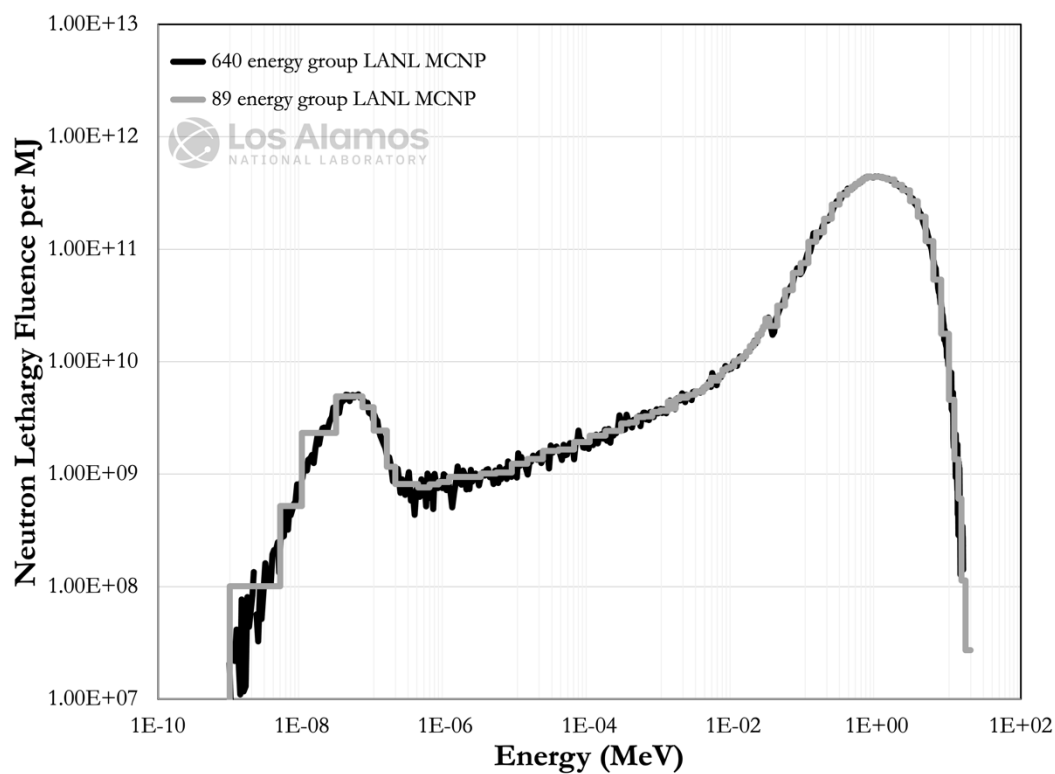


Figure 19. LANL WSMR 24-inch Irradiation Location- MCNP 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).

The energy fluence is found to peak near 1 MeV. The thermal peak occurs at ~ 0.07 eV ($7.0\text{E-}8$ MeV). The results for the 640-group and 89-group neutron energy fluence are in very close agreement, as expected. The 640-group energy fluence calculation shows higher fidelity in the spectrum, which is more notably observed in the energy range of $1\text{E-}4$ to 1 MeV. This structure is considered to be real and not an artifact of the code or cross section set. It is caused by resonances in the cross sections, especially from the oxygen elastic scattering cross section. The calculated standard deviation for each energy bin in the 640-group energy fluence in the energy range from 0.005 eV ($5.0\text{E-}9$ MeV) to 6 MeV is less than 1%. A similar but less resolved structure is also seen in the 89-group energy fluence. The 89-group energy structure is the energy grouping used in the NuGET code (DePriest, 2004).

4.1.3. LLNL MERCURY Model Neutron Energy Spectra Results

The neutron energy spectrum was calculated for a 640-group and an 89-group energy structure using the MERCURY model presented in Section 2 for the 6-cm diameter tally sphere. MERCURY version 1.60 was used with the ENDL2009.4 cross sections. The MERCURY model of the free-field environment of WSMR is not released in this report. MERCURY is a LLNL proprietary software. Requests for the MERCURY WSMR FBR model should be made directly to the LLNL report author. Room temperature cross sections were used for the calculations. The model was run in the static k mode using both neutrons and photons. This allowed for both the neutron energy spectra and the prompt gamma-ray energy spectrum to be generated in one run. The gamma-ray spectrum used a 48-group energy structure. To attain reasonable statistics in all of the energy groups, the model was run on a parallel machine for 20 billion source neutrons. The results generated in the tally sphere were in units of neutron fluence per source neutron. These results were then converted to fluence per fission in a spreadsheet. The neutron fluence results were converted from fluence per fission to fluence per MJ of reactor power using 192.4 MeV per fission. This value represents the fission fragment, neutron, prompt gamma-ray, capture gamma-ray and delayed gamma-ray energy deposition in the reactor core and surrounding water, per fission event. The 89-group neutron energy spectrum result was used as the trial function for the LSL-M3 code.

Figure 20 and Figure 21 show the MERCURY generated 640-group and 89-group neutron energy fluence at the 6-inch position on a linear and logarithmic y-axis, respectively. Figure 22 and Figure 23 show the MERCURY generated 640-group and 89-group neutron energy fluence at the 24-inch position on a linear and logarithmic y-axis, respectively as well. The units on the y-axis are in lethargy fluence or energy fluence, equal to $E d\phi/dE$ (MeV/MeV-cm²-MJ). With the energy fluence represented linearly on the y-axis and the neutron energy on the x-axis represented logarithmically, the area under the curve represents the total neutron fluence. This representation allows for the best visual depiction of the fluence over the complete neutron energy range.

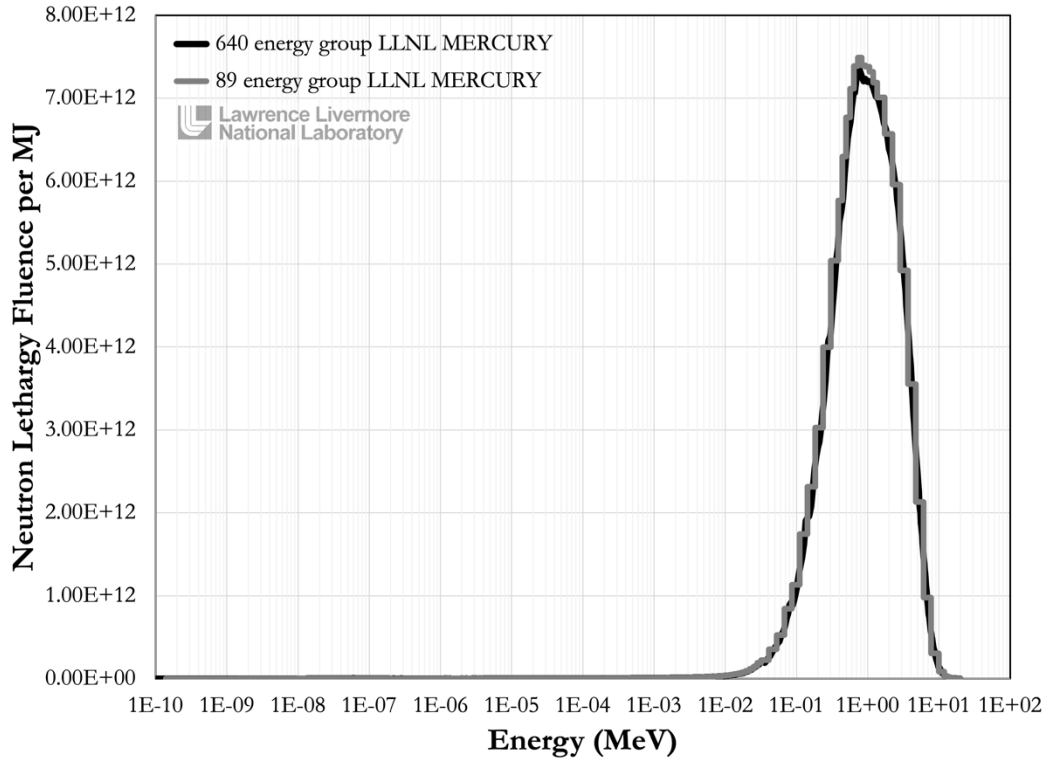


Figure 20. LLNL WSMR 6-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).

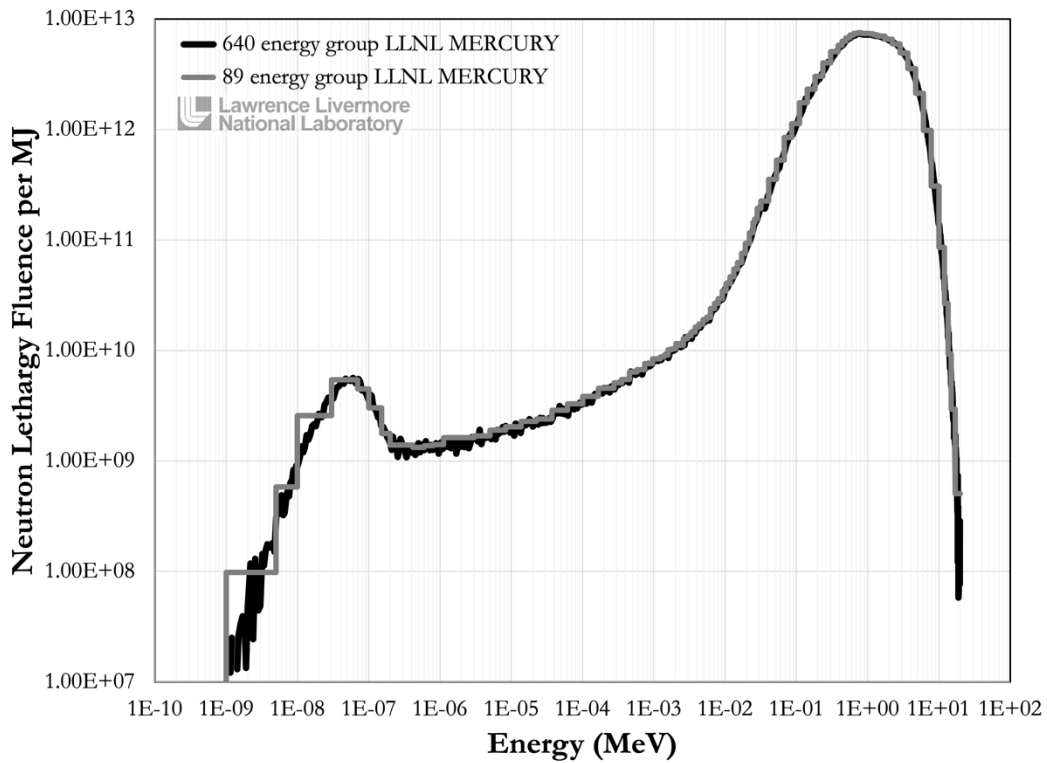


Figure 21. LLNL WSMR 6-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).

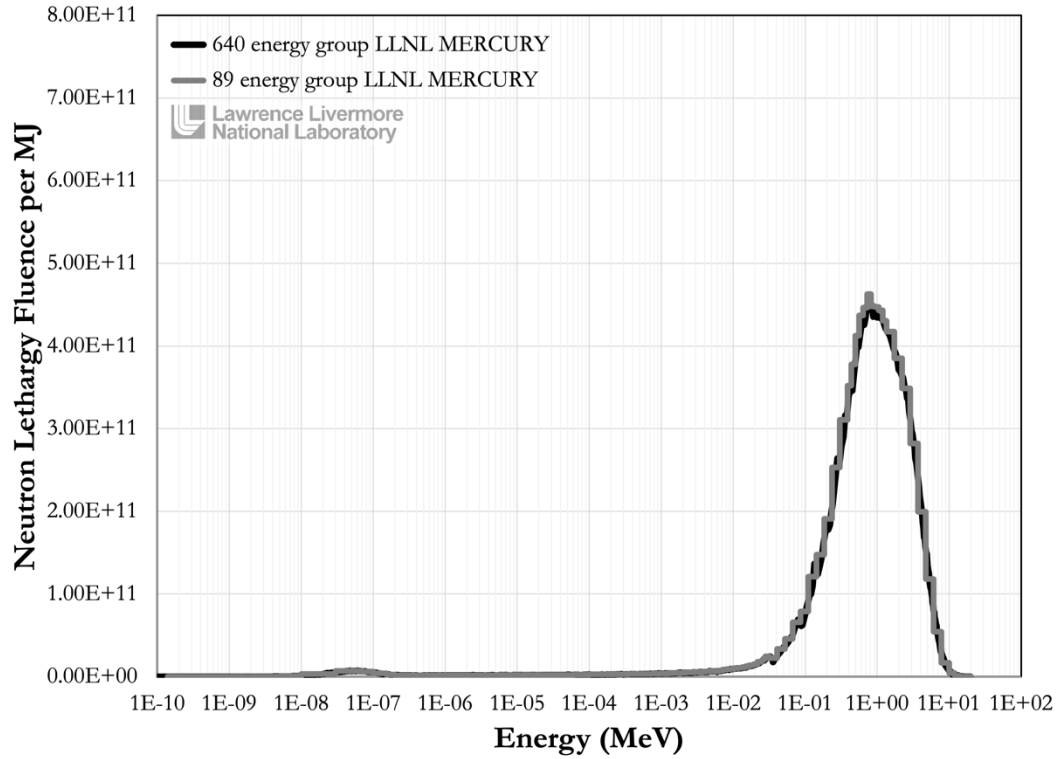


Figure 22. LLNL WSMR 24-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (linear-log).

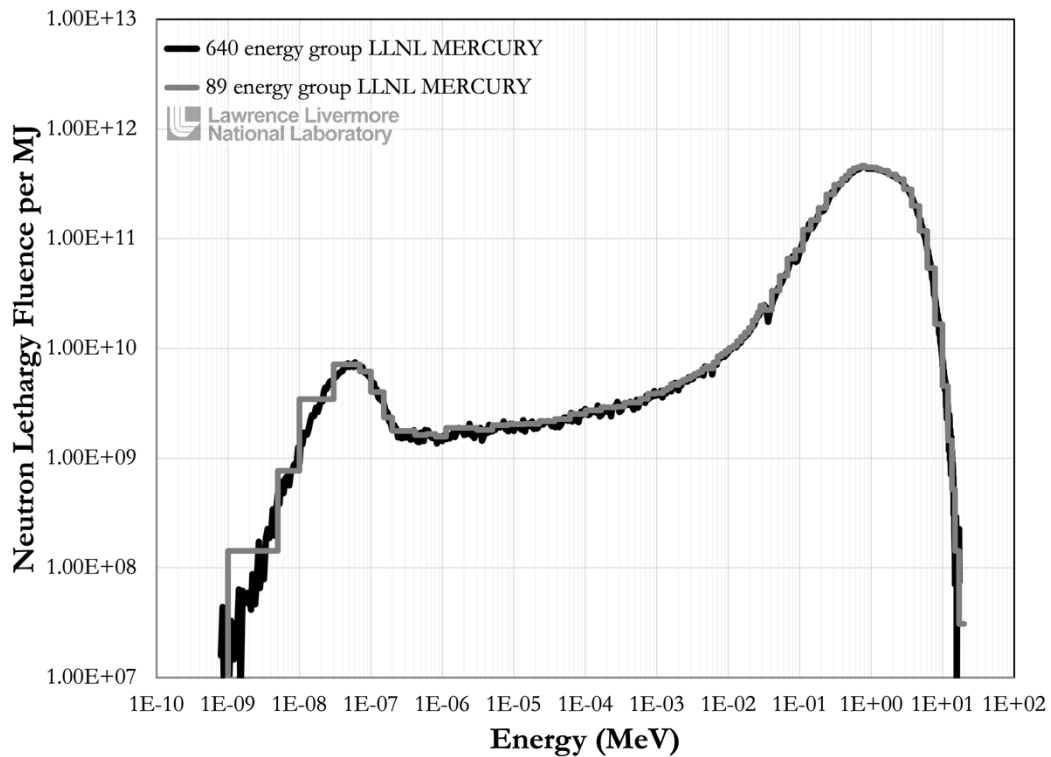


Figure 23. LLNL WSMR 24-inch Irradiation Location- MERCURY 640-Group and 89-Group Neutron Lethargy Fluence Energy Spectra (log-log).

The energy fluence is found to peak near 1 MeV. The thermal peak occurs at ~ 0.07 eV ($7.0\text{E-}8$ MeV). The results for the 640-group and 89-group neutron energy fluence are in very close agreement, as expected. The 640-group energy fluence calculation shows higher fidelity in the spectrum, which is more notably observed in the energy range of $1\text{E-}4$ to 1 MeV. This structure is considered to be real and not an artifact of the code or cross section set. It is caused by resonances in the cross sections, especially from the oxygen elastic scattering cross section. The calculated standard deviation for each energy bin in the 640-group energy fluence in the energy range from 0.005 eV ($5.0\text{E-}9$ MeV) to 6 MeV is less than 1%. A similar but less resolved structure is also seen in the 89-group energy fluence. The 89-group energy structure is the energy grouping used in the NuGET code (DePriest, 2004).

4.2. Dosimetry Foils

The results of the MCNP and MERCURY calculations of the WSMR environment represent a good initial representation for the neutron spectrum characterization. However, a considerable uncertainty in the results can exist due to model representation uncertainty (geometry, density, and composition) and uncertainty in the transport cross sections. An improved spectrum can be obtained by combining this initial trial spectrum with measured integral values that correspond to the reactions rates from high-fidelity passive dosimetry reactions. The resulting least-squares or genetic algorithm adjusted neutron fluence spectrum includes an energy-dependent uncertainty. The spectrum can then be considered “characterized,” in that it quantifies the “true” neutron-fluence energy spectrum with a stated accuracy, including energy dependent uncertainties and a covariance matrix. If the least-squares spectrum is found to have inconsistent inputs in comparing the MCNP *a priori* trial spectrum and the measured dosimetry results, as determined by a measure of the chi-squared per degree of freedom (χ^2/dof) in the spectrum adjustment, the dosimetry measurements would be reexamined and/or the MCNP or MERCURY models for the WSMR would be reexamined and modified or modeled with greater fidelity. In addition to the adjusted neutron spectrum, uncertainty and covariance results are found from the least-squares analysis using the LSL-M3 code, a modified version of the LSL-M2 code. The characterized neutron spectrum can be used, with the corresponding uncertainty values and the correlation matrix, to support the evaluation of various damage and dose metrics relevant to users of the WSMR environment. The characterized spectrum can be used directly by the NuGET code or as an isotropic shell source in MCNP or MERCURY to calculate the radiation internal to a complex test object. For this work, the LSL-M3 code was used to generate an 89-group neutron energy spectrum that is used in the NuGET code.

The selection of passive dosimetry foils and activation reactions has been studied and evaluated over many years. A summary of the work can be found in ASTM E720, Griffin (2011a), Griffin (2011b) and references therein. No complete and perfect set of activation reactions exists that allows the neutron fluence energy spectrum to be calculated by dosimetry alone. However, there are enough reactions to cover the relevant energy range with high-fidelity dosimetry cross sections to allow for adjusted neutron fluence results to be generated with a quantified accuracy. The passive dosimetry foils and the associated neutron activation reactions used to perform the neutron fluence characterization for the WSMR 6-inch and 24-inch environments are shown in Table 4 and

Table 5.

The foils and activation reactions chosen for the analysis represent expert judgment and references to previous work. A complete set of dosimetry foils and reaction data will vary for a given neutron environment being characterized. Typically, neutron activation resulting in the emission of protons (n,p), neutrons ($n,2n$), (n,n'), or alpha particles (n,α) represent high neutron-energy reactions of 1 MeV or greater. Neutron activation resulting in prompt gamma-ray emission from radiative capture (n,γ) or fission reactions determine the shape of the thermal and epithermal region of the neutron spectrum. Covering foils with cadmium (Cd) and/or boron (B) can allow for resonances above the associated cutoff energies to become more prominent, allowing for additional integral quantities to be included in the analysis. Typically, only thermal activation or fission foils are covered in Cd or B.

A total of 23 different foil types, resulting in 35 different reactions, were irradiated. The three fission foils (U-235, U-238, and Np-237) were irradiated individually in a bare or cadmium cup configuration in a single 24MJ steady-state operation. The Pu-239 foil is an activity used from a historic dosimetry set, that was characterized and run with a nickel foil for tracking purposes. This historic activity was nickel corrected to match the 24MJ steady-state operation. In both Table 4 and

Table 5, the twelve light-gray colored reactions correspond to reactions that had no detector response. The single dark gray colored reaction in both tables corresponds to reactions that were not used in the analysis due to significant inconsistencies in the spectrum adjustment process. It is unsure currently if there are problems in the measurement technique for these reactions or if there are issues with the dosimetry cross section or self-shield treatment.

Table 4. Neutron Activation Dosimetry Used for WSMR 6-inch

Activation Reaction	Half-Life	Activity (Bq/atom-iso)	Uncertainty (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ - Reference	70.83 d	1.9087E-18	4.4
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	14.957 h *	2.8766E-18	4.9
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	14.957 h *	1.4702E-18	3.4
$^{32}\text{S}(n,p)^{32}\text{P}$ Cf-equ	14.284 d	2.79E+14 n/cm ²	4.0
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	83.788 d	1.7612E-19	6.2
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	3.349 d	7.5729E-18	6.0
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	43.67 h	1.5860E-16	2.7
$^{55}\text{Mn}(n,2n)^{54}\text{Mn}$	312.3 d	----	----
$^{54}\text{Fe}(n,p)^{54}\text{Mn}$	312.3 d	----	----
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	2.579 h *	1.0830E-17	4.2
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	44.495 d	3.6730E-20	4.4
$^{59}\text{Co}(n,2n)^{58}\text{Co}$	70.83 d	3.7520E-21	9.5
$^{58}\text{Ni}(n,2n)^{57}\text{Ni}$	35.9 h	----	----
$^{60}\text{Ni}(n,p)^{60}\text{Co}$	1925.27 d	----	----
$^{63}\text{Cu}(n,\alpha)^{60}\text{Co}$	1925.27 d	----	----
$^{64}\text{Zn}(n,p)^{64}\text{Cu}$	12.701 h *	8.6240E-17	6.0
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	10.15 d	5.9710E-20	4.5
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	4.486 h *	1.3570E-15	9.2
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	14.957 h *	1.6780E-18	4.5
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$	83.788 d	----	----
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$	2.579 h *	1.6170E-16	3.9
$^{58}\text{Fe}(n,\gamma)^{59}\text{Fe}$	44.495 d	----	----
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	1925.27 d	2.4490E-20	3.3
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	12.701 h *	7.4980E-17	10.1
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	2.748 d	2.3590E-17	2.8
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	249.78 d	1.4770E-19	1.8
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	14.2 s **	1.1540E-14	2.2
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	23.72 h *	1.5860E-16	2.3
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	14.957 h *	1.4760E-18	4.7
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$ - Cd	83.788 d	5.4897E-19	7.2
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$ - Cd	2.579 h *	----	----
$^{58}\text{Fe}(n,\gamma)^{59}\text{Fe}$ - Cd	44.495 d	----	----
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$ - Cd	1925.27 d	----	----
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$ - Cd	12.701 h *	----	----
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	2.748 d	2.3290E-17	2.5
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	249.78 d	1.2980E-19	1.9
$^{115}\text{In}(n,\gamma)^{116}\text{In}$ - Cd	14.2 s **	----	----
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	23.72 h *	1.4420E-16	2.3
$^{235}\text{U}(n,f)\text{FP}$ - bare	^{140}Ba - 12.752 d	3.1810E-10	3.1
$^{238}\text{U}(n,f)\text{FP}$ - bare	^{140}Ba - 12.752 d	4.7620E-11	3.1
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	^{140}Ba - 12.752 d	3.4401E-10	11.3
$^{237}\text{Np}(n,f)\text{FP}$ - bare	^{140}Ba - 12.752 d	2.5610E-10	3.0

* half life less than one day
 ** half life less than one hour
 #fiss = units are fissions per atom isotope
 Cd = foil is located within a standard Cd cup
 Reference – all foil activities are normalized to a $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity for each irradiation

Table 5. Neutron Activation Dosimetry Used for WSMR 24-inch

Activation Reaction	Half-Life	Activity (Bq/atom-iso)	Uncertainty (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ – Reference	70.83 d	1.9820E-19	4.5
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	14.957 h *	2.9206E-19	7.1
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	14.957 h *	1.3960E-19	9.3
$^{32}\text{S}(n,p)^{32}\text{P}$ Cf-equ	14.284 d	5.64E+12 n/cm ²	5.1
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	83.788 d	1.3660E-20	23.4
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	3.349 d	7.4110E-19	5.6
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	43.67 h	2.0190E-20	5.0
$^{55}\text{Mn}(n,2n)^{54}\text{Mn}$	312.3 d	----	----
$^{54}\text{Fe}(n,p)^{54}\text{Mn}$	312.3 d	----	----
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	2.579 h *	1.1640E-18	4.6
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	44.495 d	5.2040E-21	10.1
$^{59}\text{Co}(n,2n)^{58}\text{Co}$	70.83 d	----	----
$^{58}\text{Ni}(n,2n)^{57}\text{Ni}$	35.9 h	----	----
$^{60}\text{Ni}(n,p)^{60}\text{Co}$	1925.27 d	----	----
$^{63}\text{Cu}(n,\alpha)^{60}\text{Co}$	1925.27 d	----	----
$^{64}\text{Zn}(n,p)^{64}\text{Cu}$	12.701 h *	8.7503E-18	11.1
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	10.15 d	6.1320E-21	9.3
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	4.486 h *	1.4690E-16	9.3
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	14.957 h *	1.1980E-18	4.5
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$	83.788 d	3.8230E-19	9.3
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$	2.579 h *	1.9270E-16	3.9
$^{58}\text{Fe}(n,\gamma)^{59}\text{Fe}$	44.495 d	----	----
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	1925.27 d	2.3950E-20	3.4
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	12.701 h *	1.7920E-17	17.8
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	2.748 d	3.9460E-18	3.3
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	249.78 d	5.4720E-20	3.1
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	14.2 s **	9.7990E-15	2.2
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	23.72 h *	1.4560E-16	2.2
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	14.957 h *	3.1570E-19	5.0
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$ - Cd	83.788 d	----	----
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$ - Cd	2.579 h *	----	----
$^{58}\text{Fe}(n,\gamma)^{59}\text{Fe}$ - Cd	44.495 d	----	----
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$ - Cd	1925.27 d	----	----
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$ - Cd	12.701 h *	----	----
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	2.748 d	3.5420E-18	3.0
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	249.78 d	3.7920E-20	3.3
$^{115}\text{In}(n,\gamma)^{116}\text{In}$ -Cd	14.2 s **	9.7990E-15	2.2
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	23.72 h *	9.3120E-17	2.4
$^{235}\text{U}(n,f)\text{FP}$ – bare	^{140}Ba - 12.752 d	3.3030E-11	3.1
$^{238}\text{U}(n,f)\text{FP}$ – bare	^{140}Ba - 12.752 d	4.9440E-12	3.1
$^{239}\text{Pu}(n,f)\text{FP}$ – bare	^{140}Ba - 12.752 d	3.5740E-11	11.5
$^{237}\text{Np}(n,f)\text{FP}$ – bare	^{140}Ba - 12.752 d	2.6590E-11	3.0

* half life less than one day
 ** half life less than one hour
 #fiss = units are fissions per atom isotope
 Cd = foil is located within a standard Cd cup
 Reference – all foil activities are normalized to a $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity for each irradiation

The free-field environment was used to perform all the foil irradiations identified in Table 4 and Table 5. High variation in the flux was found radially and axially within the reactor cell. However, there exists a test region where the neutron fluence varies $\pm 5\%$, this is highlighted (yellow) section noted on the curved plates in Figure 24. Additional uncertainty in the analysis was included to account for possible variation due to geometry effects.

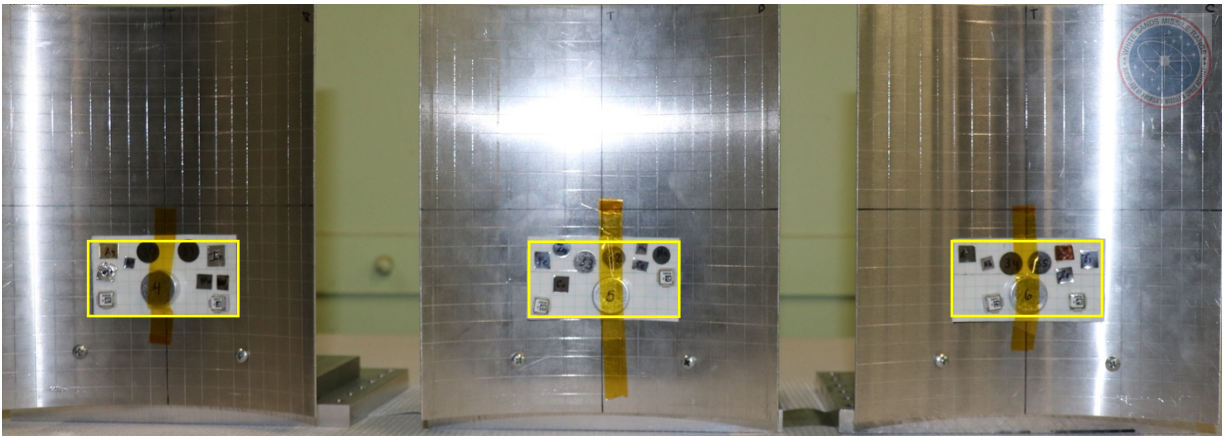


Figure 24. Typical Dosimetry Foils – Characterization Test Setup

The free-field environment requires adequate coverage of the thermal, epithermal, and high-energy neutron reactions in order to perform a successful adjustment to the neutron fluence energy spectrum. Cd covers are used to discriminate energy regions in some reactions. Both Table 4 and

Table 5 show each activation reaction used in either the 6-inch and 24-inch analysis, as well as the half-life for the transmuted isotope, the measured activity decay corrected to the end of the irradiation, and the counting uncertainty. The reactions are grouped in order of reaction type. The first group represents the high-energy (n,p), (n,2n), (n,n') and (n, α) reactions. The second group represents the low-energy radiative capture reactions for bare foils. The third group represents the radiative capture reactions with each individual foil placed in a cadmium cover. The fourth group represents the fission foils. Reactions identified with a dark-gray colored box represent reactions that were not used in the final spectrum adjustment due to inconsistencies in the results.

4.3. LSL Spectrum Unfold Results

LSL-M3 was run using the *a priori* 640-group neutron energy trial spectrum from MCNP converted to the NuGET 89-group energy structure, and the dosimetry data presented in Table 4 and Table 5. Also required in the analysis was an initial uncertainty estimate in the neutron spectrum as a function of energy, an initial energy-dependent correlation matrix, the energy dependent self-shielding factors, and the dosimetry cross section library that also included uncertainties and covariance matrices. The input decks used for the LSL calculations is included in Appendices C, D, and E of this report. In addition to the counting uncertainty, an additional 2% uncertainty was included for the foils

to address uncertainty contributions due to positioning and possible geometrical effects in the central region of the core. The output was in the 89-group NuGET format described earlier.

Figure 25 and Figure 26 show the dosimetry foil relative reaction probabilities as a function of energy from the LSL analysis. Each relative reaction probability sums to 100%. It is desirable to have diverse coverage over the complete neutron spectrum energy range. Peaks represent areas of higher probability that allow for energy discrimination in the analysis. Figure 25 shows all of the reactions used in the analysis at the 6-inch position, and Figure 26 shows the same information for the 24-inch position.

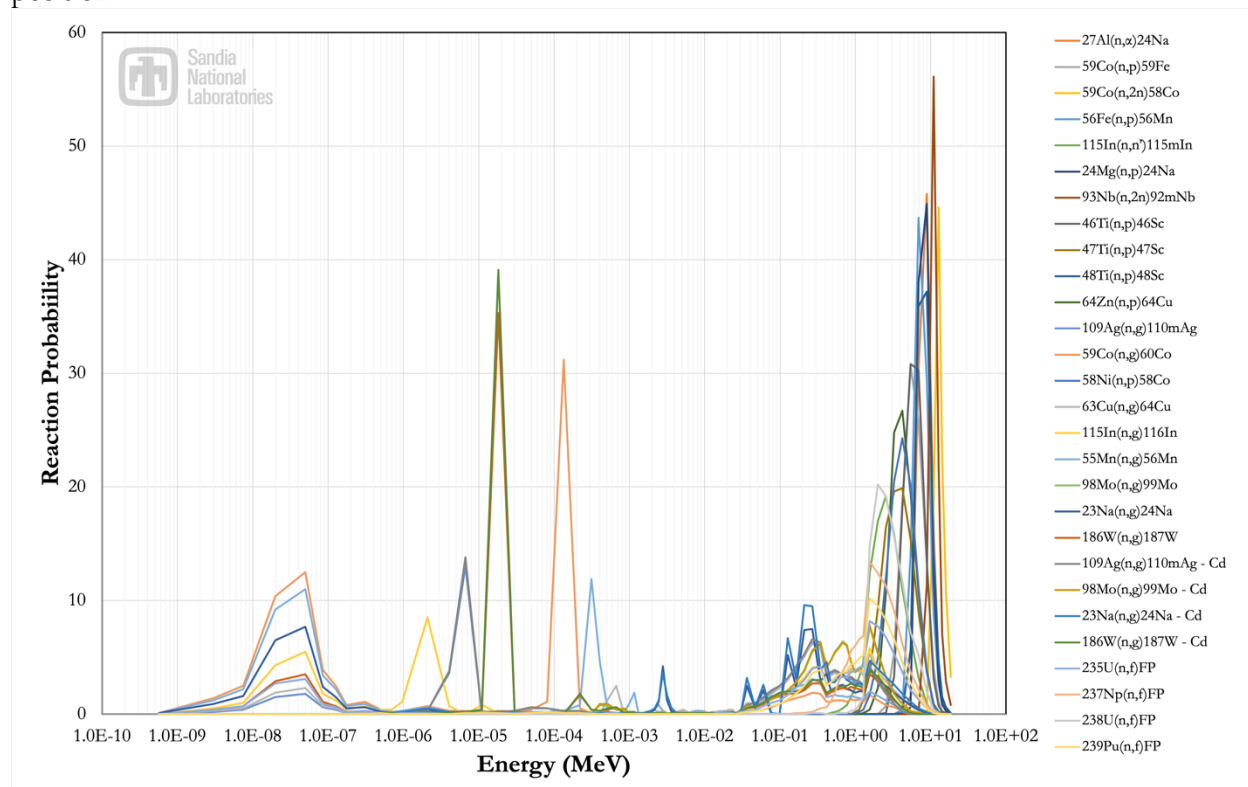


Figure 25. WSMR 6-inch - Relative Reaction Probabilities for the Complete Dosimetry Reaction Set.

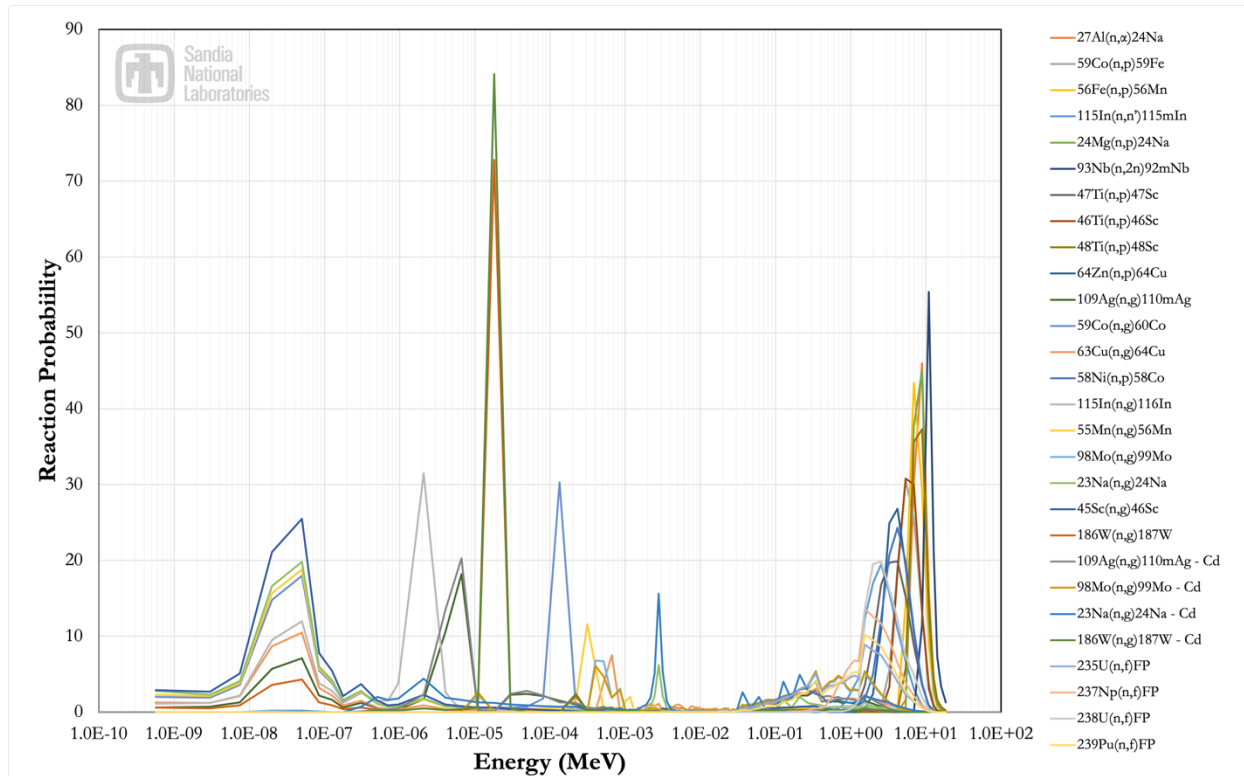


Figure 26. WSMR 24-inch - Relative Reaction Probabilities for the Complete Dosimetry Reaction Set.

4.3.1. SNL LSL Spectrum Results

The resulting values for χ^2/dof are 0.74 and 0.82, for the 6-inch and 24-inch spectra, respectively. Both χ^2/dof results represent highly acceptable values. Figure 27 and Figure 28 for the 6-inch location and Figure 29 and Figure 30 for the 24-inch location show the same representation of the neutron energy spectra as previously shown in Figure 12 and Figure 13 for 6-inch location and Figure 14 and Figure 15 for the 24-inch location, with the additional 89-group adjusted spectrum result from the LSL analysis (blue curve). Figure 31 for the 6-inch location and Figure 32 for the 24-inch location shows the percent adjustment made to the trial spectrum (black curve), and the percent standard deviation in the adjusted spectrum (purple curve). The adjusted neutron fluence in Figure 28 and Figure 30 shows very close agreement to that calculated using the MCNP model.

Table 6 for the 6-inch location and Table 7 for the 24-inch location shows the result of the calculated to experimental (C/E) dosimetry results for the trial spectrum and the adjusted spectrum. Also shown is the factor adjusted from the trial spectrum to the adjusted spectrum for the dosimetry reactions. For the high-energy reactions, the C/E-1 values are found to be both positive and negative for the trial spectrum and are reduced for the adjusted spectrum. For the radiative capture reactions, the C/E-1 values are all negative for the trial spectrum. This infers that the thermal/epithermal calculated fluence is too low. After the adjustment, the results become much closer to zero for C/E-1.

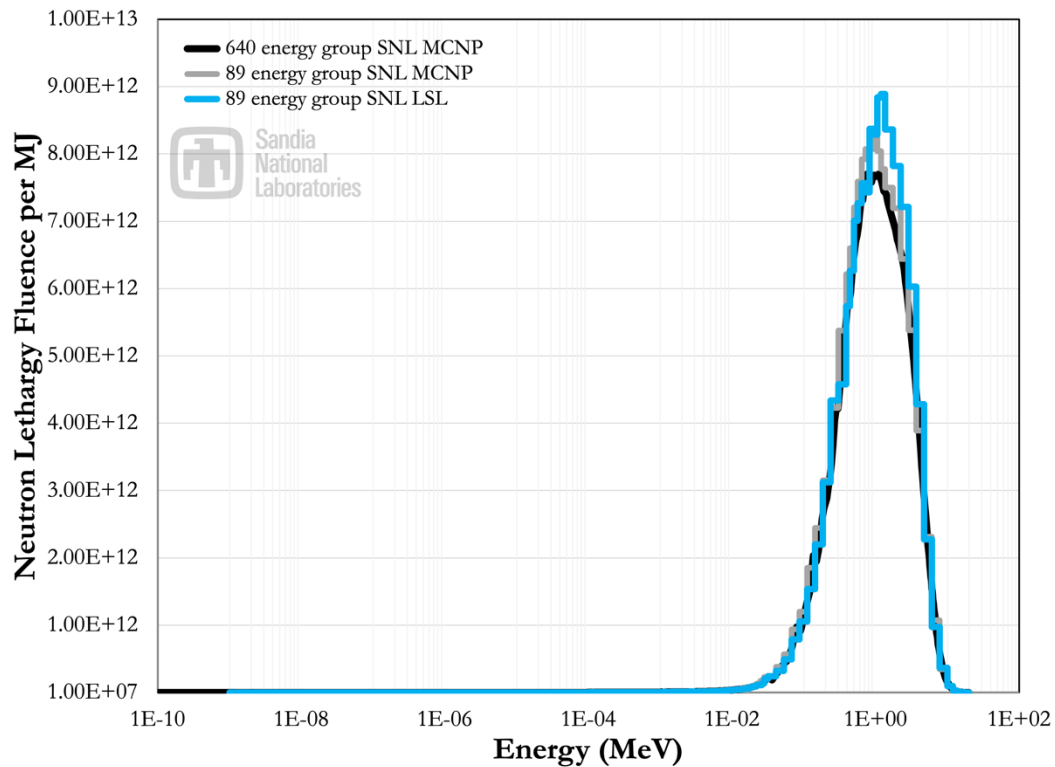


Figure 27. WSMR 6-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).

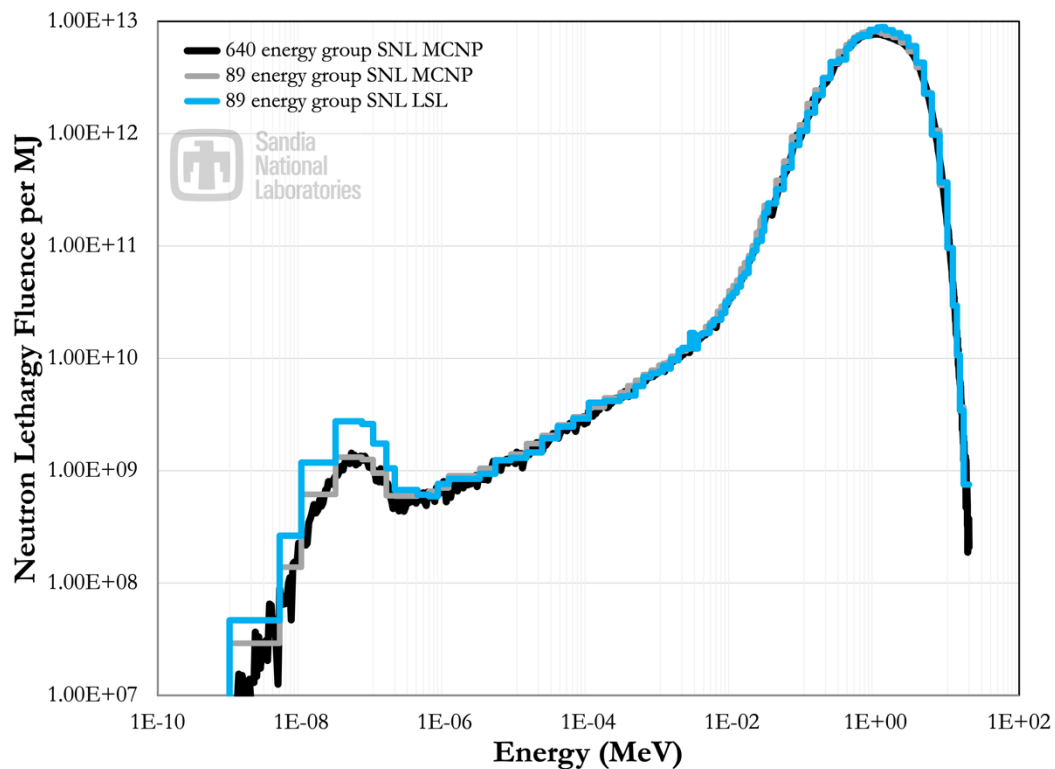


Figure 28. WSMR 6-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).

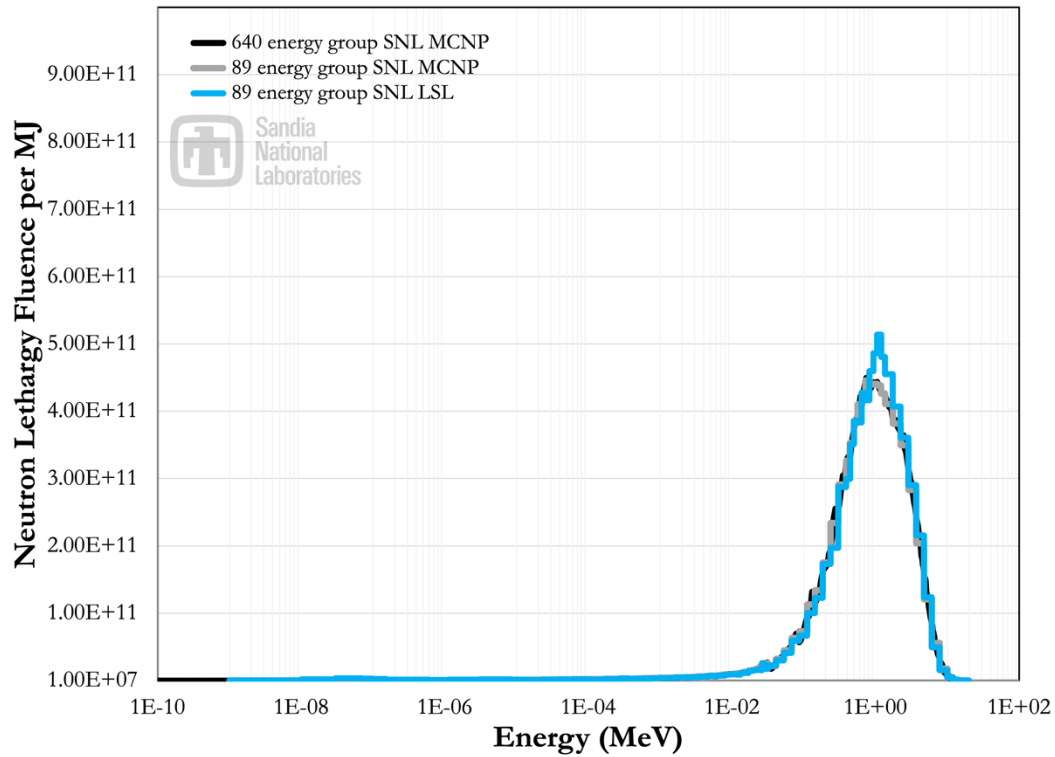


Figure 29. WSMR 24-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).

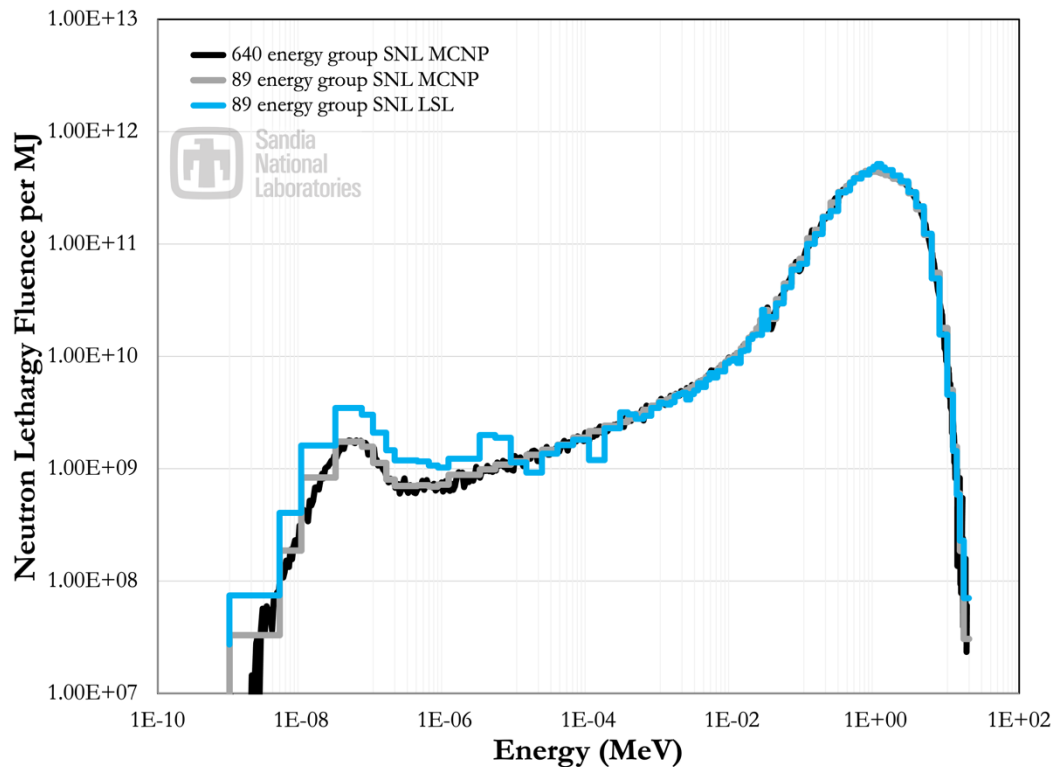


Figure 30. WSMR 24-inch – SNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).

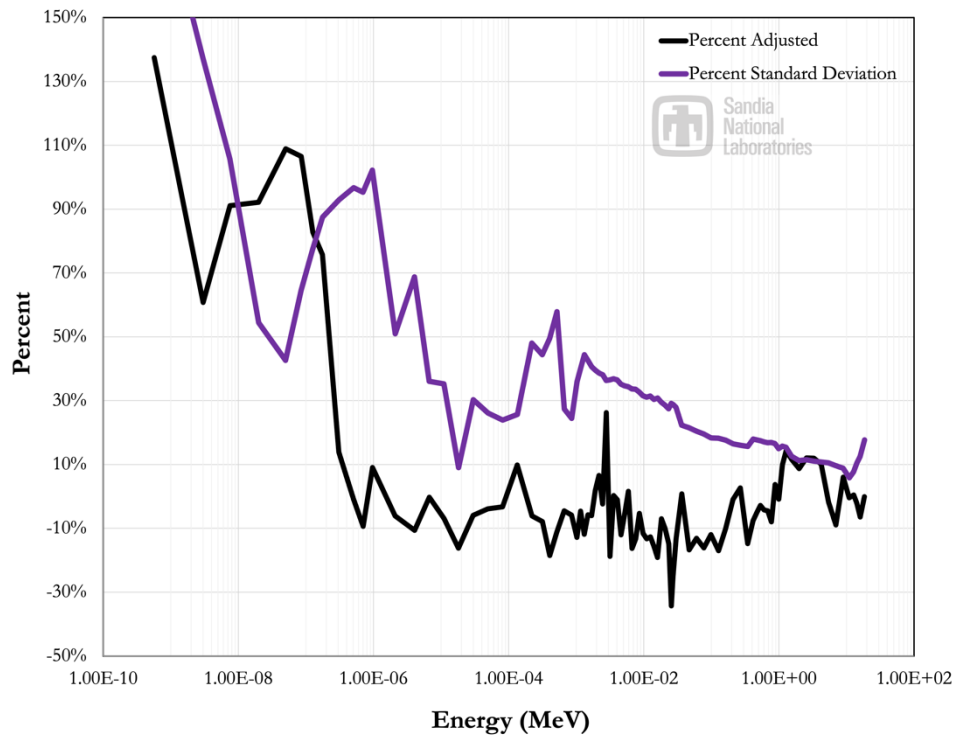


Figure 31. WSMR 6-inch – SNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.

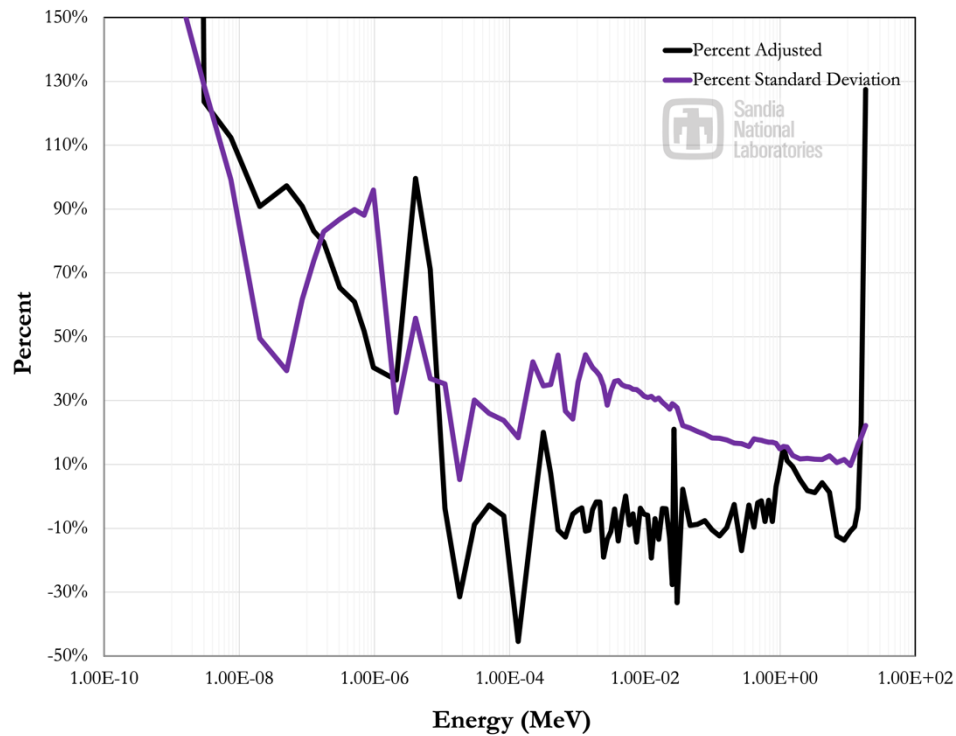


Figure 32. WSMR 24-inch – SNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum

Table 6. WSMR 6-inch - C/E Values for the Trial and Adjusted SNL LSL Neutron Energy Spectrum.

Activation Reaction	C/E-1 Trial Spectrum (%)	C/E-1 Adjusted Spectrum (%)	Factor Adjusted (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ - Reference	0.00	0.20	0.00
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	9.75	2.40	8.88
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	4.36	-2.30	4.18
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	-1.14	-7.00	-1.15
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	-10.71	-9.40	-11.99
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	2.47	-3.10	2.41
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	19.47	9.10	16.30
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	8.12	2.40	7.51
$^{59}\text{Co}(n,2n)^{58}\text{Co}$	12.35	2.70	10.99
$^{64}\text{Zn}(n,p)^{64}\text{Cu}$	3.45	3.90	3.33
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	7.31	0.30	6.81
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	0.10	2.50	0.10
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	-1.98	-0.40	-2.02
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$	4.02	0.50	3.86
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	-4.12	-0.30	-4.30
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	-26.18	-14.30	-35.46
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	1.74	0.60	1.71
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	-4.59	-0.50	-4.81
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	0.19	0.10	0.19
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	4.76	0.90	4.54
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	-16.31	-2.80	-19.49
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	0.46	0.40	0.46
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	-0.07	0.50	-0.07
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	2.10	-0.50	2.06
$^{235}\text{U}(n,f)\text{FP}$ - bare	-0.82	0.40	-0.83
$^{238}\text{U}(n,f)\text{FP}$ - bare	-1.28	0.80	-1.30
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	13.80	15.40	12.13
$^{237}\text{Np}(n,f)\text{FP}$ - bare	-2.52	-0.70	-2.59

Table 7. WSMR 24-inch - C/E Values for the Trial and Adjusted SNL LSL Neutron Energy Spectrum.

Activation Reaction	C/E-1 Trial Spectrum (%)	C/E-1 Adjusted Spectrum (%)	Factor Adjusted (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ – Reference	0.00	2.20	0.00
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	10.05	-1.90	-10.44
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	11.41	-0.20	-11.44
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	24.51	21.10	-23.37
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	-4.56	-1.70	4.77
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	11.64	0.70	-11.32
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	14.10	4.00	-11.62
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	-22.27	-24.30	26.05
$^{64}\text{Zn}(n,p)^{64}\text{Cu}$	5.70	7.80	-5.33
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	8.07	-0.40	-8.11
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	-2.86	2.60	2.78
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	-49.24	1.30	47.92
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$	-58.60	4.20	57.44
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$	-55.76	-2.80	59.09
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	-30.22	0.90	28.98
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	-27.21	1.50	27.12
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	-3.68	0.60	3.54
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	-36.15	1.40	33.66
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	-48.53	-0.10	48.76
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	4.38	-2.40	-5.66
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	-10.18	-0.10	10.22
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	0.99	1.50	-0.87
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	-32.15	-2.00	35.02
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	31.14	2.80	-20.56
$^{235}\text{U}(n,f)\text{FP}$ - bare	-10.01	-4.00	12.56
$^{238}\text{U}(n,f)\text{FP}$ – bare	-4.37	0.10	4.32
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	7.12	12.90	-6.41
$^{237}\text{Np}(n,f)\text{FP}$ - bare	-6.67	-0.40	6.84

Table 8 and Table 9 contain the LSL-M3 adjusted neutron fluence spectrum in a tabular format for the 89-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation for the adjusted spectrum. The number fraction, represented as a histogram, can be used in MCNP source calculations as an isotropic spherical surface source.

For the SNL 6-inch position, the average neutron energy is calculated to be 1.445 MeV. The peak differential number fraction occurs in energy group 4 at 0.02 eV. The differential fluence at 1 MeV (Group 74) is almost four orders of magnitude lower than the peak. The LSL adjusted results for the

number fraction, percent standard deviation, and covariance as a function of the 89-group energy structure are included in an LSL format in Appendix E of this report.

For the SNL 24-inch position, the average neutron energy is calculated to be 1.369 MeV. The peak differential number fraction occurs in energy group 4 at 0.02 eV. The differential fluence at 1 MeV (Group 74) is also four orders of magnitude lower than the peak. The LSL adjusted results for the number fraction, percent standard deviation, and covariance as a function of the 89-group energy structure are included in an LSL format in Appendix E of this report.

Table 8. SNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-10	1.0000E-09	5.5000E-10	1.2240E-07	4.4683E-17	1.3600E+02	7.4801E-08	197.40
2	1.0000E-09	5.0000E-09	3.0000E-09	2.6450E-06	5.2666E-15	6.6124E+02	1.9837E-06	137.24
3	5.0000E-09	1.0000E-08	7.5000E-09	7.4699E-06	3.7185E-14	1.4940E+03	1.1205E-05	105.80
4	1.0000E-08	3.0000E-08	2.0000E-08	5.0200E-05	6.6638E-13	2.5100E+03	5.0200E-05	54.39
5	3.0000E-08	7.0000E-08	5.0000E-08	9.3556E-05	3.1048E-12	2.3389E+03	1.1694E-04	42.63
6	7.0000E-08	1.0000E-07	8.5000E-08	3.8976E-05	2.1989E-12	1.2992E+03	1.1043E-04	64.52
7	1.0000E-07	1.5230E-07	1.2615E-07	3.0606E-05	2.5626E-12	5.8520E+02	7.3823E-05	77.47
8	1.5230E-07	2.0000E-07	1.7615E-07	1.2094E-05	1.4139E-12	2.5353E+02	4.4660E-05	87.45
9	2.0000E-07	4.1400E-07	3.0700E-07	1.9990E-05	4.0733E-12	9.3412E+01	2.8677E-05	92.89
10	4.1400E-07	6.0000E-07	5.0700E-07	9.5159E-06	3.2022E-12	5.1161E+01	2.5939E-05	96.72
11	6.0000E-07	8.0000E-07	7.0000E-07	7.1826E-06	3.3371E-12	3.5913E+01	2.5139E-05	95.27
12	8.0000E-07	1.1250E-06	9.6250E-07	1.0943E-05	6.9907E-12	3.3670E+01	3.2408E-05	102.21
13	1.1250E-06	3.0590E-06	2.0920E-06	3.3268E-05	4.6194E-11	1.7202E+01	3.5986E-05	50.92
14	3.0590E-06	5.0430E-06	4.0510E-06	1.9530E-05	5.2510E-11	9.8435E+00	3.9876E-05	68.81
15	5.0430E-06	8.3150E-06	6.6790E-06	2.5789E-05	1.1432E-10	7.8816E+00	5.2641E-05	36.10
16	8.3150E-06	1.3710E-05	1.1013E-05	2.7127E-05	1.9828E-10	5.0282E+00	5.5373E-05	35.29
17	1.3710E-05	2.2600E-05	1.8155E-05	3.0336E-05	3.6555E-10	3.4124E+00	6.1952E-05	9.00
18	2.2600E-05	3.7270E-05	2.9935E-05	4.0408E-05	8.0285E-10	2.7544E+00	8.2454E-05	30.26
19	3.7270E-05	6.1440E-05	4.9355E-05	5.1066E-05	1.6728E-09	2.1128E+00	1.0428E-04	26.12
20	6.1440E-05	1.0130E-04	8.1370E-05	6.0456E-05	3.2651E-09	1.5167E+00	1.2341E-04	23.88
21	1.0130E-04	1.6700E-04	1.3415E-04	8.3882E-05	7.4687E-09	1.2767E+00	1.7127E-04	25.67
22	1.6700E-04	2.7540E-04	2.2120E-04	8.6683E-05	1.2727E-08	7.9966E-01	1.7688E-04	47.99
23	2.7540E-04	3.5360E-04	3.1450E-04	4.8313E-05	1.0085E-08	6.1781E-01	1.9430E-04	44.39
24	3.5360E-04	4.5400E-04	4.0380E-04	4.9150E-05	1.3173E-08	4.8954E-01	1.9768E-04	49.44
25	4.5400E-04	5.8300E-04	5.1850E-04	5.9702E-05	2.0546E-08	4.6281E-01	2.3997E-04	57.91
26	5.8300E-04	7.4850E-04	6.6575E-04	7.2092E-05	3.1856E-08	4.3560E-01	2.9000E-04	27.37
27	7.4850E-04	9.6110E-04	8.5480E-04	7.7884E-05	4.4188E-08	3.6634E-01	3.1315E-04	24.48
28	9.6110E-04	1.0890E-03	1.0251E-03	4.0271E-05	2.7399E-08	3.1486E-01	3.2275E-04	35.95
29	1.0890E-03	1.2340E-03	1.1615E-03	4.5581E-05	3.5140E-08	3.1435E-01	3.6512E-04	40.23
30	1.2340E-03	1.3980E-03	1.3160E-03	4.2865E-05	3.7441E-08	2.6137E-01	3.4396E-04	44.41
31	1.3980E-03	1.5850E-03	1.4915E-03	5.2152E-05	5.1628E-08	2.7889E-01	4.1596E-04	42.51
32	1.5850E-03	1.7960E-03	1.6905E-03	5.0913E-05	5.7126E-08	2.4130E-01	4.0791E-04	40.57
33	1.7960E-03	2.0350E-03	1.9155E-03	6.2077E-05	7.8923E-08	2.5974E-01	4.9752E-04	39.54
34	2.0350E-03	2.3060E-03	2.1705E-03	6.5608E-05	9.4517E-08	2.4210E-01	5.2547E-04	38.61
35	2.3060E-03	2.6130E-03	2.4595E-03	6.4606E-05	1.0547E-07	2.1044E-01	5.1759E-04	38.09
36	2.6130E-03	2.9600E-03	2.7865E-03	8.8956E-05	1.6452E-07	2.5636E-01	7.1434E-04	36.30
37	2.9600E-03	3.3550E-03	3.1575E-03	6.5117E-05	1.3647E-07	1.6485E-01	5.2052E-04	36.51
38	3.3550E-03	3.8010E-03	3.5780E-03	8.5037E-05	2.0195E-07	1.9067E-01	6.8221E-04	36.83
39	3.8010E-03	4.3070E-03	4.0540E-03	8.8325E-05	2.3766E-07	1.7456E-01	7.0765E-04	36.53
40	4.3070E-03	4.8810E-03	4.5940E-03	8.9426E-05	2.7268E-07	1.5579E-01	7.1572E-04	35.16
41	4.8810E-03	5.5310E-03	5.2060E-03	1.0483E-04	3.6222E-07	1.6128E-01	8.3960E-04	34.63
42	5.5310E-03	6.2670E-03	5.8990E-03	1.1711E-04	4.5854E-07	1.5912E-01	9.3865E-04	34.39
43	6.2670E-03	7.1020E-03	6.6845E-03	1.1669E-04	5.1772E-07	1.3975E-01	9.3416E-04	33.65
44	7.1020E-03	8.0470E-03	7.5745E-03	1.3392E-04	6.7329E-07	1.4172E-01	1.0734E-03	33.57
45	8.0470E-03	9.1190E-03	8.5830E-03	1.6592E-04	9.4523E-07	1.5478E-01	1.3285E-03	32.70
46	9.1190E-03	1.0330E-02	9.7245E-03	1.8679E-04	1.2056E-06	1.5424E-01	1.4999E-03	31.55
47	1.0330E-02	1.1710E-02	1.1020E-02	2.0429E-04	1.4942E-06	1.4804E-01	1.6314E-03	31.07
48	1.1710E-02	1.3270E-02	1.2490E-02	2.3019E-04	1.9082E-06	1.4755E-01	1.8430E-03	31.43
49	1.3270E-02	1.5030E-02	1.4150E-02	2.7905E-04	2.6207E-06	1.5855E-01	2.2435E-03	30.41
50	1.5030E-02	1.7040E-02	1.6035E-02	3.0550E-04	3.2514E-06	1.5199E-01	2.4371E-03	30.86
51	1.7040E-02	1.9300E-02	1.8170E-02	4.0574E-04	4.8932E-06	1.7953E-01	3.2621E-03	29.54
52	1.9300E-02	2.1880E-02	2.0590E-02	4.8224E-04	6.5903E-06	1.8691E-01	3.8485E-03	28.61
53	2.1880E-02	2.4790E-02	2.3335E-02	5.9239E-04	9.1750E-06	2.0357E-01	4.7503E-03	27.42
54	2.4790E-02	2.6060E-02	2.5425E-02	2.3528E-04	3.9703E-06	1.8526E-01	4.7101E-03	29.17
55	2.6060E-02	2.8090E-02	2.7075E-02	4.3309E-04	7.7827E-06	2.1334E-01	5.7762E-03	28.83
56	2.8090E-02	3.1830E-02	2.9960E-02	1.0551E-03	2.0981E-05	2.8211E-01	8.4519E-03	27.90
57	3.1830E-02	4.0870E-02	3.6350E-02	2.5347E-03	6.1155E-05	2.8039E-01	1.0192E-02	22.30

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
58	4.0870E-02	5.2480E-02	4.6675E-02	3.3764E-03	1.0460E-04	2.9082E-01	1.3574E-02	21.54
59	5.2480E-02	6.7380E-02	5.9930E-02	5.2230E-03	2.0776E-04	3.5054E-01	2.1008E-02	20.47
60	6.7380E-02	8.6520E-02	7.6950E-02	8.3314E-03	4.2552E-04	4.3529E-01	3.3496E-02	19.52
61	8.6520E-02	1.1110E-01	9.8810E-02	1.1141E-02	7.3068E-04	4.5327E-01	4.4787E-02	18.36
62	1.1110E-01	1.4260E-01	1.2685E-01	1.6220E-02	1.3656E-03	5.1492E-01	6.5317E-02	18.22
63	1.4260E-01	1.8320E-01	1.6290E-01	2.3275E-02	2.5166E-03	5.7328E-01	9.3388E-02	17.58
64	1.8320E-01	2.3520E-01	2.0920E-01	3.2962E-02	4.5768E-03	6.3388E-01	1.3261E-01	16.42
65	2.3520E-01	3.0200E-01	2.6860E-01	4.5809E-02	8.1668E-03	6.8577E-01	1.8420E-01	16.03
66	3.0200E-01	3.8770E-01	3.4485E-01	4.8283E-02	1.1051E-02	5.6340E-01	1.9429E-01	15.62
67	3.8770E-01	4.3940E-01	4.1355E-01	3.0458E-02	8.3603E-03	5.8913E-01	2.4363E-01	17.94
68	4.3940E-01	4.9790E-01	4.6865E-01	3.3193E-02	1.0325E-02	5.6740E-01	2.6591E-01	17.67
69	4.9790E-01	5.6420E-01	5.3105E-01	3.7132E-02	1.3088E-02	5.6005E-01	2.9742E-01	17.47
70	5.6420E-01	6.3930E-01	6.0175E-01	3.8503E-02	1.5378E-02	5.1270E-01	3.0851E-01	17.06
71	6.3930E-01	7.2440E-01	6.8185E-01	4.0079E-02	1.8138E-02	4.7097E-01	3.2113E-01	16.83
72	7.2440E-01	8.2080E-01	7.7260E-01	3.9333E-02	2.0170E-02	4.0802E-01	3.1523E-01	16.89
73	8.2080E-01	9.3010E-01	8.7545E-01	4.4380E-02	2.5788E-02	4.0604E-01	3.5547E-01	16.54
74	9.3010E-01	1.0540E+00	9.9205E-01	4.3934E-02	2.8929E-02	3.5460E-01	3.5178E-01	14.98
75	1.0540E+00	1.1940E+00	1.1240E+00	4.6725E-02	3.4859E-02	3.3375E-01	3.7514E-01	15.72
76	1.1940E+00	1.3530E+00	1.2735E+00	4.7101E-02	3.9812E-02	2.9623E-01	3.7725E-01	15.43
77	1.3530E+00	1.7380E+00	1.5455E+00	8.8442E-02	9.0723E-02	2.2972E-01	3.5503E-01	12.52
78	1.7380E+00	2.2310E+00	1.9845E+00	8.2451E-02	1.0860E-01	1.6724E-01	3.3189E-01	11.27
79	2.2310E+00	2.8650E+00	2.5480E+00	7.6209E-02	1.2888E-01	1.2020E-01	3.0628E-01	11.47
80	2.8650E+00	3.6790E+00	3.2720E+00	6.3641E-02	1.3821E-01	7.8183E-02	2.5581E-01	11.03
81	3.6790E+00	4.7240E+00	4.2015E+00	4.5210E-02	1.2608E-01	4.3263E-02	1.8177E-01	10.77
82	4.7240E+00	6.0650E+00	5.3945E+00	2.3978E-02	8.5853E-02	1.7881E-02	9.6457E-02	10.54
83	6.0650E+00	7.7880E+00	6.9265E+00	1.0312E-02	4.7408E-02	5.9850E-03	4.1455E-02	9.64
84	7.7880E+00	1.0000E+01	8.8940E+00	3.8871E-03	2.2946E-02	1.7573E-03	1.5629E-02	8.84
85	1.0000E+01	1.1910E+01	1.0955E+01	7.1151E-04	5.1735E-03	3.7252E-04	4.0809E-03	5.86
86	1.1910E+01	1.3500E+01	1.2705E+01	1.5643E-04	1.3191E-03	9.8381E-05	1.2499E-03	7.72
87	1.3500E+01	1.4920E+01	1.4210E+01	4.5118E-05	4.2553E-04	3.1773E-05	4.5149E-04	10.60
88	1.4920E+01	1.6900E+01	1.5910E+01	1.8188E-05	1.9207E-04	9.1861E-06	1.4615E-04	12.59
89	1.6900E+01	2.0000E+01	1.8450E+01	5.3611E-06	6.5651E-05	1.7294E-06	3.1907E-05	17.84

Table 9. SNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-10	1.0000E-09	5.5000E-10	3.3549E-05	1.3229E-14	3.7276E+04	2.0502E-05	186.85
2	1.0000E-09	5.0000E-09	3.0000E-09	7.5032E-05	1.6138E-13	1.8758E+04	5.6274E-05	123.56
3	5.0000E-09	1.0000E-08	7.5000E-09	2.0270E-04	1.0899E-12	4.0540E+04	3.0405E-04	94.52
4	1.0000E-08	3.0000E-08	2.0000E-08	1.2161E-03	1.7437E-11	6.0805E+04	1.2161E-03	47.24
5	3.0000E-08	7.0000E-08	5.0000E-08	2.0988E-03	7.5236E-11	5.2470E+04	2.6235E-03	27.87
6	7.0000E-08	1.0000E-07	8.5000E-08	8.0611E-04	4.9124E-11	2.6870E+04	2.2840E-03	48.45
7	1.0000E-07	1.5230E-07	1.2615E-07	6.5518E-04	5.9256E-11	1.2527E+04	1.5803E-03	58.82
8	1.5230E-07	2.0000E-07	1.7615E-07	2.9872E-04	3.7726E-11	6.2626E+03	1.1031E-03	65.27
9	2.0000E-07	4.1400E-07	3.0700E-07	6.2114E-04	1.3671E-10	2.9025E+03	8.9107E-04	60.00
10	4.1400E-07	6.0000E-07	5.0700E-07	3.2167E-04	1.1692E-10	1.7294E+03	8.7680E-04	56.08
11	6.0000E-07	8.0000E-07	7.0000E-07	2.2959E-04	1.1522E-10	1.1479E+03	8.0355E-04	49.28
12	8.0000E-07	1.1250E-06	9.6250E-07	2.6090E-04	1.8004E-10	8.0276E+02	7.7266E-04	73.27
13	1.1250E-06	3.0590E-06	2.0920E-06	8.5302E-04	1.2794E-09	4.4107E+02	9.2271E-04	67.86
14	3.0590E-06	5.0430E-06	4.0510E-06	7.3632E-04	2.1385E-09	3.7113E+02	1.5034E-03	11.17
15	5.0430E-06	8.3150E-06	6.6790E-06	6.9769E-04	3.3409E-09	2.1323E+02	1.4242E-03	17.76
16	8.3150E-06	1.3710E-05	1.1013E-05	4.2117E-04	3.3253E-09	7.8067E+01	8.5972E-04	36.05
17	1.3710E-05	2.2600E-05	1.8155E-05	3.3996E-04	4.4250E-09	3.8241E+01	6.9427E-04	16.01
18	2.2600E-05	3.7270E-05	2.9935E-05	5.0367E-04	1.0810E-08	3.4333E+01	1.0278E-03	31.60
19	3.7270E-05	6.1440E-05	4.9355E-05	5.9705E-04	2.1126E-08	2.4702E+01	1.2192E-03	27.57
20	6.1440E-05	1.0130E-04	8.1370E-05	6.6629E-04	3.8870E-08	1.6716E+01	1.3602E-03	25.63
21	1.0130E-04	1.6700E-04	1.3415E-04	4.4007E-04	4.2325E-08	6.6982E+00	8.9856E-04	11.50
22	1.6700E-04	2.7540E-04	2.2120E-04	8.4517E-04	1.3403E-07	7.7967E+00	1.7246E-03	32.94
23	2.7540E-04	3.5360E-04	3.1450E-04	5.9505E-04	1.3417E-07	7.6093E+00	2.3931E-03	19.48
24	3.5360E-04	4.5400E-04	4.0380E-04	5.6996E-04	1.6501E-07	5.6769E+00	2.2923E-03	32.42
25	4.5400E-04	5.8300E-04	5.1850E-04	5.2282E-04	1.9435E-07	4.0529E+00	2.1014E-03	42.01
26	5.8300E-04	7.4850E-04	6.6575E-04	5.5356E-04	2.6422E-07	3.3448E+00	2.2268E-03	22.31
27	7.4850E-04	9.6110E-04	8.5480E-04	6.5178E-04	3.9944E-07	3.0658E+00	2.6206E-03	26.06
28	9.6110E-04	1.0890E-03	1.0251E-03	3.6386E-04	2.6740E-07	2.8449E+00	2.9162E-03	36.39
29	1.0890E-03	1.2340E-03	1.1615E-03	3.5693E-04	2.9723E-07	2.4616E+00	2.8591E-03	40.05
30	1.2340E-03	1.3980E-03	1.3160E-03	3.5071E-04	3.3089E-07	2.1385E+00	2.8142E-03	44.60
31	1.3980E-03	1.5850E-03	1.4915E-03	3.6942E-04	3.9503E-07	1.9755E+00	2.9464E-03	42.85
32	1.5850E-03	1.7960E-03	1.6905E-03	4.1699E-04	5.0540E-07	1.9763E+00	3.3409E-03	40.92
33	1.7960E-03	2.0350E-03	1.9155E-03	4.3410E-04	5.9616E-07	1.8163E+00	3.4792E-03	39.80
34	2.0350E-03	2.3060E-03	2.1705E-03	4.4603E-04	6.9408E-07	1.6459E+00	3.5724E-03	38.84
35	2.3060E-03	2.6130E-03	2.4595E-03	3.8786E-04	6.8392E-07	1.2634E+00	3.1073E-03	38.71
36	2.6130E-03	2.9600E-03	2.7865E-03	4.3473E-04	8.6849E-07	1.2528E+00	3.4910E-03	37.75
37	2.9600E-03	3.3550E-03	3.1575E-03	4.6888E-04	1.0614E-06	1.1870E+00	3.7481E-03	37.64
38	3.3550E-03	3.8010E-03	3.5780E-03	5.4238E-04	1.3913E-06	1.2161E+00	4.3512E-03	37.48
39	3.8010E-03	4.3070E-03	4.0540E-03	5.0389E-04	1.4646E-06	9.9584E-01	4.0371E-03	37.00
40	4.3070E-03	4.8810E-03	4.5940E-03	5.8753E-04	1.9351E-06	1.0236E+00	4.7023E-03	35.58
41	4.8810E-03	5.5310E-03	5.2060E-03	6.7003E-04	2.5008E-06	1.0308E+00	5.3665E-03	35.08
42	5.5310E-03	6.2670E-03	5.8990E-03	6.1030E-04	2.5811E-06	8.2921E-01	4.8915E-03	34.93
43	6.2670E-03	7.1020E-03	6.6845E-03	6.9579E-04	3.3345E-06	8.3328E-01	5.5701E-03	34.27
44	7.1020E-03	8.0470E-03	7.5745E-03	6.8875E-04	3.7402E-06	7.2883E-01	5.5205E-03	34.19
45	8.0470E-03	9.1190E-03	8.5830E-03	8.2243E-04	5.0609E-06	7.6719E-01	6.5848E-03	33.37
46	9.1190E-03	1.0330E-02	9.7245E-03	8.6065E-04	6.0004E-06	7.1069E-01	6.9111E-03	32.19
47	1.0330E-02	1.1710E-02	1.1020E-02	8.9689E-04	7.0861E-06	6.4992E-01	7.1621E-03	31.71
48	1.1710E-02	1.3270E-02	1.2490E-02	8.2480E-04	7.3858E-06	5.2872E-01	6.6037E-03	32.16
49	1.3270E-02	1.5030E-02	1.4150E-02	1.0436E-03	1.0587E-05	5.9295E-01	8.3902E-03	31.20
50	1.5030E-02	1.7040E-02	1.6035E-02	1.0739E-03	1.2346E-05	5.3427E-01	8.5670E-03	31.66
51	1.7040E-02	1.9300E-02	1.8170E-02	1.3362E-03	1.7407E-05	5.9125E-01	1.0743E-02	30.42
52	1.9300E-02	2.1880E-02	2.0590E-02	1.4605E-03	2.1560E-05	5.6610E-01	1.1656E-02	29.54
53	2.1880E-02	2.4790E-02	2.3335E-02	1.4711E-03	2.4611E-05	5.0552E-01	1.1796E-02	28.42
54	2.4790E-02	2.6060E-02	2.5425E-02	5.8608E-04	1.0683E-05	4.6148E-01	1.1733E-02	30.11
55	2.6060E-02	2.8090E-02	2.7075E-02	1.4681E-03	2.8497E-05	7.2319E-01	1.9580E-02	29.82
56	2.8090E-02	3.1830E-02	2.9960E-02	1.6468E-03	3.5373E-05	4.4032E-01	1.3192E-02	28.96
57	3.1830E-02	4.0870E-02	3.6350E-02	4.1988E-03	1.0942E-04	4.6446E-01	1.6883E-02	23.96
58	4.0870E-02	5.2480E-02	4.6675E-02	5.5681E-03	1.8633E-04	4.7960E-01	2.2385E-02	23.17
59	5.2480E-02	6.7380E-02	5.9930E-02	7.7278E-03	3.3204E-04	5.1864E-01	3.1082E-02	22.23

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
60	6.7380E-02	8.6520E-02	7.6950E-02	1.1085E-02	6.1156E-04	5.7917E-01	4.4567E-02	21.48
61	8.6520E-02	1.1110E-01	9.8810E-02	1.2511E-02	8.8628E-04	5.0898E-01	5.0292E-02	20.62
62	1.1110E-01	1.4260E-01	1.2685E-01	1.8766E-02	1.7067E-03	5.9575E-01	7.5570E-02	20.70
63	1.4260E-01	1.8320E-01	1.6290E-01	2.3038E-02	2.6906E-03	5.6743E-01	9.2435E-02	20.36
64	1.8320E-01	2.3520E-01	2.0920E-01	3.2454E-02	4.8676E-03	6.2411E-01	1.3056E-01	19.76
65	2.3520E-01	3.0200E-01	2.6860E-01	3.6982E-02	7.1216E-03	5.5362E-01	1.4870E-01	19.67
66	3.0200E-01	3.8770E-01	3.4485E-01	5.3837E-02	1.3311E-02	6.2820E-01	2.1663E-01	19.31
67	3.8770E-01	4.3940E-01	4.1355E-01	2.8220E-02	8.3671E-03	5.4585E-01	2.2574E-01	21.44
68	4.3940E-01	4.9790E-01	4.6865E-01	3.3025E-02	1.1096E-02	5.6453E-01	2.6457E-01	21.25
69	4.9790E-01	5.6420E-01	5.3105E-01	3.6329E-02	1.3832E-02	5.4795E-01	2.9099E-01	21.04
70	5.6420E-01	6.3930E-01	6.0175E-01	3.6080E-02	1.5566E-02	4.8043E-01	2.8910E-01	20.56
71	6.3930E-01	7.2440E-01	6.8185E-01	4.0244E-02	1.9673E-02	4.7290E-01	3.2245E-01	20.16
72	7.2440E-01	8.2080E-01	7.7260E-01	3.9196E-02	2.1711E-02	4.0660E-01	3.1414E-01	19.97
73	8.2080E-01	9.3010E-01	8.7545E-01	4.3280E-02	2.7165E-02	3.9597E-01	3.4666E-01	19.61
74	9.3010E-01	1.0540E+00	9.9205E-01	4.5781E-02	3.2561E-02	3.6950E-01	3.6656E-01	18.44
75	1.0540E+00	1.1940E+00	1.1240E+00	4.8247E-02	3.8879E-02	3.4462E-01	3.8735E-01	19.12
76	1.1940E+00	1.3530E+00	1.2735E+00	4.5243E-02	4.1308E-02	2.8455E-01	3.6237E-01	18.71
77	1.3530E+00	1.7380E+00	1.5455E+00	8.5463E-02	9.4697E-02	2.2198E-01	3.4307E-01	15.65
78	1.7380E+00	2.2310E+00	1.9845E+00	7.6207E-02	1.0843E-01	1.5458E-01	3.0676E-01	14.22
79	2.2310E+00	2.8650E+00	2.5480E+00	6.7697E-02	1.2367E-01	1.0678E-01	2.7207E-01	14.50
80	2.8650E+00	3.6790E+00	3.2720E+00	5.4473E-02	1.2778E-01	6.6920E-02	2.1896E-01	14.65
81	3.6790E+00	4.7240E+00	4.2015E+00	4.0481E-02	1.2194E-01	3.8737E-02	1.6276E-01	14.56
82	4.7240E+00	6.0650E+00	5.3945E+00	2.3229E-02	8.9840E-02	1.7322E-02	9.3445E-02	13.62
83	6.0650E+00	7.7880E+00	6.9265E+00	9.2677E-03	4.6022E-02	5.3788E-03	3.7256E-02	14.55
84	7.7880E+00	1.0000E+01	8.8940E+00	2.9303E-03	1.8685E-02	1.3247E-03	1.1782E-02	14.66
85	1.0000E+01	1.1910E+01	1.0955E+01	5.9773E-04	4.6946E-03	3.1295E-04	3.4283E-03	22.02
86	1.1910E+01	1.3500E+01	1.2705E+01	1.3604E-04	1.2392E-03	8.5560E-05	1.0870E-03	27.75
87	1.3500E+01	1.4920E+01	1.4210E+01	4.4236E-05	4.5067E-04	3.1152E-05	4.4267E-04	30.78
88	1.4920E+01	1.6900E+01	1.5910E+01	2.1574E-05	2.4609E-04	1.0896E-05	1.7336E-04	33.87
89	1.6900E+01	2.0000E+01	1.8450E+01	8.9539E-06	1.1844E-04	2.8883E-06	5.3290E-05	35.97

The results for several integral metrics and conversion factors are shown in Table 10 and Table 11 for the 6-inch and 24-inch test positions, respectively. The total neutron fluence is normalized to 1.00 and the other values for fluence are in reference to this value. These values were calculated as part of the LSL analysis. Conversion values to translate to n/cm² are given for fissions in the reactor, MJ of reactor energy, and ⁵⁸Ni(n,p)⁵⁸Co activity at the characterized location in the cavity. In order to maintain consistency, the experimenter should always use a reference fast neutron reaction or reactions, e.g. ⁵⁸Ni(n,p)⁵⁸Co and/or ³²S(n,p)³²P, as a normalizing metric between operations. Typically, Ni, S, and TLD sensors are included in an experiment package in order to normalize the results of the experiment. It must be noted that portions of the energy spectrum are highly correlated, so the uncertainty in the integral metric can be much less than the average uncertainty. Users should perform uncertainty propagation using the full energy-dependent covariance matrix given in Appendix C in order to determine the correlated uncertainty.

Table 10. WSMR 6-inch Location – SNL Integral Neutron Spectrum Metrics and Associated Uncertainties.

Metric	Integral Response	Standard Deviation (%)
Total Neutron Fluence Average Neutron Energy = 1.445 MeV	1.00	--
Fluence > 3 MeV	0.137	5.2
Fluence > 1 MeV	0.513	3.6
Fluence > 100 keV	0.968	0.58
Fluence > 10 keV	0.997	0.46
Fluence < 1 keV	0.001	10.7
Fluence < 1 eV	0.0002	31.6
Fluence 1-MeV(Si) Eqv. E722-94 (Ref. 1-MeV value = 95 MeV-mb)	83.8 MeV-mb 0.897	1.1
Fluence 1-MeV(GaAs) Eqv. E722-94 (Ref. 1-MeV value = 70 MeV-mb)	64.2 MeV-mb 0.919	0.9
⁵⁸ Ni(n,p) ⁵⁸ Co Spectrum Avg. Cross Section IRDFF-II	63.81 mb	4.5
³² S(n,p) ³² P Spectrum Avg. Cross Section IRDFF-II (Ref. Cf spectrum = 74.10 mb +/- 2.6%)	41.19 mb	5.2
Total Fluence Conversion ([n/cm ²]/fission)	6.791E-04	0.3
Total Fluence Conversion ([n/cm ²]/MJ)	2.403E+13	0.5
Total Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([n/cm ²]/[Bq/atom _{Ni-58}])	1.384E+32	4.5
Total Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([n/cm ²]/[Bq/g _{Ni-58}])	1.331E+10	4.5
Power Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co (MJ/[Bq/atom _{Ni-58}])	6.287E+18	4.9
Power Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co (MJ/[Bq/g _{Ni-58}])	6.048E-04	4.9
Total Fluence Conversion From S Activation ([n/cm ²]/Fluence ³² S(n,p) Cf-equiv)	1.799	3.8

Table 11. WSMR 24-inch Location – SNL Integral Neutron Spectrum Metrics and Associated Uncertainties.

Metric	Integral Response	Standard Deviation (%)
Total Neutron Fluence Average Neutron Energy = 1.369 MeV	1.00	--
Fluence > 3 MeV	0.122	5.8
Fluence > 1 MeV	0.480	3.9
Fluence > 100 keV	0.927	0.75
Fluence > 10 keV	0.974	0.51
Fluence < 1 keV	0.015	10.1
Fluence < 1 eV	0.007	24.4
Fluence 1-MeV(Si) Eqv. E722-94 (Ref. 1-MeV value = 95 MeV-mb)	81.4 MeV-mb 0.821	1.3
Fluence 1-MeV(GaAs) Eqv. E722-94 (Ref. 1-MeV value = 70 MeV-mb)	62.4 MeV-mb 0.880	1.1
⁵⁸ Ni(n,p) ⁵⁸ Co Spectrum Avg. Cross Section IRDFF-II	59.70 mb	5.3
³² S(n,p) ³² P Spectrum Avg. Cross Section IRDFF-II (Ref. Cf spectrum = 74.10 mb +/- 2.6%)	38.54 mb	5.6
Total Fluence Conversion ([n/cm ²]/fission)	3.820E-05	0.3
Total Fluence Conversion ([n/cm ²]/MJ)	1.287E+12	0.5
Total Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([n/cm ²]/[Bq/atom _{Ni-58}])	1.479E+32	5.3
Total Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([n/cm ²]/[Bq/g _{Ni-58}])	1.423E+10	5.3
Power Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co (MJ/[Bq/atom _{Ni-58}])	1.195E+20	5.7
Power Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co (MJ/[Bq/g _{Ni-58}])	1.149E-02	5.7
Total Fluence Conversion From S Activation ([n/cm ²]/Fluence ³² S(n,p) Cf-equiv)	1.923	6.2

Table 12 and Table 13 show representative integral metrics that may also be useful to the experimenter. These values were calculated using the LSL adjusted 89-group neutron energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, Si damage, C dose, and TLD dose.

Table 12. WSMR 6-inch Location – Other SNL Neutron Spectrum Metrics.

Metric	Integral Response
Total Si Dose (rad[Si]/[n/cm ²])	6.979E-11
Ionizing Si Dose(rad[Si]/[n/cm ²])	4.141E-11
Percent Neutron Si Dose Ionizing (%)	59.33
Total Carbon Dose (rad[C]/[n/cm ²])	3.168E-10
Total CaF ₂ :Mn (TLD) Dose (rad[CaF ₂ :Mn]/[n/cm ²])	1.475E-10
Effective Ionizing CaF ₂ :Mn Dose (rad[CaF ₂ :Mn]/[n/cm ²])	1.606E-11
Percent Neutron CaF ₂ :Mn Dose total light (%)	10.89

Table 13. WSMR 24-inch Location - Other SNL Neutron Spectrum Metrics.

Metric	Integral Response
Total Si Dose (rad[Si]/[n/cm ²])	6.630E-11
Ionizing Si Dose(rad[Si]/[n/cm ²])	3.912E-11
Percent Neutron Si Dose Ionizing (%)	59.0
Total Carbon Dose (rad[C]/[n/cm ²])	3.017E-10
Total CaF ₂ :Mn (TLD) Dose (rad[CaF ₂ :Mn]/[n/cm ²])	1.396E-10
Effective Ionizing CaF ₂ :Mn Dose (rad[CaF ₂ :Mn]/[n/cm ²])	1.505E-11
Percent Neutron CaF ₂ :Mn Dose total light (%)	10.8

4.3.2. LANL LSL Spectrum Results

The resulting values for χ^2/dof are 0.77, for both the 6-inch and 24-inch spectra. This result represents a highly acceptable value. Figure 33 and Figure 34 for the 6-inch location and Figure 35 and Figure 36 for the 24-inch location show the same representation of the neutron energy spectra as previously shown in Figure 16 and Figure 17 for 6-inch location and Figure 18 and Figure 19 for the 24-inch location, with the additional 89-group adjusted neutron energy spectrum result from the LSL analysis

(blue curve). Figure 37 for the 6-inch location and Figure 38 for the 24-inch location shows the percent adjustment made to the trial spectrum (black curve), and the percent standard deviation in the adjusted spectrum (purple curve). The adjusted neutron fluence in Figure 34 and Figure 36 shows very close agreement to that calculated using the MCNP model.

Table 14 for the 6-inch location and Table 15 for the 24-inch location shows the result of the calculated to experimental (C/E) dosimetry results for the trial spectrum and the adjusted spectrum. Also shown is the factor adjusted from the trial spectrum to the adjusted spectrum for the dosimetry reactions. For the high-energy reactions, the C/E-1 values are found to be both positive and negative for the trial spectrum and are reduced for the adjusted spectrum. For the radiative capture reactions, the C/E-1 values are all negative for the trial spectrum. This infers that the thermal/epithermal calculated fluence is too low. After the adjustment, the results become much closer to zero for C/E-1.

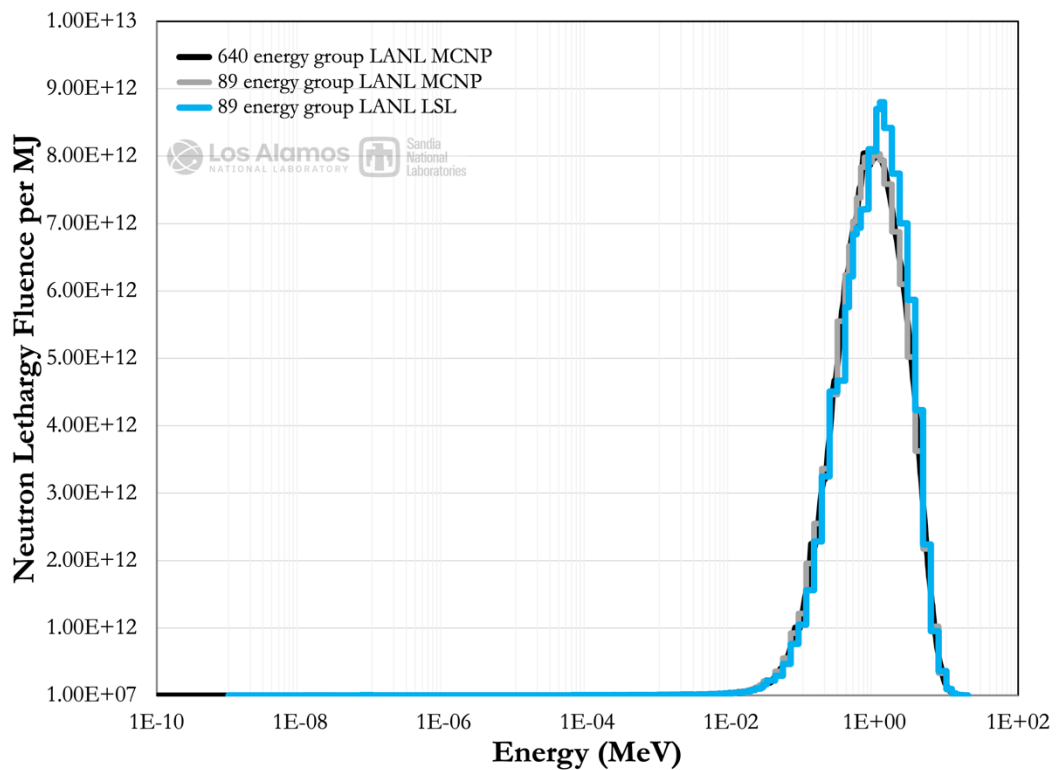


Figure 33. WSMR 6-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).

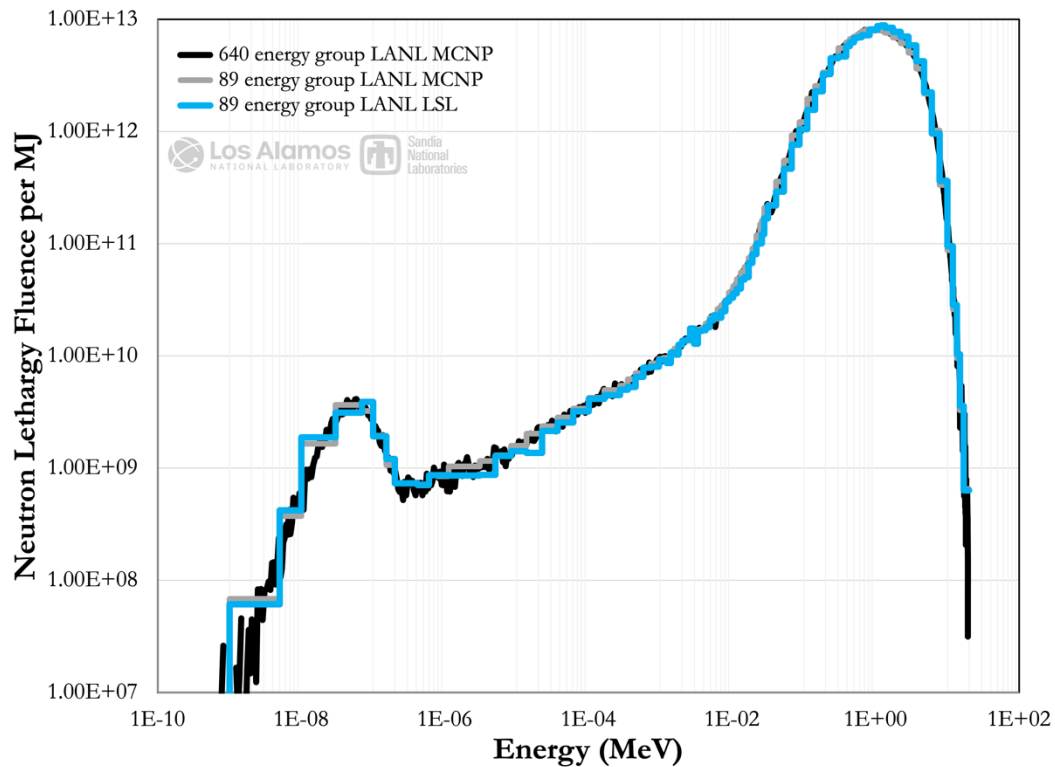


Figure 34. WSMR 6-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).

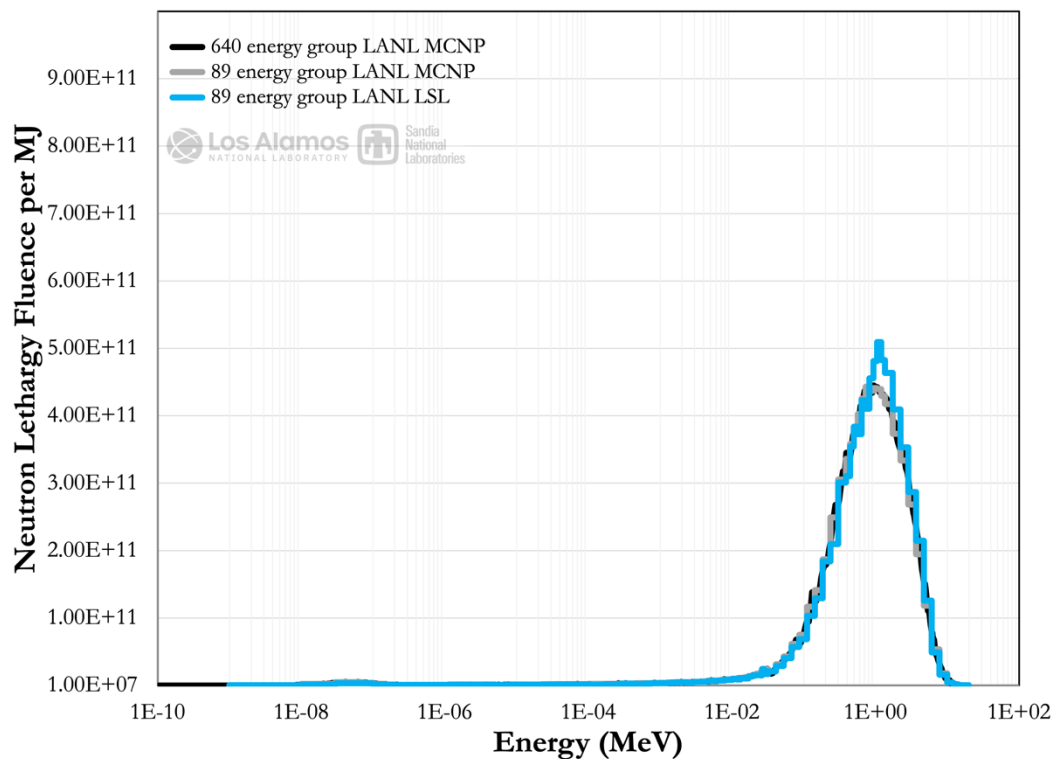


Figure 35. WSMR 24-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (linear-log).

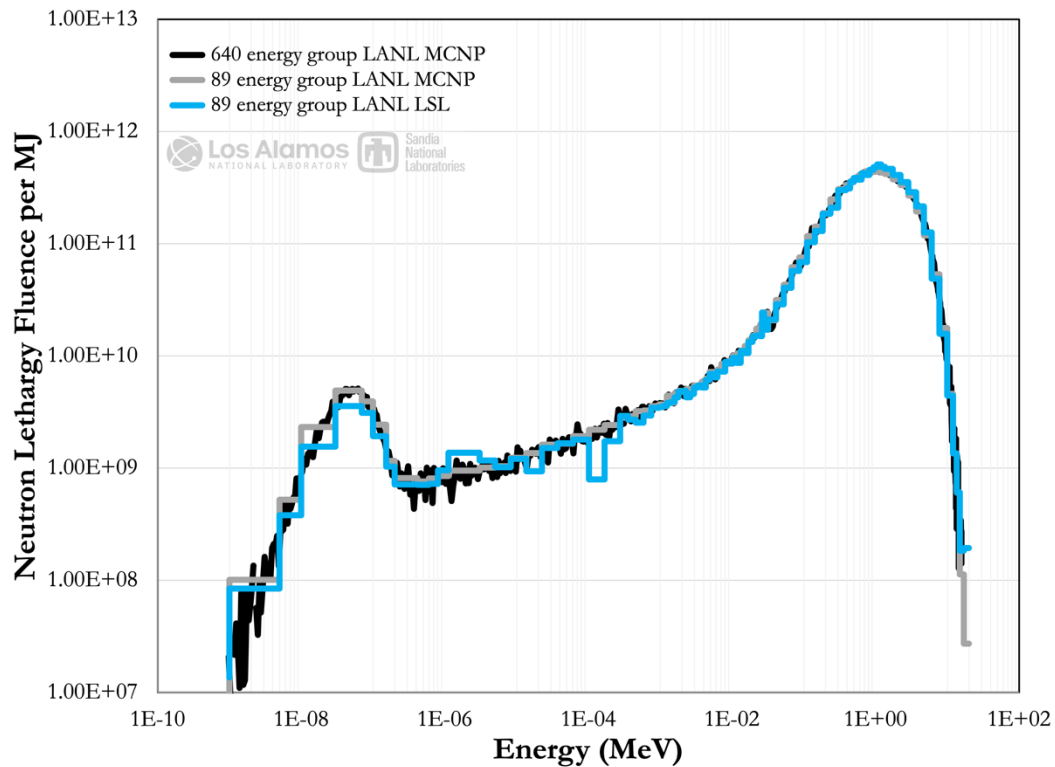


Figure 36. WSMR 24-inch – LANL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MCNP Calculated Results (log-log).

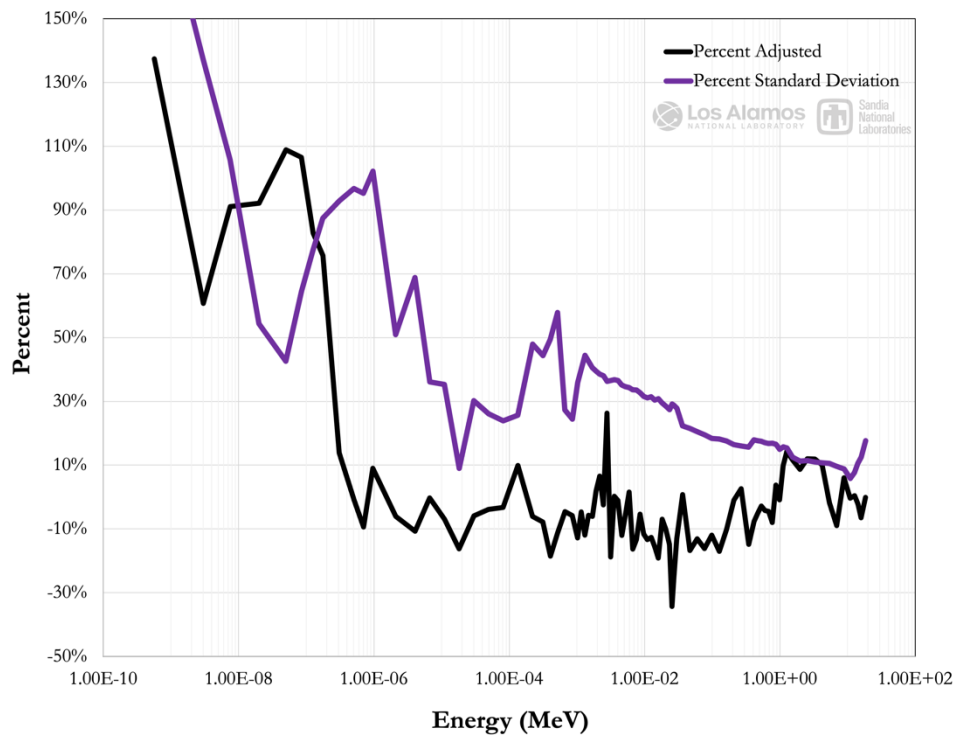


Figure 37. WSMR 6-inch – LANL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.

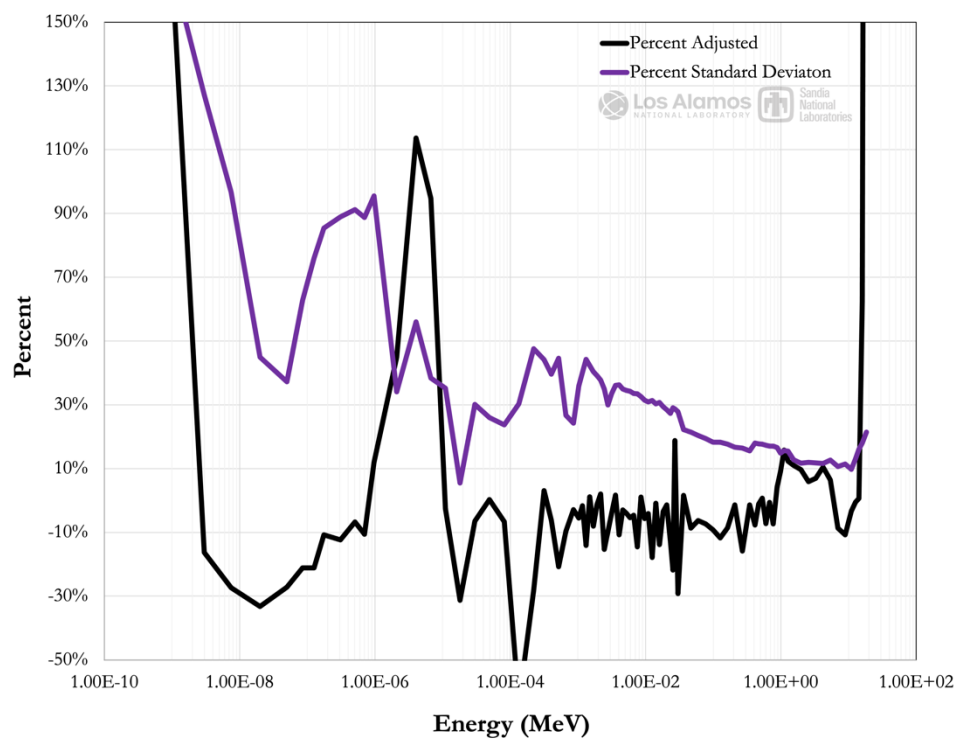


Figure 38. WSMR 24-inch – LANL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.

Table 14. WSMR 6-inch - C/E Values for the Trial and Adjusted LANL LSL Neutron Energy Spectrum.

Activation Reaction	C/E-1 Trial Spectrum (%)	C/E-1 Adjusted Spectrum (%)	Factor Adjusted (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ - Reference	0.00	-0.10	0.00
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	10.86	2.60	9.80
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	5.05	-2.20	4.81
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	-0.93	-7.00	-0.94
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	-10.34	-9.60	-11.53
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	2.96	-3.10	2.87
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	20.19	9.00	16.80
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	8.16	2.30	7.54
$^{59}\text{Co}(n,2n)^{58}\text{Co}$	5.94	1.90	5.61
$^{64}\text{Zn}(n,p)^{64}\text{Cu}$	3.16	3.60	3.06
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	3.00	0.10	2.91
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	1.98	2.40	1.94
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	-11.90	-0.40	-13.51
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$	-11.88	0.20	-13.48
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	-21.79	-0.10	-27.86
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	-24.01	-13.30	-31.60
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	8.05	0.80	7.45
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	-0.63	-0.50	-0.63
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	-6.10	0.10	-6.50
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	11.30	0.30	10.15
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	-9.24	-2.40	-10.18
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	6.88	0.50	6.44
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	7.65	0.60	7.11
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	16.14	0.40	13.90
$^{235}\text{U}(n,f)\text{FP}$ - bare	-2.28	-0.10	-2.33
$^{238}\text{U}(n,f)\text{FP}$ - bare	0.49	0.80	0.49
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	18.39	15.90	15.53
$^{237}\text{Np}(n,f)\text{FP}$ - bare	0.70	-0.90	0.70

Table 15. WSMR 24-inch - C/E Values for the Trial and Adjusted LANL LSL Neutron Energy Spectrum.

Activation Reaction	C/E-1 Trial Spectrum (%)	C/E-1 Adjusted Spectrum (%)	Factor Adjusted (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ – Reference	0.00	1.90	0.00
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	10.98	-1.80	-11.39
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	12.14	-0.30	-12.17
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	25.05	21.30	-23.87
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	-4.38	-2.10	4.63
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	12.39	0.80	-12.02
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	14.92	4.00	-12.24
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	-21.84	-24.20	25.55
$^{64}\text{Zn}(n,p)^{64}\text{Cu}$	5.45	7.40	-5.11
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	6.35	-0.90	-6.42
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	-1.53	2.30	1.49
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	21.39	1.80	-19.50
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$	24.83	2.20	-24.09
$^{55}\text{Mn}(n,\gamma)^{56}\text{Mn}$	13.27	-4.80	-17.14
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	35.31	2.50	-28.00
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	17.78	4.30	-17.50
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	2.78	0.60	-2.67
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	-2.78	0.90	2.60
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	3.01	-0.10	-3.04
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	25.58	-1.20	-30.04
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	-5.22	-0.40	5.29
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	6.28	1.50	-5.49
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	-27.24	-1.50	29.14
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	32.87	1.40	-26.98
$^{235}\text{U}(n,f)\text{FP}$ - bare	-6.31	-3.40	7.76
$^{238}\text{U}(n,f)\text{FP}$ - bare	-3.24	0.00	3.23
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	10.54	13.30	-9.41
$^{237}\text{Np}(n,f)\text{FP}$ - bare	-4.30	-0.50	4.46

Table 16 and Table 17 contain the LSL-M3 adjusted neutron fluence spectrum in a tabular format for the 89-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation for the adjusted spectrum. The number fraction, represented as a histogram, can be used in MCNP source calculations as an isotropic spherical surface source.

For the LANL 6-inch position, the average neutron energy is calculated to be 1.405 MeV. The peak differential number fraction occurs in energy group 4 at 0.02 eV. The differential fluence at 1 MeV

(Group 74) is almost four orders of magnitude lower than the peak. The LSL adjusted results for the number fraction, percent standard deviation, and covariance as a function of the 89-group energy structure are included in an LSL format in Appendix F of this report

For the LANL 24-inch position, the average neutron energy is calculated to be 1.382 MeV. The peak differential number fraction occurs in energy group 4 at 0.02 eV. The differential fluence at 1 MeV (Group 74) is also four orders of magnitude lower than the peak. The LSL adjusted results for the number fraction, percent standard deviation, and covariance as a function of the 89-group energy structure are included in an LSL format in Appendix F of this report

Table 16. LANL Neutron 89-Group Adjusted Energy Spectrum for WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-10	1.0000E-09	5.5000E-10	1.7008E-08	6.2420E-18	1.8897E+01	1.0393E-08	213.37
2	1.0000E-09	5.0000E-09	3.0000E-09	3.5001E-06	7.0068E-15	8.7501E+02	2.6250E-06	162.20
3	5.0000E-09	1.0000E-08	7.5000E-09	1.2009E-05	6.0102E-14	2.4018E+03	1.8014E-05	136.90
4	1.0000E-08	3.0000E-08	2.0000E-08	8.0876E-05	1.0794E-12	4.0438E+03	8.0876E-05	99.73
5	3.0000E-08	7.0000E-08	5.0000E-08	1.4176E-04	4.7297E-12	3.5439E+03	1.7719E-04	86.21
6	7.0000E-08	1.0000E-07	8.5000E-08	5.8954E-05	3.3439E-12	1.9651E+03	1.6704E-04	91.82
7	1.0000E-07	1.5230E-07	1.2615E-07	5.1910E-05	4.3698E-12	9.9254E+02	1.2521E-04	96.28
8	1.5230E-07	2.0000E-07	1.7615E-07	2.5627E-05	3.0124E-12	5.3726E+02	9.4638E-05	101.20
9	2.0000E-07	4.1400E-07	3.0700E-07	5.7004E-05	1.1678E-11	2.6637E+02	8.1776E-05	101.33
10	4.1400E-07	6.0000E-07	5.0700E-07	2.5564E-05	8.6487E-12	1.3744E+02	6.9681E-05	102.04
11	6.0000E-07	8.0000E-07	7.0000E-07	2.0556E-05	9.6020E-12	1.0278E+02	7.1946E-05	99.02
12	8.0000E-07	1.1250E-06	9.6250E-07	1.6210E-05	1.0411E-11	4.9875E+01	4.8005E-05	102.31
13	1.1250E-06	3.0590E-06	2.0920E-06	3.4164E-05	4.7693E-11	1.7665E+01	3.6955E-05	50.68
14	3.0590E-06	5.0430E-06	4.0510E-06	1.8271E-05	4.9391E-11	9.2092E+00	3.7306E-05	68.03
15	5.0430E-06	8.3150E-06	6.6790E-06	2.2866E-05	1.0191E-10	6.9884E+00	4.6675E-05	35.72
16	8.3150E-06	1.3710E-05	1.1013E-05	2.9665E-05	2.1800E-10	5.4986E+00	6.0554E-05	35.26
17	1.3710E-05	2.2600E-05	1.8155E-05	2.8780E-05	3.4866E-10	3.2373E+00	5.8773E-05	8.06
18	2.2600E-05	3.7270E-05	2.9935E-05	4.5003E-05	8.9898E-10	3.0677E+00	9.1832E-05	30.22
19	3.7270E-05	6.1440E-05	4.9355E-05	5.3648E-05	1.7669E-09	2.2196E+00	1.0955E-04	26.09
20	6.1440E-05	1.0130E-04	8.1370E-05	6.7420E-05	3.6608E-09	1.6914E+00	1.3763E-04	23.84
21	1.0130E-04	1.6700E-04	1.3415E-04	8.7309E-05	7.8158E-09	1.3289E+00	1.7827E-04	21.01
22	1.6700E-04	2.7540E-04	2.2120E-04	9.3994E-05	1.3874E-08	8.6710E-01	1.9180E-04	45.20
23	2.7540E-04	3.5360E-04	3.1450E-04	5.3450E-05	1.1217E-08	6.8350E-01	2.1496E-04	38.85
24	3.5360E-04	4.5400E-04	4.0380E-04	5.6347E-05	1.5183E-08	5.6122E-01	2.2662E-04	45.25
25	4.5400E-04	5.8300E-04	5.1850E-04	6.9699E-05	2.4116E-08	5.4030E-01	2.8015E-04	55.89
26	5.8300E-04	7.4850E-04	6.6575E-04	8.3735E-05	3.7200E-08	5.0595E-01	3.3684E-04	27.29
27	7.4850E-04	9.6110E-04	8.5480E-04	8.5780E-05	4.8930E-08	4.0348E-01	3.4490E-04	24.45
28	9.6110E-04	1.0890E-03	1.0251E-03	4.9125E-05	3.3602E-08	3.8409E-01	3.9371E-04	35.91
29	1.0890E-03	1.2340E-03	1.1615E-03	4.9081E-05	3.8041E-08	3.3849E-01	3.9315E-04	40.19
30	1.2340E-03	1.3980E-03	1.3160E-03	4.6241E-05	4.0608E-08	2.8196E-01	3.7106E-04	44.38
31	1.3980E-03	1.5850E-03	1.4915E-03	5.7759E-05	5.7486E-08	3.0887E-01	4.6068E-04	42.48
32	1.5850E-03	1.7960E-03	1.6905E-03	5.5244E-05	6.2320E-08	2.6182E-01	4.4261E-04	40.53
33	1.7960E-03	2.0350E-03	1.9155E-03	6.7347E-05	8.6085E-08	2.8179E-01	5.3977E-04	39.50
34	2.0350E-03	2.3060E-03	2.1705E-03	7.3264E-05	1.0611E-07	2.7035E-01	5.8678E-04	38.55
35	2.3060E-03	2.6130E-03	2.4595E-03	7.4743E-05	1.2267E-07	2.4346E-01	5.9879E-04	37.93
36	2.6130E-03	2.9600E-03	2.7865E-03	9.4046E-05	1.7487E-07	2.7102E-01	7.5521E-04	36.05
37	2.9600E-03	3.3550E-03	3.1575E-03	6.8915E-05	1.4520E-07	1.7447E-01	5.5088E-04	36.38
38	3.3550E-03	3.8010E-03	3.5780E-03	8.9609E-05	2.1395E-07	2.0092E-01	7.1888E-04	36.79
39	3.8010E-03	4.3070E-03	4.0540E-03	9.0633E-05	2.4518E-07	1.7912E-01	7.2614E-04	36.50
40	4.3070E-03	4.8810E-03	4.5940E-03	9.6640E-05	2.9626E-07	1.6836E-01	7.7346E-04	35.13
41	4.8810E-03	5.5310E-03	5.2060E-03	1.1096E-04	3.8548E-07	1.7071E-01	8.8872E-04	34.60
42	5.5310E-03	6.2670E-03	5.8990E-03	1.2351E-04	4.8618E-07	1.6781E-01	9.8992E-04	34.37
43	6.2670E-03	7.1020E-03	6.6845E-03	1.1764E-04	5.2473E-07	1.4088E-01	9.4173E-04	33.63
44	7.1020E-03	8.0470E-03	7.5745E-03	1.3342E-04	6.7439E-07	1.4119E-01	1.0694E-03	33.55
45	8.0470E-03	9.1190E-03	8.5830E-03	1.6425E-04	9.4073E-07	1.5322E-01	1.3151E-03	32.68
46	9.1190E-03	1.0330E-02	9.7245E-03	1.7637E-04	1.1445E-06	1.4564E-01	1.4163E-03	31.54
47	1.0330E-02	1.1710E-02	1.1020E-02	1.9344E-04	1.4225E-06	1.4017E-01	1.5447E-03	31.06
48	1.1710E-02	1.3270E-02	1.2490E-02	2.1381E-04	1.7820E-06	1.3706E-01	1.7118E-03	31.42
49	1.3270E-02	1.5030E-02	1.4150E-02	2.5583E-04	2.4156E-06	1.4536E-01	2.0568E-03	30.40
50	1.5030E-02	1.7040E-02	1.6035E-02	2.7069E-04	2.8965E-06	1.3467E-01	2.1595E-03	30.86
51	1.7040E-02	1.9300E-02	1.8170E-02	3.6061E-04	4.3723E-06	1.5956E-01	2.8992E-03	29.53
52	1.9300E-02	2.1880E-02	2.0590E-02	4.3449E-04	5.9698E-06	1.6841E-01	3.4675E-03	28.60
53	2.1880E-02	2.4790E-02	2.3335E-02	5.3555E-04	8.3393E-06	1.8404E-01	4.2945E-03	27.42
54	2.4790E-02	2.6060E-02	2.5425E-02	2.1632E-04	3.6701E-06	1.7033E-01	4.3306E-03	29.17
55	2.6060E-02	2.8090E-02	2.7075E-02	3.9105E-04	7.0652E-06	1.9264E-01	5.2156E-03	28.83
56	2.8090E-02	3.1830E-02	2.9960E-02	8.9915E-04	1.7976E-05	2.4042E-01	7.2028E-03	27.91
57	3.1830E-02	4.0870E-02	3.6350E-02	2.3418E-03	5.6803E-05	2.5904E-01	9.4163E-03	22.32
58	4.0870E-02	5.2480E-02	4.6675E-02	3.0978E-03	9.6486E-05	2.6682E-01	1.2454E-02	21.56
59	5.2480E-02	6.7380E-02	5.9930E-02	4.9882E-03	1.9949E-04	3.3478E-01	2.0063E-02	20.48

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
60	6.7380E-02	8.6520E-02	7.6950E-02	8.1300E-03	4.1747E-04	4.2476E-01	3.2685E-02	19.53
61	8.6520E-02	1.1110E-01	9.8810E-02	1.1188E-02	7.3770E-04	4.5517E-01	4.4975E-02	18.36
62	1.1110E-01	1.4260E-01	1.2685E-01	1.6623E-02	1.4071E-03	5.2770E-01	6.6939E-02	18.19
63	1.4260E-01	1.8320E-01	1.6290E-01	2.4424E-02	2.6550E-03	6.0158E-01	9.7998E-02	17.51
64	1.8320E-01	2.3520E-01	2.0920E-01	3.4635E-02	4.8350E-03	6.6605E-01	1.3934E-01	16.32
65	2.3520E-01	3.0200E-01	2.6860E-01	4.8146E-02	8.6295E-03	7.2074E-01	1.9359E-01	15.90
66	3.0200E-01	3.8770E-01	3.4485E-01	4.9814E-02	1.1463E-02	5.8126E-01	2.0045E-01	15.53
67	3.8770E-01	4.3940E-01	4.1355E-01	3.0907E-02	8.5292E-03	5.9781E-01	2.4723E-01	17.90
68	4.3940E-01	4.9790E-01	4.6865E-01	3.3300E-02	1.0414E-02	5.6923E-01	2.6677E-01	17.66
69	4.9790E-01	5.6420E-01	5.3105E-01	3.6674E-02	1.2996E-02	5.5316E-01	2.9375E-01	17.50
70	5.6420E-01	6.3930E-01	6.0175E-01	3.7179E-02	1.4929E-02	4.9506E-01	2.9790E-01	17.12
71	6.3930E-01	7.2440E-01	6.8185E-01	3.8621E-02	1.7572E-02	4.5383E-01	3.0944E-01	16.90
72	7.2440E-01	8.2080E-01	7.7260E-01	3.8632E-02	1.9917E-02	4.0075E-01	3.0962E-01	16.93
73	8.2080E-01	9.3010E-01	8.7545E-01	4.3413E-02	2.5361E-02	3.9719E-01	3.4772E-01	16.56
74	9.3010E-01	1.0540E+00	9.9205E-01	4.3290E-02	2.8658E-02	3.4939E-01	3.4662E-01	14.96
75	1.0540E+00	1.1940E+00	1.1240E+00	4.6510E-02	3.4885E-02	3.3222E-01	3.7341E-01	15.67
76	1.1940E+00	1.3530E+00	1.2735E+00	4.7161E-02	4.0078E-02	2.9661E-01	3.7773E-01	15.35
77	1.3530E+00	1.7380E+00	1.5455E+00	9.0013E-02	9.2832E-02	2.3380E-01	3.6134E-01	12.37
78	1.7380E+00	2.2310E+00	1.9845E+00	8.2573E-02	1.0935E-01	1.6749E-01	3.3239E-01	11.19
79	2.2310E+00	2.8650E+00	2.5480E+00	7.4799E-02	1.2718E-01	1.1798E-01	3.0061E-01	11.52
80	2.8650E+00	3.6790E+00	3.2720E+00	6.2648E-02	1.3679E-01	7.6963E-02	2.5182E-01	11.07
81	3.6790E+00	4.7240E+00	4.2015E+00	4.5165E-02	1.2663E-01	4.3220E-02	1.8159E-01	10.77
82	4.7240E+00	6.0650E+00	5.3945E+00	2.3879E-02	8.5958E-02	1.7807E-02	9.6058E-02	10.57
83	6.0650E+00	7.7880E+00	6.9265E+00	1.0208E-02	4.7180E-02	5.9243E-03	4.1035E-02	9.61
84	7.7880E+00	1.0000E+01	8.8940E+00	3.8723E-03	2.2982E-02	1.7506E-03	1.5570E-02	8.72
85	1.0000E+01	1.1910E+01	1.0955E+01	7.1439E-04	5.2224E-03	3.7403E-04	4.0975E-03	5.83
86	1.1910E+01	1.3500E+01	1.2705E+01	1.5348E-04	1.3012E-03	9.6526E-05	1.2264E-03	7.74
87	1.3500E+01	1.4920E+01	1.4210E+01	4.4478E-05	4.2176E-04	3.1323E-05	4.4510E-04	10.58
88	1.4920E+01	1.6900E+01	1.5910E+01	1.9136E-05	2.0316E-04	9.6646E-06	1.5376E-04	12.53
89	1.6900E+01	2.0000E+01	1.8450E+01	4.5617E-06	5.6162E-05	1.4715E-06	2.7149E-05	17.75

Table 17. LANL Neutron 89-Group Adjusted Energy Spectrum for WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-10	1.0000E-09	5.5000E-10	1.6735E-05	6.6381E-15	1.8594E+04	1.0227E-05	187.15
2	1.0000E-09	5.0000E-09	3.0000E-09	8.4563E-05	1.8296E-13	2.1141E+04	6.3422E-05	127.20
3	5.0000E-09	1.0000E-08	7.5000E-09	1.8975E-04	1.0263E-12	3.7949E+04	2.8462E-04	96.62
4	1.0000E-08	3.0000E-08	2.0000E-08	1.1653E-03	1.6808E-11	5.8264E+04	1.1653E-03	44.97
5	3.0000E-08	7.0000E-08	5.0000E-08	2.1437E-03	7.7303E-11	5.3593E+04	2.6796E-03	37.22
6	7.0000E-08	1.0000E-07	8.5000E-08	8.2022E-04	5.0282E-11	2.7341E+04	2.3240E-03	62.76
7	1.0000E-07	1.5230E-07	1.2615E-07	5.9742E-04	5.4354E-11	1.1423E+04	1.4410E-03	75.97
8	1.5230E-07	2.0000E-07	1.7615E-07	2.1003E-04	2.6682E-11	4.4031E+03	7.7560E-04	85.36
9	2.0000E-07	4.1400E-07	3.0700E-07	3.7347E-04	8.2690E-11	1.7452E+03	5.3577E-04	88.94
10	4.1400E-07	6.0000E-07	5.0700E-07	1.9536E-04	7.1432E-11	1.0503E+03	5.3250E-04	91.18
11	6.0000E-07	8.0000E-07	7.0000E-07	1.5525E-04	7.8377E-11	7.7626E+02	5.4338E-04	88.76
12	8.0000E-07	1.1250E-06	9.6250E-07	2.4171E-04	1.6779E-10	7.4373E+02	7.1584E-04	95.46
13	1.1250E-06	3.0590E-06	2.0920E-06	9.5235E-04	1.4369E-09	4.9242E+02	1.0302E-03	34.07
14	3.0590E-06	5.0430E-06	4.0510E-06	7.9565E-04	2.3246E-09	4.0103E+02	1.6246E-03	56.03
15	5.0430E-06	8.3150E-06	6.6790E-06	7.4230E-04	3.5756E-09	2.2686E+02	1.5152E-03	38.36
16	8.3150E-06	1.3710E-05	1.1013E-05	4.4368E-04	3.5238E-09	8.2239E+01	9.0565E-04	35.20
17	1.3710E-05	2.2600E-05	1.8155E-05	3.4466E-04	4.5128E-09	3.8769E+01	7.0386E-04	5.48
18	2.2600E-05	3.7270E-05	2.9935E-05	5.5490E-04	1.1980E-08	3.7825E+01	1.1323E-03	30.10
19	3.7270E-05	6.1440E-05	4.9355E-05	6.1018E-04	2.1719E-08	2.5245E+01	1.2460E-03	25.98
20	6.1440E-05	1.0130E-04	8.1370E-05	6.6247E-04	3.8876E-08	1.6620E+01	1.3524E-03	23.74
21	1.0130E-04	1.6700E-04	1.3415E-04	2.9226E-04	2.8276E-08	4.4484E+00	5.9676E-04	30.28
22	1.6700E-04	2.7540E-04	2.2120E-04	6.3988E-04	1.0208E-07	5.9030E+00	1.3057E-03	47.58
23	2.7540E-04	3.5360E-04	3.1450E-04	5.4377E-04	1.2334E-07	6.9535E+00	2.1869E-03	44.16
24	3.5360E-04	4.5400E-04	4.0380E-04	5.0575E-04	1.4729E-07	5.0373E+00	2.0341E-03	39.56
25	4.5400E-04	5.8300E-04	5.1850E-04	4.7534E-04	1.7775E-07	3.6848E+00	1.9106E-03	44.61
26	5.8300E-04	7.4850E-04	6.6575E-04	5.4901E-04	2.6360E-07	3.3173E+00	2.2085E-03	26.67
27	7.4850E-04	9.6110E-04	8.5480E-04	6.4569E-04	3.9806E-07	3.0371E+00	2.5961E-03	24.27
28	9.6110E-04	1.0890E-03	1.0251E-03	3.2756E-04	2.4216E-07	2.5611E+00	2.6253E-03	35.87
29	1.0890E-03	1.2340E-03	1.1615E-03	3.3516E-04	2.8076E-07	2.3115E+00	2.6848E-03	40.15
30	1.2340E-03	1.3980E-03	1.3160E-03	3.5610E-04	3.3798E-07	2.1714E+00	2.8575E-03	44.29
31	1.3980E-03	1.5850E-03	1.4915E-03	3.6524E-04	3.9288E-07	1.9532E+00	2.9131E-03	42.34
32	1.5850E-03	1.7960E-03	1.6905E-03	4.0077E-04	4.8861E-07	1.8994E+00	3.2109E-03	40.36
33	1.7960E-03	2.0350E-03	1.9155E-03	4.4988E-04	6.2149E-07	1.8823E+00	3.6056E-03	39.18
34	2.0350E-03	2.3060E-03	2.1705E-03	4.5742E-04	7.1603E-07	1.6879E+00	3.6636E-03	37.75
35	2.3060E-03	2.6130E-03	2.4595E-03	3.9989E-04	7.0932E-07	1.3026E+00	3.2037E-03	34.97
36	2.6130E-03	2.9600E-03	2.7865E-03	4.2773E-04	8.5958E-07	1.2326E+00	3.4348E-03	29.94
37	2.9600E-03	3.3550E-03	3.1575E-03	4.9061E-04	1.1172E-06	1.2420E+00	3.9217E-03	33.44
38	3.3550E-03	3.8010E-03	3.5780E-03	5.1056E-04	1.3175E-06	1.1448E+00	4.0959E-03	36.12
39	3.8010E-03	4.3070E-03	4.0540E-03	4.9030E-04	1.4335E-06	9.6898E-01	3.9282E-03	36.28
40	4.3070E-03	4.8810E-03	4.5940E-03	5.6978E-04	1.8878E-06	9.9266E-01	4.5603E-03	34.96
41	4.8810E-03	5.5310E-03	5.2060E-03	6.4566E-04	2.4242E-06	9.9332E-01	5.1712E-03	34.46
42	5.5310E-03	6.2670E-03	5.8990E-03	6.0241E-04	2.5629E-06	8.1849E-01	4.8283E-03	34.24
43	6.2670E-03	7.1020E-03	6.6845E-03	6.7672E-04	3.2624E-06	8.1045E-01	5.4174E-03	33.51
44	7.1020E-03	8.0470E-03	7.5745E-03	6.7983E-04	3.7137E-06	7.1939E-01	5.4490E-03	33.43
45	8.0470E-03	9.1190E-03	8.5830E-03	8.3093E-04	5.1435E-06	7.7512E-01	6.6529E-03	32.56
46	9.1190E-03	1.0330E-02	9.7245E-03	8.0058E-04	5.6147E-06	6.6109E-01	6.4287E-03	31.42
47	1.0330E-02	1.1710E-02	1.1020E-02	9.0713E-04	7.2096E-06	6.5734E-01	7.2439E-03	30.94
48	1.1710E-02	1.3270E-02	1.2490E-02	8.1238E-04	7.3178E-06	5.2076E-01	6.5042E-03	31.31
49	1.3270E-02	1.5030E-02	1.4150E-02	1.0287E-03	1.0498E-05	5.8447E-01	8.2703E-03	30.28
50	1.5030E-02	1.7040E-02	1.6035E-02	9.9554E-04	1.1513E-05	4.9529E-01	7.9420E-03	30.74
51	1.7040E-02	1.9300E-02	1.8170E-02	1.2427E-03	1.6284E-05	5.4986E-01	9.9909E-03	29.41
52	1.9300E-02	2.1880E-02	2.0590E-02	1.3978E-03	2.0757E-05	5.4179E-01	1.1155E-02	28.48
53	2.1880E-02	2.4790E-02	2.3335E-02	1.4275E-03	2.4024E-05	4.9055E-01	1.1447E-02	27.29
54	2.4790E-02	2.6060E-02	2.5425E-02	5.6098E-04	1.0287E-05	4.4172E-01	1.1231E-02	29.03
55	2.6060E-02	2.8090E-02	2.7075E-02	1.3672E-03	2.6697E-05	6.7351E-01	1.8235E-02	28.70
56	2.8090E-02	3.1830E-02	2.9960E-02	1.6041E-03	3.4660E-05	4.2890E-01	1.2850E-02	27.81
57	3.1830E-02	4.0870E-02	3.6350E-02	3.9355E-03	1.0317E-04	4.3535E-01	1.5825E-02	22.23
58	4.0870E-02	5.2480E-02	4.6675E-02	5.3664E-03	1.8064E-04	4.6222E-01	2.1574E-02	21.44
59	5.2480E-02	6.7380E-02	5.9930E-02	7.5355E-03	3.2570E-04	5.0574E-01	3.0309E-02	20.37

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
60	6.7380E-02	8.6520E-02	7.6950E-02	1.0673E-02	5.9230E-04	5.5761E-01	4.2908E-02	19.44
61	8.6520E-02	1.1110E-01	9.8810E-02	1.2770E-02	9.1003E-04	5.1953E-01	5.1335E-02	18.30
62	1.1110E-01	1.4260E-01	1.2685E-01	1.9217E-02	1.7581E-03	6.1006E-01	7.7386E-02	18.23
63	1.4260E-01	1.8320E-01	1.6290E-01	2.4185E-02	2.8414E-03	5.9569E-01	9.7039E-02	17.61
64	1.8320E-01	2.3520E-01	2.0920E-01	3.4360E-02	5.1841E-03	6.6077E-01	1.3823E-01	16.66
65	2.3520E-01	3.0200E-01	2.6860E-01	3.9111E-02	7.5764E-03	5.8549E-01	1.5726E-01	16.39
66	3.0200E-01	3.8770E-01	3.4485E-01	5.6140E-02	1.3962E-02	6.5507E-01	2.2590E-01	15.54
67	3.8770E-01	4.3940E-01	4.1355E-01	2.9122E-02	8.6856E-03	5.6328E-01	2.3294E-01	18.00
68	4.3940E-01	4.9790E-01	4.6865E-01	3.3191E-02	1.1218E-02	5.6737E-01	2.6590E-01	17.78
69	4.9790E-01	5.6420E-01	5.3105E-01	3.5965E-02	1.3774E-02	5.4246E-01	2.8807E-01	17.65
70	5.6420E-01	6.3930E-01	6.0175E-01	3.4914E-02	1.5152E-02	4.6489E-01	2.7975E-01	17.31
71	6.3930E-01	7.2440E-01	6.8185E-01	3.9605E-02	1.9476E-02	4.6539E-01	3.1733E-01	17.04
72	7.2440E-01	8.2080E-01	7.7260E-01	3.8397E-02	2.1395E-02	3.9831E-01	3.0774E-01	17.03
73	8.2080E-01	9.3010E-01	8.7545E-01	4.2663E-02	2.6936E-02	3.9032E-01	3.4171E-01	16.59
74	9.3010E-01	1.0540E+00	9.9205E-01	4.5070E-02	3.2246E-02	3.6376E-01	3.6087E-01	14.88
75	1.0540E+00	1.1940E+00	1.1240E+00	4.7574E-02	3.8565E-02	3.3981E-01	3.8195E-01	15.61
76	1.1940E+00	1.3530E+00	1.2735E+00	4.5204E-02	4.1518E-02	2.8430E-01	3.6206E-01	15.42
77	1.3530E+00	1.7380E+00	1.5455E+00	8.6622E-02	9.6551E-02	2.2499E-01	3.4773E-01	12.72
78	1.7380E+00	2.2310E+00	1.9845E+00	7.6286E-02	1.0918E-01	1.5474E-01	3.0708E-01	11.65
79	2.2310E+00	2.8650E+00	2.5480E+00	6.5973E-02	1.2123E-01	1.0406E-01	2.6514E-01	11.94
80	2.8650E+00	3.6790E+00	3.2720E+00	5.3597E-02	1.2648E-01	6.5844E-02	2.1544E-01	11.74
81	3.6790E+00	4.7240E+00	4.2015E+00	4.0094E-02	1.2149E-01	3.8367E-02	1.6120E-01	11.61
82	4.7240E+00	6.0650E+00	5.3945E+00	2.3454E-02	9.1247E-02	1.7490E-02	9.4347E-02	12.67
83	6.0650E+00	7.7880E+00	6.9265E+00	9.1275E-03	4.5596E-02	5.2974E-03	3.6693E-02	10.63
84	7.7880E+00	1.0000E+01	8.8940E+00	2.9449E-03	1.8890E-02	1.3313E-03	1.1841E-02	11.42
85	1.0000E+01	1.1910E+01	1.0955E+01	5.7931E-04	4.5770E-03	3.0330E-04	3.3227E-03	9.71
86	1.1910E+01	1.3500E+01	1.2705E+01	1.2678E-04	1.1617E-03	7.9738E-05	1.0131E-03	13.09
87	1.3500E+01	1.4920E+01	1.4210E+01	4.5742E-05	4.6877E-04	3.2212E-05	4.5774E-04	16.06
88	1.4920E+01	1.6900E+01	1.5910E+01	1.7191E-05	1.9726E-04	8.6825E-06	1.3814E-04	18.00
89	1.6900E+01	2.0000E+01	1.8450E+01	2.4377E-05	3.2436E-04	7.8634E-06	1.4508E-04	21.46

The results for several integral metrics and conversion factors are shown in Table 18 and Table 19 for the 6-inch and 24-inch test positions, respectively. The total neutron fluence is normalized to 1.00 and the other values for fluence are in reference to this value. These values were calculated as part of the LSL analysis. Conversion values to translate to n/cm² are given for fissions in the reactor, MJ of reactor energy, and ⁵⁸Ni(n,p)⁵⁸Co activity at the characterized location in the cavity. In order to maintain consistency, the experimenter should always use a reference fast neutron reaction or reactions, e.g. ⁵⁸Ni(n,p)⁵⁸Co and/or ³²S(n,p)³²P, as a normalizing metric between operations. Typically, Ni, S, and TLD sensors are included in an experiment package in order to normalize the results of the experiment. It must be noted that portions of the energy spectrum are highly correlated, so the uncertainty in the integral metric can be much less than the average uncertainty. Users should perform uncertainty propagation using the full energy-dependent covariance matrix given in Appendix C in order to determine the correlated uncertainty.

Table 18. WSMR 6-inch Location – LANL Integral Neutron Spectrum Metrics and Associated Uncertainties.

Metric	Integral Response	Standard Deviation (%)
Total Neutron Fluence Average Neutron Energy = 1.405 MeV	1.00	--
Fluence > 3 MeV	0.133	5.1
Fluence > 1 MeV	0.512	3.5
Fluence > 100 keV	0.963	0.57
Fluence > 10 keV	0.997	0.45
Fluence < 1 keV	0.001	10.7
Fluence < 1 eV	0.0004	33.4
Fluence 1-MeV(Si) Eqv. E722-94 (Ref. 1-MeV value = 95 MeV-mb)	83.8 MeV-mb 0.899	1.0
Fluence 1-MeV(GaAs) Eqv. E722-94 (Ref. 1-MeV value = 70 MeV-mb)	64.2 MeV-mb 0.917	0.8
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ Spectrum Avg. Cross Section IRDFF-II	61.63 mb	4.2
$^{32}\text{S}(n,p)^{32}\text{P}$ Spectrum Avg. Cross Section IRDFF-II (Ref. Cf spectrum = 74.10 mb +/- 2.6%)	38.75 mb	4.9
Total Fluence Conversion ($[\text{n}/\text{cm}^2]/\text{fission}$)	6.804E-04	0.4
Total Fluence Conversion ($[\text{n}/\text{cm}^2]/\text{MJ}$)	2.393E+13	0.5
Total Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\text{n}/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	1.433E+32	4.2
Total Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\text{n}/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	1.378E+10	4.2
Power Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($\text{MJ}/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	6.604E+18	4.6
Power Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($\text{MJ}/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	6.353E-04	4.6
Total Fluence Conversion From S Activation ($[\text{n}/\text{cm}^2]/\text{Fluence } ^{32}\text{S}(n,p) \text{ Cf-equiv.}$)	1.812	3.7

Table 19. WSMR 24-inch Location – LANL Integral Neutron Spectrum Metrics and Associated Uncertainties.

Metric	Integral Response	Standard Deviation (%)
Total Neutron Fluence Average Neutron Energy = 1.382 MeV	1.00	--
Fluence > 3 MeV	0.115	5.7
Fluence > 1 MeV	0.477	3.9
Fluence > 100 keV	0.922	0.74
Fluence > 10 keV	0.973	0.51
Fluence < 1 keV	0.016	10.0
Fluence < 1 eV	0.008	23.9
Fluence 1-MeV(Si) Eqv. E722-94 (Ref. 1-MeV value = 95 MeV-mb)	81.4 MeV-mb 0.833	1.2
Fluence 1-MeV(GaAs) Eqv. E722-94 (Ref. 1-MeV value = 70 MeV-mb)	62.4 MeV-mb 0.873	1.1
⁵⁸ Ni(n,p) ⁵⁸ Co Spectrum Avg. Cross Section IRDFF-II	57.92 mb	5.3
³² S(n,p) ³² P Spectrum Avg. Cross Section IRDFF-II (Ref. Cf spectrum = 74.10 mb +/- 2.6%)	36.43 mb	5.3
Total Fluence Conversion ([n/cm ²]/fission)	3.900E-06	0.3
Total Fluence Conversion ([n/cm ²]/MJ)	1.276E+12	0.4
Total Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([n/cm ²]/[Bq/atom _{Ni-58}])	1.524E+32	5.3
Total Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([n/cm ²]/[Bq/g _{Ni-58}])	1.467E+10	5.3
Power Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co (MJ/[Bq/atom _{Ni-58}])	1.228E+20	5.7
Power Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co (MJ/[Bq/g _{Ni-58}])	1.182E-02	5.7
Total Fluence Conversion From S Activation ([n/cm ²]/Fluence ³² S(n,p) Cf-equiv)	1.795	3.7

Table 20 and Table 21 show representative integral metrics that may also be useful to the experimenter. These values were calculated using the LSL adjusted 89-group neutron energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, Si damage, C dose, and TLD dose.

Table 20. WSMR 6-inch Location - Other LANL Neutron Spectrum Metrics.

Metric	Integral Response
Total Si Dose ($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	6.852E-11
Ionizing Si Dose($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	4.040E-11
Percent Neutron Si Dose Ionizing (%)	58.97%
Total Carbon Dose ($\text{rad}[\text{C}]/[\text{n}/\text{cm}^2]$)	3.104E-10
Total $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.410E-10
Effective Ionizing $\text{CaF}_2\text{:Mn}$ Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.544E-11
Percent Neutron $\text{CaF}_2\text{:Mn}$ Dose total light (%)	10.96

Table 21. WSMR 24-inch Location - Other LANL Neutron Spectrum Metrics.

Metric	Integral Response
Total Si Dose ($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	6.512E-11
Ionizing Si Dose($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	3.827E-11
Percent Neutron Si Dose Ionizing (%)	58.77%
Total Carbon Dose ($\text{rad}[\text{C}]/[\text{n}/\text{cm}^2]$)	2.953E-10
Total $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.336E-10
Effective Ionizing $\text{CaF}_2\text{:Mn}$ Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.456E-11
Percent Neutron $\text{CaF}_2\text{:Mn}$ Dose total light (%)	10.90

4.3.3. LLNL LSL Spectrum Results

The resulting value for χ^2/dof is 0.85 and 0.91, for the 6-inch and 24-inch spectra, respectively. Both χ^2/dof results represent highly acceptable values. Figure 39 and Figure 40 for the 6-inch location and Figure 41 and Figure 42 for the 24-inch location show the same representation of the neutron energy spectra as previously shown in Figure 20 and Figure 21 for 6-inch location and Figure 22 and Figure 23 for the 24-inch location, with the additional 89-group adjusted spectrum result from the LSL analysis (blue curve). Figure 43 for the 6-inch location and Figure 44 for the 24-inch location shows

the percent adjustment made to the trial spectrum (black curve), and the percent standard deviation in the adjusted spectrum (purple curve).

Table 22 for the 6-inch location and Table 23 for the 24-inch location shows the result of the calculated to experimental (C/E) dosimetry results for the trial spectrum and the adjusted spectrum. Also shown is the factor adjusted from the trial spectrum to the adjusted spectrum for the dosimetry reactions. For the high-energy reactions, the C/E-1 values are found to be both positive and negative for the trial spectrum and are reduced for the adjusted spectrum. For the radiative capture reactions, the C/E-1 values are all negative for the trial spectrum. This infers that the thermal/epithermal calculated fluence is too low. After the adjustment, the results become much closer to zero for C/E-1.

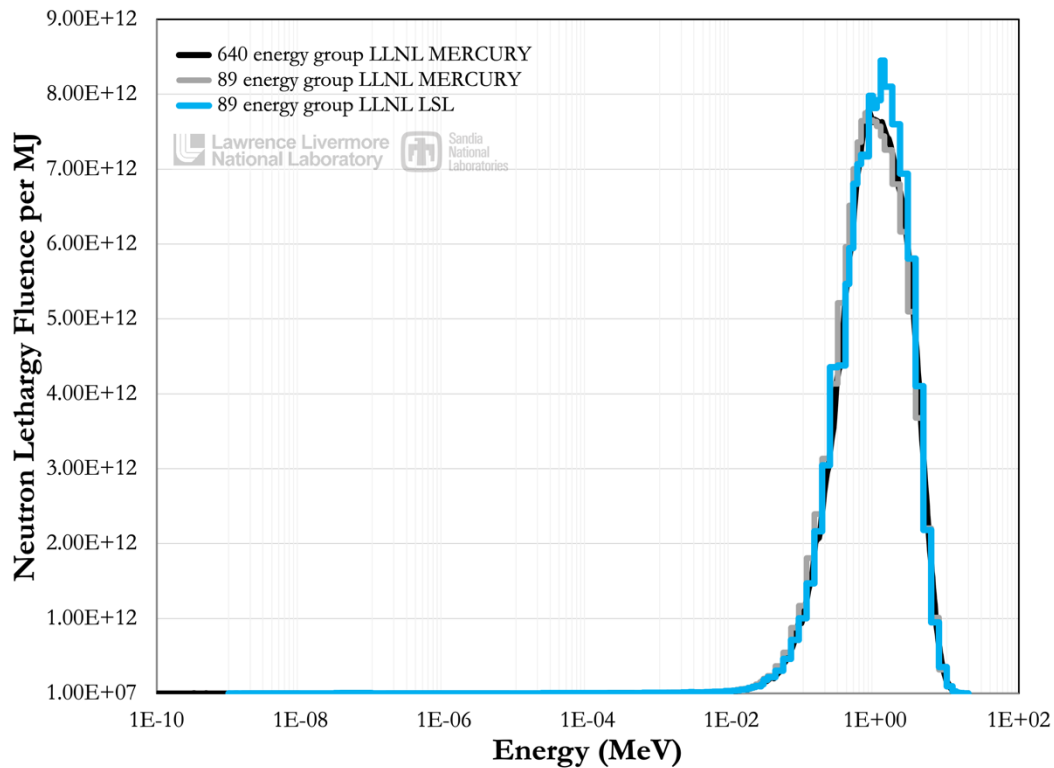


Figure 39. WSMR 6-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (linear-log).

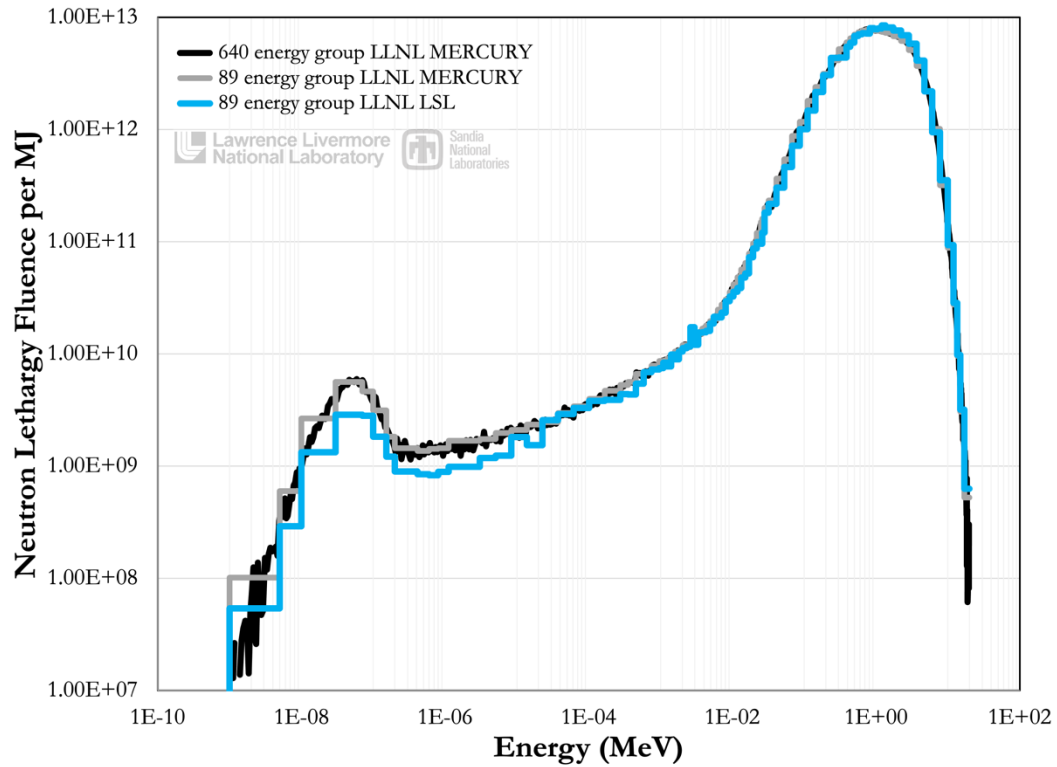


Figure 40. WSMR 6-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (log-log).

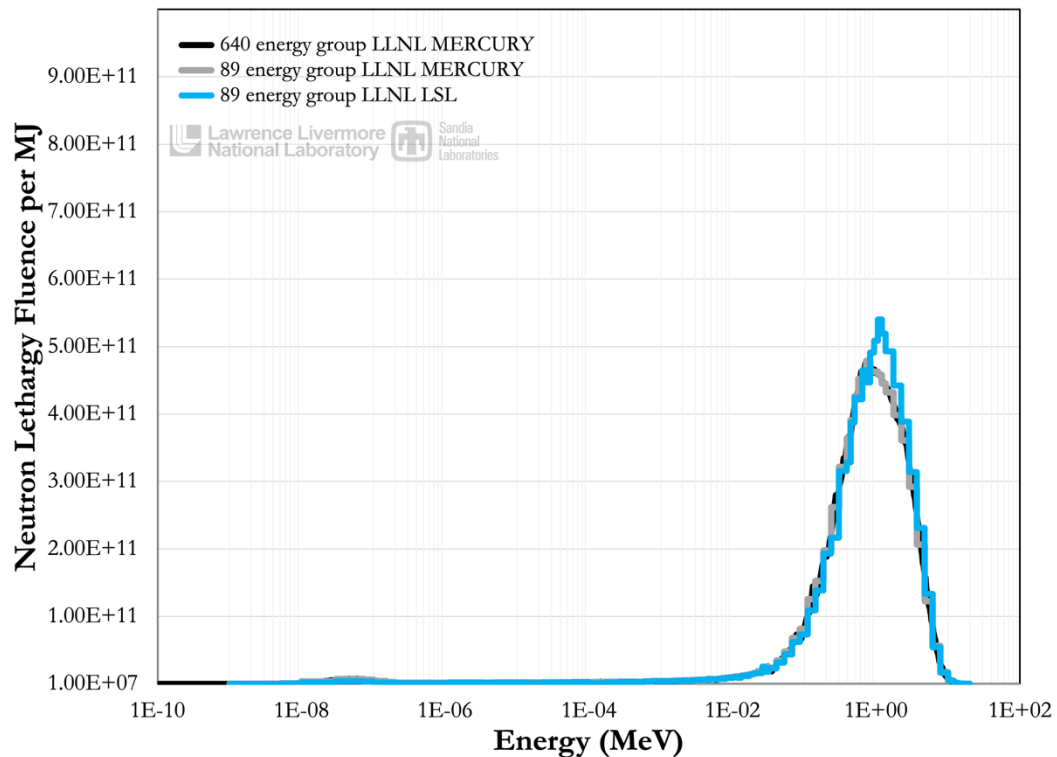


Figure 41. WSMR 24-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (linear-log).

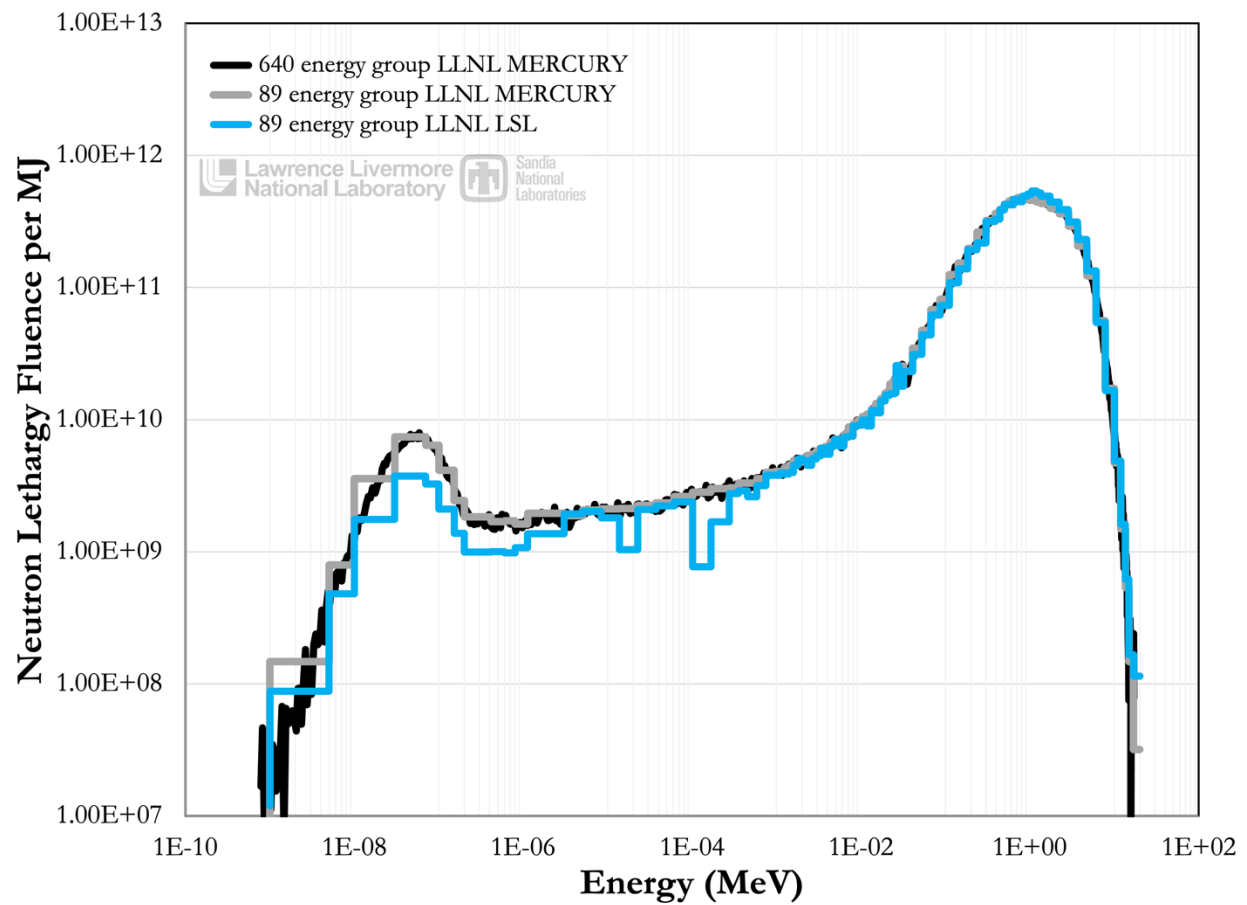


Figure 42. WSMR 24-inch – LLNL LSL Adjusted 89-Group Neutron Lethargy Fluence Energy Spectrum Compared to the MERCURY Calculated Results (log-log).

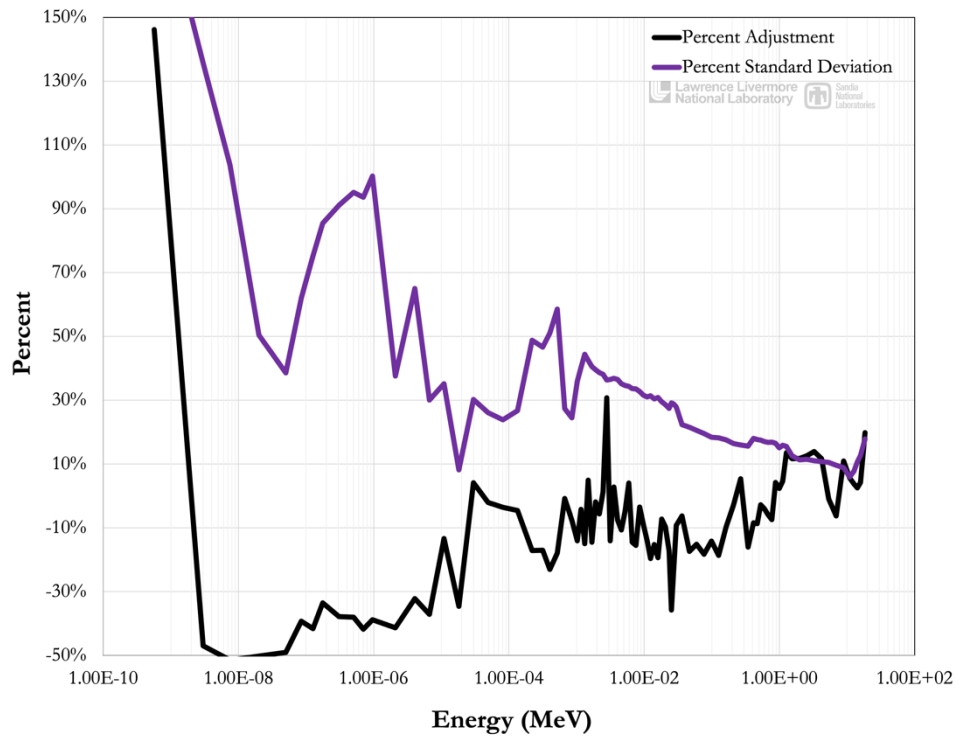


Figure 43. WSMR 6-inch – LLNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.

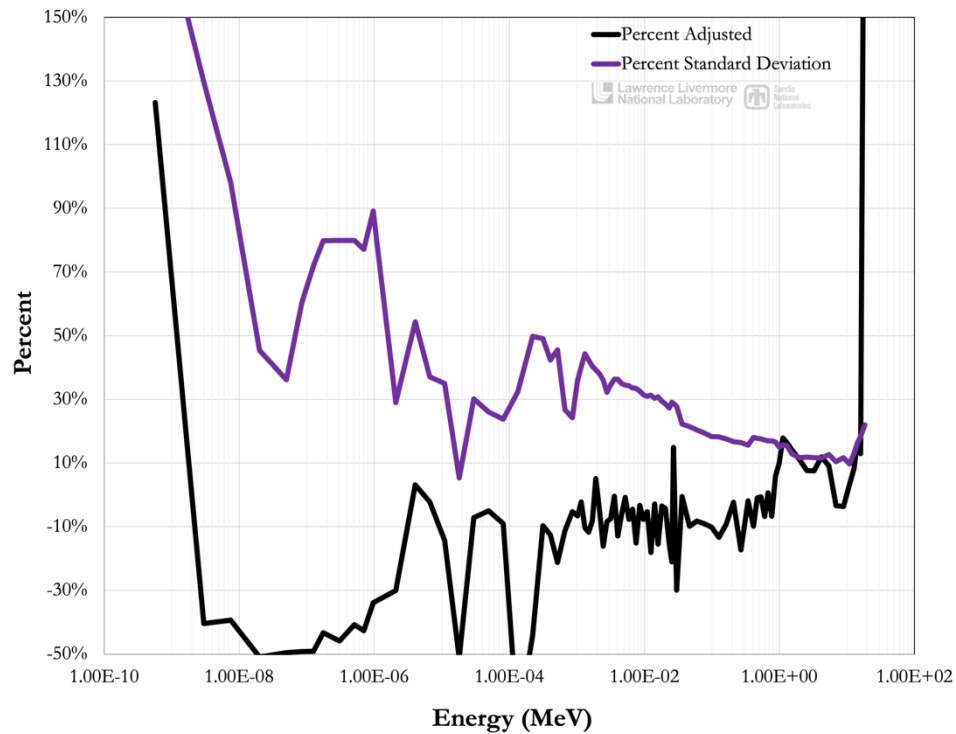


Figure 44. WSMR 24-inch – LLNL LSL Percent Adjustment to the Trial Spectrum and Standard Deviation Results for the 89-Group Adjusted Neutron Spectrum.

Table 22. WSMR 6-inch - C/E Values for the Trial and Adjusted LLNL LSL Neutron Energy Spectrum.

Activation Reaction	C/E-1 Trial Spectrum (%)	C/E-1 Adjusted Spectrum (%)	Factor Adjusted (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ - Reference	0.00	0.20	0.00
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	7.72	2.40	7.17
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	1.98	-2.40	1.94
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	-10.74	-9.30	-12.03
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	0.35	-3.10	0.35
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	18.07	9.10	15.30
$^{54}\text{Fe}(n,p)^{54}\text{Mn}$	7.60	2.40	7.06
$^{56}\text{Fe}(n,p)^{56}\text{Mn}$	5.44	1.40	5.16
$^{90}\text{Zr}(n,2n)^{89}\text{Zr}$	3.47	3.90	3.35
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	2.26	0.50	2.21
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	-0.03	2.40	-0.03
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$	18.53	-0.80	15.63
$^{58}\text{Fe}(n,\gamma)^{59}\text{Fe}$	32.43	0.60	24.49
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	29.59	-0.20	22.83
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	-18.65	-15.60	-22.93
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	4.03	0.60	3.87
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	13.27	-0.50	11.72
$^{23}\text{Na}(n,\gamma)^{24}\text{Na}$ - Cd	24.68	0.50	19.79
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$ - Cd	27.76	1.30	21.73
$^{109}\text{Ag}(n,\gamma)^{110}\text{Ag}$ - Cd	-12.32	-2.90	-14.05
$^{115}\text{In}(n,\gamma)^{116}\text{In}$ - Cd	2.75	0.40	2.68
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	14.62	0.70	12.76
$^{235}\text{U}(n,f)\text{FP}$ - bare	19.54	-0.30	16.35
$^{238}\text{U}(n,f)\text{FP}$ - bare	8.18	-0.70	7.56
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	-1.20	1.00	-1.21
$^{237}\text{Np}(n,f)\text{FP}$ - bare	15.19	15.20	13.19

Table 23. WSMR 24-inch - C/E Values for the Trial and Adjusted LLNL LSL Neutron Energy Spectrum.

Activation Reaction	C/E-1 Trial Spectrum (%)	C/E-1 Adjusted Spectrum (%)	Factor Adjusted (%)
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ - Reference	0.00	2.00	0.00
$^{24}\text{Mg}(n,p)^{24}\text{Na}$	5.78	-2.20	-6.02
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	6.65	-0.70	-6.70
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	-4.28	-1.90	4.50
$^{47}\text{Ti}(n,p)^{47}\text{Sc}$	7.48	0.50	-7.33
$^{48}\text{Ti}(n,p)^{48}\text{Sc}$	11.04	4.10	-9.10
$^{59}\text{Co}(n,p)^{59}\text{Fe}$	-23.87	-24.40	27.84
$^{90}\text{Zr}(n,2n)^{89}\text{Zr}$	5.58	7.60	-5.23
$^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$	-0.11	-1.30	0.11
$^{115}\text{In}(n,n')^{115\text{m}}\text{In}$	-1.38	2.30	1.34
$^{45}\text{Sc}(n,\gamma)^{46}\text{Sc}$	55.12	1.50	-49.87
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$	61.98	2.90	-58.85
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$	46.16	-6.40	-72.95
$^{98}\text{Mo}(n,\gamma)^{99}\text{Mo}$	71.20	3.40	-47.99
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$	41.18	0.20	-41.14
$^{115}\text{In}(n,\gamma)^{116}\text{In}$	6.28	0.40	-6.10
$^{186}\text{W}(n,\gamma)^{187}\text{W}$	31.90	1.10	-28.44
$^{197}\text{Au}(n,\gamma)^{198}\text{Au}$	46.90	0.20	-45.46
$^{59}\text{Co}(n,\gamma)^{60}\text{Co}$ - Cd	62.42	-0.80	-72.51
$^{63}\text{Cu}(n,\gamma)^{64}\text{Cu}$ - Cd	11.71	-0.40	-11.87
$^{109}\text{Ag}(n,\gamma)^{110\text{m}}\text{Ag}$ - Cd	9.11	1.50	-8.01
$^{115}\text{In}(n,\gamma)^{116}\text{In}$ - Cd	2.95	-0.90	-3.13
$^{186}\text{W}(n,\gamma)^{187}\text{W}$ - Cd	69.27	1.50	-53.13
$^{197}\text{Au}(n,\gamma)^{198}\text{Au}$ - Cd	-5.69	-4.00	7.25
$^{235}\text{U}(n,f)\text{FP}$ - bare	-3.15	0.10	3.13
$^{238}\text{U}(n,f)\text{FP}$ - bare	11.03	12.80	-9.89
$^{239}\text{Pu}(n,f)\text{FP}$ - bare	-4.19	-0.70	4.42
$^{237}\text{Np}(n,f)\text{FP}$ - bare	0.00	2.00	0.00

Table 24 and Table 25 shows the LSL-M3 adjusted neutron fluence spectrum in a tabular format for the 89-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation for the adjusted spectrum. The number fraction, represented as a histogram, can be used in MERCURY source calculations as an isotropic spherical surface source.

For the LLNL 6-inch position, the average neutron energy is calculated to be 1.405 MeV. The peak differential number fraction occurs in energy group 4 at 0.02 eV. The differential fluence at 1 MeV (Group 74) is almost four orders of magnitude lower than the peak. The LSL adjusted results for the number fraction, percent standard deviation, and covariance as a function of the 89-group energy structure are included in an LSL format in Appendix G of this report.

For the LLNL 24-inch position, the average neutron energy is calculated to be 1.382 MeV. The peak differential number fraction occurs in energy group 4 at 0.02 eV. The differential fluence at 1 MeV (Group 74) is also four orders of magnitude lower than the peak. The LSL adjusted results for the number fraction, percent standard deviation, and covariance as a function of the 89-group energy structure are included in an LSL format in Appendix G of this report.

Table 24. LLNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-10	1.0000E-09	5.5000E-10	1.4588E-07	5.3214E-17	1.6209E+02	8.9148E-08	195.76
2	1.0000E-09	5.0000E-09	3.0000E-09	3.1733E-06	6.3139E-15	7.9332E+02	2.3800E-06	135.62
3	5.0000E-09	1.0000E-08	7.5000E-09	8.5799E-06	4.2679E-14	1.7160E+03	1.2870E-05	103.66
4	1.0000E-08	3.0000E-08	2.0000E-08	5.8782E-05	7.7972E-13	2.9391E+03	5.8782E-05	50.40
5	3.0000E-08	7.0000E-08	5.0000E-08	1.0137E-04	3.3615E-12	2.5342E+03	1.2671E-04	38.60
6	7.0000E-08	1.0000E-07	8.5000E-08	4.3943E-05	2.4773E-12	1.4648E+03	1.2451E-04	61.92
7	1.0000E-07	1.5230E-07	1.2615E-07	3.3567E-05	2.8084E-12	6.4181E+02	8.0965E-05	75.24
8	1.5230E-07	2.0000E-07	1.7615E-07	1.4559E-05	1.7009E-12	3.0522E+02	5.3764E-05	85.42
9	2.0000E-07	4.1400E-07	3.0700E-07	2.7623E-05	5.6244E-12	1.2908E+02	3.9627E-05	91.09
10	4.1400E-07	6.0000E-07	5.0700E-07	1.3779E-05	4.6332E-12	7.4078E+01	3.7558E-05	95.13
11	6.0000E-07	8.0000E-07	7.0000E-07	1.0488E-05	4.8692E-12	5.2440E+01	3.6708E-05	93.64
12	8.0000E-07	1.1250E-06	9.6250E-07	1.3236E-05	8.4491E-12	4.0725E+01	3.9198E-05	100.22
13	1.1250E-06	3.0590E-06	2.0920E-06	4.0266E-05	5.5868E-11	2.0820E+01	4.3555E-05	37.56
14	3.0590E-06	5.0430E-06	4.0510E-06	2.5637E-05	6.8880E-11	1.2922E+01	5.2346E-05	65.05
15	5.0430E-06	8.3150E-06	6.6790E-06	2.6791E-05	1.1868E-10	8.1878E+00	5.4687E-05	30.06
16	8.3150E-06	1.3710E-05	1.1013E-05	3.9468E-05	2.8827E-10	7.3157E+00	8.0564E-05	35.18
17	1.3710E-05	2.2600E-05	1.8155E-05	3.3332E-05	4.0135E-10	3.7494E+00	6.8070E-05	8.13
18	2.2600E-05	3.7270E-05	2.9935E-05	5.5764E-05	1.1071E-09	3.8012E+00	1.1379E-04	30.24
19	3.7270E-05	6.1440E-05	4.9355E-05	6.2931E-05	2.0600E-09	2.6037E+00	1.2850E-04	26.10
20	6.1440E-05	1.0130E-04	8.1370E-05	7.1163E-05	3.8405E-09	1.7853E+00	1.4527E-04	23.87
21	1.0130E-04	1.6700E-04	1.3415E-04	8.2387E-05	7.3302E-09	1.2540E+00	1.6822E-04	26.71
22	1.6700E-04	2.7540E-04	2.2120E-04	8.4545E-05	1.2403E-08	7.7993E-01	1.7252E-04	48.77
23	2.7540E-04	3.5360E-04	3.1450E-04	4.8120E-05	1.0037E-08	6.1534E-01	1.9352E-04	46.62
24	3.5360E-04	4.5400E-04	4.0380E-04	4.7707E-05	1.2777E-08	4.7517E-01	1.9187E-04	51.04
25	4.5400E-04	5.8300E-04	5.1850E-04	5.9746E-05	2.0546E-08	4.6315E-01	2.4014E-04	58.58
26	5.8300E-04	7.4850E-04	6.6575E-04	7.5730E-05	3.3438E-08	4.5758E-01	3.0463E-04	27.37
27	7.4850E-04	9.6110E-04	8.5480E-04	7.9860E-05	4.5275E-08	3.7563E-01	3.2109E-04	24.46
28	9.6110E-04	1.0890E-03	1.0251E-03	4.1088E-05	2.7934E-08	3.2125E-01	3.2930E-04	35.94
29	1.0890E-03	1.2340E-03	1.1615E-03	4.5977E-05	3.5418E-08	3.1708E-01	3.6829E-04	40.22
30	1.2340E-03	1.3980E-03	1.3160E-03	4.2562E-05	3.7148E-08	2.5952E-01	3.4153E-04	44.39
31	1.3980E-03	1.5850E-03	1.4915E-03	5.4501E-05	5.3913E-08	2.9145E-01	4.3469E-04	42.50
32	1.5850E-03	1.7960E-03	1.6905E-03	4.9378E-05	5.5362E-08	2.3402E-01	3.9561E-04	40.55
33	1.7960E-03	2.0350E-03	1.9155E-03	5.8038E-05	7.3733E-08	2.4284E-01	4.6515E-04	39.53
34	2.0350E-03	2.3060E-03	2.1705E-03	6.2188E-05	8.9522E-08	2.2947E-01	4.9807E-04	38.61
35	2.3060E-03	2.6130E-03	2.4595E-03	6.4376E-05	1.0501E-07	2.0969E-01	5.1574E-04	38.09
36	2.6130E-03	2.9600E-03	2.7865E-03	9.5518E-05	1.7653E-07	2.7527E-01	7.6703E-04	36.29
37	2.9600E-03	3.3550E-03	3.1575E-03	6.6792E-05	1.3987E-07	1.6909E-01	5.3392E-04	36.49
38	3.3550E-03	3.8010E-03	3.5780E-03	8.5580E-05	2.0309E-07	1.9188E-01	6.8656E-04	36.82
39	3.8010E-03	4.3070E-03	4.0540E-03	8.6066E-05	2.3141E-07	1.7009E-01	6.8955E-04	36.52
40	4.3070E-03	4.8810E-03	4.5940E-03	8.8371E-05	2.6926E-07	1.5396E-01	7.0728E-04	35.14
41	4.8810E-03	5.5310E-03	5.2060E-03	1.0316E-04	3.5619E-07	1.5871E-01	8.2623E-04	34.62
42	5.5310E-03	6.2670E-03	5.8990E-03	1.1838E-04	4.6317E-07	1.6085E-01	9.4884E-04	34.38
43	6.2670E-03	7.1020E-03	6.6845E-03	1.1687E-04	5.1811E-07	1.3996E-01	9.3556E-04	33.63
44	7.1020E-03	8.0470E-03	7.5745E-03	1.2816E-04	6.4381E-07	1.3561E-01	1.0272E-03	33.56
45	8.0470E-03	9.1190E-03	8.5830E-03	1.6240E-04	9.2444E-07	1.5149E-01	1.3002E-03	32.69
46	9.1190E-03	1.0330E-02	9.7245E-03	1.7875E-04	1.1528E-06	1.4760E-01	1.4354E-03	31.55
47	1.0330E-02	1.1710E-02	1.1020E-02	1.9814E-04	1.4482E-06	1.4358E-01	1.5823E-03	31.07
48	1.1710E-02	1.3270E-02	1.2490E-02	2.1352E-04	1.7687E-06	1.3687E-01	1.7095E-03	31.43
49	1.3270E-02	1.5030E-02	1.4150E-02	2.6314E-04	2.4696E-06	1.4951E-01	2.1156E-03	30.40
50	1.5030E-02	1.7040E-02	1.6035E-02	2.8885E-04	3.0719E-06	1.4371E-01	2.3043E-03	30.86
51	1.7040E-02	1.9300E-02	1.8170E-02	3.9893E-04	4.8076E-06	1.7652E-01	3.2074E-03	29.54
52	1.9300E-02	2.1880E-02	2.0590E-02	4.8255E-04	6.5897E-06	1.8704E-01	3.8511E-03	28.61
53	2.1880E-02	2.4790E-02	2.3335E-02	5.4713E-04	8.4677E-06	1.8802E-01	4.3873E-03	27.43
54	2.4790E-02	2.6060E-02	2.5425E-02	2.1177E-04	3.5710E-06	1.6675E-01	4.2396E-03	29.17
55	2.6060E-02	2.8090E-02	2.7075E-02	4.0095E-04	7.1999E-06	1.9751E-01	5.3476E-03	28.83
56	2.8090E-02	3.1830E-02	2.9960E-02	9.9990E-04	1.9869E-05	2.6735E-01	8.0099E-03	27.92
57	3.1830E-02	4.0870E-02	3.6350E-02	2.3971E-03	5.7792E-05	2.6517E-01	9.6389E-03	22.34
58	4.0870E-02	5.2480E-02	4.6675E-02	3.3297E-03	1.0308E-04	2.8679E-01	1.3386E-02	21.56
59	5.2480E-02	6.7380E-02	5.9930E-02	5.0823E-03	2.0201E-04	3.4109E-01	2.0442E-02	20.50

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
60	6.7380E-02	8.6520E-02	7.6950E-02	7.8593E-03	4.0111E-04	4.1062E-01	3.1597E-02	19.57
61	8.6520E-02	1.1110E-01	9.8810E-02	1.1057E-02	7.2463E-04	4.4985E-01	4.4450E-02	18.40
62	1.1110E-01	1.4260E-01	1.2685E-01	1.6138E-02	1.3577E-03	5.1232E-01	6.4987E-02	18.24
63	1.4260E-01	1.8320E-01	1.6290E-01	2.3839E-02	2.5756E-03	5.8716E-01	9.5648E-02	17.59
64	1.8320E-01	2.3520E-01	2.0920E-01	3.3466E-02	4.6434E-03	6.4358E-01	1.3464E-01	16.40
65	2.3520E-01	3.0200E-01	2.6860E-01	4.7937E-02	8.5398E-03	7.1762E-01	1.9275E-01	15.98
66	3.0200E-01	3.8770E-01	3.4485E-01	4.8124E-02	1.1007E-02	5.6154E-01	1.9365E-01	15.65
67	3.8770E-01	4.3940E-01	4.1355E-01	3.0227E-02	8.2906E-03	5.8465E-01	2.4178E-01	17.98
68	4.3940E-01	4.9790E-01	4.6865E-01	3.2837E-02	1.0207E-02	5.6131E-01	2.6306E-01	17.70
69	4.9790E-01	5.6420E-01	5.3105E-01	3.7591E-02	1.3240E-02	5.6698E-01	3.0109E-01	17.46
70	5.6420E-01	6.3930E-01	6.0175E-01	3.9009E-02	1.5568E-02	5.1942E-01	3.1256E-01	17.04
71	6.3930E-01	7.2440E-01	6.8185E-01	3.9704E-02	1.7955E-02	4.6655E-01	3.1812E-01	16.82
72	7.2440E-01	8.2080E-01	7.7260E-01	3.9586E-02	2.0284E-02	4.1064E-01	3.1726E-01	16.87
73	8.2080E-01	9.3010E-01	8.7545E-01	4.4072E-02	2.5589E-02	4.0322E-01	3.5300E-01	16.53
74	9.3010E-01	1.0540E+00	9.9205E-01	4.3175E-02	2.8407E-02	3.4847E-01	3.4570E-01	15.10
75	1.0540E+00	1.1940E+00	1.1240E+00	4.3646E-02	3.2537E-02	3.1176E-01	3.5042E-01	15.90
76	1.1940E+00	1.3530E+00	1.2735E+00	4.6663E-02	3.9413E-02	2.9348E-01	3.7375E-01	15.54
77	1.3530E+00	1.7380E+00	1.5455E+00	8.9263E-02	9.1497E-02	2.3185E-01	3.5833E-01	12.54
78	1.7380E+00	2.2310E+00	1.9845E+00	8.3502E-02	1.0990E-01	1.6938E-01	3.3613E-01	11.26
79	2.2310E+00	2.8650E+00	2.5480E+00	7.6388E-02	1.2909E-01	1.2049E-01	3.0700E-01	11.50
80	2.8650E+00	3.6790E+00	3.2720E+00	6.3881E-02	1.3863E-01	7.8477E-02	2.5678E-01	11.05
81	3.6790E+00	4.7240E+00	4.2015E+00	4.5160E-02	1.2584E-01	4.3215E-02	1.8157E-01	10.78
82	4.7240E+00	6.0650E+00	5.3945E+00	2.4009E-02	8.5901E-02	1.7904E-02	9.6583E-02	10.54
83	6.0650E+00	7.7880E+00	6.9265E+00	1.0421E-02	4.7871E-02	6.0479E-03	4.1891E-02	9.59
84	7.7880E+00	1.0000E+01	8.8940E+00	3.8788E-03	2.2880E-02	1.7535E-03	1.5596E-02	8.90
85	1.0000E+01	1.1910E+01	1.0955E+01	7.2054E-04	5.2352E-03	3.7724E-04	4.1327E-03	5.90
86	1.1910E+01	1.3500E+01	1.2705E+01	1.5807E-04	1.3319E-03	9.9412E-05	1.2630E-03	7.75
87	1.3500E+01	1.4920E+01	1.4210E+01	4.3353E-05	4.0858E-04	3.0530E-05	4.3383E-04	10.68
88	1.4920E+01	1.6900E+01	1.5910E+01	1.7474E-05	1.8439E-04	8.8252E-06	1.4041E-04	12.69
89	1.6900E+01	2.0000E+01	1.8450E+01	4.6641E-06	5.7073E-05	1.5046E-06	2.7759E-05	17.86

Table 25. LLNL Neutron 89-Group Adjusted Energy Spectrum for WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-10	1.0000E-09	5.5000E-10	1.3664E-05	5.3983E-15	1.5182E+04	8.3499E-06	190.44
2	1.0000E-09	5.0000E-09	3.0000E-09	8.2003E-05	1.7672E-13	2.0501E+04	6.1502E-05	129.72
3	5.0000E-09	1.0000E-08	7.5000E-09	2.2426E-04	1.2082E-12	4.4852E+04	3.3639E-04	98.11
4	1.0000E-08	3.0000E-08	2.0000E-08	1.2259E-03	1.7612E-11	6.1294E+04	1.2259E-03	45.42
5	3.0000E-08	7.0000E-08	5.0000E-08	2.0816E-03	7.4767E-11	5.2041E+04	2.6021E-03	36.15
6	7.0000E-08	1.0000E-07	8.5000E-08	7.9911E-04	4.8793E-11	2.6637E+04	2.2641E-03	60.41
7	1.0000E-07	1.5230E-07	1.2615E-07	6.0779E-04	5.5078E-11	1.1621E+04	1.4660E-03	72.02
8	1.5230E-07	2.0000E-07	1.7615E-07	2.6100E-04	3.3027E-11	5.4718E+03	9.6385E-04	79.83
9	2.0000E-07	4.1400E-07	3.0700E-07	4.8343E-04	1.0661E-10	2.2590E+03	6.9352E-04	79.93
10	4.1400E-07	6.0000E-07	5.0700E-07	2.5575E-04	9.3146E-11	1.3750E+03	6.9713E-04	79.94
11	6.0000E-07	8.0000E-07	7.0000E-07	1.9612E-04	9.8618E-11	9.8061E+02	6.8642E-04	77.09
12	8.0000E-07	1.1250E-06	9.6250E-07	2.5360E-04	1.7534E-10	7.8030E+02	7.5104E-04	89.19
13	1.1250E-06	3.0590E-06	2.0920E-06	8.7968E-04	1.3220E-09	4.5485E+02	9.5155E-04	28.98
14	3.0590E-06	5.0430E-06	4.0510E-06	6.5998E-04	1.9206E-09	3.3265E+02	1.3476E-03	54.32
15	5.0430E-06	8.3150E-06	6.6790E-06	6.8915E-04	3.3064E-09	2.1062E+02	1.4067E-03	37.02
16	8.3150E-06	1.3710E-05	1.1013E-05	6.1733E-04	4.8835E-09	1.1443E+02	1.2601E-03	35.00
17	1.3710E-05	2.2600E-05	1.8155E-05	3.5441E-04	4.6221E-09	3.9866E+01	7.2377E-04	5.35
18	2.2600E-05	3.7270E-05	2.9935E-05	7.1274E-04	1.5327E-08	4.8585E+01	1.4544E-03	30.14
19	3.7270E-05	6.1440E-05	4.9355E-05	7.6130E-04	2.6991E-08	3.1498E+01	1.5546E-03	26.01
20	6.1440E-05	1.0130E-04	8.1370E-05	8.1313E-04	4.7529E-08	2.0400E+01	1.6599E-03	23.77
21	1.0130E-04	1.6700E-04	1.3415E-04	2.6383E-04	2.5424E-08	4.0156E+00	5.3870E-04	32.42
22	1.6700E-04	2.7540E-04	2.2120E-04	5.7514E-04	9.1390E-08	5.3057E+00	1.1736E-03	49.76
23	2.7540E-04	3.5360E-04	3.1450E-04	4.7780E-04	1.0795E-07	6.1100E+00	1.9216E-03	49.05
24	3.5360E-04	4.5400E-04	4.0380E-04	5.0301E-04	1.4591E-07	5.0101E+00	2.0231E-03	42.33
25	4.5400E-04	5.8300E-04	5.1850E-04	4.5333E-04	1.6885E-07	3.5142E+00	1.8221E-03	45.60
26	5.8300E-04	7.4850E-04	6.6575E-04	5.5076E-04	2.6340E-07	3.3279E+00	2.2155E-03	26.75
27	7.4850E-04	9.6110E-04	8.5480E-04	6.5707E-04	4.0347E-07	3.0906E+00	2.6419E-03	24.28
28	9.6110E-04	1.0890E-03	1.0251E-03	3.2918E-04	2.4239E-07	2.5737E+00	2.6382E-03	35.90
29	1.0890E-03	1.2340E-03	1.1615E-03	3.4528E-04	2.8809E-07	2.3812E+00	2.7658E-03	40.19
30	1.2340E-03	1.3980E-03	1.3160E-03	3.3578E-04	3.1742E-07	2.0474E+00	2.6944E-03	44.33
31	1.3980E-03	1.5850E-03	1.4915E-03	3.4886E-04	3.7377E-07	1.8656E+00	2.7825E-03	42.39
32	1.5850E-03	1.7960E-03	1.6905E-03	3.9234E-04	4.7644E-07	1.8594E+00	3.1433E-03	40.41
33	1.7960E-03	2.0350E-03	1.9155E-03	4.3868E-04	6.0363E-07	1.8355E+00	3.5159E-03	39.29
34	2.0350E-03	2.3060E-03	2.1705E-03	4.2270E-04	6.5906E-07	1.5598E+00	3.3855E-03	38.06
35	2.3060E-03	2.6130E-03	2.4595E-03	3.9127E-04	6.9129E-07	1.2745E+00	3.1346E-03	36.07
36	2.6130E-03	2.9600E-03	2.7865E-03	4.3681E-04	8.7435E-07	1.2588E+00	3.5077E-03	32.25
37	2.9600E-03	3.3550E-03	3.1575E-03	4.6555E-04	1.0560E-06	1.1786E+00	3.7215E-03	34.58
38	3.3550E-03	3.8010E-03	3.5780E-03	5.2794E-04	1.3569E-06	1.1837E+00	4.2354E-03	36.37
39	3.8010E-03	4.3070E-03	4.0540E-03	4.7672E-04	1.3883E-06	9.4213E-01	3.8194E-03	36.34
40	4.3070E-03	4.8810E-03	4.5940E-03	5.5202E-04	1.8217E-06	9.6171E-01	4.4181E-03	35.01
41	4.8810E-03	5.5310E-03	5.2060E-03	6.1568E-04	2.3025E-06	9.4720E-01	4.9311E-03	34.49
42	5.5310E-03	6.2670E-03	5.8990E-03	5.4621E-04	2.3146E-06	7.4214E-01	4.3779E-03	34.27
43	6.2670E-03	7.1020E-03	6.6845E-03	6.4436E-04	3.0941E-06	7.7169E-01	5.1583E-03	33.53
44	7.1020E-03	8.0470E-03	7.5745E-03	6.4980E-04	3.5356E-06	6.8762E-01	5.2084E-03	33.45
45	8.0470E-03	9.1190E-03	8.5830E-03	7.7847E-04	4.7997E-06	7.2618E-01	6.2328E-03	32.59
46	9.1190E-03	1.0330E-02	9.7245E-03	7.9010E-04	5.5193E-06	6.5244E-01	6.3446E-03	31.44
47	1.0330E-02	1.1710E-02	1.1020E-02	8.6966E-04	6.8844E-06	6.3019E-01	6.9447E-03	30.96
48	1.1710E-02	1.3270E-02	1.2490E-02	7.8217E-04	7.0178E-06	5.0139E-01	6.2624E-03	31.33
49	1.3270E-02	1.5030E-02	1.4150E-02	1.0148E-03	1.0315E-05	5.7656E-01	8.1584E-03	30.30
50	1.5030E-02	1.7040E-02	1.6035E-02	9.8169E-04	1.1308E-05	4.8840E-01	7.8315E-03	30.76
51	1.7040E-02	1.9300E-02	1.8170E-02	1.2047E-03	1.5724E-05	5.3304E-01	9.6853E-03	29.43
52	1.9300E-02	2.1880E-02	2.0590E-02	1.3309E-03	1.9685E-05	5.1586E-01	1.0621E-02	28.50
53	2.1880E-02	2.4790E-02	2.3335E-02	1.3688E-03	2.2944E-05	4.7037E-01	1.0976E-02	27.31
54	2.4790E-02	2.6060E-02	2.5425E-02	5.5617E-04	1.0158E-05	4.3793E-01	1.1134E-02	29.05
55	2.6060E-02	2.8090E-02	2.7075E-02	1.3395E-03	2.6053E-05	6.5987E-01	1.7866E-02	28.72
56	2.8090E-02	3.1830E-02	2.9960E-02	1.5558E-03	3.3484E-05	4.1600E-01	1.2463E-02	27.82
57	3.1830E-02	4.0870E-02	3.6350E-02	4.0150E-03	1.0484E-04	4.4414E-01	1.6145E-02	22.25
58	4.0870E-02	5.2480E-02	4.6675E-02	5.4265E-03	1.8194E-04	4.6740E-01	2.1816E-02	21.45
59	5.2480E-02	6.7380E-02	5.9930E-02	7.5726E-03	3.2601E-04	5.0823E-01	3.0458E-02	20.39

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
60	6.7380E-02	8.6520E-02	7.6950E-02	1.0744E-02	5.9390E-04	5.6134E-01	4.3195E-02	19.45
61	8.6520E-02	1.1110E-01	9.8810E-02	1.2718E-02	9.0269E-04	5.1739E-01	5.1124E-02	18.32
62	1.1110E-01	1.4260E-01	1.2685E-01	1.8802E-02	1.7133E-03	5.9688E-01	7.5715E-02	18.27
63	1.4260E-01	1.8320E-01	1.6290E-01	2.4052E-02	2.8146E-03	5.9242E-01	9.6505E-02	17.64
64	1.8320E-01	2.3520E-01	2.0920E-01	3.3457E-02	5.0278E-03	6.4340E-01	1.3460E-01	16.72
65	2.3520E-01	3.0200E-01	2.6860E-01	3.7564E-02	7.2480E-03	5.6234E-01	1.5104E-01	16.47
66	3.0200E-01	3.8770E-01	3.4485E-01	5.4709E-02	1.3553E-02	6.3837E-01	2.2014E-01	15.60
67	3.8770E-01	4.3940E-01	4.1355E-01	2.8635E-02	8.5065E-03	5.5386E-01	2.2905E-01	18.02
68	4.3940E-01	4.9790E-01	4.6865E-01	3.3691E-02	1.1342E-02	5.7591E-01	2.6990E-01	17.76
69	4.9790E-01	5.6420E-01	5.3105E-01	3.6933E-02	1.4089E-02	5.5706E-01	2.9583E-01	17.59
70	5.6420E-01	6.3930E-01	6.0175E-01	3.6703E-02	1.5865E-02	4.8872E-01	2.9409E-01	17.24
71	6.3930E-01	7.2440E-01	6.8185E-01	4.0481E-02	1.9828E-02	4.7569E-01	3.2435E-01	16.99
72	7.2440E-01	8.2080E-01	7.7260E-01	3.8898E-02	2.1588E-02	4.0350E-01	3.1174E-01	17.00
73	8.2080E-01	9.3010E-01	8.7545E-01	4.2747E-02	2.6883E-02	3.9110E-01	3.4239E-01	16.58
74	9.3010E-01	1.0540E+00	9.9205E-01	4.4307E-02	3.1575E-02	3.5760E-01	3.5476E-01	14.96
75	1.0540E+00	1.1940E+00	1.1240E+00	4.6916E-02	3.7881E-02	3.3512E-01	3.7667E-01	15.72
76	1.1940E+00	1.3530E+00	1.2735E+00	4.5194E-02	4.1344E-02	2.8424E-01	3.6197E-01	15.52
77	1.3530E+00	1.7380E+00	1.5455E+00	8.5637E-02	9.5075E-02	2.2243E-01	3.4377E-01	12.82
78	1.7380E+00	2.2310E+00	1.9845E+00	7.6624E-02	1.0923E-01	1.5542E-01	3.0844E-01	11.67
79	2.2310E+00	2.8650E+00	2.5480E+00	6.7402E-02	1.2337E-01	1.0631E-01	2.7088E-01	11.87
80	2.8650E+00	3.6790E+00	3.2720E+00	5.4471E-02	1.2803E-01	6.6918E-02	2.1895E-01	11.65
81	3.6790E+00	4.7240E+00	4.2015E+00	4.0111E-02	1.2106E-01	3.8384E-02	1.6127E-01	11.59
82	4.7240E+00	6.0650E+00	5.3945E+00	2.3156E-02	8.9734E-02	1.7268E-02	9.3152E-02	12.69
83	6.0650E+00	7.7880E+00	6.9265E+00	9.4065E-03	4.6803E-02	5.4594E-03	3.7814E-02	10.39
84	7.7880E+00	1.0000E+01	8.8940E+00	2.8790E-03	1.8394E-02	1.3015E-03	1.1576E-02	11.71
85	1.0000E+01	1.1910E+01	1.0955E+01	5.9188E-04	4.6578E-03	3.0989E-04	3.3948E-03	9.71
86	1.1910E+01	1.3500E+01	1.2705E+01	1.4158E-04	1.2921E-03	8.9042E-05	1.1313E-03	13.02
87	1.3500E+01	1.4920E+01	1.4210E+01	4.3363E-05	4.4263E-04	3.0537E-05	4.3393E-04	16.19
88	1.4920E+01	1.6900E+01	1.5910E+01	1.4492E-05	1.6562E-04	7.3190E-06	1.1645E-04	18.40
89	1.6900E+01	2.0000E+01	1.8450E+01	1.3398E-05	1.7757E-04	4.3218E-06	7.9738E-05	21.97

The results for several integral metrics and conversion factors are shown in Table 26 and Table 27 for the 6-inch and 24-inch test positions, respectively. The total neutron fluence is normalized to 1.00 and the other values for fluence are in reference to this value. These values were calculated as part of the LSL analysis. Conversion values to translate to n/cm² are given for fissions in the reactor, MJ of reactor energy, and ⁵⁸Ni(n,p)⁵⁸Co activity at the characterized location in the cavity. In order to maintain consistency, the experimenter should always use a reference fast neutron reaction or reactions, e.g. ⁵⁸Ni(n,p)⁵⁸Co and/or ³²S(n,p)³²P, as a normalizing metric between operations. Typically, Ni, S, and TLD sensors are included in an experiment package in order to normalize the results of the experiment. It must be noted that portions of the energy spectrum are highly correlated, so the uncertainty in the integral metric can be much less than the average uncertainty. Users should perform uncertainty propagation using the full energy-dependent covariance matrix given in Appendix H in order to determine the correlated uncertainty.

Table 26. WSMR 6-inch Location – LLNL Integral Neutron Spectrum Metrics and Associated Uncertainties.

Metric	Integral Response	Standard Deviation (%)
Total Neutron Fluence Average Neutron Energy = 1.405 MeV	1.00	--
Fluence > 3 MeV	0.136	5.3
Fluence > 1 MeV	0.514	3.6
Fluence > 100 keV	0.968	0.57
Fluence > 10 keV	0.997	0.46
Fluence < 1 keV	0.001	10.8
Fluence < 1 eV	0.0003	33.1
Fluence 1-MeV(Si) Eqv. E722-94 (Ref. 1-MeV value = 95 MeV-mb)	83.8 MeV-mb 0.898	1.1
Fluence 1-MeV(GaAs) Eqv. E722-94 (Ref. 1-MeV value = 70 MeV-mb)	64.2 MeV-mb 0.917	1.0
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ Spectrum Avg. Cross Section IRDFF-II	63.87 mb	4.2
$^{32}\text{S}(n,p)^{32}\text{P}$ Spectrum Avg. Cross Section IRDFF-II (Ref. Cf spectrum = 74.10 mb +/- 2.6%)	40.24 mb	4.9
Total Fluence Conversion ([n/cm ²]/fission)	6.827E-04	0.3
Total Fluence Conversion ([n/cm ²]/MJ)	2.418E+13	0.5
Total Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ([n/cm ²]/[Bq/atom _{Ni-58}])	1.382E+32	4.2
Total Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ([n/cm ²]/[Bq/g _{Ni-58}])	1.330E+10	4.2
Power Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ (MJ/[Bq/atom _{Ni-58}])	5.769E+18	4.6
Power Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ (MJ/[Bq/g _{Ni-58}])	5.550E-04	4.6
Total Fluence Conversion From S Activation ([n/cm ²]/Fluence $^{32}\text{S}(n,p)$ Cf-eqv)	1.806	3.9

Table 27. WSMR 24-inch Location – LLNL Integral Neutron Spectrum Metrics and Associated Uncertainties.

Metric	Integral Response	Standard Deviation (%)
Total Neutron Fluence Average Neutron Energy = 1.382 MeV	1.00	--
Fluence > 3 MeV	0.119	5.6
Fluence > 1 MeV	0.479	4.0
Fluence > 100 keV	0.925	0.76
Fluence > 10 keV	0.974	0.51
Fluence < 1 keV	0.02	15.4
Fluence < 1 eV	0.012	62.8
Fluence 1-MeV(Si) Eqv. E722-94 (Ref. 1-MeV value = 95 MeV-mb)	81.4 MeV-mb 0.813	1.4
Fluence 1-MeV(GaAs) Eqv. E722-94 (Ref. 1-MeV value = 70 MeV-mb)	62.4 MeV-mb 0.875	1.3
$^{58}\text{Ni}(n,p)^{58}\text{Co}$ Spectrum Avg. Cross Section IRDFF-II	56.99 mb	5.3
$^{32}\text{S}(n,p)^{32}\text{P}$ Spectrum Avg. Cross Section IRDFF-II (Ref. Cf spectrum = 74.10 mb +/- 2.6%)	35.94 mb	5.3
Total Fluence Conversion ([n/cm ²]/fission)	4.080E-05	0.3
Total Fluence Conversion ([n/cm ²]/MJ)	1.303E+12	0.5
Total Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ([n/cm ²]/[Bq/atom _{Ni-58}])	1.549E+32	5.3
Total Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ([n/cm ²]/[Bq/g _{Ni-58}])	1.490E+10	5.3
Power Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ (MJ/[Bq/atom _{Ni-58}])	1.020E+20	5.7
Power Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ (MJ/[Bq/g _{Ni-58}])	9.809E-03	5.7
Total Fluence Conversion From S Activation ([n/cm ²]/Fluence $^{32}\text{S}(n,p)$ Cf-equiv)	2.002	6.3

Table 28 and Table 29 show representative integral metrics that may also be useful to the experimenter. These values were calculated using the LSL adjusted 89-group neutron energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, Si damage, C dose, and TLD dose.

Table 28. WSMR 6-inch Location - Other LLNL Neutron Spectrum Metrics.

Metric	Integral Response
Total Si Dose ($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	7.033E-11
Ionizing Si Dose($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	4.096E-11
Percent Neutron Si Dose Ionizing (%)	58.2
Total Carbon Dose ($\text{rad}[\text{C}]/[\text{n}/\text{cm}^2]$)	3.171E-10
Total $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.463E-10
Effective Ionizing $\text{CaF}_2\text{:Mn}$ Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.587E-11
Percent Neutron $\text{CaF}_2\text{:Mn}$ Dose total light (%)	10.9

Table 29. WSMR 24-inch Location - Other LLNL Neutron Spectrum Metrics.

Metric	Integral Response
Total Si Dose ($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	6.499E-11
Ionizing Si Dose($\text{rad}[\text{Si}]/[\text{n}/\text{cm}^2]$)	3.743E-11
Percent Neutron Si Dose Ionizing (%)	57.6
Total Carbon Dose ($\text{rad}[\text{C}]/[\text{n}/\text{cm}^2]$)	2.950E-10
Total $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.341E-10
Effective Ionizing $\text{CaF}_2\text{:Mn}$ Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\text{n}/\text{cm}^2]$)	1.423E-11
Percent Neutron $\text{CaF}_2\text{:Mn}$ Dose total light (%)	10.6

4.4. Prompt Gamma-Ray

The gamma-ray environment includes both prompt and delayed gamma-rays. Prompt gamma-rays are generated from the direct fission process in the Molly-G fuel, and from radiative capture and inelastic scattering of neutrons in the Molly-G fuel and structure. Delayed gamma-rays are generated by fission-product decay in the Molly-G fuel and decay from activated materials in the core. All gamma-rays are considered to fall into one of these two categories, prompt or delayed. Gamma-rays generated from the direct fission process as the reactor power decreases following a pulse are considered prompt gamma-rays.

It is not currently practical to use experimental integral measurements to adjust the gamma-ray energy spectrum as it is for neutrons, using the current state-of-the-art technology in gamma-ray detection and energy-deposition measurements. For photon energies above the K-edges for photon cross sections (~ 80 keV), most material response functions fail to show any strong energy-dependent structure that can be used to resolve the spectrum. There is simply no effective way to discriminate energy groups in a gamma-ray fluence within a small volume in a reactor core. Integral dose measurements can be performed and are used as benchmarks for calculated integral responses. These integral measurements have value in validation but are not useful for spectrum adjustment. However, both passive dosimeters (e.g., TLDs) and active dosimeters (e.g., calorimeters) have some neutron and delayed gamma-ray contribution effects that make deciphering the results much more complex.

4.4.1. SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum Results

The prompt gamma-ray fluence can be calculated in a similar way as was performed for the neutron environment. With both neutrons and photons (gamma-rays) turned “on” in the k-code mode of MCNP, the prompt gamma-rays generated by fission, neutron radiative capture, and neutron inelastic scattering will be tracked properly, without any additional input from the user. The production and energy spectrum for the source fission gamma-rays are modeled for the MCNP6- ENDF/B-VIII supplied 00c fissile and fissionable cross sections. The radiative capture cross sections for neutron absorption are also modeled, but one must be sure that the gamma-ray production cross section is included in the nuclear cross section data for each reaction of interest. For example, radiative capture gamma-ray production for the naturally occurring cadmium isotopes is not included in the 70c or other cross sections available in the MCNP library. This information for each individual isotope can be found in Appendix G – MCNP Data Libraries of the MCNP manual. Typically, it is estimated that there are about seven gamma-rays generated in the fission process at energies of about 1 MeV each. Another 1 to 12 MeV of radiative capture gamma-rays can be emitted. This value is dependent on the type of reactor and absorbing materials in the fuel elements, structure, and control elements.

Figure 45 and Figure 46 for the 6-inch location and Figure 47 and Figure 48 for the 24-inch location show the MCNP-generated 48-group prompt gamma-ray energy fluence on a linear and logarithmic y-axis, respectively. The units on the y-axis are in energy fluence, equal to $E d\phi / dE$ (MeV/MeV-cm²-MJ). With the energy fluence represented linearly on the y-axis and the photon energy on the x-axis represented logarithmically, the area under the curve represents the total prompt gamma-ray fluence. The gamma-ray energy fluences have prominent peaks at ~ 0.5 MeV for the 6-inch and the 24-inch locations.

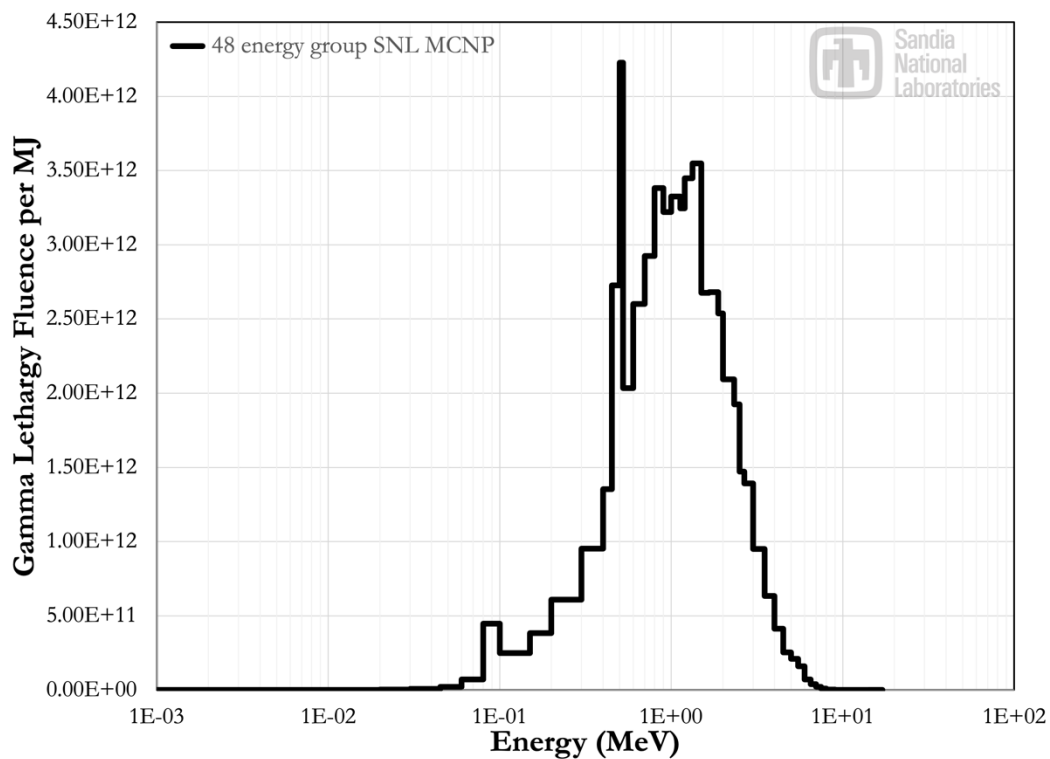


Figure 45. WSMR 6-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).

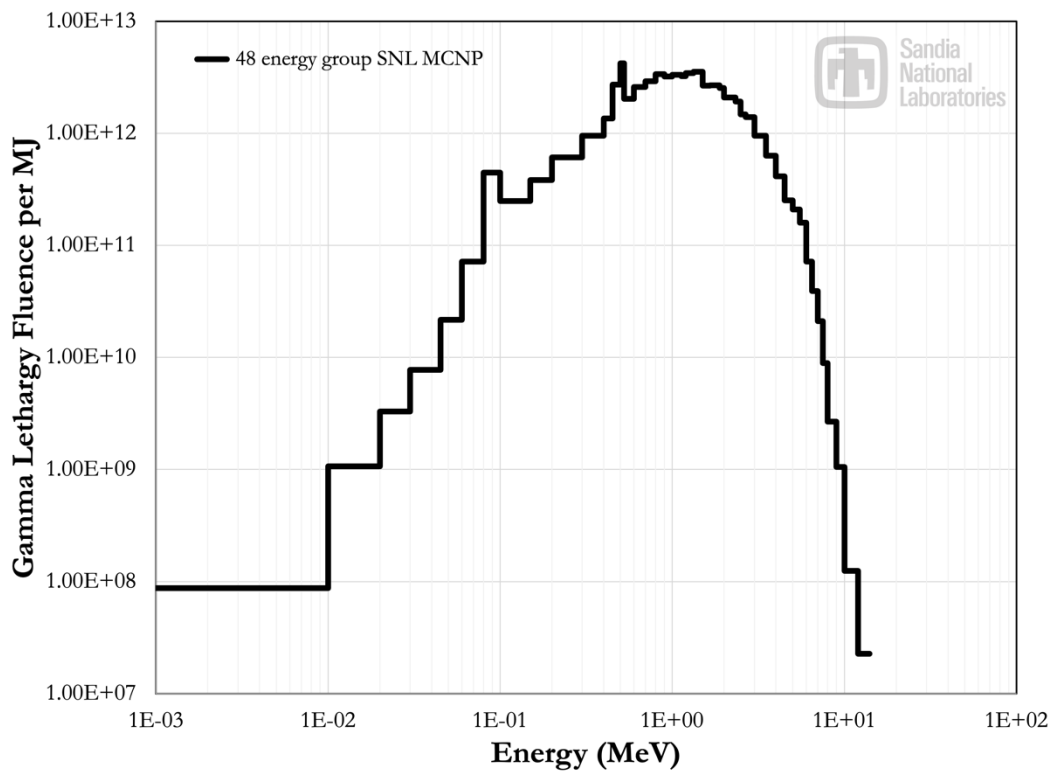


Figure 46. WSMR 6-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).

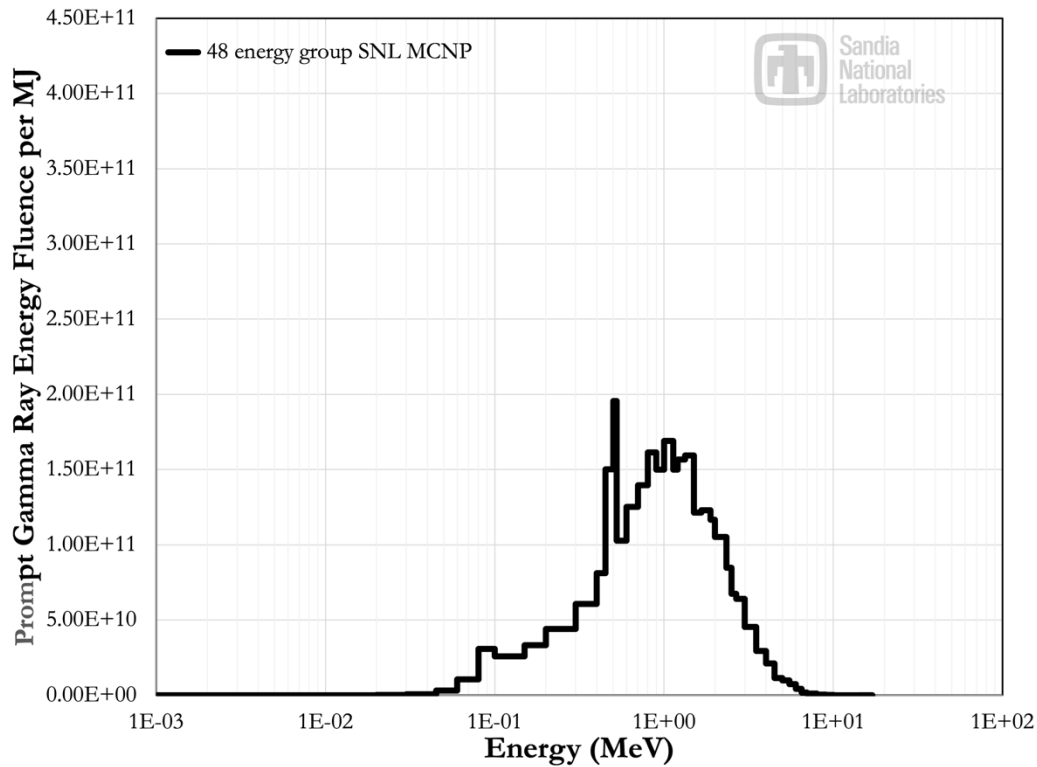


Figure 47. WSMR 24-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).

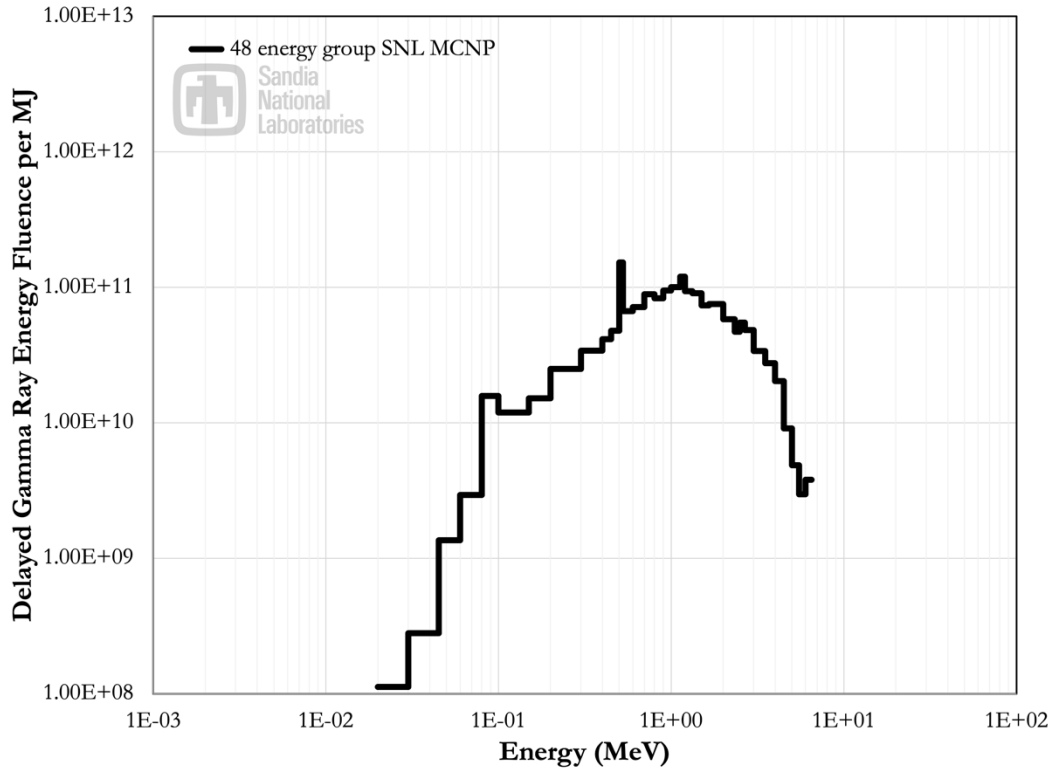


Figure 48. WSMR 24-inch – SNL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).

Table 30 and Table 31 contain the prompt gamma-ray fluence spectrum in a tabular format for the 48-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation. The number fraction, represented as a histogram, can be used in MCNP source calculations as an isotropic spherical surface source.

The average gamma-ray energy is calculated to be 1.231 MeV for the 6-inch location and 1.141 MeV for the 24-inch location. The peak differential energy fluence occurs in energy group 14 at 0.5125 MeV. This peak represents the electron-positron annihilation photon energy (0.511 MeV).

Table 30. Prompt Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	2.1975E-05	9.8225E-08	2.4416E-03	1.3429E-05	81.57
2	1.0000E-02	2.0000E-02	1.5000E-02	1.0958E-04	1.3359E-06	1.0958E-02	1.6438E-04	64.96
3	2.0000E-02	3.0000E-02	2.5000E-02	2.0175E-04	4.0992E-06	2.0175E-02	5.0439E-04	52.25
4	3.0000E-02	4.5000E-02	3.7500E-02	4.7598E-04	1.4506E-05	3.1732E-02	1.1899E-03	42.17
5	4.5000E-02	6.0000E-02	5.2500E-02	9.4819E-04	4.0456E-05	6.3213E-02	3.3187E-03	34.80
6	6.0000E-02	8.0000E-02	7.0000E-02	3.1393E-03	1.7859E-04	1.5697E-01	1.0988E-02	33.52
7	8.0000E-02	1.0000E-01	9.0000E-02	1.5253E-02	1.1156E-03	7.6263E-01	6.8636E-02	32.41
8	1.0000E-01	1.5000E-01	1.2500E-01	1.5328E-02	1.5571E-03	3.0656E-01	3.8320E-02	30.96
9	1.5000E-01	2.0000E-01	1.7500E-01	1.6834E-02	2.3942E-03	3.3668E-01	5.8919E-02	29.48
10	2.0000E-01	3.0000E-01	2.5000E-01	3.7383E-02	7.5954E-03	3.7383E-01	9.3458E-02	27.90
11	3.0000E-01	4.0000E-01	3.5000E-01	4.1758E-02	1.1878E-02	4.1758E-01	1.4615E-01	26.42
12	4.0000E-01	4.5000E-01	4.2500E-01	2.4455E-02	8.4466E-03	4.8909E-01	2.0786E-01	25.56
13	4.5000E-01	5.0000E-01	4.7500E-01	4.4054E-02	1.7006E-02	8.8108E-01	4.1851E-01	25.07
14	5.0000E-01	5.2500E-01	5.1250E-01	3.1652E-02	1.3183E-02	1.2661E+00	6.4886E-01	24.74
15	5.2500E-01	6.0000E-01	5.6250E-01	4.1650E-02	1.9040E-02	5.5533E-01	3.1237E-01	24.33
16	6.0000E-01	7.0000E-01	6.5000E-01	6.1455E-02	3.2464E-02	6.1455E-01	3.9946E-01	23.69
17	7.0000E-01	8.0000E-01	7.5000E-01	5.9879E-02	3.6498E-02	5.9879E-01	4.4909E-01	23.06
18	8.0000E-01	9.0000E-01	8.5000E-01	6.1082E-02	4.2195E-02	6.1082E-01	5.1920E-01	22.51
19	9.0000E-01	1.0000E+00	9.5000E-01	5.2031E-02	4.0172E-02	5.2031E-01	4.9430E-01	22.02
20	1.0000E+00	1.1250E+00	1.0625E+00	6.2324E-02	5.3817E-02	4.9859E-01	5.2976E-01	21.52
21	1.1250E+00	1.2000E+00	1.1625E+00	2.9931E-02	2.8277E-02	3.9907E-01	4.6392E-01	21.13
22	1.2000E+00	1.3300E+00	1.2650E+00	5.4385E-02	5.5912E-02	4.1835E-01	5.2921E-01	20.75
23	1.3300E+00	1.5000E+00	1.4150E+00	6.5440E-02	7.5255E-02	3.8494E-01	5.4470E-01	20.26
24	1.5000E+00	1.6600E+00	1.5800E+00	4.1590E-02	5.3404E-02	2.5994E-01	4.1070E-01	20.00
25	1.6600E+00	1.8750E+00	1.7675E+00	5.1139E-02	7.3458E-02	2.3785E-01	4.2041E-01	20.00
26	1.8750E+00	2.0000E+00	1.9375E+00	2.4104E-02	3.7955E-02	1.9284E-01	3.7362E-01	20.00
27	2.0000E+00	2.3330E+00	2.1665E+00	4.8986E-02	8.6250E-02	1.4710E-01	3.1870E-01	20.00
28	2.3330E+00	2.5000E+00	2.4165E+00	2.0791E-02	4.0831E-02	1.2450E-01	3.0084E-01	20.00
29	2.5000E+00	2.6600E+00	2.5800E+00	1.4860E-02	3.1157E-02	9.2872E-02	2.3961E-01	20.00
30	2.6600E+00	3.0000E+00	2.8300E+00	2.4882E-02	5.7228E-02	7.3183E-02	2.0711E-01	20.00
31	3.0000E+00	3.5000E+00	3.2500E+00	2.2441E-02	5.9273E-02	4.4882E-02	1.4587E-01	20.00
32	3.5000E+00	4.0000E+00	3.7500E+00	1.2955E-02	3.9484E-02	2.5911E-02	9.7166E-02	20.00
33	4.0000E+00	4.5000E+00	4.2500E+00	7.4738E-03	2.5815E-02	1.4948E-02	6.3527E-02	20.00
34	4.5000E+00	5.0000E+00	4.7500E+00	4.0859E-03	1.5773E-02	8.1718E-03	3.8816E-02	20.01
35	5.0000E+00	5.5000E+00	5.2500E+00	3.0601E-03	1.3056E-02	6.1202E-03	3.2131E-02	20.01
36	5.5000E+00	6.0000E+00	5.7500E+00	2.1352E-03	9.9778E-03	4.2703E-03	2.4554E-02	20.01
37	6.0000E+00	6.5000E+00	6.2500E+00	8.8004E-04	4.4701E-03	1.7601E-03	1.1000E-02	22.01
38	6.5000E+00	7.0000E+00	6.7500E+00	4.4653E-04	2.4495E-03	8.9306E-04	6.0281E-03	25.78
39	7.0000E+00	7.5000E+00	7.2500E+00	2.2269E-04	1.3121E-03	4.4539E-04	3.2291E-03	29.28
40	7.5000E+00	8.0000E+00	7.7500E+00	8.8290E-05	5.5609E-04	1.7658E-04	1.3685E-03	32.56
41	8.0000E+00	9.0000E+00	8.5000E+00	4.8185E-05	3.3286E-04	4.8185E-05	4.0957E-04	37.09
42	9.0000E+00	1.0000E+01	9.5000E+00	1.7025E-05	1.3144E-04	1.7025E-05	1.6173E-04	42.57
43	1.0000E+01	1.2000E+01	1.1000E+01	3.4663E-06	3.0988E-05	1.7332E-06	1.9065E-05	48.42
44	1.2000E+01	1.4000E+01	1.3000E+01	5.3622E-07	5.6652E-06	2.6811E-07	3.4854E-06	54.40
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	59.98
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	66.02
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	76.31
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	92.37

Table 31. Prompt Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	1.9857E-05	9.5781E-08	2.2063E-03	1.2135E-05	81.84
2	1.0000E-02	2.0000E-02	1.5000E-02	1.1225E-04	1.4766E-06	1.1225E-02	1.6837E-04	65.07
3	2.0000E-02	3.0000E-02	2.5000E-02	2.5206E-04	5.5265E-06	2.5206E-02	6.3015E-04	52.33
4	3.0000E-02	4.5000E-02	3.7500E-02	6.8574E-04	2.2553E-05	4.5716E-02	1.7144E-03	42.21
5	4.5000E-02	6.0000E-02	5.2500E-02	2.6625E-03	1.2259E-04	1.7750E-01	9.3186E-03	34.81
6	6.0000E-02	8.0000E-02	7.0000E-02	8.8996E-03	5.4635E-04	4.4498E-01	3.1148E-02	33.53
7	8.0000E-02	1.0000E-01	9.0000E-02	2.0252E-02	1.5985E-03	1.0126E+00	9.1136E-02	32.42
8	1.0000E-01	1.5000E-01	1.2500E-01	3.0667E-02	3.3619E-03	6.1333E-01	7.6666E-02	30.97
9	1.5000E-01	2.0000E-01	1.7500E-01	2.8212E-02	4.3298E-03	5.6423E-01	9.8741E-02	29.48
10	2.0000E-01	3.0000E-01	2.5000E-01	5.2263E-02	1.1459E-02	5.2263E-01	1.3066E-01	27.91
11	3.0000E-01	4.0000E-01	3.5000E-01	5.1400E-02	1.5777E-02	5.1400E-01	1.7990E-01	26.43
12	4.0000E-01	4.5000E-01	4.2500E-01	2.8238E-02	1.0525E-02	5.6475E-01	2.4002E-01	25.57
13	4.5000E-01	5.0000E-01	4.7500E-01	4.6781E-02	1.9488E-02	9.3563E-01	4.4442E-01	25.08
14	5.0000E-01	5.2500E-01	5.1250E-01	2.8266E-02	1.2705E-02	1.1307E+00	5.7946E-01	24.75
15	5.2500E-01	6.0000E-01	5.6250E-01	4.0579E-02	2.0018E-02	5.4105E-01	3.0434E-01	24.33
16	6.0000E-01	7.0000E-01	6.5000E-01	5.7089E-02	3.2544E-02	5.7089E-01	3.7108E-01	23.69
17	7.0000E-01	8.0000E-01	7.5000E-01	5.5131E-02	3.6263E-02	5.5131E-01	4.1348E-01	23.06
18	8.0000E-01	9.0000E-01	8.5000E-01	5.6224E-02	4.1912E-02	5.6224E-01	4.7790E-01	22.51
19	9.0000E-01	1.0000E+00	9.5000E-01	4.6723E-02	3.8928E-02	4.6723E-01	4.4387E-01	22.02
20	1.0000E+00	1.1250E+00	1.0625E+00	6.1091E-02	5.6926E-02	4.8873E-01	5.1928E-01	21.53
21	1.1250E+00	1.2000E+00	1.1625E+00	2.6677E-02	2.7197E-02	3.5569E-01	4.1349E-01	21.13
22	1.2000E+00	1.3300E+00	1.2650E+00	4.7667E-02	5.2882E-02	3.6667E-01	4.6383E-01	20.76
23	1.3300E+00	1.5000E+00	1.4150E+00	5.6742E-02	7.0416E-02	3.3378E-01	4.7230E-01	20.26
24	1.5000E+00	1.6600E+00	1.5800E+00	3.6395E-02	5.0431E-02	2.2747E-01	3.5940E-01	20.01
25	1.6600E+00	1.8750E+00	1.7675E+00	4.5298E-02	7.0217E-02	2.1069E-01	3.7239E-01	20.01
26	1.8750E+00	2.0000E+00	1.9375E+00	2.1365E-02	3.6304E-02	1.7092E-01	3.3116E-01	20.01
27	2.0000E+00	2.3330E+00	2.1665E+00	4.7457E-02	9.0169E-02	1.4251E-01	3.0875E-01	20.01
28	2.3330E+00	2.5000E+00	2.4165E+00	1.7680E-02	3.7469E-02	1.0587E-01	2.5583E-01	20.01
29	2.5000E+00	2.6600E+00	2.5800E+00	1.3130E-02	2.9709E-02	8.2062E-02	2.1172E-01	20.01
30	2.6600E+00	3.0000E+00	2.8300E+00	2.2117E-02	5.4893E-02	6.5050E-02	1.8409E-01	20.01
31	3.0000E+00	3.5000E+00	3.2500E+00	2.0708E-02	5.9023E-02	4.1416E-02	1.3460E-01	20.01
32	3.5000E+00	4.0000E+00	3.7500E+00	1.1591E-02	3.8121E-02	2.3183E-02	8.6935E-02	20.02
33	4.0000E+00	4.5000E+00	4.2500E+00	7.3863E-03	2.7531E-02	1.4773E-02	6.2784E-02	20.02
34	4.5000E+00	5.0000E+00	4.7500E+00	3.5870E-03	1.4943E-02	7.1740E-03	3.4076E-02	20.03
35	5.0000E+00	5.5000E+00	5.2500E+00	2.7926E-03	1.2858E-02	5.5852E-03	2.9322E-02	20.03
36	5.5000E+00	6.0000E+00	5.7500E+00	1.9021E-03	9.5919E-03	3.8042E-03	2.1874E-02	20.03
37	6.0000E+00	6.5000E+00	6.2500E+00	1.0147E-03	5.5617E-03	2.0293E-03	1.2683E-02	22.04
38	6.5000E+00	7.0000E+00	6.7500E+00	3.7042E-04	2.1928E-03	7.4085E-04	5.0007E-03	25.84
39	7.0000E+00	7.5000E+00	7.2500E+00	2.2752E-04	1.4467E-03	4.5504E-04	3.2991E-03	29.36
40	7.5000E+00	8.0000E+00	7.7500E+00	1.9418E-04	1.3198E-03	3.8836E-04	3.0098E-03	32.63
41	8.0000E+00	9.0000E+00	8.5000E+00	1.0854E-04	8.0912E-04	1.0854E-04	9.2260E-04	37.18
42	9.0000E+00	1.0000E+01	9.5000E+00	2.9392E-05	2.4488E-04	2.9392E-05	2.7922E-04	42.74
43	1.0000E+01	1.2000E+01	1.1000E+01	8.5573E-06	8.2553E-05	4.2787E-06	4.7065E-05	48.71
44	1.2000E+01	1.4000E+01	1.3000E+01	4.7437E-06	5.4084E-05	2.3719E-06	3.0834E-05	54.67
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	59.98
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	66.02
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	76.31
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	92.37

The uncertainty and covariance matrix represents a combination of expert judgment and perturbation analyses using MCNP. The covariance matrix satisfies the spectrum normalization condition and is positive semi-definite, with non-negative eigenvalues.

The results for a number of integral metrics and conversion factors are shown in Table 32 and Table 33 for the 6-inch and 24-inch test positions, respectively. Conversion values to translate to γ/cm^2 are given relative to fissions in the core, MJ of reactor energy, and $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity at the characterized location at either the 6-inch or 24-inch location. The same caveats presented in the neutron discussion using reactor power apply to the prompt gamma-rays. These values were calculated using the 48-group gamma-ray energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, C dose, and TLD dose.

Table 32. SNL WSMR 6-inch Location - Prompt Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average gamma-ray energy (MeV)	1.231
Fluence Conversion ($[\gamma/\text{cm}^2]/[\text{n}/\text{cm}^2]$)	0.296
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{fission}$)	2.010E-04
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{MJ}$)	6.513E+12
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	4.095E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	3.940E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[\gamma/\text{cm}^2]$)	1.455E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[\gamma/\text{cm}^2]$)	1.426E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\gamma/\text{cm}^2]$)	1.437E-10

Table 33. SNL WSMR 24-inch Location - Prompt Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average gamma-ray energy (MeV)	1.141
Fluence Conversion ($[\gamma/\text{cm}^2]/[\text{n}/\text{cm}^2]$)	0.273
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{fission}$)	1.042E-05
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{MJ}$)	3.376E+11
Fluence Conversion From Ni Activation $^{58}\text{Ni}(\text{n,p})^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	4.033E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(\text{n,p})^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	3.880E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[\gamma/\text{cm}^2]$)	1.250E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[\gamma/\text{cm}^2]$)	1.220E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\gamma/\text{cm}^2]$)	1.240E-10

4.4.2. LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum Results

The prompt gamma-ray fluence can be calculated in a similar way as was performed for the neutron environment. With both neutrons and photons (gamma-rays) turned “on” in the k-code mode of MCNP, the prompt gamma-rays generated by fission, neutron radiative capture, and neutron inelastic scattering will be tracked properly, without any additional input from the user. The production and energy spectrum for the source fission gamma-rays are modeled for the MCNP6 ENDF/B-VIII supplied 00c fissile and fissionable cross sections. The radiative capture cross sections for neutron absorption are also modeled, but one must be sure that the gamma-ray production cross section is included in the nuclear cross section data for each reaction of interest. For example, radiative capture gamma-ray production for the naturally occurring cadmium isotopes is not included in the 70c or other cross sections available in the MCNP library. The information for each individual isotope can be found in Appendix G – MCNP Data Libraries of the MCNP manual. Typically, it is estimated that there are about seven gamma-rays generated in the fission process at energies of about 1 MeV each. Another 1 to 12 MeV of radiative capture gamma-rays can be emitted. This value is dependent on the type of reactor and absorbing materials in the fuel elements, structure, and control elements.

Figure 49 and Figure 50 for the 6-inch location and Figure 51 and Figure 52 for the 24-inch location show the MCNP-generated 48-group prompt gamma-ray energy fluence on a linear and logarithmic y-axis, respectively. The units on the y-axis are in energy fluence, equal to $E d\phi/dE$ ($\text{MeV}/\text{MeV}\cdot\text{cm}^2\cdot\text{MJ}$). With the energy fluence represented linearly on the y-axis and the photon energy on the x-axis represented logarithmically, the area under the curve represents the total prompt gamma-ray fluence. The gamma-ray energy fluences have prominent peaks at ~ 0.5 MeV for the 6-inch and the 24-inch locations.

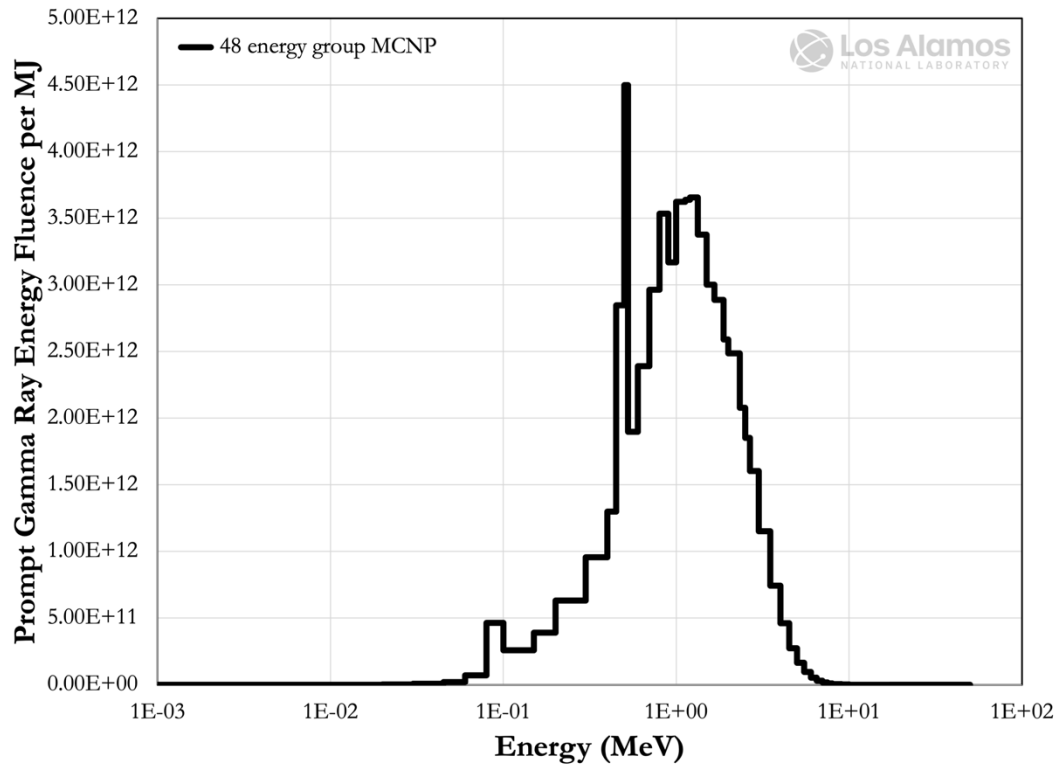


Figure 49. WSMR 6-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).

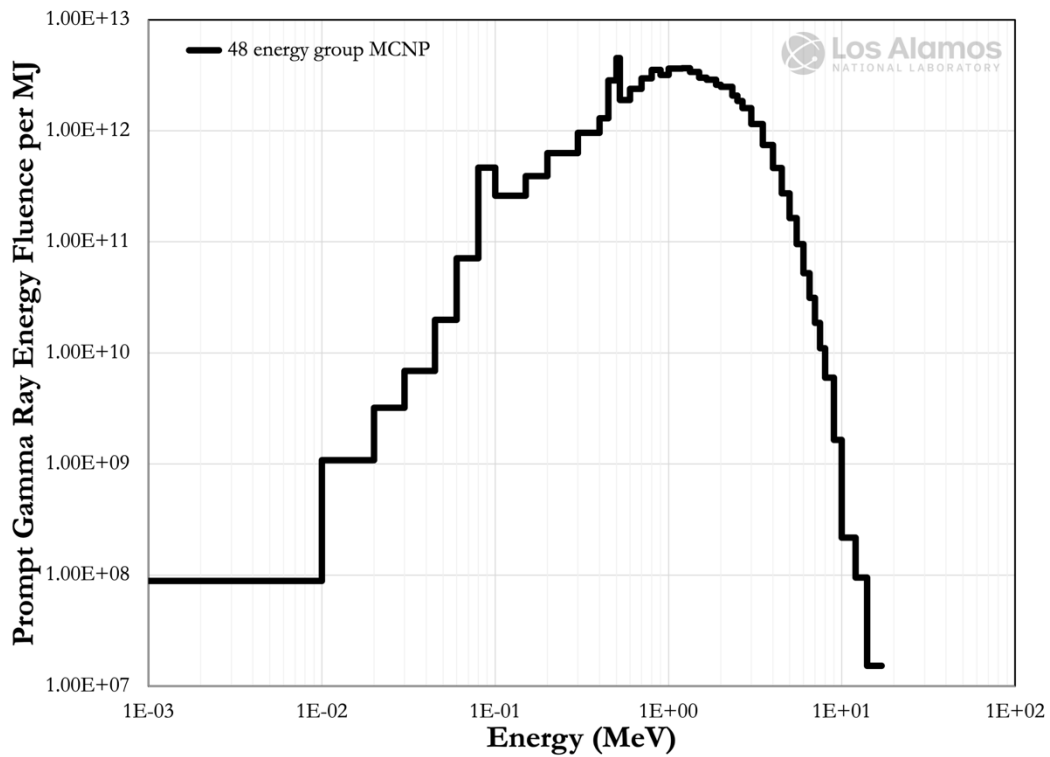


Figure 50. WSMR 6-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).

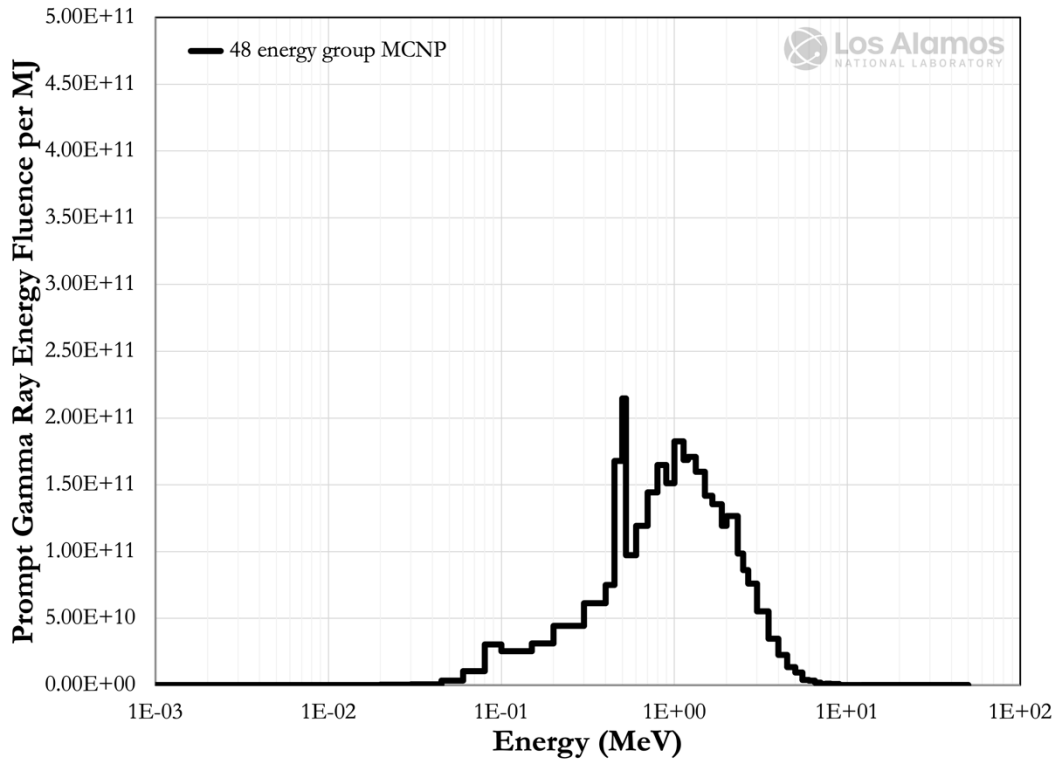


Figure 51. WSMR 24-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).

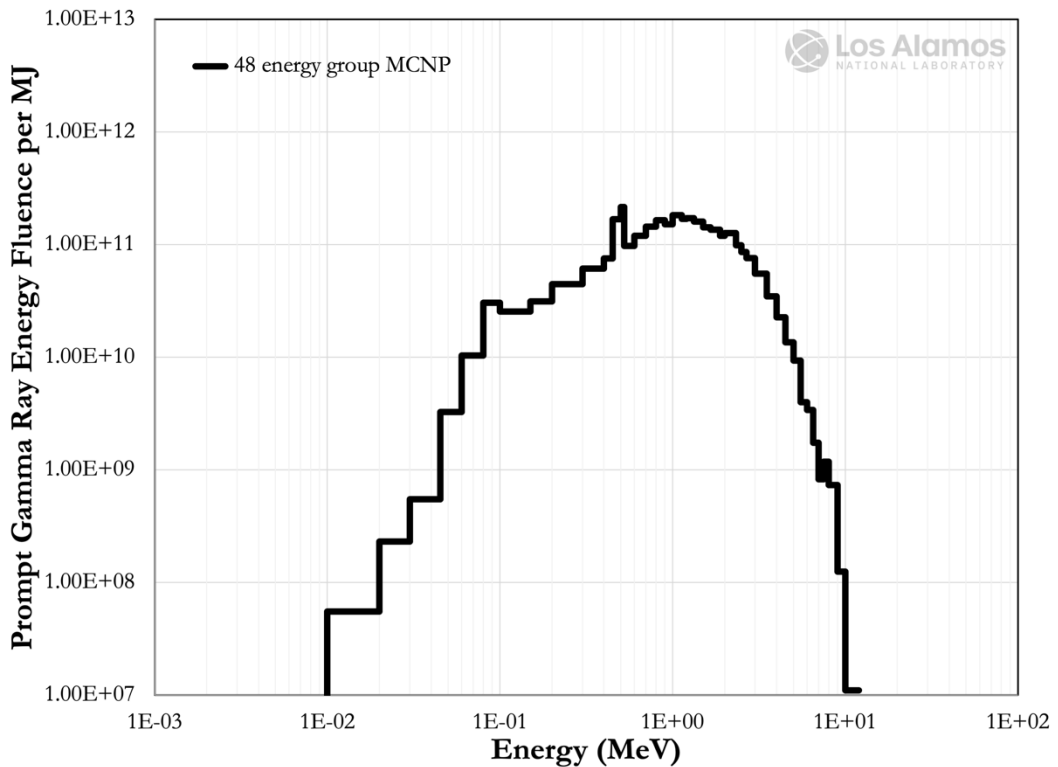


Figure 52. WSMR 24-inch – LANL MCNP 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).

Table 34 and Table 35 shows the prompt gamma-ray fluence spectrum in a tabular format for the 48-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation. The number fraction, represented as a histogram, can be used in MCNP source calculations as an isotropic spherical surface source.

The average gamma-ray energy is calculated to be 1.339 MeV for the 6-inch location and 1.129 MeV for the 24-inch location. The peak differential energy fluence occurs in energy group 14 at 0.5125 MeV. This peak represents the electron-positron annihilation photon energy (0.511 MeV).

Table 34. Prompt Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	2.1326E-05	9.2851E-08	2.3695E-03	1.3032E-05	81.61
2	1.0000E-02	2.0000E-02	1.5000E-02	1.0610E-04	1.2599E-06	1.0610E-02	1.5916E-04	64.98
3	2.0000E-02	3.0000E-02	2.5000E-02	1.8913E-04	3.7431E-06	1.8913E-02	4.7283E-04	52.27
4	3.0000E-02	4.5000E-02	3.7500E-02	4.0372E-04	1.1985E-05	2.6914E-02	1.0093E-03	42.18
5	4.5000E-02	6.0000E-02	5.2500E-02	8.3649E-04	3.4765E-05	5.5766E-02	2.9277E-03	34.80
6	6.0000E-02	8.0000E-02	7.0000E-02	2.9860E-03	1.6547E-04	1.4930E-01	1.0451E-02	33.53
7	8.0000E-02	1.0000E-01	9.0000E-02	1.5201E-02	1.0830E-03	7.6003E-01	6.8402E-02	32.41
8	1.0000E-01	1.5000E-01	1.2500E-01	1.5267E-02	1.5107E-03	3.0534E-01	3.8167E-02	30.96
9	1.5000E-01	2.0000E-01	1.7500E-01	1.6397E-02	2.2715E-03	3.2794E-01	5.7389E-02	29.48
10	2.0000E-01	3.0000E-01	2.5000E-01	3.7106E-02	7.3436E-03	3.7106E-01	9.2765E-02	27.90
11	3.0000E-01	4.0000E-01	3.5000E-01	4.0199E-02	1.1138E-02	4.0199E-01	1.4070E-01	26.42
12	4.0000E-01	4.5000E-01	4.2500E-01	2.2451E-02	7.5534E-03	4.4902E-01	1.9083E-01	25.57
13	4.5000E-01	5.0000E-01	4.7500E-01	4.4044E-02	1.6562E-02	8.8088E-01	4.1842E-01	25.07
14	5.0000E-01	5.2500E-01	5.1250E-01	3.2247E-02	1.3083E-02	1.2899E+00	6.6107E-01	24.74
15	5.2500E-01	6.0000E-01	5.6250E-01	3.7198E-02	1.6564E-02	4.9598E-01	2.7899E-01	24.33
16	6.0000E-01	7.0000E-01	6.5000E-01	5.4013E-02	2.7793E-02	5.4013E-01	3.5109E-01	23.69
17	7.0000E-01	8.0000E-01	7.5000E-01	5.8062E-02	3.4473E-02	5.8062E-01	4.3547E-01	23.06
18	8.0000E-01	9.0000E-01	8.5000E-01	6.1101E-02	4.1114E-02	6.1101E-01	5.1936E-01	22.51
19	9.0000E-01	1.0000E+00	9.5000E-01	4.9016E-02	3.6863E-02	4.9016E-01	4.6565E-01	22.02
20	1.0000E+00	1.1250E+00	1.0625E+00	6.4972E-02	5.4649E-02	5.1978E-01	5.5227E-01	21.52
21	1.1250E+00	1.2000E+00	1.1625E+00	3.2119E-02	2.9558E-02	4.2825E-01	4.9784E-01	21.13
22	1.2000E+00	1.3300E+00	1.2650E+00	5.5211E-02	5.5289E-02	4.2470E-01	5.3725E-01	20.75
23	1.3300E+00	1.5000E+00	1.4150E+00	5.9631E-02	6.6796E-02	3.5077E-01	4.9634E-01	20.26
24	1.5000E+00	1.6600E+00	1.5800E+00	4.4676E-02	5.5879E-02	2.7922E-01	4.4117E-01	20.00
25	1.6600E+00	1.8750E+00	1.7675E+00	5.2757E-02	7.3819E-02	2.4538E-01	4.3371E-01	20.00
26	1.8750E+00	2.0000E+00	1.9375E+00	2.3553E-02	3.6126E-02	1.8843E-01	3.6508E-01	20.00
27	2.0000E+00	2.3330E+00	2.1665E+00	5.5670E-02	9.5478E-02	1.6718E-01	3.6219E-01	20.00
28	2.3330E+00	2.5000E+00	2.4165E+00	2.1504E-02	4.1138E-02	1.2877E-01	3.1117E-01	20.00
29	2.5000E+00	2.6600E+00	2.5800E+00	1.7892E-02	3.6544E-02	1.1183E-01	2.8851E-01	20.00
30	2.6600E+00	3.0000E+00	2.8300E+00	2.7442E-02	6.1479E-02	8.0712E-02	2.2841E-01	20.00
31	3.0000E+00	3.5000E+00	3.2500E+00	2.6043E-02	6.7004E-02	5.2086E-02	1.6928E-01	20.00
32	3.5000E+00	4.0000E+00	3.7500E+00	1.4550E-02	4.3194E-02	2.9100E-02	1.0913E-01	20.00
33	4.0000E+00	4.5000E+00	4.2500E+00	8.0018E-03	2.6922E-02	1.6004E-02	6.8016E-02	20.01
34	4.5000E+00	5.0000E+00	4.7500E+00	4.2283E-03	1.5899E-02	8.4566E-03	4.0169E-02	20.01
35	5.0000E+00	5.5000E+00	5.2500E+00	2.2955E-03	9.5405E-03	4.5911E-03	2.4103E-02	20.01
36	5.5000E+00	6.0000E+00	5.7500E+00	1.2220E-03	5.5626E-03	2.4441E-03	1.4053E-02	20.02
37	6.0000E+00	6.5000E+00	6.2500E+00	6.1560E-04	3.0458E-03	1.2312E-03	7.6950E-03	22.02
38	6.5000E+00	7.0000E+00	6.7500E+00	3.4012E-04	1.8175E-03	6.8025E-04	4.5917E-03	25.79
39	7.0000E+00	7.5000E+00	7.2500E+00	1.8867E-04	1.0828E-03	3.7734E-04	2.7357E-03	29.30
40	7.5000E+00	8.0000E+00	7.7500E+00	1.0456E-04	6.4147E-04	2.0911E-04	1.6206E-03	32.58
41	8.0000E+00	9.0000E+00	8.5000E+00	1.0333E-04	6.9527E-04	1.0333E-04	8.7827E-04	37.10
42	9.0000E+00	1.0000E+01	9.5000E+00	2.5472E-05	1.9156E-04	2.5472E-05	2.4198E-04	42.59
43	1.0000E+01	1.2000E+01	1.1000E+01	5.7887E-06	5.0408E-05	2.8944E-06	3.1838E-05	48.48
44	1.2000E+01	1.4000E+01	1.3000E+01	2.1494E-06	2.2120E-05	1.0747E-06	1.3971E-05	54.38
45	1.4000E+01	1.7000E+01	1.5500E+01	4.3513E-07	5.3392E-06	1.4504E-07	2.2482E-06	60.69
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	66.02
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	76.31
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	92.37

Table 35. Prompt Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	1.5837E-05	7.3619E-08	1.7597E-03	9.6782E-06	82.11
2	1.0000E-02	2.0000E-02	1.5000E-02	1.0363E-04	1.3138E-06	1.0363E-02	1.5545E-04	65.17
3	2.0000E-02	3.0000E-02	2.5000E-02	2.5919E-04	5.4766E-06	2.5919E-02	6.4798E-04	52.39
4	3.0000E-02	4.5000E-02	3.7500E-02	6.1482E-04	1.9486E-05	4.0988E-02	1.5370E-03	42.25
5	4.5000E-02	6.0000E-02	5.2500E-02	2.6125E-03	1.1592E-04	1.7417E-01	9.1437E-03	34.83
6	6.0000E-02	8.0000E-02	7.0000E-02	8.3099E-03	4.9164E-04	4.1550E-01	2.9085E-02	33.54
7	8.0000E-02	1.0000E-01	9.0000E-02	1.9026E-02	1.4472E-03	9.5130E-01	8.5617E-02	32.43
8	1.0000E-01	1.5000E-01	1.2500E-01	2.8621E-02	3.0238E-03	5.7242E-01	7.1552E-02	30.97
9	1.5000E-01	2.0000E-01	1.7500E-01	2.5070E-02	3.7080E-03	5.0140E-01	8.7745E-02	29.49
10	2.0000E-01	3.0000E-01	2.5000E-01	4.9906E-02	1.0545E-02	4.9906E-01	1.2476E-01	27.91
11	3.0000E-01	4.0000E-01	3.5000E-01	4.9148E-02	1.4539E-02	4.9148E-01	1.7202E-01	26.43
12	4.0000E-01	4.5000E-01	4.2500E-01	2.4813E-02	8.9128E-03	4.9625E-01	2.1091E-01	25.58
13	4.5000E-01	5.0000E-01	4.7500E-01	4.9705E-02	1.9955E-02	9.9409E-01	4.7219E-01	25.08
14	5.0000E-01	5.2500E-01	5.1250E-01	2.9435E-02	1.2750E-02	1.1774E+00	6.0342E-01	24.75
15	5.2500E-01	6.0000E-01	5.6250E-01	3.6445E-02	1.7326E-02	4.8593E-01	2.7333E-01	24.34
16	6.0000E-01	7.0000E-01	6.5000E-01	5.1589E-02	2.8342E-02	5.1589E-01	3.3533E-01	23.70
17	7.0000E-01	8.0000E-01	7.5000E-01	5.4078E-02	3.4280E-02	5.4078E-01	4.0559E-01	23.07
18	8.0000E-01	9.0000E-01	8.5000E-01	5.4509E-02	3.9159E-02	5.4509E-01	4.6332E-01	22.52
19	9.0000E-01	1.0000E+00	9.5000E-01	4.4709E-02	3.5898E-02	4.4709E-01	4.2473E-01	22.03
20	1.0000E+00	1.1250E+00	1.0625E+00	6.2664E-02	5.6273E-02	5.0131E-01	5.3264E-01	21.53
21	1.1250E+00	1.2000E+00	1.1625E+00	2.8491E-02	2.7994E-02	3.7988E-01	4.4161E-01	21.14
22	1.2000E+00	1.3300E+00	1.2650E+00	4.9394E-02	5.2810E-02	3.7995E-01	4.8064E-01	20.76
23	1.3300E+00	1.5000E+00	1.4150E+00	5.3989E-02	6.4568E-02	3.1758E-01	4.4938E-01	20.27
24	1.5000E+00	1.6600E+00	1.5800E+00	4.0369E-02	5.3909E-02	2.5231E-01	3.9865E-01	20.01
25	1.6600E+00	1.8750E+00	1.7675E+00	4.7323E-02	7.0695E-02	2.2011E-01	3.8904E-01	20.01
26	1.8750E+00	2.0000E+00	1.9375E+00	2.0748E-02	3.3977E-02	1.6599E-01	3.2160E-01	20.02
27	2.0000E+00	2.3330E+00	2.1665E+00	5.4201E-02	9.9248E-02	1.6277E-01	3.5264E-01	20.01
28	2.3330E+00	2.5000E+00	2.4165E+00	1.9488E-02	3.9802E-02	1.1669E-01	2.8199E-01	20.02
29	2.5000E+00	2.6600E+00	2.5800E+00	1.5912E-02	3.4696E-02	9.9447E-02	2.5657E-01	20.02
30	2.6600E+00	3.0000E+00	2.8300E+00	2.4856E-02	5.9452E-02	7.3105E-02	2.0689E-01	20.02
31	3.0000E+00	3.5000E+00	3.2500E+00	2.3855E-02	6.5527E-02	4.7711E-02	1.5506E-01	20.02
32	3.5000E+00	4.0000E+00	3.7500E+00	1.3005E-02	4.1219E-02	2.6010E-02	9.7538E-02	20.02
33	4.0000E+00	4.5000E+00	4.2500E+00	7.4755E-03	2.6852E-02	1.4951E-02	6.3542E-02	20.03
34	4.5000E+00	5.0000E+00	4.7500E+00	4.0100E-03	1.6099E-02	8.0201E-03	3.8095E-02	20.04
35	5.0000E+00	5.5000E+00	5.2500E+00	2.4947E-03	1.1069E-02	4.9893E-03	2.6194E-02	20.05
36	5.5000E+00	6.0000E+00	5.7500E+00	9.7094E-04	4.7186E-03	1.9419E-03	1.1166E-02	20.08
37	6.0000E+00	6.5000E+00	6.2500E+00	7.6482E-04	4.0401E-03	1.5296E-03	9.5602E-03	22.09
38	6.5000E+00	7.0000E+00	6.7500E+00	3.6162E-04	2.0631E-03	7.2325E-04	4.8819E-03	25.89
39	7.0000E+00	7.5000E+00	7.2500E+00	1.6000E-04	9.8044E-04	3.2001E-04	2.3200E-03	29.44
40	7.5000E+00	8.0000E+00	7.7500E+00	2.1395E-04	1.4014E-03	4.2789E-04	3.3162E-03	32.67
41	8.0000E+00	9.0000E+00	8.5000E+00	2.4164E-04	1.7360E-03	2.4164E-04	2.0540E-03	37.20
42	9.0000E+00	1.0000E+01	9.5000E+00	3.6973E-05	2.9687E-04	3.6973E-05	3.5125E-04	42.93
43	1.0000E+01	1.2000E+01	1.1000E+01	5.6321E-06	5.2362E-05	2.8161E-06	3.0977E-05	48.98
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	53.97
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	59.98
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	66.02
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	76.31
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	92.37

The uncertainty and covariance matrix represents a combination of expert judgment and perturbation analyses using MCNP. The covariance matrix satisfies the spectrum normalization condition and is positive semi-definite, with non-negative eigenvalues.

The results for a number of integral metrics and conversion factors are shown in Table 36 and Table 37 for the 6-inch and 24-inch test positions, respectively. Conversion values to translate to γ/cm^2 are given relative to fissions in the core, MJ of reactor energy, and $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity at the characterized 6-inch or 24-inch locations. The same caveats presented in the neutron discussion using reactor power apply to the prompt gamma-rays. These values were calculated using the 48-group gamma-ray energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, C dose, and TLD dose.

Table 36. LANL WSMR 6-inch Location - Prompt Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average gamma-ray energy (MeV)	1.339
Fluence Conversion ($[\gamma/\text{cm}^2]/[\text{n}/\text{cm}^2]$)	0.314
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{fission}$)	3.785E-05
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{MJ}$)	6.808E+12
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	4.496E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	4.325E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[\gamma/\text{cm}^2]$)	5.020E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[\gamma/\text{cm}^2]$)	4.924E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\gamma/\text{cm}^2]$)	4.939E-10

Table 37. LANL WSMR 24-inch Location - Prompt Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average gamma-ray energy (MeV)	1.259
Fluence Conversion ($[\gamma/\text{cm}^2]/[\text{n}/\text{cm}^2]$)	0.285
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{fission}$)	1.968E-06
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{MJ}$)	3.540E+11
Fluence Conversion From Ni Activation $^{58}\text{Ni}(\text{n,p})^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	4.348E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(\text{n,p})^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	4.183E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[\gamma/\text{cm}^2]$)	4.737E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[\gamma/\text{cm}^2]$)	4.626E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\gamma/\text{cm}^2]$)	4.677E-10

4.4.3. LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum Results

The prompt gamma-ray fluence can be calculated in a similar way as was performed for the neutron environment. With both neutrons and photons (gamma-rays) transport enabled in the static k mode of MERCURY, the prompt gamma-rays generated by fission, neutron radiative capture, and neutron inelastic scattering will be tracked properly, without any additional input from the user. The production and energy spectrum for the source fission gamma-rays and radiative capture for neutron absorption are included in the ENDL2009.4 cross section library in the GNDs format. Typically, it is estimated that there are about seven gamma-rays generated in the fission process at energies of about 1 MeV each. Another 1 to 12 MeV of radiative capture gamma-rays can be emitted. This value is dependent on the type of reactor and absorbing materials in the fuel elements, structure, and control elements.

Figure 53 and Figure 54 for the 6-inch location and Figure 55 and Figure 56 for the 24-inch location show the MERCURY-generated 48-group prompt gamma-ray energy fluence on a linear and logarithmic y-axis, respectively. The units on the y-axis are in energy fluence, equal to $E d\Phi/dE$ ($\text{MeV}/\text{MeV}\cdot\text{cm}^2\cdot\text{MJ}$). With the energy fluence represented linearly on the y-axis and the photon energy on the x-axis represented logarithmically, the area under the curve represents the total prompt gamma-ray fluence. The gamma-ray energy fluences have prominent peaks at ~ 0.5 MeV for the 6-inch and the 24-inch locations.

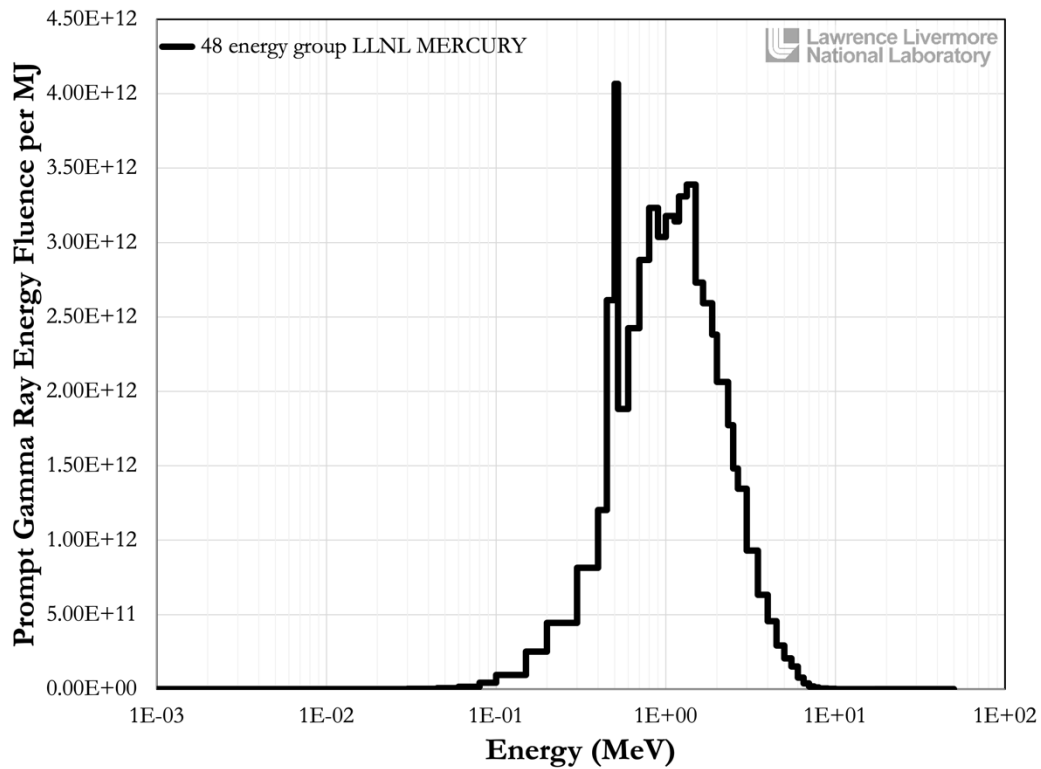


Figure 53. WSMR 6-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).

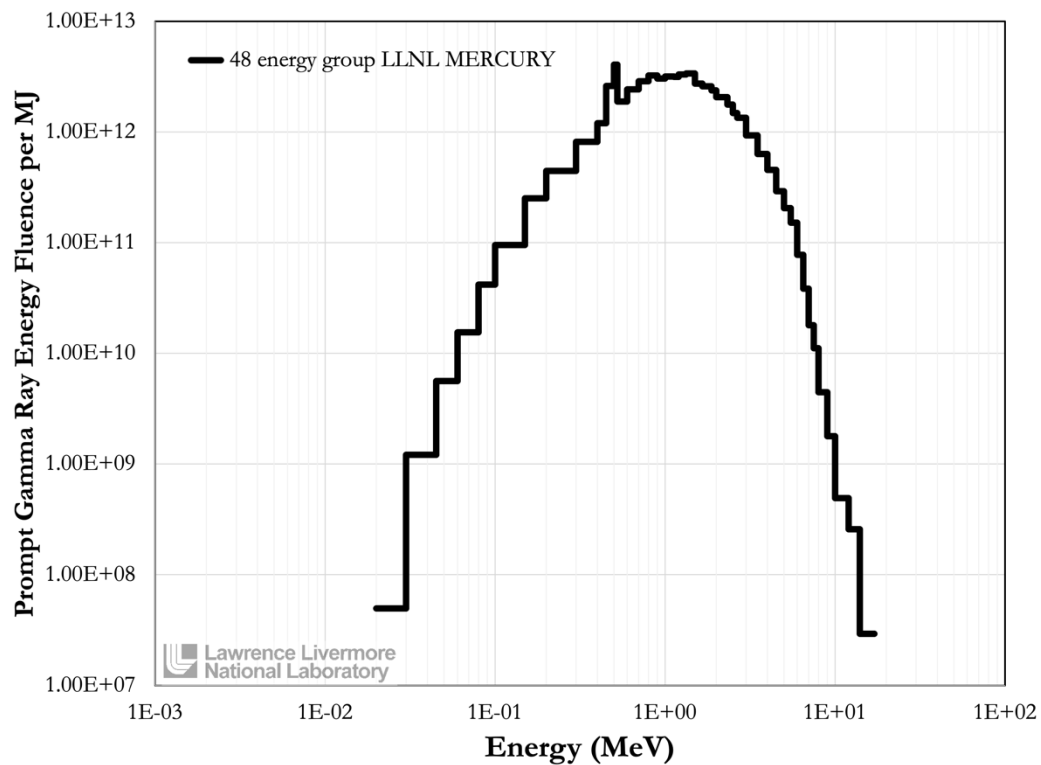


Figure 54. WSMR 6-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).

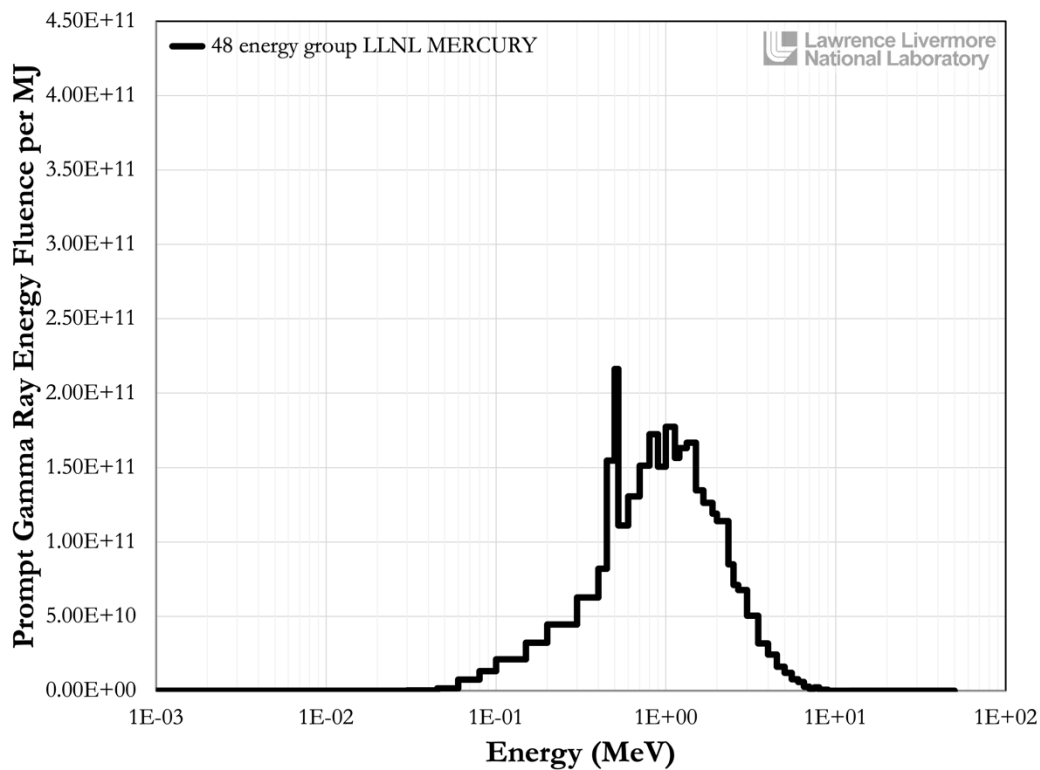


Figure 55. WSMR 24-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (linear-log).

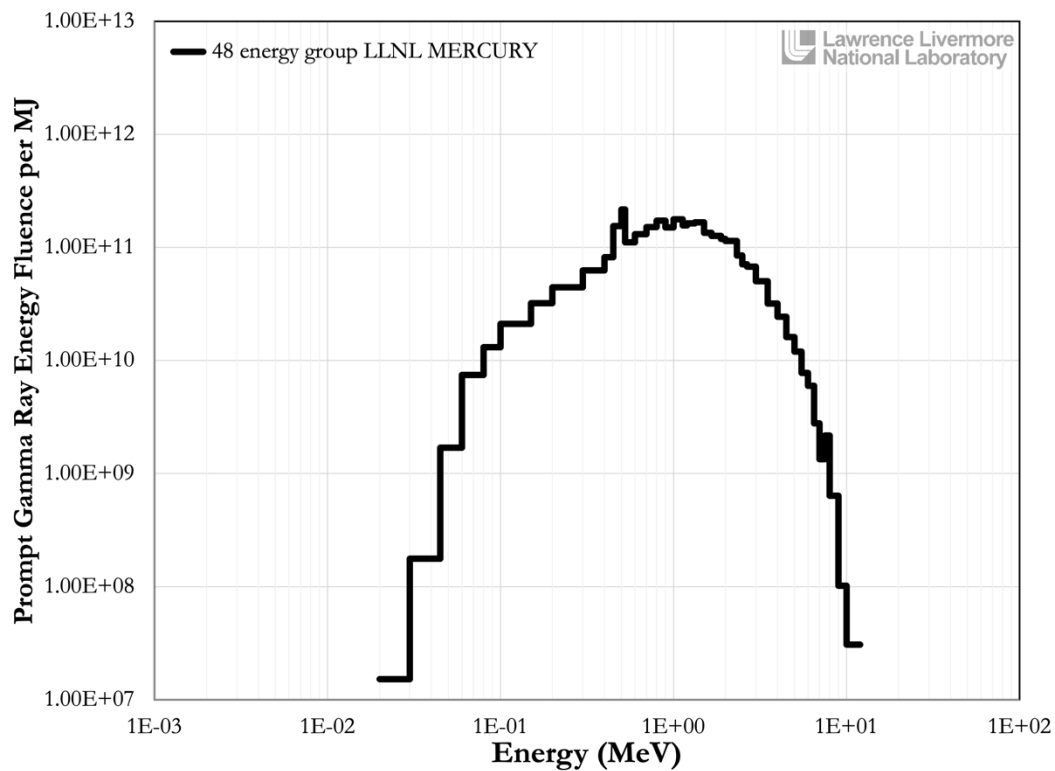


Figure 56. WSMR 24-inch – LLNL MERCURY 48-Group Prompt Gamma-Ray Energy Spectrum (log-log).

Table 38 and Table 39 contain the prompt gamma-ray fluence spectrum in a tabular format for the 48-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation. The number fraction, represented as a histogram, can be used in MERCURY source calculations as an isotropic spherical surface source.

The average gamma-ray energy is calculated to be 1.155 MeV for the 6-inch location and 1.151 MeV for the 24-inch location. The peak differential energy fluence occurs in energy group 14 at 0.5125 MeV. This peak represents the electron-positron annihilation photon energy (0.511 MeV).

Table 38. Prompt Gamma-Ray 48-Group Energy Spectrum for LLNL WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	81.49
2	1.0000E-02	2.0000E-02	1.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	64.92
3	2.0000E-02	3.0000E-02	2.5000E-02	3.3256E-06	6.4077E-08	3.3256E-04	8.3141E-06	52.72
4	3.0000E-02	4.5000E-02	3.7500E-02	8.1358E-05	2.3513E-06	5.4239E-03	2.0340E-04	42.22
5	4.5000E-02	6.0000E-02	5.2500E-02	2.6937E-04	1.0899E-05	1.7958E-02	9.4279E-04	34.83
6	6.0000E-02	8.0000E-02	7.0000E-02	7.3910E-04	3.9874E-05	3.6955E-02	2.5868E-03	33.54
7	8.0000E-02	1.0000E-01	9.0000E-02	1.5552E-03	1.0787E-04	7.7759E-02	6.9983E-03	32.43
8	1.0000E-01	1.5000E-01	1.2500E-01	6.3599E-03	6.1269E-04	1.2720E-01	1.5900E-02	30.97
9	1.5000E-01	2.0000E-01	1.7500E-01	1.1997E-02	1.6180E-03	2.3993E-01	4.1988E-02	29.48
10	2.0000E-01	3.0000E-01	2.5000E-01	2.9723E-02	5.7268E-03	2.9723E-01	7.4307E-02	27.91
11	3.0000E-01	4.0000E-01	3.5000E-01	3.8943E-02	1.0505E-02	3.8943E-01	1.3630E-01	26.42
12	4.0000E-01	4.5000E-01	4.2500E-01	2.3678E-02	7.7556E-03	4.7355E-01	2.0126E-01	25.57
13	4.5000E-01	5.0000E-01	4.7500E-01	4.5997E-02	1.6839E-02	9.1995E-01	4.3698E-01	25.07
14	5.0000E-01	5.2500E-01	5.1250E-01	3.3184E-02	1.3107E-02	1.3274E+00	6.8028E-01	24.74
15	5.2500E-01	6.0000E-01	5.6250E-01	4.1947E-02	1.8185E-02	5.5929E-01	3.1460E-01	24.33
16	6.0000E-01	7.0000E-01	6.5000E-01	6.2392E-02	3.1255E-02	6.2392E-01	4.0555E-01	23.69
17	7.0000E-01	8.0000E-01	7.5000E-01	6.4289E-02	3.7161E-02	6.4289E-01	4.8217E-01	23.06
18	8.0000E-01	9.0000E-01	8.5000E-01	6.3613E-02	4.1672E-02	6.3613E-01	5.4071E-01	22.51
19	9.0000E-01	1.0000E+00	9.5000E-01	5.3463E-02	3.9143E-02	5.3463E-01	5.0790E-01	22.02
20	1.0000E+00	1.1250E+00	1.0625E+00	6.4887E-02	5.3134E-02	5.1909E-01	5.5154E-01	21.52
21	1.1250E+00	1.2000E+00	1.1625E+00	3.1577E-02	2.8291E-02	4.2103E-01	4.8945E-01	21.13
22	1.2000E+00	1.3300E+00	1.2650E+00	5.6894E-02	5.5468E-02	4.3764E-01	5.5362E-01	20.75
23	1.3300E+00	1.5000E+00	1.4150E+00	6.8096E-02	7.4261E-02	4.0056E-01	5.6680E-01	20.26
24	1.5000E+00	1.6600E+00	1.5800E+00	4.6260E-02	5.6331E-02	2.8913E-01	4.5682E-01	20.00
25	1.6600E+00	1.8750E+00	1.7675E+00	5.3914E-02	7.3442E-02	2.5076E-01	4.4322E-01	20.00
26	1.8750E+00	2.0000E+00	1.9375E+00	2.4646E-02	3.6802E-02	1.9717E-01	3.8201E-01	20.01
27	2.0000E+00	2.3330E+00	2.1665E+00	5.2586E-02	8.7803E-02	1.5792E-01	3.4212E-01	20.00
28	2.3330E+00	2.5000E+00	2.4165E+00	2.0861E-02	3.8851E-02	1.2492E-01	3.0186E-01	20.01
29	2.5000E+00	2.6600E+00	2.5800E+00	1.5384E-02	3.0590E-02	9.6152E-02	2.4807E-01	20.01
30	2.6600E+00	3.0000E+00	2.8300E+00	2.7064E-02	5.9029E-02	7.9601E-02	2.2527E-01	20.00
31	3.0000E+00	3.5000E+00	3.2500E+00	2.3931E-02	5.9942E-02	4.7862E-02	1.5555E-01	20.00
32	3.5000E+00	4.0000E+00	3.7500E+00	1.4100E-02	4.0751E-02	2.8200E-02	1.0575E-01	20.01
33	4.0000E+00	4.5000E+00	4.2500E+00	8.9547E-03	2.9331E-02	1.7909E-02	7.6115E-02	20.01
34	4.5000E+00	5.0000E+00	4.7500E+00	5.1504E-03	1.8855E-02	1.0301E-02	4.8929E-02	20.01
35	5.0000E+00	5.5000E+00	5.2500E+00	3.2750E-03	1.3251E-02	6.5501E-03	3.4388E-02	20.01
36	5.5000E+00	6.0000E+00	5.7500E+00	2.2024E-03	9.7601E-03	4.4049E-03	2.5328E-02	20.01
37	6.0000E+00	6.5000E+00	6.2500E+00	1.0370E-03	4.9949E-03	2.0739E-03	1.2962E-02	22.03
38	6.5000E+00	7.0000E+00	6.7500E+00	4.7760E-04	2.4846E-03	9.5521E-04	6.4477E-03	25.80
39	7.0000E+00	7.5000E+00	7.2500E+00	2.0761E-04	1.1601E-03	4.1523E-04	3.0104E-03	29.31
40	7.5000E+00	8.0000E+00	7.7500E+00	1.1996E-04	7.1650E-04	2.3992E-04	1.8594E-03	32.59
41	8.0000E+00	9.0000E+00	8.5000E+00	8.7866E-05	5.7561E-04	8.7866E-05	7.4686E-04	37.12
42	9.0000E+00	1.0000E+01	9.5000E+00	3.1474E-05	2.3044E-04	3.1474E-05	2.9900E-04	42.60
43	1.0000E+01	1.2000E+01	1.1000E+01	1.5015E-05	1.2730E-04	7.5077E-06	8.2585E-05	48.45
44	1.2000E+01	1.4000E+01	1.3000E+01	6.6324E-06	6.6451E-05	3.3162E-06	4.3111E-05	54.24
45	1.4000E+01	1.7000E+01	1.5500E+01	9.5012E-07	1.1350E-05	3.1671E-07	4.9089E-06	60.77
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	66.02
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	76.31
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	92.37

Table 39. Prompt Gamma-Ray 48-Group Energy Spectrum for LLNL WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	81.49
2	1.0000E-02	2.0000E-02	1.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	64.92
3	2.0000E-02	3.0000E-02	2.5000E-02	1.7538E-05	3.6906E-07	1.7538E-03	4.3846E-05	52.99
4	3.0000E-02	4.5000E-02	3.7500E-02	2.0374E-04	6.4308E-06	1.3583E-02	5.0935E-04	42.40
5	4.5000E-02	6.0000E-02	5.2500E-02	1.3962E-03	6.1697E-05	9.3080E-02	4.8867E-03	34.87
6	6.0000E-02	8.0000E-02	7.0000E-02	6.1566E-03	3.6274E-04	3.0783E-01	2.1548E-02	33.56
7	8.0000E-02	1.0000E-01	9.0000E-02	8.4008E-03	6.3639E-04	4.2004E-01	3.7804E-02	32.44
8	1.0000E-01	1.5000E-01	1.2500E-01	2.4289E-02	2.5556E-03	4.8579E-01	6.0723E-02	30.98
9	1.5000E-01	2.0000E-01	1.7500E-01	2.6562E-02	3.9125E-03	5.3123E-01	9.2966E-02	29.49
10	2.0000E-01	3.0000E-01	2.5000E-01	5.1304E-02	1.0796E-02	5.1304E-01	1.2826E-01	27.91
11	3.0000E-01	4.0000E-01	3.5000E-01	5.1676E-02	1.5224E-02	5.1676E-01	1.8087E-01	26.43
12	4.0000E-01	4.5000E-01	4.2500E-01	2.7860E-02	9.9663E-03	5.5720E-01	2.3681E-01	25.58
13	4.5000E-01	5.0000E-01	4.7500E-01	4.7023E-02	1.8800E-02	9.4045E-01	4.4671E-01	25.09
14	5.0000E-01	5.2500E-01	5.1250E-01	3.0459E-02	1.3139E-02	1.2183E+00	6.2440E-01	24.75
15	5.2500E-01	6.0000E-01	5.6250E-01	4.2750E-02	2.0240E-02	5.7000E-01	3.2062E-01	24.34
16	6.0000E-01	7.0000E-01	6.5000E-01	5.8024E-02	3.1745E-02	5.8024E-01	3.7715E-01	23.70
17	7.0000E-01	8.0000E-01	7.5000E-01	5.8193E-02	3.6736E-02	5.8193E-01	4.3645E-01	23.07
18	8.0000E-01	9.0000E-01	8.5000E-01	5.8561E-02	4.1897E-02	5.8561E-01	4.9777E-01	22.52
19	9.0000E-01	1.0000E+00	9.5000E-01	4.5785E-02	3.6610E-02	4.5785E-01	4.3495E-01	22.03
20	1.0000E+00	1.1250E+00	1.0625E+00	6.2528E-02	5.5919E-02	5.0022E-01	5.3149E-01	21.53
21	1.1250E+00	1.2000E+00	1.1625E+00	2.7129E-02	2.6545E-02	3.6172E-01	4.2050E-01	21.14
22	1.2000E+00	1.3300E+00	1.2650E+00	4.8346E-02	5.1477E-02	3.7189E-01	4.7044E-01	20.77
23	1.3300E+00	1.5000E+00	1.4150E+00	5.7853E-02	6.8904E-02	3.4031E-01	4.8154E-01	20.27
24	1.5000E+00	1.6600E+00	1.5800E+00	3.9360E-02	5.2345E-02	2.4600E-01	3.8868E-01	20.02
25	1.6600E+00	1.8750E+00	1.7675E+00	4.5278E-02	6.7361E-02	2.1060E-01	3.7223E-01	20.02
26	1.8750E+00	2.0000E+00	1.9375E+00	2.1250E-02	3.4655E-02	1.7000E-01	3.2938E-01	20.02
27	2.0000E+00	2.3330E+00	2.1665E+00	5.0211E-02	9.1564E-02	1.5079E-01	3.2668E-01	20.02
28	2.3330E+00	2.5000E+00	2.4165E+00	1.7263E-02	3.5112E-02	1.0337E-01	2.4979E-01	20.03
29	2.5000E+00	2.6600E+00	2.5800E+00	1.2711E-02	2.7602E-02	7.9441E-02	2.0496E-01	20.03
30	2.6600E+00	3.0000E+00	2.8300E+00	2.3473E-02	5.5914E-02	6.9038E-02	1.9538E-01	20.02
31	3.0000E+00	3.5000E+00	3.2500E+00	2.2347E-02	6.1130E-02	4.4693E-02	1.4525E-01	20.02
32	3.5000E+00	4.0000E+00	3.7500E+00	1.2276E-02	3.8749E-02	2.4552E-02	9.2071E-02	20.03
33	4.0000E+00	4.5000E+00	4.2500E+00	8.2579E-03	2.9541E-02	1.6516E-02	7.0192E-02	20.04
34	4.5000E+00	5.0000E+00	4.7500E+00	4.9067E-03	1.9617E-02	9.8133E-03	4.6613E-02	20.04
35	5.0000E+00	5.5000E+00	5.2500E+00	3.2849E-03	1.4516E-02	6.5698E-03	3.4491E-02	20.05
36	5.5000E+00	6.0000E+00	5.7500E+00	1.9551E-03	9.4624E-03	3.9102E-03	2.2484E-02	20.06
37	6.0000E+00	6.5000E+00	6.2500E+00	1.3784E-03	7.2515E-03	2.7569E-03	1.7231E-02	22.10
38	6.5000E+00	7.0000E+00	6.7500E+00	5.9491E-04	3.3800E-03	1.1898E-03	8.0313E-03	25.86
39	7.0000E+00	7.5000E+00	7.2500E+00	2.6586E-04	1.6224E-03	5.3173E-04	3.8550E-03	29.41
40	7.5000E+00	8.0000E+00	7.7500E+00	4.0385E-04	2.6344E-03	8.0770E-04	6.2597E-03	32.68
41	8.0000E+00	9.0000E+00	8.5000E+00	2.1640E-04	1.5483E-03	2.1640E-04	1.8394E-03	37.23
42	9.0000E+00	1.0000E+01	9.5000E+00	3.0894E-05	2.4703E-04	3.0894E-05	2.9349E-04	43.01
43	1.0000E+01	1.2000E+01	1.1000E+01	1.6145E-05	1.4948E-04	8.0725E-06	8.8797E-05	48.98
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	53.97
45	1.4000E+01	1.7000E+01	1.5500E+01	4.8427E-06	6.3180E-05	1.6142E-06	2.5021E-05	60.98
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	66.02
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	76.31
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	92.37

The uncertainty and covariance matrix represents a combination of expert judgment and perturbation analyses using MERCURY. The covariance matrix satisfies the spectrum normalization condition and is positive semi-definite, with non-negative eigenvalues.

The results for a number of integral metrics and conversion factors are shown in Table 40 and Table 41 for the 6-inch and 24-inch test positions, respectively. Conversion values to translate to γ/cm^2 are given relative to fissions in the core, MJ of reactor energy, and $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity at the characterized location in the cavity. The same caveats presented in the neutron discussion using reactor power apply to the prompt gamma-rays. These values were calculated using the 48-group gamma-ray energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, C dose, and TLD dose.

Table 40. LLNL WSMR 6-inch Location - Prompt Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average gamma-ray energy (MeV)	1.155
Fluence Conversion ($[\gamma/\text{cm}^2]/[\text{n}/\text{cm}^2]$)	0.306
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{fission}$)	2.606E-04
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{MJ}$)	8.449E+12
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	4.437E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	4.269E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[\gamma/\text{cm}^2]$)	3.816E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[\gamma/\text{cm}^2]$)	4.817E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\gamma/\text{cm}^2]$)	4.787E-10

Table 41. LLNL WSMR 24-inch Location - Prompt Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average gamma-ray energy (MeV)	1.151
Fluence Conversion ($[\gamma/\text{cm}^2]/[\text{n}/\text{cm}^2]$)	0.300
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{fission}$)	1.184E-05
Fluence Conversion ($[\gamma/\text{cm}^2]/\text{MJ}$)	3.834E+11
Fluence Conversion From Ni Activation $^{58}\text{Ni}(\text{n,p})^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	4.306E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(\text{n,p})^{58}\text{Co}$ ($[\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	4.143E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[\gamma/\text{cm}^2]$)	3.815E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[\gamma/\text{cm}^2]$)	4.719E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[\gamma/\text{cm}^2]$)	4.787E-10

4.5. Delayed Gamma-Ray

Delayed gamma-rays are generated by fission-product decay in the Molly-G fuel and by the decay of activated materials in the reactor core. MCNP does not intrinsically calculate the source for these gamma-rays. MCNP or MERCURY can be used with the burnup feature of the code to generate fission products and activation products in defined regions of the core. But in order to generate the decay gamma-ray source, a separate calculation would need to be performed that would generate the time-dependent or time-integrated gamma-ray energy spectrum from the unique isotopic inventory and gamma-ray lines. For the analysis presented, a much simpler approach was taken. It is assumed and modeled that only early-time fission products generate decay gamma-rays. These models ignore the gamma-ray contribution from neutron activation in the core. A generic fission product decay gamma-ray energy spectrum was used in the MCNP and MERCURY analysis and transported the gamma-rays from the fission distribution in the Molly-G fuel to the detector spheres.

The total delayed gamma-ray energy released from the fission products used was 6.33 MeV per fission for U-235 fission from ENDF/B-VII.1. This energy release value is about half of the value emitted as prompt gamma-rays, and therefore cannot be ignored as a trivial quantity. The number of delayed gamma-rays emitted per fission was then calculated to be 6.57 delayed photons/fission, using the source delayed gamma-ray energy spectrum for fast U-235 fission.

Figure 57 shows the delayed gamma-ray energy source distribution in units of gamma-rays per MeV as a function of energy. This spectrum was used in a histogram format for the source calculation in MCNP or MERCURY as described above. The resulting transported gamma-ray fluence to the tally sphere is in units of fluence per source delayed gamma-ray. Although fission products continue to decay over many years, the majority of the energy (~85%) is released from the shorter-lived products over 1E4 seconds (2.8 hours). The fractional energy release up to 0.1 s is ~1%, ~6.5% up to 1 s, ~23.2% up to 10 s, and ~55% up to 300 s (5 minutes).

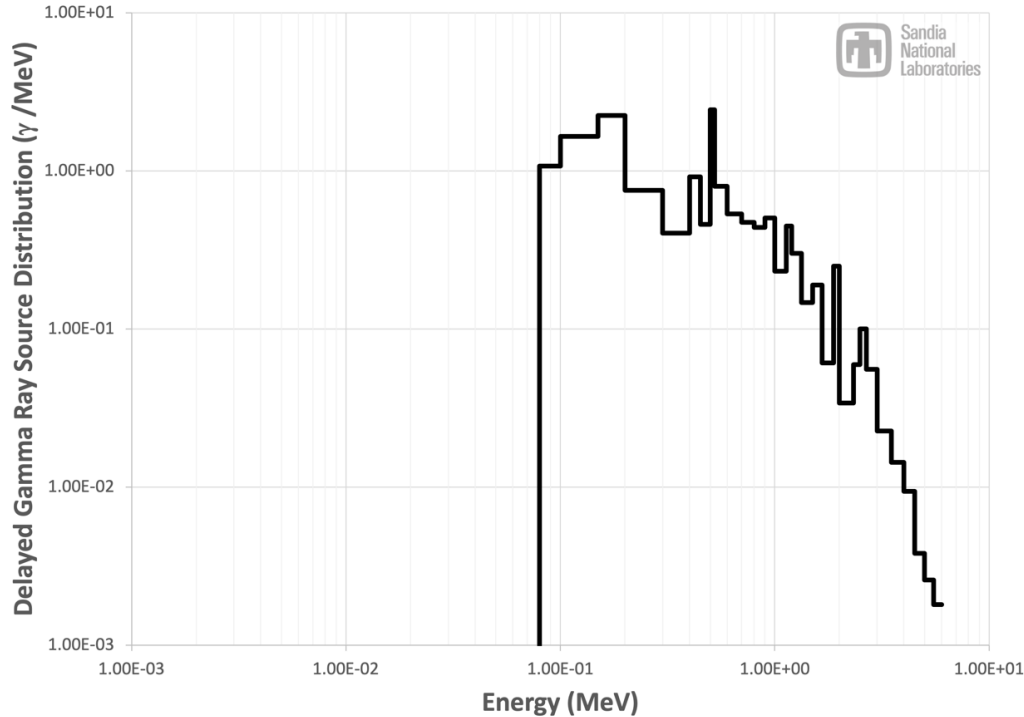


Figure 57. Delayed Gamma-Ray Source Distribution Used for MCNP and MERCURY Analysis.

4.5.1. SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum Results

The decay gamma-ray fluence was calculated with MCNP6.2 using the source mode and with photons only. The same model of the WSMR Molly-G configuration was used with a represented fission product gamma-ray source energy spectrum. The same 48-group energy structure was used as for prompt gamma-rays. The fission-product delayed gamma-ray energy spectrum used was for fast U-235 fission in the time interval from 0.2 to 0.5 seconds as given in Engle (1962) and Fisher (1964). The gamma-ray source distribution within the Molly-G fuel was calculated radially by ring in the core. The distribution function was generated from a separate MCNP k-code calculation by tallying the number of fissions in each ring of fuel. A constant axial source distribution was assumed per ring. The results gave the transported delayed gamma-ray fluence spectrum per source photon.

Figure 58 and Figure 59 for the 6-inch location and Figure 60 and Figure 61 for the 24-inch location show the MCNP-generated 48-group delayed gamma-ray energy fluence on a linear and logarithmic y-axis, respectively. The units on the y-axis are in energy fluence, equal to $E d\phi / dE$ (MeV/MeV-cm²-MJ). With the energy fluence represented linearly on the y-axis and the photon energy on the x-axis represented logarithmically, the area under the curve represents the total gamma-ray fluence. The scale

of the plots is the same as presented for the prompt gamma-rays. The delayed gamma-ray energy fluence has a prominent peak at ~ 0.5 MeV.

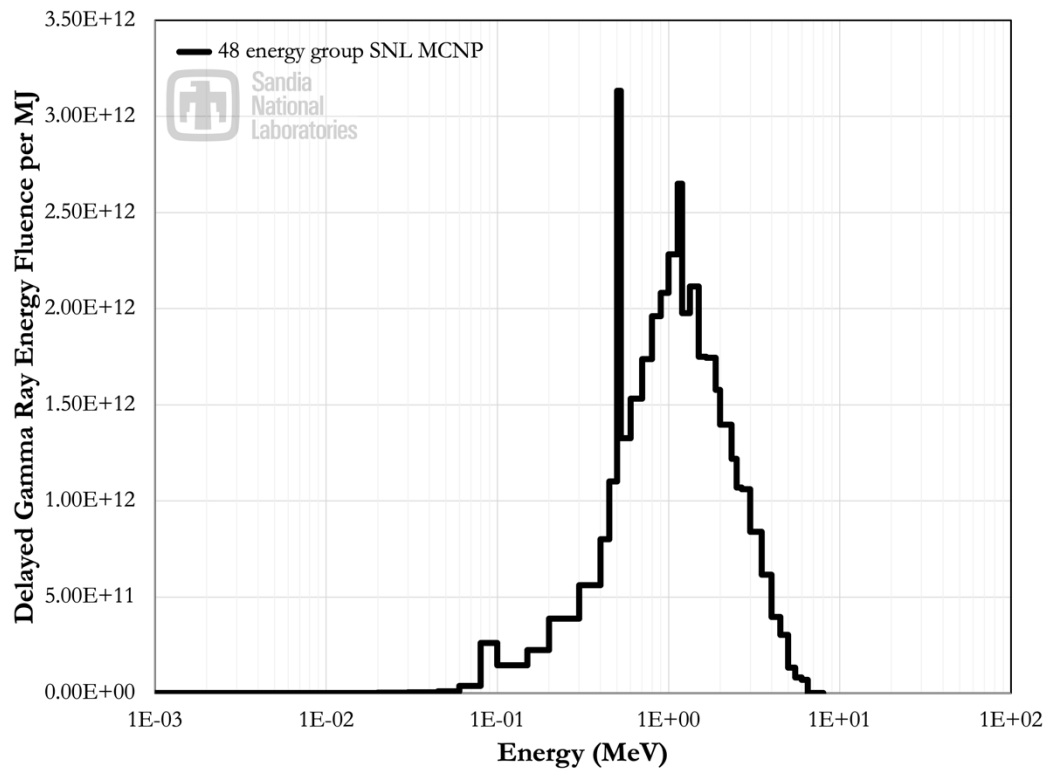


Figure 58. WSMR 6-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).

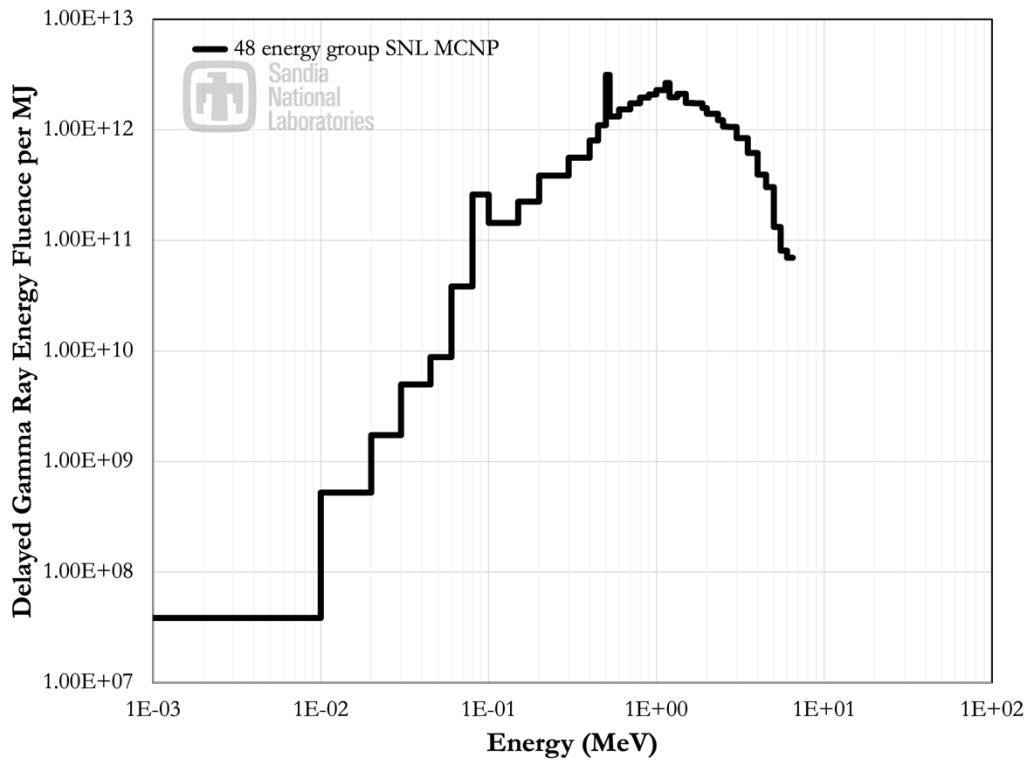


Figure 59. WSMR 6-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).

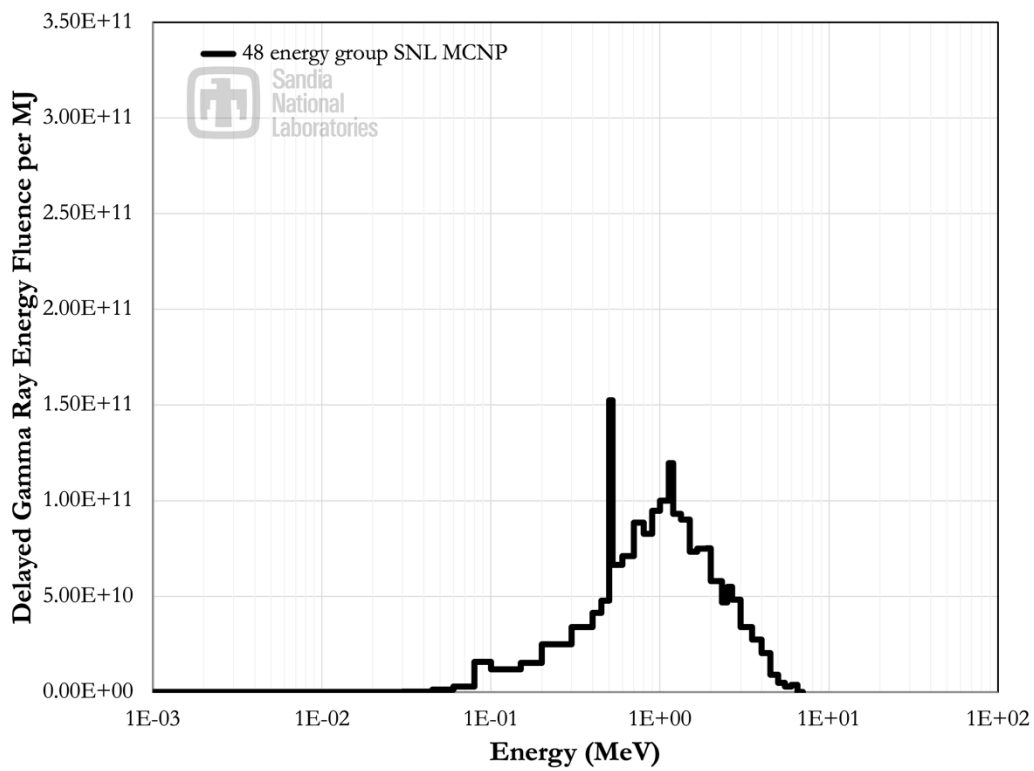


Figure 60. WSMR 24-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).

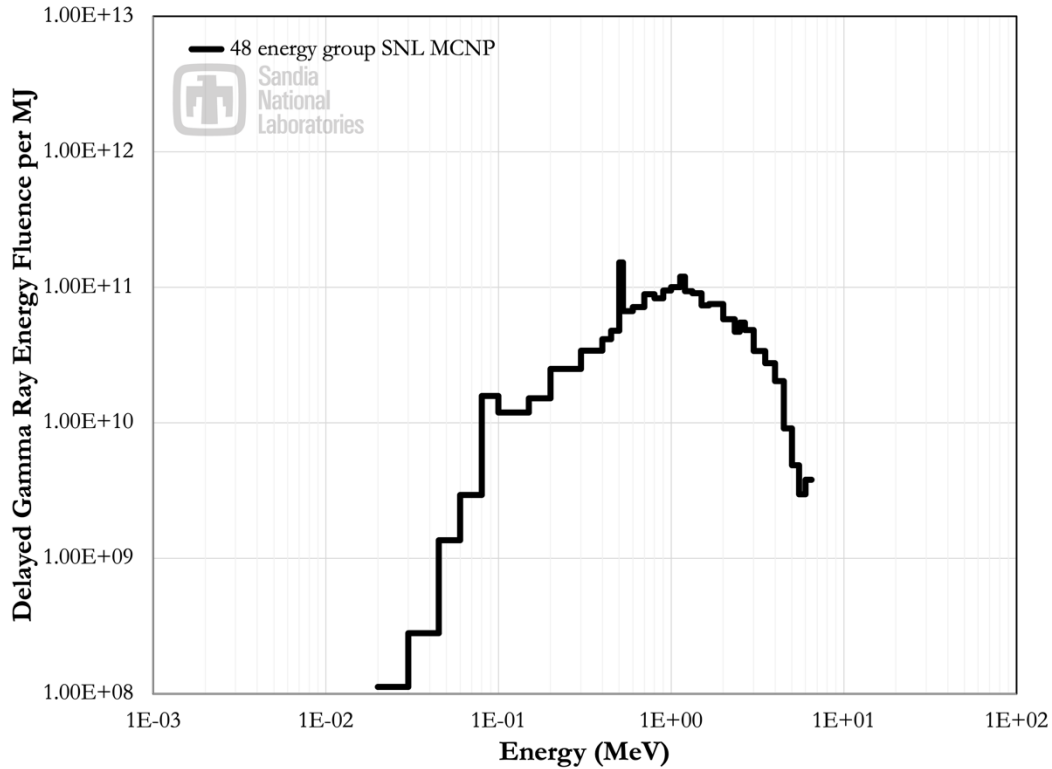


Figure 61. WSMR 24-inch – SNL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).

Table 42 for the 6-inch location and Table 43 for the 24-inch location show the delayed gamma-ray fluence spectrum in a tabular format for the 48-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation. The number fraction, represented as a histogram, can be used in MCNP source calculations as an isotropic spherical surface source.

The average delayed gamma-ray energy is calculated to be 1.320 MeV for 6-inch location and 1.233 MeV for 24-inch location. The peak differential energy fluence again occurs in energy group 14 at 0.5125 MeV. This is the large peak seen in Figure 58 and Figure 60 represents the electron-positron annihilation photon energy (0.511 MeV).

Table 42. Delayed Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	102.67
2	1.0000E-02	2.0000E-02	1.5000E-02	1.5215E-05	1.5423E-07	1.5215E-03	2.2823E-05	102.05
3	2.0000E-02	3.0000E-02	2.5000E-02	8.4143E-05	1.4215E-06	8.4143E-03	2.1036E-04	101.62
4	3.0000E-02	4.5000E-02	3.7500E-02	1.6641E-04	4.2171E-06	1.1094E-02	4.1603E-04	74.73
5	4.5000E-02	6.0000E-02	5.2500E-02	4.7874E-04	1.6985E-05	3.1916E-02	1.6756E-03	53.47
6	6.0000E-02	8.0000E-02	7.0000E-02	6.0500E-04	2.8619E-05	3.0250E-02	2.1175E-03	53.40
7	8.0000E-02	1.0000E-01	9.0000E-02	2.6264E-03	1.5973E-04	1.3132E-01	1.1819E-02	54.05
8	1.0000E-01	1.5000E-01	1.2500E-01	1.3937E-02	1.1772E-03	2.7873E-01	3.4842E-02	46.60
9	1.5000E-01	2.0000E-01	1.7500E-01	1.3851E-02	1.6380E-03	2.7702E-01	4.8478E-02	42.43
10	2.0000E-01	3.0000E-01	2.5000E-01	1.5379E-02	2.5982E-03	1.5379E-01	3.8449E-02	42.27
11	3.0000E-01	4.0000E-01	3.5000E-01	3.7191E-02	8.7964E-03	3.7191E-01	1.3017E-01	42.28
12	4.0000E-01	4.5000E-01	4.2500E-01	3.8549E-02	1.1071E-02	7.7097E-01	3.2766E-01	44.30
13	4.5000E-01	5.0000E-01	4.7500E-01	2.2610E-02	7.2577E-03	4.5221E-01	2.1480E-01	41.91
14	5.0000E-01	5.2500E-01	5.1250E-01	2.7837E-02	9.6409E-03	1.1135E+00	5.7066E-01	38.56
15	5.2500E-01	6.0000E-01	5.6250E-01	3.6715E-02	1.3956E-02	4.8953E-01	2.7536E-01	38.98
16	6.0000E-01	7.0000E-01	6.5000E-01	4.2459E-02	1.8650E-02	4.2459E-01	2.7598E-01	14.56
17	7.0000E-01	8.0000E-01	7.5000E-01	5.6626E-02	2.8700E-02	5.6626E-01	4.2470E-01	10.72
18	8.0000E-01	9.0000E-01	8.5000E-01	5.5629E-02	3.1954E-02	5.5629E-01	4.7285E-01	9.12
19	9.0000E-01	1.0000E+00	9.5000E-01	5.5399E-02	3.5565E-02	5.5399E-01	5.2629E-01	7.98
20	1.0000E+00	1.1250E+00	1.0625E+00	5.2661E-02	3.7811E-02	4.2129E-01	4.4762E-01	7.19
21	1.1250E+00	1.2000E+00	1.1625E+00	6.6903E-02	5.2558E-02	8.9204E-01	1.0370E+00	5.46
22	1.2000E+00	1.3300E+00	1.2650E+00	3.8248E-02	3.2697E-02	2.9422E-01	3.7219E-01	4.60
23	1.3300E+00	1.5000E+00	1.4150E+00	4.8794E-02	4.6658E-02	2.8703E-01	4.0614E-01	4.74
24	1.5000E+00	1.6600E+00	1.5800E+00	6.1074E-02	6.5210E-02	3.8171E-01	6.0311E-01	5.10
25	1.6600E+00	1.8750E+00	1.7675E+00	4.2571E-02	5.0848E-02	1.9801E-01	3.4997E-01	5.14
26	1.8750E+00	2.0000E+00	1.9375E+00	5.2111E-02	6.8229E-02	4.1689E-01	8.0772E-01	5.34
27	2.0000E+00	2.3330E+00	2.1665E+00	2.3431E-02	3.4305E-02	7.0364E-02	1.5244E-01	6.03
28	2.3330E+00	2.5000E+00	2.4165E+00	5.1154E-02	8.3534E-02	3.0631E-01	7.4020E-01	6.92
29	2.5000E+00	2.6600E+00	2.5800E+00	2.0619E-02	3.5949E-02	1.2887E-01	3.3249E-01	7.50
30	2.6600E+00	3.0000E+00	2.8300E+00	1.6903E-02	3.2326E-02	4.9715E-02	1.4069E-01	8.44
31	3.0000E+00	3.5000E+00	3.2500E+00	2.9681E-02	6.5187E-02	5.9362E-02	1.9293E-01	9.98
32	3.5000E+00	4.0000E+00	3.7500E+00	3.1041E-02	7.8661E-02	6.2081E-02	2.3281E-01	11.59
33	4.0000E+00	4.5000E+00	4.2500E+00	1.9750E-02	5.6721E-02	3.9499E-02	1.6787E-01	12.97
34	4.5000E+00	5.0000E+00	4.7500E+00	1.1177E-02	3.5876E-02	2.2354E-02	1.0618E-01	14.18
35	5.0000E+00	5.5000E+00	5.2500E+00	7.6600E-03	2.7176E-02	1.5320E-02	8.0430E-02	15.22
36	5.5000E+00	6.0000E+00	5.7500E+00	3.0304E-03	1.1775E-02	6.0607E-03	3.4849E-02	16.11
37	6.0000E+00	6.5000E+00	6.2500E+00	1.6936E-03	7.1530E-03	3.3872E-03	2.1170E-02	100.00
38	6.5000E+00	7.0000E+00	6.7500E+00	1.3393E-03	6.1093E-03	2.6787E-03	1.8081E-02	100.00
39	7.0000E+00	7.5000E+00	7.2500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
40	7.5000E+00	8.0000E+00	7.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
41	8.0000E+00	9.0000E+00	8.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
42	9.0000E+00	1.0000E+01	9.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
43	1.0000E+01	1.2000E+01	1.1000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00

Table 43. Delayed Gamma-Ray 48-Group Energy Spectrum for SNL WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	103.54
2	1.0000E-02	2.0000E-02	1.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	102.92
3	2.0000E-02	3.0000E-02	2.5000E-02	2.2642E-04	4.5935E-06	2.2642E-02	5.6604E-04	101.88
4	3.0000E-02	4.5000E-02	3.7500E-02	5.6313E-04	1.7137E-05	3.7542E-02	1.4078E-03	74.77
5	4.5000E-02	6.0000E-02	5.2500E-02	1.9592E-03	8.3470E-05	1.3061E-01	6.8571E-03	53.49
6	6.0000E-02	8.0000E-02	7.0000E-02	4.2186E-03	2.3964E-04	2.1093E-01	1.4765E-02	53.42
7	8.0000E-02	1.0000E-01	9.0000E-02	1.7653E-02	1.2893E-03	8.8266E-01	7.9439E-02	54.07
8	1.0000E-01	1.5000E-01	1.2500E-01	2.4057E-02	2.4404E-03	4.8114E-01	6.0143E-02	46.61
9	1.5000E-01	2.0000E-01	1.7500E-01	2.1883E-02	3.1078E-03	4.3767E-01	7.6592E-02	42.44
10	2.0000E-01	3.0000E-01	2.5000E-01	5.0229E-02	1.0191E-02	5.0229E-01	1.2557E-01	42.28
11	3.0000E-01	4.0000E-01	3.5000E-01	4.9012E-02	1.3921E-02	4.9012E-01	1.7154E-01	42.30
12	4.0000E-01	4.5000E-01	4.2500E-01	2.4528E-02	8.4596E-03	4.9056E-01	2.0849E-01	44.32
13	4.5000E-01	5.0000E-01	4.7500E-01	2.5352E-02	9.7725E-03	5.0704E-01	2.4085E-01	41.94
14	5.0000E-01	5.2500E-01	5.1250E-01	3.7559E-02	1.5621E-02	1.5024E+00	7.6996E-01	38.59
15	5.2500E-01	6.0000E-01	5.6250E-01	4.4777E-02	2.0440E-02	5.9703E-01	3.3583E-01	39.01
16	6.0000E-01	7.0000E-01	6.5000E-01	5.5254E-02	2.9146E-02	5.5254E-01	3.5915E-01	14.59
17	7.0000E-01	8.0000E-01	7.5000E-01	5.9584E-02	3.6265E-02	5.9584E-01	4.4688E-01	10.75
18	8.0000E-01	9.0000E-01	8.5000E-01	4.9122E-02	3.3884E-02	4.9122E-01	4.1754E-01	9.15
19	9.0000E-01	1.0000E+00	9.5000E-01	5.0330E-02	3.8802E-02	5.0330E-01	4.7814E-01	8.01
20	1.0000E+00	1.1250E+00	1.0625E+00	6.1624E-02	5.3135E-02	4.9299E-01	5.2381E-01	7.22
21	1.1250E+00	1.2000E+00	1.1625E+00	3.6267E-02	3.4214E-02	4.8356E-01	5.6213E-01	5.50
22	1.2000E+00	1.3300E+00	1.2650E+00	4.8341E-02	4.9626E-02	3.7186E-01	4.7040E-01	4.63
23	1.3300E+00	1.5000E+00	1.4150E+00	5.4683E-02	6.2792E-02	3.2166E-01	4.5515E-01	4.77
24	1.5000E+00	1.6600E+00	1.5800E+00	3.7519E-02	4.8107E-02	2.3450E-01	3.7050E-01	5.13
25	1.6600E+00	1.8750E+00	1.7675E+00	4.7073E-02	6.7520E-02	2.1894E-01	3.8698E-01	5.18
26	1.8750E+00	2.0000E+00	1.9375E+00	2.3463E-02	3.6891E-02	1.8770E-01	3.6368E-01	5.37
27	2.0000E+00	2.3330E+00	2.1665E+00	4.4669E-02	7.8535E-02	1.3414E-01	2.9062E-01	6.08
28	2.3330E+00	2.5000E+00	2.4165E+00	1.6633E-02	3.2619E-02	9.9602E-02	2.4069E-01	6.97
29	2.5000E+00	2.6600E+00	2.5800E+00	1.8227E-02	3.8162E-02	1.1392E-01	2.9391E-01	7.55
30	2.6600E+00	3.0000E+00	2.8300E+00	2.8333E-02	6.5069E-02	8.3332E-02	2.3583E-01	8.48
31	3.0000E+00	3.5000E+00	3.2500E+00	2.6312E-02	6.9396E-02	5.2624E-02	1.7103E-01	10.03
32	3.5000E+00	4.0000E+00	3.7500E+00	1.8485E-02	5.6252E-02	3.6969E-02	1.3864E-01	11.66
33	4.0000E+00	4.5000E+00	4.2500E+00	1.2068E-02	4.1624E-02	2.4137E-02	1.0258E-01	13.05
34	4.5000E+00	5.0000E+00	4.7500E+00	4.8328E-03	1.8629E-02	9.6657E-03	4.5912E-02	14.31
35	5.0000E+00	5.5000E+00	5.2500E+00	2.3324E-03	9.9371E-03	4.6648E-03	2.4490E-02	15.38
36	5.5000E+00	6.0000E+00	5.7500E+00	1.2994E-03	6.0631E-03	2.5987E-03	1.4943E-02	16.29
37	6.0000E+00	6.5000E+00	6.2500E+00	1.5272E-03	7.7457E-03	3.0543E-03	1.9089E-02	100.00
38	6.5000E+00	7.0000E+00	6.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
39	7.0000E+00	7.5000E+00	7.2500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
40	7.5000E+00	8.0000E+00	7.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
41	8.0000E+00	9.0000E+00	8.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
42	9.0000E+00	1.0000E+01	9.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
43	1.0000E+01	1.2000E+01	1.1000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00

The results for a number of integral metrics and conversion factors are shown in Table 44 and Table 45. Conversion values to translate to γ/cm^2 are given for fissions in the core, MJ of reactor energy, and $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity. The same caveats presented in the neutron discussion using reactor power apply to the delayed gamma-rays. Table 44 and Table 45 also shows additional integral metrics that may be useful to the experimenter. These values were calculated using the 48-group gamma-ray energy

spectrum and the NuGET code with various response functions. Included are responses for Si dose, C dose, and TLD dose.

Table 44. SNL WSMR 6-inch Location - Delayed Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average delayed gamma-ray ($d\gamma$) energy (MeV)	1.320
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\text{source } d\gamma]$)	1.955E-05
Source Delayed Gamma-Rays (source $d\gamma$ /fission)	6.567
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\gamma/\text{cm}^2]$)	0.639
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{fission}$)	1.284E-04
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{MJ}$)	4.162E+12
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	2.616E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	2.517E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[d\gamma/\text{cm}^2]$)	5.195E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[d\gamma/\text{cm}^2]$)	5.084E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[d\gamma/\text{cm}^2]$)	5.119E-10

Table 45. SNL WSMR 24-inch Location - Delayed Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average delayed gamma-ray ($d\gamma$) energy (MeV)	1.233
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\text{source } d\gamma]$)	9.305E-07
Source Delayed Gamma-Rays (source $d\gamma$ /fission)	6.567
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\gamma/\text{cm}^2]$)	0.587
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{fission}$)	6.111E-06
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{MJ}$)	1.980E+11
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	2.366E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	2.276E+09
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[d\gamma/\text{cm}^2]$)	4.892E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[d\gamma/\text{cm}^2]$)	4.783E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[d\gamma/\text{cm}^2]$)	4.823E-10

4.5.2. LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum Results

The decay gamma-ray fluence was calculated with MCNP6.3 using the source mode and with photons only. The same model of the WSMR Molly-G configuration was used with a represented fission product gamma-ray source energy spectrum. The same 48-group energy structure was used as for prompt gamma-rays. The fission-product delayed gamma-ray energy spectrum used was for fast U-235 fission in the time interval from 0.2 to 0.5 seconds as given in Engle (1962) and Fisher (1964). The gamma-ray source distribution within the Molly-G fuel was calculated radially by ring in the core. The distribution function was generated from a separate MCNP k-code calculation by tallying the number of fissions in each ring of fuel. A constant axial source distribution was assumed per ring. The results gave the transported delayed gamma-ray fluence spectrum per source photon.

Figure 62 and Figure 63 for the 6-inch location and Figure 64 and Figure 65 for the 24-inch location show the MCNP-generated 48-group delayed gamma-ray energy fluence on a linear and logarithmic y-axis, respectively. The units on the y-axis are in energy fluence, equal to $E d\Phi/dE$ (MeV/MeV-cm²-MJ). With the energy fluence represented linearly on the y-axis and the photon energy on the x-axis represented logarithmically, the area under the curve represents the total gamma-ray fluence. The scale

of the plots is the same as presented for the prompt gamma-rays. The delayed gamma-ray energy fluence has a prominent peak at ~ 0.5 MeV.

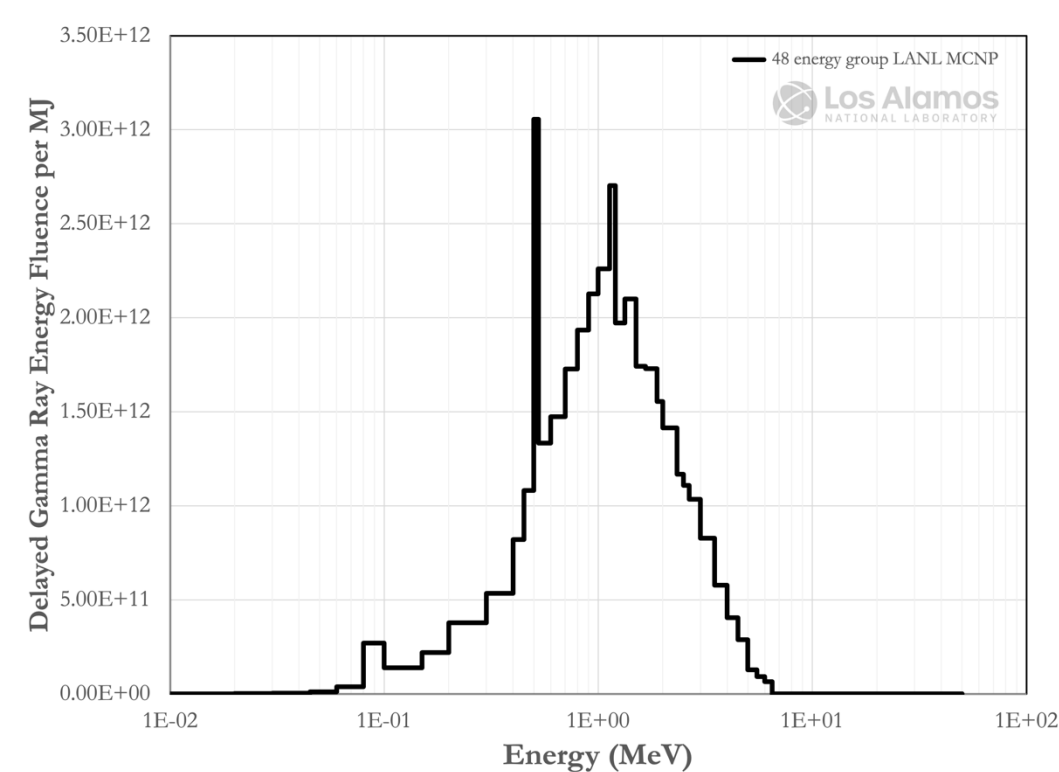


Figure 62. WSMR 6-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).

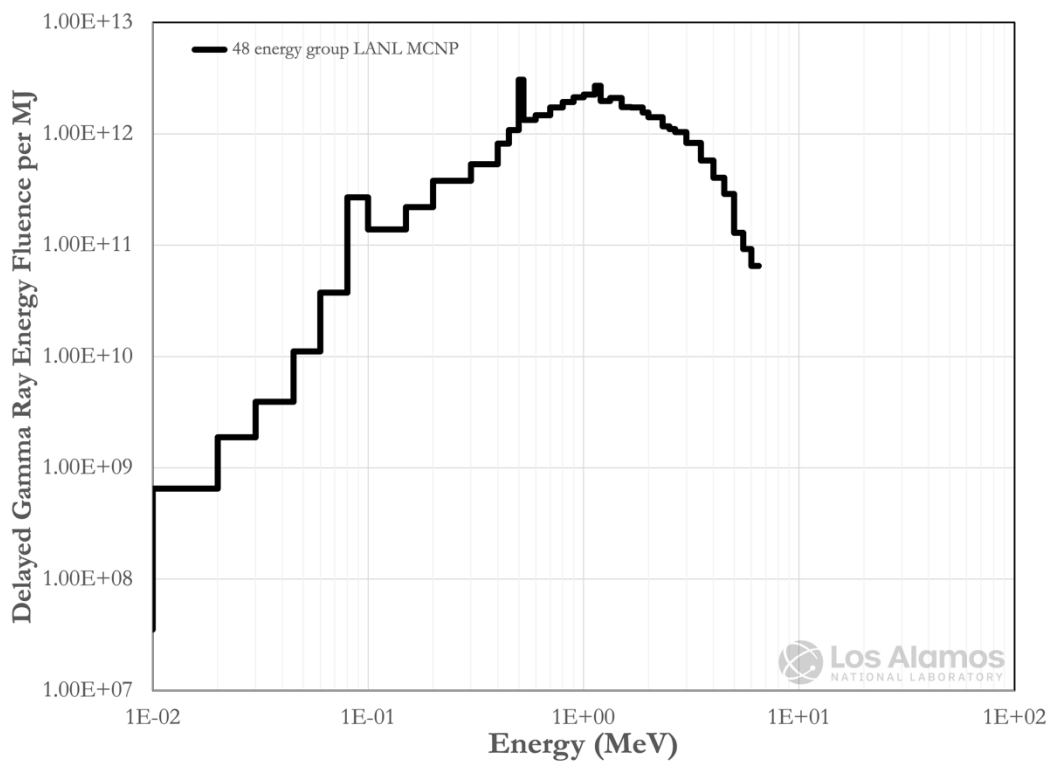


Figure 63. WSMR 6-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).

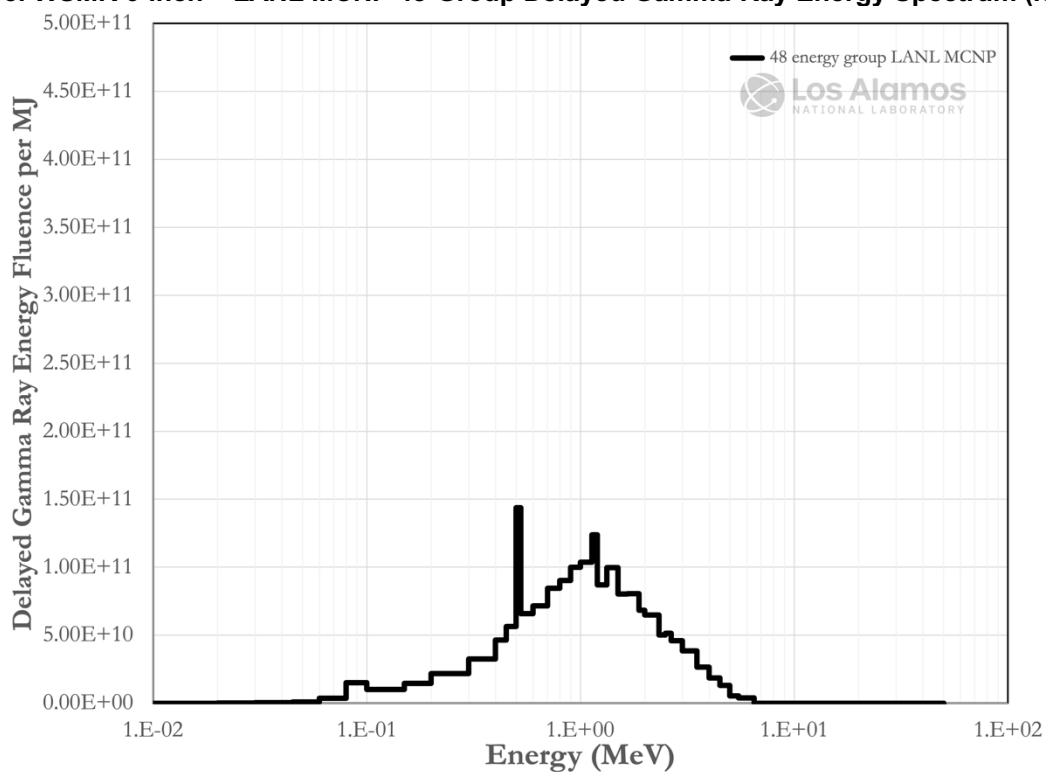


Figure 64. WSMR 24-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).

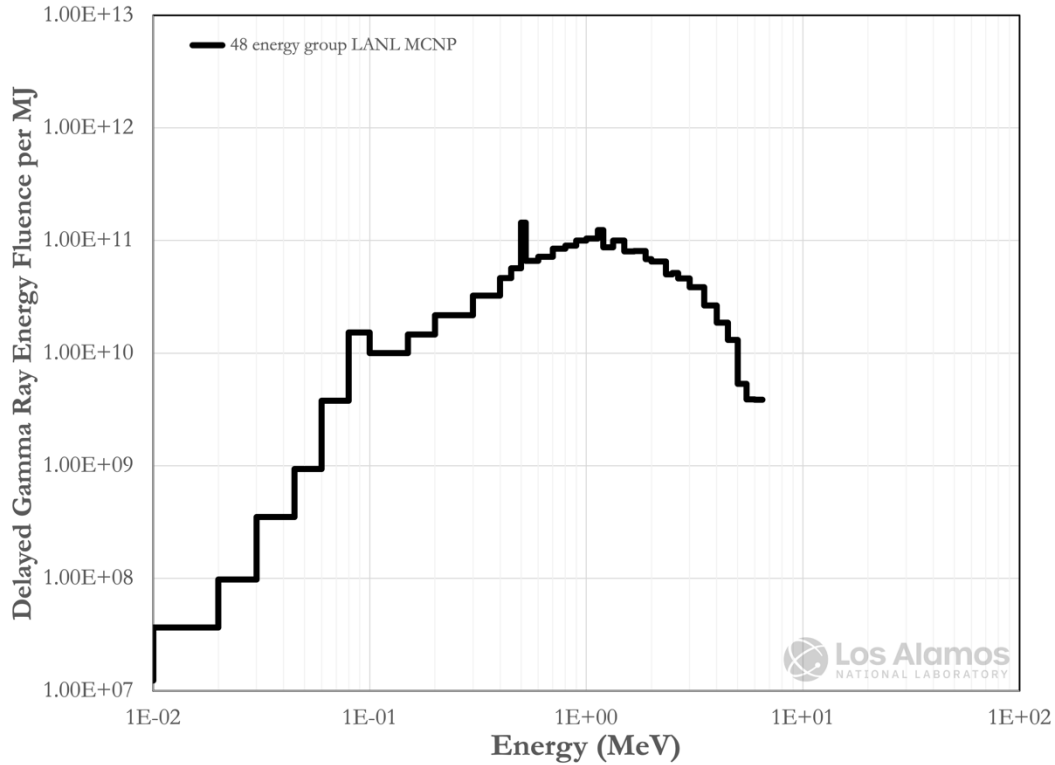


Figure 65. WSMR 24-inch – LANL MCNP 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).

Table 46 for the 6-inch location and Table 47 for the 24-inch location show the delayed gamma-ray fluence spectrum in a tabular format for the 48-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation. The number fraction, represented as a histogram, can be used in MCNP source calculations as an isotropic spherical surface source.

The average delayed gamma-ray energy is calculated to be 1.399 MeV for 6-inch location and 1.333 MeV for 24-inch location. The peak differential energy fluence again occurs in energy group 14 at 0.5125 MeV. This is the large peak seen in Figure 62 and Figure 64 represents the electron-positron annihilation photon energy (0.511 MeV).

Table 46. Delayed Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	1.3999E-05	5.8376E-08	1.5555E-03	8.5552E-06	102.35
2	1.0000E-02	2.0000E-02	1.5000E-02	1.0502E-04	1.1943E-06	1.0502E-02	1.5752E-04	101.70
3	2.0000E-02	3.0000E-02	2.5000E-02	1.8297E-04	3.4680E-06	1.8297E-02	4.5743E-04	101.55
4	3.0000E-02	4.5000E-02	3.7500E-02	3.8013E-04	1.0807E-05	2.5342E-02	9.5033E-04	74.75
5	4.5000E-02	6.0000E-02	5.2500E-02	7.7130E-04	3.0700E-05	5.1420E-02	2.6995E-03	53.48
6	6.0000E-02	8.0000E-02	7.0000E-02	2.6035E-03	1.3817E-04	1.3018E-01	9.1123E-03	53.40
7	8.0000E-02	1.0000E-01	9.0000E-02	1.4545E-02	9.9247E-04	7.2725E-01	6.5453E-02	54.05
8	1.0000E-01	1.5000E-01	1.2500E-01	1.3399E-02	1.2698E-03	2.6798E-01	3.3498E-02	46.60
9	1.5000E-01	2.0000E-01	1.7500E-01	1.5248E-02	2.0230E-03	3.0496E-01	5.3367E-02	42.43
10	2.0000E-01	3.0000E-01	2.5000E-01	3.6684E-02	6.9530E-03	3.6684E-01	9.1709E-02	42.26
11	3.0000E-01	4.0000E-01	3.5000E-01	3.7100E-02	9.8447E-03	3.7100E-01	1.2985E-01	42.28
12	4.0000E-01	4.5000E-01	4.2500E-01	2.3399E-02	7.5394E-03	4.6797E-01	1.9889E-01	44.29
13	4.5000E-01	5.0000E-01	4.7500E-01	2.7608E-02	9.9424E-03	5.5217E-01	2.6228E-01	41.90
14	5.0000E-01	5.2500E-01	5.1250E-01	3.6138E-02	1.4042E-02	1.4455E+00	7.4083E-01	38.55
15	5.2500E-01	6.0000E-01	5.6250E-01	4.3129E-02	1.8393E-02	5.7505E-01	3.2346E-01	38.97
16	6.0000E-01	7.0000E-01	6.5000E-01	5.4971E-02	2.7090E-02	5.4971E-01	3.5731E-01	14.55
17	7.0000E-01	8.0000E-01	7.5000E-01	5.5848E-02	3.1756E-02	5.5848E-01	4.1886E-01	10.71
18	8.0000E-01	9.0000E-01	8.5000E-01	5.5177E-02	3.5558E-02	5.5177E-01	4.6901E-01	9.11
19	9.0000E-01	1.0000E+00	9.5000E-01	5.4287E-02	3.9100E-02	5.4287E-01	5.1573E-01	7.97
20	1.0000E+00	1.1250E+00	1.0625E+00	6.6906E-02	5.3896E-02	5.3525E-01	5.6870E-01	7.18
21	1.1250E+00	1.2000E+00	1.1625E+00	3.9361E-02	3.4691E-02	5.2482E-01	6.1010E-01	5.45
22	1.2000E+00	1.3300E+00	1.2650E+00	4.9125E-02	4.7115E-02	3.7789E-01	4.7803E-01	4.59
23	1.3300E+00	1.5000E+00	1.4150E+00	6.1142E-02	6.5593E-02	3.5966E-01	5.0892E-01	4.73
24	1.5000E+00	1.6600E+00	1.5800E+00	4.2781E-02	5.1247E-02	2.6738E-01	4.2246E-01	5.09
25	1.6600E+00	1.8750E+00	1.7675E+00	5.2096E-02	6.9811E-02	2.4231E-01	4.2828E-01	5.12
26	1.8750E+00	2.0000E+00	1.9375E+00	2.3314E-02	3.4247E-02	1.8651E-01	3.6137E-01	5.32
27	2.0000E+00	2.3330E+00	2.1665E+00	5.2267E-02	8.5852E-02	1.5696E-01	3.4005E-01	6.02
28	2.3330E+00	2.5000E+00	2.4165E+00	1.9929E-02	3.6512E-02	1.1934E-01	2.8837E-01	6.90
29	2.5000E+00	2.6600E+00	2.5800E+00	1.7667E-02	3.4558E-02	1.1042E-01	2.8489E-01	7.48
30	2.6600E+00	3.0000E+00	2.8300E+00	2.9193E-02	6.2635E-02	8.5861E-02	2.4299E-01	8.42
31	3.0000E+00	3.5000E+00	3.2500E+00	3.0885E-02	7.6100E-02	6.1769E-02	2.0075E-01	9.96
32	3.5000E+00	4.0000E+00	3.7500E+00	1.8654E-02	5.3035E-02	3.7308E-02	1.3991E-01	11.57
33	4.0000E+00	4.5000E+00	4.2500E+00	1.1533E-02	3.7162E-02	2.3066E-02	9.8033E-02	12.95
34	4.5000E+00	5.0000E+00	4.7500E+00	7.3720E-03	2.6548E-02	1.4744E-02	7.0034E-02	14.14
35	5.0000E+00	5.5000E+00	5.2500E+00	2.9774E-03	1.1851E-02	5.9549E-03	3.1263E-02	15.17
36	5.5000E+00	6.0000E+00	5.7500E+00	1.9428E-03	8.4695E-03	3.8856E-03	2.2342E-02	16.05
37	6.0000E+00	6.5000E+00	6.2500E+00	1.2643E-03	5.9910E-03	2.5287E-03	1.5804E-02	100.00
38	6.5000E+00	7.0000E+00	6.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
39	7.0000E+00	7.5000E+00	7.2500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
40	7.5000E+00	8.0000E+00	7.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
41	8.0000E+00	9.0000E+00	8.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
42	9.0000E+00	1.0000E+01	9.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
43	1.0000E+01	1.2000E+01	1.1000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00

Table 47. Delayed Gamma-Ray 48-Group Energy Spectrum for LANL WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	104.35
2	1.0000E-02	2.0000E-02	1.5000E-02	1.0076E-04	1.0711E-06	1.0076E-02	1.5113E-04	102.85
3	2.0000E-02	3.0000E-02	2.5000E-02	1.2084E-04	2.1411E-06	1.2084E-02	3.0210E-04	102.40
4	3.0000E-02	4.5000E-02	3.7500E-02	1.9364E-04	5.1466E-06	1.2910E-02	4.8411E-04	75.19
5	4.5000E-02	6.0000E-02	5.2500E-02	6.9350E-04	2.5804E-05	4.6233E-02	2.4272E-03	53.80
6	6.0000E-02	8.0000E-02	7.0000E-02	1.3244E-03	6.5707E-05	6.6221E-02	4.6355E-03	53.57
7	8.0000E-02	1.0000E-01	9.0000E-02	5.3460E-03	3.4100E-04	2.6730E-01	2.4057E-02	54.14
8	1.0000E-01	1.5000E-01	1.2500E-01	1.6796E-02	1.4880E-03	3.3592E-01	4.1990E-02	46.68
9	1.5000E-01	2.0000E-01	1.7500E-01	1.9886E-02	2.4664E-03	3.9771E-01	6.9600E-02	42.51
10	2.0000E-01	3.0000E-01	2.5000E-01	2.0804E-02	3.6862E-03	2.0804E-01	5.2011E-02	42.32
11	3.0000E-01	4.0000E-01	3.5000E-01	4.3144E-02	1.0702E-02	4.3144E-01	1.5101E-01	42.33
12	4.0000E-01	4.5000E-01	4.2500E-01	4.6057E-02	1.3873E-02	9.2113E-01	3.9148E-01	44.36
13	4.5000E-01	5.0000E-01	4.7500E-01	2.7079E-02	9.1160E-03	5.4157E-01	2.5725E-01	41.97
14	5.0000E-01	5.2500E-01	5.1250E-01	2.9511E-02	1.0719E-02	1.1804E+00	6.0497E-01	38.61
15	5.2500E-01	6.0000E-01	5.6250E-01	3.4808E-02	1.3877E-02	4.6411E-01	2.6106E-01	39.03
16	6.0000E-01	7.0000E-01	6.5000E-01	4.3618E-02	2.0094E-02	4.3618E-01	2.8352E-01	14.60
17	7.0000E-01	8.0000E-01	7.5000E-01	5.4718E-02	2.9086E-02	5.4718E-01	4.1039E-01	10.76
18	8.0000E-01	9.0000E-01	8.5000E-01	5.6013E-02	3.3744E-02	5.6013E-01	4.7611E-01	9.17
19	9.0000E-01	1.0000E+00	9.5000E-01	5.2632E-02	3.5437E-02	5.2632E-01	5.0000E-01	8.03
20	1.0000E+00	1.1250E+00	1.0625E+00	5.2268E-02	3.9360E-02	4.1814E-01	4.4428E-01	7.22
21	1.1250E+00	1.2000E+00	1.1625E+00	6.2849E-02	5.1782E-02	8.3799E-01	9.7416E-01	5.51
22	1.2000E+00	1.3300E+00	1.2650E+00	3.6897E-02	3.3080E-02	2.8382E-01	3.5904E-01	4.65
23	1.3300E+00	1.5000E+00	1.4150E+00	4.4440E-02	4.4567E-02	2.6141E-01	3.6990E-01	4.77
24	1.5000E+00	1.6600E+00	1.5800E+00	5.9398E-02	6.6515E-02	3.7124E-01	5.8656E-01	5.15
25	1.6600E+00	1.8750E+00	1.7675E+00	4.0353E-02	5.0550E-02	1.8769E-01	3.3174E-01	5.17
26	1.8750E+00	2.0000E+00	1.9375E+00	4.9623E-02	6.8141E-02	3.9698E-01	7.6916E-01	5.41
27	2.0000E+00	2.3330E+00	2.1665E+00	2.0969E-02	3.2197E-02	6.2970E-02	1.3642E-01	6.07
28	2.3330E+00	2.5000E+00	2.4165E+00	4.9070E-02	8.4041E-02	2.9383E-01	7.1005E-01	6.99
29	2.5000E+00	2.6600E+00	2.5800E+00	1.7509E-02	3.2015E-02	1.0943E-01	2.8233E-01	7.58
30	2.6600E+00	3.0000E+00	2.8300E+00	1.6812E-02	3.3720E-02	4.9446E-02	1.3993E-01	8.49
31	3.0000E+00	3.5000E+00	3.2500E+00	2.6602E-02	6.1274E-02	5.3203E-02	1.7291E-01	10.03
32	3.5000E+00	4.0000E+00	3.7500E+00	2.9335E-02	7.7967E-02	5.8671E-02	2.2002E-01	11.66
33	4.0000E+00	4.5000E+00	4.2500E+00	1.7574E-02	5.2937E-02	3.5149E-02	1.4938E-01	13.06
34	4.5000E+00	5.0000E+00	4.7500E+00	1.0879E-02	3.6625E-02	2.1759E-02	1.0335E-01	14.28
35	5.0000E+00	5.5000E+00	5.2500E+00	6.8579E-03	2.5517E-02	1.3716E-02	7.2008E-02	15.40
36	5.5000E+00	6.0000E+00	5.7500E+00	2.5179E-03	1.0261E-02	5.0359E-03	2.8956E-02	16.34
37	6.0000E+00	6.5000E+00	6.2500E+00	1.6707E-03	7.4006E-03	3.3414E-03	2.0884E-02	100.33
38	6.5000E+00	7.0000E+00	6.7500E+00	1.5304E-03	7.3214E-03	3.0608E-03	2.0660E-02	100.00
39	7.0000E+00	7.5000E+00	7.2500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
40	7.5000E+00	8.0000E+00	7.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
41	8.0000E+00	9.0000E+00	8.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
42	9.0000E+00	1.0000E+01	9.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
43	1.0000E+01	1.2000E+01	1.1000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00

The results for a number of integral metrics and conversion factors are shown in Table 48 and Table 49. Conversion values to translate to γ/cm^2 are given for fissions in the core, MJ of reactor energy, and $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity. The same caveats presented in the neutron discussion using reactor power apply to the delayed gamma-rays. Table 48 and Table 49 also shows additional integral metrics that may be useful to the experimenter. These values were calculated using the 48-group gamma-ray energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, C dose, and TLD dose.

Table 48. LANL WSMR 6-inch Location - Delayed Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average delayed gamma-ray ($d\gamma$) energy (MeV)	1.399
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\text{source } d\gamma]$)	1.936E-05
Source Delayed Gamma-Rays (source $d\gamma$ /fission)	6.567
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\gamma/\text{cm}^2]$)	0.225
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{fission}$)	1.271E-04
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{MJ}$)	1.531E+12
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	1.011E+31
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	9.726E+08
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[d\gamma/\text{cm}^2]$)	5.197E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[d\gamma/\text{cm}^2]$)	5.087E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[d\gamma/\text{cm}^2]$)	5.113E-10

Table 49. LANL WSMR 24-inch Location - Delayed Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average delayed gamma-ray ($d\gamma$) energy (MeV)	1.333
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\text{source } d\gamma]$)	9.457E-07
Source Delayed Gamma-Rays (source $d\gamma$ /fission)	6.567
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\gamma/\text{cm}^2]$)	0.211
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{fission}$)	6.210E-06
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{MJ}$)	7.479E+10
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	9.187E+30
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	8.838E+08
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[d\gamma/\text{cm}^2]$)	4.986E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[d\gamma/\text{cm}^2]$)	4.862E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[d\gamma/\text{cm}^2]$)	4.918E-10

4.5.3. LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum Results

The decay gamma-ray fluence was calculated with MERCURY using the source mode and photon transport only. The same WSMR FBR model configuration was used as in previous calculations. The spatial distribution of the delayed gamma-ray source was generated from a separate MERCURY static k calculation by directly recording the position of each fission event. The fission-product delayed gamma-ray energy spectrum used was for fast U-235 fission in the time interval from 0.2 to 0.5 seconds as given in Engle (1962) and Fisher (1964). The results give the transported delayed gamma-ray fluence spectrum per source photon.

Figure 66 and Figure 67 for the 6-inch location and Figure 68 and Figure 69 for the 24-inch location show the MERCURY-generated 48-group delayed gamma-ray energy fluence on a linear and logarithmic y-axis, respectively. The units on the y-axis are in energy fluence, equal to $E d\phi/dE$ ($\text{MeV}/\text{MeV}\cdot\text{cm}^2\cdot\text{MJ}$). With the energy fluence represented linearly on the y-axis and the photon energy on the x-axis represented logarithmically, the area under the curve represents the total gamma-

ray fluence. The scale of the plots is the same as presented for the prompt gamma-rays. The delayed gamma-ray energy fluence has a prominent peak at ~ 0.5 MeV.

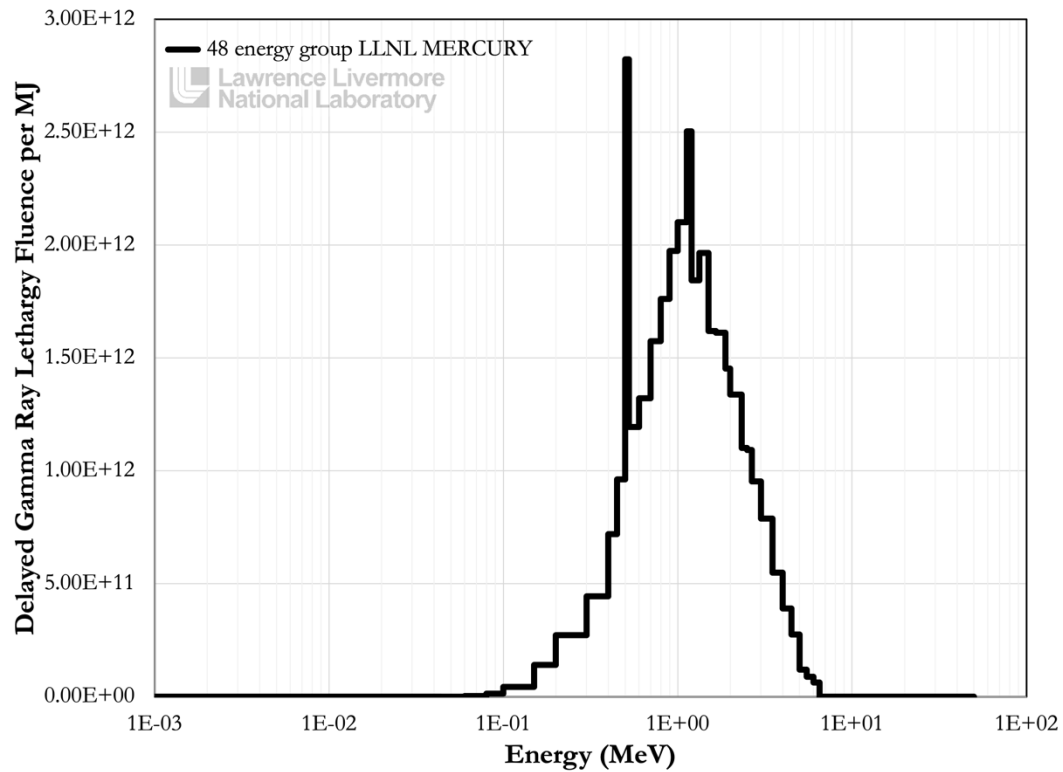


Figure 66. WSMR 6-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).

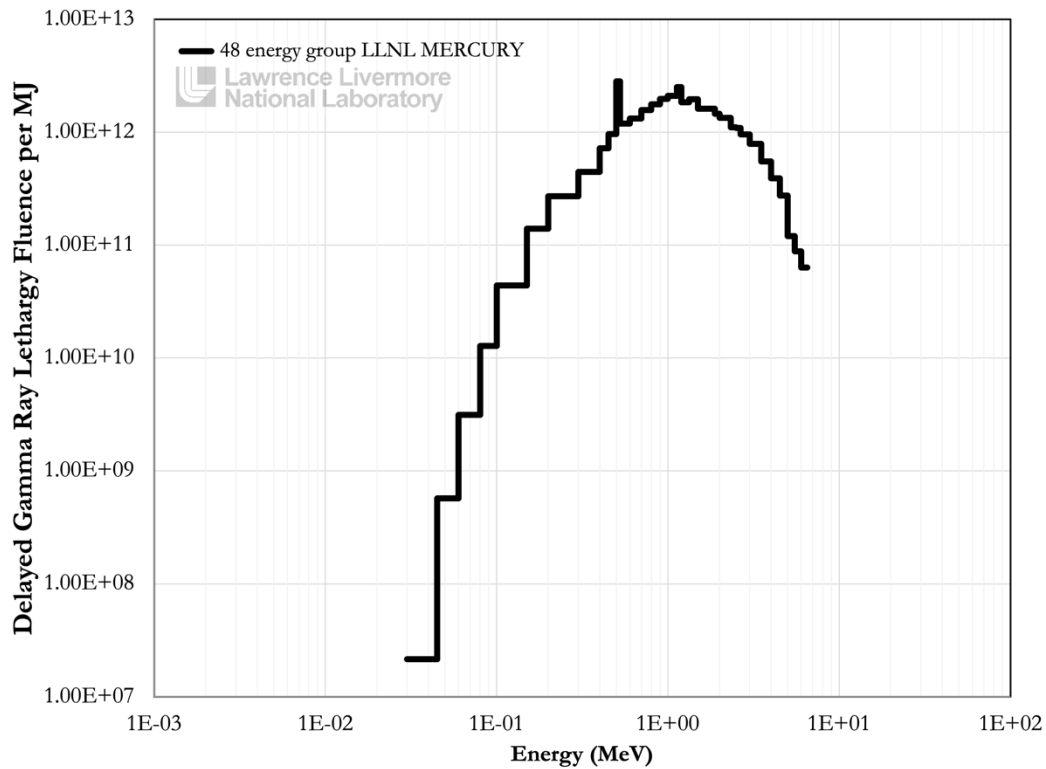


Figure 67. WSMR 6-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (log-log).

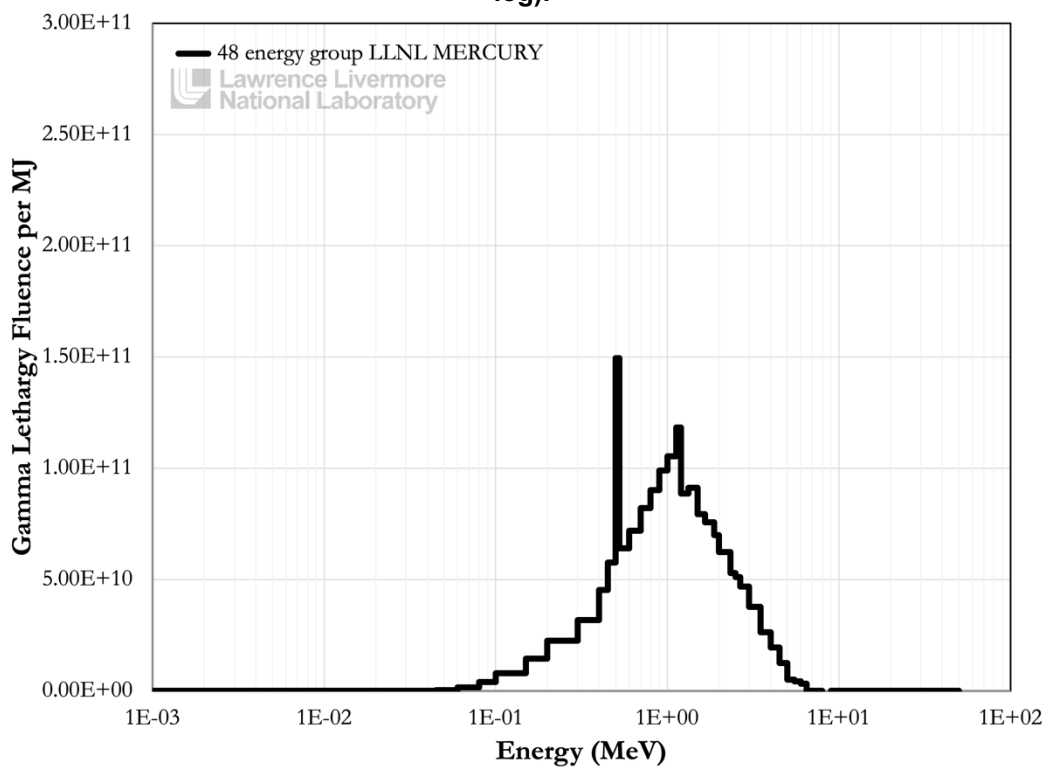


Figure 68. WSMR 24-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (linear-log).

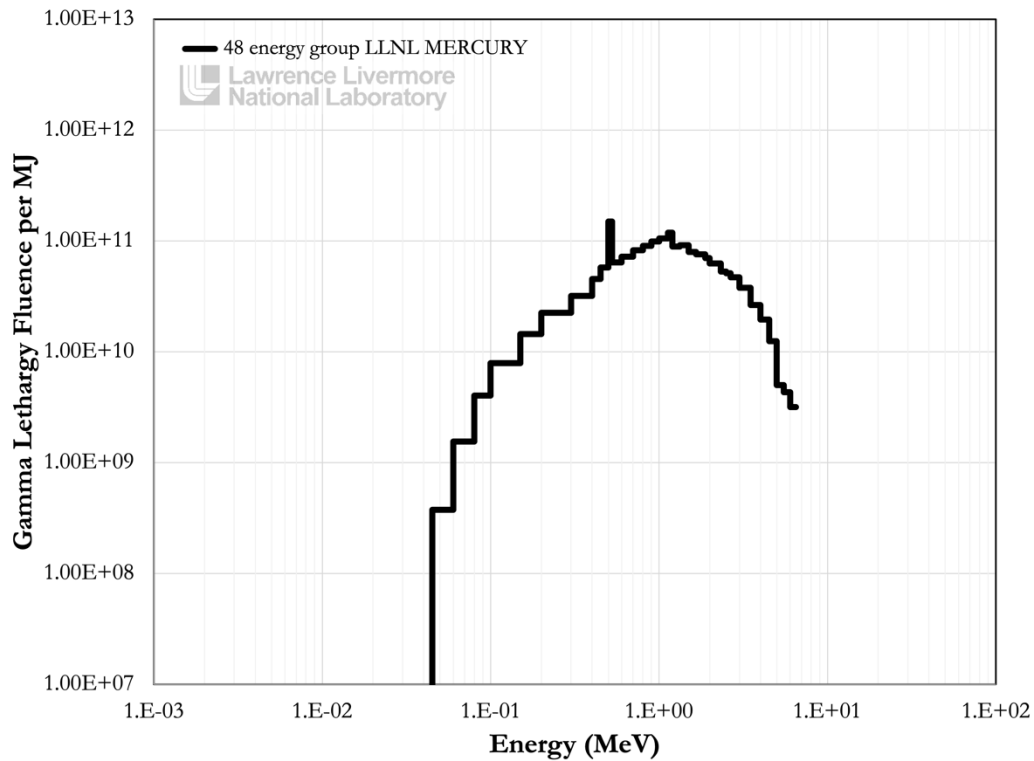


Figure 69. WSMR 24-inch – LLNL MERCURY 48-Group Delayed Gamma-Ray Energy Spectrum (log–log).

Table 50 for the 6-inch location and Table 51 for the 24-inch location show the delayed gamma-ray fluence spectrum in a tabular format for the 48-group NuGET energy structure. Column 5 represents the number fraction, column 6 the energy fraction, column 7 the differential number fraction, column 8 the differential energy fraction, and column 9 the percent standard deviation. The number fraction, represented as a histogram, can be used in MERCURY source calculations as an isotropic spherical surface source.

The average delayed gamma-ray energy is calculated to be 1.385 MeV for 6-inch location and 1.279 MeV for 24-inch location. The peak differential energy fluence again occurs in energy group 14 at 0.5125 MeV. This is the large peak seen in Figure 66 and Figure 68 represents the electron-positron annihilation photon energy (0.511 MeV).

Table 50. Delayed Gamma-Ray 48-Group Energy Spectrum for LLNL WSMR 6-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	102.26
2	1.0000E-02	2.0000E-02	1.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	101.64
3	2.0000E-02	3.0000E-02	2.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	102.00
4	3.0000E-02	4.5000E-02	3.7500E-02	2.3609E-06	6.3875E-08	1.5740E-04	5.9024E-06	74.86
5	4.5000E-02	6.0000E-02	5.2500E-02	4.4602E-05	1.6894E-06	2.9735E-03	1.5611E-04	53.54
6	6.0000E-02	8.0000E-02	7.0000E-02	2.4570E-04	1.2409E-05	1.2285E-02	8.5996E-04	53.42
7	8.0000E-02	1.0000E-01	9.0000E-02	7.8030E-04	5.0666E-05	3.9015E-02	3.5113E-03	54.05
8	1.0000E-01	1.5000E-01	1.2500E-01	4.8014E-03	4.3300E-04	9.6029E-02	1.2004E-02	46.60
9	1.5000E-01	2.0000E-01	1.7500E-01	1.0970E-02	1.3850E-03	2.1940E-01	3.8395E-02	42.43
10	2.0000E-01	3.0000E-01	2.5000E-01	2.9772E-02	5.3698E-03	2.9772E-01	7.4430E-02	42.26
11	3.0000E-01	4.0000E-01	3.5000E-01	3.4783E-02	8.7830E-03	3.4783E-01	1.2174E-01	42.28
12	4.0000E-01	4.5000E-01	4.2500E-01	2.3202E-02	7.1142E-03	4.6404E-01	1.9722E-01	44.29
13	4.5000E-01	5.0000E-01	4.7500E-01	2.7730E-02	9.5030E-03	5.5461E-01	2.6344E-01	41.90
14	5.0000E-01	5.2500E-01	5.1250E-01	3.7700E-02	1.3940E-02	1.5080E+00	7.7286E-01	38.55
15	5.2500E-01	6.0000E-01	5.6250E-01	4.3617E-02	1.7701E-02	5.8156E-01	3.2713E-01	38.98
16	6.0000E-01	7.0000E-01	6.5000E-01	5.5647E-02	2.6096E-02	5.5647E-01	3.6171E-01	14.55
17	7.0000E-01	8.0000E-01	7.5000E-01	5.7485E-02	3.1105E-02	5.7485E-01	4.3114E-01	10.71
18	8.0000E-01	9.0000E-01	8.5000E-01	5.6743E-02	3.4797E-02	5.6743E-01	4.8231E-01	9.11
19	9.0000E-01	1.0000E+00	9.5000E-01	5.6865E-02	3.8974E-02	5.6865E-01	5.4021E-01	7.97
20	1.0000E+00	1.1250E+00	1.0625E+00	7.0227E-02	5.3833E-02	5.6182E-01	5.9693E-01	7.18
21	1.1250E+00	1.2000E+00	1.1625E+00	4.1183E-02	3.4540E-02	5.4911E-01	6.3834E-01	5.45
22	1.2000E+00	1.3300E+00	1.2650E+00	5.1867E-02	4.7336E-02	3.9898E-01	5.0470E-01	4.59
23	1.3300E+00	1.5000E+00	1.4150E+00	6.4635E-02	6.5983E-02	3.8021E-01	5.3799E-01	4.73
24	1.5000E+00	1.6600E+00	1.5800E+00	4.4881E-02	5.1160E-02	2.8051E-01	4.4320E-01	5.09
25	1.6600E+00	1.8750E+00	1.7675E+00	5.4831E-02	6.9920E-02	2.5503E-01	4.5077E-01	5.12
26	1.8750E+00	2.0000E+00	1.9375E+00	2.4617E-02	3.4410E-02	1.9694E-01	3.8157E-01	5.32
27	2.0000E+00	2.3330E+00	2.1665E+00	5.5806E-02	8.7227E-02	1.6759E-01	3.6308E-01	6.02
28	2.3330E+00	2.5000E+00	2.4165E+00	2.1240E-02	3.7029E-02	1.2718E-01	3.0734E-01	6.90
29	2.5000E+00	2.6600E+00	2.5800E+00	1.8543E-02	3.4516E-02	1.1590E-01	2.9901E-01	7.48
30	2.6600E+00	3.0000E+00	2.8300E+00	3.1364E-02	6.4037E-02	9.2247E-02	2.6106E-01	8.42
31	3.0000E+00	3.5000E+00	3.2500E+00	3.3238E-02	7.7935E-02	6.6477E-02	2.1605E-01	9.96
32	3.5000E+00	4.0000E+00	3.7500E+00	2.0055E-02	5.4257E-02	4.0110E-02	1.5041E-01	11.57
33	4.0000E+00	4.5000E+00	4.2500E+00	1.2564E-02	3.8523E-02	2.5128E-02	1.0679E-01	12.95
34	4.5000E+00	5.0000E+00	4.7500E+00	7.9424E-03	2.7218E-02	1.5885E-02	7.5452E-02	14.14
35	5.0000E+00	5.5000E+00	5.2500E+00	3.1399E-03	1.1893E-02	6.2799E-03	3.2969E-02	15.16
36	5.5000E+00	6.0000E+00	5.7500E+00	2.0933E-03	8.6838E-03	4.1866E-03	2.4073E-02	16.05
37	6.0000E+00	6.5000E+00	6.2500E+00	1.3824E-03	6.2336E-03	2.7649E-03	1.7281E-02	100.00
38	6.5000E+00	7.0000E+00	6.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
39	7.0000E+00	7.5000E+00	7.2500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
40	7.5000E+00	8.0000E+00	7.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
41	8.0000E+00	9.0000E+00	8.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
42	9.0000E+00	1.0000E+01	9.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
43	1.0000E+01	1.2000E+01	1.1000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.99

Table 51. Delayed Gamma-Ray 48-Group Energy Spectrum for WSMR 24-inch Location.

Group	Lower Energy (MeV)	Upper Energy (MeV)	Midpoint Energy (MeV)	Number Fraction	Energy Fraction	Differential Number dN/dE	Differential Energy dE/dE	Standard Deviation (%)
1	1.0000E-03	1.0000E-02	5.5000E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	102.52
2	1.0000E-02	2.0000E-02	1.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	101.64
3	2.0000E-02	3.0000E-02	2.5000E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	101.50
4	3.0000E-02	4.5000E-02	3.7500E-02	1.5015E-05	4.4035E-07	1.0010E-03	3.7537E-05	77.85
5	4.5000E-02	6.0000E-02	5.2500E-02	5.4956E-04	2.2565E-05	3.6637E-02	1.9235E-03	53.96
6	6.0000E-02	8.0000E-02	7.0000E-02	2.2667E-03	1.2409E-04	1.1333E-01	7.9334E-03	53.67
7	8.0000E-02	1.0000E-01	9.0000E-02	4.5948E-03	3.2342E-04	2.2974E-01	2.0677E-02	54.19
8	1.0000E-01	1.5000E-01	1.2500E-01	1.6211E-02	1.5848E-03	3.2423E-01	4.0529E-02	46.70
9	1.5000E-01	2.0000E-01	1.7500E-01	2.1177E-02	2.8983E-03	4.2353E-01	7.4118E-02	42.49
10	2.0000E-01	3.0000E-01	2.5000E-01	4.6194E-02	9.0319E-03	4.6194E-01	1.1548E-01	42.32
11	3.0000E-01	4.0000E-01	3.5000E-01	4.6586E-02	1.2752E-02	4.6586E-01	1.6305E-01	42.34
12	4.0000E-01	4.5000E-01	4.2500E-01	2.7341E-02	9.0877E-03	5.4682E-01	2.3240E-01	44.40
13	4.5000E-01	5.0000E-01	4.7500E-01	3.1097E-02	1.1552E-02	6.2195E-01	2.9543E-01	41.92
14	5.0000E-01	5.2500E-01	5.1250E-01	3.7385E-02	1.4985E-02	1.4954E+00	7.6639E-01	38.56
15	5.2500E-01	6.0000E-01	5.6250E-01	4.3827E-02	1.9281E-02	5.8437E-01	3.2871E-01	38.99
16	6.0000E-01	7.0000E-01	6.5000E-01	5.6804E-02	2.8877E-02	5.6804E-01	3.6923E-01	14.57
17	7.0000E-01	8.0000E-01	7.5000E-01	5.6194E-02	3.2961E-02	5.6194E-01	4.2145E-01	10.73
18	8.0000E-01	9.0000E-01	8.5000E-01	5.4365E-02	3.6140E-02	5.4365E-01	4.6210E-01	9.13
19	9.0000E-01	1.0000E+00	9.5000E-01	5.3463E-02	3.9722E-02	5.3463E-01	5.0790E-01	7.99
20	1.0000E+00	1.1250E+00	1.0625E+00	6.5924E-02	5.4781E-02	5.2739E-01	5.6036E-01	7.18
21	1.1250E+00	1.2000E+00	1.1625E+00	3.6434E-02	3.3125E-02	4.8578E-01	5.6472E-01	5.46
22	1.2000E+00	1.3300E+00	1.2650E+00	4.6756E-02	4.6257E-02	3.5966E-01	4.5497E-01	4.61
23	1.3300E+00	1.5000E+00	1.4150E+00	5.6209E-02	6.2203E-02	3.3064E-01	4.6785E-01	4.74
24	1.5000E+00	1.6600E+00	1.5800E+00	4.1223E-02	5.0939E-02	2.5764E-01	4.0707E-01	5.10
25	1.6600E+00	1.8750E+00	1.7675E+00	4.8304E-02	6.6772E-02	2.2467E-01	3.9710E-01	5.14
26	1.8750E+00	2.0000E+00	1.9375E+00	2.2174E-02	3.3600E-02	1.7739E-01	3.4370E-01	5.35
27	2.0000E+00	2.3330E+00	2.1665E+00	4.8751E-02	8.2603E-02	1.4640E-01	3.1717E-01	6.03
28	2.3330E+00	2.5000E+00	2.4165E+00	1.9108E-02	3.6112E-02	1.1442E-01	2.7649E-01	6.93
29	2.5000E+00	2.6600E+00	2.5800E+00	1.6270E-02	3.2829E-02	1.0169E-01	2.6235E-01	7.50
30	2.6600E+00	3.0000E+00	2.8300E+00	2.8870E-02	6.3897E-02	8.4911E-02	2.4030E-01	8.44
31	3.0000E+00	3.5000E+00	3.2500E+00	2.9714E-02	7.5526E-02	5.9428E-02	1.9314E-01	9.98
32	3.5000E+00	4.0000E+00	3.7500E+00	1.8042E-02	5.2915E-02	3.6084E-02	1.3532E-01	11.60
33	4.0000E+00	4.5000E+00	4.2500E+00	1.1770E-02	3.9121E-02	2.3539E-02	1.0004E-01	12.98
34	4.5000E+00	5.0000E+00	4.7500E+00	6.7200E-03	2.4964E-02	1.3440E-02	6.3840E-02	14.16
35	5.0000E+00	5.5000E+00	5.2500E+00	2.4449E-03	1.0039E-02	4.8899E-03	2.5672E-02	15.20
36	5.5000E+00	6.0000E+00	5.7500E+00	1.9200E-03	8.6344E-03	3.8401E-03	2.2080E-02	16.12
37	6.0000E+00	6.5000E+00	6.2500E+00	1.2968E-03	6.3387E-03	2.5936E-03	1.6210E-02	100.10
38	6.5000E+00	7.0000E+00	6.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
39	7.0000E+00	7.5000E+00	7.2500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
40	7.5000E+00	8.0000E+00	7.7500E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
41	8.0000E+00	9.0000E+00	8.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
42	9.0000E+00	1.0000E+01	9.5000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
43	1.0000E+01	1.2000E+01	1.1000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
44	1.2000E+01	1.4000E+01	1.3000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
45	1.4000E+01	1.7000E+01	1.5500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
46	1.7000E+01	2.0000E+01	1.8500E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
47	2.0000E+01	3.0000E+01	2.5000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00
48	3.0000E+01	5.0000E+01	4.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	100.00

The results for the number fraction, percent standard deviation, and covariance as a function of the 48-group energy structure are included in an LSL format in Appendix E. The covariance matrix represents a combination of expert judgment and perturbation analyses using MERCURY. The covariance matrix satisfies the spectrum normalization condition and is positive definite, with non-negative eigenvalues.

The results for a number of integral metrics and conversion factors are shown in Table 52 and Table 53. Conversion values to translate to γ/cm^2 are given for fissions in the core, MJ of reactor energy, and $^{58}\text{Ni}(n,p)^{58}\text{Co}$ activity. The same caveats presented in the neutron discussion using reactor power apply to the delayed gamma-rays. Table 52 and Table 53 also shows additional integral metrics that may be useful to the experimenter. These values were calculated using the 48-group gamma-ray energy spectrum and the NuGET code with various response functions. Included are responses for Si dose, C dose, and TLD dose.

Table 52. LLNL WSMR 6-inch Location - Delayed Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average delayed gamma-ray ($d\gamma$) energy (MeV)	1.385
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\text{source } d\gamma]$)	1.794E-05
Source Delayed Gamma-Rays (source $d\gamma$ /fission)	6.567
Fluence Conversion ($[d\gamma/\text{cm}^2]/[\gamma/\text{cm}^2]$)	0.243
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{fission}$)	4.656E-05
Fluence Conversion ($[d\gamma/\text{cm}^2]/\text{MJ}$)	1.516E+12
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{atom}_{\text{Ni-58}}]$)	9.318E+30
Fluence Conversion From Ni Activation $^{58}\text{Ni}(n,p)^{58}\text{Co}$ ($[d\gamma/\text{cm}^2]/[\text{Bq}/\text{g}_{\text{Ni-58}}]$)	8.964E+08
Total (Ionizing) Si Dose ($\text{rad}[\text{Si}]/[d\gamma/\text{cm}^2]$)	5.426E-10
Total (Ionizing) Carbon Dose ($\text{rad}[\text{C}]/[d\gamma/\text{cm}^2]$)	5.326E-10
Total (Ionizing) $\text{CaF}_2\text{:Mn}$ (TLD) Dose ($\text{rad}[\text{CaF}_2\text{:Mn}]/[d\gamma/\text{cm}^2]$)	5.323E-10

Table 53. LLNL WSMR 24-inch Location - Delayed Gamma-Ray Spectrum Metrics.

Metric	Integral Response
Average delayed gamma-ray (dγ) energy (MeV)	1.279
Fluence Conversion ([dγ/cm ²]/[source dγ])	9.524E-07
Source Delayed Gamma-Rays (source dγ/fission)	6.567
Fluence Conversion ([dγ/cm ²]/[γ/cm ²])	0.223
Fluence Conversion ([dγ/cm ²]/fission)	2.472E-06
Fluence Conversion ([dγ/cm ²]/MJ)	8.047E+10
Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([dγ/cm ²]/[Bq/atom _{Ni-58}])	8.742E+30
Fluence Conversion From Ni Activation ⁵⁸ Ni(n,p) ⁵⁸ Co ([dγ/cm ²]/[Bq/g _{Ni-58}])	8.410E+08
Total (Ionizing) Si Dose (rad[Si]/[dγ/cm ²])	5.047E-10
Total (Ionizing) Carbon Dose (rad[C]/[dγ/cm ²])	4.947E-10
Total (Ionizing) CaF ₂ :Mn (TLD) Dose (rad[CaF ₂ :Mn]/[dγ/cm ²])	4.962E-10

5. RADIAL AND AXIAL FLUENCE PROFILES

Passive dosimetry was used to determine the axial and radial neutron and gamma-ray fluence profiles for the free-field environment. From these profiles, the peak axial fluence location can be determined as well as any radial variation. For these runs, the reactor was operated in both pulse and steady-state modes. Nickel Foils and Sulfur tablets were used for both axial and radial neutron fluence profiles. The axial profiles were performed on the 'A-Leg' position, 6-inch from the center of the WSMR FBR. The radial profiles were performed at an axial position 3 inches above the tabletop and were performed on both the 'A-Leg' and 'B-Leg' of the y-plate.

5.1. Neutron-Sulfur Map

Figure 70 shows the results for the sulfur axial (vertical) neutron fast fluence profile along the axis of the 6-inch test position on the 'A-Leg'. The sulfur activation reaction is $^{32}\text{S}(n,p)^{32}\text{P}$, which is a fast neutron reaction. The ^{32}P decays by β^- emission with a 14.3 day half-life. The y-axis indicated a normalized neutron fluence based on activation. Based on experimenters required operational metric, a fraction of the total fluence may be desired. The results show that the peak occurs at about 7.6 cm (~ 3 in.) from the tabletop on the y-plate. The peak is relatively flat between a region of 2.54 cm, across a range of about 5 cm (~ 2 in.). For reference, the axial fuel centerline is ~ 3.8 inches (9.65 cm) from the bottom of the test table. The WSMR core is has and outer diameter of 4 inches (10.16 cm) and a total height of 7.87 inches (20 cm).

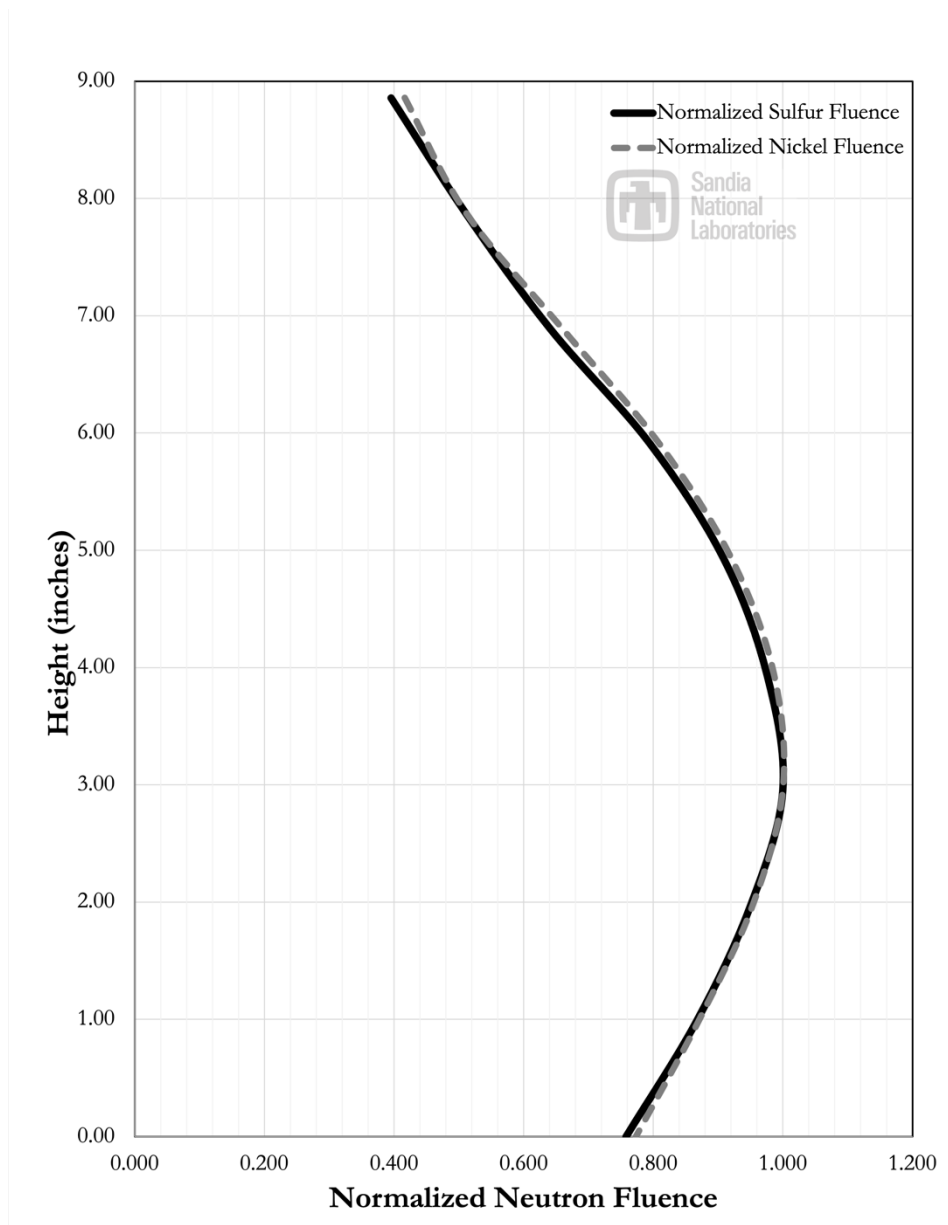


Figure 70. WSMR Sulfur Axial Neutron Fluence Profile at 6-inch location, from the bottom of Molly-G.

Figure 70 shows the results comparing the axial (vertical) sulfur normalized fluence vs the nickel normalized fluence free-field environment, using pulse and steady-state operations. Each set of nickel and sulfur dosimetry was run redundantly for pulse and steady state operations, with a pulse and steady-state variation of about 5%. No differences are found in the results which indicates that the pulse and steady-state conditions are the same.

Figure 71 shows the results for the sulfur radial neutron fluence profile for the free-field environment at an axial position of 3 inches from the bottom of the test table for the sulfur pellets arranged perpendicular from the core. The nickel foils and sulfur tablets were arranged on an extended piece of tape that spanned from the 6-inch position to end of the test table on all 3 legs of the y-plate. The

solid line represents the average value for all of the tablets measured on the 'B-Leg' at standard 1 in increments. The counting uncertainties are within each data point symbol. The results show that for the nickel and sulfur activation reactions, there is no significant variation in the fast neutron fluence between the legs on the y-plate.

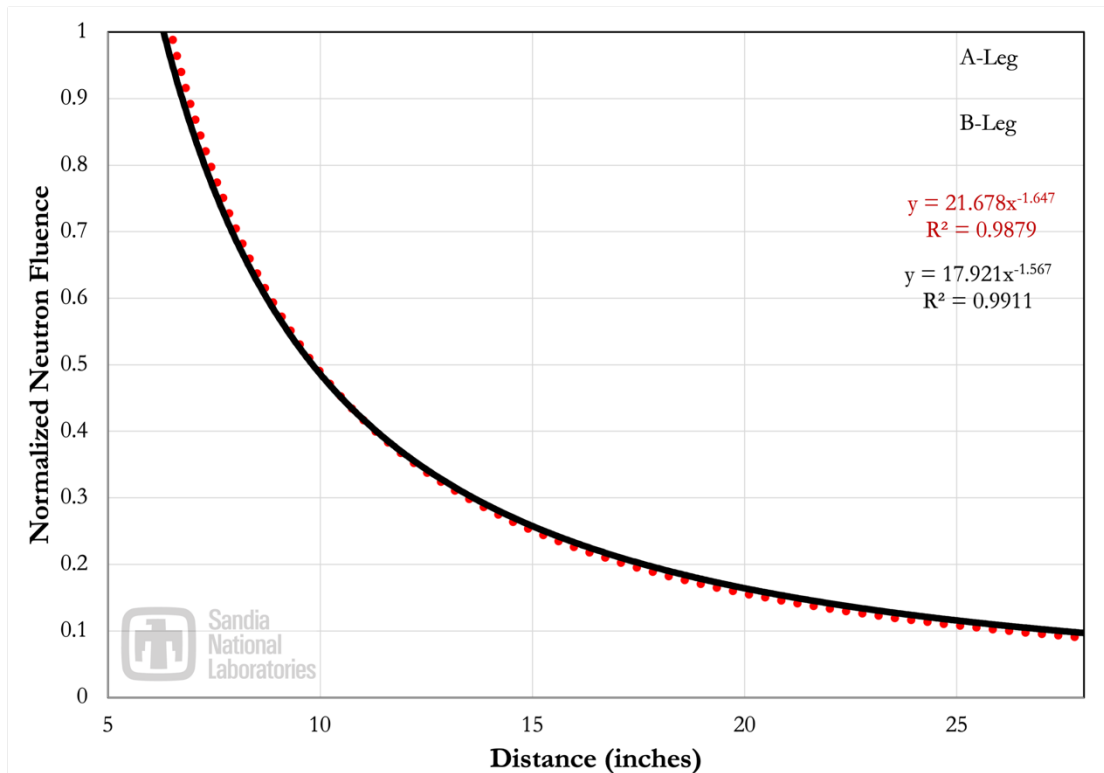


Figure 71. A-Leg and B-Leg Nickel and Sulfur Normalized Radial Neutron Fluence Profiles, referenced from the center of Molly-G.

6. SAMPLE OPERATIONS

The sample operations represent a maximum pulse (ΔT of 250°C) operation for the free-field environment at both the 6-inch and 24-inch location. For each operation active dosimetry was fielded that included two diamond photoconductive detector (PCD) and two silicon calorimeters, and one bismuth calorimeter at the axial fluence maximum of WSMR. Passive dosimetry included a Ni foil, sulfur tablets, and TLDs. The PCDs fielded were two 1 mm x 2 mm x 1 mm diamonds biased to 500 VDC. 500 VDC is the recommended voltage loading for BNC cabling, while 750 VDC is the recommended operation voltage for the PCDs. These results are presented as typical operational active dosimetry metrics.

6.1. Maximum Pulse at 6-inch Location

A large pulse operation ($\sim 2.9\text{MJ}$) was performed on March 4th, 2022; at the 6-inch position on the A-Leg of the y-plate a WSMR using both active and passive dosimetry. The reactor shot number was #21661. The reported reactor ΔT of 251.9°C taken at the peak of the pulse plus three full-width half maximum (FWHM) time values. Figure 72 and Figure 73 show the results for the linear and logarithmically amplified PCD transient responses after the data was renormalized. Figures Figure 74 and Figure 75 show the results for the Silicon (Si) and Bismuth (Bi) calorimeters transient response, respectively.

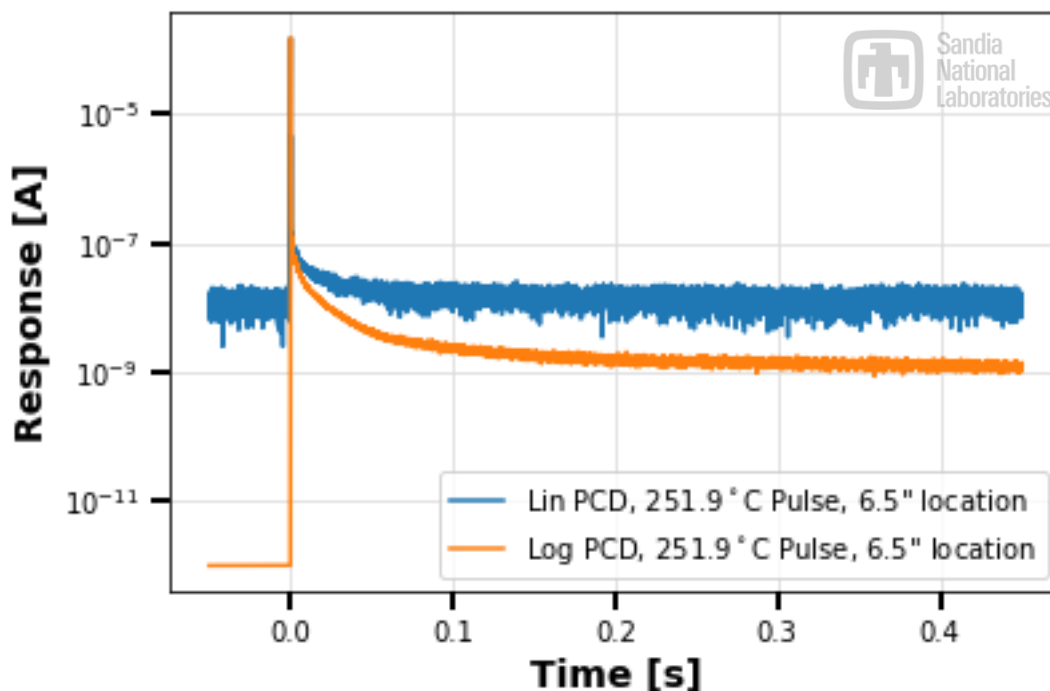


Figure 72. PCD Transient Response for Pulse Operation #21661 – 2.9 MJ (log-lin).

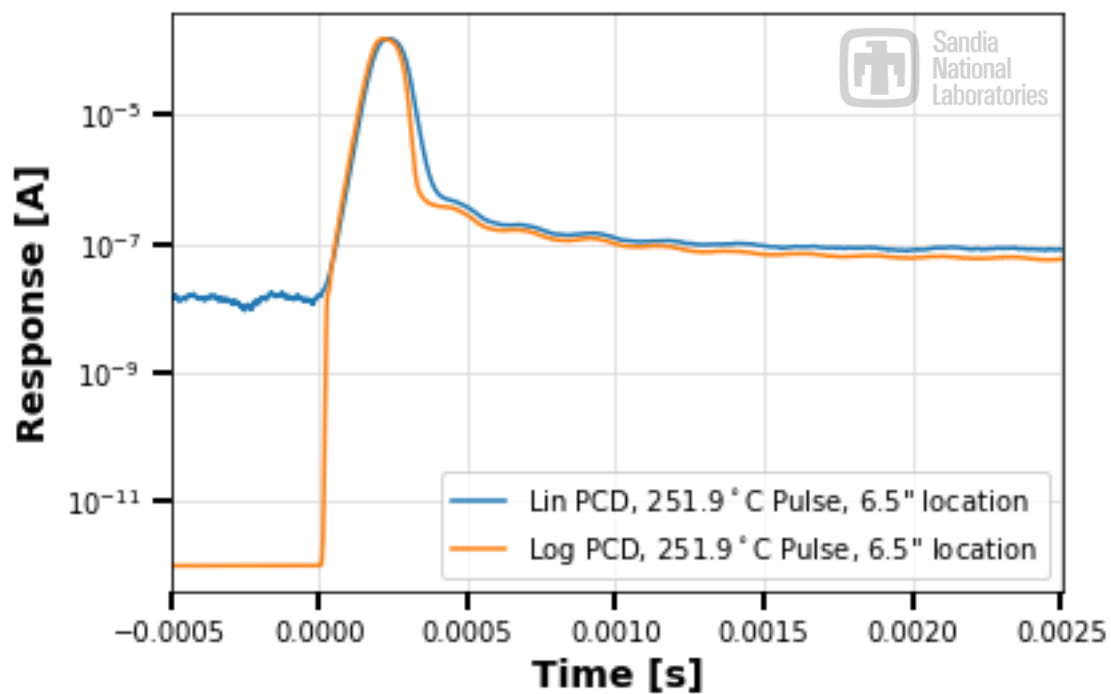


Figure 73. PCD Transient Response for Pulse Operation #21661 – 2.9 MJ (log-log).

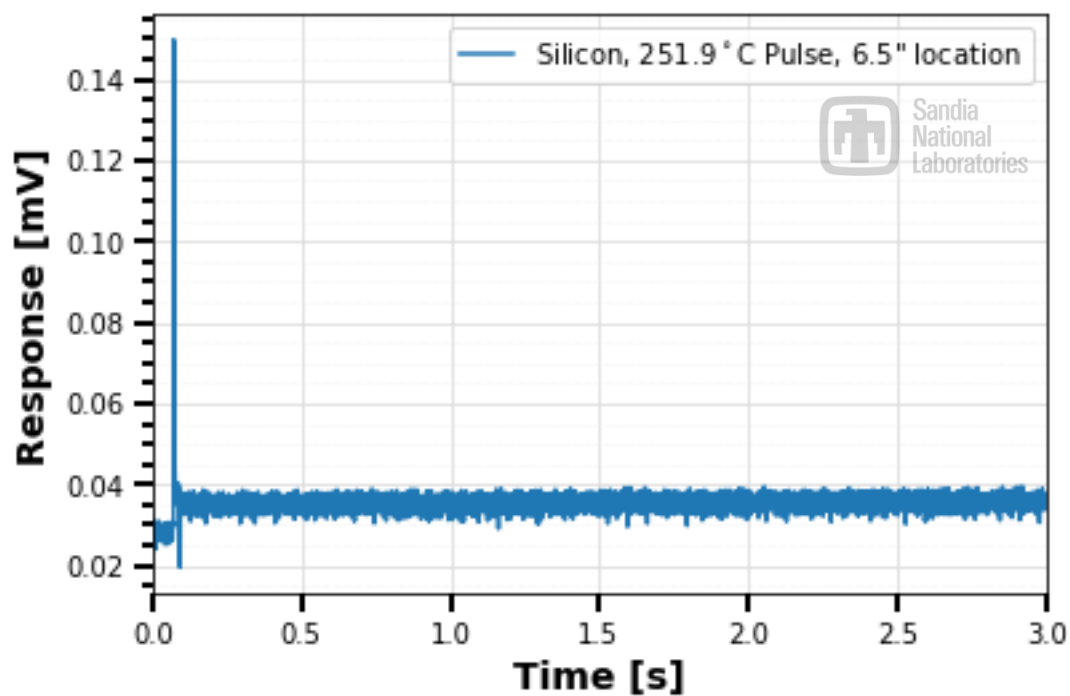


Figure 74. Si Calorimeter Transient Response for Pulse Operation #10724 – 2.9 MJ.

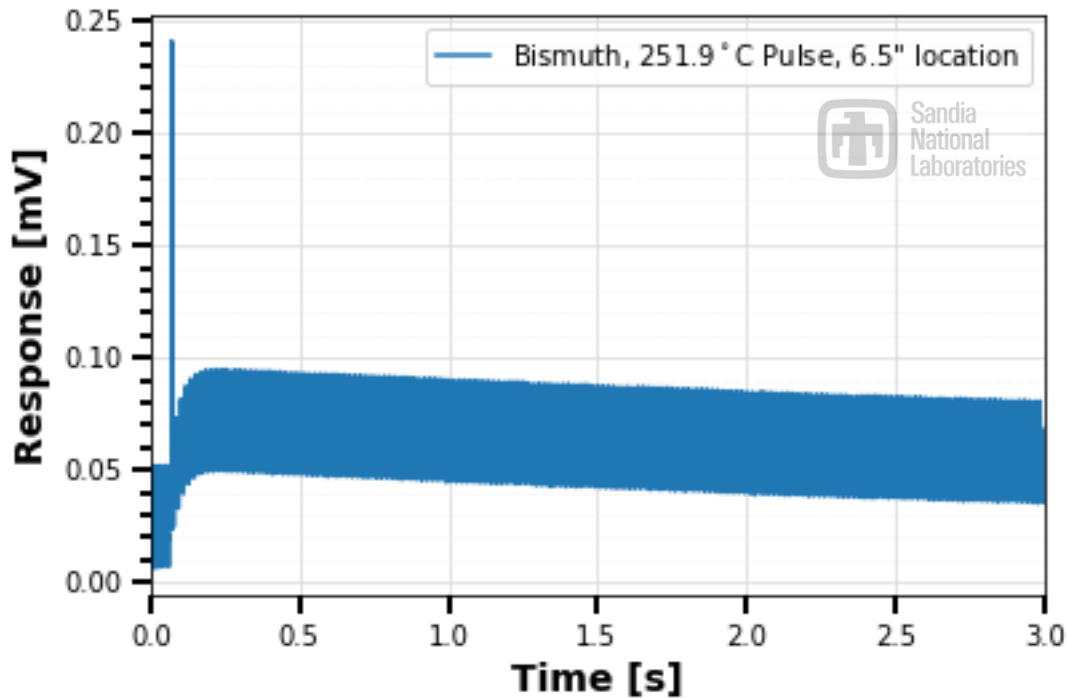


Figure 75. Bi Calorimeter Transient Response for Pulse Operation #21661 – 2.9 MJ.

6.2. Maximum Pulse at 24-inch Location

A large pulse operation (~ 2.2 MJ) was performed on March 5th, 2022; at the 24-inch position on the A-Leg of the y-plate a WSMR using both active and passive dosimetry. The reactor shot number was #21662. The reactor ΔT of 243.7°C taken at the peak of the pulse plus three full-width half maximum (FWHM) time values. Figure 76 and Figure 77 shows the results for the linear and logarithmically amplified PCD transient responses after the data was renormalized. Figure 78 shows the results for the Bismuth (Bi) calorimeter transient response. At this location a Silicon (Si) calorimeter signal could not be determined.

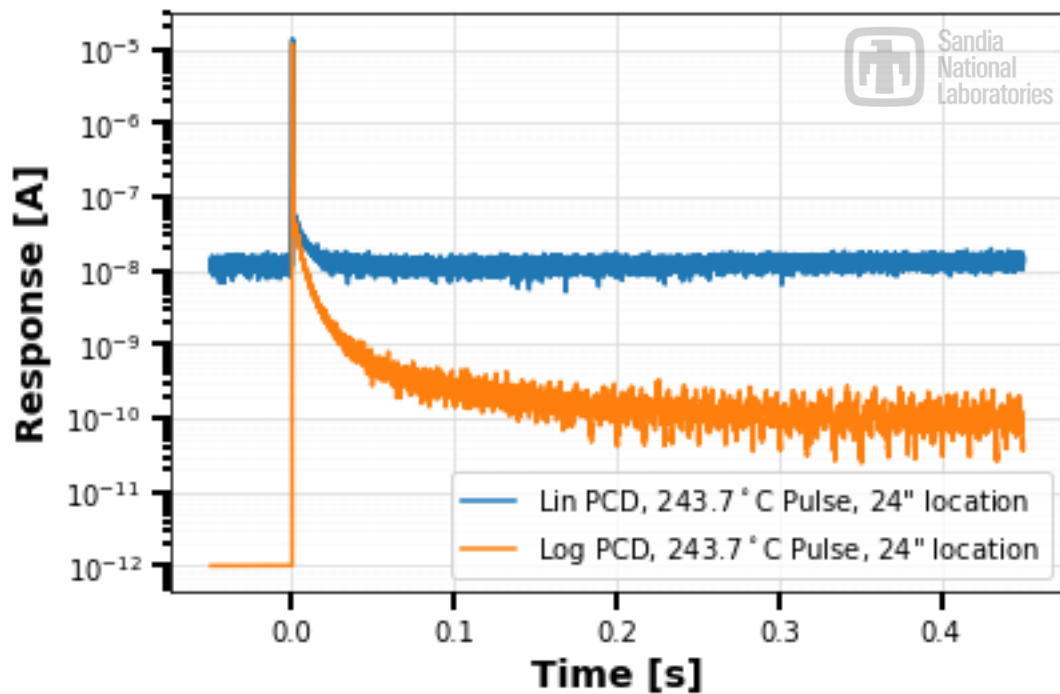


Figure 76. PCD Transient Response for Pulse Operation #21662 – 2.2 MJ (log-lin).

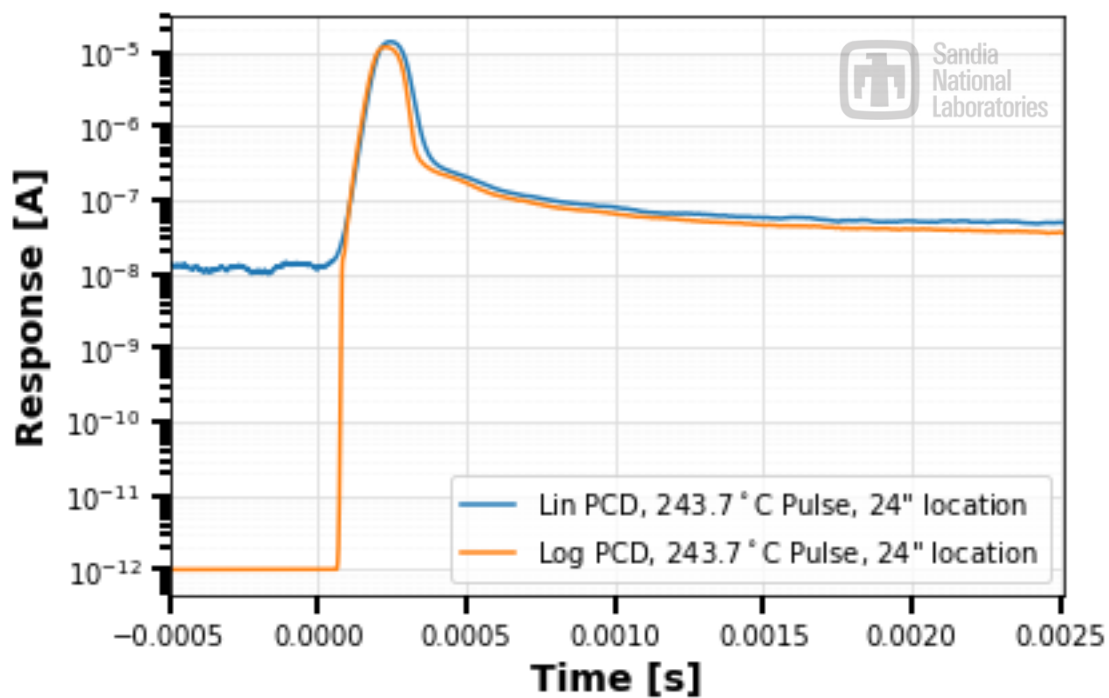


Figure 77. PCD Transient Response for Pulse Operation #21662 – 2.2 MJ (log-log).

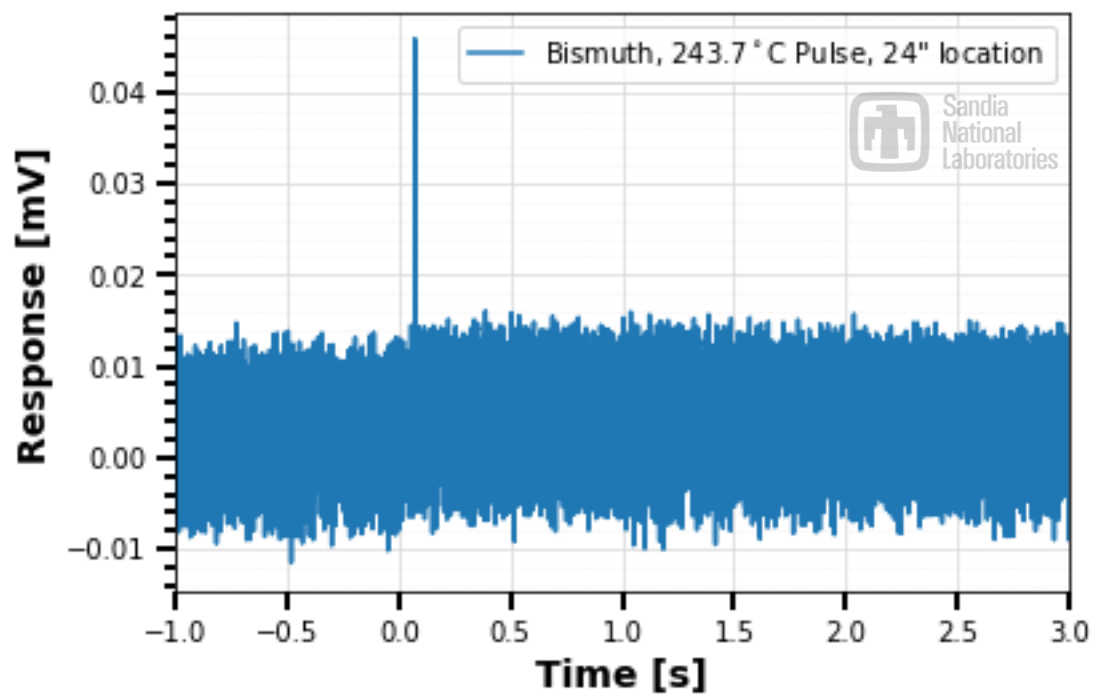


Figure 78. Bi Calorimeter Transient Response for Pulse Operation #21662 – 2.2 MJ

7. CONCLUSIONS

This report presents the characterized neutron, prompt gamma-ray, and delayed gamma-ray radiation environments for the free-field environment for the WSMR, FBR, called Molly-G. The characterized locations include the 6-inch and 24-inch locations of the y-plate on the test table. A 640-group and 89-group neutron energy spectrum, a 48-group prompt gamma-ray energy spectrum, and a 48-group delayed gamma-ray energy spectrum were calculated using either MERCURY or MCNP, utilizing newly created high-fidelity models of WSMR by SNL, LANL, and LLNL. Each neutron spectrum was adjusted to align more closely with neutron activation dosimetry, while also providing agreement between each labs' respective model. The adjustment was performed using the least-squares code LSL-M3, a modified version of LSL-M2 (Stallman, 1985). Neutron, prompt gamma-ray, and delayed gamma-ray conversion factors are presented for each respective laboratories WSMR FBR model to facilitate the conversion of various dosimetry readings into radiation metrics desired by experimenters.

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APPENDIX A. SNL MCNP WSMR MODEL

```

White Sands Missile Range - Fast Burst Reactor (Molly-G)
c Version X, New Model by Curtis Peters in correspondence with White Sands
c
c Fuel Density set to 17.04 based on average of components measured in SLA 73 0995
c
c
c TR1: Burst Rod
c TR2: Control Rods
c TR3: Safety Block
c *****
c *                               CELL CARDS                               *
c *****
c
100  3 -1.205e-3      -100 112.3 140 142  144  145  146  147 125 150 152 153
                                154 155 158 159 -11  imp:n,p = 1    $ Central Cavity
c
c
101  1 -17.044      100  -101  102  200  201  202  203  204  205  206
                                imp:n,p = 1    $ Bottom Plate
102  1 -17.044      100  (-103:-105) 104  200  201  202  203  204  205  206
                                imp:n,p = 1    $ Middle Plate 1
103  1 -17.044      100  (-106:-108) 107  200  201  202  203  204  205  206
                                imp:n,p = 1    $ Middle Plate 2
104  1 -17.044      100  (-109:-111) 110  200  201  202  203  204  205  206
                                imp:n,p = 1    $ Middle Plate 3
105  1 -17.044      (100 (-113:-115)) 201  202  203  204 $(112 (-114:-116)))
                                205 207 imp:n,p = 1    $ Intermediate Plate pt1
106  1 -17.044      (112.1 (-114:-116)) 201  202  203  204  205  207
                                imp:n,p = 1    $ Intermediate Plate Pt2
107  1 -17.044      117 118 (-120)  119  201  203  205  207  208  209
                                121 122 123 imp:n,p = 1    $ Upper Plate
108  4 -8.0300      -121  imp:n,p = 1    $ Retaining Plate Screw 2
109  4 -8.0300      -122  imp:n,p = 1    $ Retaining Plate Screw 2
110  4 -8.0300      -123  imp:n,p = 1    $ Retaining Plate Screw 3
111  4 -8.0300      -180 181 182 -183 -184 imp:n,p = 1    $ Retaining Plate
c
c ALTERNATE CELLS FOR COOLING PLATE. REPLACES 111 and ()
c
c
112  3 -1.205e-3      -181 imp:n,p = 1
c
c Shim Volumes
c (Currently backfilled with air, height is 0.05"
400  4 -8.03      100 -400 102  200  201  202  203  204  205  206
                                imp:n,p = 1
401  4 -8.03      100 105 -401 102  200  201  202  203  204  205  206
                                imp:n,p = 1
402  4 -8.03      100 108 -402 102  200  201  202  203  204  205  206
                                imp:n,p = 1
403  4 -8.03      100 111 -403 102  200  201  202  203  204  205  206
                                imp:n,p = 1
404  4 -8.03      100 115 -404 102  200  201  202  203  204  205  206
                                imp:n,p = 1
405  4 -8.03      115 -405 102.1 201 202 203 204 205  207  208  209
                                imp:n,p = 1
406  4 -8.03      100 -406 imp:n,p = 1
407  4 -8.03      100 -407 imp:n,p = 1
408  4 -8.03      100 -408 imp:n,p = 1
409  4 -8.03      100 -409 imp:n,p = 1
410  4 -8.03      112.1 -410 imp:n,p = 1
c
c
c Burst Rod and Control Rods Control Rods
200  3 -1.205e-3      -200 -220 300 303 -11  imp:n,p = 1    $ Void Space for BR
201  1 -17.044      -300 303  imp:n,p = 1    $ BR
203  3 -1.205e-3      -207  220 -118.2  imp:n,p = 1    $ Void Space Above BR (Intermediate and Top
Plates)
204  4 -8.0300      -303  imp:n,p = 1    $ Interim for SS Mandrel
c
205  3 -1.205e-3      -202 117.3 301 304 -11  imp:n,p = 1    $ Void Space for CR 1
206  1 -17.044      -301 304  imp:n,p = 1    $ CR 1

```

```

207 3 -1.205e-3 -208 -117.3 222 -118.2 imp:n,p = 1 $ Void Space Above CR 1 (Intermediate
and Top Plates)
208 4 -8.0300 -304 imp:n,p = 1 $ Interim for SS Mandrel
c
209 3 -1.205e-3 -204 117.3 302 305 -11 imp:n,p = 1 $ Void Space for CR 2
210 1 -17.044 -302 305 imp:n,p = 1 $ CR 2
211 3 -1.205e-3 -209 -117.3 -118.2 imp:n,p = 1 $ Void Space Above CR 2 (Intermediate and Top
Plates)
212 4 -8.0300 -305 imp:n,p = 1 $ Interim for SS Mandrel
c
c Safety Block (7880-08-0643 or -0606. worth examining)
220 1 -17.044 (-140 141 148 139):(-142 143) imp:n,p = 1 $ Fuel
221 4 -8.0300 (-141 139):
(-144):
(-145):(-146):(-147)
222 3 -1.205e-3 -148 imp:n,p = 1 $ SS Mandrel in block
223 4 -8.0300 (151 -150):(-152 144) imp:n,p = 1 $ SS Magnet Base
224 4 -8.0300 -151 imp:n,p = 1 $ SS Magnet gap. filled? unk.
225 100 -8.0300 -153 144 imp:n,p = 1 $ Magnet
226 4 -8.03 (154 -155):(157 -156):(-158 157):(-159 157)
imp:n,p = 1 $ Housing
227 3 -1.205e-3 153 -154 144 156 imp:n,p = 1 $ Inside housing
228 3 -1.205e-3 -157 144 imp:n,p = 1 $ Inside housing
229 3 -1.205e-3 -139 1200 imp:n,p = 1
c
c 228 4 -8.03 -158 159 imp:n,p = 1 $ Inside housing
c 222 4 -8.0300 -144 imp:n,p = 1 $ SS Mandrel in block
c
c
c TC Hole
230 3 -1.205e-3 -206 -220 221 imp:n,p = 1 $ TC Hole
c
c Fuel Plate Bolts
240 40 -8.28 -201 -211.2 -130.3 imp:n,p = 1 $ Inconel-750 bolt
241 40 -8.28 -203 -212.2 -130.3 imp:n,p = 1 $ Inconel-750 bolt
242 40 -8.28 -205 -213.2 -130.3 imp:n,p = 1 $ Inconel-750 bolt
243 40 -8.28 -214 211 imp:n,p = 1 $ Inconel-750 nut
244 40 -8.28 -215 212 imp:n,p = 1 $ Inconel-750 nut
245 40 -8.28 -216 213 imp:n,p = 1 $ Inconel-750 nut
c
c Center Insert and Mass Adjustment Rings MAR XX = 7880-27-0616
c 250 4 -8.03 (-125 126 124):(117.2 112.1 -118.1 -125.2) imp:n,p = 1 $ Center Insert (7880-
28-0617)
251 4 -8.03 -127 124 imp:n,p = 1 $ MAR 1 (7880-27-0615)
252 4 -8.03 -128 124 imp:n,p = 1 $ MAR 2 (7880-27-0616)
250 1 -17.044 (-125 126 124):(117.2 112.1 -118.1 -125.2) imp:n,p = 1 $ Center Insert (7880-28-
0617)
c 251 1 -17.04 -127 124 imp:n,p = 1 $ MAR 1 (7880-27-0615)
c 252 1 -17.04 -128 124 imp:n,p = 1 $ MAR 2 (7880-27-0616)
256 3 -1.205e-3 -124 1200 imp:n,p = 1
c
c
c Base Plate
c Note TEMP FIX TO ACCOMODATE SURFACE 146, REVISIT
c NOTE 4/15, IR of cutout on 260 pulled inward to match OR of fuel plates (.0508cm)
c
c
260 4 -8.0300 -130 100 131 200 201 202 203 204 205 206
146 imp:n,p = 1
c
c Hat
c Note: Materials subject to massive revision
270 10 -2.7 160 -161 imp:n,p =1
271 10 -2.7 161 -162 imp:n,p =1
272 10 -2.7 161 -163 imp:n,p =1
273 10 -2.7 164 -165 imp:n,p =1
274 10 -2.7 166 -167 imp:n,p =1
c 275 4 -8.0300 -168 169 170 -166.1 imp:n,p =1
276 41 -2.25 -173 161.1 imp:n,p =1
c Hat
c Voided Shroud. possibly better ways to manage this.
c 270 3 -1.205e-3 160 -161 imp:n,p =1
c 271 3 -1.205e-3 161 -162 imp:n,p =1
c 272 3 -1.205e-3 161 -163 imp:n,p =1
c 273 3 -1.205e-3 164 -165 imp:n,p =1

```

```

c 274 3 -1.205e-3      166 -167      imp:n,p =1
c 275 3 -1.205e-3     -168 169 170  -166.1      imp:n,p =1
c 276 3 -1.205e-3     -173 161.1      imp:n,p =1
c
c Containment Universe
c 10      0      -10      trcl=10 fill=1      imp:n,p = 1
11      3 -1.205e-3    150 155 146
      (-221 -11 100 200 202 204):      $ Below Reactor
      (130.1 221 -11 1201):      $ outside support ring
      (101.1 130.2 -160 -118.2 ):      $ Outside Fuel
      (173 163.2 -11 1201 ):      $ outside shroud
c      (-160 128.2 168 214 215 216 180 ):      $ Above Fuel
      (-160 128.2 214 215 216 180 ):      $ Above Fuel
      (-164):
      (-180 -182 216):
      (-180 183 214):
      (-180 184 215):
c      (-164 168):
      (163 162.2 -11 -163.2):
      (162 130.2 -11 -162.2):
      (-166 128.2 180):
c      (-169 170 -166.2 171):
      (125.2 -124.2 -160.1 126.1 214 215 216)
      imp:n,p = 1
c 12      3 -1.205e-3      10 -12 804 805 806 808 809 810 811 812 imp:n,p = 1
c Reactor Room Surfaces -1.205e-3
c Room Airspace
13      3 -1.205e-3     -1100 11 800 801 802 803 804 805 806
      808 809 810 811 812 (-813:814)
      850 852 854 856 860 862 864 866
      1110
c
      (-710:711:712:713)
      (714:-711) 715
      (724:-721) 725
      (734:-731) 735
      #710 #720 #730
      (-700:701) 702 #703 #704
      1201 1202
      imp:n,p = 1 $ Room to Wallboard
14      7 9.685e-2      1100 -1101      imp:n,p = 1 $ Wallboard 1
15      3 -1.205e-3      1101 -1102      imp:n,p = 1 $ Gap 1
16      7 9.685e-2      1102 -1103      imp:n,p = 1 $ Wallboard 2
17      3 -1.205e-3      1103 -1104      imp:n,p = 1 $ Gap 2
18      8 9.737e-2      1104 -1105      imp:n,p = 1 $ Borated Wallboard 1
19      3 -1.205e-3      1105 -1106      imp:n,p = 1 $ Gap 3
20      8 9.737e-2      1106 -1107      imp:n,p = 1 $ Borated Wallboard 1
21      3 -1.205e-3      1107 -1108      imp:n,p = 1 $ Gap 5
22      6 -2.4      1108 -1109      imp:n,p = 1 $ Concrete Building
23      0 1112      imp:n,p = 0 $ Outside World
24      42 -2.6      -1111 imp:n,p = 1 $ Borated Concrete Floor
c
c
c Table, Y Plate
701 10 -2.7      (700 -701)      imp:n,p = 1
702 10 -2.7      -702 700 701      imp:n,p = 1 $ A leg
703 10 -2.7      -703 700 701 -812.4      imp:n,p = 1
704 10 -2.7      -704 700 701 -812.3      imp:n,p = 1
c A Leg
710 3 -1.205e-3      710 -711 712 713 1201      imp:n,p = 1
c 710 10 -2.7      710 -711 712 713      imp:n,p = 1
711 10 -2.7      -714 711      imp:n,p = 1
712 10 -2.7      -715      imp:n,p = 1
c b Leg
720 3 -1.205e-3      720 -721 722 723      imp:n,p = 1
c 720 10 -2.7      720 -721 722 723      imp:n,p = 1
721 10 -2.7      -724 721      imp:n,p = 1
722 10 -2.7      -725      imp:n,p = 1
c C Leg
730 3 -1.205e-3      730 -731 732 733      imp:n,p = 1
c 730 10 -2.7      730 -731 732 733      imp:n,p = 1
731 10 -2.7      -734 731      imp:n,p = 1
732 10 -2.7      -735      imp:n,p = 1
c
c Aluminum Table Structure
800 10 -2.7 (-800 830):(-801 831):(-802 832):(-803 833):(-804 836):

```

```

(-805 836):(-806 807 836):(-808 806 838):(-809 806 839):
(-810 840):(-811 841):(813 -814):(-850 851):(-852 853):
(-854 855):(-856 857):(-860 861):(-862 863):(-864 865):
(-866 867)
c      :(-812 807)
      imp:n,p = 1    $ Metal Table structure
801  5    -1.0      -812 807      imp:n,p = 1    $ Wood/Bakelite tabletop
c
802  5    -1.0      -1110      imp:n,p = 1    $ 'Platform' for reactor
c
c      Air fill for assorted tubing
830  3 -1.205e-3    -830      imp:n,p = 1
831  3 -1.205e-3    -831      imp:n,p = 1
832  3 -1.205e-3    -832      imp:n,p = 1
833  3 -1.205e-3    -833      imp:n,p = 1
836  3 -1.205e-3    -836 807      imp:n,p = 1
838  3 -1.205e-3    -838 806      imp:n,p = 1
839  3 -1.205e-3    -839 806      imp:n,p = 1
840  3 -1.205e-3    -840      imp:n,p = 1
841  3 -1.205e-3    -841      imp:n,p = 1
851  3 -1.205e-3    -851      imp:n,p = 1
853  3 -1.205e-3    -853      imp:n,p = 1
855  3 -1.205e-3    -855      imp:n,p = 1
857  3 -1.205e-3    -857      imp:n,p = 1
861  3 -1.205e-3    -861      imp:n,p = 1
863  3 -1.205e-3    -863      imp:n,p = 1
865  3 -1.205e-3    -865      imp:n,p = 1
867  3 -1.205e-3    -867      imp:n,p = 1
c
c
c      Experiment Cells
1200 3 -1.205e-3    -1200      imp:n,p = 1    $ 2cm Dia glory hole volume
1201 3 -1.205e-3    -1201      imp:n,p = 1    $ 2cm 6 inch position
1202 3 -1.205e-3    -1202      imp:n,p = 1    $ 2cm 6 inch position

C *****
C *                      SURFACE CARDS                      *
C *****
C
c 10  RCC  0 0 -75 0 0 105 14.925
10  RCC  0 0 -75 0 0 105 18
11  RCC  0 0 -76 0 0 107 14.925
12  RCC  0 0 -105 0 0 175 56
c
c      Assorted Fuel Plates, Extrusions
c 100 RCC 0 0 0 0 0 14.6685 5.08      $ Central Cavity/Fuel Ring Boundary
100 cz 5.08      $ Central Cavity/Fuel Ring Boundary
101  RCC 0 0 0.0381 0 0 3.25374 10.16 $ Bottom Plate
102  RCC 0 0 2.9718 0 0 0.32004 5.55879 $ Cutout on Bottom Plate/Extrusion for Middle Plate 1
103 RCC 0 0 3.32994 0 0 3.25374 10.16 $ Middle Plate 1
104  RCC 0 0 6.26364 0 0 0.32004 5.55879 $ Cutout on Middle Plate 1/Extrusion for Middle Plate 2
105  RCC 0 0 3.0099 0 0 0.32004 5.55879 $ Not Used Currently: Would result in minor gaps in
extrusions.
106  RCC 0 0 6.62178 0 0 3.25374 10.16 $ Middle Plate 2
107  RCC 0 0 9.55548 0 0 0.32004 5.55879 $ Cutout on Middle Plate 2/Extrusion for Middle Plate 3
108  RCC 0 0 6.30174 0 0 0.32004 5.55879 $ Not Used Currently: Would result in minor gaps in
extrusions.
109  RCC 0 0 9.91362 0 0 3.25374 10.16 $ Middle Plate 3
110  RCC 0 0 12.84732 0 0 0.32004 5.55879 $ Cutout on Middle Plate 3/Extrusion for Intermediate
Plate
111  RCC 0 0 9.59358 0 0 0.32004 5.55879 $ Not Used Currently: Would result in minor gaps in
extrusions.
112 RCC 0 0 14.859 0 0 1.6002 4.7625 $ Reduced Diameter Safety Block in Intermediate Plate
113 RCC 0 0 13.20546 0 0 1.65354 10.16 $ Intermediate Plate PT1
114 RCC 0 0 14.859 0 0 1.6002 10.16 $ Intermediate Plate PT2
115 RCC 0 0 12.88542 0 0 0.32004 5.55879 $ Not Used Currently: Would result in minor gaps in
extrusions.
116 RCC 0 0 16.4592 0 0 0.32004 5.55879 $ Upper Extrusion on Intermediate Plate/Cutout for Upper Plate
117 RCC 0 0 16.4973 0 0 1.82372 4.7625 $ Reduced IR for Upper Plate
118 RCC 0 0 18.32102 0 0 1.2573 5.08381 $Expanded IR for Upper Plate
119 RCC 0 0 16.4973 0 0 0.32004 5.55879 $ Not Used Currently: Would result in minor gaps in extrusions.

120 RCC 0 0 16.4973 0 0 3.08102 10.16 $ Upper Plate
121 RCC -5.87375 0 18.64106 0 0 0.93726 0.5334 $ Threaded Screw hole 1
122 RCC 2.93687 5.08681 18.64106 0 0 0.93726 0.5334 $ Threaded Screw hole 2
123 RCC 2.93687 -5.08681 18.64106 0 0 0.93726 0.5334 $ Threaded Screw hole 3

```

```

124 rcc 0 0 14.6685 0 0 4.90982 1.5875 $ CI 1
125 RCC 0 0 14.6685 0 0 4.90982 4.7625 $ CI outer dimension
126 rcc 0 0 16.79956 0 0 2.77876 3.90525
127 rcc 0 0 16.79956 0 0 1.38943 3.90525
128 rcc 0 0 18.18899 0 0 1.38933 3.90525
c
c Shims
400 RCC 0 0 0 0 0 0.0381 10.16
401 RCC 0 0 3.29184 0 0 0.0381 10.16
402 RCC 0 0 6.58368 0 0 0.0381 10.16
403 RCC 0 0 9.87552 0 0 0.0381 10.16
404 RCC 0 0 13.16736 0 0 0.0381 10.16
405 RCC 0 0 16.4592 0 0 0.0381 10.16
406 RCC 0 0 2.9718 0 0 0.0381 5.55879
407 RCC 0 0 6.26364 0 0 0.0381 5.55879
408 RCC 0 0 9.55548 0 0 0.0381 5.55879
409 RCC 0 0 12.84732 0 0 0.0381 5.55879
410 RCC 0 0 16.77924 0 0 0.0381 5.55879
c Base Plate
130 RCC 0 0 -1.27 0 0 1.5875 14.2875 $ SS Base Plate starting point
131 rcc 0 0 -0 0 0 0.3175 10.16 $ SS Base Plate starting point
c
139 3 rcc 0 0 3.1496 0 0 11.45539 1.778
c Safety Block
140 3 RCC 0 0 0 0 0 14.36878 4.8895
141 3 RCC 0 0 0 0 0 3.1496 1.778
142 3 RCC 0 0 14.36878 0 0 0.23621 4.8895
143 3 RCC 0 0 14.36878 0 0 0.23621 1.778
144 3 RCC 0 0 -65.75 0 0 65.75 1.27
145 3 rcc 0 0 -1.27 0 0 1.27 3.4544
146 3 rcc 0 0 -1.9304 0 0 .6604 5.6642
147 3 rcc 0 0 -2.2606 0 0 0.3302 3.1242
148 3 rcc 0 0 2.54 0 0 10.08 0.128905 $ thermocouple hole in SB
149 3 RCC 0 0 .1 0 0 14.26878 1.678
c
c Magnet Components
150 3 rcc 0 0 -66.9438 0 0 1.1938 5.4102 $ Lower layer of bottom housing
151 3 rcc 0 0 -66.9438 0 0 1.1938 0.635
152 3 rcc 0 0 -65.75 0 0 1.27 5.08 $ Upper layer of bottom housing
153 3 rcc 0 0 -60.025 0 0 8.89 4.6863 $ Magnet volume
154 3 rcc 0 0 -64.47 0 0 13.97 4.9022
155 3 rcc 0 0 -64.47 0 0 13.97 5.4102
156 3 rcc 0 0 -51.135 0 0 .635 4.9022
157 3 rcc 0 0 -51.135 0 0 6.223 1.4605
158 3 rcc 0 0 -50.5 0 0 1.016 4.445
159 3 rcc 0 0 -49.484 0 0 4.572 2.6162
c
c Shroud/hat
160 rcc 0 0 .3175 0 0 23.9522 11.3792
161 rcc 0 0 .3175 0 0 23.9522 11.4808
162 rcc 0 0 .3175 0 0 0.54102 14.13002
163 rcc 0 0 .85852 0 0 .43688 11.86942
164 rcc 0 0 24.2697 0 0 .35306 11.2268
165 rcc 0 0 24.2697 0 0 .35306 11.4808
166 rcc 0 0 24.62276 0 0 .27051 2.419274
167 rcc 0 0 24.62276 0 0 .27051 11.4808
168 kz 20.2582759 0.307259
169 kz 20.52878 0.307259
170 cz 1.1811
171 pz 21
172 cz 1.9
173 rcc 0 0 1.2954 0 0 23.59787 11.63
174 rcc 0 0 1.2954 0 0 23.59787 11.6
c
c Retaining Plate
180 rcc 0 0 19.57832 0 0 0.635 6.6675
181 rcc 0 0 19.57832 0 0 0.635 1.1181
182 p 1 1.7320508 0 -10
c Note :abs(Ax +By) = D
183 p -1 1.7320508 0 10
184 px 5
c
c Control Rod/Transient Rod/Bolt holes
200 c/z 0 7.9375 1.32334
200 c/z 3.96748 6.87324 1.32334
201 c/z -3.96748 6.87324 0.9525 $ Bolt Passage 1

```

```

c 202 c/z 6.87324 -3.96748 1.32334
202 c/z -7.9375 0 1.32334
c
c 203 c/z 0 -7.9375 0.9525 $ Bolt Passage 2
203 c/z 7.9375 0 0.9525 $ Bolt Passage 2
c 204 c/z -6.87324 -3.96748 1.32334
204 c/z 3.96748 -6.87324 1.32334
c 205 c/z -6.87324 3.96748 0.9525 $ Bolt Passage 3
205 c/z -3.96748 -6.87324 0.9525 $ Bolt Passage 3
c
206 c/z -5.08762 2.93624 0.128905
c
207 c/z 3.96748 6.87324 0.3175
208 c/z -7.9375 0 0.3175
209 c/z 3.96748 -6.87324 0.3175
c
210 pz 20.32
211 RCC -3.96748 6.87324 19.57832 0 0 1.27 0.9525 $ NUT 1
212 RCC 7.9375 0 19.57832 0 0 1.27 0.9525 $ NUT 2
213 RCC -3.96748 -6.87324 19.57832 0 0 1.27 0.9525 $ NUT 3
214 RCC -3.96748 6.87324 19.57832 0 0 1.27 1.5875 $ NUT 1
215 RCC 7.9375 0 19.57832 0 0 1.27 1.5875 $ NUT 2
216 RCC -3.96748 -6.87324 19.57832 0 0 1.27 1.5875 $ NUT 3
c
c Assorted Surfaces for cleaner cells (not using subsurfaces of macrobodies)
220 pz 13.20546
221 pz -1.27
222 pz 16.4973
c
c
c Control/Burst Rods
c 300 1 RCC -7.9375 0 0.21336 0 0 13.1826 1.27 $ Burst Rod
c 303 1 RCC -7.9375 0 -15.17 0 0 16.27 0.381 $ BR Tap
c 301 2 RCC 3.96748 6.87324 0.0381 0 0 16.7386 1.27 $ Control Rod 1
c 304 2 RCC 3.96748 6.87324 -15.470 0 0 16.27 0.381 $ CR Tap
300 1 RCC 3.96748 6.87324 0.0 0 0 13.1826 1.27 $ Burst Rod
303 1 RCC 3.96748 6.87324 -15.17 0 0 16.27 0.381 $ BR Tap
301 2 RCC -7.9375 0 0.0381 0 0 16.7386 1.27 $ Control Rod 1
304 2 RCC -7.9375 0 -15.470 0 0 16.27 0.381 $ CR Tap
302 2 RCC 3.96748 -6.87324 0.0381 0 0 16.7386 1.27 $ Control Rod 2
305 2 RCC 3.96748 -6.87324 -15.470 0 0 16.27 0.381 $ CR Tap
c
c
c Y Plate
700 rcc 0 0 0.127 0 0 .635 19.05
701 rcc 0 0 0.127 0 0 .635 21.59
702 rpp -120.65 -19.1 -10.16 10.16 0.127 0.762
703 703 rpp 19.1 120.65 -10.16 10.16 0.127 0.762
704 704 rpp 19.1 120.65 -10.16 10.16 0.127 0.762
c Experiment Stands
c A leg stand
c 710 20 rcc 0 0 2.667 0 0 22 14.95 $ IR of target plate
710 20 rcc 0 0 2.032 0 0 22 15.24 $ IR of target plate
711 20 rcc 0 0 2.032 0 0 22 15.367 $ OR of test plate, check
712 20 p -0.7390 0.6737 0 0
713 20 p -0.6737 -0.7390 0 0
714 20 rpp -28.4005 -13.5575 -7.62 7.62 2.032 3.302 $ Upper, A Leg
715 20 rpp -32.2105 -16.9705 -9.8425 9.8425 .762 2.032 $ Base, A Leg
c
c b leg stand (Fixed)
720 rcc 0 0 2.032 0 0 22 15.24 $ IR of target plate
c 720 rcc 0 0 2.667 0 0 22 14.95 $ IR of target plate
721 rcc 0 0 2.032 0 0 22 15.367 $ OR of test plate, check
722 p 4.7905 -1.432 0 0
723 p -1.432 -4.7905 0 0
c 722 703 p 1 1 0 0
c 723 703 p 1 -1 0 0
724 703 rpp 13.5575 28.4005 -7.62 7.62 2.032 3.302 $ Upper, A Leg
725 703 rpp 16.9705 32.2105 -9.8425 9.8425 .762 2.032 $ Base, A Leg
c
c C leg stand (Fixed)
730 rcc 0 0 2.032 0 0 22 15.24 $ IR of target plate
c 730 rcc 0 0 2.032 0 0 22 14.95 $ IR of target plate
731 rcc 0 0 2.032 0 0 22 15.367 $ OR of test plate, check
732 p 4.7905 1.432 0 0
733 p -1.432 4.7905 0 0

```

```

734 704 rpp 13.5575 28.4005 -7.62 7.62 2.032 3.302 $ Upper, A Leg
735 704 rpp 16.9705 32.2105 -9.8425 9.8425 .762 2.032 $ Base, A Leg
c
c Table
800 rpp -122.24 -117.16 -61.28 61.28 -5.715 -0.635
801 rpp -117.16 117.16 56.2 61.28 -5.715 -0.635
802 rpp -117.16 117.16 -61.28 -56.2 -5.715 -0.635
803 rpp 117.16 122.24 -61.28 61.28 -5.715 -0.635
804 rpp -82.55 -81.91 -56.2 56.2 -5.715 -0.635
805 rpp 81.91 82.55 -56.2 56.2 -5.715 -0.635
806 rpp -117.16 117.16 -2.54 2.54 -5.715 -0.635
807 cz 14.925
808 rpp -43.46 -38.42 -56.2 56.2 -5.715 -0.635
809 rpp 38.42 43.46 -56.2 56.2 -5.715 -0.635
810 rpp -38.42 38.42 43.02 48.1 -5.715 -0.635
811 rpp -38.42 38.42 -48.1 -43.02 -5.715 -0.635
812 rpp -121.9225 121.9225 -60.9625 60.9625 -.635 0.127
813 rpp -121.9225 121.9225 -60.9625 60.9625 -.635 4.445
814 rpp -122.24 122.24 -61.28 61.28 -.635 4.445
830 rpp -121.605 -117.795 -60.645 60.645 -5.08 -1.27
831 rpp -116.525 116.525 56.835 60.645 -5.08 -1.27
832 rpp -116.525 116.525 -60.645 -56.835 -5.08 -1.27
833 rpp 117.795 121.605 -60.645 60.645 -5.08 -1.27
836 rpp -116.525 116.525 -1.905 1.905 -5.08 -1.27
838 rpp -42.825 -39.055 -55.565 55.565 -5.08 -1.27
839 rpp 39.055 42.825 -55.565 55.565 -5.08 -1.27
840 rpp -37.785 37.785 43.655 47.465 -5.08 -1.27
841 rpp -37.785 37.785 -47.465 -43.655 -5.08 -1.27
842 rpp -122.24 122.24 -61.28 61.28 -.635 0.127
c
850 rpp -122.24 -114.62 -61.28 -53.66 -20.955 -5.715
851 rpp -121.605 -115.255 -60.645 -54.295 -20.955 -5.715
852 rpp -122.24 -114.62 53.66 61.28 -20.955 -5.715
853 rpp -121.605 -115.255 54.295 60.645 -20.955 -5.715
854 rpp 114.62 122.24 53.66 61.28 -20.955 -5.715
855 rpp 115.255 121.605 54.295 60.645 -20.955 -5.715
856 rpp 114.62 122.24 -61.28 -53.66 -20.955 -5.715
857 rpp 115.255 121.605 -60.645 -54.295 -20.955 -5.715
860 rpp -123.51 -113.35 -62.55 -52.39 -130.82 -20.955
861 rpp -122.24 -114.62 -61.28 -53.66 -130.82 -20.955
862 rpp -123.51 -113.35 52.39 62.55 -130.82 -20.955
863 rpp -122.24 -114.62 53.66 61.28 -130.82 -20.955
864 rpp 113.35 123.51 52.39 62.55 -130.82 -20.955
865 rpp 114.62 122.24 53.66 61.28 -130.82 -20.955
866 rpp 113.35 123.51 -62.55 -52.39 -130.82 -20.955
867 rpp 114.62 122.24 -61.28 -53.66 -130.82 -20.955
c
c
c Reactor Room
1100 rpp -736.59492 736.59492 -736.59492 736.59492 -166.243 443.357
1101 rpp -741.67492 741.67492 -741.67492 741.67492 -166.243 448.437
1102 rpp -742.94492 742.94492 -742.94492 742.94492 -166.243 449.707
1103 rpp -748.02492 748.02492 -748.02492 748.02492 -166.243 454.787
1104 rpp -749.29492 749.29492 -749.29492 749.29492 -166.243 456.057
1105 rpp -754.37492 754.37492 -754.37492 754.37492 -166.243 461.137
1106 rpp -755.64492 755.64492 -755.64492 755.64492 -166.243 462.407
1107 rpp -760.72492 760.72492 -760.72492 760.72492 -166.243 467.487
1108 rpp -762.75692 762.75692 -762.75692 762.75692 -166.243 469.519
1109 rpp -823.71692 823.71692 -823.71692 823.71692 -166.243 530.479
1111 rpp -823.71692 823.71692 -823.71692 823.71692 -227.203 -166.243
1112 rpp -823.71692 823.71692 -823.71692 823.71692 -227.203 530.479
c 'Platform'
1110 rpp -110.01375 110.01375 177.79492 736.59492 -163.878 -163.243
c
c 1100 rpp -736.59492 736.59492 -736.59492 736.59492 -204.8 404.8
c 1101 rpp -756.91492 756.91492 -756.91492 756.91492 -204.8 425.12
c 1102 rpp -777.23492 777.23492 -777.23492 777.23492 -204.8 445.44
c 1103 rpp -838.19492 838.19492 -838.19492 838.19492 -265.76 506.4
c
c Experiment Surfaces
1200 sz 8.032 1.5
1201 s -15.12 0 8.032 1.5
1202 s -60.96 0 8.032 1.5
500 s 0 0 9 45

```

C *****

```

C *                                     DATA CARDS                                     *
C *****
C *****
C * TRANSFORMATIONS *
C *****
C
C
C TR1 moves the burst rod
C
C      0.0  0.0 -5.714 --> Burst rod at bottom of support plate
C
C      0.0  0.0  0.0000 --> Burst rod at location in Coats model
C
C      0.0  0.0  8.8377 --> Burst rod at top of travel
C 0.0 is fully inserted (though not as far as theoretically possible)
C -13.1826 has the top of the BR in line with the top of the support plate
C worth of this swing is reported to be ~1.05$
C
*TR1  0.0  0.0  0.0
C *TR1  0.0  0.0 -8.8377
C
C TR2 moves the control rods
C
C      0.0 is fully inserted (though not as far as theoretically possible)
C -16.7386 has the top of the CR in line with the top of the support plate
C worth of this swing is reported to be ~3$
C
C
C
*TR2  0.0  0.0 -9.6266
C *TR2  0.0  0.0 -11.2085
C
C
*TR3  0 0 0.0
C Reactor movement
*TR10  0.0  0.0  0
C Experiment Plate on A Leg
*TR20 -0.0  0.0  0
C
C Y Plate C Leg rotation
tr703 0 0 0 0.5150 -0.8572 0 0.8572 0.5150 0 0 0 1 1
C
C Y Plate b Leg rotation
tr704 0 0 0 0.5150 0.8572 0 -0.8572 0.5150 0 0 0 1 1
C *****
C * MATERIAL CARDS *
C *****
C
C Material #1 is U10-Moly Fuel
C
M1      92238.66c -0.0612      92235.66c -0.8388      42000.66c -0.1000
C
C
C Material #4 is SS303
C
M4      6000.66c  0.0068050  14028.62c  0.0178943  14029.62c  0.0009086
      14030.62c  0.0005989  15031.66c  0.0035185  16000.62c  0.0025491
      24050.62c  0.0081962  24052.62c  0.1580559  24053.62c  0.0179223
      24054.62c  0.0044612  25055.62c  0.0198371  26054.62c  0.0392953
      26056.62c  0.6168520  26057.62c  0.0142458  26058.62c  0.0018959
      28058.62c  0.0568822  28060.62c  0.0219108  28061.62c  0.0009525
      28062.62c  0.0030364  28064.62c  0.0007737  42000.66c  0.0034081
C
C
C Bakelite
C
C Bakelite has a density of ~1.3 g/cm3
C Chem formula (per https://en.wikipedia.org/wiki/Bakelite) C6H6O-CH2O (s
C
C Summary of MatMCNP (Version 3.0) Calculations:
C
C Isotope  Number Fraction      Weight Fraction      Atoms/b-cm
C H-1      0.470534              0.064941              0.0551031
C H-2      0.000054              0.000015              0.0000063
C C-12     0.407359              0.669429              0.0477048
C C-13     0.004406              0.007846              0.0005160

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```

C   O-16      0.117361      0.257071      0.0137439
C   O-17      0.000045      0.000104      0.0000052
C   O-18      0.000241      0.000594      0.0000282
C
C The total compound atom density (atom/b-cm): 0.1171077
C
C
C This material contains an isotope that is often modified by
C an S(alpha,beta). Check MCNP Manual Appendix G to see if an
C S(alpha,beta) card (i.e., an MTn card) is required.
C
M5      01001.80c  0.470534
        01002.80c  0.000054
        06000.80c  0.411765
        08016.80c  0.117361
        08017.80c  0.000045
        08016.80c  0.000241
C
C Caution: The natural zaid is used for Carbon.
C
C Caution: The O-18 has been set to O-16.
C
C To convert a particle flux to rad[Material]
C use FM 1.3211722E-09 4 -4 1 for neutrons
C or FM 1.3211722E-09 4 -5 -6 for photons.
C
C
C
C Un-borated Concrete
C
M6      1002.66c  0.0000158  8016.62c  0.4431301  8017.66c  0.0001685
        20000.62c  0.1411032  14028.62c  0.0195666  14029.62c  0.0009935
        14030.62c  0.0006549  12000.62c  0.0232244  06000.66c  0.2558650
        26054.62c  0.0001386  26056.62c  0.0021755  26057.62c  0.0000502
        26058.62c  0.0000067  13027.62c  0.0074901  01001.62c  0.1054171
C
C Material #3 is air. Mslot 5 is light blue
C
C Dry air
C Standard Density: 1.205e-3 g/cc @ 20 deg C, 1 atm
C See Attix "Introduction to Radiological Physics and Radiation
C Dosimetry" p.531-532
C
C
M3      6000.66c  0.0001502  7014.62c  0.7815582  7015.66c  0.0028710
        8016.62c  0.2106694  8017.66c  0.0000801  18000.42c  0.0046711
C
C Wall board (Material from Coats model)
C
M7      20000.62c -0.23300  16000.62c -0.18600  8016.62c -0.55800
        1001.62c -0.02300
C
C Borated wall board (Material from Coats model)
C
M8      20040.02c -0.22900  16032.02c -0.18300  8016.02c -0.54900
        1001.02c -0.02300  5010.06c -0.00300  5011.06c -0.01300
C Borated wall board (Educated Guess from notes, 1/64th by volume boron added to normal wallboard)
C
c M8      20000.62c -0.22900  16000.62c -0.18300  8016.62c -0.54900
c        1001.62c -0.02300  5010.66c -0.00907  5011.66c -0.03629
C
C
C Phenolic 1
C
C This material is described in MC4380/MC4380A Neutron Generator
C Assembly Radiation Hardness Assessment:
C Material Properties for Unclassified Materials. Revision 122.
C This is a chopped glass phenolic consisting of A 1100 finished glass
C The material is I.C.I. Fiberlite's product designation "FM5135." The
C tensile strength is 13,000 psi (Ref. 7).
C
C Summary of MatMCNP Calculations:
C
C Isotope Number Fraction Weight Fraction Atoms/b-cm
C H-1      0.3443463      0.0305908      0.0272360

```

```

C   H-2      0.0000517      0.0000092      0.0000041
C   B-10     0.0033864      0.0029889      0.0002678
C   B-11     0.0137165      0.0133111      0.0010849
C   C-12     0.2510653      0.2655698      0.0198579
C   C-13     0.0028181      0.0032302      0.0002229
C   N-14     0.0185604      0.0229098      0.0014680
C   N-15     0.0000682      0.0000902      0.0000054
C   O-16     0.2519690      0.3552547      0.0199294
C   O-17     0.0000960      0.0001438      0.0000076
C   O-18     0.0005051      0.0008014      0.0000400
C   Na-23    0.0012337      0.0025000      0.0000976
C   Mg-24    0.0017329      0.0036636      0.0001371
C   Mg-25    0.0002194      0.0004832      0.0000174
C   Mg-26    0.0002415      0.0005532      0.0000191
C   Al-27    0.0197615      0.0470000      0.0015630
C   Si-28    0.0596075      0.1469982      0.0047146
C   Si-29    0.0030266      0.0077305      0.0002394
C   Si-30    0.0019951      0.0052713      0.0001578
C   Ca-40    0.0244209      0.0860252      0.0019316
C   Ca-42    0.0001630      0.0006028      0.0000129
C   Ca-43    0.0000340      0.0001288      0.0000027
C   Ca-44    0.0005265      0.0020400      0.0000416
C   Ca-46    0.0000010      0.0000041      0.0000001
C   Ca-48    0.0000471      0.0001991      0.0000037
C   Ti-46    0.0000117      0.0000475      0.0000009
C   Ti-47    0.0000106      0.0000438      0.0000008
C   Ti-48    0.0001048      0.0004431      0.0000083
C   Ti-49    0.0000077      0.0000332      0.0000006
C   Ti-50    0.0000074      0.0000324      0.0000006
C   Fe-54    0.0000154      0.0000734      0.0000012
C   Fe-56    0.0002423      0.0011947      0.0000192
C   Fe-57    0.0000056      0.0000281      0.0000004
C   Fe-58    0.0000007      0.0000038      0.0000001
C
C   The total compound atom density (atom/b-cm):  0.07909475
C
M9      1001.62c  0.3443463  1002.66c  0.0000517  5010.66c  0.0033864
      5011.66c  0.0137165  6000.66c  0.2538835  7014.62c  0.0185604
      7015.66c  0.0000682  8016.62c  0.2524741  8017.66c  0.0000960
      11023.62c 0.0012337  12000.62c 0.0021938  13027.62c 0.0197615
      14028.62c 0.0596075  14029.62c 0.0030266  14030.62c 0.0019951
      20000.62c 0.0251925  22000.62c 0.0001422  26054.62c 0.0000154
      26056.62c 0.0002423  26057.62c 0.0000056  26058.62c 0.0000007
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
M10     12000.62c -0.011000  13027.62c -0.967000  14028.62c -0.007350
      14029.62c -0.000387  14030.62c -0.000263  22000.62c -0.000700
      24050.62c -0.000084  24052.62c -0.001674  24053.62c -0.000193
      24054.62c -0.000049  25055.62c -0.001300  26054.62c -0.000316
      26056.62c -0.005147  26057.62c -0.000121  26058.62c -0.000016
      28058.62c -0.000269  28060.62c -0.000107  28061.62c -0.000005
      28062.62c -0.000015  28064.62c -0.000004  29063.62c -0.002055
      29065.62c -0.000945  30000.42c -0.001000
C
C   Dummy Filler
m11     1000  1
C
C   This material contains an isotope that is often modified by
C   an S(alpha,beta). Check MCNP Manual Appendix G to see if an
C   S(alpha,beta) card (i.e., an MTn card) is required.
C
M40     06000.80c  0.003694
      13027.80c  0.014388
      14028.80c  0.009105

```

```

14029.80c 0.000463
14030.80c 0.000305
16032.80c 0.016429
16033.80c 0.000130
16034.80c 0.000735
16036.80c 0.000002
22046.80c 0.002390
22047.80c 0.002155
22048.80c 0.021353
22049.80c 0.001567
22050.80c 0.001500
24050.80c 0.007183
24052.80c 0.138519
24053.80c 0.015707
24054.80c 0.003910
25055.80c 0.010095
26054.80c 0.004063
26056.80c 0.063782
26057.80c 0.001473
26058.80c 0.000196
27059.80c 0.009410
28058.80c 0.450269
28060.80c 0.173442
28061.80c 0.007539
28062.80c 0.024040
28064.80c 0.006121
29063.80c 0.003017
29065.80c 0.001346
41093.80c 0.005671

C
C Caution: The natural zaid is used for Carbon.
C
C To convert a particle flux to rad[Material]
C use FM 1.7269976E-10 40 -4 1 for neutrons
C or FM 1.7269976E-10 40 -5 -6 for photons.
c
c Permanent Magnet. Needs backfilled
m100 1001 1.0
C
c
c Si-B, Density 2.255 g/cc
c 10-B 5.5500E-01 7.4247E-01
c 11-B 6.2000E-02 7.4866E-02
c 28-Si 3.5454E-01 1.6847E-01
c 29-Si 1.7382E-02 8.5547E-03
c 30-Si 1.1077E-02 5.6393E-03
M41 5010.00c 7.4247E-01
5011.00c 7.4866E-02
14028.00c 1.6847E-01
14029.00c 8.5547E-03
14030.00c 5.6393E-03

C
c Borated Concrete (J. Koglin Notes) 2.6g/cc
m42 1001.00c 1.4361E-01
1002.00c 1.6517E-05
5010.00c 2.9608E-02
5011.00c 1.1918E-01
6012.00c 1.1924E-03
6013.00c 1.2897E-05
8016.00c 4.7889E-01
11023.00c 1.0075E-02
12024.00c 9.4097E-04
12025.00c 1.1913E-04
12026.00c 1.3116E-04
13027.00c 1.8174E-02
14028.00c 1.6021E-01
14029.00c 8.1387E-03
14030.00c 5.3714E-03
19039.00c 4.4889E-03
19040.00c 5.6317E-07
19041.00c 3.2396E-04
20040.00c 1.5407E-02
20042.00c 1.0283E-04
20043.00c 2.1456E-05
20044.00c 3.3154E-04
20046.00c 6.3574E-07

```

```

20048.00c    2.9721E-05
26054.00c    2.1213E-04
26056.00c    3.3300E-03
26057.00c    7.6903E-05
26058.00c    1.0234E-05
C *****
C *      SOURCE CARDS      *
C *****
C
C vol 1.0 108r
C
C
C PRINT 10 60 100
RAND GEN=2 SEED=19073486328725 STRIDE=152917
C PRDMP j 25 1 2 500000000
C *****
C *                      DATA CARDS                      *
C *****
MODE N P
PHYS:P 4j 1
C *****
C *      SOURCE CARDS      *
C *****
C
C sdef SUR=500 WGT=6361.725124 PAR=1 ERG=1 NRM=-1
C sdef par=1 erg=1 pos=0 0 0.01
C nps 100000000
KCODE 1000000 1 10 40
KSRC 0.0 5 8 5 0.0 8 0.0 -5 8 -5 0.0 8
      0.0 5 16 5 0.0 16 0.0 -5 16 -5 0.0 12
      0.0 5 12 5 0.0 12 0.0 -5 12 -5 0.0 16
kopts blocksize=10 kinetics=yes precursor=yes

```

APPENDIX B. LANL MCNP WSMR MODEL

```

LANL WSMR FBR model primary author Ed Lum 09/29/22
C
C The WSMR model redone to include more information
C
C
C *****|*****80
C ***** Cells *****
C *****|*****80
C
C *****
C * Fuel Rings *
C *****
C
950 100 -17.044 -812 809 -800 802 (-811:801) 803 4I 808 816          imp:n,p=1 $ Bottom Fuel ring
951 100 -17.044 (-809 -813 810 806):
      (-809 -814 810 807):
      (-809 -815 810 808)          imp:n,p=1 $ Bottom Fuel Ring
Standoffs
C
952 100 -17.044 -800 802 821 -812 803 4I 808 (-811:801) (809:-820)
      816 822 823 TRCL=100          imp:n,p=1 $ Center Fuel ring
953 like 951 but TRCL=100          $ Center Fuel Ring
Standoffs
C
954 100 -17.044 -800 802 821 -812 803 4I 808 (-811:801) (809:-820)
      816 822 823 TRCL=101          imp:n,p=1 $ Center Fuel ring
955 like 951 but TRCL=101          $ Center Fuel Ring
Standoffs
C
956 100 -17.044 -800 802 821 -812 803 4I 808 (-811:801) (809:-820)
      816 822 823 TRCL=102          imp:n,p=1 $ Center Fuel ring
957 like 951 but TRCL=102          $ Center Fuel Ring
Standoffs
C
958 100 -17.044 -800 821 830 (809:-820) 821 (802:831) (-812:-820)
      833 -832 804 3I 808 833 TRCL=103          imp:n,p=1 $ Intermediate Fuel ring
959 like 951 but TRCL=103          $ Intermediate Fuel Ring
Standoffs
C
960 100 -17.044 -800 809 -840 841 (842:843) (-844:845) 806 807 808
      833 846 847 (-844:848) (-844:849) (-844:850) TRCL=104          imp:n,p=1 $ Top Fuel ring
961 like 951 but TRCL=104
C
962 100 -17.044 809 -864 -860 (-861:865) 863 (862:-866) TRCL=105          imp:n,p=1 $ Center Insert
963 2 -8 -870 871 866 -872          TRCL=105          imp:n,p=1 $ Lower Mass Adjustment
Ring
964 2 -8 -870 871 872 -873          TRCL=105          imp:n,p=1 $ Upper Mass Adjustment
Ring
C
C *****
C * Safety Block and Control Rods *
C *****
C
965 100 -17.044 (-882 883 880 -881 884 885):(881 -886 883)
      887 888 889 890          TRCL=106          imp:n,p=1 $ Safety Block
966 100 -17.044 -891 892          TRCL=107          imp:n,p=1 $ Burst Rod
967 100 -17.044 -900 901          TRCL=108          imp:n,p=1 $ West control Rod
968 100 -17.044 -902 903          TRCL=109          imp:n,p=1 $ East control Rod
C
C *****
C * Supporting Parts *
C *****
C
969 2 -8 -910 -810 911 803 804 805 806 807 808 802 912          imp:n,p=1 $ Support Plate
C
970 2 -8 (-920 -922 924):(-921 920 -809 923)          TRCL=106          imp:n,p=1 $ Safety Block Support
Rod
971 2 -8 -925:-892          TRCL=107          imp:n,p=1 $ Burst Support Rod
972 2 -8 (-926:-901)          TRCL=108          imp:n,p=1 $ West Support Rod
973 2 -8 (-927:-903)          TRCL=109          imp:n,p=1 $ East Support Rod

```

```

C
974 3 -8 -930:(930 -933):-931:(931 -934):-932:(932 -935):
      -930:(930 -936):-931:(931 -937):-932:(932 -938)
                                     imp:n,p=1 $ Inconel Bolts
C
975 4 -2.7 (-990 -991 873 806 807 808 846 847 833 993):
      (-992 993):(-994 992 -873)
                                     TRCL=105 imp:n,p=1 $ Fuel Cool plate
C
C *****
C * Decoupling Shroud *
C *****
C
976 4 -2.7 (-940 941):(-943 942):(-944 943):(-945 946)
      :(810 -947 944.1 -950 (-949:-948))
                                     imp:n,p=1 $ Decoupling Shroud
C
977 9 -2.225 -946 951 809 952 944.3
Shroud
                                     imp:n,p=1 $ Boron liner Decoupling
C
C *****
C * Table *
C *****
C
978 4 -0.327 -960 961 963 11I 975
frame Density
                                     imp:n,p=1 $ Tabletop aluminum
C
                                     $ adjusted to account
for aluminum
                                     $ tube versus aluminum
C
solid bar
979 5 -1.25 -962 963
                                     imp:n,p=1 $ Tabletop surface
Bakelite
C
C *****
C * Hi-bay cell *
C *****
C
10000 702 -1.0245e-3 -10000 -710
      #950 #951 #952 #953 #954 #955 #956 #957 #958 #959
      #960 #961 #962 #963 #964 #965 #966 #967 #968 #969
      #970 #971 #972 #973 #974 #975 #976 #977 #978 #979
      #110
      10001
                                     $ Experiment plates
                                     imp:n,p=1 $ FBR Cell
C
C The hi bay cell from the outside to inside the cell is layered like this.
C |2" BGyp|0.5" air|2" BGyp|0.5" air|2" Gyp|0.5" air|2" Gyp|.
C
10001 11 -2.3 -700 701 711
10002 8 -0.7 -701 702
layer
10003 702 -1.0245e-3 -702 703
10004 8 -0.7 -703 704
layer
10005 702 -1.0245e-3 -704 705
10006 7 -2.32 -705 706
10007 702 -1.0245e-3 -706 707
10008 7 -2.32 -707 708
10009 702 -1.0245e-3 -708 709
10010 702 -1.0245e-3 -709 710
Gypsum 3rd Layer
10011 6 -2.307 -700 701 -711
Floors
10020 0 700 -10000
10021 0 10000
10022 702 -1.0245e-3 -10001
                                     imp:n,p=1 $ Concrete walls
                                     imp:n,p=1 $ Borated Gypsum 1st
                                     imp:n,p=1 $ Air 1st layer
                                     imp:n,p=1 $ Borated Gypsum 2nd
                                     imp:n,p=1 $ Air 2st layer
                                     imp:n,p=1 $ Gypsum 1st Layer
                                     imp:n,p=1 $ Air 3st layer
                                     imp:n,p=1 $ Gypsum 2st Layer
                                     imp:n,p=1 $ Air 4th layer
                                     imp:n,p=1 $ Air but possibly
                                     imp:n,p=1 $ Borated Concrete
                                     imp:n,p=1 $ Outside cell void
                                     imp:n,p=0 $ Oblivion
                                     imp:n,p=1 $ lcc check sphere
C
C *****
C * Experiment Cells *
C *****
C
C Allowed numbers for experiment cells can be 1-949 and 1000-10000. If you need more cell numbers, you
are wrong.
C
C Support plates
C
110 4 -2.7 (-113 112 810 -114):
      (-961 113 810 -114 -115 116 -117):
      (-961 113 810 -114 -118 119 -120):
      (-961 113 810 -114 -121 122 -123)
                                     $ Y-plate annulus
                                     $ Y-plate A-leg
                                     $ Y-plate C-leg
                                     imp:n,p=1 $ Y-plate B-leg

```

```

C
C *****|*****80
C ***** Surfaces *****
C *****|*****80
C
C -----
C -----Experiment Surfaces -----
C -----
C
C Experiment surface numbers 1-800 & 1000-10000
C
C Plate support
C
112 CZ 16.51 $ Yplate annulus ID
113 CZ 20.32 $ Yplate annulus OD
114 PZ 0.5969 $ Yplate annulus top
115 PY 10.16 $ Yplate top A leg wall
116 PY -10.16 $ Yplate bottom A leg
wall
117 PX -16.51 $ Annulus hole stop A
leg
118 3 PY 10.16 $ Yplate top C leg wall
119 3 PY -10.16 $ Yplate bottom C leg
wall
120 3 PX -16.51 $ Annulus hole stop C
leg
121 4 PY 10.16 $ Yplate top B leg wall
122 4 PY -10.16 $ Yplate bottom B leg
wall
123 4 PX -16.51 $ Annulus hole stop B
leg
C
C -----
C ----- Fuel Rings -----
C -----
C
C *****
C * Bottom Fuel Ring *
C *****
C
800 120 CZ 10.1632 $ Ring Outer Radius
801 120 CZ 5.55942 $ Top Interface Radius
802 120 CZ 5.08 $ Ring Inner Radius
803 120 C/Z 0 7.9375 1.323975 $ BR InLine Bore Hole
804 120 C/Z -6.87324 -3.96748 1.323975 $ CR West Bore Hole
805 120 C/Z 6.87324 -3.96748 1.323975 $ CR Eas Bore Hole
806 120 C/Z 0 -7.9375 0.968375 $ Standoff InLine Bore
Hole
807 120 C/Z -6.87324 3.96748 0.968375 $ Standoff West Bore
Hole
808 120 C/Z 6.87324 3.96748 0.968375 $ Standoff East Bore
Hole
809 120 PZ 0 $ Bottom Fuel Ring
810 120 PZ -0.0381 $ Bottom Standoff
811 120 PZ 2.93116 $ Top Interface Bottom
812 120 PZ 3.25374 $ Top Fuel Ring
813 120 C/Z 0 -7.9375 1.905 $ Standoff InLine
814 120 C/Z -6.87324 3.96748 1.905 $ Standoff West
815 120 C/Z 6.87324 3.96748 1.905 $ Standoff East
816 120 C/Z 2.93624 5.08762 0.128905 $ Drill Thru
C
C *****
C * Center Fuel Ring *
C *****
C
820 120 CZ 5.55562 $ Bottom Interface
Radius
821 120 PZ -0.31369 $ Bottom Interface
Height
822 120 RCC -2.6670 4.6194 1.6281 -4.6736 8.0949 0 0.1289 $ 0.1015" hole
823 120 RCC -4.6736 8.0949 1.6281 -5.0800 8.7988 0 0.3175 $ 1/4" tap
C
C *****
C * Intermediate Fuel Ring *
C *****

```

```

C
830 120 CZ 4.7625
Radius
831 120 PZ 1.6535
832 120 PZ 3.5674
833 120 C/Z 0 7.9375 0.3175
C
C *****
C * Top Fuel Ring *
C *****
C
840 120 PZ 3.08102
841 120 CZ 4.76314
842 120 CZ 5.55943
Radius
843 120 PZ 0.32258
height
844 120 PZ 1.82626
845 120 CZ 5.08508
846 120 C/Z -6.87324 -3.96748 0.3175
847 120 C/Z 6.87324 -3.96748 0.3175
848 120 C/Z 0 5.87375 0.3175
849 120 C/Z -5.08682 -2.93688 0.3175
850 120 C/Z 5.08682 -2.93688 0.3175
C
C *****
C * Center Insert *
C *****
C
860 120 CZ 5.07365
861 120 CZ 4.75234
862 120 CZ 3.90525
863 120 CZ 1.5875
864 120 PZ 4.90982
865 120 PZ 3.65252
866 120 PZ 2.13106
C
C *****
C * Mass Adjustment Rings *
C *****
C
870 120 CZ 3.87604
871 120 CZ 1.5875
872 120 PZ 3.52806
873 120 PZ 4.92506
C
C -----
C ----- Safety Block and Control Rods -----
C -----
C *****
C * Safety Block *
C *****
C
880 120 PZ 0
881 120 PZ 14.4653
882 120 CZ 4.8895
883 120 CZ 1.7781
884 120 RCC 0 2.54 -0.0001 0 0 10.1601 0.12891
885 120 RCC 0 2.38 -0.0001 0 0 0.8129 0.3175
886 120 TRC 0 0 14.4653 0 0 0.1397 4.8895 1.7781
887 120 RCC 0 -5 14.605 0 10 0 0.23622
888 120 RCC -5 0 14.605 10 0 0 0.23622
889 120 RCC -5 -5 14.605 10 10 0 0.23622
890 120 RCC 5 -5 14.605 -10 10 0 0.23622
C
C *****
C * Burst Rod *
C *****
C
891 120 RCC 0 7.9375 -13.208 0 0 13.208 1.27
892 120 RCC 0 7.9375 -13.208 0 0 2 0.555625
C
C *****
C * Control Rods *
C *****

```

```

$ Bottom Interface
$ Mid plane
$ Top interface
$ Drill thru InLine
$ Top of fuel ring
$ Inner fuel ring
$ Bottom fuel interface
$ Bottom fuel interface
$ Fuel mid-plane
$ Fuel Top Interface
$ Drill thru West
$ Drill Thru East
$ Tap holes inline
$ Tap holes West
$ Tap holes East
$ Outer Radius
$ Outer Radius 2
$ Outer Radius 3
$ Outer Radius 4
$ Overall height
$ Lip height
$ Cup height
$ Outer Radius
$ Inner Radius
$ Lower MAR
$ Upper MAR
$ Thermocouple Hole
$ Clocking hole
$ Upper Chamfer
$ Air channels N to S
$ Air channels E to W
$ Air channels SW to NE
$ Air channels SW to NE
$ Burst Rod
$ Tap hole 11.684

```

```

C
900 120 RCC -6.87324 -3.96748 -16.7386 0 0 16.7386 1.27          $ Control Rod West
901 120 RCC -6.87324 -3.96748 -16.7386 0 0 2          0.555625    $ Control Rod West Tap
hole 15.1892
902 120 RCC 6.87324 -3.96748 -16.7386 0 0 16.7386 1.27          $ Control Rod East
903 120 RCC 6.87324 -3.96748 -16.7386 0 0 2          0.555625    $ Control Rod East Tap
hole
C
C -----
C ----- Supporting Parts -----
C -----
C
C *****
C * Support Plate *
C *****
C
910 120 CZ 14.2875
911 120 PZ -1.6256
912 120 CZ 5.39623
C
C *****
C * Safety Block and control rod support *
C *****
C
920 120 CZ 1.778          $ *Safety block rod
assmued SB hole*
921 120 CZ 5.08          $ *Safety block support
plate OD*
922 120 PZ 3.175          $ Safety block top
threading
923 120 PZ -1.27          $ *Safety block support
plate*
924 120 PZ -39.08204
925 120 RCC 0 7.9375 -13.20801 0 0 -39.08204 1.27          $ *2x the height of FBR*
926 120 RCC -6.87324 -3.96748 -16.73861 0 0 -39.08204 1.27          $ Burst Rod Support Rod
Support Rod
927 120 RCC 6.87324 -3.96748 -16.73861 0 0 -39.08204 1.27          $ Control Rod East
Support Rod
C
C *****
C * Fuel Ring Bolts *
C *****
C
930 120 RCC 0 -7.9375 -2.4384 0 0 23.3111 0.9525          $ Inline Fuel Ring Bolt
931 120 RCC -6.87324 3.96748 -2.4384 0 0 23.3111 0.9525          $ West Fuel Ring Bolt
932 120 RCC 6.87324 3.96748 -2.4384 0 0 23.3111 0.9525          $ East Fuel Ring Bolt
933 120 RHP 0 -7.9375 20.06 0 0 0.8128 0 1.5875          $ Inline Upper Nut
934 120 RHP -6.87324 3.96748 20.06 0 0 0.8128 0 1.5875          $ West Upper Nut
935 120 RHP 6.87324 3.96748 20.06 0 0 0.8128 0 1.5875          $ East Upper Nut
936 120 RHP 0 -7.9375 -2.4385 0 0 0.8128 0 1.5875          $ Inline Lower Nut
937 120 RHP -6.87324 3.96748 -2.4385 0 0 0.8128 0 1.5875          $ West Lower Nut
938 120 RHP 6.87324 3.96748 -2.4385 0 0 0.8128 0 1.5875          $ East Lower Nut
C
C *****
C * Cooling Plate *
C *****
C
990 120 PZ 5.41401          $ Top of plate
991 120 CZ 10.16          $ Plate radius
992 120 RCC 0 0 5.415 0 0 -14.12875 0.68707          $ Air Tube OD
993 120 CZ 0.46863          $ Air Tube ID
994 120 RCC 0 0 4.926 0 0 -1.93134 1.27          $ NPT nut
C
C -----
C ----- Decoupling Shroud -----
C -----
C
940 120 RCC 0 0 22.7711 0 0 0.0798 3.175          $ Inner ring OD
941 120 RCC 0 0 22.7711 0 0 0.0798 1.27          $ Inner ring ID
942 120 TRC 0 0 22.8509 0 0 2.2316 1.27 3.572296          $ 0.091654 thickness for
22ga on 60 degree angle
943 120 TRC 0 0 22.8509 0 0 2.2316 1.361654 3.66395          $ 0.091654 thickness for
22ga on 60 degree angle
944 120 RCC 0 0 25.0027 0 0 0.0798 11.43          $ Top shroud
945 120 RCC 0 0 0 0 0 25.0825 11.43          $ Side Shroud OD
946 120 CZ 11.350625          $ Side Shroud ID

```

```

947 120 CZ 13.97
948 120 CZ 11.7094
949 120 PZ 0.4699
950 120 PZ 0.90678
951 120 RCC 0 0 0 0 24.84395 11.191875
952 120 CZ 3.6
C
C -----
C ----- Experiment Table -----
C -----
C
960 110 RPP -122.2375 122.2375 -61.2775 61.2775 -6.1976 3.9624 $ Table outer box
961 110 RPP -121.92 121.92 -60.96 60.96 -0.8001 6 $ Table top cutout
962 110 RPP -121.919 121.919 -60.959 60.959 -0.8000 -0.0381 $ Table top
963 110 CZ 14.9225 $ FBR hole
964 110 RPP -117.1575 -80.645 2.54 56.1975 -25.4 25.4 $ Table frame
965 110 RPP -80.01 -43.4975 2.54 56.1975 -25.4 25.4 $ Table frame
966 110 RPP -38.4175 38.4175 2.54 40.4749 -25.4 25.4 $ Table frame
967 110 RPP -38.4175 38.4175 45.5549 56.1975 -25.4 25.4 $ Table frame
968 110 RPP 43.4975 80.01 2.54 56.1975 -25.4 25.4 $ Table frame
969 110 RPP 80.645 117.1575 2.54 56.1975 -25.4 25.4 $ Table frame
970 110 RPP -117.1575 -80.645 -56.1975 -2.54 -25.4 25.4 $ Table frame
971 110 RPP -80.01 -43.4975 -56.1975 -2.54 -25.4 25.4 $ Table frame
972 110 RPP -38.4175 38.4175 -40.4749 -2.54 -25.4 25.4 $ Table frame
973 110 RPP -38.4175 38.4175 -56.1975 -45.5549 -25.4 25.4 $ Table frame
974 110 RPP 43.4975 80.01 -56.1975 -2.54 -25.4 25.4 $ Table frame
975 110 RPP 80.645 117.1575 -56.1975 -2.54 -25.4 25.4 $ Table frame
C
C -----
C ----- WSMR Hi-bay -----
C -----
C
C The hi bay cell from the outside to inside the cell is layered like this.
C |2" BGyp|0.5" air|2" BGyp|0.5" air|2" Gyp|0.5" air|2" Gyp|.
C
700 RPP -822.96 822.96 -822.96 822.96 -232.806875 498.713125 $ Outer Wall
701 RPP -762 762 -762 762 -171.846875 437.753125 $ Inner Wall
702 RPP -756.92 756.92 -756.92 756.92 -171.846875 432.673125 $ Borated Gypsum 1st
layer
703 RPP -755.65 755.65 -755.65 755.65 -171.846875 431.403125 $ Air
704 RPP -750.57 750.57 -750.57 750.57 -171.846875 426.323125 $ Borated Gypsum 2nd
layer
705 RPP -749.3 749.3 -749.3 749.3 -171.846875 425.053125 $ Air
706 RPP -744.22 744.22 -744.22 744.22 -171.846875 419.973125 $ Gypsum 1st layer
707 RPP -742.95 742.95 -742.95 742.95 -171.846875 418.703125 $ Air
708 RPP -737.87 737.87 -737.87 737.87 -171.846875 413.623125 $ Gypsum 2nd layer
709 RPP -736.6 736.6 -736.6 736.6 -171.846875 412.353125 $ Air
710 RPP -731.52 731.52 -731.52 731.52 -171.846875 407.273125 $ Gypsum 3rd layer
711 PZ -171.846875 $ Seperation between
floor and walls
C
10000 SO 1300 $ ~32.8ft radius Outer
Boundary
10001 SZ 21.5 0.620350491 $ ~1cc volume sphere
C
C *****|*****80
C ***** Data *****
C *****|*****80
C
C -----
C ----- Transformations -----
C -----
C
C *****
C * Fuel Ring Positions *
C *****
C
TR100 0 0 3.292
TR101 0 0 6.584
TR102 0 0 9.876
TR103 0 0 13.168
TR104 0 0 16.460
TR105 0 0 14.6415
C

```

```

C *****
C * Control Rods and Safety Block *
C *****
C
C The 0 0 0 values for TR106-108 are for zero insertion of the rods and full insertion of the
C the safety block. These values should be changed to match the insertion in inches of the
C real core.
C
TR106 0 0 0          $ Safety Block
TR107 0 0 13         $ Burst Rod @ SS the BR sits 0.5" below the fuel support plate (0.625") Max insert
13
TR108 0 0 7.20852 $ Control Rods Max insert 16.425. Critical approx 7.86638
TR109 0 0 7.112   $ Control Rod 2 Max insert 16.425 Insert min -2.8575
C
C *****
C * Experiment Tabletop *
C *****
C
TR110 0 0 0          $ Moveable tabletop
C
*TR1 0 0 0 24.8    65.2 90 -114.8 24.8 90 $ Top transform
*TR2 0 0 0 24.8 -114.8 90    65.2 24.8 90 $ Bottom Transform
C
C Experiment Transforms
C
*TR3 0 0 0 120 30 90 150 120 90 $ NW plate
*TR4 0 0 0 120 150 90 30 120 90 $ SW plate
C
C *****
C * FBR Location *
C *****
C
*TR120 0 0 0 30 120 90 60 30 90 $ FBR rotated 90 degrees clockwise.
C
C -----
C ----- Materials -----
C -----
C
C *****
C * Nominal Fuel Spec *
C *****
C
m100    6012.00c -1.3984E-04  6013.00c -1.6389E-06  7014.00c -2.9882E-05
        7015.00c -1.1823E-07  8016.00c -1.9946E-05  8017.00c -8.0749E-09
        8018.00c -4.6125E-08  14028.00c -8.4504E-05  14029.00c -4.4442E-06
        14030.00c -4.4442E-06  15031.00c -1.0000E-04  29063.00c -4.4239E-06
        29065.00c -2.0344E-06  33075.00c -1.0000E-05  40090.00c -3.6286E-05
        40091.00c -8.0013E-06  40092.00c -1.2365E-05  40094.00c -1.2803E-05
        40096.00c -2.1066E-06  42092.00c -1.4346E-02  42094.00c -9.1364E-03
        42095.00c -1.5892E-02  42096.00c -1.6826E-02  42097.00c -9.7342E-03
        42098.00c -2.4849E-02  42100.00c -1.0120E-02  74180.00c -1.1746E-07
        74182.00c -2.6227E-05  74183.00c -1.4241E-05  74184.00c -3.0658E-05
        74186.00c -2.8757E-05  92234.00c -4.9418E-05  92235.00c -8.3742E-01
        92238.00c -6.1050E-02
C
C *****
C * Stainless Steel 316 *
C *****
C
C PNNL 8g/cc
C
m2      6012.00c -7.9073E-04  6013.00c -9.2675E-06  14028.00c -9.1873E-03
        14029.00c -4.8318E-04  14030.00c -3.2948E-04  15031.00c -4.5000E-04
        16032.00c -2.8396E-04  16033.00c -2.3445E-06  16034.00c -1.3634E-05
        16036.00c -6.7302E-08  24050.00c -7.1007E-03  24052.00c -1.4229E-01
        24053.00c -1.6445E-02  24054.00c -4.1707E-03  25055.00c -2.0000E-02
        26054.00c -3.6891E-02  26056.00c -6.0053E-01  26057.00c -1.4117E-02
        26058.00c -1.9116E-03  28058.00c -8.0637E-02  28060.00c -3.2131E-02
        28061.00c -1.4200E-03  28062.00c -4.6018E-03  28064.00c -1.2098E-03
        42092.00c -3.5540E-03  42094.00c -2.2635E-03  42095.00c -3.9371E-03
        42096.00c -4.1685E-03  42097.00c -2.4115E-03  42098.00c -6.1561E-03
        42100.00c -2.5071E-03
C
C *****
C * Inconel-X *
C *****

```

```

C
C From Matweb for Inconel 600 8.47 g/cc
C Composition "The Effect of neutron irradiation on the mechanical properties of inconel "x"
C
m3      13027.00c -7.0000E-03 14028.00c -2.5724E-03 14029.00c -1.3529E-04
        14030.00c -9.2253E-05 22046.00c -1.8375E-03 22047.00c -1.6931E-03
        22048.00c -1.7132E-02 22049.00c -1.2835E-03 22050.00c -1.2539E-03
        24050.00c -6.3907E-03 24052.00c -1.2806E-01 24053.00c -1.4801E-02
        24054.00c -3.7536E-03 26054.00c -3.7543E-03 26056.00c -6.1115E-02
        26057.00c -1.4366E-03 26058.00c -1.9454E-04 28058.00c -4.9170E-01
        28060.00c -1.9593E-01 28061.00c -8.6589E-03 28062.00c -2.8060E-02
        28064.00c -7.3769E-03 41093.00c -6.3000E-03 73180.00c -2.7447E-07
        73181.00c -2.2997E-03
C
C *****
C * Aluminum 6061-O *
C *****
C
C PNNL 2.7 g/cc
C
m4      12024.00c -7.7950E-03 12025.00c -1.0280E-03 12026.00c -1.1770E-03
        13027.00c -9.7200E-01 14028.00c -5.5124E-03 14029.00c -2.8991E-04
        14030.00c -1.9769E-04 24050.00c -8.1450E-05 24052.00c -1.6321E-03
        24053.00c -1.8864E-04 24054.00c -4.7841E-05 26054.00c -2.3079E-04
        26056.00c -3.7569E-03 26057.00c -8.8316E-05 26058.00c -1.1959E-05
        29063.00c -1.8837E-03 29065.00c -8.6626E-04 30064.00c -6.9393E-04
        30066.00c -4.1056E-04 30067.00c -6.1249E-05 30068.00c -2.8428E-04
        30070.00c -9.6770E-06
C
C *****
C * Bakelite *
C *****
C
C PNNL 1.25 g/cc
C
m5      1001.00c -5.7429E-02 1002.00c -1.3000E-05 6012.00c -7.6562E-01
        6013.00c -8.9731E-03 8016.00c -1.6751E-01 8017.00c -6.8000E-05
        8018.00c -3.8700E-04
C
C *****
C * 10% Weight Boron loaded Portland Concrete *
C *****
C
C PNNL compendium 2.307 g/cc
C
m6      1001.00c -8.9973E-03 1002.00c -1.8000E-06 5010.00c -1.8431E-02
        5011.00c -8.1569E-02 6012.00c -8.8958E-04 6013.00c -1.0426E-05
        8016.00c -4.7491E-01 8017.00c -1.9260E-04 8018.00c -1.0980E-03
        11023.00c -1.4400E-02 12024.00c -1.4031E-03 12025.00c -1.8504E-04
        12026.00c -2.1186E-04 13027.00c -3.0485E-02 14028.00c -2.7867E-01
        14029.00c -1.4656E-02 14030.00c -9.9936E-03 19039.00c -1.0874E-02
        19040.00c -1.3689E-06 19041.00c -8.2496E-04 20040.00c -3.8278E-02
        20042.00c -2.6823E-04 20043.00c -5.7303E-05 20044.00c -9.0598E-04
        20046.00c -1.8162E-06 20048.00c -8.8602E-05 26054.00c -7.1134E-04
        26056.00c -1.1580E-02 26057.00c -2.7221E-04 26058.00c -3.6861E-05
C
C *****
C * Gypsum *
C *****
C
C PNNL 2.32 g/cc
C
m7      1001.00c -2.3413E-02 1002.00c -5.3814E-06 8016.00c -5.5604E-01
        8017.00c -2.2511E-04 8018.00c -1.2858E-03 16032.00c -1.7630E-01
        16033.00c -1.4555E-03 16034.00c -8.4643E-03 16036.00c -4.1783E-05
        20040.00c -2.2501E-01 20042.00c -1.5767E-03 20043.00c -3.3684E-04
        20044.00c -5.3255E-03 20046.00c -1.0676E-05 20048.00c -5.2082E-04
C
C *****
C * 1/64 vol B in Gypsum *
C *****
C
C PNNL estimate on weights 2.31 g/cc
C
m8      1001.00c -2.3671E-02 1002.00c -5.4385E-06 5010.00c -3.2735E-04
        5011.00c -1.4487E-03 8016.00c -5.5826E-01 8017.00c -2.2600E-04

```

```

      8018.00c -1.2910E-03 16032.00c -1.7450E-01 16033.00c -1.4407E-03
      16034.00c -8.3784E-03 16036.00c -4.1359E-05 20040.00c -2.2272E-01
      20042.00c -1.5607E-03 20043.00c -3.3341E-04 20044.00c -5.2714E-03
      20046.00c -1.0568E-05 20048.00c -5.1553E-04
C
C *****
C * Boron Loaded Sylguard *
C *****
C
C Density 2.225 g/cc
C
m9      5010.00c -0.555      5011.00c -0.062      14028.00c -0.351875
      14029.00c -0.018506 14030.00c -0.012619
C
C *****
C * Portland Concrete *
C *****
C
C Density PNNL compendium 2.3 g/cc
C
m11     1001.00c 9.9977E-03 1002.00c 2.2980E-06 6012.00c 9.8842E-04
      6013.00c 1.1584E-05 8016.00c 5.2767E-01 8017.00c 2.1362E-04
      8018.00c 1.2202E-03 11023.00c 1.6000E-02 12024.00c 1.5590E-03
      12025.00c 2.0560E-04 12026.00c 2.3540E-04 13027.00c 3.3872E-02
      14028.00c 3.0963E-01 14029.00c 1.6284E-02 14030.00c 1.1104E-02
      19039.00c 1.2082E-02 19040.00c 1.5210E-06 19041.00c 9.1663E-04
      20040.00c 4.2531E-02 20042.00c 2.9804E-04 20043.00c 6.3670E-05
      20044.00c 1.0066E-03 20046.00c 2.0180E-06 20048.00c 9.8446E-05
      26054.00c 7.9038E-04 26056.00c 1.2866E-02 26057.00c 3.0245E-04
      26058.00c 4.0956E-05
C
C *****
C * Air *
C *****
C
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    7014.00c -0.752308      7015.00c -0.002960      8016.00c -0.231687
      8017.00c -0.000094      6012.00c -1.2256E-04      6013.00c -1.4365E-06
      18036.00c -3.8862E-05 18038.00c -7.7038E-06 18040.00c -1.2780E-02
C
C -----
C ----- Source -----
C -----
C
C *****
C * KCODE *
C *****
C
KCODE 1e5 1 20 520 $ 1e5 1 20 520 for non production 1e6 1 20 10020 for production
KSRC 0 -3 9 0 3 9 0 -3 15.5 0 3 15.5 0 -3 1 0 3 1
mode n p

```

APPENDIX C. INPUT DECK FOR NEUTRON SPECTRUM ADJUSTMENT USING LSL-M3 CODE FOR SNL MCNP MODEL AT 6-INCH POSITION

```

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
WSMR 6-in all foil SNL
-----
t Final
-----
@actv
1.0e+0 (activities given in bq/nucleus)
wsmr6in_sn1
@end
@description
ag109g:sld void bare -1.4770E-19 0.018
ag109g:sld void cdna -1.2980E-19 0.019
al27a:sld void bare -1.4700E-18 0.034
co59g:sld void bare -2.4490E-20 0.033
co59p:sld void bahl -3.6730E-20 0.044
co592:sld void bahl -3.7520E-21 0.095
cu63g:sld void bare -7.4980E-17 0.101
fe56p:sld void bahl -1.0830E-17 0.042
in115g:sld void bare -1.1540E-14 0.022
in115n:sld void bare -1.3570E-15 0.092
mg24p:sld void bahl -2.8766E-18 0.049
mn55g:sld void bare -1.6170E-16 0.039
mo98g:sld void baep -2.3590E-17 0.028
mo98g:sld void cdna -2.3290E-17 0.025
na23g:sld pelt bare -1.6780E-18 0.045
na23g:sld pelt cdep -1.4760E-18 0.047
nb932:sld void baep -5.9710E-20 0.045
ni58p:sld void bare -1.9087E-18 0.044 *
np237f:sld void fiiss -2.5610E-10 0.030
rmldu:sld void fiiss -4.7620E-11 0.031
rmlleu:sld void bare -3.1810E-10 0.031
rmlpu:sld void bare -3.4400E-10 0.113
ti46p:sld void bare -1.7600E-19 0.062
ti47p:sld void bare -7.5730E-18 0.060
ti48p:sld void bare -2.1820E-19 0.027
w186g:sld void bare -1.5860E-16 0.023
w186g:sld void cdnm -1.4420E-16 0.023
zn64p:sld void bahl -8.6240E-17 0.060
@end
@posit
0.02
@end
@actcov
@end
@outgrd
= nug89
@end
@trlgrd
= ref640
@end
@calf
group fluences
89 1
1.00
@end
@hsty
1,3600
dosimetry position
10 26 17 00 1.000000E+0 1
10 26 17 01 0.000000000 1
-1 26 17 01 0.000000000 1
@end
@cora
correction file not needed
end
@end
@refflx
ref640 wattlm
@end
@trflx
= wsmr6in_sn1.drr
@end
@covf
wsmr_nsva
@end

```

APPENDIX D. INPUT DECK FOR NEUTRON SPECTRUM ADJUSTMENT USING LSL-M3 CODE FOR LANL MCNP MODEL AT 6-INCH POSITION

```

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
WSMR 6 in all foil LANL
-----
t Final
-----
@actv
1.0e+0 (activities given in bq/nucleus)
wsmr6in_lanl
@end
@description
ag109g:sld void bare -1.4770E-19 0.018
ag109g:sld void cdna -1.2980E-19 0.019
al27a:sld void bare -1.4700E-18 0.034
co59g:sld void bare -2.4490E-20 0.033
co59p:sld void bahl -3.6730E-20 0.044
co592:sld void bahl -3.7520E-21 0.095
cu63g:sld void bare -7.4980E-17 0.101
fe56p:sld void bahl -1.0830E-17 0.042
in115g:sld void bare -1.1540E-14 0.022
in115n:sld void bare -1.3570E-15 0.092
mg24p:sld void bahl -2.8766E-18 0.049
mn55g:sld void bare -1.6170E-16 0.039
mo98g:sld void baep -2.3590E-17 0.028
mo98g:sld void cdna -2.3290E-17 0.025
na23g:sld pelt bare -1.6780E-18 0.045
na23g:sld pelt cdep -1.4760E-18 0.047
nb932:sld void baep -5.9710E-20 0.045
ni58p:sld void bare -1.9087E-18 0.044 *
np237f:sld void fiiss -2.5610E-10 0.030
rmldu:sld void fiiss -4.7620E-11 0.031
rmlleu:sld void bare -3.1810E-10 0.031
rmlpu:sld void bare -3.4400E-10 0.113
ti46p:sld void bare -1.7600E-19 0.062
ti47p:sld void bare -7.5730E-18 0.060
ti48p:sld void bare -2.1820E-19 0.027
w186g:sld void bare -1.5860E-16 0.023
w186g:sld void cdnm -1.4420E-16 0.023
zn64p:sld void bahl -8.6240E-17 0.060
@end
@posit
0.02
@end
@actcov
@end
@outgrd
= nug89
@end
@trlgrd
= ref640
@end
@calf
group fluences
89 1
1.00
@end
@hsty
1,3600
dosimetry position
10 26 17 00 1.000000E+0 1
10 26 17 01 0.000000000 1
-1 26 17 01 0.000000000 1
@end
@cora
correction file not needed
end
@end
@refflx
ref640 wattlm
@end
@trflx
= wsmr6in_lanl.drr
@end
@covf
wsmr_nsva
@end

```

APPENDIX E. INPUT DECK FOR NEUTRON SPECTRUM ADJUSTMENT USING LSL-M3 CODE FOR LLNL MERCURY MODEL AT 6-INCH POSITION

```

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
WSMR 6 in all foil LLNL
-----
t Final
-----
@actv
1.0e+0 (activities given in bq/nucleus)
wsmr6in_llnl
@end
@description
ag109g:sld void bare -1.4770E-19 0.018
ag109g:sld void cdna -1.2980E-19 0.019
al27a:sld void bare -1.4700E-18 0.034
co59g:sld void bare -2.4490E-20 0.033
co59p:sld void bahl -3.6730E-20 0.044
co592:sld void bahl -3.7520E-21 0.095
cu63g:sld void bare -7.4980E-17 0.101
fe56p:sld void bahl -1.0830E-17 0.042
in115g:sld void bare -1.1540E-14 0.022
in115n:sld void bare -1.3570E-15 0.092
mg24p:sld void bahl -2.8766E-18 0.049
mn55g:sld void bare -1.6170E-16 0.039
mo98g:sld void baep -2.3590E-17 0.028
mo98g:sld void cdna -2.3290E-17 0.025
na23g:sld pelt bare -1.6780E-18 0.045
na23g:sld pelt cdep -1.4760E-18 0.047
nb932:sld void baep -5.9710E-20 0.045
ni58p:sld void bare -1.9087E-18 0.044 *
np237f:sld void fiiss -2.5610E-10 0.030
rmldu:sld void fiiss -4.7620E-11 0.031
rmlleu:sld void bare -3.1810E-10 0.031
rmlpu:sld void bare -3.4400E-10 0.113
ti46p:sld void bare -1.7600E-19 0.062
ti47p:sld void bare -7.5730E-18 0.060
ti48p:sld void bare -2.1820E-19 0.027
w186g:sld void bare -1.5860E-16 0.023
w186g:sld void cdnm -1.4420E-16 0.023
zn64p:sld void bahl -8.6240E-17 0.060
@end
@posit
0.02
@end
@actcov
@end
@outgrd
= nug89
@end
@trlgrd
= ref640
@end
@calf
group fluences
89 1
1.00
@end
@hsty
1,3600
dosimetry position
10 26 17 00 1.000000E+0 1
10 26 17 01 0.000000000 1
-1 26 17 01 0.000000000 1
@end
@cora
correction file not needed
end
@end
@refflx
ref640 wattlm
@end
@trlflx
= wsmr6in_llnl.drr
@end
@covf
wsmr_nsva
@end

```

APPENDIX F. SNL LSL-M3 FORMAT NEUTRON OUTPUT

```

*cor      (library)      (mat.#)      (temp)k
*number of energies plus 1
90
*energy grid ( 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
1.22401E-07 2.64496E-06 7.46986E-06 5.01998E-05 9.35559E-05 3.89763E-05 3.06061E-05 1.20935E-05
1.99901E-05 9.51593E-06 7.18264E-06 1.09428E-05 3.32682E-05 1.95295E-05 2.57886E-05 2.71271E-05
3.03360E-05 4.04077E-05 5.10657E-05 6.04555E-05 8.38815E-05 8.66828E-05 4.83129E-05 4.91502E-05
5.97022E-05 7.20917E-05 7.78836E-05 4.02710E-05 4.55813E-05 4.28648E-05 5.21522E-05 5.09133E-05
6.20769E-05 6.56083E-05 6.46064E-05 8.89558E-05 6.51166E-05 8.50374E-05 8.83250E-05 8.94261E-05
1.04829E-04 1.17113E-04 1.16691E-04 1.33923E-04 1.65923E-04 1.86788E-04 2.04289E-04 2.30185E-04
2.79046E-04 3.05496E-04 4.05738E-04 4.82235E-04 5.92392E-04 2.35275E-04 4.33085E-04 1.05508E-03
2.53474E-03 3.37640E-03 5.22302E-03 8.33144E-03 1.11413E-02 1.62199E-02 2.32753E-02 3.29616E-02
4.58092E-02 4.82832E-02 3.04580E-02 3.31929E-02 3.71316E-02 3.85034E-02 4.00792E-02 3.93329E-02
4.43803E-02 4.39344E-02 4.67254E-02 4.71006E-02 8.84418E-02 8.24509E-02 7.62092E-02 6.36409E-02
4.52102E-02 2.39780E-02 1.03122E-02 3.88705E-03 7.11506E-04 1.56425E-04 4.51177E-05 1.81884E-05
5.36112E-06

*% standard deviation
1.97404E+02 1.37237E+02 1.05796E+02 5.43880E+01 4.26317E+01 6.45245E+01 7.74670E+01 8.74507E+01
9.28937E+01 9.67223E+01 9.52723E+01 1.02210E+02 5.09154E+01 6.88096E+01 3.61014E+01 3.52917E+01
8.99681E+00 3.02561E+01 2.61188E+01 2.38797E+01 2.56671E+01 4.79919E+01 4.43874E+01 4.94391E+01
5.79062E+01 2.73728E+01 2.44784E+01 3.59451E+01 4.02269E+01 4.44092E+01 4.25134E+01 4.05653E+01
3.95403E+01 3.86121E+01 3.80865E+01 3.62956E+01 3.65101E+01 3.68335E+01 3.65323E+01 3.51550E+01
3.46272E+01 3.43933E+01 3.36461E+01 3.35651E+01 3.26950E+01 3.15527E+01 3.10724E+01 3.14345E+01
3.04065E+01 3.08646E+01 2.95404E+01 2.86068E+01 2.74197E+01 2.91676E+01 2.88257E+01 2.79026E+01
2.22992E+01 2.15416E+01 2.04672E+01 1.95237E+01 1.83596E+01 1.82188E+01 1.75752E+01 1.64239E+01
1.60348E+01 1.56199E+01 1.79445E+01 1.76737E+01 1.74717E+01 1.70606E+01 1.68318E+01 1.68921E+01
1.65408E+01 1.49767E+01 1.57155E+01 1.54290E+01 1.25183E+01 1.12661E+01 1.14710E+01 1.10329E+01
1.07659E+01 1.05443E+01 9.64010E+00 8.84408E+00 5.85858E+00 7.72373E+00 1.06001E+01 1.25901E+01
1.78382E+01

*correlation coefficient -- upper triangular
1.00000E+02 7.22452E+01 5.13994E+01 1.71438E+01 -2.67505E+01 -2.67311E+01 -2.32729E+01 -2.04436E+01
-1.71888E+01 -1.45200E+01 -1.34182E+01 -6.57711E+00 2.58348E+00 1.36232E+00 2.71265E+00 3.43367E-01
4.07863E+00 -1.92060E-01 -2.31878E-01 -6.03012E-01 -9.76570E+00 -6.23754E+00 -7.96242E+00 -5.94582E+00
-3.49032E+00 -6.33548E-01 -1.93499E-01 -4.74709E-01 -5.10354E-01 -2.27595E-01 -1.07639E-01 -1.93468E-01
-2.81510E-01 -3.65502E-01 -6.44684E-01 -8.07613E-01 -5.22382E-01 -2.45857E-01 -1.51067E-01 -1.43270E-01
-1.39913E-01 -1.40103E-01 -1.35040E-01 -1.34181E-01 -2.26006E-01 -2.12939E-01 -2.06012E-01 -1.09855E-01
-1.98591E-01 -2.05466E-01 -1.88117E-01 -1.74309E-01 -2.55018E-01 -1.81938E-01 -1.76948E-01 -2.59276E-01
-4.36200E-01 -3.30975E-01 -5.09458E-01 -5.09879E-01 -5.88550E-01 -8.93789E-01 -1.02999E+00 -1.33030E+00
-1.49744E+00 -1.31649E+00 -9.61002E-01 -8.44158E-01 -4.95925E-01 -2.25324E-01 -6.62448E-02 5.39140E-02
-4.87984E-02 -7.81751E-02 1.22280E-01 4.10991E-01 9.20598E-01 1.21947E+00 1.18812E+00 1.22124E+00
1.37654E+00 1.44625E+00 1.69196E+00 1.67486E+00 2.78404E+00 1.94518E+00 1.30545E+00 8.53471E-01
6.08992E-01
1.00000E+02 8.04686E+01 2.89605E+01 -3.81133E+01 -3.96072E+01 -3.45239E+01 -3.01347E+01 -2.59039E+01
-2.18541E+01 -2.00534E+01 -9.94963E+00 3.39049E+00 1.94922E+00 4.21433E+00 4.94804E-01 6.33773E+00
-4.46607E-01 -5.49848E-01 -1.00085E+00 -1.50299E+01 -9.66467E+00 -1.22972E+01 -9.13151E+00 -5.45885E+00
-1.05471E+00 -3.89288E-01 -7.75628E-01 -8.32747E-01 -4.62487E-01 -3.31848E-01 -3.09132E-01 -4.90498E-01
-6.66044E-01 -1.03490E+00 -1.27854E+00 -8.00726E-01 -4.35434E-01 -2.42688E-01 -2.29361E-01 -2.23677E-01
-2.23572E-01 -3.15091E-01 -3.13715E-01 -4.00235E-01 -3.79254E-01 -3.68316E-01 -2.74747E-01 -3.56260E-01
3.67119E-01 -4.39458E-01 -4.17430E-01 -3.86291E-01 -4.29709E-01 -4.21737E-01 -4.93810E-01 -6.98435E-01
-6.88679E-01 -8.52528E-01 -8.49104E-01 -1.01297E+00 -1.41913E+00 -1.66956E+00 -2.16496E+00 -2.25698E+00
-1.98209E+00 -1.56344E+00 -1.23320E+00 -8.65973E-01 -4.60565E-01 -7.02884E-02 5.77164E-02 -1.44820E-01
-2.81636E-02 2.66404E-01 6.96490E-01 1.47196E+00 1.87673E+00 1.82836E+00 1.88283E+00 2.16579E+00
2.36687E+00 2.59897E+00 2.53848E+00 4.44671E+00 2.96181E+00 2.01175E+00 1.31924E+00 8.76757E-01
1.00000E+02 4.74405E+01 -4.16060E+01 -4.67127E+01 -4.11870E+01 -3.68276E+01 -3.11240E+01 -2.64916E+01
-2.45913E+01 -1.27255E+01 2.78575E+00 2.22115E+00 5.68070E+00 6.18135E-01 8.30657E+00 -6.31780E-01
-7.02977E-01 -1.33677E+00 -2.01089E+01 -1.28998E+01 -1.62373E+01 -1.21266E+01 -7.23867E+00 -1.50944E+00
-5.23120E-01 -1.00187E+00 -1.07766E+00 -6.18141E-01 -4.77915E-01 -5.47675E-01 -6.23047E-01 -8.90609E-01
-1.34944E+00 -1.67508E+00 -1.10456E+00 -6.50365E-01 -4.59897E-01 -4.42061E-01 -4.34462E-01 -4.34241E-01
-5.22772E-01 -5.20948E-01 -5.02917E-01 -4.75064E-01 -4.60592E-01 -4.69284E-01 -5.44568E-01 -5.58936E-01
6.22079E-01 -5.92883E-01 -6.51721E-01 -6.09184E-01 -5.98614E-01 -6.61564E-01 -1.00246E+00 -9.89095E-01
-1.14041E+00 -1.23553E+00 -1.38634E+00 -1.99442E+00 -2.25852E+00 -2.84914E+00 -2.96828E+00 -2.60038E+00
-2.00943E+00 -1.67263E+00 -1.08248E+00 -5.45200E-01 -2.79926E-02 1.07588E-01 -2.96941E-01 -1.42450E-01
3.50561E-01 9.19858E-01 1.94508E+00 2.54401E+00 2.38245E+00 2.45503E+00 2.86290E+00 3.09595E+00
3.49833E+00 3.29018E+00 5.84898E+00 3.94490E+00 2.62467E+00 1.70703E+00 1.18891E+00
1.00000E-02 -7.57428E-06 -4.79230E+01 -4.78023E+01 -4.39478E+01 -3.92229E+01 -3.38685E+01 -3.17767E+01
-1.85819E+01 -4.39331E+00 2.18302E+00 1.12497E+01 9.34249E-01 1.53222E+01 -1.25873E+00 -1.61491E+00
-2.78429E+00 -3.96211E+01 -2.52685E+01 -3.14990E+01 -2.35398E+01 -1.40306E+01 -3.01358E+00 -1.26631E+00
-2.07510E+00 -2.31566E+00 -1.39664E+00 -1.02275E+00 -1.16483E+00 -1.41593E+00 -1.85060E+00 -2.86297E+00
-3.51502E+00 -2.38088E+00 -1.37779E+00 -9.99713E-01 -9.67260E-01 -9.53394E-01 -9.53377E-01 -1.13097E+00
-1.22682E+00 -1.19341E+00 -1.14156E+00 -1.11443E+00 -1.13055E+00 -1.18400E+00 -1.21094E+00 -1.34084E+00
-1.38569E+00 -1.40799E+00 -1.31665E+00 -1.39627E+00 -1.52514E+00 -2.13189E+00 -2.10928E+00 -2.51655E+00

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-2.61118E+00	-2.91970E+00	-3.92733E+00	-4.45306E+00	-5.43163E+00	-5.76680E+00	-4.93419E+00	-3.84273E+00
-3.17688E+00	-2.11182E+00	-1.15487E+00	-2.35019E+01	3.33804E-02	-6.71776E-01	-2.83042E-01	7.02245E-01
1.82225E+00	3.89755E+00	5.04806E+00	4.63643E+00	4.67329E+00	5.27952E+00	5.73354E+00	6.50258E+00
6.06201E+00	1.11311E+01	7.21302E+00	4.80144E+00	3.03010E+00	2.07794E+00		
1.00000E+02	5.01149E+01	2.46396E+01	1.57322E+01	8.74367E+00	4.82855E+00	2.68202E+00	-4.36826E+00
-2.30135E+01	-1.16820E+00	1.41184E+01	9.16700E-01	1.66351E+01	-1.62699E+00	-2.05015E+00	-3.60064E+00
-4.86901E+01	-3.06308E+01	-3.80454E+01	-2.83223E+01	-1.70117E+01	-3.82813E+00	-1.67945E+00	-2.59091E+00
-2.84894E+00	-1.74065E+00	-1.35424E+00	-1.48793E+00	-1.82816E+00	-2.44544E+00	-3.63135E+00	-4.54618E+00
-3.13546E+00	-1.96229E+00	-1.39537E+00	-1.36158E+00	-1.34696E+00	-1.34833E+00	-1.52384E+00	-1.61878E+00
-1.68059E+00	-1.62232E+00	-1.59119E+00	-1.51031E+00	-1.55827E+00	-1.58916E+00	-1.80835E+00	-1.84556E+00
-1.95580E+00	-1.87945E+00	-1.85719E+00	-2.07295E+00	-2.90136E+00	-2.78446E+00	-3.28061E+00	-3.38923E+00
-3.79252E+00	-4.99924E+00	-5.46809E+00	-6.65888E+00	-6.85855E+00	-5.75548E+00	-4.48155E+00	-3.70806E+00
-2.51137E+00	-1.50166E+00	-5.33550E-01	-2.46495E-01	-1.05720E+00	-4.32383E-01	8.63207E-01	2.25514E+00
4.73758E+00	6.12510E+00	5.79059E+00	5.55012E+00	6.10100E+00	6.51661E+00	7.57158E+00	6.96735E+00
1.28874E+01	8.29180E+00	5.45082E+00	3.32193E+00	2.26133E+00			
1.00000E+02	7.81867E+01	6.16819E+01	4.78516E+01	3.82891E+01	3.32369E+01	1.16075E+01	-2.42185E+01
-2.80908E+00	9.27515E+00	5.13877E-01	9.26410E+00	-1.01411E+00	-1.25585E+00	-2.28073E+00	-2.98508E+01
-1.87202E+01	-2.29750E+01	-1.71422E+01	-1.02942E+01	-2.34558E+00	-1.05199E+00	-1.63732E+00	-1.73094E+00
-1.07512E+00	-8.20295E-01	-9.81798E-01	-1.14745E+00	-1.59914E+00	-2.33313E+00	-2.92263E+00	-2.07163E+00
-1.24701E+00	-8.66214E-01	-8.48057E-01	-8.40083E-01	-8.41735E-01	-1.02899E+00	-1.02675E+00	-1.00540E+00
-1.07093E+00	-1.05230E+00	-9.63000E-01	-1.03331E+00	-1.05180E+00	-1.20585E+00	-1.16945E+00	-1.21731E+00
-1.18921E+00	-1.27586E+00	-1.32672E+00	-1.99257E+00	-1.88690E+00	-2.13118E+00	-2.14577E+00	-2.39669E+00
-3.20965E+00	-3.42767E+00	-4.14035E+00	-4.34123E+00	-3.49859E+00	-2.71343E+00	-2.26551E+00	-1.63677E+00
-9.33777E-01	-4.59087E-01	-3.00191E-01	-8.16372E-01	-4.24504E-01	4.92438E-01	1.35101E+00	3.00881E+00
3.95845E+00	3.67681E+00	3.56526E+00	3.63029E+00	3.93077E+00	4.53342E+00	4.24611E+00	7.79428E+00
4.99276E+00	3.31547E+00	2.02281E+00	1.38812E+00				
1.00000E+02	8.84707E+01	7.02672E+01	5.72234E+01	5.07663E+01	2.07686E+01	-2.47784E+01	-3.40938E+00
7.66710E+00	3.69372E-01	6.67544E+00	-7.46534E-01	-1.02272E+00	-1.76673E+00	-2.29695E+01	-1.43059E+01
-1.75571E+01	-1.29757E+01	-7.74024E+00	-1.81373E+00	-8.39728E-01	-1.22559E+00	-1.29940E+00	-8.31677E-01
-6.86993E-01	-7.57025E-01	-9.29582E-01	-1.19137E+00	-1.83820E+00	-2.24966E+00	-1.58846E+00	-9.49135E-01
-6.64669E-01	-6.51046E-01	-6.45016E-01	-6.46654E-01	-7.37363E-01	-8.35448E-01	-8.18795E-01	-7.91908E-01
-7.77088E-01	-7.85231E-01	-7.62262E-01	-7.76959E-01	-9.41031E-01	-9.12279E-01	-9.71165E-01	-9.27797E-01
-1.01740E+00	-1.07828E+00	-1.51443E+00	-1.51164E+00	-1.66891E+00	-1.68390E+00	-1.94814E+00	-2.56012E+00
-2.76055E+00	-3.37735E+00	-3.44243E+00	-2.79146E+00	-2.17693E+00	-1.83844E+00	-1.33205E+00	-8.66883E-01
-4.21254E-01	-3.72898E-01	-6.87337E-01	-3.35393E-01	-2.82155E-01	1.09758E+00	2.39141E+00	3.23555E+00
3.06825E+00	2.83942E+00	2.97148E+00	3.13783E+00	3.65935E+00	3.42201E+00	6.18856E+00	4.01952E+00
2.64132E+00	1.58503E+00	1.14018E+00					
1.00000E+02	8.40815E+01	6.88469E+01	6.14868E+01	2.65014E+01	-2.46171E+01	-3.61834E+00	6.84016E+00
3.41386E-01	5.30113E+00	-5.64682E-01	-8.58300E-01	-1.41103E+00	-1.89467E+01	-1.17359E+01	-1.43817E+01
-1.06339E+01	-6.31038E+00	-1.45013E+00	-6.86208E-01	-1.02043E+00	-1.08411E+00	-6.11088E-01	-5.71903E-01
-6.46078E-01	-7.22428E-01	-9.89148E-01	-1.54292E+00	-1.86589E+00	-1.29947E+00	-8.52161E-01	-5.65875E-01
-5.54419E-01	-5.49324E-01	-5.50885E-01	-6.43095E-01	-6.41571E-01	-6.27260E-01	-7.04053E-01	-6.91216E-01
-5.98233E-01	-6.78491E-01	-6.91223E-01	-7.60384E-01	-7.35542E-01	-8.00078E-01	-7.48906E-01	-8.40014E-01
-9.06117E-01	-1.37827E+00	-1.27648E+00	-1.44021E+00	-1.45467E+00	-1.62433E+00	-2.13524E+00	-2.32646E+00
-2.84075E+00	-2.98895E+00	-2.43299E+00	-1.90451E+00	-1.56973E+00	-1.17713E+00	-7.30848E-01	-4.03441E-01
-3.60491E-01	-6.74793E-01	-3.43411E-01	1.74055E-01	8.64789E-01	2.07139E+00	2.85890E+00	2.70047E+00
2.46194E+00	2.57759E+00	2.72382E+00	3.10671E+00	2.94261E+00	5.35378E+00	3.55758E+00	2.33693E+00
1.45257E+00	1.00783E+00						
1.00000E+02	9.02420E+01	8.11836E+01	3.73329E+01	-2.53030E+01	-4.08492E+00	6.20742E+00	3.45670E-01
4.02140E+00	-4.61755E-01	-5.69848E-01	-1.13102E+00	-1.51396E+01	-9.37041E+00	-1.13112E+01	-8.28447E+00
-4.86596E+00	-1.06014E+00	-5.06222E-01	-8.00001E-01	-7.55278E-01	-4.76757E-01	-3.41633E-01	-4.91575E-01
-5.97885E-01	-7.67836E-01	-1.22548E+00	-1.55544E+00	-1.08619E+00	-6.35023E-01	-4.47969E-01	-4.38865E-01
-4.34747E-01	-4.36510E-01	-4.30245E-01	-5.28916E-01	-5.16701E-01	-4.96634E-01	-4.85331E-01	-4.91338E-01
-4.76447E-01	-4.85653E-01	-5.58957E-01	-6.37419E-01	-6.06392E-01	-6.48936E-01	-6.41173E-01	-7.11184E-01
-1.11134E+00	-1.01177E+00	-1.18138E+00	-1.19799E+00	-1.37424E+00	-1.88556E+00	-1.97009E+00	-2.49085E+00
-2.52721E+00	-2.17509E+00	-1.73247E+00	-1.40045E+00	-1.01419E+00	-6.81050E-01	-3.62569E-01	-3.22053E-01
-6.37724E-01	-4.25576E-01	-4.86486E-03	6.73725E-01	1.72170E+00	2.57108E+00	2.51678E+00	2.26945E+00
2.27647E+00	2.41098E+00	2.76272E+00	2.67275E+00	4.70096E+00	3.13434E+00	2.12781E+00	1.29700E+00
9.28141E-01							
1.00000E+02	9.36263E+01	4.79787E+01	-2.42770E+01	-4.53263E+00	5.81077E+00	3.72844E-01	3.19169E+00
-2.37067E-01	-4.56661E-01	-8.24097E-01	-1.18280E+01	-7.29695E+00	-8.73350E+00	-6.32301E+00	-3.60823E+00
-7.45092E-01	-2.99242E-01	-5.61980E-01	-6.10727E-01	-3.27855E-01	-2.95567E-01	-3.75710E-01	-4.56386E-01
-6.28558E-01	-8.89038E-01	-1.22413E+00	-8.52877E-01	-4.98912E-01	-3.11560E-01	-3.04365E-01	-3.01037E-01
-3.03002E-01	-2.97917E-01	-3.96777E-01	-3.86210E-01	-3.68577E-01	-3.58459E-01	-3.63682E-01	-3.49038E-01
-3.59067E-01	-4.35615E-01	-4.16471E-01	-4.89055E-01	-5.26671E-01	-5.19822E-01	-5.92798E-01	-9.14423E-01
-8.16815E-01	-9.91153E-01	-1.00998E+00	-1.09060E+00	-1.60225E+00	-1.68468E+00	-2.10728E+00	-2.24030E+00
-1.88654E+00	-1.53390E+00	-1.30678E+00	-1.02741E+00	-7.01515E-01	-3.88909E-01	-3.49790E-01	-6.66924E-01
-4.68511E-01	-1.45201E-01	5.25192E-01	1.52909E+00	2.35104E+00	2.39939E+00	2.14508E+00	2.04625E+00
2.17249E+00	2.50073E+00	2.39253E+00	4.27175E+00	2.81118E+00	1.89350E+00	1.20093E+00	8.90291E-01
1.00000E+02	6.51203E+01	-2.16833E+01	-5.81310E+00	6.41741E+00	3.84061E-01	3.24674E+00	-2.27303E-01
-3.45268E-01	-6.11492E-01	-8.85491E+00	-5.38514E+00	-6.31526E+00	-4.41534E+00	-2.50438E+00	-5.33770E-01
-2.87076E-01	-4.54203E-01	-4.03826E-01	-2.21435E-01	-1.88642E-01	-2.68424E-01	-3.48797E-01	-4.20671E-01
-6.80693E-01	-9.15251E-01	-6.44020E-01	-3.90429E-01	-3.03137E-01	-2.95792E-01	-2.92396E-01	-2.94384E-01
-2.89196E-01	-2.88011E-01	-2.77232E-01	-3.59324E-01	-3.49036E-01	-3.54355E-01	-3.39447E-01	-3.49648E-01
-4.25773E-01	-4.06299E-01	-4.78401E-01	-4.16562E-01	-5.09702E-01	-5.82215E-01	-8.00588E-01	-8.03110E-01
-8.76473E-01	-9.95849E-01	-1.07598E+00	-1.48655E+00	-1.56930E+00	-1.99114E+00	-2.12492E+00	-1.87500E+00
-1.52390E+00	-1.29643E+00	-1.01598E+00	-7.90444E-01	-4.75802E-01	-4.35902E-01	-7.53344E-01	-6.55512E-01
-3.31074E-01	3.43340E-01	1.45734E+00	2.48176E+00	2.62756E+00	2.27609E+00	2.08061E+00	2.11198E+00
2.54089E+00	2.53104E+00	4.24731E+00	2.85987E+00	1.92856E+00	1.32820E+00	9.10322E-01	
1.00000E+02	-6.71322E+00	-8.00149E+00	6.40576E+00	5.30824E-01	2.77371E+00	2.11154E-01	6.86403E-02
1.89096E-01	2.16186E+00	1.47159E+00	2.36040E+00	2.21055E+00	1.60727E+00	4.85236E-01	1.13344E-01
2.12611E-01	2.77052E-01	1.68833E-01	9.55813E-02	1.10204E-01	1.25995E-01	1.49648E-01	3.84279E-01
4.38551E-01	3.14026E-01	7.31931E-02	6.08314E-02	6.38772E-02	6.55031E-02	6.29991E-02	6.55479E-02
6.63926E-02	-2.65217E-02	-1.38210E-02	-6.04053E-03	-9.65876E-03	3.62953E-04	-7.34200E-03	-9.04360E-02
-7.63124E-02	-1.55918E-01	-1.83623E-01	-1.78607E-01	-1.57173E-01	-2.20839E-01	-3.28396E-01	-3.11511E-01
-5.37100E-01	-6.29273E-01	-5.34960E-01	-8.16644E-01	-8.38335E-01	-1.16448E+00	-1.22212E+00	-1.04840E+00
-1.13401E+00	-9.64344E-01	-7.53047E-01	-6.53167E-01	-6.15213E-01	-8.34923E-01	-1.07310E+00	-9.40079E-01
-2.78216E-01	7.49842E-01	2.21276E+00	2.56471E+00	2.19813E+00	1.59412E+00	1.60948E+00	1.89341E+00

1.93897E+00	3.25309E+00	2.27308E+00	1.62886E+00	1.21208E+00	8.18470E-01		
1.00000E+02	1.56824E+01	7.57104E-01	-1.93478E+00	9.88836E+00	1.17986E+00	7.74944E-01	2.00152E+00
3.54880E+01	2.24862E+01	2.94017E+01	2.35990E+01	1.52798E+01	3.60590E+00	1.05318E+00	1.70332E+00
1.94322E+00	1.13856E+00	8.88753E-01	9.13247E-01	1.34055E+00	2.08208E+00	3.84082E+00	5.33278E+00
3.59568E+00	1.62565E+00	8.03556E-01	6.05974E-01	6.07438E-01	6.01656E-01	6.04095E-01	6.05484E-01
6.16563E-01	5.37606E-01	4.51327E-01	3.45870E-01	3.61416E-01	3.48074E-01	3.76132E-01	2.99945E-01
2.34947E-01	1.88645E-01	1.96985E-01	2.34946E-01	9.69991E-01	3.50936E-01	2.75432E-01	-7.84099E-01
-6.78340E-01	7.18011E-01	-1.45044E-01	7.21973E-01	-2.22228E-01	-1.88375E+00	-1.71428E+00	-2.29837E+00
-2.47398E+00	-2.25983E+00	-1.95924E+00	-1.98237E+00	-2.32570E+00	-3.23511E+00	-3.25513E+00	-1.82998E+00
5.68539E-01	4.72615E+00	6.11976E+00	4.98510E+00	3.08546E+00	2.33403E+00	3.25073E+00	3.58988E+00
5.42156E+00	3.99582E+00	2.85653E+00	2.28347E+00	1.59688E+00			
1.00000E+02	-2.41004E+01	-1.04899E+01	1.05541E+01	-3.04542E-01	-6.58644E-01	-4.89462E-01	3.98856E+00
2.79147E+00	4.29100E+00	4.08637E+00	2.99833E+00	7.43518E-01	3.67234E-02	8.70905E-02	9.99891E-02
-3.84001E-02	1.30167E-02	4.77314E-02	1.78249E-01	5.19310E-01	1.07289E+00	1.56597E+00	1.03035E+00
4.69027E-01	1.54361E-01	7.14790E-02	-2.08513E-02	-1.22093E-01	-1.10994E-01	-1.08921E-01	-1.88963E-01
-2.57197E-01	-2.40000E-01	-2.49601E-01	-3.22273E-01	-3.39333E-01	-3.97224E-01	-4.63454E-01	-6.15270E-01
-5.81522E-01	-5.69430E-01	-6.24137E-01	-6.17170E-01	-1.01102E+00	-1.35971E+00	-2.17657E+00	-2.43317E+00
-2.23847E+00	-3.25710E+00	-3.36070E+00	-4.16254E+00	-4.45282E+00	-3.54082E+00	-3.30072E+00	-2.77857E+00
-1.87946E+00	-1.10713E+00	-6.46690E-01	-6.57245E-01	3.30028E-01	1.14386E+00	1.98049E+00	3.36769E+00
4.46412E+00	4.19032E+00	3.77885E+00	3.43994E+00	3.43608E+00	4.00969E+00	4.18515E+00	6.98309E+00
4.77596E+00	3.31375E+00	2.27325E+00	1.61429E+00				
1.00000E+02	1.87552E+01	2.82529E+01	-2.50028E+00	-3.61979E+00	-3.86717E+00	-1.22235E+01	-6.71460E+00
-6.69283E+00	-3.38849E+00	-1.19790E+00	-9.28872E-01	-1.59560E+00	-1.69911E+00	-1.66662E+00	-1.42434E+00
-1.29335E+00	-1.09339E+00	-8.18742E-01	-3.28271E-01	5.70092E-01	1.57381E+00	8.13463E-01	-1.93575E-01
-8.01719E-01	-1.02816E+00	-1.09790E+00	-1.28977E+00	-1.44324E+00	-1.53450E+00	-1.56924E+00	-1.76636E+00
-1.81532E+00	-1.84541E+00	-1.95469E+00	-2.10053E+00	-2.26705E+00	-2.46052E+00	-2.71129E+00	-2.61424E+00
-2.67581E+00	-2.94290E+00	-3.24051E+00	-4.45428E+00	-5.35830E+00	-7.38358E+00	-8.28760E+00	-8.48846E+00
-1.09430E+01	-1.19514E+01	-1.37272E+01	-1.36722E+01	-1.04834E+01	-9.48774E+00	-7.53807E+00	-4.83152E+00
-2.29814E+00	-7.10256E-01	-5.93673E-01	3.51756E+00	6.28912E+00	8.42630E+00	1.13596E+01	1.15378E+01
9.61658E+00	9.10966E+00	9.47072E+00	9.80116E+00	1.12841E+01	1.09802E+01	1.95631E+01	1.28299E+01
8.50690E+00	5.43344E+00	3.71183E+00					
1.00000E+02	1.76315E+00	1.94436E+00	2.14944E+00	2.40006E+00	-2.74360E-01	-4.66099E-01	-3.77088E-01
6.47054E-02	3.55437E-01	2.24682E+00	2.59787E+00	1.72459E+00	1.51424E+00	1.36365E+00	1.40895E+00
1.51557E+00	1.64063E+00	1.68916E+00	1.77730E+00	1.89200E+00	1.82655E+00	1.71739E+00	1.77535E+00
1.75126E+00	1.84253E+00	1.82950E+00	1.81710E+00	1.81729E+00	1.91347E+00	1.91582E+00	1.92292E+00
1.92390E+00	1.91972E+00	1.91277E+00	1.91709E+00	2.02363E+00	2.03609E+00	1.82370E+00	1.82561E+00
1.85117E+00	2.26472E+00	2.10040E+00	1.97717E+00	1.64600E+00	1.48066E+00	9.46338E-01	7.29939E-02
-5.00677E-01	-1.68587E+00	-1.88558E+00	-1.85138E+00	-1.93056E+00	-1.66288E+00	-1.19853E+00	-6.42559E-01
-1.27822E-01	1.99543E+01	-5.01624E-01	-1.04553E+00	-5.53299E-01	2.88550E-01	1.61383E+00	2.13021E+00
2.19128E+00	1.96973E+00	1.94027E+00	2.10448E+00	2.42325E+00	2.95956E+00	2.77003E+00	2.31619E+00
2.46565E+00	1.77650E+00						
1.00000E+02	-2.71673E+00	-6.96656E-01	-8.33489E-01	-1.31446E+01	-2.20478E+01	-1.42206E+01	-8.11605E+00
-6.67597E+00	-5.08696E+00	-1.36529E+00	-2.08780E+00	-1.72753E+00	-1.17430E+00	-1.26942E+00	-9.04666E-01
-5.86583E-01	1.67968E-01	1.32199E+00	2.30186E+00	1.25294E+00	-2.36550E-01	-7.34327E-01	-9.29898E-01
-1.10750E+00	-1.23297E+00	-1.23864E+00	-1.14642E+00	-1.28019E+00	-1.54103E+00	-1.65184E+00	-1.67313E+00
-1.78982E+00	-1.76472E+00	-1.90802E+00	-1.97961E+00	-2.25922E+00	-2.28453E+00	-2.33574E+00	-2.58643E+00
-2.55240E+00	-3.92894E+00	-5.25416E+00	-8.26295E+00	-9.73136E+00	-8.17070E+00	-7.66502E+00	-7.03681E+00
-8.78346E+00	-1.04716E+01	-9.11968E+00	-9.23475E+00	-8.34818E+00	-6.49922E+00	-4.90308E+00	-4.47365E+00
-5.15207E+00	-2.75196E+00	3.36238E-01	4.39333E+00	1.01472E+01	1.32805E+01	1.28899E+01	1.32410E+01
1.39028E+01	1.43135E+01	1.62113E+01	1.53953E+01	2.71061E+01	1.83242E+01	1.24473E+01	8.51062E+00
5.79785E+00							
1.00000E+02	6.10338E+00	4.06069E+00	1.53693E+00	3.79487E-01	4.17304E-01	4.87669E-01	6.01901E-01
3.33278E+00	4.09203E+00	2.65622E+00	2.40471E+00	2.20945E+00	2.24073E+00	2.32521E+00	2.34096E+00
2.38431E+00	2.27822E+00	2.18339E+00	2.31133E+00	2.49093E+00	2.63863E+00	2.68867E+00	2.77008E+00
2.85140E+00	2.92405E+00	2.92278E+00	3.00237E+00	3.08242E+00	3.08034E+00	3.08922E+00	3.16249E+00
3.06415E+00	3.23993E+00	3.32500E+00	3.40837E+00	3.13790E+00	3.23220E+00	3.23754E+00	3.88426E+00
3.98092E+00	4.00634E+00	3.91476E+00	3.88012E+00	3.22994E+00	2.59342E+00	1.82358E+00	6.77093E-01
5.34469E-01	-9.58826E-02	-3.95912E-01	-4.31156E-01	-3.73191E-01	-1.07179E-01	1.22517E-01	6.20214E-01
-1.54409E+00	-2.81594E+00	-2.68563E+00	-2.13035E+00	-5.92579E-01	5.39046E-01	8.16978E-01	3.76113E-01
2.49136E-01	7.43131E-02	7.51988E-01	-8.08666E-01	7.22182E-01	1.09446E+00	1.99106E+00	1.53647E+00
1.00000E+02	7.24433E+00	1.72362E+00	5.59283E-01	6.71577E-01	7.47904E-01	8.44357E-01	3.93855E+00
4.77352E+00	3.15529E+00	2.81278E+00	2.53505E+00	2.67108E+00	2.75236E+00	2.77014E+00	2.81990E+00
2.62782E+00	2.64885E+00	2.76573E+00	2.92675E+00	3.06613E+00	3.20811E+00	3.28633E+00	3.36460E+00
3.43253E+00	3.43101E+00	3.50685E+00	3.58300E+00	3.68089E+00	3.59078E+00	3.75978E+00	3.66202E+00
3.83300E+00	3.91496E+00	3.99466E+00	3.73032E+00	3.72275E+00	3.82883E+00	4.56165E+00	4.74187E+00
4.75389E+00	4.63064E+00	4.67426E+00	3.81338E+00	3.12349E+00	2.20767E+00	8.89994E-01	7.08024E-01
-7.81404E-02	-3.77561E-01	-4.89928E-01	-3.91702E-01	-1.86765E-01	2.67574E-01	7.47221E-01	-1.74972E+00
-3.28703E+00	-3.19060E+00	-2.65753E+00	-7.55317E-01	5.68069E-01	8.25490E-01	4.06123E-01	2.21086E-01
-3.88124E-02	7.65666E-01	-1.04032E+00	8.45516E-01	1.22741E+00	2.40333E+00	1.77293E+00	
1.00000E+02	3.11086E+00	4.67981E-01	2.08057E+00	2.12663E+00	1.77789E+00	4.50966E+00	5.21946E+00
3.53708E+00	3.20647E+00	2.84441E+00	2.98152E+00	3.05851E+00	3.07641E+00	3.12935E+00	3.04663E+00
3.07553E+00	3.08492E+00	3.23398E+00	3.36745E+00	3.50171E+00	3.57699E+00	3.55213E+00	3.71640E+00
3.71457E+00	3.78636E+00	3.95860E+00	3.95442E+00	3.96682E+00	4.02974E+00	3.93325E+00	4.19916E+00
4.27692E+00	4.35124E+00	4.09509E+00	4.08584E+00	4.18988E+00	4.99677E+00	5.16242E+00	5.16060E+00
5.11266E+00	5.13434E+00	4.26671E+00	3.53699E+00	2.68719E+00	1.21843E+00	9.03433E-01	6.18833E-02
-2.39039E-01	-4.39167E-01	-4.19973E-01	-1.88969E-01	2.79946E-01	7.45392E-01	-1.88607E+00	-3.59647E+00
-3.45773E+00	-2.90389E+00	-9.74053E-01	3.50225E-01	6.86050E-01	1.77816E-01	1.60172E-02	-2.53894E-01
5.85136E-01	-1.59226E+00	5.46167E-01	1.09879E+00	2.39178E+00	1.82198E+00		
1.00000E+02	5.38505E+01	6.21369E+01	4.71979E+01	2.91337E+01	6.52708E+00	2.39829E+00	3.76796E+00
4.20635E+00	2.61700E+00	2.18321E+00	2.40617E+00	3.00344E+00	4.25078E+00	6.69969E+00	8.48546E+00
5.74629E+00	3.05414E+00	1.43761E+00	9.03618E-01	9.58307E-01	1.43824E+00	1.88157E+00	2.08159E+00
1.90729E+00	1.81779E+00	1.78641E+00	1.81876E+00	1.92897E+00	1.85747E+00	2.25661E+00	2.27612E+00
2.26950E+00	2.12640E+00	2.19798E+00	2.65131E+00	4.31854E+00	3.89894E+00	4.39147E+00	3.72198E+00
3.68700E+00	5.59169E+00	5.42903E+00	7.23946E+00	6.94182E+00	4.68544E+00	3.55484E+00	2.35410E+00
1.12953E+00	2.87390E-01	-4.06031E-01	-5.63304E-01	3.83169E-01	-3.23988E-01	-1.42946E+00	-2.17149E+00
-3.69802E+00	-4.64117E+00	-4.60466E+00	-4.84602E+00	-5.30414E+00	-5.30714E+00	-5.99371E+00	-5.81226E+00
-1.10224E+01	-6.78603E+00	-4.24784E+00	-2.27612E+00	-1.45628E+00			
1.00000E+02	6.48405E+01	3.02225E+01	1.63252E+01	3.02821E+00	6.84804E-01	-1.90443E+00	-2.58950E+00

-7.33891E-01	-3.82522E-02	3.20879E-01	4.12349E-01	5.22182E-01	1.88078E+00	4.12112E+00	3.07541E+00
1.49643E+00	6.49600E-01	2.82532E-01	2.57300E-01	2.39163E-01	1.00902E-01	9.79175E-02	6.05206E-02
2.15868E-01	4.01699E-01	4.18587E-01	4.69651E-01	3.84834E-01	2.23591E-01	2.81234E-01	3.25420E-01
3.10604E-01	3.95330E-01	6.67112E-01	1.46980E+00	1.05258E+00	1.03244E+00	3.30649E-01	4.50816E-01
1.84099E+00	1.78653E+00	3.27068E+00	3.20243E+00	1.86985E+00	1.65627E+00	1.01450E+00	3.69914E-01
-3.11676E-02	-3.07044E-01	-3.26047E-01	1.82125E-01	4.38666E-01	2.68125E-01	-1.35375E-01	-1.09193E+00
-2.09972E+00	-2.47762E+00	-2.65661E+00	-2.72766E+00	-2.71792E+00	-3.01233E+00	-3.05321E+00	-5.52232E+00
-3.54299E+00	-2.25876E+00	-1.33245E+00	-8.97927E-01				
1.00000E+02	5.60794E+01	2.98969E+01	4.97909E+00	3.81505E-01	-5.59363E+00	-7.37549E+00	-2.66841E+00
-8.62560E-01	-4.07427E-01	-5.19657E-01	-8.13642E-01	6.52364E-01	4.30879E+00	3.46030E+00	1.67209E+00
7.19346E-01	3.44682E-01	1.14474E-01	-6.60831E-03	-4.52647E-01	-7.59390E-01	-7.00246E-01	-1.45794E-01
1.39349E-01	1.58289E-01	2.03483E-01	1.20691E-01	-3.51903E-01	-2.99683E-01	-1.61496E-01	-1.65426E-01
1.86076E-02	3.87539E-01	1.15072E+00	6.19013E-01	3.81218E-01	-8.52786E-01	-3.47283E-01	1.55189E+00
1.26527E+00	3.44403E+00	3.45548E+00	1.78934E+00	1.72770E+00	9.77883E-01	2.33831E-01	-2.64244E-01
-6.33497E-01	-5.42505E-01	2.63893E-01	1.21159E+00	1.16342E+00	6.63987E-01	-5.46559E-01	-2.17815E+00
-2.94851E+00	-3.14838E+00	-3.12192E+00	-3.10702E+00	-3.43341E+00	-3.53299E+00	-6.22328E+00	-4.08347E+00
-2.65671E+00	-1.67683E+00	-1.14217E+00					
1.00000E+02	7.21085E+01	1.14305E+01	4.08146E-01	-4.68719E+00	-6.21940E+00	-2.19187E+00	-6.79122E-01
-4.04362E-01	-5.04645E-01	-6.87662E-01	4.70737E-01	3.42563E+00	2.88333E+00	1.50827E+00	6.68364E-01
3.19518E-01	1.00050E-01	-1.54232E-02	-3.44365E-01	-5.47499E-01	-5.72568E-01	-9.87313E-02	9.39662E-02
2.05740E-01	2.73282E-01	8.05997E-02	-2.59221E-01	-2.85599E-01	-1.17683E-01	-6.51839E-02	-7.52317E-02
3.13824E-01	8.48277E-01	4.56300E-01	1.69951E-01	-9.00867E-01	-4.29516E-01	9.61899E-01	5.24004E-01
2.15929E+00	1.79233E+00	3.76505E-01	2.61186E-01	-3.66039E-01	-1.09862E+00	-1.36933E+00	-1.52419E+00
-1.13532E+00	-1.00199E-01	1.27589E+00	1.36121E+00	1.07059E+00	4.35157E-01	-5.43886E-01	-9.43489E-01
-1.16570E+00	-1.30364E+00	-1.26857E+00	-1.33183E+00	-1.41787E+00	-2.64054E+00	-1.65737E+00	-1.01102E+00
-5.12429E-01	-3.38229E-01						
1.00000E+02	1.85765E+01	5.42057E-01	-2.72161E+00	-3.69451E+00	-1.22780E+00	-2.09516E-01	-1.83330E-02
-1.10609E-01	-1.88094E-01	4.62706E-01	2.41764E+00	2.08047E+00	1.21678E+00	5.87590E-01	3.59681E-01
2.48994E-01	1.38357E-01	-7.76048E-02	-1.78650E-01	-1.90478E-01	1.99106E-01	2.97997E-01	3.03014E-01
3.88017E-01	2.89178E-01	7.37349E-02	6.45559E-02	1.54587E-01	1.73049E-01	1.69374E-01	3.72258E-01
8.37265E-01	4.77698E-01	3.33959E-01	-3.80356E-01	-1.55981E-01	6.32058E-01	2.47946E-01	1.02887E+00
4.98524E-01	-5.66894E-01	-6.03787E-01	-1.11492E+00	-1.53810E+00	-1.70365E+00	-1.66060E+00	-1.18313E+00
-2.27256E-01	8.32133E-01	9.59820E-01	8.63143E-01	7.12948E-01	5.25511E-01	4.03591E-01	2.14880E-01
2.43985E-02	6.38846E-02	1.17461E-01	1.01671E-01	-1.51729E-01	1.78142E-01	2.36070E-01	4.38751E-01
2.75785E-01							
1.00000E+02	1.10906E+01	2.28011E+00	1.82428E+00	2.03524E+00	2.27372E+00	2.35997E+00	2.37940E+00
2.32901E+00	2.33462E+00	2.65582E+00	2.77560E+00	2.74107E+00	2.68303E+00	2.73092E+00	2.81158E+00
2.79095E+00	2.86251E+00	2.86134E+00	2.94105E+00	3.12272E+00	3.12194E+00	3.13063E+00	3.20422E+00
3.10467E+00	3.18154E+00	3.26827E+00	3.45496E+00	3.18128E+00	3.17557E+00	3.28563E+00	3.95370E+00
4.04336E+00	4.06780E+00	3.86035E+00	3.81985E+00	3.26804E+00	2.49814E+00	1.81369E+00	5.20962E-01
1.46854E-01	-5.74815E-01	-8.71089E-01	-9.87566E-01	-8.94648E-01	-6.97247E-01	-2.49321E-01	4.42728E-01
-1.30452E+00	-2.55925E+00	-2.38221E+00	-1.82640E+00	-1.19212E-01	1.00201E+00	1.17980E+00	6.63782E-01
5.71095E-01	4.36221E-01	1.10145E+00	-2.27774E-01	1.23673E+00	1.38974E+00	2.31655E+00	1.79325E+00
1.00000E+02	3.95323E+00	3.00678E+00	2.73426E+00	2.87402E+00	2.95554E+00	2.97537E+00	2.92882E+00
2.84503E+00	2.77563E+00	2.98698E+00	3.13825E+00	3.27380E+00	3.41324E+00	3.49056E+00	3.56758E+00
3.63417E+00	3.63264E+00	3.70788E+00	3.88451E+00	3.88224E+00	3.89299E+00	3.96058E+00	3.86236E+00
4.03326E+00	4.11542E+00	4.29647E+00	4.03173E+00	4.02420E+00	4.03150E+00	4.87223E+00	5.04628E+00
5.05535E+00	5.02155E+00	4.95722E+00	4.09367E+00	3.38055E+00	2.34707E+00	8.94199E-01	5.90176E-01
-2.84785E-01	-5.82364E-01	-6.79965E-01	-6.61294E-01	-3.30969E-01	3.14567E-02	7.07601E-01	-1.79050E+00
-3.41393E+00	-3.28237E+00	-2.68696E+00	-6.39800E-01	7.76294E-01	1.02925E+00	5.25908E-01	3.64056E-01
1.24645E-01	1.00837E+00	-8.72825E-01	1.02587E+00	1.35163E+00	2.59131E+00	1.93348E+00	
1.00000E+02	4.75327E+00	1.19383E+01	4.93017E+00	2.90479E+00	2.11244E+00	1.84563E+00	1.82369E+00
1.90808E+00	2.04820E+00	2.14774E+00	2.20276E+00	2.25715E+00	2.34012E+00	2.32335E+00	2.39822E+00
2.39690E+00	2.47711E+00	2.55664E+00	2.65377E+00	2.56194E+00	2.63588E+00	2.63942E+00	2.71373E+00
2.79750E+00	2.87845E+00	2.71103E+00	2.70435E+00	2.70492E+00	3.22944E+00	3.33751E+00	3.36671E+00
3.29809E+00	3.27435E+00	2.73081E+00	2.24303E+00	1.70700E+00	8.32510E-01	6.21611E-01	7.19716E-02
-1.29217E-01	-1.94821E-01	-1.84765E-01	-6.72415E-02	1.42458E-01	5.52566E-01	-1.20481E+00	-2.30470E+00
-2.24938E+00	-1.93658E+00	-6.99809E-01	1.50051E-01	3.35960E-01	6.04458E-02	-1.15354E-01	-3.38828E-01
2.71406E-01	-1.28539E+00	2.54882E-01	5.72658E-01	1.55102E+00	1.17032E+00		
1.00000E+02	4.19851E+01	1.39958E+01	6.05214E+00	2.84980E+00	1.87674E+00	1.54549E+00	1.62066E+00
1.76709E+00	1.87731E+00	1.93704E+00	1.99601E+00	2.08068E+00	2.06564E+00	2.14303E+00	2.04138E+00
2.12348E+00	2.20491E+00	2.30223E+00	2.31012E+00	2.38659E+00	2.28935E+00	2.36602E+00	2.45125E+00
2.53387E+00	2.36350E+00	2.35744E+00	2.35766E+00	2.88809E+00	2.90488E+00	2.94100E+00	2.88964E+00
2.87827E+00	2.44020E+00	1.98226E+00	1.46958E+00	7.36176E-01	5.47360E-01	7.39045E-02	-1.27968E-01
-2.08587E-01	-2.21602E-01	-2.52959E-02	1.72818E-01	4.91098E-01	-1.04956E+00	-1.96843E+00	-1.95227E+00
-1.68806E+00	-6.88836E-01	6.63283E-02	2.62884E-01	-2.53817E-02	-1.26411E-01	-2.62547E-01	1.89619E-01
-1.12485E+00	1.61142E-01	4.83968E-01	1.27911E+00	9.91042E-01			
1.00000E+02	4.03334E+01	1.51530E+01	5.33407E+00	2.55480E+00	1.61636E+00	1.38646E+00	1.53743E+00
1.65544E+00	1.71928E+00	1.88431E+00	1.87085E+00	1.85756E+00	1.93820E+00	1.93726E+00	2.02247E+00
2.10764E+00	2.10565E+00	2.11212E+00	2.19273E+00	2.09437E+00	2.17586E+00	2.26446E+00	2.35145E+00
2.17437E+00	2.16961E+00	2.17191E+00	2.62464E+00	2.65204E+00	2.69853E+00	2.66561E+00	2.67059E+00
2.13513E+00	1.70383E+00	1.21683E+00	4.11050E-01	3.45158E-01	-6.07770E-02	-2.61398E-01	-2.48891E-01
-2.76640E-01	-9.65446E-02	9.24557E-02	4.20800E-01	-9.95204E-01	-1.83521E+00	-1.74438E+00	-1.48553E+00
-4.00274E-01	2.56143E-01	3.69620E-01	1.74211E-01	5.87746E-02	-6.62828E-02	3.35702E-01	-7.01115E-01
3.31717E-01	5.86030E-01	1.26298E+00	1.02152E+00				
1.00000E+02	4.95656E+01	1.49829E+01	5.48830E+00	2.34816E+00	1.52253E+00	1.47083E+00	1.68478E+00
1.84753E+00	1.91225E+00	1.99914E+00	1.98556E+00	2.06627E+00	2.06539E+00	2.05071E+00	2.13683E+00
2.23588E+00	2.14171E+00	2.22299E+00	2.22443E+00	2.30722E+00	2.29648E+00	2.38510E+00	2.20587E+00
2.20150E+00	2.20564E+00	2.66952E+00	2.79645E+00	2.74334E+00	2.80858E+00	2.71265E+00	2.17654E+00
1.73734E+00	1.14505E+00	3.26915E-01	2.54861E-01	-2.55262E-01	-3.51181E-01	-4.34987E-01	-3.49169E-01
-2.61194E-01	3.37087E-02	3.59955E-01	-1.05061E+00	-1.88658E+00	-1.78035E+00	-1.38245E+00	-2.71341E-01
3.81122E-01	5.94575E-01	3.08581E-01	2.04118E-01	9.55025E-02	4.99085E-01	-4.39137E-01	5.24260E-01
8.21309E-01	1.47130E+00	1.09785E+00					
1.00000E+02	4.50534E+01	1.45002E+01	4.64572E+00	2.22062E+00	1.56611E+00	1.67572E+00	1.83665E+00
1.99999E+00	2.08626E+00	2.07204E+00	2.15184E+00	2.15092E+00	2.13557E+00	2.22107E+00	2.32009E+00
2.22618E+00	2.30660E+00	2.30809E+00	2.39011E+00	2.47937E+00	2.56752E+00	2.38918E+00	2.38463E+00
2.28855E+00	2.75104E+00	2.87441E+00	2.81879E+00	2.87740E+00	2.87821E+00	2.13779E+00	1.78855E+00
1.08481E+00	2.51253E-01	2.74411E-01	-2.26037E-01	-4.24751E-01	-3.99629E-01	-4.07423E-01	-2.08073E+01

9.10856E-02	4.13627E-01	-1.00054E+00	-1.93035E+00	-1.80964E+00	-1.49228E+00	-2.66166E-01	3.84583E-01
5.94248E-01	3.13590E-01	2.18293E-01	1.14097E-01	6.02079E-01	-5.03656E-01	6.32487E-01	8.27586E-01
1.56875E+00	1.19552E+00						
1.00000E+02	4.91883E+01	1.33739E+01	4.54096E+00	2.18462E+00	1.79120E+00	1.85102E+00	2.01419E+00
2.00010E+00	2.08597E+00	2.16573E+00	2.16484E+00	2.14971E+00	2.23565E+00	2.33501E+00	2.24100E+00
2.32173E+00	2.32287E+00	2.40552E+00	2.49534E+00	2.58433E+00	2.40491E+00	2.40055E+00	2.30552E+00
2.67344E+00	2.79572E+00	2.84116E+00	2.99871E+00	2.89811E+00	1.95436E+00	1.59858E+00	7.88851E+00
-5.48107E-02	1.71045E-01	-3.28676E-01	-4.23349E-01	-3.94295E-01	-3.95743E-01	-1.90488E-01	1.11010E-01
4.32210E-01	-9.79101E-01	-1.80449E+00	-1.77645E+00	-1.33714E+00	-1.95325E-01	4.53118E-01	6.63217E-01
3.87378E-01	2.98816E-01	2.03958E-01	6.91772E-01	-3.58484E-01	7.38668E-01	9.03107E-01	1.62825E+00
1.23703E+00							
1.00000E+02	4.20379E+01	1.27828E+01	4.32653E+00	2.22976E+00	1.88821E+00	1.95186E+00	2.03839E+00
2.02388E+00	2.10411E+00	2.10331E+00	2.18940E+00	2.27674E+00	2.27646E+00	2.28241E+00	2.36433E+00
2.36472E+00	2.44923E+00	2.44010E+00	2.53118E+00	2.34889E+00	2.34507E+00	2.25206E+00	2.43246E+00
2.75599E+00	2.70302E+00	2.96091E+00	2.86263E+00	1.61477E+00	1.35525E+00	2.37528E-01	-5.13577E-01
1.93455E-02	-4.85812E-01	-5.78915E-01	-4.42119E-01	-4.35848E-01	-2.23818E-01	7.99065E-02	5.02581E-01
-7.97851E-01	-1.62381E+00	-1.48581E+00	-1.11440E+00	-4.99739E-02	5.94715E-01	8.08212E-01	5.39014E-01
4.58637E-01	3.80514E-01	8.76181E-01	-7.03836E-02	9.53179E-01	1.05755E+00	1.65515E+00	1.22580E+00
1.00000E+02	4.74324E+01	1.37051E+01	4.61072E+00	2.36786E+00	2.03362E+00	1.92080E+00	2.00688E+00
1.98845E+00	1.98785E+00	2.07605E+00	2.16646E+00	2.26796E+00	2.27287E+00	2.25741E+00	2.25631E+00
2.34490E+00	2.43932E+00	2.53479E+00	2.34629E+00	2.24331E+00	2.05366E+00	1.75895E+00	2.38629E+00
2.23871E+00	3.00435E+00	2.81299E+00	7.56105E-01	6.96590E-01	-1.13351E+00	-1.69082E+00	-4.35681E-01
-9.56838E-01	-7.38078E-01	-4.93763E-01	-4.79300E-01	-2.60934E-01	1.45529E-01	6.72080E-01	-3.02480E-01
-1.03452E+00	-8.91359E-01	-4.72967E-01	4.21208E-01	8.63751E-01	8.89525E-01	7.28255E-01	7.54959E-01
7.05762E-01	1.12859E+00	5.53776E-01	1.26004E+00	1.25143E+00	1.79885E+00	1.29719E+00	
1.00000E+02	5.05519E+01	1.47992E+01	4.95855E+00	2.92638E+00	2.21412E+00	1.99977E+00	2.08285E+00
2.08248E+00	2.17282E+00	2.26662E+00	2.26966E+00	2.27350E+00	2.36129E+00	2.25818E+00	2.45150E+00
2.44924E+00	2.54979E+00	2.35428E+00	2.25273E+00	1.86751E+00	1.20445E+00	2.13313E+00	1.99152E+00
3.15960E+00	2.87395E+00	-9.21944E-02	3.93639E-02	-2.50626E+00	-2.98502E+00	-8.08194E-01	-1.34350E+00
-9.15439E-01	-5.58296E-01	-5.26834E-01	-2.93760E-01	2.18749E-01	8.46515E-01	9.69605E-02	-5.35811E-01
-3.73704E-01	2.08539E-02	7.67270E-01	1.10301E+00	1.23575E+00	1.08955E+00	1.13448E+00	1.22072E+00
1.56795E+00	1.32789E+00	1.77031E+00	1.61920E+00	2.00074E+00	1.50842E+00		
1.00000E+02	4.82676E+01	1.38094E+01	5.56839E+00	3.15244E+00	2.23651E+00	2.11796E+00	2.11744E+00
2.20613E+00	2.29755E+00	2.39971E+00	2.30411E+00	2.38964E+00	2.38786E+00	2.47782E+00	2.57342E+00
2.67066E+00	2.37955E+00	2.37733E+00	2.08945E+00	1.70666E+00	2.43277E+00	2.28630E+00	3.25011E+00
2.95811E+00	5.97271E-01	6.29262E-01	-1.40914E+00	-1.98215E+00	-5.27739E-01	-1.04960E+00	-8.29254E-01
-4.74900E-01	-4.48925E-01	-3.21815E-01	1.90563E-01	7.14812E-01	-3.55805E-01	-1.08310E+00	-9.22709E-01
-4.60843E-01	4.63432E-01	9.99643E-01	1.12524E+00	8.74460E-01	9.13437E-01	8.82297E-01	1.30630E+00
8.39535E-01	1.46971E+00	1.40089E+00	1.91734E+00	1.47944E+00			
1.00000E+02	4.23804E+01	1.47906E+01	5.75456E+00	3.03242E+00	2.41016E+00	2.20875E+00	2.29468E+00
2.38212E+00	2.48251E+00	2.38814E+00	2.46988E+00	2.46996E+00	2.55466E+00	2.64625E+00	2.73789E+00
2.55503E+00	2.45090E+00	2.35903E+00	2.44399E+00	2.86515E+00	2.81118E+00	3.16446E+00	3.06366E+00
1.71333E+00	1.44254E+00	1.12898E-01	-6.54952E-01	-2.72372E-02	-6.29744E-01	-6.18685E-01	-4.74713E-01
-4.57098E-01	-2.34112E-01	7.43826E-02	4.93533E-01	-8.06291E-01	-1.72671E+00	-1.57093E+00	-1.16585E-01
2.15959E-02	6.63071E-01	8.74862E-01	6.13330E-01	5.44611E-01	4.78015E-01	9.66427E-01	8.46982E-02
1.06329E+00	1.13424E+00	1.81089E+00	1.36448E+00				
1.00000E+02	5.04557E+01	1.63429E+01	5.99598E+00	3.36594E+00	2.56221E+00	2.44614E+00	2.53182E+00
2.53110E+00	2.53770E+00	2.61770E+00	2.51812E+00	2.60049E+00	2.69032E+00	2.77959E+00	2.60018E+00
2.59580E+00	2.60259E+00	2.97509E+00	3.09223E+00	3.13512E+00	3.28267E+00	3.17639E+00	2.33191E+00
1.85587E+00	9.31246E-01	6.21771E-02	1.70003E-01	-4.20715E-01	-6.17182E-01	-5.76188E-01	-5.58954E-01
-3.35349E-01	-2.55534E-02	4.93100E-01	-1.12448E+00	-2.03773E+00	-1.98038E+00	-1.49112E+00	-2.12977E-01
6.27489E-01	8.33486E-01	4.70785E-01	4.00743E-01	3.21182E-01	7.92970E-01	-2.64759E-01	8.65797E-01
1.08779E+00	1.78747E+00	1.37756E+00					
1.00000E+02	5.06263E+01	1.52878E+01	6.13169E+00	3.52038E+00	2.80045E+00	2.58309E+00	2.68223E+00
2.58906E+00	2.66710E+00	2.66852E+00	2.74862E+00	2.83685E+00	2.92405E+00	2.64733E+00	2.74282E+00
2.74857E+00	3.21061E+00	3.32303E+00	3.36114E+00	3.29828E+00	3.28548E+00	2.54041E+00	2.05248E+00
1.32147E+00	3.36766E-01	2.28454E-01	-3.45236E-01	-5.42333E-01	-5.99840E-01	-5.75790E-01	-3.44634E-01
-3.05154E-02	3.81415E-01	-1.24732E+00	-2.25127E+00	-2.18075E+00	-1.68851E+00	-3.05557E-01	6.33756E-01
8.32630E-01	4.71838E-01	3.10174E-01	2.24994E-01	6.74770E-01	-4.27946E-01	7.36165E-01	9.90549E-01
1.79849E+00	1.31466E+00						
1.00000E+02	4.61925E+01	1.54534E+01	6.01357E+00	3.48562E+00	2.86586E+00	2.66344E+00	2.67097E+00
2.74827E+00	2.64943E+00	2.82914E+00	2.81626E+00	2.90266E+00	2.72765E+00	2.72241E+00	2.72781E+00
3.28628E+00	3.39682E+00	3.43309E+00	3.36691E+00	3.35122E+00	2.70687E+00	2.21471E+00	1.47960E+00
4.90044E-01	2.74647E-01	-2.92669E-01	-5.93204E-01	-6.48694E-01	-5.19127E-01	-3.87235E-01	-7.12842E-02
4.40764E-01	-1.29429E+00	-2.39571E+00	-2.21830E+00	-1.82449E+00	-3.39403E-01	6.00027E-01	7.96087E-01
4.36366E-01	2.77385E-01	9.39498E-02	7.28649E-01	-5.77254E-01	7.84368E-01	9.55039E-01	1.76610E+00
1.39116E+00							
1.00000E+02	4.89820E+01	1.53369E+01	6.28055E+00	3.65116E+00	2.94609E+00	2.65243E+00	2.72905E+00
2.73093E+00	2.80930E+00	2.89631E+00	2.98189E+00	2.80809E+00	2.80260E+00	2.80747E+00	3.36124E+00
3.47050E+00	3.50521E+00	3.43697E+00	3.41905E+00	2.77420E+00	2.27948E+00	1.54122E+00	5.49005E-01
3.31773E-01	-3.33746E-01	-5.31463E-01	-5.86542E-01	-5.59053E-01	-3.23868E-01	-7.22984E-03	4.01734E-01
-1.33748E+00	-2.43602E+00	-2.35779E+00	-1.86733E+00	-3.83920E-01	5.56177E-01	7.49849E-01	3.89836E-01
2.31386E-01	4.41310E-02	6.72009E-01	-6.60183E-01	7.20535E-01	9.08064E-01	1.82464E+00	1.36241E+00
1.00000E+02	4.72602E+01	1.57001E+01	6.43813E+00	3.82313E+00	2.92675E+00	2.80129E+00	2.80349E+00
2.88059E+00	2.96672E+00	3.05115E+00	2.87911E+00	2.87328E+00	2.87761E+00	3.42544E+00	3.53185E+00
3.56378E+00	3.49051E+00	3.46817E+00	2.82214E+00	3.21991E+00	1.67719E+00	5.73288E-01	3.50560E-01
-2.01901E-01	-5.03188E-01	-5.5521E-01	-5.23996E-01	-2.84390E-01	3.47428E-02	4.41054E-01	-1.40656E+00
-2.49866E+00	-2.41291E+00	-1.92038E+00	-5.31462E-01	5.07083E-01	6.96615E-01	3.38227E-01	1.83794E-01
-6.22180E-03	6.09138E-01	-7.45981E-01	6.51981E-01	9.54401E-01	1.77748E+00	1.32866E+00	
1.00000E+02	4.77516E+01	1.55823E+01	6.53541E+00	3.62894E+00	3.10152E+00	2.80216E+00	2.87921E+00
2.96530E+00	3.04969E+00	2.87774E+00	2.87189E+00	2.87623E+00	3.42389E+00	3.53005E+00	3.56180E+00
3.48805E+00	3.46539E+00	2.81923E+00	2.31624E+00	1.57012E+00	5.67975E-01	3.44673E-01	-2.07052E-01
-5.08326E-01	-5.60282E-01	-5.28179E-01	-2.87988E-01	3.14326E-02	4.37486E-01	-1.41044E+00	-2.50200E+00
-2.41534E+00	-1.92172E+00	-5.31888E-01	5.06577E-01	6.95836E-01	3.37765E-01	1.83894E-01	-5.92117E-03
6.08565E-01	-7.45802E-01	6.51711E-01	9.54007E-01	1.77671E+00	1.42780E+00		
1.00000E+02	4.76299E+01	1.61654E+01	6.32239E+00	3.98493E+00	3.08244E+00	2.95744E+00	3.04289E+00
3.12647E+00	2.95581E+00	2.94972E+00	2.95386E+00	3.59849E+00	3.70190E+00	3.63038E+00	3.55139E+00
3.52453E+00	2.97875E+00	2.36566E+00	1.71502E+00	5.99605E-01	3.70110E-01	-2.75923E-01	-4.73966E+01

-5.22197E-01	-4.84455E-01	-3.40538E-01	-1.78787E-02	4.87231E-01	-1.46779E+00	-2.65451E+00	-2.45618E+00
-2.05357E+00	-5.55807E-01	4.82109E-01	6.67674E-01	3.12587E-01	1.64487E-01	-2.50201E-02	5.77827E-01
-7.80776E-01	6.20758E-01	9.29349E-01	1.85044E+00	1.40929E+00			
1.00000E+02	5.28455E+01	1.60545E+01	7.08123E+00	3.96631E+00	3.23698E+00	3.12061E+00	3.20349E+00
3.03406E+00	3.02772E+00	3.03193E+00	3.67384E+00	3.77353E+00	3.80010E+00	3.71455E+00	3.68292E+00
3.03405E+00	2.51158E+00	1.74943E+00	6.19451E-01	3.81534E-01	-2.53818E-01	-5.54968E-01	-5.97422E-01
-5.50819E-01	-2.95718E-01	3.11613E-02	4.30368E-01	-1.52975E+00	-2.70780E+00	-2.59661E+00	-2.17637E+00
-5.65057E-01	4.71585E-01	7.51619E-01	3.02627E-01	1.63151E-01	-2.34902E-02	5.65568E-01	-8.73465E-01
6.12664E-01	9.20463E-01	1.93556E+00	1.39855E+00				
1.00000E+02	4.67160E+01	1.68336E+01	6.47782E+00	4.13960E+00	3.41971E+00	3.30138E+00	3.03144E+00
3.12565E+00	3.13014E+00	3.77280E+00	3.87128E+00	3.89717E+00	3.80925E+00	3.77627E+00	3.12688E+00
2.49784E+00	1.73224E+00	5.95784E-01	3.54258E-01	-2.77703E-01	-5.78573E-01	-6.18315E-01	-5.67476E-01
-3.08198E-01	2.05913E-02	4.18269E-01	-1.54260E+00	-2.81937E+00	-2.70090E+00	-2.16903E+00	-5.49753E-01
4.85906E-01	7.64801E-01	3.18460E-01	1.83249E-01	-1.62917E-04	5.84768E-01	-8.37218E-01	6.37288E-01
1.03507E+00	1.94652E+00	1.50570E+00					
1.00000E+02	5.07287E+01	1.53352E+01	6.66353E+00	4.23427E+00	3.41214E+00	3.04101E+00	3.03475E+00
3.03930E+00	3.68338E+00	3.78307E+00	3.81001E+00	3.72433E+00	3.69305E+00	3.04418E+00	2.41875E+00
1.75893E+00	6.27757E-01	2.85120E-01	-3.50304E-01	-5.47880E-01	-6.92546E-01	-6.44161E-01	-3.87399E-01
-5.98819E-02	4.41124E-01	-1.51760E+00	-2.79743E+00	-2.58242E+00	-2.15616E+00	-5.40980E-01	4.94980E-01
7.75508E-01	3.27713E-01	1.89749E-01	5.95214E-03	5.96077E-01	-8.25490E-01	6.48248E-01	9.46021E-01
1.95625E+00	1.51283E+00						
1.00000E+02	4.48818E+01	1.53884E+01	6.92149E+00	4.28692E+00	3.51471E+00	3.20627E+00	3.11000E+00
3.85006E+00	3.94597E+00	3.86878E+00	3.87715E+00	3.84051E+00	3.08840E+00	2.55347E+00	1.78145E+00
6.35753E-01	2.84538E-01	-3.38682E-01	-6.39611E-01	-6.75798E-01	-6.19569E-01	-3.54669E-01	-2.29957E-02
4.74134E-01	-1.59334E+00	-2.86417E+00	-2.73704E+00	-2.29712E+00	-5.70703E-01	4.64476E-01	7.40122E-01
2.96409E-01	1.66337E-01	-1.67780E-02	6.55063E-01	-8.67732E-01	6.10237E-01	1.01352E+00	1.92425E+00
1.48949E+00							
1.00000E+02	4.47679E+01	1.56785E+01	6.60462E+00	4.42293E+00	3.81276E+00	3.31374E+00	3.75126E+00
3.84840E+00	3.87282E+00	3.78261E+00	3.74735E+00	3.09739E+00	2.46516E+00	1.69604E+00	5.55922E-01
3.12003E-01	-3.14635E-01	-6.15834E-01	-6.54727E-01	-6.02705E-01	-4.44142E-01	-1.14140E-01	3.84283E-01
-1.58023E+00	-2.85430E+00	-2.73359E+00	-2.20427E+00	-5.85540E-01	4.50611E-01	7.27406E-01	2.81069E-01
1.46754E-01	-3.95350E-02	5.39253E-01	-9.03048E-01	5.86301E-01	9.97429E-01	1.91369E+00	1.48239E+00
1.00000E+02	4.97747E+01	1.58382E+01	8.21974E+00	5.99906E+00	4.19162E+00	4.02219E+00	4.01392E+00
3.93384E+00	3.93591E+00	3.89438E+00	3.14078E+00	2.59547E+00	1.81472E+00	5.52427E-01	2.97365E-01
-4.18680E-01	-7.19628E-01	-7.50915E-01	-6.87217E-01	-4.14575E-01	-7.89743E-02	4.14521E-01	-1.65862E+00
-3.02349E+00	-2.88360E+00	-2.33091E+00	-6.92237E-01	4.40560E-01	7.11963E-01	2.72004E-01	1.49078E-01
-3.30693E-02	6.25276E-01	-9.89220E-01	6.76779E-01	9.89866E-01	1.99792E+00	1.47076E+00	
1.00000E+02	4.61306E+01	2.06847E+01	1.30285E+01	6.69107E+00	4.70865E+00	4.09257E+00	4.01003E+00
4.00561E+00	3.95953E+00	3.20440E+00	2.54555E+00	1.75556E+00	4.78069E-01	2.14298E-01	-4.91395E-01
-7.92040E-01	-8.17459E-01	-7.44715E-01	-5.65153E-01	-1.22918E-01	3.66783E-01	-1.81304E+00	-3.06718E+00
-2.91316E+00	-2.44180E+00	-6.88221E-01	5.41657E-01	8.09536E-01	3.74175E-01	1.61903E-01	-1.60496E-02
6.29928E-01	-9.66133E-01	6.88027E-01	9.95075E-01	1.99572E+00	1.56823E+00		
1.00000E+02	7.37246E+01	4.29137E+01	1.73444E+01	7.20734E+00	4.37050E+00	4.18406E+00	4.06990E+00
4.01791E+00	3.26073E+00	2.58647E+00	1.78492E+00	3.83961E-01	1.08469E-01	-5.84047E-01	-8.84161E-01
-1.00458E+00	-9.18834E-01	-6.23960E-01	-1.75699E-01	3.08933E-01	-1.87567E+00	-3.22096E+00	-3.04664E+00
-2.54667E+00	-6.71500E-01	5.56077E-01	8.19295E-01	3.91270E-01	1.91437E-01	2.03639E-02	6.50532E-01
-1.00329E+00	7.19752E-01	1.11218E+00	2.10190E+00	1.67186E+00			
1.00000E+02	7.87640E+01	2.97526E+01	9.76133E+00	4.41519E+00	3.83006E+00	3.72816E+00	3.68469E+00
3.03205E+00	2.37949E+00	1.49171E+00	3.24831E-01	-3.87886E-02	-6.45799E-01	-9.46529E-01	-9.74870E-01
-9.06574E-01	-6.29308E-01	-2.91552E-01	3.02353E-01	-1.77172E+00	-3.03123E+00	-2.88561E+00	-2.32347E+00
-5.79280E-01	5.52835E-01	7.24689E-01	2.87096E-01	1.67965E-01	-1.12256E-02	6.43589E-01	-9.55166E-01
6.04556E-01	1.00564E+00	2.00856E+00	1.47794E+00				
1.00000E+02	5.07829E+01	1.44876E+01	4.70884E+00	3.82008E+00	3.81694E+00	3.77190E+00	3.01710E+00
2.36012E+00	1.46886E+00	1.92634E-01	-7.05007E-02	-6.73556E-01	-9.74187E-01	-1.10348E+00	-9.28781E-01
-7.50384E-01	-3.08781E-01	2.83718E-01	-1.79199E+00	-3.04842E+00	-2.89765E+00	-2.42879E+00	-5.79370E-01
5.52224E-01	8.21420E-01	3.85141E-01	1.71005E-01	-6.79927E-03	6.43303E-01	-9.49695E-01	6.06401E-01
1.00590E+00	2.00635E+00	1.47609E+00					
1.00000E+02	3.58468E+01	6.53149E+00	3.92725E+00	3.81759E+00	3.76975E+00	2.81045E+00	2.14128E+00
1.13922E+00	-1.54198E-01	-3.22648E-01	-9.18462E-01	-1.21817E+00	-1.23723E+00	-1.15440E+00	-8.62824E-01
-4.16596E-01	1.72424E-01	-1.80061E+00	-3.15230E+00	-2.88398E+00	-2.38567E+00	-5.14871E-01	6.13788E-01
8.81383E-01	4.52099E-01	2.48642E-01	8.12943E-02	7.24622E-01	-8.09656E-01	7.05735E-01	1.07502E+00
2.05738E+00	1.51123E+00						
1.00000E+02	3.19825E+01	6.45443E+00	4.68072E+00	4.50167E+00	2.81949E+00	2.05914E+00	3.74302E-01
-1.14630E+00	-8.63144E-01	-1.59852E+00	-1.79024E+00	-1.75962E+00	-1.59940E+00	-1.23108E+00	-6.47220E-01
2.19963E-01	-2.07799E+00	-3.57265E+00	-3.28595E+00	-2.59997E+00	-3.86658E-01	9.22281E-01	1.26587E+00
6.86149E-01	5.59792E-01	3.49729E-01	1.10551E+00	-5.19735E-01	1.27007E+00	1.51839E+00	2.60774E+00
2.01217E+00							
1.00000E+02	2.75490E+01	6.43478E+00	4.61664E+00	3.13275E+00	2.35280E+00	8.51273E-01	-8.97939E-01
-9.41417E-01	-1.74670E+00	-2.04408E+00	-2.00709E+00	-1.83792E+00	-1.45870E+00	-8.67406E-01	-7.61707E-03
-2.43390E+00	-4.11472E+00	-3.80896E+00	-3.03296E+00	-7.18349E-01	7.91854E-01	1.12169E+00	5.41689E-01
3.23720E-01	9.52706E-02	9.07431E-01	-9.46609E-01	9.39844E-01	1.37273E+00	2.49449E+00	1.96120E+00
1.00000E+02	2.94756E+01	6.30125E+00	2.97764E+00	1.96324E+00	3.30360E-01	-1.45798E+00	-1.62886E+00
-2.29359E+00	-2.59177E+00	-2.54209E+00	-2.35374E+00	-1.95406E+00	-1.24932E+00	-2.96579E-01	-2.84569E+00
-4.50486E+00	-4.16816E+00	-3.36921E+00	-8.31687E-01	7.77648E-01	9.96070E-01	4.23603E-01	2.22060E-01
6.60805E-03	7.63602E-01	1.22151E+00	7.87898E-01	1.25615E+00	2.48273E+00	1.88108E+00	
1.00000E+02	2.94737E+01	4.87261E+00	1.98179E+00	5.13876E-01	-1.52151E+00	-2.24158E+00	-2.84297E+00
-3.33987E-00	-3.39873E+00	-3.09383E+00	-2.57451E+00	-1.85722E+00	-9.16273E-01	-3.72128E+00	-5.45287E+00
-4.98709E+00	-4.12165E+00	-1.39055E+00	4.27057E-01	7.20083E-01	4.45076E-02	-2.48880E-01	-6.16618E-01
1.82203E-01	-2.07383E+00	2.29947E-01	7.75553E-01	2.16891E+00	1.68831E+00		
1.00000E+02	2.67643E+01	3.32223E+00	-1.50131E-01	-2.44968E+00	-3.09879E+00	-3.74732E+00	-4.15703E+00
-4.08211E+00	-3.75372E+00	-3.20829E+00	-2.47546E+00	-1.44446E+00	-4.28727E+00	-5.98879E+00	-5.48380E+00
-4.60708E+00	-1.75182E+00	1.69719E-01	5.41992E-01	-2.27085E-01	-5.01862E-01	-8.85636E-01	-5.04371E-02
-2.62388E+00	-1.31922E-01	6.03704E-01	2.02568E+00	1.51461E+00			
1.00000E+02	2.35887E+01	-1.07189E+00	-5.37738E+00	-5.09924E+00	-5.50940E+00	-5.71182E+00	-5.42352E+00
-5.08822E+00	-4.43131E+00	-3.38461E+00	-2.25426E+00	-4.59233E+00	-5.97851E+00	-5.36824E+00	-4.50462E+00
-1.75458E+00	7.03027E-02	2.38081E-01	-4.32078E-01	-6.07023E-01	-9.02442E-01	-3.75500E-01	-2.54065E+00
-3.73718E-01	2.99174E-01	1.53402E+00	1.24868E+00				
1.00000E+02	2.44646E+01	-5.29448E+00	-7.15890E+00	-7.46267E+00	-7.67438E+00	-7.48330E+00	-7.03582E+00

-6.15557E+00	-4.98767E+00	-3.76686E+00	-6.08574E+00	-7.43296E+00	-6.70051E+00	-5.74062E+00	-2.63280E+00
-6.83461E-01	-5.54256E-01	-1.34312E+00	-1.52478E+00	-1.90315E+00	-1.48384E+00	-4.20103E+00	-1.73052E+00
-7.19547E-01	6.56963E-01	5.99164E-01					
1.00000E+02	1.54295E+01	-8.32323E+00	-1.03311E+01	-1.05488E+01	-1.00194E+01	-9.54056E+00	-8.51725E+00
-7.01010E+00	-5.38904E+00	-7.46407E+00	-8.45359E+00	-7.57102E+00	-6.43499E+00	-3.21640E+00	-1.15056E+00
-1.05568E+00	-1.94735E+00	-2.11307E+00	-2.43929E+00	-2.31846E+00	-5.08274E+00	-2.65043E+00	-1.42611E+00
-1.73257E-01	-8.01015E-02						
1.00000E+02	1.84427E+01	-1.02353E+01	-1.28089E+01	-1.31246E+01	-1.28539E+01	-1.17079E+01	-9.86084E+00
-7.93405E+00	-9.90475E+00	-1.05319E+01	-9.42690E+00	-8.23906E+00	-4.47507E+00	-2.06839E+00	-2.12164E+00
-3.04554E+00	-3.43137E+00	-3.76992E+00	-3.87845E+00	-7.00609E+00	-4.41517E+00	-2.84082E+00	-1.60050E+00
-1.10772E+00							
1.00000E+02	2.46764E+01	-3.39982E+00	-1.18591E+01	-1.38272E+01	-1.33032E+01	-1.16484E+01	-9.62171E+00
-1.21867E+01	-1.28818E+01	-1.15383E+01	-1.01991E+01	-5.52245E+00	-2.48179E+00	-2.46133E+00	-3.60487E+00
-4.09744E+00	-4.49491E+00	-4.68438E+00	-8.20907E+00	-5.33069E+00	-3.50958E+00	-2.16749E+00	-1.50878E+00
1.00000E+02	4.36374E+01	1.11248E+00	-1.01156E+01	-1.25024E+01	-1.19413E+01	-1.04253E+01	-1.28045E+01
-1.33534E+01	-1.18963E+01	-1.02897E+01	-5.19207E+00	-2.07481E+00	-2.00831E+00	-3.06388E+00	-3.60355E+00
-3.87676E+00	-4.22165E+00	-7.03604E+00	-4.71229E+00	-3.27136E+00	-2.28319E+00	-1.56332E+00	
1.00000E+02	3.68890E+01	-9.47637E-01	-1.10319E+01	-1.27751E+01	-1.18927E+01	-1.53289E+01	-1.59650E+01
-1.42674E+01	-1.20912E+01	-5.73621E+00	-1.91327E+00	-1.64423E+00	-2.79701E+00	-3.53038E+00	-3.79441E+00
-4.14263E+00	-6.71871E+00	-4.71534E+00	-3.20444E+00	-2.33391E+00	-1.63032E+00		
1.00000E+02	3.82494E+01	-7.64955E-01	-1.12994E+01	-1.29254E+01	-1.81110E+01	-1.92621E+01	-1.71086E+01
-1.41845E+01	-6.13758E+00	-1.32657E+00	-9.40626E-01	-2.07530E+00	-2.99077E+00	-3.20215E+00	-3.60691E+00
-5.74641E+00	-3.98357E+00	-2.77455E+00	-2.09662E+00	-1.42226E+00			
1.00000E+02	4.07639E+01	-1.23572E+00	-1.14828E+01	-2.07797E+01	-2.26520E+01	-2.04450E+01	-1.66097E+01
-6.44480E+00	-5.65600E-01	1.45400E-01	-1.05943E+00	-2.14165E+00	-2.26923E+00	-2.61011E+00	-4.12413E+00
-2.93154E+00	-2.04208E+00	-1.50788E+00	-1.03857E+00				
1.00000E+02	3.76523E+01	-1.10411E+00	-2.07956E+01	-2.50573E+01	-2.33266E+01	-1.89101E+01	-6.85920E+00
7.73909E-02	1.11163E+00	3.49565E-02	-1.21769E+00	-1.36417E+00	-1.63650E+00	-2.54595E+00	-1.81123E+00
-1.22918E+00	-9.31741E-01	-5.61715E-01					
1.00000E+02	3.97297E+01	-1.33193E+01	-2.44432E+01	-2.52788E+01	-2.09877E+01	-7.99954E+00	-1.88866E-01
1.45586E+00	6.88523E-01	-7.54361E-01	-9.65405E-01	-1.20056E+00	-1.98035E+00	-1.21581E+00	-7.66471E-01
-4.24513E-01	-3.45813E-01						
1.00000E+02	1.94097E+01	-1.42709E+01	-2.48404E+01	-2.32113E+01	-1.02776E+01	-1.54930E+00	8.85341E-01
6.15314E-01	-8.29337E-01	-1.26094E+00	-1.53735E+00	-2.65588E+00	-1.49803E+00	-9.46067E-01	-3.63711E-01
-2.13102E-01							
1.00000E+02	6.44779E+01	1.13623E+01	-1.35467E+01	-1.90816E+01	-1.12548E+01	-3.72139E+00	9.63806E-01
9.47766E-01	-1.05799E+00	-2.20340E+00	-2.12142E+00	-1.83814E+00	-1.49742E+00	-1.45475E+00	-1.08767E+00
1.00000E+02	5.14727E+01	4.15146E+00	-2.16221E+01	-1.80458E+01	-7.43154E+00	1.43457E+00	2.79059E+00
-1.48625E-01	-2.08209E+00	-6.35887E-01	-1.13765E+00	-1.20604E+00	-1.74466E+00	-1.32902E+00	
1.00000E+02	4.24890E+01	-2.02732E+01	-2.58683E+01	-1.21370E+01	1.96346E+00	5.60589E+00	1.53856E+00
-1.05539E+00	1.65731E+00	5.96949E-01	5.61527E-02	-7.86409E-01	-5.82771E-01		
1.00000E+02	9.79551E+00	-3.65971E+01	-2.31509E+01	6.01171E-01	1.08688E+01	4.79726E+00	8.28786E-01
5.59157E+00	3.88886E+00	2.47173E+00	1.38985E+00	8.61754E-01			
1.00000E+02	8.15356E+00	-3.00473E+01	-1.31278E+01	8.95167E+00	8.56746E+00	2.43735E+00	8.15149E+00
6.27156E+00	4.50041E+00	3.69293E+00	2.47984E+00				
1.00000E+02	1.20631E+01	-2.93477E+01	-7.00357E+00	8.69876E+00	4.55799E+00	7.38697E+00	5.78362E+00
4.38216E+00	3.62043E+00	2.55670E+00					
1.00000E+02	1.16878E+00	-3.16382E+01	1.25784E+00	1.21672E+01	9.41682E+00	4.33689E+00	2.28205E+00
1.41299E-01	1.82449E-01						
1.00000E+02	-1.36815E+01	-1.94773E+01	2.31178E+01	1.62398E+01	2.57903E+00	-5.17978E-01	-5.60171E+00
-4.07766E+00							
1.00000E+02	-5.13980E+00	-3.30753E+00	1.37160E+01	9.14406E+00	5.78189E+00	4.29792E+00	2.84526E+00
1.00000E+02	-6.15342E+01	-2.07124E+01	2.54688E+01	2.93600E+01	4.50015E+01	3.19426E+01	
1.00000E+02	2.67177E+01	-2.88164E+01	-3.18680E+01	-5.58757E+01	-3.93573E+01		
1.00000E+02	3.78486E+01	1.01995E+01	2.93414E+01	1.94862E+01			
1.00000E+02	5.28906E+01	2.48722E+01	1.34923E+01				
1.00000E+02	7.45104E+01	4.76740E+01					
1.00000E+02	7.75449E+01						
1.00000E+02							

APPENDIX G. LANL LSL-M3 FORMAT NEUTRON OUTPUT

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*cor      (library)      (mat.#)      (temp)k
*number of energies plus 1
90
*energy grid ( 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
1.67350E-05 8.45628E-05 1.89746E-04 1.16528E-03 2.14371E-03 8.20222E-04 5.97423E-04 2.10027E-04
3.73470E-04 1.95356E-04 1.55251E-04 2.41713E-04 9.52349E-04 7.95649E-04 7.42295E-04 4.43678E-04
3.44659E-04 5.54897E-04 6.10183E-04 6.62465E-04 2.92261E-04 6.39881E-04 5.43766E-04 5.05748E-04
4.75342E-04 5.49014E-04 6.45685E-04 3.27564E-04 3.35164E-04 3.56103E-04 3.65241E-04 4.00768E-04
4.49875E-04 4.57417E-04 3.99889E-04 4.27728E-04 4.90605E-04 5.10560E-04 4.90304E-04 5.69784E-04
6.45659E-04 6.02408E-04 6.76723E-04 6.79825E-04 8.30932E-04 8.00576E-04 9.07131E-04 8.12380E-04
1.02867E-03 9.95537E-04 1.24268E-03 1.39781E-03 1.42751E-03 5.60983E-04 1.36722E-03 1.60410E-03
3.93554E-03 5.36639E-03 7.53546E-03 1.06727E-02 1.27701E-02 1.92169E-02 2.41852E-02 3.43599E-02
3.91109E-02 5.61398E-02 2.91216E-02 3.31910E-02 3.59649E-02 3.49135E-02 3.96046E-02 3.83972E-02
4.26625E-02 4.50701E-02 4.75738E-02 4.52042E-02 8.66221E-02 7.62857E-02 6.59733E-02 5.35974E-02
4.00935E-02 2.34535E-02 9.12749E-03 2.94488E-03 5.79311E-04 1.26783E-04 4.57416E-05 1.71913E-05
2.43766E-05
*% standard deviation
1.87550E+02 1.27284E+02 9.66683E+01 4.49899E+01 3.72320E+01 6.27823E+01 7.60041E+01 8.54211E+01
8.89800E+01 9.12476E+01 8.88310E+01 9.55183E+01 3.41040E+01 5.60759E+01 3.84059E+01 3.52483E+01
5.52341E+00 3.01400E+01 2.60222E+01 2.37752E+01 3.03122E+01 4.76093E+01 4.41992E+01 3.95967E+01
4.46485E+01 2.67116E+01 2.43046E+01 3.59145E+01 4.02002E+01 4.43304E+01 4.23890E+01 4.03981E+01
3.92219E+01 3.77972E+01 3.50122E+01 2.99826E+01 3.34817E+01 3.61563E+01 3.63212E+01 3.50000E+01
3.44935E+01 3.42761E+01 3.35419E+01 3.34623E+01 3.25955E+01 3.14545E+01 3.09695E+01 3.13348E+01
3.03087E+01 3.07700E+01 2.94393E+01 2.85061E+01 2.73154E+01 2.90659E+01 2.87257E+01 2.78273E+01
2.22463E+01 2.14504E+01 2.03769E+01 1.94497E+01 1.83077E+01 1.82338E+01 1.76137E+01 1.66641E+01
1.63989E+01 1.55438E+01 1.80038E+01 1.77815E+01 1.76516E+01 1.73167E+01 1.70490E+01 1.70371E+01
1.65987E+01 1.48889E+01 1.56121E+01 1.54267E+01 1.27281E+01 1.16548E+01 1.19433E+01 1.17424E+01
1.16105E+01 1.26730E+01 1.06416E+01 1.14355E+01 9.75639E+00 1.31817E+01 1.62108E+01 1.83015E+01
2.20656E+01
*correlation coefficient -- upper triangular
1.00000E+02 6.86262E+01 4.43568E+01 -5.14519E-01 -4.89981E+01 -3.46038E+01 -2.76053E+01 -2.33009E+01
-1.87797E+01 -1.52663E+01 -1.32535E+01 -3.76902E+00 1.78827E+01 2.93597E+00 2.47528E+00 9.17494E-01
-1.48474E+00 5.46671E-01 4.64846E-01 9.87128E-01 9.35278E+00 3.11750E+00 6.33721E-01 2.02425E-01
1.88651E-01 3.61973E-01 4.08967E-01 2.07346E-01 9.75755E-02 1.94543E-01 2.11900E-01 2.18865E-01
2.36575E-01 3.70542E-01 5.44585E-01 7.41625E-01 6.50877E-01 4.71691E-01 3.46454E-01 3.43049E-01
3.39096E-01 3.33701E-01 3.31002E-01 3.29203E-01 3.30878E-01 3.33661E-01 3.34857E-01 3.33431E-01
3.36588E-01 3.31489E-01 3.35137E-01 3.40612E-01 3.46573E-01 3.36261E-01 3.37578E-01 3.45068E-01
4.86841E-01 3.82063E-01 3.83402E-01 3.70926E-01 3.69324E-01 3.49476E-01 3.14029E-01 2.90255E-01
2.42899E-01 9.60073E-02 1.01413E-01 1.11105E-01 1.40088E-01 1.88000E-01 2.35306E-01 2.77648E-01
3.06448E-01 2.87070E-01 3.20239E-01 3.89448E-01 5.72811E-01 7.13022E-01 7.17686E-01 6.93719E-01
6.67019E-01 6.17178E-01 7.82853E-01 7.03182E-01 8.36253E-01 6.79701E-01 5.53784E-01 4.71492E-01
4.04093E-01
1.00000E+02 7.70325E+01 1.08105E+01 -6.65299E+01 -5.00699E+01 -4.02705E+01 -3.38635E+01 -2.79326E+01
-2.27138E+01 -1.98960E+01 -6.22087E+00 2.22412E+01 3.82084E+00 2.72176E+00 1.17562E+00 -8.01400E-01
6.63102E-01 5.81701E-01 1.10710E+00 8.85207E+00 2.49517E+00 -3.59165E-02 -3.39135E-01 3.61000E-02
5.26562E-01 6.43036E-01 2.13894E-01 2.04601E-01 3.03620E-01 3.27539E-01 4.36082E-01 5.60977E-01
9.09011E-01 1.61156E+00 2.53682E+00 1.71885E+00 9.08956E-01 5.72205E-01 4.65460E-01 4.58973E-01
4.50734E-01 4.45747E-01 4.42985E-01 4.44196E-01 4.46537E-01 4.47513E-01 4.46006E-01 4.48948E-01
4.42218E-01 4.45271E-01 4.51579E-01 4.57943E-01 4.46238E-01 4.47532E-01 4.56790E-01 7.04455E-01
5.95353E-01 5.93632E-01 5.71883E-01 5.64782E-01 6.37425E-01 4.80746E-01 5.44500E-01 3.70648E-01
1.99597E-01 2.19523E-01 1.29132E-01 1.71054E-01 2.39723E-01 3.07778E-01 3.69864E-01 4.09763E-01
3.16626E-01 3.70428E-01 4.71187E-01 6.20759E-01 9.14744E-01 9.24900E-01 9.84780E-01 8.46445E-01
7.84439E-01 1.00470E+00 8.97641E-01 1.06988E+00 8.34704E-01 6.71286E-01 6.60649E-01 4.76361E-01
1.00000E+02 3.30769E+01 -7.35963E+01 -5.91516E+01 -4.81496E+01 -4.14384E+01 -3.36997E+01 -2.75754E+01
-2.44529E+01 -8.58374E+00 2.36848E+01 4.08837E+00 2.44451E+00 1.30283E+00 2.07366E-01 7.43834E-01
6.57237E-01 1.08128E+00 6.72729E+00 1.45162E+00 -8.30220E-01 -8.12965E-01 -1.43667E-01 5.50443E-01
7.32269E-01 2.90889E-01 1.84716E-01 3.88431E-01 5.17797E-01 6.26528E-01 8.57662E-01 1.31854E+00
2.54698E+00 4.19498E+00 2.75345E+00 1.41590E+00 7.68094E-01 6.57117E-01 5.47563E-01 4.36124E-01
4.28157E-01 4.24357E-01 4.24233E-01 4.24911E-01 4.25119E-01 4.23946E-01 4.25487E-01 4.17674E-01
4.18511E-01 5.24886E-01 5.30015E-01 4.18839E-01 5.20130E-01 5.29929E-01 7.72978E-01 7.58601E-01
7.51244E-01 6.16433E-01 6.00174E-01 7.64946E-01 5.87288E-01 6.32108E-01 4.34330E-01 2.35903E-01
1.75953E-01 1.91813E-01 1.42506E-01 2.30454E-01 3.17988E-01 3.99486E-01 4.48666E-01 2.74017E-01
2.50527E-01 3.82324E-01 6.81538E-01 1.02191E+00 1.03969E+00 1.08460E+00 1.02924E+00 8.65001E-01
1.12298E+00 9.95888E-01 1.19067E+00 9.06443E-01 7.21208E-01 6.90449E-01 5.98957E-01
1.00000E+02 -4.61734E-01 -7.09963E+01 -6.31751E+01 -5.52467E+01 -4.67685E+01 -3.87195E+01 -3.44779E+01
-1.32929E+01 2.20031E+01 4.38654E+00 1.58302E+00 1.38684E+00 3.14598E+00 6.95137E-01 6.74708E-01
6.86932E-01 -1.67052E+00 -2.51338E+00 -3.96534E+00 -2.38813E+00 -2.43737E-01 7.01721E-01 1.01154E+00
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8.34666E+00 5.37563E+00 2.50236E+00 1.20166E+00 8.68375E-01 6.44016E-01 5.17941E-01 4.94765E-01
4.85914E-01 4.78150E-01 4.69105E-01 4.64853E-01 4.65880E-01 4.58999E-01 4.46845E-01 4.34778E-01
4.37008E-01 5.33915E-01 4.31361E-01 5.29656E-01 6.40511E-01 1.04735E+00 7.98843E-01 8.60275E-01
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-1.77958E-01	-1.68893E-01	9.59532E-03	1.88947E-01	2.61460E-01	2.50841E-01	-4.15081E-02	-4.75782E-02
2.28271E-01	7.42005E-01	1.29350E+00	1.44823E+00	1.41926E+00	1.29065E+00	1.21621E+00	1.53108E+00
1.31922E+00	1.59651E+00	1.12252E+00	9.55825E-01	8.41216E-01	7.31954E-01		
1.00000E+02	4.70728E+01	2.26102E+01	1.47587E+01	8.95469E+00	5.62805E+00	4.37984E+00	-8.94426E-01
-1.76533E+01	-1.59007E+00	-5.75014E-01	1.96810E-02	4.49785E+00	-5.04333E-01	-4.77076E-01	-1.20004E+00
-1.52284E+01	-7.76600E+00	-5.85366E+00	-2.00545E+00	7.56697E-01	1.52973E-01	-3.37071E-02	-5.30093E-01
-4.84899E-01	-2.28233E-01	-7.26862E-02	-7.39079E-02	-7.61754E-03	2.34251E-01	8.45094E-01	1.49125E+00
8.38072E-01	2.02391E-01	-2.20471E-02	-7.21555E-02	-2.05735E-01	-2.39028E-01	-2.72994E-01	-2.84403E-01
-3.01044E-01	-3.22131E-01	-3.31818E-01	-3.27154E-01	-3.45326E-01	-3.55636E-01	-3.83660E-01	-3.91045E-01
-4.09217E-01	-3.91785E-01	-3.98012E-01	-3.95496E-01	-4.73216E-01	-5.46815E-01	-6.18559E-01	-7.57623E-01
-8.68969E-01	-8.76086E-01	-1.12013E+00	-1.24340E+00	-1.41359E+00	-1.63180E+00	-1.32906E+00	-1.30188E+00
-1.16853E+00	-9.60971E-01	-7.50550E-01	-6.40177E-01	-7.47085E-01	-6.48875E-01	-3.84748E-01	-6.01209E-02
4.34851E-01	9.15468E-01	1.00360E+00	8.38195E-01	6.73538E-01	6.47686E-01	1.01243E+00	8.14571E-01
1.01548E+00	5.61246E-01	3.65608E-01	1.68475E-01	1.19125E-01			
1.00000E+02	7.78999E+01	6.14153E+01	4.76548E+01	3.79913E+01	3.30166E+01	1.08495E+01	-3.07703E+01
-4.10191E+00	-4.25981E-01	-6.25718E-01	1.88450E+00	-1.05015E+00	-1.00475E+00	-1.62770E+00	-1.22521E+01
-5.82361E+00	-3.62594E+00	-5.06536E-01	1.27655E+00	-2.84071E-01	-6.23470E-01	-8.53635E-01	-8.20471E-01
-6.81835E-01	-6.50866E-01	-8.54389E-01	-1.31687E+00	-2.03304E+00	-3.93850E+00	-6.29850E+00	-4.14434E+00
-1.95501E+00	-9.29155E-01	-6.60779E-01	-5.81351E-01	-5.01307E-01	-5.22867E-01	-6.30182E-01	-6.41760E-01
-6.56661E-01	-6.63479E-01	-5.59473E-01	-5.72533E-01	-5.77669E-01	-6.97954E-01	-7.04679E-01	-7.18728E-01
-7.03721E-01	-7.08290E-01	-8.09711E-01	-1.17795E+00	-1.12520E+00	-1.17398E+00	-1.06033E+00	-1.23628E+00
-1.60908E+00	-1.55792E+00	-1.91032E+00	-1.76960E+00	-1.66064E+00	-1.35288E+00	-1.23447E+00	-1.05199E+00
-9.30227E-01	-8.06307E-01	-6.79289E-01	-7.26602E-01	-5.19773E-01	-5.37067E-02	1.34967E-01	3.96784E-01
4.67760E-01	4.26912E-01	2.28395E-01	2.26356E-01	2.25528E-01	4.11571E-01	3.07344E-01	3.96246E-01
1.80391E-01	-6.43825E-03	-2.09430E-01	-2.20194E-01				
1.00000E+02	8.82060E+01	6.95309E+01	5.59598E+01	4.92794E+01	1.78260E+01	-3.61339E+01	-5.23550E+00
-1.07394E-01	-7.96396E-01	9.67710E-01	-1.25980E+00	-1.29850E+00	-1.91317E+00	-1.10550E+01	-5.33753E+00
-3.18995E+00	9.55958E-02	1.67600E+00	-3.31858E-01	-8.25943E-01	-1.07019E+00	-1.04679E+00	-9.17952E-01
-9.90878E-01	-1.39251E+00	-2.06025E+00	-3.38795E+00	-6.91107E+00	-1.10681E+01	-7.21321E+00	-3.30496E+00
-1.46738E+00	-9.91985E-01	-7.08052E-01	-6.24341E-01	-7.41657E-01	-7.47341E-01	-7.55824E-01	-7.66614E-01
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-8.05230E-01	-1.00544E+00	-1.65265E+00	-1.48927E+00	-1.62833E+00	-1.29506E+00	-1.45498E+00	-2.12314E+00
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-7.85618E-01	-6.79725E-01	-7.33954E-01	-3.31308E-01	2.02829E-01	4.58905E-01	6.91800E-01	6.25790E-01
4.74877E-01	2.96033E-01	2.14671E-01	3.01486E-01	4.77152E-01	3.81528E-01	5.73301E-01	1.61181E-01
-3.17828E-02	-3.27379E-01	-2.50287E-01					
1.00000E+02	8.34165E+01	6.72430E+01	5.94607E+01	2.24196E+01	-3.83845E+01	-5.73498E+00	2.73607E-01
-9.52470E-01	5.17751E-01	-1.37948E+00	-1.50495E+00	-2.01107E+00	-1.03237E+01	-5.12335E+00	-3.00026E+00
3.19516E-01	1.89336E+00	-4.66926E-01	-1.03437E+00	-1.19880E+00	-1.18344E+00	-1.06200E+00	-1.23595E+00
-1.73536E+00	-2.60505E+00	-4.33728E+00	-8.96500E+00	-1.44092E+01	-9.26403E+00	-4.25059E+00	-1.80751E+00
-1.12735E+00	-8.40945E-01	-7.55176E-01	-8.69483E-01	-8.74440E-01	-8.80538E-01	-8.88105E-01	-8.91611E-01
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-2.11519E+00	-1.94278E+00	-1.67188E+00	-1.80284E+00	-1.35707E+00	-1.60717E+00	-2.37160E+00	-2.17859E+00
-2.79308E+00	-2.20467E+00	-1.83095E+00	-1.59562E+00	-1.27167E+00	-1.00422E+00	-9.09720E-01	-7.11535E-01
-6.16683E-01	-6.72987E-01	-6.40956E-02	4.48939E-01	6.88197E-01	9.19699E-01	8.40192E-01	5.83300E-01
3.18695E-01	3.45606E-01	4.19772E-01	7.01629E-01	5.07385E-01	7.17522E-01	1.79691E-01	-3.09134E-02
-3.29985E-01	-2.68467E-01						
1.00000E+02	8.94174E+01	7.95368E+01	3.18266E+01	-4.32407E+01	-6.87376E+00	6.43626E-01	-1.05230E+00
4.78637E-03	-1.75492E-00	-1.76036E+00	-2.25313E+00	-1.02095E+01	-5.25279E+00	-3.23130E+00	6.66639E-01
2.42587E+00	-5.32954E-01	-1.18152E+00	-1.49272E+00	-1.48859E+00	-1.37629E+00	-1.64733E+00	-2.24246E+00
-3.51013E+00	-6.03868E+00	-1.26482E+01	-2.02403E+01	-1.30415E+01	-5.84773E+00	-2.40528E+00	-1.42074E+00
-1.03232E+00	-9.45460E-01	-9.56686E-01	-1.06149E+00	-9.64188E-01	-9.67430E-01	-9.68993E-01	-9.68955E-01
-9.71130E-01	-9.78157E-01	-9.82557E-01	-1.08043E+00	-1.08037E+00	-1.08426E+00	-1.08484E+00	-1.37942E+00
-2.37531E+00	-1.99720E+00	-2.22000E+00	-1.56255E+00	-1.80027E+00	-2.97061E+00	-2.66850E+00	-3.38106E+00
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-6.43129E-01	1.91043E-01	8.89957E-01	1.12477E+00	1.49367E+00	1.23285E+00	6.89816E-01	5.15912E-01
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-2.05631E-01							
1.00000E+02	9.29142E+01	4.25207E+01	-4.50426E+01	-7.92492E+00	1.29383E+00	-1.07744E+00	-4.01261E-01
-1.76213E+00	-1.85333E+00	-2.33614E+00	-9.52800E+00	-5.10030E+00	-3.17954E+00	1.00541E+00	2.75684E+00
-5.33139E-01	-1.26844E+00	-1.61436E+00	-1.61853E+00	-1.61305E+00	-1.78162E+00	-2.57363E+00	-4.03945E+00
-6.96496E+00	-1.46620E+01	-2.36194E+01	-1.50515E+01	-6.70900E+00	-2.72931E+00	-1.64186E+00	-1.15204E+00
-9.64241E-01	-1.07368E+00	-1.07792E+00	-1.07864E+00	-9.78418E-01	-9.78559E-01	-9.79572E-01	-9.78684E-01
-9.68939E-01	-1.08757E+00	-1.08195E+00	-1.17813E+00	-1.08758E+00	-1.18747E+00	-1.47899E+00	-2.65156E+00
-2.16803E+00	-2.38397E+00	-1.71992E+00	-1.94874E+00	-3.21970E+00	-2.91226E+00	-3.71936E+00	-2.80835E+00
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3.78809E-01	1.16736E+00	1.40010E+00	1.79949E+00	1.45452E+00	1.08509E+00	7.36840E-01	7.73870E-01
9.00967E-01	1.26790E+00	1.03796E+00	1.33764E+00	5.45665E-01	2.50197E-01	-1.87956E-01	-1.84332E-01
1.00000E+02	6.08912E+01	-4.66586E+01	-1.00688E+01	2.93603E+00	-1.02099E+00	-4.74712E-01	-1.80255E+00
-1.98524E+00	-2.36088E+00	-8.66313E+00	-4.65565E+00	-2.62954E+00	1.37112E+00	3.11763E+00	-5.60095E-01
-1.39340E+00	-1.66517E+00	-1.67438E+00	-1.67259E+00	-1.93854E+00	-2.72818E+00	-4.29142E+00	-7.41213E+00
-1.54963E+01	-2.50285E+01	-1.60824E+01	-7.11641E+00	-2.97797E+00	-1.68936E+00	-1.19928E+00	-1.01159E+00
-1.12021E+00	-1.22469E+00	-1.12389E+00	-1.12216E+00	-1.02119E+00	-1.02285E+00	-1.12049E+00	-1.02946E+00
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-2.49951E+00	-1.73200E+00	-1.95626E+00	-3.43182E+00	-3.02278E+00	-3.93053E+00	-2.91914E+00	-2.21004E+00
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1.00000E+02	-3.53308E+01	-1.33575E+01	6.96787E+00	-4.08538E-01	-4.84200E-01	-9.66968E-01	-1.24273E+00
-1.41346E+00	-2.80131E+00	-1.37128E+00	-6.62588E-02	2.49872E+00	3.06869E+00	-2.37970E-01	-9.55154E-01
-1.03358E+00	-1.14695E+00	-1.14888E+00	-1.41591E+00	-2.00449E+00	-3.26950E+00	-5.69595E+00	-1.20017E+01
-1.94779E+01	-1.23878E+01	-5.49774E+00	-2.25396E+00	-1.26297E+00	-8.71572E-01	-6.82658E-01	-7.89680E-01
-7.93550E-01	-6.91522E-01	-6.88194E-01	-6.86813E-01	-6.88923E-01	-6.84786E-01	-6.94142E-01	-6.89868E-01
-7.81536E-01	-7.72762E-01	-7.88946E-01	-7.87164E-01	-1.07567E+00	-2.02054E+00	-1.63149E+00	-1.83887E+00
-1.16503E+00	-1.38207E+00	-2.54728E+00	-2.22754E+00	-2.91539E+00	-2.20077E+00	-1.68345E+00	-1.43119E+00
-1.10253E+00	-8.36768E-01	-6.37729E-01	-5.42572E-01	-3.53378E-01	-3.99736E-01	4.65412E-01	1.03968E+00
1.37093E+00	1.70133E+00	1.66308E+00	1.28669E+00	1.04271E+00	1.08578E+00	1.09640E+00	1.49622E+00
1.25277E+00	1.58831E+00	8.33211E-01	5.04799E-01	1.51909E-01	3.24088E-02		

1.00000E+02	3.96068E+00	-6.65291E-01	-4.69780E+00	5.88602E+00	8.76274E-01	9.38770E-02	1.34149E+00
2.36423E+01	1.47010E+01	1.62868E+01	1.31912E+01	6.94227E+00	1.05229E+00	9.94206E-02	9.49533E-01
1.14301E+00	5.63209E-01	4.43284E-01	6.62514E-01	1.44523E+00	2.80951E+00	6.35272E+00	1.03468E+01
6.36867E+00	2.49908E+00	7.70013E-01	3.35979E-01	1.07860E-01	-2.49056E-02	1.49115E-01	1.37950E-01
1.34335E-01	3.18471E-02	3.03662E-02	2.85735E-02	2.84793E-02	8.13832E-03	4.38018E-03	1.66611E-02
2.47758E-02	3.48177E-03	4.12728E-03	1.27461E-01	4.08273E-01	2.58235E-01	2.24972E-01	-1.86768E-01
-2.50446E-01	3.97128E-02	-3.95480E-01	-4.82091E-01	-1.28181E+00	-2.10258E+00	-1.81189E+00	-1.97544E+00
-1.92128E+00	-1.66856E+00	-1.41565E+00	-9.72343E-01	-5.31669E-01	-1.84461E-01	1.52207E-01	6.24990E-01
1.62097E+00	2.76684E+00	3.11406E+00	2.96219E+00	2.41279E+00	2.15461E+00	2.82912E+00	2.49345E+00
2.98866E+00	2.00439E+00	1.53075E+00	1.28546E+00	1.06071E+00			
1.00000E+02	-7.07730E+01	-1.82189E+01	7.59317E+00	-4.97036E+00	-4.49694E+00	-3.32068E+00	1.69191E+00
-2.33961E-01	1.81339E+00	5.70085E+00	5.55570E+00	4.39988E-01	-5.27775E-01	-9.22245E-01	-8.65482E-01
-9.84844E-01	-9.21734E-01	-7.93948E-01	-4.31629E-01	1.85663E-01	1.34022E+00	2.57945E+00	1.26896E+00
9.47113E-02	-3.90652E-01	-4.98361E-01	-6.10281E-01	-7.28075E-01	-8.35131E-01	-9.41006E-01	-1.03255E+00
-1.11935E+00	-1.11367E+00	-1.11979E+00	-1.20551E+00	-1.22479E+00	-1.30781E+00	-1.38556E+00	-1.46059E+00
-1.40272E+00	-1.39698E+00	-1.36756E+00	-1.60126E+00	-1.91396E+00	-2.10675E+00	-2.55422E+00	-2.65999E+00
-2.73460E+00	-3.17500E+00	-3.37171E+00	-3.55523E+00	-3.72446E+00	-2.65934E+00	-2.41738E+00	-2.00274E+00
-1.41799E+00	-8.38424E-01	-4.84938E-01	-3.79481E-01	1.04346E+00	1.94716E+00	2.57659E+00	3.43168E+00
3.42767E+00	2.94994E+00	2.68269E+00	2.49992E+00	2.30226E+00	3.01830E+00	2.72406E+00	3.32914E+00
1.97227E+00	1.38757E+00	7.80992E-01	6.14121E-01				
1.00000E+02	2.27468E+01	1.01682E+01	-8.68398E+00	-7.25207E+00	-5.52802E+00	-2.84855E-01	-2.64288E+00
-3.17600E-01	3.22998E+00	3.22664E+00	-3.03741E-01	-1.12644E+00	-1.19765E+00	-1.18163E+00	-1.62222E+00
-1.52289E+00	-1.27597E+00	-6.83448E-01	9.10950E-02	1.67089E+00	3.49246E+00	1.62211E+00	1.28763E-02
-6.09785E-01	-8.12550E-01	-1.02569E+00	-1.14992E+00	-1.35452E+00	-1.36283E+00	-1.44446E+00	-1.61621E+00
-1.60456E+00	-1.61603E+00	-1.78649E+00	-1.71874E+00	-1.88263E+00	-2.04127E+00	-2.09373E+00	-2.07090E+00
-2.05977E+00	-2.10859E+00	-2.50078E+00	-2.90566E+00	-3.17709E+00	-3.82774E+00	-4.11569E+00	-4.22447E+00
-4.91747E+00	-5.34303E+00	-5.60963E+00	-5.94530E+00	-4.40819E+00	-3.94160E+00	-3.27133E+00	-2.39539E+00
-1.52815E+00	-8.00709E-01	-4.33773E-01	2.07651E+00	3.59748E+00	4.43197E+00	5.77697E+00	5.75437E+00
4.88425E+00	4.40176E+00	4.18657E+00	3.84857E+00	5.14383E+00	4.57417E+00	5.61077E+00	3.34003E+00
2.33721E+00	1.34488E+00	1.08970E+00					
1.00000E+02	-8.71829E-01	3.95329E-01	9.55388E-01	1.36234E+00	-1.96718E+00	-2.41679E+00	-4.15405E+00
-8.84350E+00	-8.95938E+00	-1.93561E-01	1.22132E+00	1.53511E+00	1.26182E+00	8.05071E-01	6.70021E-01
7.76296E-01	6.50905E-01	5.07020E-01	1.53731E-01	-3.32905E-01	1.54838E-01	5.80989E-01	6.48987E-01
8.03083E-01	8.70881E-01	9.37317E-01	1.00615E+00	1.09484E+00	1.08275E+00	1.16836E+00	1.16160E+00
1.16394E+00	1.25248E+00	1.23846E+00	1.31948E+00	1.31931E+00	1.31077E+00	1.21367E+00	1.20994E+00
1.22010E+00	1.50228E+00	1.43806E+00	1.38135E+00	1.35640E+00	1.36697E+00	7.48127E-01	3.05494E-01
-3.18078E-01	-9.08681E-01	-1.74996E+00	-1.68853E+00	-1.75868E+00	-1.71652E+00	-1.48716E+00	-1.25571E+00
-6.19498E-01	2.43493E-03	-2.50188E-01	-6.97125E-01	-4.43960E-01	1.78816E-01	1.32885E+00	1.98996E+00
2.02113E+00	1.56305E+00	1.29350E+00	1.67830E+00	1.62173E+00	1.73678E+00	1.57625E+00	1.38027E+00
1.52739E+00	1.31635E+00						
1.00000E+02	-2.81810E+00	-9.84474E-03	6.09717E-01	2.08434E+00	-1.58062E+01	-2.43029E+00	1.23157E+01
1.26447E+01	1.23232E-03	8.43250E-01	-1.89884E+00	-1.50557E+00	-7.36199E-01	-3.01688E-01	2.16841E-02
6.00492E-01	2.05269E+00	4.98131E+00	8.32104E+00	4.83652E+00	1.64548E+00	7.10690E-01	4.33679E-01
1.45448E-01	-6.82076E-02	-2.59613E-01	-3.32368E-01	-3.97757E-01	-5.62363E-01	-5.98391E-01	-5.89106E-01
-6.48057E-01	-7.46703E-01	-8.49210E-01	-8.33540E-01	-8.66097E-01	-8.78312E-01	-8.96321E-01	-8.13187E-01
-8.06725E-01	-1.38196E+00	-1.81032E+00	-2.87838E+00	-3.53172E+00	-3.98834E+00	-5.25736E+00	-6.32900E+00
-8.12910E+00	-1.00379E+01	-8.48034E+00	-8.25598E+00	-7.32609E+00	-5.85248E+00	-4.27993E+00	-2.92272E+00
-2.44219E+00	-7.73688E-01	9.14432E-01	3.32567E+00	7.55963E+00	1.12256E+01	1.16976E+01	1.06670E+01
9.69998E+00	9.10050E+00	1.23604E+01	1.06424E+01	1.28833E+01	8.25238E+00	6.09851E+00	4.35457E+00
3.47281E+00							
1.00000E+02	5.38731E+00	3.30044E+00	-4.40425E-01	-7.60437E-01	-9.71487E-01	-1.54492E+00	-1.19029E+00
2.59898E+00	3.39867E+00	2.34752E+00	2.03722E+00	1.73285E+00	1.68611E+00	1.76998E+00	1.53918E+00
1.19722E+00	3.49733E-01	-3.76719E-01	4.23809E-01	1.44363E+00	1.89705E+00	2.12457E+00	2.28013E+00
2.33836E+00	2.38999E+00	2.37538E+00	2.44596E+00	2.50723E+00	2.59010E+00	2.49967E+00	2.66585E+00
2.55898E+00	2.70869E+00	2.78677E+00	2.84689E+00	2.59255E+00	2.57996E+00	2.66970E+00	3.17307E+00
3.26975E+00	3.25856E+00	3.37642E+00	3.31439E+00	2.57309E+00	2.16786E+00	1.56107E+00	8.16867E-01
-1.22155E-01	-3.93522E-01	-4.73388E-01	-4.22434E-01	-2.90338E-01	-1.51946E-01	1.03110E-01	4.04671E-01
-1.69282E+00	-2.94837E+00	-2.74664E+00	-2.39222E+00	-7.88898E-01	4.20976E-01	6.88731E-01	2.79759E-01
-4.96761E-02	-9.33645E-02	1.39665E-01	-2.99214E-01	6.76397E-01	9.28829E-01	1.48607E+00	1.35056E+00
1.00000E+02	6.44480E+00	-9.31028E-01	-9.28455E-01	-1.24910E+00	-1.98524E+00	-1.61848E+00	3.12303E+00
4.04354E+00	2.80993E+00	2.41535E+00	2.12789E+00	2.08849E+00	2.16882E+00	1.94794E+00	1.62927E+00
7.32530E-01	5.63411E-02	8.01434E-01	1.86650E+00	2.29764E+00	2.61382E+00	2.66134E+00	2.71286E+00
2.85724E+00	2.84027E+00	2.90553E+00	3.06072E+00	3.03949E+00	3.05185E+00	3.11079E+00	3.10432E+00
3.24485E+00	3.31850E+00	3.37096E+00	3.12576E+00	3.11082E+00	3.19793E+00	3.86492E+00	4.04557E+00
4.01500E+00	4.00029E+00	4.01231E+00	3.25022E+00	2.69381E+00	1.93427E+00	1.13792E+00	2.64041E-02
-3.77007E-01	-5.58105E-01	-4.83325E-01	-3.15367E-01	-1.40083E-01	1.54892E-01	5.73125E-01	-2.02301E+00
-3.52520E+00	-3.36119E+00	-2.94628E+00	-1.06672E+00	3.64167E-01	7.92288E-01	2.50291E-01	-6.27932E-02
-1.80133E-01	3.46479E-02	-5.08298E-01	6.57286E-01	1.01547E+00	1.75834E+00	1.54109E+00	
1.00000E+02	9.14463E-01	-1.18161E+00	-4.38901E-01	-1.31966E+00	-1.34114E+00	3.41462E+00	4.38359E+00
3.14776E+00	2.76116E+00	2.28097E+00	2.24797E+00	2.32719E+00	2.21503E+00	1.91387E+00	1.15568E+00
5.19728E-01	1.22252E+00	2.14606E+00	2.46057E+00	2.76950E+00	2.81230E+00	2.96027E+00	3.09980E+00
3.08127E+00	3.14374E+00	3.29535E+00	3.27244E+00	3.28574E+00	3.34145E+00	3.33404E+00	3.46982E+00
3.54165E+00	3.69179E+00	3.34918E+00	3.43435E+00	3.52090E+00	4.27276E+00	4.34139E+00	4.29972E+00
4.36779E+00	4.36367E+00	3.48452E+00	2.89545E+00	2.20857E+00	1.27241E+00	1.15569E-02	-4.51384E-01
-6.29628E-01	-5.37651E-01	-4.46946E-01	-2.44312E-01	7.91402E-02	6.11947E-01	-2.17109E+00	-3.73816E+00
-3.63136E+00	-3.15920E+00	-1.11877E+00	4.24897E-01	9.28153E-01	2.64583E-01	-4.58530E-02	-1.27748E-01
1.64678E-01	-4.63330E-01	7.65205E-01	1.21066E+00	1.93497E+00	1.71937E+00		
1.00000E+02	4.63388E+01	3.68167E+01	2.55614E+01	1.16445E+01	9.98634E-01	-7.02897E-01	1.32102E+00
1.41855E+00	6.46146E-01	2.36114E-01	5.55247E-01	1.24743E+00	2.13423E+00	4.63181E+00	7.30330E+00
4.54883E+00	1.72093E+00	-1.24174E-01	-7.63605E-01	-7.97081E-01	-4.36409E-01	-1.67304E-01	1.93344E-02
-8.57628E-02	-9.06257E-02	-9.31188E-02	-1.94267E-01	-9.64108E-02	-1.86956E-02	-2.53068E-02	-1.32973E-02
-1.06582E-01	-1.26897E-01	-1.26847E-01	-2.53742E-03	1.72979E-01	1.37749E-02	-2.80269E-02	-3.56710E-01
-5.34954E-01	-4.63174E-01	-9.32601E-01	-1.15338E+00	-1.99282E+00	-2.96440E+00	-2.73290E+00	-2.89200E+00
-2.92010E+00	-2.63518E+00	-2.34953E+00	-1.67056E+00	-8.09636E-01	2.77470E-01	7.44896E-01	1.15825E+00
-2.02745E+00	2.94852E+00	3.20974E+00	3.03574E+00	2.56177E+00	2.29537E+00	3.02968E+00	2.66265E+00
3.19549E+00	2.13131E+00	1.62158E+00	1.24550E+00	1.00772E+00			
1.00000E+02	6.16341E+01	2.63565E+01	9.07386E+00	-1.24086E-01	-1.46809E+00	-2.27276E+00	-2.78664E+00
-1.38324E+00	-9.22178E-01	-6.03645E-01	-4.38592E-01	-2.10114E-01	1.26460E+00	3.59588E+00	2.27452E+00

5.82699E-01	-5.14446E-01	-9.35447E-01	-1.05463E+00	-9.78100E-01	-8.94177E-01	-8.02065E-01	-8.01564E-01
-6.99095E-01	-6.98196E-01	-7.00986E-01	-5.96701E-01	-6.13415E-01	-7.10425E-01	-6.97129E-01	-7.85451E-01
-8.09511E-01	-8.07459E-01	-6.85920E-01	-6.93129E-01	-8.24055E-01	-8.39651E-01	-1.21496E+00	-1.25104E+00
-1.13259E+00	-1.50232E+00	-1.63337E+00	-2.15237E+00	-2.88885E+00	-2.56511E+00	-2.63479E+00	-2.62010E+00
-2.42910E+00	-2.23830E+00	-1.65250E+00	-8.35101E-01	5.59728E-01	1.01482E+00	1.38044E+00	2.10108E+00
2.59625E+00	2.62825E+00	2.33144E+00	2.02521E+00	1.87936E+00	2.42667E+00	2.15844E+00	2.67339E+00
1.66057E+00	1.26026E+00	7.84287E-01	6.82666E-01				
1.00000E+02	5.30609E+01	1.68820E+01	-1.11809E+00	-3.51886E+00	-5.06365E+00	-6.41914E+00	-3.06971E+00
-2.28958E+00	-1.75293E+00	-1.57000E+00	-1.51225E+00	6.12987E-01	4.22925E+00	2.82770E+00	5.85781E-01
-1.31196E+00	-1.91498E+00	-2.02877E+00	-2.05138E+00	-2.05863E+00	-1.96660E+00	-1.95322E+00	-1.63387E+00
-1.52524E+00	-1.53439E+00	-1.41266E+00	-1.43900E+00	-1.61122E+00	-1.67843E+00	-1.74058E+00	-1.70274E+00
-1.69392E+00	-1.45287E+00	-1.60553E+00	-1.81320E+00	-1.89245E+00	-2.33933E+00	-2.43155E+00	-2.11884E+00
-2.68208E+00	-2.78185E+00	-3.62152E+00	-4.64986E+00	-4.12456E+00	-4.38492E+00	-4.45039E+00	-4.31930E+00
-3.88469E+00	-2.87007E+00	-1.31048E+00	1.53190E+00	2.64823E+00	3.14256E+00	4.03460E+00	4.68126E+00
4.48758E+00	4.01552E+00	3.62094E+00	3.14825E+00	4.18444E+00	3.78649E+00	4.68045E+00	2.77130E+00
2.00272E+00	1.18877E+00	9.14756E-01					
1.00000E+02	5.44499E+01	-1.62967E+00	-8.01588E+00	-5.33894E+00	-6.80639E+00	-3.89206E+00	-3.85270E+00
-2.97596E+00	-2.75299E+00	-2.82940E+00	9.03632E-02	4.50912E+00	2.62865E+00	-6.09561E-01	-3.68249E+00
-4.63063E+00	-4.72910E+00	-4.45353E+00	-4.14222E+00	-3.85327E+00	-3.80662E+00	-3.44411E+00	-3.41419E+00
-3.41116E+00	-3.17491E+00	-3.02800E+00	-3.23430E+00	-3.44859E+00	-3.54242E+00	-3.40466E+00	-3.47701E+00
-3.18804E+00	-3.63704E+00	-3.97833E+00	-3.96027E+00	-4.52238E+00	-4.69299E+00	-4.29647E+00	-5.01836E+00
-5.53020E+00	-6.88801E+00	-8.86814E+00	-8.02227E+00	-8.54854E+00	-8.76647E+00	-8.74193E+00	-8.12081E+00
-5.96324E+00	-2.43585E+00	4.00471E+00	6.58029E+00	7.32679E+00	8.87026E+00	9.67919E+00	9.21065E+00
8.31870E+00	7.38132E+00	6.38980E+00	8.61849E+00	7.71659E+00	9.59122E+00	5.67519E+00	3.95337E+00
2.31463E+00	1.80796E+00						
1.00000E+02	7.00483E+00	-8.06998E+00	-3.32024E+00	-4.30798E+00	-2.87237E+00	-3.42823E+00	-2.64667E+00
-2.52816E+00	-2.61956E+00	-3.12886E-01	3.11052E+00	1.45056E+00	-1.07737E+00	-3.84942E+00	-4.79340E+00
-4.69138E+00	-4.41147E+00	-3.89826E+00	-3.60737E+00	-3.55804E+00	-3.28995E+00	-3.25844E+00	-3.18610E+00
-3.01653E+00	-2.86860E+00	-3.07096E+00	-3.18521E+00	-3.37454E+00	-3.24039E+00	-3.21318E+00	-3.02151E+00
-3.45477E+00	-3.78719E+00	-3.75895E+00	-4.30481E+00	-4.36061E+00	-4.15105E+00	-4.84628E+00	-5.43312E+00
-6.76380E+00	-8.71088E+00	-8.00479E+00	-8.63626E+00	-8.86819E+00	-8.76305E+00	-8.16195E+00	-6.02201E+00
-2.39565E+00	4.14356E+00	6.59420E+00	7.30860E+00	8.91237E+00	9.67739E+00	9.29160E+00	8.41742E+00
7.49718E+00	6.40370E+00	8.61109E+00	7.72291E+00	9.59318E+00	5.69421E+00	3.97721E+00	2.44789E+00
1.93727E+00							
1.00000E+02	8.93760E+00	2.14240E+00	1.69225E+00	1.46086E+00	1.14103E+00	1.34350E+00	1.13786E+00
8.38493E-01	6.82310E-01	7.92018E-01	1.07500E+00	1.39748E+00	1.12510E+00	1.05950E+00	1.21503E+00
1.37002E+00	1.62607E+00	1.61066E+00	1.69098E+00	1.86672E+00	1.95561E+00	1.96055E+00	2.04012E+00
2.02416E+00	2.09192E+00	2.18656E+00	2.26826E+00	1.98219E+00	2.07565E+00	2.18385E+00	2.61756E+00
2.72739E+00	2.64207E+00	2.56832E+00	2.63850E+00	1.88392E+00	1.36211E+00	5.59195E-01	-4.28880E-01
-1.90257E+00	-2.03023E+00	-2.19679E+00	-2.21451E+00	-2.12425E+00	-1.92637E+00	-1.11537E+00	-5.77280E-02
-8.74142E-01	-1.62486E+00	-1.35997E+00	-7.00589E-01	1.18587E+00	2.36794E+00	2.43787E+00	1.72751E+00
1.27512E+00	1.64126E+00	1.73144E+00	1.57924E+00	1.83320E+00	1.71499E+00	2.01792E+00	1.71918E+00
1.00000E+02	3.61840E+00	2.60930E+00	2.21564E+00	2.08673E+00	2.17271E+00	2.06345E+00	1.66455E+00
1.01291E+00	4.97756E-01	1.08762E+00	1.90415E+00	2.22033E+00	2.33472E+00	2.48134E+00	2.63084E+00
2.77463E+00	2.75684E+00	2.92504E+00	2.98258E+00	3.06373E+00	3.07465E+00	3.13709E+00	3.12703E+00
3.27184E+00	3.35026E+00	3.40850E+00	3.15431E+00	3.14085E+00	3.23375E+00	3.93726E+00	4.01691E+00
4.09271E+00	4.07523E+00	4.09169E+00	3.21806E+00	2.64593E+00	1.87938E+00	8.50729E-01	-4.90096E-01
-8.98014E-01	-1.17644E+00	-1.18782E+00	-9.89952E-01	-8.88176E-01	-3.62055E-01	3.81787E-01	-1.74424E+00
-3.23238E+00	-3.03112E+00	-2.59488E+00	-5.32548E-01	1.08930E+00	1.40992E+00	7.58811E-01	4.06771E-01
4.04209E-01	6.62808E-01	1.20404E-01	1.10114E+00	1.36615E+00	2.05141E+00	1.78188E+00	
1.00000E+02	4.74679E+01	1.16186E+01	4.61968E+00	2.49137E+00	1.64373E+00	1.17267E+00	4.62283E-01
-3.89671E-02	6.36856E-01	1.32413E+00	1.80199E+00	1.93803E+00	1.99918E+00	2.06374E+00	2.12154E+00
2.10911E+00	2.18233E+00	2.24691E+00	2.33129E+00	2.24024E+00	2.30832E+00	2.30467E+00	2.35785E+00
2.43654E+00	2.49902E+00	2.34391E+00	2.33227E+00	2.42067E+00	2.83129E+00	2.94080E+00	2.94146E+00
2.98213E+00	2.93846E+00	2.32026E+00	1.96006E+00	1.49751E+00	9.09895E-01	1.37026E-01	-1.88195E-01
-2.73859E-01	-2.49559E-01	-1.59271E-01	-6.31268E-02	1.49797E-01	3.28697E-01	-1.60733E+00	-2.70983E+00
-2.67516E+00	-2.33002E+00	-1.02582E+00	7.00405E-02	3.69027E-01	-8.30744E-03	-2.29377E-01	-3.55116E-01
-7.87396E-02	-5.67036E-01	4.16556E-01	6.16542E-01	1.21625E+00	1.09641E+00		
1.00000E+02	4.18221E+01	1.37188E+01	5.56777E+00	2.30355E+00	1.11638E+00	7.67048E-02	-4.51852E-01
2.54334E-01	1.07280E+00	1.46288E+00	1.60599E+00	1.77189E+00	1.73970E+00	1.80219E+00	1.79109E+00
1.86743E+00	1.93615E+00	1.92166E+00	1.93023E+00	2.00209E+00	1.99865E+00	2.05732E+00	2.03785E+00
2.10487E+00	1.94420E+00	2.03477E+00	2.02397E+00	2.45796E+00	2.47643E+00	2.48837E+00	2.54660E+00
2.51915E+00	2.01484E+00	1.68241E+00	1.14428E+00	6.89428E-01	-4.57217E-02	-3.10263E-01	-3.97525E-01
-3.86224E-01	-2.12139E-01	-1.36449E-01	5.42413E-02	2.25624E-01	-1.41118E+00	-2.44616E+00	-2.34592E+00
-2.03277E+00	-8.69868E-01	1.14083E-01	3.35794E-01	-2.19041E-02	-1.54932E-01	-1.95900E-01	-1.04821E-01
-3.92576E-01	2.96635E-01	5.89968E-01	1.09732E+00	9.65598E-01			
1.00000E+02	4.00739E+01	1.46681E+01	4.67516E+00	1.57209E+00	-8.93955E-02	-1.23220E+00	-2.07951E-01
7.32255E-01	1.13192E+00	1.38170E+00	1.45069E+00	1.52212E+00	1.48822E+00	1.47821E+00	1.55757E+00
1.63036E+00	1.71837E+00	1.62511E+00	1.70071E+00	1.69704E+00	1.76111E+00	1.74463E+00	1.81633E+00
1.64966E+00	1.74152E+00	1.73296E+00	2.09109E+00	2.11875E+00	2.14134E+00	2.11328E+00	2.10058E+00
1.60509E+00	1.29465E+00	7.79660E-01	3.46927E-01	-2.53000E-01	-4.52925E-01	-5.40873E-01	-5.39171E-01
-3.79197E-01	-3.18090E-01	-1.43969E-01	1.25205E-01	-1.20555E+00	-2.06679E+00	-1.99423E+00	-1.69592E+00
-5.62286E-01	2.13875E-01	4.52759E-01	1.11565E-01	-3.51708E-02	-7.39082E-02	1.95655E-02	-2.51780E-01
3.17924E-01	5.95633E-01	1.00341E+00	8.55110E-01				
1.00000E+02	4.92245E+01	1.42477E+01	4.32984E+00	1.80795E-01	-1.83333E+00	-8.33727E-01	3.86565E-01
9.81112E-01	1.23081E+00	1.39965E+00	1.36965E+00	1.43611E+00	1.52631E+00	1.50604E+00	1.58017E+00
1.68875E+00	1.67555E+00	1.65194E+00	1.64688E+00	1.71272E+00	1.79887E+00	1.77213E+00	1.70257E+00
1.69424E+00	1.68800E+00	1.95970E+00	2.08867E+00	2.01182E+00	2.08410E+00	2.07316E+00	1.47161E+00
1.15450E+00	6.36068E-01	1.93438E-01	-5.19231E-01	-7.20839E-01	-8.06282E-01	-7.97801E-01	-6.26484E-01
-5.54155E-01	-2.68017E-01	1.10409E-01	-1.09609E+00	-1.95297E+00	-1.76587E+00	-1.52146E+00	-3.55158E-01
4.19982E-01	6.55223E-01	3.09704E-01	1.47598E-01	1.53111E-01	2.25844E-01	-7.54074E-03	4.91118E-01
6.33379E-01	1.01881E+00	9.49940E-01					
1.00000E+02	4.44319E+01	1.31433E+01	1.69003E+00	-2.40320E+00	-1.52132E+00	8.29600E-02	8.72471E-01
1.22024E+00	1.38760E+00	1.45660E+00	1.52158E+00	1.51078E+00	1.59025E+00	1.66338E+00	1.75151E+00
1.65795E+00	1.73408E+00	1.72863E+00	1.79314E+00	1.87890E+00	1.85125E+00	1.78261E+00	1.77399E+00
1.76775E+00	1.93433E+00	2.05995E+00	2.08109E+00	2.14742E+00	2.13164E+00	1.42327E+00	1.09534E+00
5.66664E-01	1.11977E-01	-6.15227E-01	-8.02554E-01	-8.86913E-01	-7.69114E-01	-5.89245E-01	-5.08255E-01
-2.13292E-01	6.68766E-02	-1.13189E+00	-1.97709E+00	-1.87649E+00	-1.51179E+00	-3.25434E-01	4.53831E-01

6.81780E-01	3.29008E-01	1.66592E-01	1.86145E-01	2.51080E-01	2.46359E-02	5.06760E-01	7.41650E-01
1.11988E+00	9.50016E-01						
1.00000E+02	4.80385E+01	9.45074E+00	-2.49997E+00	-2.73554E+00	-5.51033E-01	5.34133E-01	1.08322E+00
1.25049E+00	1.41929E+00	1.48477E+00	1.47381E+00	1.55466E+00	1.62982E+00	1.61826E+00	1.62454E+00
1.70269E+00	1.69575E+00	1.76294E+00	1.75043E+00	1.82661E+00	1.65256E+00	1.64473E+00	1.64125E+00
1.72585E+00	1.95402E+00	1.77606E+00	2.04610E+00	2.03430E+00	1.11897E+00	8.89459E-01	5.03222E-02
-2.05309E-01	-8.31986E-01	-9.24206E-01	-1.00605E+00	-8.83038E-01	-6.93987E-01	-6.04073E-01	-3.02231E-01
8.67663E-02	-9.86871E-01	-1.73053E+00	-1.61976E+00	-1.20939E+00	-9.16811E-02	6.84601E-01	9.11236E-01
5.56369E-01	2.77444E-01	4.42118E-01	4.85650E-01	3.01434E-01	7.05992E-01	8.01521E-01	1.15644E+00
9.62595E-01							
1.00000E+02	3.78982E+01	1.86776E+00	-4.05778E+00	-1.60580E+00	-2.82249E-02	6.23470E-01	9.91702E-01
1.15984E+00	1.22715E+00	1.21609E+00	1.30025E+00	1.48058E+00	1.47123E+00	1.47573E+00	1.55863E+00
1.44827E+00	1.52178E+00	1.61525E+00	1.59789E+00	1.51398E+00	1.40747E+00	1.30935E+00	1.13413E+00
1.46769E+00	1.29885E+00	1.77634E+00	1.67376E+00	3.47203E-01	2.15850E-01	-7.22778E-01	-7.81904E-01
-1.20022E+00	-1.42273E+00	-1.29255E+00	-1.05797E+00	-8.54229E-01	-7.50230E-01	-3.36683E-01	6.39108E-02
-6.58724E-01	-1.20580E+00	-9.80392E-01	-4.84550E-01	5.85077E-01	1.15826E+00	1.28843E+00	9.32480E-01
7.13281E-01	9.69937E-01	9.72000E-01	8.74104E-01	1.02358E+00	1.03698E+00	1.24710E+00	1.00277E+00
1.00000E+02	3.33320E+01	-2.28242E+00	-3.07599E+00	-9.18744E-01	3.75290E-02	4.06287E-01	6.72873E-01
7.44168E-01	7.32926E-01	9.24400E-01	1.01488E+00	1.11044E+00	1.11105E+00	1.10426E+00	1.08781E+00
1.17529E+00	1.18025E+00	1.17869E+00	1.07157E+00	9.69476E-01	5.84053E-01	-3.00230E-01	3.44362E-01
-6.15670E-03	1.08654E+00	9.06805E-01	-1.44177E+00	-1.17456E+00	-2.82416E+00	-2.18630E+00	-2.08673E+00
-2.16013E+00	-1.81351E+00	-1.35548E+00	-1.11980E+00	-8.82945E-01	-3.47828E-01	7.81702E-02	6.37696E-02
7.67169E-03	3.63803E-01	1.04849E+00	1.93646E+00	2.20032E+00	2.13867E+00	1.78058E+00	1.57434E+00
2.13125E+00	1.94484E+00	2.23018E+00	1.74293E+00	1.47681E+00	1.38879E+00	1.13288E+00	
1.00000E+02	3.71074E+01	5.22951E+00	5.09460E-01	1.74014E-01	2.41911E-01	4.03798E-01	3.76953E-01
3.64490E-01	5.61976E-01	7.61728E-01	7.61725E-01	7.58433E-01	8.61582E-01	8.36923E-01	8.37688E-01
8.55362E-01	8.69766E-01	7.38469E-01	5.41164E-01	7.26946E-02	-1.90824E+00	-5.61115E-01	-1.09481E+00
5.95892E-01	2.32648E-01	-3.33876E+00	-2.80143E+00	-5.17349E+00	-3.87361E+00	-3.29125E+00	-3.29750E+00
-2.63029E+00	-1.83408E+00	-1.54378E+00	-1.15218E+00	-3.73631E-01	2.91287E-01	9.08041E-01	1.16062E+00
1.68088E+00	2.62287E+00	3.29375E+00	3.35320E+00	3.18269E+00	2.90472E+00	2.69923E+00	3.51388E+00
3.11152E+00	3.72243E+00	2.61651E+00	2.03384E+00	1.62028E+00	1.33528E+00		
1.00000E+02	4.53535E+01	1.14406E+01	3.81398E+00	1.68509E+00	9.51156E-01	8.20762E-01	8.08958E-01
9.99368E-01	1.08848E+00	1.18341E+00	1.18436E+00	1.17636E+00	1.15958E+00	1.24525E+00	1.29515E+00
1.24659E+00	1.14101E+00	1.03851E+00	6.52863E-01	-2.37891E-01	4.02670E-01	1.48878E-01	1.23458E+00
9.47523E-01	-1.40606E+00	-1.15085E+00	-2.91477E+00	-2.29069E+00	-2.20811E+00	-2.26356E+00	-1.91589E+00
-1.34848E+00	-1.20601E+00	-8.56910E-01	-4.13657E-01	1.18172E-01	9.55540E-03	-1.33309E-01	2.39104E-01
9.44561E-01	1.85509E+00	2.22084E+00	2.15065E+00	1.78424E+00	1.57918E+00	2.14874E+00	1.95493E+00
2.24495E+00	1.74460E+00	1.47374E+00	1.37849E+00	1.22284E+00			
1.00000E+02	4.16013E+01	1.39103E+01	4.85677E+00	2.21622E+00	1.57927E+00	1.36695E+00	1.44946E+00
1.62759E+00	1.61721E+00	1.62238E+00	1.70321E+00	1.59299E+00	1.66354E+00	1.75536E+00	1.83599E+00
1.65487E+00	1.64814E+00	1.44814E+00	1.35949E+00	1.68827E+00	1.51365E+00	1.98315E+00	1.87251E+00
5.41077E-01	3.98136E-01	-5.53023E-01	-7.27613E-01	-1.16282E+00	-1.36325E+00	-1.33635E+00	-1.09650E+00
-8.85164E-01	-7.73267E-01	-3.50577E-01	1.54380E-01	-7.72356E-01	-1.50609E+00	-1.26563E+00	-7.62242E-01
4.20523E-01	1.09770E+00	1.21877E+00	8.54175E-01	6.42853E-01	8.96801E-01	8.98301E-01	7.90328E-01
1.05185E+00	1.07513E+00	1.28593E+00	1.15105E+00				
1.00000E+02	4.99246E+01	1.56730E+01	5.29925E+00	2.65065E+00	1.83502E+00	1.71319E+00	1.78611E+00
1.77354E+00	1.78039E+00	1.85655E+00	1.84917E+00	1.91341E+00	1.89966E+00	1.97358E+00	1.80214E+00
1.79360E+00	1.89031E+00	2.06498E+00	2.18602E+00	2.10290E+00	2.26059E+00	2.23922E+00	1.41815E+00
1.06836E+00	4.18536E-01	-6.35221E-02	-9.24439E-01	-1.09271E+00	-1.17298E+00	-1.14358E+00	-9.39039E-01
-8.33269E-01	-4.12427E-01	8.51025E-02	-1.18221E+00	-2.00453E+00	-1.86817E+00	-1.42661E+00	-7.89441E-02
8.02740E-01	1.01649E+00	5.50782E-01	3.72987E-01	4.56953E-01	4.89833E-01	3.10856E-01	7.97431E-01
8.88214E-01	1.23344E+00	1.14206E+00					
1.00000E+02	5.01750E+01	1.45829E+01	5.49997E+00	2.77322E+00	2.14656E+00	1.91493E+00	1.90104E+00
1.90879E+00	1.98229E+00	1.97548E+00	2.03597E+00	2.12060E+00	2.19108E+00	1.92352E+00	2.01473E+00
2.00872E+00	2.36586E+00	2.48159E+00	2.39169E+00	2.43924E+00	2.51047E+00	1.78751E+00	1.32452E+00
7.65541E-01	6.57902E-02	-8.11611E-01	-1.05903E+00	-1.13967E+00	-1.10644E+00	-9.99879E-01	-8.88121E-01
-4.59399E-01	3.89985E-02	-1.33698E+00	-2.34622E+00	-2.19736E+00	-1.76043E+00	-3.06826E-01	6.80193E-01
8.85005E-01	5.09129E-01	2.45910E-01	3.14808E-01	3.52736E-01	1.52319E-01	6.73180E-01	8.83342E-01
1.33527E+00	1.16007E+00						
1.00000E+02	4.58135E+01	1.49144E+01	5.34751E+00	2.90896E+00	2.17253E+00	2.05725E+00	1.96486E+00
2.03679E+00	2.03044E+00	2.08874E+00	2.17192E+00	2.24026E+00	2.07636E+00	2.06624E+00	2.15966E+00
2.60602E+00	2.61780E+00	2.62549E+00	2.56718E+00	2.63332E+00	1.90860E+00	1.54333E+00	8.74973E-01
1.70858E-01	-8.19326E-01	-9.48446E-01	-1.13348E+00	-1.09895E+00	-9.90937E-01	-8.77461E-01	-4.45822E-01
5.21375E-02	-1.43233E+00	-2.53532E+00	-2.28115E+00	-1.95305E+00	-4.99066E-01	5.89796E-01	8.88130E-01
4.10617E-01	1.56031E-01	2.11447E-01	2.54632E-01	-5.84527E-02	6.84831E-01	8.11210E-01	1.36922E+00
1.20512E+00							
1.00000E+02	4.86874E+01	1.48701E+01	5.68824E+00	3.03790E+00	2.31778E+00	2.02440E+00	2.09494E+00
2.08914E+00	2.14549E+00	2.22729E+00	2.29369E+00	2.13254E+00	2.12188E+00	2.21397E+00	2.64903E+00
2.65842E+00	2.66279E+00	2.70276E+00	2.66273E+00	2.03934E+00	1.56818E+00	9.98305E-01	2.92265E-01
-7.02640E-01	-9.25367E-01	-1.11116E+00	-1.07653E+00	-8.65561E-01	-7.52617E-01	-4.22835E-01	7.38492E-02
-1.52080E+00	-2.61861E+00	-2.46378E+00	-2.04895E+00	-6.00348E-01	4.92076E-01	7.87672E-01	3.07710E-01
6.18670E-02	3.93117E-03	1.50932E-01	-1.79741E-01	5.94106E-01	8.36507E-01	1.30268E+00	1.14983E+00
1.00000E+02	4.69457E+01	1.52105E+01	5.81123E+00	3.27676E+00	2.37926E+00	2.24658E+00	2.14039E+00
2.29513E+00	2.27453E+00	2.43952E+00	2.18058E+00	2.16926E+00	2.26000E+00	2.78321E+00	2.78905E+00
2.78892E+00	2.82329E+00	2.77714E+00	2.15109E+00	1.67268E+00	1.09437E+00	3.81649E-01	-6.23703E-01
-8.30527E-01	-1.01669E+00	-9.79948E-01	-8.69524E-01	-7.53171E-01	-4.18763E-01	7.82466E-02	-1.62375E+00
-2.81322E+00	-2.65100E+00	-2.24093E+00	-6.90643E-01	4.07014E-01	6.97026E-01	2.11762E-01	-2.54237E-02
-9.44356E-02	1.54354E-01	-2.89185E-01	5.08991E-01	7.65343E-01	1.33636E+00	1.19449E+00	
1.00000E+02	4.74274E+01	1.50670E+01	5.98341E+00	3.07045E+00	2.53431E+00	2.22672E+00	2.27996E+00
2.35977E+00	2.42319E+00	2.16519E+00	2.25458E+00	2.24397E+00	2.76320E+00	2.76815E+00	2.76679E+00
2.79981E+00	2.75200E+00	2.12551E+00	1.64560E+00	1.06526E+00	3.51344E-01	-6.56392E-01	-8.58718E-01
-1.04514E+00	-1.00823E+00	-7.94381E-01	-6.78274E-01	-3.43761E-01	5.03964E-02	-1.65429E+00	-2.84193E+00
-2.67920E+00	-2.27372E+00	-7.25122E-01	3.73784E-01	6.62817E-01	1.76660E-01	-5.75363E-02	-1.32085E-01
1.19034E-01	-3.30496E-01	4.78039E-01	7.39992E-01	1.31361E+00	1.17557E+00		
1.00000E+02	4.72912E+01	1.56310E+01	5.76192E+00	3.41050E+00	2.39705E+00	2.34774E+00	2.42664E+00
2.48859E+00	2.23244E+00	2.32141E+00	2.41108E+00	2.82154E+00	2.92478E+00	2.92006E+00	2.84624E+00
2.89557E+00	2.26600E+00	1.77868E+00	1.19067E+00	3.64834E-01	-6.53988E-01	-8.42819E-01	-1.02896E+00
-9.88633E-01	-8.73089E-01	-7.51344E-01	-4.10489E-01	8.79764E-02	-1.82041E+00	-2.99789E+00	-2.82536E+00

-2.41301E+00	-8.53042E-01	3.47747E-01	6.31075E-01	1.39313E-01	-9.09180E-02	-1.64799E-01	8.49230E-02
-3.68833E-01	5.43238E-01	8.09636E-01	1.28268E+00	1.14934E+00			
1.00000E+02	5.25039E+01	1.55044E+01	6.49664E+00	3.36465E+00	2.60700E+00	2.48285E+00	2.54283E+00
2.39005E+00	2.37752E+00	2.46639E+00	2.96775E+00	3.06691E+00	3.05754E+00	2.97667E+00	3.01939E+00
2.28288E+00	1.88736E+00	1.18465E+00	4.51420E-01	-6.87406E-01	-8.57548E-01	-1.04325E+00	-9.97993E-01
-8.75132E-01	-7.45819E-01	-3.96540E-01	2.23807E-03	-1.90454E+00	-3.06904E+00	-2.98445E+00	-2.56193E+00
-8.88446E-01	3.18179E-01	5.93622E-01	1.92549E-01	-1.31166E-01	-2.02870E-01	4.43612E-02	-4.14070E-01
5.02272E-01	7.72752E-01	1.34401E+00	1.21661E+00				
1.00000E+02	4.63484E+01	1.62647E+01	5.86844E+00	3.39488E+00	2.76548E+00	2.62264E+00	2.36997E+00
2.45815E+00	2.54666E+00	3.04349E+00	3.03940E+00	3.02777E+00	3.04537E+00	3.08512E+00	2.34663E+00
1.84331E+00	1.23879E+00	3.96266E-01	-6.44681E-01	-9.11170E-01	-1.09667E+00	-1.04911E+00	-9.22827E-01
-7.89962E-01	-4.36701E-01	6.57660E-02	-1.94282E+00	-3.20294E+00	-3.01124E+00	-2.58488E+00	-9.05103E-01
3.04166E-01	6.74018E-01	1.71536E-01	-1.49915E-01	-2.20791E-01	2.53927E-02	-4.35283E-01	4.83237E-01
7.55672E-01	1.42634E+00	1.20145E+00					
1.00000E+02	5.03700E+01	1.48575E+01	6.03083E+00	3.58516E+00	2.73617E+00	2.38185E+00	2.36920E+00
2.45788E+00	2.95719E+00	3.05573E+00	3.04556E+00	2.96361E+00	3.00522E+00	2.37062E+00	1.87112E+00
1.16673E+00	4.32028E-01	-7.08980E-01	-8.76069E-01	-1.06180E+00	-1.01603E+00	-8.92441E-01	-7.62354E-01
-4.12106E-01	-1.31635E-02	-1.92054E+00	-3.18480E+00	-2.99746E+00	-2.57537E+00	-9.01037E-01	3.06476E-01
5.80925E-01	1.78905E-01	-1.43553E-01	-2.16553E-01	3.10764E-02	-4.29408E-01	4.90137E-01	7.62515E-01
1.33431E+00	1.20846E+00						
1.00000E+02	4.44948E+01	1.47778E+01	6.27220E+00	3.60346E+00	2.84681E+00	2.53067E+00	2.51766E+00
3.10902E+00	3.20377E+00	3.08767E+00	3.10073E+00	3.13621E+00	2.39479E+00	1.88453E+00	1.27288E+00
4.23133E-01	-7.32768E-01	-9.86600E-01	-1.17182E+00	-1.12100E+00	-8.86385E-01	-7.48882E-01	-4.93079E-01
1.12093E-02	-1.99646E+00	-3.24841E+00	-3.14938E+00	-2.71616E+00	-1.02575E+00	2.84941E-01	6.49830E-01
1.42430E-01	-1.75869E-01	-2.45466E-01	-8.16280E-04	-4.64547E-01	4.56858E-01	8.31693E-01	1.40153E+00
1.28065E+00							
1.00000E+02	4.43609E+01	1.51563E+01	5.92263E+00	3.75103E+00	3.23293E+00	2.71445E+00	3.10204E+00
3.09608E+00	3.08190E+00	2.99472E+00	3.03081E+00	2.39359E+00	1.88714E+00	1.17474E+00	4.33464E+00
-7.17655E-01	-9.74083E-01	-1.16007E+00	-1.11187E+00	-8.81490E-01	-7.48218E-01	-4.96378E-01	5.58740E-03
-2.00834E+00	-3.26415E+00	-3.07064E+00	-2.75213E+00	-1.07307E+00	2.36786E-01	6.04248E-01	9.95213E-02
-2.15761E-01	-2.97432E-01	-4.68050E-02	-5.19599E-01	4.19674E-01	8.03159E-01	1.37915E+00	1.16216E+00
1.00000E+02	4.94670E+01	1.52668E+01	7.53351E+00	5.29669E+00	3.56410E+00	3.23057E+00	3.21907E+00
3.19863E+00	3.10191E+00	3.12905E+00	2.38319E+00	1.86168E+00	1.23744E+00	3.76622E-01	-7.95553E-01
-1.02693E+00	-1.21233E+00	-1.15757E+00	-1.02092E+00	-8.77138E-01	-5.10945E-01	-5.32357E-03	-2.11987E+00
-3.46017E+00	-3.34993E+00	-2.91777E+00	-1.12050E+00	1.97190E-01	5.54325E-01	3.93300E-02	-1.70651E-01
-3.48343E-01	-1.00937E-01	-5.80034E-01	4.64209E-01	7.54161E-01	1.42801E+00	1.21879E+00	
1.00000E+02	4.57875E+01	2.01436E+01	1.24482E+01	6.06467E+00	3.90671E+00	3.28339E+00	3.25936E+00
3.15645E+00	3.17828E+00	2.42789E+00	1.89611E+00	1.15809E+00	2.85385E-01	-9.01625E-01	-1.11747E+00
-1.30204E+00	-1.24189E+00	-1.09698E+00	-9.44760E-01	-5.69685E-01	-6.04446E-02	-2.27198E+00	-3.60005E+00
-3.37513E+00	-3.02660E+00	-1.11209E+00	2.10281E-01	5.60242E-01	3.80219E-02	-1.70653E-01	-3.38485E-01
-9.69406E-02	-5.72988E-01	4.61856E-01	7.48633E-01	1.41693E+00	1.30918E+00		
1.00000E+02	7.35043E+01	4.24468E+01	1.67416E+01	6.38413E+00	3.52372E+00	3.29073E+00	3.28060E+00
3.29438E+00	2.53778E+00	1.88838E+00	1.13541E+00	2.46697E-01	-1.06637E+00	-1.25832E+00	-1.44198E+00
-1.37454E+00	-1.21863E+00	-1.05509E+00	-6.67794E-01	-1.53990E-01	-2.36061E+00	-3.77376E+00	-3.53024E+00
-3.16275E+00	-1.22408E+00	2.03321E-01	6.41163E-01	1.09204E-01	-1.94175E-01	-3.52997E-01	-1.17516E-01
-5.93910E-01	4.36095E+01	8.22620E-01	1.48599E+00	1.28214E+00			
1.00000E+02	7.86705E+01	2.93284E+01	9.08946E+00	3.60188E+00	3.07156E+00	2.97150E+00	2.99551E+00
2.24748E+00	1.72072E+00	9.87197E-01	1.20164E-01	-1.06048E+00	-1.28152E+00	-1.46672E+00	-1.40943E+00
-1.26901E+00	-1.12130E+00	-6.48007E-01	-2.43624E-01	-2.25480E+00	-3.58939E+00	-3.37258E+00	-2.93688E+00
-1.13396E+00	1.86056E-01	5.40134E-01	2.20957E-02	-1.85987E-01	-3.62769E-01	-1.16370E-01	-5.97227E-01
4.48587E-01	7.40072E-01	1.31289E+00	1.20616E+00				
1.00000E+02	5.04516E+01	1.38383E+01	3.98868E+00	3.05031E+00	3.04964E+00	2.96907E+00	2.21926E+00
1.68827E+00	9.50412E-01	7.88812E-02	-1.10767E+00	-1.32190E+00	-1.50690E+00	-1.44769E+00	-1.30440E+00
-1.15373E+00	-6.77160E-01	-1.69098E-01	-2.28187E+00	-3.61190E+00	-3.39042E+00	-2.95072E+00	-1.14216E+00
1.79886E-01	5.31176E-01	1.03531E-02	-1.96319E-01	-3.71481E-01	-1.26356E-01	-6.08095E-01	4.37825E-01
7.30020E-01	1.40205E+00	1.19664E+00					
1.00000E+02	3.54244E+01	5.89794E+00	3.23000E+00	3.12218E+00	3.13982E+00	2.28313E+00	1.74252E+00
9.95836E-01	1.13385E-01	-1.19136E+00	-1.39306E+00	-1.57695E+00	-1.51211E+00	-1.25648E+00	-1.09733E+00
-7.14944E-01	-2.02695E-01	-2.30725E+00	-3.72819E+00	-3.49236E+00	-3.03022E+00	-1.19948E+00	2.24196E+00
5.68691E-01	4.09592E-02	-1.67036E-01	-3.26589E-01	-8.98570E-02	-5.62852E-01	4.63517E-01	7.47192E-01
1.41090E+00	1.30356E+00						
1.00000E+02	3.15511E+01	5.72536E+00	3.83183E+00	3.70256E+00	2.60293E+00	1.87424E+00	9.39507E-01
-1.40974E-01	-1.66987E+00	-1.84991E+00	-2.02765E+00	-1.92020E+00	-1.70317E+00	-1.47707E+00	-9.20525E-01
-2.77331E-01	-2.96140E+00	4.59240E+00	-4.24687E+00	-3.65873E+00	-1.38526E+00	3.72696E-01	7.57263E-01
1.71173E-01	-2.19325E-01	-3.09187E-01	-1.70348E-02	-6.71125E-01	5.93434E-01	9.62398E-01	1.78900E+00
1.59635E+00							
1.00000E+02	2.69229E+01	5.59685E+00	3.81206E+00	2.60117E+00	1.85254E+00	7.90709E-01	-3.09916E-01
-1.97503E+00	-2.21707E+00	-2.39543E+00	-2.28072E+00	-1.94957E+00	-1.71306E+00	-1.24618E+00	-4.97348E-01
-3.29596E+00	-5.00644E+00	-4.64170E+00	-4.05905E+00	-1.67212E+00	1.97913E-01	6.67749E-01	-3.02863E-02
-4.02673E-01	-5.13280E-01	-2.14109E-01	-8.99537E-01	5.14353E-01	9.12786E-01	1.74923E+00	1.47876E+00
1.00000E+02	2.88201E+01	5.54891E+00	2.47077E+00	1.48667E+00	3.93209E-01	-8.42304E-01	-2.65668E+00
-2.73884E+00	-3.02187E+00	-2.79090E+00	-2.54723E+00	-2.18903E+00	-1.59821E+00	-9.46744E-01	3.85449E+00
-5.53404E+00	-5.13979E+00	-4.44628E+00	-1.83245E+00	1.52760E-01	5.06699E-01	-2.09834E-01	-4.65713E-01
-6.85565E-01	-3.85210E-01	-1.09592E+00	3.54381E-01	7.75600E-01	1.61575E+00	1.46734E+00	
1.00000E+02	2.89884E+01	4.08081E+00	1.40751E+00	6.74130E-02	-1.30436E+00	-3.27509E+00	-3.39038E+00
-3.67573E+00	-3.53970E+00	-3.17829E+00	-2.80566E+00	-2.19483E+00	-1.43762E+00	-4.47761E+00	-6.32848E+00
-5.90750E+00	-5.13755E+00	-2.31167E+00	-2.03395E-01	2.29738E-01	-5.07002E-01	-8.27546E-01	-1.09728E+00
-7.77910E-01	-1.65116E+00	4.08945E-03	5.85711E-01	1.44989E+00	1.34587E+00		
1.00000E+02	2.62019E+01	2.91440E+00	-2.45791E-01	-1.86830E+00	-4.00427E+00	-4.04515E+00	-4.33123E+00
-4.07555E+00	-3.69357E+00	-3.40363E+00	-2.66179E+00	-1.79367E+00	-5.16074E+00	-6.97215E+00	-6.51400E+00
-5.73956E+00	-2.67780E+00	-4.45032E-01	6.39746E-02	-6.97335E-01	-1.09107E+00	-1.48258E+00	-1.05854E+00
-1.97554E+00	-1.53312E-01	4.68750E-01	1.34363E+00	1.27332E+00			
1.00000E+02	2.37471E+01	1.40894E-01	-3.50192E+00	-5.88424E+00	-5.55193E+00	-5.73546E+00	-5.47759E+00
-5.09423E+00	-4.59256E+00	-3.73994E+00	-2.87449E+00	-5.96238E+00	-7.55455E+00	-6.89024E+00	-6.06482E+00
-0.02341E+00	-7.77068E-01	-2.73265E-01	-1.14081E+00	-1.40659E+00	-1.75918E+00	-1.40750E+00	-2.28760E+00
-6.56111E-01	2.18596E-02	9.25173E-01	7.89634E-01				
1.00000E+02	2.53844E+01	-3.10746E+00	-7.48166E+00	-7.14569E+00	-7.33476E+00	-7.06874E+00	-6.46561E+00
-5.95353E+00	-4.97546E+00	-4.11215E+00	-7.26623E+00	-8.81918E+00	-8.03083E+00	-7.18602E+00	-3.85718E+00

-1.37468E+00	-9.90472E-01	-1.78095E+00	-2.08547E+00	-2.55357E+00	-2.25328E+00	-3.16155E+00	-1.30853E+00
-6.12852E-01	3.46616E-01	3.93573E-01					
1.00000E+02	1.84054E+01	-7.85181E+00	-9.12536E+00	-9.42545E+00	-9.03674E+00	-8.41197E+00	-7.77054E+00
-6.65297E+00	-5.57445E+00	-8.78261E+00	-1.00765E+01	-9.14655E+00	-8.24882E+00	-4.59968E+00	-1.97432E+00
-1.51663E+00	-2.43854E+00	-2.68750E+00	-3.24512E+00	-2.90973E+00	-3.92776E+00	-1.99135E+00	-1.19471E+00
-2.95044E-01	-1.75550E-01						
1.00000E+02	1.95507E+01	-8.05051E+00	-1.07287E+01	-1.09819E+01	-1.05690E+01	-9.81540E+00	-8.57408E+00
-7.39399E+00	-1.06841E+01	-1.18364E+01	-1.06847E+01	-9.58728E+00	-5.56337E+00	-2.69684E+00	-2.25358E+00
-3.29596E+00	-3.47527E+00	-4.17830E+00	-3.78018E+00	-4.94997E+00	-2.84875E+00	-1.91106E+00	-1.04408E+00
-8.32430E-01							
1.00000E+02	2.46395E+01	-3.29378E+00	-1.14775E+01	-1.31067E+01	-1.28666E+01	-1.16896E+01	-1.02892E+01
-1.39853E+01	-1.48562E+01	-1.33373E+01	-1.18999E+01	-6.93260E+00	-3.49603E+00	-3.08207E+00	-4.05916E+00
-4.36404E+00	-5.21201E+00	-4.85678E+00	-5.98925E+00	-3.80842E+00	-2.82127E+00	-1.98986E+00	-1.56784E+00
1.00000E+02	4.40522E+01	2.18465E+00	-8.48597E+00	-1.11862E+01	-1.10421E+01	-1.01986E+01	-1.37252E+01
-1.45878E+01	-1.29624E+01	-1.13268E+01	-6.27726E+00	-2.93157E+00	-2.45816E+00	-3.26250E+00	-3.63536E+00
-4.31576E+00	-4.17894E+00	-5.09077E+00	-3.29864E+00	-2.52557E+00	-1.82796E+00	-1.49944E+00	
1.00000E+02	3.78685E+01	9.27656E-01	-9.24502E+00	-1.13266E+01	-1.12185E+01	-1.57846E+01	-1.66286E+01
-1.48744E+01	-1.28784E+01	-6.67387E+00	-2.72375E+00	-2.15174E+00	-3.05990E+00	-3.44014E+00	-4.19826E+00
-4.07286E+00	-4.86503E+00	-3.31260E+00	-2.45623E+00	-1.87400E+00	-1.55592E+00		
1.00000E+02	3.97220E+01	1.53646E+00	-9.24107E+00	-1.16569E+01	-1.79610E+01	-1.93173E+01	-1.72230E+01
-1.46076E+01	-7.13078E+00	-2.29349E+00	-1.41686E+00	-2.31996E+00	-2.93707E+00	-3.71495E+00	-3.62534E+00
-4.33902E+00	-2.92784E+00	-2.24842E+00	-1.70601E+00	-1.33148E+00			
1.00000E+02	4.23928E+01	1.18186E+00	-9.73393E+00	-2.01496E+01	-2.23250E+01	-2.01901E+01	-1.69000E+01
-7.51994E+00	-1.60922E+00	-4.31602E-01	-1.22960E+00	-2.20260E+00	-2.94843E+00	-3.01806E+00	-3.50618E+00
-2.32165E+00	-1.76034E+00	-1.28223E+00	-1.08415E+00				
1.00000E+02	3.90013E+01	2.50777E-01	-2.05255E+01	-2.51866E+01	-2.34261E+01	-1.95652E+01	-8.19463E+00
-1.02152E+00	5.55204E-01	-1.37060E-01	-1.26233E+00	-2.17745E+00	-2.30491E+00	-2.76676E+00	-1.81141E+00
-1.26752E+00	-9.55680E-01	-7.29208E-01					
1.00000E+02	4.02979E+01	-1.33722E+01	-2.47876E+01	-2.56868E+01	-2.18939E+01	-9.17014E+00	-7.51654E-01
1.32344E+00	9.40874E-01	-4.35615E-01	-1.32755E+00	-1.60608E+00	-1.94667E+00	-1.10693E+00	-7.78504E-01
-5.25005E-01	-3.72513E-01						
1.00000E+02	1.92178E+01	-1.47611E+01	-2.54258E+01	-2.39817E+01	-1.07856E+01	-1.18968E+00	1.56942E+00
1.58020E+00	1.79799E-01	-9.36778E-01	-1.34916E+00	-1.52513E+00	-8.07052E-01	-4.39131E-01	-1.20352E-01
-1.05151E-01							
1.00000E+02	6.39478E+01	1.03693E+01	-1.45070E+01	-1.82331E+01	-9.42296E+00	-2.28505E+00	2.45241E+00
2.69827E+00	6.74023E-01	-1.21790E+00	-6.39232E-01	-6.31124E-01	-7.20732E-01	-8.11939E-01	-7.74283E-01
1.00000E+02	5.10569E+01	3.71019E+00	-1.97119E+01	-1.54965E+01	-6.14632E+00	2.42264E+00	4.38366E+00
1.88336E+00	-9.23412E-01	3.69406E-01	-3.35188E-01	-5.46954E-01	-1.09237E+00	-9.40818E-01	
1.00000E+02	4.28187E+01	-1.70359E+01	-2.28005E+01	-1.15010E+01	1.69154E+00	6.20686E+00	3.42269E+00
-2.28659E-01	1.53751E+00	5.96606E-01	2.08553E-01	-4.25808E-01	-4.88791E-01		
1.00000E+02	1.42483E+01	-3.20886E+01	-2.30922E+01	-2.27283E+00	8.92751E+00	6.24406E+00	1.26868E+00
3.58048E+00	2.32155E+00	1.48626E+00	7.28274E-01	5.74751E-01			
1.00000E+02	1.22400E+01	-2.75765E+01	-1.78538E+01	1.20334E+00	7.36929E+00	5.13789E+00	6.21606E+00
3.70509E+00	2.66704E+00	1.73456E+00	1.30618E+00				
1.00000E+02	1.75802E+01	-3.08800E+01	-1.81183E+01	3.85594E+00	1.06732E+01	8.07635E+00	3.92070E+00
2.46417E+00	8.43777E-01	6.76960E-01					
1.00000E+02	4.00606E+00	-3.36419E+01	-4.04199E+00	1.60957E+01	1.00363E+01	3.47552E+00	1.22378E+00
-1.14947E+00	-9.68979E-01						
1.00000E+02	3.84541E+00	-1.43047E+01	1.27742E+01	1.05942E+01	3.79796E+00	1.82033E+00	-6.17790E-01
-7.68949E-01							
1.00000E+02	8.79030E+00	-1.99667E+01	1.85033E+00	7.48229E+00	7.93088E+00	1.00844E+01	8.29608E+00
1.00000E+02	-5.09157E+01	-2.47345E+01	7.25911E+00	1.48717E+01	2.62563E+01	2.25295E+01	
1.00000E+02	7.85731E+00	-3.59774E+01	-4.30609E+01	-5.94716E+01	-4.98070E+01		
1.00000E+02	7.32318E+01	5.53954E+01	5.89943E+01	4.63535E+01			
1.00000E+02	8.07207E+01	6.71507E+01	5.23655E+01				
1.00000E+02	8.79675E+01	6.93238E+01					
1.00000E+02	8.58417E+01						
1.00000E+02							

APPENDIX H. LLNL LSL-M3 FORMAT NEUTRON OUTPUT

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*cor      (library)      (mat.#)      (temp)k
*number of energies plus 1
90
*energy grid ( 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
1.45879E-07 3.17329E-06 8.57986E-06 5.87817E-05 1.01368E-04 4.39431E-05 3.35668E-05 1.45589E-05
2.76227E-05 1.37786E-05 1.04880E-05 1.32356E-05 4.02658E-05 2.56366E-05 2.67906E-05 3.94683E-05
3.33321E-05 5.57635E-05 6.29311E-05 7.11633E-05 8.23865E-05 8.45447E-05 4.81197E-05 4.77067E-05
5.97458E-05 7.57295E-05 7.98596E-05 4.10879E-05 4.59766E-05 4.25615E-05 5.45005E-05 4.93775E-05
5.80376E-05 6.21875E-05 6.43761E-05 9.55178E-05 6.67923E-05 8.55804E-05 8.60663E-05 8.83711E-05
1.03160E-04 1.18384E-04 1.16866E-04 1.28156E-04 1.62395E-04 1.78746E-04 1.98141E-04 2.13516E-04
2.63144E-04 2.88850E-04 3.98934E-04 4.82552E-04 5.47126E-04 2.11771E-04 4.00948E-04 9.99901E-04
2.39713E-03 3.32968E-03 5.08229E-03 7.85926E-03 1.10573E-02 1.61380E-02 2.38387E-02 3.34661E-02
4.79372E-02 4.81242E-02 3.02265E-02 3.28369E-02 3.75907E-02 3.90085E-02 3.97038E-02 3.95859E-02
4.40717E-02 4.31749E-02 4.36464E-02 4.66633E-02 8.92631E-02 8.35021E-02 7.63878E-02 6.38805E-02
4.51598E-02 2.40093E-02 1.04205E-02 3.87880E-03 7.20535E-04 1.58065E-04 4.33528E-05 1.74739E-05
4.66411E-06
*% standard deviation
1.96451E+02 1.35694E+02 1.03703E+02 5.04214E+01 3.86128E+01 6.19357E+01 7.52585E+01 8.54478E+01
9.11112E+01 9.51649E+01 9.36792E+01 1.00253E+02 3.75881E+01 6.50737E+01 3.00783E+01 3.52011E+01
8.16690E+00 3.02583E+01 2.61235E+01 2.38832E+01 2.67263E+01 4.87972E+01 4.66447E+01 5.10635E+01
5.86031E+01 2.73869E+01 2.44777E+01 3.59630E+01 4.02517E+01 4.44179E+01 4.25199E+01 4.05725E+01
3.95507E+01 3.86270E+01 3.81114E+01 3.63044E+01 3.65123E+01 3.68368E+01 3.65331E+01 3.51612E+01
3.46333E+01 3.43975E+01 3.36501E+01 3.35688E+01 3.27032E+01 3.15597E+01 3.10805E+01 3.14398E+01
3.04144E+01 3.08739E+01 2.95472E+01 2.86162E+01 2.74302E+01 2.91814E+01 2.88397E+01 2.79230E+01
2.23433E+01 2.15668E+01 2.04979E+01 1.95679E+01 1.83970E+01 1.82445E+01 1.75960E+01 1.63989E+01
1.59819E+01 1.56466E+01 1.79834E+01 1.77019E+01 1.74634E+01 1.70395E+01 1.68158E+01 1.68686E+01
1.65345E+01 1.50982E+01 1.58999E+01 1.55388E+01 1.25374E+01 1.12631E+01 1.15045E+01 1.10532E+01
1.07852E+01 1.05386E+01 9.59232E+00 8.90084E+00 5.90730E+00 7.76054E+00 1.07042E+01 1.27153E+01
1.79487E+01
*correlation coefficient -- upper triangular
1.00000E+02 7.18360E+01 5.06798E+01 1.46939E+01 -3.37183E+01 -3.00979E+01 -2.56031E+01 -2.23467E+01
-1.86702E+01 -1.55873E+01 -1.40845E+01 -6.12545E+00 9.04272E+00 1.99524E+00 1.37704E+00 2.43326E+01
3.83487E+00 -9.85720E-02 -5.62978E-02 -2.38527E+01 -3.91378E+00 -2.87431E+00 -3.58745E+00 -2.68782E+00
-1.53117E+00 -1.46439E-01 -2.52195E-02 -1.63812E+01 -1.91244E-01 -1.00435E-01 1.81547E-02 2.84612E-02
-6.18685E-02 -4.78645E-02 -1.24216E-01 -8.80317E-02 -5.60780E-03 6.85407E-02 5.94520E-02 6.58481E-02
6.71710E-02 6.55796E-02 -3.21418E-02 -3.25162E-02 -2.45498E-02 -1.58810E-02 -1.01974E-02 -1.49801E-02
-6.11168E-03 -1.06349E-02 7.52589E-04 1.19251E-02 -7.56036E-02 5.42730E-03 -9.19601E-02 -7.78638E-02
-8.57975E-02 -8.46613E-02 -1.72706E-01 -2.81565E-01 -3.71513E-01 -4.74991E-01 -7.24015E-01 -8.27111E-01
-1.10520E+00 -1.02549E+00 -8.44762E-01 -7.26554E-01 -4.80921E-01 -3.10274E-01 -4.67052E-02 7.63523E-02
-3.45145E-02 -9.09008E-02 1.50774E-02 2.02469E-01 6.76946E-01 9.65752E-01 9.42621E-01 1.06447E+00
1.11376E+00 1.17784E+00 1.30706E+00 1.34225E+00 2.19492E+00 1.56703E+00 1.11933E+00 8.09775E-01
5.39011E-01
1.00000E+02 7.99568E+01 2.56042E+01 -4.87426E+01 -4.51503E+01 -3.84152E+01 -3.31866E+01 -2.82250E+01
-2.35546E+01 -2.12520E+01 -9.22247E+00 1.28356E+01 2.85272E+00 2.17816E+00 2.47106E-01 5.90702E+00
-2.05948E+01 -2.36161E-01 -4.03930E+01 -6.46960E+00 -4.52640E+00 -5.74467E+00 -4.20133E+00 -2.42392E+00
-3.24315E-01 -8.63567E-02 3.09519E-01 -3.54317E-01 -1.71645E-01 -4.30801E-02 -1.26246E-01 -1.10979E-01
-8.96309E-02 -2.54557E-01 -2.99529E-01 -1.25618E-01 -6.37596E-02 2.33872E-02 -6.56100E-02 -6.29868E-02
-6.49950E-02 -6.03150E-02 -6.07367E-02 -1.48005E-01 -1.33573E-01 -1.24500E-01 -1.32067E-01 -1.17408E+01
-1.24791E-01 -1.05845E-01 -1.88056E-01 -1.66916E-01 -9.83448E-02 -1.93651E-01 -1.71264E-01 -2.22676E-01
-2.18503E-01 -3.97538E-01 -5.06545E-01 -6.87522E-01 -7.91206E-01 -1.16006E+00 -1.35999E+00 -1.66928E+00
-1.59910E+00 -1.23593E+00 -1.10952E+00 -7.41618E-01 -4.34999E-01 -4.11891E-02 9.12538E-02 -1.23640E-01
-1.50026E-01 5.43531E-02 3.84385E-01 1.00913E+00 1.49867E+00 1.46189E+00 1.60037E+00 1.77369E+00
1.96693E+00 2.16932E+00 2.13861E+00 3.52123E+00 2.49274E+00 1.68544E+00 1.15594E+00 8.22466E-01
1.00000E+02 4.41901E+01 -5.53716E+01 -5.43200E+01 -4.67330E+01 -4.13258E+01 -3.46823E+01 -2.91243E+01
-2.65223E+01 -1.21241E+01 1.44095E+00 3.39357E+00 3.03848E+00 3.19724E-01 7.75779E+00 -3.48767E-01
3.56738E-01 -6.14160E-01 -9.26459E+00 -6.39797E+00 -8.02093E+00 -5.93293E+00 -3.43299E+00 -5.41237E-01
-1.91457E-01 -4.84929E-01 -5.43865E-01 -2.66999E-01 -1.29585E-01 -2.07331E-01 -1.87268E-01 -2.59147E-01
-4.12949E-01 -4.40673E-01 -2.74963E-01 -1.25239E-01 -4.21625E-02 -1.27546E-01 -1.24070E-01 -1.26682E-01
-2.20553E-01 -2.21107E-01 -2.04146E-01 -1.85138E-01 -1.73206E-01 -1.83148E-01 -1.63838E-01 -1.73560E-01
-2.48766E-01 -2.25014E-01 -2.97386E-01 -2.38905E-01 -2.32367E-01 -3.03122E-01 -3.07278E-01 -4.02113E-01
-5.73952E-01 -7.86195E-01 -8.59028E-01 -1.16589E+00 -1.55447E+00 -1.85487E+00 -2.19600E+00 -2.13633E+00
-1.58318E+00 -1.44957E+00 -9.60783E-01 -5.20491E-01 -9.98315E-02 4.21508E-02 -1.76092E-01 -1.78373E-01
1.27253E-01 4.96484E-01 1.35384E+00 1.93460E+00 1.98399E+00 2.13540E+00 2.33211E+00 2.55531E+00
2.82157E+00 2.71553E+00 4.66195E+00 3.18270E+00 2.14946E+00 1.51508E+00 1.04517E+00
1.00000E+02 -2.73538E+01 -6.43535E+01 -6.11823E+01 -5.53636E+01 -4.85853E+01 -4.13940E+01 -3.78074E+01
-1.8843E+01 1.21930E+01 3.93765E+00 6.73485E+00 2.6829E-01 1.39130E+01 -8.32518E-01 -9.70688E-01
-1.69916E+00 -2.27729E+01 -1.52216E+01 -1.87562E+01 -1.40748E+01 -8.38373E+00 -1.72426E+00 -6.51956E-01
-1.28239E+00 -1.38705E+00 -8.25118E-01 -5.54910E-01 -6.14900E-01 -6.76523E-01 -9.20110E-01 -1.42286E+00
-1.67797E+00 -1.05299E+00 -6.58532E-01 -4.95940E-01 -4.71938E-01 -4.67212E-01 -4.73703E-01 -6.63509E-01
-6.65049E-01 -6.34562E-01 -7.01147E-01 -6.79326E-01 -5.98228E-01 -6.64034E-01 -6.81289E-01 -7.37669E-01
-7.94540E-01 -8.45344E-01 -7.19750E-01 -8.08157E-01 -8.53548E-01 -1.09754E+00 -1.19515E+00 -1.44836E+00
-1.68322E+00 -2.04482E+00 -2.55688E+00 -3.14242E+00 -3.86204E+00 -4.34954E+00 -3.92873E+00 -3.00046E+00

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-2.53291E+00	-1.86848E+00	-9.93893E-01	-2.57169E-01	2.82144E-02	-4.12623E-01	-2.38303E-01	3.85248E-01
1.21915E+00	2.86848E+00	3.79627E+00	3.61022E+00	3.79781E+00	4.28056E+00	4.62489E+00	5.21650E+00
4.87057E+00	8.71653E+00	5.83534E+00	3.91433E+00	2.50939E+00	1.76134E+00		
1.00000E+02	4.43022E+01	1.72683E+01	8.48118E+00	2.01408E+00	-7.88084E-01	-1.85299E+00	-4.72379E+00
-1.77513E+01	-6.17446E-01	9.48855E+00	5.04215E-01	1.30188E+01	-1.25308E+00	-1.40159E+00	-2.54566E+00
-3.39937E+01	-2.22407E+01	-2.69859E+01	-2.04744E+01	-1.24163E+01	-2.81446E+00	-1.17610E+00	-1.91682E+00
-2.01918E+00	-1.24424E+00	-9.64373E-01	-1.02515E+00	-1.28046E+00	-1.71166E+00	-2.68299E+00	-3.40244E+00
-2.30497E+00	-1.34691E+00	-9.01390E-01	-8.82410E-01	-8.81250E-01	-8.91994E-01	-1.08594E+00	-1.08877E+00
-1.15730E+00	-1.12715E+00	-1.10431E+00	-1.02485E+00	-1.09246E+00	-1.10934E+00	-1.26834E+00	-1.22531E+00
-1.27833E+00	-1.24985E+00	-1.23994E+00	-1.38099E+00	-1.91681E+00	-1.93249E+00	-2.19835E+00	-2.26896E+00
-2.65310E+00	-3.57292E+00	-4.03064E+00	-4.99726E+00	-5.27347E+00	-4.27496E+00	-3.29880E+00	-2.72289E+00
-1.92321E+00	-9.91362E-01	-3.00229E-01	-9.01073E-02	-6.54150E-01	-8.62758E-02	7.75713E-01	1.78523E+00
3.46584E+00	4.40517E+00	4.02047E+00	4.00060E+00	4.41815E+00	4.81384E+00	5.54456E+00	5.14646E+00
9.31677E+00	6.09030E+00	4.05136E+00	2.47210E+00	1.67043E+00			
1.00000E+02	7.68180E+01	5.95836E+01	4.54388E+01	3.59707E+01	3.13037E+01	1.12466E+01	-2.80736E+01
-3.29677E+00	6.46265E+00	2.38943E-01	5.30616E+00	-7.49705E-01	-8.80703E-01	-1.66792E+00	-2.21521E+01
-1.42626E+01	-1.71167E+01	-1.30606E+01	-7.95143E+00	-1.82542E+00	-8.14029E-01	-1.19160E+00	-1.24172E+00
-7.42940E-01	-5.96885E-01	-6.78045E-01	-8.54523E-01	-1.21657E+00	-1.94265E+00	-2.53951E+00	-1.79760E+00
-9.80689E-01	-7.13375E-01	-6.06655E-01	-6.07933E-01	-6.15538E-01	-7.15678E-01	-7.17775E-01	-7.02300E-01
-6.88601E-01	-6.76632E-01	-6.87252E-01	-6.72472E-01	-7.80736E-01	-7.62780E-01	-8.41098E-01	-8.19206E-01
-8.53261E-01	-8.48964E-01	-9.18420E-01	-1.33704E+00	-1.35421E+00	-1.54551E+00	-1.39850E+00	-1.60429E+00
-2.32439E+00	-2.49193E+00	-3.15630E+00	-3.19067E+00	-2.34470E+00	-1.82606E+00	-1.48085E+00	-9.57673E-01
-5.60363E-01	-1.83332E-01	-1.14897E-01	-4.61970E-01	2.16269E-02	5.77482E-01	1.12531E+00	2.08778E+00
2.56609E+00	2.22347E+00	2.15750E+00	2.38382E+00	2.56020E+00	2.94958E+00	2.67259E+00	5.02622E+00
3.27915E+00	2.10083E+00	1.21771E+00	8.38970E-01				
1.00000E+02	8.79456E+01	6.90123E+01	5.58532E+01	4.94826E+01	2.02498E+01	-3.23684E+01	-4.14900E+00
5.86845E+00	2.79347E+00	2.95880E+00	-5.80694E-01	-7.29212E-01	-1.42315E+00	-1.80917E+01	-1.15674E+01
-1.37144E+01	-1.04175E+01	-6.43856E+00	-1.48309E+00	-6.76863E-01	-9.92711E-01	-1.03107E+00	-6.29288E+00
-4.92280E-01	-5.77968E-01	-7.59412E-01	-1.02920E+00	-1.76924E+00	-2.28611E+00	-1.63318E+00	-9.00620E-01
-6.27504E-01	-5.22922E-01	-5.24397E-01	-5.30848E-01	-6.31703E-01	-6.33502E-01	-6.21541E-01	-6.11353E-01
-6.01981E-01	-6.10363E-01	-5.99252E-01	-6.05572E-01	-6.92355E-01	-6.75543E-01	-7.59205E-01	-6.84903E-01
-6.81756E-01	-7.57859E-01	-1.21824E+00	-1.13359E+00	-1.32919E+00	-1.17454E+00	-1.38307E+00	-2.00111E+00
-2.03918E+00	-2.69923E+00	-2.69259E+00	-1.93500E+00	-1.51194E+00	-1.17369E+00	-7.73716E-01	-5.14521E-01
-2.70303E-01	-1.12167E-01	-4.53214E-01	1.18278E-02	5.62630E-01	9.63953E-01	1.79263E+00	2.17488E+00
1.84265E+00	1.76764E+00	1.87118E+00	2.01422E+00	2.34254E+00	2.15178E+00	3.96121E+00	2.55583E+00
1.68300E+00	9.99612E-01	6.46880E-01					
1.00000E+02	8.34549E+01	6.78018E+01	6.05292E+01	2.59090E+01	-3.39482E+01	-4.51607E+00	5.48890E+00
2.23570E-01	1.74542E+00	-5.15660E-01	-6.68049E-01	-1.16083E+00	-1.55017E+01	-9.84055E+00	-1.16817E+01
-8.82175E+00	-5.36477E+00	-1.22840E+00	-6.20737E-01	-8.16796E-01	-8.51989E-01	-5.51395E-01	-4.18291E-01
-5.05195E-01	-6.88625E-01	-9.61812E-01	-1.60910E+00	-2.13522E+00	-1.47676E+00	-8.36021E-01	-5.59515E-01
-4.54943E-01	-4.56041E-01	-4.61631E-01	-4.62037E-01	-5.63690E-01	-5.52785E-01	-5.43304E-01	-5.34820E-01
-5.42374E-01	-5.32092E-01	-5.37884E-01	-6.25636E-01	-6.10320E-01	-5.95042E-01	-6.18877E-01	-6.15916E-01
-6.94406E-01	-1.06744E+00	-9.80134E-01	-1.17537E+00	-1.01401E+00	-1.22039E+00	-1.83730E+00	-1.85838E+00
-2.51201E+00	-2.48216E+00	-7.11527E+00	-1.29680E+00	-1.06454E+00	-6.74864E-01	-4.33579E-01	-2.05900E-01
-1.56096E-01	-3.90884E-01	-3.19466E-02	5.12784E-01	7.90344E-01	1.56432E+00	2.00381E+00	1.67526E+00
1.59915E+00	1.69139E+00	1.81839E+00	2.12339E+00	1.93616E+00	3.61062E+00	2.29998E+00	1.50266E+00
8.58138E-01	6.47578E-01						
1.00000E+02	9.00298E+01	8.07597E+01	3.66691E+01	-3.72655E+01	-5.24419E+00	5.59615E+00	2.96536E-01
4.71345E-01	-4.32804E-01	-5.87079E-01	-9.79250E-01	-1.32378E+01	-8.32449E+00	-9.86118E+00	-7.42262E+00
-4.47749E+00	-1.05038E+00	-4.41871E-01	-7.28793E-01	-7.62428E-01	-4.62326E-01	-3.31067E-01	-4.18563E-01
-6.02928E-01	-8.77719E-01	-1.42842E+00	-1.95898E+00	-1.39771E+00	-8.53205E-01	-4.75170E-01	-3.70628E-01
-3.71555E-01	-3.76747E-01	-3.76978E-01	-4.78536E-01	-4.68143E-01	-4.59007E-01	-4.50949E-01	-4.58109E-01
-4.48234E-01	-4.53771E-01	-4.41766E-01	-5.27399E-01	-5.12743E-01	-5.35566E-01	-5.32704E-01	-6.12327E-01
-9.91570E-01	-9.03089E-01	-9.97558E-01	-9.33843E-01	-1.03803E+00	-1.75574E+00	-1.66692E+00	-2.41980E+00
-2.37927E+00	-1.60814E+00	-1.29464E+00	-9.60715E-01	-6.78736E-01	-4.45509E-01	-2.25220E-01	-1.78437E-01
-3.09378E-01	-5.44723E-02	3.85976E-01	7.54533E-01	1.40277E+00	1.92200E+00	1.69305E+00	1.51846E+00
1.60544E+00	1.72499E+00	2.01893E+00	1.83304E+00	3.35431E+00	2.27251E+00	1.51393E+00	8.89017E-01
6.00276E-01							
1.00000E+02	9.35191E+01	4.73346E+01	-3.77954E+01	-5.96408E+00	5.72796E+00	3.73499E-01	-3.41611E-01
-3.50209E-01	-4.06351E-01	-7.98884E-01	-1.10888E+01	-7.01613E+00	-8.14842E+00	-6.12605E+00	-3.68910E+00
-7.71455E-01	-3.63497E-01	-5.41694E-01	-5.73820E-01	-3.73727E-01	-3.43863E-01	-3.31952E-01	-5.17053E-01
-7.93007E-01	-1.34593E+00	-1.87955E+00	-1.31659E+00	-7.69610E-01	-3.90562E-01	-2.86234E-01	-2.87131E-01
-2.92094E-01	-2.92330E-01	-3.93840E-01	-3.83926E-01	-3.75218E-01	-3.67528E-01	-3.74361E-01	-3.64947E-01
-3.70230E-01	-3.58786E-01	-4.45104E-01	-4.31130E-01	-4.52894E-01	-4.50165E-01	-5.30745E-01	-9.15690E-01
-8.26712E-01	-9.21528E-01	-7.55188E-01	-9.60348E-01	-1.57641E+00	-1.58412E+00	-2.23307E+00	-2.28835E+00
-1.51457E+00	-1.20106E+00	-9.71268E-01	-6.92432E-01	-4.64568E-01	-2.49267E-01	-2.04391E-01	-3.34252E-01
-8.19027E-02	2.55845E-01	7.18941E-01	1.34723E+00	1.85207E+00	1.72250E+00	1.44893E+00	1.53208E+00
1.64643E+00	1.93142E+00	1.84136E+00	3.21378E+00	2.16879E+00	1.44027E+00	9.28791E-01	6.58336E-01
1.00000E+02	6.45922E+01	-3.77736E+01	-7.64064E+00	6.92369E+00	3.90670E-01	-4.23500E-01	-3.33351E-01
-3.86989E-01	-7.78093E-01	-9.13603E+00	-5.70277E+00	-6.63241E+00	-4.81510E+00	-2.78069E+00	-6.52039E-01
-3.42576E-01	-5.28053E-01	-4.61590E-01	-3.62431E-01	-2.31764E-01	-3.19269E-01	-5.03905E-01	-6.79286E-01
-1.23142E+00	-1.66392E+00	-1.20127E+00	-6.55100E-01	-3.76290E-01	-3.71584E-01	-2.72297E-01	-2.72770E-01
-2.77287E-01	-3.78783E-01	-3.68443E-01	-3.59217E-01	-3.51240E-01	-3.58308E-01	-3.48373E-01	-3.53905E-01
-3.41786E-01	-4.27496E-01	-4.12779E-01	-4.35643E-01	-4.32730E-01	-5.12601E-01	-8.92591E-01	-8.03224E-01
-8.97082E-01	-7.30464E-01	-9.34483E-01	-1.55043E+00	-1.55900E+00	-2.20683E+00	-2.16003E+00	-1.49030E+00
-1.17984E+00	-1.05246E+00	-7.71997E-01	-5.41346E-01	-3.23449E-01	-2.77695E-01	-4.07827E-01	-1.53090E-01
1.84522E-01	6.51388E-01	1.29314E+00	1.90540E+00	1.87253E+00	1.60068E+00	1.58791E+00	1.70480E+00
1.99598E+00	1.90875E+00	3.31804E+00	2.24700E+00	1.49642E+00	9.74986E-01	6.90881E-01	
1.00000E+02	-2.52741E+01	-1.09893E+01	8.90320E+00	6.02667E-01	-9.27122E-02	7.95397E-02	-8.69744E-02
-8.30301E-02	-6.15222E-01	-2.07703E-01	7.50810E-02	3.50739E-01	4.68752E-01	1.48830E-01	-5.04319E-02
1.32042E-03	-2.47001E-02	-2.14259E-02	5.19893E-03	-8.53049E-02	-7.22023E-02	-1.50587E-01	-3.07628E-01
-4.48875E-01	-3.81837E-01	-2.30462E-01	-1.50417E-01	-4.79063E-02	-4.93994E-02	-5.43701E-02	-5.55512E-02
-5.69467E-02	-4.87696E-02	-4.21824E-02	-1.35876E-01	-4.15509E-02	-1.34484E-01	-1.38734E-01	-1.30107E-01
-1.18605E-01	-2.07959E-01	-1.24954E-01	-2.23260E-01	-2.06411E-01	-4.10615E-01	-4.23356E-01	-4.21019E-01
-4.56485E-01	-5.64838E-01	-8.76799E-01	-8.77215E-01	-2.1891E+00	-1.36291E+00	-1.10482E+00	-9.88746E-01
-8.64645E-01	-6.93939E-01	-5.77415E-01	-4.70654E-01	-4.27404E-01	-5.58175E-01	-5.22403E-01	-2.80675E-01
7.44351E-02	8.62172E-01	1.73278E+00	1.80368E+00	1.62186E+00	1.30496E+00	1.31331E+00	1.57461E+00
1.56692E+00	2.61329E+00	1.85114E+00	1.30925E+00	9.37365E-01	6.24404E-01		

1.00000E+02	8.01628E+00	1.44098E+00	-2.69385E+00	9.18446E+00	1.01222E+00	5.68835E-01	1.75650E+00
3.37663E+01	2.22859E+01	2.80594E+01	2.29300E+01	1.51442E+01	3.36344E+00	7.48006E-01	1.53842E+00
1.78792E+00	1.01480E+00	7.79822E-01	7.97462E-01	1.22591E+00	2.07472E+00	3.97281E+00	5.60252E+00
3.73341E+00	1.62181E+00	7.71987E-01	5.72227E-01	4.65782E-01	4.51307E-01	4.43848E-01	4.39679E-01
4.56006E-01	3.66306E-01	2.80562E-01	2.67460E-01	2.79551E-01	2.71582E-01	1.84942E-01	2.07983E-01
1.27086E-01	9.59592E-02	9.84786E-02	1.35382E-01	7.31809E-01	1.89547E-01	2.81419E-01	-7.29467E-01
-7.67589E-01	6.22379E-01	-2.51665E-01	8.71126E-01	-2.03332E-01	-1.99901E+00	-1.81759E+00	-2.38348E+00
-2.51569E+00	-2.21374E+00	-1.93319E+00	-1.91693E+00	-2.20614E+00	-2.86420E+00	-2.73276E+00	-1.51911E+00
7.16381E-01	4.34575E+00	5.55329E+00	4.59311E+00	3.02116E+00	2.61095E+00	3.46503E+00	3.57960E+00
5.53924E+00	4.02912E+00	2.83356E+00	2.20927E+00	1.53781E+00			
1.00000E+02	-5.34317E+01	-1.38984E+01	8.33486E+00	-4.38039E-01	-8.34721E-01	-5.94496E-01	2.29706E+00
1.64353E+00	2.62863E+00	2.67024E+00	2.12391E+00	4.02627E-01	-1.52561E-01	-1.11343E-01	-8.09058E-02
-9.88239E-02	-4.77045E-02	-2.17971E-02	1.04480E-01	2.43514E-01	7.11056E-01	1.11128E+00	7.61738E-01
2.87026E-01	-4.05586E-02	-2.62092E-02	-1.24037E-01	-1.29797E-01	-2.25137E-01	-2.26599E-01	-2.06188E-01
-2.85024E-01	-2.70122E-01	-2.82865E-01	-3.60993E-01	-3.72373E-01	-4.44750E-01	-5.16122E-01	-5.84447E-01
-5.32568E-01	-5.25557E-01	-5.88230E-01	-6.50653E-01	-9.55703E-01	-1.23037E+00	-1.76979E+00	-2.05531E+00
-1.96282E+00	-2.82153E+00	-2.94620E+00	-3.58164E+00	-3.76555E+00	-2.87561E+00	-2.73150E+00	-2.20399E+00
-1.49211E+00	-8.06234E-01	-4.35929E-01	-4.69523E-01	2.53591E-01	9.86728E-01	1.63362E+00	-2.87127E+00
3.67853E+00	3.42335E+00	3.08934E+00	2.93452E+00	3.02159E+00	3.56031E+00	3.53374E+00	5.93139E+00
4.04163E+00	2.75360E+00	1.88780E+00	1.27406E+00				
1.00000E+02	1.78395E+01	2.49629E+01	-2.51827E+00	-3.71587E+00	-3.53774E+00	-1.00884E+01	-6.19967E+00
-6.02819E+00	-3.06592E+00	-9.35018E-01	-8.49916E-01	-1.51804E+00	-1.57406E+00	-1.51180E+00	-1.32046E+00
-1.08481E+00	-9.98258E-01	-7.28875E-01	-3.35157E-01	5.05208E-01	1.44189E+00	7.43797E-01	-2.06595E-01
-7.48958E-01	-9.81113E-01	-1.06271E+00	-1.16745E+00	-1.33530E+00	-1.43397E+00	-1.46587E+00	-1.58545E+00
-1.63735E+00	-1.67496E+00	-1.79394E+00	-1.83170E+00	-2.02556E+00	-2.12894E+00	-2.41001E+00	-2.28016E+00
-2.35167E+00	-2.53235E+00	-2.94783E+00	-3.89485E+00	-4.65715E+00	-6.25387E+00	-7.12339E+00	-7.32999E+00
-9.70731E+00	-1.03718E+01	-1.20716E+01	-1.20331E+01	-9.17133E+00	-8.25584E+00	-6.57131E+00	-4.19044E+00
-1.89013E+00	-5.62140E-01	-6.05525E-01	2.66935E+00	4.99917E+00	6.93172E+00	9.89982E+00	1.03787E+01
8.77119E+00	8.32228E+00	8.77884E+00	9.14165E+00	1.06141E+01	1.01413E+01	1.80593E+01	1.19046E+01
7.87926E+00	4.98724E+00	3.39240E+00					
1.00000E+02	1.73148E-01	1.99430E+00	2.26872E+00	2.50046E+00	-6.91836E-02	-3.01769E-01	-2.78300E-01
6.61580E-02	2.65326E-01	2.30535E+00	2.71109E+00	1.79912E+00	1.49576E+00	1.35994E+00	1.51067E+00
1.61061E+00	1.63216E+00	1.67817E+00	1.78873E+00	1.91917E+00	1.83274E+00	1.80443E+00	1.74387E+00
1.82569E+00	1.81146E+00	1.89309E+00	1.87484E+00	1.86931E+00	1.97373E+00	1.96635E+00	1.97307E+00
1.96530E+00	2.06089E+00	1.96029E+00	2.05090E+00	2.05736E+00	2.15331E+00	1.95521E+00	1.95139E+00
1.97163E+00	2.43538E+00	2.36716E+00	2.22142E+00	1.97754E+00	1.89268E+00	1.35691E+00	5.41866E-01
-2.44114E-01	-1.26988E+00	-1.43895E+00	-1.54216E+00	-1.60713E+00	-1.54122E+00	-1.15035E+00	-6.71495E-01
-2.44743E-01	2.60735E+01	-5.82639E-01	-1.11647E+00	-8.25494E-01	-9.75595E-02	1.18525E+00	1.83652E+00
1.98460E+00	1.75104E+00	1.70510E+00	1.75471E+00	2.20918E+00	2.44326E+00	2.51301E+00	2.03854E+00
2.31834E+00	1.69736E+00						
1.00000E+02	-3.09782E+00	-9.39551E-01	-1.06482E+00	-1.43279E+01	-2.52383E+01	-1.73106E+01	-9.49758E+00
-6.67317E+00	-4.45814E+00	-1.32287E+00	-1.96857E+00	-1.61726E+00	-1.17783E+00	-1.13110E+00	-8.72495E-01
-6.42810E-01	1.16665E-01	1.22422E+00	2.32448E+00	1.33877E+00	-1.77877E-01	-6.82079E-01	-8.48635E-01
-1.04783E+00	-1.19882E+00	-1.22953E+00	-1.16337E+00	-1.25299E+00	-1.45534E+00	-1.55784E+00	-1.62086E+00
-1.72853E+00	-1.76846E+00	-1.86918E+00	-1.92598E+00	-2.17001E+00	-2.15727E+00	-2.22827E+00	-2.47606E+00
-2.53250E+00	-3.74878E+00	-4.88910E+00	-7.52807E+00	-8.98441E+00	-7.79835E+00	-8.12342E+00	-7.74215E+00
-9.90738E+00	-1.12796E+01	-9.63746E+00	-9.57753E+00	-8.42095E+00	-6.33812E+00	-4.45287E+00	-3.83814E+00
-4.64791E+00	-2.69109E+00	1.66405E-01	4.11357E+00	9.96494E+00	1.36980E+01	1.33250E+01	1.34828E+01
1.42642E+01	1.49191E+01	1.69482E+01	1.58316E+01	2.79342E+01	1.89960E+01	1.28079E+01	8.72551E+01
5.96261E+00							
1.00000E+02	6.08411E+00	4.12554E+00	1.44780E+00	4.93943E-01	5.89708E-01	6.48681E-01	6.55852E-01
3.35116E+00	4.06786E+00	2.77465E+00	2.42412E+00	2.24035E+00	2.28008E+00	2.35930E+00	2.37218E+00
2.41390E+00	2.23393E+00	2.25992E+00	2.36340E+00	2.52106E+00	2.64788E+00	2.80791E+00	2.78339E+00
2.85908E+00	2.92655E+00	2.91885E+00	3.00970E+00	3.08110E+00	3.18033E+00	3.07765E+00	3.25374E+00
3.16165E+00	3.22427E+00	3.31185E+00	3.48036E+00	3.22148E+00	3.20955E+00	3.31219E+00	3.92317E+00
4.01824E+00	4.02421E+00	4.02487E+00	3.97413E+00	3.22061E+00	2.64111E+00	1.86667E+00	6.68449E-01
5.66007E-01	-4.28320E-03	-2.87745E-01	-4.23062E-01	-3.31372E-01	-1.38734E-01	2.06684E-01	5.77679E-01
-1.40530E+00	-2.67043E+00	-2.64627E+00	-2.28502E+00	-7.66205E-01	4.09811E-01	6.80651E-01	3.29355E-01
1.82914E-01	-2.95535E-03	6.52858E-01	-8.98485E-01	7.03993E-01	9.96256E-01	1.99402E+00	1.55911E+00
1.00000E+02	7.28253E+00	1.64513E+00	6.71414E-01	8.51063E-01	8.13454E-01	9.02701E-01	4.03618E+00
4.82114E+00	3.25450E+00	2.81373E+00	2.54979E+00	2.69544E+00	2.87096E+00	2.88524E+00	2.83233E+00
2.67067E+00	2.61470E+00	2.80373E+00	2.93945E+00	3.05463E+00	3.30809E+00	3.37996E+00	3.35100E+00
3.41276E+00	3.40377E+00	3.49244E+00	3.65908E+00	3.75774E+00	3.65496E+00	3.82632E+00	3.73592E+00
3.89211E+00	3.97670E+00	4.13886E+00	3.78760E+00	3.87427E+00	3.87538E+00	4.66560E+00	4.84385E+00
4.83289E+00	4.80029E+00	4.82481E+00	3.96158E+00	3.21984E+00	2.19423E+00	8.15701E-01	7.84566E-01
6.89874E-02	-3.15209E-01	-4.24311E-01	-3.90787E-01	-1.52642E-01	2.15461E-01	7.68772E-01	-1.65462E+00
-3.18349E+00	-3.19465E+00	-2.75912E+00	-9.65561E-01	4.10333E-01	7.57421E-01	3.26712E-01	1.18304E-01
-1.57271E-01	6.20860E-01	-1.19035E+00	6.79198E-01	1.08905E+00	2.27165E+00	1.76905E+00	
1.00000E+02	3.24820E+00	5.80394E-01	2.16690E+00	2.19866E+00	1.84120E+00	4.49467E+00	5.14901E+00
3.62525E+00	3.19670E+00	2.84977E+00	2.99731E+00	3.06719E+00	3.18205E+00	3.13188E+00	3.08245E+00
3.13673E+00	3.11520E+00	3.23667E+00	3.34366E+00	3.48966E+00	3.55794E+00	3.62665E+00	3.68336E+00
3.77429E+00	3.86008E+00	3.92012E+00	4.01757E+00	3.91533E+00	4.08157E+00	3.99316E+00	4.14187E+00
4.32345E+00	4.47854E+00	4.13683E+00	4.12028E+00	4.21974E+00	5.18080E+00	5.24287E+00	5.31712E+00
5.25756E+00	5.25798E+00	4.38769E+00	3.60102E+00	2.64019E+00	1.20878E+00	1.04928E+00	1.80614E-01
-2.03730E-01	-4.00848E-01	-4.43448E-01	-1.76146E-01	2.07825E-01	8.47144E-01	-1.71252E+00	-3.41375E+00
-3.48637E+00	-3.13246E+00	-1.20436E+00	2.77316E-01	6.02928E-01	8.20220E-02	-1.06264E-01	-4.92029E-01
4.17075E-01	-1.77031E+00	4.48328E-01	1.03861E+00	2.34160E+00	1.80409E+00		
1.00000E+02	5.36940E+01	5.87331E+01	4.51433E+01	2.84146E+01	6.36379E+00	2.22913E+00	3.55826E+00
3.87395E+00	2.48690E+00	1.96639E+00	2.19071E+00	2.78680E+00	4.03137E+00	6.60405E+00	8.61459E+00
5.85868E+00	3.05065E+00	1.41814E+00	9.05450E-01	9.57350E-01	1.32903E+00	1.66804E+00	1.86081E+00
1.80841E+00	1.61451E+00	1.68995E+00	1.70694E+00	1.72476E+00	1.76016E+00	2.05166E+00	2.08180E+00
2.06802E+00	1.92351E+00	1.99146E+00	2.34495E+00	3.82642E+00	3.41746E+00	4.01037E+00	3.35584E+00
3.43223E+00	5.44239E+00	5.25924E+00	7.41157E+00	6.98379E+00	4.37362E+00	3.24477E+00	2.06656E+00
8.39783E-01	3.27100E-02	-6.30995E-01	-8.84234E-01	-5.71231E-02	-8.17432E-01	-1.82208E+00	-2.48128E+00
-3.72797E+00	-4.04547E+00	-3.64946E+00	-4.07464E+00	-4.73483E+00	-4.77072E+00	-5.43990E+00	-5.14248E+00
-9.84856E+00	-6.03727E+00	-3.79356E+00	-1.92114E+00	-1.25688E+00			
1.00000E+02	6.57992E+01	3.30269E+01	1.85070E+01	3.46368E+01	6.99756E-01	-1.38578E+00	-1.97580E+00
-5.23359E-01	1.79266E-01	3.68801E-01	5.27757E-01	8.39133E-01	2.41497E+00	4.66750E+00	3.30625E+00

1.61432E+00	6.54698E-01	3.97343E-01	2.68902E-01	3.48709E-01	2.08839E-01	2.01984E-01	1.73665E-01
3.26154E-01	4.12536E-01	5.22638E-01	4.76667E-01	3.94772E-01	3.29963E-01	3.91813E-01	4.29696E-01
4.17350E-01	4.99547E-01	6.70914E-01	1.37214E+00	1.05805E+00	1.13385E+00	4.33820E-01	6.54559E-01
2.15021E+00	1.97609E+00	3.67834E+00	3.59195E+00	1.97775E+00	1.56921E+00	9.37248E-01	1.87241E-01
-1.94063E-01	-5.54863E-01	-5.67432E-01	-6.95236E-02	-1.58611E-03	-2.69754E-01	-5.77705E-01	-1.30534E+00
-1.85745E+00	-2.00350E+00	-2.27819E+00	-2.54977E+00	-2.55701E+00	-2.85334E+00	-2.84866E+00	-5.08309E+00
-3.31635E+00	-2.08955E+00	-1.19667E+00	-8.13511E-01				
1.00000E+02	5.93800E+01	3.28911E+01	5.67635E+00	4.67431E-01	-4.51361E+00	-5.90161E+00	-2.01137E+00
-6.02680E-01	-1.46743E-01	-1.57939E-01	-1.49225E-01	1.53234E+00	4.99637E+00	3.83336E+00	1.83440E+00
7.70350E-01	4.07763E-01	2.77344E-01	1.53916E-01	-2.92033E-01	-4.00422E-01	-3.30136E-01	2.07844E-02
2.07006E-01	3.18147E-01	3.69623E-01	1.88082E-01	-1.85409E-01	-1.26921E-01	7.03333E-03	2.00246E-03
8.27964E-02	4.53708E-01	1.12857E+00	7.05006E-01	5.67926E-01	-4.52469E-01	-4.25462E-02	1.86106E+00
1.56613E+00	3.97532E+00	3.77060E+00	1.83153E+00	1.55910E+00	8.20855E-01	-3.09378E-02	-5.11157E-01
-8.65392E-01	-7.70628E-01	-7.39750E-02	5.94104E-01	4.40303E-01	3.09152E-02	-9.35981E-01	-1.80481E+00
-2.14330E+00	-2.53007E+00	-2.80394E+00	-2.81017E+00	-3.12914E+00	-3.15776E+00	-5.62437E+00	-3.57025E+00
-2.34570E+00	-1.41791E+00	-9.71162E-01					
1.00000E+02	7.29338E+01	1.18105E+01	3.79975E-01	-3.82667E+00	-5.06674E+00	-1.74782E+00	-5.29334E-01
-1.53282E-01	-1.52905E-01	-2.35227E-01	1.13841E+00	4.10480E+00	3.24908E+00	1.56231E+00	7.11923E-01
3.73421E-01	2.53088E-01	1.35228E-01	-1.94116E-01	-4.00879E-01	-3.15360E-01	5.65934E-02	2.51382E-01
2.54426E-01	3.27381E-01	2.37575E-01	-2.05299E-01	-1.25405E-01	3.83898E-02	-1.04904E-02	7.82664E-02
3.68429E-01	9.12978E-01	5.26478E-01	3.38851E-01	-5.23543E-01	-2.51239E-01	1.24630E+00	6.93049E-01
2.55453E+00	2.07014E+00	2.68271E-01	5.42669E-02	-6.64980E-01	-1.29409E+00	-1.64682E+00	-1.68187E+00
-1.38954E+00	-3.63376E-01	8.24620E-01	9.05900E-01	6.11614E-01	2.24520E-01	-1.93559E-01	-2.71091E-01
-6.79855E-01	-1.01564E+00	-9.93404E-01	-1.13747E+00	-1.08642E+00	-2.11339E+00	-1.28346E+00	-7.41024E-01
-2.89764E-01	-1.88655E-01						
1.00000E+02	1.87487E+01	5.06643E-01	-2.27323E+00	-3.05423E+00	-8.90598E-01	-1.65709E-01	1.26478E-01
3.46185E-02	5.80680E-02	1.02320E+00	2.99071E+00	2.34149E+00	1.26654E+00	6.27478E-01	4.08159E-01
2.96052E-01	1.83136E-01	6.68807E-02	-3.73567E-02	-4.06262E-02	2.47603E-01	3.48404E-01	3.46432E-01
4.36061E-01	3.39028E-01	1.21501E-01	1.17153E-01	2.03632E-01	2.21467E-01	2.16098E-01	4.20782E-01
7.94305E-01	5.39518E-01	3.92939E-01	-2.18008E-01	-9.28745E-02	7.99882E-01	2.97679E-01	1.19624E+00
5.43223E-01	-7.08015E-01	-8.39586E-01	-1.33966E+00	-1.75917E+00	-2.00442E+00	-1.94232E+00	-1.35591E+00
-4.09655E-01	5.55468E-01	6.78734E-01	6.87105E-01	6.89019E-01	8.62258E-01	9.54914E-01	7.04555E-01
2.92432E-01	3.26754E-01	4.02643E-01	4.04947E-01	4.19219E-01	5.24774E-01	4.79774E-01	5.38759E-01
4.11928E-01							
1.00000E+02	1.10953E+01	2.41291E+00	1.95619E+00	2.07769E+00	2.32652E+00	2.40789E+00	2.42470E+00
2.37294E+00	2.50845E+00	2.75332E+00	2.84596E+00	2.78682E+00	2.70573E+00	2.76502E+00	2.84003E+00
2.81326E+00	2.87963E+00	2.87137E+00	2.96422E+00	3.13732E+00	3.23826E+00	3.13398E+00	3.31143E+00
3.21840E+00	3.28260E+00	3.37305E+00	3.44312E+00	3.28118E+00	3.26956E+00	3.37689E+00	4.11333E+00
4.10191E+00	4.10670E+00	3.99203E+00	3.93625E+00	3.28208E+00	2.56560E+00	1.88066E+00	4.27967E-01
7.74437E-02	-5.62830E-01	-8.39615E-01	-1.05456E+00	-1.02478E+00	-7.93553E-01	-3.30036E-01	4.37374E-01
-1.22923E+00	-2.37690E+00	-2.30412E+00	-1.92735E+00	-1.25420E-01	9.44052E-01	1.21609E+00	6.92346E-01
5.80579E-01	4.43017E-01	1.08750E+00	-1.85095E-01	1.22141E+00	1.45743E+00	2.37498E+00	1.75509E+00
1.00000E+02	4.05155E+00	3.00576E+00	2.74756E+00	2.89780E+00	2.97270E+00	2.98894E+00	3.04079E+00
2.88909E+00	2.84488E+00	2.92567E+00	3.15029E+00	3.26002E+00	3.41119E+00	3.48176E+00	3.55183E+00
3.61195E+00	3.60245E+00	3.79229E+00	3.85751E+00	3.95679E+00	3.85330E+00	4.02424E+00	3.93380E+00
4.08916E+00	4.17434E+00	4.33608E+00	4.08590E+00	4.07137E+00	4.07432E+00	4.97121E+00	5.04231E+00
5.12849E+00	5.08329E+00	5.10039E+00	4.13261E+00	3.36356E+00	2.32307E+00	8.05034E-01	6.54269E-01
-1.46403E-01	-5.27153E-01	-7.24242E-01	-6.63823E-01	-3.99882E-01	8.19563E-02	7.27919E-01	-1.59534E+00
-3.21106E+00	-3.18730E+00	-2.78701E+00	-8.40480E-01	6.30910E-01	9.73773E-01	4.58903E-01	2.72805E-01
1.90492E-02	8.74491E-01	-1.00218E+00	8.72604E-01	1.31893E+00	2.56424E+00	1.93290E+00	
1.00000E+02	4.75971E+01	1.19870E+01	4.98158E+00	2.95072E+00	2.15553E+00	1.98762E+00	1.88755E+00
1.98919E+00	2.00847E+00	2.18986E+00	2.22730E+00	2.39025E+00	2.36817E+00	2.34661E+00	2.41716E+00
2.41043E+00	2.50016E+00	2.57248E+00	2.67028E+00	2.66982E+00	2.74565E+00	2.65385E+00	2.71763E+00
2.80358E+00	2.97225E+00	2.71384E+00	2.70244E+00	2.80093E+00	3.39681E+00	3.40278E+00	3.41590E+00
3.44149E+00	3.40455E+00	2.85983E+00	2.33523E+00	1.79588E+00	7.74932E-01	7.02716E-01	2.02216E-01
-8.85980E-02	-1.51847E-01	-2.16804E-01	-7.49060E-02	1.46076E-01	5.35772E-01	-1.13643E+00	-2.22979E+00
-2.28050E+00	-2.06276E+00	-8.58268E-01	2.98294E-02	3.08130E-01	2.49746E-02	-1.67749E-01	-4.01625E-01
1.94566E-01	-1.34956E+00	1.66046E-01	5.94540E-01	1.47548E+00	1.20833E+00		
1.00000E+02	4.19520E+01	1.40523E+01	6.10037E+00	2.89401E+00	2.01939E+00	1.60744E+00	1.69773E+00
1.82584E+00	1.91965E+00	1.96363E+00	2.02957E+00	2.11012E+00	2.09075E+00	2.16416E+00	2.15812E+00
2.14803E+00	2.32337E+00	2.32059E+00	2.32035E+00	2.39826E+00	2.30580E+00	2.37277E+00	2.45972E+00
2.53037E+00	2.36919E+00	2.35881E+00	2.45695E+00	2.95921E+00	3.07537E+00	2.99569E+00	3.03888E+00
3.01513E+00	2.47422E+00	2.08496E+00	1.56849E+00	6.93347E-01	6.39435E-01	1.07853E-01	-8.18161E-02
-1.60647E-01	-2.52050E-01	-3.40880E-02	1.74099E-01	4.73896E-01	-9.80774E-01	-1.99513E+00	-1.98303E+00
-1.81801E+00	-7.61932E-01	2.79986E-02	2.18411E-01	-7.70829E-02	-1.93918E-01	-3.41697E-01	9.67318E-02
-1.21926E+00	5.39598E-02	4.93793E-01	1.29382E+00	1.02352E+00			
1.00000E+02	4.03073E+01	1.52131E+01	5.28743E+00	2.60598E+00	1.58490E+00	1.36897E+00	1.50320E+00
1.70641E+00	1.75599E+00	1.82714E+00	1.91030E+00	1.89312E+00	1.97023E+00	1.96490E+00	2.05777E+00
2.13703E+00	2.13548E+00	2.13454E+00	2.21659E+00	2.12249E+00	2.19537E+00	2.28567E+00	2.36200E+00
2.19296E+00	2.18434E+00	2.18429E+00	2.71300E+00	2.73924E+00	2.77257E+00	2.73362E+00	2.72757E+00
2.19093E+00	1.83151E+00	1.23884E+00	3.97694E-01	4.64064E-01	-4.98340E-03	-1.94339E-01	-2.82830E-01
-2.87678E-01	-8.77556E-02	1.10452E-01	4.22026E-01	-9.06744E-01	-1.74153E+00	-1.75548E+00	-1.59306E+00
-5.52828E-01	1.34166E-01	3.40998E-01	1.39252E-01	1.03496E-02	-1.23070E-01	2.65144E-01	-7.66653E-01
3.45771E-01	6.14699E-01	1.29434E+00	9.67155E-01				
1.00000E+02	4.95452E+01	1.50471E+01	5.54757E+00	2.42487E+00	1.51405E+00	1.44474E+00	1.64285E+00
1.79074E+00	1.96288E+00	1.94567E+00	2.02847E+00	2.00528E+00	1.99984E+00	2.09381E+00	2.17412E+00
2.27388E+00	2.17173E+00	2.25490E+00	2.26072E+00	2.33502E+00	2.32634E+00	2.40434E+00	2.3329E+00
2.32505E+00	2.32711E+00	2.76828E+00	2.79391E+00	2.82848E+00	2.88833E+00	2.88335E+00	2.24469E+00
1.77417E+00	1.07683E+00	2.21320E-01	2.82364E-01	-1.87302E-01	-3.74148E-01	-4.55156E-01	-4.47102E-01
-2.35516E-01	6.91139E-02	3.78052E-01	-9.44670E-01	-1.77649E+00	-1.77412E+00	-1.46623E+00	-3.94395E-01
3.87091E-01	5.96664E-01	3.05112E-01	1.87682E-01	7.43813E-02	5.61475E-01	-4.49194E-01	5.80044E-01
7.81114E-01	1.42752E+00	1.16010E+00					
1.00000E+02	4.50281E+01	1.45600E+01	4.72005E+00	2.20979E+00	1.63696E+00	1.73007E+00	1.87547E+00
2.04623E+00	2.02818E+00	2.11015E+00	2.18627E+00	2.18057E+00	2.17376E+00	2.25310E+00	2.35281E+00
2.25058E+00	2.33289E+00	2.33901E+00	2.41203E+00	2.50345E+00	2.58035E+00	2.41018E+00	2.40155E+00
2.40367E+00	2.84163E+00	2.96439E+00	2.99577E+00	3.04884E+00	2.93710E+00	2.29691E+00	1.81317E+00
1.10663E+00	1.30696E-01	2.88658E-01	-1.68636E-01	-3.54584E-01	-4.29739E-01	-4.11744E-01	-1.90317E-01
1.71764E-02	4.23361E-01	-9.04064E-01	-1.82936E+00	-1.81267E+00	-1.58607E+00	-3.97028E-01	3.84469E-01

5.89856E-01	3.03145E-01	1.94053E-01	8.42392E-02	5.57504E-01	-5.26372E-01	5.81570E-01	7.78572E-01
1.51709E+00	1.15225E+00						
1.00000E+02	4.92634E+01	1.34491E+01	4.62919E+00	2.25395E+00	1.84348E+00	1.88730E+00	2.05805E+00
2.03986E+00	2.12147E+00	2.19742E+00	2.19162E+00	2.18523E+00	2.26481E+00	2.36487E+00	2.36281E+00
2.34495E+00	2.35086E+00	2.42421E+00	2.51621E+00	2.59361E+00	2.42265E+00	2.41407E+00	2.41712E+00
2.75933E+00	2.98175E+00	2.91204E+00	3.06363E+00	2.95115E+00	2.10712E+00	1.71810E+00	8.02667E-01
-8.06840E-02	1.77513E-01	-2.77376E-01	-3.58701E-01	-4.29768E-01	-4.04760E-01	-1.76890E-01	3.32493E-02
4.37505E-01	-8.88117E-01	-1.70877E+00	-1.78474E+00	-1.43616E+00	-3.30175E-01	4.49753E-01	6.55452E-01
3.73270E-01	2.70606E-01	1.69993E-01	6.41538E-01	-3.89155E-01	6.81422E-01	8.48818E-01	1.57191E+00
1.19042E+00							
1.00000E+02	4.21210E+01	1.28716E+01	4.39579E+00	2.28111E+00	1.92298E+00	1.99433E+00	2.07670E+00
2.05778E+00	2.13410E+00	2.12826E+00	2.22338E+00	2.30420E+00	2.30456E+00	2.30185E+00	2.38572E+00
2.39098E+00	2.46597E+00	2.45898E+00	2.53814E+00	2.36455E+00	2.35639E+00	2.36135E+00	2.61554E+00
2.83809E+00	2.77018E+00	3.12335E+00	3.01315E+00	1.76267E+00	1.46907E+00	1.41756E-01	-6.50964E-01
2.00984E-02	-4.38787E-01	-5.18103E-01	-4.80910E-01	-4.47412E-01	-2.12196E-01	1.02343E-01	5.05734E-01
-7.10175E-01	-1.53160E+00	-1.49704E+00	-1.21575E+00	-8.75538E-02	5.90983E-01	8.00145E-01	5.24411E-01
4.29906E-01	3.46617E-01	8.23732E-01	-1.04138E-01	8.93721E-01	1.00060E+00	1.69532E+00	1.27720E+00
1.00000E+02	4.75376E+01	1.37971E+01	4.58445E+00	2.42472E+00	2.09900E+00	1.98223E+00	1.96377E+00
2.04212E+00	2.03647E+00	2.13448E+00	2.21919E+00	2.32180E+00	2.21727E+00	2.30494E+00	2.30839E+00
2.38852E+00	2.48612E+00	2.57075E+00	2.28883E+00	2.28212E+00	2.19118E+00	1.97628E+00	2.50455E+00
2.34346E+00	3.10567E+00	2.90444E+00	7.42213E-01	7.50543E-01	-1.28786E+00	-1.88717E+00	-3.86003E-01
-7.63113E-01	-6.32002E-01	-4.85956E-01	-4.42418E-01	-3.01849E-01	1.15789E-01	6.23311E-01	-2.63571E-01
-9.93644E-01	-9.50933E-01	-6.07143E-01	3.60560E-01	9.33107E-01	1.05650E+00	7.92081E-01	8.06698E-01
7.61672E-01	1.16897E+00	6.58530E-01	1.40269E+00	1.36801E+00	1.80349E+00	1.39398E+00	
1.00000E+02	5.06566E+01	1.47909E+01	5.03270E+00	2.90965E+00	2.19344E+00	1.97462E+00	2.05448E+00
2.04884E+00	2.15000E+00	2.23855E+00	2.24304E+00	2.23705E+00	2.32854E+00	2.33006E+00	2.41526E+00
2.51731E+00	2.60746E+00	2.31755E+00	2.31223E+00	2.02619E+00	1.54772E+00	2.27849E+00	2.12415E+00
3.18928E+00	2.89502E+00	-1.77477E-01	1.22470E-01	-2.83532E+00	-3.35983E+00	-8.28637E-01	-1.22170E+00
-8.79193E-01	-5.15626E-01	-5.54514E-01	-2.94796E-01	2.29477E-01	8.37730E-01	7.52451E-02	-5.57602E-01
-3.91796E-01	4.12064E-02	8.69944E-01	1.23729E+00	1.37195E+00	1.22220E+00	1.25688E+00	1.35558E+00
1.68800E+00	1.55293E+00	1.91034E+00	1.70241E+00	2.15753E+00	1.54388E+00		
1.00000E+02	4.83519E+01	1.37681E+01	5.63191E+00	3.11074E+00	2.29010E+00	2.16780E+00	2.16200E+00
2.26088E+00	2.34628E+00	2.34927E+00	2.34444E+00	2.43288E+00	2.33553E+00	2.51690E+00	2.51536E+00
2.60113E+00	2.41782E+00	2.41133E+00	2.22190E+00	2.01770E+00	2.54434E+00	2.48434E+00	3.24260E+00
3.04099E+00	6.75657E-01	6.72202E-01	-1.57526E+00	-2.29637E+00	-4.90378E-01	-9.68722E-01	-7.32071E-01
-5.78265E-01	-5.21291E-01	-2.66456E-01	1.55839E-01	6.59996E-01	-3.24831E-01	-9.48207E-01	-8.88465E-01
-5.01552E-01	4.97892E-01	1.06720E+00	1.19181E+00	9.36050E-01	9.62690E-01	9.36053E-01	1.34169E+00
9.38090E-01	1.60703E+00	1.51223E+00	2.01589E+00	1.47317E+00			
1.00000E+02	4.24423E+01	1.48412E+01	5.79564E+00	3.06721E+00	2.44044E+00	2.23361E+00	2.32909E+00
2.40983E+00	2.51102E+00	2.40746E+00	2.49136E+00	2.49649E+00	2.57137E+00	2.66542E+00	2.74476E+00
2.57076E+00	2.56253E+00	2.46813E+00	2.62643E+00	2.94692E+00	2.87750E+00	3.32611E+00	3.11157E+00
1.75839E+00	1.45119E+00	1.40885E-02	-7.97374E-01	-2.96421E-02	-4.81182E-01	-5.58609E-01	-5.13815E-01
-4.67304E-01	-2.19805E-01	1.00067E-01	6.01095E-01	-7.16793E-01	-1.63293E+00	-1.58015E+00	-1.26233E+00
-1.04658E-01	6.69932E-01	8.77709E-01	6.09588E-01	5.26497E-01	4.55982E-01	9.25106E-01	6.93710E-02
1.01682E+00	1.18343E+00	1.75850E+00	1.32065E+00				
1.00000E+02	5.04174E+01	1.63749E+01	6.01497E+00	3.37819E+00	2.56838E+00	2.46126E+00	2.53951E+00
2.53920E+00	2.53686E+00	2.61837E+00	2.52409E+00	2.69622E+00	2.68730E+00	2.76324E+00	2.59410E+00
2.58493E+00	2.58859E+00	3.02923E+00	3.24566E+00	3.17092E+00	3.31073E+00	3.29152E+00	2.34331E+00
1.93153E+00	8.98495E-01	-1.43780E-02	2.31362E-01	-3.07610E-01	-4.90260E-01	-5.49648E-01	-5.04744E-01
-3.59519E-01	-3.81294E-02	4.59695E-01	-9.74905E-01	-1.98407E+00	-1.93017E+00	-1.63932E+00	-2.97828E-01
5.79429E-01	7.79018E-01	4.08426E-01	3.22131E-01	2.31910E-01	6.81179E-01	-3.84987E-01	7.38152E-01
9.80986E-01	1.78525E+00	1.29877E+00					
1.00000E+02	5.05901E+01	1.53219E+01	6.15439E+00	3.53543E+00	2.82455E+00	2.59967E+00	2.69953E+00
2.95683E+00	2.67685E+00	2.68368E+00	2.75315E+00	2.84369E+00	2.91763E+00	2.75123E+00	2.74141E+00
2.74438E+00	3.27713E+00	3.38852E+00	3.41022E+00	3.44118E+00	3.41506E+00	2.66846E+00	2.14257E+00
1.30529E+00	2.75668E-01	3.06354E-01	-2.16808E-01	-5.02670E-01	-5.57078E-01	-6.06446E-01	-3.49800E-01
-2.3758E-02	4.69052E-01	-1.17909E+00	-2.17725E+00	-2.11002E+00	-1.81039E+00	-4.56366E-01	5.20398E-01
7.13767E-01	4.44021E-01	2.66300E-01	7.71951E-02	7.01182E-01	-4.83984E-01	7.50771E-01	1.01573E+00
1.82451E+00	1.35502E+00						
1.00000E+02	4.62482E+01	1.54795E+01	6.02588E+00	3.60574E+00	2.87735E+00	2.77587E+00	2.67331E+00
2.75249E+00	2.75969E+00	2.82794E+00	2.91778E+00	2.99056E+00	2.82576E+00	2.81560E+00	2.81800E+00
3.44589E+00	3.55531E+00	3.47370E+00	3.50096E+00	3.47130E+00	2.82560E+00	2.29472E+00	1.45266E+00
4.17398E-01	3.40935E-01	-1.74023E-01	-4.60052E-01	-6.15993E-01	-5.59443E-01	-2.99735E-01	2.80629E-02
4.16583E-01	-1.23670E+00	-2.22989E+00	-2.25917E+00	-1.95897E+00	-5.02896E-01	4.74990E-01	6.64991E-01
3.95881E-01	2.20188E-01	2.75834E-02	6.42272E-01	-6.55546E-01	6.85513E-01	9.67107E-01	1.78096E+00
1.32373E+00							
1.00000E+02	4.90350E+01	1.53535E+01	6.29743E+00	3.65792E+00	2.95267E+00	2.74975E+00	2.82811E+00
2.73508E+00	2.80216E+00	2.89122E+00	3.06351E+00	2.79969E+00	2.78918E+00	2.89150E+00	3.51317E+00
3.52009E+00	3.53737E+00	3.56218E+00	3.52970E+00	2.88336E+00	2.24687E+00	1.50335E+00	4.64847E-01
3.86672E-01	-2.25183E-01	-4.08217E-01	-5.63935E-01	-5.07018E-01	-3.48739E-01	-1.99030E-02	4.69301E-01
-1.18862E+00	-2.28085E+00	-2.30867E+00	-2.01544E+00	-5.62052E-01	4.17260E-01	7.02651E-01	3.34419E-01
1.58678E-01	-3.95521E-02	5.67562E-01	-7.65341E-01	6.00843E-01	9.05201E-01	1.72778E+00	1.38562E+00
1.00000E+02	4.73057E+01	1.57212E+01	6.44265E+00	3.92603E+00	3.01903E+00	2.89502E+00	2.80244E+00
2.86787E+00	2.95597E+00	3.12670E+00	2.86506E+00	2.85405E+00	2.95570E+00	3.56987E+00	3.67464E+00
3.68867E+00	3.60696E+00	3.56939E+00	2.92178E+00	2.37916E+00	1.62841E+00	4.76601E-01	3.93709E-01
-1.02764E-01	-3.89439E-01	-5.42508E-01	-4.81095E-01	-3.17956E-01	1.36433E-02	4.99685E-01	-1.26754E+00
-2.35275E+00	-2.37341E+00	-2.07982E+00	-6.22135E-01	3.8646E-01	6.39397E-01	2.72338E-01	9.98428E-02
-1.02628E-01	4.91472E-01	-8.70063E-01	5.17002E-01	8.42469E-01	1.77020E+00	1.34483E+00	
1.00000E+02	4.76990E+01	1.55908E+01	6.63504E+00	3.61523E+00	3.18919E+00	2.79481E+00	2.96053E+00
2.94773E+00	3.11810E+00	2.85696E+00	2.94653E+00	2.94728E+00	3.55950E+00	3.66373E+00	3.67706E+00
3.59442E+00	3.55585E+00	2.90800E+00	2.36408E+00	1.61184E+00	5.62694E-01	4.79528E-01	-1.19084E-01
-4.05897E-01	-5.58748E-01	-4.96971E-01	-3.33331E-01	-1.36751E-03	4.84162E-01	-1.28463E+00	-2.36867E+00
-2.38875E+00	-2.09705E+00	-6.39993E-01	3.41220E-01	6.21027E-01	2.53796E-01	8.13766E-02	-1.22753E-01
4.68916E-01	-9.03022E-01	4.91508E-01	8.23784E-01	1.75409E+00	1.33335E+00		
1.00000E+02	4.76792E+01	1.61842E+01	6.32190E+00	3.98375E+00	3.08619E+00	3.04998E+00	3.03704E+00
3.20685E+00	2.94640E+00	3.03577E+00	3.03673E+00	3.64811E+00	3.75005E+00	3.76144E+00	3.77577E+00
3.73427E+00	3.08553E+00	2.43108E+00	1.67323E+00	5.09002E-01	4.20751E-01	-1.69757E-01	-3.52279E-01
-5.01019E-01	-5.35001E-01	-2.61760E-01	7.34046E-02	4.53713E-01	-1.31777E+00	-2.49814E+00	-2.50719E+00

-2.19886E+00	-7.26511E-01	3.52628E-01	6.30065E-01	2.66541E-01	1.00270E-01	-1.00006E-01	4.83247E-01
-9.58256E-01	5.12197E-01	9.34193E-01	1.85864E+00	1.43616E+00			
1.00000E+02	5.28961E+01	1.60568E+01	7.17532E+00	3.96225E+00	3.32043E+00	3.20604E+00	3.27367E+00
3.11591E+00	3.10407E+00	3.10478E+00	3.81158E+00	3.90963E+00	3.91725E+00	3.82285E+00	3.87697E+00
3.12471E+00	2.55928E+00	1.79180E+00	6.11889E-01	4.12163E-01	-1.64127E-01	-4.49604E-01	-5.92600E-01
-5.13996E-01	-3.33616E-01	6.52832E-03	4.84104E-01	-1.39653E+00	-2.56740E+00	-2.56287E+00	-2.24068E+00
-7.53446E-01	3.26415E-01	5.98848E-01	2.39371E-01	8.06224E-02	-1.18845E-01	5.45796E-01	-9.92686E-01
5.73814E-01	9.06394E-01	1.82829E+00	1.41356E+00				
1.00000E+02	4.67545E+01	1.68387E+01	6.57774E+00	4.12390E+00	3.40533E+00	3.37212E+00	3.11373E+00
3.20255E+00	3.20356E+00	3.91116E+00	3.90706E+00	4.01491E+00	3.91815E+00	3.86907E+00	3.21812E+00
2.64787E+00	1.77457E+00	5.87530E-01	4.89485E-01	-1.87587E-01	-4.72452E-01	-6.12605E-01	-5.29142E-01
-3.44094E-01	-1.84404E-03	4.73886E-01	-1.40752E+00	-2.67735E+00	-2.66547E+00	-2.33021E+00	-7.33384E-01
3.46013E-01	6.17463E-01	2.60634E-01	1.06024E-01	-8.96907E-02	5.70868E-01	-9.46965E-01	6.05207E-01
9.27561E-01	1.94209E+00	1.42341E+00					
1.00000E+02	5.07672E+01	1.54354E+01	6.74099E+00	4.31026E+00	3.47122E+00	3.11215E+00	3.10025E+00
3.10092E+00	3.80706E+00	3.90462E+00	3.91180E+00	3.91798E+00	3.86988E+00	3.11743E+00	2.55042E+00
1.78172E+00	5.99870E-01	3.99284E-01	-1.75274E-01	-4.60696E-01	-6.03074E-01	-6.26227E-01	-3.41960E-01
-1.27032E-03	4.75753E-01	-1.40569E+00	-2.57550E+00	-2.56950E+00	-2.34583E+00	-7.57153E-01	3.22810E-01
5.94665E-01	2.35609E-01	7.76578E-02	-1.21802E-01	5.41076E-01	-9.97916E-01	5.69043E-01	9.02567E-01
1.82431E+00	1.41062E+00						
1.00000E+02	4.48170E+01	1.53781E+01	7.00283E+00	4.34892E+00	3.58815E+00	3.27357E+00	3.27413E+00
3.97596E+00	3.96886E+00	4.07368E+00	3.97156E+00	3.91779E+00	3.26557E+00	2.58378E+00	1.80560E+00
6.07819E-01	4.00270E-01	-1.61315E-01	-4.46087E-01	-6.86424E-01	-5.97135E-01	-4.06003E-01	-6.05175E-02
5.14091E-01	-1.47577E+00	-2.73882E+00	-2.71873E+00	-2.37889E+00	-7.74968E-01	3.05503E-01	6.71356E-01
2.17914E-01	6.74535E-02	-1.30346E-01	5.18180E-01	-1.10506E+00	5.48524E-01	8.84318E-01	1.90143E+00
1.49373E+00							
1.00000E+02	4.48003E+01	1.56765E+01	6.67716E+00	4.50433E+00	3.88785E+00	3.38461E+00	3.88608E+00
3.98153E+00	3.98661E+00	3.88738E+00	3.83573E+00	3.18415E+00	2.50767E+00	1.73310E+00	5.41883E-01
4.41796E-01	-2.29054E-01	-5.14206E-01	-6.53605E-01	-5.68848E-01	-3.82205E-01	-3.88848E-02	4.35459E-01
-1.44986E+00	-2.71670E+00	-2.70283E+00	-2.37118E+00	-7.75016E-01	3.05428E-01	5.74507E-01	2.17480E-01
6.33893E-02	-1.36035E-01	5.18327E-01	-1.11263E+00	5.46065E-01	8.84087E-01	1.90433E+00	1.49629E+00
1.00000E+02	4.98070E+01	1.59105E+01	8.29285E+00	6.06327E+00	4.24922E+00	4.13903E+00	4.12838E+00
4.12844E+00	4.01946E+00	3.95990E+00	3.30612E+00	2.61232E+00	1.82474E+00	5.08079E-01	3.98262E-01
-2.53693E-01	-5.38091E-01	-7.73584E-01	-6.75954E-01	-4.76293E-01	-1.26432E-01	4.43731E-01	-1.55301E+00
-2.80747E+00	-2.87715E+00	-2.52587E+00	-8.10102E-01	3.69688E-01	6.32390E-01	1.82121E-01	3.79018E-02
-1.60436E-01	4.73517E-01	-1.15735E+00	5.02456E-01	9.45974E-01	1.96410E+00	1.46689E+00	
1.00000E+02	4.61499E+01	2.06760E+01	1.31047E+01	6.75433E+00	4.82916E+00	4.20966E+00	4.20704E+00
4.09162E+00	4.12940E+00	3.37234E+00	2.66608E+00	1.76720E+00	4.33870E-01	3.16971E-01	-3.23787E-01
-7.10767E-01	-8.36507E-01	-7.28395E-01	-5.18472E-01	-1.63783E-01	4.01923E-01	-1.59858E+00	-2.94728E+00
-2.90049E+00	-2.52781E+00	-8.91184E-01	3.86570E-01	6.46008E-01	2.98952E-01	6.52941E-02	-1.27571E-01
4.94761E-01	-1.10771E+00	5.32736E-01	9.64419E-01	1.97255E+00	1.57166E+00		
1.00000E+02	7.36846E+01	4.29220E+01	1.74082E+01	7.31071E+00	4.46479E+00	4.35629E+00	4.23118E+00
4.26143E+00	3.40012E+00	2.67554E+00	1.76330E+00	4.07180E-01	2.80421E-01	-4.45979E-01	-7.28332E-01
-9.49767E-01	-8.27995E-01	-6.04383E-01	-1.40790E-01	4.18638E-01	-1.69252E+00	-3.13125E+00	3.06485E+00
-2.66868E+00	-9.09904E-01	3.68525E-01	7.20463E-01	2.80785E-01	5.77873E-02	-2.28340E-01	5.67762E-01
-1.20994E+00	5.13171E-01	9.45525E-01	2.04651E+00	1.55223E+00			
1.00000E+02	7.88334E+01	2.98475E+01	9.88782E+00	4.52821E+00	4.02184E+00	4.01162E+00	3.95045E+00
3.19421E+00	2.49478E+00	1.60030E+00	2.75396E-01	1.62002E-01	-4.84067E-01	-7.67968E-01	-8.97136E-01
-8.97175E-01	-5.90691E-01	-2.38726E-01	3.29507E-01	-1.66859E+00	-2.91963E+00	-2.88151E+00	-2.52088E+00
-7.97123E-01	3.82381E-01	6.44076E-01	2.93996E-01	5.52283E-02	-1.40328E-01	4.89701E-01	-1.12611E+00
5.23304E-01	9.59718E-01	1.97291E+00	1.47270E+00				
1.00000E+02	5.09064E+01	1.46164E+01	4.91533E+00	4.00300E+00	3.98981E+00	3.92609E+00	3.16915E+00
2.46440E+00	1.56575E+00	2.34287E-01	1.17993E-01	-5.22174E-01	-8.05907E-01	-9.33011E-01	-9.30113E-01
-6.19436E-01	-2.65632E-01	3.00748E-01	-1.70016E+00	-2.94764E+00	-2.90461E+00	-2.53954E+00	-8.10640E+00
3.69247E-01	6.28968E-01	2.80267E-01	4.41445E-02	-1.51503E-01	4.72508E-01	-1.14570E+00	5.05749E-01
9.45745E-01	1.95865E+00	1.46220E+00					
1.00000E+02	3.59159E+01	6.73621E+00	4.10383E+00	3.98350E+00	3.91638E+00	3.05627E+00	2.33824E+00
1.22562E+00	-1.25103E-01	-1.44776E-01	-7.75117E-01	-1.05725E+00	-1.17704E+00	-1.05872E+00	-7.36516E-01
-3.77587E-01	2.86766E-01	-1.71491E+00	-2.95552E+00	-2.89697E+00	-2.50216E+00	-8.47551E-01	4.29170E-01
6.87189E-01	3.45042E-01	1.18941E-01	-6.64130E-02	5.49370E-01	-1.01126E+00	6.00063E-01	1.01037E+00
2.00551E+00	1.49424E+00						
1.00000E+02	3.21993E+01	6.67386E+00	4.98320E+00	4.67748E+00	3.19367E+00	2.37243E+00	6.76244E-01
-9.14549E-01	-5.72699E-01	-1.32475E+00	-1.49412E+00	-1.66757E+00	-1.56660E+00	-1.16013E+00	-5.57337E-01
2.76612E-01	-2.06085E+00	-3.54485E+00	-3.36732E+00	-2.88874E+00	-7.73572E-01	7.95203E-01	1.02827E+00
5.31855E-01	3.76332E-01	1.42555E-01	9.57492E-01	-8.14948E-01	9.88733E-01	1.39074E+00	2.59981E+00
1.95421E+00							
1.00000E+02	2.77291E+01	6.73885E+00	4.88996E+00	3.40097E+00	2.55721E+00	1.04416E+00	-7.79968E-01
-6.59457E-01	-1.47929E+00	-1.75382E+00	-1.92108E+00	-1.80927E+00	-1.38999E+00	-7.79007E-01	4.64433E-02
-2.41886E+00	-3.98611E+00	-3.89245E+00	-3.32231E+00	-1.00241E+00	5.73373E-01	8.90891E-01	3.94191E-01
1.46092E-01	-2.03375E-01	6.69845E-01	-1.31653E+00	7.62525E-01	1.25177E+00	2.49164E+00	1.90579E+00
1.00000E+02	2.97293E+01	6.64801E+00	3.31140E+00	2.22855E+00	5.81595E-01	-1.39067E+00	-1.28945E+00
-1.96091E+00	-2.33948E+00	-2.39086E+00	-2.25859E+00	-1.81743E+00	-1.09182E+00	-1.74927E-01	-2.76704E+00
-4.31135E+00	-4.18934E+00	-3.60468E+00	-1.25881E+00	4.20996E-01	8.23166E-01	2.33088E-01	-1.62938E-03
-3.60207E-01	4.71553E-01	-1.58038E+00	5.47796E-01	1.08943E+00	2.44128E+00	1.89761E+00	
1.00000E+02	2.97985E+01	5.19783E+00	2.22783E+00	7.45391E-01	-1.37413E+00	-1.81937E+00	-2.42337E+00
-2.91055E+00	-3.16248E+00	-2.91219E+00	-2.45288E+00	-1.71383E+00	-7.07000E-01	-3.34796E+00	-5.17070E+00
-5.02536E+00	-4.47912E+00	-1.83596E+00	5.73465E-02	4.34226E-01	-1.60891E-01	-4.90659E-01	-8.93175E-01
-3.01738E-02	-2.54656E+00	-1.28171E-01	6.93409E-01	2.11563E+00	1.59442E+00		
1.00000E+02	2.70538E+01	3.53868E+00	3.88500E-02	-2.45856E+00	-2.72140E+00	-3.36404E+00	-3.85278E+00
-3.98514E+00	-3.70798E+00	-3.11574E+00	-2.35954E+00	-1.26455E+00	-3.94561E+00	-5.73674E+00	-5.55451E+00
-5.00192E+00	-2.12979E+00	-1.25893E-01	2.29397E-01	-4.60755E-01	-7.75302E-01	-1.19900E+00	-3.97479E-01
-3.14712E+00	-4.36644E-01	3.92049E-01	1.94621E+00	1.50137E+00			
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