S

HNF-EDC-02 - 13292 Page 1 of 2

ENGINEERING DOCUMENT CHANGE CONTROL

Change Identification

21. Release:

DEC 16 2002 DATE: STA: 22 HANFORD RELEASE ID: 43

1. Change Category:
☐ Direct Revision ☐ Supplemental Change ☐ Page Change
☐ Supersedure ☐ Cancel/Void ☒ New

2. Classification of Change:
☒ Major ☐ Minor ☐ Conf Baseline

3. Date: 10/24/2002

4. Originator's Name, Organization, MSIN, and Telephone No.:
J. V. Nelson, FH Nuclear & Criticality Safety, A0-26, 376-4480

5. USQ Required? ☐ Yes ☒ No USQ No.: _____ CX No.: 4 12/16/02

6. Technical Authority: J. V. Nelson

7. Project/Program (WMP, FFTF, etc.): FFTF

8. Area: 400

9. Building:

10. Reviewer Designator: N

11. Plan:
Estimate the radionuclide inventory in the Fast Flux Test Facility (FFTF) reactor vessel (activated reactor hardware and irradiated non-fuel core components). From the spatial distribution of this inventory, estimate dose rates at locations in the reactor cavity where worker access may be required if the vessel is to be removed from the FFTF.

12. Criteria:
Defensible estimates of the radionuclide inventory are needed to determine the waste disposal classification of the reactor vessel and its internals/contents. If a decision is made to remove the reactor vessel, doses to D&D workers and during transportation will need to be predicted for work planning. Also in that case, radionuclide activities and possible doses from the vessel must be shown to comply with waste acceptance criteria and restrictions for Hanford's Environmental Restoration Disposal Facility (ERDF) and Low-Level Burial Grounds.

13. Change Description:
New Document

14. Documents Issued or Changed by this EDC:

Document	Page	Revision	Comments
FFTF-14010		0	Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

15. Technical Justification (Need):
Information in this report is needed to determine the waste disposal classification of the FFTF reactor vessel and its contents and to evaluate waste disposal options.

Evaluation and Coordination

16. Change Impact:
N/A

17. Affected Documents:

Document Number	Page	Revision	Person Notified/Comments

ENGINEERING DOCUMENT CHANGE CONTROL (continued)

N/A			

Verification

18. Verification:

Document was peer reviewed for technical accuracy.

19. Approvals/Reviews:

Initials, Last Name, Date, MSIN	Initials, Last Name, Date, MSIN
Technical Authority: J. V. Nelson JV Nelson 10/31/02 T5-54	Technical Authority Manager: H. Toffer H Toffer 10/31/02 T5-54
Reviewer (Title): S. W. Scott (ESH&Q) N2-57 12/10/02	Reviewer (Title): J. V. Nelson (Author) A0-26 JV Nelson 10/31/02
Reviewer (Title): J. S. Lan (Tech Reviewer) E6-17 J. S. Lan 10/31/02	Reviewer (Title): D. W. Wootan (Tech Reviewer) A0-26 D J Wootan 10/31/02
Reviewer (Title): D. L. Nielsen (FFTF Engineering) D.L. Nielsen 11/6/02 N2-53	Reviewer (Title): W. W. Bowen (FFTF Engineering Mgr.) WW Bowen 11/15/02
Reviewer (Title):	Reviewer (Title):

Solution

20. Change Description (Solution) - Continuation Sheet:

N/A

DISTRIBUTION SHEET

To	From	Page 1 of 1
DISTRIBUTION	Fluor Hanford	Date October 24, 2002
Project Title/Work Order		EDT No. N/A
HNF-EDC-02-13292 - FFTF-14010 -- Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
Fluor Hanford					
T. M. Burke	N2-53	X			
S. W. Hiller	N2-02	X			
J. S. Lan	E6-17	X			
J. V. Nelson	A0-26	X			
D. L. Nielsen	N2-53	X			
A. L. Ramble	A0-26	X			
A. B. Rau (H)	E6-17	X			
S. W. Scott	N2-57	X			
H. Toffer	A0-26	X			
D. W. Wootan	A0-26	X			
DOE/RL Reading Room	H2-53	X			
Docket Files (2 copies)	A3-02	X			

Date Received for Clearance Process (MM/YY/DD)

INFORMATION CLEARANCE FORM

kmc 12-12-02

A. Information Category

- ☐ Abstract
- ☐ Journal Article
- ☐ Summary
- ☐ Internet
- ☐ Visual Aid
- ☐ Software
- ☐ Full Paper
- ☒ Report
- ☐ Other _____

B. Document Number ~~HNF-10604, Rev. 0~~ FFTF-14010, Rev. 0

C. Title

"Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel"

D. Internet Address

E. Required Information

1. Is document potentially Classified? ☒ No ☐ Yes (MANDATORY)

Manager's Signature Required

If Yes _____ ☐ No ☐ Yes Classified

ADC Signature Required

2. References in the Information are Applied Technology ☒ No ☐ Yes

Export Controlled Information ☒ No ☐ Yes

3. Does Information Contain the Following: (MANDATORY)

a. New or Novel (Patentable) Subject Matter? ☒ No ☐ Yes

If "Yes", Disclosure No.: _____

b. Information Received in Confidence, Such as Proprietary and/or Inventions?

☒ No ☐ Yes If "Yes", Affix Appropriate Legends/Notices.

c. Copyrights? ☒ No ☐ Yes If "Yes", Attach Permission.

d. Trademarks? ~~☒ No~~ DN 12/11/02 ☒ Yes If "Yes", Identify in Document.

4. Is Information requiring submission to OSTI? ☒ No ☐ Yes

5. Release Level? ☒ Public ☐ Limited

F. Complete for a Journal Article

1. Title of Journal

G. Complete for a Presentation

1. Title for Conference or Meeting _____

2. Group Sponsoring _____

3. Date of Conference _____ 4. City/State _____

5. Will Information be Published in Proceedings? ☐ No ☐ Yes 6. Will Material be Handed Out? ☐ No ☐ Yes

H. Author/Requestor

D L Nielsen DL Nielsen
(Print and Sign)

Responsible Manager

S W Scott SW Scott
(Print and Sign)

I. Reviewers

	Yes	Print	Signature	Public Y/N (If N, complete J)
General Counsel	☐			Y / N
Office of External Affairs	☐			Y / N
DOE-RL	☐			Y / N
Other	☒	D A Gantt, Applied Tech	DG Gantt 12/11/02	(Y) N
Other	☒	M A Williams, ECI	MAWilliams	(Y) / N

J. If Information Includes Sensitive Information and is not to be released to the Public indicate category below.

- ☐ Applied Technology
- ☐ Personal/Private
- ☐ Proprietary
- ☐ Business-Sensitive
- ☐ Predecisional
- ☐ UCNI
- ☐ Protected CRADA
- ☐ Export Controlled
- ☐ Procurement-Sensitive
- ☐ Patentable
- ☐ Other (Specify) _____

Information Clearance Approval

APPROVED FOR RELEASE OFFICIAL DOCUMENT MAW Date 12/16/02

K. If Additional Comments, Please Attach Separate Sheet

* per telecon with M.A. Williams 12/16/02

FFTF-14010
Revision 0

Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Fluor Hanford
P. O. Box 1000
Richland, Washington

Project Hanford Management Contract for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Approved for Public Release
(Upon receipt of Clearance approval)
Further Dissemination Unlimited

S

FFTF-14010
Revision 0

Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

J. V. Nelson, Fluor Hanford

October 2002

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Fluor Hanford
P. O. Box 1000
Richland, Washington

Project Hanford Management Contract for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

DEC 16 2002
DATE:
HANFORD
STA: 22 RELEASE ID: 43

*M. A. Williams
Clearance Approval

DEC 16 2002
Date

Release Approval (stamp)

*per telecon with M.A. Williams S.C.P. 12/16/02

Approved for Public Release
(Upon receipt of Clearance approval)
Further Dissemination Unlimited

FFTF-14010
Revision 0

For use with Technical Documents (when appropriate)	
EDC- 02-13292	FMP-
EDT-	ECN-
Project No.:	Division: FFTF
Document Type: TR	Page Count: 408

For use with Speeches, Articles, or Presentations (when appropriate)							
Abstract		Summary		Full Paper		Visual Aid	
Conference Name:							
Conference Date:							
Conference Location:							
Conference Sponsor:							
Published in:							
Publication Date:							

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, Process, or service by trade name trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

Key Words: FFTF, Radionuclide Activity, dose, decommissioning, Radionuclide Inventory

Abstract: Preparations are being made to decommission the Fast Flux Test Facility (FFTF). As a part of that work, calculations have been completed to estimate the inventory of radionuclides remaining in the FFTF reactor vessel that are important to waste disposal classification. These radionuclides are activation products in reactor hardware and the non-fuel core components that remain in the reactor vessel. All fuel assemblies and tests have been previously removed from the vessel and are outside the scope of this assessment. Also, dose rates in the reactor cavity following sodium drain have been predicted. If the option of removing the reactor vessel from the FFTF site is exercised, worker access to locations in the reactor cavity will be required. Dose rates at these locations are elevated due the radioactive decay of the activation products in the vessel. Reasonable estimates of these dose rates will be needed for work planning.

Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

October 2002

Prepared by
Fluor Hanford

Prepared by: J. V. Nelson Date: 10/30/02

Reviewed by: J. S. Lan Date: 10/30/02

Reviewed by: D. W. Wootan Date: 10/31/02

Approved by: H. Toffer Date: 10/31/02

EXECUTIVE SUMMARY

Preparations are being made to deactivate and decommission (D&D) the Fast Flux Test Facility (FFTF). This report supports the planning for those activities by documenting an assessment of the inventory of radionuclides in fixed reactor hardware and core components remaining in the FFTF reactor vessel, and potential dose rates associated with D&D operations. The fixed reactor hardware includes the reactor vessel, its internals, the closure head assembly, and head-mounted refueling equipment. Tabulated in this report are masses, activities, and concentrations of significant radionuclides in each major reactor hardware component and in each type of irradiated non-fuel assembly (reflector, control rod, etc.) in the reactor vessel. There are no fuel assemblies remaining in the vessel.

Radionuclides were considered significant if they are present in quantities that could pose a hazard to workers or the environment during D&D activities or those that could pose a long-term hazard to workers or the public. Radionuclides determined to meet those criteria are: ^{14}C, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{94}Nb, ^{93}Mo and ^{99}Tc. Their selection was based in part on guidelines contained in Title 10, Code of Federal Regulations (10 CFR), Part 61.55, *Waste Classification*. Data for five dates are presented: 2003, 2008, 2013, 2023 and 2053. Quantities of only ^{60}Co, with a half life of 5.3 years, and ^{63}Ni, with a half life of 100 years, change significantly over the included time span. Radionuclide activities are summarized in the table below.

Summary of Radionuclide Inventory in the FFTF Reactor Vessel – September 2003

Radio-Nuclide	Half Life (years)	Activity (curies)		
		Reactor Hardware	Core Components	Total
^{14}C	5.7×10^{3}	4.56×10^{1}	6.73×10^{0}	5.23×10^{1}
^{60}Co	5.3×10^{0}	2.19×10^{5}	4.77×10^{5}	6.97×10^{5}
^{59}Ni	7.6×10^{4}	1.77×10^{2}	1.41×10^{3}	1.59×10^{3}
^{63}Ni	1.0×10^{2}	1.72×10^{4}	1.83×10^{5}	2.00×10^{5}
^{94}Nb	2.0×10^{4}	1.20×10^{1}	3.37×10^{1}	4.56×10^{1}
^{93}Mo	3.5×10^{3}	1.06×10^{-7}	2.75×10^{2}	2.75×10^{2}
^{99}Tc	2.1×10^{5}	6.52×10^{-8}	2.69×10^{1}	2.69×10^{1}
Total		2.37×10^{5}	6.62×10^{5}	8.99×10^{5}

Calculations of nuclide reaction rates leading to the production and depletion of the tabulated radionuclides were made using the Monte Carlo code MCNP4C™ and a detailed model of the FFTF. Quantities of radionuclides other than the nickel isotopes depend on the concentrations of trace elements and impurities in metal alloys. The largest uncertainties in the

™ MCNP is a trademark of the Regents of the University of California, Los Alamos National Laboratory.

inventories reported for those radionuclides are probably due to uncertainties in concentrations of nuclides from which they are produced. In computing radionuclide inventories from the MCNP4C-calculated reaction rate data, conservative estimates of trace element and impurity levels were used. Thus, the resulting radionuclide inventories are expected to be bounding values.

If the decision is made to remove the reactor vessel, preparatory work in the reactor cavity will be required. In that case, estimates of the dose rates, which result from the buildup of radionuclides (primarily ^{60}Co) in the fixed reactor hardware and core components in the vessel, will be needed for work planning to keep personnel doses as low as reasonably achievable (ALARA). Again using MCNP4C, those dose rates were computed assuming that the work occurs in 2010 with all sodium removed from the vessel.

Computed doses rates in the upper reactor cavity average 3 mrem/hr with a peak of 8 mrem/hr; personnel access there is required to remove the main support structure studs. Dose rates range from 60 to 120 mrem/hr near the inlet and outlet piping, which will need to be cut to remove the vessel. Peak dose rates in the cavity occur at the core midplane elevation, where the computed range is 1,800 to 16,200 mrem/hr. However, at midplane locations where personnel access might be required, computed dose rates do not exceed 2,500 mrem/hr. Dose rates at the midplane are dominated by photon sources in irradiated core components stored in In-Vessel Storage Modules that are near the vessel perimeter. However, sources in fixed reactor hardware contribute significantly to dose rates at most anticipated work locations. Sources in core components stored in the 199 core positions have a negligible effect on dose rates in the reactor cavity. Because the photon sources used in the dose rate calculations were based on conservative estimates of radionuclide concentrations, the given dose rates are also expected to be bounding.

TABLE OF CONTENTS

1.0 PURPOSE AND OBJECTIVE 8
2.0 BACKGROUND AND INTRODUCTION 8
3.0 METHODOLOGY 10
3.1 FFTF MODELING 10
3.2 IDENTIFICATION OF IMPORTANT REACTIONS 17
3.3 PROCESSING OF REACTION RATE DATA TO OBTAIN RADIONUCLIDE INVENTORIES 19
3.4 DOSE RATE CALCULATIONS 19
3.5 COMPUTER PROGRAM VALIDATION 21
4.0 ASSUMPTIONS 22
4.1 CORE LOADING 22
4.2 MCNP MODEL 22
4.3 BURNUP AND DECAY CALCULATIONS 23
5.0 INPUT DATA AND CALCULATIONS 24
5.1 MCNP CALCULATION OF NEUTRON FLUX AND REACTION RATES 24
5.2 RADIONUCLIDE INVENTORY CALCULATIONS 25
5.3 DOSE RATE CALCULATIONS 34
6.0 RESULTS 42
6.1 RADIONUCLIDE INVENTORIES 42
6.2 RADIONUCLIDE CONCENTRATION AT BOTTOM OF THE CORE SUPPORT STRUCTURE 43
6.3 DOSE RATES IN THE REACTOR CAVITY 43
6.4 DOSE RATES IN THE HEAD COMPARTMENT AFTER SODIUM DRAIN 44
7.0 CONCLUSIONS 163
8.0 REFERENCES 164

APPENDICES

APPENDIX A - FFTF CORE COMPONENTS STORED IN THE REACTOR VESSEL A-1
APPENDIX B – COMPARISON OF FLUX DATA IN HIGH POWER PHYSICS TEST LOADING WITH OTHER OPERATING CYCLES B-1
APPENDIX C – MCNP4C REACTION RATE OUTPUT FILES C-1
APPENDIX D - PROGRAM TO REFORMAT MCNP REACTION RATE TALLY FILE D-1
APPENDIX E - COMPUTATION OF RADIONUCLIDE INVENTORIES E-1
APPENDIX F – COMPARISON OF NEUTRON AND PHOTON ATTENUATION IN FFTF SHIELD MATERIALS F-1

APPENDIX G – ADJUSTMENTS MADE TO RADIONUCLIDE INVENTORIES IN THE CLOSURE HEAD ASSEMBLY G-1

APPENDIX H – ANALYSIS OF FFTF REACTION RATE MEASUREMENTS TO VALIDATE METHODS AND MODELS H-1

APPENDIX I – SUPPORTING DOCUMENTATION FOR STEEL COMPOSITIONS USED IN COMPUTING RADIONUCLIDE INVENTORIES I-1

APPENDIX J - MCNP INPUT FILES J-1

APPENDIX K - STATEMENT OF WORK K-1

APPENDIX L – SELECTED PLOTS OF FFTF GEOMETRY AND PHOTON SOURCE DISTRIBUTION L-1

APPENDIX M - PEER REVIEW SHEET M-1

LIST OF TABLES

Table 3-1. Regions where Reaction Rates Were Computed for Irradiated Assemblies in the MCNP Calculation (2 sheets) 11
Table 3-2. Regions where Reaction Rates Were Computed for Fixed Reactor Hardware in the MCNP Calculation (2 sheets) 13
Table 3-3. Radionuclides of Significance in the FFTF Vessel with Production and Burnout Reactions Computed 18
Table 5-1. Summary of MCNP cases to Compute Neutron Flux and Reaction Rate Data 24
Table 5-2 Compositions of Steel and Inconel Materials in the FFTF Vessel Used to Compute Radionuclide Inventories (2 sheets) 26
Table 5-3. Summary of Transmut2 Runs to Compute Radionuclide Inventories 30
Table 5-4. Irradiation History and Grouping of Control and Safety Rods Residing in the Reactor Vessel 31
Table 5-5. Summary of Control and Safety Rod Groups 32
Table 5-6. Irradiation History and Grouping of In-Core Shim Assemblies Residing in the Reactor Vessel 32
Table 5-7. Summary of In-Core Shim Assembly Groups 33
Table 5-8. Irradiation History and Grouping of Peripheral Shim Rods Residing in the Reactor Vessel 33
Table 5-9. Summary of Peripheral Shim Rod Groups 33
Table 5-10. Summary of Additional Transmut2 Runs to Compute Radionuclide Inventory Details for Input to Dose Rate Calculations 36
Table 5-11. Inventory of Irradiated Assemblies in In-Vessel Storage Modules (2 sheets) 38
Table 5-12. Points at which Dose Rates Were Evaluated 40
Table 5-13. Summary of MCNP4C Dose Rate Calculations 41
Table 6-1. Summary of the Content of Radionuclide Inventory Tables 44
Table 6-2. Contents of each Radionuclide Inventory Table 45
Table 6-3. Radionuclide Inventories in Activated Reactor Hardware – September 2003 46
Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 57

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware – September 2008.....69
Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel –September 2008.....80
Table 6-7. Radionuclide Inventories in Activated Reactor Hardware – September 2013.....92
Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013.....103
Table 6-9. Radionuclide Inventories in Activated Reactor Hardware – September 2023.....115
Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023...126
Table 6-11. Radionuclide Inventories in Activated Reactor Hardware – September 2053.....138
Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053...149
Table 6-13. Summary of Radionuclide Inventory in the FFTF Reactor Vessel – September 2003 161
Table 6-14. Radionuclide Concentrations in the Bottom - Center of the Core Support Structure.....161
Table 6-15. Dose Rates above Boron Carbide Shield (18.3 ft above Core Midplane and 11.3 ft from Core Centerline).....162
Table 6-16. Dose Rates in Reactor Cavity 9 ft 11 in. above Core Midplane and 12 ft from Core Centerline 162
Table 6-17. Dose Rates in Reactor Cavity 10 ft 7 in. below Core Midplane, 12 ft from Core Centerline 162
Table 6-18. Dose Rates in Reactor Cavity at Core Midplane, 12 ft from Core Centerline 163

LIST OF FIGURES

Figure 3-1. Plan View of the Model of FFTF Used in the MCNP Calculation.....15
Figure 3-2. Elevation View of the Model of FFTF Used in the MCNP Calculation.....16
Figure 5-1. Diagram of In-Vessel Storage Modules with Current Loading 37

ACRONYMS

BOC	Beginning of Cycle
C/E	Calculation to measurement [ratio]
CDE	Core Demonstration Experiment
CFR	Code of Federal Regulations
Ci	Curies [activity]
CR	Control Rod
CRFS	Control Rod Fixed Shim (same as PSR)
D&D	Deactivation and Decommissioning
DOE	Department of Energy
EFPD	Effective Full Power Days
ENDF/B-V	Evaluated Nuclear Data File, Version V
EPR	Extended Power Run [in FFTF] (same as HPC)
ERDF	Environmental Restoration Disposal Facility
FFTF	Fast Flux Test Facility
FH	Fluor Hanford, Inc.
FLAN	Fluor Local Area Network
HPC	High Power Characterization [irradiation in FFTF] (same as EPR)
HPPT	High Power Physics Test [Loading in FFTF]
ICSA	In-Core Shim Assembly
IRT	In-Reactor Thimble
IPR	Initial Power Run [in FFTF]
IVHM	In-Vessel Handling Machine
IVSM	In-Vessel Storage Module
MCNP	Monte Carlo N-Particle [computer program]
MW	Megawatt
MWd	Megawatt-days
NCT	Natural Circulation Testing [in FFTF]
PSR	Peripheral Shim Rod (same as CRFS)
RICS	Refueling Inventory Control System
SOW	Statement of Work
SS-304	Type 304 stainless steel
SS-316	Type 316 stainless steel
SS-410	Type 410 stainless steel

1.0 PURPOSE AND OBJECTIVE

This report documents an assessment of inventories of long-lived radionuclides in the Fast Flux Test Facility (FFTF) reactor vessel, and potential dose rates associated with its deactivation and decommissioning (D&D). This information was requested by Fluor Hanford (FH) to support the preparation of D&D plans and supporting documentation leading to selection of a final end state for the reactor. The Statement of Work (SOW) issued by FH is included in this report as Appendix K. Radionuclide inventories for all hardware components and irradiated assemblies remaining in the reactor vessel were computed and are tabulated in Section 6 for five dates ranging from 2003 through 2053.

To assure that hardware components and assemblies in the vessel meet the requirements for near-surface disposal, the SOW suggested that Tables 1 and 2 of Title 10, Code of Federal Regulations (10 CFR), Part 61.55, *Waste Classification*, be used as a basis for determining which radionuclides should be in the inventory list. Radionuclides are considered significant if they are present in quantities that could pose a hazard to workers or the environment during D&D activities or those that could pose a long-term hazard to workers or the public. Based on 10 CFR 61.55 Tables 1 and 2, the long-lived and mobile isotopes potentially present in the FFTF vessel were determined to include: ^{60}Co, ^{59}Ni, ^{63}Ni, ^{99}Tc, ^{94}Nb, ^{14}C. One other radionuclide (^{93}Mo), not listed in 10 CFR 61.55, was deemed potentially significant and also tabulated.

This report is also intended to provide information needed to complete the following evaluations:

- If a decision is made to entomb the reactor vessel, a determination must be made that exposures to the public will be acceptable over a long period of time (typically 10,000 years at Hanford).
- An assessment must be made that credible intruder scenarios occurring within a certain time period (typically 500 years) do not result in an acute dose exceeding 500 mrem or a chronic dose exceeding 100 mrem/year.
- If a decision is made to remove the reactor vessel, doses to D&D workers and during transportation will need to be predicted.
- Also in that case, radionuclide activities and possibly doses from the vessel must be shown to comply with waste acceptance criteria and restrictions for Hanford's Environmental Restoration Disposal Facility (ERDF) and Low-Level Burial Grounds.

2.0 BACKGROUND AND INTRODUCTION

In 1994, the U.S. Department of Energy (DOE) issued a termination order for the FFTF. Shortly thereafter, a complex and detailed task was initiated at Hanford to assess the radionuclide

inventory in all fixed components in the reactor vessel plus the non-fuel core components that were to remain in the vessel following deactivation. This activity continued with limited resources through 1995.

In late 1995, DOE made a decision to include the FFTF as one of the options being considered for producing tritium for national defense applications. FFTF was also to be considered for producing ^{238}Pu as a power source for deep-space missions and other isotopes needed for medical applications. At that time, preparations for deactivating the FFTF were suspended and funding that had been allocated for the analysis of radionuclide inventories was diverted for studying potential restart missions. Electronic and paper files generated during the radionuclide inventory analysis were archived without formal documentation.

Work completed during 1994 and 1995 to evaluate radionuclide inventories in the FFTF reactor vessel included: (1) preparation of a detailed calculational model, (2) an assessment of which radionuclides were important, (3) determination of the sources of these radionuclides, and (4) development of methods to estimate radionuclide inventories from reaction rates computed by the MCNP Monte Carlo program. However, that early work included preparation for computing radionuclide inventories only in fixed hardware components.

In late January 2001, the DOE concluded that isotope production needs could be carried out without restarting the FFTF, and another deactivation order was issued. As part of that order, FH was required to provide an initial shutdown plan within 90 days. To support preparation of that plan work on the project was resumed and a report documenting limited preliminary studies was prepared.

Subsequently FH requested this report to provide complete, formal documentation of the radionuclide inventories in the FFTF vessel. Irradiated materials in the vessel include various fixed reactor components such as the radial shields and the core support structure, and non-fueled assemblies irradiated in the FFTF core. The assemblies include radial reflectors, control and safety rods, in-core shims and peripheral shim rods that currently reside in core locations and in-vessel storage modules. The non-fueled assembles are expected to remain there for final disposal. All fuel and blanket assemblies have been removed from the reactor vessel and are outside the scope of this report.

Also, the scope of the preliminary report was extended to include computation of dose rates due to the buildup of radionuclides (primarily ^{60}Co) in the reactor vessel. Specified points at which dose rates were computed were in the reactor cavity at locations where access may be required to perform necessary D&D work.

3.0 METHODOLOGY

Estimating the required radionuclide inventories involved a number of steps. In summary, these steps were:

1. Prepare a detailed MCNP model of the contents of the reactor vessel during power operations, including a core loading.

2. Determine which radionuclides in the vessel are important to disposal classification and need to be tracked, and how these nuclides are produced in the FFTF.

3. Run MCNP4C (Briesmeister 2001 and Johnson 2002) to tally nuclear reaction rates by region for the nuclides needed to compute buildup and depletion of the radionuclides identified in step 2.

4. Process the reaction rate tallies produced by MCNP4C to obtain radionuclide inventories by region, accounting for isotope buildup, depletion and radioactive decay.

Subsequent steps necessary to compute dose rates at the required locations after sodium drain can be summarized as follows:

1. From the ^{60}Co inventories calculated in the steps above, generate photon source rate distributions for use as input to MCNP4C photon dose rate calculations.

2. Convert the MCNP model used to compute neutron reaction rates to a model designed to compute photon dose rates from ^{60}Co activation of reactor hardware and the irradiated assemblies remaining in the vessel after sodium is drained.

3. Run MCNP4C to tally photon dose rates and tabulate the results.

These steps to obtain radionuclide inventories and resulting dose rates, summarized above, are described in more detail in the remainder of this section.

3.1 FFTF MODELING

The very detailed MCNP model prepared for this analysis extends radially from the central core region out to the concrete shielding outside the reactor vessel and vertically from the concrete base below the vessel up to the operating deck (see Figures 3-1 and 3-2). The model contains sufficient detail to compute radionuclide inventories anywhere in the vessel. For this analysis, needed reaction rates, discussed below, were tallied in the 60 regions listed in Tables 3-1 and 3-2, which also list the problem cell numbers that constitute each of the tally regions. Radionuclide inventories were computed and reported for each tally region separately, with the following exceptions:

- For control and safety rods, the duct regions between the rod follower and lower shield regions were combined with the absorber regions.

- For each axial component, control and safety rod inventories were combined, since these assemblies are identical in construction.

- Core basket structure and interior steel were combined for reporting purposes.

Only one core loading was modeled in this analysis – the High Power Physics Test (HPPT) loading irradiated prior to the first operating cycle. This HPPT loading was used because it had been previously modeled in MCNP for other applications. Starting with this existing model saved a great deal of time and effort. An assumption is that space and energy distribution of the neutron flux in the HPPT loading is representative of that in loadings for all FFTF operating cycles (1A through 12B-2). Comparison of total neutron flux data computed at three row 6 locations in the HPPT loading with flux data from other operating cycles confirmed this assumption (see Appendix B) These flux data were extracted from the core reload design reports issued prior to each operating cycle. The computed total flux at the row 6 locations averaged 1.2% higher over the life of the reactor operation than computed for the HPPT loading. This small difference was applied as an adjustment to the radionuclide inventory computations described in Section 3.3.

Table 3-1. Regions where Reaction Rates Were Computed for Irradiated Assemblies in the MCNP Calculation (2 sheets)

	Region Description	Cells in MCNP Model
1	Inconel® section of radial reflectors in row 7 (33 assemblies in the model)	92 – 101, 103, 104 – 115, 116 – 122, 124, 125, 127, 292 – 301, 303, 304 – 315, 316 – 322, 324, 325, 327, 492 – 501, 503, 504 – 515, 516 – 522, 524, 525, 527
2	Upper shield section of the 33 row 7 radial reflectors, plus the other 3 row 7 positions that did not contain reflector assemblies.	892 – 927, 1618
3	Lower shield/orifice region for all 36 row 7 positions	692 – 727
4	Handling socket region for the row 7 positions	1619
5	Nozzle region for rows 7 and 8A assemblies	1615, 1616
6	Inconel section of radial reflectors in rows 8 and 9 (72 assemblies)	128 – 199, 328 – 399, 528 – 599
7	Upper shield section of the rows 8 and 9 radial reflector assemblies.	928 – 999, 1658
8	Lower shield/orifice region for the row 8	728 – 799

® Inconel is a registered trademark of Special Metals Corporation., Huntington, West Virginia.

	Region Description	Cells in MCNP Model
	and 9 positions	
9	Handling socket region for the row 8 and 9 positions	1659
10	The boron carbide section of the 6 control rods (CRs), which were modeled as being withdrawn 26.5 in.	439, 1041, 839, 441, 1043, 841, 447, 1045, 847, 449, 1047, 849, 455, 1049, 855, 457, 1051, 857
11	Follower (below absorber) section of the six CRs	3339, 41, 47, 49, 55, 57
12	CR duct between the follower and the lower shield	239, 241, 247, 249, 255, 257, 1040, 1042, 1044, 1046, 1048, 1050
13	CR lower shield/orifice	639, 641, 647, 649, 655, 657
14	Nozzle region for rows 5 and 6	1575, 1576
15	Above-absorber region of the CRs	1504 – 1509
16	Driveline/plenum region for rows 5 and 6	1578
17	Handling socket region for rows 5 and 6	1579
18	The boron carbide section of the 3 safety rods (SRs), which were modeled as being withdrawn 36 in.	409, 809, 413, 813, 417, 817
19	Follower (below absorber) section of the three SRs	3309, 3313, 3317
20	SR duct between the follower and the lower shield	209, 213, 217, 1037, 1038, 1039
21	SR lower shield/orifice	609, 613, 617
22	Nozzle region for rows 1 – 4	1527, 1528
23	Above-absorber region of the SRs	1501, 1502, 1503
24	Driveline/plenum region for rows 1 – 4	1530
25	Handling socket region for rows 1 – 4	1531
26	Three In-Core Shim Assemblies (ICSAs) in locations 1404, 2405 and 3406 over the axial range 24.5 in. below, to 57.1 in. above the core midplane.	3323, 223, 423, 823, 3330, 230, 430, 830, 3337, 237, 437, 837
27	Lower shield region of the ICSAs	623, 630, 637
28	The boron carbide section of the peripheral shim rod (PSR) in location 3711	126
29	Region below PSR absorber region	326
30	Region above PSR absorber region	526, 926
31	PSR plenum region	1618
32	PSR lower shield region	702

Note: Steel in each of the listed regions is type 316 stainless steel (SS-316).

Table 3-2. Regions where Reaction Rates Were Computed for Fixed Reactor Hardware in the MCNP Calculation (2 sheets)

	Region Description	Cells in MCNP Model
1	Thermal liner inside the reactor vessel – type 304 stainless steel (SS-304)	3207 – 3240
2	Reactor vessel (SS-304)	1516, 2882, 2883, 2884, 2885, 2892 – 2896, 2903 – 2907, 2831 – 2874
3	Guard vessel (SS-304)	1513, 1514, 2912, 2913
4	Core support structure (SS-304)	1519 – 1522, 3111, 3112
5	Closure head (low-alloy carbon steel)	1559, 1607, 1647, 1687, 1723, 1773, 1824, 1874, 1924, 1973, 2023, 2073, 2126, 2174, 2224, 2274, 2323, 2373, 2424, 2474, 2523, 2569, 2624, 2674, 2723, 2773, 2823, 2875, 2886, 2897, 2908, 2918, 2919, 2920, 2921, 2922, 2923, 2932, 2942, 3020, 3062, 3104, 3153, 3203, 3249
6	Steel roof (SS-304)	1562, 1610, 1650, 1690, 1726, 1776, 1827, 1877, 1927, 1976, 2026, 2076, 2129, 2177, 2227, 2277, 2326, 2376, 2427, 2477, 2526, 2572, 2627, 2677, 2726, 2776, 2826, 2878, 2889, 2900, 2911, 2926, 2935, 2945, 2951, 2957, 2964, 2969, 2973, 2977, 2981, 3023, 3065, 3107, 3156, 3206, 3252
7	Sides of the core basket (SS-304)	1651 – 1656
8	Steel in the interior of the core basket (20 volume percent) (SS-304)	1523 – 1526, 1571 – 1574, 1611 – 1614
9	Grid plate (SS-304)	1529, 1577, 1617, 1657, 1693, 1733, 1783, 1833, 1883, 1933, 1983, 2032, 2083, 2133, 2183, 2233, 2283, 2333, 2383, 2433, 2483, 2529, 2583, 2633, 2683, 2733, 2984, 3026, 3068, 3113, 3163
10	Instrument tree hold down (SS-304)	1532, 1580, 1620, 1660, 1696
11	Instrument tree lower frame (SS-304)	1533, 1581, 1621, 1661, 1697
12	Instrument tree guide tubes (SS-304)	1534 – 1543, 1582 – 1591, 1622 – 1631, 1662 – 1671, 1698 – 1707
13	Instrument tree columns (SS-304)	1746 – 1757, 1797 – 1808
14	Inner radial shield (SS-304)	1201 – 1308, 1488, 1694, 1695, 1735 – 1745
15	Shield support (SS-304)	1734, 1784, 1834, 1884
16	Outer radial shield (SS-304)	1785 – 1795, 1835 – 1845, 1885 – 1895
17	Core barrel (SS-304)	2031, 2033 – 2042, 2094
18	In-vessel handling machine (SS-304)	2099 – 2114, 2147 – 2162, 2197 – 2212, 2247 – 2262, 2397 – 2412, 2447 – 2462, 2597 – 2612, 2647 – 2662

	Region Description	Cells in MCNP Model
19	In-vessel fuel storage modules (SS-304)	2982, 2983, 2985 – 2991, 3024, 3025, 3027 – 3033, 3066, 3067, 3069 - 3075
20	Baffle plates (SS-304)	1796, 1846, 1896, 1945, 1995, 2045, 2097, 2145, 2195, 2245, 2295, 2345, 2395, 2445, 2495, 2541, 2595, 2645, 2695, 2745, 2992, 3034, 3076, 3125, 3175
21	Boron carbide shield	2890, 2901, 2914, 2928, 2936
22	Z ring (SS-304)	2940, 2948, 2954, 2961, 2966
23	Suppressor plate (SS-316)	1548 ,1596, 1636, 1676, 1712, 1762, 1813, 1863, 1913, 1962, 2012, 2062, 2115, 2163, 2213, 2263, 2312, 2362, 2413, 2463, 2512, 2558, 2613, 2663, 2712, 2762, 2812, 3009, 3051, 3093, 3142, 3192
24	Thermal shield plates (SS-304)	1551, 1599, 1639, 1679, 1715, 1765, 1816, 1866, 1916, 1965, 2015, 2065, 2118, 2166, 2216, 2266, 2315, 2365, 2416, 2466, 2515, 2561, 2616, 2666, 2715, 2765, 2815, 3012, 3054, 3096, 3145, 3195, 3241
25	Inconel-600 shield plate	1553, 1601, 1641, 1681, 1717, 1767, 1818, 1868, 1918, 1967, 2017, 2067, 2120, 2168, 2218, 2268, 2317, 2367, 2418, 2468, 2517, 2563, 2618, 2668, 2717, 2767, 2817, 3014, 3056, 3098, 3147, 3197, 3243
26	SS-410 shield plates	1555, 1603, 1643, 1683, 1719, 1769, 1820, 1870, 1920, 1969, 2019, 2069, 2122, 2170, 2220, 2270, 2319, 2369, 2420, 2470, 2519, 2565, 2620, 2670, 2719, 2769, 2819, 3016, 3058, 3100, 3149, 3199, 3245
27	Low-carbon steel (A-516) shield plates	1557, 1605, 1645, 1685, 1721, 1771, 1822, 1872, 1922, 1971, 2021, 2071, 2124, 2172, 2222, 2272, 2321, 2371, 2422, 2472, 2521, 2567, 2622, 2672, 2721, 2771, 2821, 3018, 3060, 3102, 3151, 3201, 3247
28	Bottom-center cell in core support structure (SS-304)	1519

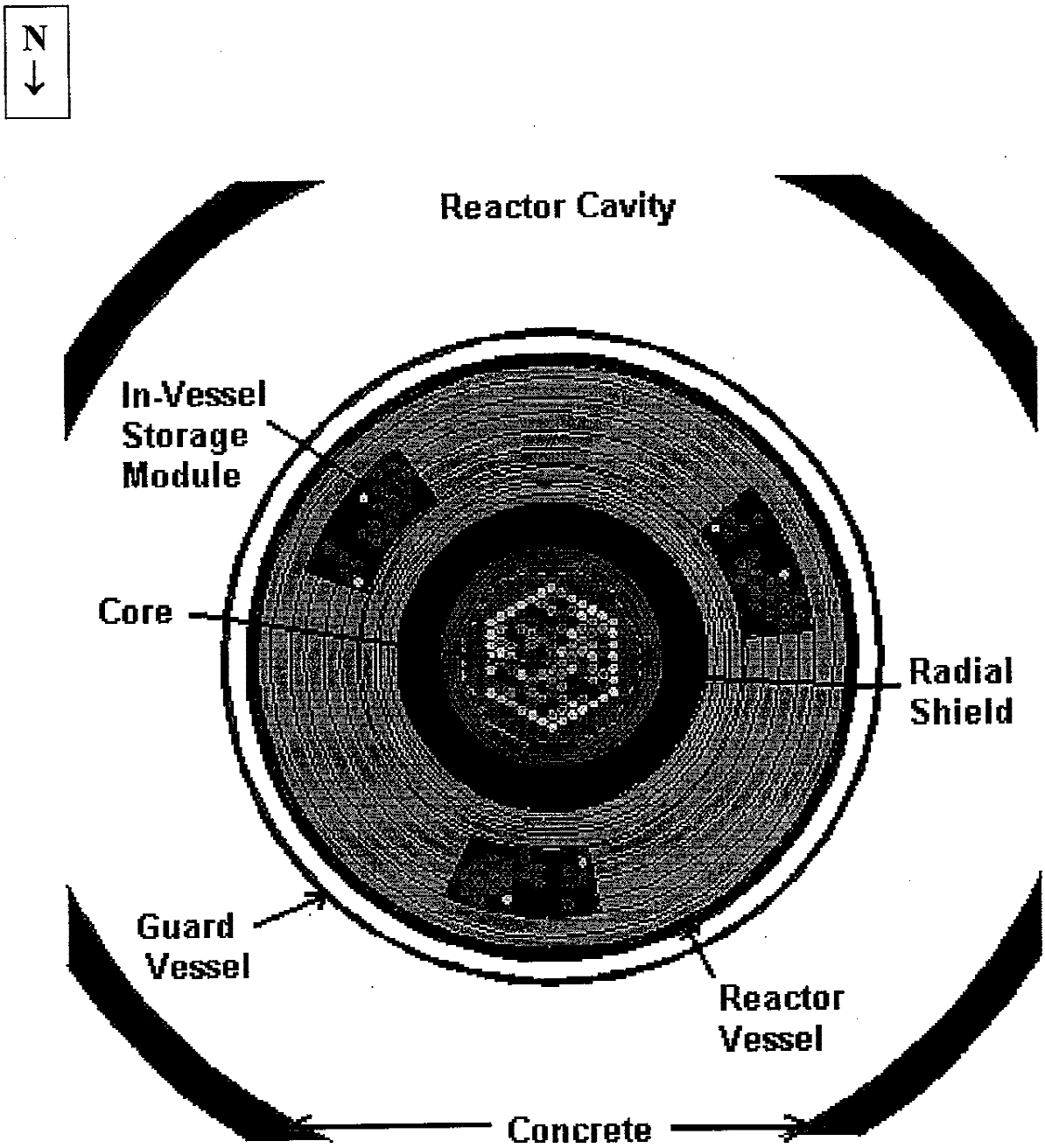


Figure 3-1. Plan View of the Model of FFTF Used in the MCNP Calculation

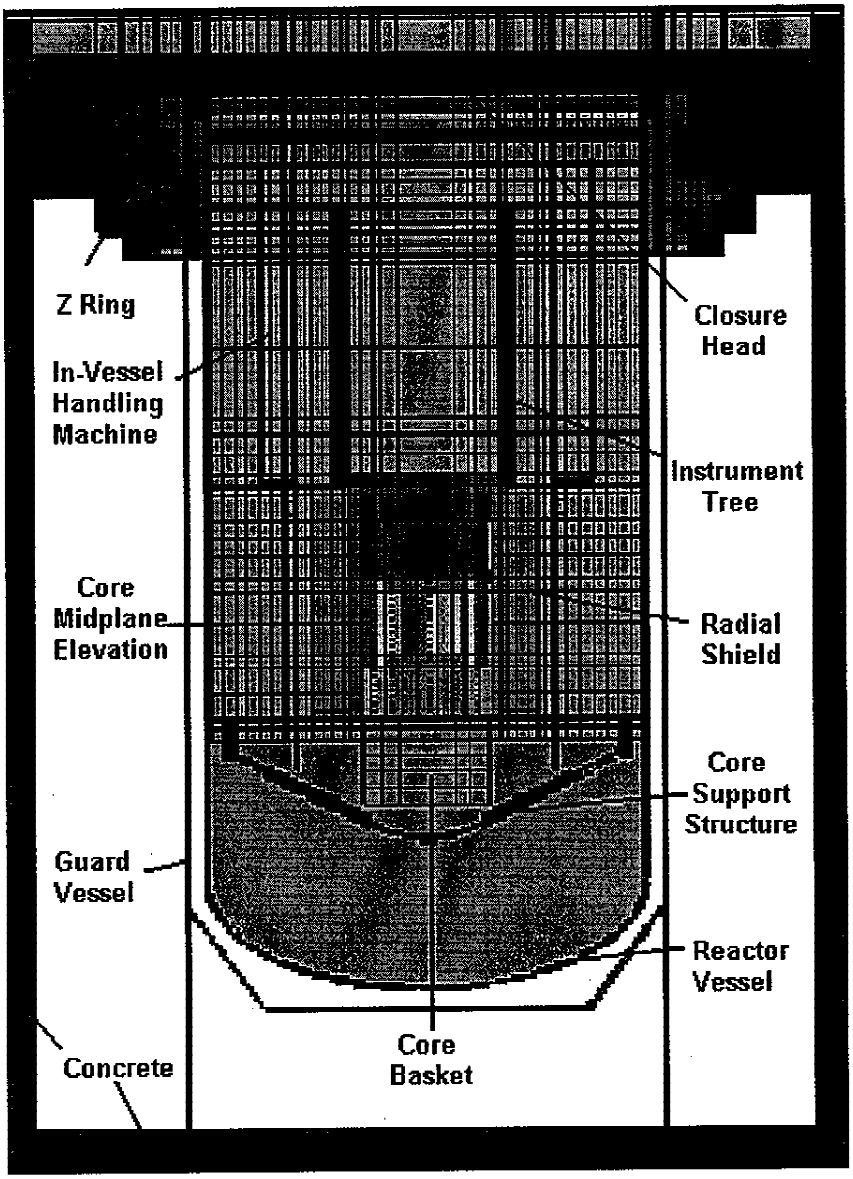


Figure 3-2. Elevation View of the Model of FFTF Used in the MCNP Calculation

3.2 IDENTIFICATION OF IMPORTANT REACTIONS

Initial MCNP calculations were made to generate tallies of the total neutron flux levels in the regions of interest (i.e., those listed in Table 3-2). The resulting flux values were used as input for the ORIGEN2 program (Croff 1980) to perform isotope buildup and depletion calculations. The results of the ORIGEN2 calculations were used to help identify the important radionuclides from a lengthy list of candidates. The eight radionuclides that were determined to be potentially significant in the FFTF vessel are listed in Table 3-3. Six of the eight radionuclides are listed in 10 CFR 61.55, *Waste Classification*. One of the two radionuclides that are not listed is ^{55}Fe, which decays by electron capture to a stable isotope (^{55}Mn). No ionizing radiation is emitted and ^{55}Fe has a relatively short half life (2.73 y), so it has no long-term consequences. Thus, ^{55}Fe inventories were not tabulated. The second radionuclide (^{93}Mo) also decays by electron capture (to stable ^{93} Nb), but has a long half life (3500 y) and emits a low-energy (0.03 MeV) gamma ray. Thus, ^{93}Mo was considered to be potentially significant and its inventories were tabulated.

Radionuclides listed in 10 CFR 61.55, but not listed in Table 3-3 are not produced in FFTF hardware and non-fueled assemblies, except tritium (^{3}H). Tritium production was not computed because it is gaseous and migrates out of the material in which it is produced.

Radionuclides were selected for evaluation if they, or their progeny, were long lived and were potentially produced in significant quantities in components remaining in the FFTF vessel, or if they had half lives greater than one year and could potentially contribute measurably to dose rates in work spaces following sodium drain. Quantities of any radionuclides with half lives less than one year are negligible since they have decayed at least 11 half lives from the end of irradiation to the initial point of interest (September 2003).

The MCNP input file used for preliminary studies was updated to tally the 22 reactions that lead to the production and loss of the radionuclides listed in Table 3-3. The reaction types are also listed in Table 3-3.

Table 3-3. Radionuclides of Significance in the FFTF Vessel with Production and Burnout Reactions Computed

Radionuclide	Production Reactions	Burnout Reactions
Co-60	Co-59 (n, γ) Ni-60 (n, p)	Co-60(n, γ)
Ni-59	Ni-58(n, γ)	Ni-59 (n, γ) Ni-59 (n, p) Ni-59 (n, γ)
Ni-63	Ni-62 (n, γ)	Ni-63 (n, γ)
Fe-55[a]	Fe-54 (n, γ)	Fe-55(n, γ)
Mo-93	Mo-92 (n, γ)	Mo-93 (n, γ) Mo-93 (n, p)[b]
Tc-99[c]	Mo-98 (n, γ) $\rightarrow$ Mo-99 β^- $\rightarrow$ Tc-99	Tc-99 (n, γ)
Nb-94	Nb-93 (n, γ) Mo-94(n, p)	Nb-94(n, γ)
C-14	C-13 (n, γ) N-14 (n, p)	C-14 (n, γ)[d]

[a] Although Fe-55 was initially identified as a potential radionuclide of significance, it was not included in the final radionuclide inventory calculations because it decays by electron capture, so no ionizing radiation is emitted, and it has a half life of only 2.73 y, so has no long-term consequences. Also, it is not listed in 10 CFR 61.55 as being important to waste classification.

[b] The Mo-93 (n, p) reaction produces Nb-93, but the amount is negligible and not accounted for.

[c] The Mo-98 (n, γ) reaction produces Mo-99, which has a half life of 66 hours and beta decays to Tc-99. As a simplifying approximation, it was assumed that Tc-99 is produced directly from the Mo-98 (n, γ) reaction. The error introduced by this approximation is negligible.

[d] C-14 burnout was not computed. It is insignificant and was assumed to be zero.

3.3 PROCESSING OF REACTION RATE DATA TO OBTAIN RADIONUCLIDE INVENTORIES

The mctal output files produced by MCNP (See Appendix C) were first processed through a special-purpose computer program, Mctalrd2, to reformat the data for subsequent processing. MCNP output files read by Mctalrd2, the files produced by Mctalrd2, and a source-code listing of the program are included in Appendix D. The output files from Mctalrd2 contain reaction rates for 18 nuclides (see Table 3-3) in 60 regions (see Tables 3-1 and 3-2). For each nuclide, activities for up to three types of nuclear reactions [(n,γ), (n,p) and (n,α)] are included. As noted in Table 3-3, ^{14}C burnout was assumed to be zero instead of having MCNP compute values that would have been insignificantly small. Output tables from Mctalrd2 were manually modified to include zero entries for ^{14}C reaction rates.

Two files, one containing the reformatted reaction rate data, and the other containing material compositions for each region, were then read by another computer program developed for this application, Transmut2. This program also reads:

- a transmutation matrix identifying the nuclear reactions that lead to the production and depletion of each of the eight important radionuclides,
- a factor that scales the MCNP results [reactions per source neutron per atom in each region) to reaction rates at an appropriate time-averaged reactor power level (MW thermal)],
- an irradiation period (days),
- a decay time (years) following the end of irradiation.

The function of Transmut2 is to compute radionuclide inventories (grams and curies) and concentrations (g/cm^3, Ci/m^3 and μCi/g) in each region for the given reactor power scaling factor, irradiation period and decay time following irradiation. The Transmut2 program is described in Appendix E. The assumptions upon which the program is based are summarized in Section 4.0 and details of how the program was applied are given in Section 5.0.

3.4 DOSE RATE CALCULATIONS

The SOW specified that dose rates be computed at unshielded locations where work may need to be performed following sodium drain. For the time period when this work would be performed, the dose rates will be dominated by the photon sources from ^{60}Co decay; contributions from the other six radionuclides inventoried will be negligible. Dose rates were also computed in the head compartment to show that the loss of 5 m of sodium shielding above the reactor core does not lead to significantly elevated dose rates in normally occupied spaces.

MCNP calculations were rerun to provide spatial detail on ^{60}Co production in the radial shields, the core barrel, the reactor vessel wall, the guard vessel, and the upper axial shield regions of radial reflectors. This detail was not necessary to compute component radionuclide inventories, but was needed to accurately assess resulting dose rates.

The MCNP model of the FFTF HPPT loading was modified for dose rate calculations by:

- changing the loading to adequately match the current core and in-vessel storage module (IVSM) loading detailed in Appendix A,
- removing sodium from all regions in the model,
- changing the MCNP4C input file from neutron kcode mode to photon fixed source mode,
- changing the tallies from reaction rates and total flux in various core and reactor components to dose rates at the specified location.

Dose rates were expected to be dominated by the sources from the irradiated assemblies (radial reflectors, in particular) stored in the IVSMs. Thus, the IVSM loading was accurately modeled. However, the current core loading in rows 1 – 6 was not represented accurately; positions other than the nine normally occupied by control and safety rods were modeled as containing radial reflectors. This approximation did not significantly affect the accuracy of computed dose rates because the sources important to the dose rates are located in the lower shield, nozzle, and upper end of the upper axial shield regions. Sources in these regions were represented with sufficient accuracy to obtain reliable dose rate estimates.

To bound the task of converting the ^{60}Co inventory distribution to photon source rates, a study was made to compare neutron and photon attenuation through shield material. This study described in Appendix F indicated photons are attenuated at a much higher rate than neutrons. Thus, only photon sources near unshielded areas are important to the dose rate calculations. Also, it is reasonable to assume that sources in material regions shielded by significant quantities of sodium can be neglected because regions closer to the core will have much higher source rates, and after sodium drain, photon attenuation to the dose points is similar. Thus, only sources in the following regions were accounted for in the MCNP model to compute dose rates:

- all of the outer radial shield
- the upper 49 cm and lower 35 cm of the inner radial shield
- the radial shield support
- the grid plate
- the baffle plate
- instrument tree components
- core barrel
- IVSM hardware
- thermal liner
- reactor vessel
- guard vessel

- core basket
- all regions of all irradiated assemblies in IVSMs
- the lower shields and nozzles of all assemblies in core
- upper 39 cm of the upper shield on all radial reflector assemblies in core

Omitted from the above list is the highly-activated Inconel sections of the radial reflectors located in core. Sources in this material are shielded by enough steel to attenuate the photon flux by over seven orders of magnitude. The source density in the nozzles of radial reflectors, which are not shielded, is only about three orders of magnitude less. Thus, sources in the Inconel make an insignificant contribution to dose rates below the core compared to sources in the nozzles.

3.5 COMPUTER PROGRAM VALIDATION

The SOW specifies that computer software be under configuration control consistent with HNF-PRO-309, *Computer Software Quality Assurance Requirements*, or previous practices for software that has not been changed. MCNP4C has been formally validated and certified (Johnson 2002) on Hanford personal computers attached to the Fluor Local Area Network (FLAN). These computers are Dell Precision™ 620 workstations operating under Windows NT® Version 4.0 (Build 1381: Service Pack 6).

MCNP4C was also used to analyze ^{59}Co (n,γ) reaction rate measurements made during the High Power Characterization (HPC) Run, also called the Extended Power Run (EPR), using essentially the same model used to compute reaction rates processed through Transmut2 to compute radionuclide inventories. The HPC Run followed the HPPT Run and the loadings for the two runs were the same, except that core characterizer assemblies were loaded prior to the HPC Run. In all cases, these test assemblies were of the same composition as the HPPT assemblies they replaced. This analysis serves to not only validate the MCNP4C program for this application, but also to validate the calculational model. Comparison of experimental and calculated results in Appendix H indicates that MCNP4C with the HPPT computational model produces very defensible results.

ORIGEN2 calculations were made as a part of the preliminary work to determine which radionuclides were significant in the FFTF. Those calculations were completed in 1994 and 1995. ORIGEN2 was formally validated on the engineering workstations used to make the calculations (Wittekind 1989).

The two Fortran 77 programs (Mctalrd2 and Transmut2) were written specifically to post-process the MCNP results. These programs fall outside the scope of HNF-PRO-309, which states in Section 1.0:

™ Dell Precision is a trademark of Dell Computer Corporation, Round Rock, Texas.
® Windows NT is a registered trademark of Microsoft Corporation, Bellevue, Washington.

"This procedure does not apply to software that enables an engineer to develop calculations not embedded within the software code or that can be checked by visual inspection or alternate calculations through the design verification process."

Tranmut2 solves simplified nuclide transmutation equations to compute the net effect of radionuclide buildup, depletion and radioactive decay. The program was verified by hand calculations (see Appendix E for a description of Transmut2 and its verification). Mctalrd2 merely picks data values from a MCNP output file and reformats these data for use by Transmut2. Mctalrd2 does not perform any calculations and can easily be checked by visual inspection. A description of the program and its testing are included in Appendix D.

4.0 ASSUMPTIONS

4.1 CORE LOADING

A number of assumptions were made to simplify this analysis. First, as mentioned in Section 3.0, only one core loading, the HPPT, was modeled in this analysis. It was assumed that the neutron flux space and energy distribution in the HPPT loading is representative of that in all FFTF operating cycles. As mentioned in Section 3.1 and described in Appendix B, calculations were completed that indicate the radial flux distribution in the HPPT is representative of an average FFTF loading. No such calculations were made to directly confirm that the axial flux distribution in the HPPT is also representative. The greatest variation in axial flux distributions is probably due to control rod movement between beginning and end of cycle. However, these variations were comparable in every cycle. The HPPT model had control rods positioned at a typical cycle-averaged elevation. Axial flux profiles were also affected by fuel burnout that tended to flatten the distribution for the first few cycles until equilibrium conditions were achieved. From cycles 9 through 11, the Core Demonstration Experiment (CDE) was conducted. Core loadings during those cycles contained a number of axially-blanketed fuel test assemblies and internal blanket assemblies. These also tended to flatten the axial flux distribution. Thus, use of the HPPT loading is expected to under predict the neutron flux above and below the core. However, net errors were judged to be only a few percent at most based on results of CDE physics studies.

4.2 MCNP MODEL

The lower axial shield regions of most assemblies were simplified somewhat in that two material regions were combined into only one region in the model. The model includes only one region between the elevation of the bottom of the lower axial reflectors and the top of the nozzles. Most assembly types include two different material regions over that range. However, the effect of the modeling simplification on flux and reaction rate tallies was judged to be minor.

4.3 BURNUP AND DECAY CALCULATIONS

The Transmut2 computer program, described briefly in Section 3.0 and in more detail in Appendix E, was used to estimate radionuclide inventories from the MCNP-computed reaction rate data. A detailed operating history needed to precisely compute radionuclide production, burnout and decay was not input to Transmut2. Instead, the reactor was assumed to operate continuously from April 1982 (the start of the first full operating cycle, 1A) until March 1992 (the end of the last operating cycle, 12B-2) at a time-averaged power level of 206 MW, derived in Section 5.0. The effect of this simplification is expected to be insignificant or slightly conservative.

In deriving the equations solved by Transmut2 (see Appendix E), the following simplifying assumptions were made:

- Concentration of the source isotope for each radionuclide does not change with irradiation (i.e., burnout of the source isotopes is neglected).

- Each radionuclide is the product of 1 to 3 single-step nuclear processes [i.e., S — (n, x) → R, where S is a source isotope, R is a radionuclide and (n, x) is a nuclear process]. Production of radionuclides by radioactive decay is not accounted for directly. Neglecting the burnout of source isotopes is slightly conservative, leading to production over-estimations of a few percent at most. Errors resulting from the second simplification are negligible.

- Major sources for the production of certain radionuclides are trace elements and contaminants in steel and Inconel. Concentrations of these trace elements are typically not well known, and may not be listed in most references. A number of references for the compositions of Inconel 600, stainless steel 304, 316 and 410 (SS-304, SS-316 and SS-410) and low-carbon steel were examined. To be conservative, the maximum quoted values for all relevant trace elements were used as input to Transmut2, as discussed in Section 5.0.

5.0 INPUT DATA AND CALCULATIONS

5.1 MCNP CALCULATION OF NEUTRON FLUX AND REACTION RATES

The input file listed in Appendix J was read by MCNP4C to compute the total flux and the 22 reaction rates listed in Table 3-3 averaged over each of the reactor hardware regions listed in Table 3-2. The reactor loading modeled in this input file was based on the HPPT configuration irradiated in September 1981, as described in Section 3.1. The identifier for this case is fftf10ef. Appendix J also includes the flux and reaction rate tally specifications used in other MCNP calculations that are summarized in Table 5-1. The MCNP problem cell numbers that constitute each of the reaction rate tally regions were listed in Tables 3-1 and 3-2.

Details of the reactor hardware in vessel used in constructing the FFTF model were obtained from a number of sources including HEDL-400 (Cabell 1980).

Table 5-1. Summary of MCNP cases to Compute Neutron Flux and Reaction Rate Data

Case ID	Description
fftf10em	Run to compute neutron flux and reaction rates in the assembly regions listed in Table 3-1.
fftf10ef	Run to compute neutron flux and reaction rates in the fixed reactor hardware listed in Table 3-2.
fftf10ed	Run to compute neutron flux and reaction rates in individual cells composing the inner and outer radial shields, shield support (see Table 3-2), and the upper shields on radial reflectors (see Table 3-1). This detail was needed to determine the photon source distribution from Co-60 decay for use in dose rate calculations.
fftf10eh	Run to compute neutron flux and reaction rates in the central cells of the head, suppressor plate, thermal reflector plates, Inconel 600 shield plate, SS-410 shield plate and the low-carbon steel shield plate (the cells are the first listed for these regions in Table 3-2). The results of this case were used in estimating the effect that the In-Reactor Thimble had on reaction rates in these components during the initial power run (see Section 4.0 and Appendix G).
fftf10ev	Run to compute spatial detail of reaction rates in the core barrel, thermal liner, reactor vessel and guard vessel. This detail was needed to determine the photon source distribution from Co-60 decay for use in dose rate calculations.
vol10em	Run to stochastically compute volumes of each tally region of case fftf10em. These volumes were reformatted and read by Transmut2, as described in Appendix E.
vol10ef	Run to stochastically compute volumes of each tally region of case fftf10ef.
vol10ed	Run to stochastically compute volumes of each tally region of case fftf10ed.
vol10ev	Run to stochastically compute volumes of each tally region of case fftf10ev.

Cross section data read by MCNP4C to compute the space and energy neutron flux distribution in the FFTF HPPT loading were from ENDF/B-V libraries distributed with the MCNP4C package. However, cross section data required to accurately compute some needed reaction rates were not available in the standard MCNP4C libraries. The needed reaction cross section data included: Co-59(n,γ), Ni-60(n, p), Co-60(n,γ), Ni-59(n, γ), (n, p) and (n,α) , Ni-63(n, γ) , Mo-93(n, γ) and (n, p), and Mo-94(n, p). These data were obtained from the FENDL2/A library (Pashchenko and Wienke 1997), as discussed further in Appendix H.

5.2 RADIONUCLIDE INVENTORY CALCULATIONS

Compositions used as input to the program Transmut2 for the regions where reaction rates were computed are listed in Appendix E, Tables E-12 and E-14. The compositions in those tables are not complete – data for only the 19 nuclides needed to compute radionuclide inventories are listed (see Table 3-3). The data in Tables E-12 and E-14 are based on the assumed steel and Inconel compositions listed in Table 5-2. Complete sets of input data read for key Transmut2 cases are also listed in Appendix E, except for the reaction rate files, which are listed in Appendix D.

The concentrations of some radionuclides in the reactor vessel may depend largely on trace elements in the steel or Inconel compositions. The concentrations of such elements vary widely and thus are uncertain without having specific assay data. The compositions listed in Table 5-2 were obtained from several references, as indicated in the table. To be conservative, maximum values found in the references examined were specified.

Boron carbide in the control rods, safety rods and peripheral shim rods also contain trace elements. However, only ^{14}N is significant. Based on a limited sampling of vendor data, a nitrogen content of 0.03 weight percent was assumed in this analysis. This amount constitutes only about 4% of the total nitrogen content in a boron carbide absorber assembly. The remaining 96% is in the SS-316 cladding and duct.

Three variables read by Transmut2 are a power scaling factor (FNORM), an irradiation length (ET) and a decay period (DT) following the end of irradiation. MCNP-computed reaction rates are based on one fission neutron generated per unit time. The factor FNORM, which has units of fission neutrons/sec, was used to scale these results up to some reactor power level, P (MW). FNORM was computed as follows:

$$\text{FNORM} = \frac{1.012[2.9 \text{ fission neutrons/fission}][P \text{ MW}]}{[212 \text{ MeV/fission}][1.602 \times 10^{-19} \text{ MW per MeV/s}]} = P \cdot 8.64 \times 10^{16}.$$

The factor of 1.012 was derived in Appendix B as an adjustment to approximately account for the difference in the radial power peaking in the HPPT loading versus later loadings.

Table 5-2 Compositions of Steel and Inconel Materials in the FFTF Vessel Used to Compute Radionuclide Inventories (2 sheets)

Constituent	SS-304		SS-316		SS-410	
	wt.%	Ref.s[a]	wt.%	Ref.s[a]	wt.%	Ref.s[a]
Fe	68.7	balance	64.3	balance	83.8	balance
Cr	19.0[b]	1, 2, 3	17.0[b]	1, 2, 3	12.5[d]	1, 2
Ni	10.5[c]	1, 2, 3	14.0[c]	1, 2, 3	2.5[c]	2
C	0.08[c]	1, 2, 3	0.08[c]	1, 2, 3	0.15[c]	2
Mn	1.00[b]	3	1.00[b]	1, 2. 3	0.5[b]	2
Mo			3.00[c]	1, 2		
Si	0.50[b]	3	0.50[b]	3	0.5[b]	2
N	0.10[c]	1	0.01[c]	5, 6, 7	0.03[c]	1
Co	0.08[c]	4	0.05[c]	5, 6, 7	0.02	assumed
Nb	0.02[c]	4	0.05[c]	5, 6, 7		

Constituent	Low Carbon (A516) Steel		Inconel-600	
	wt.%	Ref.s[a]	wt.%	Ref.s[a]
Fe	98.7	balance	8.0[b]	1
Cr			15.5[b]	1
Ni			75.8	balance
C	0.31[c]	8	0.15[c]	1
Mn	1.0[b]	8	0.50[b]	1
Mo				
Si				
N				
Co	0.015	assumed	0.10[c]	9
Nb				

[a] References for material compositions:

1. Lamb, S. (Tech. Ed.), 1999, *Practical Handbook of Stainless Steel & Nickel Alloys*, CASTI Publishing, Inc., Edmonton, Alberta, Canada.
2. Budinski, K. G. and M. K. Budinski, 1999, *Engineering Materials Properties and Selection*, Sixth Edition, Prentice Hall, Upper Dalle River, New Jersey.
3. *300 Series Properties*, Stainless Steel Processing, Inc., Coatesville, PA. (see Appendix I)
4. From a previous survey of SS-304 Compositions (See Appendix I)
5. RDT E 6-20T, 1971, *RDT Standard, Austenitic Stainless Steel Hexagonal Duct Tubes for Core Components and Assemblies*, U.S. Atomic Energy Commission,
6. RDT E 5-19T , 1971, *RDT Standard, Austenitic Stainless Steel Plate, Sheet and Strip for Core Components*, U.S. Atomic Energy Commission.

Footnotes for Table 5-2 (continued)

7. NE M 3-35T, 1982, *Nuclear Standard, Austenitic and Ferritic Stainless Steel Duct Tubes for Breeder Reactor Core Components*, U.S. Dept. of Energy.
8. *ASTM A516 Chemical Requirements*, Thompson Metal and Tubing, Fairfield, Ohio (see Appendix I)
9. NE M 5-4T, 1982, *Nuclear Standard Nickel-Chromium-Iron Alloy Plate, Steel and Strip (ASME SB-168 with Additional Requirements)*, U.S. Dept. of Energy

[b] Mean value of specified range was used, or half the maximum specified.
[c] Maximum value specified or permitted was used.
[d] The value of 12.5 wt.% Cr in SS-410 is the maximum specified in Ref. 1 above and within the range specified in Ref. 2.

FFTF cycle 1 began in April 1982 and the last cycle (12B-2) ended in March 1992, a period spanning about 9.9 years or 3620 days. The total reactor exposure was 747,152 MWd. Thus the average power level over that period was 206 MW. The factor FNORM used as input to Transmut2 is then [206 MW][8.64 x 10^{16} fission neutrons/s per MW] = 1.78 x 10^{19} fission neutron/s at 206 MW. For this analysis, it was assumed the reactor operated continuously for 9.9 years at 206 MW.

Although, radionuclide inventories for fixed reactor hardware could be obtained from three Transmut2 runs, 16 other runs were required to obtain inventories for the non-fueled assemblies remaining in the vessel. These runs differed in the input values of exposure and decay time, reaction rate and flux data, and component atom densities, as summarized in Table 5-3. Transmut2 input files are listed in Appendix E.

The first case (tmut10ef) applied to all fixed components. The second (tmut10efsp2) was required to obtain inventories in the shield plugs for the In-Vessel Handling Machines (IVHMs) and instrument trees. The same reaction rates used in the first case for the closure head were applied in the second case. The second case was required because the shield plugs have a different composition (SS-304) than the head (low-carbon steel), as described further in Appendix G.

The last Transmut2 run listed in Table 5-3 was made as part of a study, described in Appendix G, to account for the effect of the In-Reactor Thimble (IRT) on radionuclide inventories in the lead assembly. The IRT was designed to be used in the reactor during initial reactor testing at very low power levels. It consisted of an insulated hollow tube extending from the operating deck down through the reactor core. Samples could then easily be inserted and positioned for reactivity worth measurements. The IRT was not intended to be in the core during power operation, but was left in for the 9-day initial power run in December 1982 to accelerate the testing schedule. A shield plug was inserted into the IRT to reduce neutron streaming, but the neutron flux to reactor head assembly was greatly elevated in the vicinity of the IRT. A study of this effect was made and is documented in Appendix G.

The other cases applied to irradiated assemblies in the reactor vessel. The inventory of assemblies currently in the vessel was obtained from reports documented in Appendix A. The assembly inventory was checked against an assembly irradiation history data base generated by the FFTF Core Engineering group to determine which assemblies had actually been irradiated. Only those were counted.

Transmut2 case tmut10emrr was made to compute inventories in the radial reflectors. The vast majority of the radial reflectors irradiated in the FFTF still reside in the vessel. Thus one run, in which the reflector assemblies in the model were assumed to have been irradiated the full operational lifetime of the FFTF (3620 days), was adequate to obtain defensible estimates of the radionuclide inventories in these elements. The decay time (11.5 years) accounts for the period from March 1992 to September 2003. The fact that the row 7 radial reflectors were all replaced was accounted for in spreadsheet post-processing of Transmut2 output. The HPPT loading had in row 7: 33 reflector assemblies, one PSR, one blanket test and one absorber test. To get the total inventories in all row 7 reflectors that were irradiated, the total inventory for each radionuclide in the 33 assemblies tallied was scaled up by a factor of 36/33, since in most cycles, there were 36 reflectors in row 7. To get the average radionuclide concentrations (Ci/m^3 or $\mu Ci/g$) in the 81 reflector assemblies irradiated in row 7 and currently residing in the vessel, the concentrations computed by Transmut2 were scaled by a factor of 36/81. For rows 8 and 9, the model contained 72 reflector assemblies, the usual number for FFTF operating cycles, so no adjustment to the Transmut2-computed inventories were required. However, there are 73 reflector assemblies in the vessel that were irradiated in rows 8 and 9. Thus, radionuclide concentrations were scaled by a factor of 72/73.

Irradiated control rods were divided according to their exposure and decay history into five groups, as shown in Tables 5-4 and 5-5. One Transmut2 run was made to obtain inventories for each group (tmut10emcr1 – 5). Similarly, safety rods were divided into four groups, also as shown in Tables 5-4 and 5-5, and one Transmut2 run was made for each group (tmut10emsr1 – 4). Four groups and Transmut2 runs (tmut10emic1 – 4) were also required to adequately cover the different irradiation and decay histories in the In-Core Shim Assemblies (ICSAs) (see Tables 5-6 and 5-7). Only three PSRs were irradiated in the FFTF (see Tables 5-8 and 5-9). Two runs (tmut10emps1 – 2) adequately covered these assemblies.

The inventories computed in the Transmut2 runs were post-processed through a spreadsheet program to do the following:

- adjust the radionuclide inventories and concentrations in radial reflectors, as described above;
- combine data from the five Transmut2 runs made for control rods and the four runs made for safety rods into a single set of tables;
- combine data from the four Transmut2 runs made for the ICSAs into a single set of tables and the two runs made for PSRs into a single set of tables;

- combine results for other regions together where appropriate (e. g., instrument tree components);
- adjust radionuclide inventories to account for component mass differences between documented and modeled values (such adjustments were applied to the head and shield plug assemblies, as described in Appendix G);
- correct radionuclide inventories in the head assembly to account for the effect of the IRT, as described in Appendix G;
- decay the inventories to dates beyond September 2003 (i.e., September 2008, 2013, 2023, and 2053).

Table 5-3. Summary of Transmut2 Runs to Compute Radionuclide Inventories

	Names of Transmut2 Input File and Output File	Source of Reaction Rate Data (MCNP Case[a])	Source of Material Compositions (File Name)	Irradiation Time (days) and Decay Time to 9/2003 (years)	Description
1	tmutf.inp tmut10ef.out	fftf10ef	atdens9f.prn	3620 / 11.5	Main run to obtain inventories for fixed reactor hardware in vessel.
2	tmutf.inp tmut10efsp2.out	fftf10ef	atdens9fsp.prn	3620 / 11.5	Same as first run, except composition of the reactor head region was changed to SS-304 to obtain inventories for IVHM and instrument tree shield plugs.
3	tmutmrr.inp tmut10emrr.out	fftf10em	atdens9m.prn	3620 / 11.5	Run to compute inventories in radial reflectors
4	tmutmcr1.inp tmut10emcr1.out	fftf10em	atdens9m.prn	1051 / 14.0	Run to compute inventories in first group of control rods in Table 5-4.
5	tmutmcr2.inp tmut10emcr2.out	fftf10em	atdens9m.prn	932 / 13.5	Run to compute inventories in the second group of control rods in Table 5-4.
6	tmutmcr3.inp tmut10emcr3.out	fftf10em	atdens9m.prn	974 / 15.3	Run to compute inventories in the third of control rods in Table 5-4.
7	tmutmcr4.inp tmut10emcr4.out	fftf10em	atdens9m.prn	778 / 11.5	Run to compute inventories in the fourth group of control rods in Table 5-4.
8	tmutmcr5.inp tmut10emcr5.out	fftf10em	atdens9m.prn	1142 / 16.6	Run to compute inventories in the fifth group of control rods in Table 5-4.
9	tmutmsr1.inp tmut10emsr1.out	fftf10em	atdens9m.prn	652 / 19.9	Run to compute inventories in the first group of safety rods in Table 5-4.
10	tmutmsr2.inp tmut10emsr2.out	fftf10em	atdens9m.prn	774 / 14.0	Run to compute inventories in the second group of safety rods in Table 5-4.
11	tmutmsr3.inp tmut10emsr3.out	fftf10em	atdens9m.prn	789 / 17.2	Run to compute inventories in the third group of safety rods in Table 5-4.
12	tmutmsr4.inp tmut10emsr4.out	fftf10em	atdens9m.prn	900 / 11.5	Run to compute inventories in the fourth group of safety rods in Table 5-4.
13	tmutmis1.inp tmut10emis1.out	fftf10em	atdens9m.prn	710 / 14.0	Run to compute inventories in the first group of ICSAs in Table 5-5.
14	tmutmis2.inp tmut10emis2.out	fftf10em	atdens9m.prn	641 / 11.5	Run to compute inventories in the second group of ICSAs in Table 5-5.
15	tmutmis3.inp tmut10emis3.out	fftf10em	atdens9m.prn	787 / 19.9	Run to compute inventories in the third group of ICSAs in Table 5-5.
16	tmutmis4.inp tmut10emis4.out	fftf10em	atdens9m.prn	641 / 11.5	Run to compute inventories in the fourth group of ICSAs in Table 5-5.
17	tmutmps1.inp tmut10emps1out	fftf10em	atdens9m.prn	22 / 22.5	Run to compute inventories in the first group of PSRs in Table 5-6.
18	tmutmps2.inp tmut10emps2out	fftf10em	atdens9m.prn	260 / 20.9	Run to compute inventories in the second group of PSRs in Table 5-6.
19	tmuth.inp tmut10eh.out	fftf10eh	atdens9h.prn	17.5 /22.8	Run to assess the activation of the closure head assembly during the FFTF initial power run. in December 1980.

[a] MCNP cases are summarized in Table 5-1.

Table 5-4. Irradiation History and Grouping of Control and Safety Rods Residing in the Reactor Vessel

Serial No.	Cycles Irradiated		Discharge Date	Core Locations (Lattice No.s)	Assembly Exposure (MWd)	Equivalent Exposure at 206 MW (days)	Use[a]	Group
	First	Last						
529	IPR[b]	3	10/23/83	2302	134520	651.7	SR	1
530	IPR	3	10/23/83	3302	134520	651.7	SR	1
531	4	10C3	3/13/89	2504	214429	1038.9	CR	1
532	2A	10C3	3/13/89	1302	155679	754.3	SR	2
533	5A	7C	1/3/86	1302	151800	735.5	SR	3
534	4	10C3	3/13/89	2302	177559	860.3	SR	2
536	IPR	11B1	4/8/90	1504 1502	193273	936.4	CR	2
538	IPR	10C3	3/13/89	2502	240539	1165.4	CR	1
539	IPR	10B	6/11/88	2504	196270	950.9	CR	3
540	IPR	11B1	4/8/90	3502 3504 2504	193273	936.4	CR	2
542	8A	10B	6/11/88	1504	205707	996.6	CR	3
543	3	11A3	9/19/89	3502 1504	198431	961.4	CR	1
545	8A	10C3	3/13/89	3504	196715	953.1	CR	1
546	7A	9C	7/18/86	3302	173784	842.0	SR	3
547	4	11A3	9/19/89	3502	211471	1024.6	CR	1
554	10A1	11A3	9/19/89	3302	145995	707.3	SR	2
553	12B1	12B2	3/14/92	1302	29653	143.7	SR	4
555	11A1	12A2	9/21/91	1302	150593	729.6	SR	4
556	8A	12A2	9/21/91	1302 2504	235797	1142.4	SR	4
557	11A1	12A2	9/21/91	2302	150593	729.6	SR	4
558	11B2	12B2	3/14/92	1504	121493	588.6	CR	4
559	11A1	12B2	3/14/92	2502	180245	873.3	CR	4
560	11B2	12B2	3/14/92	1502	121493	588.6	CR	4
561	8A	11B1	4/8/90	1502 2502 2302 1504	190517	923.0	CR	2
562	8A	11A3	9/19/89	3502 3504	239580	1160.8	CR	1
563	11B1	12B2	3/14/92	3302	146373	709.2	SR	4
565	7A	12B2	3/14/92	2504	247611	1199.7	CR	4
566	11B1	12B2	3/14/92	3502	146373	709.2	CR	4
567	11B1	12B2	3/14/92	3504	146373	709.2	CR	4
569	12B1	12B2	3/14/92	2302	29653	143.7	SR	4
573	4	9A2	2/5/87	1502 3504	235671	1141.8	CR	5

[a] Use: SR= safety rod, CR = control rod

[b] IPR = Initial Power Run

Table 5-5. Summary of Control and Safety Rod Groups

Use[a]	Group	Discharge Date Range		No. of Assemblies	Average Exposure[b]	Decay Years[c]
SR	1	10/23/83	10/23/83	2	652	19.9
	2	3/13/89	9/19/89	3	774	14.0
	3	1/3/86	7/18/86	2	789	17.2
	4	9/21/91	3/14/92	6	900	11.5
	Total			13		
CR	1	3/13/89	9/19/89	6	1051	14.0
	2	4/8/90	4/8/90	3	932	13.5
	3	6/11/88	6/11/88	2	974	15.3
	4	3/14/92	3/14/92	6	778	11.5
	5	2/5/87	2/5/87	1	1142	16.6
	Total			18		

[a] Use: SR = safety rod, CR = control rod
[b] Effective average exposure time is in days at 206 MW
[c] Elapsed time between the latest discharge date (col. 4) and 9/30/2003

Table 5-6. Irradiation History and Grouping of In-Core Shim Assemblies Residing in the Reactor Vessel

Serial No.	Cycles Irradiated		Discharge Date	Core Locations (Lattice No.s)	Assembly Exposure (MWd)	Equivalent Exposure at 206 MW (days)	Group
	First	Last					
292	IPR[a]	11A3	9/19/89	1406 1405 1608 2406	146607	710.3	1
295	IPR	12B2	3/14/92	1404 1406 3507	131766	638.4	2
299	IPR	4	4/23/84	2202 2405 2406	178320	864.0	3
301	IPR	12B2	3/14/92	2404 1710 1608	132629	642.6	2
302	IPR	2B	5/22/83	3404	90480	438.4	4
304	IPR	4	4/23/84	3406	178320	864.0	3
305	NCT[b]	3	10/23/83	3202	130920	634.3	3

[a] IPR = Initial Power Run
[b] NCT = Natural Circulation Testing

Table 5-7. Summary of In-Core Shim Assembly Groups

Group	Discharge Date Range		No. of Assemblies	Average Exposure[a]	Decay Years[b]
1	9/19/89	9/19/89	1	710.3	14.0
2	3/14/92	3/14/92	2	640.5	11.5
3	4/23/84	10/23/83	3	787.4	19.9
4	5/22/83	5/22/83	1	438.4	20.4
Total			7		

[a] Effective average exposure time is in days at 206 MW
[b] Elapsed time between the latest discharge date (col. 3) and 9/30/2003

Table 5-8. Irradiation History and Grouping of Peripheral Shim Rods Residing in the Reactor Vessel

Serial No.	Cycles Irradiated		Discharge Date	Core Locations (Lattice No.s)	Assembly Exposure (MWd)	Equivalent Exposure at 206 MW (days)	Group
	First	Last					
514	IPR[a]	NCT[b]	3/16/81	1711	5480	26.6	1
519	IPR	IPR	12/23/80	2610	3600	17.4	1
521	IPR	01B	11/12/82	3711	53720	260.3	2

[a] IPR = Initial Power Run
[b] NCT = Natural Circulation Testing

Table 5-9. Summary of Peripheral Shim Rod Groups

Group	Discharge Date Range		No. of Assemblies	Average Exposure[a]	Decay Years[b]
1	12/23/80	3/16/81	2	22.0	22.7
2	11/12/82	11/12/82	1	260.3	20.9
Total			3		

[a] Effective average exposure time is in days at 206 MW
[b] Elapsed time between the latest discharge date (col. 3) and 9/30/2003

5.3 DOSE RATE CALCULATIONS

The ^{60}Co inventories in reactor components and assemblies were converted to photon source rates, which were used as input to MCNP4C dose rate calculations. For some components, spatial detail of the activation levels (not available from the results of the Transmut2 runs listed in Table 5-3) was important. Thus, the additional MCNP4C and Transmut2 runs, listed in Table 5-10, were made. These runs provided spatial detail of ^{60}Co concentration in the radial shield, the core barrel, thermal liner, reactor vessel, the guard vessel and upper shield on radial reflectors.

Additional Transmut2 runs were also needed to determine the source strength in irradiated reflector, control rod, and safety rod assemblies stored in IVSM locations. Because of the relative proximity of the IVSMs to dose points in the reactor cavity, and the high activation of many assemblies in the IVSMs, an accurate determination of their ^{60}Co content was necessary. These runs are also summarized in Table 5-10. The inventory of assemblies, both irradiated and unirradiated, in the IVSMs is listed in Table 5-11 and Figure 5-1.

Representation of the ^{60}Co distribution within each IVSM was somewhat simplified in that:

- Each activated assembly of the same type (e.g., row 7 radial reflector) was assigned the same source distribution. Also, three assemblies with insignificant exposure were treated as unirradiated assemblies (i.e., they were represented in the model as shown in Figure 5-1 and Table 5-11, but were not modeled as radiation sources). These assemblies are in locations 3-C, 3-D and 3-S.

- Each assembly was divided into three axial source regions. One was the three-foot (91.4-cm) long central region. All sources above this region were assumed to be concentrated in a 6-in. (15.2-cm) long upper region and all sources below this region were assumed to be concentrated in a 6-in. long lower region.

These simplifications do not affect the total source strength in each IVSM and were judged to have a very small impact on computed dose rates.

A sequence of 11 MCNP4C runs was completed to evaluate photon dose rates from the ^{60}Co sources at the points identified in Table 5-12. The runs are summarized in Table 5-13. The model used for these calculations was based on the one used to compute radionuclide inventories in the vessel, as discussed in Section 3.4. The dose rate calculations differed mainly in their photon source specifications. However, the first three calculations listed, s01a, s01b and s01c, had the same source specification, but different dose points. These runs included photon sources only in irradiated assemblies in the IVSMs. Case s01b was necessary because of a limitation in MCNP4C on the number of point and ring detectors that can be specified in a single run. Case s01c used volume tallies rather than a ring-detector tally to determine the azimuthal-average dose rate above the boron carbide shield. It was run in an attempt to reduce the large statistical uncertainties obtained for that elevation from cases s01a and s01b. The other eight cases (s02

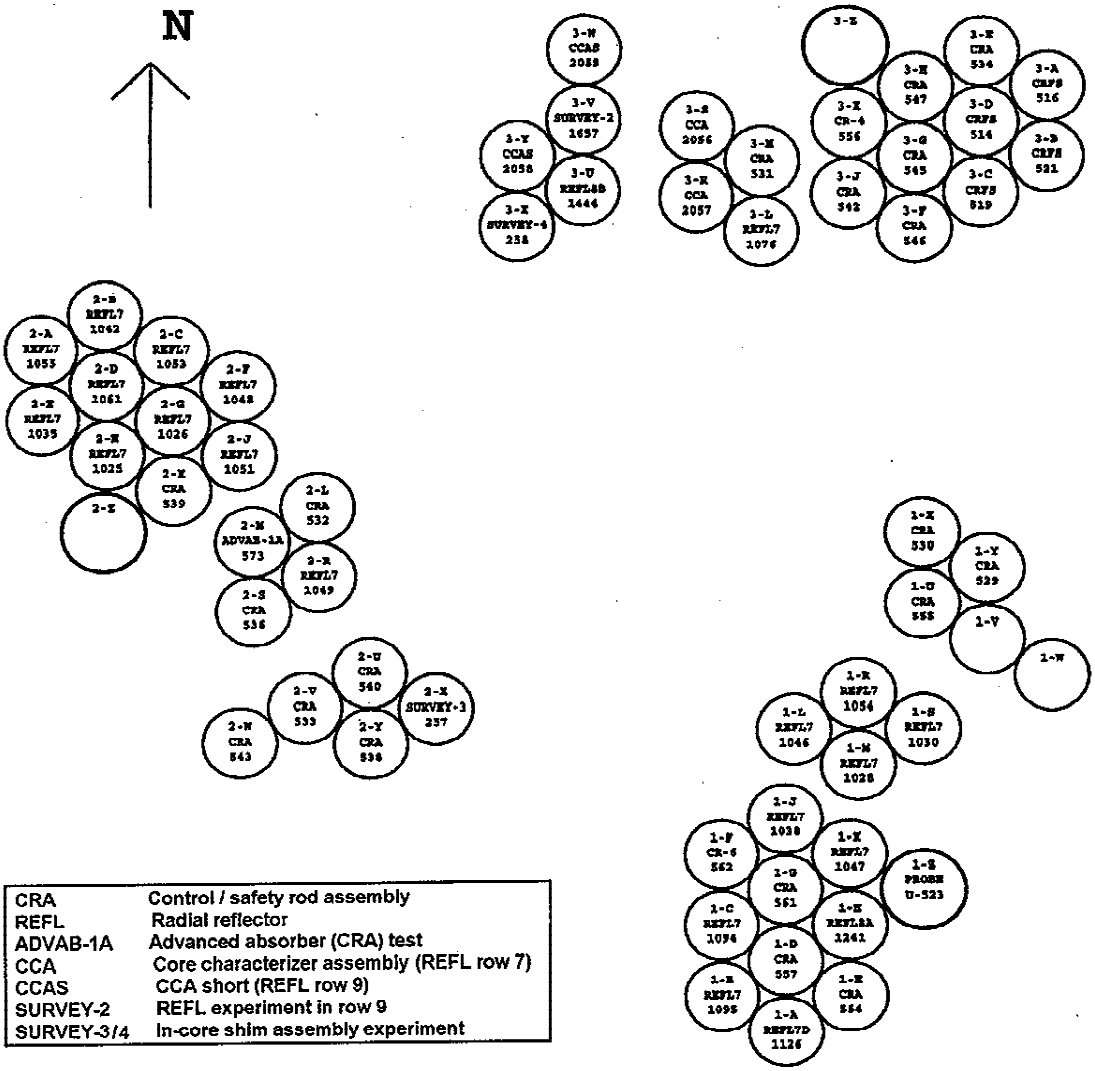
through s09), included sources from one or more hardware components and irradiated assemblies located in core, as indicated in Table 5-13. This procedure allowed a limited assessment of the relative importance of different components to the total dose rates. For example, from the calculations, it was determined that irradiated assemblies located in core contribute very little to the total dose rates, while irradiated assemblies in the IVSMs contribute significantly to the total dose rates, particularly at the core midplane locations.

The source distributions in cases s02 through s09 were azimuthally symmetric. So instead of computing dose rates at the specific points listed in Table 5-12, ring detectors at each elevation were used to obtain azimuthally-averaged dose rates. This approach was warranted because of the azimuthal symmetry of reactor components as well as the photon sources developed as input. Also, it reduced computation times and statistical uncertainties inherent with the Monte Carlo method.

Table 5-10. Summary of Additional Transmut2 Runs to Compute Radionuclide Inventory Details for Input to Dose Rate Calculations

	Names of Transmut2 Input File and Output File	Source of Reaction Rate Data (MCNP Case[a])	Source of Material Compositions (File Name)	Irradiation Time (days) and Decay Time to 9/2003 (years)	Description
1	tmutd.inp tmut10ed.out	fftf10ed	atdensd8.prn	3620 / 11.5	Run to obtain reaction rate distributions in radial shields, shield support structure and upper reflector shields. Tallies were made for each cell in the inner radial shield (122 cells), outer radial shield (33 cells) and shield support (4). The upper shields for the row 7 reflectors were divided into 2 axial regions; the same for upper shields of rows 8 and 9 reflectors.
2	tumutves.inp tmut10ev.out	fftf10ev	atdens9fves.prn	3620 / 11.5	Run to compute reaction rate distributions in the core barrel, thermal shield, reactor vessel and the guard vessel. The barrel, liner, vessel and guard vessel were divided into 2, 6, 9 and 4 regions, respectively.
3	tmutmiv1.inp tmut10emiv1.out	fftf10em	atdens9m.prn	1160 / 18.7	Run to compute inventories in row 7 radial reflectors stored in sector 1 IVSM
4	tmutmiv2.inp tmut10emiv2.out	fftf10em	atdens9m.prn	2067 / 16.1	Run to compute inventories in row 7 radial reflectors stored in sector 2 IVSM
5	tmutmiv3.inp tmut10emiv3.out	fftf10em	atdens9m.prn	2323 / 12.0	Run to compute inventories in row 7 radial reflectors stored in sector 3 IVSM
6	tmutmiv4.inp tmut10emiv4.out	fftf10em	atdens9m.prn	3011 / 13.5	Run to compute inventories in the one row 8/ 9 radial reflector stored in sector 3 IVSM
7	tmutmiv5.inp tmut10emiv5.out	fftf10em	atdens9m.prn	1022 / 14.2	Run to compute inventories in the control rods stored in the IVSMs
8	tmutmiv6.inp tmut10emiv6.out	fftf10em	atdens9m.prn	721 / 15.9	Run to compute inventories in the safety rods stored in sectors 1 and 2 IVSMs
9	tmutmiv7.inp tmut10emiv7.out	fftf10em	atdens9m.prn	1548 / 16.6	Run to compute inventories in the safety rods stored in sector 3 IVSM

[a] MCNP cases are summarized in Table 5-1.



CRA	Control / safety rod assembly
REFL	Radial reflector
ADVAB-1A	Advanced absorber (CRA) test
CCA	Core characterizer assembly (REFL row 7)
CCAS	CCA short (REFL row 9)
SURVEY-2	REFL experiment in row 9
SURVEY-3/4	In-core shim assembly experiment

Figure 5-1. Diagram of In-Vessel Storage Modules with Current Loading

Table 5-11. Inventory of Irradiated Assemblies in In-Vessel Storage Modules (2 sheets)

IVSM Location	Assembly Serial No.	Assembly Type[a]	Cycles Irradiated[b]		Discharge Date	Assembly Exposure (MWd)	Equiv. Exposure at 206 MW (days)	Decay Time (y)
			First	Last				
1-A	1126	REFL7				0		
1-B	1095	REFL7				0		
1-C	1094	REFL7				0		
1-D	557	SR	11A1	12A2	09/21/91	150593	731.0	12.0
1-E	554	SR	10A1	11A3	09/19/89	145995	708.7	14.0
1-F	562	CR	8A	11A3	09/19/89	239580	1163.0	14.0
1-G	561	CR	8A	11B1	04/08/90	190517	924.8	13.5
1-H	1241	REFL8A				0		
1-J	1038	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
1-K	1047	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
1-L	1046	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
1-M	1028	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
1-R	1054	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
1-S	1030	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
1-U	555	SR	11A1	12A2	09/21/91	150593	731.0	12.0
1-V								
1-W								
1-X	530	SR	IPR	3	10/23/83	134520	653.0	19.9
1-Y	529	SR	IPR	3	10/23/83	134520	653.0	19.9
1-Z								
2-A	1055	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
2-B	1042	REFL7	IPR	8A	04/25/86	352080	1709.1	17.4
2-C	1053	REFL7	IPR	8A	04/25/86	352080	1709.1	17.4
2-D	1061	REFL7	IPR	10A4	05/07/88	498958	2422.1	15.4
2-E	1035	REFL7	IPR	6A	01/26/85	238960	1160.0	18.7
2-F	1048	REFL7	IPR	10A4	05/07/88	498958	2422.1	15.4
2-G	1026	REFL7	IPR	10B	06/11/88	437627	2124.4	15.3
2-H	1025	REFL7	IPR	10C3	03/13/89	566906	2752.0	14.5
2-J	1051	REFL7	IPR	10C3	03/13/89	566906	2752.0	14.5
2-K	539	CR	IPR	10B	06/11/88	196270	952.8	15.3
2-L	532	SR	2A	10C3	03/13/89	155679	755.7	14.5
2-M	573	CR-EX	4	9A2	02/05/87	235671	1141.8	
2-R	1049	REFL7	3	11A3	09/19/89	506859	2460.5	14.0
2-S	536	CR	IPR	11B1	04/08/90	193273	938.2	13.5
2-U	540	CR	IPR	11B1	04/08/90	193273	938.2	13.5
2-V	533	SR	5A	7C	01/03/86	151800	736.9	17.7
2-W	543	CR	3	11A3	09/19/89	198431	963.3	14.0

IVSM Location	Assembly Serial No.	Assembly Type[a]	Cycles Irradiated[b]		Discharge Date	Assembly Exposure (MWd)	Equiv. Exposure at 206 MW (days)	Decay Time (y)
			First	Last				
2-X	257	ICSA				0		
2-Y	538	CR	IPR	9A1	03/13/89	240539	1167.7	14.5
2-Z								
3-A	516	CRFS				0		
3-B	521	CRFS	IPR	1B	11/12/82	53720	260.8	20.9
3-C	519	CRFS	IPR	IPR	12/23/80	3600	17.5	22.8
3-D	514	CRFS	IPR	NCT	03/16/81	5480	26.6	22.5
3-E	534	SR	4	10C3	03/13/89	177559	861.9	14.5
3-F	546	SR	7A	9C	07/18/86	173784	843.6	17.2
3-G	545	CR	8A	10C3	03/13/89	196715	954.9	14.5
3-H	547	CR	4	11A3	09/19/89	211471	1026.6	14.0
3-J	542	CR	8A	10B	06/11/88	205707	998.6	15.3
3-K	556	SR	8A	12A2	09/21/91	235797	1144.6	12.0
3-L	1076	REFL7	6B	12A1	09/21/91	478539	2323.0	12.0
3-M	531	CR	4	10C3	03/13/89	214429	1040.9	14.5
3-R	2057	REFL7-CC				0		
3-S	2056	REFL7-CC	EPR	EPR	11/23/81	3240	15.7	23.7
3-U	1444	REFL8B				0		
3-V	1657	REFL9-EX	HPPT	11B1	04/08/90	620179	3010.6	13.5
3-W	2059	REFL9-CC				0		
3-X	258	ICSA				0		
3-Y	2058	REFL9-CC				0		
3-Z								

[a] Assembly types: REFL = radial reflector, CR = control rod, SR = safety rod, ICSA = in-core shim assembly, CRFS = control rod fixed shim (also referred to in this report as a peripheral shim rod or PSR), EX = experiment, CC = core characterizer (assembly).

[b] At-power Testing periods prior to Cycle 1 are abbreviated as: IPR = initial power run, NCT = natural circulation testing, HPPT = high power physics testing, EPR = extended power run.

Table 5-12. Points at which Dose Rates Were Evaluated

General Location	Elevation (Relative to Core Midplane)	Radius	Azimuthal Positions (Degrees True)	Coordinates (X, Y, Z) in MCNP Model (cm from Core Center)
Reactor cavity above boron carbide shield (access to remove main support structure studs)	18.3 ft (5.60 m)	11.6 ft (3.55 m)	0* 30 60 90 120 150 180 210 240 270 300 330	0.0, -355.0, 560.0 -177.5, -307.4, 560.0 -307.4, -177.5, 560.0 -355.0, 0.0, 560.0 -307.4, 177.5, 560.0 -177.5, 307.4, 560.0 0.0, 355.0, 560.0 177.5, 307.4, 560.0 307.4, 177.5, 560.0 355.0, 0.0, 560.0 307.4, -177.5, 560.0 177.5, -307.4, 560.0
Reactor cavity (access to cut inlet and guard pipes)	9.9 ft (3.02 m)	12.0 ft (3.66 m)	60 180 300	-316.1, -182.5, 302.0. 0.0, 365.0, 302.0. 316.1, -182.5, 302.0.
Reactor cavity at core midplane	0.0 ft (0.00 m)	12.0 ft (3.66 m)	8 69 127 188 249 307	-49.0, -362.7, 0.0 -340.7, -133.7, 0.0 -292.6, 219.9, 0.0 49.0, 362.7, 0.0 340.7, 133.7, 0.0 292.6, -219.9, 0.0
Reactor cavity (access to cut outlet and guard pipes)	-10.6 ft (-3.23 m)	12.0 ft (3.66 m)	90 210 330	-365.8, 0.0, -322.6 182.5, 316.1, -322.6 182.5, -316.1, -322.6
Head Compartment	29.5 ft (9.00 m)	1.3 ft (0.40 m)	Average[b]	NA[c]
Head Compartment	29.5 ft (9.00 m)	11.5 ft (3.50 m)	Average[b]	NA[c]

[a] The azimuthal dose rate distribution at an elevation and radius above the boron carbide shield was requested by FFTF personnel. The twelve points listed were chosen to characterize that distribution.

[b] Dose rates for the head compartment were azimuthal averages.

[c] NA = not applicable because the ring detector option was used to give azimuthal averages.

Table 5-13. Summary of MCNP4C Dose Rate Calculations

MCNP4C Case	Photon Source Description	Source Rate (photons/s)	Dose Points
s01a	Sources in irradiated assemblies in IVSMs[a] from a total Co-60 inventory of 38,300 Ci[b].	2.83e+15	Point detectors at all dose points listed in Table 5-12, except at the elev. of 18.3 ft. Ring detectors at 18.3 ft elev. and in the head compartment
s01b			Point detectors at the twelve dose points listed for the 18.3 ft elev. in Table 5-12.
s01c			Volume tally over two cells to get a second estimate of the azimuthal average of dose rates at the 18.3 ft elevation
s02	Sources in the outer radial shield, the shield support structure and part of the inner radial shield (the outer half plus the top portion of the inner half) from a total Co-60 inventory of 83,200 Ci[b].	6.16e+15	Six ring detectors at the elevations and radii listed for the reactor cavity in Table 5.13, plus two ring detectors in the head compartment
s03	Sources in the bottom 35 cm of the inner half of the inner radial shield from a total Co-60 inventory of 3,000 Ci.	2.22e+14	
s04b	Sources in the core barrel, IVSM hardware, thermal liner, reactor vessel and guard vessel from a total Co-60 inventory of 2,610 Ci[b].	1.93e+14	
s05	Sources in instrument tree components and baffle plate from a total Co-60 inventory of 337 Ci.	2.49e+13	
s06	Sources in core basket structure and internals and in the grid plate from a total Co-60 inventory of 4,100 Ci[b].	3.04e+14	
s07	Sources in the upper 39 cm of the upper shield section of radial reflectors located in the core from a total Co-60 inventory of 343 Ci[b].	2.54e+13	
s08	Sources in lower axial shield/orifice and nozzle regions of all assemblies in core from a total Co-60 inventory of 22,200 Ci[b].	1.64e+15	
s09	Source in the IVHM[a] hardware from a total Co-60 inventory of 7.75 Ci.	5.74e+11	

[a] IVSM = In-Vessel Storage Module, IVHM = In-Vessel Handling Machine
[b] See Appendix L for plots of the source distribution

6.0 RESULTS

6.1 RADIONUCLIDE INVENTORIES

Radionuclide inventories in selected FFTF components at five different dates are tabulated in Tables 6-3 through 6-12. The content of these tables is summarized in Tables 6-1 and 6-2. The five dates are: September of 2003, 2008, 2013, 2023 and 2053. By 2053, ^{60}Co will have decayed over 11 half-lives from final shut down (March 1992), but concentrations may still be significant. Concentration of long-lived radionuclides ^{59}Ni, ^{93}Mo, ^{99}Tc and ^{14}C will not change significantly over the next few centuries, at least, but inventories of ^{63}Ni, with a half-life of 100 years, will continue to change significantly after 2053.

Included in the tables are radionuclide inventories (grams and curies) and concentrations (g/cm^3, Ci/m^3 and μCi/g) in all major components in the FFTF vessel. Radionuclides listed in the tables include: ^{60}Co, ^{59}Ni, ^{63}Ni, ^{93}Mo, ^{99}Tc, ^{94}Nb and ^{14}C.

Data for assemblies remaining in vessel are totals for all irradiated assemblies of each type. The total number irradiated is indicated in the tables for each type. Masses, volumes and radionuclide concentrations do not include unirradiated assemblies in the vessel. Data for each assembly type are given for each axial material region. In addition, totals are given for each assembly type. Data are listed for each major component of the instrument trees, IVHMs and the reactor closure head assembly. Totals for these multi-part reactor hardware items are also listed.

Table 6-13 summarizes the radionuclide inventories in the reactor vessel projected for September 2003. This table contains a summation of the inventories given in Tables 6-3 through 6-12.

Quantities of ^{60}Co, ^{94}Nb and ^{14}C depend on the levels of trace elements and impurities in Inconel and steel, so have a high degree of variability and uncertainty. In general, maximum concentrations of these constituents were assumed, to be conservative, as previously stated. Some radionuclides, namely ^{60}Co, ^{94}Nb, and ^{14}C, have multiple sources. One source is always dominant, at least for the levels of trace elements in steel and Inconel assumed. Approximately 80% of the ^{60}Co produced in SS-316 in the fueled region of the core is from (n, γ) reactions in ^{59}Co, with the remaining 20% from ^{60}Ni (n, p) reactions. ^{60}Ni (n, p) reactions contribute significantly to ^{60}Co production only in materials in or very near the fuel region. In the row 7 radial reflectors, the ^{60}Ni (n,p)-reaction contribution is down to about one percent. The vast majority of ^{14}C comes from ^{14}N (n,p) reactions in steel rather than from ^{13}C (n,γ) reactions because ^{13}C has such a low cross section. Even in boron carbide absorbers (control rods, safety rods and PSRs), over 90% of the ^{14}C is due to ^{14}N (n,p) reactions; in most components, it is a much higher percentage. Less than 0.02% of the ^{94}Nb comes from (n,p) reactions in ^{94}Mo; the vast majority comes from (n,γ) reactions in ^{93}Nb, especially outside the fuel region.

6.2 RADIONUCLIDE CONCENTRATION AT BOTTOM OF THE CORE SUPPORT STRUCTURE

To remove all the sodium from the reactor vessel, it will be necessary to remotely drill a drain hole through the bottom of the core support structure at its low point near the core centerline (See Figure 3-2 or Appendix L, Figure L-6). Some activated steel from the support structure may be removed with the drill bit. Therefore, the level of activation at this region of the core support structure is of concern, and was requested by FFTF personnel as a part of this analysis. As noted in Table 3-2 (last row), a separate tally of reaction rates was made over the bottom-center cell of the structure, in addition to a tally over the whole structure. Concentration of the radionuclides being tracked (Ci/m^3 and $\mu Ci/g$) in the bottom-center cell are listed in Table 6-14 for two dates, September 2003 and 2008.

6.3 DOSE RATES IN THE REACTOR CAVITY

Operations inside the reactor cavity will be required if the reactor vessel is to be removed from the FFTF for disposal elsewhere. These operations include removing studs and cutting sodium inlet and outlet pipes. Computed dose rates at the places where access may be required are listed in Tables 6-15 through 6-18 (one table for each of four elevations in the cavity). All these dose rates were computed using a model of the FFTF with all sodium removed from the vessel and were projected to January 2010.

Table 6-15 provides data at 18.3 ft (560 cm) above the core midplane where shielding blocks may need to be removed for access to nuts on the Main Support Structure studs. Table 6-16 provides data at 9 ft 11 in. (302 cm) above the core midplane where the outlet and guard pipes would be cut. Table 6-17 provides data at 10 ft 7 in. (323 cm) below the core midplane where the inlet and guard pipes would be cut. Dose rates were computed at the core midplane to show the peak levels in the cavity; those data are shown in Table 6-18. Six dose points are included in Table 6-18: three directly outboard of the IVSMs and three between the modules. While maximum dose rates exceed 16 rem/h at the core midplane elevation, locations where personnel access may be required are less than 2.5 rem/h.

Each table contains three columns of dose rates for each dose point. The first column contains dose rates from photon sources in irradiated assemblies located in the IVSMs. The second column contains dose rates from activated reactor hardware and other irradiated assemblies located in the reactor core. The third column contains the total dose rates. Dose rates are broken down in this way to establish the contribution of assemblies in the IVSMs. These assemblies, which are close to the vessel wall, could be removed if they result in excessively high dose rates.

Dose points in Tables 6-15 through 6-18 are as listed in Table 5-12, with one exception. Dose rates of adequate accuracy to reliably characterize the azimuthal distribution at the 18.3 ft elevation above the boron carbide shield could not be obtained without undue effort. Instead, an

azimuthally-averaged value at the specified radius of 355 cm (11.7 ft) was computed and reported (see Table 6-15). Also, the peak value obtained is given in Table 6-15. The peak value had a large uncertainty, but an assessment determined that it is conservative (overestimated). In that assessment, dose rates were computed below the boron carbide shield 500 cm above the core midplane, where reliable MCNP4C results (<10% uncertainty) could be obtained. At that elevation, the peak dose rate was computed to be 75 mrem/h with a peak-to-average factor of 2.0. In the other tables, azimuthal dependence of the dose rates is shown only for the assemblies stored in the IVSMs. Because of the azimuthal symmetry in the calculational model and source distributions in other components, only azimuthally-averaged dose rates are listed for those components.

While dose rates from irradiated assemblies located in the IVSMs are significant, especially at the core midplane, the contribution from the other assemblies stored in core is negligible. Less than 0.01% of the dose rates listed under "Dose Rates from Other Sources" in Tables 6-15 through 6-18 are attributable to the presence of the in-core assemblies.

6.4 DOSE RATES IN THE HEAD COMPARTMENT AFTER SODIUM DRAIN

As indicated in Section 3.4 and Table 5-12, dose rates were computed in the head compartment to show that the loss of 5 m of sodium shielding above the reactor core does not lead to significantly elevated dose rates in normally occupied spaces. The results of these calculations indicated that no measurable increase in dose rates will occur when sodium is drained from the reactor vessel.

Table 6-1. Summary of the Content of Radionuclide Inventory Tables

Table	Date Included	Description of Contents*
6-3	September 2003	Activated reactor hardware components
6-4	September 2003	Irradiated assemblies remaining in vessel
6-5	September 2008	Activated reactor hardware components
6-6	September 2008	Irradiated assemblies remaining in vessel
6-7	September 2013	Activated reactor hardware components
6-8	September 2013	Irradiated assemblies remaining in vessel
6-9	September 2023	Activated reactor hardware components
6-10	September 2023	Irradiated assemblies remaining in vessel
6-11	September 2053	Activated reactor hardware components
6-12	September 2053	Irradiated assemblies remaining in vessel

* Contents of each of the two table types are identified in Table 6-2.

Table 6-2. Contents of each Radionuclide Inventory Table

Reactor Hardware Component Tables (11 sheets per table)	
Component Description	**Sheet(s)**
Inner radial Shield	1
Outer radial Shield	1
Radial Support	1
Core Basket	2
Grid Plate	2
Core Support Structure	2
Reactor Vessel	3
Thermal Liner	3
Guard Vessel	3
Core barrel	4
In-vessel Storage Module Structure	4
Baffle Plate	4
Instrument Trees	5 – 7
In-Vessel Handling Machine	7 – 8
Reactor Closure Head Assembly, including reflector, shield and suppressor plates	8 – 10
Z Ring	11
Boron Carbide Shield	11
Steel Roof	11

Irradiated Assembly Tables (12 sheets per table)	
Component Description	**Sheet(s)**
Row 7 Radial Reflectors	1 – 2
Row 8 and 9 Radial Reflectors	3 – 4
Control and Safety Rods	5 – 7
In-Core Shim Assemblies	8 – 9
Peripheral Shims Rods	10 – 12

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware – September 2003 (sheet 1 of 11)

Inner Radial Shield Volume = 4.514E+06 cm^3, Mass = 3.227E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.31E+02	2.89E-05	1.48E+05	3.27E+04	4.57E+03
Ni-59	7.60E+04	1.46E+03	3.24E-04	1.17E+02	2.59E+01	3.61E+00
Ni-63	1.00E+02	1.99E+02	4.42E-05	1.13E+04	2.51E+03	3.50E+02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.16E+01	9.21E-06	7.91E+00	1.75E+00	2.45E-01
C-14	5.73E+03	6.94E+00	1.54E-06	3.09E+01	6.85E+00	9.57E-01
Total		1.84E+03	4.08E-04	1.59E+05	3.53E+04	4.92E+03

Outer Radial Shield Volume = 1.221E+07 cm^3, Mass = 8.834E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.73E+01	4.70E-06	6.49E+04	5.31E+03	7.33E+02
Ni-59	7.60E+04	6.83E+02	5.59E-05	5.45E+01	4.46E+00	6.16E-01
Ni-63	1.00E+02	9.26E+01	7.59E-06	5.26E+03	4.31E+02	5.94E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.98E+01	1.63E-06	3.78E+00	3.09E-01	4.27E-02
C-14	5.73E+03	2.93E+00	2.40E-07	1.31E+01	1.07E+00	1.48E-01
Total		8.56E+02	7.01E-05	7.02E+04	5.75E+03	7.93E+02

Radial Shield Support Volume = 4.556E+05 cm^3, Mass = 2.192E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.39E-01	7.44E-07	3.84E+02	8.42E+02	1.75E+02
Ni-59	7.60E+04	3.99E+00	8.76E-06	3.18E-01	6.99E-01	1.45E-01
Ni-63	1.00E+02	5.50E-01	1.21E-06	3.12E+01	6.86E+01	1.42E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	9.12E-02	2.00E-07	1.74E-02	3.81E-02	7.91E-03
C-14	5.73E+03	1.80E-02	3.95E-08	8.02E-02	1.76E-01	3.65E-02
Total		4.99E+00	1.09E-05	4.15E+02	9.12E+02	1.89E+02

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 2 of 11)

Core Basket Volume = 2.453E+06 cm^3, Mass = 5.399E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.51E-01	3.06E-07	8.49E+02	3.46E+02	1.57E+02
Ni-59	7.60E+04	9.41E+00	3.84E-06	7.51E-01	3.06E-01	1.39E-01
Ni-63	1.00E+02	1.32E+00	5.37E-07	7.48E+01	3.05E+01	1.39E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.68E-01	6.85E-08	3.20E-02	1.30E-02	5.93E-03
C-14	5.73E+03	4.48E-02	1.83E-08	2.00E-01	8.15E-02	3.70E-02
Total		1.17E+01	4.77E-06	9.25E+02	3.77E+02	1.71E+02

Grid Plate Volume = 1.818E+06 cm^3, Mass = 1.041E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.16E+00	1.19E-06	2.44E+03	1.34E+03	2.34E+02
Ni-59	7.60E+04	2.33E+01	1.28E-05	1.86E+00	1.02E+00	1.78E-01
Ni-63	1.00E+02	3.23E+00	1.78E-06	1.83E+02	1.01E+02	1.76E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	5.92E-01	3.26E-07	1.13E-01	6.19E-02	1.08E-02
C-14	5.73E+03	1.05E-01	5.77E-08	4.67E-01	2.57E-01	4.48E-02
Total		2.94E+01	1.62E-05	2.62E+03	1.44E+03	2.52E+02

Core Support Structure Volume = 5.355E+06 cm^3, Mass = 4.156E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.76E-01	3.29E-08	1.99E+02	3.72E+01	4.80E+00
Ni-59	7.60E+04	3.76E+00	7.02E-07	3.00E-01	5.60E-02	7.22E-03
Ni-63	1.00E+02	5.27E-01	9.83E-08	2.99E+01	5.58E+00	7.20E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.27E-02	4.24E-09	4.32E-03	8.07E-04	1.04E-04
C-14	5.73E+03	1.90E-02	3.55E-09	8.48E-02	1.58E-02	2.04E-03
Total		4.50E+00	8.41E-07	2.30E+02	4.29E+01	5.53E+00

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 3 of 11)

Reactor Vessel Volume = 2.001E+07 cm^3, Mass = 1.601E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.47E-01	7.34E-09	1.66E+02	8.31E+00	1.04E+00
Ni-59	7.60E+04	3.03E+00	1.52E-07	2.42E-01	1.21E-02	1.51E-03
Ni-63	1.00E+02	4.24E-01	2.12E-08	2.41E+01	1.20E+00	1.51E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	1.03E-09	3.91E-03	1.95E-04	2.44E-05
C-14	5.73E+03	1.54E-02	7.67E-10	6.84E-02	3.42E-03	4.27E-04
Total		3.64E+00	1.82E-07	1.91E+02	9.52E+00	1.19E+00

Thermal Liner Volume = 4.226E+06 cm^3, Mass = 2.874E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.13E-01	2.67E-08	1.28E+02	3.02E+01	4.44E+00
Ni-59	7.60E+04	2.34E+00	5.53E-07	1.87E-01	4.42E-02	6.49E-03
Ni-63	1.00E+02	3.26E-01	7.71E-08	1.85E+01	4.38E+00	6.44E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.54E-02	3.65E-09	2.94E-03	6.95E-04	1.02E-04
C-14	5.73E+03	1.18E-02	2.80E-09	5.28E-02	1.25E-02	1.84E-03
Total		2.80E+00	6.64E-07	1.46E+02	3.46E+01	5.09E+00

Guard Vessel Volume = 1.669E+07 cm^3, Mass = 1.335E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.54E-02	1.53E-09	2.88E+01	1.73E+00	2.16E-01
Ni-59	7.60E+04	7.22E-01	4.32E-08	5.76E-02	3.45E-03	4.31E-04
Ni-63	1.00E+02	1.01E-01	6.02E-09	5.71E+00	3.42E-01	4.28E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.21E-03	2.52E-10	8.01E-04	4.80E-05	6.00E-06
C-14	5.73E+03	3.65E-03	2.19E-10	1.63E-02	9.75E-04	1.22E-04
Total		8.55E-01	5.13E-08	3.46E+01	2.07E+00	2.59E-01

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 4 of 11)

Core Barrel Volume = 2.570E+06 cm^3, Mass = 2.056E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.72E+00	6.70E-07	1.95E+03	7.58E+02	9.48E+01
Ni-59	7.60E+04	2.05E+01	7.96E-06	1.63E+00	6.35E-01	7.94E-02
Ni-63	1.00E+02	2.88E+00	1.12E-06	1.64E+02	6.37E+01	7.96E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.04E-01	1.57E-07	7.68E-02	2.99E-02	3.74E-03
C-14	5.73E+03	9.68E-02	3.77E-08	4.31E-01	1.68E-01	2.10E-02
Total		2.56E+01	9.94E-06	2.11E+03	8.23E+02	1.03E+02

In-Vessel Storage Modules (3) Volume = 8.566E+06 cm^3, Mass = 1.358E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.98E-01	3.48E-08	3.37E+02	3.94E+01	2.48E+01
Ni-59	7.60E+04	4.32E+00	5.04E-07	3.45E-01	4.02E-02	2.53E-02
Ni-63	1.00E+02	5.82E-01	6.80E-08	3.31E+01	3.86E+00	2.43E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.85E-04
Nb-94	2.00E+04	7.05E-02	8.23E-09	1.34E-02	1.57E-03	7.31E-03
C-14	5.73E+03	2.23E-02	2.61E-09	9.95E-02	1.16E-02	2.72E+01
Total		5.29E+00	6.18E-07	3.71E+02	4.33E+01	5.45E+01

Baffle Plate Volume = 1.237E+06 cm^3, Mass = 9.892E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.68E-02	2.17E-08	3.03E+01	2.45E+01	3.07E+00
Ni-59	7.60E+04	6.28E-01	5.08E-07	5.01E-02	4.05E-02	5.07E-03
Ni-63	1.00E+02	8.75E-02	7.08E-08	4.97E+00	4.02E+00	5.02E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.76E-03	3.04E-09	7.16E-04	5.79E-04	7.24E-05
C-14	5.73E+03	3.16E-03	2.56E-09	1.41E-02	1.14E-02	1.42E-03
Total		7.49E-01	6.06E-07	3.54E+01	2.86E+01	3.58E+00

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 5 of 11)

Instrument Tree Hold Downs Volume = 5.894E+05 cm^3, Mass = 7.031E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.82E-02	1.50E-07	9.97E+01	1.69E+02	1.42E+02
Ni-59	7.60E+04	9.81E-01	1.67E-06	7.83E-02	1.33E-01	1.11E-01
Ni-63	1.00E+02	1.34E-01	2.28E-07	7.63E+00	1.29E+01	1.08E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	3.48E-08	3.90E-03	6.62E-03	5.54E-03
C-14	5.73E+03	4.58E-03	7.77E-09	2.04E-02	3.46E-02	2.90E-02
Total		1.23E+00	2.09E-06	1.07E+02	1.82E+02	1.53E+02

Instrument Tree Lower Frames Volume = 1.040E+06 cm^3, Mass = 3.795E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.64E-01	1.58E-07	1.86E+02	1.79E+02	4.89E+01
Ni-59	7.60E+04	2.09E+00	2.01E-06	1.66E-01	1.60E-01	4.38E-02
Ni-63	1.00E+02	2.92E-01	2.81E-07	1.66E+01	1.59E+01	4.36E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.42E-02	3.29E-08	6.51E-03	6.26E-03	1.71E-03
C-14	5.73E+03	1.00E-02	9.65E-09	4.47E-02	4.30E-02	1.18E-02
Total		2.59E+00	2.49E-06	2.03E+02	1.95E+02	5.34E+01

Instrument Tree Guide Tubes Volume = 1.224E+07 cm^3, Mass = 4.614E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.42E-03	6.06E-10	8.39E+00	6.86E-01	1.81E+00
Ni-59	7.60E+04	1.53E-01	1.25E-08	1.22E-02	9.95E-04	2.63E-03
Ni-63	1.00E+02	2.11E-02	1.72E-09	1.20E+00	9.79E-02	2.59E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.33E-03	1.09E-10	2.54E-04	2.08E-05	5.49E-05
C-14	5.73E+03	7.59E-04	6.20E-11	3.38E-03	2.76E-04	7.31E-04
Total		1.83E-01	1.50E-08	9.61E+00	7.85E-01	2.08E+00

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 6 of 11)

Instrument Tree Columns Volume = 7.201E+06 cm^3, Mass = 7.215E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.10E-02	1.52E-09	1.24E+01	1.72E+00	1.72E+00
Ni-59	7.60E+04	1.97E-01	2.74E-08	1.57E-02	2.19E-03	2.18E-03
Ni-63	1.00E+02	2.73E-02	3.79E-09	1.55E+00	2.15E-01	2.15E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.04E-03	2.83E-10	3.88E-04	5.39E-05	5.37E-05
C-14	5.73E+03	9.73E-04	1.35E-10	4.34E-03	6.02E-04	6.01E-04
Total		2.39E-01	3.31E-08	1.40E+01	1.94E+00	1.93E+00

Instrument Tree Shield Plugs Volume = 2.864E+06 cm^3, Mass = 2.292E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.08E-07	2.47E-13	8.01E-04	2.80E-04	3.50E-05
Ni-59	7.60E+04	1.52E-05	5.32E-12	1.22E-06	4.25E-07	5.31E-08
Ni-63	1.00E+02	2.15E-06	7.51E-13	1.22E-04	4.27E-05	5.33E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.60E-07	5.59E-14	3.05E-08	1.06E-08	1.33E-09
C-14	5.73E+03	7.54E-08	2.63E-14	3.36E-07	1.17E-07	1.47E-08
Total		1.83E-05	6.40E-12	9.25E-04	3.23E-04	4.04E-05

Instrument Tree Shield Plates Volume = 1.967E+06 cm^3, Mass = 1.577E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.24E-07	3.68E-14	7.06E-04	4.16E-05	5.19E-06
Ni-59	7.60E+04	3.42E-05	2.02E-12	2.73E-06	1.61E-07	2.01E-08
Ni-63	1.00E+02	4.82E-06	2.84E-13	2.74E-04	1.61E-05	2.01E-06
Mo-93	3.50E+03	3.51E-09	2.07E-16	3.86E-09	2.28E-10	2.84E-11
Tc-99	2.13E+05	1.19E-07	7.03E-15	2.02E-09	1.19E-10	1.49E-11
Nb-94	2.00E+04	7.01E-08	4.13E-15	1.33E-08	7.87E-10	9.81E-11
C-14	5.73E+03	5.70E-08	3.36E-15	2.54E-07	1.50E-08	1.87E-09
Total		3.99E-05	2.36E-12	9.82E-04	5.79E-05	7.22E-06

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 7 of 11)

Instrument Trees Composite Volume = 2.590E+07 cm^3, Mass = 5.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.71E-01	1.05E-08	3.07E+02	1.18E+01	5.57E+00
Ni-59	7.60E+04	3.42E+00	1.32E-07	2.73E-01	1.05E-02	4.95E-03
Ni-63	1.00E+02	4.74E-01	1.83E-08	2.69E+01	1.04E+00	4.90E-01
Mo-93	3.50E+03	3.51E-09	1.36E-16	3.86E-09	1.49E-10	7.02E-11
Tc-99	2.13E+05	1.19E-07	4.60E-15	2.02E-09	7.81E-11	3.68E-11
Nb-94	2.00E+04	5.81E-02	2.24E-09	1.11E-02	4.27E-04	2.01E-04
C-14	5.73E+03	1.63E-02	6.31E-10	7.28E-02	2.81E-03	1.32E-03
Total		4.24E+00	1.64E-07	3.34E+02	1.29E+01	6.07E+00

In-Vessel Handling Machines (3) Volume = 2.482E+07 cm^3, Mass = 4.329E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.85E-03	2.76E-10	7.75E+00	3.12E-01	1.79E-01
Ni-59	7.60E+04	2.05E-01	8.24E-09	1.63E-02	6.58E-04	3.77E-04
Ni-63	1.00E+02	2.84E-02	1.14E-09	1.61E+00	6.49E-02	3.72E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	8.41E-04	3.39E-11	1.60E-04	6.44E-06	3.69E-06
C-14	5.73E+03	1.04E-03	4.18E-11	4.62E-03	1.86E-04	1.07E-04
Total		2.42E-01	9.74E-09	9.38E+00	3.78E-01	2.16E-01

IVHM Shield Plug Volume = 4.543E+06 cm^3, Mass = 3.636E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.12E-06	2.47E-13	1.27E-03	2.80E-04	3.50E-05
Ni-59	7.60E+04	2.42E-05	5.32E-12	1.93E-06	4.25E-07	5.31E-08
Ni-63	1.00E+02	3.41E-06	7.51E-13	1.94E-04	4.27E-05	5.33E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.54E-07	5.59E-14	4.84E-08	1.06E-08	1.33E-09
C-14	5.73E+03	1.20E-07	2.63E-14	5.33E-07	1.17E-07	1.47E-08
Total		2.91E-05	6.40E-12	1.47E-03	3.23E-04	4.04E-05

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 8 of 11)

IVHM Shield Plates Volume = 3.120E+06 cm^3, Mass = 2.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.89E-07	5.83E-14	1.12E-03	6.60E-05	8.23E-06
Ni-59	7.60E+04	5.43E-05	3.20E-12	4.33E-06	2.56E-07	3.19E-08
Ni-63	1.00E+02	7.64E-06	4.51E-13	4.34E-04	2.56E-05	3.19E-06
Mo-93	3.50E+03	5.58E-09	3.29E-16	6.13E-09	3.61E-10	4.51E-11
Tc-99	2.13E+05	1.89E-07	1.12E-14	3.21E-09	1.89E-10	2.36E-11
Nb-94	2.00E+04	1.11E-07	6.56E-15	2.12E-08	1.25E-09	1.56E-10
C-14	5.73E+03	9.03E-08	5.33E-15	4.03E-07	2.37E-08	2.96E-09
Total		6.33E-05	3.74E-12	1.56E-03	9.19E-05	1.15E-05

IVHM Composite Volume = 3.248E+07 cm^3, Mass = 1.047E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.85E-03	2.11E-10	7.748E+00	2.39E-01	7.40E-02
Ni-59	7.60E+04	2.05E-01	6.30E-09	1.633E-02	5.03E-04	1.56E-04
Ni-63	1.00E+02	2.84E-02	8.73E-10	1.612E+00	4.96E-02	1.54E-02
Mo-93	3.50E+03	5.58E-09	1.72E-16	6.129E-09	1.89E-10	5.86E-11
Tc-99	2.13E+05	1.89E-07	5.82E-15	3.209E-09	9.88E-11	3.07E-11
Nb-94	2.00E+04	8.41E-04	2.59E-11	1.600E-04	4.92E-06	1.53E-06
C-14	5.73E+03	1.04E-03	3.19E-11	4.621E-03	1.42E-04	4.41E-05
Total		2.42E-01	7.44E-09	9.38E+00	2.89E-01	8.96E-02

Closure Head Volume = 2.469E+07 cm^3, Mass = 1.360E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.94E-07	3.22E-14	8.98E-04	3.64E-05	6.60E-06
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	3.16E-11	1.28E-18	1.41E-10	5.70E-12	1.04E-12
Total		7.94E-07	3.22E-14	8.98E-04	3.64E-05	6.60E-06

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 9 of 11)

Suppressor Plate Volume = 1.874E+05 cm^3, Mass = 1.052E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.35E-07	1.79E-12	3.79E-04	2.02E-03	3.60E-04
Ni-59	7.60E+04	8.26E-05	4.41E-10	6.59E-06	3.52E-05	6.27E-06
Ni-63	1.00E+02	1.09E-05	5.83E-11	6.20E-04	3.31E-03	5.89E-04
Mo-93	3.50E+03	8.71E-08	4.65E-13	9.58E-08	5.11E-07	9.10E-08
Tc-99	2.13E+05	3.33E-06	1.78E-11	5.66E-08	3.02E-07	5.38E-08
Nb-94	2.00E+04	3.04E-07	1.62E-12	5.79E-08	3.09E-07	5.51E-08
C-14	5.73E+03	3.15E-08	1.68E-13	1.40E-07	7.48E-07	1.33E-07
Total		9.76E-05	5.21E-10	1.01E-03	5.37E-03	9.56E-04

Thermal Reflector Plates Volume = 3.811E+06 cm^3, Mass = 2.134E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.75E-06	2.03E-12	8.77E-03	2.30E-03	4.11E-04
Ni-59	7.60E+04	7.00E-04	1.84E-10	5.58E-05	1.47E-05	2.62E-06
Ni-63	1.00E+02	9.28E-05	2.44E-11	5.27E-03	1.38E-03	2.47E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.10E-06	5.50E-13	3.99E-07	1.05E-07	1.87E-08
C-14	5.73E+03	3.54E-06	9.29E-13	1.58E-05	4.14E-06	7.39E-07
Total		8.06E-04	2.11E-10	1.41E-02	3.70E-03	6.61E-04

Inconel Shield Plate Volume = 3.811E+06 cm^3, Mass = 2.254E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.56E-06	6.72E-13	2.90E-03	7.61E-04	1.29E-04
Ni-59	7.60E+04	8.06E-04	2.11E-10	6.43E-05	1.69E-05	2.85E-06
Ni-63	1.00E+02	1.09E-04	2.85E-11	6.16E-03	1.62E-03	2.73E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.13E-11	2.97E-18	5.04E-11	1.32E-11	2.24E-12
Total		9.17E-04	2.41E-10	9.13E-03	2.39E-03	4.05E-04

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 10 of 11)

SS-410 Shield Plate Volume = 3.049E+06 cm^3, Mass = 1.665E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.19E-07	3.91E-14	1.35E-04	4.42E-05	8.10E-06
Ni-59	7.60E+04	2.54E-06	8.32E-13	2.03E-07	6.64E-08	1.22E-08
Ni-63	1.00E+02	3.47E-07	1.14E-13	1.97E-05	6.46E-06	1.18E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.54E-08	5.04E-15	6.85E-08	2.25E-08	4.12E-09
Total		3.02E-06	9.90E-13	1.55E-04	5.08E-05	9.30E-06

Low-Carbon Steel Shield Plate Volume = 6.097E+06 cm^3, Mass = 3.359E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.40E-08	1.21E-14	8.37E-05	1.37E-05	2.49E-06
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	4.02E-12	6.60E-19	1.79E-11	2.94E-12	5.33E-13
Total		7.40E-08	1.21E-14	8.37E-05	1.37E-05	2.49E-06

Head Assembly Composite (Head + Suppressor, Reflector and Shield Plates) Volume = 4.165E+07 cm^3, Mass = 2.312E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.16E-05	2.79E-13	1.32E-02	3.16E-04	5.69E-05
Ni-59	7.60E+04	1.59E-03	3.82E-11	1.27E-04	3.05E-06	5.49E-07
Ni-63	1.00E+02	2.13E-04	5.11E-12	1.21E-02	2.90E-04	5.22E-05
Mo-93	3.50E+03	8.71E-08	2.09E-15	9.58E-08	2.30E-09	4.14E-10
Tc-99	2.13E+05	3.33E-06	8.01E-14	5.66E-08	1.36E-09	2.45E-10
Nb-94	2.00E+04	2.40E-06	5.76E-14	4.57E-07	1.10E-08	1.98E-09
C-14	5.73E+03	3.59E-06	8.62E-14	1.60E-05	3.84E-07	6.92E-08
Total		1.82E-03	4.38E-11	2.54E-02	6.09E-04	1.10E-04

Table 6-3. Radionuclide Inventories in Activated Reactor Hardware - September 2003 (sheet 11 of 11)

Z Ring Volume = 1.989E+07 cm^3, Mass = 1.591E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.39E-05	6.98E-13	1.57E-02	7.90E-04	9.87E-05
Ni-59	7.60E+04	3.06E-04	1.54E-11	2.44E-05	1.23E-06	1.53E-07
Ni-63	1.00E+02	4.31E-05	2.16E-12	2.45E-03	1.23E-04	1.54E-05
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.82E-06	1.42E-13	5.37E-07	2.70E-08	3.37E-09
C-14	5.73E+03	1.52E-06	7.66E-14	6.79E-06	3.41E-07	4.27E-08
Total		3.67E-04	1.84E-11	1.82E-02	9.14E-04	1.14E-04

Boron Carbide Shield Volume = 1.932E+06 cm^3, Mass = 4.831E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	7.32E-09	3.79E-15	3.26E-08	1.69E-08	6.76E-09
Total		7.32E-09	3.79E-15	3.26E-08	1.69E-08	6.76E-09

Steel Roof Volume = 5.468E+06 cm^3, Mass = 4.303E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.71E-10	6.78E-17	4.19E-07	7.67E-08	9.74E-09
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	2.01E-07	3.68E-14	3.41E-09	6.24E-10	7.93E-11
Nb-94	2.00E+04	2.37E-08	4.33E-15	4.50E-09	8.23E-10	1.05E-10
C-14	5.73E+03	4.55E-14	8.31E-21	2.03E-13	3.70E-14	4.71E-15
Total		2.25E-07	4.12E-14	4.27E-07	7.81E-08	9.93E-09

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 1 of 12)

Irradiated Row 7 Radial Reflectors 81 total in vessel

Inconel Reflector Section Volume = 1.287E+06 cm^3, Mass = 9.011E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.59E+02	1.24E-04	1.80E+05	1.40E+05	2.00E+04
Ni-59	7.60E+04	6.85E+03	5.32E-03	5.47E+02	4.25E+02	6.07E+01
Ni-63	1.00E+02	1.33E+03	1.04E-03	7.57E+04	5.88E+04	8.40E+03
Mo-93	3.50E+03	6.82E+01	5.30E-05	7.50E+01	5.83E+01	8.32E+00
Tc-99	2.13E+05	3.61E+02	2.81E-04	6.13E+00	4.76E+00	6.80E-01
Nb-94	2.00E+04	3.64E+01	2.83E-05	6.93E+00	5.39E+00	7.70E-01
C-14	5.73E+03	4.14E-01	3.22E-07	1.85E+00	1.43E+00	2.05E-01
Total		8.81E+03	6.85E-03	2.56E+05	1.99E+05	2.85E+04

Upper Shield Section Volume = 1.253E+06 cm^3, Mass = 8.386E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.49E+00	4.38E-06	6.21E+03	4.96E+03	7.41E+02
Ni-59	7.60E+04	1.54E+02	1.23E-04	1.23E+01	9.80E+00	1.46E+00
Ni-63	1.00E+02	1.97E+01	1.57E-05	1.12E+03	8.92E+02	1.33E+02
Mo-93	3.50E+03	1.24E+01	9.90E-06	1.36E+01	1.09E+01	1.63E+00
Tc-99	2.13E+05	8.85E+01	7.06E-05	1.50E+00	1.20E+00	1.79E-01
Nb-94	2.00E+04	1.15E+01	9.17E-06	2.19E+00	1.75E+00	2.61E-01
C-14	5.73E+03	5.41E-02	4.31E-08	2.41E-01	1.92E-01	2.87E-02
Total		2.92E+02	2.33E-04	7.36E+03	5.87E+03	8.78E+02

Lower Shield/Orifice Volume = 7.371E+05 cm^3, Mass = 4.516E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.81E+00	1.20E-05	9.97E+03	1.35E+04	2.21E+03
Ni-59	7.60E+04	2.26E+02	3.07E-04	1.80E+01	2.45E+01	3.99E+00
Ni-63	1.00E+02	3.12E+01	4.23E-05	1.77E+03	2.40E+03	3.92E+02
Mo-93	3.50E+03	1.57E+01	2.12E-05	1.72E+01	2.33E+01	3.81E+00
Tc-99	2.13E+05	1.17E+02	1.58E-04	1.98E+00	2.69E+00	4.39E-01
Nb-94	2.00E+04	1.50E+01	2.03E-05	2.85E+00	3.87E+00	6.32E-01
C-14	5.73E+03	8.40E-02	1.14E-07	3.74E-01	5.08E-01	8.28E-02
Total		4.13E+02	5.61E-04	1.18E+04	1.60E+04	2.61E+03

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 2 of 12)

Irradiated Row 7 Radial Reflectors (continued)

Handling Socket Volume = 1.540E+05 cm^3, Mass = 2.125E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.84E-03	6.39E-08	1.11E+01	7.23E+01	5.24E+01
Ni-59	7.60E+04	2.20E-01	1.43E-06	1.76E-02	1.14E-01	8.27E-02
Ni-63	1.00E+02	2.97E-02	1.93E-07	1.69E+00	1.10E+01	7.94E+00
Mo-93	3.50E+03	6.22E-03	4.04E-08	6.84E-03	4.44E-02	3.22E-02
Tc-99	2.13E+05	1.14E-01	7.40E-07	1.93E-03	1.26E-02	9.09E-03
Nb-94	2.00E+04	1.02E-02	6.59E-08	1.93E-03	1.25E-02	9.08E-03
C-14	5.73E+03	7.41E-05	4.81E-10	3.30E-04	2.14E-03	1.55E-03
Total		3.90E-01	2.53E-06	1.29E+01	8.35E+01	6.05E+01

Nozzle Volume = 1.466E+05 cm^3, Mass = 4.922E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.56E-02	4.47E-07	7.42E+01	5.06E+02	1.51E+02
Ni-59	7.60E+04	1.57E+00	1.07E-05	1.25E-01	8.56E-01	2.55E-01
Ni-63	1.00E+02	2.17E-01	1.48E-06	1.23E+01	8.40E+01	2.50E+01
Mo-93	3.50E+03	5.35E-02	3.65E-07	5.88E-02	4.01E-01	1.19E-01
Tc-99	2.13E+05	7.55E-01	5.15E-06	1.28E-02	8.74E-02	2.60E-02
Nb-94	2.00E+04	7.85E-02	5.36E-07	1.49E-02	1.02E-01	3.04E-02
C-14	5.73E+03	5.27E-04	3.59E-09	2.35E-03	1.60E-02	4.77E-03
Total		2.74E+00	1.87E-05	8.67E+01	5.91E+02	1.76E+02

Row 7 Radial Reflectors Composite Volume = 3.578E+06 cm^3, Mass = 2.262E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.74E+02	4.85E-05	1.96E+05	5.49E+04	8.68E+03
Ni-59	7.60E+04	7.23E+03	2.02E-03	5.77E+02	1.61E+02	2.55E+01
Ni-63	1.00E+02	1.38E+03	3.87E-04	7.86E+04	2.20E+04	3.47E+03
Mo-93	3.50E+03	9.64E+01	2.69E-05	1.06E+02	2.96E+01	4.68E+00
Tc-99	2.13E+05	5.67E+02	1.59E-04	9.63E+00	2.69E+00	4.26E-01
Nb-94	2.00E+04	6.30E+01	1.76E-05	1.20E+01	3.35E+00	5.30E-01
C-14	5.73E+03	5.53E-01	1.55E-07	2.46E+00	6.89E-01	1.09E-01
Total		9.52E+03	2.66E-03	2.76E+05	7.70E+04	1.22E+04

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 3 of 12)

Irradiated Row 8 and 9 Radial Reflectors 73 total in vessel

Inconel Reflector Section Volume = 1.160E+06 cm^3, Mass = 8.439E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.25E+02	1.94E-04	2.55E+05	2.19E+05	3.02E+04
Ni-59	7.60E+04	9.59E+03	8.27E-03	7.65E+02	6.60E+02	9.07E+01
Ni-63	1.00E+02	1.75E+03	1.51E-03	9.93E+04	8.56E+04	1.18E+04
Mo-93	3.50E+03	7.96E+01	6.86E-05	8.75E+01	7.54E+01	1.04E+01
Tc-99	2.13E+05	5.66E+02	4.88E-04	9.60E+00	8.28E+00	1.14E+00
Nb-94	2.00E+04	5.90E+01	5.09E-05	1.12E+01	9.68E+00	1.33E+00
C-14	5.73E+03	5.19E-01	4.48E-07	2.31E+00	2.00E+00	2.74E-01
Total		1.23E+04	1.06E-02	3.55E+05	3.06E+05	4.20E+04

Upper Shield Section Volume = 1.128E+06 cm^3, Mass = 7.969E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.19E+00	5.48E-06	7.00E+03	6.20E+03	8.79E+02
Ni-59	7.60E+04	1.81E+02	1.61E-04	1.45E+01	1.28E+01	1.82E+00
Ni-63	1.00E+02	2.34E+01	2.07E-05	1.33E+03	1.17E+03	1.66E+02
Mo-93	3.50E+03	1.39E+01	1.23E-05	1.53E+01	1.36E+01	1.92E+00
Tc-99	2.13E+05	9.91E+01	8.78E-05	1.68E+00	1.49E+00	2.11E-01
Nb-94	2.00E+04	1.28E+01	1.13E-05	2.43E+00	2.16E+00	3.05E-01
C-14	5.73E+03	5.82E-02	5.15E-08	2.59E-01	2.30E-01	3.25E-02
Total		3.37E+02	2.98E-04	8.36E+03	7.41E+03	1.05E+03

Lower Shield/Orifice Volume = 6.643E+05 cm^3, Mass = 3.115E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.48E+00	1.13E-05	8.47E+03	1.27E+04	2.72E+03
Ni-59	7.60E+04	2.03E+02	3.06E-04	1.62E+01	2.44E+01	5.20E+00
Ni-63	1.00E+02	2.68E+01	4.03E-05	1.52E+03	2.29E+03	4.88E+02
Mo-93	3.50E+03	1.29E+01	1.94E-05	1.42E+01	2.14E+01	4.56E+00
Tc-99	2.13E+05	1.05E+02	1.58E-04	1.78E+00	2.68E+00	5.72E-01
Nb-94	2.00E+04	1.33E+01	2.00E-05	2.53E+00	3.81E+00	8.14E-01
C-14	5.73E+03	6.85E-02	1.03E-07	3.05E-01	4.60E-01	9.80E-02
Total		3.69E+02	5.55E-04	1.00E+04	1.51E+04	3.22E+03

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 4 of 12)

Irradiated Row 8 and 9 Radial Reflectors (continued)

Handling Socket Volume = 1.384E+05 cm^3, Mass = 1.910E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.86E-03	7.12E-08	1.12E+01	8.06E+01	5.84E+01
Ni-59	7.60E+04	2.43E-01	1.76E-06	1.94E-02	1.40E-01	1.01E-01
Ni-63	1.00E+02	3.30E-02	2.38E-07	1.87E+00	1.35E+01	9.80E+00
Mo-93	3.50E+03	6.37E-03	4.60E-08	7.00E-03	5.06E-02	3.66E-02
Tc-99	2.13E+05	1.21E-01	8.71E-07	2.05E-03	1.48E-02	1.07E-02
Nb-94	2.00E+04	1.06E-02	7.62E-08	2.01E-03	1.45E-02	1.05E-02
C-14	5.73E+03	8.29E-05	5.99E-10	3.69E-04	2.67E-03	1.93E-03
Total		4.23E-01	3.06E-06	1.31E+01	9.43E+01	6.83E+01

Nozzle Volume = 5.925E+04 cm^3, Mass = 1.989E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.88E-02	9.92E-07	6.65E+01	1.12E+03	3.35E+02
Ni-59	7.60E+04	1.41E+00	2.38E-05	1.13E-01	1.90E+00	5.66E-01
Ni-63	1.00E+02	1.94E-01	3.28E-06	1.10E+01	1.86E+02	5.55E+01
Mo-93	3.50E+03	4.79E-02	8.09E-07	5.27E-02	8.90E-01	2.65E-01
Tc-99	2.13E+05	6.77E-01	1.14E-05	1.15E-02	1.94E-01	5.78E-02
Nb-94	2.00E+04	7.04E-02	1.19E-06	1.34E-02	2.26E-01	6.74E-02
C-14	5.73E+03	4.72E-04	7.97E-09	2.11E-03	3.55E-02	1.06E-02
Total		2.46E+00	4.15E-05	7.78E+01	1.31E+03	3.91E+02

Row 8 and 9 Reflectors Composite Volume = 3.150E+06 cm^3, Mass = 1.991E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.39E+02	7.58E-05	2.70E+05	8.57E+04	1.36E+04
Ni-59	7.60E+04	9.98E+03	3.17E-03	7.96E+02	2.53E+02	4.00E+01
Ni-63	1.00E+02	1.80E+03	5.71E-04	1.02E+05	3.24E+04	5.13E+03
Mo-93	3.50E+03	1.06E+02	3.38E-05	1.17E+02	3.72E+01	5.88E+00
Tc-99	2.13E+05	7.71E+02	2.45E-04	1.31E+01	4.15E+00	6.57E-01
Nb-94	2.00E+04	8.52E+01	2.70E-05	1.62E+01	5.14E+00	8.14E-01
C-14	5.73E+03	6.46E-01	2.05E-07	2.88E+00	9.14E-01	1.45E-01
Total		1.30E+04	4.12E-03	3.73E+05	1.18E+05	1.87E+04

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 5 of 12)

Irradiated Control and Safety Rods 31 total in vessel

Absorber Region Volume = 3.601E+05 cm^3, Mass = 1.198E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.63E-01	2.67E-06	1.09E+03	3.02E+03	9.09E+02
Ni-59	7.60E+04	1.12E+02	3.10E-04	8.90E+00	2.47E+01	7.43E+00
Ni-63	1.00E+02	8.20E+00	2.28E-05	4.66E+02	1.29E+03	3.89E+02
Mo-93	3.50E+03	1.44E+01	4.01E-05	1.59E+01	4.41E+01	1.33E+01
Tc-99	2.13E+05	5.59E+01	1.55E-04	9.48E-01	2.63E+00	7.91E-01
Nb-94	2.00E+04	6.86E+00	1.91E-05	1.31E+00	3.63E+00	1.09E+00
C-14	5.73E+03	1.12E-01	3.11E-07	4.99E-01	1.38E+00	4.16E-01
Total		1.98E+02	5.50E-04	1.58E+03	4.39E+03	1.32E+03

Control Rod Follower Volume = 7.607E+04 cm^3, Mass = 2.362E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.22E-01	4.24E-06	3.65E+02	4.80E+03	1.54E+03
Ni-59	7.60E+04	6.18E+01	8.12E-04	4.93E+00	6.48E+01	2.09E+01
Ni-63	1.00E+02	4.59E+00	6.04E-05	2.61E+02	3.43E+03	1.10E+03
Mo-93	3.50E+03	8.64E+00	1.14E-04	9.50E+00	1.25E+02	4.02E+01
Tc-99	2.13E+05	3.05E+01	4.00E-04	5.17E-01	6.79E+00	2.19E+00
Nb-94	2.00E+04	4.02E+00	5.28E-05	7.64E-01	1.00E+01	3.23E+00
C-14	5.73E+03	5.39E-02	7.09E-07	2.40E-01	3.16E+00	1.02E+00
Total		1.10E+02	1.44E-03	6.42E+02	8.44E+03	2.72E+03

Control Shield Volume = 2.806E+05 cm^3, Mass = 1.537E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.62E+00	2.00E-05	6.36E+03	2.27E+04	4.14E+03
Ni-59	7.60E+04	1.14E+02	4.06E-04	9.08E+00	3.24E+01	5.91E+00
Ni-63	1.00E+02	1.57E+01	5.58E-05	8.89E+02	3.17E+03	5.78E+02
Mo-93	3.50E+03	6.95E+00	2.48E-05	7.64E+00	2.72E+01	4.97E+00
Tc-99	2.13E+05	7.02E+01	2.50E-04	1.19E+00	4.24E+00	7.75E-01
Nb-94	2.00E+04	7.43E+00	2.65E-05	1.41E+00	5.04E+00	9.20E-01
C-14	5.73E+03	4.40E-02	1.57E-07	1.96E-01	6.98E-01	1.27E-01
Total		2.20E+02	7.83E-04	7.27E+03	2.59E+04	4.73E+03

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 6 of 12)

Irradiated Control and Safety Rods (continued)

Nozzle Volume = 1.136E+05 cm^3, Mass = 3.811E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.09E-02	6.24E-07	8.02E+01	7.06E+02	2.11E+02
Ni-59	7.60E+04	1.44E+00	1.27E-05	1.15E-01	1.01E+00	3.01E-01
Ni-63	1.00E+02	1.99E-01	1.76E-06	1.13E+01	9.97E+01	2.97E+01
Mo-93	3.50E+03	4.77E-02	4.20E-07	5.24E-02	4.62E-01	1.38E-01
Tc-99	2.13E+05	7.15E-01	6.30E-06	1.21E-02	1.07E-01	3.18E-02
Nb-94	2.00E+04	7.14E-02	6.29E-07	1.36E-02	1.20E-01	3.57E-02
C-14	5.73E+03	4.82E-04	4.25E-09	2.15E-03	1.89E-02	5.64E-03
Total		2.54E+00	2.24E-05	9.17E+01	8.08E+02	2.41E+02

Above Absorber Volume = 1.258E+05 cm^3, Mass = 3.729E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.77E-02	5.38E-07	7.66E+01	6.09E+02	2.05E+02
Ni-59	7.60E+04	1.44E+00	1.14E-05	1.15E-01	9.13E-01	3.08E-01
Ni-63	1.00E+02	1.89E-01	1.50E-06	1.07E+01	8.52E+01	2.87E+01
Mo-93	3.50E+03	1.18E-01	9.42E-07	1.30E-01	1.04E+00	3.49E-01
Tc-99	2.13E+05	1.11E+00	8.79E-06	1.88E-02	1.49E-01	5.03E-02
Nb-94	2.00E+04	1.19E-01	9.47E-07	2.27E-02	1.80E-01	6.08E-02
C-14	5.73E+03	4.37E-04	3.48E-09	1.95E-03	1.55E-02	5.23E-03
Total		3.04E+00	2.42E-05	8.76E+01	6.97E+02	2.35E+02

Driveline Volume = 1.523E+05 cm^3, Mass = 2.901E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.67E-02	2.41E-07	4.15E+01	2.73E+02	1.43E+02
Ni-59	7.60E+04	7.33E-01	4.82E-06	5.85E-02	3.84E-01	2.02E-01
Ni-63	1.00E+02	9.92E-02	6.51E-07	5.63E+00	3.70E+01	1.94E+01
Mo-93	3.50E+03	3.45E-02	2.26E-07	3.79E-02	2.49E-01	1.31E-01
Tc-99	2.13E+05	4.80E-01	3.15E-06	8.14E-03	5.34E-02	2.81E-02
Nb-94	2.00E+04	4.75E-02	3.12E-07	9.05E-03	5.94E-02	3.12E-02
C-14	5.73E+03	2.34E-04	1.54E-09	1.04E-03	6.85E-03	3.59E-03
Total		1.43E+00	9.40E-06	4.73E+01	3.11E+02	1.63E+02

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 7 of 12)

Irradiated Control and Safety Rods (continued)

Handling Socket Volume = 5.873E+04 cm^3, Mass = 8.105E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.10E-03	8.69E-08	5.77E+00	9.83E+01	7.12E+01
Ni-59	7.60E+04	9.63E-02	1.64E-06	7.69E-03	1.31E-01	9.49E-02
Ni-63	1.00E+02	1.30E-02	2.21E-07	7.37E-01	1.26E+01	9.10E+00
Mo-93	3.50E+03	2.71E-03	4.62E-08	2.98E-03	5.08E-02	3.68E-02
Tc-99	2.13E+05	5.12E-02	8.72E-07	8.68E-04	1.48E-02	1.07E-02
Nb-94	2.00E+04	4.57E-03	7.79E-08	8.70E-04	1.48E-02	1.07E-02
C-14	5.73E+03	3.22E-05	5.48E-10	1.43E-04	2.44E-03	1.77E-03
Total		1.73E-01	2.94E-06	6.52E+00	1.11E+02	8.05E+01

Control and Safety Rods Composite Volume = 1.167E+06 cm^3, Mass = 4.097E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.09E+00	6.07E-06	8.02E+03	6.87E+03	1.96E+03
Ni-59	7.60E+04	2.91E+02	2.49E-04	2.32E+01	1.99E+01	5.67E+00
Ni-63	1.00E+02	2.90E+01	2.48E-05	1.64E+03	1.41E+03	4.01E+02
Mo-93	3.50E+03	3.02E+01	2.59E-05	3.32E+01	2.85E+01	8.12E+00
Tc-99	2.13E+05	1.59E+02	1.36E-04	2.70E+00	2.31E+00	6.58E-01
Nb-94	2.00E+04	1.85E+01	1.59E-05	3.53E+00	3.02E+00	8.61E-01
C-14	5.73E+03	2.11E-01	1.81E-07	9.40E-01	8.06E-01	2.30E-01
Total		5.35E+02	4.58E-04	9.73E+03	8.33E+03	2.37E+03

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 8 of 12)

Irradiated In-Core Shim Assemblies 7 total in vessel

Central and Upper Region Volume = 1.851E+05 cm^3, Mass = 8.482E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.56E+00	8.41E-06	1.76E+03	9.51E+03	2.08E+03
Ni-59	7.60E+04	1.11E+02	6.02E-04	8.89E+00	4.80E+01	1.05E+01
Ni-63	1.00E+02	1.03E+01	5.57E-05	5.85E+02	3.16E+03	6.90E+02
Mo-93	3.50E+03	1.49E+01	8.05E-05	1.64E+01	8.85E+01	1.93E+01
Tc-99	2.13E+05	6.98E+01	3.77E-04	1.18E+00	6.40E+00	1.40E+00
Nb-94	2.00E+04	8.28E+00	4.47E-05	1.57E+00	8.51E+00	1.86E+00
C-14	5.73E+03	8.74E-02	4.72E-07	3.90E-01	2.11E+00	4.59E-01
Total		2.16E+02	1.17E-03	2.37E+03	1.28E+04	2.80E+03

Lower Shield Volume = 6.372E+04 cm^3, Mass = 4.767E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.09E+00	1.72E-05	1.24E+03	1.94E+04	2.59E+03
Ni-59	7.60E+04	2.99E+01	4.70E-04	2.39E+00	3.75E+01	5.01E+00
Ni-63	1.00E+02	3.92E+00	6.15E-05	2.23E+02	3.50E+03	4.67E+02
Mo-93	3.50E+03	1.72E+00	2.70E-05	1.89E+00	2.97E+01	3.97E+00
Tc-99	2.13E+05	1.81E+01	2.84E-04	3.07E-01	4.82E+00	6.44E-01
Nb-94	2.00E+04	1.86E+00	2.93E-05	3.55E-01	5.57E+00	7.44E-01
C-14	5.73E+03	1.12E-02	1.77E-07	5.01E-02	7.87E-01	1.05E-01
Total		5.66E+01	8.89E-04	1.46E+03	2.30E+04	3.07E+03

Nozzle Volume = 2.562E+04 cm^3, Mass = 8.595E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.16E-02	4.53E-07	1.31E+01	5.13E+02	1.53E+02
Ni-59	7.60E+04	3.17E-01	1.24E-05	2.53E-02	9.87E-01	2.94E-01
Ni-63	1.00E+02	4.27E-02	1.67E-06	2.43E+00	9.47E+01	2.82E+01
Mo-93	3.50E+03	1.05E-02	4.11E-07	1.16E-02	4.51E-01	1.34E-01
Tc-99	2.13E+05	1.51E-01	5.91E-06	2.57E-03	1.00E-01	2.99E-02
Nb-94	2.00E+04	1.54E-02	6.03E-07	2.94E-03	1.15E-01	3.42E-02
C-14	5.73E+03	1.06E-04	4.13E-09	4.71E-04	1.84E-02	5.48E-03
Total		5.48E-01	2.14E-05	1.56E+01	6.09E+02	1.82E+02

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 9 of 12)

Irradiated In-Core Shim Assemblies (continued)

Handling Socket Volume = 1.325E+04 cm^3, Mass = 1.828E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.37E-04	6.32E-08	9.47E-01	7.15E+01	5.18E+01
Ni-59	7.60E+04	2.08E-02	1.57E-06	1.66E-03	1.25E-01	9.08E-02
Ni-63	1.00E+02	2.75E-03	2.08E-07	1.56E-01	1.18E+01	8.54E+00
Mo-93	3.50E+03	5.80E-04	4.38E-08	6.38E-04	4.81E-02	3.49E-02
Tc-99	2.13E+05	1.13E-02	8.52E-07	1.91E-04	1.44E-02	1.05E-02
Nb-94	2.00E+04	9.87E-04	7.45E-08	1.88E-04	1.42E-02	1.03E-02
C-14	5.73E+03	6.95E-06	5.25E-10	3.10E-05	2.34E-03	1.69E-03
Total		3.72E-02	2.81E-06	1.11E+00	8.35E+01	6.05E+01

ICSAs Composite Volume = 2.877E+05 cm^3, Mass = 1.429E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.66E+00	9.25E-06	3.01E+03	1.05E+04	2.11E+03
Ni-59	7.60E+04	1.42E+02	4.92E-04	1.13E+01	3.93E+01	7.91E+00
Ni-63	1.00E+02	1.43E+01	4.96E-05	8.10E+02	2.82E+03	5.67E+02
Mo-93	3.50E+03	1.66E+01	5.78E-05	1.83E+01	6.35E+01	1.28E+01
Tc-99	2.13E+05	8.80E+01	3.06E-04	1.49E+00	5.19E+00	1.04E+00
Nb-94	2.00E+04	1.02E+01	3.53E-05	1.93E+00	6.72E+00	1.35E+00
C-14	5.73E+03	9.88E-02	3.43E-07	4.40E-01	1.53E+00	3.08E-01
Total		2.73E+02	9.51E-04	3.86E+03	1.34E+04	2.70E+03

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 10 of 12)

Irradiated Peripheral Shim Rods 3 total in vessel

Absorber Region Volume = 3.465E+04 cm^3, Mass = 1.154E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.07E-03	5.99E-08	2.35E+00	6.77E+01	2.03E+01
Ni-59	7.60E+04	1.02E+00	2.93E-05	8.10E-02	2.34E+00	7.02E-01
Ni-63	1.00E+02	7.25E-02	2.09E-06	4.12E+00	1.19E+02	3.57E+01
Mo-93	3.50E+03	1.53E-01	4.41E-06	1.68E-01	4.85E+00	1.46E+00
Tc-99	2.13E+05	5.61E-01	1.62E-05	9.52E-03	2.75E-01	8.25E-02
Nb-94	2.00E+04	6.19E-02	1.79E-06	1.18E-02	3.40E-01	1.02E-01
C-14	5.73E+03	1.54E-03	4.45E-08	6.88E-03	1.98E-01	5.96E-02
Total		1.87E+00	5.39E-05	6.74E+00	1.95E+02	5.84E+01

Below Absorber Volume = 6.249E+03 cm^3, Mass = 1.941E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.38E-03	5.41E-07	3.83E+00	6.12E+02	1.97E+02
Ni-59	7.60E+04	2.14E-01	3.42E-05	1.70E-02	2.73E+00	8.78E-01
Ni-63	1.00E+02	2.69E-02	4.31E-06	1.53E+00	2.45E+02	7.88E+01
Mo-93	3.50E+03	2.34E-02	3.75E-06	2.58E-02	4.12E+00	1.33E+00
Tc-99	2.13E+05	1.18E-01	1.89E-05	2.01E-03	3.21E-01	1.03E-01
Nb-94	2.00E+04	1.72E-02	2.75E-06	3.27E-03	5.24E-01	1.69E-01
C-14	5.73E+03	1.09E-04	1.74E-08	4.84E-04	7.74E-02	2.49E-02
Total		4.03E-01	6.44E-05	5.41E+00	8.65E+02	2.79E+02

Lower Shield Volume = 2.735E+04 cm^3, Mass = 1.498E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.33E-03	2.31E-07	7.16E+00	2.62E+02	4.78E+01
Ni-59	7.60E+04	3.82E-01	1.40E-05	3.05E-02	1.11E+00	2.03E-01
Ni-63	1.00E+02	4.67E-02	1.71E-06	2.65E+00	9.69E+01	1.77E+01
Mo-93	3.50E+03	2.48E-02	9.06E-07	2.72E-02	9.96E-01	1.82E-01
Tc-99	2.13E+05	1.97E-01	7.19E-06	3.34E-03	1.22E-01	2.23E-02
Nb-94	2.00E+04	2.60E-02	9.52E-07	4.95E-03	1.81E-01	3.31E-02
C-14	5.73E+03	1.29E-04	4.71E-09	5.74E-04	2.10E-02	3.83E-03
Total		6.83E-01	2.50E-05	9.87E+00	3.61E+02	6.59E+01

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 11 of 12)

Irradiated Peripheral Shim Rods (continued)

Nozzle Volume = 2.713E+04 cm^3, Mass = 9.108E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.71E-04	1.37E-08	4.19E-01	1.55E+01	4.61E+00
Ni-59	7.60E+04	1.84E-02	6.79E-07	1.47E-03	5.42E-02	1.61E-02
Ni-63	1.00E+02	2.44E-03	9.00E-08	1.39E-01	5.11E+00	1.52E+00
Mo-93	3.50E+03	6.23E-04	2.30E-08	6.85E-04	2.52E-02	7.52E-03
Tc-99	2.13E+05	8.86E-03	3.27E-07	1.50E-04	5.54E-03	1.65E-03
Nb-94	2.00E+04	9.19E-04	3.39E-08	1.75E-04	6.45E-03	1.92E-03
C-14	5.73E+03	6.14E-06	2.26E-10	2.73E-05	1.01E-03	3.00E-04
Total		3.16E-02	1.17E-06	5.61E-01	2.07E+01	6.16E+00

Above Absorber Volume = 3.756E+04 cm^3, Mass = 1.113E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.53E-03	1.74E-07	7.38E+00	1.97E+02	6.63E+01
Ni-59	7.60E+04	3.73E-01	9.94E-06	2.98E-02	7.93E-01	2.68E-01
Ni-63	1.00E+02	4.48E-02	1.19E-06	2.54E+00	6.77E+01	2.28E+01
Mo-93	3.50E+03	2.92E-02	7.77E-07	3.21E-02	8.54E-01	2.88E-01
Tc-99	2.13E+05	2.32E-01	6.17E-06	3.93E-03	1.05E-01	3.53E-02
Nb-94	2.00E+04	2.84E-02	7.57E-07	5.41E-03	1.44E-01	4.86E-02
C-14	5.73E+03	1.56E-04	4.15E-09	6.94E-04	1.85E-02	6.23E-03
Total		7.14E-01	1.90E-05	1.00E+01	2.66E+02	8.98E+01

Plenum Volume = 1.478E+04 cm^3, Mass = 2.815E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.05E-05	4.09E-09	6.84E-02	4.63E+00	2.43E+00
Ni-59	7.60E+04	3.37E-03	2.28E-07	2.69E-04	1.82E-02	9.55E-03
Ni-63	1.00E+02	4.40E-04	2.98E-08	2.50E-02	1.69E+00	8.87E-01
Mo-93	3.50E+03	1.82E-04	1.23E-08	2.00E-04	1.35E-02	7.10E-03
Tc-99	2.13E+05	1.68E-03	1.14E-07	2.85E-05	1.93E-03	1.01E-03
Nb-94	2.00E+04	2.14E-04	1.45E-08	4.08E-05	2.76E-03	1.45E-03
C-14	5.73E+03	1.04E-06	7.01E-11	4.62E-06	3.12E-04	1.64E-04
Total		5.95E-03	4.02E-07	9.39E-02	6.36E+00	3.34E+00

Table 6-4. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2003 (sheet 12 of 12)

Irradiated Peripheral Shim Rods (continued)

Handling Socket Volume = 5.704E+03 cm^3, Mass = 7.871E+00 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.11E-05	1.95E-09	1.26E-02	2.21E+00	1.60E+00
Ni-59	7.60E+04	5.14E-04	9.02E-08	4.11E-05	7.19E-03	5.21E-03
Ni-63	1.00E+02	6.70E-05	1.17E-08	3.80E-03	6.67E-01	4.83E-01
Mo-93	3.50E+03	1.45E-05	2.54E-09	1.59E-05	2.80E-03	2.03E-03
Tc-99	2.13E+05	2.66E-04	4.67E-08	4.52E-06	7.92E-04	5.74E-04
Nb-94	2.00E+04	2.37E-05	4.15E-09	4.51E-06	7.90E-04	5.73E-04
C-14	5.73E+03	1.73E-07	3.03E-11	7.69E-07	1.35E-04	9.77E-05
Total		8.97E-04	1.57E-07	1.65E-02	2.89E+00	2.09E+00

Peripheral Shim Rods Composite Volume = 1.534E+05 cm^3, Mass = 5.230E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.88E-02	1.22E-07	2.12E+01	1.38E+02	4.06E+01
Ni-59	7.60E+04	2.01E+00	1.31E-05	1.60E-01	1.04E+00	3.06E-01
Ni-63	1.00E+02	1.94E-01	1.26E-06	1.10E+01	7.17E+01	2.10E+01
Mo-93	3.50E+03	2.31E-01	1.51E-06	2.54E-01	1.65E+00	4.85E-01
Tc-99	2.13E+05	1.12E+00	7.29E-06	1.90E-02	1.24E-01	3.63E-02
Nb-94	2.00E+04	1.35E-01	8.78E-07	2.56E-02	1.67E-01	4.90E-02
C-14	5.73E+03	1.94E-03	1.27E-08	8.66E-03	5.65E-02	1.66E-02
Total		3.71E+00	2.41E-05	3.27E+01	2.13E+02	6.25E+01

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware – September 2008 (sheet 1 of 11)

Inner Radial Shield Volume = 4.514E+06 cm^3, Mass = 3.227E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.76E+01	1.50E-05	7.65E+04	1.70E+04	2.37E+03
Ni-59	7.60E+04	1.46E+03	3.24E-04	1.17E+02	2.59E+01	3.61E+00
Ni-63	1.00E+02	1.93E+02	4.27E-05	1.09E+04	2.42E+03	3.38E+02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.16E+01	9.21E-06	7.91E+00	1.75E+00	2.45E-01
C-14	5.73E+03	6.93E+00	1.54E-06	3.09E+01	6.84E+00	9.56E-01
Total		1.77E+03	3.93E-04	8.76E+04	1.94E+04	2.71E+03

Outer Radial Shield Volume = 1.221E+07 cm^3, Mass = 8.834E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.97E+01	2.43E-06	3.36E+04	2.75E+03	3.80E+02
Ni-59	7.60E+04	6.83E+02	5.59E-05	5.45E+01	4.46E+00	6.16E-01
Ni-63	1.00E+02	8.95E+01	7.33E-06	5.08E+03	4.16E+02	5.74E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.98E+01	1.62E-06	3.77E+00	3.09E-01	4.27E-02
C-14	5.73E+03	2.93E+00	2.40E-07	1.30E+01	1.07E+00	1.47E-01
Total		8.25E+02	6.76E-05	3.88E+04	3.18E+03	4.38E+02

Radial Shield Support Volume = 4.556E+05 cm^3, Mass = 2.192E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.76E-01	3.86E-07	1.99E+02	4.36E+02	9.06E+01
Ni-59	7.60E+04	3.99E+00	8.75E-06	3.18E-01	6.99E-01	1.45E-01
Ni-63	1.00E+02	5.31E-01	1.17E-06	3.02E+01	6.62E+01	1.37E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	9.12E-02	2.00E-07	1.74E-02	3.81E-02	7.91E-03
C-14	5.73E+03	1.80E-02	3.95E-08	8.02E-02	1.76E-01	3.65E-02
Total		4.80E+00	1.05E-05	2.29E+02	5.04E+02	1.05E+02

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 2 of 11)

Core Basket Volume = 2.453E+06 cm^3, Mass = 5.399E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.89E-01	1.59E-07	4.40E+02	1.79E+02	8.15E+01
Ni-59	7.60E+04	9.41E+00	3.84E-06	7.51E-01	3.06E-01	1.39E-01
Ni-63	1.00E+02	1.27E+00	5.19E-07	7.22E+01	2.95E+01	1.34E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.68E-01	6.85E-08	3.20E-02	1.30E-02	5.92E-03
C-14	5.73E+03	4.48E-02	1.83E-08	2.00E-01	8.14E-02	3.70E-02
Total		1.13E+01	4.60E-06	5.13E+02	2.09E+02	9.51E+01

Grid Plate Volume = 1.818E+06 cm^3, Mass = 1.041E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.12E+00	6.14E-07	1.26E+03	6.95E+02	1.21E+02
Ni-59	7.60E+04	2.33E+01	1.28E-05	1.86E+00	1.02E+00	1.78E-01
Ni-63	1.00E+02	3.12E+00	1.71E-06	1.77E+02	9.74E+01	1.70E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	5.92E-01	3.25E-07	1.13E-01	6.19E-02	1.08E-02
C-14	5.73E+03	1.05E-01	5.77E-08	4.67E-01	2.57E-01	4.48E-02
Total		2.82E+01	1.55E-05	1.44E+03	7.94E+02	1.38E+02

Core Support Structure Volume = 5.355E+06 cm^3, Mass = 4.156E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.14E-02	1.71E-08	1.03E+02	1.93E+01	2.49E+00
Ni-59	7.60E+04	3.76E+00	7.02E-07	3.00E-01	5.60E-02	7.21E-03
Ni-63	1.00E+02	5.09E-01	9.50E-08	2.89E+01	5.39E+00	6.95E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.27E-02	4.24E-09	4.32E-03	8.07E-04	1.04E-04
C-14	5.73E+03	1.90E-02	3.55E-09	8.48E-02	1.58E-02	2.04E-03
Total		4.40E+00	8.21E-07	1.33E+02	2.48E+01	3.19E+00

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 3 of 11)

Reactor Vessel Volume = 2.001E+07 cm^3, Mass = 1.601E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.61E-02	3.80E-09	8.61E+01	4.30E+00	5.38E-01
Ni-59	7.60E+04	3.03E+00	1.51E-07	2.42E-01	1.21E-02	1.51E-03
Ni-63	1.00E+02	4.10E-01	2.05E-08	2.33E+01	1.16E+00	1.45E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	1.03E-09	3.91E-03	1.95E-04	2.44E-05
C-14	5.73E+03	1.53E-02	7.67E-10	6.84E-02	3.42E-03	4.27E-04
Total		3.55E+00	1.78E-07	1.10E+02	5.48E+00	6.85E-01

Thermal Liner Volume = 4.226E+06 cm^3, Mass = 2.874E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.84E-02	1.38E-08	6.61E+01	1.56E+01	2.30E+00
Ni-59	7.60E+04	2.34E+00	5.53E-07	1.87E-01	4.42E-02	6.49E-03
Ni-63	1.00E+02	3.15E-01	7.44E-08	1.79E+01	4.23E+00	6.22E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.54E-02	3.65E-09	2.94E-03	6.95E-04	1.02E-04
C-14	5.73E+03	1.18E-02	2.80E-09	5.27E-02	1.25E-02	1.83E-03
Total		2.74E+00	6.48E-07	8.42E+01	1.99E+01	2.93E+00

Guard Vessel Volume = 1.669E+07 cm^3, Mass = 1.335E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.32E-02	7.90E-10	1.49E+01	8.94E-01	1.12E-01
Ni-59	7.60E+04	7.22E-01	4.32E-08	5.76E-02	3.45E-03	4.31E-04
Ni-63	1.00E+02	9.71E-02	5.82E-09	5.51E+00	3.30E-01	4.13E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.21E-03	2.52E-10	8.01E-04	4.80E-05	6.00E-06
C-14	5.73E+03	3.65E-03	2.19E-10	1.63E-02	9.75E-04	1.22E-04
Total		8.40E-01	5.03E-08	2.05E+01	1.23E+00	1.54E-01

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 4 of 11)

Core Barrel Volume = 2.570E+06 cm^3, Mass = 2.056E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.92E-01	3.47E-07	1.01E+03	3.93E+02	4.91E+01
Ni-59	7.60E+04	2.04E+01	7.96E-06	1.63E+00	6.35E-01	7.94E-02
Ni-63	1.00E+02	2.78E+00	1.08E-06	1.58E+02	6.15E+01	7.69E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.04E-01	1.57E-07	7.68E-02	2.99E-02	3.74E-03
C-14	5.73E+03	9.68E-02	3.76E-08	4.31E-01	1.68E-01	2.10E-02
Total		2.46E+01	9.58E-06	1.17E+03	4.55E+02	5.69E+01

In-Vessel Storage Modules (3) Volume = 8.566E+06 cm^3, Mass = 1.358E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.55E-01	1.80E-08	1.75E+02	2.04E+01	1.28E+01
Ni-59	7.60E+04	4.32E+00	5.04E-07	3.45E-01	4.02E-02	2.53E-02
Ni-63	1.00E+02	5.62E-01	6.56E-08	3.19E+01	3.73E+00	2.35E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.85E-04
Nb-94	2.00E+04	7.05E-02	8.22E-09	1.34E-02	1.57E-03	7.30E-03
C-14	5.73E+03	2.23E-02	2.60E-09	9.94E-02	1.16E-02	2.72E+01
Total		5.13E+00	5.98E-07	2.07E+02	2.42E+01	4.24E+01

Baffle Plate Volume = 1.237E+06 cm^3, Mass = 9.892E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.39E-02	1.12E-08	1.57E+01	1.27E+01	1.59E+00
Ni-59	7.60E+04	6.28E-01	5.08E-07	5.01E-02	4.05E-02	5.06E-03
Ni-63	1.00E+02	8.45E-02	6.84E-08	4.80E+00	3.88E+00	4.85E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.76E-03	3.04E-09	7.16E-04	5.79E-04	7.24E-05
C-14	5.73E+03	3.16E-03	2.56E-09	1.41E-02	1.14E-02	1.42E-03
Total		7.33E-01	5.93E-07	2.06E+01	1.66E+01	2.08E+00

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 5 of 11)

Instrument Tree Hold Downs Volume = 5.894E+05 cm^3, Mass = 7.031E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.57E-02	7.75E-08	5.17E+01	8.77E+01	7.34E+01
Ni-59	7.60E+04	9.81E-01	1.66E-06	7.83E-02	1.33E-01	1.11E-01
Ni-63	1.00E+02	1.30E-01	2.20E-07	7.37E+00	1.25E+01	1.05E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	3.48E-08	3.90E-03	6.61E-03	5.54E-03
C-14	5.73E+03	4.57E-03	7.76E-09	2.04E-02	3.46E-02	2.89E-02
Total		1.18E+00	2.01E-06	5.92E+01	1.00E+02	8.40E+01

Instrument Tree Lower Frames Volume = 1.040E+06 cm^3, Mass = 3.795E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.52E-02	8.19E-08	9.64E+01	9.27E+01	2.54E+01
Ni-59	7.60E+04	2.09E+00	2.00E-06	1.66E-01	1.60E-01	4.38E-02
Ni-63	1.00E+02	2.82E-01	2.71E-07	1.60E+01	1.54E+01	4.21E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.42E-02	3.29E-08	6.51E-03	6.26E-03	1.71E-03
C-14	5.73E+03	1.00E-02	9.65E-09	4.47E-02	4.30E-02	1.18E-02
Total		2.50E+00	2.40E-06	1.13E+02	1.08E+02	2.96E+01

Instrument Tree Guide Tubes Volume = 1.224E+07 cm^3, Mass = 4.614E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.84E-03	3.14E-10	4.35E+00	3.55E-01	9.40E-01
Ni-59	7.60E+04	1.52E-01	1.25E-08	1.22E-02	9.95E-04	2.63E-03
Ni-63	1.00E+02	2.04E-02	1.67E-09	1.16E+00	9.46E-02	2.50E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.33E-03	1.09E-10	2.54E-04	2.07E-05	5.49E-05
C-14	5.73E+03	7.58E-04	6.20E-11	3.38E-03	2.76E-04	7.31E-04
Total		1.79E-01	1.46E-08	5.52E+00	4.51E-01	1.19E+00

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 6 of 11)

Instrument Tree Columns Volume = 7.201E+06 cm^3, Mass = 7.215E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.67E-03	7.88E-10	6.42E+00	8.91E-01	8.89E-01
Ni-59	7.60E+04	1.97E-01	2.74E-08	1.57E-02	2.19E-03	2.18E-03
Ni-63	1.00E+02	2.64E-02	3.66E-09	1.50E+00	2.08E-01	2.07E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.04E-03	2.83E-10	3.88E-04	5.38E-05	5.37E-05
C-14	5.73E+03	9.73E-04	1.35E-10	4.33E-03	6.02E-04	6.01E-04
Total		2.32E-01	3.23E-08	7.93E+00	1.10E+00	1.10E+00

Instrument Tree Shield Plugs Volume = 2.864E+06 cm^3, Mass = 2.292E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.67E-07	1.28E-13	4.15E-04	1.45E-04	1.81E-05
Ni-59	7.60E+04	1.52E-05	2.76E-12	1.22E-06	2.20E-07	2.75E-08
Ni-63	1.00E+02	2.08E-06	3.89E-13	1.18E-04	2.21E-05	2.76E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.60E-07	2.90E-14	3.05E-08	5.51E-09	6.89E-10
C-14	5.73E+03	7.53E-08	1.36E-14	3.36E-07	6.08E-08	7.60E-09
Total		1.79E-05	3.32E-12	5.35E-04	1.67E-04	2.09E-05

Instrument Tree Shield Plates Volume = 1.967E+06 cm^3, Mass = 1.577E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.23E-07	1.91E-14	3.66E-04	2.16E-05	2.69E-06
Ni-59	7.60E+04	3.42E-05	2.02E-12	2.73E-06	1.61E-07	2.01E-08
Ni-63	1.00E+02	4.65E-06	2.74E-13	2.64E-04	1.56E-05	1.94E-06
Mo-93	3.50E+03	3.51E-09	2.07E-16	3.86E-09	2.28E-10	2.84E-11
Tc-99	2.13E+05	1.19E-07	7.03E-15	2.02E-09	1.19E-10	1.49E-11
Nb-94	2.00E+04	7.01E-08	4.13E-15	1.33E-08	7.87E-10	9.81E-11
C-14	5.73E+03	5.69E-08	3.36E-15	2.54E-07	1.50E-08	1.87E-09
Total		3.95E-05	2.33E-12	6.33E-04	3.73E-05	4.66E-06

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 7 of 11)

Instrument Trees Composite Volume = 2.590E+07 cm^3, Mass = 5.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.40E-01	5.42E-09	1.59E+02	6.13E+00	2.89E+00
Ni-59	7.60E+04	3.42E+00	1.32E-07	2.73E-01	1.05E-02	4.95E-03
Ni-63	1.00E+02	4.58E-01	1.77E-08	2.60E+01	1.00E+00	4.73E-01
Mo-93	3.50E+03	3.51E-09	1.36E-16	3.86E-09	1.49E-10	7.02E-11
Tc-99	2.13E+05	1.19E-07	4.60E-15	2.02E-09	7.81E-11	3.68E-11
Nb-94	2.00E+04	5.81E-02	2.24E-09	1.10E-02	4.27E-04	2.01E-04
C-14	5.73E+03	1.63E-02	6.31E-10	7.28E-02	2.81E-03	1.32E-03
Total		4.09E+00	1.58E-07	1.85E+02	7.15E+00	3.37E+00

In-Vessel Handling Machines (3) Volume = 2.482E+07 cm^3, Mass = 4.329E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.55E-03	1.43E-10	4.01E+00	1.62E-01	9.26E-02
Ni-59	7.60E+04	2.04E-01	8.24E-09	1.63E-02	6.58E-04	3.76E-04
Ni-63	1.00E+02	2.74E-02	1.10E-09	1.56E+00	6.27E-02	3.59E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	8.40E-04	3.39E-11	1.60E-04	6.44E-06	3.69E-06
C-14	5.73E+03	1.04E-03	4.17E-11	4.62E-03	1.86E-04	1.06E-04
Total		2.37E-01	9.56E-09	5.59E+00	2.25E-01	1.29E-01

IVHM Shield Plug Volume = 4.543E+06 cm^3, Mass = 3.636E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.82E-07	1.28E-13	6.59E-04	1.45E-04	1.81E-05
Ni-59	7.60E+04	2.42E-05	2.76E-12	1.93E-06	2.20E-07	2.75E-08
Ni-63	1.00E+02	3.30E-06	3.89E-13	1.87E-04	2.21E-05	2.76E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.54E-07	2.90E-14	4.83E-08	5.51E-09	6.89E-10
C-14	5.73E+03	1.19E-07	1.36E-14	5.33E-07	6.08E-08	7.60E-09
Total		2.84E-05	3.32E-12	8.48E-04	1.67E-04	2.09E-05

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 8 of 11)

IVHM Shield Plates Volume = 3.120E+06 cm^3, Mass = 2.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.13E-07	3.02E-14	5.80E-04	3.42E-05	4.27E-06
Ni-59	7.60E+04	5.43E-05	3.20E-12	4.33E-06	2.56E-07	3.19E-08
Ni-63	1.00E+02	7.38E-06	4.35E-13	4.19E-04	2.47E-05	3.08E-06
Mo-93	3.50E+03	5.57E-09	3.28E-16	6.12E-09	3.61E-10	4.50E-11
Tc-99	2.13E+05	1.89E-07	1.12E-14	3.21E-09	1.89E-10	2.36E-11
Nb-94	2.00E+04	1.11E-07	6.56E-15	2.12E-08	1.25E-09	1.56E-10
C-14	5.73E+03	9.03E-08	5.32E-15	4.02E-07	2.37E-08	2.96E-09
Total		6.26E-05	3.69E-12	1.00E-03	5.92E-05	7.38E-06

IVHM Composite Volume = 3.248E+07 cm^3, Mass = 1.047E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.55E-03	1.09E-10	4.015E+00	1.24E-01	3.84E-02
Ni-59	7.60E+04	2.05E-01	6.30E-09	1.633E-02	5.03E-04	1.56E-04
Ni-63	1.00E+02	2.74E-02	8.44E-10	1.557E+00	4.79E-02	1.49E-02
Mo-93	3.50E+03	5.57E-09	1.71E-16	6.123E-09	1.88E-10	5.85E-11
Tc-99	2.13E+05	1.89E-07	5.82E-15	3.209E-09	9.88E-11	3.07E-11
Nb-94	2.00E+04	8.41E-04	2.59E-11	1.599E-04	4.92E-06	1.53E-06
C-14	5.73E+03	1.04E-03	3.19E-11	4.618E-03	1.42E-04	4.41E-05
Total		2.37E-01	7.31E-09	5.59E+00	1.72E-01	5.34E-02

Closure Head Volume = 2.469E+07 cm^3, Mass = 1.360E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.11E-07	1.67E-14	4.65E-04	1.89E-05	3.42E-06
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	3.16E-11	1.28E-18	1.41E-10	5.70E-12	1.03E-12
Total		4.11E-07	1.67E-14	4.65E-04	1.89E-05	3.42E-06

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 9 of 11)

Suppressor Plate Volume = 1.874E+05 cm^3, Mass = 1.052E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.73E-07	9.25E-13	1.96E-04	1.05E-03	1.86E-04
Ni-59	7.60E+04	8.26E-05	4.41E-10	6.59E-06	3.52E-05	6.27E-06
Ni-63	1.00E+02	1.05E-05	5.63E-11	5.99E-04	3.20E-03	5.69E-04
Mo-93	3.50E+03	8.70E-08	4.64E-13	9.57E-08	5.10E-07	9.09E-08
Tc-99	2.13E+05	3.33E-06	1.78E-11	5.66E-08	3.02E-07	5.38E-08
Nb-94	2.00E+04	3.04E-07	1.62E-12	5.79E-08	3.09E-07	5.51E-08
C-14	5.73E+03	3.14E-08	1.68E-13	1.40E-07	7.48E-07	1.33E-07
Total		9.71E-05	5.18E-10	8.02E-04	4.28E-03	7.62E-04

Thermal Reflector Plates Volume = 3.811E+06 cm^3, Mass = 2.134E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.02E-06	1.05E-12	4.54E-03	1.19E-03	2.13E-04
Ni-59	7.60E+04	7.00E-04	1.84E-10	5.58E-05	1.47E-05	2.62E-06
Ni-63	1.00E+02	8.97E-05	2.35E-11	5.09E-03	1.34E-03	2.39E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.09E-06	5.50E-13	3.99E-07	1.05E-07	1.87E-08
C-14	5.73E+03	3.54E-06	9.29E-13	1.58E-05	4.14E-06	7.39E-07
Total		7.99E-04	2.10E-10	9.71E-03	2.55E-03	4.55E-04

Inconel Shield Plate Volume = 3.811E+06 cm^3, Mass = 2.254E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.33E-06	3.48E-13	1.50E-03	3.94E-04	6.67E-05
Ni-59	7.60E+04	8.06E-04	2.11E-10	6.43E-05	1.69E-05	2.85E-06
Ni-63	1.00E+02	1.05E-04	2.75E-11	5.95E-03	1.56E-03	2.64E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.13E-11	2.97E-18	5.04E-11	1.32E-11	2.24E-12
Total		9.12E-04	2.39E-10	7.52E-03	1.97E-03	3.34E-04

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware – September 2008 (sheet 10 of 11)

SS-410 Shield Plate Volume = 3.049E+06 cm^3, Mass = 1.665E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.18E-08	2.03E-14	6.99E-05	2.29E-05	4.20E-06
Ni-59	7.60E+04	2.54E-06	8.32E-13	2.03E-07	6.64E-08	1.22E-08
Ni-63	1.00E+02	3.35E-07	1.10E-13	1.90E-05	6.24E-06	1.14E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.54E-08	5.04E-15	6.85E-08	2.25E-08	4.12E-09
Total		2.95E-06	9.68E-13	8.92E-05	2.93E-05	5.36E-06

Low-Carbon Steel Shield Plate Volume = 6.097E+06 cm^3, Mass = 3.359E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.83E-08	6.29E-15	4.34E-05	7.11E-06	1.29E-06
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	4.02E-12	6.59E-19	1.79E-11	2.94E-12	5.33E-13
Total		3.83E-08	6.29E-15	4.34E-05	7.11E-06	1.29E-06

Head Assembly Composite (Head + Suppressor, Reflector and Shield Plates) Volume = 4.165E+07 cm^3, Mass = 2.312E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.03E-06	1.45E-13	6.82E-03	1.64E-04	2.95E-05
Ni-59	7.60E+04	1.59E-03	3.82E-11	1.27E-04	3.05E-06	5.49E-07
Ni-63	1.00E+02	2.05E-04	4.93E-12	1.17E-02	2.80E-04	5.05E-05
Mo-93	3.50E+03	8.70E-08	2.09E-15	9.57E-08	2.30E-09	4.14E-10
Tc-99	2.13E+05	3.33E-06	8.01E-14	5.66E-08	1.36E-09	2.45E-10
Nb-94	2.00E+04	2.40E-06	5.76E-14	4.57E-07	1.10E-08	1.98E-09
C-14	5.73E+03	3.59E-06	8.61E-14	1.60E-05	3.84E-07	6.91E-08
Total		1.81E-03	4.35E-11	1.86E-02	4.47E-04	8.06E-05

Table 6-5. Radionuclide Inventories in Activated Reactor Hardware - September 2008 (sheet 11 of 11)

Z Ring Volume = 1.989E+07 cm^3, Mass = 1.591E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.20E-06	3.62E-13	8.14E-03	4.09E-04	5.12E-05
Ni-59	7.60E+04	3.06E-04	1.54E-11	2.44E-05	1.23E-06	1.53E-07
Ni-63	1.00E+02	4.16E-05	2.09E-12	2.36E-03	1.19E-04	1.48E-05
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.82E-06	1.42E-13	5.37E-07	2.70E-08	3.37E-09
C-14	5.73E+03	1.52E-06	7.65E-14	6.78E-06	3.41E-07	4.26E-08
Total		3.59E-04	1.80E-11	1.05E-02	5.30E-04	6.62E-05

Boron Carbide Shield Volume = 1.932E+06 cm^3, Mass = 4.831E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	7.32E-09	3.79E-15	3.26E-08	1.69E-08	6.75E-09
Total		7.32E-09	3.79E-15	3.26E-08	1.69E-08	6.75E-09

Steel Roof Volume = 5.468E+06 cm^3, Mass = 4.303E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.92E-10	3.51E-17	2.17E-07	3.97E-08	5.05E-09
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	2.01E-07	3.68E-14	3.41E-09	6.24E-10	7.93E-11
Nb-94	2.00E+04	2.36E-08	4.33E-15	4.50E-09	8.23E-10	1.05E-10
C-14	5.73E+03	4.54E-14	8.31E-21	2.02E-13	3.70E-14	4.70E-15
Total		2.25E-07	4.11E-14	2.25E-07	4.12E-08	5.23E-09

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 1 of 12)

Irradiated Row 7 Radial Reflectors 81 total in vessel

Inconel Reflector Section Volume = 1.287E+06 cm^3, Mass = 9.011E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.25E+01	6.41E-05	9.33E+04	7.25E+04	1.04E+04
Ni-59	7.60E+04	6.85E+03	5.32E-03	5.47E+02	4.25E+02	6.07E+01
Ni-63	1.00E+02	1.29E+03	1.00E-03	7.31E+04	5.68E+04	8.11E+03
Mo-93	3.50E+03	6.82E+01	5.30E-05	7.49E+01	5.82E+01	8.32E+00
Tc-99	2.13E+05	3.61E+02	2.81E-04	6.13E+00	4.76E+00	6.80E-01
Nb-94	2.00E+04	3.64E+01	2.83E-05	6.93E+00	5.39E+00	7.70E-01
C-14	5.73E+03	4.14E-01	3.22E-07	1.85E+00	1.43E+00	2.05E-01
Total		8.69E+03	6.75E-03	1.67E+05	1.30E+05	1.85E+04

Upper Shield Section Volume = 1.253E+06 cm^3, Mass = 8.386E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.84E+00	2.27E-06	3.22E+03	2.57E+03	3.84E+02
Ni-59	7.60E+04	1.54E+02	1.23E-04	1.23E+01	9.80E+00	1.46E+00
Ni-63	1.00E+02	1.90E+01	1.52E-05	1.08E+03	8.62E+02	1.29E+02
Mo-93	3.50E+03	1.24E+01	9.89E-06	1.36E+01	1.09E+01	1.62E+00
Tc-99	2.13E+05	8.85E+01	7.06E-05	1.50E+00	1.20E+00	1.79E-01
Nb-94	2.00E+04	1.15E+01	9.17E-06	2.19E+00	1.75E+00	2.61E-01
C-14	5.73E+03	5.40E-02	4.31E-08	2.41E-01	1.92E-01	2.87E-02
Total		2.88E+02	2.30E-04	4.33E+03	3.45E+03	5.16E+02

Lower Shield/Orifice Volume = 7.371E+05 cm^3, Mass = 4.516E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.56E+00	6.19E-06	5.16E+03	7.01E+03	1.14E+03
Ni-59	7.60E+04	2.26E+02	3.07E-04	1.80E+01	2.45E+01	3.99E+00
Ni-63	1.00E+02	3.01E+01	4.08E-05	1.71E+03	2.32E+03	3.79E+02
Mo-93	3.50E+03	1.56E+01	2.12E-05	1.72E+01	2.33E+01	3.81E+00
Tc-99	2.13E+05	1.17E+02	1.58E-04	1.98E+00	2.69E+00	4.39E-01
Nb-94	2.00E+04	1.50E+01	2.03E-05	2.85E+00	3.87E+00	6.31E-01
C-14	5.73E+03	8.39E-02	1.14E-07	3.74E-01	5.07E-01	8.28E-02
Total		4.08E+02	5.54E-04	6.91E+03	9.38E+03	1.53E+03

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 2 of 12)

Irradiated Row 7 Radial Reflectors (continued)

Handling Socket Volume = 1.540E+05 cm^3, Mass = 2.125E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.10E-03	3.31E-08	5.77E+00	3.75E+01	2.72E+01
Ni-59	7.60E+04	2.20E-01	1.43E-06	1.76E-02	1.14E-01	8.27E-02
Ni-63	1.00E+02	2.87E-02	1.86E-07	1.63E+00	1.06E+01	7.67E+00
Mo-93	3.50E+03	6.22E-03	4.04E-08	6.83E-03	4.44E-02	3.22E-02
Tc-99	2.13E+05	1.14E-01	7.40E-07	1.93E-03	1.26E-02	9.09E-03
Nb-94	2.00E+04	1.01E-02	6.59E-08	1.93E-03	1.25E-02	9.08E-03
C-14	5.73E+03	7.40E-05	4.81E-10	3.30E-04	2.14E-03	1.55E-03
Total		3.84E-01	2.50E-06	7.43E+00	4.82E+01	3.50E+01

Nozzle Volume = 1.466E+05 cm^3, Mass = 4.922E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.40E-02	2.32E-07	3.84E+01	2.62E+02	7.81E+01
Ni-59	7.60E+04	1.57E+00	1.07E-05	1.25E-01	8.56E-01	2.55E-01
Ni-63	1.00E+02	2.09E-01	1.43E-06	1.19E+01	8.11E+01	2.42E+01
Mo-93	3.50E+03	5.34E-02	3.64E-07	5.87E-02	4.00E-01	1.19E-01
Tc-99	2.13E+05	7.55E-01	5.15E-06	1.28E-02	8.74E-02	2.60E-02
Nb-94	2.00E+04	7.85E-02	5.35E-07	1.49E-02	1.02E-01	3.04E-02
C-14	5.73E+03	5.26E-04	3.59E-09	2.35E-03	1.60E-02	4.77E-03
Total		2.70E+00	1.84E-05	5.05E+01	3.45E+02	1.03E+02

Row 7 Radial Reflectors Composite Volume = 3.578E+06 cm^3, Mass = 2.262E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.99E+01	2.51E-05	1.02E+05	2.84E+04	4.50E+03
Ni-59	7.60E+04	7.23E+03	2.02E-03	5.77E+02	1.61E+02	2.55E+01
Ni-63	1.00E+02	1.34E+03	3.74E-04	7.59E+04	2.12E+04	3.36E+03
Mo-93	3.50E+03	9.63E+01	2.69E-05	1.06E+02	2.96E+01	4.68E+00
Tc-99	2.13E+05	5.67E+02	1.59E-04	9.63E+00	2.69E+00	4.26E-01
Nb-94	2.00E+04	6.30E+01	1.76E-05	1.20E+01	3.35E+00	5.30E-01
C-14	5.73E+03	5.53E-01	1.54E-07	2.46E+00	6.88E-01	1.09E-01
Total		9.39E+03	2.62E-03	1.78E+05	4.98E+04	7.89E+03

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 3 of 12)

Irradiated Row 8 and 9 Radial Reflectors 73 total in vessel

Inconel Reflector Section Volume = 1.160E+06 cm^3, Mass = 8.439E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.17E+02	1.00E-04	1.32E+05	1.14E+05	1.56E+04
Ni-59	7.60E+04	9.59E+03	8.27E-03	7.65E+02	6.60E+02	9.07E+01
Ni-63	1.00E+02	1.69E+03	1.46E-03	9.59E+04	8.27E+04	1.14E+04
Mo-93	3.50E+03	7.95E+01	6.86E-05	8.74E+01	7.54E+01	1.04E+01
Tc-99	2.13E+05	5.66E+02	4.88E-04	9.60E+00	8.27E+00	1.14E+00
Nb-94	2.00E+04	5.90E+01	5.08E-05	1.12E+01	9.68E+00	1.33E+00
C-14	5.73E+03	5.19E-01	4.47E-07	2.31E+00	1.99E+00	2.74E-01
Total		1.21E+04	1.04E-02	2.29E+05	1.97E+05	2.71E+04

Upper Shield Section Volume = 1.128E+06 cm^3, Mass = 7.969E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.21E+00	2.84E-06	3.63E+03	3.22E+03	4.55E+02
Ni-59	7.60E+04	1.81E+02	1.61E-04	1.45E+01	1.28E+01	1.82E+00
Ni-63	1.00E+02	2.26E+01	2.00E-05	1.28E+03	1.13E+03	1.61E+02
Mo-93	3.50E+03	1.39E+01	1.23E-05	1.53E+01	1.35E+01	1.92E+00
Tc-99	2.13E+05	9.91E+01	8.78E-05	1.68E+00	1.49E+00	2.11E-01
Nb-94	2.00E+04	1.28E+01	1.13E-05	2.43E+00	2.16E+00	3.05E-01
C-14	5.73E+03	5.81E-02	5.15E-08	2.59E-01	2.30E-01	3.25E-02
Total		3.33E+02	2.95E-04	4.94E+03	4.38E+03	6.20E+02

Lower Shield/Orifice Volume = 6.643E+05 cm^3, Mass = 3.115E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.88E+00	5.84E-06	4.39E+03	6.60E+03	1.41E+03
Ni-59	7.60E+04	2.03E+02	3.06E-04	1.62E+01	2.44E+01	5.20E+00
Ni-63	1.00E+02	2.58E+01	3.89E-05	1.47E+03	2.21E+03	4.71E+02
Mo-93	3.50E+03	1.29E+01	1.94E-05	1.42E+01	2.13E+01	4.55E+00
Tc-99	2.13E+05	1.05E+02	1.58E-04	1.78E+00	2.68E+00	5.72E-01
Nb-94	2.00E+04	1.33E+01	2.00E-05	2.53E+00	3.81E+00	8.13E-01
C-14	5.73E+03	6.85E-02	1.03E-07	3.05E-01	4.59E-01	9.80E-02
Total		3.64E+02	5.48E-04	5.89E+03	8.87E+03	1.89E+03

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 4 of 12)

Irradiated Row 8 and 9 Radial Reflectors (continued)

Handling Socket Volume = 1.384E+05 cm^3, Mass = 1.910E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.11E-03	3.69E-08	5.78E+00	4.17E+01	3.02E+01
Ni-59	7.60E+04	2.43E-01	1.76E-06	1.94E-02	1.40E-01	1.01E-01
Ni-63	1.00E+02	3.19E-02	2.30E-07	1.81E+00	1.31E+01	9.47E+00
Mo-93	3.50E+03	6.36E-03	4.60E-08	6.99E-03	5.05E-02	3.66E-02
Tc-99	2.13E+05	1.21E-01	8.71E-07	2.04E-03	1.48E-02	1.07E-02
Nb-94	2.00E+04	1.05E-02	7.62E-08	2.01E-03	1.45E-02	1.05E-02
C-14	5.73E+03	8.28E-05	5.98E-10	3.69E-04	2.67E-03	1.93E-03
Total		4.18E-01	3.02E-06	7.62E+00	5.50E+01	3.99E+01

Nozzle Volume = 5.925E+04 cm^3, Mass = 1.989E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.05E-02	5.14E-07	3.45E+01	5.82E+02	1.73E+02
Ni-59	7.60E+04	1.41E+00	2.38E-05	1.13E-01	1.90E+00	5.66E-01
Ni-63	1.00E+02	1.88E-01	3.17E-06	1.07E+01	1.80E+02	5.36E+01
Mo-93	3.50E+03	4.79E-02	8.08E-07	5.26E-02	8.89E-01	2.65E-01
Tc-99	2.13E+05	6.77E-01	1.14E-05	1.15E-02	1.94E-01	5.78E-02
Nb-94	2.00E+04	7.04E-02	1.19E-06	1.34E-02	2.26E-01	6.74E-02
C-14	5.73E+03	4.72E-04	7.97E-09	2.10E-03	3.55E-02	1.06E-02
Total		2.42E+00	4.09E-05	4.53E+01	7.65E+02	2.28E+02

Row 8 and 9 Reflectors Composite Volume = 3.150E+06 cm^3, Mass = 1.991E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.24E+02	3.93E-05	1.40E+05	4.44E+04	7.03E+03
Ni-59	7.60E+04	9.98E+03	3.17E-03	7.96E+02	2.53E+02	4.00E+01
Ni-63	1.00E+02	1.74E+03	5.52E-04	9.87E+04	3.13E+04	4.96E+03
Mo-93	3.50E+03	1.06E+02	3.38E-05	1.17E+02	3.71E+01	5.87E+00
Tc-99	2.13E+05	7.71E+02	2.45E-04	1.31E+01	4.15E+00	6.57E-01
Nb-94	2.00E+04	8.51E+01	2.70E-05	1.62E+01	5.14E+00	8.13E-01
C-14	5.73E+03	6.46E-01	2.05E-07	2.88E+00	9.14E-01	1.45E-01
Total		1.28E+04	4.06E-03	2.40E+05	7.61E+04	1.20E+04

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 5 of 12)

Irradiated Control and Safety Rods 31 total in vessel

Absorber Region Volume = 3.601E+05 cm^3, Mass = 1.198E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.99E-01	1.39E-06	5.64E+02	1.57E+03	4.71E+02
Ni-59	7.60E+04	1.12E+02	3.10E-04	8.90E+00	2.47E+01	7.43E+00
Ni-63	1.00E+02	7.92E+00	2.20E-05	4.50E+02	1.25E+03	3.76E+02
Mo-93	3.50E+03	1.44E+01	4.01E-05	1.59E+01	4.41E+01	1.32E+01
Tc-99	2.13E+05	5.59E+01	1.55E-04	9.48E-01	2.63E+00	7.91E-01
Nb-94	2.00E+04	6.86E+00	1.90E-05	1.30E+00	3.62E+00	1.09E+00
C-14	5.73E+03	1.12E-01	3.11E-07	4.98E-01	1.38E+00	4.16E-01
Total		1.97E+02	5.48E-04	1.04E+03	2.89E+03	8.69E+02

Control Rod Follower Volume = 7.607E+04 cm^3, Mass = 2.362E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.67E-01	2.20E-06	1.89E+02	2.49E+03	8.00E+02
Ni-59	7.60E+04	6.18E+01	8.12E-04	4.93E+00	6.48E+01	2.09E+01
Ni-63	1.00E+02	4.44E+00	5.83E-05	2.52E+02	3.31E+03	1.07E+03
Mo-93	3.50E+03	8.64E+00	1.14E-04	9.49E+00	1.25E+02	4.02E+01
Tc-99	2.13E+05	3.05E+01	4.00E-04	5.17E-01	6.79E+00	2.19E+00
Nb-94	2.00E+04	4.02E+00	5.28E-05	7.64E-01	1.00E+01	3.23E+00
C-14	5.73E+03	5.39E-02	7.08E-07	2.40E-01	3.16E+00	1.02E+00
Total		1.10E+02	1.44E-03	4.57E+02	6.01E+03	1.93E+03

Control Shield Volume = 2.806E+05 cm^3, Mass = 1.537E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.91E+00	1.04E-05	3.30E+03	1.17E+04	2.14E+03
Ni-59	7.60E+04	1.14E+02	4.06E-04	9.08E+00	3.24E+01	5.91E+00
Ni-63	1.00E+02	1.51E+01	5.39E-05	8.59E+02	3.06E+03	5.59E+02
Mo-93	3.50E+03	6.94E+00	2.47E-05	7.63E+00	2.72E+01	4.97E+00
Tc-99	2.13E+05	7.02E+01	2.50E-04	1.19E+00	4.24E+00	7.75E-01
Nb-94	2.00E+04	7.43E+00	2.65E-05	1.41E+00	5.04E+00	9.19E-01
C-14	5.73E+03	4.39E-02	1.57E-07	1.96E-01	6.98E-01	1.27E-01
Total		2.16E+02	7.71E-04	4.17E+03	1.49E+04	2.72E+03

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 6 of 12)

Irradiated Control and Safety Rods (continued)

Nozzle Volume = 1.136E+05 cm^3, Mass = 3.811E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.67E-02	3.24E-07	4.16E+01	3.66E+02	1.09E+02
Ni-59	7.60E+04	1.44E+00	1.27E-05	1.15E-01	1.01E+00	3.01E-01
Ni-63	1.00E+02	1.93E-01	1.70E-06	1.09E+01	9.63E+01	2.87E+01
Mo-93	3.50E+03	4.77E-02	4.20E-07	5.24E-02	4.61E-01	1.37E-01
Tc-99	2.13E+05	7.15E-01	6.30E-06	1.21E-02	1.07E-01	3.18E-02
Nb-94	2.00E+04	7.14E-02	6.29E-07	1.36E-02	1.20E-01	3.57E-02
C-14	5.73E+03	4.82E-04	4.25E-09	2.15E-03	1.89E-02	5.64E-03
Total		2.50E+00	2.20E-05	5.27E+01	4.64E+02	1.38E+02

Above Absorber Volume = 1.258E+05 cm^3, Mass = 3.729E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.51E-02	2.79E-07	3.97E+01	3.16E+02	1.06E+02
Ni-59	7.60E+04	1.44E+00	1.14E-05	1.15E-01	9.13E-01	3.08E-01
Ni-63	1.00E+02	1.82E-01	1.45E-06	1.03E+01	8.23E+01	2.78E+01
Mo-93	3.50E+03	1.18E-01	9.41E-07	1.30E-01	1.03E+00	3.49E-01
Tc-99	2.13E+05	1.11E+00	8.79E-06	1.88E-02	1.49E-01	5.03E-02
Nb-94	2.00E+04	1.19E-01	9.47E-07	2.27E-02	1.80E-01	6.08E-02
C-14	5.73E+03	4.37E-04	3.48E-09	1.95E-03	1.55E-02	5.22E-03
Total		3.00E+00	2.38E-05	5.03E+01	4.00E+02	1.35E+02

Driveline Volume = 1.523E+05 cm^3, Mass = 2.901E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.90E-02	1.25E-07	2.15E+01	1.41E+02	7.42E+01
Ni-59	7.60E+04	7.33E-01	4.81E-06	5.85E-02	3.84E-01	2.02E-01
Ni-63	1.00E+02	9.58E-02	6.29E-07	5.44E+00	3.57E+01	1.88E+01
Mo-93	3.50E+03	3.44E-02	2.26E-07	3.78E-02	2.48E-01	1.30E-01
Tc-99	2.13E+05	4.80E-01	3.15E-06	8.14E-03	5.34E-02	2.81E-02
Nb-94	2.00E+04	4.75E-02	3.12E-07	9.05E-03	5.94E-02	3.12E-02
C-14	5.73E+03	2.34E-04	1.54E-09	1.04E-03	6.84E-03	3.59E-03
Total		1.41E+00	9.26E-06	2.71E+01	1.78E+02	9.33E+01

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 7 of 12)

Irradiated Control and Safety Rods (continued)

Handling Socket Volume = 5.873E+04 cm^3, Mass = 8.105E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.64E-03	4.50E-08	2.99E+00	5.09E+01	3.69E+01
Ni-59	7.60E+04	9.63E-02	1.64E-06	7.69E-03	1.31E-01	9.49E-02
Ni-63	1.00E+02	1.25E-02	2.14E-07	7.12E-01	1.21E+01	8.79E+00
Mo-93	3.50E+03	2.71E-03	4.61E-08	2.98E-03	5.07E-02	3.67E-02
Tc-99	2.13E+05	5.12E-02	8.71E-07	8.68E-04	1.48E-02	1.07E-02
Nb-94	2.00E+04	4.57E-03	7.78E-08	8.70E-04	1.48E-02	1.07E-02
C-14	5.73E+03	3.22E-05	5.48E-10	1.43E-04	2.44E-03	1.77E-03
Total		1.70E-01	2.89E-06	3.72E+00	6.33E+01	4.59E+01

Control and Safety Rods Composite Volume = 1.167E+06 cm^3, Mass = 4.097E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.67E+00	3.15E-06	4.16E+03	3.56E+03	1.01E+03
Ni-59	7.60E+04	2.91E+02	2.49E-04	2.32E+01	1.99E+01	5.67E+00
Ni-63	1.00E+02	2.80E+01	2.40E-05	1.59E+03	1.36E+03	3.88E+02
Mo-93	3.50E+03	3.02E+01	2.59E-05	3.32E+01	2.85E+01	8.11E+00
Tc-99	2.13E+05	1.59E+02	1.36E-04	2.70E+00	2.31E+00	6.58E-01
Nb-94	2.00E+04	1.85E+01	1.59E-05	3.53E+00	3.02E+00	8.61E-01
C-14	5.73E+03	2.11E-01	1.81E-07	9.40E-01	8.05E-01	2.29E-01
Total		5.30E+02	4.54E-04	5.81E+03	4.98E+03	1.42E+03

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 8 of 12)

Irradiated In-Core Shim Assemblies 7 total in vessel

Central and Upper Region Volume = 1.851E+05 cm^3, Mass = 8.482E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.06E-01	4.36E-06	9.12E+02	4.93E+03	1.08E+03
Ni-59	7.60E+04	1.11E+02	6.02E-04	8.89E+00	4.80E+01	1.05E+01
Ni-63	1.00E+02	9.95E+00	5.38E-05	5.65E+02	3.05E+03	6.66E+02
Mo-93	3.50E+03	1.49E+01	8.04E-05	1.64E+01	8.84E+01	1.93E+01
Tc-99	2.13E+05	6.98E+01	3.77E-04	1.18E+00	6.39E+00	1.40E+00
Nb-94	2.00E+04	8.27E+00	4.47E-05	1.57E+00	8.51E+00	1.86E+00
C-14	5.73E+03	8.74E-02	4.72E-07	3.89E-01	2.10E+00	4.59E-01
Total		2.15E+02	1.16E-03	1.51E+03	8.14E+03	1.78E+03

Lower Shield Volume = 6.372E+04 cm^3, Mass = 4.767E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.67E-01	8.89E-06	6.41E+02	1.01E+04	1.34E+03
Ni-59	7.60E+04	2.99E+01	4.70E-04	2.39E+00	3.75E+01	5.01E+00
Ni-63	1.00E+02	3.79E+00	5.94E-05	2.15E+02	3.38E+03	4.51E+02
Mo-93	3.50E+03	1.72E+00	2.70E-05	1.89E+00	2.97E+01	3.96E+00
Tc-99	2.13E+05	1.81E+01	2.84E-04	3.07E-01	4.82E+00	6.44E-01
Nb-94	2.00E+04	1.86E+00	2.93E-05	3.55E-01	5.57E+00	7.44E-01
C-14	5.73E+03	1.12E-02	1.76E-07	5.01E-02	7.86E-01	1.05E-01
Total		5.60E+01	8.78E-04	8.61E+02	1.35E+04	1.81E+03

Nozzle Volume = 2.562E+04 cm^3, Mass = 8.595E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.02E-03	2.35E-07	6.81E+00	2.66E+02	7.92E+01
Ni-59	7.60E+04	3.17E-01	1.24E-05	2.53E-02	9.87E-01	2.94E-01
Ni-63	1.00E+02	4.13E-02	1.61E-06	2.34E+00	9.15E+01	2.73E+01
Mo-93	3.50E+03	1.05E-02	4.10E-07	1.15E-02	4.51E-01	1.34E-01
Tc-99	2.13E+05	1.51E-01	5.91E-06	2.57E-03	1.00E-01	2.99E-02
Nb-94	2.00E+04	1.54E-02	6.02E-07	2.94E-03	1.15E-01	3.42E-02
C-14	5.73E+03	1.06E-04	4.12E-09	4.71E-04	1.84E-02	5.48E-03
Total		5.41E-01	2.11E-05	9.19E+00	3.59E+02	1.07E+02

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 9 of 12)

Irradiated In-Core Shim Assemblies (continued)

Handling Socket Volume = 1.325E+04 cm^3, Mass = 1.828E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.34E-04	3.28E-08	4.91E-01	3.70E+01	2.68E+01
Ni-59	7.60E+04	2.08E-02	1.57E-06	1.66E-03	1.25E-01	9.08E-02
Ni-63	1.00E+02	2.66E-03	2.00E-07	1.51E-01	1.14E+01	8.25E+00
Mo-93	3.50E+03	5.80E-04	4.38E-08	6.37E-04	4.81E-02	3.49E-02
Tc-99	2.13E+05	1.13E-02	8.52E-07	1.91E-04	1.44E-02	1.05E-02
Nb-94	2.00E+04	9.87E-04	7.45E-08	1.88E-04	1.42E-02	1.03E-02
C-14	5.73E+03	6.95E-06	5.24E-10	3.10E-05	2.34E-03	1.69E-03
Total		3.67E-02	2.77E-06	6.44E-01	4.86E+01	3.52E+01

ICSAs Composite Volume = 2.877E+05 cm^3, Mass = 1.429E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.38E+00	4.79E-06	1.56E+03	5.42E+03	1.09E+03
Ni-59	7.60E+04	1.42E+02	4.92E-04	1.13E+01	3.93E+01	7.91E+00
Ni-63	1.00E+02	1.38E+01	4.79E-05	7.83E+02	2.72E+03	5.48E+02
Mo-93	3.50E+03	1.66E+01	5.78E-05	1.83E+01	6.35E+01	1.28E+01
Tc-99	2.13E+05	8.80E+01	3.06E-04	1.49E+00	5.19E+00	1.04E+00
Nb-94	2.00E+04	1.02E+01	3.53E-05	1.93E+00	6.72E+00	1.35E+00
C-14	5.73E+03	9.87E-02	3.43E-07	4.40E-01	1.53E+00	3.08E-01
Total		2.72E+02	9.44E-04	2.38E+03	8.26E+03	1.66E+03

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 10 of 12)

Irradiated Peripheral Shim Rods 3 total in vessel

Absorber Region Volume = 3.465E+04 cm^3, Mass = 1.154E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.08E-03	3.10E-08	1.22E+00	3.51E+01	1.05E+01
Ni-59	7.60E+04	1.02E+00	2.93E-05	8.10E-02	2.34E+00	7.02E-01
Ni-63	1.00E+02	7.00E-02	2.02E-06	3.98E+00	1.15E+02	3.45E+01
Mo-93	3.50E+03	1.53E-01	4.40E-06	1.68E-01	4.84E+00	1.45E+00
Tc-99	2.13E+05	5.61E-01	1.62E-05	9.52E-03	2.75E-01	8.25E-02
Nb-94	2.00E+04	6.19E-02	1.79E-06	1.18E-02	3.40E-01	1.02E-01
C-14	5.73E+03	1.54E-03	4.45E-08	6.87E-03	1.98E-01	5.96E-02
Total		1.86E+00	5.38E-05	5.47E+00	1.58E+02	4.74E+01

Below Absorber Volume = 6.249E+03 cm^3, Mass = 1.941E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.75E-03	2.80E-07	1.98E+00	3.17E+02	1.02E+02
Ni-59	7.60E+04	2.14E-01	3.42E-05	1.70E-02	2.73E+00	8.78E-01
Ni-63	1.00E+02	2.60E-02	4.16E-06	1.48E+00	2.36E+02	7.61E+01
Mo-93	3.50E+03	2.34E-02	3.75E-06	2.57E-02	4.12E+00	1.33E+00
Tc-99	2.13E+05	1.18E-01	1.89E-05	2.01E-03	3.21E-01	1.03E-01
Nb-94	2.00E+04	1.72E-02	2.75E-06	3.27E-03	5.24E-01	1.69E-01
C-14	5.73E+03	1.08E-04	1.74E-08	4.83E-04	7.74E-02	2.49E-02
Total		4.00E-01	6.40E-05	3.51E+00	5.62E+02	1.81E+02

Lower Shield Volume = 2.735E+04 cm^3, Mass = 1.498E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.28E-03	1.20E-07	3.71E+00	1.36E+02	2.48E+01
Ni-59	7.60E+04	3.82E-01	1.40E-05	3.05E-02	1.11E+00	2.03E-01
Ni-63	1.00E+02	4.51E-02	1.65E-06	2.56E+00	9.36E+01	1.71E+01
Mo-93	3.50E+03	2.48E-02	9.05E-07	2.72E-02	9.95E-01	1.82E-01
Tc-99	2.13E+05	1.97E-01	7.19E-06	3.34E-03	1.22E-01	2.23E-02
Nb-94	2.00E+04	2.60E-02	9.51E-07	4.95E-03	1.81E-01	3.31E-02
C-14	5.73E+03	1.29E-04	4.71E-09	5.74E-04	2.10E-02	3.83E-03
Total		6.78E-01	2.48E-05	6.33E+00	2.32E+02	4.23E+01

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 11 of 12)

Irradiated Peripheral Shim Rods (continued)

Nozzle Volume = 2.713E+04 cm^3, Mass = 9.108E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.92E-04	7.08E-09	2.17E-01	8.01E+00	2.39E+00
Ni-59	7.60E+04	1.84E-02	6.79E-07	1.47E-03	5.42E-02	1.61E-02
Ni-63	1.00E+02	2.36E-03	8.69E-08	1.34E-01	4.93E+00	1.47E+00
Mo-93	3.50E+03	6.22E-04	2.29E-08	6.84E-04	2.52E-02	7.51E-03
Tc-99	2.13E+05	8.86E-03	3.27E-07	1.50E-04	5.54E-03	1.65E-03
Nb-94	2.00E+04	9.19E-04	3.39E-08	1.75E-04	6.44E-03	1.92E-03
C-14	5.73E+03	6.13E-06	2.26E-10	2.73E-05	1.01E-03	3.00E-04
Total		3.14E-02	1.16E-06	3.54E-01	1.30E+01	3.89E+00

Above Absorber Volume = 3.756E+04 cm^3, Mass = 1.113E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.38E-03	9.00E-08	3.83E+00	1.02E+02	3.44E+01
Ni-59	7.60E+04	3.73E-01	9.94E-06	2.98E-02	7.93E-01	2.68E-01
Ni-63	1.00E+02	4.32E-02	1.15E-06	2.46E+00	6.53E+01	2.21E+01
Mo-93	3.50E+03	2.92E-02	7.76E-07	3.20E-02	8.53E-01	2.88E-01
Tc-99	2.13E+05	2.32E-01	6.17E-06	3.93E-03	1.05E-01	3.53E-02
Nb-94	2.00E+04	2.84E-02	7.57E-07	5.41E-03	1.44E-01	4.86E-02
C-14	5.73E+03	1.56E-04	4.14E-09	6.94E-04	1.85E-02	6.23E-03
Total		7.09E-01	1.89E-05	6.35E+00	1.69E+02	5.71E+01

Plenum Volume = 1.478E+04 cm^3, Mass = 2.815E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.13E-05	2.12E-09	3.55E-02	2.40E+00	1.26E+00
Ni-59	7.60E+04	3.37E-03	2.28E-07	2.69E-04	1.82E-02	9.54E-03
Ni-63	1.00E+02	4.25E-04	2.87E-08	2.41E-02	1.63E+00	8.57E-01
Mo-93	3.50E+03	1.82E-04	1.23E-08	2.00E-04	1.35E-02	7.10E-03
Tc-99	2.13E+05	1.68E-03	1.14E-07	2.85E-05	1.93E-03	1.01E-03
Nb-94	2.00E+04	2.14E-04	1.45E-08	4.08E-05	2.76E-03	1.45E-03
C-14	5.73E+03	1.03E-06	7.00E-11	4.61E-06	3.12E-04	1.64E-04
Total		5.90E-03	3.99E-07	6.01E-02	4.07E+00	2.14E+00

Table 6-6. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2008 (sheet 12 of 12)

Irradiated Peripheral Shim Rods (continued)

Handling Socket Volume = 5.704E+03 cm^3, Mass = 7.871E+00 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.77E-06	1.01E-09	6.53E-03	1.15E+00	8.30E-01
Ni-59	7.60E+04	5.14E-04	9.01E-08	4.10E-05	7.19E-03	5.21E-03
Ni-63	1.00E+02	6.47E-05	1.13E-08	3.68E-03	6.44E-01	4.67E-01
Mo-93	3.50E+03	1.45E-05	2.54E-09	1.59E-05	2.79E-03	2.02E-03
Tc-99	2.13E+05	2.66E-04	4.67E-08	4.52E-06	7.92E-04	5.74E-04
Nb-94	2.00E+04	2.37E-05	4.15E-09	4.51E-06	7.90E-04	5.73E-04
C-14	5.73E+03	1.73E-07	3.02E-11	7.69E-07	1.35E-04	9.77E-05
Total		8.89E-04	1.56E-07	1.03E-02	1.80E+00	1.30E+00

Peripheral Shim Rods Composite Volume = 1.534E+05 cm^3, Mass = 5.230E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.72E-03	6.33E-08	1.10E+01	7.17E+01	2.10E+01
Ni-59	7.60E+04	2.01E+00	1.31E-05	1.60E-01	1.04E+00	3.06E-01
Ni-63	1.00E+02	1.87E-01	1.22E-06	1.06E+01	6.93E+01	2.03E+01
Mo-93	3.50E+03	2.31E-01	1.50E-06	2.54E-01	1.65E+00	4.85E-01
Tc-99	2.13E+05	1.12E+00	7.29E-06	1.90E-02	1.24E-01	3.63E-02
Nb-94	2.00E+04	1.35E-01	8.78E-07	2.56E-02	1.67E-01	4.90E-02
C-14	5.73E+03	1.94E-03	1.27E-08	8.66E-03	5.64E-02	1.66E-02
Total		3.69E+00	2.40E-05	2.21E+01	1.44E+02	4.22E+01

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware – September 2013 (sheet 1 of 11)

Inner Radial Shield Volume = 4.514E+06 cm^3, Mass = 3.227E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.50E+01	7.76E-06	3.97E+04	8.78E+03	1.23E+03
Ni-59	7.60E+04	1.46E+03	3.24E-04	1.17E+02	2.59E+01	3.61E+00
Ni-63	1.00E+02	1.86E+02	4.12E-05	1.06E+04	2.34E+03	3.27E+02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.16E+01	9.21E-06	7.91E+00	1.75E+00	2.45E-01
C-14	5.73E+03	6.93E+00	1.54E-06	3.09E+01	6.84E+00	9.55E-01
Total		1.73E+03	3.84E-04	5.04E+04	1.12E+04	1.56E+03

Outer Radial Shield Volume = 1.221E+07 cm^3, Mass = 8.834E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.54E+01	1.26E-06	1.74E+04	1.43E+03	1.97E+02
Ni-59	7.60E+04	6.83E+02	5.59E-05	5.45E+01	4.46E+00	6.16E-01
Ni-63	1.00E+02	8.64E+01	7.08E-06	4.91E+03	4.02E+02	5.55E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.98E+01	1.62E-06	3.77E+00	3.09E-01	4.26E-02
C-14	5.73E+03	2.93E+00	2.40E-07	1.30E+01	1.07E+00	1.47E-01
Total		8.07E+02	6.61E-05	2.24E+04	1.83E+03	2.53E+02

Radial Shield Support Volume = 4.556E+05 cm^3, Mass = 2.192E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.11E-02	2.00E-07	1.03E+02	2.26E+02	4.69E+01
Ni-59	7.60E+04	3.99E+00	8.75E-06	3.18E-01	6.99E-01	1.45E-01
Ni-63	1.00E+02	5.13E-01	1.13E-06	2.91E+01	6.40E+01	1.33E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	9.12E-02	2.00E-07	1.74E-02	3.81E-02	7.91E-03
C-14	5.73E+03	1.80E-02	3.95E-08	8.01E-02	1.76E-01	3.65E-02
Total		4.70E+00	1.03E-05	1.33E+02	2.91E+02	6.04E+01

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 2 of 11)

Core Basket Volume = 2.453E+06 cm^3, Mass = 5.399E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.02E-01	8.22E-08	2.28E+02	9.30E+01	4.22E+01
Ni-59	7.60E+04	9.41E+00	3.84E-06	7.51E-01	3.06E-01	1.39E-01
Ni-63	1.00E+02	1.23E+00	5.01E-07	6.98E+01	2.84E+01	1.29E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.68E-01	6.85E-08	3.20E-02	1.30E-02	5.92E-03
C-14	5.73E+03	4.48E-02	1.83E-08	2.00E-01	8.14E-02	3.70E-02
Total		1.11E+01	4.51E-06	2.99E+02	1.22E+02	5.54E+01

Grid Plate Volume = 1.818E+06 cm^3, Mass = 1.041E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.79E-01	3.18E-07	6.55E+02	3.60E+02	6.28E+01
Ni-59	7.60E+04	2.33E+01	1.28E-05	1.86E+00	1.02E+00	1.78E-01
Ni-63	1.00E+02	3.01E+00	1.66E-06	1.71E+02	9.40E+01	1.64E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	5.92E-01	3.25E-07	1.13E-01	6.19E-02	1.08E-02
C-14	5.73E+03	1.05E-01	5.76E-08	4.67E-01	2.57E-01	4.48E-02
Total		2.76E+01	1.52E-05	8.28E+02	4.55E+02	7.94E+01

Core Support Structure Volume = 5.355E+06 cm^3, Mass = 4.156E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.73E-02	8.84E-09	5.35E+01	1.00E+01	1.29E+00
Ni-59	7.60E+04	3.76E+00	7.02E-07	3.00E-01	5.60E-02	7.21E-03
Ni-63	1.00E+02	4.91E-01	9.17E-08	2.79E+01	5.21E+00	6.71E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.27E-02	4.24E-09	4.32E-03	8.06E-04	1.04E-04
C-14	5.73E+03	1.90E-02	3.55E-09	8.47E-02	1.58E-02	2.04E-03
Total		4.34E+00	8.10E-07	8.18E+01	1.53E+01	1.97E+00

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 3 of 11)

Reactor Vessel Volume = 2.001E+07 cm^3, Mass = 1.601E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.94E-02	1.97E-09	4.46E+01	2.23E+00	2.79E-01
Ni-59	7.60E+04	3.03E+00	1.51E-07	2.42E-01	1.21E-02	1.51E-03
Ni-63	1.00E+02	3.96E-01	1.98E-08	2.25E+01	1.12E+00	1.41E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	1.03E-09	3.91E-03	1.95E-04	2.44E-05
C-14	5.73E+03	1.53E-02	7.66E-10	6.83E-02	3.41E-03	4.27E-04
Total		3.50E+00	1.75E-07	6.74E+01	3.37E+00	4.21E-01

Thermal Liner Volume = 4.226E+06 cm^3, Mass = 2.874E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.03E-02	7.16E-09	3.42E+01	8.10E+00	1.19E+00
Ni-59	7.60E+04	2.34E+00	5.53E-07	1.87E-01	4.42E-02	6.49E-03
Ni-63	1.00E+02	3.04E-01	7.19E-08	1.73E+01	4.08E+00	6.01E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.54E-02	3.65E-09	2.94E-03	6.95E-04	1.02E-04
C-14	5.73E+03	1.18E-02	2.80E-09	5.27E-02	1.25E-02	1.83E-03
Total		2.70E+00	6.39E-07	5.17E+01	1.22E+01	1.80E+00

Guard Vessel Volume = 1.669E+07 cm^3, Mass = 1.335E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.83E-03	4.10E-10	7.73E+00	4.63E-01	5.79E-02
Ni-59	7.60E+04	7.22E-01	4.32E-08	5.76E-02	3.45E-03	4.31E-04
Ni-63	1.00E+02	9.38E-02	5.62E-09	5.32E+00	3.19E-01	3.99E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.21E-03	2.52E-10	8.01E-04	4.80E-05	6.00E-06
C-14	5.73E+03	3.65E-03	2.19E-10	1.63E-02	9.74E-04	1.22E-04
Total		8.30E-01	4.97E-08	1.31E+01	7.87E-01	9.83E-02

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 4 of 11)

Core Barrel Volume = 2.570E+06 cm^3, Mass = 2.056E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.62E-01	1.80E-07	5.23E+02	2.04E+02	2.54E+01
Ni-59	7.60E+04	2.04E+01	7.96E-06	1.63E+00	6.35E-01	7.94E-02
Ni-63	1.00E+02	2.69E+00	1.05E-06	1.53E+02	5.94E+01	7.43E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.04E-01	1.57E-07	7.68E-02	2.99E-02	3.74E-03
C-14	5.73E+03	9.67E-02	3.76E-08	4.31E-01	1.68E-01	2.10E-02
Total		2.41E+01	9.38E-06	6.78E+02	2.64E+02	3.30E+01

In-Vessel Storage Modules (3) Volume = 8.566E+06 cm^3, Mass = 1.358E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.01E-02	9.35E-09	9.06E+01	1.06E+01	6.65E+00
Ni-59	7.60E+04	4.32E+00	5.04E-07	3.44E-01	4.02E-02	2.53E-02
Ni-63	1.00E+02	5.43E-01	6.34E-08	3.09E+01	3.60E+00	2.27E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.85E-04
Nb-94	2.00E+04	7.04E-02	8.22E-09	1.34E-02	1.56E-03	7.30E-03
C-14	5.73E+03	2.23E-02	2.60E-09	9.94E-02	1.16E-02	2.72E+01
Total		5.03E+00	5.88E-07	1.22E+02	1.42E+01	3.62E+01

Baffle Plate Volume = 1.237E+06 cm^3, Mass = 9.892E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.20E-03	5.82E-09	8.15E+00	6.59E+00	8.24E-01
Ni-59	7.60E+04	6.28E-01	5.08E-07	5.01E-02	4.05E-02	5.06E-03
Ni-63	1.00E+02	8.16E-02	6.60E-08	4.64E+00	3.75E+00	4.69E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.76E-03	3.04E-09	7.16E-04	5.79E-04	7.24E-05
C-14	5.73E+03	3.16E-03	2.55E-09	1.41E-02	1.14E-02	1.42E-03
Total		7.24E-01	5.85E-07	1.28E+01	1.04E+01	1.30E+00

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 5 of 11)

Instrument Tree Hold Downs Volume = 5.894E+05 cm^3, Mass = 7.031E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.37E-02	4.02E-08	2.68E+01	4.54E+01	3.80E+01
Ni-59	7.60E+04	9.81E-01	1.66E-06	7.83E-02	1.33E-01	1.11E-01
Ni-63	1.00E+02	1.25E-01	2.13E-07	7.12E+00	1.21E+01	1.01E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	3.48E-08	3.90E-03	6.61E-03	5.53E-03
C-14	5.73E+03	4.57E-03	7.76E-09	2.04E-02	3.46E-02	2.89E-02
Total		1.15E+00	1.96E-06	3.40E+01	5.77E+01	4.83E+01

Instrument Tree Lower Frames Volume = 1.040E+06 cm^3, Mass = 3.795E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.41E-02	4.25E-08	4.99E+01	4.80E+01	1.31E+01
Ni-59	7.60E+04	2.09E+00	2.00E-06	1.66E-01	1.60E-01	4.38E-02
Ni-63	1.00E+02	2.72E-01	2.62E-07	1.55E+01	1.49E+01	4.07E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.42E-02	3.29E-08	6.51E-03	6.26E-03	1.71E-03
C-14	5.73E+03	1.00E-02	9.64E-09	4.47E-02	4.30E-02	1.18E-02
Total		2.45E+00	2.35E-06	6.56E+01	6.31E+01	1.73E+01

Instrument Tree Guide Tubes Volume = 1.224E+07 cm^3, Mass = 4.614E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.99E-03	1.63E-10	2.25E+00	1.84E-01	4.87E-01
Ni-59	7.60E+04	1.52E-01	1.25E-08	1.22E-02	9.95E-04	2.63E-03
Ni-63	1.00E+02	1.97E-02	1.61E-09	1.12E+00	9.14E-02	2.42E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.33E-03	1.09E-10	2.54E-04	2.07E-05	5.49E-05
C-14	5.73E+03	7.58E-04	6.19E-11	3.38E-03	2.76E-04	7.30E-04
Total		1.76E-01	1.44E-08	3.39E+00	2.77E-01	7.32E-01

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 6 of 11)

Instrument Tree Columns Volume = 7.201E+06 cm^3, Mass = 7.215E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.94E-03	4.08E-10	3.32E+00	4.62E-01	4.61E-01
Ni-59	7.60E+04	1.97E-01	2.74E-08	1.57E-02	2.19E-03	2.18E-03
Ni-63	1.00E+02	2.55E-02	3.54E-09	1.45E+00	2.01E-01	2.00E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.04E-03	2.83E-10	3.88E-04	5.38E-05	5.37E-05
C-14	5.73E+03	9.72E-04	1.35E-10	4.33E-03	6.01E-04	6.00E-04
Total		2.29E-01	3.18E-08	4.79E+00	6.66E-01	6.64E-01

Instrument Tree Shield Plugs Volume = 2.864E+06 cm^3, Mass = 2.292E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.90E-07	6.64E-14	2.15E-04	7.51E-05	9.39E-06
Ni-59	7.60E+04	1.52E-05	1.43E-12	1.22E-06	1.14E-07	1.43E-08
Ni-63	1.00E+02	2.01E-06	2.02E-13	1.14E-04	1.15E-05	1.43E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.60E-07	1.50E-14	3.05E-08	2.86E-09	3.57E-10
C-14	5.73E+03	7.53E-08	7.07E-15	3.36E-07	3.15E-08	3.94E-09
Total		1.77E-05	1.72E-12	3.31E-04	8.67E-05	1.08E-05

Instrument Tree Shield Plates Volume = 1.967E+06 cm^3, Mass = 1.577E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.67E-07	9.88E-15	1.89E-04	1.12E-05	1.39E-06
Ni-59	7.60E+04	3.42E-05	2.02E-12	2.73E-06	1.61E-07	2.01E-08
Ni-63	1.00E+02	4.49E-06	2.65E-13	2.55E-04	1.51E-05	1.88E-06
Mo-93	3.50E+03	3.51E-09	2.07E-16	3.86E-09	2.27E-10	2.84E-11
Tc-99	2.13E+05	1.19E-07	7.03E-15	2.02E-09	1.19E-10	1.49E-11
Nb-94	2.00E+04	7.01E-08	4.13E-15	1.33E-08	7.86E-10	9.81E-11
C-14	5.73E+03	5.69E-08	3.35E-15	2.54E-07	1.50E-08	1.86E-09
Total		3.92E-05	2.31E-12	4.48E-04	2.64E-05	3.29E-06

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 7 of 11)

Instrument Trees Composite Volume = 2.590E+07 cm^3, Mass = 5.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.28E-02	2.81E-09	8.23E+01	3.18E+00	1.50E+00
Ni-59	7.60E+04	3.42E+00	1.32E-07	2.73E-01	1.05E-02	4.95E-03
Ni-63	1.00E+02	4.43E-01	1.71E-08	2.51E+01	9.71E-01	4.57E-01
Mo-93	3.50E+03	3.51E-09	1.35E-16	3.86E-09	1.49E-10	7.01E-11
Tc-99	2.13E+05	1.19E-07	4.60E-15	2.02E-09	7.81E-11	3.68E-11
Nb-94	2.00E+04	5.81E-02	2.24E-09	1.10E-02	4.27E-04	2.01E-04
C-14	5.73E+03	1.63E-02	6.30E-10	7.28E-02	2.81E-03	1.32E-03
Total		4.01E+00	1.55E-07	1.08E+02	4.16E+00	1.96E+00

In-Vessel Handling Machines (3) Volume = 2.482E+07 cm^3, Mass = 4.329E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.84E-03	7.41E-11	2.08E+00	8.38E-02	4.80E-02
Ni-59	7.60E+04	2.04E-01	8.24E-09	1.63E-02	6.58E-04	3.76E-04
Ni-63	1.00E+02	2.65E-02	1.07E-09	1.50E+00	6.05E-02	3.47E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	8.40E-04	3.38E-11	1.60E-04	6.44E-06	3.69E-06
C-14	5.73E+03	1.04E-03	4.17E-11	4.61E-03	1.86E-04	1.06E-04
Total		2.35E-01	9.46E-09	3.60E+00	1.45E-01	8.31E-02

IVHM Shield Plug Volume = 4.543E+06 cm^3, Mass = 3.636E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.02E-07	6.64E-14	3.41E-04	7.51E-05	9.39E-06
Ni-59	7.60E+04	2.42E-05	1.43E-12	1.93E-06	1.14E-07	1.43E-08
Ni-63	1.00E+02	3.18E-06	2.02E-13	1.81E-04	1.15E-05	1.43E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.54E-07	1.50E-14	4.83E-08	2.86E-09	3.57E-10
C-14	5.73E+03	1.19E-07	7.07E-15	5.32E-07	3.15E-08	3.94E-09
Total		2.80E-05	1.72E-12	5.25E-04	8.67E-05	1.08E-05

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 8 of 11)

IVHM Shield Plates Volume = 3.120E+06 cm^3, Mass = 2.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.66E-07	1.57E-14	3.01E-04	1.77E-05	2.21E-06
Ni-59	7.60E+04	5.43E-05	3.20E-12	4.33E-06	2.56E-07	3.19E-08
Ni-63	1.00E+02	7.13E-06	4.20E-13	4.05E-04	2.39E-05	2.98E-06
Mo-93	3.50E+03	5.56E-09	3.28E-16	6.12E-09	3.61E-10	4.50E-11
Tc-99	2.13E+05	1.89E-07	1.12E-14	3.21E-09	1.89E-10	2.36E-11
Nb-94	2.00E+04	1.11E-07	6.56E-15	2.12E-08	1.25E-09	1.56E-10
C-14	5.73E+03	9.02E-08	5.32E-15	4.02E-07	2.37E-08	2.96E-09
Total		6.21E-05	3.66E-12	7.10E-04	4.19E-05	5.22E-06

IVHM Composite Volume = 3.248E+07 cm^3, Mass = 1.047E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.84E-03	5.66E-11	2.081E+00	6.41E-02	1.99E-02
Ni-59	7.60E+04	2.05E-01	6.30E-09	1.632E-02	5.03E-04	1.56E-04
Ni-63	1.00E+02	2.65E-02	8.15E-10	1.504E+00	4.63E-02	1.44E-02
Mo-93	3.50E+03	5.56E-09	1.71E-16	6.117E-09	1.88E-10	5.84E-11
Tc-99	2.13E+05	1.89E-07	5.82E-15	3.209E-09	9.88E-11	3.07E-11
Nb-94	2.00E+04	8.41E-04	2.59E-11	1.599E-04	4.92E-06	1.53E-06
C-14	5.73E+03	1.04E-03	3.19E-11	4.615E-03	1.42E-04	4.41E-05
Total		2.35E-01	7.23E-09	3.61E+00	1.11E-01	3.44E-02

Closure Head Volume = 2.469E+07 cm^3, Mass = 1.360E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.13E-07	8.63E-15	2.41E-04	9.77E-06	1.77E-06
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	3.16E-11	1.28E-18	1.41E-10	5.70E-12	1.03E-12
Total		2.13E-07	8.64E-15	2.41E-04	9.77E-06	1.77E-06

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 9 of 11)

Suppressor Plate Volume = 1.874E+05 cm^3, Mass = 1.052E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.99E-08	4.79E-13	1.02E-04	5.43E-04	9.66E-05
Ni-59	7.60E+04	8.26E-05	4.41E-10	6.59E-06	3.52E-05	6.27E-06
Ni-63	1.00E+02	1.02E-05	5.44E-11	5.79E-04	3.09E-03	5.50E-04
Mo-93	3.50E+03	8.70E-08	4.64E-13	9.56E-08	5.10E-07	9.08E-08
Tc-99	2.13E+05	3.33E-06	1.78E-11	5.66E-08	3.02E-07	5.38E-08
Nb-94	2.00E+04	3.04E-07	1.62E-12	5.79E-08	3.09E-07	5.51E-08
C-14	5.73E+03	3.14E-08	1.68E-13	1.40E-07	7.47E-07	1.33E-07
Total		9.67E-05	5.16E-10	6.87E-04	3.67E-03	6.53E-04

Thermal Reflector Plates Volume = 3.811E+06 cm^3, Mass = 2.134E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.08E-06	5.46E-13	2.35E-03	6.18E-04	1.10E-04
Ni-59	7.60E+04	7.00E-04	1.84E-10	5.58E-05	1.47E-05	2.62E-06
Ni-63	1.00E+02	8.66E-05	2.27E-11	4.92E-03	1.29E-03	2.30E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.09E-06	5.50E-13	3.99E-07	1.05E-07	1.87E-08
C-14	5.73E+03	3.54E-06	9.28E-13	1.58E-05	4.13E-06	7.38E-07
Total		7.94E-04	2.08E-10	7.35E-03	1.93E-03	3.44E-04

Inconel Shield Plate Volume = 3.811E+06 cm^3, Mass = 2.254E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.88E-07	1.81E-13	7.79E-04	2.04E-04	3.45E-05
Ni-59	7.60E+04	8.06E-04	2.11E-10	6.43E-05	1.69E-05	2.85E-06
Ni-63	1.00E+02	1.01E-04	2.66E-11	5.75E-03	1.51E-03	2.55E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.13E-11	2.96E-18	5.04E-11	1.32E-11	2.23E-12
Total		9.07E-04	2.38E-10	6.59E-03	1.73E-03	2.93E-04

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 10 of 11)

SS-410 Shield Plate Volume = 3.049E+06 cm^3, Mass = 1.665E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.20E-08	1.05E-14	3.62E-05	1.19E-05	2.18E-06
Ni-59	7.60E+04	2.54E-06	8.32E-13	2.02E-07	6.64E-08	1.22E-08
Ni-63	1.00E+02	3.24E-07	1.06E-13	1.84E-05	6.03E-06	1.10E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.54E-08	5.04E-15	6.85E-08	2.25E-08	4.11E-09
Total		2.91E-06	9.54E-13	5.49E-05	1.80E-05	3.30E-06

Low-Carbon Steel Shield Plate Volume = 6.097E+06 cm^3, Mass = 3.359E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.99E-08	3.26E-15	2.25E-05	3.69E-06	6.69E-07
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	4.02E-12	6.59E-19	1.79E-11	2.94E-12	5.33E-13
Total		1.99E-08	3.26E-15	2.25E-05	3.69E-06	6.69E-07

Head Assembly Composite (Head + Suppressor, Reflector and Shield Plates) Volume = 4.165E+07 cm^3, Mass = 2.312E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.12E-06	7.50E-14	3.53E-03	8.49E-05	1.53E-05
Ni-59	7.60E+04	1.59E-03	3.82E-11	1.27E-04	3.05E-06	5.49E-07
Ni-63	1.00E+02	1.98E-04	4.76E-12	1.13E-02	2.71E-04	4.87E-05
Mo-93	3.50E+03	8.70E-08	2.09E-15	9.56E-08	2.29E-09	4.13E-10
Tc-99	2.13E+05	3.33E-06	8.01E-14	5.66E-08	1.36E-09	2.45E-10
Nb-94	2.00E+04	2.40E-06	5.76E-14	4.57E-07	1.10E-08	1.97E-09
C-14	5.73E+03	3.58E-06	8.61E-14	1.60E-05	3.83E-07	6.91E-08
Total		1.80E-03	4.33E-11	1.49E-02	3.59E-04	6.46E-05

Table 6-7. Radionuclide Inventories in Activated Reactor Hardware - September 2013 (sheet 11 of 11)

Z Ring Volume = 1.989E+07 cm^3, Mass = 1.591E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration (µCi/g)
Co-60	5.27E+00	3.73E-06	1.87E-13	4.22E-03	2.12E-04	2.65E-05
Ni-59	7.60E+04	3.06E-04	1.54E-11	2.44E-05	1.23E-06	1.53E-07
Ni-63	1.00E+02	4.02E-05	2.02E-12	2.28E-03	1.15E-04	1.43E-05
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.82E-06	1.42E-13	5.37E-07	2.70E-08	3.37E-09
C-14	5.73E+03	1.52E-06	7.65E-14	6.78E-06	3.41E-07	4.26E-08
Total		3.54E-04	1.78E-11	6.53E-03	3.28E-04	4.10E-05

Boron Carbide Shield Volume = 1.932E+06 cm^3, Mass = 4.831E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration (µCi/g)
Co-60	5.27E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	7.31E-09	3.79E-15	3.26E-08	1.69E-08	6.75E-09
Total		7.31E-09	3.79E-15	3.26E-08	1.69E-08	6.75E-09

Steel Roof Volume = 5.468E+06 cm^3, Mass = 4.303E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration (µCi/g)
Co-60	5.27E+00	9.95E-11	1.82E-17	1.13E-07	2.06E-08	2.62E-09
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	2.01E-07	3.68E-14	3.41E-09	6.24E-10	7.93E-11
Nb-94	2.00E+04	2.36E-08	4.32E-15	4.50E-09	8.23E-10	1.05E-10
C-14	5.73E+03	4.54E-14	8.30E-21	2.02E-13	3.70E-14	4.70E-15
Total		2.25E-07	4.11E-14	1.20E-07	2.20E-08	2.80E-09

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 1 of 12)

Irradiated Row 7 Radial Reflectors 81 total in vessel

Inconel Reflector Section Volume = 1.287E+06 cm^3, Mass = 9.011E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.27E+01	3.32E-05	4.84E+04	3.76E+04	5.37E+03
Ni-59	7.60E+04	6.85E+03	5.32E-03	5.47E+02	4.25E+02	6.07E+01
Ni-63	1.00E+02	1.24E+03	9.66E-04	7.06E+04	5.49E+04	7.84E+03
Mo-93	3.50E+03	6.81E+01	5.29E-05	7.49E+01	5.82E+01	8.31E+00
Tc-99	2.13E+05	3.61E+02	2.81E-04	6.13E+00	4.76E+00	6.80E-01
Nb-94	2.00E+04	3.64E+01	2.83E-05	6.93E+00	5.38E+00	7.70E-01
C-14	5.73E+03	4.14E-01	3.22E-07	1.84E+00	1.43E+00	2.05E-01
Total		8.60E+03	6.69E-03	1.20E+05	9.29E+04	1.33E+04

Upper Shield Section Volume = 1.253E+06 cm^3, Mass = 8.386E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.47E+00	1.18E-06	1.67E+03	1.33E+03	1.99E+02
Ni-59	7.60E+04	1.54E+02	1.23E-04	1.23E+01	9.80E+00	1.46E+00
Ni-63	1.00E+02	1.84E+01	1.47E-05	1.04E+03	8.32E+02	1.24E+02
Mo-93	3.50E+03	1.24E+01	9.88E-06	1.36E+01	1.09E+01	1.62E+00
Tc-99	2.13E+05	8.85E+01	7.06E-05	1.50E+00	1.20E+00	1.79E-01
Nb-94	2.00E+04	1.15E+01	9.17E-06	2.19E+00	1.74E+00	2.61E-01
C-14	5.73E+03	5.40E-02	4.31E-08	2.41E-01	1.92E-01	2.87E-02
Total		2.86E+02	2.28E-04	2.74E+03	2.19E+03	3.27E+02

Lower Shield/Orifice Volume = 7.371E+05 cm^3, Mass = 4.516E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.37E+00	3.21E-06	2.68E+03	3.63E+03	5.93E+02
Ni-59	7.60E+04	2.26E+02	3.07E-04	1.80E+01	2.45E+01	3.99E+00
Ni-63	1.00E+02	2.91E+01	3.94E-05	1.65E+03	2.24E+03	3.66E+02
Mo-93	3.50E+03	1.56E+01	2.12E-05	1.72E+01	2.33E+01	3.80E+00
Tc-99	2.13E+05	1.17E+02	1.58E-04	1.98E+00	2.69E+00	4.39E-01
Nb-94	2.00E+04	1.50E+01	2.03E-05	2.85E+00	3.87E+00	6.31E-01
C-14	5.73E+03	8.38E-02	1.14E-07	3.74E-01	5.07E-01	8.27E-02
Total		4.05E+02	5.49E-04	4.37E+03	5.93E+03	9.68E+02

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 2 of 12)

Irradiated Row 7 Radial Reflectors (continued)

Handling Socket Volume = 1.540E+05 cm^3, Mass = 2.125E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.64E-03	1.72E-08	2.99E+00	1.94E+01	1.41E+01
Ni-59	7.60E+04	2.20E-01	1.43E-06	1.76E-02	1.14E-01	8.27E-02
Ni-63	1.00E+02	2.77E-02	1.80E-07	1.57E+00	1.02E+01	7.41E+00
Mo-93	3.50E+03	6.21E-03	4.03E-08	6.83E-03	4.43E-02	3.21E-02
Tc-99	2.13E+05	1.14E-01	7.40E-07	1.93E-03	1.26E-02	9.09E-03
Nb-94	2.00E+04	1.01E-02	6.58E-08	1.93E-03	1.25E-02	9.08E-03
C-14	5.73E+03	7.40E-05	4.80E-10	3.30E-04	2.14E-03	1.55E-03
Total		3.81E-01	2.47E-06	4.60E+00	2.98E+01	2.16E+01

Nozzle Volume = 1.466E+05 cm^3, Mass = 4.922E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.76E-02	1.20E-07	1.99E+01	1.36E+02	4.05E+01
Ni-59	7.60E+04	1.57E+00	1.07E-05	1.25E-01	8.56E-01	2.55E-01
Ni-63	1.00E+02	2.02E-01	1.38E-06	1.15E+01	7.83E+01	2.33E+01
Mo-93	3.50E+03	5.34E-02	3.64E-07	5.86E-02	4.00E-01	1.19E-01
Tc-99	2.13E+05	7.55E-01	5.15E-06	1.28E-02	8.74E-02	2.60E-02
Nb-94	2.00E+04	7.85E-02	5.35E-07	1.49E-02	1.02E-01	3.04E-02
C-14	5.73E+03	5.26E-04	3.59E-09	2.34E-03	1.60E-02	4.76E-03
Total		2.68E+00	1.83E-05	3.16E+01	2.16E+02	6.43E+01

Row 7 Radial Reflectors Composite Volume = 3.578E+06 cm^3, Mass = 2.262E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.66E+01	1.30E-05	5.27E+04	1.47E+04	2.33E+03
Ni-59	7.60E+04	7.23E+03	2.02E-03	5.77E+02	1.61E+02	2.55E+01
Ni-63	1.00E+02	1.29E+03	3.61E-04	7.33E+04	2.05E+04	3.24E+03
Mo-93	3.50E+03	9.62E+01	2.69E-05	1.06E+02	2.95E+01	4.67E+00
Tc-99	2.13E+05	5.67E+02	1.59E-04	9.63E+00	2.69E+00	4.26E-01
Nb-94	2.00E+04	6.30E+01	1.76E-05	1.20E+01	3.35E+00	5.30E-01
C-14	5.73E+03	5.52E-01	1.54E-07	2.46E+00	6.88E-01	1.09E-01
Total		9.30E+03	2.60E-03	1.27E+05	3.54E+04	5.60E+03

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 3 of 12)

Irradiated Row 8 and 9 Radial Reflectors 73 total in vessel

Inconel Reflector Section Volume = 1.160E+06 cm^3, Mass = 8.439E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.04E+01	5.21E-05	6.83E+04	5.89E+04	8.10E+03
Ni-59	7.60E+04	9.59E+03	8.27E-03	7.65E+02	6.60E+02	9.07E+01
Ni-63	1.00E+02	1.63E+03	1.41E-03	9.27E+04	7.99E+04	1.10E+04
Mo-93	3.50E+03	7.94E+01	6.85E-05	8.73E+01	7.53E+01	1.03E+01
Tc-99	2.13E+05	5.66E+02	4.88E-04	9.60E+00	8.27E+00	1.14E+00
Nb-94	2.00E+04	5.90E+01	5.08E-05	1.12E+01	9.67E+00	1.33E+00
C-14	5.73E+03	5.19E-01	4.47E-07	2.31E+00	1.99E+00	2.74E-01
Total		1.20E+04	1.03E-02	1.62E+05	1.40E+05	1.92E+04

Upper Shield Section Volume = 1.128E+06 cm^3, Mass = 7.969E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.66E+00	1.47E-06	1.88E+03	1.67E+03	2.36E+02
Ni-59	7.60E+04	1.81E+02	1.61E-04	1.45E+01	1.28E+01	1.82E+00
Ni-63	1.00E+02	2.18E+01	1.93E-05	1.24E+03	1.10E+03	1.55E+02
Mo-93	3.50E+03	1.39E+01	1.23E-05	1.53E+01	1.35E+01	1.92E+00
Tc-99	2.13E+05	9.91E+01	8.78E-05	1.68E+00	1.49E+00	2.11E-01
Nb-94	2.00E+04	1.28E+01	1.13E-05	2.43E+00	2.16E+00	3.05E-01
C-14	5.73E+03	5.81E-02	5.15E-08	2.59E-01	2.29E-01	3.25E-02
Total		3.31E+02	2.93E-04	3.15E+03	2.79E+03	3.96E+02

Lower Shield/Orifice Volume = 6.643E+05 cm^3, Mass = 3.115E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.01E+00	3.02E-06	2.27E+03	3.42E+03	7.30E+02
Ni-59	7.60E+04	2.03E+02	3.06E-04	1.62E+01	2.44E+01	5.20E+00
Ni-63	1.00E+02	2.50E+01	3.76E-05	1.42E+03	2.13E+03	4.55E+02
Mo-93	3.50E+03	1.29E+01	1.94E-05	1.42E+01	2.13E+01	4.55E+00
Tc-99	2.13E+05	1.05E+02	1.58E-04	1.78E+00	2.68E+00	5.72E-01
Nb-94	2.00E+04	1.33E+01	2.00E-05	2.53E+00	3.81E+00	8.13E-01
C-14	5.73E+03	6.84E-02	1.03E-07	3.05E-01	4.59E-01	9.79E-02
Total		3.61E+02	5.44E-04	3.73E+03	5.61E+03	1.20E+03

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 4 of 12)

Irradiated Row 8 and 9 Radial Reflectors (continued)

Handling Socket Volume = 1.384E+05 cm^3, Mass = 1.910E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.65E-03	1.91E-08	2.99E+00	2.16E+01	1.57E+01
Ni-59	7.60E+04	2.43E-01	1.76E-06	1.94E-02	1.40E-01	1.01E-01
Ni-63	1.00E+02	3.08E-02	2.22E-07	1.75E+00	1.26E+01	9.15E+00
Mo-93	3.50E+03	6.36E-03	4.59E-08	6.99E-03	5.05E-02	3.66E-02
Tc-99	2.13E+05	1.21E-01	8.71E-07	2.04E-03	1.48E-02	1.07E-02
Nb-94	2.00E+04	1.05E-02	7.62E-08	2.01E-03	1.45E-02	1.05E-02
C-14	5.73E+03	8.28E-05	5.98E-10	3.69E-04	2.66E-03	1.93E-03
Total		4.14E-01	2.99E-06	4.77E+00	3.45E+01	2.50E+01

Nozzle Volume = 5.925E+04 cm^3, Mass = 1.989E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.58E-02	2.66E-07	1.79E+01	3.01E+02	8.98E+01
Ni-59	7.60E+04	1.41E+00	2.38E-05	1.13E-01	1.90E+00	5.66E-01
Ni-63	1.00E+02	1.81E-01	3.06E-06	1.03E+01	1.74E+02	5.18E+01
Mo-93	3.50E+03	4.78E-02	8.08E-07	5.26E-02	8.88E-01	2.64E-01
Tc-99	2.13E+05	6.77E-01	1.14E-05	1.15E-02	1.94E-01	5.78E-02
Nb-94	2.00E+04	7.04E-02	1.19E-06	1.34E-02	2.26E-01	6.74E-02
C-14	5.73E+03	4.72E-04	7.96E-09	2.10E-03	3.55E-02	1.06E-02
Total		2.40E+00	4.06E-05	2.84E+01	4.78E+02	1.43E+02

Row 8 and 9 Reflectors Composite Volume = 3.150E+06 cm^3, Mass = 1.991E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.41E+01	2.03E-05	7.25E+04	2.30E+04	3.64E+03
Ni-59	7.60E+04	9.98E+03	3.17E-03	7.96E+02	2.53E+02	4.00E+01
Ni-63	1.00E+02	1.68E+03	5.33E-04	9.53E+04	3.03E+04	4.79E+03
Mo-93	3.50E+03	1.06E+02	3.37E-05	1.17E+02	3.71E+01	5.87E+00
Tc-99	2.13E+05	7.71E+02	2.45E-04	1.31E+01	4.15E+00	6.57E-01
Nb-94	2.00E+04	8.51E+01	2.70E-05	1.62E+01	5.14E+00	8.13E-01
C-14	5.73E+03	6.46E-01	2.05E-07	2.88E+00	9.13E-01	1.45E-01
Total		1.27E+04	4.03E-03	1.69E+05	5.36E+04	8.48E+03

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 5 of 12)

Irradiated Control and Safety Rods 31 total in vessel

Absorber Region Volume = 3.601E+05 cm^3, Mass = 1.198E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.58E-01	7.18E-07	2.92E+02	8.12E+02	2.44E+02
Ni-59	7.60E+04	1.12E+02	3.10E-04	8.90E+00	2.47E+01	7.43E+00
Ni-63	1.00E+02	7.65E+00	2.13E-05	4.35E+02	1.21E+03	3.63E+02
Mo-93	3.50E+03	1.44E+01	4.00E-05	1.58E+01	4.40E+01	1.32E+01
Tc-99	2.13E+05	5.59E+01	1.55E-04	9.48E-01	2.63E+00	7.91E-01
Nb-94	2.00E+04	6.86E+00	1.90E-05	1.30E+00	3.62E+00	1.09E+00
C-14	5.73E+03	1.12E-01	3.10E-07	4.98E-01	1.38E+00	4.16E-01
Total		1.97E+02	5.46E-04	7.55E+02	2.10E+03	6.30E+02

Control Rod Follower Volume = 7.607E+04 cm^3, Mass = 2.362E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.66E-02	1.14E-06	9.80E+01	1.29E+03	4.15E+02
Ni-59	7.60E+04	6.18E+01	8.12E-04	4.93E+00	6.48E+01	2.09E+01
Ni-63	1.00E+02	4.29E+00	5.64E-05	2.43E+02	3.20E+03	1.03E+03
Mo-93	3.50E+03	8.63E+00	1.13E-04	9.48E+00	1.25E+02	4.01E+01
Tc-99	2.13E+05	3.05E+01	4.00E-04	5.17E-01	6.79E+00	2.19E+00
Nb-94	2.00E+04	4.01E+00	5.28E-05	7.64E-01	1.00E+01	3.23E+00
C-14	5.73E+03	5.39E-02	7.08E-07	2.40E-01	3.15E+00	1.02E+00
Total		1.09E+02	1.44E-03	3.57E+02	4.70E+03	1.51E+03

Control Shield Volume = 2.806E+05 cm^3, Mass = 1.537E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.51E+00	5.38E-06	1.71E+03	6.09E+03	1.11E+03
Ni-59	7.60E+04	1.14E+02	4.06E-04	9.08E+00	3.24E+01	5.91E+00
Ni-63	1.00E+02	1.46E+01	5.21E-05	8.29E+02	2.96E+03	5.40E+02
Mo-93	3.50E+03	6.94E+00	2.47E-05	7.62E+00	2.72E+01	4.96E+00
Tc-99	2.13E+05	7.02E+01	2.50E-04	1.19E+00	4.24E+00	7.75E-01
Nb-94	2.00E+04	7.42E+00	2.65E-05	1.41E+00	5.03E+00	9.19E-01
C-14	5.73E+03	4.39E-02	1.57E-07	1.96E-01	6.97E-01	1.27E-01
Total		2.14E+02	7.64E-04	2.56E+03	9.11E+03	1.66E+03

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 6 of 12)

Irradiated Control and Safety Rods (continued)

Nozzle Volume = 1.136E+05 cm^3, Mass = 3.811E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.90E-02	1.68E-07	2.15E+01	1.90E+02	5.65E+01
Ni-59	7.60E+04	1.44E+00	1.27E-05	1.15E-01	1.01E+00	3.01E-01
Ni-63	1.00E+02	1.86E-01	1.64E-06	1.06E+01	9.30E+01	2.77E+01
Mo-93	3.50E+03	4.76E-02	4.19E-07	5.23E-02	4.61E-01	1.37E-01
Tc-99	2.13E+05	7.15E-01	6.30E-06	1.21E-02	1.07E-01	3.18E-02
Nb-94	2.00E+04	7.14E-02	6.29E-07	1.36E-02	1.20E-01	3.57E-02
C-14	5.73E+03	4.82E-04	4.24E-09	2.15E-03	1.89E-02	5.63E-03
Total		2.48E+00	2.18E-05	3.23E+01	2.84E+02	8.48E+01

Above Absorber Volume = 1.258E+05 cm^3, Mass = 3.729E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.82E-02	1.45E-07	2.06E+01	1.64E+02	5.52E+01
Ni-59	7.60E+04	1.44E+00	1.14E-05	1.15E-01	9.12E-01	3.08E-01
Ni-63	1.00E+02	1.76E-01	1.40E-06	1.00E+01	7.95E+01	2.68E+01
Mo-93	3.50E+03	1.18E-01	9.40E-07	1.30E-01	1.03E+00	3.49E-01
Tc-99	2.13E+05	1.11E+00	8.79E-06	1.88E-02	1.49E-01	5.03E-02
Nb-94	2.00E+04	1.19E-01	9.47E-07	2.27E-02	1.80E-01	6.08E-02
C-14	5.73E+03	4.37E-04	3.47E-09	1.95E-03	1.55E-02	5.22E-03
Total		2.98E+00	2.37E-05	3.09E+01	2.45E+02	8.28E+01

Driveline Volume = 1.523E+05 cm^3, Mass = 2.901E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Cl)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.86E-03	6.47E-08	1.12E+01	7.32E+01	3.84E+01
Ni-59	7.60E+04	7.33E-01	4.81E-06	5.85E-02	3.84E-01	2.02E-01
Ni-63	1.00E+02	9.26E-02	6.08E-07	5.26E+00	3.45E+01	1.81E+01
Mo-93	3.50E+03	3.44E-02	2.26E-07	3.78E-02	2.48E-01	1.30E-01
Tc-99	2.13E+05	4.80E-01	3.15E-06	8.14E-03	5.34E-02	2.81E-02
Nb-94	2.00E+04	4.75E-02	3.12E-07	9.04E-03	5.94E-02	3.12E-02
C-14	5.73E+03	2.34E-04	1.53E-09	1.04E-03	6.84E-03	3.59E-03
Total		1.40E+00	9.18E-06	1.65E+01	1.09E+02	5.70E+01

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 7 of 12)

Irradiated Control and Safety Rods (continued)

Handling Socket Volume = 5.873E+04 cm^3, Mass = 8.105E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.37E-03	2.33E-08	1.55E+00	2.64E+01	1.91E+01
Ni-59	7.60E+04	9.63E-02	1.64E-06	7.69E-03	1.31E-01	9.49E-02
Ni-63	1.00E+02	1.21E-02	2.06E-07	6.88E-01	1.17E+01	8.49E+00
Mo-93	3.50E+03	2.71E-03	4.61E-08	2.98E-03	5.07E-02	3.67E-02
Tc-99	2.13E+05	5.12E-02	8.71E-07	8.68E-04	1.48E-02	1.07E-02
Nb-94	2.00E+04	4.57E-03	7.78E-08	8.70E-04	1.48E-02	1.07E-02
C-14	5.73E+03	3.21E-05	5.47E-10	1.43E-04	2.44E-03	1.77E-03
Total		1.68E-01	2.87E-06	2.25E+00	3.83E+01	2.78E+01

Control and Safety Rods Composite Volume = 1.167E+06 cm^3, Mass = 4.097E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.90E+00	1.63E-06	2.15E+03	1.84E+03	5.26E+02
Ni-59	7.60E+04	2.91E+02	2.49E-04	2.32E+01	1.99E+01	5.67E+00
Ni-63	1.00E+02	2.70E+01	2.31E-05	1.53E+03	1.31E+03	3.74E+02
Mo-93	3.50E+03	3.02E+01	2.59E-05	3.32E+01	2.84E+01	8.10E+00
Tc-99	2.13E+05	1.59E+02	1.36E-04	2.70E+00	2.31E+00	6.58E-01
Nb-94	2.00E+04	1.85E+01	1.59E-05	3.53E+00	3.02E+00	8.61E-01
C-14	5.73E+03	2.11E-01	1.81E-07	9.39E-01	8.05E-01	2.29E-01
Total		5.28E+02	4.52E-04	3.75E+03	3.21E+03	9.16E+02

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 8 of 12)

Irradiated In-Core Shim Assemblies 7 total in vessel

Central and Upper Region Volume = 1.851E+05 cm^3, Mass = 8.482E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.18E-01	2.26E-06	4.73E+02	2.55E+03	5.57E+02
Ni-59	7.60E+04	1.11E+02	6.02E-04	8.89E+00	4.80E+01	1.05E+01
Ni-63	1.00E+02	9.61E+00	5.19E-05	5.46E+02	2.95E+03	6.44E+02
Mo-93	3.50E+03	1.49E+01	8.03E-05	1.63E+01	8.83E+01	1.93E+01
Tc-99	2.13E+05	6.98E+01	3.77E-04	1.18E+00	6.39E+00	1.40E+00
Nb-94	2.00E+04	8.27E+00	4.47E-05	1.57E+00	8.50E+00	1.86E+00
C-14	5.73E+03	8.73E-02	4.72E-07	3.89E-01	2.10E+00	4.59E-01
Total		2.14E+02	1.16E-03	1.05E+03	5.66E+03	1.23E+03

Lower Shield Volume = 6.372E+04 cm^3, Mass = 4.767E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.94E-01	4.61E-06	3.32E+02	5.21E+03	6.97E+02
Ni-59	7.60E+04	2.99E+01	4.70E-04	2.39E+00	3.75E+01	5.01E+00
Ni-63	1.00E+02	3.66E+00	5.74E-05	2.08E+02	3.26E+03	4.36E+02
Mo-93	3.50E+03	1.72E+00	2.70E-05	1.89E+00	2.96E+01	3.96E+00
Tc-99	2.13E+05	1.81E+01	2.84E-04	3.07E-01	4.82E+00	6.44E-01
Nb-94	2.00E+04	1.86E+00	2.93E-05	3.55E-01	5.57E+00	7.44E-01
C-14	5.73E+03	1.12E-02	1.76E-07	5.00E-02	7.86E-01	1.05E-01
Total		5.56E+01	8.72E-04	5.45E+02	8.55E+03	1.14E+03

Nozzle Volume = 2.562E+04 cm^3, Mass = 8.595E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.12E-03	1.22E-07	3.53E+00	1.38E+02	4.10E+01
Ni-59	7.60E+04	3.17E-01	1.24E-05	2.53E-02	9.87E-01	2.94E-01
Ni-63	1.00E+02	3.99E-02	1.56E-06	2.26E+00	8.84E+01	2.63E+01
Mo-93	3.50E+03	1.05E-02	4.10E-07	1.15E-02	4.50E-01	1.34E-01
Tc-99	2.13E+05	1.51E-01	5.91E-06	2.57E-03	1.00E-01	2.99E-02
Nb-94	2.00E+04	1.54E-02	6.02E-07	2.94E-03	1.15E-01	3.42E-02
C-14	5.73E+03	1.06E-04	4.12E-09	4.70E-04	1.84E-02	5.47E-03
Total		5.37E-01	2.10E-05	5.83E+00	2.28E+02	6.79E+01

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 9 of 12)

Irradiated In-Core Shim Assemblies (continued)

Handling Socket Volume = 1.325E+04 cm^3, Mass = 1.828E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.25E-04	1.70E-08	2.54E-01	1.92E+01	1.39E+01
Ni-59	7.60E+04	2.08E-02	1.57E-06	1.66E-03	1.25E-01	9.08E-02
Ni-63	1.00E+02	2.56E-03	1.94E-07	1.46E-01	1.10E+01	7.97E+00
Mo-93	3.50E+03	5.79E-04	4.37E-08	6.36E-04	4.80E-02	3.48E-02
Tc-99	2.13E+05	1.13E-02	8.52E-07	1.91E-04	1.44E-02	1.05E-02
Nb-94	2.00E+04	9.87E-04	7.45E-08	1.88E-04	1.42E-02	1.03E-02
C-14	5.73E+03	6.94E-06	5.24E-10	3.09E-05	2.34E-03	1.69E-03
Total		3.64E-02	2.75E-06	4.03E-01	3.04E+01	2.20E+01

ICSAs Composite Volume = 2.877E+05 cm^3, Mass = 1.429E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.15E-01	2.48E-06	8.09E+02	2.81E+03	5.66E+02
Ni-59	7.60E+04	1.42E+02	4.92E-04	1.13E+01	3.93E+01	7.91E+00
Ni-63	1.00E+02	1.33E+01	4.63E-05	7.56E+02	2.63E+03	5.29E+02
Mo-93	3.50E+03	1.66E+01	5.77E-05	1.82E+01	6.34E+01	1.28E+01
Tc-99	2.13E+05	8.80E+01	3.06E-04	1.49E+00	5.19E+00	1.04E+00
Nb-94	2.00E+04	1.02E+01	3.53E-05	1.93E+00	6.72E+00	1.35E+00
C-14	5.73E+03	9.87E-02	3.43E-07	4.40E-01	1.53E+00	3.08E-01
Total		2.71E+02	9.40E-04	1.60E+03	5.56E+03	1.12E+03

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 10 of 12)

Irradiated Peripheral Shim Rods 3 total in vessel

Absorber Region Volume = 3.465E+04 cm^3, Mass = 1.154E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.57E-04	1.61E-08	6.30E-01	1.82E+01	5.46E+00
Ni-59	7.60E+04	1.02E+00	2.93E-05	8.10E-02	2.34E+00	7.02E-01
Ni-63	1.00E+02	6.77E-02	1.95E-06	3.84E+00	1.11E+02	3.33E+01
Mo-93	3.50E+03	1.52E-01	4.40E-06	1.68E-01	4.84E+00	1.45E+00
Tc-99	2.13E+05	5.61E-01	1.62E-05	9.52E-03	2.75E-01	8.25E-02
Nb-94	2.00E+04	6.19E-02	1.79E-06	1.18E-02	3.40E-01	1.02E-01
C-14	5.73E+03	1.54E-03	4.45E-08	6.87E-03	1.98E-01	5.95E-02
Total		1.86E+00	5.37E-05	4.75E+00	1.37E+02	4.12E+01

Below Absorber Volume = 6.249E+03 cm^3, Mass = 1.941E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.08E-04	1.45E-07	1.03E+00	1.64E+02	5.30E+01
Ni-59	7.60E+04	2.14E-01	3.42E-05	1.70E-02	2.73E+00	8.78E-01
Ni-63	1.00E+02	2.51E-02	4.02E-06	1.43E+00	2.28E+02	7.35E+01
Mo-93	3.50E+03	2.34E-02	3.74E-06	2.57E-02	4.12E+00	1.33E+00
Tc-99	2.13E+05	1.18E-01	1.89E-05	2.01E-03	3.21E-01	1.03E-01
Nb-94	2.00E+04	1.72E-02	2.75E-06	3.27E-03	5.23E-01	1.69E-01
C-14	5.73E+03	1.08E-04	1.73E-08	4.83E-04	7.73E-02	2.49E-02
Total		3.99E-01	6.37E-05	2.50E+00	4.01E+02	1.29E+02

Lower Shield Volume = 2.735E+04 cm^3, Mass = 1.498E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.70E-03	6.21E-08	1.92E+00	7.03E+01	1.28E+01
Ni-59	7.60E+04	3.82E-01	1.40E-05	3.05E-02	1.11E+00	2.03E-01
Ni-63	1.00E+02	4.35E-02	1.59E-06	2.47E+00	9.04E+01	1.65E+01
Mo-93	3.50E+03	2.47E-02	9.04E-07	2.72E-02	9.94E-01	1.81E-01
Tc-99	2.13E+05	1.97E-01	7.19E-06	3.34E-03	1.22E-01	2.23E-02
Nb-94	2.00E+04	2.60E-02	9.51E-07	4.95E-03	1.81E-01	3.31E-02
C-14	5.73E+03	1.29E-04	4.71E-09	5.74E-04	2.10E-02	3.83E-03
Total		6.75E-01	2.47E-05	4.46E+00	1.63E+02	2.98E+01

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 11 of 12)

Irradiated Peripheral Shim Rods (continued)

Nozzle Volume = 2.713E+04 cm^3, Mass = 9.108E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.96E-05	3.67E-09	1.13E-01	4.15E+00	1.24E+00
Ni-59	7.60E+04	1.84E-02	6.79E-07	1.47E-03	5.42E-02	1.61E-02
Ni-63	1.00E+02	2.28E-03	8.39E-08	1.29E-01	4.77E+00	1.42E+00
Mo-93	3.50E+03	6.22E-04	2.29E-08	6.83E-04	2.52E-02	7.50E-03
Tc-99	2.13E+05	8.86E-03	3.27E-07	1.50E-04	5.54E-03	1.65E-03
Nb-94	2.00E+04	9.19E-04	3.39E-08	1.75E-04	6.44E-03	1.92E-03
C-14	5.73E+03	6.13E-06	2.26E-10	2.73E-05	1.01E-03	3.00E-04
Total		3.12E-02	1.15E-06	2.44E-01	9.01E+00	2.68E+00

Above Absorber Volume = 3.756E+04 cm^3, Mass = 1.113E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.75E-03	4.66E-08	1.98E+00	5.28E+01	1.78E+01
Ni-59	7.60E+04	3.73E-01	9.94E-06	2.98E-02	7.93E-01	2.68E-01
Ni-63	1.00E+02	4.18E-02	1.11E-06	2.37E+00	6.31E+01	2.13E+01
Mo-93	3.50E+03	2.91E-02	7.75E-07	3.20E-02	8.52E-01	2.88E-01
Tc-99	2.13E+05	2.32E-01	6.17E-06	3.93E-03	1.05E-01	3.53E-02
Nb-94	2.00E+04	2.84E-02	7.56E-07	5.41E-03	1.44E-01	4.86E-02
C-14	5.73E+03	1.56E-04	4.14E-09	6.93E-04	1.85E-02	6.22E-03
Total		7.06E-01	1.88E-05	4.43E+00	1.18E+02	3.98E+01

Plenum Volume = 1.478E+04 cm^3, Mass = 2.815E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.62E-05	1.10E-09	1.84E-02	1.24E+00	6.53E-01
Ni-59	7.60E+04	3.37E-03	2.28E-07	2.69E-04	1.82E-02	9.54E-03
Ni-63	1.00E+02	4.10E-04	2.78E-08	2.33E-02	1.58E+00	8.28E-01
Mo-93	3.50E+03	1.82E-04	1.23E-08	2.00E-04	1.35E-02	7.09E-03
Tc-99	2.13E+05	1.68E-03	1.14E-07	2.85E-05	1.93E-03	1.01E-03
Nb-94	2.00E+04	2.14E-04	1.45E-08	4.08E-05	2.76E-03	1.45E-03
C-14	5.73E+03	1.03E-06	7.00E-11	4.61E-06	3.12E-04	1.64E-04
Total		5.87E-03	3.97E-07	4.22E-02	2.86E+00	1.50E+00

Table 6-8. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2013 (sheet 12 of 12)

Irradiated Peripheral Shim Rods (continued)

Handling Socket Volume = 5.704E+03 cm^3, Mass = 7.871E+00 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.99E-06	5.24E-10	3.38E-03	5.93E-01	4.30E-01
Ni-59	7.60E+04	5.14E-04	9.01E-08	4.10E-05	7.19E-03	5.21E-03
Ni-63	1.00E+02	6.25E-05	1.10E-08	3.55E-03	6.22E-01	4.51E-01
Mo-93	3.50E+03	1.45E-05	2.54E-09	1.59E-05	2.79E-03	2.02E-03
Tc-99	2.13E+05	2.66E-04	4.67E-08	4.52E-06	7.92E-04	5.74E-04
Nb-94	2.00E+04	2.37E-05	4.15E-09	4.51E-06	7.90E-04	5.73E-04
C-14	5.73E+03	1.72E-07	3.02E-11	7.68E-07	1.35E-04	9.76E-05
Total		8.84E-04	1.55E-07	7.00E-03	1.23E+00	8.89E-01

Peripheral Shim Rods Composite Volume = 1.534E+05 cm^3, Mass = 5.230E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.04E-03	3.28E-08	5.70E+00	3.71E+01	1.09E+01
Ni-59	7.60E+04	2.01E+00	1.31E-05	1.60E-01	1.04E+00	3.06E-01
Ni-63	1.00E+02	1.81E-01	1.18E-06	1.03E+01	6.69E+01	1.96E+01
Mo-93	3.50E+03	2.30E-01	1.50E-06	2.53E-01	1.65E+00	4.84E-01
Tc-99	2.13E+05	1.12E+00	7.29E-06	1.90E-02	1.24E-01	3.63E-02
Nb-94	2.00E+04	1.35E-01	8.78E-07	2.56E-02	1.67E-01	4.90E-02
C-14	5.73E+03	1.94E-03	1.27E-08	8.65E-03	5.64E-02	1.65E-02
Total		3.68E+00	2.40E-05	1.64E+01	1.07E+02	3.14E+01

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware – September 2023 (sheet 1 of 11)

Inner Radial Shield Volume = 4.514E+06 cm^3, Mass = 3.227E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.41E+00	2.08E-06	1.07E+04	2.36E+03	3.29E+02
Ni-59	7.60E+04	1.46E+03	3.24E-04	1.17E+02	2.59E+01	3.61E+00
Ni-63	1.00E+02	1.74E+02	3.85E-05	9.86E+03	2.18E+03	3.05E+02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.16E+01	9.21E-06	7.91E+00	1.75E+00	2.45E-01
C-14	5.73E+03	6.92E+00	1.53E-06	3.08E+01	6.83E+00	9.54E-01
Total		1.70E+03	3.76E-04	2.07E+04	4.58E+03	6.39E+02

Outer Radial Shield Volume = 1.221E+07 cm^3, Mass = 8.834E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.13E+00	3.39E-07	4.68E+03	3.83E+02	5.28E+01
Ni-59	7.60E+04	6.83E+02	5.59E-05	5.45E+01	4.46E+00	6.16E-01
Ni-63	1.00E+02	8.06E+01	6.60E-06	4.58E+03	3.75E+02	5.17E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.98E+01	1.62E-06	3.77E+00	3.09E-01	4.26E-02
C-14	5.73E+03	2.92E+00	2.39E-07	1.30E+01	1.07E+00	1.47E-01
Total		7.90E+02	6.47E-05	9.33E+03	7.64E+02	1.05E+02

Radial Shield Support Volume = 4.556E+05 cm^3, Mass = 2.192E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.45E-02	5.37E-08	2.77E+01	6.07E+01	1.26E+01
Ni-59	7.60E+04	3.99E+00	8.75E-06	3.18E-01	6.99E-01	1.45E-01
Ni-63	1.00E+02	4.79E-01	1.05E-06	2.72E+01	5.97E+01	1.24E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	9.12E-02	2.00E-07	1.73E-02	3.81E-02	7.90E-03
C-14	5.73E+03	1.80E-02	3.94E-08	8.00E-02	1.76E-01	3.64E-02
Total		4.60E+00	1.01E-05	5.53E+01	1.21E+02	2.52E+01

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 2 of 11)

Core Basket Volume = 2.453E+06 cm^3, Mass = 5.399E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.41E-02	2.21E-08	6.13E+01	2.50E+01	1.13E+01
Ni-59	7.60E+04	9.41E+00	3.84E-06	7.51E-01	3.06E-01	1.39E-01
Ni-63	1.00E+02	1.15E+00	4.67E-07	6.51E+01	2.65E+01	1.21E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.68E-01	6.85E-08	3.20E-02	1.30E-02	5.92E-03
C-14	5.73E+03	4.47E-02	1.82E-08	1.99E-01	8.13E-02	3.69E-02
Total		1.08E+01	4.41E-06	1.27E+02	5.19E+01	2.36E+01

Grid Plate Volume = 1.818E+06 cm^3, Mass = 1.041E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.55E-01	8.55E-08	1.76E+02	9.67E+01	1.69E+01
Ni-59	7.60E+04	2.33E+01	1.28E-05	1.86E+00	1.02E+00	1.78E-01
Ni-63	1.00E+02	2.81E+00	1.55E-06	1.60E+02	8.78E+01	1.53E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	5.91E-01	3.25E-07	1.13E-01	6.19E-02	1.08E-02
C-14	5.73E+03	1.05E-01	5.76E-08	4.66E-01	2.56E-01	4.47E-02
Total		2.70E+01	1.48E-05	3.38E+02	1.86E+02	3.24E+01

Core Support Structure Volume = 5.355E+06 cm^3, Mass = 4.156E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.27E-02	2.37E-09	1.44E+01	2.69E+00	3.46E-01
Ni-59	7.60E+04	3.76E+00	7.01E-07	3.00E-01	5.60E-02	7.21E-03
Ni-63	1.00E+02	4.58E-01	8.56E-08	2.60E+01	4.86E+00	6.26E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.27E-02	4.24E-09	4.32E-03	8.06E-04	1.04E-04
C-14	5.73E+03	1.90E-02	3.55E-09	8.46E-02	1.58E-02	2.04E-03
Total		4.27E+00	7.97E-07	4.08E+01	7.62E+00	9.82E-01

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 3 of 11)

Reactor Vessel Volume = 2.001E+07 cm^3, Mass = 1.601E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.06E-02	5.29E-10	1.20E+01	5.99E-01	7.49E-02
Ni-59	7.60E+04	3.03E+00	1.51E-07	2.42E-01	1.21E-02	1.51E-03
Ni-63	1.00E+02	3.69E-01	1.85E-08	2.10E+01	1.05E+00	1.31E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	1.03E-09	3.91E-03	1.95E-04	2.44E-05
C-14	5.73E+03	1.53E-02	7.65E-10	6.83E-02	3.41E-03	4.26E-04
Total		3.45E+00	1.72E-07	3.33E+01	1.66E+00	2.08E-01

Thermal Liner Volume = 4.226E+06 cm^3, Mass = 2.874E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.13E-03	1.92E-09	9.19E+00	2.18E+00	3.20E-01
Ni-59	7.60E+04	2.34E+00	5.53E-07	1.87E-01	4.42E-02	6.49E-03
Ni-63	1.00E+02	2.84E-01	6.71E-08	1.61E+01	3.81E+00	5.60E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.54E-02	3.65E-09	2.93E-03	6.95E-04	1.02E-04
C-14	5.73E+03	1.18E-02	2.80E-09	5.26E-02	1.25E-02	1.83E-03
Total		2.66E+00	6.29E-07	2.55E+01	6.04E+00	8.89E-01

Guard Vessel Volume = 1.669E+07 cm^3, Mass = 1.335E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.83E-03	1.10E-10	2.08E+00	1.24E-01	1.55E-02
Ni-59	7.60E+04	7.21E-01	4.32E-08	5.76E-02	3.45E-03	4.31E-04
Ni-63	1.00E+02	8.75E-02	5.24E-09	4.97E+00	2.98E-01	3.72E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.21E-03	2.52E-10	8.00E-04	4.80E-05	5.99E-06
C-14	5.73E+03	3.64E-03	2.18E-10	1.62E-02	9.73E-04	1.22E-04
Total		8.19E-01	4.91E-08	7.12E+00	4.27E-01	5.33E-02

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 4 of 11)

Core Barrel Volume = 2.570E+06 cm^3, Mass = 2.056E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.24E-01	4.83E-08	1.40E+02	5.47E+01	6.83E+00
Ni-59	7.60E+04	2.04E+01	7.96E-06	1.63E+00	6.35E-01	7.94E-02
Ni-63	1.00E+02	2.51E+00	9.76E-07	1.43E+02	5.54E+01	6.93E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.04E-01	1.57E-07	7.68E-02	2.99E-02	3.74E-03
C-14	5.73E+03	9.66E-02	3.76E-08	4.30E-01	1.67E-01	2.09E-02
Total		2.36E+01	9.18E-06	2.85E+02	1.11E+02	1.39E+01

In-Vessel Storage Modules (3) Volume = 8.566E+06 cm^3, Mass = 1.358E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.15E-02	2.51E-09	2.43E+01	2.84E+00	1.79E+00
Ni-59	7.60E+04	4.32E+00	5.04E-07	3.44E-01	4.02E-02	2.53E-02
Ni-63	1.00E+02	5.07E-01	5.92E-08	2.88E+01	3.36E+00	2.11E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.85E-04
Nb-94	2.00E+04	7.04E-02	8.22E-09	1.34E-02	1.56E-03	7.30E-03
C-14	5.73E+03	2.23E-02	2.60E-09	9.92E-02	1.16E-02	2.72E+01
Total		4.94E+00	5.76E-07	5.36E+01	6.25E+00	3.11E+01

Baffle Plate Volume = 1.237E+06 cm^3, Mass = 9.892E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.93E-03	1.56E-09	2.19E+00	1.77E+00	2.21E-01
Ni-59	7.60E+04	6.28E-01	5.08E-07	5.01E-02	4.05E-02	5.06E-03
Ni-63	1.00E+02	7.62E-02	6.16E-08	4.33E+00	3.50E+00	4.37E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.76E-03	3.04E-09	7.16E-04	5.79E-04	7.23E-05
C-14	5.73E+03	3.15E-03	2.55E-09	1.41E-02	1.14E-02	1.42E-03
Total		7.13E-01	5.76E-07	6.58E+00	5.32E+00	6.65E-01

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 5 of 11)

Instrument Tree Hold Downs Volume = 5.894E+05 cm^3, Mass = 7.031E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.36E-03	1.08E-08	7.19E+00	1.22E+01	1.02E+01
Ni-59	7.60E+04	9.81E-01	1.66E-06	7.83E-02	1.33E-01	1.11E-01
Ni-63	1.00E+02	1.17E-01	1.98E-07	6.64E+00	1.13E+01	9.43E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	3.47E-08	3.90E-03	6.61E-03	5.53E-03
C-14	5.73E+03	4.56E-03	7.75E-09	2.03E-02	3.45E-02	2.89E-02
Total		1.13E+00	1.92E-06	1.39E+01	2.36E+01	1.98E+01

Instrument Tree Lower Frames Volume = 1.040E+06 cm^3, Mass = 3.795E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.19E-02	1.14E-08	1.34E+01	1.29E+01	3.53E+00
Ni-59	7.60E+04	2.09E+00	2.00E-06	1.66E-01	1.60E-01	4.38E-02
Ni-63	1.00E+02	2.54E-01	2.44E-07	1.44E+01	1.39E+01	3.80E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.42E-02	3.29E-08	6.51E-03	6.26E-03	1.71E-03
C-14	5.73E+03	1.00E-02	9.63E-09	4.46E-02	4.29E-02	1.17E-02
Total		2.40E+00	2.30E-06	2.81E+01	2.70E+01	7.38E+00

Instrument Tree Guide Tubes Volume = 1.224E+07 cm^3, Mass = 4.614E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.35E-04	4.37E-11	6.05E-01	4.94E-02	1.31E-01
Ni-59	7.60E+04	1.52E-01	1.25E-08	1.22E-02	9.95E-04	2.63E-03
Ni-63	1.00E+02	1.84E-02	1.50E-09	1.04E+00	8.52E-02	2.25E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.33E-03	1.09E-10	2.54E-04	2.07E-05	5.49E-05
C-14	5.73E+03	7.57E-04	6.19E-11	3.37E-03	2.76E-04	7.29E-04
Total		1.73E-01	1.42E-08	1.66E+00	1.36E-01	3.60E-01

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 6 of 11)

Instrument Tree Columns Volume = 7.201E+06 cm^3, Mass = 7.215E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.90E-04	1.10E-10	8.93E-01	1.24E-01	1.24E-01
Ni-59	7.60E+04	1.97E-01	2.74E-08	1.57E-02	2.19E-03	2.18E-03
Ni-63	1.00E+02	2.37E-02	3.30E-09	1.35E+00	1.87E-01	1.87E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.04E-03	2.83E-10	3.87E-04	5.38E-05	5.37E-05
C-14	5.73E+03	9.71E-04	1.35E-10	4.33E-03	6.01E-04	6.00E-04
Total		2.25E-01	3.12E-08	2.26E+00	3.14E-01	3.14E-01

Instrument Tree Shield Plugs Volume = 2.864E+06 cm^3, Mass = 2.292E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.11E-08	1.78E-14	5.78E-05	2.02E-05	2.52E-06
Ni-59	7.60E+04	1.52E-05	3.84E-13	1.22E-06	3.06E-08	3.83E-09
Ni-63	1.00E+02	1.87E-06	5.42E-14	1.06E-04	3.08E-06	3.84E-07
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.60E-07	4.03E-15	3.05E-08	7.67E-10	9.59E-11
C-14	5.73E+03	7.52E-08	1.90E-15	3.35E-07	8.46E-09	1.06E-09
Total		1.74E-05	4.62E-13	1.66E-04	2.33E-05	2.91E-06

Instrument Tree Shield Plates Volume = 1.967E+06 cm^3, Mass = 1.577E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.50E-08	2.65E-15	5.09E-05	3.00E-06	3.74E-07
Ni-59	7.60E+04	3.42E-05	2.02E-12	2.73E-06	1.61E-07	2.01E-08
Ni-63	1.00E+02	4.19E-06	2.47E-13	2.38E-04	1.40E-05	1.75E-06
Mo-93	3.50E+03	3.50E-09	2.06E-16	3.85E-09	2.27E-10	2.83E-11
Tc-99	2.13E+05	1.19E-07	7.03E-15	2.02E-09	1.19E-10	1.49E-11
Nb-94	2.00E+04	7.00E-08	4.13E-15	1.33E-08	7.86E-10	9.80E-11
C-14	5.73E+03	5.68E-08	3.35E-15	2.53E-07	1.49E-08	1.86E-09
Total		3.87E-05	2.28E-12	2.92E-04	1.72E-05	2.15E-06

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 7 of 11)

Instrument Trees Composite Volume = 2.590E+07 cm^3, Mass = 5.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.95E-02	7.54E-10	2.21E+01	8.53E-01	4.02E-01
Ni-59	7.60E+04	3.42E+00	1.32E-07	2.73E-01	1.05E-02	4.95E-03
Ni-63	1.00E+02	4.13E-01	1.59E-08	2.35E+01	9.06E-01	4.26E-01
Mo-93	3.50E+03	3.50E-09	1.35E-16	3.85E-09	1.49E-10	7.00E-11
Tc-99	2.13E+05	1.19E-07	4.60E-15	2.02E-09	7.81E-11	3.68E-11
Nb-94	2.00E+04	5.80E-02	2.24E-09	1.10E-02	4.26E-04	2.01E-04
C-14	5.73E+03	1.63E-02	6.30E-10	7.27E-02	2.81E-03	1.32E-03
Total		3.92E+00	1.51E-07	4.59E+01	1.77E+00	8.35E-01

In-Vessel Handling Machines (3) Volume = 2.482E+07 cm^3, Mass = 4.329E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.94E-04	1.99E-11	5.59E-01	2.25E-02	1.29E-02
Ni-59	7.60E+04	2.04E-01	8.24E-09	1.63E-02	6.58E-04	3.76E-04
Ni-63	1.00E+02	2.47E-02	9.95E-10	1.40E+00	5.65E-02	3.23E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	8.40E-04	3.38E-11	1.60E-04	6.44E-06	3.69E-06
C-14	5.73E+03	1.03E-03	4.17E-11	4.61E-03	1.86E-04	1.06E-04
Total		2.32E-01	9.33E-09	1.98E+00	7.98E-02	4.57E-02

IVHM Shield Plug Volume = 4.543E+06 cm^3, Mass = 3.636E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.10E-08	1.78E-14	9.17E-05	2.02E-05	2.52E-06
Ni-59	7.60E+04	2.42E-05	3.84E-13	1.93E-06	3.06E-08	3.83E-09
Ni-63	1.00E+02	2.97E-06	5.42E-14	1.69E-04	3.08E-06	3.84E-07
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.54E-07	4.03E-15	4.83E-08	7.67E-10	9.59E-11
C-14	5.73E+03	1.19E-07	1.90E-15	5.32E-07	8.46E-09	1.06E-09
Total		2.76E-05	4.62E-13	2.63E-04	2.33E-05	2.91E-06

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 8 of 11)

IVHM Shield Plates Volume = 3.120E+06 cm^3, Mass = 2.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.13E-08	4.21E-15	8.07E-05	4.76E-06	5.94E-07
Ni-59	7.60E+04	5.43E-05	3.20E-12	4.33E-06	2.56E-07	3.19E-08
Ni-63	1.00E+02	6.65E-06	3.92E-13	3.78E-04	2.23E-05	2.78E-06
Mo-93	3.50E+03	5.55E-09	3.28E-16	6.10E-09	3.60E-10	4.49E-11
Tc-99	2.13E+05	1.89E-07	1.12E-14	3.21E-09	1.89E-10	2.36E-11
Nb-94	2.00E+04	1.11E-07	6.55E-15	2.11E-08	1.25E-09	1.56E-10
C-14	5.73E+03	9.01E-08	5.32E-15	4.02E-07	2.37E-08	2.95E-09
Total		6.14E-05	3.62E-12	4.63E-04	2.73E-05	3.41E-06

IVHM Composite Volume = 3.248E+07 cm^3, Mass = 1.047E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.94E-04	1.52E-11	5.587E-01	1.72E-02	5.34E-03
Ni-59	7.60E+04	2.05E-01	6.30E-09	1.632E-02	5.03E-04	1.56E-04
Ni-63	1.00E+02	2.47E-02	7.60E-10	1.403E+00	4.32E-02	1.34E-02
Mo-93	3.50E+03	5.55E-09	1.71E-16	6.105E-09	1.88E-10	5.83E-11
Tc-99	2.13E+05	1.89E-07	5.82E-15	3.209E-09	9.88E-11	3.07E-11
Nb-94	2.00E+04	8.40E-04	2.59E-11	1.599E-04	4.92E-06	1.53E-06
C-14	5.73E+03	1.03E-03	3.19E-11	4.610E-03	1.42E-04	4.40E-05
Total		2.32E-01	7.13E-09	1.98E+00	6.10E-02	1.89E-02

Closure Head Volume = 2.469E+07 cm^3, Mass = 1.360E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.72E-08	2.32E-15	6.48E-05	2.62E-06	4.76E-07
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	3.15E-11	1.28E-18	1.40E-10	5.69E-12	1.03E-12
Total		5.73E-08	2.32E-15	6.48E-05	2.62E-06	4.76E-07

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 9 of 11)

Suppressor Plate Volume = 1.874E+05 cm^3, Mass = 1.052E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.41E-08	1.29E-13	2.73E-05	1.46E-04	2.59E-05
Ni-59	7.60E+04	8.26E-05	4.41E-10	6.59E-06	3.52E-05	6.27E-06
Ni-63	1.00E+02	9.51E-06	5.07E-11	5.40E-04	2.88E-03	5.13E-04
Mo-93	3.50E+03	8.68E-08	4.63E-13	9.54E-08	5.09E-07	9.07E-08
Tc-99	2.13E+05	3.33E-06	1.78E-11	5.66E-08	3.02E-07	5.38E-08
Nb-94	2.00E+04	3.04E-07	1.62E-12	5.79E-08	3.09E-07	5.50E-08
C-14	5.73E+03	3.14E-08	1.67E-13	1.40E-07	7.46E-07	1.33E-07
Total		9.59E-05	5.12E-10	5.74E-04	3.06E-03	5.46E-04

Thermal Reflector Plates Volume = 3.811E+06 cm^3, Mass = 2.134E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.59E-07	1.47E-13	6.32E-04	1.66E-04	2.96E-05
Ni-59	7.60E+04	7.00E-04	1.84E-10	5.58E-05	1.47E-05	2.62E-06
Ni-63	1.00E+02	8.08E-05	2.12E-11	4.59E-03	1.20E-03	2.15E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.09E-06	5.49E-13	3.99E-07	1.05E-07	1.87E-08
C-14	5.73E+03	3.53E-06	9.27E-13	1.57E-05	4.13E-06	7.37E-07
Total		7.87E-04	2.06E-10	5.29E-03	1.39E-03	2.48E-04

Inconel Shield Plate Volume = 3.811E+06 cm^3, Mass = 2.254E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.85E-07	4.85E-14	2.09E-04	5.49E-05	9.28E-06
Ni-59	7.60E+04	8.05E-04	2.11E-10	6.43E-05	1.69E-05	2.85E-06
Ni-63	1.00E+02	9.45E-05	2.48E-11	5.37E-03	1.41E-03	2.38E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.13E-11	2.96E-18	5.03E-11	1.32E-11	2.23E-12
Total		9.00E-04	2.36E-10	5.64E-03	1.48E-03	2.50E-04

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 10 of 11)

SS-410 Shield Plate Volume = 3.049E+06 cm^3, Mass = 1.665E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.60E-09	2.82E-15	9.73E-06	3.19E-06	5.84E-07
Ni-59	7.60E+04	2.54E-06	8.32E-13	2.02E-07	6.64E-08	1.22E-08
Ni-63	1.00E+02	3.02E-07	9.90E-14	1.72E-05	5.63E-06	1.03E-06
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.53E-08	5.03E-15	6.84E-08	2.24E-08	4.11E-09
Total		2.86E-06	9.39E-13	2.72E-05	8.91E-06	1.63E-06

Low-Carbon Steel Shield Plate Volume = 6.097E+06 cm^3, Mass = 3.359E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.33E-09	8.75E-16	6.03E-06	9.90E-07	1.80E-07
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	4.01E-12	6.58E-19	1.79E-11	2.93E-12	5.32E-13
Total		5.34E-09	8.76E-16	6.03E-06	9.90E-07	1.80E-07

Head Assembly Composite (Head + Suppressor, Reflector and Shield Plates) Volume = 4.165E+07 cm^3, Mass = 2.312E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.39E-07	2.01E-14	9.49E-04	2.28E-05	4.11E-06
Ni-59	7.60E+04	1.59E-03	3.82E-11	1.27E-04	3.05E-06	5.49E-07
Ni-63	1.00E+02	1.85E-04	4.44E-12	1.05E-02	2.52E-04	4.55E-05
Mo-93	3.50E+03	8.68E-08	2.08E-15	9.54E-08	2.29E-09	4.13E-10
Tc-99	2.13E+05	3.33E-06	8.01E-14	5.66E-08	1.36E-09	2.45E-10
Nb-94	2.00E+04	2.40E-06	5.76E-14	4.56E-07	1.10E-08	1.97E-09
C-14	5.73E+03	3.58E-06	8.60E-14	1.59E-05	3.83E-07	6.90E-08
Total		1.79E-03	4.29E-11	1.16E-02	2.79E-04	5.02E-05

Table 6-9. Radionuclide Inventories in Activated Reactor Hardware - September 2023 (sheet 11 of 11)

Z Ring Volume = 1.989E+07 cm^3, Mass = 1.591E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.00E-06	5.03E-14	1.13E-03	5.70E-05	7.12E-06
Ni-59	7.60E+04	3.06E-04	1.54E-11	2.44E-05	1.23E-06	1.53E-07
Ni-63	1.00E+02	3.75E-05	1.88E-12	2.13E-03	1.07E-04	1.34E-05
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.82E-06	1.42E-13	5.37E-07	2.70E-08	3.37E-09
C-14	5.73E+03	1.52E-06	7.64E-14	6.77E-06	3.40E-07	4.25E-08
Total		3.48E-04	1.75E-11	3.29E-03	1.66E-04	2.07E-05

Boron Carbide Shield Volume = 1.932E+06 cm^3, Mass = 4.831E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	7.31E-09	3.78E-15	3.26E-08	1.68E-08	6.74E-09
Total		7.31E-09	3.78E-15	3.26E-08	1.68E-08	6.74E-09

Steel Roof Volume = 5.468E+06 cm^3, Mass = 4.303E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.67E-11	4.89E-18	3.02E-08	5.53E-09	7.02E-10
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	2.01E-07	3.68E-14	3.41E-09	6.24E-10	7.93E-11
Nb-94	2.00E+04	2.36E-08	4.32E-15	4.50E-09	8.23E-10	1.05E-10
C-14	5.73E+03	4.53E-14	8.29E-21	2.02E-13	3.70E-14	4.69E-15
Total		2.25E-07	4.11E-14	3.81E-08	6.98E-09	8.86E-10

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 1 of 12)

Irradiated Row 7 Radial Reflectors 81 total in vessel

Inconel Reflector Section Volume = 1.287E+06 cm^3, Mass = 9.011E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.15E+01	8.92E-06	1.30E+04	1.01E+04	1.44E+03
Ni-59	7.60E+04	6.85E+03	5.32E-03	5.47E+02	4.25E+02	6.07E+01
Ni-63	1.00E+02	1.16E+03	9.02E-04	6.59E+04	5.12E+04	7.31E+03
Mo-93	3.50E+03	6.80E+01	5.28E-05	7.47E+01	5.80E+01	8.29E+00
Tc-99	2.13E+05	3.61E+02	2.81E-04	6.13E+00	4.76E+00	6.80E-01
Nb-94	2.00E+04	3.64E+01	2.83E-05	6.93E+00	5.38E+00	7.69E-01
C-14	5.73E+03	4.13E-01	3.21E-07	1.84E+00	1.43E+00	2.04E-01
Total		8.49E+03	6.60E-03	7.95E+04	6.18E+04	8.82E+03

Upper Shield Section Volume = 1.253E+06 cm^3, Mass = 8.386E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.96E-01	3.16E-07	4.48E+02	3.57E+02	5.34E+01
Ni-59	7.60E+04	1.54E+02	1.23E-04	1.23E+01	9.80E+00	1.46E+00
Ni-63	1.00E+02	1.71E+01	1.37E-05	9.73E+02	7.77E+02	1.16E+02
Mo-93	3.50E+03	1.24E+01	9.86E-06	1.36E+01	1.08E+01	1.62E+00
Tc-99	2.13E+05	8.85E+01	7.06E-05	1.50E+00	1.20E+00	1.79E-01
Nb-94	2.00E+04	1.15E+01	9.17E-06	2.19E+00	1.74E+00	2.61E-01
C-14	5.73E+03	5.39E-02	4.30E-08	2.40E-01	1.92E-01	2.87E-02
Total		2.84E+02	2.26E-04	1.45E+03	1.16E+03	1.73E+02

Lower Shield/Orifice Volume = 7.371E+05 cm^3, Mass = 4.516E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Cl)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.35E-01	8.62E-07	7.19E+02	9.75E+02	1.59E+02
Ni-59	7.60E+04	2.26E+02	3.07E-04	1.80E+01	2.45E+01	3.99E+00
Ni-63	1.00E+02	2.71E+01	3.68E-05	1.54E+03	2.09E+03	3.41E+02
Mo-93	3.50E+03	1.56E+01	2.11E-05	1.71E+01	2.32E+01	3.79E+00
Tc-99	2.13E+05	1.17E+02	1.58E-04	1.98E+00	2.69E+00	4.39E-01
Nb-94	2.00E+04	1.50E+01	2.03E-05	2.85E+00	3.87E+00	6.31E-01
C-14	5.73E+03	8.37E-02	1.14E-07	3.73E-01	5.06E-01	8.26E-02
Total		4.01E+02	5.44E-04	2.30E+03	3.12E+03	5.09E+02

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 2 of 12)

Irradiated Row 7 Radial Reflectors (continued)

Handling Socket Volume = 1.540E+05 cm^3, Mass = 2.125E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.10E-04	4.61E-09	8.03E-01	5.21E+00	3.78E+00
Ni-59	7.60E+04	2.20E-01	1.43E-06	1.76E-02	1.14E-01	8.27E-02
Ni-63	1.00E+02	2.59E-02	1.68E-07	1.47E+00	9.54E+00	6.91E+00
Mo-93	3.50E+03	6.20E-03	4.02E-08	6.81E-03	4.42E-02	3.21E-02
Tc-99	2.13E+05	1.14E-01	7.40E-07	1.93E-03	1.26E-02	9.09E-03
Nb-94	2.00E+04	1.01E-02	6.58E-08	1.93E-03	1.25E-02	9.08E-03
C-14	5.73E+03	7.39E-05	4.80E-10	3.29E-04	2.14E-03	1.55E-03
Total		3.77E-01	2.45E-06	2.30E+00	1.49E+01	1.08E+01

Nozzle Volume = 1.466E+05 cm^3, Mass = 4.922E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.73E-03	3.22E-08	5.35E+00	3.65E+01	1.09E+01
Ni-59	7.60E+04	1.57E+00	1.07E-05	1.25E-01	8.56E-01	2.55E-01
Ni-63	1.00E+02	1.89E-01	1.29E-06	1.07E+01	7.31E+01	2.18E+01
Mo-93	3.50E+03	5.32E-02	3.63E-07	5.85E-02	3.99E-01	1.19E-01
Tc-99	2.13E+05	7.55E-01	5.15E-06	1.28E-02	8.74E-02	2.60E-02
Nb-94	2.00E+04	7.85E-02	5.35E-07	1.49E-02	1.02E-01	3.03E-02
C-14	5.73E+03	5.26E-04	3.58E-09	2.34E-03	1.60E-02	4.76E-03
Total		2.65E+00	1.81E-05	1.63E+01	1.11E+02	3.31E+01

Row 7 Radial Reflectors Composite Volume = 3.578E+06 cm^3, Mass = 2.262E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.25E+01	3.50E-06	1.42E+04	3.96E+03	6.26E+02
Ni-59	7.60E+04	7.23E+03	2.02E-03	5.77E+02	1.61E+02	2.55E+01
Ni-63	1.00E+02	1.21E+03	3.37E-04	6.84E+04	1.91E+04	3.02E+03
Mo-93	3.50E+03	9.60E+01	2.68E-05	1.05E+02	2.95E+01	4.66E+00
Tc-99	2.13E+05	5.67E+02	1.59E-04	9.63E+00	2.69E+00	4.26E-01
Nb-94	2.00E+04	6.30E+01	1.76E-05	1.20E+01	3.35E+00	5.30E-01
C-14	5.73E+03	5.52E-01	1.54E-07	2.46E+00	6.87E-01	1.09E-01
Total		9.18E+03	2.56E-03	8.33E+04	2.33E+04	3.68E+03

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 3 of 12)

Irradiated Row 8 and 9 Radial Reflectors 73 total in vessel

Inconel Reflector Section Volume = 1.160E+06 cm^3, Mass = 8.439E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.62E+01	1.40E-05	1.84E+04	1.58E+04	2.17E+03
Ni-59	7.60E+04	9.59E+03	8.27E-03	7.65E+02	6.60E+02	9.07E+01
Ni-63	1.00E+02	1.52E+03	1.31E-03	8.65E+04	7.46E+04	1.02E+04
Mo-93	3.50E+03	7.93E+01	6.84E-05	8.71E+01	7.51E+01	1.03E+01
Tc-99	2.13E+05	5.66E+02	4.88E-04	9.60E+00	8.27E+00	1.14E+00
Nb-94	2.00E+04	5.89E+01	5.08E-05	1.12E+01	9.67E+00	1.33E+00
C-14	5.73E+03	5.18E-01	4.47E-07	2.31E+00	1.99E+00	2.74E-01
Total		1.18E+04	1.02E-02	1.06E+05	9.11E+04	1.25E+04

Upper Shield Section Volume = 1.128E+06 cm^3, Mass = 7.969E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.46E-01	3.96E-07	5.05E+02	4.47E+02	6.34E+01
Ni-59	7.60E+04	1.81E+02	1.61E-04	1.45E+01	1.28E+01	1.82E+00
Ni-63	1.00E+02	2.03E+01	1.80E-05	1.15E+03	1.02E+03	1.45E+02
Mo-93	3.50E+03	1.39E+01	1.23E-05	1.52E+01	1.35E+01	1.91E+00
Tc-99	2.13E+05	9.91E+01	8.78E-05	1.68E+00	1.49E+00	2.11E-01
Nb-94	2.00E+04	1.28E+01	1.13E-05	2.43E+00	2.15E+00	3.05E-01
C-14	5.73E+03	5.80E-02	5.14E-08	2.59E-01	2.29E-01	3.24E-02
Total		3.28E+02	2.91E-04	1.69E+03	1.50E+03	2.12E+02

Lower Shield/Orifice Volume = 6.643E+05 cm^3, Mass = 3.115E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.40E-01	8.12E-07	6.10E+02	9.19E+02	1.96E+02
Ni-59	7.60E+04	2.03E+02	3.06E-04	1.62E+01	2.44E+01	5.20E+00
Ni-63	1.00E+02	2.33E+01	3.51E-05	1.32E+03	1.99E+03	4.25E+02
Mo-93	3.50E+03	1.29E+01	1.94E-05	1.41E+01	2.13E+01	4.54E+00
Tc-99	2.13E+05	1.05E+02	1.58E-04	1.78E+00	2.68E+00	5.72E-01
Nb-94	2.00E+04	1.33E+01	2.00E-05	2.53E+00	3.81E+00	8.13E-01
C-14	5.73E+03	6.83E-02	1.03E-07	3.04E-01	4.58E-01	9.78E-02
Total		3.58E+02	5.39E-04	1.97E+03	2.96E+03	6.32E+02

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 4 of 12)

Irradiated Row 8 and 9 Radial Reflectors (continued)

Handling Socket Volume = 1.384E+05 cm^3, Mass = 1.910E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.11E-04	5.13E-09	8.04E-01	5.81E+00	4.21E+00
Ni-59	7.60E+04	2.43E-01	1.76E-06	1.94E-02	1.40E-01	1.01E-01
Ni-63	1.00E+02	2.87E-02	2.07E-07	1.63E+00	1.18E+01	8.54E+00
Mo-93	3.50E+03	6.34E-03	4.58E-08	6.97E-03	5.04E-02	3.65E-02
Tc-99	2.13E+05	1.21E-01	8.71E-07	2.04E-03	1.48E-02	1.07E-02
Nb-94	2.00E+04	1.05E-02	7.61E-08	2.01E-03	1.45E-02	1.05E-02
C-14	5.73E+03	8.27E-05	5.97E-10	3.68E-04	2.66E-03	1.93E-03
Total		4.10E-01	2.96E-06	2.47E+00	1.78E+01	1.29E+01

Nozzle Volume = 5.925E+04 cm^3, Mass = 1.989E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.24E-03	7.15E-08	4.80E+00	8.09E+01	2.41E+01
Ni-59	7.60E+04	1.41E+00	2.38E-05	1.13E-01	1.90E+00	5.66E-01
Ni-63	1.00E+02	1.69E-01	2.86E-06	9.61E+00	1.62E+02	4.83E+01
Mo-93	3.50E+03	4.78E-02	8.06E-07	5.25E-02	8.86E-01	2.64E-01
Tc-99	2.13E+05	6.77E-01	1.14E-05	1.15E-02	1.94E-01	5.78E-02
Nb-94	2.00E+04	7.04E-02	1.19E-06	1.34E-02	2.26E-01	6.73E-02
C-14	5.73E+03	4.71E-04	7.95E-09	2.10E-03	3.55E-02	1.06E-02
Total		2.38E+00	4.02E-05	1.46E+01	2.46E+02	7.34E+01

Row 8 and 9 Reflectors Composite Volume = 3.150E+06 cm^3, Mass = 1.991E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.72E+01	5.46E-06	1.95E+04	6.18E+03	9.78E+02
Ni-59	7.60E+04	9.98E+03	3.17E-03	7.96E+02	2.53E+02	4.00E+01
Ni-63	1.00E+02	1.57E+03	4.97E-04	8.90E+04	2.82E+04	4.47E+03
Mo-93	3.50E+03	1.06E+02	3.37E-05	1.17E+02	3.70E+01	5.85E+00
Tc-99	2.13E+05	7.71E+02	2.45E-04	1.31E+01	4.15E+00	6.57E-01
Nb-94	2.00E+04	8.51E+01	2.70E-05	1.62E+01	5.14E+00	8.13E-01
C-14	5.73E+03	6.45E-01	2.05E-07	2.87E+00	9.12E-01	1.44E-01
Total		1.25E+04	3.97E-03	1.09E+05	3.47E+04	5.49E+03

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 5 of 12)

Irradiated Control and Safety Rods 31 total in vessel

Absorber Region Volume = 3.601E+05 cm^3, Mass = 1.198E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.94E-02	1.93E-07	7.85E+01	2.18E+02	6.55E+01
Ni-59	7.60E+04	1.12E+02	3.10E-04	8.90E+00	2.47E+01	7.43E+00
Ni-63	1.00E+02	7.14E+00	1.98E-05	4.05E+02	1.13E+03	3.38E+02
Mo-93	3.50E+03	1.44E+01	4.00E-05	1.58E+01	4.39E+01	1.32E+01
Tc-99	2.13E+05	5.59E+01	1.55E-04	9.48E-01	2.63E+00	7.91E-01
Nb-94	2.00E+04	6.85E+00	1.90E-05	1.30E+00	3.62E+00	1.09E+00
C-14	5.73E+03	1.12E-01	3.10E-07	4.97E-01	1.38E+00	4.15E-01
Total		1.96E+02	5.44E-04	5.11E+02	1.42E+03	4.27E+02

Control Rod Follower Volume = 7.607E+04 cm^3, Mass = 2.362E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.33E-02	3.06E-07	2.63E+01	3.46E+02	1.11E+02
Ni-59	7.60E+04	6.18E+01	8.12E-04	4.93E+00	6.48E+01	2.09E+01
Ni-63	1.00E+02	4.00E+00	5.26E-05	2.27E+02	2.99E+03	9.62E+02
Mo-93	3.50E+03	8.61E+00	1.13E-04	9.46E+00	1.24E+02	4.01E+01
Tc-99	2.13E+05	3.05E+01	4.00E-04	5.17E-01	6.79E+00	2.19E+00
Nb-94	2.00E+04	4.01E+00	5.28E-05	7.64E-01	1.00E+01	3.23E+00
C-14	5.73E+03	5.38E-02	7.07E-07	2.40E-01	3.15E+00	1.01E+00
Total		1.09E+02	1.43E-03	2.69E+02	3.54E+03	1.14E+03

Control Shield Volume = 2.806E+05 cm^3, Mass = 1.537E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.05E-01	1.44E-06	4.59E+02	1.63E+03	2.98E+02
Ni-59	7.60E+04	1.14E+02	4.06E-04	9.08E+00	3.24E+01	5.91E+00
Ni-63	1.00E+02	1.36E+01	4.86E-05	7.74E+02	2.76E+03	5.04E+02
Mo-93	3.50E+03	6.92E+00	2.47E-05	7.61E+00	2.71E+01	4.95E+00
Tc-99	2.13E+05	7.02E+01	2.50E-04	1.19E+00	4.24E+00	7.75E-01
Nb-94	2.00E+04	7.42E+00	2.65E-05	1.41E+00	5.03E+00	9.19E-01
C-14	5.73E+03	4.39E-02	1.56E-07	1.95E-01	6.97E-01	1.27E-01
Total		2.12E+02	7.57E-04	1.25E+03	4.46E+03	8.15E+02

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 6 of 12)

Irradiated Control and Safety Rods (continued)

Nozzle Volume = 1.136E+05 cm^3, Mass = 3.811E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.11E-03	4.50E-08	5.78E+00	5.09E+01	1.52E+01
Ni-59	7.60E+04	1.44E+00	1.27E-05	1.15E-01	1.01E+00	3.01E-01
Ni-63	1.00E+02	1.74E-01	1.53E-06	9.86E+00	8.68E+01	2.59E+01
Mo-93	3.50E+03	4.75E-02	4.18E-07	5.22E-02	4.60E-01	1.37E-01
Tc-99	2.13E+05	7.15E-01	6.30E-06	1.21E-02	1.07E-01	3.18E-02
Nb-94	2.00E+04	7.14E-02	6.29E-07	1.36E-02	1.20E-01	3.57E-02
C-14	5.73E+03	4.81E-04	4.24E-09	2.14E-03	1.89E-02	5.63E-03
Total		2.45E+00	2.16E-05	1.58E+01	1.39E+02	4.16E+01

Above Absorber Volume = 1.258E+05 cm^3, Mass = 3.729E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.88E-03	3.88E-08	5.53E+00	4.39E+01	1.48E+01
Ni-59	7.60E+04	1.44E+00	1.14E-05	1.15E-01	9.12E-01	3.08E-01
Ni-63	1.00E+02	1.64E-01	1.31E-06	9.33E+00	7.41E+01	2.50E+01
Mo-93	3.50E+03	1.18E-01	9.38E-07	1.30E-01	1.03E+00	3.48E-01
Tc-99	2.13E+05	1.11E+00	8.79E-06	1.88E-02	1.49E-01	5.03E-02
Nb-94	2.00E+04	1.19E-01	9.46E-07	2.27E-02	1.80E-01	6.07E-02
C-14	5.73E+03	4.36E-04	3.47E-09	1.94E-03	1.55E-02	5.21E-03
Total		2.95E+00	2.35E-05	1.51E+01	1.20E+02	4.06E+01

Driveline Volume = 1.523E+05 cm^3, Mass = 2.901E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.65E-03	1.74E-08	3.00E+00	1.97E+01	1.03E+01
Ni-59	7.60E+04	7.33E-01	4.81E-06	5.85E-02	3.84E-01	2.02E-01
Ni-63	1.00E+02	8.64E-02	5.67E-07	4.90E+00	3.22E+01	1.69E+01
Mo-93	3.50E+03	3.43E-02	2.25E-07	3.77E-02	2.48E-01	1.30E-01
Tc-99	2.13E+05	4.80E-01	3.15E-06	8.14E-03	5.34E-02	2.81E-02
Nb-94	2.00E+04	4.75E-02	3.12E-07	9.04E-03	5.94E-02	3.12E-02
C-14	5.73E+03	2.33E-04	1.53E-09	1.04E-03	6.83E-03	3.59E-03
Total		1.38E+00	9.09E-06	8.01E+00	5.26E+01	2.76E+01

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 7 of 12)

Irradiated Control and Safety Rods (continued)

Handling Socket Volume = 5.873E+04 cm^3, Mass = 8.105E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.68E-04	6.26E-09	4.16E-01	7.09E+00	5.14E+00
Ni-59	7.60E+04	9.63E-02	1.64E-06	7.69E-03	1.31E-01	9.48E-02
Ni-63	1.00E+02	1.13E-02	1.92E-07	6.42E-01	1.09E+01	7.92E+00
Mo-93	3.50E+03	2.70E-03	4.60E-08	2.97E-03	5.06E-02	3.66E-02
Tc-99	2.13E+05	5.12E-02	8.71E-07	8.68E-04	1.48E-02	1.07E-02
Nb-94	2.00E+04	4.57E-03	7.78E-08	8.70E-04	1.48E-02	1.07E-02
C-14	5.73E+03	3.21E-05	5.47E-10	1.43E-04	2.44E-03	1.77E-03
Total		1.66E-01	2.83E-06	1.07E+00	1.82E+01	1.32E+01

Control and Safety Rods Composite Volume = 1.167E+06 cm^3, Mass = 4.097E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.11E-01	4.38E-07	5.78E+02	4.95E+02	1.41E+02
Ni-59	7.60E+04	2.91E+02	2.49E-04	2.32E+01	1.99E+01	5.67E+00
Ni-63	1.00E+02	2.52E+01	2.16E-05	1.43E+03	1.23E+03	3.49E+02
Mo-93	3.50E+03	3.01E+01	2.58E-05	3.31E+01	2.84E+01	8.08E+00
Tc-99	2.13E+05	1.59E+02	1.36E-04	2.70E+00	2.31E+00	6.58E-01
Nb-94	2.00E+04	1.85E+01	1.59E-05	3.53E+00	3.02E+00	8.61E-01
C-14	5.73E+03	2.10E-01	1.80E-07	9.38E-01	8.04E-01	2.29E-01
Total		5.24E+02	4.49E-04	2.07E+03	1.78E+03	5.06E+02

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 8 of 12)

Irradiated In-Core Shim Assemblies 7 total in vessel

Central and Upper Region Volume = 1.851E+05 cm^3, Mass = 8.482E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.12E-01	6.06E-07	1.27E+02	6.86E+02	1.50E+02
Ni-59	7.60E+04	1.11E+02	6.02E-04	8.89E+00	4.80E+01	1.05E+01
Ni-63	1.00E+02	8.97E+00	4.85E-05	5.09E+02	2.75E+03	6.01E+02
Mo-93	3.50E+03	1.48E+01	8.02E-05	1.63E+01	8.81E+01	1.92E+01
Tc-99	2.13E+05	6.98E+01	3.77E-04	1.18E+00	6.39E+00	1.40E+00
Nb-94	2.00E+04	8.27E+00	4.47E-05	1.57E+00	8.50E+00	1.86E+00
C-14	5.73E+03	8.72E-02	4.71E-07	3.89E-01	2.10E+00	4.58E-01
Total		2.13E+02	1.15E-03	6.65E+02	3.59E+03	7.84E+02

Lower Shield Volume = 6.372E+04 cm^3, Mass = 4.767E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.88E-02	1.24E-06	8.92E+01	1.40E+03	1.87E+02
Ni-59	7.60E+04	2.99E+01	4.69E-04	2.39E+00	3.75E+01	5.01E+00
Ni-63	1.00E+02	3.41E+00	5.36E-05	1.94E+02	3.04E+03	4.07E+02
Mo-93	3.50E+03	1.71E+00	2.69E-05	1.88E+00	2.96E+01	3.95E+00
Tc-99	2.13E+05	1.81E+01	2.84E-04	3.07E-01	4.82E+00	6.44E-01
Nb-94	2.00E+04	1.86E+00	2.92E-05	3.55E-01	5.57E+00	7.44E-01
C-14	5.73E+03	1.12E-02	1.76E-07	5.00E-02	7.85E-01	1.05E-01
Total		5.51E+01	8.65E-04	2.88E+02	4.52E+03	6.04E+02

Nozzle Volume = 2.562E+04 cm^3, Mass = 8.595E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.37E-04	3.27E-08	9.47E-01	3.70E+01	1.10E+01
Ni-59	7.60E+04	3.17E-01	1.24E-05	2.53E-02	9.86E-01	2.94E-01
Ni-63	1.00E+02	3.72E-02	1.45E-06	2.11E+00	8.25E+01	2.46E+01
Mo-93	3.50E+03	1.05E-02	4.09E-07	1.15E-02	4.49E-01	1.34E-01
Tc-99	2.13E+05	1.51E-01	5.91E-06	2.57E-03	1.00E-01	2.99E-02
Nb-94	2.00E+04	1.54E-02	6.02E-07	2.93E-03	1.15E-01	3.41E-02
C-14	5.73E+03	1.05E-04	4.12E-09	4.70E-04	1.83E-02	5.47E-03
Total		5.32E-01	2.08E-05	3.10E+00	1.21E+02	3.61E+01

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 9 of 12)

Irradiated In-Core Shim Assemblies (continued)

Handling Socket Volume = 1.325E+04 cm^3, Mass = 1.828E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	6.04E-05	4.56E-09	6.83E-02	5.16E+00	3.74E+00
Ni-59	7.60E+04	2.08E-02	1.57E-06	1.66E-03	1.25E-01	9.08E-02
Ni-63	1.00E+02	2.39E-03	1.81E-07	1.36E-01	1.03E+01	7.44E+00
Mo-93	3.50E+03	5.78E-04	4.36E-08	6.35E-04	4.79E-02	3.47E-02
Tc-99	2.13E+05	1.13E-02	8.52E-07	1.91E-04	1.44E-02	1.05E-02
Nb-94	2.00E+04	9.86E-04	7.45E-08	1.88E-04	1.42E-02	1.03E-02
C-14	5.73E+03	6.93E-06	5.24E-10	3.09E-05	2.33E-03	1.69E-03
Total		3.61E-02	2.72E-06	2.07E-01	1.56E+01	1.13E+01

ICSAs Composite Volume = 2.877E+05 cm^3, Mass = 1.429E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.92E-01	6.67E-07	2.17E+02	7.55E+02	1.52E+02
Ni-59	7.60E+04	1.42E+02	4.92E-04	1.13E+01	3.93E+01	7.91E+00
Ni-63	1.00E+02	1.24E+01	4.32E-05	7.06E+02	2.45E+03	4.94E+02
Mo-93	3.50E+03	1.66E+01	5.76E-05	1.82E+01	6.33E+01	1.27E+01
Tc-99	2.13E+05	8.80E+01	3.06E-04	1.49E+00	5.19E+00	1.04E+00
Nb-94	2.00E+04	1.01E+01	3.53E-05	1.93E+00	6.71E+00	1.35E+00
C-14	5.73E+03	9.85E-02	3.43E-07	4.39E-01	1.53E+00	3.07E-01
Total		2.69E+02	9.35E-04	9.56E+02	3.32E+03	6.69E+02

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 10 of 12)

Irradiated Peripheral Shim Rods 3 total in vessel

Absorber Region Volume = 3.465E+04 cm^3, Mass = 1.154E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.50E-04	4.32E-09	1.69E-01	4.88E+00	1.47E+00
Ni-59	7.60E+04	1.01E+00	2.93E-05	8.10E-02	2.34E+00	7.02E-01
Ni-63	1.00E+02	6.31E-02	1.82E-06	3.58E+00	1.03E+02	3.11E+01
Mo-93	3.50E+03	1.52E-01	4.39E-06	1.67E-01	4.83E+00	1.45E+00
Tc-99	2.13E+05	5.61E-01	1.62E-05	9.52E-03	2.75E-01	8.25E-02
Nb-94	2.00E+04	6.18E-02	1.78E-06	1.18E-02	3.40E-01	1.02E-01
C-14	5.73E+03	1.54E-03	4.44E-08	6.86E-03	1.98E-01	5.95E-02
Total		1.85E+00	5.35E-05	4.03E+00	1.16E+02	3.49E+01

Below Absorber Volume = 6.249E+03 cm^3, Mass = 1.941E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.44E-04	3.90E-08	2.76E-01	4.42E+01	1.42E+01
Ni-59	7.60E+04	2.14E-01	3.41E-05	1.70E-02	2.73E+00	8.78E-01
Ni-63	1.00E+02	2.35E-02	3.75E-06	1.33E+00	2.13E+02	6.86E+01
Mo-93	3.50E+03	2.34E-02	3.74E-06	2.57E-02	4.11E+00	1.32E+00
Tc-99	2.13E+05	1.18E-01	1.89E-05	2.01E-03	3.21E-01	1.03E-01
Nb-94	2.00E+04	1.72E-02	2.75E-06	3.27E-03	5.23E-01	1.68E-01
C-14	5.73E+03	1.08E-04	1.73E-08	4.83E-04	7.72E-02	2.49E-02
Total		3.96E-01	6.34E-05	1.66E+00	2.65E+02	8.53E+01

Lower Shield Volume = 2.735E+04 cm^3, Mass = 1.498E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.56E-04	1.67E-08	5.16E-01	1.89E+01	3.45E+00
Ni-59	7.60E+04	3.82E-01	1.40E-05	3.05E-02	1.11E+00	2.03E-01
Ni-63	1.00E+02	4.06E-02	1.48E-06	2.31E+00	8.43E+01	1.54E+01
Mo-93	3.50E+03	2.47E-02	9.03E-07	2.71E-02	9.92E-01	1.81E-01
Tc-99	2.13E+05	1.97E-01	7.19E-06	3.34E-03	1.22E-01	2.23E-02
Nb-94	2.00E+04	2.60E-02	9.51E-07	4.95E-03	1.81E-01	3.30E-02
C-14	5.73E+03	1.29E-04	4.70E-09	5.73E-04	2.09E-02	3.82E-03
Total		6.71E-01	2.45E-05	2.89E+00	1.06E+02	1.93E+01

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 11 of 12)

Irradiated Peripheral Shim Rods (continued)

Nozzle Volume = 2.713E+04 cm^3, Mass = 9.108E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.67E-05	9.86E-10	3.02E-02	1.11E+00	3.32E-01
Ni-59	7.60E+04	1.84E-02	6.78E-07	1.47E-03	5.42E-02	1.61E-02
Ni-63	1.00E+02	2.12E-03	7.83E-08	1.21E-01	4.45E+00	1.33E+00
Mo-93	3.50E+03	6.20E-04	2.29E-08	6.82E-04	2.51E-02	7.49E-03
Tc-99	2.13E+05	8.86E-03	3.27E-07	1.50E-04	5.54E-03	1.65E-03
Nb-94	2.00E+04	9.18E-04	3.38E-08	1.75E-04	6.44E-03	1.92E-03
C-14	5.73E+03	6.12E-06	2.26E-10	2.73E-05	1.01E-03	3.00E-04
Total		3.10E-02	1.14E-06	1.53E-01	5.65E+00	1.68E+00

Above Absorber Volume = 3.756E+04 cm^3, Mass = 1.113E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.71E-04	1.25E-08	5.32E-01	1.42E+01	4.78E+00
Ni-59	7.60E+04	3.73E-01	9.94E-06	2.98E-02	7.93E-01	2.68E-01
Ni-63	1.00E+02	3.90E-02	1.04E-06	2.21E+00	5.89E+01	1.99E+01
Mo-93	3.50E+03	2.91E-02	7.74E-07	3.19E-02	8.51E-01	2.87E-01
Tc-99	2.13E+05	2.32E-01	6.17E-06	3.93E-03	1.05E-01	3.53E-02
Nb-94	2.00E+04	2.84E-02	7.56E-07	5.41E-03	1.44E-01	4.86E-02
C-14	5.73E+03	1.55E-04	4.14E-09	6.92E-04	1.84E-02	6.22E-03
Total		7.02E-01	1.87E-05	2.82E+00	7.50E+01	2.53E+01

Plenum Volume = 1.478E+04 cm^3, Mass = 2.815E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.36E-06	2.95E-10	4.93E-03	3.34E-01	1.75E-01
Ni-59	7.60E+04	3.37E-03	2.28E-07	2.69E-04	1.82E-02	9.54E-03
Ni-63	1.00E+02	3.83E-04	2.59E-08	2.17E-02	1.47E+00	7.72E-01
Mo-93	3.50E+03	1.81E-04	1.23E-08	1.99E-04	1.35E-02	7.08E-03
Tc-99	2.13E+05	1.68E-03	1.14E-07	2.85E-05	1.93E-03	1.01E-03
Nb-94	2.00E+04	2.14E-04	1.45E-08	4.08E-05	2.76E-03	1.45E-03
C-14	5.73E+03	1.03E-06	6.99E-11	4.60E-06	3.12E-04	1.64E-04
Total		5.83E-03	3.95E-07	2.72E-02	1.84E+00	9.67E-01

Table 6-10. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2023 (sheet 12 of 12)

Irradiated Peripheral Shim Rods (continued)

Handling Socket Volume = 5.704E+03 cm^3, Mass = 7.871E+00 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.03E-07	1.41E-10	9.09E-04	1.59E-01	1.15E-01
Ni-59	7.60E+04	5.14E-04	9.01E-08	4.10E-05	7.19E-03	5.21E-03
Ni-63	1.00E+02	5.83E-05	1.02E-08	3.31E-03	5.80E-01	4.21E-01
Mo-93	3.50E+03	1.44E-05	2.53E-09	1.59E-05	2.78E-03	2.02E-03
Tc-99	2.13E+05	2.66E-04	4.67E-08	4.52E-06	7.92E-04	5.74E-04
Nb-94	2.00E+04	2.37E-05	4.15E-09	4.51E-06	7.90E-04	5.73E-04
C-14	5.73E+03	1.72E-07	3.02E-11	7.68E-07	1.35E-04	9.75E-05
Total		8.78E-04	1.54E-07	4.29E-03	7.52E-01	5.44E-01

Peripheral Shim Rods Composite Volume = 1.534E+05 cm^3, Mass = 5.230E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.35E-03	8.81E-09	1.53E+00	9.97E+00	2.92E+00
Ni-59	7.60E+04	2.01E+00	1.31E-05	1.60E-01	1.04E+00	3.06E-01
Ni-63	1.00E+02	1.69E-01	1.10E-06	9.58E+00	6.25E+01	1.83E+01
Mo-93	3.50E+03	2.30E-01	1.50E-06	2.53E-01	1.65E+00	4.83E-01
Tc-99	2.13E+05	1.12E+00	7.29E-06	1.90E-02	1.24E-01	3.63E-02
Nb-94	2.00E+04	1.35E-01	8.77E-07	2.56E-02	1.67E-01	4.90E-02
C-14	5.73E+03	1.94E-03	1.26E-08	8.64E-03	5.63E-02	1.65E-02
Total		3.66E+00	2.39E-05	1.16E+01	7.55E+01	2.21E+01

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware – September 2053 (sheet 1 of 11)

Inner Radial Shield Volume = 4.514E+06 cm^3, Mass = 3.227E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.82E-01	4.04E-08	2.06E+02	4.57E+01	6.38E+00
Ni-59	7.60E+04	1.46E+03	3.24E-04	1.17E+02	2.59E+01	3.61E+00
Ni-63	1.00E+02	1.41E+02	3.12E-05	8.01E+03	1.77E+03	2.48E+02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.15E+01	9.20E-06	7.90E+00	1.75E+00	2.44E-01
C-14	5.73E+03	6.90E+00	1.53E-06	3.07E+01	6.81E+00	9.51E-01
Total		1.65E+03	3.66E-04	8.37E+03	1.85E+03	2.59E+02

Outer Radial Shield Volume = 1.221E+07 cm^3, Mass = 8.834E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.01E-02	6.56E-09	9.06E+01	7.42E+00	1.02E+00
Ni-59	7.60E+04	6.83E+02	5.59E-05	5.45E+01	4.46E+00	6.16E-01
Ni-63	1.00E+02	6.55E+01	5.36E-06	3.72E+03	3.05E+02	4.20E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.98E+01	1.62E-06	3.77E+00	3.09E-01	4.26E-02
C-14	5.73E+03	2.91E+00	2.38E-07	1.30E+01	1.06E+00	1.47E-01
Total		7.71E+02	6.31E-05	3.88E+03	3.18E+02	4.39E+01

Radial Shield Support Volume = 4.556E+05 cm^3, Mass = 2.192E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.74E-04	1.04E-09	5.36E-01	1.18E+00	2.44E-01
Ni-59	7.60E+04	3.99E+00	8.75E-06	3.18E-01	6.98E-01	1.45E-01
Ni-63	1.00E+02	3.89E-01	8.53E-07	2.21E+01	4.85E+01	1.01E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	9.11E-02	2.00E-07	1.73E-02	3.80E-02	7.90E-03
C-14	5.73E+03	1.79E-02	3.93E-08	7.97E-02	1.75E-01	3.63E-02
Total		4.48E+00	9.84E-06	2.30E+01	5.06E+01	1.05E+01

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 2 of 11)

Core Basket Volume = 2.453E+06 cm^3, Mass = 5.399E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.05E-03	4.27E-10	1.19E+00	4.84E-01	2.20E-01
Ni-59	7.60E+04	9.41E+00	3.84E-06	7.51E-01	3.06E-01	1.39E-01
Ni-63	1.00E+02	9.31E-01	3.80E-07	5.29E+01	2.16E+01	9.79E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.68E-01	6.84E-08	3.19E-02	1.30E-02	5.91E-03
C-14	5.73E+03	4.46E-02	1.82E-08	1.99E-01	8.10E-02	3.68E-02
Total		1.06E+01	4.30E-06	5.50E+01	2.24E+01	1.02E+01

Grid Plate Volume = 1.818E+06 cm^3, Mass = 1.041E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.01E-03	1.65E-09	3.40E+00	1.87E+00	3.26E-01
Ni-59	7.60E+04	2.33E+01	1.28E-05	1.86E+00	1.02E+00	1.78E-01
Ni-63	1.00E+02	2.28E+00	1.26E-06	1.30E+02	7.13E+01	1.24E+01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	5.91E-01	3.25E-07	1.12E-01	6.18E-02	1.08E-02
C-14	5.73E+03	1.04E-01	5.73E-08	4.65E-01	2.56E-01	4.45E-02
Total		2.63E+01	1.45E-05	1.35E+02	7.45E+01	1.30E+01

Core Support Structure Volume = 5.355E+06 cm^3, Mass = 4.156E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.46E-04	4.60E-11	2.78E-01	5.20E-02	6.70E-03
Ni-59	7.60E+04	3.76E+00	7.01E-07	3.00E-01	5.60E-02	7.21E-03
Ni-63	1.00E+02	3.72E-01	6.95E-08	2.11E+01	3.95E+00	5.09E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.27E-02	4.23E-09	4.31E-03	8.05E-04	1.04E-04
C-14	5.73E+03	1.89E-02	3.53E-09	8.43E-02	1.57E-02	2.03E-03
Total		4.17E+00	7.79E-07	2.18E+01	4.07E+00	5.25E-01

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 3 of 11)

Reactor Vessel Volume = 2.001E+07 cm^3, Mass = 1.601E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.05E-04	1.02E-11	2.32E-01	1.16E-02	1.45E-03
Ni-59	7.60E+04	3.03E+00	1.51E-07	2.42E-01	1.21E-02	1.51E-03
Ni-63	1.00E+02	3.00E-01	1.50E-08	1.70E+01	8.51E-01	1.06E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	1.02E-09	3.90E-03	1.95E-04	2.44E-05
C-14	5.73E+03	1.53E-02	7.63E-10	6.80E-02	3.40E-03	4.25E-04
Total		3.37E+00	1.68E-07	1.76E+01	8.79E-01	1.10E-01

Thermal Liner Volume = 4.226E+06 cm^3, Mass = 2.874E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.57E-04	3.72E-11	1.78E-01	4.21E-02	6.20E-03
Ni-59	7.60E+04	2.34E+00	5.53E-07	1.87E-01	4.41E-02	6.49E-03
Ni-63	1.00E+02	2.30E-01	5.45E-08	1.31E+01	3.10E+00	4.55E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.54E-02	3.65E-09	2.93E-03	6.94E-04	1.02E-04
C-14	5.73E+03	1.18E-02	2.79E-09	5.25E-02	1.24E-02	1.82E-03
Total		2.60E+00	6.14E-07	1.35E+01	3.19E+00	4.70E-01

Guard Vessel Volume = 1.669E+07 cm^3, Mass = 1.335E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.55E-05	2.13E-12	4.02E-02	2.41E-03	3.01E-04
Ni-59	7.60E+04	7.21E-01	4.32E-08	5.76E-02	3.45E-03	4.31E-04
Ni-63	1.00E+02	7.11E-02	4.26E-09	4.04E+00	2.42E-01	3.02E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.20E-03	2.52E-10	7.99E-04	4.79E-05	5.99E-06
C-14	5.73E+03	3.63E-03	2.17E-10	1.62E-02	9.69E-04	1.21E-04
Total		8.00E-01	4.79E-08	4.15E+00	2.49E-01	3.11E-02

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware – September 2053 (sheet 4 of 11)

Core Barrel Volume = 2.570E+06 cm^3, Mass = 2.056E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.40E-03	9.35E-10	2.72E+00	1.06E+00	1.32E-01
Ni-59	7.60E+04	2.04E+01	7.95E-06	1.63E+00	6.35E-01	7.93E-02
Ni-63	1.00E+02	2.04E+00	7.93E-07	1.16E+02	4.50E+01	5.63E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.03E-01	1.57E-07	7.67E-02	2.98E-02	3.73E-03
C-14	5.73E+03	9.62E-02	3.74E-08	4.29E-01	1.67E-01	2.09E-02
Total		2.30E+01	8.94E-06	1.21E+02	4.69E+01	5.87E+00

In-Vessel Storage Modules (3) Volume = 8.566E+06 cm^3, Mass = 1.358E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.16E-04	4.86E-11	4.71E-01	5.50E-02	3.46E-02
Ni-59	7.60E+04	4.32E+00	5.04E-07	3.44E-01	4.02E-02	2.53E-02
Ni-63	1.00E+02	4.12E-01	4.80E-08	2.34E+01	2.73E+00	1.72E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.85E-04
Nb-94	2.00E+04	7.03E-02	8.21E-09	1.34E-02	1.56E-03	7.29E-03
C-14	5.73E+03	2.22E-02	2.59E-09	9.89E-02	1.15E-02	2.71E+01
Total		4.82E+00	5.63E-07	2.43E+01	2.84E+00	2.89E+01

Baffle Plate Volume = 1.237E+06 cm^3, Mass = 9.892E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.74E-05	3.03E-11	4.24E-02	3.43E-02	4.28E-03
Ni-59	7.60E+04	6.28E-01	5.07E-07	5.01E-02	4.05E-02	5.06E-03
Ni-63	1.00E+02	6.19E-02	5.00E-08	3.51E+00	2.84E+00	3.55E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.76E-03	3.04E-09	7.15E-04	5.78E-04	7.23E-05
C-14	5.73E+03	3.14E-03	2.54E-09	1.40E-02	1.13E-02	1.42E-03
Total		6.96E-01	5.63E-07	3.62E+00	2.93E+00	3.66E-01

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 5 of 11)

Instrument Tree Hold Downs Volume = 5.894E+05 cm^3, Mass = 7.031E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.23E-04	2.09E-10	1.39E-01	2.36E-01	1.98E-01
Ni-59	7.60E+04	9.81E-01	1.66E-06	7.83E-02	1.33E-01	1.11E-01
Ni-63	1.00E+02	9.50E-02	1.61E-07	5.39E+00	9.15E+00	7.66E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.05E-02	3.47E-08	3.89E-03	6.60E-03	5.53E-03
C-14	5.73E+03	4.55E-03	7.72E-09	2.03E-02	3.44E-02	2.88E-02
Total		1.10E+00	1.87E-06	5.64E+00	9.56E+00	8.00E+00

Instrument Tree Lower Frames Volume = 1.040E+06 cm^3, Mass = 3.795E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.30E-04	2.21E-10	2.60E-01	2.50E-01	6.83E-02
Ni-59	7.60E+04	2.09E+00	2.00E-06	1.66E-01	1.60E-01	4.38E-02
Ni-63	1.00E+02	2.06E-01	1.98E-07	1.17E+01	1.13E+01	3.08E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	3.42E-02	3.28E-08	6.50E-03	6.25E-03	1.71E-03
C-14	5.73E+03	9.98E-03	9.60E-09	4.45E-02	4.28E-02	1.17E-02
Total		2.34E+00	2.25E-06	1.22E+01	1.17E+01	3.21E+00

Instrument Tree Guide Tubes Volume = 1.224E+07 cm^3, Mass = 4.614E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.04E-05	8.46E-13	1.17E-02	9.57E-04	2.53E-03
Ni-59	7.60E+04	1.52E-01	1.25E-08	1.22E-02	9.94E-04	2.63E-03
Ni-63	1.00E+02	1.49E-02	1.22E-09	8.47E-01	6.92E-02	1.83E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.33E-03	1.09E-10	2.53E-04	2.07E-05	5.48E-05
C-14	5.73E+03	7.54E-04	6.16E-11	3.36E-03	2.75E-04	7.27E-04
Total		1.69E-01	1.38E-08	8.75E-01	7.15E-02	1.89E-01

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 6 of 11)

Instrument Tree Columns Volume = 7.201E+06 cm^3, Mass = 7.215E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.53E-05	2.12E-12	1.73E-02	2.40E-03	2.40E-03
Ni-59	7.60E+04	1.97E-01	2.74E-08	1.57E-02	2.19E-03	2.18E-03
Ni-63	1.00E+02	1.93E-02	2.68E-09	1.10E+00	1.52E-01	1.52E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.03E-03	2.83E-10	3.87E-04	5.38E-05	5.36E-05
C-14	5.73E+03	9.67E-04	1.34E-10	4.31E-03	5.99E-04	5.97E-04
Total		2.20E-01	3.05E-08	1.13E+00	1.57E-01	1.57E-01

Instrument Tree Shield Plugs Volume = 2.864E+06 cm^3, Mass = 2.292E+04 kg

Radio-Nuclide	Half LIfe (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.89E-10	3.45E-16	1.12E-06	3.91E-07	4.88E-08
Ni-59	7.60E+04	1.52E-05	7.43E-15	1.22E-06	5.93E-10	7.41E-11
Ni-63	1.00E+02	1.52E-06	1.05E-15	8.64E-05	5.96E-08	7.45E-09
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	1.60E-07	7.81E-17	3.04E-08	1.49E-11	1.86E-12
C-14	5.73E+03	7.49E-08	3.67E-17	3.34E-07	1.64E-10	2.05E-11
Total		1.70E-05	8.94E-15	8.91E-05	4.51E-07	5.64E-08

Instrument Tree Shield Plates Volume = 1.967E+06 cm^3, Mass = 1.577E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.71E-10	5.14E-17	9.85E-07	5.81E-08	7.25E-09
Ni-59	7.60E+04	3.42E-05	2.02E-12	2.73E-06	1.61E-07	2.01E-08
Ni-63	1.00E+02	3.41E-06	2.01E-13	1.93E-04	1.14E-05	1.42E-06
Mo-93	3.50E+03	3.48E-09	2.05E-16	3.83E-09	2.26E-10	2.81E-11
Tc-99	2.13E+05	1.19E-07	7.03E-15	2.02E-09	1.19E-10	1.49E-11
Nb-94	2.00E+04	7.00E-08	4.13E-15	1.33E-08	7.85E-10	9.79E-11
C-14	5.73E+03	5.66E-08	3.34E-15	2.52E-07	1.49E-08	1.86E-09
Total		3.79E-05	2.23E-12	1.97E-04	1.16E-05	1.45E-06

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 7 of 11)

Instrument Trees Composite Volume = 2.590E+07 cm^3, Mass = 5.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.78E-04	1.46E-11	4.28E-01	1.65E-02	7.78E-03
Ni-59	7.60E+04	3.42E+00	1.32E-07	2.72E-01	1.05E-02	4.95E-03
Ni-63	1.00E+02	3.36E-01	1.30E-08	1.91E+01	7.36E-01	3.46E-01
Mo-93	3.50E+03	3.48E-09	1.34E-16	3.83E-09	1.48E-10	6.95E-11
Tc-99	2.13E+05	1.19E-07	4.60E-15	2.02E-09	7.81E-11	3.68E-11
Nb-94	2.00E+04	5.80E-02	2.24E-09	1.10E-02	4.26E-04	2.01E-04
C-14	5.73E+03	1.62E-02	6.27E-10	7.24E-02	2.80E-03	1.32E-03
Total		3.83E+00	1.48E-07	1.98E+01	7.66E-01	3.61E-01

In-Vessel Handling Machines (3) Volume = 2.482E+07 cm^3, Mass = 4.329E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.56E-06	3.85E-13	1.08E-02	4.36E-04	2.49E-04
Ni-59	7.60E+04	2.04E-01	8.24E-09	1.63E-02	6.57E-04	3.76E-04
Ni-63	1.00E+02	2.01E-02	8.08E-10	1.14E+00	4.59E-02	2.63E-02
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	8.39E-04	3.38E-11	1.60E-04	6.43E-06	3.68E-06
C-14	5.73E+03	1.03E-03	4.15E-11	4.59E-03	1.85E-04	1.06E-04
Total		2.26E-01	9.12E-09	1.17E+00	4.72E-02	2.70E-02

IVHM Shield Plug Volume = 4.543E+06 cm^3, Mass = 3.636E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.57E-09	3.45E-16	1.77E-06	3.91E-07	4.88E-08
Ni-59	7.60E+04	2.42E-05	7.43E-15	1.93E-06	5.93E-10	7.41E-11
Ni-63	1.00E+02	2.41E-06	1.05E-15	1.37E-04	5.96E-08	7.45E-09
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.54E-07	7.81E-17	4.83E-08	1.49E-11	1.86E-12
C-14	5.73E+03	1.19E-07	3.67E-17	5.30E-07	1.64E-10	2.05E-11
Total		2.70E-05	8.94E-15	1.41E-04	4.51E-07	5.64E-08

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 8 of 11)

IVHM Shield Plates Volume = 3.120E+06 cm^3, Mass = 2.502E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.38E-09	8.15E-17	1.56E-06	9.22E-08	1.15E-08
Ni-59	7.60E+04	5.43E-05	3.20E-12	4.33E-06	2.55E-07	3.19E-08
Ni-63	1.00E+02	5.40E-06	3.19E-13	3.07E-04	1.81E-05	2.26E-06
Mo-93	3.50E+03	5.52E-09	3.26E-16	6.07E-09	3.58E-10	4.46E-11
Tc-99	2.13E+05	1.89E-07	1.12E-14	3.21E-09	1.89E-10	2.36E-11
Nb-94	2.00E+04	1.11E-07	6.55E-15	2.11E-08	1.25E-09	1.55E-10
C-14	5.73E+03	8.98E-08	5.30E-15	4.00E-07	2.36E-08	2.94E-09
Total		6.01E-05	3.54E-12	3.13E-04	1.85E-05	2.30E-06

IVHM Composite Volume = 3.248E+07 cm^3, Mass = 1.047E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.56E-06	2.94E-13	1.082E-02	3.33E-04	1.03E-04
Ni-59	7.60E+04	2.04E-01	6.30E-09	1.632E-02	5.02E-04	1.56E-04
Ni-63	1.00E+02	2.01E-02	6.18E-10	1.140E+00	3.51E-02	1.09E-02
Mo-93	3.50E+03	5.52E-09	1.70E-16	6.069E-09	1.87E-10	5.80E-11
Tc-99	2.13E+05	1.89E-07	5.82E-15	3.208E-09	9.88E-11	3.07E-11
Nb-94	2.00E+04	8.39E-04	2.58E-11	1.597E-04	4.92E-06	1.53E-06
C-14	5.73E+03	1.03E-03	3.17E-11	4.593E-03	1.41E-04	4.39E-05
Total		2.26E-01	6.97E-09	1.17E+00	3.61E-02	1.12E-02

Closure Head Volume = 2.469E+07 cm^3, Mass = 1.360E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.11E-09	4.49E-17	1.25E-06	5.08E-08	9.22E-09
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	3.14E-11	1.27E-18	1.40E-10	5.67E-12	1.03E-12
Total		1.14E-09	4.62E-17	1.25E-06	5.08E-08	9.22E-09

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 9 of 11)

Suppressor Plate Volume = 1.874E+05 cm^3, Mass = 1.052E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.67E-10	2.49E-15	5.29E-07	2.82E-06	5.02E-07
Ni-59	7.60E+04	8.26E-05	4.41E-10	6.59E-06	3.52E-05	6.26E-06
Ni-63	1.00E+02	7.72E-06	4.12E-11	4.39E-04	2.34E-03	4.17E-04
Mo-93	3.50E+03	8.63E-08	4.60E-13	9.48E-08	5.06E-07	9.01E-08
Tc-99	2.13E+05	3.33E-06	1.78E-11	5.66E-08	3.02E-07	5.38E-08
Nb-94	2.00E+04	3.04E-07	1.62E-12	5.78E-08	3.09E-07	5.50E-08
C-14	5.73E+03	3.13E-08	1.67E-13	1.39E-07	7.43E-07	1.32E-07
Total		9.41E-05	5.02E-10	4.46E-04	2.38E-03	4.24E-04

Thermal Reflector Plates Volume = 3.811E+06 cm^3, Mass = 2.134E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.08E-08	2.84E-15	1.22E-05	3.21E-06	5.74E-07
Ni-59	7.60E+04	6.99E-04	1.84E-10	5.58E-05	1.46E-05	2.62E-06
Ni-63	1.00E+02	6.56E-05	1.72E-11	3.73E-03	9.78E-04	1.75E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.09E-06	5.49E-13	3.98E-07	1.04E-07	1.87E-08
C-14	5.73E+03	3.52E-06	9.24E-13	1.57E-05	4.12E-06	7.35E-07
Total		7.71E-04	2.02E-10	3.81E-03	1.00E-03	1.79E-04

Inconel Shield Plate Volume = 3.811E+06 cm^3, Mass = 2.254E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.58E-09	9.39E-16	4.05E-06	1.06E-06	1.80E-07
Ni-59	7.60E+04	8.05E-04	2.11E-10	6.43E-05	1.69E-05	2.85E-06
Ni-63	1.00E+02	7.67E-05	2.01E-11	4.36E-03	1.14E-03	1.93E-04
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.12E-11	2.95E-18	5.01E-11	1.31E-11	2.22E-12
Total		8.82E-04	2.31E-10	4.43E-03	1.16E-03	1.96E-04

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 10 of 11)

SS-410 Shield Plate Volume = 3.049E+06 cm^3, Mass = 1.665E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.66E-10	5.46E-17	1.88E-07	6.18E-08	1.13E-08
Ni-59	7.60E+04	2.54E-06	8.32E-13	2.02E-07	6.64E-08	1.22E-08
Ni-63	1.00E+02	2.45E-07	8.04E-14	1.39E-05	4.57E-06	8.37E-07
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	1.53E-08	5.01E-15	6.81E-08	2.23E-08	4.09E-09
Total		2.80E-06	9.18E-13	1.44E-05	4.72E-06	8.65E-07

Low-Carbon Steel Shield Plate Volume = 6.097E+06 cm^3, Mass = 3.359E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.03E-10	1.69E-17	1.17E-07	1.92E-08	3.48E-09
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	4.00E-12	6.56E-19	1.78E-11	2.92E-12	5.30E-13
Total		1.07E-10	1.76E-17	1.17E-07	1.92E-08	3.48E-09

Head Assembly Composite (Head + Suppressor, Reflector and Shield Plates) Volume = 4.165E+07 cm^3, Mass = 2.312E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.62E-08	3.90E-16	1.84E-05	4.41E-07	7.95E-08
Ni-59	7.60E+04	1.59E-03	3.82E-11	1.27E-04	3.05E-06	5.49E-07
Ni-63	1.00E+02	1.50E-04	3.61E-12	8.54E-03	2.05E-04	3.69E-05
Mo-93	3.50E+03	8.63E-08	2.07E-15	9.48E-08	2.28E-09	4.10E-10
Tc-99	2.13E+05	3.33E-06	8.01E-14	5.66E-08	1.36E-09	2.45E-10
Nb-94	2.00E+04	2.40E-06	5.75E-14	4.56E-07	1.09E-08	1.97E-09
C-14	5.73E+03	3.57E-06	8.57E-14	1.59E-05	3.82E-07	6.87E-08
Total		1.75E-03	4.20E-11	8.70E-03	2.09E-04	3.76E-05

Table 6-11. Radionuclide Inventories in Activated Reactor Hardware - September 2053 (sheet 11 of 11)

Z Ring Volume = 1.989E+07 cm^3, Mass = 1.591E+05 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.94E-08	9.75E-16	2.19E-05	1.10E-06	1.38E-07
Ni-59	7.60E+04	3.05E-04	1.54E-11	2.44E-05	1.23E-06	1.53E-07
Ni-63	1.00E+02	3.04E-05	1.53E-12	1.73E-03	8.69E-05	1.09E-05
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	2.82E-06	1.42E-13	5.36E-07	2.69E-08	3.37E-09
C-14	5.73E+03	1.51E-06	7.61E-14	6.75E-06	3.39E-07	4.24E-08
Total		3.40E-04	1.71E-11	1.78E-03	8.96E-05	1.12E-05

Boron Carbide Shield Volume = 1.932E+06 cm^3, Mass = 4.831E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.73E+03	7.28E-09	3.77E-15	3.24E-08	1.68E-08	6.72E-09
Total		7.28E-09	3.77E-15	3.24E-08	1.68E-08	6.72E-09

Steel Roof Volume = 5.468E+06 cm^3, Mass = 4.303E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.17E-13	9.46E-20	5.85E-10	1.07E-10	1.36E-11
Ni-59	7.60E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	2.01E-07	3.68E-14	3.41E-09	6.24E-10	7.93E-11
Nb-94	2.00E+04	2.36E-08	4.32E-15	4.49E-09	8.22E-10	1.04E-10
C-14	5.73E+03	4.52E-14	8.26E-21	2.01E-13	3.68E-14	4.68E-15
Total		2.25E-07	4.11E-14	8.49E-09	1.55E-09	1.97E-10

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 1 of 12)

Irradiated Row 7 Radial Reflectors 81 total in vessel

Inconel Reflector Section Volume = 1.287E+06 cm^3, Mass = 9.011E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.22E-01	1.73E-07	2.51E+02	1.95E+02	2.79E+01
Ni-59	7.60E+04	6.85E+03	5.32E-03	5.47E+02	4.25E+02	6.07E+01
Ni-63	1.00E+02	9.43E+02	7.32E-04	5.35E+04	4.16E+04	5.94E+03
Mo-93	3.50E+03	6.76E+01	5.25E-05	7.43E+01	5.77E+01	8.24E+00
Tc-99	2.13E+05	3.61E+02	2.81E-04	6.13E+00	4.76E+00	6.80E-01
Nb-94	2.00E+04	3.64E+01	2.83E-05	6.92E+00	5.38E+00	7.68E-01
C-14	5.73E+03	4.12E-01	3.20E-07	1.84E+00	1.43E+00	2.04E-01
Total		8.26E+03	6.42E-03	5.44E+04	4.23E+04	6.04E+03

Upper Shield Section Volume = 1.253E+06 cm^3, Mass = 8.386E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.67E-03	6.12E-09	8.67E+00	6.92E+00	1.03E+00
Ni-59	7.60E+04	1.54E+02	1.23E-04	1.23E+01	9.80E+00	1.46E+00
Ni-63	1.00E+02	1.39E+01	1.11E-05	7.91E+02	6.31E+02	9.43E+01
Mo-93	3.50E+03	1.23E+01	9.80E-06	1.35E+01	1.08E+01	1.61E+00
Tc-99	2.13E+05	8.85E+01	7.06E-05	1.50E+00	1.20E+00	1.79E-01
Nb-94	2.00E+04	1.15E+01	9.16E-06	2.18E+00	1.74E+00	2.60E-01
C-14	5.73E+03	5.38E-02	4.29E-08	2.40E-01	1.91E-01	2.86E-02
Total		2.80E+02	2.24E-04	8.29E+02	6.61E+02	9.89E+01

Lower Shield/Orifice Volume = 7.371E+05 cm^3, Mass = 4.516E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.23E-02	1.67E-08	1.39E+01	1.89E+01	3.08E+00
Ni-59	7.60E+04	2.26E+02	3.06E-04	1.80E+01	2.45E+01	3.99E+00
Ni-63	1.00E+02	2.20E+01	2.99E-05	1.25E+03	1.70E+03	2.77E+02
Mo-93	3.50E+03	1.55E+01	2.10E-05	1.70E+01	2.31E+01	3.77E+00
Tc-99	2.13E+05	1.17E+02	1.58E-04	1.98E+00	2.69E+00	4.39E-01
Nb-94	2.00E+04	1.50E+01	2.03E-05	2.85E+00	3.86E+00	6.30E-01
C-14	5.73E+03	8.34E-02	1.13E-07	3.72E-01	5.04E-01	8.23E-02
Total		3.95E+02	5.36E-04	1.31E+03	1.77E+03	2.89E+02

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 2 of 12)

Irradiated Row 7 Radial Reflectors (continued)

Handling Socket Volume = 1.540E+05 cm^3, Mass = 2.125E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.37E-05	8.92E-11	1.56E-02	1.01E-01	7.32E-02
Ni-59	7.60E+04	2.20E-01	1.43E-06	1.76E-02	1.14E-01	8.26E-02
Ni-63	1.00E+02	2.10E-02	1.36E-07	1.19E+00	7.75E+00	5.62E+00
Mo-93	3.50E+03	6.16E-03	4.00E-08	6.77E-03	4.40E-02	3.19E-02
Tc-99	2.13E+05	1.14E-01	7.40E-07	1.93E-03	1.25E-02	9.09E-03
Nb-94	2.00E+04	1.01E-02	6.58E-08	1.93E-03	1.25E-02	9.07E-03
C-14	5.73E+03	7.36E-05	4.78E-10	3.28E-04	2.13E-03	1.54E-03
Total		3.71E-01	2.41E-06	1.24E+00	8.04E+00	5.82E+00

Nozzle Volume = 1.466E+05 cm^3, Mass = 4.922E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.16E-05	6.24E-10	1.04E-01	7.06E-01	2.11E-01
Ni-59	7.60E+04	1.57E+00	1.07E-05	1.25E-01	8.56E-01	2.55E-01
Ni-63	1.00E+02	1.53E-01	1.05E-06	8.70E+00	5.94E+01	1.77E+01
Mo-93	3.50E+03	5.29E-02	3.61E-07	5.82E-02	3.97E-01	1.18E-01
Tc-99	2.13E+05	7.55E-01	5.15E-06	1.28E-02	8.74E-02	2.60E-02
Nb-94	2.00E+04	7.84E-02	5.35E-07	1.49E-02	1.02E-01	3.03E-02
C-14	5.73E+03	5.24E-04	3.57E-09	2.33E-03	1.59E-02	4.74E-03
Total		2.61E+00	1.78E-05	9.02E+00	6.15E+01	1.83E+01

Row 7 Radial Reflectors Composite Volume = 3.578E+06 cm^3, Mass = 2.262E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.42E-01	6.77E-08	2.74E+02	7.66E+01	1.21E+01
Ni-59	7.60E+04	7.23E+03	2.02E-03	5.77E+02	1.61E+02	2.55E+01
Ni-63	1.00E+02	9.79E+02	2.74E-04	5.56E+04	1.55E+04	2.46E+03
Mo-93	3.50E+03	9.54E+01	2.67E-05	1.05E+02	2.93E+01	4.64E+00
Tc-99	2.13E+05	5.67E+02	1.59E-04	9.63E+00	2.69E+00	4.26E-01
Nb-94	2.00E+04	6.29E+01	1.76E-05	1.20E+01	3.35E+00	5.29E-01
C-14	5.73E+03	5.50E-01	1.54E-07	2.45E+00	6.85E-01	1.08E-01
Total		8.94E+03	2.50E-03	5.66E+04	1.58E+04	2.50E+03

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 3 of 12)

Irradiated Row 8 and 9 Radial Reflectors 73 total in vessel

Inconel Reflector Section Volume = 1.160E+06 cm^3, Mass = 8.439E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.14E-01	2.71E-07	3.55E+02	3.06E+02	4.21E+01
Ni-59	7.60E+04	9.59E+03	8.27E-03	7.65E+02	6.60E+02	9.07E+01
Ni-63	1.00E+02	1.24E+03	1.07E-03	7.02E+04	6.06E+04	8.32E+03
Mo-93	3.50E+03	7.88E+01	6.80E-05	8.66E+01	7.47E+01	1.03E+01
Tc-99	2.13E+05	5.66E+02	4.88E-04	9.60E+00	8.27E+00	1.14E+00
Nb-94	2.00E+04	5.89E+01	5.08E-05	1.12E+01	9.66E+00	1.33E+00
C-14	5.73E+03	5.16E-01	4.45E-07	2.30E+00	1.98E+00	2.73E-01
Total		1.15E+04	9.94E-03	7.15E+04	6.16E+04	8.47E+03

Upper Shield Section Volume = 1.128E+06 cm^3, Mass = 7.969E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.64E-03	7.66E-09	9.78E+00	8.66E+00	1.23E+00
Ni-59	7.60E+04	1.81E+02	1.61E-04	1.45E+01	1.28E+01	1.82E+00
Ni-63	1.00E+02	1.65E+01	1.46E-05	9.38E+02	8.31E+02	1.18E+02
Mo-93	3.50E+03	1.38E+01	1.22E-05	1.51E+01	1.34E+01	1.90E+00
Tc-99	2.13E+05	9.91E+01	8.78E-05	1.68E+00	1.49E+00	2.11E-01
Nb-94	2.00E+04	1.28E+01	1.13E-05	2.43E+00	2.15E+00	3.05E-01
C-14	5.73E+03	5.78E-02	5.12E-08	2.58E-01	2.28E-01	3.23E-02
Total		3.24E+02	2.87E-04	9.81E+02	8.69E+02	1.23E+02

Lower Shield/Orifice Volume = 6.643E+05 cm^3, Mass = 3.115E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.04E-02	1.57E-08	1.18E+01	1.78E+01	3.80E+00
Ni-59	7.60E+04	2.03E+02	3.05E-04	1.62E+01	2.44E+01	5.20E+00
Ni-63	1.00E+02	1.89E+01	2.85E-05	1.07E+03	1.62E+03	3.45E+02
Mo-93	3.50E+03	1.28E+01	1.92E-05	1.41E+01	2.12E+01	4.51E+00
Tc-99	2.13E+05	1.05E+02	1.58E-04	1.78E+00	2.68E+00	5.72E-01
Nb-94	2.00E+04	1.33E+01	2.00E-05	2.53E+00	3.81E+00	8.12E-01
C-14	5.73E+03	6.81E-02	1.02E-07	3.03E-01	4.57E-01	9.74E-02
Total		3.53E+02	5.31E-04	1.12E+03	1.69E+03	3.60E+02

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 4 of 12)

Irradiated Row 8 and 9 Radial Reflectors (continued)

Handling Socket Volume = 1.384E+05 cm^3, Mass = 1.910E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.38E-05	9.94E-11	1.56E-02	1.12E-01	8.15E-02
Ni-59	7.60E+04	2.43E-01	1.75E-06	1.94E-02	1.40E-01	1.01E-01
Ni-63	1.00E+02	2.33E-02	1.68E-07	1.32E+00	9.57E+00	6.93E+00
Mo-93	3.50E+03	6.31E-03	4.55E-08	6.93E-03	5.01E-02	3.63E-02
Tc-99	2.13E+05	1.21E-01	8.71E-07	2.04E-03	1.48E-02	1.07E-02
Nb-94	2.00E+04	1.05E-02	7.61E-08	2.00E-03	1.45E-02	1.05E-02
C-14	5.73E+03	8.24E-05	5.95E-10	3.67E-04	2.65E-03	1.92E-03
Total		4.04E-01	2.92E-06	1.37E+00	9.90E+00	7.18E+00

Nozzle Volume = 5.925E+04 cm^3, Mass = 1.989E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.21E-05	1.39E-09	9.29E-02	1.57E+00	4.67E-01
Ni-59	7.60E+04	1.41E+00	2.38E-05	1.12E-01	1.90E+00	5.66E-01
Ni-63	1.00E+02	1.37E-01	2.32E-06	7.81E+00	1.32E+02	3.93E+01
Mo-93	3.50E+03	4.75E-02	8.01E-07	5.22E-02	8.81E-01	2.62E-01
Tc-99	2.13E+05	6.77E-01	1.14E-05	1.15E-02	1.94E-01	5.78E-02
Nb-94	2.00E+04	7.03E-02	1.19E-06	1.34E-02	2.26E-01	6.73E-02
C-14	5.73E+03	4.70E-04	7.93E-09	2.09E-03	3.53E-02	1.05E-02
Total		2.34E+00	3.95E-05	8.09E+00	1.37E+02	4.07E+01

Row 8 and 9 Reflectors Composite Volume = 3.150E+06 cm^3, Mass = 1.991E+04 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.33E-01	1.06E-07	3.77E+02	1.20E+02	1.89E+01
Ni-59	7.60E+04	9.97E+03	3.17E-03	7.96E+02	2.53E+02	4.00E+01
Ni-63	1.00E+02	1.27E+03	4.04E-04	7.23E+04	2.29E+04	3.63E+03
Mo-93	3.50E+03	1.05E+02	3.35E-05	1.16E+02	3.68E+01	5.82E+00
Tc-99	2.13E+05	7.71E+02	2.45E-04	1.31E+01	4.15E+00	6.56E-01
Nb-94	2.00E+04	8.50E+01	2.70E-05	1.62E+01	5.13E+00	8.12E-01
C-14	5.73E+03	6.43E-01	2.04E-07	2.86E+00	9.09E-01	1.44E-01
Total		1.22E+04	3.87E-03	7.36E+04	2.34E+04	3.69E+03

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 5 of 12)

Irradiated Control and Safety Rods 31 total in vessel

Absorber Region Volume = 3.601E+05 cm^3, Mass = 1.198E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.34E-03	3.73E-09	1.52E+00	4.22E+00	1.27E+00
Ni-59	7.60E+04	1.12E+02	3.10E-04	8.90E+00	2.47E+01	7.43E+00
Ni-63	1.00E+02	5.80E+00	1.61E-05	3.29E+02	9.15E+02	2.75E+02
Mo-93	3.50E+03	1.43E+01	3.97E-05	1.57E+01	4.37E+01	1.31E+01
Tc-99	2.13E+05	5.59E+01	1.55E-04	9.48E-01	2.63E+00	7.91E-01
Nb-94	2.00E+04	6.85E+00	1.90E-05	1.30E+00	3.62E+00	1.09E+00
C-14	5.73E+03	1.11E-01	3.09E-07	4.96E-01	1.38E+00	4.14E-01
Total		1.94E+02	5.40E-04	3.58E+02	9.95E+02	2.99E+02

Control Rod Follower Volume = 7.607E+04 cm^3, Mass = 2.362E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.50E-04	5.92E-09	5.09E-01	6.70E+00	2.16E+00
Ni-59	7.60E+04	6.18E+01	8.12E-04	4.93E+00	6.48E+01	2.09E+01
Ni-63	1.00E+02	3.25E+00	4.27E-05	1.85E+02	2.43E+03	7.81E+02
Mo-93	3.50E+03	8.56E+00	1.13E-04	9.41E+00	1.24E+02	3.98E+01
Tc-99	2.13E+05	3.05E+01	4.00E-04	5.17E-01	6.79E+00	2.19E+00
Nb-94	2.00E+04	4.01E+00	5.27E-05	7.63E-01	1.00E+01	3.23E+00
C-14	5.73E+03	5.36E-02	7.04E-07	2.39E-01	3.14E+00	1.01E+00
Total		1.08E+02	1.42E-03	2.01E+02	2.64E+03	8.50E+02

Control Shield Volume = 2.806E+05 cm^3, Mass = 1.537E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.85E-03	2.80E-08	8.88E+00	3.17E+01	5.78E+00
Ni-59	7.60E+04	1.14E+02	4.05E-04	9.08E+00	3.23E+01	5.91E+00
Ni-63	1.00E+02	1.11E+01	3.95E-05	6.29E+02	2.24E+03	4.09E+02
Mo-93	3.50E+03	6.88E+00	2.45E-05	7.56E+00	2.70E+01	4.92E+00
Tc-99	2.13E+05	7.01E+01	2.50E-04	1.19E+00	4.24E+00	7.74E-01
Nb-94	2.00E+04	7.41E+00	2.64E-05	1.41E+00	5.03E+00	9.18E-01
C-14	5.73E+03	4.37E-02	1.56E-07	1.95E-01	6.94E-01	1.27E-01
Total		2.09E+02	7.46E-04	6.57E+02	2.34E+03	4.27E+02

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 6 of 12)

Irradiated Control and Safety Rods (continued)

Nozzle Volume = 1.136E+05 cm^3, Mass = 3.811E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.90E-05	8.72E-10	1.12E-01	9.86E-01	2.94E-01
Ni-59	7.60E+04	1.44E+00	1.27E-05	1.15E-01	1.01E+00	3.01E-01
Ni-63	1.00E+02	1.41E-01	1.24E-06	8.01E+00	7.05E+01	2.10E+01
Mo-93	3.50E+03	4.72E-02	4.16E-07	5.19E-02	4.57E-01	1.36E-01
Tc-99	2.13E+05	7.15E-01	6.29E-06	1.21E-02	1.07E-01	3.18E-02
Nb-94	2.00E+04	7.13E-02	6.28E-07	1.36E-02	1.19E-01	3.56E-02
C-14	5.73E+03	4.80E-04	4.22E-09	2.14E-03	1.88E-02	5.61E-03
Total		2.41E+00	2.12E-05	8.31E+00	7.32E+01	2.18E+01

Above Absorber Volume = 1.258E+05 cm^3, Mass = 3.729E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.46E-05	7.52E-10	1.07E-01	8.51E-01	2.87E-01
Ni-59	7.60E+04	1.44E+00	1.14E-05	1.15E-01	9.12E-01	3.08E-01
Ni-63	1.00E+02	1.33E-01	1.06E-06	7.58E+00	6.02E+01	2.03E+01
Mo-93	3.50E+03	1.17E-01	9.32E-07	1.29E-01	1.02E+00	3.46E-01
Tc-99	2.13E+05	1.11E+00	8.79E-06	1.88E-02	1.49E-01	5.03E-02
Nb-94	2.00E+04	1.19E-01	9.45E-07	2.26E-02	1.80E-01	6.07E-02
C-14	5.73E+03	4.35E-04	3.46E-09	1.94E-03	1.54E-02	5.20E-03
Total		2.91E+00	2.32E-05	7.97E+00	6.34E+01	2.14E+01

Driveline Volume = 1.523E+05 cm^3, Mass = 2.901E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.13E-05	3.37E-10	5.80E-02	3.81E-01	2.00E-01
Ni-59	7.60E+04	7.33E-01	4.81E-06	5.85E-02	3.84E-01	2.02E-01
Ni-63	1.00E+02	7.01E-02	4.61E-07	3.98E+00	2.62E+01	1.37E+01
Mo-93	3.50E+03	3.41E-02	2.24E-07	3.75E-02	2.46E-01	1.29E-01
Tc-99	2.13E+05	4.80E-01	3.15E-06	8.14E-03	5.34E-02	2.81E-02
Nb-94	2.00E+04	4.75E-02	3.12E-07	9.03E-03	5.93E-02	3.11E-02
C-14	5.73E+03	2.33E-04	1.53E-09	1.04E-03	6.81E-03	3.57E-03
Total		1.36E+00	8.96E-06	4.16E+00	2.73E+01	1.43E+01

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 7 of 12)

Irradiated Control and Safety Rods (continued)

Handling Socket Volume = 5.873E+04 cm^3, Mass = 8.105E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	7.12E-06	1.21E-10	8.06E-03	1.37E-01	9.95E-02
Ni-59	7.60E+04	9.63E-02	1.64E-06	7.69E-03	1.31E-01	9.48E-02
Ni-63	1.00E+02	9.18E-03	1.56E-07	5.21E-01	8.88E+00	6.43E+00
Mo-93	3.50E+03	2.69E-03	4.57E-08	2.95E-03	5.03E-02	3.64E-02
Tc-99	2.13E+05	5.12E-02	8.71E-07	8.68E-04	1.48E-02	1.07E-02
Nb-94	2.00E+04	4.56E-03	7.77E-08	8.69E-04	1.48E-02	1.07E-02
C-14	5.73E+03	3.20E-05	5.45E-10	1.43E-04	2.43E-03	1.76E-03
Total		1.64E-01	2.79E-06	5.42E-01	9.23E+00	6.69E+00

Control and Safety Rods Composite Volume = 1.167E+06 cm^3, Mass = 4.097E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.90E-03	8.48E-09	1.12E+01	9.59E+00	2.73E+00
Ni-59	7.60E+04	2.91E+02	2.49E-04	2.32E+01	1.99E+01	5.66E+00
Ni-63	1.00E+02	2.05E+01	1.75E-05	1.16E+03	9.96E+02	2.84E+02
Mo-93	3.50E+03	2.99E+01	2.57E-05	3.29E+01	2.82E+01	8.04E+00
Tc-99	2.13E+05	1.59E+02	1.36E-04	2.70E+00	2.31E+00	6.58E-01
Nb-94	2.00E+04	1.85E+01	1.59E-05	3.52E+00	3.02E+00	8.60E-01
C-14	5.73E+03	2.10E-01	1.80E-07	9.34E-01	8.01E-01	2.28E-01
Total		5.19E+02	4.44E-04	1.24E+03	1.06E+03	3.02E+02

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 8 of 12)

Irradiated In-Core Shim Assemblies 7 total in vessel

Central and Upper Region Volume = 1.851E+05 cm^3, Mass = 8.482E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.17E-03	1.17E-08	2.46E+00	1.33E+01	2.90E+00
Ni-59	7.60E+04	1.11E+02	6.01E-04	8.88E+00	4.80E+01	1.05E+01
Ni-63	1.00E+02	7.29E+00	3.94E-05	4.14E+02	2.24E+03	4.88E+02
Mo-93	3.50E+03	1.48E+01	7.97E-05	1.62E+01	8.76E+01	1.91E+01
Tc-99	2.13E+05	6.98E+01	3.77E-04	1.18E+00	6.39E+00	1.40E+00
Nb-94	2.00E+04	8.26E+00	4.46E-05	1.57E+00	8.49E+00	1.85E+00
C-14	5.73E+03	8.69E-02	4.70E-07	3.87E-01	2.09E+00	4.57E-01
Total		2.11E+02	1.14E-03	4.44E+02	2.40E+03	5.24E+02

Lower Shield Volume = 6.372E+04 cm^3, Mass = 4.767E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.53E-03	2.40E-08	1.73E+00	2.71E+01	3.62E+00
Ni-59	7.60E+04	2.99E+01	4.69E-04	2.39E+00	3.75E+01	5.01E+00
Ni-63	1.00E+02	2.77E+00	4.35E-05	1.57E+02	2.47E+03	3.30E+02
Mo-93	3.50E+03	1.70E+00	2.67E-05	1.87E+00	2.94E+01	3.93E+00
Tc-99	2.13E+05	1.81E+01	2.84E-04	3.07E-01	4.82E+00	6.44E-01
Nb-94	2.00E+04	1.86E+00	2.92E-05	3.54E-01	5.56E+00	7.43E-01
C-14	5.73E+03	1.12E-02	1.75E-07	4.98E-02	7.82E-01	1.04E-01
Total		5.43E+01	8.53E-04	1.64E+02	2.58E+03	3.44E+02

Nozzle Volume = 2.562E+04 cm^3, Mass = 8.595E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.62E-05	6.33E-10	1.83E-02	7.16E-01	2.13E-01
Ni-59	7.60E+04	3.17E-01	1.24E-05	2.53E-02	9.86E-01	2.94E-01
Ni-63	1.00E+02	3.02E-02	1.18E-06	1.72E+00	6.70E+01	2.00E+01
Mo-93	3.50E+03	1.04E-02	4.06E-07	1.14E-02	4.47E-01	1.33E-01
Tc-99	2.13E+05	1.51E-01	5.91E-06	2.57E-03	1.00E-01	2.99E-02
Nb-94	2.00E+04	1.54E-02	6.01E-07	2.93E-03	1.14E-01	3.41E-02
C-14	5.73E+03	1.05E-04	4.10E-09	4.68E-04	1.83E-02	5.45E-03
Total		5.24E-01	2.05E-05	1.78E+00	6.94E+01	2.07E+01

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 9 of 12)

Irradiated In-Core Shim Assemblies (continued)

Handling Socket Volume = 1.325E+04 cm^3, Mass = 1.828E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.17E-06	8.83E-11	1.32E-03	9.98E-02	7.23E-02
Ni-59	7.60E+04	2.08E-02	1.57E-06	1.66E-03	1.25E-01	9.08E-02
Ni-63	1.00E+02	1.94E-03	1.47E-07	1.10E-01	8.33E+00	6.04E+00
Mo-93	3.50E+03	5.74E-04	4.34E-08	6.31E-04	4.77E-02	3.45E-02
Tc-99	2.13E+05	1.13E-02	8.51E-07	1.91E-04	1.44E-02	1.05E-02
Nb-94	2.00E+04	9.85E-04	7.44E-08	1.87E-04	1.42E-02	1.03E-02
C-14	5.73E+03	6.91E-06	5.22E-10	3.08E-05	2.32E-03	1.68E-03
Total		3.56E-02	2.69E-06	1.14E-01	8.64E+00	6.26E+00

ICSAs Composite Volume = 2.877E+05 cm^3, Mass = 1.429E+03 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	3.72E-03	1.29E-08	4.20E+00	1.46E+01	2.94E+00
Ni-59	7.60E+04	1.42E+02	4.92E-04	1.13E+01	3.93E+01	7.90E+00
Ni-63	1.00E+02	1.01E+01	3.51E-05	5.73E+02	1.99E+03	4.01E+02
Mo-93	3.50E+03	1.65E+01	5.72E-05	1.81E+01	6.29E+01	1.27E+01
Tc-99	2.13E+05	8.80E+01	3.06E-04	1.49E+00	5.19E+00	1.04E+00
Nb-94	2.00E+04	1.01E+01	3.52E-05	1.93E+00	6.71E+00	1.35E+00
C-14	5.73E+03	9.82E-02	3.41E-07	4.38E-01	1.52E+00	3.06E-01
Total		2.66E+02	9.26E-04	6.11E+02	2.12E+03	4.27E+02

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 10 of 12)

Irradiated Peripheral Shim Rods 3 total in vessel

Absorber Region Volume = 3.465E+04 cm^3, Mass = 1.154E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.90E-06	8.36E-11	3.28E-03	9.46E-02	2.84E-02
Ni-59	7.60E+04	1.01E+00	2.93E-05	8.10E-02	2.34E+00	7.02E-01
Ni-63	1.00E+02	5.13E-02	1.48E-06	2.91E+00	8.40E+01	2.52E+01
Mo-93	3.50E+03	1.51E-01	4.36E-06	1.66E-01	4.80E+00	1.44E+00
Tc-99	2.13E+05	5.61E-01	1.62E-05	9.52E-03	2.75E-01	8.25E-02
Nb-94	2.00E+04	6.18E-02	1.78E-06	1.18E-02	3.39E-01	1.02E-01
C-14	5.73E+03	1.53E-03	4.43E-08	6.84E-03	1.97E-01	5.93E-02
Total		1.84E+00	5.31E-05	3.19E+00	9.21E+01	2.77E+01

Below Absorber Volume = 6.249E+03 cm^3, Mass = 1.941E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	4.72E-06	7.56E-10	5.34E-03	8.55E-01	2.75E-01
Ni-59	7.60E+04	2.13E-01	3.41E-05	1.70E-02	2.72E+00	8.78E-01
Ni-63	1.00E+02	1.91E-02	3.05E-06	1.08E+00	1.73E+02	5.57E+01
Mo-93	3.50E+03	2.32E-02	3.71E-06	2.55E-02	4.08E+00	1.31E+00
Tc-99	2.13E+05	1.18E-01	1.89E-05	2.00E-03	3.21E-01	1.03E-01
Nb-94	2.00E+04	1.72E-02	2.75E-06	3.27E-03	5.23E-01	1.68E-01
C-14	5.73E+03	1.08E-04	1.73E-08	4.81E-04	7.69E-02	2.48E-02
Total		3.91E-01	6.26E-05	1.14E+00	1.82E+02	5.85E+01

Lower Shield Volume = 2.735E+04 cm^3, Mass = 1.498E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.83E-06	3.23E-10	9.99E-03	3.65E-01	6.67E-02
Ni-59	7.60E+04	3.82E-01	1.40E-05	3.05E-02	1.11E+00	2.03E-01
Ni-63	1.00E+02	3.30E-02	1.21E-06	1.87E+00	6.85E+01	1.25E+01
Mo-93	3.50E+03	2.45E-02	8.97E-07	2.70E-02	9.86E-01	1.80E-01
Tc-99	2.13E+05	1.97E-01	7.19E-06	3.34E-03	1.22E-01	2.23E-02
Nb-94	2.00E+04	2.60E-02	9.50E-07	4.94E-03	1.81E-01	3.30E-02
C-14	5.73E+03	1.28E-04	4.68E-09	5.71E-04	2.09E-02	3.81E-03
Total		6.62E-01	2.42E-05	1.95E+00	7.13E+01	1.30E+01

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 11 of 12)

Irradiated Peripheral Shim Rods (continued)

Nozzle Volume = 2.713E+04 cm^3, Mass = 9.108E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	5.18E-07	1.91E-11	5.86E-04	2.16E-02	6.43E-03
Ni-59	7.60E+04	1.84E-02	6.78E-07	1.47E-03	5.41E-02	1.61E-02
Ni-63	1.00E+02	1.73E-03	6.36E-08	9.80E-02	3.61E+00	1.08E+00
Mo-93	3.50E+03	6.17E-04	2.27E-08	6.78E-04	2.50E-02	7.44E-03
Tc-99	2.13E+05	8.86E-03	3.26E-07	1.50E-04	5.54E-03	1.65E-03
Nb-94	2.00E+04	9.17E-04	3.38E-08	1.75E-04	6.43E-03	1.92E-03
C-14	5.73E+03	6.10E-06	2.25E-10	2.72E-05	1.00E-03	2.99E-04
Total		3.05E-02	1.13E-06	1.01E-01	3.73E+00	1.11E+00

Above Absorber Volume = 3.756E+04 cm^3, Mass = 1.113E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	9.11E-06	2.43E-10	1.03E-02	2.74E-01	9.26E-02
Ni-59	7.60E+04	3.73E-01	9.93E-06	2.98E-02	7.93E-01	2.67E-01
Ni-63	1.00E+02	3.17E-02	8.43E-07	1.80E+00	4.78E+01	1.61E+01
Mo-93	3.50E+03	2.89E-02	7.69E-07	3.18E-02	8.46E-01	2.85E-01
Tc-99	2.13E+05	2.32E-01	6.16E-06	3.93E-03	1.05E-01	3.53E-02
Nb-94	2.00E+04	2.84E-02	7.55E-07	5.40E-03	1.44E-01	4.85E-02
C-14	5.73E+03	1.55E-04	4.12E-09	6.90E-04	1.84E-02	6.19E-03
Total		6.94E-01	1.85E-05	1.88E+00	5.00E+01	1.69E+01

Plenum Volume = 1.478E+04 cm^3, Mass = 2.815E+01 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	8.45E-08	5.71E-12	9.56E-05	6.47E-03	3.40E-03
Ni-59	7.60E+04	3.37E-03	2.28E-07	2.69E-04	1.82E-02	9.54E-03
Ni-63	1.00E+02	3.11E-04	2.10E-08	1.77E-02	1.20E+00	6.27E-01
Mo-93	3.50E+03	1.80E-04	1.22E-08	1.98E-04	1.34E-02	7.03E-03
Tc-99	2.13E+05	1.68E-03	1.14E-07	2.85E-05	1.93E-03	1.01E-03
Nb-94	2.00E+04	2.14E-04	1.45E-08	4.07E-05	2.76E-03	1.45E-03
C-14	5.73E+03	1.03E-06	6.97E-11	4.59E-06	3.10E-04	1.63E-04
Total		5.75E-03	3.89E-07	1.83E-02	1.24E+00	6.50E-01

Table 6-12. Radionuclide Inventories in Irradiated Assemblies in Vessel – September 2053 (sheet 12 of 12)

Irradiated Peripheral Shim Rods (continued)

Handling Socket Volume = 5.704E+03 cm^3, Mass = 7.871E+00 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	1.56E-08	2.73E-12	1.76E-05	3.09E-03	2.24E-03
Ni-59	7.60E+04	5.14E-04	9.01E-08	4.10E-05	7.19E-03	5.21E-03
Ni-63	1.00E+02	4.74E-05	8.30E-09	2.69E-03	4.71E-01	3.42E-01
Mo-93	3.50E+03	1.44E-05	2.52E-09	1.58E-05	2.77E-03	2.01E-03
Tc-99	2.13E+05	2.66E-04	4.67E-08	4.52E-06	7.92E-04	5.74E-04
Nb-94	2.00E+04	2.37E-05	4.15E-09	4.50E-06	7.89E-04	5.72E-04
C-14	5.73E+03	1.72E-07	3.01E-11	7.65E-07	1.34E-04	9.72E-05
Total		8.66E-04	1.52E-07	2.77E-03	4.86E-01	3.52E-01

Peripheral Shim Rods Composite Volume = 1.534E+05 cm^3, Mass = 5.230E+02 kg

Radio-Nuclide	Half Life (y)	Mass (g)	Density (g/cm^3)	Activity (Ci)	Concentration (Ci/m^3)	Concentration ($\mu Ci/g$)
Co-60	5.27E+00	2.62E-05	1.71E-10	2.96E-02	1.93E-01	5.66E-02
Ni-59	7.60E+04	2.01E+00	1.31E-05	1.60E-01	1.04E+00	3.06E-01
Ni-63	1.00E+02	1.37E-01	8.93E-07	7.78E+00	5.07E+01	1.49E+01
Mo-93	3.50E+03	2.29E-01	1.49E-06	2.51E-01	1.64E+00	4.81E-01
Tc-99	2.13E+05	1.12E+00	7.29E-06	1.90E-02	1.24E-01	3.63E-02
Nb-94	2.00E+04	1.34E-01	8.76E-07	2.56E-02	1.67E-01	4.89E-02
C-14	5.73E+03	1.93E-03	1.26E-08	8.61E-03	5.61E-02	1.65E-02
Total		3.63E+00	2.36E-05	8.28E+00	5.39E+01	1.58E+01

Table 6-13. Summary of Radionuclide Inventory in the FFTF Reactor Vessel – September 2003

Radio-Nuclide	Half Life (y)	Reactor Hardware		Core Components		Total	
		Mass (g)	Activity (Ci)	Mass (g)	Activity (Ci)	Mass (g)	Activity (Ci)
Co-60	5.27E+00	1.94E+02	2.19E+05	4.22E+02	4.77E+05	6.16E+02	6.97E+05
Ni-59	7.60E+04	2.22E+03	1.77E+02	1.76E+04	1.41E+03	1.99E+04	1.59E+03
Ni-63	1.00E+02	3.03E+02	1.72E+04	3.23E+03	1.83E+05	3.53E+03	2.00E+05
Mo-93	3.50E+03	9.62E-08	1.06E-07	2.50E+02	2.75E+02	2.50E+02	2.75E+02
Tc-99	2.13E+05	3.84E-06	6.52E-08	1.59E+03	2.69E+01	1.59E+03	2.69E+01
Nb-94	2.00E+04	6.29E+01	1.20E+01	1.77E+02	3.37E+01	2.40E+02	4.56E+01
C-14	5.73E+03	1.02E+01	4.56E+01	1.51E+00	6.73E+00	1.17E+01	5.23E+01
Total		2.79E+03	2.37E+05	2.33E+04	6.62E+05	2.61E+04	8.99E+05

Table 6-14. Radionuclide Concentrations in the Bottom - Center of the Core Support Structure.

Radio-Nuclide	Half Life (y)	September 2003			September 2008		
		Density (g/cm^3)	Concentration		Density (g/cm^3)	Concentration	
			(Ci/m^3)	($\mu Ci/g$)		(Ci/m^3)	($\mu Ci/g$)
Co-60	5.27E+00	4.65E-08	5.27E+01	6.58E+00	2.41E-08	2.73E+01	3.41E+00
Ni-59	7.60E+04	9.02E-07	7.20E-02	9.00E-03	9.02E-07	7.20E-02	9.00E-03
Ni-63	1.00E+02	1.26E-07	7.16E+00	8.94E-01	1.22E-07	6.91E+00	8.64E-01
Mo-93	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99	2.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	2.00E+04	4.66E-09	8.87E-04	1.11E-04	4.66E-09	8.87E-04	1.11E-04
C-14	5.73E+03	7.32E-09	3.26E-02	4.08E-03	7.32E-09	3.26E-02	4.08E-03
Total		1.09E-06	5.99E+01	7.49E+00	1.06E-06	3.43E+01	4.29E+00

Table 6-15. Dose Rates above Boron Carbide Shield (18.3 ft above Core Midplane and 11.3 ft from Core Centerline)

	Dose Rate (mrem/h) and Statistical Uncertainty (%)					
	From Sources in Irradiated Assemblies in the IVSMs		From Other Sources[a]		Totals	
Azimuthal average	0.9	23%[b]	2.3	3%	3.1	7%
Peak	5.5	91%[c]	2.3	3%	7.8	64%

[a] Other sources include those in reactor hardware and irradiated assemblies residing in core.
[b] In general, MCNP volume tallies with uncertainties between 20% and 50% may be in error by a factor of a few. However, an evaluation of this tally indicated that the MCNP tally of 2.0 mrem/h and corresponding uncertainty of 23% are reasonable estimates.
[c] In general, tally results with uncertainties greater than 50% are considered unreliable. However, an assessment of dose rates at an elevations just below the boron carbide shield indicated that the azimuthal peak-to-average value should be about 2. Thus, the 5.5 mrem/h value is judged to be conservative (over estimated).

Table 6-16. Dose Rates in Reactor Cavity 9 ft 11 in. above Core Midplane and 12 ft from Core Centerline

Azimuthal Position (Deg. True)	Dose Rate (mrem/h) and Statistical Uncertainty (%)					
	From Sources in Irradiated Assemblies in the IVSMs		From Other Sources[a]		Totals	
60	11	6%	59	0.5%	70	1%
180	17	5%	59	0.5%	76	1%
300	52	4%	59	0.5%	111	2%

[a] Other sources include those in reactor hardware and irradiated assemblies residing in core.

Table 6-17. Dose Rates in Reactor Cavity 10 ft 7 in. below Core Midplane, 12 ft from Core Centerline

Azimuthal Position (Deg. True)	Dose Rate (mrem/h) and Statistical Uncertainty (%)					
	From Sources in Irradiated Assemblies in the IVSMs		From Other Sources[a]		Totals	
90	14	8%	52	1%	66	2%
210	35	5%	52	1%	87	2%
330	29	3%	52	1%	81	1%

[a] Other sources include those in reactor hardware and irradiated assemblies residing in core.

Table 6-18. Dose Rates in Reactor Cavity at Core Midplane, 12 ft from Core Centerline

Azimuthal Position[a] (Deg. True)	Dose Rate (mrem/h) and Statistical Uncertainty (%)					
	From Sources in Irradiated Assemblies in the IVSMs		From Other Sources[b]		Totals	
8	2621	4%	1604	1%	4224	3%
69	224	13%[b]	1604	1%	1828	2%
127	3730	4%	1604	1%	5334	3%
188	147	14%[b]	1604	1%	1751	1%
249	14606	2%	1604	1%	16210	2%
307	843	7%	1604	1%	2447	3%

[a] Dose points at azimuthal positions of 8°, 127° and 249° are directly outboard of IVSMs in trisectors 3, 1 and 2, respectively. The other three azimuthal positions are midway between IVSMs.
[b] MCNP uncertainties greater than 10% for point-detector tallies may be under predicted. Results might be a factor of two in error.

7.0 CONCLUSIONS

The tables described in Section 6.1 (Tables 6-3 through 6-12) provide defensible estimates of the radionuclide inventories and concentrations in activated components in the FFTF reactor vessel over the next 50 years. Table 6-13 provides an inventory summary and shows that there is currently about 0.9 MCi (mega-curies) activity in the vessel. Every component of significance was accounted for in these tables.

Inventory calculations were based on well-validated methods using the MCNP4C program. A specific validation for this application was made by using MCNP4C and the FFTF calculational model to analyze reaction rate measurements completed during the reactor characterization program. The largest uncertainty in the tabulated data is probably due to uncertainties in impurities and trace elements in steel and Inconel compositions that are major sources for the radionuclides of interest. In general, conservative estimates of the concentrations of these elements were used in deriving radionuclide inventories from MCNP4C-computed reaction rates.

The accuracy of MCNP4C and the calculational model of FFTF in computing ^{59}Co (n,γ) reaction rates, the primary mode of ^{60}Co production, was confirmed by comparison of calculations with measurements. Therefore, calculations of ^{60}Co distribution in the vessel are expected to be accurate given the concentrations of ^{59}Co impurities in Inconel, SS-316 and SS-304. However, conservatisms used in assigning ^{59}Co concentrations in these materials should have lead to conservative (high) predictions of dose rates in the reactor cavity.

Not all input and output files and data from the work described in this report are listed herein because of the volume of information. However, all pertinent information, including spreadsheets, have been archived to compact disk for future reference.

8.0 REFERENCES

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

Budinski, K. G. and M. K. Budinski, 1999, *Engineering Materials Properties and Selection*, Sixth Edition, Prentice Hall, Upper Dalle River, New Jersey

Cabell, C. P., 1980, *A Summary Description of the Fast Flux Test Facility*, HEDL-400, Westinghouse Hanford Company, Richland, Washington.

Croff, A. G., 1980, *A User's manual for the ORIGEN2 Code*, ORNL / TM-7175, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Johnson, L. E., 2002, *MCNP Version 4C Approval for Use Documentation, and Authorized User List*, FFS-LEJ-02-002, February 18, 2002, Fluor Federal Services, Richland, Washington.

Lamb, S. (Tech. Ed.), 1999, *Practical Handbook of Stainless Steel & Nickel Alloys*, CASTI Publishing, Inc., Edmonton, Alberta, Canada.

NE M 3-35T, 1982, *Nuclear Standard, Austenitic and Ferritic Stainless Steel Duct Tubes for Breeder Reactor Core Components*, U.S. Dept. of Energy.

NE M 5-4T, 1982, *Nuclear Standard Nickel-Chromium-Iron Alloy Plate, Steel and Strip (ASME SB-168 with Additional Requirements)*, U.S. Dept. of Energy.

Pashchenko, A. B. and H. Wienke, 1997, *FENDL2/A-MCNP, FENDL2/A-VITJ_E and FENDL2/A-VITJ_FLAT, the processed FENDL-2 neutron activation cross-section data files*, report IAEA-NDS-174, International Atomic Energy Agency.

RDT E 5-19T , 1971, *RDT Standard, Austenitic Stainless Steel Plate, Sheet and Strip for Core Components,* U.S. Atomic Energy Commission.

RDT E 6-20T, 1971, *RDT Standard, Austenitic Stainless Steel Hexagonal Duct Tubes for Core Components and Assemblies*, U.S. Atomic Energy Commission,

Wittekind, W. D., 1989, *Software Certification Package for the ORIGEN2 Computer Code,* WHC-SD-NR-SWD-006, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A
FAST FLUX TEST FACILITY
CORE COMPONENTS STORED IN THE REACTOR VESSEL

FAST FLUX TEST FACILITY CORE COMPONENTS STORED IN THE REACTOR VESSEL

Two reports are included in this appendix. The first, consisting of eight pages, lists all the core components currently stored in the 199 core locations. The second, consisting of three pages, lists the core components currently stored in in-vessel storage modules (IVSM). The reports were obtained from the FFTF Refueling Inventory Control System (RICS) database.

PRODUCTION Facility Inventory Page 1
P099/1/1/4 03/19/01
R320 For CORE 07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
1201		1	305	ICSA	07/12/94	05:41	IN_CORE	N	0		
1202		1	15	PIOTA	08/28/94	03:57	ABOVE_CORE	N	0		
1301		1	1130	MTA1	07/20/94	22:03	IN_CORE	N	0		
1302		1	553	CRA	08/04/93	15:13	IN_CORE	N	0		
1303		1	1128	MTA1	07/10/94	10:26	IN_CORE	N	0		
1304		1	299	ICSA	06/02/94	22:06	IN_CORE	N	0		
			THERMALLY SHOCKED WHEN INSERTED INTO IDS								
1401											
1402		1	1129	MTA1	07/11/94	07:35	IN_CORE	N	0		
1403											
1404		1	35500	MSCA	07/10/94	22:52	IN_CORE	N	0		
1405		1	1125	MTA1	07/09/94	13:14	IN_CORE	N	0		
1406		1	13	PIOTA	08/18/94	03:06	ABOVE_CORE	N	0		
			FLOWMETER IS BAD								
		1	1132	MTA1	08/16/94	16:55	IN_CORE	N	0		
1501		1	2077	NEX	07/11/94	20:24	IN_CORE	N	0		
			MOVE MADE PER SRI 19								
1502		1	560	CRA	05/13/90	05:41	IN_CORE	N	0		
1503											
1504		1	558	CRA	05/13/90	11:15	IN_CORE	N	0		
1505		1	2080	NEX	08/26/94	18:27	IN_CORE	N	0		
1506											
1507		1	2081	NEX	08/26/94	21:50	IN_CORE	N	0		
1508											
1601		1	1069	REFL7	06/10/94	20:10	IN_CORE	N	0		
			THERMALLY SHOCKED WHEN INSERTED INTO IDS								
1602		1	1057	REFL7	06/10/94	10:00	IN_CORE	N	0		
			THERMALLY SHOCKED WHEN INSERTED INTO IDS								
1603		1	1029	REFL7	07/08/94	03:26	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1604		1	1072	REFL7	06/09/94	06:42	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1605		1	1027	REFL7	07/08/94	11:40	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								

1606	1	1037	REFL7	06/08/94	22:24	IN_CORE	N	0	
		THERMALLY SHOCKED WHEN INSERTED INTO IDS							
1607	1	1043	REFL7	07/09/94	08:26	IN_CORE	N	0	
		THERMALLY SHOCKED IN BLTC XFR							

PRODUCTION Facility Inventory Page 2
P099/1/1/4 03/19/01
R320 For CORE 07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
1608		1	1034	REFL7	06/04/94	18:37	IN_CORE	N	0		
			THERMALLY SHOCKED WHEN INSERTED INTO IDS								
1609		1	1052	REFL7	06/03/94	10:56	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1610		1	1060	REFL7	08/14/94	02:31	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
		1	2	PIOTA	08/14/94	18:15	ABOVE_CORE	N	0		
			FLOWMETER IS BAD; PRIOR TO REINSERTION INTO REACTOR, SEE CORE COMPONENT FILE, NCR B05010								
1701		1	1119	REFL7D	11/12/91	05:43	IN_CORE	N	0		
1702		1	1077	REFL7	05/12/88	03:03	IN_CORE	N	0		
1703		1	1081	REFL7	10/23/88	07:34	IN_CORE	N	0		
1704		1	1151	REFL7D	11/05/90	03:12	IN_CORE	N	0		
1705		1	1070	REFL7	11/03/87	02:10	IN_CORE	N	0		
1706		1	1115	REFL7D	04/05/91	14:26	IN_CORE	N	0		
1707		1	1116	REFL7D	10/31/92	01:27	IN_CORE	N	0		
			MOVE MADE BY SRI 17								
1708		1	1082	REFL7	05/12/88	04:19	IN_CORE	N	0		
1709		1	1087	REFL7	04/06/91	03:39	IN_CORE	N	0		
1710		1	1114	REFL7D	11/05/90	07:30	IN_CORE	N	0		
1711		1	1092	REFL7	09/28/91	02:28	IN_CORE	N	0		
1712		1	1040	REFL7	10/23/88	05:47	IN_CORE	N	0		
1801		1	1245	REFL8A	02/15/87	16:28	IN_CORE	N	0		
1802		1	1225	REFL8A	11/03/87	00:03	IN_CORE	N	0		
1803		1	1442	REFL8B	10/23/88	10:35	IN_CORE	N	0		
1804		1	1425	REFL8B	11/08/90	07:47	IN_CORE	N	0		
1805		1	1428	REFL8B	10/23/88	13:53	IN_CORE	N	0		
1806		1	1228	REFL8A	11/03/87	08:41	IN_CORE	N	0		
1807		1	1236	REFL8A	02/15/87	18:52	IN_CORE	N	0		
1808		1	1233	REFL8A	02/15/87	21:49	IN_CORE	N	0		
1809		1	1238	REFL8A	11/03/87	09:08	IN_CORE	N	0		

1810	1	1246 REFL8B	10/26/88 13:07	IN_CORE	N	0	
1811	1	1432 REFL8B	11/08/90 09:41	IN_CORE	N	0	
1812	1	1434 REFL8B	10/26/88 14:20	IN_CORE	N	0	
1813	1	1232 REFL8A	11/07/87 07:17	IN_CORE	N	0	
1814	1	1240 REFL8A	02/15/87 14:22	IN_CORE	N	0	

PRODUCTION
P099/1/1/4
R320

Facility Inventory
For CORE

Page 3
03/19/01
07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
1901		1	1627	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1902		1	1628	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1903		1	1629	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1907		1	1631	REFL9	10/11/78	06:40	IN_CORE	N	0		
1908		1	1632	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1909		1	1636	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1910		1	1637	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1911		1	1640	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1915		1	1642	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
1916		1	1643	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
2101		1	302	ICSA	08/04/93	09:56	IN_CORE	N	0		
			THERMALLY SHOCKED, PENDING ANALYSIS								
2201		1	304	ICSA	07/23/94	05:32	IN_CORE	N	0		
2202											
2301		1	1133	MTA1	07/30/94	02:30	IN_CORE	N	0		
2302		1	569	CRA	10/06/91	20:24	IN_CORE	N	0		
2303		1	2055	CCA	11/02/94	01:02	IN_CORE	N	0		
			THERMAL SHOCKED IN THE IEMC								
2304		1	1136	MTA1	10/31/94	17:51	IN_CORE	N	0		
2401											
2402		1	1134	MTA1	10/21/94	16:52	IN_CORE	N	0		
2403											

2404	1	1135	MTA1	10/29/94	08:34	IN_CORE	N	0
2405	1	301	ICSA	10/29/94	02:05	IN_CORE	N	0
2406	1	292	ICSA	12/01/92	16:00	IN_CORE	N	0
	1	1	LPMA	03/06/95	17:30	ABOVE_CORE	N	0
	O-RINGS ARE BAD; REPLC PRIOR TO STARTUP SEE WORK REQUEST F2-2062/W							
2501	1	2082	NEX	08/01/94	11:08	IN_CORE	N	0
2502	1	559	CRA	04/08/89	08:00	IN_CORE	N	0
2503								

PRODUCTION Facility Inventory Page 4
P099/1/1/4 03/19/01
R320 For CORE 07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
2504		1	565	CRA	10/05/91	23:43	IN_CORE	N	0		
2505		1	2078	NEX	07/23/94	01:52	IN_CORE	N	0		
	ASSEMBLY MOVE MADE PER SRI-37 STEP B10										
2506											
2507		1	2085	NEX	10/21/94	06:50	IN_CORE	N	0		
2508											
2601		1	1036	REFL7	10/24/94	05:06	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2602		1	1064	REFL7	10/28/94	13:00	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2603		1	1058	REFL7	10/25/94	22:55	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2604		1	1044	REFL7	10/28/94	00:09	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2605		1	1059	REFL7	10/26/94	17:37	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2606		1	1050	REFL7	10/27/94	18:31	IN_CORE	N	0		
	THERMAL SHOCK IEMC & BLTC XFR										
2607		1	1659	NEX	07/04/93	12:00	IN_CORE	N	0		
2608		1	1033	REFL7	10/27/94	08:02	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2609		1	1056	REFL7	10/27/94	01:21	IN_CORE	N	0		
	THERMALLY SHOCKED IN BLTC XFR										
2610		1	17	VOTA	02/10/95	23:20	BOTH	N	0		
2701		1	1139	REFL7D	11/11/91	23:53	IN_CORE	N	0		
2702		1	1123	REFL7D	10/05/91	17:20	IN_CORE	N	0		
2703		1	1088	REFL7	04/15/91	08:20	IN_CORE	N	0		

2704	1	1113	REFL7D	11/15/90	01:04	IN_CORE	N	0
2705	1	1117	REFL7D	04/15/91	07:17	IN_CORE	N	0
2706	1	1080	REFL7	10/22/88	04:25	IN_CORE	N	0
2707	1	1149	REFL7D	10/08/89	17:31	IN_CORE	N	0
2708	1	1127	REFL7D	04/07/89	20:31	IN_CORE	N	0
2709	1	1074	REFL7	05/25/88	19:53	IN_CORE	N	0
2710	1	1073	REFL7	10/19/87	01:52	IN_CORE	N	0
2711	1	1083	REFL7	10/22/88	12:05	IN_CORE	N	0
2712	1	1118	REFL7D	04/15/91	01:18	IN_CORE	N	0
2801	1	1431	REFL8A	02/15/87	05:00	IN_CORE	N	0
2802	1	1229	REFL8A	11/04/87	14:22	IN_CORE	N	0

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
2803		1	1437	REFL8B	10/22/88	02:17	IN_CORE	N	0		
2804		1	1438	REFL8B	11/18/90	22:11	IN_CORE	N	0		
2805		1	1443	REFL8B	10/22/88	03:30	IN_CORE	N	0		
2806		1	1243	REFL8A	11/04/87	12:14	IN_CORE	N	0		
2807		1	1433	REFL8A	02/15/87	06:45	IN_CORE	N	0		
2808		1	1435	REFL8A	02/15/87	08:24	IN_CORE	N	0		
2809		1	1244	REFL8A	10/19/87	06:50	IN_CORE	N	0		
2810		1	1247	REFL8B	10/22/88	09:30	IN_CORE	N	0		
2811		1	1249	REFL8B	11/18/90	19:53	IN_CORE	N	0		
			DIFFICULT TO INSERT DURING 10B & 11B-1								
2812		1	1248	REFL8B	10/08/89	09:29	IN_CORE	N	0		
2813		1	1242	REFL8A	10/19/87	08:58	IN_CORE	N	0		
2814		1	1250	REFL8A	02/16/87	08:35	IN_CORE	N	0		
2901		1	1646	REFL9	05/03/90	11:30	IN_CORE	N	0		
2902		1	1647	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
2903		1	1650	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
2907		1	1656	REFL9	10/15/78	06:30	IN_CORE	N	0		
2908		1	1654	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								
2909		1	1426	REFL9	12/03/81	15:28	IN_CORE	N	0		

2910	1	1652	REFL9	11/11/75 11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319					
2911	1	1651	REFL9	11/11/75 11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319					
2915	1	1649	REFL9	09/16/78 21:44	IN_CORE	N	0
2916	1	1648	REFL9	11/11/75 11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319					
3201	1	1137	MTA1	01/21/95 18:37	IN_CORE	N	0
3202	1	7	PIOTA	02/17/95 17:30	ABOVE_CORE	N	0
		FAST RESPONSE - NO FLOWMETER					
3301	1	1146	MTA1	01/19/95 03:19	IN_CORE	N	0
3302	1	563	CRA	10/03/89 10:15	IN_CORE	N	0
3303	1	1138	MTA1	01/22/95 00:24	IN_CORE	N	0
3304	1	1147	MTA1	01/22/95 18:48	IN_CORE	N	0
3401							
3402	1	1150	MTA1	01/18/95 17:07	IN_CORE	N	0

PRODUCTION
P099/1/1/4
R320

Facility Inventory

For CORE

Page 6
03/19/01
07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
3403											
3404		1	1141	MTA1	01/21/95	21:09	IN_CORE	N	0		
3405		1	1140	MTA1	01/22/95	05:47	IN_CORE	N	0		
3406		1	2	LPMA	08/24/94	17:31	ABOVE_CORE	N	0		
		1	295	ICSA	08/23/94	18:17	IN_CORE	N	0		
3501		1	2084	NEX	01/18/95	01:28	IN_CORE	N	0		
3502		1	566	CRA	10/03/89	05:36	IN_CORE	N	0		
3503											
3504		1	567	CRA	10/01/89	16:05	IN_CORE	N	0		
3505		1	2083	NEX	01/17/95	15:19	IN_CORE	N	0		
3506											
3507		1	2079	NEX	01/17/95	17:03	IN_CORE	N	0		
3508											
3601		1	1075	REFL7	01/19/95	12:45	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
3602		1	1065	REFL7	01/21/95	11:19	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
3603		1	1063	REFL7	01/19/95	19:47	IN_CORE	N	0		
			THERMALLY SHOCKED IN BLBC XFR								

3604	1	1066	REFL7	01/21/95 06:28	IN_CORE	N	0
		THERMALLY SHOCKED IN BLTC XFR					
3605	1	1068	REFL7	01/20/95 00:26	IN_CORE	N	0
		THERMALLY SHOCKED IN BLTC XFR					
3606	1	1031	REFL7	01/20/95 02:05	IN_CORE	N	0
		THERMALLY SHOCKED IN BLTC XFR					
3607	1	1032	REFL7	01/20/95 06:34	IN_CORE	N	0
		THERMALLY SHOCKED IN BLTC XFR					
3608	1	1067	REFL7	01/20/95 20:50	IN_CORE	N	0
		THERMALLY SHOCKED IN BLTC XFR					
3609	1	1062	REFL7	01/20/95 14:34	IN_CORE	N	0
		PRIOR TO HANDLING, SEE COMPONENT FILE; WORK REQUEST F1-2832/W					
		THERMALLY SHOCKED DURING BLTC XFR					
3610	1	14	PIOTA	02/27/95 21:40	ABOVE_CORE	N	0
		FLOWMETER IS BAD					
	1	1152	MTA1	02/23/95 17:58	IN_CORE	N	0
3701	1	1078	REFL7	11/11/91 15:29	IN_CORE	N	0
3702	1	1079	REFL7	10/22/88 23:27	IN_CORE	N	0
3703	1	1084	REFL7	03/25/89 23:50	IN_CORE	N	0
3704	1	1089	REFL7	05/18/88 07:10	IN_CORE	N	0

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
3705		1	1085	REFL7	03/26/89	01:55	IN_CORE	N	0		
3706		1	1120	REFL7D	04/07/91	23:15	IN_CORE	N	0		
3707		1	1121	REFL7D	04/08/91	05:19	IN_CORE	N	0		
3708		1	1122	REFL7D	04/09/91	06:20	IN_CORE	N	0		
3709		1	1124	REFL7D	07/26/93	14:51	IN_CORE	N	0		
3710		1	1071	REFL7	05/17/88	15:05	IN_CORE	N	0		
3711		1	1086	REFL7	10/03/89	16:41	IN_CORE	N	0		
3712		1	1131	REFL7D	03/27/89	22:51	IN_CORE	N	0		
3801		1	1235	REFL8A	02/16/87	01:40	IN_CORE	N	0		
3802		1	1239	REFL8A	10/27/87	02:35	IN_CORE	N	0		
3803		1	1436	REFL8B	10/23/88	00:24	IN_CORE	N	0		
3804		1	1430	REFL8B	11/10/90	17:20	IN_CORE	N	0		
3805		1	1429	REFL8B	07/27/93	09:07	IN_CORE	N	0		
3806		1	1237	REFL8A	10/27/87	10:57	IN_CORE	N	0		
3807		1	1439	REFL8A	06/05/89	03:23	IN_CORE	N	0		

3808	1	1234	REFL8A	06/04/89	03:00	IN_CORE	N	0
3809	1	1230	REFL8A	06/04/89	11:52	IN_CORE	N	0
3810	1	1446	REFL8B	10/23/88	02:33	IN_CORE	N	0
3811	1	1447	REFL8B	11/10/90	18:40	IN_CORE	N	0
3812	1	1633	REFL8B	10/23/88	03:32	IN_CORE	N	0
3813	1	1231	REFL8A	10/19/87	22:05	IN_CORE	N	0
3814	1	1227	REFL8A	10/31/87	19:50	IN_CORE	N	0
3901	1	1645	REFL9	09/08/78	22:46	IN_CORE	N	0
3902	1	1644	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						
3903	1	1641	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						
3907	1	1639	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						
3908	1	1638	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						
3909	1	1635	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						
3910	1	1634	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						
3911	1	1630	REFL9	11/11/75	11:11	IN_CORE	N	0
		INSTALL PROCED CI/IP 5319						

PRODUCTION
P099/1/1/4
R320

Facility Inventory

For CORE

Page 8
03/19/01
07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
3915		1	1625	REFL9	09/09/78	02:45	IN_CORE	N	0		
3916		1	1655	REFL9	11/11/75	11:11	IN_CORE	N	0		
			INSTALL PROCED CI/IP 5319								

PRODUCTION
P099/1/1/4
R320

Facility Inventory

For IVSM

Page 1
03/19/01
07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
1-A		1	1126	REFL7D	08/31/94	01:20	1	N	0		
1-B		1	1095	REFL7	08/31/94	07:57	1	N	0		
1-C		1	1094	REFL7	08/31/94	22:13	1	N	0		
1-D		1	557	CRA	09/01/94	04:24	1	N	0		
1-E		1	554	CRA	09/01/94	13:56	1	N	0		
1-F		1	562	CRA	09/01/94	22:36	1	N	0		
1-G		1	561	CRA	09/03/94	00:57	1	N	0		
1-H		1	1241	REFL8A	09/03/94	10:18	1	N	0		
1-J		1	1038	REFL7	09/03/94	17:39	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1-K		1	1047	REFL7	09/03/94	23:09	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1-L		1	1046	REFL7	09/04/94	04:35	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1-M		1	1028	REFL7	09/04/94	13:29	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1-R		1	1054	REFL7	09/04/94	20:02	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1-S		1	1030	REFL7	09/05/94	01:07	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
1-U		1	555	CRA	09/06/94	17:30	1	N	0		
1-V											
1-W											
1-X		1	530	CRA	09/07/94	05:38	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
1-Y		1	529	CRA	09/07/94	13:17	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
1-Z											
2-A		1	1055	REFL7	11/02/94	21:01	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-B		1	1042	REFL7	11/03/94	04:47	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-C		1	1053	REFL7	11/03/94	12:15	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-D		1	1061	REFL7	11/04/94	00:44	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-E		1	1035	REFL7	11/02/94	12:50	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								

PRODUCTION Facility Inventory Page 2
P099/1/1/4 03/19/01
R320 For IVSM 07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
2-F		1	1048	REFL7	11/04/94	09:44	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-G		1	1026	REFL7	11/04/94	22:15	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-H		1	1025	REFL7	11/07/94	06:57	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-J		1	1051	REFL7	11/07/94	13:06	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-K		1	539	CRA	11/07/94	20:55	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-L		1	532	CRA	11/08/94	04:03	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-M		1	573	NEX	03/11/95	03:44	1	N	0		
2-R		1	1049	REFL7	03/13/95	18:21	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
2-S		1	536	CRA	11/08/94	11:32	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-U		1	540	CRA	11/08/94	20:32	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-V		1	533	CRA	11/09/94	02:42	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-W		1	543	CRA	11/09/94	14:04	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-X		1	257	MSA			1	N	0		
			NOT APPVD FOR INSERTION INTO RX CORE (SEE COMPONENT FILE; MEMO CLB: 90-102)								
2-Y		1	538	CRA	03/14/95	04:04	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
2-Z											
3-A		1	516	CRFS	03/21/95	07:21	1	N	0		
3-B		1	521	CRFS	03/21/95	13:41	1	N	0		
3-C		1	519	CRFS	03/21/95	19:34	1	N	0		
3-D		1	514	CRFS	03/22/95	01:26	1	N	0		
3-E		1	534	CRA	04/07/95	04:22	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
3-F		1	546	CRA	04/07/95	13:20	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
3-G		1	545	CRA	04/08/95	01:32	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								

PRODUCTION
P099/1/1/4
R320

Facility Inventory

For IVSM

Page 3
03/19/01
07:56

Facility Location	P	L	ACE SN	ACE Type	Move Date	Move Time	Internal Location	N M	Pin Count	CCP SN	CCP Type
3-H		1	547	CRA	04/10/95	05:55	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
3-J		1	542	CRA	04/10/95	14:24	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
3-K		1	556	CRA	04/11/95	01:23	1	N	0		
3-L		1	1076	REFL7	04/11/95	10:19	1	N	0		
			THERMALLY SHOCKED IN BLTC XFR								
3-M		1	531	CRA	04/12/95	00:04	1	N	0		
			DO NOT PUT IN RX - SEE COMPONENT FILE								
3-R		1	2057	CCA	04/15/95	11:01	1	N	0		
			THERMAL SHOCKED IN THE IEMC								
3-S		1	2056	CCA	04/15/95	16:35	1	N	0		
			THERMAL SHOCKED IN THE IEMC								
3-U		1	1444	REFL8B	04/16/95	11:29	1	N	0		
			THERMALLY SHOCKED - PER SRI-13								
3-V		1	1657	NEX-O	04/17/95	08:40	1	N	0		
			THERMALLY SHOCKED IN BLTC								
3-W		1	2059	CCAS	04/18/95	02:44	1	N	0		
3-X		1	258	MSA			1	N	0		
			NOT APPVD FOR INSERTION INTO RX CORE (SEE COMPONENT FILE; MEMO CLB:90-102)								
3-Y		1	2058	CCAS	04/19/95	02:51	1	N	0		
3-Z											

This page intentionally left blank

APPENDIX B
COMPARISON OF FLUX DATA IN HIGH POWER PHYSICS TEST LOADING WITH OTHER OPERATING CYCLES

COMPARISON OF FLUX DATA IN HIGH POWER PHYSICS TEST LOADING WITH OTHER OPERATING CYCLES

As discussed is Section 3.1 of this report, only one core loading was modeled for this analysis – the High Power Physics Test (HPPT) loading irradiated prior to the first operating cycle. This HPPT loading was used because it had been previously modeled in MCNP for other applications. To assure that the neutron flux space and energy distribution in the HPPT loading was representative of that in an average FFTF operating cycle (1A through 12B-2), comparison of total neutron flux data computed at three row 6 locations in HPPT loading with flux data from other operating cycles was made These flux data were extracted from the core reload design reports issued prior to each operating cycle. The details of this comparison are given in Table B-1. The computed total flux (normalized to 400 MW reactor thermal power) at the row 6 locations averaged 2.79 x 10^{15} n/cm^2-s over the life of the reactor, 1.2% higher than computed for the HPPT loading. This small difference was applied as an adjustment to the radionuclide inventory computations.

Table B-1. Computation of Cycle-Averaged Total Flux Data and Comparison with Flux Data in the HPPT Loading

Cycle	Reactor Power (MW)	Cycle Length (EFPD[a])	BOC[b] Flux (10^{15} n/cm^2/s)				Normalized Average[e]	Cycle Length (MWd)	(Norm. Avg. Flux) x (Cycle Len.)
			1608[c]	2608[c]	3608[c]	Average[d]			
HPPT	400	32.4	2.43	2.90	2.94	2.76	2.76	12960	35726
1	400	101.9	NR[g]	NR[g]	NR[g]	2.76[g]	2.76	40760	112362
2	400	100.5	NR[g]	NR[g]	NR[g]	2.74[g]	2.74	40200	110215
3	400	101.5	NR[g]	NR[g]	NR[g]	2.73[g]	2.73	40600	110703
4	400	109.5	2.35	2.57	3.26	2.73	2.73	43800	119428
5	400	122.7	2.01	2.87	3.12	2.67	2.67	49080	130880
6	400	134.0	2.06	2.90	2.86	2.61	2.61	53600	139717
7	400	122.8	2.85	2.64	2.93	2.81	2.81	49120	137863
8A	400	63.0	2.80	2.78	2.84	2.81	2.81	25200	70728
9A	291	137.7	2.45	1.67	1.87	2.00	2.74	40071	109976
9B	291	106.4	2.43	1.88	2.33	2.21	3.04	30962	94199
9C	291	97.7	3.21	1.41	1.61	2.08	2.85	28431	81156
10A	291	151.8	ICSA[f]	2.08	2.20	2.14	2.94	44174	129941
10B	291	126.7	1.80	2.25	2.31	2.12	2.91	36870	107442
10C	291	106.8	2.01	2.12	1.95	2.03	2.79	31079	86579
11A	291	116.4	1.98	2.26	2.21	2.15	2.96	33872	100104
11B1	291	85.5	1.94	2.25	1.98	2.06	2.83	24881	70338
11B2	291	132.7	1.94	2.13	1.94	2.00	2.75	38616	106337
11C	291	81.5	2.01	2.12	1.95	2.03	2.79	23717	66069
12A1	291	52.8	2.30	1.98	1.84	2.04	2.80	15365	43085
12A2	291	48.6	2.32	1.95	1.82	2.03	2.79	14143	39463
12B1	291	50.3	2.24	2.05	1.77	2.02	2.78	14637	40642
12B2	291	51.6	2.20	2.00	1.81	2.00	2.75	15016	41349
Total or Average							2.79[h]	747152	2084304

(See next page for footnotes)

Footnotes for Table B-1

[a] EFPD = Effective Full Power Days
[b] BOC = Beginning of Cycle
[c] 1608, 2608 and 3608 are row 6 lattice positions containing fuel assemblies, unless noted otherwise.
[d] Average value of flux in locations 1608, 2608 and 3608.
[e] Normalized Average Flux = Average Flux scaled up to 400 MW reactor power.
[f] ICSA = non-fueled assembly in location 1608 during cycle 10A. Flux values in locations 2608 and 3608 only were used in computing the average flux in this case.
[g] NR = Not Reported. Flux data by lattice position were not reported in the Reload Design Reports for Cycles 1, 2 and 3. The average flux value for Cycle 1 was assumed to be the same as in the HPPT loading. The average flux value for Cycle 3 was assumed to be the same as in Cycle 4. And, the average flux value for Cycle 2 was assumed to be the average of those for the HPPT and Cycle 4.
[h] An average flux (ϕ_A) of 2.79×10^{15} n/cm^2/s was computed as:

$$\phi_A = \frac{\Sigma\, \phi_c \cdot L_c}{\Sigma\, L_c}$$

where, ϕ_c = the normalized average flux for Cycle c and
L_c = the length of Cycle c (MWd)

L_c and $\phi_c \cdot L_c$ values for each cycle are given in the last two columns of the table, with summations at the bottom of each column.

This page intentionally left blank

APPENDIX C
MCNP4C REACTION RATE OUTPUT FILES

MCNP4C REACTION RATE OUTPUT FILES

Listed below are the reaction rate data written to the "mctal" files by MCNP4C (Briesmeister 2001 and Johnson 2002) for one of the key calculations (fftf10ef) described in Section 5.1 of this report. Appendix J contains a listing of the MCNP4C input file for case fftf10ef, with differences from other cases described.

Reaction rate data for each region are under the heading "vals." The MCNP4C estimate of the statistical uncertanty for each reaction rate follows the listed value. Units of the reaction rates are 10^{-24} reaction/s per atom in the region per source neutron. For each region, there are 21 reaction rate values listed followed by the neutron track length (total flux x volume) in the region. Reaction rates are given for the processes identified in Table C-1. Processes listed in Table C-1 are in the order they appear in the mctal files.

References

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

Johnson, L. E., 2002, *MCNP Version 4C Approval for Use Documentation, and Authorized User List*, FFS-LEJ-02-002, February 18, 2002, Fluor Federal Services, Richland, Washington.

Table C-1. Nuclear Processes for Which Reaction Rates Are Given in the Mctal Files

1. Co-59(n,γ)	2. Ni-60(n,p)	3. Co-60(n, γ)	4. Ni-58(n, γ)
5. Ni-59(n, γ)	6. Ni-59(n, p)	7. Ni-59(n, α)	8. Ni-62(n, γ)
9. Ni-63(n, γ)	10. Fe-54(n, γ)	11. Fe-55(n, γ)	12. N-14(n,p)
13. Mo-92(n,γ)	14. Mo-93(n,γ)	15. Mo-93(n,p)	16. Mo-98(n,γ)
17. Tc-99(n,γ)	18. Nb-93(n,γ)	19. Nb-94(n,γ)	20. C-13(n,γ)
21. Mo-94(n,p)	22. Neutron track length		

Mctal Output File, fftf10ef.mct, from MCNP4C Case fftf10ef

```
mcnp       4c     08/05/02 19:39:01    3    2421150    50431948092
 FFTF HPPT ldg. Compute nuclide reaction rates in fixed RX components  fftf10ef
ntal    28
   34   44   54   64   74   84  104  114  134  174  184  194  204  214  224  234
  244  254  264  284  294  304  314  324  334  344  354  364
tally   34    1
       m431 cells,   thermal liner
f        1
      0
d        1
u        0
s        0
m       22
c        0
```

```
e        0
t        0
vals
  2.97301E-02 0.0122  2.52939E-08 0.6063  5.99720E-04 0.0111  8.48319E-04 0.0077
  4.66542E-02 0.0128  1.14671E-03 0.0133  6.91487E-03 0.0128  2.51915E-03 0.0077
  4.22567E-03 0.0075  1.85303E-03 0.0076  1.38799E-03 0.0105  3.14603E-04 0.0076
  8.24888E-05 0.0337  5.26471E-03 0.0126  1.09892E-08 0.2933  1.93830E-03 0.0176
  1.42342E-01 0.0084  2.02029E-03 0.0190  4.24549E-02 0.0141  3.47092E-07 0.0245
  1.23033E-09 0.7352  3.45337E-03 0.0170
tfc   19       1       1       1       1       1       1       1       1
     128000  2.93154E-02  5.70400E-02  2.06015E+00
     256000  2.76095E-02  3.54046E-02  2.65800E+00
     384000  2.80198E-02  2.98443E-02  2.36661E+00
     512000  2.79579E-02  2.49694E-02  2.52790E+00
     640000  2.83974E-02  2.24990E-02  2.42728E+00
     768000  2.91257E-02  2.09851E-02  2.28775E+00
     896000  2.93624E-02  1.96350E-02  2.22334E+00
    1024000  2.99577E-02  1.89799E-02  2.04927E+00
    1152000  2.96602E-02  1.77164E-02  2.10451E+00
    1280000  2.96123E-02  1.67002E-02  2.13449E+00
    1408000  2.95650E-02  1.58733E-02  2.14662E+00
    1536000  2.94814E-02  1.52877E-02  2.11806E+00
    1664000  2.92825E-02  1.45261E-02  2.17688E+00
    1792000  2.94876E-02  1.40505E-02  2.15226E+00
    1920000  2.93771E-02  1.35197E-02  2.17868E+00
    2048000  2.98449E-02  1.33316E-02  2.07578E+00
    2176000  2.97537E-02  1.29159E-02  2.08739E+00
    2304000  2.97673E-02  1.25673E-02  2.07786E+00
    2421150  2.97301E-02  1.22182E-02  2.08782E+00
tally   44    1
       m431 cells,  reactor vessel
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.29336E-02 0.0161  3.06850E-08 0.6238  6.48093E-04 0.0144  9.34493E-04 0.0097
  4.83181E-02 0.0168  1.19890E-03 0.0176  7.15825E-03 0.0168  2.79070E-03 0.0098
  4.64458E-03 0.0094  2.20280E-03 0.0095  1.52457E-03 0.0134  3.46727E-04 0.0097
  1.16994E-04 0.0398  5.79782E-03 0.0164  1.60459E-08 0.2553  2.28182E-03 0.0206
  1.85265E-01 0.0100  2.28452E-03 0.0247  4.53382E-02 0.0184  4.44230E-07 0.0314
  1.50591E-09 0.7562  4.34917E-03 0.0217
tfc   19       1       1       1       1       1       1       1       1
     128000  3.30666E-02  7.58496E-02  1.16507E+00
     256000  3.01711E-02  4.73637E-02  1.48519E+00
     384000  3.07567E-02  4.02419E-02  1.30164E+00
     512000  3.05330E-02  3.33505E-02  1.41700E+00
     640000  3.12397E-02  3.03022E-02  1.33812E+00
     768000  3.21264E-02  2.81869E-02  1.26804E+00
     896000  3.23812E-02  2.63547E-02  1.23411E+00
    1024000  3.33829E-02  2.52349E-02  1.15927E+00
    1152000  3.29109E-02  2.35353E-02  1.19250E+00
    1280000  3.28410E-02  2.22409E-02  1.20346E+00
    1408000  3.27386E-02  2.11709E-02  1.20673E+00
    1536000  3.26442E-02  2.03224E-02  1.19860E+00
    1664000  3.23023E-02  1.93584E-02  1.22573E+00
    1792000  3.25886E-02  1.86097E-02  1.22687E+00
    1920000  3.24074E-02  1.79001E-02  1.24284E+00
    2048000  3.30579E-02  1.75957E-02  1.19161E+00
    2176000  3.29377E-02  1.70172E-02  1.20247E+00
    2304000  3.29623E-02  1.65566E-02  1.19718E+00
    2421150  3.29336E-02  1.61100E-02  1.20092E+00
tally   54    1
       m431 cells,    guard vessel
f        1
      0
```

```
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  5.70448E-03 0.0250  7.11823E-09 0.6567  1.35494E-04 0.0226  2.22477E-04 0.0179
  8.68959E-03 0.0255  2.19763E-04 0.0268  1.28647E-03 0.0255  6.60780E-04 0.0179
  1.09946E-03 0.0174  4.78710E-04 0.0156  3.57552E-04 0.0217  8.24601E-05 0.0179
  3.21564E-05 0.0473  1.10513E-03 0.0251  4.73833E-09 0.2154  4.62737E-04 0.0282
  3.87007E-02 0.0147  4.68164E-04 0.0351  7.77952E-03 0.0277  1.25476E-07 0.0419
  3.46186E-10 0.7815  9.82642E-04 0.0314
tfc   19       1       1       1       1       1       1       1       1
     128000  5.74934E-03  1.25154E-01  4.27930E-01
     256000  4.95701E-03  8.38454E-02  4.73932E-01
     384000  5.15384E-03  6.75210E-02  4.62352E-01
     512000  5.10298E-03  5.64208E-02  4.95105E-01
     640000  5.30720E-03  5.04364E-02  4.83011E-01
     768000  5.49180E-03  4.54580E-02  4.87539E-01
     896000  5.56638E-03  4.19516E-02  4.87049E-01
    1024000  5.81447E-03  3.93145E-02  4.77619E-01
    1152000  5.69254E-03  3.68210E-02  4.87201E-01
    1280000  5.67484E-03  3.48417E-02  4.90385E-01
    1408000  5.65406E-03  3.32151E-02  4.90251E-01
    1536000  5.63786E-03  3.18416E-02  4.88242E-01
    1664000  5.53865E-03  3.04991E-02  4.93812E-01
    1792000  5.59504E-03  2.91037E-02  5.01627E-01
    1920000  5.54567E-03  2.80309E-02  5.06821E-01
    2048000  5.71646E-03  2.72655E-02  4.96272E-01
    2176000  5.69081E-03  2.63285E-02  5.02344E-01
    2304000  5.70427E-03  2.56110E-02  5.00319E-01
    2421150  5.70448E-03  2.50082E-02  4.98356E-01
tally   64    1
       m431 cells,    core support
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  4.07410E-02 0.0073  2.38877E-10 0.8917  8.14389E-04 0.0067  1.19426E-03 0.0063
  6.10269E-02 0.0072  1.48910E-03 0.0072  9.04347E-03 0.0072  3.56849E-03 0.0064
  5.97847E-03 0.0063  2.82363E-03 0.0064  1.90955E-03 0.0065  4.42973E-04 0.0063
  9.52573E-05 0.0129  7.14945E-03 0.0071  1.32530E-09 0.0407  2.73673E-03 0.0082
  2.36700E-01 0.0067  2.60342E-03 0.0080  5.62839E-02 0.0074  3.57183E-07 0.0072
  1.06958E-11 0.9178  4.67886E-03 0.0071
tfc   19       1       1       1       1       1       1       1       1
     128000  4.13553E-02  3.42439E-02  5.71600E+00
     256000  4.20064E-02  2.31501E-02  6.21685E+00
     384000  4.14256E-02  1.87812E-02  5.97589E+00
     512000  4.16892E-02  1.60216E-02  6.13994E+00
     640000  4.14159E-02  1.43637E-02  5.95542E+00
     768000  4.12822E-02  1.30899E-02  5.87976E+00
     896000  4.07818E-02  1.21293E-02  5.82637E+00
    1024000  4.09821E-02  1.13097E-02  5.77144E+00
    1152000  4.07183E-02  1.06434E-02  5.83092E+00
    1280000  4.06787E-02  1.00743E-02  5.86550E+00
    1408000  4.06308E-02  9.58780E-03  5.88374E+00
    1536000  4.06264E-02  9.16280E-03  5.89615E+00
    1664000  4.06542E-02  8.78692E-03  5.94924E+00
    1792000  4.07617E-02  8.45132E-03  5.94877E+00
    1920000  4.04739E-02  8.17925E-03  5.95254E+00
    2048000  4.05559E-02  7.90170E-03  5.90890E+00
    2176000  4.06303E-02  7.66077E-03  5.93344E+00
    2304000  4.06661E-02  7.43195E-03  5.94147E+00
```

```
    2421150  4.07410E-02  7.26021E-03  5.91299E+00
tally   74    1
       m431 cells,    closure head
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.36892E-06 0.0561  0.00000E+00 0.0000  3.08666E-08 0.0474  4.05160E-08 0.0389
  2.21185E-06 0.0532  5.60496E-08 0.0541  3.27367E-07 0.0532  1.21945E-07 0.0389
  1.99586E-07 0.0383  9.65204E-08 0.0385  7.84897E-08 0.0450  1.46746E-08 0.0382
  1.03216E-08 0.0812  2.74906E-07 0.0526  5.19380E-13 0.1088  1.42303E-07 0.0616
  8.35044E-06 0.0448  1.53610E-07 0.0634  2.17976E-06 0.0572  2.77437E-11 0.0901
  4.76425E-19 0.9741  2.53171E-07 0.0582
tfc   19       1       1       1       1       1       1       1       1
     128000  1.35589E-06  3.05953E-01  7.16060E-02
     256000  1.03152E-06  2.17203E-01  7.06225E-02
     384000  1.19528E-06  1.63596E-01  7.87596E-02
     512000  1.14270E-06  1.39393E-01  8.11139E-02
     640000  1.20859E-06  1.19492E-01  8.60533E-02
     768000  1.25121E-06  1.05655E-01  9.02500E-02
     896000  1.26782E-06  9.71901E-02  9.07456E-02
    1024000  1.32852E-06  8.80017E-02  9.53247E-02
    1152000  1.28694E-06  8.31674E-02  9.54978E-02
    1280000  1.28588E-06  7.87448E-02  9.60044E-02
    1408000  1.28266E-06  7.60735E-02  9.34596E-02
    1536000  1.31307E-06  7.29624E-02  9.29878E-02
    1664000  1.27414E-06  7.12417E-02  9.05037E-02
    1792000  1.29550E-06  6.75461E-02  9.31269E-02
    1920000  1.27916E-06  6.55699E-02  9.26233E-02
    2048000  1.36826E-06  6.20855E-02  9.57122E-02
    2176000  1.36742E-06  5.97014E-02  9.76974E-02
    2304000  1.37354E-06  5.76477E-02  9.87498E-02
    2421150  1.36892E-06  5.60535E-02  9.91974E-02
tally   84    1
       m431 cells,      steel roof
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.74295E-10 0.3875  0.00000E+00 0.0000  9.31961E-12 0.3877  2.27362E-11 0.3877
  3.77034E-10 0.3875  9.13918E-12 0.3875  5.58028E-11 0.3875  6.65209E-11 0.3880
  1.13659E-10 0.3878  1.91785E-11 0.3955  3.02918E-11 0.3878  8.49462E-12 0.3879
  1.64004E-13 0.3860  4.53787E-11 0.3874  1.89209E-19 0.8561  6.24135E-13 0.3746
  9.62777E-11 0.3824  5.45208E-12 0.3858  6.59947E-11 0.3847  6.15453E-15 0.3873
  0.00000E+00 0.0000  1.03268E-11 0.3989
tfc   19       1       1       1       1       1       1       1       1
     128000  1.08181E-10  8.85291E-01  8.55237E-03
     256000  4.96729E-11  8.81755E-01  4.28528E-03
     384000  1.74111E-10  6.65307E-01  4.76218E-03
     512000  1.78835E-10  5.47920E-01  5.24978E-03
     640000  3.34247E-10  6.15269E-01  3.24574E-03
     768000  2.80915E-10  6.06168E-01  2.74186E-03
     896000  2.43190E-10  5.98022E-01  2.39682E-03
    1024000  2.74262E-10  5.10566E-01  2.83194E-03
    1152000  2.45640E-10  5.05645E-01  2.58350E-03
    1280000  2.36925E-10  4.75897E-01  2.62851E-03
    1408000  2.17200E-10  4.71121E-01  2.43683E-03
    1536000  2.00170E-10  4.68041E-01  2.25973E-03
    1664000  1.84919E-10  4.67201E-01  2.10440E-03
```

```
    1792000  1.83673E-10  4.40637E-01  2.18834E-03
    1920000  1.72434E-10  4.37725E-01  2.07839E-03
    2048000  1.66790E-10  4.24268E-01  2.04959E-03
    2176000  1.57104E-10  4.23716E-01  1.93955E-03
    2304000  1.49289E-10  4.20840E-01  1.85296E-03
    2421150  1.74295E-10  3.87471E-01  2.07600E-03
tally  104    1
       m407 cells,    core support, vertical
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  8.46818E-02 0.0092  3.46385E-10 1.0000  1.56049E-03 0.0076  1.39373E-03 0.0079
  1.36187E-01 0.0087  3.44225E-03 0.0086  2.01676E-02 0.0087  4.20438E-03 0.0077
  6.69983E-03 0.0078  3.08619E-03 0.0081  3.48186E-03 0.0074  4.81539E-04 0.0078
  6.96267E-04 0.0188  1.57799E-02 0.0078  2.31340E-08 0.0148  8.42023E-03 0.0152
  2.63555E-01 0.0102  9.77783E-03 0.0079  1.40346E-01 0.0081  1.09827E-06 0.0148
  9.30356E-12 0.9981  1.31735E-02 0.0075
tfc   19       1       1       1       1       1       1       1       1
     128000  7.85948E-02  4.37357E-02  3.50418E+00
     256000  8.45293E-02  2.87278E-02  4.03711E+00
     384000  8.32928E-02  2.34626E-02  3.82912E+00
     512000  8.52329E-02  2.01417E-02  3.88495E+00
     640000  8.46732E-02  1.80862E-02  3.75622E+00
     768000  8.43009E-02  1.64665E-02  3.71557E+00
     896000  8.35875E-02  1.52791E-02  3.67176E+00
    1024000  8.44637E-02  1.43456E-02  3.58717E+00
    1152000  8.43713E-02  1.34767E-02  3.63693E+00
    1280000  8.42748E-02  1.28310E-02  3.61589E+00
    1408000  8.39924E-02  1.21848E-02  3.64297E+00
    1536000  8.44057E-02  1.16455E-02  3.65012E+00
    1664000  8.45777E-02  1.11556E-02  3.69107E+00
    1792000  8.46555E-02  1.07169E-02  3.69946E+00
    1920000  8.45658E-02  1.03460E-02  3.72038E+00
    2048000  8.47352E-02  9.99209E-03  3.69518E+00
    2176000  8.46337E-02  9.68000E-03  3.71622E+00
    2304000  8.47582E-02  9.39078E-03  3.72131E+00
    2421150  8.46818E-02  9.15731E-03  3.71681E+00
tally  114    1
       m419 cells, Na below nozzle
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  5.25874E-01 0.0086  4.15514E-09 0.9968  9.88136E-03 0.0080  9.49891E-03 0.0080
  8.42415E-01 0.0085  2.09707E-02 0.0084  1.24880E-01 0.0085  2.79946E-02 0.0080
  4.62123E-02 0.0080  2.13327E-02 0.0080  2.21817E-02 0.0079  3.33800E-03 0.0080
  3.12739E-03 0.0139  9.79569E-02 0.0081  9.67605E-08 0.0184  4.93517E-02 0.0115
  1.81287E+00 0.0088  5.61927E-02 0.0085  8.65027E-01 0.0083  5.78040E-06 0.0127
  1.12135E-10 0.9920  7.35307E-02 0.0083
tfc   19       1       1       1       1       1       1       1       1
     128000  5.47673E-01  3.92726E-02  4.34590E+00
     256000  5.63684E-01  2.65903E-02  4.71223E+00
     384000  5.32824E-01  2.17464E-02  4.45735E+00
     512000  5.42431E-01  1.86733E-02  4.51995E+00
     640000  5.39066E-01  1.67406E-02  4.38432E+00
     768000  5.37885E-01  1.53278E-02  4.28814E+00
     896000  5.29643E-01  1.42209E-02  4.23852E+00
    1024000  5.31076E-01  1.32152E-02  4.22705E+00
```

```
    1152000  5.29156E-01  1.25024E-02  4.22583E+00
    1280000  5.24866E-01  1.18862E-02  4.21359E+00
    1408000  5.22084E-01  1.13151E-02  4.22448E+00
    1536000  5.21656E-01  1.08178E-02  4.23004E+00
    1664000  5.23066E-01  1.04242E-02  4.22721E+00
    1792000  5.24229E-01  1.00370E-02  4.21766E+00
    1920000  5.24193E-01  9.70051E-03  4.23195E+00
    2048000  5.23539E-01  9.38720E-03  4.18673E+00
    2176000  5.26178E-01  9.09933E-03  4.20565E+00
    2304000  5.25673E-01  8.82788E-03  4.21101E+00
    2421150  5.25874E-01  8.58846E-03  4.22547E+00
tally  134    1
       m405 cells,     grid plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  6.73788E-01 0.0089  5.22553E-08 0.7050  1.26166E-02 0.0069  1.00444E-02 0.0073
  1.10601E+00 0.0084  2.86207E-02 0.0080  1.63815E-01 0.0084  2.96003E-02 0.0073
  4.60527E-02 0.0076  2.13146E-02 0.0081  2.87287E-02 0.0065  3.30202E-03 0.0077
  7.27252E-03 0.0103  1.30640E-01 0.0072  4.05159E-07 0.0240  7.20342E-02 0.0099
  1.81148E+00 0.0102  9.19573E-02 0.0067  1.17007E+00 0.0077  1.48302E-05 0.0113
  1.53665E-09 0.7041  1.31256E-01 0.0057
tfc   19       1       1       1       1       1       1       1       1
     128000  6.39876E-01  4.04668E-02  4.09317E+00
     256000  6.92110E-01  2.85545E-02  4.08624E+00
     384000  6.85247E-01  2.29498E-02  4.00213E+00
     512000  6.92421E-01  1.96071E-02  4.09967E+00
     640000  6.85758E-01  1.74651E-02  4.02813E+00
     768000  6.79979E-01  1.59984E-02  3.93621E+00
     896000  6.75489E-01  1.47900E-02  3.91865E+00
    1024000  6.74160E-01  1.38290E-02  3.86019E+00
    1152000  6.70092E-01  1.30082E-02  3.90358E+00
    1280000  6.69026E-01  1.23078E-02  3.92983E+00
    1408000  6.68902E-01  1.17029E-02  3.94918E+00
    1536000  6.68632E-01  1.11476E-02  3.98347E+00
    1664000  6.67889E-01  1.06834E-02  4.02451E+00
    1792000  6.69605E-01  1.02943E-02  4.00945E+00
    1920000  6.69776E-01  9.94164E-03  4.02915E+00
    2048000  6.74116E-01  9.63459E-03  3.97449E+00
    2176000  6.73390E-01  9.35979E-03  3.97484E+00
    2304000  6.74415E-01  9.10230E-03  3.96093E+00
    2421150  6.73788E-01  8.87248E-03  3.95928E+00
tally  174    1
       m403 cells,      IT hold down
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.32306E-01 0.0118  2.38235E-11 0.9968  2.41343E-03 0.0107  2.02714E-03 0.0111
  2.12510E-01 0.0114  5.32584E-03 0.0113  3.15025E-02 0.0114  5.91367E-03 0.0110
  9.66749E-03 0.0111  4.46827E-03 0.0113  5.33620E-03 0.0106  6.91771E-04 0.0112
  9.09001E-04 0.0186  2.46434E-02 0.0108  3.33850E-08 0.0191  1.29911E-02 0.0159
  3.92270E-01 0.0129  1.52707E-02 0.0110  2.23225E-01 0.0110  1.65164E-06 0.0168
  1.58788E-12 0.6906  1.94584E-02 0.0107
tfc   19       1       1       1       1       1       1       1       1
     128000  1.36023E-01  5.64111E-02  2.10634E+00
     256000  1.32658E-01  3.76225E-02  2.35385E+00
     384000  1.31630E-01  3.00452E-02  2.33506E+00
```

```
     512000  1.29159E-01  2.61204E-02  2.31001E+00
     640000  1.29721E-01  2.33138E-02  2.26057E+00
     768000  1.31464E-01  2.11423E-02  2.25385E+00
     896000  1.32581E-01  1.95478E-02  2.24324E+00
    1024000  1.33674E-01  1.81984E-02  2.22905E+00
    1152000  1.34084E-01  1.71315E-02  2.25065E+00
    1280000  1.33956E-01  1.62455E-02  2.25564E+00
    1408000  1.33246E-01  1.54897E-02  2.25425E+00
    1536000  1.33144E-01  1.48141E-02  2.25565E+00
    1664000  1.33546E-01  1.41817E-02  2.28392E+00
    1792000  1.32826E-01  1.37036E-02  2.26259E+00
    1920000  1.32947E-01  1.32232E-02  2.27747E+00
    2048000  1.32926E-01  1.28032E-02  2.25066E+00
    2176000  1.32663E-01  1.24037E-02  2.26333E+00
    2304000  1.32682E-01  1.20599E-02  2.25639E+00
    2421150  1.32306E-01  1.17907E-02  2.24195E+00
tally  184    1
       m402 cells,    IT lower frame
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  8.07082E-02 0.0117  8.90378E-15 0.6828  1.46426E-03 0.0111  1.40825E-03 0.0110
  1.27114E-01 0.0115  3.17001E-03 0.0115  1.88406E-02 0.0115  4.20032E-03 0.0110
  6.86007E-03 0.0110  3.28059E-03 0.0110  3.22501E-03 0.0111  4.96353E-04 0.0110
  4.74265E-04 0.0174  1.47016E-02 0.0113  1.53403E-08 0.0222  7.33454E-03 0.0141
  2.94618E-01 0.0117  8.33477E-03 0.0118  1.29978E-01 0.0115  8.67013E-07 0.0168
  8.46421E-14 0.4523  1.13384E-02 0.0117
tfc   19       1       1       1       1       1       1       1       1
     128000  7.81410E-02  5.48726E-02  2.22611E+00
     256000  8.08417E-02  3.66769E-02  2.47678E+00
     384000  8.29232E-02  2.95752E-02  2.40988E+00
     512000  7.99312E-02  2.57112E-02  2.38413E+00
     640000  7.95341E-02  2.29980E-02  2.32309E+00
     768000  8.00044E-02  2.09056E-02  2.30519E+00
     896000  8.10281E-02  1.92828E-02  2.30532E+00
    1024000  8.14481E-02  1.80218E-02  2.27297E+00
    1152000  8.15768E-02  1.70000E-02  2.28559E+00
    1280000  8.15080E-02  1.60713E-02  2.30481E+00
    1408000  8.12219E-02  1.53419E-02  2.29792E+00
    1536000  8.11524E-02  1.46642E-02  2.30200E+00
    1664000  8.10119E-02  1.40549E-02  2.32532E+00
    1792000  8.09885E-02  1.35344E-02  2.31951E+00
    1920000  8.09342E-02  1.30614E-02  2.33426E+00
    2048000  8.08095E-02  1.26334E-02  2.31157E+00
    2176000  8.09696E-02  1.22626E-02  2.31571E+00
    2304000  8.09357E-02  1.19235E-02  2.30830E+00
    2421150  8.07082E-02  1.16560E-02  2.29408E+00
tally  194    1
       m401 cells,    IT guide tubes
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.52110E-02 0.0163  0.00000E+00 0.0000  7.58886E-04 0.0150  9.95882E-04 0.0144
  5.74656E-02 0.0160  1.41129E-03 0.0160  8.51833E-03 0.0160  2.93838E-03 0.0144
  4.93839E-03 0.0144  2.15723E-03 0.0144  1.84639E-03 0.0147  3.62841E-04 0.0144
  1.57099E-04 0.0239  6.67543E-03 0.0156  2.88153E-09 0.0304  2.92419E-03 0.0189
  1.62502E-01 0.0152  3.14277E-03 0.0168  5.46456E-02 0.0163  3.59351E-07 0.0176
```

```
  7.20238E-15 0.4969  4.51718E-03 0.0156
tfc   19       1       1       1       1       1       1       1       1
     128000  3.63844E-02  7.58578E-02  1.16482E+00
     256000  3.72149E-02  5.12814E-02  1.26694E+00
     384000  3.76822E-02  4.08922E-02  1.26058E+00
     512000  3.61251E-02  3.59658E-02  1.21842E+00
     640000  3.62280E-02  3.16517E-02  1.22646E+00
     768000  3.60576E-02  2.86731E-02  1.22541E+00
     896000  3.65931E-02  2.64741E-02  1.22300E+00
    1024000  3.61801E-02  2.47175E-02  1.20831E+00
    1152000  3.59466E-02  2.33627E-02  1.21019E+00
    1280000  3.59908E-02  2.21214E-02  1.21649E+00
    1408000  3.59199E-02  2.13507E-02  1.18650E+00
    1536000  3.59371E-02  2.04171E-02  1.18751E+00
    1664000  3.57668E-02  1.96459E-02  1.19012E+00
    1792000  3.57655E-02  1.89360E-02  1.18495E+00
    1920000  3.57073E-02  1.82902E-02  1.19040E+00
    2048000  3.54602E-02  1.76758E-02  1.18083E+00
    2176000  3.52752E-02  1.71365E-02  1.18579E+00
    2304000  3.52123E-02  1.66813E-02  1.17934E+00
    2421150  3.52110E-02  1.62506E-02  1.18022E+00
tally  204    1
       m140 cells,      inner shield
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.26995E+01 0.0021  2.06431E-05 0.0662  6.45534E-01 0.0018  5.24326E-01 0.0019
  5.44441E+01 0.0020  1.51855E+00 0.0019  8.05606E+00 0.0020  1.46683E+00 0.0019
  2.18973E+00 0.0021  1.05385E+00 0.0021  1.55373E+00 0.0017  1.74998E-01 0.0020
  5.70769E-01 0.0025  6.73756E+00 0.0018  7.39148E-05 0.0046  3.88396E+00 0.0027
  9.05055E+01 0.0026  5.35965E+00 0.0017  5.93695E+01 0.0019  1.64167E-03 0.0021
  8.55769E-07 0.0967  9.95365E+00 0.0015
tfc   19       1       1       1       1       1       1       1       1
     128000  3.26266E+01  9.81117E-03  6.96334E+01
     256000  3.27026E+01  6.63929E-03  7.55842E+01
     384000  3.28048E+01  5.35010E-03  7.36421E+01
     512000  3.27270E+01  4.60445E-03  7.43397E+01
     640000  3.26581E+01  4.10014E-03  7.30881E+01
     768000  3.26550E+01  3.72568E-03  7.25802E+01
     896000  3.26090E+01  3.44454E-03  7.22450E+01
    1024000  3.26568E+01  3.21831E-03  7.12743E+01
    1152000  3.27083E+01  3.02876E-03  7.20061E+01
    1280000  3.27539E+01  2.87040E-03  7.22521E+01
    1408000  3.27072E+01  2.73691E-03  7.22055E+01
    1536000  3.27305E+01  2.62071E-03  7.20750E+01
    1664000  3.27443E+01  2.51624E-03  7.25487E+01
    1792000  3.27264E+01  2.42335E-03  7.23509E+01
    1920000  3.27322E+01  2.34046E-03  7.26989E+01
    2048000  3.27214E+01  2.26460E-03  7.19393E+01
    2176000  3.27217E+01  2.19631E-03  7.21881E+01
    2304000  3.26987E+01  2.13365E-03  7.20861E+01
    2421150  3.26995E+01  2.08094E-03  7.19755E+01
tally  214    1
       m410 cells,    shield support
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
```

```
  1.26209E-01 0.0082  1.64848E-11 0.9999  2.37321E-03 0.0068  2.04422E-03 0.0072
  2.01917E-01 0.0078  5.19377E-03 0.0076  2.99084E-02 0.0078  6.00546E-03 0.0071
  9.45120E-03 0.0073  4.53967E-03 0.0076  5.49875E-03 0.0066  6.74682E-04 0.0074
  1.29408E-03 0.0116  2.43137E-02 0.0070  5.43493E-08 0.0106  1.32658E-02 0.0104
  4.00930E-01 0.0092  1.68710E-02 0.0068  2.14677E-01 0.0073  2.16059E-06 0.0117
  1.20991E-12 0.9621  2.38857E-02 0.0063
tfc   19       1       1       1       1       1       1       1       1
     128000  1.27109E-01  3.87550E-02  4.46276E+00
     256000  1.29956E-01  2.57175E-02  5.03754E+00
     384000  1.28147E-01  2.08308E-02  4.85780E+00
     512000  1.29201E-01  1.79506E-02  4.89121E+00
     640000  1.27571E-01  1.62508E-02  4.65257E+00
     768000  1.26455E-01  1.47498E-02  4.63083E+00
     896000  1.26113E-01  1.36269E-02  4.61613E+00
    1024000  1.26400E-01  1.26786E-02  4.59248E+00
    1152000  1.26244E-01  1.18978E-02  4.66619E+00
    1280000  1.26883E-01  1.13067E-02  4.65652E+00
    1408000  1.26479E-01  1.07598E-02  4.67176E+00
    1536000  1.26199E-01  1.02553E-02  4.70686E+00
    1664000  1.26618E-01  9.84947E-03  4.73489E+00
    1792000  1.26479E-01  9.52162E-03  4.68656E+00
    1920000  1.25700E-01  9.22092E-03  4.68361E+00
    2048000  1.25932E-01  8.92785E-03  4.62864E+00
    2176000  1.26256E-01  8.65379E-03  4.64986E+00
    2304000  1.26363E-01  8.38643E-03  4.66601E+00
    2421150  1.26209E-01  8.17548E-03  4.66315E+00
tally  224    1
       m142 cells,      outer shield
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.41873E+01 0.0021  9.58934E-07 0.2188  2.87642E-01 0.0020  2.33889E-01 0.0021
  2.35893E+01 0.0021  6.47122E-01 0.0020  3.48724E+00 0.0021  6.72295E-01 0.0020
  9.92840E-01 0.0021  4.79075E-01 0.0021  7.11438E-01 0.0019  7.29852E-02 0.0021
  2.56865E-01 0.0025  2.97933E+00 0.0020  1.85861E-05 0.0038  1.74555E+00 0.0025
  4.10762E+01 0.0024  2.44987E+00 0.0019  2.60131E+01 0.0020  5.39234E-04 0.0026
  6.68022E-08 0.4333  4.06426E+00 0.0020
tfc   19       1       1       1       1       1       1       1       1
     128000  1.43961E+01  1.00050E-02  6.69611E+01
     256000  1.43388E+01  6.73866E-03  7.33716E+01
     384000  1.42145E+01  5.43088E-03  7.14676E+01
     512000  1.42202E+01  4.67071E-03  7.22453E+01
     640000  1.42089E+01  4.17104E-03  7.06247E+01
     768000  1.41918E+01  3.79595E-03  6.99180E+01
     896000  1.41745E+01  3.51232E-03  6.94833E+01
    1024000  1.41915E+01  3.28258E-03  6.85104E+01
    1152000  1.41887E+01  3.09367E-03  6.90162E+01
    1280000  1.42124E+01  2.93262E-03  6.92186E+01
    1408000  1.41965E+01  2.79599E-03  6.91862E+01
    1536000  1.41942E+01  2.67493E-03  6.91832E+01
    1664000  1.42126E+01  2.56921E-03  6.95882E+01
    1792000  1.42064E+01  2.47606E-03  6.93032E+01
    1920000  1.41943E+01  2.39245E-03  6.95733E+01
    2048000  1.41971E+01  2.31580E-03  6.87934E+01
    2176000  1.41973E+01  2.24638E-03  6.90058E+01
    2304000  1.41859E+01  2.18259E-03  6.88896E+01
    2421150  1.41873E+01  2.12823E-03  6.88127E+01
tally  234    1
       m412 cells,       core barrel
f        1
      0
d        1
u        0
s        0
```

```
m       22
c        0
e        0
t        0
vals
  3.85992E-01 0.0036  8.08826E-08 0.4695  7.22708E-03 0.0033  6.31046E-03 0.0034
  6.42884E-01 0.0035  1.61947E-02 0.0035  9.52240E-02 0.0035  1.89486E-02 0.0034
  3.03793E-02 0.0034  1.37512E-02 0.0034  1.60578E-02 0.0033  2.18617E-03 0.0035
  2.99287E-03 0.0057  7.25227E-02 0.0033  1.32945E-07 0.0721  3.83797E-02 0.0046
  1.16118E+00 0.0038  4.49507E-02 0.0034  6.56221E-01 0.0034  5.00728E-06 0.0067
  2.38428E-09 0.4578  5.87749E-02 0.0038
tfc   19       1       1       1       1       1       1       1       1
     128000  3.94843E-01  1.66321E-02  2.42305E+01
     256000  3.87186E-01  1.08995E-02  2.80455E+01
     384000  3.85774E-01  8.93755E-03  2.63884E+01
     512000  3.85496E-01  7.68818E-03  2.66641E+01
     640000  3.84764E-01  6.87316E-03  2.60095E+01
     768000  3.86239E-01  6.33966E-03  2.50667E+01
     896000  3.86019E-01  5.87202E-03  2.48596E+01
    1024000  3.87160E-01  5.53087E-03  2.41324E+01
    1152000  3.86147E-01  5.18033E-03  2.46141E+01
    1280000  3.86517E-01  4.89634E-03  2.48309E+01
    1408000  3.85912E-01  4.66601E-03  2.48427E+01
    1536000  3.85568E-01  4.47427E-03  2.47275E+01
    1664000  3.85232E-01  4.28354E-03  2.50340E+01
    1792000  3.85764E-01  4.14582E-03  2.47204E+01
    1920000  3.85061E-01  4.00569E-03  2.48185E+01
    2048000  3.85813E-01  3.89441E-03  2.43257E+01
    2176000  3.85401E-01  3.78173E-03  2.43484E+01
    2304000  3.85627E-01  3.67556E-03  2.42914E+01
    2421150  3.85992E-01  3.58357E-03  2.42703E+01
tally  244    1
       m413 cells,              IVHM
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  7.02623E-03 0.0111  1.08132E-10 0.8765  1.68932E-04 0.0098  2.88863E-04 0.0088
  1.11872E-02 0.0109  2.72229E-04 0.0110  1.65799E-03 0.0109  8.53883E-04 0.0088
  1.44234E-03 0.0088  6.33069E-04 0.0089  4.36283E-04 0.0093  1.07182E-04 0.0088
  1.38227E-05 0.0199  1.31702E-03 0.0106  2.01921E-10 0.1299  4.68411E-04 0.0127
  4.62116E-02 0.0095  4.28042E-04 0.0127  9.37820E-03 0.0118  8.28498E-08 0.0098
  3.06735E-12 0.8693  8.66312E-04 0.0104
tfc   19       1       1       1       1       1       1       1       1
     128000  7.01979E-03  5.27739E-02  2.40669E+00
     256000  6.86167E-03  3.46115E-02  2.78121E+00
     384000  7.00708E-03  2.78768E-02  2.71246E+00
     512000  6.82512E-03  2.39973E-02  2.73684E+00
     640000  6.84644E-03  2.12814E-02  2.71296E+00
     768000  6.92754E-03  1.98050E-02  2.56849E+00
     896000  7.02924E-03  1.83887E-02  2.53495E+00
    1024000  7.07779E-03  1.72090E-02  2.49274E+00
    1152000  7.06670E-03  1.61471E-02  2.53342E+00
    1280000  7.04654E-03  1.52316E-02  2.56594E+00
    1408000  7.00946E-03  1.45127E-02  2.56801E+00
    1536000  7.04369E-03  1.40850E-02  2.49523E+00
    1664000  7.03260E-03  1.35456E-02  2.50343E+00
    1792000  7.06226E-03  1.30382E-02  2.49945E+00
    1920000  7.04225E-03  1.25699E-02  2.52040E+00
    2048000  7.01921E-03  1.21521E-02  2.49832E+00
    2176000  7.01098E-03  1.17655E-02  2.51555E+00
    2304000  7.02294E-03  1.14427E-02  2.50636E+00
    2421150  7.02623E-03  1.11442E-02  2.50964E+00
tally  254    1
       m414 cells,              IVFSM
```

```
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.36349E-01 0.0113  4.31457E-06 0.2628  6.73589E-03 0.0116  6.70158E-03 0.0101
  5.63016E-01 0.0117  1.47628E-02 0.0139  8.35050E-02 0.0117  1.92658E-02 0.0090
  3.17228E-02 0.0086  1.42230E-02 0.0090  1.56367E-02 0.0125  2.53710E-03 0.0124
  2.80256E-03 0.0271  6.54157E-02 0.0122  1.54043E-06 0.1595  3.40905E-02 0.0165
  1.12066E+00 0.0091  3.94792E-02 0.0164  5.76839E-01 0.0123  8.96650E-06 0.0389
  1.49642E-07 0.2961  6.38530E-02 0.0240
tfc   19       1       1       1       1       1       1       1       1
     128000  3.34393E-01  5.36824E-02  2.32593E+00
     256000  3.10674E-01  3.21757E-02  3.21823E+00
     384000  3.10659E-01  2.67073E-02  2.95521E+00
     512000  3.14392E-01  2.29564E-02  2.99066E+00
     640000  3.21166E-01  2.09636E-02  2.79585E+00
     768000  3.28194E-01  1.98722E-02  2.55116E+00
     896000  3.30550E-01  1.87246E-02  2.44481E+00
    1024000  3.38168E-01  1.78268E-02  2.32296E+00
    1152000  3.33989E-01  1.65893E-02  2.40017E+00
    1280000  3.33569E-01  1.55058E-02  2.47599E+00
    1408000  3.32799E-01  1.47078E-02  2.50031E+00
    1536000  3.31748E-01  1.40270E-02  2.51592E+00
    1664000  3.29938E-01  1.33303E-02  2.58497E+00
    1792000  3.34298E-01  1.30749E-02  2.48540E+00
    1920000  3.32734E-01  1.25969E-02  2.50959E+00
    2048000  3.35896E-01  1.23264E-02  2.42814E+00
    2176000  3.36234E-01  1.19223E-02  2.44983E+00
    2304000  3.36392E-01  1.15897E-02  2.44316E+00
    2421150  3.36349E-01  1.12678E-02  2.45487E+00
tally  264    1
       m409 cells,         IT column
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.95846E-02 0.0138  0.00000E+00 0.0000  3.98471E-04 0.0129  4.85416E-04 0.0123
  3.14484E-02 0.0136  7.75096E-04 0.0136  4.66175E-03 0.0136  1.43189E-03 0.0123
  2.39479E-03 0.0122  1.07316E-03 0.0123  9.39190E-04 0.0126  1.75358E-04 0.0122
  9.04892E-05 0.0216  3.64965E-03 0.0133  1.98295E-09 0.0253  1.66611E-03 0.0167
  8.52531E-02 0.0132  1.80925E-03 0.0142  3.05771E-02 0.0137  1.93437E-07 0.0167
  2.30163E-15 0.4470  2.54685E-03 0.0135
tfc   19       1       1       1       1       1       1       1       1
     128000  1.93780E-02  6.60653E-02  1.53572E+00
     256000  1.98222E-02  4.45282E-02  1.68036E+00
     384000  2.04859E-02  3.54395E-02  1.67832E+00
     512000  1.97735E-02  3.08383E-02  1.65728E+00
     640000  1.97755E-02  2.74531E-02  1.63028E+00
     768000  1.95654E-02  2.48138E-02  1.63622E+00
     896000  1.98968E-02  2.28542E-02  1.64111E+00
    1024000  1.98793E-02  2.12582E-02  1.63355E+00
    1152000  1.98639E-02  1.99545E-02  1.65889E+00
    1280000  1.99091E-02  1.89199E-02  1.66303E+00
    1408000  1.98525E-02  1.81961E-02  1.63356E+00
    1536000  1.98485E-02  1.74363E-02  1.62823E+00
    1664000  1.97958E-02  1.67515E-02  1.63692E+00
    1792000  1.98192E-02  1.61350E-02  1.63206E+00
    1920000  1.97853E-02  1.55746E-02  1.64171E+00
    2048000  1.96686E-02  1.50668E-02  1.62520E+00
```

```
    2176000  1.96482E-02  1.46048E-02  1.63254E+00
    2304000  1.96265E-02  1.41730E-02  1.63373E+00
    2421150  1.95846E-02  1.38254E-02  1.63062E+00
tally  284    1
       m435 cells,              B4C
f        1
       0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.44463E-06 0.0529  1.15901E-11 0.9023  4.11546E-08 0.0491  4.38949E-08 0.0505
  2.50922E-06 0.0499  8.46522E-08 0.0538  3.68704E-07 0.0500  1.16475E-07 0.0451
  1.42659E-07 0.0398  7.33446E-08 0.0474  1.31398E-07 0.0518  1.18980E-08 0.0482
  8.56403E-08 0.0736  4.00233E-07 0.0500  9.39248E-12 0.2517  3.06213E-07 0.0706
  3.85014E-06 0.0429  4.81450E-07 0.0563  3.12149E-06 0.0494  2.04750E-10 0.0780
  4.14635E-13 0.9152  1.02693E-06 0.0647
tfc   19       1       1       1       1       1       1       1       1
     128000  1.70497E-06  2.89858E-01  7.97791E-02
     256000  1.20822E-06  2.21071E-01  6.81726E-02
     384000  1.25382E-06  1.68246E-01  7.44667E-02
     512000  1.22223E-06  1.40432E-01  7.99182E-02
     640000  1.30453E-06  1.16776E-01  9.01024E-02
     768000  1.37598E-06  1.00875E-01  9.90062E-02
     896000  1.41470E-06  9.23849E-02  1.00431E-01
    1024000  1.48212E-06  8.28794E-02  1.07472E-01
    1152000  1.44434E-06  7.89786E-02  1.05896E-01
    1280000  1.39982E-06  7.50109E-02  1.05800E-01
    1408000  1.41564E-06  7.20375E-02  1.04225E-01
    1536000  1.43306E-06  6.90458E-02  1.03836E-01
    1664000  1.38949E-06  6.69203E-02  1.02570E-01
    1792000  1.40568E-06  6.32024E-02  1.06367E-01
    1920000  1.38550E-06  6.07839E-02  1.07783E-01
    2048000  1.47035E-06  5.76003E-02  1.11198E-01
    2176000  1.44209E-06  5.59482E-02  1.11245E-01
    2304000  1.44774E-06  5.42326E-02  1.11578E-01
    2421150  1.44463E-06  5.29211E-02  1.11288E-01
tally  294    1
       m431 cells,    Z ring
f        1
       0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.11347E-06 0.0504  7.91663E-13 1.0000  6.87449E-08 0.0442  9.42336E-08 0.0357
  4.93002E-06 0.0493  1.23864E-07 0.0500  7.29739E-07 0.0492  2.83141E-07 0.0360
  4.66389E-07 0.0353  2.13875E-07 0.0352  1.74328E-07 0.0418  3.43956E-08 0.0352
  2.07942E-08 0.0708  5.98355E-07 0.0490  1.06374E-12 0.1932  2.88582E-07 0.0540
  1.78882E-05 0.0375  3.13864E-07 0.0585  4.68118E-06 0.0531  5.04860E-11 0.0631
  2.86866E-14 1.0000  5.10455E-07 0.0529
tfc   19       1       1       1       1       1       1       1       1
     128000  3.30881E-06  2.67419E-01  9.37288E-02
     256000  2.35539E-06  1.87066E-01  9.52104E-02
     384000  2.75333E-06  1.42035E-01  1.04486E-01
     512000  2.66560E-06  1.19975E-01  1.09494E-01
     640000  2.86526E-06  1.05353E-01  1.10701E-01
     768000  3.00230E-06  9.25919E-02  1.17512E-01
     896000  3.02993E-06  8.47642E-02  1.19301E-01
    1024000  3.19254E-06  7.76039E-02  1.22580E-01
    1152000  3.07687E-06  7.35589E-02  1.22076E-01
    1280000  3.05192E-06  6.96897E-02  1.22574E-01
    1408000  3.02563E-06  6.71757E-02  1.19858E-01
```

```
    1536000  3.06749E-06  6.44622E-02  1.19128E-01
    1664000  2.96104E-06  6.30956E-02  1.15382E-01
    1792000  3.01946E-06  5.99048E-02  1.18400E-01
    1920000  2.97820E-06  5.82892E-02  1.17207E-01
    2048000  3.13469E-06  5.52643E-02  1.20798E-01
    2176000  3.10323E-06  5.34687E-02  1.21802E-01
    2304000  3.11629E-06  5.17761E-02  1.22417E-01
    2421150  3.11347E-06  5.04395E-02  1.22508E-01
tally  304    1
       m411 cells,  baffle plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  6.01172E-03 0.0090  8.94203E-11 0.7745  1.28382E-04 0.0079  1.93584E-04 0.0070
  9.37941E-03 0.0089  2.29925E-04 0.0089  1.38975E-03 0.0089  5.75459E-04 0.0070
  9.63956E-04 0.0069  4.31434E-04 0.0070  3.11879E-04 0.0075  7.13919E-05 0.0069
  1.80586E-05 0.0175  1.08897E-03 0.0086  3.89319E-10 0.0572  4.16824E-04 0.0112
  3.34039E-02 0.0077  4.18589E-04 0.0103  8.41220E-03 0.0094  6.21197E-08 0.0096
  2.53040E-12 0.7618  7.35771E-04 0.0088
tfc   19       1       1       1       1       1       1       1       1
    128000  5.95886E-03  3.95327E-02  4.28890E+00
    256000  5.70293E-03  2.39832E-02  5.79243E+00
    384000  5.77005E-03  1.93899E-02  5.60660E+00
    512000  5.69591E-03  1.64386E-02  5.83238E+00
    640000  5.74226E-03  1.49348E-02  5.50869E+00
    768000  5.85644E-03  1.49362E-02  4.51593E+00
    896000  5.93277E-03  1.39461E-02  4.40719E+00
   1024000  5.99123E-03  1.37245E-02  3.91919E+00
   1152000  5.99083E-03  1.27793E-02  4.04466E+00
   1280000  5.94993E-03  1.18952E-02  4.20721E+00
   1408000  5.94347E-03  1.12566E-02  4.26848E+00
   1536000  5.98499E-03  1.12645E-02  3.90123E+00
   1664000  5.96959E-03  1.08025E-02  3.93628E+00
   1792000  6.00202E-03  1.04689E-02  3.87679E+00
   1920000  6.00105E-03  1.00566E-02  3.93758E+00
   2048000  6.01984E-03  9.78567E-03  3.85271E+00
   2176000  6.01264E-03  9.48197E-03  3.87307E+00
   2304000  6.01911E-03  9.26618E-03  3.82206E+00
   2421150  6.01172E-03  8.98833E-03  3.85787E+00
tally  314    1
       m431 cells, ss-304 suppressor plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  4.91651E-08 0.0591  3.97700E-16 1.0000  1.27212E-09 0.0495  2.20369E-09 0.0424
  8.20734E-08 0.0567  2.00869E-09 0.0569  1.21622E-08 0.0567  6.49001E-09 0.0425
  1.09745E-08 0.0423  4.24788E-09 0.0462  3.39231E-09 0.0460  8.15318E-10 0.0422
  1.51461E-10 0.0930  9.51367E-09 0.0555  4.17309E-15 0.1136  3.15114E-09 0.0741
  2.66514E-07 0.0545  3.38015E-09 0.0660  6.55033E-08 0.0635  7.38140E-13 0.0518
  1.04249E-17 0.9992  6.18257E-09 0.0584
tfc   19       1       1       1       1       1       1       1       1
    128000  5.99154E-08  3.58092E-01  5.22722E-02
    256000  4.00897E-08  2.59601E-01  4.94382E-02
    384000  4.45662E-08  1.81455E-01  6.40195E-02
    512000  4.38348E-08  1.55803E-01  6.49263E-02
    640000  4.75193E-08  1.29677E-01  7.30669E-02
    768000  4.75731E-08  1.14063E-01  7.74359E-02
```

```
     896000  4.76924E-08  1.03186E-01  8.05054E-02
    1024000  4.94151E-08  9.32185E-02  8.49539E-02
    1152000  4.78662E-08  8.81579E-02  8.49917E-02
    1280000  4.71537E-08  8.32285E-02  8.59392E-02
    1408000  4.78233E-08  7.93752E-02  8.58463E-02
    1536000  4.79986E-08  7.61375E-02  8.53940E-02
    1664000  4.66456E-08  7.44032E-02  8.29759E-02
    1792000  4.75441E-08  6.98975E-02  8.69668E-02
    1920000  4.67229E-08  6.78509E-02  8.65004E-02
    2048000  4.88136E-08  6.38072E-02  9.06167E-02
    2176000  4.80088E-08  6.18294E-02  9.10881E-02
    2304000  4.85685E-08  5.96894E-02  9.21096E-02
    2421150  4.91651E-08  5.90516E-02  8.93803E-02
tally  324    1
       m431 cells, ss-304 thermal reflector plates
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  7.60012E-07 0.0590  5.36217E-15 1.0000  1.81205E-08 0.0513  2.89396E-08 0.0442
  1.24119E-06 0.0576  3.06217E-08 0.0579  1.83874E-07 0.0576  8.56969E-08 0.0444
  1.43823E-07 0.0441  6.07955E-08 0.0469  4.65669E-08 0.0480  1.06675E-08 0.0440
  2.86845E-09 0.0784  1.45119E-07 0.0566  1.20250E-13 0.1184  5.58591E-08 0.0646
  4.37523E-06 0.0530  5.87447E-08 0.0655  1.06602E-06 0.0624  1.12307E-11 0.0603
  1.41509E-16 0.9997  1.04834E-07 0.0593
tfc   19       1       1       1       1       1       1       1       1
     128000  8.98095E-07  3.30194E-01  6.14780E-02
     256000  5.70191E-07  2.48025E-01  5.41607E-02
     384000  6.58817E-07  1.76377E-01  6.77586E-02
     512000  6.36719E-07  1.52303E-01  6.79453E-02
     640000  7.00077E-07  1.29033E-01  7.37974E-02
     768000  7.08595E-07  1.12719E-01  7.92930E-02
     896000  7.25983E-07  1.02164E-01  8.21250E-02
    1024000  7.64334E-07  9.23141E-02  8.66266E-02
    1152000  7.40611E-07  8.77687E-02  8.57472E-02
    1280000  7.26387E-07  8.31127E-02  8.61788E-02
    1408000  7.38970E-07  8.01432E-02  8.42088E-02
    1536000  7.49853E-07  7.67334E-02  8.40727E-02
    1664000  7.25651E-07  7.48512E-02  8.19856E-02
    1792000  7.39135E-07  7.03825E-02  8.57722E-02
    1920000  7.25036E-07  6.85629E-02  8.47133E-02
    2048000  7.66679E-07  6.43395E-02  8.91235E-02
    2176000  7.53984E-07  6.24674E-02  8.92372E-02
    2304000  7.57607E-07  6.02135E-02  9.05131E-02
    2421150  7.60012E-07  5.89571E-02  8.96673E-02
tally  334    1
       m430 cells, Inconel 600 shield plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  2.74641E-07 0.0622  2.05161E-15 1.0000  5.85713E-09 0.0568  7.65775E-09 0.0488
  4.34491E-07 0.0611  1.08689E-08 0.0616  6.43294E-08 0.0611  2.31559E-08 0.0493
  3.82330E-08 0.0487  1.80561E-08 0.0501  1.44346E-08 0.0544  2.82141E-09 0.0486
  1.79465E-09 0.0789  5.20585E-08 0.0609  7.91718E-14 0.1182  2.45057E-08 0.0673
  1.46558E-06 0.0537  2.66743E-08 0.0682  4.17367E-07 0.0644  5.19307E-12 0.0855
  5.35828E-17 0.9997  4.29129E-08 0.0646
tfc   19       1       1       1       1       1       1       1       1
     128000  2.93450E-07  3.52071E-01  5.40751E-02
```

```
     256000  1.96653E-07  2.59436E-01  4.95011E-02
     384000  2.39754E-07  1.88812E-01  5.91274E-02
     512000  2.34114E-07  1.62104E-01  5.99772E-02
     640000  2.52413E-07  1.37202E-01  6.52719E-02
     768000  2.59612E-07  1.20313E-01  6.95992E-02
     896000  2.59867E-07  1.08387E-01  7.29658E-02
    1024000  2.73004E-07  9.71997E-02  7.81373E-02
    1152000  2.62461E-07  9.26849E-02  7.68920E-02
    1280000  2.61459E-07  8.76854E-02  7.74249E-02
    1408000  2.63283E-07  8.42601E-02  7.61810E-02
    1536000  2.67807E-07  8.08372E-02  7.57534E-02
    1664000  2.59520E-07  7.89681E-02  7.36601E-02
    1792000  2.63492E-07  7.45619E-02  7.64261E-02
    1920000  2.57462E-07  7.25313E-02  7.56969E-02
    2048000  2.74517E-07  6.77349E-02  8.04125E-02
    2176000  2.71204E-07  6.57344E-02  8.05874E-02
    2304000  2.73960E-07  6.35856E-02  8.11674E-02
    2421150  2.74641E-07  6.21801E-02  8.06127E-02
tally  344    1
       m436 cells, ss-410 shield plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.27638E-07 0.0643  1.20037E-16 1.0000  2.71994E-09 0.0578  3.31274E-09 0.0497
  2.01722E-07 0.0643  5.21253E-09 0.0649  2.98509E-08 0.0643  9.79304E-09 0.0493
  1.57451E-08 0.0485  7.58816E-09 0.0489  6.84510E-09 0.0556  1.16145E-09 0.0486
  1.39530E-09 0.0864  2.50733E-08 0.0623  6.72113E-14 0.1167  1.35057E-08 0.0731
  6.48776E-07 0.0538  1.54162E-08 0.0706  2.05467E-07 0.0664  2.50208E-12 0.0918
  3.27350E-18 0.9981  2.56779E-08 0.0679
tfc   19       1       1       1       1       1       1       1       1
     128000  1.24265E-07  2.70323E-01  9.17261E-02
     256000  8.69250E-08  2.12367E-01  7.38758E-02
     384000  1.03556E-07  1.70830E-01  7.22305E-02
     512000  1.05107E-07  1.52492E-01  6.77764E-02
     640000  1.11891E-07  1.32030E-01  7.04852E-02
     768000  1.17614E-07  1.17181E-01  7.33695E-02
     896000  1.21772E-07  1.07328E-01  7.44121E-02
    1024000  1.26242E-07  9.67806E-02  7.88154E-02
    1152000  1.18634E-07  9.30074E-02  7.63597E-02
    1280000  1.22192E-07  8.85661E-02  7.58927E-02
    1408000  1.21717E-07  8.50815E-02  7.47172E-02
    1536000  1.23742E-07  8.37541E-02  7.05686E-02
    1664000  1.19294E-07  8.20636E-02  6.82078E-02
    1792000  1.23260E-07  7.74415E-02  7.08482E-02
    1920000  1.19678E-07  7.52133E-02  7.03948E-02
    2048000  1.28492E-07  7.09483E-02  7.32933E-02
    2176000  1.26868E-07  6.87016E-02  7.37765E-02
    2304000  1.27224E-07  6.63006E-02  7.46559E-02
    2421150  1.27638E-07  6.42945E-02  7.53978E-02
tally  354    1
       m437 cells, low carbon steel shield plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.13357E-07 0.0735  0.00000E+00 0.0000  2.45382E-09 0.0696  2.87422E-09 0.0634
  1.84158E-07 0.0722  4.93852E-09 0.0732  2.72260E-08 0.0722  8.21817E-09 0.0624
  1.27166E-08 0.0609  6.05280E-09 0.0612  6.28045E-09 0.0688  9.39231E-10 0.0611
```

```
  1.91873E-09 0.0890  2.33026E-08 0.0726  9.55250E-14 0.1247  1.26854E-08 0.0772
  5.01275E-07 0.0645  1.64948E-08 0.0788  1.93440E-07 0.0747  2.91598E-12 0.1049
  1.65647E-20 1.0000  2.89578E-08 0.0800
tfc   19       1       1       1       1       1       1       1       1
     128000  8.95626E-08  3.09358E-01  7.00386E-02
     256000  5.99003E-08  2.46401E-01  5.48768E-02
     384000  8.23110E-08  2.11231E-01  4.72426E-02
     512000  8.93617E-08  2.00889E-01  3.90538E-02
     640000  9.73907E-08  1.64878E-01  4.51981E-02
     768000  1.02330E-07  1.43087E-01  4.92073E-02
     896000  1.01858E-07  1.28408E-01  5.19859E-02
    1024000  1.03971E-07  1.15174E-01  5.56521E-02
    1152000  9.86674E-08  1.10247E-01  5.43458E-02
    1280000  1.02970E-07  1.04212E-01  5.48150E-02
    1408000  1.04771E-07  9.95821E-02  5.45417E-02
    1536000  1.05778E-07  9.58699E-02  5.38592E-02
    1664000  1.02956E-07  9.44432E-02  5.14984E-02
    1792000  1.05356E-07  8.87336E-02  5.39635E-02
    1920000  1.03647E-07  8.60556E-02  5.37738E-02
    2048000  1.13125E-07  8.12012E-02  5.59530E-02
    2176000  1.12044E-07  7.85718E-02  5.64052E-02
    2304000  1.12425E-07  7.57826E-02  5.71426E-02
    2421150  1.13357E-07  7.34532E-02  5.77676E-02
tally  364    1
       bottom of core support structure
f        1
   1519
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.23639E-03 0.0163  0.00000E+00 0.0000  2.64261E-05 0.0126  4.12137E-05 0.0118
  1.88956E-03 0.0152  4.60365E-05 0.0152  2.80010E-04 0.0153  1.22721E-04 0.0118
  2.06327E-04 0.0118  9.51208E-05 0.0118  6.43785E-05 0.0120  1.53043E-05 0.0118
  2.57407E-06 0.0421  2.20049E-04 0.0140  2.72769E-11 0.0499  8.36723E-05 0.0228
  7.50743E-03 0.0148  7.68412E-05 0.0172  1.67986E-03 0.0159  1.18586E-08 0.0140
  0.00000E+00 0.0000  1.43782E-04 0.0129
tfc   19       1       1       1       1       1       1       1       1
     128000  1.09227E-03  7.24075E-02  1.27847E+00
     256000  1.22504E-03  4.97328E-02  1.34707E+00
     384000  1.22206E-03  4.10102E-02  1.25333E+00
     512000  1.23473E-03  3.50156E-02  1.28544E+00
     640000  1.25141E-03  3.19620E-02  1.20276E+00
     768000  1.24481E-03  2.92577E-02  1.17693E+00
     896000  1.21881E-03  2.74282E-02  1.13940E+00
    1024000  1.21366E-03  2.55128E-02  1.13415E+00
    1152000  1.20571E-03  2.39746E-02  1.14920E+00
    1280000  1.19576E-03  2.26868E-02  1.15662E+00
    1408000  1.19394E-03  2.16127E-02  1.15791E+00
    1536000  1.19946E-03  2.07019E-02  1.15506E+00
    1664000  1.22211E-03  1.96764E-02  1.18643E+00
    1792000  1.22893E-03  1.89607E-02  1.18187E+00
    1920000  1.21181E-03  1.83778E-02  1.17908E+00
    2048000  1.21253E-03  1.78041E-02  1.16388E+00
    2176000  1.23209E-03  1.72420E-02  1.17133E+00
    2304000  1.23383E-03  1.66817E-02  1.17928E+00
    2421150  1.23639E-03  1.62525E-02  1.17996E+00
```

Mctal Output File, fftf10em.mct, from MCNP4C Case fftf10em

```
mcnp       4c     08/05/02 19:39:01    3    2421150    50431948092
 FFTF HPPT ldg. Compute nuclide reaction rates in fixed RX components  fftf10ef
ntal    28
   34   44   54   64   74   84  104  114  134  174  184  194  204  214  224  234
  244  254  264  284  294  304  314  324  334  344  354  364
```

```
tally   34    1
       m431 cells,   thermal liner
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  2.97301E-02 0.0122  2.52939E-08 0.6063  5.99720E-04 0.0111  8.48319E-04 0.0077
  4.66542E-02 0.0128  1.14671E-03 0.0133  6.91487E-03 0.0128  2.51915E-03 0.0077
  4.22567E-03 0.0075  1.85303E-03 0.0076  1.38799E-03 0.0105  3.14603E-04 0.0076
  8.24888E-05 0.0337  5.26471E-03 0.0126  1.09892E-08 0.2933  1.93830E-03 0.0176
  1.42342E-01 0.0084  2.02029E-03 0.0190  4.24549E-02 0.0141  3.47092E-07 0.0245
  1.23033E-09 0.7352  3.45337E-03 0.0170
tfc   19       1       1       1       1       1       1       1       1
     128000  2.93154E-02  5.70400E-02  2.06015E+00
     256000  2.76095E-02  3.54046E-02  2.65800E+00
     384000  2.80198E-02  2.98443E-02  2.36661E+00
     512000  2.79579E-02  2.49694E-02  2.52790E+00
     640000  2.83974E-02  2.24990E-02  2.42728E+00
     768000  2.91257E-02  2.09851E-02  2.28775E+00
     896000  2.93624E-02  1.96350E-02  2.22334E+00
    1024000  2.99577E-02  1.89799E-02  2.04927E+00
    1152000  2.96602E-02  1.77164E-02  2.10451E+00
    1280000  2.96123E-02  1.67002E-02  2.13449E+00
    1408000  2.95650E-02  1.58733E-02  2.14662E+00
    1536000  2.94814E-02  1.52877E-02  2.11806E+00
    1664000  2.92825E-02  1.45261E-02  2.17688E+00
    1792000  2.94876E-02  1.40505E-02  2.15226E+00
    1920000  2.93771E-02  1.35197E-02  2.17868E+00
    2048000  2.98449E-02  1.33316E-02  2.07578E+00
    2176000  2.97537E-02  1.29159E-02  2.08739E+00
    2304000  2.97673E-02  1.25673E-02  2.07786E+00
    2421150  2.97301E-02  1.22182E-02  2.08782E+00
tally   44    1
       m431 cells,  reactor vessel
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.29336E-02 0.0161  3.06850E-08 0.6238  6.48093E-04 0.0144  9.34493E-04 0.0097
  4.83181E-02 0.0168  1.19890E-03 0.0176  7.15825E-03 0.0168  2.79070E-03 0.0098
  4.64458E-03 0.0094  2.20280E-03 0.0095  1.52457E-03 0.0134  3.46727E-04 0.0097
  1.16994E-04 0.0398  5.79782E-03 0.0164  1.60459E-08 0.2553  2.28182E-03 0.0206
  1.85265E-01 0.0100  2.28452E-03 0.0247  4.53382E-02 0.0184  4.44230E-07 0.0314
  1.50591E-09 0.7562  4.34917E-03 0.0217
tfc   19       1       1       1       1       1       1       1       1
     128000  3.30666E-02  7.58496E-02  1.16507E+00
     256000  3.01711E-02  4.73637E-02  1.48519E+00
     384000  3.07567E-02  4.02419E-02  1.30164E+00
     512000  3.05330E-02  3.33505E-02  1.41700E+00
     640000  3.12397E-02  3.03022E-02  1.33812E+00
     768000  3.21264E-02  2.81869E-02  1.26804E+00
     896000  3.23812E-02  2.63547E-02  1.23411E+00
    1024000  3.33829E-02  2.52349E-02  1.15927E+00
    1152000  3.29109E-02  2.35353E-02  1.19250E+00
    1280000  3.28410E-02  2.22409E-02  1.20346E+00
    1408000  3.27386E-02  2.11709E-02  1.20673E+00
    1536000  3.26442E-02  2.03224E-02  1.19860E+00
    1664000  3.23023E-02  1.93584E-02  1.22573E+00
    1792000  3.25886E-02  1.86097E-02  1.22687E+00
```

```
    1920000  3.24074E-02  1.79001E-02  1.24284E+00
    2048000  3.30579E-02  1.75957E-02  1.19161E+00
    2176000  3.29377E-02  1.70172E-02  1.20247E+00
    2304000  3.29623E-02  1.65566E-02  1.19718E+00
    2421150  3.29336E-02  1.61100E-02  1.20092E+00
tally   54    1
       m431 cells,    guard vessel
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  5.70448E-03 0.0250  7.11823E-09 0.6567  1.35494E-04 0.0226  2.22477E-04 0.0179
  8.68959E-03 0.0255  2.19763E-04 0.0268  1.28647E-03 0.0255  6.60780E-04 0.0179
  1.09946E-03 0.0174  4.78710E-04 0.0156  3.57552E-04 0.0217  8.24601E-05 0.0179
  3.21564E-05 0.0473  1.10513E-03 0.0251  4.73833E-09 0.2154  4.62737E-04 0.0282
  3.87007E-02 0.0147  4.68164E-04 0.0351  7.77952E-03 0.0277  1.25476E-07 0.0419
  3.46186E-10 0.7815  9.82642E-04 0.0314
tfc   19       1       1       1       1       1       1       1       1
     128000  5.74934E-03  1.25154E-01  4.27930E-01
     256000  4.95701E-03  8.38454E-02  4.73932E-01
     384000  5.15384E-03  6.75210E-02  4.62352E-01
     512000  5.10298E-03  5.64208E-02  4.95105E-01
     640000  5.30720E-03  5.04364E-02  4.83011E-01
     768000  5.49180E-03  4.54580E-02  4.87539E-01
     896000  5.56638E-03  4.19516E-02  4.87049E-01
    1024000  5.81447E-03  3.93145E-02  4.77619E-01
    1152000  5.69254E-03  3.68210E-02  4.87201E-01
    1280000  5.67484E-03  3.48417E-02  4.90385E-01
    1408000  5.65406E-03  3.32151E-02  4.90251E-01
    1536000  5.63786E-03  3.18416E-02  4.88242E-01
    1664000  5.53865E-03  3.04991E-02  4.93812E-01
    1792000  5.59504E-03  2.91037E-02  5.01627E-01
    1920000  5.54567E-03  2.80309E-02  5.06821E-01
    2048000  5.71646E-03  2.72655E-02  4.96272E-01
    2176000  5.69081E-03  2.63285E-02  5.02344E-01
    2304000  5.70427E-03  2.56110E-02  5.00319E-01
    2421150  5.70448E-03  2.50082E-02  4.98356E-01
tally   64    1
       m431 cells,    core support
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  4.07410E-02 0.0073  2.38877E-10 0.8917  8.14389E-04 0.0067  1.19426E-03 0.0063
  6.10269E-02 0.0072  1.48910E-03 0.0072  9.04347E-03 0.0072  3.56849E-03 0.0064
  5.97847E-03 0.0063  2.82363E-03 0.0064  1.90955E-03 0.0065  4.42973E-04 0.0063
  9.52573E-05 0.0129  7.14945E-03 0.0071  1.32530E-09 0.0407  2.73673E-03 0.0082
  2.36700E-01 0.0067  2.60342E-03 0.0080  5.62839E-02 0.0074  3.57183E-07 0.0072
  1.06958E-11 0.9178  4.67886E-03 0.0071
tfc   19       1       1       1       1       1       1       1       1
     128000  4.13553E-02  3.42439E-02  5.71600E+00
     256000  4.20064E-02  2.31501E-02  6.21685E+00
     384000  4.14256E-02  1.87812E-02  5.97589E+00
     512000  4.16892E-02  1.60216E-02  6.13994E+00
     640000  4.14159E-02  1.43637E-02  5.95542E+00
     768000  4.12822E-02  1.30899E-02  5.87976E+00
     896000  4.07818E-02  1.21293E-02  5.82637E+00
    1024000  4.09821E-02  1.13097E-02  5.77144E+00
    1152000  4.07183E-02  1.06434E-02  5.83092E+00
```

```
    1280000  4.06787E-02  1.00743E-02  5.86550E+00
    1408000  4.06308E-02  9.58780E-03  5.88374E+00
    1536000  4.06264E-02  9.16280E-03  5.89615E+00
    1664000  4.06542E-02  8.78692E-03  5.94924E+00
    1792000  4.07617E-02  8.45132E-03  5.94877E+00
    1920000  4.04739E-02  8.17925E-03  5.95254E+00
    2048000  4.05559E-02  7.90170E-03  5.90890E+00
    2176000  4.06303E-02  7.66077E-03  5.93344E+00
    2304000  4.06661E-02  7.43195E-03  5.94147E+00
    2421150  4.07410E-02  7.26021E-03  5.91299E+00
tally   74    1
       m431 cells,    closure head
f       1
      0
d       1
u       0
s       0
m      22
c       0
e       0
t       0
vals
  1.36892E-06 0.0561  0.00000E+00 0.0000  3.08666E-08 0.0474  4.05160E-08 0.0389
  2.21185E-06 0.0532  5.60496E-08 0.0541  3.27367E-07 0.0532  1.21945E-07 0.0389
  1.99586E-07 0.0383  9.65204E-08 0.0385  7.84897E-08 0.0450  1.46746E-08 0.0382
  1.03216E-08 0.0812  2.74906E-07 0.0526  5.19380E-13 0.1088  1.42303E-07 0.0616
  8.35044E-06 0.0448  1.53610E-07 0.0634  2.17976E-06 0.0572  2.77437E-11 0.0901
  4.76425E-19 0.9741  2.53171E-07 0.0582
tfc   19       1       1       1       1       1       1       1       1
     128000  1.35589E-06  3.05953E-01  7.16060E-02
     256000  1.03152E-06  2.17203E-01  7.06225E-02
     384000  1.19528E-06  1.63596E-01  7.87596E-02
     512000  1.14270E-06  1.39393E-01  8.11139E-02
     640000  1.20859E-06  1.19492E-01  8.60533E-02
     768000  1.25121E-06  1.05655E-01  9.02500E-02
     896000  1.26782E-06  9.71901E-02  9.07456E-02
    1024000  1.32852E-06  8.80017E-02  9.53247E-02
    1152000  1.28694E-06  8.31674E-02  9.54978E-02
    1280000  1.28588E-06  7.87448E-02  9.60044E-02
    1408000  1.28266E-06  7.60735E-02  9.34596E-02
    1536000  1.31307E-06  7.29624E-02  9.29878E-02
    1664000  1.27414E-06  7.12417E-02  9.05037E-02
    1792000  1.29550E-06  6.75461E-02  9.31269E-02
    1920000  1.27916E-06  6.55699E-02  9.26233E-02
    2048000  1.36826E-06  6.20855E-02  9.57122E-02
    2176000  1.36742E-06  5.97014E-02  9.76974E-02
    2304000  1.37354E-06  5.76477E-02  9.87498E-02
    2421150  1.36892E-06  5.60535E-02  9.91974E-02
tally   84    1
       m431 cells,      steel roof
f       1
      0
d       1
u       0
s       0
m      22
c       0
e       0
t       0
vals
  1.74295E-10 0.3875  0.00000E+00 0.0000  9.31961E-12 0.3877  2.27362E-11 0.3877
  3.77034E-10 0.3875  9.13918E-12 0.3875  5.58028E-11 0.3875  6.65209E-11 0.3880
  1.13659E-10 0.3878  1.91785E-11 0.3955  3.02918E-11 0.3878  8.49462E-12 0.3879
  1.64004E-13 0.3860  4.53787E-11 0.3874  1.89209E-19 0.8561  6.24135E-13 0.3746
  9.62777E-11 0.3824  5.45208E-12 0.3858  6.59947E-11 0.3847  6.15453E-15 0.3873
  0.00000E+00 0.0000  1.03268E-11 0.3989
tfc   19       1       1       1       1       1       1       1       1
     128000  1.08181E-10  8.85291E-01  8.55237E-03
     256000  4.96729E-11  8.81755E-01  4.28528E-03
     384000  1.74111E-10  6.65307E-01  4.76218E-03
     512000  1.78835E-10  5.47920E-01  5.24978E-03
```

```
     640000  3.34247E-10  6.15269E-01  3.24574E-03
     768000  2.80915E-10  6.06168E-01  2.74186E-03
     896000  2.43190E-10  5.98022E-01  2.39682E-03
    1024000  2.74262E-10  5.10566E-01  2.83194E-03
    1152000  2.45640E-10  5.05645E-01  2.58350E-03
    1280000  2.36925E-10  4.75897E-01  2.62851E-03
    1408000  2.17200E-10  4.71121E-01  2.43683E-03
    1536000  2.00170E-10  4.68041E-01  2.25973E-03
    1664000  1.84919E-10  4.67201E-01  2.10440E-03
    1792000  1.83673E-10  4.40637E-01  2.18834E-03
    1920000  1.72434E-10  4.37725E-01  2.07839E-03
    2048000  1.66790E-10  4.24268E-01  2.04959E-03
    2176000  1.57104E-10  4.23716E-01  1.93955E-03
    2304000  1.49289E-10  4.20840E-01  1.85296E-03
    2421150  1.74295E-10  3.87471E-01  2.07600E-03
tally  104    1
       m407 cells,    core support, vertical
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  8.46818E-02 0.0092  3.46385E-10 1.0000  1.56049E-03 0.0076  1.39373E-03 0.0079
  1.36187E-01 0.0087  3.44225E-03 0.0086  2.01676E-02 0.0087  4.20438E-03 0.0077
  6.69983E-03 0.0078  3.08619E-03 0.0081  3.48186E-03 0.0074  4.81539E-04 0.0078
  6.96267E-04 0.0188  1.57799E-02 0.0078  2.31340E-08 0.0148  8.42023E-03 0.0152
  2.63555E-01 0.0102  9.77783E-03 0.0079  1.40346E-01 0.0081  1.09827E-06 0.0148
  9.30356E-12 0.9981  1.31735E-02 0.0075
tfc   19       1       1       1       1       1       1       1       1
     128000  7.85948E-02  4.37357E-02  3.50418E+00
     256000  8.45293E-02  2.87278E-02  4.03711E+00
     384000  8.32928E-02  2.34626E-02  3.82912E+00
     512000  8.52329E-02  2.01417E-02  3.88495E+00
     640000  8.46732E-02  1.80862E-02  3.75622E+00
     768000  8.43009E-02  1.64665E-02  3.71557E+00
     896000  8.35875E-02  1.52791E-02  3.67176E+00
    1024000  8.44637E-02  1.43456E-02  3.58717E+00
    1152000  8.43713E-02  1.34767E-02  3.63693E+00
    1280000  8.42748E-02  1.28310E-02  3.61589E+00
    1408000  8.39924E-02  1.21848E-02  3.64297E+00
    1536000  8.44057E-02  1.16455E-02  3.65012E+00
    1664000  8.45777E-02  1.11556E-02  3.69107E+00
    1792000  8.46555E-02  1.07169E-02  3.69946E+00
    1920000  8.45658E-02  1.03460E-02  3.72038E+00
    2048000  8.47352E-02  9.99209E-03  3.69518E+00
    2176000  8.46337E-02  9.68000E-03  3.71622E+00
    2304000  8.47582E-02  9.39078E-03  3.72131E+00
    2421150  8.46818E-02  9.15731E-03  3.71681E+00
tally  114    1
       m419 cells, Na below nozzle
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  5.25874E-01 0.0086  4.15514E-09 0.9968  9.88136E-03 0.0080  9.49891E-03 0.0080
  8.42415E-01 0.0085  2.09707E-02 0.0084  1.24880E-01 0.0085  2.79946E-02 0.0080
  4.62123E-02 0.0080  2.13327E-02 0.0080  2.21817E-02 0.0079  3.33800E-03 0.0080
  3.12739E-03 0.0139  9.79569E-02 0.0081  9.67605E-08 0.0184  4.93517E-02 0.0115
  1.81287E+00 0.0088  5.61927E-02 0.0085  8.65027E-01 0.0083  5.78040E-06 0.0127
  1.12135E-10 0.9920  7.35307E-02 0.0083
```

```
tfc   19       1       1       1       1       1       1       1       1
     128000  5.47673E-01  3.92726E-02  4.34590E+00
     256000  5.63684E-01  2.65903E-02  4.71223E+00
     384000  5.32824E-01  2.17464E-02  4.45735E+00
     512000  5.42431E-01  1.86733E-02  4.51995E+00
     640000  5.39066E-01  1.67406E-02  4.38432E+00
     768000  5.37885E-01  1.53278E-02  4.28814E+00
     896000  5.29643E-01  1.42209E-02  4.23852E+00
    1024000  5.31076E-01  1.32152E-02  4.22705E+00
    1152000  5.29156E-01  1.25024E-02  4.22583E+00
    1280000  5.24866E-01  1.18862E-02  4.21359E+00
    1408000  5.22084E-01  1.13151E-02  4.22448E+00
    1536000  5.21656E-01  1.08178E-02  4.23004E+00
    1664000  5.23066E-01  1.04242E-02  4.22721E+00
    1792000  5.24229E-01  1.00370E-02  4.21766E+00
    1920000  5.24193E-01  9.70051E-03  4.23195E+00
    2048000  5.23539E-01  9.38720E-03  4.18673E+00
    2176000  5.26178E-01  9.09933E-03  4.20565E+00
    2304000  5.25673E-01  8.82788E-03  4.21101E+00
    2421150  5.25874E-01  8.58846E-03  4.22547E+00
tally  134    1
       m405 cells,     grid plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  6.73788E-01 0.0089  5.22553E-08 0.7050  1.26166E-02 0.0069  1.00444E-02 0.0073
  1.10601E+00 0.0084  2.86207E-02 0.0080  1.63815E-01 0.0084  2.96003E-02 0.0073
  4.60527E-02 0.0076  2.13146E-02 0.0081  2.87287E-02 0.0065  3.30202E-03 0.0077
  7.27252E-03 0.0103  1.30640E-01 0.0072  4.05159E-07 0.0240  7.20342E-02 0.0099
  1.81148E+00 0.0102  9.19573E-02 0.0067  1.17007E+00 0.0077  1.48302E-05 0.0113
  1.53665E-09 0.7041  1.31256E-01 0.0057
tfc   19       1       1       1       1       1       1       1       1
     128000  6.39876E-01  4.04668E-02  4.09317E+00
     256000  6.92110E-01  2.85545E-02  4.08624E+00
     384000  6.85247E-01  2.29498E-02  4.00213E+00
     512000  6.92421E-01  1.96071E-02  4.09967E+00
     640000  6.85758E-01  1.74651E-02  4.02813E+00
     768000  6.79979E-01  1.59984E-02  3.93621E+00
     896000  6.75489E-01  1.47900E-02  3.91865E+00
    1024000  6.74160E-01  1.38290E-02  3.86019E+00
    1152000  6.70092E-01  1.30082E-02  3.90358E+00
    1280000  6.69026E-01  1.23078E-02  3.92983E+00
    1408000  6.68902E-01  1.17029E-02  3.94918E+00
    1536000  6.68632E-01  1.11476E-02  3.98347E+00
    1664000  6.67889E-01  1.06834E-02  4.02451E+00
    1792000  6.69605E-01  1.02943E-02  4.00945E+00
    1920000  6.69776E-01  9.94164E-03  4.02915E+00
    2048000  6.74116E-01  9.63459E-03  3.97449E+00
    2176000  6.73390E-01  9.35979E-03  3.97484E+00
    2304000  6.74415E-01  9.10230E-03  3.96093E+00
    2421150  6.73788E-01  8.87248E-03  3.95928E+00
tally  174    1
       m403 cells,      IT hold down
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.32306E-01 0.0118  2.38235E-11 0.9968  2.41343E-03 0.0107  2.02714E-03 0.0111
```

```
  2.12510E-01 0.0114  5.32584E-03 0.0113  3.15025E-02 0.0114  5.91367E-03 0.0110
  9.66749E-03 0.0111  4.46827E-03 0.0113  5.33620E-03 0.0106  6.91771E-04 0.0112
  9.09001E-04 0.0186  2.46434E-02 0.0108  3.33850E-08 0.0191  1.29911E-02 0.0159
  3.92270E-01 0.0129  1.52707E-02 0.0110  2.23225E-01 0.0110  1.65164E-06 0.0168
  1.58788E-12 0.6906  1.94584E-02 0.0107
tfc   19       1       1       1       1       1       1       1       1
     128000  1.36023E-01  5.64111E-02  2.10634E+00
     256000  1.32658E-01  3.76225E-02  2.35385E+00
     384000  1.31630E-01  3.00452E-02  2.33506E+00
     512000  1.29159E-01  2.61204E-02  2.31001E+00
     640000  1.29721E-01  2.33138E-02  2.26057E+00
     768000  1.31464E-01  2.11423E-02  2.25385E+00
     896000  1.32581E-01  1.95478E-02  2.24324E+00
    1024000  1.33674E-01  1.81984E-02  2.22905E+00
    1152000  1.34084E-01  1.71315E-02  2.25065E+00
    1280000  1.33956E-01  1.62455E-02  2.25564E+00
    1408000  1.33246E-01  1.54897E-02  2.25425E+00
    1536000  1.33144E-01  1.48141E-02  2.25565E+00
    1664000  1.33546E-01  1.41817E-02  2.28392E+00
    1792000  1.32826E-01  1.37036E-02  2.26259E+00
    1920000  1.32947E-01  1.32232E-02  2.27747E+00
    2048000  1.32926E-01  1.28032E-02  2.25066E+00
    2176000  1.32663E-01  1.24037E-02  2.26333E+00
    2304000  1.32682E-01  1.20599E-02  2.25639E+00
    2421150  1.32306E-01  1.17907E-02  2.24195E+00
tally  184    1
       m402 cells,    IT lower frame
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  8.07082E-02 0.0117  8.90378E-15 0.6828  1.46426E-03 0.0111  1.40825E-03 0.0110
  1.27114E-01 0.0115  3.17001E-03 0.0115  1.88406E-02 0.0115  4.20032E-03 0.0110
  6.86007E-03 0.0110  3.28059E-03 0.0110  3.22501E-03 0.0111  4.96353E-04 0.0110
  4.74265E-04 0.0174  1.47016E-02 0.0113  1.53403E-08 0.0222  7.33454E-03 0.0141
  2.94618E-01 0.0117  8.33477E-03 0.0118  1.29978E-01 0.0115  8.67013E-07 0.0168
  8.46421E-14 0.4523  1.13384E-02 0.0117
tfc   19       1       1       1       1       1       1       1       1
     128000  7.81410E-02  5.48726E-02  2.22611E+00
     256000  8.08417E-02  3.66769E-02  2.47678E+00
     384000  8.29232E-02  2.95752E-02  2.40988E+00
     512000  7.99312E-02  2.57112E-02  2.38413E+00
     640000  7.95341E-02  2.29980E-02  2.32309E+00
     768000  8.00044E-02  2.09056E-02  2.30519E+00
     896000  8.10281E-02  1.92828E-02  2.30532E+00
    1024000  8.14481E-02  1.80218E-02  2.27297E+00
    1152000  8.15768E-02  1.70000E-02  2.28559E+00
    1280000  8.15080E-02  1.60713E-02  2.30481E+00
    1408000  8.12219E-02  1.53419E-02  2.29792E+00
    1536000  8.11524E-02  1.46642E-02  2.30200E+00
    1664000  8.10119E-02  1.40549E-02  2.32532E+00
    1792000  8.09885E-02  1.35344E-02  2.31951E+00
    1920000  8.09342E-02  1.30614E-02  2.33426E+00
    2048000  8.08095E-02  1.26334E-02  2.31157E+00
    2176000  8.09696E-02  1.22626E-02  2.31571E+00
    2304000  8.09357E-02  1.19235E-02  2.30830E+00
    2421150  8.07082E-02  1.16560E-02  2.29408E+00
tally  194    1
       m401 cells,    IT guide tubes
f        1
      0
d        1
u        0
s        0
m       22
```

```
c        0
e        0
t        0
vals
  3.52110E-02 0.0163  0.00000E+00 0.0000  7.58886E-04 0.0150  9.95882E-04 0.0144
  5.74656E-02 0.0160  1.41129E-03 0.0160  8.51833E-03 0.0160  2.93838E-03 0.0144
  4.93839E-03 0.0144  2.15723E-03 0.0144  1.84639E-03 0.0147  3.62841E-04 0.0144
  1.57099E-04 0.0239  6.67543E-03 0.0156  2.88153E-09 0.0304  2.92419E-03 0.0189
  1.62502E-01 0.0152  3.14277E-03 0.0168  5.46456E-02 0.0163  3.59351E-07 0.0176
  7.20238E-15 0.4969  4.51718E-03 0.0156
tfc    19       1       1       1       1       1       1       1
     128000  3.63844E-02  7.58578E-02  1.16482E+00
     256000  3.72149E-02  5.12814E-02  1.26694E+00
     384000  3.76822E-02  4.08922E-02  1.26058E+00
     512000  3.61251E-02  3.59658E-02  1.21842E+00
     640000  3.62280E-02  3.16517E-02  1.22646E+00
     768000  3.60576E-02  2.86731E-02  1.22541E+00
     896000  3.65931E-02  2.64741E-02  1.22300E+00
    1024000  3.61801E-02  2.47175E-02  1.20831E+00
    1152000  3.59466E-02  2.33627E-02  1.21019E+00
    1280000  3.59908E-02  2.21214E-02  1.21649E+00
    1408000  3.59199E-02  2.13507E-02  1.18650E+00
    1536000  3.59371E-02  2.04171E-02  1.18751E+00
    1664000  3.57668E-02  1.96459E-02  1.19012E+00
    1792000  3.57655E-02  1.89360E-02  1.18495E+00
    1920000  3.57073E-02  1.82902E-02  1.19040E+00
    2048000  3.54602E-02  1.76758E-02  1.18083E+00
    2176000  3.52752E-02  1.71365E-02  1.18579E+00
    2304000  3.52123E-02  1.66813E-02  1.17934E+00
    2421150  3.52110E-02  1.62506E-02  1.18022E+00
tally  204     1
       m140 cells,      inner shield
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.26995E+01 0.0021  2.06431E-05 0.0662  6.45534E-01 0.0018  5.24326E-01 0.0019
  5.44441E+01 0.0020  1.51855E+00 0.0019  8.05606E+00 0.0020  1.46683E+00 0.0019
  2.18973E+00 0.0021  1.05385E+00 0.0021  1.55373E+00 0.0017  1.74998E-01 0.0020
  5.70769E-01 0.0025  6.73756E+00 0.0018  7.39148E-05 0.0046  3.88396E+00 0.0027
  9.05055E+01 0.0026  5.35965E+00 0.0017  5.93695E+01 0.0019  1.64167E-03 0.0021
  8.55769E-07 0.0967  9.95365E+00 0.0015
tfc    19       1       1       1       1       1       1       1
     128000  3.26266E+01  9.81117E-03  6.96334E+01
     256000  3.27026E+01  6.63929E-03  7.55842E+01
     384000  3.28048E+01  5.35010E-03  7.36421E+01
     512000  3.27270E+01  4.60445E-03  7.43397E+01
     640000  3.26581E+01  4.10014E-03  7.30881E+01
     768000  3.26550E+01  3.72568E-03  7.25802E+01
     896000  3.26090E+01  3.44454E-03  7.22450E+01
    1024000  3.26568E+01  3.21831E-03  7.12743E+01
    1152000  3.27083E+01  3.02876E-03  7.20061E+01
    1280000  3.27539E+01  2.87040E-03  7.22521E+01
    1408000  3.27072E+01  2.73691E-03  7.22055E+01
    1536000  3.27305E+01  2.62071E-03  7.20750E+01
    1664000  3.27443E+01  2.51624E-03  7.25487E+01
    1792000  3.27264E+01  2.42335E-03  7.23509E+01
    1920000  3.27322E+01  2.34046E-03  7.26989E+01
    2048000  3.27214E+01  2.26460E-03  7.19393E+01
    2176000  3.27217E+01  2.19631E-03  7.21881E+01
    2304000  3.26987E+01  2.13365E-03  7.20861E+01
    2421150  3.26995E+01  2.08094E-03  7.19755E+01
tally  214     1
       m410 cells,     shield support
f        1
```

```
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.26209E-01 0.0082  1.64848E-11 0.9999  2.37321E-03 0.0068  2.04422E-03 0.0072
  2.01917E-01 0.0078  5.19377E-03 0.0076  2.99084E-02 0.0078  6.00546E-03 0.0071
  9.45120E-03 0.0073  4.53967E-03 0.0076  5.49875E-03 0.0066  6.74682E-04 0.0074
  1.29408E-03 0.0116  2.43137E-02 0.0070  5.43493E-08 0.0106  1.32658E-02 0.0104
  4.00930E-01 0.0092  1.68710E-02 0.0068  2.14677E-01 0.0073  2.16059E-06 0.0117
  1.20991E-12 0.9621  2.38857E-02 0.0063
tfc   19       1       1       1       1       1       1       1       1
     128000  1.27109E-01  3.87550E-02  4.46276E+00
     256000  1.29956E-01  2.57175E-02  5.03754E+00
     384000  1.28147E-01  2.08308E-02  4.85780E+00
     512000  1.29201E-01  1.79506E-02  4.89121E+00
     640000  1.27571E-01  1.62508E-02  4.65257E+00
     768000  1.26455E-01  1.47498E-02  4.63083E+00
     896000  1.26113E-01  1.36269E-02  4.61613E+00
    1024000  1.26400E-01  1.26786E-02  4.59248E+00
    1152000  1.26244E-01  1.18978E-02  4.66619E+00
    1280000  1.26883E-01  1.13067E-02  4.65652E+00
    1408000  1.26479E-01  1.07598E-02  4.67176E+00
    1536000  1.26199E-01  1.02553E-02  4.70686E+00
    1664000  1.26618E-01  9.84947E-03  4.73489E+00
    1792000  1.26479E-01  9.52162E-03  4.68656E+00
    1920000  1.25700E-01  9.22092E-03  4.68361E+00
    2048000  1.25932E-01  8.92785E-03  4.62864E+00
    2176000  1.26256E-01  8.65379E-03  4.64986E+00
    2304000  1.26363E-01  8.38643E-03  4.66601E+00
    2421150  1.26209E-01  8.17548E-03  4.66315E+00
tally  224    1
       m142 cells,      outer shield
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.41873E+01 0.0021  9.58934E-07 0.2188  2.87642E-01 0.0020  2.33889E-01 0.0021
  2.35893E+01 0.0021  6.47122E-01 0.0020  3.48724E+00 0.0021  6.72295E-01 0.0020
  9.92840E-01 0.0021  4.79075E-01 0.0021  7.11438E-01 0.0019  7.29852E-02 0.0021
  2.56865E-01 0.0025  2.97933E+00 0.0020  1.85861E-05 0.0038  1.74555E+00 0.0025
  4.10762E+01 0.0024  2.44987E+00 0.0019  2.60131E+01 0.0020  5.39234E-04 0.0026
  6.68022E-08 0.4333  4.06426E+00 0.0020
tfc   19       1       1       1       1       1       1       1       1
     128000  1.43961E+01  1.00050E-02  6.69611E+01
     256000  1.43388E+01  6.73866E-03  7.33716E+01
     384000  1.42145E+01  5.43088E-03  7.14676E+01
     512000  1.42202E+01  4.67071E-03  7.22453E+01
     640000  1.42089E+01  4.17104E-03  7.06247E+01
     768000  1.41918E+01  3.79595E-03  6.99180E+01
     896000  1.41745E+01  3.51232E-03  6.94833E+01
    1024000  1.41915E+01  3.28258E-03  6.85104E+01
    1152000  1.41887E+01  3.09367E-03  6.90162E+01
    1280000  1.42124E+01  2.93262E-03  6.92186E+01
    1408000  1.41965E+01  2.79599E-03  6.91862E+01
    1536000  1.41942E+01  2.67493E-03  6.91832E+01
    1664000  1.42126E+01  2.56921E-03  6.95882E+01
    1792000  1.42064E+01  2.47606E-03  6.93032E+01
    1920000  1.41943E+01  2.39245E-03  6.95733E+01
    2048000  1.41971E+01  2.31580E-03  6.87934E+01
    2176000  1.41973E+01  2.24638E-03  6.90058E+01
```

```
    2304000  1.41859E+01  2.18259E-03  6.88896E+01
    2421150  1.41873E+01  2.12823E-03  6.88127E+01
tally  234    1
       m412 cells,       core barrel
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.85992E-01 0.0036  8.08826E-08 0.4695  7.22708E-03 0.0033  6.31046E-03 0.0034
  6.42884E-01 0.0035  1.61947E-02 0.0035  9.52240E-02 0.0035  1.89486E-02 0.0034
  3.03793E-02 0.0034  1.37512E-02 0.0034  1.60578E-02 0.0033  2.18617E-03 0.0035
  2.99287E-03 0.0057  7.25227E-02 0.0033  1.32945E-07 0.0721  3.83797E-02 0.0046
  1.16118E+00 0.0038  4.49507E-02 0.0034  6.56221E-01 0.0034  5.00728E-06 0.0067
  2.38428E-09 0.4578  5.87749E-02 0.0038
tfc   19       1       1       1       1       1       1       1       1
     128000  3.94843E-01  1.66321E-02  2.42305E+01
     256000  3.87186E-01  1.08995E-02  2.80455E+01
     384000  3.85774E-01  8.93755E-03  2.63884E+01
     512000  3.85496E-01  7.68818E-03  2.66641E+01
     640000  3.84764E-01  6.87316E-03  2.60095E+01
     768000  3.86239E-01  6.33966E-03  2.50667E+01
     896000  3.86019E-01  5.87202E-03  2.48596E+01
    1024000  3.87160E-01  5.53087E-03  2.41324E+01
    1152000  3.86147E-01  5.18033E-03  2.46141E+01
    1280000  3.86517E-01  4.89634E-03  2.48309E+01
    1408000  3.85912E-01  4.66601E-03  2.48427E+01
    1536000  3.85568E-01  4.47427E-03  2.47275E+01
    1664000  3.85232E-01  4.28354E-03  2.50340E+01
    1792000  3.85764E-01  4.14582E-03  2.47204E+01
    1920000  3.85061E-01  4.00569E-03  2.48185E+01
    2048000  3.85813E-01  3.89441E-03  2.43257E+01
    2176000  3.85401E-01  3.78173E-03  2.43484E+01
    2304000  3.85627E-01  3.67556E-03  2.42914E+01
    2421150  3.85992E-01  3.58357E-03  2.42703E+01
tally  244    1
       m413 cells,              IVHM
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  7.02623E-03 0.0111  1.08132E-10 0.8765  1.68932E-04 0.0098  2.88863E-04 0.0088
  1.11872E-02 0.0109  2.72229E-04 0.0110  1.65799E-03 0.0109  8.53883E-04 0.0088
  1.44234E-03 0.0088  6.33069E-04 0.0089  4.36283E-04 0.0093  1.07182E-04 0.0088
  1.38227E-05 0.0199  1.31702E-03 0.0106  2.01921E-10 0.1299  4.68411E-04 0.0127
  4.62116E-02 0.0095  4.28042E-04 0.0127  9.37820E-03 0.0118  8.28498E-08 0.0098
  3.06735E-12 0.8693  8.66312E-04 0.0104
tfc   19       1       1       1       1       1       1       1       1
     128000  7.01979E-03  5.27739E-02  2.40669E+00
     256000  6.86167E-03  3.46115E-02  2.78121E+00
     384000  7.00708E-03  2.78768E-02  2.71246E+00
     512000  6.82512E-03  2.39973E-02  2.73684E+00
     640000  6.84644E-03  2.12814E-02  2.71296E+00
     768000  6.92754E-03  1.98050E-02  2.56849E+00
     896000  7.02924E-03  1.83887E-02  2.53495E+00
    1024000  7.07779E-03  1.72090E-02  2.49274E+00
    1152000  7.06670E-03  1.61471E-02  2.53342E+00
    1280000  7.04654E-03  1.52316E-02  2.56594E+00
    1408000  7.00946E-03  1.45127E-02  2.56801E+00
    1536000  7.04369E-03  1.40850E-02  2.49523E+00
```

```
    1664000  7.03260E-03  1.35456E-02  2.50343E+00
    1792000  7.06226E-03  1.30382E-02  2.49945E+00
    1920000  7.04225E-03  1.25699E-02  2.52040E+00
    2048000  7.01921E-03  1.21521E-02  2.49832E+00
    2176000  7.01098E-03  1.17655E-02  2.51555E+00
    2304000  7.02294E-03  1.14427E-02  2.50636E+00
    2421150  7.02623E-03  1.11442E-02  2.50964E+00
tally  254    1
       m414 cells,              IVFSM
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.36349E-01 0.0113  4.31457E-06 0.2628  6.73589E-03 0.0116  6.70158E-03 0.0101
  5.63016E-01 0.0117  1.47628E-02 0.0139  8.35050E-02 0.0117  1.92658E-02 0.0090
  3.17228E-02 0.0086  1.42230E-02 0.0090  1.56367E-02 0.0125  2.53710E-03 0.0124
  2.80256E-03 0.0271  6.54157E-02 0.0122  1.54043E-06 0.1595  3.40905E-02 0.0165
  1.12066E+00 0.0091  3.94792E-02 0.0164  5.76839E-01 0.0123  8.96650E-06 0.0389
  1.49642E-07 0.2961  6.38530E-02 0.0240
tfc   19       1       1       1       1       1       1       1       1
     128000  3.34393E-01  5.36824E-02  2.32593E+00
     256000  3.10674E-01  3.21757E-02  3.21823E+00
     384000  3.10659E-01  2.67073E-02  2.95521E+00
     512000  3.14392E-01  2.29564E-02  2.99066E+00
     640000  3.21166E-01  2.09636E-02  2.79585E+00
     768000  3.28194E-01  1.98722E-02  2.55116E+00
     896000  3.30550E-01  1.87246E-02  2.44481E+00
    1024000  3.38168E-01  1.78268E-02  2.32296E+00
    1152000  3.33989E-01  1.65893E-02  2.40017E+00
    1280000  3.33569E-01  1.55058E-02  2.47599E+00
    1408000  3.32799E-01  1.47078E-02  2.50031E+00
    1536000  3.31748E-01  1.40270E-02  2.51592E+00
    1664000  3.29938E-01  1.33303E-02  2.58497E+00
    1792000  3.34298E-01  1.30749E-02  2.48540E+00
    1920000  3.32734E-01  1.25969E-02  2.50959E+00
    2048000  3.35896E-01  1.23264E-02  2.42814E+00
    2176000  3.36234E-01  1.19223E-02  2.44983E+00
    2304000  3.36392E-01  1.15897E-02  2.44316E+00
    2421150  3.36349E-01  1.12678E-02  2.45487E+00
tally  264    1
       m409 cells,          IT column
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.95846E-02 0.0138  0.00000E+00 0.0000  3.98471E-04 0.0129  4.85416E-04 0.0123
  3.14484E-02 0.0136  7.75096E-04 0.0136  4.66175E-03 0.0136  1.43189E-03 0.0123
  2.39479E-03 0.0122  1.07316E-03 0.0123  9.39190E-04 0.0126  1.75358E-04 0.0122
  9.04892E-05 0.0216  3.64965E-03 0.0133  1.98295E-09 0.0253  1.66611E-03 0.0167
  8.52531E-02 0.0132  1.80925E-03 0.0142  3.05771E-02 0.0137  1.93437E-07 0.0167
  2.30163E-15 0.4470  2.54685E-03 0.0135
tfc   19       1       1       1       1       1       1       1       1
     128000  1.93780E-02  6.60653E-02  1.53572E+00
     256000  1.98222E-02  4.45282E-02  1.68036E+00
     384000  2.04859E-02  3.54395E-02  1.67832E+00
     512000  1.97735E-02  3.08383E-02  1.65728E+00
     640000  1.97755E-02  2.74531E-02  1.63028E+00
     768000  1.95654E-02  2.48138E-02  1.63622E+00
     896000  1.98968E-02  2.28542E-02  1.64111E+00
```

```
    1024000  1.98793E-02  2.12582E-02  1.63355E+00
    1152000  1.98639E-02  1.99545E-02  1.65889E+00
    1280000  1.99091E-02  1.89199E-02  1.66303E+00
    1408000  1.98525E-02  1.81961E-02  1.63356E+00
    1536000  1.98485E-02  1.74363E-02  1.62823E+00
    1664000  1.97958E-02  1.67515E-02  1.63692E+00
    1792000  1.98192E-02  1.61350E-02  1.63206E+00
    1920000  1.97853E-02  1.55746E-02  1.64171E+00
    2048000  1.96686E-02  1.50668E-02  1.62520E+00
    2176000  1.96482E-02  1.46048E-02  1.63254E+00
    2304000  1.96265E-02  1.41730E-02  1.63373E+00
    2421150  1.95846E-02  1.38254E-02  1.63062E+00
tally  284    1
       m435 cells,              B4C
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.44463E-06 0.0529  1.15901E-11 0.9023  4.11546E-08 0.0491  4.38949E-08 0.0505
  2.50922E-06 0.0499  8.46522E-08 0.0538  3.68704E-07 0.0500  1.16475E-07 0.0451
  1.42659E-07 0.0398  7.33446E-08 0.0474  1.31398E-07 0.0518  1.18980E-08 0.0482
  8.56403E-08 0.0736  4.00233E-07 0.0500  9.39248E-12 0.2517  3.06213E-07 0.0706
  3.85014E-06 0.0429  4.81450E-07 0.0563  3.12149E-06 0.0494  2.04750E-10 0.0780
  4.14635E-13 0.9152  1.02693E-06 0.0647
tfc   19       1       1       1       1       1       1       1       1
     128000  1.70497E-06  2.89858E-01  7.97791E-02
     256000  1.20822E-06  2.21071E-01  6.81726E-02
     384000  1.25382E-06  1.68246E-01  7.44667E-02
     512000  1.22223E-06  1.40432E-01  7.99182E-02
     640000  1.30453E-06  1.16776E-01  9.01024E-02
     768000  1.37598E-06  1.00875E-01  9.90062E-02
     896000  1.41470E-06  9.23849E-02  1.00431E-01
    1024000  1.48212E-06  8.28794E-02  1.07472E-01
    1152000  1.44434E-06  7.89786E-02  1.05896E-01
    1280000  1.39982E-06  7.50109E-02  1.05800E-01
    1408000  1.41564E-06  7.20375E-02  1.04225E-01
    1536000  1.43306E-06  6.90458E-02  1.03836E-01
    1664000  1.38949E-06  6.69203E-02  1.02570E-01
    1792000  1.40568E-06  6.32024E-02  1.06367E-01
    1920000  1.38550E-06  6.07839E-02  1.07783E-01
    2048000  1.47035E-06  5.76003E-02  1.11198E-01
    2176000  1.44209E-06  5.59482E-02  1.11245E-01
    2304000  1.44774E-06  5.42326E-02  1.11578E-01
    2421150  1.44463E-06  5.29211E-02  1.11288E-01
tally  294    1
       m431 cells,    z ring
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  3.11347E-06 0.0504  7.91663E-13 1.0000  6.87449E-08 0.0442  9.42336E-08 0.0357
  4.93002E-06 0.0493  1.23864E-07 0.0500  7.29739E-07 0.0492  2.83141E-07 0.0360
  4.66389E-07 0.0353  2.13875E-07 0.0352  1.74328E-07 0.0418  3.43956E-08 0.0352
  2.07942E-08 0.0708  5.98355E-07 0.0490  1.06374E-12 0.1932  2.88582E-07 0.0540
  1.78882E-05 0.0375  3.13864E-07 0.0585  4.68118E-06 0.0531  5.04860E-11 0.0631
  2.86866E-14 1.0000  5.10455E-07 0.0529
tfc   19       1       1       1       1       1       1       1       1
     128000  3.30881E-06  2.67419E-01  9.37288E-02
     256000  2.35539E-06  1.87066E-01  9.52104E-02
```

```
     384000  2.75333E-06  1.42035E-01  1.04486E-01
     512000  2.66560E-06  1.19975E-01  1.09494E-01
     640000  2.86526E-06  1.05353E-01  1.10701E-01
     768000  3.00230E-06  9.25919E-02  1.17512E-01
     896000  3.02993E-06  8.47642E-02  1.19301E-01
    1024000  3.19254E-06  7.76039E-02  1.22580E-01
    1152000  3.07687E-06  7.35589E-02  1.22076E-01
    1280000  3.05192E-06  6.96897E-02  1.22574E-01
    1408000  3.02563E-06  6.71757E-02  1.19858E-01
    1536000  3.06749E-06  6.44622E-02  1.19128E-01
    1664000  2.96104E-06  6.30956E-02  1.15382E-01
    1792000  3.01946E-06  5.99048E-02  1.18400E-01
    1920000  2.97820E-06  5.82892E-02  1.17207E-01
    2048000  3.13469E-06  5.52643E-02  1.20798E-01
    2176000  3.10323E-06  5.34687E-02  1.21802E-01
    2304000  3.11629E-06  5.17761E-02  1.22417E-01
    2421150  3.11347E-06  5.04395E-02  1.22508E-01
tally  304    1
       m411 cells,  baffle plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  6.01172E-03 0.0090  8.94203E-11 0.7745  1.28382E-04 0.0079  1.93584E-04 0.0070
  9.37941E-03 0.0089  2.29925E-04 0.0089  1.38975E-03 0.0089  5.75459E-04 0.0070
  9.63956E-04 0.0069  4.31434E-04 0.0070  3.11879E-04 0.0075  7.13919E-05 0.0069
  1.80586E-05 0.0175  1.08897E-03 0.0086  3.89319E-10 0.0572  4.16824E-04 0.0112
  3.34039E-02 0.0077  4.18589E-04 0.0103  8.41220E-03 0.0094  6.21197E-08 0.0096
  2.53040E-12 0.7618  7.35771E-04 0.0088
tfc   19       1       1       1       1       1       1       1       1
     128000  5.95886E-03  3.95327E-02  4.28890E+00
     256000  5.70293E-03  2.39832E-02  5.79243E+00
     384000  5.77005E-03  1.93899E-02  5.60660E+00
     512000  5.69591E-03  1.64386E-02  5.83238E+00
     640000  5.74226E-03  1.49348E-02  5.50869E+00
     768000  5.85644E-03  1.49362E-02  4.51593E+00
     896000  5.93277E-03  1.39461E-02  4.40719E+00
    1024000  5.99123E-03  1.37245E-02  3.91919E+00
    1152000  5.99083E-03  1.27793E-02  4.04466E+00
    1280000  5.94993E-03  1.18952E-02  4.20721E+00
    1408000  5.94347E-03  1.12566E-02  4.26848E+00
    1536000  5.98499E-03  1.12645E-02  3.90123E+00
    1664000  5.96959E-03  1.08025E-02  3.93628E+00
    1792000  6.00202E-03  1.04689E-02  3.87679E+00
    1920000  6.00105E-03  1.00566E-02  3.93758E+00
    2048000  6.01984E-03  9.78567E-03  3.85271E+00
    2176000  6.01264E-03  9.48197E-03  3.87307E+00
    2304000  6.01911E-03  9.26618E-03  3.82206E+00
    2421150  6.01172E-03  8.98833E-03  3.85787E+00
tally  314    1
       m431 cells, ss-304 suppressor plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  4.91651E-08 0.0591  3.97700E-16 1.0000  1.27212E-09 0.0495  2.20369E-09 0.0424
  8.20734E-08 0.0567  2.00869E-09 0.0569  1.21622E-08 0.0567  6.49001E-09 0.0425
  1.09745E-08 0.0423  4.24788E-09 0.0462  3.39231E-09 0.0460  8.15318E-10 0.0422
  1.51461E-10 0.0930  9.51367E-09 0.0555  4.17309E-15 0.1136  3.15114E-09 0.0741
```

```
  2.66514E-07 0.0545  3.38015E-09 0.0660  6.55033E-08 0.0635  7.38140E-13 0.0518
  1.04249E-17 0.9992  6.18257E-09 0.0584
tfc   19       1       1       1       1       1       1       1       1
     128000  5.99154E-08  3.58092E-01  5.22722E-02
     256000  4.00897E-08  2.59601E-01  4.94382E-02
     384000  4.45662E-08  1.81455E-01  6.40195E-02
     512000  4.38348E-08  1.55803E-01  6.49263E-02
     640000  4.75193E-08  1.29677E-01  7.30669E-02
     768000  4.75731E-08  1.14063E-01  7.74359E-02
     896000  4.76924E-08  1.03186E-01  8.05054E-02
    1024000  4.94151E-08  9.32185E-02  8.49539E-02
    1152000  4.78662E-08  8.81579E-02  8.49917E-02
    1280000  4.71537E-08  8.32285E-02  8.59392E-02
    1408000  4.78233E-08  7.93752E-02  8.58463E-02
    1536000  4.79986E-08  7.61375E-02  8.53940E-02
    1664000  4.66456E-08  7.44032E-02  8.29759E-02
    1792000  4.75441E-08  6.98975E-02  8.69668E-02
    1920000  4.67229E-08  6.78509E-02  8.65004E-02
    2048000  4.88136E-08  6.38072E-02  9.06167E-02
    2176000  4.80088E-08  6.18294E-02  9.10881E-02
    2304000  4.85685E-08  5.96894E-02  9.21096E-02
    2421150  4.91651E-08  5.90516E-02  8.93803E-02
tally  324    1
       m431 cells, ss-304 thermal reflector plates
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  7.60012E-07 0.0590  5.36217E-15 1.0000  1.81205E-08 0.0513  2.89396E-08 0.0442
  1.24119E-06 0.0576  3.06217E-08 0.0579  1.83874E-07 0.0576  8.56969E-08 0.0444
  1.43823E-07 0.0441  6.07955E-08 0.0469  4.65669E-08 0.0480  1.06675E-08 0.0440
  2.86845E-09 0.0784  1.45119E-07 0.0566  1.20250E-13 0.1184  5.58591E-08 0.0646
  4.37523E-06 0.0530  5.87447E-08 0.0655  1.06602E-06 0.0624  1.12307E-11 0.0603
  1.41509E-16 0.9997  1.04834E-07 0.0593
tfc   19       1       1       1       1       1       1       1       1
     128000  8.98095E-07  3.30194E-01  6.14780E-02
     256000  5.70191E-07  2.48025E-01  5.41607E-02
     384000  6.58817E-07  1.76377E-01  6.77586E-02
     512000  6.36719E-07  1.52303E-01  6.79453E-02
     640000  7.00077E-07  1.29033E-01  7.37974E-02
     768000  7.08595E-07  1.12719E-01  7.92930E-02
     896000  7.25983E-07  1.02164E-01  8.21250E-02
    1024000  7.64334E-07  9.23141E-02  8.66266E-02
    1152000  7.40611E-07  8.77687E-02  8.57472E-02
    1280000  7.26387E-07  8.31127E-02  8.61788E-02
    1408000  7.38970E-07  8.01432E-02  8.42088E-02
    1536000  7.49853E-07  7.67334E-02  8.40727E-02
    1664000  7.25651E-07  7.48512E-02  8.19856E-02
    1792000  7.39135E-07  7.03825E-02  8.57722E-02
    1920000  7.25036E-07  6.85629E-02  8.47133E-02
    2048000  7.66679E-07  6.43395E-02  8.91235E-02
    2176000  7.53984E-07  6.24674E-02  8.92372E-02
    2304000  7.57607E-07  6.02135E-02  9.05131E-02
    2421150  7.60012E-07  5.89571E-02  8.96673E-02
tally  334    1
       m430 cells, Inconel 600 shield plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
```

```
vals
  2.74641E-07 0.0622  2.05161E-15 1.0000  5.85713E-09 0.0568  7.65775E-09 0.0488
  4.34491E-07 0.0611  1.08689E-08 0.0616  6.43294E-08 0.0611  2.31559E-08 0.0493
  3.82330E-08 0.0487  1.80561E-08 0.0501  1.44346E-08 0.0544  2.82141E-09 0.0486
  1.79465E-09 0.0789  5.20585E-08 0.0609  7.91718E-14 0.1182  2.45057E-08 0.0673
  1.46558E-06 0.0537  2.66743E-08 0.0682  4.17367E-07 0.0644  5.19307E-12 0.0855
  5.35828E-17 0.9997  4.29129E-08 0.0646
tfc   19       1       1       1       1       1       1       1       1
     128000  2.93450E-07  3.52071E-01  5.40751E-02
     256000  1.96653E-07  2.59436E-01  4.95011E-02
     384000  2.39754E-07  1.88812E-01  5.91274E-02
     512000  2.34114E-07  1.62104E-01  5.99772E-02
     640000  2.52413E-07  1.37202E-01  6.52719E-02
     768000  2.59612E-07  1.20313E-01  6.95992E-02
     896000  2.59867E-07  1.08387E-01  7.29658E-02
    1024000  2.73004E-07  9.71997E-02  7.81373E-02
    1152000  2.62461E-07  9.26849E-02  7.68920E-02
    1280000  2.61459E-07  8.76854E-02  7.74249E-02
    1408000  2.63283E-07  8.42601E-02  7.61810E-02
    1536000  2.67807E-07  8.08372E-02  7.57534E-02
    1664000  2.59520E-07  7.89681E-02  7.36601E-02
    1792000  2.63492E-07  7.45619E-02  7.64261E-02
    1920000  2.57462E-07  7.25313E-02  7.56969E-02
    2048000  2.74517E-07  6.77349E-02  8.04125E-02
    2176000  2.71204E-07  6.57344E-02  8.05874E-02
    2304000  2.73960E-07  6.35856E-02  8.11674E-02
    2421150  2.74641E-07  6.21801E-02  8.06127E-02
tally  344    1
       m436 cells, ss-410 shield plate
f        1
      0
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.27638E-07 0.0643  1.20037E-16 1.0000  2.71994E-09 0.0578  3.31274E-09 0.0497
  2.01722E-07 0.0643  5.21253E-09 0.0649  2.98509E-08 0.0643  9.79304E-09 0.0493
  1.57451E-08 0.0485  7.58816E-09 0.0489  6.84510E-09 0.0556  1.16145E-09 0.0486
  1.39530E-09 0.0864  2.50733E-08 0.0623  6.72113E-14 0.1167  1.35057E-08 0.0731
  6.48776E-07 0.0538  1.54162E-08 0.0706  2.05467E-07 0.0664  2.50208E-12 0.0918
  3.27350E-18 0.9981  2.56779E-08 0.0679
tfc   19       1       1       1       1       1       1       1       1
     128000  1.24265E-07  2.70323E-01  9.17261E-02
     256000  8.69250E-08  2.12367E-01  7.38758E-02
     384000  1.03556E-07  1.70830E-01  7.22305E-02
     512000  1.05107E-07  1.52492E-01  6.77764E-02
     640000  1.11891E-07  1.32030E-01  7.04852E-02
     768000  1.17614E-07  1.17181E-01  7.33695E-02
     896000  1.21772E-07  1.07328E-01  7.44121E-02
    1024000  1.26242E-07  9.67806E-02  7.88154E-02
    1152000  1.18634E-07  9.30074E-02  7.63597E-02
    1280000  1.22192E-07  8.85661E-02  7.58927E-02
    1408000  1.21717E-07  8.50815E-02  7.47172E-02
    1536000  1.23742E-07  8.37541E-02  7.05686E-02
    1664000  1.19294E-07  8.20636E-02  6.82078E-02
    1792000  1.23260E-07  7.74415E-02  7.08482E-02
    1920000  1.19678E-07  7.52133E-02  7.03948E-02
    2048000  1.28492E-07  7.09483E-02  7.32933E-02
    2176000  1.26868E-07  6.87016E-02  7.37765E-02
    2304000  1.27224E-07  6.63006E-02  7.46559E-02
    2421150  1.27638E-07  6.42945E-02  7.53978E-02
tally  354    1
       m437 cells, low carbon steel shield plate
f        1
      0
d        1
u        0
```

```
s        0
m       22
c        0
e        0
t        0
vals
  1.13357E-07 0.0735  0.00000E+00 0.0000  2.45382E-09 0.0696  2.87422E-09 0.0634
  1.84158E-07 0.0722  4.93852E-09 0.0732  2.72260E-08 0.0722  8.21817E-09 0.0624
  1.27166E-08 0.0609  6.05280E-09 0.0612  6.28045E-09 0.0688  9.39231E-10 0.0611
  1.91873E-09 0.0890  2.33026E-08 0.0726  9.55250E-14 0.1247  1.26854E-08 0.0772
  5.01275E-07 0.0645  1.64948E-08 0.0788  1.93440E-07 0.0747  2.91598E-12 0.1049
  1.65647E-20 1.0000  2.89578E-08 0.0800
tfc   19       1       1       1       1       1       1       1       1
     128000  8.95626E-08  3.09358E-01  7.00386E-02
     256000  5.99003E-08  2.46401E-01  5.48768E-02
     384000  8.23110E-08  2.11231E-01  4.72426E-02
     512000  8.93617E-08  2.00889E-01  3.90538E-02
     640000  9.73907E-08  1.64878E-01  4.51981E-02
     768000  1.02330E-07  1.43087E-01  4.92073E-02
     896000  1.01858E-07  1.28408E-01  5.19859E-02
    1024000  1.03971E-07  1.15174E-01  5.56521E-02
    1152000  9.86674E-08  1.10247E-01  5.43458E-02
    1280000  1.02970E-07  1.04212E-01  5.48150E-02
    1408000  1.04771E-07  9.95821E-02  5.45417E-02
    1536000  1.05778E-07  9.58699E-02  5.38592E-02
    1664000  1.02956E-07  9.44432E-02  5.14984E-02
    1792000  1.05356E-07  8.87336E-02  5.39635E-02
    1920000  1.03647E-07  8.60556E-02  5.37738E-02
    2048000  1.13125E-07  8.12012E-02  5.59530E-02
    2176000  1.12044E-07  7.85718E-02  5.64052E-02
    2304000  1.12425E-07  7.57826E-02  5.71426E-02
    2421150  1.13357E-07  7.34532E-02  5.77676E-02
tally  364    1
       bottom of core support structure
f        1
   1519
d        1
u        0
s        0
m       22
c        0
e        0
t        0
vals
  1.23639E-03 0.0163  0.00000E+00 0.0000  2.64261E-05 0.0126  4.12137E-05 0.0118
  1.88956E-03 0.0152  4.60365E-05 0.0152  2.80010E-04 0.0153  1.22721E-04 0.0118
  2.06327E-04 0.0118  9.51208E-05 0.0118  6.43785E-05 0.0120  1.53043E-05 0.0118
  2.57407E-06 0.0421  2.20049E-04 0.0140  2.72769E-11 0.0499  8.36723E-05 0.0228
  7.50743E-03 0.0148  7.68412E-05 0.0172  1.67986E-03 0.0159  1.18586E-08 0.0140
  0.00000E+00 0.0000  1.43782E-04 0.0129
tfc   19       1       1       1       1       1       1       1       1
     128000  1.09227E-03  7.24075E-02  1.27847E+00
     256000  1.22504E-03  4.97328E-02  1.34707E+00
     384000  1.22206E-03  4.10102E-02  1.25333E+00
     512000  1.23473E-03  3.50156E-02  1.28544E+00
     640000  1.25141E-03  3.19620E-02  1.20276E+00
     768000  1.24481E-03  2.92577E-02  1.17693E+00
     896000  1.21881E-03  2.74282E-02  1.13940E+00
    1024000  1.21366E-03  2.55128E-02  1.13415E+00
    1152000  1.20571E-03  2.39746E-02  1.14920E+00
    1280000  1.19576E-03  2.26868E-02  1.15662E+00
    1408000  1.19394E-03  2.16127E-02  1.15791E+00
    1536000  1.19946E-03  2.07019E-02  1.15506E+00
    1664000  1.22211E-03  1.96764E-02  1.18643E+00
    1792000  1.22893E-03  1.89607E-02  1.18187E+00
    1920000  1.21181E-03  1.83778E-02  1.17908E+00
    2048000  1.21253E-03  1.78041E-02  1.16388E+00
    2176000  1.23209E-03  1.72420E-02  1.17133E+00
    2304000  1.23383E-03  1.66817E-02  1.17928E+00
    2421150  1.23639E-03  1.62525E-02  1.17996E+00
```

APPENDIX D
PROGRAM TO REFORMAT MCNP REACTION RATE TALLY FILE

PROGRAM TO REFORMAT MCNP REACTION RATE TALLY FILE

A Fortran 77 program, Mctalrd2, was written to read an MCNP4C (Briesmeister 2001) tally file (mctal) and reformat the data for use by the Transmut2 program (see Appendix E). This is the only file read by Mctalrd2. The program actually reads a file named "tally," so the MCNP mctal file must be renamed or copied to tally. The mctal file created by one important MCNP run made for this analysis and read by Mctalrd2 is listed in Appendix C. The format of the output file (fort.7) written by Mctalrd2 is defined in Table D-1. Output files created by two key Mctalrd2 runs are listed in Tables D-2 and D-3. The information in these two tables is also written to the standard output device. Each of these tables contains three columns of reaction rates for 19 nuclides in each region. Columns 1, 2 and 3 contain (n,γ), (n,p) and (n,α) reaction rates, respectively. The 19 nuclides for which reaction rate data are listed are: (1) Co-59, (2) Ni-60, (3) Co-60, (4) Ni-58, (5) Ni-59, (6) Ni-62, (7) Ni-63, (8) Fe-54, (9) Fe-55, (10) N-14, (11) Mo-92, (12) Mo-93, (13) Mo-98, (14) Tc-99, (15) Nb-93, (16) Nb-94, (17) C-14, (18) C-13 and (19) Mo-94. A description of the 28 regions in Table D-2 is given in Table 3-2. and a description of the 32 regions in Table D-3 is given in Table 3-1. Data for ^{14}C were not tallied in the MCNP4C calculations or written to the mctal file because ^{14}C has low cross sections and ^{14}C burnout is insignificant. Each record for ^{14}C in Tables D-2 and D-3, containing all zeros, was entered manually.

Finally, the Fortran source code for Mctalrd2 is listed in Table D-4. Information needed by Mctalrd2, other than reaction rates, are preset internally in the program (in parameter or data statements) or read from the mctal file.

Mctalrd2 was compiled and run on Hanford personal computers attached to the Fluor Local Area Network (FLAN). These computers currently are Dell Precision 620 workstations operating under Windows NT Version 4.0 (Build 1381: Service Pack 6). The compiler used was DIGITAL Visual Optimizing Compiler, Version 6.0.

With the program executable file (Mctalrd2.exe) and the MCNP reaction rate data in file tally both in the working directory, the program is executed by entering:

Mctalrd2 >out-file

where information normally written to the standard output device (i.e., the computer monitor) is redirected to a file named out-file. The reformatted reaction rate data are also written to a file named fort.7, which must be renamed "react" to be read by Transmut2 (see Appendix E). Main reaction rate files written to fort.7 are stored under the names given in Tables D-2 and D-3.

Mctalrd2 was validated simply by comparing the contents of the input (tally) file and the output file, fort.7.

Table D-1. Format and Content of Reaction Rate Files Written by Mctalrd2

Record	Field	Columns	Description
1	1	1 – 24	Identifier for first region [" region" followed by a sequence number (1)]
2	1	1 – 12	First reaction rate for first nuclide in first region
	2	13 – 24	Second reaction rate for first nuclide in first region
	3	25 – 36	Third reaction rate for first nuclide in first region
	Record 2 is repeated for all 18 nuclides in the first region for which reaction rates were tallied. The 18 nuclides are listed in Table C-1.		
Then, records 1 and 2 are repeated for all regions.			

Table D-2. Reaction Rate File react10ef.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10ef (sheet 1 of 5)

region 1		
2.9730E-02	0.0000E+00	0.0000E+00
0.0000E+00	2.5294E-08	0.0000E+00
5.9972E-04	0.0000E+00	0.0000E+00
8.4832E-04	0.0000E+00	0.0000E+00
4.6654E-02	1.1467E-03	6.9149E-03
2.5192E-03	0.0000E+00	0.0000E+00
4.2257E-03	0.0000E+00	0.0000E+00
1.8530E-03	0.0000E+00	0.0000E+00
1.3880E-03	0.0000E+00	0.0000E+00
0.0000E+00	3.1460E-04	0.0000E+00
8.2489E-05	0.0000E+00	0.0000E+00
5.2647E-03	1.0989E-08	0.0000E+00
1.9383E-03	0.0000E+00	0.0000E+00
1.4234E-01	0.0000E+00	0.0000E+00
2.0203E-03	0.0000E+00	0.0000E+00
4.2455E-02	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
3.4709E-07	0.0000E+00	0.0000E+00
0.0000E+00	1.2303E-09	0.0000E+00
flux 3.4534E-03		
region 2		
3.2934E-02	0.0000E+00	0.0000E+00
0.0000E+00	3.0685E-08	0.0000E+00
6.4809E-04	0.0000E+00	0.0000E+00
9.3449E-04	0.0000E+00	0.0000E+00
4.8318E-02	1.1989E-03	7.1583E-03
2.7907E-03	0.0000E+00	0.0000E+00
4.6446E-03	0.0000E+00	0.0000E+00
2.2028E-03	0.0000E+00	0.0000E+00
1.5246E-03	0.0000E+00	0.0000E+00
0.0000E+00	3.4673E-04	0.0000E+00
1.1699E-04	0.0000E+00	0.0000E+00
5.7978E-03	1.6046E-08	0.0000E+00
2.2818E-03	0.0000E+00	0.0000E+00
1.8527E-01	0.0000E+00	0.0000E+00
2.2845E-03	0.0000E+00	0.0000E+00
4.5338E-02	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
4.4423E-07	0.0000E+00	0.0000E+00
0.0000E+00	1.5059E-09	0.0000E+00
flux 4.3492E-03		
region 3		
5.7045E-03	0.0000E+00	0.0000E+00
0.0000E+00	7.1182E-09	0.0000E+00
1.3549E-04	0.0000E+00	0.0000E+00
2.2248E-04	0.0000E+00	0.0000E+00
8.6896E-03	2.1976E-04	1.2865E-03
6.6078E-04	0.0000E+00	0.0000E+00
1.0995E-03	0.0000E+00	0.0000E+00
4.7871E-04	0.0000E+00	0.0000E+00
3.5755E-04	0.0000E+00	0.0000E+00
0.0000E+00	8.2460E-05	0.0000E+00
3.2156E-05	0.0000E+00	0.0000E+00
1.1051E-03	4.7383E-09	0.0000E+00
4.6274E-04	0.0000E+00	0.0000E+00
3.8701E-02	0.0000E+00	0.0000E+00
4.6816E-04	0.0000E+00	0.0000E+00
7.7795E-03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
1.2548E-07	0.0000E+00	0.0000E+00
0.0000E+00	3.4619E-10	0.0000E+00
flux 9.8264E-04		

region 4		
4.0741E-02	0.0000E+00	0.0000E+00
0.0000E+00	2.3888E-10	0.0000E+00
8.1439E-04	0.0000E+00	0.0000E+00
1.1943E-03	0.0000E+00	0.0000E+00
6.1027E-02	1.4891E-03	9.0435E-03
3.5685E-03	0.0000E+00	0.0000E+00
5.9785E-03	0.0000E+00	0.0000E+00
2.8236E-03	0.0000E+00	0.0000E+00
1.9096E-03	0.0000E+00	0.0000E+00
0.0000E+00	4.4297E-04	0.0000E+00
9.5257E-05	0.0000E+00	0.0000E+00
7.1495E-03	1.3253E-09	0.0000E+00
2.7367E-03	0.0000E+00	0.0000E+00
2.3670E-01	0.0000E+00	0.0000E+00
2.6034E-03	0.0000E+00	0.0000E+00
5.6284E-02	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
3.5718E-07	0.0000E+00	0.0000E+00
0.0000E+00	1.0696E-11	0.0000E+00
flux 4.6789E-03		
region 5		
1.3689E-06	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
3.0867E-08	0.0000E+00	0.0000E+00
4.0516E-08	0.0000E+00	0.0000E+00
2.2118E-06	5.6050E-08	3.2737E-07
1.2195E-07	0.0000E+00	0.0000E+00
1.9959E-07	0.0000E+00	0.0000E+00
9.6520E-08	0.0000E+00	0.0000E+00
7.8490E-08	0.0000E+00	0.0000E+00
0.0000E+00	1.4675E-08	0.0000E+00
1.0322E-08	0.0000E+00	0.0000E+00
2.7491E-07	5.1938E-13	0.0000E+00
1.4230E-07	0.0000E+00	0.0000E+00
8.3504E-06	0.0000E+00	0.0000E+00
1.5361E-07	0.0000E+00	0.0000E+00
2.1798E-06	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
2.7744E-11	0.0000E+00	0.0000E+00
0.0000E+00	4.7643E-19	0.0000E+00
flux 2.5317E-07		
region 6		
1.7429E-10	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
9.3196E-12	0.0000E+00	0.0000E+00
2.2736E-11	0.0000E+00	0.0000E+00
3.7703E-10	9.1392E-12	5.5803E-11
6.6521E-11	0.0000E+00	0.0000E+00
1.1366E-10	0.0000E+00	0.0000E+00
1.9179E-11	0.0000E+00	0.0000E+00
3.0292E-11	0.0000E+00	0.0000E+00
0.0000E+00	8.4946E-12	0.0000E+00
1.6400E-13	0.0000E+00	0.0000E+00
4.5379E-11	1.8921E-19	0.0000E+00
6.2414E-13	0.0000E+00	0.0000E+00
9.6278E-11	0.0000E+00	0.0000E+00
5.4521E-12	0.0000E+00	0.0000E+00
6.5995E-11	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
6.1545E-15	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
flux 1.0327E-11		

Table D-2. Reaction Rate File react10ef.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10ef (sheet 2 of 5)

region	7		region	10	
8.4682E-02	0.0000E+00	0.0000E+00	1.3231E-01	0.0000E+00	0.0000E+00
0.0000E+00	3.4639E-10	0.0000E+00	0.0000E+00	2.3824E-11	0.0000E+00
1.5605E-03	0.0000E+00	0.0000E+00	2.4134E-03	0.0000E+00	0.0000E+00
1.3937E-03	0.0000E+00	0.0000E+00	2.0271E-03	0.0000E+00	0.0000E+00
1.3619E-01	3.4422E-03	2.0168E-02	2.1251E-01	5.3258E-03	3.1503E-02
4.2044E-03	0.0000E+00	0.0000E+00	5.9137E-03	0.0000E+00	0.0000E+00
6.6998E-03	0.0000E+00	0.0000E+00	9.6675E-03	0.0000E+00	0.0000E+00
3.0862E-03	0.0000E+00	0.0000E+00	4.4683E-03	0.0000E+00	0.0000E+00
3.4819E-03	0.0000E+00	0.0000E+00	5.3362E-03	0.0000E+00	0.0000E+00
0.0000E+00	4.8154E-04	0.0000E+00	0.0000E+00	6.9177E-04	0.0000E+00
6.9627E-04	0.0000E+00	0.0000E+00	9.0900E-04	0.0000E+00	0.0000E+00
1.5780E-02	2.3134E-08	0.0000E+00	2.4643E-02	3.3385E-08	0.0000E+00
8.4202E-03	0.0000E+00	0.0000E+00	1.2991E-02	0.0000E+00	0.0000E+00
2.6355E-01	0.0000E+00	0.0000E+00	3.9227E-01	0.0000E+00	0.0000E+00
9.7778E-03	0.0000E+00	0.0000E+00	1.5271E-02	0.0000E+00	0.0000E+00
1.4035E-01	0.0000E+00	0.0000E+00	2.2322E-01	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.0983E-06	0.0000E+00	0.0000E+00	1.6516E-06	0.0000E+00	0.0000E+00
0.0000E+00	9.3036E-12	0.0000E+00	0.0000E+00	1.5879E-12	0.0000E+00
flux	1.3174E-02		flux	1.9458E-02	
region	8		region	11	
5.2587E-01	0.0000E+00	0.0000E+00	8.0708E-02	0.0000E+00	0.0000E+00
0.0000E+00	4.1551E-09	0.0000E+00	0.0000E+00	8.9038E-15	0.0000E+00
9.8814E-03	0.0000E+00	0.0000E+00	1.4643E-03	0.0000E+00	0.0000E+00
9.4989E-03	0.0000E+00	0.0000E+00	1.4082E-03	0.0000E+00	0.0000E+00
8.4241E-01	2.0971E-02	1.2488E-01	1.2711E-01	3.1700E-03	1.8841E-02
2.7995E-02	0.0000E+00	0.0000E+00	4.2003E-03	0.0000E+00	0.0000E+00
4.6212E-02	0.0000E+00	0.0000E+00	6.8601E-03	0.0000E+00	0.0000E+00
2.1333E-02	0.0000E+00	0.0000E+00	3.2806E-03	0.0000E+00	0.0000E+00
2.2182E-02	0.0000E+00	0.0000E+00	3.2250E-03	0.0000E+00	0.0000E+00
0.0000E+00	3.3380E-03	0.0000E+00	0.0000E+00	4.9635E-04	0.0000E+00
3.1274E-03	0.0000E+00	0.0000E+00	4.7426E-04	0.0000E+00	0.0000E+00
9.7957E-02	9.6761E-08	0.0000E+00	1.4702E-02	1.5340E-08	0.0000E+00
4.9352E-02	0.0000E+00	0.0000E+00	7.3345E-03	0.0000E+00	0.0000E+00
1.8129E+00	0.0000E+00	0.0000E+00	2.9462E-01	0.0000E+00	0.0000E+00
5.6193E-02	0.0000E+00	0.0000E+00	8.3348E-03	0.0000E+00	0.0000E+00
8.6503E-01	0.0000E+00	0.0000E+00	1.2998E-01	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
5.7804E-06	0.0000E+00	0.0000E+00	8.6701E-07	0.0000E+00	0.0000E+00
0.0000E+00	1.1214E-10	0.0000E+00	0.0000E+00	8.4642E-14	0.0000E+00
flux	7.3531E-02		flux	1.1338E-02	
region	9		region	12	
6.7379E-01	0.0000E+00	0.0000E+00	3.5211E-02	0.0000E+00	0.0000E+00
0.0000E+00	5.2255E-08	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.2617E-02	0.0000E+00	0.0000E+00	7.5889E-04	0.0000E+00	0.0000E+00
1.0044E-02	0.0000E+00	0.0000E+00	9.9588E-04	0.0000E+00	0.0000E+00
1.1060E+00	2.8621E-02	1.6382E-01	5.7466E-02	1.4113E-03	8.5183E-03
2.9600E-02	0.0000E+00	0.0000E+00	2.9384E-03	0.0000E+00	0.0000E+00
4.6053E-02	0.0000E+00	0.0000E+00	4.9384E-03	0.0000E+00	0.0000E+00
2.1315E-02	0.0000E+00	0.0000E+00	2.1572E-03	0.0000E+00	0.0000E+00
2.8729E-02	0.0000E+00	0.0000E+00	1.8464E-03	0.0000E+00	0.0000E+00
0.0000E+00	3.3020E-03	0.0000E+00	0.0000E+00	3.6284E-04	0.0000E+00
7.2725E-03	0.0000E+00	0.0000E+00	1.5710E-04	0.0000E+00	0.0000E+00
1.3064E-01	4.0516E-07	0.0000E+00	6.6754E-03	2.8815E-09	0.0000E+00
7.2034E-02	0.0000E+00	0.0000E+00	2.9242E-03	0.0000E+00	0.0000E+00
1.8115E+00	0.0000E+00	0.0000E+00	1.6250E-01	0.0000E+00	0.0000E+00
9.1957E-02	0.0000E+00	0.0000E+00	3.1428E-03	0.0000E+00	0.0000E+00
1.1701E+00	0.0000E+00	0.0000E+00	5.4646E-02	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.4830E-05	0.0000E+00	0.0000E+00	3.5935E-07	0.0000E+00	0.0000E+00
0.0000E+00	1.5367E-09	0.0000E+00	0.0000E+00	7.2024E-15	0.0000E+00
flux	1.3126E-01		flux	4.5172E-03	

Table D-2. Reaction Rate File react10ef.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10ef (sheet 3 of 5)

```
region   13
  3.2700E+01  0.0000E+00  0.0000E+00
  0.0000E+00  2.0643E-05  0.0000E+00
  6.4553E-01  0.0000E+00  0.0000E+00
  5.2433E-01  0.0000E+00  0.0000E+00
  5.4444E+01  1.5186E+00  8.0561E+00
  1.4668E+00  0.0000E+00  0.0000E+00
  2.1897E+00  0.0000E+00  0.0000E+00
  1.0539E+00  0.0000E+00  0.0000E+00
  1.5537E+00  0.0000E+00  0.0000E+00
  0.0000E+00  1.7500E-01  0.0000E+00
  5.7077E-01  0.0000E+00  0.0000E+00
  6.7376E+00  7.3915E-05  0.0000E+00
  3.8840E+00  0.0000E+00  0.0000E+00
  9.0506E+01  0.0000E+00  0.0000E+00
  5.3597E+00  0.0000E+00  0.0000E+00
  5.9369E+01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.6417E-03  0.0000E+00  0.0000E+00
  0.0000E+00  8.5577E-07  0.0000E+00
 flux  9.9537E+00
 region   14
  1.2621E-01  0.0000E+00  0.0000E+00
  0.0000E+00  1.6485E-11  0.0000E+00
  2.3732E-03  0.0000E+00  0.0000E+00
  2.0442E-03  0.0000E+00  0.0000E+00
  2.0192E-01  5.1938E-03  2.9908E-02
  6.0055E-03  0.0000E+00  0.0000E+00
  9.4512E-03  0.0000E+00  0.0000E+00
  4.5397E-03  0.0000E+00  0.0000E+00
  5.4988E-03  0.0000E+00  0.0000E+00
  0.0000E+00  6.7468E-04  0.0000E+00
  1.2941E-03  0.0000E+00  0.0000E+00
  2.4314E-02  5.4349E-08  0.0000E+00
  1.3266E-02  0.0000E+00  0.0000E+00
  4.0093E-01  0.0000E+00  0.0000E+00
  1.6871E-02  0.0000E+00  0.0000E+00
  2.1468E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  2.1606E-06  0.0000E+00  0.0000E+00
  0.0000E+00  1.2099E-12  0.0000E+00
 flux  2.3886E-02
 region   15
  1.4187E+01  0.0000E+00  0.0000E+00
  0.0000E+00  9.5893E-07  0.0000E+00
  2.8764E-01  0.0000E+00  0.0000E+00
  2.3389E-01  0.0000E+00  0.0000E+00
  2.3589E+01  6.4712E-01  3.4872E+00
  6.7229E-01  0.0000E+00  0.0000E+00
  9.9284E-01  0.0000E+00  0.0000E+00
  4.7908E-01  0.0000E+00  0.0000E+00
  7.1144E-01  0.0000E+00  0.0000E+00
  0.0000E+00  7.2985E-02  0.0000E+00
  2.5686E-01  0.0000E+00  0.0000E+00
  2.9793E+00  1.8586E-05  0.0000E+00
  1.7456E+00  0.0000E+00  0.0000E+00
  4.1076E+01  0.0000E+00  0.0000E+00
  2.4499E+00  0.0000E+00  0.0000E+00
  2.6013E+01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.3923E-04  0.0000E+00  0.0000E+00
  0.0000E+00  6.6802E-08  0.0000E+00
 flux  4.0643E+00
```

```
region   16
  3.8599E-01  0.0000E+00  0.0000E+00
  0.0000E+00  8.0883E-08  0.0000E+00
  7.2271E-03  0.0000E+00  0.0000E+00
  6.3105E-03  0.0000E+00  0.0000E+00
  6.4288E-01  1.6195E-02  9.5224E-02
  1.8949E-02  0.0000E+00  0.0000E+00
  3.0379E-02  0.0000E+00  0.0000E+00
  1.3751E-02  0.0000E+00  0.0000E+00
  1.6058E-02  0.0000E+00  0.0000E+00
  0.0000E+00  2.1862E-03  0.0000E+00
  2.9929E-03  0.0000E+00  0.0000E+00
  7.2523E-02  1.3295E-07  0.0000E+00
  3.8380E-02  0.0000E+00  0.0000E+00
  1.1612E+00  0.0000E+00  0.0000E+00
  4.4951E-02  0.0000E+00  0.0000E+00
  6.5622E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.0073E-06  0.0000E+00  0.0000E+00
  0.0000E+00  2.3843E-09  0.0000E+00
 flux  5.8775E-02
 region   17
  7.0262E-03  0.0000E+00  0.0000E+00
  0.0000E+00  1.0813E-10  0.0000E+00
  1.6893E-04  0.0000E+00  0.0000E+00
  2.8886E-04  0.0000E+00  0.0000E+00
  1.1187E-02  2.7223E-04  1.6580E-03
  8.5388E-04  0.0000E+00  0.0000E+00
  1.4423E-03  0.0000E+00  0.0000E+00
  6.3307E-04  0.0000E+00  0.0000E+00
  4.3628E-04  0.0000E+00  0.0000E+00
  0.0000E+00  1.0718E-04  0.0000E+00
  1.3823E-05  0.0000E+00  0.0000E+00
  1.3170E-03  2.0192E-10  0.0000E+00
  4.6841E-04  0.0000E+00  0.0000E+00
  4.6212E-02  0.0000E+00  0.0000E+00
  4.2804E-04  0.0000E+00  0.0000E+00
  9.3782E-03  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  8.2850E-08  0.0000E+00  0.0000E+00
  0.0000E+00  3.0673E-12  0.0000E+00
 flux  8.6631E-04
 region   18
  3.3635E-01  0.0000E+00  0.0000E+00
  0.0000E+00  4.3146E-06  0.0000E+00
  6.7359E-03  0.0000E+00  0.0000E+00
  6.7016E-03  0.0000E+00  0.0000E+00
  5.6302E-01  1.4763E-02  8.3505E-02
  1.9266E-02  0.0000E+00  0.0000E+00
  3.1723E-02  0.0000E+00  0.0000E+00
  1.4223E-02  0.0000E+00  0.0000E+00
  1.5637E-02  0.0000E+00  0.0000E+00
  0.0000E+00  2.5371E-03  0.0000E+00
  2.8026E-03  0.0000E+00  0.0000E+00
  6.5416E-02  1.5404E-06  0.0000E+00
  3.4091E-02  0.0000E+00  0.0000E+00
  1.1207E+00  0.0000E+00  0.0000E+00
  3.9479E-02  0.0000E+00  0.0000E+00
  5.7684E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  8.9665E-06  0.0000E+00  0.0000E+00
  0.0000E+00  1.4964E-07  0.0000E+00
 flux  6.3853E-02
```

Table D-2. Reaction Rate File react10ef.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10ef (sheet 4 of 5)

```
region   19
 1.9585E-02  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 3.9847E-04  0.0000E+00  0.0000E+00
 4.8542E-04  0.0000E+00  0.0000E+00
 3.1448E-02  7.7510E-04  4.6618E-03
 1.4319E-03  0.0000E+00  0.0000E+00
 2.3948E-03  0.0000E+00  0.0000E+00
 1.0732E-03  0.0000E+00  0.0000E+00
 9.3919E-04  0.0000E+00  0.0000E+00
 0.0000E+00  1.7536E-04  0.0000E+00
 9.0489E-05  0.0000E+00  0.0000E+00
 3.6496E-03  1.9830E-09  0.0000E+00
 1.6661E-03  0.0000E+00  0.0000E+00
 8.5253E-02  0.0000E+00  0.0000E+00
 1.8092E-03  0.0000E+00  0.0000E+00
 3.0577E-02  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 1.9344E-07  0.0000E+00  0.0000E+00
 0.0000E+00  2.3016E-15  0.0000E+00
flux  2.5468E-03
region   20
 1.4446E-06  0.0000E+00  0.0000E+00
 0.0000E+00  1.1590E-11  0.0000E+00
 4.1155E-08  0.0000E+00  0.0000E+00
 4.3895E-08  0.0000E+00  0.0000E+00
 2.5092E-06  8.4652E-08  3.6870E-07
 1.1648E-07  0.0000E+00  0.0000E+00
 1.4266E-07  0.0000E+00  0.0000E+00
 7.3345E-08  0.0000E+00  0.0000E+00
 1.3140E-07  0.0000E+00  0.0000E+00
 0.0000E+00  1.1898E-08  0.0000E+00
 8.5640E-08  0.0000E+00  0.0000E+00
 4.0023E-07  9.3925E-12  0.0000E+00
 3.0621E-07  0.0000E+00  0.0000E+00
 3.8501E-06  0.0000E+00  0.0000E+00
 4.8145E-07  0.0000E+00  0.0000E+00
 3.1215E-06  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 2.0475E-10  0.0000E+00  0.0000E+00
 0.0000E+00  4.1463E-13  0.0000E+00
flux  1.0269E-06
region   21
 3.1135E-06  0.0000E+00  0.0000E+00
 0.0000E+00  7.9166E-13  0.0000E+00
 6.8745E-08  0.0000E+00  0.0000E+00
 9.4234E-08  0.0000E+00  0.0000E+00
 4.9300E-06  1.2386E-07  7.2974E-07
 2.8314E-07  0.0000E+00  0.0000E+00
 4.6639E-07  0.0000E+00  0.0000E+00
 2.1387E-07  0.0000E+00  0.0000E+00
 1.7433E-07  0.0000E+00  0.0000E+00
 0.0000E+00  3.4396E-08  0.0000E+00
 2.0794E-08  0.0000E+00  0.0000E+00
 5.9835E-07  1.0637E-12  0.0000E+00
 2.8858E-07  0.0000E+00  0.0000E+00
 1.7888E-05  0.0000E+00  0.0000E+00
 3.1386E-07  0.0000E+00  0.0000E+00
 4.6812E-06  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 5.0486E-11  0.0000E+00  0.0000E+00
 0.0000E+00  2.8687E-14  0.0000E+00
flux  5.1045E-07
```

```
region   22
 6.0117E-03  0.0000E+00  0.0000E+00
 0.0000E+00  8.9420E-11  0.0000E+00
 1.2838E-04  0.0000E+00  0.0000E+00
 1.9358E-04  0.0000E+00  0.0000E+00
 9.3794E-03  2.2993E-04  1.3898E-03
 5.7546E-04  0.0000E+00  0.0000E+00
 9.6396E-04  0.0000E+00  0.0000E+00
 4.3143E-04  0.0000E+00  0.0000E+00
 3.1188E-04  0.0000E+00  0.0000E+00
 0.0000E+00  7.1392E-05  0.0000E+00
 1.8059E-05  0.0000E+00  0.0000E+00
 1.0890E-03  3.8932E-10  0.0000E+00
 4.1682E-04  0.0000E+00  0.0000E+00
 3.3404E-02  0.0000E+00  0.0000E+00
 4.1859E-04  0.0000E+00  0.0000E+00
 8.4122E-03  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 6.2120E-08  0.0000E+00  0.0000E+00
 0.0000E+00  2.5304E-12  0.0000E+00
flux  7.3577E-04
region   23
 4.9165E-08  0.0000E+00  0.0000E+00
 0.0000E+00  3.9770E-16  0.0000E+00
 1.2721E-09  0.0000E+00  0.0000E+00
 2.2037E-09  0.0000E+00  0.0000E+00
 8.2073E-08  2.0087E-09  1.2162E-08
 6.4900E-09  0.0000E+00  0.0000E+00
 1.0975E-08  0.0000E+00  0.0000E+00
 4.2479E-09  0.0000E+00  0.0000E+00
 3.3923E-09  0.0000E+00  0.0000E+00
 0.0000E+00  8.1532E-10  0.0000E+00
 1.5146E-10  0.0000E+00  0.0000E+00
 9.5137E-09  4.1731E-15  0.0000E+00
 3.1511E-09  0.0000E+00  0.0000E+00
 2.6651E-07  0.0000E+00  0.0000E+00
 3.3801E-09  0.0000E+00  0.0000E+00
 6.5503E-08  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 7.3814E-13  0.0000E+00  0.0000E+00
 0.0000E+00  1.0425E-17  0.0000E+00
flux  6.1826E-09
region   24
 7.6001E-07  0.0000E+00  0.0000E+00
 0.0000E+00  5.3622E-15  0.0000E+00
 1.8121E-08  0.0000E+00  0.0000E+00
 2.8940E-08  0.0000E+00  0.0000E+00
 1.2412E-06  3.0622E-08  1.8387E-07
 8.5697E-08  0.0000E+00  0.0000E+00
 1.4382E-07  0.0000E+00  0.0000E+00
 6.0796E-08  0.0000E+00  0.0000E+00
 4.6567E-08  0.0000E+00  0.0000E+00
 0.0000E+00  1.0667E-08  0.0000E+00
 2.8684E-09  0.0000E+00  0.0000E+00
 1.4512E-07  1.2025E-13  0.0000E+00
 5.5859E-08  0.0000E+00  0.0000E+00
 4.3752E-06  0.0000E+00  0.0000E+00
 5.8745E-08  0.0000E+00  0.0000E+00
 1.0660E-06  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 1.1231E-11  0.0000E+00  0.0000E+00
 0.0000E+00  1.4151E-16  0.0000E+00
flux  1.0483E-07
```

Table D-2. Reaction Rate File react10ef.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10ef (sheet 5 of 5)

```
region   25
  2.7464E-07  0.0000E+00  0.0000E+00
  0.0000E+00  2.0516E-15  0.0000E+00
  5.8571E-09  0.0000E+00  0.0000E+00
  7.6577E-09  0.0000E+00  0.0000E+00
  4.3449E-07  1.0869E-08  6.4329E-08
  2.3156E-08  0.0000E+00  0.0000E+00
  3.8233E-08  0.0000E+00  0.0000E+00
  1.8056E-08  0.0000E+00  0.0000E+00
  1.4435E-08  0.0000E+00  0.0000E+00
  0.0000E+00  2.8214E-09  0.0000E+00
  1.7946E-09  0.0000E+00  0.0000E+00
  5.2058E-08  7.9172E-14  0.0000E+00
  2.4506E-08  0.0000E+00  0.0000E+00
  1.4656E-06  0.0000E+00  0.0000E+00
  2.6674E-08  0.0000E+00  0.0000E+00
  4.1737E-07  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.1931E-12  0.0000E+00  0.0000E+00
  0.0000E+00  5.3583E-17  0.0000E+00
 flux  4.2913E-08
 region   26
  1.2764E-07  0.0000E+00  0.0000E+00
  0.0000E+00  1.2004E-16  0.0000E+00
  2.7199E-09  0.0000E+00  0.0000E+00
  3.3127E-09  0.0000E+00  0.0000E+00
  2.0172E-07  5.2125E-09  2.9851E-08
  9.7930E-09  0.0000E+00  0.0000E+00
  1.5745E-08  0.0000E+00  0.0000E+00
  7.5882E-09  0.0000E+00  0.0000E+00
  6.8451E-09  0.0000E+00  0.0000E+00
  0.0000E+00  1.1615E-09  0.0000E+00
  1.3953E-09  0.0000E+00  0.0000E+00
  2.5073E-08  6.7211E-14  0.0000E+00
  1.3506E-08  0.0000E+00  0.0000E+00
  6.4878E-07  0.0000E+00  0.0000E+00
  1.5416E-08  0.0000E+00  0.0000E+00
  2.0547E-07  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  2.5021E-12  0.0000E+00  0.0000E+00
  0.0000E+00  3.2735E-18  0.0000E+00
 flux  2.5678E-08
 region   27
  1.1336E-07  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  2.4538E-09  0.0000E+00  0.0000E+00
  2.8742E-09  0.0000E+00  0.0000E+00
  1.8416E-07  4.9385E-09  2.7226E-08
  8.2182E-09  0.0000E+00  0.0000E+00
  1.2717E-08  0.0000E+00  0.0000E+00
  6.0528E-09  0.0000E+00  0.0000E+00
  6.2804E-09  0.0000E+00  0.0000E+00
  0.0000E+00  9.3923E-10  0.0000E+00
  1.9187E-09  0.0000E+00  0.0000E+00
  2.3303E-08  9.5525E-14  0.0000E+00
  1.2685E-08  0.0000E+00  0.0000E+00
  5.0127E-07  0.0000E+00  0.0000E+00
  1.6495E-08  0.0000E+00  0.0000E+00
  1.9344E-07  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  2.9160E-12  0.0000E+00  0.0000E+00
  0.0000E+00  1.6565E-20  0.0000E+00
 flux  2.8958E-08
```

```
region   28
  1.2364E-03  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  2.6426E-05  0.0000E+00  0.0000E+00
  4.1214E-05  0.0000E+00  0.0000E+00
  1.8896E-03  4.6037E-05  2.8001E-04
  1.2272E-04  0.0000E+00  0.0000E+00
  2.0633E-04  0.0000E+00  0.0000E+00
  9.5121E-05  0.0000E+00  0.0000E+00
  6.4379E-05  0.0000E+00  0.0000E+00
  0.0000E+00  1.5304E-05  0.0000E+00
  2.5741E-06  0.0000E+00  0.0000E+00
  2.2005E-04  2.7277E-11  0.0000E+00
  8.3672E-05  0.0000E+00  0.0000E+00
  7.5074E-03  0.0000E+00  0.0000E+00
  7.6841E-05  0.0000E+00  0.0000E+00
  1.6799E-03  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.1859E-08  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
 flux  1.4378E-04
```

Table D-3. Reaction Rate File react10em.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10em (sheet 1 of 6)

```
region    1
  3.4305E+01  0.0000E+00  0.0000E+00
  0.0000E+00  2.0783E-03  0.0000E+00
  8.8912E-01  0.0000E+00  0.0000E+00
  5.9402E-01  0.0000E+00  0.0000E+00
  7.0947E+01  2.4785E+00  1.0512E+01
  1.6491E+00  0.0000E+00  0.0000E+00
  2.1662E+00  0.0000E+00  0.0000E+00
  1.1727E+00  0.0000E+00  0.0000E+00
  2.4225E+00  0.0000E+00  0.0000E+00
  0.0000E+00  3.5819E-01  0.0000E+00
  1.4048E+00  0.0000E+00  0.0000E+00
  9.3088E+00  9.3401E-04  0.0000E+00
  6.3211E+00  0.0000E+00  0.0000E+00
  7.5722E+01  0.0000E+00  0.0000E+00
  9.5218E+00  0.0000E+00  0.0000E+00
  8.2567E+01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  7.2403E-03  0.0000E+00  0.0000E+00
  0.0000E+00  7.3719E-05  0.0000E+00
 flux  2.4868E+01
 region    2
  2.3546E+00  0.0000E+00  0.0000E+00
  0.0000E+00  7.8631E-06  0.0000E+00
  6.1995E-02  0.0000E+00  0.0000E+00
  4.3911E-02  0.0000E+00  0.0000E+00
  5.3143E+00  1.5866E-01  7.8615E-01
  1.1620E-01  0.0000E+00  0.0000E+00
  1.5632E-01  0.0000E+00  0.0000E+00
  7.5708E-02  0.0000E+00  0.0000E+00
  1.6013E-01  0.0000E+00  0.0000E+00
  0.0000E+00  1.4578E-02  0.0000E+00
  7.4555E-02  0.0000E+00  0.0000E+00
  6.5593E-01  1.3761E-05  0.0000E+00
  3.3447E-01  0.0000E+00  0.0000E+00
  5.5992E+00  0.0000E+00  0.0000E+00
  6.2949E-01  0.0000E+00  0.0000E+00
  5.7615E+00  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  2.5166E-04  0.0000E+00  0.0000E+00
  0.0000E+00  2.4635E-07  0.0000E+00
 flux  1.2819E+00
 region    3
  4.1284E+00  0.0000E+00  0.0000E+00
  0.0000E+00  2.0002E-05  0.0000E+00
  1.0196E-01  0.0000E+00  0.0000E+00
  7.4545E-02  0.0000E+00  0.0000E+00
  8.9578E+00  2.5672E-01  1.3261E+00
  2.0122E-01  0.0000E+00  0.0000E+00
  2.8640E-01  0.0000E+00  0.0000E+00
  1.3651E-01  0.0000E+00  0.0000E+00
  2.5190E-01  0.0000E+00  0.0000E+00
  0.0000E+00  2.4727E-02  0.0000E+00
  1.0335E-01  0.0000E+00  0.0000E+00
  1.0786E+00  2.0046E-05  0.0000E+00
  5.1224E-01  0.0000E+00  0.0000E+00
  1.0582E+01  0.0000E+00  0.0000E+00
  9.4345E-01  0.0000E+00  0.0000E+00
  9.5236E+00  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  3.4449E-04  0.0000E+00  0.0000E+00
  0.0000E+00  8.4129E-07  0.0000E+00
 flux  1.8152E+00
```

```
region    4
  2.0466E-02  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  3.7560E-04  0.0000E+00  0.0000E+00
  2.9569E-04  0.0000E+00  0.0000E+00
  3.2217E-02  8.2099E-04  4.7748E-03
  8.4984E-04  0.0000E+00  0.0000E+00
  1.3644E-03  0.0000E+00  0.0000E+00
  6.3653E-04  0.0000E+00  0.0000E+00
  8.4669E-04  0.0000E+00  0.0000E+00
  0.0000E+00  9.6897E-05  0.0000E+00
  1.8076E-04  0.0000E+00  0.0000E+00
  3.8568E-03  8.0086E-09  0.0000E+00
  2.0342E-03  0.0000E+00  0.0000E+00
  5.4370E-02  0.0000E+00  0.0000E+00
  2.6209E-03  0.0000E+00  0.0000E+00
  3.4727E-02  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  3.4287E-07  0.0000E+00  0.0000E+00
  0.0000E+00  4.9061E-14  0.0000E+00
 flux  3.4867E-03
 region    5
  2.8009E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.6448E-03  0.0000E+00  0.0000E+00
  4.3532E-03  0.0000E+00  0.0000E+00
  4.9722E-01  1.2764E-02  7.3674E-02
  1.2736E-02  0.0000E+00  0.0000E+00
  2.0008E-02  0.0000E+00  0.0000E+00
  9.2809E-03  0.0000E+00  0.0000E+00
  1.2978E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.4164E-03  0.0000E+00
  3.1921E-03  0.0000E+00  0.0000E+00
  5.8645E-02  1.4150E-07  0.0000E+00
  2.7834E-02  0.0000E+00  0.0000E+00
  7.8949E-01  0.0000E+00  0.0000E+00
  4.1781E-02  0.0000E+00  0.0000E+00
  5.2437E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.7469E-06  0.0000E+00  0.0000E+00
  0.0000E+00  1.5012E-13  0.0000E+00
 flux  5.6539E-02
 region    6
  5.3724E+01  0.0000E+00  0.0000E+00
  0.0000E+00  3.8666E-04  0.0000E+00
  1.2271E+00  0.0000E+00  0.0000E+00
  8.3999E-01  0.0000E+00  0.0000E+00
  1.0605E+02  3.1009E+00  1.5700E+01
  2.4691E+00  0.0000E+00  0.0000E+00
  3.5884E+00  0.0000E+00  0.0000E+00
  1.7815E+00  0.0000E+00  0.0000E+00
  3.0033E+00  0.0000E+00  0.0000E+00
  0.0000E+00  3.6700E-01  0.0000E+00
  1.3039E+00  0.0000E+00  0.0000E+00
  1.2926E+01  3.7643E-04  0.0000E+00
  7.6361E+00  0.0000E+00  0.0000E+00
  1.4233E+02  0.0000E+00  0.0000E+00
  1.0914E+01  0.0000E+00  0.0000E+00
  1.1729E+02  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.8512E-03  0.0000E+00  0.0000E+00
  0.0000E+00  1.4385E-05  0.0000E+00
 flux  2.2738E+01
```

Table D-3. Reaction Rate File react10em.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10em (sheet 2 of 6)

```
region    7
 2.5157E+00  0.0000E+00  0.0000E+00
 0.0000E+00  1.8004E-06  0.0000E+00
 6.5612E-02  0.0000E+00  0.0000E+00
 4.8318E-02  0.0000E+00  0.0000E+00
 5.5475E+00  1.6220E-01  8.2012E-01
 1.3052E-01  0.0000E+00  0.0000E+00
 1.7799E-01  0.0000E+00  0.0000E+00
 8.5359E-02  0.0000E+00  0.0000E+00
 1.7027E-01  0.0000E+00  0.0000E+00
 0.0000E+00  1.4861E-02  0.0000E+00
 7.9146E-02  0.0000E+00  0.0000E+00
 6.9036E-01  9.8006E-06  0.0000E+00
 3.5071E-01  0.0000E+00  0.0000E+00
 6.3966E+00  0.0000E+00  0.0000E+00
 6.5437E-01  0.0000E+00  0.0000E+00
 6.0163E+00  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 2.2981E-04  0.0000E+00  0.0000E+00
 0.0000E+00  5.9538E-08  0.0000E+00
flux  1.2546E+00
region    8
 4.5803E+00  0.0000E+00  0.0000E+00
 0.0000E+00  6.4205E-06  0.0000E+00
 1.1477E-01  0.0000E+00  0.0000E+00
 8.4139E-02  0.0000E+00  0.0000E+00
 9.9715E+00  2.8035E-01  1.4766E+00
 2.2545E-01  0.0000E+00  0.0000E+00
 3.2810E-01  0.0000E+00  0.0000E+00
 1.5506E-01  0.0000E+00  0.0000E+00
 2.8638E-01  0.0000E+00  0.0000E+00
 0.0000E+00  2.6362E-02  0.0000E+00
 1.1099E-01  0.0000E+00  0.0000E+00
 1.2046E+00  1.4909E-05  0.0000E+00
 5.7918E-01  0.0000E+00  0.0000E+00
 1.2056E+01  0.0000E+00  0.0000E+00
 1.0572E+00  0.0000E+00  0.0000E+00
 1.0656E+01  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 3.4735E-04  0.0000E+00  0.0000E+00
 0.0000E+00  2.4646E-07  0.0000E+00
flux  1.9050E+00
region    9
 2.0496E-02  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 3.9834E-04  0.0000E+00  0.0000E+00
 3.2612E-04  0.0000E+00  0.0000E+00
 3.4579E-02  8.7579E-04  5.1253E-03
 9.4298E-04  0.0000E+00  0.0000E+00
 1.5256E-03  0.0000E+00  0.0000E+00
 6.9981E-04  0.0000E+00  0.0000E+00
 9.0337E-04  0.0000E+00  0.0000E+00
 0.0000E+00  1.0846E-04  0.0000E+00
 1.8494E-04  0.0000E+00  0.0000E+00
 4.1093E-03  6.9876E-09  0.0000E+00
 2.1502E-03  0.0000E+00  0.0000E+00
 5.9054E-02  0.0000E+00  0.0000E+00
 2.7226E-03  0.0000E+00  0.0000E+00
 3.6848E-02  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 3.0907E-07  0.0000E+00  0.0000E+00
 0.0000E+00  2.1757E-14  0.0000E+00
flux  3.5466E-03
```

```
region   10
 1.2909E-01  0.0000E+00  0.0000E+00
 0.0000E+00  3.0746E-04  0.0000E+00
 1.5973E-02  0.0000E+00  0.0000E+00
 3.3250E-02  0.0000E+00  0.0000E+00
 3.5558E-01  8.0644E-02  5.4408E-02
 4.5063E-02  0.0000E+00  0.0000E+00
 3.5881E-02  0.0000E+00  0.0000E+00
 4.0516E-02  0.0000E+00  0.0000E+00
 7.4359E-02  0.0000E+00  0.0000E+00
 0.0000E+00  2.2133E-02  0.0000E+00
 9.4465E-02  0.0000E+00  0.0000E+00
 1.5994E-01  1.0995E-04  0.0000E+00
 1.9057E-01  0.0000E+00  0.0000E+00
 1.0742E+00  0.0000E+00  0.0000E+00
 3.4520E-01  0.0000E+00  0.0000E+00
 7.7744E-01  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 5.0029E-04  0.0000E+00  0.0000E+00
 0.0000E+00  1.0710E-05  0.0000E+00
flux  1.8315E+00
region   11
 1.9138E-01  0.0000E+00  0.0000E+00
 0.0000E+00  4.2126E-04  0.0000E+00
 1.9579E-02  0.0000E+00  0.0000E+00
 3.1540E-02  0.0000E+00  0.0000E+00
 4.7454E-01  9.1671E-02  7.3287E-02
 4.7446E-02  0.0000E+00  0.0000E+00
 4.1603E-02  0.0000E+00  0.0000E+00
 3.8499E-02  0.0000E+00  0.0000E+00
 8.7960E-02  0.0000E+00  0.0000E+00
 0.0000E+00  2.7253E-02  0.0000E+00
 9.1309E-02  0.0000E+00  0.0000E+00
 1.9336E-01  1.4292E-04  0.0000E+00
 2.1801E-01  0.0000E+00  0.0000E+00
 1.1419E+00  0.0000E+00  0.0000E+00
 3.9533E-01  0.0000E+00  0.0000E+00
 1.0522E+00  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 5.1409E-04  0.0000E+00  0.0000E+00
 0.0000E+00  1.4922E-05  0.0000E+00
flux  1.9451E+00
region   12
 1.5914E+00  0.0000E+00  0.0000E+00
 0.0000E+00  1.2327E-03  0.0000E+00
 7.8117E-02  0.0000E+00  0.0000E+00
 1.0240E-01  0.0000E+00  0.0000E+00
 3.5049E+00  3.0441E-01  5.2830E-01
 1.5918E-01  0.0000E+00  0.0000E+00
 1.6992E-01  0.0000E+00  0.0000E+00
 1.3055E-01  0.0000E+00  0.0000E+00
 2.9820E-01  0.0000E+00  0.0000E+00
 0.0000E+00  7.5370E-02  0.0000E+00
 2.6568E-01  0.0000E+00  0.0000E+00
 7.8600E-01  4.0560E-04  0.0000E+00
 7.6790E-01  0.0000E+00  0.0000E+00
 5.1337E+00  0.0000E+00  0.0000E+00
 1.2907E+00  0.0000E+00  0.0000E+00
 5.3644E+00  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 1.4438E-03  0.0000E+00  0.0000E+00
 0.0000E+00  4.5289E-05  0.0000E+00
flux  5.4325E+00
```

Table D-3. Reaction Rate File react10em.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10em (sheet 3 of 6)

```
region   13
  1.7458E+00  0.0000E+00  0.0000E+00
  0.0000E+00  1.0440E-05  0.0000E+00
  4.0870E-02  0.0000E+00  0.0000E+00
  2.8893E-02  0.0000E+00  0.0000E+00
  3.6322E+00  1.0248E-01  5.3815E-01
  7.8414E-02  0.0000E+00  0.0000E+00
  1.1562E-01  0.0000E+00  0.0000E+00
  5.3798E-02  0.0000E+00  0.0000E+00
  9.8078E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.0168E-02  0.0000E+00
  3.5964E-02  0.0000E+00  0.0000E+00
  4.3466E-01  8.6621E-06  0.0000E+00
  2.3220E-01  0.0000E+00  0.0000E+00
  4.5048E+00  0.0000E+00  0.0000E+00
  3.6036E-01  0.0000E+00  0.0000E+00
  3.8981E+00  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.3218E-04  0.0000E+00  0.0000E+00
  0.0000E+00  3.5123E-07  0.0000E+00
 flux  6.7302E-01
 region   14
  3.0633E-01  0.0000E+00  0.0000E+00
  0.0000E+00  3.1569E-13  0.0000E+00
  6.1698E-03  0.0000E+00  0.0000E+00
  4.7304E-03  0.0000E+00  0.0000E+00
  5.4025E-01  1.3940E-02  8.0049E-02
  1.3890E-02  0.0000E+00  0.0000E+00
  2.1817E-02  0.0000E+00  0.0000E+00
  1.0174E-02  0.0000E+00  0.0000E+00
  1.4220E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.5499E-03  0.0000E+00
  3.3838E-03  0.0000E+00  0.0000E+00
  6.4250E-02  1.7955E-07  0.0000E+00
  3.2417E-02  0.0000E+00  0.0000E+00
  8.7273E-01  0.0000E+00  0.0000E+00
  4.5942E-02  0.0000E+00  0.0000E+00
  5.7062E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  7.2305E-06  0.0000E+00  0.0000E+00
  0.0000E+00  1.6424E-12  0.0000E+00
 flux  6.3816E-02
 region   15
  6.4864E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.6146E-08  0.0000E+00
  1.6546E-03  0.0000E+00  0.0000E+00
  1.0530E-03  0.0000E+00  0.0000E+00
  1.4764E-01  4.1435E-03  2.1859E-02
  2.8793E-03  0.0000E+00  0.0000E+00
  4.0123E-03  0.0000E+00  0.0000E+00
  1.8851E-03  0.0000E+00  0.0000E+00
  4.3313E-03  0.0000E+00  0.0000E+00
  0.0000E+00  3.1046E-04  0.0000E+00
  1.9034E-03  0.0000E+00  0.0000E+00
  1.7373E-02  1.8240E-07  0.0000E+00
  1.0941E-02  0.0000E+00  0.0000E+00
  1.2216E-01  0.0000E+00  0.0000E+00
  1.6775E-02  0.0000E+00  0.0000E+00
  1.5575E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  5.0814E-06  0.0000E+00  0.0000E+00
  0.0000E+00  4.3808E-10  0.0000E+00
 flux  2.8290E-02
```

```
 region   16
  2.8805E-01  0.0000E+00  0.0000E+00
  0.0000E+00  6.7163E-08  0.0000E+00
  6.6104E-03  0.0000E+00  0.0000E+00
  4.3912E-03  0.0000E+00  0.0000E+00
  5.9496E-01  1.5661E-02  8.8151E-02
  1.2574E-02  0.0000E+00  0.0000E+00
  1.9147E-02  0.0000E+00  0.0000E+00
  8.8216E-03  0.0000E+00  0.0000E+00
  1.5528E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.3671E-03  0.0000E+00
  4.6508E-03  0.0000E+00  0.0000E+00
  6.9746E-02  3.3302E-07  0.0000E+00
  3.7968E-02  0.0000E+00  0.0000E+00
  7.4147E-01  0.0000E+00  0.0000E+00
  5.5232E-02  0.0000E+00  0.0000E+00
  6.3620E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.0492E-05  0.0000E+00  0.0000E+00
  0.0000E+00  1.8827E-09  0.0000E+00
 flux  7.9227E-02
 region   17
  5.3517E-02  0.0000E+00  0.0000E+00
  0.0000E+00  5.2397E-13  0.0000E+00
  1.0156E-03  0.0000E+00  0.0000E+00
  7.8302E-04  0.0000E+00  0.0000E+00
  8.7501E-02  2.2300E-03  1.2970E-02
  2.2252E-03  0.0000E+00  0.0000E+00
  3.5878E-03  0.0000E+00  0.0000E+00
  1.6331E-03  0.0000E+00  0.0000E+00
  2.2856E-03  0.0000E+00  0.0000E+00
  0.0000E+00  2.5474E-04  0.0000E+00
  4.8067E-04  0.0000E+00  0.0000E+00
  1.0544E-02  2.3265E-08  0.0000E+00
  5.4219E-03  0.0000E+00  0.0000E+00
  1.3863E-01  0.0000E+00  0.0000E+00
  7.1458E-03  0.0000E+00  0.0000E+00
  9.5002E-02  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.0195E-06  0.0000E+00  0.0000E+00
  0.0000E+00  2.7430E-12  0.0000E+00
 flux  9.4087E-03
 region   18
  7.0776E-02  0.0000E+00  0.0000E+00
  0.0000E+00  3.0534E-05  0.0000E+00
  5.5703E-03  0.0000E+00  0.0000E+00
  7.9061E-03  0.0000E+00  0.0000E+00
  2.0534E-01  1.8731E-02  3.0382E-02
  1.3415E-02  0.0000E+00  0.0000E+00
  1.1811E-02  0.0000E+00  0.0000E+00
  1.1861E-02  0.0000E+00  0.0000E+00
  2.3443E-02  0.0000E+00  0.0000E+00
  0.0000E+00  3.8305E-03  0.0000E+00
  2.3709E-02  0.0000E+00  0.0000E+00
  5.5193E-02  1.4460E-05  0.0000E+00
  5.2719E-02  0.0000E+00  0.0000E+00
  3.2449E-01  0.0000E+00  0.0000E+00
  1.0438E-01  0.0000E+00  0.0000E+00
  3.3391E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.1424E-04  0.0000E+00  0.0000E+00
  0.0000E+00  1.0750E-06  0.0000E+00
 flux  4.1770E-01
```

Table D-3. Reaction Rate File react10em.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10em (sheet 4 of 6)

region 19		
6.8289E-02	0.0000E+00	0.0000E+00
0.0000E+00	1.7401E-04	0.0000E+00
9.1223E-03	0.0000E+00	0.0000E+00
1.3835E-02	0.0000E+00	0.0000E+00
2.7793E-01	3.8007E-02	4.2238E-02
2.1558E-02	0.0000E+00	0.0000E+00
1.9347E-02	0.0000E+00	0.0000E+00
1.5849E-02	0.0000E+00	0.0000E+00
4.0466E-02	0.0000E+00	0.0000E+00
0.0000E+00	1.0388E-02	0.0000E+00
4.2680E-02	0.0000E+00	0.0000E+00
8.9064E-02	5.7498E-05	0.0000E+00
8.6954E-02	0.0000E+00	0.0000E+00
5.1189E-01	0.0000E+00	0.0000E+00
1.8098E-01	0.0000E+00	0.0000E+00
5.1977E-01	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
2.1190E-04	0.0000E+00	0.0000E+00
0.0000E+00	5.8922E-06	0.0000E+00
flux 7.9181E-01		
region 20		
1.0925E+00	0.0000E+00	0.0000E+00
0.0000E+00	1.1271E-03	0.0000E+00
6.7457E-02	0.0000E+00	0.0000E+00
9.2826E-02	0.0000E+00	0.0000E+00
2.6308E+00	2.6493E-01	3.9776E-01
1.4148E-01	0.0000E+00	0.0000E+00
1.4717E-01	0.0000E+00	0.0000E+00
1.1857E-01	0.0000E+00	0.0000E+00
2.7025E-01	0.0000E+00	0.0000E+00
0.0000E+00	6.7643E-02	0.0000E+00
2.4372E-01	0.0000E+00	0.0000E+00
6.7199E-01	3.7156E-04	0.0000E+00
6.6172E-01	0.0000E+00	0.0000E+00
4.1822E+00	0.0000E+00	0.0000E+00
1.1777E+00	0.0000E+00	0.0000E+00
4.3435E+00	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
1.3664E-03	0.0000E+00	0.0000E+00
0.0000E+00	4.0775E-05	0.0000E+00
flux 5.0222E+00		
region 21		
1.1467E+00	0.0000E+00	0.0000E+00
0.0000E+00	5.9821E-06	0.0000E+00
2.7103E-02	0.0000E+00	0.0000E+00
1.8898E-02	0.0000E+00	0.0000E+00
2.4649E+00	6.9140E-02	3.6524E-01
5.2136E-02	0.0000E+00	0.0000E+00
7.7058E-02	0.0000E+00	0.0000E+00
3.6067E-02	0.0000E+00	0.0000E+00
6.4375E-02	0.0000E+00	0.0000E+00
0.0000E+00	6.7489E-03	0.0000E+00
2.3819E-02	0.0000E+00	0.0000E+00
2.8580E-01	5.4587E-06	0.0000E+00
1.5920E-01	0.0000E+00	0.0000E+00
2.9314E+00	0.0000E+00	0.0000E+00
2.3630E-01	0.0000E+00	0.0000E+00
2.6072E+00	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
8.5502E-05	0.0000E+00	0.0000E+00
0.0000E+00	3.0709E-07	0.0000E+00
flux 4.3929E-01		

region 22		
3.0925E-01	0.0000E+00	0.0000E+00
0.0000E+00	1.1855E-12	0.0000E+00
6.2073E-03	0.0000E+00	0.0000E+00
4.8924E-03	0.0000E+00	0.0000E+00
5.4418E-01	1.4052E-02	8.0632E-02
1.4174E-02	0.0000E+00	0.0000E+00
2.2255E-02	0.0000E+00	0.0000E+00
1.0440E-02	0.0000E+00	0.0000E+00
1.4273E-02	0.0000E+00	0.0000E+00
0.0000E+00	1.5900E-03	0.0000E+00
3.5116E-03	0.0000E+00	0.0000E+00
6.4182E-02	1.9003E-07	0.0000E+00
3.1088E-02	0.0000E+00	0.0000E+00
8.6240E-01	0.0000E+00	0.0000E+00
4.5844E-02	0.0000E+00	0.0000E+00
5.7355E-01	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
7.5111E-06	0.0000E+00	0.0000E+00
0.0000E+00	4.6090E-12	0.0000E+00
flux 6.4538E-02		
region 23		
5.1003E-03	0.0000E+00	0.0000E+00
0.0000E+00	2.0146E-08	0.0000E+00
1.3957E-04	0.0000E+00	0.0000E+00
8.6877E-05	0.0000E+00	0.0000E+00
1.1166E-02	3.1305E-04	1.6528E-03
2.5541E-04	0.0000E+00	0.0000E+00
3.4998E-04	0.0000E+00	0.0000E+00
1.6986E-04	0.0000E+00	0.0000E+00
3.6110E-04	0.0000E+00	0.0000E+00
0.0000E+00	2.5811E-05	0.0000E+00
1.2803E-04	0.0000E+00	0.0000E+00
1.4411E-03	1.5838E-08	0.0000E+00
7.2692E-04	0.0000E+00	0.0000E+00
1.5342E-02	0.0000E+00	0.0000E+00
1.3815E-03	0.0000E+00	0.0000E+00
1.2921E-02	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
4.0296E-07	0.0000E+00	0.0000E+00
0.0000E+00	5.4540E-10	0.0000E+00
flux 2.2558E-03		
region 24		
2.7275E-01	0.0000E+00	0.0000E+00
0.0000E+00	4.5985E-08	0.0000E+00
6.2883E-03	0.0000E+00	0.0000E+00
4.2285E-03	0.0000E+00	0.0000E+00
5.5896E-01	1.4692E-02	8.2822E-02
1.1979E-02	0.0000E+00	0.0000E+00
1.8336E-02	0.0000E+00	0.0000E+00
8.3920E-03	0.0000E+00	0.0000E+00
1.4860E-02	0.0000E+00	0.0000E+00
0.0000E+00	1.3099E-03	0.0000E+00
4.0893E-03	0.0000E+00	0.0000E+00
6.6305E-02	3.0867E-07	0.0000E+00
3.7011E-02	0.0000E+00	0.0000E+00
7.0381E-01	0.0000E+00	0.0000E+00
5.2227E-02	0.0000E+00	0.0000E+00
6.0157E-01	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00
1.0261E-05	0.0000E+00	0.0000E+00
0.0000E+00	1.2537E-09	0.0000E+00
flux 7.4233E-02		

Table D-3. Reaction Rate File react10em.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10em (sheet 5 of 6)

```
region   25
  5.4226E-02  0.0000E+00  0.0000E+00
  0.0000E+00  4.0852E-14  0.0000E+00
  1.0127E-03  0.0000E+00  0.0000E+00
  7.8018E-04  0.0000E+00  0.0000E+00
  8.9963E-02  2.2911E-03  1.3335E-02
  2.2173E-03  0.0000E+00  0.0000E+00
  3.5734E-03  0.0000E+00  0.0000E+00
  1.6105E-03  0.0000E+00  0.0000E+00
  2.2734E-03  0.0000E+00  0.0000E+00
  0.0000E+00  2.5431E-04  0.0000E+00
  4.7117E-04  0.0000E+00  0.0000E+00
  1.0512E-02  2.4151E-08  0.0000E+00
  5.6239E-03  0.0000E+00  0.0000E+00
  1.3787E-01  0.0000E+00  0.0000E+00
  7.1235E-03  0.0000E+00  0.0000E+00
  9.5795E-02  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.0472E-06  0.0000E+00  0.0000E+00
  0.0000E+00  3.3313E-13  0.0000E+00
flux  9.4319E-03
region   26
  2.3960E+00  0.0000E+00  0.0000E+00
  0.0000E+00  9.1476E-04  0.0000E+00
  1.0060E-01  0.0000E+00  0.0000E+00
  1.0688E-01  0.0000E+00  0.0000E+00
  5.8224E+00  3.5882E-01  8.6845E-01
  2.0314E-01  0.0000E+00  0.0000E+00
  2.1121E-01  0.0000E+00  0.0000E+00
  1.4390E-01  0.0000E+00  0.0000E+00
  3.5364E-01  0.0000E+00  0.0000E+00
  0.0000E+00  7.7983E-02  0.0000E+00
  2.9739E-01  0.0000E+00  0.0000E+00
  1.0184E+00  3.3570E-04  0.0000E+00
  8.8402E-01  0.0000E+00  0.0000E+00
  6.0938E+00  0.0000E+00  0.0000E+00
  1.5339E+00  0.0000E+00  0.0000E+00
  7.6488E+00  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.5121E-03  0.0000E+00  0.0000E+00
  0.0000E+00  3.3982E-05  0.0000E+00
flux  5.8540E+00
region   27
  1.0595E+00  0.0000E+00  0.0000E+00
  0.0000E+00  5.0492E-06  0.0000E+00
  2.4330E-02  0.0000E+00  0.0000E+00
  1.7615E-02  0.0000E+00  0.0000E+00
  2.1342E+00  5.9918E-02  3.1626E-01
  4.7350E-02  0.0000E+00  0.0000E+00
  7.0922E-02  0.0000E+00  0.0000E+00
  3.3550E-02  0.0000E+00  0.0000E+00
  5.8196E-02  0.0000E+00  0.0000E+00
  0.0000E+00  6.1486E-03  0.0000E+00
  2.1013E-02  0.0000E+00  0.0000E+00
  2.5744E-01  4.6434E-06  0.0000E+00
  1.4220E-01  0.0000E+00  0.0000E+00
  2.7165E+00  0.0000E+00  0.0000E+00
  2.1050E-01  0.0000E+00  0.0000E+00
  2.3110E+00  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  7.6215E-05  0.0000E+00  0.0000E+00
  0.0000E+00  1.5611E-07  0.0000E+00
flux  3.9136E-01
region   28
  5.0692E-02  0.0000E+00  0.0000E+00
  0.0000E+00  7.5346E-05  0.0000E+00
  4.8118E-03  0.0000E+00  0.0000E+00
  8.6067E-03  0.0000E+00  0.0000E+00
  1.2167E-01  2.3182E-02  1.8436E-02
  1.3548E-02  0.0000E+00  0.0000E+00
  1.0638E-02  0.0000E+00  0.0000E+00
  1.1407E-02  0.0000E+00  0.0000E+00
  2.1759E-02  0.0000E+00  0.0000E+00
  0.0000E+00  6.3993E-03  0.0000E+00
  2.8036E-02  0.0000E+00  0.0000E+00
  4.8336E-02  2.9125E-05  0.0000E+00
  6.3339E-02  0.0000E+00  0.0000E+00
  3.1284E-01  0.0000E+00  0.0000E+00
  1.0109E-01  0.0000E+00  0.0000E+00
  2.5298E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.4871E-04  0.0000E+00  0.0000E+00
  0.0000E+00  2.9646E-06  0.0000E+00
flux  5.2318E-01
region   29
  7.6633E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.1690E-06  0.0000E+00
  2.2381E-03  0.0000E+00  0.0000E+00
  1.5439E-03  0.0000E+00  0.0000E+00
  1.9432E-01  6.2449E-03  2.8804E-02
  4.2218E-03  0.0000E+00  0.0000E+00
  5.6593E-03  0.0000E+00  0.0000E+00
  2.7525E-03  0.0000E+00  0.0000E+00
  6.0066E-03  0.0000E+00  0.0000E+00
  0.0000E+00  7.5090E-04  0.0000E+00
  3.6148E-03  0.0000E+00  0.0000E+00
  2.3523E-02  1.1519E-06  0.0000E+00
  1.1317E-02  0.0000E+00  0.0000E+00
  1.8272E-01  0.0000E+00  0.0000E+00
  2.3898E-02  0.0000E+00  0.0000E+00
  2.1100E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.3515E-05  0.0000E+00  0.0000E+00
  0.0000E+00  3.8227E-08  0.0000E+00
flux  5.7378E-02
region   30
  1.5491E-01  0.0000E+00  0.0000E+00
  0.0000E+00  1.5892E-06  0.0000E+00
  4.0047E-03  0.0000E+00  0.0000E+00
  2.7906E-03  0.0000E+00  0.0000E+00
  3.5569E-01  1.0907E-02  5.2687E-02
  7.3459E-03  0.0000E+00  0.0000E+00
  9.9406E-03  0.0000E+00  0.0000E+00
  5.0142E-03  0.0000E+00  0.0000E+00
  1.0419E-02  0.0000E+00  0.0000E+00
  0.0000E+00  1.1291E-03  0.0000E+00
  4.7062E-03  0.0000E+00  0.0000E+00
  4.2473E-02  1.5342E-06  0.0000E+00
  2.2977E-02  0.0000E+00  0.0000E+00
  3.2213E-01  0.0000E+00  0.0000E+00
  4.0876E-02  0.0000E+00  0.0000E+00
  3.7812E-01  0.0000E+00  0.0000E+00
  0.0000E+00  0.0000E+00  0.0000E+00
  1.8959E-05  0.0000E+00  0.0000E+00
  0.0000E+00  4.7244E-08  0.0000E+00
flux  8.9796E-02
```

Table D-3. Reaction Rate File react10em.tbl Created by Mctalrd2 from Mctal File Written by MCNP4C Case fftf10em (sheet 6 of 6)

```
region   31
 8.0479E-02  0.0000E+00  0.0000E+00
 0.0000E+00  5.4536E-09  0.0000E+00
 1.9681E-03  0.0000E+00  0.0000E+00
 1.4015E-03  0.0000E+00  0.0000E+00
 1.7812E-01  4.7863E-03  2.6358E-02
 4.0410E-03  0.0000E+00  0.0000E+00
 5.8679E-03  0.0000E+00  0.0000E+00
 2.7687E-03  0.0000E+00  0.0000E+00
 4.7382E-03  0.0000E+00  0.0000E+00
 0.0000E+00  4.2074E-04  0.0000E+00
 1.6421E-03  0.0000E+00  0.0000E+00
 2.0866E-02  1.0958E-07  0.0000E+00
 9.3078E-03  0.0000E+00  0.0000E+00
 2.3097E-01  0.0000E+00  0.0000E+00
 1.7178E-02  0.0000E+00  0.0000E+00
 1.8602E-01  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 3.4512E-06  0.0000E+00  0.0000E+00
 0.0000E+00  1.5247E-10  0.0000E+00
flux  2.6533E-02
region   32
 8.1312E-02  0.0000E+00  0.0000E+00
 0.0000E+00  4.8163E-07  0.0000E+00
 2.1188E-03  0.0000E+00  0.0000E+00
 1.5429E-03  0.0000E+00  0.0000E+00
 1.8702E-01  5.4145E-03  2.7687E-02
 4.1438E-03  0.0000E+00  0.0000E+00
 5.8100E-03  0.0000E+00  0.0000E+00
 2.8722E-03  0.0000E+00  0.0000E+00
 5.3481E-03  0.0000E+00  0.0000E+00
 0.0000E+00  5.0585E-04  0.0000E+00
 2.1627E-03  0.0000E+00  0.0000E+00
 2.2310E-02  4.6358E-07  0.0000E+00
 1.0559E-02  0.0000E+00  0.0000E+00
 1.9682E-01  0.0000E+00  0.0000E+00
 2.0227E-02  0.0000E+00  0.0000E+00
 1.9733E-01  0.0000E+00  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00
 7.0924E-06  0.0000E+00  0.0000E+00
 0.0000E+00  1.4158E-08  0.0000E+00
flux  3.9630E-02
```

Table D-4. Fortran Source Code for Mctalrd2 (3 sheets)

```
Program Mctalrd2
C**********************************************************************
c**   This is a special purpose program written to read a mctal file
c**   from an MCNP run to generate region-averaged reaction rates and
c**   fluxes needed to compute radionuclide inventories in FFTF fixed
c**   components.  The MCNP input file used is fftfx.in
c**
c**   The mctalread2 program assumes the following:
c**   1.  Tallies are averaged over max 32 regions (NREG) in mctal,
c**   2.  There are a total of 22 tallies (NTAL) for each region, the
c**       first (NTAL - 1) tallies being reaction rates, and the last
c**       being total flux,
c**   3.  There are 3 different reaction types (NRTYPE), (n,g), (n,p) &
c**       (n,a), where g = gamma, p = proton, a = alpha),
c**   4.  There a total of 18 isotopes (NISO) for which reaction were
c**       generated in the MCNP run,
c**
c**   The order of the (NTAL - 1) reaction rates tallied is given in
c**   the table below, along with the assigned isotope & reaction no.s
c**
c**                          liso      lrr
c**     seq.   isotope &  isotope  reaction
c**      no.   reaction     no.       no.
c**     ---   ----------   ---       ---
c**       1   Co59 (n,g)     1         1
c**       2   Ni60 (n,p)     2         2
c**       3   Co60 (n,g)     3         1
c**       4   Ni58 (n,g)     4         1
c**       5   Ni59 (n,g)     5         1
c**       6   Ni59 (n,p)     5         2
c**       7   Ni59 (n,a)     5         3
c**       8   Ni62 (n,g)     6         1
c**       9   Ni63 (n,g)     7         1
c**      10   Fe54 (n,g)     8         1
c**      11   Fe55 (n,g)     9         1
c**      12   N 14 (n,p)    10         2
c**      13   Mo92 (n,g)    11         1
c**      14   Mo93 (n,g)    12         1
c**      15   Mo93 (n,p)    12         2
c**      16   Mo98 (n,g)    13         1
c**      17   Tc99 (n,g)    14         1
c**      18   Nb93 (n,g)    15         1
c**      19   Nb94 (n,g)    16         1
c**      20   C 13 (n,g)    17         1
c**      21   Mo94 (n,p)    18         2
c**
C**********************************************************************
      Parameter (nreg=32, ntal=22, nrrtal=ntal-1, nrtype=3, niso=18)
c**
      real      f(nreg,ntal), u(nreg,ntal), flux(nreg),
     +          rr(nreg,nrrtal,nrtype)
      integer liso(nrrtal), lrr(nrrtal)
      character aline*80, b*4 , aa*4
c**
c**   Isotope no. & reaction type no. for each of the nrrtal reaction
c**   rates tallied.
      Data (liso(i), lrr(I), I=1,nrrtal)/
     +     1,1,  2,2,  3,1,  4,1,  5,1,  5,2,  5,3,  6,1,  7,1,  8,1,
     +     9,1, 10,2, 11,1, 12,1, 12,2, 13,1, 14,1, 15,1, 16,1, 17,1,
     +    18,2 /
c**
c**   Open the mctal file
      open(11,file='tally',form='formatted',status='old')
c**   Initialize variables and arrays
      ital=0
      kcount=0
      do 20 i=1,nreg
```

Table D-4. Fortran Source Code for Mctalrd2 (3 sheets)

```
         flux(i)=0.0
         do 18 j=1,nrrtal
            do 16 k=1,nrtype
               rr(i,j,k)=0.0
16          continue
18       continue
20    continue
      do 30 i=1,nreg
         do 28 j=1,ntal
            f(i,j)=0.0
            u(i,j)=0.0
28       continue
30    continue
c**
c** Begin loop to read and process data on mctal file
c**
50    do 60, k=1,100
         read(11,908,end=65) aline
         if(aline(1:5) .eq. 'tally') go to 70
60    continue
      write(6,906) '** tally not found when expected - input ended'
      go to 110
c**
65    write(6,906) '** end of tally file reached'
      go to 110
c**
70    ital=ital+1
      write(6,901) 'tally ', ital
      read(11,908) aline
      write(6,906) aline
c**   read the no. of regions inbcluded in this tally (is)
      read(11,907) b, is
      write(6,901) 'no. of regions included in this tally =',is
      read(11,908) aline
c**   find no. of reactions included in this tally, and then
c**   read down to when reaction/flux data start.
      Nreac=0
      Do 80, k=1,10
         read(11,907) aa,nn
         if(aa .eq. 'm') nreac=nn
         if(aa .eq. 'vals') go to 90
80    continue
      write(6,906) '** error - word vals not found when expected'
      stop
90    if(nreac .le. 0) then
         write(6,906) '** error - word m not found where expected'
         stop
      endif
      if(nreac .ne. ntal) write(6,912) nreac,ntal
      k1=kcount+1
      k2=kcount+is
      read(11,*) ((f(k,i),u(k,i), i=1,nreac), k=k1,k2)
      do 100 k=k1,k2
         write(6,901) 'kcount =', k
         write(6,903) (f(k,i),u(k,i), i=1,nreac)
100   continue
      kcount=k2
      if(kcount .lt. nreg) go to 50
      write(6,906) '** max. no. of tallies read - input ended'
c**
c** end of loop to read mctal file
c**
c**   store data read in output arrays
110   write(6,913) kcount, nreg
      do 150 k=1,kcount
c**      store reaction rates
         do 140 i=1,nrrtal
            iso=liso(i)
            irr=lrr(i)
```

Table D-4. Fortran Source Code for Mctalrd2 (3 sheets)

```
            rr(k,iso,irr)=f(k,i)
140       continue
c**       store total flux
          flux(k)=f(k,ntal)
150    continue
c**
c**    write output data
       write(6,908)
       write(6,908)
       write(6,906) 'reaction rate & flux data extracted from mctal file'
       write(6,908)
         kk=0
       do 200 k=1,kcount
c          If(k.eq.28)go to 200
c          If(k.eq.31)go to 200
           kk=kk+1
          write(6,901) 'region ', kk
          write(7,901) 'region' , kk
          do 180 i=1,niso
             write(6,911) rr(kk,i,1),rr(kk,i,2),rr(kk,i,3)
             write(7,914) rr(kk,i,1),rr(kk,i,2),rr(kk,i,3)
180       continue
c         write(6,911) 0.00,0.00,0.00
c         write(7,914) 0.00,0.00,0.00
          write(6,900) flux(kk)
          write(7,900) flux(kk)
200    continue
       write(6,908)
       write(6,906) ' end of problem'
c**
c**    Format statements
 900   format(' flux', 1pe12.4)
 901   format(' ',a,i5)
 903   format(' ',e12.5,f10.4)
 906   format (' ',a)
 907   format(a4,3x,i3)
 908   format(a)
 911   format(' ',1p3e12.4)
 912   format(/' ** warning - no. of reactions for this tally indicated'/
     +        ' ** by variable m on mctal file,',i5, ' is not the', i5,
     +        ' expected'/)
 913   format(/' ** no. of regions read =', i5,/
     +        ' ** max. no.=',i5/)
  914  format(1p3e12.4)
       end
```

Reference

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

This page intentionally left blank

APPENDIX E
COMPUTATION OF RADIONUCLIDE INVENTORIES

COMPUTATION OF RADIONUCLIDE INVENTORIES

A Fortran 77 program, Transmut2, was written to compute radionuclide inventories by material region using reaction rates tallied by MCNP4C (Briesmeister 2001). The program also reads material compositions for each region, irradiation and decay lengths, and other data described below. To simplify the programming in Transmut2, several approximations were made. First, it was assumed that a radionuclide of interest is produced by a single nuclear reaction, as opposed to a chain of nuclear reactions or decay processes. That is: S — (n,x)→ R, where S is a stable source nuclide, (n,x) is some type of nuclear reaction [(n,γ) or (n,p) usually], and R is the radionuclide produced by the reaction. Second, it was assumed that all source nuclides, S, neither buildup or deplete over time. Thus, the atom density of S in a region remains constant at N_S atoms/cm^3.

With these assumptions, the production rate of R can be expressed as:

$dN_R/dt = \dot{N}_R$ = {production rate of R} – {loss rate of R} = P(R) – L(R)

$P(R) = N_S\sigma_x\Phi$, where σ_x is the microscopic nuclear cross section (barns) for reaction (n,x) and Φ is the neutron flux (n/cm^2-s).

L(R) = {burnout rate} + {decay rate} = $N_R\sigma_a\Phi + N_R\lambda = N_R(\sigma_a\Phi + \lambda)$

where σ_a is the microscopic absorption cross section (cm^2) for the radionuclide R, λ is the decay constant (sec^{-1}) for R.

Thus,

$$\dot{N}_R = N_s\sigma_x\Phi - N_R(\sigma_a\Phi + \lambda) \quad (1)$$

Integrating differential equation (1) to solve for N_R as a function of time, t, gives:

$$N_R = N_S\sigma_x\Phi(1 - \exp[-(\sigma_a\Phi + \lambda)t]) / (\sigma_a\Phi + \lambda) \quad (2)$$

where, $\exp[y] = e^y$.

In equation (2), atom densities are in units of atoms/cm^3 and the reaction rates, $\sigma\Phi$, are in units of reactions/sec per atom. The tallies produced by MCNP were scaled such that the reaction rates were actually the region volume (cm^3) times the total reactions in a region per 10^{24} atoms per fission neutron. Since the reaction rates from MCNP are for one fission neutron, they must be scaled up by a factor, FNORM, to be appropriate for the reactor operating at some power level. This scaling factor is provided to Transmut2 as an input parameter.

Thus, the quantities $(\sigma_x\Phi)_r$ and $(\sigma_a\Phi)_r$ in region r, which has a volume of V cm^3, in terms of the MCNP tallies $T_{r,x}$ and $T_{r,a}$ are:

$$(\sigma_x\Phi)_v = 10^{-24}T_{r,x}/V \text{ and } (\sigma_a\Phi)_v = 10^{-24}T_{r,a}/V \quad (3)$$

The equation solved in Transmut2 has the quantities in equation (3) substituted into equation (2). Also, Transmut2 initially computes the radionuclide mass in the region, M_R. Thus, the equation becomes:

$$M_R = F \bullet N_S \bullet A_R \bullet T_{r,x} (1 - \exp[-(10^{-24}F \bullet T_{r,a}/V + \lambda)t]) / [N_A (10^{-24}F \bullet T_{r,a}/V + \lambda)] \quad (4)$$

where F is the power scaling factor, A_R is the atomic weight of R, and N_A is the Avogadro constant (6.023×10^{23} atoms/mole), and N_S is in units of atoms/b-cm, instead of atoms/cm^3.

Equation (4) gives the mass of a radionuclide in a material region at the end of irradiation. The Transmut2 program also accounts for radioactive decay following the end of irradiation. The program reads a decay period (dt years), and computes the mass of radionuclide R after the specified decay period, M_R (dt) as follows:

$$M_R(dt) = M_R \bullet \exp[-\lambda \bullet dt]$$

E.1 Transmut2 Input

Transmut2 reads data from three files: a user file read from the standard input device, a composition file (atden) and a reaction rate file (tally). The format and content of these files are listed in Tables E-1 and E-2. The reaction rate file, created by the Mctalrd2 program, is described in Appendix D.

E.2 Transmut2 Execution

To run Transmut2, three input files must be available in the working directory. The first is a user input file (see Tables E-1 and E-3). The second is a file named "atden" containing the total density and constituent atom densities in each region (see Tables E-2 and E-4). The third file is the reaction rate output from Mctalrd2 (see Appendix D), which must be renamed "react." The executable file for Transmut2 is named "Transmut2.exe." Assuming this file is also in the working directory, the following command is entered to run Transmut2:

Transmut2 < in-file > out-file

where in-file is the name given to the Transmut2 user input file and out-file is the name to be given to the output file.

E.3 Transmut2 Verification and Validation

A typical Transmut2 run was made as a test case. In that run, the user input file listed in Table E-3, the composition file listed in Table E-4 and the reaction rate file listed in Table E-5 were read by Transmut2. The results of the Transmut2 test run, listed in Table E-6, were checked by creating a spreadsheet calculation for two radionuclides (^{59}Ni and ^{60}Co) in one region

(row 7 radial reflectors). This spreadsheet is printed in Table E-7. Comparison of spreadsheet and Transmut2 results indicated that the program operates correctly.

A validation check was also made by comparing MCNP4C / Transmut2 calculations of ^{60}Co production to measurements in FFTF (Wootan, et. al, 1984). That comparison, which is described in Appendix H, also indicates that Transmut2 gives valid results.

A Fortran source code listing of the Transmut2 program is given in Table E-8. The code was compiled using the DIGITAL Visual Fortran Optimizing Compiler, Version 6.0 on a Dell Precision 620 computer under windows NT, version 4.0.

E.4 Transmut2 Production Runs

Transmut2 production runs made for this radionuclide inventory and dose rate analysis were described in Sections 5.2 and 5.3. Those runs, which are summarized in Tables E-9 and E-10, differed in values of input for variables et (irradiation time) and dt (decay time) on the second record of the user input file (see Table E-1), atom density input file and reaction rate input file. The first run listed in Table E-9 (tmut10ef) provided radionuclide inventories for all reactor hardware components, which were irradiated during every FFTF operating cycle. The user input file and atom density (atden) file for that run are listed in Tables E-11 and E-12. The reaction rate input file (react) is listed in Appendix D, Table D-2. Another major run, tmut10emrr, was made to provide data for the radial reflectors. The user input file and atom density files for that run are listed in Tables E-13 and E-14. The reaction rate input file is listed in Appendix D, Table D-3. Output files for these runs are listed in Tables E-15 and E-16.

E.5 Reference

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

Wootan, D. W., Rawlings, J. A., and Dobbin, K. D., 1984 "Reaction Rates and Flux Spector in the FFTF at Full Power," *Transaction of the American Nuclear Society*, **46, 743**.

Table E-1. Description of User File Read from the Standard Input Device

Record	Field	Columns	Program Variable Name	Description
1	1	Free field format	nreg	Number of material regions - 200 max.
	2		niso	Total number of nuclides (radionuclides + stable source nuclides) – 30 max.
	3		nrad	Number of radionuclides
	4		nrt	Number of reaction types – 6 max.
2	1	Free field format	fnorm	Power scaling factor
	2		et	Irradiation time (days)
	3		dt	Decay time following irradiation (years)
3	1	Free field format	vol(1)	Volume (cm^3) of the first region
	2		vol(2)	Volume (cm^3) of the second region
	.		.	.
	.		.	.
	Nreg		vol(nreg)	Volume (cm^3) of the last region (nreg)
4	1	2 – 9	iso(1)	Name of first of the niso nuclides
	2	13 – 20	iso(2)	Name of second nuclide
	3	24 – 31	iso(3)	Name of third nuclide
	4	35 – 42	iso(4)	Name of fourth nuclide
	5	46 – 53	iso(5)	Name of fifth nuclide
	6	57 – 64	iso(6)	Name of sixth nuclide
5	1	1 – 11	alam(1)	Decay constant for first nuclide (y^{-1})
	2	12 – 22	alam(2)	Decay constant for second nuclide (y^{-1})
	3	23 – 33	alam(3)	Decay constant for third nuclide (y^{-1})
	4	34 – 44	alam(4)	Decay constant for fourth nuclide (y^{-1})
	5	45 – 55	alam(5)	Decay constant for fifth nuclide (y^{-1})
	6	56 – 66	alam(6)	Decay constant for sixth nuclide (y^{-1})
6	1	1 – 11	awt(1)	Atomic weight for first nuclide
	2	12 – 22	awt(2)	Atomic weight for second nuclide
	3	23 – 33	awt(3)	Atomic weight for third nuclide
	4	34 – 44	awt(4)	Atomic weight for fourth nuclide
	5	45 – 55	awt(5)	Atomic weight for fifth nuclide
	6	56 – 66	awt(6)	Atomic weight for sixth nuclide
Repeat records 4, 5 and 6 as needed to include all nuclides (niso)				
7	1	1 – 6	irad(1)	Transmutation matrix Input sequence number of first radionuclide
	2	7 – 12	isrc(1,1)	Input sequence number of first source nuclide for producing the first radionuclide
	3	13 – 18	irt(1,1)	Reaction type (1, 2, …) for producing the first radionuclide from the source nuclide identified in the previous field.
	Repeat fields 2 and 3 for all nuclide/reactions that produce the first radionuclide. Then repeat record 7 for each radionuclide.			

Table E-2. Description of Region Composition File Read from File Atden

Record	Field	Columns	Program Variable Name	Description
1	1	1 – 16	regid	Identifier for first region
2	1	1 – 12	tadens	Density (g/cm^3) for material in first region
3 (ignored by the program)	1	2 – 9	-	Name of first of the niso nuclides
	2	13 – 20	-	Name of second nuclide
	3	24 – 31	-	Name of third nuclide
	. .	. .		. .
	8	78 – 88	-	Name of fifth nuclide
	9	89 – 99	-	Name of sixth nuclide
4	1	1 – 11	adens(1)	Atom density (a/b-cm) for first nuclide in first region
	2	12 – 22	adens(2)	Atom density (a/b-cm) for second nuclide in first region
	3	23 – 33	adens(3)	Atom density (a/b-cm) for third nuclide in first region
	. .	. .		. .
	8	78 – 88	adens(8)	Atom density (a/b-cm) for eighth nuclide in first region
	9	89 – 99	adens(9)	Atom density (a/b-cm) for ninth nuclide in first region
Repeat records 2 and 3 as needed to include all nuclides (niso). Then repeat records 1, 2 and 3 for all regions (nreg)				

Table E-3. User Input File for Transmut2 Test Run

```
15  19  8  3
1.79E+19  3620.0  9.5
  5.2310E+05  6.6601E+05  4.7572E+05  3.3536E+05  2.1110E+06  3.7896E+05
  4.4150E+06  1.2181E+07  7.5791E+05  6.9924E+04  3.4962E+04  7.9155E+04
  1.1654E+04  4.4255E+05  1.0682E+05
 Co-59       Ni-60       Co-60       Ni-58       Ni-59       Ni-62
 0.0000E+00 0.0000E+00 1.3147E-01 0.0000E+00 9.1184E-06 0.0000E+00
    58.93     59.93        59.93       57.94       58.93       61.93
 Ni-63       Fe-54       Fe-55       N-14        Mo-92       Mo-93
 6.9300E-03 0.0000E+00 2.5864E-01 0.0000E+00 0.0000E+00 1.9800E-04
    62.93      53.94        54.94       14.00       91.91       92.91
 Mo-98       Tc-99       Nb-93       Nb-94       C-14        C-13
 0.0000E+00 3.2535E-06 0.0000E+00 3.4650E-05 1.2097E-04  0.0
   97.91       98.91       92.91       93.91       14.00       13.00
 Mo-94
 0.0000E+00
   93.91
     3      1      1      2      2
     5      4      1
     7      6      1
     9      8      1
    12     11      1
    14     13      1
    16     15      1     19      2
    17     10      2     18      1
```

Table E-4. Composition File Used in the Transmut2 Test Run (Partial Listing – Data for Row 7 Radial Reflectors Only)

```
Row 7 Reflectors
6.957
Co-59       Ni-60       Co-60       Ni-58       NI-59       Ni-62       Ni-63       Fe-54       Fe-55
3.5380E-05 1.1361E-02 0.0000E+00 2.9718E-02 0.0000E+00 1.5627E-03 0.0000E+00 9.4813E-04 0.0000E+00
N-14        Mo-92       Mo-93       Mo-98       Tc-99       Nb-93       Nb-94       C-14        C-13
8.0700E-05 4.0439E-05 0.0000E+00 6.5754E-05 0.0000E+00 6.0800E-06 0.0000E+00 0.0000E+00 1.0700E-06
Mo-94
2.5200E-05
```

Table E-5. Reaction Rate File Used in the Transmut2 Test Run (Partial Listing – Data for Row 7 Radial Reflectors Only)

```
Region    1
  3.4664E+01  0.0000E+00  0.0000E+00
  0.0000E+00  2.2511E-03  0.0000E+00
  8.9347E-01  0.0000E+00  0.0000E+00
  5.9655E-01  0.0000E+00  0.0000E+00
  7.1494E+01  2.4930E+00  1.0593E+01
  1.6578E+00  0.0000E+00  0.0000E+00
  2.1799E+00  0.0000E+00  0.0000E+00
  1.1792E+00  0.0000E+00  0.0000E+00
  2.4306E+00  0.0000E+00  0.0000E+00
  0.0000E+00  3.5938E-01  0.0000E+00
  1.4008E+00  0.0000E+00  0.0000E+00
  9.3579E+00  9.6936E-04  0.0000E+00
  6.3519E+00  0.0000E+00  0.0000E+00
  7.6178E+01  0.0000E+00  0.0000E+00
  9.5436E+00  0.0000E+00  0.0000E+00
  8.3032E+01  0.0000E+00  0.0000E+00
  7.2267E-03  0.0000E+00  0.0000E+00
  0.0000E+00  8.5228E-05  0.0000E+00
 flux  2.4878E+01
```

Table E-6. Output from the Transmut2 Test Run (Partial Listing)

```
transmut version 2.0  3/22/01
==============================

 nreg    number of component regions                    15
 niso    total number of isotopes                       19
 nrad    number of radionuclides                         8
 nrt     number of reaction types                        3
 fnorm   reaction rate normalization factor    1.79000E+19
 et      reactor operating time (days)         3.62000E+03
 dt      decay time (years)                    9.50000E+00

 region volumes (cc)
   5.2310E+05   6.6601E+05   4.7572E+05   3.3536E+05   2.1110E+06   3.7896E+05
   4.4150E+06   1.2181E+07   7.5791E+05   6.9924E+04   3.4962E+04   7.9155E+04
   1.1654E+04   4.4255E+05   1.0682E+05

 decay constants (1/yr) and atomic weights

      isotope        lambda    atomic wt
   1   Co-59       0.0000E+00  5.8930E+01
   2   Ni-60       0.0000E+00  5.9930E+01
   3   Co-60       1.3147E-01  5.9930E+01
   4   Ni-58       0.0000E+00  5.7940E+01
   5   Ni-59       9.1184E-06  5.8930E+01
   6   Ni-62       0.0000E+00  6.1930E+01
   7   Ni-63       6.9300E-03  6.2930E+01
   8   Fe-54       0.0000E+00  5.3940E+01
   9   Fe-55       2.5864E-01  5.4940E+01
  10   N-14        0.0000E+00  1.4000E+01
  11   Mo-92       0.0000E+00  9.1910E+01
  12   Mo-93       1.9800E-04  9.2910E+01
  13   Mo-98       0.0000E+00  9.7910E+01
  14   Tc-99       3.2535E-06  9.8910E+01
  15   Nb-93       0.0000E+00  9.2910E+01
  16   Nb-94       3.4650E-05  9.3910E+01
  17   C-14        1.2097E-04  1.4000E+01
  18   C-13        0.0000E+00  1.3000E+01
  19   Mo-94       0.0000E+00  9.3910E+01
```

Table E-6. Output from the Transmut2 Test Run (Partial Listing)

transmutation matrix

isotope no.	source 1 isotope	source 1 reaction	source 2 isotope	source 2 reaction	. . .	
3	1	1	2	2	0	0
5	4	1	0	0	0	0
7	6	1	0	0	0	0
9	8	1	0	0	0	0
12	11	1	0	0	0	0
14	13	1	0	0	0	0
16	15	1	19	2	0	0
17	10	2	18	1	0	0

Irradiation time = 3620.0 days. Decay period = 9.5 years

1 Row 7 Reflectors Volume = 5.231E+05 cc
Flux = 8.513E+14 n/cm2/s (time avg.) Total Mass = 3.639E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	Concentration (uCi/g)
Co-60	59.93	5.272E+00	1.114E+02	2.130E-04	1.260E+05	2.409E+05	3.463E+04
Ni-59	58.93	7.602E+04	6.389E+03	1.221E-02	5.099E+02	9.747E+02	1.401E+02
Ni-63	62.93	1.000E+02	1.356E+03	2.592E-03	7.700E+04	1.472E+05	2.116E+04
Fe-55	54.94	2.680E+00	1.748E+01	3.341E-05	4.244E+04	8.112E+04	1.166E+04
Mo-93	92.91	3.501E+03	4.643E+01	8.875E-05	5.103E+01	9.755E+01	1.402E+01
Tc-99	98.91	2.130E+05	2.626E+02	5.020E-04	4.455E+00	8.517E+00	1.224E+00
Nb-94	93.91	2.000E+04	3.355E+01	6.413E-05	6.384E+00	1.220E+01	1.754E+00
C-14	14.00	5.730E+03	3.768E+00	7.203E-06	1.679E+01	3.210E+01	4.614E+00
Total			8.220E+03	1.571E-02	2.461E+05	4.704E+05	6.761E+04

2 Row 8 Reflectors Volume = 6.660E+05 cc
Flux = 4.092E+14 n/cm2/s (time avg.) Total Mass = 4.647E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	Concentration (uCi/g)
Co-60	59.93	5.272E+00	1.074E+02	1.613E-04	1.216E+05	1.825E+05	2.616E+04
Ni-59	58.93	7.602E+04	5.560E+03	8.348E-03	4.437E+02	6.662E+02	9.547E+01
Ni-63	62.93	1.000E+02	1.122E+03	1.685E-03	6.375E+04	9.572E+04	1.372E+04
Fe-55	54.94	2.680E+00	2.128E+01	3.196E-05	5.168E+04	7.759E+04	1.112E+04
Mo-93	92.91	3.501E+03	4.191E+01	6.293E-05	4.607E+01	6.917E+01	9.912E+00
Tc-99	98.91	2.130E+05	3.059E+02	4.593E-04	5.190E+00	7.792E+00	1.117E+00
Nb-94	93.91	2.000E+04	3.743E+01	5.620E-05	7.122E+00	1.069E+01	1.533E+00
C-14	14.00	5.730E+03	3.408E+00	5.117E-06	1.519E+01	2.281E+01	3.268E+00
Total			7.200E+03	1.081E-02	2.375E+05	3.566E+05	5.111E+04

.
.
.

program done

Table E-7. Transmut2 Verification – Spreadsheet Calculation of Ni-59 and Co-60 Inventories in Row 7 Radial Reflectors (2 sheets)

Power scaling factor, F	1.79E+19 (for 206 MW) (from Table E-3, line 1)
Irradiation time, et	3620 days (312768000 sec.)
Decay time, dt	9.5 years
Rregion volume, V	5.231E+05 cc (from Table E-3, line 3, first entry)
Avogadro constant, NA	6.023E+23 atoms/mole
Compute Ni-59 inventory from Ni-58 (n,g) reactions	
Atom density of Ni-58 NS	0.029718 a/b-cm (from Table E-4)
Atomic weight of Ni-59, AR	58.93 (from Table E-3)
MCNP-computed Ni-58 (n,g) rate, Tr,x	0.59655 (10^-24 reactions/s per atom)*V
MCNP-computed Ni-59 (n,g) + (n,p) + (n,a) rate, Ta,x	84.58 (from Table E-5, lines 4 & 5 under "region 1")
Decay constant for Ni-59 (1/y), L	9.118E-06 /y = 2.88945E-13/sec (from Table E-3)
Calculation of Ni-59 inventory:	
B = F*1.0e-24*Tr,a/V + L	2.895E-09 /s
A=f*NS*AR*Tr,x	1.870E+19 reactions/s in region x g/mole of Ni-59
MR=A*(1-exp(-B*et))/(NA*B)	6.389E+03 g
Decay: MR(9.5y) = MR*exp(-L*dt)	6.388E+03 g
Transmut2 result	6.389E+03 g
Ni-59 density = MR(9.5)/V	1.221E-02 g/cc (same as Transmut2 result)
Ni-59 Ci = Ni-59 atoms x L/3.7E+10	509.9 Ci
Transmut2 result	509.9
Ni-59 Ci/m^3 = Ni-59 Ci/(V*10^-6)	9.747E+02 Ci/m^3
Transmut2 result	9.747E+02
Reflector mass = density*volume	= (6.957 g/cc)*(5.231E+05 cc) = 3.639E+06 g = 3639 kg (density from Table E-4, line 2, volume as listed above)
Ni-59 uCi/g = 1000000*Ci/(3639*1000)	1.401E+02 uCi/g
Transmut2 result	1.401E+02
Compute Co-60 inventory from Co-59 (n,g) reactions	
Atom density of Co-59 NS	0.00003538 a/b-cm (from Table E-4)
Atomic weight of Co-60, AR	59.93
MCNP-computed Co-59 (n,g) rate, Tr,x	34.66000 (10^-24 reactions/s per atom)*V
MCNP-computedCo-60 (n,g) rate, Ta,x	0.89347 (from Table E-5, lines 1 & 3 under "region 1")
Decay constant for Co-60 (1/y), L	1.315E-01 /y = 4.16603E-09/sec
Calculation of Co-60 inventory from Co-59:	
B = F*1.0e-24*Tr,a/V + L	4.197E-09 /s
A=f*NS*AR*Tr,x	1.315E+18 reactions/s in region x g/mole of Co-60
MR=A*(1-exp(-B*et))/(NA*B)	3.804E+02 g

Table E-7. Transmut2 Verification – Spreadsheet Calculation of Ni-59 and Co-60 Inventories in Row 7 Radial Reflectors (2 sheets)

Compute Co-60 inventory from Ni-60 (n,p) reactions	
Atom density of Ni-60 NS	0.011361 a/b-cm (from Table E-4)
Atomic weight of Co-60, AR	59.93
MCNP-computed Ni-60 (n,p) rate, Tr,x	0.00225 (10^-24 reactions/s per atom)*V
MCNP-computedCo-60 (n,g) rate, Ta,x	0.89347 (from Table E-5, lines 2 & 3 under "region 1)
Decay constant for Co-60 (1/y), L	1.315E-01 /y = 4.16603E-09/sec
Calculation of Co-60 inventory from Ni-60	
B = F*1.0e-24*Tr,a/V + L	4.197E-09 /s
A=f*NS*AR*Tr,x	2.744E+16 reactions/s in region x g/mole of Co-60
MR=A*(1-exp(-B*et))/(NA*B)	7.933E+00 g
Total Co-60 production after irradiation	= 3.804E+02 g + 7.933E+00 g = 3.883E+02 g
Decay: MR(9.5y) = MR*exp(-L*dt)	1.114E+02 g
Transmut2 result	1.114E+02 g
Ni-59 density = MR(9.5)/V	2.129E-04 g/cc (Transmut2 result = 2.130E-04 g/cc)
Ni-59 Ci = Ni-59 atoms x L/3.7E+10	1.260E+05 Ci
Transmut2 result	1.260E+05
Ni-59 Ci/m^3 = Ni-59 Ci/(V*10^-6)	2.409E+05 Ci/m^3
Transmut2 result	2.409E+05
Reflector mass	3639 kg
Ni-59 uCi/g = 1000000*Ci/(3639*1000)	3.463E+04 uCi/g
Transmut2 result	3.463E+04

Table E-8. Source Code Listing for the Transmut2 Program (4 sheets)

```
program transmut
c**   version 2.0   (3/22/01)
c**********************************************************************
c**   transmut computes radionuclide inventories in fftf in-vessel
c**   components using reaction rates computed by mcnp.  Inventories
c**   are computed in units of grams, grams/cc and curies for each
c**   isotope.
c**   The program assumes:
c**     1.  simple transmutation chains (i.e., x --> y --> out , where
c**         x is a stable parent isotope, and y is daughter nuclide)
c**     2.  no production of radionuclides by decay.
c**     3.  concentration of stable isotopes with initial non-zero
c**         density does not change with time.
c**
c**   Inventories at end-of-irradiation time (et) are decayed for a
c**   specified time period (dt).
c**********************************************************************
      parameter (mxiso=30, mxreg=200, mxrad=30, mxrt=6)
      integer irad(mxrad), isrc(mxrt*mxrad), irt(mxrt*mxrad)
      real    adens(mxiso), vol(mxreg), alam(mxiso),  act(mxrt*mxiso),
     +        awt(mxiso)
      character iso(mxiso)*8
c**
      write(6,2) 'transmut version 2.0  3/22/01',
     +           '=============================='
c**   read all input data except atom densities & reaction rates
      call inp1(nreg,niso,nrad,nrt,fnorm,et,mxreg,mxiso,mxrad,
     +          mxrt,dt)
      call inp2(nreg,niso,nrad,nrt,vol,iso,alam,awt,irad,isrc,irt)
c**   compute transmutation and decay of isotopes
      call calc(nreg,niso,nrad,nrt,fnorm,et,dt,vol,iso,alam,awt,irad,
     +          isrc,irt,adens,act)

      write(6,2) ' program done'
c**
2     format(/a/a)
      end

      subroutine inp1(nreg,niso,nrad,nrt,fnorm,et,mxreg,mxiso,mxrad,
     +                mxrt,dt)
c**********************************************************************
c**   inp1 reads all scalar input data.
c**********************************************************************
c**
c**   read integer parameters.
      read(5,*) nreg, niso, nrad, nrt
      write(6,1) nreg, niso, nrad, nrt
30    if(nreg .gt. mxreg) call erroff('inp1','30',
     +   'no. of regions exceeds the limit')
32    if(niso .gt. mxiso) call erroff('inp1','32',
     +   'no. of isotopes exceeds the limit')
34    if(nrad .gt. mxrad) call erroff('inp1','34',
     +   'no. of radionuclides exceeds the limit')
36    if(nrt .gt. mxrt) call erroff('inp1','36',
     +   'no. of reactions exceeds the limit')
c**   read scalar real parameters.
      read(5,*) fnorm, et,dt
      write(6,2) fnorm, et,dt
      return
c**
```

Table E-8. Source Code Listing for the Transmut2 Program (4 sheets)

```
1     format(/' nreg   number of component regions              ',i6/
     +        ' niso   total number of isotopes                 ',i6/
     +        ' nrad   number of radionuclides                  ',i6/
     +        ' nrt    number of reaction types                 ',i6)
2     format( ' fnorm  reaction rate normalization factor  ',1pe12.5/
     +        ' et     reactor operating time (days)       ',  e12.5/
     +        ' dt     decay time (years)                  ',  e12.5)
      end

      subroutine inp2(nreg,niso,nrad,nrt,vol,iso,alam,awt,irad,isrc,irt)
c**********************************************************************
c**   inp2 reads all input arrays except reaction rates and atom
c**   densitiies.  Input includes region volumes, decay constants and
c**   transmutation matrix.
c**********************************************************************
      integer irad(nrad), isrc(nrt,nrad), irt(nrt,nrad)
      real    vol(nreg), alam(niso), awt(niso)
      character*(*) iso(niso)
c**
c**   read region volumes (cc)
      write(6,3) 'region volumes (cc)'
      read(5,*) (vol(k), k=1,nreg)
      write(6,10) (vol(k), k=1,nreg)
c**   read decay constants (1/yr) & atomic wts
      write(6,3) 'decay constants (1/yr) and atomic weights'
      nlines=(niso+5)/6
      istart=1
      do 50 l=1,nlines
         iend=min(niso,istart+5)
         read(5,5) (iso(m), m=istart,iend)
         read(5,6) (alam(m), m=istart,iend)
         read(5,6) (awt(m), m=istart,iend)
         istart=iend+1
50    continue
      write(6,3) '     isotope        lambda    atomic wt'
      write(6,7) (m, iso(m), alam(m), awt(m), m=1,niso)
c**   read transmutation matrix
      write(6,3) 'transmutation matrix'
      write(6,3) 'isotope      source 1          source 2'
      write(6,*) '    no.   isotope  reaction  isotope  reaction  . . .'
      do 100 m=1,nrad
         read(5,8) iradm, (isrc(i,m), irt(i,m), i=1,nrt)
         write(6,9) iradm, (isrc(i,m), irt(i,m), i=1,nrt)
80       if(iradm .le. 0 .or. iradm .gt. niso)
     +      call erroff('inp','80','invalid isotope no.')
         if(alam(iradm) .le. 0.0) write(6,*)
     +      ' ** warning - above radionuclide has a zero decay constant'
         irad(m)=iradm
         do 90 i=1,nrt
82          if(isrc(i,m) .gt. niso)
     +         call erroff('inp','82','invalid source isotope')
84          if(irt(i,m) .gt. nrt)
     +         call erroff('inp','84','invalid source reaction')
90       continue
100   continue
      return
c**
3     format(/1x,a)
5     format(6(1x,a8,2x))
6     format(6e11.0)
7     format(i4,3x,a8,2x,1p2e12.4)
8     format(13i6)
```

Table E-8. Source Code Listing for the Transmut2 Program (4 sheets)

```
9     format(i6,6(2i9,1x))
10    format(1p6e13.4)
      end

      subroutine erroff(subr,loc,msg)
c**********************************************************************
c**   erroff prints error messages and aborts.
c**********************************************************************
      character*(*) subr,loc,msg
c**
      write(6,1) subr,loc,msg
      stop
1     format(/' *** error in ', a,' at ',a/' *** ',a/' *** run aborted')
      end

      subroutine calc(nreg,niso,nrad,nrt,fnorm,et,dt,vol,iso,alam,awt,
     +                irad,isrc,irt,adens,act)
c**********************************************************************
c**   Calc computes production and losses of radionuclides.
c**********************************************************************
      parameter (avgn=6.02205E+23)
      integer irad(nrad), isrc(nrt,nrad), irt(nrt,nrad)
      real    vol(nreg), alam(niso), awt(niso), adens(niso),
     +        act(nrt,niso)
      character iso(niso)*(*), regid*24, hdr*16
c**
      write(6,9) et,dt
c**   convert data to units of seconds
      et=et*24.0*3600.0
      yps=1.0/(365.25*24.0*3600.0)
      dt=dt/yps
      do 50 m=1,niso
         alam(m)=alam(m)*yps
50    continue
c**   open atom density and reaction rate files
      lur=7
      open(lur,file='react', form='formatted', status='old')
      lua=8
      open(lua,file='atden', form='formatted', status='old')
c**   loop over regions
      do 300 k=1,nreg
c**      read region id, total material density and atom densities
         read(lua,1) regid
         read(lua,3) tsdens
         read(lua,2) (adens(i), i=1,niso)
c**      read reaction rates
         read(lur,1) hdr
         do 60 m=1,niso
            read(lur,3) (act(j,m), j=1,nrt)
60       continue
         read(lur,8) flux
         tflux=(fnorm*flux)/vol(k)
         tsmass=tsdens*vol(k)
         write(6,4) k, regid, vol(k), tflux, 0.001*tsmass
         write(6,7) '        ',' Atomic',' Half Life',
     +               '    Mass   ','   Density ','  Inventory',
     +               '     Concen', 'tration    '
         write(6,7) 'Isotope ',' Weight','     (y)    ',
     +               '     (g)   ','    (g/cc) ','    (Ci)    ',
     +               '   (Ci/m3) ','   (uCi/g) '
c**      compute radionuclide masses, densities and curies
         tci=0.0
```

Table E-8. Source Code Listing for the Transmut2 Program (4 sheets)

```
      tfmass=0.0
      tfdens=0.0
      tcipcm=0.0
      tucipg=0.0
      do 200 m=1,nrad
         mr=irad(m)
c**      compute prod. rate
         rp=0.0
         do 80 j=1,nrt
            jsi=isrc(j,m)
            jsr=irt(j,m)
            if(jsi .gt. 0 .and. jsr .gt. 0)
     +         rp=rp+fnorm*adens(jsi)*act(jsr,jsi)
80       continue
c**      compute loss rate
         rl=alam(mr)
         do 100 j=1,nrt
            rl=rl+1.0E-24*fnorm*act(j,mr)/vol(k)
100      continue
c**      compute mass of isotope mr at end of irrad. time (et)
         fmass=awt(mr)*rp*(1.0-exp(-rl*et))/(rl*avgn)
c**      decay for time interval dt
         fmass=fmass*exp(-alam(mr)*dt)
c**      compute density & curies of isotope mr after decay period
         fdens=fmass/vol(k)
         curies=fmass*avgn*alam(mr)/(awt(mr)*3.7E+10)
         tfmass=tfmass+fmass
         tfdens=tfdens+fdens
         tci=tci+curies
         cipcm=1E6*curies/vol(k)
         ucipg=1E6*curies/tsmass
         thalf=0.693147*yps/alam(mr)
c**      print results
         write(6,5) iso(mr), awt(mr), thalf, fmass, fdens,
     +              curies, cipcm, ucipg
         tcipcm=tcipcm+cipcm
         tucipg=tucipg+ucipg
200    continue
       trndens=tfmass/vol(k)
       write(6,6) 'Total   ',tfmass,tfdens,tci,tcipcm,tucipg
300   continue
      close(lua)
      close(lur)
      return
c**
1     format(a)
2     format(/9e11.0)
3     format(6e12.0)
4     format(//i4,2x,a,' Volume =',1pe10.3,' cc'/6x,'Flux =',e10.3,
     +       ' n/cm2/s (time avg.)  Total Mass =',e10.3,' kg'/)
5     format(1x,a8,f7.2,1p6e11.3)
6     format(1x,a8,18x,1p5e11.3)
7     format (1x,a8,a7,6a11)
8     format(5x,e12.0)
9     format(//' Irradiation time =',f7.1,' days.  Decay period =',
     +       f7.1,' years')
      end
```

Table E-9. Summary of Transmut2 Runs to Compute Radionuclide Inventories

	Names of Transmut2 Input File and Output File	Source of Reaction Rate Data (MCNP Case[a])	Source of Material Compositions (File Name)	Irradiation Time (days) and Decay Time to 9/2003 (years)	Description
1	tmutf.inp tmut10ef.out	fftf10ef	atdens9f.prn	3620 / 11.5	Main run to obtain inventories for fixed reactor hardware in vessel.
2	tumutf.inp tmut10efsp2.out	fftf10ef	atdens9fsp.prn	3620 / 11.5	Same as first run, except composition of the reactor head region was changed to SS-304 to obtain inventories for IVHM and instrument tree shield plugs.
3	tmutmrr.inp tmut10emrr.out	fftf10em	atdens9m.prn	3620 / 11.5	Run to compute inventories in radial reflectors
4	tmutmcr1.inp tmut10emcr1.out	fftf10em	atdens9m.prn	1051 / 14.0	Run to compute inventories in first group of control rods in Table 5-4.
5	tmutmcr2inp tmut10emcr2.out	fftf10em	atdens9m.prn	932 / 13.5	Run to compute inventories in the second group of control rods in Table 5-4.
6	tmutmcr3inp tmut10emcr3.out	fftf10em	atdens9m.prn	974 / 15.3	Run to compute inventories in the third of control rods in Table 5-4.
7	tmutmcr4inp tmut10emcr4.out	fftf10em	atdens9m.prn	778 / 11.5	Run to compute inventories in the fourth group of control rods in Table 5-4.
8	tmutmcr5inp tmut10emcr5.out	fftf10em	atdens9m.prn	1142 / 16.6	Run to compute inventories in the fifth group of control rods in Table 5-4.
9	tmutmsr1inp tmut10emsr1.out	fftf10em	atdens9m.prn	652 / 19.9	Run to compute inventories in the first group of safety rods in Table 5-4.
10	tmutmsr2inp tmut10emsr2.out	fftf10em	atdens9m.prn	774 / 14.0	Run to compute inventories in the second group of safety rods in Table 5-4.
11	tmutmsr3inp tmut10emsr3.out	fftf10em	atdens9m.prn	789 / 17.2	Run to compute inventories in the third group of safety rods in Table 5-4.
12	tmutmsr4inp tmut10emsr4.out	fftf10em	atdens9m.prn	900 / 11.5	Run to compute inventories in the fourth group of safety rods in Table 5-4.
13	tmutmis1.inp tmut10emis1.out	fftf10em	atdens9m.prn	710 / 14.0	Run to compute inventories in the first group of ICSAs in Table 5-5.
14	tmutmis2.inp tmut10emis2.out	fftf10em	atdens9m.prn	641 / 11.5	Run to compute inventories in the second group of ICSAs in Table 5-5.
15	tmutmis3.inp tmut10emis3.out	fftf10em	atdens9m.prn	787 / 19.9	Run to compute inventories in the third group of ICSAs in Table 5-5.
16	tmutmis4.inp tmut10emis4.out	fftf10em	atdens9m.prn	641 / 11.5	Run to compute inventories in the fourth group of ICSAs in Table 5-5.
17	tmutmps1.inp tmut10emps1out	fftf10em	atdens9m.prn	22 / 22.5	Run to compute inventories in the first group of PSRs in Table 5-6.
18	tmutmps2.inp tmut10emps2out	fftf10em	atdens9m.prn	260 / 20.9	Run to compute inventories in the second group of PSRs in Table 5-6.
19	tmuth.inp tmut10eh.out	fftf10eh	atdens9h.prn	17.5 /22.8	Run to assess the activation of the closure head assembly during the FFTF initial power run. in December 1980.

[a] MCNP cases were summarized in Table 5-1.

Table E-10. Summary of Additional Transmut2 Runs to Compute Radionuclide Inventory Details for Input to Dose Rate Calculations

	Names of Transmut2 Input File and Output File	Source of Reaction Rate Data (MCNP Case[a])	Source of Material Compositions (File Name)	Irradiation Time (days) and Decay Time to 9/2003 (years)	Description
1	tmutd.inp tmut10ed.out	fftf10ed	atdensd8.prn	3620 / 11.5	Run to obtain reaction rate distributions in radial shields, shield support structure and upper reflector shields. Tallies were made for each cell in the inner radial shield (122 cells), outer radial shield (33 cells) and shield support (4). The upper shields for the row 7 reflectors were divided into 2 axial regions; the same for upper shields of rows 8 and 9 reflectors.
2	tumutves.inp tmut10ev.out	fftf10ev	atdens9fves.prn	3620 / 11.5	Run to compute reaction rate distributions in the core barrel, thermal shield, reactor vessel and the guard vessel. The barrel, liner, vessel and guard vessel were divided into 2, 6, 9 and 4 regions, respectively.
3	tmutmiv1.inp tmut10emiv1.out	fftf10em	atdens9m.prn	1160 / 18.7	Run to compute inventories in row 7 radial reflectors stored in sector 1 IVSM
4	tmutmiv2.inp tmut10emiv2.out	fftf10em	atdens9m.prn	2067 / 16.1	Run to compute inventories in row 7 radial reflectors stored in sector 2 IVSM
5	tmutmiv3.inp tmut10emiv3.out	fftf10em	atdens9m.prn	2323 / 12.0	Run to compute inventories in row 7 radial reflectors stored in sector 3 IVSM
6	tmutmiv4.inp tmut10emiv4.out	fftf10em	atdens9m.prn	3011 / 13.5	Run to compute inventories in the one row 8/ 9 radial reflectors stored in sector 3 IVSM
7	tmutmiv5.inp tmut10emiv5.out	fftf10em	atdens9m.prn	1022 / 14.2	Run to compute inventories in the control rods stored in the IVSMs
8	tmutmiv6.inp tmut10emiv6.out	fftf10em	atdens9m.prn	721 / 15.9	Run to compute inventories in the safety rods stored in sectors 1 and 2 IVSMs
9	tmutmiv7.inp tmut10emiv7.out	fftf10em	atdens9m.prn	1548 / 16.6	Run to compute inventories in the safety rods stored in sector 3 IVSM

[a] MCNP cases are summarized in Table 5-1.

Table E-11. User Input File, tmutf.inp, for Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components

```
28  19  7  3
1.78E+19  3620.0 11.5
  4.2260E+06  2.0011E+07  1.6688E+07  5.3552E+06  2.4694E+07  5.4680E+06
  3.3849E+05  2.1139E+06  1.8181E+06  5.8935E+05  1.0400E+06  1.2238E+07
  4.5141E+06  4.5555E+05  1.2209E+07  2.5697E+06  2.4820E+07  8.5661E+06
  7.2008E+06  1.9322E+06  1.9893E+07  1.2365E+06  1.8744E+05  3.8109E+06
  3.8109E+06  3.0487E+06  6.0974E+06  1.4813E+05
 Co-59       Ni-60       Co-60       Ni-58       Ni-59       Ni-62
 0.0000E+00 0.0000E+00 1.3147E-01 0.0000E+00 9.1184E-06 0.0000E+00
    58.93     59.93        59.93       57.94        58.93      61.93
 Ni-63       Fe-54       Fe-55       N-14        Mo-92       Mo-93
 6.9300E-03 0.0000E+00 2.5864E-01 0.0000E+00 0.0000E+00 1.9800E-04
    62.93      53.94        54.94       14.00        91.91      92.91
 Mo-98       Tc-99       Nb-93       Nb-94       C-14        C-13
 0.0000E+00 3.2535E-06 0.0000E+00 3.4650E-05 1.2097E-04  0.0
   97.91       98.91       92.91       93.91       14.00      13.00
 Mo-94
 0.0000E+00
   93.91
     3     1     1     2     2
     5     4     1
     7     6     1
    12    11     1
    14    13     1
    16    15     1    19     2
    17    10     2    18     1
```

Table E-12. Atom Density File atdens9f.prn Used as Input to Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (4 Sheets)

```
Thermal Liner
   6.800
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 5.553E-05 1.870E-03 0.000E+00 5.061E-03 0.000E+00 2.490E-04 0.000E+00 3.023E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 2.914E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 8.806E-06 0.000E+00 0.000E+00 2.772E-06
Mo-94
 0.000E+00
RX Vessel
   8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
Guard Vessel
   8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
Core Support
   7.761
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.337E-05 2.135E-03 0.000E+00 5.776E-03 0.000E+00 2.842E-04 0.000E+00 3.450E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.326E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.005E-05 0.000E+00 0.000E+00 3.164E-06
Mo-94
 0.000E+00
Closure Head
   7.870
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.205E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.023E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.243E-05
Mo-94
 0.000E+00
Steel roof
   7.870
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.205E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.023E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 0.000E+00 0.000E+00 0.000E+00 7.661E-02 0.000E+00 1.087E-03 0.000E+00 0.000E+00 1.243E-05
Mo-94
 0.000E+00
Core Basket support
   8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
Below Nozzle
   1.273
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.039E-05 3.501E-04 0.000E+00 9.475E-04 0.000E+00 4.661E-05 0.000E+00 5.658E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 5.456E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.649E-06 0.000E+00 0.000E+00 5.189E-07
Mo-94
 0.000E+00
```

Table E-12. Atom Density File atdens9f.prn Used as Input to Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (4 Sheets)

Grid Plate
5.737
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
4.684E-05 1.578E-03 0.000E+00 4.270E-03 0.000E+00 2.100E-04 0.000E+00 2.550E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
2.459E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 7.430E-06 0.000E+00 0.000E+00 2.339E-06
Mo-94
0.000E+00
IT hold down
1.195
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
9.758E-06 3.287E-04 0.000E+00 8.895E-04 0.000E+00 4.375E-05 0.000E+00 5.312E-04 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
5.121E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.548E-06 0.000E+00 0.000E+00 4.872E-07
Mo-94
0.000E+00
IT lower frame
3.655
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
2.984E-05 1.005E-03 0.000E+00 2.720E-03 0.000E+00 1.338E-04 0.000E+00 1.625E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.566E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.733E-06 0.000E+00 0.000E+00 1.490E-06
Mo-94
0.000E+00
IT guide tubes
0.378
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
3.085E-06 1.039E-04 0.000E+00 2.812E-04 0.000E+00 1.383E-05 0.000E+00 1.679E-04 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.619E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.893E-07 0.000E+00 0.000E+00 1.540E-07
Mo-94
0.000E+00
Inner shield
7.161
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
5.847E-05 1.970E-03 0.000E+00 5.330E-03 0.000E+00 2.622E-04 0.000E+00 3.183E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
3.069E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 9.274E-06 0.000E+00 0.000E+00 2.919E-06
Mo-94
0.000E+00
shield support
4.819
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
3.935E-05 1.326E-03 0.000E+00 3.587E-03 0.000E+00 1.764E-04 0.000E+00 2.142E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
2.065E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 6.241E-06 0.000E+00 0.000E+00 1.965E-06
Mo-94
0.000E+00
Outer shield
7.249
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
5.919E-05 1.994E-03 0.000E+00 5.395E-03 0.000E+00 2.654E-04 0.000E+00 3.222E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
3.107E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 9.388E-06 0.000E+00 0.000E+00 2.955E-06
Mo-94
0.000E+00
Core Barrel
8.000
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
0.000E+00
IVHM

Table E-12. Atom Density File atdens9f.prn Used as Input to Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (4 Sheets)

```
   1.747
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.427E-05 4.806E-04 0.000E+00 1.300E-03 0.000E+00 6.397E-05 0.000E+00 7.766E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 7.488E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.263E-06 0.000E+00 0.000E+00 7.123E-07
Mo-94
 0.000E+00
IVFSM
   0.883
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 7.210E-06 2.429E-04 0.000E+00 6.572E-04 0.000E+00 3.233E-05 0.000E+00 3.925E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.784E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.143E-06 0.000E+00 0.000E+00 3.599E-07
Mo-94
 0.000E+00
IT Column
   1.002
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 8.185E-06 2.757E-04 0.000E+00 7.461E-04 0.000E+00 3.670E-05 0.000E+00 4.456E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 4.296E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.298E-06 0.000E+00 0.000E+00 4.086E-07
Mo-94
 0.000E+00
B4C Shield
   2.500
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.769E-04
Mo-94
 0.000E+00
Z Ring
   8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
Baffle Plates
   8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
Suppressor Plate
   8.020
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 4.093E-05 2.941E-03 0.000E+00 7.959E-03 0.000E+00 3.915E-04 0.000E+00 3.336E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.437E-05 2.337E-04 0.000E+00 3.568E-04 0.000E+00 2.597E-05 0.000E+00 0.000E+00 3.269E-06
Mo-94
 1.426E-04
thermal reflector plates
   8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
Inconel Shield Plate
   8.450
```

Table E-12. Atom Density File atdens9f.prn Used as Input to Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (4 Sheets)

```
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 8.625E-05 1.677E-02 0.000E+00 4.537E-02 0.000E+00 2.232E-03 0.000E+00 4.372E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 6.459E-06
Mo-94
 0.000E+00
SS-410 Shield Plate
    7.800
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.592E-05 5.108E-04 0.000E+00 1.382E-03 0.000E+00 6.800E-05 0.000E+00 4.228E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 1.003E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.962E-06
Mo-94
 0.000E+00
low carbon (A516) steel shield plates
    7.870
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.205E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.023E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.243E-05
Mo-94
 0.000E+00
Bottom of Core Support Structure
    8.000
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 6.532E-05 2.200E-03 0.000E+00 5.954E-03 0.000E+00 2.929E-04 0.000E+00 3.556E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.428E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.036E-05 0.000E+00 0.000E+00 3.261E-06
Mo-94
 0.000E+00
```

Table E-13. User Input File, tmutmrr.inp, for Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors

```
32  19  7  3
1.78E+19  3620.0 11.5
  5.2437E+05  5.5705E+05  3.2762E+05  6.8445E+04  3.2557E+05  1.1439E+06
  1.1132E+06  6.5521E+05  1.3654E+05  7.0006E+04  1.4793E+04  4.9341E+04
  5.4561E+04  1.9798E+05  2.4352E+04  2.6529E+05  1.0240E+05  3.4623E+04
  7.3163E+03  3.3550E+04  2.6984E+04  1.3536E+05  2.8965E+03  1.8138E+05
  7.0011E+04  7.9317E+04  2.7305E+04  1.1554E+04  2.0834E+03  1.2521E+04
  1.7732E+05  9.1173E+03
 Co-59       Ni-60       Co-60       Ni-58       Ni-59       Ni-62
 0.0000E+00 0.0000E+00 1.3147E-01 0.0000E+00 9.1184E-06 0.0000E+00
    58.93      59.93        59.93       57.94       58.93       61.93
 Ni-63       Fe-54       Fe-55       N-14        Mo-92       Mo-93
 6.9300E-03 0.0000E+00 2.5864E-01 0.0000E+00 0.0000E+00 1.9800E-04
    62.93      53.94        54.94       14.00       91.91       92.91
 Mo-98       Tc-99       Nb-93       Nb-94       C-14        C-13
 0.0000E+00 3.2535E-06 0.0000E+00 3.4650E-05 1.2097E-04  0.0
   97.91       98.91       92.91       93.91       14.00       13.00
 Mo-94
 0.0000E+00
   93.91
     3      1      1      2      2
     5      4      1
     7      6      1
    12     11      1
    14     13      1
    16     15      1     19      2
    17     10      2     18      1
```

Table E-14. Atom Density File atdens9m.prn Used as Input to Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (4 Sheets)

```
Row 7 Reflectors
    7.000
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 6.188E-05 1.084E-02 0.000E+00 2.933E-02 0.000E+00 1.443E-03 0.000E+00 1.045E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 8.035E-06 5.463E-05 0.000E+00 8.340E-05 0.000E+00 6.070E-06 0.000E+00 0.000E+00 4.682E-06
 Mo-94
 3.333E-05
RRA-7 uppershield
    6.691
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 3.415E-05 2.454E-03 0.000E+00 6.640E-03 0.000E+00 3.266E-04 0.000E+00 2.783E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 2.867E-05 1.950E-04 0.000E+00 2.976E-04 0.000E+00 2.166E-05 0.000E+00 0.000E+00 2.727E-06
 Mo-94
 1.189E-04
RR-7 lower shield/orifice
    6.125
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 3.126E-05 2.246E-03 0.000E+00 6.079E-03 0.000E+00 2.990E-04 0.000E+00 2.548E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 2.625E-05 1.785E-04 0.000E+00 2.725E-04 0.000E+00 1.983E-05 0.000E+00 0.000E+00 2.497E-06
 Mo-94
 1.089E-04
Handling Socket
    1.380
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 7.043E-06 5.061E-04 0.000E+00 1.369E-03 0.000E+00 6.737E-05 0.000E+00 5.740E-04 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 5.914E-06 4.022E-05 0.000E+00 6.139E-05 0.000E+00 4.468E-06 0.000E+00 0.000E+00 5.626E-07
 Mo-94
 2.453E-05
Nozzle
    3.356
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 1.713E-05 1.231E-03 0.000E+00 3.330E-03 0.000E+00 1.638E-04 0.000E+00 1.396E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 1.438E-05 9.780E-05 0.000E+00 1.493E-04 0.000E+00 1.087E-05 0.000E+00 0.000E+00 1.368E-06
 Mo-94
 5.966E-05
Row 8 Refl.
    7.276
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 6.138E-05 1.034E-02 0.000E+00 2.797E-02 0.000E+00 1.376E-03 0.000E+00 1.296E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 1.082E-05 7.357E-05 0.000E+00 1.123E-04 0.000E+00 8.174E-06 0.000E+00 0.000E+00 4.661E-06
 Mo-94
 4.488E-05
RRA-8&9 upper shield
    7.061
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 3.604E-05 2.590E-03 0.000E+00 7.007E-03 0.000E+00 3.447E-04 0.000E+00 2.937E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 3.026E-05 2.058E-04 0.000E+00 3.141E-04 0.000E+00 2.286E-05 0.000E+00 0.000E+00 2.879E-06
 Mo-94
 1.255E-04
RR-8&9 lower shield/orifice
    4.688
 Co-59     Ni-60     Co-60     Ni-58     Ni-59     Ni-62     Ni-63     Fe-54     Fe-55
 2.393E-05 1.719E-03 0.000E+00 4.653E-03 0.000E+00 2.289E-04 0.000E+00 1.950E-03 0.000E+00
 N-14      Mo-92     Mo-93     Mo-98     Tc-99     Nb-93     Nb-94     C-14      C-13
 2.009E-05 1.366E-04 0.000E+00 2.086E-04 0.000E+00 1.518E-05 0.000E+00 0.000E+00 1.911E-06
 Mo-94
 8.335E-05
Handling Socket
```

Table E-14. Atom Density File atdens9m.prn Used as Input to Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (4 Sheets)

```
   1.380
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 7.043E-06 5.061E-04 0.000E+00 1.369E-03 0.000E+00 6.737E-05 0.000E+00 5.740E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 5.914E-06 4.022E-05 0.000E+00 6.139E-05 0.000E+00 4.468E-06 0.000E+00 0.000E+00 5.626E-07
Mo-94
 2.453E-05
Control Rod B4C
   3.328
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.329E-05 9.552E-04 0.000E+00 2.585E-03 0.000E+00 1.271E-04 0.000E+00 1.083E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 2.050E-05 7.590E-05 0.000E+00 1.159E-04 0.000E+00 8.433E-06 0.000E+00 0.000E+00 7.512E-05
Mo-94
 4.630E-05
Control Rod Follower
   3.105
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.585E-05 1.139E-03 0.000E+00 3.081E-03 0.000E+00 1.516E-04 0.000E+00 1.292E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 1.331E-05 9.048E-05 0.000E+00 1.381E-04 0.000E+00 1.005E-05 0.000E+00 0.000E+00 1.266E-06
Mo-94
 5.520E-05
Control Rod Sodium Channel
   0.747
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 3.815E-06 2.741E-04 0.000E+00 7.418E-04 0.000E+00 3.649E-05 0.000E+00 3.109E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 3.203E-06 2.178E-05 0.000E+00 3.325E-05 0.000E+00 2.420E-06 0.000E+00 0.000E+00 3.047E-07
Mo-94
 1.329E-05
Control Shield
   5.477
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 2.795E-05 2.009E-03 0.000E+00 5.435E-03 0.000E+00 2.674E-04 0.000E+00 2.278E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 2.347E-05 1.596E-04 0.000E+00 2.436E-04 0.000E+00 1.773E-05 0.000E+00 0.000E+00 2.233E-06
Mo-94
 9.737E-05
Nozzle
   3.356
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.713E-05 1.231E-03 0.000E+00 3.330E-03 0.000E+00 1.638E-04 0.000E+00 1.396E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 1.438E-05 9.780E-05 0.000E+00 1.493E-04 0.000E+00 1.087E-05 0.000E+00 0.000E+00 1.368E-06
Mo-94
 5.966E-05
Control Rod above B4C
   2.964
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 1.513E-05 1.087E-03 0.000E+00 2.942E-03 0.000E+00 1.447E-04 0.000E+00 1.233E-03 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 1.270E-05 8.638E-05 0.000E+00 1.319E-04 0.000E+00 9.597E-06 0.000E+00 0.000E+00 1.208E-06
Mo-94
 5.270E-05
Control Rod Driveline
   1.905
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 9.725E-06 6.988E-04 0.000E+00 1.891E-03 0.000E+00 9.302E-05 0.000E+00 7.926E-04 0.000E+00
N-14     Mo-92    Mo-93    Mo-98    Tc-99    Nb-93    Nb-94    C-14     C-13
 8.166E-06 5.553E-05 0.000E+00 8.476E-05 0.000E+00 6.169E-06 0.000E+00 0.000E+00 7.768E-07
Mo-94
 3.388E-05
Handling Socket
   1.380
Co-59    Ni-60    Co-60    Ni-58    Ni-59    Ni-62    Ni-63    Fe-54    Fe-55
 7.043E-06 5.061E-04 0.000E+00 1.369E-03 0.000E+00 6.737E-05 0.000E+00 5.740E-04 0.000E+00
```

Table E-14. Atom Density File atdens9m.prn Used as Input to Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (4 Sheets)

N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
5.914E-06 4.022E-05 0.000E+00 6.139E-05 0.000E+00 4.468E-06 0.000E+00 0.000E+00 5.626E-07
Mo-94
2.453E-05
Safety Rod B4C
3.328
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.329E-05 9.552E-04 0.000E+00 2.585E-03 0.000E+00 1.271E-04 0.000E+00 1.083E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
2.050E-05 7.590E-05 0.000E+00 1.159E-04 0.000E+00 8.433E-06 0.000E+00 0.000E+00 7.512E-05
Mo-94
4.630E-05
Safety Rod Follower
3.105
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.585E-05 1.139E-03 0.000E+00 3.081E-03 0.000E+00 1.516E-04 0.000E+00 1.292E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.331E-05 9.048E-05 0.000E+00 1.381E-04 0.000E+00 1.005E-05 0.000E+00 0.000E+00 1.266E-06
Mo-94
5.520E-05
Safety Rod Sodium Channel
0.747
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
3.815E-06 2.741E-04 0.000E+00 7.418E-04 0.000E+00 3.649E-05 0.000E+00 3.109E-04 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
3.203E-06 2.178E-05 0.000E+00 3.325E-05 0.000E+00 2.420E-06 0.000E+00 0.000E+00 3.047E-07
Mo-94
1.329E-05
Control Shield
5.477
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
2.795E-05 2.009E-03 0.000E+00 5.435E-03 0.000E+00 2.674E-04 0.000E+00 2.278E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
2.347E-05 1.596E-04 0.000E+00 2.436E-04 0.000E+00 1.773E-05 0.000E+00 0.000E+00 2.233E-06
Mo-94
9.737E-05
Nozzle
3.356
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.713E-05 1.231E-03 0.000E+00 3.330E-03 0.000E+00 1.638E-04 0.000E+00 1.396E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.438E-05 9.780E-05 0.000E+00 1.493E-04 0.000E+00 1.087E-05 0.000E+00 0.000E+00 1.368E-06
Mo-94
5.966E-05
Safety Rod above B4C
2.964
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.513E-05 1.087E-03 0.000E+00 2.942E-03 0.000E+00 1.447E-04 0.000E+00 1.233E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.270E-05 8.638E-05 0.000E+00 1.319E-04 0.000E+00 9.597E-06 0.000E+00 0.000E+00 1.208E-06
Mo-94
5.270E-05
Safety Rod Driveline
1.905
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
9.725E-06 6.988E-04 0.000E+00 1.891E-03 0.000E+00 9.302E-05 0.000E+00 7.926E-04 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
8.166E-06 5.553E-05 0.000E+00 8.476E-05 0.000E+00 6.169E-06 0.000E+00 0.000E+00 7.768E-07
Mo-94
3.388E-05
Handling Socket
1.380
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
7.043E-06 5.061E-04 0.000E+00 1.369E-03 0.000E+00 6.737E-05 0.000E+00 5.740E-04 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
5.914E-06 4.022E-05 0.000E+00 6.139E-05 0.000E+00 4.468E-06 0.000E+00 0.000E+00 5.626E-07
Mo-94

Table E-14. Atom Density File atdens9m.prn Used as Input to Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (4 Sheets)

2.453E-05
ICSA
4.583
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
2.339E-05 1.681E-03 0.000E+00 4.548E-03 0.000E+00 2.238E-04 0.000E+00 1.907E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.964E-05 1.336E-04 0.000E+00 2.039E-04 0.000E+00 1.484E-05 0.000E+00 0.000E+00 1.868E-06
Mo-94
8.148E-05
ICSA Lower Shield
7.482
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
3.818E-05 2.744E-03 0.000E+00 7.425E-03 0.000E+00 3.653E-04 0.000E+00 3.112E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
3.206E-05 2.180E-04 0.000E+00 3.328E-04 0.000E+00 2.422E-05 0.000E+00 0.000E+00 3.050E-06
Mo-94
1.330E-04
Peripheral Shiml Rod B4C
3.328
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.329E-05 9.552E-04 0.000E+00 2.585E-03 0.000E+00 1.271E-04 0.000E+00 1.083E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
2.050E-05 7.590E-05 0.000E+00 1.159E-04 0.000E+00 8.433E-06 0.000E+00 0.000E+00 7.512E-05
Mo-94
4.630E-05
PSR Below B4C
3.105
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.585E-05 1.139E-03 0.000E+00 3.081E-03 0.000E+00 1.516E-04 0.000E+00 1.292E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.331E-05 9.048E-05 0.000E+00 1.381E-04 0.000E+00 1.005E-05 0.000E+00 0.000E+00 1.266E-06
Mo-94
5.520E-05
PSR above B4C
2.964
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
1.513E-05 1.087E-03 0.000E+00 2.942E-03 0.000E+00 1.447E-04 0.000E+00 1.233E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
1.270E-05 8.638E-05 0.000E+00 1.319E-04 0.000E+00 9.597E-06 0.000E+00 0.000E+00 1.208E-06
Mo-94
5.270E-05
PSR Plenum
1.905
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
9.725E-06 6.988E-04 0.000E+00 1.891E-03 0.000E+00 9.302E-05 0.000E+00 7.926E-04 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
8.166E-06 5.553E-05 0.000E+00 8.476E-05 0.000E+00 6.169E-06 0.000E+00 0.000E+00 7.768E-07
Mo-94
3.388E-05
PSR Lower Shield
5.477
Co-59 Ni-60 Co-60 Ni-58 Ni-59 Ni-62 Ni-63 Fe-54 Fe-55
2.795E-05 2.009E-03 0.000E+00 5.435E-03 0.000E+00 2.674E-04 0.000E+00 2.278E-03 0.000E+00
N-14 Mo-92 Mo-93 Mo-98 Tc-99 Nb-93 Nb-94 C-14 C-13
2.347E-05 1.596E-04 0.000E+00 2.436E-04 0.000E+00 1.773E-05 0.000E+00 0.000E+00 2.233E-06
Mo-94
9.737E-05

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

```
transmut version 2.0  3/22/01
==============================

 nreg   number of component regions                  28
 niso   total number of isotopes                     19
 nrad   number of radionuclides                       7
 nrt    number of reaction types                      3
 fnorm  reaction rate normalization factor   1.78000E+19
 et     reactor operating time (days)        3.62000E+03
 dt     decay time (years)                   1.15000E+01

 region volumes (cc)
   4.2260E+06   2.0011E+07   1.6688E+07   5.3552E+06   2.4694E+07   5.4680E+06
   3.3849E+05   2.1139E+06   1.8181E+06   5.8935E+05   1.0400E+06   1.2238E+07
   4.5141E+06   4.5555E+05   1.2209E+07   2.5697E+06   2.4820E+07   8.5661E+06
   7.2008E+06   1.9322E+06   1.9893E+07   1.2365E+06   1.8744E+05   3.8109E+06
   3.8109E+06   3.0487E+06   6.0974E+06   1.4813E+05

 decay constants (1/yr) and atomic weights

      isotope        lambda    atomic wt
   1    Co-59       0.0000E+00  5.8930E+01
   2    Ni-60       0.0000E+00  5.9930E+01
   3    Co-60       1.3147E-01  5.9930E+01
   4    Ni-58       0.0000E+00  5.7940E+01
   5    Ni-59       9.1184E-06  5.8930E+01
   6    Ni-62       0.0000E+00  6.1930E+01
   7    Ni-63       6.9300E-03  6.2930E+01
   8    Fe-54       0.0000E+00  5.3940E+01
   9    Fe-55       2.5864E-01  5.4940E+01
  10    N-14        0.0000E+00  1.4000E+01
  11    Mo-92       0.0000E+00  9.1910E+01
  12    Mo-93       1.9800E-04  9.2910E+01
  13    Mo-98       0.0000E+00  9.7910E+01
  14    Tc-99       3.2535E-06  9.8910E+01
  15    Nb-93       0.0000E+00  9.2910E+01
  16    Nb-94       3.4650E-05  9.3910E+01
  17    C-14        1.2097E-04  1.4000E+01
  18    C-13        0.0000E+00  1.3000E+01
  19    Mo-94       0.0000E+00  9.3910E+01

 transmutation matrix

 isotope      source 1          source 2
     no.   isotope  reaction  isotope  reaction  . . .
      3        1        1        2        2        0        0
      5        4        1        0        0        0        0
      7        6        1        0        0        0        0
     12       11        1        0        0        0        0
     14       13        1        0        0        0        0
     16       15        1       19        2        0        0
     17       10        2       18        1        0        0


 Irradiation time = 3620.0 days.  Decay period =   11.5 years


   1  Thermal Liner            Volume = 4.226E+06 cc
      Flux = 1.455E+10 n/cm2/s (time avg.)  Total Mass = 2.874E+04 kg

          Atomic  Half Life     Mass       Density   Inventory      Concentration
 Isotope  Weight     (y)         (g)        (g/cc)     (Ci)        (Ci/m3)     (uCi/g)
 Co-60     59.93  5.272E+00  1.409E-01  3.334E-08  1.594E+02  3.772E+01  5.547E+00
 Ni-59     58.93  7.602E+04  2.339E+00  5.534E-07  1.866E-01  4.416E-02  6.494E-03
 Ni-63     62.93  1.000E+02  3.257E-01  7.706E-08  1.850E+01  4.377E+00  6.437E-01
```

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	1.544E-02	3.653E-09	2.937E-03	6.951E-04	1.022E-04
C-14	14.00	5.730E+03	1.895E-02	4.484E-09	8.445E-02	1.998E-02	2.939E-03
Total			2.840E+00	6.719E-07	1.782E+02	4.216E+01	6.201E+00

2 RX Vessel Volume = 2.001E+07 cc
Flux = 3.869E+09 n/cm2/s (time avg.) Total Mass = 1.601E+05 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.836E-01	9.175E-09	2.077E+02	1.038E+01	1.298E+00
Ni-59	58.93	7.602E+04	3.031E+00	1.515E-07	2.419E-01	1.209E-02	1.511E-03
Ni-63	62.93	1.000E+02	4.244E-01	2.121E-08	2.410E+01	1.204E+00	1.506E-01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	2.054E-02	1.026E-09	3.908E-03	1.953E-04	2.441E-05
C-14	14.00	5.730E+03	2.457E-02	1.228E-09	1.095E-01	5.472E-03	6.840E-04
Total			3.684E+00	1.841E-07	2.322E+02	1.160E+01	1.450E+00

3 Guard Vessel Volume = 1.669E+07 cc
Flux = 1.048E+09 n/cm2/s (time avg.) Total Mass = 1.335E+05 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.180E-02	1.906E-09	3.598E+01	2.156E+00	2.695E-01
Ni-59	58.93	7.602E+04	7.216E-01	4.324E-08	5.758E-02	3.451E-03	4.313E-04
Ni-63	62.93	1.000E+02	1.005E-01	6.021E-09	5.707E+00	3.420E-01	4.275E-02
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	4.208E-03	2.522E-10	8.008E-04	4.799E-05	5.999E-06
C-14	14.00	5.730E+03	5.843E-03	3.502E-10	2.604E-02	1.560E-03	1.951E-04
Total			8.639E-01	5.177E-08	4.177E+01	2.503E+00	3.129E-01

4 Core Support Volume = 5.355E+06 cc
Flux = 1.555E+10 n/cm2/s (time avg.) Total Mass = 4.156E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.204E-01	4.115E-08	2.493E+02	4.656E+01	5.999E+00
Ni-59	58.93	7.602E+04	3.757E+00	7.016E-07	2.999E-01	5.599E-02	7.215E-03
Ni-63	62.93	1.000E+02	5.265E-01	9.832E-08	2.990E+01	5.584E+00	7.195E-01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	2.270E-02	4.239E-09	4.320E-03	8.067E-04	1.039E-04
C-14	14.00	5.730E+03	3.045E-02	5.686E-09	1.357E-01	2.534E-02	3.265E-03
Total			4.558E+00	8.510E-07	2.797E+02	5.222E+01	6.729E+00

5 Closure Head Volume = 2.469E+07 cc
Flux = 1.825E+05 n/cm2/s (time avg.) Total Mass = 1.943E+05 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.126E-06	4.561E-14	1.274E-03	5.160E-05	6.557E-06
Ni-59	58.93	7.602E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	62.93	1.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	4.455E-11	1.804E-18	1.985E-10	8.039E-12	1.021E-12
Total			1.126E-06	4.561E-14	1.274E-03	5.160E-05	6.557E-06

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

6 Steel roof Volume = 5.468E+06 cc
Flux = 3.362E+01 n/cm2/s (time avg.) Total Mass = 4.303E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.434E-10	2.623E-17	1.622E-07	2.967E-08	3.770E-09
Ni-59	58.93	7.602E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	62.93	1.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	9.882E-15	1.807E-21	4.404E-14	8.054E-15	1.023E-15
Total			1.434E-10	2.623E-17	1.622E-07	2.967E-08	3.770E-09

7 Core Basket support Volume = 3.385E+05 cc
Flux = 6.928E+11 n/cm2/s (time avg.) Total Mass = 2.708E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.721E-01	1.395E-06	5.341E+02	1.578E+03	1.972E+02
Ni-59	58.93	7.602E+04	4.514E+00	1.334E-05	3.602E-01	1.064E+00	1.330E-01
Ni-63	62.93	1.000E+02	6.393E-01	1.889E-06	3.631E+01	1.073E+02	1.341E+01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	8.779E-02	2.594E-07	1.671E-02	4.936E-02	6.170E-03
C-14	14.00	5.730E+03	3.412E-02	1.008E-07	1.521E-01	4.493E-01	5.616E-02
Total			5.747E+00	1.698E-05	5.710E+02	1.687E+03	2.109E+02

8 Below Nozzle Volume = 2.114E+06 cc
Flux = 6.192E+11 n/cm2/s (time avg.) Total Mass = 2.691E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.664E-01	2.206E-07	5.277E+02	2.496E+02	1.961E+02
Ni-59	58.93	7.602E+04	4.896E+00	2.316E-06	3.907E-01	1.848E-01	1.452E-01
Ni-63	62.93	1.000E+02	6.774E-01	3.205E-07	3.847E+01	1.820E+01	1.430E+01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	8.031E-02	3.799E-08	1.528E-02	7.230E-03	5.679E-03
C-14	14.00	5.730E+03	3.764E-02	1.780E-08	1.677E-01	7.935E-02	6.233E-02
Total			6.158E+00	2.913E-06	5.668E+02	2.681E+02	2.106E+02

9 Grid Plate Volume = 1.818E+06 cc
Flux = 1.285E+12 n/cm2/s (time avg.) Total Mass = 1.041E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.689E+00	1.479E-06	3.042E+03	1.673E+03	2.922E+02
Ni-59	58.93	7.602E+04	2.327E+01	1.280E-05	1.857E+00	1.021E+00	1.784E-01
Ni-63	62.93	1.000E+02	3.222E+00	1.772E-06	1.830E+02	1.007E+02	1.758E+01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	5.907E-01	3.249E-07	1.124E-01	6.183E-02	1.080E-02
C-14	14.00	5.730E+03	1.675E-01	9.213E-08	7.464E-01	4.106E-01	7.169E-02
Total			2.994E+01	1.647E-05	3.228E+03	1.776E+03	3.100E+02

10 IT hold down Volume = 5.894E+05 cc
Flux = 5.877E+11 n/cm2/s (time avg.) Total Mass = 7.031E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.100E-01	1.867E-07	1.245E+02	2.112E+02	1.771E+02
Ni-59	58.93	7.602E+04	9.793E-01	1.662E-06	7.815E-02	1.326E-01	1.111E-01
Ni-63	62.93	1.000E+02	1.341E-01	2.275E-07	7.616E+00	1.292E+01	1.083E+01

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	2.045E-02	3.470E-08	3.892E-03	6.603E-03	5.535E-03
C-14	14.00	5.730E+03	7.309E-03	1.240E-08	3.257E-02	5.527E-02	4.633E-02
Total			1.251E+00	2.123E-06	1.322E+02	2.244E+02	1.881E+02

11 IT lower frame Volume = 1.040E+06 cc
Flux = 1.941E+11 n/cm2/s (time avg.) Total Mass = 3.795E+03 kg

	Atomic	Half Life	Mass	Density	Inventory	Concentration	
Isotope	Weight	(y)	(g)	(g/cc)	(Ci)	(Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.052E-01	1.973E-07	2.322E+02	2.233E+02	6.118E+01
Ni-59	58.93	7.602E+04	2.083E+00	2.002E-06	1.662E-01	1.598E-01	4.379E-02
Ni-63	62.93	1.000E+02	2.913E-01	2.801E-07	1.655E+01	1.591E+01	4.360E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	3.416E-02	3.285E-08	6.500E-03	6.250E-03	1.713E-03
C-14	14.00	5.730E+03	1.604E-02	1.542E-08	7.149E-02	6.874E-02	1.884E-02
Total			2.629E+00	2.528E-06	2.490E+02	2.394E+02	6.561E+01

12 IT guide tubes Volume = 1.224E+07 cc
Flux = 6.570E+09 n/cm2/s (time avg.) Total Mass = 4.614E+03 kg

	Atomic	Half Life	Mass	Density	Inventory	Concentration	
Isotope	Weight	(y)	(g)	(g/cc)	(Ci)	(Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	9.256E-03	7.563E-10	1.047E+01	8.557E-01	2.270E+00
Ni-59	58.93	7.602E+04	1.523E-01	1.244E-08	1.215E-02	9.929E-04	2.634E-03
Ni-63	62.93	1.000E+02	2.107E-02	1.722E-09	1.197E+00	9.777E-02	2.593E-01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	1.332E-03	1.088E-10	2.535E-04	2.071E-05	5.494E-05
C-14	14.00	5.730E+03	1.212E-03	9.904E-11	5.401E-03	4.414E-04	1.171E-03
Total			1.851E-01	1.513E-08	1.169E+01	9.550E-01	2.533E+00

13 inner shield Volume = 4.514E+06 cc
Flux = 3.925E+13 n/cm2/s (time avg.) Total Mass = 3.227E+04 kg

	Atomic	Half Life	Mass	Density	Inventory	Concentration	
Isotope	Weight	(y)	(g)	(g/cc)	(Ci)	(Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.629E+02	3.608E-05	1.843E+05	4.082E+04	5.710E+03
Ni-59	58.93	7.602E+04	1.461E+03	3.237E-04	1.166E+02	2.583E+01	3.613E+00
Ni-63	62.93	1.000E+02	1.990E+02	4.409E-05	1.130E+04	2.504E+03	3.503E+02
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	4.152E+01	9.197E-06	7.900E+00	1.750E+00	2.448E-01
C-14	14.00	5.730E+03	1.108E+01	2.455E-06	4.938E+01	1.094E+01	1.530E+00
Total			1.875E+03	4.155E-04	1.957E+05	4.336E+04	6.066E+03

14 shield support Volume = 4.556E+05 cc
Flux = 9.333E+11 n/cm2/s (time avg.) Total Mass = 2.192E+03 kg

	Atomic	Half Life	Mass	Density	Inventory	Concentration	
Isotope	Weight	(y)	(g)	(g/cc)	(Ci)	(Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.231E-01	9.288E-07	4.787E+02	1.051E+03	2.184E+02
Ni-59	58.93	7.602E+04	3.982E+00	8.740E-06	3.178E-01	6.975E-01	1.450E-01
Ni-63	62.93	1.000E+02	5.490E-01	1.205E-06	3.118E+01	6.845E+01	1.423E+01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	9.108E-02	1.999E-07	1.733E-02	3.805E-02	7.908E-03
C-14	14.00	5.730E+03	2.875E-02	6.311E-08	1.281E-01	2.813E-01	5.846E-02
Total			5.074E+00	1.114E-05	5.104E+02	1.120E+03	2.329E+02

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

15 Outer shield Volume = 1.221E+07 cc
Flux = 5.926E+12 n/cm2/s (time avg.) Total Mass = 8.834E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	7.154E+01	5.860E-06	8.094E+04	6.630E+03	9.162E+02
Ni-59	58.93	7.602E+04	6.819E+02	5.585E-05	5.442E+01	4.457E+00	6.160E-01
Ni-63	62.93	1.000E+02	9.244E+01	7.571E-06	5.250E+03	4.300E+02	5.943E+01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	1.980E+01	1.622E-06	3.769E+00	3.087E-01	4.266E-02
C-14	14.00	5.730E+03	4.678E+00	3.832E-07	2.085E+01	1.708E+00	2.360E-01
Total			8.703E+02	7.129E-05	8.627E+04	7.066E+03	9.766E+02

16 Core Barrel Volume = 2.570E+06 cc
Flux = 4.071E+11 n/cm2/s (time avg.) Total Mass = 2.056E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.152E+00	8.374E-07	2.435E+03	9.475E+02	1.184E+02
Ni-59	58.93	7.602E+04	2.045E+01	7.958E-06	1.632E+00	6.351E-01	7.938E-02
Ni-63	62.93	1.000E+02	2.881E+00	1.121E-06	1.637E+02	6.369E+01	7.961E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	4.038E-01	1.571E-07	7.684E-02	2.990E-02	3.738E-03
C-14	14.00	5.730E+03	1.549E-01	6.029E-08	6.904E-01	2.687E-01	3.358E-02
Total			2.604E+01	1.013E-05	2.601E+03	1.012E+03	1.265E+02

17 IVHM Volume = 2.482E+07 cc
Flux = 6.213E+08 n/cm2/s (time avg.) Total Mass = 4.329E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	8.539E-03	3.441E-10	9.662E+00	3.893E-01	2.232E-01
Ni-59	58.93	7.602E+04	2.042E-01	8.229E-09	1.630E-02	6.567E-04	3.765E-04
Ni-63	62.93	1.000E+02	2.831E-02	1.141E-09	1.608E+00	6.478E-02	3.715E-02
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	8.390E-04	3.380E-11	1.597E-04	6.433E-06	3.688E-06
C-14	14.00	5.730E+03	1.656E-03	6.671E-11	7.379E-03	2.973E-04	1.705E-04
Total			2.436E-01	9.814E-09	1.129E+01	4.550E-01	2.609E-01

18 IVFSM Volume = 8.566E+06 cc
Flux = 1.327E+11 n/cm2/s (time avg.) Total Mass = 7.547E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.067E-01	2.413E-08	2.338E+02	2.730E+01	3.098E+01
Ni-59	58.93	7.602E+04	2.394E+00	2.795E-07	1.911E-01	2.230E-02	2.532E-02
Ni-63	62.93	1.000E+02	3.228E-01	3.768E-08	1.833E+01	2.140E+00	2.429E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	3.908E-02	4.562E-09	7.436E-03	8.681E-04	9.854E-04
C-14	14.00	5.730E+03	1.981E-02	2.312E-09	8.827E-02	1.030E-02	1.170E-02
Total			2.983E+00	3.482E-07	2.524E+02	2.947E+01	3.345E+01

19 IT Column Volume = 7.201E+06 cc
Flux = 6.296E+09 n/cm2/s (time avg.) Total Mass = 7.208E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.365E-02	1.896E-09	1.545E+01	2.145E+00	2.143E+00
Ni-59	58.93	7.602E+04	1.969E-01	2.735E-08	1.572E-02	2.183E-03	2.180E-03
Ni-63	62.93	1.000E+02	2.724E-02	3.783E-09	1.547E+00	2.148E-01	2.146E-01

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	2.034E-03	2.825E-10	3.871E-04	5.376E-05	5.371E-05
C-14	14.00	5.730E+03	1.554E-03	2.158E-10	6.926E-03	9.618E-04	9.609E-04
Total			2.414E-01	3.353E-08	1.702E+01	2.363E+00	2.361E+00

20 B4C Shield Volume = 1.932E+06 cc
Flux = 9.460E+06 n/cm2/s (time avg.) Total Mass = 4.831E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-59	58.93	7.602E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	62.93	1.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	7.323E-09	3.790E-15	3.264E-08	1.689E-08	6.756E-09
Total			7.323E-09	3.790E-15	3.264E-08	1.689E-08	6.756E-09

21 Z Ring Volume = 1.989E+07 cc
Flux = 4.567E+05 n/cm2/s (time avg.) Total Mass = 1.591E+05 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.736E-05	8.726E-13	1.964E-02	9.872E-04	1.234E-04
Ni-59	58.93	7.602E+04	3.056E-04	1.536E-11	2.439E-05	1.226E-06	1.533E-07
Ni-63	62.93	1.000E+02	4.306E-05	2.164E-12	2.445E-03	1.229E-04	1.537E-05
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	2.821E-06	1.418E-13	5.369E-07	2.699E-08	3.374E-09
C-14	14.00	5.730E+03	2.437E-06	1.225E-13	1.086E-05	5.460E-07	6.825E-08
Total			3.713E-04	1.866E-11	2.212E-02	1.112E-03	1.390E-04

22 Baffle Plates Volume = 1.237E+06 cc
Flux = 1.059E+10 n/cm2/s (time avg.) Total Mass = 9.892E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.352E-02	2.710E-08	3.792E+01	3.067E+01	3.833E+00
Ni-59	58.93	7.602E+04	6.278E-01	5.077E-07	5.010E-02	4.052E-02	5.065E-03
Ni-63	62.93	1.000E+02	8.751E-02	7.077E-08	4.970E+00	4.019E+00	5.024E-01
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	3.763E-03	3.043E-09	7.160E-04	5.791E-04	7.238E-05
C-14	14.00	5.730E+03	5.059E-03	4.091E-09	2.255E-02	1.823E-02	2.279E-03
Total			7.577E-01	6.127E-07	4.296E+01	3.475E+01	4.343E+00

23 Suppressor Plate Volume = 1.874E+05 cc
Flux = 5.871E+05 n/cm2/s (time avg.) Total Mass = 1.500E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.741E-07	1.462E-12	3.101E-04	1.654E-03	2.068E-04
Ni-59	58.93	7.602E+04	7.147E-06	3.813E-11	5.704E-07	3.043E-06	3.804E-07
Ni-63	62.93	1.000E+02	9.869E-07	5.265E-12	5.605E-05	2.990E-04	3.738E-05
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	3.038E-08	1.621E-13	5.782E-09	3.085E-08	3.856E-09
C-14	14.00	5.730E+03	5.778E-08	3.082E-13	2.575E-07	1.374E-06	1.717E-07
Total			8.496E-06	4.533E-11	3.670E-04	1.958E-03	2.447E-04

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

24 thermal reflector plates Volume = 3.811E+06 cc
Flux = 4.896E+05 n/cm2/s (time avg.) Total Mass = 3.049E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.237E-06	1.112E-12	4.794E-03	1.258E-03	1.572E-04
Ni-59	58.93	7.602E+04	9.386E-05	2.463E-11	7.490E-06	1.965E-06	2.457E-07
Ni-63	62.93	1.000E+02	1.303E-05	3.420E-12	7.401E-04	1.942E-04	2.428E-05
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	5.281E-07	1.386E-13	1.005E-07	2.637E-08	3.296E-09
C-14	14.00	5.730E+03	7.559E-07	1.984E-13	3.369E-06	8.839E-07	1.105E-07
Total			1.124E-04	2.950E-11	5.545E-03	1.455E-03	1.819E-04

25 Inconel Shield Plate Volume = 3.811E+06 cc
Flux = 2.004E+05 n/cm2/s (time avg.) Total Mass = 3.220E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.617E-06	4.244E-13	1.830E-03	4.802E-04	5.683E-05
Ni-59	58.93	7.602E+04	1.889E-04	4.956E-11	1.507E-05	3.955E-06	4.681E-07
Ni-63	62.93	1.000E+02	2.679E-05	7.029E-12	1.521E-03	3.992E-04	4.724E-05
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	8.667E-12	2.274E-18	3.862E-11	1.013E-11	1.199E-12
Total			2.173E-04	5.701E-11	3.366E-03	8.833E-04	1.045E-04

26 SS-410 Shield Plate Volume = 3.049E+06 cc
Flux = 1.499E+05 n/cm2/s (time avg.) Total Mass = 2.378E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.387E-07	4.551E-14	1.570E-04	5.149E-05	6.601E-06
Ni-59	58.93	7.602E+04	4.988E-07	1.636E-13	3.980E-08	1.306E-08	1.674E-09
Ni-63	62.93	1.000E+02	6.915E-08	2.268E-14	3.927E-06	1.288E-06	1.651E-07
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	1.927E-12	6.320E-19	8.587E-12	2.817E-12	3.611E-13
Total			7.067E-07	2.318E-13	1.609E-04	5.279E-05	6.768E-06

27 low carbon (A516) steel Volume = 6.097E+06 cc
Flux = 8.454E+04 n/cm2/s (time avg.) Total Mass = 4.799E+04 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	9.327E-08	1.530E-14	1.055E-04	1.731E-05	2.199E-06
Ni-59	58.93	7.602E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	62.93	1.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	4.682E-12	7.678E-19	2.086E-11	3.422E-12	4.348E-13
Total			9.327E-08	1.530E-14	1.055E-04	1.731E-05	2.199E-06

28 Bottom of Core Support S Volume = 1.481E+05 cc
Flux = 1.728E+10 n/cm2/s (time avg.) Total Mass = 1.185E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	6.893E-03	4.653E-08	7.799E+00	5.265E+01	6.581E+00
Ni-59	58.93	7.602E+04	1.337E-01	9.023E-07	1.067E-02	7.201E-02	9.001E-03

Table E-15. Output File from Transmut2 Case tmut10ef to Compute Radionuclide Inventories in Reactor Hardware Components (8 Sheets)

```
Ni-63      62.93   1.000E+02   1.866E-02   1.260E-07   1.060E+00   7.155E+00   8.944E-01
Mo-93      92.91   3.501E+03   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
Tc-99      98.91   2.130E+05   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
Nb-94      93.91   2.000E+04   6.907E-04   4.663E-09   1.314E-04   8.873E-04   1.109E-04
C-14       14.00   5.730E+03   1.084E-03   7.321E-09   4.833E-03   3.263E-02   4.078E-03
Total                          1.610E-01   1.087E-06   8.874E+00   5.991E+01   7.489E+00

program done
```

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

```
transmut version 2.0  3/22/01
==============================

 nreg   number of component regions                32
 niso   total number of isotopes                   19
 nrad   number of radionuclides                     7
 nrt    number of reaction types                    3
 fnorm  reaction rate normalization factor   1.78000E+19
 et     reactor operating time (days)        3.62000E+03
 dt     decay time (years)                   1.15000E+01

 region volumes (cc)
   5.2437E+05   5.5705E+05   3.2762E+05   6.8445E+04   3.2557E+05   1.1439E+06
   1.1132E+06   6.5521E+05   1.3654E+05   7.0006E+04   1.4793E+04   4.9341E+04
   5.4561E+04   1.9798E+05   2.4352E+04   2.6529E+05   1.0240E+05   3.4623E+04
   7.3163E+03   3.3550E+04   2.6984E+04   1.3536E+05   2.8965E+03   1.8138E+05
   7.0011E+04   7.9317E+04   2.7305E+04   1.1554E+04   2.0834E+03   1.2521E+04
   1.7732E+05   9.1173E+03

 decay constants (1/yr) and atomic weights

      isotope        lambda     atomic wt
   1   Co-59       0.0000E+00  5.8930E+01
   2   Ni-60       0.0000E+00  5.9930E+01
   3   Co-60       1.3147E-01  5.9930E+01
   4   Ni-58       0.0000E+00  5.7940E+01
   5   Ni-59       9.1184E-06  5.8930E+01
   6   Ni-62       0.0000E+00  6.1930E+01
   7   Ni-63       6.9300E-03  6.2930E+01
   8   Fe-54       0.0000E+00  5.3940E+01
   9   Fe-55       2.5864E-01  5.4940E+01
  10   N-14        0.0000E+00  1.4000E+01
  11   Mo-92       0.0000E+00  9.1910E+01
  12   Mo-93       1.9800E-04  9.2910E+01
  13   Mo-98       0.0000E+00  9.7910E+01
  14   Tc-99       3.2535E-06  9.8910E+01
  15   Nb-93       0.0000E+00  9.2910E+01
  16   Nb-94       3.4650E-05  9.3910E+01
  17   C-14        1.2097E-04  1.4000E+01
  18   C-13        0.0000E+00  1.3000E+01
  19   Mo-94       0.0000E+00  9.3910E+01

 transmutation matrix

isotope      source 1          source 2
    no.   isotope  reaction  isotope  reaction  . . .
     3        1         1         2         2         0         0
     5        4         1         0         0         0         0
     7        6         1         0         0         0         0
    12       11         1         0         0         0         0
```

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

14	13	1	0	0	0	0
16	15	1	19	2	0	0
17	10	2	18	1	0	0

Irradiation time = 3620.0 days. Decay period = 11.5 years

1 Row 7 Reflectors Volume = 5.244E+05 cc
Flux = 8.442E+14 n/cm2/s (time avg.) Total Mass = 3.671E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.459E+02	2.783E-04	1.651E+05	3.149E+05	4.498E+04
Ni-59	58.93	7.602E+04	6.281E+03	1.198E-02	5.013E+02	9.559E+02	1.366E+02
Ni-63	62.93	1.000E+02	1.222E+03	2.330E-03	6.938E+04	1.323E+05	1.890E+04
Mo-93	92.91	3.501E+03	6.256E+01	1.193E-04	6.876E+01	1.311E+02	1.873E+01
Tc-99	98.91	2.130E+05	3.312E+02	6.317E-04	5.619E+00	1.072E+01	1.531E+00
Nb-94	93.91	2.000E+04	3.340E+01	6.370E-05	6.356E+00	1.212E+01	1.732E+00
C-14	14.00	5.730E+03	3.798E-01	7.243E-07	1.693E+00	3.228E+00	4.611E-01
Total			8.076E+03	1.540E-02	2.351E+05	4.483E+05	6.404E+04

2 RRA-7 uppershield Volume = 5.571E+05 cc
Flux = 4.096E+13 n/cm2/s (time avg.) Total Mass = 3.727E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	5.490E+00	9.856E-06	6.212E+03	1.115E+04	1.667E+03
Ni-59	58.93	7.602E+04	1.540E+02	2.764E-04	1.229E+01	2.206E+01	3.296E+00
Ni-63	62.93	1.000E+02	1.969E+01	3.534E-05	1.118E+03	2.007E+03	3.000E+02
Mo-93	92.91	3.501E+03	1.241E+01	2.227E-05	1.364E+01	2.448E+01	3.658E+00
Tc-99	98.91	2.130E+05	8.851E+01	1.589E-04	1.502E+00	2.696E+00	4.029E-01
Nb-94	93.91	2.000E+04	1.150E+01	2.064E-05	2.188E+00	3.927E+00	5.870E-01
C-14	14.00	5.730E+03	5.408E-02	9.707E-08	2.410E-01	4.326E-01	6.466E-02
Total			2.916E+02	5.235E-04	7.360E+03	1.321E+04	1.975E+03

3 RR-7 lower shield/orific Volume = 3.276E+05 cc
Flux = 9.862E+13 n/cm2/s (time avg.) Total Mass = 2.007E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	8.809E+00	2.689E-05	9.966E+03	3.042E+04	4.967E+03
Ni-59	58.93	7.602E+04	2.260E+02	6.898E-04	1.804E+01	5.505E+01	8.988E+00
Ni-63	62.93	1.000E+02	3.116E+01	9.511E-05	1.770E+03	5.402E+03	8.820E+02
Mo-93	92.91	3.501E+03	1.565E+01	4.777E-05	1.720E+01	5.250E+01	8.572E+00
Tc-99	98.91	2.130E+05	1.168E+02	3.566E-04	1.982E+00	6.049E+00	9.876E-01
Nb-94	93.91	2.000E+04	1.499E+01	4.575E-05	2.852E+00	8.706E+00	1.421E+00
C-14	14.00	5.730E+03	8.395E-02	2.563E-07	3.741E-01	1.142E+00	1.864E-01
Total			4.135E+02	1.262E-03	1.178E+04	3.595E+04	5.869E+03

4 Handling Socket Volume = 6.845E+04 cc
Flux = 9.068E+11 n/cm2/s (time avg.) Total Mass = 9.445E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	9.842E-03	1.438E-07	1.114E+01	1.627E+02	1.179E+02
Ni-59	58.93	7.602E+04	2.202E-01	3.217E-06	1.757E-02	2.567E-01	1.860E-01
Ni-63	62.93	1.000E+02	2.972E-02	4.343E-07	1.688E+00	2.466E+01	1.787E+01
Mo-93	92.91	3.501E+03	6.223E-03	9.092E-08	6.840E-03	9.994E-02	7.242E-02
Tc-99	98.91	2.130E+05	1.139E-01	1.665E-06	1.933E-03	2.824E-02	2.046E-02
Nb-94	93.91	2.000E+04	1.015E-02	1.482E-07	1.931E-03	2.821E-02	2.044E-02
C-14	14.00	5.730E+03	7.405E-05	1.082E-09	3.300E-04	4.821E-03	3.494E-03
Total			3.901E-01	5.700E-06	1.285E+01	1.878E+02	1.361E+02

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

5 Nozzle Volume = 3.256E+05 cc
Flux = 3.091E+12 n/cm2/s (time avg.) Total Mass = 1.093E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.276E-01	1.006E-06	3.706E+02	1.138E+03	3.392E+02
Ni-59	58.93	7.602E+04	7.857E+00	2.413E-05	6.270E-01	1.926E+00	5.739E-01
Ni-63	62.93	1.000E+02	1.083E+00	3.326E-06	6.150E+01	1.889E+02	5.629E+01
Mo-93	92.91	3.501E+03	2.671E-01	8.205E-07	2.936E-01	9.019E-01	2.687E-01
Tc-99	98.91	2.130E+05	3.774E+00	1.159E-05	6.403E-02	1.967E-01	5.860E-02
Nb-94	93.91	2.000E+04	3.923E-01	1.205E-06	7.465E-02	2.293E-01	6.833E-02
C-14	14.00	5.730E+03	2.632E-03	8.084E-09	1.173E-02	3.603E-02	1.073E-02
Total			1.370E+01	4.209E-05	4.332E+02	1.331E+03	3.965E+02

6 Row 8 Refl. Volume = 1.144E+06 cc
Flux = 3.538E+14 n/cm2/s (time avg.) Total Mass = 8.323E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.249E+02	1.966E-04	2.545E+05	2.224E+05	3.057E+04
Ni-59	58.93	7.602E+04	9.591E+03	8.384E-03	7.654E+02	6.691E+02	9.196E+01
Ni-63	62.93	1.000E+02	1.749E+03	1.529E-03	9.932E+04	8.683E+04	1.193E+04
Mo-93	92.91	3.501E+03	7.960E+01	6.959E-05	8.749E+01	7.648E+01	1.051E+01
Tc-99	98.91	2.130E+05	5.657E+02	4.945E-04	9.597E+00	8.390E+00	1.153E+00
Nb-94	93.91	2.000E+04	5.898E+01	5.156E-05	1.122E+01	9.812E+00	1.349E+00
C-14	14.00	5.730E+03	5.192E-01	4.539E-07	2.314E+00	2.023E+00	2.780E-01
Total			1.227E+04	1.073E-02	3.547E+05	3.100E+05	4.261E+04

7 RRA-8&9 upper shield Volume = 1.113E+06 cc
Flux = 2.006E+13 n/cm2/s (time avg.) Total Mass = 7.860E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	6.190E+00	5.561E-06	7.004E+03	6.291E+03	8.910E+02
Ni-59	58.93	7.602E+04	1.814E+02	1.630E-04	1.448E+01	1.301E+01	1.842E+00
Ni-63	62.93	1.000E+02	2.335E+01	2.097E-05	1.326E+03	1.191E+03	1.687E+02
Mo-93	92.91	3.501E+03	1.392E+01	1.251E-05	1.530E+01	1.374E+01	1.947E+00
Tc-99	98.91	2.130E+05	9.913E+01	8.905E-05	1.682E+00	1.511E+00	2.140E-01
Nb-94	93.91	2.000E+04	1.279E+01	1.149E-05	2.433E+00	2.186E+00	3.096E-01
C-14	14.00	5.730E+03	5.817E-02	5.226E-08	2.592E-01	2.329E-01	3.298E-02
Total			3.369E+02	3.026E-04	8.364E+03	7.513E+03	1.064E+03

8 RR-8&9 lower shield/orif Volume = 6.552E+05 cc
Flux = 5.175E+13 n/cm2/s (time avg.) Total Mass = 3.072E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	7.482E+00	1.142E-05	8.465E+03	1.292E+04	2.756E+03
Ni-59	58.93	7.602E+04	2.030E+02	3.098E-04	1.620E+01	2.472E+01	5.273E+00
Ni-63	62.93	1.000E+02	2.676E+01	4.084E-05	1.520E+03	2.319E+03	4.947E+02
Mo-93	92.91	3.501E+03	1.291E+01	1.971E-05	1.419E+01	2.166E+01	4.621E+00
Tc-99	98.91	2.130E+05	1.050E+02	1.603E-04	1.781E+00	2.719E+00	5.799E-01
Nb-94	93.91	2.000E+04	1.331E+01	2.032E-05	2.533E+00	3.867E+00	8.248E-01
C-14	14.00	5.730E+03	6.850E-02	1.045E-07	3.052E-01	4.659E-01	9.938E-02
Total			3.685E+02	5.624E-04	1.002E+04	1.529E+04	3.262E+03

9 Handling Socket Volume = 1.365E+05 cc
Flux = 4.624E+11 n/cm2/s (time avg.) Total Mass = 1.884E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	9.856E-03	7.219E-08	1.115E+01	8.167E+01	5.918E+01
Ni-59	58.93	7.602E+04	2.430E-01	1.780E-06	1.939E-02	1.420E-01	1.029E-01

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

Ni-63	62.93	1.000E+02	3.298E-02	2.416E-07	1.873E+00	1.372E+01	9.941E+00
Mo-93	92.91	3.501E+03	6.368E-03	4.664E-08	6.999E-03	5.126E-02	3.714E-02
Tc-99	98.91	2.130E+05	1.206E-01	8.829E-07	2.045E-03	1.498E-02	1.085E-02
Nb-94	93.91	2.000E+04	1.055E-02	7.725E-08	2.007E-03	1.470E-02	1.065E-02
C-14	14.00	5.730E+03	8.288E-05	6.070E-10	3.693E-04	2.705E-03	1.960E-03
Total			4.234E-01	3.101E-06	1.306E+01	9.562E+01	6.929E+01

10 Control Rod B4C Volume = 7.001E+04 cc
Flux = 4.657E+14 n/cm2/s (time avg.) Total Mass = 2.330E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.371E-01	1.959E-06	1.551E+02	2.216E+03	6.659E+02
Ni-59	58.93	7.602E+04	4.592E+01	6.559E-04	3.664E+00	5.234E+01	1.573E+01
Ni-63	62.93	1.000E+02	2.969E+00	4.242E-05	1.686E+02	2.409E+03	7.239E+02
Mo-93	92.91	3.501E+03	6.100E+00	8.713E-05	6.704E+00	9.576E+01	2.878E+01
Tc-99	98.91	2.130E+05	1.936E+01	2.765E-04	3.284E-01	4.691E+00	1.410E+00
Nb-94	93.91	2.000E+04	2.450E+00	3.499E-05	4.662E-01	6.659E+00	2.001E+00
C-14	14.00	5.730E+03	6.346E-02	9.065E-07	2.828E-01	4.040E+00	1.214E+00
Total			7.699E+01	1.100E-03	3.352E+02	4.789E+03	1.439E+03

11 Control Rod Follower Volume = 1.479E+04 cc
Flux = 2.340E+15 n/cm2/s (time avg.) Total Mass = 4.593E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.392E-01	1.617E-05	2.706E+02	1.829E+04	5.892E+03
Ni-59	58.93	7.602E+04	4.704E+01	3.180E-03	3.754E+00	2.538E+02	8.174E+01
Ni-63	62.93	1.000E+02	3.706E+00	2.505E-04	2.105E+02	1.423E+04	4.582E+03
Mo-93	92.91	3.501E+03	6.822E+00	4.612E-04	7.498E+00	5.069E+02	1.632E+02
Tc-99	98.91	2.130E+05	2.238E+01	1.513E-03	3.796E-01	2.566E+01	8.265E+00
Nb-94	93.91	2.000E+04	2.847E+00	1.925E-04	5.418E-01	3.663E+01	1.180E+01
C-14	14.00	5.730E+03	4.694E-02	3.173E-06	2.092E-01	1.414E+01	4.554E+00
Total			8.308E+01	5.616E-03	4.935E+02	3.336E+04	1.074E+04

12 Control Rod Sodium Chann Volume = 4.934E+04 cc
Flux = 1.960E+15 n/cm2/s (time avg.) Total Mass = 3.686E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.361E-01	8.838E-06	4.934E+02	1.000E+04	1.339E+04
Ni-59	58.93	7.602E+04	3.272E+01	6.631E-04	2.611E+00	5.292E+01	7.084E+01
Ni-63	62.93	1.000E+02	2.987E+00	6.054E-05	1.697E+02	3.439E+03	4.603E+03
Mo-93	92.91	3.501E+03	4.741E+00	9.608E-05	5.211E+00	1.056E+02	1.414E+02
Tc-99	98.91	2.130E+05	1.772E+01	3.592E-04	3.006E-01	6.093E+00	8.157E+00
Nb-94	93.91	2.000E+04	2.034E+00	4.122E-05	3.870E-01	7.843E+00	1.050E+01
C-14	14.00	5.730E+03	3.124E-02	6.331E-07	1.392E-01	2.822E+00	3.777E+00
Total			6.067E+01	1.230E-03	6.717E+02	1.361E+04	1.822E+04

13 Control Shield Volume = 5.456E+04 cc
Flux = 2.196E+14 n/cm2/s (time avg.) Total Mass = 2.988E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.328E+00	6.099E-05	3.765E+03	6.900E+04	1.260E+04
Ni-59	58.93	7.602E+04	6.933E+01	1.271E-03	5.533E+00	1.014E+02	1.851E+01
Ni-63	62.93	1.000E+02	1.082E+01	1.984E-04	6.147E+02	1.127E+04	2.057E+03
Mo-93	92.91	3.501E+03	4.807E+00	8.810E-05	5.283E+00	9.683E+01	1.768E+01
Tc-99	98.91	2.130E+05	4.146E+01	7.599E-04	7.034E-01	1.289E+01	2.354E+00
Nb-94	93.91	2.000E+04	4.574E+00	8.383E-05	8.704E-01	1.595E+01	2.913E+00
C-14	14.00	5.730E+03	3.086E-02	5.657E-07	1.375E-01	2.521E+00	4.603E-01
Total			1.344E+02	2.462E-03	4.392E+03	8.050E+04	1.470E+04

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

14 Nozzle Volume = 1.980E+05 cc
Flux = 5.738E+12 n/cm2/s (time avg.) Total Mass = 6.644E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.583E-01	1.810E-06	4.053E+02	2.047E+03	6.101E+02
Ni-59	58.93	7.602E+04	8.504E+00	4.296E-05	6.787E-01	3.428E+00	1.021E+00
Ni-63	62.93	1.000E+02	1.181E+00	5.965E-06	6.707E+01	3.388E+02	1.009E+02
Mo-93	92.91	3.501E+03	2.831E-01	1.430E-06	3.111E-01	1.572E+00	4.683E-01
Tc-99	98.91	2.130E+05	4.371E+00	2.208E-05	7.416E-02	3.746E-01	1.116E-01
Nb-94	93.91	2.000E+04	4.299E-01	2.171E-06	8.180E-02	4.132E-01	1.231E-01
C-14	14.00	5.730E+03	2.880E-03	1.455E-08	1.284E-02	6.483E-02	1.932E-02
Total			1.513E+01	7.643E-05	4.736E+02	2.392E+03	7.128E+02

15 Control Rod above B4C Volume = 2.435E+04 cc
Flux = 2.068E+13 n/cm2/s (time avg.) Total Mass = 7.218E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	6.700E-02	2.751E-06	7.580E+01	3.113E+03	1.050E+03
Ni-59	58.93	7.602E+04	1.654E+00	6.794E-05	1.320E-01	5.422E+00	1.829E+00
Ni-63	62.93	1.000E+02	2.162E-01	8.878E-06	1.228E+01	5.043E+02	1.701E+02
Mo-93	92.91	3.501E+03	1.405E-01	5.769E-06	1.544E-01	6.341E+00	2.139E+00
Tc-99	98.91	2.130E+05	1.301E+00	5.344E-05	2.208E-02	9.065E-01	3.058E-01
Nb-94	93.91	2.000E+04	1.372E-01	5.635E-06	2.611E-02	1.072E+00	3.618E-01
C-14	14.00	5.730E+03	5.101E-04	2.095E-08	2.273E-03	9.335E-02	3.149E-02
Total			3.517E+00	1.444E-04	8.842E+01	3.631E+03	1.225E+03

16 Control Rod Driveline Volume = 2.653E+05 cc
Flux = 5.316E+12 n/cm2/s (time avg.) Total Mass = 5.054E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.913E-01	7.210E-07	2.164E+02	8.157E+02	4.282E+02
Ni-59	58.93	7.602E+04	4.490E+00	1.693E-05	3.583E-01	1.351E+00	7.090E-01
Ni-63	62.93	1.000E+02	6.071E-01	2.289E-06	3.448E+01	1.300E+02	6.823E+01
Mo-93	92.91	3.501E+03	2.209E-01	8.328E-07	2.428E-01	9.154E-01	4.805E-01
Tc-99	98.91	2.130E+05	2.920E+00	1.101E-05	4.953E-02	1.867E-01	9.801E-02
Nb-94	93.91	2.000E+04	2.937E-01	1.107E-06	5.589E-02	2.107E-01	1.106E-01
C-14	14.00	5.730E+03	1.443E-03	5.440E-09	6.431E-03	2.424E-02	1.273E-02
Total			8.724E+00	3.289E-05	2.516E+02	9.484E+02	4.978E+02

17 Handling Socket Volume = 1.024E+05 cc
Flux = 1.635E+12 n/cm2/s (time avg.) Total Mass = 1.413E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.574E-02	2.513E-07	2.912E+01	2.843E+02	2.060E+02
Ni-59	58.93	7.602E+04	5.823E-01	5.686E-06	4.647E-02	4.538E-01	3.288E-01
Ni-63	62.93	1.000E+02	7.782E-02	7.600E-07	4.420E+00	4.316E+01	3.128E+01
Mo-93	92.91	3.501E+03	1.655E-02	1.616E-07	1.819E-02	1.776E-01	1.287E-01
Tc-99	98.91	2.130E+05	3.032E-01	2.961E-06	5.144E-03	5.023E-02	3.640E-02
Nb-94	93.91	2.000E+04	2.763E-02	2.698E-07	5.258E-03	5.135E-02	3.721E-02
C-14	14.00	5.730E+03	1.947E-04	1.901E-09	8.675E-04	8.472E-03	6.139E-03
Total			1.033E+00	1.009E-05	3.361E+01	3.283E+02	2.379E+02

18 Safety Rod B4C Volume = 3.462E+04 cc
Flux = 2.147E+14 n/cm2/s (time avg.) Total Mass = 1.152E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	6.619E-02	1.912E-06	7.489E+01	2.163E+03	6.499E+02
Ni-59	58.93	7.602E+04	1.091E+01	3.150E-04	8.705E-01	2.514E+01	7.555E+00

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

Ni-63	62.93	1.000E+02	8.844E-01	2.554E-05	5.023E+01	1.451E+03	4.359E+02
Mo-93	92.91	3.501E+03	1.534E+00	4.430E-05	1.686E+00	4.869E+01	1.463E+01
Tc-99	98.91	2.130E+05	5.444E+00	1.572E-04	9.235E-02	2.667E+00	8.015E-01
Nb-94	93.91	2.000E+04	7.437E-01	2.148E-05	1.415E-01	4.087E+00	1.228E+00
C-14	14.00	5.730E+03	1.125E-02	3.250E-07	5.014E-02	1.448E+00	4.352E-01
Total			1.959E+01	5.658E-04	1.280E+02	3.696E+03	1.111E+03

19 Safety Rod Follower Volume = 7.316E+03 cc
Flux = 1.926E+15 n/cm2/s (time avg.) Total Mass = 2.272E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	8.720E-02	1.192E-05	9.866E+01	1.348E+04	4.343E+03
Ni-59	58.93	7.602E+04	2.032E+01	2.778E-03	1.622E+00	2.217E+02	7.140E+01
Ni-63	62.93	1.000E+02	1.684E+00	2.302E-04	9.567E+01	1.308E+04	4.211E+03
Mo-93	92.91	3.501E+03	3.197E+00	4.369E-04	3.513E+00	4.802E+02	1.547E+02
Tc-99	98.91	2.130E+05	9.094E+00	1.243E-03	1.543E-01	2.109E+01	6.791E+00
Nb-94	93.91	2.000E+04	1.304E+00	1.782E-04	2.481E-01	3.391E+01	1.092E+01
C-14	14.00	5.730E+03	1.789E-02	2.446E-06	7.974E-02	1.090E+01	3.510E+00
Total			3.571E+01	4.881E-03	1.999E+02	2.733E+04	8.802E+03

20 Safety Rod Sodium Channe Volume = 3.355E+04 cc
Flux = 2.665E+15 n/cm2/s (time avg.) Total Mass = 2.506E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.043E-01	9.071E-06	3.443E+02	1.026E+04	1.374E+04
Ni-59	58.93	7.602E+04	2.890E+01	8.613E-04	2.306E+00	6.873E+01	9.201E+01
Ni-63	62.93	1.000E+02	2.648E+00	7.893E-05	1.504E+02	4.483E+03	6.001E+03
Mo-93	92.91	3.501E+03	4.300E+00	1.282E-04	4.727E+00	1.409E+02	1.886E+02
Tc-99	98.91	2.130E+05	1.451E+01	4.324E-04	2.461E-01	7.335E+00	9.820E+00
Nb-94	93.91	2.000E+04	1.763E+00	5.254E-05	3.354E-01	9.997E+00	1.338E+01
C-14	14.00	5.730E+03	2.804E-02	8.358E-07	1.250E-01	3.725E+00	4.986E+00
Total			5.245E+01	1.563E-03	5.025E+02	1.498E+04	2.005E+04

21 Control Shield Volume = 2.698E+04 cc
Flux = 2.898E+14 n/cm2/s (time avg.) Total Mass = 1.478E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.184E+00	8.095E-05	2.471E+03	9.159E+04	1.672E+04
Ni-59	58.93	7.602E+04	4.211E+01	1.560E-03	3.360E+00	1.245E+02	2.274E+01
Ni-63	62.93	1.000E+02	7.181E+00	2.661E-04	4.079E+02	1.512E+04	2.760E+03
Mo-93	92.91	3.501E+03	3.161E+00	1.171E-04	3.474E+00	1.287E+02	2.350E+01
Tc-99	98.91	2.130E+05	2.661E+01	9.860E-04	4.514E-01	1.673E+01	3.054E+00
Nb-94	93.91	2.000E+04	2.812E+00	1.042E-04	5.350E-01	1.983E+01	3.620E+00
C-14	14.00	5.730E+03	2.048E-02	7.591E-07	9.129E-02	3.383E+00	6.177E-01
Total			8.407E+01	3.116E-03	2.887E+03	1.070E+05	1.954E+04

22 Nozzle Volume = 1.354E+05 cc
Flux = 8.487E+12 n/cm2/s (time avg.) Total Mass = 4.543E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.617E-01	2.672E-06	4.092E+02	3.023E+03	9.008E+02
Ni-59	58.93	7.602E+04	8.759E+00	6.471E-05	6.990E-01	5.164E+00	1.539E+00
Ni-63	62.93	1.000E+02	1.205E+00	8.901E-06	6.843E+01	5.055E+02	1.506E+02
Mo-93	92.91	3.501E+03	2.936E-01	2.169E-06	3.227E-01	2.384E+00	7.105E-01
Tc-99	98.91	2.130E+05	4.170E+00	3.080E-05	7.074E-02	5.226E-01	1.557E-01
Nb-94	93.91	2.000E+04	4.273E-01	3.157E-06	8.132E-02	6.008E-01	1.790E-01
C-14	14.00	5.730E+03	2.955E-03	2.183E-08	1.317E-02	9.728E-02	2.899E-02
Total			1.522E+01	1.124E-04	4.788E+02	3.537E+03	1.054E+03

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

23 Safety Rod above B4C Volume = 2.897E+03 cc
Flux = 1.386E+13 n/cm2/s (time avg.) Total Mass = 8.585E+00 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	5.270E-03	1.819E-06	5.962E+00	2.058E+03	6.945E+02
Ni-59	58.93	7.602E+04	1.375E-01	4.747E-05	1.097E-02	3.788E+00	1.278E+00
Ni-63	62.93	1.000E+02	1.918E-02	6.622E-06	1.089E+00	3.761E+02	1.269E+02
Mo-93	92.91	3.501E+03	9.455E-03	3.264E-06	1.039E-02	3.588E+00	1.210E+00
Tc-99	98.91	2.130E+05	8.639E-02	2.983E-05	1.466E-03	5.060E-01	1.707E-01
Nb-94	93.91	2.000E+04	1.136E-02	3.923E-06	2.162E-03	7.465E-01	2.519E-01
C-14	14.00	5.730E+03	4.240E-05	1.464E-08	1.890E-04	6.524E-02	2.201E-02
Total			2.692E-01	9.293E-05	7.077E+00	2.443E+03	8.243E+02

24 Safety Rod Driveline Volume = 1.814E+05 cc
Flux = 7.285E+12 n/cm2/s (time avg.) Total Mass = 3.455E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.811E-01	9.984E-07	2.049E+02	1.130E+03	5.930E+02
Ni-59	58.93	7.602E+04	4.312E+00	2.377E-05	3.441E-01	1.897E+00	9.959E-01
Ni-63	62.93	1.000E+02	5.784E-01	3.189E-06	3.285E+01	1.811E+02	9.507E+01
Mo-93	92.91	3.501E+03	1.942E-01	1.071E-06	2.135E-01	1.177E+00	6.178E-01
Tc-99	98.91	2.130E+05	2.838E+00	1.564E-05	4.814E-02	2.654E-01	1.393E-01
Nb-94	93.91	2.000E+04	2.770E-01	1.527E-06	5.271E-02	2.906E-01	1.526E-01
C-14	14.00	5.730E+03	1.383E-03	7.623E-09	6.162E-03	3.397E-02	1.783E-02
Total			8.382E+00	4.621E-05	2.384E+02	1.314E+03	6.900E+02

25 Handling Socket Volume = 7.001E+04 cc
Flux = 2.398E+12 n/cm2/s (time avg.) Total Mass = 9.662E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.608E-02	3.725E-07	2.950E+01	4.214E+02	3.054E+02
Ni-59	58.93	7.602E+04	5.794E-01	8.275E-06	4.623E-02	6.604E-01	4.785E-01
Ni-63	62.93	1.000E+02	7.754E-02	1.108E-06	4.404E+00	6.291E+01	4.558E+01
Mo-93	92.91	3.501E+03	1.622E-02	2.316E-07	1.782E-02	2.546E-01	1.845E-01
Tc-99	98.91	2.130E+05	3.140E-01	4.484E-06	5.326E-03	7.608E-02	5.513E-02
Nb-94	93.91	2.000E+04	2.751E-02	3.930E-07	5.235E-03	7.478E-02	5.419E-02
C-14	14.00	5.730E+03	1.943E-04	2.776E-09	8.661E-04	1.237E-02	8.964E-03
Total			1.041E+00	1.487E-05	3.398E+01	4.854E+02	3.517E+02

26 ICSA Volume = 7.932E+04 cc
Flux = 1.314E+15 n/cm2/s (time avg.) Total Mass = 3.635E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.921E+00	4.943E-05	4.436E+03	5.592E+04	1.220E+04
Ni-59	58.93	7.602E+04	2.089E+02	2.633E-03	1.667E+01	2.101E+02	4.585E+01
Ni-63	62.93	1.000E+02	2.343E+01	2.954E-04	1.331E+03	1.678E+04	3.661E+03
Mo-93	92.91	3.501E+03	3.283E+01	4.139E-04	3.608E+01	4.549E+02	9.926E+01
Tc-99	98.91	2.130E+05	1.341E+02	1.691E-03	2.275E+00	2.868E+01	6.258E+00
Nb-94	93.91	2.000E+04	1.529E+01	1.927E-04	2.909E+00	3.667E+01	8.002E+00
C-14	14.00	5.730E+03	1.982E-01	2.499E-06	8.833E-01	1.114E+01	2.430E+00
Total			4.186E+02	5.278E-03	5.825E+03	7.344E+04	1.603E+04

27 ICSA Lower Shield Volume = 2.731E+04 cc
Flux = 2.551E+14 n/cm2/s (time avg.) Total Mass = 2.043E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	2.758E+00	1.010E-04	3.120E+03	1.143E+05	1.527E+04
Ni-59	58.93	7.602E+04	5.576E+01	2.042E-03	4.450E+00	1.630E+02	2.178E+01

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

Ni-63	62.93	1.000E+02	8.916E+00	3.265E-04	5.064E+02	1.855E+04	2.479E+03
Mo-93	92.91	3.501E+03	3.821E+00	1.399E-04	4.199E+00	1.538E+02	2.056E+01
Tc-99	98.91	2.130E+05	3.322E+01	1.217E-03	5.637E-01	2.064E+01	2.759E+00
Nb-94	93.91	2.000E+04	3.528E+00	1.292E-04	6.713E-01	2.459E+01	3.286E+00
C-14	14.00	5.730E+03	2.549E-02	9.336E-07	1.136E-01	4.161E+00	5.561E-01
Total			1.080E+02	3.957E-03	3.636E+03	1.332E+05	1.780E+04

28 Peripheral Shiml Rod B4C Volume = 1.155E+04 cc
Flux = 8.060E+14 n/cm2/s (time avg.) Total Mass = 3.845E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	5.087E-02	4.403E-06	5.755E+01	4.981E+03	1.497E+03
Ni-59	58.93	7.602E+04	1.165E+01	1.009E-03	9.301E-01	8.050E+01	2.419E+01
Ni-63	62.93	1.000E+02	8.917E-01	7.718E-05	5.065E+01	4.383E+03	1.317E+03
Mo-93	92.91	3.501E+03	1.801E+00	1.559E-04	1.979E+00	1.713E+02	5.147E+01
Tc-99	98.91	2.130E+05	6.231E+00	5.393E-04	1.057E-01	9.149E+00	2.749E+00
Nb-94	93.91	2.000E+04	6.965E-01	6.028E-05	1.325E-01	1.147E+01	3.447E+00
C-14	14.00	5.730E+03	1.839E-02	1.592E-06	8.195E-02	7.092E+00	2.131E+00
Total			2.134E+01	1.847E-03	1.114E+02	9.644E+03	2.898E+03

29 PSR Below B4C Volume = 2.083E+03 cc
Flux = 4.902E+14 n/cm2/s (time avg.) Total Mass = 6.469E+00 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	8.283E-02	3.976E-05	9.371E+01	4.498E+04	1.449E+04
Ni-59	58.93	7.602E+04	1.937E+00	9.298E-04	1.546E-01	7.420E+01	2.390E+01
Ni-63	62.93	1.000E+02	3.298E-01	1.583E-04	1.873E+01	8.991E+03	2.896E+03
Mo-93	92.91	3.501E+03	2.714E-01	1.303E-04	2.983E-01	1.432E+02	4.611E+01
Tc-99	98.91	2.130E+05	1.131E+00	5.427E-04	1.918E-02	9.207E+00	2.965E+00
Nb-94	93.91	2.000E+04	1.593E-01	7.646E-05	3.031E-02	1.455E+01	4.686E+00
C-14	14.00	5.730E+03	1.293E-03	6.207E-07	5.763E-03	2.766E+00	8.909E-01
Total			3.912E+00	1.878E-03	1.130E+02	5.422E+04	1.746E+04

30 PSR above B4C Volume = 1.252E+04 cc
Flux = 1.277E+14 n/cm2/s (time avg.) Total Mass = 3.711E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.600E-01	1.278E-05	1.811E+02	1.446E+04	4.879E+03
Ni-59	58.93	7.602E+04	4.080E+00	3.258E-04	3.256E-01	2.600E+01	8.773E+00
Ni-63	62.93	1.000E+02	5.507E-01	4.398E-05	3.127E+01	2.498E+03	8.427E+02
Mo-93	92.91	3.501E+03	3.448E-01	2.754E-05	3.789E-01	3.026E+01	1.021E+01
Tc-99	98.91	2.130E+05	2.582E+00	2.062E-04	4.380E-02	3.498E+00	1.180E+00
Nb-94	93.91	2.000E+04	3.133E-01	2.502E-05	5.962E-02	4.762E+00	1.607E+00
C-14	14.00	5.730E+03	1.855E-03	1.482E-07	8.268E-03	6.603E-01	2.228E-01
Total			8.032E+00	6.415E-04	2.132E+02	1.702E+04	5.744E+03

31 PSR Plenum Volume = 1.773E+05 cc
Flux = 2.663E+12 n/cm2/s (time avg.) Total Mass = 3.378E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	5.344E-02	3.014E-07	6.046E+01	3.410E+02	1.790E+02
Ni-59	58.93	7.602E+04	1.439E+00	8.115E-06	1.148E-01	6.476E-01	3.399E-01
Ni-63	62.93	1.000E+02	1.951E-01	1.100E-06	1.108E+01	6.250E+01	3.281E+01
Mo-93	92.91	3.501E+03	7.804E-02	4.401E-07	8.578E-02	4.837E-01	2.539E-01
Tc-99	98.91	2.130E+05	7.188E-01	4.053E-06	1.219E-02	6.877E-02	3.610E-02
Nb-94	93.91	2.000E+04	9.168E-02	5.170E-07	1.745E-02	9.839E-02	5.165E-02
C-14	14.00	5.730E+03	4.441E-04	2.505E-09	1.979E-03	1.116E-02	5.859E-03
Total			2.576E+00	1.453E-05	7.178E+01	4.048E+02	2.125E+02

Table E-16 Output File from Transmut2 Case tmut10emrr to Compute Radionuclide Inventories in Radial Reflectors (9 Sheets)

32 PSR Lower Shield Volume = 9.117E+03 cc
Flux = 7.737E+13 n/cm2/s (time avg.) Total Mass = 4.994E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	Concentration (uCi/g)
Co-60	59.93	5.272E+00	1.552E-01	1.702E-05	1.756E+02	1.925E+04	3.516E+03
Ni-59	58.93	7.602E+04	4.274E+00	4.688E-04	3.411E-01	3.741E+01	6.831E+00
Ni-63	62.93	1.000E+02	5.743E-01	6.299E-05	3.262E+01	3.577E+03	6.532E+02
Mo-93	92.91	3.501E+03	2.935E-01	3.219E-05	3.226E-01	3.538E+01	6.460E+00
Tc-99	98.91	2.130E+05	2.216E+00	2.431E-04	3.759E-02	4.123E+00	7.529E-01
Nb-94	93.91	2.000E+04	2.932E-01	3.215E-05	5.579E-02	6.119E+00	1.117E+00
C-14	14.00	5.730E+03	1.536E-03	1.684E-07	6.843E-03	7.506E-01	1.370E-01
Total			7.808E+00	8.564E-04	2.089E+02	2.292E+04	4.184E+03

program done

This page intentionally left blank

APPENDIX F
COMPARISON OF NEUTRON AND PHOTON ATTENUATION IN FFTF SHIELD MATERIALS

COMPARISON OF NEUTRON AND PHOTON ATTENUATION IN FFTF SHIELD MATERIALS

As described in the main part of this report, dose rates were computed at points outside the reactor vessel from photon sources in activated materials in the vessel. Photon sources now and in the near-term future are dominated by ^{60}Co in steel and Inconel. In preparation for computing these dose rates, a study was completed to bound the task of converting the complete ^{60}Co inventory distribution to photon source rate distributions for input to MCNP4C (Briesmeister 2001). In this study, neutron and photon attenuation through shield materials were compared.

From the results of MCNP4C case fftf10ed, a distribution of ^{60}Co production rates through the radial shield was obtained. Then, a point-kernel shielding calculation using ISOSHLD 1.6 (Lourant 1989) was completed to characterize the photon attenuation (i.e., dose rate drop) as the thickness of a steel shield is increased. In this calculation, a ^{60}Co source was assumed as just to the inside of the radial shield. The input file for the ISOSHLD calculation is listed in Table F-1.

Normalized dose and ^{60}Co production rates are plotted in Figure F-1. This figure shows that the photon dose rate drops much more rapidly as the shield thickness is increased than the ^{60}Co production rate drops off through the radial shield due to neutron attenuation. This indicates that photons are attenuated at a much higher rate than neutrons in steel. Thus, the conclusion is that materials with reduced photon sources (due to neutron attenuation), but at locations with little shielding to a dose point are much more important to the dose rate than materials nearer the reactor core with higher photon sources, but which are heavily shielded to a dose point. For example, from figure F-1 the outer edge of the radial shield has a ^{60}Co concentration only about 3% of that near the inside edge. But, the dose rate outside the shield due to a unit source at the outer edge of the shield is almost seven orders of magnitude higher than the dose rate due to a unit source near the inside edge of the shield. Even considering the factor of 30 difference between ^{60}Co production rates (and hence photon source rates) between the inside and outside edges of the radial shield, sources in a unit mass near the outer part of the shield will contribute about five orders of magnitude more to the dose rate outboard of the shield than sources in a unit mass near the inner part of the shield.

References

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

Lourant, I. O, and P. D. Rittmann, 1989, *Validation of ISOSHLD-PC on the IBM PC (PS-2/AT/XT*, WHC-SD-SQA-CSWD-303, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

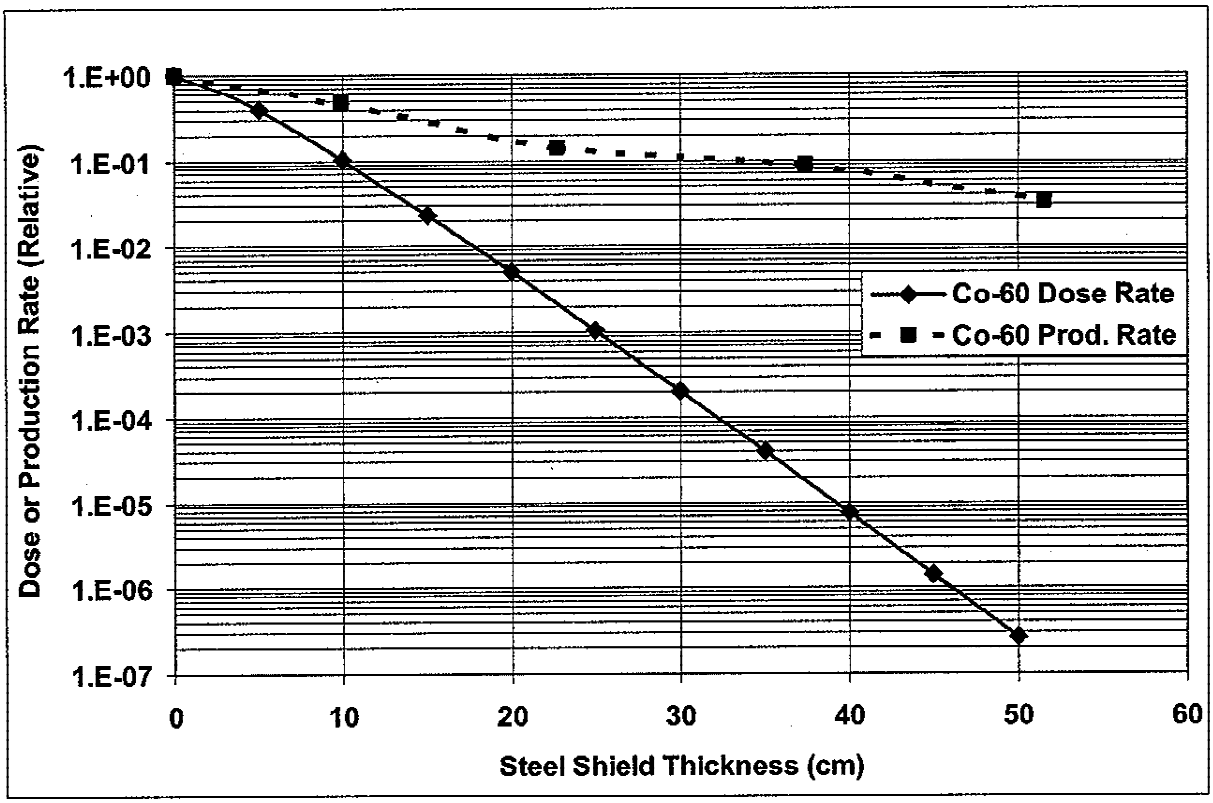


Figure F-1. Comparison of ^{60}Co Production Rate and Dose Rate through the FFTF Radial Shield

Table F-1. ISOSHLD 1.6 Input File to Compute Dose Rates as a Function of Steel Shield Thickness

```
0          2FFTF Co-60 Source Shielded by Varying Thicknesses of Steel @ 7.2 g/cc
Dose Rate 2 m from source shielded by  0 cm steel
 &INPUT NEXT=1, IGEOM=9, SLTH=1, OPTION=0,
  NSHLD=2, JBUF=2,
  T(1)=1, T(2)=.01, X=100, ICONC=0, SFACT=1,
     Weight(472) = 1,
 &
1IRON     9       7.2        7.2
Dose Rate 2 m from source shielded by  5 cm steel
 &INPUT NEXT=4, T(2)=5 &
Dose Rate 2 m from source shielded by 10 cm steel
 &INPUT NEXT=4, T(2)=10 &
Dose Rate 2 m from source shielded by 15 cm steel
 &INPUT NEXT=4, T(2)=15 &
Dose Rate 2 m from source shielded by 20 cm steel
 &INPUT NEXT=4, T(2)=20 &
Dose Rate 2 m from source shielded by 25 cm steel
 &INPUT NEXT=4, T(2)=25 &
Dose Rate 2 m from source shielded by 30 cm steel
 &INPUT NEXT=4, T(2)=30 &
Dose Rate 2 m from source shielded by 35 cm steel
 &INPUT NEXT=4, T(2)=35 &
Dose Rate 2 m from source shielded by 40 cm steel
 &INPUT NEXT=4, T(2)=40 &
Dose Rate 2 m from source shielded by 45 cm steel
 &INPUT NEXT=4, T(2)=45 &
Dose Rate 2 m from source shielded by 50 cm steel
 &INPUT NEXT=4, T(2)=50 &
END OF RUN
 &INPUT NEXT=6 &  END
```

APPENDIX G
ADJUSTMENTS MADE TO RADIONUCLIDE INVENTORIES IN THE CLOSURE HEAD ASSEMBLY

ADJUSTMENTS MADE TO RADIONUCLIDE INVENTORIES IN THE CLOSURE HEAD ASSEMBLY

Radionuclide inventories for the closure head assembly (the head itself plus shield, reflector and suppressor plates below the head) were computed in Transmut2 case tmut10ef from reaction rates tallied in MCNP4C (Briesmeister 2001, Johnson 2002) case fftf10ef. The Transmut2 results for the head assembly components are included in Appendix E, Table E-15. However, two significant adjustments to those raw results were necessary. The first adjustment was made to account for penetrations through the head assembly. The second adjustment was included to account for the effect of the In-Reactor Thimble (IRT) during the FFTF initial power run. The adjustments are described in Sections G.1 and G.3 below. Section G.2 describes how the shield plug assemblies for the instrument trees and IVHMs were accounted for.

G.1 Penetrations in the Closure Head Assembly

The reactor closure head is 25 ft in diameter and about 22 in. thick. The complete assembly, including under-the-head shielding, weighs about 214 tons (Cabell 1980). Starting at the top, this shielding consists of:

1. two 4-in. carbon steel (A-516) shield plates,

2. one 4-in. type 410 stainless steel (SS-410) shield plate,

3. one 5-in. Inconel 600 shield plate,

4. eight type 304 stainless steel (SS-304) thermal reflector plates consisting of seven 16-gauge (0.0598-in thick) SS-304 plates and one 0.25-in thick SS-304 plate spaced so they extend over about 5 in. (estimated from Figure 3-19 in Cabell 1980, which contains a photograph of an instrument tree that clearly shows the shield plug assembly),

5. one 0.25-in. type 316 stainless steel (SS-316) gas-entrainment suppressor plate.

The head assembly has 50 major penetrations (Cabell 1980), but all are small compared to the three instrument tree and three In-Vessel Handling Machine (IVHM) penetrations. However, the FFTF model did not include these penetrations. So, the metal removed from the head assembly for the six largest penetrations was accounted for during post-processing of the Transmut2 results. The radionuclide contents of material in the remaining penetrations (plugs, bolts, etc.) were considered to be part of the head assembly for accounting purposes.

The surface areas of the IVHM and instrument tree penetrations were estimated from Figure 4-8 in Cabell 1980. That Figure is included in this appendix as Figure G-1. Based on these estimates, 18.4% of the head surface area consists of the IVHM penetrations, 11.6% consists of instrument tree penetrations and 10% consists of other penetrations. Radionuclide inventories (grams and curies) computed by Transmut2 thus were reduced by 30% to account for

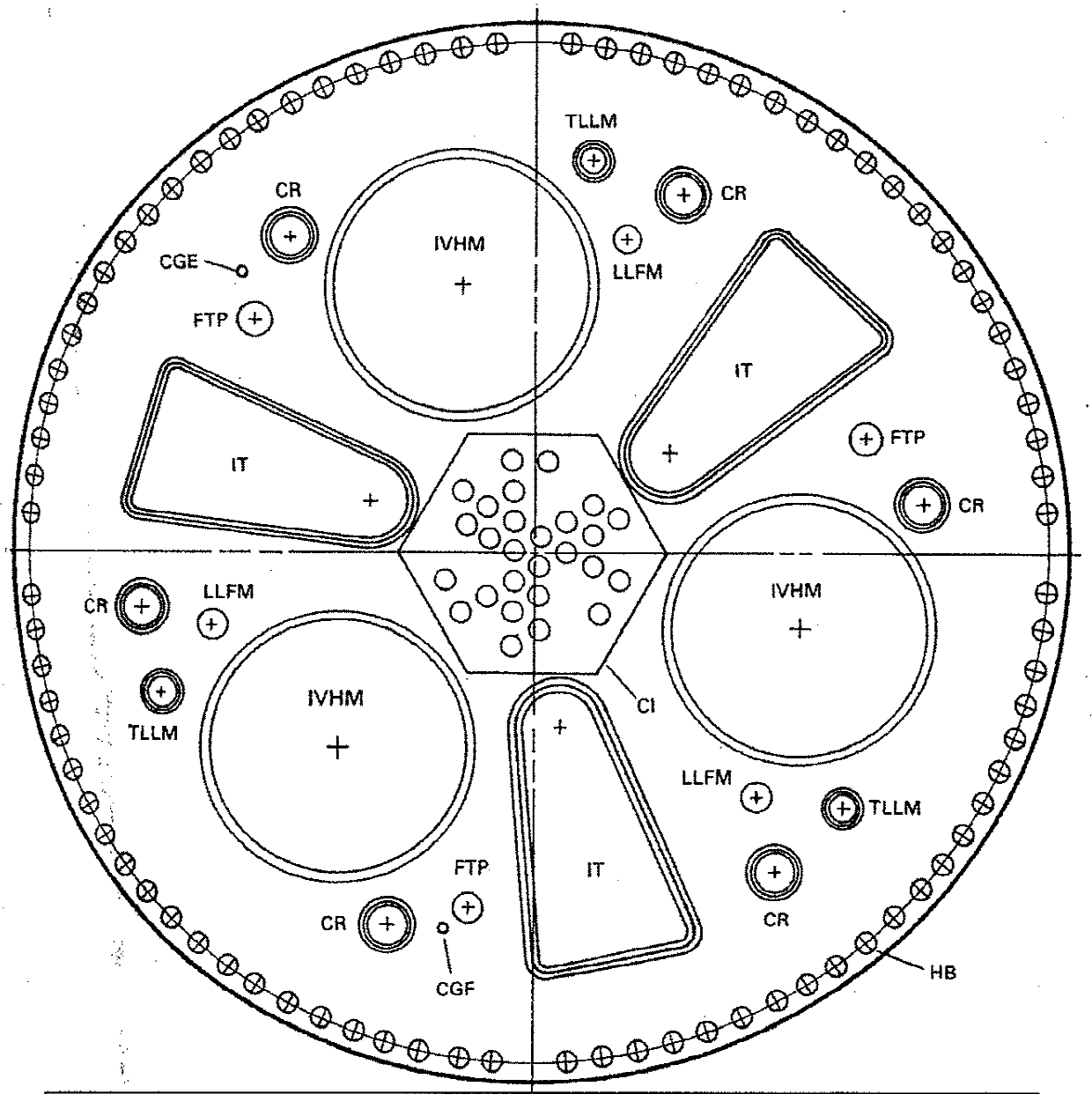
the IVHM and instrument tree penetrations. After this reduction, plus another 10% for the other penetrations, the as-modeled head assembly was computed to weigh 218 tons, within 1.9% over the stated mass of 214 tons.

G.2 Shield Plug Assemblies for the Instrument Trees and In-Vessel Handling Machines

Radionuclide inventories in the shield plug assemblies for the instrument trees and IVHMs were estimated based on results computed for the reactor head assembly. The construction of the shield plug assemblies was nearly the same as that of the head assembly. That is, the arrangement and composition of the shield, reflector and suppressor plates below the plugs were identical to those for the head assembly. The only significant difference between the construction of the head assembly and shield plug assemblies is that the shield plugs are constructed of SS-304, while the head is constructed of carbon steel.

The radionuclide inventories in the shield, reflector and suppressor plates below the instrument tree shield plugs were estimated to be 11.6% of those computed in Tranmut2 case tmut10ef. Likewise, the inventories in the shield, reflector and suppressor plates below the IVHM shield plugs was estimated to be 18.4% of those computed in the same tranmut2 case. In applying the 11.6% and 18.4% factors described in Section G.1, it was assumed that the shield plug assemblies were exposed to neutron flux levels that were the same as the average flux levels in the head and shield plug assemblies combined. This assumption is justified because both types of shield plug assemblies extend radially over a large portion of the head and are centered slightly more than half way between the center and edge of the head, as seen in Figure G-1.

Because the shield plugs were constructed of a different type of steel than the reactor head, a separate Transmut2 case was run to obtain inventories in the shield plugs. Input for this case (tmut10efsp2) was identical to the input for case tmut10ef, except that the composition of the head in the atom density file was changed from carbon steel to SS-304. The revised atom density file was named atdens9fsp.prn. The results of the Transmut2 calculation for the head, after specifying its composition to be SS-304 is listed in Table G-1. The data listed in Table 6-3 for the instrument tree and IVHM shield plugs are, respectively, 11.6% and 18.4% of the values listed in Table G-1.



LEGEND

CGE – Cover Gas Equilization Port (1)
CGE – Cover Gas Feed Port (1)
CI – Center Island (27 penetrations)
CR – Core Restraint
FTP – Fuel Transfer Port
HB – Head Bolt Penetrations (84)
IT – Instrument Trees (3)
IVHM – In-Vessel handling Machine (3)
LLFM – Low Level Flux Monitor (3)
TLLM - Temperature/Liquid Level Monitor (3)

Figure G-1. Reactor Head Penetrations (Cabell 1980, Figure 4-8)

Table G-1. Results of Transmut2 Case tmut10efsp2 to Estimate Radionuclide Inventories in Instrument Tree and IVHM Shield Plugs

5 Shield Plugs in Head Volume = 2.469E+07 cc
Flux = 1.825E+05 n/cm2/s (time avg.) Total Mass = 1.976E+05 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	6.105E-06	2.472E-13	6.908E-03	2.797E-04	3.497E-05
Ni-59	58.93	7.602E+04	1.314E-04	5.321E-12	1.049E-05	4.247E-07	5.308E-08
Ni-63	62.93	1.000E+02	1.854E-05	7.510E-13	1.053E-03	4.265E-05	5.332E-06
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	1.381E-06	5.592E-14	2.628E-07	1.064E-08	1.330E-09
C-14	14.00	5.730E+03	6.498E-07	2.631E-14	2.896E-06	1.173E-07	1.466E-08
Total			1.581E-04	6.402E-12	7.974E-03	3.229E-04	4.037E-05

G.3 Effect of the In-Reactor Thimble

The In-Reactor Thimble (IRT) was inserted into a row 2 location for low-power reactor experiments performed prior to high-power testing. In essence, the IRT was a hollow tube extending from the operating deck down through the reactor core. It was designed to allow small samples to be lowered and positioned at various elevations to obtain material reactivity worth measurements. It was originally planned to remove the IRT before any high-power testing took place. However, to accelerate the schedule for the initial power run (IPR), the decision was made to leave the IRT in the core for the IPR.

A shield plug was fabricated and lowered into the IRT to reduce neutron streaming above the reactor head. However, the flux levels at the head assembly during the IPR were grossly higher than those during subsequent operations after the IRT was removed. In 1995, L. L. Carter completed an analysis to quantify the increased flux levels in the head assembly due to neutron streaming through the IRT. Documentation of that analysis is included as an attachment to this appendix. Carter's conclusion was that during the IPR, the total neutron flux in the central area of the head assembly was about 60,000 times higher than it would have been without the IRT. Based on that analysis, it was deemed important to evaluate the overall effect of the IRT on activation of the head assembly.

In MCNP4C case fftf10ef, reaction rates over all head assembly components were computed. The IRT was not in the calculational model in that case, or in any other case completed as part of this analysis. To properly assess the effect of the IRT, more detailed information on the reaction rates and total flux was needed. So, two additional cases were analyzed using MCNP4C. In the first case (fftf10eh), a complete set of reaction rates was tallied for each of the central two cells in each head assembly component (the head plus the shield, reflector and suppressor plates below the head). In the second case (fftf10eh2), the total flux was tallied in each of the cells in the head so that the radial distribution of the flux in the head could be obtained.

The average flux level in the closure head from MCNP4C case fftf10ef and Transmut2 case tmut10ef, described elsewhere in this report, was computed to be 1.8×10^5 n/cm^2-s. However, Carter reported a total neutron flux of only 870 n/cm^2-s at the center of the head without the IRT based on a reactor power of 400 MW thermal. But, considering statistical uncertainties, Carter's value is in good agreement with the value of 386 n/cm^2-s at the center of the head from MCNP4C case fftf10eh and Transmut2 case tmut10eh, where the power was scaled to 206 MW. Normalizing to 400 MW gives a flux of 750 n/cm^2-s, which is 14% less than Carter's result, but well within the 31% uncertainty in Carter's result.

The graph in Figure G-2 explains the difference between the central flux of 386 n/cm^2-s and the head average value computed to be 1.8×10^5 n/cm^2-s at 206 MW. The data in that graph, which were from MCNP4C case fftf10eh2 and Transmut2 case tmut10eh2, show that the flux at the outer part of the head is orders of magnitude higher than at the center. This is presumably due to neutrons streaming up through the very-low density spaces outside the vessel wall, bypassing the 5 m of sodium between the core and the head. The total flux at the vessel wall was computed to average 3.9×10^9 n/cm^2-s, so flux levels near 10^6 n/cm^2-s at the outside edge of the head are not unreasonable.

The effect of the IRT is local, so its overall effect on the activation of the head assembly is not as dramatic as might be expected from Carter's results alone. The overall effect was calculated to be significant only in the suppressor plate, reflector plate and the Inconel shield plate. Corrections to radionuclide inventories in the head assembly were made using the following procedure. First, Transmut2 case tmut10eh was used to compute radionuclide inventories in the central cell (radius = 38 cm) of each component of the head assembly resulting from the exposure received during the IPR only (3600 MWd, which is effectively the 17.4 days at 206 MW specified in the Transmut2 input). From Carter's analysis, the radionuclide inventories computed by Transmut2 (Table G-2) should be increased by a factor of 60,000 to account for the effect of the IRT. However, that only accounts for the IRT's effect in the central part (38-cm radius) of the head assembly. Carter did not evaluate the effect of neutron streaming through the IRT on flux levels outside the central part of the head assembly. To conservatively account for elevated flux levels outside the central 38 cm of the head assembly, it was assumed that the increase in radionuclide inventories outside the 38 cm radius was comparable to the increase inside that radius. Thus, the inventories in Table G-1 were multiplied by 120,000 and added to the inventories as adjusted in Section G.1. A sample calculation of the net ^{60}Co inventory computed for the head is given in Table G-3.

It was assumed that the instrument tree and IVHM shield plug assemblies were too far from the IRT to be significantly affected by neutron streaming up the IRT.

G.4 References

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

Cabell, C. P., 1980, *A Summary Description of the Fast Flux Test Facility*, HEDL-400, Westinghouse Hanford Company, Richland, Washington.

Johnson, L. E., 2002, *MCNP Version 4C Approval for Use Documentation, and Authorized User List*, FFS-LEJ-02-002, February 18, 2002, Fluor Federal Services, Richland, Washington.

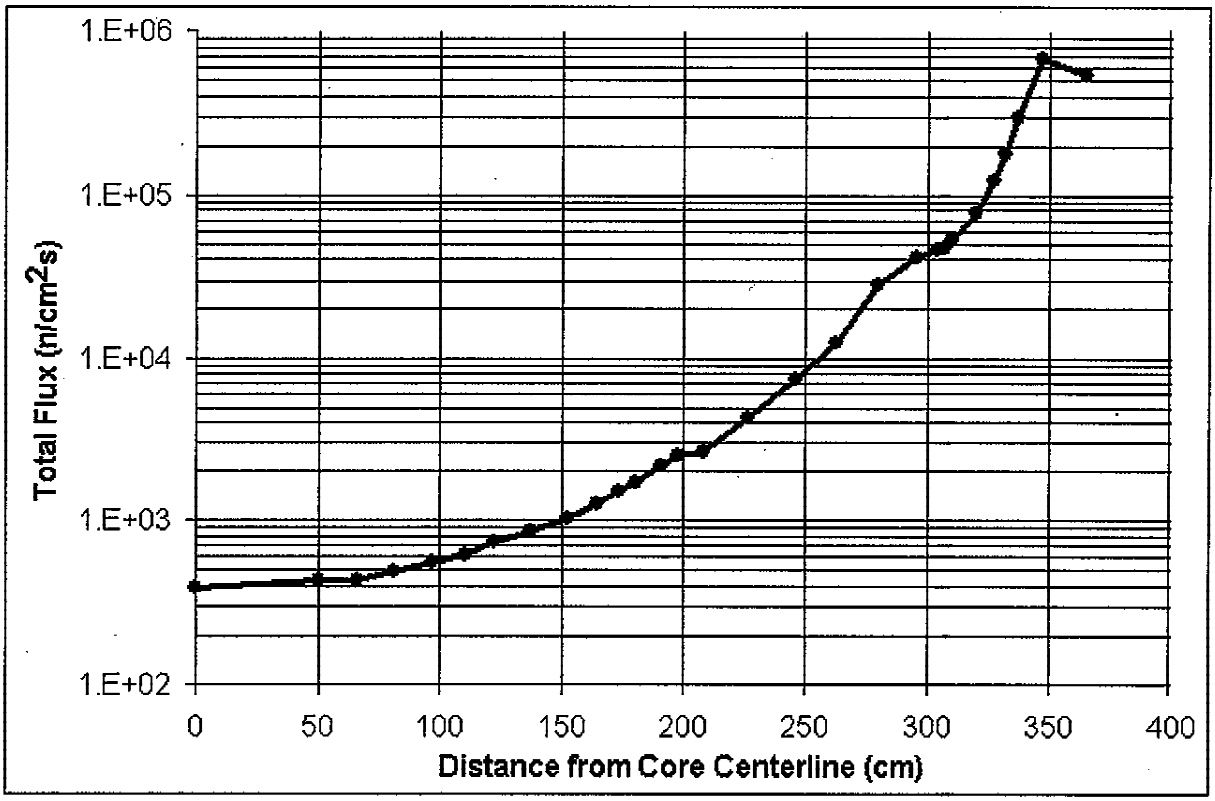


Figure G-2. Radial Traverse of the Total Neutron Flux through the Reactor Head

Table G-2. September 2003 Radionuclide Inventories Computed in Transmut2 Case tmut10eh for the Central Cells of Head Assembly Components (2 sheets)

Irradiation time = 17.5 days. Decay period = 22.8 years

1 Closure Head Volume = 2.570E+05 cc
Flux = 3.861E+02 n/cm2/s (time avg.) Total Mass = 2.023E+03 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.685E-14	1.823E-19	5.301E-11	2.063E-10	2.621E-11
Ni-59	58.93	7.602E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	62.93	1.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	3.436E-18	1.337E-23	1.531E-17	5.958E-17	7.571E-18
Total			4.686E-14	1.823E-19	5.301E-11	2.063E-10	2.621E-11

4 Suppressor Plate Volume = 2.991E+03 cc
Flux = 2.774E+05 n/cm2/s (time avg.) Total Mass = 2.392E+01 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	3.171E-12	1.060E-15	3.588E-09	1.200E-06	1.500E-07
Ni-59	58.93	7.602E+04	4.734E-10	1.583E-13	3.778E-11	1.263E-08	1.579E-09
Ni-63	62.93	1.000E+02	6.232E-11	2.084E-14	3.539E-09	1.184E-06	1.479E-07
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	8.349E-13	2.792E-16	1.589E-13	5.312E-11	6.640E-12
C-14	14.00	5.730E+03	2.404E-12	8.038E-16	1.071E-11	3.582E-09	4.478E-10
Total			5.422E-10	1.813E-13	7.176E-09	2.399E-06	2.999E-07

7 thermal reflector plates Volume = 5.981E+04 cc
Flux = 2.083E+05 n/cm2/s (time avg.) Total Mass = 4.785E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	4.481E-11	7.491E-16	5.069E-08	8.476E-07	1.059E-07
Ni-59	58.93	7.602E+04	5.284E-09	8.834E-14	4.217E-10	7.050E-09	8.812E-10
Ni-63	62.93	1.000E+02	6.976E-10	1.166E-14	3.962E-08	6.624E-07	8.280E-08
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	1.438E-11	2.404E-16	2.737E-12	4.575E-11	5.719E-12
C-14	14.00	5.730E+03	2.676E-11	4.474E-16	1.192E-10	1.994E-09	2.492E-10
Total			6.067E-09	1.014E-13	9.086E-08	1.519E-06	1.899E-07

10 Inconel Shield Plate Volume = 5.981E+04 cc
Flux = 4.276E+04 n/cm2/s (time avg.) Total Mass = 5.054E+02 kg

Isotope	Atomic Weight	Half Life (y)	Mass (g)	Density (g/cc)	Inventory (Ci)	Concentration (Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.192E-11	1.994E-16	1.349E-08	2.256E-07	2.669E-08
Ni-59	58.93	7.602E+04	5.609E-09	9.377E-14	4.476E-10	7.483E-09	8.856E-10
Ni-63	62.93	1.000E+02	7.477E-10	1.250E-14	4.247E-08	7.100E-07	8.403E-08
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table G-2. September 2003 Radionuclide Inventories Computed in Transmut2 Case tmut10eh for the Central Cells of Head Assembly Components (2 sheets)

Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	6.900E-17	1.154E-21	3.075E-16	5.141E-15	6.084E-16
Total			6.368E-09	1.065E-13	5.641E-08	9.431E-07	1.116E-07

13 SS-410 Shield Plate Volume = 4.785E+04 cc
Flux = 4.902E+03 n/cm2/s (time avg.) Total Mass = 3.732E+02 kg

	Atomic	Half Life	Mass	Density	Inventory	Concentration	
Isotope	Weight	(y)	(g)	(g/cc)	(Ci)	(Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	1.842E-13	3.849E-18	2.084E-10	4.355E-09	5.583E-10
Ni-59	58.93	7.602E+04	6.602E-12	1.380E-16	5.268E-13	1.101E-11	1.412E-12
Ni-63	62.93	1.000E+02	8.742E-13	1.827E-17	4.965E-11	1.038E-09	1.330E-10
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	4.038E-14	8.439E-19	1.800E-13	3.761E-12	4.822E-13
Total			7.700E-12	1.609E-16	2.587E-10	5.407E-09	6.932E-10

16 low carbon (A516) steel Volume = 9.570E+04 cc
Flux = 2.050E+03 n/cm2/s (time avg.) Total Mass = 7.532E+02 kg

	Atomic	Half Life	Mass	Density	Inventory	Concentration	
Isotope	Weight	(y)	(g)	(g/cc)	(Ci)	(Ci/m3)	(uCi/g)
Co-60	59.93	5.272E+00	7.242E-14	7.567E-19	8.193E-11	8.561E-10	1.088E-10
Ni-59	58.93	7.602E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	62.93	1.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mo-93	92.91	3.501E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	98.91	2.130E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	93.91	2.000E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	14.00	5.730E+03	6.198E-18	6.477E-23	2.762E-17	2.886E-16	3.667E-17
Total			7.242E-14	7.568E-19	8.193E-11	8.561E-10	1.088E-10

Table G-3. Sample Calculation of Net ^{60}Co Inventory in the Reactor Closure Head

Co-60 inventory in head: C0 = 1.274E-03 Ci (from case tmutef in Appendix E, Table E-14, sheet 2)
Reduce inventory by 30% to account for the IVHM and instrument tree penetrations in the head: C1 = 0.7 * C0 = 0.7 * 1.274E-03 Ci = 8.918E-04 Ci
Co-60 in central cell of head (without IRT): C2 = 5.301E-11 Ci (from case tmut10eh in Table G-2, sheet 1)
Estimated increased inventory in head because of the IRT in the Initial Power Run: C3 = 120000 * C2 = 120000 * 5.301E-11 Ci = 6.361E-06 Ci
Net Co-60 inventory in head : C4 = C1 + C3 = 8.918E-04 + 6.361E-06 Ci = 8.982E-04 Ci (the value listed in Table 6-2, sheet 8)

ATTACHMENT TO APPENDIX G

DON'T SAY IT --- *Write It!*

DATE: June 19, 1995

TO: Ken Dobbin

FROM: L. L. Carter

Telephone: 376-3929

cc: Joe Nelson
Wilbur Bunch
Steve Kessler

SUBJECT: **FFTF ACTIVATION FROM FULL POWER RUN WITH IRT**

I have made calculations with the IRT that predict neutron fluxes above the elevation of the plug within the IRT (and radially near the IRT) are about $6x10^4$ greater at full power (400 MW) than the corresponding neutron fluxes in Joe's main activation calculation at 400 MW. Since I understand there was about 9 equivalent full power days with the IRT in place, this would indicate the activation in the vicinity above the IRT (and radially within perhaps 100 cm) from these 9 equivalent full power days is substantially greater than the activation from the subsequent cycles. In this memo I describe in some detail what was done. Joe may want to review, and I assume you will want to make some ORIGIN calculations using my mctal files with the IRT in place to determine how to treat this additional activation. I also computed neutron fluxes and activation rates in depleted uranium alloy at approximately the elevation where it occurs at about 110 cm above the top of the head. The most important input files for the calculations are stored in the directory /u1_frs3/llcfftf/.

MCNP CALCULATION OF FLUX INCIDENT UPON THE PLUG OF IRT

I started with my i3 input file for the activation model -- the geometry of i3 is identical to Joe's i5 geometry, and the only differences involve weight windows and tallies (I later replaced the tallies with Joe's). This input model was modified to the input file i3irtv to include the following:

- an empty (no vacuum bottle) IRT that extends from the core support area to 725 cm above cmp.
- replaced weight windows with importances that were 1 except for the outside world and for the two IRT cells that were set to 16.
- removed all tallies and replaced with a flux tally along core and upper axial reflector, and a point detector tally at the center of the IRT at an elevation of 720 cm above cmp.
- Note: This is not the core loading for the IRT, but it would have taken a lot of work to use that core loading.

The calculation at the point detector at approximately the elevation of the bottom of the plug obtained (see o3irtv outp file) a total flux of $2.576x10^{10}$ (2.3%) neutrons/cm^2-s at 400 MW, with a spectrum very close to that of the core. This calculation also obtained an average total flux at the IRT along core length of $5.70x10^{15}$ (1.9%) and along the upper axial reflector of $2.17x10^{15}$ along the upper axial reflector. Using these latter two flux values, the flux at the bottom of the plug of $2.0x10^{10}$ was estimated from a back of the envelop calculation:

$$Flux = Flux_0 \, r^2 \, L \, / \, (2 \, d^3),$$

where Flux$_o$ is the flux along the core (or upper axial reflector), r is the inside radius to the steel of the IRT (5.10 cm), L is the length of this flux (assumed to be 92.28 and 16.64, respectively) and d is the distance from this center of the core (or upper axial reflector) to the bottom of the plug (720 cm for core) -- the above equation is evaluated for both contributions and they are then added together. Thus, the MCNP flux agrees reasonably well with what would be expected from a back of the envelop.

The current incident on the bottom of the plug is assumed to be the total flux of 2.576×10^{10} multiplied by the plug area of 81.7 cm^2, or

Current = 2.10×10^{12} neutrons/second at 400 MW.

This current becomes the source (weight) for the 2nd MCNP calculation, where the neutrons are started (uniformly in radial area) at the bottom of a 6" thick cylindrical steel plug in the straight upward direction. The first point detector calculation obtained the flux within each decade of neutron energy. This source spectrum was included in the source description of the 2nd IRT activation calculation.

MCNP ACTIVATION CALCULATION FROM CURRENT INCIDENT ON IRT PLUG

DISCUSSION OF INPUT FILE

The i3irtv input file was modified to the file i3irtvd (see Figures 1 and 2) with the following modifications:

- The model was extended upward to include a cylindrical zone of depleted uranium alloy.
- The empty IRT was extended upward all the way to the top of the depleted uranium alloy area (cell 3409 in Figure 1).
- The polyethylene in the cells for the next to the top zone of the model (cells 1561, 1609, ...1,775) were replaced with a void since this polyethylene layer does not exist near radial centerline. Note: there is an error in the i5 model since material 434 says its borated polyethylene, but the material has no boron.
- The upward sdef neutron source (see above discussion) replaced the kcode source.
- Importances were set based upon the weight windows in the i5 model and were later adjusted based upon preliminary results. Importances were set to zero for elevations below the plug and for large radial distances.
- Flux and activation tallies at and above the elevation of the IRT plug were included like in Joe's i5 model [tally 24, 74, 84, 324, 374, 384, 624, 674, 684] except cells only out to a radius of 114.63 cm (surface 790) were included in these tallies. The first of the cell tallies in the 300 series of tallies will be the maximum adjacent to the IRT and may be the only tallies of interest for comparison purposes.
- Tallies 4 and 14 were added as the flux and standard (i5) activation tallies within the depleted uranium alloy. These tallies are identical except that tally 4 is integrated over volume and tally 14 is per unit

volume. They are made at 4 elevations within the depleted uranium alloy:

Elevation in Model (cm)	Elevation Above Top of Head (cm)
890 to 910	65 to 85
910 to 935	85 to 110
935 to 965	110 to 140
965 to 1,000	140 to 175

Figure 4-49 of WARD-2171-54 indicates that the 110 to 140 cm above the top of the head is representative of the lower portion of some depleted uranium alloy. I haven't been able to find any depleted uranium at lower elevations.

- Tallies 304 and 314 are like tallies 4 and 14 within the depleted uranium alloy except they are capture and fission rates for U235, U238, and Pu239, respectively, in case they are needed.

RESULTS:

The results of a 60 hour calculation on a Sun Workstation are in the m3irtvd mctal file and the o3irtvd outp file. Comparisons are made in Table 1 between neutron fluxes for these IRT activation calculations and the main i5 calculation without the IRT for cells adjacent to the IRT. The right hand column gives the ratio of the IRT flux to the non-IRT flux, where each flux is for 400 MW. Statistical uncertainties are high for the non-IRT flux, but all three ratios are likely considerably greater than 10^4. In fact the ratio for the head summed over cells out to a radius of 105 cm is 1.70×10^4 -- by summing obtain statistics better than 20%. The ratio would clearly be higher in close. Thus, the activation from the approximately nine equivalent full power days with the IRT is greater radially near the IRT, for elevations above the plug, than for the non-IRT flux from years of operation.

Also shown in Table 1 are the fluxes in the uranium alloy near the top of the model. The calculated dose rates on the z surface (surface number 995 in Figure 1) at an elevation of 1,000 cm (at top of the uranium) was 34,200 rem/hr (1.9%) radially inside the projected IRT steel radius, and 2.30 rem/hr (7%) radially outside the projected IRT and inside the projected inside radius of the uranium alloy.

Table 1. Comparison of Neutron Flux for IRT and No IRT.

Cell	Without IRT, i5		With IRT, i3irtvd		Ratio
	Volume (cm**3)	Flux (n/cm**2 s)	Volume (cm**3)	Flux (n/cm**2 s)	
1551	84,822	2.57×10^4, 14%	81,760	1.55×10^9, .3%	6.0×10^4
1559 Head	155,507	868, 31%	149,893	5.35×10^7, .8%	6.2×10^4
1562	14,137	12, 79%	13,627	5.90×10^5, 4%	5.0×10^4
	Elevation (cm)				
3409 Depl. Uran.	890 to 910			7.88×10^4, 3%	
	910 to 935			5.93×10^4, 4%	
	935 to 965			4.75×10^4, 4%	
	965 to 1,000			3.11×10^4, 4%	

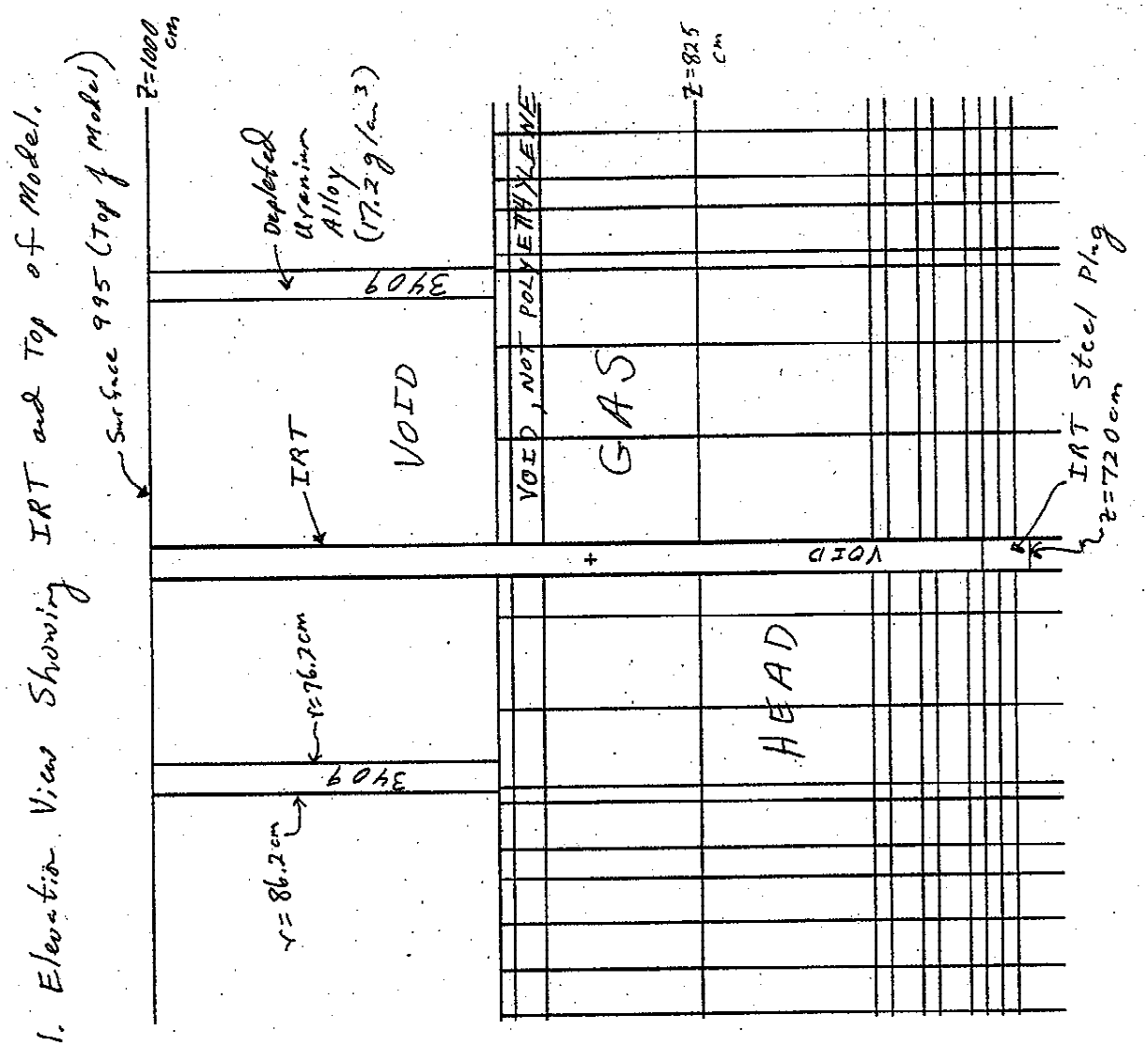
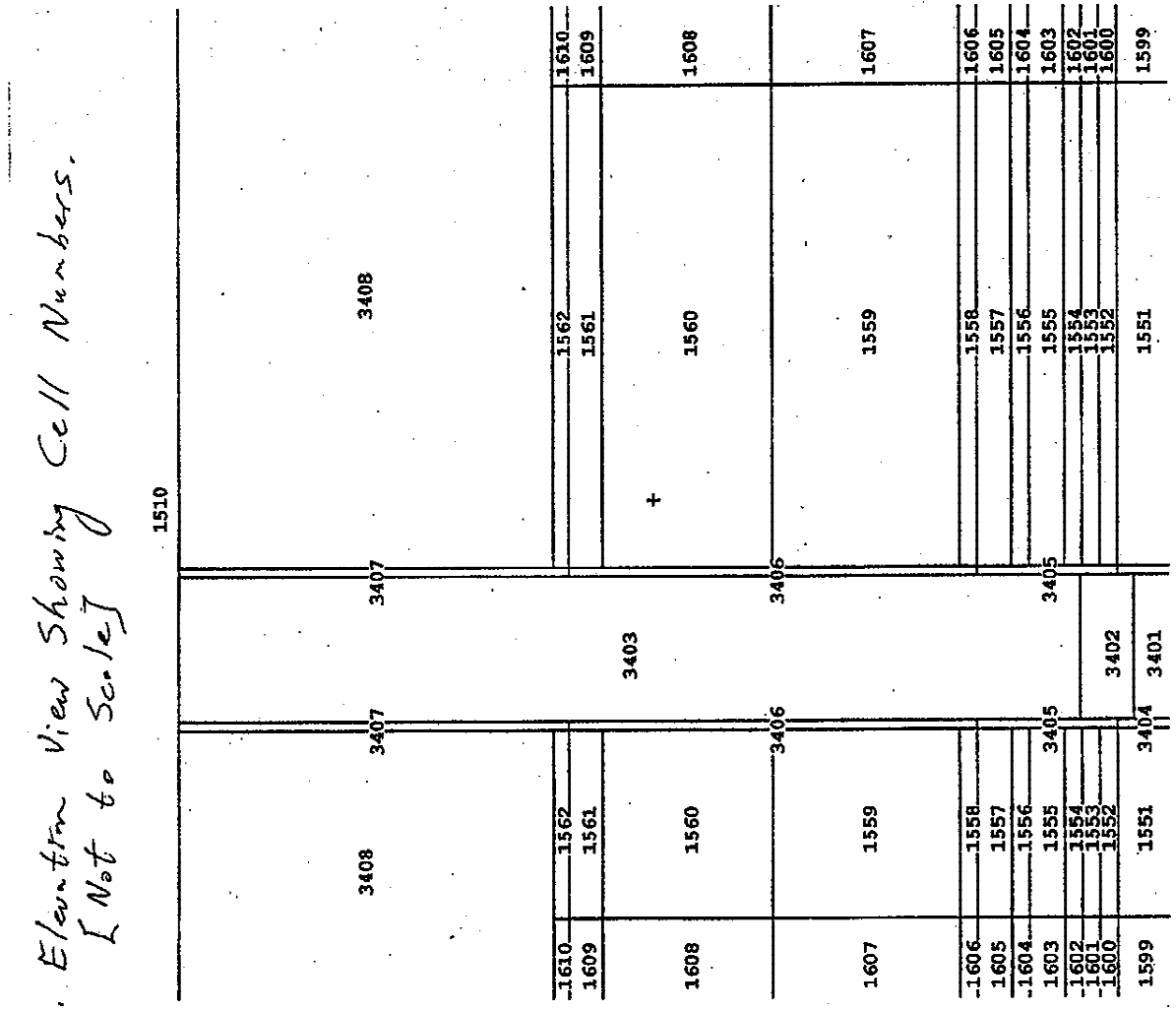


Figure 1. Elevation View Showing IRT and Top of Model.

```
06/19/95 14:25:54
FFTF irt , no thermos,
streaming, dep u on top,
131rtvd
probid =  06/19/95 14:14:18
basis:
( 1.000000, 0.000000, 0.000000)
( 0.000000, 0.000000, 1.000000)
origin:
(  -10.46,   -6.05,   860.00)
extent = (  150.00,   150.00)
```

Figure 2. Elevation View Showing Cell Numbers.
[Not to Scale]



This page intentionally left blank

APPENDIX H
ANALYSIS OF FFTF REACTION RATE MEASUREMENTS TO VALIDATE METHODS AND MODELS

ANALYSIS OF FFTF REACTION RATE MEASUREMENTS TO VALIDATE METHODS AND MODELS

H.1 Introduction

An irradiation at full power of neutron dosimeters was conducted in the FFTF during the High Power Characterization (HPC) Run, also called the Extended Power Run (EPR). The HPC Run was conducted prior to FFTF Cycle 1. The purpose of these experiments was to provide neutronic characterization throughout the FFTF. Samples were irradiated in nearly prototypic assemblies in the fuel and reflector regions, as well as in In-Vessel Storage (IVS) transfer ports and in the reactor cavity.

The HPC Run followed immediately after the High Power Physics Testing (HPPT) Run, and the loadings for the two runs were the same, except for the core characterizer assemblies that were loaded prior to the HPC Run. In all cases, these test assemblies were of the same composition as the HPPT assemblies they replaced. As described in the main body of this report, the HPPT core loading was analyzed with MCNP4C (Briesmeister 2001 and Johnson 2002) to compute reaction rates that were in turn used to compute radionuclide inventories in the FFTF vessel. Thus, the analysis of HPC experiments was a natural means of validating the methods and models used to determine radionuclide inventories in the FFTF vessel.

One of the samples irradiated contained ^{59}Co from which $^{59}Co(n,\gamma)$ reaction rates were inferred from measurements of ^{60}Co activity (Wootan, et. al., 1984). No samples contained any other nuclide leading to the production of a radionuclide of interest for waste disposal and classification. Thus, only experimentally-derived $^{59}Co(n,\gamma)$ reaction rates were analyzed to support the work described in this report. This reaction is dominant in the production of ^{60}Co in the FFTF reactor vessel. The locations of the samples analyzed were at several elevations in row 7, 8, and 9 radial reflectors, in two IVS fuel transfer ports and in the reactor cavity.

H.2 MCNP4C Calculations

The only changes made to the geometric model of the HPPT loading to analyze the reaction rate experiments in the HPC Run was in IVS locations. The HPPT model used to obtain radionuclide inventories had a generic loading in the IVS locations that simulated fuel assemblies in most IVS positions. To analyze the reaction rate measurements, the actual IVS loading during the HPC Run was simulated. Also, tallies of reaction rates over cell volumes were made in MCNP4C calculations for use in computing radionuclide inventories. To analyze the measurements made in the HPC Run, volume, surface, and point detector tallies were used. Volume tallies were used where practical without modifying the geometric model.

Three MCNP4C cases were completed to tally ^{59}Co (n,γ) reaction rates for comparison with measurements. In all three cases neutron cross section data used were the same as used in computing the reaction rates for assessing radionuclide inventories. That is, ENDF/B-V libraries distributed with the MCNP4C package were applied, with the exception that data for Co-59(n,γ) reactions were obtained from the FENDL2/A library (Pashchenko and Wienke 1997).

In the first case, fftf10er3, measurements in the IVS transfer ports were analyzed. The transfer ports where measurements were made are identified as 2-Z and 3-Z in Figure 5-1. Tallies on the surfaces of these locations were made for four elevations where samples were located. Tallies were made over 30-cm axial ranges centered on the elevations of the four samples analyzed.

In the second case, fftf10er4, measurements in the reactor cavity were analyzed. The location of these measurements in the horizontal plane was estimated from the FFTF schematic shown in Figure H-1 and a description of the measurements. Measurements made at five elevations were analyzed.

In the third case (fftf10er5), measurement made on the centerlines of characterizers in three radial reflector locations (2704, 3811 and 2909) were analyzed. Sample measurements at five axial elevations were analyzed using volume tallies in the MCNP4C calculation. The volumes over which reaction rates were tallied extended over the whole assembly in the horizontal plane. For the three central measurement elevations at 0, 20 and –20 cm relative to the core midplane, tallies extended axially 20 cm centered about the sample elevations. For the other two sample locations analyzed (± 54 cm), tallies extended from ±46.44 to ±62.78 cm to take advantage of existing cell boundaries in the MCNP model.

As in the MCNP4C calculations of reaction rates for the determination of radionuclide inventories, the unnormalized results from the three calculations described above were based on one fission neutron. Similar to the description in Section 5.2, the tallied reaction rates had to be normalized to the fission source rate at the reactor power during the sample irradiation. The normalization factor, FNORM, was computed as:

$$\text{FNORM} = \frac{\text{[2.9 fission neutrons/fission][P MW]}}{\text{[212 MeV/fission][1.602 x } 10^{-19} \text{ MW per MeV/s]}} = P \cdot 8.54 \times 10^{16}.$$

A total average reactor power level of 395.6 MW (98.9% of full power), based on thermal-calorimetric calibration during the HPC run was used to infer reaction rates from activity measurements. Thus, FNORM = 3.38×10^{19} fission neutrons per second was used to normalize the MCNP4C results. In case fftf10er4, the normalization factor was specified in the input data. In the other two cases, the normalization factor was applied to the MCNP4C results.

H.3 Comparison of MCNP4C Results with Reaction Rate Measurements

Results of the analysis are presented in Tables H-1, H-2 and H-3. All computed results in these tables have been normalized to a power level of 395.6 MWth. MCNP4C estimates of the statistical uncertainty of reaction rates tallied at locations in IVS transfer ports (Table H-1) are larger than preferable to provide a good comparison of measurement and calculation. These estimated uncertainties range from 13 to 22%, but MCNP4C tends to underestimate uncertainties larger than 10%, so some uncertainties could significantly exceed 22%. Given the magnitude of the uncertainties, agreement between calculation and measurement (C/E) is very reasonable. At

worst, C/E was 0.57. However, averaging results for a number of points reduces the overall statistical uncertainty, and on the average, agreement is very good - within 10% for each port and within 1.5% for the two ports combined.

Calculations of ^{59}Co (n,γ) reaction rates in the reactor cavity agreed quite well with measurements, except at the 366 and 549 cm elevations, as shown in Table H-2. The cause of the discrepancies was not determined, but could possibly be the results of shielding effects of piping in the cavity. Again, on the average, agreement is very good (C/E = 0.993).

Comparison of reaction rates computed in the three radial reflector positions is shown in Table H-3. Agreement between calculations and measurements is very good. There is only one instance where the difference exceeds 10% and at most locations differences are less than 6%. The C/E value for the averages of all 11 points where calculations and measurements where made is 1.036.

H.4 Transmut2 Calculations of ^{60}Co Activity and Comparison with Measurement

In one case,Transmut2 was used to compute the ^{60}Co activity from the ^{59}Co (n,γ) reaction rate computed by MCNP4C. The purpose of this calculation was to compare the results with the measured ^{60}Co activity, providing further evidence that Transmut2 produces valid data.

The measurement selected for analysis with Transmut2 was made in the reactor cavity at the core midplane. The MCNP-computed ^{59}Co (n,γ) reaction rate given in Table H-2 is 6.93×10^{-15} reactions/s per nucleus at a reactor power of 395.6 MW. The normalization factor entered in the Transmut2 input file, listed in Table H-4, to convert the reaction rates to units of reactions/s per 10^{24} nuclei was 10^{24}. The irradiation time entered (8.7 days) was based on 8.6 effective full-power days (EFPD) for the HPC run, with full power being 400 MW. The total reactor exposure was then 3440 MWd, or effectively 8.7 days at 395.6 MW.

The measured ^{60}Co activity, reported to be 299 decays/s per mg of cobalt, had been scaled back to the end of irradiation. So, an insignificant decay time of 0.01 years was entered into the Transmut2 input file. In the atom density file used (see Table H-5), the sample density was arbitrarily set to 1 g/cm^3 and the atom density of ^{59}Co entered (0.01022 atoms/b-cm) was computed based on that mass density. The reaction rate input file, listed in Table H-6, contains the MCNP-computed reaction rate of 6.93×10^{-15} reactions/s per nucleus. The ^{60}Co capture rate of 1.65×10^{-16} reactions/s per nucleus was estimated from ^{59}Co and ^{60}Co reaction rates from MCNP4C case fftf10ef. Burnout of ^{60}Co was very low over the relatively low exposure, so any errors introduced by estimating the ^{60}Co burnout rate are inconsequential.

Using input listed in Tables H-4, H-5 and H-6, Transmut2 computed an activity of 5.98 μCi/g, which is equivalent to 221 decays/s per mg (see Table H-7). Compared to the measured activity of 299 decays/s per mg, the C/E value is 0.739. The C/E value listed in Table H-2 is 0.747. In theory, the C/E from the Transmut2 result should be the same. The reason for the small difference (1.1%) was not determined, but could have been due to differences in reactor exposure data. In the analysis, (Wootan, et al., 1984) a detailed power vs. time history was processed, rather than the simplified one-step model used by Transmut2.

H.5 Conclusion

The conclusion is that the accuracy of MCNP4C, with the cross section libraries and the calculational model of FFTF used, in computing space and energy distributions of neutron flux and ^{59}Co (n,γ) reaction rates was confirmed. Since ^{59}Co (n,γ) reactions are the primary mode of ^{60}Co production, calculations of ^{60}Co distribution in the vessel are expected to be accurate given the actual concentrations of ^{59}Co in Inconel, SS-316 and SS-304. Other distributions of other reaction rates leading to the production of radionuclides of interest should also be accurate, assuming that the other reaction cross section data are also sufficiently accurate. This assumption is justified because the FENDL2/A data sets applied were judged to be the best available, are used internationally and are mature (they were released 5 years ago).

The Transmut2 result obtained for the one measurement evaluated indicates the program will give very reliable estimates of radionuclide inventories, assuming of course, accurate input data. All but about 1% of the difference between calculation and measurement is attributable to the discrepancy between experimental data and the MCNP4C calculation.

H.6 References

Briesmeister, J. F., Editor, 2001, *Monte Carlo N-Particle Transport Code System*, CCC-701, Transport Methods Group, Los Alamos National Laboratory, June, 2001, Los Alamos, New Mexico.

Johnson, L. E., 2002, *MCNP Version 4C Approval for Use Documentation, and Authorized User List*, FFS-LEJ-02-002, February 18, 2002, Fluor Federal Services, Richland, Washington.

Pashchenko, A. B. and H. Wienke, 1997, *FENDL2/A-MCNP, FENDL2/A-VITJ_E and FENDL2/A-VITJ_FLAT, the processed FENDL-2 neutron activation cross-section data files*, report IAEA-NDS-174, International Atomic Energy Agency.

Wootan, D. W., Rawlings, J. A., and Dobbin, K. D., 1984 "Reaction Rates and Flux Spectra in the FFTF at Full Power," *Transaction of the American Nuclear Society*, 47, 743

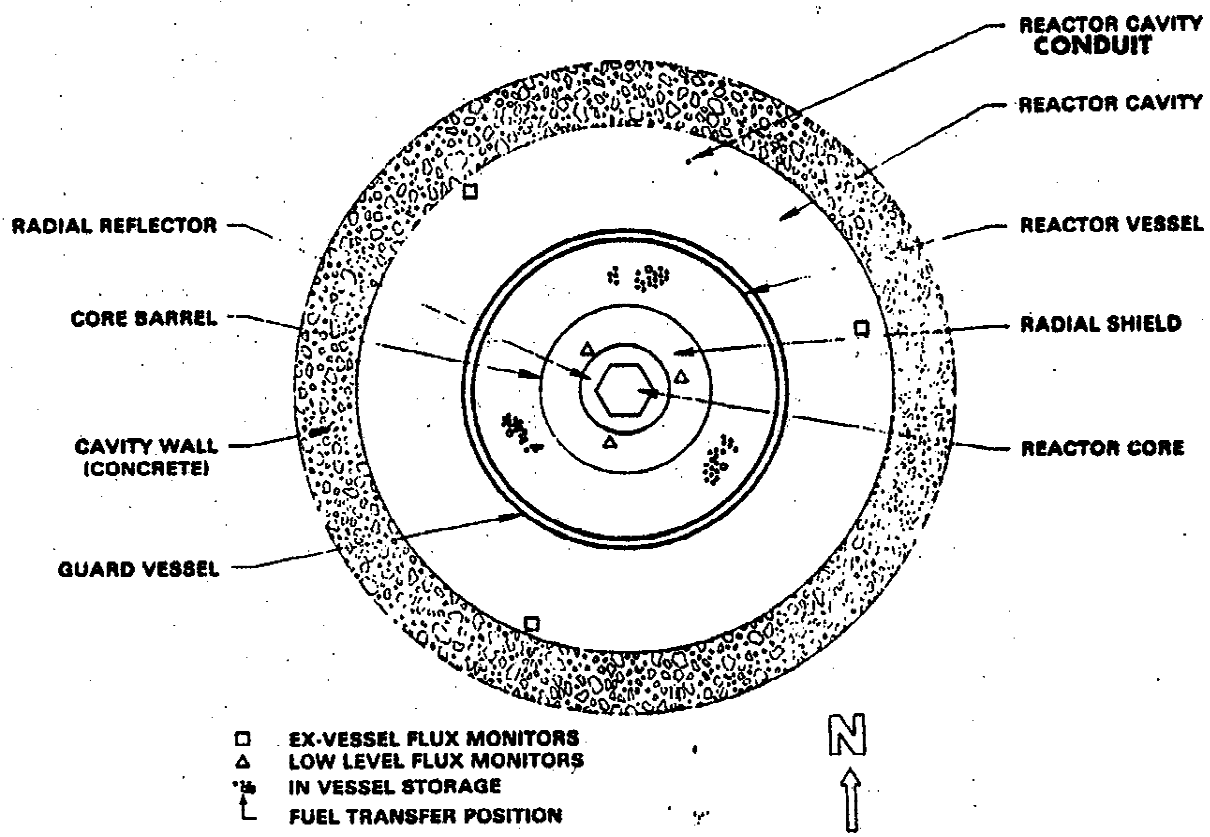


Figure H-1. FFTF schematic showing location of the reactor cavity access conduit in which dosimeters were irradiated.

Table H-1. Comparison of Calculated and Measured Reaction Rates in In-Vessel Storage Transfer Ports

Port	Elevation (cm)	Computed Co-59(n,γ) Reaction Rate* and Uncertainty		Measured Co-59(n,γ) Reaction Rate* and Uncertainty		Calculation Measurement (C/E)
2	-117	5.72E-13	18.3%	6.68E-13	2.3%	0.857
	0	7.65E-13	14.7%	1.34E-12	2.3%	0.571
	50	1.23E-12	22.1%	1.13E-12	2.3%	1.092
	122	4.16E-13	20.3%	4.55E-13	2.3%	0.913
	Port 2 Average	7.47E-13	10.8%	8.98E-13	1.2%	0.831
3	-117	1.01E-12	12.8%	9.32E-13	2.3%	1.085
	0	2.37E-12	18.9%	2.29E-12	2.3%	1.033
	50	1.83E-12	21.2%	1.66E-12	2.3%	1.105
	122	6.63E-13	22.1%	5.12E-13	2.3%	1.296
	Port 3 Average	1.47E-12	10.6%	1.35E-12	1.2%	1.089
Average of Ports 2 & 3		1.11E-12	7.9%	1.12E-12	0.8%	0.986

* Units of reaction rates are reactions/s per nucleus

Table H-2. Comparison of Calculated and Measured Reaction Rates in the Reactor Cavity

Detector Location[a] (X, Y, Z in cm)	Computed Co-59(n,γ) Reaction Rate[b] and Uncertainty		Measured Co-59(n,γ) Reaction Rate[b] and Uncertainty		Calculation Measurement (C/E)
-183	4.90E-15	3.4%	5.71E-15	3.0%	0.858
0	6.93E-15	3.1%	9.28E-15	3.0%	0.747
183	4.98E-15	3.5%	5.03E-15	3.0%	0.989
366	3.25E-15	4.4%	2.22E-15	3.0%	1.466
549	2.75E-15	6.8%	7.32E-16	3.0%	3.754
Average	4.56E-15	1.8%	4.59E-15	1.3%	0.993

[a] Detector locations are coordinates in cm relative to the core center in the calculational model.

[b] Units of reaction rates are reactions/s per nucleus

Table H-3. Comparison of Calculated and Measured Reaction Rates in Radial Reflector Locations

Core Lattice Position	Elevation (cm)	Computed Co-59(n,γ) Reaction Rate* and Uncertainty		Measured Co-59(n,γ) Reaction Rate* and Uncertainty		Calculation Measurement (C/E)
2704	-54	2.04E-09	6.1%	1.88E-09	2.8%	1.080
	-20	2.64E-09	5.9%	2.76E-09	2.9%	0.956
	0	2.76E-09	5.7%	2.73E-09	2.8%	1.012
	20	2.42E-09	6.2%	2.18E-09	2.9%	1.110
	54	1.18E-09	7.6%	1.08E-09	2.7%	1.095
	Average	2.21E-09	2.8%	2.13E-09	1.3%	1.038
3803	-54	9.56E-10	7.2%	9.11E-10	2.7%	1.049
	0	1.72E-09	5.2%	1.63E-09	2.7%	1.055
	54	8.03E-10	6.3%	7.63E-10	2.7%	1.054
	Average	1.16E-09	3.6%	1.10E-09	1.6%	1.053
2909	-54	8.80E-10	5.9%	8.84E-10	2.7%	0.996
	0	1.74E-09	4.1%	1.70E-09	3.0%	1.021
	54	6.31E-10	6.0%	6.29E-10	2.7%	1.003
	Average	1.08E-09	3.0%	1.07E-09	1.8%	1.011
Average of all 2704, 3803 & 2909 locations		1.61E-09	2.0%	1.56E-09	0.9%	1.036

* Units of reaction rates are reactions/s nucleus.

Table H-4. Transmut2 Input File for Analysis of ^{60}Co Activity Measurement in the Reactor Cavity

```
1    3  1  3
1.00E+24      8.7   0.01
 1.00000E+00
 Co-59       Ni-60       Co-60
 0.0000E+00 0.0000E+00 1.3147E-01
    58.93     59.93        59.93
     3      1      1      2      2
```

Table H-5. Atom Density Input File for Transmut2 Analysis of ^{60}Co Activity Measurement in the Reactor Cavity

```
Co-59 Sample
      1.000
Co-59       Ni-60       Co-60
  1.022E-02  0.000E+00  0.000E+00
```

Table H-6. Reaction Rate Input File for Transmut2 Analysis of ^{60}Co Activity Measurement in the Reactor Cavity

```
region    1
  6.9278E-15  0.0000E+00  0.0000E+00
  0.0000E+00  7.0000E-21  0.0000E+00
  1.6500E-16  0.0000E+00  0.0000E+00
 flux  1.1900E-15
```

Table H-7. Output File from Transmut2 Analysis of ^{60}Co Activity Measurement in the Reactor Cavity

```
transmut version 2.0  3/22/01
==============================

 nreg    number of component regions                    1
 niso    total number of isotopes                       3
 nrad    number of radionuclides                        1
 nrt     number of reaction types                       3
 fnorm   reaction rate normalization factor    1.00000E+24
 et      reactor operating time (days)         8.70000E+00
 dt      decay time (years)                    1.00000E-02

 region volumes (cc)
   1.0000E+00

 decay constants (1/yr) and atomic weights

      isotope        lambda     atomic wt
   1   Co-59       0.0000E+00  5.8930E+01
   2   Ni-60       0.0000E+00  5.9930E+01
   3   Co-60       1.3147E-01  5.9930E+01

 transmutation matrix

 isotope      source 1          source 2
    no.   isotope  reaction  isotope  reaction  . . .
    3        1        1         2        2         0        0


 Irradiation time =    8.7 days.  Decay period =    0.0 years


   1  Co-59 Sample              Volume = 1.000E+00 cc
      Flux = 1.190E+09 n/cm2/s (time avg.)  Total Mass = 1.000E-03 kg

          Atomic  Half Life     Mass       Density    Inventory
Concentration
 Isotope  Weight      (y)         (g)        (g/cc)      (Ci)        (Ci/m3)
(uCi/g)
 Co-60     59.93  5.272E+00  5.281E-09  5.281E-09  5.975E-06  5.975E+00
5.975E+00
 Total                       5.281E-09  5.281E-09  5.975E-06  5.975E+00
5.975E+00

 program done
```

This page intentionally left blank

APPENDIX I
SUPPORTING DOCUMENTATION FOR STEEL COMPOSITIONS USED IN COMPUTING RADIONUCLIDE INVENTORIES

SUPPORTING DOCUMENTATION FOR STEEL COMPOSITIONS USED IN COMPUTING RADIONUCLIDE INVENTORIES

Compositions of the various types of steel and Inconel 600 assumed in computing radionuclide inventories were described in Section 5.2 and listed in Table 5-2. Most of the sources of composition data applied were clearly referencable. However, three sources were vender data that may not be retrievable in the future and may be subject to change. So, those data are listed below.

The first data sheet is from Stainless Steel Processing, Inc., Coatesville, PA. The second data sheet is from Thompson Metal and Tubing, Fairfield, Ohio. The Third data sheet, which is from a previous survey of SS-304 compositions, contains data from Allegheny Ludlum Steel Corporation, Pittsburg, PA, Republic Steel Corporation, Cleveland, OH, Cameron Iron Works, Inc., Houston, TX, United States Steel Corporation, Pittsburg, PA, and Carlson Steel Company, Coatsville, PA.

"Stainless Plate Specialists"

"Specialists in stainless steel custom shapes, rings, discs, plate flanges and tube sheets"

300 series properties

Physical
(Values appear as percentages.)

Type	Tensile (ksi)	Yield (ksi)	Elongation	Hardness (Brinell)	Hardness (Rockwell B)
302	75	30	40% in 2"	183	88
304	75	30	40% in 2"	183	88
304L	70	30	40% in 2"	183	88
309	75	30	40% in 2"	217	95
309S	75	30	40% in 2"	217	95
310	75	30	40% in 2"	217	95
310S	75	30	40% in 2"	217	95
316	75	30	40% in 2"	217	95
316L	70	25	35% in 2"	217	95
317	75	30	35% in 2"	217	95
317L	75	30	35% in 2"	217	95
321	75	30	40% in 2"	183	88
347	75	30	40% in 2"	183	88

Chemical
(Values appear as percentages.)

Type	C	Mn	P	S	Si	Cr	Ni	Mb
302	0.15 max	2.00 max	0.045 max	0.030 max	1.00 max	17.00/19.00	8.00/10.00	-
304	0.08 max	2.00 max	0.045 max	0.030 max	1.00 max	18.00/20.00	8.00/10.50	-
304L	0.03 max	2.00 max	0.045 max	0.030 max	1.00 max	18.00/20.00	8.00/12.00	-
309	0.20 max	2.00 max	0.045 max	0.030 max	1.00 max	22.00/24.00	12.00/15.00	-
309S	0.08 max	2.00 max	0.045 max	-	1.00 max	22.00/24.00	-	-
310	0.25 max	2.00 max	0.045 max	0.030 max	1.5 max	24.00/26.00	19.00/22.00	-
310S	0.08 max	2.00 max	0.045 max	0.030 max	1.5 max	24.00/26.00	19.00/22.00	-
316	0.08 max	2.00 max	0.045 max	0.030 max	1.00 max	16.00/18.00	10.00/14.00	2.00/3.00
316L	0.03 max	2.00 max	0.045 max	0.030 max	1.00 max	16.00/18.00	10.00/14.00	2.00/3.00
317	0.08 max	2.00 max	0.045 max	0.030 max	1.00 max	18.00/20.00	11.00/15.00	3.00/4.00
317L	0.03 max	2.00 max	0.045 max	0.030 max	0.75 max	18.00/20.00	11.00/15.00	3.00/4.00
321	0.08 max	2.00 max	0.040 max	0.030 max	1.00 max	17.00/19.00	9.00/12.00	0.75/0.75
347	0.08 max	2.00 max	0.040 max	0.030 max	0.5/1.00	17.00/19.00	9.00/12.00	0.5/0.75

Thompson Metals & Tubing
"Your First Choice"

ASTM A516				
PRESSURE VESSEL QUALITY **General Description** - Carbon-silicon steel plates four tensile strength ranges (Grades 55, 60, 65 and 70). Plates are made to a fine grade practive				
Mechanical Properties - Tensile Requirements				
	Grade 55	**Grade 60**	**Grade 65**	**Grade 70**
Tensile Strength, ksi	55/75	60/80	65/85	70/90
Yield Strength min, ksi.	30	32	35	38
Chemical Requirements - Composition Percent, %				
Elements	**Grade 55**	**Grade 60**	**Grade 65**	**Grade 70**
Carbon, max. % 1 in. and under Over 1 to 2 in. incl. Over 2 to 4 in. incl. Over 4 to 8 in incl. Over 8 to 12 in. incl.	 0.18 0.20 0.22 0.24 0.26	 0.21 0.23 0.25 0.27 0.27	 0.24 0.26 0.28 0.29 0.29	 0.27 0.28 0.30 0.31 0.31
Manganese, max, % 1/2 in. and under Over 1/2 in.	 0.60/0.90 0.60/1.20	 0.60/0.90 0.60/1.20	 0.85/1.20 0.85/1.20	 0.85/1.20 0.85/1.20

Phosphorus, max, %	0.035	0.035	0.035	0.035
Sulfur, max. %	0.04	0.04	0.04	0.04
Silicon, %	015/0.30	015/0.30	015/0.30	015/0.30

Plates 1-1/2" Thick and Under are supplied in as-rolled condition unless ordered heat treated.
Plates Over 1-1/2" Thick should be normalized.

When Charpy V-Notch Impact Tests are required, the plates should be normalized regardless of thickness.

Applications - Intended primarily for service in welded pressure vessels where improved notch toughness is important (low temperatures - cryogenics).

304 SS, LABORATORY REANNEALED

Vendor[a]	Heat Number	Content of Element, Wt. %									
		S	Nb	V	Ti	Ta	W	Cu	Co	Pb	Sn
Allegheny Ludlum	337187	0.008	0.0020	0.060	0.003	<0.0005	0.015	0.15	0.05		
	55697	0.037	0.0030	0.030	0.002	<0.0005	0.011	0.10	0.05		
	345866	0.007	0.0010	0.010	0.0005	0.0005	0.007	0.13	0.04		
	346544	0.006	0.0050	0.025	0.017	0.0006	0.026	0.12	0.05		
	337330	0.008	0.0100	0.025	0.002	<0.0005	0.0060	0.15	0.05		
	346845	0.006	0.0100	0.050	0.008	<0.0005	0.007	0.11	0.07		
	346779	0.005	0.0035	0.029	0.010	0.0020	0.043	0.16	0.02		
Cameron	3121	0.010	0.0010	0.035	0.016	<0.0005	0.015	0.07	0.07	<0.0003	0.002
Carlson	310390	0.006	0.0160	0.020	0.001	0.0006	0.043	0.20	0.07	0.0007	0.002
	600414	0.015	0.0100	0.025	0.002	<0.0005	0.027	0.10	0.05		
	60551	0.018	0.0140	0.050	0.025	<0.0005	0.049	0.25	0.08		
	616737	0.012	0.0140	0.031	0.001	<0.0005	0.016	0.50	0.07	<0.0003	0.0050
	300380	0.010	0.0100	0.028	0.004	<0.0005	0.016	0.10	0.05		
	544086	0.016	0.0030	0.019	0.006	<0.0005	0.021	0.10	0.05		
Republic	8D43813	0.004	0.0200	0.022	0.002	<0.0005	0.02	-	-	-	-
United States Steel	9T2796	0.012	0.008	0.037	0.003	<0.0005	0.022	0.10	0.05		
	X22807	0.023	0.0016	0.012	0.002	<0.0005	0.020	0.11	0.03		
	9T2797	0.011	0.0050	0.020	0.005	0.0005	0.050	0.30	0.07	0.002	0.005
	R23283	0.020	0.0030	0.030	0.0010	<0.0005	0.021	0.14	0.05		
	R22926	0.025	0.0180	0.050	0.0100	0.0010	0.030	0.070	0.05		

a Allegheny Ludlum = Allegheny Ludlum Steel Corporation, Pittsburgh, PA; Cameron = Cameron Iron Works, Inc., Houston, TX; Carlson = Carlson Steel Company, Coatesville, PA; Republic = Republic Steel Corporation, Cleveland, OH; United States Steel = United States Steel Corporation, Pittsburgh, PA.

APPENDIX J
MCNP INPUT FILES

MCNP INPUT FILES

This appendix contains the complete input file for one MCNP4C case, fftf10ef, that was used to compute reaction rates in fixed reactor hardware. Following that listing are partial listings of other input files. These include:

- Reaction rate tally specifications from MCNP4C case fftf10em where reaction rates in core components were computed. The only differences between cases fftf10ef and fftf10em were the tally specifications and the number of kcode cycles (neutron generations). Reaction rate tallies in case fftf10ef extended to the vessel boundaries and thus required more neutron histories (1210 kcode cycles) than case fftf10em (410 kcode cycles) to achieve acceptable precision.
- Reaction rate tally specifications for MCNP4C case fftf10eh that was otherwise like case fftf10ef.
- Reaction rate tally specifications for MCNP4C case fftf10ev that was otherwise like case fftf10ef.
- Differences between cases fftf10ef and vol10ef, in which volumes of tally regions in case fftf10ef were stochastically computed.
- Photon source specification for MCNP4C cases s01a, s01b and s01c.
- Dose rate tally specifications for cases s01a, s01b and s01c.
- Photon source specification for MCNP4C case s04b.
- Dose rate tally specifications for case s04b.

The MCNP4C cases referenced above are described in Tables 5-1 and 5-13 in the main part of this report.

Listing of Input File for MCNP4C Case fftf10ef

```
FFTF HPPT ldg. Compute nuclide reaction rates in fixed RX components  fftf10ef
c     Results to be used to compute component activation for D&D
c
c    67890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
c
c     Case "G" for DFA in FSM locations G, J, M, and K.
c     (1) positive z extention
c     (2) eliminated extra 818, 819 surfaces in r direction
c     (3) transfer the IVFS 120 and 240 degrees clockwise
c     (4) negative z extention
c     (5) positive z extention
c     Changes from i4: wgt windows adjusted to reduce n-population
c     in some cells.
c
c    ------------------------------------------------------------------------
c    Revision Log (from fftf8au1 or earlier model):
c
c    mats. 133, 134, 137, 138 updated  (6/5/00)
c
c    ICSA (loc.s 3202, x404, 2405 & 1406) axial detail reviewed and updated
c    composition between surf.s 94 & 95 not accurate but conservative) (6/13/00)
c
c    C-12 atom dens. in CRs & SRs (m194) reduced from 0.008064 to 0.007294 to
c    match NADB value.
c    Total atom dens. of m194 was correspondingly reduced from 0.07569 to
c    0.074918.
c    m1302 changed to below poison material.  All CR & SR below poison cells
c    changed to have this material at total atom dens. of 0.04684. mats. m2303,
c    m3302, m1502, m1504, m2502, m2504, m3502 & m3504 deleted (The mx50z mats.
c    were not used anyway.
```

```
c     pz 104 changed from 26.71 to 26.64 to get below poison section of SRs =
c     19.50 cm
c     pz 608 & 609 adjusted slightly to get the B4C sections of SRs & CRs to be
c     92.28 cm long.
c     mat. m190 (above poison) added and CR & SR regions above poison changed to
c     contain this material at atom dens. of 0.03913.
c     c/z surf.s 785, 786, 787 & 788 (equiv, radii of inner core, outer core,
c     row 7 and row 9) corrected to conserve area. But, 787 & 788 are also used
c     as radii of core support structure So, surf.s 780 & 781 added with old
c     values of 787 & 788. The following core basket and nozzle cells changed to
c     use 780: 1611 - 1616.  Likewise, core support struct. cells 1651 - 1656
c     changed to use 780 & 781. Cells 1518, 1691 & 1692 changed to use surf.
c     781 as inner boundary. (6/14, 18/02)
c
c     m420 - m429 deleted. Cells using m424 & m429 replaced with m137 & 138 resp.
c     Other mat.s were not used. (6/17/02)
c
c     All row 7 reflector cells containing inconel were changed to use m1701.
c     Other R7 refl. mat.s (1702, 1703, etc.) were deleted.  Other unused mat.s
c     and surf.s deleted. (6/18/02)
c
c     Atom density of m133 (orfice for r7 refl.) was changed from 0.0671096 to
c     0.07078.  Atom density of m134 (orfice for r8&9 refl.) was changed from
c     0.069077 to 0.05938.  Atom density of m137 (upper shld for r7 refl.) was
c     changed from 0.076567 to 0.07527.  Atom density of m138  was changed from
c     0.0790496 to 0.07830. (6/24/02)
c
c     Composition & atom density of handling socket (m404) changed
c     2 files containing tally specs.created: (1) for moveable core components
c     and (2) fixed RX components.(7/2/02)
c
c     Density of SS in thermal liner (cells 3207-3240) changed to 6.82 g/cc
c     (85% of full density).
c     Cell 2940 added to Z-ring tally. Cells 3020, 3062, 3104, 3153 & 3203
c     removed from Z-ring tally and added to closure head tally.
c     Tally 314 over cell 1519 added. (7/9/02)
c
c     Contents of cells 326 & 526 (above & below B4C sec. of PSR in 3711) changed
c     from m405 to m1302 (CR/SR below poison). Density in these cells unchanged.
c     Tally cells for IVFSM corrected (7/10/02)
c
c     Tally changes: (1) cell 3241 removed from f14 (supress. plate) tally,
c     (2) tally 304 added for baffle plate (m411) cells, (3) cells 3111 & 3112
c     added to f64 tally (core support), (4) cells 2892 & 2903 added to f44 tally
c     (rx vessel)  (7/16/02)
c
c     approx. representation of suppressor plate, refl. plates and thermal shld
c     replaced by more accurate model. Tally for these regions replaced by 3
c     tallies (1 per material type) (7/18/02)
c
c     Changes from fftf10df fftf10ef: thicknesses & densities of  suppressor and
c     thermal shield plates changes to account for thermal expansion (adjustment
c     factors of 1.0078 applied to thicknesses and 1.0078^-3 to densities).(8/5/02)
c     ------------------------------------------------------------------------
c
c     This is the core region.
3301 2101   0.05058  127  -124   128  -125   126  -123    96   -97 $  2101
3302 1201   0.05060   14   -16    44  -128    78   -80    96   -97 $  1201
3303 1202   0.05062   16   -18    45   -47   123   -81    96   -97 $  1202
3304 2201   0.05060  124   -19    47   -49    78   -80    96   -97 $  2201
3305 2202   0.05061   16   -18   125   -50    76   -78    96   -97 $  2202
3306 3201   0.05060   14   -16    47   -49    75  -126    96   -97 $  3201
3307 3202   0.05876   13  -127    45   -47    76   -78    96   -97 $  3202
3308 1301   0.05060   12   -14    43   -45    77   -79    96   -97 $  1301
3309 1302   0.04684   13   -15    42   -44    79   -81   104   -97 $  1302
3310 1303   0.05052   15   -17    43   -45    80   -82    96   -97 $  1303
3311 1304   0.05060   17   -19    44   -46    81   -83    96   -97 $  1304
3312 2301   0.05053   18   -20    46   -48    80   -82    96   -97 $  2301
3313 1302   0.04684   19  -145    48   -50    79   -81   104   -97 $  2302
3314 2303   0.05061   18   -20    49   -51    77   -79    96   -97 $  2303
3315 2304   0.05059   17   -19    50   -52    75   -77    96   -97 $  2304
3316 3301   0.05061   15   -17    49   -51    74   -76    96   -97 $  3301
3317 1302   0.04684   13   -15    48   -50    73   -75   104   -97 $  3302
3318 3303   0.05059  130   -14    46   -48    74   -76    96   -97 $  3303
3319 3304   0.05062   11   -13    44   -46   129   -77    96   -97 $  3304
3320 1401   0.05048   11   -13    41   -43    78   -80    96   -97 $  1401
3321 1402   0.05053   12   -14    40   -42    80   -82    96   -97 $  1402
3322 1403   0.05054   14   -16    41   -43    81   -83    96   -97 $  1403
3323 1404   0.05876   16   -18    42   -44    82   -84    96   -97 $  1404
3324 1405   0.05054   18   -20    43   -45    83   -85    96   -97 $  1405
3325 1406   0.05876   19   -21    45   -47    82   -84    96   -97 $  1406
3326 2401   0.05053   20   -22    47  -146    81   -83    96   -97 $  2401
3327 2402   0.05057  145  -142   146  -143   144  -141    96   -97 $  2402
3328 2403   0.05062   20   -22    50   -52    78  -144    96   -97 $  2403
3329 2404   0.05876   19   -21    51   -53    76   -78    96   -97 $  2404
3330 2405   0.05876   18   -20    52   -54    74   -76    96   -97 $  2405
3331 2406   0.05059   16   -18    51   -53    73   -75    96   -97 $  2406
3332 3401   0.05058   14   -16    50   -52    72   -74    96   -97 $  3401
3333 3402   0.05054   12   -14    49   -51    71   -73    96   -97 $  3402
```

3334	3403	0.05055	11	-13	131	-49	72	-74	96	-97	$ 3403
3335	3404	0.05876	133	-130	134	-131	132	-129	96	-97	$ 3404
3336	3405	0.05062	9	-11	43	-134	74	-76	96	-97	$ 3405
3337	3406	0.05876	10	-12	42	-44	76	-78	96	-97	$ 3406
3338	1501	0.05063	9	-11	40	-42	77	-79	96	-97	$ 1501
3339	1302	0.04684	10	-12	39	-41	79	-81	105	-106	$ 1502
3340	1503	0.05068	11	-13	38	-40	81	-83	96	-97	$ 1503
41	1302	0.04684	13	-15	39	-41	82	-84	105	-106	$ 1504
42	1505	0.05068	15	-17	40	-42	83	-85	96	-97	$ 1505
43	1506	0.05068	17	-19	41	-43	84	-86	96	-97	$ 1506
44	1507	0.05070	19	-21	42	-44	85	-87	96	-97	$ 1507
45	1508	0.05069	20	-22	44	-46	84	-86	96	-97	$ 1508
46	2501	0.05069	21	-23	46	-48	83	-85	96	-97	$ 2501
47	1302	0.04684	22	-24	48	-151	141	-84	105	-106	$ 2502
48	2503	0.05068	142	-148	151	-149	150	-147	96	-97	$ 2503
49	1302	0.04684	22	-24	143	-53	79	-150	105	-106	$ 2504
50	2505	0.05070	21	-23	52	-54	77	-79	96	-97	$ 2505
51	2506	0.05068	20	-22	53	-55	75	-77	96	-97	$ 2506
52	2507	0.05063	19	-21	54	-56	73	-75	96	-97	$ 2507
53	2508	0.05068	17	-19	53	-55	72	-74	96	-97	$ 2508
54	3501	0.05064	15	-17	52	-54	71	-73	96	-97	$ 3501
55	1302	0.04684	13	-15	51	-53	70	-72	105	-106	$ 3502
56	3503	0.05070	11	-13	50	-52	69	-71	96	-97	$ 3503
57	1302	0.04684	10	-12	48	-50	70	-72	105	-106	$ 3504
58	3505	0.05071	9	-11	46	-48	71	-132	96	-97	$ 3505
59	3506	0.05069	8	-133	44	-46	72	-74	96	-97	$ 3506
60	3507	0.05059	7	-9	42	-44	73	-75	96	-97	$ 3507
61	3508	0.05068	8	-10	41	-43	75	-77	96	-97	$ 3508
62	1601	0.05069	8	-10	38	-40	78	-80	96	-97	$ 3610
63	1602	0.05069	9	-11	37	-39	80	-82	96	-97	$ 1601
64	1603	0.05070	10	-12	36	-38	82	-84	96	-97	$ 1602
65	1604	0.05070	12	-14	37	-39	83	-85	96	-97	$ 1603
66	1605	0.05068	14	-16	38	-40	84	-86	96	-97	$ 1604
67	1606	0.05068	16	-18	39	-41	85	-87	96	-97	$ 1605
68	1607	0.05396	18	-20	40	-42	86	-88	96	-97	$ 1606
69	1608	0.05068	20	-22	41	-43	87	-89	96	-97	$ 1607
70	1609	0.05069	21	-23	43	-45	86	-88	96	-97	$ 1608
71	1610	0.03284	22	-24	45	-47	85	-87	96	-97	$ 1609
72	2601	0.05070	23	-25	47	-49	84	-86	96	-97	$ 2601
73	2602	0.05068	24	-26	49	-156	147	-85	96	-97	$ 2602
74	2603	0.05061	148	-153	156	-154	155	-152	96	-97	$ 2603
75	2604	0.05069	24	-26	149	-54	80	-155	96	-97	$ 2604
76	2605	0.05069	23	-25	53	-55	78	-80	96	-97	$ 2605
77	2606	0.05069	22	-24	54	-56	76	-78	96	-97	$ 2606
78	2607	0.05068	21	-23	55	-57	74	-76	96	-97	$ 2607
79	2608	0.05063	20	-22	56	-58	72	-74	96	-97	$ 2608
80	2609	0.05067	18	-20	55	-57	71	-73	96	-97	$ 2609
81	2610	0.04330	16	-18	54	-56	70	-72	96	-97	$ 2610
82	3601	0.05070	14	-16	53	-55	69	-71	96	-97	$ 3601
83	3602	0.05068	12	-14	52	-54	68	-70	96	-97	$ 3602
84	3603	0.05071	10	-12	51	-53	67	-69	96	-97	$ 3603
85	3604	0.05058	9	-11	49	-51	68	-70	96	-97	$ 3604
86	3605	0.05068	8	-10	47	-49	69	-71	96	-97	$ 3605
87	3606	0.05070	7	-9	45	-47	70	-72	96	-97	$ 3606
88	3607	0.05068	6	-8	43	-45	71	-73	96	-97	$ 3607
89	3608	0.05068	5	-7	41	-43	72	-74	96	-97	$ 3608
90	3609	0.05068	6	-8	40	-42	74	-76	96	-97	$ 3609
91	3610	0.05072	7	-9	39	-41	76	-78	96	-97	$ 3610
92	1701	0.07674	6	-8	37	-39	77	-79	96	-97	$ 1701
93	1701	0.07674	7	-9	36	-38	79	-81	96	-97	$ 1702
94	1701	0.07674	8	-10	35	-37	81	-83	96	-97	$ 1703
95	1701	0.07674	9	-11	34	-36	83	-85	96	-97	$ 1704
96	1701	0.07674	11	-13	35	-37	84	-86	96	-97	$ 1705
97	1701	0.07674	13	-15	36	-38	85	-87	96	-97	$ 1706
98	1701	0.07674	15	-17	37	-39	86	-88	96	-97	$ 1707
99	1701	0.07674	17	-19	38	-40	87	-89	96	-97	$ 1708
100	1701	0.07674	19	-21	39	-41	88	-90	96	-97	$ 1709
101	1701	0.07674	21	-23	40	-42	89	-91	96	-97	$ 1710
102	1711	0.06001	22	-24	42	-44	88	-90	96	-97	$ 1711
103	1701	0.07674	23	-25	44	-46	87	-89	96	-97	$ 2701
104	1701	0.07674	24	-26	46	-48	86	-88	96	-97	$ 2702
105	1701	0.07674	25	-27	48	-50	85	-87	96	-97	$ 2703
106	1701	0.07674	26	-28	50	-161	152	-86	96	-97	$ 2704
107	1701	0.07674	153	-158	161	-159	160	-157	96	-97	$ 2705
108	1701	0.07674	26	-28	154	-55	81	-160	96	-97	$ 2706
109	1701	0.07674	25	-27	54	-56	79	-81	96	-97	$ 2707
110	1701	0.07674	24	-26	55	-57	77	-79	96	-97	$ 2708
111	1701	0.07674	23	-25	56	-58	75	-77	96	-97	$ 2709
112	1701	0.07674	22	-24	57	-59	73	-75	96	-97	$ 2710
113	1701	0.07674	21	-23	58	-60	71	-73	96	-97	$ 2711
114	1701	0.07674	19	-21	57	-59	70	-72	96	-97	$ 2712
115	1701	0.07674	17	-19	56	-58	69	-71	96	-97	$ 2713
116	1701	0.07674	15	-17	55	-57	68	-70	96	-97	$ 3701
117	1701	0.07674	13	-15	54	-56	67	-69	96	-97	$ 3702
118	1701	0.07674	11	-13	53	-55	66	-68	96	-97	$ 3703
119	1701	0.07674	9	-11	52	-54	65	-67	96	-97	$ 3704
120	1701	0.07674	8	-10	50	-52	66	-68	96	-97	$ 3705
121	1701	0.07674	7	-9	48	-50	67	-69	96	-97	$ 3706
122	1701	0.07674	6	-8	46	-48	68	-70	96	-97	$ 3707

```
 123 3708   0.05456     5    -7    44   -46    69   -71    96   -97 $  3708
 124 1701   0.07674     4    -6    42   -44    70   -72    96   -97 $  3709
 125 1701   0.07674   136    -5    40   -42    71   -73    96   -97 $  3710
 126 3711   0.07489     4    -6    39   -41    73   -75    96   -97 $  3711
 127 1701   0.07674     5    -7    38   -40    75   -77    96   -97 $  3712
 128 1801   0.07653     5    -7    35   -37    78   -80    96   -97 $  1801
 129 1801   0.07653     6    -8    34   -36    80   -82    96   -97 $  1802
 130 1801   0.07653     7    -9    33   -35    82   -84    96   -97 $  1803
 131 1801   0.07653     8   -10    32   -34    84   -86    96   -97 $  1804
 132 1801   0.07653    10   -12    33   -35    85   -87    96   -97 $  1805
 133 1801   0.07653    12   -14    34   -36    86   -88    96   -97 $  1806
 134 1801   0.07653    14   -16    35   -37    87   -89    96   -97 $  1807
 135 1801   0.07653    16   -18    36   -38    88   -90    96   -97 $  1808
 136 1801   0.07653    18   -20    37   -39    89   -91    96   -97 $  1809
 137 1801   0.07653    20   -22    38   -40    90   -92    96   -97 $  1810
 138 1801   0.07653    22   -24    39   -41    91   -93    96   -97 $  1811
 139 1801   0.07653    23   -25    41   -43    90   -92    96   -97 $  1812
 140 1801   0.07653    24   -26    43   -45    89   -91    96   -97 $  1813
 141 1801   0.07653    25   -27    45   -47    88   -90    96   -97 $  1814
 142 1801   0.07653    26   -28    47   -49    87   -89    96   -97 $  2801
 143 1801   0.07653    27   -29    49   -51    86   -88    96   -97 $  2802
 144 1801   0.07653    28   -30    51   -53   157   -87    96   -97 $  2803
 145 1801   0.07653   158   -31    53   -55    84   -86    96   -97 $  2804
 146 1801   0.07653    28   -30   159   -56    82   -84    96   -97 $  2805
 147 1801   0.07653    27   -29    55   -57    80   -82    96   -97 $  2806
 148 1801   0.07653    26   -28    56  -167    78   -80    96   -97 $  2807
 149 1801   0.07653    25  -166    57   -59    76   -78    96   -97 $  2808
 150 1801   0.07653    24   -26    58   -60    74   -76    96   -97 $  2809
 151 1801   0.07653    23   -25    59   -61    72   -74    96   -97 $  2810
 152 1801   0.07653    22   -24    60   -62    70   -72    96   -97 $  2811
 153 1801   0.07653    20   -22    59   -61    69   -71    96   -97 $  2812
 154 1801   0.07653    18   -20    58   -60    68   -70    96   -97 $  2813
 155 1801   0.07653    16   -18    57   -59    67   -69    96   -97 $  2814
 156 1801   0.07653    14   -16    56   -58    66   -68    96   -97 $  3801
 157 1801   0.07653    12   -14    55   -57    65   -67    96   -97 $  3802
 158 1801   0.07653    10   -12    54   -56    64   -66    96   -97 $  3803
 159 1801   0.07653     8   -10    53   -55    63   -65    96   -97 $  3804
 160 1801   0.07653     7    -9    51   -53    64   -66    96   -97 $  3805
 161 1801   0.07653     6    -8    49   -51    65   -67    96   -97 $  3806
 162 1801   0.07653     5    -7    47   -49    66   -68    96   -97 $  3807
 163 1801   0.07653     4    -6    45   -47    67   -69    96   -97 $  3808
 164 1801   0.07653     3    -5    43   -45    68   -70    96   -97 $  3809
 165 1801   0.07653     2    -4   137   -43    69   -71    96   -97 $  3810
 166 1801   0.07653     1  -136   140  -137   138  -135    96   -97 $  3811
 167 1801   0.07653     2    -4    38   -40   135   -74    96   -97 $  3812
 168 1801   0.07653     3    -5    37   -39    74   -76    96   -97 $  3813
 169 1801   0.07653     4    -6    36   -38    76   -78    96   -97 $  3814
 170 1801   0.07653     3    -5    34   -36    77   -79    96   -97 $  1901
 171 1801   0.07653     4    -6    33   -35    79   -81    96   -97 $  1902
 172 1801   0.07653     5    -7    32   -34    81   -83    96   -97 $  1903
 173 1801   0.07653    11   -13    32   -34    87   -89    96   -97 $  1907
 174 1801   0.07653    13   -15    33   -35    88   -90    96   -97 $  1908
 175 1801   0.07653    15   -17    34   -36    89   -91    96   -97 $  1909
 176 1801   0.07653    17   -19    35   -37    90   -92    96   -97 $  1910
 177 1801   0.07653    19   -21    36   -38    91   -93    96   -97 $  1911
 178 1801   0.07653    25   -27    42   -44    91   -93    96   -97 $  1915
 179 1801   0.07653    26   -28    44   -46    90   -92    96   -97 $  1916
 180 1801   0.07653    27   -29    46   -48    89   -91    96   -97 $  1917
 181 1801   0.07653    28   -30    48   -50    88   -90    96   -97 $  1918
 182 1801   0.07653    29   -31    50   -52    87   -89    96   -97 $  1919
 183 1801   0.07653    29   -31    56   -58    81   -83    96   -97 $  2907
 184 1801   0.07653    28   -30    57   -59   162   -81    96   -97 $  2908
 185 1801   0.07653   166  -163   167  -164   165  -162    96   -97 $  2909
 186 1801   0.07653    26   -28    59   -61    75  -165    96   -97 $  2910
 187 1801   0.07653    25   -27    60   -62    73   -75    96   -97 $  2911
 188 1801   0.07653    19   -21    60   -62    67   -69    96   -97 $  2915
 189 1801   0.07653    17   -19    59   -61    66   -68    96   -97 $  2916
 190 1801   0.07653    15   -17    58   -60    65   -67    96   -97 $  2917
 191 1801   0.07653    13   -15    57   -59    64   -66    96   -97 $  2918
 192 1801   0.07653    11   -13    56   -58    63   -65    96   -97 $  2919
 193 1801   0.07653     5    -7    50   -52    63   -65    96   -97 $  3907
 194 1801   0.07653     4    -6    48   -50    64   -66    96   -97 $  3908
 195 1801   0.07653     3    -5    46   -48    65   -67    96   -97 $  3909
 196 1801   0.07653     2    -4    44   -46    66   -68    96   -97 $  3910
 197 1801   0.07653     1    -3    42   -44    67   -69    96   -97 $  3911
 198 1801   0.07653     1    -3    36   -38    73   -75    96   -97 $  3915
 199 1801   0.07653     2    -4    35   -37    75   -77    96   -97 $  3916
c      200  139    0.0222     1   -73    -2  -140          96   -97 $  ha
c       this is the lower axial reflector
 201  111 0.0564252  127  -124   128  -125   126  -123    95   -96 $  2101
 202  111 0.0564252   14   -16    44  -128    78   -80    95   -96 $  1201
 203  111 0.0564252   16   -18    45   -47   123   -81    95   -96 $  1202
 204  111 0.0564252  124   -19    47   -49    78   -80    95   -96 $  2201
 205  111 0.0564252   16   -18   125   -50    76   -78    95   -96 $  2202
 206  111 0.0564252   14   -16    47   -49    75  -126    95   -96 $  3201
 207 3202 0.05876     13  -127    45   -47    76   -78    95   -96 $  3202
 208  111 0.0564252   12   -14    43   -45    77   -79    95   -96 $  1301
 209  193 0.0280912   13   -15    42   -44    79   -81    96  -104 $  1302
 210  111 0.0564252   15   -17    43   -45    80   -82    95   -96 $  1303
```

211	111	0.0564252	17	-19	44	-46	81	-83	95	-96	$ 1304
212	111	0.0564252	18	-20	46	-48	80	-82	95	-96	$ 2301
213	193	0.0280912	19	-145	48	-50	79	-81	96	-104	$ 2302
214	111	0.0564252	18	-20	49	-51	77	-79	95	-96	$ 2303
215	111	0.0564252	17	-19	50	-52	75	-77	95	-96	$ 2304
216	111	0.0564252	15	-17	49	-51	74	-76	95	-96	$ 3301
217	193	0.0280912	13	-15	48	-50	73	-75	96	-104	$ 3302
218	111	0.0564252	130	-14	46	-48	74	-76	95	-96	$ 3303
219	111	0.0564252	11	-13	44	-46	129	-77	95	-96	$ 3304
220	111	0.0564252	11	-13	41	-43	78	-80	95	-96	$ 1401
221	111	0.0564252	12	-14	40	-42	80	-82	95	-96	$ 1402
222	111	0.0564252	14	-16	41	-43	81	-83	95	-96	$ 1403
223	1404	0.0587600	16	-18	42	-44	82	-84	95	-96	$ 1404
224	111	0.0564252	18	-20	43	-45	83	-85	95	-96	$ 1405
225	1406	0.05876	19	-21	45	-47	82	-84	95	-96	$ 1406
226	111	0.0564252	20	-22	47	-146	81	-83	95	-96	$ 2401
227	111	0.0564252	145	-142	146	-143	144	-141	95	-96	$ 2402
228	111	0.0564252	20	-22	50	-52	78	-144	95	-96	$ 2403
229	2404	0.05876	19	-21	51	-53	76	-78	95	-96	$ 2404
230	2405	0.0587600	18	-20	52	-54	74	-76	95	-96	$ 2405
231	111	0.0564252	16	-18	51	-53	73	-75	95	-96	$ 2406
232	111	0.0564252	14	-16	50	-52	72	-74	95	-96	$ 3401
233	111	0.0564252	12	-14	49	-51	71	-73	95	-96	$ 3402
234	111	0.0564252	11	-13	131	-49	72	-74	95	-96	$ 3403
235	3404	0.05876	133	-130	134	-131	132	-129	95	-96	$ 3404
236	111	0.0564252	9	-11	43	-134	74	-76	95	-96	$ 3405
237	3406	0.0587600	10	-12	42	-44	76	-78	95	-96	$ 3406
238	111	0.0564252	9	-11	40	-42	77	-79	95	-96	$ 1501
239	193	0.0280912	10	-12	39	-41	79	-81	96	-105	$ 1502
240	111	0.0564252	11	-13	38	-40	81	-83	95	-96	$ 1503
241	193	0.0280912	13	-15	39	-41	82	-84	96	-105	$ 1504
242	111	0.0564252	15	-17	40	-42	83	-85	95	-96	$ 1505
243	111	0.0564252	17	-19	41	-43	84	-86	95	-96	$ 1506
244	111	0.0564252	19	-21	42	-44	85	-87	95	-96	$ 1507
245	111	0.0564252	20	-22	44	-46	84	-86	95	-96	$ 1508
246	111	0.0564252	21	-23	46	-48	83	-85	95	-96	$ 2501
247	193	0.0280912	22	-24	48	-151	141	-84	96	-105	$ 2502
248	111	0.0564252	142	-148	151	-149	150	-147	95	-96	$ 2503
249	193	0.0280912	22	-24	143	-53	79	-150	96	-105	$ 2504
250	111	0.0564252	21	-23	52	-54	77	-79	95	-96	$ 2505
251	111	0.0564252	20	-22	53	-55	75	-77	95	-96	$ 2506
252	111	0.0564252	19	-21	54	-56	73	-75	95	-96	$ 2507
253	111	0.0564252	17	-19	53	-55	72	-74	95	-96	$ 2508
254	111	0.0564252	15	-17	52	-54	71	-73	95	-96	$ 3501
255	193	0.0280912	13	-15	51	-53	70	-72	96	-105	$ 3502
256	222	0.0507462	11	-13	50	-52	69	-71	95	-96	$ 3503
257	193	0.0280912	10	-12	48	-50	70	-72	96	-105	$ 3504
258	111	0.0564252	9	-11	46	-48	71	-132	95	-96	$ 3505
259	111	0.0564252	8	-133	44	-46	72	-74	95	-96	$ 3506
260	111	0.0564252	7	-9	42	-44	73	-75	95	-96	$ 3507
261	111	0.0564252	8	-10	41	-43	75	-77	95	-96	$ 3508
262	111	0.0564252	8	-10	38	-40	78	-80	95	-96	$ 3610
263	111	0.0564252	9	-11	37	-39	80	-82	95	-96	$ 1601
264	111	0.0564252	10	-12	36	-38	82	-84	95	-96	$ 1602
265	111	0.0564252	12	-14	37	-39	83	-85	95	-96	$ 1603
266	111	0.0564252	14	-16	38	-40	84	-86	95	-96	$ 1604
267	111	0.0564252	16	-18	39	-41	85	-87	95	-96	$ 1605
268	1607	0.0539600	18	-20	40	-42	86	-88	95	-96	$ 1606
269	111	0.0564252	20	-22	41	-43	87	-89	95	-96	$ 1607
270	111	0.0564252	21	-23	43	-45	86	-88	95	-96	$ 1608
271	111	0.0564252	22	-24	45	-47	85	-87	95	-96	$ 1609
272	111	0.0564252	23	-25	47	-49	84	-86	95	-96	$ 2601
273	111	0.0564252	24	-26	49	-156	147	-85	95	-96	$ 2602
274	111	0.0564252	148	-153	156	-154	155	-152	95	-96	$ 2603
275	111	0.0564252	24	-26	149	-54	80	-155	95	-96	$ 2604
276	111	0.0564252	23	-25	53	-55	78	-80	95	-96	$ 2605
277	111	0.0564252	22	-24	54	-56	76	-78	95	-96	$ 2606
278	111	0.0564252	21	-23	55	-57	74	-76	95	-96	$ 2607
279	222	0.0507462	20	-22	56	-58	72	-74	95	-96	$ 2608
280	111	0.0564252	18	-20	55	-57	71	-73	95	-96	$ 2609
281	111	0.0564252	16	-18	54	-56	70	-72	95	-96	$ 2610
282	111	0.0564252	14	-16	53	-55	69	-71	95	-96	$ 3601
283	111	0.0564252	12	-14	52	-54	68	-70	95	-96	$ 3602
284	111	0.0564252	10	-12	51	-53	67	-69	95	-96	$ 3603
285	111	0.0564252	9	-11	49	-51	68	-70	95	-96	$ 3604
286	111	0.0564252	8	-10	47	-49	69	-71	95	-96	$ 3605
287	111	0.0564252	7	-9	45	-47	70	-72	95	-96	$ 3606
288	111	0.0564252	6	-8	43	-45	71	-73	95	-96	$ 3607
289	111	0.0564252	5	-7	41	-43	72	-74	95	-96	$ 3608
290	111	0.0564252	6	-8	40	-42	74	-76	95	-96	$ 3609
291	111	0.0564252	7	-9	39	-41	76	-78	95	-96	$ 3610
292	1701	0.07674	6	-8	37	-39	77	-79	95	-96	$ 1701
293	1701	0.07674	7	-9	36	-38	79	-81	95	-96	$ 1702
294	1701	0.07674	8	-10	35	-37	81	-83	95	-96	$ 1703
295	1701	0.07674	9	-11	34	-36	83	-85	95	-96	$ 1704
296	1701	0.07674	11	-13	35	-37	84	-86	95	-96	$ 1705
297	1701	0.07674	13	-15	36	-38	85	-87	95	-96	$ 1706
298	1701	0.07674	15	-17	37	-39	86	-88	95	-96	$ 1707
299	1701	0.07674	17	-19	38	-40	87	-89	95	-96	$ 1708

300	1701	0.07674	19	-21	39	-41	88	-90	95	-96	$ 1709
301	1701	0.07674	21	-23	40	-42	89	-91	95	-96	$ 1710
302	1711	0.06001	22	-24	42	-44	88	-90	95	-96	$ 1711
303	1701	0.07674	23	-25	44	-46	87	-89	95	-96	$ 2701
304	1701	0.07674	24	-26	46	-48	86	-88	95	-96	$ 2702
305	1701	0.07674	25	-27	48	-50	85	-87	95	-96	$ 2703
306	1701	0.07674	26	-28	50	-161	152	-86	95	-96	$ 2704
307	1701	0.07674	153	-158	161	-159	160	-157	95	-96	$ 2705
308	1701	0.07674	26	-28	154	-55	81	-160	95	-96	$ 2706
309	1701	0.07674	25	-27	54	-56	79	-81	95	-96	$ 2707
310	1701	0.07674	24	-26	55	-57	77	-79	95	-96	$ 2708
311	1701	0.07674	23	-25	56	-58	75	-77	95	-96	$ 2709
312	1701	0.07674	22	-24	57	-59	73	-75	95	-96	$ 2710
313	1701	0.07674	21	-23	58	-60	71	-73	95	-96	$ 2711
314	1701	0.07674	19	-21	57	-59	70	-72	95	-96	$ 2712
315	1701	0.07674	17	-19	56	-58	69	-71	95	-96	$ 2713
316	1701	0.07674	15	-17	55	-57	68	-70	95	-96	$ 3701
317	1701	0.07674	13	-15	54	-56	67	-69	95	-96	$ 3702
318	1701	0.07674	11	-13	53	-55	66	-68	95	-96	$ 3703
319	1701	0.07674	9	-11	52	-54	65	-67	95	-96	$ 3704
320	1701	0.07674	8	-10	50	-52	66	-68	95	-96	$ 3705
321	1701	0.07674	7	-9	48	-50	67	-69	95	-96	$ 3706
322	1701	0.07674	6	-8	46	-48	68	-70	95	-96	$ 3707
323	3708	0.05456	5	-7	44	-46	69	-71	95	-96	$ 3708
324	1701	0.07674	4	-6	42	-44	70	-72	95	-96	$ 3709
325	1701	0.07674	136	-5	40	-42	71	-73	95	-96	$ 3710
326	1302	0.03819	4	-6	39	-41	73	-75	95	-96	$ 3711
327	1701	0.07674	5	-7	38	-40	75	-77	95	-96	$ 3712
328	1801	0.07653	5	-7	35	-37	78	-80	95	-96	$ 1801
329	1801	0.07653	6	-8	34	-36	80	-82	95	-96	$ 1802
330	1801	0.07653	7	-9	33	-35	82	-84	95	-96	$ 1803
331	1801	0.07653	8	-10	32	-34	84	-86	95	-96	$ 1804
332	1801	0.07653	10	-12	33	-35	85	-87	95	-96	$ 1805
333	1801	0.07653	12	-14	34	-36	86	-88	95	-96	$ 1806
334	1801	0.07653	14	-16	35	-37	87	-89	95	-96	$ 1807
335	1801	0.07653	16	-18	36	-38	88	-90	95	-96	$ 1808
336	1801	0.07653	18	-20	37	-39	89	-91	95	-96	$ 1809
337	1801	0.07653	20	-22	38	-40	90	-92	95	-96	$ 1810
338	1801	0.07653	22	-24	39	-41	91	-93	95	-96	$ 1811
339	1801	0.07653	23	-25	41	-43	90	-92	95	-96	$ 1812
340	1801	0.07653	24	-26	43	-45	89	-91	95	-96	$ 1813
341	1801	0.07653	25	-27	45	-47	88	-90	95	-96	$ 1814
342	1801	0.07653	26	-28	47	-49	87	-89	95	-96	$ 2801
343	1801	0.07653	27	-29	49	-51	86	-88	95	-96	$ 2802
344	1801	0.07653	28	-30	51	-53	157	-87	95	-96	$ 2803
345	1801	0.07653	158	-31	53	-55	84	-86	95	-96	$ 2804
346	1801	0.07653	28	-30	159	-56	82	-84	95	-96	$ 2805
347	1801	0.07653	27	-29	55	-57	80	-82	95	-96	$ 2806
348	1801	0.07653	26	-28	56	-167	78	-80	95	-96	$ 2807
349	1801	0.07653	25	-166	57	-59	76	-78	95	-96	$ 2808
350	1801	0.07653	24	-26	58	-60	74	-76	95	-96	$ 2809
351	1801	0.07653	23	-25	59	-61	72	-74	95	-96	$ 2810
352	1801	0.07653	22	-24	60	-62	70	-72	95	-96	$ 2811
353	1801	0.07653	20	-22	59	-61	69	-71	95	-96	$ 2812
354	1801	0.07653	18	-20	58	-60	68	-70	95	-96	$ 2813
355	1801	0.07653	16	-18	57	-59	67	-69	95	-96	$ 2814
356	1801	0.07653	14	-16	56	-58	66	-68	95	-96	$ 3801
357	1801	0.07653	12	-14	55	-57	65	-67	95	-96	$ 3802
358	1801	0.07653	10	-12	54	-56	64	-66	95	-96	$ 3803
359	1801	0.07653	8	-10	53	-55	63	-65	95	-96	$ 3804
360	1801	0.07653	7	-9	51	-53	64	-66	95	-96	$ 3805
361	1801	0.07653	6	-8	49	-51	65	-67	95	-96	$ 3806
362	1801	0.07653	5	-7	47	-49	66	-68	95	-96	$ 3807
363	1801	0.07653	4	-6	45	-47	67	-69	95	-96	$ 3808
364	1801	0.07653	3	-5	43	-45	68	-70	95	-96	$ 3809
365	1801	0.07653	2	-4	137	-43	69	-71	95	-96	$ 3810
366	1801	0.07653	1	-136	140	-137	138	-135	95	-96	$ 3811
367	1801	0.07653	2	-4	38	-40	135	-74	95	-96	$ 3812
368	1801	0.07653	3	-5	37	-39	74	-76	95	-96	$ 3813
369	1801	0.07653	4	-6	36	-38	76	-78	95	-96	$ 3814
370	1801	0.07653	3	-5	34	-36	77	-79	95	-96	$ 1901
371	1801	0.07653	4	-6	33	-35	79	-81	95	-96	$ 1902
372	1801	0.07653	5	-7	32	-34	81	-83	95	-96	$ 1903
373	1801	0.07653	11	-13	32	-34	87	-89	95	-96	$ 1907
374	1801	0.07653	13	-15	33	-35	88	-90	95	-96	$ 1908
375	1801	0.07653	15	-17	34	-36	89	-91	95	-96	$ 1909
376	1801	0.07653	17	-19	35	-37	90	-92	95	-96	$ 1910
377	1801	0.07653	19	-21	36	-38	91	-93	95	-96	$ 1911
378	1801	0.07653	25	-27	42	-44	91	-93	95	-96	$ 1915
379	1801	0.07653	26	-28	44	-46	90	-92	95	-96	$ 1916
380	1801	0.07653	27	-29	46	-48	89	-91	95	-96	$ 1917
381	1801	0.07653	28	-30	48	-50	88	-90	95	-96	$ 1918
382	1801	0.07653	29	-31	50	-52	87	-89	95	-96	$ 1919
383	1801	0.07653	29	-31	56	-58	81	-83	95	-96	$ 2907
384	1801	0.07653	28	-30	57	-59	162	-81	95	-96	$ 2908
385	1801	0.07653	166	-163	167	-164	165	-162	95	-96	$ 2909
386	1801	0.07653	26	-28	59	-61	75	-165	95	-96	$ 2910
387	1801	0.07653	25	-27	60	-62	73	-75	95	-96	$ 2911
388	1801	0.07653	19	-21	60	-62	67	-69	95	-96	$ 2915

```
 389 1801   0.07653   17   -19    59   -61    66   -68    95   -96 $  2916
 390 1801   0.07653   15   -17    58   -60    65   -67    95   -96 $  2917
 391 1801   0.07653   13   -15    57   -59    64   -66    95   -96 $  2918
 392 1801   0.07653   11   -13    56   -58    63   -65    95   -96 $  2919
 393 1801   0.07653    5    -7    50   -52    63   -65    95   -96 $  3907
 394 1801   0.07653    4    -6    48   -50    64   -66    95   -96 $  3908
 395 1801   0.07653    3    -5    46   -48    65   -67    95   -96 $  3909
 396 1801   0.07653    2    -4    44   -46    66   -68    95   -96 $  3910
 397 1801   0.07653    1    -3    42   -44    67   -69    95   -96 $  3911
 398 1801   0.07653    1    -3    36   -38    73   -75    95   -96 $  3915
 399 1801   0.07653    2    -4    35   -37    75   -77    95   -96 $  3916
c      400  139    0.0222    1   -73    -2  -140          95   -96 $  ha
c     this is the upper axial reflector
 401  111 0.0564252  127  -124   128  -125   126  -123    97   -98 $  2101
 402  111 0.0564252   14   -16    44  -128    78   -80    97   -98 $  1201
 403  111 0.0564252   16   -18    45   -47   123   -81    97   -98 $  1202
 404  111 0.0564252  124   -19    47   -49    78   -80    97   -98 $  2201
 405  111 0.0564252   16   -18   125   -50    76   -78    97   -98 $  2202
 406  111 0.0564252   14   -16    47   -49    75  -126    97   -98 $  3201
 407 3202 0.05876     13  -127    45   -47    76   -78    97   -98 $  3202
 408  111 0.0564252   12   -14    43   -45    77   -79    97   -98 $  1301
 409  194 0.0749180   13   -15    42   -44    79   -81    97   -98 $  1302
 410  111 0.0564252   15   -17    43   -45    80   -82    97   -98 $  1303
 411  111 0.0564252   17   -19    44   -46    81   -83    97   -98 $  1304
 412  111 0.0564252   18   -20    46   -48    80   -82    97   -98 $  2301
 413  194 0.0749180   19  -145    48   -50    79   -81    97   -98 $  2302
 414  111 0.0564252   18   -20    49   -51    77   -79    97   -98 $  2303
 415  111 0.0564252   17   -19    50   -52    75   -77    97   -98 $  2304
 416  111 0.0564252   15   -17    49   -51    74   -76    97   -98 $  3301
 417  194 0.0749180   13   -15    48   -50    73   -75    97   -98 $  3302
 418  111 0.0564252  130   -14    46   -48    74   -76    97   -98 $  3303
 419  111 0.0564252   11   -13    44   -46   129   -77    97   -98 $  3304
 420  111 0.0564252   11   -13    41   -43    78   -80    97   -98 $  1401
 421  111 0.0564252   12   -14    40   -42    80   -82    97   -98 $  1402
 422  111 0.0564252   14   -16    41   -43    81   -83    97   -98 $  1403
 423 1404 0.0587600   16   -18    42   -44    82   -84    97   -98 $  1404
 424  111 0.0564252   18   -20    43   -45    83   -85    97   -98 $  1405
 425 1404 0.05876     19   -21    45   -47    82   -84    97   -98 $  1406
 426  111 0.0564252   20   -22    47  -146    81   -83    97   -98 $  2401
 427  111 0.0564252  145  -142   146  -143   144  -141    97   -98 $  2402
 428  111 0.0564252   20   -22    50   -52    78  -144    97   -98 $  2403
 429 2404 0.05876     19   -21    51   -53    76   -78    97   -98 $  2404
 430 2405 0.0587600   18   -20    52   -54    74   -76    97   -98 $  2405
 431  111 0.0564252   16   -18    51   -53    73   -75    97   -98 $  2406
 432  111 0.0564252   14   -16    50   -52    72   -74    97   -98 $  3401
 433  111 0.0564252   12   -14    49   -51    71   -73    97   -98 $  3402
 434  111 0.0564252   11   -13   131   -49    72   -74    97   -98 $  3403
 435 3404 0.05876     133  -130   134  -131   132  -129    97   -98 $  3404
 436  111 0.0564252    9   -11    43  -134    74   -76    97   -98 $  3405
 437 3406 0.0587600   10   -12    42   -44    76   -78    97   -98 $  3406
 438  111 0.0564252    9   -11    40   -42    77   -79    97   -98 $  1501
 439  194 0.0749180   10   -12    39   -41    79   -81   106   -97 $  1502
 440  111 0.0564252   11   -13    38   -40    81   -83    97   -98 $  1503
 441  194 0.0749180   13   -15    39   -41    82   -84   106   -97 $  1504
 442  111 0.0564252   15   -17    40   -42    83   -85    97   -98 $  1505
 443  111 0.0564252   17   -19    41   -43    84   -86    97   -98 $  1506
 444  111 0.0564252   19   -21    42   -44    85   -87    97   -98 $  1507
 445  111 0.0564252   20   -22    44   -46    84   -86    97   -98 $  1508
 446  111 0.0564252   21   -23    46   -48    83   -85    97   -98 $  2501
 447  194 0.0749180   22   -24    48  -151   141   -84   106   -97 $  2502
 448  111 0.0564252  142  -148   151  -149   150  -147    97   -98 $  2503
 449  194 0.0749180   22   -24   143   -53    79  -150   106   -97 $  2504
 450  111 0.0564252   21   -23    52   -54    77   -79    97   -98 $  2505
 451  111 0.0564252   20   -22    53   -55    75   -77    97   -98 $  2506
 452  222 0.0507462   19   -21    54   -56    73   -75    97   -98 $  2507
 453  111 0.0564252   17   -19    53   -55    72   -74    97   -98 $  2508
 454  111 0.0564252   15   -17    52   -54    71   -73    97   -98 $  3501
 455  194 0.0749180   13   -15    51   -53    70   -72   106   -97 $  3502
 456  111 0.0564252   11   -13    50   -52    69   -71    97   -98 $  3503
 457  194 0.0749180   10   -12    48   -50    70   -72   106   -97 $  3504
 458  111 0.0564252    9   -11    46   -48    71  -132    97   -98 $  3505
 459  111 0.0564252    8  -133    44   -46    72   -74    97   -98 $  3506
 460  111 0.0564252    7    -9    42   -44    73   -75    97   -98 $  3507
 461  111 0.0564252    8   -10    41   -43    75   -77    97   -98 $  3508
 462  111 0.0564252    8   -10    38   -40    78   -80    97   -98 $  3610
 463  111 0.0564252    9   -11    37   -39    80   -82    97   -98 $  1601
 464  111 0.0564252   10   -12    36   -38    82   -84    97   -98 $  1602
 465  111 0.0564252   12   -14    37   -39    83   -85    97   -98 $  1603
 466  111 0.0564252   14   -16    38   -40    84   -86    97   -98 $  1604
 467  111 0.0564252   16   -18    39   -41    85   -87    97   -98 $  1605
 468 1607 0.0539600   18   -20    40   -42    86   -88    97   -98 $  1606
 469  111 0.0564252   20   -22    41   -43    87   -89    97   -98 $  1607
 470  111 0.0564252   21   -23    43   -45    86   -88    97   -98 $  1608
 471  111 0.0564252   22   -24    45   -47    85   -87    97   -98 $  1609
 472  111 0.0564252   23   -25    47   -49    84   -86    97   -98 $  2601
 473  111 0.0564252   24   -26    49  -156   147   -85    97   -98 $  2602
 474  111 0.0564252  148  -153   156  -154   155  -152    97   -98 $  2603
 475  111 0.0564252   24   -26   149   -54    80  -155    97   -98 $  2604
 476  111 0.0564252   23   -25    53   -55    78   -80    97   -98 $  2605
```

477	111	0.0564252	22	-24	54	-56	76	-78	97	-98	$ 2606
478	111	0.0564252	21	-23	55	-57	74	-76	97	-98	$ 2607
479	222	0.0507462	20	-22	56	-58	72	-74	97	-98	$ 2608
480	111	0.0564252	18	-20	55	-57	71	-73	97	-98	$ 2609
481	111	0.0564252	16	-18	54	-56	70	-72	97	-98	$ 2610
482	111	0.0564252	14	-16	53	-55	69	-71	97	-98	$ 3601
483	111	0.0564252	12	-14	52	-54	68	-70	97	-98	$ 3602
484	111	0.0564252	10	-12	51	-53	67	-69	97	-98	$ 3603
485	111	0.0564252	9	-11	49	-51	68	-70	97	-98	$ 3604
486	111	0.0564252	8	-10	47	-49	69	-71	97	-98	$ 3605
487	111	0.0564252	7	-9	45	-47	70	-72	97	-98	$ 3606
488	111	0.0564252	6	-8	43	-45	71	-73	97	-98	$ 3607
489	111	0.0564252	5	-7	41	-43	72	-74	97	-98	$ 3608
490	111	0.0564252	6	-8	40	-42	74	-76	97	-98	$ 3609
491	111	0.0564252	7	-9	39	-41	76	-78	97	-98	$ 3610
492	1701	0.07674	6	-8	37	-39	77	-79	97	-109	$ 1701
493	1701	0.07674	7	-9	36	-38	79	-81	97	-109	$ 1702
494	1701	0.07674	8	-10	35	-37	81	-83	97	-109	$ 1703
495	1701	0.07674	9	-11	34	-36	83	-85	97	-109	$ 1704
496	1701	0.07674	11	-13	35	-37	84	-86	97	-109	$ 1705
497	1701	0.07674	13	-15	36	-38	85	-87	97	-98	$ 1706
498	1701	0.07674	15	-17	37	-39	86	-88	97	-98	$ 1707
499	1701	0.07674	17	-19	38	-40	87	-89	97	-98	$ 1708
500	1701	0.07674	19	-21	39	-41	88	-90	97	-109	$ 1709
501	1701	0.07674	21	-23	40	-42	89	-91	97	-109	$ 1710
502	1711	0.06001	22	-24	42	-44	88	-90	97	-109	$ 1711
503	1701	0.07674	23	-25	44	-46	87	-89	97	-109	$ 2701
504	1701	0.07674	24	-26	46	-48	86	-88	97	-109	$ 2702
505	1701	0.07674	25	-27	48	-50	85	-87	97	-109	$ 2703
506	1701	0.07674	26	-28	50	-161	152	-86	97	-109	$ 2704
507	1701	0.07674	153	-158	161	-159	160	-157	97	-109	$ 2705
508	1701	0.07674	26	-28	154	-55	81	-160	97	-109	$ 2706
509	1701	0.07674	25	-27	54	-56	79	-81	97	-98	$ 2707
510	1701	0.07674	24	-26	55	-57	77	-79	97	-98	$ 2708
511	1701	0.07674	23	-25	56	-58	75	-77	97	-98	$ 2709
512	1701	0.07674	22	-24	57	-59	73	-75	97	-109	$ 2710
513	1701	0.07674	21	-23	58	-60	71	-73	97	-109	$ 2711
514	1701	0.07674	19	-21	57	-59	70	-72	97	-109	$ 2712
515	1701	0.07674	17	-19	56	-58	69	-71	97	-109	$ 2713
516	1701	0.07674	15	-17	55	-57	68	-70	97	-109	$ 3701
517	1701	0.07674	13	-15	54	-56	67	-69	97	-109	$ 3702
518	1701	0.07674	11	-13	53	-55	66	-68	97	-109	$ 3703
519	1701	0.07674	9	-11	52	-54	65	-67	97	-109	$ 3704
520	1701	0.07674	8	-10	50	-52	66	-68	97	-109	$ 3705
521	1701	0.07674	7	-9	48	-50	67	-69	97	-98	$ 3706
522	1701	0.07674	6	-8	46	-48	68	-70	97	-98	$ 3707
523	3708	0.05456	5	-7	44	-46	69	-71	97	-98	$ 3708
524	1701	0.07674	4	-6	42	-44	70	-72	97	-109	$ 3709
525	1701	0.07674	136	-5	40	-42	71	-73	97	-109	$ 3710
526	1302	0.03819	4	-6	39	-41	73	-75	97	-109	$ 3711
527	1701	0.07674	5	-7	38	-40	75	-77	97	-109	$ 3712
528	1801	0.07653	5	-7	35	-37	78	-80	97	-109	$ 1801
529	1801	0.07653	6	-8	34	-36	80	-82	97	-109	$ 1802
530	1801	0.07653	7	-9	33	-35	82	-84	97	-109	$ 1803
531	1801	0.07653	8	-10	32	-34	84	-86	97	-109	$ 1804
532	1801	0.07653	10	-12	33	-35	85	-87	97	-109	$ 1805
533	1801	0.07653	12	-14	34	-36	86	-88	97	-109	$ 1806
534	1801	0.07653	14	-16	35	-37	87	-89	97	-109	$ 1807
535	1801	0.07653	16	-18	36	-38	88	-90	97	-109	$ 1808
536	1801	0.07653	18	-20	37	-39	89	-91	97	-109	$ 1809
537	1801	0.07653	20	-22	38	-40	90	-92	97	-109	$ 1810
538	1801	0.07653	22	-24	39	-41	91	-93	97	-109	$ 1811
539	1801	0.07653	23	-25	41	-43	90	-92	97	-109	$ 1812
540	1801	0.07653	24	-26	43	-45	89	-91	97	-109	$ 1813
541	1801	0.07653	25	-27	45	-47	88	-90	97	-109	$ 1814
542	1801	0.07653	26	-28	47	-49	87	-89	97	-109	$ 2801
543	1801	0.07653	27	-29	49	-51	86	-88	97	-109	$ 2802
544	1801	0.07653	28	-30	51	-53	157	-87	97	-109	$ 2803
545	1801	0.07653	158	-31	53	-55	84	-86	97	-109	$ 2804
546	1801	0.07653	28	-30	159	-56	82	-84	97	-109	$ 2805
547	1801	0.07653	27	-29	55	-57	80	-82	97	-109	$ 2806
548	1801	0.07653	26	-28	56	-167	78	-80	97	-109	$ 2807
549	1801	0.07653	25	-166	57	-59	76	-78	97	-109	$ 2808
550	1801	0.07653	24	-26	58	-60	74	-76	97	-109	$ 2809
551	1801	0.07653	23	-25	59	-61	72	-74	97	-109	$ 2810
552	1801	0.07653	22	-24	60	-62	70	-72	97	-109	$ 2811
553	1801	0.07653	20	-22	59	-61	69	-71	97	-109	$ 2812
554	1801	0.07653	18	-20	58	-60	68	-70	97	-109	$ 2813
555	1801	0.07653	16	-18	57	-59	67	-69	97	-109	$ 2814
556	1801	0.07653	14	-16	56	-58	66	-68	97	-109	$ 3801
557	1801	0.07653	12	-14	55	-57	65	-67	97	-109	$ 3802
558	1801	0.07653	10	-12	54	-56	64	-66	97	-109	$ 3803
559	1801	0.07653	8	-10	53	-55	63	-65	97	-109	$ 3804
560	1801	0.07653	7	-9	51	-53	64	-66	97	-109	$ 3805
561	1801	0.07653	6	-8	49	-51	65	-67	97	-109	$ 3806
562	1801	0.07653	5	-7	47	-49	66	-68	97	-109	$ 3807
563	1801	0.07653	4	-6	45	-47	67	-69	97	-109	$ 3808
564	1801	0.07653	3	-5	43	-45	68	-70	97	-109	$ 3809
565	1801	0.07653	2	-4	137	-43	69	-71	97	-109	$ 3810

```
 566 1801   0.07653    1  -136   140  -137   138  -135    97  -109 $  3811
 567 1801   0.07653    2    -4    38   -40   135   -74    97  -109 $  3812
 568 1801   0.07653    3    -5    37   -39    74   -76    97  -109 $  3813
 569 1801   0.07653    4    -6    36   -38    76   -78    97  -109 $  3814
 570 1801   0.07653    3    -5    34   -36    77   -79    97  -109 $  1901
 571 1801   0.07653    4    -6    33   -35    79   -81    97  -109 $  1902
 572 1801   0.07653    5    -7    32   -34    81   -83    97  -109 $  1903
 573 1801   0.07653   11   -13    32   -34    87   -89    97  -109 $  1907
 574 1801   0.07653   13   -15    33   -35    88   -90    97  -109 $  1908
 575 1801   0.07653   15   -17    34   -36    89   -91    97  -109 $  1909
 576 1801   0.07653   17   -19    35   -37    90   -92    97  -109 $  1910
 577 1801   0.07653   19   -21    36   -38    91   -93    97  -109 $  1911
 578 1801   0.07653   25   -27    42   -44    91   -93    97  -109 $  1915
 579 1801   0.07653   26   -28    44   -46    90   -92    97  -109 $  1916
 580 1801   0.07653   27   -29    46   -48    89   -91    97  -109 $  1917
 581 1801   0.07653   28   -30    48   -50    88   -90    97  -109 $  1918
 582 1801   0.07653   29   -31    50   -52    87   -89    97  -109 $  1919
 583 1801   0.07653   29   -31    56   -58    81   -83    97  -109 $  2907
 584 1801   0.07653   28   -30    57   -59   162   -81    97  -109 $  2908
 585 1801   0.07653  166  -163   167  -164   165  -162    97  -109 $  2909
 586 1801   0.07653   26   -28    59   -61    75  -165    97  -109 $  2910
 587 1801   0.07653   25   -27    60   -62    73   -75    97  -109 $  2911
 588 1801   0.07653   19   -21    60   -62    67   -69    97  -109 $  2915
 589 1801   0.07653   17   -19    59   -61    66   -68    97  -109 $  2916
 590 1801   0.07653   15   -17    58   -60    65   -67    97  -109 $  2917
 591 1801   0.07653   13   -15    57   -59    64   -66    97  -109 $  2918
 592 1801   0.07653   11   -13    56   -58    63   -65    97  -109 $  2919
 593 1801   0.07653    5    -7    50   -52    63   -65    97  -109 $  3907
 594 1801   0.07653    4    -6    48   -50    64   -66    97  -109 $  3908
 595 1801   0.07653    3    -5    46   -48    65   -67    97  -109 $  3909
 596 1801   0.07653    2    -4    44   -46    66   -68    97  -109 $  3910
 597 1801   0.07653    1    -3    42   -44    67   -69    97  -109 $  3911
 598 1801   0.07653    1    -3    36   -38    73   -75    97  -109 $  3915
 599 1801   0.07653    2    -4    35   -37    75   -77    97  -109 $  3916
c      600  139      0.0222    1   -73    -2  -140          97  -109 $  ha
c     this is the below core region
 601  121 0.0499349  127  -124   128  -125   126  -123    94   -95 $  2101
 602  121 0.0499349   14   -16    44  -128    78   -80    94   -95 $  1201
 603  121 0.0499349   16   -18    45   -47   123   -81    94   -95 $  1202
 604  121 0.0499349  124   -19    47   -49    78   -80    94   -95 $  2201
 605  121 0.0499349   16   -18   125   -50    76   -78    94   -95 $  2202
 606  121 0.0499349   14   -16    47   -49    75  -126    94   -95 $  3201
 607  121 0.0499349   13  -127    45   -47    76   -78    94   -95 $  3202
 608  121 0.0499349   12   -14    43   -45    77   -79    94   -95 $  1301
 609  192 0.0604416   13   -15    42   -44    79   -81    94   -95 $  1302
 610  121 0.0499349   15   -17    43   -45    80   -82    94   -95 $  1303
 611  121 0.0499349   17   -19    44   -46    81   -83    94   -95 $  1304
 612  121 0.0499349   18   -20    46   -48    80   -82    94   -95 $  2301
 613  192 0.0604416   19  -145    48   -50    79   -81    94   -95 $  2302
 614  121 0.0499349   18   -20    49   -51    77   -79    94   -95 $  2303
 615  121 0.0499349   17   -19    50   -52    75   -77    94   -95 $  2304
 616  121 0.0499349   15   -17    49   -51    74   -76    94   -95 $  3301
 617  192 0.0604416   13   -15    48   -50    73   -75    94   -95 $  3302
 618  121 0.0499349  130   -14    46   -48    74   -76    94   -95 $  3303
 619  121 0.0499349   11   -13    44   -46   129   -77    94   -95 $  3304
 620  121 0.0499349   11   -13    41   -43    78   -80    94   -95 $  1401
 621  121 0.0499349   12   -14    40   -42    80   -82    94   -95 $  1402
 622  121 0.0499349   14   -16    41   -43    81   -83    94   -95 $  1403
 623  121 0.0499349   16   -18    42   -44    82   -84    94   -95 $  1404
 624  121 0.0499349   18   -20    43   -45    83   -85    94   -95 $  1405
 625  121 0.0499349   19   -21    45   -47    82   -84    94   -95 $  1406
 626  121 0.0499349   20   -22    47  -146    81   -83    94   -95 $  2401
 627  121 0.0499349  145  -142   146  -143   144  -141    94   -95 $  2402
 628  121 0.0499349   20   -22    50   -52    78  -144    94   -95 $  2403
 629  121 0.0499349   19   -21    51   -53    76   -78    94   -95 $  2404
 630  121 0.0499349   18   -20    52   -54    74   -76    94   -95 $  2405
 631  121 0.0499349   16   -18    51   -53    73   -75    94   -95 $  2406
 632  121 0.0499349   14   -16    50   -52    72   -74    94   -95 $  3401
 633  121 0.0499349   12   -14    49   -51    71   -73    94   -95 $  3402
 634  121 0.0499349   11   -13   131   -49    72   -74    94   -95 $  3403
 635  121 0.0499349  133  -130   134  -131   132  -129    94   -95 $  3404
 636  121 0.0499349    9   -11    43  -134    74   -76    94   -95 $  3405
 637  121 0.0499349   10   -12    42   -44    76   -78    94   -95 $  3406
 638  121 0.0499349    9   -11    40   -42    77   -79    94   -95 $  1501
 639  192 0.0604416   10   -12    39   -41    79   -81    94   -95 $  1502
 640  121 0.0499349   11   -13    38   -40    81   -83    94   -95 $  1503
 641  192 0.0604416   13   -15    39   -41    82   -84    94   -95 $  1504
 642  121 0.0499349   15   -17    40   -42    83   -85    94   -95 $  1505
 643  121 0.0499349   17   -19    41   -43    84   -86    94   -95 $  1506
 644  121 0.0499349   19   -21    42   -44    85   -87    94   -95 $  1507
 645  121 0.0499349   20   -22    44   -46    84   -86    94   -95 $  1508
 646  121 0.0499349   21   -23    46   -48    83   -85    94   -95 $  2501
 647  192 0.0604416   22   -24    48  -151   141   -84    94   -95 $  2502
 648  121 0.0499349  142  -148   151  -149   150  -147    94   -95 $  2503
 649  192 0.0604416   22   -24   143   -53    79  -150    94   -95 $  2504
 650  121 0.0499349   21   -23    52   -54    77   -79    94   -95 $  2505
 651  121 0.0499349   20   -22    53   -55    75   -77    94   -95 $  2506
 652  121 0.0499349   19   -21    54   -56    73   -75    94   -95 $  2507
 653  121 0.0499349   17   -19    53   -55    72   -74    94   -95 $  2508
```

654	121	0.0499349	15	-17	52	-54	71	-73	94	-95	$ 3501
655	192	0.0604416	13	-15	51	-53	70	-72	94	-95	$ 3502
656	121	0.0499349	11	-13	50	-52	69	-71	94	-95	$ 3503
657	192	0.0604416	10	-12	48	-50	70	-72	94	-95	$ 3504
658	121	0.0499349	9	-11	46	-48	71	-132	94	-95	$ 3505
659	121	0.0499349	8	-133	44	-46	72	-74	94	-95	$ 3506
660	121	0.0499349	7	-9	42	-44	73	-75	94	-95	$ 3507
661	121	0.0499349	8	-10	41	-43	75	-77	94	-95	$ 3508
662	121	0.0499349	8	-10	38	-40	78	-80	94	-95	$ 3610
663	121	0.0499349	9	-11	37	-39	80	-82	94	-95	$ 1601
664	121	0.0499349	10	-12	36	-38	82	-84	94	-95	$ 1602
665	121	0.0499349	12	-14	37	-39	83	-85	94	-95	$ 1603
666	121	0.0499349	14	-16	38	-40	84	-86	94	-95	$ 1604
667	121	0.0499349	16	-18	39	-41	85	-87	94	-95	$ 1605
668	121	0.0499349	18	-20	40	-42	86	-88	94	-95	$ 1606
669	121	0.0499349	20	-22	41	-43	87	-89	94	-95	$ 1607
670	121	0.0499349	21	-23	43	-45	86	-88	94	-95	$ 1608
671	121	0.0499349	22	-24	45	-47	85	-87	94	-95	$ 1609
672	121	0.0499349	23	-25	47	-49	84	-86	94	-95	$ 2601
673	121	0.0499349	24	-26	49	-156	147	-85	94	-95	$ 2602
674	121	0.0499349	148	-153	156	-154	155	-152	94	-95	$ 2603
675	121	0.0499349	24	-26	149	-54	80	-155	94	-95	$ 2604
676	121	0.0499349	23	-25	53	-55	78	-80	94	-95	$ 2605
677	121	0.0499349	22	-24	54	-56	76	-78	94	-95	$ 2606
678	121	0.0499349	21	-23	55	-57	74	-76	94	-95	$ 2607
679	121	0.0499349	20	-22	56	-58	72	-74	94	-95	$ 2608
680	121	0.0499349	18	-20	55	-57	71	-73	94	-95	$ 2609
681	121	0.0499349	16	-18	54	-56	70	-72	94	-95	$ 2610
682	121	0.0499349	14	-16	53	-55	69	-71	94	-95	$ 3601
683	121	0.0499349	12	-14	52	-54	68	-70	94	-95	$ 3602
684	121	0.0499349	10	-12	51	-53	67	-69	94	-95	$ 3603
685	121	0.0499349	9	-11	49	-51	68	-70	94	-95	$ 3604
686	121	0.0499349	8	-10	47	-49	69	-71	94	-95	$ 3605
687	121	0.0499349	7	-9	45	-47	70	-72	94	-95	$ 3606
688	121	0.0499349	6	-8	43	-45	71	-73	94	-95	$ 3607
689	121	0.0499349	5	-7	41	-43	72	-74	94	-95	$ 3608
690	121	0.0499349	6	-8	40	-42	74	-76	94	-95	$ 3609
691	121	0.0499349	7	-9	39	-41	76	-78	94	-95	$ 3610
692	133	0.07078	6	-8	37	-39	77	-79	94	-95	$ 1701
693	133	0.07078	7	-9	36	-38	79	-81	94	-95	$ 1702
694	133	0.07078	8	-10	35	-37	81	-83	94	-95	$ 1703
695	133	0.07078	9	-11	34	-36	83	-85	94	-95	$ 1704
696	133	0.07078	11	-13	35	-37	84	-86	94	-95	$ 1705
697	133	0.07078	13	-15	36	-38	85	-87	94	-95	$ 1706
698	133	0.07078	15	-17	37	-39	86	-88	94	-95	$ 1707
699	133	0.07078	17	-19	38	-40	87	-89	94	-95	$ 1708
700	133	0.07078	19	-21	39	-41	88	-90	94	-95	$ 1709
701	133	0.07078	21	-23	40	-42	89	-91	94	-95	$ 1710
702	133	0.07078	22	-24	42	-44	88	-90	94	-95	$ 1711
703	133	0.07078	23	-25	44	-46	87	-89	94	-95	$ 2701
704	133	0.07078	24	-26	46	-48	86	-88	94	-95	$ 2702
705	133	0.07078	25	-27	48	-50	85	-87	94	-95	$ 2703
706	133	0.07078	26	-28	50	-161	152	-86	94	-95	$ 2704
707	133	0.07078	153	-158	161	-159	160	-157	94	-95	$ 2705
708	133	0.07078	26	-28	154	-55	81	-160	94	-95	$ 2706
709	133	0.07078	25	-27	54	-56	79	-81	94	-95	$ 2707
710	133	0.07078	24	-26	55	-57	77	-79	94	-95	$ 2708
711	133	0.07078	23	-25	56	-58	75	-77	94	-95	$ 2709
712	133	0.07078	22	-24	57	-59	73	-75	94	-95	$ 2710
713	133	0.07078	21	-23	58	-60	71	-73	94	-95	$ 2711
714	133	0.07078	19	-21	57	-59	70	-72	94	-95	$ 2712
715	133	0.07078	17	-19	56	-58	69	-71	94	-95	$ 2713
716	133	0.07078	15	-17	55	-57	68	-70	94	-95	$ 3701
717	133	0.07078	13	-15	54	-56	67	-69	94	-95	$ 3702
718	133	0.07078	11	-13	53	-55	66	-68	94	-95	$ 3703
719	133	0.07078	9	-11	52	-54	65	-67	94	-95	$ 3704
720	133	0.07078	8	-10	50	-52	66	-68	94	-95	$ 3705
721	133	0.07078	7	-9	48	-50	67	-69	94	-95	$ 3706
722	133	0.07078	6	-8	46	-48	68	-70	94	-95	$ 3707
723	133	0.07078	5	-7	44	-46	69	-71	94	-95	$ 3708
724	133	0.07078	4	-6	42	-44	70	-72	94	-95	$ 3709
725	133	0.07078	136	-5	40	-42	71	-73	94	-95	$ 3710
726	133	0.07078	4	-6	39	-41	73	-75	94	-95	$ 3711
727	133	0.07078	5	-7	38	-40	75	-77	94	-95	$ 3712
728	134	0.05938	5	-7	35	-37	78	-80	94	-95	$ 1801
729	134	0.05938	6	-8	34	-36	80	-82	94	-95	$ 1802
730	134	0.05938	7	-9	33	-35	82	-84	94	-95	$ 1803
731	134	0.05938	8	-10	32	-34	84	-86	94	-95	$ 1804
732	134	0.05938	10	-12	33	-35	85	-87	94	-95	$ 1805
733	134	0.05938	12	-14	34	-36	86	-88	94	-95	$ 1806
734	134	0.05938	14	-16	35	-37	87	-89	94	-95	$ 1807
735	134	0.05938	16	-18	36	-38	88	-90	94	-95	$ 1808
736	134	0.05938	18	-20	37	-39	89	-91	94	-95	$ 1809
737	134	0.05938	20	-22	38	-40	90	-92	94	-95	$ 1810
738	134	0.05938	22	-24	39	-41	91	-93	94	-95	$ 1811
739	134	0.05938	23	-25	41	-43	90	-92	94	-95	$ 1812
740	134	0.05938	24	-26	43	-45	89	-91	94	-95	$ 1813
741	134	0.05938	25	-27	45	-47	88	-90	94	-95	$ 1814
742	134	0.05938	26	-28	47	-49	87	-89	94	-95	$ 2801

```
 743  134  0.05938     27   -29    49   -51    86   -88    94   -95 $  2802
 744  134  0.05938     28   -30    51   -53   157   -87    94   -95 $  2803
 745  134  0.05938    158   -31    53   -55    84   -86    94   -95 $  2804
 746  134  0.05938     28   -30   159   -56    82   -84    94   -95 $  2805
 747  134  0.05938     27   -29    55   -57    80   -82    94   -95 $  2806
 748  134  0.05938     26   -28    56  -167    78   -80    94   -95 $  2807
 749  134  0.05938     25  -166    57   -59    76   -78    94   -95 $  2808
 750  134  0.05938     24   -26    58   -60    74   -76    94   -95 $  2809
 751  134  0.05938     23   -25    59   -61    72   -74    94   -95 $  2810
 752  134  0.05938     22   -24    60   -62    70   -72    94   -95 $  2811
 753  134  0.05938     20   -22    59   -61    69   -71    94   -95 $  2812
 754  134  0.05938     18   -20    58   -60    68   -70    94   -95 $  2813
 755  134  0.05938     16   -18    57   -59    67   -69    94   -95 $  2814
 756  134  0.05938     14   -16    56   -58    66   -68    94   -95 $  3801
 757  134  0.05938     12   -14    55   -57    65   -67    94   -95 $  3802
 758  134  0.05938     10   -12    54   -56    64   -66    94   -95 $  3803
 759  134  0.05938      8   -10    53   -55    63   -65    94   -95 $  3804
 760  134  0.05938      7    -9    51   -53    64   -66    94   -95 $  3805
 761  134  0.05938      6    -8    49   -51    65   -67    94   -95 $  3806
 762  134  0.05938      5    -7    47   -49    66   -68    94   -95 $  3807
 763  134  0.05938      4    -6    45   -47    67   -69    94   -95 $  3808
 764  134  0.05938      3    -5    43   -45    68   -70    94   -95 $  3809
 765  134  0.05938      2    -4   137   -43    69   -71    94   -95 $  3810
 766  134  0.05938      1  -136   140  -137   138  -135    94   -95 $  3811
 767  134  0.05938      2    -4    38   -40   135   -74    94   -95 $  3812
 768  134  0.05938      3    -5    37   -39    74   -76    94   -95 $  3813
 769  134  0.05938      4    -6    36   -38    76   -78    94   -95 $  3814
 770  134  0.05938      3    -5    34   -36    77   -79    94   -95 $  1901
 771  134  0.05938      4    -6    33   -35    79   -81    94   -95 $  1902
 772  134  0.05938      5    -7    32   -34    81   -83    94   -95 $  1903
 773  134  0.05938     11   -13    32   -34    87   -89    94   -95 $  1907
 774  134  0.05938     13   -15    33   -35    88   -90    94   -95 $  1908
 775  134  0.05938     15   -17    34   -36    89   -91    94   -95 $  1909
 776  134  0.05938     17   -19    35   -37    90   -92    94   -95 $  1910
 777  134  0.05938     19   -21    36   -38    91   -93    94   -95 $  1911
 778  134  0.05938     25   -27    42   -44    91   -93    94   -95 $  1915
 779  134  0.05938     26   -28    44   -46    90   -92    94   -95 $  1916
 780  134  0.05938     27   -29    46   -48    89   -91    94   -95 $  1917
 781  134  0.05938     28   -30    48   -50    88   -90    94   -95 $  1918
 782  134  0.05938     29   -31    50   -52    87   -89    94   -95 $  1919
 783  134  0.05938     29   -31    56   -58    81   -83    94   -95 $  2907
 784  134  0.05938     28   -30    57   -59   162   -81    94   -95 $  2908
 785  134  0.05938    166  -163   167  -164   165  -162    94   -95 $  2909
 786  134  0.05938     26   -28    59   -61    75  -165    94   -95 $  2910
 787  134  0.05938     25   -27    60   -62    73   -75    94   -95 $  2911
 788  134  0.05938     19   -21    60   -62    67   -69    94   -95 $  2915
 789  134  0.05938     17   -19    59   -61    66   -68    94   -95 $  2916
 790  134  0.05938     15   -17    58   -60    65   -67    94   -95 $  2917
 791  134  0.05938     13   -15    57   -59    64   -66    94   -95 $  2918
 792  134  0.05938     11   -13    56   -58    63   -65    94   -95 $  2919
 793  134  0.05938      5    -7    50   -52    63   -65    94   -95 $  3907
 794  134  0.05938      4    -6    48   -50    64   -66    94   -95 $  3908
 795  134  0.05938      3    -5    46   -48    65   -67    94   -95 $  3909
 796  134  0.05938      2    -4    44   -46    66   -68    94   -95 $  3910
 797  134  0.05938      1    -3    42   -44    67   -69    94   -95 $  3911
 798  134  0.05938      1    -3    36   -38    73   -75    94   -95 $  3915
 799  134  0.05938      2    -4    35   -37    75   -77    94   -95 $  3916
c      800  139    0.0222    1   -73    -2  -140          94   -95 $  ha
c      this is the above core region
 801  124 0.0337755  127  -124   128  -125   126  -123    98   -99 $  2101
 802  124 0.0337755   14   -16    44  -128    78   -80    98   -99 $  1201
 803  124 0.0337755   16   -18    45   -47   123   -81    98   -99 $  1202
 804  124 0.0337755  124   -19    47   -49    78   -80    98   -99 $  2201
 805  124 0.0337755   16   -18   125   -50    76   -78    98   -99 $  2202
 806  124 0.0337755   14   -16    47   -49    75  -126    98   -99 $  3201
 807 3202 0.05876     13  -127    45   -47    76   -78    98   -99 $  3202
 808  124 0.0337755   12   -14    43   -45    77   -79    98   -99 $  1301
 809  194 0.0749180   13   -15    42   -44    79   -81    98  -608 $  1302
 810  124 0.0337755   15   -17    43   -45    80   -82    98   -99 $  1303
 811  124 0.0337755   17   -19    44   -46    81   -83    98   -99 $  1304
 812  124 0.0337755   18   -20    46   -48    80   -82    98   -99 $  2301
 813  194 0.0749180   19  -145    48   -50    79   -81    98  -608 $  2302
 814  124 0.0337755   18   -20    49   -51    77   -79    98   -99 $  2303
 815  124 0.0337755   17   -19    50   -52    75   -77    98   -99 $  2304
 816  124 0.0337755   15   -17    49   -51    74   -76    98   -99 $  3301
 817  194 0.0749180   13   -15    48   -50    73   -75    98  -608 $  3302
 818  124 0.0337755  130   -14    46   -48    74   -76    98   -99 $  3303
 819  124 0.0337755   11   -13    44   -46   129   -77    98   -99 $  3304
 820  124 0.0337755   11   -13    41   -43    78   -80    98   -99 $  1401
 821  124 0.0337755   12   -14    40   -42    80   -82    98   -99 $  1402
 822  124 0.0337755   14   -16    41   -43    81   -83    98   -99 $  1403
 823 1404 0.0587600   16   -18    42   -44    82   -84    98   -99 $  1404
 824  124 0.0337755   18   -20    43   -45    83   -85    98   -99 $  1405
 825 1406 0.05876     19   -21    45   -47    82   -84    98   -99 $  1406
 826  124 0.0337755   20   -22    47  -146    81   -83    98   -99 $  2401
 827  124 0.0337755  145  -142   146  -143   144  -141    98   -99 $  2402
 828  124 0.0337755   20   -22    50   -52    78  -144    98   -99 $  2403
 829 2404 0.05876     19   -21    51   -53    76   -78    98   -99 $  2404
 830 2405 0.0587600   18   -20    52   -54    74   -76    98   -99 $  2405
```

831	124	0.0337755	16	-18	51	-53	73	-75	98	-99	$ 2406
832	124	0.0337755	14	-16	50	-52	72	-74	98	-99	$ 3401
833	124	0.0337755	12	-14	49	-51	71	-73	98	-99	$ 3402
834	124	0.0337755	11	-13	131	-49	72	-74	98	-99	$ 3403
835	3404	0.05876	133	-130	134	-131	132	-129	98	-99	$ 3404
836	124	0.0337755	9	-11	43	-134	74	-76	98	-99	$ 3405
837	3406	0.05876	10	-12	42	-44	76	-78	98	-99	$ 3406
838	124	0.0337755	9	-11	40	-42	77	-79	98	-99	$ 1501
839	194	0.0749180	10	-12	39	-41	79	-81	98	-609	$ 1502
840	124	0.0337755	11	-13	38	-40	81	-83	98	-99	$ 1503
841	194	0.0749180	13	-15	39	-41	82	-84	98	-609	$ 1504
842	124	0.0337755	15	-17	40	-42	83	-85	98	-99	$ 1505
843	124	0.0337755	17	-19	41	-43	84	-86	98	-99	$ 1506
844	124	0.0337755	19	-21	42	-44	85	-87	98	-99	$ 1507
845	124	0.0337755	20	-22	44	-46	84	-86	98	-99	$ 1508
846	124	0.0337755	21	-23	46	-48	83	-85	98	-99	$ 2501
847	194	0.0749180	22	-24	48	-151	141	-84	98	-609	$ 2502
848	124	0.0337755	142	-148	151	-149	150	-147	98	-99	$ 2503
849	194	0.0749180	22	-24	143	-53	79	-150	98	-609	$ 2504
850	124	0.0337755	21	-23	52	-54	77	-79	98	-99	$ 2505
851	124	0.0337755	20	-22	53	-55	75	-77	98	-99	$ 2506
852	124	0.0337755	19	-21	54	-56	73	-75	98	-99	$ 2507
853	124	0.0337755	17	-19	53	-55	72	-74	98	-99	$ 2508
854	124	0.0337755	15	-17	52	-54	71	-73	98	-99	$ 3501
855	194	0.0749180	13	-15	51	-53	70	-72	98	-609	$ 3502
856	124	0.0337755	11	-13	50	-52	69	-71	98	-99	$ 3503
857	194	0.0749180	10	-12	48	-50	70	-72	98	-609	$ 3504
858	124	0.0337755	9	-11	46	-48	71	-132	98	-99	$ 3505
859	124	0.0337755	8	-133	44	-46	72	-74	98	-99	$ 3506
860	124	0.0337755	7	-9	42	-44	73	-75	98	-99	$ 3507
861	124	0.0337755	8	-10	41	-43	75	-77	98	-99	$ 3508
862	124	0.0337755	8	-10	38	-40	78	-80	98	-99	$ 3610
863	124	0.0337755	9	-11	37	-39	80	-82	98	-99	$ 1601
864	124	0.0337755	10	-12	36	-38	82	-84	98	-99	$ 1602
865	124	0.0337755	12	-14	37	-39	83	-85	98	-99	$ 1603
866	124	0.0337755	14	-16	38	-40	84	-86	98	-99	$ 1604
867	124	0.0337755	16	-18	39	-41	85	-87	98	-99	$ 1605
868	124	0.0337755	18	-20	40	-42	86	-88	98	-99	$ 1606
869	124	0.0337755	20	-22	41	-43	87	-89	98	-99	$ 1607
870	124	0.0337755	21	-23	43	-45	86	-88	98	-99	$ 1608
871	124	0.0337755	22	-24	45	-47	85	-87	98	-99	$ 1609
872	124	0.0337755	23	-25	47	-49	84	-86	98	-99	$ 2601
873	124	0.0337755	24	-26	49	-156	147	-85	98	-99	$ 2602
874	124	0.0337755	148	-153	156	-154	155	-152	98	-99	$ 2603
875	124	0.0337755	24	-26	149	-54	80	-155	98	-99	$ 2604
876	124	0.0337755	23	-25	53	-55	78	-80	98	-99	$ 2605
877	124	0.0337755	22	-24	54	-56	76	-78	98	-99	$ 2606
878	124	0.0337755	21	-23	55	-57	74	-76	98	-99	$ 2607
879	124	0.0337755	20	-22	56	-58	72	-74	98	-99	$ 2608
880	124	0.0337755	18	-20	55	-57	71	-73	98	-99	$ 2609
881	124	0.0337755	16	-18	54	-56	70	-72	98	-99	$ 2610
882	124	0.0337755	14	-16	53	-55	69	-71	98	-99	$ 3601
883	124	0.0337755	12	-14	52	-54	68	-70	98	-99	$ 3602
884	124	0.0337755	10	-12	51	-53	67	-69	98	-99	$ 3603
885	124	0.0337755	9	-11	49	-51	68	-70	98	-99	$ 3604
886	124	0.0337755	8	-10	47	-49	69	-71	98	-99	$ 3605
887	124	0.0337755	7	-9	45	-47	70	-72	98	-99	$ 3606
888	124	0.0337755	6	-8	43	-45	71	-73	98	-99	$ 3607
889	124	0.0337755	5	-7	41	-43	72	-74	98	-99	$ 3608
890	124	0.0337755	6	-8	40	-42	74	-76	98	-99	$ 3609
891	124	0.0337755	7	-9	39	-41	76	-78	98	-99	$ 3610
892	137	0.07527	6	-8	37	-39	77	-79	109	-99	$ 1701
893	137	0.07527	7	-9	36	-38	79	-81	109	-99	$ 1702
894	137	0.07527	8	-10	35	-37	81	-83	109	-99	$ 1703
895	137	0.07527	9	-11	34	-36	83	-85	109	-99	$ 1704
896	137	0.07527	11	-13	35	-37	84	-86	109	-99	$ 1705
897	137	0.07527	13	-15	36	-38	85	-87	98	-99	$ 1706
898	137	0.07527	15	-17	37	-39	86	-88	98	-99	$ 1707
899	137	0.07527	17	-19	38	-40	87	-89	98	-99	$ 1708
900	137	0.07527	19	-21	39	-41	88	-90	109	-99	$ 1709
901	137	0.07527	21	-23	40	-42	89	-91	109	-99	$ 1710
902	137	0.07527	22	-24	42	-44	88	-90	109	-99	$ 1711
903	137	0.07527	23	-25	44	-46	87	-89	109	-99	$ 2701
904	137	0.07527	24	-26	46	-48	86	-88	109	-99	$ 2702
905	137	0.07527	25	-27	48	-50	85	-87	109	-99	$ 2703
906	137	0.07527	26	-28	50	-161	152	-86	109	-99	$ 2704
907	137	0.07527	153	-158	161	-159	160	-157	109	-99	$ 2705
908	137	0.07527	26	-28	154	-55	81	-160	109	-99	$ 2706
909	137	0.07527	25	-27	54	-56	79	-81	98	-99	$ 2707
910	137	0.07527	24	-26	55	-57	77	-79	98	-99	$ 2708
911	137	0.07527	23	-25	56	-58	75	-77	98	-99	$ 2709
912	137	0.07527	22	-24	57	-59	73	-75	109	-99	$ 2710
913	137	0.07527	21	-23	58	-60	71	-73	109	-99	$ 2711
914	137	0.07527	19	-21	57	-59	70	-72	109	-99	$ 2712
915	137	0.07527	17	-19	56	-58	69	-71	109	-99	$ 2713
916	137	0.07527	15	-17	55	-57	68	-70	109	-99	$ 3701
917	137	0.07527	13	-15	54	-56	67	-69	109	-99	$ 3702
918	137	0.07527	11	-13	53	-55	66	-68	109	-99	$ 3703
919	137	0.07527	9	-11	52	-54	65	-67	109	-99	$ 3704

```
 920  137  0.07527     8   -10     50   -52     66   -68   109   -99 $  3705
 921  137  0.07527     7    -9     48   -50     67   -69    98   -99 $  3706
 922  137  0.07527     6    -8     46   -48     68   -70    98   -99 $  3707
 923  137  0.07527     5    -7     44   -46     69   -71    98   -99 $  3708
 924  137  0.07527     4    -6     42   -44     70   -72   109   -99 $  3709
 925  137  0.07527   136    -5     40   -42     71   -73   109   -99 $  3710
 926  137  0.07527     4    -6     39   -41     73   -75   109   -99 $  3711
 927  137  0.07527     5    -7     38   -40     75   -77   109   -99 $  3712
 928  138 0.07830      5    -7     35   -37     78   -80   109   -99 $  1801
 929  138 0.07830      6    -8     34   -36     80   -82   109   -99 $  1802
 930  138 0.07830      7    -9     33   -35     82   -84   109   -99 $  1803
 931  138 0.07830      8   -10     32   -34     84   -86   109   -99 $  1804
 932  138 0.07830     10   -12     33   -35     85   -87   109   -99 $  1805
 933  138 0.07830     12   -14     34   -36     86   -88   109   -99 $  1806
 934  138 0.07830     14   -16     35   -37     87   -89   109   -99 $  1807
 935  138 0.07830     16   -18     36   -38     88   -90   109   -99 $  1808
 936  138 0.07830     18   -20     37   -39     89   -91   109   -99 $  1809
 937  138 0.07830     20   -22     38   -40     90   -92   109   -99 $  1810
 938  138 0.07830     22   -24     39   -41     91   -93   109   -99 $  1811
 939  138 0.07830     23   -25     41   -43     90   -92   109   -99 $  1812
 940  138 0.07830     24   -26     43   -45     89   -91   109   -99 $  1813
 941  138 0.07830     25   -27     45   -47     88   -90   109   -99 $  1814
 942  138 0.07830     26   -28     47   -49     87   -89   109   -99 $  2801
 943  138 0.07830     27   -29     49   -51     86   -88   109   -99 $  2802
 944  138 0.07830     28   -30     51   -53    157   -87   109   -99 $  2803
 945  138 0.07830    158   -31     53   -55     84   -86   109   -99 $  2804
 946  138 0.07830     28   -30    159   -56     82   -84   109   -99 $  2805
 947  138 0.07830     27   -29     55   -57     80   -82   109   -99 $  2806
 948  138 0.07830     26   -28     56  -167     78   -80   109   -99 $  2807
 949  138 0.07830     25  -166     57   -59     76   -78   109   -99 $  2808
 950  138 0.07830     24   -26     58   -60     74   -76   109   -99 $  2809
 951  138 0.07830     23   -25     59   -61     72   -74   109   -99 $  2810
 952  138 0.07830     22   -24     60   -62     70   -72   109   -99 $  2811
 953  138 0.07830     20   -22     59   -61     69   -71   109   -99 $  2812
 954  138 0.07830     18   -20     58   -60     68   -70   109   -99 $  2813
 955  138 0.07830     16   -18     57   -59     67   -69   109   -99 $  2814
 956  138 0.07830     14   -16     56   -58     66   -68   109   -99 $  3801
 957  138 0.07830     12   -14     55   -57     65   -67   109   -99 $  3802
 958  138 0.07830     10   -12     54   -56     64   -66   109   -99 $  3803
 959  138 0.07830      8   -10     53   -55     63   -65   109   -99 $  3804
 960  138 0.07830      7    -9     51   -53     64   -66   109   -99 $  3805
 961  138 0.07830      6    -8     49   -51     65   -67   109   -99 $  3806
 962  138 0.07830      5    -7     47   -49     66   -68   109   -99 $  3807
 963  138 0.07830      4    -6     45   -47     67   -69   109   -99 $  3808
 964  138 0.07830      3    -5     43   -45     68   -70   109   -99 $  3809
 965  138 0.07830      2    -4    137   -43     69   -71   109   -99 $  3810
 966  138 0.07830      1  -136    140  -137    138  -135   109   -99 $  3811
 967  138 0.07830      2    -4     38   -40    135   -74   109   -99 $  3812
 968  138 0.07830      3    -5     37   -39     74   -76   109   -99 $  3813
 969  138 0.07830      4    -6     36   -38     76   -78   109   -99 $  3814
 970  138 0.07830      3    -5     34   -36     77   -79   109   -99 $  1901
 971  138 0.07830      4    -6     33   -35     79   -81   109   -99 $  1902
 972  138 0.07830      5    -7     32   -34     81   -83   109   -99 $  1903
 973  138 0.07830     11   -13     32   -34     87   -89   109   -99 $  1907
 974  138 0.07830     13   -15     33   -35     88   -90   109   -99 $  1908
 975  138 0.07830     15   -17     34   -36     89   -91   109   -99 $  1909
 976  138 0.07830     17   -19     35   -37     90   -92   109   -99 $  1910
 977  138 0.07830     19   -21     36   -38     91   -93   109   -99 $  1911
 978  138 0.07830     25   -27     42   -44     91   -93   109   -99 $  1915
 979  138 0.07830     26   -28     44   -46     90   -92   109   -99 $  1916
 980  138 0.07830     27   -29     46   -48     89   -91   109   -99 $  1917
 981  138 0.07830     28   -30     48   -50     88   -90   109   -99 $  1918
 982  138 0.07830     29   -31     50   -52     87   -89   109   -99 $  1919
 983  138 0.07830     29   -31     56   -58     81   -83   109   -99 $  2907
 984  138 0.07830     28   -30     57   -59    162   -81   109   -99 $  2908
 985  138 0.07830    166  -163    167  -164    165  -162   109   -99 $  2909
 986  138 0.07830     26   -28     59   -61     75  -165   109   -99 $  2910
 987  138 0.07830     25   -27     60   -62     73   -75   109   -99 $  2911
 988  138 0.07830     19   -21     60   -62     67   -69   109   -99 $  2915
 989  138 0.07830     17   -19     59   -61     66   -68   109   -99 $  2916
 990  138 0.07830     15   -17     58   -60     65   -67   109   -99 $  2917
 991  138 0.07830     13   -15     57   -59     64   -66   109   -99 $  2918
 992  138 0.07830     11   -13     56   -58     63   -65   109   -99 $  2919
 993  138 0.07830      5    -7     50   -52     63   -65   109   -99 $  3907
 994  138 0.07830      4    -6     48   -50     64   -66   109   -99 $  3908
 995  138 0.07830      3    -5     46   -48     65   -67   109   -99 $  3909
 996  138 0.07830      2    -4     44   -46     66   -68   109   -99 $  3910
 997  138 0.07830      1    -3     42   -44     67   -69   109   -99 $  3911
 998  138 0.07830      1    -3     36   -38     73   -75   109   -99 $  3915
 999  138 0.07830      2    -4     35   -37     75   -77   109   -99 $  3916
c      000  139     0.0222    1   -73    -2  -140                109   -99 $ ha
c     1001  140   0.08037 -103    94   -99   100  -101 (-110:-111:-121)    $ in
c     1002  140   0.08037 -103    94   -99   101  -102 (-111:112:113)      $ in
c     1003  140   0.08037 -103    94   -99   101   102 (113:114:115)       $ in
c     1004  140   0.08037 -103    94   -99   100  -101 (115:116:117)       $ in
c     1005  140   0.08037 -103    94   -99  -101   102 (117:-118:-119)     $ in
c     1006  140   0.08037 -103    94   -99  -100  -102 (-119:-120:-121)    $ in
c     This is the radial sodium gap at core level
1007      139  0.0222        100  -101     121     110     111    96   -97
```

```
      (( -32 :       -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :       -1 ))
1008     139  0.0222         101  -102     111    -112    -113    96   -97
      ((  93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (   89 :      -32 ))
1009     139  0.0222         102   100    -113    -114    -115    96   -97
      ((  93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (   89 :       31 ))
1010     139  0.0222         101  -100    -115    -116    -117    96   -97
      ((  31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (   27 :       62 ))
1011     139  0.0222        -101   102    -117     118     119    96   -97
      ((  62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
      (   58 :      -63 ))
1012     139  0.0222        -100  -102     119     120     121    96   -97
      ((  -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
      (   -5 :      -63 ))
c     This is the radial sodium gap at lower reflector level.
1013     139  0.0222         100  -101     121     110     111    95   -96
      (( -32 :       -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :       -1 ))
1014     139  0.0222         101  -102     111    -112    -113    95   -96
      ((  93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (   89 :      -32 ))
1015     139  0.0222         102   100    -113    -114    -115    95   -96
      ((  93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (   89 :       31 ))
1016     139  0.0222         101  -100    -115    -116    -117    95   -96
      ((  31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (   27 :       62 ))
1017     139  0.0222        -101   102    -117     118     119    95   -96
      ((  62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
      (   58 :      -63 ))
1018     139  0.0222        -100  -102     119     120     121    95   -96
      ((  -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
      (   -5 :      -63 ))
c     This is the radial sodium gap at the upper reflector level.
1019     139  0.0222         100  -101     121     110     111    97   -569
      (( -32 :       -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :       -1 ))
1020     139  0.0222         101  -102     111    -112    -113    97   -569
      ((  93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (   89 :      -32 ))
1021     139  0.0222         102   100    -113    -114    -115    97   -569
      ((  93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (   89 :       31 ))
1022     139  0.0222         101  -100    -115    -116    -117    97   -569
      ((  31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (   27 :       62 ))
1023     139  0.0222        -101   102    -117     118     119    97   -569
      ((  62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
      (   58 :      -63 ))
1024     139  0.0222        -100  -102     119     120     121    97   -569
      ((  -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
      (   -5 :      -63 ))
c     This is the radial sodium gap at the lower shld level.
1025     139  0.0222         100  -101     121     110     111    94   -95
      (( -32 :       -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :       -1 ))
1026     139  0.0222         101  -102     111    -112    -113    94   -95
      ((  93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (   89 :      -32 ))
1027     139  0.0222         102   100    -113    -114    -115    94   -95
      ((  93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (   89 :       31 ))
1028     139  0.0222         101  -100    -115    -116    -117    94   -95
      ((  31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (   27 :       62 ))
1029     139  0.0222        -101   102    -117     118     119    94   -95
      ((  62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
      (   58 :      -63 ))
1030     139  0.0222        -100  -102     119     120     121    94   -95
      ((  -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
      (   -5 :      -63 ))
c     This is the radial sodium gap at the CR yoke level.
1031     141 0.041118         100  -101     121     110     111    569 -570
      (( -32 :       -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :       -1 ))
1032     141 0.041118         101  -102     111    -112    -113    569 -570
      ((  93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (   89 :      -32 ))
1033     141 0.041118         102   100    -113    -114    -115    569 -570
      ((  93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (   89 :       31 ))
1034     141 0.041118         101  -100    -115    -116    -117    569 -570
      ((  31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (   27 :       62 ))
1035     141 0.041118        -101   102    -117     118     119    569 -570
      ((  62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
```

```
       (   58 :      -63 ))
1036     141 0.041118       -100  -102     119     120     121    569 -570
       ((  -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
       (   -5 :      -63 ))
c     These are components of the SR and CR.
1037     193 0.0280912    13   -15      42     -44      79   -81     95  -96
1038     193 0.0280912    19   -145     48     -50      79   -81     95  -96
1039     193 0.0280912    13   -15      48     -50      73   -75     95  -96
1040     193 0.0280912    10   -12      39     -41      79   -81     95  -96
1041     194 0.0749180    10   -12      39     -41      79   -81     97  -98
1042     193 0.0280912    13   -15      39     -41      82   -84     95  -96
1043     194 0.0749180    13   -15      39     -41      82   -84     97  -98
1044     193 0.0280912    22   -24      48     -151    141   -84     95  -96
1045     194 0.0749180    22   -24      48     -151    141   -84     97  -98
1046     193 0.0280912    22   -24     143     -53      79   -150    95  -96
1047     194 0.0749180    22   -24     143     -53      79   -150    97  -98
1048     193 0.0280912    13   -15      51     -53      70   -72     95  -96
1049     194 0.0749180    13   -15      51     -53      70   -72     97  -98
1050     193 0.0280912    10   -12      48     -50      70   -72     95  -96
1051     194 0.0749180    10   -12      48     -50      70   -72     97  -98
1201     140 0.08037    -789     94     -211     74      -82    -110 $ inr sh
1202     140 0.08037    -789    211     -212     74      -82    -110 $ inr sh
1203     140 0.08037    -789    212     -213     74      -82    -110 $ inr sh
1204     140 0.08037    -789    213     -214     74      -82    -110 $ inr sh
1205     140 0.08037    -789    214     -215     74      -82    -110 $ inr sh
1206     140 0.08037    -789    215     -216     74      -82    -110 $ inr sh
1207     140 0.08037    -789    216     -217     74      -82    -110 $ inr sh
1208     140 0.08037    -789    217     -218     74      -82    -110 $ inr sh
1209     140 0.08037    -789    218      -99     74      -82    -110 $ inr sh
1210     140 0.08037    -789     94     -211    -43      -74    -121 $ inr sh
1211     140 0.08037    -789    211     -212    -43      -74    -121 $ inr sh
1212     140 0.08037    -789    212     -213    -43      -74    -121 $ inr sh
1213     140 0.08037    -789    213     -214    -43      -74    -121 $ inr sh
1214     140 0.08037    -789    214     -215    -43      -74    -121 $ inr sh
1215     140 0.08037    -789    215     -216    -43      -74    -121 $ inr sh
1216     140 0.08037    -789    216     -217    -43      -74    -121 $ inr sh
1217     140 0.08037    -789    217     -218    -43      -74    -121 $ inr sh
1218     140 0.08037    -789    218      -99    -43      -74    -121 $ inr sh
1219     140 0.08037    -789     94     -211    -51       43    -120 $ inr sh
1220     140 0.08037    -789    211     -212    -51       43    -120 $ inr sh
1221     140 0.08037    -789    212     -213    -51       43    -120 $ inr sh
1222     140 0.08037    -789    213     -214    -51       43    -120 $ inr sh
1223     140 0.08037    -789    214     -215    -51       43    -120 $ inr sh
1224     140 0.08037    -789    215     -216    -51       43    -120 $ inr sh
1225     140 0.08037    -789    216     -217    -51       43    -120 $ inr sh
1226     140 0.08037    -789    217     -218    -51       43    -120 $ inr sh
1227     140 0.08037    -789    218      -99    -51       43    -120 $ inr sh
1228     140 0.08037    -789     94     -211    -12       51    -119 $ inr sh
1229     140 0.08037    -789    211     -212    -12       51    -119 $ inr sh
1230     140 0.08037    -789    212     -213    -12       51    -119 $ inr sh
1231     140 0.08037    -789    213     -214    -12       51    -119 $ inr sh
1232     140 0.08037    -789    214     -215    -12       51    -119 $ inr sh
1233     140 0.08037    -789    215     -216    -12       51    -119 $ inr sh
1234     140 0.08037    -789    216     -217    -12       51    -119 $ inr sh
1235     140 0.08037    -789    217     -218    -12       51    -119 $ inr sh
1236     140 0.08037    -789    218      -99    -12       51    -119 $ inr sh
1237     140 0.08037    -789     94     -211    -20       12    -118 $ inr sh
1238     140 0.08037    -789    211     -212    -20       12    -118 $ inr sh
1239     140 0.08037    -789    212     -213    -20       12    -118 $ inr sh
1240     140 0.08037    -789    213     -214    -20       12    -118 $ inr sh
1241     140 0.08037    -789    214     -215    -20       12    -118 $ inr sh
1242     140 0.08037    -789    215     -216    -20       12    -118 $ inr sh
1243     140 0.08037    -789    216     -217    -20       12    -118 $ inr sh
1244     140 0.08037    -789    217     -218    -20       12    -118 $ inr sh
1245     140 0.08037    -789    218      -99    -20       12    -118 $ inr sh
1246     140 0.08037    -789     94     -211    -74       20     117 $ inr sh
1247     140 0.08037    -789    211     -212    -74       20     117 $ inr sh
1248     140 0.08037    -789    212     -213    -74       20     117 $ inr sh
1249     140 0.08037    -789    213     -214    -74       20     117 $ inr sh
1250     140 0.08037    -789    214     -215    -74       20     117 $ inr sh
1251     140 0.08037    -789    215     -216    -74       20     117 $ inr sh
1252     140 0.08037    -789    216     -217    -74       20     117 $ inr sh
1253     140 0.08037    -789    217     -218    -74       20     117 $ inr sh
1254     140 0.08037    -789    218      -99    -74       20     117 $ inr sh
1255     140 0.08037    -789     94     -211    -82       74     116 $ inr sh
1256     140 0.08037    -789    211     -212    -82       74     116 $ inr sh
1257     140 0.08037    -789    212     -213    -82       74     116 $ inr sh
1258     140 0.08037    -789    213     -214    -82       74     116 $ inr sh
1259     140 0.08037    -789    214     -215    -82       74     116 $ inr sh
1260     140 0.08037    -789    215     -216    -82       74     116 $ inr sh
1261     140 0.08037    -789    216     -217    -82       74     116 $ inr sh
1262     140 0.08037    -789    217     -218    -82       74     116 $ inr sh
1263     140 0.08037    -789    218      -99    -82       74     116 $ inr sh
1264     140 0.08037    -789     94     -211     51       82     115 $ inr sh
1265     140 0.08037    -789    211     -212     51       82     115 $ inr sh
1266     140 0.08037    -789    212     -213     51       82     115 $ inr sh
1267     140 0.08037    -789    213     -214     51       82     115 $ inr sh
1268     140 0.08037    -789    214     -215     51       82     115 $ inr sh
1269     140 0.08037    -789    215     -216     51       82     115 $ inr sh
```

```
1270     140 0.08037    -789     216    -217      51      82     115 $ inr sh
1271     140 0.08037    -789     217    -218      51      82     115 $ inr sh
1272     140 0.08037    -789     218     -99      51      82     115 $ inr sh
1273     140 0.08037    -789      94    -211      43     -51     114 $ inr sh
1274     140 0.08037    -789     211    -212      43     -51     114 $ inr sh
1275     140 0.08037    -789     212    -213      43     -51     114 $ inr sh
1276     140 0.08037    -789     213    -214      43     -51     114 $ inr sh
1277     140 0.08037    -789     214    -215      43     -51     114 $ inr sh
1278     140 0.08037    -789     215    -216      43     -51     114 $ inr sh
1279     140 0.08037    -789     216    -217      43     -51     114 $ inr sh
1280     140 0.08037    -789     217    -218      43     -51     114 $ inr sh
1281     140 0.08037    -789     218     -99      43     -51     114 $ inr sh
1282     140 0.08037    -789      94    -211      20     -43     113 $ inr sh
1283     140 0.08037    -789     211    -212      20     -43     113 $ inr sh
1284     140 0.08037    -789     212    -213      20     -43     113 $ inr sh
1285     140 0.08037    -789     213    -214      20     -43     113 $ inr sh
1286     140 0.08037    -789     214    -215      20     -43     113 $ inr sh
1287     140 0.08037    -789     215    -216      20     -43     113 $ inr sh
1288     140 0.08037    -789     216    -217      20     -43     113 $ inr sh
1289     140 0.08037    -789     217    -218      20     -43     113 $ inr sh
1290     140 0.08037    -789     218     -99      20     -43     113 $ inr sh
1291     140 0.08037    -789      94    -211      12     -20     112 $ inr sh
1292     140 0.08037    -789     211    -212      12     -20     112 $ inr sh
1293     140 0.08037    -789     212    -213      12     -20     112 $ inr sh
1294     140 0.08037    -789     213    -214      12     -20     112 $ inr sh
1295     140 0.08037    -789     214    -215      12     -20     112 $ inr sh
1296     140 0.08037    -789     215    -216      12     -20     112 $ inr sh
1297     140 0.08037    -789     216    -217      12     -20     112 $ inr sh
1298     140 0.08037    -789     217    -218      12     -20     112 $ inr sh
1299     140 0.08037    -789     218     -99      12     -20     112 $ inr sh
1300     140 0.08037    -789      94    -211      82     -12    -111 $ inr sh
1301     140 0.08037    -789     211    -212      82     -12    -111 $ inr sh
1302     140 0.08037    -789     212    -213      82     -12    -111 $ inr sh
1303     140 0.08037    -789     213    -214      82     -12    -111 $ inr sh
1304     140 0.08037    -789     214    -215      82     -12    -111 $ inr sh
1305     140 0.08037    -789     215    -216      82     -12    -111 $ inr sh
1306     140 0.08037    -789     216    -217      82     -12    -111 $ inr sh
1307     140 0.08037    -789     217    -218      82     -12    -111 $ inr sh
1308     140 0.08037    -789     218     -99      82     -12    -111 $ inr sh
c     This is the CR yoke in the radial soudium gap.
1441     141 0.041118        100  -101     121     110     111     570 -571
      (( -32 :      -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :      -1 ))
1442     141 0.041118        101  -102     111    -112    -113     570 -571
      (( 93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (  89 :      -32 ))
1443     141 0.041118        102   100    -113    -114    -115     570 -571
      (( 93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (  89 :       31 ))
1444     141 0.041118        101  -100    -115    -116    -117     570 -571
      (( 31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (  27 :       62 ))
1445     141 0.041118       -101   102    -117     118     119     570 -571
      (( 62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
      (  58 :      -63 ))
1446     141 0.041118       -100  -102     119     120     121     570 -571
      (( -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
      (  -5 :      -63 ))
1447     139 0.0222          100  -101     121     110     111     571 -99
      (( -32 :      -5 ) ( -33 :  -4 ) ( -34 :    -3 ) ( -35 :  -2 )
      (  -36 :      -1 ))
1448     139 0.0222          101  -102     111    -112    -113     571 -99
      (( 93 :      -36 ) (  92 : -35 ) (  91 :   -34 ) (  90 : -33 )
      (  89 :      -32 ))
1449     139 0.0222          102   100    -113    -114    -115     571 -99
      (( 93 :       27 ) (  92 :  28 ) (  91 :    29 ) (  90 :  30 )
      (  89 :       31 ))
1450     139 0.0222          101  -100    -115    -116    -117     571 -99
      (( 31 :       58 ) (  30 :  59 ) ( 163 :   164 ) (  28 :  61 )
      (  27 :       62 ))
1451     139 0.0222         -101   102    -117     118     119     571 -99
      (( 62 :      -67 ) (  61 : -66 ) (  60 :   -65 ) (  59 : -64 )
      (  58 :      -63 ))
1452     139 0.0222         -100  -102     119     120     121     571 -99
      (( -1 :      -67 ) (  -2 : -66 ) (  -3 :   -65 ) (  -4 : -64 )
      (  -5 :      -63 ))
1453  139     0.0222    1  -73   -2 -140   94 -572 $ na
1454  139     0.0222   32   -8   -33   83   94 -575 $ na
1455  139     0.0222   32  -11   -33   86   94 -578 $ na
1456  139     0.0222  -93  -39    92   21   94 -581 $ na
1457  139     0.0222  -93   24    92  -42   94 -584 $ na
1458  139     0.0222  -31   52    30   86   94 -587 $ na
1459  139     0.0222  -31   55    30   83   94 -590 $ na
1460  139     0.0222  -62  -73    61   24   94 -593 $ na
1461  139     0.0222  -62  -70    61   21   94 -596 $ na
1462  139     0.0222   63  -11   -64   55   94 -599 $ na
1463  139     0.0222   63   52   -64   -8   94 -602 $ na
1464  139     0.0222    1 -138    -2  -42   94 -605 $ na
1465  141 0.041118      1  -73    -2 -140  572 -573 $ bottom
```

```
1466  141 0.041118    32   -8  -33   83  575 -576 $ bottom
1467  141 0.041118    32  -11  -33   86  578 -579 $ bottom
1468  141 0.041118   -93  -39   92   21  581 -582 $ bottom
1469  141 0.041118   -93   24   92  -42  584 -585 $ bottom
1470  141 0.041118   -31   52   30   86  587 -588 $ bottom
1471  141 0.041118   -31   55   30   83  590 -591 $ bottom
1472  141 0.041118   -62  -73   61   24  593 -594 $ bottom
1473  141 0.041118   -62  -70   61   21  596 -597 $ bottom
1474  141 0.041118    63  -11  -64   55  599 -600 $ bottom
1475  141 0.041118    63   52  -64   -8  602 -603 $ bottom
1476  141 0.041118     1 -138   -2  -42  605 -606 $ bottom
1477  141 0.041118     1  -73   -2 -140  573 -574 $ middle
1478  141 0.041118    32   -8  -33   83  576 -577 $ middle
1479  141 0.041118    32  -11  -33   86  579 -580 $ middle
1480  141 0.041118   -93  -39   92   21  582 -583 $ middle
1481  141 0.041118   -93   24   92  -42  585 -586 $ middle
1482  141 0.041118   -31   52   30   86  588 -589 $ middle
1483  141 0.041118   -31   55   30   83  591 -592 $ middle
1484  141 0.041118   -62  -73   61   24  594 -595 $ middle
1485  141 0.041118   -62  -70   61   21  597 -598 $ middle
1486  141 0.041118    63  -11  -64   55  600 -601 $ middle
1487  141 0.041118    63   52  -64   -8  603 -604 $ middle
1488  140   0.08037    1 -138   -2  -42  606 -607 $ middle
1489  139    0.0222     1  -73   -2 -140  574  -99 $ top
1490  139    0.0222    32   -8  -33   83  577  -99 $ top
1491  139    0.0222    32  -11  -33   86  580  -99 $ top
1492  139    0.0222   -93  -39   92   21  583  -99 $ top
1493  139    0.0222   -93   24   92  -42  586  -99 $ top
1494  139    0.0222   -31   52   30   86  589  -99 $ top
1495  139    0.0222   -31   55   30   83  592  -99 $ top
1496  139    0.0222   -62  -73   61   24  595  -99 $ top
1497  139    0.0222   -62  -70   61   21  598  -99 $ top
1498  139    0.0222    63  -11  -64   55  601  -99 $ top
1499  139    0.0222    63   52  -64   -8  604  -99 $ top
1500  139    0.0222     1 -138   -2  -42  607  -99 $ top
1501  190   0.03913    13   -15    42   -44    79   -81   608   -99  $  1302
1502  190   0.03913    19  -145    48   -50    79   -81   608   -99  $  2302
1503  190   0.03913    13   -15    48   -50    73   -75   608   -99  $  3302
1504  190   0.03913    10   -12    39   -41    79   -81   609   -99  $  1502
1505  190   0.03913    13   -15    39   -41    82   -84   609   -99  $  1504
1506  190   0.03913    22   -24    48  -151   141   -84   609   -99  $  2502
1507  190   0.03913    22   -24   143   -53    79  -150   609   -99  $  2504
1508  190   0.03913    13   -15    51   -53    70   -72   609   -99  $  3502
1509  190   0.03913    10   -12    48   -50    70   -72   609   -99  $  3504
c     Two dimensional model of out-of-core structural components.
c     ASTM atom densities, WARD volume fraction < MP and HEDL volume
c     fraction > MP.
c     ---------------------------------------------------
1511   417 0.081300   -806   270  -271
1512   433 -.001251   -264   271 (-272:277)
1513   431 -7.87000   -277   272  -273
1514   431 -7.87000    278  -277   273  -264
1515   433 -.001251  (-231 261 -264 276):(-276 274 -278 273 -264)
1516   431 -7.87000   -274   275  -276
1517   139 0.022260  (((((-206 -260 276):(-275 -276)) (-323:318:-317))
                     (-325:321:-316:317)) (-325:322:316:-315)) (314:315)
1518   139 0.022260  (((-317 (-202:781) -206 325 (-795:-204:796)
                     ) (317:-316:-320)) (316:-319:-315))
                     (315:-313:323)
1519   431 -7.87000    313 -314 -315 -323
1520   431 -7.87000    315  319 -322 -316  276
1521   431 -7.87000    316 -321  320 -317  276
1522   431 -7.87000   -318 -206  317  323
1523   419 0.032501   -785   202  -203          $ core 1
1524   419 0.032501   -785   203  -204          $
1525   419 0.032501   -785   204  -205          $
1526   419 0.032501   -785   205  -206          $
1527   406 0.049029   -785   206  -207          $
1528   406 0.049029   -785   207  -208          $
1529   405 0.068718   -785   208   -94          $
1530   124 0.033780   -785    99  -222          $
1531   404 0.033044   -785   222  -224          $
1532   403 0.031939   -785   224  -226          $
1533   402 0.052081   -785   226  -227          $
1534   401 0.025320   -785   227  -228          $
1535   401 0.025320   -785   228  -229          $
1536   401 0.025320   -785   229  -808          $
1537   401 0.025320   -785   808  -230
1538   401 0.025320   -785   230  -231
1539   401 0.025320   -785   231  -232
1540   401 0.025320   -785   232  -233
1541   401 0.025320   -785   233  -234
1542   401 0.025320   -785   234  -235
1543   401 0.025320   -785   235  -236
1544   139 0.022260   -785   236  -237
1545   139 0.022260   -785   237  -238
1546   139 0.022260   -785   238  -239
1547   139 0.022260   -785   239  -240
1548   431 -7.81000   -785   240  -241          $ suppressor plate
```

```
1549   139 0.022260   -785   241  -242
1550   432 -.001784   -785   242  -243
1551   431 -1.04550   -785   243  -245
1552   432 -.001784   -785   245  -246
1553   430 -8.26000   -785   246  -248
1554   432 -.001784   -785   248  -249
1555   436 -7.62000   -785   249  -250
1556   432 -.001784   -785   250  -251
1557   437 -7.69000   -785   251  -253
1558   432 -.001784   -785   253  -254
1559   431 -7.87000   -785   254  -255
1560   433 -.001251   -785   255  -256
1561   434 -0.90000   -785   256  -257
1562   431 -7.87000   -785   257  -258
c      ---------------------------------------------------
1571   419 0.032501   -786   202  -203      785 $ core 2
1572   419 0.032501   -786   203  -204      785 $
1573   419 0.032501   -786   204  -205      785 $
1574   419 0.032501   -786   205  -206      785 $
1575   406 0.049029   -786   206  -207      785 $
1576   406 0.049029   -786   207  -208      785 $
1577   405 0.068718   -786   208  -94       785 $
1578   124 0.033780   -786    99  -222      785 $
1579   404 0.033044   -786   222  -224      785 $
1580   403 0.031939   -786   224  -226      785 $
1581   402 0.052081   -786   226  -227      785 $
1582   401 0.025320   -786   227  -228      785 $
1583   401 0.025320   -786   228  -229      785 $
1584   401 0.025320   -786   229  -808      785 $
1585   401 0.025320   -786   808  -230      785
1586   401 0.025320   -786   230  -231      785
1587   401 0.025320   -786   231  -232      785
1588   401 0.025320   -786   232  -233      785
1589   401 0.025320   -786   233  -234      785
1590   401 0.025320   -786   234  -235      785
1591   401 0.025320   -786   235  -236      785
1592   139 0.022260   -786   236  -237      785
1593   139 0.022260   -786   237  -238      785
1594   139 0.022260   -786   238  -239      785
1595   139 0.022260   -786   239  -240      785
1596   431  -7.81000   -786   240  -241      785 $ suppressor plate
1597   139   0.022260   -786   241  -242      785
1598   432   -.001784   -786   242  -243      785
1599   431   -1.04550   -786   243  -245      785
1600   432   -.001784   -786   245  -246      785
1601   430   -8.26000   -786   246  -248      785
1602   432   -.001784   -786   248  -249      785
1603   436   -7.62000   -786   249  -250      785
1604   432   -.001784   -786   250  -251      785
1605   437   -7.69000   -786   251  -253      785
1606   432 -.001784   -786   253  -254      785
1607   431 -7.87000   -786   254  -255      785
1608   433 -.001251   -786   255  -256      785
1609   434 -0.90000   -786   256  -257      785
1610   431 -7.87000   -786   257  -258      785
c      ---------------------------------------------------
1611   419 0.032501   -780   202  -203      786 $ refl-1
1612   419 0.032501   -780   203  -204      786 $
1613   419 0.032501   -780   204  -205      786 $
1614   419 0.032501   -780   205  -206      786 $
1615   406 0.049029   -780   206  -207      786 $
1616   406 0.049029   -780   207  -208      786 $
1617   405 0.068718   -787   208  -94       786 $
1618   137 0.07527    -787    99  -222      786 $
1619   404 0.033044   -787   222  -224      786 $
1620   403 0.031939   -787   224  -226      786 $
1621   402 0.052081   -787   226  -227      786 $
1622   401 0.025320   -787   227  -228      786 $
1623   401 0.025320   -787   228  -229      786 $
1624   401 0.025320   -787   229  -808      786 $
1625   401 0.025320   -787   808  -230      786
1626   401 0.025320   -787   230  -231      786
1627   401 0.025320   -787   231  -232      786
1628   401 0.025320   -787   232  -233      786
1629   401 0.025320   -787   233  -234      786
1630   401 0.025320   -787   234  -235      786
1631   401 0.025320   -787   235  -236      786
1632   139 0.022260   -787   236  -237      786
1633   139 0.022260   -787   237  -238      786
1634   139 0.022260   -787   238  -239      786
1635   139 0.022260   -787   239  -240      786
1636   431  -7.81000   -787   240  -241      786 $ suppressor plate
1637   139   0.022260   -787   241  -242      786
1638   432   -.001784   -787   242  -243      786
1639   431   -1.04550   -787   243  -245      786
1640   432   -.001784   -787   245  -246      786
1641   430   -8.26000   -787   246  -248      786
1642   432   -.001784   -787   248  -249      786
1643   436   -7.62000   -787   249  -250      786
```

```
1644   432  -.001784   -787   250  -251      786
1645   437  -7.69000   -787   251  -253      786
1646   432 -.001784   -787   253  -254      786
1647   431 -7.87000   -787   254  -255      786
1648   433 -.001251   -787   255  -256      786
1649   434 -0.90000   -787   256  -257      786
1650   431 -7.87000   -787   257  -258      786
c      ------------------------------------------------
1651   407 0.084704   -781   202  -203      780 $ refl-2
1652   407 0.084704   -781   203  -204      780 $
1653   407 0.084704   -781   204  -205      780 $
1654   407 0.084704   -781   205  -206      780 $
1655   407 0.084704   -781   206  -207      780 $
1656   407 0.084704   -781   207  -208      780 $
1657   405 0.068718   -788   208  -94       787 $
1658   138 0.07830    -788    99  -222      787 $
1659   404 0.033044   -788   222  -224      787 $
1660   403 0.031939   -788   224  -226      787 $
1661   402 0.052081   -788   226  -227      787 $
1662   401 0.025320   -788   227  -228      787 $
1663   401 0.025320   -788   228  -229      787 $
1664   401 0.025320   -788   229  -808      787 $
1665   401 0.025320   -788   808  -230      787
1666   401 0.025320   -788   230  -231      787
1667   401 0.025320   -788   231  -232      787
1668   401 0.025320   -788   232  -233      787
1669   401 0.025320   -788   233  -234      787
1670   401 0.025320   -788   234  -235      787
1671   401 0.025320   -788   235  -236      787
1672   139 0.022260   -788   236  -237      787
1673   139 0.022260   -788   237  -238      787
1674   139 0.022260   -788   238  -239      787
1675   139 0.022260   -788   239  -240      787
1676   431 -7.81000   -788   240  -241      787 $ suppressor plate
1677   139 0.022260   -788   241  -242      787
1678   432 -.001784   -788   242  -243      787
1679   431 -1.04550   -788   243  -245      787
1680   432 -.001784   -788   245  -246      787
1681   430 -8.26000   -788   246  -248      787
1682   432 -.001784   -788   248  -249      787
1683   436 -7.62000   -788   249  -250      787
1684   432 -.001784   -788   250  -251      787
1685   437 -7.69000   -788   251  -253      787
1686   432 -.001784   -788   253  -254      787
1687   431 -7.87000   -788   254  -255      787
1688   433 -.001251   -788   255  -256      787
1689   434 -0.90000   -788   256  -257      787
1690   431 -7.87000   -788   257  -258      787
c      ------------------------------------------------
1691   139 0.022260   -789   206  -207      781 $ irs-1
1692   139 0.022260   -789   207  -208      781 $
1693   405 0.068718   -789   208  -94       788 $
1694   140 0.080370   -789    99  -222      788 $
1695   140 0.080370   -789   222  -224      788 $
1696   403 0.031939   -789   224  -226      788 $
1697   402 0.052081   -789   226  -227      788 $
1698   401 0.025320   -789   227  -228      788 $
1699   401 0.025320   -789   228  -229      788 $
1700   401 0.025320   -789   229  -808      788 $
1701   401 0.025320   -789   808  -230      788
1702   401 0.025320   -789   230  -231      788
1703   401 0.025320   -789   231  -232      788
1704   401 0.025320   -789   232  -233      788
1705   401 0.025320   -789   233  -234      788
1706   401 0.025320   -789   234  -235      788
1707   401 0.025320   -789   235  -236      788
1708   139 0.022260   -789   236  -237      788
1709   139 0.022260   -789   237  -238      788
1710   139 0.022260   -789   238  -239      788
1711   139 0.022260   -789   239  -240      788
1712   431  -7.81000 -789   240  -241      788 $ suppressor plate
1713   139  0.022260  -789   241  -242      788
1714   432  -.001784  -789   242  -243      788
1715   431  -1.04550  -789   243  -245      788
1716   432  -.001784  -789   245  -246      788
1717   430  -8.26000  -789   246  -248      788
1718   432  -.001784  -789   248  -249      788
1719   436  -7.62000  -789   249  -250      788
1720   432  -.001784  -789   250  -251      788
1721   437  -7.69000  -789   251  -253      788
1722   432 -.001784   -789   253  -254      788
1723   431 -7.87000   -789   254  -255      788
1724   433 -.001251   -789   255  -256      788
1725   434 -0.90000   -789   256  -257      788
1726   431 -7.87000   -789   257  -258      788
c      ------------------------------------------------
1731   139 0.022260   -790   206  -207      789 $ irs-2
1732   139 0.022260   -790   207  -208      789 $
1733   405 0.068718   -790   208  -209      789 $
```

```
1734   410 0.061288   -790   209  -210      789 $
1735   140 0.080370   -790   210  -211      789 $
1736   140 0.080370   -790   211  -212      789 $
1737   140 0.080370   -790   212  -213      789 $
1738   140 0.080370   -790   213  -214      789 $
1739   140 0.080370   -790   214  -215      789 $
1740   140 0.080370   -790   215  -216      789 $
1741   140 0.080370   -790   216  -217      789 $
1742   140 0.080370   -790   217  -218      789 $
1743   140 0.080370   -790   218  -219      789 $
1744   140 0.080370   -790   219  -222      789 $
1745   140 0.080370   -790   222  -224      789 $
1746   409 0.030378   -790   224  -226      789 $
1747   409 0.030378   -790   226  -227      789 $
1748   409 0.030378   -790   227  -228      789 $
1749   409 0.030378   -790   228  -229      789 $
1750   409 0.030378   -790   229  -808      789 $
1751   409 0.030378   -790   808  -230      789
1752   409 0.030378   -790   230  -231      789
1753   409 0.030378   -790   231  -232      789
1754   409 0.030378   -790   232  -233      789
1755   409 0.030378   -790   233  -234      789
1756   409 0.030378   -790   234  -235      789
1757   409 0.030378   -790   235  -236      789
1758   139 0.022260   -790   236  -237      789
1759   139 0.022260   -790   237  -238      789
1760   139 0.022260   -790   238  -239      789
1761   139 0.022260   -790   239  -240      789
1762   431  -7.81000   -790   240  -241      789
1763   139   0.022260   -790   241  -242      789
1764   432  -.001784   -790   242  -243      789
1765   431  -1.04550   -790   243  -245      789
1766   432  -.001784   -790   245  -246      789
1767   430  -8.26000   -790   246  -248      789
1768   432  -.001784   -790   248  -249      789
1769   436  -7.62000   -790   249  -250      789
1770   432  -.001784   -790   250  -251      789
1771   437  -7.69000   -790   251  -253      789
1772   432 -.001784   -790   253  -254      789
1773   431 -7.87000   -790   254  -255      789
1774   433 -.001251   -790   255  -256      789
1775   434 -0.90000   -790   256  -257      789
1776   431 -7.87000   -790   257  -258      789
c      ------------------------------------------------
1781   139   0.02226   -791   206  -207      790 $ ors-1
1782   139   0.02226   -791   207  -208      790 $
1783   405 0.068718   -791   208  -209      790 $
1784   410 0.061288   -791   209  -210      790 $
1785   142   0.08323   -791   210  -211      790 $
1786   142   0.08323   -791   211  -212      790 $
1787   142   0.08323   -791   212  -213      790 $
1788   142   0.08323   -791   213  -214      790 $
1789   142   0.08323   -791   214  -215      790 $
1790   142   0.08323   -791   215  -216      790 $
1791   142   0.08323   -791   216  -217      790 $
1792   142   0.08323   -791   217  -218      790 $
1793   142   0.08323   -791   218  -219      790 $
1794   142   0.08323   -791   219  -222      790 $
1795   142   0.08323   -791   222  -223      790 $
1796   411 0.084704   -791   223  -224      790 $
1797   409 0.030378   -791   224  -226      790 $
1798   409 0.030378   -791   226  -227      790 $
1799   409 0.030378   -791   227  -228      790 $
1800   409 0.030378   -791   228  -229      790 $
1801   409 0.030378   -791   229  -808      790 $
1802   409 0.030378   -791   808  -230      790
1803   409 0.030378   -791   230  -231      790
1804   409 0.030378   -791   231  -232      790
1805   409 0.030378   -791   232  -233      790
1806   409 0.030378   -791   233  -234      790
1807   409 0.030378   -791   234  -235      790
1808   409 0.030378   -791   235  -236      790
1809   139 0.022260   -791   236  -237      790
1810   139 0.022260   -791   237  -238      790
1811   139 0.022260   -791   238  -239      790
1812   139 0.022260   -791   239  -240      790
1813   431  -7.81000   -791   240  -241      790
1814   139   0.022260   -791   241  -242      790
1815   432  -.001784   -791   242  -243      790
1816   431  -1.04550   -791   243  -245      790
1817   432  -.001784   -791   245  -246      790
1818   430  -8.26000   -791   246  -248      790
1819   432  -.001784   -791   248  -249      790
1820   436  -7.62000   -791   249  -250      790
1821   432  -.001784   -791   250  -251      790
1822   437  -7.69000   -791   251  -253      790
1823   432 -.001784   -791   253  -254      790
1824   431 -7.87000   -791   254  -255      790
1825   433 -.001251   -791   255  -256      790
```

```
1826   434 -0.90000   -791   256  -257      790
1827   431 -7.87000   -791   257  -258      790
c      ------------------------------------------------
1831   139  0.02226   -792   206  -207      791 $ ors-2
1832   139  0.02226   -792   207  -208      791 $
1833   405 0.068718   -792   208  -209      791 $
1834   410 0.061288   -792   209  -210      791 $
1835   142  0.08323   -792   210  -211      791 $
1836   142  0.08323   -792   211  -212      791 $
1837   142  0.08323   -792   212  -213      791 $
1838   142  0.08323   -792   213  -214      791 $
1839   142  0.08323   -792   214  -215      791 $
1840   142  0.08323   -792   215  -216      791 $
1841   142  0.08323   -792   216  -217      791 $
1842   142  0.08323   -792   217  -218      791 $
1843   142  0.08323   -792   218  -219      791 $
1844   142  0.08323   -792   219  -222      791 $
1845   142  0.08323   -792   222  -223      791 $
1846   411 0.084704   -792   223  -224      791 $
1847   139  0.02226   -792   224  -226      791 $
1848   139  0.02226   -792   226  -227      791 $
1849   139  0.02226   -792   227  -228      791 $
1850   139  0.02226   -792   228  -229      791 $
1851   139  0.02226   -792   229  -808      791 $
1852   139 0.022260   -792   808  -230      791
1853   139 0.022260   -792   230  -231      791
1854   139 0.022260   -792   231  -232      791
1855   139 0.022260   -792   232  -233      791
1856   139 0.022260   -792   233  -234      791
1857   139 0.022260   -792   234  -235      791
1858   139 0.022260   -792   235  -236      791
1859   139 0.022260   -792   236  -237      791
1860   139 0.022260   -792   237  -238      791
1861   139 0.022260   -792   238  -239      791
1862   139 0.022260   -792   239  -240      791
1863   431  -7.81000  -792   240  -241      791
1864   139  0.022260  -792   241  -242      791
1865   432  -.001784  -792   242  -243      791
1866   431  -1.04550  -792   243  -245      791
1867   432  -.001784  -792   245  -246      791
1868   430  -8.26000  -792   246  -248      791
1869   432  -.001784  -792   248  -249      791
1870   436  -7.62000  -792   249  -250      791
1871   432  -.001784  -792   250  -251      791
1872   437  -7.69000  -792   251  -253      791
1873   432 -.001784   -792   253  -254      791
1874   431 -7.87000   -792   254  -255      791
1875   433 -.001251   -792   255  -256      791
1876   434 -0.90000   -792   256  -257      791
1877   431 -7.87000   -792   257  -258      791
c      ------------------------------------------------
1881   139  0.02226   -793   206  -207      792 $ ors-3
1882   139  0.02226   -793   207  -208      792 $
1883   405 0.068718   -793   208  -209      792 $
1884   410 0.061288   -793   209  -210      792 $
1885   142  0.08323   -793   210  -211      792 $
1886   142  0.08323   -793   211  -212      792 $
1887   142  0.08323   -793   212  -213      792 $
1888   142  0.08323   -793   213  -214      792 $
1889   142  0.08323   -793   214  -215      792 $
1890   142  0.08323   -793   215  -216      792 $
1891   142  0.08323   -793   216  -217      792 $
1892   142  0.08323   -793   217  -218      792 $
1893   142  0.08323   -793   218  -219      792 $
1894   142  0.08323   -793   219  -222      792 $
1895   142  0.08323   -793   222  -223      792 $
1896   411 0.084704   -793   223  -224      792 $
1897   139  0.02226   -793   224  -226      792 $
1898   139  0.02226   -793   226  -227      792 $
1899   139  0.02226   -793   227  -228      792 $
1900   139  0.02226   -793   228  -229      792 $
1901   139  0.02226   -793   229  -808      792 $
1902   139 0.022260   -793   808  -230      792
1903   139 0.022260   -793   230  -231      792
1904   139 0.022260   -793   231  -232      792
1905   139 0.022260   -793   232  -233      792
1906   139 0.022260   -793   233  -234      792
1907   139 0.022260   -793   234  -235      792
1908   139 0.022260   -793   235  -236      792
1909   139 0.022260   -793   236  -237      792
1910   139 0.022260   -793   237  -238      792
1911   139 0.022260   -793   238  -239      792
1912   139 0.022260   -793   239  -240      792
1913   431  -7.81000  -793   240  -241      792
1914   139  0.022260  -793   241  -242      792
1915   432  -.001784  -793   242  -243      792
1916   431  -1.04550  -793   243  -245      792
1917   432  -.001784  -793   245  -246      792
1918   430  -8.26000  -793   246  -248      792
```

```
1919   432  -.001784  -793   248  -249      792
1920   436  -7.62000  -793   249  -250      792
1921   432  -.001784  -793   250  -251      792
1922   437  -7.69000  -793   251  -253      792
1923   432 -.001784   -793   253  -254      792
1924   431 -7.87000   -793   254  -255      792
1925   433 -.001251   -793   255  -256      792
1926   434 -0.90000   -793   256  -257      792
1927   431 -7.87000   -793   257  -258      792
c      ------------------------------------------------
1931   139  0.02226   -794   206  -207      793 $ Na-1
1932   139  0.02226   -794   207  -208      793 $
1933   405 0.068718   -794   208  -209      793 $
1934   139  0.02226   -794   209  -211      793 $
1935   139  0.02226   -794   211  -212      793 $
1936   139  0.02226   -794   212  -213      793 $
1937   139  0.02226   -794   213  -214      793 $
1938   139  0.02226   -794   214  -215      793 $
1939   139  0.02226   -794   215  -216      793 $
1940   139  0.02226   -794   216  -217      793 $
1941   139  0.02226   -794   217  -218      793 $
1942   139  0.02226   -794   218  -219      793 $
1943   139  0.02226   -794   219  -222      793 $
1944   139  0.02226   -794   222  -223      793 $
1945   411 0.084704   -794   223  -224      793 $
1946   139  0.02226   -794   224  -226      793 $
1947   139  0.02226   -794   226  -227      793 $
1948   139  0.02226   -794   227  -228      793 $
1949   139  0.02226   -794   228  -229      793 $
1950   139  0.02226   -794   229  -808      793 $
1951   139 0.022260   -794   808  -230      793
1952   139 0.022260   -794   230  -231      793
1953   139 0.022260   -794   231  -232      793
1954   139 0.022260   -794   232  -233      793
1955   139 0.022260   -794   233  -234      793
1956   139 0.022260   -794   234  -235      793
1957   139 0.022260   -794   235  -236      793
1958   139 0.022260   -794   236  -237      793
1959   139 0.022260   -794   237  -238      793
1960   139 0.022260   -794   238  -239      793
1961   139 0.022260   -794   239  -240      793
1962   431  -7.81000  -794   240  -241      793
1963   139  0.022260  -794   241  -242      793
1964   432  -.001784  -794   242  -243      793
1965   431  -1.04550  -794   243  -245      793
1966   432  -.001784  -794   245  -246      793
1967   430  -8.26000  -794   246  -248      793
1968   432  -.001784  -794   248  -249      793
1969   436  -7.62000  -794   249  -250      793
1970   432  -.001784  -794   250  -251      793
1971   437  -7.69000  -794   251  -253      793
1972   432 -.001784   -794   253  -254      793
1973   431 -7.87000   -794   254  -255      793
1974   433 -.001251   -794   255  -256      793
1975   434 -0.90000   -794   256  -257      793
1976   431 -7.87000   -794   257  -258      793
c      ------------------------------------------------
1981   139  0.02226   -795   206  -207      794 $ Na-2
1982   139  0.02226   -795   207  -208      794 $
1983   405 0.068718   -795   208  -209      794 $
1984   139  0.02226   -795   209  -211      794 $
1985   139  0.02226   -795   211  -212      794 $
1986   139  0.02226   -795   212  -213      794 $
1987   139  0.02226   -795   213  -214      794 $
1988   139  0.02226   -795   214  -215      794 $
1989   139  0.02226   -795   215  -216      794 $
1990   139  0.02226   -795   216  -217      794 $
1991   139  0.02226   -795   217  -218      794 $
1992   139  0.02226   -795   218  -219      794 $
1993   139  0.02226   -795   219  -222      794 $
1994   139  0.02226   -795   222  -223      794 $
1995   411 0.084704   -795   223  -224      794 $
1996   139  0.02226   -795   224  -226      794 $
1997   139  0.02226   -795   226  -227      794 $
1998   139  0.02226   -795   227  -228      794 $
1999   139  0.02226   -795   228  -229      794 $
2000   139  0.02226   -795   229  -808      794 $
2001   139 0.022260   -795   808  -230      794
2002   139 0.022260   -795   230  -231      794
2003   139 0.022260   -795   231  -232      794
2004   139 0.022260   -795   232  -233      794
2005   139 0.022260   -795   233  -234      794
2006   139 0.022260   -795   234  -235      794
2007   139 0.022260   -795   235  -236      794
2008   139 0.022260   -795   236  -237      794
2009   139 0.022260   -795   237  -238      794
2010   139 0.022260   -795   238  -239      794
2011   139 0.022260   -795   239  -240      794
2012   431  -7.81000   -795   240  -241      794
```

```
2013   139  0.022260   -795   241  -242      794
2014   432  -.001784   -795   242  -243      794
2015   431  -1.04550   -795   243  -245      794
2016   432  -.001784   -795   245  -246      794
2017   430  -8.26000   -795   246  -248      794
2018   432  -.001784   -795   248  -249      794
2019   436  -7.62000   -795   249  -250      794
2020   432  -.001784   -795   250  -251      794
2021   437  -7.69000   -795   251  -253      794
2022   432 -.001784   -795   253  -254      794
2023   431 -7.87000   -795   254  -255      794
2024   433 -.001251   -795   255  -256      794
2025   434 -0.90000   -795   256  -257      794
2026   431 -7.87000   -795   257  -258      794
C      ------------------------------------------------
2031   412 0.084704   -796   204  -208      795 $ Core barrel-1
2032   405 0.068718   -796   208  -209      795 $
2033   412 0.084704   -796   209  -211      795 $
2034   412 0.084704   -796   211  -212      795 $
2035   412 0.084704   -796   212  -213      795 $
2036   412 0.084704   -796   213  -214      795 $
2037   412 0.084704   -796   214  -215      795 $
2038   412 0.084704   -796   215  -216      795 $
2039   412 0.084704   -796   216  -217      795 $
2040   412 0.084704   -796   217  -218      795 $
2041   412 0.084704   -796   218  -219      795 $
2042   412 0.084704   -796   219  -221      795 $
2043   139  0.02226   -796   221  -222      795 $
2044   139  0.02226   -796   222  -223      795 $
2045   411 0.084704   -796   223  -224      795 $
2046   139  0.02226   -796   224  -226      795 $
2047   139  0.02226   -796   226  -227      795 $
2048   139  0.02226   -796   227  -228      795 $
2049   139  0.02226   -796   228  -229      795 $
2050   139  0.02226   -796   229  -808      795 $
2051   139 0.022260   -796   808  -230      795
2052   139 0.022260   -796   230  -231      795
2053   139 0.022260   -796   231  -232      795
2054   139 0.022260   -796   232  -233      795
2055   139 0.022260   -796   233  -234      795
2056   139 0.022260   -796   234  -235      795
2057   139 0.022260   -796   235  -236      795
2058   139 0.022260   -796   236  -237      795
2059   139 0.022260   -796   237  -238      795
2060   139 0.022260   -796   238  -239      795
2061   139 0.022260   -796   239  -240      795
2062   431  -7.81000   -796   240  -241      795
2063   139  0.022260   -796   241  -242      795
2064   432  -.001784   -796   242  -243      795
2065   431  -1.04550   -796   243  -245      795
2066   432  -.001784   -796   245  -246      795
2067   430  -8.26000   -796   246  -248      795
2068   432  -.001784   -796   248  -249      795
2069   436  -7.62000   -796   249  -250      795
2070   432  -.001784   -796   250  -251      795
2071   437  -7.69000   -796   251  -253      795
2072   432 -.001784   -796   253  -254      795
2073   431 -7.87000   -796   254  -255      795
2074   433 -.001251   -796   255  -256      795
2075   434 -0.90000   -796   256  -257      795
2076   431 -7.87000   -796   257  -258      795
C      ------------------------------------------------
2081   139  0.02226   -797   206  -207      796 $ Core barrel-2
2082   139  0.02226   -797   207  -208      796 $
2083   405 0.068718   -797   208  -209      796 $
2084   139  0.02226   -797   209  -211      796 $
2085   139  0.02226   -797   211  -212      796 $
2086   139  0.02226   -797   212  -213      796 $
2087   139  0.02226   -797   213  -214      796 $
2088   139  0.02226   -797   214  -215      796 $
2089   139  0.02226   -797   215  -216      796 $
2090   139  0.02226   -797   216  -217      796 $
2091   139  0.02226   -797   217  -218      796 $
2092   139  0.02226   -797   218  -219      796 $
2093   139  0.02226   -797   219  -220      796 $
2094   412 0.084704   -797   220  -221      796 $
2095   139  0.02226   -797   221  -222      796 $
2096   139  0.02226   -797   222  -223      796 $
2097   411 0.084704   -797   223  -224      796 $
2098   139  0.02226   -797   224  -225      796 $
2099   413  0.03641   -797   225  -226      796 $
2100   413  0.03641   -797   226  -227      796 $
2101   413  0.03641   -797   227  -228      796 $
2102   413  0.03641   -797   228  -229      796 $
2103   413  0.03641   -797   229  -808      796 $
2104   413  0.03641   -797   808  -230      796
2105   413  0.03641   -797   230  -231      796
2106   413  0.03641   -797   231  -232      796
2107   413  0.03641   -797   232  -233      796
```

```
2108   413  0.03641   -797   233  -234      796
2109   413  0.03641   -797   234  -235      796
2110   413  0.03641   -797   235  -236      796
2111   413  0.03641   -797   236  -237      796
2112   413  0.03641   -797   237  -238      796
2113   413  0.03641   -797   238  -239      796
2114   413  0.03641   -797   239  -240      796
2115   431  -7.81000  -797   240  -241      796
2116   139  0.022260  -797   241  -242      796
2117   432  -.001784  -797   242  -243      796
2118   431  -1.04550  -797   243  -245      796
2119   432  -.001784  -797   245  -246      796
2120   430  -8.26000  -797   246  -248      796
2121   432  -.001784  -797   248  -249      796
2122   436  -7.62000  -797   249  -250      796
2123   432  -.001784  -797   250  -251      796
2124   437  -7.69000  -797   251  -253      796
2125   432 -.001784   -797   253  -254      796
2126   431 -7.87000   -797   254  -255      796
2127   433 -.001251   -797   255  -256      796
2128   434 -0.90000   -797   256  -257      796
2129   431 -7.87000   -797   257  -258      796
c      ------------------------------------------------
2131   139  0.02226   -798   206  -207      797 $ Na-3
2132   139  0.02226   -798   207  -208      797 $
2133   405 0.068718   -798   208  -209      797 $
2134   139  0.02226   -798   209  -211      797 $
2135   139  0.02226   -798   211  -212      797 $
2136   139  0.02226   -798   212  -213      797 $
2137   139  0.02226   -798   213  -214      797 $
2138   139  0.02226   -798   214  -215      797 $
2139   139  0.02226   -798   215  -216      797 $
2140   139  0.02226   -798   216  -217      797 $
2141   139  0.02226   -798   217  -218      797 $
2142   139  0.02226   -798   218  -219      797 $
2143   139  0.02226   -798   219  -222      797 $
2144   139  0.02226   -798   222  -223      797 $
2145   411 0.084704   -798   223  -224      797 $
2146   139  0.02226   -798   224  -225      797 $
2147   413  0.03641   -798   225  -226      797 $
2148   413  0.03641   -798   226  -227      797 $
2149   413  0.03641   -798   227  -228      797 $
2150   413  0.03641   -798   228  -229      797 $
2151   413  0.03641   -798   229  -808      797 $
2152   413  0.03641   -798   808  -230      797
2153   413  0.03641   -798   230  -231      797
2154   413  0.03641   -798   231  -232      797
2155   413  0.03641   -798   232  -233      797
2156   413  0.03641   -798   233  -234      797
2157   413  0.03641   -798   234  -235      797
2158   413  0.03641   -798   235  -236      797
2159   413  0.03641   -798   236  -237      797
2160   413  0.03641   -798   237  -238      797
2161   413  0.03641   -798   238  -239      797
2162   413  0.03641   -798   239  -240      797
2163   431  -7.81000   -798   240  -241       797
2164   139  0.022260   -798   241  -242       797
2165   432  -.001784   -798   242  -243       797
2166   431  -1.04550   -798   243  -245       797
2167   432  -.001784   -798   245  -246       797
2168   430  -8.26000   -798   246  -248       797
2169   432  -.001784   -798   248  -249       797
2170   436  -7.62000   -798   249  -250       797
2171   432  -.001784   -798   250  -251       797
2172   437  -7.69000   -798   251  -253       797
2173   432 -.001784   -798   253  -254      797
2174   431 -7.87000   -798   254  -255      797
2175   433 -.001251   -798   255  -256      797
2176   434 -0.90000   -798   256  -257      797
2177   431 -7.87000   -798   257  -258      797
c      ------------------------------------------------
2181   139  0.02226   -799   206  -207   818 -821 798 $ IVSM-1
2182   139  0.02226   -799   207  -208   818 -821 798 $
2183   405 0.068718   -799   208  -209   818 -821 798 $
2184   139  0.02226   -799   209  -211   818 -821 798 $
2185   139  0.02226   -799   211  -212   818 -821 798 $
2186   139  0.02226   -799   212  -213   818 -821 798 $
2187   139  0.02226   -799   213  -214   818 -821 798 $
2188   139  0.02226   -799   214  -215   818 -821 798 $
2189   139  0.02226   -799   215  -216   818 -821 798 $
2190   139  0.02226   -799   216  -217   818 -821 798 $
2191   139  0.02226   -799   217  -218   818 -821 798 $
2192   139  0.02226   -799   218  -219   818 -821 798 $
2193   139  0.02226   -799   219  -222   818 -821 798 $
2194   139  0.02226   -799   222  -223   818 -821 798 $
2195   411 0.084704   -799   223  -224   818 -821 798 $
2196   139  0.02226   -799   224  -225   818 -821 798 $
2197   413  0.03641   -799   225  -226   818 -821 798 $
2198   413  0.03641   -799   226  -227   818 -821 798 $
```

```
2199   413  0.03641   -799   227  -228   818 -821 798 $
2200   413  0.03641   -799   228  -229   818 -821 798 $
2201   413  0.03641   -799   229  -808   818 -821 798 $
2202   413  0.03641   -799   808  -230   818 -821 798
2203   413  0.03641   -799   230  -231   818 -821 798
2204   413  0.03641   -799   231  -232   818 -821 798
2205   413  0.03641   -799   232  -233   818 -821 798
2206   413  0.03641   -799   233  -234   818 -821 798
2207   413  0.03641   -799   234  -235   818 -821 798
2208   413  0.03641   -799   235  -236   818 -821 798
2209   413  0.03641   -799   236  -237   818 -821 798
2210   413  0.03641   -799   237  -238   818 -821 798
2211   413  0.03641   -799   238  -239   818 -821 798
2212   413  0.03641   -799   239  -240   818 -821 798
2213   431  -7.81000   -799   240  -241   818 -821 798
2214   139  0.022260   -799   241  -242   818 -821 798
2215   432  -.001784   -799   242  -243   818 -821 798
2216   431  -1.04550   -799   243  -245   818 -821 798
2217   432  -.001784   -799   245  -246   818 -821 798
2218   430  -8.26000   -799   246  -248   818 -821 798
2219   432  -.001784   -799   248  -249   818 -821 798
2220   436  -7.62000   -799   249  -250   818 -821 798
2221   432  -.001784   -799   250  -251   818 -821 798
2222   437  -7.69000   -799   251  -253   818 -821 798
2223   432 -.001784   -799   253  -254   818 -821 798
2224   431 -7.87000   -799   254  -255   818 -821 798
2225   433 -.001251   -799   255  -256   818 -821 798
2226   434 -0.90000   -799   256  -257   818 -821 798
2227   431 -7.87000   -799   257  -258   818 -821 798
c      ------------------------------------------------
2231   139  0.02226   -800   206  -207   818 -821 799 $ IVSM-2
2232   139  0.02226   -800   207  -208   818 -821 799 $
2233   405 0.068718   -800   208  -209   818 -821 799 $
2234   139  0.02226   -800   209  -211   818 -821 799 $
2235   139  0.02226   -800   211  -212   818 -821 799 $
2236   139  0.02226   -800   212  -213   818 -821 799 $
2237   139  0.02226   -800   213  -214   818 -821 799 $
2238   139  0.02226   -800   214  -215   818 -821 799 $
2239   139  0.02226   -800   215  -216   818 -821 799 $
2240   139  0.02226   -800   216  -217   818 -821 799 $
2241   139  0.02226   -800   217  -218   818 -821 799 $
2242   139  0.02226   -800   218  -219   818 -821 799 $
2243   139  0.02226   -800   219  -222   818 -821 799 $
2244   139  0.02226   -800   222  -223   818 -821 799 $
2245   411 0.084704   -800   223  -224   818 -821 799 $
2246   139  0.02226   -800   224  -225   818 -821 799 $
2247   413  0.03641   -800   225  -226   818 -821 799 $
2248   413  0.03641   -800   226  -227   818 -821 799 $
2249   413  0.03641   -800   227  -228   818 -821 799 $
2250   413  0.03641   -800   228  -229   818 -821 799 $
2251   413  0.03641   -800   229  -808   818 -821 799 $
2252   413  0.03641   -800   808  -230   818 -821 799
2253   413  0.03641   -800   230  -231   818 -821 799
2254   413  0.03641   -800   231  -232   818 -821 799
2255   413  0.03641   -800   232  -233   818 -821 799
2256   413  0.03641   -800   233  -234   818 -821 799
2257   413  0.03641   -800   234  -235   818 -821 799
2258   413  0.03641   -800   235  -236   818 -821 799
2259   413  0.03641   -800   236  -237   818 -821 799
2260   413  0.03641   -800   237  -238   818 -821 799
2261   413  0.03641   -800   238  -239   818 -821 799
2262   413  0.03641   -800   239  -240   818 -821 799
2263   431  -7.81000   -800   240  -241   818 -821 799
2264   139  0.022260   -800   241  -242   818 -821 799
2265   432  -.001784   -800   242  -243   818 -821 799
2266   431  -1.04550   -800   243  -245   818 -821 799
2267   432  -.001784   -800   245  -246   818 -821 799
2268   430  -8.26000   -800   246  -248   818 -821 799
2269   432  -.001784   -800   248  -249   818 -821 799
2270   436  -7.62000   -800   249  -250   818 -821 799
2271   432  -.001784   -800   250  -251   818 -821 799
2272   437  -7.69000   -800   251  -253   818 -821 799
2273   432 -.001784   -800   253  -254   818 -821 799
2274   431 -7.87000   -800   254  -255   818 -821 799
2275   433 -.001251   -800   255  -256   818 -821 799
2276   434 -0.90000   -800   256  -257   818 -821 799
2277   431 -7.87000   -800   257  -258   818 -821 799
c      ------------------------------------------------
2281   139  0.02226   -801   206  -207   818 -821 800 $ IVSM-3
2282   139  0.02226   -801   207  -208   818 -821 800 $
2283   405 0.068718   -801   208  -209   818 -821 800 $
2284   139  0.02226   -801   209  -211   818 -821 800 $
2285   139  0.02226   -801   211  -212   818 -821 800 $
2286   139  0.02226   -801   212  -213   818 -821 800 $
2287   139  0.02226   -801   213  -214   818 -821 800 $
2288   139  0.02226   -801   214  -215   818 -821 800 $
2289   139  0.02226   -801   215  -216   818 -821 800 $
2290   139  0.02226   -801   216  -217   818 -821 800 $
2291   139  0.02226   -801   217  -218   818 -821 800 $
```

```
2292   139  0.02226   -801   218  -219   818 -821 800 $
2293   139  0.02226   -801   219  -222   818 -821 800 $
2294   139  0.02226   -801   222  -223   818 -821 800 $
2295   411 0.084704   -801   223  -224   818 -821 800 $
2296   139  0.02226   -801   224  -226   818 -821 800 $
2297   139  0.02226   -801   226  -227   818 -821 800 $
2298   139  0.02226   -801   227  -228   818 -821 800 $
2299   139  0.02226   -801   228  -229   818 -821 800 $
2300   139  0.02226   -801   229  -808   818 -821 800 $
2301   139 0.022260   -801   808  -230   818 -821 800
2302   139 0.022260   -801   230  -231   818 -821 800
2303   139 0.022260   -801   231  -232   818 -821 800
2304   139 0.022260   -801   232  -233   818 -821 800
2305   139 0.022260   -801   233  -234   818 -821 800
2306   139 0.022260   -801   234  -235   818 -821 800
2307   139 0.022260   -801   235  -236   818 -821 800
2308   139 0.022260   -801   236  -237   818 -821 800
2309   139 0.022260   -801   237  -238   818 -821 800
2310   139 0.022260   -801   238  -239   818 -821 800
2311   139 0.022260   -801   239  -240   818 -821 800
2312   431  -7.81000   -801   240  -241   818 -821 800
2313   139  0.022260   -801   241  -242   818 -821 800
2314   432  -.001784   -801   242  -243   818 -821 800
2315   431  -1.04550   -801   243  -245   818 -821 800
2316   432  -.001784   -801   245  -246   818 -821 800
2317   430  -8.26000   -801   246  -248   818 -821 800
2318   432  -.001784   -801   248  -249   818 -821 800
2319   436  -7.62000   -801   249  -250   818 -821 800
2320   432  -.001784   -801   250  -251   818 -821 800
2321   437  -7.69000   -801   251  -253   818 -821 800
2322   432 -.001784   -801   253  -254   818 -821 800
2323   431 -7.87000   -801   254  -255   818 -821 800
2324   433 -.001251   -801   255  -256   818 -821 800
2325   434 -0.90000   -801   256  -257   818 -821 800
2326   431 -7.87000   -801   257  -258   818 -821 800
c      ------------------------------------------------------
2331   139  0.02226   -802   206  -207   818 -821 801 $ IVSM-4
2332   139  0.02226   -802   207  -208   818 -821 801 $
2333   405 0.068718   -802   208  -209   818 -821 801 $
2334   139  0.02226   -802   209  -211   818 -821 801 $
2335   139  0.02226   -802   211  -212   818 -821 801 $
2336   139  0.02226   -802   212  -213   818 -821 801 $
2337   139  0.02226   -802   213  -214   818 -821 801 $
2338   139  0.02226   -802   214  -215   818 -821 801 $
2339   139  0.02226   -802   215  -216   818 -821 801 $
2340   139  0.02226   -802   216  -217   818 -821 801 $
2341   139  0.02226   -802   217  -218   818 -821 801 $
2342   139  0.02226   -802   218  -219   818 -821 801 $
2343   139  0.02226   -802   219  -222   818 -821 801 $
2344   139  0.02226   -802   222  -223   818 -821 801 $
2345   411 0.084704   -802   223  -224   818 -821 801 $
2346   139  0.02226   -802   224  -226   818 -821 801 $
2347   139  0.02226   -802   226  -227   818 -821 801 $
2348   139  0.02226   -802   227  -228   818 -821 801 $
2349   139  0.02226   -802   228  -229   818 -821 801 $
2350   139  0.02226   -802   229  -808   818 -821 801 $
2351   139 0.022260   -802   808  -230   818 -821 801
2352   139 0.022260   -802   230  -231   818 -821 801
2353   139 0.022260   -802   231  -232   818 -821 801
2354   139 0.022260   -802   232  -233   818 -821 801
2355   139 0.022260   -802   233  -234   818 -821 801
2356   139 0.022260   -802   234  -235   818 -821 801
2357   139 0.022260   -802   235  -236   818 -821 801
2358   139 0.022260   -802   236  -237   818 -821 801
2359   139 0.022260   -802   237  -238   818 -821 801
2360   139 0.022260   -802   238  -239   818 -821 801
2361   139 0.022260   -802   239  -240   818 -821 801
2362   431  -7.81000   -802   240  -241   818 -821 801
2363   139  0.022260   -802   241  -242   818 -821 801
2364   432  -.001784   -802   242  -243   818 -821 801
2365   431  -1.04550   -802   243  -245   818 -821 801
2366   432  -.001784   -802   245  -246   818 -821 801
2367   430  -8.26000   -802   246  -248   818 -821 801
2368   432  -.001784   -802   248  -249   818 -821 801
2369   436  -7.62000   -802   249  -250   818 -821 801
2370   432  -.001784   -802   250  -251   818 -821 801
2371   437  -7.69000   -802   251  -253   818 -821 801
2372   432 -.001784   -802   253  -254   818 -821 801
2373   431 -7.87000   -802   254  -255   818 -821 801
2374   433 -.001251   -802   255  -256   818 -821 801
2375   434 -0.90000   -802   256  -257   818 -821 801
2376   431 -7.87000   -802   257  -258   818 -821 801
c      ------------------------------------------------------
2381   139  0.02226   -799   206  -207   820 -823 798 $ IVSM-1
2382   139  0.02226   -799   207  -208   820 -823 798 $
2383   405 0.068718   -799   208  -209   820 -823 798 $
2384   139  0.02226   -799   209  -211   820 -823 798 $
2385   139  0.02226   -799   211  -212   820 -823 798 $
2386   139  0.02226   -799   212  -213   820 -823 798 $
```

```
2387   139  0.02226   -799   213  -214   820 -823 798 $
2388   139  0.02226   -799   214  -215   820 -823 798 $
2389   139  0.02226   -799   215  -216   820 -823 798 $
2390   139  0.02226   -799   216  -217   820 -823 798 $
2391   139  0.02226   -799   217  -218   820 -823 798 $
2392   139  0.02226   -799   218  -219   820 -823 798 $
2393   139  0.02226   -799   219  -222   820 -823 798 $
2394   139  0.02226   -799   222  -223   820 -823 798 $
2395   411 0.084704   -799   223  -224   820 -823 798 $
2396   139  0.02226   -799   224  -225   820 -823 798 $
2397   413  0.03641   -799   225  -226   820 -823 798 $
2398   413  0.03641   -799   226  -227   820 -823 798 $
2399   413  0.03641   -799   227  -228   820 -823 798 $
2400   413  0.03641   -799   228  -229   820 -823 798 $
2401   413  0.03641   -799   229  -808   820 -823 798 $
2402   413  0.03641   -799   808  -230   820 -823 798
2403   413  0.03641   -799   230  -231   820 -823 798
2404   413  0.03641   -799   231  -232   820 -823 798
2405   413  0.03641   -799   232  -233   820 -823 798
2406   413  0.03641   -799   233  -234   820 -823 798
2407   413  0.03641   -799   234  -235   820 -823 798
2408   413  0.03641   -799   235  -236   820 -823 798
2409   413  0.03641   -799   236  -237   820 -823 798
2410   413  0.03641   -799   237  -238   820 -823 798
2411   413  0.03641   -799   238  -239   820 -823 798
2412   413  0.03641   -799   239  -240   820 -823 798
2413   431 -7.81000   -799   240  -241   820 -823 798
2414   139 0.022260   -799   241  -242   820 -823 798
2415   432 -.001784   -799   242  -243   820 -823 798
2416   431 -1.04550   -799   243  -245   820 -823 798
2417   432 -.001784   -799   245  -246   820 -823 798
2418   430 -8.26000   -799   246  -248   820 -823 798
2419   432 -.001784   -799   248  -249   820 -823 798
2420   436 -7.62000   -799   249  -250   820 -823 798
2421   432 -.001784   -799   250  -251   820 -823 798
2422   437 -7.69000   -799   251  -253   820 -823 798
2423   432 -.001784   -799   253  -254   820 -823 798
2424   431 -7.87000   -799   254  -255   820 -823 798
2425   433 -.001251   -799   255  -256   820 -823 798
2426   434 -0.90000   -799   256  -257   820 -823 798
2427   431 -7.87000   -799   257  -258   820 -823 798
C      ------------------------------------------------
2431   139  0.02226   -800   206  -207   820 -823 799 $ IVSM-2
2432   139  0.02226   -800   207  -208   820 -823 799 $
2433   405 0.068718   -800   208  -209   820 -823 799 $
2434   139  0.02226   -800   209  -211   820 -823 799 $
2435   139  0.02226   -800   211  -212   820 -823 799 $
2436   139  0.02226   -800   212  -213   820 -823 799 $
2437   139  0.02226   -800   213  -214   820 -823 799 $
2438   139  0.02226   -800   214  -215   820 -823 799 $
2439   139  0.02226   -800   215  -216   820 -823 799 $
2440   139  0.02226   -800   216  -217   820 -823 799 $
2441   139  0.02226   -800   217  -218   820 -823 799 $
2442   139  0.02226   -800   218  -219   820 -823 799 $
2443   139  0.02226   -800   219  -222   820 -823 799 $
2444   139  0.02226   -800   222  -223   820 -823 799 $
2445   411 0.084704   -800   223  -224   820 -823 799 $
2446   139  0.02226   -800   224  -225   820 -823 799 $
2447   413  0.03641   -800   225  -226   820 -823 799 $
2448   413  0.03641   -800   226  -227   820 -823 799 $
2449   413  0.03641   -800   227  -228   820 -823 799 $
2450   413  0.03641   -800   228  -229   820 -823 799 $
2451   413  0.03641   -800   229  -808   820 -823 799 $
2452   413  0.03641   -800   808  -230   820 -823 799
2453   413  0.03641   -800   230  -231   820 -823 799
2454   413  0.03641   -800   231  -232   820 -823 799
2455   413  0.03641   -800   232  -233   820 -823 799
2456   413  0.03641   -800   233  -234   820 -823 799
2457   413  0.03641   -800   234  -235   820 -823 799
2458   413  0.03641   -800   235  -236   820 -823 799
2459   413  0.03641   -800   236  -237   820 -823 799
2460   413  0.03641   -800   237  -238   820 -823 799
2461   413  0.03641   -800   238  -239   820 -823 799
2462   413  0.03641   -800   239  -240   820 -823 799
2463   431  -7.81000  -800   240  -241   820 -823 799
2464   139  0.022260  -800   241  -242   820 -823 799
2465   432  -.001784  -800   242  -243   820 -823 799
2466   431  -1.04550  -800   243  -245   820 -823 799
2467   432  -.001784  -800   245  -246   820 -823 799
2468   430  -8.26000  -800   246  -248   820 -823 799
2469   432  -.001784  -800   248  -249   820 -823 799
2470   436  -7.62000  -800   249  -250   820 -823 799
2471   432  -.001784  -800   250  -251   820 -823 799
2472   437  -7.69000  -800   251  -253   820 -823 799
2473   432 -.001784   -800   253  -254   820 -823 799
2474   431 -7.87000   -800   254  -255   820 -823 799
2475   433 -.001251   -800   255  -256   820 -823 799
2476   434 -0.90000   -800   256  -257   820 -823 799
2477   431 -7.87000   -800   257  -258   820 -823 799
```

```
c       ---------------------------------------------------
2481    139  0.02226    -801   206  -207   820 -823 800 $ IVSM-3
2482    139  0.02226    -801   207  -208   820 -823 800 $
2483    405 0.068718    -801   208  -209   820 -823 800 $
2484    139  0.02226    -801   209  -211   820 -823 800 $
2485    139  0.02226    -801   211  -212   820 -823 800 $
2486    139  0.02226    -801   212  -213   820 -823 800 $
2487    139  0.02226    -801   213  -214   820 -823 800 $
2488    139  0.02226    -801   214  -215   820 -823 800 $
2489    139  0.02226    -801   215  -216   820 -823 800 $
2490    139  0.02226    -801   216  -217   820 -823 800 $
2491    139  0.02226    -801   217  -218   820 -823 800 $
2492    139  0.02226    -801   218  -219   820 -823 800 $
2493    139  0.02226    -801   219  -222   820 -823 800 $
2494    139  0.02226    -801   222  -223   820 -823 800 $
2495    411 0.084704    -801   223  -224   820 -823 800 $
2496    139  0.02226    -801   224  -226   820 -823 800 $
2497    139  0.02226    -801   226  -227   820 -823 800 $
2498    139  0.02226    -801   227  -228   820 -823 800 $
2499    139  0.02226    -801   228  -229   820 -823 800 $
2500    139  0.02226    -801   229  -808   820 -823 800 $
2501    139 0.022260    -801   808  -230   820 -823 800
2502    139 0.022260    -801   230  -231   820 -823 800
2503    139 0.022260    -801   231  -232   820 -823 800
2504    139 0.022260    -801   232  -233   820 -823 800
2505    139 0.022260    -801   233  -234   820 -823 800
2506    139 0.022260    -801   234  -235   820 -823 800
2507    139 0.022260    -801   235  -236   820 -823 800
2508    139 0.022260    -801   236  -237   820 -823 800
2509    139 0.022260    -801   237  -238   820 -823 800
2510    139 0.022260    -801   238  -239   820 -823 800
2511    139 0.022260    -801   239  -240   820 -823 800
2512    431  -7.81000   -801   240  -241   820 -823 800
2513    139  0.022260   -801   241  -242   820 -823 800
2514    432  -.001784   -801   242  -243   820 -823 800
2515    431  -1.04550   -801   243  -245   820 -823 800
2516    432  -.001784   -801   245  -246   820 -823 800
2517    430  -8.26000   -801   246  -248   820 -823 800
2518    432  -.001784   -801   248  -249   820 -823 800
2519    436  -7.62000   -801   249  -250   820 -823 800
2520    432  -.001784   -801   250  -251   820 -823 800
2521    437  -7.69000   -801   251  -253   820 -823 800
2522    432 -.001784    -801   253  -254   820 -823 800
2523    431 -7.87000    -801   254  -255   820 -823 800
2524    433 -.001251    -801   255  -256   820 -823 800
2525    434 -0.90000    -801   256  -257   820 -823 800
2526    431 -7.87000    -801   257  -258   820 -823 800
c       ---------------------------------------------------
2527    139  0.02226    -802   206  -207   820 -823 801 $ IVSM-4
2528    139  0.02226    -802   207  -208   820 -823 801 $
2529    405 0.068718    -802   208  -209   820 -823 801 $
2530    139  0.02226    -802   209  -211   820 -823 801 $
2531    139  0.02226    -802   211  -212   820 -823 801 $
2532    139  0.02226    -802   212  -213   820 -823 801 $
2533    139  0.02226    -802   213  -214   820 -823 801 $
2534    139  0.02226    -802   214  -215   820 -823 801 $
2535    139  0.02226    -802   215  -216   820 -823 801 $
2536    139  0.02226    -802   216  -217   820 -823 801 $
2537    139  0.02226    -802   217  -218   820 -823 801 $
2538    139  0.02226    -802   218  -219   820 -823 801 $
2539    139  0.02226    -802   219  -222   820 -823 801 $
2540    139  0.02226    -802   222  -223   820 -823 801 $
2541    411 0.084704    -802   223  -224   820 -823 801 $
2542    139  0.02226    -802   224  -226   820 -823 801 $
2543    139  0.02226    -802   226  -227   820 -823 801 $
2544    139  0.02226    -802   227  -228   820 -823 801 $
2545    139  0.02226    -802   228  -229   820 -823 801 $
2546    139  0.02226    -802   229  -808   820 -823 801 $
2547    139 0.022260    -802   808  -230   820 -823 801
2548    139 0.022260    -802   230  -231   820 -823 801
2549    139 0.022260    -802   231  -232   820 -823 801
2550    139 0.022260    -802   232  -233   820 -823 801
2551    139 0.022260    -802   233  -234   820 -823 801
2552    139 0.022260    -802   234  -235   820 -823 801
2553    139 0.022260    -802   235  -236   820 -823 801
2554    139 0.022260    -802   236  -237   820 -823 801
2555    139 0.022260    -802   237  -238   820 -823 801
2556    139 0.022260    -802   238  -239   820 -823 801
2557    139 0.022260    -802   239  -240   820 -823 801
2558    431  -7.81000    -802   240  -241   820 -823 801
2559    139  0.022260    -802   241  -242   820 -823 801
2560    432  -.001784    -802   242  -243   820 -823 801
2561    431  -1.04550    -802   243  -245   820 -823 801
2562    432  -.001784    -802   245  -246   820 -823 801
2563    430  -8.26000    -802   246  -248   820 -823 801
2564    432  -.001784    -802   248  -249   820 -823 801
2565    436  -7.62000    -802   249  -250   820 -823 801
2566    432  -.001784    -802   250  -251   820 -823 801
2567    437  -7.69000    -802   251  -253   820 -823 801
```

```
2568   432 -.001784   -802   253  -254   820 -823 801
2569   431 -7.87000   -802   254  -255   820 -823 801
2570   433 -.001251   -802   255  -256   820 -823 801
2571   434 -0.90000   -802   256  -257   820 -823 801
2572   431 -7.87000   -802   257  -258   820 -823 801
c      ------------------------------------------------
2581   139  0.02226   -799   206  -207   822 -819 798 $ IVSM-1
2582   139  0.02226   -799   207  -208   822 -819 798 $
2583   405 0.068718   -799   208  -209   822 -819 798 $
2584   139  0.02226   -799   209  -211   822 -819 798 $
2585   139  0.02226   -799   211  -212   822 -819 798 $
2586   139  0.02226   -799   212  -213   822 -819 798 $
2587   139  0.02226   -799   213  -214   822 -819 798 $
2588   139  0.02226   -799   214  -215   822 -819 798 $
2589   139  0.02226   -799   215  -216   822 -819 798 $
2590   139  0.02226   -799   216  -217   822 -819 798 $
2591   139  0.02226   -799   217  -218   822 -819 798 $
2592   139  0.02226   -799   218  -219   822 -819 798 $
2593   139  0.02226   -799   219  -222   822 -819 798 $
2594   139  0.02226   -799   222  -223   822 -819 798 $
2595   411 0.084704   -799   223  -224   822 -819 798 $
2596   139  0.02226   -799   224  -225   822 -819 798 $
2597   413  0.03641   -799   225  -226   822 -819 798 $
2598   413  0.03641   -799   226  -227   822 -819 798 $
2599   413  0.03641   -799   227  -228   822 -819 798 $
2600   413  0.03641   -799   228  -229   822 -819 798 $
2601   413  0.03641   -799   229  -808   822 -819 798 $
2602   413  0.03641   -799   808  -230   822 -819 798
2603   413  0.03641   -799   230  -231   822 -819 798
2604   413  0.03641   -799   231  -232   822 -819 798
2605   413  0.03641   -799   232  -233   822 -819 798
2606   413  0.03641   -799   233  -234   822 -819 798
2607   413  0.03641   -799   234  -235   822 -819 798
2608   413  0.03641   -799   235  -236   822 -819 798
2609   413  0.03641   -799   236  -237   822 -819 798
2610   413  0.03641   -799   237  -238   822 -819 798
2611   413  0.03641   -799   238  -239   822 -819 798
2612   413  0.03641   -799   239  -240   822 -819 798
2613   431  -7.81000   -799   240  -241   822 -819 798
2614   139  0.022260   -799   241  -242   822 -819 798
2615   432  -.001784   -799   242  -243   822 -819 798
2616   431  -1.04550   -799   243  -245   822 -819 798
2617   432  -.001784   -799   245  -246   822 -819 798
2618   430  -8.26000   -799   246  -248   822 -819 798
2619   432  -.001784   -799   248  -249   822 -819 798
2620   436  -7.62000   -799   249  -250   822 -819 798
2621   432  -.001784   -799   250  -251   822 -819 798
2622   437  -7.69000   -799   251  -253   822 -819 798
2623   432 -.001784   -799   253  -254   822 -819 798
2624   431 -7.87000   -799   254  -255   822 -819 798
2625   433 -.001251   -799   255  -256   822 -819 798
2626   434 -0.90000   -799   256  -257   822 -819 798
2627   431 -7.87000   -799   257  -258   822 -819 798
c      ------------------------------------------------
2631   139  0.02226   -800   206  -207   822 -819 799 $ IVSM-2
2632   139  0.02226   -800   207  -208   822 -819 799 $
2633   405 0.068718   -800   208  -209   822 -819 799 $
2634   139  0.02226   -800   209  -211   822 -819 799 $
2635   139  0.02226   -800   211  -212   822 -819 799 $
2636   139  0.02226   -800   212  -213   822 -819 799 $
2637   139  0.02226   -800   213  -214   822 -819 799 $
2638   139  0.02226   -800   214  -215   822 -819 799 $
2639   139  0.02226   -800   215  -216   822 -819 799 $
2640   139  0.02226   -800   216  -217   822 -819 799 $
2641   139  0.02226   -800   217  -218   822 -819 799 $
2642   139  0.02226   -800   218  -219   822 -819 799 $
2643   139  0.02226   -800   219  -222   822 -819 799 $
2644   139  0.02226   -800   222  -223   822 -819 799 $
2645   411 0.084704   -800   223  -224   822 -819 799 $
2646   139  0.02226   -800   224  -225   822 -819 799 $
2647   413  0.03641   -800   225  -226   822 -819 799 $
2648   413  0.03641   -800   226  -227   822 -819 799 $
2649   413  0.03641   -800   227  -228   822 -819 799 $
2650   413  0.03641   -800   228  -229   822 -819 799 $
2651   413  0.03641   -800   229  -808   822 -819 799 $
2652   413  0.03641   -800   808  -230   822 -819 799
2653   413  0.03641   -800   230  -231   822 -819 799
2654   413  0.03641   -800   231  -232   822 -819 799
2655   413  0.03641   -800   232  -233   822 -819 799
2656   413  0.03641   -800   233  -234   822 -819 799
2657   413  0.03641   -800   234  -235   822 -819 799
2658   413  0.03641   -800   235  -236   822 -819 799
2659   413  0.03641   -800   236  -237   822 -819 799
2660   413  0.03641   -800   237  -238   822 -819 799
2661   413  0.03641   -800   238  -239   822 -819 799
2662   413  0.03641   -800   239  -240   822 -819 799
2663   431  -7.81000   -800   240  -241   822 -819 799
2664   139  0.022260   -800   241  -242   822 -819 799
2665   432  -.001784   -800   242  -243   822 -819 799
```

```
2666   431  -1.04550   -800   243  -245   822 -819 799
2667   432  -.001784   -800   245  -246   822 -819 799
2668   430  -8.26000   -800   246  -248   822 -819 799
2669   432  -.001784   -800   248  -249   822 -819 799
2670   436  -7.62000   -800   249  -250   822 -819 799
2671   432  -.001784   -800   250  -251   822 -819 799
2672   437  -7.69000   -800   251  -253   822 -819 799
2673   432 -.001784   -800   253  -254   822 -819 799
2674   431 -7.87000   -800   254  -255   822 -819 799
2675   433 -.001251   -800   255  -256   822 -819 799
2676   434 -0.90000   -800   256  -257   822 -819 799
2677   431 -7.87000   -800   257  -258   822 -819 799
c      ---------------------------------------------
2681   139  0.02226   -801   206  -207   822 -819 800 $ IVSM-3
2682   139  0.02226   -801   207  -208   822 -819 800 $
2683   405 0.068718   -801   208  -209   822 -819 800 $
2684   139  0.02226   -801   209  -211   822 -819 800 $
2685   139  0.02226   -801   211  -212   822 -819 800 $
2686   139  0.02226   -801   212  -213   822 -819 800 $
2687   139  0.02226   -801   213  -214   822 -819 800 $
2688   139  0.02226   -801   214  -215   822 -819 800 $
2689   139  0.02226   -801   215  -216   822 -819 800 $
2690   139  0.02226   -801   216  -217   822 -819 800 $
2691   139  0.02226   -801   217  -218   822 -819 800 $
2692   139  0.02226   -801   218  -219   822 -819 800 $
2693   139  0.02226   -801   219  -222   822 -819 800 $
2694   139  0.02226   -801   222  -223   822 -819 800 $
2695   411 0.084704   -801   223  -224   822 -819 800 $
2696   139  0.02226   -801   224  -226   822 -819 800 $
2697   139  0.02226   -801   226  -227   822 -819 800 $
2698   139  0.02226   -801   227  -228   822 -819 800 $
2699   139  0.02226   -801   228  -229   822 -819 800 $
2700   139  0.02226   -801   229  -808   822 -819 800 $
2701   139 0.022260   -801   808  -230   822 -819 800
2702   139 0.022260   -801   230  -231   822 -819 800
2703   139 0.022260   -801   231  -232   822 -819 800
2704   139 0.022260   -801   232  -233   822 -819 800
2705   139 0.022260   -801   233  -234   822 -819 800
2706   139 0.022260   -801   234  -235   822 -819 800
2707   139 0.022260   -801   235  -236   822 -819 800
2708   139 0.022260   -801   236  -237   822 -819 800
2709   139 0.022260   -801   237  -238   822 -819 800
2710   139 0.022260   -801   238  -239   822 -819 800
2711   139 0.022260   -801   239  -240   822 -819 800
2712   431  -7.81000   -801   240  -241   822 -819 800
2713   139  0.022260   -801   241  -242   822 -819 800
2714   432  -.001784   -801   242  -243   822 -819 800
2715   431  -1.04550   -801   243  -245   822 -819 800
2716   432  -.001784   -801   245  -246   822 -819 800
2717   430  -8.26000   -801   246  -248   822 -819 800
2718   432  -.001784   -801   248  -249   822 -819 800
2719   436  -7.62000   -801   249  -250   822 -819 800
2720   432  -.001784   -801   250  -251   822 -819 800
2721   437  -7.69000   -801   251  -253   822 -819 800
2722   432 -.001784   -801   253  -254   822 -819 800
2723   431 -7.87000   -801   254  -255   822 -819 800
2724   433 -.001251   -801   255  -256   822 -819 800
2725   434 -0.90000   -801   256  -257   822 -819 800
2726   431 -7.87000   -801   257  -258   822 -819 800
c      ---------------------------------------------
2731   139  0.02226   -802   206  -207   822 -819 801 $ IVSM-4
2732   139  0.02226   -802   207  -208   822 -819 801 $
2733   405 0.068718   -802   208  -209   822 -819 801 $
2734   139  0.02226   -802   209  -211   822 -819 801 $
2735   139  0.02226   -802   211  -212   822 -819 801 $
2736   139  0.02226   -802   212  -213   822 -819 801 $
2737   139  0.02226   -802   213  -214   822 -819 801 $
2738   139  0.02226   -802   214  -215   822 -819 801 $
2739   139  0.02226   -802   215  -216   822 -819 801 $
2740   139  0.02226   -802   216  -217   822 -819 801 $
2741   139  0.02226   -802   217  -218   822 -819 801 $
2742   139  0.02226   -802   218  -219   822 -819 801 $
2743   139  0.02226   -802   219  -222   822 -819 801 $
2744   139  0.02226   -802   222  -223   822 -819 801 $
2745   411 0.084704   -802   223  -224   822 -819 801 $
2746   139  0.02226   -802   224  -226   822 -819 801 $
2747   139  0.02226   -802   226  -227   822 -819 801 $
2748   139  0.02226   -802   227  -228   822 -819 801 $
2749   139  0.02226   -802   228  -229   822 -819 801 $
2750   139  0.02226   -802   229  -808   822 -819 801 $
2751   139 0.022260   -802   808  -230   822 -819 801
2752   139 0.022260   -802   230  -231   822 -819 801
2753   139 0.022260   -802   231  -232   822 -819 801
2754   139 0.022260   -802   232  -233   822 -819 801
2755   139 0.022260   -802   233  -234   822 -819 801
2756   139 0.022260   -802   234  -235   822 -819 801
2757   139 0.022260   -802   235  -236   822 -819 801
2758   139 0.022260   -802   236  -237   822 -819 801
2759   139 0.022260   -802   237  -238   822 -819 801
```

```
2760   139 0.022260   -802   238  -239   822 -819 801
2761   139 0.022260   -802   239  -240   822 -819 801
2762   431  -7.81000   -802   240  -241   822 -819 801
2763   139   0.022260   -802   241  -242   822 -819 801
2764   432   -.001784   -802   242  -243   822 -819 801
2765   431  -1.04550   -802   243  -245   822 -819 801
2766   432   -.001784   -802   245  -246   822 -819 801
2767   430  -8.26000   -802   246  -248   822 -819 801
2768   432   -.001784   -802   248  -249   822 -819 801
2769   436  -7.62000   -802   249  -250   822 -819 801
2770   432   -.001784   -802   250  -251   822 -819 801
2771   437  -7.69000   -802   251  -253   822 -819 801
2772   432 -.001784   -802   253  -254   822 -819 801
2773   431 -7.87000   -802   254  -255   822 -819 801
2774   433 -.001251   -802   255  -256   822 -819 801
2775   434 -0.90000   -802   256  -257   822 -819 801
2776   431 -7.87000   -802   257  -258   822 -819 801
c      ------------------------------------------------
2781   433 -.001251   -260   206  -207      805 $ Cavity/Insul
2782   433 -.001251   -260   207  -208      805 $
2783   433 -.001251   -260   208  -209      805 $
2784   433 -.001251   -260   209  -211      805 $
2785   433 -.001251   -260   211  -212      805 $
2786   433 -.001251   -260   212  -213      805 $
2787   433 -.001251   -260   213  -214      805 $
2788   433 -.001251   -260   214  -215      805 $
2789   433 -.001251   -260   215  -216      805 $
2790   433 -.001251   -260   216  -217      805 $
2791   433 -.001251   -260   217  -218      805 $
2792   433 -.001251   -260   218  -219      805 $
2793   433 -.001251   -260   219  -222      805 $
2794   433 -.001251   -260   222  -223      805 $
2795   433 -.001251   -260   223  -224      805 $
2796   433 -.001251   -260   224  -226      805 $
2797   433 -.001251   -260   226  -227      805 $
2798   433 -.001251   -260   227  -228      805 $
2799   433 -.001251   -260   228  -229      805 $
2800   433 -.001251   -260   229  -808      805 $
2801   139 0.022260   -260   808  -230      805
2802   139 0.022260   -260   230  -231      805
2803   139 0.022260   -260   231  -232      805
2804   139 0.022260   -260   232  -233      805
2805   139 0.022260   -260   233  -234      805
2806   139 0.022260   -260   234  -235      805
2807   139 0.022260   -260   235  -236      805
2808   139 0.022260   -260   236  -237      805
2809   139 0.022260   -260   237  -238      805
2810   139 0.022260   -260   238  -239      805
2811   139 0.022260   -260   239  -240      805
2812   431  -7.81000   -260   240  -241      805
2813   139   0.022260   -260   241  -242      805
2814   432   -.001784   -260   242  -243      805
2815   431  -1.04550   -260   243  -245      805
2816   432   -.001784   -260   245  -246      805
2817   430  -8.26000   -260   246  -248      805
2818   432   -.001784   -260   248  -249      805
2819   436  -7.62000   -260   249  -250      805
2820   432   -.001784   -260   250  -251      805
2821   437  -7.69000   -260   251  -253      805
2822   432 -.001784   -260   253  -254      805
2823   431 -7.87000   -260   254  -255      805
2824   433 -.001251   -260   255  -256      805
2825   434 -0.90000   -260   256  -257      805
2826   431 -7.87000   -260   257  -258      805
c      ------------------------------------------------
2831   431 -7.87000   -261   276  -809      260
2832   431 -7.87000   -261   809  -206      260 $  Cavity/Insul
2833   431 -7.87000   -261   206  -207      260 $
2834   431 -7.87000   -261   207  -208      260 $
2835   431 -7.87000   -261   208  -209      260 $
2836   431 -7.87000   -261   209  -211      260 $
2837   431 -7.87000   -261   211  -212      260 $
2838   431 -7.87000   -261   212  -213      260 $
2839   431 -7.87000   -261   213  -214      260 $
2840   431 -7.87000   -261   214  -215      260 $
2841   431 -7.87000   -261   215  -216      260 $
2842   431 -7.87000   -261   216  -217      260 $
2843   431 -7.87000   -261   217  -218      260 $
2844   431 -7.87000   -261   218  -219      260 $
2845   431 -7.87000   -261   219  -222      260 $
2846   431 -7.87000   -261   222  -223      260 $
2847   431 -7.87000   -261   223  -224      260 $
2848   431 -7.87000   -261   224  -226      260 $
2849   431 -7.87000   -261   226  -227      260 $
2850   431 -7.87000   -261   227  -228      260 $
2851   431 -7.87000   -261   228  -229      260 $
2852   431 -7.87000   -261   229  -808      260 $
2853   431 -7.87000   -261   808  -230      260
2854   431 -7.87000   -261   230  -231      260
```

```
2855   431 -7.87000   -261   231  -232       260
2856   431 -7.87000   -261   232  -233       260
2857   431 -7.87000   -261   233  -234       260
2858   431 -7.87000   -261   234  -235       260
2859   431 -7.87000   -261   235  -236       260
2860   431 -7.87000   -261   236  -237       260
2861   431 -7.87000   -261   237  -238       260
2862   431 -7.87000   -261   238  -239       260
2863   431 -7.87000   -261   239  -240       260
2864   431 -7.87000   -261   240  -241       260
2865   431 -7.87000   -261   241  -242       260
2866   431 -7.87000   -261   242  -243       260
2867   431 -7.87000   -261   243  -245       260
2868   431 -7.87000   -261   245  -246       260
2869   431 -7.87000   -261   246  -248       260
2870   431 -7.87000   -261   248  -249       260
2871   431 -7.87000   -261   249  -250       260
2872   431 -7.87000   -261   250  -251       260
2873   431 -7.87000   -261   251  -253       260
2874   431 -7.87000   -261   253  -254       260
2875   431 -7.87000   -261   254  -255       260
2876   433 -.001251   -261   255  -256       260
2877   434 -0.90000   -261   256  -257       260
2878   431 -7.87000   -261   257  -258       260
c      ------------------------------------------------
2881   433 -.001251   -262   231  -247       261 $ Cavity/Insul
2882   431 -7.87000   -262   247  -250       261
2883   431 -7.87000   -262   250  -251       261
2884   431 -7.87000   -262   251  -253       261
2885   431 -7.87000   -262   253  -254       261
2886   431 -7.87000   -262   254  -255       261
2887   433 -.001251   -262   255  -256       261
2888   434 -0.90000   -262   256  -257       261
2889   431 -7.87000   -262   257  -258       261
c      ------------------------------------------------
2890   435 -2.50000   -263   231  -232       262 $ Cavity/Insul
2891   433 -.001251   -263   232  -247       262
2892   431 -7.87000   -263   247  -251       262
2893   431 -7.87000   -263   251  -402       262
2894   431 -7.87000   -263   402  -252       262
2895   431 -7.87000   -263   252  -253       262
2896   431 -7.87000   -263   253  -254       262
2897   431 -7.87000   -263   254  -255       262
2898   433 -.001251   -263   255  -256       262
2899   434 -0.90000   -263   256  -257       262
2900   431 -7.87000   -263   257  -258       262
c      ------------------------------------------------
2901   435 -2.50000   -264   231  -232       263 $ Cavity/Insul
2902   433 -.001251   -264   232  -247       263
2903   431 -7.87000   -264   247  -250       263
2904   431 -7.87000   -264   250  -251       263
2905   431 -7.87000   -264   251  -252       263
2906   431 -7.87000   -264   252  -253       263
2907   431 -7.87000   -264   253  -254       263
2908   431 -7.87000   -264   254  -255       263
2909   433 -.001251   -264   255  -256       263
2910   434 -0.90000   -264   256  -257       263
2911   431 -7.87000   -264   257  -258       263
c      ------------------------------------------------
2912   431 -7.87000   -265   271   277       264 $ Cavity/Insul
2913   431 -7.87000   -265  -277  -231       264
2914   435 -2.50000   -265   231  -232       264
2915   433 -.001251   -265   232  -235       264
2916   417 0.081300   -265   235  -237       264
2917   433 -.001251   -265   237  -401       264
2918   431 -7.87000   -265   401  -250       264
2919   431 -7.87000   -265   250  -251       264
2920   431 -7.87000   -265   251  -252       264
2921   431 -7.87000   -265   252  -253       264
2922   431 -7.87000   -265   253  -254       264
2923   431 -7.87000   -265   254  -255       264
2924   433 -.001251   -265   255  -256       264
2925   434 -0.90000   -265   256  -257       264
2926   431 -7.87000   -265   257  -258       264
c      ------------------------------------------------
2927   433 -.001251   -806   271 (-231:370)
                           (-233:372) -238   265 $ Cavity/Insul
2928   435 -2.50000   -266   231  -232       265
2929   433 -.001251   -266   232  -235       265
2930   417 0.081300   -266   235  -237       265
2931   433 -.001251   -266   237  -254       265
2932   431 -7.87000   -266   254  -255       265
2933   433 -.001251   -266   255  -256       265
2934   434 -0.90000   -266   256  -257       265
2935   431 -7.87000   -266   257  -258       265
c      ------------------------------------------------
2936   435 -2.50000   -267   231  -232       266 $ Cavity/Insul
2937   433 -.001251   -267   232  -233       266
2938   417 0.081300   -267   233  -237       266
```

```
2939   433 -.001251   -267   237  -239       266
2940   431 -7.87000   -267   239  -244       266
2941   433 -.001251   -267   244  -254       266
2942   431 -7.87000   -267   254  -255       266
2943   433 -.001251   -267   255  -256       266
2944   434 -0.90000   -267   256  -257       266
2945   431 -7.87000   -267   257  -258       266
c      ------------------------------------------------------
2946   417 0.081300   -268   231  -237       267 $ Cavity/Insul
2947   433 -.001251   -268   237  -239       267
2948   431 -7.87000   -268   239  -255       267
2949   433 -.001251   -268   255  -256       267
2950   434 -0.90000   -268   256  -257       267
2951   431 -7.87000   -268   257  -258       267
c      ------------------------------------------------------
2952   417 0.081300   -269   231  -237       268 $ Cavity/Insul
2953   433 -.001251   -269   237  -239       268
2954   431 -7.87000   -269   239  -255       268
2955   433 -.001251   -269   255  -256       268
2956   434 -0.90000   -269   256  -257       268
2957   431 -7.87000   -269   257  -258       268
c      ------------------------------------------------------
2958   417 0.081300   -370   231  -237       269 $ Cavity/Insul
2959   433 -.001251   -370   237  -238       269
2960   417 0.081300   -370   238  -252       269
2961   431 -7.87000   -370   252  -255       269
2962   433 -.001251   -370   255  -256       269
2963   434 -0.90000   -370   256  -257       269
2964   431 -7.87000   -370   257  -258       269
c      ------------------------------------------------------
2965   417 0.081300   -371   233  -252       370 $ Cavity/Insul
2966   431 -7.87000   -371   252  -255       370
2967   433 -.001251   -371   255  -256       370
2968   434 -0.90000   -371   256  -257       370
2969   431 -7.87000   -371   257  -258       370
c      ------------------------------------------------------
2970   417 0.081300   -372   233  -255       371 $ Cavity/Insul
2971   433 -.001251   -372   255  -256       371
2972   434 -0.90000   -372   256  -257       371
2973   431 -7.87000   -372   257  -258       371
c      ------------------------------------------------------
2974   417 0.081300   -806   238  -255       372 $ Cavity/Insul
2975   433 -.001251   -806   255  -256       372
2976   434 -0.90000   -806   256  -257       372
2977   431 -7.87000   -806   257  -258       372
c      ------------------------------------------------------
2978   417 0.081300   -807   270  -255       806 $ Concrete
2979   433 -.001251   -807   255  -256       806
2980   434 -0.90000   -807   256  -257       806
2981   431 -7.87000   -807   257  -258       806
c      ------------------------------------------------
c     ivfsm in sector 1 of fttf.
2982   414  0.02941   -802   206  -207   819  -818   798 $  **IVFSM**
2983   414  0.02941   -802   207  -208   819  -818   798 $  na
2984   405 0.068718   -802   208  -209   819  -818   798 $  grid
2985   414  0.02941   -802   209  -212   819  -818   798 $  shld
                916    917   918   919   920   921
                922    923   924   925   926   927
                928    929   930   931   932   933   934  935
2986   414  0.02941   -802   212  -213   819  -818   798 $  refl
                916    917   918   919   920   921
                922    923   924   925   926   927
                928    929   930   931   932   933   934  935
2987   414  0.02941   -802   213  -215   819  -818   798 $  core
                916    917   918   919   920   921
                922    923   924   925   926   927
                928    929   930   931   932   933   934  935
2988   414  0.02941   -802   215  -216   819  -818   798 $  refl
                916    917   918   919   920   921
                922    923   924   925   926   927
                928    929   930   931   932   933   934  935
2989   414  0.02941   -802   216  -219   819  -818   798 $  plenum
                916    917   918   919   920   921
                922    923   924   925   926   927
                928    929   930   931   932   933   934  935
2990   414  0.02941   -802   219  -222   819  -818   798 $  plenum
2991   414  0.02941   -802   222  -223   819  -818   798 $  hs+Na
2992   411 0.084704   -802   223  -224   819  -818   798 $  baffle
2993   139  0.02226   -802   224  -226   819  -818   798 $  ivhm/na
2994   139  0.02226   -802   226  -227   819  -818   798 $  ivhm/na
2995   139  0.02226   -802   227  -228   819  -818   798 $  ivhm/na
2996   139  0.02226   -802   228  -229   819  -818   798 $  ivhm/na
2997   139  0.02226   -802   229  -808   819  -818   798 $  ivhm/na
2998   139 0.022260   -802   808  -230   819  -818   798
2999   139 0.022260   -802   230  -231   819  -818   798
3000   139 0.022260   -802   231  -232   819  -818   798
3001   139 0.022260   -802   232  -233   819  -818   798
3002   139 0.022260   -802   233  -234   819  -818   798
3003   139 0.022260   -802   234  -235   819  -818   798
```

```
3004   139 0.022260   -802   235  -236   819  -818   798
3005   139 0.022260   -802   236  -237   819  -818   798
3006   139 0.022260   -802   237  -238   819  -818   798
3007   139 0.022260   -802   238  -239   819  -818   798
3008   139 0.022260   -802   239  -240   819  -818   798
3009   431  -7.81000   -802   240  -241   819  -818   798
3010   139   0.022260  -802   241  -242   819  -818   798
3011   432  -.001784   -802   242  -243   819  -818   798
3012   431  -1.04550   -802   243  -245   819  -818   798
3013   432  -.001784   -802   245  -246   819  -818   798
3014   430  -8.26000   -802   246  -248   819  -818   798
3015   432  -.001784   -802   248  -249   819  -818   798
3016   436  -7.62000   -802   249  -250   819  -818   798
3017   432  -.001784   -802   250  -251   819  -818   798
3018   437  -7.69000   -802   251  -253   819  -818   798
3019   432 -.001784   -802   253  -254   819  -818   798
3020   431 -7.87000   -802   254  -255   819  -818   798
3021   433 -.001251   -802   255  -256   819  -818   798
3022   434 -0.90000   -802   256  -257   819  -818   798
3023   431 -7.87000   -802   257  -258   819  -818   798
c      ------------------------------------------------
c     ivfsm in sector 2 of fftf.
3024   414  0.02941   -802   206  -207   821  -820   798 $  **IVFSM**
3025   414  0.02941   -802   207  -208   821  -820   798 $  na
3026   405 0.068718   -802   208  -209   821  -820   798 $  grid
3027   414  0.02941   -802   209  -212   821  -820   798 $  shld
                936    937   938   939   940   941
                942    943   944   945   946   947
                948    949   950   951   952   953   954  955
3028   414  0.02941   -802   212  -213   821  -820   798 $  ref
                936    937   938   939   940   941
                942    943   944   945   946   947
                948    949   950   951   952   953   954  955
3029   414  0.02941   -802   213  -215   821  -820   798 $  core
                936    937   938   939   940   941
                942    943   944   945   946   947
                948    949   950   951   952   953   954  955
3030   414  0.02941   -802   215  -216   821  -820   798 $  ref
                936    937   938   939   940   941
                942    943   944   945   946   947
                948    949   950   951   952   953   954  955
3031   414  0.02941   -802   216  -219   821  -820   798 $  plenum
                936    937   938   939   940   941
                942    943   944   945   946   947
                948    949   950   951   952   953   954  955
3032   414  0.02941   -802   219  -222   821  -820   798 $  plenum
3033   414  0.02941   -802   222  -223   821  -820   798 $  hs+Na
3034   411 0.084704   -802   223  -224   821  -820   798 $  baffle
3035   139  0.02226   -802   224  -226   821  -820   798 $  ivhm/na
3036   139  0.02226   -802   226  -227   821  -820   798 $  ivhm/na
3037   139  0.02226   -802   227  -228   821  -820   798 $  ivhm/na
3038   139  0.02226   -802   228  -229   821  -820   798 $  ivhm/na
3039   139  0.02226   -802   229  -808   821  -820   798 $  ivhm/na
3040   139 0.022260   -802   808  -230   821  -820   798
3041   139 0.022260   -802   230  -231   821  -820   798
3042   139 0.022260   -802   231  -232   821  -820   798
3043   139 0.022260   -802   232  -233   821  -820   798
3044   139 0.022260   -802   233  -234   821  -820   798
3045   139 0.022260   -802   234  -235   821  -820   798
3046   139 0.022260   -802   235  -236   821  -820   798
3047   139 0.022260   -802   236  -237   821  -820   798
3048   139 0.022260   -802   237  -238   821  -820   798
3049   139 0.022260   -802   238  -239   821  -820   798
3050   139 0.022260   -802   239  -240   821  -820   798
3051   431  -7.81000   -802   240  -241   821  -820   798
3052   139   0.022260  -802   241  -242   821  -820   798
3053   432  -.001784   -802   242  -243   821  -820   798
3054   431  -1.04550   -802   243  -245   821  -820   798
3055   432  -.001784   -802   245  -246   821  -820   798
3056   430  -8.26000   -802   246  -248   821  -820   798
3057   432  -.001784   -802   248  -249   821  -820   798
3058   436  -7.62000   -802   249  -250   821  -820   798
3059   432  -.001784   -802   250  -251   821  -820   798
3060   437  -7.69000   -802   251  -253   821  -820   798
3061   432 -.001784   -802   253  -254   821  -820   798
3062   431 -7.87000   -802   254  -255   821  -820   798
3063   433 -.001251   -802   255  -256   821  -820   798
3064   434 -0.90000   -802   256  -257   821  -820   798
3065   431 -7.87000   -802   257  -258   821  -820   798
c      ------------------------------------------------
c     ivfsm in sector 3 of fftf.
3066   414  0.02941   -802   206  -207   823  -822   798 $  **IVFSM**
3067   414  0.02941   -802   207  -208   823  -822   798 $  na
3068   405 0.068718   -802   208  -209   823  -822   798 $  grid
3069   414  0.02941   -802   209  -212   823  -822   798 $  shld
                956    957   958   959   960   961
                962    963   964   965   966   967
                968    969   970   971   972   973   974  975
3070   414  0.02941   -802   212  -213   823  -822   798 $  refl
```

```
                956    957   958   959   960   961
                962    963   964   965   966   967
                968    969   970   971   972   973   974  975
3071   414  0.02941   -802   213  -215   823  -822   798 $  core
                956    957   958   959   960   961
                962    963   964   965   966   967
                968    969   970   971   972   973   974  975
3072   414  0.02941   -802   215  -216   823  -822   798 $  refl
                956    957   958   959   960   961
                962    963   964   965   966   967
                968    969   970   971   972   973   974  975
3073   414  0.02941   -802   216  -219   823  -822   798 $  plenum
                956    957   958   959   960   961
                962    963   964   965   966   967
                968    969   970   971   972   973   974  975
3074   414  0.02941   -802   219  -222   823  -822   798 $  plenum
3075   414  0.02941   -802   222  -223   823  -822   798 $  hs+Na
3076   411 0.084704   -802   223  -224   823  -822   798 $  baffle
3077   139  0.02226   -802   224  -226   823  -822   798 $  ivhm/na
3078   139  0.02226   -802   226  -227   823  -822   798 $  ivhm/na
3079   139  0.02226   -802   227  -228   823  -822   798 $  ivhm/na
3080   139  0.02226   -802   228  -229   823  -822   798 $  ivhm/na
3081   139  0.02226   -802   229  -808   823  -822   798 $  ivhm/na
3082   139 0.022260   -802   808  -230   823  -822   798
3083   139 0.022260   -802   230  -231   823  -822   798
3084   139 0.022260   -802   231  -232   823  -822   798
3085   139 0.022260   -802   232  -233   823  -822   798
3086   139 0.022260   -802   233  -234   823  -822   798
3087   139 0.022260   -802   234  -235   823  -822   798
3088   139 0.022260   -802   235  -236   823  -822   798
3089   139 0.022260   -802   236  -237   823  -822   798
3090   139 0.022260   -802   237  -238   823  -822   798
3091   139 0.022260   -802   238  -239   823  -822   798
3092   139 0.022260   -802   239  -240   823  -822   798
3093   431  -7.81000   -802   240  -241   823  -822   798
3094   139  0.022260   -802   241  -242   823  -822   798
3095   432  -.001784   -802   242  -243   823  -822   798
3096   431  -1.04550   -802   243  -245   823  -822   798
3097   432  -.001784   -802   245  -246   823  -822   798
3098   430  -8.26000   -802   246  -248   823  -822   798
3099   432  -.001784   -802   248  -249   823  -822   798
3100   436  -7.62000   -802   249  -250   823  -822   798
3101   432  -.001784   -802   250  -251   823  -822   798
3102   437  -7.69000   -802   251  -253   823  -822   798
3103   432 -.001784   -802   253  -254   823  -822   798
3104   431 -7.87000   -802   254  -255   823  -822   798
3105   433 -.001251   -802   255  -256   823  -822   798
3106   434 -0.90000   -802   256  -257   823  -822   798
3107   431 -7.87000   -802   257  -258   823  -822   798
c      ---------------------------------------------------
3111   431 -7.87000   -803   206  -207       802 $ Na-4
3112   431 -7.87000   -803   207  -208       802 $
3113   405 0.068718   -803   208  -209       802 $
3114   139  0.02226   -803   209  -211       802 $
3115   139  0.02226   -803   211  -212       802 $
3116   139  0.02226   -803   212  -213       802 $
3117   139  0.02226   -803   213  -214       802 $
3118   139  0.02226   -803   214  -215       802 $
3119   139  0.02226   -803   215  -216       802 $
3120   139  0.02226   -803   216  -217       802 $
3121   139  0.02226   -803   217  -218       802 $
3122   139  0.02226   -803   218  -219       802 $
3123   139  0.02226   -803   219  -222       802 $
3124   139  0.02226   -803   222  -223       802 $
3125   411 0.084704   -803   223  -224       802 $
3126   139  0.02226   -803   224  -226       802 $
3127   139  0.02226   -803   226  -227       802 $
3128   139  0.02226   -803   227  -228       802 $
3129   139  0.02226   -803   228  -229       802 $
3130   139  0.02226   -803   229  -808       802 $
3131   139 0.022260   -803   808  -230       802
3132   139 0.022260   -803   230  -231       802
3133   139 0.022260   -803   231  -232       802
3134   139 0.022260   -803   232  -233       802
3135   139 0.022260   -803   233  -234       802
3136   139 0.022260   -803   234  -235       802
3137   139 0.022260   -803   235  -236       802
3138   139 0.022260   -803   236  -237       802
3139   139 0.022260   -803   237  -238       802
3140   139 0.022260   -803   238  -239       802
3141   139 0.022260   -803   239  -240       802
3142   431  -7.81000   -803   240  -241       802
3143   139  0.022260   -803   241  -242       802
3144   432  -.001784   -803   242  -243       802
3145   431  -1.04550   -803   243  -245       802
3146   432  -.001784   -803   245  -246       802
3147   430  -8.26000   -803   246  -248       802
3148   432  -.001784   -803   248  -249       802
3149   436  -7.62000   -803   249  -250       802
```

```
3150   432  -.001784   -803   250  -251      802
3151   437  -7.69000   -803   251  -253      802
3152   432 -.001784   -803   253  -254      802
3153   431 -7.87000   -803   254  -255      802
3154   433 -.001251   -803   255  -256      802
3155   434 -0.90000   -803   256  -257      802
3156   431 -7.87000   -803   257  -258      802
C      ------------------------------------------------
3161   139  0.02226   -804   206  -207      803 $ Na-5
3162   139  0.02226   -804   207  -208      803 $
3163   405 0.068718   -804   208  -209      803 $
3164   139  0.02226   -804   209  -211      803 $
3165   139  0.02226   -804   211  -212      803 $
3166   139  0.02226   -804   212  -213      803 $
3167   139  0.02226   -804   213  -214      803 $
3168   139  0.02226   -804   214  -215      803 $
3169   139  0.02226   -804   215  -216      803 $
3170   139  0.02226   -804   216  -217      803 $
3171   139  0.02226   -804   217  -218      803 $
3172   139  0.02226   -804   218  -219      803 $
3173   139  0.02226   -804   219  -222      803 $
3174   139  0.02226   -804   222  -223      803 $
3175   411 0.084704   -804   223  -224      803 $
3176   139  0.02226   -804   224  -226      803 $
3177   139  0.02226   -804   226  -227      803 $
3178   139  0.02226   -804   227  -228      803 $
3179   139  0.02226   -804   228  -229      803 $
3180   139  0.02226   -804   229  -808      803 $
3181   139 0.022260   -804   808  -230      803
3182   139 0.022260   -804   230  -231      803
3183   139 0.022260   -804   231  -232      803
3184   139 0.022260   -804   232  -233      803
3185   139 0.022260   -804   233  -234      803
3186   139 0.022260   -804   234  -235      803
3187   139 0.022260   -804   235  -236      803
3188   139 0.022260   -804   236  -237      803
3189   139 0.022260   -804   237  -238      803
3190   139 0.022260   -804   238  -239      803
3191   139 0.022260   -804   239  -240      803
3192   431  -7.81000   -804   240  -241      803
3193   139  0.022260   -804   241  -242      803
3194   432  -.001784   -804   242  -243      803
3195   431  -1.04550   -804   243  -245      803
3196   432  -.001784   -804   245  -246      803
3197   430  -8.26000   -804   246  -248      803
3198   432  -.001784   -804   248  -249      803
3199   436  -7.62000   -804   249  -250      803
3200   432  -.001784   -804   250  -251      803
3201   437  -7.69000   -804   251  -253      803
3202   432 -.001784   -804   253  -254      803
3203   431 -7.87000   -804   254  -255      803
3204   433 -.001251   -804   255  -256      803
3205   434 -0.90000   -804   256  -257      803
3206   431 -7.87000   -804   257  -258      803
C      ------------------------------------------------
3207   431 -6.82000   -805   206  -207      804 $ TS-Vessel
3208   431 -6.82000   -805   207  -208      804 $
3209   431 -6.82000   -805   208  -209      804 $
3210   431 -6.82000   -805   209  -211      804 $
3211   431 -6.82000   -805   211  -212      804 $
3212   431 -6.82000   -805   212  -213      804 $
3213   431 -6.82000   -805   213  -214      804 $
3214   431 -6.82000   -805   214  -215      804 $
3215   431 -6.82000   -805   215  -216      804 $
3216   431 -6.82000   -805   216  -217      804 $
3217   431 -6.82000   -805   217  -218      804 $
3218   431 -6.82000   -805   218  -219      804 $
3219   431 -6.82000   -805   219  -222      804 $
3220   431 -6.82000   -805   222  -223      804 $
3221   431 -6.82000   -805   223  -224      804 $
3222   431 -6.82000   -805   224  -226      804 $
3223   431 -6.82000   -805   226  -227      804 $
3224   431 -6.82000   -805   227  -228      804 $
3225   431 -6.82000   -805   228  -229      804 $
3226   431 -6.82000   -805   229  -808      804 $
3227   431 -6.82000   -805   808  -230      804
3228   431 -6.82000   -805   230  -231      804
3229   431 -6.82000   -805   231  -232      804
3230   431 -6.82000   -805   232  -233      804
3231   431 -6.82000   -805   233  -234      804
3232   431 -6.82000   -805   234  -235      804
3233   431 -6.82000   -805   235  -236      804
3234   431 -6.82000   -805   236  -237      804
3235   431 -6.82000   -805   237  -238      804
3236   431 -6.82000   -805   238  -239      804
3237   431 -6.82000   -805   239  -240      804
3238   431 -6.82000   -805   240  -241      804
3239   431 -6.82000   -805   241  -242      804
3240   431 -6.82000   -805   242  -243      804
```

```
3241   431 -1.04550   -805   243  -245       804
3242   432 -.001784   -805   245  -246       804
3243   430 -8.26000   -805   246  -248       804
3244   432 -.001784   -805   248  -249       804
3245   436 -7.62000   -805   249  -250       804
3246   432 -.001784   -805   250  -251       804
3247   437 -7.69000   -805   251  -253       804
3248   432 -.001784   -805   253  -254       804
3249   431 -7.87000   -805   254  -255       804
3250   433 -.001251   -805   255  -256       804
3251   434 -0.90000   -805   256  -257       804
3252   431 -7.87000   -805   257  -258       804
c      ------------------------------------------------
3253   121 0.049935    208  -212 u=1                      $  DFA
3254   111 0.056425    212  -213 u=1                      $
3255  2101 0.050580    213  -215 u=1                      $
3256   111 0.056425    215  -216 u=1                      $
3257   124 0.033776    216  -222 u=1                      $
3258   133 0.067110    208  -212 u=2                      $  RRA-7
3259  1701 0.076740    212  -213 u=2                      $
3260  1701 0.076740    213  -215 u=2                      $
3261  1701 0.076740    215  -216 u=2                      $
3262   137 0.07527     216  -222 u=2                      $
3263   139 0.022260    208  -212 u=3                      $  Na
3264   139 0.022260    212  -213 u=3                      $
3265   139 0.022260    213  -215 u=3                      $
3266   139 0.022260    215  -216 u=3                      $
3267   139 0.022260    216  -222 u=3                      $
c     Sector 1 IVFSM locations: 18 DFA around characterizers
3268     0             -916  209   -219 fill=1            $  L
3269     0             -917  209   -219 fill=2            $  X
3270     0             -918  209   -219 fill=1            $  F
3271     0             -919  209   -219 fill=1            $  R
3272     0             -920  209   -219 fill=1            $  J
3273     0             -921  209   -219 fill=1            $  U
3274     0             -922  209   -219 fill=1            $  M
3275     0             -923  209   -219 fill=1            $  C
3276     0             -924  209   -219 fill=1            $  Y
3277     0             -925  209   -219 fill=1            $  G
3278     0             -926  209   -219 fill=1            $  S
3279     0             -927  209   -219 fill=1            $  K
3280     0             -928  209   -219 fill=1            $  V
3281     0             -929  209   -219 fill=1            $  B
3282     0             -930  209   -219 fill=1            $  D
3283     0             -931  209   -219 fill=1            $  H
3284     0             -932  209   -219 fill=1            $  W
3285     0             -933  209   -219 fill=1            $  A
3286     0             -934  209   -219 fill=1            $  E
3287     0             -935  209   -219 fill=2            $  Z
c      Sector 2   ------------------------------------------
   1     0             -936  209   -219 fill=1
   2     0             -937  209   -219 fill=2
   3     0             -938  209   -219 fill=1
   4     0             -939  209   -219 fill=1
   5     0             -940  209   -219 fill=1
   6     0             -941  209   -219 fill=1
   7     0             -942  209   -219 fill=1
   8     0             -943  209   -219 fill=1
   9     0             -944  209   -219 fill=1
  10     0             -945  209   -219 fill=1
  11     0             -946  209   -219 fill=1
  12     0             -947  209   -219 fill=1
  13     0             -948  209   -219 fill=1
  14     0             -949  209   -219 fill=1
  15     0             -950  209   -219 fill=1
  16     0             -951  209   -219 fill=1
  17     0             -952  209   -219 fill=1
  18     0             -953  209   -219 fill=1
  19     0             -954  209   -219 fill=1
  20     0             -955  209   -219 fill=2
c      Sector 3   ------------------------------------------
  21     0             -956  209   -219 fill=1
  22     0             -957  209   -219 fill=2
  23     0             -958  209   -219 fill=1
  24     0             -959  209   -219 fill=1
  25     0             -960  209   -219 fill=1
  26     0             -961  209   -219 fill=1
  27     0             -962  209   -219 fill=1
  28     0             -963  209   -219 fill=1
  29     0             -964  209   -219 fill=1
  30     0             -965  209   -219 fill=1
  31     0             -966  209   -219 fill=1
  32     0             -967  209   -219 fill=1
  33     0             -968  209   -219 fill=1
  34     0             -969  209   -219 fill=1
  35     0             -970  209   -219 fill=1
  36     0             -971  209   -219 fill=1
  37     0             -972  209   -219 fill=1
  38     0             -973  209   -219 fill=1
```

```
  39      0            -974  209   -219 fill=1
  40      0            -975  209   -219 fill=2
c        ------------
1510      0          (807:258:-270)    -200
3290      0                             200          $  outside world

   1 p     0.8660254     0.50  0.00     -90.57
   2 p     0.8660254     0.50  0.00     -84.532
   3 p     0.8660254     0.50  0.00     -78.494
   4 p     0.8660254     0.50  0.00     -72.456
   5 p     0.8660254     0.50  0.00     -66.418
   6 p     0.8660254     0.50  0.00      -60.38
   7 p     0.8660254     0.50  0.00     -54.342
   8 p     0.8660254     0.50  0.00     -48.304
   9 p     0.8660254     0.50  0.00     -42.266
  10 p     0.8660254     0.50  0.00     -36.228
  11 p     0.8660254     0.50  0.00      -30.19
  12 p     0.8660254     0.50  0.00     -24.152
  13 p     0.8660254     0.50  0.00     -18.114
  14 p     0.8660254     0.50  0.00     -12.076
  15 p     0.8660254     0.50  0.00      -6.038
  16 p     0.8660254     0.50  0.00           0
  17 p     0.8660254     0.50  0.00       6.038
  18 p     0.8660254     0.50  0.00      12.076
  19 p     0.8660254     0.50  0.00      18.114
  20 p     0.8660254     0.50  0.00      24.152
  21 p     0.8660254     0.50  0.00       30.19
  22 p     0.8660254     0.50  0.00      36.228
  23 p     0.8660254     0.50  0.00      42.266
  24 p     0.8660254     0.50  0.00      48.304
  25 p     0.8660254     0.50  0.00      54.342
  26 p     0.8660254     0.50  0.00       60.38
  27 p     0.8660254     0.50  0.00      66.418
  28 p     0.8660254     0.50  0.00      72.456
  29 p     0.8660254     0.50  0.00      78.494
  30 p     0.8660254     0.50  0.00      84.532
  31 p     0.8660254     0.50  0.00       90.57
  32 p     0.8660254    -0.50  0.00      -90.57
  33 p     0.8660254    -0.50  0.00     -84.532
  34 p     0.8660254    -0.50  0.00     -78.494
  35 p     0.8660254    -0.50  0.00     -72.456
  36 p     0.8660254    -0.50  0.00     -66.418
  37 p     0.8660254    -0.50  0.00      -60.38
  38 p     0.8660254    -0.50  0.00     -54.342
  39 p     0.8660254    -0.50  0.00     -48.304
  40 p     0.8660254    -0.50  0.00     -42.266
  41 p     0.8660254    -0.50  0.00     -36.228
  42 p     0.8660254    -0.50  0.00      -30.19
  43 p     0.8660254    -0.50  0.00     -24.152
  44 p     0.8660254    -0.50  0.00     -18.114
  45 p     0.8660254    -0.50  0.00     -12.076
  46 p     0.8660254    -0.50  0.00      -6.038
  47 p     0.8660254    -0.50  0.00           0
  48 p     0.8660254    -0.50  0.00       6.038
  49 p     0.8660254    -0.50  0.00      12.076
  50 p     0.8660254    -0.50  0.00      18.114
  51 p     0.8660254    -0.50  0.00      24.152
  52 p     0.8660254    -0.50  0.00       30.19
  53 p     0.8660254    -0.50  0.00      36.228
  54 p     0.8660254    -0.50  0.00      42.266
  55 p     0.8660254    -0.50  0.00      48.304
  56 p     0.8660254    -0.50  0.00      54.342
  57 p     0.8660254    -0.50  0.00       60.38
  58 p     0.8660254    -0.50  0.00      66.418
  59 p     0.8660254    -0.50  0.00      72.456
  60 p     0.8660254    -0.50  0.00      78.494
  61 p     0.8660254    -0.50  0.00      84.532
  62 p     0.8660254    -0.50  0.00       90.57
  63 py      -90.57
  64 py     -84.532
  65 py     -78.494
  66 py     -72.456
  67 py     -66.418
  68 py      -60.38
  69 py     -54.342
  70 py     -48.304
  71 py     -42.266
  72 py     -36.228
  73 py      -30.19
  74 py     -24.152
  75 py     -18.114
  76 py     -12.076
  77 py      -6.038
  78 py           0
  79 py       6.038
  80 py      12.076
  81 py      18.114
  82 py      24.152
  83 py       30.19
```

```
 84 py       36.228
 85 py       42.266
 86 py       48.304
 87 py       54.342
 88 py        60.38
 89 py       66.418
 90 py       72.456
 91 py       78.494
 92 py       84.532
 93 py        90.57
 94 pz      -134.70
 95 pz       -62.78
 96 pz       -46.14
 97 pz        46.14
 98 pz        62.78
 99 pz       146.14
100 p       -0.5774  1  0  0
101 p        0.5774  1  0  0
102 px            0
103 cz        105.0
104 pz        26.64
105 pz         2.26
106 pz        21.76
c   107 pz      -65.25
c   108 pz      -54.33
109 pz        62.78
110 px      -93.6287
111 p     0.8660254     -0.50  0.00   -93.1608
112 p    -0.5773502      1.00  0.00 108.113066
113 py      93.1608
114 p    0.57735026      1.00  0.00 108.113066
115 p     0.8660254      0.50  0.00    93.1608
116 px      93.6287
117 p     0.8660254     -0.50  0.00    93.1608
118 p    -0.5773502      1.00  0.00 -108.11306
119 py     -93.1608
120 p    0.57735026      1.00  0.00 -108.11306
121 p     0.8660254      0.50  0.00   -93.1608
c   122 cz    105.303864
123 py        6.038
124 p     0.8660254      0.50  0.00      6.038
125 p     0.8660254     -0.50  0.00      6.038
126 py       -6.038
127 p     0.8660254      0.50  0.00     -6.038
128 p     0.8660254     -0.50  0.00     -6.038
129 py      -18.114
130 p     0.8660254      0.50  0.00    -24.152
131 p     0.8660254     -0.50  0.00          0
132 py      -30.19
133 p     0.8660254      0.50  0.00    -36.228
134 p     0.8660254     -0.50  0.00    -12.076
135 py      -36.228
136 p     0.8660254      0.50  0.00    -78.494
137 p     0.8660254     -0.50  0.00    -36.228
138 py      -48.304
139 p     0.8660254      0.50  0.00     -90.57
140 p     0.8660254     -0.50  0.00    -48.304
141 py       24.152
142 p     0.8660254      0.50  0.00     42.266
143 p     0.8660254     -0.50  0.00     24.152
144 py       12.076
145 p     0.8660254      0.50  0.00      30.19
146 p     0.8660254     -0.50  0.00     12.076
147 py       30.19
148 p     0.8660254      0.50  0.00     54.342
149 p     0.8660254     -0.50  0.00      30.19
150 py       18.114
151 p     0.8660254     -0.50  0.00     18.114
152 py       36.228
153 p     0.8660254      0.50  0.00     66.418
154 p     0.8660254     -0.50  0.00     36.228
155 py       24.152
156 p     0.8660254     -0.50  0.00     24.152
157 py       42.266
158 p     0.8660254      0.50  0.00     78.494
159 p     0.8660254     -0.50  0.00     42.266
160 py       30.19
161 p     0.8660254     -0.50  0.00      30.19
162 py        6.038
163 p     0.8660254      0.50  0.00     78.494
164 p     0.8660254     -0.50  0.00     78.494
165 py       -6.038
166 p     0.8660254      0.50  0.00     66.418
167 p     0.8660254     -0.50  0.00     66.418
c   196 pz      -20
c   197 pz       20
200 so    2000.00
c   201 pz     -310.00 $  inner core
202 pz     -263.00 $  (-272.00)
```

```
 203 pz    -240.00 $
 204 pz    -215.00 $
 205 pz    -190.00 $
 206 pz    -170.00 $
 207 pz    -151.00 $
 208 pz    -141.00 $
 209 pz    -134.70 $
 210 pz    -124.54 $
 211 pz    -100.00 $
 212 pz     -62.78 $
 213 pz     -46.44 $
 214 pz       0.00 $
 215 pz      46.44 $
 216 pz      62.78 $
 217 pz     100.00 $
 218 pz     125.00 $
 219 pz     146.14 $
 220 pz     155.00 $
 221 pz     175.00 $
 222 pz     185.00 $
 223 pz     195.00 $
 224 pz     200.00 $
 225 pz     205.00 $
 226 pz     217.00 $
 227 pz     247.00 $
 228 pz     275.00 $
 229 pz     300.00 $
 230 pz     525.00
 231 pz     532.42
 232 pz     550.00
 233 pz     570.00
 234 pz     580.00
 235 pz     585.00
 236 pz     600.00
 237 pz     610.00
 238 pz     620.20 $ (631.2)
 239 pz     640.00
 240 pz     659.36
 241 pz     660.00
 242 pz     667.00
 243 pz     701.02
 244 pz     718.00
 245 pz     713.82
 246 pz     715.12
 247 pz     733.00
 248 pz     727.92
 249 pz     729.22
 250 pz     739.46
 251 pz     740.76
 252 pz     760.00
 253 pz     761.24
 254 pz     770.00
 255 pz     825.00
 256 pz     875.00
 257 pz     885.00
 258 pz     890.00
 260 cz     307.66 $ vessel wall
 261 cz     314.64 $ 2.75" thick
 262 cz     325.00
 263 cz     330.00
 264 cz     334.80 $ guard vessel
 265 cz     339.88 $ 2"    thick
 266 cz     355.00
 267 cz     375.00
 268 cz     380.00
 269 cz     400.00
 370 cz     425.00
 371 cz     430.00
 372 cz     465.00
 270 pz    -800.00
 271 pz    -740.00
 272 pz    -561.34 $ (-650.00)
 273 pz    -554.99 $ (-630.00)
c           274 pz    -580.00
c           275 pz    -560.00
 274 sq     0.000010101 0.000010101 0.000039053 0.00000000 0.00000000
            0.00000000 -1.00000000  0.          0.         -373.38000
 275 sq     0.000010565 0.000010565 0.000042699 0.00000000 0.00000000
            0.00000000 -1.00000000  0.00000000  0.00000000 -373.38000
 276 pz    -373.38
 277 kz    -875.1690    0.53691764   1.0000
 278 kz    -864.4843    0.53691764   1.0000
 313 sz    -152.8600 154.8900
 314 sz    -152.8600 162.1000
 315 cz      78.2000
 316 cz     204.4700
 317 cz     270.0500
 318 cz     290.0500
 319 kz    -316.0260 4.0110 1.0000
```

```
 320 kz     -339.5910 3.0000 1.0000
 321 kz     -349.8510 3.0000 1.0000
 322 kz     -337.3560 4.0110 1.0000
 323 pz     -192.2200
c    324 pz     -134.8700
 325 pz     -314.9600
 401 pz      735.00 $
 402 pz      750.00 $
 569 pz       58.42 $ YOKE
 570 pz       66.04 $ YOKE
 571 pz       73.66 $ YOKE
 572 pz       58.42 $ HEX --  1031
 573 pz       66.04 $ HEX --  1031
 574 pz       73.66 $ HEX --  1031
 575 pz       58.42 $ HEX --  1031
 576 pz       66.04 $ HEX --  1031
 577 pz       73.66 $ HEX --  1031
 578 pz       58.42 $ HEX --  1032
 579 pz       66.04 $ HEX --  1032
 580 pz       73.66 $ HEX --  1032
 581 pz       58.42 $ HEX --  1032
 582 pz       66.04 $ HEX --  1032
 583 pz       73.66 $ HEX --  1032
 584 pz       58.42 $ HEX --  1033
 585 pz       66.04 $ HEX --  1033
 586 pz       73.66 $ HEX --  1033
 587 pz       58.42 $ HEX --  1033
 588 pz       66.04 $ HEX --  1033
 589 pz       73.66 $ HEX --  1033
 590 pz       58.42 $ HEX --  1034
 591 pz       66.04 $ HEX --  1034
 592 pz       73.66 $ HEX --  1034
 593 pz       58.42 $ HEX --  1034
 594 pz       66.04 $ HEX --  1034
 595 pz       73.66 $ HEX --  1034
 596 pz       58.42 $ HEX --  1035
 597 pz       66.04 $ HEX --  1035
 598 pz       73.66 $ HEX --  1035
 599 pz       58.42 $ HEX --  1035
 600 pz       66.04 $ HEX --  1035
 601 pz       73.66 $ HEX --  1035
 602 pz       58.42 $ HEX --  1036
 603 pz       66.04 $ HEX --  1036
 604 pz       73.66 $ HEX --  1036
 605 pz       58.42 $ HEX --  1036
 606 pz       66.04 $ HEX --  1036
 607 pz       73.66 $ HEX --  1036
 608 pz      138.42 $ SR
 609 pz      114.04 $ CR
 c
 780 cz       85.000    $  core support inner radius
 781 cz       90.000    $  core support outer radius
c    outer radial dimensions of rz model cells
 785 cz       38.567    $  core 1
 786 cz       60.483    $  core 2
 787 cz       71.452    $  refl 1
 788 cz       89.442    $  refl 2
 789 cz          105.0  $  irs 1
 790 cz          114.63 $  irs 2 (113.3)
 791 cz          129.41 $  ors 1 (121.6)
 792 cz          144.20 $  ors 2 (130.6)
 793 cz          158.98 $  ors 3 (139.6)
 794 cz          168.39 $  na 1  (157.0)
 795 cz          177.8  $  na 2
 796 cz          182.9  $  cb 1
 797 cz          196.9  $  cb 2
 798 cz          200.0  $  na 3
 799 cz          217.5  $  ivsm 1
 800 cz          235.0  $  ivsm 2
 801 cz          255.0  $  ivsm 3
 802 cz          270.0  $  ivsm 4
 803 cz          290.0  $  na 4
 804 cz          302.895$  na 5
 805 cz          305.435$  ts-vessel, 1" thick
 806 cz          550.0  $  cavity
 807 cz          590.0  $  concrete & outside world
 808 pz          400.0  $  top of world
 809 pz         -360.0  $  bottom of world (-350.0)
 818   p  +1.4010  1.0  0.0  0.0
 819   p  +0.3623  1.0  0.0  0.0
 820   p  +0.0966 -1.0  0.0  0.0
 821   p  +0.8416 -1.0  0.0  0.0
 822   p  -2.1962  1.0  0.0  0.0
 823   p  -5.6228 -1.0  0.0  0.0
c        sector 1, assembly locations in IVFS
   916 c/z       -165.467      129.696     6.333  $ L
   917 c/z       -198.666       80.710     6.333  $ X
   918 c/z       -147.590      157.168     6.333  $ F
   919 c/z       -180.315      121.121     6.333  $ R
```

```
  920 c/z       -162.440     148.594     6.333  $ J
  921 c/z       -198.670      97.844     6.333  $ U
  922 c/z       -180.319     138.263     6.333  $ M
  923 c/z       -147.603     174.294     6.333  $ C
  924 c/z       -213.503      89.310     6.333  $ Y
  925 c/z       -162.427     165.749     6.333  $ G
  926 c/z       -195.154     129.709     6.333  $ S
  927 c/z       -177.279     157.174     6.333  $ K
  928 c/z       -213.523     106.412     6.333  $ V
  929 c/z       -147.592     191.444     6.333  $ B
  930 c/z       -162.433     182.888     6.333  $ D
  931 c/z       -177.302     174.295     6.333  $ H
  932 c/z       -228.354     115.000     6.333  $ W
  933 c/z       -162.448     200.028     6.333  $ A
  934 c/z       -177.289     191.455     6.333  $ E
  935 c/z       -192.555     166.005     6.333  $ Z
c         sector 2, assembly locations in IVFS
  936 c/z        195.054      78.451     6.333  $ L
  937 c/z        169.230     131.695     6.333  $ X
  938 c/z        209.906      49.233     6.333  $ F
  939 c/z        195.051      95.597     6.333  $ R
  940 c/z        209.906      66.380     6.333  $ J
  941 c/z        184.070     123.131     6.333  $ U
  942 c/z        209.899      87.029     6.333  $ M
  943 c/z        224.745      40.681     6.333  $ C
  944 c/z        184.096     140.244     6.333  $ Y
  945 c/z        224.756      57.791     6.333  $ G
  946 c/z        209.908     104.154     6.333  $ S
  947 c/z        224.756      74.941     6.333  $ K
  948 c/z        198.917     131.710     6.333  $ V
  949 c/z        239.591      32.096     6.333  $ B
  950 c/z        239.602      49.227     6.333  $ D
  951 c/z        239.595      66.401     6.333  $ H
  952 c/z        213.770     140.260     6.333  $ W
  953 c/z        254.453      40.670     6.333  $ A
  954 c/z        254.449      57.809     6.333  $ E
  955 c/z        240.042      83.755     6.333  $ Z
c         sector 3, assembly locations in IVFS
  956 c/z        -29.587    -208.147     6.333  $ L
  957 c/z         29.436    -212.405     6.333  $ X
  958 c/z        -62.316    -206.401     6.333  $ F
  959 c/z        -14.736    -216.718     6.333  $ R
  960 c/z        -47.466    -214.974     6.333  $ J
  961 c/z         14.600    -220.975     6.333  $ U
  962 c/z        -29.580    -225.292     6.333  $ M
  963 c/z        -77.142    -214.975     6.333  $ C
  964 c/z         29.407    -229.554     6.333  $ Y
  965 c/z        -62.329    -223.540     6.333  $ G
  966 c/z        -14.754    -233.863     6.333  $ S
  967 c/z        -47.477    -232.115     6.333  $ K
  968 c/z         14.606    -238.122     6.333  $ V
  969 c/z        -91.999    -223.540     6.333  $ B
  970 c/z        -77.169    -232.115     6.333  $ D
  971 c/z        -62.293    -240.696     6.333  $ H
  972 c/z         14.584    -255.260     6.333  $ W
  973 c/z        -92.005    -240.698     6.333  $ A
  974 c/z        -77.160    -249.264     6.333  $ E
  975 c/z        -47.487    -249.760     6.333  $ Z
c       tally surfaces for fs cards
  981   cz  555.0     $ 1st 5 cm of concrete

m2101 94239.55 1.3000E-03  94240.5 1.7040E-04 94241.50 1.9810E-05
      94242.50 2.9730E-06  92235.5 3.7650E-05  92238.5 5.3290E-03
      94241.50 6.9410E-06 11023.50 9.1130E-03  24000.5 4.0420E-03
      25055.50 3.8050E-04 26000.55 1.3660E-02  28000.5 2.7620E-03
      42000.50 3.1070E-04 27059.50 9.9500E-06 73181.50 6.4990E-07
       8016.5 1.3430E-02
m1201 94239.55 1.3660E-03  94240.5 1.9280E-04 94241.50 1.9810E-05
      94242.50 3.0330E-06  92235.5 3.8470E-05  92238.5 5.5940E-03
      94241.50 1.0210E-05 50120.35 3.5510E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m1202 94239.55 1.3810E-03  94240.5 1.9030E-04 94241.50 2.2270E-05
      94242.50 4.1110E-06  92235.5 3.8480E-05  92238.5 5.5940E-03
      94241.50 9.5260E-06 50120.35 3.6410E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m2201 94239.55 1.3660E-03  94240.5 1.9220E-04 94241.50 1.8040E-05
      94242.50 3.3680E-06  92235.5 3.8480E-05  92238.5 5.5940E-03
      94241.50 7.4600E-06 50120.35 3.5430E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m2202 94239.55 1.3700E-03  94240.5 1.9510E-04 94241.50 1.8680E-05
      94242.50 3.4040E-06  92235.5 3.8560E-05  92238.5 5.5960E-03
      94241.50 9.8180E-06 50120.35 3.3770E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
```

```
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m3201 94239.55 1.3690E-03  94240.5 1.9340E-04 94241.50 1.7720E-05
     94242.50 3.3880E-06  92235.5 3.8470E-05  92238.5 5.5940E-03
     94241.50 7.2890E-06 50120.35 3.5330E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m3202 11023.50 9.1130E-03  24000.5 9.4770E-03 25055.50 8.9230E-04
     26000.55 3.2040E-02  28000.5 6.4760E-03 42000.50 7.2870E-04
     27059.50 2.3330E-05 73181.50 1.5240E-06
m1301 94239.55 1.3680E-03  94240.5 1.9120E-04 94241.50 1.9460E-05
     94242.50 3.1290E-06  92235.5 3.8500E-05  92238.5 5.5950E-03
     94241.50 9.3230E-06 50120.35 3.3760E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m1302  11023.50 1.336E-02  24000.50 6.391E-03  25055.50 6.017E-04 $ below poison
      26000.55 2.161E-02  28000.50 4.367E-03  42000.50 4.916E-04
      27059.50 1.574E-05  73181.50 1.028E-06
m1303 94239.55 1.3820E-03  94240.5 1.8980E-04 94241.50 1.8170E-05
     94242.50 3.0340E-06  92235.5 3.9080E-05  92238.5 5.5260E-03
     94241.50 7.4170E-06 50120.35 1.4230E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m1304 94239.55 1.3680E-03  94240.5 1.8850E-04 94241.50 1.9410E-05
     94242.50 3.0460E-06  92235.5 3.8540E-05  92238.5 5.5960E-03
     94241.50 8.9380E-06 50120.35 3.3090E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m2301 94239.55 1.3920E-03  94240.5 1.9110E-04 94241.50 1.8300E-05
     94242.50 3.0640E-06  92235.5 3.9020E-05  92238.5 5.5200E-03
     94241.50 7.5400E-06 50120.35 1.4140E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
c
m2303 94239.55 1.3830E-03  94240.5 1.9350E-04 94241.50 1.7450E-05
     94242.50 3.3740E-06  92235.5 3.8520E-05  92238.5 5.5950E-03
     94241.50 6.0420E-06 50120.35 3.3700E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m2304 94239.55 1.3580E-03  94240.5 1.9210E-04 94241.50 1.7870E-05
     94242.50 3.3750E-06  92235.5 3.8540E-05  92238.5 5.5960E-03
     94241.50 6.5130E-06 50120.35 3.2930E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m3301 94239.55 1.3820E-03  94240.5 1.9040E-04 94241.50 1.6960E-05
     94242.50 3.3090E-06  92235.5 3.8540E-05  92238.5 5.5960E-03
     94241.50 5.9420E-06 50120.35 3.3680E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
c
m3303 94239.55 1.3580E-03  94240.5 1.8830E-04 94241.50 1.8910E-05
     94242.50 3.2650E-06  92235.5 3.8510E-05  92238.5 5.5950E-03
     94241.50 8.3940E-06 50120.35 3.3370E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m3304 94239.55 1.3930E-03  94240.5 1.9050E-04 94241.50 1.7200E-05
     94242.50 3.3430E-06  92235.5 3.9110E-05  92238.5 5.6070E-03
     94241.50 6.0660E-06 50120.35 1.4530E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m1401 94239.55 1.5490E-03  94240.5 2.1340E-04 94241.50 2.0980E-05
     94242.50 3.5550E-06  92235.5 1.0700E-05  92238.5 5.3210E-03
     94241.50 5.1300E-06 50120.35 1.3710E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m1402 94239.55 1.5580E-03  94240.5 2.1410E-04 94241.50 2.1050E-05
     94242.50 3.5720E-06  92235.5 1.0800E-05  92238.5 5.3650E-03
     94241.50 5.1550E-06 50120.35 1.2330E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m1403 94239.55 1.5530E-03  94240.5 2.1380E-04 94241.50 2.1010E-05
     94242.50 3.5740E-06  92235.5 1.0810E-05  92238.5 5.3750E-03
     94241.50 5.1510E-06 50120.35 1.3360E-05 11023.50 9.1130E-03
      24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
      28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
     73181.50 6.1250E-07   8016.5 1.4280E-02
m1404 11023.50 9.1130E-03  24000.5 9.4770E-03 25055.50 8.9230E-04
```

```
      26000.55 3.2040E-02  28000.5 6.4760E-03 42000.50 7.2870E-04
      27059.50 2.3330E-05 73181.50 1.5240E-06
m1405 94239.55 1.3870E-03  94240.5 1.9000E-04 94241.50 1.8190E-05
      94242.50 3.0300E-06  92235.5 3.9240E-05  92238.5 5.5410E-03
      94241.50 7.4950E-06 50120.35 1.1760E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m1406 11023.50 9.1130E-03  24000.5 9.4770E-03 25055.50 8.9230E-04
      26000.55 3.2040E-02  28000.5 6.4760E-03 42000.50 7.2870E-04
      27059.50 2.3330E-05 73181.50 1.5240E-06
m2401 94239.55 1.5590E-03  94240.5 2.1450E-04 94241.50 2.1090E-05
      94242.50 3.5730E-06  92235.5 1.0780E-05  92238.5 5.3540E-03
      94241.50 5.1730E-06 50120.35 1.2930E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m2402 94239.55 1.3190E-03  94240.5 1.7340E-04 94241.50 1.9920E-05
      94242.50 2.9730E-06  92235.5 3.7650E-05  92238.5 5.3400E-03
      94241.50 6.9410E-06 11023.50 9.1130E-03  24000.5 4.0210E-03
      25055.50 3.7850E-04 26000.55 1.3590E-02  28000.5 2.7470E-03
      42000.50 3.0910E-04 27059.50 9.8980E-06 73181.50 6.4650E-07
       8016.5 1.3500E-02
m2403 94239.55 1.3830E-03  94240.5 1.9320E-04 94241.50 1.8520E-05
      94242.50 3.3310E-06  92235.5 3.8670E-05  92238.5 5.5980E-03
      94241.50 8.8980E-06 50120.35 2.8900E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m2404 11023.50 9.1130E-03  24000.5 9.4770E-03 25055.50 8.9230E-04
      26000.55 3.2040E-02  28000.5 6.4760E-03 42000.50 7.2870E-04
      27059.50 2.3330E-05 73181.50 1.5240E-06
m2405 11023.50 9.1130E-03  24000.5 9.4770E-03 25055.50 8.9230E-04
      26000.55 3.2040E-02  28000.5 6.4760E-03 42000.50 7.2870E-04
      27059.50 2.3330E-05 73181.50 1.5240E-06
m2406 94239.55 1.3640E-03  94240.5 1.8970E-04 94241.50 1.7360E-05
      94242.50 3.3540E-06  92235.5 3.8670E-05  92238.5 5.5980E-03
      94241.50 6.2810E-06 50120.35 2.9650E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m3401 94239.55 1.3560E-03  94240.5 1.8430E-04 94241.50 1.8120E-05
      94242.50 3.0390E-06  92235.5 3.8700E-05  92238.5 5.5990E-03
      94241.50 8.3790E-06 50120.35 2.8180E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m3402 94239.55 1.5540E-03  94240.5 2.1360E-04 94241.50 2.1010E-05
      94242.50 3.5710E-06  92235.5 1.0820E-05  92238.5 5.3730E-03
      94241.50 5.1550E-06 50120.35 1.2280E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m3403 94239.55 1.5560E-03  94240.5 2.1130E-04 94241.50 2.1010E-05
      94242.50 3.0270E-06  92235.5 1.0890E-05  92238.5 5.3830E-03
      94241.50 8.1240E-06 50120.35 1.3780E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m3404 11023.50 9.1130E-03  24000.5 8.7930E-03 25055.50 8.2790E-04
      26000.55 2.9730E-02  28000.5 6.0090E-03 42000.50 6.7610E-04
      27059.50 2.1650E-05 73181.50 1.4140E-06
m3405 94239.55 1.3880E-03  94240.5 1.9270E-04 94241.50 1.7610E-05
      94242.50 3.3780E-06  92235.5 3.8630E-05  92238.5 5.5980E-03
      94241.50 5.9850E-06 50120.35 3.0880E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4280E-02
m3406 11023.50 9.1130E-03  24000.5 9.4770E-03 25055.50 8.9230E-04
      26000.55 3.2040E-02  28000.5 6.4760E-03 42000.50 7.2870E-04
      27059.50 2.3330E-05 73181.50 1.5240E-06
m1501 94239.55 1.8130E-03  94240.5 2.4510E-04 94241.50 2.3990E-05
      94242.50 3.5260E-06  92235.5 1.0900E-05  92238.5 5.1100E-03
      94241.50 9.1520E-06 50120.35 1.4050E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
c
m1503 94239.55 1.6760E-03  94240.5 2.3210E-04 94241.50 2.1180E-05
      94242.50 4.1080E-06  92235.5 3.6690E-05  92238.5 5.2750E-03
      94241.50 9.4370E-06 50120.35 2.4960E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
c
m1505 94239.55 1.6670E-03  94240.5 2.3440E-04 94241.50 2.3080E-05
      94242.50 4.1640E-06  92235.5 3.6560E-05  92238.5 5.2730E-03
      94241.50 9.7990E-06 50120.35 3.0330E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
```

```
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m1506  94239.55 1.6770E-03  94240.5 2.3200E-04 94241.50 2.2800E-05
       94242.50 3.7620E-06  92235.5 3.7000E-05  92238.5 5.2810E-03
       94241.50 9.3900E-06 50120.35 1.2150E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m1507  94239.55 1.6840E-03  94240.5 2.3410E-04 94241.50 2.2600E-05
       94242.50 3.6670E-06  92235.5 3.6650E-05  92238.5 5.2740E-03
       94241.50 9.3250E-06 50120.35 2.7310E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m1508  94239.55 1.6830E-03  94240.5 2.3310E-04 94241.50 2.2070E-05
       94242.50 4.0110E-06  92235.5 3.6580E-05  92238.5 5.2730E-03
       94241.50 8.8820E-06 50120.35 2.9250E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m2501  94239.55 1.6770E-03  94240.5 2.3210E-04 94241.50 2.2110E-05
       94242.50 3.9030E-06  92235.5 3.6590E-05  92238.5 5.2730E-03
       94241.50 9.2010E-06 50120.35 2.8380E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
c
m2503  94239.55 1.6050E-03  94240.5 2.1600E-04 94241.50 2.3770E-05
       94242.50 3.9630E-06  92235.5 3.4680E-05  92238.5 5.0030E-03
       94241.50 7.9330E-06 11023.50 9.1130E-03  24000.5 4.0420E-03
       25055.50 3.8050E-04 26000.55 1.3660E-02  28000.5 2.7620E-03
       42000.50 3.1070E-04 27059.50 9.9500E-06 73181.50 6.4990E-07
         8016.5 1.3500E-02
c
m2505  94239.55 1.6820E-03  94240.5 2.3460E-04 94241.50 2.2700E-05
       94242.50 3.7560E-06  92235.5 3.6560E-05  92238.5 5.2730E-03
       94241.50 9.5970E-06 50120.35 3.0320E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m2506  94239.55 1.6760E-03  94240.5 2.3220E-04 94241.50 2.2820E-05
       94242.50 3.7640E-06  92235.5 3.6980E-05  92238.5 5.2810E-03
       94241.50 9.3850E-06 50120.35 1.3080E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m2507  94239.55 1.8140E-03  94240.5 2.4490E-04 94241.50 2.3960E-05
       94242.50 3.5230E-06  92235.5 1.0920E-05  92238.5 5.1110E-03
       94241.50 9.1590E-06 50120.35 1.2560E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m2508  94239.55 1.6670E-03  94240.5 2.3200E-04 94241.50 2.2490E-05
       94242.50 3.7100E-06  92235.5 3.6610E-05  92238.5 5.2730E-03
       94241.50 9.2150E-06 50120.35 2.8590E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m3501  94239.55 1.6860E-03  94240.5 2.3030E-04 94241.50 2.2070E-05
       94242.50 3.6990E-06  92235.5 3.7120E-05  92238.5 5.2350E-03
       94241.50 9.1380E-06 50120.35 1.1910E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
c
m3503  94239.55 1.6900E-03  94240.5 2.3350E-04 94241.50 2.2740E-05
       94242.50 4.2310E-06  92235.5 3.6720E-05  92238.5 5.2750E-03
       94241.50 1.0050E-05 50120.35 2.4260E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
c
m3505  94239.55 1.6920E-03  94240.5 2.3730E-04 94241.50 2.3040E-05
       94242.50 4.4130E-06  92235.5 3.6540E-05  92238.5 5.2720E-03
       94241.50 1.0100E-05 50120.35 3.1620E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m3506  94239.55 1.6780E-03  94240.5 2.3340E-04 94241.50 2.4200E-05
       94242.50 3.8520E-06  92235.5 3.6520E-05  92238.5 5.2720E-03
       94241.50 1.0090E-05 50120.35 3.2810E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
       73181.50 6.1250E-07   8016.5 1.4340E-02
m3507  94239.55 1.6820E-03  94240.5 2.2980E-04 94241.50 2.2020E-05
       94242.50 3.6990E-06  92235.5 3.6760E-05  92238.5 5.1860E-03
       94241.50 9.1120E-06 50120.35 1.2690E-05 11023.50 9.1130E-03
        24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
        28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
```

	73181.50	6.1250E-07	8016.5	1.4340E-02		
m3508	94239.55	1.6760E-03	94240.5	2.3210E-04	94241.50	2.2810E-05
	94242.50	3.7630E-06	92235.5	3.6970E-05	92238.5	5.2800E-03
	94241.50	9.3840E-06	50120.35	1.3720E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1601	94239.55	1.6790E-03	94240.5	2.3300E-04	94241.50	2.2420E-05
	94242.50	4.2670E-06	92235.5	3.6670E-05	92238.5	5.2750E-03
	94241.50	1.0300E-05	50120.35	2.4830E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1602	94239.55	1.6790E-03	94240.5	2.3210E-04	94241.50	2.2590E-05
	94242.50	3.9750E-06	92235.5	3.6730E-05	92238.5	5.2760E-03
	94241.50	9.3730E-06	50120.35	2.2250E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1603	94239.55	1.6920E-03	94240.5	2.3260E-04	94241.50	2.2680E-05
	94242.50	3.8340E-06	92235.5	3.6790E-05	92238.5	5.2770E-03
	94241.50	9.6480E-06	50120.35	1.9650E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1604	94239.55	1.6860E-03	94240.5	2.3300E-04	94241.50	2.3220E-05
	94242.50	3.8580E-06	92235.5	3.6740E-05	92238.5	5.2760E-03
	94241.50	9.9650E-06	50120.35	2.2140E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1605	94239.55	1.6730E-03	94240.5	2.3090E-04	94241.50	2.2630E-05
	94242.50	3.6420E-06	92235.5	3.6680E-05	92238.5	5.2750E-03
	94241.50	9.3850E-06	50120.35	2.4170E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1606	94239.55	1.6740E-03	94240.5	2.3370E-04	94241.50	2.2890E-05
	94242.50	3.7040E-06	92235.5	3.6660E-05	92238.5	5.2750E-03
	94241.50	9.4630E-06	50120.35	2.5310E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1607	94239.55	8.8300E-06	94240.5	7.1660E-09	92235.5	2.1350E-05
	92238.5	1.2310E-02	50120.35	1.2230E-06	11023.50	5.9430E-03
	24000.5	2.7700E-03	25055.50	2.6070E-04	26000.55	9.3640E-03
	28000.5	1.8920E-03	42000.50	2.1290E-04	27059.50	6.8180E-06
	73181.50	4.4540E-07	8016.5	2.1170E-02		
m1608	94239.55	1.6740E-03	94240.5	2.3180E-04	94241.50	2.2910E-05
	94242.50	3.5910E-06	92235.5	3.6830E-05	92238.5	5.2780E-03
	94241.50	9.6910E-06	50120.35	1.8500E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1609	94239.55	1.6790E-03	94240.5	2.3160E-04	94241.50	2.4050E-05
	94242.50	3.8180E-06	92235.5	3.6760E-05	92238.5	5.2770E-03
	94241.50	1.0090E-05	50120.35	2.1480E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m1610	11023.50	1.8040E-02	24000.5	2.8250E-03	25055.50	2.6600E-04
	26000.55	9.5520E-03	28000.5	1.9300E-03	42000.50	2.1720E-04
	27059.50	6.9550E-06	73181.50	4.5430E-07		
m2601	94239.55	1.6880E-03	94240.5	2.3270E-04	94241.50	2.1650E-05
	94242.50	4.4540E-06	92235.5	3.6700E-05	92238.5	5.2760E-03
	94241.50	1.0130E-05	50120.35	2.2640E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m2602	94239.55	1.6750E-03	94240.5	2.3350E-04	94241.50	2.2930E-05
	94242.50	3.7050E-06	92235.5	3.6770E-05	92238.5	5.2770E-03
	94241.50	9.6300E-06	50120.35	2.0450E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m2603	94239.55	1.6160E-03	94240.5	2.1700E-04	94241.50	2.3770E-05
	94242.50	3.9630E-06	92235.5	3.5670E-05	92238.5	5.0610E-03
	94241.50	7.9330E-06	11023.50	9.1130E-03	24000.5	3.9790E-03
	25055.50	3.7460E-04	26000.55	1.3450E-02	28000.5	2.7190E-03
	42000.50	3.0590E-04	27059.50	9.7950E-06	73181.50	6.3980E-07
	8016.5	1.3690E-02				
m2604	94239.55	1.6860E-03	94240.5	2.3180E-04	94241.50	2.2750E-05
	94242.50	4.0360E-06	92235.5	3.6760E-05	92238.5	5.2770E-03
	94241.50	6.4600E-06	50120.35	2.1120E-05	11023.50	9.1130E-03
	24000.5	3.8090E-03	25055.50	3.5860E-04	26000.55	1.2880E-02
	28000.5	2.6030E-03	42000.50	2.9280E-04	27059.50	9.3770E-06
	73181.50	6.1250E-07	8016.5	1.4340E-02		
m2605	94239.55	1.6830E-03	94240.5	2.3390E-04	94241.50	2.2870E-05
	94242.50	3.7310E-06	92235.5	3.6690E-05	92238.5	5.2750E-03

```
      94241.50 9.3600E-06 50120.35 2.3920E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m2606 94239.55 1.6790E-03  94240.5 2.3310E-04 94241.50 2.2240E-05
      94242.50 3.9690E-06  92235.5 3.6660E-05  92238.5 5.2750E-03
      94241.50 8.9100E-06 50120.35 2.5760E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m2607 94239.55 1.6790E-03  94240.5 2.2870E-04 94241.50 2.1180E-05
      94242.50 3.9650E-06  92235.5 3.6920E-05  92238.5 5.2800E-03
      94241.50 8.0880E-06 50120.35 1.5140E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m2608 94239.55 1.8160E-03  94240.5 2.4470E-04 94241.50 2.3970E-05
      94242.50 3.5210E-06  92235.5 1.0930E-05  92238.5 5.1120E-03
      94241.50 9.1690E-06 50120.35 9.4510E-06 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m2609 94239.55 1.6670E-03  94240.5 2.2970E-04 94241.50 2.2910E-05
      94242.50 3.7950E-06  92235.5 3.6740E-05  92238.5 5.2760E-03
      94241.50 9.2380E-06 50120.35 2.1960E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m2610 11023.50 7.5230E-03  24000.5 4.2190E-03 25055.50 3.9720E-04
      26000.55 1.4260E-02  28000.5 2.8830E-03 42000.50 3.2440E-04
      27059.50 1.0390E-05 73181.50 6.7840E-07   5010.5 2.1690E-03
       5011.55 8.7770E-03   6000.5 2.7370E-03
m3601 94239.55 1.6890E-03  94240.5 2.3420E-04 94241.50 2.4080E-05
      94242.50 3.8190E-06  92235.5 3.6760E-05  92238.5 5.2770E-03
      94241.50 9.8430E-06 50120.35 2.1120E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3602 94239.55 1.6770E-03  94240.5 2.3240E-04 94241.50 2.2820E-05
      94242.50 4.1220E-06  92235.5 3.6780E-05  92238.5 5.2770E-03
      94241.50 1.0040E-05 50120.35 2.0450E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3603 94239.55 1.6990E-03  94240.5 2.3480E-04 94241.50 2.3640E-05
      94242.50 3.9740E-06  92235.5 3.6810E-05  92238.5 5.2780E-03
      94241.50 9.5430E-06 50120.35 1.8930E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3604 94239.55 1.6820E-03  94240.5 2.2950E-04 94241.50 2.1990E-05
      94242.50 3.6780E-06  92235.5 3.6800E-05  92238.5 5.1850E-03
      94241.50 9.1190E-06 50120.35 9.3120E-06 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3605 94239.55 1.6740E-03  94240.5 2.3100E-04 94241.50 2.2640E-05
      94242.50 3.6420E-06  92235.5 3.6670E-05  92238.5 5.2750E-03
      94241.50 9.3820E-06 50120.35 2.4730E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3606 94239.55 1.6910E-03  94240.5 2.3440E-04 94241.50 2.2260E-05
      94242.50 3.9990E-06  92235.5 3.6640E-05  92238.5 5.2740E-03
      94241.50 1.0130E-05 50120.35 2.6890E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3607 94239.55 1.6760E-03  94240.5 2.3130E-04 94241.50 2.1670E-05
      94242.50 4.3720E-06  92235.5 3.6670E-05  92238.5 5.2750E-03
      94241.50 1.0140E-05 50120.35 2.5690E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3608 94239.55 1.6780E-03  94240.5 2.3060E-04 94241.50 2.3030E-05
      94242.50 3.7920E-06  92235.5 3.6780E-05  92238.5 5.2770E-03
      94241.50 9.4660E-06 50120.35 2.0820E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3609 94239.55 1.6690E-03  94240.5 2.3110E-04 94241.50 2.2580E-05
      94242.50 3.9510E-06  92235.5 3.6730E-05  92238.5 5.2760E-03
      94241.50 9.3280E-06 50120.35 2.3830E-05 11023.50 9.1130E-03
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m3610 94239.55 1.6960E-03  94240.5 2.4490E-04 94241.50 2.2470E-05
      94242.50 4.0890E-06  92235.5 3.6630E-05  92238.5 5.2740E-03
      94241.50 1.1300E-05 50120.35 2.6590E-05 11023.50 9.1130E-03
```

```
       24000.5 3.8090E-03 25055.50 3.5860E-04 26000.55 1.2880E-02
       28000.5 2.6030E-03 42000.50 2.9280E-04 27059.50 9.3770E-06
      73181.50 6.1250E-07   8016.5 1.4340E-02
m1701 11023.50 3.2240E-03  24000.5 1.3160E-02 25055.50 4.4960E-04 $ RR7
      26000.55 1.6070E-02  28000.5 4.3530E-02 42000.50 2.7250E-04
      27059.50 3.5380E-05 73181.50 2.3340E-06
c
m1711 11023.50 9.2370E-03  24000.5 5.1610E-03 25055.50 4.8590E-04 $ HA003
      26000.55 1.7450E-02  28000.5 3.5270E-03 42000.50 3.9680E-04
      27059.50 1.2710E-05 73181.50 8.2990E-07   5010.5 7.4520E-03
       5011.55 1.1540E-02   6000.5 4.7480E-03
c
m3708 94239.55 8.6170E-06  94240.5 8.0310E-09  92235.5 2.1840E-05 $ WB018
       92238.5 1.2540E-02 50120.35 8.8050E-07 11023.50 5.9430E-03
       24000.5 2.7700E-03 25055.50 2.6070E-04 26000.55 9.3640E-03
       28000.5 1.8920E-03 42000.50 2.1290E-04 27059.50 6.8180E-06
      73181.50 4.4540E-07   8016.5 2.1540E-02
c
m3711 11023.50 7.1580E-03  24000.5 5.3860E-03 25055.50 5.0710E-04 $ PSR
      26000.55 1.8210E-02  28000.5 3.6810E-03 42000.50 4.1410E-04
      27059.50 1.3260E-05 73181.50 8.6620E-07   5010.5 6.3080E-03
       5011.55 2.5920E-02   6000.5 7.2940E-03
c
m1801 11023.50 2.6080E-03  24000.5 1.3370E-02 25055.50 5.8310E-04
      26000.55 2.0880E-02  28000.5 3.8660E-02 42000.50 3.9520E-04
      27059.50 3.5450E-05 73181.50 2.3350E-06
 m190  11023.50 7.164E-03  24000.50 6.102E-03  25055.50 5.745E-04 $ above poison
       26000.55 2.064E-02  28000.50 4.169E-03  42000.50 4.693E-04
       27059.50 1.503E-05  73181.50 9.814E-07
c
 m193 11023.50 2.0030E-02  24000.5 1.5390E-03 25055.50 1.4490E-04
      26000.55 5.2030E-03  28000.5 1.0520E-03 42000.50 1.1830E-04
      27059.50 3.7890E-06 73181.50 2.4750E-07
 m111 11023.50 9.1130E-03  24000.5 8.5990E-03 25055.50 4.1630E-04
      26000.55 1.4910E-02  28000.5 2.3070E-02 42000.50 2.9280E-04
      27059.50 2.2650E-05 73181.50 1.4910E-06
 m194 11023.50 7.1580E-03  24000.5  5.3860E-03 25055.50 5.0710E-04
      26000.55 1.8210E-02  28000.5  3.6810E-03 42000.50 4.1410E-04
      27059.50 1.3260E-05  73181.50 8.6620E-07  5010.5  6.3860E-03
       5011.55 2.5870E-02   6000.5  7.2940E-03
 m121 11023.50 1.2240E-02  24000.5 7.1970E-03 25055.50 6.7760E-04
      26000.55 2.4330E-02  28000.5 4.9180E-03 42000.50 5.5340E-04
      27059.50 1.7720E-05 73181.50 1.1570E-06
c
c     CR/SR shield/orifice
 m192 11023.50 8.5120E-03  24000.5 9.9140E-03 25055.50 9.3340E-04
      26000.55 3.3520E-02  28000.5 6.7740E-03 42000.50 7.6220E-04
       27059.50 2.4410E-05 73181.50 1.5940E-06
c
c     Lower shield/orifice - row 7 refl
 m133  11023.50 4.800E-03   24000.50 1.037E-02   25055.50 1.289E-03
       26000.55 4.438E-02   28000.50 6.198E-03   42000.50 3.377E-03
       27059.50 2.352E-05   14000.50 3.296E-04    6000.50 1.127E-05
c     Lower shield/orifice - row 8 & 9 refl
 m134  11023.50 8.872E-03   24000.50 7.940E-03   25055.50 9.869E-04
       26000.55 3.397E-02   28000.50 4.744E-03   42000.50 2.585E-03
       27059.50 1.800E-05   14000.50 2.523E-04    6000.50 8.630E-06
 m124 11023.50 9.1130E-03  24000.5 4.7080E-03 25055.50 4.4320E-04
      26000.55 1.5920E-02  28000.5 3.2170E-03 42000.50 3.6200E-04
       27059.50 1.1590E-05 73181.50 7.5710E-07
c    upper reflector shield - 7
 m137  11023.50 3.198E-03   24000.50 1.133E-02   25055.50 1.408E-03
       26000.55 4.848E-02   28000.50 6.770E-03   42000.50 3.689E-03
       27059.50 2.569E-05   14000.50 3.600E-04    6000.50 1.232E-05
c    upper reflector shield - 8 & 9
 m138  11023.50 2.147E-03   24000.50 1.197E-02   25055.50 1.488E-03
       26000.55 5.122E-02   28000.50 7.153E-03   42000.50 3.898E-03
       27059.50 2.714E-05   14000.50 3.804E-04    6000.50 1.302E-05
c
 m139 11023.50 2.2200E-02
 m140  11023.50 1.7700E-03 26000.55 5.3687E-02  24000.5 1.5892E-02
        28000.5 6.6670E-03 25055.50 1.1875E-03 42000.50 2.2666E-04
         6000.5 2.1726E-04  14000.5 7.8702E-04
 m141  11023.50 0.015529   26000.55 0.017479    24000.5 0.005083
        28000.5 0.002338   25055.50 0.000371   42000.50 0.000055
         6000.5 0.000109    14000.5 0.000150
 m142  11023.50 0.8330E-03 26000.55 5.4347E-02  24000.5 1.60872E-02
        28000.5 6.7489E-03 25055.50 1.2021E-03 42000.50 2.2944E-04
         6000.5 2.1993E-04  14000.5 7.9669E-04
c
 m222  92235.5 1.600E-05 92238.5  7.222E-03  8016.5 1.4444E-02
       11023.50  9.113E-03  24000.5  3.751E-03  25055.50  3.192E-04
       26000.55 1.2769E-02  28000.5  2.5936E-03 42000.50 2.594E-04
       14000.5  2.195E-04  6000.5 0.399E-04
c    m304  $ SS 304 for heating rate tally
c       26000.55 0.6961  25055.50 0.1918  28000.5 0.0937  24000.5 0.0144
c       6000.5 0.0040
 m401  $ IT guide tubes  0.02532
      11023.50 0.021169 14000.50 2.45E-05 24000.50 0.000775 25055.50 7.98E-05
```

```
      26000.55 0.002852 6000.50  5.15E-06 28000.50 0.000414
m402   $ IT lower frame 0.052081
      11023.50 0.011931 14000.50 0.000237 24000.50   0.0075 25055.50 0.000772
      26000.55 0.027588 6000.50  4.98E-05 28000.50 0.004003
m403   $ IT hold down   0.031939
      11023.50  0.01881 14000.50 7.75E-05 24000.50 0.002452 25055.50 0.000252
      26000.55 0.009021 6000.50  1.63E-05 28000.50 0.001309
m404   $ Handling Socket 0.03304  ss-316 vol. fr. = 0.172   (revised 7/2/02)
      11023.50 0.018096  14000.50 8.82E-05  24000.50 0.002792  25055.50 0.000287
      26000.55 0.010271   6000.50 1.85E-05  28000.50 0.001490
m405   $ Grid plate     0.068718
      11023.50 0.005699 14000.50 0.000372 24000.50 0.011772 25055.50 0.001212
      26000.55 0.043302 6000.50  7.81E-05 28000.50 0.006284
m406   $ Nozzle         0.049029
      11023.50 0.012679 14000.50 0.000215 24000.50 0.006097 25055.50 0.000702
      26000.55 0.023881 6000.50  4.52E-05 28000.50 0.004719 42000.50  0.00069
m407   $ Core support   0.084704
                        14000.50   0.0005 24000.50 0.015822 25055.50 0.001629
      26000.55 0.058202 6000.50  0.000105 28000.50 0.008446
m409   $ IT column      0.030378
      11023.50 0.019366 14000.50  6.5E-05 24000.50 0.002057 25055.50 0.000212
      26000.55 0.007566 6000.50  1.37E-05 28000.50 0.001098
m410   $ Shield Support 0.061288
      11023.50 0.008348 14000.50 0.000313 24000.50 0.009889 25055.50 0.001018
      26000.55 0.036376 6000.50  6.56E-05 28000.50 0.005279
m411   $ Baffle         0.084704
                        14000.50   0.0005 24000.50 0.015822 25055.50 0.001629
      26000.55 0.058202 6000.50  0.000105 28000.50 0.008446
m412   $ Core barrel    0.084704
                        14000.50   0.0005 24000.50 0.015822 25055.50 0.001629
      26000.55 0.058202 6000.50  0.000105 28000.50 0.008446
m413   $ IVHM           0.03641
      11023.50 0.017216 14000.50 0.000113 24000.50 0.003585 25055.50 0.000369
      26000.55 0.013189 6000.50  2.38E-05 28000.50 0.001914
m414   $ IVSM           0.02941
      11023.50 0.019711 14000.50 5.73E-05 24000.50 0.001812 25055.50 0.000187
      26000.55 0.006664 6000.50   1.2E-05 28000.50 0.000967
c    m415   $ TS-Vessel      0.074297
c      11023.50  0.00371 14000.50 0.000417 24000.50 0.013185 25055.50 0.001357
c      26000.55 0.048502 6000.50  8.75E-05 28000.50 0.007038
m433   $ Cavity insulati0.000913
       8016.5 0.000377  14000.50 0.000221  20000.5 0.000315
m417   $ H. D. Concrete   0.0813
       1001.5  0.00766   8016.5  0.04753 26000.55  0.01576
      14000.50  0.00704  20000.5  0.00331
c    m418   $ Na-Vessel      0.046975
c      11023.50 0.013449 14000.50 0.000198 24000.50 0.006262 25055.50 0.000645
c      26000.55 0.023036 6000.50  4.16E-05 28000.50 0.003343
m419   $ Na Below Nozzle0.032501
      11023.50 0.018609 14000.50  8.2E-05 24000.50 0.002595 25055.50 0.000267
      26000.55 0.009545 6000.50  1.72E-05 28000.50 0.001385
c
m430   $ inconel (8.47 g/cc)
      26000.55 -0.080    6000.50 -0.003    25055.50 -0.020    14000.50 -0.005
      24000.50 -0.150   28000.50 -0.742
m431   $ 304 ss        (7.870 g/cc)
      26000.55 -0.5884   6000.50 -0.0008  25055.50 -0.02000 28000.50 -0.19000
      24000.50 -0.1900  14000.50 -0.0100  15031.50 -0.00045 16032.50 -0.00035
m432   $ Argon         (1.784 g/cc)
      17000.50  1.00000
c    m416   $ Nitrogen      (1.251 g/cc)
c      7014.50  1.00000
m434   $ polyethylene  (0.900 g/cc) borated
       6000.50 -0.8571   1001.50  -0.1429
m435   $ B4C (2.5 g/cc)
       5010.50 -0.14336  5011.55  -0.63928 6012.50 -0.21736
m436   $ 410 ss        (7.80 g/cc)
      26000.55 -0.8600   6000.50 -0.0010  25055.50 -0.00500 28000.50 -0.00500
      24000.50 -0.1240  14000.50 -0.0050
m437   $ low carbon steel (7.87 g/cc)
      26000.55 -0.9922   6000.50 -0.0018  25055.50 -0.0060
c
totnu
mode    n
kcode   2000  1.018  10  1210
ksrc    0.0 0.0 -30.0  0.0 0.0 0.0   0.0 0.0 30.0
tmp1    0.0618e-6  2939r
thtme   0.
cut:n   1.0e+12  0.0  0.0  0.0
print    20 60 90 100 110 126 130
prdmp     j -2000  1
lost    100
idum    j j j j j j j j 1
*tr1    0    0    0   120   210   90   30   120   90   90   90   0
*tr2    0    0    0   240   330   90  150   240   90   90   90   0
wwp:n    2.5 j 8 0 0
wwn1:n  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3306
        0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3312
        0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3318
```

0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 3324
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 3330
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 3336
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 42
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 48
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 54
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 60
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 66
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 72
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 78
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 84
0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	0.450E+00	$ 90
0.450E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 96
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 102
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 108
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 114
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 120
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 126
0.225E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 132
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 138
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 144
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 150
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 156
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 162
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 168
0.112E+00	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 174
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 180
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 186
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 192
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 198
0.562E-01	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 205
0.225E+00	0.225E+00	0.225E+00	0.450E+00	0.225E+00	0.225E+00	$ 211
0.225E+00	0.450E+00	0.225E+00	0.225E+00	0.225E+00	0.450E+00	$ 217
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 223
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 229
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 235
0.225E+00	0.225E+00	0.225E+00	0.450E+00	0.225E+00	0.450E+00	$ 241
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.450E+00	$ 247
0.225E+00	0.450E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 253
0.225E+00	0.450E+00	0.225E+00	0.450E+00	0.225E+00	0.225E+00	$ 259
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 265
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 271
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 277
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 283
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 289
0.225E+00	0.225E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 295
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 301
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 307
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 313
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 319
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 325
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 331
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 337
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 343
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 349
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 355
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 361
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 367
0.112E+00	0.112E+00	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 373
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 379
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 385
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 391
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 397
0.562E-01	0.562E-01	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 404
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 410
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 416
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 422
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 428
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 434
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.450E+00	0.225E+00	$ 440
0.450E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 446
0.450E+00	0.225E+00	0.450E+00	0.225E+00	0.225E+00	0.225E+00	$ 452
0.225E+00	0.225E+00	0.450E+00	0.225E+00	0.450E+00	0.225E+00	$ 458
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 464
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 470
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 476
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 482
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 488
0.225E+00	0.225E+00	0.225E+00	0.112E+00	0.112E+00	0.112E+00	$ 494
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 500
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 506
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 512
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 518
0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	0.112E+00	$ 524
0.112E+00	0.112E+00	0.112E+00	0.562E-01	0.562E-01	0.562E-01	$ 530
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 536
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 542
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 548
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 554

0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 560
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 566
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 572
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 578
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 584
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 590
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 596
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 603
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 609
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 615
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 621
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 627
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 633
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 639
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 645
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 651
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 657
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 663
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 669
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 675
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 681
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 687
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 693
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 699
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 705
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 711
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 717
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 723
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 729
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 735
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 741
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 747
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 753
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 759
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 765
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	$ 771
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 777
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 783
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 789
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 795
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.562E-01	0.562E-01	$ 802
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 808
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 814
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 820
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 826
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 832
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 838
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 844
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 850
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 856
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 862
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 868
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 874
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 880
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 886
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 892
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 898
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 904
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 910
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 916
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 922
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.281E-01	$ 928
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 934
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 940
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 946
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 952
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 958
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 964
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 970
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 976
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 982
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 988
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 994
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.562E-01	$ 1007
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.281E-01	$ 1013
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 1019
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.141E-01	$ 1025
0.141E-01	0.141E-01	0.141E-01	0.141E-01	0.141E-01	0.281E-01	$ 1031
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.225E+00	$ 1037
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 1043
0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	0.225E+00	$ 1049
0.225E+00	0.225E+00	0.703E-02	0.281E-01	0.562E-01	0.562E-01	$ 1204
0.281E-01	0.281E-01	0.141E-01	0.352E-02	0.176E-02	0.703E-02	$ 1210
0.281E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.141E-01	$ 1216
0.352E-02	0.176E-02	0.703E-02	0.281E-01	0.562E-01	0.562E-01	$ 1222
0.281E-01	0.281E-01	0.141E-01	0.352E-02	0.176E-02	0.703E-02	$ 1228
0.281E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.141E-01	$ 1234
0.352E-02	0.176E-02	0.703E-02	0.281E-01	0.562E-01	0.562E-01	$ 1240
0.281E-01	0.281E-01	0.141E-01	0.352E-02	0.176E-02	0.703E-02	$ 1246

0.281E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.141E-01	$ 1252
0.352E-02	0.176E-02	0.703E-02	0.281E-01	0.562E-01	0.562E-01	$ 1258
0.281E-01	0.281E-01	0.141E-01	0.352E-02	0.176E-02	0.703E-02	$ 1264
0.281E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.141E-01	$ 1270
0.352E-02	0.176E-02	0.703E-02	0.281E-01	0.562E-01	0.562E-01	$ 1276
0.281E-01	0.281E-01	0.141E-01	0.352E-02	0.176E-02	0.703E-02	$ 1282
0.281E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.141E-01	$ 1288
0.352E-02	0.176E-02	0.703E-02	0.281E-01	0.562E-01	0.562E-01	$ 1294
0.281E-01	0.281E-01	0.141E-01	0.352E-02	0.176E-02	0.703E-02	$ 1300
0.281E-01	0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.141E-01	$ 1306
0.352E-02	0.176E-02	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 1444
0.281E-01	0.281E-01	0.703E-02	0.703E-02	0.703E-02	0.703E-02	$ 1450
0.703E-02	0.703E-02	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 1456
0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	0.562E-01	$ 1462
0.562E-01	0.562E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 1468
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 1474
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 1480
0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	0.281E-01	$ 1486
0.281E-01	0.281E-01	0.141E-01	0.141E-01	0.141E-01	0.141E-01	$ 1492
0.141E-01	0.141E-01	0.141E-01	0.141E-01	0.141E-01	0.141E-01	$ 1498
0.141E-01	0.141E-01	0.703E-02	0.703E-02	0.703E-02	0.703E-02	$ 1504
0.703E-02	0.703E-02	0.703E-02	0.703E-02	0.703E-02	0.167E-05	$ 1511
0.255E-06	0.195E-06	0.447E-06	0.687E-05	0.274E-06	0.298E-05	$ 1517
0.223E-03	0.353E-04	0.677E-04	0.391E-04	0.262E-04	0.220E-03	$ 1523
0.439E-03	0.879E-03	0.176E-02	0.352E-02	0.352E-02	0.352E-02	$ 1529
0.352E-02	0.879E-03	0.879E-03	0.439E-03	0.110E-03	0.549E-04	$ 1535
0.137E-04	0.429E-06	0.536E-07	0.536E-07	0.268E-07	0.134E-07	$ 1541
0.134E-07	0.134E-07	0.671E-08	0.671E-08	0.671E-08	0.335E-08	$ 1547
0.838E-09	0.838E-09	0.335E-08	0.419E-09	0.210E-09	0.210E-09	$ 1553
0.419E-09	0.210E-09	0.105E-09	0.262E-10	0.524E-10	0.131E-10	$ 1559
0.262E-10	0.164E-11	0.256E-13	0.220E-03	0.439E-03	0.879E-03	$ 1573
0.176E-02	0.352E-02	0.352E-02	0.457E-02	0.359E-02	0.879E-03	$ 1579
0.879E-03	0.439E-03	0.110E-03	0.549E-04	0.137E-04	0.438E-06	$ 1585
0.536E-07	0.536E-07	0.268E-07	0.134E-07	0.134E-07	0.134E-07	$ 1591
0.671E-08	0.671E-08	0.671E-08	0.335E-08	0.838E-09	0.838E-09	$ 1597
0.335E-08	0.419E-09	0.210E-09	0.210E-09	0.419E-09	0.210E-09	$ 1603
0.105E-09	0.262E-10	0.524E-10	0.131E-10	0.262E-10	0.164E-11	$ 1609
0.256E-13	0.220E-03	0.439E-03	0.879E-03	0.176E-02	0.352E-02	$ 1615
0.352E-02	0.352E-02	0.352E-02	0.879E-03	0.879E-03	0.439E-03	$ 1621
0.110E-03	0.549E-04	0.137E-04	0.429E-06	0.536E-07	0.536E-07	$ 1627
0.268E-07	0.134E-07	0.134E-07	0.134E-07	0.671E-08	0.671E-08	$ 1633
0.671E-08	0.335E-08	0.838E-09	0.838E-09	0.335E-08	0.419E-09	$ 1639
0.210E-09	0.210E-09	0.419E-09	0.210E-09	0.105E-09	0.262E-10	$ 1645
0.524E-10	0.131E-10	0.262E-10	0.164E-11	0.256E-13	0.220E-03	$ 1651
0.439E-03	0.879E-03	0.176E-02	0.352E-02	0.352E-02	0.352E-02	$ 1657
0.352E-02	0.879E-03	0.879E-03	0.439E-03	0.110E-03	0.549E-04	$ 1663
0.137E-04	0.429E-06	0.536E-07	0.536E-07	0.268E-07	0.134E-07	$ 1669
0.134E-07	0.134E-07	0.671E-08	0.671E-08	0.671E-08	0.335E-08	$ 1675
0.838E-09	0.838E-09	0.335E-08	0.419E-09	0.210E-09	0.210E-09	$ 1681
0.419E-09	0.210E-09	0.105E-09	0.262E-10	0.524E-10	0.131E-10	$ 1687
0.262E-10	0.164E-11	0.256E-13	0.176E-02	0.176E-02	0.176E-02	$ 1693
0.755E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	0.275E-04	$ 1699
0.137E-04	0.215E-06	0.536E-07	0.536E-07	0.268E-07	0.134E-07	$ 1705
0.671E-08	0.134E-07	0.671E-08	0.671E-08	0.671E-08	0.671E-08	$ 1711
0.168E-08	0.838E-09	0.335E-08	0.419E-09	0.419E-09	0.262E-10	$ 1717
0.419E-09	0.105E-09	0.105E-09	0.262E-10	0.524E-10	0.262E-10	$ 1723
0.262E-10	0.164E-11	0.256E-13	0.879E-03	0.879E-03	0.176E-02	$ 1733
0.176E-02	0.352E-02	0.758E-02	0.141E-01	0.281E-01	0.281E-01	$ 1739
0.141E-01	0.703E-02	0.176E-02	0.879E-03	0.439E-03	0.110E-03	$ 1745
0.110E-03	0.110E-03	0.549E-04	0.549E-04	0.687E-05	0.215E-06	$ 1751
0.536E-07	0.536E-07	0.268E-07	0.134E-07	0.134E-07	0.134E-07	$ 1757
0.134E-07	0.134E-07	0.134E-07	0.671E-08	0.168E-08	0.168E-08	$ 1763
0.671E-08	0.419E-09	0.838E-09	0.210E-09	0.419E-09	0.210E-09	$ 1769
0.210E-09	0.105E-09	0.105E-09	0.131E-10	0.262E-10	0.327E-11	$ 1775
0.102E-12	0.879E-03	0.879E-03	0.879E-03	0.879E-03	0.176E-02	$ 1785
0.352E-02	0.141E-01	0.141E-01	0.141E-01	0.703E-02	0.352E-02	$ 1791
0.879E-03	0.439E-03	0.220E-03	0.275E-04	0.549E-04	0.549E-04	$ 1797
0.549E-04	0.549E-04	0.137E-04	0.687E-05	0.215E-06	0.536E-07	$ 1803
0.536E-07	0.268E-07	0.134E-07	0.134E-07	0.134E-07	0.671E-08	$ 1809
0.671E-08	0.134E-07	0.671E-08	0.168E-08	0.419E-09	0.671E-08	$ 1815
0.838E-09	0.419E-09	0.105E-09	0.419E-09	0.105E-09	0.210E-09	$ 1821
0.524E-10	0.524E-10	0.131E-10	0.262E-10	0.327E-11	0.256E-13	$ 1827
0.879E-03	0.879E-03	0.439E-03	0.439E-03	0.879E-03	0.176E-02	$ 1836
0.352E-02	0.703E-02	0.703E-02	0.352E-02	0.176E-02	0.439E-03	$ 1842
0.220E-03	0.786E-04	0.137E-04	0.275E-04	0.549E-04	0.549E-04	$ 1848
0.275E-04	0.275E-04	0.357E-05	0.107E-06	0.536E-07	0.107E-06	$ 1854
0.536E-07	0.268E-07	0.134E-07	0.268E-07	0.134E-07	0.134E-07	$ 1860
0.134E-07	0.671E-08	0.335E-08	0.168E-08	0.671E-08	0.838E-09	$ 1866
0.838E-09	0.524E-10	0.419E-09	0.210E-09	0.210E-09	0.524E-10	$ 1872
0.105E-09	0.131E-10	0.262E-10	0.327E-11	0.256E-13	0.439E-03	$ 1881
0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.879E-03	0.176E-02	$ 1887
0.180E-02	0.176E-02	0.176E-02	0.879E-03	0.220E-03	0.220E-03	$ 1893
0.549E-04	0.275E-04	0.275E-04	0.275E-04	0.275E-04	0.275E-04	$ 1899
0.275E-04	0.687E-05	0.107E-06	0.536E-07	0.107E-06	0.536E-07	$ 1905
0.268E-07	0.268E-07	0.268E-07	0.134E-07	0.134E-07	0.671E-08	$ 1911
0.671E-08	0.168E-08	0.168E-08	0.671E-08	0.419E-09	0.419E-09	$ 1917
0.524E-10	0.419E-09	0.105E-09	0.210E-09	0.105E-09	0.105E-09	$ 1923
0.524E-10	0.262E-10	0.327E-11	0.512E-13	0.439E-03	0.439E-03	$ 1932
0.439E-03	0.439E-03	0.879E-03	0.879E-03	0.879E-03	0.879E-03	$ 1938

0.879E-03	0.459E-03	0.220E-03	0.132E-03	0.549E-04	0.275E-04	$ 1944
0.275E-04	0.275E-04	0.275E-04	0.275E-04	0.137E-04	0.687E-05	$ 1950
0.107E-06	0.107E-06	0.107E-06	0.536E-07	0.268E-07	0.268E-07	$ 1956
0.268E-07	0.134E-07	0.134E-07	0.134E-07	0.671E-08	0.335E-08	$ 1962
0.168E-08	0.671E-08	0.838E-09	0.419E-09	0.105E-09	0.419E-09	$ 1968
0.419E-09	0.210E-09	0.105E-09	0.105E-09	0.524E-10	0.524E-10	$ 1974
0.655E-11	0.102E-12	0.439E-03	0.439E-03	0.439E-03	0.439E-03	$ 1984
0.439E-03	0.176E-02	0.176E-02	0.879E-03	0.879E-03	0.879E-03	$ 1990
0.439E-03	0.220E-03	0.549E-04	0.549E-04	0.275E-04	0.275E-04	$ 1996
0.275E-04	0.275E-04	0.137E-04	0.343E-05	0.107E-06	0.536E-07	$ 2002
0.107E-06	0.536E-07	0.268E-07	0.268E-07	0.268E-07	0.134E-07	$ 2008
0.134E-07	0.134E-07	0.671E-08	0.335E-08	0.168E-08	0.671E-08	$ 2014
0.838E-09	0.838E-09	0.268E-07	0.838E-09	0.210E-09	0.419E-09	$ 2020
0.105E-09	0.105E-09	0.524E-10	0.524E-10	0.655E-11	0.512E-13	$ 2026
0.220E-03	0.220E-03	0.220E-03	0.879E-03	0.879E-03	0.879E-03	$ 2036
0.879E-03	0.879E-03	0.439E-03	0.220E-03	0.148E-03	0.549E-04	$ 2042
0.549E-04	0.549E-04	0.275E-04	0.275E-04	0.275E-04	0.137E-04	$ 2048
0.137E-04	0.343E-05	0.107E-06	0.107E-06	0.107E-06	0.536E-07	$ 2054
0.268E-07	0.268E-07	0.268E-07	0.134E-07	0.134E-07	0.134E-07	$ 2060
0.671E-08	0.335E-08	0.671E-08	0.134E-07	0.168E-08	0.172E-05	$ 2066
0.275E-10	0.429E-06	0.838E-09	0.419E-09	0.210E-09	0.210E-09	$ 2072
0.524E-10	0.524E-10	0.655E-11	0.512E-13	0.110E-03	0.110E-03	$ 2082
0.220E-03	0.220E-03	0.439E-03	0.879E-03	0.879E-03	0.439E-03	$ 2088
0.879E-03	0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	$ 2094
0.549E-04	0.549E-04	0.275E-04	0.137E-04	0.137E-04	0.137E-04	$ 2100
0.137E-04	0.687E-05	0.343E-05	0.536E-07	0.536E-07	0.536E-07	$ 2106
0.268E-07	0.134E-07	0.134E-07	0.134E-07	0.134E-07	0.134E-07	$ 2112
0.671E-08	0.671E-08	0.335E-08	0.168E-08	0.671E-08	0.838E-09	$ 2118
0.419E-09	0.268E-07	0.838E-09	0.419E-09	0.210E-09	0.105E-09	$ 2124
0.105E-09	0.105E-09	0.524E-10	0.655E-11	0.512E-13	0.110E-03	$ 2131
0.110E-03	0.110E-03	0.220E-03	0.262E-03	0.539E-03	0.879E-03	$ 2137
0.879E-03	0.460E-03	0.244E-03	0.220E-03	0.110E-03	0.549E-04	$ 2143
0.549E-04	0.275E-04	0.137E-04	0.275E-04	0.137E-04	0.687E-05	$ 2149
0.687E-05	0.104E-05	0.536E-07	0.536E-07	0.536E-07	0.536E-07	$ 2155
0.268E-07	0.268E-07	0.268E-07	0.268E-07	0.134E-07	0.134E-07	$ 2161
0.134E-07	0.671E-08	0.671E-08	0.134E-07	0.168E-08	0.168E-08	$ 2167
0.419E-09	0.168E-08	0.838E-09	0.838E-09	0.419E-09	0.419E-09	$ 2173
0.524E-10	0.105E-09	0.131E-10	0.205E-12	0.110E-03	0.110E-03	$ 2182
0.220E-03	0.439E-03	0.439E-03	0.879E-03	0.879E-03	0.879E-03	$ 2188
0.879E-03	0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	$ 2194
0.275E-04	0.137E-04	0.275E-04	0.687E-05	0.687E-05	0.343E-05	$ 2200
0.429E-06	0.248E-07	0.268E-07	0.536E-07	0.134E-07	0.671E-08	$ 2206
0.134E-07	0.134E-07	0.671E-08	0.671E-08	0.671E-08	0.335E-08	$ 2212
0.168E-08	0.335E-08	0.671E-08	0.838E-09	0.838E-09	0.838E-09	$ 2218
0.838E-09	0.838E-09	0.419E-09	0.210E-09	0.210E-09	0.524E-10	$ 2224
0.131E-10	0.164E-11	0.256E-13	0.549E-04	0.110E-03	0.220E-03	$ 2233
0.220E-03	0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.439E-03	$ 2239
0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	0.275E-04	$ 2245
0.275E-04	0.137E-04	0.687E-05	0.343E-05	0.172E-05	0.429E-06	$ 2251
0.268E-07	0.536E-07	0.536E-07	0.536E-07	0.268E-07	0.268E-07	$ 2257
0.268E-07	0.134E-07	0.134E-07	0.268E-07	0.134E-07	0.671E-08	$ 2263
0.335E-08	0.134E-07	0.168E-08	0.838E-09	0.838E-09	0.168E-08	$ 2269
0.168E-08	0.838E-09	0.210E-09	0.419E-09	0.105E-09	0.262E-10	$ 2275
0.327E-11	0.256E-13	0.110E-03	0.110E-03	0.220E-03	0.220E-03	$ 2284
0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.439E-03	$ 2290
0.220E-03	0.220E-03	0.110E-03	0.549E-04	0.549E-04	0.137E-04	$ 2296
0.137E-04	0.343E-05	0.343E-05	0.429E-06	0.268E-07	0.107E-06	$ 2302
0.107E-06	0.536E-07	0.536E-07	0.268E-07	0.536E-07	0.536E-07	$ 2308
0.268E-07	0.268E-07	0.134E-07	0.671E-08	0.671E-08	0.134E-07	$ 2314
0.335E-08	0.168E-08	0.168E-08	0.335E-08	0.168E-08	0.838E-09	$ 2320
0.838E-09	0.419E-09	0.105E-09	0.131E-10	0.164E-11	0.256E-13	$ 2326
0.549E-04	0.110E-03	0.110E-03	0.220E-03	0.220E-03	0.439E-03	$ 2336
0.439E-03	0.439E-03	0.439E-03	0.220E-03	0.220E-03	0.110E-03	$ 2342
0.110E-03	0.549E-04	0.549E-04	0.137E-04	0.137E-04	0.687E-05	$ 2348
0.343E-05	0.858E-06	0.536E-07	0.107E-06	0.107E-06	0.536E-07	$ 2354
0.536E-07	0.536E-07	0.536E-07	0.536E-07	0.536E-07	0.268E-07	$ 2360
0.268E-07	0.134E-07	0.671E-08	0.134E-07	0.671E-08	0.335E-08	$ 2366
0.335E-08	0.671E-08	0.168E-08	0.168E-08	0.168E-08	0.838E-09	$ 2372
0.210E-09	0.131E-10	0.819E-12	0.256E-13	0.220E-03	0.220E-03	$ 2382
0.220E-03	0.220E-03	0.439E-03	0.879E-03	0.879E-03	0.879E-03	$ 2388
0.879E-03	0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	$ 2394
0.549E-04	0.275E-04	0.275E-04	0.687E-05	0.687E-05	0.343E-05	$ 2400
0.858E-06	0.350E-07	0.268E-07	0.268E-07	0.268E-07	0.134E-07	$ 2406
0.134E-07	0.134E-07	0.671E-08	0.134E-07	0.335E-08	0.335E-08	$ 2412
0.168E-08	0.335E-08	0.671E-08	0.168E-08	0.210E-09	0.419E-09	$ 2418
0.419E-09	0.210E-09	0.419E-09	0.210E-09	0.210E-09	0.105E-09	$ 2424
0.105E-09	0.524E-10	0.819E-12	0.110E-03	0.110E-03	0.220E-03	$ 2433
0.220E-03	0.439E-03	0.879E-03	0.879E-03	0.879E-03	0.879E-03	$ 2439
0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	0.549E-04	$ 2445
0.275E-04	0.137E-04	0.137E-04	0.343E-05	0.172E-05	0.429E-06	$ 2451
0.536E-07	0.536E-07	0.107E-06	0.536E-07	0.536E-07	0.268E-07	$ 2457
0.268E-07	0.134E-07	0.268E-07	0.268E-07	0.134E-07	0.335E-08	$ 2463
0.335E-08	0.671E-08	0.168E-08	0.838E-09	0.838E-09	0.838E-09	$ 2469
0.838E-09	0.838E-09	0.419E-09	0.210E-09	0.105E-09	0.210E-09	$ 2475
0.524E-10	0.819E-12	0.110E-03	0.110E-03	0.220E-03	0.220E-03	$ 2484
0.220E-03	0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.220E-03	$ 2490
0.220E-03	0.110E-03	0.110E-03	0.549E-04	0.549E-04	0.137E-04	$ 2496
0.137E-04	0.687E-05	0.343E-05	0.858E-06	0.286E-07	0.107E-06	$ 2502
0.107E-06	0.107E-06	0.536E-07	0.268E-07	0.536E-07	0.536E-07	$ 2508

0.268E-07	0.268E-07	0.134E-07	0.134E-07	0.335E-08	0.134E-07	$ 2514
0.168E-08	0.168E-08	0.168E-08	0.168E-08	0.838E-09	0.838E-09	$ 2520
0.838E-09	0.419E-09	0.210E-09	0.105E-09	0.655E-11	0.102E-12	$ 2526
0.549E-04	0.110E-03	0.220E-03	0.220E-03	0.220E-03	0.439E-03	$ 2532
0.439E-03	0.220E-03	0.439E-03	0.220E-03	0.220E-03	0.110E-03	$ 2538
0.110E-03	0.549E-04	0.549E-04	0.137E-04	0.137E-04	0.687E-05	$ 2544
0.343E-05	0.858E-06	0.536E-07	0.215E-06	0.107E-06	0.107E-06	$ 2550
0.536E-07	0.536E-07	0.536E-07	0.536E-07	0.536E-07	0.268E-07	$ 2556
0.134E-07	0.134E-07	0.671E-08	0.134E-07	0.335E-08	0.335E-08	$ 2562
0.335E-08	0.671E-08	0.335E-08	0.168E-08	0.168E-08	0.838E-09	$ 2568
0.210E-09	0.524E-10	0.655E-11	0.102E-12	0.110E-03	0.110E-03	$ 2582
0.220E-03	0.220E-03	0.439E-03	0.879E-03	0.879E-03	0.879E-03	$ 2588
0.879E-03	0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	$ 2594
0.549E-04	0.137E-04	0.137E-04	0.687E-05	0.687E-05	0.343E-05	$ 2600
0.553E-06	0.268E-07	0.268E-07	0.536E-07	0.134E-07	0.134E-07	$ 2606
0.134E-07	0.134E-07	0.134E-07	0.671E-08	0.671E-08	0.335E-08	$ 2612
0.335E-08	0.168E-08	0.671E-08	0.838E-09	0.838E-09	0.210E-09	$ 2618
0.419E-09	0.419E-09	0.419E-09	0.105E-09	0.105E-09	0.105E-09	$ 2624
0.655E-11	0.819E-12	0.320E-14	0.110E-03	0.110E-03	0.220E-03	$ 2633
0.220E-03	0.220E-03	0.879E-03	0.439E-03	0.439E-03	0.879E-03	$ 2639
0.439E-03	0.220E-03	0.220E-03	0.110E-03	0.549E-04	0.275E-04	$ 2645
0.275E-04	0.137E-04	0.687E-05	0.343E-05	0.172E-05	0.858E-06	$ 2651
0.268E-07	0.536E-07	0.536E-07	0.536E-07	0.268E-07	0.268E-07	$ 2657
0.268E-07	0.134E-07	0.268E-07	0.134E-07	0.671E-08	0.335E-08	$ 2663
0.335E-08	0.671E-08	0.168E-08	0.838E-09	0.838E-09	0.838E-09	$ 2669
0.419E-09	0.419E-09	0.210E-09	0.105E-09	0.105E-09	0.655E-11	$ 2675
0.164E-11	0.320E-14	0.110E-03	0.110E-03	0.220E-03	0.220E-03	$ 2684
0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.439E-03	0.220E-03	$ 2690
0.220E-03	0.220E-03	0.110E-03	0.549E-04	0.275E-04	0.137E-04	$ 2696
0.687E-05	0.687E-05	0.343E-05	0.429E-06	0.268E-07	0.107E-06	$ 2702
0.107E-06	0.107E-06	0.536E-07	0.536E-07	0.536E-07	0.536E-07	$ 2708
0.268E-07	0.268E-07	0.268E-07	0.671E-08	0.671E-08	0.671E-08	$ 2714
0.168E-08	0.168E-08	0.168E-08	0.335E-08	0.168E-08	0.838E-09	$ 2720
0.419E-09	0.210E-09	0.210E-09	0.655E-11	0.819E-12	0.320E-14	$ 2726
0.549E-04	0.110E-03	0.220E-03	0.110E-03	0.220E-03	0.439E-03	$ 2736
0.220E-03	0.220E-03	0.439E-03	0.220E-03	0.110E-03	0.220E-03	$ 2742
0.549E-04	0.110E-03	0.275E-04	0.137E-04	0.137E-04	0.687E-05	$ 2748
0.343E-05	0.429E-06	0.268E-07	0.107E-06	0.215E-06	0.107E-06	$ 2754
0.107E-06	0.536E-07	0.536E-07	0.536E-07	0.536E-07	0.268E-07	$ 2760
0.268E-07	0.671E-08	0.671E-08	0.134E-07	0.168E-08	0.671E-08	$ 2766
0.335E-08	0.671E-08	0.335E-08	0.168E-08	0.168E-08	0.419E-09	$ 2772
0.419E-09	0.131E-10	0.655E-11	0.320E-14	0.687E-05	0.137E-04	$ 2782
0.275E-04	0.549E-04	0.110E-03	0.110E-03	0.110E-03	0.110E-03	$ 2788
0.110E-03	0.110E-03	0.549E-04	0.549E-04	0.275E-04	0.275E-04	$ 2794
0.137E-04	0.687E-05	0.343E-05	0.343E-05	0.172E-05	0.429E-06	$ 2800
0.536E-07	0.429E-06	0.215E-06	0.107E-06	0.536E-07	0.536E-07	$ 2806
0.536E-07	0.536E-07	0.268E-07	0.268E-07	0.268E-07	0.268E-07	$ 2812
0.268E-07	0.268E-07	0.536E-07	0.536E-07	0.536E-07	0.536E-07	$ 2818
0.536E-07	0.134E-07	0.268E-07	0.671E-08	0.168E-08	0.262E-10	$ 2824
0.262E-10	0.819E-12	0.429E-06	0.343E-05	0.687E-05	0.137E-04	$ 2834
0.275E-04	0.549E-04	0.643E-04	0.110E-03	0.110E-03	0.811E-04	$ 2840
0.110E-03	0.651E-04	0.549E-04	0.275E-04	0.275E-04	0.137E-04	$ 2846
0.137E-04	0.687E-05	0.343E-05	0.343E-05	0.172E-05	0.547E-06	$ 2852
0.661E-07	0.429E-06	0.215E-06	0.107E-06	0.536E-07	0.536E-07	$ 2858
0.536E-07	0.536E-07	0.268E-07	0.268E-07	0.268E-07	0.268E-07	$ 2864
0.268E-07	0.536E-07	0.107E-06	0.107E-06	0.215E-06	0.107E-06	$ 2870
0.536E-07	0.268E-07	0.268E-07	0.671E-08	0.335E-08	0.262E-10	$ 2876
0.131E-10	0.409E-12	0.107E-06	0.536E-07	0.134E-07	0.335E-08	$ 2884
0.838E-09	0.118E-08	0.105E-09	0.105E-09	0.105E-09	0.429E-06	$ 2890
0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2896
0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.429E-06	0.107E-06	$ 2902
0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2908
0.107E-06	0.107E-06	0.107E-06	0.687E-05	0.687E-05	0.429E-06	$ 2914
0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2920
0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2926
0.687E-05	0.429E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2932
0.107E-06	0.107E-06	0.107E-06	0.429E-06	0.107E-06	0.107E-06	$ 2938
0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2944
0.107E-06	0.429E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2950
0.107E-06	0.807E-06	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2956
0.107E-06	0.125E-05	0.107E-06	0.107E-06	0.107E-06	0.107E-06	$ 2962
0.107E-06	0.107E-06	0.429E-06	0.429E-06	0.429E-06	0.429E-06	$ 2968
0.429E-06	0.142E-05	0.429E-06	0.429E-06	0.429E-06	0.231E-05	$ 2974
0.429E-06	0.429E-06	0.429E-06	0.687E-05	0.429E-06	0.429E-06	$ 2980
0.429E-06	0.110E-03	0.110E-03	0.110E-03	0.439E-03	0.879E-03	$ 2986
0.879E-03	0.879E-03	0.439E-03	0.110E-03	0.549E-04	0.275E-04	$ 2992
0.137E-04	0.137E-04	0.687E-05	0.343E-05	0.172E-05	0.536E-07	$ 2998
0.107E-06	0.107E-06	0.536E-07	0.536E-07	0.536E-07	0.536E-07	$ 3004
0.536E-07	0.268E-07	0.268E-07	0.268E-07	0.671E-08	0.671E-08	$ 3010
0.671E-08	0.335E-08	0.168E-08	0.335E-08	0.168E-08	0.168E-08	$ 3016
0.168E-08	0.838E-09	0.838E-09	0.210E-09	0.524E-10	0.131E-10	$ 3022
0.205E-12	0.110E-03	0.110E-03	0.110E-03	0.439E-03	0.879E-03	$ 3028
0.879E-03	0.879E-03	0.439E-03	0.110E-03	0.549E-04	0.275E-04	$ 3034
0.137E-04	0.137E-04	0.687E-05	0.343E-05	0.172E-05	0.536E-07	$ 3040
0.107E-06	0.107E-06	0.536E-07	0.536E-07	0.536E-07	0.536E-07	$ 3046
0.536E-07	0.268E-07	0.268E-07	0.268E-07	0.671E-08	0.671E-08	$ 3052
0.671E-08	0.335E-08	0.168E-08	0.335E-08	0.168E-08	0.168E-08	$ 3058
0.168E-08	0.838E-09	0.838E-09	0.210E-09	0.524E-10	0.131E-10	$ 3064
0.205E-12	0.110E-03	0.110E-03	0.110E-03	0.439E-03	0.879E-03	$ 3070

```
          0.879E-03  0.879E-03  0.439E-03  0.110E-03  0.549E-04  0.275E-04 $ 3076
          0.137E-04  0.137E-04  0.687E-05  0.343E-05  0.172E-05  0.536E-07 $ 3082
          0.107E-06  0.107E-06  0.536E-07  0.536E-07  0.536E-07  0.536E-07 $ 3088
          0.536E-07  0.268E-07  0.268E-07  0.268E-07  0.671E-08  0.671E-08 $ 3094
          0.671E-08  0.335E-08  0.168E-08  0.335E-08  0.168E-08  0.168E-08 $ 3100
          0.168E-08  0.838E-09  0.838E-09  0.210E-09  0.524E-10  0.131E-10 $ 3106
          0.205E-12  0.275E-04  0.275E-04  0.110E-03  0.220E-03  0.220E-03 $ 3115
          0.439E-03  0.439E-03  0.439E-03  0.439E-03  0.220E-03  0.220E-03 $ 3121
          0.110E-03  0.549E-04  0.549E-04  0.549E-04  0.137E-04  0.137E-04 $ 3127
          0.687E-05  0.343E-05  0.858E-06  0.536E-07  0.215E-06  0.215E-06 $ 3133
          0.107E-06  0.536E-07  0.536E-07  0.536E-07  0.536E-07  0.536E-07 $ 3139
          0.536E-07  0.268E-07  0.134E-07  0.671E-08  0.134E-07  0.671E-08 $ 3145
          0.134E-07  0.671E-08  0.671E-08  0.671E-08  0.335E-08  0.335E-08 $ 3151
          0.168E-08  0.168E-08  0.524E-10  0.262E-10  0.205E-12  0.137E-04 $ 3161
          0.275E-04  0.110E-03  0.110E-03  0.220E-03  0.220E-03  0.220E-03 $ 3167
          0.220E-03  0.220E-03  0.220E-03  0.110E-03  0.110E-03  0.549E-04 $ 3173
          0.549E-04  0.275E-04  0.137E-04  0.687E-05  0.687E-05  0.343E-05 $ 3179
          0.858E-06  0.536E-07  0.215E-06  0.215E-06  0.107E-06  0.107E-06 $ 3185
          0.536E-07  0.536E-07  0.536E-07  0.536E-07  0.536E-07  0.268E-07 $ 3191
          0.134E-07  0.134E-07  0.134E-07  0.134E-07  0.268E-07  0.268E-07 $ 3197
          0.268E-07  0.268E-07  0.671E-08  0.671E-08  0.335E-08  0.335E-08 $ 3203
          0.105E-09  0.131E-10  0.409E-12  0.687E-05  0.137E-04  0.275E-04 $ 3209
          0.110E-03  0.110E-03  0.220E-03  0.220E-03  0.220E-03  0.110E-03 $ 3215
          0.110E-03  0.110E-03  0.549E-04  0.275E-04  0.275E-04  0.137E-04 $ 3221
          0.687E-05  0.687E-05  0.343E-05  0.343E-05  0.429E-06  0.536E-07 $ 3227
          0.429E-06  0.215E-06  0.215E-06  0.107E-06  0.536E-07  0.536E-07 $ 3233
          0.536E-07  0.536E-07  0.536E-07  0.536E-07  0.134E-07  0.268E-07 $ 3239
          0.268E-07  0.268E-07  0.536E-07  0.536E-07  0.536E-07  0.536E-07 $ 3245
          0.268E-07  0.134E-07  0.671E-08  0.335E-08  0.262E-10  0.262E-10 $ 3251
          0.819E-12  0.439E-03  0.439E-03  0.176E-02  0.879E-03  0.220E-03 $ 3257
          0.439E-03  0.439E-03  0.879E-03  0.879E-03  0.220E-03  0.439E-03 $ 3263
          0.439E-03  0.879E-03  0.879E-03  0.220E-03  0.450E+00  0.450E+00 $ 3269
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3275
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3281
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3287
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $    6
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $   12
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $   18
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $   24
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $   30
          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $   36
          0.450E+00  0.450E+00  0.450E+00  0.450E+00 -0.100E+01 -0.100E+01 $ 3290
c      materials for activity tallies
m51    27059.50c 1.          $ Co-59(n,g)Co-60
m52    28060.26y 1.          $ Ni-60(n,p)Co-60
m53    27060.66y 1.          $ Co-60(n,g)burnup
m54    28058.26y 1.          $ Ni-58(n,g)Ni-59
m55    28059.66y 1.          $ Ni-59(n,g),(n,p),(n,a)burnup
m56    28062.26y 1.          $ Ni-62(n,g)Ni-63
m57    28063.66y 1.          $ Ni-63(n,g)burnup
m58    26054.26y 1.          $ Fe-54(n,g)Fe-55
m59    26055.66y 1.          $ Fe-55(n,g)burnup
m60     7014.50c  1.    $ N-14(n,p)C-14
m61    42092.26y  1.    $ Mo-92(n,g)Mo-93
m62    42093.66y  1.    $ Mo-93(n,g)Burnup (n,p)Nb-93
m63    42098.26y  1.    $ Mo-98(n,g)Mo-99
m64    43099.50c  1.    $ Tc-99(n,g)Burnup
m65    41093.30y  1.    $ Nb-93(n,g)Nb-94
m66    41094.30y  1.    $ Nb-94(n,g)Burnup
m67     6013.35c  1.    $ C-13(n,g)C-14
m68    42094.66y  1.    $ Mo-94(n,p)Nb-94
c      ------------------- FIXED RX COMPONENT ACTIVATION TALLY ------------------
fc34   m431 cells,    thermal liner
f34:n  (3207 32i 3240)
fm34   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd34   1.0
c
fc44   m431 cells,  reactor vessel
f44:n  (1516 2882 2883 2884 2885 2892 3i 2896 2903 3i 2907 2831 42i 2874)
fm44   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd44   1.0
c
fc54   m431 cells,    guard vessel
f54:n  (1513 1514 2912 2913)
fm54   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd54   1.0
c
fc64   m431 cells,    core support
f64:n  (1519 2i 1522 3111 3112)
fm64   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
```

```
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd64   1.0
c
fc74   m431 cells,    closure head
f74:n  (1559 1607 1647 1687 1723 1773 1824 1874 1924 1973 2023 2073
        2126 2174 2224 2274 2323 2373 2424 2474 2523 2569 2624 2674
        2723 2773 2823 2875 2886 2897 2908 2918 2919 2920 2921 2922
        2923 2932 2942 3020 3062 3104 3153 3203 3249)
fm74   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd74   1.0
c
fc84   m431 cells,      steel roof
f84:n  (1562 1610 1650 1690 1726 1776 1827 1877 1927 1976 2026 2076
        2129 2177 2227 2277 2326 2376 2427 2477 2526 2572 2627 2677
        2726 2776 2826 2878 2889 2900 2911 2926 2935 2945 2951 2957
        2964 2969 2973 2977 2981 3023 3065 3107 3156 3206 3252)
fm84   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd84   1.0
c
fc104  m407 cells,    core support, vertical
f104:n (1651 4i 1656)
fm104  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd104  1.0
c
fc114  m419 cells, Na below nozzle
f114:n (1523 2i 1526  1571 2i 1574  1611 2i 1614)
fm114  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd114  1.0
c
fc134  m405 cells,      grid plate
f134:n (1529 1577 1617 1657 1693 1733 1783 1833 1883 1933 1983 2032
        2083 2133 2183 2233 2283 2333 2383 2433 2483 2529 2583 2633
        2683 2733 2984 3026 3068 3113 3163)
fm134  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd134  1.0
c
fc174  m403 cells,      IT hold down
f174:n (1532 1580 1620 1660 1696)
fm174  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd174  1.0
c
fc184  m402 cells,    IT lower frame
f184:n (1533 1581 1621 1661 1697)
fm184  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd184  1.0
c
fc194  m401 cells,    IT guide tubes
f194:n (1534 8i 1543 1582 8i 1591 1622 8i 1631 1662 8i 1671 1698 8i 1707)
fm194  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd194  1.0
c
fc204  m140 cells,      inner shield
f204:n (1201 106i 1308 1488 1694 1695 1735 9i 1745)
fm204  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd204  1.0
c
fc214  m410 cells,    shield support
f214:n (1734 1784 1834 1884)
fm214  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
```

```
      (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
      (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd214  1.0
c
fc224  m142 cells,      outer shield
f224:n (1785 9i 1795 1835 9i 1845 1885 9i 1895)
fm224  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd224  1.0
c
fc234  m412 cells,       core barrel
f234:n (2031 2033 8i 2042 2094)
fm234  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd234  1.0
c
fc244  m413 cells,              IVHM
f244:n (2099 14i 2114 2147 14i 2162 2197 14i 2212 2247 14i 2262
        2397 14i 2412 2447 14i 2462 2597 14i 2612 2647 14i 2662)
fm244  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd244  1.0
c
fc254  m414 cells,              IVFSM
f254:n (2982 2983 2985 5i 2991 3024 3025 3027 5i 3033 3066 3067 3069 5i 3075)
fm254  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd254  1.0
c
fc264  m409 cells,          IT column
f264:n (1746 10i 1757 1797 10i 1808)
fm264  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd264  1.0
c
fc284  m435 cells,              B4C
f284:n (2890 2901 2914 2928 2936)
fm284  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd284  1.0
c
fc294  m431 cells,    Z ring
f294:n (2940 2948 2954 2961 2966)
fm294  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd294   1.0
c
fc304  m411 cells,  baffle plate
f304:n (1796 1846 1896 1945 1995 2045 2097 2145 2195 2245
        2295 2345 2395 2445 2495 2541 2595 2645 2695 2745
        2992 3034 3076 3125 3175)
fm304  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd304   1.0
c
fc314  m431 cells, ss-304 suppressor plate
f314:n (1548   1596   1636   1676   1712   1762   1813   1863   1913
        1962   2012   2062   2115   2163   2213   2263   2312   2362
        2413   2463   2512   2558   2613   2663   2712   2762   2812
        3009   3051   3093   3142   3192)
fm314  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd314    1.0
c
fc324  m431 cells, ss-304 thermal reflector plates
f324:n  (1551  1599 1639  1679  1715  1765  1816  1866    1916
         1965  2015 2065  2118  2166  2216  2266  2315    2365
         2416  2466 2515  2561  2616  2666  2715  2765    2815
         3012  3054 3096  3145  3195  3241)
fm324  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
```

```
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd324   1.0
c
fc334  m430 cells, Inconel 600 shield plate
f334:n  (1553  1601 1641  1681  1717  1767  1818  1868    1918
         1967  2017 2067  2120  2168  2218  2268  2317    2367
         2418  2468 2517  2563  2618  2668  2717  2767    2817
         3014  3056 3098  3147  3197  3243)
fm334  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd334   1.0
c
fc344  m436 cells, ss-410 shield plate
f344:n  (1555  1603  1643 1683  1719  1769  1820  1870  1920
         1969  2019  2069 2122  2170  2220  2270  2319  2369
         2420  2470  2519 2565  2620  2670  2719  2769  2819
         3016  3058  3100 3149  3199  3245)
fm344  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd344   1.0
c
fc354  m437 cells, low carbon steel shield plate
f354:n  (1557  1605  1645 1685  1721  1771  1822  1872  1922
         1971  2021  2071 2124  2172  2222  2272  2321  2371
         2422  2472  2521 2567  2622  2672  2721  2771  2821
         3018  3060  3102 3151  3201  3247)
fm354  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd354   1.0
c
fc364  bottom of core support structure
f364:n (1519)
fm364  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd364   1.0
```

Reaction Rate Tally Specifications for MCNP4C Case fftf10em

```
c      ------------------- CORE COMPONENT ACTIVATION TALLY ------------------
fc4     row 7 reflectors along core -- not incl. special assemblies
f4:n   ( 92 8i 101 103 104 10i 115 116 5i 122 124 125 127
         292 8i 301 303 304 10i 315 316 5i 322 324 325 327
         492 8i 501 503 504 10i 515 516 5i 522 524 525 527)
fm4    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd4      1.
c
fc14  m137 cells, rra-7 upper shield
f14:n (892 34i 927 1618)
fm14   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd14  1.0
c
fc24  m133 cells, rra-7 lower shield/orifice
f24:n (692 34i 727)
fm24   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd24  1.0
c
fc34  m404 cell, rra-7 handling sockets
f34:n (1619)
fm34   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd34  1.0
c
fc44  m406 cell, rra-7,8&9 nozzle
f44:n (1615 1616)
fm44   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
```

```
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd44  1.0
c
fc104     row 8 & row 9 reflectors along core
f104:n   (128 40i 169 328 40i 369 528 40i 569
        170 28i 199 370 28i 399 570 28i 599)
fm104     (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd104      1.
c
fc114  m138 cells, RRA-8 & 9 Upper shield
f114:n (928 70i 999 1658)
fm114  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd114  1.0
c
fc124  m134 cells, rra-8&9 lower shield/orifice
f124:n (728 70i 799)
fm124  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd124  1.0
c
fc134  m404 cell, rra-8&9 handling sockets
f134:n (1659)
fm134  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd134  1.0
c
fc204  m194 CR cells,                B4C
f204:n (439 1041 839 441 1043 841 447 1045 847 449 1047 849 455 1049 855
        457 1051 857)
fm204  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103)  (1.)
sd204  1.0
c
fc214  m1302 cell, CR follower
f214:n (3339 41 47 49 55 57)
fm214  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd214  1.0
c
fc224  m193 cell, CR sodium channel
f224:n (239 241 247 249 255 257 1040 1042 1044 1046 1048 1050)
fm224  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd224  1.0
c
fc234  m192 cell, CR control shield/orifice
f234:n (639 641 647 649 655 657)
fm234  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd234  1.0
c
fc244  m406 cell, CR nozzle
f244:n (1575 1576)
fm244  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd244  1.0
fc254  m190 cell, CR above poison section
f254:n (1504 4i 1509)
fm254  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd254  1.0
c
fc264  m124 cell, CR driveline
f264:n (1578)
fm264  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
```

```
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd264  1.0
c
fc274  m404 cell, CR handling socket
f274:n (1579)
fm274  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd274  1.0
c
fc304  m194 SR cells,                B4C
f304:n (409 809 413 813 417 817)
fm304  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103)  (1.)
sd304  1.0
c
fc314  m1302 cell, SR follower
f314:n (3309 3313 3317)
fm314  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd314  1.0
c
fc324  m193 cell, SR sodium channel
f324:n (209 213 217 1037 1038 1039)
fm324  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd324  1.0
c
fc334  m192 cell, SR control shield/orifice
f334:n (609 613 617)
fm334  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd334  1.0
c
fc344  m406 cell, SR & ICSA nozzle
f344:n (1527 1528)
fm344  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd344  1.0
c
fc354  m190 cell, SR above poison section
f354:n (1501 1502 1503)
fm354  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd354  1.0
c
fc364  m124 cell, Plenum, SR driveline and ICSA
f364:n (1530)
fm364  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd364  1.0
c
fc374  m404 cell, SR handling socket
f374:n (1531)
fm374  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd374  1.0
c
fc404  ICSA cells (1404, 2405, 3406)
f404:n (3323 223 423 823 3330 230 430 830 3337 237 437 837)
fm404  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103)  (1.)
sd404  1.0
c
fc414  Lower shield in ICSAs
f414:n (623 630 637)
fm414  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
```

```
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103)  (1.)
sd414  1.0
c
fc504  m3711 PSR cell,              B4C
f504:n (126)
fm504  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103)  (1.)
sd504  1.0
c
fc514  m1302 cell, below poison section of PSR
f514:n (326)
fm514  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd514  1.0
c
fc524  m1302 cells, above poison section of PSR (lower part)
f524:n (526 926)
fm524  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd524  1.0
c
fc534  m1302 cell, above poison section of PSR (upper part)
f534:n (1618)
fm534  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd534  1.0
c
fc544  m133 cell, lower shield on PSR
f544:n (702)
fm544  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd544  1.0
```

Reaction Rate Tally Specifications for MCNP4C Case fftf10eh

```
c      --------------- RX HEAD & SHIELD CELLS ACTIVATION TALLY ---------------
fc74   m431 cells,    closure head
f74:n   1559 1607 1647
fm74   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd74   1.0   1.0   1.0
fc314  m431 cells, ss-304 suppressor plate
f314:n  1548   1596   1636
fm314  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd314    1.0  1.0   1.0
c
fc324  m431 cells, ss-304 thermal reflector plates
f324:n   1551  1599 1639
fm324  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd324   1.0  1.0   1.0
c
fc334  m430 cells, Inconel 600 shield plate
f334:n   1553  1601 1641
fm334  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd334   1.0  1.0   1.0
c
fc344  m436 cells, ss-410 shield plate
f344:n   1555  1603  1643
fm344  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd344   1.0  1.0   1.0
c
```

```
fc354  m437 cells, low carbon steel shield plate
f354:n   1557  1605  1645
fm354  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd354   1.0  1.0   1.0
c
```

Reaction Rate Tally Specifications for MCNP4C Case fftf10ev

```
c      ------------------- FIXED RX COMPONENT ACTIVATION TALLY -----------------
fc34   m431 cells,   thermal liner
f34:n  (3207 3i 3211) (3212 2i 3215) (3216 4i 3221) (3222 3i 3226) (3227 3228)
       (3229 10i 3240)
fm34   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd34   1.0  5r
c
fc44   m431 cells,  reactor vessel
f44:n  (1516) (2882 2883 2884 2885 2892 3i 2896 2903 3i 2907)
       (2831 2832) (2833 3i 2837) (2838 2i 2841) (2842 4i 2847)
       (2848 3i 2852) (2853 2854 2855) (2856 17i 2874)
fm44   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd44   1.0 8r
c
fc54   m431 cells,    guard vessel
f54:n  (1513) (1514) (2912) (2913)
fm54   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd54   1.0 3r
c
fc234  m412 cells,       core barrel
f234:n (2031) (2033 8i 2042 2094)
fm234  (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
       (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
       (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
       (1. 66 102) (1. 67 102) (1. 68 103) (1.)
sd234  1.0  1.0
c
```

Differences between Cases fftf10ef and vol10ef

```
1c1
< FFTF HPPT ldg. Compute nuclide reaction rates in fixed RX components  fftf10ef
---
> FFTF HPPT ldg. Compute tally region volumes for fixed RX components in fftf10ef
4288,4292d4287
< kcode    2000  1.018  10  1210
< ksrc     0.0 0.0 -30.0  0.0 0.0 0.0    0.0 0.0 30.0
< tmp1     0.0618e-6  2939r
< thtme    0.
< cut:n    1.0e+12  0.0  0.0  0.0
4299,4789d4294,4299
< wwp:n     2.5 j 8 0 0
< wwn1:n   0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3306
<          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $ 3312
                :          :          :          :          :          :        :
                :          :          :          :          :          :        :
<          0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00  0.450E+00 $   36
<          0.450E+00  0.450E+00  0.450E+00  0.450E+00 -0.100E+01 -0.100E+01 $ 3290
---
> imp:n  1  2938r  0
> void
> sdef sur=270  pos= 0 0 -800  rad=d2  axs=0.0 0.0 1.0  dir= 1
>       wgt=1.0936e+6
> sc2  radial range of source
> si2  0  590
4812,4815d4321
< fm34    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4820,4823d4325
< fm44    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
```

```
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4828,4831d4329
< fm54     (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4836,4839d4333
< fm64     (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4847,4850d4340
< fm74     (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4858,4861d4347
< fm84     (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4866,4869d4351
< fm104    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4874,4877d4355
< fm114    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4884,4887d4361
< fm134    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4892,4895d4365
< fm174    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4900,4903d4369
< fm184    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4908,4911d4373
< fm194    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4916,4919d4377
< fm204    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4924,4927d4381
< fm214    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4932,4935d4385
< fm224    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4940,4943d4389
< fm234    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4949,4952d4394
< fm244    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4957,4960d4398
< fm254    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4965,4968d4402
< fm264    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<          (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<          (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4973,4976d4406
< fm284    (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<          (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
```

```
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4981,4984d4410
< fm294   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
4991,4994d4416
< fm304   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5002,5005d4423
< fm314   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5013,5016d4430
< fm324   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5024,5027d4437
< fm334   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5035,5038d4444
< fm344   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5046,5049d4451
< fm354   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5054,5057d4455
< fm364   (1. 51 102) (1. 52 103) (1. 53 102) (1. 54 102) (1. 55 102) (1. 55 103)
<         (1. 55 107) (1. 56 102) (1. 57 102) (1. 58 102) (1. 59 102) (1. 60 103)
<         (1. 61 102) (1. 62 102) (1. 62 103) (1. 63 102) (1. 64 102) (1. 65 102)
<         (1. 66 102) (1. 67 102) (1. 68 103) (1.)
5058a4457
> nps   1.0e+7
```

Photon Source Specification for MCNP4C Cases s01a, s01b and s01c

```
sdef    cel= d6
        erg = d2  pos fcel  d3    axs= 0 0 1  rad= d4
        ext= fcel  d5             wgt=2.833E+15
c
sc2      Co-60 photon energy spectrum
#           si2       sp2
              1         d
          1.173       0.5
          1.333       0.5
c
c        sector 1 IVS cells
si6   L       3268                    3268                    3268     $ L
              3269                    3269                    3269     $ X
              3270                    3270                    3270     $ F
              3271                    3271                    3271     $ R
              3272                    3272                    3272     $ J
              3273                    3273                    3273     $ U
              3274                    3274                    3274     $ M
              3275                    3275                    3275     $ C
              3276                    3276                    3276     $ Y
              3277                    3277                    3277     $ G
              3278                    3278                    3278     $ S
              3279                    3279                    3279     $ K
              3280                    3280                    3280     $ V
              3281                    3281                    3281     $ B
              3282                    3282                    3282     $ D
              3283                    3283                    3283     $ H
              3284                    3284                    3284     $ W
              3285                    3285                    3285     $ A
              3286                    3286                    3286     $ E
              3287                    3287                    3287     $ Z
c
c         sector 2 cells
                1                       1                       1     $ L
                2                       2                       2     $ X
                3                       3                       3     $ F
                4                       4                       4     $ R
                5                       5                       5     $ J
```

```
                6                    6                    6      $ U
                7                    7                    8      $ M
                8                    8                    8      $ C
                9                    9                    9      $ Y
               10                   10                   10      $ G
               11                   11                   11      $ S
               12                   12                   12      $ K
               13                   13                   13      $ V
               14                   14                   14      $ B
               15                   15                   15      $ D
               16                   16                   16      $ H
               17                   17                   17      $ W
               18                   18                   18      $ A
               19                   19                   19      $ E
               20                   20                   20      $ Z
c
c         sector 3 cells
               21                   21                   21      $ L
               22                   22                   22      $ X
               23                   23                   23      $ F
               24                   24                   24      $ R
               25                   25                   25      $ J
               26                   26                   26      $ U
               27                   27                   27      $ M
               28                   28                   28      $ C
               29                   29                   29      $ Y
               30                   30                   30      $ G
               31                   31                   31      $ S
               32                   32                   32      $ K
               33                   33                   33      $ V
               34                   34                   34      $ B
               35                   35                   35      $ D
               36                   36                   36      $ H
               37                   37                   37      $ W
               38                   38                   38      $ A
               39                   39                   39      $ E
               40                   40                   40      $ Z
c
c         sector 1  curie loading
sp6           150.                 670.                 173.     $ L
                1.5                 24.7                 153.     $ X
                5.0                 32.2                 202.     $ F
              150.                 670.                 173.     $ R
              150.                 670.                 173.     $ J
                1.5                 24.7                 153.     $ U
              150.                 670.                 173.     $ M
                0.001                0.001                0.001  $ C
                1.5                 24.7                 153.     $ Y
                5.0                 32.2                 202.     $ G
              150.                 670.                 173.     $ S
              150.                 670.                 173.     $ K
                0.001                0.001                0.001  $ V
                0.001                0.001                0.     $ B
                1.5                 24.7                 153.     $ D
                0.001                0.001                0.001  $ H
                0.001                0.001                0.001  $ W
                0.001                0.001                0.001  $ A
                1.5                 24.7                 153.     $ E
                0.001                0.001                0.001  $ Z
c
c          sector 2 curie loading
                1.5                 24.7                 153.     $ L
                0.001                0.001                0.001  $ X
              329.                1449.                 374.     $ F
              329.                1449.                 374.     $ R
              329.                1449.                 374.     $ J
                5.                  32.2                 202.     $ U
                5.                  32.2                 202.     $ M
              329.                1449.                 374.     $ C
                5.                  32.2                 202.     $ Y
              329.                1449.                 374.     $ G
                5.                  32.2                 202.     $ S
                5.                  32.2                 202.     $ K
                1.5                 24.7                 153.     $ V
              329.                1449.                 374.     $ B
              329.                1449.                 374.     $ D
              329.                1449.                 374.     $ H
                5.                  32.2                 202.     $ W
              329.                1449.                 374.     $ A
              329.                1449.                 374.     $ E
                0.001                0.001                0.001  $ Z
c          sector 3 curie loading
              609.                2681.                 693.     $ L
                0.001                0.001                0.001  $ X
                2.5                 42.                 261.     $ F
                0.001                0.001                0.001  $ R
                5.                  32.2                 202.     $ J
                0.001                0.001                0.001  $ U
                5.                  32.2                 202.     $ M
```

```
                0.001                    0.001                    0.001 $ C
                0.001                    0.001                    0.001 $ Y
                5.                      32.2                    202.    $ G
                0.001                    0.001                    0.001 $ S
                2.5                     42.                     261.    $ K
              273.                    1178.                     313.    $ V
                6.6                      2.1                     10.    $ B
                0.001                    0.001                    0.001 $ D
                5.                      32.2                    202.    $ H
                0.001                    0.001                    0.001 $ W
                0.001                    0.001                    0.01  $ A
                2.5                     42.                     261.    $ E
                0.001                    0.001                    0.001 $ Z
c
c          sector one in-vessel storage centerlines
ds3  L -165.467 129.696 54.61  -165.467  129.696  0.0  -165.467 129.696 -54.61   $ L
       -198.666  80.710 54.61  -198.666   80.710  0.0  -198.666  80.710 -54.61   $ X
       -147.590 157.168 54.61  -147.590  157.168  0.0  -147.590 157.168 -54.61   $ F
       -180.315 121.121 54.61  -180.315  121.121  0.0  -180.315 121.121 -54.61   $ R
       -162.440 148.594 54.61  -162.440  148.594  0.0  -162.440 148.594 -54.61   $ J
       -198.670  97.844 54.61  -198.670   97.844  0.0  -198.670  97.844 -54.61   $ U
       -180.319 138.263 54.61  -180.319  138.263  0.0  -180.319 138.263 -54.61   $ M
       -147.603 174.294 54.61  -147.603  174.294  0.0  -147.603 174.294 -54.61   $ C
       -213.503  89.310 54.61  -213.503   89.310  0.0  -213.503  89.310 -54.61   $ Y
       -162.427 165.749 54.61  -162.427  165.749  0.0  -162.427 165.749 -54.61   $ G
       -195.154 129.709 54.61  -195.154  129.709  0.0  -195.154 129.709 -54.61   $ S
       -177.279 157.174 54.61  -177.279  157.174  0.0  -177.279 157.174 -54.61   $ K
       -213.523 106.412 54.61  -213.523  106.412  0.0  -213.523 106.412 -54.61   $ V
       -147.592 191.444 54.61  -147.592  191.444  0.0  -147.592 191.444 -54.61   $ B
       -162.433 182.888 54.61  -162.433  182.888  0.0  -162.433 182.888 -54.61   $ D
       -177.302 174.295 54.61  -177.302  174.295  0.0  -177.302 174.295 -54.61   $ H
       -228.354 115.000 54.61  -228.354  115.000  0.0  -228.354 115.000 -54.61   $ W
       -162.448 200.028 54.61  -162.448  200.028  0.0  -162.448 200.028 -54.61   $ A
       -177.289 191.455 54.61  -177.289  191.455  0.0  -177.289 191.455 -54.61   $ E
       -192.555 166.005 54.61  -192.555  166.005  0.0  -192.555 166.005 -54.61   $ Z
c
c            sector 2 centerlines
        195.054  78.451 54.61   195.054   78.451  0.0   195.054  78.451 -54.61   $ L
        169.230 131.695 54.61   169.230  131.695  0.0   169.230 131.695 -54.61   $ X
        209.906  49.233 54.61   209.906   49.233  0.0   209.906  49.233 -54.61   $ F
        195.051  95.597 54.61   195.051   95.597  0.0   195.051  95.597 -54.61   $ R
        209.906  66.380 54.61   209.906   66.380  0.0   209.906  66.380 -54.61   $ J
        184.070 123.131 54.61   184.070  123.131  0.0   184.070 123.131 -54.61   $ U
        209.899  87.029 54.61   209.899   87.029  0.0   209.899  87.029 -54.61   $ M
        224.745  40.681 54.61   224.745   40.681  0.0   224.745  40.681 -54.61   $ C
        184.096 140.244 54.61   184.096  140.244  0.0   184.096 140.244 -54.61   $ Y
        224.756  57.791 54.61   224.756   57.791  0.0   224.756  57.791 -54.61   $ G
        209.908 104.154 54.61   209.908  104.154  0.0   209.908 104.154 -54.61   $ S
        224.756  74.941 54.61   224.756   74.941  0.0   224.756  74.941 -54.61   $ K
        198.917 131.710 54.61   198.917  131.710  0.0   198.917 131.710 -54.61   $ V
        239.591  32.096 54.61   239.591   32.096  0.0   239.591  32.096 -54.61   $ B
        239.602  49.227 54.61   239.602   49.227  0.0   239.602  49.227 -54.61   $ D
        239.595  66.401 54.61   239.595   66.401  0.0   239.595  66.401 -54.61   $ H
        213.770 140.260 54.61   213.770  140.260  0.0   213.770 140.260 -54.61   $ W
        254.453  40.670 54.61   254.453   40.670  0.0   254.453  40.670 -54.61   $ A
        254.449  57.809 54.61   254.449   57.809  0.0   254.449  57.809 -54.61   $ E
        240.042  83.755 54.61   240.042   83.755  0.0   240.042  83.755 -54.61   $ Z
c
c            sector 3 centerlines
       -29.587 -208.147 54.61  -29.587 -208.147  0.0   -29.587 -208.147 -54.61   $ L
        29.436 -212.405 54.61   29.436 -212.405  0.0    29.436 -212.405 -54.61   $ X
       -62.316 -206.401 54.61  -62.316 -206.401  0.0   -62.316 -206.401 -54.61   $ F
       -14.736 -216.718 54.61  -14.736 -216.718  0.0   -14.736 -216.718 -54.61   $ R
       -47.466 -214.974 54.61  -47.466 -214.974  0.0   -47.466 -214.974 -54.61   $ J
        14.600 -220.975 54.61   14.600 -220.975  0.0    14.600 -220.975 -54.61   $ U
       -29.580 -225.292 54.61  -29.580 -225.292  0.0   -29.580 -225.292 -54.61   $ M
       -77.142 -214.975 54.61  -77.142 -214.975  0.0   -77.142 -214.975 -54.61   $ C
        29.407 -229.554 54.61   29.407 -229.554  0.0    29.407 -229.554 -54.61   $ Y
       -62.329 -223.540 54.61  -62.329 -223.540  0.0   -62.329 -223.540 -54.61   $ G
       -14.754 -233.863 54.61  -14.754 -233.863  0.0   -14.754 -233.863 -54.61   $ S
       -47.477 -232.115 54.61  -47.477 -232.115  0.0   -47.477 -232.115 -54.61   $ K
        14.606 -238.122 54.61   14.606 -238.122  0.0    14.606 -238.122 -54.61   $ V
       -91.999 -223.540 54.61  -91.999 -223.540  0.0   -91.999 -223.540 -54.61   $ B
       -77.169 -232.115 54.61  -77.169 -232.115  0.0   -77.169 -232.115 -54.61   $ D
       -62.293 -240.696 54.61  -62.293 -240.696  0.0   -62.293 -240.696 -54.61   $ H
        14.584 -255.260 54.61   14.584 -255.260  0.0    14.584 -255.260 -54.61   $ W
       -92.005 -240.698 54.61  -92.005 -240.698  0.0   -92.005 -240.698 -54.61   $ A
       -77.160 -249.264 54.61  -77.160 -249.264  0.0   -77.160 -249.264 -54.61   $ E
       -47.487 -249.760 54.61  -47.487 -249.760  0.0   -47.487 -249.760 -54.61   $ Z
c
c
c          radial distribution
si4         0.0          6.332
sp4       -21            1
c
c
c          extent distribution
ds5   s     15   16   15
            15   16   15
```

```
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
          15   16   15
c
si15       -8.1699    8.1699
sp15      -21   0
si16      -46.4399   46.4399
sp16      -21   0
```

Dose Rate Tally Specifications for Case s01a

```
c      ansi/ans-6.1.1-1991 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de0    log   .01    .015   .02    .03    .04    .05
             .06    .08    .10    .15    .20    .30
             .40    .50    .60    .80   1.0    1.5
           2.0    3.0    4.0    5.0    6.0    8.0
          10.   12.
df0    log  2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
            1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
            7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
            2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
            8.892e-3 1.040e-2
c
fc05      mrem/hr, point detectors at core midplane, at 12' radius
          azimuthally outboard od the 3 IVFSMs and between modules
f05:p  $    x       y        z       r0
         -49.0  -362.7     0.0      5  $ out from N IVFSM
        -292.6   219.9     0.0      5  $ out from SE IVFSM
         340.7   133.7     0.0      5  $ out from SW IVFSM
        -340.7  -133.7     0.0      5  $ between N & SE modules
          49.0   362.7     0.0      5  $ between SE & SW modules
         292.6  -219.9     0.0      5  $ between N & SW modules
```

```
c
fc15    mrem/hr, point detectors at inlet & outlet pipes (R = 12')
f15:p   $    x        y        z       r0
        -365.8      0.0   -322.58     5  $ inlet pipe, 90 deg. true
         182.5    316.1   -322.58     5  $ inlet pipe, 210 deg. true
         182.5   -316.1   -322.58     5  $ inlet pipe, 330 deg. true
        -316.1   -182.5    302.0      5  $ outlet pipe, 60 deg.
           0.0    365.8    302.0      5  $ outlet pipe, 180 deg.
         316.1   -182.5    302.0      5  $ outlet pipe, 300 deg.
c
fc25     mrem/hr, ring detector in cavity above B4C shield
f25z:p    560.0  355.0      5  $ R=11'8"=355 cm, Z=560 cm = 18.4'
c

fc35     mrem/hr, ring detectors in head compartment
f35z:p   900.0    40.0      5  $ near center of head compartment
         900.0   350.0      5  $ outer head compartment
c
```

Dose Rate Tally Specifications for Case s01b

```
c      ansi/ans-6.1.1-1991 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de0    log   .01    .015    .02    .03    .04    .05
             .06    .08     .10    .15    .20    .30
             .40    .50     .60    .80   1.0    1.5
            2.0    3.0     4.0    5.0    6.0    8.0
           10.    12.
df0    log  2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
            1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
            7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
            2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
            8.892e-3 1.040e-2
c
fc15    mrem/hr, from in-vessel storage @ z=560 r=355
f15:p         0.0    355.0     560.       5.
            177.5    307.4     560.       5.
            307.4    177.5     560.       5.
            355.0      0.0     560.       5.
            307.4   -177.5     560.       5.
            177.5   -307.4     560.       5.
              0.0   -355.0     560.       5
           -177.5   -307.4     560.       5.
           -307.4   -177.5     560.       5.
           -355.0      0.0     560.       5.
           -307.4    177.5     560.       5.
           -177.5    307.4     560.       5
c
fc25     mrem/hr, ring detector in cavity above B4C shield
f25z:p    560.0  355.0      5  $ R=11'8"=355 cm, Z=560 cm = 18.4'
```

Dose Rate Tally Specifications for Case s01c

```
de0    log   .01    .015    .02    .03    .04    .05
             .06    .08     .10    .15    .20    .30
             .40    .50     .60    .80   1.0    1.5
            2.0    3.0     4.0    5.0    6.0    8.0
           10.    12.
df0    log  2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
            1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
            7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
            2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
            8.892e-3 1.040e-2
c
fc4   dose rates in cells above b4c shield
f4:p    2929      2937
sd4   1.155e+6  9.173e+5
```

Photon Source Specification for MCNP4C Case s04b

```
c     photon source from core barrel, IVFSM h/w, thermal liner, vessel wall
c     and guard vessel
c     src rate = (2610 Ci Co-60)*(3.7e10 disint./s/Ci)*(2 photons/disint.)
c                      = 1.93e14 photons/s
sdef    erg= d2   pos= 0 0 0  rad=d3
        ext=frad d4   axs= 0 0 1     wgt=1.93e14
sc3   source distribution for 4 source components
#       si3      sp3     sb3    ds4
         s        d       d      s
         71     1.43E+02     20     201 $  core barrel 1
         72     1.81E+03     80     202 $  core barrel 2
         81     2.56E+01     10     211 $  thermal liner 1
         82     7.14E+01     20     212 $  thermal liner 2
         83     2.97E+01     10     213 $  thermal liner 3
         84     8.53E-01      2     214 $  thermal liner 4
         85     3.48E-02      1     215 $  thermal liner 5
```

```
          86    4.27E-03      1    216 $  thermal liner 6
          91    2.62E+00      5    221 $  vessel wall 1
          92    3.24E+01     20    222 $  vessel wall 2
          93    9.20E+01     30    223 $  vessel wall 3
          94    3.72E+01     20    224 $  vessel wall 4
          95    1.73E+00      5    225 $  vessel wall 5
          96    1.87E-01      1    226 $  vessel wall 6
          97    1.32E-02      1    227 $  vessel wall 7
         101    1.03E+00      5    231 $  guard vessel 1
         102    3.92E-01      3    232 $  guard vessel 2
         103    5.43E+00     10    233 $  guard vessel 3
         104    1.54E+01     20    234 $  guard vessel 4
         105    6.22E+00     10    235 $  guard vessel 5
         106    2.90E-01      3    236 $  guard vessel 6
         107    3.13E-02      1    237 $  guard vessel 7
         111    3.37E+02     70    241 $  IVSFM h/w
c     -------------------------
c     total    2610 Ci Co-60
c     -------------------------
sc2   Co-60 photon energy spectrum
#         si2         sp2
            1           d
        1.173         0.5
        1.333         0.5
c     radial distributions
si71    177.80      182.90    $ core barrel
sp71   -21    0
si72    177.80      182.90    $ core barrel
sp72   -21    0
c
si81    302.90      305.43    $ thermal liner
sp81   -21    0
si82    302.90      305.43    $ thermal liner
sp82   -21    0
si83    302.90      305.43    $ thermal liner
sp83   -21    0
si84    302.90      305.43    $ thermal liner
sp84   -21    0
si85    302.90      305.43    $ thermal liner
sp85   -21    0
si86    302.90      305.43    $ thermal liner
sp86   -21    0
c
si91     307.66      314.64   $ vessel wall
sp91    -21    0
si92     307.66      314.64   $ vessel wall
sp92    -21    0
si93     307.66      314.64   $ vessel wall
sp93    -21    0
si94     307.66      314.64   $ vessel wall
sp94    -21    0
si95     307.66      314.64   $ vessel wall
sp95    -21    0
si96     307.66      314.64   $ vessel wall
sp96    -21    0
si97    307.66      314.64    $ vessel wall
sp97   -21    0
c
si101    334.80      339.88   $ guard vessel
sp101   -21    0
si102    334.80      339.88   $ guard vessel
sp102   -21    0
si103    334.80      339.88   $ guard vessel
sp103   -21    0
si104    334.80      339.88   $ guard vessel
sp104   -21    0
si105    334.80      339.88   $ guard vessel
sp105   -21    0
si106    334.80      339.88   $ guard vessel
sp106   -21    0
si107   334.80      339.88    $ guard vessel
sp107  -21    0
c
si111   200.00      290.00    $ IVFSM h/w
sp111  -21    0
c     axial disutions
si201   -215.00 -141.00        $ core barrel
sp201   -21       0
si202   -134.70  175.00        $ core barrel
sp202   -21       0
c
si211   -170.00  -62.78        $ thermal liner
sp211   -21       0
si212    -62.78   62.78        $ thermal liner
sp212    -21       0
si213     62.78  200.00        $ thermal liner
sp213     -21       0
si214    200.00  400.00        $ thermal liner
sp214    -21       0
```

```
si215    400.00  532.42       $ thermal liner
sp215    -21       0
si216    532.42  701.02       $ thermal liner
sp216    -21       0
c
si221   -373.38 -170.00       $ vessel wall
sp221   -21       0
si222   -170.00  -62.78       $ vessel wall
sp222   -21       0
si223    -62.78   62.78       $ vessel wall
sp223   -21       0
si224     62.78  200.00       $ vessel wall
sp224    -21       0
si225    200.00  400.00       $ vessel wall
sp225   -21       0
si226    400.00  550.00       $ vessel wall
sp226   -21       0
si227    550.00  701.02       $ vessel wall
sp227   -21       0
c
si231   -740.00 -400.00       $ guard vessel
sp231   -21       0
si232   -400.00 -170.00       $ guard vessel
sp232   -21       0
si233   -170.00  -62.78       $ guard vessel
sp233   -21       0
si234    -62.78   62.78       $ guard vessel
sp234    -21       0
si235     62.78  200.00       $ guard vessel
sp235    -21       0
si236    200.00  400.00       $ guard vessel
sp236    -21       0
si237    400.00  532.42       $ guard vessel
sp237    -21       0
c
si241   -170.00   195.00       $ IVFSM h/w
sp241    -21   0
```

Dose Rate Tally Specifications for Case s04b

```
c      ansi/ans-6.1.1-1991 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de0    log   .01    .015    .02    .03    .04    .05
             .06    .08     .10    .15    .20    .30
             .40    .50     .60    .80   1.0    1.5
            2.0    3.0     4.0    5.0    6.0    8.0
           10.    12.
df0    log  2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
            1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
            7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
            2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
            8.892e-3 1.040e-2
c
fc05       mrem/hr, ring detector in rx cavity
           photon source from outer radial shld, shld support and part of
           inner shield (i.e., the outer ring and the top of inner ring)
f05z:p  560   355    5  $ R=11'8", Z=above B4C shld
       -323   366    5  $ R=12', Z=-10'7"
        302   366    5  $ R=12', Z=9'11"
          0   366    5  $ R=12'. Z= core midplane
        900    40    5  $ in center of head compartment
        900   350    5  $ outerhead compartment
```

This page intentionally left blank

APPENDIX K
STATEMENT OF WORK

STATEMENT OF WORK

Tracking Number - 002153

Posting Number -

FLUOR HANFORD STAFFING WORKSHEET

Section 1 – JOB DUTIES AND QUALIFICATIONS (Attach additional sheet if necessary)

Job Duties

FFTF-02-013

Perform Radionuclide Inventory for the FFTF per the attached statement of work (SOW)

Required Qualifications (Minimum education, skills, and experience individuals must have to perform this work)

Employees performing this work must be current in Hanford General Employee Training (HGET). The contracting/affliate employees shall possess the skills, qualifications and competence to perform all activities identified in the SOW.

Other Desirable Qualifications (Additional education, skills, and experience that would enhance an individual's ability to perform this work)

Preferred Candidate Name (Last, First, MI): Nelson, J.V. and Wootan, D.W.

PH Contract/Release No. (If Applicable): N/A

Estimated Duration of Assignment: Start Date ASAP End Date 06/24/02

No. Hours Per Week: 40

Funding Source: ☒ Direct ☐ Indirect

On Approved Staffing Plan? ☐ Yes ☒ No (P/P Director Signature Required)

Security Clearance Level: ☒ None ☐ L ☐ Q

Nuclear Facility Position? ☐ Yes (See HNF-PRO-179) ☒ No

PSAP Position? ☐ Yes ☒ No

Shift Work Required? ☐ Yes ☒ No

Actual Work Location (Area/Bldg.): FFS Location

Is This Opening ☒ New ☐ Replaces Who?

Travel/Relocation Authorized? ☐ Yes ☐ No

Job Reports To: Name (Last, First, MI)/Signature and Date: S.W. Scott [signature] 4/1/02

Phone: 376-0943

Dept. No.: M5000000

Cost Code: M5500

CACN: 117190

COA: AQ31

Project/Function Director Signature: D.E. Kies [signature] Date

Optional Signature: J.E. Parker [signature] Date 4/1/02

Optional Signature: W.D. Pollard [signature] Date 5-2-2

Section 2 – PROJECT OPERATIONS CENTER/FUNCTIONAL GROUP REVIEW/APPROVAL

Fill By: ☐ Internal Lateral Reassignment ☐ Internal Promotion (HR - Posting May be Reqd) ☒ Affiliate Short Term (< 12 Months) ☐ Affiliate Long Term (≥ 12 Months - HR) ☐ Managed Task ☐ Staff Augmentation ☐ FH External Hire (HR) ☐ FFS External Hire (HR)

Internal Reassignee or Affiliate Name (Last, First, MI): Nelson, JV / Wootan, DW

HID: [signature]

Current PH Dept ID:

New FH Dept ID:

Effective Date: 5-2-2

Functional Approval Signature: [signature] for A.L. RAMBLE Date 4/2/02

HR Staffing/IR Rep. Signature (As Required Above): [signature] for L.E. Johnson Date

Section 3 – EXTERNAL HIRE REVIEW/APPROVAL

Project/Function Director Date

FH HR Director Date

Section 4 – STAFFING INFORMATION (HR/IR Use Only)

Job Title

Job Code

Grade

Posting Duration (Minimum = 3 Days): ☐ 2 Weeks ☐ Other

Classification: ☐ MGT ☐ EX ☐ SNE ☐ HAMTC ☐ HGU ☐ OPEIU

Affirmative Action Utilization: ☐ Under In Minorities ☐ Under In Females ☐ Not Under

LAMP Avail? ☐ Yes ☐ No

Employee Status (Check Two - Regular or Non-Regular/Full or Part-Time): ☐ Regular ☐ Non-Regular ☐ Full-Time ☐ Part-Time

HR Staffing/IR Rep. Signature Date

Posting Number -

A-5003-111 (09/01)

FH HR
Finance
J. Nelson
D. Wootan
S. Felch
L. Johnson

5/2/2

04/02/02 06:42 ☎505 376 6820 FFTF/FMEP PNUG

HEADER INFORMATION FOR CONTRACT REQUISITION NO.

CONTRACT NUMBER:	FFTF-02-013
CONTRACT RELEASE NUMBER:	N/A
CONTRACT AMENDMENT NUMBER:	N/A
STATEMENT OF WORK REVISION NUMBER:	0
COST ACCOUNT PLAN NUMBER (CAPN):	1B1051
COST ACCOUNT CHARGE NUMBER (CACN):	117190
CODE OF ACCOUNT (COA):	AQ31
PERFORMING ORG/COST CENTER:	M5500
DATE:	03/22/02
INITIAL AUTHORIZED BUDGET:	$50,000
ASSIGNED PROJECT CONTROL ANALYST:	Mary Davenport (376-1857)
BUYER'S TECHNICAL REPRESENTATIVE:	Stan W. Scott (376-0943)
CONTRACT RELEASE TYPE:	N/A

STATEMENT OF WORK
FOR
Perform Radionuclide Inventory for the FFTF

1.0 OBJECTIVE

The objective of this statement of work is to provide direction to Fluor Federal Services (FFS) to perform an evaluation to determine radionuclide inventory as it relates to a final end-state of the reactor vessel at the Fast Flux Test Facility.

2.0 INTRODUCTION

Perform a radionuclide inventory of the FFTF reactor vessel.

3.0 WORK SCOPE/DESCRIPTION OF REQUIRED SERVICES

Determine the radionuclide inventory of the FFTF reactor vessel and reactor internals. Provide an isotopic breakdown with the amounts and locations of any "significant" radionuclide. A dose assessment also needs to be conducted that will estimate dose rates to workers if the reactor vessel is removed for transport and disposition. This work should expand on and complete the initial assessments conducted in "Radionuclide Inventory In the FFTF Vessel" (Contract 8299 Release 10) and should include activity levels for all removable reactor components and the major structural components within and including the reactor vessel. Need date for this information is 6/24/02.

3.1 The term "significant" relates to those nuclides that (by direction from us or in the opinion of the authors) could pose a hazard to workers or to the environment during deactivation, S&M, and decommissioning activities and those that could provide a long-term hazard to workers or the public.

3.1.1 If we decide to entomb the reactor vessel, we will need to prove that the exposure to the public will be acceptable over a long period of time (typically 10,000 years is used at Hanford). These limits will probably be 25 mRem/year general and 4 mRem/year drinking water.

3.1.2 We also have to show that various intruder scenarios will not exceed certain exposure levels. These scenarios generally have a 500 year window and limit exposure to 500 mRem one time (acute) or 100 mRem/yr (chronic).

3.1.3 Based on these issues, long-lived isotopes and/or highly mobile isotopes will need to be scrutinized. It is suggested that the isotopes listed in Tables 1&2 of 10 CFR 61.55 be used as a starting point for these.

3.1.4 If the reactor vessel is removed we will need to be concerned with; 1) the dose to the workers and any possible dose/transportation issues and, 2) activity limits/restrictions (and possibly dose here as well) associated with the waste acceptance criteria for ERDF and the Low-Level Burial Grounds.

4.0 DELIVERABLES

Provide a Rough Order of Magnitude (ROM) cost estimate for the work scope described in this statement of work. This cost estimate is to be provided to the Buyer who will forward to the assigned Project Control Analyst. The Buyer's Technical Representative identified below will conduct further review and approval.

4.1 Technical report of analysis of work described in item 3.

5.0 OBJECTIVE ACCEPTANCE CRITERIA FOR SERVICES TO BE PERFORMED

Completion and documentation of analyses described above in Section 3.0 will satisfy this requirement.

6.0 SCHEDULE

6.1 Start Date: As soon as possible

6.2 Completion Date: June 24, 2002

7.0 SAFETY REQUIREMENTS (INCLUDING IDENTIFIABLE SAFETY HAZARDS)

7.1 Safety Class: GS

7.2 Approval Designator: SQ

8.0 ES&H REQUIREMENTS

The Integrated Environment, Safety, and Health Management System (ISMS) Clause Flow Down Prescreening Questionnaire has been completed. (Note to buyer: a copy of this completed questionnaire is imbedded in the Comm Log of the Contract Requisition.) After a review of the statement of work and the answers provided on the ISMS Clause Flow Down Prescreening Questionnaire, no potential hazards were identified. Therefore, it was determined that the SP-5B provisions covering services performed on the Hanford Site (including standard ES&H requirements only) apply to this work scope and shall be flowed down to the Contractor.

9.0 QUALITY ASSURANCE

9.1 Quality Level: 3

Reference item 16.

10.0 HOLD POINTS AND/OR SOURCE OR RECEIVING INSPECTION POINTS

N/A

11.0 CONFIGURATION MANAGEMENT REQUIREMENTS

No changes/software revisions are expected while these codes are being maintained. Therefore configuration management of the software shall be maintained consistent with past practices.

12.0 CONFIGURATION MANAGEMENT REQUIREMENTS

Though it is not expected that any revisions of the physics codes will be required any changes that are necessary will be documented consistent with requirements of HNF-PRO-309, Computer Software Quality Assurance Requirements.

13.0 REQUIRED TRAINING FOR CONTRACTOR (TO INCLUDE QUALIFICATION OR CERTIFICATION REQUIREMENTS IF NECESSARY)

The FFS Project Manager shall verify assigned personnel utilizing FFTF physics codes for analytical analysis are properly trained in their use and interpreting code's output/results.

14.0 MINIMUM QUALIFICATION AND COMPETENCE REQUIREMENTS WHICH CONTRACTOR MUST MEET

The FFS Project Manager shall verify assigned personnel are qualified and competent to perform the identified activities, i.e., only personnel who have previously demonstrated competence in the utilization of the physics codes shall be assigned tasks of performing analytical analysis in support of FFTF.

15.0 UNIQUE REQUIREMENTS

N/A

15.1 RADIOLOGICAL CONTROL REQUIREMENTS

N/A

15.2 OTHER UNIQUE REQUIREMENTS

N/A

16.0 STANDARDS AND SPECIFICATIONS

All work shall be performed in accordance with Hanford Site safety, quality, and environmental regulations. By accepting this contract release, the Contractor is agreeing to complete the identified work scope in accordance with site procedures and regulations identified in the blanket contract agreement.

17.0 FLOWDOWN OF REQUIREMENTS

N/A

18.0 CONTRACTOR SUBJECT TO TITLE 10, CODE OF FEDERAL REGULATIONS, PART 830.120 (10 CFR 830.120), QUALITY ASSURANCE REQUIREMENTS, AND THE ENFORCEMENT ACTIONS UNDER 10 CFR 820, *GENERAL STATEMENT OF ENFORCEMENT POLICY.*

19.0 ADMINISTRATIVE

19.1 Contract Type

Cost Plus Fixed Fee

19.2 Key Contractor Personnel

FFS:

Hans Toffer	Phone: 376-5230	825 Jadwin/G-8D/700 Area	M/S: A0-26
Joseph V. Nelson	Phone: 376-4480	825 Jadwin/G7E-2/700 Area	M/S: A0-26
David W. Wootan	Phone: 376-4635	825 Jadwin/G7D-3/700 Area	M/S: A0-26

19.3 Key FFTF Personnel (technical, project control analyst, EJTA POC, BTR)

Assigned Project Control Analyst

Mary C. Davenport Phone: 376-1857 4710 /519/400 Area M/S: N2-51

EJTA Point of Contact (POC)

Don G. Quilici Phone: 376-6549 4710/313/400 Area M/S: N2-57

Buyer's Technical Representative (BTR)

Stan W. Scott Phone: 376-0943 4710/607A/400 Area M/S: N2-57

19.4 Employee Job Task Analysis (EJTA) Requirements

FFS will be required to complete an Employee Job Task Analysis for each employee performing work described in this statement of work. If this has already been done, FFS should so state in their cost and fee proposal response.

19.5 Badging Requirements

Not applicable.

19.6 Escorting Requirements

Not applicable.

19.7 Project Management

Not applicable.

19.8 Reporting requirements (if a deliverable, include in "Deliverables")

Not applicable.

19.9 Meetings

19.9.1 Kickoff Meetings

As this is a continuation of services, a kickoff meeting will not be required.

19.9.2 Progress Meetings

Not applicable.

19.9.3 Monthly Review Meetings

Not applicable.

19.10 Documents (if a deliverable, include in "Deliverables")

Not applicable.

19.10.1 Documentation Control Requirements

Not applicable.

19.11 Other Administrative Requirements, etc.

None.

19.12 Reference

HNF-PRO-309, Computer Software Quality Assurance Requirements.

APPENDIX L
SELECTED PLOTS OF FFTF GEOMETRY AND PHOTON SOURCE DISTRIBUTION

SELECTED PLOTS OF FFTF GEOMETRY AND PHOTON SOURCE DISTRIBUTION

Figures L-1 through L-7 contain various views of the FFTF geometry as modeled in MCNP4C. Figures L-1 through L-6 also illustrate the photon source distributions in MCNP4C cases s01a, s01b, s01c, s02, s06, s07 and s08, which are described in Table 5-13.

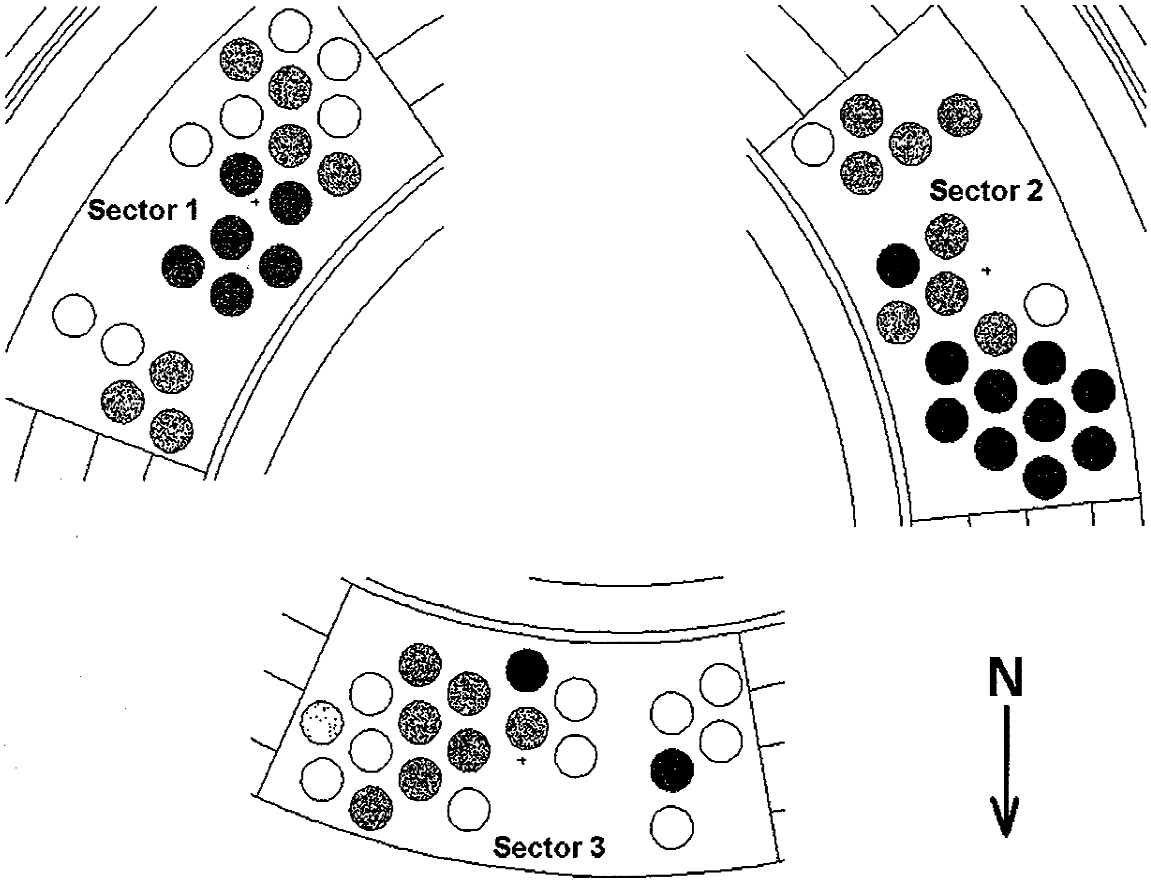


Figure L-1. Compressed plan view of In-Vessel Storage Modules showing photon source distribution as modeled in MCNP4C cases s01a, s01b and s01c. See Figure 3-1 for actual locations of the three modules. Dot density in the assembly storage positions indicates the relative source strength.

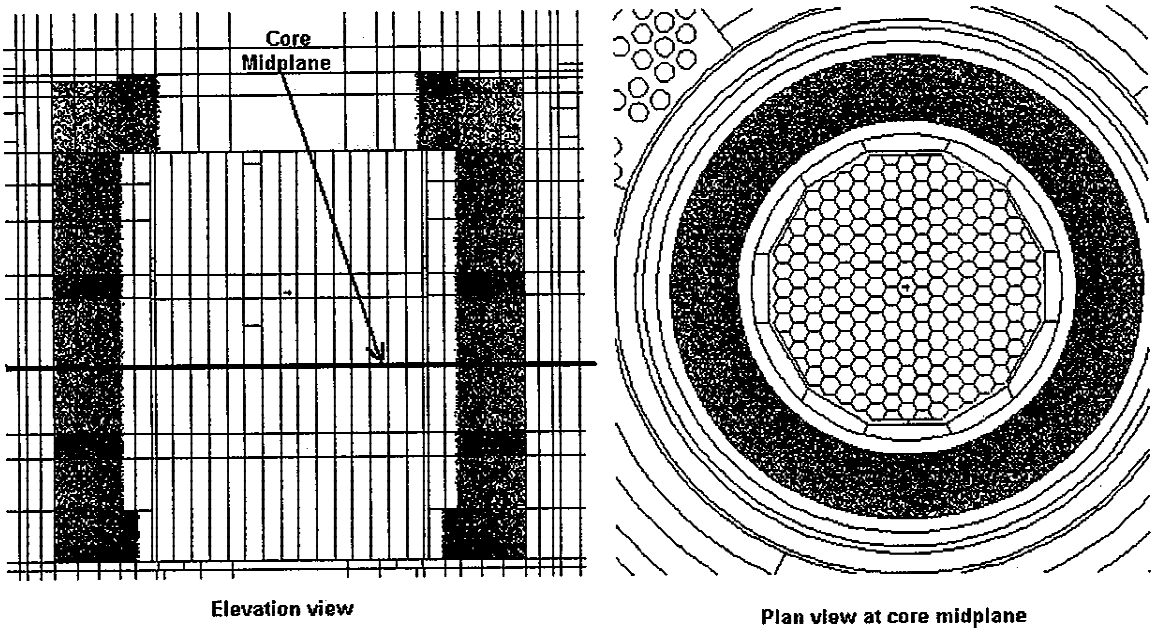


Figure L-2. Views of the FFTF model showing the photon source distribution in MCNP4C case s02. Sources are in the outer radial shield, the shield support structure and part of the inner radial shield (the outer half plus the top portion of the inner half).

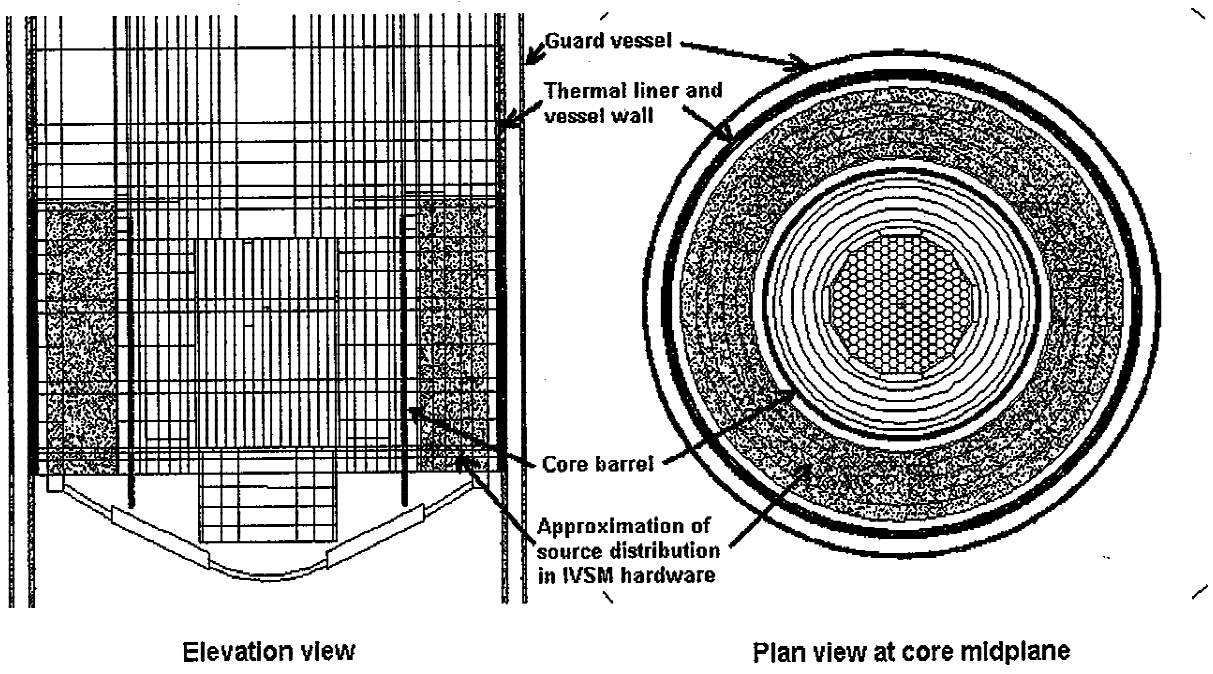


Figure L-3. Views of the FFTF model showing the photon source distribution in MCNP4C case s04b. Sources are in the core barrel, IVSM hardware, thermal liner, reactor vessel and guard vessel. Sources in the IVSM hardware were approximated as an annular distribution.

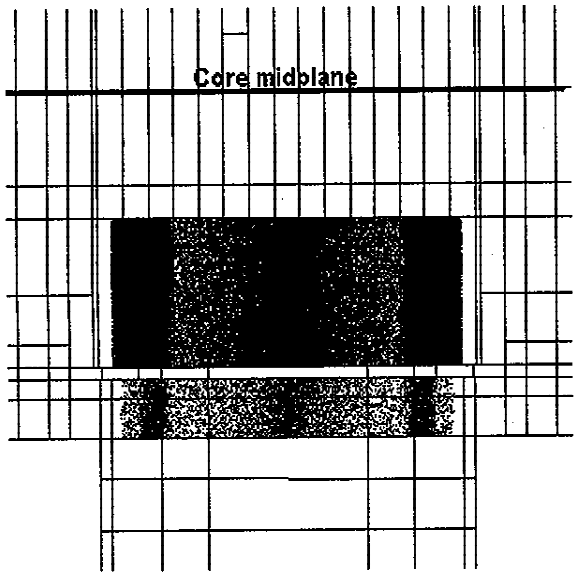


Figure L-4. Elevation view of the FFTF model showing the photon source distribution in MCNP4C case s08. Sources are in the lower axial shield/orifice and nozzle regions of all assemblies in core

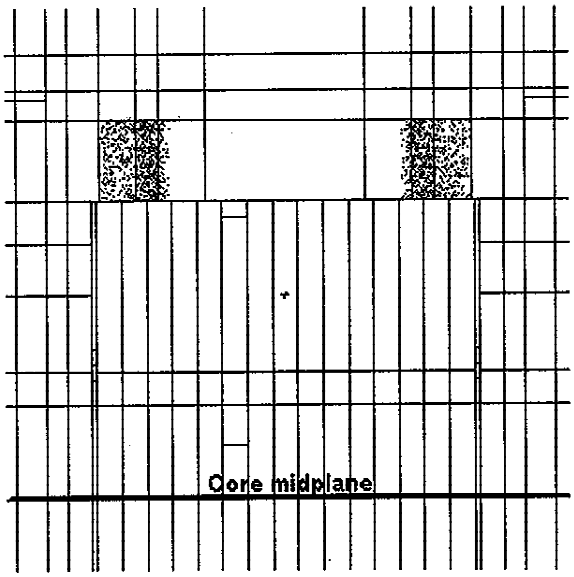


Figure L-5. Elevation view of the FFTF model showing the photon source distribution in MCNP4C case s07. Sources are in the upper 39 cm of the upper shield section of radial reflectors located in the core.

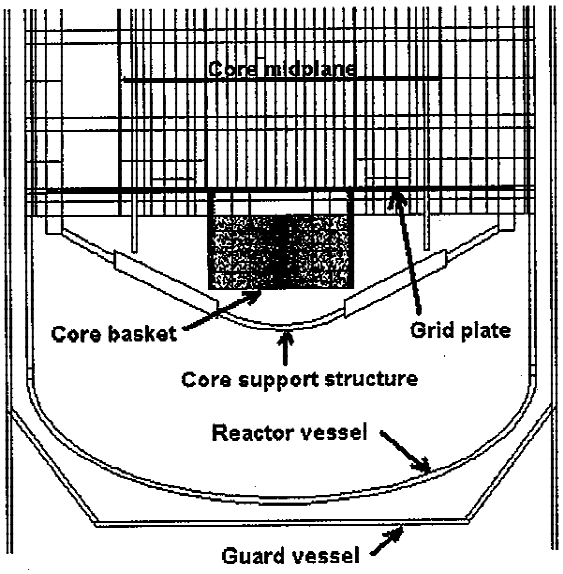


Figure L-6. Elevation view of the FFTF model showing the photon source distribution in MCNP4C case s06. Sources are in the core basket and grid plate.

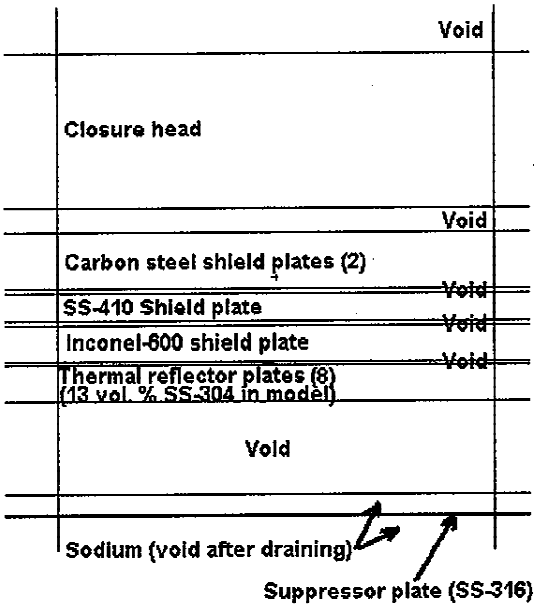


Figure L-7. Elevation view of the MCNP4C model of the FFTF showing the head assembly. Details of the head assembly are given in Appendix G.1.

This page intentionally left blank

APPENDIX M
PEER REVIEW SHEET

Place Peer Review Sheet Here

Desk Instruction 2.0, Rev. 1

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed - FFTF-14010, Rev. 0

Title: Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

Author: J. V. Nelson

Date: October 2002

Yes	No*	NA		
[✓]	[ ]	[ ]		Referenced analyses appropriate.
[✓]	[ ]	[ ]		Problem completely defined and all potential configurations considered.
[ ]	[ ]	[✓]		Accident scenarios developed in a clear and logical manner.
[✓]	[ ]	[ ]		Necessary assumptions explicitly stated and supported.
[✓]	[ ]	[ ]		Computer codes and data files documented.
[✓]	[ ]	[ ]		Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]		Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]		Mathematical derivations checked including dimensional consistency of results
[✓]	[ ]	[ ]		Models appropriate and used within range of validity, or use outside range of established validity justified.
[✓]	[ ]	[ ]		Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[✓]	[ ]	[ ]		Software input correct and consistent with document reviewed.
[✓]	[ ]	[ ]		Software output consistent with input and with results reported in document reviewed.
[✓]	[ ]	[ ]		Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[✓]		Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]		Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]		Results and conclusions address all points required in the problem statement.
[✓]	[ ]	[ ]		Format consistent with applicable guides or other standards.
[ ]	[✓]	[ ]	**	Review calculations, comments, and/or notes are attached.
[✓]	[ ]	[ ]		Document approved (for example, the reviewer affirms the technical accuracy of the document).

D. W. Wootan D W Wootan
Technical Peer Reviewer (printed name and signature)

10/31/02
Date

* All "no" responses must be explained below or on an additional sheet.

** Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. The material should be labeled and recorded in such a manner as to be understandable to a technically qualified third party.

Desk Instruction 2.0, Rev. 1

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed - FFTF-14010, Rev. 0

Title: Radionuclide Inventory in the Fast Flux Test Facility Reactor Vessel

Author: J. V. Nelson

Date: October 2002

Yes	No*	NA		
[X]	[ ]	[ ]		Referenced analyses appropriate.
[X]	[ ]	[ ]		Problem completely defined and all potential configurations considered.
[ ]	[ ]	[X]		Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]		Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]		Computer codes and data files documented.
[X]	[ ]	[ ]		Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]		Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]		Mathematical derivations checked including dimensional consistency of results
[X]	[ ]	[ ]		Models appropriate and used within range of validity, or use outside range of established validity justified.
[X]	[ ]	[ ]		Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]		Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]		Software output consistent with input and with results reported in document reviewed.
[X]	[ ]	[ ]		Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]		Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]		Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]		Results and conclusions address all points required in the problem statement.
[X]	[ ]	[ ]		Format consistent with applicable guides or other standards.
[ ]	[ ]	[X]	**	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]		Document approved (for example, the reviewer affirms the technical accuracy of the document).

J. S. Lan J. S. Lan
Technical Peer Reviewer (printed name and signature)

10/30/02
Date

* All "no" responses must be explained below or on an additional sheet.

** Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. The material should be labeled and recorded in such a manner as to be understandable to a technically qualified third party.