

## OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT DESIGN CALCULATION OR ANALYSIS COVER SHEET

1. QA: QA  
2. Page 1

3. System: Uncanistered Disposal Container System	4. Document Identifier: CAL-UDC-NU-000011 Rev A	5. Verified: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
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6. Title:  
Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations

7. Group:  
Risk & Criticality

8. Document Status Designation:  
 Preliminary   
  Final   
  Superseded   
  Cancelled

9. Notes/Comments:  
Attachment III is a compact disc attachment to this calculation.

Attachments	Total Number of Pages
Attachment I	2
Attachment II	2
Attachment III	SEE Box 9

### RECORD OF REVISIONS

10. No.	11. Reason for Revision	12. Total No. of Pages	13. Last Page No.	14. Originator (Print/Sign)	15. Checker (Print/Sign)	16. Quality Engineering Representative (Print/Sign)	17. Approved/ Accepted (Print/Sign)	18. Date
A	Initial issue	65	II-2	John M. Scaglione <i>John M. Scaglione</i>	Peter M. Noel <i>Peter Noel</i>	Daniel J. Tunney <i>Daniel J. Tunney</i> 4/19/2002	Halim Alsacd <i>alsacd</i>	4/19/02

CONTENTS

	Page
1. PURPOSE.....	6
2. METHOD .....	7
3. ASSUMPTIONS.....	8
4. USE OF COMPUTER SOFTWARE AND MODELS.....	9
4.1 SOFTWARE APPROVED FOR QA WORK.....	9
4.1.1 SAS2H.....	9
4.1.2 MCNP.....	9
5. CALCULATION .....	10
5.1 CALCULATION METHOD.....	10
5.1.1 SAS2H Fuel Depletion Description .....	10
5.2 SAMPLE DESCRIPTION .....	11
5.3 FUEL ASSEMBLY DESIGN AND OPERATING PARAMETERS.....	15
5.3.1 SAS2H Material Specifications.....	16
5.3.2 SAS2H Operating History Specifications .....	20
5.4 SAS2H PATH B REPRESENTATIONS.....	38
5.4.1 Path B Radii for Assembly NJ05YU.....	38
5.4.2 Path B Radii for Assembly NJ070G.....	42
5.5 MCNP SPECIFICATIONS .....	44
6. RESULTS .....	48
6.1 SAMPLE RESULTS FROM ASSEMBLY NJ05YU .....	48
6.2 SAMPLE RESULTS FOR ASSEMBLY NJ070G.....	53
6.3 MCNP CALCULATION RESULTS .....	56
7. REFERENCES .....	59
8. ATTACHMENTS.....	61

Originator:      Date: 4/19/02

Checker:      Date: 4/19/02

**FIGURES**

	<b>Page</b>
1. Cross-Sectional View of Sampled Rod Assembly Positions.....	13
2. Path B Representation for Assembly NJ05YU.....	42
3. Path B Representation for Assembly NJ070G.....	44
4. MCNP Results for Assembly NJ05YU.....	57
5. MCNP Results for Assembly NJ070G.....	58

Originator: JWS Date: 4/19/02

Checker: [Signature] Date: 4/19/02

TABLES

	Page
1. Fuel Sample Characteristic Parameters.....	12
2. Measured Concentrations for Assembly NJ05YU.....	13
3. Measured Concentrations for Assembly NJ070G.....	14
4. Fuel Assembly Geometric and Material Information .....	15
5. Trace Isotopes Specified in Fresh Fuel Compositions.....	16
6. SAS2H Zircaloy-4 Composition.....	16
7. Initial Sample Location Moderator Density Values.....	17
8. SAS2H Compositions Specific to Assembly NJ05YU.....	17
9. Volume Fractions for Homogenization of BPR Unit Cells .....	18
10. SAS2H Compositions Specific to Assembly NJ070G.....	19
11. Operating History Information for Assembly NJ05YU Sample TMI A1B .....	21
12. Operating History Information for Assembly NJ05YU Sample TMI B2 .....	21
13. Operating History Information for Assembly NJ05YU Sample TMI C3 .....	22
14. Operating History Information for Assembly NJ05YU Sample TMI C2B .....	22
15. Operating History Information for Assembly NJ05YU Sample TMI C1 .....	23
16. Operating History Information for Assembly NJ05YU Sample TMI D1A2.....	24
17. Operating History Information for Assembly NJ05YU Sample TMI D1A4.....	24
18. Operating History Information for Assembly NJ05YU Sample TMI D2.....	25
19. Operating History Information for Assembly NJ05YU Sample TMI B1B .....	25
20. Operating History Information for Assembly NJ05YU Sample TMI A2.....	26
21. Operating History Information for Assembly NJ05YU Sample TMI B3J .....	26
22. Operating History Information for Assembly NJ070G Sample O1 S1.....	27
23. Operating History Information for Assembly NJ070G Sample O1 S2.....	27
24. Operating History Information for Assembly NJ070G Sample O1 S3.....	27
25. Operating History Information for Assembly NJ070G Sample O12 S4.....	28
26. Operating History Information for Assembly NJ070G Sample O12 S5.....	28
27. Operating History Information for Assembly NJ070G Sample O12 S6.....	28
28. Operating History Information for Assembly NJ070G Sample O13 S7.....	29
29. Operating History Information for Assembly NJ070G Sample O13 S8.....	29
30. Measured Sample and Operating History Burnup Percent Differences.....	29
31. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI A1B .....	30
32. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI B2 .....	31
33. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI C3 .....	31
34. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI C2B .....	32
35. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI C1 .....	32

Originator: MW Date: 4/19/02

Checker: Ph Date: 4/19/02

TABLES (Continued)

	Page
36. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI D1A2 .....	33
37. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI D1A4 .....	33
38. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI D2 .....	34
39. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI B1B .....	34
40. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI A2 .....	35
41. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI B3J.....	35
42. Measured Burnup Operating History Information for Assembly NJ070G Sample O1 S1 ....	36
43. Measured Burnup Operating History Information for Assembly NJ070G Sample O1 S2 ....	36
44. Measured Burnup Operating History Information for Assembly NJ070G Sample O1 S3 ....	36
45. Measured Burnup Operating History Information for Assembly NJ070G Sample O12 S4 ..	37
46. Measured Burnup Operating History Information for Assembly NJ070G Sample O12 S5 ..	37
47. Measured Burnup Operating History Information for Assembly NJ070G Sample O12 S6 ..	37
48. Measured Burnup Operating History Information for Assembly NJ070G Sample O13 S7 ..	38
49. Measured Burnup Operating History Information for Assembly NJ070G Sample O13 S8 ..	38
50. Assembly NJ05YU General Fuel-Unit-Cell Values .....	40
51. SB-575 N06022 Material Composition .....	46
52. Material Specifications for SS316NG .....	46
53. Material Specifications for Neutronit A978 with 1.62 wt% Boron .....	47
54. Material Specifications for Al 6061 .....	47
55. Grade 70 A516 Carbon Steel Composition .....	47
56. Zircaloy-4 Material Composition.....	47
57. SAS2H Calculated Results for Assembly NJ05YU Samples .....	48
58. SAS2H Calculated Results for Assembly NJ05YU Samples Using Measured Burnups .....	50
59. Assembly NJ05YU Sample Percent Differences .....	51
60. Assembly NJ05YU Sample Percent Differences from Cases Using Measured Burnups .....	52
61. SAS2H Calculated Results for Assembly NJ070G Samples .....	53
62. SAS2H Calculated Results for Assembly NJ070G Samples Using Measured Burnups .....	54
63. Assembly NJ070G Sample Percent Differences .....	55
64. Assembly NJ070G Sample Percent Differences from Cases Using Measured Burnups .....	55
65. MCNP Results for Spent Nuclear Fuel Samples .....	56
66. Attachment Listing.....	61
II-1. Sample and MCNP Filename Identification .....	II-1

Originator: [Signature] Date: 4/19/02

Checker: [Signature] Date: 4/19/02

**Title:** Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations**Document Identifier:** CAL-UDC-NU-000011 REV A**Page 6 of 61**

### 1. PURPOSE

The objective of the *Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations* is to determine the accuracy of the SAS2H control module of the SCALE 4.4a code system (Ref. 7.11) in predicting the isotopic concentrations of spent fuel, and to quantify the overall effect that the differences between the calculated and measured isotopic concentrations have on system reactivity. The scope of this calculation covers 19 different spent fuel samples from two different fuel assemblies that were irradiated in the Three Mile Island Unit 1 pressurized water reactor (PWR). The spent fuel samples evaluated are from a one cycle burn period and a two cycle burn period, representing burnups from 22.8 GWd/MTU through 55.7 GWd/MTU (Refs 7.18 and 7.20).

This report is an engineering calculation supporting the development of validation reports to be used for License Application of the potential Monitored Geologic Repository (MGR), and was performed under Administrative Procedure-3.12Q Revision 1 Interim Change Notice 1 (Ref. 7.22). This calculation is subject to the Quality Assurance Requirements and Description (Ref. 7.21) per the activity evaluation under work package number P3212234F4 in the technical work plan TWP-EBS-MD-000004 REV 02 (Ref. 7.14).

The control of the electronic management of data was accomplished in accordance with methods specified in Reference 7.14.

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## 2. METHOD

The calculational method used to determine the spent nuclear fuel (SNF) isotopics consisted of using the SAS2H control sequence of the SCALE, Version 4.4a, code system (Ref. 7.11) to deplete the fuel for various initial fuel enrichments and burnups. The isotopic predictions are then compared against measured concentrations from the fuel assemblies that were represented in the depletion calculations to determine the accuracy of the predicted values.

The analytical methods employed for this evaluation were the SAS2H control module of the SCALE 4.4a code system (Ref. 7.11) and MCNP (Ref. 7.12). Based upon fuel assembly design, power history, and operating data for the specific assemblies in the Three Mile Island Unit 1 core, a computational representation was developed for use with SAS2H. The SAS2H module is used to perform a fuel depletion analysis to predict the isotopic concentrations in localized areas of assembly pins. The isotopic concentrations predicted by the SAS2H module are then compared with measured concentrations of the same localized areas (axial locations) of the assembly pins to determine the accuracy of the developed calculational representation. The measured and calculated isotopic compositions from SCALE were then used as input to the MCNP code (Ref. 7.12) to calculate the neutron multiplication factor in order to quantify the overall effect that the variations between measured and calculated isotopics have on system neutron multiplication. The measured isotopic concentrations used for comparisons in this evaluation come from References 7.18 and 7.20.

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### 3. ASSUMPTIONS

- 3.1 It was assumed that the omission of the isotopes Nd-146 and Nd-150 from the MCNP cases would have a negligible effect on system reactivity. The rationale for these isotopes being omitted is that the MCNP cross section libraries for these isotopes were not available, and their concentrations were very small ( $< 0.1$  wt%). This assumption was used in Section 5.
- 3.2 It was assumed that using the Al material cross-section for Zn in the MCNP cases has a negligible impact on the results of criticality calculations. The basis for this assumption is that the neutronic characteristics for Zn and Al are sufficiently similar. The Zn neutron cross-section libraries were not available for MCNP. Also, the Zn material that is substituted only appears in Al6061 and is in trace amounts. This assumption is used in Section 5.

Originator: AMJ Date: 4/19/02

Checker: SM Date: 4/19/02



#### 4. USE OF COMPUTER SOFTWARE AND MODELS

##### 4.1 SOFTWARE APPROVED FOR QA WORK

###### 4.1.1 SAS2H

The SAS2H control module of the baselined SCALE, Version 4.4a, modular code system (Ref. 7.11) was used to perform the fuel assembly depletion calculations required for this evaluation. The software specifications are as follows:

- Program Name: SAS2H of the SCALE Modular Code System
- Version/Revision Number: Version 4.4a
- Status/Operating System: Qualified/HP-UX B.10.20
- Software Tracking Number (STN) Number: 10129-4.4A-00
- Computer Type: Hewlett Packard (HP) 9000 Series Workstations
- Computer Processing Unit (CPU) number: 700887

The input and output files for the various SAS2H calculations were documented in Attachments II and III to this calculation as described in Sections 5 and 8, such that an independent repetition of the software use could be performed. The SAS2H software used was: (a) appropriate for the application of commercial fuel assembly depletion, (b) used only within the range of validation as documented in References 7.1 and 7.2, and (c) obtained from Software Configuration Management in accordance with appropriate procedures.

###### 4.1.2 MCNP

The baselined MCNP code (Ref. 7.12) was used to calculate the neutron multiplication factor for the various spent fuel compositions. The software specifications are as follows:

- Program Name: MCNP
- Version/Revision Number: Version 4B2LV
- Status/Operating System: Qualified/HP-UX B.10.20
- Computer Software Configuration Item Number: 30033 V4B2LV
- Computer Type: HP 9000 Series Workstations
- CPU number: 700887

The input and output files for the various MCNP calculations are documented in Attachments II and III to this calculation file as described in Sections 5 and 8, such that an independent repetition of the software use may be performed. The MCNP software used was: (a) appropriate for the application of multiplication factor calculations, (b) used only within the range of validation as documented throughout References 7.4 and 7.5, and (c) obtained from Software Configuration Management in accordance with appropriate procedures.

Originator: JMS Date: 4/19/02

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## 5. CALCULATION

This report evaluates the accuracy to which the SAS2H control module can predict the composition of spent nuclear fuel for several different radiochemical assay samples from Three Mile Island Unit 1 PWR assemblies.

### 5.1 CALCULATION METHOD


The method of calculation is based upon the calculation of isotopic constituents of irradiated fuel using the SAS2H sequence of the SCALE computer code system. The SAS2H sequence provides the isotopics present in the fuel when it is discharged from the reactor. All SAS2H inputs were set up as representing the corresponding assembly axial node from Reference 7.3 from which the measured fuel sample resided while in the reactor.


#### 5.1.1 SAS2H Fuel Depletion Description

The SAS2H control sequence accesses five calculation modules of the SCALE code system for performing fuel depletion and decay calculations. The five modules include BONAMI, NITAWL-II, XSDRNPM, COUPLE, and ORIGEN-S. Each of the modules has a specific purpose in the sequence to perform the fuel depletion and decay calculations. The following provides a brief description of what each module does with a more detailed description being provided in Reference 7.1.

- BONAMI – applies the Bondarenko method of resonance self-shielding to nuclides for which Bondarenko data are available.
- NITAWL-II – performs Nordheim resonance self-shielding corrections for nuclides that have resonance parameter data available.
- XSDRNPM – performs a one-dimensional (1-D) neutron transport calculation on a specified geometry to facilitate production of cell-weighted cross sections for fuel depletion calculations.
- COUPLE – updates all cross section constants included on an ORIGEN-S working nuclear data library with data from the cell-weighted cross section library obtained from the XSDRNPM calculation. Additionally, the weighting spectrum produced by XSDRNPM is applied to update all nuclides in the ORIGEN-S working library which were not included in the XSDRNPM calculation.
- ORIGEN-S – performs point depletion, buildup, and decay calculations for the specified assembly irradiation history. Additionally, can be run as a stand alone case to provide isotopic concentrations at various decay times.

The SAS2H control module uses ORIGEN-S to perform a point depletion calculation for the fuel assembly section described in the SAS2H input file. The ORIGEN-S module uses cell-weighted cross sections based on 1-D transport calculations performed by XSDRNPM. One-dimensional transport calculations are performed on two models, Path A and Path B, to calculate energy dependent spatial neutron flux distributions necessary to perform cross section cell-weighting calculations.

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The Path A model is simply a unit cell of the fuel assembly lattice containing a fuel rod. In the Path A model, the fuel, clad, and moderator are modeled explicitly. The only modification required to develop the Path A model is the conversion of the fuel assembly's square lattice unit cell perimeter to a radial perimeter conserving moderator volume within the unit cell (exterior to the fuel rod cladding). This modification is performed automatically by the SAS2H control module. A 1-D transport calculation is performed on the Path A model for each energy group, and the spatial flux distributions for each energy group are used to calculate cell-weighted cross sections for the fuel.

The Path B model is a larger representation of the assembly than the Path A model. The Path B model approximates spectral effects due to heterogeneity within the fuel assembly such as water gaps, burnable poison rods, control rods, or axial power shaping rods. The structure of the Path B model is based on a uniform distribution of non-fuel lattice cells. In reality, most fuel assemblies do not have uniformly distributed non-fuel lattice cells, but the approximation of uniformly distributed non-fuel lattice cells is considered acceptable within the fidelity of these calculations as documented in Section S2.2.3.1 of Volume 1, Rev. 6 in Reference 7.1.

The basic structure of the Path B model for the fuel assembly depletion calculations performed in this analysis included an inner region composed of a representation of the non-fuel assembly lattice cell. A region containing the homogenization of the Path A model surrounds the inner region in the Path B model. A final region representing the moderator in the assembly-to-assembly spacing surrounds the homogenized region in the Path B model. The size of each radial region that surrounds the inner region in the Path B model is determined by conserving both the fuel-to-moderator mass ratio and the fuel-to-absorber (burnable poison) mass ratio in the corresponding section of the fuel assembly. The cell-weighted cross sections from the Path A model are applied to the homogenized region during the Path B model transport calculations. New cell-weighted cross sections for each energy group are then developed using the unit cell spatial flux distribution results from the Path B model transport calculations. These cell-weighted cross sections are ultimately used in the point depletion calculations performed by ORIGEN-S to calculate the depleted fuel isotopic compositions in the corresponding fuel assembly. A detailed description of the calculations used to produce time-dependent cross sections by SAS2H is documented in Section S2.2.4 of Volume 1, Rev. 6 in Reference 7.1.

The Path B model for the fuel assembly configuration is provided to the SAS2H control module. The essential rule in deriving the zone radii is to maintain the relative volumes for all zones in the actual assembly (p. S2.2.5, Ref. 7.1).

## 5.2 SAMPLE DESCRIPTION

Radiochemical analyses for 19 spent fuel samples from two different assemblies (p. 1, Ref. 7.20, vol. 1 and 2; pp. 7 and 8, Ref. 7.18) from the Three Mile Unit 1 core were evaluated in this report. The basic fuel assembly design for this core uses a Babcock and Wilcox (B&W) 15x15 design which contains 16 guide tube positions and one instrument tube position. The samples assayed came from various axial locations of four irradiated fuel rods that were taken from two different assemblies identified as NJ05YU and NJ070G. Basic sample characteristics and

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locations are provided in Table 1. A cross-sectional view of a fuel assembly and the corresponding position of the sampled rods is illustrated in Figure 1. The radiochemical assay measured isotopic concentrations for assemblies NJ05YU and NJ070G are presented in Tables 2 and 3, respectively.


The time of the measurements is used to calculate the amount of decay time associated with each sample. Reference 7.20 (pp. 11 through 14, vol. 2), indicated measurement dates of November 4, 5, and 26 (1999) for various samples, therefore a date of November 15, 1999 is used for these samples. Reference 7.20 (pp. 11 through 14, vol. 1) indicates measurement dates in the March/April time frame of 1999, therefore a date of March 29, 1999 is used for these samples. Reference 7.18 indicates Phase I sample measurement dates in September 1998, therefore September 15, 1998 is used; and Phase II sample measurement dates were in May 2000, therefore May 15, 2000 is used. These dates correspond to a downtime of 1529 days for samples O1 S2, O12 S5, O13 S7, and O13 S8; downtime of 1298 days for samples O1 S1, O1 S3, O12 S4, and O12 S6; downtime of 1103 days for samples TMI A2, B2, C1, C3, and D2; and a downtime of 1711 days for samples TMI A1B, B1B, B3J, C2B, D1A2, and D1A4.

Table 1. Fuel Sample Characteristic Parameters

Assembly	Rod Number	ANLCMT/TRW Sample Identifier	Axial Position <sup>a</sup> (in. / cm)	Initial Enrichment (Wt% U-235)	Measured Burnup (GWd/MTU)
NJ05YU	H6	TMI A2	29.4 / 74.676	4.00	50.6
NJ05YU	H6	TMI B2	45.3 / 115.062	4.00	50.1
NJ05YU	H6	TMI C1	92.7 / 235.458	4.00	50.2
NJ05YU	H6	TMI C3	61.5 / 156.21	4.00	51.3
NJ05YU	H6	TMI D2	126.8 / 322.072	4.00	44.8
NJ05YU	H6	TMI A1B	15.25 / 38.735	4.00	44.8
NJ05YU	H6	TMI B1B	61.40 / 155.956	4.00	54.5
NJ05YU	H6	TMI B3J	30.32 / 77.013	4.00	53.0
NJ05YU	H6	TMI C2B	76.62 / 194.615	4.00	52.6
NJ05YU	H6	TMI D1A2	103.11 / 261.899	4.00	55.7
NJ05YU	H6	TMI D1A4	115.11 / 292.379	4.00	50.5
NJ070G	O1	O1 S1	15.5 / 39.37	4.65	25.8
NJ070G	O1	O1 S2	77.6 / 197.104	4.65	29.9
NJ070G	O1	O1 S3	109.5 / 278.13	4.65	26.7
NJ070G	O12	O12 S4	15.5 / 39.37	4.65	23.7
NJ070G	O12	O12 S5	77.6 / 197.104	4.65	26.5
NJ070G	O12	O12 S6	109.5 / 278.13	4.65	24.0
NJ070G	O13	O13 S7	15.5 / 39.37	4.65	22.8
NJ070G	O13	O13 S8	77.6 / 197.104	4.65	26.3

Sources: Refs. 7.18 and 7.20

NOTE: <sup>a</sup> Position is measured in in. from tip of bottom end plug; cm value provided was converted from in.

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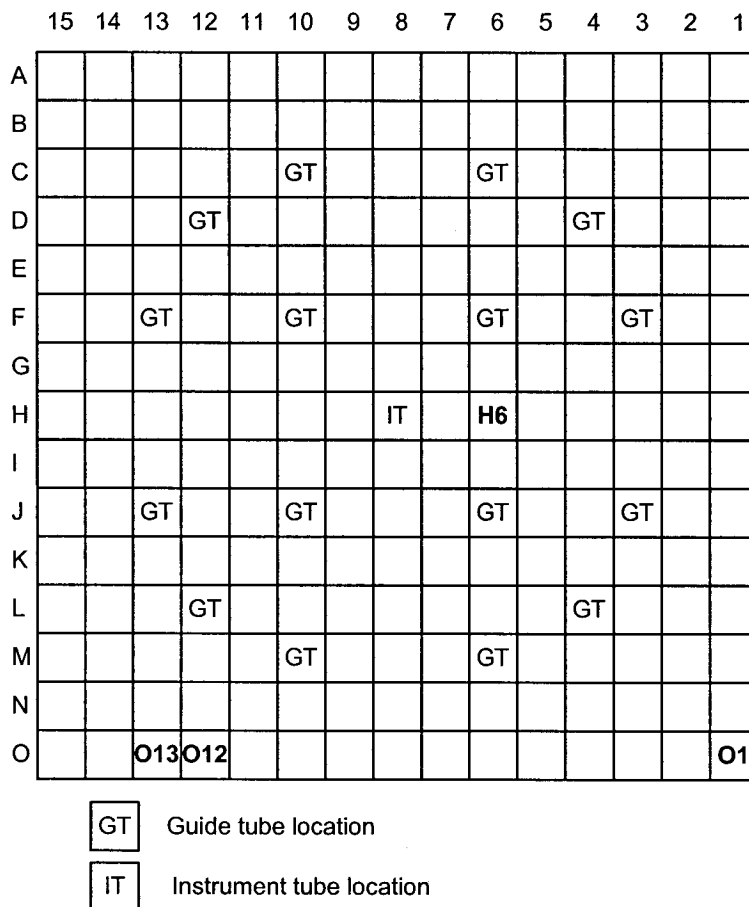


Figure 1. Cross-Sectional View of Sampled Rod Assembly Positions (pp. A-4 and A-5, Ref. 7.3)

Table 2. Measured Concentrations for Assembly NJ05YU

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Avg BU (MWd/MTU)	50600	50100	50200	51300	44800	44800	54500	53000	52600
Isotope	Concentration (mg/mg U-238)								
U-234	2.07E-04	2.02E-04	2.14E-04	2.00E-04	2.07E-04	2.21E-04	2.04E-04	1.99E-04	1.96E-04
U-235	6.84E-03	6.71E-03	7.13E-03	6.77E-03	7.94E-03	9.26E-03	6.94E-03	6.63E-03	6.75E-03
U-236	5.95E-03	5.84E-03	5.92E-03	5.77E-03	5.74E-03	5.50E-03	5.87E-03	5.92E-03	5.62E-03
Pu-238	3.83E-04	3.40E-04	3.57E-04	2.72E-04	3.50E-04	4.34E-04	4.69E-04	4.32E-04	4.97E-04
Pu-239	5.78E-03	5.72E-03	5.85E-03	5.97E-03	5.84E-03	5.45E-03	5.55E-03	5.52E-03	5.41E-03
Pu-240	3.01E-03	2.95E-03	2.98E-03	3.08E-03	2.87E-03	2.52E-03	2.86E-03	2.88E-03	2.76E-03
Pu-241	1.47E-03	1.50E-03	1.54E-03	1.52E-03	1.47E-03	1.30E-03	1.48E-03	1.48E-03	1.44E-03
Pu-242	9.99E-04	9.89E-04	9.74E-04	1.00E-03	8.55E-04	7.31E-04	1.04E-03	1.20E-03	1.01E-03
Nd-143	1.03E-03	1.08E-03	1.06E-03	1.03E-03	9.83E-04	1.06E-03	1.18E-03	1.15E-03	1.12E-03
Nd-145	9.50E-04	9.80E-04	9.71E-04	9.71E-04	8.92E-04	9.17E-04	1.07E-03	1.06E-03	1.02E-03
Nd-148	5.96E-04	5.89E-04	5.90E-04	6.04E-04	5.24E-04	5.24E-04	6.44E-04	6.25E-04	6.20E-04
Cs-137	1.91E-03	1.89E-03	1.96E-03	1.84E-03	1.74E-03	1.81E-03	1.91E-03	1.88E-03	1.91E-03
Eu-151	9.56E-07	8.58E-07	7.42E-07	9.18E-07	7.57E-07	7.08E-07	6.19E-07	8.11E-07	7.62E-07
Eu-153	1.85E-04	1.81E-04	1.81E-04	1.74E-04	1.68E-04	1.58E-04	2.02E-04	1.99E-04	1.87E-04
Eu-155	1.39E-05	1.42E-05	1.55E-05	1.38E-05	1.32E-05	1.08E-05	1.68E-05	1.12E-05	1.08E-05
Sm-147	2.13E-04	2.01E-04	2.02E-04	1.97E-04	1.96E-04	2.43E-04	2.77E-04	2.69E-04	2.48E-04
Sm-149	4.13E-06	3.53E-06	3.45E-06	3.14E-06	3.33E-06	3.35E-06	3.72E-06	3.46E-06	3.64E-06
Sm-150	4.05E-04	4.06E-04	4.15E-04	3.92E-04	3.75E-04	3.85E-04	5.08E-04	4.91E-04	4.54E-04
Sm-151	1.36E-05	1.45E-05	1.35E-05	1.36E-05	1.36E-05	1.39E-05	1.63E-05	1.60E-05	1.44E-05

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Table 2. Measured Concentrations for Assembly NJ05YU

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Avg BU (MWd/MTU)	50600	50100	50200	51300	44800	44800	54500	53000	52600
<b>Isotope</b>	<b>Concentration (mg/mg U-238)</b>								
Sm-152	1.43E-04	1.40E-04	1.37E-04	1.36E-04	1.30E-04	1.31E-04	1.56E-04	1.54E-04	1.41E-04
Gd-155	5.65E-06	7.08E-06	6.88E-06	7.22E-06	6.02E-06	8.85E-06	1.09E-05	1.13E-05	1.02E-05
Am-241	3.27E-04	3.69E-04	4.08E-04	3.28E-04	3.72E-04	3.73E-04	3.13E-04	5.49E-04	5.50E-04
Am-242m	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.12E-06	1.35E-06	1.82E-06
Am-243	2.75E-04	2.76E-04	2.66E-04	2.67E-04	2.07E-04	1.34E-04	2.22E-04	2.29E-04	2.12E-04
Np-237	7.51E-04	7.48E-04	7.62E-04	7.39E-04	7.27E-04	6.50E-04	7.62E-04	7.66E-04	7.44E-04
Mo-95	1.21E-03	1.22E-03	1.19E-03	1.09E-03	9.90E-04	1.12E-03	1.25E-03	1.22E-03	1.19E-03
Tc-99	1.17E-03	1.18E-03	1.17E-03	1.12E-03	1.05E-03	1.53E-03	1.43E-03	1.35E-03	1.47E-03
Ru-101	1.25E-03	1.30E-03	1.26E-03	1.11E-03	1.02E-03	1.20E-03	1.29E-03	1.27E-03	1.27E-03
Rh-103	6.70E-04	6.80E-04	6.69E-04	5.93E-04	5.55E-04	6.41E-04	6.81E-04	6.73E-04	6.66E-04
Ag-109	6.46E-05	5.71E-05	5.80E-05	1.00E-04	5.01E-05	5.50E-05	4.78E-05	8.45E-05	7.08E-05
<b>Sample</b>	<b>TMI D1A2</b>	<b>TMI D1A4</b>							
Avg BU (MWd/MTU)	55700	50500							
<b>Isotope</b>	<b>Concentration (mg/mg U-238)</b>								
U-234	2.10E-04	2.14E-04							
U-235	7.59E-03	8.11E-03							
U-236	5.94E-03	5.81E-03							
Pu-238	4.15E-04	4.06E-04							
Pu-239	5.94E-03	5.85E-03							
Pu-240	2.95E-03	2.84E-03							
Pu-241	1.60E-03	1.55E-03							
Pu-242	1.05E-03	1.02E-03							
Nd-143	1.21E-03	1.17E-03							
Nd-145	1.09E-03	1.04E-03							
Nd-148	6.60E-04	5.94E-04							
Cs-137	1.67E-03	1.79E-03							
Eu-151	7.21E-07	7.23E-07							
Eu-153	2.06E-04	1.89E-04							
Eu-155	1.07E-05	1.37E-05							
Sm-147	2.74E-04	2.55E-04							
Sm-149	4.20E-06	3.90E-06							
Sm-150	4.93E-04	4.47E-04							
Sm-151	1.69E-05	1.53E-05							
Sm-152	1.55E-04	1.45E-04							
Gd-155	1.11E-05	1.51E-05							
Am-241	3.65E-04	5.70E-04							
Am-242m	6.63E-07	9.09E-07							
Am-243	2.24E-04	2.00E-04							
Np-237	7.69E-04	7.42E-04							
Mo-95	1.21E-03	1.18E-03							
Tc-99	1.24E-03	1.29E-03							
Ru-101	1.23E-03	1.19E-03							
Rh-103	6.72E-04	6.53E-04							
Ag-109	5.02E-05	9.17E-05							

Source: Ref. 7.18

Table 3. Measured Concentrations for Assembly NJ070G

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Avg BU (MWd/MTU)	25800	29900	26700	23700	26500	24000	22800	26300
<b>Isotope</b>	<b>Concentration (mg/mg U-238)</b>							
U-234	3.48E-04	3.25E-04	3.35E-04	3.55E-04	3.34E-04	3.48E-04	3.65E-04	3.40E-04
U-235	2.35E-02	2.05E-02	2.32E-02	2.51E-02	2.33E-02	2.55E-02	2.53E-02	2.34E-02
U-236	4.83E-03	5.34E-03	4.99E-03	4.58E-03	4.93E-03	4.68E-03	4.49E-03	4.89E-03
Pu-238	7.67E-05	1.16E-04	1.00E-04	6.68E-05	9.40E-05	8.29E-05	6.41E-05	9.29E-05
Pu-239	5.81E-03	5.98E-03	6.44E-03	5.79E-03	6.41E-03	6.60E-03	5.77E-03	6.28E-03

Originator: *JMA* Date: *4/19/02*

Checker: *[Signature]* Date: *4/19/02*

Table 3. Measured Concentrations for Assembly NJ070G

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Avg BU (MWd/MTU)	25800	29900	26700	23700	26500	24000	22800	26300
Isotope	Concentration (mg/mg U-238)							
Pu-240	1.62E-03	1.98E-03	1.83E-03	1.48E-03	1.76E-03	1.61E-03	1.46E-03	1.73E-03
Pu-241	8.04E-04	9.79E-04	9.56E-04	7.34E-04	8.97E-04	8.54E-04	7.04E-04	8.79E-04
Pu-242	1.92E-04	3.04E-04	2.36E-04	1.58E-04	2.20E-04	1.76E-04	1.54E-04	2.16E-04
Nd-143	7.95E-04	8.92E-04	8.28E-04	7.51E-04	8.16E-04	7.66E-04	7.41E-04	8.11E-04
Nd-145	6.00E-04	6.87E-04	6.21E-04	5.59E-04	6.11E-04	5.64E-04	5.51E-04	6.08E-04
Nd-146	5.56E-04	6.58E-04	5.87E-04	5.12E-04	5.76E-04	5.26E-04	5.04E-04	5.72E-04
Nd-148	3.05E-04	3.58E-04	3.21E-04	2.81E-04	3.14E-04	2.88E-04	2.77E-04	3.12E-04
Nd-150	1.38E-04	1.64E-04	1.47E-04	1.26E-04	1.43E-04	1.31E-04	1.25E-04	1.42E-04
Cs-134	2.51E-05	2.76E-05	2.90E-05	2.22E-05	2.27E-05	2.44E-05	1.76E-05	2.27E-05
Cs-137	9.71E-04	1.17E-03	1.03E-03	9.05E-04	1.00E-03	9.18E-04	8.92E-04	1.01E-03
Eu-151	4.15E-07	4.74E-07	4.61E-07	4.29E-07	5.02E-07	4.89E-07	4.48E-07	4.99E-07
Eu-153	8.05E-05	1.01E-04	8.80E-05	7.37E-05	8.65E-05	7.69E-05	7.13E-05	8.61E-05
Sm-147	1.91E-04	2.20E-04	1.94E-04	1.81E-04	2.01E-04	1.79E-04	1.86E-04	1.99E-04
Sm-149	4.32E-06	4.36E-06	4.72E-06	4.32E-06	4.44E-06	4.73E-06	4.23E-06	4.42E-06
Sm-150	2.30E-04	2.78E-04	2.47E-03	2.11E-04	2.41E-04	2.17E-04	2.06E-04	2.38E-04
Sm-151	1.36E-05	1.47E-05	1.53E-05	1.38E-05	1.51E-05	1.58E-05	1.35E-05	1.51E-05
Sm-152	9.23E-05	1.07E-04	9.54E-05	8.62E-05	9.27E-05	8.41E-05	8.47E-05	9.19E-05
Gd-155	2.46E-06	3.09E-06	2.82E-06	2.03E-06	2.68E-06	2.33E-06	2.10E-06	2.70E-06
Cm-242 [as] <sup>a</sup>	1.58E-08	1.20E-08	2.60E-08	1.90E-08	1.10E-08	1.80E-08	7.40E-09	1.10E-08
Cm-242 [ms] <sup>b</sup>	2.20E-08	2.30E-08	3.20E-08	2.70E-08	1.30E-08	2.20E-08	7.50E-09	1.40E-08
Cm-243	5.50E-08	1.25E-07	1.04E-07	6.36E-08	1.07E-07	6.99E-08	5.97E-08	1.01E-07
Cm244	2.66E-06	7.68E-06	5.32E-06	2.89E-06	5.51E-06	3.22E-06	2.62E-06	5.23E-06
Cm-245	1.19E-07	4.02E-07	2.81E-07	1.24E-07	2.90E-07	1.67E-07	1.14E-07	2.74E-07
Am-241	1.22E-04	2.12E-04	1.83E-04	1.62E-04	2.22E-04	1.47E-04	1.73E-04	2.16E-04
Am-242m	2.93E-07	4.53E-07	4.50E-07	3.77E-07	5.18E-07	3.97E-07	3.36E-07	4.99E-07
Am-243	1.60E-05	3.75E-05	2.74E-05	1.80E-05	2.96E-05	1.76E-05	1.71E-05	2.85E-05
Np-237	3.24E-04	4.23E-04	3.89E-04	3.23E-04	3.72E-04	3.50E-04	3.01E-04	3.71E-04

Source: Ref. 7.20

NOTES: <sup>a</sup> [as] indicates alpha spectrometer  
<sup>b</sup> [ms] indicates mass spectrometer

### 5.3 FUEL ASSEMBLY DESIGN AND OPERATING PARAMETERS

The general fuel assembly design parameters are presented in Table 4.

Table 4. Fuel Assembly Geometric and Material Information

Fuel Assembly Identification	NJ05YU	NJ070G
<b>Fuel Assembly Data</b>		
Lattice	15x15	15x15
Number of fuel rods	208	208
Number of guide tubes	16	16
Number of instrument tubes	1	1
Lattice pitch (cm) (p. 2-5, Ref. 7.3)	1.44272	1.44272
<b>Fuel Rod Data</b>		
Clad OD (cm)	1.0922	1.0922
Clad ID (cm) (p. 2-5, Ref. 7.3)	0.95758	0.95758
Fuel rod length (cm)	391.5664	391.5664
Fill gas	Helium	Helium
Cladding material (p. 2-5, Ref. 7.3)	Zircaloy-4	Zircaloy-4
<b>Fuel Pellet Data</b>		
Diameter (cm)	0.9362	0.9398

Originator: *JMA* Date: 4/19/02

Checker: *RM* Date: 4/19/02

Table 4. Fuel Assembly Geometric and Material Information

Active fuel length (cm)	360.172	357.124
Wt% U-235	4.00	4.65/4.19 (Gd) <sup>a</sup>
Pellet Composition (p. A-7, Ref. 7.3)		
U-234 (Wt% heavy metal)	0.040	0.045
U-235 (Wt% heavy metal)	4.013	4.657
U-236 (Wt% heavy metal)	<0.001	<0.001
U-238 (Wt% heavy metal)	95.947	95.298
Burnable Poison Rod Data (p. 2-49, Ref. 7.3)		
Absorber diameter (cm)	0.8636	0.8636
Cladding outer diameter (cm)	1.0922	1.0922
Cladding inner diameter (cm)	0.9144	0.9144
Pellet density (g/cm <sup>3</sup> )	3.7	3.7
Pellet material	Al <sub>2</sub> O <sub>3</sub> -B <sub>4</sub> C	Al <sub>2</sub> O <sub>3</sub> -B <sub>4</sub> C
Wt% B <sub>4</sub> C (pp. A-2, A-3, 3-13, 3-14; Ref. 7.3)	1.7	2.1
Cladding material	Zircaloy-4	Zircaloy-4

Source: Page A-6 of Reference 7.3 unless otherwise noted

NOTE: <sup>a</sup> Four of the fuel rods contain 2.0 wt% Gd<sub>2</sub>O<sub>3</sub> with 4.19 wt% U-235

5.3.1 SAS2H Material Specifications

The material specification section defines the UO<sub>2</sub> fresh fuel composition to which the SAS2H calculation pertains, along with the other materials necessary to describe the fuel assembly. The UO<sub>2</sub> fresh fuel composition is characterized by the fuel density, fuel temperature, and weight percentages of U-234, U-235, U-236, and U-238. For fresh fuel SAS2H cases, a number of additional isotopes are specified in trace amounts in the fuel composition to assure that their buildup and decay is tracked during the depletion calculation. Table 5 contains a listing of the trace isotopes, which are specified as each having a concentration of 1E-21 atoms/b-cm in the fresh fuel composition.

Table 5. Trace Isotopes Specified in Fresh Fuel Compositions

kr-83	kr-85	sr-90	y-89	mo-95	zr-93	zr-94
zr-95	nb-94	tc-99	rh-103	rh-105	ru-101	ru-106
pd-105	pd-108	ag-109	sb-124	xe-131	xe-132	xe-135
xe-136	cs-134	cs-135	cs-137	ba-136	la-139	ce-144
nd-143	nd-145	pm-147	pm-148	nd-147	sm-147	sm-149
sm-150	sm-151	sm-152	gd-155	eu-153	eu-154	eu-155

The fuel rod cladding material was given a base temperature of 640 K. The fuel rod cladding was made up of Zircaloy-4. The Zircaloy-4 cladding specifications used in the SAS2H input are presented in Table 6.

Table 6. SAS2H Zircaloy-4 Composition

Element	Composition ID	Wt%
Cr	24000	0.10
Fe	26000	0.21
O	8016	0.125
Sn	50000	1.45

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Table 6. SAS2H Zircaloy-4 Composition

Element	Composition ID	Wt%
Zr	40000	98.115
Density = 6.56 g/cm <sup>3</sup>		

Source: Ref. 7.13

The fuel rod fill gas material was specified as helium. The helium material temperature was allowed to default to 293 degrees Kelvin.

The cycle moderator density information comes from Appendix A of Reference 7.3. The initial input values are presented in Table 7 for each sample.

Table 7. Initial Sample Location Moderator Density Values

Sample ID	Moderator Specific Volume <sup>a</sup>	Moderator Density <sup>a</sup>
	(ft <sup>3</sup> /lbm)	(g/cm <sup>3</sup> )
TMI A2	0.0219	0.7314
TMI B2	0.0221	0.7248
TMI C1	0.0230	0.6965
TMI C3	0.0224	0.7151
TMI D2	0.0236	0.6787
TMI A1B	0.0217	0.7382
TMI B1B	0.0224	0.7151
TMI B3J	0.0219	0.7314
TMI C2B	0.0227	0.7057
TMI D1A2	0.0231	0.6934
TMI D1A4	0.0233	0.6875
O1 S1	0.0217	0.7382
O1 S2	0.0227	0.7057
O1 S3	0.0233	0.6875
O12 S4	0.0217	0.7382
O12 S5	0.0227	0.7057
O12 S6	0.0233	0.6875
O13 S7	0.0217	0.7382
O13 S8	0.0227	0.7057

NOTE: <sup>a</sup> Appendix A of Reference 7.3 provides moderator specific volume in units of ft<sup>3</sup>/lbm which were converted to the SAS2H required density format of g/cm<sup>3</sup>

The fresh fuel compositions for each U-235 enrichment used in this evaluation and other materials specific to a particular assembly design are specified in Tables 8 and 10.

Table 8. SAS2H Compositions Specific to Assembly NJ05YU

Description	SAS2H Mixture #	Density (g/cm <sup>3</sup> )	SAS2H Identifier	Concentration
Fuel	1	10.196 <sup>a</sup>	92234	0.040 wt% heavy metal <sup>b</sup>
			92235	4.013 wt% heavy metal <sup>b</sup>
			92236	0.001 wt% heavy metal <sup>b</sup>
			92238	95.947 wt% heavy metal <sup>b</sup>
Burnable Poison Rod (B <sub>4</sub> C-Al <sub>2</sub> O <sub>3</sub> )	4	3.70 <sup>c</sup>	B <sub>4</sub> C	1.70 wt% <sup>d</sup>
	4	3.70 <sup>c</sup>	Al	52.025 wt% <sup>e</sup>
	4	3.70 <sup>c</sup>	O	46.275 wt% <sup>e</sup>

Originator: *JMS* Date: 4/19/02

Checker: *[Signature]* Date: 4/19/02

- NOTES: <sup>a</sup> The fuel density was calculated by dividing the initial UO<sub>2</sub> loading of the rod by the active fuel volume  
<sup>b</sup> Page A-7 of Reference 7.3  
<sup>c</sup> Page 2-49 of Reference 7.3  
<sup>d</sup> Page 3-13 of Reference 7.3  
<sup>e</sup> Calculated based on mass fractions of Al and O in Al<sub>2</sub>O<sub>3</sub> with element masses from Reference 7.15

Volume fractions were calculated for the homogenized burnable poison rod unit cell composition by conservation of area from values listed in Table 4. The resultant calculated volume fractions and mass fractions calculated from Equation 2 for the component materials are listed in Table 9. The homogenized compositions specified in Table 10 were calculated using a combination of the derived Equations 1 through 7. Equation 4 comes from page 20 of Reference 7.19.

Table 9. Volume Fractions for Homogenization of BPR Unit Cells

Material	B <sub>4</sub> C	Gas	Water	Zircaloy
Density	3.7 <sup>a</sup>	0.1780 <sup>b</sup>	0.7382, 0.7057, 0.6875 <sup>c</sup>	6.56 <sup>d</sup>
Volume Fraction	0.2814	0.0341	0.4698	0.2147
Mass Fraction	0.3715	0.0022	0.1237, 0.1189, 0.1162	0.5026

- Sources: <sup>a</sup> p. 2-49, Ref. 7.3  
<sup>b</sup> p. 63, Ref. 7.15  
<sup>c</sup> See Table 7  
<sup>d</sup> Ref. 7.13

$$HMD = \sum_m^M [(\rho)_m * (VF)_m]$$

(Eq. 1)

where

- HMD* = the homogenized material density  
*m* = a single component material of the homogenized material  
*M* = total number of component materials in the homogenized material  
 $\rho$  = the mass density of the component material  
*VF* = the volume fraction in the homogenized material

$$MF_m = \frac{(\rho)_m * (VF)_m}{HMD}$$

(Eq. 2)

where

*MF<sub>m</sub>* = mass fraction of component material in the homogenized material

$$WP_i = MF_m * WP_m$$

(Eq. 3)

where

- WP<sub>i</sub>* = weight percent of component material constituent in homogeneous material  
*WP<sub>m</sub>* = weight percent of component material constituent in component material

$$U^{234} \text{ wt}\% = (0.007731) * (U^{235} \text{ wt}\%)^{1.0837}$$

$$U^{236} \text{ wt}\% = (0.0046) * (U^{235} \text{ wt}\%)$$

$$U^{238} \text{ wt}\% = 100 - U^{234} \text{ wt}\% - U^{235} \text{ wt}\% - U^{236} \text{ wt}\%$$

(Eq. 4)

In Equations 5 and 6 the atomic mass values (*A*) come from Reference 7.15.

$$\frac{U \text{ Mass}}{\text{mol } UO_2} = \left[ \frac{(A)(U^{234} \text{ wt}\%) + (A)(U^{235} \text{ wt}\%) + (A)(U^{236} \text{ wt}\%) + (A)(U^{238} \text{ wt}\%)}{(A)(U^{234} \text{ wt}\%) + (A)(U^{235} \text{ wt}\%) + (A)(U^{236} \text{ wt}\%) + (A)(U^{238} \text{ wt}\%)} \right] (0.01)$$

(Eq. 5)

where the weight percentages of the uranium isotopes ( $U^{234}$ ,  $U^{236}$ , and  $U^{238}$ ) in uranium for a given initial enrichment were calculated using Equation 4.

$$\frac{O \text{ Mass}}{\text{mol } UO_2} = (2)(A \text{ for oxygen})$$

(Eq. 6)

The mass fractions for the uranium isotopes and oxygen in the  $UO_2$  are calculated using Equation 7.

$$MF_i = \frac{M_i}{X + Y}$$

(Eq. 7)

where

$M_i$  = mass of element or isotope *i* per mol of  $UO_2$

$X$  = U mass per mol  $UO_2$

$Y$  = O mass per mol  $UO_2$

Table 10. SAS2H Compositions Specific to Assembly NJ070G

Description	SAS2H Mixture #	Density (g/cm <sup>3</sup> )	SAS2H Identifier	Concentration
Fuel	1	10.217	92234	0.045 wt% heavy metal
			92235	4.657 wt% heavy metal
			92236	0.001 wt% heavy metal
			92238	95.298 wt% heavy metal
Integral Fuel Burnable Absorber ( $UO_2$ - $Gd_2O_3$ )	4	10.217	64152	3.349E-03 wt%
			64154	3.698E-02 wt%
			64155	0.2527 wt%
			64156	0.3518 wt%
			64157	0.2707 wt%

Originator: gms Date: 4/19/02

Checker: gms Date: 4/19/02

Table 10. SAS2H Compositions Specific to Assembly NJ070G

Description	SAS2H Mixture #	Density (g/cm <sup>3</sup> )	SAS2H Identifier	Concentration		
				S1, S4, S7	S2, S5, S8	S3, S6
			64158	0.4324 wt%		
			64160	0.3853 wt%		
			92234	3.155E-02 wt%		
			92235	3.6194 wt%		
			92236	1.665E-02 wt%		
			92238	82.7146 wt%		
			8016	11.8846 wt%		
				<b>S1, S4, S7</b>	<b>S2, S5, S8</b>	<b>S3, S6</b>
Homogenized Burnable Poison Rod Unit Cells <sup>a</sup>	5		6012	0.170 wt%	0.171 wt%	0.171 wt%
			2004	0.216 wt%	0.218 wt%	0.218 wt%
			24000	0.050 wt%	0.051 wt%	0.051 wt%
			26000	0.106 wt%	0.106 wt%	0.106 wt%
			40000	49.309 wt%	49.579 wt%	49.731 wt%
			1001	1.385 wt%	1.331 wt%	1.301 wt%
			5010	1.125E-01 wt%	1.132E-01 wt%	1.135E-01 wt%
			5011	4.981E-01 wt%	5.008E-01 wt%	5.023E-01 wt%
			8016	28.175 wt%	27.843 wt%	27.655 wt%
			13027	19.250 wt%	19.356 wt%	19.415 wt%
			50000	0.729 wt%	0.733 wt%	0.735 wt%
		Density (g/cm <sup>3</sup> )		2.8026	2.7873	2.7788

NOTE: <sup>a</sup> The soluble boron concentration from the moderator was omitted from the homogenized mixture composition since it changes over time, and the spectral effects in this region will be dominated by the boron from the burnable poison rods

5.3.2 SAS2H Operating History Specifications

Input parameters necessary for the SAS2H input specifications were derived from the detailed fuel assembly operating history information in Appendix A of Reference 7.3. Assembly NJ05YU was irradiated during cycles 9 and 10, and NJ070G was irradiated during cycle 10. Due to a different assembly design being introduced in cycle 10, the operating history information for NJ05YU was adjusted to correspond to that for the new design thereby changing the mass of fuel per axial node in the referenced documentation. Due to a SAS2H limitation, the burnups for cycle 10 of assembly NJ05YU must be adjusted to correspond to the original cycle 9 mass loading using a renormalization factor. Since the nodal axial length of each sampled node is the same, the renormalization factor is calculated by taking the cycle 9 active fuel height and dividing it by the cycle 10 active fuel height which corresponds to 1.008571. It should also be noted that SAS2H determines the final burnup of the run based on input parameters provided which were backtracked from the final desired burnup. Therefore, due to computational roundoff variations, differences of less than 0.1 GWd/MTU are present between the adjusted burnup cases and the final SAS2H reported burnups at each irradiation step. The SAS2H input parameters used for each sample are provided in Tables 11 through 49.

In Tables 11 through 49 the column headings are as follows:

EFPD – Cumulative cycle effective full power days

ppmB – parts per million boron by mass

BU – averaged nodal burnup (GWd/MTU)

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Document Identifier: CAL-UDC-NU-000011 REV A

- Adj BU – adjusted averaged nodal burnup (GWd/MTU)
- Step Length – number of days for each irradiation step (d)
- BU/step – amount of burnup for a given step length (GWd/MTU)
- Power – nodal power for a given irradiation step (MW)
- Bfrac – average fraction of first depletion step soluble boron concentration
- H2Ofrac – average fraction of first depletion step moderator density
- TFUEL – average fuel temperature during irradiation step (K)

Note that in the following tables, at 0.0 EFPDs in Cycle 10, parameters listed with N/A are not applicable due to the irradiation step being from end-of-cycle 9 (which is equivalent to the beginning-of-cycle 10) to the first time step in Cycle 10.

Table 11. Operating History Information for Assembly NJ05YU Sample TMI A1B

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	2.45	N/A	74.2	2.450	0.8495	0.9434	1.0000	948.65
141.1	1342	4.907	N/A	66.9	2.457	0.9449	0.8452	1.0000	957.48
214.0	1175	7.521	N/A	72.9	2.614	0.9225	0.7536	1.0000	959.34
283.9	990	10.245	N/A	69.9	2.724	1.0026	0.6482	1.0000	953.48
349.7	772	12.9	N/A	65.8	2.655	1.0381	0.5275	1.0000	947.65
425.0	545	16.023	N/A	75.3	3.123	1.0670	0.3943	1.0000	940.48
483.9	352	18.484	N/A	58.9	2.461	1.0750	0.2686	1.0000	927.57
549.2	134	21.227	N/A	65.3	2.743	1.0807	0.1455	1.0000	913.93
608.0	13	23.628	N/A	58.8	2.401	1.0505	0.0440	1.0046	886.48
639.4	2	24.767	N/A	31.4	1.139	0.9332	0.0045	0.9864	771.65
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	26.617	26.845	68.0	2.078	0.7862	1.0326	1.0000	787.87
131.8	1521	28.445	28.689	63.8	1.844	0.7435	0.9491	1.0000	785.79
209.0	1322	30.742	31.005	77.2	2.317	0.7721	0.8512	1.0000	786.23
272.1	1140	32.698	32.978	63.1	1.973	0.8043	0.7371	1.0000	791.43
347.4	918	35.112	35.413	75.3	2.435	0.8319	0.6162	1.0000	796.54
416.4	718	37.386	37.706	69.0	2.293	0.8552	0.4898	1.0000	799.84
486.4	506	39.74	40.081	70.0	2.374	0.8726	0.3665	1.0000	801.23
556.3	298	42.123	42.484	69.9	2.403	0.8846	0.2407	1.0000	800.98
626.1	103	44.515	44.897	69.8	2.413	0.8892	0.1201	1.0000	799.18
660.3	1.8	45.687	46.079	34.2	1.182	0.8892	0.0314	1.0000	797.96

Table 12. Operating History Information for Assembly NJ05YU Sample TMI B2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.456	N/A	74.2	3.456	1.1983	0.9434	0.9955	1085.37
141.1	1342	6.701	N/A	66.9	3.245	1.2479	0.8452	0.9955	1058.79
214.0	1175	9.953	N/A	72.9	3.252	1.1477	0.7536	0.9955	1030.34
283.9	990	13.178	N/A	69.9	3.225	1.1870	0.6482	0.9955	1001.96
349.7	772	16.158	N/A	65.8	2.980	1.1652	0.5275	0.9955	976.62
425.0	545	19.505	N/A	75.3	3.347	1.1436	0.3943	0.9955	950.04
483.9	352	22.055	N/A	58.9	2.550	1.1138	0.2686	0.9955	925.90

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Table 12. Operating History Information for Assembly NJ05YU Sample TMI B2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
549.2	134	24.819	N/A	65.3	2.764	1.0890	0.1455	0.9955	907.79
608.0	13	27.24	N/A	58.8	2.421	1.0593	0.0440	1.0045	884.01
639.4	2	28.444	N/A	31.4	1.204	0.9865	0.0045	0.9955	777.37
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.04	31.306	68.0	2.862	1.0828	1.0326	1.0000	861.01
131.8	1521	33.423	33.709	63.8	2.403	0.9692	0.9491	1.0000	846.96
209.0	1322	36.253	36.564	77.2	2.854	0.9512	0.8512	1.0000	835.65
272.1	1140	38.541	38.871	63.1	2.308	0.9409	0.7371	1.0000	828.87
347.4	918	41.249	41.603	75.3	2.731	0.9332	0.6162	1.0000	823.12
416.4	718	43.701	44.076	69.0	2.473	0.9221	0.4898	1.0000	816.71
486.4	506	46.153	46.549	70.0	2.473	0.9089	0.3665	1.0000	809.93
556.3	298	48.568	48.984	69.9	2.436	0.8965	0.2407	1.0000	802.59
626.1	103	50.941	51.378	69.8	2.393	0.8822	0.1201	1.0000	796.93
660.3	1.8	52.089	52.535	34.2	1.158	0.8710	0.0314	1.0000	795.18

Table 13. Operating History Information for Assembly NJ05YU Sample TMI C3

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.551	N/A	74.2	3.551	1.2312	0.9434	1.0000	1098.34
141.1	1342	6.819	N/A	66.9	3.268	1.2568	0.8452	1.0000	1062.90
214.0	1175	10.045	N/A	72.9	3.226	1.1385	0.7536	0.9956	1029.37
283.9	990	13.213	N/A	69.9	3.168	1.1660	0.6482	0.9956	998.18
349.7	772	16.119	N/A	65.8	2.906	1.1362	0.5275	0.9956	971.18
425.0	545	19.370	N/A	75.3	3.251	1.1108	0.3943	0.9956	944.23
483.9	352	21.854	N/A	58.9	2.484	1.0850	0.2686	0.9956	920.59
549.2	134	24.550	N/A	65.3	2.696	1.0622	0.1455	1.0000	903.40
608.0	13	26.966	N/A	58.8	2.416	1.0571	0.0440	1.0090	889.62
639.4	2	28.230	N/A	31.4	1.264	1.0357	0.0045	1.0045	790.98
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.883	31.148	68.0	2.918	1.1039	1.0326	1.0045	871.32
131.8	1521	33.294	33.579	63.8	2.432	0.9806	0.9491	1.0045	853.46
209.0	1322	36.121	36.431	77.2	2.851	0.9502	0.8512	1.0045	838.76
272.1	1140	38.384	38.713	63.1	2.282	0.9306	0.7371	1.0045	829.29
347.4	918	41.047	41.399	75.3	2.686	0.9177	0.6162	1.0045	822.09
416.4	718	43.451	43.823	69.0	2.425	0.9040	0.4898	1.0045	815.18
486.4	506	45.856	46.249	70.0	2.426	0.8915	0.3665	1.0045	808.54
556.3	298	48.227	48.640	69.9	2.391	0.8802	0.2407	1.0045	801.59
626.1	103	50.563	50.996	69.8	2.356	0.8684	0.1201	1.0045	796.15
660.3	1.8	51.696	52.139	34.2	1.143	0.8596	0.0314	1.0045	794.37

Table 14. Operating History Information for Assembly NJ05YU Sample TMI C2B

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.588	N/A	74.2	3.588	1.2441	0.9434	1.0000	1106.12
141.1	1342	6.866	N/A	66.9	3.278	1.2606	0.8452	1.0000	1066.84
214.0	1175	10.077	N/A	72.9	3.211	1.1332	0.7536	1.0000	1031.18

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Table 14. Operating History Information for Assembly NJ05YU Sample TMI C2B

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
283.9	990	13.218	N/A	69.9	3.141	1.1561	0.6482	1.0000	998.93
349.7	772	16.092	N/A	65.8	2.874	1.1237	0.5275	1.0000	971.23
425.0	545	19.305	N/A	75.3	3.213	1.0978	0.3943	1.0000	944.23
483.9	352	21.764	N/A	58.9	2.459	1.0741	0.2686	1.0000	920.98
549.2	134	24.433	N/A	65.3	2.669	1.0516	0.1455	1.0000	904.04
608.0	13	26.846	N/A	58.8	2.413	1.0558	0.0440	1.0134	895.07
639.4	2	28.155	N/A	31.4	1.309	1.0725	0.0045	1.0134	801.65
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.817	31.081	68.0	2.926	1.1071	1.0326	1.0089	874.84
131.8	1521	33.232	33.517	63.8	2.436	0.9822	0.9491	1.0089	856.84
209.0	1322	36.053	36.362	77.2	2.845	0.9482	0.8512	1.0089	841.84
272.1	1140	38.309	38.637	63.1	2.275	0.9277	0.7371	1.0089	831.71
347.4	918	40.958	41.309	75.3	2.672	0.9128	0.6162	1.0089	823.98
416.4	718	43.350	43.722	69.0	2.413	0.8995	0.4898	1.0089	816.96
486.4	506	45.744	46.136	70.0	2.415	0.8874	0.3665	1.0089	810.51
556.3	298	48.104	48.516	69.9	2.380	0.8761	0.2407	1.0089	803.76
626.1	103	50.432	50.864	69.8	2.348	0.8654	0.1201	1.0089	798.34
660.3	1.8	51.563	52.005	34.2	1.141	0.8581	0.0314	1.0089	796.26

Table 15. Operating History Information for Assembly NJ05YU Sample TMI C1

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.543	N/A	74.2	3.543	1.2285	0.9434	1.0000	1105.65
141.1	1342	6.805	N/A	66.9	3.262	1.2545	0.8452	1.0000	1069.12
214.0	1175	10.004	N/A	72.9	3.199	1.1290	0.7536	1.0000	1034.43
283.9	990	13.142	N/A	69.9	3.138	1.1550	0.6482	1.0000	1003.15
349.7	772	16.021	N/A	65.8	2.879	1.1257	0.5275	1.0000	976.01
425.0	545	19.237	N/A	75.3	3.216	1.0988	0.3943	1.0000	948.93
483.9	352	21.703	N/A	58.9	2.466	1.0771	0.2686	1.0000	925.46
549.2	134	24.376	N/A	65.3	2.673	1.0531	0.1455	1.0044	907.79
608.0	13	26.788	N/A	58.8	2.412	1.0554	0.0440	1.0132	900.23
639.4	2	28.132	N/A	31.4	1.344	1.1012	0.0045	1.0222	810.43
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.743	31.006	68.0	2.874	1.0875	1.0326	1.0088	871.01
131.8	1521	33.131	33.415	63.8	2.408	0.9712	0.9491	1.0132	856.62
209.0	1322	35.944	36.252	77.2	2.837	0.9455	0.8512	1.0132	844.68
272.1	1140	38.205	38.532	63.1	2.280	0.9298	0.7371	1.0132	835.79
347.4	918	40.867	41.217	75.3	2.685	0.9173	0.6162	1.0132	828.46
416.4	718	43.276	43.647	69.0	2.430	0.9059	0.4898	1.0132	821.65
486.4	506	45.689	46.081	70.0	2.434	0.8945	0.3665	1.0132	815.29
556.3	298	48.065	48.477	69.9	2.396	0.8820	0.2407	1.0132	808.43
626.1	103	50.407	50.839	69.8	2.362	0.8706	0.1201	1.0132	802.65
660.3	1.8	51.545	51.987	34.2	1.148	0.8634	0.0314	1.0132	799.87

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Document Identifier: CAL-UDC-NU-000011 REV A

Page 24 of 61

Table 16. Operating History Information for Assembly NJ05YU Sample TMI D1A2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.476	N/A	74.2	3.476	1.2052	0.9434	1.0000	1100.73
141.1	1342	6.709	N/A	66.9	3.233	1.2433	0.8452	0.9957	1068.40
214.0	1175	9.892	N/A	72.9	3.183	1.1233	0.7536	0.9957	1035.79
283.9	990	13.030	N/A	69.9	3.138	1.1550	0.6482	0.9957	1006.15
349.7	772	15.922	N/A	65.8	2.892	1.1308	0.5275	1.0000	980.18
425.0	545	19.155	N/A	75.3	3.233	1.1046	0.3943	1.0000	953.43
483.9	352	21.639	N/A	58.9	2.484	1.0850	0.2686	1.0000	929.87
549.2	134	24.331	N/A	65.3	2.692	1.0606	0.1455	1.0000	911.73
608.0	13	26.750	N/A	58.8	2.419	1.0584	0.0440	1.0132	904.15
639.4	2	28.115	N/A	31.4	1.365	1.1184	0.0045	1.0221	815.26
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.667	30.930	68.0	2.815	1.0650	1.0326	1.0087	865.43
131.8	1521	33.022	33.305	63.8	2.375	0.9578	0.9491	1.0132	854.23
209.0	1322	35.820	36.127	77.2	2.822	0.9404	0.8512	1.0132	845.32
272.1	1140	38.084	38.410	63.1	2.283	0.9310	0.7371	1.0132	838.01
347.4	918	40.759	41.108	75.3	2.698	0.9218	0.6162	1.0132	831.46
416.4	718	43.186	43.556	69.0	2.448	0.9127	0.4898	1.0132	825.09
486.4	506	45.621	46.012	70.0	2.456	0.9026	0.3665	1.0132	818.96
556.3	298	48.020	48.432	69.9	2.420	0.8905	0.2407	1.0132	812.15
626.1	103	50.383	50.815	69.8	2.383	0.8784	0.1201	1.0132	806.21
660.3	1.8	51.530	51.972	34.2	1.157	0.8702	0.0314	1.0132	803.01

Table 17. Operating History Information for Assembly NJ05YU Sample TMI D1A4

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.365	N/A	74.2	3.365	1.1668	0.9434	1.0000	1091.18
141.1	1342	6.540	N/A	66.9	3.175	1.2210	0.8452	1.0000	1065.04
214.0	1175	9.687	N/A	72.9	3.147	1.1106	0.7536	1.0000	1035.82
283.9	990	12.813	N/A	69.9	3.126	1.1506	0.6482	1.0000	1008.98
349.7	772	15.715	N/A	65.8	2.902	1.1347	0.5275	1.0000	985.07
425.0	545	18.971	N/A	75.3	3.256	1.1125	0.3943	1.0000	959.34
483.9	352	21.483	N/A	58.9	2.512	1.0972	0.2686	1.0043	936.23
549.2	134	24.208	N/A	65.3	2.725	1.0736	0.1455	1.0043	917.79
608.0	13	26.645	N/A	58.8	2.437	1.0663	0.0440	1.0130	909.82
639.4	2	28.034	N/A	31.4	1.389	1.1381	0.0045	1.0310	821.01
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	29.947	30.204	68.0	2.170	0.8209	1.0326	1.0087	843.34
131.8	1521	32.156	32.432	63.8	2.228	0.8984	0.9491	1.0087	840.48
209.0	1322	34.852	35.151	77.2	2.719	0.9062	0.8512	1.0087	840.87
272.1	1140	37.080	37.398	63.1	2.247	0.9162	0.7371	1.0087	838.93
347.4	918	39.756	40.097	75.3	2.699	0.9221	0.6162	1.0087	836.07
416.4	718	42.215	42.577	69.0	2.480	0.9247	0.4898	1.0130	832.48
486.4	506	44.706	45.089	70.0	2.512	0.9234	0.3665	1.0130	828.43
556.3	298	47.174	47.578	69.9	2.489	0.9162	0.2407	1.0130	823.34
626.1	103	49.620	50.045	69.8	2.467	0.9093	0.1201	1.0130	817.73
660.3	1.8	50.810	51.245	34.2	1.200	0.9029	0.0314	1.0130	813.51

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
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Table 18. Operating History Information for Assembly NJ05YU Sample TMI D2

FFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	2.839	N/A	74.2	2.839	0.9844	0.9434	1.0000	1029.01
141.1	1342	5.639	N/A	66.9	2.800	1.0768	0.8452	1.0000	1025.21
214.0	1175	8.474	N/A	72.9	2.835	1.0005	0.7536	1.0000	1009.34
283.9	990	11.359	N/A	69.9	2.885	1.0619	0.6482	1.0000	995.65
349.7	772	14.123	N/A	65.8	2.764	1.0807	0.5275	1.0000	982.57
425.0	545	17.275	N/A	75.3	3.152	1.0769	0.3943	1.0000	963.71
483.9	352	19.756	N/A	58.9	2.481	1.0837	0.2686	1.0043	945.73
549.2	134	22.490	N/A	65.3	2.734	1.0772	0.1455	1.0043	929.26
608.0	13	24.933	N/A	58.8	2.443	1.0689	0.0440	1.0172	924.34
639.4	2	26.366	N/A	31.4	1.433	1.1741	0.0045	1.0351	837.01
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	28.260	28.502	68.0	2.136	0.8082	1.0326	1.0172	825.07
131.8	1521	30.302	30.562	63.8	2.060	0.8305	0.9491	1.0172	825.54
209.0	1322	32.841	33.122	77.2	2.561	0.8534	0.8512	1.0172	829.98
272.1	1140	34.970	35.270	63.1	2.147	0.8755	0.7371	1.0172	831.73
347.4	918	37.561	37.883	75.3	2.613	0.8928	0.6162	1.0172	832.12
416.4	718	39.971	40.314	69.0	2.431	0.9063	0.4898	1.0172	831.46
486.4	506	42.435	42.799	70.0	2.485	0.9134	0.3665	1.0172	829.93
556.3	298	44.900	45.285	69.9	2.486	0.9150	0.2407	1.0216	827.37
626.1	103	47.363	47.769	69.8	2.484	0.9156	0.1201	1.0216	823.76
660.3	1.8	48.569	48.985	34.2	1.216	0.9150	0.0314	1.0216	819.26

Table 19. Operating History Information for Assembly NJ05YU Sample TMI B1B

FFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.551	N/A	74.2	3.551	1.2312	0.9434	1.0000	1098.34
141.1	1342	6.819	N/A	66.9	3.268	1.2568	0.8452	1.0000	1062.90
214.0	1175	10.045	N/A	72.9	3.226	1.1385	0.7536	0.9956	1029.37
283.9	990	13.213	N/A	69.9	3.168	1.1660	0.6482	0.9956	998.18
349.7	772	16.119	N/A	65.8	2.906	1.1362	0.5275	0.9956	971.18
425.0	545	19.370	N/A	75.3	3.251	1.1108	0.3943	0.9956	944.23
483.9	352	21.854	N/A	58.9	2.484	1.0850	0.2686	0.9956	920.59
549.2	134	24.550	N/A	65.3	2.696	1.0622	0.1455	1.0000	903.40
608.0	13	26.966	N/A	58.8	2.416	1.0571	0.0440	1.0090	889.62
639.4	2	28.230	N/A	31.4	1.264	1.0357	0.0045	1.0045	790.98
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.883	31.148	68.0	2.918	1.1039	1.0326	1.0045	871.32
131.8	1521	33.294	33.579	63.8	2.432	0.9806	0.9491	1.0045	853.46
209.0	1322	36.121	36.431	77.2	2.851	0.9502	0.8512	1.0045	838.76
272.1	1140	38.384	38.713	63.1	2.282	0.9306	0.7371	1.0045	829.29
347.4	918	41.047	41.399	75.3	2.686	0.9177	0.6162	1.0045	822.09
416.4	718	43.451	43.823	69.0	2.425	0.9040	0.4898	1.0045	815.18
486.4	506	45.856	46.249	70.0	2.426	0.8915	0.3665	1.0045	808.54
556.3	298	48.227	48.640	69.9	2.391	0.8802	0.2407	1.0045	801.59
626.1	103	50.563	50.996	69.8	2.356	0.8684	0.1201	1.0045	796.15
660.3	1.8	51.696	52.139	34.2	1.143	0.8596	0.0314	1.0045	794.37

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Title: Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations

Document Identifier: CAL-UDC-NU-000011 REV A

Page 26 of 61

Table 20. Operating History Information for Assembly NJ05YU Sample TMI A2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.184	N/A	74.2	3.184	1.1040	0.9434	1.0000	1051.15
141.1	1342	6.269	N/A	66.9	3.085	1.1864	0.8452	1.0000	1040.93
214.0	1175	9.446	N/A	72.9	3.177	1.1212	0.7536	0.9955	1023.32
283.9	990	12.660	N/A	69.9	3.214	1.1829	0.6482	0.9955	1002.04
349.7	772	15.690	N/A	65.8	3.030	1.1847	0.5275	0.9955	982.09
425.0	545	19.139	N/A	75.3	3.449	1.1784	0.3943	0.9955	959.40
483.9	352	21.785	N/A	58.9	2.646	1.1558	0.2686	0.9955	936.52
549.2	134	24.662	N/A	65.3	2.877	1.1335	0.1455	0.9955	918.46
608.0	13	27.148	N/A	58.8	2.486	1.0877	0.0440	1.0046	888.21
639.4	2	28.338	N/A	31.4	1.190	0.9750	0.0045	0.9910	772.90
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.741	31.004	68.0	2.666	1.0088	1.0326	1.0000	835.54
131.8	1521	32.991	33.274	63.8	2.269	0.9151	0.9491	1.0000	828.60
209.0	1322	35.730	36.036	77.2	2.762	0.9206	0.8512	1.0000	824.52
272.1	1140	37.994	38.320	63.1	2.283	0.9310	0.7371	1.0000	823.77
347.4	918	40.714	41.063	75.3	2.743	0.9373	0.6162	1.0000	822.13
416.4	718	43.209	43.579	69.0	2.516	0.9383	0.4898	1.0000	818.71
486.4	506	45.728	46.120	70.0	2.541	0.9338	0.3665	1.0000	813.82
556.3	298	48.220	48.633	69.9	2.513	0.9251	0.2407	1.0000	807.62
626.1	103	50.674	51.108	69.8	2.475	0.9123	0.1201	1.0000	801.96
660.3	1.8	51.861	52.305	34.2	1.197	0.9006	0.0314	1.0000	799.90

Table 21. Operating History Information for Assembly NJ05YU Sample TMI B3J

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.184	N/A	74.2	3.184	1.1040	0.9434	1.0000	1051.15
141.1	1342	6.269	N/A	66.9	3.085	1.1864	0.8452	1.0000	1040.93
214.0	1175	9.446	N/A	72.9	3.177	1.1212	0.7536	0.9955	1023.32
283.9	990	12.660	N/A	69.9	3.214	1.1829	0.6482	0.9955	1002.04
349.7	772	15.690	N/A	65.8	3.030	1.1847	0.5275	0.9955	982.09
425.0	545	19.139	N/A	75.3	3.449	1.1784	0.3943	0.9955	959.40
483.9	352	21.785	N/A	58.9	2.646	1.1558	0.2686	0.9955	936.52
549.2	134	24.662	N/A	65.3	2.877	1.1335	0.1455	0.9955	918.46
608.0	13	27.148	N/A	58.8	2.486	1.0877	0.0440	1.0046	888.21
639.4	2	28.338	N/A	31.4	1.190	0.9750	0.0045	0.9910	772.90
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.741	31.004	68.0	2.666	1.0088	1.0326	1.0000	835.54
131.8	1521	32.991	33.274	63.8	2.269	0.9151	0.9491	1.0000	828.60
209.0	1322	35.730	36.036	77.2	2.762	0.9206	0.8512	1.0000	824.52
272.1	1140	37.994	38.320	63.1	2.283	0.9310	0.7371	1.0000	823.77
347.4	918	40.714	41.063	75.3	2.743	0.9373	0.6162	1.0000	822.13
416.4	718	43.209	43.579	69.0	2.516	0.9383	0.4898	1.0000	818.71
486.4	506	45.728	46.120	70.0	2.541	0.9338	0.3665	1.0000	813.82
556.3	298	48.220	48.633	69.9	2.513	0.9251	0.2407	1.0000	807.62
626.1	103	50.674	51.108	69.8	2.475	0.9123	0.1201	1.0000	801.96
660.3	1.8	51.861	52.305	34.2	1.197	0.9006	0.0314	1.0000	799.90

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Table 22. Operating History Information for Assembly NJ070G Sample O1 S1

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	2.488	68.0	2.488	0.9509	0.9581	1.0000	960.29
131.8	1521	4.955	63.8	2.467	1.0050	0.8806	1.0000	960.71
209.0	1322	8.108	77.2	3.153	1.0615	0.7897	1.0000	958.68
272.1	1140	10.769	63.1	2.661	1.0960	0.6839	1.0000	954.18
347.4	918	13.976	75.3	3.207	1.1069	0.5717	1.0000	946.12
416.4	718	16.936	69.0	2.960	1.1149	0.4544	1.0000	937.15
486.4	506	19.951	70.0	3.015	1.1194	0.3400	1.0000	926.04
556.3	298	22.982	69.9	3.031	1.1270	0.2233	1.0000	914.37
626.1	103	26.015	69.8	3.033	1.1293	0.1114	1.0000	904.09
660.3	1.8	27.498	34.2	1.483	1.1270	0.0291	1.0000	897.82

Table 23. Operating History Information for Assembly NJ070G Sample O1 S2

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.676	68.0	3.676	1.4050	0.9581	0.9956	1119.51
131.8	1521	7.107	63.8	3.431	1.3977	0.8806	0.9956	1084.79
209.0	1322	11.106	77.2	3.999	1.3463	0.7897	0.9956	1043.23
272.1	1140	14.205	63.1	3.099	1.2764	0.6839	1.0000	1007.09
347.4	918	17.742	75.3	3.537	1.2208	0.5717	1.0000	978.57
416.4	718	20.865	69.0	3.123	1.1763	0.4544	1.0000	951.57
486.4	506	23.95	70.0	3.085	1.1454	0.3400	1.0000	929.82
556.3	298	26.97	69.9	3.020	1.1229	0.2233	1.0000	912.15
626.1	103	29.938	69.8	2.968	1.1051	0.1114	1.0000	896.84
660.3	1.8	31.377	34.2	1.439	1.0936	0.0291	1.0000	886.54

Table 24. Operating History Information for Assembly NJ070G Sample O1 S3

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.312	68.0	3.312	1.2659	0.9581	0.9957	1083.65
131.8	1521	6.485	63.8	3.173	1.2926	0.8806	0.9957	1067.32
209.0	1322	10.328	77.2	3.843	1.2938	0.7897	1.0000	1043.46
272.1	1140	13.397	63.1	3.069	1.2641	0.6839	1.0000	1016.43
347.4	918	16.954	75.3	3.557	1.2277	0.5717	1.0000	991.65
416.4	718	20.127	69.0	3.173	1.1952	0.4544	1.0000	967.21
486.4	506	23.274	70.0	3.147	1.1684	0.3400	1.0000	945.98
556.3	298	26.355	69.9	3.081	1.1456	0.2233	1.0000	928.04
626.1	103	29.382	69.8	3.027	1.1271	0.1114	1.0043	912.12
660.3	1.8	30.848	34.2	1.466	1.1141	0.0291	1.0043	899.73

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Table 25. Operating History Information for Assembly NJ070G Sample O12 S4

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	2.384	68.0	2.384	0.9112	0.9581	1.0000	960.29
131.8	1521	4.693	63.8	2.309	0.9406	0.8806	1.0000	960.71
209.0	1322	7.583	77.2	2.890	0.9729	0.7897	1.0000	958.68
272.1	1140	10.004	63.1	2.421	0.9972	0.6839	1.0000	954.18
347.4	918	12.937	75.3	2.933	1.0123	0.5717	1.0000	946.12
416.4	718	15.663	69.0	2.726	1.0268	0.4544	1.0000	937.15
486.4	506	18.468	70.0	2.805	1.0415	0.3400	1.0000	926.04
556.3	298	21.311	69.9	2.843	1.0571	0.2233	1.0000	914.37
626.1	103	24.179	69.8	2.868	1.0679	0.1114	1.0000	904.09
660.3	1.8	25.592	34.2	1.413	1.0738	0.0291	1.0000	897.82

Table 26. Operating History Information for Assembly NJ070G Sample O12 S5

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.532	68.0	3.532	1.3499	0.9581	0.9956	1119.51
131.8	1521	6.718	63.8	3.186	1.2979	0.8806	0.9956	1084.79
209.0	1322	10.368	77.2	3.650	1.2288	0.7897	0.9956	1043.23
272.1	1140	13.201	63.1	2.833	1.1669	0.6839	1.0000	1007.09
347.4	918	16.453	75.3	3.252	1.1224	0.5717	1.0000	978.57
416.4	718	19.35	69.0	2.897	1.0912	0.4544	1.0000	951.57
486.4	506	22.234	70.0	2.884	1.0708	0.3400	1.0000	929.82
556.3	298	25.081	69.9	2.847	1.0586	0.2233	1.0000	912.15
626.1	103	27.898	69.8	2.817	1.0489	0.1114	1.0000	896.84
660.3	1.8	29.271	34.2	1.373	1.0434	0.0291	1.0000	886.54

Table 27. Operating History Information for Assembly NJ070G Sample O12 S6

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.184	68.0	3.184	1.2169	0.9581	0.9957	1083.65
131.8	1521	6.143	63.8	2.959	1.2054	0.8806	0.9957	1067.32
209.0	1322	9.659	77.2	3.516	1.1837	0.7897	1.0000	1043.46
272.1	1140	12.462	63.1	2.803	1.1545	0.6839	1.0000	1016.43
347.4	918	15.729	75.3	3.267	1.1276	0.5717	1.0000	991.65
416.4	718	18.666	69.0	2.937	1.1063	0.4544	1.0000	967.21
486.4	506	21.603	70.0	2.937	1.0905	0.3400	1.0000	945.98
556.3	298	24.499	69.9	2.896	1.0768	0.2233	1.0000	928.04
626.1	103	27.365	69.8	2.866	1.0671	0.1114	1.0043	912.12
660.3	1.8	28.76	34.2	1.395	1.0601	0.0291	1.0043	899.73

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Table 28. Operating History Information for Assembly NJ070G Sample O13 S7

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	2.323	68.0	2.323	0.8879	0.9581	1.0000	960.29
131.8	1521	4.586	63.8	2.263	0.9219	0.8806	1.0000	960.71
209.0	1322	7.443	77.2	2.857	0.9618	0.7897	1.0000	958.68
272.1	1140	9.849	63.1	2.406	0.9910	0.6839	1.0000	954.18
347.4	918	12.764	75.3	2.915	1.0061	0.5717	1.0000	946.12
416.4	718	15.472	69.0	2.708	1.0200	0.4544	1.0000	937.15
486.4	506	18.257	70.0	2.785	1.0340	0.3400	1.0000	926.04
556.3	298	21.079	69.9	2.822	1.0493	0.2233	1.0000	914.37
626.1	103	23.927	69.8	2.848	1.0604	0.1114	1.0000	904.09
660.3	1.8	25.331	34.2	1.404	1.0670	0.0291	1.0000	897.82

Table 29. Operating History Information for Assembly NJ070G Sample O13 S8

EFPD	ppmB	BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10								
0.0	1800	0	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.455	68.0	3.455	1.3205	0.9581	0.9956	1119.51
131.8	1521	6.604	63.8	3.149	1.2828	0.8806	0.9956	1084.79
209.0	1322	10.234	77.2	3.630	1.2221	0.7897	0.9956	1043.23
272.1	1140	13.053	63.1	2.819	1.1611	0.6839	1.0000	1007.09
347.4	918	16.288	75.3	3.235	1.1166	0.5717	1.0000	978.57
416.4	718	19.164	69.0	2.876	1.0833	0.4544	1.0000	951.57
486.4	506	22.028	70.0	2.864	1.0634	0.3400	1.0000	929.82
556.3	298	24.856	69.9	2.828	1.0515	0.2233	1.0000	912.15
626.1	103	27.655	69.8	2.799	1.0422	0.1114	1.0000	896.84
660.3	1.8	29.02	34.2	1.365	1.0373	0.0291	1.0000	886.54

Since the operating history information burnup for a particular node and the burnup based on isotopic measurements from the samples has a certain degree of variability, SAS2H depletions were also performed using the sample burnups. In order to provide SAS2H input parameters that would yield the final sample burnup, the burnup for each irradiation step length was adjusted by the percentage that the sample burnup was off from the operating history burnup. The percentage factors are presented in Table 30 for each sample, and the resultant operating history parameters are presented in Tables 31 through 49.

Table 30. Measured Sample and Operating History Burnup Percent Differences

Sample ID <sup>a</sup>	MBU <sup>b</sup> (MWd/MTU)	OPHBU <sup>c</sup> (MWd/MTU)	ΔBU (MWd/MTU)	Percent Difference <sup>d</sup>
TMI A2	50600	52305	1705	3.371
TMI B2	50100	52535	2435	4.861
TMI C1	50200	51987	1787	3.559
TMI C3	51300	52139	839	1.636
TMI D2	44800	48985	4185	9.342
TMI A1B	44800	46079	1279	2.854
TMI B1B	54500	52139	-2361	-4.332
TMI B3J	53000	52305	-695	-1.310
TMI C2B	52600	52005	-595	-1.131

Originator: *JMA* Date: 4/19/02

Checker: *[Signature]* Date: 4/19/02

Table 30. Measured Sample and Operating History Burnup Percent Differences

Sample ID <sup>a</sup>	MBU <sup>b</sup> (MWd/MTU)	OPHBU <sup>c</sup> (MWd/MTU)	ΔBU (MWd/MTU)	Percent Difference <sup>d</sup>
TMI D1A2	55700	51972	-3728	-6.694
TMI D1A4	50500	51245	745	1.476
O1 S1	25800	27498	1698	6.581
O1 S2	29900	31380 <sup>e</sup>	1480	4.950
O1 S3	26700	30848	4148	15.536
O12 S4	23700	25592	1892	7.983
O12 S5	26500	29271	2771	10.457
O12 S6	24000	28760	4760	19.833
O13 S7	22800	25331	2531	11.101
O13 S8	26300	29020	2720	10.342

NOTES: <sup>a</sup> ID = identifier

<sup>b</sup> MBU = measured sample burnup

<sup>c</sup> OPHBU = operating history burnup (adjusted burnup at end-of-life)


<sup>d</sup> Percent difference = (OPHBU/MBU-1)\*100 [The values for OPHBU and MBU as reported in Table 30 were rounded off, but the percent difference values were calculated from the unrounded numbers so there is roundoff error present in the percent difference values reported]

<sup>e</sup> This value was actually rounded off from 31377

In Tables 31 through 41 the cycle 10 BU values correspond to the adjusted values listed in Tables 11 through 21, and the adjusted burnup values and powers were calculated based on the percent difference values listed in Table 30 for each sample.

Table 31. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI A1B

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	2.450	2.380	74.2	2.380	0.8252	0.9434	1.0000	948.65
141.1	1342	4.907	4.767	66.9	2.387	0.9179	0.8452	1.0000	957.48
214.0	1175	7.521	7.306	72.9	2.539	0.8962	0.7536	1.0000	959.34
283.9	990	10.245	9.953	69.9	2.646	0.9740	0.6482	1.0000	953.48
349.7	772	12.900	12.532	65.8	2.579	1.0085	0.5275	1.0000	947.65
425.0	545	16.023	15.566	75.3	3.034	1.0366	0.3943	1.0000	940.48
483.9	352	18.484	17.956	58.9	2.391	1.0443	0.2686	1.0000	927.57
549.2	134	21.227	20.621	65.3	2.665	1.0499	0.1455	1.0000	913.93
608.0	13	23.628	22.954	58.8	2.332	1.0206	0.0440	1.0046	886.48
639.4	2	24.767	24.060	31.4	1.106	0.9066	0.0045	0.9864	771.65
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	26.845	26.079	68.0	2.019	0.7638	1.0326	1.0000	787.87
131.8	1521	28.689	27.870	63.8	1.791	0.7222	0.9491	1.0000	785.79
209.0	1322	31.005	30.121	77.2	2.251	0.7500	0.8512	1.0000	786.23
272.1	1140	32.978	32.037	63.1	1.916	0.7814	0.7371	1.0000	791.43
347.4	918	35.413	34.402	75.3	2.365	0.8081	0.6162	1.0000	796.54
416.4	718	37.706	36.630	69.0	2.228	0.8307	0.4898	1.0000	799.84
486.4	506	40.081	38.937	70.0	2.306	0.8477	0.3665	1.0000	801.23
556.3	298	42.484	41.272	69.9	2.335	0.8594	0.2407	1.0000	800.98
626.1	103	44.897	43.615	69.8	2.344	0.8638	0.1201	1.0000	799.18
660.3	1.8	46.079	44.763	34.2	1.148	0.8638	0.0314	1.0000	797.96

Originator:  Date: 4/19/02


Checker:  Date: 4/19/02

Table 32. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI B2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.456	3.288	74.2	3.288	1.1401	0.9434	0.9955	1085.37
141.1	1342	6.701	6.375	66.9	3.087	1.1873	0.8452	0.9955	1058.79
214.0	1175	9.953	9.469	72.9	3.094	1.0919	0.7536	0.9955	1030.34
283.9	990	13.178	12.537	69.9	3.068	1.1293	0.6482	0.9955	1001.96
349.7	772	16.158	15.373	65.8	2.835	1.1085	0.5275	0.9955	976.62
425.0	545	19.505	18.557	75.3	3.184	1.0880	0.3943	0.9955	950.04
483.9	352	22.055	20.983	58.9	2.426	1.0597	0.2686	0.9955	925.90
549.2	134	24.819	23.613	65.3	2.630	1.0360	0.1455	0.9955	907.79
608.0	13	27.240	25.916	58.8	2.303	1.0078	0.0440	1.0045	884.01
639.4	2	28.444	27.061	31.4	1.145	0.9385	0.0045	0.9955	777.37
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.306	29.784	68.0	2.723	1.0302	1.0326	1.0000	861.01
131.8	1521	33.709	32.071	63.8	2.287	0.9221	0.9491	1.0000	846.96
209.0	1322	36.564	34.786	77.2	2.716	0.9050	0.8512	1.0000	835.65
272.1	1140	38.871	36.982	63.1	2.195	0.8951	0.7371	1.0000	828.87
347.4	918	41.603	39.580	75.3	2.598	0.8878	0.6162	1.0000	823.12
416.4	718	44.076	41.933	69.0	2.353	0.8773	0.4898	1.0000	816.71
486.4	506	46.549	44.286	70.0	2.353	0.8647	0.3665	1.0000	809.93
556.3	298	48.984	46.603	69.9	2.317	0.8529	0.2407	1.0000	802.59
626.1	103	51.378	48.880	69.8	2.277	0.8393	0.1201	1.0000	796.93
660.3	1.8	52.535	49.982	34.2	1.102	0.8287	0.0314	1.0000	795.18

Table 33. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI C3

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.551	3.493	74.2	3.493	1.2111	0.9434	1.0000	1098.34
141.1	1342	6.819	6.707	66.9	3.215	1.2362	0.8452	1.0000	1062.90
214.0	1175	10.045	9.881	72.9	3.173	1.1199	0.7536	0.9956	1029.37
283.9	990	13.213	12.997	69.9	3.116	1.1469	0.6482	0.9956	998.18
349.7	772	16.119	15.855	65.8	2.858	1.1176	0.5275	0.9956	971.18
425.0	545	19.370	19.053	75.3	3.198	1.0926	0.3943	0.9956	944.23
483.9	352	21.854	21.496	58.9	2.443	1.0673	0.2686	0.9956	920.59
549.2	134	24.550	24.148	65.3	2.652	1.0448	0.1455	1.0000	903.40
608.0	13	26.966	26.525	58.8	2.376	1.0398	0.0440	1.0090	889.62
639.4	2	28.230	27.768	31.4	1.243	1.0187	0.0045	1.0045	790.98
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.148	30.638	68.0	2.870	1.0858	1.0326	1.0045	871.32
131.8	1521	33.579	33.030	63.8	2.392	0.9645	0.9491	1.0045	853.46
209.0	1322	36.431	35.835	77.2	2.805	0.9346	0.8512	1.0045	838.76
272.1	1140	38.713	38.080	63.1	2.245	0.9154	0.7371	1.0045	829.29
347.4	918	41.399	40.722	75.3	2.642	0.9026	0.6162	1.0045	822.09
416.4	718	43.823	43.106	69.0	2.385	0.8893	0.4898	1.0045	815.18
486.4	506	46.249	45.492	70.0	2.386	0.8769	0.3665	1.0045	808.54
556.3	298	48.640	47.845	69.9	2.352	0.8658	0.2407	1.0045	801.59
626.1	103	50.996	50.162	69.8	2.317	0.8542	0.1201	1.0045	796.15
660.3	1.8	52.139	51.286	34.2	1.124	0.8456	0.0314	1.0045	794.37

Originator: *JW* Date: *4/19/02*

Checker: *Ph* Date: *4/19/02*

Table 34. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI C2B

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.588	3.629	74.2	3.629	1.2581	0.9434	1.0000	1106.12
141.1	1342	6.866	6.944	66.9	3.315	1.2749	0.8452	1.0000	1066.84
214.0	1175	10.077	10.191	72.9	3.247	1.1460	0.7536	1.0000	1031.18
283.9	990	13.218	13.367	69.9	3.177	1.1692	0.6482	1.0000	998.93
349.7	772	16.092	16.274	65.8	2.907	1.1364	0.5275	1.0000	971.23
425.0	545	19.305	19.523	75.3	3.249	1.1102	0.3943	1.0000	944.23
483.9	352	21.764	22.010	58.9	2.487	1.0862	0.2686	1.0000	920.98
549.2	134	24.433	24.709	65.3	2.699	1.0634	0.1455	1.0000	904.04
608.0	13	26.846	27.150	58.8	2.440	1.0677	0.0440	1.0134	895.07
639.4	2	28.155	28.473	31.4	1.324	1.0847	0.0045	1.0134	801.65
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.081	31.433	68.0	2.959	1.1196	1.0326	1.0089	874.84
131.8	1521	33.517	33.896	63.8	2.463	0.9933	0.9491	1.0089	856.84
209.0	1322	36.362	36.773	77.2	2.877	0.9589	0.8512	1.0089	841.84
272.1	1140	38.637	39.074	63.1	2.301	0.9382	0.7371	1.0089	831.71
347.4	918	41.309	41.776	75.3	2.702	0.9232	0.6162	1.0089	823.98
416.4	718	43.722	44.216	69.0	2.440	0.9097	0.4898	1.0089	816.96
486.4	506	46.136	46.658	70.0	2.442	0.8975	0.3665	1.0089	810.51
556.3	298	48.516	49.065	69.9	2.407	0.8860	0.2407	1.0089	803.76
626.1	103	50.864	51.440	69.8	2.375	0.8752	0.1201	1.0089	798.34
660.3	1.8	52.005	52.593	34.2	1.154	0.8678	0.0314	1.0089	796.26

Table 35. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI C1

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.543	3.417	74.2	3.417	1.1847	0.9434	1.0000	1105.65
141.1	1342	6.805	6.563	66.9	3.146	1.2098	0.8452	1.0000	1069.12
214.0	1175	10.004	9.648	72.9	3.085	1.0888	0.7536	1.0000	1034.43
283.9	990	13.142	12.674	69.9	3.026	1.1139	0.6482	1.0000	1003.15
349.7	772	16.021	15.451	65.8	2.777	1.0856	0.5275	1.0000	976.01
425.0	545	19.237	18.552	75.3	3.102	1.0597	0.3943	1.0000	948.93
483.9	352	21.703	20.931	58.9	2.378	1.0388	0.2686	1.0000	925.46
549.2	134	24.376	23.508	65.3	2.578	1.0157	0.1455	1.0044	907.79
608.0	13	26.788	25.835	58.8	2.326	1.0178	0.0440	1.0132	900.23
639.4	2	28.132	27.131	31.4	1.296	1.0620	0.0045	1.0222	810.43
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.006	29.903	68.0	2.772	1.0488	1.0326	1.0088	871.01
131.8	1521	33.415	32.226	63.8	2.323	0.9367	0.9491	1.0132	856.62
209.0	1322	36.252	34.962	77.2	2.736	0.9118	0.8512	1.0132	844.68
272.1	1140	38.532	37.161	63.1	2.199	0.8967	0.7371	1.0132	835.79
347.4	918	41.217	39.750	75.3	2.589	0.8847	0.6162	1.0132	828.46
416.4	718	43.647	42.094	69.0	2.343	0.8737	0.4898	1.0132	821.65
486.4	506	46.081	44.441	70.0	2.347	0.8626	0.3665	1.0132	815.29
556.3	298	48.477	46.752	69.9	2.311	0.8506	0.2407	1.0132	808.43
626.1	103	50.839	49.030	69.8	2.278	0.8396	0.1201	1.0132	802.65
660.3	1.8	51.987	50.137	34.2	1.107	0.8327	0.0314	1.0132	799.87

Originator: *JMU* Date: *4/19/02*

Checker: *RM* Date: *4/19/02*



Title: Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations

Document Identifier: CAL-UDC-NU-000011 REV A

Table 36. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI D1A2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.476	3.709	74.2	3.709	1.2859	0.9434	1.0000	1100.73
141.1	1342	6.709	7.158	66.9	3.449	1.3265	0.8452	0.9957	1068.40
214.0	1175	9.892	10.554	72.9	3.396	1.1985	0.7536	0.9957	1035.79
283.9	990	13.030	13.902	69.9	3.348	1.2323	0.6482	0.9957	1006.15
349.7	772	15.922	16.988	65.8	3.086	1.2064	0.5275	1.0000	980.18
425.0	545	19.155	20.437	75.3	3.449	1.1785	0.3943	1.0000	953.43
483.9	352	21.639	23.088	58.9	2.650	1.1576	0.2686	1.0000	929.87
549.2	134	24.331	25.960	65.3	2.872	1.1316	0.1455	1.0000	911.73
608.0	13	26.750	28.541	58.8	2.581	1.1293	0.0440	1.0132	904.15
639.4	2	28.115	29.997	31.4	1.456	1.1933	0.0045	1.0221	815.26
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.930	33.000	68.0	3.003	1.1363	1.0326	1.0087	865.43
131.8	1521	33.305	35.534	63.8	2.534	1.0219	0.9491	1.0132	854.23
209.0	1322	36.127	38.545	77.2	3.011	1.0034	0.8512	1.0132	845.32
272.1	1140	38.410	40.982	63.1	2.436	0.9933	0.7371	1.0132	838.01
347.4	918	41.108	43.860	75.3	2.879	0.9835	0.6162	1.0132	831.46
416.4	718	43.556	46.472	69.0	2.612	0.9738	0.4898	1.0132	825.09
486.4	506	46.012	49.092	70.0	2.620	0.9630	0.3665	1.0132	818.96
556.3	298	48.432	51.674	69.9	2.582	0.9502	0.2407	1.0132	812.15
626.1	103	50.815	54.216	69.8	2.543	0.9372	0.1201	1.0132	806.21
660.3	1.8	51.972	55.451	34.2	1.234	0.9285	0.0314	1.0132	803.01

Table 37. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI D1A4

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.365	3.315	74.2	3.275	1.1495	0.9434	1.0000	1091.18
141.1	1342	6.540	6.443	66.9	3.090	1.2030	0.8452	1.0000	1065.04
214.0	1175	9.687	9.544	72.9	3.063	1.0942	0.7536	1.0000	1035.82
283.9	990	12.813	12.624	69.9	3.042	1.1336	0.6482	1.0000	1008.98
349.7	772	15.715	15.483	65.8	2.824	1.1179	0.5275	1.0000	985.07
425.0	545	18.971	18.691	75.3	3.169	1.0960	0.3943	1.0000	959.34
483.9	352	21.483	21.166	58.9	2.445	1.0810	0.2686	1.0043	936.23
549.2	134	24.208	23.851	65.3	2.652	1.0578	0.1455	1.0043	917.79
608.0	13	26.645	26.252	58.8	2.372	1.0506	0.0440	1.0130	909.82
639.4	2	28.034	27.620	31.4	1.352	1.1213	0.0045	1.0310	821.01
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	30.204	29.758	68.0	2.112	0.8088	1.0326	1.0087	843.34
131.8	1521	32.432	31.953	63.8	2.168	0.8852	0.9491	1.0087	840.48
209.0	1322	35.151	34.632	77.2	2.646	0.8928	0.8512	1.0087	840.87
272.1	1140	37.398	36.846	63.1	2.187	0.9027	0.7371	1.0087	838.93
347.4	918	40.097	39.505	75.3	2.627	0.9085	0.6162	1.0087	836.07
416.4	718	42.577	41.948	69.0	2.414	0.9111	0.4898	1.0130	832.48
486.4	506	45.089	44.424	70.0	2.445	0.9097	0.3665	1.0130	828.43
556.3	298	47.578	46.876	69.9	2.422	0.9026	0.2407	1.0130	823.34
626.1	103	50.045	49.307	69.8	2.401	0.8959	0.1201	1.0130	817.73
660.3	1.8	51.245	50.489	34.2	1.168	0.8895	0.0314	1.0130	813.51

Originator:  Date: 4/19/02


Checker:  Date: 4/19/02

Table 38. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI D2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	2.839	2.574	74.2	2.574	0.8924	0.9434	1.0000	1029.01
141.1	1342	5.639	5.112	66.9	2.538	0.9762	0.8452	1.0000	1025.21
214.0	1175	8.474	7.682	72.9	2.570	0.9070	0.7536	1.0000	1009.34
283.9	990	11.359	10.298	69.9	2.615	0.9627	0.6482	1.0000	995.65
349.7	772	14.123	12.804	65.8	2.506	0.9797	0.5275	1.0000	982.57
425.0	545	17.275	15.661	75.3	2.858	0.9763	0.3943	1.0000	963.71
483.9	352	19.756	17.910	58.9	2.249	0.9825	0.2686	1.0043	945.73
549.2	134	22.490	20.389	65.3	2.479	0.9765	0.1455	1.0043	929.26
608.0	13	24.933	22.604	58.8	2.215	0.9691	0.0440	1.0172	924.34
639.4	2	26.366	23.903	31.4	1.299	1.0644	0.0045	1.0351	837.01
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	28.502	25.840	68.0	1.937	0.7327	1.0326	1.0172	825.07
131.8	1521	30.562	27.707	63.8	1.867	0.7529	0.9491	1.0172	825.54
209.0	1322	33.122	30.028	77.2	2.322	0.7737	0.8512	1.0172	829.98
272.1	1140	35.270	31.975	63.1	1.947	0.7937	0.7371	1.0172	831.73
347.4	918	37.883	34.344	75.3	2.369	0.8094	0.6162	1.0172	832.12
416.4	718	40.314	36.547	69.0	2.204	0.8216	0.4898	1.0172	831.46
486.4	506	42.799	38.800	70.0	2.253	0.8280	0.3665	1.0172	829.93
556.3	298	45.285	41.054	69.9	2.254	0.8296	0.2407	1.0216	827.37
626.1	103	47.769	43.306	69.8	2.252	0.8301	0.1201	1.0216	823.76
660.3	1.8	48.985	44.409	34.2	1.103	0.8295	0.0314	1.0216	819.26

Table 39. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI B1B

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.551	3.705	74.2	3.705	1.2846	0.9434	1.0000	1098.34
141.1	1342	6.819	7.114	66.9	3.410	1.3112	0.8452	1.0000	1062.90
214.0	1175	10.045	10.480	72.9	3.366	1.1878	0.7536	0.9956	1029.37
283.9	990	13.213	13.785	69.9	3.305	1.2165	0.6482	0.9956	998.18
349.7	772	16.119	16.817	65.8	3.032	1.1855	0.5275	0.9956	971.18
425.0	545	19.370	20.209	75.3	3.392	1.1589	0.3943	0.9956	944.23
483.9	352	21.854	22.801	58.9	2.592	1.1320	0.2686	0.9956	920.59
549.2	134	24.550	25.614	65.3	2.813	1.1082	0.1455	1.0000	903.40
608.0	13	26.966	28.134	58.8	2.521	1.1029	0.0440	1.0090	889.62
639.4	2	28.230	29.453	31.4	1.319	1.0805	0.0045	1.0045	790.98
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.148	32.497	68.0	3.044	1.1517	1.0326	1.0045	871.32
131.8	1521	33.579	35.034	63.8	2.537	1.0231	0.9491	1.0045	853.46
209.0	1322	36.431	38.009	77.2	2.975	0.9914	0.8512	1.0045	838.76
272.1	1140	38.713	40.390	63.1	2.381	0.9709	0.7371	1.0045	829.29
347.4	918	41.399	43.192	75.3	2.802	0.9574	0.6162	1.0045	822.09
416.4	718	43.823	45.722	69.0	2.530	0.9432	0.4898	1.0045	815.18
486.4	506	46.249	48.253	70.0	2.531	0.9301	0.3665	1.0045	808.54
556.3	298	48.640	50.747	69.9	2.495	0.9183	0.2407	1.0045	801.59
626.1	103	50.996	53.206	69.8	2.458	0.9060	0.1201	1.0045	796.15
660.3	1.8	52.139	54.398	34.2	1.192	0.8969	0.0314	1.0045	794.37

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Table 40. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI A2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.184	3.077	74.2	3.077	1.0668	0.9434	1.0228	1051.15
141.1	1342	6.269	6.058	66.9	2.981	1.1464	0.8452	1.0228	1040.93
214.0	1175	9.446	9.128	72.9	3.070	1.0834	0.7536	1.0182	1023.32
283.9	990	12.660	12.233	69.9	3.106	1.1431	0.6482	1.0182	1002.04
349.7	772	15.690	15.161	65.8	2.928	1.1448	0.5275	1.0182	982.09
425.0	545	19.139	18.494	75.3	3.333	1.1387	0.3943	1.0182	959.40
483.9	352	21.785	21.051	58.9	2.557	1.1168	0.2686	1.0182	936.51
549.2	134	24.662	23.831	65.3	2.780	1.0953	0.1455	1.0182	918.46
608.0	13	27.148	26.233	58.8	2.402	1.0511	0.0440	1.0275	888.21
639.4	2	28.338	27.383	31.4	1.150	0.9422	0.0045	1.0136	772.90
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.004	29.959	68.0	2.577	0.9748	1.0326	1.0228	835.54
131.8	1521	33.274	32.152	63.8	2.193	0.8842	0.9491	1.0228	828.59
209.0	1322	36.036	34.821	77.2	2.669	0.8896	0.8512	1.0228	824.51
272.1	1140	38.320	37.028	63.1	2.206	0.8996	0.7371	1.0228	823.76
347.4	918	41.063	39.679	75.3	2.651	0.9057	0.6162	1.0228	822.12
416.4	718	43.579	42.110	69.0	2.432	0.9066	0.4898	1.0228	818.71
486.4	506	46.120	44.565	70.0	2.455	0.9023	0.3665	1.0228	813.82
556.3	298	48.633	46.994	69.9	2.429	0.8939	0.2407	1.0228	807.62
626.1	103	51.108	49.385	69.8	2.392	0.8815	0.1201	1.0228	801.96
660.3	1.8	52.305	50.542	34.2	1.157	0.8702	0.0314	1.0228	799.90

Table 41. Measured Burnup Operating History Information for Assembly NJ05YU Sample TMI B3J

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 9									
0.0	1670	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
74.2	1481	3.184	3.226	74.2	3.226	1.1185	0.9434	1.0228	1051.15
141.1	1342	6.269	6.351	66.9	3.125	1.2019	0.8452	1.0228	1040.93
214.0	1175	9.446	9.570	72.9	3.219	1.1359	0.7536	1.0182	1023.32
283.9	990	12.660	12.826	69.9	3.256	1.1984	0.6482	1.0182	1002.04
349.7	772	15.690	15.896	65.8	3.070	1.2002	0.5275	1.0182	982.09
425.0	545	19.139	19.390	75.3	3.494	1.1938	0.3943	1.0182	959.40
483.9	352	21.785	22.070	58.9	2.681	1.1709	0.2686	1.0182	936.51
549.2	134	24.662	24.985	65.3	2.915	1.1484	0.1455	1.0182	918.46
608.0	13	27.148	27.504	58.8	2.519	1.1020	0.0440	1.0275	888.21
639.4	2	28.338	28.709	31.4	1.206	0.9878	0.0045	1.0136	772.90
Cycle 10									
0.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	31.004	31.411	68.0	2.701	1.0221	1.0326	1.0228	835.54
131.8	1521	33.274	33.710	63.8	2.299	0.9271	0.9491	1.0228	828.59
209.0	1322	36.036	36.508	77.2	2.799	0.9327	0.8512	1.0228	824.51
272.1	1140	38.320	38.822	63.1	2.313	0.9432	0.7371	1.0228	823.76
347.4	918	41.063	41.601	75.3	2.779	0.9496	0.6162	1.0228	822.12
416.4	718	43.579	44.150	69.0	2.549	0.9506	0.4898	1.0228	818.71
486.4	506	46.120	46.724	70.0	2.574	0.9460	0.3665	1.0228	813.82
556.3	298	48.633	49.270	69.9	2.546	0.9372	0.2407	1.0228	807.62
626.1	103	51.108	51.778	69.8	2.507	0.9242	0.1201	1.0228	801.96
660.3	1.8	52.305	52.991	34.2	1.213	0.9124	0.0314	1.0228	799.90

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Table 42. Measured Burnup Operating History Information for Assembly NJ070G Sample O1 S1

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	2.488	2.324	68.0	2.324	0.8883	0.9581	1.0000	960.29
131.8	1521	4.955	4.629	63.8	2.305	0.9388	0.8806	1.0000	960.71
209.0	1322	8.108	7.574	77.2	2.946	0.9916	0.7897	1.0000	958.68
272.1	1140	10.769	10.060	63.1	2.486	1.0239	0.6839	1.0000	954.18
347.4	918	13.976	13.056	75.3	2.996	1.0341	0.5717	1.0000	946.12
416.4	718	16.936	15.821	69.0	2.765	1.0416	0.4544	1.0000	937.15
486.4	506	19.951	18.638	70.0	2.817	1.0458	0.3400	1.0000	926.04
556.3	298	22.982	21.470	69.9	2.832	1.0528	0.2233	1.0000	914.37
626.1	103	26.015	24.303	69.8	2.833	1.0550	0.1114	1.0000	904.09
660.3	1.8	27.498	25.688	34.2	1.385	1.0528	0.0291	1.0000	897.82

Table 43. Measured Burnup Operating History Information for Assembly NJ070G Sample O1 S2

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.676	3.494	68.0	3.494	1.3354	0.9581	0.9956	1119.51
131.8	1521	7.107	6.755	63.8	3.261	1.3285	0.8806	0.9956	1084.79
209.0	1322	11.106	10.556	77.2	3.801	1.2796	0.7897	0.9956	1043.23
272.1	1140	14.205	13.502	63.1	2.946	1.2132	0.6839	1.0000	1007.09
347.4	918	17.742	16.864	75.3	3.362	1.1604	0.5717	1.0000	978.57
416.4	718	20.865	19.832	69.0	2.968	1.1181	0.4544	1.0000	951.57
486.4	506	23.950	22.764	70.0	2.932	1.0887	0.3400	1.0000	929.82
556.3	298	26.970	25.635	69.9	2.871	1.0673	0.2233	1.0000	912.15
626.1	103	29.938	28.456	69.8	2.821	1.0504	0.1114	1.0000	896.84
660.3	1.8	31.377	29.824	34.2	1.368	1.0394	0.0291	1.0000	886.54

Table 44. Measured Burnup Operating History Information for Assembly NJ070G Sample O1 S3

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.312	2.797	68.0	2.797	1.0692	0.9581	0.9957	1083.65
131.8	1521	6.485	5.477	63.8	2.680	1.0918	0.8806	0.9957	1067.32
209.0	1322	10.328	8.723	77.2	3.246	1.0928	0.7897	1.0000	1043.46
272.1	1140	13.397	11.316	63.1	2.592	1.0677	0.6839	1.0000	1016.43
347.4	918	16.954	14.320	75.3	3.004	1.0370	0.5717	1.0000	991.65
416.4	718	20.127	17.000	69.0	2.680	1.0095	0.4544	1.0000	967.21
486.4	506	23.274	19.658	70.0	2.658	0.9869	0.3400	1.0000	945.98
556.3	298	26.355	22.260	69.9	2.602	0.9676	0.2233	1.0000	928.04
626.1	103	29.382	24.817	69.8	2.557	0.9520	0.1114	1.0043	912.12
660.3	1.8	30.848	26.055	34.2	1.238	0.9410	0.0291	1.0043	899.73

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Table 45. Measured Burnup Operating History Information for Assembly NJ070G Sample O12 S4

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	2.384	2.194	68.0	2.194	0.8384	0.9581	1.0000	960.29
131.8	1521	4.693	4.318	63.8	2.125	0.8655	0.8806	1.0000	960.71
209.0	1322	7.583	6.978	77.2	2.659	0.8953	0.7897	1.0000	958.68
272.1	1140	10.004	9.205	63.1	2.228	0.9176	0.6839	1.0000	954.18
347.4	918	12.937	11.904	75.3	2.699	0.9315	0.5717	1.0000	946.12
416.4	718	15.663	14.413	69.0	2.508	0.9448	0.4544	1.0000	937.15
486.4	506	18.468	16.994	70.0	2.581	0.9583	0.3400	1.0000	926.04
556.3	298	21.311	19.610	69.9	2.616	0.9727	0.2233	1.0000	914.37
626.1	103	24.179	22.249	69.8	2.639	0.9826	0.1114	1.0000	904.09
660.3	1.8	25.592	23.549	34.2	1.300	0.9881	0.0291	1.0000	897.82

Table 46. Measured Burnup Operating History Information for Assembly NJ070G Sample O12 S5

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.532	3.163	68.0	3.163	1.2088	0.9581	0.9956	1119.51
131.8	1521	6.718	6.015	63.8	2.853	1.1621	0.8806	0.9956	1084.79
209.0	1322	10.368	9.284	77.2	3.268	1.1003	0.7897	0.9956	1043.23
272.1	1140	13.201	11.821	63.1	2.537	1.0448	0.6839	1.0000	1007.09
347.4	918	16.453	14.733	75.3	2.912	1.0051	0.5717	1.0000	978.57
416.4	718	19.350	17.327	69.0	2.594	0.9771	0.4544	1.0000	951.57
486.4	506	22.234	19.909	70.0	2.582	0.9588	0.3400	1.0000	929.82
556.3	298	25.081	22.458	69.9	2.549	0.9479	0.2233	1.0000	912.15
626.1	103	27.898	24.981	69.8	2.522	0.9392	0.1114	1.0000	896.84
660.3	1.8	29.271	26.210	34.2	1.229	0.9343	0.0291	1.0000	886.54

Table 47. Measured Burnup Operating History Information for Assembly NJ070G Sample O12 S6

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.184	2.553	68.0	2.553	0.9756	0.9581	0.9957	1083.65
131.8	1521	6.143	4.925	63.8	2.372	0.9663	0.8806	0.9957	1067.32
209.0	1322	9.659	7.743	77.2	2.819	0.9489	0.7897	1.0000	1043.46
272.1	1140	12.462	9.990	63.1	2.247	0.9255	0.6839	1.0000	1016.43
347.4	918	15.729	12.609	75.3	2.619	0.9040	0.5717	1.0000	991.65
416.4	718	18.666	14.964	69.0	2.355	0.8869	0.4544	1.0000	967.21
486.4	506	21.603	17.318	70.0	2.355	0.8742	0.3400	1.0000	945.98
556.3	298	24.499	19.640	69.9	2.322	0.8632	0.2233	1.0000	928.04
626.1	103	27.365	21.938	69.8	2.298	0.8555	0.1114	1.0043	912.12
660.3	1.8	28.760	23.056	34.2	1.118	0.8499	0.0291	1.0043	899.73

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Table 48. Measured Burnup Operating History Information for Assembly NJ070G Sample O13 S7

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	2.323	2.065	68.0	2.065	0.7893	0.9581	1.0000	960.29
131.8	1521	4.586	4.077	63.8	2.012	0.8195	0.8806	1.0000	960.71
209.0	1322	7.443	6.617	77.2	2.540	0.8551	0.7897	1.0000	958.68
272.1	1140	9.849	8.756	63.1	2.139	0.8810	0.6839	1.0000	954.18
347.4	918	12.764	11.347	75.3	2.591	0.8944	0.5717	1.0000	946.12
416.4	718	15.472	13.754	69.0	2.407	0.9068	0.4544	1.0000	937.15
486.4	506	18.257	16.230	70.0	2.476	0.9192	0.3400	1.0000	926.04
556.3	298	21.079	18.739	69.9	2.509	0.9328	0.2233	1.0000	914.37
626.1	103	23.927	21.271	69.8	2.532	0.9427	0.1114	1.0000	904.09
660.3	1.8	25.331	22.519	34.2	1.248	0.9485	0.0291	1.0000	897.82

Table 49. Measured Burnup Operating History Information for Assembly NJ070G Sample O13 S8

EFPD	ppmB	BU	Adj BU	Step Length	BU/step	Power	Bfrac	H2Ofrac	TFUEL
Cycle 10									
0.0	1800	0.000	0.000	N/A	N/A	N/A	N/A	N/A	N/A
68.0	1649	3.455	3.098	68.0	3.098	1.1839	0.9581	0.9956	1119.51
131.8	1521	6.604	5.921	63.8	2.823	1.1501	0.8806	0.9956	1084.79
209.0	1322	10.234	9.176	77.2	3.255	1.0957	0.7897	0.9956	1043.23
272.1	1140	13.053	11.703	63.1	2.527	1.0410	0.6839	1.0000	1007.09
347.4	918	16.288	14.603	75.3	2.900	1.0011	0.5717	1.0000	978.57
416.4	718	19.164	17.182	69.0	2.579	0.9713	0.4544	1.0000	951.57
486.4	506	22.028	19.750	70.0	2.568	0.9534	0.3400	1.0000	929.82
556.3	298	24.856	22.285	69.9	2.536	0.9427	0.2233	1.0000	912.15
626.1	103	27.655	24.795	69.8	2.510	0.9344	0.1114	1.0000	896.84
660.3	1.8	29.020	26.019	34.2	1.224	0.9300	0.0291	1.0000	886.54

5.4 SAS2H PATH B REPRESENTATIONS

5.4.1 Path B Radii for Assembly NJ05YU

Fuel assembly NJ05YU was irradiated for cycles 9 and 10 in the Three Mile Island Unit 1 core. While inserted in cycle 9, burnable poison rods were inserted in the 16 guide tube positions, and removed during cycle 10. Equations 8 through 14 provide the general formulas derived in order to calculate the zone radii for the assembly NJ05YU Path B representation.

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$$\frac{F}{M} = \frac{FR * \frac{\pi}{4} * POD^2}{FR * (RP^2 - COD^2 * \frac{\pi}{4}) + BPR * (RP^2 - \frac{\pi}{4} * (GTOD^2 - GTID^2 + BPROD^2)) + (RP^2 - \frac{\pi}{4} * (ITOD^2 - ITID^2))} \quad (\text{Eq. 8})$$

$$FV = POD^2 * \frac{\pi}{4} \quad (\text{Eq. 9})$$

$$CUCMV = RP^2 \quad (\text{Eq. 10})$$

$$MV = RP^2 - (COD^2 * \frac{\pi}{4}) \quad (\text{Eq. 11})$$

$$x = \frac{\frac{F}{M} * CUCMV}{FV - (\frac{F}{M} * MV)} \quad (\text{Eq. 12})$$

$$\frac{F}{Abs} = \frac{FR * POD^2 * \left(\frac{\pi}{4}\right)}{BPR * \left(\frac{\pi}{4}\right) * ABSOD^2} \quad (\text{Eq. 13})$$

$$RAA = \frac{x * POD^2 * \left(\frac{\pi}{4}\right)}{\frac{F}{Abs}} \quad (\text{Eq. 14})$$

where

$F/M$  = Fuel to moderator volume ratio

$FR$  = Number of fuel rods

$POD$  = Fuel pellet outer diameter

$RP$  = Rod pitch

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- BPR* = Number of burnable poison rods
- GTOD* = Guide tube outer diameter
- GTID* = Guide tube inner diameter
- ITOD* = Instrument tube outer diameter
- ITID* = Instrument tube inner diameter
- BPROD* = Burnable poison rod cladding outer diameter
- COD* = Fuel rod cladding outer diameter
- CUCMV* = Central unit cell moderator volume
- FV* = Fuel volume in one fuel unit cell
- MV* = Moderator volume in one fuel unit cell
- x* = Number of unit fuel cells per central unit cell
- F/Abs* = Fuel to neutron absorber volume ratio
- ABSOD* = Neutron absorber pellet outer diameter
- RAA* = Required absorber area for Path B representation

The Path B representation for assembly NJ05YU is basically as follows: The central zone is represented as a guide tube with a BPR inserted, with the remaining zones being the homogenized fuel region and the inter-assembly moderator region. The results of the fuel-unit-cell calculations for use in developing the Path B zone radii are presented in Table 50, and Equations 15 through 22 were used in calculating the Path B zone radii. Figure 2 illustrates the Path B representation for assembly NJ05YU.

Table 50. Assembly NJ05YU General Fuel-Unit-Cell Values


Variable	Value
<i>F/M</i>	0.56036
<i>FV</i>	0.68844
<i>CUCMV</i>	0.97785
<i>MV</i>	1.14454
<i>x</i>	11.63512
<i>F/Abs</i>	15.2789
<i>RAA</i>	0.52426


$$R1 = \sqrt{\frac{RAA}{\pi}} \tag{Eq. 15}$$

$$R2 = \frac{BPRID}{2} \tag{Eq. 16}$$

where

*BPRID* = Burnable poison rod cladding inner diameter

Originator:  Date: 4/19/02

Checker:  Date: 4/19/02



$$R3 = \frac{BPROD}{2} \tag{Eq. 17}$$

$$R4 = \frac{GTID}{2} \tag{Eq. 18}$$

$$R5 = \frac{GTOD}{2} \tag{Eq. 19}$$

$$R6 = \sqrt{\frac{RP^2}{\pi}} \tag{Eq. 20}$$

$$R7 = \sqrt{\left(\frac{x}{\pi} * RP^2\right) + R6^2} \tag{Eq. 21}$$

$$R8 = \sqrt{R7^2 + \frac{x+1}{NCell} * \left(\frac{AP^2 - (RP^2 * NCell)}{\pi}\right)} \tag{Eq. 22}$$

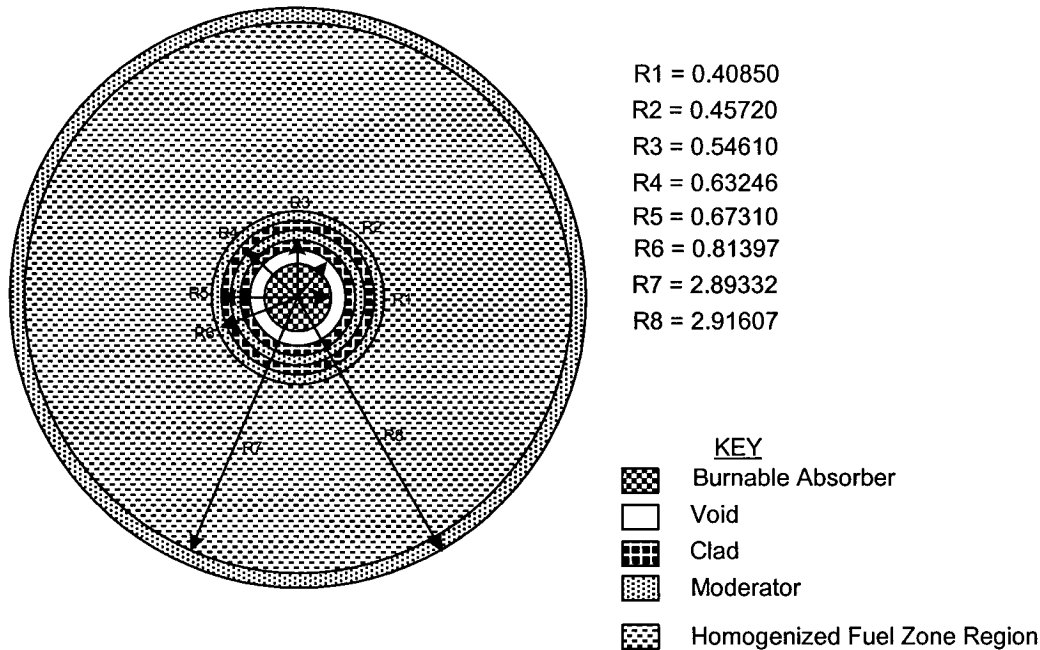
where

*AP* = Assembly pitch

*NCell* = Total unit cells in assembly

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NOTE: Figure not to scale

Figure 2. Path B Representation for Assembly NJ05YU

**5.4.2 Path B Radii for Assembly NJ070G**

Fuel assembly NJ070G was irradiated for cycle 10 in the Three Mile Island Unit 1 core. This assembly had four standard fuel rods replaced with integral fuel burnable absorber rods (Gd rods), and burnable poison rods inserted in the 16 guide tube positions. This amount of heterogeneity produces a non-typical path B representation for SAS2H. In order to accommodate the different types of rods in this assembly, a quarter assembly representation was used which placed a Gd rod in the center zone and a homogeneous mixture representing four burnable poison rod cells external to the homogenized fuel zone. Equations 8 through 14 provide the general formulas derived in order to calculate the zone radii for the assembly NJ070G Path B representation.

The Path B representation for assembly NJ070G is basically as follows: The central zone is represented as an integral burnable absorber rod ( $UO_2-Gd_2O_3$ ), with the remaining zones being the homogenized fuel region, a homogenized region consisting of the guide tube unit cells with burnable poison rods inserted, and the inter-assembly moderator region. Equations 23 through 29 were used in calculating the Path B zone radii. Figure 3 illustrates the Path B representation for assembly NJ070G.

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$$R1 = \frac{POD}{2} \tag{Eq. 23}$$

$$R2 = \frac{CID}{2} \tag{Eq. 24}$$

where

CID = Fuel rod cladding inner diameter

$$R3 = \frac{COD}{2} \tag{Eq. 25}$$

$$R4 = \sqrt{\frac{RP^2}{\pi}} \tag{Eq. 26}$$


$$R5 = \sqrt{\left(\frac{FR}{4} - 1\right) * \frac{RP^2}{\pi}} \tag{Eq. 27}$$


where

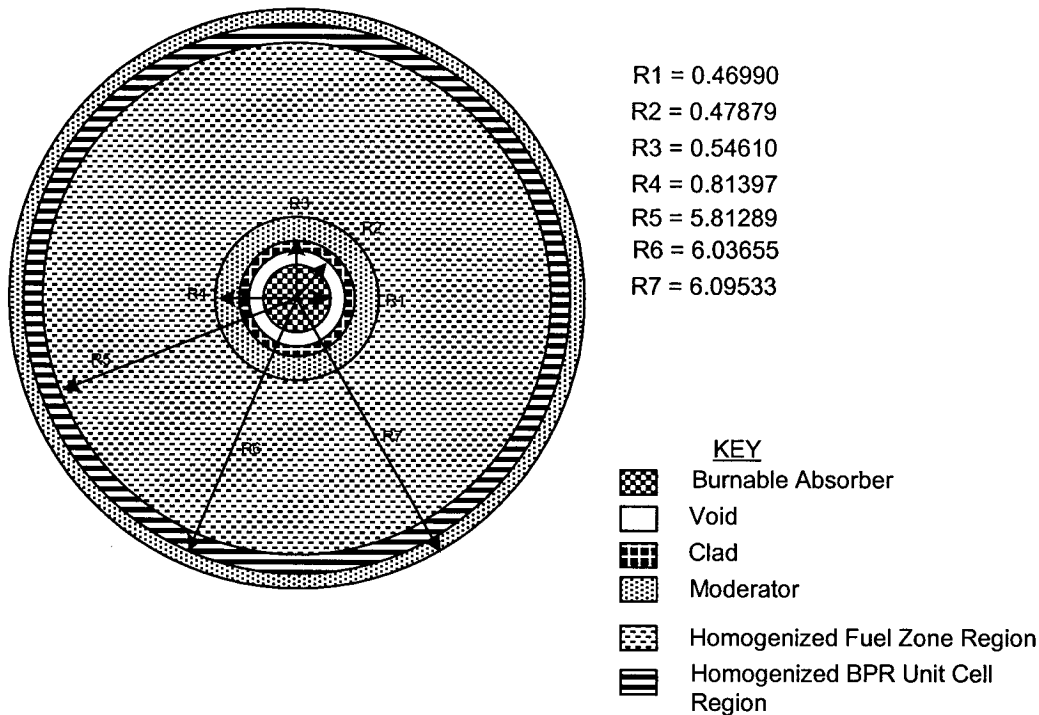
the number "4" comes from there being four integral burnable absorber rods

$$R6 = \sqrt{R5^2 + \frac{4 * RP^2}{\pi}} \tag{Eq. 28}$$

$$R7 = \sqrt{R6^2 + \frac{AP^2 - N_{Cell} * RP^2 + RP^2 - \frac{\pi * ITOD^2}{4} + \frac{\pi * ITID^2}{4}}{4 * \pi}} \tag{Eq. 29}$$

Originator:  Date: 4/19/02

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NOTE: Figure not to scale

Figure 3. Path B Representation for Assembly NJ070G

**5.5 MCNP SPECIFICATIONS**

In order to quantify the overall effect that the differences between the calculated and measured isotopic concentrations have on system reactivity, MCNP calculations were performed to calculate the multiplication factor (k) that results from using the different sets of isotopics and provide a comparison in terms of  $\Delta k$ .

The axial nodes from which the samples came from were used to represent fuel assemblies in a flooded storage package configuration. The storage package design parameters used in the MCNP representations is illustrated in Attachment I. Axially reflective boundary conditions were used for each nodal representation. The general assembly design parameters for each assembly were presented in Table 4. Burnable poison rods were not represented in the MCNP cases, and the isotopic constituents from the integral fuel burnable absorber rods were smeared across the entire node for the NJ070G samples.

The spent fuel isotopes used in the MCNP cases correspond to those from the SAS2H calculations and the measured sample isotopes. Isotopes were extracted from the SAS2H outputs and measured results, and then combined with the initial oxygen mass and renormalized to the total mass in terms of weight percents. The values from the SAS2H calculations are given in units of mols, which were converted to units of grams using Equation 31. In order to keep changes in reactivity limited to variations from isotopic concentrations, the MCNP density input for each spent fuel composition was kept constant at an arbitrary value representative of depleted

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Checker: *RM* Date: 4/19/02

fuel – 9.886 g/cm<sup>3</sup>. In addition, the specific isotopes were kept constant between calculated material cases and measured material cases. Certain isotopes were omitted from the MCNP calculations for having concentrations less than 0.0001 wt% in either the measured or calculated composition. Among these were the isotopes Eu-151 and Am-242m in the assembly NJ05YU MCNP calculations, and the isotopes Eu-151, Am-242m, Mo-95, Tc-99, Ru-101, and Rh-103 in the NJ070G MCNP cases. In addition, the isotopes Nd-146 and Nd-150 were also omitted since the MCNP cross section libraries for these isotopes were not available, and their concentrations were very small (< 0.1 wt%). Equations 4 through 6 and 30 were used for determining the initial oxygen mass. Each depleted fuel composition is listed in the MCNP input files contained in Attachment III in terms of ZAID's and weight percents, and can be verified by visual inspection from the SAS2H outputs along with the equations provided. The SAS2H output files for each calculation are contained on a compact disc attachment (Attachment III).

$$O \text{ Mass in } UO_2 = \left( \frac{O \text{ Mass} / \text{mol } UO_2}{U \text{ Mass} / \text{mol } UO_2} \right) (U \text{ Mass in } UO_2)$$

(Eq. 30)

$$\text{mols Isotope}_i * A_i$$

(Eq. 31)


where

i is the particular isotope

A is the atomic mass value from Reference 7.17

The outer barrier of the storage package was represented as SB-575 N06022 as described in Table 51. The inner barrier was represented as SA-240 S31600, which is nuclear grade 316 stainless steel (SS) with tightened control on carbon and nitrogen content (p. 931, Ref. 7.10, and Section II, SA-240, Table 1, Ref. 7.9) as described in Table 52. The fuel basket plates were represented as Neutronit A978 with 1.62 wt% boron as described in Table 53, and the thermal shunts were represented as aluminum 6061 as described in Table 54. The basket side and corner guides were represented as Grade 70 A 516 carbon steel as described in Table 55. The basket stiffeners were represented as water since they are not solid over the length of the basket.

The chromium, nickel, and iron elemental weight percents obtained from the references were expanded into their constituent natural isotopic weight percents for use in MCNP. This expansion was performed by: (1) calculating a natural weight fraction of each isotope in the elemental state, and (2) multiplying the elemental weight percent in the material of interest by the natural weight fraction of the isotope in the elemental state to obtain the weight percent of the isotope in the material of interest. This process is described mathematically in Equations 32 and 33. The atomic mass values and atom percent of natural element values for these calculations are from Reference 7.15.

Originator:  Date: 4/19/02

Checker:  Date: 4/19/02

$$\left( \begin{array}{l} \text{Weight Fraction} \\ \text{of Isotope}_i \text{ in the} \\ \text{Natural Element} \end{array} \right) = \frac{(\text{Atomic Mass of Isotope}_i)(\text{Atom Percent of Isotope}_i \text{ in Natural Element})}{\sum_{i=1}^I (\text{Atomic Mass of Isotope}_i)(\text{Atom Percent of Isotope}_i \text{ in Natural Element})}$$

(Eq. 32)

where

$I$  = the total number of isotopes in the natural element

$$\left( \begin{array}{l} \text{Weight Percent} \\ \text{of Isotope}_i \text{ in} \\ \text{Material Composition} \end{array} \right) = \left( \begin{array}{l} \text{Weight Fraction} \\ \text{of Isotope}_i \text{ in the} \\ \text{Natural Element} \end{array} \right) \left( \begin{array}{l} \text{Reference Weight Percent of} \\ \text{Element in Material Composition} \end{array} \right)$$

(Eq. 33)

Table 51. SB-575 N06022 Material Composition


Element/ Isotope	ZAID	Wt%	Element/ Isotope	ZAID	Wt%
C-nat	6000.50c	0.0150	Co-59	27059.50c	2.5000
Mn-55	25055.50c	0.5000	W-182	74182.55c	0.7877
Si-nat	14000.50c	0.0800	W-183	74183.55c	0.4278
Cr-50	24050.60c	0.8879	W-184	74184.55c	0.9209
Cr-52	24052.60c	17.7863	W-186	74186.55c	0.8636
Cr-53	24053.60c	2.0554	V	23000.50c	0.3500
Cr-54	24054.60c	0.5202	Fe-54	26054.60c	0.2260
Ni-58	28058.60c	36.8024	Fe-56	26056.60c	3.6759
Ni-60	28060.60c	14.6621	Fe-57	26057.60c	0.0865
Ni-61	28061.60c	0.6481	Fe-58	26058.60c	0.0116
Ni-62	28062.60c	2.0975	S-32	16032.50c	0.0200
Ni-64	28064.60c	0.5547	P-31	15031.50c	0.0200
Mo-nat	42000.50c	13.5000	Density = 8.69 g/cm <sup>3</sup>		

Source: Ref. 7.7

Table 52. Material Specifications for SS316NG

Element/Isotope	ZAID	Wt%	Element/Isotope	ZAID	Wt%
C-nat	6000.50c	0.0200	Fe-54	26054.60c	3.6911
N-14	7014.50c	0.0800	Fe-56	26056.60c	60.0322
Si-nat	14000.50c	1.0000	Fe-57	26057.60c	1.4119
P-31	15031.50c	0.0450	Fe-58	26058.60c	0.1897
S-32	16032.50c	0.0300	Ni-58	28058.60c	8.0641
Cr-50	24050.60c	0.7103	Ni-60	28060.60c	3.2127
Cr-52	24052.60c	14.2291	Ni-61	28061.60c	0.1420
Cr-53	24053.60c	1.6443	Ni-62	28062.60c	0.4596
Cr-54	24054.60c	0.4162	Ni-64	28064.60c	0.1216
Mn-55	25055.50c	2.0000	Mo-nat	42000.50c	2.5000
Density = 7.98 g/cm <sup>3</sup>					

Source: p. 931, Ref. 7.10 and Section II, SA-240, Table 1, Ref. 7.9

Originator:  Date: 4/19/02


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Table 53. Material Specifications for Neutronit A978 with 1.62 wt% Boron

Element/Isotope	ZAID	Wt%	Element/Isotope	ZAID	Wt%
B-10	5010.50c	0.2986	Fe-57	26057.60c	1.3928
B-11	5011.56c	1.3214	Fe-58	26058.60c	0.1872
C-nat	6000.50c	0.0400	Co-59	27059.50c	0.2000
Cr-50	24050.60c	0.7730	Ni-58	28058.60c	8.7361
Cr-52	24052.60c	15.4846	Ni-60	28060.60c	3.4805
Cr-53	24053.60c	1.7894	Ni-61	28061.60c	0.1539
Cr-54	24054.60c	0.4529	Ni-62	28062.60c	0.4979
Fe-54	26054.60c	3.6411	Ni-64	28064.60c	0.1317
Fe-56	26056.60c	59.2189	Mo-nat	42000.50c	2.2000
Density = 7.76 g/cm <sup>3</sup>					

Source: Ref. 7.16

Table 54. Material Specifications for Al 6061

Element/Isotope	ZAID	Wt%	Element/Isotope	ZAID	Wt%
Si-nat	14000.50c	0.6000	Mg-nat	12000.50c	1.0000
Fe-54	26054.60c	0.0396	Cr-50	24050.60c	0.0081
Fe-56	26056.60c	0.6433	Cr-52	24052.60c	0.1632
Fe-57	26057.60c	0.0151	Cr-53	24053.60c	0.0189
Fe-58	26058.60c	0.0020	Cr-54	24054.60c	0.0048
Cu-63	29063.60c	0.1884	Ti-nat	22000.50c	0.1500
Cu-65	29065.60c	0.0866	Al-27	13027.50c	96.9300
Mn-55	25055.50c	0.1500	Density = 2.7065 g/cm <sup>3</sup>		

Source: Ref. 7.13

NOTE: Zn cross-section data unavailable, therefore it was substituted as Al-27 (See assumption 3.2)

Table 55. Grade 70 A516 Carbon Steel Composition

Element/Isotope	ZAID	Wt%	Element/Isotope	ZAID	Wt%
C-nat	6000.50c	0.2700	Fe-54	26054.60c	5.5558
Mn-55	25055.50c	1.0450	Fe-56	26056.60c	90.3584
P-31	15031.50c	0.0350	Fe-57	26057.60c	2.1252
S-32	16032.50c	0.0350	Fe-58	26058.60c	0.2856
Si-nat	14000.50c	0.2900	Density = 7.850 g/cm <sup>3</sup>		

Source: Ref. 7.8

Table 56. Zircaloy-4 Material Composition

Element/Isotope	ZAID	Wt%	Element/Isotope	ZAID	Wt%
Cr-50	24050.60c	0.0042	Fe-57	26057.60c	0.0045
Cr-52	24052.60c	0.0837	Fe-58	26058.60c	0.0006
Cr-53	24053.60c	0.0097	O-16	8016.50c	0.1250
Cr-54	24054.60c	0.0024	Zr-nat	40000.60c	98.1150
Fe-54	26054.60c	0.0119	Sn-nat	50000.35c	1.4500
Fe-56	26056.60c	0.1930	Density = 6.56 g/cm <sup>3</sup>		

Source: Ref. 7.13

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6. RESULTS

The TMI-1 radiochemical assay comparison results are presented in this section. Two different sets of isotopics were calculated. One set which uses the assembly nodal burnup from the reactor follow calculations, and one set using the sample burnup based on specific isotopic concentrations. The results presented provide a comparison of the calculated isotopics with the measured isotopics on a percent difference basis. The difference between the measured and the calculated value was divided by the measured value to determine the accuracy of the SAS2H calculation. A positive percent difference represents an over prediction by the code, while a negative percent difference represents an under prediction by the code. It should be noted that when dealing with very small concentrations, the percent difference between measured and calculated results may appear to be large for some isotopes, but in reality may be on the order of less than a tenth of a gram per assembly.

In order to quantify the overall effect that the differences between the calculated and measured isotopic concentrations have on system reactivity, MCNP calculations were performed to calculate the multiplication factor (k) that results from using the different sets of isotopics and provide a comparison in terms of  $\Delta k$ . The results represent the average combined collision, absorption, and track-length estimator from the MCNP calculations. The standard deviation ( $\sigma$ ) represents the standard deviation of k about the average combined collision, absorption, and track-length estimate due to the Monte Carlo calculation statistics.

The SAS2H and MCNP input and output files used in this evaluation are contained on an attachment compact disc to this calculation file as listed in Attachment III.

6.1 SAMPLE RESULTS FROM ASSEMBLY NJ05YU

Tables 57 through 60 present the SAS2H calculated results for the samples from assembly NJ05YU. Table 57 presents the SAS2H calculated results based on the core follow information from Reference 7.3. Table 58 presents the SAS2H calculated results using the sample-measured burnups to adjust the core follow information. Tables 59 and 60 show the results in terms of percent difference for the two methods compared with the RCA measured results.

Table 57. SAS2H Calculated Results for Assembly NJ05YU Samples

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Avg BU (MWd/MTU)	5.23E+04	5.26E+04	5.21E+04	5.21E+04	4.90E+04	4.61E+04	5.21E+04	5.23E+04	5.20E+04
Isotope	(g/g U-238)								
U-234	2.03E-04	1.99E-04	2.03E-04	2.03E-04	2.11E-04	2.22E-04	2.07E-04	2.07E-04	2.07E-04
U-235	6.38E-03	6.40E-03	6.76E-03	6.58E-03	7.78E-03	8.25E-03	6.58E-03	6.58E-03	6.68E-03
U-236	6.05E-03	6.05E-03	6.04E-03	6.04E-03	5.95E-03	5.84E-03	6.04E-03	6.04E-03	6.04E-03
Pu-238	4.05E-04	4.14E-04	4.14E-04	4.10E-04	3.71E-04	3.06E-04	4.05E-04	4.05E-04	4.05E-04
Pu-239	7.62E-03	7.71E-03	7.90E-03	7.77E-03	7.99E-03	7.44E-03	7.77E-03	7.77E-03	7.83E-03
Pu-240	3.20E-03	3.22E-03	3.24E-03	3.22E-03	3.12E-03	2.89E-03	3.23E-03	3.23E-03	3.23E-03
Pu-241	1.70E-03	1.72E-03	1.75E-03	1.73E-03	1.71E-03	1.42E-03	1.60E-03	1.60E-03	1.60E-03
Pu-242	1.03E-03	1.03E-03	1.01E-03	1.02E-03	8.97E-04	7.89E-04	1.02E-03	1.02E-03	1.01E-03
Nd-143	1.20E-03	1.21E-03	1.21E-03	1.21E-03	1.19E-03	1.13E-03	1.21E-03	1.21E-03	1.21E-03
Nd-145	1.07E-03	1.08E-03	1.07E-03	1.07E-03	1.02E-03	9.74E-04	1.07E-03	1.07E-03	1.07E-03
Nd-148	6.24E-04	6.27E-04	6.20E-04	6.22E-04	5.84E-04	5.48E-04	6.22E-04	6.22E-04	6.20E-04


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Table 57. SAS2H Calculated Results for Assembly NJ05YU Samples

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Cs-137	1.96E-03	1.97E-03	1.94E-03	1.95E-03	1.83E-03	1.65E-03	1.88E-03	1.88E-03	1.87E-03
Eu-151	4.22E-07	4.22E-07	4.22E-07	4.22E-07	4.21E-07	4.20E-07	8.45E-07	8.44E-07	8.45E-07
Eu-153	2.12E-04	2.14E-04	2.11E-04	2.12E-04	1.96E-04	1.81E-04	2.12E-04	2.12E-04	2.11E-04
Eu-155	7.18E-06	7.60E-06	7.18E-06	7.18E-06	6.74E-06	4.62E-06	5.91E-06	5.91E-06	5.91E-06
Sm-147	2.39E-04	2.40E-04	2.38E-04	2.39E-04	2.34E-04	2.69E-04	2.75E-04	2.74E-04	2.74E-04
Sm-149	4.64E-06	4.65E-06	4.65E-06	4.65E-06	5.06E-06	4.62E-06	4.65E-06	4.64E-06	4.65E-06
Sm-150	5.14E-04	5.17E-04	5.12E-04	5.13E-04	4.81E-04	4.46E-04	5.13E-04	5.13E-04	5.12E-04
Sm-151	1.73E-05	1.77E-05	1.82E-05	1.77E-05	1.81E-05	1.59E-05	1.73E-05	1.73E-05	1.77E-05
Sm-152	2.04E-04	2.04E-04	2.01E-04	2.02E-04	1.91E-04	1.83E-04	2.02E-04	2.02E-04	2.02E-04
Gd-155	4.22E-06	4.22E-06	4.22E-06	4.22E-06	3.79E-06	4.62E-06	5.91E-06	5.91E-06	5.91E-06
Am-241	3.42E-04	3.46E-04	3.55E-04	3.51E-04	3.45E-04	4.28E-04	4.81E-04	4.81E-04	4.86E-04
Am-242m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243	2.91E-04	2.96E-04	2.91E-04	2.91E-04	2.49E-04	2.01E-04	2.91E-04	2.91E-04	2.87E-04
Np-237	8.32E-04	8.41E-04	8.41E-04	8.36E-04	7.96E-04	7.18E-04	8.36E-04	8.36E-04	8.40E-04
Mo-95	1.24E-03	1.25E-03	1.24E-03	1.24E-03	1.17E-03	1.12E-03	1.24E-03	1.24E-03	1.24E-03
Tc-99	1.29E-03	1.30E-03	1.28E-03	1.29E-03	1.22E-03	1.16E-03	1.29E-03	1.29E-03	1.28E-03
Ru-101	1.29E-03	1.30E-03	1.28E-03	1.29E-03	1.21E-03	1.14E-03	1.29E-03	1.29E-03	1.28E-03
Rh-103	7.31E-04	7.34E-04	7.31E-04	7.31E-04	7.01E-04	6.65E-04	7.31E-04	7.30E-04	7.30E-04
Ag-109	1.55E-04	1.56E-04	1.55E-04	1.55E-04	1.43E-04	1.30E-04	1.55E-04	1.55E-04	1.55E-04
Sample	TMI D1A2	TMI D1A4							
Avg BU (MWd/MTU)	5.20E+04	5.13E+04							
Isotope	(g/g U-238)								
U-234	2.07E-04	2.07E-04							
U-235	6.80E-03	7.05E-03							
U-236	6.05E-03	6.02E-03							
Pu-238	4.10E-04	4.01E-04							
Pu-239	7.94E-03	7.99E-03							
Pu-240	3.25E-03	3.23E-03							
Pu-241	1.63E-03	1.62E-03							
Pu-242	1.01E-03	9.79E-04							
Nd-143	1.22E-03	1.21E-03							
Nd-145	1.06E-03	1.05E-03							
Nd-148	6.20E-04	6.11E-04							
Cs-137	1.87E-03	1.84E-03							
Eu-151	8.45E-07	8.44E-07							
Eu-153	2.11E-04	2.08E-04							
Eu-155	5.91E-06	5.49E-06							
Sm-147	2.73E-04	2.73E-04							
Sm-149	4.65E-06	5.07E-06							
Sm-150	5.12E-04	5.05E-04							
Sm-151	1.82E-05	1.82E-05							
Sm-152	2.01E-04	1.98E-04							
Gd-155	5.91E-06	5.49E-06							
Am-241	4.90E-04	4.90E-04							
Am-242m	0.00E+00	0.00E+00							
Am-243	2.91E-04	2.79E-04							
Np-237	8.45E-04	8.36E-04							
Mo-95	1.23E-03	1.22E-03							
Tc-99	1.28E-03	1.27E-03							
Ru-101	1.28E-03	1.27E-03							
Rh-103	7.31E-04	7.24E-04							
Ag-109	1.55E-04	1.52E-04							

Originator:  Date: 4/19/02


Checker:  Date: 4/19/02

Table 58. SAS2H Calculated Results for Assembly NJ05YU Samples Using Measured Burnups

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Avg BU (MWd/MTU)	5.06E+04	5.00E+04	5.01E+04	5.13E+04	4.44E+04	4.48E+04	5.43E+04	5.30E+04	5.26E+04
Isotope	(g/g U-238)								
U-234	2.07E-04	2.06E-04	2.07E-04	2.03E-04	2.22E-04	2.26E-04	1.99E-04	1.99E-04	2.07E-04
U-235	6.90E-03	7.16E-03	7.31E-03	6.83E-03	9.37E-03	8.73E-03	5.97E-03	5.96E-03	6.51E-03
U-236	5.99E-03	5.98E-03	5.99E-03	6.02E-03	5.76E-03	5.78E-03	6.10E-03	6.09E-03	6.06E-03
Pu-238	3.79E-04	3.75E-04	3.84E-04	3.97E-04	3.06E-04	2.89E-04	4.36E-04	4.35E-04	4.14E-04
Pu-239	7.61E-03	7.68E-03	7.88E-03	7.76E-03	7.89E-03	7.42E-03	7.78E-03	7.77E-03	7.83E-03
Pu-240	3.12E-03	3.11E-03	3.15E-03	3.18E-03	2.88E-03	2.82E-03	3.32E-03	3.32E-03	3.26E-03
Pu-241	1.67E-03	1.66E-03	1.71E-03	1.71E-03	1.58E-03	1.38E-03	1.64E-03	1.64E-03	1.62E-03
Pu-242	9.57E-04	9.35E-04	9.40E-04	9.87E-04	7.30E-04	7.42E-04	1.10E-03	1.10E-03	1.04E-03
Nd-143	1.19E-03	1.18E-03	1.19E-03	1.20E-03	1.13E-03	1.12E-03	1.23E-03	1.23E-03	1.22E-03
Nd-145	1.05E-03	1.04E-03	1.04E-03	1.06E-03	9.43E-04	9.52E-04	1.10E-03	1.10E-03	1.08E-03
Nd-148	6.02E-04	5.95E-04	5.97E-04	6.11E-04	5.28E-04	5.31E-04	6.49E-04	6.48E-04	6.28E-04
Cs-137	1.89E-03	1.87E-03	1.87E-03	1.92E-03	1.65E-03	1.60E-03	1.96E-03	1.96E-03	1.89E-03
Eu-151	4.22E-07	4.21E-07	4.22E-07	4.22E-07	4.19E-07	4.19E-07	8.47E-07	8.45E-07	8.45E-07
Eu-153	2.04E-04	2.01E-04	2.02E-04	2.08E-04	1.74E-04	1.75E-04	2.23E-04	2.22E-04	2.14E-04
Eu-155	7.17E-06	6.74E-06	6.75E-06	7.17E-06	5.87E-06	4.61E-06	5.93E-06	5.92E-06	5.92E-06
Sm-147	2.39E-04	2.38E-04	2.37E-04	2.38E-04	2.30E-04	2.68E-04	2.76E-04	2.75E-04	2.75E-04
Sm-149	4.64E-06	4.64E-06	4.64E-06	4.64E-06	4.61E-06	4.61E-06	4.66E-06	4.65E-06	4.65E-06
Sm-150	4.95E-04	4.89E-04	4.92E-04	5.04E-04	4.30E-04	4.31E-04	5.37E-04	5.36E-04	5.19E-04
Sm-151	1.69E-05	1.73E-05	1.77E-05	1.77E-05	1.72E-05	1.55E-05	1.78E-05	1.77E-05	1.77E-05
Sm-152	1.98E-04	1.96E-04	1.96E-04	2.00E-04	1.76E-04	1.79E-04	2.10E-04	2.09E-04	2.04E-04
Gd-155	4.22E-06	3.79E-06	3.79E-06	4.22E-06	3.36E-06	4.61E-06	6.35E-06	6.34E-06	5.92E-06
Am-241	3.37E-04	3.41E-04	3.50E-04	3.46E-04	3.23E-04	4.19E-04	4.95E-04	4.94E-04	4.90E-04
Am-242m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243	2.66E-04	2.57E-04	2.61E-04	2.79E-04	1.85E-04	1.84E-04	3.26E-04	3.25E-04	2.96E-04
Np-237	8.01E-04	7.96E-04	8.10E-04	8.23E-04	7.13E-04	6.96E-04	8.72E-04	8.70E-04	8.49E-04
Mo-95	1.21E-03	1.20E-03	1.20E-03	1.22E-03	1.08E-03	1.09E-03	1.28E-03	1.28E-03	1.25E-03
Tc-99	1.25E-03	1.24E-03	1.24E-03	1.27E-03	1.12E-03	1.13E-03	1.33E-03	1.33E-03	1.30E-03
Ru-101	1.25E-03	1.24E-03	1.24E-03	1.27E-03	1.10E-03	1.11E-03	1.34E-03	1.34E-03	1.30E-03
Rh-103	7.13E-04	7.08E-04	7.12E-04	7.22E-04	6.51E-04	6.50E-04	7.52E-04	7.51E-04	7.36E-04
Ag-109	1.48E-04	1.46E-04	1.48E-04	1.51E-04	1.25E-04	1.25E-04	1.63E-04	1.63E-04	1.57E-04
Sample	TMI D1A2	TMI D1A4							
Avg BU (MWd/MTU)	5.54E+04	4.99E+04							
Isotope	(g/g U-238)								
U-234	1.99E-04	2.11E-04							
U-235	5.85E-03	7.47E-03							
U-236	6.13E-03	5.98E-03							
Pu-238	4.62E-04	3.79E-04							
Pu-239	7.97E-03	7.97E-03							
Pu-240	3.40E-03	3.16E-03							
Pu-241	1.70E-03	1.59E-03							
Pu-242	1.14E-03	9.28E-04							
Nd-143	1.25E-03	1.20E-03							
Nd-145	1.12E-03	1.03E-03							
Nd-148	6.63E-04	5.94E-04							
Cs-137	2.00E-03	1.79E-03							
Eu-151	8.48E-07	8.43E-07							
Eu-153	2.28E-04	2.01E-04							
Eu-155	6.36E-06	5.48E-06							
Sm-147	2.75E-04	2.72E-04							
Sm-149	5.09E-06	5.06E-06							
Sm-150	5.51E-04	4.90E-04							
Sm-151	1.87E-05	1.77E-05							
Sm-152	2.12E-04	1.94E-04							
Gd-155	6.36E-06	5.48E-06							
Am-241	5.09E-04	4.81E-04							
Am-242m	0.00E+00	0.00E+00							
Am-243	3.43E-04	2.57E-04							
Np-237	8.99E-04	8.10E-04							

Originator: *MW* Date: *4/19/02*

Checker: *[Signature]* Date: *4/19/02*

Table 58. SAS2H Calculated Results for Assembly NJ05YU Samples Using Measured Burnups

Sample	TMI D1A2	TMI D1A4
Mo-95	1.30E-03	1.19E-03
Tc-99	1.35E-03	1.24E-03
Ru-101	1.37E-03	1.23E-03
Rh-103	7.65E-04	7.10E-04
Ag-109	1.68E-04	1.47E-04

Table 59. Assembly NJ05YU Sample Percent Differences

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Avg BU (MWd/MTU)	2.560	4.058	2.824	0.754	8.401	1.961	-5.161	-2.084	-2.018
Isotope	Percent Difference								
U-234	-2.087	-1.712	-5.254	1.359	1.764	0.633	1.442	3.971	5.587
U-235	-6.722	-4.622	-5.210	-2.808	-2.050	-10.910	-5.189	-0.775	-1.014
U-236	1.624	3.655	2.106	4.741	3.711	6.126	2.956	2.067	7.541
Pu-238	5.838	21.760	15.956	50.610	5.928	-29.419	-13.553	-6.167	-18.420
Pu-239	31.862	34.705	35.099	30.094	36.779	36.512	39.939	40.673	44.738
Pu-240	6.334	9.259	8.721	4.623	8.629	14.730	12.818	12.013	17.064
Pu-241	15.759	14.901	13.831	13.640	16.360	9.102	7.865	7.845	11.453
Pu-242	2.709	4.647	3.651	1.781	4.956	7.919	-2.133	-15.198	0.360
Nd-143	16.631	11.866	14.489	17.268	20.819	6.964	2.361	5.012	8.038
Nd-145	12.852	9.703	9.713	10.041	14.063	6.210	-0.141	0.782	4.511
Nd-148	4.712	6.433	5.101	2.995	11.356	4.505	-3.402	-0.484	0.069
Cs-137	2.467	3.999	-0.798	5.973	5.156	-8.727	-1.759	-0.210	-2.019
Eu-151	-55.832	-50.766	-43.071	-53.995	-44.346	-40.731	36.455	4.130	10.853
Eu-153	14.806	18.094	16.688	21.602	16.861	14.732	4.746	6.305	12.928
Eu-155	-48.358	-46.452	-53.671	-47.974	-48.933	-57.261	-64.806	-47.219	-45.251
Sm-147	12.402	19.163	17.940	21.339	19.512	10.863	-0.897	2.030	10.526
Sm-149	12.463	31.636	34.681	47.950	51.821	37.786	24.882	34.241	27.633
Sm-150	26.988	27.354	23.466	30.901	28.188	15.750	1.010	4.487	12.750
Sm-151	27.296	22.359	34.545	30.425	33.206	14.717	6.230	8.201	23.185
Sm-152	42.325	45.739	47.073	48.747	47.132	39.981	29.677	31.336	43.179
Gd-155	-25.266	-40.335	-38.603	-41.506	-37.015	-47.844	-45.756	-47.686	-42.031
Am-241	4.594	-6.126	-13.033	6.870	-7.132	14.749	53.820	-12.320	-11.691
Am-242m	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Am-243	5.946	7.138	9.572	9.141	20.081	50.312	31.265	27.228	35.470
Np-237	10.763	12.385	10.314	13.155	9.527	10.393	9.739	9.145	12.967
Mo-95	2.840	2.318	3.792	13.719	18.561	-0.115	-0.837	1.582	3.884
Tc-99	10.326	9.760	9.610	14.859	16.119	-24.139	-10.041	-4.728	-12.715
Ru-101	3.367	-0.176	1.881	16.007	18.584	-5.096	-0.180	1.373	1.131
Rh-103	9.092	7.906	9.233	23.209	26.315	3.694	7.288	8.543	9.582
Ag-109	139.885	173.729	166.555	54.995	185.914	136.514	224.257	83.391	118.333
Sample	TMI D1A2	TMI D1A4							
Avg BU (MWd/MTU)	-7.525	0.642							
Isotope	Percent Difference								
U-234	-1.428	-3.331							
U-235	-10.445	-13.064							
U-236	1.772	3.694							
Pu-238	-1.259	-1.212							
Pu-239	33.634	36.616							
Pu-240	10.267	13.575							
Pu-241	1.652	4.594							
Pu-242	-3.842	-3.973							
Nd-143	0.446	3.454							
Nd-145	-2.294	1.285							
Nd-148	-6.037	2.917							
Cs-137	12.013	3.000							
Eu-151	17.185	16.788							
Eu-153	2.537	9.903							
Eu-155	-44.726	-59.938							

Originator: *[Signature]* Date: 4/19/02

Checker: *[Signature]* Date: 4/19/02

Table 59. Assembly NJ05YU Sample Percent Differences

Sample	TMI D1A2	TMI D1A4
Sm-147	-0.246	6.954
Sm-149	10.642	29.904
Sm-150	3.942	12.867
Sm-151	7.487	18.654
Sm-152	29.733	36.847
Gd-155	-46.718	-63.653
Am-241	34.258	-14.081
Am-242m	-100.000	-100.000
Am-243	30.130	39.322
Np-237	9.870	12.659
Mo-95	2.052	3.365
Tc-99	3.364	-1.849
Ru-101	4.308	6.328
Rh-103	8.819	10.881
Ag-109	208.002	65.745

Table 60. Assembly NJ05YU Sample Percent Differences from Cases Using Measured Burnups

Sample	TMI A2	TMI B2	TMI C1	TMI C3	TMI D2	TMI A1B	TMI B1B	TMI B3J	TMI C2B
Avg BU (MWd/MTU)	-0.099	-0.140	-0.159	0.000	-0.893	-0.112	-0.330	0.038	0.019
Isotope	Percent Difference								
U-234	-0.215	2.217	-3.455	1.277	7.398	2.410	-2.484	-0.206	5.648
U-235	0.948	6.696	2.543	0.915	18.073	-5.720	-14.006	-10.140	-3.524
U-236	0.745	2.387	1.138	4.363	0.408	5.086	3.904	2.849	7.829
Pu-238	-0.943	10.303	7.478	45.833	-12.512	-33.365	-7.045	0.742	-16.672
Pu-239	31.641	34.224	34.710	29.988	35.176	36.196	40.248	40.767	44.822
Pu-240	3.775	5.417	5.835	3.304	0.408	12.099	16.175	15.169	18.050
Pu-241	13.272	10.964	11.161	12.437	7.576	6.393	10.677	10.486	12.398
Pu-242	-4.214	-5.413	-3.463	-1.255	-14.636	1.484	6.222	-8.099	2.510
Nd-143	15.085	9.638	12.730	16.517	15.128	5.532	4.022	6.551	8.516
Nd-145	10.000	5.647	6.735	8.691	5.665	3.844	3.007	3.799	5.399
Nd-148	1.071	1.089	1.266	1.235	0.703	1.422	0.820	3.706	1.218
Cs-137	-1.125	-1.276	-4.485	4.166	-5.043	-11.428	2.580	4.037	-0.857
Eu-151	-55.906	-50.888	-43.175	-54.032	-44.589	-40.802	36.756	4.200	10.916
Eu-153	10.057	11.049	11.584	19.320	3.367	10.617	10.215	11.684	14.348
Eu-155	-48.444	-52.520	-56.475	-48.016	-55.512	-57.311	-64.728	-47.184	-45.220
Sm-147	12.016	18.448	17.309	21.026	17.278	10.214	-0.373	2.413	10.760
Sm-149	12.275	31.309	34.437	47.829	38.561	37.623	25.158	34.331	27.706
Sm-150	22.195	20.499	18.568	28.533	14.541	12.020	5.732	9.204	14.211
Sm-151	23.983	19.150	31.178	30.319	26.455	11.565	9.061	10.914	23.256
Sm-152	38.254	39.959	42.805	46.764	35.518	36.615	34.304	35.814	44.460
Gd-155	-25.391	-46.434	-44.843	-41.553	-44.258	-47.906	-41.753	-43.912	-41.997
Am-241	3.130	-7.501	-14.224	5.496	-13.176	12.366	58.216	-9.952	-10.872
Am-242m	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Am-243	-3.428	-6.868	-1.722	4.311	-10.839	37.623	46.807	42.074	39.535
Np-237	6.649	6.472	6.241	11.349	-1.914	7.038	14.425	13.631	14.168
Mo-95	-0.084	-1.908	0.698	12.155	9.018	-2.554	2.666	5.009	4.867
Tc-99	7.223	5.274	6.348	13.296	6.823	-25.982	-6.912	-1.566	-11.888
Ru-101	-0.078	-4.994	-1.717	14.126	7.579	-7.793	4.011	5.466	2.254
Rh-103	6.455	4.168	6.388	21.757	17.222	1.414	10.446	11.566	10.470
Ag-109	129.042	156.077	154.440	51.493	150.337	127.089	241.796	93.014	121.443
Sample	TMI D1A2	TMI D1A4							
Avg BU (MWd/MTU)	-0.592	-1.248							
Isotope	Percent Difference								
U-234	-5.125	-1.490							
U-235	-22.925	-7.877							
U-236	3.194	2.975							
Pu-238	11.340	-6.536							
Pu-239	34.238	36.289							

Originator: *JW* Date: 4/19/02

Checker: *SM* Date: 4/19/02

Table 60. Assembly NJ05YU Sample Percent Differences from Cases Using Measured Burnups

Sample	TMI D1A2	TMI D1A4
Pu-240	15.390	11.196
Pu-241	5.978	2.550
Pu-242	9.005	-9.061
Nd-143	3.070	2.235
Nd-145	2.516	-0.797
Nd-148	0.454	0.012
Cs-137	19.863	0.130
Eu-151	17.590	16.632
Eu-153	10.711	6.187
Eu-155	-40.573	-59.992
Sm-147	0.408	6.481
Sm-149	21.117	29.731
Sm-150	11.696	9.509
Sm-151	10.367	15.740
Sm-152	37.019	33.757
Gd-155	-42.715	-63.701
Am-241	39.368	-15.675
Am-242m	-100.000	-100.000
Am-243	53.289	28.595
Np-237	16.865	9.100
Mo-95	7.729	1.011
Tc-99	9.054	-4.040
Ru-101	11.251	3.493
Rh-103	13.863	8.731
Ag-109	235.244	60.006

6.2 SAMPLE RESULTS FOR ASSEMBLY NJ070G

Tables 61 through 64 present the SAS2H calculated results for the samples from assembly NJ070G. Table 61 presents the SAS2H calculated results based on the core follow information from Reference 7.3. Table 62 presents the SAS2H calculated results using the sample-measured burnups to adjust the core follow information. Tables 63 and 64 show the results in terms of percent difference for the two methods compared with the RCA measured results.

Table 61. SAS2H Calculated Results for Assembly NJ070G Samples

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Avg BU (MWd/MTU)	2.75E+04	3.14E+04	3.09E+04	2.56E+04	2.93E+04	2.88E+04	2.53E+04	2.90E+04
Isotope	(g/g U-238)							
U-234	3.33E-04	3.18E-04	3.18E-04	3.41E-04	3.26E-04	3.26E-04	3.45E-04	3.26E-04
U-235	2.30E-02	2.07E-02	2.11E-02	2.43E-02	2.20E-02	2.25E-02	2.45E-02	2.22E-02
U-236	4.95E-03	5.40E-03	5.35E-03	4.71E-03	5.17E-03	5.11E-03	4.68E-03	5.14E-03
U-238	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Np-237	3.91E-04	4.83E-04	4.79E-04	3.53E-04	4.37E-04	4.33E-04	3.49E-04	4.33E-04
Pu-238	8.64E-05	1.24E-04	1.20E-04	6.99E-05	1.03E-04	1.03E-04	6.98E-05	1.03E-04
Pu-239	7.20E-03	7.84E-03	7.94E-03	7.00E-03	7.65E-03	7.74E-03	6.97E-03	7.63E-03
Pu-240	1.64E-03	1.95E-03	1.92E-03	1.51E-03	1.80E-03	1.78E-03	1.49E-03	1.79E-03
Pu-241	8.72E-04	1.05E-03	1.08E-03	7.85E-04	9.57E-04	9.81E-04	7.52E-04	9.44E-04
Pu-242	1.93E-04	2.77E-04	2.68E-04	1.60E-04	2.35E-04	2.23E-04	1.56E-04	2.27E-04
Am-241	1.85E-04	2.64E-04	2.31E-04	1.68E-04	2.43E-04	2.10E-04	1.89E-04	2.39E-04
Am-242m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243	2.88E-05	4.96E-05	4.96E-05	2.05E-05	3.71E-05	3.71E-05	2.05E-05	3.71E-05
Cm-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-244	4.12E-06	8.26E-06	8.26E-06	4.11E-06	8.25E-06	8.25E-06	4.11E-06	8.25E-06
Cm-245	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	2.43E-05	2.52E-05	3.06E-05	2.10E-05	2.23E-05	2.68E-05	1.68E-05	2.18E-05

Originator: *[Signature]* Date: 4/19/02

Checker: *[Signature]* Date: 4/19/02

Table 61. SAS2H Calculated Results for Assembly NJ070G Samples

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Cs-137	1.03E-03	1.16E-03	1.15E-03	9.54E-04	1.08E-03	1.07E-03	9.31E-04	1.07E-03
Nd-143	8.73E-04	9.65E-04	9.54E-04	8.26E-04	9.17E-04	9.05E-04	8.19E-04	9.11E-04
Nd-145	6.48E-04	7.24E-04	7.13E-04	6.08E-04	6.82E-04	6.70E-04	6.02E-04	6.77E-04
Nd-146	6.05E-04	6.98E-04	6.86E-04	5.60E-04	6.47E-04	6.35E-04	5.53E-04	6.41E-04
Nd-148	3.28E-04	3.75E-04	3.69E-04	3.05E-04	3.50E-04	3.43E-04	3.02E-04	3.47E-04
Nd-150	1.49E-04	1.73E-04	1.70E-04	1.38E-04	1.60E-04	1.57E-04	1.36E-04	1.59E-04
Sm-147	1.88E-04	2.15E-04	1.98E-04	1.80E-04	2.07E-04	1.91E-04	1.92E-04	2.07E-04
Sm-149	5.76E-06	6.20E-06	6.19E-06	5.75E-06	5.77E-06	6.18E-06	5.75E-06	5.77E-06
Sm-150	2.61E-04	3.07E-04	3.02E-04	2.40E-04	2.82E-04	2.77E-04	2.37E-04	2.79E-04
Sm-151	1.60E-05	1.73E-05	1.78E-05	1.56E-05	1.69E-05	1.73E-05	1.52E-05	1.69E-05
Sm-152	1.16E-04	1.30E-04	1.28E-04	1.08E-04	1.22E-04	1.20E-04	1.07E-04	1.21E-04
Eu-151	4.12E-07	4.13E-07	4.13E-07	4.11E-07	4.12E-07	4.12E-07	4.11E-07	4.12E-07
Eu-153	8.64E-05	1.05E-04	1.03E-04	7.77E-05	9.53E-05	9.32E-05	7.68E-05	9.40E-05
Gd-155	1.65E-06	2.07E-06	2.06E-06	1.23E-06	2.06E-06	1.65E-06	1.64E-06	2.06E-06

Table 62. SAS2H Calculated Results for Assembly NJ070G Samples Using Measured Burnups

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Avg BU (MWd/MTU)	2.57E+04	2.98E+04	2.61E+04	2.36E+04	2.62E+04	2.31E+04	2.25E+04	2.60E+04
Isotope	(g/g U-238)							
U-234	3.41E-04	3.22E-04	3.37E-04	3.53E-04	3.37E-04	3.49E-04	3.57E-04	3.37E-04
U-235	2.43E-02	2.17E-02	2.43E-02	2.59E-02	2.41E-02	2.65E-02	2.67E-02	2.43E-02
U-236	4.72E-03	5.23E-03	4.78E-03	4.44E-03	4.80E-03	4.39E-03	4.29E-03	4.77E-03
U-238	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Np-237	3.53E-04	4.50E-04	3.78E-04	3.12E-04	3.74E-04	3.16E-04	2.95E-04	3.70E-04
Pu-238	7.40E-05	1.07E-04	8.23E-05	5.74E-05	7.82E-05	6.16E-05	5.33E-05	7.81E-05
Pu-239	7.02E-03	7.71E-03	7.45E-03	6.77E-03	7.34E-03	7.06E-03	6.63E-03	7.32E-03
Pu-240	1.51E-03	1.84E-03	1.59E-03	1.36E-03	1.59E-03	1.37E-03	1.29E-03	1.58E-03
Pu-241	7.89E-04	9.82E-04	8.52E-04	6.93E-04	8.19E-04	7.10E-04	6.27E-04	8.10E-04
Pu-242	1.60E-04	2.43E-04	1.73E-04	1.27E-04	1.77E-04	1.27E-04	1.15E-04	1.73E-04
Am-241	1.68E-04	2.48E-04	1.85E-04	1.48E-04	2.10E-04	1.52E-04	1.56E-04	2.06E-04
Am-242m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243	2.47E-05	4.13E-05	2.47E-05	1.64E-05	2.47E-05	1.64E-05	1.23E-05	2.47E-05
Cm-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-244	4.11E-06	8.25E-06	4.11E-06	4.10E-06	4.11E-06	4.10E-06	0.00E+00	4.11E-06
Cm-245	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	2.14E-05	2.31E-05	2.22E-05	1.81E-05	1.77E-05	1.76E-05	1.31E-05	1.77E-05
Cs-137	9.58E-04	1.10E-03	9.71E-04	8.77E-04	9.62E-04	8.57E-04	8.26E-04	9.55E-04
Nd-143	8.28E-04	9.30E-04	8.38E-04	7.73E-04	8.42E-04	7.60E-04	7.45E-04	8.37E-04
Nd-145	6.10E-04	6.93E-04	6.15E-04	5.64E-04	6.19E-04	5.51E-04	5.42E-04	6.15E-04
Nd-146	5.62E-04	6.60E-04	5.71E-04	5.12E-04	5.74E-04	5.01E-04	4.88E-04	5.70E-04
Nd-148	3.06E-04	3.56E-04	3.11E-04	2.80E-04	3.13E-04	2.75E-04	2.68E-04	3.10E-04
Nd-150	1.38E-04	1.63E-04	1.42E-04	1.26E-04	1.42E-04	1.24E-04	1.20E-04	1.41E-04
Sm-147	1.80E-04	2.10E-04	1.81E-04	1.71E-04	1.95E-04	1.68E-04	1.78E-04	1.95E-04
Sm-149	5.75E-06	5.78E-06	5.76E-06	5.33E-06	5.76E-06	5.34E-06	5.33E-06	5.76E-06
Sm-150	2.41E-04	2.89E-04	2.46E-04	2.17E-04	2.47E-04	2.12E-04	2.05E-04	2.45E-04
Sm-151	1.56E-05	1.69E-05	1.65E-05	1.52E-05	1.60E-05	1.60E-05	1.48E-05	1.60E-05
Sm-152	1.08E-04	1.24E-04	1.09E-04	9.93E-05	1.10E-04	9.69E-05	9.51E-05	1.09E-04
Eu-151	4.11E-07	4.13E-07	4.11E-07	4.10E-07	4.11E-07	4.10E-07	4.10E-07	4.11E-07
Eu-153	7.81E-05	9.78E-05	8.06E-05	6.89E-05	8.10E-05	6.77E-05	6.44E-05	8.02E-05
Gd-155	1.23E-06	2.06E-06	1.23E-06	1.23E-06	1.65E-06	1.23E-06	1.23E-06	1.65E-06

Originator: *ms* Date: 4/19/02

Checker: *gm* Date: 4/19/02

Table 63. Assembly NJ070G Sample Percent Differences

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Avg BU (MWd/MTU)	6.589	4.950	15.543	7.975	10.453	19.833	11.096	10.342
Isotope	Percent Difference							
U-234	-4.214	3.18E-04	-5.076	-3.924	-2.471	-6.408	-5.448	-4.210
U-235	-2.232	2.07E-02	-8.984	-3.015	-5.410	-11.837	-3.020	-5.110
U-236	2.413	5.40E-03	7.176	2.732	4.799	9.236	4.131	5.046
U-238	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Np-237	20.663	4.83E-04	23.151	9.411	17.494	23.684	16.021	16.678
Pu-238	12.673	1.24E-04	19.764	4.577	9.665	24.330	8.962	10.942
Pu-239	23.954	7.84E-03	23.252	20.936	19.392	17.250	20.834	21.512
Pu-240	1.103	1.95E-03	5.163	1.899	2.382	10.624	1.868	3.184
Pu-241	8.512	1.05E-03	25.920	6.931	6.647	14.898	6.798	7.404
Pu-242	0.738	2.77E-04	13.744	1.431	6.833	26.495	1.379	4.974
Am-241	51.792	2.64E-04	26.376	4.000	9.586	43.036	9.243	10.700
Am-242m	-100.000	0.00E+00	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Am-243	80.043	4.96E-05	80.867	14.146	25.373	110.825	20.131	30.188
Cm-242 <sup>a</sup>	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Cm-243	-100.000	0.00E+00	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Cm-244	54.709	8.26E-06	55.255	42.189	49.669	156.074	56.813	57.652
Cm-245	-100.000	0.00E+00	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Cs-134	-3.267	2.52E-05	5.381	-5.598	-1.911	9.829	-4.291	-3.745
Cs-137	5.742	1.16E-03	11.985	5.434	7.662	16.947	4.325	5.678
Nd-143	9.844	9.65E-04	15.265	9.927	12.332	18.194	10.558	12.291
Nd-145	7.957	7.24E-04	14.783	8.723	11.622	18.859	9.311	11.337
Nd-146	8.729	6.98E-04	16.788	9.313	12.319	20.784	9.804	12.074
Nd-148	7.536	3.75E-04	14.888	8.508	11.358	19.246	8.868	11.125
Nd-150	7.951	1.73E-04	15.747	9.255	12.168	20.222	9.122	11.775
Sm-147	-1.751	2.15E-04	1.968	-0.560	3.187	6.640	3.154	3.790
Sm-149	33.365	6.20E-06	31.243	33.171	30.017	30.744	35.979	30.580
Sm-150	13.617	3.07E-04	-87.778	13.541	17.029	27.674	14.878	17.269
Sm-151	18.011	1.73E-05	16.066	13.154	11.960	9.593	12.603	11.938
Sm-152	25.286	1.30E-04	33.764	24.899	31.664	42.165	26.117	31.439
Eu-151	-0.837	4.13E-07	-10.417	-4.213	-17.861	-15.689	-8.292	-17.383
Eu-153	7.355	1.05E-04	16.854	5.380	10.116	21.164	7.754	9.170
Gd-155	-33.085	2.07E-06	-26.777	-39.272	-23.071	-29.222	-21.743	-23.655

NOTE: <sup>a</sup> Cm-242 SAS2H calculated concentration was 0.00 g, therefore using either the alpha spectrometer or mass spectrometer measured value will yield a -100.000 percent difference

Table 64. Assembly NJ070G Sample Percent Differences from Cases Using Measured Burnups

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Avg BU (MWd/MTU)	-0.426	-0.268	-2.397	-0.633	-1.094	-3.958	-1.228	-1.065
Isotope	Percent Difference							
U-234	-1.982	-0.992	0.703	-0.600	0.991	0.253	-2.273	-0.806
U-235	3.301	5.729	4.927	3.085	3.632	4.076	5.402	3.773
U-236	-2.321	-2.120	-4.114	-3.156	-2.711	-6.246	-4.393	-2.433
U-238	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Np-237	9.084	6.303	-2.700	-3.456	0.626	-9.702	-1.926	-0.225
Pu-238	-3.554	-7.536	-17.718	-14.006	-16.854	-25.733	-16.848	-15.882
Pu-239	20.743	28.865	15.693	16.857	14.485	7.027	14.972	16.512
Pu-240	-6.645	-7.076	-13.222	-7.957	-9.783	-14.851	-11.540	-8.945
Pu-241	-1.859	0.289	-0.512	-5.528	-8.741	-16.853	-10.894	-7.821
Pu-242	-16.522	-19.936	-26.783	-19.496	-19.599	-27.705	-25.454	-20.026
Am-241	38.112	16.755	1.166	-8.820	-5.500	3.310	-9.941	-4.793
Am-242m	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Am-243	54.112	10.009	-9.910	-8.820	-16.618	-6.717	-28.069	-13.412
Cm-242 <sup>a</sup>	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Cm-243	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Cm-244	54.499	7.430	-22.667	41.976	-25.345	27.468	-100.000	-21.359

Originator: *JWD* Date: *4/19/02*

Checker: *RM* Date: *4/19/02*

Table 64. Assembly NJ070G Sample Percent Differences from Cases Using Measured Burnups

Sample	O1 S1	O1 S2	O1 S3	O12 S4	O12 S5	O12 S6	O13 S7	O13 S8
Cm-245	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000	-100.000
Cs-134	-14.860	-16.298	-23.393	-18.677	-22.079	-27.667	-25.454	-22.090
Cs-137	-1.343	-6.175	-5.775	-3.112	-3.785	-6.643	-7.427	-5.443
Nd-143	4.163	4.243	1.262	2.933	3.191	-0.764	0.592	3.204
Nd-145	1.646	0.881	-1.023	0.926	1.256	-2.337	-1.703	1.132
Nd-146	1.042	0.375	-2.720	0.014	-0.304	-4.723	-3.112	-0.412
Nd-148	0.384	-0.439	-3.236	-0.269	-0.437	-4.657	-3.346	-0.604
Nd-150	0.359	-0.388	-3.725	-0.027	-0.758	-5.378	-3.895	-0.652
Sm-147	-5.542	-4.742	-6.903	-5.470	-2.790	-6.216	-4.112	-2.240
Sm-149	33.183	32.465	22.028	23.474	29.705	12.808	26.006	30.274
Sm-150	4.707	3.875	-90.040	2.675	2.411	-2.212	-0.285	2.824
Sm-151	14.829	15.060	7.558	10.011	6.243	1.313	9.334	6.228
Sm-152	17.101	16.049	14.280	15.192	18.480	15.179	12.303	18.600
Eu-151	-0.972	-12.968	-10.757	-4.356	-18.057	-16.064	-8.481	-17.576
Eu-153	-3.002	-3.198	-8.368	-6.469	-6.316	-11.933	-9.719	-6.850
Gd-155	-49.882	-33.247	-56.233	-39.363	-38.604	-47.153	-41.428	-39.068

NOTE: <sup>a</sup> Cm-242 SAS2H calculated concentration was 0.00 g, therefore using either the alpha spectrometer or mass spectrometer measured value will yield a -100.000 percent difference

6.3 MCNP CALCULATION RESULTS

Table 65 presents the MCNP results for each of the samples. The results are presented graphically in Figures 4 and 5 for assemblies NJ05YU and NJ070G, respectively. In Figures 4 and 5 the legend corresponds as follows:

MBU Op. Hist. – results based on SAS2H isotopics generated from operating history information adjusted to sample measured burnups

RCA – results based on sample measured materials

Op. Hist. – results based on SAS2H isotopics generated from operating history information

Table 65. MCNP Results for Spent Nuclear Fuel Samples

Sample	RCA <sup>a</sup>		Operating History <sup>b</sup>		RCA Burnup with Adjusted Operating History <sup>c</sup>		Delta (Operating History - RCA) <sup>d</sup>	
	k	σ	k	σ	k	σ	k	σ <sup>e</sup>
TMI A2	0.7466	0.0006	0.7815	0.0006	0.7917	0.0006	0.0349	0.0008
TMI B2	0.7450	0.0006	0.7845	0.0007	0.7980	0.0006	0.0395	0.0009
TMI C1	0.7557	0.0006	0.7937	0.0007	0.8027	0.0006	0.0380	0.0009
TMI C3	0.7578	0.0006	0.7885	0.0007	0.7925	0.0007	0.0307	0.0009
TMI D2	0.7738	0.0005	0.8130	0.0007	0.8320	0.0006	0.0392	0.0008
TMI A1B	0.7713	0.0006	0.8017	0.0007	0.8087	0.0006	0.0305	0.0009
TMI B1B	0.7346	0.0005	0.7791	0.0007	0.7702	0.0006	0.0444	0.0008
TMI B3J	0.7222	0.0006	0.7789	0.0007	0.7697	0.0006	0.0567	0.0009
TMI C2B	0.7260	0.0006	0.7817	0.0006	0.7787	0.0006	0.0557	0.0008
TMI D1A2	0.7534	0.0006	0.7863	0.0007	0.7706	0.0005	0.0329	0.0009
TMI D1A4	0.7514	0.0005	0.7925	0.0006	0.7945	0.0006	0.0412	0.0008
O1 S1	0.9717	0.0007	0.9786	0.0007	0.9896	0.0007	0.0069	0.0010
O1 S2	0.9407	0.0007	0.9613	0.0007	0.9702	0.0007	0.0206	0.0010
O1 S3	0.9622	0.0008	0.9674	0.0007	0.9922	0.0007	0.0052	0.0011
O12 S4	0.9847	0.0007	0.9901	0.0007	1.0020	0.0008	0.0055	0.0010
O12 S5	0.9732	0.0007	0.9727	0.0007	0.9891	0.0007	-0.0006	0.0010
O12 S6	0.9964	0.0007	0.9804	0.0007	1.0082	0.0008	-0.0160	0.0010

Originator: *AWA* Date: *4/19/02*

Checker: *[Signature]* Date: *4/19/02*



Table 65. MCNP Results for Spent Nuclear Fuel Samples

Sample	RCA <sup>a</sup>		Operating History <sup>b</sup>		RCA Burnup with Adjusted Operating History <sup>c</sup>		Delta (Operating History - RCA) <sup>d</sup>	
	k	$\sigma$	k	$\sigma$	k	$\sigma$	k	$\sigma^e$
O13 S7	0.9879	0.0008	0.9909	0.0007	1.0093	0.0007	0.0030	0.0010
O13 S8	0.9720	0.0008	0.9737	0.0007	0.9903	0.0007	0.0017	0.0010

- NOTES: <sup>a</sup> Results based on measured sample material composition  
<sup>b</sup> Results based on SAS2H calculated materials from reactor operating history information  
<sup>c</sup> Results based on adjusting reactor operating history information to yield the sample measured burnup  
<sup>d</sup> Values reported were calculated from MCNP reported values which lists results out to six significant digits, therefore computing delta values from table values will introduce some roundoff error.  
<sup>e</sup> Delta  $\sigma$  value equals the square root of the sum of the squares

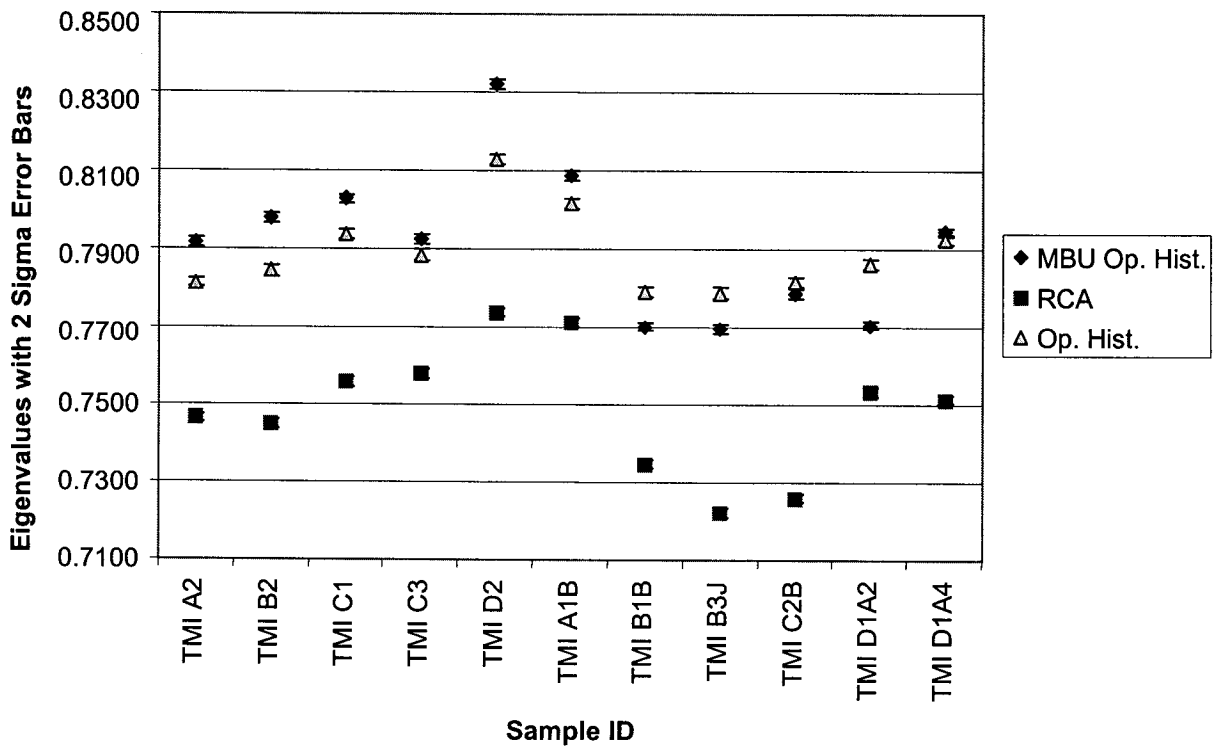


Figure 4. MCNP Results for Assembly NJ05YU

Originator: AW Date: 4/19/02

Checker: [Signature] Date: 4/19/02

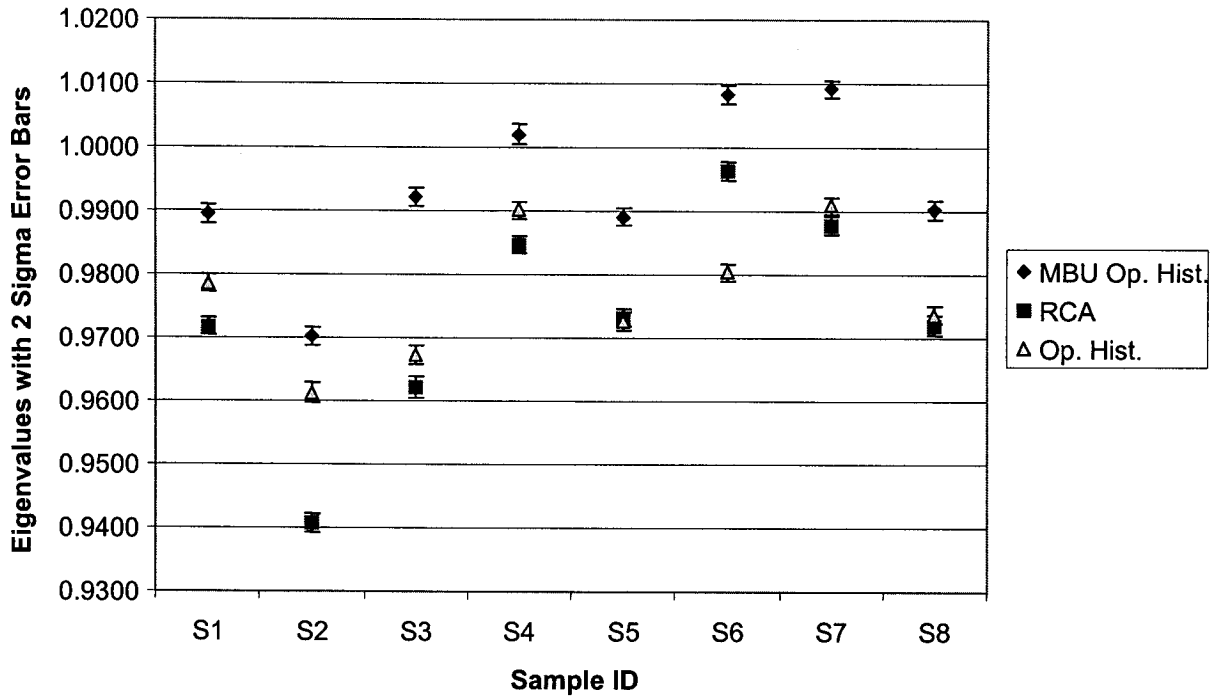


Figure 5. MCNP Results for Assembly NJ070G

Originator: DM Date: 4/19/02

Checker: RM Date: 4/19/02

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- 7.6 CRWMS M&O 1997. *Waste Container Cavity Size Determination*. BBAA00000-01717-0200-00026 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980106.0061.
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Originator: hru Date: 4/19/02Checker: [Signature] Date: 4/19/02

**Title:** Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations

**Document Identifier:** CAL-UDC-NU-000011 REV A

Page 60 of 61

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- 7.15 Parrington, J.R.; Knox, H.D.; Breneman, S.L.; Baum, E.M.; and Feiner, F. 1996. *Nuclides and Isotopes, Chart of the Nuclides*. 15th Edition. San Jose, California: General Electric Company and KAPL, Inc. TIC: 233705.
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Originator: gms Date: 4/19/02

Checker: gms Date: 4/19/02

**8. ATTACHMENTS**

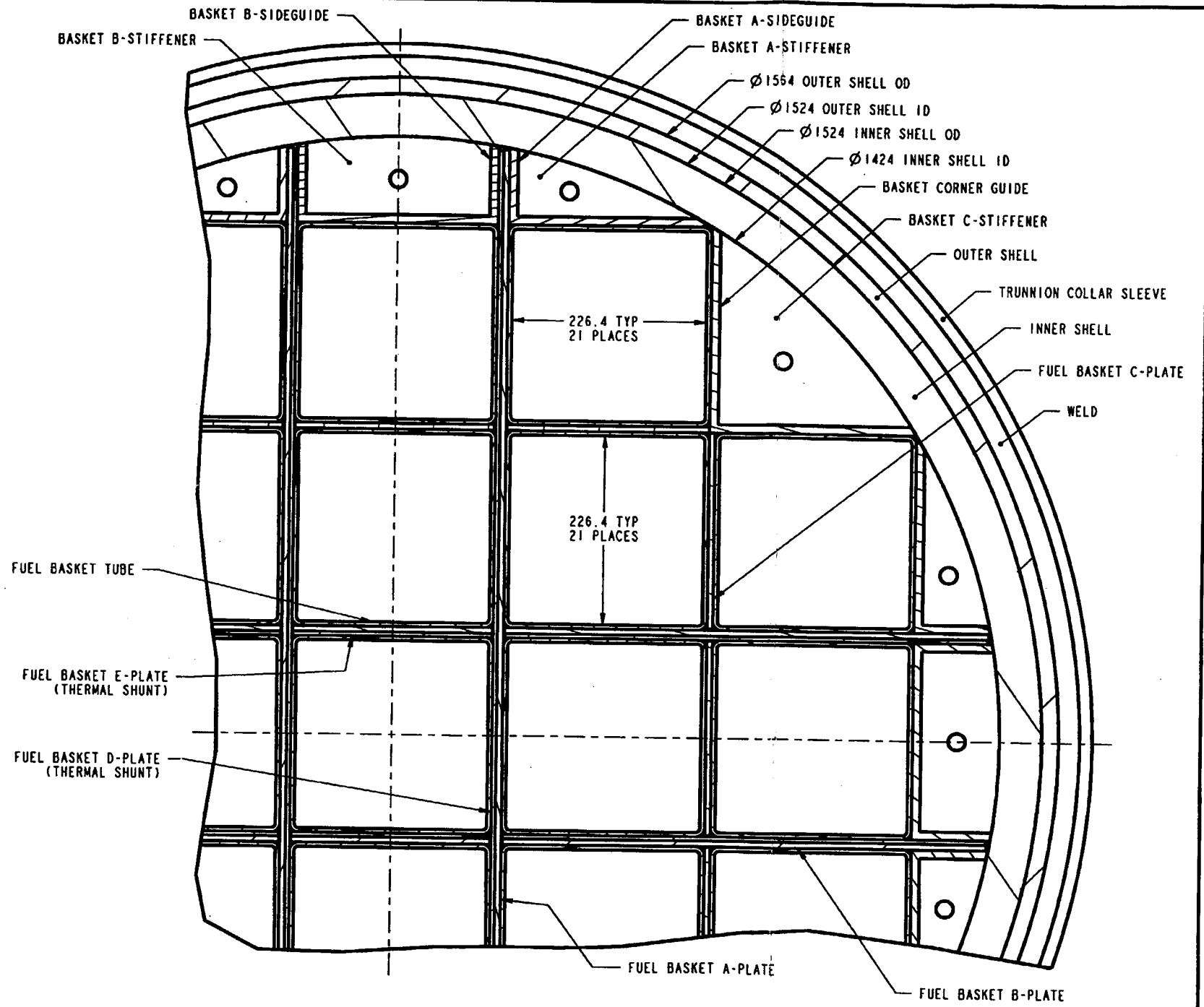
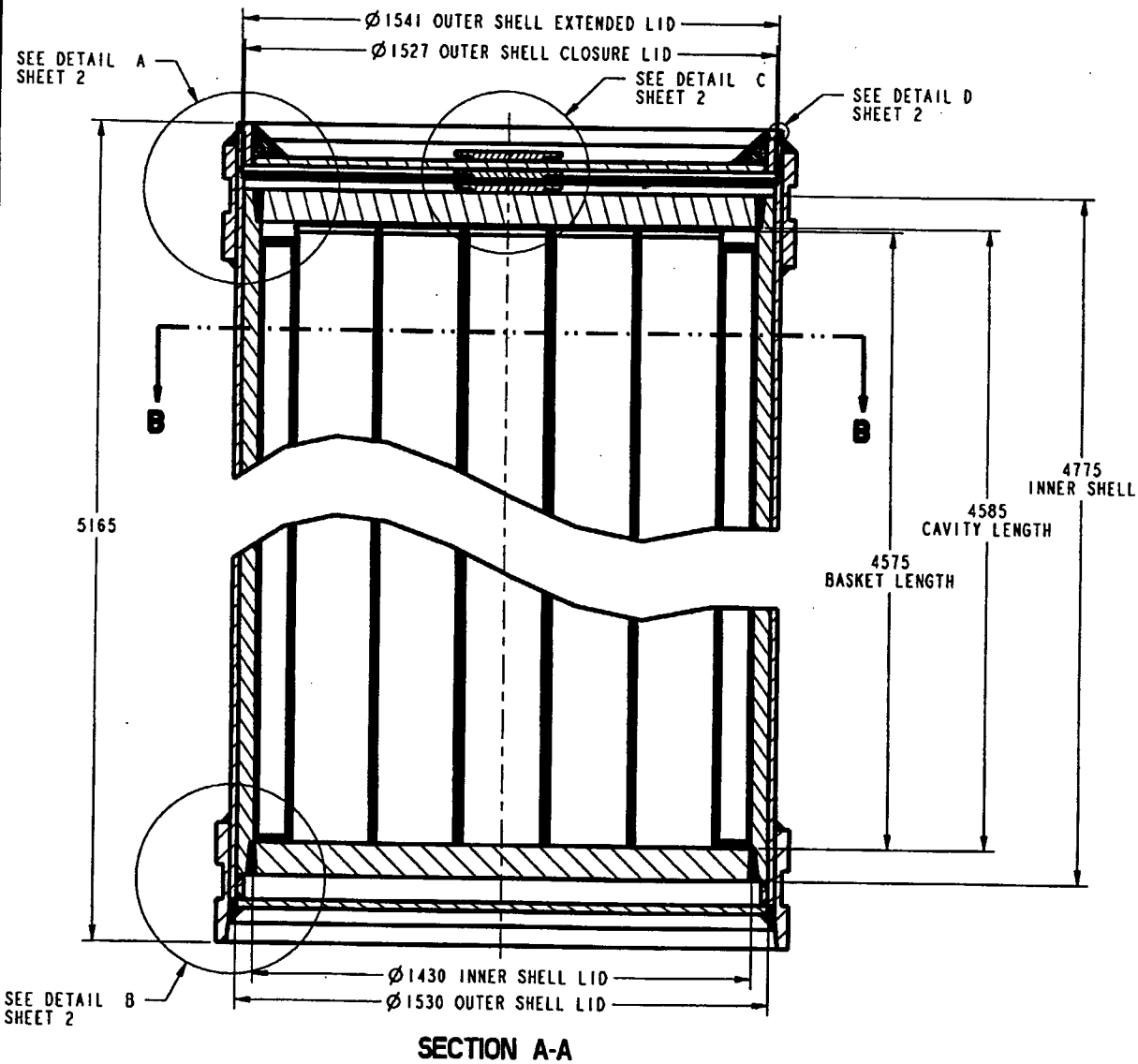
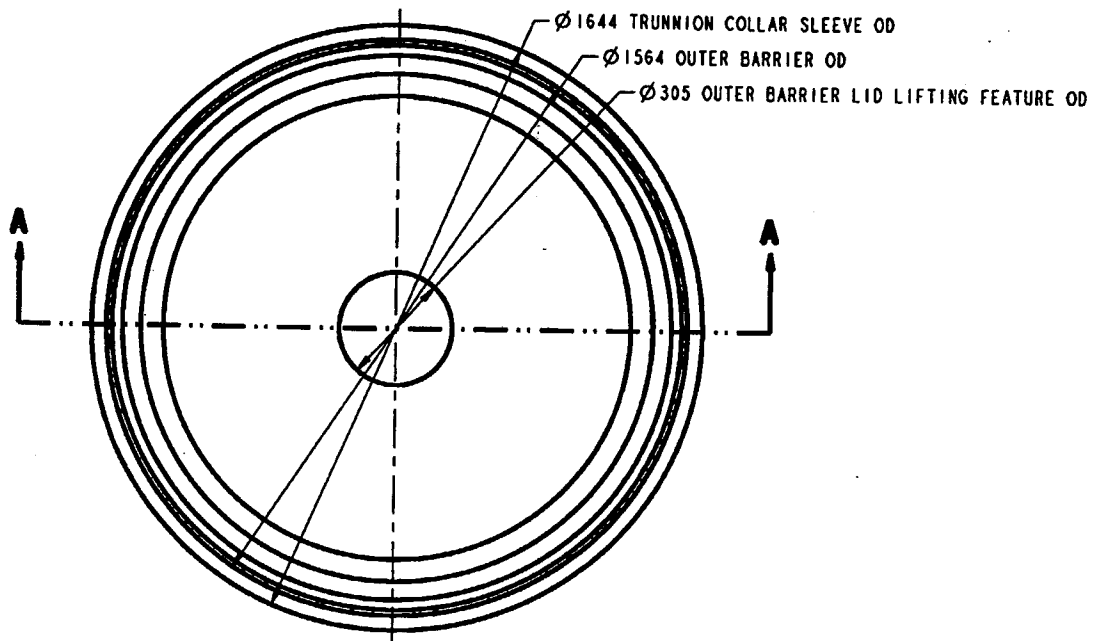
Table 66 presents the attachment specifications for this calculation file. The contents of Attachment II are provided electronically on an attachment CD to this calculation file. A listing of the contents of the CD is provided in hard-copy form for Attachment II in the attachments to this calculation file.

Table 66. Attachment Listing

<b>Attachment #</b>	<b># of Pages</b>	<b>Description</b>
I	2	21-PWR Waste Package Configurations for Site Recommendation Sketch
II	2	SAS2H input files, SAS2H outputs, MCNP inputs, and MCNP outputs
III	N/A	Compact Disc attachment containing information listed in Attachment II

Originator: *MWS* Date: 4/19/02

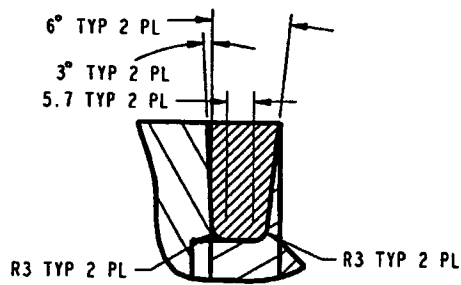
Checker: *Phu* Date: 4/19/02



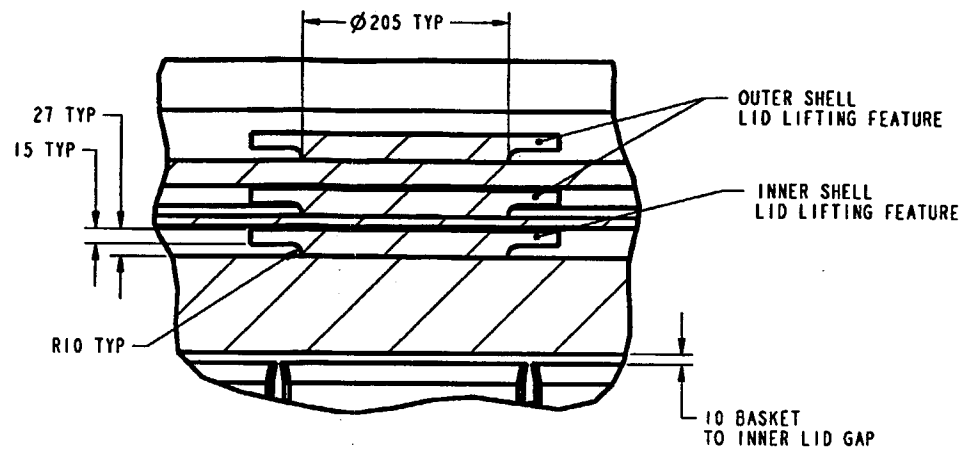
"FOR INFORMATION ONLY"

21-PWR WASTE PACKAGE CONFIGURATIONS FOR SITE RECOMMENDATION	
SKETCH NUMBER:	SK-0175 REV 02
SKETCHED BY:	BRYAN HARKINS <i>BH</i>
DATE:	01/26/00 <i>26 Jan 00 Joe</i>
FILE:	<i>100,00</i> /home/pro-library/checkout/sketches/21pwr/sk-0175.dwg

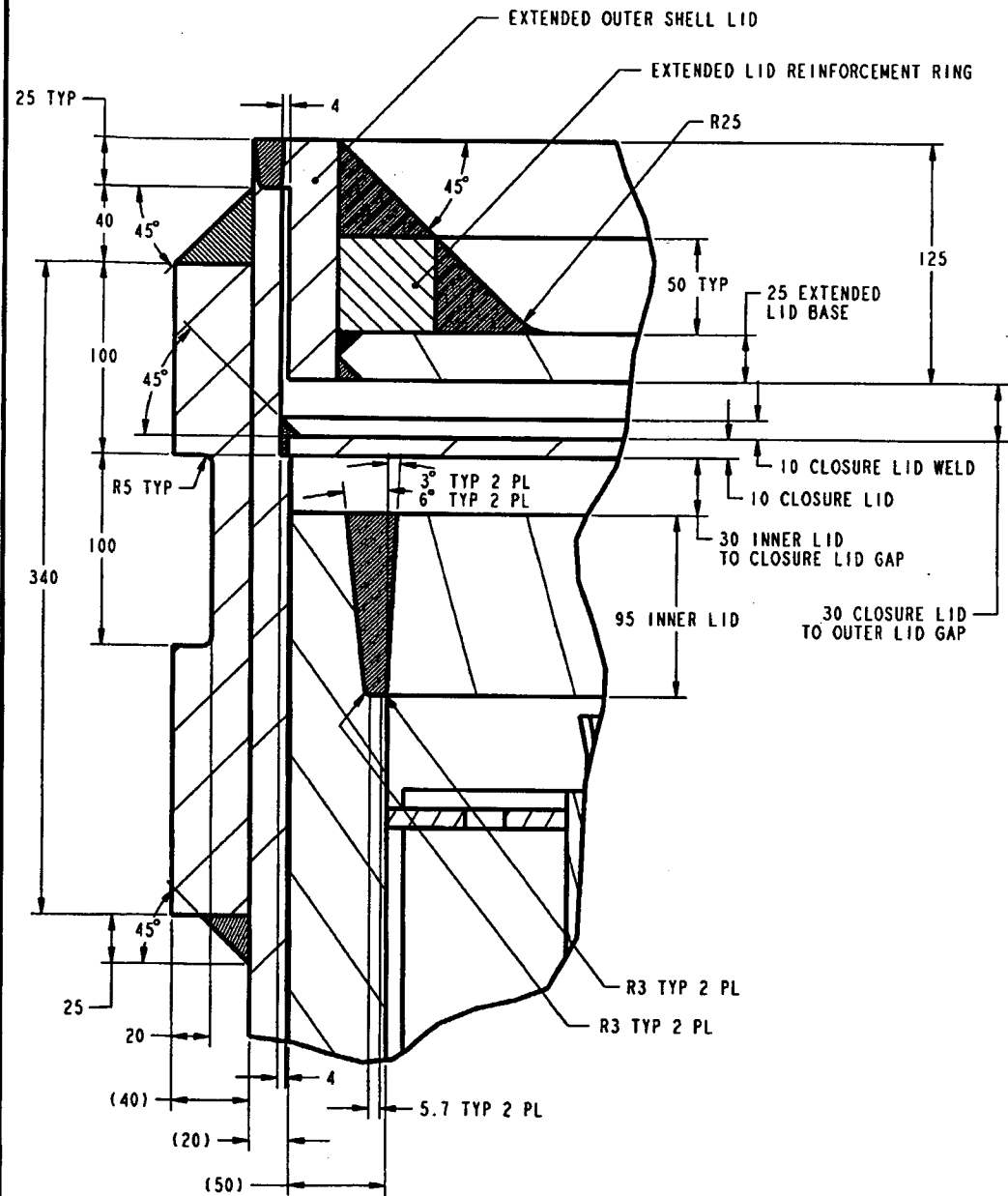
UNITS: mm  
DO NOT SCALE FROM SKETCH



DETAIL D



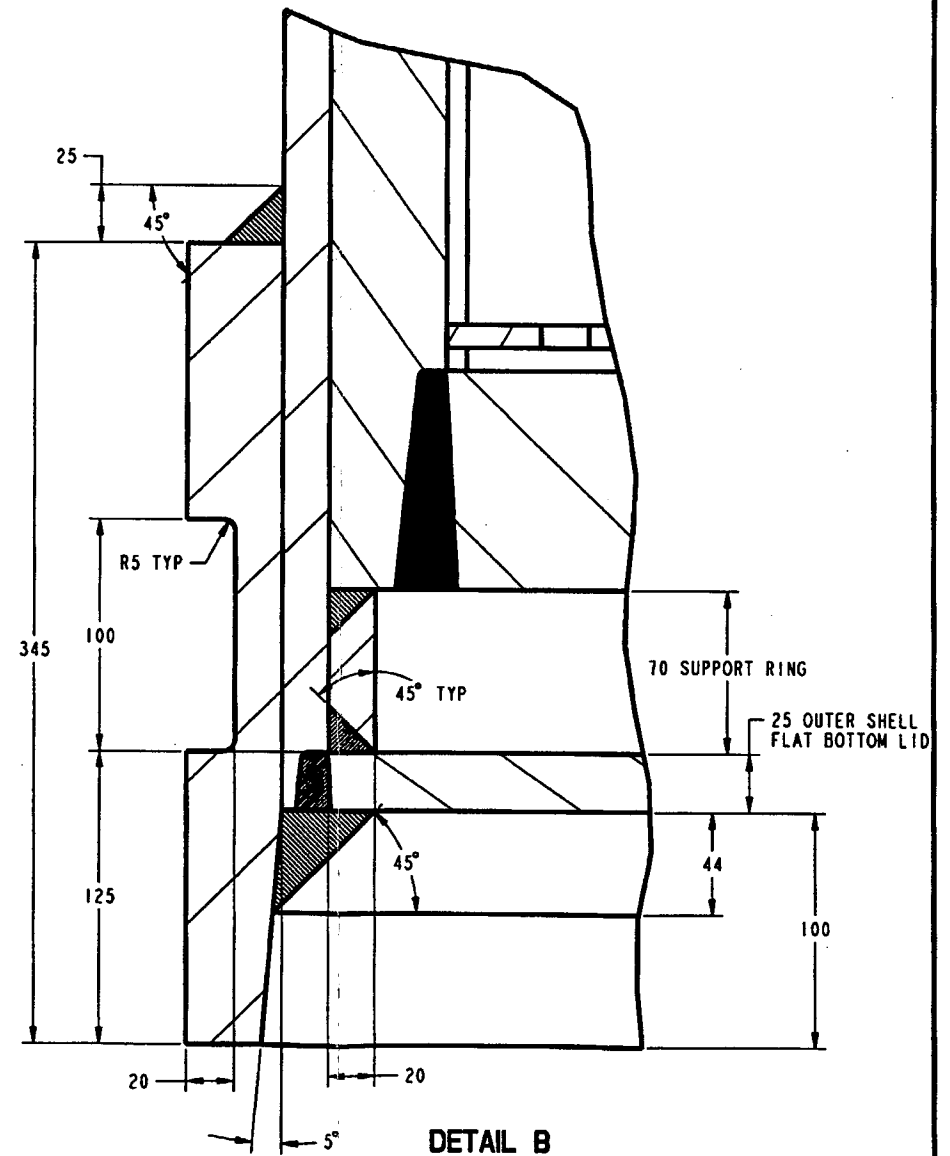
DETAIL C



DETAIL A

21-PWR WASTE PACKAGE ASSEMBLY WITH STAINLESS STEEL/BORON PLATES  
 # 21-PWR CONTROL ROD WASTE PACKAGE ASSEMBLY WITH CARBON STEEL PLATES

COMPONENT NAME	MATERIAL	THICKNESS	MASS (KG)	QTY	ROD
BASKET A-SIDEGUIDE	SA-516 K02700	10	27	32	
BASKET A-STIFFENER	SA-516 K02700	10	0.72	64	
BASKET B-SIDEGUIDE	SA-516 K02700	10	36	16	
BASKET B-STIFFENER	SA-516 K02700	10	1.5	32	
BASKET C-STIFFENER	SA-516 K02700	10	2.3	32	
BASKET CORNERGUIDE	SA-516 K02700	10	42	16	
FUEL BASKET A-PLATE	NEUTRONIT A 978	7	85	8	
	#SA-516 K02700	#7	#86	#8	
FUEL BASKET B-PLATE	NEUTRONIT A 978	7	85	8	
	#SA-516 K02700	#7	#86	#8	
FUEL BASKET C-PLATE	NEUTRONIT A 978	7	44	16	
	#SA-516 K02700	#7	#45	#16	
FUEL BASKET D-PLATE	SB-209 A96061 T4	5	21	8	
FUEL BASKET E-PLATE	SB-209 A96061 T4	5	21	8	
FUEL BASKET TUBE	SA-516 K02700	5	164	21	
INNER SHELL	SA-240 S31600	50	8709	1	
INNER SHELL LID	SA-240 S31600	95	1200	2	
INNER LID LIFTING FEATURE	SA-240 S31600	27	12	1	
OUTER SHELL	SB-575 N06022	20	4193	1	
EXTENDED OUTER SHELL LID	SB-575 N06022	25	132	1	
EXTENDED OUTER SHELL LID BASE	SB-575 N06022	25	366	1	
OUTER LID LIFTING FEATURE	SB-575 N06022	27	13	2	
EXTENDED LID REINFORCEMENT RING	SB-575 N06022	50	97	1	
OUTER SHELL FLAT CLOSURE LID	SB-575 N06022	10	159	1	
OUTER SHELL FLAT BOTTOM LID	SB-575 N0-6022	25	396	1	
UPPER TRUNNION COLLAR SLEEVE	SB-575 N06022	40	507	1	
LOWER TRUNNION COLLAR SLEEVE	SB-575 N06022	40	497	1	
INNER SHELL SUPPORT RING	SB-575 N06022	20	41	1	
TOTAL ALLOY 22 WELDS	SFA-5.14 N06022	-	249	**	
TOTAL 316 WELDS	SFA-5.9 S31680	-	128	**	
WASTE PACKAGE ASSEMBLY	-	-	26035	1	
	-	-	#26059	#1	
PWR FUEL ASSEMBLY	-	-	773.4*	21	
WP ASSEMBLY WITH SNF	-	-	42277	1	
	-	-	#42301	#1	



DETAIL B

\* CRWMS M&O 1997. WASTE CONTAINER CAVITY SIZE DETERMINATION. BBAA0000-01717-0200-00026 REV 00. LAS VEGAS, NV: CRWMS M&O. ACC: MOL.19980106.0061

\*\* REFER TO SK-0191 REV 00 "21-PWR WASTE PACKAGE WELD CONFIGURATION"

**ATTACHMENT II**

This attachment contains a listing and description of the zip file contained on the attachment CD of this calculation. The CD was written using the Hewlett Packard (HP) CD-Writer Plus model 7200e external CD-rewritable drive for personal computers, and the zip archive was created using WINZIP 7.0. The zip file attributes on the CD are as follows:

<u>Archive Filename</u>	<u>File Size (bytes)</u>	<u>File Date</u>	<u>File Time</u>
Att.zip	10,188,494	04-19-02	2:07p

There are 304 total files contained in a unique directory structure. Upon file extraction, the file naming system corresponds as follows for the SAS2H cases, and as listed in Table II-1 for the MCNP cases.

- *N\*.inp* files are the SAS2H input files
- *N\*.msgs* files contain the standard run-time messages associated with the SAS2H calculations (these are generated by SAS2H).
- *ft72f001.N\** files are temporary ASCII files generated by SAS2H, which must be retained, that contain the isotopic concentrations as a function of time (the actual SAS2H output file contains a large amount of information that is not needed for this calculation, therefore it is discarded, but the temporary files SAS2H creates are retained).
- *act\_N\*.mass* files contain the extracted actinide isotopes from the *ft72f001.N\** files and provides them in units of grams
- *fp\_N\*.mass files* contain the extracted fission product isotopes from the *ft72f001.N\** files and provides them in units of grams

Table II-1. Sample and MCNP Filename Identification

File Name	Sample ID	File Name	Sample ID	File Name	Sample ID	File Name	Sample ID
Yu1	TMI A2	Yu6	TMI A1B	Yu11	TMI D1A4	S5	O12 S5
Yu2	TMI B2	Yu7	TMI B1B	S1	O1 S1	S6	O12 S6
Yu3	TMI C1	Yu8	TMI B3J	S2	O1 S2	S7	O13 S7
Yu4	TMI C3	Yu9	TMI C2B	S3	O1 S3	S8	O13 S8
Yu5	TMI D2	Yu10	TMI D1A2	S4	O12 S4		

NOTE: Output files have an "O" at the end of the file name

The following extracted directory structure corresponds as follows:

- /5yu/: contains the SAS2H inputs and outputs for samples from assembly NJ05YU, with subdirectories identifying each sample. Subdirectory name c3\_b1b is for samples c3 and b1b.
- /70g/: contains the SAS2H inputs and outputs for samples from assembly NJ070G, with subdirectories identifying each sample
- /Mcnp/: contains the MCNP input and output files. The subdirectory structure used corresponds as follows:

Originator: AW Date: 4/19/02

Checker: AW Date: 4/19/02



Title: Three Mile Island Unit 1 Radiochemical Assay Comparisons to SAS2H Calculations

Document Identifier: CAL-UDC-NU-000011 REV A

Attachment II, Page II-2 of 2

- 5yuc – Cases for samples from assembly NJ05YU using operating history information SAS2H generated isotopics
- 5yum – Cases for samples from assembly NJ05YU radiochemical assay measured isotopics
- 5yumbu – Cases for samples from assembly NJ05YU using operating history information adjusted to sample measured burnup SAS2H generated isotopics
- 70g – Cases for samples from assembly NJ070G using operating history information SAS2H generated isotopics
- 70gm – Cases for samples from assembly NJ070G radiochemical assay measured isotopics
- 70gmbu – Cases for samples from assembly NJ070G using operating history information adjusted to sample measured burnup SAS2H generated isotopics

/Meas\_BU/: contains SAS2H inputs and outputs using operating history information adjusted to the sample measured burnup, with the same subdirectory structures as /5yu/ and /70g/ described previously

Originator: DMU Date: 4/19/02

Checker: JMA Date: 4/19/02

## OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

1. QA: QA

## SPECIAL INSTRUCTION SHEET

Page: 1 of: 1

Complete Only Applicable Items

file list  
05-6-02  
nfc

This is a placeholder page for records that cannot be scanned.

2. Record Date  
04/19/2002

3. Accession Number

ATT TO: MDL. 20020501. 04/16

4. Author Name(s)  
SCAGLIONE JOHN M5. Author Organization  
N/A

6. Title/Description

THREE MILE ISLAND UNIT 1 RADIOCHEMICAL ASSAY COMPARISONS TO SAS2H CALCULATIONS

7. Document Number(s)  
CAL-UDC-NU-0000118. Version Designator  
REV. A9. Document Type  
DATA10. Medium  
CD-ROM11. Access Control Code  
PUB12. Traceability Designator  
DC# 31532

13. Comments

THIS IS A SPECIAL PROCESS CD-ROM AS PART OF ATTACHMENT III AND CAN BE LOCATED THROUGH THE RPC.

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