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Design Analysis Cover Sheet

Complete only applicable items.

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11. REMARKS

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Table of Contents:

1. Purpose

The purpose of this design analysis is to determine the accuracy of the SAS2H module of SCALE 4.3 in predicting isotopic concentrations of spent fuel assemblies. The objective is to develop a methodology for modeling assemblies similar to those evaluated within this analysis and to establish the consistency of SAS2H predictions. The results of this analysis may then be applied to future depletion calculations using SAS2H in which no measurements are available.

2. Quality Assurance

The Quality Assurance (QA) program applies to this analysis. The work reported in this document is part of the Waste Package Design analysis that will eventually support the License Application Design phase. This activity, when appropriately confirmed, can impact the proper functioning of the Mined Geologic Disposal System (MGDS) waste package; the waste package has been identified as an MGDS Q-List item important to safety and waste isolation (pp. 4, 15, Reference 5.1). The waste package is on the Q-List by direct inclusion by the Department of Energy (DOE), without conducting a QAP-2-3 evaluation. The Waste Package Development Department (WPDD) responsible manager has evaluated this activity in accordance with QAP-2-0, *Conduct of Activities*. The *Perform Criticality, Thermal, Structural, and Shielding Analyses* (Reference 5.2) evaluation has determined the preparation and review of this design analysis is subject to *Quality Assurance Requirements and Description* (Reference 5.3) requirements. As specified in NLP-3-18, this activity is subject to QA controls.

The analysis described in this document supports development of the disposal criticality analysis methodology. No designs were analyzed in this document. This document will not directly support any construction, fabrication, or procurement activity and therefore is not required to be procedurally controlled as TBV (to be verified). The calculation design inputs or information used in this document come from data accepted by the Nuclear Regulatory Commission and by the scientific and engineering community as established fact. The specific references are listed in Section 5 and identified in Section 7. The information is therefore not treated as unqualified data.

3. Method

The analytical model employed for this analysis was the SAS2H module of the SCALE sequence. Based upon fuel design, power history, and operating data for specific assemblies in the Cooper boiling water reactor (BWR), a computational model was developed for use with the SAS2H module of SCALE. The SAS2H module is used to perform a fuel depletion analysis to predict the isotopic concentrations in localized areas of assembly pins (pellet samples) subsequent to irradiation and cooling time. 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 model. The measured isotopic concentrations used for comparisons in the analysis are obtained from a separate report (Reference 5.6).

4. Design Inputs

The sources for the design parameters are References 5.4 through 5.9. References 5.4 and 5.5 provide information on molar masses and half-lives; the assembly design, power history and operating parameters are obtained from References 5.6 and 5.7; the cladding composition from Reference 5.8; and a list of trace elements in the fuel is derived from Reference 5.9.

4.1 Design Parameters

The half-lives of selected isotopes and molar masses of selected elements are obtained from Reference 5.4, while molar masses for selected isotopes are obtained from Reference 5.5. The half-life and molar masses are provided below within three significant figures. Precision beyond three significant figures is not necessary since the calculated isotopic concentrations from SCALE are only to three significant figures. Also, the weight per mole of enriched uranium is approximated by the weight per mole of natural uranium since the weight percent of enrichment is small.

Mole of natural uranium = 238 g,
Half-Life of $^{99}Tc = 2.13 \times 10^{5}$ years,
Half-Life of $^{237}Np = 2.14 \times 10^{6}$ years,
Half-Life of $^{241}Am = 432.7$ years,
6.02×10^{23} atoms per mole. (Reference 5.4)
Mole of $^{99}Tc = 98.9$ g,
Mole of $^{237}Np = 237$ g,
Mole of $^{241}Am = 241$ g. (Reference 5.5)

General spent fuel characteristics for each test sample are presented in Table 4-1 and include the initial ^{235}U enrichment, final burnup and the cooling time (p. 4.93, Figure 4.2, and Tables 4.17 and D.1; Reference 5.6). The initial enrichment for the type 1 fuel rod, which includes over half of the assembly's fuel rods, is 2.93 wt% ^{235}U and the burnup ranges from 17.84 to 33.94 GWd/MTU. The cooling time reflects the time after shutdown in which the burnup measurements were performed.

Assembly design parameters are presented in Table 4-2 (Table 4.1, Reference 5.6; Table 1 and 3, Reference 5.6). The assembly is a General Electric (GE) 7 x 7 and contains four types of fuel rods and three types of burnable poison rods. Assembly channel dimensions are obtained for Quad Cities, which also uses a GE 7 x 7 assembly (Table 1, Reference 5.7). A cross section of the assembly is presented in Figure 4-1 (Figure 4.2, Reference 5.6; Figure 8, Reference 5.7). The initial enrichments of ^{235}U and Gd_2O_3 for each type of fuel rod and burnable poison rod are included in Table 4-3. Power histories for each assembly during the three cycles of irradiation are presented in Table 4-4 in the form of Linear Heat Generation Rates (LHGRs) (Table A.2, Reference 5.6). The assemblies were irradiated for 5 cycles during cycles 1, 2, 3, 6 and 7. Both rods ADD2966 and ADD2974 are Type 1 fuel rods.

The composition of the channel, Zircaloy-4, is presented in Table 4-5, and has a density of 6.56 g/cm^3 (Reference 5.8). A list of trace elements in the fuel used in updating cross sections during the depletion analysis is presented in Table 4-6 and developed with consideration of elements used in (Table 1, Reference 5.9).

The measured isotopic concentrations for plutonium and uranium isotopes are presented in Table 4-7, given in g/gUO_2 (Table 4.17, Reference 5.6). Also measured isotopic concentrations for ^{99}Tc, ^{237}Np and ^{241}Am are presented in Table 4-8, given in Ci/gUO_2 (Table 4.17, Reference 5.6). The measurements were performed at the Materials Characterization Center at Pacific Northwest Laboratory for fuel pellets at three different axial positions in Rods ADD2974 and ADD2966, of Bundle CZ346.

Table 4-1. Spent Fuel Characteristic Parameters for Cooper BWR

Sample	Axial Location from Top, cm	Enrichment, wt % ^{235}U	Burnup, MWd/kgM	Cooling Time, years
ADD2966-B	55.107	2.93	18.96	5.35
ADD2966-K	218.869	2.93	33.07	5.35
ADD2966-T	274.777	2.93	33.94	5.35
ADD2974-B	55.723	2.93	17.84	5.28
ADD2974-J	115.042	2.93	29.23	5.28
ADD2974-U	291.087	2.93	31.04	5.28

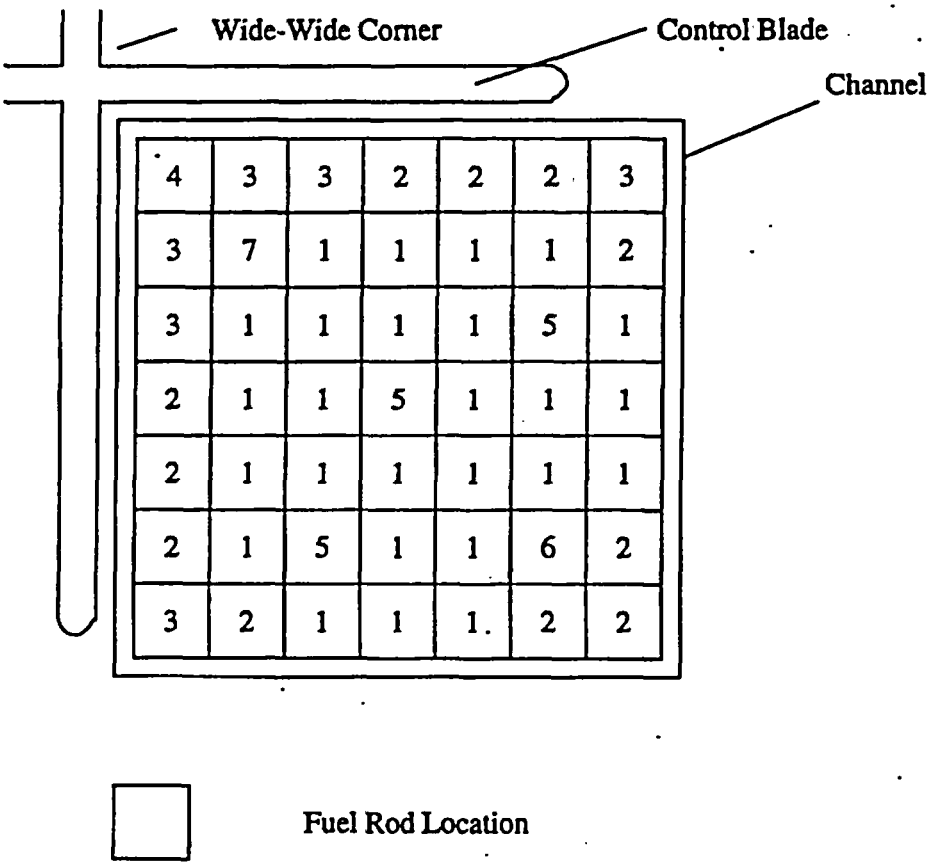
Reference 5.6

Table 4-2. Assembly Design Parameters for Cooper BWR

Parameter	Data
Assembly general data:	
Designer	General Electric
Lattice	7 x 7
Number of Fuel Rods	49
Assembly Pitch, in. (cm)	6.0 (15.24)
Channel	
Outside Dimension, in. (cm)	5.438 (13.813)
Thickness, in. (cm)	0.080 (0.203)
Material	Zircaloy-4
Fuel Rod Data:	
Type of Fuel Pellet	UO_2
Pellet immersion density, g/cm^3	10.32
Rod Pitch, cm	1.87
Rod Outside Diameter (OD), cm	1.43
Cladding Thickness, cm	0.094
Pellet Diameter, cm	1.21
Active Fuel Length, cm	371
Clad Material	Zircaloy-2
Peripheral-Rod-to-Channel Spacing, in. (cm)	0.1435 (0.364)

Dimensions are converted from inches to centimeters by the following relationship: 1 in. = 2.54 cm.
Reference 5.6

Figure 4-1. Cross Section of Cooper BWR Assembly



See Table 4-3 for Rod Enrichments

References 5.6 and 5.7

Table 4-3. Rod Enrichments for Cooper BWR

Rod Type	Enrichment, wt % ^{235}U	wt % Gd_2O_3	Number of Rods
1	2.93	0	26
2	1.94	0	11
3	1.69	0	6
4	1.33	0	1
5	2.93	3.0	3
6	2.93	4.0	1
7	1.94	4.0	1

Reference 5.6

Table 4-4. Power History for Bundle CZ346 from Cooper BWR

Elapsed Time, days	Time Interval, days	Power Density, MW/MTU	Cumulative Burnup, MWd/MTU	Average LHGR, kW/m
Cycle 1				
19	19	15.63	0.297	16.34
27	8	0	0.297	0
90	63	14.21	1.192	14.84
157	67	22.74	2.715	23.76
174	17	0	2.715	0
182	8	14.21	2.829	14.84
215	33	25.58	3.673	26.73
225	10	0	3.673	0
296	71	27.01	5.591	28.22
451	155	14.21	7.793	14.84
486	35	0	8.062	0
505	19	14.21	8.574	14.84

Table 4-4. Power History for Bundle CZ346 from Cooper BWR

Elapsed Time, days	Time Interval, days	Power Density, MW/MTU	Cumulative Burnup, MWd/MTU	Average LHGR, kW/m
525	20	25.58	8.574	26.73
532	7	0	9.074	0
554	22	22.74	9.074	23.76
566	12	0	10.325	0
621	55	22.74	11.379	23.76
674	53	19.89	11.379	20.79
693	19	0	11.876	0
718	25	19.89	11.876	20.79
807	89	22.74	13.900	23.76
Cycle 2				
866	59	0	13.900	0
880	14	15.46	14.116	16.15
904	24	20.98	14.620	21.92
919	15	11.04	14.785	11.53
945	26	20.99	15.331	21.93
953	8	0	15.331	0
996	43	20.99	16.234	21.93
1001	5	8.84	16.278	9.24
1017	16	20.99	16.614	21.93
1022	5	0	16.614	0
1044	22	19.88	17.051	20.77
1083	39	13.25	17.568	13.84
1172	89	17.67	19.140	18.46

Table 4-4. Power History for Bundle CZ346 from Cooper BWR

Elapsed Time, days	Time Interval, days	Power Density, MW/MTU	Cumulative Burnup, MWd/MTU	Average LHGR, kW/m
Cycle 3				
1203	31	0	19.140	0
1367	164	16.95	21.920	17.71
Cycle 6				
2166	799	0	21.920	0
2189	23	10.33	22.158	10.80
2214	25	11.48	22.445	12.00
2228	14	5.74	23.525	6.00
2326	98	10.91	23.594	11.40
2335	9	0	23.594	0
2377	42	10.91	24.052	11.40
2393	16	11.48	24.236	12.00
2452	59	10.91	24.880	11.40
2483	31	10.33	25.200	10.80
Cycle 7				
2531	48	0	25.200	0
2539	8	4.38	25.235	4.57
2548	9	8.75	25.314	9.14
2627	79	10.71	26.160	11.19
2688	61	0	26.160	0
2743	55	10.71	26.749	11.19
2817	74	10.39	27.518	10.86

Table 4-4. Power History for Bundle CZ346 from Cooper BWR

Elapsed Time, days	Time Interval, days	Power Density, MW/MTU	Cumulative Burnup, MWd/MTU	Average LHGR, kW/m
2822	5	0	27.518	0
2853	31	9.84	27.823	10.28
2879	26	8.75	28.050	9.14

Reference 5.6

Table 4-5. Composition of Zircaloy-4

Material	Weight Percent
O	0.12
Cr	0.10
Fe	0.20
Sn	1.40
Zr	98.18
Density = 6.56 g/cm^3	

Reference 5.8

Table 4-6. Nuclides Updated in SAS2H

^{83}Kr	^{85}Kr	^{89}Y	^{90}Sr	^{95}Mo	^{93}Zr
^{94}Zr	^{94}Nb	^{95}Zr	^{99}Tc	^{101}Ru	^{103}Rh
^{105}Rh	^{106}Ru	^{105}Pd	^{108}Pd	^{109}Ag	^{124}Sb
^{131}Xe	^{132}Xe	^{134}Cs	^{135}Xe	^{135}Cs	^{136}Xe
^{136}Ba	^{137}Cs	^{139}La	^{141}Pr	^{143}Pr	^{143}Nd
^{144}Ce	^{145}Nd	^{147}Nd	^{147}Pm	^{147}Sm	^{148}Pm
^{149}Sm	^{150}Sm	^{151}Sm	^{152}Sm	^{153}Eu	^{154}Eu
^{155}Gd	^{155}Eu				

Reference 5.9

Table 4-7. Measured Isotopic Concentrations (g/gUO_2)

Sample	ADD2966-B	ADD2966-K	ADD2966-T	ADD2974-B	ADD2974-J	ADD2974-U
Burnup, MWd/kgM	18.96	33.07	33.94	17.84	29.23	31.04
^{234}U	1.7E-4	1.35E-4	1.44E-4	1.74E-4	1.46E-4	1.54E-4
^{235}U	1.191E-2	5.34E-3	4.83E-3	1.30E-2	7.76E-3	6.28E-3
^{236}U	2.63E-3	3.53E-3	3.62E-3	2.48E-3	3.36E-3	3.48E-3
^{238}U	8.437E-1	8.346E-1	8.391E-1	8.545E-1	8.490E-1	8.455E-1
^{238}Pu	5.35E-5	1.743E-4	1.706E-4	5.21E-5	1.64E-4	1.389E-4
^{239}Pu	3.738E-3	3.579E-3	3.336E-3	4.056E-3	4.526E-3	3.668E-3
^{240}Pu	1.220E-3	2.216E-3	2.190E-3	1.184E-3	2.164E-3	2.082E-3
^{241}Pu	3.403E-4	6.390E-4	6.201E-4	3.415E-4	6.649E-4	6.139E-4
^{242}Pu	9.892E-5	4.407E-4	4.737E-4	8.742E-5	3.247E-4	3.823E-4

Reference 5.6

Table 4-8. Measure Isotopic Concentrations (Ci/gUO_2)

Sample	ADD2966-B	ADD2966-K	ADD2966-T	ADD2974-B	ADD2974-J	ADD2974-U
Burnup, MWd/kgM	18.96	33.07	33.94	17.84	29.23	31.04
^{99}Tc	6.26E-6	1.03E-5	1.06E-5	6.17E-6	9.86E-6	1.00E-5
^{237}Np	1.11E-7	2.54E-7	2.46E-7	1.09E-7	2.35E-7	2.36E-7
^{241}Am	5.18E-4	8.78E-4	8.38E-4	5.23E-4	9.46E-4	8.69E-4

Reference 5.6

4.2 Criteria

The design of the waste package will depend on waste package configuration criticality analyses performed using an acceptable disposal criticality analysis methodology. Criteria that relate to the development and design of repository and engineered barrier components are derived from the applicable requirements and planning documents. The Engineered Barrier Design Requirements Document (EBDRD, Reference 5.12) provides requirements for engineered barrier segment design. The Repository Design Requirements Document (RDRD, Reference 5.13) provides requirements for repository design. The Controlled Design Assumptions Document (Reference 5.14) provides guidance for requirements listed in the EBDRD and RDRD which have unqualified or unconfirmed data associated with the requirement.

This analysis supports the disposal criticality analysis methodology by providing input, in the form of fuel depletion results, to benchmark calculations which address the prediction of both spent fuel isotopic compositions and their associated reactivity. These benchmark calculations will contribute to the determination of bias values in the method of critical multiplication factor calculation that is implemented by the analytic tools to be used in the disposal criticality methodology. The requirements for utilizing the bias in the method of calculation of the critical multiplication factor for disposal configurations containing spent nuclear fuel are located in Section 3.2.2.5 of the RDRD and Section 3.2.2.6 of the EBDRD. This analysis does not satisfy these requirements, but the results from this analysis will be used as input to subsequent analyses which will satisfy these requirements.

4.3 Assumptions

4.3.1 The average fuel temperature is unknown and assumed to be 840 K. The value for average fuel temperature is taken from an example depletion case on p. S2.6.12 of Reference 5.10. The basis for this assumption is that this is a representative value for the average fuel temperature in a BWR operating under normal conditions. Sensitivity analyses of fuel temperature changes are documented in Section 7.7 of this analysis. This assumption is used in Section 7.2.

4.3.2 The cladding temperature is unknown and assumed to be of 620 K. The value for the cladding temperature is taken from an example depletion case on p. S2.6.12 of Reference 5.10. The basis for this assumption is that this is a representative value for the cladding temperature in a BWR operating under normal conditions. Furthermore, it is expected that the cladding temperature will not significantly effect the resulting isotopic concentrations, since the composition contains no nuclides that are strong neutron absorbers. This assumption is used in Section 7.2.

4.3.3 The moderator temperature is unknown and assumed to be 557 K. The value for the moderator temperature in an example depletion case on p. S2.6.12 of Reference 5.10 is 558 K. The basis for this assumption is that this is a representative value for the cladding temperature in a BWR operating under normal conditions. This assumption is used in Section 7.2.

4.3.4 The moderator density profile is unknown and is assumed to be an inverse exponential function with an entrance density of 0.862 g/cm^3 and plateau density of 0.240 g/cm^3. The basis for this assumption is that this is a representative function for the moderator density profile in a BWR operating under normal conditions. Additional supporting data for the moderator density profile is to be determined and will be included in revision(s) to this analysis. This assumption is used in Section 7.2.

4.4 Codes and Standards

There are no applicable codes or standards for this design analysis.

5. References

5.1 *Yucca Mountain Site Characterization Project Q-List*, YMP/90-55Q REV 04, Yucca Mountain Site Characterization Project.

5.2 *QAP-2-0 Activity Evaluations: ID #WP-20, Perform Criticality, Thermal, Structural, and Shielding Analyses*, Civilian Radioactive Waste Management System (CRWMS) Management and Operating Contractor (M&O), August 3, 1997.

5.3 *Quality Assurance Requirements and Description*, DOE/RW-0333P REV 07, U.S. Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM).

5.4 *Nuclides and Isotopes*, General Electric Company, 14ed., 1989.

5.5 G. Audi and A. H. Wapstra, *Atomic Mass Adjustments: 'The 1995 Update to the Atomic Mass Evaluation'*, Nuclear Physics A595 Vol. 4, p. 409-480.

5.6 R. J. Guenther et. al., *Characterization of Spent Fuel Approved Testing Material - ATM-105*, PNL-5109-105, Pacific Northwest Laboratory, 1991.

5.7 *Core Design and Operating Data for Cycles 1 and 2 of Quad Cities 1*, EPRI NP-240, November 1976.

5.8 *Material Compositions and Number Densities for Neutronics Calculations*, Document Identifier Number (DI#): BBA000000-01717-0200-00002 REV 00, CRWMS M&O.

5.9 *SCALE-4 Analysis of Pressurized Water Reactor Critical Configurations: Volume 2-Sequoyah Unit 2 Cycle 3*, ORNL/TM-12294/V2, March 1995.

5.10 *SCALE 4.3, A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation for Workstations and Personal Computers*, NUREG/CR-0200 REV 05, ORNL/NUREG/CSD-2/R5, Volumes 1-3, Oak Ridge National Laboratory.

5.11 *Software Qualification Report for the SCALE Modular Code System*, DI#: 30011-2002 REV 01, CRWMS M&O.

5.12 *Engineered Barrier Design Requirements Document*, YMP/CM-0024, REV 00, ICN 01, DOE OCRWM.

5.13 *Repository Design Requirements Document*, YMP/CM-0023, REV 00, ICN 01, DOE OCRWM.

5.14 *Controlled Design Assumptions Document*, DI#: B00000000-01717-4600-00032 REV 04, ICN 01, CRWMS M&O.

6. Use of Computer Software

A. Reference 5.10 describes the SAS2H module of SCALE 4.3 that is used with the 44GROUPNDF5 cross section library to calculate the isotopic concentrations for the specified burnup and cooling time. The computer code's spatially independent point depletion model is appropriate for comparison with pellet sample measurements, and is used within the range of validation, as described in Reference 5.11, in accordance with the QAP-SI series procedures. SCALE is obtained from the Software Configuration Management in accordance with appropriate procedures. SCALE's CSCI number is 30011 V4.3 and is installed on the WPDD HP 9000, 700 Workstation with CRWMS M&O tag number 110433.

B. *Lotus 1-2-3* Release 5 for Windows 95 is an Acquired Software spreadsheet program as defined in QAP-SI-0. User defined formulas and/or algorithms, inputs and results, are documented in the appropriate sections.

7. Design Analysis

The SAS2H module of SCALE 4.3 is used to perform one-dimensional (1-D) neutron transport and point depletion analyses on the Cooper samples using the preferred 44GROUPNDF5 cross-section library. To properly model the neutron flux spectrum and the nuclide composition changes, it is necessary to define the compositions, temperatures, and geometry of the fuel assembly. This is accomplished with the use of data blocks in which similar parameters are grouped together.

7.1 SCALE Input Data Blocks 1, 2, and 3

Data blocks 1 through 3 define the SCALE module to be used, the title of the input file, the cross section library to be used, and the lattice type to be modeled. The module used is SAS2H and the cross sectional library is 44GROUPNDF5, abbreviated as 44GROUP. The 44GROUP cross section library is recommended by Oak Ridge National Laboratory. Since SAS2H is only to be used for isotopic depletion/generation, the 'parm=skipshipdata' option is used so that a shipping cask shielding analysis is not performed. The title is arbitrary and should contain information that is sample specific, while the lattice type is "latticecell" to reflect the array characteristic of the assembly.

7.2 SCALE Input Data Block 4

Data block 4 defines the material compositions present in the assembly. A unique mixture number is assigned to each composition, and follows the form of mixture 1 for fuel, mixture 2 for cladding and mixture 3 for moderator.

The fuel mixture is UO_2 with a density and isotopic weight percentages of the pellet on which the measurements are performed. This is to ensure that the proper amount of ^{235}U is present in the fuel region. The density is approximated as the pellet immersion density. Also, since only the ^{235}U enrichment is known, the enrichment of ^{234}U and ^{236}U are approximated by the following relationship with results for each rod type presented in Table 7-1: wt% ^{234}U = 0.0046 * wt% ^{235}U and wt% ^{236}U = 0.0089 wt% ^{235}U. The fuel temperature is unknown and assumed to be 840 K. The basis for this assumption is that this is a typical value for the average fuel temperature in a BWR. Isotopes which are selected as needing their cross sections updated during the depletion analysis are included in the fuel mixture. A standard list of trace fuel elements is given in Table 4-6 and defined in the fuel mixture to have a concentration of 10^{-20} atoms/barn·cm.

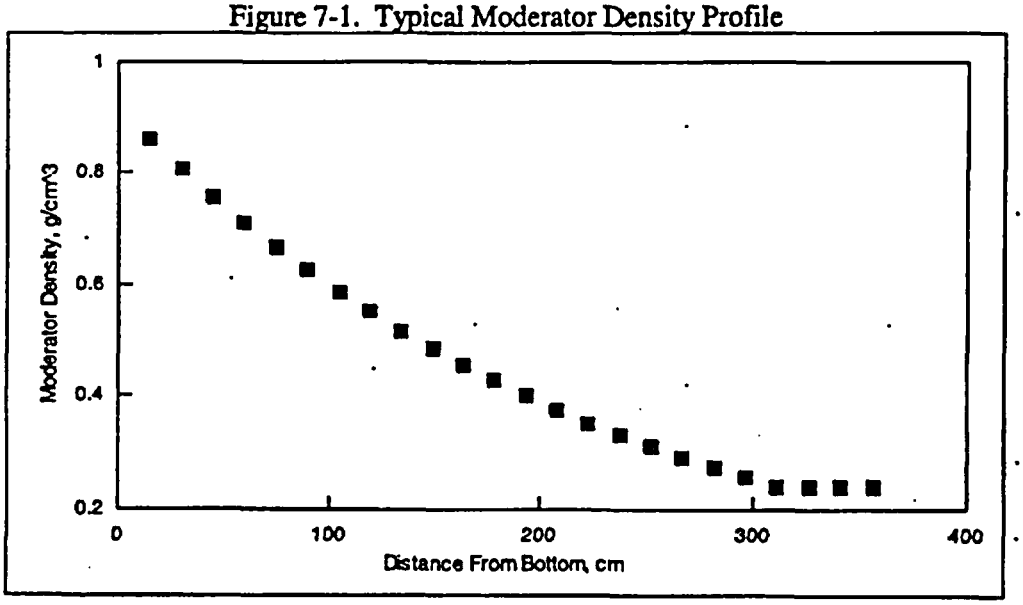
The cladding material is Zircaloy-2. The cladding temperature could not be obtained, therefore, a cladding temperature of 620 K is assumed for each sample. This value is consistent with the expectation that the cladding temperature is closer to the moderator temperature than the fuel temperature. Furthermore, it is expected that the cladding temperature will not significantly effect the resulting isotopic concentrations.

Table 7-1. Enrichment of Fuel Rods

Rod Type	wt% 236U	wt% 235U	wt% 234U	wt% 238U
1	0.013	2.93	0.026	97.031
2	0.009	1.94	0.017	98.034
3	0.008	1.69	0.015	98.287
4	0.006	1.33	0.011	98.663
5	0.013	2.93	0.026	97.031
6	0.013	2.93	0.026	97.031
7	0.009	1.94	0.017	98.034

The moderator temperature and density are unknown. Therefore, a moderator temperature of 557 K will be assumed. The basis for this assumption is that this is a typical value for the average moderator temperature in a BWR. The BWR moderator density profile used in this analysis is assumed to be an inverse exponential function with an average entrance density of 0.862 g/cm^3 and plateau density of 0.240 g/cm^3. Figure 7-1 shows a typical moderator density profile for a BWR.

Figure 7-1. Typical Moderator Density Profile



Several other material compositions must be specified. The material for the air between the fuel rod and cladding is nitrogen at 5 x 10^{-5} atoms/barn·cm, and the material for the channel is Zircaloy-4. The temperature for these materials is the same as the moderator temperature and the mixture numbers are 4 and 5, respectively. The average Gadolinium rod mixture is specified as mixture 6

and is an average of all 5 Gd rods. To obtain the average Gadolinium rod composition, the weight percentages for both Gd and ^{235}U are averaged by the number of rods. The resulting weight percents are 3.4 wt% Gd and 2.732 wt% ^{235}U; resulting in 0.024 wt% ^{234}U, 0.013 wt% ^{236}U and 97.231 wt% ^{238}U from the method described previously. The moderator between assemblies does not behave in the same manner as the moderator within the assembly. Between assembly moderator must be defined as mixture 7 and has a density and temperature of the inlet conditions.

The channel material of Zircaloy-4 is not contained within the Standard Composition Library in SCALE 4.3 and must be defined as an arbitrary material. The channel is defined with a density and isotopic weight percentages from Table 4-5 and temperature given in Table 4-2.

7.3 SCALE Input Data Blocks 5 Through 7

The unit fuel rod cell geometry is defined in data block 5. The 'squarepitch' designation for the type of lattice is appropriate since the fuel assembly consists of a square array of fuel rods. Fuel rod, cladding and pitch dimensions are given in Table 4-2 with the mixture number for each composition defined in Section 7.2. The gap mixture is defined as 0.

Data block 6 allows the user to specify such parameters as the spatial mesh, angular quadrature and the convergence criteria. It is determined that the default values are sufficient and such options are not used in this design model.

In data block 7 the user defines general assembly data and determines the level of detail in which the assembly is to be modeled. The number of fuel rods per assembly is given in Table 4-2 and the length is calculated so that an assembly contains 1 Metric Ton of Uranium Dioxide ($MTUO_2$), using the following equation:

$$Length = \frac{1}{\frac{\pi}{4}(POD)^2(PDen)(NFR)} * \frac{10^6 gUO_2}{1 MTUO_2} \qquad \text{Equation 7-1}$$

Where:

Length = Length Required for an Assembly to Contain 1 $MTUO_2$ (cm)
POD = Fuel Pellet Diameter (cm)
PDen = Fuel Pellet Density (gUO_2/cm^3)
NFR = Number of Fuel Rods

Since, measured isotopic concentrations are presented in grams of isotope per gram UO_2 and SCALE presents concentrations in grams of isotope per assembly, it is possible to alter the length so that the assembly contains 1 $MTUO_2$. This is possible since the 1-D transport calculation is axially independent, consequently the length of the assembly does not impact the neutron flux spectrum nor the nuclide cross sections. The resulting calculated length for the Cooper assembly is 1719.74 cm.

Each assembly was irradiated for five cycles, which are divided into a total of 17 intervals so that

all periods of downtime may be modeled. It is determined that approximately 80 days per cross section library is sufficient to accurately model the change in nuclide cross sections with increasing burnup, without over-burdening the SAS2H code. Therefore, the number of libraries per cycle are specified as two. To obtain the concentrations of all interested nuclides, a print level of 5 is chosen, while an input level of 2 is defined so that a Path B model may be utilized. The number of light elements is zero, while the number of zones is eight which is determined by the Path B model described in Section 7.4.

7.4 SCALE Input Data Block 8

It should be noted that control blade insertion information could not be obtained for the pertinent cycles, even though such information is important in the modeling of BWR assemblies. Calculated concentrations obtained from a BWR model without control blade insertion information are not expected to agree closely with corresponding measurements.

The Path B model for Cooper is a centralized average Gadolinium rod unit cell surrounded by an homogenized fuel and moderator mixture that conserves the fuel to moderator volume ratio. Further surrounding the homogenized fuel and moderator mixture are the moderator between the fuel cells and channel, the channel, and the moderator between assemblies. The equation below is used to determine the number of fuel unit cells that surround the central guide tube. All of the following equations used to calculate the Path B model dimensions are derived. The results of the fuel-unit-cell calculations are presented in Table 7-2, and the resulting Path B model dimensions are presented in Table 7-3.

$$x = \frac{(\frac{F}{M})(CUCMV)}{(FV)-(\frac{F}{M})(MV)} \quad \text{Equation 7-2}$$

$$\frac{F}{M} = \frac{(NFR)(\frac{\pi}{4})(POD)^2}{(NFR)[RP^2-(\frac{\pi}{4})(COD)^2]+(NGdR)[RP^2-(\frac{\pi}{4})(COD)^2]} \quad \text{Equation 7-3}$$

$$CUCMV = RP^2-(\frac{\pi}{4})(COD)^2 \quad \text{Equation 7-4}$$

$$FV = (\frac{\pi}{4})(POD)^2 \quad \text{Equation 7-5}$$

$$MV = RP^2-(\frac{\pi}{4})(COD)^2 \quad \text{Equation 7-6}$$

Where:

x = Number of Unit Fuel Cells
F/M = Fuel to Moderator Volume Ratio
NFR = Number of Fuel Rods
POD = Fuel Pellet Outer Diameter
RP = Rod Pitch
COD = Cladding Outer Diameter
NGdR = Number of Gadolinium Rods
CUCMV = Central Unit Cell Moderator Volume
FV = Fuel Volume of Fuel Unit Cell
MV = Moderator Volume of Fuel Unit Cell

Once the number of fuel cells per central Gd rod is determined the geometry of the Path B model may be calculated. Since the Gd rod is centralized, the dimensions of the first three zones are the same as the Gd rod pellet radius, cladding inside radius and cladding outside radius.

The radius for the moderator surrounding the Gd rod, but still within the Gd rod unit cell, is calculated with the following equation:

$$R_4 = \sqrt{(\frac{1}{\pi})RP^2} \quad \text{Equation 7-7}$$

Where:

R_4 = Radius of Moderator Surrounding Gd Rod

The area of an annular region is calculated by the difference between the outer circular area and the inner circular area. Equation 7-8 is the basis for the Equations 7-9 and 7-10 which determine the radii of the homogenized fuel zone and the outer moderator zone.

$$ARA = \pi(ORAR^2 - IRAR^2) \quad \text{Equation 7-8}$$

Where:

ARA = Annular Region Area
ORAR = Outer Radius of Annular Region
IRAR = Inner Radius of Annular Region

The area of the homogenized fuel zone surrounding the Gd rod unit cell is equal to the number of fuel unit cells surrounding the Gd rod multiplied by the area of a fuel unit cell. Consequently, the radius of the homogenized fuel zone is computed with the following equation:

$$R_5 = \sqrt{(\frac{x}{\pi})RP^2 + R_4^2} \quad \text{Equation 7-9}$$

Where:

R_5 = Radius of Homogenized Fuel and Moderator Zone

The mixture number of the homogenized fuel and moderator mixture must be specified as 500. The code then determines the composition of the region using cell averages or homogenized densities of the fuel-pin-cell.

The area of the moderator between the unit cells and the channel is determined by calculating the total moderator volume and multiplying by the fraction of unit cells surrounding the Gd rod in the Path B model. The volume is calculated by determining the distance from the unit cells and the channel using the following equation:

$$R_6 = \sqrt{\frac{(x+1)}{\pi * NCell} * 4[(NCpR * RP + CCsp - \frac{RP-POD}{2}) * (CCsp - \frac{RP-POD}{2})] + R_5^2} \quad \text{Equation 7-10}$$

Where:

R_6 = Radius of Moderator Between Unit Cell and Channel
NCell = Number of Cells in Assembly
NCpR = Number of Cells per Row
CCsp = Cell to Channel Spacing

The area of the channel is calculated from the total channel volume and multiplying by the fraction of unit cells surrounding the Gd rod in the Path B model. The total channel volume of the assembly is calculated by the following equation:

$$R_7 = \sqrt{\frac{(x+1)}{\pi * NCell} * [4(CHOD - CHthick) * (CHthick)] + R_6^2} \qquad \text{Equation 7-11}$$

Where:

R_7 = Radius of Channel
CHOD = Channel Outer Dimension
CHthick = Channel Thickness

The area of the moderator between assemblies is calculated from the total moderator between assemblies volume and multiplying by the fraction of unit cells surrounding the Gd rod in the Path B model. The total volume of the moderator between assemblies is calculated by the following equation:

$$R_8 = \sqrt{\frac{(x+1)}{\pi * NCell} * [2 * (CHOD + W_{1/2}) * (N_{1/2}) + 2 * (CHOD + N_{1/2}) * (W_{1/2})] + R_7^2} \qquad \text{Equation 7-12}$$

Where:

R_8 = Radius of Moderator Between Assemblies
$W_{1/2}$ = Wide-Wide Half Dimension
$N_{1/2}$ = Narrow-Narrow Half Dimension

Table 7-2. Calculation of Fuel Unit Cell per Guide Tube Unit Cell

F/M	CUCMV, cm²	FV, cm²	MV, cm²	x
0.5461	1.8908	1.1499	1.8908	8.8

Table 7-3. Path B Model Dimensions

	Radius, cm	Composition
R_1	0.6050	Average Gd Rod
R_2	0.6210	Air
R_3	0.7150	Cladding
R_4	1.0550	Moderator
R_5	3.3028	Homogenized Fuel and Moderator
R_6	3.3179	Moderator
R_7	3.4223	Channel
R_8	3.7883	Moderator

7.5 SCALE Input Data Blocks 9 Through 16

Data block 9 is used to describe the power history of the reactor. The specific power, fuel irradiation period, the length of downtime, the fraction of boron and moderator density, and the temperature during the cycle may all be defined. The specific power is in units of $MW/MTUO_2$ while the irradiation period and length of downtime are both defined in days. The specific power is determined from Table 4-4 by developing intervals that allow modeling of the downtime during and after each cycle. The power during the interval is determined by the cumulative burnup of that interval and the length of the interval. Tables 7-4 and 7-5 contain values for the specific powers and the interval lengths. The moderator density fractions and the individual cycle temperature options are not used in modeling the Cooper assemblies because data obtained were not in sufficient detail to determine cycle specific values.

Table 7-4. Approximated Power History for Samples from Rod ADD2966

	Time Interval, days		Specific Power, $MW/MTUO_2$		
Cycle	Uptime	Downtime	Axial Level B	Axial Level K	Axial Level T
One	19	8	9.313	16.243	16.671
	130	17	11.086	19.336	19.845
	41	10	13.919	24.278	24.917
	226	35	10.863	18.947	19.445
	39	7	11.941	20.827	21.375
	22	12	13.549	23.632	24.254
	108	19	12.716	22.179	22.762
	114	59	13.177	22.983	23.587
Two	79	8	10.795	18.829	19.324
	64	5	11.941	20.827	21.375
	150	31	10.037	17.506	17.966
Three	164	799	10.099	17.615	18.078
Six	160	9	6.234	10.874	11.160
	148	48	6.465	11.276	11.573
Seven	96	61	5.958	10.391	10.664
	129	5	6.272	10.939	11.227
	57	See Table 4-1	5.567	9.709	9.965

Table 7-5. Approximated Power History for Samples from Rod ADD2974

	Time Interval, days		Specific Power, $MW/MTUO_2$		
Cycle	Uptime	Downtime	Axial Level B	Axial Level J	Axial Level U
One	19	8	8.763	14.357	15.246
	130	17	10.431	17.091	18.149
	41	10	13.097	21.459	22.788
	226	35	10.221	16.747	17.784
	39	7	11.235	18.409	19.549
	22	12	12.749	20.888	22.182
	108	19	11.965	19.603	20.817
	114	59	12.398	20.314	21.572
Two	79	8	10.157	16.642	17.673
	64	5	11.235	18.409	19.549
	150	31	9.444	15.473	16.431
Three	164	799	9.503	15.570	16.534
Six	160	9	5.866	9.611	10.206
	148	48	6.083	9.967	10.584
Seven	96	61	5.606	9.184	9.753
	129	5	5.901	9.669	10.268
	57	See Table 4-1	5.238	8.582	9.113

Light elements and their effective weight, in kg per assembly, are entered in data block 10. However, information concerning the light elements could not be obtained and this option is not used.

Data blocks 11 through 15 describe parameters used in the radial shielding analysis of a shipping cask and are not necessary in performing the depletion analysis. Data block 16 denotes the end of the SCALE input.

7.6 Comparison of Calculated and Measured Concentrations

Comparisons of corresponding calculated and measured concentrations are performed on a percent difference basis. The difference between the measured and the calculated value is 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.

Measured concentrations presented in Table 4-7 have units of g of isotope per g of UO_2, while calculated concentrations presented in Table 7-6 have units of g of isotope per Metric Ton of UO_2. Therefore, the measured concentrations must be multiplied by 10^6 $gUO_2/MTUO_2$ to obtain similar units.

Measured concentrations are presented in Table 4-8 with units of Curies per g UO_2. The activity of a particular isotope per gram UO_2 is converted to grams of that isotope per gram UO_2 using the half-life and molar mass presented in Section 4.1 and the following equation:

$$\left(\frac{Y_g}{gUO_2}\right)=\left(\frac{XCi}{gUO_2}\right)\left(\frac{3.7\times10^{10}Bq}{Ci}\right)\left(\frac{1}{\lambda}\right)\left(\frac{3.16\times10^{7}s}{1yr}\right)\left(\frac{1mole}{6.02\times10^{23}atoms}\right)\left(\frac{Mass}{1mole}\right) \qquad \text{Equation 7-13}$$

Where:

Y = Measured Value Used in Comparison (g isotope/g UO_2)
X = Measured Value from SAS2H (Ci isotope/g UO_2)

$$\lambda=\frac{\ln(2)}{T_{1/2}}\ (yr^{-1})$$

$T_{1/2}$ = Half-life of Isotope (yr)
Mass = Molar Mass of Isotope

Percent differences for the actinides and fission products are presented in Table 7-6.

In an attempt to determine the impact of the assumptions from Section 4.3 on the calculated isotopic concentrations, a sensitivity analysis is performed on the fuel temperature and moderator density. It is determined that the effect of the moderator temperature is not significant in the absorption of neutrons and the effect of up-scattering is not significant over the expected range of moderator temperatures. Also it is determined that the cladding temperature has no significant effect because it does not contribute significantly to either neutron absorption or scattering. Two samples representing low and high burnups, ADD2966-B and ADD2974-B, are used to observe the changes in isotopic concentrations for both: 1) a 100 K increase in fuel temperature, and 2) a 10 percent increase in moderator density for the sample taken near the bottom of the assembly and a 50 percent increase in moderator density for the sample taken near the top of the assembly. The results are reported in Tables 7-8 and 7-9.

7.7 Results

SAS2H predicted isotopic concentrations are presented in Table 7-6. The calculated concentrations are obtained through the methodology described in Sections 7.1 through 7.5, and with the input parameters defined in Section 4.1. Calculated concentrations are compared with measured concentrations as describe in Section 7.6 to determine the accuracy of the SAS2H module. Results of the comparison, in the form of percent differences, are presented in Table 7-6. Also the results of the sensitivity analysis are reported in Tables 7-8 and 7-9.

Table 7-6. Calculated concentrations ($g/MTUO_2$)

Sample	ADD2966-B	ADD2966-K	ADD2966-T	ADD2974-B	ADD2974-J	ADD2974-U
Burnup, MWd/kgM	18.96	33.07	33.94	17.84	29.23	31.04
^{99}Tc	4.22E2	7.02E2	7.22E2	3.99E2	6.24E2	6.71E2
^{234}U	1.67E2	1.39E2	1.38E2	1.70E2	1.44E2	1.45E2
^{235}U	1.20E4	5.22E3	4.50E3	1.25E4	7.22E3	5.32E3
^{236}U	2.61E3	3.46E3	3.51E3	2.52E3	3.29E3	3.40E3
^{238}U	8.42E5	8.34E5	8.34E5	8.43E5	8.35E5	8.37E5
^{237}Np	2.00E2	3.44E2	3.32E2	1.85E2	3.29E2	2.93E2
^{238}Pu	5.93E1	1.60E2	1.54E2	5.15E1	1.44E2	1.25E2
^{239}Pu	4.41E3	3.95E3	3.57E3	4.32E3	4.61E3	3.47E3
^{240}Pu	1.30E3	2.10E3	2.08E3	1.21E3	1.98E3	1.92E3
^{241}Pu	4.28E2	6.87E2	6.44E2	3.93E2	6.93E2	5.82E2
^{242}Pu	1.22E2	4.60E2	4.91E2	1.05E2	3.42E2	3.98E2
^{241}Am	2.08E2	3.06E2	2.83E2	1.92E2	3.19E2	2.60E2

Table 7-7. Percent Difference Between Measured and Calculated [(C/M-1)*100]

Sample	ADD2966-B	ADD2966-K	ADD2966-T	ADD2974-B	ADD2974-J	ADD2974-U
Burnup, MWd/kgM	18.96	33.07	33.94	17.84	29.23	31.04
^{99}Tc	14.18	15.44	15.37	9.53	7.19	13.65
^{234}U	-1.76	2.96	-4.17	-2.30	-1.37	-5.84
^{235}U	0.76	-2.25	-6.83	-3.85	-6.96	-15.29
^{236}U	-0.76	-1.98	-3.04	1.61	-2.08	-2.30
^{238}U	-0.20	-0.07	-0.61	-1.35	-1.65	-1.01
^{237}Np	26.76	-4.72	-5.05	19.41	-1.51	-12.66
^{238}Pu	10.84	-8.20	-9.73	-1.15	-12.20	-10.01
^{239}Pu	17.98	10.37	7.01	6.51	1.86	-5.40
^{240}Pu	6.56	-5.23	-5.02	2.20	-8.50	-7.78
^{241}Pu	25.77	7.51	3.85	15.08	4.23	-5.20
^{242}Pu	23.33	4.38	3.65	20.11	5.33	4.11
^{241}Am	37.39	19.25	15.55	25.61	15.38	2.37

Table 7-8. Sensitivity Analyses for Sample ADD2966-T

Case	Modeled Conditions	Fuel Temperature Increase of 100 K		Moderator Density Increase of 10%	
Isotope	Calculated Concentration, g/MTU	Calculated Concentration, g/MTU	% Change in Calculated	Calculated Concentration, g/MTU	% Change in Calculated
^{99}Tc	7.22E2	7.22E2	0.00	7.24E2	0.28
^{234}U	1.38E2	1.38E2	0.00	1.38E2	0.00
^{235}U	4.50E3	4.54E3	0.89	4.31E3	-4.22
^{236}U	3.51E3	3.50E3	-0.28	3.52E3	0.28
^{238}U	8.34E5	8.34E5	0.00	8.35E5	0.12
^{237}Np	3.32E2	3.34E2	0.60	3.23E2	-2.71
^{238}Pu	1.54E2	1.55E2	0.65	1.48E2	-3.90
^{239}Pu	3.57E3	3.61E3	1.12	3.42E3	-4.20
^{240}Pu	2.08E3	2.08E3	0.00	2.06E3	-0.96
^{241}Pu	6.44E2	6.50E2	0.93	6.21E2	-3.57
^{242}Pu	4.91E2	4.92E2	0.20	4.92E2	0.20
^{241}Am	2.83E2	2.86E2	1.06	2.71E2	-4.24

Table 7-9. Sensitivity Analyses for Sample ADD2974-B

Case	Modeled Conditions	Fuel Temperature Increase of 100 K		Moderator Density Increase of 50%	
Isotope	Calculated Concentration, g/MTU	Calculated Concentration, g/MTU	% Change in Calculated	Calculated Concentration, g/MTU	% Change in Calculated
^{99}Tc	3.99E2	3.99E2	0.00	4.02E2	0.75
^{234}U	1.70E2	1.70E2	0.00	1.72E2	1.18
^{235}U	1.25E4	1.26E4	0.80	1.22E4	-2.40
^{236}U	2.52E3	2.51E3	-0.40	2.51E3	-0.40
^{238}U	8.43E5	8.43E5	0.00	8.44E5	0.12
^{237}Np	1.85E2	1.86E2	0.54	1.69E2	-8.65
^{238}Pu	5.15E1	5.17E1	0.39	4.53E1	-12.04
^{239}Pu	4.32E3	4.36E3	0.93	3.93E3	-9.03
^{240}Pu	1.21E3	1.21E3	0.00	1.16E3	-4.13
^{241}Pu	3.93E2	3.97E2	1.02	3.64E2	-7.38
^{242}Pu	1.05E2	1.05E2	0.00	1.03E2	-1.90
^{241}Am	1.92E2	1.94E2	1.04	1.77E2	-7.81

8. Conclusions

The accuracy with which the SAS2H module is able to predict isotopic concentrations is indicated by the percent differences presented in Table 7-7. Inspection of such results reveals that the code has a tendency to over-predict ^{99}Tc, ^{242}Pu and ^{241}Am while it tends to under-predict ^{238}U.

An analysis of the sensitivity of isotopic concentrations in relation to the fuel temperature reveals that for a 100 K increase in the fuel temperature, most of the plutonium isotopic concentrations increase by approximately 1%. For the sample at relatively low burnup, ADD2974-B, the isotopes of ^{235}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{241}Pu and ^{241}Am increase by 1.04% or less; ^{236}U decreases by 0.4% and the remaining isotopes are unchanged. For the sample at relatively high burnup, ADD2966-T, the isotopes of ^{235}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{241}Pu, ^{242}Pu and ^{241}Am all increase by 1.12% or less; ^{236}U decreases by 0.28% and the remaining isotopes remain unchanged. Since the actual fuel temperature is not expected to deviate more than 200 K from the temperature assumed, the assumption of a fuel temperature of 840 K does not significantly effect the calculated isotopic concentrations.

An analysis of the sensitivity of isotopic concentrations in relation to the moderator density reveals that for a 10 percent increase in the moderator density of sample ADD2966-T and a 50 percent change in sample ADD2974-B, the isotopic concentrations change significantly. For the sample at relatively low burnup, ADD2974-B, the isotopes of ^{235}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{241}Am decrease between 2.4 to 12.04%, and the remaining isotopes change by less than 2%. For the sample at relatively high burnup, ADD2966-T, the isotopes of ^{235}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{241}Pu and ^{241}Am decrease between 2.72 to 4.24% or less, and the remaining isotopes change by less than 2%. The moderator density is not expected to deviate more than 10 percent from the assumed value near the bottom of the assembly, or not more than 50 percent from the assumed value near the top of the assembly. Therefore, it may be concluded that an incorrect assumption of the moderator density would significantly effect the calculated isotopic concentrations.

The SAS2H code normally predicts isotopic concentrations as a radial assembly average; however, measurements are performed on individual pellet samples. Therefore, local pellet conditions are modeled as closely as possible in this analysis so that a more realistic pellet composition can be determined. However, it was necessary to approximate the fuel temperature and the moderator temperature as typical assembly average values. Furthermore, approximations made to obtain local pellet conditions will influence the calculated isotopic concentrations.

No final conclusions can be drawn from inspection of the measured to calculated ratios presented in this analysis. Although the assumptions for the fuel temperature and the moderator density do effect the resulting isotopic concentrations, the effect is not significant enough to account for all variation between the measured and calculated concentrations. More detailed operating data, especially data concerning control blade insertion, would be expected to improve the accuracy of the calculated concentrations in relation to the corresponding measurements. It is expected that future revision(s) to this analysis will incorporate more detailed operating data thereby providing more conclusive results.

9. Attachments

Attachment I includes ten pages and contains the input files used in the modeling of the Cooper samples. A description of the parameters contained within the input files is found in Sections 7.1 through 7.5.

Included in Attachment II is an extraction from each of the output files, containing the following information:

- echo of the SAS2H input deck,
- time/date stamp for when the SAS2H depletion calculation was performed,
- the output extraction of information pertinent to the Radiochemical Assay evaluations from the final ORIGEN calculation of the SAS2H depletion calculation.

coop2966b.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2966-B, Height 55.107 cm from top, Aug 97
'
'
'
'  mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 840  end
kr-85  1 0 1-20 840  end
y-89   1 0 1-20 840  end
sr-90  1 0 1-20 840  end
zr-93  1 0 1-20 840  end
zr-94  1 0 1-20 840  end
zr-95  1 0 1-20 840  end
nb-94  1 0 1-20 840  end
mo-95  1 0 1-20 840  end
tc-99  1 0 1-20 840  end
ru-101 1 0 1-20 840  end
ru-106 1 0 1-20 840  end
rh-103 1 0 1-20 840  end
rh-105 1 0 1-20 840  end
pd-105 1 0 1-20 840  end
pd-108 1 0 1-20 840  end
ag-109 1 0 1-20 840  end
sb-124 1 0 1-20 840  end
xe-131 1 0 1-20 840  end
xe-132 1 0 1-20 840  end
xe-135 1 0 1-20 840  end
xe-136 1 0 1-20 840  end
cs-134 1 0 1-20 840  end
cs-135 1 0 1-20 840  end
cs-137 1 0 1-20 840  end
ba-136 1 0 1-20 840  end
la-139 1 0 1-20 840  end
pr-141 1 0 1-20 840  end
pr-143 1 0 1-20 840  end
ce-144 1 0 1-20 840  end
nd-143 1 0 1-20 840  end
nd-145 1 0 1-20 840  end
nd-147 1 0 1-20 840  end
pm-147 1 0 1-20 840  end
pm-148 1 0 1-20 840  end
sm-147 1 0 1-20 840  end
sm-149 1 0 1-20 840  end
sm-150 1 0 1-20 840  end
sm-151 1 0 1-20 840  end
sm-152 1 0 1-20 840  end
eu-153 1 0 1-20 840  end
eu-154 1 0 1-20 840  end
eu-155 1 0 1-20 840  end
gd-155 1 0 1-20 840  end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.240  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
       40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'-----------------------------
end comp
'
'-----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch  1.87  1.21 1  3  1.43  2  1.242  0  end
'
'-----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=9.313  burn=19   down=8    end
power=11.086 burn=130  down=17   end
power=13.919 burn=41   down=10   end
power=10.863 burn=226  down=35   end
power=11.941 burn=39   down=7    end
power=13.549 burn=22   down=12   end
power=12.716 burn=108  down=19   end
power=13.177 burn=114  down=59   end
power=10.795 burn=79   down=8    end
power=11.941 burn=64   down=5    end
power=10.037 burn=150  down=31   end
power=10.099 burn=164  down=799  end
power=6.234  burn=160  down=9    end
power=6.465  burn=148  down=48   end
power=5.958  burn=96   down=61   end
power=6.272  burn=129  down=5    end
power=5.567  burn=57   down=1954.09   end
'
'-----------------------------
'
end
```

coop2966k.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2966-K, Height 218.869 cm from top, Aug 97
'
'
'
' mixtures of fuel-pin-unit-cell:
'
44group      latticecell
'uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031  end
kr-83  1 0 1-20 840 end
kr-85  1 0 1-20 840 end
y-89   1 0 1-20 840 end
sr-90  1 0 1-20 840 end
zr-93  1 0 1-20 840 end
zr-94  1 0 1-20 840 end
zr-95  1 0 1-20 840 end
nb-94  1 0 1-20 840 end
mo-95  1 0 1-20 840 end
tc-99  1 0 1-20 840 end
ru-101 1 0 1-20 840 end
ru-106 1 0 1-20 840 end
rh-103 1 0 1-20 840 end
rh-105 1 0 1-20 840 end
pd-105 1 0 1-20 840 end
pd-108 1 0 1-20 840 end
ag-109 1 0 1-20 840 end
sb-124 1 0 1-20 840 end
xe-131 1 0 1-20 840 end
xe-132 1 0 1-20 840 end
xe-135 1 0 1-20 840 end
xe-136 1 0 1-20 840 end
cs-134 1 0 1-20 840 end
cs-135 1 0 1-20 840 end
cs-137 1 0 1-20 840 end
ba-136 1 0 1-20 840 end
la-139 1 0 1-20 840 end
pr-141 1 0 1-20 840 end
pr-143 1 0 1-20 840 end
ce-144 1 0 1-20 840 end
nd-143 1 0 1-20 840 end
nd-145 1 0 1-20 840 end
nd-147 1 0 1-20 840 end
pm-147 1 0 1-20 840 end
pm-148 1 0 1-20 840 end
sm-147 1 0 1-20 840 end
sm-149 1 0 1-20 840 end
sm-150 1 0 1-20 840 end
sm-151 1 0 1-20 840 end
sm-152 1 0 1-20 840 end
eu-153 1 0 1-20 840 end
eu-154 1 0 1-20 840 end
eu-155 1 0 1-20 840 end
gd-155 1 0 1-20 840 end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.478  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557  end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231  end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'
'-----------------------------
end comp
'
'-----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch  1.87  1.21 1  3  1.43  2  1.242  0 end
'
'-----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=16.243 burn=19  down=8  end
power=19.336 burn=130  down=17  end
power=24.278 burn=41  down=10  end
power=18.947 burn=226  down=35  end
power=20.827 burn=39  down=7  end
power=23.632 burn=22  down=12  end
power=22.179 burn=108  down=19  end
power=22.983 burn=114  down=59  end
power=18.829 burn=79  down=8  end
power=20.827 burn=64  down=5  end
power=17.506 burn=150  down=31  end
power=17.615 burn=164  down=799  end
power=10.874 burn=160  down=9  end
power=11.276 burn=148  down=48  end
power=10.391 burn=96  down=61  end
power=10.939 burn=129  down=5  end
power=9.709  burn=57  down=1954.09  end
'
'-----------------------------
'
end
```

coop2966t.input

```
=as2h   parm=skipshipdata
Cooper BWR Sample ADD2966-T, Height 274.777 cm from top, Aug 97
'
'
'
' mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 840  end
kr-85  1 0 1-20 840  end
y-89   1 0 1-20 840  end
sr-90  1 0 1-20 840  end
zr-93  1 0 1-20 840  end
zr-94  1 0 1-20 840  end
zr-95  1 0 1-20 840  end
nb-94  1 0 1-20 840  end
mo-95  1 0 1-20 840  end
tc-99  1 0 1-20 840  end
ru-101 1 0 1-20 840  end
ru-106 1 0 1-20 840  end
rh-103 1 0 1-20 840  end
rh-105 1 0 1-20 840  end
pd-105 1 0 1-20 840  end
pd-108 1 0 1-20 840  end
ag-109 1 0 1-20 840  end
sb-124 1 0 1-20 840  end
xe-131 1 0 1-20 840  end
xe-132 1 0 1-20 840  end
xe-135 1 0 1-20 840  end
xe-136 1 0 1-20 840  end
cs-134 1 0 1-20 840  end
cs-135 1 0 1-20 840  end
cs-137 1 0 1-20 840  end
ba-136 1 0 1-20 840  end
la-139 1 0 1-20 840  end
pr-141 1 0 1-20 840  end
pr-143 1 0 1-20 840  end
ce-144 1 0 1-20 840  end
nd-143 1 0 1-20 840  end
nd-145 1 0 1-20 840  end
nd-147 1 0 1-20 840  end
pm-147 1 0 1-20 840  end
pm-148 1 0 1-20 840  end
sm-147 1 0 1-20 840  end
sm-149 1 0 1-20 840  end
sm-150 1 0 1-20 840  end
sm-151 1 0 1-20 840  end
sm-152 1 0 1-20 840  end
eu-153 1 0 1-20 840  end
eu-154 1 0 1-20 840  end
eu-155 1 0 1-20 840  end
gd-155 1 0 1-20 840  end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.607  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
       40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'-----------------------------
end comp
'
'-----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
'
'-----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=16.671  burn=19   down=8    end
power=19.845 burn=130  down=17   end
power=24.917 burn=41   down=10   end
power=19.445 burn=226  down=35   end
power=21.375 burn=39   down=7    end
power=24.254 burn=22   down=12   end
power=22.762 burn=108  down=19   end
power=23.587 burn=114  down=59   end
power=19.324 burn=79   down=8    end
power=21.375 burn=64   down=5    end
power=17.966 burn=150  down=31   end
power=18.078 burn=164  down=799  end
power=11.160 burn=160  down=9    end
power=11.573 burn=148  down=48   end
power=10.664 burn=96   down=61   end
power=11.227 burn=129  down=5    end
power=9.965  burn=57   down=1954.09  end
'
'-----------------------------
'
end
```

coop2974b.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2974-B, Height 55.723 cm from top, Aug 97
'
'
'
' mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 840 end
kr-85  1 0 1-20 840 end
y-89   1 0 1-20 840 end
sr-90  1 0 1-20 840 end
zr-93  1 0 1-20 840 end
zr-94  1 0 1-20 840 end
zr-95  1 0 1-20 840 end
nb-94  1 0 1-20 840 end
mo-95  1 0 1-20 840 end
tc-99  1 0 1-20 840 end
ru-101 1 0 1-20 840 end
ru-106 1 0 1-20 840 end
rh-103 1 0 1-20 840 end
rh-105 1 0 1-20 840 end
pd-105 1 0 1-20 840 end
pd-108 1 0 1-20 840 end
ag-109 1 0 1-20 840 end
sb-124 1 0 1-20 840 end
xe-131 1 0 1-20 840 end
xe-132 1 0 1-20 840 end
xe-135 1 0 1-20 840 end
xe-136 1 0 1-20 840 end
cs-134 1 0 1-20 840 end
cs-135 1 0 1-20 840 end
cs-137 1 0 1-20 840 end
ba-136 1 0 1-20 840 end
la-139 1 0 1-20 840 end
pr-141 1 0 1-20 840 end
pr-143 1 0 1-20 840 end
ce-144 1 0 1-20 840 end
nd-143 1 0 1-20 840 end
nd-145 1 0 1-20 840 end
nd-147 1 0 1-20 840 end
pm-147 1 0 1-20 840 end
pm-148 1 0 1-20 840 end
sm-147 1 0 1-20 840 end
sm-149 1 0 1-20 840 end
sm-150 1 0 1-20 840 end
sm-151 1 0 1-20 840 end
sm-152 1 0 1-20 840 end
eu-153 1 0 1-20 840 end
eu-154 1 0 1-20 840 end
eu-155 1 0 1-20 840 end
gd-155 1 0 1-20 840 end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.240  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'
'----------------------------
end comp
'
'----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
'
'----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=8.763  burn=19   down=8   end
power=10.431 burn=130  down=17   end
power=13.097 burn=41   down=10   end
power=10.221 burn=226  down=35   end
power=11.235 burn=39   down=7    end
power=12.749 burn=22   down=12   end
power=11.965 burn=108  down=19   end
power=12.398 burn=114  down=59   end
power=10.157 burn=79   down=8    end
power=11.235 burn=64   down=5    end
power=9.444  burn=150  down=31   end
power=9.503  burn=164  down=799  end
power=5.866  burn=160  down=9    end
power=6.083  burn=148  down=48   end
power=5.606  burn=96   down=61   end
power=5.901  burn=129  down=5    end
power=5.238  burn=57   down=1954.09   end
'
'----------------------------
'
end
```

coop2974j.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2974-J, Height 115.042 cm from top, Aug 97
'
'
' mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 840  end
kr-85  1 0 1-20 840  end
y-89   1 0 1-20 840  end
sr-90  1 0 1-20 840  end
zr-93  1 0 1-20 840  end
zr-94  1 0 1-20 840  end
zr-95  1 0 1-20 840  end
nb-94  1 0 1-20 840  end
mo-95  1 0 1-20 840  end
tc-99  1 0 1-20 840  end
ru-101 1 0 1-20 840  end
ru-106 1 0 1-20 840  end
rh-103 1 0 1-20 840  end
rh-105 1 0 1-20 840  end
pd-105 1 0 1-20 840  end
pd-108 1 0 1-20 840  end
ag-109 1 0 1-20 840  end
sb-124 1 0 1-20 840  end
xe-131 1 0 1-20 840  end
xe-132 1 0 1-20 840  end
xe-135 1 0 1-20 840  end
xe-136 1 0 1-20 840  end
cs-134 1 0 1-20 840  end
cs-135 1 0 1-20 840  end
cs-137 1 0 1-20 840  end
ba-136 1 0 1-20 840  end
la-139 1 0 1-20 840  end
pr-141 1 0 1-20 840  end
pr-143 1 0 1-20 840  end
ce-144 1 0 1-20 840  end
nd-143 1 0 1-20 840  end
nd-145 1 0 1-20 840  end
nd-147 1 0 1-20 840  end
pm-147 1 0 1-20 840  end
pm-148 1 0 1-20 840  end
sm-147 1 0 1-20 840  end
sm-149 1 0 1-20 840  end
sm-150 1 0 1-20 840  end
sm-151 1 0 1-20 840  end
sm-152 1 0 1-20 840  end
eu-153 1 0 1-20 840  end
eu-154 1 0 1-20 840  end
eu-155 1 0 1-20 840  end
gd-155 1 0 1-20 840  end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.306  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'-----------------------------
end comp
'
'-----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch  1.87  1.21 1  3  1.43  2  1.242   0  end
'
'-----------------------------
'
' assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numzonal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=14.357 burn=19   down=8   end
power=17.091 burn=130  down=17  end
power=21.459 burn=41   down=10  end
power=16.747 burn=226  down=35  end
power=18.409 burn=39   down=7   end
power=20.888 burn=22   down=12  end
power=19.603 burn=108  down=19  end
power=20.314 burn=114  down=59  end
power=16.642 burn=79   down=8   end
power=18.409 burn=64   down=5   end
power=15.473 burn=150  down=31  end
power=15.570 burn=164  down=799 end
power=9.611  burn=160  down=9   end
power=9.967  burn=148  down=48  end
power=9.184  burn=96   down=61  end
power=9.669  burn=129  down=5   end
power=8.582  burn=57   down=1954.09  end
'
'-----------------------------
'
end
```

coop2974u.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2974-U, Height 291.087 cm from top, Aug 97
'
'
'
' mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031  end
kr-83  1 0 1-20 840 end
kr-85  1 0 1-20 840 end
y-89   1 0 1-20 840 end
sr-90  1 0 1-20 840 end
zr-93  1 0 1-20 840 end
zr-94  1 0 1-20 840 end
zr-95  1 0 1-20 840 end
nb-94  1 0 1-20 840 end
mo-95  1 0 1-20 840 end
tc-99  1 0 1-20 840 end
ru-101 1 0 1-20 840 end
ru-106 1 0 1-20 840 end
rh-103 1 0 1-20 840 end
rh-105 1 0 1-20 840 end
pd-105 1 0 1-20 840 end
pd-108 1 0 1-20 840 end
ag-109 1 0 1-20 840 end
sb-124 1 0 1-20 840 end
xe-131 1 0 1-20 840 end
xe-132 1 0 1-20 840 end
xe-135 1 0 1-20 840 end
xe-136 1 0 1-20 840 end
cs-134 1 0 1-20 840 end
cs-135 1 0 1-20 840 end
cs-137 1 0 1-20 840 end
ba-136 1 0 1-20 840 end
la-139 1 0 1-20 840 end
pr-141 1 0 1-20 840 end
pr-143 1 0 1-20 840 end
ce-144 1 0 1-20 840 end
nd-143 1 0 1-20 840 end
nd-145 1 0 1-20 840 end
nd-147 1 0 1-20 840 end
pm-147 1 0 1-20 840 end
pm-148 1 0 1-20 840 end
sm-147 1 0 1-20 840 end
sm-149 1 0 1-20 840 end
sm-150 1 0 1-20 840 end
sm-151 1 0 1-20 840 end
sm-152 1 0 1-20 840 end
eu-153 1 0 1-20 840 end
eu-154 1 0 1-20 840 end
eu-155 1 0 1-20 840 end
gd-155 1 0 1-20 840 end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.652  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557  end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231  end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'----------------------------
end comp
'
'----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
'
'----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=15.246 burn=19   down=8   end
power=18.149 burn=130  down=17  end
power=22.788 burn=41   down=10  end
power=17.784 burn=226  down=35  end
power=19.549 burn=39   down=7   end
power=22.182 burn=22   down=12  end
power=20.817 burn=108  down=19  end
power=21.572 burn=114  down=59  end
power=17.673 burn=79   down=8   end
power=19.549 burn=64   down=5   end
power=16.431 burn=150  down=31  end
power=16.534 burn=164  down=799 end
power=10.206 burn=160  down=9   end
power=10.584 burn=148  down=48  end
power=9.753  burn=96   down=61  end
power=10.268 burn=129  down=5   end
power=9.113  burn=57   down=1954.09  end
'
'----------------------------
'
end
```

2966tplus100deg.input

```
=xs2h   parm=skipthipdata
Cooper BWR Sample ADD2966-T, Height 274.777 cm from top, Aug 97
*
* 100 K increase in fuel temperature
*
*  mixtures of fuel-pin-unit-cell:
*
44group      latticecell
uo2  1 den=10.32  1  940
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 940  end
kr-85  1 0 1-20 940  end
y-89   1 0 1-20 940  end
sr-90  1 0 1-20 940  end
zr-93  1 0 1-20 940  end
zr-94  1 0 1-20 940  end
zr-95  1 0 1-20 940  end
nb-94  1 0 1-20 940  end
mo-95  1 0 1-20 940  end
tc-99  1 0 1-20 940  end
ru-101 1 0 1-20 940  end
ru-106 1 0 1-20 940  end
rh-103 1 0 1-20 940  end
rh-105 1 0 1-20 940  end
pd-105 1 0 1-20 940  end
pd-108 1 0 1-20 940  end
ag-109 1 0 1-20 940  end
sb-124 1 0 1-20 940  end
xe-131 1 0 1-20 940  end
xe-132 1 0 1-20 940  end
xe-135 1 0 1-20 940  end
xe-136 1 0 1-20 940  end
cs-134 1 0 1-20 940  end
cs-135 1 0 1-20 940  end
cs-137 1 0 1-20 940  end
ba-136 1 0 1-20 940  end
la-139 1 0 1-20 940  end
pr-141 1 0 1-20 940  end
pr-143 1 0 1-20 940  end
ce-144 1 0 1-20 940  end
nd-143 1 0 1-20 940  end
nd-145 1 0 1-20 940  end
nd-147 1 0 1-20 940  end
pm-147 1 0 1-20 940  end
pm-148 1 0 1-20 940  end
sm-147 1 0 1-20 940  end
sm-149 1 0 1-20 940  end
sm-150 1 0 1-20 940  end
sm-151 1 0 1-20 940  end
sm-152 1 0 1-20 940  end
eu-153 1 0 1-20 940  end
eu-154 1 0 1-20 940  end
eu-155 1 0 1-20 940  end
gd-155 1 0 1-20 940  end
*
zirc2  2 1 620  end
*
*
*
h2o  3 den=0.607  1  557 end
*
n   4 0 5-5 557 end
*
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557   end
*
uo2  6 den=10.32  1  940
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 940  end
*
h2o  7 den=0.862  1  557  end
*
'----------------------------
end comp
'
'----------------------------
*
*    fuel-pin-cell geometry:
*
squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
*
'----------------------------
*
*   assembly and cycle parameters:
*
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numxtotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=16.671  burn=19   down=8    end
power=19.845 burn=130  down=17   end
power=24.917 burn=41   down=10   end
power=19.445 burn=226  down=35   end
power=21.375 burn=39   down=7    end
power=24.254 burn=22   down=12   end
power=22.762 burn=108  down=19   end
power=23.587 burn=114  down=59   end
power=19.324 burn=79   down=8    end
power=21.375 burn=64   down=5    end
power=17.966 burn=150  down=31   end
power=18.078 burn=164  down=799  end
power=11.160 burn=160  down=9    end
power=11.573 burn=148  down=48   end
power=10.664 burn=96   down=61   end
power=11.227 burn=129  down=5    end
power=9.965  burn=57   down=1954.09   end
*
'----------------------------
*
end
```

2966tplus10den.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2966-T, Height 274.777 cm from top, Aug 97
'
' increase moderator density by 10%
'
'  mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 840  end
kr-85  1 0 1-20 840  end
y-89   1 0 1-20 840  end
sr-90  1 0 1-20 840  end
zr-93  1 0 1-20 840  end
zr-94  1 0 1-20 840  end
zr-95  1 0 1-20 840  end
nb-94  1 0 1-20 840  end
mo-95  1 0 1-20 840  end
tc-99  1 0 1-20 840  end
ru-101 1 0 1-20 840  end
ru-106 1 0 1-20 840  end
rh-103 1 0 1-20 840  end
rh-105 1 0 1-20 840  end
pd-105 1 0 1-20 840  end
pd-108 1 0 1-20 840  end
ag-109 1 0 1-20 840  end
sb-124 1 0 1-20 840  end
xe-131 1 0 1-20 840  end
xe-132 1 0 1-20 840  end
xe-135 1 0 1-20 840  end
xe-136 1 0 1-20 840  end
cs-134 1 0 1-20 840  end
cs-135 1 0 1-20 840  end
cs-137 1 0 1-20 840  end
ba-136 1 0 1-20 840  end
la-139 1 0 1-20 840  end
pr-141 1 0 1-20 840  end
pr-143 1 0 1-20 840  end
ce-144 1 0 1-20 840  end
nd-143 1 0 1-20 840  end
nd-145 1 0 1-20 840  end
nd-147 1 0 1-20 840  end
pm-147 1 0 1-20 840  end
pm-148 1 0 1-20 840  end
sm-147 1 0 1-20 840  end
sm-149 1 0 1-20 840  end
sm-150 1 0 1-20 840  end
sm-151 1 0 1-20 840  end
sm-152 1 0 1-20 840  end
eu-153 1 0 1-20 840  end
eu-154 1 0 1-20 840  end
eu-155 1 0 1-20 840  end
gd-155 1 0 1-20 840  end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.668  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
       40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'------------------------------
end comp
'
'------------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch   1.87  1.21 1  3  1.43  2  1.242   0 end
'
'------------------------------
'
'   assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=16.671  burn=19  down=8   end
power=19.845 burn=130  down=17   end
power=24.917 burn=41   down=10   end
power=19.445 burn=226  down=35   end
power=21.375 burn=39   down=7    end
power=24.254 burn=22   down=12   end
power=22.762 burn=108  down=19   end
power=23.587 burn=114  down=59   end
power=19.324 burn=79   down=8    end
power=21.375 burn=64   down=5    end
power=17.966 burn=150  down=31   end
power=18.078 burn=164  down=799  end
power=11.160 burn=160  down=9    end
power=11.573 burn=148  down=48   end
power=10.664 burn=96   down=61   end
power=11.227 burn=129  down=5    end
power=9.965  burn=57   down=1954.09   end
'
'------------------------------
'
end
```

2974bplus100deg.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2974-B, Height 55.723 cm from top, Aug 97
'
' increase fuel temperature 100 K
'
'  mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  940
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 940  end
kr-85  1 0 1-20 940  end
y-89   1 0 1-20 940  end
sr-90  1 0 1-20 940  end
zr-93  1 0 1-20 940  end
zr-94  1 0 1-20 940  end
zr-95  1 0 1-20 940  end
nb-94  1 0 1-20 940  end
mo-95  1 0 1-20 940  end
tc-99  1 0 1-20 940  end
ru-101 1 0 1-20 940  end
ru-106 1 0 1-20 940  end
rh-103 1 0 1-20 940  end
rh-105 1 0 1-20 940  end
pd-105 1 0 1-20 940  end
pd-108 1 0 1-20 940  end
ag-109 1 0 1-20 940  end
sb-124 1 0 1-20 940  end
xe-131 1 0 1-20 940  end
xe-132 1 0 1-20 940  end
xe-135 1 0 1-20 940  end
xe-136 1 0 1-20 940  end
cs-134 1 0 1-20 940  end
cs-135 1 0 1-20 940  end
cs-137 1 0 1-20 940  end
ba-136 1 0 1-20 940  end
la-139 1 0 1-20 940  end
pr-141 1 0 1-20 940  end
pr-143 1 0 1-20 940  end
ce-144 1 0 1-20 940  end
nd-143 1 0 1-20 940  end
nd-145 1 0 1-20 940  end
nd-147 1 0 1-20 940  end
pm-147 1 0 1-20 940  end
pm-148 1.0 1-20 940  end
sm-147 1 0 1-20 940  end
sm-149 1 0 1-20 940  end
sm-150 1 0 1-20 940  end
sm-151 1 0 1-20 940  end
sm-152 1 0 1-20 940  end
eu-153 1 0 1-20 940  end
eu-154 1 0 1-20 940  end
eu-155 1 0 1-20 940  end
gd-155 1 0 1-20 940  end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.240  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  940
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 940  end
'
h2o  7 den=0.862  1  557  end
'
'-----------------------------
end comp
'
'-----------------------------
'
'    fuel-pin-cell geometry:
'
squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
'
'-----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=8.763  burn=19   down=8    end
power=10.431 burn=130  down=17   end
power=13.097 burn=41   down=10   end
power=10.221 burn=226  down=35   end
power=11.235 burn=39   down=7    end
power=12.749 burn=22   down=12   end
power=11.965 burn=108  down=19   end
power=12.398 burn=114  down=59   end
power=10.157 burn=79   down=8    end
power=11.235 burn=64   down=5    end
power=9.444  burn=150  down=31   end
power=9.503  burn=164  down=799  end
power=5.866  burn=160  down=9    end
power=6.083  burn=148  down=48   end
power=5.606  burn=96   down=61   end
power=5.901  burn=129  down=5    end
power=5.238  burn=57   down=1954.09  end
'
'-----------------------------
'
end
```

2974bplus50den.input

```
=sas2h   parm=skipshipdata
Cooper BWR Sample ADD2974-B, Height 55.723 cm from top, Aug 97
'
' increase moderator density by 50%
'
' mixtures of fuel-pin-unit-cell:
'
44group      latticecell
uo2  1 den=10.32  1  840
  92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
kr-83  1 0 1-20 840  end
kr-85  1 0 1-20 840  end
y-89   1 0 1-20 840  end
zr-90  1 0 1-20 840  end
zr-93  1 0 1-20 840  end
zr-94  1 0 1-20 840  end
zr-95  1 0 1-20 840  end
nb-94  1 0 1-20 840  end
mo-95  1 0 1-20 840  end
tc-99  1 0 1-20 840  end
ru-101 1 0 1-20 840  end
ru-106 1 0 1-20 840  end
rh-103 1 0 1-20 840  end
rh-105 1 0 1-20 840  end
pd-105 1 0 1-20 840  end
pd-108 1 0 1-20 840  end
ag-109 1 0 1-20 840  end
sb-124 1 0 1-20 840  end
xe-131 1 0 1-20 840  end
xe-132 1 0 1-20 840  end
xe-135 1 0 1-20 840  end
xe-136 1 0 1-20 840  end
cs-134 1 0 1-20 840  end
cs-135 1 0 1-20 840  end
cs-137 1 0 1-20 840  end
ba-136 1 0 1-20 840  end
la-139 1 0 1-20 840  end
pr-141 1 0 1-20 840  end
pr-143 1 0 1-20 840  end
ce-144 1 0 1-20 840  end
nd-143 1 0 1-20 840  end
nd-145 1 0 1-20 840  end
nd-147 1 0 1-20 840  end
pm-147 1 0 1-20 840  end
pm-148 1 0 1-20 840  end
sm-147 1 0 1-20 840  end
sm-149 1 0 1-20 840  end
sm-150 1 0 1-20 840  end
sm-151 1 0 1-20 840  end
sm-152 1 0 1-20 840  end
eu-153 1 0 1-20 840  end
eu-154 1 0 1-20 840  end
eu-155 1 0 1-20 840  end
gd-155 1 0 1-20 840  end
'
zirc2  2 1 620  end
'
'
'
h2o  3 den=0.36  1  557 end
'
n   4 0 5-5 557 end
'
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
        40000 98.18 5 1.0 557   end
'
uo2  6 den=10.32  1  840
  92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
'
h2o  7 den=0.862  1  557  end
'
'-----------------------------
end comp
'
'-----------------------------
'
'   fuel-pin-cell geometry:
'
squarepitch  1.87  1.21 1  3  1.43  2  1.242   0  end
'
'-----------------------------
'
'  assembly and cycle parameters:
'
npin/assm=49 fuelnght=1719.74 ncycles=17 nlib/cyc=2
printlevel=5 inplevel=2 numztotal=8 end
6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5
3.4223 7 3.7883
power=8.763  burn=19   down=8    end
power=10.431 burn=130  down=17   end
power=13.097 burn=41   down=10   end
power=10.221 burn=226  down=35   end
power=11.235 burn=39   down=7    end
power=12.749 burn=22   down=12   end
power=11.965 burn=108  down=19   end
power=12.398 burn=114  down=59   end
power=10.157 burn=79   down=8    end
power=11.235 burn=64   down=5    end
power=9.444  burn=150  down=31   end
power=9.503  burn=164  down=799  end
power=5.866  burn=160  down=9    end
power=6.083  burn=148  down=48   end
power=5.606  burn=96   down=61   end
power=5.901  burn=129  down=5    end
power=5.238  burn=57   down=1954.09   end
'
'-----------------------------
'
end
```

coop2966b.sum

```
                    SCALE4.3  Bulletin  Board
                    --------  --------  -----

                      Welcome to SCALE-4.3.

1         primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
      Cooper BWR Sample ADO2966-B, Height 55.107 cm from top, Aug 97
      '
      '
      '   mixtures of fuel-pin-unit-cell:
      '
      44group         latticecell
      uo2  1 den=10.32  1  840
         92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
      kr-83   1 0 1-20 840  end
      kr-85   1 0 1-20 840  end
      y-89    1 0 1-20 840  end
      sr-90   1 0 1-20 840  end
      zr-93   1 0 1-20 840  end
      zr-94   1 0 1-20 840  end
      zr-95   1 0 1-20 840  end
      nb-94   1 0 1-20 840  end
      mo-95   1 0 1-20 840  end
      tc-99   1 0 1-20 840  end
      ru-101  1 0 1-20 840  end
      ru-106  1 0 1-20 840  end
      rh-103  1 0 1-20 840  end
      rh-105  1 0 1-20 840  end
      pd-105  1 0 1-20 840  end
      pd-108  1 0 1-20 840  end
      ag-109  1 0 1-20 840  end
      sb-124  1 0 1-20 840  end
      xe-131  1 0 1-20 840  end
      xe-132  1 0 1-20 840  end
      xe-135  1 0 1-20 840  end
      xe-136  1 0 1-20 840  end
      cs-134  1 0 1-20 840  end
      cs-135  1 0 1-20 840  end
      cs-137  1 0 1-20 840  end
      ba-136  1 0 1-20 840  end
      la-139  1 0 1-20 840  end
      pr-141  1 0 1-20 840  end
      pr-143  1 0 1-20 840  end
      ce-144  1 0 1-20 840  end
      nd-143  1 0 1-20 840  end
      nd-145  1 0 1-20 840  end
      nd-147  1 0 1-20 840  end
      pm-147  1 0 1-20 840  end
      pm-148  1 0 1-20 840  end
      sm-147  1 0 1-20 840  end
      sm-149  1 0 1-20 840  end
      sm-150  1 0 1-20 840  end
      sm-151  1 0 1-20 840  end
      sm-152  1 0 1-20 840  end
      eu-153  1 0 1-20 840  end
      eu-154  1 0 1-20 840  end
      eu-155  1 0 1-20 840  end
      gd-155  1 0 1-20 840  end
      '
      zirc2  2 1 620  end
      '
      '
      h2o  3 den=0.240  1  557 end
      '
      n    4 0 5-5 557 end
      '
    . arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
                 40000 98.18 5 1.0 557   end
      '
      uo2  6 den=10.32  1  840
         92234 0.026 92235 2.732 92236 0.013 92238 97.231   end
      arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.036 840  end
      '
      h2o  7 den=0.862  1  557  end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      end comp
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
      '     fuel-pin-cell geometry:
      '
      squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
      '    assembly and cycle parameters:
      '
      npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
      printlevel=5 inplevel=2 numstotal=8 end
      6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
      power=9.313  burn=19   down=8    end
      power=11.086 burn=130  down=17   end
      power=13.919 burn=41   down=10   end
      power=10.863 burn=226  down=35   end
      power=11.941 burn=39   down=7    end
      power=13.549 burn=22   down=12   end
      power=12.716 burn=108  down=19   end
      power=13.177 burn=114  down=59   end
      power=10.795 burn=79   down=8    end
      power=11.941 burn=64   down=5    end
      power=10.037 burn=150  down=31   end
      power=10.099 burn=164  down=799  end
      power=6.234  burn=160  down=9    end
      power=6.465  burn=148  down=48   end
```

```
power=5.958  burn=96   down=61   end
power=6.272  burn=129  down=5    end
power=5.567  burn=57   down=1954.09   end
```

```
                    program verification information
                    code system:    scale  version:    4.3
                          program:  sas2
                    creation date:  03/07/97
                          library:  /opt/neut/Scale4.3/bin
                  this is not a   scale  configuration controlled code
                          jobname:  nichol
                  date of execution:  08/14/97
                  time of execution:  18:13:04
```

nuclide concentrations, grams

basis =single reactor assembly

	initial	18-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	18-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	1.57E-06	1.57E-06	1.57E-06	1.57E-06	1.57E-06	1.57E-06	1.57E-06
sm152	1.33E-05	1.34E-05	1.34E-05	1.35E-05	1.35E-05	1.36E-05	1.36E-05
eu153	6.92E-01	7.52E-01	7.76E-01	7.85E-01	7.89E-01	7.90E-01	7.91E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	3.49E-01	3.52E-01	3.54E-01	3.56E-01	3.57E-01	3.59E-01	3.60E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.44E-03	1.51E-03	1.57E-03	1.61E-03	1.70E-03	1.76E-03	1.82E-03
u234	1.64E+02	1.65E+02	1.65E+02	1.65E+02	1.66E+02	1.66E+02	1.67E+02
u235	1.20E+04	1.20E+04	1.20E+04	1.20E+04	1.20E+04	1.20E+04	1.20E+04
u236	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03
u238	8.42E+05	8.42E+05	8.42E+05	8.42E+05	8.42E+05	8.42E+05	8.42E+05
np237	1.98E+02	1.99E+02	1.99E+02	1.99E+02	1.99E+02	2.00E+02	2.00E+02
pu236	1.10E-04	8.91E-05	7.20E-05	5.82E-05	4.70E-05	3.80E-05	3.07E-05
pu238	5.58E+01	5.99E+01	6.06E+01	6.04E+01	6.01E+01	5.97E+01	5.93E+01
pu238	5.58E+01	5.99E+01	6.06E+01	6.04E+01	6.01E+01	5.97E+01	5.93E+01
pu239	4.40E+03	4.41E+03	4.41E+03	4.41E+03	4.41E+03	4.41E+03	4.41E+03
pu240	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03
pu241	5.55E+02	5.31E+02	5.09E+02	4.88E+02	4.67E+02	4.47E+02	4.28E+02
pu242	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02
am241	8.30E+01	1.06E+02	1.28E+02	1.50E+02	1.70E+02	1.89E+02	2.08E+02
am242m	1.63E+00	1.62E+00	1.62E+00	1.61E+00	1.60E+00	1.60E+00	1.59E+00
am243	1.81E+01	1.81E+01	1.81E+01	1.81E+01	1.81E+01	1.81E+01	1.80E+01
total	8.64E+05	8.64E+05	8.64E+05	8.64E+05	8.64E+05	8.64E+05	8.64E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	3.86E+02	4.02E+02	4.03E+02	4.03E+02	4.03E+02	4.03E+02	4.03E+02
tc 99	4.22E+02	4.22E+02	4.22E+02	4.22E+02	4.22E+02	4.22E+02	4.22E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	3.91E+02	3.91E+02	3.91E+02	3.91E+02	3.91E+02	3.91E+02	3.91E+02
rh103	2.50E+02	2.57E+02	2.57E+02	2.57E+02	2.57E+02	2.57E+02	2.57E+02
ag109	3.79E+01	3.79E+01	3.79E+01	3.79E+01	3.79E+01	3.79E+01	3.79E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	4.80E+02	4.83E+02	4.83E+02	4.83E+02	4.83E+02	4.83E+02	4.83E+02
nd145	3.65E+02	3.65E+02	3.65E+02	3.65E+02	3.65E+02	3.65E+02	3.65E+02
sm147	1.09E+02	1.22E+02	1.32E+02	1.40E+02	1.47E+02	1.52E+02	1.56E+02
sm149	1.59E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00
sm150	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02
sm151	1.03E+01	1.03E+01	1.02E+01	1.01E+01	1.01E+01	1.00E+01	9.94E+00
eu151	8.04E-02	1.51E-01	2.22E-01	2.92E-01	3.61E-01	4.30E-01	4.99E-01
sm152	6.86E+01	6.86E+01	6.87E+01	6.87E+01	6.87E+01	6.87E+01	6.87E+01
eu153	4.91E+01	4.92E+01	4.92E+01	6.92E+01	4.92E+01	4.92E+01	4.92E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	8.35E-02	3.12E-01	5.12E-01	6.88E-01	8.41E-01	9.76E-01	1.09E+00
total	1.72E+04	1.72E+04	1.72E+04	1.72E+04	1.72E+04	1.72E+04	1.72E+04

coop2966k.sum

```
0
                    SCALE4.3  Bulletin  Board
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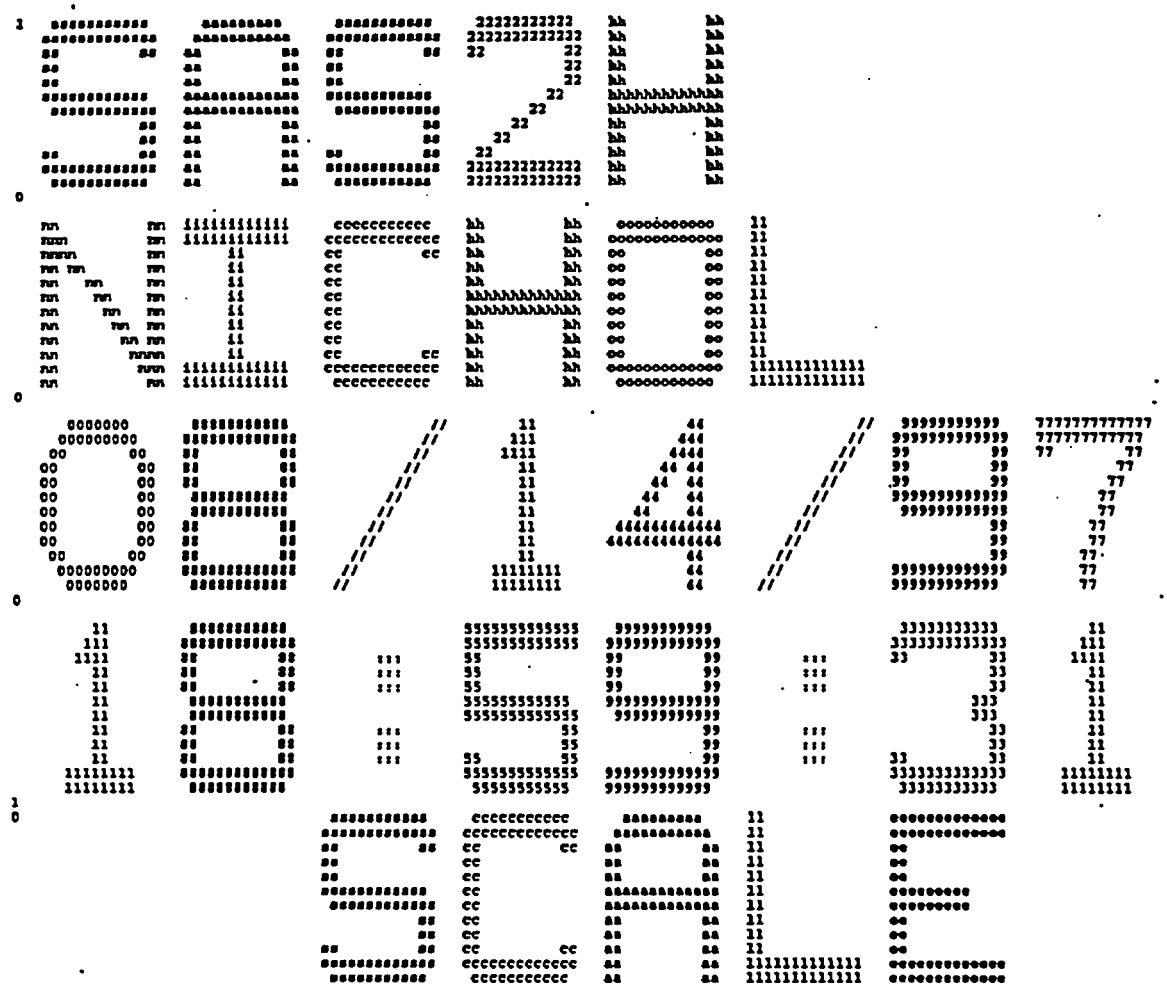
                      Welcome to SCALE-4.3.

1         primary module access and input record | scale driver - 95/03/29 - 09:06:37 |
-   module sas2h    will be called
      Cooper BWR Sample ADD2966-K, Height 218.869 cm from top, Aug 97
      '
      '
      '
      '   mixtures of fuel-pin-unit-cell:
      '
      44group          latticecell
      uo2  1 den=10.32  1  840
         92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
      kr-83  1 0 1-20 840  end
      kr-85  1 0 1-20 840  end
      y-89   1 0 1-20 840  end
      sr-90  1 0 1-20 840  end
      zr-93  1 0 1-20 840  end
      zr-94  1 0 1-20 840  end
      zr-95  1 0 1-20 840  end
      nb-94  1 0 1-20 840  end
      mo-95  1 0 1-20 840  end
      tc-99  1 0 1-20 840  end
      ru-101 1 0 1-20 840  end
      ru-106 1 0 1-20 840  end
      rh-103 1 0 1-20 840  end
      rh-105 1 0 1-20 840  end
      pd-105 1 0 1-20 840  end
      pd-108 1 0 1-20 840  end
      ag-109 1 0 1-20 840  end
      sb-124 1 0 1-20 840  end
      xe-131 1 0 1-20 840  end
      xe-132 1 0 1-20 840  end
      xe-135 1 0 1-20 840  end
      xe-136 1 0 1-20 840  end
      cs-134 1 0 1-20 840  end
      cs-135 1 0 1-20 840  end
      cs-137 1 0 1-20 840  end
      ba-136 1 0 1-20 840  end
      la-139 1 0 1-20 840  end
      pr-141 1 0 1-20 840  end
      pr-143 1 0 1-20 840  end
      ce-144 1 0 1-20 840  end
      nd-143 1 0 1-20 840  end
      nd-145 1 0 1-20 840  end
      nd-147 1 0 1-20 840  end
      pm-147 1 0 1-20 840  end
      pm-148 1 0 1-20 840  end
      sm-147 1 0 1-20 840  end
      sm-149 1 0 1-20 840  end
      sm-150 1 0 1-20 840  end
      sm-151 1 0 1-20 840  end
      sm-152 1 0 1-20 840  end
      eu-153 1 0 1-20 840  end
      eu-154 1 0 1-20 840  end
      eu-155 1 0 1-20 840  end
      gd-155 1 0 1-20 840  end
      '
      zirc2  2 1 620  end
      '
      '
      '
      h2o  3 den=0.478  1  557 end
      '
      n    4 0 5-5 557 end
      '
      arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
                 40000 98.18 5 1.0 557   end
      '
      uo2  6 den=10.32  1  840
         92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
      arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
      '
      h2o  7 den=0.862  1  557  end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      end comp
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
      '     fuel-pin-cell geometry:
      '
      squarepitch   1.87  1.21 1  3  1.43  2  1.262   0  end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
      '   assembly and cycle parameters:
      '
      npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
      printlevel=5 implevel=2 numstotal=8 end
      6 0.6050 4 0.6210 2 0.7150 3  1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
      power=16.243 burn=19   down=8   end
      power=19.336 burn=130  down=17  end
      power=24.278 burn=41   down=10  end
      power=18.947 burn=226  down=35  end
      power=20.827 burn=39   down=7   end
      power=21.632 burn=22   down=12  end
      power=22.179 burn=108  down=19  end
      power=22.983 burn=114  down=59  end
      power=18.829 burn=79   down=8   end
      power=20.827 burn=64   down=5   end
      power=17.506 burn=150  down=31  end
      power=17.615 burn=164  down=799 end
      power=10.874 burn=160  down=9   end
      power=11.276 burn=148  down=48  end
```

```
power=10.391 burn=96   down=61   end
power=10.939 burn=129  down=5    end
power=9.709  burn=57   down=1956.69   end
```



```
                    program verification information
                    code system:  scale  version:    4.3

                program:  sas2
             creation date:  03/07/97
                library:  /opt/neut/Scale4.3/bin

        this is not a  scale  configuration controlled code
                jobname:  nichol
          date of execution:  08/14/97
          time of execution:  18:59:32
```

nuclide concentrations, grams

basis =single reactor assembly

	initial	1E-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
sm147	.00E+00	1.19E-22	4.47E-22	9.56E-22	1.63E-21	1.63E-21
sm149	.00E+00	3.33E-12	5.99E-12	8.12E-12	9.81E-12	9.81E-12
sm150	.00E+00	1.76E-11	3.59E-11	5.47E-11	7.40E-11	7.40E-11
sm151	.00E+00	3.55E-10	7.01E-10	1.04E-09	1.37E-09	1.37E-09
sm152	.00E+00	3.77E-10	7.59E-10	1.13E-09	1.54E-09	1.54E-09
eu151	.00E+00	1.81E-12	3.60E-12	5.37E-12	7.11E-12	7.11E-12
eu153	.00E+00	6.57E-08	1.82E-07	4.08E-07	7.23E-07	7.23E-07
gd155m	.00E+00	4.65E-12	4.63E-12	4.61E-12	4.59E-12	4.58E-27
gd155	2.81E+00	2.82E+00	2.81E+00	2.80E+00	2.78E+00	2.78E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.97E-08	3.93E-08	5.89E-08	7.84E-08	7.84E-08
u234	9.79E-01	9.79E-01	9.78E-01	9.77E-01	9.76E-01	9.76E-01
u235	1.10E+02	1.10E+02	1.09E+02	1.09E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.21E-01	5.57E-01	5.93E-01	6.29E-01	6.29E-01
u238	3.59E+03	3,59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	7.22E-05	2.69E-04	5.65E-04	9.40E-04	9.40E-04
pu236	.00E+00	3.71E-14	4.35E-13	1.70E-12	4.27E-12	4.27E-12
pu238	.00E+00	5.22E-09	6.78E-08	2.88E-07	7.73E-07	7.73E-07
pu238	.00E+00	5.22E-09	6.78E-08	2.88E-07	7.73E-07	7.73E-07
pu239	.00E+00	2.65E-02	8.74E-02	1.65E-01	2.51E-01	2.51E-01
pu240	.00E+00	4.65E-05	2.26E-04	5.73E-04	1.10E-03	1.10E-03
pu241	.00E+00	1.13E-07	1.08E-06	4.06E-06	1.04E-05	1.04E-05
pu242	.00E+00	3.95E-11	7.42E-10	4.18E-09	1.43E-08	1.43E-08

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	8.45E-12	1.59E-10	8.94E-10	3.06E-09	3.06E-09
am242m	.00E+00	1.02E-15	3.74E-14	3.13E-13	1.42E-12	1.42E-12
am243	.00E+00	7.95E-15	2.84E-13	2.46E-12	1.14E-11	1.14E-11
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi
0 1697 total number of nuclides in library
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06
sm152	1.34E-05	1.35E-05	1.35E-05	1.36E-05	1.37E-05	1.37E-05	1.38E-05
eu153	7.80E-01	8.71E-01	9.06E-01	9.20E-01	9.26E-01	9.28E-01	9.29E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	2.12E-01	2.16E-01	2.20E-01	2.23E-01	2.26E-01	2.28E-01	2.30E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.49E-03	1.60E-03	1.71E-03	1.81E-03	1.93E-03	2.03E-03	2.14E-03
u234	1.32E+02	1.33E+02	1.34E+02	1.35E+02	1.37E+02	1.38E+02	1.39E+02
u235	5.22E+03	5.22E+03	5.22E+03	5.22E+03	5.22E+03	5.22E+03	5.22E+03
u236	3.46E+03	3.46E+03	3.46E+03	3.46E+03	3.46E+03	3.46E+03	3.46E+03
u238	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05
np237	3.40E+02	3.42E+02	3.42E+02	3.43E+02	3.43E+02	3.43E+02	3.44E+02
pu236	3.30E-04	2.68E-04	2.16E-04	1.75E-04	1.41E-04	1.14E-04	9.22E-05
pu238	1.50E+02	1.62E+02	1.64E+02	1.63E+02	1.62E+02	1.61E+02	1.60E+02
pu238	1.50E+02	1.62E+02	1.64E+02	1.63E+02	1.62E+02	1.61E+02	1.60E+02
pu239	3.93E+03	3.96E+03	3.96E+03	3.96E+03	3.95E+03	3.95E+03	3.95E+03
pu240	2.09E+03	2.09E+03	2.09E+03	2.09E+03	2.10E+03	2.10E+03	2.10E+03
pu241	8.90E+02	8.52E+02	8.16E+02	7.82E+02	7.49E+02	7.17E+02	6.87E+02
pu242	4.60E+02	4.60E+02	4.60E+02	4.60E+02	4.60E+02	4.60E+02	4.60E+02
am241	1.05E+02	1.43E+02	1.78E+02	2.13E+02	2.43E+02	2.76E+02	3.06E+02
am242m	1.99E+00	1.98E+00	1.97E+00	1.96E+00	1.95E+00	1.94E+00	1.93E+00
am243	9.47E+01	9.47E+01	9.47E+01	9.47E+01	9.47E+01	9.47E+01	9.47E+01
total	8.51E+05	8.51E+05	8.51E+05	8.51E+05	8.51E+05	8.51E+05	8.51E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	6.38E+02	6.65E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02
tc 99	7.01E+02	7.02E+02	7.02E+02	7.02E+02	7.02E+02	7.02E+02	7.02E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	6.78E+02	6.78E+02	6.78E+02	6.78E+02	6.78E+02	6.78E+02	6.78E+02
rh103	3.95E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02
ag109	7.93E+01	7.94E+01	7.94E+01	7.94E+01	7.94E+01	7.94E+01	7.94E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	6.56E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02
nd145	5.89E+02	5.89E+02	5.89E+02	5.89E+02	5.89E+02	5.89E+02	5.89E+02
sm147	1.51E+02	1.70E+02	1.85E+02	1.96E+02	2.06E+02	2.13E+02	2.19E+02
sm149	1.38E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00
sm150	2.37E+02	2.37E+02	2.37E+02	2.37E+02	2.37E+02	2.37E+02	2.37E+02
sm151	9.81E+00	9.82E+00	9.76E+00	9.69E+00	9.62E+00	9.56E+00	9.49E+00
eu151	2.87E-02	9.64E-02	1.64E-01	2.30E-01	2.97E-01	3.63E-01	4.28E-01
sm152	1.17E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02
eu153	1.03E+02	1.03E+02	1.03E+02	1.03E+02	1.03E+02	1.03E+02	1.03E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	8.07E-02	6.45E-01	1.14E+00	1.57E+00	1.95E+00	2.29E+00	2.58E+00
total	2.99E+04	2.99E+04	2.99E+04	2.99E+04	2.99E+04	2.99E+04	2.99E+04

coop2966t.sum

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0
                    SCALE4.3  Bulletin  Board
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                      Welcome to SCALE-4.3.

1          primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-    module sas2h     will be called
     Cooper BWR Sample ADD2966-T, Height 274.777 cm from top, Aug 97
      '
      '
      '   mixtures of fuel-pin-unit-cell:
      '
      44group          latticecell
      uo2  1 den=10.32  1  840
         92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
      kr-83   1 0 1-20 840  end
      kr-85   1 0 1-20 840  end
      y-89    1 0 1-20 840  end
      sr-90   1 0 1-20 840  end
      zr-93   1 0 1-20 840  end
      zr-94   1 0 1-20 840  end
      zr-95   1 0 1-20 840  end
      nb-94   1 0 1-20 840  end
      mo-95   1 0 1-20 840  end
      tc-99   1 0 1-20 840  end
      ru-101  1 0 1-20 840  end
      ru-106  1 0 1-20 840  end
      rh-103  1 0 1-20 840  end
      rh-105  1 0 1-20 840  end
      pd-105  1 0 1-20 840  end
      pd-108  1 0 1-20 840  end
      ag-109  1 0 1-20 840  end
      sb-124  1 0 1-20 840  end
      xe-131  1 0 1-20 840  end
      xe-132  1 0 1-20 840  end
      xe-135  1 0 1-20 840  end
      xe-136  1 0 1-20 840  end
      cs-134  1 0 1-20 840  end
      cs-135  1 0 1-20 840  end
      cs-137  1 0 1-20 840  end
      ba-136  1 0 1-20 840  end
      la-139  1 0 1-20 840  end
      pr-141  1 0 1-20 840  end
      pr-143  1 0 1-20 840  end
      ce-144  1 0 1-20 840  end
      nd-143  1 0 1-20 840  end
      nd-145  1 0 1-20 840  end
      nd-147  1 0 1-20 840  end
      pm-147  1 0 1-20 840  end
      pm-148  1 0 1-20 840  end
      sm-147  1 0 1-20 840  end
      sm-149  1 0 1-20 840  end
      sm-150  1 0 1-20 840  end
      sm-151  1 0 1-20 840  end
      sm-152  1 0 1-20 840  end
      eu-153  1 0 1-20 840  end
      eu-154  1 0 1-20 840  end
      eu-155  1 0 1-20 840  end
      gd-155  1 0 1-20 840  end
      '
      zirc2  2 1 620  end
      '
      '
      h2o  3 den=0.607  1  557 end
      '
      n    4 0 5-5 557 end
      '
     arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
                40000 98.18 5 1.0 557   end
      '
      uo2  6 den=10.32  1  840
         92234 0.026 92235 2.732 92236 0.013 92238 97.231   end
      arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
      '
      h2o  7 den=0.862  1  557  end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      end comp
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
      '     fuel-pin-cell geometry:
      '
      squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
      '    assembly and cycle parameters:
      '
      npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
      printlevel=5 inplevel=2 numstotal=8 end
      6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
      power=16.671  burn=19   down=8    end
      power=19.865 burn=130  down=17   end
      power=24.917 burn=41   down=10   end
      power=19.445 burn=226  down=35   end
      power=21.375 burn=39   down=7    end
      power=24.254 burn=22   down=12   end
      power=22.762 burn=108  down=19   end
      power=23.587 burn=114  down=39   end
      power=19.324 burn=79   down=8    end
      power=21.375 burn=64   down=5    end
      power=17.966 burn=150  down=31   end
      power=18.078 burn=164  down=799  end
      power=11.160 burn=160  down=9    end
      power=11.573 burn=148  down=48   end
```

```
     power=10.666 burn=96   down=61   end
     power=11.227 burn=129  down=5    end
     power=9.965  burn=57   down=1954.09   end
```

```
                    program verification information
                    code system:    scale  version:    4.3

                 program:  sas2
              creation date:  03/07/97
                 library:  /opt/nsut/Scale4.3/bin

        this is not a   scale  configuration controlled code

                 jobname:  nichol
           date of execution:  08/14/97
           time of execution:  19:46:24
```

```
                    nuclide concentrations, grams
```

basis =single reactor assembly

	initial	1E-18 d
gd155	6.39E+02	6.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
sm147	.00E+00	1.05E-22	3.94E-22	8.37E-22	1.42E-21	1.42E-21
sm149	.00E+00	3.08E-12	5.50E-12	7.40E-12	8.90E-12	8.90E-12
sm150	.00E+00	1.65E-11	3.37E-11	5.13E-11	6.94E-11	6.94E-11
sm151	.00E+00	3.31E-10	6.56E-10	9.67E-10	1.27E-09	1.27E-09
sm152	.00E+00	3.51E-10	7.07E-10	1.07E-09	1.44E-09	1.44E-09
eu151	.00E+00	1.71E-12	3.40E-12	5.06E-12	6.70E-12	6.70E-12
eu153	.00E+00	4.19E-08	1.67E-07	3.74E-07	6.62E-07	6.62E-07
gd155m	.00E+00	4.12E-12	4.10E-13	4.09E-12	4.07E-12	4.07E-27
gd155	2.83E+00	2.82E+00	2.81E+00	2.80E+00	2.78E+00	2.78E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.88E-08	3.75E-08	5.62E-08	7.48E-08	7.48E-08
u234	9.79E-01	9.79E-01	9.78E-01	9.77E-01	9.77E-01	9.77E-01
u235	1.10E+02	1.10E+02	1.09E+02	1.09E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.22E-01	5.58E-01	5.94E-01	6.30E-01	6.30E-01
u238	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	6.83E-05	2.56E-04	5.35E-04	8.90E-04	8.90E-04
pu236	.00E+00	3.34E-14	3.93E-13	1.53E-12	3.86E-12	3.86E-12
pu238	.00E+00	4.79E-09	6.22E-08	2.64E-07	7.09E-07	7.09E-07
pu238	.00E+00	4.79E-09	6.22E-08	2.64E-07	7.09E-07	7.09E-07
pu239	.00E+00	2.54E-02	8.38E-02	1.58E-01	2.41E-01	2.41E-01
pu240	.00E+00	4.30E-05	2.13E-04	5.43E-04	1.05E-03	1.05E-03
pu241	.00E+00	9.70E-08	9.40E-07	3.58E-06	9.24E-06	9.24E-06
pu242	.00E+00	3.48E-11	6.63E-10	3.77E-09	1.30E-08	1.30E-08

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	7.25E-12	1.38E-10	7.85E-10	2.70E-09	2.70E-09
am242m	.00E+00	8.58E-16	3.20E-14	2.70E-13	1.23E-12	1.23E-12
am243	.00E+00	6.15E-15	2.35E-13	2.05E-12	9.53E-12	9.54E-12
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi
0 1697 total number of nuclides in library
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	2.06E-06	2.06E-06	2.06E-06	2.06E-06	2.06E-06	2.06E-06	2.06E-06
sm152	1.28E-05	1.28E-05	1.29E-05	1.29E-05	1.30E-05	1.31E-05	1.31E-05
eu153	7.37E-01	8.25E-01	8.60E-01	8.74E-01	8.79E-01	8.81E-01	8.82E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	1.86E-01	1.90E-01	1.93E-01	1.96E-01	1.99E-01	2.01E-01	2.04E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.36E-03	1.47E-03	1.57E-03	1.68E-03	1.78E-03	1.89E-03	1.99E-03
u234	1.31E+02	1.32E+02	1.33E+02	1.35E+02	1.36E+02	1.37E+02	1.38E+02
u235	4.49E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03
u236	3.51E+03	3.51E+03	3.51E+03	3.51E+03	3.51E+03	3.51E+03	3.51E+03
u238	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05
np237	3.28E+02	3.30E+02	3.31E+02	3.31E+02	3.31E+02	3.31E+02	3.32E+02
pu236	3.08E-04	2.50E-04	2.02E-04	1.63E-04	1.32E-04	1.06E-04	8.60E-05
pu238	1.44E+02	1.56E+02	1.58E+02	1.57E+02	1.56E+02	1.55E+02	1.54E+02
pu238	1.44E+02	1.56E+02	1.58E+02	1.57E+02	1.56E+02	1.55E+02	1.54E+02
pu239	3.54E+03	3.57E+03	3.57E+03	3.57E+03	3.57E+03	3.57E+03	3.57E+03
pu240	2.08E+03	2.08E+03	2.08E+03	2.08E+03	2.08E+03	2.08E+03	2.08E+03
pu241	8.34E+02	7.99E+02	7.65E+02	7.33E+02	7.02E+02	6.72E+02	6.44E+02
pu242	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02
am241	9.45E+01	1.30E+02	1.63E+02	1.95E+02	2.26E+02	2.55E+02	2.83E+02
am242m	1.68E+00	1.67E+00	1.67E+00	1.66E+00	1.65E+00	1.64E+00	1.64E+00
am243	9.61E+01	9.62E+01	9.62E+01	9.62E+01	9.62E+01	9.61E+01	9.61E+01
total	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	6.56E+02	6.84E+02	6.85E+02	6.85E+02	6.85E+02	6.85E+02	6.85E+02
tc 99	7.21E+02	7.22E+02	7.22E+02	7.22E+02	7.22E+02	7.22E+02	7.22E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02
rh103	4.00E+02	4.13E+02	4.13E+02	4.13E+02	4.13E+02	4.13E+02	4.13E+02
ag109	8.12E+01	8.12E+01	8.12E+01	8.12E+01	8.12E+01	8.12E+01	8.12E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	6.44E+02	6.51E+02	6.51E+02	6.51E+02	6.51E+02	6.51E+02	6.51E+02
nd145	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02
sm147	1.57E+02	1.76E+02	1.91E+02	2.03E+02	2.12E+02	2.20E+02	2.26E+02
sm149	1.02E+00	1.36E+00	1.36E+00	1.36E+00	1.36E+00	1.36E+00	1.36E+00
sm150	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02
sm151	8.81E+00	8.83E+00	8.77E+00	8.71E+00	8.65E+00	8.59E+00	8.53E+00
eu151	2.25E-02	8.33E-02	1.44E-01	2.04E-01	2.63E-01	3.23E-01	3.81E-01
sm152	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02
eu153	1.05E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02

0 nuclide concentrations, grams
basis =single reactor assembly

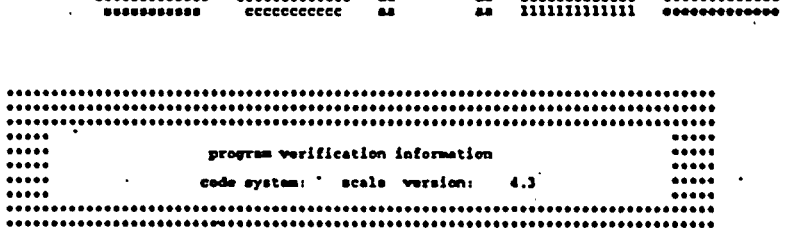
	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	6.88E-02	6.53E-01	1.16E+00	1.61E+00	2.01E+00	2.35E+00	2.65E+00
total	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04

coop2974b.sum

```
                    SCALE4.3  Bulletin  Board
                    --------  --------  -----

                      Welcome to SCALE-4.3.

1          primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
    Cooper BWR Sample ADD2974-B, Height 55.723 cm from top, Aug 97
    '
    '
    '   mixtures of fuel-pin-unit-cell:
    '
    44group        latticecell
    uo2   1 den=10.32  1   840
      92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
    kr-83   1 0 1-20 840  end
    kr-85   1 0 1-20 840  end
    y-89    1 0 1-20 840  end
    sr-90   1 0 1-20 840  end
    zr-93   1 0 1-20 840  end
    zr-94   1 0 1-20 840  end
    zr-95   1 0 1-20 840  end
    nb-94   1 0 1-20 840  end
    mo-95   1 0 1-20 840  end
    tc-99   1 0 1-20 840  end
    ru-101  1 0 1-20 840  end
    ru-106  1 0 1-20 840  end
    rh-103  1 0 1-20 840  end
    rh-105  1 0 1-20 840  end
    pd-105  1 0 1-20 840  end
    pd-108  1 0 1-20 840  end
    ag-109  1 0 1-20 840  end
    sb-124  1 0 1-20 840  end
    xe-131  1 0 1-20 840  end
    xe-132  1 0 1-20 840  end
    xe-135  1 0 1-20 840  end
    xe-136  1 0 1-20 840  end
    cs-134  1 0 1-20 840  end
    cs-135  1 0 1-20 840  end
    cs-137  1 0 1-20 840  end
    ba-136  1 0 1-20 840  end
    la-139  1 0 1-20 840  end
    pr-141  1 0 1-20 840  end
    pr-143  1 0 1-20 840  end
    ce-144  1 0 1-20 840  end
    nd-143  1 0 1-20 840  end
    nd-145  1 0 1-20 840  end
    nd-147  1 0 1-20 840  end
    pm-147  1 0 1-20 840  end
    pm-148  1 0 1-20 840  end
    sm-147  1 0 1-20 840  end
    sm-149  1 0 1-20 840  end
    sm-150  1 0 1-20 840  end
    sm-151  1 0 1-20 840  end
    sm-152  1 0 1-20 840  end
    eu-153  1 0 1-20 840  end
    eu-154  1 0 1-20 840  end
    eu-155  1 0 1-20 840  end
    gd-155  1 0 1-20 840  end
    '
    zirc2  2 1 620  end
    '
    '
    h2o  3 den=0.240  1  557 end
    '
    n    4 0 5-5 557 end
    '
    arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.60
               40000 98.18 5 1.0 557   end
    '
    uo2  6 den=10.32  1  840
       92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
    arbm-gdrod  10.32 2 0 1.0 8016 3 64000 2 6 0.034 840  end
    '
    h2o  7 den=0.862  1  557  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    end comp
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '     fuel-pin-cell geometry:
    '
    squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '   assembly and cycle parameters:
    '
    npin/assm=49 fuelnght=1719.76 ncycles=17  nlib/cyc=2
    printlevel=5 inplevel=2 numstotal=8 end
    6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
    power=8.763  burn=19   down=6    end
    power=10.431 burn=130  down=17   end
    power=13.097 burn=41   down=10   end
    power=10.221 burn=226  down=35   end
    power=11.235 burn=39   down=7    end
    power=12.749 burn=22   down=12   end
    power=11.965 burn=108  down=19   end
    power=12.398 burn=116  down=59   end
    power=10.157 burn=79   down=8    end
    power=11.235 burn=64   down=5    end
    power=9.444  burn=150  down=31   end
    power=9.503  burn=164  down=799  end
    power=5.866  burn=160  down=9    end
    power=6.083  burn=148  down=48   end
```



program verification information

code system: scale version: 4.3

program: sas2

creation date: 03/07/97

library: /opt/neut/Scale4.3/bin

this is not a scale configuration controlled code

jobname: nichol

date of execution: 08/14/97

time of execution: 20:34:30

nuclide concentrations, grams

basis =single reactor assembly

	initial	1E-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am147	.00E+00	5.14E-23	2.00E-22	4.42E-22	7.76E-22	7.76E-22
am149	.00E+00	2.35E-12	4.65E-12	6.33E-12	8.01E-12	8.01E-12
am150	.00E+00	1.14E-11	2.31E-11	3.50E-11	4.70E-11	4.70E-11
am151	.00E+00	2.36E-10	4.68E-10	6.98E-10	9.24E-10	9.24E-10
am152	.00E+00	2.49E-10	4.99E-10	7.51E-10	1.00E-09	1.00E-09
eu151	.00E+00	1.17E-12	2.33E-12	3.50E-12	4.65E-12	4.65E-12
eu153	.00E+00	3.17E-08	1.26E-07	2.83E-07	5.01E-07	5.01E-07
gd155m	.00E+00	3.50E-12	3.49E-12	3.48E-12	3.47E-12	3.47E-27
gd155	2.81E+00	2.81E+00	2.82E+00	2.81E+00	2.81E+00	2.81E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.24E-08	2.47E-08	3.70E-08	4.93E-08	4.93E-08
u234	9.79E-01	9.79E-01	9.78E-01	9.78E-01	9.78E-01	9.78E-01
u235	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.06E-01	5.26E-01	5.46E-01	5.66E-01	5.66E-01
u238	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	4.60E-05	1.71E-04	3.39E-04	5.96E-04	5.96E-04
pu236	.00E+00	1.49E-14	1.74E-13	6.79E-13	1.71E-12	1.71E-12
pu238	.00E+00	2.05E-09	2.66E-08	1.13E-07	3.03E-07	3.03E-07
pu238	.00E+00	2.05E-09	2.66E-08	1.13E-07	3.03E-07	3.03E-07
pu239	.00E+00	1.64E-02	5.42E-02	1.02E-01	1.56E-01	1.56E-01
pu240	.00E+00	1.81E-05	8.52E-05	2.11E-04	4.02E-04	4.02E-04
pu241	.00E+00	2.93E-08	2.71E-07	1.00E-06	2.54E-06	2.54E-06
pu242	.00E+00	5.58E-12	1.02E-10	5.61E-10	1.89E-09	1.89E-09

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	2.23E-12	4.05E-11	2.24E-10	7.53E-10	7.54E-10
am242m	.00E+00	1.38E-16	5.66E-15	4.65E-14	2.08E-13	2.08E-13
am243	.00E+00	7.21E-16	2.64E-14	2.23E-13	1.02E-12	1.02E-12
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi
0 1697 total number of nuclides in library
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06
sm152	1.32E-05	1.32E-05	1.33E-05	1.33E-05	1.34E-05	1.34E-05	1.34E-05
eu153	6.66E-01	7.23E-01	7.45E-01	7.54E-01	7.57E-01	7.59E-01	7.59E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	3.53E-01	3.56E-01	3.58E-01	3.59E-01	3.61E-01	3.62E-01	3.63E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.40E-03	1.45E-03	1.51E-03	1.57E-03	1.63E-03	1.69E-03	1.75E-03
u234	1.68E+02	1.68E+02	1.68E+02	1.69E+02	1.69E+02	1.69E+02	1.70E+02
u235	1.25E+04	1.25E+04	1.25E+04	1.25E+04	1.25E+04	1.25E+04	1.25E+04
u236	2.52E+03	2.52E+03	2.52E+03	2.52E+03	2.52E+03	2.52E+03	2.52E+03
u238	8.43E+05	8.43E+05	8.43E+05	8.43E+05	8.43E+05	8.43E+05	8.43E+05
np237	1.82E+02	1.84E+02	1.84E+02	1.84E+02	1.84E+02	1.84E+02	1.85E+02
pu236	9.44E-05	7.65E-05	6.11E-05	4.99E-05	4.06E-05	3.26E-05	2.63E-05
pu238	4.86E+01	5.21E+01	5.27E+01	5.25E+01	5.22E+01	5.19E+01	5.15E+01
pu238	4.86E+01	5.21E+01	5.27E+01	5.25E+01	5.22E+01	5.19E+01	5.15E+01
pu239	4.31E+03	4.32E+03	4.32E+03	4.32E+03	4.32E+03	4.32E+03	4.32E+03
pu240	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03
pu241	5.10E+02	4.88E+02	4.67E+02	4.48E+02	4.29E+02	4.11E+02	3.93E+02
pu242	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02
am241	7.71E+01	9.85E+01	1.19E+02	1.38E+02	1.57E+02	1.75E+02	1.92E+02
am242m	1.49E+00	1.48E+00	1.47E+00	1.47E+00	1.46E+00	1.46E+00	1.45E+00
am243	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01
total	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	3.65E+02	3.81E+02	3.81E+02	3.81E+02	3.81E+02	3.81E+02	3.81E+02
tc 99	3.99E+02	3.99E+02	3.99E+02	3.99E+02	3.99E+02	3.99E+02	3.99E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02
rh103	2.37E+02	2.43E+02	2.43E+02	2.43E+02	2.43E+02	2.43E+02	2.43E+02
ag109	3.47E+01	3.47E+01	3.47E+01	3.47E+01	3.47E+01	3.47E+01	3.47E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	4.58E+02	4.62E+02	4.62E+02	4.62E+02	4.62E+02	4.62E+02	4.62E+02
nd145	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02
sm147	1.05E+02	1.18E+02	1.27E+02	1.35E+02	1.41E+02	1.46E+02	1.50E+02
sm149	1.58E+00	1.73E+00	1.73E+00	1.73E+00	1.73E+00	1.73E+00	1.73E+00
sm150	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02
sm151	1.01E+01	1.01E+01	9.99E+00	9.92E+00	9.85E+00	9.78E+00	9.71E+00
eu151	8.52E-02	1.55E-01	2.23E-01	2.92E-01	3.60E-01	4.27E-01	4.94E-01
sm152	6.48E+01	6.48E+01	6.48E+01	6.48E+01	6.48E+01	6.48E+01	6.48E+01
eu153	4.50E+01	4.51E+01	4.51E+01	4.51E+01	4.51E+01	4.51E+01	4.51E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	8.04E-02	2.87E-01	4.69E-01	6.27E-01	7.67E-01	8.89E-01	9.96E-01
total	1.62E+04	1.62E+04	1.62E+04	1.62E+04	1.62E+04	1.62E+04	1.62E+04

coop2974j.sum

```
0*************************************************************************
*                                                                       *
*                  SCALE4.3  Bulletin  Board                            *
*                  --------  --------  -----                            *
*                                                                       *
*                    Welcome to SCALE-4.3.                              *
*                                                                       *
*                                                                       *
*************************************************************************
1         primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
    Cooper BWR Sample ADD2974-J, Height 115.042 cm from top, Aug 97
    '
    '
    '
    '   mixtures of fuel-pin-unit-cell:
    '
    44group         latticecell
    uo2  1 den=10.32  1  840
       92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
    kr-83   1 0 1-20 840  end
    kr-85   1 0 1-20 840  end
    y-89    1 0 1-20 840  end
    sr-90   1 0 1-20 840  end
    zr-93   1 0 1-20 840  end
    zr-94   1 0 1-20 840  end
    zr-95   1 0 1-20 840  end
    nb-94   1 0 1-20 840  end
    mo-95   1 0 1-20 840  end
    tc-99   1 0 1-20 840  end
    ru-101  1 0 1-20 840  end
    ru-106.1 0 1-20 840  end
    rh-103  1 0 1-20 840  end
    rh-105  1 0 1-20 840  end
    pd-105  1 0 1-20 840  end
    pd-108  1 0 1-20 840  end
    ag-109  1 0 1-20 840  end
    sb-124  1 0 1-20 840  end
    xe-131  1 0 1-20 840  end
    xe-132  1 0 1-20 840  end
    xe-135  1 0 1-20 840  end
    xe-136  1 0 1-20 840  end
    cs-134  1 0 1-20 840  end
    cs-135  1 0 1-20 840  end
    cs-137  1 0 1-20 840  end
    ba-136  1 0 1-20 840  end
    la-139  1 0 1-20 840  end
    pr-141  1 0 1-20 840  end
    pr-143  1 0 1-20 840  end
    ce-144  1 0 1-20 840  end
    nd-143  1 0 1-20 840  end
    nd-145  1 0 1-20 840  end
    nd-147  1 0 1-20 840  end
    pm-147  1 0 1-20 840  end
    pm-148  1 0 1-20 840  end
    sm-147  1 0 1-20 840  end
    sm-149  1 0 1-20 840  end
    sm-150  1 0 1-20 840  end
    sm-151  1 0 1-20 840  end
    sm-152  1 0 1-20 840  end
    eu-153  1 0 1-20 840  end
    eu-154  1 0 1-20 840  end
    eu-155  1 0 1-20 840  end
    gd-155  1 0 1-20 840  end
    '
    zirc2  2 1 620  end
    '
    '
    '
    h2o  3 den=0.306  1  557 end
    '
    n    4 0 5-5 557 end
    '
    arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
               40000 98.18 5 1.0 557   end
    '
    uo2  6 den=10.32  1  840
       92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
    arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
    '
    h2o  7 den=0.862  1  557  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    end comp
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '      fuel-pin-cell geometry:
    '
    squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '    assembly and cycle parameters:
    '
    npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
    printlevel=5 implevel=2 numstotal=8 end
    6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
    power=16.357 burn=19   down=8    end
    power=17.091 burn=130  down=17   end
    power=21.459 burn=41   down=10   end
    power=16.747 burn=226  down=35   end
    power=18.409 burn=39   down=7    end
    power=20.888 burn=22   down=12   end
    power=19.603 burn=108  down=19   end
    power=20.316 burn=116  down=59   end
    power=16.642 burn=79   down=8    end
    power=18.409 burn=64   down=5    end
    power=15.473 burn=150  down=31   end
    power=15.570 burn=164  down=799  end
    power=9.611  burn=160  down=9    end
    power=9.967  burn=148  down=48   end
```

```
      power=9.184  burn=96   down=61    end
      power=9.669  burn=129  down=5     end
      power=8.582  burn=57   down=1934.09    end
      .
      . - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      .
1   ssssssssss     aaaaaaaa     ssssssssss    2222222222    hh        hh
   ssssssssssss   aaaaaaaaaa   ssssssssssss  222222222222   hh        hh
   ss        ss  aa        aa  ss        ss  22        22   hh        hh
   ss            aa        aa  ss                      22   hh        hh
   ss            aa        aa  ss                      22   hh        hh
   sssssssssss   aaaaaaaaaaaa  sssssssssss            22    hhhhhhhhhhhh
    sssssssssss  aaaaaaaaaaaa   sssssssssss          22     hhhhhhhhhhhh
             ss  aa        aa            ss        22       hh        hh
             ss  aa        aa            ss      22         hh        hh
   ss        ss  aa        aa  ss        ss    22           hh        hh
   ssssssssssss  aa        aa  ssssssssssss  222222222222   hh        hh
    ssssssssss   aa        aa   ssssssssss   222222222222   hh        hh
0
   nn        nn  iiiiiiiiii     cccccccccc   hh        hh    oooooooooo    ll
   nnn       nn  iiiiiiiiii    cccccccccccc  hh        hh   oooooooooooo   ll
   nnnn      nn      ii       cc        cc   hh        hh   oo        oo   ll
   nn nn     nn      ii       cc             hh        hh   oo        oo   ll
   nn  nn    nn      ii       cc             hh        hh   oo        oo   ll
   nn   nn   nn      ii       cc             hhhhhhhhhhhh   oo        oo   ll
   nn    nn  nn      ii       cc             hhhhhhhhhhhh   oo        oo   ll
   nn     nn nn      ii       cc             hh        hh   oo        oo   ll
   nn      nnnn      ii       cc             hh        hh   oo        oo   ll
   nn       nnn      ii       cc        cc   hh        hh   oo        oo   ll
   nn        nn  iiiiiiiiii    cccccccccccc  hh        hh   oooooooooooo   llllllllllll
   nn        nn  iiiiiiiiii     cccccccccc   hh        hh    oooooooooo    llllllllllll
0
     0000000      8888888888          //        11          44          //   9999999999    777777777777
    000000000    888888888888        //        111         444         //   999999999999   777777777777
   00       00   88        88       //        1111        4444        //    99        99   77        77
   00       00   88        88      //           11       44 44       //     99        99             77
   00       00   88        88     //            11      44  44      //      99        99            77
   00       00    8888888888     //             11     44   44     //       999999999999           77
   00       00    8888888888    //              11    44    44    //         99999999999          77
   00       00   88        88  //               11   444444444444 //                  99         77
   00       00   88        88 //                11   444444444444//                   99        77
   00       00   88        88//                 11          44  //                    99       77
    000000000    888888888888//              11111111       44 //          999999999999      77
     0000000      8888888888//               11111111       44//           99999999999      77
0
   2222222222        11                  2222222222        11                  0000000          44
  222222222222      111                 222222222222      111                 000000000        444
  22        22     1111        :::      22        22     1111        :::    00       00      4444
            22       11        :::                22       11        :::    00       00     44 44
            22       11        :::                22       11        :::    00       00    44  44
           22        11                          22        11               00       00   44   44
         22          11                        22          11               00       00  44    44
       22            11        :::           22            11        :::    00       00  444444444444
     22              11        :::         22              11        :::    00       00  444444444444
   22                11        :::       22                11        :::    00       00         44
  222222222222    11111111              222222222222    11111111             000000000          44
  222222222222    11111111              222222222222    11111111              0000000           44
1
0
                         ssssssssss     cccccccccc      aaaaaaaa    ll            eeeeeeeeeeee
                        ssssssssssss   cccccccccccc    aaaaaaaaaa   ll            eeeeeeeeeeee
                        ss        ss  cc        cc    aa        aa  ll            ee
                        ss            cc              aa        aa  ll            ee
                        ss            cc              aa        aa  ll            ee
                        sssssssssss   cc              aaaaaaaaaaaa  ll            eeeeeeee
                         sssssssssss  cc              aaaaaaaaaaaa  ll            eeeeeeee
                                  ss  cc              aa        aa  ll            ee
                                  ss  cc              aa        aa  ll            ee
                        ss        ss  cc        cc    aa        aa  ll            ee
                        ssssssssssss  cccccccccccc    aa        aa  llllllllllll  eeeeeeeeeeee
                         ssssssssss    cccccccccc     aa        aa  llllllllllll  eeeeeeeeeeee
```

```
          ************************************************************************
          ************************************************************************
          *****                                                              *****
          *****                  program verification information            *****
          *****                                                              *****
          *****                code system:    scale  version:    4.3        *****
          *****                                                              *****
          ************************************************************************
          ************************************************************************
          *****                                                              *****
          *****                                                              *****
          *****             program:  sas2                                   *****
          *****                                                              *****
          *****       creation date:  03/07/97                               *****
          *****                                                              *****
          *****             library:  /opt/neut/Scale4.3/bin                 *****
          *****                                                              *****
          *****                                                              *****
          *****   this is not a   scale  configuration controlled code       *****
          *****                                                              *****
          *****             jobname:  nichol                                 *****
          *****                                                              *****
          *****   date of execution:  08/14/97                               *****
          *****                                                              *****
          *****   time of execution:  21:21:04                               *****
          *****                                                              *****
          ************************************************************************
          ************************************************************************
1
0
0
0
0                            nuclide concentrations, grams
```

basis =single reactor assembly

	initial	1E-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	2.25E-06	2.25E-06	2.25E-06	2.25E-06	2.25E-06	2.25E-06	2.25E-06
sm152	1.41E-05	1.42E-05	1.42E-05	1.43E-05	1.44E-05	1.45E-05	1.45E-05
eu153	8.25E-01	9.22E-01	9.46E-01	9.59E-01	9.64E-01	9.67E-01	9.67E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	2.78E-01	2.82E-01	2.85E-01	2.89E-01	2.91E-01	2.94E-01	2.96E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.64E-03	1.75E-03	1.85E-03	1.95E-03	2.06E-03	2.16E-03	2.27E-03
u234	1.38E+02	1.39E+02	1.40E+02	1.41E+02	1.42E+02	1.43E+02	1.44E+02
u235	7.22E+03	7.22E+03	7.22E+03	7.22E+03	7.22E+03	7.22E+03	7.22E+03
u236	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03
u238	8.35E+05	8.35E+05	8.35E+05	8.35E+05	8.35E+05	8.35E+05	8.35E+05
np237	3.25E+02	3.27E+02	3.27E+02	3.28E+02	3.28E+02	3.29E+02	3.29E+02
pu236	2.99E-04	2.42E-04	1.96E-04	1.58E-04	1.28E-04	1.03E-04	8.34E-05
pu238	1.35E+02	1.45E+02	1.47E+02	1.47E+02	1.46E+02	1.45E+02	1.44E+02
pu239	1.35E+02	1.45E+02	1.47E+02	1.47E+02	1.46E+02	1.45E+02	1.44E+02
pu239	4.59E+03	4.61E+03	4.61E+03	4.61E+03	4.61E+03	4.61E+03	4.61E+03
pu240	1.98E+03	1.98E+03	1.98E+03	1.98E+03	1.98E+03	1.98E+03	1.98E+03
pu241	8.97E+02	8.59E+02	8.23E+02	7.88E+02	7.55E+02	7.23E+02	6.93E+02
pu242	3.42E+02	3.42E+02	3.42E+02	3.42E+02	3.42E+02	3.42E+02	3.42E+02
am241	1.17E+02	1.54E+02	1.90E+02	2.25E+02	2.58E+02	2.89E+02	3.19E+02
am242m	2.41E+00	2.40E+00	2.39E+00	2.38E+00	2.37E+00	2.36E+00	2.34E+00
am243	7.13E+01	7.13E+01	7.13E+01	7.13E+01	7.13E+01	7.13E+01	7.13E+01
total	8.55E+05	8.55E+05	8.55E+05	8.55E+05	8.55E+05	8.55E+05	8.55E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	5.67E+02	5.92E+02	5.93E+02	5.93E+02	5.93E+02	5.93E+02	5.93E+02
tc 99	6.23E+02	6.24E+02	6.24E+02	6.24E+02	6.24E+02	6.24E+02	6.24E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	5.98E+02	5.98E+02	5.98E+02	5.98E+02	5.98E+02	5.98E+02	5.98E+02
rh103	3.62E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02
ag109	6.85E+01	6.85E+01	6.85E+01	6.85E+01	6.85E+01	6.85E+01	6.85E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	6.37E+02	6.42E+02	6.42E+02	6.42E+02	6.42E+02	6.42E+02	6.42E+02
nd145	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02
sm147	1.38E+02	1.55E+02	1.69E+02	1.79E+02	1.88E+02	1.94E+02	2.00E+02
sm149	1.48E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00	1.76E+00
sm150	2.11E+02	2.11E+02	2.11E+02	2.11E+02	2.11E+02	2.11E+02	2.11E+02
sm151	1.13E+01	1.13E+01	1.13E+01	1.12E+01	1.11E+01	1.10E+01	1.09E+01
eu151	4.55E-02	1.24E-01	2.01E-01	2.78E-01	3.55E-01	4.31E-01	5.06E-01
sm152	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
eu153	8.85E+01	8.87E+01	8.87E+01	8.87E+01	8.88E+01	8.88E+01	8.88E+01
gd155	9.99E-02	5.68E-01	9.73E-01	1.34E+00	1.65E+00	1.93E+00	2.17E+00
total	2.64E+04	2.64E+04	2.64E+04	2.64E+04	2.64E+04	2.64E+04	2.64E+04

coop2974u.sum

```
                    SCALE4.3  Bulletin  Board
                    --------  --------  -----

                      Welcome to SCALE-4.3.

1          primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
    Cooper BWR Sample ADO2974-U, Height 291.087 cm from top, Aug 97
    '
    '
    '   mixtures of fuel-pin-unit-cell:
    '
    44group         latticecell
    uo2  1 den=10.32  1  840
       92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
    kr-83   1 0 1-20 840  end
    kr-85   1 0 1-20 840  end
    y-89    1 0 1-20 840  end
    sr-90   1 0 1-20 840  end
    zr-93   1 0 1-20 840  end
    zr-94   1 0 1-20 840  end
    zr-95   1 0 1-20 840  end
    nb-94   1 0 1-20 840  end
    mo-95   1 0 1-20 840  end
    tc-99   1 0 1-20 840  end
    ru-101  1 0 1-20 840  end
    ru-106  1 0 1-20 840  end
    rh-103  1 0 1-20 840  end
    rh-105  1 0 1-20 840  end
    pd-105  1 0 1-20 840  end
    pd-108  1 0 1-20 840  end
    ag-109  1 0 1-20 840  end
    sb-124  1 0 1-20 840  end
    xe-131  1 0 1-20 840  end
    xe-132  1 0 1-20 840  end
    xe-135  1 0 1-20 840  end
    xe-136  1 0 1-20 840  end
    cs-134  1 0 1-20 840  end
    cs-135  1 0 1-20 840  end
    cs-137  1 0 1-20 840  end
    ba-136  1 0 1-20 840  end
    la-139  1 0 1-20 840  end
    pr-141  1 0 1-20 840  end
    pr-143  1 0 1-20 840  end
    ce-144  1 0 1-20 840  end
    nd-143  1 0 1-20 840  end
    nd-145  1 0 1-20 840  end
    nd-147  1 0 1-20 840  end
    pm-147  1 0 1-20 840  end
    pm-148  1 0 1-20 840  end
    sm-147  1 0 1-20 840  end
    sm-149  1 0 1-20 840  end
    sm-150  1 0 1-20 840  end
    sm-151  1 0 1-20 840  end
    sm-152  1 0 1-20 840  end
    eu-153  1 0 1-20 840  end
    eu-154  1 0 1-20 840  end
    eu-155  1 0 1-20 840  end
    gd-155  1 0 1-20 840  end
    '
    zirc2  2 1 620  end
    '
    '
    '
    h2o  3 den=0.652  1  557 end
    '
    n    4 0 5-5 557 end
    '
    arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
               40000 98.18 5 1.0 557   end
    '
    uo2  6 den=10.32  1  840
       92234 0.024 92235 2.732 92236 0.013 92238 97.231   end
    arbm-gdrod  10.32 2 0 1.0 8016 3 64000 2 6 0.034 840  end
    '
    h2o  7 den=0.862  1  557  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    end comp
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '     fuel-pin-cell geometry:
    '
    squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '   assembly and cycle parameters:
    '
    npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
    printlevel=5 inplevel=2 numstotal=8 end
    6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
    power=15.246 burn=19   down=8    end
    power=18.149 burn=130  down=17   end
    power=22.788 burn=81   down=10   end
    power=17.786 burn=226  down=35   end
    power=19.549 burn=39   down=7    end
    power=22.182 burn=22   down=12   end
    power=20.817 burn=108  down=19   end
    power=21.572 burn=114  down=59   end
    power=17.673 burn=79   down=8    end
    power=19.549 burn=64   down=5    end
    power=16.431 burn=150  down=31   end
    power=16.534 burn=164  down=799  end
    power=10.206 burn=160  down=9    end
    power=10.584 burn=148  down=48   end
```

```
      power=9.753  burn=96   down=61    end
      power=10.268 burn=129  down=5     end
      power=9.113  burn=57   down=1954.09   end
      '
      ' - - - - - - - - - - - - - - - - - - - - - - - - - -
      '
1   sssssssssss     aaaaaaaaa     sssssssssss   22222222222   hh         hh
   sssssssssssss   aaaaaaaaaaa   sssssssssssss 2222222222222  hh         hh
   ss         ss  aa         aa  ss         ss 22         22  hh         hh
   ss             aa         aa  ss                       22  hh         hh
   ss             aa         aa  ss                       22  hh         hh
   ssssssssssss   aaaaaaaaaaaaa  ssssssssssss            22   hhhhhhhhhhhhh
    ssssssssssss  aaaaaaaaaaaaa   ssssssssssss         22     hhhhhhhhhhhhh
              ss  aa         aa             ss       22       hh         hh
              ss  aa         aa             ss     22         hh         hh
   ss         ss  aa         aa  ss         ss   22           hh         hh
   sssssssssssss  aa         aa  sssssssssssss 2222222222222  hh         hh
    sssssssssss   aa         aa   sssssssssss  2222222222222  hh         hh
0
   nn         nn  iiiiiiiiiiii    cccccccccc   hh         hh   ooooooooooo   ll
   nnn        nn  iiiiiiiiiiii   cccccccccccc  hh         hh  ooooooooooooo  ll
   nnnn       nn       ii       cc         cc  hh         hh  oo         oo  ll
   nn nn      nn       ii       cc             hh         hh  oo         oo  ll
   nn  nn     nn       ii       cc             hh         hh  oo         oo  ll
   nn   nn    nn       ii       cc             hhhhhhhhhhhhh  oo         oo  ll
   nn    nn   nn       ii       cc             hhhhhhhhhhhhh  oo         oo  ll
   nn     nn  nn       ii       cc             hh         hh  oo         oo  ll
   nn      nn nn       ii       cc             hh         hh  oo         oo  ll
   nn       nnnn       ii       cc         cc  hh         hh  oo         oo  ll
   nn        nnn  iiiiiiiiiiii   cccccccccccc  hh         hh  ooooooooooooo  llllllllllll
   nn         nn  iiiiiiiiiiii    cccccccccc   hh         hh   ooooooooooo   llllllllllll
0
      0000000      8888888888           //        11           44           //   9999999999   777777777777
    000000000    888888888888          //        111          444          //   999999999999  777777777777
   00       00   88        88         //        1111         4444         //    99        99  77        77
   00       00   88        88        //           11        44 44        //     99        99            77
   00       00   88        88       //            11       44  44       //      99        99           77
   00       00    8888888888       //             11      44   44      //       999999999999          77
   00       00    8888888888      //              11     44    44     //         99999999999         77
   00       00   88        88    //               11    44444444444  //                   99        77
   00       00   88        88   //                11    44444444444 //                    99        77
    00     00    88        88  //                 11           44  //                     99       77
    000000000    888888888888 //               11111111        44 //        999999999999       77
      0000000     8888888888 //                11111111        44//         99999999999        77
0
   22222222222   22222222222              0000000     777777777777            3333333333   22222222222
  2222222222222 2222222222222           000000000     777777777777           333333333333 2222222222222
  22         22 22         22   :::    00       00    77        77    :::    33        33 22         22
             22            22   :::    00       00             77     :::              33            22
             22            22   :::    00       00            77      :::              33            22
           22            22            00       00           77                      333           22
         22            22              00       00           77                      333         22
       22            22         :::    00       00          77        :::              33      22
     22            22           :::    00       00          77        :::              33    22
   22            22             :::     00     00           77        :::    33        33  22
  2222222222222 2222222222222            000000000          77               333333333333 2222222222222
  2222222222222 2222222222222              0000000          77                3333333333  2222222222222
1
0                           sssssssssss    cccccccccc      aaaaaaaaa    ll            eeeeeeeeeeee
                           sssssssssssss  cccccccccccc    aaaaaaaaaaa   ll            eeeeeeeeeeee
                           ss         ss  cc         cc  aa         aa  ll            ee
                           ss             cc             aa         aa  ll            ee
                           ss             cc             aa         aa  ll            ee
                           ssssssssssss   cc             aaaaaaaaaaaaa  ll            eeeeeeeee
                            ssssssssssss  cc             aaaaaaaaaaaaa  ll            eeeeeeeee
                                      ss  cc             aa         aa  ll            ee
                                      ss  cc             aa         aa  ll            ee
                           ss         ss  cc         cc  aa         aa  ll            ee
                           sssssssssssss  cccccccccccc   aa         aa  llllllllllll  eeeeeeeeeeee
                            sssssssssss    cccccccccc    aa         aa  llllllllllll  eeeeeeeeeeee


          **************************************************************************
          **************************************************************************
          **************************************************************************
          *****                                                              *****
          *****              program verification information               *****
          *****                                                              *****
          *****            code system:    scale  version:    4.3           *****
          *****                                                              *****
          **************************************************************************
          **************************************************************************
          *****                                                              *****
          *****                                                              *****
          *****             program:  sas2                                   *****
          *****                                                              *****
          *****       creation date:  03/07/97                               *****
          *****                                                              *****
          *****             library:  /opt/neut/Scale4.3/bin                 *****
          *****                                                              *****
          *****                                                              *****
          *****    this is not a   scale  configuration controlled code      *****
          *****                                                              *****
          *****             jobname:  nichol                                 *****
          *****                                                              *****
          *****   date of execution:  08/14/97                               *****
          *****                                                              *****
          *****   time of execution:  22:07:32                               *****
          *****                                                              *****
          **************************************************************************
          **************************************************************************
          **************************************************************************
1
0
0
0
0                              nuclide concentrations, grams
```

basis =single reactor assembly

	initial	1E-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =

0	initial	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
0	initial	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	1.85E-06	1.85E-06	1.85E-06	1.85E-06	1.85E-06	1.85E-06	1.85E-06
sm152	1.22E-05	1.22E-05	1.23E-05	1.24E-05	1.24E-05	1.25E-05	1.25E-05
eu153	6.97E-01	7.76E-01	8.07E-01	8.20E-01	8.24E-01	8.26E-01	8.27E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	1.89E-01	1.92E-01	1.96E-01	1.98E-01	2.01E-01	2.03E-01	2.05E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.32E-03	1.41E-03	1.51E-03	1.60E-03	1.69E-03	1.78E-03	1.88E-03
u234	1.39E+02	1.40E+02	1.41E+02	1.42E+02	1.43E+02	1.44E+02	1.45E+02
u235	5.32E+03	5.32E+03	5.32E+03	5.32E+03	5.32E+03	5.32E+03	5.32E+03
u236	3.40E+03	3.40E+03	3.40E+03	3.40E+03	3.40E+03	3.40E+03	3.40E+03
u238	8.37E+05	8.37E+05	8.37E+05	8.37E+05	8.37E+05	8.37E+05	8.37E+05
np237	2.89E+02	2.91E+02	2.91E+02	2.92E+02	2.92E+02	2.92E+02	2.93E+02
pu236	2.34E-04	1.90E-04	1.53E-04	1.24E-04	1.00E-04	8.08E-05	6.53E-05
pu238	1.16E+02	1.26E+02	1.28E+02	1.27E+02	1.27E+02	1.26E+02	1.25E+02
pu238	1.16E+02	1.26E+02	1.28E+02	1.27E+02	1.27E+02	1.26E+02	1.25E+02
pu239	3.45E+03	3.47E+03	3.47E+03	3.47E+03	3.47E+03	3.47E+03	3.47E+03
pu240	1.92E+03	1.92E+03	1.92E+03	1.92E+03	1.92E+03	1.92E+03	1.92E+03
pu241	7.54E+02	7.22E+02	6.92E+02	6.63E+02	6.35E+02	6.08E+02	5.82E+02
pu242	3.98E+02	3.98E+02	3.98E+02	3.98E+02	3.98E+02	3.98E+02	3.98E+02
am241	9.00E+01	1.22E+02	1.52E+02	1.81E+02	2.08E+02	2.35E+02	2.60E+02
am242m	1.57E+00	1.56E+00	1.56E+00	1.55E+00	1.54E+00	1.54E+00	1.53E+00
am243	7.00E+01	7.00E+01	7.00E+01	7.00E+01	7.00E+01	7.00E+01	7.00E+01
total	8.53E+05	8.53E+05	8.53E+05	8.53E+05	8.53E+05	8.53E+05	8.53E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	6.11E+02	6.37E+02	6.38E+02	6.38E+02	6.38E+02	6.38E+02	6.38E+02
tc 99	6.70E+02	6.71E+02	6.71E+02	6.71E+02	6.71E+02	6.71E+02	6.71E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	6.39E+02	6.39E+02	6.39E+02	6.39E+02	6.39E+02	6.39E+02	6.39E+02
rh103	3.74E+02	3.86E+02	3.86E+02	3.86E+02	3.86E+02	3.86E+02	3.86E+02
ag109	7.13E+01	7.13E+01	7.13E+01	7.13E+01	7.13E+01	7.13E+01	7.13E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	6.20E+02	6.26E+02	6.26E+02	6.26E+02	6.26E+02	6.26E+02	6.26E+02
nd145	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02
sm147	1.54E+02	1.72E+02	1.87E+02	1.98E+02	2.07E+02	2.14E+02	2.20E+02
sm149	1.00E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00
sm150	2.19E+02	2.19E+02	2.19E+02	2.19E+02	2.19E+02	2.19E+02	2.19E+02
sm151	8.32E+00	8.33E+00	8.27E+00	8.22E+00	8.16E+00	8.11E+00	8.05E+00
eu151	2.44E-02	8.18E-02	1.39E-01	1.95E-01	2.52E-01	3.08E-01	3.63E-01
sm152	1.14E+02	1.14E+02	1.14E+02	1.14E+02	1.14E+02	1.14E+02	1.14E+02
eu153	9.29E+01	9.32E+01	9.32E+01	9.32E+01	9.32E+01	9.32E+01	9.32E+01

0 nuclide concentrations, grams
basis =single reactor assembly

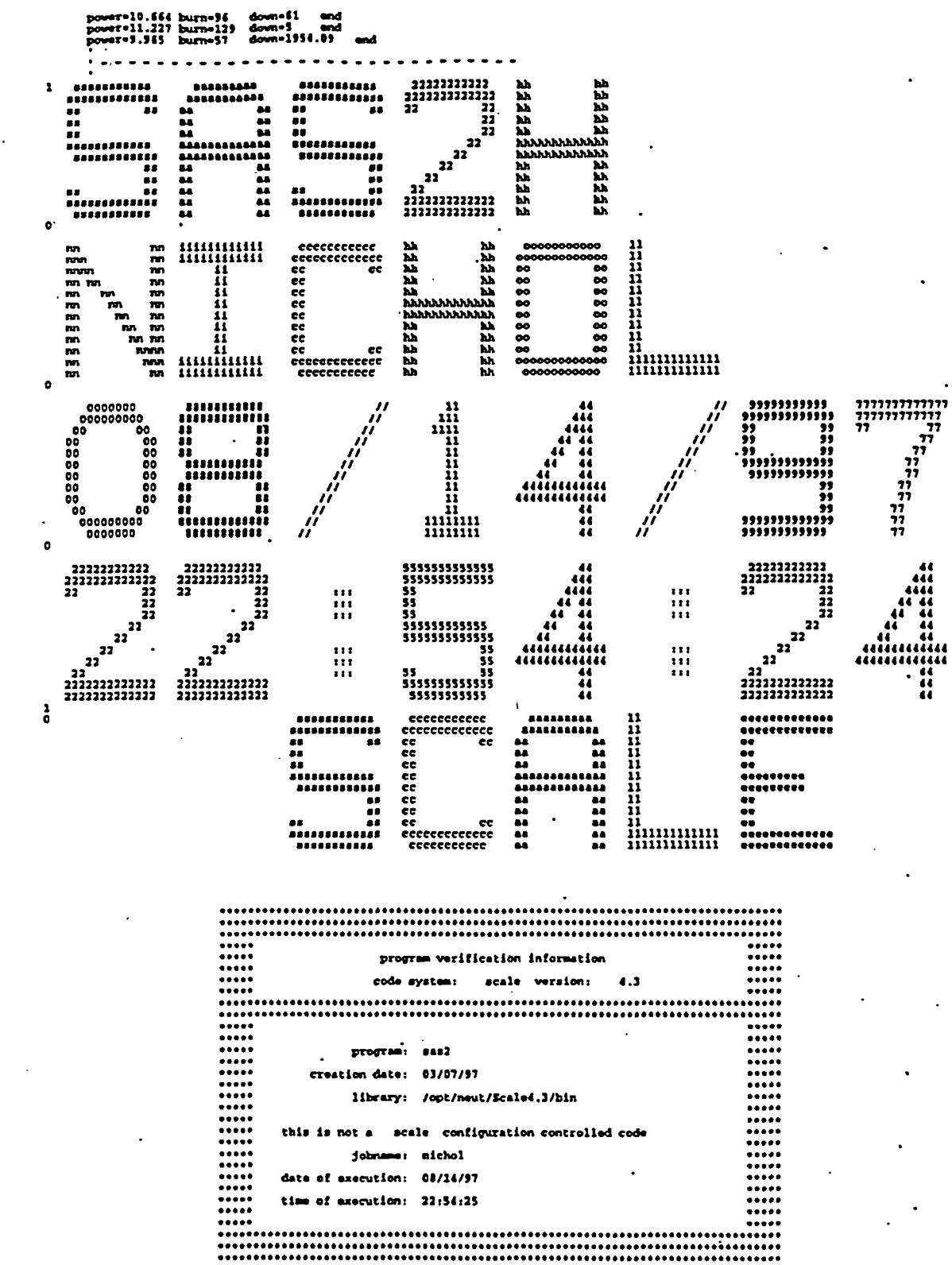
	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	6.27E-02	5.64E-01	1.00E+00	1.39E+00	1.72E+00	2.02E+00	2.28E+00
total	2.81E+04	2.81E+04	2.81E+04	2.81E+04	2.81E+04	2.81E+04	2.81E+04

2966tplus100deg.sum

```
                SCALE4.3  Bulletin  Board
                --------  --------  -----

                  Welcome to SCALE-4.3.

1         primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
    Cooper BWR Sample ADD2966-T, Height 274.777 cm from top, Aug 97
    '
    '  100 K increase in fuel temperature
    '
    '   mixtures of fuel-pin-unit-cell:
    '
    44group        latticecell
    uo2  1 den=10.32  1  940
       92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
    kr-83   1 0 1-20 940  end
    kr-85   1 0 1-20 940  end
    y-89    1 0 1-20 940  end
    sr-90   1 0 1-20 940  end
    zr-93   1 0 1-20 940  end
    zr-94   1 0 1-20 940  end
    zr-95   1 0 1-20 940  end
    nb-94   1 0 1-20 940  end
    mo-95   1 0 1-20 940  end
    tc-99   1 0 1-20 940  end
    ru-101  1 0 1-20 940  end
    ru-106  1 0 1-20 940  end
    rh-103  1 0 1-20 940  end
    rh-105  1 0 1-20 940  end
    pd-105  1 0 1-20 940  end
    pd-108  1 0 1-20 940  end
    ag-109  1 0 1-20 940  end
    sb-124  1 0 1-20 940  end
    xe-131  1 0 1-20 940  end
    xe-132  1 0 1-20 940  end
    xe-135  1 0 1-20 940  end
    xe-136  1 0 1-20 940  end
    cs-134  1 0 1-20 940  end
    cs-135  1 0 1-20 940  end
    cs-137  1 0 1-20 940  end
    ba-136  1 0 1-20 940  end
    la-139  1 0 1-20 940  end
    pr-141  1 0 1-20 940  end
    pr-143  1 0 1-20 940  end
    ce-144  1 0 1-20 940  end
    nd-143  1 0 1-20 940  end
    nd-145  1 0 1-20 940  end
    nd-147  1 0 1-20 940  end
    pm-147  1 0 1-20 940  end
    pm-148  1 0 1-20 940  end
    sm-147  1 0 1-20 940  end
    sm-149  1 0 1-20 940  end
    sm-150  1 0 1-20 940  end
    sm-151  1 0 1-20 940  end
    sm-152  1 0 1-20 940  end
    eu-153  1 0 1-20 940  end
    eu-154  1 0 1-20 940  end
    eu-155  1 0 1-20 940  end
    gd-155  1 0 1-20 940  end
    '
    zirc2  2 1 620  end
    '
    '
    '
    h2o  3 den=0.607  1  557 end
    '
    n    4 0 5-5 557 end
    '
  . arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
                60000 98.18 5 1.0 557   end
    '
    uo2  6 den=10.32  1  940
       92234 0.026 92235 2.732 92236 0.013 92238 97.231   end
    arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.036 940  end
    '
    h2o  7 den=0.862  1  557  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    end comp
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '      fuel-pin-cell geometry:
    '
    squarepitch   1.87  1.21 1  3  1.43  2  1.242   0 end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '    assembly and cycle parameters:
    '
    npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
    printlevel=5 inplevel=2 numstotal=8 end
    6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
    power=16.671  burn=19   down=8    end
    power=19.845 burn=130  down=17   end
    power=24.917 burn=41   down=10   end
    power=19.445 burn=226  down=35   end
    power=21.375 burn=39   down=7    end
    power=24.254 burn=22   down=12   end
    power=22.762 burn=108  down=19   end
    power=21.587 burn=114  down=59   end
    power=19.324 burn=79   down=8    end
    power=21.375 burn=64   down=5    end
    power=17.966 burn=150  down=31   end
    power=18.078 burn=164  down=799  end
    power=11.160 burn=160  down=9    end
    power=11.573 burn=148  down=48   end
```


power=10.666 burn=96 down=61 end
power=11.227 burn=129 down=5 end
power=9.965 burn=57 down=1954.09 end
program verification information
code system: scale version: 4.3
program: sas2
creation date: 03/07/97
library: /opt/neut/Scale4.3/bin
this is not a scale configuration controlled code
jobname: michol
date of execution: 08/14/97
time of execution: 22:54:25
100 K increase in fuel temperature
nuclide concentrations, grams

basis =single reactor assembly

	initial	1E-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am147	.00E+00	1.05E-22	3.95E-22	8.40E-22	1.43E-21	1.43E-21
am149	.00E+00	3.08E-12	5.51E-12	7.41E-12	8.91E-12	8.91E-12
am150	.00E+00	1.65E-11	3.37E-11	5.14E-11	6.95E-11	6.95E-11
am151	.00E+00	3.32E-10	6.55E-10	9.69E-10	1.27E-09	1.27E-09
am152	.00E+00	3.51E-10	7.08E-10	1.07E-09	1.44E-09	1.44E-09
eu151	.00E+00	1.71E-12	3.40E-12	5.07E-12	6.71E-12	6.71E-12
eu153	.00E+00	4.19E-08	1.67E-07	3.74E-07	6.62E-07	6.62E-07
gd155m	.00E+00	4.13E-12	4.11E-12	4.09E-12	4.07E-12	4.07E-27
gd155	2.83E+00	2.82E+00	2.81E+00	2.80E+00	2.78E+00	2.78E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.88E-08	3.76E-08	5.63E-08	7.49E-08	7.49E-08
u234	9.77E-01	9.77E-01	9.77E-01	9.77E-01	9.77E-01	9.77E-01
u235	1.10E+02	1.10E+02	1.09E+02	1.09E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.22E-01	5.58E-01	5.94E-01	6.30E-01	6.30E-01
u238	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	6.84E-05	2.55E-04	5.35E-04	8.91E-04	8.92E-04
pu236	.00E+00	3.35E-14	3.94E-13	1.34E-12	3.87E-12	3.87E-12
pu238	.00E+00	4.79E-09	6.23E-08	2.64E-07	7.10E-07	7.10E-07
pu238	.00E+00	4.79E-09	6.23E-08	2.64E-07	7.10E-07	7.10E-07
pu239	.00E+00	2.56E-02	8.44E-02	1.60E-01	2.42E-01	2.42E-01
pu240	.00E+00	4.33E-05	2.14E-04	5.47E-04	1.06E-03	1.06E-03
pu241	.00E+00	9.77E-08	9.47E-07	3.61E-06	9.31E-06	9.31E-06
pu242	.00E+00	3.51E-11	6.68E-10	3.80E-09	1.31E-08	1.31E-08

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	7.30E-12	1.39E-10	7.90E-10	2.72E-09	2.72E-09
am242m	.00E+00	8.66E-16	3.23E-14	2.73E-13	1.24E-12	1.24E-12
am243	.00E+00	6.19E-15	2.36E-13	2.06E-12	9.60E-12	9.60E-12
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi

0 1697 total number of nuclides in library
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	2.07E-06	2.07E-06	2.07E-06	2.07E-06	2.07E-06	2.07E-06	2.07E-06
sm152	1.28E-05	1.29E-05	1.29E-05	1.30E-05	1.30E-05	1.31E-05	1.32E-05
eu153	7.37E-01	8.26E-01	8.61E-01	8.76E-01	8.80E-01	8.82E-01	8.82E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	1.87E-01	1.91E-01	1.95E-01	1.98E-01	2.00E-01	2.03E-01	2.05E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.37E-03	1.48E-03	1.58E-03	1.69E-03	1.79E-03	1.90E-03	2.00E-03
u234	1.32E+02	1.33E+02	1.34E+02	1.35E+02	1.36E+02	1.37E+02	1.38E+02
u235	4.54E+03	4.54E+03	4.54E+03	4.54E+03	4.54E+03	4.54E+03	4.54E+03
u236	3.50E+03	3.50E+03	3.50E+03	3.50E+03	3.50E+03	3.50E+03	3.50E+03
u238	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05	8.34E+05
np237	3.29E+02	3.32E+02	3.32E+02	3.33E+02	3.33E+02	3.33E+02	3.34E+02
pu236	3.10E-04	2.51E-04	2.03E-04	1.64E-04	1.32E-04	1.07E-04	8.64E-05
pu238	1.44E+02	1.56E+02	1.58E+02	1.58E+02	1.57E+02	1.56E+02	1.55E+02
pu238	1.44E+02	1.56E+02	1.58E+02	1.58E+02	1.57E+02	1.56E+02	1.55E+02
pu239	3.58E+03	3.61E+03	3.61E+03	3.61E+03	3.61E+03	3.61E+03	3.61E+03
pu240	2.08E+03	2.08E+03	2.08E+03	2.08E+03	2.08E+03	2.08E+03	2.08E+03
pu241	8.41E+02	8.06E+02	7.72E+02	7.39E+02	7.08E+02	6.78E+02	6.50E+02
pu242	4.92E+02	4.92E+02	4.92E+02	4.92E+02	4.92E+02	4.92E+02	4.92E+02
am241	9.58E+01	1.31E+02	1.65E+02	1.97E+02	2.28E+02	2.58E+02	2.86E+02
am242m	1.71E+00	1.70E+00	1.69E+00	1.69E+00	1.68E+00	1.67E+00	1.66E+00
am243	9.67E+01	9.67E+01	9.67E+01	9.67E+01	9.67E+01	9.67E+01	9.66E+01
total	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	6.56E+02	6.84E+02	6.85E+02	6.85E+02	6.85E+02	6.85E+02	6.85E+02
tc 99	7.21E+02	7.22E+02	7.22E+02	7.22E+02	7.22E+02	7.22E+02	7.22E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02
rh103	4.01E+02	4.14E+02	4.14E+02	4.14E+02	4.14E+02	4.14E+02	4.14E+02
ag109	8.15E+01	8.15E+01	8.15E+01	8.15E+01	8.15E+01	8.15E+01	8.15E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	6.46E+02	6.52E+02	6.52E+02	6.52E+02	6.52E+02	6.52E+02	6.52E+02
nd145	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02
sm147	1.57E+02	1.76E+02	1.91E+02	2.03E+02	2.13E+02	2.20E+02	2.26E+02
sm149	1.03E+00	1.37E+00	1.37E+00	1.37E+00	1.37E+00	1.37E+00	1.37E+00
sm150	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02
sm151	8.88E+00	8.90E+00	8.84E+00	8.78E+00	8.71E+00	8.66E+00	8.60E+00
eu151	2.29E-02	8.42E-02	1.45E-01	2.06E-01	2.66E-01	3.25E-01	3.85E-01
sm152	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02
eu153	1.05E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	6.95E-02	6.94E-01	1.17E+00	1.61E+00	2.01E+00	2.35E+00	2.65E+00
total	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04

2966tplus10den.sum

```
0
*                                                                              *
*                    SCALE4.3  Bulletin  Board                                 *
*                    --------  --------  -----                                 *
*                                                                              *
*                      Welcome to SCALE-4.3.                                   *
*                                                                              *
*                                                                              *
********************************************************************************
1       primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
    Cooper BWR Sample ADD2966-T, Height 274.777 cm from top, Aug 97
    '
    '  increase moderator density by 10%
    '
    '  mixtures of fuel-pin-unit-cell:
    '
    44group        latticecell
    uo2  1 den=10.32  1  840
       92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
    kr-83   1 0 1-20 840  end
    kr-85   1 0 1-20 840  end
    y-89    1 0 1-20 840  end
    sr-90   1 0 1-20 840  end
    zr-93   1 0 1-20 840  end
    zr-94   1 0 1-20 840  end
    zr-95   1 0 1-20 840  end
    nb-94   1 0 1-20 840  end
    mo-95   1 0 1-20 840  end
    tc-99   1 0 1-20 840  end
    ru-101  1 0 1-20 840  end
    ru-106  1 0 1-20 840  end
    rh-103  1 0 1-20 840  end
    rh-105  1 0 1-20 840  end
    pd-105  1 0 1-20 840  end
    pd-108  1 0 1-20 840  end
    ag-109  1 0 1-20 840  end
    sb-124  1 0 1-20 840  end
    xe-131  1 0 1-20 840  end
    xe-132  1 0 1-20 840  end
    xe-135  1 0 1-20 840  end
    xe-136  1 0 1-20 840  end
    cs-134  1 0 1-20 840  end
    cs-135  1 0 1-20 840  end
    cs-137  1 0 1-20 840  end
    ba-136  1 0 1-20 840  end
    la-139  1 0 1-20 840  end
    pr-141  1 0 1-20 840  end
    pr-143  1 0 1-20 840  end
    ce-144  1 0 1-20 840  end
    nd-143  1 0 1-20 840  end
    nd-145  1 0 1-20 840  end
    nd-147  1 0 1-20 840  end
    pm-147  1 0 1-20 840  end
    pm-148  1 0 1-20 840  end
    sm-147  1 0 1-20 840  end
    sm-149  1 0 1-20 840  end
    sm-150  1 0 1-20 840  end
    sm-151  1 0 1-20 840  end
    sm-152  1 0 1-20 840  end
    eu-153  1 0 1-20 840  end
    eu-154  1 0 1-20 840  end
    eu-155  1 0 1-20 840  end
    gd-155  1 0 1-20 840  end
    '
    zirc2  2 1 620  end
    '
    '
    h2o  3 den=0.668  1  557 end
    '
    n    4 0 5-5 557 end
    '
    arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
               40000 98.18 5 1.0 557   end
    '
    uo2  6 den=10.32  1  840
       92234 0.026 92235 2.732 92236 0.013 92238 97.231   end
    arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 840  end
    '
    h2o  7 den=0.862  1  557  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    end comp
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '     fuel-pin-cell geometry:
    '
    squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '    assembly and cycle parameters:
    '
    npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
    printlevel=5 implevel=2 numstotal=8 end
    6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
    power=16.671  burn=19   down=8    end
    power=19.845 burn=130  down=17   end
    power=24.917 burn=41   down=10   end
    power=19.445 burn=226  down=35   end
    power=21.375 burn=39   down=7    end
    power=24.254 burn=22   down=12   end
    power=22.762 burn=108  down=19   end
    power=23.587 burn=114  down=59   end
    power=19.324 burn=79   down=8    end
    power=21.375 burn=64   down=5    end
    power=17.966 burn=150  down=31   end
    power=18.078 burn=164  down=799  end
    power=11.160 burn=160  down=9    end
    power=11.573 burn=148  down=48   end
```

```
      power=10.664 burn=96   down=61   end
      power=11.227 burn=129  down=5    end
      power=9.965  burn=57   down=1954.09   end
      - - - - - - - - - - - - - - - - - - - - - - - - -
1
    SAS2H
0
    NICHOL
0
    08/14/97
0
    23:41:08
1
0
    SCALE
```

```
***********************************************************************
***********************************************************************
*****                                                            *****
*****               program verification information            *****
*****                                                            *****
*****            code system:   scale  version:   4.3           *****
*****                                                            *****
***********************************************************************
***********************************************************************
*****                                                            *****
*****                    program:  sas2                         *****
*****                                                            *****
*****              creation date:  03/07/97                     *****
*****                                                            *****
*****                    library:  /opt/neut/Scale4.3/bin       *****
*****                                                            *****
*****      this is not a   scale  configuration controlled code *****
*****                                                            *****
*****                    jobname:  nichol                       *****
*****                                                            *****
*****          date of execution:  08/14/97                     *****
*****                                                            *****
*****          time of execution:  23:41:08                     *****
*****                                                            *****
***********************************************************************
***********************************************************************
1
0
0  increase moderator density by 10%
0
0                         nuclide concentrations, grams
```

basis =single reactor assembly

	initial	1E-18 d
gd155	4.39E+02	4.39E+02
total	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

0 basis =
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d
0 initial 2.4 d 4.8 d 7.1 d 9.5 d 9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
sm147	.00E+00	9.74E-23	3.64E-22	7.74E-22	1.31E-21	1.31E-21
sm149	.00E+00	2.94E-12	5.24E-12	7.05E-12	8.47E-12	8.47E-12
sm150	.00E+00	1.59E-11	3.23E-11	4.93E-11	6.66E-11	6.66E-11
sm151	.00E+00	3.18E-10	6.37E-10	9.27E-10	1.22E-09	1.22E-09
sm152	.00E+00	3.36E-10	6.78E-10	1.02E-09	1.38E-09	1.38E-09
eu151	.00E+00	1.65E-12	3.27E-12	4.87E-12	6.46E-12	6.46E-12
eu153	.00E+00	3.98E-08	1.59E-07	3.56E-07	6.30E-07	6.30E-07
gd155m	.00E+00	3.87E-12	3.85E-12	3.84E-12	3.82E-12	3.82E-27
gd155	2.83E+00	2.82E+00	2.81E+00	2.80E+00	2.78E+00	2.78E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.82E-08	3.63E-08	5.44E-08	7.24E-08	7.24E-08
u234	9.79E-01	9.79E-01	9.78E-01	9.77E-01	9.77E-01	9.77E-01
u235	1.10E+02	1.10E+02	1.09E+02	1.09E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.22E-01	5.57E-01	5.93E-01	6.29E-01	6.29E-01
u238	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	6.60E-05	2.46E-04	5.16E-04	8.59E-04	8.59E-04
pu236	.00E+00	3.13E-14	3.67E-13	1.43E-12	3.61E-12	3.61E-12
pu238	.00E+00	4.51E-09	5.86E-08	2.49E-07	6.68E-07	6.68E-07
pu238	.00E+00	4.51E-09	5.86E-08	2.49E-07	6.68E-07	6.68E-07
pu239	.00E+00	2.47E-02	8.14E-02	1.54E-01	2.34E-01	2.34E-01
pu240	.00E+00	4.07E-05	2.02E-04	5.19E-04	1.00E-03	1.00E-03
pu241	.00E+00	8.80E-08	8.58E-07	3.28E-06	8.49E-06	8.49E-06
pu242	.00E+00	3.15E-11	6.04E-10	3.45E-09	1.19E-08	1.19E-08

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	6.56E-12	1.26E-10	7.17E-10	2.47E-09	2.47E-09
am242m	.00E+00	7.64E-16	2.87E-14	2.43E-13	1.11E-12	1.11E-12
am243	.00E+00	5.32E-15	2.04E-13	1.79E-12	8.35E-12	8.36E-12
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi

0 1697 total number of nuclides in library
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	1.99E-06	1.99E-06	1.99E-06	1.99E-06	1.99E-06	1.99E-06	1.99E-06
sm152	1.24E-05	1.25E-05	1.26E-05	1.26E-05	1.27E-05	1.27E-05	1.28E-05
eu153	7.15E-01	8.02E-01	8.37E-01	8.50E-01	8.55E-01	8.57E-01	8.58E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	1.78E-01	1.82E-01	1.85E-01	1.88E-01	1.91E-01	1.93E-01	1.95E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.31E-03	1.41E-03	1.51E-03	1.61E-03	1.72E-03	1.82E-03	1.92E-03
u234	1.32E+02	1.33E+02	1.34E+02	1.35E+02	1.36E+02	1.37E+02	1.38E+02
u235	4.31E+03	4.31E+03	4.31E+03	4.31E+03	4.31E+03	4.31E+03	4.31E+03
u236	3.52E+03	3.52E+03	3.52E+03	3.52E+03	3.52E+03	3.52E+03	3.52E+03
u238	8.35E+05	8.35E+05	8.35E+05	8.35E+05	8.35E+05	8.35E+05	8.35E+05
np237	3.19E+02	3.21E+02	3.21E+02	3.22E+02	3.22E+02	3.22E+02	3.23E+02
pu236	2.91E-04	2.35E-04	1.90E-04	1.54E-04	1.24E-04	1.00E-04	8.11E-05
pu238	1.38E+02	1.50E+02	1.52E+02	1.51E+02	1.50E+02	1.49E+02	1.48E+02
pu238	1.38E+02	1.50E+02	1.52E+02	1.51E+02	1.50E+02	1.49E+02	1.48E+02
pu239	3.40E+03	3.42E+03	3.42E+03	3.42E+03	3.42E+03	3.42E+03	3.42E+03
pu240	2.06E+03	2.06E+03	2.06E+03	2.06E+03	2.06E+03	2.06E+03	2.06E+03
pu241	8.04E+02	7.70E+02	7.38E+02	7.07E+02	6.77E+02	6.48E+02	6.21E+02
pu242	4.92E+02	4.92E+02	4.92E+02	4.92E+02	4.92E+02	4.92E+02	4.92E+02
am241	8.99E+01	1.24E+02	1.56E+02	1.87E+02	2.16E+02	2.44E+02	2.71E+02
am242m	1.56E+00	1.56E+00	1.55E+00	1.54E+00	1.53E+00	1.53E+00	1.52E+00
am243	9.33E+01	9.33E+01	9.33E+01	9.33E+01	9.33E+01	9.33E+01	9.33E+01
total	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05	8.50E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	6.58E+02	6.86E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02
tc 99	7.23E+02	7.24E+02	7.24E+02	7.24E+02	7.24E+02	7.24E+02	7.24E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02
rh103	3.98E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02
ag109	8.07E+01	8.08E+01	8.08E+01	8.08E+01	8.08E+01	8.08E+01	8.08E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	6.36E+02	6.42E+02	6.42E+02	6.42E+02	6.42E+02	6.42E+02	6.42E+02
nd145	6.06E+02	6.07E+02	6.07E+02	6.07E+02	6.07E+02	6.07E+02	6.07E+02
sm147	1.58E+02	1.78E+02	1.93E+02	2.05E+02	2.14E+02	2.22E+02	2.28E+02
sm149	9.66E-01	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00
sm150	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02
sm151	8.41E+00	8.41E+00	8.37E+00	8.31E+00	8.26E+00	8.20E+00	8.14E+00
eu151	2.06E-02	7.87E-02	1.36E-01	1.94E-01	2.51E-01	3.07E-01	3.63E-01
sm152	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02
eu153	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	6.41E-02	6.46E-01	1.16E+00	1.60E+00	2.00E+00	2.36E+00	2.64E+00
total	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04	3.07E+04

2974bplus100deg.sum

```
                    SCALE4.3  Bulletin  Board
                    --------  --------  -----

                      Welcome to SCALE-4.3.

1          primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-   module sas2h    will be called
    Cooper BWR Sample ADD2974-B, Height 55.723 cm from top, Aug 97
    '
    '  increase fuel temperature 100 K
    '
    '   mixtures of fuel-pin-unit-cell:
    '
    44group         latticecell
    uo2  1 den=10.32  1  940
       92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
    kr-83  1 0 1-20 940  end
    kr-85  1 0 1-20 940  end
    y-89   1 0 1-20 940  end
    sr-90  1 0 1-20 940  end
    sr-93  1 0 1-20 940  end
    sr-94  1 0 1-20 940  end
    sr-95  1 0 1-20 940  end
    nb-94  1 0 1-20 940  end
    mo-95  1 0 1-20 940  end
    tc-99  1 0 1-20 940  end
    ru-101 1 0 1-20 940  end
    ru-106 1 0 1-20 940  end
    rh-103 1 0 1-20 940  end
    rh-105 1 0 1-20 940  end
    pd-105 1 0 1-20 940  end
    pd-108 1 0 1-20 940  end
    ag-109 1 0 1-20 940  end
    sb-124 1 0 1-20 940  end
    xe-131 1 0 1-20 940  end
    xe-132 1 0 1-20 940  end
    xe-135 1 0 1-20 940  end
    xe-136 1 0 1-20 940  end
    cs-134 1 0 1-20 940  end
    cs-135 1 0 1-20 940  end
    cs-137 1 0 1-20 940  end
    ba-136 1 0 1-20 940  end
    la-139 1 0 1-20 940  end
    pr-141 1 0 1-20 940  end
    pr-143 1 0 1-20 940  end
    ce-144 1 0 1-20 940  end
    nd-143 1 0 1-20 940  end
    nd-145 1 0 1-20 940  end
    nd-147 1 0 1-20 940  end
    pm-147 1 0 1-20 940  end
    pm-148 1 0 1-20 940  end
    sm-147 1 0 1-20 940  end
    sm-149 1 0 1-20 940  end
    sm-150 1 0 1-20 940  end
    sm-151 1 0 1-20 940  end
    sm-152 1 0 1-20 940  end
    eu-153 1 0 1-20 940  end
    eu-154 1 0 1-20 940  end
    eu-155 1 0 1-20 940  end
    gd-155 1 0 1-20 940  end
    '
    zirc2  2 1 620  end
    '
    '
    '
    h2o  3 den=0.240  1  557 end
    '
    n    4 0 5-5 557 end
    '
    arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
               40000 98.18 5 1.0 557   end
    '
    uo2  6 den=10.32  1  940
       92234 0.026 92235 2.732 92236 0.013 92238 97.231   end
    arbm-gdrod  10.32 2 0 1 0 8016 3 64000 2 6 0.034 940  end
    '
    h2o  7 den=0.862  1  557  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    end comp
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '      fuel-pin-cell geometry:
    '
    squarepitch   1.87  1.21 1  3  1.43  2  1.242   0  end
    '
    ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    '
    '    assembly and cycle parameters:
    '
    npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
    printlevel=5 inplevel=2 sumatotal=8 end
    6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
    power=8.763  burn=19   down=8    end
    power=10.431 burn=130  down=17   end
    power=13.097 burn=41   down=10   end
    power=10.221 burn=226  down=35   end
    power=11.235 burn=39   down=7    end
    power=12.749 burn=22   down=12   end
    power=11.965 burn=108  down=19   end
    power=12.398 burn=114  down=59   end
    power=10.157 burn=79   down=8    end
    power=11.235 burn=64   down=5    end
    power=9.444  burn=150  down=31   end
    power=9.503  burn=164  down=799  end
    power=5.866  burn=160  down=9    end
    power=6.083  burn=148  down=48   end
```

```
   power=5.606  burn=96   down=61    end
   power=5.901  burn=129  down=5     end
   power=5.238  burn=57   down=1954.89    end
   .
   .-----------------------------------
   .
1
 ssssssssss      aaaaaaaa      ssssssssss     2222222222    hh        hh
ssssssssssss    aaaaaaaaaa    ssssssssssss   222222222222   hh        hh
ss        ss   aa        aa   ss        ss   22        22   hh        hh
ss             aa        aa   ss                       22   hh        hh
ss             aa        aa   ss                       22   hh        hh
sssssssssss    aaaaaaaaaaaa   sssssssssss             22    hhhhhhhhhhhh
 sssssssssss   aaaaaaaaaaaa    sssssssssss          22      hhhhhhhhhhhh
          ss   aa        aa             ss        22        hh        hh
          ss   aa        aa             ss      22          hh        hh
ss        ss   aa        aa   ss        ss    22            hh        hh
ssssssssssss   aa        aa   ssssssssssss   222222222222   hh        hh
 ssssssssss    aa        aa    ssssssssss    222222222222   hh        hh
0
nn        nn   iiiiiiiiiiii    cccccccccc    hh        hh    oooooooooo    ll
nnn       nn   iiiiiiiiiiii   cccccccccccc   hh        hh   oooooooooooo   ll
nnnn      nn        ii        cc        cc   hh        hh   oo        oo   ll
nn nn     nn        ii        cc             hh        hh   oo        oo   ll
nn  nn    nn        ii        cc             hh        hh   oo        oo   ll
nn   nn   nn        ii        cc             hhhhhhhhhhhh   oo        oo   ll
nn    nn  nn        ii        cc             hhhhhhhhhhhh   oo        oo   ll
nn     nn nn        ii        cc             hh        hh   oo        oo   ll
nn      nnnn        ii        cc             hh        hh   oo        oo   ll
nn       nnn        ii        cc        cc   hh        hh   oo        oo   ll
nn        nn   iiiiiiiiiiii   cccccccccccc   hh        hh   oooooooooooo   llllllllllll
nn        nn   iiiiiiiiiiii    cccccccccc    hh        hh    oooooooooo    llllllllllll
0
  00000000      8888888888              //        11        555555555555             //    9999999999    777777777777
 0000000000    888888888888            //        111        555555555555            //    999999999999   777777777777
 00      00    88        88           //        1111        55                     //     99        99   77        77
00        00   88        88          //           11        55                    //      99        99             77
00        00   88        88         //            11        55                   //       99        99            77
00        00    8888888888         //             11        55555555555         //        999999999999           77
00        00    8888888888         //             11        555555555555        //         99999999999           77
00        00   88        88       //              11                  55       //                   99          77
00        00   88        88      //               11                  55      //                    99         77
 00      00    88        88     //                11        55        55     //                     99         77
 0000000000    888888888888    //               11111111    555555555555    //            999999999999         77
  00000000      8888888888    //                11111111     5555555555    //              9999999999          77
0
  00000000       00000000                     2222222222     8888888888                     00000000              44
 0000000000     0000000000                   222222222222   888888888888                   0000000000            444
 00      00     00      00        :::        22        22   88        88       :::         00      00           4444
00        00   00        00       :::                  22   88        88       :::        00        00         44 44
00        00   00        00       :::                  22   88        88       :::        00        00        44  44
00        00   00        00                           22     8888888888                   00        00       44   44
00        00   00        00                         22       8888888888                   00        00      44    44
00        00   00        00       :::             22        88        88       :::        00        00   444444444444
00        00   00        00       :::           22          88        88       :::        00        00   444444444444
 00      00     00      00        :::         22            88        88       :::         00      00             44
 0000000000     0000000000                   222222222222   888888888888                   0000000000             44
  00000000       00000000                    222222222222    8888888888                     00000000              44
1
0
                          ssssssssss     cccccccccc      aaaaaaaa     ll             eeeeeeeeeeee
                         ssssssssssss   cccccccccccc    aaaaaaaaaa    ll             eeeeeeeeeeee
                         ss        ss   cc        cc   aa        aa   ll             ee
                         ss             cc             aa        aa   ll             ee
                         ss             cc             aa        aa   ll             ee
                         sssssssssss    cc             aaaaaaaaaaaa   ll             eeeeeeeee
                          sssssssssss   cc             aaaaaaaaaaaa   ll             eeeeeeeee
                                   ss   cc             aa        aa   ll             ee
                                   ss   cc             aa        aa   ll             ee
                         ss        ss   cc        cc   aa        aa   ll             ee
                         ssssssssssss   cccccccccccc   aa        aa   llllllllllll   eeeeeeeeeeee
                          ssssssssss     cccccccccc    aa        aa   llllllllllll   eeeeeeeeeeee


      *************************************************************************
      *************************************************************************
      *************************************************************************
      *****                                                               *****
      *****              program verification information                 *****
      *****                                                               *****
      *****            code system:    scale  version:    4.3             *****
      *****                                                               *****
      *************************************************************************
      *************************************************************************
      *****                                                               *****
      *****                                                               *****
      *****              program:  sas2                                   *****
      *****                                                               *****
      *****        creation date:  03/07/97                               *****
      *****                                                               *****
      *****              library:  /opt/neut/Scale4.3/bin                 *****
      *****                                                               *****
      *****                                                               *****
      *****   this is not a   scale  configuration controlled code        *****
      *****                                                               *****
      *****              jobname:  nichol                                 *****
      *****                                                               *****
      *****    date of execution:  08/15/97                               *****
      *****                                                               *****
      *****    time of execution:  00:28:04                               *****
      *****                                                               *****
      *****                                                               *****
      *************************************************************************
      *************************************************************************
      *************************************************************************
1
0
0  increase fuel temperature 100 K
0
0                                         nuclide concentrations, grams
```

basis =single reactor assembly

	initial	1E-18 d					
gd155	4.39E+02	4.39E+02					
total	1.97E+04	1.97E+04					

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d					
u234	2.29E+02	2.29E+02					
u235	2.58E+04	2.58E+04					
u236	1.15E+02	1.15E+02					
u238	8.55E+05	8.55E+05					
total	8.81E+05	8.81E+05					

basis =

0	initial	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
0	initial	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
sm147	.00E+00	5.16E-33	2.01E-22	4.43E-22	7.78E-22	7.78E-22
sm149	.00E+00	2.35E-12	4.46E-12	6.34E-12	8.03E-12	8.03E-12
sm150	.00E+00	1.15E-11	2.31E-11	3.50E-11	4.71E-11	4.71E-11
sm151	.00E+00	2.36E-10	4.69E-10	6.99E-10	9.25E-10	9.25E-10
sm152	.00E+00	2.49E-10	5.00E-10	7.53E-10	1.01E-09	1.01E-09
eu151	.00E+00	1.17E-12	2.34E-12	3.50E-12	4.66E-12	4.66E-12
eu153	.00E+00	3.17E-08	1.26E-07	2.83E-07	5.01E-07	5.01E-07
gd155m	.00E+00	3.51E-12	3.50E-12	3.49E-12	3.48E-12	3.48E-27
gd155	2.83E+00	2.83E+00	2.82E+00	2.81E+00	2.81E+00	2.81E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.24E-08	2.47E-08	3.71E-08	4.94E-08	4.94E-08
u234	9.78E-01	9.78E-01	9.78E-01	9.78E-01	9.78E-01	9.78E-01
u235	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.06E-01	5.26E-01	5.46E-01	5.66E-01	5.66E-01
u238	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	4.61E-05	1.71E-04	3.59E-04	5.97E-04	5.97E-04
pu236	.00E+00	1.49E-14	1.75E-13	6.81E-13	1.71E-12	1.71E-12
pu238	.00E+00	2.05E-09	2.67E-08	1.13E-07	3.03E-07	3.03E-07
pu238	.00E+00	2.05E-09	2.67E-08	1.13E-07	3.03E-07	3.03E-07
pu239	.00E+00	1.65E-02	5.45E-02	1.03E-01	1.57E-01	1.57E-01
pu240	.00E+00	1.83E-05	8.58E-05	2.13E-04	4.05E-04	4.05E-04
pu241	.00E+00	2.95E-08	2.73E-07	1.01E-06	2.55E-06	2.55E-06
pu242	.00E+00	5.62E-12	1.02E-10	5.64E-10	1.90E-09	1.90E-09

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	2.24E-12	4.08E-11	2.25E-10	7.58E-10	7.59E-10
am242m	.00E+00	1.59E-16	5.70E-15	4.69E-14	2.10E-13	2.10E-13
am243	.00E+00	7.26E-16	2.66E-14	2.25E-13	1.03E-12	1.03E-12
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi

0 1697 total number of nuclides in library

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	1.49E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06
sm152	1.32E-05	1.33E-05	1.33E-05	1.34E-05	1.34E-05	1.34E-05	1.35E-05
eu153	6.67E-01	7.23E-01	7.45E-01	7.54E-01	7.57E-01	7.59E-01	7.59E-01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	3.55E-01	3.58E-01	3.60E-01	3.61E-01	3.63E-01	3.64E-01	3.65E-01
total	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04	1.97E+04

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.40E-03	1.46E-03	1.52E-03	1.58E-03	1.64E-03	1.69E-03	1.75E-03
u234	1.68E+02	1.68E+02	1.68E+02	1.69E+02	1.69E+02	1.69E+02	1.70E+02
u235	1.26E+04	1.26E+04	1.26E+04	1.26E+04	1.26E+04	1.26E+04	1.26E+04
u236	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03
u238	8.43E+05	8.43E+05	8.43E+05	8.43E+05	8.43E+05	8.43E+05	8.43E+05
np237	1.81E+02	1.85E+02	1.85E+02	1.85E+02	1.85E+02	1.85E+02	1.86E+02
pu236	9.51E-05	7.70E-05	6.22E-05	5.03E-05	4.06E-05	3.28E-05	2.65E-05
pu238	4.87E+01	5.23E+01	5.29E+01	5.27E+01	5.24E+01	5.21E+01	5.17E+01
pu238	4.87E+01	5.23E+01	5.29E+01	5.27E+01	5.24E+01	5.21E+01	5.17E+01
pu239	4.35E+03	4.36E+03	4.36E+03	4.36E+03	4.36E+03	4.36E+03	4.36E+03
pu240	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03	1.21E+03
pu241	5.14E+02	4.92E+02	4.72E+02	4.52E+02	4.33E+02	4.15E+02	3.97E+02
pu242	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02	1.05E+02
am241	7.79E+01	9.94E+01	1.20E+02	1.40E+02	1.59E+02	1.77E+02	1.94E+02
am242m	1.50E+00	1.50E+00	1.49E+00	1.48E+00	1.48E+00	1.47E+00	1.47E+00
am243	1.47E+01	1.47E+01	1.47E+01	1.47E+01	1.47E+01	1.47E+01	1.47E+01
total	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05

0 element concentrations, grams
0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	3.65E+02	3.81E+02	3.81E+02	3.81E+02	3.81E+02	3.81E+02	3.81E+02
tc 99	3.99E+02	3.99E+02	3.99E+02	3.99E+02	3.99E+02	3.99E+02	3.99E+02

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02
rh103	2.37E+02	2.44E+02	2.44E+02	2.44E+02	2.44E+02	2.44E+02	2.44E+02
ag109	3.48E+01	3.49E+01	3.49E+01	3.49E+01	3.49E+01	3.49E+01	3.49E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	4.58E+02	4.62E+02	4.62E+02	4.62E+02	4.62E+02	4.62E+02	4.62E+02
nd145	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02
sm147	1.05E+02	1.18E+02	1.27E+02	1.35E+02	1.41E+02	1.46E+02	1.50E+02
sm149	1.59E+00	1.74E+00	1.74E+00	1.74E+00	1.74E+00	1.74E+00	1.74E+00
sm150	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02	1.23E+02
sm151	1.01E+01	1.01E+01	1.00E+01	9.97E+00	9.90E+00	9.83E+00	9.77E+00
eu151	8.60E-02	1.56E-01	2.25E-01	2.94E-01	3.62E-01	4.30E-01	4.97E-01
sm152	6.48E+01	6.48E+01	6.48E+01	6.49E+01	6.49E+01	6.49E+01	6.49E+01
eu153	4.50E+01	4.51E+01	4.51E+01	4.51E+01	4.51E+01	4.51E+01	4.51E+01

0 nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	8.11E-02	2.88E-01	4.70E-01	6.29E-01	7.66E-01	8.90E-01	9.97E-01
total	1.62E+04	1.62E+04	1.62E+04	1.62E+04	1.62E+04	1.62E+04	1.62E+04

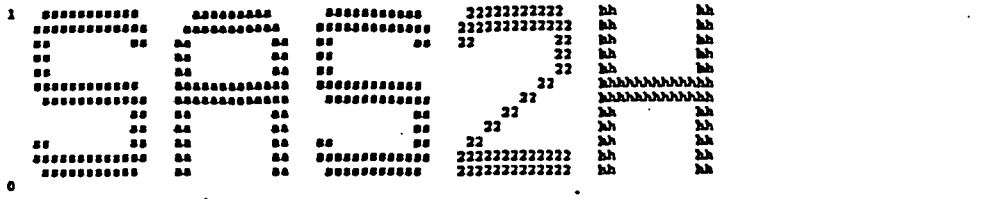
2974bplus50den.sum

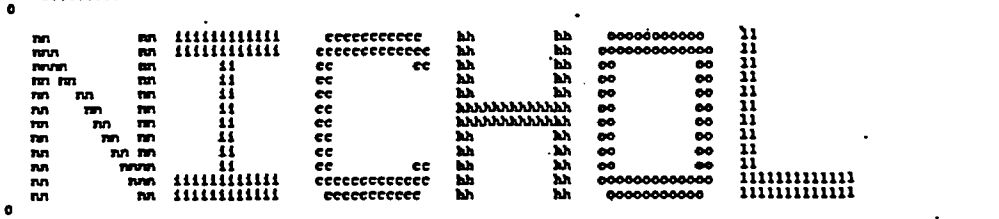
```
                    SCALE4.3  Bulletin  Board
                    --------  --------  -----

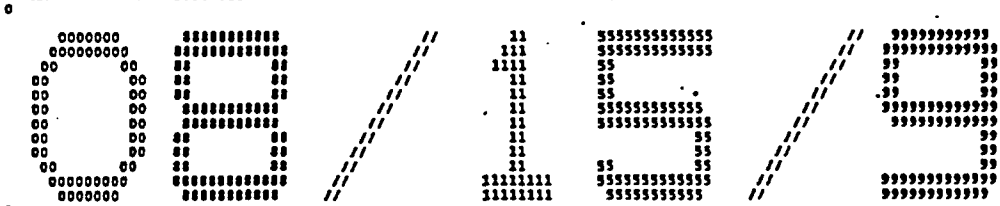
                      Welcome to SCALE-4.3.

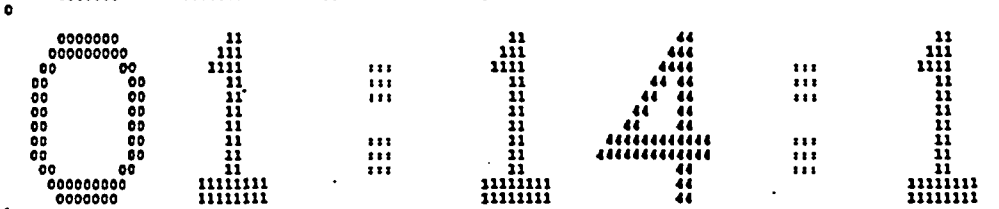
1          primary module access and input record ( scale driver - 95/03/29 - 09:06:37 )
-  module sas2h     will be called
     Cooper BWR Sample ADD2974-B, Height 55.723 cm from top, Aug 97
     '
     '   increase moderator density by 50%
     '
     '   mixtures of fuel-pin-unit-cell:
     '
     44group        latticecell
     uo2  1 den=10.32   1   840
        92234 0.026 92235 2.93 92236 0.013 92238 97.031   end
     kr-83   1 0 1-20 840  end
     kr-85   1 0 1-20 840  end
     y-89    1 0 1-20 840  end
     sr-90   1 0 1-20 840  end
     zr-93   1 0 1-20 840  end
     zr-94   1 0 1-20 840  end
     zr-95   1 0 1-20 840  end
     nb-94   1 0 1-20 840  end
     mo-95   1 0 1-20 840  end
     tc-99   1 0 1-20 840  end
     ru-101  1 0 1-20 840  end
     ru-106  1 0 1-20 840  end
     rh-103  1 0 1-20 840  end
     rh-105  1 0 1-20 840  end
     pd-105  1 0 1-20 840  end
     pd-108  1 0 1-20 840  end
     ag-109  1 0 1-20 840  end
     sb-124  1 0 1-20 840  end
     xe-131  1 0 1-20 840  end
     xe-132  1 0 1-20 840  end
     xe-135  1 0 1-20 840  end
     xe-136  1 0 1-20 840  end
     cs-134  1 0 1-20 840  end
     cs-135  1 0 1-20 840  end
     cs-137  1 0 1-20 840  end
     ba-136  1 0 1-20 840  end
     la-139  1 0 1-20 840  end
     pr-141  1 0 1-20 840  end
     pr-143  1 0 1-20 840  end
     ce-144  1 0 1-20 840  end
     nd-143  1 0 1-20 840  end
     nd-145  1 0 1-20 840  end
     nd-147  1 0 1-20 840  end
     pm-147  1 0 1-20 840  end
     pm-148  1 0 1-20 840  end
     sm-147  1 0 1-20 840  end
     sm-149  1 0 1-20 840  end
     sm-150  1 0 1-20 840  end
     sm-151  1 0 1-20 840  end
     sm-152  1 0 1-20 840  end
     eu-153  1 0 1-20 840  end
     eu-154  1 0 1-20 840  end
     eu-155  1 0 1-20 840  end
     gd-155  1 0 1-20 840  end
     '
     zirc2  2 1 620  end
     '
     '
     h2o  3 den=0.36  1  557 end
     '
     n    4 0 5-5 557 end
     '
     arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
                40000 98.18 5 1.0 557   end
     '
     uo2  6 den=10.32  1  840
        92234 0.026 92235 2.732 92236 0.013 92238 97.231   end
     arbm-gdrod  10.32 2 0 1.0 8016 3 64000 2 6 0.034 840  end
     '
     h2o  7 den=0.862  1  557  end
     '
     ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     end comp
     '
     ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     '
     '      fuel-pin-cell geometry:
     '
     squarepitch   1.87  1.21 1  3  1.41  2  1.242   0  end
     '
     ' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     '
     '    assembly and cycle parameters:
     '
     npin/assm=49 fuelnght=1719.74 ncycles=17  nlib/cyc=2
     printlevel=5 inplevel=2 numstotal=8 end
     6 0.6050 4 0.6210 2 0.7150 3 1.0550 500 3.3028 3 3.3179 5 3.4223 7 3.7883
     power=8.763  burn=19   down=8    end
     power=10.431 burn=130  down=17   end
     power=13.087 burn=41   down=10   end
     power=10.221 burn=226  down=35   end
     power=11.235 burn=39   down=7    end
     power=12.749 burn=22   down=12   end
     power=11.965 burn=108  down=19   end
     power=12.398 burn=114  down=59   end
     power=10.157 burn=79   down=8    end
     power=11.235 burn=64   down=5    end
     power=9.444  burn=150  down=31   end
     power=9.503  burn=164  down=799  end
     power=5.866  burn=160  down=9    end
     power=6.083  burn=148  down=48   end
```

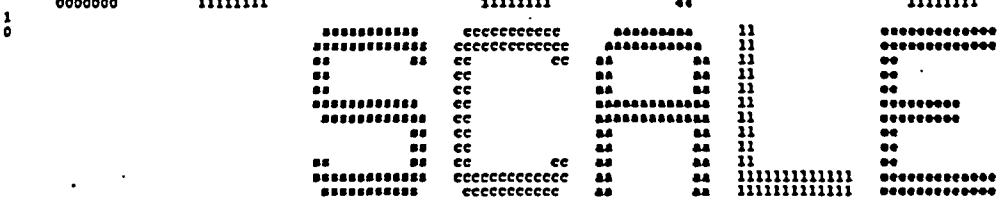
```
    power=5.606  burn=96   down=61   end
    power=5.901  burn=129  down=5    end
    power=5.238  burn=57   down=1954.09   end
```











```
                    program verification information
                    code system:  scale  version:    4.3

                program:  sas2
             creation date:  03/07/97
                library:  /opt/nevt/Scale4.3/bin

        this is not a   scale  configuration controlled code
                jobname:  michol
        date of execution:  08/15/97
        time of execution:  01:14:19
```

```
increase moderator density by 50%

                                nuclide concentrations, grams
```

basis =single reactor assembly

	initial	1E-18 d
gd155	6.39E+02	6.39E+02
total	1.97E+06	1.97E+06

nuclide concentrations, grams
basis =single reactor assembly

	initial	1E-18 d
u234	2.29E+02	2.29E+02
u235	2.58E+04	2.58E+04
u236	1.15E+02	1.15E+02
u238	8.55E+05	8.55E+05
total	8.81E+05	8.81E+05

basis =

	initial	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
	initial	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
sm147	.00E+00	4.22E-23	1.64E-22	3.61E-22	6.32E-22	6.32E-22
sm149	.00E+00	2.09E-12	3.94E-12	5.59E-12	7.06E-12	7.06E-12
sm150	.00E+00	1.03E-11	2.08E-11	3.15E-11	4.24E-11	4.24E-11
sm151	.00E+00	2.11E-10	4.26E-10	6.25E-10	8.28E-10	8.28E-10
sm152	.00E+00	2.22E-10	4.46E-10	6.72E-10	8.99E-10	8.99E-10
eu151	.00E+00	1.06E-12	2.13E-12	3.18E-12	4.24E-12	4.24E-12
eu153	.00E+00	2.76E-08	1.20E-07	2.47E-07	4.37E-07	4.37E-07
gd155m	.00E+00	2.92E-12	2.91E-12	2.90E-12	2.89E-12	2.89E-27
gd155	2.83E+00	2.83E+00	2.82E+00	2.81E+00	2.81E+00	2.81E+00
totals	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03	6.95E+03

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
u233	.00E+00	1.14E-08	2.28E-08	3.41E-08	4.54E-08	4.54E-08
u234	9.79E-01	9.79E-01	9.78E-01	9.78E-01	9.78E-01	9.78E-01
u235	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.09E+02	1.09E+02
u236	4.85E-01	5.05E-01	5.25E-01	5.45E-01	5.64E-01	5.64E-01
u238	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03	3.59E+03
np237	.00E+00	4.20E-05	1.56E-04	3.27E-04	5.43E-04	5.43E-04
pu236	.00E+00	1.25E-14	1.46E-13	5.69E-13	1.43E-12	1.43E-12
pu238	.00E+00	1.74E-09	2.26E-08	9.55E-08	2.56E-07	2.56E-07
pu238	.00E+00	1.74E-09	2.26E-08	9.55E-08	2.56E-07	2.56E-07
pu239	.00E+00	1.52E-02	5.04E-02	9.52E-02	1.45E-01	1.45E-01
pu240	.00E+00	1.55E-05	7.41E-05	1.86E-04	3.57E-04	3.57E-04
pu241	.00E+00	2.22E-08	3.09E-07	7.84E-07	2.00E-06	2.00E-06
pu242	.00E+00	4.22E-12	7.82E-11	4.37E-10	1.49E-09	1.49E-09

basis = single reactor assembly

	charge	2.4 d	4.8 d	7.1 d	9.5 d	9.5 d
am241	.00E+00	1.68E-12	3.11E-11	1.74E-10	5.90E-10	5.90E-10
am242m	.00E+00	1.13E-16	4.12E-15	3.43E-14	1.55E-13	1.55E-13
am243	.00E+00	4.81E-16	1.79E-14	1.53E-13	7.07E-13	7.07E-13
totals	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03	3.70E+03

decay data, including gamma and total energy, are from endf/b-vi

1697 total number of nuclides in library

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
sm150	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06
sm152	1.22E-05	1.23E-05	1.23E-05	1.23E-05	1.24E-05	1.24E-05	1.24E-05
eu153	6.06E-01	6.58E-01	6.78E-01	6.86E-01	6.89E-01	6.90E-01	6.90E-01

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	3.00E-01	3.02E-01	3.04E-01	3.06E-01	3.07E-01	3.08E-01	3.09E-01
total	1.97E+06	1.97E+06	1.97E+06	1.97E+06	1.97E+06	1.97E+06	1.97E+06

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
u233	1.30E-03	1.35E-03	1.41E-03	1.46E-03	1.51E-03	1.57E-03	1.62E-03
u234	1.70E+02	1.71E+02	1.71E+02	1.71E+02	1.72E+02	1.72E+02	1.72E+02
u235	1.22E+04	1.22E+04	1.22E+04	1.22E+04	1.22E+04	1.22E+04	1.22E+04
u236	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03
u238	8.44E+05	8.44E+05	8.44E+05	8.44E+05	8.44E+05	8.44E+05	8.44E+05
np237	1.67E+02	1.68E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02
pu236	7.92E-05	6.41E-05	5.18E-05	4.19E-05	3.38E-05	2.73E-05	2.21E-05
pu238	4.24E+01	4.57E+01	4.63E+01	4.62E+01	4.59E+01	4.56E+01	4.53E+01
pu238	4.24E+01	4.57E+01	4.63E+01	4.62E+01	4.59E+01	4.56E+01	4.53E+01
pu239	3.92E+03	3.93E+03	3.93E+03	3.93E+03	3.93E+03	3.93E+03	3.93E+03
pu240	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03
pu241	4.71E+02	4.52E+02	4.32E+02	4.14E+02	3.97E+02	3.80E+02	3.64E+02
pu242	1.03E+02	1.03E+02	1.03E+02	1.03E+02	1.03E+02	1.03E+02	1.03E+02
am241	7.07E+01	9.05E+01	1.09E+02	1.27E+02	1.45E+02	1.61E+02	1.77E+02
am242m	1.28E+00	1.28E+00	1.27E+00	1.27E+00	1.26E+00	1.26E+00	1.25E+00
am243	1.27E+01	1.27E+01	1.27E+01	1.27E+01	1.27E+01	1.27E+01	1.27E+01
total	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05	8.65E+05

element concentrations, grams

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
mo 95	3.68E+02	3.84E+02	3.85E+02	3.85E+02	3.85E+02	3.85E+02	3.85E+02
tc 99	4.02E+02	4.02E+02	4.02E+02	4.02E+02	4.02E+02	4.02E+02	4.02E+02

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
ru101	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02
rh103	2.36E+02	2.43E+02	2.43E+02	2.43E+02	2.43E+02	2.43E+02	2.43E+02
ag109	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
nd143	4.57E+02	4.61E+02	4.61E+02	4.61E+02	4.61E+02	4.61E+02	4.61E+02
nd145	3.49E+02	3.49E+02	3.49E+02	3.49E+02	3.49E+02	3.49E+02	3.49E+02
sm147	1.09E+02	1.21E+02	1.31E+02	1.39E+02	1.45E+02	1.50E+02	1.54E+02
sm149	1.39E+00	1.54E+00	1.54E+00	1.54E+00	1.54E+00	1.54E+00	1.54E+00
sm150	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02
sm151	9.04E+00	9.01E+00	8.95E+00	8.89E+00	8.83E+00	8.77E+00	8.71E+00
eu151	7.51E-02	1.37E-01	1.99E-01	2.60E-01	3.21E-01	3.81E-01	4.41E-01
sm152	6.62E+01	6.62E+01	6.62E+01	6.62E+01	6.62E+01	6.62E+01	6.62E+01
eu153	4.39E+01	4.40E+01	4.40E+01	4.40E+01	4.40E+01	4.40E+01	4.40E+01

nuclide concentrations, grams
basis =single reactor assembly

	initial	325.7 d	651.4 d	977.0 d	1302.7 d	1628.4 d	1954.1 d
gd155	6.67E-02	2.69E-01	4.46E-01	6.01E-01	7.37E-01	8.57E-01	9.61E-01
total	1.62E+06	1.62E+06	1.62E+06	1.62E+06	1.62E+06	1.62E+06	1.62E+06