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NUREG/CR-3064, VOL. 1
(ORNL/TM-9968/V1)

OAK RIDGE NATIONAL LABORATORY

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Computational Methodology for the Oak Ridge Research Reactor (ORR) and Bulk Shielding Reactor (BSR): Cross-Section Generation and Validation, Volume I

L. F. Miller
M. L. Williams

Prepared for the
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
under Interagency Agreement DOE 40-551-75 and 40-552-75

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Post Office Box 37082
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and

National Technical Information Service
Springfield, VA 22161

NUREG/CR-3064, Vol. 1
ORNL/TM-9968/V1
Dist. Category RF

Operations Division

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Manuscript Completed - February 1986
Date of Issue - March 1986

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NRC FIN Nos. B-0119 and B0415

Prepared by the
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

ACKNOWLEDGEMENTS

The authors wish to express appreciation to F. B. K. Kam for his technical guidance and to Brenda Taylor for the preparation of this report. Also, we acknowledge the support of the Materials Engineering Branch, Division of Engineering Technology, of the U.S. Nuclear Regulatory Commission.

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ABSTRACT

A neutronics library suitable for low-enrichment uranium (LEU) and high-enrichment uranium (HEU) fueled cores for both the Oak Ridge Research Reactor (ORR) and the Bulk Shielding Reactor (BSR) is documented herein. The library is obtained from version V of the Evaluated Nuclear Data File (ENDF/B-V) and contains 223 nuclides weighted over a variety of region-dependent neutron spectra. Self-shielding and zone-weighting effects are incorporated with 227-group calculations for several reactor-core configurations. Libraries are archived for both transport and diffusion theory seven-group calculations. Complete listings of processing details are included so that libraries with different specifications can be easily obtained. Results from validation calculations indicate that the neutronics libraries obtained from this effort are suitable for neutronics computations for the ORR and BSR.

INTRODUCTION

There is a continuing need for neutron transport and diffusion theory calculations for the Oak Ridge Research Reactor (ORR) and the Bulk Shielding Reactor (BSR). Neutronics calculations are required to support irradiation experiments, fuel management studies, and safety evaluations. The primary motivation for generating new cross section libraries is that the previously used library (obtained from ENDF/B-IV) does not contain nuclides with cross section processing based on a low-enrichment uranium (LEU) fueled core. Secondary considerations are based on the observation that there are significant adjustments to ENDF/B-IV data relative to ENDF/B-V. Self-shielding and zone-weighting effects are incorporated into the new library through the use of 227-group cell and zone calculations. Resolved and unresolved resonances are treated with the NITAWL[1] and the BONAMI[2] methodologies, respectively.

Cross sections are included for nuclides weighted over a variety of spectra. Cell- and zone-weighting of cross sections are accomplished for LEU and high-enrichment uranium (HEU) fueled core spectra. Cell-weighting is performed for all nuclides interior to the fuel plate. Zone-weighting is performed for all other nuclides (for a total of 223). Separate 227-group zone-dependent weighting calculations are performed for the ORR and BSR control rod assemblies.

Test calculations are included that validate the expected trends of the updated cross-section libraries and complete descriptions of input specifications are provided so that new cross sections with different processing specifications can be easily generated. Some recommendations for improving the neutronics calculations are also included.

2. METHODS FOR CROSS-SECTION GENERATION

Cross-section libraries for the Oak Ridge Research Reactor (ORR) and Bulk Shielding Reactor (BSR) are obtained through the use of computer programs available on the Oak Ridge National Laboratory (ORNL) computer system. This processing is accomplished with the AMPX,[3] SCALE,[4] and BOLD VENTURE[5] code (or computer program) systems. Figure 2.1 illustrates the major steps associated with this effort, and listings of the input for each calculation are provided in the appendix.

All of the cross sections selected for the ORR/BSR library are extracted from a general-purpose neutron master library (CSRL-V) which is, in turn, obtained from the ENDF/B-V data file.[6] The nuclides which are important resonance nuclides (or located in the fuel) are processed with the BONAMI code. BONAMI[2] uses the Bondarenko resonance self-shielding method to process resonance nuclides on a master library which has Bondarenko self-shielding data for the unresolved resonance range. Several Dancoff expressions are incorporated into BONAMI to account for different cell-pin and cell-lattice geometries. The symmetric slab-cell option is chosen for this application. Inter-cell effects are accounted for through the Dancoff factor which BONAMI calculates but does not include in its self-shielding of the group-dependent cross sections in the resolved resonance range.

The master library processed by BONAMI is input to the NITAWL[1] program which processes resolved resonances (not treated by BONAMI) based on the Nordheim Integral Treatment and includes the intercell (Dancoff) effects. The fractional fuel volume in the cell is chosen to be unity so that spatial effects are not treated by NITAWL, but they are treated by the transport-theory cell calculation.

The 227-group cell-weighted cross sections for the high-enriched uranium (HEU) and for the low-enriched uranium (LEU) [along with infinite dilution (ID) cross sections] are obtained from separate one-dimentional (1-D) cell calculations. Dimensions of the zones for this 1-D cell model, along with zone identifications, are illustrated in Fig. 2.2. Number densities are specified in Table 2.1. Geometry data for ORR fuel elements are listed in Table 2.2.

Seven-group cross sections for various regions of the ORR core for HEU and LEU fuel are obtained by 1-D, 227-group, zone-collapse calculations. Geometry and number density specifications are given by Fig. 2.3 and Table 2.3, respectively.

Seven-group cross sections are also obtained for the ORR and BSR control-rod regions from 1-D, 227-group transport calculations. The mockup for the ORR control rods is shown in Fig. 2.4. The associated numbered densities are listed in Table 2.4. Corresponding illustrations for the BSR control-rod mockup are given by Fig. 2.5 and Table 2.5.

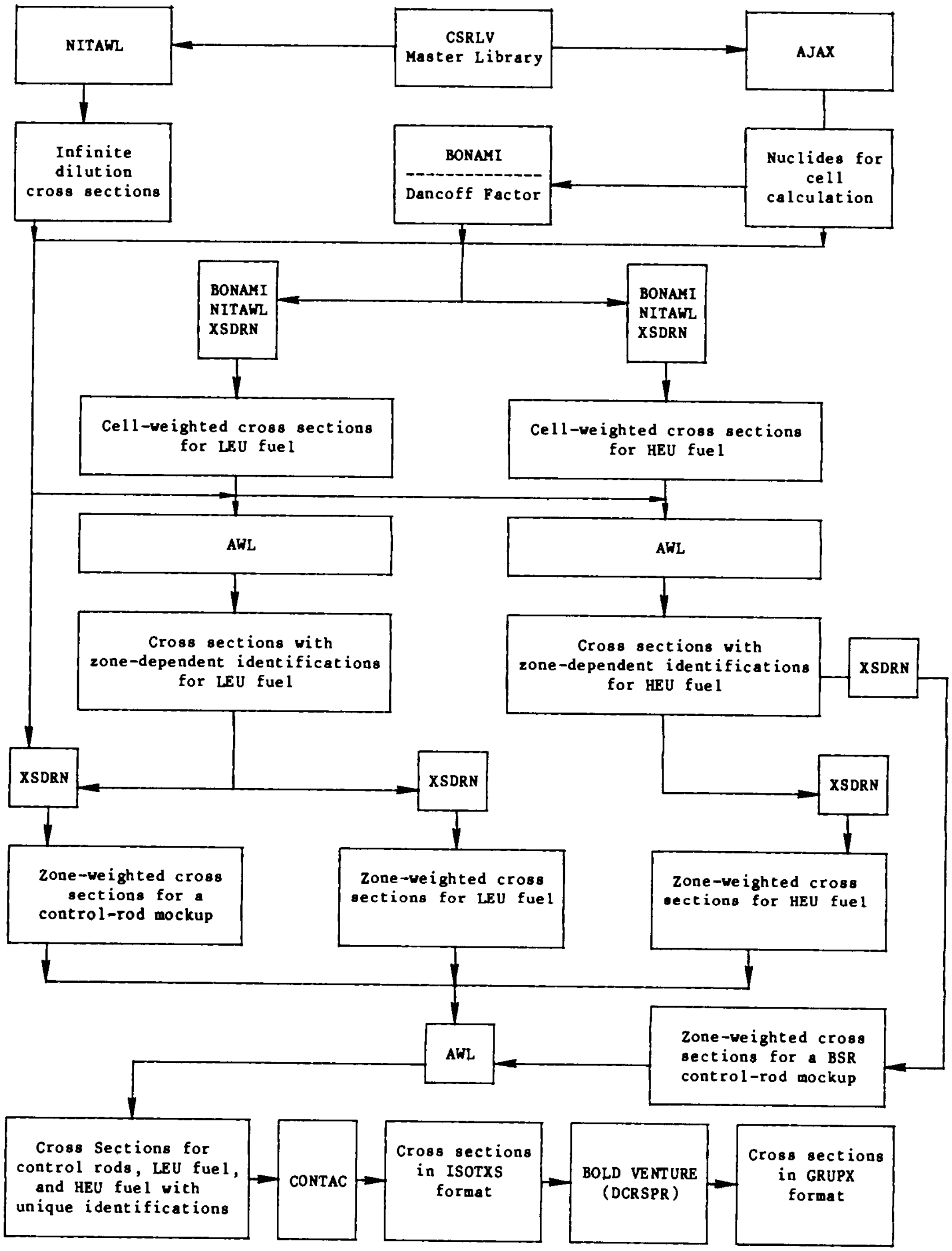


Fig. 2.1. Block diagram for cross-section processing.

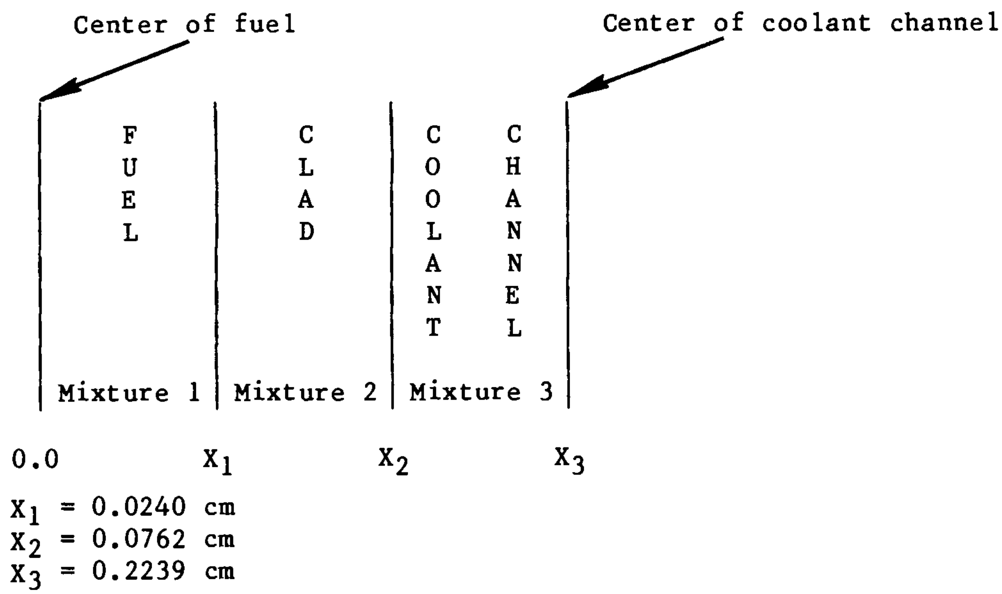
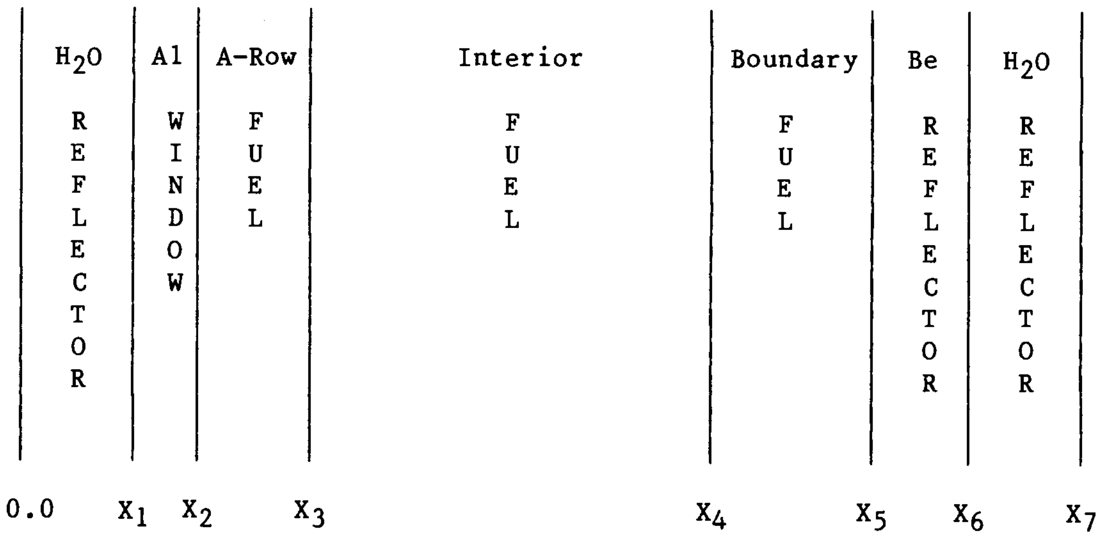


Fig. 2.2. Mockup of the one-dimensional transport cell calculations for the LEU and HEU problems.

Table 2.1. Atom densities for HEU and LEU cell calculations

Mixture	Isotope	Atom density [atom/(b·cm)] HEU	LEU
1	^{235}U	1.30-3	1.64-3
1	^{238}U	8.67-5	9.50-3
1	^{27}Al	5.80-2	5.80-2
1	^{236}U	1.00-10	1.00-10
1	^{238}Pu	1.00-10	1.00-10
1	^{239}Pu	1.00-10	1.09-5
1	^{240}Pu	1.00-10	5.00-6
1	^{241}Pu	1.00-10	2.00-6
1	^{135}Xe	1.00-10	1.00-10
1	^{149}Sm	1.00-10	1.00-10
2	^{27}Al	6.03-2	6.03-2
3	^{1}H	6.68-2	6.68-2
3	^{16}O	3.34-2	3.34-2

*Refer to Fig. 2.2 for mixture identifications.



X_1 = 25 cm, X_2 = 27.54 cm, X_3 = 35.16 cm, X_4 = 58.02 cm, X_5 = 65.65 cm, X_6 = 73.26 cm, and X_7 = 98.26 cm.

Fig. 2.3. Mockup of the one-dimensional zone calculation for collapsing the 227-group ORR fuel cross sections to seven groups.

Table 2.2. Geometry data for standard ORR fuel elements

Item	Value
Length of fuel element	24.625 in.
Depth of fuel element	3.169 in.
Width of fuel element	2.996 in.
Length of fueled region in plate	23.625 in.
Width of fueled region in plate	2.500 in.
Thickness of fueled region in plate	0.020 in.
Number of plates	19
Cladding thickness (inside plate)	0.015 in.
Cladding thickness (end plate)	0.0225 in.
Thickness of water gap	0.116 in.

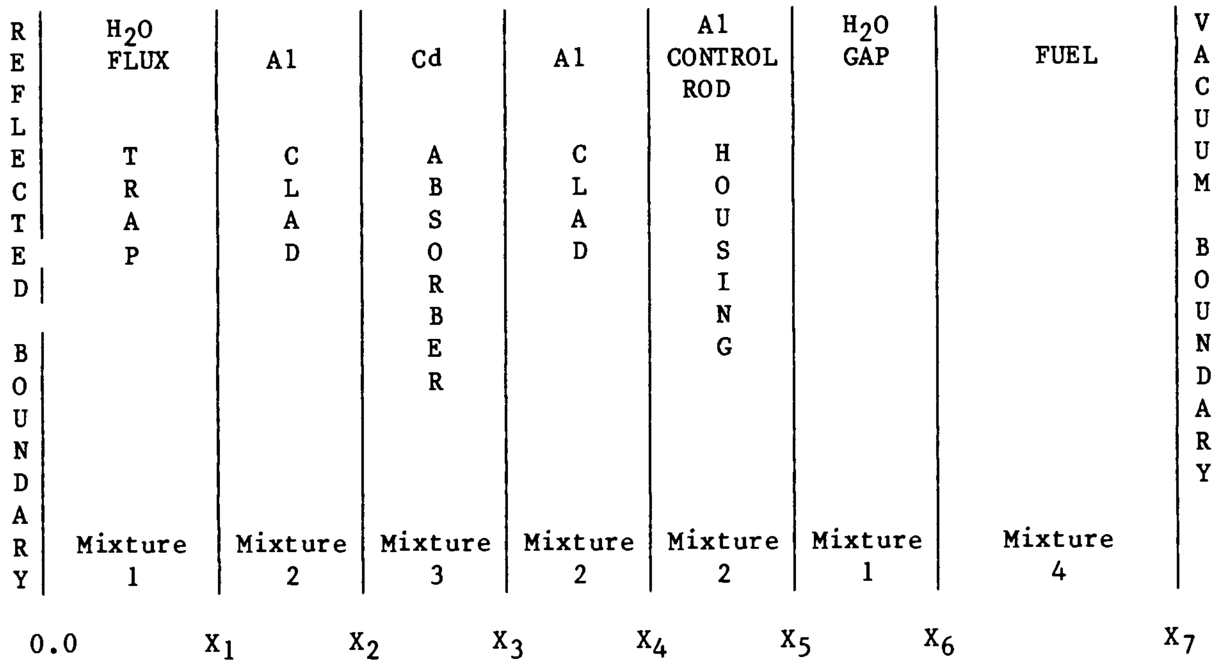
Table 2.3. Atom densities for the 1-D zone-collapse calculation of 227 groups to seven groups for HEU and LEU ORR fuel assembly

Mixture	Isotope	Atom density [atom/(b·cm)] HEU	LEU
1	^{1}H	6.70-2	6.70-2
1	^{16}O	3.35-2	3.35-2
2	^{27}Al	6.02-2	6.02-2
3	^{235}U	1.30-4	1.64-4
3	^{238}U	8.67-6	9.50-4
3	^{236}U	1.00-10	1.00-10
3	^{238}Pu	1.00-10	1.00-10
3	^{239}Pu	1.00-10	1.09-6
3	^{240}Pu	1.00-10	5.00-7
3	^{241}Pu	1.00-10	2.00-7
3	^{27}Al	2.40-2	2.40-2
3	^{1}H	3.85-2	3.85-2
3	^{16}O	1.92-2	1.92-2
3	^{135}Xe	1.70-9	1.70-9
3	^{149}Sm	1.40-8	1.40-8
4	^{235}U	1.30-4	1.64-4
4	^{238}U	8.67-6	9.50-4
4	^{236}U	1.00-10	1.00-10
4	^{238}Pu	1.00-10	1.00-10
4	^{239}Pu	1.00-10	1.09-6
4	^{240}Pu	1.00-10	5.00-7
4	^{241}Pu	1.00-10	2.00-7

Table 2.3. Continued

Mixture	Isotope	Atom density [atom/(b·cm)] HEU	LEU
4	^{27}Al	2.40-2	2.40-2
4	^{1}H	3.85-2	3.85-2
4	^{16}O	1.92-2	1.92-2
4	^{135}Xe	1.70-9	1.70-9
4	^{149}Sm	1.40-8	1.40-8
4	Fission products	N/A	1.00-10
5	^{235}U	1.30-4	1.64-4
5	^{238}U	8.67-6	9.50-4
5	^{236}U	1.00-10	1.00-10
5	^{238}Pu	1.00-10	1.00-10
5	^{239}Pu	1.00-10	1.09-6
5	^{240}Pu	1.00-10	5.00-7
5	^{241}Pu	1.00-10	2.00-7
5	^{27}Al	2.40-2	2.40-2
5	^{1}H	3.85-2	3.85-2
5	^{16}O	1.92-2	1.92-2
5	^{135}Xe	1.70-9	1.70-9
5	^{149}Sm	1.40-8	1.40-8
6	^{27}Al	1.24-1	1.24-1
7	^{1}H	6.70-2	6.70-2
7	^{16}O	3.35-2	3.35-2

*Refer to Fig. 2.3 for mixture identifications with zones. Nuclides generated by NITAWL with the infinite dilution option are used in the calculation with a concentration of 1.0 x 10^{-10} atom/(b·cm).



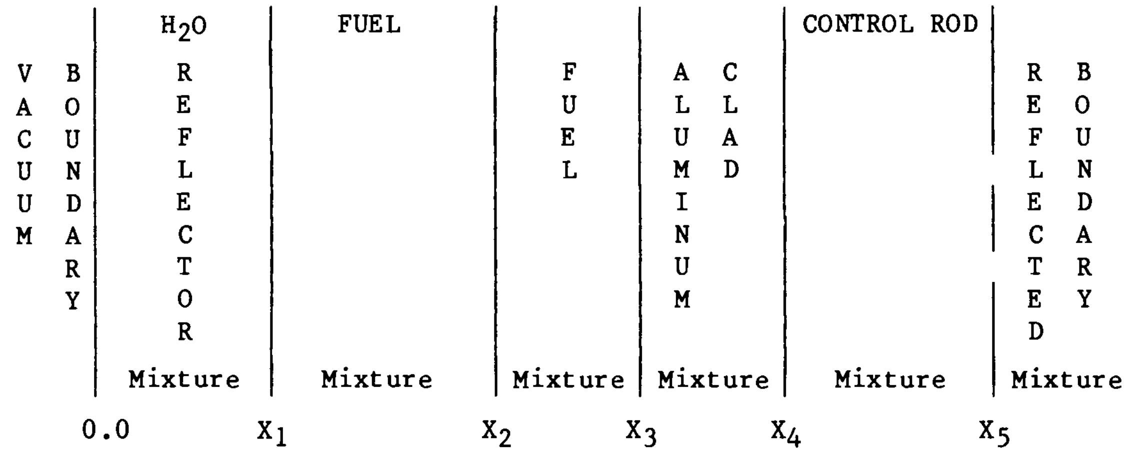
X_1 = 2.81 cm, X_2 = 2.85 cm, X_3 = 2.959 cm, X_4 = 3.01 cm, X_5 = 3.604 cm, X_6 = 3.85 cm, and X_7 = 40.0 cm.

Fig. 2.4. Mockup of the one-dimensional zone calculation for collapsing the 227-group ORR control-rod cross sections to seven groups. [Ref. ORNL Drawing M20394, Ser. 105.]

Table 2.4. Atom densities for the 1-D zone collapse calculation of 227 groups to seven groups for the ORR shim rods

Mixture	Isotope	Atom density [atom/(b·cm)]
1	^{1}H	6.68-2
1	^{16}O	3.34-2
2	^{27}Al	6.02-2
3	Cd	4.63-2
4	^{235}U	1.64-4
4	^{238}U	2.34-4
4	^{239}Pu	1.09-6
4	^{27}Al	2.40-2
4	^{16}O	1.92-2
4	^{1}H	3.85-2

*Refer for Fig. 2.4 for mixture identifications with zones.



X_1 = 15.0 cm, X_2 = 65.0 cm, X_3 = 67.717 cm, X_4 = 68.034 cm, and X_5 = 71.209 cm.

Fig. 2.5. Mockup for the one-dimensional zone calculations for collapsing the 227-group BSR control-rod cross sections to seven groups [Ref. ORNL Drawing M-11470-QB-125E.] The control-rod material contains 1.5 to 1.8% natural boron in stainless steel 304. The maximum cobalt content is 0.25%.

Table 2.5. Atom densities for the 1-D zone collapse calculation of 227 groups to seven groups for the BSR shim rods

Mixture	Isotope	Atom density [atom/(b·cm)]
1	^{1}H	6.680-2
1	^{16}O	3.340-2
2	^{238}U	7.185-6
2	^{235}U	9.545-5
2	^{1}H	4.048-2
2	^{16}O	2.024-2
2	Al	2.339-2
2	Fe	1.509-3
2	Ni	2.052-4
2	Cr	4.625-4
3	Al	6.020-3
4	Fe	6.039-2
4	Ni	8.210-3
4	Cr	1.850-2
4	^{10}B	1.356-3
4	^{11}B	5.424-3

*Refer for Fig. 2.5 for mixture identifications with zones.

Cross sections from these four calculations are combined into a single library and converted to the ISOTXS format with the AWL and CONTAC modules of the AMPX[3] code system, respectively. Listings that identify the 223 nuclides in the AMPX and ISOTXS formats are provided by Tables A.1 and A.2 in the appendix.

2.1 CALCULATIONS OF NUMBER DENSITIES

In order to perform the cross-section generation calculations, number densities need to be calculated for conditions that include fuel depletion and fission-product generation. Several of the isotopic number densities are obtained through the differential equations that govern their behavior. For ^{235}U (^{25}N), ^{238}U (^{28}N), and ^{239}Pu (^{39}N), the following approximate differential equations apply,

$$\frac{d\,^{25}N(t)}{dt} = -\,^{25}N\,\sigma_a^{25}\phi$$

$$\frac{d\,^{28}N(t)}{dt} = -\,^{28}N\,\sigma_a^{28}\phi$$

$$\frac{d\,^{49}N(t)}{dt} = \,^{28}N\,\sigma_a^{28}\phi - \,^{49}N\,\sigma_a^{49}\phi$$

where ϕ = effective one-group flux and

σ_a = effective one-group microscopic absorption cross section.

The solutions are

$$^{25}N(t) = \,^{25}N_{(0)}\exp(-\sigma_a^{25}\phi t)$$

$$^{28}N(t) = \,^{28}N_{(0)}\exp(-\sigma_a^{28}\phi t)$$

$$^{49}N(t) = \frac{^{28}N(0)\,\sigma_a^{28}}{(\sigma_a^{49}-\sigma_a^{28})}\left(f(t)^{\alpha} - f(t)^{\beta}\right)$$

where $\alpha = \sigma_a^{28}/\sigma_a^{25}$

$\beta = \sigma_a^{49}/\sigma_a^{25}$

$f(t) = \,^{25}N(t)/^{25}N_{(0)}$

$^{49}N_{(0)} = 0$.

The solution for ^{240}Pu (^{40}N) is somewhat more detailed. The differential equation is

$$\frac{d\,^{40}N(t)}{dt} + \sigma_a^{40}\,\phi\,^{40}N = \sigma_c^{49}\,\phi\,^{49}N(t) \quad .$$

After performing the integration and rearranging terms, one obtains,

$$^{40}N(t) = \left(\frac{\sigma_c^{49}}{\sigma_a^{25}}\right) \frac{^{28}N(0)\,\sigma_a^{28}}{(\sigma_a^{49} - \sigma_a^{28})} \left(\frac{[f(t)^{\gamma} - f(t)^{\alpha}]}{\delta} - \frac{[f(t)^{\gamma} - f(t)^{\beta}]}{\xi}\right)$$

where $\delta = (\sigma_a^{28} - \sigma_a^{40})/\sigma_a^{25}$

$\xi = (\sigma_a^{49} - \sigma_a^{40})/\sigma_a^{25}$

$\gamma = \sigma_a^{40}/\sigma_a^{25}$.

Note that these results are point quantities and, hence, are valid for any axial location where the axial burnup, f(t), is known.

The differential equation for ^{241}Pu is

$$\frac{d\,^{41}N(t)}{dt} + \sigma_a^{41}\,\phi\,^{41}N(t) = \sigma_c^{40}\,^{40}N(t)\phi \quad .$$

Although this equation can be solved analytically, the solution process would be rather lengthy, and an accurate estimate of the ^{41}N number density is not considered to be very important. The equilibrium result, however, is easily obtained. In particular,

$$^{41}N(\infty) = \frac{\sigma_c^{40}}{\sigma_a^{41}}\,^{40}N(\infty)$$

and

$$^{41}N(\infty) \sim \,^{40}N(\infty) \quad .$$

Since one-group cross sections are difficult to accurately determine, both ^{40}N and ^{41}N are estimated from the ^{49}N. Even though, in principle, the ^{40}N and ^{41}N values could asymptotically approach the ^{49}N value (depending on the spectrum under consideration and fuel geometry), it is assumed that for 30% burnup [i.e., $^{25}N(t)/^{25}N_{(0)}$ equal to 0.7] they attain approximately one-half the concentration of the parent nuclide.

The number density estimate for ^{238}Pu is more difficult than for those already cited. This isotope results from the decay of ^{242}Cm or ^{238}Np which, in turn, originates from at least two transmutations. Thus, ^{48}N is assumed to be essentially zero [i.e., 1.0×10^{-10} atom/(b·cm)].

Only two fission products are considered explicitly. These are ^{135}Xe and ^{149}Sm. The applicable differential equations are

$$\frac{dN_I}{dt} = \gamma_I \, \xi_f \, \phi - \lambda_I \, N_I$$

$$\frac{dN_X}{dt} = \gamma_X \, \xi_f \, \phi + \lambda_I \, N_I - \sigma_a^X \, N_X \phi$$

$$\frac{dN_P}{dt} = \gamma_P \, \Sigma_f \, \phi - \lambda_P \, N_P$$

$$\frac{dN_S}{dt} = \lambda_P \, N_P - \sigma_a^S \, N_S \phi$$

where N_I, N_X, N_P, and N_S are the number densities of iodine, xenon, promethium, and samarium, respectively, and where

$\Sigma_f \phi$ = the fission rate,

γ = fission yield,

λ = decay constant,

σ_a = absorption cross section, and

ϕ = neutron flux.

For this application, only equilibrium values of xenon and samarium are needed. These results are

$$N_X^{eq} = \frac{(\gamma_I + \gamma_X)\ \Sigma_f \phi}{\lambda_X + \sigma_a^X \phi}$$

$$N_X^{eq} = {}^{25}N \left(\frac{(\gamma_X + \gamma_I)\ (\sigma_f^{25}/\sigma_a^X)}{[1 + \psi_X/\phi]} \right)$$

$$N_S^{eq} = {}^{25}N\ \gamma_P\ (\sigma_f^{25}/\sigma_a^S)$$

where $\psi_X = \lambda_X/\sigma_a^X$.

When the values from Table 2.6 are substituted into the above equations, one obtains

$$N_X \cong 1.1 \times 10^{-5}\ {}^{25}N$$

$$N_S \cong 5.2 \times 10^{-5}\ {}^{25}N \quad .$$

These values agree well with results obtained from previous three-dimensional diffusion theory calculations for the ORR (which are used for the cross-section processing).

The effective number densities of the remaining fission products, along with their effective absorption cross section, are not explicitly determined. They have a variety of half-lives, effective absorption cross sections, and complicated decay chains. In addition, the operating history also affects the fission product number densities. The explicit incorporation of many fission products into the diffusion theory calculation is beyond the scope of the work defined herein; however, procedures for doing this are straightforward. The disadvantage of not explicitly including more fission products should be primarily reflected in the calculated eigenvalue. The effect on power distribution should be negligible since the error in the absorption cross sections (primarily epithermal) should not be strongly spatially dependent.

Table 2.6. Parameters for determining equilibrium xenon and samarium number densities

Parameter	Value*
Fission yield of xenon (γ_X)	1.36-2
Fission yield of iodine (γ_I)	4.88-2
Fission yield of promethium (γ_P)	6.60-3
Decay constant of xenon (λ_X, s^{-1})	2.09-5
Average ^{135}Xe absorption cross section (σ_a^X)(barns)	4.22+5
Average ^{149}Sm absorption cross section (σ_a^S)(barns)	1.07+4
Average ^{235}U fission cross section (σ_a^{25})(barns)	8.48+1
Average flux (ϕ $n/cm^2 \cdot s$)	~7.50+14

*Cross sections are based on the LEU spectrum.

2.2 FISSION PRODUCT CROSS SECTIONS

Fission product cross sections are typically treated by considering selected nuclides explicitly and the remainder as lumped fission products. The number of nuclides which should be treated explicitly varies with application and with the available computational and technical development resources. For example, Iijima and Yamamoto[7] recommend that 45 nuclides be treated explicitly, whereas Bennett[8] recommends that 26 be treated explicitly. It is apparent from these papers and others[9] that more fission product nuclides are included in neutronics as computational resources improve. Computer programs, such as ORIGEN,[10] can be used to calculate fission product number densities as a function of fuel depletion. These results can, in turn, be used to mix microscopic cross sections to form burnup-dependent cross sections. This method is not currently implemented for the ORR and BSR cross-section libraries since the need in not clearly demonstrated for short-duration fuel cycles and since resource constraints preclude its implementation. Instead, ^{135}Xe and ^{149}Sm are treated explicitly and the remainder are represented as a $1/\nu$ absorber.

It is frequently the practice to separate the lumped fission products (FPs) into two categories: (1) slowly saturating (SS) and (2) nonsaturating (NS). The macroscopic lumped fission product poisons cross section ($\Sigma_P(E)$) is given by

$$\Sigma_P(E) = \Sigma_{SS}(E) + \Sigma_{NS}(E)$$

where

$$\Sigma_{SS}(E) = \alpha_{SS}\, N_F\, \sigma_{SS}{}^\circ\, f(E)$$

$$\Sigma_{NS}(E) = \alpha_{NS}\, N_F\, \sigma_{NS}{}^\circ\, f(E)$$

α_{SS} = number of slowly saturating fission products (SSPP) produced per fission,

α_{NS} = number of nonsaturating fission products (NSFP) produced per fission,

$\sigma_{SS}{}^\circ$ = microscopic cross section of SSFP at 2200 m/s,

$\sigma_{NS}{}^\circ$ = microscopic cross section of NSFP at 2200 m/s,

N_F = number of fissions, and

$f(E) = \nu_o/E$, ν_o = 2200 m/s.

Note that there is only one linearly independent function. Thus, only one group-dependent lumped-parameter fission product cross section is required.

3. RESULTS AND DISCUSSIONS

Three-dimensional neutronics calculations are obtained for the following cases:

1. preprocessing program VIPOR with the ENDF/B-IV library,
2. preprocessing program VICTORR with the ENDF/B-IV library, and
3. preprocessing program VICTORR with the ENDF/B-V library.

The horizontal plane source neutron distributions for each of these calculations are listed in Tables 3.1 through 3.3, respectively. A comparison between the latter two is shown in Table 3.4. Note that the subdivisions (row and column) represent individual assemblies and that the nine numbers in each subdivision represent equal areas. Results listed in these tables indicate that revisions of the preprocessor and of updating library are accomplished with no apparent inconsistencies. Except for the experiment located in B8, the maximum difference between the source distributions based on the ENDF/B-IV and ENDF/B-V libraries is 3%. The 13% discrepancy at location B8 is apparently a result of differences in self-shielding effects. Some additional revisions may be desirable, however, because the eigenvalue calculated for case 3 is not as close to unity as some would expect.

Differences among eigenvalues are cited in Table 3.5. Geometry specifications are not exactly the same for the VIPOR and VICTORR preprocessing programs, and there are some differences in number density specifications.

These changes in the problem setup (Case 1 to Case 2) result in an almost exact estimate for the effective multiplication constant (eigenvalue) for the VICTORR setup with the ENDF/B-IV Library. This is apparently due to compensating errors, however. For example, the average number of neutrons released per fission is increased by 0.7% for ENDF/B-V relative to ENDF/B-IV. Thus, if this were the only change, the calculated eigenvalue should increase by 0.7%. However, some scattering cross sections are also increased, and self-shielding treatments for the ENDF/B-IV and ENDF/B-V are apparently different (documentation is not available for the ENDF/B-IV Library).

These observations about known changes in nuclear data imply that the relative difference between eigenvalues obtained for case 2 and case 3 is expected. Very close agreement would indicate an error in cross-section generation.

Minor adjustments to mesh specifications in the VICTORR preprocessing were implemented after Tables 3.1 through 3.4 were generated. Consequently, the calculated power distribution in experiments in the same rows as control rods will be somewhat different for future calculations. Although this modification has no effect on the cross-section library validation calculations cited herein, it may affect the calculated eigenvalue somewhat.

Table 3.1. Neutron source distribution (x 10^{15}) in units of n/(cm^2·s) for ORR core 151A. The calculation is set up with the preprocessing program VIPOR with the library based on ENDF/B-IV.

Row \ Col	1	2	3	4	5	6	7	8	9
A	0 0 0 0 0 0 0 0 0	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1.30 1.22 1.24 1.39 1.27 1.28 1.51 1.41 1.42	1.14 1.16 1.15 1.19 1.21 1.19 1.33 1.38 1.35	1.32 1.27 1.26 1.34 1.29 1.27 1.51 1.45 1.43	1.01 0.99 0.94 1.04 1.02 0.96 1.17 1.15 1.08	0.97 0.91 0.96 0.98 0.93 1.04 1.08 1.03 1.18	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0 0 0 0 0 0 0 0 0
B	0 0 0 0 0 0 0 0 0	1.59 1.52 1.47 1.58 1.49 1.46 1.61 1.51 1.49	1.73 1.67 1.71 1.78 1.74 1.80 1.84 1.82 1.87	0.51 0.54 0.54 0.55 0.58 0.58 0.56 0.60 0.60	1.58 1.51 1.49 1.70 1.62 1.60 1.82 1.75 1.71	0.48 0.47 0.43 0.51 0.50 0.46 0.53 0.51 0.47	1.30 1.22 1.43 1.36 1.27 1.51 1.40 1.34 1.51	0.00 0.18 0.00 0.00 0.34 0.00 0.00 0.19 0.00	0 0 0 0 0 0 0 0 0
C	0 0 0 0 0 0 0 0 0	1.75 1.62 1.58 1.78 1.65 1.60 1.84 1.71 1.65	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1.39 1.50 1.54 1.40 1.52 1.57 1.37 1.46 1.50	1.52 1.48 1.43 1.58 1.55 1.49 1.56 1.55 1.48	1.36 1.27 1.13 1.38 1.28 1.13 1.33 1.23 1.10	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1.31 1.31 1.31 1.12 1.08 1.14 1.18 1.17 1.23	0 0 0 0 0 0 0 0 0
D	0 0 0 0 0 0 0 0 0	1.48 1.40 1.37 1.46 1.38 1.36 1.37 1.28 1.26	1.46 1.43 1.38 1.47 1.44 1.37 1.34 1.33 1.30	1.01 1.01 1.05 0.98 0.97 0.99 0.97 0.98 0.98	1.33 1.36 1.26 1.25 1.28 1.19 1.15 1.16 1.12	0.94 0.86 0.81 0.89 0.83 0.78 0.88 0.83 0.76	1.04 1.03 1.06 1.00 0.98 1.02 0.81 0.76 0.79	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0 0 0 0 0 0 0 0 0
E	0 0 0 0 0 0 0 0 0	1.96 1.79 1.79 1.81 1.64 1.67 1.77 1.62 1.67	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1.16 1.21 1.18 1.18 1.26 1.21 1.21 1.30 1.24	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1.06 1.01 0.83 1.09 1.04 0.84 1.11 1.08 0.88	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1.07 1.20 1.31 0.89 1.00 1.13 0.90 0.99 1.10	0 0 0 0 0 0 0 0 0
F	0 0 0 0 0 0 0 0 0	1.15 1.10 1.12 1.13 1.10 1.12 1.12 1.12 1.15	1.19 1.21 1.28 1.19 1.23 1.31 1.24 1.28 1.37	0.48 0.50 0.48 0.49 0.51 0.48 0.50 0.52 0.50	1.62 1.49 1.55 1.59 1.43 1.51 1.72 1.56 1.62	0.39 0.39 0.35 0.39 0.40 0.37 0.41 0.41 0.39	0.96 0.80 0.77 1.11 0.95 0.89 1.21 1.06 0.99	0.68 0.70 0.73 0.73 0.72 0.73 0.78 0.75 0.74	0 0 0 0 0 0 0 0 0
G	0 0 0 0 0 0 0 0 0	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0 0 0 0 0 0 0 0 0

NOTE: Letters A through G represent rows of the ORR core, and numbers 1 through 9 represent the columns. Row A faces west.

Table 3.2. Neutron source distribution (x 10^{15}) in units of $n/(cm^2 \cdot s)$ for ORR core 151A. The calculation is set up with the preprocessing program VICTORR with the library based on ENDF/B-IV

Row \ Col	1	2	3	4	5	6	7	8	9
A	0 0 0	0.00 0.00 0.00	1.22 1.14 1.15	1.05 1.07 1.06	1.23 1.18 1.17	0.94 0.92 0.87	0.90 0.85 0.90	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	1.33 1.21 1.22	1.12 1.14 1.12	1.27 1.22 1.21	0.99 0.97 0.92	0.93 0.88 0.98	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	1.47 1.36 1.37	1.28 1.31 1.29	1.44 1.38 1.36	1.13 1.11 1.04	1.04 0.98 1.13	0.00 0.00 0.00	0 0 0
B	0 0 0	1.50 1.44 1.39	1.65 1.60 1.66	0.48 0.50 0.50	1.53 1.45 1.44	0.44 0.43 0.40	1.25 1.16 1.37	0.00 0.18 0.00	0 0 0
	0 0 0	1.49 1.41 1.38	1.70 1.67 1.74	0.50 0.53 0.53	1.64 1.55 1.54	0.47 0.45 0.42	1.30 1.21 1.44	0.00 0.33 0.00	0 0 0
	0 0 0	1.53 1.43 1.40	1.76 1.74 1.79	0.52 0.55 0.55	1.74 1.65 1.63	0.49 0.47 0.43	1.33 1.25 1.43	0.00 0.19 0.00	0 0 0
C	0 0 0	1.66 1.53 1.49	0.00 0.00 0.00	1.31 1.42 1.45	1.42 1.38 1.33	1.27 1.20 1.05	0.00 0.00 0.00	1.21 1.21 1.22	0 0 0
	0 0 0	1.69 1.55 1.50	0.00 0.00 0.00	1.32 1.43 1.47	1.47 1.44 1.38	1.29 1.20 1.05	0.00 0.00 0.00	1.02 0.98 1.02	0 0 0
	0 0 0	1.74 1.60 1.55	0.00 0.00 0.00	1.30 1.38 1.42	1.45 1.43 1.37	1.25 1.16 1.03	0.00 0.00 0.00	0.98 0.94 0.99	0 0 0
D	0 0 0	1.39 1.31 1.28	1.37 1.35 1.31	0.96 0.95 0.98	1.24 1.25 1.17	0.88 0.80 0.76	0.96 0.93 0.87	0.00 0.00 0.00	0 0 0
	0 0 0	1.39 1.31 1.31	1.45 1.43 1.36	0.95 0.91 0.93	1.19 1.21 1.13	0.83 0.77 0.73	0.96 0.92 0.85	0.00 0.00 0.00	0 0 0
	0 0 0	1.32 1.25 1.27	1.51 1.53 1.45	0.97 0.92 0.92	1.10 1.11 1.06	0.82 0.76 0.71	0.83 0.77 0.74	0.00 0.00 0.00	0 0 0
E	0 0 0	1.86 1.72 1.90	0.00 0.00 0.00	1.35 1.21 1.10	0.00 0.00 0.00	0.98 0.93 0.77	0.00 0.00 0.00	0.91 1.00 1.08	0 0 0
	0 0 0	1.71 1.57 1.80	0.00 0.00 0.00	1.40 1.25 1.12	0.00 0.00 0.00	0.99 0.95 0.76	0.00 0.00 0.00	0.82 0.92 1.03	0 0 0
	0 0 0	1.65 1.53 1.74	0.00 0.00 0.00	1.38 1.26 1.13	0.00 0.00 0.00	1.01 0.97 0.80	0.00 0.00 0.00	0.84 0.93 1.03	0 0 0
F	0 0 0	1.07 1.01 1.06	1.23 1.28 1.33	0.47 0.47 0.44	1.48 1.37 1.42	0.36 0.36 0.32	0.89 0.75 0.72	0.64 0.65 0.68	0 0 0
	0 0 0	1.03 0.99 1.02	1.10 1.14 1.21	0.45 0.47 0.44	1.45 1.30 1.38	0.36 0.37 0.34	1.01 0.87 0.83	0.67 0.66 0.68	0 0 0
	0 0 0	1.02 1.00 1.03	1.12 1.15 1.23	0.46 0.48 0.46	1.56 1.42 1.48	0.37 0.38 0.36	1.10 0.97 0.91	0.72 0.69 0.69	0 0 0
G	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0

Table 3.3. Neutron source distribution (x 10^{15}) in units of $n/(cm^2 \cdot s)$ for ORR core 151A. The calculation is set up with the preprocessing program VICTORR with the library based on ENDF/B-V.

Row \ Col	1	2	3	4	5	6	7	8	9
A	0 0 0	0.00 0.00 0.00	1.28 1.20 1.21	1.10 1.12 1.11	1.29 1.25 1.23	0.99 0.96 0.91	0.95 0.89 0.93	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	1.39 1.27 1.28	1.17 1.19 1.17	1.33 1.28 1.27	1.03 1.01 0.96	0.98 0.93 1.02	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	1.52 1.41 1.43	1.32 1.36 1.34	1.51 1.44 1.43	1.17 1.15 1.08	1.08 1.03 1.16	0.00 0.00 0.00	0 0 0
B	0 0 0	1.54 1.47 1.42	1.68 1.63 1.69	0.47 0.49 0.49	1.56 1.48 1.47	0.43 0.42 0.39	1.28 1.20 1.40	0.00 0.16 0.00	0 0 0
	0 0 0	1.53 1.44 1.41	1.72 1.70 1.77	0.49 0.52 0.52	1.67 1.58 1.57	0.46 0.44 0.41	1.33 1.25 1.46	0.00 0.29 0.00	0 0 0
	0 0 0	1.57 1.46 1.43	1.78 1.77 1.82	0.51 0.53 0.54	1.77 1.69 1.66	0.48 0.46 0.42	1.35 1.28 1.44	0.00 0.16 0.00	0 0 0
C	0 0 0	1.69 1.56 1.52	0.00 0.00 0.00	1.31 1.42 1.45	1.42 1.39 1.34	1.27 1.19 1.05	0.00 0.00 0.00	1.21 1.21 1.22	0 0 0
	0 0 0	1.72 1.58 1.54	0.00 0.00 0.00	1.32 1.42 1.47	1.47 1.44 1.38	1.28 1.19 1.04	0.00 0.00 0.00	1.03 0.99 1.03	0 0 0
	0 0 0	1.77 1.63 1.58	0.00 0.00 0.00	1.30 1.37 1.41	1.45 1.43 1.36	1.24 1.14 1.02	0.00 0.00 0.00	0.99 0.95 0.99	0 0 0
D	0 0 0	1.41 1.33 1.30	1.36 1.34 1.30	0.96 0.95 0.99	1.22 1.24 1.15	0.87 0.80 0.75	0.94 0.91 0.85	0.00 0.00 0.00	0 0 0
	0 0 0	1.41 1.33 1.32	1.44 1.42 1.35	0.95 0.93 0.94	1.17 1.18 1.11	0.83 0.76 0.72	0.92 0.88 0.82	0.00 0.00 0.00	0 0 0
	0 0 0	1.34 1.26 1.28	1.49 1.50 1.43	0.97 0.93 0.92	1.09 1.09 1.04	0.81 0.75 0.70	0.80 0.74 0.71	0.00 0.00 0.00	0 0 0
E	0 0 0	1.90 1.76 1.94	0.00 0.00 0.00	1.31 1.20 1.09	0.00 0.00 0.00	0.95 0.89 0.74	0.00 0.00 0.00	0.90 0.99 1.08	0 0 0
	0 0 0	1.74 1.61 1.83	0.00 0.00 0.00	1.35 1.23 1.10	0.00 0.00 0.00	0.96 0.91 0.73	0.00 0.00 0.00	0.79 0.91 1.02	0 0 0
	0 0 0	1.69 1.57 1.77	0.00 0.00 0.00	1.34 1.24 1.12	0.00 0.00 0.00	0.98 0.93 0.76	0.00 0.00 0.00	0.81 0.91 1.01	0 0 0
F	0 0 0	1.07 1.02 1.06	1.23 1.29 1.33	0.47 0.47 0.44	1.50 1.39 1.43	0.35 0.35 0.31	0.87 0.73 0.70	0.62 0.63 0.67	0 0 0
	0 0 0	1.04 1.00 1.03	1.11 1.15 1.22	0.45 0.47 0.44	1.47 1.32 1.38	0.35 0.36 0.33	1.00 0.85 0.81	0.65 0.65 0.67	0 0 0
	0 0 0	1.03 1.02 1.04	1.13 1.16 1.24	0.46 0.47 0.45	1.57 1.43 1.48	0.37 0.37 0.35	1.09 0.95 0.90	0.70 0.68 0.67	0 0 0
G	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0

Table 3.4. Fractional differences between horizontal neutron source distributions calculated with libraries based on ENDF/B-IV and ENDF/B-V. The preprocessing program VICTORR is used for each calculation. The ENDF/B-IV library is used as the reference. The ORR core calculated is 151A.

Row \ Col	1	2	3	4	5	6	7	8	9
A	0 0 0	0.00 0.00 0.00	-0.05 -0.05 -0.05	-0.05 -0.05 -0.05	-0.05 -0.05 -0.05	-0.05 -0.05 -0.05	-0.05 -0.05 -0.04	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	-0.04 -0.05 -0.05	-0.04 -0.04 -0.04	-0.05 -0.05 -0.05	-0.04 -0.04 -0.04	-0.05 -0.05 -0.04	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	-0.04 -0.04 -0.04	-0.04 -0.04 -0.04	-0.05 -0.05 -0.05	-0.04 -0.04 -0.04	-0.04 -0.04 -0.03	0.00 0.00 0.00	0 0 0
B	0 0 0	-0.02 -0.02 -0.02	-0.02 -0.02 -0.02	0.01 0.01 0.01	-0.02 -0.02 -0.02	0.01 0.01 0.01	-0.03 -0.03 -0.02	0.00 0.12 0.00	0 0 0
	0 0 0	-0.03 -0.02 -0.02	-0.02 -0.02 -0.02	0.02 0.02 0.02	-0.02 -0.02 -0.02	0.02 0.02 0.02	-0.02 -0.03 -0.01	0.00 0.12 0.00	0 0 0
	0 0 0	-0.02 -0.02 -0.02	-0.01 -0.02 -0.02	0.02 0.02 0.02	-0.02 -0.02 -0.02	0.02 0.02 0.02	-0.02 -0.02 -0.01	0.00 0.13 0.00	0 0 0
C	0 0 0	-0.02 -0.02 -0.02	0.00 0.00 0.00	0.00 0.01 0.00	0.00 0.00 0.00	0.00 0.01 0.01	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	-0.02 -0.02 -0.02	0.00 0.00 0.00	0.00 0.01 0.00	0.00 0.00 0.00	0.00 0.01 0.01	0.00 0.00 0.00	-0.01 -0.01 0.00	0 0 0
	0 0 0	-0.02 -0.02 -0.02	0.00 0.00 0.00	0.00 0.01 0.00	0.00 0.00 0.00	0.01 0.01 0.01	0.00 0.00 0.00	-0.01 0.00 0.00	0 0 0
D	0 0 0	-0.01 -0.02 -0.01	0.00 0.00 0.00	0.00 -0.01 0.00	0.01 0.02 0.02	0.01 0.00 0.01	0.02 0.02 0.02	0.00 0.00 0.00	0 0 0
	0 0 0	-0.01 -0.01 -0.01	0.01 0.01 0.01	0.00 -0.01 -0.01	0.02 0.02 0.02	0.01 0.00 0.01	0.04 0.04 0.04	0.00 0.00 0.00	0 0 0
	0 0 0	-0.01 -0.01 -0.01	0.02 0.02 0.02	0.01 -0.01 0.00	0.01 0.02 0.02	0.01 0.01 0.02	0.04 0.04 0.04	0.00 0.00 0.00	0 0 0
E	0 0 0	-0.02 -0.02 -0.02	0.00 0.00 0.00	0.03 0.01 0.01	0.00 0.00 0.00	0.03 0.04 0.04	0.00 0.00 0.00	0.01 0.01 0.01	0 0 0
	0 0 0	-0.02 -0.02 -0.01	0.00 0.00 0.00	0.03 0.01 0.01	0.00 0.00 0.00	0.03 0.04 0.04	0.00 0.00 0.00	0.03 0.02 0.01	0 0 0
	0 0 0	-0.02 -0.02 -0.02	0.00 0.00 0.00	0.03 0.01 0.02	0.00 0.00 0.00	0.03 0.04 0.04	0.00 0.00 0.00	0.03 0.02 0.01	0 0 0
F	0 0 0	-0.01 -0.01 -0.01	0.00 0.00 0.00	0.00 0.01 0.01	-0.01 -0.01 -0.01	0.02 0.03 0.03	0.02 0.03 0.03	0.04 0.03 0.03	0 0 0
	0 0 0	-0.01 -0.01 -0.01	-0.01 -0.01 -0.01	0.00 0.01 0.01	-0.01 -0.01 0.00	0.02 0.03 0.03	0.02 0.02 0.02	0.03 0.02 0.02	0 0 0
	0 0 0	-0.01 -0.01 -0.01	-0.01 -0.01 -0.01	0.01 0.01 0.01	-0.01 -0.01 0.00	0.02 0.03 0.03	0.01 0.01 0.02	0.02 0.02 0.02	0 0 0
G	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0
	0 0 0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0 0 0

Table 3.5. Eigenvalues for sample problems

Calculation	Eigenvalue	Percent deviation from critical
Setup with VIPOR, ENDF/B-IV Library	1.00797	0.797
Setup with VICTORR, END/B-IV Library	1.00014	0.014
Setup with VICTORR, ENDF/B-V Library	1.00430	0.430

4. CONCLUSIONS AND RECOMMENDATIONS

The ENDF/B-V Library documented herein should satisfy essentially any anticipated neutronics calculations for the ORR and BSR. Results from test calculations indicate the library is generated with no apparent discrepancies in processing specifications. Also, the results are consistent with known changes implemented in the ENDF/B-V Library.

There are some improvements that could be incorporated in the library. In particular, only one linearly independent function $1/\nu(E)$ is used to represent the fission product cross sections other than xenon and samarium. This probably underestimates the absorptions by fission products since the epithermal resonance cross sections should be significantly larger than the $1/\nu(E)$ function would predict when normalized to the thermal cross section. Zero-dimensional depletion calculations that explicitly track approximately 20 fission product concentrations as a function of burnup should be performed. The preprocessing program (VICTORR) could then mix the appropriate fission product cross sections for each unique burnup zone of the reactor core based on functional approximations based on a single depletion calculation although a more accurate treatment of the fission products would result in an improved estimate of the eigenvalue, it should have only a second order effect on the power distribution. This is because variations in fission product cross sections should (in a relative sense) have little spatial variation.

A less significant improvement could be achieved by utilizing cross sections that are self-shielded as a function of burnup. This could be accomplished by linear combinations of cross sections generated for several burnup conditions, or the cross sections could be parameterized. The latter approach would probably be more difficult than the former and is not recommended for implementation.

Some additional studies should also be performed relative to the treatment of control-rod regions which are essentially black to thermal neutrons but not to epithermal or fast neutrons.

5. REFERENCES

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11. Computer Program written by C. A. Baldwin, Oak Ridge National Laboratory, Oak Ridge, TN.

12. Computer Program written by Richard Lin, Oak Ridge National Laboratory, Oak Ridge, TN.

APPENDIX A

A.1. IDENTIFICATIONS OF NUCLIDES IN THE ORR/BSR LIBRARIES

Nuclides in the ORR/BSR library for neutronics calculations are obtained for a variety of spectral fields:

1. HEU fuel on the boundary of the ORR core,
2. HEU fuel in the ORR core interior,
3. LEU fuel on the boundary of the ORR core,
4. LEU fuel in the ORR core interior,
5. ORR shim rods,
6. BSR shim rods, and
7. ex-core water reflector.

Most of the nuclides weighted over the spectra in the fuel are cell-weighted prior to zone-weighting and collapsing to seven groups. Nuclides weighted over the control-rod or ex-core spectra are not cell-weighted and are based on infinite-dilution resonance processing. The six-digit identification code for the 223 nuclides in the AMPX, ISOTXS, and GRUPX libraries is keyed to the location, fuel type, and reactor. Table A.1 defines the identification code, Table A.2 correlates the identifier with the alphanumeric identifier, and Table A.3 lists parameters for the ISOTXS library needed for over-ride of identifiers. Libraries generated in conjunction with the overall processing are identified in Table A.4.

Table A.1. Six-digit identification code for specifying nuclide location, fuel type, and reactor

Identifier code Column	Value	Description
1	0-9	First digit of atomic number
2	0-9	Second digit of atomic number
3	0-9	Last digit of mass number (several exceptions)
4	1-8	Location in the XSDRN zone-collapse calculation
	1	H2O reflector
	2	Al window
	3	A-row of fuel
	4	Interior of fuel
	5	Boundary of fuel
	6	Be reflector
	7	H2O outside the core
	8	Control rod
5	1-2	Enrichment
	1	HEU
	2	LEU
6	1-3	Reactor
	1	ORR
	2	BSR
	3	PCA (none generated)

Table A.2. List of nuclide identifications for the AMPX working library (X.LLM17459.ZONE.GXS7.ORRLIB)

ENTRY	IDENTIFIER	TITLE
1	11321	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
2	86321	O-16 (1276) CSRL-V
3	137321	AL-27 (1313) CSRL-V
4	545321	XE-135 (1294) CSRL-V
5	629321	SM-149 (1319) CSRL-V
6	925321	U-235 (1395) CSRL-V
7	926321	U-236 (1396) CSRL-V
8	928321	U-238 (1398) CSRL-V
9	948321	PU-238 (1338) CSRL-V
10	949321	PU-239 (1399) CSRL-V
11	940321	PU-240 (1380) CSRL-V
12	941321	PU-241 (1381) CSRL-V
13	11421	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
14	86421	O-16 (1276) CSRL-V
15	137421	AL-27 (1313) CSRL-V
16	545421	XE-135 (1294) CSRL-V
17	629421	SM-149 (1319) CSRL-V
18	925421	U-235 (1395) CSRL-V
19	926421	U-236 (1396) CSRL-V
20	928421	U-238 (1398) CSRL-V
21	948421	PU-238 (1338) CSRL-V
22	949421	PU-239 (1399) CSRL-V
23	940421	PU-240 (1380) CSRL-V
24	941421	PU-241 (1381) CSRL-V
25	11521	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
26	86521	O-16 (1276) CSRL-V
27	137521	AL-27 (1313) CSRL-V
28	545521	XE-135 (1294) CSRL-V
29	629521	SM-149 (1319) CSRL-V
30	925521	U-235 (1395) CSRL-V
31	926521	U-236 (1396) CSRL-V
32	928521	U-238 (1398) CSRL-V
33	948521	PU-238 (1338) CSRL-V
34	949521	PU-239 (1399) CSRL-V
35	940521	PU-240 (1380) CSRL-V
36	941521	PU-241 (1381) CSRL-V
37	999421	1/V ****** CSRL-V SPECIAL 1/V DATA SET
38	999721	1/V ****** CSRL-V SPECIAL 1/V DATA SET
39	11121	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
40	11721	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
41	12721	H-2 (1302) CSRL-V D2O BOUND (1004) 8 TEMPS
42	13721	H-3 (1169) CSRL-V
43	19721	H-1 (1301) CSRL-V POLY BOUND (1011) 2 TEMPS
44	23721	HE-3 (1146) CSRL-V
45	24721	HE-4 (1270) CSRL-V

Table A.2. Continued

ENTRY	IDENTIFIER	T I T L E
46	36721	LI-6 (1303) CSRL-V
47	37721	LI-7 (1272) CSRL-V
48	49621	BE-9 (1304) CSRL-V
49	49721	BE-9 (1304) CSRL-V
50	50721	B-10 (1305) CSRL-V
51	51721	B-11 (1160) CSRL-V
52	62721	C-12 (1306) CSRL-V FREE GAS 300,900,1200
53	63721	GPHITE (1306) CSRL-V
54	74721	N-14 (1275) CSRL-V
55	75721	N-15 (1307) CSRL-V
56	86121	O-16 (1276) CSRL-V
57	86721	O-16 (1276) CSRL-V
58	87721	O-17 (1317) CSRL-V
59	99721	F-19 (1309) CSRL-V
60	113721	NA-23 (1311) CSRL-V
61	120721	MG (1312) CSRL-V
62	137221	AL-27 (1313) CSRL-V
63	137721	AL-27 (1313) CSRL-V
64	140721	SI (1314) CSRL-V
65	151721	P-31 (1315) CSRL-V
66	162721	S-32 (1316) CSRL-V
67	170721	CL (1149) CSRL-V
68	180721	AR (7124) CSRL-V
69	190721	K (1150) CSRL-V
70	200721	CA (1320) CSRL-V
71	215721	SC-45 (7127) CSRL-V
72	220721	TI (1322) CSRL-V
73	230721	V (1323) CSRL-V
74	240721	CR (1324) CSRL-V
75	255721	MN-55 (1325) CSRL-V
76	260721	FE (1326) CSRL-V
77	279721	CO-59 (1327) CSRL-V
78	280721	NI (1328) CSRL-V
79	290721	CU (1329) CSRL-V
80	304721	ZN-64 (7139) CSRL-V
81	310721	GA (7140) CSRL-V
82	368721	KR-78 (1330) CSRL-V
83	360721	KR-80 (1331) CSRL-V
84	362721	KR-82 (1332) CSRL-V
85	363721	KR-83 (1333) CSRL-V
86	364721	KR-84 (1334) CSRL-V
87	366721	KR-86 (1336) CSRL-V
88	409721	ZR (1340) CSRL-V
89	400721	ZR-90 (1385) CSRL-V
90	401721	ZR-91 (1386) CSRL-V
91	402721	ZR-92 (1387) CSRL-V
92	404721	ZR-94 (1388) CSRL-V

Table A.2. Continued

ENTRY	IDENTIFIER	T I T L E
93	406721	ZR-96 (1389) CSRL-V
94	408721	ZIRC-2 ****** CSRL-V PREPARED FROM 999 AND 40000
95	413721	NB-93 (1189) CSRL-V
96	420721	MO (1321) CSRL-V
97	439721	TC-99 (1308) CSRL-V
98	453721	RH-103 (1310) CSRL-V
99	477721	AG-107 (1371) CSRL-V
100	479721	AG-109 (1373) CSRL-V
101	480721	CD (1281) CSRL-V
102	483721	CD-113 (1318) CSRL-V
103	500721	SN (7150) CSRL-V
104	543721	XE-124 (1335) CSRL-V
105	547721	XE-126 (1339) CSRL-V
106	548721	XE-128 (1348) CSRL-V
107	549721	XE-129 (1349) CSRL-V
108	540721	XE-130 (1350) CSRL-V
109	541721	XE-131 (1351) CSRL-V
110	542721	XE-132 (1352) CSRL-V
111	544721	XE-134 (1354) CSRL-V
112	545721	XE-135 (1294) CSRL-V
113	546721	XE-136 (1356) CSRL-V
114	553721	CS-133 (1355) CSRL-V
115	568721	BA-138 (1353) CSRL-V
116	629721	SM-149 (1319) CSRL-V
117	631721	EU-151 (1357) CSRL-V
118	632721	EU-152 (1292) CSRL-V
119	633721	EU-153 (1359) CSRL-V
120	634721	EU-154 (1293) CSRL-V
121	642721	GD-152 (1362) CSRL-V
122	644721	GD-154 (1364) CSRL-V
123	645721	GD-155 (1365) CSRL-V
124	646721	GD-156 (1366) CSRL-V
125	647721	GD-157 (1367) CSRL-V
126	648721	GD-158 (1368) CSRL-V
127	640721	GD-160 (1370) CSRL-V
128	664721	DY-164 (1031) CSRL-V
129	715721	LU-175 (1032) CSRL-V
130	716721	LU-176 (1033) CSRL-V
131	728721	HF (1372) CSRL-V
132	724721	HF-174 (1374) CSRL-V
133	726721	HF-176 (1376) CSRL-V
134	729721	HF-179 (1383) CSRL-V
135	720721	HF-180 (1384) CSRL-V
136	731721	TA-181 (1285) CSRL-V
137	732721	TA-182 (1127) CSRL-V
138	742721	W-182 (1128) CSRL-V
139	743721	W-183 (1129) CSRL-V

Table A.2. Continued

ENTRY	IDENTIFIER	TITLE
140	744721	W-184 (1130) CSRL-V
141	746721	W-186 (1131) CSRL-V
142	755721	RE-185 (1083) CSRL-V
143	757721	RE-187 (1084) CSRL-V
144	771721	IR-191 (7160) CSRL-V
145	773721	IR-193 (7161) CSRL-V
146	797721	AU-197 (1379) CSRL-V
147	820721	PB (1382) CSRL-V
148	902721	TH-232 (1390) CSRL-V
149	913721	PA-233 (1391) CSRL-V
150	923721	U-233 (1393) CSRL-V
151	924721	U-234 (1394) CSRL-V
152	925721	U-235 (1395) CSRL-V
153	926721	U-236 (1396) CSRL-V
154	928721	U-238 (1398) CSRL-V
155	937721	NP-237 (1337) CSRL-V
156	948721	PU-238 (1338) CSRL-V
157	949721	PU-239 (1399) CSRL-V
158	940721	PU-240 (1380) CSRL-V
159	941721	PU-241 (1381) CSRL-V
160	942721	PU-242 (1342) CSRL-V
161	951721	AM-241 (1361) CSRL-V
162	959721	AM-242M(1369) CSRL-V
163	953721	AM-243 (1363) CSRL-V
164	963721	CM-243 (1343) CSRL-V
165	964721	CM-244 (1344) CSRL-V
166	965721	CM-245 (1345) CSRL-V
167	966721	CM-246 (1346) CSRL-V
168	987721	DOSFAC ****** CSRL-V 20 SETS OF NEUTRON DOSE FACTORS
169	11311	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
170	86311	O-16 (1276) CSRL-V
171	137311	AL-27 (1313) CSRL-V
172	545311	XE-135 (1294) CSRL-V
173	629311	SM-149 (1319) CSRL-V
174	925311	U-235 (1395) CSRL-V
175	926311	U-236 (1396) CSRL-V
176	928311	U-238 (1398) CSRL-V
177	948311	PU-238 (1338) CSRL-V
178	949311	PU-239 (1399) CSRL-V
179	940311	PU-240 (1380) CSRL-V
180	941311	PU-241 (1381) CSRL-V
181	11411	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
182	86411	O-16 (1276) CSRL-V
183	137411	AL-27 (1313) CSRL-V
184	545411	XE-135 (1294) CSRL-V
185	629411	SM-149 (1319) CSRL-V
186	925411	U-235 (1395) CSRL-V

Table A.2. Continued

ENTRY	IDENTIFIER	T I T L E
187	926411	U-236 (1396) CSRL-V
188	928411	U-238 (1398) CSRL-V
189	948411	PU-238 (1338) CSRL-V
190	949411	PU-239 (1399) CSRL-V
191	940411	PU-240 (1380) CSRL-V
192	941411	PU-241 (1381) CSRL-V
193	11511	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
194	86511	O-16 (1276) CSRL-V
195	137511	AL-27 (1313) CSRL-V
196	545511	XE-135 (1294) CSRL-V
197	629511	SM-149 (1319) CSRL-V
198	925511	U-235 (1395) CSRL-V
199	926511	U-236 (1396) CSRL-V
200	928511	U-238 (1398) CSRL-V
201	948511	PU-238 (1338) CSRL-V
202	949511	PU-239 (1399) CSRL-V
203	940511	PU-240 (1380) CSRL-V
204	941511	PU-241 (1381) CSRL-V
205	999411	1/V ****** CSRL-V SPECIAL 1/V DATA SET
206	11111	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
207	11711	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
208	49611	BE-9 (1304) CSRL-V
209	86111	O-16 (1276) CSRL-V
210	86711	O-16 (1276) CSRL-V
211	137211	AL-27 (1313) CSRL-V
212	925821	U-235 (1395) CSRL-V
213	928821	U-238 (1398) CSRL-V
214	949821	PU-239 (1399) CSRL-V
215	11821	H-1 (1301) CSRL-V H2O BOUND (1002) 8 TEMPS
216	86821	O-16 (1276) CSRL-V
217	137821	AL-27 (1313) CSRL-V
218	480821	CD (1281) CSRL-V
219	50812	B-10 (1305) CSRL-V
220	51812	B-11 (1160) CSRL-V
221	240812	CR (1324) CSRL-V
222	260812	FE (1326) CSRL-V
223	280812	NI (1328) CSRL-V

Table A.3. List of nuclide identifiers and parameters for the library in the ISOTXS format (X.LLM17459.ZONE.ISOTXS.GXS7.ORRLIB)

A CCCC ISOTXS INTERFACE WILL BE WRITTEN ON LOGICAL 64

HISONM	HABSID	HMAT	KBR	EFISS	ECAPT	AMASS
11321	01001	1301	0	0.0	3.600E-13	1.008E+00
86321	08016	1276	0	0.0	6.600E-13	1.599E+01
137321	13027	1313	0	0.0	0.0	2.698E+01
545321	54135	1294	0	0.0	1.260E-12	1.337E+02
629321	62149	1319	0	0.0	1.280E-12	1.489E+02
925321	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926321	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928321	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
948321	94238	1338	2	3.200E-11	0.0	2.380E+02
949321	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940321	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941321	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
11421	01001	1301	0	0.0	3.600E-13	1.008E+00
86421	08016	1276	0	0.0	6.600E-13	1.599E+01
137421	13027	1313	0	0.0	0.0	2.698E+01
545421	54135	1294	0	0.0	1.260E-12	1.337E+02
629421	62149	1319	0	0.0	1.280E-12	1.489E+02
925421	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926421	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928421	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
948421	94238	1338	2	3.200E-11	0.0	2.380E+02
949421	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940421	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941421	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
11521	01001	1301	0	0.0	3.600E-13	1.008E+00
86521	08016	1276	0	0.0	6.600E-13	1.599E+01
137521	13027	1313	0	0.0	0.0	2.698E+01
545521	54135	1294	0	0.0	1.260E-12	1.337E+02
629521	62149	1319	0	0.0	1.280E-12	1.489E+02
925521	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926521	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928521	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
948521	94238	1338	2	3.200E-11	0.0	2.380E+02
949521	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940521	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941521	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
999421	00000	0000	0	0.0	0.0	0.0
999721	00000	0000	0	0.0	0.0	0.0
11121	01001	1301	0	0.0	3.600E-13	1.008E+00
11721	01001	1301	0	0.0	3.600E-13	1.008E+00
12721	01002	1302	0	0.0	0.0	2.014E+00
13721	01003	1169	0	0.0	0.0	3.016E+00
19721	01001	1301	0	0.0	3.600E-13	1.008E+00

Table A.3. Continued

HISONM	HABSID	HMAT	KBR	EFISS	ECAPT	AMASS
23721	02003	1146	0	0.0	0.0	3.016E+00
24721	02004	1270	0	0.0	0.0	4.003E+00
36721	03006	1303	0	0.0	0.0	6.015E+00
37721	03007	1272	0	0.0	0.0	7.016E+00
49621	04009	1304	0	0.0	0.0	9.012E+00
49721	04009	1304	0	0.0	0.0	9.012E+00
50721	05010	1305	7	0.0	1.830E-12	1.001E+01
51721	05011	1160	7	0.0	0.0	1.101E+01
62721	06000	1306	0	0.0	0.0	1.190E+01
63721	06000	1306	0	0.0	0.0	1.190E+01
74721	07014	1275	0	0.0	0.0	1.400E+01
75721	07015	1307	0	0.0	0.0	1.500E+01
86121	08016	1276	0	0.0	6.600E-13	1.599E+01
86721	08016	1276	0	0.0	6.600E-13	1.599E+01
87721	08017	1317	0	0.0	0.0	1.700E+01
99721	09019	1309	0	0.0	0.0	1.900E+01
113721	11023	1311	5	0.0	0.0	2.299E+01
120721	12000	1312	0	0.0	0.0	2.410E+01
137221	13027	1313	0	0.0	0.0	2.698E+01
137721	13027	1313	0	0.0	0.0	2.698E+01
140721	14000	1314	0	0.0	0.0	2.784E+01
151721	15031	1315	0	0.0	0.0	3.097E+01
162721	16032	1316	0	0.0	0.0	3.197E+01
170721	17000	1149	0	0.0	0.0	3.515E+01
180721	18000	7124	0	0.0	0.0	3.960E+01
190721	19000	1150	0	0.0	0.0	3.877E+01
200721	20000	1320	0	0.0	0.0	3.974E+01
215721	21045	7127	0	0.0	0.0	4.496E+01
220721	22000	1322	0	0.0	0.0	4.747E+01
230721	23000	1323	0	0.0	0.0	5.050E+01
240721	24000	1324	0	0.0	0.0	5.155E+01
255721	25055	1325	5	0.0	0.0	5.494E+01
260721	26000	1326	0	0.0	0.0	5.536E+01
279721	27059	1327	0	0.0	1.650E-12	5.893E+01
280721	28000	1328	0	0.0	0.0	5.818E+01
290721	29000	1329	0	0.0	0.0	6.355E+01
304721	30064	7139	0	0.0	0.0	6.393E+01
310721	31000	7140	0	0.0	0.0	6.912E+01
368721	36078	1330	0	0.0	0.0	7.792E+01
360721	36080	1331	0	0.0	0.0	7.992E+01
362721	36082	1332	0	0.0	0.0	8.191E+01
363721	36083	1333	0	0.0	0.0	8.291E+01
364721	36084	1334	0	0.0	0.0	8.391E+01
366721	36086	1336	0	0.0	0.0	8.591E+01
409721	40000	1340	0	0.0	0.0	9.044E+01
400721	40090	1385	0	0.0	0.0	8.990E+01
401721	40091	1386	0	0.0	1.390E-12	9.091E+01

Table A.3. Continued

HISONM	HABSID	HMAT	KBR	EFISS	ECAPT	AMASS
402721	40092	1387	0	0.0	0.0	9.191E+01
404721	40094	1388	0	0.0	0.0	9.391E+01
406721	40096	1389	0	0.0	0.0	9.591E+01
408721	40000	1340	0	0.0	0.0	9.044E+01
413721	41093	1189	0	0.0	0.0	9.291E+01
420721	42000	1321	0	0.0	0.0	9.512E+01
439721	43099	1308	0	0.0	0.0	9.815E+01
453721	45103	1310	0	0.0	0.0	1.029E+02
477721	47107	1371	0	0.0	0.0	1.069E+02
479721	47109	1373	0	0.0	0.0	1.089E+02
480721	48000	1281	0	0.0	0.0	1.115E+02
483721	48113	1318	0	0.0	0.0	1.129E+02
500721	50000	7150	0	0.0	0.0	1.177E+02
543721	54124	1335	0	0.0	0.0	1.239E+02
547721	54126	1339	0	0.0	0.0	1.259E+02
548721	54128	1348	0	0.0	0.0	1.279E+02
549721	54129	1349	0	0.0	0.0	1.289E+02
540721	54130	1350	0	0.0	0.0	1.299E+02
541721	54131	1351	0	0.0	0.0	1.309E+02
542721	54132	1352	0	0.0	0.0	1.319E+02
544721	54134	1354	0	0.0	0.0	1.339E+02
545721	54135	1294	0	0.0	1.260E-12	1.337E+02
546721	54136	1356	0	0.0	0.0	1.359E+02
553721	55133	1355	0	0.0	0.0	1.329E+02
568721	56138	1353	0	0.0	0.0	1.379E+02
629721	62149	1319	0	0.0	1.280E-12	1.489E+02
631721	63151	1357	0	0.0	0.0	1.509E+02
632721	63152	1292	0	0.0	0.0	1.506E+02
633721	63153	1359	0	0.0	0.0	1.529E+02
634721	63154	1293	0	0.0	0.0	1.526E+02
642721	64152	1362	0	0.0	0.0	1.519E+02
644721	64154	1364	0	0.0	0.0	1.539E+02
645721	64155	1365	0	0.0	0.0	1.549E+02
646721	64156	1366	0	0.0	0.0	1.559E+02
647721	64157	1367	0	0.0	0.0	1.569E+02
648721	64158	1368	0	0.0	0.0	1.579E+02
640721	64160	1370	0	0.0	0.0	1.599E+02
664721	66164	1031	0	0.0	0.0	1.639E+02
715721	71175	1032	0	0.0	0.0	1.749E+02
716721	71176	1033	0	0.0	0.0	1.759E+02
728721	72000	1372	0	0.0	0.0	1.770E+02
724721	72174	1374	0	0.0	0.0	1.739E+02
726721	72176	1376	0	0.0	0.0	1.759E+02
729721	72179	1383	0	0.0	0.0	1.789E+02
720721	72180	1384	0	0.0	0.0	1.799E+02
731721	73181	1285	0	0.0	0.0	1.809E+02
732721	73182	1127	0	0.0	0.0	1.804E+02
742721	74182	1128	0	0.0	0.0	1.819E+02

Table A.3. Continued

HISONM	HABSID	HMAT	KBR	EFISS	ECAPT	AMASS
743721	74183	1129	0	0.0	0.0	1.830E+02
744721	74184	1130	0	0.0	0.0	1.840E+02
746721	74186	1131	0	0.0	0.0	1.860E+02
755721	75185	1083	0	0.0	0.0	1.850E+02
757721	75187	1084	0	0.0	0.0	1.870E+02
771721	77191	7160	0	0.0	0.0	1.910E+02
773721	77193	7161	0	0.0	0.0	1.930E+02
797721	79197	1379	0	0.0	0.0	1.970E+02
820721	82000	1382	0	0.0	0.0	2.054E+02
902721	90232	1390	3	3.049E-11	7.900E-13	2.320E+02
913721	91233	1391	1	0.0	0.0	2.330E+02
923721	92233	1393	1	3.123E-11	0.0	2.330E+02
924721	92234	1394	2	3.136E-11	0.0	2.340E+02
925721	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926721	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928721	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
937721	93237	1337	3	3.200E-11	0.0	2.370E+02
948721	94238	1338	2	3.200E-11	0.0	2.380E+02
949721	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940721	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941721	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
942721	94242	1342	3	3.276E-11	8.100E-13	2.421E+02
951721	95241	1361	3	3.200E-11	0.0	2.411E+02
959721	95242	1369	3	0.0	0.0	2.421E+02
953721	95243	1363	3	3.200E-11	0.0	2.431E+02
963721	96243	1343	3	0.0	0.0	2.431E+02
964721	96244	1344	3	3.200E-11	0.0	2.441E+02
965721	96245	1345	3	0.0	0.0	2.451E+02
966721	96246	1346	3	0.0	0.0	2.461E+02
987721	00000	0000	0	0.0	0.0	0.0
11311	01001	1301	0	0.0	3.600E-13	1.008E+00
86311	08016	1276	0	0.0	6.600E-13	1.599E+01
137311	13027	1313	0	0.0	0.0	2.698E+01
545311	54135	1294	0	0.0	1.260E-12	1.337E+02
629311	62149	1319	0	0.0	1.280E-12	1.489E+02
925311	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926311	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928311	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
948311	94238	1338	2	3.200E-11	0.0	2.380E+02
949311	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940311	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941311	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
11411	01001	1301	0	0.0	3.600E-13	1.008E+00
86411	08016	1276	0	0.0	6.600E-13	1.599E+01
137411	13027	1313	0	0.0	0.0	2.698E+01
545411	54135	1294	0	0.0	1.260E-12	1.337E+02
629411	62149	1319	0	0.0	1.280E-12	1.489E+02

Table A.3. Continued

HISONM	HABSID	HMAT	KBR	EFISS	ECAPT	AMASS
925411	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926411	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928411	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
948411	94238	1338	2	3.200E-11	0.0	2.380E+02
949411	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940411	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941411	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
11511	01001	1301	0	0.0	3.600E-13	1.008E+00
86511	08016	1276	0	0.0	6.600E-13	1.599E+01
137511	13027	1313	0	0.0	0.0	2.698E+01
545511	54135	1294	0	0.0	1.260E-12	1.337E+02
629511	62149	1319	0	0.0	1.280E-12	1.489E+02
925511	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
926511	92236	1396	3	3.126E-11	8.500E-13	2.360E+02
928511	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
948511	94238	1338	2	3.200E-11	0.0	2.380E+02
949511	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
940511	94240	1380	2	3.283E-11	8.700E-13	2.401E+02
941511	94241	1381	1	3.305E-11	1.000E-12	2.411E+02
999411	00000	0000	0	0.0	0.0	0.0
11111	01001	1301	0	0.0	3.600E-13	1.008E+00
11711	01001	1301	0	0.0	3.600E-13	1.008E+00
49611	04009	1304	0	0.0	0.0	9.012E+00
86111	08016	1276	0	0.0	6.600E-13	1.599E+01
86711	08016	1276	0	0.0	6.600E-13	1.599E+01
137211	13027	1313	0	0.0	0.0	2.698E+01
925821	92235	1395	1	3.148E-11	1.040E-12	2.350E+02
928821	92238	1398	2	3.162E-11	7.600E-13	2.381E+02
949821	94239	1399	1	3.283E-11	1.030E-12	2.391E+02
11821	01001	1301	0	0.0	3.600E-13	1.008E+00
86821	08016	1276	0	0.0	6.600E-13	1.599E+01
137821	13027	1313	0	0.0	0.0	2.698E+01
480821	48000	1281	0	0.0	0.0	1.115E+02
50812	05010	1305	7	0.0	1.830E-12	1.001E+01
51812	05011	1160	7	0.0	0.0	1.101E+01
240812	24000	1324	0	0.0	0.0	5.155E+01
260812	26000	1326	0	0.0	0.0	5.536E+01
280812	28000	1328	0	0.0	0.0	5.818E+01

Table A.4. Data sets retained after generating seven-group cross sections for the ORR from the 227-group CSRLV Library (on mass storage unit VCSRLV with data set name NMG.X227.FINAL1)

Data set name (volume)	Description
X.LLM17459.AJAX.G227.CSRLV(VZLLM1)	Selected nuclides CSRLV Library for use in cell calculations
WWLIB.LLM17459.CSRLV.INFD(X08471)	Infinite dilution (227-group) cross sections of all nuclides on the CSRLV Library
X.LLM17459.CELLB30.XSDRN.G227.CSRLV (VZLLM1)	Cell-weighted (227-group) cross sections for LEU fuel with 30% burnup
X.LLM17459.CELLA.XSDRN.G227.CSRLV (VZLLM1)	Cell-weighted (227-group) cross sections for HEU fuel
CELLB30.LLM17459.INFD.ZONE(X22653)	Cell-weighted plus infinite dilution (227-group) cross sections for the LEU zone collapse calculation
CELLA.LLM17459.INFD.ZONE(X03729)	Cell-weighted plus infinite dilution (227-group) cross sections for the HEU zone collapse calculation
X.LLM17459.ZONE.XSDRN.GXS7.CELLA (VZLLM1)	Zone-weighted (7-group) cross sections from the HEU zone collapse calculation
X.LLM17459.ZONE.XSDRN.GXS7.CELLB30 (VZLLM1)	Zone-weighted (7-group) cross sections from the LEU zone collapse calculation
X.LLM17459.ZONE.XSDRN.G7B30ZW.CROD (VZLLM1)	Zone-weighted (7-group) cross sections from a control-rod mockup calculation for the ORR
X.LLM17459.ZONE.XSDRN.G7BSRZW.CROD (VZLLM1)	Zone-weighted (7-group) cross sections from a control-rod mockup for the BSR
X.LLM17459.ZONE.GXS7.ORRLIB (VZLLM1)	Zone-weighted (7-group) cross sections from the HEU, LEU, ORR control-rod, and BSR control-rod zone collapse calculation in the AMPX format
X.LLM17459.ZONE.ISOTXS.GXS7.ORRLIB (VZLLM1)	Zone-weighted (7-group) cross sections from the HEU, LEU, ORR control-rod, and BSR control-rod zone collapse calculations in the ISOTXS format (nuclide ordered)
X.LLM17459.GXS7.ORRBSR.GRUPX (VZLLM1)	Zone-weighted (7-group) cross sections from the HEU, LEU, and control-rod zone collapse calculations in the GRUPX format (group ordered)

A.2. LISTINGS OF JOB CONTROL LANGUAGE (JCL) AND INPUT DATA FOR GENERATING CROSS-SECTION LIBRARIES

The JCL and input specifications for the data processing to generate AMPX-, ISOTXS-, and GRUPX-formatted cross-section libraries are listed below. Each of these listings corresponds to a block in Fig. 2.1.

A.2.1 LISTING FOR SELECTING NUCLIDES FROM THE MASTER CSRLV LIBRARY WITH THE AJAX MODULE OF AMPX (Archive file AJAX.CEL)

```
//LLMCXG JOB (17459,I020),'SAVE7132,22 B-3001',TIME=(0,30)
/*ROUTE XEQ MSS
/*ROUTE PRINT RMT45
//CXG EXEC AMPX,GOTIME=1,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT58F001 DD UNIT=3330V,VOL=SER=VCSRLV,DSN=NMG.X227.FINAL1,
//  DISP=SHR
//GO.FT59F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//  DSN=X.LLM17459.AJAX.G227.CSRLV,SPACE=(TRK,(400,200),RLSE)
//GO.SYSIN DD *
=AJAX
0$$ 59 58
1$$ 1 T
2$$ 58 12 T
3$$ 1001 8016 13027 54135 62149 92235 92236 92238 94238 94239
 94240 94241
T
/*
//
```

A.2.2 LISTING FOR GENERATING A LIBRARY OF NUCLIDES WITH INFINITE DILUTION PROCESSING WITH THE NITAWL MODULE OF AMPX (Archive file NITAWL.INF)

```
//LLMINF JOB (17459,TAPE,I0400),'SAVE7132,22 B-3001',TIME=(5,30)
/*ROUTE XEQ STANDBY
/*ROUTE XEQ MSS
/*ROUTE PRINT RMT45
//CXG EXEC AMPX,GOTIME=5,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT58F001 DD UNIT=3330V,VOL=SER=VCSRLV,DSN=NMG.X227.FINAL1,
//   DISP=SHR
//GO.FT61F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X08471,DSN=WWLIB.LLM17459.CSRLV.INFD,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=NITAWL
0$$ 58 0 0 61 E
1$$ 0 127 0 0 0 0 0 0 0 0 0 0
T
2$$
999 1001 1002 1003 1901 2003 2004 3006 3007 4009 5010 5011 6012
6312 7014 7015 8016 8017 9019 11023 12000 13027 14000 15031 16032
17000 18000 19000 20000 21045 22000 23000 24000 25055 26000 27059
28000 29000 30064 31000 36078 36080 36082 36083 36084 36086 40000
40090 40091 40092 40094 40096 40302 41093 42000 43099 45103 47107
47109 48000 48113 50000 54124 54126 54128 54129 54130 54131 54132
54134 54135 54136 55133 56138 62149 63151 63152 63153 63154 64152
64154 64155 64156 64157 64158 64160 66164 71175 71176 72000 72174
72176    72179 72180 73181 73182 74182 74183 74184 74186
75185 75187 77191 77193 79197 82000 90232 91233 92233 92234 92235
92236 92238 93237 94238 94239 94240 94241 94242 95241 95601 95243
96243 96244 96245 96246 500000
4** F300.0
2T
/*
//
```

A.2.3 LISTING FOR CALCULATING THE DANCOFF FACTOR WITH THE BONAMI MODULE OF AMPX (Archive file BONAMI.DCF)

```
//LLMDCF JOB (17459,I080),'SAVE7132,22 B-3001',TIME=(5,30)
/*ROUTE XEQ MSS
/*ROUTE PRINT RMT45
//CXG EXEC AMPX,GOTIME=5,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT58F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//  DSN=X.LLM17459.AJAX.G227.CSRLV
//GO.SYSIN DD *
=BONAMI2
0$$ 58 24 18 22
1$$ 1 3 6 0 0 3
2** 0.0001 0.0
T
3$$ 1 1 1 2 3 3

4$$ 92235 92238 13027 13027 1001 8016
5** 0.00164 0.000234 0.01 0.0603 0.0668 0.0334
6$$ 1 2 3
7** 0.0254 0.0762 0.2239
8** 300 300 300
10$$ 92235 92238 13027 1302708 1001 8016
11$$ 0 2 1
T
/*
//
```

A.2.4 LISTING FOR OBTAINING 227-GROUP CELL-WEIGHTED CROSS SECTIONS FOR HEU FUEL WITH THE BONAMI, NITAWL, AND XSDRN MODULES OF AMPX (Archive file XSC227.HEU)

```
//LLMCPH JOB (17459,TAPE,IO400),'MILLER LF B-3001',TIME=(20,30)
/*ROUTE XEQ STANDBY
/*ROUTE XEQ MSS
//CXG EXEC AMPX,GOTIME=20,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT59F001 DD UNIT=3330V,VOL=SER=VZLLM1,
//   DSN=X.LLM17459.AJAX.G227.CSRLV,DISP=SHR
//GO.FT60F001 DD UNIT=SYSDA,DISP=(NEW,PASS),DSN=&&BONAMI,
//   SPACE=(TRK,(400,200),RLSE)
//GO.FT61F001 DD UNIT=SYSDA,DISP=(NEW,PASS),DSN=&&NITAWL,
//   SPACE=(TRK,(400,200),RLSE)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   DSN=X.LLM17459.CELLA.XSDRN.G227.CSRLV,
//   SPACE=(TRK,(100,100),RLSE)
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X18804,DSN=CELLA.LLM17459.FLUXES.XSDRN,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=BONAMI2
0$$ 59 24 18 60
1$$ 1 3 13 0 1 3
2** 0.0005 0.0
T
3$$ 1 1 1 1 1 1 1 1 1 1 2 3 3
4$$ 92235 92238 13027 92236 94238 94239 94240 94241 54135 62149 13027
 1001 8016
5** 0.0013 8.7-5 0.058 7R1.0-10  0.0603 0.0668
0.0334
6$$ 1 2 3
7** 0.0254 0.0762 0.2239
8** 300 300 300
11$$ 0 2 1
12** F300.0
T
=NITAWL
0$$ 60 0 0 61 E
1$$ 0 13 0 0 0 0 0 7 0 0 0 0
T
2$$ 9223501 9223801 9223601 9423801 9423901 9424001 9424101
   1302701 5413501 6214901  1302702 100103 801603
3**
9223501 300 1 0.0508 0.55 3.7+3 1.30-3 1 27 100 1 238 10 0 1.0
9223801 300 1 0.0508 0.55 5.7+4 8.67-5 1 27 1000 1 235 10 0 1.0
9223601 300 1 0.0508 0.55 7.7+4 1.0-10 1 27 2000 1 235 10 0 1.0
9423801 300 1 0.0508 0.55 2.5+5 1.0-10 1 27 5000 1 235 10 0 1.0
9423901 300 1 0.0508 0.55 1.0+5 1.0-10 1 27 2000 1 235 10 0 1.0
9424001 300 1 0.0508 0.55 2.0+5 1.0-10 1 27 4000 1 235 10 0 1.0
9424101 300 1 0.0508 0.55 4.0+5 1.0-10 1 27 8000 1 235 10 0 1.0
```

```
4** F300.0
T
=XSDRN
XSDRN CELL TO COLLAPSE CSRLV TO 227 GROUPS
0$$ 7 10 61 20 62 E
1$$ 1 3 10 1 3 3 13 16 3 1 10 15 0 0 0
2$$ -2 -63 -1 0 0 0 -3 0 0 0
3$$ 1 0 0 0 20 0 2 0 0 0 1 0
4$$ -1 227 3 -2 3 4 230 -1 0
5** 1-4 1-4 1.0 1.0 0 1.42 0.0 0.0 100.0 0.0 1-3 0.75
T
13$$ 10R1 2 2R3
14$$
9223501 9223801 1302701 9223601 9423801 9423901 9424001 9424101
 5413501 6214901
 1302701
100103 801603
15** 1.3-3 8.67-5 0.058 7R1.0-10
0.0603
0.0668 0.0334
T
33## F1.0
T
35**
3I0.0 1I0.0254 3I0.0762 0.2239
36$$ 4R1 2R2 4R3
39$$ 1 2 3
40$$ 3 3 3
51$$
225I1 227
T
/*
//
```

A.2.5 LISTING FOR OBTAINING 227-GROUP CELL-WEIGHTED CROSS SECTIONS FOR LEU FUEL WITH THE BONAMI, NITAWL, AND XSDRN MODULES OF AMPX (Archive file XSC227.LEU)

```
//LLMCPL JOB (17459,TAPE,IO400),'MILLER LF B-3001',TIME=(20,30)
/*ROUTE XEQ STANDBY
/*ROUTE XEQ MSS
//CXG EXEC AMPX,GOTIME=20,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT59F001 DD UNIT=3330V,VOL=SER=VZLLM1,
//   DSN=X.LLM17459.AJAX.G227.CSRLV,DISP=SHR
//GO.FT60F001 DD UNIT=SYSDA,DISP=(NEW,PASS),DSN=&&BONAMI,
//   SPACE=(TRK,(400,200),RLSE)
//GO.FT61F001 DD UNIT=SYSDA,DISP=(NEW,PASS),DSN=&&NITAWL,
//   SPACE=(TRK,(400,200),RLSE)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   DSN=X.LLM17459.CELLB30.XSDRN.G227.CSRLV,
//   SPACE=(TRK,(100,100),RLSE)
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X18804,DSN=CELLA.LLM17459.FLUXES.XSDRN,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=BONAMI2
0$$ 59 24 18 60
1$$ 1 3 13 0 1 3
2** 0.0005 0.0
T
3$$ 1 1 1 1 1 1 1 1 1 1 2 3 3
4$$ 92235 92238 13027 92236 94238 94239 94240 94241 54135 62149 13027
 1001 8016
5** 1.64-3 9.5-3 0.058 2R1.0-10 1.09-5 5.0-6 2.0-6  2R1.0-10
  0.0603 0.0668
0.0334
6$$ 1 2 3
7** 0.0254 0.0762 0.2239
8** 300 300 300
11$$ 0 2 1
12** F300.0
T
=NITAWL
0$$ 60 0 0 61 E
1$$ 0 13 0 0 0 0 0 7 0 0 0 0
T
2$$ 9223501 9223801 9223601 9423801 9423901 9424001 9424101
   1302701 5413501 6214901 1302702 100103 801603
```

```
3**
9223501 300 1 0.0508 0.55 3.0+3 1.64-3 1 27 100 1 238 10 0 1.0
9223801 300 1 0.0508 0.55 5.0+2 9.50-3 1 27 1000 1 235 10 0 1.0
9223601 300 1 0.0508 0.55 7.7+4 6.50-5 1 27 2000 1 235 10 0 1.0
9423801 300 1 0.0508 0.55 2.5+5 5.00-7 1 27 5000 1 235 10 0 1.0
9423901 300 1 0.0508 0.55 5.0+3 1.09-5 1 27 2000 1 235 10 0 1.0
9424001 300 1 0.0508 0.55 1.0+4 5.00-6 1 27 4000 1 235 10 0 1.0
9424101 300 1 0.0508 0.55 2.0+4 2.00-6 1 27 8000 1 235 10 0 1.0
4** F300.0
T
=XSDRN
XSDRN CELL TO COLLAPSE CSRLV TO 227 GROUPS
0$$ 7 10 61 20 62 E
1$$ 1 3 10 1 3 3 13 16 3 1 10 15 0 0 0
2$$ -2 -63 -1 0 0 0 -3 0 0 0
3$$ 1 0 0 0 20 0 2 0 0 0 1 0
4$$ -1 227 3 -2 3 4 230 -1 0
5** 1-4 1-4 1.0 1.0 0 1.42 0.0 0.0 100.0 0.0 1-3 0.75
T
13$$ 10R1 2 2R3
14$$
9223501 9223801 1302701 9223601 9423801 9423901 9424001 9424101
 5413501 6214901
1302702
100103 801603
15** 1.64-3 9.5-3 0.058 2R1.0-10 1.09-5 5.0-6 2.0-6
 2R1.0-10
0.0603
0.0668 0.0334
T
33## F1.0
T
35**
3I0.0 1I0.0254 3I0.0762 0.2239
36$$ 4R1 2R2 4R3
39$$ 1 2 3
40$$ 3 3 3
51$$
225I1 227
T
/*
//
```

A.2.6 LISTING FOR GENERATING ZONE-DEPENDENT NUCLIDE IDENTIFICATIONS FOR HEU ZONE COLLAPSE CALCULATIONS WITH THE AWL MODULE OF AMPX (Archive file AWLHEU.CEL)

```
//LLMWLH JOB (17459,TAPE,I0400),'SAVE7132,22 B-3001',TIME=(5,30)
/*ROUTE PRINT RMT45
/*ROUTE XEQ MSS
//CXG EXEC AMPX,GOTIME=5,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(1500,500),RLSE)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,
//   DSN=X.LLM17459.CELLA.XSDRN.G227.CSRLV,DISP=SHR
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X03729,DSN=CELLA.LLM17459.INFD.ZONE,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT61F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),LABEL=(1,SL,,IN),
//   VOL=SER=X08471,DSN=WWLIB.LLM17459.CSRLV.INFD,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=AWL
0$$ 63 62
1$$ 5
T
2$$ 62 12
T
3$$
100103 801603 1302701 5413501 6214901
9223501 9223801 9223601 9423801 9423901 9424001 9424101
4$$
13 83 133 543 623
2503 2803 2603 4803 4903 4003 4103
T
2$$ 62 12
T
3$$
100103 801603 1302701 5413501 6214901
9223501 9223801 9223601 9423801 9423901 9424001 9424101
4$$
14 84 134 544 624
2504 2804 2604 4804 4904 4004 4104
T
2$$ 62 12
T
3$$
100103 801603 1302701 5413501 6214901
9223501 9223801 9223601 9423801 9423901 9424001 9424101
4$$
15 85 135 545 625
2505 2805 2605 4805 4905 4005 4105
T
2$$ 62 0
T
2$$ 61 0
T
/*
//
```

A.2.7 LISTING FOR GENERATING ZONE-DEPENDENT NUCLIDE IDENTIFICATIONS FOR LEU ZONE COLLAPSE CALCULATIONS WITH THE AWL MODULE OF AMPX (Archive File AWLLEU.B30)

```
//LLMWLL JOB (17459,TAPE,IO400),'SAVE7132,22 B-3001',TIME=(5,30)
/*ROUTE PRINT RMT45
/*ROUTE XEQ MSS
//CXG EXEC AMPX,GOTIME=5,GOSIZE=1024K,SBUF=8148
//GO.FT18F001 DD SPACE=(TRK,(1500,500))
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,
//   DSN=X.LLM17459.CELLB30.XSDRN.G227.CSRLV,DISP=SHR
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X22653,DSN=CELLB30.LLM17459.INFD.ZONE,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT61F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),LABEL=(1,SL,,IN),
//   VOL=SER=X08471,DSN=WWLIB.LLM17459.CSRLV.INFD,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=AWL
0$$ 63 62
1$$ 5
T
2$$ 62 12
T
3$$
100103 801603 1302701 5413501 6214901
9223501 9223801 9223601 9423801 9423901 9424001 9424101
4$$
13 83 133 543 623
2503 2803 2603 4803 4903 4003 4103
T
2$$ 62 12
T
3$$
100103 801603 1302701 5413501 6214901
9223501 9223801 9223601 9423801 9423901 9424001 9424101
4$$
14 84 134 544 624
2504 2804 2604 4804 4904 4004 4104
T
2$$ 62 12
T
3$$
100103 801603 1302701 5413501 6214901
9223501 9223801 9223601 9423801 9423901 9424001 9424101
4$$
15 85 135 545 625
2505 2805 2605 4805 4905 4005 4105
T
2$$ 62 0
T
2$$ 61 0
T
/*
//
```

A.2.8 LISTING FOR OBTAINING SEVEN-GROUP ZONE-DEPENDENT CROSS SECTIONS FOR HEU FUEL WITH THE XSDRN MODULE OF AMPX (Archive file XSZNFP.HEU)

This particular calculations is for a restart.

```
//LLMZNC JOB (17459,TAPE,IO200),'MILLER LF B-3001',TIME=(10,30)
/*JOBPARM LINES=30
/*ROUTE XEQ MSS
//CXG EXEC AMPX,GOTIME=10,GOSIZE=1024K,SBUF=8148
//GO.FT16F001 DD SPACE=(TRK,(500,100),RLSE)
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT61F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),LABEL=(1,SL,,IN),
//   VOL=SER=X03729,DSN=CELLA.LLM17459.INFD.ZONE,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   DSN=X.LLM17459.ZONE.XSDRN.GXS7.CELLA,
//   SPACE=(TRK,(100,50),RLSE)
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X04938,DSN=ZONE.LLM17459.FLUXES.XSDRN,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT64F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),LABEL=(1,SL,,IN),
//   VOL=SER=X03548,DSN=ZONE.LLM17459.FLUXES.XSDRN,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=XSDRN
XSDRN ZONE TO COLLAPSE CSRLV CELL TO 7 GROUPS
0$$ 7 10 61 20 62 E
1$$ 1 7 108 1 1 7 43 8 3 1 1 1 0 0 0
2$$ -2 -63 1 1 0 0 -3 0 0 0
3$$ 1 0 0 64 70 0 0 0 0 0 1 0
4$$ 0 7 1 -1 3 4 10 -1 0
5** 3.0-4 1.0-3 1.0 1.0 0 1.4208 80.0 80.0 100.0 1.0 1.0-3 0.75
T
13$$ 2R1 2 12R3 13R4 12R5 6 2R7
14$$
1001 8016
13027
2503 2803 2603 4803 4903 4003 4103 133 13 83 543 623
2504 2804 2604 4804 4904 4004 4104 134 14 84 544 624
999
2505 2805 2605 4805 4905 4005 4105 135 15 85 545 625
4009
 1001 8016
15**
0.067 0.0335
0.0602
1.3-4 8.67-6 5R1.0-10 0.024 0.0385 0.0192 1.7-9
 1.4-8
1.3-4 8.67-6 5R1.0-10 0.024 0.0385 0.0192 1.7-9
 1.4-8
```

```
 1.0-10
1.3-4 8.67-6 5R1.0-10 0.024 0.0385 0.0192 1.7-9
1.4-8
0.1238
 0.067  0.0335
T
35**
 25I0.0 2I25.0 7I27.24 28I35.16 7I65.64 7I73.26 25I80.88 105.88
36$$ 26R1 3R2 8R3 29R4 8R5 8R6 26R7
39$$ 1 2 3 4 5 6 7
40$$ 7R3
51$$ 24R1 17R2 15R3 12R4 63R5 69R6 27R7
T
/*
//
```

A.2.9 LISTING FOR OBTAINING SEVEN-GROUP ZONE-DEPENDENT CROSS SECTIONS FOR LEU FUEL WITH THE XSDRN MODULE OF AMPX (Archive file XSZNFP.LEU)

(This particular calculation is for a restart.)

```
//LLMXZC JOB (17459,TAPE,IO200),'MILLER LF B-3001',TIME=(10,30)
/*JOBPARM LINES=30
/*ROUTE XEQ MSS
//CXG EXEC AMPX,GOTIME=10,GOSIZE=1024K,SBUF=8148
//GO.FT16F001 DD SPACE=(TRK,(500,100),RLSE)
//GO.FT18F001 DD SPACE=(TRK,(900,60))
//GO.FT61F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),LABEL=(1,SL,,IN),
//  VOL=SER=X22653,DSN=CELLB30.LLM17459.INFD.ZONE,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//  DSN=X.LLM17459.ZONE.XSDRN.GXS7.CELLB30,
//  SPACE=(TRK,(100,50),RLSE)
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//  VOL=SER=X22196,DSN=ZONE.LLM17459.FLUXES.XSDRN,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT64F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),LABEL=(1,SL,,IN),
//  VOL=SER=X08044,DSN=ZONE.LLM17459.FLUXES.XSDRN,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=XSDRN
XSDRN ZONE TO COLLAPSE CSRLV CELL TO 7 GROUPS(B30)
0$$ 7 10 61 20 62 E
1$$ 1 7 108 1 1 7 168 8 3 1 1 1 0 0 0
2$$ -2 -63 1 1 0 0 -3 0 0 0
3$$ 1 0 0 64 70 0 0 0 0 0 1 0
4$$ 0 7 1 -1 3 4 10 -1 0
5** 3.0-4 1.0-3 1.0 1.0 0 1.4208 80.0 80.0 100.0 1.0 1.0-3 0.75
T
13$$ 2R1 2 12R3 13R4 12R5 6 127R7
14$$
1001 8016
13027
2503 2803 2603 4803 4903 4003 4103 133 13 83 543 623
2504 2804 2604 4804 4904 4004 4104 134 14 84 544 624
 999
2505 2805 2605 4805 4905 4005 4105 135 15 85 545 625
4009
999 1001 1002 1003 1901 2003 2004 3006 3007 4009 5010 5011 6012
6312 7014 7015 8016 8017 9019 11023 12000 13027 14000 15031 16032
17000 18000 19000 20000 21045 22000 23000 24000 25055 26000 27059
28000 29000 30064 31000 36078 36080 36082 36083 36084 36086 40000
40090 40091 40092 40094 40096 40302 41093 42000 43099 45103 47107
47109 48000 48113 50000 54124 54126 54128 54129 54130 54131 54132
54134 54135 54136 55133 56138 62149 63151 63152 63153 63154 64152
64154 64155 64156 64157 64158 64160 66164 71175 71176 72000 72174
72176    72179 72180 73181 73182 74182 74183 74184 74186
75185 75187 77191 77193 79197 82000 90232 91233 92233 92234 92235
92236 92238 93237 94238 94239 94240 94241 94242 95241 95601 95243
96243 96244 96245 96246 500000
```

```
15**
0.067 0.0335
0.0602
1.64-4 9.50-4 2R1.0-10 1.09-6 5.0-7 2.0-7 0.024 0.0385 0.0192 1.7-9
1.4-8
1.64-4 9.50-4 2R1.0-10 1.09-6 5.0-7 2.0-7 0.024 0.0385 0.0192 1.7-9
 1.4-8
 1.0-10
1.64-4 9.50-4 2R1.0-10 1.09-6 5.0-7 2.0-7 0.024 0.0385 0.0192 1.7-9
 1.4-8
0.1238
1.0-10 0.067 14R1.0-10 0.0335 110R1.0-10
T
35**
25I0.0 2I25.0 7I27.24 28I35.16 7I65.64 7I73.26 25I80.88 105.88
36$$ 26R1 3R2 8R3 29R4 8R5 8R6 26R7
39$$ 1 2 3 4 5 6 7
40$$ 7R3
51$$ 24R1 17R2 15R3 12R4 63R5 69R6 27R7
T
/*
//
```

A.2.10 LISTING FOR OBTAINING SEVEN-GROUP ZONE-DEPENDENT CROSS SECTIONS FOR THE ORR SHIM RODS WITH THE XSDRN MODULE OF AMPX (Archive file XSCR7G.LEU)

(NOTE: Based on LEU fuel.)

```
//LLMXCR JOB (17459,TAPE,IO200),'MILLER LF B-3001',TIME=(60,30)
/*ROUTE XEQ WHENEVER
/*ROUTE XEQ MSS
//XCR EXEC AMPX,GOTIME=60,GOSIZE=1024K,SBUF=8148
//GO.FT16F001 DD SPACE=(TRK,(500,100),RLSE)
//GO.FT18F001 DD SPACE=(TRK,(900,60),RLSE)
//GO.FT61F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),
//   LABEL=(1,SL,,IN),VOL=SER=X22653,DSN=CELLB30.LLM17459.INFD.ZONE,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   DSN=X.LLM17459.ZONE.XSDRN.G7B30ZW.CROD,
//   SPACE=(TRK,(10,50),RLSE)
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=X21524,DSN=ZONE.LLM17459.FLUXES.XSDRN,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=XSDRN
XSDRN CONTROL ROD MOCKUP TO GENERATE 7 GROUP (B30) CROSS SECTION
0$$ 7 10 61 20 62 E
1$$ 1 7 54 1 0 4 10 8 3 1 10 10 0 0 0
2$$ -2 -63 1 1 0 0 -3 0 0 0
3$$ 1 0 0 0 50 0 0 0 0 0 1 0
4$$ 0 7 1 -1 3 4 10 -1 0
5** 3.0-4 3.0-4 1.0 1.0 0 1.4208 0.0 0.0
    100.0 1.0 1.0-3 0.75
T
13$$ 1 1 2 3 4 4 4 4 4 4
14$$ 1001 8016 13027 48000 2503 2803 4903 13027 8016 1001
15** 6.68-2 3.34-2 6.02-2 4.63-2 1.64-4 9.50-4 1.09-6 2.40-2 1.92-2
  3.85-2
T
33## F1.0
T
35** 5I0.0 2.81 2.85 2.959 2I3.01 3.604 40I3.85 40.0
36$$ 6R1 2 3 4 3R5 6 41R7
39$$ 1 2 3 2 2 1 4
40$$ 7R3
51$$ 24R1 17R2 15R3 12R4 63R5 69R6 27R7
T
/*
//
```

A.2.11 LISTING FOR OBTAINING SEVEN-GROUP ZONE-DEPENDENT CROSS SECTIONS FOR THE BSR SHIM RODS WITH THE XSDRN MODULE OF AMPX (Archive file XSCR7G.BSR)

(NOTE: Based on HEU fuel.)

```
//LLMXCR JOB (17459,TAPE,IO200),'MILLER LF B-3001',TIME=(99,30)
/*ROUTE XEQ STANDBY
/*ROUTE XEQ MSS
//XCR EXEC AMPX,GOTIME=95,GOSIZE=1024K,SBUF=8148
//GO.FT16F001 DD SPACE=(TRK,(300,100),RLSE)
//GO.FT18F001 DD SPACE=(TRK,(300,100),RLSE)
//GO.FT61F001 DD UNIT=TAPE62,DISP=(OLD,KEEP),
//   LABEL=(1,SL,,IN),VOL=SER=X22653,DSN=CELLB30.LLM17459.INFD.ZONE,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   DSN=X.LLM17459.ZONE.XSDRN.G7BSRZW.CROD,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520,BUFNO=1),
//   SPACE=(TRK,(10,50),RLSE)
//GO.FT63F001 DD UNIT=TAPE62,DISP=(NEW,KEEP),LABEL=(1,SL),
//   VOL=SER=SCRTCH,DSN=ZONE.LLM17459.FLUXES.XSDRN,
//   DCB=(RECFM=VBS,LRECL=X,BLKSIZE=8000,BUFL=8148,DEN=4)
//GO.SYSIN DD *
=XSDRN
XSDRN CONTROL ROD MOCKUP TO GENERATE 7 GROUP BSR CROSS SECTION
0$$ 7 10 61 20 62 E
1$$ 1 5 78 0 1 4 16 8 3 1 10 15 0 0 0
2$$ -2 -63 1 1 0 0 -3 0 0 0
3$$ 1 0 0 0 89 0 0 0 0 0 1 0
4$$ 0 7 1 -1 3 4 10 -1 0
5** 3.0-4 3.0-4 1.0 1.0 0 1.4208 0.0 0.0
    100.0 1.0 1.0-3 0.75
T
13$$ 2R1 8R2 3 5R4
14$$  1001 8016 2804 2504 1001 8016 13027 26000 28000 24000 13027
  26000 28000 24000 5010 5011
15** 6.68-2 3.34-2 7.185-6 9.545-5 4.048-2 2.024-2 2.339-2
 1.509-3 2.052-4 4.625-4 6.02-3
6.039-2 8.21-3 1.85-3 1.356-3 5.424-3
T
33## F1.0
T
35**  15I0.0 50I15.0 3I65.0  67.717  5I68.034  71.209
36$$  16R1 51R2 4R3 4 6R5
39$$ 1 2 2 3 4
40$$ 5R3
51$$ 24R1 17R2 15R3 12R4 63R5 69R6 27R7
T
/*
//
```

A.2.12 LISTING FOR COMBINING CROSS SECTION LIBRARIES FROM HEU FUEL, LEU FUEL, ORR CONTROL RODS, AND BSR CONTROL RODS WITH THE AWL MODULE OF AMPX (Archive file AWL.XS)

```
//LLMAWL JOB (17459,IO100),'SAVE7132,22 B-3001',TIME=(2,30)
/*ROUTE PRINT RMT45
/*ROUTE XEQ MSS
//AWL EXEC AMPX,GOTIME=2,GOSIZE=1024K,SBUF=8148
//GO.FT60F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//  DSN=X.LLM17459.ZONE.XSDRN.G7BSRZW.CROD
//GO.FT61F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//  DSN=X.LLM17459.ZONE.XSDRN.G7B30ZW.CROD
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//  DSN=X.LLM17459.ZONE.XSDRN.GXS7.CELLA
//GO.FT63F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//  DSN=X.LLM17459.ZONE.XSDRN.GXS7.CELLB30
//GO.FT64F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//  DSN=X.LLM17459.ZONE.GXS7.ORRLIB,
//  SPACE=(TRK,(100,50),RLSE)
//GO.SYSIN DD *
=AWL
0$$ 64 63
1$$ 4
T
2$$ 63 168 T
3$$
313     383     3133    3543    3623    32503   32603
32803   34803   34903   34003   34103   414     484
4134    4544    4624    42504   42604   42804   44804
44904   44004   44104   515     585     5135    5545
5625    52505   52605   52805   54805   54905   54005
54105   7999    11001   71001   71002   71003   71901
72003   72004   73006   73007   64009   74009   75010
75011   76012   76312   77014   77015   18016   78016
78017   79019   711023  712000  213027  713027  714000
715031  716032  717000  718000  719000  720000  721045
722000  723000  724000  725055  726000  727059  728000
729000  730064  731000  736078  736080  736082  736083
736084  736086  740000  740090  740091  740092  740094
740096  740302  741093  742000  743099  745103  747107
747109  748000  748113  750000  754124  754126  754128
754129  754130  754131  754132  754134  754135  754136
755133  756138  762149  763151  763152  763153  763154
764152  764154  764155  764156  764157  764158  764160
766164  771175  771176  772000  772174  772176  772179
772180  773181  773182  774182  774183  774184  774186
775185  775187  777191  777193  779197  782000  790232
791233  792233  792234  792235  792236  792238  793237
794238  794239  794240  794241  794242  795241  795601
795243  796243  796244  796245  796246  7500000
 4999
```

```
4$$
 11321  86321 137321 545321 629321 925321 926321
928321 948321 949321 940321 941321  11421  86421
137421 545421 629421 925421 926421 928421 948421
949421 940421 941421  11521  86521 137521 545521
629521 925521 926521 928521 948521 949521 940521
941521 999721  11121  11721  12721  13721  19721
 23721  24721  36721  37721  49621  49721  50721
 51721  62721  63721  74721  75721  86121  86721
 87721  99721 113721 120721 137221 137721 140721
151721 162721 170721 180721 190721 200721 215721
220721 230721 240721 255721 260721 279721 280721
290721 304721 310721 368721 360721 362721 363721
364721 366721 409721 400721 401721 402721 404721
406721 408721 413721 420721 439721 453721 477721
479721 480721 483721 500721 543721 547721 548721
549721 540721 541721 542721 544721 545721 546721
553721 568721 629721 631721 632721 633721 634721
642721 644721 645721 646721 647721 648721 640721
664721 715721 716721 728721 724721 726721 729721
720721 731721 732721 742721 743721 744721 746721
755721 757721 771721 773721 797721 820721 902721
913721 923721 924721 925721 926721 928721 937721
948721 949721 940721 941721 942721 951721 959721
953721 963721 964721 965721 966721 987721
 999421
T
2$$ 62 43 T
3$$
313    383    3133   3543   3623   32503  32603
32803  34803  34903  34003  34103  414    484
4134   4544   4624   42504  42604  42804  44804
44904  44004  44104  515    585    5135   5545
5625   52505  52605  52805  54805  54905  54005
54105  11001  71001  64009  18016  78016 213027
4999
4$$
 11311  86311 137311 545311 629311 925311 926311
928311 948311 949311 940311 941311  11411  86411
137411 545411 629411 925411 926411 928411 948411
949411 940411 941411  11511  86511 137511 545511
629511 925511 926511 928511 948511 949511 940511
941511  11111  11711  49611  86111  86711 137211
999411
T
2$$ 61 7 T
3$$
72503 72803 74903 11001 18016 213027 348000
4$$
925821 928821 949821  11821  86821 137821 480821
```

```
T
2$$  60  5  T
3$$
 55010  55011  524000  526000  528000
4$$
  50812  51812  240812  260812  280812
T
/*
//
```

A.2.13 LISTING FOR GENERATING A LIBRARY (223 NUCLIDES) IN THE ISOTXS FORMAT WITH THE CONTAC MODULE OF AMPX (Archive file CTC.XS)

```
//LLMCTC JOB (17459,I0200),'SAVE7132,22 B-3001',TIME=(2,30)
/*ROUTE XEQ MSS
/*ROUTE PRINT RMT45
//CTC EXEC AMPX,GOTIME=2,GOSIZE=1024K,SBUF=8148
//GO.FT62F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//   DSN=X.LLM17459.ZONE.GXS7.ORRLIB
//GO.FT64F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   DSN=X.LLM17459.ZONE.ISOTXS.GXS7.ORRLIB,
//   SPACE=(TRK,(100,50),RLSE)
//GO.SYSIN DD *
=CONTAC
0$$  62 64 18 7
1$$ 1 223
T
3$$
 11321  86321 137321 545321 629321 925321 926321
928321 948321 949321 940321 941321  11421  86421
137421 545421 629421 925421 926421 928421 948421
949421 940421 941421  11521  86521 137521 545521
629521 925521 926521 928521 948521 949521 940521
941521 999721  11121  11721  12721  13721  19721
 23721  24721  36721  37721  49621  49721  50721
 51721  62721  63721  74721  75721  86121  86721
 87721  99721 113721 120721 137221 137721 140721
151721 162721 170721 180721 190721 200721 215721
220721 230721 240721 255721 260721 279721 280721
290721 304721 310721 368721 360721 362721 363721
364721 366721 409721 400721 401721 402721 404721
406721 408721 413721 420721 439721 453721 477721
479721 480721 483721 500721 543721 547721 548721
549721 540721 541721 542721 544721 545721 546721
553721 568721 629721 631721 632721 633721 634721
642721 644721 645721 646721 647721 648721 640721
664721 715721 716721 728721 724721 726721 729721
720721 731721 732721 742721 743721 744721 746721
755721 757721 771721 773721 797721 820721 902721
913721 923721 924721 925721 926721 928721 937721
948721 949721 940721 941721 942721 951721 959721
953721 963721 964721 965721 966721 987721  11311
 86311 137311 545311 629311 925311 926311 928311
948311 949311 940311 941311  11411  86411 137411
545411 629411 925411 926411 928411 948411 949411
940411 941411  11511  86511 137511 545511 629511
925511 926511 928511 948511 949511 940511 941511
999421  11111  11711  49611  86111  86711 137211
999411
925821 928821 949821  11821  86821 137821 480821
  50812  51812 240812 260812 280812
```

```
 5U
(7(A4,A2,1X))
 11321  86321 137321 545321 629321 925321 926321
928321 948321 949321 940321 941321  11421  86421
137421 545421 629421 925421 926421 928421 948421
949421 940421 941421  11521  86521 137521 545521
629521 925521 926521 928521 948521 949521 940521
941521 999721  11121  11721  12721  13721  19721
 23721  24721  36721  37721  49621  49721  50721
 51721  62721  63721  74721  75721  86121  86721
 87721  99721 113721 120721 137221 137721 140721
151721 162721 170721 180721 190721 200721 215721
220721 230721 240721 255721 260721 279721 280721
290721 304721 310721 368721 360721 362721 363721
364721 366721 409721 400721 401721 402721 404721
406721 408721 413721 420721 439721 453721 477721
479721 480721 483721 500721 543721 547721 548721
549721 540721 541721 542721 544721 545721 546721
553721 568721 629721 631721 632721 633721 634721
642721 644721 645721 646721 647721 648721 640721
664721 715721 716721 728721 724721 726721 729721
720721 731721 732721 742721 743721 744721 746721
755721 757721 771721 773721 797721 820721 902721
913721 923721 924721 925721 926721 928721 937721
948721 949721 940721 941721 942721 951721 959721
953721 963721 964721 965721 966721 987721  11311
 86311 137311 545311 629311 925311 926311 928311
948311 949311 940311 941311  11411  86411 137411
545411 629411 925411 926411 928411 948411 949411
940411 941411  11511  86511 137511 545511 629511
925511 926511 928511 948511 949511 940511 941511
999421  11111  11711  49611  86111  86711 137211
999411 925821 928821 949821  11821  86821 137821
480821  50812  51812 240812 260812 280812
E T
/*
//
```

A.2.14 LISTING FOR CONVERTING THE ISOTXS (NUCLIDE-ORDERED) LIBRARY TO A GRUPX (GROUP-ORDERED) LIBRARY WITH THE DCRSPR MODULE OF BOLDVENT (Archive file GRUPXS.XS)

```
//LLMGPX JOB (17459,I0400),'SAVE7132,22 B-3001',TIME=(8,30)
/*JOBPARM LINES=40
//*ROUTE XEQ STANDBY
/*ROUTE XEQ MSS
/*ROUTE PRINT RMT45
//GPX EXEC BOLDVENT,
//  NB1=1,NB2=1,B1=3520,B2=32000,NX=20,NS=50,N1=100,
//  N2=3520,N3=1,N4=1,N5=1,N6=1,N7=1,N8=1,N9=1,N10=1,
//  N11=1,N12=1,N13=1,N14=1,N15=1,N16=1,
//  GOSIZE=1024K,GOTIME=2
//GO.FT11F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//  DSN=X.LLM17459.GXS7.ORRBSR.GRUPX,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520,BUFNO=1)
//GO.FT32F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,
//  DSN=X.LLM17459.ZONE.ISOTXS.GXS7.ORRLIB
//GO.SYSIN DD *
=CONTROL1
 CONVERT ORR ISOTOXS LIBRARY TO GRUPXS
09000
  2  6  0
END
DCRSPR
  0  0  0  1  0  0  1  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0
END
/*
//
```

A.2.15 LISTING FOR PERFORMING A THREE-DIMENSIONAL DIFFUSION THEORY CALCULATION WITH THE PREPROCESSING PROGRAM VICTORR COUPLED TO THE BOLDVENT SYSTEM [Archive file LLM.LIB3(VSETUP)]

This example is for core 151A of the ORR.

```
//LLM  JOB (17459,I300),'MILLER LF B-3001',TIME=(80,20),NOTIFY=LLM,
//    MSGCLASS=T
/*JOBPARM LINES=40
/*ROUTE  XEQ   STANDBY
//  EXEC FORTGCLG,PARM.LKED='NOXREF,NOMAP',REGION.GO=540K
//*SYSPRINT DD DUMMY
//FORT.SYSIN DD DSN=LLM.LIB3(FORT),DISP=SHR
//LKED.HEX DD DSN=XMW.HEXLIB,DISP=SHR
//LKED.SYSIN DD *
  INCLUDE HEX(FIDO,FFREAD,WOT,WOT8)
//GO.FT09F001 DD UNIT=SYSDA,DISP=(NEW,PASS),DSN=&&VINP,
//  SPACE=(TRK,(10,10)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//GO.FT05F001 DD *
 POWER DISTRIBUTION CALCULATION FOR THE STARTUP EXPERIMENT
1$$ 1 7 9 8 15 0 0 0 1 0 0 0 0
2** 4.0 19.0 30.0 F0.0
T
3$$
3 3 1 1 1 1 1 3 3
3 1 1 2 1 2 1 4 3
3 1 6 1 1 1 6 1 3
3 1 1 2 1 2 1 4 3
3 1 4 1 6 1 4 1 3
3 1 1 2 1 2 1 1 3
3 3 3 3 3 3 3 3 3
T
4**
7R285.0 167.0 285.0 167.0 8R285.0 167.0 285.0 167.0 7R285.0
167.0 285.0 167.0 2R285.0
5**
241.0 211.0 265.0 209.0 241.0
196.0 265.0 77.0 239.0 77.0 265.0
208.0 176.0 176.0 176.0 214.0
157.0 174.0 138.0 157.0 137.0 178.0
265.0 157.0 157.0 265.0
157.0 165.0 53.0 246.0 49.0 199.0 158.0
6$$  925411 11411 86411 137411 280721 240721 255721 260721
7$$ 4R1 2R2 3 3R4 5R5
8$$
925411 11411 86411 137411
11411 86411
137411
11411 86411 137411
137411 280721 240721 255721 260721
9**
1.63-5 5.91-2 2.96-2 1.75-3
```

```
6.67-2 3.34-2
6.02-2
1.97-2 9.83-3 4.25-2
3.01-2 4.55-3 7.78-3 3.3-4 2.82-2
10$$ 2 1 2R3 2R4 2R5
T
//STP2 EXEC BOLDVENT,
//   NB1=1,NB2=1,B1=3520,B2=32000,NX=2,NS=50,N1=100,
//   N2=1120,N3=5334,N4=1,N5=492,N6=10,N7=18,N8=18,N9=160,N10=160,
//   N11=205,N12=1,N13=1,N14=1,N15=1,
//   GOSIZE=750K
//PRINT DD SYSOUT=*
//GO.FT06F001 DD SYSOUT=*
//GO.FT11F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=SHR,LABEL=(,,,IN),
//   DSN=X.LLM17459.GXS7.ORRBSR.GRUPX
//GO.FT16F001 DD DUMMY
//GO.FT17F001 DD DUMMY
//GO.FT34F001 DD UNIT=3330V,VOL=SER=VZLLM1,DISP=(NEW,CATLG),
//   SPACE=(TRK,(30,10),RLSE),
//   DSN=X.LLM17459.ORRBSR.ORR151A.FISSOR
//GO.FT35F001 DD DUMMY
//GO.FT99F001 DD SYSOUT=*
//GO.SYSIN DD DSN=&&VINP,DISP=(OLD,DELETE)
//
```

A.3. PROCESSING OF THE THREE-DIMENSIONAL NEUTRON SOURCE DISTRIBUTION

Comparisons of power distributions from VIPOR and VICTORR preprocessors and from ENDF/B-IV and ENDF/B-V cross-section libraries are accomplished in three steps:

1. the VTDOSR program is run (on an IBM mainframe) to obtain horizontal and vertical plane power distributions by integrating in the transverse directions,

2. the NUMESH[11] program is run (on a DEC10) to redefine the mesh on a 3 x 3 grid for each fuel element, and

3. the HORZGRIG[12] program is run (on an IBM PC/AT) to compare horizontal power distributions.

Each of these programs is listed below.

A.3.1 LISTING OF COMPUTER PROGRAM VTDOSR WHICH READS THE THREE-DIMENSIONAL NEUTRON SOURCE DISTRIBUTIONS AND GENERATES HORIZONTAL AND VERTICAL SOURCE DISTRIBUTIONS (Archive file VTDOSR.LFM)

```
//LLMVDB JOB (17459,I2),'SAVE7132,22 B-3001',TIME=(0,10)
/*ROUTE PUNCH RMT45
/*ROUTE PRINT RMT45
//  EXEC FORTQCLG,REGION.GO=640K
//FORT.SYSIN DD *
      DIMENSION XPS(51),YPS(51),ZPS(51),FS(50,50,50),VPLS(50,50),
     1 HPLS(50,50)
      READ(5,*)NXPS,NYPS,NZPS
      WRITE(6,100)NXPS,NYPS,NZPS
100   FORMAT('   NXPS,NYPS,NZPS  =  '3I5)
      READ(5,*)(XPS(I),I=1,NXPS)
      READ(5,*)(YPS(I),I=1,NYPS)
      READ(5,*)(ZPS(I),I=1,NZPS)
      WRITE(6,200)(XPS(I),I=1,NXPS)
      WRITE(6,300)(YPS(I),I=1,NYPS)
      WRITE(6,400)(ZPS(I),I=1,NZPS)
200   FORMAT('  XPS = '/(10E12.3))
300   FORMAT('  YPS = '/(10E12.3))
400   FORMAT('  ZPS = '/(10E12.3))
C**READ HEADER RECORD
      READ(1)XYZ
C**READ PARAMETERS ON THE FISSION SOURCE FILE
      READ(1)XYZ
C**READ CHIS
      READ(1)XYZ
C**READ THE FISSION SOURCE FILE
      NZM=NZPS-1
      NYM=NYPS-1
      NXM=NXPS-1
```

```
        DO 10 K=1,NZM
        READ(1)((FS(I,J,K),I=1,NXM),J=1,NYM)
10      CONTINUE
C***CALCULATE THE HORIZONTAL PLANE SOURCE
        DO 20 I=1,NXM
        DO 20 K=1,NZM
        HPLS(I,K)=0.0
        DO 20 J=1,NYM
        DY=YPS(J+1)-YPS(J)
        HPLS(I,K)=HPLS(I,K)+DY*FS(I,J,K)
20      CONTINUE
C***CALCULATE THE VERTICAL PLANE SOURCE
        DO 30 J=1,NYM
        DO 30 K=1,NZM
        VPLS(J,K)=0.0
        DO 30 I=1,NXM
        DX=XPS(I+1)-XPS(I)
        VPLS(J,K)=VPLS(J,K)+DX*FS(I,J,K)
30      CONTINUE
C**WRITE OUT THE HORIZONTAL PLANE SOURCE
        WRITE(6,1100)
        DO 40 K=1,NZM
        WRITE(6,1000)(HPLS(I,K),I=1,NXM)
40      CONTINUE
1000    FORMAT(' ',10E12.5)
C***PUNCH THE HORIZONTAL PLANE SOURCE FOR DOT
        WRITE(7,1100)
        DO 50 K=1,NZM
        WRITE(7,1010)(HPLS(I,K),I=1,NXM)
50      CONTINUE
1010    FORMAT(6E12.5)
1100    FORMAT('  HORIZONTAL PLANE SOURCE')
1200    FORMAT('   VERTICAL PLANE SOURCE')
C***WRITE OUT THE VERTICAL PLANE SOURCE
        WRITE(6,1200)
        DO 60 J=1,NYM
        WRITE(6,1000)(VPLS(J,K),K=1,NZM)
60      CONTINUE
C***PUNCH THE VERTICAL PLANE SOURCE
        WRITE(7,1200)
        DO 70 K=1,NZM
        WRITE(7,1010)(VPLS(J,K),J=1,NYM)
70      CONTINUE
        STOP
        END
//GO.FT07F001 DD SYSOUT=B
//GO.FT01F001 DD UNIT=3330V,VOL=SER=VZLLM1,
//  DSN=X.LLM17459.ORRBSR.ORR151A.FISSOR,DISP=SHR
//GO.FT05F001 DD *
```

A.3.1.1 Input for the Case With the VIPOR Preprocessor (Archive file MESH.C51)

```
 44 37 46
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 46.5518
46.9074 49.53 52.1525 52.5081 53.34 55.88 58.42 60.96
61.7918 62.1474 64.77 67.3925 67.7481 68.58 71.12 73.66
76.2 78.74 81.28 83.82 86.36 88.9 91.44 93.98
96.52 102.4467 108.3733 114.3
0.0 6.35 12.7 15.24 17.78 20.32 22.86 25.4
27.94 30.48 33.02 35.56 38.1 40.64 43.18 45.72
48.26 50.8 53.34 55.88 58.42 60.96 63.5 66.04
68.58 71.12 73.66 76.2 78.74 81.28 83.82 86.36
88.9 91.44 93.98 100.33 106.68
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 46.5518
46.9074 49.53 52.1525 52.5081 53.34 55.88 58.42 60.96
61.7918 62.1474 64.77 67.3925 67.7481 68.58 69.85 71.12
72.39 73.66 74.93 76.2 76.7 79.24 81.78 84.32
86.86 89.86 92.86 95.86 98.86 101.86
/*
//
```

A.3.1.2 Input for the Case With the VICTORR Preprocessor (Archive file MESHRV.C51)

```
 44 37 42
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 46.5518
46.9074 49.53 52.1525 52.5081 53.34 55.88 58.42 60.96
61.7918 62.1474 64.77 67.3925 67.7481 68.58 71.12 73.66
76.2 78.74 81.28 83.82 86.36 88.9 91.44 93.98
96.52 102.4467 108.3733 114.3
0.0 6.35 12.7 15.24 17.78 20.32 22.86 25.4
27.94 30.48 33.02 35.56 38.1 40.64 43.18 45.72
48.26 50.8 53.34 55.88 58.42 60.96 63.5 66.04
68.58 71.12 73.66 76.2 78.74 81.28 83.82 86.36
88.9 91.44 93.98 100.33 106.68
0.0 5.9267 11.8533 17.78 20.32 22.86 25.56 28.26
30.96 33.66 36.36 39.06 41.76 44.46 47.16 47.9918
48.3474 51.21 54.0726 54.4282 55.2601 57.9601 60.6601 63.3601
64.1919 64.5475 67.4101 70.2727 70.6283 71.4602 74.1602 76.8602
79.5602 82.4177 85.2752 88.1327 90.9902 93.8477 96.7052 99.5627
103.3727 107.1827
/*
//
```

A.3.2 LISTING OF COMPUTER PROGRAM NUMESH WHICH REDEFINES THE SOURCE ON A 3 X 3 GRID FOR EACH FUEL ELEMENT (Archive file NUMESH.FOR)

Input is concatinated prior to execution.

```
      REAL*8 XMO(50),YMO(50),XMN(50),YMN(50),FISO(50,50)
      REAL*8 FISN(50,50),TEMP(50,50),SUM,DELX,DELY,NAREA
      REAL*8 XLB,XUB,YLB,YUB,CONST
C
      IN=30
      IO=31
C
C              READ INPUT DATA
C
      READ(IN,*)KOX,KOY,KNX,KNY,IREV,JREV,CONST
      KOX1=KOX+1
      KOY1=KOY+1
      KNX1=KNX+1
      KNY1=KNY+1
      READ(IN,*)(XMO(I),I=1,KOX1)
      READ(IN,*)(YMO(I),I=1,KOY1)
      READ(IN,*)(XMN(I),I=1,KNX1)
      READ(IN,*)(YMN(I),I=1,KNY1)
      READ(IN,*)((FISO(I,J),I=1,KOX),J=1,KOY)
C
C              INTEGRATE INPUT FISSION SOURCE OVER X AND Y
C
      SUM=0.0D+0
      DO 100 I=1,KOX
      DO 100 J=1,KOY
      FISO(I,J)=FISO(I,J)*CONST
      SUM=SUM+FISO(I,J)*(XMO(I+1)-XMO(I))*(YMO(J+1)-YMO(J))
 100  CONTINUE
      WRITE(IO,10) SUM
 10   FORMAT(10X,'INTEGRATED INPUT FISSION SOURCE = ',1PD13.6,/)
C
C              COMPUTE NEW FISSION SOURCE DISTRIBUTION
C
      DO 1000 I=1,KNX
C
      DO 1010 IX=1,KOX
      IF(XMO(IX).GE.XMN(I+1)) GO TO 1020
 1010 CONTINUE
 1020 DO 1030 IXX=1,KOX
      IF(XMO(IXX).GT.XMN(I)) GO TO 1040
 1030 CONTINUE
 1040 IXX=IXX-1
      IDX=IX-IXX
C
      DO 2000 J=1,KNY
C
```

```
      DO 2010 JY=1,KOY
      IF(YMO(JY).GE.YMN(J+1)) GO TO 2020
 2010 CONTINUE
 2020 DO 2030 JYY=1,KOY
      IF(YMO(JYY).GT.YMN(J)) GO TO 2040
 2030 CONTINUE
 2040 JYY=JYY-1
      JDY=JY-JYY
C
      NAREA=(XMN(I+1)-XMN(I))*(YMN(J+1)-YMN(J))
      SUM=0.0D+0
      DO 3000 II=1,IDX
      IIM1=II-1
      XLB=DMAX1(XMO(IXX+IIM1),XMN(I))
      XUB=DMIN1(XMO(IXX+II),XMN(I+1))
      DELX=XUB-XLB
C
      DO 3000 JJ=1,JDY
      JJM1=JJ-1
      YLB=DMAX1(YMO(JYY+JJM1),YMN(J))
      YUB=DMIN1(YMO(JYY+JJ),YMN(J+1))
      DELY=YUB-YLB
C
      SUM=SUM+FISO(IXX+IIM1,JYY+JJM1)*(DELX*DELY)/NAREA
C
 3000 CONTINUE
C
      FISN(I,J)=SUM
C
 2000 CONTINUE
 1000 CONTINUE
C
C              INTEGRATE NEW FISSION SOURCE OVER X AND Y
C
      SUM=0.0D+0
      DO 200 I=1,KNX
      DO 200 J=1,KNY
      SUM=SUM+FISN(I,J)*(XMN(I+1)-XMN(I))*(YMN(J+1)-YMN(J))
 200  CONTINUE
      WRITE(IO,50) SUM
 50   FORMAT(10X,'INTEGRATED NEW FISSION SOURCE   = ',1PD13.6,/)
C
C              REVERSE ORDER OF FISSION SOURCE IN X AND/OR Y
C              DIRECTION(S) IF NECESSARY
C
      IF(IREV.EQ.0) GO TO 7000
      DO 6000 J=1,KNY
      DO 6000 I=1,KNX
      IR=KNX1-I
      TEMP(I,J)=FISN(IR,J)
 6000 CONTINUE
```

```
       DO 6050 J=1,KNY
       DO 6050 I=1,KNX
       FISN(I,J)=TEMP(I,J)
 6050  CONTINUE
C
 7000  IF(JREV.EQ.0) GO TO 8000
       DO 7050 I=1,KNX
       DO 7050 J=1,KNY
       JR=KNY1-J
       TEMP(I,J)=FISN(I,JR)
 7050  CONTINUE
       DO 7100 I=1,KNX
       DO 7100 J=1,KNY
       FISN(I,J)=TEMP(I,J)
 7100  CONTINUE
C
C                WRITE NEW FISSION SOURCE DISTRIBUTION
C                    (INVERT X AND Y)
C
 8000  DO 5000 J=1,KNY

       WRITE(IO,60)(FISN(I,J),i=1,KNx)
 5000  CONTINUE
 60    FORMAT(1P5D12.5)
C
       IF(IREV.EQ.0) GO TO 9000
       SUM=XMN(KNX1)
       DO 9100 I=1,KNX1
       XMN(I)=SUM-XMN(I)
 9100  CONTINUE
       DO 9200 I=1,KNX1
       IR=KNX1+1-I

       WRITE(IO,70) XMN(IR)
 9200  CONTINUE
C
 9000  IF(JREV.EQ.0) GO TO 9999
       SUM=YMN(KNY1)
       DO 9500 J=1,KNY1
       YMN(J)=SUM-YMN(J)
 9500  CONTINUE
       DO 9600 J=1,KNY1
       JR=KNY1+1-J

       WRITE(IO,70) YMN(JR)
 9600  CONTINUE
 70    FORMAT(1X,1PD11.4,1X,1PD11.4,1X,1PD11.4,1X,1PD11.4,1X,
     1 1PD11.4)
C
 9999  STOP
       END
```

A.3.2.1 Input for the Case With the VIPOR Preprocessor (Archive file MESH.HPL)

```
 43 45 37 36 0 0 1.0
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 46.5518
46.9074 49.53 52.1525 52.5081 53.34 55.88 58.42 60.96
61.7918 62.1474 64.77 67.3925 67.7481 68.58 71.12 73.66
76.2 78.74 81.28 83.82 86.36 88.9 91.44 93.98
96.52 102.4467 108.3733 114.3
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 46.5518
46.9074 49.53 52.1525 52.5081 53.34 55.88 58.42 60.96
61.7918 62.1474 64.77 67.3925 67.7481 68.58 69.85 71.12
72.39 73.66 74.93 76.2 76.7 79.24 81.78 84.32
86.86 89.86 92.86 95.86 98.86 101.86
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 47.26
49.8    53.34 55.88 58.42 60.96
63.5 66.04    68.58 71.12 73.66
76.2 78.74 81.28 83.82 86.36 88.9 91.44 93.98
96.52 102.4467 108.3733 114.3
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 47.26
49.8    53.34 55.88 58.42 60.96
63.5 66.04    68.58  71.12
 73.66  76.2 76.7 79.24 81.78 84.32
86.86 89.86 92.86 95.86 98.86 101.86
```

A.3.2.2 Input for the Case With the VICTORR Preprocessor (Archive file MESHRV.HPL)

```
 43 41 37 35 0 0 1.0
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 46.5518
46.9074 49.53 52.1525 52.5081 53.34 55.88 58.42 60.96
61.7918 62.1474 64.77 67.3925 67.7481 68.58 71.12 73.66
76.2 78.74 81.28 83.82 86.36 88.9 91.44 93.98
96.52 102.4467 108.3733 114.3
0.0 5.9267 11.8533 17.78 20.32 22.86 25.56 28.26
30.96 33.66 36.36 39.06 41.76 44.46 47.16 47.9918
48.3474 51.21 54.0726 54.4282 55.2601 57.9601 60.6601 63.3601
64.1919 64.5475 67.4101 70.2727 70.6283 71.4602 74.1602 76.8602
79.5602 82.4177 85.2752 88.1327 90.9902 93.8477 96.7052 99.5627
103.3727 107.1827
0.0 5.9267 11.8533 17.78 20.32 22.86 25.4 27.94
30.48 33.02 35.56 38.1 40.64 43.18 45.72 47.26
49.8    53.34 55.88 58.42 60.96
63.5 66.04    68.58 71.12 73.66
76.2 78.74 81.28 83.82 86.36 88.9 91.44 93.98
96.52 102.4467 108.3733 114.3
0.0 5.9267 11.8533 17.78 20.32 22.86 25.56 28.26
30.96 33.66 36.36 39.06 41.76 44.46 47.16
49.86  52.56  55.2601 57.9601 60.6601 63.3601
 66.06  68.76  71.4602 74.1602 76.8602
79.5602 82.4177 85.2752 88.1327 90.9902 93.8477 96.7052 99.5627
103.3727 107.1827
```

A.3.3 LISTING OF COMPUTER PROGRAM HORZGRID WHICH COMPARES POWER DISTRIBUTIONS AND PRINTS RESULTS (Archive file HORZGRID.FOR)

```
C    *******PROGRAM TO TAKE PLANE PROJECTIONS OF FLUX******************
C           THROUGH CORE AND ANALYZE--HORIZONTAL SECTIONS
C    *****************************************************************
C
C THIS PROGRAM IS DESIGNED TO WORK WITH DATA FROM THE ORR PSF,
C WHICH IS MODELLED AS A 7 BY 9 SECTION GRID VIEWED FROM A X-Z ASPECT.
C IN THIS PROGRAM, EACH GRID SECTION IS ASSUMED TO BE SUBDIVIDED INTO
C 3 BY 3 SUBGRID.
C
C INFORMATION NEEDED INCLUDES THE LOCATIONS OF DATA POINTS ASSIGNED TO
C NON-CORE ELEMENTS SUCH AS WATER, BERYLLIUM REFLECTORS, AND OTHER
C STRUCTURAL COMPONENTS.
C    *****************************************************************
        DOUBLE PRECISION GRID(30,30)
        DOUBLE PRECISION OLDYRW(50),NEWYRW(50)
        CHARACTER ROWLAB
        CHARACTER*80 CARD
        CHARACTER*40 OLDFIL,NEWFIL,DATFIL,PRFIL
        INTEGER*2 NZH2O,NYH2O,NYBER,NUMCOL,NUMROW,NUMDIV,NDATRW,NDATCL
        INTEGER*2 NYSTRT,NYEND
        INTEGER IERR
C    *****************************************************************
C GIVE THE PROGRAM THE NULL GRID LOCATIONS.....
C    WATER ROWS...
        NZH2O=5
C    WATER SUBCOLUMNS...
        NYH2O=5
C    BERYLLIUM (NOT USED--IS CURRENTLY COLUMNS 1 AND 9)
        NYBER=2
C
C GIVE THE PROGRAM INFORMATION ABOUT THE CORE GRID.....
        NUMROW=7
        NUMCOL=9
        NUMDIV=3
C    *****************************************************************
C CALCULATE NUMBER OF DATA POINTS IN EACH ROW AND NUMBER OF ROWS
C TO READ.....
        NDATRW=NUMROW*NUMDIV
        NDATCL=(2*NYH2O)+(NUMCOL*NUMDIV)
C
C    *****************************************************************
C    INPUT FILES.....
        OLDFIL='S51NME.HPL'
        NEWFIL='S51NMX.HPL'
        DATFIL='S51HPLOT.DAT'
        PRFIL='S51HDIF.DAT'
C    *****************************************************************
```

```
      WRITE(6,*) ' NOW OPENING INPUT DATA FILES....'
      CLOSE(7)
      CLOSE(8)
      OPEN(UNIT=7, IOSTAT=IERR, ERR=95, FILE=OLDFIL, STATUS='OLD')
      OPEN(UNIT=8, IOSTAT=IERR, ERR=95, FILE=NEWFIL, STATUS='OLD')
      REWIND(7)
      REWIND(8)
C   READ OVER FIRST COUPLE OF COMMENT CARDS....
      WRITE(6,*) ' READING OVER FIRST INFORMATION CARDS....'
 20   FORMAT(A80)
      DO 25 I=1,4
        READ(7,20,ERR=95,END=110) CARD
        READ(8,20,ERR=95,END=110) CARD
 25   CONTINUE
C
C   FORMAT FOR DATA POINTS.....
 40   FORMAT(1P5D12.5)
C
C   SKIP OVER WATER ROWS BEFORE G-ROW.....
      WRITE(6,*) ' SKIPPING DATA OUTSIDE CORE....'
      DO 30 I=1, NZH2O
        READ(7,40,IOSTAT=IERR,ERR=95,END=110) (OLDYRW(J),J=1,NDATCL)
        READ(8,40,IOSTAT=IERR,ERR=95,END=110) (NEWYRW(J),J=1,NDATCL)
 30   CONTINUE
C
C   FIGURE OUT WHERE IN EACH ROW DATA ARE LOCATED....
      NYSTRT=NYH2O
      NYEND=NYSTRT+(NUMCOL*NUMDIV)
C
C   READ DATA ROWS G THROUGH A AND CALCULATE FRACTIONAL DIFFERENCE...
C   (ONLY EXAMINE NON-STRUCTURAL POINTS IN THE CORE)
      WRITE(6,*) ' NOW READING CORE DATA.........'
      DO 50 I=1,NDATRW
        READ(7,40,IOSTAT=IERR,ERR=95,END=95) (OLDYRW(J),J=1,NDATCL)
        READ(8,40,IOSTAT=IERR,ERR=95,END=95) (NEWYRW(J),J=1,NDATCL)
           DO 60 K=(NYSTRT+1),NYEND
C   IF ONE FLUX VALUE IS ZERO, ASSUME THAT THE OTHER IS ALSO ZERO AND
C   SKIP THE DIVISION...
              IF (OLDYRW(K).EQ.0D0) THEN
                 GRID(I,(K-NYSTRT))=0
                ELSE
                 GRID(I,(K-NYSTRT))=(OLDYRW(K)-NEWYRW(K))/OLDYRW(K)
                ENDIF
 60        CONTINUE
 50   CONTINUE
      CLOSE(7)
      CLOSE(8)
C
C   *******************************************************************
```

```
C
C   WRITE DATA OUT TO FILE FOR ENERGRAPHICS PROCESSING....
        WRITE(6,*) ' NOW WRITING ENERGRAPHICS FILE...'
        OPEN(UNIT=7, IOSTAT=IERR, ERR=95, FILE=DATFIL, STATUS='NEW')
 90     FORMAT(1X,E12.5)
        DO 70 I=NDATRW,1,-1
          DO 80 J=1,(NUMCOL*NUMDIV)
            WRITE(7,90) SNGL(GRID(I,J))
 80       CONTINUE
 70     CONTINUE
        CLOSE(7)
C   ******************************************************************
C  WRITE OUT DATA FOR SUBSEQUENT PRINTING (THIS PROGRAM SEGMENT
C                                          ASSUMES THE GRID IS SUBDIVIDED
C                                          INTO 3X3 AND THAT ROW G AND
C                                          COLUMNS 1 AND 9 HAVE NO
C                                          FISSIONABLE CONTENTS)
        OPEN(UNIT=7, IOSTAT=IERR, ERR=95, FILE=PRFIL, STATUS='NEW')
        WRITE(6,*) ' NOW WRITING DUMP FILES....'
C ---------------------------------------------------------------------
C  FORMAT STATEMENTS FOR:
C  COLUMN LABELS....
 115    FORMAT(1X,6X,'1',13X,'2',19X,'3',19X,'4')
 116    FORMAT(1X,3X,'5',19X,'6',19X,'7',19X,'8',13X,'9')
C  ROW LABELS AND DATA....
 120    FORMAT(1X,A1,2H ½,3I2,3(2H ½,3F6.2),2H ½,F6.2)
 130    FORMAT(1X,2F6.2,3(2H ½,3F6.2),2H ½,3I2,2H ½)
C  ROW DIVIDERS...
 150    FORMAT(1X,'----------------------------------------------------
     1------------------------')
 160    FORMAT(1X,'----------------------------------------------------
     1-----------------------------')
C ---------------------------------------------------------------------
C  SET ASCII CODE FOR ROW LABELS....
        M=65
C
C  WRITE APPROPRIATE CHARACTERS TO FILE FOR PRINTER CONTROL
C   12 CPI....
        WRITE(7,*) CHAR(27),CHAR(58)
C   PAGE LENGTH OF 11 INCHES.....
        WRITE(7,*) CHAR(27),CHAR(67),CHAR(0),CHAR(11)
C
        WRITE(7,115)
        WRITE(7,150)
C
        DO 140 I=21,1,-1
          IF (MOD ((I+1),3).EQ.0) THEN
              ROWLAB=CHAR(M)
              M=M+1
            ELSE
              ROWLAB=' '
            ENDIF
```

```
          WRITE(7,120,IOSTAT=IERR) ROWLAB,(IDINT(GRID(I,J)),J=1,3),
     1                             (GRID(I,J),J=4,13)
          IF (MOD((I+2),3).EQ.0) THEN
               WRITE(7,150)
            ELSE
            ENDIF
 140    CONTINUE
        WRITE(7,*) CHAR(12)
        WRITE(7,116)
        WRITE(7,160)
        DO 200 I=21,1,-1
          WRITE(7,130,IOSTAT=IERR) (GRID(I,J),J=14,24),
     1                             (IDINT(GRID(I,J)),J=24,27)
          IF (MOD((I+2),3).EQ.0) THEN
               WRITE(7,160)
            ELSE
            ENDIF
 200    CONTINUE
C
C  RESET PRINTER TO 10 CPI....
        WRITE(7,*) CHAR(18)
        CLOSE(7)
        GOTO 100
 95     WRITE(6,*) ' IO ERROR ',IERR
 100    STOP
 110    END
```

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2. TITLE AND SUBTITLE COMPUTATIONAL METHODOLOGY FOR THE OAK RIDGE RESEARCH REACTOR (ORR) AND BULK SHIELDING REACTOR (BSR): CROSS-SECTION GENERATION AND VALIDATION, VOLUME I	3. LEAVE BLANK
	4. DATE REPORT COMPLETED MONTH: February YEAR: 1986
5. AUTHOR(S) L. F. Miller and M. L. Williams	6. DATE REPORT ISSUED MONTH: YEAR:
7. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Oak Ridge National Laboratory P.O. Box X Oak Ridge TN 37831	8. PROJECT/TASK/WORK UNIT NUMBER NRC B&R No. 60 19 10
	9. FIN OR GRANT NUMBER B0415
10. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Division of Engineering Technology Office of Nuclear Regulatory Research U.S. Nuclear Regulatory Commission Washington DC 20555	11a. TYPE OF REPORT Topical
	b. PERIOD COVERED (Inclusive dates) December 1985
12. SUPPLEMENTARY NOTES	

13. ABSTRACT (200 words or less)

A neutronics library suitable for low-enriched-uranium (LEU) and high-enriched-uranium (HEU) fueled cores for both the Oak Ridge Research Reactor (ORR) and the Bulk Shielding Reactor (BSR) is documented herein. The library is obtained from version V of the Evaluated Nuclear Data File (ENDF/B-V) and contains 223 nuclides weighted over a variety of region-dependent neutron spectra. Self-shielding and zone-weighting effects are incorporated with 227-group calculations for several reactor-core configurations. Libraries are archived for both transport and diffusion theory seven-group calculations. Complete listings of processing details are included so that libraries with different specifications can be easily obtained. Results from validation calculations indicate that the neutronics libraries obtained from this effort are suitable for neutronics computations for the ORR and BSR.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS	15. AVAILABILITY STATEMENT Unlimited
b. IDENTIFIERS/OPEN-ENDED TERMS	16. SECURITY CLASSIFICATION (This page) Unclassified (This report) Unclassified
	17. NUMBER OF PAGES
	18. PRICE