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ANSL-V: ENDF/B-V Based Multiqroup Cross-Section Libraries for Advanced Neutron Source Reactor Studies Supplement 1

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ANSL-V: ENDF/B-V BASED MULTIGROUP CROSS-SECTION LIBRARIES FOR ADVANCED NEUTRON SOURCE (ANS) REACTOR STUDIES SUPPLEMENT 1

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ACRONYMS

1-D	one-dimensional
2-D	two-dimensional
ANS	Advanced Neutron Source
BCD	binary coded decimal
IBM	International Business Machines
JCL	job control language
MAT	material number
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
RSIC	Radiation Shielding Information Center

ABSTRACT

The original ANSL-V cross-section libraries (ORNL-6618) were developed over a period of several years for the physics analysis of the ANS reactor, with little thought toward including the materials commonly needed for shielding applications. Materials commonly used for shielding applications include calcium, barium, sulfur, phosphorous, and bismuth. These materials, as well as ^{6}Li, ^{7}Li, and the naturally occurring isotopes of hafnium, have been added to the ANSL-V libraries. The gamma-ray production and gamma-ray interaction cross sections were completely regenerated for the ANSL-V 99n/44g library which did not exist previously. The MALOCS module was used to collapse the 99n/44g coupled library to the 39n/44g broad-group library. COMET was used to renormalize the two-dimensional (2-D) neutron matrix sums to agree with the one-dimensional (1-D) averaged values. The FRESH module was used to adjust the thermal scattering matrices on the 99n/44g and 39n/44g ANSL-V libraries. PERFUME was used to correct the original XLACS Legendre polynomial fits to produce acceptable distributions. The final ANSL-V 99n/44g and 39n/44g cross-section libraries were both checked by running RADE. The AIM module was used to convert the master cross-section libraries from binary coded decimal to binary format (or vice versa).

1. INTRODUCTION

The original ANSL-V cross-section libraries[1] were developed over a period of several years for the physics analysis of the Advanced Neutron Source (ANS) reactor, with little thought, initially, toward including the materials commonly needed for shielding applications. As a result, there were a number of materials that had to be added before the ANSL-V libraries could be used for shielding analyses. Materials commonly used for shielding applications include calcium, barium, phosphorous, sulfur, zinc, and bismuth, none of which were included in the initial ANSL-V libraries described in ref. 1. Unfortunately there is no evaluation for zinc in ENDF/B format, so it was not possible to include data for zinc. This is not a serious problem since (1) zinc is only present as a trace element in materials used in the ANS shielding analyses, and (2) activation sources due to zinc (in Al-6061, for example) may still be calculated using the standard activation libraries available with the ORIGEN-S code.

In the original work, there was a 99-group neutron library, including 125 material isotopes, a 39-group neutron library, including 125 material isotopes, and a 39n/44g (39 neutron groups/44 gamma groups) coupled library, including only 57 material isotopes. For shielding applications, a 99n/44g coupled library was considered to be a much better alternative. This 99n/44g coupled library could be produced with very little effort since the 99-group neutron library was already available. In the newly enhanced libraries, it was decided to include the gamma-ray interaction data for all materials (including those for which no gamma-ray production data were available) so as to make the coupled libraries as complete as possible. Some important materials in the ENDF/B-V library do not have gamma-ray production files in the evaluation. As a result, data from the LENDL-V evaluations were used for 12 materials.

When the LENDL-V evaluations are used, it is very important to use the evaluation for both neutron cross sections and the gamma-ray production cross sections. The use of hybrid (ENDF/B-V and LENDL) data sets would be a potentially very serious mistake. This was clearly demonstrated in the 1991 work on ^{11}B (see ref. 2 and/or Appendix A). There, it was also shown that the old hybrid ENDF/B-V neutron/LENDL gamma-ray production data for hafnium gave excessive gamma heating in the ANS control rods. From that experience, it was concluded that such hybrid sets should never be used.

The remainder of this report documents the work done since the publication of the original ANSL-V report[1] in Sept. 1990. Most of the additional work described here was performed between May and July of 1993. The present report concentrates on a description of the final libraries, including a detailed summary of the content of the libraries, and typical input files for the AMPX[3] programs used to generate these libraries. The materials in the final 99n/44g and 39n/44g ANSL-V libraries are given in Table B-1, which also gives a brief summary of the data available for all of the 138 materials.

2. ANSL-V LIBRARY SPECIFICATIONS

We will not attempt to discuss all the ANSL-V specifications in this report. Only the most important specifications will be briefly reviewed, and the reader should consult ref. 1 for other details not covered here. The ANSL-V 99-group energy boundaries are given in Table 1. The photon 44-group energy boundaries are given in Table 2. The 39-group (neutron) energy boundaries are given in Table 3. The reader should consult ref. 1 for a discussion of the neutron weighting functions (type A, B, C) used for the ANSL-V libraries. A new gamma-ray weighting function was used for this work. All the gamma-ray interaction data was regenerated using this new gamma-ray weighting function. The new gamma-ray weighting function (1/E plus high- and low-energy rolloffs) is shown in Table 4. The reader should note that the function is only defined for four different energies. Thus it is very important to use log-log interpolation with this weighting function.

A summary of the AMPX modules used for the ANSL-V generation is given in Table 5. The reader should consult the AMPX-77 report[3] for additional details and for the input descriptions. Sample input files for each of the programs used here are given in Appendix C. Materials taken from the LENDL-V library are shown in Table 6. The table also has a brief discussion of the LENDL-V library and includes a list of ten materials not available in either the ENDF/B-V or ENDF/B-VI libraries. Six of these materials have half-lives less than 120 days.

LENDL-V Data Library:

LENDL-V contains evaluated neutron cross-section and photon production data for 94 materials. All reactions are complete, covering all relevant reactions for incident energies from 0.0001 eV to 20 MeV. Resonance parameters are not used in the LENDL-V library (in general, this is a serious limitation of the library; for this reason, ENDF/B evaluations were used for the ANSL-V library whenever possible). The LENDL-V data were used whenever photon production data were needed and were not available in the ENDF/B evaluation. The LENDL-V library was converted to the ENDF/B-V format by R. J. Howerton, Lawrence Livermore National Laboratory, starting from the ENDL-84 library in 1984. The LENDL-V library is available from the Oak Ridge Radiation Shielding Information Center (RSIC) as data library DLC-120. LENDL-V includes ten materials not available in either the ENDF/B-V or ENDF/B-VI libraries:

MATERIAL	MAT	HALF-LIFE	MATERIAL	MAT	HALF-LIFE
33-As-74	830	17.78 d	90-Th-233	7865	22.3 m
39-Y-88	8303	106.6 d	92-U-239	7872	23.5 m
50-Sn-nat	7850	Stable	92-U -240	7873	14.1 h
78-Pt-nat	7860	Stable	93-Np-235	8307	1.085 y
90-Th-231	7863	1.063 d	93-Np-236	8308	155000 y

Table 1. Neutron group energy boundaries for the 99-group ANSL-V library (eV)

1	2.0000E+07	34	1.7411E+05	67	7.8600E+00
2	1.5941E+07	35	1.3195E+05	68	6.1780E+00
3	1.2706E+07	36	1.0000E+05	69	4.8559E+00
4	1.0127E+07	37	7.0160E+04	70	3.8168E+00
5	8.0722E+06	38	4.9224E+04	71	3.0000E+00
6	6.4340E+06	39	3.4536E+04	72	2.6996E+00
7	5.5234E+06	40	2.4230E+04	73	2.4292E+00
8	4.7417E+06	41	1.7000E+04	74	2.1859E+00
9	4.0707E+06	42	1.2017E+04	75	1.9670E+00
10	3.4946E+06	43	8.4941E+03	76	1.7700E+00
11	3.0000E+06	44	6.0042E+03	77	1.3000E+00
12	2.7235E+06	45	4.2441E+03	78	1.0000E+00
13	2.4725E+06	46	3.0000E+03	79	7.6500E-01
14	2.2447E+06	47	2.1368E+03	80	6.2500E-01
15	2.0378E+06	48	1.5220E+03	81	4.7900E-01
16	1.8500E+06	49	1.0841E+03	82	3.9700E-01
17	1.7497E+06	50	7.7217E+02	83	3.3000E-01
18	1.6548E+06	51	5.5000E+02	84	2.7000E-01
19	1.5651E+06	52	3.9110E+02	85	2.1500E-01
20	1.4803E+06	53	2.7811E+02	86	1.6200E-01
21	1.4000E+06	54	1.9776E+02	87	1.0400E-01
22	1.2816E+06	55	1.4063E+02	88	5.0000E-02
23	1.1732E+06	56	1.0000E+02	89	3.0000E-02
24	1.0740E+06	57	7.8600E+01	90	1.0000E-02
25	9.8315E+05	58	6.1780E+01	91	4.4500E-03
26	9.0000E+05	59	4.8559E+01	92	3.2500E-03
27	7.6525E+05	60	3.8168E+01	93	2.6000E-03
28	6.5068E+05	61	3.0000E+01	94	2.1500E-03
29	5.5326E+05	62	2.4082E+01	95	1.8000E-03
30	4.7043E+05	63	1.9332E+01	96	1.4500E-03
31	4.0000E+05	64	1.5518E+01	97	1.1500E-03
32	3.0314E+05	65	1.2457E+01	98	8.5000E-04
33	2.2974E+05	66	1.0000E+01	99	5.5000E-04

Table 2. Photon group energy boundaries for ANSL-V library (eV)

1	2.0000E+07	23	1.5000E+01
2	1.4000E+07	24	1.4400E+06
3	1.2000E+07	25	1.3300E+06
4	1.0000E+07	26	1.2000E+06
5	8.0000E+06	27	1.0000E+06
6	7.5000E+06	28	8.0000E+05
7	7.0000E+06	29	7.0000E+05
8	6.5000E+06	30	6.0000E+05
9	6.0000E+06	31	5.1200E+05
10	5.5000E+06	32	5.1000E+05
11	5.0000E+06	33	4.5000E+05
12	4.5000E+06	34	4.0000E+05
13	4.0000E+06	35	3.0000E+05
14	3.5000E+06	36	2.0000E+05
15	3.0000E+06	37	1.5000E+05
16	2.5000E+06	38	1.0000E+05
17	2.3500E+06	39	7.5000E+04
18	2.1500E+06	40	7.0000E+04
19	2.0000E+06	41	6.0000E+04
20	1.8000E+06	42	4.5000E+04
21	1.6600E+06	43	3.0000E+04
22	1.5700E+06	44	2.0000E+04
			1.0000E+04

Table 3. Broad-group neutron energy boundaries for 39-group library (eV)

1	2.0000E+07	21	4.7900E-01
2	6.4340E+06	22	3.9700E-01
3	3.0000E+06	23	3.3000E-01
4	1.8500E+06	24	2.7000E-01
5	1.4000E+06	25	2.1500E-01
6	9.0000E+05	26	1.6200E-01
7	4.0000E+05	27	1.0400E-01
8	1.0000E+05	28	5.0000E-02
9	1.7000E+04	29	3.0000E-02
10	3.0000E+03	30	1.0000E-02
11	5.5000E+02	31	4.4500E-03
12	1.0000E+02	32	3.2500E-03
13	3.0000E+01	33	2.6000E-03
14	1.0000E+01	34	2.1500E-03
15	3.0000E+00	35	1.8000E-03
16	1.7700E+00	36	1.4500E-03
17	1.3000E+00	37	1.1500E-03
18	1.0000E+00	38	8.5000E-04
19	7.6500E-01	39	5.5000E-04
20	6.2500E-01		1.0000E-05

Table 4. Gamma-ray weighting function

	Energy (eV)	Weight
1	1.0000E+03	1.0000E-04
2	1.0000E+05	1.0000E+00
3	1.0000E+07	1.0000E-02
4	3.0000E+07	1.0000E-04

Note: use log-log interpolation

Table 5. Summary of AMPX modules[3] used for ANSL-V generation

Module	Function[a]
XLACS	Module to generate multigroup neutron-only cross-section libraries. XLACS produces a multigroup library in the AMPX master library format by averaging pointwise neutron cross-section data taken from the ENDF/B data files. For most nuclides the pointwise cross sections are constructed from resonance parameter data given in the ENDF/B evaluation.
SMUG	Module to generate multigroup gamma-ray cross-section libraries. SMUG calculates multigroup photon cross sections, with transfer coefficients represented by a Legendre approximation of an arbitrary order. The scattering moments are computed from the Klein-Nishina equation. The photoelectric and pair-production cross sections are obtained from the ENDF/B evaluations.
LAPHNGAS	Module to generate multigroup neutron/gamma production terms. LAPHNGAS retrieves photon production data from the ENDF/B data file and calculates either multigroup gamma-ray production cross sections (SGRPXS) and/or multigroup secondary gamma-ray yields (multiplicities) that are written to an AMPX master interface.
UNITAB	Module to combine the XLACS, LAPHNGAS, and SMUG files into a coupled neutron/gamma AMPX master interface.
MALOCS	Module to collapse AMPX master cross-section libraries. MALOCS can be used to collapse neutron, gamma-ray, or coupled neutron-gamma libraries. For this project, MALOCS was used to collapse the 99/44 neutron-gamma coupled library to a 39/44 coupled library. Note that only the neutron groups were collapsed; the gamma-ray groups were not collapsed.
COMET	Module to force consistency between groupwise average cross sections and the transfer matrices in the AMPX master interface. Operations are provided to ensure that transfer matrices are normalized to the proper 1-D values, or vice versa. Although coupled neutron-gamma libraries can be read in, COMET only operates on the neutron data on a master library.
FRESH	Module that allows one to post-process the thermal-scattering matrices for many resonance nuclides produced by XLACS in order to normalize them to user-specified values. For the 99/44 ANSL-V cross section library, some thermal matrices were not adjusted (option 0) and the thermal matrices for some nuclides were renormalized to averaged values produced by the resonance calculation in XLACS; see Sect. 3.2.3 of ref. 1 and/or the FRESH input file given elsewhere in this documentation.

Table 5 (continued)

Module	Function[a]
PERFUME	Module to correct the group-to-group Legendre transfer coefficients for minor roundoff problems that otherwise may prevent the Monte Carlo codes (KENO and MORSE) from finding moment-preserving scattering angles in the range from -1 to +1 (which would have precluded the use of the ANSL-V libraries in these codes, had these corrections not been made). It is important to note that the order in which COMET, FRESH, and PERFUME are executed is very important. The preferred order is COMET-FRESH- PERFUME; in any case, PERFUME should be executed last.
RADE	Module to check AMPX master or working libraries. RADE will also check an ANISN binary-formatted library. The AMPX file can be a neutron, gamma, or a coupled neutron-gamma library. RADE performs a number of very important checks; generally it is worthwhile to do a RADE run even for intermediate libraries to make sure that errors are not introduced.
AJAX	Module to combine data from AMPX interfaces. Options are provided to allow merging from any number of files in a manner as to allow the user to determine the final nuclide ordering. Any form of master interface (neutron, gamma, or neutron-gamma) can be accessed.
AIM	Module to read a binary-formatted master library and to write a card-image (BCD) format or vice versa. Because all machines can read card-image files, the BCD format serves to transmit data between different computers.

[a]See ref. 3 for additional details.

Table 6. Materials taken from LENDL library

Nuclide	AMPX ID	MAT Number
^{11}B	5011	7811
Zr	40000	7841
^{107}Ag	47107	7845
^{109}Ag	47109	7846
Cd	48000	7847
Sn	50000	7850
Eu	63000	7852
Hf	72000	8305
^{233}U	92233	7866
^{234}U	92234	7867
^{236}U	92236	7869
^{238}Pu	94238	7875

3. METHODOLOGY USED TO GENERATE CROSS-SECTION LIBRARIES

The AMPX modules used to generate the various libraries are (1) XLACS for the neutron- only library, (2) SMUG for the gamma-ray interaction library, and (3) LAPHNGAS for the gamma-ray production library. Details concerning these AMPX modules, including the input descriptions, are given in ref. 3. In the text below we will give only a brief summary of what was done, while typical input files for each of the modules may be found in Appendix C. These files clearly document the options used in the generation of the various libraries.

3.1. NEUTRON CROSS-SECTION LIBRARIES (XLACS)

Most of the materials included in the ANSL-V neutron cross-section libraries were generated prior to 1990 and were extensively documented in the first release of the library (cf. ref. 1, September 1990). Since that time, a number of additions or revisions have been made to the 99-group neutron cross-section library:

23 May 1991: Replacement of the data for carbon bound in graphite with new data based on a more correct representation of the S(alpha,beta) scattering kernel. The previous data had been found to be incorrect. These revised data were therefore deemed necessary for work being done on graphite-moderated reactors and on the ANS hot source.

5 June 1991: Revision of the cross-section data for ten different nuclides in the existing ANSL-V coupled neutron/gamma library. They were ^{11}B, Zr, ^{107}Ag, ^{109}Ag, Cd, natural Hf, ^{233}U, ^{234}U, ^{236}U, and ^{238}Pu. In the initial ANSL-V library, the data for each of these nuclides were based on a hybrid combination of ENDF/B-V neutron data and LENDL (n,g) production data. (This was necessitated by the fact that not all the necessary data were available in the ENDF/B-V data libraries.) As noted in Appendix A, however, this led to certain inconsistencies, including the generation of excessively high gamma heating rates in the ANS hafnium control rods. Moreover, it was concluded that such hybrid datasets should never be used. The new datasets for these ten nuclides are based entirely on self-consistent LENDL datasets.

22 June 1991: Addition of data for ^{6}Li and ^{7}Li. These isotopes were not in the original ANSL-V library, but were needed for reactor physics studies then being performed by J. P. Renier.

25 Aug 1991: Addition of data for 11 new isotopes that were not in the original ANSL-V library. These included ^{31}P, ^{32}S, natural sulfur, natural calcium, ^{209}Bi, ^{134}Ba, ^{135}Ba, ^{136}Ba, ^{137}Ba, ^{138}Ba, and ^{140}Ba. These were deemed necessary for many of the shielding calculations that were to be undertaken the following year. (Without such data, for example, it would have been impossible to model regular concrete, barytes concrete, and several other materials outside the reactor itself.) Also addition of data for six specific hafnium isotopes that were not in the original ANSL-V library. These included ^{174}Hf, ^{176}Hf, ^{177}Hf, ^{178}Hf, ^{179}Hf, and ^{180}Hf. These were added so that his ongoing reactor physics studies could explicitly model the actual depletion in the hafnium control rods.

1 April 1993: Revision of the existing cross-section data for 8 isotopes: ^{235}U, ^{238}U, ^{181}Ta, ^{182}Ta, ^{151}Eu, ^{152}Eu, ^{153}Eu, and ^{154}Eu. (Data for ^{155}Eu were left unchanged.)

3 June 1993: Replacement of the existing multigroup data for natural Eu (based on ENDFB/V) with revised multigroup data based on the LENDL-V library.

Whereas the original 99-group neutron-only library had data for 125 isotopes, and whereas data for 19 new isotopes have been added as noted above, the new ANSL-V 99n/44g and 39n/44g libraries only have data for 138 isotopes. The difference is that 6 of the earlier datasets have been deleted in the new libraries. These include the Type B weighted data for ^{107}Ag, ^{109}Ag, natural europium, and natural hafnium (although the Type C weighted data have been retained in all four cases). The two quasi-realistic "lumped" datasets corresponding to "moderately absorbing fission products" and "weakly absorbing fission products" (which previously existed in the original 99-group neutron-only ANSL-V library) have also been deleted. In addition, the user should also note that many of the AMPX nuclide ID numbers for the various isotopes have now been changed so as to conform more closely to the actual ZA ID numbers in common usage in most of the SCALE and AMPX cross-section libraries. For that reason, the previous users are urged to consult the new AMPX nuclide numbers listed in Table B-1 of the present report.

As noted above, data for several nuclides in the original ANSL-V library were revised in 1991 and 1993. Several of these involved replacing the earlier data (based on ENDFB/V) with data based on the LENDL-V evaluations. One of these LENDL-V materials was natural europium (Eu-nat). The XLACS input file for Eu-nat is given in Appendix C (Table C-1). Since the ANSL-V runs were done on the IBM mainframe, Table C-1 includes the IBM JCL as well as the input data. Note that a RADE run was also done as part of this same sequence.

All of the remarks above apply to the neutron data in the ANSL-V 99-group neutron-only library and the ANSL-V 99n/44g coupled library. Lastly, it should be noted that all of the data in the ANSL-V 39n/44g coupled library were subsequently regenerated completely by collapsing the data in the 99n/44g library to the 39n/44g energy group structure in order to ensure consistency between the two libraries.

3.2. GAMMA-RAY INTERACTION CROSS SECTIONS (SMUG)

The gamma-ray interaction (photon) cross sections in the ANSL-V libraries were completely regenerated. The SMUG module was used for this purpose. The 44-group ANSL-V gamma-ray energy structure is listed in Table 2. The materials in the original ANSL-V library are listed in Table 5.1 of ref. 1. Only 34 materials (elements) were included in the original work. For this revision, it was decided to include all elements from Z = 1 to 99. This choice was made because the SMUG runs required very little computer time and it was considered desirable to have a complete set of gamma-ray interaction cross sections for all elements.

A brief summary of the SMUG module is given in Table 5. A typical input file for SMUG is given in Table C-2. The SMUG input weighting function is shown in Table 4 and is included as the 7** array in the SMUG input in Table C-2. The input case shown in Table C-2 was for 24 elements, from Z = 76 to 99, inclusive. The SMUG output file was written on unit 60 for the case shown in Table C-2. The AJAX module (see brief summary given in Table 5) was used to combine the SMUG files into a single AMPX master interface containing the gamma-ray interaction data for all 99 elements.

3.3. GAMMA-RAY PRODUCTION CROSS SECTIONS (LAPHNGAS)

The gamma-ray production cross sections in the ANSL-V 99n/44g library were completely regenerated between May 18 and June 4, 1993. This was necessary since the 99n/44g library did not exist previously. The LAPHNGAS module is summarized briefly in Table 5, but the reader should consult ref. 3 for additional details. A typical input file for LAPHNGAS is given in Table C-3. This case included four materials, ^{250}Cf, ^{251}Cf, ^{252}Cf, and Sn. The first three materials were read from unit 62 (ENDF/B-V) and the Sn data were read from unit 63 (LENDL-V). Note the input unit for each material can be on a different input unit (input as the third entry in the 14$$ array). The total number of materials which were processed by LAPHNGAS was 69. Allowing for cases where the same basic data appear in more than one AMPX data set (i.e., ^{1}H, ^{2}H, ^{12}C, Al, and Si), the total number of materials with gamma-ray production cross sections is 76. There are 62 materials which do not have gamma-ray production data. Those that do and do not can be determined by checking the number of "neutron-to-gamma processes" for each nuclide in Table B-1 of Appendix B.

3.4. ANSL-V COUPLED 99N/44G NEUTRON-GAMMA LIBRARY (UNITAB)

The neutron-only, gamma-only, and gamma-ray production libraries were combined using the UNITAB module. The output from UNITAB is a coupled neutron/gamma AMPX master interface. The AJAX module can be used to combine data from two or more neutron/gamma master interfaces. The materials included in the ANSL-V 99n/44g neutron-gamma library are given in Table B-1 which also gives a brief summary of the data available for all 138 materials. Table B-1 gives the AMPX ID number, the alphanumeric nuclide name, the date created, the type of weighting function used for the neutron cross-section data, the number of neutron-to-gamma processes, and the ENDF/B MAT (material number) corresponding to the fast neutron data. The ENDF/B thermal scattering data may come from a different evaluation which is completely separate from the fast data.

3.5. ANSL-V COUPLED 39N/44G NEUTRON-GAMMA LIBRARY (MALOCS)

The MALOCS module (see brief summary in Table 5) was used to collapse the 99n/44g coupled library to the 39n/44g broad-group library. Note that only the neutron groups are collapsed, while the gamma-ray groups are not collapsed. The 39-group (neutron) energy boundaries are given in Table 3. The MALOCS input file is given in Table C-5. The value of IWN (5th entry in the 1$$ array was set to 1; this flag specifies that the original fine-group neutron weighting function (MT=1099) from the fine-group master data set should be used to collapse the data to the broad-group energy structure. The neutron broad-group numbers by fine group are given in the 4$$ array. Other MALOCS input is discussed in ref. 3. The contents of the 39n/44g AMPX master interface are given in Table B-1. The information in Table B-1 applies to both the 99n/44g and the 39n/44g libraries. Additional information concerning the 39n/44g ANSL-V library is given in Table B-2. Most of the information in Table B-2 also applies to the 99n/44g library, but some of the numbers will be different. The data that do not apply to the 99n/44g library are the maximum lengths of the two-dimensional (2-D) length and the number of Bondarenko groups. The other data are the same for both libraries. The temperature-independent 1-D processes for each material are shown in Table B-3. A description of the various types of nuclear reactions associated with each of the MT process IDs listed in Table B-3 may be found in Sect. 4 of the AMPX-77 manual.[3] The number of such processes will vary greatly from one material to another. This variation is a function of the data given in the ENDF/B format evaluation. Table B-3 is very useful for anyone who is interested in the content of the ENDF/B evaluations and/or the content of the AMPX master interface files. In some cases, reactions of interest for an application of interest to the user may be missing from the ENDF/B evaluation. This can be determined quite easily from an examination of information given in Table B-3.

4. FUNCTIONS OF THE OTHER AMPX MODULES

The generation of the ANSL-V cross-section libraries was discussed in Sect. 3. The purpose of this section is to discuss the other AMPX modules which were subsequently used on the AMPX master interface files to produce the final ANSL-V cross-section libraries. These modules were executed for both the 99n/44g and 39n/44g libraries.

4.1. TREATMENT OF DELAYED FISSION GAMMAS

In early 1993, results of studies by J. V. Pace (using the original ANSL-V library for analyses of the HFIR reactor) suggested that not all of the fission gammas from ^{235}U and ^{238}U were being accounted for properly. (Note that there are two types of fission gammas: prompt fission gammas which typically include only those gammas released in the first 50 to 100 nanoseconds after fission, and delayed fission-product decay gammas. While some of the latter are released over a period of many years, the bulk of the more energetic ones are released in the first 1 to 10 seconds after fission, if not in the first few hundredths of a second after fission. As such, the effect of these delayed fission gammas really should be included in steady-state shielding analyses.) In this case, it was found that the yield data for the prompt fission gammas were being properly folded with the appropriate fission cross sections, but the delayed fission gamma yields were not, even though these data were in the ANSL-V library. As per Sect. 4.6 of ref. 1, the failure of the AMPX/NITAWL code to include these data in working libraries subsequently created from the AMPX master library was due to the fact that, unlike the prompt fission gamma yields which are folded with reaction type MT=18 (the fission cross section), the delayed fission product gamma yields were to be folded with reaction type MT=181 (a fictitious, nonexistent cross section). Subsequent processing of the ^{235}U and ^{238}U data through the NITAWL code therefore gave a message saying "the neutron cross section cannot be found to convert the yield data for MT=181," which meant that the delayed fission gammas would not be included in the (n,g) production terms. [See discussion of the MT=181 data in Sect. 4.6 of ref. 1.] In reality, these secondary gamma source terms should be included, and these particular yield data should be folded with the fission cross section (MT=18) to obtain the (n,g) production terms. To remedy this deficiency, the following small block of programming

```
    DO 135 JAB=1,N2DY
    IF (MTX(JAB).EQ.181)  MTX(JAB)=18
135 CONTINUE
```

was inserted between the end of do-loop 130 and the beginning of do-loop 150 in subroutine KOPY in a special (ANS) version of the AJAX module in the AMPX code system. This special ANS version of the AJAX program was then used to copy the entire master library from one dataset to another, while making this one small change for the ^{235}U and ^{238}U data. (This allows both the prompt and the delayed fission gammas to be folded with the fission cross section, and allows both to be included in the secondary gamma production cross sections in all subsequent working libraries created by NITAWL.) Since May 1993, this enhancement has been a permanent feature of both the 99n/44g and the 39n/44g AMPX master libraries.

4.2. RENORMALIZATION OF 2-D ARRAYS (COMET)

COMET was used to renormalize the 2-D neutron-scattering matrices to agree with the 1-D averaged values. A brief summary of the COMET code is given in Table 5. Additional details regarding the function of the code are given in Sect. 3.2.5 of the original ANSL-V document,[1] while details regarding the input data are described in ref. 3. The COMET input file used for the 99n/44g library is given in Table C-6. For all materials in the 99n/44g library, the 2-D matrices for MT = 2, 4, 16, 17, 22, 23, 24, 25, 28, and 37 were renormalized to the corresponding 1-D averaged values.

4.3. ADJUST THERMAL SCATTERING MATRICES (FRESH)

The FRESH module was used to adjust the thermal scattering matrices in the 99n/44g and 39n/44g ANSL-V libraries. The function of the FRESH module is discussed briefly in Table 5 and more fully (in terms of the nuclear physics) in Sect. 3.2.3 of the original ANSL-V document.[1] The general input description for the FRESH code is given in ref. 3, while the particular input file for the 99n/44g library is given in Table C-7. The 6$$ array contains the nuclide ID and the option to be used for that nuclide. An entry of option 0 in the 6$$ array means that the thermal scattering matrix for that nuclide was not changed. An entry of option 1 in the 6$$ array means that the thermal scattering matrix is renormalized to agree with the group-averaged resonance value.

4.4. CORRECT LEGENDRE POLYNOMIAL FITS (PERFUME)

PERFUME was not used in the development of the original ANSL-V library described in ref. 1. Nevertheless, this module performs an important function, as described briefly in Table 5. PERFUME examines scattering matrices to locate those that yield nonphysical fits to the angular scattering distributions and makes slight adjustments to produce acceptable distributions. This procedure involves an examination of the moments of the scattering cross sections and is described in Appendix F9.D.2 of ref. 4. The PERFUME input data are described in ref. 3; the input file for the 99n/44g library is given in Table B-8. The PERFUME input file is very short, consisting of only the title card and the 0$$ and 1$$ arrays. The entry in the 1$$ array is only used for edit purposes. As noted in Table 5, PERFUME should be executed after COMET and FRESH since those modules may impact what was already done by PERFUME. Moreover, because of the inevitable small roundoff errors that occur whenever cross-section libraries are converted from binary to card image form on one computer and back to binary on another computer using the AIM module described below, the PERFUME module should be run again.

February 1995 Update Regarding the PERFUME Module:

In February 1995, work on a completely unrelated project for the U.S. Nuclear Regulatory Commission (NRC) revealed that all previous versions of the PERFUME module contained a long-standing but previously undiscovered problem that could potentially affect some of the (n,g) production data for some nuclides. In particular, the problem was found to occur only when one had more neutron groups than gamma groups. Moreover, it affected only the (n,g) production data, and then only those (n,g) production terms that are anisotropic in nature [i.e., the most common, isotropic (n,g) production terms were not affected; only the anisotropic production terms resulting from high-energy (n,n',g) reactions were affected]. Nevertheless, this raised some concern since the ANSL-V cross sections had also been processed using this module. Thus once the error in the PERFUME module had been repaired, both the 99n/44g and the 39n/44g ANSL-V cross-section libraries were regenerated (from pre-PERFUMED versions) and checked. As noted above, the ANSL-V 39n/44g library was not affected—the new library agreed byte-per-byte with the version previously generated in July 1993. The ANSL-V 99n/44g library did, however, differ slightly from the earlier (July 1993) version. Fortunately, the 39n/44g library was the only one ever used in a production mode on the ANS shielding task. Thus all results reported to date were totally unaffected. Also, since the 99n/44g library has only been used in a very limited number of benchmark calculations that did not involve the affected nuclides, those results were also unaffected. The new versions of the ANSL-V libraries, however, are the ones that will be made available through RSIC for future use.

4.5. ANSL-V CROSS-SECTION LIBRARY CHECKING (RADE)

The final ANSL-V 99n/44g and 39n/44g cross-section libraries were both checked by running the RADE module. RADE performs a number of very important consistency checks. The function of the RADE module is described briefly in Table 5. Other details are discussed in Sect. 3.2.2 of ref. 1, and in ref. 3. Cross-section checks performed by RADE are summarized in Table 7. RADE will also compute an estimate of the capture binding energy for each neutron group in a coupled neutron-gamma set. This can be a very useful tool for locating errors in coupled neutron-gamma libraries. RADE also generates an output file with much of the same information given in Table B-2. The reader should consult ref. 3 for the RADE input description.

Table 7. Cross-section checks performed by RADE on AMPX master interface files[a]

1	$\sigma_t = \sigma_a + \sigma_s$
2	$\sigma_{in} = \Sigma\ \sigma_{in}(\text{partial})$
3	$\sigma_a = \sigma_c + \sigma_f$
4	$\sigma_c = \sigma_{ng} + \sigma_{n\alpha} + \sigma_{np} + \sigma_{nd} + \ldots$
5	$\sigma_{e\ell}(g) = \sum_{g'} \sigma_{e\ell,0}(g \rightarrow g')$ (for all processes with scattering matrix)
6	$\sigma_0(g \rightarrow g') > 0$
7	$\sigma_t, \sigma_a, \sigma_f, \sigma_{n\alpha}, \sigma_{np}, \ldots > 0$
8	$-1 \le \{\mu(g \rightarrow g') = \sigma_\ell(g \rightarrow g')/(2\ell + 1)\sigma_0(g \rightarrow g')\} \le 1$, for all odd ℓ.[b]

[a]Deviations between the right- and left-hand sides of the above relationships are printed if greater than a user-supplied tolerance.

[b]For even ℓ, the left-hand side of this inequality is given by the table:

ℓ	$\mu(g \rightarrow g')$
2	−0.5
4	−0.433
6	−0.419
8	−0.414

4.6. MODULE TO CONVERT MASTER CROSS-SECTION LIBRARIES FROM BCD TO BINARY FORMAT (OR VICE VERSA): AIM

AIM is the name of the AMPX module used to read a binary-formatted master library and write a card-image (BCD) file or vice versa. Because all machines can read card-image files, the BCD format serves to transmit AMPX libraries between different computers.

4.7. A CAUTIONARY NOTE REGARDING PHOTONEUTRONS

On page 24 of the section on Radiation Shielding in Vol. III of the 1962 Reactor Handbook,[5] it was noted that "With a shield which attenuates neutrons rapidly but is practically transparent to gamma rays, photoneutrons can provide most of the observed dose in the outer regions of the shield." More recent calculations by J. A. Bucholz[6] confirmed that this was the case for the ANS reactor where photoneutron production is compounded by the fact that low energy (n,g) reactions in the aluminum reflector vessel yield high-energy gammas which are also capable of producing photoneutrons in the D2O reflector. Moreover, Bucholz found that fast neutron fluxes deep in the reflector close to the vessel may be as much as 3300 times higher than one would estimate if one did not account for photoneutrons. Likewise, Gallmeier and Bucholz[7] have found that the neutron dose rate at the top of the subpile room (below the ANS core) may be as much as 5 or 6 orders of magnitude greater than one would estimate if one did not account for photoneutrons. Lastly, other studies by Bucholz have shown that the neutron dose rate directly above the heavy-water-filled spent fuel transfer canal may be rather large and 7 to 8 orders of magnitude greater than one would predict if one does not account for photoneutrons produced in the heavy water by high-energy gammas coming from a typical spent fuel element in the canal.

Unfortunately, neither the 99n/44g or the 39n/44g ANSL-V master cross-section libraries include the (g,n) photoneutron production cross sections for deuterium. This deficiency stems not from an ignorance of the data or any oversight, but from an intrinsic limitation in the basic structure of the AMPX master cross-section interface files. Because photoneutron production data have not traditionally been included in the basic ENDF/B-II, -III, -IV, or -V cross-section files, none of the cross-section processing codes in the AMPX code system are capable of processing such data. As a result, the basic structure of the AMPX cross-section interface files simply do not provide positions and/or pointers to accommodate such data. The present ANSL-V libraries are no exception, and users are cautioned that straightforward blind use of these libraries (in the presence of heavy water) will not account for this potentially important physical phenomenon.

Fortunately, data in the ANSL-V AMPX master libraries are never used directly in shielding analysis codes, but are always processed through a series of other codes prior to use. During this processing, the necessary photoneutron production data may be incorporated in the final DORT-ready cross-section library. Briefly, some of the common application-oriented processing steps are as follows: (1) After the shielding material mixtures have been identified, the data from the AMPX master library will have to be resonance-self-shielded using the BONAMI or NITAWL modules from the AMPX code system. The latter module will also convert the resonance-shielded microscopic data to an AMPX working format. (2) The ICE module is then used to mix the microscopic data with the appropriate atomic number densities for the nuclides in the various materials, thereby creating a macroscopic cross-section library in an ANISN "nuclide-oriented" format. (3) This library will then be processed using the GIP code (or a newer derivative called JIPSY) to convert the ANISN "nuclide-oriented" library to an ANISN "group-independent" library which may be used with either the 1-D ANISN shielding code or the 2-D DORT shielding code. (4) At this point, the SPARK program (described in Sect 4.3 and Appendix B of ref. 6 may be used to read the original DORT-ready macroscopic cross-section library prepared by GIP or JIPSY (without photoneutrons), automatically expand the group-to-group scattering matrix to include the (g,n) photoneutron production terms as additional scattering data, and output the final DORT-ready macroscopic cross-section library with photoneutron data.

The total photoneutron production cross section as a function of gamma energy, the assumptions and algorithms used to obtain the corresponding gamma-group-to-neutron-group scattering matrix, and the SPARK program itself, are all described in Sect. 4.3 and Appendix B of ref. 6. The point here is that whenever one has a problem involving heavy water or pure deuterium, the ANSL-V cross-section libraries must first be supplemented in this fashion to account for photoneutrons.

5. AVAILABILITY

The three ANSL-V cross-section libraries described here in Supplement 1 (the 99n/44g coupled library, the 39n/44g coupled library, and the 44-group gamma-only library) will all be made available through RSIC at ORNL.

6. REFERENCES

1. W. E. Ford et al., *ANSL-V: ENDF/B-V Based Multigroup Cross-Section Libraries for Advanced Neutron Source (ANS) Reactor Studies*, ORNL-6618, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., September 1990.

2. Personal communication, R. Q. Wright to R. T. Primm III, dated June 12, 1991.

3. N. M. Greene, W. E. Ford III, L. M. Petrie, and J. W. Arwood, *AMPX-77: A Modular Code System for Generating Coupled Multigroup Neutron-Gamma Cross-Section Libraries from ENDF/B-IV and/or ENDF/B-V*, ORNL/CSD/TM-283, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1992.

4. J. T. West, T. J. Hoffman, and M. B. Emmett, "MORSE-SGC for the SCALE System," Sect. F9 of *SCALE: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation*, NUREG/CR-0200, Rev. 4 (ORNL/NUREG/CSD-2/R4), Vols. I, II, and III (April 1995). Available from Radiation Shielding Information Center as CCC-545.

5. E. P. Blizzard, ed., Vol. III, Part B on Radiation Shielding in the "Reactor Handbook," Interscience Publishers, a Division of John Wiley and Sons, 1962.

6. J. A. Bucholz, *Initial Global 2-D Shielding Analysis for the ANS Core and Reflector*, ORNL/TM-12672, Lockheed Martin Energy Systems, Inc., Oak Ridge Natl. Lab., 1995.

7. F. Gallmeier et al., *Analyses of the In-Vessel Control Rod Guide Tube and Subpile Room Shielding Design for the ANS Reactor*, ORNL/TM-12996, Lockheed Martin Energy Systems, Inc., Oak Ridge Natl. Lab., to be published in 1995.

APPENDIX A

UPDATE TO ANSL-V COUPLED NEUTRON-GAMMA LIBRARY (JUNE 1991)

APPENDIX A

UPDATE TO ANSL-V COUPLED NEUTRON-GAMMA LIBRARY (JUNE 1991)

June 12, 1991

R. T. Primm, III, 6025, MS-6363 (4-0566)

Update to ANSL-V Coupled Neutron-Gamma Library

The requested update to the ANSL-V Coupled Library has now been completed. The procedure outlined in your memorandum of March 7, 1991 was followed. The purpose of this memo is to document the new libraries and also to briefly document the problem which is encountered in using the old ENDF/B-V, LENDL hybrid data sets.

XLACS cases were executed for the 10 nuclides shown in Table 1. As we discussed previously, weight function C was used for these cases. The XLACS runs were done using the 99 group structure. Table 1 gives the LENDL MAT numbers, as well as the AMPX IDs for the 99 group cases. MALOCS was then used to collapse the 99 group cross sections to 39 groups. The UNITAB module was then used to produce the final 39 neutron group, 44 gamma-ray group coupled library. The IBM data set names are given in Table 2. The input for the UNITAB run is shown in Table 3. Note that the Hf AMPX ID is 72000 in the Coupled Library rather than 720001 as in the 99- and 39-group neutron only libraries.

As has been previously noted in Ref. 1, the old hybrid ENDF/B-V neutron/LENDL gamma-ray production data for Hf gave excessive gamma heating in the ANS control rods; the reason for this is now clearly understood. Table 4 shows the output from the RADE module for the B-11 n-gamma (MT 102) reaction for both the HYBRID set and the ALL LENDL set. This table gives the total energy and the n-gamma (capture) cross sections as computed by RADE for the two data sets. The problem is that the calculation of the total energy uses the n-gamma cross sections. In the hybrid set there are actually two different n-gamma cross sections; the LENDL set is used for gamma-ray production and the ENDF/B-V data (HYBRID set in Table 4) is used for the neutron cross sections. The RADE calculation uses the gamma-ray production set in the numerator and the neutron set in the denominator. Thus the total energy will be in error by a factor equal to the ratio of the two cross sections, e.g. a factor of 3348 for group 5 and a factor of 35 for group 10, as shown in Table 4. A similar problem would also occur in the case of Hf and, in general, for all of the hybrid sets since the n-gamma cross sections can be quite different in the different evaluations, especially at high energies where the cross sections are usually small and sometimes poorly known. As a result of this problem, it can be generally expected that the hybrid sets will not give the correct total energy and for this reason hybrid sets should never be used.

Another reservation concerning the LENDL B-11 evaluation should be stated, however. In my opinion, the ENDF/B-V evaluation for the n-gamma cross section is likely to be more nearly correct. This conclusion is supported by the fact that in the ENDF/B-VI evaluation for B-11 the n-gamma cross section is unchanged from ENDF/B-V. As a consequence if the new all LENDL set is used for calculations in which the B-11 absorption rate is important and is needed to high accuracy extreme care should be exercised. This same comment also applies to the other LENDL evaluations.

R. Q. Wright

RQW:jh

cc: R. G. Alsmiller
N. M. Greene
D. T. Ingersoll
R. A. Lillie
C. V. Parks
R. M. Westfall
B. A. Worley

REFERENCE

1. R. A. Lillie, "Cause of Calculated Excessive Heating in ANS Control Rods," Internal Correspondence, Sept. 24, 1990.

Table A-1. 99 Group XLACS Cases from LENDL Library

Nuclide	AMPX ID	MAT Number
B-11	5011	7811
Zr	40000	7841
Cd	48000	7847
Hf	720001	8305
Ag-107	47107	7845
Ag-109	47109	7846
U-233	92233	7866
U-234	92234	7867
U-236	92236	7869
Pu-238	94238	7875

Table A-2. IBM Data Set Names

99 Group Neutron	X.RQW39085.LENDL.GRP99N
39 Group Neutron	X.RQW39085.LENDL.GRP39N
44 Grp. Interaction	A.JZW28697.SNUG
39/44 Grp. Production	A.JZW28697.IAPHNGAS
39/44 Grp. Coupled	X.RQW39085.LENDL.N39G44

Table A-3. UNITAB Input Data

Nuclide	ID	File	ID	Type of Data
Ag-107	47107	62	47107	Neutron
Ag	47107	61	47	Gamma Interaction
Ag-107	47107	60	7845	Production
Ag-109	47109	62	47109	Neutron
Ag	47109	61	47	Gamma Interaction
Ag-109	47109	60	7846	Production
B-11	5011	62	5011	Neutron
B	5011	61	5	Gamma Interaction
B-11	5011	60	7811	Production
Cd	48000	62	48000	Neutron
Cd	48000	61	48	Gamma Interaction
Cd	48000	60	7847	Production
Hf	72000	62	720001	Neutron
Hf	72000	61	72	Gamma Interaction
Hf	72000	60	8305	Production
U-233	92233	62	92233	Neutron
U	92233	61	92	Gamma Interaction
U-233	92233	60	7866	Production
U-234	92234	62	92234	Neutron
U	92234	61	92	Gamma Interaction
U-234	92234	60	7867	Production
U-236	92236	62	92236	Neutron
U	92236	61	92	Gamma Interaction
U-236	92236	60	7869	Production
Zr	40000	62	40000	Neutron
Zr	40000	61	40	Gamma Interaction
Zr	40000	60	7841	Production
Pu-238	94238	62	94238	Neutron
Pu	94238	61	94	Gamma Interaction
Pu-238	94238	60	7875	Production

Table A-4. Gamma Ray Production Process 102
for B-11, Total Energy and Cross Section

Grp.	HYBRID SET Total Energy	HYBRID SET Cross Section	ALL LENDL Total Energy	ALL LENDL Cross Section
1	1.9912e+09	4.4459e-07	1.0642e+07	8.3188e-05
2	3.8318e+09	9.7979e-07	6.8470e+06	5.4831e-04
3	2.3217e+10	1.8093e-06	5.5301e+06	7.5959e-03
4	1.7318e+10	2.4472e-06	4.9152e+06	8.6225e-03
5	1.4856e+10	3.1718e-06	4.4379e+06	1.0618e-02
6	1.3033e+10	3.8360e-06	3.9499e+06	1.2658e-02
7	1.6673e+10	2.6545e-06	3.6823e+06	1.2019e-02
8	9.7851e+05	4.2809e-05	3.4336e+06	1.2200e-03
9	1.7116e+08	1.6162e-05	3.4359e+06	8.0508e-04
10	1.2617e+08	2.2887e-05	3.6096e+06	8.0000e-04

Note: Only groups 1 to 10 are shown in this table; smaller differences in the total energy are also seen for groups 11 to 39.

APPENDIX B

SUMMARY OF ANSL-V LIBRARY DATA

Table B-1. Brief summary of data for all 138 nuclides in the 99n/44g and 39n/44g ANSL-V coupled libraries.

ampx za nuclide id number	1001	1002	1003	1401	1402	1501	1801
alphanumeric nuclide name	H-1-WATER	H-2-D20	H-3	H-1-PARA	H-2-PARA	H-1-ORTHO	H-1-FGAS
date created	05-05-87	05-06-87	05-29-87	09-28-87	09-30-87	09-30-87	05-29-87
weighting type	type A	type A	type A	type A	type A	type A	type A
neut-to-gamma processes	1	1	0	1	1	1	1
endf mat of fast neut data	1301	1302	1169	1301	1302	1301	1301
ampx za nuclide id number	2003	2004	3006	3007	4009	5010	5011
alphanumeric nuclide name	HE-3	HE-4	LI-6	LI-7	BE-9	B-10	B-11
date created	05-19-87	05-19-87	06-22-90	06-25-90	08-07-87	05-19-87	06-05-91
weighting type	type A	type A	type C	type C	type A	type A	type C
neut-to-gamma processes	0	0	2	2	2	4	8
endf mat of fast neut data	1146	1270	1303	1397	1304	1305	7811
ampx za nuclide id number	6012	6312	7014	7015	8016	9019	11023
alphanumeric nuclide name	C-12	GRAPHITE	N-14	N-15	O-16	F-19	NA-23
date created	12-04-89	05-23-91	05-29-87	10-24-89	05-06-87	01-12-90	06-05-87
weighting type	type A	type A	type A	type A	type A	M-1E-F	type B
neut-to-gamma processes	2	2	6	6	5	4	3
endf mat of fast neut data	1306	1306	1275	1307	1276	1309	1311
ampx za nuclide id number	12000	13027	13327	14000	14300	15031	16000
alphanumeric nuclide name	MG	AL-27	AL-27	SI	SI	P-31	S-NAT
date created	05-19-87	05-06-87	05-06-87	05-19-87	05-19-87	08-25-91	08-25-91
weighting type	type B	type B	type C	type B	type C	type B	type B
neut-to-gamma processes	2	4	4	6	6	2	2
endf mat of fast neut data	1312	1313	1313	1314	1314	1315	1347
ampx za nuclide id number	16032	19000	20000	22000	23000	24000	25055
alphanumeric nuclide name	S-32	K	CA-NAT	TI	V	CR	MN-55
date created	08-25-91	05-29-87	08-25-91	06-05-87	06-05-87	06-15-87	08-11-87
weighting type	type B	type B	type B	type B	type B	type B	type B
neut-to-gamma processes	2	21	6	2	2	3	2
endf mat of fast neut data	1316	1150	1320	1322	1323	1324	1325
ampx za nuclide id number	26000	27059	28000	29000	36082	36083	40000
alphanumeric nuclide name	FE	CO-59	NI	CU	KR-82	KR-83	ZIRC
date created	06-05-87	06-15-87	05-29-87	12-04-89	10-11-89	10-11-89	06-05-91
weighting type	type B	type B	type B	type B	type C	type C	type C
neut-to-gamma processes	13	2	2	2	0	0	2
endf mat of fast neut data	1326	1327	1328	1329	1332	1333	7841
ampx za nuclide id number	40090	40091	40092	40093	40094	40096	42000
alphanumeric nuclide name	ZR-90	ZR-91	ZR-92	ZR-93	ZR-94	ZR-96	MO
date created	06-05-87	06-15-87	06-15-87	05-29-87	06-15-87	06-04-87	12-04-89
weighting type	type C	type C	type C	type C	type C	type C	type B
neut-to-gamma processes	0	0	0	0	0	0	2
endf mat of fast neut data	1385	1386	1387	9232	1388	1389	1321
ampx za nuclide id number	42097	43099	44101	44103	45103	45105	47107
alphanumeric nuclide name	MO-97	TC-99	RU-101	RU-103	RH-103	RH-105	AG-107
date created	10-11-89	10-11-89	10-11-89	10-11-89	10-11-89	10-11-89	06-05-91
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	0	0	0	0	0	0	2
endf mat of fast neut data	9284	1308	9330	9332	1310	9355	7845
ampx za nuclide id number	47109	48000	48113	50000	53135	54131	54133
alphanumeric nuclide name	AG-109	CDC	CD-113	SN	I-135	XE-131	XE-133
date created	06-05-91	06-05-91	08-07-87	01-02-90	10-11-89	10-11-89	10-12-89
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	2	2	0	2	0	0	0
endf mat of fast neut data	7846	7847	1318	8850	9618	1351	9643

Table B-1 (continued)

ampx za nuclide id number	54135	55133	55134	55135	56134	56135	56136
alphanumeric nuclide name	XE-135	CS-133	CS-134	CS-135	BA-134	BA-135	BA-136
date created	10-12-89	10-12-89	10-12-89	10-12-89	08-25-91	08-25-91	08-25-91
weighting type	type C	type C	type C	type C	type B	type B	type B
neut-to-gamma processes	0	0	0	0	0	0	0
endf mat of fast neut data	1294	1355	4663	9665	9684	9685	9687
ampx za nuclide id number	56137	56138	56140	58141	59143	60143	60145
alphanumeric nuclide name	BA-137	BA-138	BA-140	CE-141	PR-143	ND-143	ND-145
date created	08-25-91	08-25-91	08-25-91	08-11-87	08-11-87	10-19-89	10-19-89
weighting type	type B	type B	type B	type C	type C	type C	type C
neut-to-gamma processes	0	2	0	0	0	0	0
endf mat of fast neut data	9689	1353	9693	9725	9745	9764	9766
ampx za nuclide id number	60147	61147	61148	61149	61601	62149	62150
alphanumeric nuclide name	ND-147	PM-147	PM-148	PM-149	PM-148M	SM-149	SM-150
date created	10-19-89	06-05-87	10-19-89	10-19-89	10-19-89	08-31-87	10-23-89
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	0	0	0	0	0	0	0
endf mat of fast neut data	4768	9783	9784	9786	9785	1319	9809
ampx za nuclide id number	62151	62152	62153	63000	63151	63152	63153
alphanumeric nuclide name	SM-151	SM-152	SM-153	EU-NAT	EU-151	EU-152	EU-153
date created	10-23-89	10-23-89	08-11-87	06-03-93	04-01-93	04-01-93	04-01-93
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	0	0	0	2	11	0	13
endf mat of fast neut data	9810	9811	9812	7852	1357	4292	1359
ampx za nuclide id number	63154	63155	72000	72174	72176	72177	72178
alphanumeric nuclide name	EU-154	EU-155	HF-NAT	HF-174	HF-176	HF-177	HF-178
date created	04-01-93	10-23-89	05-24-91	08-25-91	08-25-91	08-25-91	08-25-91
weighting type	type C	type C	type C	poldnt	poldnt	poldnt	poldnt
neut-to-gamma processes	0	0	2	0	0	0	0
endf mat of fast neut data	4293	4832	8305	1374	1376	1377	1378
ampx za nuclide id number	72179	72180	73181	73182	82000	83209	90232
alphanumeric nuclide name	HF-179	HF-180	TA-181	TA-182	PB	BI-209	TH-232
date created	08-25-91	08-25-91	04-01-93	04-01-93	12-04-89	08-25-91	12-11-89
weighting type	poldnt	poldnt	type B	type B	type B	type B	type C
neut-to-gamma processes	0	0	2	0	2	2	3
endf mat of fast neut data	1383	1384	1285	1127	1382	1375	1390
ampx za nuclide id number	92233	92234	92235	92236	92237	92238	93237
alphanumeric nuclide name	U-233	U-234	U-235	U-236	U-237	U-238	NP-237
date created	06-05-91	06-05-91	04-01-93	06-05-91	12-04-89	04-01-93	12-11-89
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	3	3	4	3	3	3	0
endf mat of fast neut data	7866	7867	1395	7869	8237	1398	1337
ampx za nuclide id number	93238	93239	94238	94239	94240	94241	94242
alphanumeric nuclide name	NP-238	NP-239	PU-238	PU-239	PU-240	PU-241	PU-242
date created	12-12-89	12-12-89	06-05-91	12-12-89	12-11-89	12-12-89	12-11-89
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	0	0	3	4	4	3	3
endf mat of fast neut data	8338	2932	7875	1399	1380	2945	1342
ampx za nuclide id number	94243	95241	95242	95243	95601	96242	96243
alphanumeric nuclide name	PU-243	AM-241	AM-242	AM-243	AM-242M	CM-242	CM-243
date created	12-11-89	12-11-89	12-11-89	12-11-89	12-07-89	12-05-89	12-07-89
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	3	3	0	3	3	3	3
endf mat of fast neut data	8443	1361	8542	1363	1369	8642	1343

Table B-1 (continued)

ampx za nuclide id number	96244	96245	96246	96247	96248	97249	98249
alphanumeric nuclide name	CM-244	CM-245	CM-246	CM-247	CM-248	BK-249	CF-249
date created	12-05-89	12-05-89	12-05-89	12-05-89	12-07-89	12-07-89	12-07-89
weighting type	type C	type C	type C	type C	type C	type C	type C
neut-to-gamma processes	3	3	3	3	3	0	0
endf mat of fast neut data	1344	1345	1346	8647	8648	8749	8849
ampx za nuclide id number	98250	98251	98252	98253	99253		
alphanumeric nuclide name	CF-250	CF-251	CF-252	CF-253	ES-253		
date created	12-07-89	12-07-89	12-07-89	12-07-89	12-07-89		
weighting type	type C	type C	type C	type C	type C		
neut-to-gamma processes	3	3	3	0	0		
endf mat of fast neut data	8850	8851	8852	8853	8953		

Table B-2. Type of nuclear data available for all 138 nuclides in the 39n/44g ANSL-V coupled library

ampx za nuclide id number	1001	1002	1003	1401	1402	1501	1801	2003	2004	3006	3007	4009
alphanumeric nuclide name	H-1-WATER	H-2-D20	H-3	H-1-PARA	H-2-PARA	H-1-ORTHO	H-1-FGAS	HE-3	HE-4	LI-6	LI-7	BE-9
number of data records	53	54	32	25	26	25	33	31	31	221	229	58
date created	05-05-87	05-06-87	05-29-87	09-28-87	09-30-87	09-30-87	05-29-87	05-19-87	05-19-87	06-22-90	06-25-90	08-07-87
weighting type	type A	type A	type A	type A	type A	type A	type A	type A	type A	type C	type C	type A
resolved resonances	0	0	0	0	0	0	0	0	0	0	0	0
temp ind 1-d neut processes	15	16	14	15	16	15	15	15	13	50	52	29
2-d neut processes	2	3	3	2	3	2	2	2	2	34	37	6
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	1	1	0	1	1	1	1	0	0	2	2	2
total 2-d arrays	18	19	18	18	19	18	18	17	17	206	214	23
mass(neutron equivalents)	.999	1.997	2.990	.999	1.997	.999	.999	2.990	4.002	5.963	6.956	8.935
max 2-d length	707	707	707	707	707	707	707	707	707	707	707	707
bondarenko processes	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko temps	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko groups	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	1301	1302	1169	1301	1302	1301	1301	1146	1270	1303	1397	1304
endf mat of thermal neut data ..	1002	1004	0	1001	1002	1001	0	0	0	0	0	1064
endf mat of gamma prod data	1301	1302	0	1301	1302	1301	1301	0	0	1303	1397	1304

ampx za nuclide id number	5010	5011	6012	6312	7014	7015	8016	9019	11023	12000	13027	13327
alphanumeric nuclide name	B-10	B-11	C-12	GRAPHITE	N-14	N-15	O-16	F-19	NA-23	MG	AL-27	AL-27
number of data records	246	60	153	181	261	84	296	166	146	278	277	277
date created	05-19-87	06-05-91	12-04-89	05-23-91	05-29-87	10-24-89	05-06-87	01-12-90	06-05-87	05-19-87	05-06-87	05-06-87
weighting type	type A	type C	type A	type A	type A	type A	type A	M-1E-F	type B	type B	type B	type C
resolved resonances	0	0	0	0	0	0	0	0	6	0	0	0
temp ind 1-d neut processes	61	24	42	42	76	51	62	46	39	63	61	61
2-d neut processes	37	7	21	21	35	13	41	27	22	46	43	43
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	4	8	2	2	6	6	5	4	3	2	4	4
total 2-d arrays	231	45	138	138	246	69	281	151	130	263	262	262
mass(neutron equivalents)	9.927	10.914	11.897	11.897	13.883	14.871	15.858	18.835	22.792	24.096	26.750	26.750
max 2-d length	707	1266	707	707	707	707	707	895	923	1192	932	932
bondarenko processes	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko temps	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko groups	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	1305	7811	1306	1306	1275	1307	1276	1309	1311	1312	1313	1313
endf mat of thermal neut data ..	0	0	0	1065	0	0	0	0	0	0	0	0
endf mat of gamma prod data	1305	7811	1306	1306	1275	1307	1276	1309	1311	1312	1313	1313

Table B-2 (continued)

ampx za nuclide id number	14000	14300	15031	16000	16032	19000	20000	22000	23000	24000	25055	26000
alphanumeric nuclide name	SI	SI	P-31	S-NAT	S-32	K	CA-NAT	TI	V	CR	MN-55	FE
number of data records	174	174	37	279	37	159	156	111	80	281	112	290
date created	05-19-87	05-19-87	08-25-91	08-25-91	08-25-91	05-29-87	08-25-91	06-05-87	06-05-87	06-15-87	08-11-87	06-05-87
weighting type	type B	type C	type B	type B	type B	type B	type B	type B	type B	type B	type B	type B
resolved resonances	0	0	0	19	0	0	0	0	0	86	45	62
temp ind 1-d neut processes	77	77	21	69	22	39	48	42	33	72	37	66
2-d neut processes	28	28	5	46	5	23	25	19	13	47	19	46
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	6	6	2	2	2	21	6	2	2	3	2	13
total 2-d arrays	159	159	22	263	22	144	141	96	65	265	96	274
mass(neutron equivalents)	27.844	27.844	30.708	31.788	31.697	38.766	39.736	47.468	50.504	51.549	54.466	55.365
max 2-d length	898	898	1608	1045	707	962	848	1173	1204	1445	1080	1342
bondarenko processes	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko temps	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko groups	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	1314	1314	1315	1347	1316	1150	1320	1322	1323	1324	1325	1326
endf mat of thermal neut data ..	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	1314	1314	1315	1347	1316	1150	1320	1322	1323	1324	1325	1326

ampx za nuclide id number	27059	28000	29000	36082	36083	40000	40090	40091	40092	40093	40094	40096
alphanumeric nuclide name	CO-59	NI	CU	KR-82	KR-83	ZIRC	ZR-90	ZR-91	ZR-92	ZR-93	ZR-94	ZR-96
number of data records	105	195	106	88	71	85	64	100	70	92	82	58
date created	06-15-87	05-29-87	12-04-89	10-11-89	10-11-89	06-05-91	06-05-87	06-15-87	06-15-87	05-29-87	06-15-87	06-04-87
weighting type	type B	type B	type B	type C	type C	type C	type C	type C	type C	type C	type C	type C
resolved resonances	74	134	49	3	4	0	36	37	17	0	24	10
temp ind 1-d neut processes	36	53	37	33	31	28	25	31	26	27	28	23
2-d neut processes	17	32	18	13	11	13	9	15	10	13	12	8
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	2	2	2	0	0	2	0	0	0	0	0	0
total 2-d arrays	89	179	90	73	56	70	49	85	55	78	67	43
mass(neutron equivalents)	58.427	58.183	63.546	81.210	82.202	90.440	89.132	90.122	91.112	92.108	93.096	95.081
max 2-d length	1297	1434	1496	707	707	1646	707	707	707	707	707	707
bondarenko processes	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko temps	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko groups	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	1327	1328	1329	1332	1333	7841	1385	1386	1387	9232	1388	1389
endf mat of thermal neut data ..	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	1327	1328	1329	0	0	7841	0	0	0	0	0	0

Table B-2 (continued)

alphanumeric nuclide name	MO	MO-97	TC-99	RU-101	RU-103	RH-103	RH-105	AG-107	AG-109	CDC	CD-113	SN
number of data records	52	147	110	147	116	118	50	73	67	37	52	37
date created	12-04-89	10-11-89	10-11-89	10-11-89	10-11-89	10-11-89	10-11-89	06-05-91	06-05-91	06-05-91	08-07-87	01-02-90
weighting type	type B	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C
resolved resonances	33	32	44	9	0	61	0	0	0	0	14	0
temp ind 1-d neut processes	19	36	29	36	31	32	20	29	26	19	23	20
2-d neut processes	5	22	15	22	17	18	6	11	10	5	7	5
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	2	0	0	0	0	0	0	2	2	2	0	2
total 2-d arrays	22	132	85	132	102	103	36	58	52	22	37	22
mass(neutron equivalents)	95.116	96.074	98.150	100.039	102.022	102.021	104.005	105.992	107.964	111.434	111.930	117.670
max 2-d length	1318	707	707	707	707	707	707	1570	1532	1304	707	1646
bondarenko processes	6	0	4	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	5	0	4	0	0	0	0	0	0	0	0	0
bondarenko temps	5	0	5	0	0	0	0	0	0	0	0	0
bondarenko groups	3	0	4	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	1321	9284	1308	9330	9332	1310	9355	7845	7846	7847	1318	8850
endf mat of thermal neut data	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	1321	0	0	0	0	0	0	7845	7846	7847	0	7850

ampx za nuclide id number	53135	54131	54133	54135	55133	55134	55135	56134	56135	56136	56137	56138
alphanumeric nuclide name	I-135	XE-131	XE-133	XE-135	CS-133	CS-134	CS-135	BA-134	BA-135	BA-136	BA-137	BA-138
number of data records	32	71	38	38	64	63	50	75	87	93	81	37
date created	10-11-89	10-11-89	10-12-89	10-12-89	10-12-89	10-12-89	10-12-89	08-25-91	08-25-91	08-25-91	08-25-91	08-25-91
weighting type	type C	type C	type C	type C	type C	type C	type C	type B	type B	type B	type B	type B
resolved resonances	0	41	0	0	125	8	0	8	15	4	7	0
temp ind 1-d neut processes	17	29	18	18	25	22	20	24	26	27	25	21
2-d neut processes	3	11	4	4	9	8	6	10	12	13	11	5
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	0	0	0	0	0	0	0	0	0	0	0	2
total 2-d arrays	18	56	24	24	49	48	36	60	72	78	66	22
mass(neutron equivalents)	133.751	129.781	131.764	133.748	131.764	132.757	133.747	132.754	133.747	134.737	135.729	136.715
max 2-d length	707	707	707	707	707	707	707	707	707	707	707	1380
bondarenko processes	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko temps	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko groups	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	9618	1351	9643	1294	1355	4663	9665	9684	9685	9687	9689	1353
endf mat of thermal neut data	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	0	0	0	0	0	0	0	0	0	0	0	1353

Table B-2 (continued)

ampx za nuclide id number	56140	58141	59143	60143	60145	60147	61147	61148	61149	61601	62149	62150
alphanumeric nuclide name	BA-140	CE-141	PR-143	ND-143	ND-145	ND-147	PM-147	PM-148	PM-149	PM-148M	SM-149	SM-150
number of data records	32	56	68	85	121	51	67	32	68	33	95	129
date created	08-25-91	08-11-87	08-11-87	10-19-89	10-19-89	10-19-89	06-05-87	10-19-89	10-19-89	10-19-89	08-31-87	10-23-89
weighting type	type B	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C
resolved resonances	0	0	0	19	81	9	15	0	0	3	31	13
temp ind 1-d neut processes	17	21	23	34	40	20	31	17	23	17	31	33
2-d neut processes	3	7	9	15	21	6	12	3	9	3	15	19
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	0	0	0	0	0	0	0	0	0	0	0	0
total 2-d arrays	18	42	54	70	106	36	52	18	54	18	80	114
mass(neutron equivalents)	138.709	139.698	141.683	141.682	143.668	145.654	145.653	146.647	147.639	146.647	147.638	148.629
max 2-d length	707	707	707	707	707	707	707	707	707	707	707	707
bondarenko processes	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko sigma zeros	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko temps	0	0	0	0	0	0	0	0	0	0	0	0
bondarenko groups	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of fast neut data	9693	9725	9745	9764	9766	4768	9783	9784	9786	9785	1319	9809
endf mat of thermal neut data ..	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	0	0	0	0	0	0	0	0	0	0	0	0

ampx za nuclide id number	62151	62152	62153	63000	63151	63152	63153	63154	63155	72000	72174	72176
alphanumeric nuclide name	SM-151	SM-152	SM-153	EU-NAT	EU-151	EU-152	EU-153	EU-154	EU-155	HF-NAT	HF-174	HF-176
number of data records	103	121	104	37	117	81	131	81	91	61	52	52
date created	10-23-89	10-23-89	08-11-87	06-03-93	04-01-93	04-01-93	04-01-93	04-01-93	10-23-89	05-24-91	08-25-91	08-25-91
weighting type	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	poldnt	poldnt
resolved resonances	9	59	0	0	93	85	73	61	9	0	12	24
temp ind 1-d neut processes	37	40	29	19	35	31	38	31	35	23	22	22
2-d neut processes	18	21	15	5	16	12	18	12	16	9	7	7
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	0	0	0	2	11	0	13	0	0	2	0	0
total 2-d arrays	88	106	90	22	87	52	101	52	76	46	37	37
mass(neutron equivalents)	149.623	150.615	151.608	150.655	.000	.000	.000	.000	153.592	176.957	172.446	174.430
max 2-d length	707	707	707	1494	1346	707	1346	707	707	1228	707	707
bondarenko processes	0	0	0	0	6	6	6	6	0	0	0	0
bondarenko sigma zeros	0	0	0	0	5	5	5	5	0	0	0	0
bondarenko temps	0	0	0	0	5	5	5	5	0	0	0	0
bondarenko groups	0	0	0	0	4	4	4	4	0	0	0	0
endf mat of fast neut data	9810	9811	9812	7852	1357	4292	1359	4293	4832	8305	1374	1376
endf mat of thermal neut data ..	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	0	0	0	7852	1357	0	1359	0	0	8305	0	0

Table B-2 (continued)

ampx za nuclide id number	72177	72178	72179	72180	73181	73182	82000	83209	90232	92233	92234	92235
alphanumeric nuclide name	HF-177	HF-178	HF-179	HF-180	TA-181	TA-182	PB	BI-209	TH-232	U-233	U-234	U-235
number of data records	94	52	58	52	112	97	247	74	143	38	38	148
date created	08-25-91	08-25-91	08-25-91	08-25-91	04-01-93	04-01-93	12-04-89	08-25-91	12-11-89	06-05-91	06-05-91	04-01-93
weighting type	poldnt	poldnt	poldnt	poldnt	type B	type B	type B	type B	type C	type C	type C	type C
resolved resonances	101	27	51	32	77	11	0	0	243	0	0	131
temp ind 1-d neut processes	29	22	23	22	30	28	55	28	40	25	25	39
2-d neut processes	14	7	8	7	15	13	40	12	20	5	5	21
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	0	0	0	0	2	0	2	2	3	3	3	4
total 2-d arrays	79	37	43	37	82	68	232	59	113	23	23	120
mass(neutron equivalents)	175.423	176.415	177.409	178.401	.000	.000	205.430	207.185	230.040	231.038	232.029	.000
max 2-d length	707	707	707	707	1235	707	707	707	1380	1570	1380	1482
bondarenko processes	0	0	0	0	6	6	0	0	6	0	0	5
bondarenko sigma zeros	0	0	0	0	4	7	0	0	7	0	0	7
bondarenko temps	0	0	0	0	5	5	0	0	5	0	0	5
bondarenko groups	0	0	0	0	3	4	0	0	2	0	0	5
endf mat of fast neut data	1377	1378	1383	1384	1285	1127	1382	1375	1390	7866	7867	1395
endf mat of thermal neut data ..	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	0	0	0	0	1285	0	1382	1375	1390	7866	7867	1395

ampx za nuclide id number	92236	92237	92238	93237	93238	93239	94238	94239	94240	94241	94242	94243
alphanumeric nuclide name	U-236	U-237	U-238	NP-237	NP-238	NP-239	PU-238	PU-239	PU-240	PU-241	PU-242	PU-243
number of data records	38	53	215	113	32	82	29	162	126	119	167	51
date created	06-05-91	12-04-89	04-01-93	12-11-89	12-12-89	12-12-89	06-05-91	12-12-89	12-11-89	12-12-89	12-11-89	12-11-89
weighting type	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C
resolved resonances	0	29	165	170	96	0	0	129	202	93	69	42
temp ind 1-d neut processes	25	23	51	34	21	31	25	44	37	33	42	24
2-d neut processes	5	5	32	16	2	13	5	23	17	16	24	5
1-d gamma processes	9	9	9	9	9	9	0	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	0	2	2	2	2	2
neut-to-gamma processes	3	3	3	0	0	0	3	4	4	3	3	3
total 2-d arrays	23	23	185	86	17	68	16	132	96	89	137	23
mass(neutron equivalents)	234.022	235.012	.000	235.012	236.006	236.999	236.005	236.999	237.992	238.986	239.979	240.974
max 2-d length	1570	1570	1570	707	707	707	1570	1482	1482	1297	1400	1570
bondarenko processes	0	6	6	5	0	0	0	6	6	6	6	5
bondarenko sigma zeros	0	7	7	7	0	0	0	7	7	7	7	4
bondarenko temps	0	5	5	5	0	0	0	5	5	5	5	5
bondarenko groups	0	3	3	4	0	0	0	4	2	4	2	3
endf mat of fast neut data	7869	8237	1398	1337	8338	2932	7875	1399	1380	2945	1342	8443
endf mat of thermal neut data ..	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	7869	8237	1398	0	0	0	7875	1399	1380	1381	1342	8443

Table B-2 (continued)

alphanumeric nuclide name	AM-241	AM-242	AM-243	AM-242M	CM-242	CM-243	CM-244	CM-245	CM-246	CM-247	CM-248	BK-249
number of data records	161	44	155	129	71	141	71	39	119	53	95	49
date created	12-11-89	12-11-89	12-11-89	12-07-89	12-05-89	12-07-89	12-05-89	12-05-89	12-05-89	12-05-89	12-07-89	12-07-89
weighting type	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C	type C
resolved resonances	67	83	221	8	22	17	39	40	12	36	48	93
temp ind 1-d neut processes	41	19	41	37	26	39	26	28	35	24	31	24
2-d neut processes	23	2	22	18	8	20	8	5	16	5	12	5
1-d gamma processes	9	9	9	9	9	9	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2	2	2	2	2	2	2
neut-to-gamma processes	3	0	3	3	3	3	3	3	3	3	3	0
total 2-d arrays	131	17	125	101	41	113	41	23	89	23	65	20
mass(neutron equivalents)	238.986	239.980	240.973	239.980	239.979	240.973	241.966	242.960	243.953	244.950	245.941	246.935
max 2-d length	1400	707	1176	1608	1400	1400	1400	1570	1570	1570	1570	707
bondarenko processes	6	5	6	5	6	5	6	0	6	6	6	6
bondarenko sigma zeros	7	4	5	3	7	4	7	0	7	7	7	5
bondarenko temps	5	5	5	5	5	5	5	0	5	5	5	5
bondarenko groups	4	3	3	6	3	5	3	0	3	4	2	3
endf mat of fast neut data	1361	8542	1363	1369	8642	1343	1344	1345	1346	8647	8648	8749
endf mat of thermal neut data	0	0	0	0	0	0	0	0	0	0	0	0
endf mat of gamma prod data	1361	0	1363	1369	8642	1343	1344	1345	1346	8647	8648	0

ampx za nuclide id number	98249	98250	98251	98252	98253	99253
alphanumeric nuclide name	CF-249	CF-250	CF-251	CF-252	CF-253	ES-253
number of data records	49	53	53	53	46	42
date created	12-07-89	12-07-89	12-07-89	12-07-89	12-07-89	12-07-89
weighting type	type C	type C	type C	type C	type C	type C
resolved resonances	54	22	22	22	121	29
temp ind 1-d neut processes	24	24	24	24	19	15
2-d neut processes	5	5	5	5	2	2
1-d gamma processes	9	9	9	9	9	9
2-d gamma processes	2	2	2	2	2	2
neut-to-gamma processes	0	3	3	3	0	0
total 2-d arrays	20	23	23	23	17	17
mass(neutron equivalents)	246.935	247.928	248.923	249.916	250.910	250.910
max 2-d length	707	1380	1570	1570	707	707
bondarenko processes	6	6	6	6	6	4
bondarenko sigma zeros	5	7	7	7	5	4
bondarenko temps	5	5	5	5	5	5
bondarenko groups	4	3	3	3	3	3
endf mat of fast neut data	8849	8850	8851	8852	8853	8953
endf mat of thermal neut data	0	0	0	0	0	0
endf mat of gamma prod data	0	8850	8851	8852	0	0

Other general notes:
----

max order of scatter	5	for all 138 nuclides
unresolved resonance points	0	for all 138 nuclides
temp dep 1-d neut processes	0	for all 138 nuclides
neutron wgting option	0	for all 138 nuclides
neutron wgt id	0	for all 138 nuclides
gamma wgting option	0	for all 138 nuclides
power/fission(watt-sec/fis)	0	for all 138 nuclides
energy/capture(watt-sec/cap)	0	for all 138 nuclides
id(41) not used	0	for all 138 nuclides
gamma prod wgt id	0	for all 138 nuclides
id(43) not used	0	for all 138 nuclides
gamma prod wgting option	0	for all 138 nuclides
endf mat of gamma data	0	for all 138 nuclides

Table B-3. Temperature-independent 1-D neutron processes for each nuclide

```
AMPX Nuclide ID   1001  has  15 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   1002  has  16 temperature-independent 1-D processes. These include MT numbers:
     1     2    16    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   1003  has  14 temperature-independent 1-D processes. These include MT numbers:
     1     2    16    27   101   251   252   253  1007  1099  3002  3099  9002  9901

AMPX Nuclide ID   1401  has  15 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   1402  has  16 temperature-independent 1-D processes. These include MT numbers:
     1     2    16    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   1501  has  15 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   1801  has  15 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   2003  has  15 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   103   104   251   252   253  1007  1099  3002  3099  9002  9901

AMPX Nuclide ID   2004  has  13 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   251   252   253  1007  1099  3002  3099  9002  9901

AMPX Nuclide ID   3006  has  50 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    24    27    51    52    53    54    55    56    57    58    59    60    61
    62    63    64    65    66    67    68    69    70    71    72    73    74    75    76    77
    78    79    80    81   101   102   103   105   251   252   253  1007  1099  3002  3099  3102
  9002  9901

AMPX Nuclide ID   3007  has  52 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    24    25    27    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    67    68    69    70    71    72    73    74    75
    76    77    78    79    80    81    82   101   102   104   251   252   253  1007  1099  3002
  3099  3102  9002  9901

AMPX Nuclide ID   4009  has  29 temperature-independent 1-D processes. These include MT numbers:
     1     2     6     7     8     9    27    46    47    48    49   101   102   103   104   105
   107   251   252   253   740   741  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   5010  has  61 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    61    62
    63    64    65    66    67    68    69    70    71    72    73    74    75    76    77    78
    79    80    81    82    83    84    85   101   102   103   104   107   113   251   252   253
   700   701   702   703   780   781  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID   5011  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    91   101   102   103   105   107   251   252
   253  1007  1099  3002  3099  3102  9002  9901
```

Table B-3 (continued)

AMPX Nuclide ID 6012 has 42 temperature-independent 1-D processes. These include MT numbers:

1	2	3	4	27	51	52	53	54	55	56	57	58	59	60	61
62	63	64	65	66	67	68	91	101	102	103	104	107	203	204	207
251	252	253	1007	1099	3002	3099	3102	9002	9901						

AMPX Nuclide ID 6312 has 42 temperature-independent 1-D processes. These include MT numbers:

1	2	3	4	27	51	52	53	54	55	56	57	58	59	60	61
62	63	64	65	66	67	68	91	101	102	103	104	107	203	204	207
251	252	253	1007	1099	3002	3099	3102	9002	9901						

AMPX Nuclide ID 7014 has 76 temperature-independent 1-D processes. These include MT numbers:

1	2	4	16	27	51	52	53	54	55	56	57	58	59	60	61
62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	101	102	103	104	105	107	108	251	252	253	700
701	702	703	704	720	721	722	723	740	741	780	781	782	783	784	785
786	787	788	789	790	1007	1099	3002	3099	3102	9002	9901				

AMPX Nuclide ID 7015 has 51 temperature-independent 1-D processes. These include MT numbers:

1	2	4	16	22	27	28	51	52	53	54	55	56	57	91	101
102	103	104	105	107	251	252	253	700	701	718	719	720	721	722	738
740	741	742	758	780	781	782	783	784	785	798	799	1007	1099	3002	3099
3102	9002	9901													

AMPX Nuclide ID 8016 has 62 temperature-independent 1-D processes. These include MT numbers:

1	2	4	27	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
79	80	81	82	83	84	85	86	87	88	89	101	102	103	104	107
251	252	253	780	781	782	783	1007	1099	3002	3099	3102	9002	9901		

AMPX Nuclide ID 9019 has 46 temperature-independent 1-D processes. These include MT numbers:

1	2	3	4	16	22	27	28	51	52	53	54	55	56	57	58
59	60	61	62	63	64	65	66	67	68	69	70	71	91	101	102
103	104	105	107	251	252	253	1007	1099	3002	3099	3102	9002	9901		

AMPX Nuclide ID 11023 has 39 temperature-independent 1-D processes. These include MT numbers:

1	2	3	4	16	27	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	91	101	102	103	107	251	252	253
1007	1099	3002	3099	3102	9002	9901									

AMPX Nuclide ID 12000 has 63 temperature-independent 1-D processes. These include MT numbers:

1	2	3	4	16	22	27	28	51	52	53	54	55	56	57	58
59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	101	102	103	107	251	252	253	1007	1099	3002	3099	3102	9002	9901	

AMPX Nuclide ID 13027 has 61 temperature-independent 1-D processes. These include MT numbers:

1	2	4	16	27	51	52	53	54	55	56	57	58	59	60	61
62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88	89	90	101	102	103
104	105	107	251	252	253	1007	1099	3002	3099	3102	9002	9901			

Table B-3 (continued)

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AMPX Nuclide ID  13327  has  61 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    56    57    58    59    60    61
    62    63    64    65    66    67    68    69    70    71    72    73    74    75    76    77
    78    79    80    81    82    83    84    85    86    87    88    89    90   101   102   103
   104   105   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  14000  has  77 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    68    69    70    71    72    91   101
   102   103   104   107   251   252   253   700   701   702   703   704   705   706   707   708
   709   710   711   712   713   714   718   719   780   781   782   783   784   785   786   787
   788   789   790   791   798   799  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  14300  has  77 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    68    69    70    71    72    91   101
   102   103   104   107   251   252   253   700   701   702   703   704   705   706   707   708
   709   710   711   712   713   714   718   719   780   781   782   783   784   785   786   787
   788   789   790   791   798   799  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  15031  has  21 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    28    91   101   102   103   107   251   252   253  1007  1099
  3002  3099  3102  9002  9901

AMPX Nuclide ID  16000  has  69 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    22    27    28    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    67    68    69    70    71    72    73    74    75
    76    77    78    79    80    81    82    83    84    85    86    87    88    89    90    91
   101   102   103   104   105   107   111   203   204   205   207   251   252   253  1007  1099
  3002  3099  3102  9002  9901

AMPX Nuclide ID  16032  has  22 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    28    91   101   102   103   105   107   251   252   253  1007
  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  19000  has  39 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    22    27    28    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    67    91   101   102   103   107   251   252   253
  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  20000  has  48 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    68    69    91   101   102   103   104
   105   106   107   108   111   112   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  22000  has  42 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    91   101   102   103   104   105   106   107   111   112   203   207
   251   252   253  1007  1099  3002  3099  3102  9002  9901
```

Table B-3 (continued)

```
AMPX Nuclide ID  23000  has  33 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    22    27    28    51    52    53    54    55    56    57    91   101
   102   103   104   105   107   203   207   251   252   253  1007  1099  3002  3099  3102  9002
  9901

AMPX Nuclide ID  24000  has  72 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    17    22    27    28    51    52    53    54    55    56    57
    58    59    60    61    62    63    64    65    66    67    68    69    70    71    72    73
    74    75    76    77    78    79    80    81    82    83    84    85    86    87    88    89
    90    91   101   102   103   104   105   106   107   203   204   205   206   207   251   252
   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  25055  has  37 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    91   101   102   103   104   106   107   251   252   253  1007  1099
  3002  3099  3102  9002  9901

AMPX Nuclide ID  26000  has  66 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    68    69    70    71    72    73    74
    75    76    77    78    79    80    81    82    83    84    85    86    87    88    89    90
    91   101   102   103   104   105   106   107   251   252   253  1007  1099  3002  3099  3102
  9002  9901

AMPX Nuclide ID  27059  has  36 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    22    27    28    51    52    53    54    55    56    57    58    59
    60    61    91   101   102   103   104   105   106   107   251   252   253  1007  1099  3002
  3099  3102  9002  9901

AMPX Nuclide ID  28000  has  53 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    22    27    28    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    67    68    69    70    71    72    73    74    75
    76    91   101   102   103   104   107   111   203   204   207   251   252   253  1007  1099
  3002  3099  3102  9002  9901

AMPX Nuclide ID  29000  has  37 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    17    22    27    28    51    52    53    54    55    56    57
    58    59    60    61    91   101   102   103   104   106   107   251   252   253  1007  1099
  3002  3099  3102  9002  9901

AMPX Nuclide ID  36082  has  33 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    27    51    52    53    54    55    56    57    58    59    91
   101   102   103   104   105   106   107   251   252   253  1007  1099  3002  3099  3102  9002
  9901

AMPX Nuclide ID  36083  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    17    27    51    52    53    54    55    56    91   101   102
   103   104   105   106   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  40000  has  28 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    51    52    53    54    55    56    57    58    91   101
   102   103   251   252   253  1007  1099  3002  3099  3102  9002  9901
```

Table B-3 (continued)

```
AMPX Nuclide ID  40090  has  25 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    91   101   102   103   107   251
   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  40091  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    56    57    58    59    60    61
    91   101   102   103   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  40092  has  26 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    56    91   101   102   103   107
   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  40093  has  27 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    91   101
   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  40094  has  28 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    56    57    58    91   101   102
   103   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  40096  has  23 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    91   101   102   107   251   252   253
  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  42000  has  19 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    91   101   102   251   252   253  1007  1099  3002  3099
  3102  9002  9901

AMPX Nuclide ID  42097  has  36 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    61    62
    63    64    65    66    67    68    69    91   101   102   251   252   253  1007  1099  3002
  3099  3102  9002  9901

AMPX Nuclide ID  43099  has  29 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    56    57    58    59    60    61
    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  44101  has  36 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    61    62
    63    64    65    66    67    68    69    91   101   102   251   252   253  1007  1099  3002
  3099  3102  9002  9901

AMPX Nuclide ID  44103  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    61    62
    63    64    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  45103  has  32 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    56    57    58    59    60    61
    62    63    64    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901
```

Table B-3 (continued)

```
AMPX Nuclide ID  45105  has  20 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    91   101   102   251   252   253  1007  1099  3002
  3099  3102  9002  9901

AMPX Nuclide ID  47107  has  29 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    51    52    53    54    55    56    91   101   102   103
   104   105   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  47109  has  26 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    51    52    53    54    55    91   101   102   103   107
   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  48000  has  19 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    91   101   102   251   252   253  1007  1099  3002  3099
  3102  9002  9901

AMPX Nuclide ID  48113  has  23 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    91   101   102   103   107   251   252   253
  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  50000  has  20 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    91   101   102   251   252   253   285  1007  1099  3002
  3099  3102  9002  9901

AMPX Nuclide ID  53135  has  17 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002
  9901

AMPX Nuclide ID  54131  has  29 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    51    52    53    54    55    56    91   101   102   103
   104   105   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  54133  has  18 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    91   101   102   251   252   253  1007  1099  3002  3099  3102
  9002  9901

AMPX Nuclide ID  54135  has  18 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    91   101   102   251   252   253  1007  1099  3002  3099  3102
  9002  9901

AMPX Nuclide ID  55133  has  25 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    27    51    52    53    54    55    91   101   102   103   107   251
   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  55134  has  22 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    91   101   102   251   252   253  1007
  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  55135  has  20 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    91   101   102   251   252   253  1007  1099  3002
  3099  3102  9002  9901
```

Table B-3 (continued)

AMPX Nuclide ID 56134 has 24 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 54 55 56 57 91 101 102 251 252
253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 56135 has 26 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 54 55 56 57 58 59 91 101 102
251 252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 56136 has 27 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 54 55 56 57 58 59 60 91 101
102 251 252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 56137 has 25 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 54 55 56 57 58 91 101 102 251
252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 56138 has 21 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 27 91 101 102 103 107 251 252 253 1007 1099
3002 3099 3102 9002 9901

AMPX Nuclide ID 56140 has 17 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 91 101 102 251 252 253 1007 1099 3002 3099 3102 9002
9901

AMPX Nuclide ID 58141 has 21 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 54 91 101 102 251 252 253 1007 1099
3002 3099 3102 9002 9901

AMPX Nuclide ID 59143 has 23 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 54 55 56 91 101 102 251 252 253
1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 60143 has 34 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 22 27 28 51 52 53 54 55 56 57 58
91 101 102 103 104 105 106 107 251 252 253 1007 1099 3002 3099 3102
9002 9901

AMPX Nuclide ID 60145 has 40 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 22 27 28 51 52 53 54 55 56 57 58
59 60 61 62 63 64 91 101 102 103 104 105 106 107 251 252
253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 60147 has 20 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 51 52 53 91 101 102 251 252 253 1007 1099 3002
3099 3102 9002 9901

AMPX Nuclide ID 61147 has 31 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 22 27 28 51 52 53 54 55 91 101 102
103 104 105 106 107 251 252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 61148 has 17 temperature-independent 1-D processes. These include MT numbers:
1 2 4 27 91 101 102 251 252 253 1007 1099 3002 3099 3102 9002
9901

Table B-3 (continued)

```
AMPX Nuclide ID  61149  has  23 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    91   101   102   251   252   253
  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  61601  has  17 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002
  9901

AMPX Nuclide ID  62149  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    51    52    53    54    55    56    57    58    59    60
    91   101   102   103   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  62150  has  33 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    61    62
    63    64    65    66    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002
  9901

AMPX Nuclide ID  62151  has  37 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    91   101   102   103   104   105   106   107   251   252   253  1007  1099
  3002  3099  3102  9002  9901

AMPX Nuclide ID  62152  has  40 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    91   101   102   103   104   105   106   107   251   252
   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  62153  has  29 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    27    51    52    53    54    55    56    57    58    59    60    61    62
    91   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  63000  has  19 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    27    91   101   102   251   252   253  1007  1099  3002  3099
  3102  9002  9901

AMPX Nuclide ID  63151  has  35 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    56    57    58
    59    91   101   102   103   104   105   106   107   251   252   253  1007  1099  3002  3099
  3102  9002  9901

AMPX Nuclide ID  63152  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    91   101   102
   103   104   105   106   107   251   252   253  1007  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  63153  has  38 temperature-independent 1-D processes. These include MT numbers:
     1     2     3     4    16    17    22    27    28    51    52    53    54    55    56    57
    58    59    60    61    91   101   102   103   104   105   106   107   251   252   253  1007
  1099  3002  3099  3102  9002  9901

AMPX Nuclide ID  63154  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    22    27    28    51    52    53    54    55    91   101   102
   103   104   105   106   107   251   252   253  1007  1099  3002  3099  3102  9002  9901
```

Table B-3 (continued)

AMPX Nuclide ID 63155 has 35 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 22 27 28 51 52 53 54 55 56 57 58
59 91 101 102 103 104 105 106 107 251 252 253 1007 1099 3002 3099
3102 9002 9901

AMPX Nuclide ID 72000 has 23 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 27 51 52 53 54 91 101 102 251 252 253
1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 72174 has 22 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 27 51 52 53 91 101 102 103 251 252 253 1007
1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 72176 has 22 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 27 51 52 53 91 101 102 103 251 252 253 1007
1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 72177 has 29 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 27 51 52 53 54 55 56 57 58 59 60 91
101 102 103 251 252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 72178 has 22 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 27 51 52 53 91 101 102 103 251 252 253 1007
1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 72179 has 23 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 27 51 52 53 54 91 101 102 103 251 252 253
1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 72180 has 22 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 27 51 52 53 91 101 102 103 251 252 253 1007
1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 73181 has 30 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 27 51 52 53 54 55 56 57 58 59 60
91 101 102 103 251 252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 73182 has 28 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 27 51 52 53 54 55 56 57 58 91 101
102 107 251 252 253 1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 82000 has 55 temperature-independent 1-D processes. These include MT numbers:
1 2 3 4 16 17 27 51 52 53 54 55 56 57 58 59
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 91 101 102 251 252 253
1007 1099 3002 3099 3102 9002 9901

AMPX Nuclide ID 83209 has 28 temperature-independent 1-D processes. These include MT numbers:
1 2 4 16 17 22 27 51 52 53 54 55 56 91 101 102
103 107 251 252 253 1007 1099 3002 3099 3102 9002 9901

Table B-3 (continued)

```
AMPX Nuclide ID  90232  has  40 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    91   101   102   251   252   253   452   455   456  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  92233  has  25 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    91   101   102   251   252   253   452   455   456
  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  92234  has  25 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    91   101   102   251   252   253   452   455   456
  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  92235  has  39 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    91   101   102   251   252   253   452  1007  1018
  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  92236  has  25 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    91   101   102   251   252   253   452   455   456
  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  92237  has  23 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    91   101   102   251   252   253   452  1007  1018
  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  92238  has  51 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    38    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    68    69    70    71    72    73    74
    75    76    77    91   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099
  3102  9002  9901

AMPX Nuclide ID  93237  has  34 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    59
    60    61    91   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099  3102
  9002  9901

AMPX Nuclide ID  93238  has  21 temperature-independent 1-D processes. These include MT numbers:
     1     2    18    27   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099
  3102  9002  9452  9452  9901

AMPX Nuclide ID  93239  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    91
   101   102   251   452  1007  1018  1099  3002  3018  3099  3102  9002  9452  9452  9901

AMPX Nuclide ID  94238  has  25 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    91   101   102   251   252   253   452   455   456
  1007  1018  1099  3002  3018  3099  3102  9002  9901
```

Table B-3 (continued)

```
AMPX Nuclide ID  94239  has  44 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    68    91   101   102   251   252   253
   452   455   456  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  94240  has  37 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    59
    60    61    62    91   101   102   251   252   253   452   455   456  1007  1018  1099  3002
  3018  3099  3102  9002  9901

AMPX Nuclide ID  94241  has  33 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    58
    59    60    61    91   101   102   251   452  1007  1018  1099  3002  3018  3099  3102  9002
  9901

AMPX Nuclide ID  94242  has  42 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    67    68    69    91   101   102   251   252   253
   452  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  94243  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  95241  has  41 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    54    55    56    57    58    59
    60    61    62    63    64    65    66    67    68    91   101   102   251   252   253   452
  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  95242  has  19 temperature-independent 1-D processes. These include MT numbers:
     1     2    18    27   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099
  3102  9002  9901

AMPX Nuclide ID  95243  has  41 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    66    67    91   101   102   251   252   253   452
  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  95601  has  37 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    58
    59    60    61    62    63    91   101   102   251   252   253   452  1007  1018  1099  3002
  3018  3099  3102  9002  9901

AMPX Nuclide ID  96242  has  26 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    91   101   102   251   252   253
   452  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  96243  has  39 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    58
    59    60    61    62    63    64    65    91   101   102   251   252   253   452  1007  1018
  1099  3002  3018  3099  3102  9002  9901
```

Table B-3 (continued)

```
AMPX Nuclide ID  96244  has  26 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    51    52    53    91   101   102   251   252   253
   452  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  96245  has  28 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452   455
   456  1007  1018  1099  3002  3018  3099  3102  9002  9452  9452  9901

AMPX Nuclide ID  96246  has  35 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    58
    59    60    61    91   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099
  3102  9002  9901

AMPX Nuclide ID  96247  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  96248  has  31 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    51    52    53    54    55    56    57    91
   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  97249  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  98249  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  98250  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  98251  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  98252  has  24 temperature-independent 1-D processes. These include MT numbers:
     1     2     4    16    17    18    27    37    91   101   102   251   252   253   452  1007
  1018  1099  3002  3018  3099  3102  9002  9901

AMPX Nuclide ID  98253  has  19 temperature-independent 1-D processes. These include MT numbers:
     1     2    18    27   101   102   251   252   253   452  1007  1018  1099  3002  3018  3099
  3102  9002  9901

AMPX Nuclide ID  99253  has  15 temperature-independent 1-D processes. These include MT numbers:
     1     2    27   101   102   251   252   253  1007  1099  3002  3099  3102  9002  9901
```

Note: The RADE output from which the above data was taken shows nuclides 1003 and 2004 as having neutron disappearance data (MT=101) and neutron absorption data (MT=27), where MT(27)=MT(101)+MT(18). While these data flags do exist, all the multigroup data in the library for these two processes are zero for both of these nuclides. Likewise, the RADE output shows nuclide 3007 as having MT=82 [i.e., inelastic (n,n') data for the 32nd excited state] and nuclide 5010 as having MT=85 [i.e. inelastic (n,n') data for the 35th excited state]. While these data flags do exist, all the multigroup data in the library for these two processes are zero for these two nuclides.

APPENDIX C

ANSL-V LIBRARY: AMPX INPUT DATA FILES

Table C-1. XLACS input file

```
//RQWEUC   JOB (56465),'6011 R Q WRIGHT',
// TIME=(15,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC POOLSCR
  X.RQW56465.XLACS.EUC
// EXEC AMPX77,REGION.GO=2000K
//GO.FT07F001 DD SYSOUT=B,SPACE=(3520,(30),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=3520)
//GO.FT11F001 DD DSN=X.RQW00000.ANY.LENDL84.F01,DISP=SHR,
//  LABEL=(,,,IN),
//  DCB=(RECFM=FB,LRECL=80,BLKSIZE=8960,BUFL=8960)
//GO.FT23F001 DD UNIT=DISK,
// DISP=(NEW,CATLG),SPACE=(TRK,(10,5),RLSE),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136),
// DSN=X.RQW56465.XLACS.EUC
//GO.FT46F001 DD DSN=NMG.XLACS7.WTFCNS,DISP=SHR
#XLACS
ANSL-5 CROSS SECTION LIBRARY
XLACS77 MODULE
06-03-93

EU
1$$ 1 99 29
2$$ 100 20000 E T
7** 4L2+7 4L6.4340+6 4L3.0+6 4L1.85+6 4L1.4+6
4L9.0+5 4L4.0+5 4L1.0+5 4L1.7+4 4L3.0+3 4L550
4L100 4L30 4L10 4L3
1.77 1.3 1.0 0.765 0.625 0.479 0.397 0.330
0.270 0.215 0.162 0.104 0.05 0.03 0.01 0.00445
3.25-3 2.6-3 2.15-3 1.8-3 1.45-3 1.15-3 8.5-4
5.5-4 1.0-5 T
EU          06-03-93 WEIGHTING TYPE C
10$$  63000  7852   0
11$$ 6 0 0 111
12$$ 5 3 E
13$$ 11 2 A5  0
15$$  3
17$$ 10 10 10 E
T
22**  296. 500. 900.
T
#RADE
1$$ 23 E  T
```

Table C-2. SMUG input file

```
//RQWSMUG4 JOB (56465),'SAVE6137,547 BL6011',TIME=(5,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//*MAIN CLASS=FIVE
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K
//FT46F001 DD DISP=(,PASS&DA&BLKS,(40,20)),DSN=&&FT46
//GO.FT60F001 DD DSN=X.RQW56465.ANSLV.SMUG4,DISP=(NEW,CATLG),
// UNIT=DISK,SPACE=(TRK,(50,10)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//GO.SYSIN DD *
#SMUG
-1$$ 50000
0$$ 60 14 15
1$$ 44 24 5
2$$ 6 1 4 E T
6$$ 4 5
7** 1.0E+3 1.0E-4 1.0E+5 1.0 1.0E+7 1.0E-2
   3.0E+7 1.0E-4
 T
10$$ 76 5 40 0 -1 T
10$$ 77 5 40 0 -1 T
10$$ 78 5 40 0 -1 T
10$$ 79 5 40 0 -1 T
10$$ 80 5 40 0 -1 T
10$$ 81 5 40 0 -1 T
10$$ 82 5 40 0 -1 T
10$$ 83 5 40 0 -1 T
10$$ 84 5 40 0 -1 T
10$$ 85 5 40 0 -1 T
10$$ 86 5 40 0 -1 T
10$$ 87 5 40 0 -1 T
10$$ 88 5 40 0 -1 T
10$$ 89 5 40 0 -1 T
10$$ 90 5 40 0 -1 T
10$$ 91 5 40 0 -1 T
10$$ 92 5 40 0 -1 T
10$$ 93 5 40 0 -1 T
10$$ 94 5 40 0 -1 T
10$$ 95 5 40 0 -1 T
10$$ 96 5 40 0 -1 T
10$$ 97 5 40 0 -1 T
10$$ 98 5 40 0 -1 T
10$$ 99 5 40 0 -1 T
//
```

Table C-3. LAPHNGAS input file

```
//RQWLAPH3 JOB (56465),'SAVE6137,547 BL6011',TIME=(15,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K,TIME.GO=15
//GO.FT15F001 DD UNIT=SYSDA,SPACE=(6136,(2000,50)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//GO.FT24F001 DD DSN=X.RQW56465.LAPHNGAS.RUN11,DISP=(NEW,CATLG),
// UNIT=DISK,SPACE=(TRK,(10,2)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//FT46F001 DD DISP=(,PASS&DA&BLKS,(40,20)),DSN=&&FT46
//GO.FT61F001 DD DSN=X.RQW35918.ENDFB5.B01TO31,DISP=SHR,
// LABEL=(,,,IN)
//GO.FT62F001 DD DSN=X.RQW35918.ENDFB5.B90TO99,DISP=SHR,
// LABEL=(,,,IN)
//GO.FT63F001 DD DSN=X.RQW00000.ANY.LENDL84.F01,DISP=SHR,
// LABEL=(,,,IN)
//GO.SYSIN DD *
#LAPHNGAS
 LAPHNGAS INPUT FOR CASE #11, R. Q. WRIGHT, JUNE-01-1993
1$$ 4 99 44 3   T
7**
   2.0000E+07 1.5941E+07 1.2706E+07 1.0127E+07
   8.0722E+06 6.4340E+06 5.5234E+06 4.7417E+06
   4.0707E+06 3.4946E+06 3.0000E+06 2.7235E+06
   2.4725E+06 2.2447E+06 2.0378E+06 1.8500E+06
   1.7497E+06 1.6548E+06 1.5651E+06 1.4803E+06
   1.4000E+06 1.2816E+06 1.1732E+06 1.0740E+06
   9.8315E+05 9.0000E+05 7.6525E+05 6.5068E+05
   5.5326E+05 4.7043E+05 4.0000E+05 3.0314E+05
   2.2974E+05 1.7411E+05 1.3195E+05 1.0000E+05
   7.0160E+04 4.9224E+04 3.4536E+04 2.4230E+04
   1.7000E+04 1.2017E+04 8.4941E+03 6.0042E+03
   4.2441E+03 3.0000E+03 2.1368E+03 1.5220E+03
   1.0841E+03 7.7217E+02 5.5000E+02 3.9110E+02
   2.7811E+02 1.9776E+02 1.4063E+02 1.0000E+02
   7.8600E+01 6.1780E+01 4.8559E+01 3.8168E+01
   3.0000E+01 2.4082E+01 1.9332E+01 1.5518E+01
   1.2457E+01 1.0000E+01 7.8600E+00 6.1780E+00
   4.8559E+00 3.8168E+00 3.00000+00 2.6996E+00
   2.4292E+00 2.1859E+00 1.9670E+00 1.7700E+00
   1.3000E+00 1.0000E+00 7.6500E-01 6.2500E-01
   4.7900E-01 3.9700E-01 3.3000E-01 2.7000E-01
   2.1500E-01 1.6200E-01 1.0400E-01 5.0000E-02
   3.0000E-02 1.0000E-02 4.4500E-03 3.2500E-03
   2.6000E-03 2.1500E-03 1.8000E-03 1.4500E-03
```

Table C-3 (continued)

```
   1.1500E-03  8.5000E-04  5.5000E-04  1.0000E-05
    T
14$$  8850  5  62  E   T
14$$  8851  5  62  E   T
14$$  8852  5  62  E   T
14$$  7850  5  63  2   E   T
//
```

Table C-4. UNITAB input file

```
//RQWUTAB7 JOB (56465),'6011 R Q WRIGHT',
// MSGCLASS=A,NOTIFY=RQW,TIME=(10,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K
//GO.FT06F001 DD SYSOUT=Q,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//GO.FT08F001 DD SPACE=(CYL,(50,5))
//GO.FT09F001 DD SPACE=(CYL,(50,5))
//GO.FT61F001 DD DSN=X.RQW56465.ANSLV.SMUG,DISP=SHR,
// LABEL=(,,,IN)
//GO.FT62F001 DD DSN=X.RQW56465.ANSLV.LIB99G,DISP=SHR,
// LABEL=(,,,IN)
//GO.FT70F001 DD DSN=X.RQW56465.N99G44.RUN7,DISP=(OLD,KEEP),
// UNIT=DISK,
// SPACE=(TRK,(100,20)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136)
#UNITAB
'MASTER ID--------LOG NUMBER-------IDENTIFIER ON LOG----DATA TYPE
'                        1111,NEUT--2222,GP--3333,GAMMA
-1$$ 200000
0$$ 70 18 9 8  61 62  F0
'1$$ (# SETS TO MAKE) (# COMMANDS) 6$$ 2000 880  T
1$$ 23 46                   6$$ 12000 880 T
2$$
93237   62   93237   1111
93237   61   93      3333

36082   62   36082   1111
36082   61   36      3333

36083   62   36083   1111
36083   61   36      3333

42097   62   42097   1111
42097   61   42      3333

44101   62   44101   1111
44101   61   44      3333

44103   62   44103   1111
44103   61   44      3333

45103   62   45103   1111
45103   61   45      3333
```

Table C-4 (continued)

45105	62	45105	1111
45105	61	45	3333
53135	62	53135	1111
53135	61	53	3333
54131	62	54131	1111
54131	61	54	3333
54133	62	54133	1111
54133	61	54	3333
54135	62	54135	1111
54135	61	54	3333
55133	62	55133	1111
55133	61	55	3333
55134	62	55134	1111
55134	61	55	3333
55135	62	55135	1111
55135	61	55	3333
60145	62	60145	1111
60145	61	60	3333
60147	62	60147	1111
60147	61	60	3333
61148	62	61148	1111
61148	61	61	3333
61601	62	61601	1111
61601	61	61	3333
61149	62	61149	1111
61149	61	61	3333
62151	62	62151	1111
62151	61	62	3333
62152	62	62152	1111
62152	61	62	3333

Table C-4 (continued)

```
63155    62    63155    1111
63155    61    63       3333
T

//
```

Table C-5. MALOCS input file

```
//RQWMALX1 JOB (56465),'6011 R Q WRIGHT',
// MSGCLASS=A,NOTIFY=RQW,TIME=(5,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//*MAIN CLASS=FIVE
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K
//GO.FT60F001 DD UNIT=DISK,DISP=(NEW,CATLG),
//  SPACE=(TRK,(200,20)),
//  DSN=X.RQW56465.MALOCS.N39G44,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//GO.FT61F001 DD DSN=X.RQW56465.ANSLV.N99G44,DISP=SHR,
// LABEL=(,,,IN)
#MALOCS     COLLAPSE 99/44 GROUP LIB. TO 39/44
1$$ 99 39 44 44 1 1 2$$ 61 60  3$$ 0 0 1 1 E T
4$$ 5R1 5R2 5R3 5R4 5R5 5R6 5R7 5R8 5R9 5R10 5R11 5R12 5R13 5R14 5R15
   22I 16 39
6$$  42I 1  44   T
/*
//
```

Table C-6. COMET input file

```
//RQWCOMET JOB (56465),'6011 R Q WRIGHT',
// MSGCLASS=A,NOTIFY=RQW,TIME=(10,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K
//GO.FT18F001 DD SPACE=(6136,(4000,50))
//GO.FT60F001 DD UNIT=DISK,DISP=(OLD,KEEP),
//  SPACE=(TRK,(420,20)),
//  DSN=X.RQW56465.COMET.N99G44,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//GO.FT61F001 DD DSN=X.RQW56465.ANSLV.N99G44,DISP=SHR,
// LABEL=(,,,IN)
#COMET    RUN COMET FOR 99/44 GROUP LIB.
0$$ 61 60 18
1$$ 0 100000
2$$ 2 4 16 17 22 23 24 25 28 37 F0
6$$ 1000 1000  T
/*
//
```

Table C-7. FRESH input file

```
//RQWFRESH JOB (56465),'6011 R Q WRIGHT',
// MSGCLASS=A,NOTIFY=RQW,TIME=(5,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//*MAIN CLASS=FIVE
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K
//GO.FT18F001 DD SPACE=(6136,(4000,50))
//GO.FT60F001 DD UNIT=DISK,DISP=(OLD,KEEP),
//  SPACE=(TRK,(420,20)),
//  DSN=X.RQW56465.FRESH.N99G44,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//GO.FT61F001 DD DSN=X.RQW56465.COMET.N99G44,DISP=SHR,
//  LABEL=(,,,IN)
#FRESH    RUN FRESH FOR 99/44 GROUP LIB.
0$$ 60 E
1$$ 1 T
2$$ 61 138  E  T
6$$ 19000 1 7014 0 8016 0 1801 0 1501 0 1401 0 1001 0 1002 0
     1402 0 4009 0 5010 0 7015 0 11023 1 13027 0 3006 0 14000 0
    14300 0 22000 0 23000 0 24000 0 25055 1 26000 1 27059 0
    28000 0 29000 1 3007 0 73181 1 42000 1 63151 0 63153 0
    82000 1 15031 0 20000 0 16000 0 94242 1 94240 1 94241 1
    90232 1 92235 0 92238 1 94239 1 56138 0 83209 0 5011 0
    40000 0 47107 0 47109 0 48000 0 92233 0 92234 0 92236 0
    94238 0 72000 0 6012 0 6312 0 12000 0 13327 0 63000 0
     9019 0 16032 0 95241 1 95601 1 92237 1 94243 1 96244 1
    96245 1 96246 1 95243 1 96242 1 96247 1 96248 1 98250 1
    98251 1 98252 1 50000 1 96243 1 36082 1 36083 1 42097 1
    44101 1 44103 0 45103 1 45105 0 53135 0 54131 1 54133 0
    54135 1 55133 1 55134 1 55135 1 60145 1 60147 0 61148 1
    61601 1 61149 1 62151 1 62152 1 63155 1 93237 1 1003 0
     2003 0 2004 0 43099 1 48113 0 58141 0 59143 0 60143 1
    61147 0 62150 1 62149 0 62153 0 63152 0 63154 0 93238 1
    93239 0 95242 1 97249 1 98249 1 98253 1 99253 1 40090 0
    40091 1 40092 1 40093 0 40094 1 40096 1 56134 0 56135 0
    56136 0 56137 0 56140 0 72174 0 72176 0 72177 0 72178 0
    72179 0 72180 0 73182 1  T
/*
//
```

Table C-8. PERFUME input file

```
//RQWPERFU JOB (56465),'6011 R Q WRIGHT',
// MSGCLASS=A,NOTIFY=RQW,TIME=(10,0)
//*FORMAT PR,DDNAME=,DEST=RM055
//PROCLIB DD DSN=NMG.PROCLIB,DISP=SHR
// EXEC AMPX77,REGION.GO=2000K
//GO.FT60F001 DD UNIT=DISK,DISP=(OLD,KEEP),
//  SPACE=(TRK,(420,20)),
//  DSN=X.RQW56465.PERFUME.N99G44,
//  DCB=(RECFM=VBS,LRECL=X,BLKSIZE=6136,BUFL=6136)
//GO.FT61F001 DD DSN=X.RQW56465.FRESH.N99G44,DISP=SHR,
// LABEL=(,,,IN)
//GO.FT66F001 DD DUMMY
#PERFUME     RUN PERFUME FOR 99/44 GROUP LIB.
0$$  61  60  66
1$$  0.01    T
/*
//
```

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