Covariances for ENDF/B-VII

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Objective

Determine which covariance files will be included in ENDF/B-VII

Acknowledgment: Valuable assistance in carrying out this review project has been provided by the staff of the NNDC

Covariance Sources

- Migration of existing covariance information from ENDF/B-VI.8

- New covariance files

  --- Corresponding to new evaluations not found in ENDF/B-VI.8 or to recent modifications of older evaluations

Criteria for Inclusion

- Insure that the quality of included numerical covariance information will be consistent with CSEWG's object to produce an ENDF/B-VII that is superior overall to the earlier versions of ENDF/B

- Insure that the included covariance files will ultimately be usable for applications

  --- e.g., they can be processed by codes such as ERRORJ into formats that are compatible with all the requirements for applied user libraries

Quality Factors

- Errors and correlations adequately represented for indicated evaluations (in detail and accuracy)
- Covariances produced from evaluations based on statistical analysis of uncertainties in the available expt'l data and (where applicable) properly combined with covariances propagated from uncertainties in nuclear model parameters
- Avoidance of ad hoc estimates of errors and correlations uncoupled from evaluation process
- Adherence to the simplest possible allowed covariance formats consistent with the need to adequately represent the uncertainty information

Review Procedure

- Preliminary Review (January 2006)

  --- Based on an examination of ENDF/B-VII.b1 content

  --- Triage was guided by a subjective consideration of eval'n methodology, file detail, correlations, formats, etc.

  Report: http://www.nndc.bnl.gov/csewg_members/

- Final Review (June 2006)

  --- Based on ENDF/B-VII.b2 content plus a check of ENDF/B-VI.8 to insure that nothing gets "lost"

  --- Visual examination of covariance plots generated by ERRORJ and comparison of evaluations with expt'l data

  --- Results are subjected to a "Reality Check" (i.e., are the indicated errors and correlations reasonable?)

Report: This talk plus a document to be posted on the Web

Status Overview

MF	Description	ENDF/B-VI.8	ENDF/B-VII
31	Nu-bar	9 (2)	3 [1]
32	Resonance Parameters	4 (1)	10 [9]
33	Cross Sections	739 (26)	147 [121]
34	Angular Distributions	0	0
35	Secondary Particles	1 (1)	1 [0]
40	Radioactive Nuclei	2 (2)	2 [0]
	Totals	755 (32)	163 [131]

(…) Candidate ENDF/B-VI.8 files to be migrated to ENDF/B-VII

[…] Candidate new files to be introduced in ENDF/B-VII

• There will be a dramatic decrease in the number of covariances files in ENDF/B-VII relative to ENDF/B-VI.8 as a consequence of imposing stringent quality criteria

Covariance File Inventory - 1

MF = 31

MAT	Isotope	Candidate Covariance Files for ENDF/B-VII by MT Number
9040	Th-232	452
9228	U-235	452,456

MF = 32

MAT	Isotope	Candidate Covariance Files for ENDF/B-VII by MT Number
1125	Na-23	**151**
6425	Gd-152	151
6428	Gd-153	151
6431	Gd-154	151
6434	Gd-155	151
6437	Gd-156	151
6440	Gd-157	151
6443	Gd-158	151
6449	Gd-160	151
9040	Th-232	151

Covariance File Inventory - 2

MF = 35

MAT	Isotope	Candidate Covariance Files for ENDF/B-VII by MT Number
9861	Cf-252	18*

MF = 40

MAT	Isotope	Candidate Covariance Files for ENDF/B-VII by MT Number
4125	Nb-93	4
4931	In-115	4*

Covariance File Inventory - 3

MF = 33

A = 1-100

MAT	Isotope	Candidate Covariance Files for ENDF/B-VII by MT Number
325	Li-6	**105**,105(Std)
328	Li-7	**1**,**2**,**4**,**102**,**851**
525	B-10	**107**,**800**,**801**
600	C-nat	2(Std)
925	F-19	**4**,**16**,**22**,**28**
2231	Ti-48	**1**,**4**,**16**,**28**,**102**,**103**,**107**
2300	V-nat	**1**
2725	Co-59	**1**,**16**,**103**,**107**
2825	Ni-58	**16**
3925	Y-89	1*
4125	Nb-93	**1**

Notes:

- Files highlighted in yellow are from ENDF/B-VI.8. All other files are new.
- Files marked with "*" do not appear in ENDF/B-VII.b2.
- (Std) indicates files taken from the ENDF/B-VII Standards File.
- (All) indicates that all files in the indicated MT number range are included.
- Black font: File apparently not yet processed with ERRORJ.
- Green font: File was processed successfully with ERRORJ and plot is available.
- Red font: File could not be processed in present form with ERRORJ.

Covariance File Inventory - 4

MF = 33

A = 100 - 238

MAT	Isotope	Candidate Covariance Files for ENDF/B-VII by MT Number
6425	Gd-152	**1**,**2**,**4**,**16**,**102**,**103**
6428	Gd-153	**1**,**2**,**4**,**16**,**102**,**103**
6431	Gd-154	**1**,**2**,**4**,**16**,**102**,**103**,**107**
6434	Gd-155	**1**,**2**,**4**,**16**,**102**,**103**
6437	Gd-156	**1**,**2**,**4**,**16**,**102**,**103**,**107**
6440	Gd-157	**1**,**2**,**4**,**16**,**102**,**103**
6443	Gd-158	**1**,**2**,**4**,**16**,**102**,**103**,**107**
6449	Gd-160	**1**,**2**,**4**,**16**,**102**,**103**,**107**
7925	Au-197	**1**,102(Std)
8325	Bi-209	**1**
9040	Th-232	**1**,**2**,**5**,16,**17**,**18**,22,24,28,41,**51**,52-89(All),91,**102**,600,649,800,849, 851,852,853,854,855
9228	U-235	18(Std)
9237	U-238	18(Std)

Recommendations - 1

MAT	Isotope	Abund	MT	Reaction	Cov Qual
925	F-19	100%	4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			22	(n,na)	Marginal
			28	(n,np)	Marginal
2231	Ti-48	73.7%	1	(n,tot)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			28	(n,np)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
			107	(n,a)	Marginal
2300	V-nat	NA	1	(n,tot)	Acceptable
2725	Co-59	100%	1	(n,tot)	Marginal
			16	(n,2n)	Acceptable
			103	(n,p)	Acceptable
			107	(n,a)	Acceptable
2825	Ni-58	68.1%	16	(n,2n)	Marginal
4125	Nb-93	100%	1	(n,tot)	Acceptable

Recommendations - 2

MAT	Isotope	Abund	MT	Reaction	Cov Qual
6425	Gd-152	0.2%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
6428	Gd-153	RA	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
6431	Gd-154	2.2%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Marginal
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
			107	(n,a)	Acceptable

Recommendations - 3

MAT	Isotope	Abund	MT	Reaction	Cov Qual
6434	Gd-155	14.8%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
6437	Gd-156	20.5%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
			107	(n,a)	Acceptable
6440	Gd-157	15.7%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable

Recommendations - 4

MAT	Isotope	Abund	MT	Reaction	Cov Qual
6443	Gd-158	24.8%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
			107	(n,a)	Marginal
6449	Gd-160	21.9%	1	(n,tot)	Acceptable
			2	(n,el)	Acceptable
			4	(n,inel)	Acceptable
			16	(n,2n)	Acceptable
			102	(n,g)	Acceptable
			103	(n,p)	Acceptable
			107	(n,a)	Acceptable
7925	Au-197	100%	1	(n,tot)	Acceptable
8325	Bi-209	100%	1	(n,tot)	Acceptable
9040	Th-232	RA	1	(n,tot)	Unacceptable
			2	(n,el)	Marginal
			5	(n,X)	Unacceptable
			17	(n,3n)	Marginal
			18	(n,f)	Unacceptable
			51	(n,n1)	Unacceptable

“Loose Ends”

- Quite a few candidate covariance files could not be processed with ERRORJ in order to provide plots that could be used in judging their quality

  --- Convenient and comprehensive visualization of covariances is an issue that must be addressed eventually
- Present review emphasizes the fast-neutron region.

  --- This reviewer observed that some of low-energy MF=33 results generated by ERRORJ look rather “suspicious”

  --- Procedures to generate useful covariances for the low-energy region appear to be unduly obscure for non-experts
- Some of the covariances generated in a recent evaluation of Th-232 appear to be problematic in spite of the use of modern evaluation techniques (Monte Carlo error propagation implemented within the GANDR system)

  --- Apparently these are preliminary results that will be replaced soon

Conclusions

- The price of improved quality is reduced content

  "When in doubt … leave it out"

  --- However, a compensating factor is the fact that older covariances remain in ENDF/B-VI.8 and are not lost

- Rigorous methods needed to produce good quality covariances are well developed and are now being used widely, but the quality of results obtained depends strongly on the input information (GIGO)

  --- So, evaluations cannot be on "autopilot" … The selection of expt'l data values and errors, as well as the model parameters and errors, must be very carefully considered