National Nuclear Data Center
Brookhaven National Laboratory, Upton, NY 11973-5000

Summary of the

57th Cross Section Evaluation Working Group Meeting November 6-8, 2007

and

10th U.S. Nuclear Data Program Meeting November 7-9, 2007

Edited by Pavel Oblozinsky
National Nuclear Data Center, BNL

www.nndc.bnl.gov/proceedings/2007/csewgusndp

Participants of the CSEWG and USNDP Annual Meetings'2007

Preface

In 2007, following tradition established in the previous four years, the Cross Section Evaluation Working Group (CSEWG) and the U.S. Nuclear Data Program (USNDP) Annual Meetings were organized jointly. In the week of November 6 - 9, 2007, three nuclear data meetings were held at BNL:

- Nuclear Data Advisory Group, Criticality Safety Program Meeting, Nov 5,
- CSEWG Annual Meeting, Nov 6-8, and
- USNDP Annual Meeting, Nov 7-9.

The present document contains the Summary of the CSEWG and USNDP Meetings that is, for the first time, produced in the electronic form only. This document along with all presentations is available at www.nndc.bnl.gov/proceedings/2007csewgusndp.

December 18, 2007

Pavel Oblozinsky
CSEWG chair
USNDP chair

Table of Contents

Agenda

CSEWG & USNDP Annual Meetings
November 6-9, 2007

Nov 6, 2007, Tuesday, *Berkner B*

8:30 - 12:30 Berkner B

- **CSEWG Opening**, Oblozinsky, 10'
- **CSEWG After ENDF/B-VII.0** (chair Oblozinsky), 2h
  - CSEWG organization, Oblozinsky, 10'
  - Need for the Covariance Committee, D. Smith, 10'
  - Plans for ENDF/B-VII.1 release, Chadwick, 10'
  - ENDF database management, Herman, 10'
  - Discussion, all
- **Evaluation Committee** (chair Chadwick), 1.5h
  - Overview comments, Chadwick, 5'
  - Known deficiencies in B-VII, Herman, 15'
  - Summary of Am cross sections as discussed at recent Santa Fe workshop, including possible future upgrades, Chadwick, 15'
  - Progress at LANL on Pu isotopes, Young or designee, 15'
  - Overview of JENDL activities & WPEC SG29 235U capture, Fukahori, 20'
  - New LLNL evaluations of 237U, 240Am and structural materials, Brown and Summers (LLNL), 15'

12:30-14:00 Lunch break

- ***CSEWG Executive Committee working lunch**, Berkner A*
  - *CSEWG after ENDF/B-VII.0 (organization, VII.1 release)*
  - *Covariance Workshop (Port Jefferson, end of June 2008)*
  - *WPEC matters (CSEWG team, new subgroups)*
  - *Next meeting (proposed Nov 4-6, 2008, Tue-Thu)*
  - *AOB*

14:00 - 18:00 Berkner B

- **Evaluation Committee cont.** (chair Chadwick), 1.5h
  - Titanium cross section evaluation (with LANL collaborators), Oh, 15'
  - Delayed neutron spectra work, Kawano, 15'
  - Tungsten upgrades including pulsed sphere testing, Leal? 10'
  - Prompt Pu and U fission spectra & fiss cross sections - possible upgrades in the future LANL & LLNL plans (McNabb/Chadwick), 15'
  - Fidget: a widget for simulating fission neutron spectra and fission fragment distribution, Vogt, LLNL 15'
  - Evaluation work at KAERI, Lee, 10'
  - Impact of ENDF/B-VII.0 release on the fusion library FENDL-2.1, Sawan, 10'
  - Update on neutron cross section evaluations at IAEA, Abriola, 5'
- **Validation Committee** (chair McKnight), 2h
  - Summary of VII.0 validation, McKnight, 20'
  - Recent ENDF/B-VII.0 Validation Work, Kozier, 15'
  - Recent ENDF/B-VII.0 Validation Work, Zerkle, 15'

- Validation Testing of ENDF/B-VII.0 from VNIIEF, Kahler, 15'
- Library comparisons of Neutron Capture Rates, Pritychenko, 10'
- Validation testing for Ir, Y, and Tm, Chadwick, 15'
- ENDF/B-VII results in ICSBEP Handbook, Briggs, 15'
- Review of new Russian Integral Experiments for ICSBEP Handbook, Briggs, 15'

Nov 7, 2007, Wednesday, *Berkner B, Berkner C*

8:30 - 12:30 Berkner B

- **Validation Committee cont.** (chair McKnight), 1h
  - Performance of the new JEFF and ENDF Data, Rugama, 15'
  - Verification Activities, McKnight, 10'
  - Testing of the new Cd-113 capture cross section, Mosteller, by Mughabghab, 15'
  - B-VII Energy Balance, MacFarlane, 10'
- **Measurements Committee** (chair Danon), 2h
  - Neutron cross section measurements
    - Research directions at LANSCE, Haight, 15'
    - Status report of ORNL measurement activities, Dunn, 15'
    - NIST measurements, including standards activity, Carlson, 15'
    - Neutron Cross Section Measurem. at LBNL, Firestone, 15'
    - Determining the Np-237(n, f) cross section with surrogate method, Basunia, 15'
    - Cross Section Measurements and Analysis at Rensselaer, Danon, 15'
    - Experiments at LLNL, Wu, 15'
  - Other topics
    - Improvement of EXFOR (WPEC SG30), Oblozinsky, 5'
- **Formats & Processing Committee** (chair Dunn)
  - Proposed LB=8 covariance format modification, Trkov
  - Definition of “stable nuclei” for cumulative yields, Mills and Trkov
  - Inclusion of LCT flag in MF34, Trkov
  - Resolve ambiguity of data representation in MF35, Trkov
  - Issue with File 5 requirement for JEFF 3.1 Be-9 MT16 (n,2n), Dean
  - Total prompt energy deposition in fission, LANL
  - Reduced scattering radius uncertainty, BNL
  - Format proposal related to PKA/KERMA, Fukahori, 5'
  - Fission Energy Release Format Revision, Kahler, 10'
  - Other format proposals

10:00-12:30, Berkner C

- **USNDP Opening**, Oblozinsky, 10', Berkner C
- **USNDP Nuclear Structure WG** (chair Baglin), Berkner C
  - NDS Publication Issues (discussion leader Tuli)
    - Opening remarks, Tuli, 5'
    - New NDS production software, Singh, 10'
    - Discussion of new NDS format, all

12:30-13:50 Lunch break

13:50 - 14:00 Common Photo

14:00 - 18:00 Berkner B

- **Formats and Processing Committee cont.** (chair Dunn), 1.5h
  - Resonance scattering kernel, Dagan, 10'
  - Processing Codes, 1h
    - NJOY Status Report, Kahler & MacFarlane, 10'
    - AMPX Status Report, Dunn, 10'
    - LLNL Status Report, Brown, 10'
    - ANL Status Report, McKnight, 10'
    - Report on Other Processing Codes, All, 10'
    - Status of MCNP B-VII.0 library, Little, 5'
    - ENDF/B-VII.0 library in ACE Format, Arcilla, 5'
  - BNL Activities Related to Formats and Processing
    - Checking Codes, Herman, 5'
    - ENDF-102 Manual, Herman, 10'

- **Covariance Committee** (chair D. Smith), 1.5h, with USNDP
  - Lessons from low-fidelity project: Fast neutrons, Pigni, 15'
  - Lessons from low-fidelity project: Thermal and RRR, Dunn/Williams, 15'
  - Status of WPEC SG 26 work on covariances, Oblozinsky/Dunn, 10'
  - Covariance activities in Japan, Fukahori, 15'
  - How does KALMAN work, Kawano, 20'
  - Covariance Web interface at NNDC, Arcilla, 10'

- **Model code development** (chair Kawano), common session with USNDP, 0.5h

12:30-13:50 Lunch break

13:50 - 14:00 Common Photo

14:00-17:30, Berkner C and B

- **USNDP Nuclear Structure WG cont.** (chair Baglin), Berkner C
  - Databases
    - ENSDF Status, Tuli, 10'
    - NSR Status, Bhattacharya 10'
    - XUNDL Status, Singh, 10'
  - Software, Web services
    - NuDat Revision, Sonzogni 10'
    - Status of ENSDF Analysis and Utility Codes, Burrows, 15'
  - Reports
    - ENSDF and NSR efforts and future plans at IAEA, Abriola, 20'
    - CRP on Updated Decay Data Library for Actinides, Kondev, 30'
    - Proposed topical evaluation near N~20 Island of Inversion, Basunia, 10'
    - BRICC: How good are CCs now? Burrows, 20'
    - Recent precision ICC measurements at TAMU, Nica, 20'

- **USNDP Nuclear Reaction WG**, common session with CSEWG, Berkner B
  - **Covariances**, with CSEWG
  - **Model code development**, comon session with CSEWG (chair Kawano)
    - PRECO status and future plans, Walker, 10'
    - GNASH status and future plans, Talou, 10'
    - EMPIRE status and future plans, Oblozinsky/Herman, 10'

Nov 8, 2007, Thursday, *Berkner B, Berkner C*

8:30 - 13:00 Berkner B

- **Covariance Committee cont.** (chair D. Smith), 1.5h
  - Material-material correlations in ENDF, Muir, 15'
  - Paradigm shift for resonance-region uncertanties, Larson, 10'
  - Covariances in XML, Brown, 10'
  - Organization of the Covariance Committee, All
  - What users really want (thermal, RRR, URR, fast)? All
  - Formats, visualization etc. All
  - Covariance Workshop in 2008, Oblozinsky, 5'
- **Services and Other Topics** (chair Herman)
  - Sigma Web interface, Pritychenko, 15'
  - Introduction to NSR, Bhattacharya, 10'
- **Concluding Session** (Oblozinsky)

13:00 CSEWG adjourns

8:30-12:30 Berkner C

- **USNDP Nuclear Structure WG cont.** (chair Baglin)
  - Reports continued
    - Role of ENSDF in reaction evaluations, Herman, 20'
    - Status of Atomic Mass Evaluation Effort, Kondev, 10'
    - Update on European support for ENSDF evaluations, Tuli, 10'
  - Outreach
    - Outreach activities at the NNDC, Pritychenko, 10'
    - Nuclear Data Mini-symposium at an APS/DNP meeting? Kelley, 5'
    - USNDP visibility at major 2008 conferences (NS'08, ENAM'08)?
    - Other ways to increase visibility?
  - Formats/Procedures/Policies
    - Include both Absolute and Relative Intensities in ENSDF? Browne
    - Excessively large BM3W values in ENSDF, Singh
    - Evaluation with EGAF thermal neutron capture data, Firestone, 15'
    - How should PGAA data (2007ChZX) be used in ENSDF?
    - Guidance needed for handling widely different $T_{1/2}$ values for first 2+ states in some nuclides, Singh
    - Priority addition of newly-discovered nuclides in ENSDF in mass regions not handled by McMaster, Singh
    - Treatment of cluster decay in ENSDF; Consistency of $T_{1/2}$ in ENSDF and Wallet Cards, Sonzogni, 10'
    - Format/procedure changes following NSDD'2007 meeting
  - Other business/discussions

12:30- 14:00 Lunch break

- ***USNDP Coordinating Committee working lunch***, *Berkner A*
  - *Situation in USNDP laboratories*
  - *Report FY07 & Workplan FY09*
  - *Budget briefing FY10*
  - *Next meeting (proposed Nov 5-7, 2008, Wed-Fri)*
  - AOB

14:00-17:30 Berkner B

- **USNDP User Forum** (chair Sonzogni)
  - NNDC services, Sonzogni, 10'
  - Nuclear Astrophysics at the National Ignition Facility, R. Boyd, LLNL, 30'
  - Current Status of REACLIB, R. Cyburt, JINA, 30'
  - The UNEDF Project in Nuclear Structure Theory, G. Bertsch, U. of Washington, 30'
  - Nuclear Structure Physics Research in Jyvaskyla, H. Penttila, Jyvaskyla, 30'
  - Discussion, all

Nov 9, 2007, Friday, *Berkner B*

8:30 - 13:00, Berkner B

- **Task Force Reports** (chair Tuli) 10' each
  - Nuclear data for astrophysics, Smith/Nesaraja
    - Astrophysics reaction rates, Pritychenko, 5'
  - Nuclear data for homeland security, McNabb/Brown
- **Laboratory Reports** (chair Tuli) 10' each
  - NNDC report, Oblozinsky
  - ANL report, Kondev
  - LANL report, Kawano
  - LBNL report, Clark/Baglin
  - LLNL report, Brown
  - NIST report, Carlson
  - McMaster report, Chen/Singh
  - ORNL report, Smith/Nesaraja
  - TUNL report, Kelley
- **Concluding Discussion** (Oblozinsky)

13:00 USNDP adjourns

List of Participants

CSEWG Annual Meeting, November 6-8, 2007
USNDP Annual Meeting, November 7-9, 2007
NDAG*) Meeting, November 5, 2007

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				20	**59**	**39**

*) Nuclear Data Advisory Group of the US Nuclear Criticality Safety Program

Summary of the 57th Cross Section Evaluation Working Group Meeting

Held at
Brookhaven National Laboratory
November 6 - 8, 2007

Cross Section Evaluation Working Group

Chairman's Summary

Pavel Oblozinsky
National Nuclear Data Center, BNL

CSEWG Annual Meeting

The 57th CSEWG meeting was held on November 6-8, 2007 at BNL and attended by 59 participants. This unexpectedly high number confirms renewed interest in evaluated nuclear reaction data. Among the participants were representatives of national laboratories, academia and nuclear industry of the United States and Canada, as well as a few participants from abroad. The CSEWG meeting was held adjacent to the USNDP annual meeting, with a common session on neutron cross section covariance data.

ENDF/B-VII.0 validation

After successful release of the new ENDF/B-VII.0 library in December 2006, CSEWG continued to work on the validation of the library. In general, the new results confirm an overall excellent performance of the library. Equally important is that deficiencies continued to be identified, with the due record to be kept by the NNDC and to be used for VII.1 release. As a part of careful testing of the Monte Carlo library (ACE) by LANL, several, mostly small, fixes are to be made. These fixes should be included in the ENDF/B-VII.0.1 version (fix 1), to be released by the NNDC early 2008.

The 'big paper' on the ENDF/B-VII.0 library was published in Nuclear Data Sheets **107**(2006) pp. 2931-3060, followed by four related papers in NDS **108**, December 2007.

CSEWG after ENDF/B-VII.0 release

Broad discussion was held on CSEWG in the post-ENDF/B-VII.0 era. The current structure and organization of CSEWG was found to be working well. In view of the considerable interest in the covariance data the new Covariance Committee was established with Don Smith, ANL, as its chair. Yaron Danon, RPI will serve as the new chair of the Measurements Committee.

Next release, ENDF/B-VII.1, is tentatively expected in 2010, with assembly and testing starting in 2009.

Next Meeting

The next CSEWG annual meeting will be held at BNL on Nov 4-6, 2008 (Tuesday – Thursday), while the USNDP annual meeting will be held on Nov 5-7, 2008 (Wednesday – Friday). The NDAG Criticality Safety meeting will be held on Nov 3, 2008 (Monday).

CSEWG Executive Committee Meeting

The Executive Committee met during the lunchtime on November 6, 2007, with all 10 members present. This included chair (P. Oblozinsky), five committee chairs (M. Chadwick, Y. Danon, M. Dunn, R. McKnight, D. Smith) as well as four regular members (R. Block, D. Brown, A. Carlson, L. Leal).

Agenda

- CSEWG after ENDF/B-VII.0: Don Smith stepped down from his position as the chair of the Measurements Committee and the CSEWG chair thanked him for his dedicated and excellent service to CSEWG over many years. Yaron Danon, RPI, was approved as the new chair of this Committee. The new Covariance Committee was established, with Don Smith, ANL, as its chair.

- Release of ENDF/B-VII.0 fix. LANL, when working on official release of the Monte Carlo library (ACE), identified several problems, mostly minor format issues that would need immediate fix. This issue triggered lively discussion. It was agreed that, early 2008, the NNDC would release ENDF/B-VII.0.1 (VII.0, fix 1) once LANL completes the ACE library. Links to the ENDF/B-VII.0 deficiencies and pre-VII.1 files (ENDF/A) should be made more visible by the NNDC.

- Covariance Workshop. The NNDC intends to organize a workshop in Port Jeff, June 23-27, 2008. The committee found this important and timely and endorsed the event.

- WPEC matters. The US delegation should include P. Oblozinsky - head, R. McKnight, M. Dunn and Y. Danon - members. Several other US representatives should attend as chairs or active contributors to the subgroups (Herman, Kahler, Leal, etc.). The next WPEC meeting should be held at Tokai, Japan, June 5-6, 2008. Two topics for future subgroups were mentioned, URR representation - methodology (L. Leal) and 239Pu resonances (M. Chadwick).

- Next meeting: See above.

Cross Section Evaluation Working Group

Evaluation Committee Report

Chair M.B. Chadwick, LANL

ENDF/B-VII.0 fix

A main issue for tracking changes in ENDF/BB-VII.0 evaluations: We agreed that the changes that Bob Little has deemed necessary to make for creating an MCNP ENDF/B-VII library will be sent back to BNL and released as something like "ENDF/B-VII.0.fix1". The changes will not impact any of the criticality testing – we don't think – except for the 233U delayed neutron fix, which could make very small changes in some assemblies (MacFarlane has done for one case and saw a tiny change). Additionally, we agreed that it would be worthwhile to have a smaller suite of V&V data testing criticality – eg, 30 or so, possibly built upon Mosteller's MCNP testing suite – to run so as to ensure no/tiny changes in the calculated k-effs. A list is being maintained of target evaluations for ENDF/B-VII.1 release (eg, in ~ 2010).

Mike Herman - ENDF status

ENDF/A is a holding ground for upgrades, and contains several files already for consideration for release in B/VII.1. These include minor fixes (eg ZAIDs), as well as more substantive upgrades (eg Zr90 "beta4" that was successfully tested by KAPL last year but ultimately not adopted because it was too late to be in vdMark's large-scale VII.0 testing.

Discussion:

- Could we have a web page that has a few sentences on each of these files/fixes? For example, the interpolation problem for fission spectra above 10 MeV (for 235U and 239Pu) which needs a finer emission energy grid.

- Covariances – Dick McKnight did not think we should have a large suite (say, 300+) high quality files. Rather, we should have a smaller suite of major actinides.

- How do we deal with fixes to the files, known deficiencies etc.?

- Release of ENDF/B-VII.0 fix1, to fix 'minor' issues that would not impact data testing.

- Beta version of ENDF/B-VII.1 should contain substantial upgrades for consideration for release.

Mike Herman – known ENDF/B-VII.0 deficiencies

- Resonances – often fakes in VI.8, but in VII.0 taken from real compilations, though in many applications fakes are useful. Applies to Cd, Ru, Pd, Te and He isotopes. This would require real work, though. Morgan will send an email summarizing this situation.

- Thermal gamma production data in VII.0 - did not include Stephanie and Phil's better photon production data (ACTI data), many got dropped (data in file 6).

- David Brown has LLNL additional fixes; LANL (Little) has another additional fixes. The list of these will be integrated into Mike Herman's power point summary.

Tokio Fukahori, JAEA

- Noted the ongoing work on minor actinides such as 243Cm.

- He reminded us that ENDF/B-VII.0 carried over some old and crude evaluations for various minor Cm and Pu isotopes (see also Ignatyuk's ND2007 talk). These could be improved in ENDF/B-VII.1 – some could be adopted eg from JENDL.

- Discussed that 56-Fe alpha production needs improvement below 20 MeV for agreement with Haight new data – this was fixed above 20 MeV.

- 235U(n, gamma): Sodium voided reactivity, there is a big sensitivity near 1 keV region. Criticality of FCA-IX assemblies: B-VII and JEFF have a bias; although JENDL-3.2 does not show a bias, but he has concernes about 3.2 evaluation. Control rod worth of ZPPR-18A provides useful testing, ZEUS data in ICSBEP useful, 235U capture is part of the high-priority request list.

Dave Brown, LLNL activity

LLNL may submit some of their new evaluations – eg 237U, 240Am, and Cu and Mn isotopes. We will need to discuss which of these could be considered for Beta-1 release: Am240 probably; 237U is there from LANL and we may not want to change it, though there are some indications from our LANL data testing (Fig. 114 in the big paper'2007 on U evaluations by Young et al) that our fast region 237U fission cross section could be increased by ~ 20%, and LLNL evaluation does look a bit lower here). Also, work needs top be coordinated with future planned work at LANL eg on Mn, through the criticality safety program.

Luiz Leal, ORNL activity

- Described 182,183,186-W work in the resolved resonance range that matched Mughabghab's evaluation fairly well; he included covariance data.

- 55Mn was described up to 120 keV, uses data from Geel (capture) and Harvey, Macklin, etc.)
- Pu – carbon steel criticality safety related experiment showed a big discrepancy, possibly due to Pu, Cr, or Manganese (B-V performed well).
- Leal has submitted 35, 37-Cl evaluations to the NNDC in 2007. This was the first use of the RM limited Compact Format for the proton channel. The files have covariance data.
- He also has 19F results.
- Also 48Ti results for capture that allows k-eff uncertainties to be reduced from 1.5% to 0.44%. ENDF/B-VII Ti data (from JENDL-3.3) appear to perform less well than VI data (an elemental evaluation). 14 MeV data were tested with neutron transmission/pulsed sphere data, and showed some deficiencies. New work focuses on keV to 20 MeV. Uses modern GNASH, CoH, KALMAN etc codes in the fast region, uses Mughabghab's 2006 compilations (with some modifications). Thermal capture for 48Ti was increased by 6%. Preliminary data testing against HMF and HMM assemblies was done. The preliminary results are encouraging and the decreased calculated criticality is from the revised resonance data and reduced elastic above 100 keV. Now focuses on elastic and inelastic scattering cross sections, and revisit the scattering lengths.
- New ORNL Mn file should be delivered by end of March – would be good to see how it performs in ANL ZPR Pu-Mn-Cr assembly.

Ken Kozier

- Appreciative of ACE files generated by Ramon Arcilla, NNDC.
- Various cases show improvements using ENDF/B-VII.0, for CANDU, Advanced CANDU, MAPLE reactor, ZED-2, etc.
- Problem – need to run NJOY at different temperatures (for reactor coolant and moderator cases, and high temperatures). But Bob's high-temp files were on a crashed computer – Ken needs these; there should be temperature-dependent ENDF/B-VII.0 data on the IAEA website produced by R. Cullen, though probably not suitable for Ken's needs.
- ZED - zero energy density D2O moderated fuels. Excellent new results with ENDF/B-VII.0 data and using scattering kernels in VII.0. Improvements were based on the new scattering kernels and on the 238U improvements.
- MAPLE is used for making 99Mo, it has 93% HEU and also quite a bit of Zr in it. Changes due to Zr isotopes 90, seemed to cancel, K-eff predicted superbly!
- (n,d) measurements at IRMM-Gelina, ORNL, AECL being planned.
- New RPI measurements for Gd – did not make it into B-VII but we should consider them in the future.

Mike Zerkle

RCP01 testing (continuous energy MC), looked at HST assemblies – overall the comparisons were good, but he showed some small biases that warrant future study.

Cross Section Evaluation Working Group

Validation Committee Report

Chair R. McKnight, ANL

Dick McKnight (ANL): Summary of ENDF/B-VII.0 Validation

Dick presented a review of the validation results made a year ago in support of the release of ENDF/B-VII.0. With regard to criticality, it was noted:

- agreement with experiment is improved in many cases, including bare and reflected U and Pu systems and arrays of LEU fuel rod lattices
- C/E's for HEU and Pu are increased and closer to unity
- the reflector bias for the 238U-reflected Flattop assemblies has been largely eliminated
- major improvement for the intermediate spectra assemblies, particularly for Big Ten and to a lesser extent for some of the ZPR assemblies
- improved result for the fast 237Np assembly
- excellent agreement for (HEU and LEU) uranium solution assemblies
- elimination of the under-prediction for thermal low-enriched U fuel rod lattice assemblies
- much improved performance for fast and thermal systems with 233U and 232Th
- large bias and trends remain for un-moderated and moderated Zeus assemblies which question 235U scattering data and Cu data.

With regard to delayed neutron results, it was noted:

- Thermal 235U systems show ~5% decrease in k_{eff} resulting in C/E's close to unity
- Fast Pu/U systems show smaller (±2%) changes yielding slightly better or worse results.

With regard to reaction rates, it was noted:

- Calculation of spatial reaction rate measurements in the fast LANL assemblies are in excellent agreement
- Nevertheless some discrepancies in the spectral indices persist in several of those assemblies.

With regard to shielding and pulsed-sphere testing, it was noted:

- C/E's based on the Fusion Neutronics Source (FNS) benchmark improve for several new evaluations (including ^{235}U, ^{238}U, ^{239}Pu, Pb, Li and Be) and persist for older evaluations (such as W)
- Pulsed-sphere results confirm the quality of the inelastic scattering data for ^{235}U and ^{239}Pu.

Dick summarized that while the performance of the ENDF/B-VII.0 data is overall much improved and eliminates a number of long standing discrepancies, there remain a number of apparent data deficiencies as evident in the validation effort. It is important that some of our current measurement and evaluation effort address these deficiencies. He provided the following short list of apparent data discrepancies in ENDF/B-VII.0:

1. Large discrepancies in ^{239}Pu in thermal (e.g., solutions) and intermediate spectra systems
2. RR/URR range of Cr as evidenced in Pu/C/SST assembly
3. RR/URR range of Mn as evidenced in Pu/C/SST assembly
4. Very poor trend for assemblies with clean assemblies with W
5. Still puzzling results with ^{233}U data testing
6. Some issues remain with Zr isotopes
7. Although largely improved, some large discrepancies remain with ^{9}Be
8. Some discrepancies with ^{238}U capture
9. Many polyethylene moderated and reflected critical assemblies very high (also Teflon)
10. Some Pb biases remain in thermal systems

Ken Kozier (AECL): Impact of ENDF/B-VII.0 for AECL

Ken described the status of the AECL implementation of ENDF/B-VII.0 and presented a variety of data validation results using the new data. He also emphasized the high value of (and thanks to) Ramon Arcilla and NNDC, LANL and RSICC for processing and distributing ENDF/B-VII.0 as MCNP-useable ACE-formats files. Their early testing against ZED-2 (D_2O/air-cooled Natural Uranium critical experiments) indicate a systematic increase in calculated k_{eff}'s by ~0.43% dk which generally improve C/E's (except for the ZEEP NU metal lattices) and show a small ~0.4% dk consistent reduction of the D_2O coolant void reactivity bias using the new S(α,∃) data for U and O in UO_2.

Ken also noted the large increase in the new σ(n,γ) for ^{90}Zr is offset by a decrease in the new σ(n,γ) for ^{91}Zr, leading to a low net reactivity impact (as demonstrated in MCNP5 calculations with ENDF/B-VII.0 calculations for MAPLE reactor) and reduces the incentive to develop Zr materials enriched in ^{90}Zr.

Ken indicated the results of their validation calculations have led to recommend early adoption of ENDF/B-VII.0 for all AECL applications.

Mike Zerkle (Bettis): ENDF/B-VII.0 Validation Testing using selected ^{235}U Thermal Solution Benchmarks

Mike reviewed results of continuous-energy Monte Carlo results using their RCP01 code for a variety of ICSBEP ^{235}U-fueled thermal solution benchmarks with ENDF/B-VI.8 and -VII.0 cross sections. This testing included 72 critical configurations (33 high-enriched

solution criticals and 39 low-enriched solution criticals); 27 of these configurations included a H_2O reflector. Results indicated the very good agreement obtained with ENDF/B-VI.8 data has been maintained with the ENDF/B-VII.0 data (with some benchmarks slightly improved; others slightly worsened). Mike presented extensive trending analyses based on these results and observed some small reduction (within the tight statistics of the analyses) in performance with respect to trend with ATLF, ATFF, H_{abs} with ENDF/B-VII.0 for these HST and LST benchmarks.

Skip Kahler (LANL): Summary of ENDF/B-VII.0 Validation Work at VNIIEF

Skip summarized results of validation calculations performed with ENDF/B-VII.0 data by RFNC-VNIIEF (Sarov, Russia). Calculations were reported based on the VNIIEF Monte Carlo code C-95 and the multigroup S_n code from the BEND suite. Results included calculated keff's and fission rate ratios for 120 ICSBEP benchmark assemblies and 6 VNIIEF open benchmark assemblies. Their ENDF/B-VII.0 results were compared with results obtained by LANL using MCNP with ENDF/B-VII.0 data (and reported in the NDS Big Paper). The calculated results generally confirmed the good performance of the ENDF/B-VII.0 data. However, inconsistent agreement between the C-95 and MCNP results limited conclusions which could be drawn from these results. A principal question regarding these analyses is in details of the Monte Carlo methods (continuous-energy?).

Boris Pritychenko (NNDC): Library Comparison of Neutron Capture Rates

Boris described an extensive effort to compare 400 different neutron materials in four evaluated data libraries (ENDF/B-VII.0, JEFF-3.1, JENDL-3.3 and ENDF/B-VI.8) and compilations of Atlas of Neutron Resonances (Mughabghab) and Bao *et al*. Evaluated data for (n, γ), (n,tot), (n,el), (n,inel), (n,f), (n,2n), (n,p) and (n,α) reactions were compared and 3200 spectra were analyzed. Potential problems with the data were rated by severity into three categories. It was recommended that Severity 1 problems should be addressed in ENDF/B-VII.1; Severity 2 problems should be further investigated and possibly addressed in future releases. Preliminary rating of these cross sections in the four evaluated libraries has been performed.

Mark Chadwick (LANL): Validation Testing for Ir, Y, and Tm (using Bethe Spheres and Critical Assemblies)

Mark described reaction rate measured using a 14-MeV source at the center of an all-^{6}LiD sphere (30 cm) and an Oralloy sphere surrounded by ^{6}LiD. The focus of this study was on Ir, Y, and Tm, although other reaction rates, including ^{238}U, ^{90}Zr and ^{197}Au, are available. The threshold (n,2n) reaction in ^{191}Ir (yielding ^{190}Ir) is sensitive to the 14Mev neutrons, whereas the (n n') reaction in ^{193}Ir (yielding ^{193m}Ir) is sensitive to the fission spectrum neutrons. Therefore the comparison of calculated to measured values of

$^{193m}Ir/^{190}Ir$ is good measure of the hardness of the neutron spectrum (14 MeV/fission energy). He displayed comparisons of calculations versus measurements for this $^{193m}Ir/^{190}Ir$ ratio spanning over three orders of magnitude. The comparison to experiments with HEU were considerable poorer. This motivates questions about the 14 MeV induced prompt neutron spectra and preequilibrium/inelastic scattering for ^{235}U.

Blair Briggs (INL): END/B-VII.0 Results in the ICSBEP Handbook

Blair reported that as calculated results based on ENDF/B-VII.0 (and future releases of other evaluated libraries) are provided to the ICSBEP project, the data will be included in the Handbook. This will be done by inserting a link in Section 4 of the benchmark to the new results. Evaluators will be encouraged to use the modern evaluated data libraries and to include these results in their benchmark reports.

Blair Briggs (INL): Review of new Russian Integral Experiments for the ICSBEP Handbook

Blair reviewed a recent series of Russian critical experiments which should be of high interest to the CSEWG and nuclear data community. VNIITF recently completed a series of high-multiplication, vanadium-reflected, HEU-metal experiments in which five different thickness of vanadium were used. These experiments are very clean and should be excellent for data testing once they are evaluated. VNIITF also performed five experiments with vanadium as a diluent, one with vanadium only, two with vanadium and beryllium, and two with vanadium and polyethylene. Reports of these experiments will be submitted for publication in the 2008 Edition of the ICSBEP Handbook. Similar experiments with either tungsten or molybdenum are being considered for next year.

Blair also indicated that the ICSBEP is collaborating with IRSN, AREVA, and ANDRA (the French National Radioactive Waste Management Agency) to perform a series of about 20 structural materials experiments in 2008 and 2009. These experiments involve arrays of low-enriched fuel rods in water with various interstitial or reflector materials. Materials included in this experimental program are iron, nickel, copper, zircalloy, titanium, SiO_2, and concrete.

Yolanda Rugama (OECD/NEA): NEA Activities and Validation of JEFF-3.1

Yolanda provided a brief overview of the activities within the OECD/NEA Working Party of international nuclear data Evaluation Co-operation (WPEC) of high interest to the CSEWG/ENDF community. She described the efforts of WPEC SG-C (High Priority Nuclear Data Request List) and illustrated the NEA Nuclear Data Request List website (www.nea.fr/html/dbdata/hprl). She also described the mission and progress of the new WPEC SG-30 on EXFOR. Yolanda distributed some copies of JEFF Report 21: "The JEFF-3.1 Nuclear Data Library" (available from the NEA) and presented select results

from the JEFF Report 22: "Validation of the JEFF-3.1 nuclear data library". She illustrated the web page on Feedback on JEFF3.1 and discussed plans for JEFF-3.2 (tentative release date of 2009). She also described the new version of Janis 3, the NEA data display software (www.nea.fr/janis).

Dick McKnight (ANL): Verification Activities of ENDF/B-VII.0

Dick described the excellent verification activity initiated by D.E. Cullen (LLNL) and participated in by LLNL, ANL, CEA, ORNL, and LANL. This study was based on calculations of three fast critical assemblies: Godiva (U235), Jezebel (Pu239) and Jezebel23 (U233). The results are documented in the LLNL report (UCRL-TR-233310) "ENDF/B-VII.0 Data Testing for Three Fast Critical Assemblies" which is posted on the NNDC website.

Said Mughabghab (BNL): Development and Testing of a Revised ENDF/B-VII.0 Cross Section for Cd-113

Said presented the results of work by Mosteller (LANL), MacFarlane (LANL), Kim (LLNL) and himself to test and improve the ENDF/B evaluation of the ^{113}Cd cross section. Results were presented of calculations of 21 experiments with high enriched uranyl nitrate solutions containing Cd performed at PNL in 1978-1979. It was noted that ENDF/B-VI results for these benchmarks are poor, even though results with ENDF/B-V were reasonable. Although the performance with ENDF/B-VII.0 data is somewhat improved – that improvement is the result of better data for isotopes other than Cd (e.g., ^{235}U). A review of these results and a close comparison of the ENDF/B-V, -VI and -VII evaluations indicated the most like cause of the deterioration in performance was thermal absorption in Cd. A new evaluation for the thermal capture cross section of ^{113}Cd was developed and the resulting cross section was demonstrated to produce marked improvement in the benchmark C/E's. The new ^{113}Cd evaluation will be included in the next release of ENDF/B-VII data.

Skip Kahler for R. E. MacFarlane: ENDF/B-VII.0 Energy Balance

Skip reported that Bob MacFarlane has (as in the past) performed energy balance testing for the ENDF/B-VII.0 data. This is done using the NJOY HEATR module which includes a capability to calculate reasonable bounds for the heating and photon production and to graphically compare the values computed from the evaluation with these bounds. Skip displayed one energy balance check (for 47Ti) of the many problem nuclides. Complete results of these energy balance checks are available at: http://t1.lanl.gov/data/evalVII/summary.html. At that site there is a list of all the non-fissionable isotopes from ENDF/B-VII with a link to the testing plots and short comments about the quality of the energy balance for that evaluation. He indicated that materials that rate "poor" on the list should be priorities for improvement.

Cross Section Evaluation Working Group

Covariance Committee Report

Chair D.L. Smith, ANL

The CSEWG Covariance Committee (hereafter referred to as CovCom for convenience) was formed earlier this year (2007). CovCom is the first new committee to be formed since the early 1990's when the Measurement Committee was added to the roster of technical committees under the umbrella of CSEWG. The main objective in forming this new committee was to address numerous technical issues that are emerging from the growing demand for covariance information from nuclear data user communities and the corresponding need of CSEWG to respond to these needs. The issues to be faced by CovCom are many. Among them are:

1. development and benchmarking of methodologies required to produce covariances,
2. quality control of covariances generated for ENDF/B,
3. technical issues in the area of covariances that impact upon the ENDF formats,
4. interfacing with user communities to define the requirements for ENDF,
5. interfacing with the CSEWG Validation Committee to find a common ground between the results from propagated uncertainties and the more traditional C/E comparisons,
6. close collaboration with the CSEWG Evaluation Committee to expedite the inclusion of covariances in new evaluations,
7. co-operation with the CSEWG Measurement Committee to insure that new nuclear data experiments generate data that provide evaluators with sufficient and well formulated uncertainty information, etc.

The work of this committee, as is the case for all CSEWG committees, will be carried out by interested technical experts on a voluntary basis. The Chair of CovCom has been contacting a number of potential experts to ask if they would serve in this capacity.

The response so far has been very encouraging.

The first meeting of the CSEWG Covariance Committee (CSEWG CovCom) since its formation was held during two sessions: afternoon, Wednesday, 7 November, and morning, Wednesday, 8 November. These sessions were components of the annual CSEWG meeting (CSEWG-2007) held at BNL. In total, 3 hours of meeting time were devoted to this committee. During the first afternoon, and continuing on into the early portion of the following morning, the time was devoted to 10 individual formal presentations. The presentation titles, their authors, and brief synopses of these presentations prepared by the Chair appear below. The actual presentations – as either Microsoft PowerPoint or PDF files – can be found through direct HTML links from the CSEWG-2007 meeting agenda Web pabe that appears at the BNL-NNDC website devoted to CSEWG-2007 (http://www.nndc.bnl.gov/meetings/csewg2007/#agenda).

Presentations

M. Pigni (BNL) --- *Lessons from the low-fidelity project (fast neutron domain)*

A short-term project to generate preliminary covariance information for a large number of materials of interest to criticality safety (the low-fidelity covariance project) was undertaken by several laboratories owing to the fact that only 7% of the materials in the neutron sub-library for ENDF/B-VII.0 offer covariance information. BNL-NNDC has focused on the fast-neutron region which, in this case, is defined as the region above 5 keV and below 20 MeV for all materials. An energy grid of 30 mesh points was selected. The approach has also been used to generate comparable results for considerations by the GNEP community. This work generated covariance information based entirely on model calculations performed using the nuclear model code EMPIRE in conjunction with Bayesian code KALMAN. The output are covariance files in the ENDF format. The scope of this work initially encompassed 219 fission product materials, but it is being extended to include 57 structural nuclei and 31 heavy nuclei. The emphasis is on elastic and inelastic scattering, neutron capture, and the (n,2n) reaction. Fissionable nuclei are being investigated by LANL. The covariances were generated by allowing for 18 nuclear model parameters to be varied. The range of parameter variations is based on the experience of the BNL investigators as well as on others who are active in the nuclear modeling area. These parameter uncertainties fall in the range 3-20%, depending on parameter type. No experimental data have considered. Plots of the evaluated uncertainty results, correlations, and parameter sensitivity profiles were generated to facilitate reality checking. Of course, actual ENDF covariance files were also produced. The visualization exercise led to a better understanding of systematic features of the uncertainty landscape that can be traced to underlying characteristics of nuclear modeling in this energy range.

M. Williams (ORNL) --- *Lessons from the low-fidelity project (thermal and RR domains)*

ORNL contributed to the low-fidelity covariance project mentioned in the preceding contribution by addressing the energy region below 5 keV which encompasses the thermal and epithermal regions. In the basic plan for low-fidelity covariances, the approach taken has been to assume that there are three uncorrelated regions, thermal, epithermal (with resolved resonances, i.e., RR), and fast (which also includes the unresolved resonances). Thus, the ORNL activity focused on generating a reasonable two group representation applicable to the thermal and epithermal regions based on a methodology developed earlier at this laboratory. Only MT = 2, 18 (for fissionable nuclei), and 102 have been considered. Uncertainties for the thermal region are generally well established so the major effort involved addressing the epithermal region with its associated resolved resonances. An integral approximation is used to average over the extensive detail that would have been be required to represent the resolved resonance information for a "high-fidelity" ENDF-quality evaluation. The presentation at CovCom explored the issue of how integral quantities, e.g., resonance integrals, relate to more detailed differential information such as might be represented in an actual comprehensive resonance representation or a multigroup representation of that region. The main point is that the uncertainties calculated from propagating multigroup uncertainties ought to agree

reasonably well (within the uncertainties) with well determined resonance integral information obtained from measurements and documented, e.g., in the Mughabghab *Atlas*. Using this approach, ORNL has been able to generate covariances for approximately 300 materials. This information has been combined with corresponding information for the fast region from BNL for those materials where the databases overlap.

P. Oblozinsky (BNL) --- *Status of WPEC SG-26 work on covariances*

SG-26 of WPEC was organized by the NEA to identify nuclear data needs for sodium, gas, and lead cooled fast reactors. Considerable covariance information was requested to satisfy the requirements for carrying out this study using sensitivity analysis techniques. The request for covariances encompasses 19 actinides, 26 structural elements, and 8 light nuclei. Data have been provided for MT = 1, 2, 4, 16, 18 cross sections as well as nu-bar for the actinides. A coarse 15-group representation was selected. Covariance information has been provided by BNL, ORNL, LANL, and NRG (Petten). In the case of BNL and ORNL, methods developed during the low-fidelity covariance project mentioned in the two proceeding presentations were applied to provide the requested information. For LANL, the results for high-fidelity evaluations of ^{235,238}U and ^{239}Pu that are being generated for later release in ENDF/B-VII.1 are being submitted. This presentation offered comments on the procedures used and some of the results obtained. It was stressed that the information provide for this subgroup project should be treated as preliminary and not considered to be carefully validated ENDF-quality information.

T. Fukahori (JAEA, Tokai, Japan) --- *Covariance activities in Japan*

This presentation discussed the covariance work that contributed to JENDL-3.3 as well as work carried out after the formal release of this library. In JENDL-3.3, covariance information is available for 20 materials: H-1, B-10, B-11, O-16, Na-23, Ti-48, V, Cr-52, Mn-55, Fe-56, Co-59, Ni-58, Ni-60, Zr-90, U-233, U-235, U-238, Pu-239, Pu-240, and Pu-241. Covariance information for an additional 12 nuclides has been generated following the release of this library: N-15, Pb-206, Pb-207, Pb-208, Bi-209, Np-237, Pu-238, Pu-242, Am-241, Am242m, Am-243, and Cm-244. The following techniques were used in preparing the evaluations and covariances: Experimental data were analyzed using a least-squares fitting code GMA developed by Poenitz. The covariance generating code KALMAN has also been applied for analyses where experimental data are limited. Covariance matrices were calculated from sensitivities and uncertainties of nuclear model parameters. For the resonance parameters, standard deviations were given to a resonance energy, neutron capture, and fission widths of each resonance. Some examples of the results from this work were shown in this presentation. In response to a question concerning covariances for JENDL-4, it was indicated that a much larger number of materials would eventually be provided with covariances and further development of the methodologies to produce these covariances is in progress to further this goal.

T. Kawano (LANL) --- *How does KALMAN work?*

This presentation provides an intuitive guide to how the covariance generating code KALMAN works. This code is used to produce covariance information by means of approximations that linearize certain information that can be inherently non-linear, e.g., results calculated using nuclear models. KALMAN normally operates in conjunction with a nuclear model code such as GNASH or EMPIRE. There is a provision to include experimental data by applying the Bayesian formalism. Statistical and systematic errors in the experimental data are included along with information generated from nuclear modeling. There is an ability to propagate uncertainties from experimental data to the model parameters and then determine a covariance matrix for the calculated quantities that represents a merger of experimental and model calculated information in a consistent manner. The application of this method to the ^{232}Th total cross section is demonstrated. Furthermore, the presentation offers a comparison between results obtained using the KALMAN approach and the Monte Carlo method for a simple example involving a Lorentzian function as the model. It was noted that the results from these two methods tend to be fairly comparable although small but noticeable differences can be observed due to the fact that one approach involves linearization while the other does not.

R. Arcilla (BNL) --- *Covariance Web interface at NNDC*

An ability to visualize covariance information (percent uncertainties profiles and correlation patterns) in a graphical manner is very important for assessing whether the presented covariance information is reasonable or not. A capability to do this has been developed at BNL. It involves processing MF = 32 and 33 covariance information from ENDF format using the code NJOY, ERRORJ or PUFF and then using the ability of NJOY to generate plots to provide the desired visualization files. Using this method, most MF = 32 and 33 covariances available from ENDF/B-VII.0, ENDF/B-VI.8, JEFF-3.1, and JENDL-3.3 have been processed and corresponding plots generated from this work are posted on the Web. The individual plots are contained in PDF files (one for each evaluated material). This information can be found at the following Web address: http://www.nndc.bnl.gov/exfor7/4web/covarplots.html from which it can be easily downloaded.

D. Muir (LANL, Guest Scientist) --- *Material-material correlations in ENDF*

The fundamental point made in this presentation is that the only true and reliable test of the validity and usefulness of covariance information from ENDF involves considering how this information can be incorporated into actual nuclear system analyses and how reasonable the thus propagated results are. If the available covariance information is incomplete, e.g., if materials and significant reaction channels are missing, or if cross-material correlations are absent, then the results obtained from system analyses that are based on these covariance data and sensitivity studies will be quite misleading. A compromise between convenience in visualizing the covariance information in ENDF, as well as attempting to keep the library size to what traditionally has been considered as a "manageable", is difficult to achieve. It is stressed that this is an "inconvenient truth" that

cannot be avoided if covariance information is to be truly useful to users and misleading erroneous conclusions are to be avoided. The ability of contemporary user analysis tools to properly utilize covariance information is also a contributing factor in this context. The presentation discusses factors that lead to correlations between materials. One of the most important of these factors is that most experiments rely on a common set of fundamental measurement standards that introduce unavoidable correlations. Recognizing the reluctance of the applied nuclear science community to accept a requirement for enormously large nuclear data libraries, this presentation also offered some suggestions for addressing this problem.

N. Larson (ORNL) --- *Paradigm shift for resonance-region uncertainties*

It has been recognized for some time that the assumption that the uncertainties of cross sections calculated for the resolved resonance region from resonance parameter uncertainties alone tends to lead to what appear to be unrealistically small uncertainties in many instances. Therefore, this presentation suggests that the notion that all covariance information for the resonance region can be confined to MF = 32 files for the individual materials is flawed. This presentation points out that in order to obtain realistic uncertainties for cross sections in the resonance region, one must consider uncertainties in background and normalization effects (most prominently) as well as a variety of other uncertainties related to the data measurement and analysis processes. These uncertainties need to included in an MF = 33 file that accompanies the MF = 32 file. The only way that the uncertainties could be completely represented by an MF = 32 file alone would be to assume perfection of the R-matrix model, data corrections for background, etc. This is simply unrealistic. Some examples are given that show how inclusion of additional uncertainty information in a corresponding MF = 33 files can alter the uncertainty profiles and correlation patterns significantly.

P. Oblozinsky (BNL) --- *Covariance Workshop in 2008*

The BNL-NNDC is organizing a covariance workshop that will take place at the Danford Inn in Port Jefferson, New York, from 24-27 June 2008. The objectives of this workshop will be to identify issues associated with covariance methodologies and agree on procedures, to generate some good examples of covariance evaluations, and to explore the issue from the users' perspectives and requirements. It is anticipated that as many as 60 scientists could be expected to attend, with roughly half from the United States, 15 from Europe, and 15 from Asia and elsewhere. A program committee will be organized early in 2008. Roughly half of the accepted contributions will be oral talks while the rest will be posters. It is planned to publish peer-refereed papers in the journal *Nuclear Data Sheets*. The number of these refereed, accepted papers, as well the length limitations, will need to be decided upon based on the page quota allotted by the *Nuclear Data Sheets*.

D. Brown (LLNL) --- A *new approach for dealing with covariances using XML*

This paper offered a simple primer on how covariance information is generated and suggested that some of the problems being faced by the CSEWG community is

dealing with covariances in the ENDF format might be avoided by using more advanced data management procedures and formats, e.g., using representations in XML. It was pointed out that by resorting to techniques of linear algebra it may well be possible to reduce the quantity of information that needs to be stored. Furthermore, the opportunity to use hyperlinks within the XML framework could be very useful when it is necessary to refer to information related to more than one material, or when other forms of cross correlation information are involved. LLNL is just beginning to think about this approach. For the foreseeable future, CSEWG will, by necessity, be required to work within the framework of the existing formats, however inconvenient that may be in many instances. There are two reasons: First, limited resources in the nuclear data community simply would not allow such a massive undertaking as would be required to make a major transformation of formats and file structures. Second, the user communities, which rely on interfacing procedures to "process" ENDF data, such as provided by NJOY or AMPX, simply are not equipped to deal with drastic changes in formats and file structures. But, who knows what will happen in the future. It is clearly beneficial and useful to the nuclear data community for LLNL to be exploring new approaches such as the one presented in this contribution.

Discussion

Following these formal presentations, an hour-long session was held that was devoted to an open discussion of a number of issues that will impact on the functioning of CovCom in the future. The various topics explored generally fell into the following seven broad categories:

- Objectives of CovCom
- Working methods of CovCom
- Interaction with other CSEWG committees
- Participation in CovCom
- Users of covariances and their tools
- Requirements and distinct problems for thermal, RR, and fast neutron regions
- Library C/E "tweaking" vs. error propagation results.

These various discussion areas were not addressed to an even extent at this meeting, nor did these discussions proceed in an orderly fashion. Rather, this exercise amounted to a "brainstorming" session that was held to benefit from spontaneous thoughts and ideas that might emerge from the attendees. The session was well attended (well in excess of 20 people), and the discussions were lively and very informative. The following talking bullets attempt to capture the essence of some of this material:

- The main mission of CovCom ought to be to stimulate methods development and aid in the production of good quality covariance files for inclusion in future releases of ENDF/B (ENDF/B-VII.1 and beyond).
- CovCom should offer advice to evaluators and CSEWG on how to generate the best possible covariance information consistent with practical considerations.

- CovCom should work to establish good contacts with various user communities and to provide feedback to CSEWG on their needs and expectations for ENDF evaluations in the area of covariances.
- The question was raised as to whether the analytical tools to provide checks on the quality and utility of generated covariance information were available. These would include applications codes that can calculate system sensitivities and thereby propagate uncertainty information in evaluated nuclear data files to generate system parameter uncertainties. It's clearly an open question.
- It was acknowledged that C/E comparisons for well established benchmarks will, and should, continue to play an important role in validating evaluated nuclear data libraries. Just how the results of propagating library covariance information might be considered and interpreted by the applied community, vis-à-vis results from the traditional data testing approaches, needs to be explored.
- It was generally agreed that in most instances the system parameter uncertainties propagated from covariance files (e.g., for k-eff) are likely to be considerably larger than what the applied communities are likely to accept as differences of C/E from unity for acceptably validated libraries. As a consequence, "tweaking" and data adjusted libraries for specific applications are likely to be the norm for the foreseeable future as is the case at present.
- This line of discussion led to a lively exchange of views about the merits and pitfalls of "tweaking" evaluations based on integral benchmark data. This is an old controversy that is indeed familiar to long-standing CSEWG members (the old-timers). From a practical point of view it was generally accepted (although reluctantly by some attendees) that some degree of "tweaking" of evaluations for important materials such as U-235 and Pu-239 is probably necessary and acceptable as long as this "tweaking" lies within the range of uncertainties to be expected from evaluations based solely on differential data.
- The point was made that while actual evaluated results based on "tweaking" to provide C/E agreements closer to unity than might be expected as a consequence of considering only differential data are to be expected, the evaluated libraries should still retain uncertainties based on analysis with differential information alone. This would be the conservative approach. What users then do to actually adjust their processed libraries to reflect reduced uncertainties from inclusion of integral data is up to them. Owing to the obvious differences of opinion in this touchy area, it is clear that this topic will need to be revisited many times again in the future.
- The question was raised as to what procedures could be implemented to provide the equivalent of file Phase 1 and Phase CSEWG reviewing for covariances. It was suggested that covariance files should satisfy all the basic requirements of having positive-definite matrices, of being processable, of satisfying the NNDC checking codes, etc. In addition, it was agreed that further human intervention and critical review was absolutely necessary. In other words, the final evaluated covariances ought to be examined visually by considering plots of uncertainty profiles and correlations, e.g., as generated by processing codes such as NJOY or AMPX. The status of such visualization procedures was discussed briefly in this context.

- A novel suggestion was offered that random variations of evaluated cross sections produced by Monte Carlo simulation might produce pseudo data that could then be compared in plots along with real experimental data thereby providing a "reality" check.
- A question as to how experimentalists ought to go about generating information needed by evaluators to produce reasonable covariances stimulated a lively discussion. How much detail should be included, etc.? It was suggested that at the very least attention ought to be given to quantifying the main sources of uncertainty in experiments such as normalization factors, background effects, etc., that tend to lead to long range correlations. The example of covariances for the resolved resonance region, where consideration of resonance parameter uncertainties alone tends to lead to an underestimation of the true uncertainties for cross sections calculated using these parameters, was discussed as an example of this problem.
- There was strong support for a suggestion that CovCom ought to work with the Measurement Committee to establish guidelines for experimenters in generating covariances for their experimental data. It was agreed that this recommendation would be pursued further.
- There was minimal discussion at this meeting as to how the various suggestions and agreed upon procedures for generating covariances would impact on file format issues. In particular, there was no consensus reached at the meeting regarding a suggestion that uncertainties in the resolved resonance region would involve components in both the MF=32 and MF=33 file categories (see contribution above from N. Larson). In the past it has generally been assumed that all uncertainty information for the RR region would be contained in MF=32 files.
- There was a discussion on how the peculiarities of measured data for the RR region (e.g., transmission, capture, and fission) could lead to the need for MF=33 contributions to the uncertainty as well as to the strange patterns (structure) observed in the uncertainty profiles for processed for processed covariance information in this region.
- It was suggested that while the extensive covariance information that could be generated for MF=32 files by evaluators might not end up being included in final ENDF libraries because their inclusion in full would seriously bloat the library, especially for actinides and other heavy nuclei. However, they nevertheless should be retained in "safe" repositories, e.g., on disk storage at the individual laboratories, in the event that the detail might be required in the future for some special applications such as those instances where self-shielding effects are important.
- It was suggested that procedures such as those introduced many years ago by Bondarenko might be used to handle self-shielding effects while reducing the content of information required that needs to be included in the ENDF libraries.
- The hour-long discussion period at this meeting ended with a lively exchange concerning what users actually need in the way of covariance information vis-à-vis what evaluators can produce. It was acknowledge that the needs of users vary widely depending on the application, but no consensus was reached concerning what would be the optimal level of detail to include in ENDF evaluated libraries.

In view of the clear benefits gained from the open discussions held during this meeting of CovCom, the Chair stated that such sessions will likely be an important feature of future meetings of this committee at CSEWG along with individual presentations. The meeting was adjourned with no clear list of actions. However, several obvious areas of activity of this committee have been identified as a consequence of this meeting.

Cross Section Evaluation Working Group

Formats and Processing Committee Report

Michael E. Dunn, ORNL
Committee Chairman

The Formats and Processing Committee meeting was convened on November 7, 2007. The initial part of the meeting was devoted to review and discussion of eight ENDF-6 format proposals. Subsequently, a special presentation about new methods for treating resonance scattering was provided by Ron Dagan (KIT). After the presentation by Dagan, status reports on the major processing codes were presented. The Formats and Processing meeting concluded with a status report from BNL concerning NNDC activities related to Formats and Processing.

Proposed Format Revisions

Eight ENDF-6 format proposals were presented to the CSEWG for discussion. The first five format proposals were provided by the JEFF community. Because the authors of the JEFF proposals were not able to attend the meeting, the proposals were presented for discussion by the Format Committee Chairman, Mike Dunn. The remaining proposals were presented by the appropriate author, and a summary of the CSEWG review is provided in the following discussion:

Proposed LB=8 covariance format modification (Andrej Trkov)

The LB=8 covariance section is designed to represent the fluctuations of a cross section within an energy interval for which the average covariance data are given in other sections. Andrej Trkov provided a formal proposal describing the numerical issues with the implementation of the LB=8 equation as defined in the ENDF/B manual. Depending on the choice of energy grid by the evaluator and/or end-user, the calculated variance contribution can become nonphysical and unrealistic. To this end, Trkov proposed a new LB=9 format with an equation that places reasonable bounds on the variance calculation. The entire proposal is available at the 2007 CSEWG meeting website. After discussion by the CSEWG, the LB=9 format was conditionally approved pending the additional action by the author. Further guidance is needed on the use of the LB=9 format in the manual. Some CSEWG members noted that the proposed LB=9 alleviates the numerical problem created with the LB=8 format; however, there could be numerical problems with the proposed LB=9 format. The CSEWG is concerned that we may solve one problem but introduce a separate problem with the new format. Another observation is the variance goes to zero when the user group boundaries (delta Ej) coincide with the evaluation boundaries (delta Ek). Is this the intended result when the evaluator and group boundaries coincide? In summary, the format was conditionally approved pending resolution of the noted issues.

Definition of stable nuclei for cumulative yields (Robert Mills and Andrej Trkov)

When comparing the cumulative yields between JEFF-3.1 and other libraries, very large differences for some nuclides are observed. Such an analysis was done by Liu Tingjin within the scope of the Th-U CRP of the IAEA. Based on the study, the differences are attributed to the definition of stable nuclei. There exist nuclides with extremely long half-lives; however, there is no formal consensus as to what constitutes a stable nuclide. If a formalistic approach is adopted, cumulative yields should include all precursors, even if their half-lives are longer than 10^{10} years. Unfortunately, this is not a practical approach; rather, the question is, where to draw the line. The JEFF evaluator placed it at some practical limit applicable to waste disposal studies. Other evaluators assumed a higher limit, and hence the differences. Per the JEFF community, the ENDF manual should contain a recommendation to the evaluators that would unify the definition of cumulative yields in different libraries.

Robert Mills provided a format revision to ENDF/B File 8, and the CSEWG reviewed and discussed the proposal. The CSEWG agreed that there is an issue with providing a consistent definition of what constitutes "stable" nuclei. The proposal from Mills specified a definition of 0.32 million years. This may be an acceptable definition for one application, but others may prefer a different value. As a possible example, Skip Kahler noted that the Yucca Mountain Project staff may need a much longer definition due to their regulatory constraints. There could be other users that have different requirements. Therefore, the CSEWG would prefer a more general solution to this problem. An alternative would be to allow the evaluator to use MF8/MT459 to specify a cutoff half-life as a parameter in the evaluation. The CSEWG would prefer this generalized approach. Therefore, the CSEWG decided that the proposal should be revised to be more general.

Inclusion of LCT flag in MF34 (Andrej Trkov and Ivo Kodeli)

In the ENDF/B format procedures for angular distributions, a transformation matrix for converting Legendre coefficients between center-of-mass (CM) and laboratory (LAB) system is a full matrix. Uncertainty in one component in the LAB system affects all components in the CM system, and vice versa. The Legendre terms in MF4 of an ENDF file are usually given in the CM system. Since the covariances in MF34 are restricted to a small number of terms, some information from an "accurately known" covariance of a P1 scattering cross section will be lost when converting to CM, and again when reconstructing the Pl cross sections in the LAB system.

A proposal was submitted by Trkov and Kodeli to allow a covariance matrix in MF34 of an ENDF file to be given in the LAB system even when Legendre coefficients in MF4 are given in the CM system. The details of the full proposal are provided at the 2007 CSEWG meeting website. A description of the proposed

changes to the ENDF/B manual is included in the full proposal. The CSEWG reviewed the proposal, and the proposed format was approved.

Resolve ambiguity of data representation in MF35 (Andrej Trkov)

In the current version of the ENDF-6 manual, there is some confusion concerning the procedures with defining covariance matrices for the energy distribution of secondary particles. The unnumbered equation in Section 35.2 on page 35.3 defines the covariance of the energy distributions of emitted particles as the covariance of the probability density distribution. This is the form in which various laws in MF5 are defined, including the option giving the data in tabular form.

In Section 35.3 that follows, the constraint is elaborated that the probability density distribution must be normalized to one. The need to specify the absolute covariance is a natural consequence of this requirement, but it is also stated, that the sum of any row or column of the covariance matrix must be zero. This is only true in general if the covariance data are given on the energy-bin probabilities (i.e. the covariance of the probabilities that particles appear in a certain energy bin). The difference between the two definitions is that elements of the matrix are scaled by the corresponding bin-widths. The equation suggesting the corrective action on checking the summation condition is also affected. The question is whether the additional constraint is needed. In other words, is it absolutely necessary that that the sum of any row or column of the covariance matrix be zero?

Currently, there are different implementations of the MF35 covariance data procedure. In particular, the spontaneous fission spectrum covariance data for ^{252}Cf of the Mannhart were adopted for ENDF/B-VII (unchanged from ENDF/B-VI) and follow the recommendations outlined in the procedures in Section 35.3. Actinide evaluations in JENDL-3.3 follow the definition implied by the first equation in Section 35.2 on page 35.2, and the JENDL evaluations do not impose the additional constraint that the sum of any row or column of the covariance matrix be zero. To compound the issue, the ERRORJ code that can process MF35 data follows the conventions adopted in the JENDL-3.3 files. The status of ERRORJ is important because of the intentions to incorporate it in full as a module of the official NJOY distribution.

The CSEWG discussed the issue and agreed that further study is needed before a formal decision/ruling can be made. The ENDF/B-VII.0 ^{252}Cf evaluation is in compliance with the procedures outlined in the ENDF manual; however, the JENDL evaluations are not in strict compliance per the manual. With that said, the CSEWG could not provide a reasonable explanation as to why the extra constraint is provided in Section 35.3. The recommendation was made for the new Covariance Committee, which is chaired by Don Smith, to investigate the File 35 issue raised in the proposal and provide recommendations to the CSEWG

on the procedures outlined in Section 35.3.

File 5 Issue for ^{9}Be (n,2n) (Chris Dean):

JEFF3.1 has adopted the EFF file where there are cross sections in MF=3, MT=875 to 891 and a detailed description of neutron emission spectra is provided in MF=6, MT= 875 to 891. Furthermore, the fusion experts believe that a neutron emission spectra cannot be designed to associate with MT=16. The data must be input in MT= 875 to 891. Based on Chris Dean's understanding of the ENDF/B format, if a cross-section for MT=16 is present, emission spectra must be provided in MF=5 or MF=6. Dean requested that this format restriction be removed. Removal of the restriction would allow cross sections for MT=16 (i.e., sum of MT 875 to 891) to be present in a File 3 without the addition of a neutron emission spectrum with MT=16 in File 5 or File 6. Otherwise, the evaluation would contain no MF=3, MT=16 data and the total cross section would be too small.

The CSEWG reviewed the issue raised by Chris Dean. Based on the ENDF/B File 5 format description, the CSEWG determined that there is no requirement that a File 5 must be present for MT=16. As stated in Section 5.1 of the ENDF/B manual, "Data should be given in File 5 for MT=91 (inelastic scattering to a continuum of levels), MT=18 (fission),MT=16 (n,2n), MT=17 (n,3n), MT=455 (delayed neutrons from fission), and certain other nonelastic reactions that produce secondary neutrons." The procedure states that the data "should" be given in File 5 instead of "shall" be given. Therefore, the JEFF3.1 ^{9}Be evaluation is in compliance with the ENDF/B Format requirements and procedures (i.e., in a strict interpretation of the procedure). The representatives of the major processing codes participated in the CSEWG discussion (i.e., NJOY, PREPRO, and AMPX), and the processing developers concurred that the codes should be updated to process the evaluation accordingly.

LANL Fission Energy Release (Skip Kahler)

At the 2006 CSEWG meeting, LANL proposed a revision to the ENDF Fission Energy Release Format (MF=1 Section 458). The proposed format accommodates Dave Madland's work recommending the use of polynomial expansions to describe the energy dependence of the various energy release terms. The 2006 proposal was conditionally approved until LANL provided a revised manual description for Section 1.5 of the format manual. Per the 2006 CSEWG meeting, LANL provided the revised Section 1.5. Therefore, the proposed energy release format was changed from conditionally approved to approved by the CSEWG.

BNL uncertainty on scattering radius (Mike Herman)

Mike Herman provided an informal description of the possible need for transmitting the uncertainty of the resonance parameter scattering radius. No formal proposal was

provided to the CSEWG for consideration. Additional study will be needed by the newly formed Covariance Committee.

ENDF-6 format proposal related to JENDL PKA/KERMA File (Tokio Fukahori)

Tokio Fukahori (JAEA) gave a presentation requesting permission to develop two new ENDF/B format files for DPA cross-section data (MF=63) and damage energy spectra (MF=66). The proposed files are needed to supply fundamental data for the estimation of the radiation damage in solid materials. Although the presentation provided a very thorough explanation for the needed data with a description for providing the data, a format proposal with the ENDF manual description was not provided. As a result, the CSEWG could not make a decision without this information. The CSEWG requested that Tokio Fukahori prepare the required ENDF manual description for MF=63 and 66. This description should be provided as part of a formal proposal package for the next CSEWG meeting.

After the review and discussion of the proposed format issues, Ron Dagan provided a special presentation titled "On the Effect of the Resonant Dependent Scattering Kernel for Heavy Isotopes." Dagan noted that there are computational issues with the current approach for calculating the scattering kernel term for heavy isotopes in the Boltzmann transport equation. In reality, the resonant scattering cross section is temperature and independent; however, the scattering kernel is usually used at 0 K and is assumed to be energy independent. Dagan provided results showing the consequences of this approximation. The presentation demonstrates an improved scattering kernel treatment for fuel cycle applications. For example, the improved treatment for ^{238}U results in a 2% change in the prediction of the ^{239}Pu inventory in spent fuel analyses. Dagan reported that new time-of-flight measurements have been performed, and the results, thus far, confirm the new scattering kernel development. Additional details can be found in the presentation that is provided at the 2007 CSEWG meeting website.

Status of Processing Codes

NJOY (Skip Kahler)

The latest version of the processing code is NJOY99.259 (as of October 16, 2007). The latest version includes the ERRORJ module developed by Go Chiba. Skip noted that LANL is currently working on a Fortran 90/95 version of NJOY for release during FY08. The new version will include the capability to process the LRF=7 resonance format. At the 2006 CSEWG meeting, the latest version of the processing code was NJOY99.161. The detailed NJOY presentation is provided at the 2007 CSEWG meeting website, and the presentation provides specific details concerning the updates made between NJOY99.161 and NJOY99.259. With the latest version of NJOY, all 393 ENDF/B-VII.0 files can be processed. In addition, NJOY99.259 has been used to process all 381 JEFF3.1 files. With regard to JENDL, 335 of 337 JENDL-3.3 files can be processed.

There are known evaluation issues for ^{93}Nb and ^{207}Pb that affect the HEATR module. LANL plans to conduct a NJOY User Group meeting with a workshop/tutorial at the 2007 JEFF/EFF meeting. In addition, LANL will offer "hands-on" workshops at the April 2008 RPSD Topical Meeting (Atlanta, GA) and the June 2008 ANS meeting in Anaheim, CA.

AMPX (Mike Dunn)

Mike Dunn gave a presentation covering the current status of the ORNL AMPX system that includes continuous-energy, multi-group, and covariance processing capabilities. With regard to covariance processing capabilities, the PUFF-IV module has been updated to process the ENDF/B Compact Covariance Format. In addition, ORNL has developed an automated tool to combine low-energy (< 5 keV) File 33 low-fidelity covariance data files from ORNL with high-energy low-fidelity File 33 covariance data recently produced by BNL (219 fission products). The combined data have been processed with PUFF-IV into COVERX format for testing with SCALE sensitivity/uncertainty (S/U) analysis tools. In addition to the File 33 efforts, ORNL has developed a computational tool to convert File 32 resonance parameter covariance matrices into File 33 multi-group covariance matrices. With regard to cross-section processing updates, the POLIDENT module that generates continuous-energy cross-section data from resonance parameters has been updated to FORTRAN 90/95. Furthermore, POLIDENT has been updated to process the LRF=7 resonance parameter format. Since the 2006 CSEWG meeting, AMPX has been used to develop continuous-energy ENDF/B-VI.7, VI.8 and VII.0 neutron libraries for the SCALE continuous-energy KENO Monte Carlo code (CE-KENO). AMPX has been used to produce a coupled neutron-gamma shielding library (200 neutron groups and 44 gamma groups) based on ENDF/B-VI.8. The library is currently being testing for release with SCALE 6 in 2008. AMPX has also been used to produce covariance data libraries that will be released with SCALE 6. In addition to SCALE support, AMPX has been used to prepare 15-group ^{235}U, ^{238}U, and ^{239}Pu covariance data files for WPEC Subgroup 26.

LLNL Processing Codes (David Brown)

David Brown provided an overview of the LLNL nuclear data processing system that supplies data to the LLNL Monte Carlo and deterministic transport codes Mercury and AMTRAN, respectively. Data testing is an integral part of the LLNL data processing activities, and there is an ongoing effort to developing a comprehensive test suite and automation tools to address the ASC program Quality Assurance mandate. Additional details concerning the LLNL deterministic and Monte Carlo processing status is provided in the presentation by Brown at the 2007 CSEWG Meeting website.

ANL Processing Codes (Dick McKnight)

Dick McKnight provided the status report on the ANL processing codes. Dick noted that ANL has two new staff members that are working on the cross-section processing methods development. During the past year, the new staff members have made valuable improvements to the ANL processing tools.

After the processing code status reports, two additional presentations were provided on MCNP library production efforts:

Status of MCNP ENDF/B-VII.0 Library (Bob Little)

LANL has been working to develop a MCNP ENDF/B-VII.0 library (ENDF70) that will be distributed to MCNP users. Bob Little provided a status report on the library production effort. The library has 392 isotopes (excludes incomplete evaluation for ^{7}Be). The cross-section data are provided at five different temperatures (i.e., 293.6 K, 600 K, 900 K, 1200 K, and 2500 K). NJOY99.248 was used to prepare the library. The library is currently 8.8 GB uncompressed. During the library production effort, LANL encountered evaluation problems for 10-15 ENDF/B-VII.0 evaluations. LANL made corrections to the evaluations to facilitate processing by NJOY. LANL will provide the corrected evaluations to BNL for NNDC to release as updated ENDF/B-VII evaluations. Currently, LANL is in the final QA, testing, and documentation phase. The library will be distributed with a new MCNP 5 update (MCNP5 1.50). The new library and code should be provided to RSICC during the first quarter of FY08. The MCNP library will definitely include neutron and proton data; however, the library may include thermal scattering law data and photonuclear data. The ENDF70 library will not include photo-atomic data or data for other charged particles (e.g., D, T, ^{3}He incident).

ENDF/B-VII.0 Library in ACE Format (Ramon Arcilla)

As part of NNDC efforts to test ENDF/B-VII.0 for distribution, BNL used NJOY to process the ENDF/B-VII.0 evaluations and prepare ACE-formatted files for use with MCNP. As a result of these efforts, NNDC received requests from MCNP users to make the ENDF/B-VII.0 ACE files available to the public. Ramon Arcilla provided an overview of the NNDC ACE library generation and distribution efforts. The ENDF/B-VII.0-ACE library includes 392 materials (neutron reactions) at 300 K. The library also includes neutron thermal scattering law data (20 materials, one temperature for each material). The library is available to data testers through RSICC. For a data tester to receive the library, the data tester must request the library from RSICC. Subsequently, RSICC will ask the CSEWG chairman to approve the release of the library to the requestor. At this point, RSICC has received requests from more than 50 MCNP users who are mostly CSEWG members.

BNL Activities Related to Formats and Processing (Mike Herman)

Mike Herman provided a status report on the NNDC Checking Codes and the ENDF-102 Manual. Mike provided a status report on CHECKR-7.04, FIZCON-7.05, PSYCHE-7.03, and STANEF-7.02. Additional details for each checking code are provided in the presentation at the 2007 CSEWG Meeting website.

With regard to the ENDF-102 Manual, Mike noted the problems with the current manual. Due to the use of MS Word, the manual lacks modern features (i.e., structuring, hyperlinks, automatic indexing, and referencing). Furthermore, the MS Word version of the manual requires 1.5 hours to convert to PDF and 3 hours to print a hardcopy. To compound the issue, recent format updates have not been included, and some manual changes were lost in 2005. Based on the noted problems, NNDC is in the process of converting the manual to LaTeX. An automatic MS Word to LaTeX conversion tool is being used. Thus far, four rounds of editing have been performed on each file. Mike noted that Chapters 2, 32, and Appendix D may require additional editing. Two draft copies of the manual were passed around the meeting room, and Mike summarized the changes that have been made to the manual. During the discussion, Skip Kahler asked whether CSEWG should adopt a set of the latest recommended constants for inclusion in the manual. The evaluation codes and processing codes would then be expected to use the recommended constants. The issue was discussed by the CSEWG, but no decision was made concerning the constants. Furthermore, Pavel Oblozinsky noted that NNDC needs help from the Formats and Processing Committee to help review and polish the manual. Dick McKnight suggested that different CSEWG members should be asked to review specific sections to help NNDC finalize the ENDF manual. The CSEWG members agreed that a shared effort should be used to finalize the manual.

The Formats and Processing Committee adjourned at 4 pm on November 7, 2007.

Cross Section Evaluation Working Group

Measurements Committee Report

Y. Danon, RPI
Committee Chairman

The Measurements Committee session was held on the morning of November 7, 2007. Seven presentations were given from representatives of experimental programs at LANL, ORNL, NIST, LBNL, LLNL and RPI. The presentations give a general overview of current research and measurement performed at the different laboratories.

Agenda

Neutron cross section measurements

- Research directions at LANSCE, Haight, 15'
- Status report of ORNL measurement activities, Dunn, 15'
- NIST measurements, including standards activity, Carlson, 15'
- Neutron Cross Section Measurements at LBNL, Firestone, 15'
- Determining the Np-237(n, f) cross section with surrogate method, Basunia, 15'
- Cross Section Measurements and Analysis at Rensselaer, Danon, 15'
- Experiments at LLNL, Wu, 15'
- Others

Other topics

- Improvement of EXFOR (WPEC SG30), Oblozinsky, 5'

U.S. Laboratory Measurement Programs

1. Research directions at LANSCE, Robert Haight (LANL)

Recent measurements with GEANIE in the energy range from 1 MeV to 200 MeV include: isomer lifetimes for ^{203}Tl, ^{205}Tl and cross section measurements ^{48}Ti(n,xγ). Levels and isomers studies on ^{103}Rh, ^{169}Tm and nat-Lu (n,xγ). Data was also acquired for ^{70,72,74}Ge, ^{100}Mo, ^{124}Sn, ^{130}Te, 136Xe, ^{138}Ba. Spin studies on ^{135}Xe and ^{202}Tl were also presented.

An array of neutron detector called FIGARO was used to measure fission neutron and gamma emission in the energy range from 1 MeV to 200 MeV for ^{239}Pu, ^{235}U and ^{237}Np. The scattered neutron distribution in a double TOF experiment for ^{56}Fe and natural Mo was measured.

Measurements of ^{6}Li(n,t)α cross section and angular distributions in the energy range from 0.5 MeV to 10 MeV are in progress. The goal is better than 5% accuracy.

Helium production cross section measurements resulting from neutrons on Fe, Cr and Ta in the energy range from 5 MeV to 100 MeV were completed.

Measurements of (n, γ) cross section with DANCE were performed on isotopes of Mo, Nd, Sm, Gd, Eu, Sm, Tl, Pu, and Am.

Fission cross section measurements on ^{237}Np were published. Fission Measurements of on ^{240,242,241,239}Pu and ^{233}U are in progress.

A new time projection detector is under construction as a NERI project lead by Georgia Institute of Technology and will be initially used for high accuracy measurements of the fission cross section of ^{239}Pu.

2. ORNL, presented by Mike Dunn (ORNL)

ORELA is now running after a long shutdown. Capture and transmission measurements on ^{41}KCl were recently completed. New ^{41}K evaluation is expected to result from this analysis. Mn capture measurements were completed including preliminary SAMMY fits. Transmission measurements on Cr and capture measurements on ^{58}Ni were started Analysis of elemental Mn and ^{95}Mo measurements are in progress.

Plans to finish total and capture measurements of ^{53}Cr, ^{58}Ni, ^{60}Ni, ^{63}Cu, ^{65}Cu, ^{86,87}Sr, ^{149}Sm(n,α), and ^{64}Zn(n,α).

3. NIST Nuclear Data Standards Measurements - Allan D. Carlson (NIST)

Several efforts related to standard cross section measurements were discussed.

H(n,n): Collaboration with Ohio University, LANL and the University of Guelma to measure H(n,n) cross section at different angles at 14.9 MeV. New TPC detector is now being developed and will improve these measurements. The cross section is a bit lower than ENDF/B-VII.0 at angles near 180 deg in CM.

^{3}He(n,p): New measurements on ^{3}He(n,p) has been designed. This measurement will allow separation of the real part of the two spin channels of this interaction. (collaboration with Indiana University and the University of North Carolina)

^{6}Li(n,t): New measurements of the ^{6}Li(n,t) cross section standard at ~ 4 meV are in progress. This is the first direct and absolute measurement of this cross sections in this neutron energy range using mono-energetic neutrons.

^{10}B(n,α): The same experimental setup will be used to measure the ^{10}B(n,α) cross section.

Au(n,γ): Measurements of the capture cross section for Au have been made at the n-TOF facility by Massimi et al. with the objective of adding the energy range from 1 eV to 10 keV to the standards energy region. Data obtained from 1 eV to 1 keV using two

different detector systems were shown at the ND2007 conference. Analysis of the data should provide results up to 1 MeV.

^{235}U(n,f), ^{238}U(n,f): The Nolte et al. ^{235}U(n,f) and ^{238}U(n,f) cross section measurements which extend from about 32 MeV to 200 MeV were published this year. Some of the data were used in the standards evaluation. Measurements of the ^{238}U(n,f)/^{235}U(n,f) cross section ratio have been made by two experimental groups at the n_TOF facility. Both groups gave papers on their work at the ND2007 conference.

Data Development Project Activities: Pronyaev has worked on a new method for smoothing the Au(n,γ) cross section by using statistical model calculations. The objective is to remove non-physical fluctuations (structure) and maintain real structure such as the cusps that occur from competition with inelastic scattering. The model fit will be used in the standards database as shape input. One plans to investigate the possibility of developing an inelastic scattering cross section standard; consider adding additional standards energy ranges for the Au(n,γ) cross-section; propose updates for the evaluations of the ^{252}Cf spontaneous fission neutron spectrum and the ^{235}U thermal neutron-induced fission neutron spectrum.

4. Neutron Cross Section Measurements at LBNL - Richard B. Firestone (LBNL)

Thermal neutron γ-ray (capture) cross sections were measured at the Budapest Reactor for all elements with Z=1-83, 92 except He and Pm. These measurement feature: pure thermal guided neutron beam, internal standard calibrations, precision of <3% for strong transitions. IAEA sponsored an evaluation of the capture cross section. Results for low Z isotopes were shown.

Extension to heavier elements where the prompt gamma spectrum is more complicated and it requires physics models and calculations to determine the population of observable low energy states from higher state excitations.

5. Determining the ^{237}Np(n,f) cross section with surrogate method - Shamsu Basunia (LBNL)

The surrogate method was described. It uses measurements of ^{238}U(^{3}He,t)^{238}Np and models to determine the ^{237}Np(n,f) fission cross section. These measurements are typically done from about 0.5 MeV to 20 MeV. The measurements are done at LIBERACE and STARS detectors at the 88-Inch Cyclotron at LBNL.

Measurements of ^{236}U(n,f) using the ^{238}U(^{3}He,α)/^{235}U(^{3}He,α) ration and (n,γ) cross section for ^{153,155,157}Gd isotopes measured using the excitation with (p, p′) reaction were also presented.

6. Cross Section Measurements and Analysis at Rensselaer – Yaron Danon (RPI)

Total cross section of Mo in the energy range from 0.01 to 20 MeV were measured using the iron filtered beam technique and also at the 100m flight path. Below 1 MeV the data are in agreement with ENDF/B-VI.8.

Measurements of beryllium using the same two systems were also presented below 0.6 MeV the data is in better agreement with ENDF/V-VI.8 and significantly higher than ENDF/B-VII.0.

A neutron scattering system to be operated in the energy range from 0.5 MeV to 15 MeV was tested with graphite and preliminary results were shown. This system will be used to benchmark of scattering cross section evaluations.

Thermal neutron transmission and capture measurements of elemental Cd were presented. The data is 5% lower than ENDF/B-VII.0. This measurement supports results from benchmarks that were reported by Mosteller during the Validation Committee session.

A new detector system for high resolution total cross section measurements in the resonance region is under development.

Results of measurement with the RPI LSDS for ^{235}U fission cross section and simultaneous measurements of the energy dependent fission fragment mass and energy distributions were presented. Measurements on ^{239}Pu are next.

RPI is developing detectors for (n,α) measurements on small samples (micrograms) that will be done using the RPI and LANL LSDS.

7. Experimental program at LLNL Ching-Yen Wu (LLNL)

Measurements of ^{241}Am(n,2n) that were done at TUNL using activation analysis were presented. This method provides about 11 points in the energy range from 7 MeV to 15 MeV. The data is in good agreement with ENDF/B-VII.0. This method can measure cross sections of the order of 10^{-2} barn. The accuracy of the data or method was not given. Measurements of ^{239}Pu(n,2n) using prompt gamma are planed. In this method partial (n,γn) reactions are measured and theoretical models are used to find the contribution of the missing levels. The measurement is done in anticoincidence with fission.

Surrogate reaction: ^{238}U(α,α') was used to measure the ^{237}U(n,f) cross section from 0.5 MeV to 20 MeV with accuracy of 10-30%.

Capture measurements of ^{241m}Am were done at DANCE with sample size of 47 μg covering the energy range from about 1eV to 105 eV.

A new Time Projection Chamber was discussed. It will be operated at LANL.

ALEXIS: an intense, pelletron (accelerates p and D) based tunable neutron source at LLNL was described. Using different targets this source can be tuned between 0.01 MeV to 15MeV with typical energy resolution of about 1% to 10%. And neutron flux of up to 10^{10} n/sec this can be useful for variety of measurements.

Other Topics

8. Improvement of EXFOR (WPEC SG30) – Pavel Oblozinsky (NNDC)

The objective of WPEC Subgroup 30 was presented. This new subgroup, SG30, chaired by A. Koning, NRG Petten, met at 1-day meeting at the IAEA, Vienna in October 2007. The objective of SG30 is to improve the database of experimental cross sections, EXFOR. In short term SG30 should address obvious deficiencies and improve EXFOR conversion from X4 format to the computational format C4. Later, it should proceed with a deeper level of improvements in order to achieve "quality EXFOR".

Summary of the
10th U.S. Nuclear Data Program Meeting

Held at
Brookhaven National Laboratory
November 7 - 9, 2007

US Nuclear Data Program

Chairman's Summary

P. Oblozinsky
National Nuclear Data Center, BNL

USNDP Annual Meeting

The 10th Annual Meeting of the United States Nuclear Data Program was held on November 7-9, 2007 and attended by 39 participants. The meeting was held adjacent to the CSEWG Annual Meeting, with a common USNDP-CSEWG session on neutron cross section covariance data.

Nuclear Structure Working Group

The status of basic databases NSR, XUNDL and ENSDF was reviewed. The ENSDF evaluation productivity continued to be fairly high, while increasing amount of contributions from young evaluators were noted with satisfaction. To strengthen this positive trend, two post-docs are being hired (TUNL and ANL), each with approximately equal share between the structure evaluation and structure research work.

Procedures were agreed to shorten the size of papers in Nuclear Data Sheets and modernization of the NDS publication technology including drawings was recommended.

Nuclear Reaction Working Group

A common CSEWG-USNDP session was devoted to covariance methodology, stimulated by the growing needs for cross-section covariance data in many applications.

Recent progress in the nuclear reaction model code development was reported in several US laboratories.

User Discussion Forum

This activity, established in 2005-2006 and aimed to strengthen interaction between the user community and USNDP, continued in 2007. A half-day session was devoted to presentations and discussions with three prominent scientists from the United States and one from Europe.

Task Forces

The Task Force on Nuclear Data for/from RIA should be terminated. This activity should be restarted once the funding for RIA facilities will become better defined. The other two task forces will continue (Nuclear Data for Astrophysics, Nuclear Data for Homeland Security).

Planning and Reporting

- Summary of the present Annual Meeting should be issued in December 2007,
- Annual Report for FY07 in January 2008, and
- Workplan FY09 in February 2007.

The next budget briefing is likely to be held in February 2008, as a preparation for FY 2010. The budget briefing team should include Pavel Oblozinsky and WG chairs Coral Baglin and Toshihiko Kawano. If possible, Filip Kondev, Mike Herman and Rick Firestone should be included to provide fresh perspectives. One should emphasize positive trend in solving the ENSDF manpower issue and explain ENSDF value for nuclear structure science, cross section evaluations, and applications.

Next Meeting

The next USNDP annual meeting will be held at BNL on Nov 5-7, 2008 (Wed – Fri), while the CSEWG annual meeting will be held on Nov 4-6, 2008 (Tue – Wed). The NDAG Criticality Safety meeting will be held on Nov 3, 2008 (Mon).

USNDP Coordinating Committee Meeting

The Coordinating Committee met at working lunchtime on Wednesday, November 8, 2006. All 9 members or their representatives attended the meeting, including P. Oblozinsky (chair), C. Baglin, A. Carlson, T. Kawano, J. Kelley, F. Kondev, D. Brown (replaced D. McNabb), B. Singh, and M. Smith. The meeting was also attended by S. Coon and Ted Barnes, DOE-SC.

Agenda

- DOE perspective: Sid Coon briefly explained the situation in DOE-SC Office of Nuclear Physics. D. Kovar took over responsibility for the high energy physics, Jehanne Simon-Gillo is the acting NP director, Sid retires early 2008 and Ted Barnes might become his successor.

- USNDP Status: An overall manpower and funding situation at the USNDP laboratories was discussed. The overall situation looks stable, though smaller players with modest funding (NIST, LLNL, TUNL) indicated potential problems if relatively low level of budget will continue. On a positive side several new postdocs were brought to the system (BNL, McMaster, ANL, TUNL) and new postdoc positions are being advertised (BNL).

- Annual Report FY07 and Workplan FY09: See above

- Budget Briefing FY10: Sid Coon suggested that it might help to bring some new people to the Budget Briefing. New initiative should be brought up (AFC, covariances, Global Nuclear Data Initiative, RIA, improved fission modeling).

- Next Meeting: See above

US Nuclear Data Program

Minutes of the Structure and Decay Data Working Group Meeting

10:10 am - 6:15 pm Wednesday 7 November 2007
8:30 am – 12:40 pm Thursday 8 November 2007

C. Baglin, LBNL (Chair)

Present: D. Abriola, C. Baglin, S. Basunia, M. Bhattacharya, E. Browne, T.W. Burrows, J. Cameron, R. Firestone, J. Kelley, F.G. Kondev, E. Kwan, C. Nesaraja, N. Nica, C. Ouellet, B. Pritychenko, C. Reich, B. Singh, A. Sonzogni, J. Tuli. Also, T. Barnes, R. Boyd, S. Coon, R. Cyburt, R. Haight, M. Herman, N. Holden, T. Kawano, P. Oblozinsky, and H. Pentilla were present for segments of the meeting.

An especially warm welcome was extended to the two Postdocs who have recently joined the ENSDF data evaluation effort (E. Kwan (TUNL) and C. Ouellet (McMaster)) and to D. Abriola, visiting from IAEA Nuclear Data Section.

Nuclear Data Sheets (NDS) Issues (J. Tuli and B. Singh)

Modernization of NDS: Following many years of concern about the quality of drawings in NDS and a resolution at the 2006 USNDP meeting to look for new technologies to improve/modernize the NDS publications, NNDC contracted last December with R. Zywina (who was already familiar with ENSDF) to prepare new software for drawing preparation which could then be integrated into the NNDC production codes and which would also provide evaluators with some control over the appearance of drawings in their mass-chain publications. Part way into the project, and thinking it would be straightforward to accomplish, he undertook to revise the NDS tabular data layout as well. The latter proved to be a much more detailed and time-consuming task than anticipated and ultimately slowed down the entire project. The **drawings** will include color (for the web version of NDS) and limit the number of γ's shown from a given level in band drawings, saving space. J. Tuli proposed (and the meeting agreed) that the contract work should now be divided into segments which would be submitted separately. a) Vastly improved band drawings have been achieved but band labels and some refinements suggested by a group of evaluators during the St. Petersburg NSDD meeting have yet to be added; it seems reasonable to suppose this segment could be completed and submitted by 31 Dec. '07. b) An acceptable prototype decay drawing has been prepared but the skeleton scheme drawing has yet to be done; if codes for these could be submitted by 29 Feb. '08, the drawing package could be considered complete. Integration into the NNDC production codes can begin when sample .eps files are provided, but that process may take considerable effort; the integrated code needs to be fully tested before any control options are made available to evaluators. c) Modernization of **tables** is desirable, but clear specifications are essential and these are still at a formative stage. The current suggestion is a two-column format whenever

practical, with comments in a separate section, and J. Tuli suggests that we present property-oriented tables. It was felt that we really need to see a prototype for various possibilities (especially the separation of comments from data for a large table), however. It was considered desirable to have a committee propose detailed specifications and then consult users before finalizing the specifications.

NDS Space Limitations: Elsevier's limitation to ~2800 printed pages/yr is concrete and the ENSDF component of NDS appears to be static. However, J. Tuli (Editor) sees no present need for drastic new steps to cut mass-chain length. It was noted that some journals now publish papers accompanied by electronic supplementary material; perhaps, several years hence, we will need to look into such a possibility. It is important to maintain some hardcopy product, however.

Database Status Reports

- **ENSDF (J.Tuli):** The ENSDF database has grown into a 171 Mb file containing ~16170 datasets that provide structure and decay data for ~3020 nuclides. It is distributed twice a year (last release in September 2007). 20 mass chain evaluations occupying a total of 2585 pages were published in NDS during CY2007. This averages out to 129 p./chain, a reduction from the previous year's 154 p./chain. J. Tuli recently visited Elsevier, and found they were well satisfied with NDS. They have 4533 online user accounts, the journal's impact factor of 0.95 (*cf.* 4 for Nucl. Phys. A) significantly exceeds that of many journals and Elsevier's total paid downloads from the entire journal will probably exceed 9000 in 2007 (42% to Europe, 32% to Asia, 24% to the Americas).

- **NSR (M. Bhattacharya):** M. Bhattacharya assumed management of this database in June 2007 following D. Winchell's ~10 years of service in that capacity. An improved software suite for NSR was installed in May 2007. A new "prep" program had been written and used to regenerate selectors (needed for expanded indexing) for all NSR entries. The *Recent References* web page continues to be updated quarterly. As of October 2007, NSR contained 191,401 entries. The meeting affirmed the basic importance of the database to the research community as well as to structure evaluators, and was pleased to note that the key wording work being done in Vienna was currently up-to-date and was expected to remain that way. Data are being collected at NNDC to better understand the profile of NSR users from outside of the ENSDF evaluation community.

- **XUNDL (B. Singh):** This database now contains 2380 datasets created from ~1750 journal publications in 1995-2007 for nuclides ranging from ^{7}Li to ^{294}118. From about 200 current publications, 368 new datasets were created and another 25 were revised on account of the newer papers in FY07 by B. Singh and McMaster undergraduate students S. Geraedts and M. Mitchell. Compilation of data from recent experimental structure papers from the eight journals covered is up-to-date. B. Singh

continues to communicate with authors to request details of data and whenever significant data inconsistencies or omissions are found in the publications. Responsibility at NNDC for database maintenance and distribution changed from D. Winchell to J. Tuli in May 2007. It is anticipated that the compilation work will continue as usual at McMaster for another 2-3 years; after that, it may slow down there. It is perhaps time to start considering the longer-term future of this activity. The database is being used by many evaluators and is believed to be very valuable to the structure research community although we could benefit from a better knowledge of the users' perspective. Possibly, some consideration should be given to making the database searchable.

Software and web pages

- **Revision of NuDat (A. Sonzogni):** There have been two recent upgrades to NuDat; NuDat 2.3 was released in March 2007, providing uncertainties in both NDS and standard notation, and NuDat 2.4, released in September 2007, allows searches for B(Eλ)(W.u.) and B(Mλ)(W.u.) data as well as providing direct access to ENSDF files. All these changes were made in response to users' requests. Transition probability searches can also be an effective means to identify any unreasonable values in ENSDF. Plots of the number of nuclides as a function of the number of known levels or the highest known spin can now be created online, as can the distribution of values of the quadrupole deformation parameter. NuDat is being used widely, in national labs, research organizations and as a tool in nuclear physics education, and its use currently constitutes 56% of NNDC data retrievals.

- **Status of ENSDF analysis and utility codes (T. Burrows):** Updates have recently been provided for ENSDAT (updated to correspond to May 2007 version of NDS publication program), FMTCHK (additional checks for format errors as suggested by St. Petersburg Data Group), GTOL (added check for unrealistically large diagonal matrix elements to handle compiler differences plus some other minor corrections) and RULER (new coding to correctly handle total widths or very short $T_{1/2}$ data in the T field of level records, the logic for handling asymmetric uncertainties on output was rewritten, and a comparison of calculated transition probabilities with RUL was added, accompanied by auto-creation of a small file summarizing possible inconsistencies). Upgrades to BrIcc are planned in the near future in collaboration with T. Kibedi *et al.* (extension of Z range, correct calculation of coefficients for transitions including an E0 component, possible update and/or/extension of Ω(E0) tables, correct handling of shell ratio uncertainties, *etc.*).

Reports

- **ENSDF and NSR efforts and future plans at IAEA (D. Abriola):** Personnel at IAEA Nuclear Data Section are involved in both key wording for NSR (primarily M. Kellett; Nucl. Phys. A, E.P.J.-A and Phys. Lett. B; 1430 papers completed since Sept.

2005) and ENSDF evaluation (D. Abriola; in collaboration with A. Sonzogni at NNDC). A worrisome backlog in key wording at IAEA earlier in 2007 has now been cleared, and the new streamlined processing of articles makes it unlikely that the problem will recur. Another IAEA-ICTP Workshop in Trieste is being planned in 2008 (28 Apr-9 May). Looking further into the future, IAEA-NDS could be of service by organizing a technical meeting on an NSDD topic if we can identify a suitable topic. Several possible areas of interest immediately came to attendees' minds, but more time and thought will be needed to develop an appropriate proposal.

- **CRP on updated decay data library for actinides (F.G. Kondev):** Participants in this CRP held their 2nd meeting in March 2007; F.G. Kondev (ANL) is the US representative for this CRP, and he summarized the scope of the CRP and the work completed at ANL on the evaluation of γ- and X-ray emission probabilities for ^{206}Tl and measurements of $T_{1/2}$ and α emission probabilities for ^{246}Cm. An attempt to resolve discrepancies between previous measurements of γ-emission probabilities for the ^{233}Pa 28.557-keV line is ongoing.

- **Proposed topical evaluation of nuclides near the N≈20 'Island of Inversion' (S. Basunia}:** In response to an expressed interest within the nuclear structure research community, a collaboration between LBNL, McMaster and NNDC plans to evaluate about 21 nuclides in or near the N≈20 'Island of Inversion'. This would provide up-to-date ENSDF evaluations for these nuclides plus topical web-based dissemination of this information from NNDC.

- **BrIcc: how good are conversion coefficients now? (T. Burrows):** The collaboration that developed the network's BrIcc package has continued to work on a thorough, systematic comparison of the most precise experimental conversion coefficient and sub-shell ratio data now extant with the values calculated using three different Dirac-Fock methods ('no hole', 'frozen orbital' and 'self-consistent') and the results of this analysis were presented. Data, in general, do not favor the 'no-hole' treatment, and they appear to indicate a slight preference for 'frozen orbital' over 'self-consistent' calculations.

- **Recent precision ICC measurements at TAMU (N. Nica):** Precision conversion coefficient measurements provide a particularly important test of different calculation techniques. In addition to work already reported, TAMU now has preliminary α_K data for ^{134m}Cs(E3, 127.5γ) and ^{137}Ba(M4, 661.7γ) which favor 'frozen orbital' calculations, and data for the emission probability of the 34 keV X-ray associated with the ^{139}La(M1, 165.9γ).

- **Role of ENSDF in reaction data evaluations (M. Herman):** A summary of the extensive array of structure and decay information of importance to reaction data evaluators was presented. ENSDF data, however, need to be reworked before they can be used in reactions codes because the data are not 'complete' and the database

format is unfriendly. The RIPL database serves as an intermediary; Version 3 should be released in 2008

- **Status of atomic mass data evaluation effort (F.G. Kondev):** Following Georges Audi's momentous announcement last April that he planned no further atomic mass evaluations, strong concern was expressed by nuclear physics research communities, data groups and sponsoring agencies alike. This has resulted in a European-led effort (spearheaded by Y. Litvinov at GSI) to establish a network of mass evaluators at centers with active mass-measurement programs and to appoint a post-doctoral level network coordinator who would spend 2 yr. at Orsay and 2 yr. at GSI. A Letter of Intent was submitted at the Helsinki EURONS meeting (Sept. 2007) and, in Nov. 2007, a proposal was submitted seeking EU funding. It is envisioned that an active network of evaluators could be created by spring 2008 and a new mass evaluation could be completed by 2012.

- **Update on efforts to increase European support for ENSDF evaluation efforts (J. Tuli):** Non-US support for ENSDF evaluation has decreased dramatically since the mid-1980s, especially in Europe. Attempts have been made in recent years to encourage greater European support and, as detailed in this report, prospects now seem much more promising. In September 2007, J. Tuli attended the Eurisol/Eurons Joint Town Meeting in Helsinki and presented a well-received invited talk on the NSDD (its product, content, users, contributors and funding) to about 250 attendees from the EU's nuclear structure community. NuPECC has also agreed to include an NSDD 'awareness' article in their journal *Nuclear Physics News* and this has already been written. NuPECC now seems convinced that there is a need for European participation. At this stage, 'interested groups' in Europe need to apply to NuPNET for funds, and D. Balabanski (Bulgaria) will probably create one such group.

Outreach

- **Outreach activities at the NNDC (B. Pritychenko):** To address NNDC's mission to provide nuclear data services, personnel have engaged in various forms of both direct and indirect outreach to users in order to inform them of the products available, answer their queries, and to gather input from them so their needs/desires can be better understood and provided for. Activities have included NNDC booths at major conferences, posters at meetings, representation at meetings to enable informal contacts, handouts of sample products, and provision of a convenient means to convey comments to NNDC. Ultimately, this should lead to the creation of products that are better tailored to users' needs

- **Nuclear data minisymposium at an APS/DNP meeting (J. Kelley):** At last year's USNDP meeting, J. Kelley agreed to try to set up a nuclear data miniymposium during the October 2007 APS-DNP meeting in Virginia. This entailed finding a sponsor among the organizing committee members, justifying the timeliness of the

proposed minisymposium and preparing a non-binding list of possible speakers. The 2007 meeting organizers did not choose to include the proposed minisymposium, but it was agreed that we definitely want to try for one at the 2008 (Oakland) meeting. F.G. Kondev and J. Kelley will work together on a small committee to propose this although, ultimately, it is desirable that there be a group effort to promote such a minisymposium. It was recommended that the committee should have user representation also.

- **USNDP visibility at major conferences in 2008:** These include *NS2008* (NSCL, Michigan, 3-6 Jun.), *Nuclei in the Cosmos X* (JINA, Michigan, 27 Jul.-1 Aug.), and *Exotic Nuclei and Atomic Masses (ENAM*) (Poland, 7-13 Sept.). USNDP representation is anticipated at these meetings. J. Tuli would be willing to attend the latter (subject to travel approval). It would be good to have IAEA representation there also.

- **Other ways to increase our visibility**: Data symposia have been organized in the past at ACS meetings – maybe it is time for another of these if a supportive organizing committee member can be identified. The establishment of a new nuclear data center at a strong nuclear structure research University may also be helpful. In addition to the NNDC outreach effort, evaluators at other data centers have also been active during the past year (*e.g. via* conference talks or seminars) and this is an activity which needs to be maintained.

Formats/Procedures/Jπ Rules/Policies

- **Inclusion of both relative and absolute intensities in ENSDF (E. Browne):** Since it may not be a trivial procedure to deduce absolute intensities with correct uncertainties from measured relative intensities (due to cancellation effects which the program GABS takes account of), it was proposed that both absolute I_γ and relative I_γ for all transitions be included for decay datasets in ENSDF and one or both in NDS (last year's meeting had recommended that absolute values be shown only when cancellation effects had a significant effect). GABS can perform this operation. It was noted that this would increase the space needed for the relevant NDS gamma tables and that, for the majority of transitions, there would be no cancellation effects anyway. After discussion, it was decided that the calculated absolute intensities could be written into the ENSDF database but we will not add another column to NDS γ tables. When GABS automatically generates the new continuation records, care will need to be taken to accommodate absolute intensity information already in the dataset and there may be other implementation questions to be addressed after the new version of GABS is submitted to NNDC.

- **Excessively large B(M3)(W.u.) values in ENSDF (B. Singh):** In the course of a survey of B(M3)(W.u.) data from ENSDF, a number of values were noticed which grossly exceed the recommended upper limit (RUL) value of 10. Typically, these

arose in cases where the E2/M3 mixing ratio (δ) had an uncertainty that allowed overlap with 0. Similar cases have been found in ENSDF for M2 transitions and for other multipolarities. An example of large and incorrect values of B(M1)(W.u.) and B(E2)(W.u.) values was also discussed. Evaluators are reminded that they need to look critically at output from RULER to avoid the introduction of unreasonable values of B(EL)(W.u.) and B(ML)(W.u.) into ENSDF. In some cases, RUL can profitably be used to place a limit on the uncertainty in an adopted δ. (This is relevant for other multipolarities also.) It was agreed that the relevant evaluators should be alerted to the above B(M3)(W.u.) problems and, if they do not fix the problems within a prescribed period of time, ENSDF should be corrected for them.

- **Evaluation with EGAF thermal neutron capture data (R. Firestone):** The EGAF database of elemental E=thermal (n,γ) radiative cross sections is the product of an IAEA-CRP completed in Dec. 2003 (2003ChZS) and now accessible as IAEA STI/PUB/1263 (2007ChZX). For discrete lines, 2007ChZX provides both recommended evaluated data and previously unpublished Eγ and absolute cross section data measured at the Budapest Reactor. Since the γ spectra for Z>20 are typically too complex for all lines to be resolved, statistical model calculations (*e.g.,* using the DICEBOX code) can be useful for describing the unresolved continuum. DICEBOX calculations for the Pd isotopes were described and nuclear structure data they could elucidate were illustrated. It was proposed that EGAF cross sections be quoted in ENSDF and that the NR and BR fields be used to renormalize to photons 100 n/captures. However, BR field entries are not allowed for capture reaction datasets, and accepted parameters such as abundance, needed to deduce cross sections from measured relative intensities, may change over time. The consensus of the meeting was that ENSDF should continue to give relative Iγ or Iγ/100 n captures, not cross sections. Comments giving a means of obtaining cross sections could be provided. It would also be helpful if evaluators included SIGMAN from 2006MuZX and target elemental abundance at the beginning of thermal neutron capture data sets.

- **How should PGAA data (2007ChZX) be used in ENSDF?:** Several evaluators have already attempted to include EGAF data in their evaluations and have encountered some problems. B. Singh, T. Burrows, C. Baglin and N. Nica noted some of the questions/problems they had experienced. First and foremost, EGAF's adopted E_γ data are derived from level energy differences whereas ENSDF needs experimental values. Also, the sources of adopted data may be unclear; the means of normalizing primary I_γ, in cases where existing primary and secondary I_γ are on different relative scales and the Budapest data include no primaries, is unclear; observed Budapest lines may be multiplets (with unexpectedly large I_γ) due to the complexity of the elemental spectra; in some cases, it is unclear whether the E_γ datum listed with the Budapest data was measured at Budapest or taken from elsewhere; *etc.* Evaluators are encouraged to channel examples of problems to C. Baglin so we can obtain a more comprehensive list of issues that need to be addressed. R. Firestone suggested that evaluators concentrate on using the Budapest data and ignore the recommended E_γ and I_γ data in the evaluated EGAF files for the present.

- **Guidance needed for handling widely different $T_{1/2}$ values for 1^{st} 2^+ states in some nuclides (B. Singh):** Two specific problem-cases (^{58}Ni and ^{112}Sn) were summarized. For ^{112}Sn, recent $T_{1/2}$ data obtained from BE2(up) and from DSAM in (n,n'γ) almost agreed within uncertainties, but the ^{58}Ni data were much more seriously discrepant. It was felt that DSAM measurements, in general, should be treated with caution since they rely on knowledge of stopping powers which typically have a 15-20% uncertainty that sometimes is not included in the uncertainty of the reported $T_{1/2}$. However, there is also a disturbingly large and unexplained spread of B(E2) values for ^{58}Ni**.**

- **Priority inclusion in ENSDF of newly-observed nuclides in mass regions outside McMaster's responsibility (B. Singh):** Last year's USNDP meeting authorized McMaster to include in ENSDF the data from any primary publication that reported either the first experimental identification of a nuclide far from stability or the first data on levels in such a nuclide, thereby ensuring its prompt inclusion as an evaluated nuclide in both ENSDF and NuDat. However, at the St. Petersburg NSDD meeting, it was recommended that the Center responsible for the relevant nuclide should be consulted first. J. Tuli believes he knows the very few Centers/evaluators that would prefer to be consulted first and will convey that information to McMaster.

- **Treatment of cluster decay in ENSDF (A. Sonzogni):** A new type of ENSDF record is being suggested to identify the emitted cluster in cluster-emission decays. NNDC plans to study how best to make the necessary format modifications and will do a horizontal evaluation to check for potential conflicts with existing records in ENSDF.

- **Consistency of $T_{1/2}$ data in ENSDF and in Nuclear Wallet Cards (A. Sonzogni):** Updates to ENSDF and the Nuclear Wallet Cards are unsynchronized leading, in some cases, to different values for $T_{1/2}$, isomer energy, Jπ and/or decay modes from these two sources. An action item from the St. Petersburg NSDD meeting calls for NNDC to decide which data are problematic and to communicate with the relevant data centers in order to resolve the discrepancies where practical.

- **Guidelines for band nomenclature and presentation of transition quadrupole moments in ENSDF (C. Baglin):** The need for such guidelines has been highlighted in previous USNDP meetings. As requested in last year's meeting and in consultation with several other evaluators, B. Singh and F.G. Kondev prepared documents on these topics that were presented and accepted at the June 2007 NSDD meeting in St. Petersburg. These documents are available from the NSDD2007 website, and evaluators should consult that site (http://nrd.pnpi.spb.ru/NSDD/17meeting.html) for full details.

US Nuclear Data Program

Minutes of the Nuclear Reaction Working Group Meeting

T. Kawano, LANL (Chair)

Nuclear reaction model code development

Kalbach, TUNL, presented recent work leading to the release of the exciton model code PRECO-2006. Funding cuts have slowed progress in recent years. Work is continuing on a phenomenological projectile breakup model. Initially developed for deuteron projectiles, it is being extended to He-3 and alpha particles. This model is needed to complete the description of complex-particle-induced reactions in PRECO. The peak energy and width systematics were investigated, while angular distributions and total breakup cross sections remain to be studied.

Talou, LANL, summarized the current status of the model and theory developments at LANL. The McGNASH code, which is the improved version of GNASH, now has the direct/semi-direct (DSD) capture model using the Skyrme-Hartree-Fock-BCS formalism, and the improved fission model including the class II coupling. Other important topics addressed were the prompt neutron fission spectra by the Monte Carlo technique, the direct reaction in the Hauser-Feshbach calculations, and the microscopic quantum mechanical MSD theory for deformed nuclei.

Herman, BNL, presented recent developments of the EMPIRE code for nuclear data evaluation work that included formatting of isomeric cross sections, generation of fake resonances using unresolved resonance parameters, use of parity dependent level densities based on the HF-BCS, deformed MSD calculations with the Cassini potential and further refinements of the fission channel. The deformed MSD model calculations were applied to demonstrate the impact of the Cassini potential on neutron spectra from 232-Th.

Standards

Carlson, NIST, gave a talk on the status of neutron cross-section standards. New measurements on H(n,n)H were performed at the neutron incident energy of 14.9 MeV, at the laboratory angles of 0, 24, 36, 48, and 60 degrees. New plans to measure neutron cross sections, such as 3He(n,p), 6Li(n,t), and 10B(n, alpha) were also discussed. The IAEA Nuclear Data Section began a project "Maintenance of the Neutron Cross Section Standards," which updates the standards database.

Astrophysics

Nesaraja, ORNL, gave a talk on the computational infrastructure for nuclear astrophysics. New workflow management tools were added to help new international

collaborations, which streamline, standardize, and automate many tasks needed to perform reaction rate evaluations.

US Nuclear Data Program

User Community-USNDP Discussion Forum

A. Sonzogni, BNL (Chair)

This year's user forum speakers were Richard Boyd from LLNL, Richard Cyburt from Michigan State University, George Bertsch from the University of Washington and Heikki Penttila from the University of Jyvaskyla (Finland).

Richard Boyd gave a presentation on the National Ignition Facility (NIF) which is being built in LLNL. The goal of NIF is to focus the energy on many laser beams into the mm-sized capsule containing deuterium and tritium. It is expected that NIF will achieve unprecedented environments on earth, such as a temperature in excess of 10 Mega Kelvins and a neutron density of 10^{26} neutrons per cubic centimeter. Boyd produced a list of nuclear data needs to support nuclear astrophysics research in NIF, including a) thermonuclear reaction rates, b) nuclear masses, decay modes and half-lives for nuclides far from stability.

Richard Cyburt presented the status of the REACLIB database, which contains cross section and reaction rates for a large number of nuclear reactions that are of astrophysics relevance. This work is produced under the auspices of JINA, the Joint Institute for Nuclear Astrophysics. These reaction rates are crucial to understand nucleosynthesis, that is, the study of the formation of different nuclear species. Richard Cyburt briefly reviewed the NNDC tools most frequently used and the possibility of including ENDF/B-VII.0 reaction rates in REACLIB was discussed.

George Bertsch presented the Universal Nuclear Energy Density Functional (UNEDF) theoretical initiative. The goal is to apply Density Functional Theory to calculate different properties of atomic nuclides, keeping in mind that about 3,000 are known to mankind, and yet, up to 6,000 would not break up immediately upon formation. Several examples of the UNEDF were presented, such as a calculation of nuclear binding energies, electromagnetic transition strengths and quadrupole deformations.

Heikki Penttila gave the last talk on recent experimental programs in Jyvaskyla. Beams are produced by a cyclotron and delivered to different stations. Many different projects were presented, such as a) a study of surrogate reactions using 238U(d,pf) cross sections, b) beta recoil tagging which allows to study very proton rich nuclides, c) the study of excited states in No isotopes, d) very impressive mass measurements using Penning traps. Several suggestions to mainly nuclear structure USNDP databases were made.

US Nuclear Data Program

USNDP Reports 2007

Altogether 11 reports were given, two on Task Force activities and nine on laboratory activities. Actual reports are at www.nndc.bnl.gov/proceedings/2007csewgusndp.

Task Force Reports

1. Nuclear Data for Astrophysics (C. Nesaraja for M. Smith)
2. Nuclear Data for Homeland Security (D. Brown, replaced D. McNabb)

Laboratory Reports

1. NNDC report (P. Oblozinsky)
2. ANL report (F. Kondev)
3. LANL report (T. Kawano)
4. LBNL report (C. Baglin)
5. LLNL report (D. Brown)
6. NIST report (A. Carlson)
7. McMaster report (B. Singh)
8. ORNL report (C. Nesaraja)
9. TUNL report (J. Kelley and C. Kalbach)

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